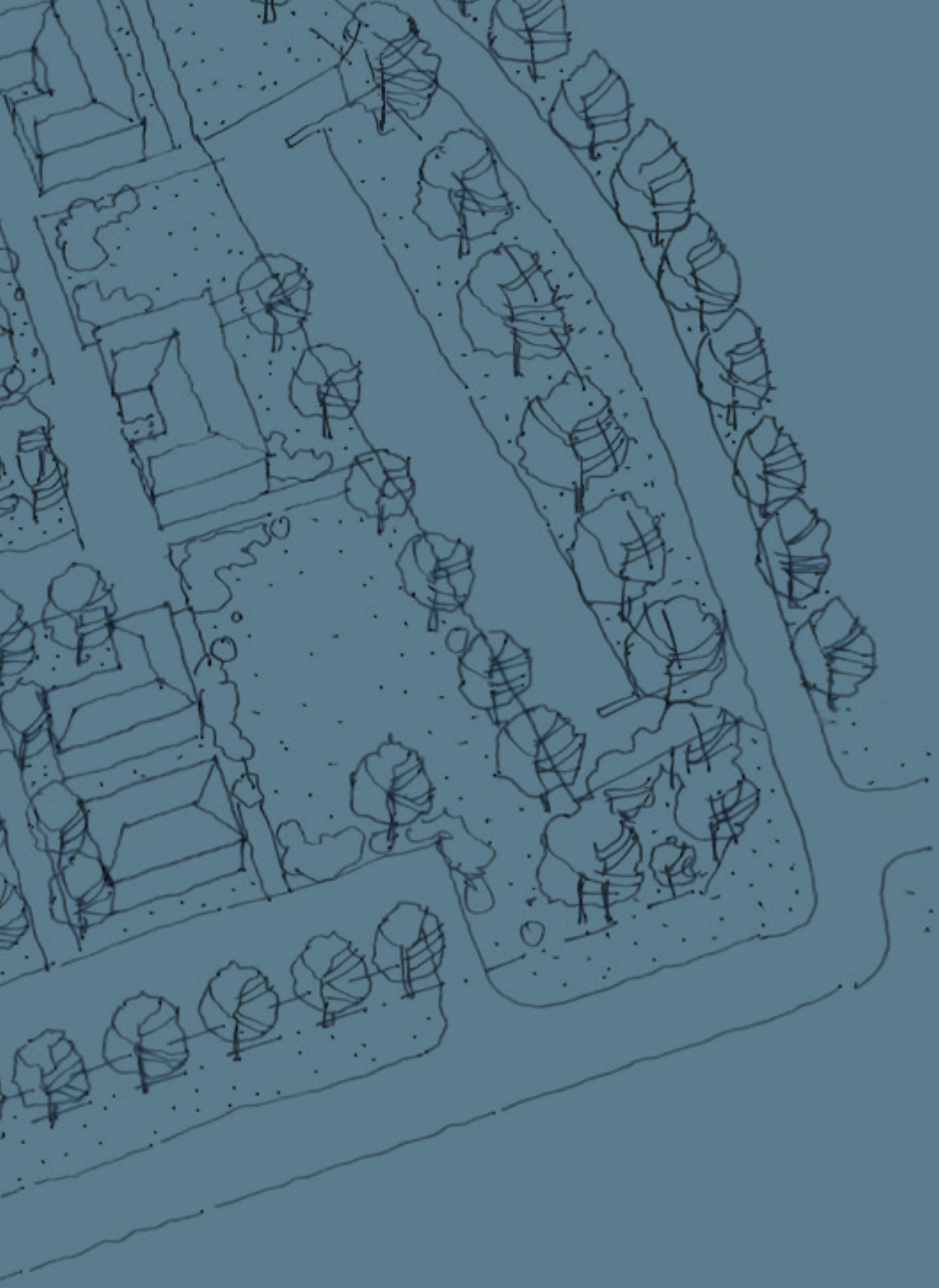

APPENDIX 5

LOCAL WATER MANAGEMENT STRATEGY

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23 May 2024

Attention: Duane Cole
Hatch Roberts Day

Delivered by email to: duanec@hatch.com

Dear Duane

NORTH STONEVILLE (SP34) STRUCTURE PLAN REVISION AND WATER PLANNING SUPPORT

The Local Water Management Strategy (LWMS) which supported the North Stoneville Structure Plan (SP34) was prepared by Emerge Associates and approved by the Department of Water and Environmental Regulation (DWER) and Department of Biodiversity Conservation and Attractions (DBCA) in 2019.

We understand that following initial refusal by the Western Australian Planning Commission (WAPC) SP34 has been modified resulting in a reduced lot yield (from 1,400 to 1,001), road realignments and exclusion of Lot 340 Roland Road from the proposal.

The purpose of this letter is to summarise the likely changes that will be required to the LWMS to accurately reflect the amended SP34 and support future planning and design stages.

Local Water Management Strategy Design Principles and Criteria

The water management approach that was documents in the LWMS was based on design principles reflecting the site's natural attributes and the vision of the client and project team that was documented in SP34. The design principles included:

1. Take a sustainable approach to water use within the site.
2. Mimic the existing environmental discharge to the environment, for both peak flow rates and water quality.
3. As much as practicable, attenuate stormwater at source, high in each catchment.
4. Minimise the amount of imported fill and engineered lot design approaches to retain existing landform.
5. Adopt lot drainage practices which align with the size of lots and attributes of the existing environment – these will aim to assist at-source detention.
6. Integrate the drainage network into the road reserve in a manner which aligns with the intent of the design transects.
7. Utilise natural hydrological features of the site to achieve flood conveyance and detention where possible.
8. Enhance natural hydrological features of the site, and ensure that drainage infrastructure is consistent with these.

The design principles then guided the LWMS water management design criteria, which included:

Water conservation

- Lot scale potable water use to be less than 60 kL/person/year.
- No potable water to be used for non-potable uses in any public spaces.

Recycled water

- Maximise the re-use of recycled water within the site.
- All open space long term irrigation requirements to be met by recycled water.
- Open space irrigated areas to use an average of 7,500 kL/ha/year.
- Recycled water will be retained within the site and will not be discharged to the environment.

Stormwater management

- Major rainfall event post-development peak flow rates leaving the site should be equal to or less than pre-development peak flow rates.
- Flood detention to achieve pre-development discharge rates should occur as high in the catchment as practical.
- Frequent rainfall event runoff should be treated at source, or as close to source as practical.
- Water quality treatment structures to be sized to retain the first 15 mm from directly connected impervious areas.
- Sediment control and erosion protection to be incorporated in to road reserves where practicable.
- Road drainage network to be designed to accommodate and convey the minor rainfall event.

Groundwater management

- Where utilised, subsoil drains are to be set at or above the low permeability soil layer.
- Finished lot levels are to be at least 1.2 m above the controlled groundwater level formed by the invert of subsoil drains.
- Subsoil drains to be discharged via a free draining outlet to an appropriate water quality treatment structure.
- Soil profile beneath T4 and T5 lots to be deep ripped/filled to a minimum depth of 1.0 m.

The above criteria all remain relevant to the amended SP34, and demonstration that these can be met will be required to guide future planning and design stages.

Updates required to the Local Water Management Strategy

The demonstration of compliance with criteria regarding non-potable water use, recycled water and those which demonstrate spatial requirements for water management will require update. Given that the amendment to SP34 involves a reduction of lots by approximately 40%, the extent of impervious areas of the catchment are anticipated to decrease, and on this basis the spatial requirements for water management are unlikely to increase. The locations of drainage infrastructure are largely dictated by the topography of the site; flood detention areas will need to be at the low point of the catchments, regardless of lot numbers and density. Further, the majority of flood detention is provided by retention of existing farm dams, and this will be continued in future revisions of the LWMS.

The water balance and amount of available recycled water to meet non-potable needs versus amount of public open space proposed to be irrigated will also require update, however the irrigation rates per hectare (of irrigable open space) are not materially different. This difference (i.e.

reduction) in available recycled water is offset by the increase in the proportion of open spaces that will be more passive uses and therefore not irrigated.

These aspects can adequately be assessed in a revision of the LWMS to ensure that future planning and design stages are appropriately informed/guided.

Summary and closing

The approved LWMS provides an appropriate framework, objectives and design criteria to support future planning processes and design stages at North Stoneville. The criteria are all still relevant and applicable to the amend SP34. The demonstration of compliance of some aspects relevant to recycled/non-potable water and stormwater management will require update. However, these are not anticipated to change the overall design outcome or level of protection provided to the local and downstream environment. This could be documented in an update to the existing LWMS to support the final (amended) SP34.

Should you have any queries or concerns feel free to contact the undersigned.

Yours sincerely
Emerge Associates

Dave Coremans
DIRECTOR, PRINCIPAL ENVIROMENTAL CONSULTANT

cc: none

Encl: none

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Integrated Science & Design

Local Water Management Strategy

North Stoneville LSP34

Project No: EP17-013(01)

Prepared for Satterley
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Executive Summary

Satterley (the 'proponent') is developing Lot 48 (on plan 29855), 4685 Stoneville Road and Lot 1 (on plan 69650), 340 Roland Road (herein referred to as the site) for residential and associated uses. The site is located approximately 30 km north east of Perth Central Business District within the Shire of Mundaring (SoM). The site covers approximately 555 ha and is bound by Roland Road to the west, Cameron Road to the North and existing rural residential development to the east and south.

The site is zoned "Rural" with large sections zoned "Urban" under the Metropolitan Region Scheme (MRS), and "Development Zone" with a parcel zoned "Rural Smallholdings" to the south of the site under the SoM Local Planning Scheme (LPS) No. 4.

It is important that the manner in which stormwater runoff from residential zoned areas is to be managed to avoid flooding and protect the environment and that this approach is clearly documented early in the planning process. This Local Water Management Strategy (LWMS) details the water management approach to support the North Stoneville Structure Plan 34 Amendment (SP34).

The guiding State and Local Government policies have informed the water management objectives for the site, and these have in turn guided the design criteria proposed to ensure that the objectives are met.

An integrated water cycle management approach requires a thorough understanding of the existing attributes of a site. In summary, the environmental investigations conducted to date indicate that:

- The site receives 1,079 mm of average annual rainfall with the majority of rainfall received between June and August.
- Topography of the site ranges from 264 to 316 m AHD and exhibits average slopes up to 15%. Some minor portions of the site may contain slopes exceeding 15%.
- The majority of the site is comprised of laterite overlain by and associated with gravel (LA1), becoming progressively sandy near streamlines.
- Elevated TN was observed in some surface water monitoring sites.
- Surface water flows discharging to the north of the site show elevated salinity.
- There are some relatively minor upstream contributing catchments. With the exception of these, the site is at the top of catchment.
- The site contains four main dams that currently capture runoff from within the site and could potentially be used to achieve flood detention within the site (with some minor modifications). A minor dam exists in the eastern portion of the site
- Runoff from the site discharges to Clutterbuck Creek, a tributary of Jane Brook (to the south) and tributaries to Susannah Brook (to the north).
- Peak flow rates leaving the site (at six locations) have been characterised for frequent (1 EY) minor (20% AEP) and major (1% AEP) events. This has been undertaken using XPSWMM, and has been informed by calibrated runoff modelling from nearby Gidgegannup townsite.
- There is no true groundwater beneath the site. Shallow clayey soils above gravels/laterite may be seasonally saturated and express some water at the low points (valleys) within the site.

The hydrological conditions of the site have driven the design criteria, which have in turn been reflected in the spatial layout of SP34. The principle has been to understand and quantify the site

hydrology, and to then prepare an approach which mimics this. The water management response to the guiding documents, site characteristics and water management principles seeks to guide outcomes for:

- Water Conservation
- Wastewater servicing provision
- Non-potable water demand and supply
- Surface water management
- Groundwater management.

The site has low permeability soils with steep slopes and significant areas of vegetation. The water management approach seeks to address water quality concerns at source, and to mimic the outflow conditions (peak flows and volumes) from the site. This has also considered the landform, and retention and use of existing features (dams, streamlines) is proposed to minimise additional disturbance to the site and subsequent vegetation loss.

A significant component of the water management approach is the ability to provide treated water to public open space (POS) to provide appropriate amenity. This is achieved by potable water serviced by the Water Corporation, teamed with a private, licensed service provider that will recycle wastewater within the site. Recycled water will be used to meet POS irrigation demand, and the POS design has been carefully considered to ensure that the right amount of water is available for irrigation without applying excessive amounts of nutrients.

The design criteria, the manner in which they will be achieved, responsibility for implementation and timing of implementation are summarised in **Table E1**.

The SP34 development proposal includes:

- 1, 410 residential lots
- Neighbourhood Centre
- Primary School and high school
- Approximately 145 ha of open space
- Retained streamlines with appropriate foreshore areas
- A recycled water plant
- Conservation bushland
- Community gardens and common spaces.

Within the development, five characteristic urban-rural transects will gradually integrate several village cores within the surrounding rural landscape, avoiding urban sprawl. Each transect incorporates varying planning and design schemes suited to the relevant land use, including transect specific drainage systems and road layout. Transects include:

T5 Village Core - lots will be 400-600 m^2, and will include higher density mixed use buildings that can accommodate retail, offices, cottages and townhouses. It has a tight network of streets, with wide sidewalks, steady street tree planting and buildings set close to the sidewalks. T5 lots typically frame a central focal point with strong civic presence and have a more formal structure.

T4 Village Urban lot areas will be 800-1,000 m^2 and will primarily be residential traditional neighbourhood grid structure, with some mixed use closer to village core. Setbacks and landscaping

will be modest, encouraging public-private interaction at street level. Streets will have kerbs and sidewalks define medium-sized blocks.

T3 sub urban transect lots will be 1,000-2,000 m^2 and will be low density residential areas, within walking distance of T4 village urban areas. Home businesses and outbuildings are allowed within T3 areas. Planting is naturalistic and setbacks are relatively deep. Blocks may be large and the roads irregular to accommodate natural conditions.

T2 Natural Living lots will be 1-2 ha and will be sparsely settled lands in open or cultivated states, with dry rolling land. These include existing cleared agricultural land, grassland, and drainage areas. Typical buildings are pseudo-farmhouses, ranches with large porches, and rural style buildings

T1 Conservation and open space portions of the site will be areas approximating or reverting to a wilderness condition, including lands unsuitable for settlement due to topography, hydrology, vegetation or cultural heritage.

The approach to water management across the site reflects the transect approach, where development transitions from rural character in T1 areas through to urban/village core characteristics in T5 areas.

This LWMS demonstrates that SP34 implements a water sensitive urban design (WSUD) approach, which considers all sources of water, manages water at its source and which utilises the natural/existing characteristics of the site to meet future development needs and to protect the existing and downstream environments.

Table E1: *Water management criteria and compliance*

Management element	Criteria number	Criteria description	Manner in which compliance has been achieved	Responsibility for implementation	When implemented
Water Conservation	WC1	Lot scale potable water use to be less than 60 kL/person/year	Rainwater tank uptake to be encouraged for non-potable water uses in T3 lots and mandated in T2 lots.	Proponent	At time of sale
			Water efficient fittings and appliances adopted within all lots, schools and the local centre.	Residents	Post house construction
			Waterwise gardening principles promoted for use within lots and adopted in all POS areas.	Proponent	At time of sale
	WC2	Non-potable water to be used to irrigate open spaces	Recycled water from the RWP will be used to meet irrigation requirements for all open space areas.	Proponent/SoM	Landscape design
Recycled Water	RW1	Maximise the re-use of recycled water within the site	Recycled water will be stored onsite to provide water to meet non-potable irrigation needs.	Proponent/RWP operator	RWP construction and operation
			Recycled water will be used to irrigate POS, open spaces and schools.	Proponent/SoM	Following POS construction
	RW2	All open space long term irrigation requirements to be ultimately met by recycled water	Initial irrigation demand will be met by onsite surface water dams.	Proponent	During construction, establishment and maintenance period
			The wastewater recycling system will ultimately provide treated wastewater to meet the irrigation requirements of all open space within the development.	Proponent/RWP operator/SoM	Following construction, establishment and maintenance period
	RW3	Open space irrigated areas to use an average of 7,500 kL/ha/year	The actual irrigation rate will vary with climate and demand. The water balance confirms that on average open space will achieve the required irrigation capacity.	Landscape maintenance contractor	Following POS construction
	RW4	Recycled water will be retained within the site and will not be discharged to the environment	Water quality from the RWP will be appropriate for long term irrigation of vegetation within the site.	Proponent/RWP operator	After construction, establishment and maintenance period

Table E1: *Water Management Criteria and Compliance (continued)*

Management element	Criteria number	Criteria description	Manner in which compliance has been achieved	Responsibility for Implementation	When implemented
Recycled Water	RW4	Recycled water will be retained within the site and will not be discharged to the environment	Design and operational contingencies are existing, or can be implemented, within the wastewater management approach and RWP. No discharge is required, even in a 'wet' year scenario.	RWP operator	During and following construction of entire estate
			Additional contingency will be provided by WSUD features (e.g. the living streams), which will provide nutrient removal to any incidental recycled water runoff.	Proponent/SoM	Following construction
Stormwater	SW1	Major event post-development peak flow rates leaving the site should be equal to or less than pre-development peak flow rates	Roadside swales, median swales and bio-retention areas (BRAs) will provide significant retention/detention storage for frequent events and will contribute to peak flow management in major events.	Proponent/SoM	Following construction
			Flood detention will be achieved by using the significant capacity of onsite dams with the addition of controlled outlet structures.	Proponent	Detailed subdivision design
			Flood storage areas (FSAs) will be constructed to detain runoff from catchments which cannot discharge to one of the existing dams. FSAs will be within private property and protected by easements	Proponent	Detailed subdivision design
	SW2	Flood detention to achieve pre-development discharge rates should occur as high in the catchment as practical	Roadside swales will provide flood detention at source, minimising the need for traditional pipe networks.	Proponent	Detailed subdivision design
			Existing dams will be utilised, which will detain runoff from immediately adjacent and upstream catchments.	Proponent	Detailed subdivision design
			Catchment areas are generally relatively small, and FSAs will be located at the nearest practicable downstream location	Proponent	Detailed subdivision design

Table E1: *Water Management Criteria and Compliance (continued)*

Management element	Criteria number	Criteria description	Manner in which compliance has been achieved	Responsibility for Implementation	When implemented
Stormwater	SW3	Frequent event runoff should be treated at source, or as close to source as practical. This may include detention at source and/or additional treatment if appropriate	Roadside swales will provide water quality treatment at source, minimising the need for downstream water quality treatment.	Proponent	Detailed civil design
			Median swales will provide water quality treatment at source.	Proponent	Detailed civil design
			BRAs will be used in catchments where full treatment of the 1EY event cannot be achieved at source.	Proponent	Detailed civil design
			Living Stream approach will be used to convey treated runoff.	Proponent	Detailed civil design
	SW4	Water quality treatment structures to be sized to detain and/or retain the first 15 mm from directly connected impervious areas	Combined capacity of roadside swales, median swales and BRAs are sufficient to detain and/or retain the first 15 mm of runoff.	Proponent	Detailed civil design
			Living Stream approaches used for onsite streamlines, providing additional water quality treatment prior to discharge.	Proponent	Detailed civil design
	SW5	Sediment control and erosion protection to be incorporated in to road reserves and water quality treatment structures	Roadside swales, median swales and BRAs will utilise mortared and/or loose rock spawls at entry and exit points (using local laterite materials).	Proponent	Detailed civil design
			Roadside and median swales on slopes >5% will utilise rock armoured intermediate weirs to slow down flow, control erosion and to drop out any mobilised sediments.	Proponent	Detailed civil design
	SW6	Road drainage network to be designed to accommodate the minor event	The roadside swales will convey minor event runoff.	Proponent	Detailed civil design
			Where required (i.e. adjacent to T4 and T5 lots or where slope >5%) pit and pipe network may be utilised, and will be designed to convey the minor event.	Proponent	Detailed civil design

Table E1: *Water Management Criteria and Compliance (continued)*

Management element	Criteria number	Criteria description	Manner in which compliance has been achieved	Responsibility for Implementation	When implemented
Groundwater	GW1	Where utilised, subsoil drains are to be set at or above the low permeability soil layer.	Subsoil drains may be utilised in road reserve, beneath T4 and T5 lots or to ensure WSUD features remain dry in between rainfall events.	Proponent	Detailed civil design
			Where utilised, subsoil drains will be set at or above the underlying low permeability (rock or impermeable clays) layer.	Proponent	Detailed civil design
	GW2	Finished lot levels are to be at least 1.2 m above the CGL formed by the invert of subsoil drains.	Where subsoil drains are used, deep ripped soil and/or imported fill will provide finished lot levels with at least 1.2 m clearance from the CGL.	Proponent	Detailed civil design
	GW3	Subsoil drains to be discharged via a free draining outlet to an appropriate water quality treatment structure.	Subsoil drainage will be constructed such that intercepted water will freely drain to a discharge location (e.g. through appropriate grading and via the invert being at least 150 mm above the receiving environment).	Proponent	Detailed civil design
			Groundwater will be treated by discharging intercepted water into treatment structures (i.e. swales or BRAs), or by providing treatment prior the water entering the drain (e.g. by constructing pipes in filter media).	Proponent	Detailed civil design
	GW4	Soil profile beneath T4 and T5 lots to be deep ripped/filled to a minimum depth of 1.0 m.	The soil profile beneath T4/T5 lots will be deep ripped to an approximate depth of 0.4-0.6 m.	Proponent	Detailed civil design
			T4/T5 lots will be filled with permeable material to an approximate depth or 0.4-0.6 m to ensure a minimum profile of 1.0 m of ripped/filled soil.	Proponent	Detailed civil design

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North Stoneville SP34

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Geotechnical Investigations

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Modelling Assumptions Report

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Foreshore Assessment Report

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Modelling Assumptions Report

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Surface Water Quality Monitoring Results

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Landscape Concepts

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Stoneville Wastewater Servicing Concept Design Assessment

Appendix H

Interim Position Statement: Constructed Lakes - Audit

Abbreviation Tables

Table A1: Abbreviations – general terms

General terms	
AEP	Annual exceedance probability
AHD	Australian height datum
ASS	Acid sulfate soils
DWMS	District water management strategy
EC	Electrical conductivity
EY	Exceedance year
FRP	Filterable reactive phosphorous
LWMS	Local water management strategy
NH_4	Ammonium
NO_X	Nitrate and nitrite

Table A1: Abbreviations – general terms (continued)

RWP	Recycled water plant
SP	Structure plan
TKN	Total Kjeldahl nitrogen
TN	Total nitrogen
TP	Total phosphorous
UWMP	Urban water management plan
WSUD	Water sensitive urban design
WWG	Waterwise gardens

Table A2: Abbreviations – organisations

Organisations	
ABS	Australian Bureau of Statistics
ANZECC	Australian and New Zealand Environment and Conservation Council
BoM	Bureau of Meteorology
DBCA	Department of Biodiversity, Conservation and Attractions
DER	Department of Environmental Regulation (now DWER)
DoH	Department of Health
DoW	Department of Water (now DWER)
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
ERA	Economic Regulation Authority
SoM	Shire of Mundaring
WAPC	Western Australian Planning Commission

Table A3: Abbreviations – units of measurement

Units of measurement	
ha	Hectare
kL	Kilolitres
kL/annum	Kilolitres per annum
kL/ha/annum	Kilolitres per square meter per annum
km	Kilometre
m	Metre
m AHD	Metres in relation to the Australian height datum
m/day	Metres per day
mm	Millimetre
mg/L	Milligrams per litre
µg/L	Micro-grams per litre
°C	Degrees centigrade
%	Percentage
µS/cm	Micro Siemens per centimetre

Terminology Tables

Table A4: Terminology - design rainfall

Equivalent average recurrence interval (ARI) terminology	Average exceedance probability (AEP) terminology utilised
1 in 1 year ARI event	1 exceedance year (EY) event
1 in 1.5 year ARI event	50% AEP event
1 in 5 year ARI event	20% AEP event
1 in 10 year ARI event	10% AEP event
1 in 20 ARI event	5% AEP event
1 in 50 ARI event	2% AEP event
1 in 100 ARI event	1% AEP event
1 in 200 ARI event	1 in 200 AEP event
1 in 500 ARI event	1 in 500 AEP event

1 Introduction

1.1 Background

Satterley (the 'proponent') is developing Lot 48 (on plan 29855), 4685 Stoneville Road and Lot 1 (on plan 69650), 340 Roland Road (herein referred to as the site) for residential and associated purposes. The site is located approximately 30 km north east of Perth Central Business District within the Shire of Mundaring (SoM). The site covers approximately 555 ha and is bound by Roland Road to the west, Cameron Road to the North and existing rural residential development to the east and south. The location and extent of the site is shown on **Figure 1**.

It is important that the manner in which stormwater runoff from residential zoned areas is to be managed to avoid flooding and protect the environment and that this approach is clearly documented early in the planning process. This Local Water Management Strategy (LWMS) details the water management approach to support the North Stoneville Structure Plan 34 Amendment (SP34).

1.2 Town planning context

The site is zoned "Rural" with large sections zoned "Urban" under the Metropolitan Region Scheme (MRS), and "Development Zone" with a parcel zoned "Rural Smallholdings" to the south of the site under SoM Local Planning Scheme (LPS) No. 4.

1.3 Policy framework

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

- *State Water Strategy* (Government of WA 2003)
- *State Water Plan* (Government of WA 2007)
- *State Planning Policy 2.9 Water Resources* (WAPC 2006)
- *Liveable Neighbourhoods (4th Edition)* (WAPC 2007, 2015)
- *Guidance Statement No. 33: Environmental Guidance for Planning and Development* (EPA 2008)
- *State Planning Policy 2.10 Swan Canning River System* (WAPC 2006).

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

- *Better Urban Water Management* (WAPC 2008)
- *Guideline for the approval of non-drinking water systems Western Australia* (DoW 2013)
- *Australian Runoff Quality* (Engineers Australia 2006)
- *Australian Rainfall and Runoff* (Engineers Australia 2016)
- *Decision Process for Stormwater Management in Western Australia* (DWER 2017)
- *Stormwater Management Manual for Western Australia* (DoW 2007)

- *National Water Quality Management Strategy (NWQMS)* (ANZECC 2000)
- *Separation Distances for Groundwater Controlled Urban Development* (IPWEA 2016)
- *Draft Government Sewerage Policy* (DoP 2016)
- *Guidelines for the Non-potable Uses of Recycled Water in Western Australia* (DoH 2011).

The guidance documents listed indicate a need for accurate water quality baseline data prior to urban development. This will ensure that any future development is able to fulfil the stormwater management requirements of Department of Water and Environmental Regulation (DWER) and engineering standards specified by the SoM, but will also ensure that realistic water quality criteria that are practically achievable are adopted.

1.4 Previous studies

A District Water Management Strategy (DWMS) was prepared in 2009 to support rezoning of Lot 69 Roland Road (Cardno 2009). The DWMS proposed measures to managed water within the site, including the possible onsite management and reuse of treated wastewater. The approach to water management and recycling has significantly progressed since preparation of the DWMS, and therefore the approaches proposed are superseded by this LWMS.

1.5 LWMS objectives

This LWMS has been developed in consideration of the objectives and principles detailed in *Better Urban Water Management* (WAPC 2008). It is intended to support SP34, and is further based on the following major objectives:

- Design and implement a water management approach that is consistent with the surrounding hills landscape.
- Take a sustainable approach to water use within the site.
- Mimic the existing environmental discharge to the environment, for both peak flow rates and water quality.
- As much as practicable, attenuate stormwater at source, high in each catchment.
- Minimise the amount of imported fill and engineered lot design approaches to retain existing landform.
- Adopt lot drainage practices which align with the size of lots and attributes of the existing environment – these will aim to assist at-source detention.
- Integrate the drainage network into the road reserve in a manner which aligns with the intent of the design transects.
- Utilise natural hydrological features of the site to achieve flood conveyance and detention where possible.
- Enhance natural hydrological features of the site, and ensure that drainage infrastructure is consistent with these.

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

2 Proposed Development

The SP34 area includes a total land area of approximately 555 ha and the development includes:

- 1, 410 residential lots
- Neighbourhood Centre
- Primary school and high school
- Approximately 145 ha of open space
- Retained streamlines with appropriate foreshore areas
- A recycled water plant (RWP)
- Conservation bushland
- Community gardens and common spaces.

North Stoneville SP34 is provided in **Appendix A**.

Within the development, five characteristic urban-rural transects will gradually integrate several village cores within the surrounding rural landscape, avoiding urban sprawl. Each transect incorporates varying planning and design schemes suited to the relevant land use, including transect specific drainage systems and road layout. The transect approach is illustrated in **Plate 1**.

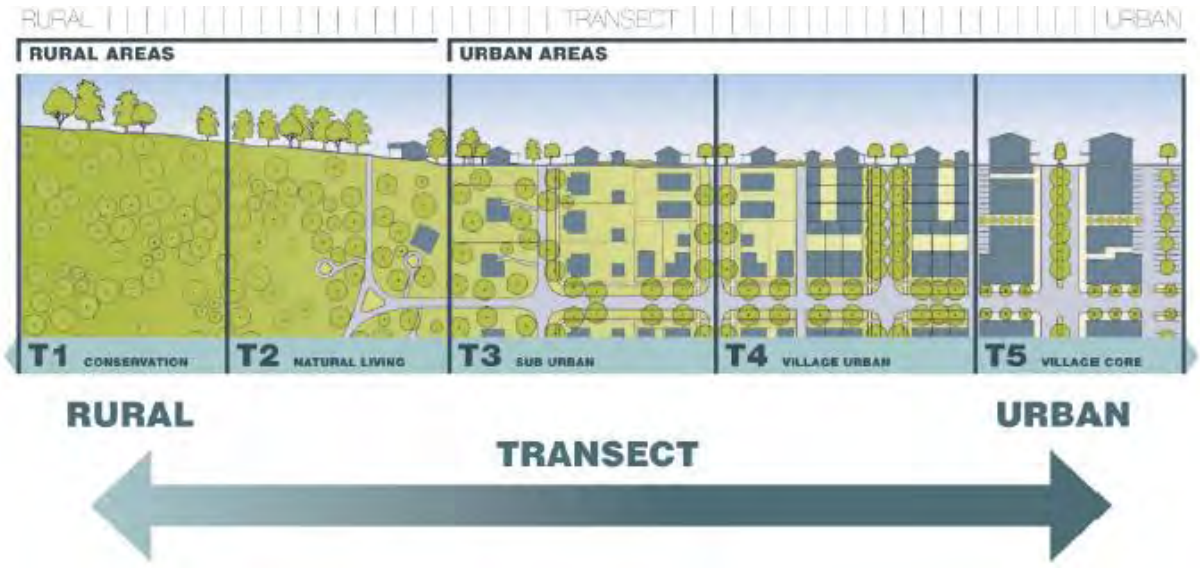

Plate 1: transect development approach

Each transect has different characteristics and approaches to water management. These characteristics and approaches are summarised in the following sections.

2.1 T5 Village Core

T5 transect lots will be 400-600 m^2, and will include higher density mixed use buildings that can accommodate retail, offices, cottages and townhouses. It has a tight network of streets, with wide

sidewalks, steady street tree planting and buildings set close to the sidewalks. T5 lots typically frame a central focal point with strong civic presence and have a more formal structure.

The parameters relevant to water management for T5 lots include:

- Lots to be deep ripped to ~600 mm, ~600 mm sand fill.
- Lot connections will be provided as per SoM requirements
- Onsite soakage unlikely to be appropriate given small lots sizes, setback requirements and low permeability of underlying soil profiles.
- Lots to be encouraged to include rainwater tanks, though optional.
- Road carriageway to be kerbed and stormwater drainage to be conveyed via a conventional pit and pipe network.
- At source treatment of the frequent (1% average exceedance probability – AEP) in road reserves to be within:
  - Bio-retention areas (BRAs) (where practicable). These may be smaller 1:3 side sloped vegetated treatment areas within adjacent open space or locally widened verges.
  - Tree pits. Adjacent to or incorporated into side entry pits (SEPs).
- No minor (20% AEP) event or major (1% AEP) event flood detention proposed in open spaces (as the urban core public open space (POS) spaces are intended to provide maximum amenity).

2.2 T4 Village Urban

T4 transect lot areas will be 800-1,000 m^2 and will primarily be residential traditional neighbourhood grid structure, with some mixed use closer to the village core. Setbacks and landscaping will be modest, encouraging public-private interaction at street level. Streets will have kerbs and sidewalks define medium-sized blocks.

The parameters relevant to water management for T4 lots include:

- Building pad area and immediate surrounds as necessary to be deep ripped to ~600 mm, ~600 mm sand fill.
- Onsite soakage will not be enforced due to minimal infiltration profile, however may be possible where geotechnical conditions indicate this is appropriate.
- The exception to ripping/fill is lots >4% slope, where lots may take alternative approaches to building (e.g. split level/pole homes)
- Lots to be encouraged to include rainwater tanks, though optional.
- Road carriageway to be kerbed and stormwater drainage to be conveyed via a conventional pit and pipe network.
- To reduce pit and pipe network infrastructure, stormwater conveyance within road pavement formation is likely to be applied, subject to gutter flow depth and width.
- At source treatment of the frequent event in road reserves to be within verge/median conveyance swales: 1:3 side slopes and maximum depth of 0.5 m. Average depth likely to be less due to slope. May be vegetated or rock pitched, depending on slope.
- No minor or major event flood detention proposed in open spaces, however green corridors are used for conveyance and will provide some in-line detention (via weir like structures).
- Where green corridors used for conveyance, erosion and downstream sedimentation must be considered in design (particularly where road reserve grade > 4 %)

2.3 T3 Sub Urban

T3 transect lots will be 1,000-2,000 m^2 and will be low density residential areas, within walking distance of T4 village urban areas. Home businesses and outbuildings are allowed within T3 areas. Planting is naturalistic and setbacks are relatively deep. Blocks may be large and the roads irregular to accommodate natural conditions.

The parameters relevant to water management for T3 lots include:

- Rainwater tanks mandatory as per SoM specifications.
- Road reserve to preferentially utilise roadside swales for <5 % slope. Roads >5 % slope to utilise pit and pipe network. To reduce pit and pipe network infrastructure, stormwater conveyance within the road pavement formation is likely to be applied, subject to gutter flow depth and width.
- Where lot slope >5 % controls (e.g. contour bunds) at downstream boundary are to be installed, with flow pathway (via easement or similar) directed along downstream property boundary to the nearest road reserve. Nominally this may be needed every 2nd lot boundary.
- At source treatment of frequent event rainfall from road reserves to be via in-line detention, achieved in roadside swales or conveyance in green corridors where possible. Swales may be vegetated and/or rock pitched, depending on localised slope.
- Downstream treatment structures (for sediments) provided at catchment low points for all runoff from frequent events that is not achieved either in lot or road reserves higher in the catchment.
- Minor and major event flood detention to occur either within road reserve swales, at critical low points or in flood storage areas (FSAs) at minor catchment low points or within retained dam structures.
- All discharge locations from road reserves and drainage reserves to be scour protected.

2.4 T2 Natural Living

T2 transect lots will be 1-2 ha and will be sparsely settled land in open or cultivated states, with dry rolling land. These include existing cleared agricultural land, grassland, and drainage areas. Typical buildings are pseudo-farmhouses, ranches with large porches, and rural style buildings.

The parameters relevant to water management for T2 lots include:

- Rainwater tanks mandatory as per SoM specifications – consistent with rural feel of the area.
- Soakwells not required, though may be used for convenience if desired and based on localised constraints/conditions.
- Roads to be unkerbed, table drains only to be utilised where slope and road geometry dictate, or where longitudinal grade >5 %.
- No formal water quality treatment (sediment) structures, except at discharge locations from table drains.
- Where a significant upstream catchment terminates in a T2 area:
  - Catchment runoff may need to be conveyed through T2 lots to the site discharge location to be protected by easements.

- Minor and major event flood detention may need to occur within T2 lots to achieve required flood detention to be protected in easements.
- All discharge locations from road reserves and drainage reserves to be scour protected.

2.5 T1 Conservation & Open Space

T1 transect portions of the site will be areas approximating or reverting to a wilderness condition, including lands unsuitable for settlement due to topography, hydrology, vegetation or cultural heritage.

- No lot development (this land will be vested to SoM and/or Department of Biodiversity Conservation and Attractions (DBCA) for public amenity).
- Roads to be unkerbed with no formal drainage. Table drains only to be utilised where slope and road geometry dictate, or where longitudinal grade >5 %.

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:

- *Regional 1:50 000 Geology Map Sheet* (Smurthwaite 1986)
- *Climate Data Online* (BOM 2018)
- *National Water Quality Management Strategy* (ANZECC 2000).

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

- Surface water quality monitoring conducted by Cardno (2009).
- Surface water quality monitoring conducted by Emerge Associates (2017 to 2018)
- Geotechnical Investigations conducted by Galt Geotechnics (2017a, 2017b).

3.2 Climate

The site experiences a 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 1,079 mm on average annually with approximately half of the regions rainfall received between June and August (BoM 2018). The region experiences rainfall (>1 mm) on 87 days annually (on average) (BoM 2018).

3.3 Geotechnical conditions

3.3.1 Topography

Topographical survey indicates that the site is characterised by undulating topography with a prominent valley running laterally through the site. Available contours indicate that topography within the site ranges from 247 metres Australian height datum (m AHD) to 316 m AHD. The highest point within the site is located on a crest within a section of remnant vegetation toward the centre of the site. The lowest point is located at the discharge of the central streamline on the southern boundary. Slope varies within the site to a maximum gradient of 15 %. The flattest areas within the site are generally located at higher elevations on saddles, ridgelines and crests.

Topographic contours across the site are shown on **Figure 2**.

3.3.2 Soils and geology

The site lies within the “surface of planation and lateric uplands” (Dp), and “narrow, shallow valley floors” (Fv), geological classifications (Smurthwaite 1986).

Regional geological mapping indicates that ground conditions throughout the site are largely comprised of laterite (LA1), which is known to exhibit poor drainage, low permeability and can be difficult to excavate. Laterites are hard and cemented up to 4 m thick, with an overlying layer of Gravel.

Streamline banks, lower lying areas and valleys throughout the site are generally underlain by sand and silt (G2) and fine to coarse grained granites (GR). Gravelly silty sand (Smg), white to grey in colour with fine gravel and common clay underlay streamlines.

Recent geotechnical investigations at the site (Galt Geotechnics 2017a, b) confirm that the site is underlain by materials consistent with the regional mapping, including:

- Gravelly sand/sandy gravel/gravel: fine to coarse grained sand, fine to medium pisolitic gravel, dark grey brown typically becoming pale brown, yellow brown or orange brown, typically dry and loose, trace very well cemented cobbles and boulders, present from ground surface and extending to depths ranging from 0.15 m to 1.2 m;
- Hardpan laterite: very well iron cemented, massive, typically dark red brown variably mottled yellow brown and off-white, becoming yellow brown and weakly to well cemented at depths ranging from 1.8 m to 2.8 m, present from ground surface and extending to investigated depths ranging from 1.0 m to 3.3 m;
- Clayey sand/sandy clay (SC-CI): fine to coarse grained sand, between 15% to 50% low to medium plasticity fines, either mottled red-brown and yellow brown or off-white and yellow brown, varying between laterised clayey soils and extremely weathered granitic rock, present from depths as shallow as 1.5 m and extending to a depth of up to 2.8 m.

The geotechnical investigations (Galt Geotechnics 2017a, b) are provided in **Appendix B**. Geological mapping is shown on **Figure 3**.

3.3.3 Acid sulfate soils

Acid sulfate soils (ASS) were not encountered during the two recent Geotechnical Site Investigations undertaken by Galt Geotechnics (2017a, 2017b). There is no known risk of ASS occurring within 3 m of the natural soil in the surrounding area, including the John Forrest National Park, and it is therefore inferred that the site will contain a similarly low level of ASS risk. The risk associated with ASS is further reduced by the proposed earthworks strategy which favours importing or generating clean sand for filling over excavation into in situ material due to the presence of hardpan laterite.

3.4 Wetlands

There are no mapped geomorphic wetlands located within the site. There is however one portion of the site which exhibits wetland-like characteristics, located immediately downstream of the north-eastern dam and south of Cameron Road. The location of the 'wetland' area within the site is shown on **Figure 4**.

3.5 Surface water

3.5.1 Streamlines

The majority of the site is underlain by low permeability soils and an undulating topography grading towards shallow valleys, as described in **Sections 3.3.2** and **3.3.1**. During rainfall events, runoff from the surrounding catchments are concentrated within streamlines within the site. Clutterbuck Creek flows through the eastern portion of the site, and the main central catchment discharges to this Creek south of the site. Clutterbuck Creek is a tributary of Jane Brook and those catchments which discharge northwards eventually discharge to Susannah Brook. There are four main streamlines present within the site, all of which have had surface water capture dams constructed in the past. The locations of streamlines and site discharges is shown in **Figure 4**.

A foreshore area report (FAR) has been prepared by Emerge to establish the extent of hydrological features across the site, identify existing wetland and riparian vegetation, and identify associated foreshore areas. Preparation of the FAR has been based on biophysical assessment including desktop studies, surface water modelling, site inspections and flora and wetland surveys carried out by Emerge Associates.

The FAR proposes that the foreshore should be considered to be the sum of:

- The extent of frequent event flooding within and adjacent to streamlines
- The presence of trees and vegetation immediately adjacent to the dams/storage areas
- The extent of wetland/riparian vegetation adjacent to the streamlines
- Existing trees/vegetation adjacent to Clutterbuck Creek and its tributaries, to the extent that these are intersected by frequent event flooding

If a foreshore reserve were to be spatially determined, an additional 10 m from the outermost of the above features to allow for side slope integration and management access could be adopted. It is noted that where maintenance access and topographical integration can be addressed in an alternative manner this requirement would not be relevant.

The FAR is provided in **Appendix C**.

3.5.2 Roadside swales

Roadside swales are present along the majority of the western and northern boundaries (Roland Road and Cameron Road respectively).

The roadside swale adjacent to Roland Road is located on the eastern side of the road and is conveyed under Roland Road via culverts. Topography grades from east to west in the vicinity of the Roland Road swale and runoff from the western facing portion of the site contributes runoff to the swale. Roland Road swale flows are concentrated and discharged southwards, towards Clutterbuck Creek (a tributary of Jane Brook) (at discharge location Out 7) or locally to a dam west of the site (discharge location Out 3).

The roadside swale within the site and adjacent to Cameron Road is located to the south of the road. The eastern section of the swale conveys runoff from the site towards a localised streamline which discharges under Cameron Road via a 900 mm culvert (discharge location Out 1). The western section of the swale directs flow from the site and an upstream catchment towards the low lying wetland area and culvert (Out 2), which also discharges to the north towards Susannah Brook. The locations of roadside swales and discharge locations are shown in **Figure 4**.

3.5.3 Dams

Surface runoff storage dams have historically been constructed within natural streamlines and would have historically served as a water source for agricultural uses. The four main dams are described in the following sections and are shown in **Figure 4**.

3.5.3.1 Central Dam

The Central Dam is the largest within the site and is within the largest catchment of 186 ha. The seasonal peak water elevation is approximately 262 mAHD (based on surface contours and observations) at which point it is an estimated 2-3 m deep. Above the seasonal peak water level it has a potential storage area of approximately 6,500 m^2 between 266.5 and 267.5 mAHD, providing approximately 16,500 m^3 of detention capacity. The valley immediately upstream provides an additional 13,000 m^2 of potential storage area, providing up to 9,300 m^3 of detention capacity. The main wall of the Dam has been breached and heavily eroded and the wall would need to be repaired to be able to utilise the storage potential of this dam.

3.5.3.2 North-eastern Dam

The North-eastern Dam is located adjacent to a valley floor which is heavily vegetated and has wetland characteristics. The area surrounding the Dam is likely fed by shallow soil saturation which expresses at the base of the valley. The Dam sits within a 168 ha catchment. The seasonal peak water level is assumed to be 272 mAHD (based on surface contours and observations). The potential storage area of the exiting dam is approximately 5,000 m^2. The capacity of this Dam could be increased by minor extension of the western wall, which would inundate an 8,400 m^2 area and provide an estimated flood storage depth of 1.5 m with capacity of 8,000 m^3 of detention storage.

3.5.3.3 North-western Dam

The North-western Dam is located close to Cameron Road within an 88 ha catchment. The Dam has an assumed seasonal peak level of 272 mAHD (based on surface contours and observations) and a surface area of 4,400 m^2. The dam wall is at approximately 273.5 mAHD, with a top water level surface area of approximately 5,500m^2. In order to realise the full capacity of the dam, the two side slopes or the up-slope side of the dam would require some additional bunding (of approximately 0.5 m) to ensure that a flood storage depth of 1.0 m could be achieved. This would provide detention storage of approximately 5,000 m^3.

3.5.3.4 Eastern Dam

The Eastern Dam intersects runoff from within the site and also from an upstream catchment. The catchment within the site is approximately 14 ha, while the upstream catchment is 160 ha. The maximum top water elevation is controlled by an overflow weir, which sits at approximately 266.5 mAHD. However, based on observations onsite and aerial photography the seasonal peak is assumed to be 265 mAHD, at which point the Dam is 9,000 m^2. The top of wall is at 266.75 mAHD, and if a top water level was assumed at 266 mAHD the Dam surface area would be approximately 18,000m^2, and provide a detention volume of 12,000 m^3.

In addition to the main dams, there is a minor dam which intersects a streamline which enters the site from the north. This dam is minor in size and therefore has not been detailed.

Discharge from dams is conveyed offsite via natural streamlines to be ultimately discharged into Clutterbuck Creek (a tributary of Jane Brook) to the south and Susannah Brook to the north.

All surface water features are shown in **Figure 4**.

3.5.4 Pre-development surface runoff modelling

The catchments within and adjacent to the site have been determined by analysis of topographical contours, aerial photography and ground truthing of assumptions (e.g. road crossings, culvert locations and sizes, etc.). Geotechnical analysis of the site shows varying levels of clays, gravel and laterite at varying depths to the surface. For the purposes of catchment analysis it is assumed that the soil types are generally consistent across the site.

The catchment analysis shows varied amounts and density of vegetation across the site, which influence catchment losses. For the purposes of modelling, the existing land uses (and losses) have been based on three vegetation classifications: Sparse, Medium and Dense. The spatial extent of these have been determined by aerial photography analysis. The pre-development catchments and land type are shown in **Figure 5**.

In order to determine appropriate losses for the catchments and land uses, reference was made to runoff modelling undertaken in nearby Gidgegannup to support a District Water Management Strategy (DWMS) (Cardno 2009). The Gidgegannup modelling was calibrated to onsite measurements of flow and rainfall, and the soil types and land uses are very similar to those in Stoneville. The loss rates adopted in the modelling for this LWMS are based with those from the Gidgegannup DWMS. The methodology adopted to convert the Gidgegannup loss rates is described in the modelling assumptions report (MAR; provided in **Appendix D**), as are the resulting initial and continuing loss rates.

The site has been modelled using XPSWMM to determine inflows to and outflows from the site. Analysis within XPSWMM indicates that the critical duration storm event is 6 hours for the 1 % AEP and varies between 12 hours and 48 hours for the 20 %AEP event. The peak flow results of the critical duration are summarised in **Table 2**.

Table 1: Pre-development peak flow analysis results

Flow location	Contributing catchment	Catchment area (ha)	Major (1% AEP) peak discharge (m^3/s)	Minor (20% AEP) peak discharge (m^3/s)	Frequent (15 mm) event peak discharge (m^3/s)
Out1	Ct1	88.7	2.81	1.03	0.20
Out2	Ct2	168	6.34	2.19	0.40
Out3	Ct3	21.9	0.74	0.27	0.05
Out4	Ct4	186.9	7.30	2.70	0.51
Out5*	Ct5	160	3.24	0.87	0.10
Out6*	Ct6	98.8	2.94	1.06	0.20
Out7	Ct7	75.6	3.60	1.48	0.30
Out8	Ct5, Ct6, Ct8	423	10.58	3.33	0.52
Out9**	Ct9	18.9	0.64	0.14	0.00
Out10**	Ct10	20.7	1.31	0.56	0.14

**site inflow*

***sheet flow, no defined 'channel'*

3.5.5 Surface water quality

Surface water quality monitoring was undertaken by Cardno (2009) at two locations within the site as part of DWMS investigations. The samples were taken within existing surface water storages that intersected streamlines (North-Western Dam and the lake adjacent to SW5, shown on **Figure 4**). The intent of the DWMS monitoring was to provide an initial indication of surface water quality within the site. The monitoring locations (in standing water bodies) are not considered appropriate to develop site specific triggers as the samples were taken from a static water source, and not from water flowing/discharging from the site. It is noted in the DWMS report that analysis of surface runoff within streamlines in response to rainfall would be more useful and should be included in a subsequent LWMS. This updated monitoring has been conducted and is discussed below.

Emerge has undertaken surface water quality monitoring between July 2017 and September 2018 at six locations across the site. The locations of the surface water monitoring sites are shown on **Figure 2**. The results of the monitoring are summarised in **Table 2**, with the full results provided in **Appendix E**.

Table 2: Pre-development surface water quality monitoring (2017 – 2018)

Site ID	Description	pH average	EC average (mS/cm)	TSS (mg/L)	TN average (mg/L)	TP average (mg/L)
SW1	North west discharge	6.24	0.850	5.00	1.0	0.02
SW2	North east discharge	6.56	0.491	<5	1.2	0.02
SW3	South east inflow	6.12	0.387	<5	0.1	<0.01
SW4	South west discharge	6.46	0.300	<5	3.7	0.04
SW5	Eastern Dam discharge	5.75	0.364	<5	3.0	0.02
SW6	Central northern inflow	5.55	0.226	-	8.2	0.02
NWQMS	Lowland river	6.5-8	0.3	-	1.2	0.065

Total phosphorus (TP) was observed to be generally below the NWQMS trigger value for lowland rivers (which is most relevant as the destination is a lowland river). This is unusual given the long term and continued agricultural use of the land, and suggests that the clayey soils beneath the site may be very effective at mitigating TP export from the site. Total nitrogen (TN) was above the trigger level values for three sites (SW4, SW5 and SW6).

Measurements of pH across the site ranges from moderately acidic to neutral. Site discharges in particular reached lower pH values on one round of observations (5/7/18). For this round of testing, SW3 was dry and therefore not tested. Surface water throughout the site shows elevated levels of salinity (EC); up to five times greater than the upper limit of the acceptable range.

Pre-development surface water quality monitoring is ongoing. At the time of preparing this revision of the LWMS (Rev C) monitoring had been attempted in June 2019 however no discharge was evident from site following rainfall. Monitoring will continue thoughout the winter 2019 season to ensure that data can be captured once the catchment is saturated and runoff occurs.

Updated results will be provided in future water management documentation, and will be used to refine the preliminary trigger values proposed in this LWMS (see **Section 10.2.1**).

3.6 Groundwater

The low permeability of underlying laterite soils exhibit poor drainage and act as an aquiclude. There is therefore not expected to be any substantial and/or connected aquifers within the site. It is possible that there may be fractured rock aquifers at some locations, however there is no evidence onsite of this occurring. Groundwater is not expected to significantly recharge within the site, and

therefore the quality of any limited groundwater contributions are therefore not relevant to the ongoing management of the site.

Runoff from rainfall events is conveyed as sheetflow over the steeply sloped terrain towards low lying areas and streamlines, resulting in localised inundation and increased streamflow. It is likely that there would be seasonal saturation of the shallow clayey soil profile, and that the moisture in this shallow layer would migrate to the lower parts of the site. This is evidenced by the vegetation that is sustained in the low points (valleys) of the site.

3.7 Current and historical land uses

Historically, sections of the site have been cleared for agricultural/grazing purposes. To date approximately half of the site has been cleared including the majority of streamline areas. Large sections of discontinuous remnant vegetation have been retained throughout the site.

Historical aerials show that the southern section of the site was partially cleared and the two dams/lakes along the southern site boundary were constructed prior to 1965 (earliest available imagery). The northern section of the site was cleared and the three significant dams constructed between 1965 and 1974. There have been no significant clearing activities observed within the site since 1974.

Between February and September of 2016 contour bunds were installed in three areas to the south west of the site to control erosion, and these are visible on **Figure 1**.

3.8 Summary of existing environment

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

- The site receives 1,079 mm of average annual rainfall with the majority of rainfall received between June and August.
- Topography of the site ranges from 264 to 316 m AHD and exhibits average slopes up to 15%. Some minor portions of the site may contain slopes exceeding 15%.
- The majority of the site is comprised of laterite overlain by and associated with gravel (LA1), becoming progressively sandy near streamlines.
- Elevated TN was observed in some surface water monitoring sites.
- Surface water flows discharging to the north of the site show elevated salinity.
- There are some relatively minor upstream contributing catchments. With the exception of these, the site is at the top of catchment.
- The site contains four main dams that currently capture runoff from within the site and could potentially be used to achieve flood detention within the site (with some minor modifications). A minor dam exists in the eastern portion of the site
- Runoff from the site discharges to Clutterbuck Creek, a tributary of Jane Brook (to the south) and tributaries to Susannah Brook (to the north).
- Peak flow rates leaving the site (at six locations) have been characterised for frequent (1 EY) minor (20% AEP) and major (1% AEP) events. This has been undertaken using XPSWMM, and has been informed by calibrated runoff modelling from nearby Gidgegannup townsite.

- There is no true groundwater beneath the site. Shallow clayey soils above gravels/laterite may be seasonally saturated and express some water at the low points (valleys) within the site.

4 Design Criteria and Objectives

This section outlines the objectives and design criteria that this LWMS and future Urban Water Management Plans (UWMPs) must achieve. The water management strategy covers stormwater management, groundwater management and water consumption. Design criteria are based on the guiding documentation and policies discussed in **Sections 1.3** and **1.4**.

4.1 Water conservation

Criteria WC1 Lot scale potable water use to be less than 60 kL/person/year.

Criteria WC2 No potable water to be used for non-potable uses in any public spaces.

4.2 Recycled water

Criteria RW1 Maximise the re-use of recycled water within the site

Criteria RW2 All open space long term irrigation requirements to be met by recycled water

Criteria RW3 Open space irrigated areas to use an average of 7,500 kL/ha/year

Criteria RW4 Recycled water will be retained within the site and will not be discharged to the environment

4.3 Stormwater management

Criteria SW1 Major event post-development peak flow rates leaving the site should be equal to or less than pre-development peak flow rates.

Criteria SW2 Flood detention to achieve pre-development discharge rates should occur as high in the catchment as practical.

Criteria SW3 Frequent event runoff should be treated at source, or as close to source as practical. This may include detention at source and/or additional treatment if appropriate.

Criteria SW4 Water quality treatment structures to be sized to retain the first 15 mm from directly connected impervious areas.

Criteria SW5 Sediment control and erosion protection to be incorporated in to road reserves where practicable.

Criteria SW6 Road drainage network to be designed to accommodate and convey the minor event.

4.4 Groundwater management

Criteria GW1 Where utilised, subsoil drains are to be set at or above the low permeability soil layer.

Criteria GW2 Finished lot levels are to be at least 1.2 m above the CGL formed by the invert of subsoil drains.

Criteria GW3 Subsoil drains to be discharged via a free draining outlet to an appropriate water quality treatment structure.

Criteria GW4 Soil profile beneath T4 and T5 lots to be deep ripped/filled to a minimum depth of 1.0 m.

5 Water Conservation Strategy

5.1 Fit-for-purpose water use

Conservation of water through fit-for-purpose use and best management practices is encouraged so that scheme water is not wasted.

5.1.1 Scheme water

All lots will utilise scheme water supplied by the Water Corporation for potable water requirements.

The *Parkerville/Stoneville Water Supply – Initial Submission Report* (Worley Parsons 2009) was prepared in consultation with Water Corporation and took into account both the proposed development of Stoneville and nearby Parkerville (to the west of Roland Road). The proposed strategy involved sourcing potable water from the existing Water Corporation Zamia tank site located on the northern edge of the Zamia State Forrest approximately 10 km south of the proposed Stoneville development and supplying the site via predominantly a new pipeline to a new tank site to be located within the proposed Stoneville development. The tank site would be capable of servicing both the Stoneville and Parkerville developments.

Taking into consideration only the Stoneville Development, recent advice from the Water Corporation indicated that the water reticulation requirements for the site would involve the following elements (Cossill & Webley 2018):

- Extension of the water reticulation from the Zamia Tanks via a DN400 and DN300 water main.
- Cross connections of the water retic extension would be required with the existing water reticulation pipework.
- A staged approach to tank construction involving:
  - A single 2.0 ML on-ground tank to be installed followed by a second 2.0 ML on-ground tank at a later stage.
  - An elevated 100 kL tank on a 17.7 m high stand was also proposed to supply the most elevated parts of the proposed Stoneville development.

5.1.2 Recycled wastewater

Recycled wastewater will be utilised to meet all open space irrigation needs. The recycled wastewater system is discussed in detail in **Section 6.3**.

5.1.3 Rainwater harvesting

Rainwater harvesting systems will be encouraged throughout the development and mandated to varying degrees within respective transects. Rainwater harvesting will not be mandated in transects T1 or T5. Lots within T4 and T3 transect areas will be encouraged to utilise rainwater tanks to supply non-potable water requirements however they will not be mandatory. Lots within T2 areas are required to install 10,000 L rainwater tank storage to supply potable and non-potable water

requirements in accordance with SoM requirements. It is assumed that rainwater harvested from roof areas in T2 lots will only be utilised for irrigation purposes.

5.1.4 Groundwater

Groundwater is unlikely to be available in any reliable quantity, and will therefore not be relied upon to meet development non-potable needs. Individual lots will be serviced with harvested rainwater, recycled water and scheme water for non-potable water requirements (**Sections 5.1.3**, **5.1.2** and **6.3**).

5.1.5 Surface water

Surface water from nearby dams may be required during construction and for irrigation during the establishment of open space. The existing dams proposed to be utilised for such purposes (Central Dam, North-eastern Dam and North-western Dam) do not have an upstream catchment, and therefore will only capture and re-use surface runoff from within the site.

5.2 Water conservation measures

5.2.1 Water efficient fixtures and appliances

Significant reduction of internal water consumption can be achieved with the adoption of water efficient fittings and appliances (WEFA). The water conservation strategy for the site proposes that all lots (schools, the local centre and residential dwellings) implement WEFA. Water efficient fittings will be mandated through the building licence, while uptake of water efficient appliances can be encouraged by state and local government rebates.

5.2.2 Waterwise gardens

Employing water use efficiency measures can significantly reduce total water usage. In addition to retaining significant areas of remnant vegetation, irrigation requirements can be reduced across the development by employing waterwise garden (WWG) measures including:

- Improve soil with conditioner certified to Australian Standard AS4454 to a minimum depth of 150 mm where turf is to be planted and a minimum depth of 300 mm for garden beds.
- Design and install the irrigation system according to best water efficient practices.
  - Control systems must be able to irrigate different zones with different irrigation rates.
  - Emitters must disperse coarse droplets or be subterranean.
  - Utilise subsoil irrigation where appropriate.
- Minimise the amount of turf areas.
- Mulch garden beds to 75 mm with a product certified to Australian Standard AS4454.
- Retain remnant native trees and vegetation where possible.
- Minimise use of fertiliser and utilise slow release fertilisers.

5.3 Lot water balance

A water balance analysis has been undertaken to demonstrate the effectiveness of the water conservation strategy proposed. The analysis considers realistic uptakes of non-mandatory water conservation measures including WEFA and WWG. Uptake rate and population assumptions are calculated using data from the Australian Bureau of Statistics (ABS) (ABS 2004, 2010). Rainwater tanks are assumed to be taken up by all T2 lots.

The water balance analysis has been based on the rates and calculation methodology presented in the Water Corporation Spreadsheet *AltWaterSupply_Water_Use_Model.xls* (Water Corporation 2011). This spreadsheet has been adapted to model the effects of using rainwater tanks, WWG and WEFA.

The water balance analysis assumes an average of 2.8 people per lot. Values are calculated from data provided by the ABS for new housing developments in Perth (ABS 2009). The results of the water balance indicate that on average, if households in the development adopt the proposed water conservation measures at typical uptake rates, they will use 54 kL/year/person. This achieves the state water consumption target of no more than 60 kL/year/person and satisfies **Criteria WC1**.

5.4 Irrigation demand

SP34 provides 153 ha of open space, though some of this is conservation area and will not be irrigated. In addition to the school ovals and formal POS areas, there will be some irrigation requirements for BRAs, road verges and other open space areas (e.g. adjacent to and including the living streams). For the purposes of matching irrigation demand with the available non-potable water (from the recycled water plant (RWP)), irrigation rates have been assumed to be either active POS (turf) areas irrigated at 7,500 kL/ha/year or recreational POS (which will include some turf, garden beds and other areas described above) assumed to be irrigated at 6,750 kL/ha/year. In reality, some of these irrigation rates may vary to meet the requirements of different POS types and to match with the available water from the RWP (which may differ in 'dry' or 'wet' years. **Table 3** provides a summary of the irrigated areas and rates proposed across the development, and **Appendix F** shows the overall irrigated area assumptions.

Table 3: Irrigated areas and rates

Land use type	Total area (ha)	Irrigation rate (kL/ha/yr)	Annual irrigation demand (kL)
POS - active	10	7,500	75,334
POS – recreation	24	6,750	162,309

5.5 Water conservation criteria compliance summary

A summary of the proposed water conservation design criteria and how these are addressed within the site is provided in **Table 4**.

Table 4: Water conservation compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
WC1	Lot scale potable water use to be less than 60 kL/person/year	Rainwater tank uptake to be encouraged for non-potable water uses in T3 lots and mandated in T2 lots
		WEFA adopted within all lots, schools and the local centre
		WWG principles promoted for use within lots and adopted in all POS areas.
		Combined water conservation measures result in average use of 54 kL/person/year
WC2	Non-potable water to be used to irrigate open spaces	Recycled water from the RWP will be used to meet irrigation requirements for all open space areas.

6 Wastewater management

6.1 Introduction

A key requirement for the planning approval and subsequent development of the site was the implementation of a technically and economically feasible wastewater servicing solution. The proponent engaged Water West to investigate and propose a solution to the wastewater requirement. Initial investigations identified a suitable approach which was expanded upon in the succeeding *Stoneville Wastewater Servicing Concept Design Assessment* (CDA) (Water West 2019), provided in **Appendix G**. The servicing approach considered most appropriate involves the on-site tertiary treatment of wastewater within a RWP and the re-use of treated wastewater to meet non-potable irrigation requirements. The overall approach of the wastewater recycling system is outlined in the following sections and is discussed in detail within the CDA (**Appendix G**).

6.2 Assumptions

6.2.1 Structure Plan and population

The CDA has been based on the structure plan, and includes assessment of lot yield, type, creation rate and irrigation requirements for open spaces and are summarised within Section 4 of the CDA. Key inputs include a total yield of 1,410 lots, dwelling population density of 2.8 and an open space irrigation area of 34 ha.

An additional allowance for the potential future inclusion of treatment capacity required to service the nearby Parkerville development has been made by Water West in the event that the adjacent development proceeds, providing a flexible and future proofed approach. Note however that this does not influence the approach proposed for the Stoneville development.

It is noted that the assumptions specified in the report were based on SP34, and that the yield estimates and therefore design approach for the site will be subject to detailed design in the future, and this will be finalised within future documentation detailing ultimate RWP design.

6.3 Sewer and recycled water reticulation networks

A pressurised sewer system will supply the RWP with raw sewage from developed areas. Pressurised sewage systems will limit excavation requirements within the underlying rocky soils, enable lot specific contamination and production tracking (through nodal monitoring) and can minimise excessive system demand during rainfall events. Recycled treated water will be distributed via piped flow pumped from the RWP and several booster pumps along the piped network.

Water West will ultimately own and maintain the sewer reticulation system, the RWP and the encompassing lot after handover.

6.4 Recycled water plant

All wastewater produced within the site will be processed through the on-site RWP located in the north west of the site (in the vicinity of a former gravel quarry). Access to the RWP will be provided from Cameron Road and along a 6 m wide service access track located within the site. The RWP will be situated on a levelled pad covering approximately 0.6 ha hardstand. The location and extent of the RWP is detailed in the CDA.

The RWP will be a tertiary-treatment facility that will utilise membrane technology and biological processes, typically referred to as a membrane bio-reactor (MBR). Permeate from the membranes will be treated to ensure recycled wastewater is of a suitable quality for irrigation as per the *Guidelines for the Non-potable Uses of Recycled Water in Western Australia* (DoH 2011). The treated water characteristics typically achieved by the RWP are provided in the CDA and are summarised in **Table 5**.

Table 5: Treated wastewater characteristics (Water West 2018).

Parameter	Units	Design water quality
5 day Biological oxygen demand	mg/L	<10
Total suspended solids	mg/L	<10
TN	mg/L	10-15
TP	mg/L	3-5
pH	-	6.5-8.5
E.coli	cfu/100 mL	<1
Clostridium perfringens	cfu/100 mL	<1
Somatic Coliphage	pfu/100 mL	<1
Free chlorine residual	mg/L	0.2-2.0
Turbidity	NTU	<0.3
Alkalinity	mg/L	<50

The treated wastewater characteristics will mean that it is suitable for use as irrigation water, with the vegetation taking up the nutrient being irrigated within the treated water, this is discussed further in **Section 6.5.1**. Water West are aware that a modification to their existing ERA licence will be required, and that the RWP will require a works approval to construct. It is accepted that water quality criteria will be agreed with DWER through the RWP licencing process under the *Environmental Protection Act 1986.*

The RWP is expected to service approximately 650 kL/day. Storage of treated/recycled wastewater will be required to ensure the supply of open space and lot irrigation demands over the summer period. The final required storage capacity of 84 ML will be provided by high density polyethylene (HDPE) lined dams adjacent to the RWP on the site of the former quarry. The lined dams will be constructed in two stages, with approximately 40 ML provided in each stage. The staged construction

will allow the final storage capacity to be revised based on monitoring of wastewater production from earlier stages of development and/or any required adjustments (e.g. to irrigation rates). The final storage volume will have the capacity to fully contain recycled water without the need to discharge directly to the environment under any circumstance (i.e. even in 'wet' years).

6.5 Recycled water management approach

The use of recycled wastewater provides an important fit-for-purpose irrigation source for open spaces within the development. The operational and risk management approach associated with the supply of recycled wastewater has been developed in consideration of receiving environments, site-specific conditions, development requirements and in consultation with government agencies. In light of these considerations, a key requirement of the approach is to ensure the constituents (e.g. nutrients) present in treated wastewater are suitably managed and that appropriate contingencies are available. These are discussed in the following sections.

6.5.1 Irrigation nutrient uptake

A water balance analysis conducted by Water West has determined that that the volume of recycled wastewater produced from the RWP will meet the irrigation demand from the approximately 34 ha of irrigated POS assuming an irrigation rate of 6,750 - 7,500 kL/ha/year (derived from MEDLI modelling using the median of 50 years of climate data). The use of recycled wastewater will also provide the majority of the nutrient requirements for open spaces. It is anticipated that active open spaces/turf may require additional nutrient inputs, and this would be guided by leaf and tissue analysis to ensure that the potential for excess nutrients to leave the site is mitigated.

A nutrient balance has been prepared which accounts for the differing requirements of various surface treatments and the proposed irrigation application rates (see **Table 6**). The target nutrient application rates have been referenced from Geritse et al (1990).

Table 6: Nutrient application and balance

Land use type	Area irrigated (ha)	Annual irrigation rate (kL/ha/yr)	Nutrient	Nutrient application via recycled water (kg/ha/yr)	Additional nutrient required beyond recycled water (kg/ha/yr)
POS - sport	10	7,500	TN	75	75-125
			TP	22.5	7.5-17.5
POS – recreation	24	6,750	TN	67.5	82.5-232.5
			TP	20.25	9.75-19.75

As demonstrated in **Table 6**, the irrigation demand and associated nutrient application to open spaces will result in full uptake of nutrients by vegetation within open space areas. Comparison to the nutrient application rates provided in Geritse et al (1990) suggest that additional nutrients may still be required in some areas to meet typical application rates. As indicated above, the need for this would be determined by leaf and tissue analysis or similar. While there are no excess nutrients

expected, if there were to be any nutrients exported from open space areas these would be captured and further treated within WSUD features (discussed in **Section 7.1**) such as the living streams.

Surface water leaving the site will be monitored to ensure that water quality does not exceed trigger level values (see **Section 10.2.1**). There are contingencies proposed (see **Section 10.3**) that can be implemented if any trigger criteria are exceeded. These include utilising the RWP ability to decrease nutrient levels to meet the needs of the receiving environment.

6.5.2 Contingency and risk management

As discussed in **Section 6.5.1**, the proposed approach is that all nutrients and water will be taken up by POS and landscaped areas. However, it is noted that there may be extenuating circumstances where the effectiveness of the proposed approach may require refinement. There are a number of contingency and redundancy measures that are inherently present within the RWP infrastructure and operation, as well as the wider development. Active measures can also be implemented when required. An overview of the contingency measures are provided below.

6.5.2.1 Recycled water plant design and operation

The RWP has been designed based upon a number of assumptions (e.g. lot creation rate, total lot numbers, persons per household, irrigation rate, etc.). Monitoring of recycled water and irrigation of this during earlier stages of development will serve to validate, or form the basis for updating, the assumptions and associated design responses. The linear nature of development stage creation will mean that ample time is available for data analysis and any required changes can be implemented well within an appropriate timeframe (i.e. before there is any risk to consumers or the environment). For example, any projected additional storage requirement can be accommodated by making the second lined dam (i.e. stage 2) larger, or with provision of an above ground storage tank.

The quality of recycled water can also be verified through ongoing monitoring and operations, and this can be adjusted to meet the desired quality. For example, recycled water can be passed back through the treatment facility to achieve further treatment of water quality (e.g. additional removal of phosphorous can be achieved by use of Alum and subsequent settling).

The RWP has itself been designed to include redundancy (e.g. additional capacity in the bioreactor and flow balance tank) and duty/standby of key equipment (e.g. pumps and a diesel-powered generator). These will cater for scheduled maintenance and unscheduled shutdown events. Given the RWP is designed to cater for scheduled maintenance shutdowns/reduced operations, any unscheduled shutdown can also be catered for.

In the unlikely event of a prolonged shutdown, raw sewerage would be pumped out and tankered off-site to a waste receival destination (e.g. via a trade waste agreement to Water Corporation's network) until the unscheduled shutdown event was resolved.

6.5.2.2 Development WSUD

The living streams within the site are proposed primarily as a WSUD approach for the management of stormwater and are discussed in **Section 7.1.6**. The implementation of livings streams will provide a measure of indirect contingency for recycled water irrigation. In line with living stream principles (see **Section 7.1.6**), the landscaping approach to the 60 m corridor (required for heritage purposes) within which the living streams are located will facilitate a vegetated buffer (nominally 5 m - 30 m in width) encompassing the low flow channel. This buffer and selective location of irrigation will prevent any potential spray drift from directly entering receiving the streamlines. The vegetation buffer/green corridors may also provide some uptake of nutrients that may be mobilised in localised runoff if soils are saturated (though irrigation of effluent would not occur if soils are saturated).

The bio-chemical and physical processes occurring within the living streams will provide a polishing effect for stormwater runoff from the site (up to 50% removal of TN and 30% removal of TP) (see **Section 7.1.6**). Any nutrients from recycled water that could potentially be mobilised under extenuating circumstances (e.g. where intense rainfall runoff sheet flows from the site) and enter the waterway will likewise be treated within the living streams.

6.6 Recycled water compliance summary

The manner in which the recycled water system will achieve the recycled water design objectives is summarised in **Table 7**.

Table 7: Recycled water management compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
RW1	Maximise the re-use of recycled water within the site	• Recycled water will be stored onsite to provide water to meet non-potable irrigation needs. • Recycled water will be used to irrigate POS, open spaces and schools.
RW2	All open space long term irrigation requirements to be ultimately met by recycled water	• Initial irrigation demand will be met by onsite surface water dams. • The wastewater recycling system will ultimately provide treated wastewater to meet the irrigation requirements of all open space within the development.
RW3	Open space irrigated areas to use an average of 7,500kL/ha/year	• The actual irrigation rate will vary with rainfall. • The water balance confirms that on average open space will achieve the required irrigation capacity.
RW4	Recycled water will be retained within the site and will not be discharged to the environment	• Water quality from the RWP will be appropriate for long term irrigation of vegetation within the site. • Design and operational contingencies are existing, or can be implemented, within the wastewater management approach and RWP. No discharge is required, even in a 'wet' year scenario. • Additional contingency will be provided by WSUD features (e.g. the living streams), which will provide nutrient removal to any incidental recycled water runoff.

7 Stormwater Management Strategy

The principle behind the stormwater management strategy for the site is to maintain the existing hydrology by treating frequent event runoff at source, matching pre-development flow rates leaving the site and maintaining upstream flows through the site.

Each stormwater management component has been designed to achieve the objectives and criteria stated in **Section 4.2**. The size of some management features has been determined using XPSWMM hydrological modelling. The MAR provided in **Appendix D** presents the detailed methods and assumptions used to develop the model.

The water sensitive urban design (WSUD) approaches utilised include:

- Roadside swales used for conveyance in preference to traditional pipe network. This will occur in all roads adjacent to T1, T2 and T3 areas, and where roads abut open spaces.
- At source treatment within roadside BRAs, provided within roadside swales.
- Tree pits, which will typically be collocated with SEPs in appropriate areas.
- Median BRAs within swales at entry roads to provide additional treatment for suitable catchments.
- Catchment scale BRAs to address treatment requirements where they cannot be achieved at source by roadside or median BRAs. Note there are approximately 50 catchments within the site, which ensures these are as close to source as possible.
- Living stream approaches for the streamlines which convey runoff through and out of the site.
- Retention and use of existing dams within the site to achieve major event runoff detention. This will minimise changes to the existing landform.
- Flood conveyance via minor open swales in preference to a traditional pipe network. These will be either in public open space or private lots, where they will be protected by appropriate easements.
- FSAs will be utilised where runoff cannot be accommodated within the existing site features (dams). These will be located within private lots and protected by easements.

The above WSUD measures are further described in the following sections.

7.1 Development drainage strategy

A number of WSUD strategies will be required to treat frequent event runoff and maintain the pre-development hydrological regime within lots. Drainage strategies are adapted to transect specific drainage requirements. The overall approach for water quality treatment at the site is to retain/detain the 1 EY event from impervious surfaces. Runoff from a 1 EY event will be retained in the context of the storm event, however will actually be detained to discharge over a much longer time period via long vegetated/rocky roadside swales and semi-permeable retention structures. This is consistent with the infiltration losses across the site determined by pre-development flood modelling in **Section 3.5.4**.

7.1.1 Lot drainage strategy

7.1.1.1 Lot soakage

The majority of the site will not be suitable to adopt onsite infiltration as a mandated stormwater retention method. This is due to the low permeability of most onsite clay based soils, shallow laterite and gravel within the soil profile and the minimal amount of site works (and imported fill) proposed to develop the site. Some residents may elect to adopt soakwells to achieve localised amenity outcomes, however these are not mandated and any site storage capacity provided by these is not relied upon by the overall runoff treatment and flood management system.

While onsite soakage is not mandated, the frequent event will still be predominantly retained within development lots due to the large average lot sizes, which result in relatively minor changes in lot imperviousness. Stormwater runoff from development lots in excess of the frequent event will be discharged to road surfaces via overland flow, or sheet flow according to the existing hydrological regime. The retention of runoff from the frequent event on lot will help to achieve **Criteria SW3.**

7.1.1.2 Rainwater harvesting and storage

Lots throughout the development will be encouraged to incorporate rainwater harvesting and storage systems. While it is anticipated that many lot owners will elect to install rainwater tanks, their uptake for T3, T4 and T5 lots will not be mandatory.

Rainwater harvesting and storage systems will be mandated for T2 lots, and will be required to provide at least 10,000 L of rainwater storage. This will substitute the water required for both potable and non-potable uses.

The volume of rainwater harvested at a lot scale has not been accounted for when sizing stormwater infrastructure, as per CoM requirements.

7.1.2 Roadside swales and bio-retention

Roadside swales will be used for conveyance in preference to traditional pipe network, subject to gutter flow depth and width. This will occur in all roads adjacent to T1, T2 and T3 areas and where roads abut open spaces. These carriageways will be typically unkerbed and will use either table drains or roadside conveyance swales.

The exception to this will be where the longitudinal grade exceeds 5%, in which case kerbing and kerb breaks may be used to discharge to swales. Alternatively conveyance via a traditional pit and pipe network may be necessary in order to manage erosion.

The general profile of roadside swales will be up to 0.5 m deep, with 1:4 side slopes adjacent to pavement and 1:3 side slopes adjacent to lots.

Roads which abut T4 and T5 lot areas will be kerbed and stormwater drainage conveyed via a conventional pit and pipe network.

The roadside swales will be treated according to the slope environment and density of adjacent development. Where swales are adjacent to T4 and T5 lots (e.g. where frontage also exists to a POS

or other open space) and where slopes are less than 5% native vegetation may be used to assist in slowing down runoff, to uptake nutrients and to slow down sediments.

Where swales are adjacent to T1, T2 and T3 areas or where the slope is >5% the primary management consideration will be erosion and retarding velocity of flows. For these areas the swales are likely to be rock spawl armoured to provide appropriate erosion protection. Armouring will be un-mortared when possible.

Runoff with the roadside swales will be slowed using permeable rock armoured check dams. This will force runoff to slow, allowing sediments to drop out of suspension and providing an opportunity for nutrients to be taken up by vegetation where present.

While the swales could retain runoff up to a depth of 0.5 m, it has conservatively been assumed that swales only achieve an average depth of 0.3 m, thereby providing 0.285 m^3 per linear metre of swale. This conservative approach allows for losses that may occur due to cross overs and other features, and inefficiencies that may occur due to longitudinal slope.

7.1.3 Tree pits

Tree pits will be utilised adjacent to T4 and T5 areas where a pit and pipe network is used to capture and convey runoff. These will typically be collocated with or will be adjacent to SEPs and will provide capture and treatment of frequent runoff events. Tree-pits provide a minor storage volume individually, however collectively they can assist in achieving infiltration and treatment higher in the catchment, and can help to reduce peak flows leaving the site.

7.1.4 Median bio-retention

The entry roads to the estate (i.e. those from Roland Road) have the opportunity to provide additional treatment via swales located in the median. These roads are 30 m wide and therefore have sufficient room to accommodate a 6 m wide median swale. The median swales will be treated as per roadside swales in that they will be vegetated with native reeds and rushes if slope permits (i.e. <5%). Where the slope exceeds 5% the swales will be reinforced with rock spawls. Permeable check dams will be utilised within the median swales to ensure that the appropriate amount of treatment/storage is provided. The locations of median bio-retention swales are shown on **Figure 6**.

7.1.5 Catchment scale bio-retention areas

To address water quality treatment requirements where they cannot be achieved at source by roadside or median bio-retention swales, BRAs will be adopted at the bottom of each catchment. Note there are approximately 50 catchments within the site, which ensures that even with the use of a BRA at the bottom of some catchments runoff is still addressed at source. Due to the significant volume provided by roadside and median bio-retention swales, there will only be the requirement for six BRAs. The remaining (44) catchments are able to achieve treatment at source within the roadside and median swales or do not require specific water quality treatment measures.

BRAs have been assumed to accommodate an average depth of 0.3 m and they will be vegetated with plant species suitable for the removal of nutrients from surface runoff, consistent with the

Vegetation guidelines for stormwater biofilters in the south-west of Western Australia (Monash University 2014). It is possible that these could achieve up to 0.5 m depth, however a conservative assumption of 0.3 m has been used to account for varied site slope and site conditions likely to be encountered during construction.

The site soils are generally clay based, and it is therefore not proposed to underly BRAs with an additional layer of high phosphorus retention index (PRI) soil or engineered media as the parent soils will achieve this requirement.

BRAs will nominally have 1:3 side slopes, however both the side slopes and depths will be varied at each location to suit localised site constraints to ensure that these integrate well with the adjacent road network and/or POS/open spaces.

The combined capacity of the roadside and median bio-retention swales and the downstream BRAs will meet the requirement to address runoff from the 1 EY event, being the first 15 mm of runoff. This is consistent with the losses experienced at the site under the existing (pre-development) site conditions (as discussed in **Section 3.5.4**). The locations of BRAs are shown in **Figure 6**.

7.1.6 Living Streams

There are up to five existing streamlines which convey runoff through and out of the site. The form of the existing streamlines is generally that of erosion lines at the base of a valley, with some being more incised than others. Vegetation on all streamlines is generally sparse, with the exception of the north-eastern streamline. The streamlines will be retained as living streams within a 60 m wide corridor that will also meet Heritage considerations according to the existing S18 approval under the *Aboriginal Heritage Act 1972*.

The living streams will be designed in consideration of *Living Stream design principles* (DoW 2007) and *Drainage for Liveability* (Water Corporation, 2017 #2183) and with a profile that varies depending on localised topography. They will nominally have 1:3 to 1:4 side slopes and either a V shape or a flat base, which will be up to 1 m wide and will readily convey the 1 EY event runoff. The living stream approach within the site, where appropriate and in consideration of landscaping and civil requirements, will provide a vegetated buffer (nominally 5 m-30 m wide) encompassing the low flow (1 EY) channel. The flow channel/flood plain for minor events and major events up to the 1% AEP will spill out to a wide floodplain that will require 5-10 m width, depending on localised topographical conditions and location in the catchment. The greatest streamline width will be immediately upstream of the central dam and at the central living stream discharge points, where major event flows will be up to 10 m wide. Given the incised nature of the streamlines the 20% AEP and 1% AEP events will occupy similar footprints. A nominal cross section of the living stream which shows the design intent is contained in **Appendix F**.

Living streams will also provide additional 'polishing' treatment for site runoff. The effectiveness of the living stream at removing nutrients has been estimated based on the Infosheet provided in the UNDO tool (DWER 2019), which indicates that a Living Stream could potentially provide up to 50% removal of TN and 30% removal of TP. The locations of living streams are shown in **Figure 6.**

7.1.7 Retention and use of existing dams

The site contains four major dams (North-western, North-eastern, Eastern and Central), all of which retain water following winter. Due to the topography and geotechnical conditions beneath the site there is limited opportunity to create multiple smaller flood storage areas to achieve the required flood detention to detain runoff from the site to pre-development conditions once fully developed. Taking an approach which creates new detention storage would result in multiple small storages which would be highly likely to result in loss of additional native vegetation and additional infrastructure for SoM to maintain. Therefore, it is proposed that the existing dams will be utilised to achieve flood detention storage for the majority of the site. The approach that has been taken with the four dams is to achieve sufficient detention capacity such that there are no additional FSAs required for the catchments which contribute runoff to the key discharge locations from site (i.e. existing streamlines). The existing major dams are shown on **Figure 4**.

The dams will predominantly retain their existing form, however will require installation of discharge culverts at specified elevations and design of overflow weirs to be able to meet pre-development flow conditions leaving the site under the 1 EY, 20% AEP and 1% AEP events. It will also be necessary for the upstream banks of the Northeast dam to be modified to meet surrounding earth contours to ensure that the required storage is achieved. This modification is relatively minor. The Central dam will require repair to the main dam wall, which has been breached in the past. All dams will require detailed design to be undertaken by a structural engineer to ensure structural integrity. The Eastern dam and Northwest dam will require installation of a low flow culvert to ensure that the required amount of flood storage is achieved. The locations of retained dams (FSAs) are shown in **Figure 6**.

A preliminary concept design for the Central dam which shows how the site will achieve the required flood storage and be integrated into the landscape are contained in the landscape concept drawings in **Appendix F**.

It is recognised that consideration should be given to the Interim Position Statement: Constructed Lakes (DoW 2007). The requirements of the Position Statement have been considered, with the context that the dams are existing/retained, and not newly created features. An audit has been undertaken against the Policy, and this is included in **Appendix H**.

7.1.8 Flood conveyance via minor open swales

Roadside swales will be used for the majority of flood conveyance within road reserve, with some sections of pit and pipe network utilised where slope is >5% and/or adjacent to T4 and T5 lots. There are several points along the western and southern boundaries of the site (predominantly along Roland Road) where flood conveyance will need to occur through either public or private land to be able to discharge to the existing catchment low points. The form of these will be minor V-shaped channels, nominal 0.5 m deep with 1:3 side slopes. Some sections may need protection from erosion (e.g. where slopes are >5%), and in these instances local rock spawls will be used to create permeable barriers within the swale to slow down flows and to minimise erosion.

Where located within private land, these will need to be protected via easements to ensure that they will continue to provide the required flood conveyance into the future. The locations of minor swales/flow paths are shown in **Figure 6**.

7.1.9 Flood storage areas

Some catchments will not be able to be directed to the living streams and/or retained dams to achieve flood detention. This is the case for catchments which discharge westwards towards Roland Road and directly south to Brindle Road. For these catchments FSAs will be constructed within private lots and protected by easements. The FSAs will be designed to detain minor and event major runoff, however are not expected to receive significant runoff from frequent runoff events as this will predominantly be accommodated within the upstream roadside swales, median swales and BRAs.

The FSAs have been designed with a nominal depth of 1.2 m and with 1:6 side slopes, however this may need to be varied to meet localised site constraints. FSAs will be integrated with any contour bunding that may be required across steeper lots. The FSAs will be designed as online flood storage, and will overtop via a combination of low flow pipe (to meet frequent/minor event flow requirements) and a weir structure or similar. The design of FSAs has not assumed any infiltration, and the design and capacity of these could be updated based on localised site conditions and site specific infiltration testing. The locations for FSAs are shown on **Figure 6**.

7.2 Flood modelling assessment

The post-development environment (SP34) was modelled using XPSWMM software. The overarching aim of the flood modelling has to appropriately size the water quality treatment structures (roadside bio-retention, median bio-retention, BRAs) to accommodate the 1 EY event, and to size flood detentions structures (dams, FSAs) so that runoff leaving the site in a 1 EY (frequent), 20% AEP (minor) and 1% AEP (major) flood event do not exceed pre-development flow rates.

7.2.1 Post-development catchments

The post-development catchments were based on the structure plan, site topography and preliminary road geometry advised by the project team civil engineers. Catchments within lots are assumed to follow existing landform with the exception of T4 and T5 lots, which will be earthworked to provide relatively flat building parcels and are therefore directed according to road frontage. Post-development catchments are shown in **Figure 7**.

7.2.2 Loss assumptions

The loss assumptions utilised follow those used in the pre-development environment for all areas except T4 and T5 lots. All lots are assumed to have a 300 m^2 roof/hardstand/paved area. A detailed list of assumptions is provided in the MAR contained in **Appendix D**.

7.2.3 Results

The 1 EY (treatment) volumes required and those provided by the proposed structures are summarised in **Table 8**. Note that water quality treatment requirements are only provided for those catchments which need it i.e. catchments which receive runoff from roads, T3, T4 and T5 lots schools, town centre lots and the RWP area. Formal water quality treatment structures are not required or proposed for school pervious areas, T1 areas and T2 lots.

Table 8: 1 EY treatment volumes

Discharge location	Contributing catchment	Storage volume required (m^3)	Roadside swale volume (m^3)	Median swale volume (m^3)	BRA volume (m^3)	BRA surface area (m^2)	Total volume provided (m^3)
Out 1	Ct 5	184	171		13	56	184
Out 2	Ct 7	444	234		210	748	444
	Ct 9	94	171				171
	Ct 10	254	342				342
Out 3	Ct 13	150	150				150
	Ct 14	95	86	40			126
Out 4	Ct 11	195	256				256
	Ct 16	995	370		625	2166	995
	Ct 19	307	307				307
	Ct 21	49	86				86
	Ct 22	136	171				171
	Ct 23	310	370				370
	Ct 24	243	256				256
	Ct 30	144	228				228
	Ct 31	99	228				228
	Ct 32	517	370		147	530	517
	Ct 36	124	171				171
	Ct 37	56	114				114
Out 7	Ct 15	159	143		16	67	159
	Ct 17	555	370	185			555
	Ct 26	467	399	68			467
Out 8	Ct 40	205	157		49	187	206
	Ct 41	353	570				570
	Ct 44	86	142				142

Table 8: 1 EY treatment volumes (continued)

Discharge location	Contributing catchment	Storage volume required (m^3)	Roadside swale volume (m^3)	Median swale volume (m^3)	BRA volume (m^3)	BRA surface area (m^2)	Total volume provided (m^3)
Out 8	Ct 45	237	340				340
	Ct 50	93	142				142
	Ct 52	76	76				76
	Ct 54	28	35				35
Out 10	Ct 29	117	142				142

The flood detention requirements and volumes provided by the various flood detention measures are summarised in **Table 9**. Note that flood detention structures are not required for all catchments for the site to be able to meet the pre-development flow conditions at the key discharge locations.

Table 9: 1% AEP and 20% AEP flood detention volumes and areas

Downstream outlet location	Storage name	Storage volume required (m^3)	20% AEP volume (m^3)	20% AEP surface area (m^2)	20% AEP Maximum depth (m)	1% AEP volume	1% AEP Surface area (m^2)	1% AEP Maximum depth (m)
Out 1	FSA5*	5,100	4,860	5,010	0.44	5,100	5,800	1.0
Out 2	FSA10*	8,000	4,920	6,500	1.05	8,000	8,500	1.5
Out 3	FSA13	1,428	445	1,090	0.49	1428	1,718	1.2
	FSA14	504	145	380	0.55	504	744	1.2
Out 4	FSA30*	25,800	16,700	15,000	3.1	25,800	19,353	4.0
Out 7	FSA15	3,504	1,320	2,820	0.53	3,504	3,730	1.2
	FSA17	6,120	2,720	5,100	0.59	6,120	6,161	1.2
	FSA26	5,280	2,270	4,360	0.58	5,280	5,388	1.2
Out 8	FSA50*	11,500	4,100	11,000	0.40	11,500	15,000	1.0
Out 10	FSA29	840	455	815	0.80	780	1,047	1.2

**flood storage achieved in existing dam*

Note that all dam storage volumes and depths indicated in **Table 9** are based on an assumed existing top water level within the dams that would be maintained by installation of the discharge culverts (see **Appendix D** for further dam design assumptions). All dams could potentially provide further storage if the assumed existing top water level were to be lowered, thereby providing significant flexibility in design for future stages.

Note also that FSA 17 (while modelled as a single storage area) will be split in to seven to eight smaller storage FSAs distributed evenly between the relevant T2 lots. This is to avoid a single large storage that will be difficult to construct on this sloped part of the site. Further, a single large storage

would also result in loss of additional vegetation and spreading the required detention volume provides the opportunity to maximise vegetation retention along Roland Road.

The peak flow rates leaving the site will not exceed pre-development peak flow rates. A summary of the critical control points/key discharge locations is provided in **Table 10**.

Table 10: Post-development peak flow rates at critical control points/key discharge locations

Critical control point	20% AEP		1% AEP	
	Pre-development	Post -Development	Pre-development	Post -Development
Out 1	1.03	1.02	2.81	2.80
Out 2	2.19	2.15	6.34	6.21
Out 3	0.27	0.28	0.74	0.72
Out 4	2.70	2.67	7.30	7.27
Out 7	1.48	1.35	3.60	3.62
Out 8	3.33	3.32	10.57	10.64
Out 10	0.56	0.50	1.31	1.30

As shown in **Table 10**, the post-development peak flows are consistent with the pre-development flow regime, and therefore the hydrology of the streamlines and downstream catchments will be maintained.

7.3 Non-structural water quality 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 2007). Non-structural measures that will be implemented within the site include:

- Use of natural site grades and features to create water management features, which are already stabilised and will involve less ongoing maintenance.
- Regular maintenance of WSUD features, in particular to remove sediments and to repair any erosion which may occur after rainfall events.
- Minimising fertiliser use to establish and maintain vegetation within landscaped areas.
- Active and ongoing measurement of leaf and tissue samples to guide the application of any additional nutrients to POS and open spaces.
- Drought tolerant plant species that require minimal water and nutrients will be used.

7.4 Stormwater criteria compliance summary

The proposed stormwater design criteria and how these are addressed are summarised in **Table 11**.

Table 11: Stormwater management compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
SW1	Major event post-development peak flow rates leaving the site should be equal to or less than pre-development peak flow rates	• Roadside swales, median swales and BRAs will provide significant retention/detention storage for frequent events and will contribute to peak flow management in major events. • Flood detention will be achieved by using capacity of onsite dams with the addition of controlled outlet structures. • FSAs will be constructed to detain runoff from catchments which cannot discharge to one of the existing dams. FSAs will be within private property and protected by easements.
SW2	Flood detention to achieve pre-development discharge rates should occur as high in the catchment as practical	• Roadside swales will provide flood detention at source, minimising the need for traditional pipe networks. • Existing dams will be utilised, which will detain runoff from immediately adjacent and upstream catchments. • Catchment areas are generally relatively small, and FSAs will be located at the nearest practicable downstream location.
SW3	Frequent event runoff should be treated at source, or as close to source as practical. This may include detention at source and/or additional treatment if appropriate	• Roadside swales provide water quality treatment at source, minimising downstream water quality treatment. • Median swales provide water quality treatment at source. • Bio-retention areas will be used in catchments where full treatment of the 1 EY event cannot be achieved at source. • Living Stream approach will be used to convey initially treated runoff within the site.
SW4	Water quality treatment structures to be sized to detain and/or retain the first 15 mm from directly connected impervious areas	• Combined capacity of roadside swales, median swales and BRAs are sufficient to detain and/or retain the first 15 mm. • Living stream approaches used for onsite streamlines, providing addition water quality treatment prior to discharge.
SW5	Sediment control and erosion protection to be incorporated in to road reserves and water quality treatment structures	• Roadside swales, median swales and BRAs will utilise mortared and/or loose rock spawls at entry and exit points (using local laterite materials) • Roadside and median swales on slopes >5% will utilise rock armoured intermediate weirs to slow down flow, control erosion and to drop out any mobilised sediments
SW6	Road drainage network to be designed to accommodate the minor event	• The roadside swales will convey minor event runoff. • Where required (i.e. adjacent to T4 and T5 lots or where slope >5%) pit and pipe network may be utilised, and will be designed to convey the minor event.

8 Groundwater Management Strategy

8.1 Groundwater level management

The primary objective for groundwater level management is to ensure that finished floor levels have appropriate clearance from any localised rise of perched groundwater (i.e. saturated shallow soil profile, which is not true groundwater/aquifer) (see **Section 3.6**). This will be achieved with a combination of fill and subsoil drains to maintain clearances and control potential rise of groundwater to ensure that flooding of properties and infrastructure does not occur.

8.1.1 Subsoil drains

Subsoil drains may be utilised in some sections of road reserve to ensure pavement integrity and to control the rise of groundwater beneath T4 and T5 lots. Groundwater can be expected to mound approximately 0.7 m -0.8 m at the back of lots where lots are up to 30 m deep, depending on the localised extent and depth of rock in the underlying soil profile and the permeability of fill utilised. Given that T4 and T5 lots will not have soakwells mandated the creation of saturated soil conditions beneath these lots is unlikely, and the estimate provided above is therefore very conservative. Where subsoil drains are required, these would be set no lower than the shallow low permeability (rock) layer, and finished lot levels would be set at least 1.2 m above the subsoil drain invert levels. Subsoil drains are to be discharged via a free draining outlet to an appropriate water quality treatment structure.

Subsoil drains may also be required beneath some portions of roadside swales, tree pits or BRAs to ensure that these can dry out before the next storm event. This is not expected to be required as a wholescale measure, rather it is identified now as a small scale and localised potential measure that could be used to ensure the continued functionality of stormwater management infrastructure.

Subsoil drains are not proposed to control localised soil saturation beneath the remainder of the development.

8.1.2 Imported fill and earthworks

The development of the site will not be taking a broadscale cut to fill approach. There may be some deep ripping of localised soils beneath T4 and T5 lots, and some measure of imported permeable fill will likely be used for these lots. It is anticipated that the average depth of deep ripping will be 0.5 m, and the average fill depth may be 0.5 m, both dependent on localised soil conditions (which vary significantly across the site). The aim of the combined earthworks and fill approach will be to provide T4 and T5 lots with a minimum 1.0 m ripped/permeable soil profile that has been created to facilitate lot-scale construction.

Building footprints within T2 and T3 lots may also require similar treatment to the above, however this will not be undertaken by the developer, and will be the responsibility of each lot owner at time of house construction.

8.2 Groundwater criteria compliance summary

A summary of the proposed groundwater quantity design criteria and how these are addressed within the site is provided in **Table 12**.

Table 12: Groundwater criteria compliance summary

Criteria number	Criteria description	Manner in which compliance will be achieved
GW1	Where utilised, subsoil drains are to be set at or above the low permeability soil layer.	• Subsoil drains may be utilised in road reserve, beneath T4 and T5 lots or to ensure WSUD features remain dry in between rainfall events. • Where utilised, subsoil drains will be set at or above the underlying low permeability (rock or impermeable clays) layer.
GW2	Finished lot levels are to be at least 1.2 m above the CGL formed by the invert of subsoil drains.	• Where subsoil drains are used, deep ripped soil, and/or imported fill will provide finished lot levels with at least 1.2 m clearance from the CGL.
GW3	Subsoil drains to be discharged via a free draining outlet to an appropriate water quality treatment structure.	• Subsoil drainage will be constructed such that intercepted water will freely drain to a discharge location (e.g. through appropriate grading and via the invert being at least 150 mm above the receiving environment). • Groundwater will be treated by discharging intercepted water into treatment structures (i.e. swales or BRAs), or by providing treatment prior the water entering the drain (e.g. by constructing pipes in filter media).
GW4	Soil profile beneath T4 and T5 lots to be deep ripped/filled to a minimum depth of 1.0 m.	• The soil profile beneath T4/T5 lots will be deep ripped to an approximate depth of 0.4-0.6 m. • T4/T5 lots will be filled with permeable material to an approximate depth or 0.4-0.6 m to ensure a minimum profile of 1.0 m of ripped/filled soil.

9 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 2008).

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

- Which WSUD measures will be implemented in the subdivision area
- Design specifications for WSUD measures
- Retention and design of farm dams
- Temporary irrigation measures
- Imported fill and subsoil drainage specifications and requirements
- Recycled water management approach update
- Nutrient and Irrigation Management Plan
- Non-structural water quality improvement measures
- Vegetation retention
- Management and maintenance requirements
- Construction period management strategy
- Monitoring and evaluation program.

These are further detailed in the following sections.

9.1 Selection of WSUD measures specific to subdivision

The incorporation of any of the WSUD measures presented in this LWMS or additional measures are required to display compliance to the criteria specified in this LWMS and applicable SoM requirements. The site is significantly varied in terms of topography and geotechnical conditions. These will dictate which WSUD measures may be able to be utilised in the relevant subdivision area. The selection of WSUD measures will follow the guidance of this LWMS, however it is expected that their adoption across the site may vary as successive stages and subdivision areas seek to improve the WSUD outcomes for the site. The UWMP should include the rationale for these and any detailed design considerations.

9.2 Design specification for WSUD measures

The WSUD measures discussed in **Section 7.1** will require further spatial, design and landscape specification and incorporation of any planning updates within future UWMPs. The initial designs for WSUD features will be provided in the first UWMP, however it is expected that these may evolve

based on experience implementing these on the site. The supportive design calculations and rationale for any design changes should be fully explained and contained within the future UWMPs.

The living streams will be central WSUD features that will be the central green spine of the development water management system. They are generally located centrally within the 60 m streamline corridors set aside (though the corridors are wider than 60 m at some points). While conceptual designs have been provided for key POS areas and the living streams (see **Appendix F**) these will be further developed at future stages. The future design will consider requirements of the Shire of Mundaring, DWER and DBCA (e.g. no direct connection of turf to the waterways and setback of irrigation outlets from waterways). Where available these updates will be included within the relevant UWMP.

Any specific monitoring and maintenance requirements for WSUD measures are to be provided within the relevant UWMP.

9.3 Subsoil drain design details

As discussed previously, groundwater rise beneath earthworked portions of lot areas (T4 and T5 only if earthworked) is to be controlled by use of subsoil drains to meet IPWEA guideline clearances. Future UWMPs will provide detailed earthwork and subsoil drainage drawings to demonstrate that the required protection is achieved. These will be specific to each subdivision area due to the variance in topography, soil conditions and proposed lot product, and design details and supportive modelling should be provided in the UWMP where relevant.

9.4 Retention and design of farm dams

The proposed retention of existing farm drains will require a number of design considerations, including safety in design, structural stability, ongoing maintenance requirements, etc. The design of each dam structure should be fully explored in the relevant UWMP that will require development of one of the dams. The most attention will most likely be required for the central dam as this has the largest catchment and the greatest depth.

9.5 Temporary irrigation measures

The water balance described in this LWMS is based on the ultimate development of the site. This may take some years to achieve, and POS establishment for individual stages is likely to occur prior to dwelling construction. Until the RWP has sufficient catchment inflows (or wastewater) there may not be sufficient treated water to irrigate all open space areas.

As a temporary approach it is envisaged that the surface water dams may be utilised to capture runoff from within the site and that this would be utilised to meet irrigation demand. The extent of this is unknown as the staging of subdivision and construction is yet to be determined. If surface water from within the site is proposed to meet temporary irrigation requirements, the UWMP will

need to demonstrate via appropriate water balance analysis that the irrigation needs of the development can be met.

9.6 Imported fill specifications and requirements

The requirement for imported fill will vary across the site, depending on the localised site conditions and the lot product being delivered within the subdivision area. This will also be the case for subsoil drains as described in **Section 9.3**. It is expected that the future UWMP will assess the requirement for imported fill and will provide designs and calculations/modelling to justify the depth of imported fill being proposed.

9.7 Recycled water management approach update

The recycled wastewater management approach is discussed **Section 6.5**. Some aspects of the approach are to be confirmed as the design of the system progresses. This is an intentional approach which allows for the adaptation of design and/or processes to account for any required updates following ongoing monitoring. Monitoring is discussed in **Section 10.2.3**.

An update on the recycled wastewater management approach (including the processes, design and contingencies proposed for the RWP) will be provided in a future UWMP. This update will demonstrate compliance with the relevant guidelines and policies (see **Section 1.3**).

9.8 Nutrient and Irrigation Management Plan

Where irrigation of nutrient rich recycled water is proposed, a Nutrient and Irrigation Management Plan (NIMP) may be required. The purpose of a NIMP is to minimise the probability of environmental impact by assessing the factors such as soil properties in irrigation areas, recycled water nutrient concentrations and nutrient management practices. Guidance on preparing a NIMP is provided in the *Guidelines for the non-potable uses of recycled water in Western Australia* (DoH 2011). The NIMP will be provided when and will address the possibility of algal growth within the RWP storage dams.

9.9 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 2007).

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 drainage reserves. It is expected that the future UWMPs will provide a schedule of management and maintenance actions including timing and responsible parties.

9.10 Vegetation retention

Any existing native trees or vegetation proposed to be retained throughout development (e.g. verge trees or those within private lots) will be identified in the landscape designs that will accompany a future UWMP. The UWMP will also describe how these assets will be protected during development of the site.

9.11 Management and maintenance requirements

The management measures to be implemented to address surface water quality, such as the use of vegetation within median swales, BRAs and FSAs will require ongoing maintenance.

It is expected that the future UWMPs will set out maintenance actions (e.g. gross pollutant removal), timing (e.g. how often it will occur), locations (e.g. exactly where it will occur) and responsibilities (e.g. who will be responsible for carrying out the actions).

The future UWMP will set out ongoing management and maintenance responsibilities.

9.12 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, sediment, erosion etc.). The management measures undertaken for construction management will be addressed either in the future UWMPs or a separate Construction Management Plan.

9.13 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 handover to the SoM. 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 10** of this LWMS and will be further detailed at the UWMP stage.

10 Monitoring and Maintenance

10.1 Management and maintenance

The overall condition of developed stages 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. While two years is proposed per subdivision area, in reality, due to the long term staging anticipated, it is likely that post-development monitoring of open space condition will be ongoing, and will conclude nominally two years after the last POS area has been delivered.

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:

- Gross pollutants
- Terrestrial weeds
- Irrigation
- Vegetation density
- Paths, walkways and other infrastructure.

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

10.2 Water quality monitoring

10.2.1 Surface water monitoring

Annual water quality monitoring will be undertaken and will initially be tied to the relevant UWMP/subdivision area. However, in the longer term the monitoring will need to be undertaken as a part of the operating licence conditions of the RWP.

The indicative proposed locations for surface water monitoring are shown in **Figure 7** and have been selected to provide an indication of the effects of the development on water quality leaving the site.

Post development water quality monitoring will be conducted on a quarterly basis. A summary of the post-development monitoring program is shown in **Table 13**. The post-development monitoring will be conducted for two years post construction of the final stages of development.

Table 13: Surface water monitoring program summary

Monitoring Type	Locations	Frequency	Parameters
Surface Water	Upstream inflows and downstream discharge points at the boundary of the site	• Five times per year. • Weekly when recycled water being discharged.	*In situ* pH, EC, temperature. *Lab analysis* TSS, TN, TKN, NH_4, NO_X, TP, FRP.

An upstream-downstream comparison for surface water across the site is proposed to confirm that the water treatment infrastructure is performing as intended.

10.2.2 Post-development trigger values

Water quality targets have been identified in consideration of the surface water quality monitoring carried out across the site. Short term trigger values have been determined using the pre-development monitoring locations and in consideration of the *NWQMS* (ANZECC and ARMCANZ 2000), whichever is higher. The trigger criteria proposed are shown in **Table 14** with TN and TP values representative of the mean pre-development values discussed in **Section 3** and the default trigger values expected for downstream environments.

Table 14: Short term water quality trigger values

Location	Analyte	
	TN (mg/L)	TP (mg/L)
Northwest Dam outlet (Out 1)	1.0	0.065
Northeast Dam outlet (Out 2)	2.0	0.065
Central Dam outlet	3.7	0.07
Eastern Dam outlet	3.0	0.065
Roland Road north (Out 3)	3.7	0.065
Roland Road south (Out 7)	3.7	0.065
Central southern living stream (Out 4)	3.7	0.07
Eastern living stream (Out 8)	3.0	0.065

While trigger values have been defined in **Table 14**, the water quality data shows some measure of temporal variability. Furthermore, the high levels of measured TN is expected to be attributable to current land use practises, which are proposed to be discontinued. It is therefore proposed that the post-development trigger values provided in **Table 14** are dynamic and short term values. These values should be reviewed and updated with the results of continued pre-development surface water quality monitoring and in consultation with DWER. This will be documented within future UWMPs.

Long term water quality trigger values will be determined in consultation with DWER and SoM, these values are expected to be closer to ANZECC default trigger values (ANZECC and ARMCANZ 2000).

10.2.3 Recycled water plant monitoring

The RWP will have separate and additional monitoring requirements in accordance with its ERA licence and the Prescribed Premises Licence. The monitoring and reporting requirements for the RWP are yet to be developed, however these will be detailed in future works approval applications and ongoing management documentation specific to the operation of the RWP. It is envisaged that

the approval process for the ERA and Prescribed Premises Licence will run concurrent with the SP34 assessment process.

The monitoring and reporting commitments for the RWP will be summarised in future UWMPs as relevant. It should be noted that the monitoring proposed in this LWMS is that which relates to urban water management and open space management, and is not intended to address the monitoring requirements for the RWP and processes therein.

10.3 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.

10.3.1 Operational 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 implemented.

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. Incoming nutrient concentrations will be taken either at the inlet to the site or at the top end of the living streams to provide an indication of nutrients that may exported from POS areas.

The secondary trigger to implement a contingency action will be if the downstream concentration of the above parameters is greater than 20% higher than the upstream concentration.

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

- Compare monitoring results with ongoing water quality data from the RWP.
- Review nutrient application practices to identify source if possible.
- Conduct surveillance of subdivision area to determine any other potential and obvious nutrient inputs, including within lot treatment structures.
- 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 (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 SoM to determine if the trigger values should be revised.

If the upstream (incoming) water quality within the site is >20% higher than the downstream/discharge location nutrient concentrations, the need for additional treatment of

relevant parameters (most likely TP) within the RWP will be assessed. If it is determined that additional treatment is warranted this can be achieved by further processing within the RWP.

10.3.2 Recycled water contingency actions

Should it be determined that there is the potential for nutrients from recycled water to contribute to the environment (indirectly), there are a number of contingencies that can be implemented. It is expected that any contingency would be a temporary measure, to be utilised until the cause or source of the water quality breach can be resolved or otherwise remedied. The contingency measures are discussed in **Section 6.5.2**. These include operational measures designed to prevent any occurrence of plant failure or consequential pollution event; such as progressive implementation, continuous monitoring and backup systems. Actionable measures may include provision of additional storage, retreatment within the RWP, further treatment using chemical processes (e.g, Alum dosing) or removing wastewater from the site via tankers. The actual contingency response will be determined in response to the identified fault or cause of nutrient discharge.

10.4 Reporting

A post-development monitoring report will be prepared annually, and will be made available to the SoM, DWER and DBCA on request.

The proponent will be responsible for post-development monitoring activities over a two year period following construction. As indicated, this is anticipated to result in ongoing monitoring which aligns with the staging of the project, and importantly with the delivery of open space areas and water quality treatment structures. The actual monitoring period will be dependent on the progression of the overall development. It is expected that the development (and therefore the overall monitoring period) will occur over a period in excess of 10 years, and that open space areas will be monitored for at least two years post-construction. Monitoring of open spaces may therefore occur over a much longer timeframe (i.e. for the construction life of the project plus two years).

If the overall management objectives are not met during the monitoring period, the proponent will undertake a review of the system to determine why the objectives are not being met. On completion of the review, the SoM and proponent are to agree on the recommended course of action(s) to be undertaken by the proponent to ensure the objectives are met to the satisfaction of the SoM.

11 Implementation

The LWMS is a key supportive document for the Stoneville SP34. 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.

11.1 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 SoM. The responsibility for working within the framework established within the LWMS rests with the proponent. It is anticipated that future UWMPs will be developed in consultation with the SoM and DWER, will consider the requirements of ERA and will consider other relevant policies and documents. A summary of the key responsibilities for major future stages/actions is provided in **Table 15**.

Table 15: Roles and responsibilities

Management/design element	Location	Timing for commencement	Duration	Responsibility
Subdivision design in compliance with LWMS	Entire Estate	At time of subdivision	During subdivision design and development	Proponent
Construction and maintenance of RWP	RWP location	On commencement of construction	Permanent ongoing	Water West
Construction of estate scale WSUD measures	Entire estate	At time of subdivision	During subdivision design and development	Proponent
Construction and implementation of retained dams	Existing dam locations	When catchments which require flood detention from a dam	During subdivision design and development	Proponent
Maintenance of estate scale WSUD measures	Road reserves	Immediately following road construction	Until practical completion	Proponent, thereafter SoM
	POS and other open spaces	Immediately following POS/open space landscaping	Two years from completion of landscaping	Proponent, thereafter SoM
Maintenance of retained dams	Existing dam locations	Immediately following dam construction	Permanent ongoing, until last contributing catchment has been developed	Proponent while constructing catchments which discharge to dams, SoM thereafter
Construction of estate scale conveyance swales and FSAs	Within T2 lots	When relevant catchments require swales and flood detention	During subdivision design and development	Proponent

Management/design element	Location	Timing for commencement	Duration	Responsibility
Maintenance of swales and FSAs within easements	Within T2 lots	Following construction	Permanent ongoing	Proponent
Implementation and maintenance of in-lot water supply and conservation measures	T2, T3, T4 & T5 areas	At time of house construction	Permanent ongoing	Lot owner

11.2 Funding

Estate scale drainage infrastructure is to be funded by the proponent. This will include construction of swales and FSAs within T2 lots, which will be maintained in the future by SoM. The implementation of the remaining drainage infrastructure is to be funded by the relevant landholder. Funding for lot drainage infrastructure (i.e. soakwells) will be the responsibility of the lot owner. Funding for drainage infrastructure within the school sites will be provided by the future school operator.

11.3 Review

It is not anticipated that this LWMS will be reviewed, unless SP34 undergoes significant change post-lodgement/approval of the LWMS. If the SP34 is substantially modified, surface runoff modelling undertaken for this LWMS will need to be reviewed and the criteria proposed revised to ensure that all are still appropriate.

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 9**, the UWMP will address:

- Compliance with design objectives within the LWMS.
- Detailed stormwater 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 SoM through policy (or modification of these where necessary), building licence or awareness programs.

12 References

12.1 General references

Australian Bureau of Statistics (ABS) 2004, 1367.5 - Western Australian Statistical Indicators, Canberra.

Australian Bureau of Statistics (ABS) 2009, Population and Household Characteristics, Canberra.

Australian Bureau of Statistics (ABS) 2010, 4602.0.55.003 - Environmental Issues: Water Use and Conservation, Canberra.

Australian and New Zealand Environment and Conservation Council (ANZECC) 2000, Australia and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy Australian and New Zealand Environment and Conservation Council.

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ) 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy, Commonwealth of Australia, Canberra.

Department of Health (DoH) 2011, Guidelines for the non-potable uses of recycled water in Western Australia, Government of Western Australia, Perth.

Department of Planning (DoP) 2016, Draft Government Sewerage Policy, Perth, Western Australia.

Department of Water (DoW) 2007, Stormwater Management Manual for Western Australia, Perth.

Department of Water (DoW) 2008, Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions, Perth.

Department of Water and Environmental Regulation (DWER) 2017, Decision Process for Stormwater Management in Western Australia, Government of Western Australia, Perth.

Engineers Australia 2006, Australian Runoff Quality: A guide to Water Sensitive Urban Design, National Committee for Water Engineering, Engineers Australia, Canberra.

Engineers Australia 2016, Australian Rainfall and Runoff, National Committee for Water Engineering, Canberra.

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

Galt Geotechnics 2017a, Preliminary Geotechnical Study - Proposed Stoneville Project, Lot 48 Roland Road, Stoneville.

Galt Geotechnics 2017b, Supplementary Geotechnical Study - Proposed Stoneville Project, Lot 48 Roland Road, Stoneville.

Monash University 2014, Vegetation Guidelines for Stormwater Biofilters within South-west of Western Australia Melbourne.

Smurthwaite, A. J. 1986, Mundaring Part Sheets 2134 II and 2134 III, Perth Metropolitan Region, Environmental Geology Series, Geological Survey of Western Australia, Perth.

Western Australian Planning Commission (WAPC) 2006, State Planning Policy 2.9: Water Resources, Gazetted in December 2006. Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WAPC) 2007, Liveable Neighbourhoods (Edition 4), Western Australian Planning Commission and Department for Planning and Infrastructure, Perth.

Western Australian Planning Commission (WAPC) 2008, Better Urban Water Management, Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WAPC) 2015, Draft Liveable Neighbourhoods, Department of Planning, Perth.

Water West 2019, North Stoneville Wastewater Servicing Concept Design Assessment.

12.2 Online references

Bureau of Meteorology (BoM) 2018, *Climate Data Online,* viewed 17 July 2018*,* Available from: <http://www.bom.gov.au/climate/data/>.

Department of Water and Environment Regulation (DWER) 2019, *UNDO tool*, accessed May 2019, <http://www.water.wa.gov.au/planning-for-the-future/water-and-land-use-planning/undo-tool>.

Figures

Figure 1: Site Location

Figure 2: Topography

Figure 3: Geological Mapping

Figure 4: Hydrological Features

Figure 5: Pre-development Catchment and Land Uses

Figure 6: Stormwater Management Plan

Figure 7: Post-development Catchments, Detention Storage and Discharge Characteristics

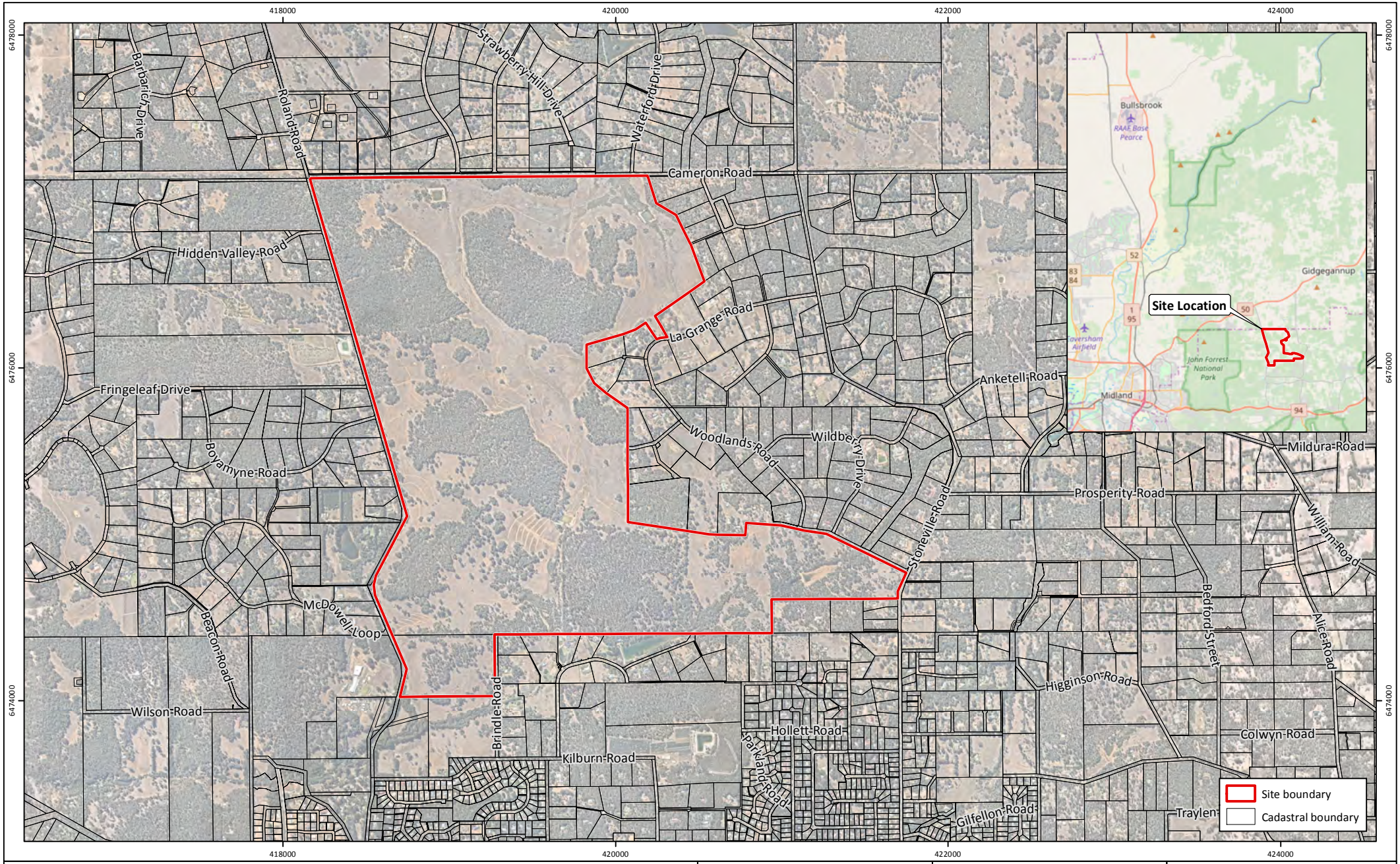

Figure 1: Site Location

Project:	Local Water Management Strategy North Stoneville SP34
Client:	Satterley

Plan Number:
EP17-013(01)--F03a

Drawn:	KNM
Date:	31/05/2019
Checked:	MGB
Approved:	DPC
Date:	31/05/2019

N

0 500 1,000
Metres

Scale: 1:30,000@A4

GDA 1994 MGA Zone 50

emerge ASSOCIATES

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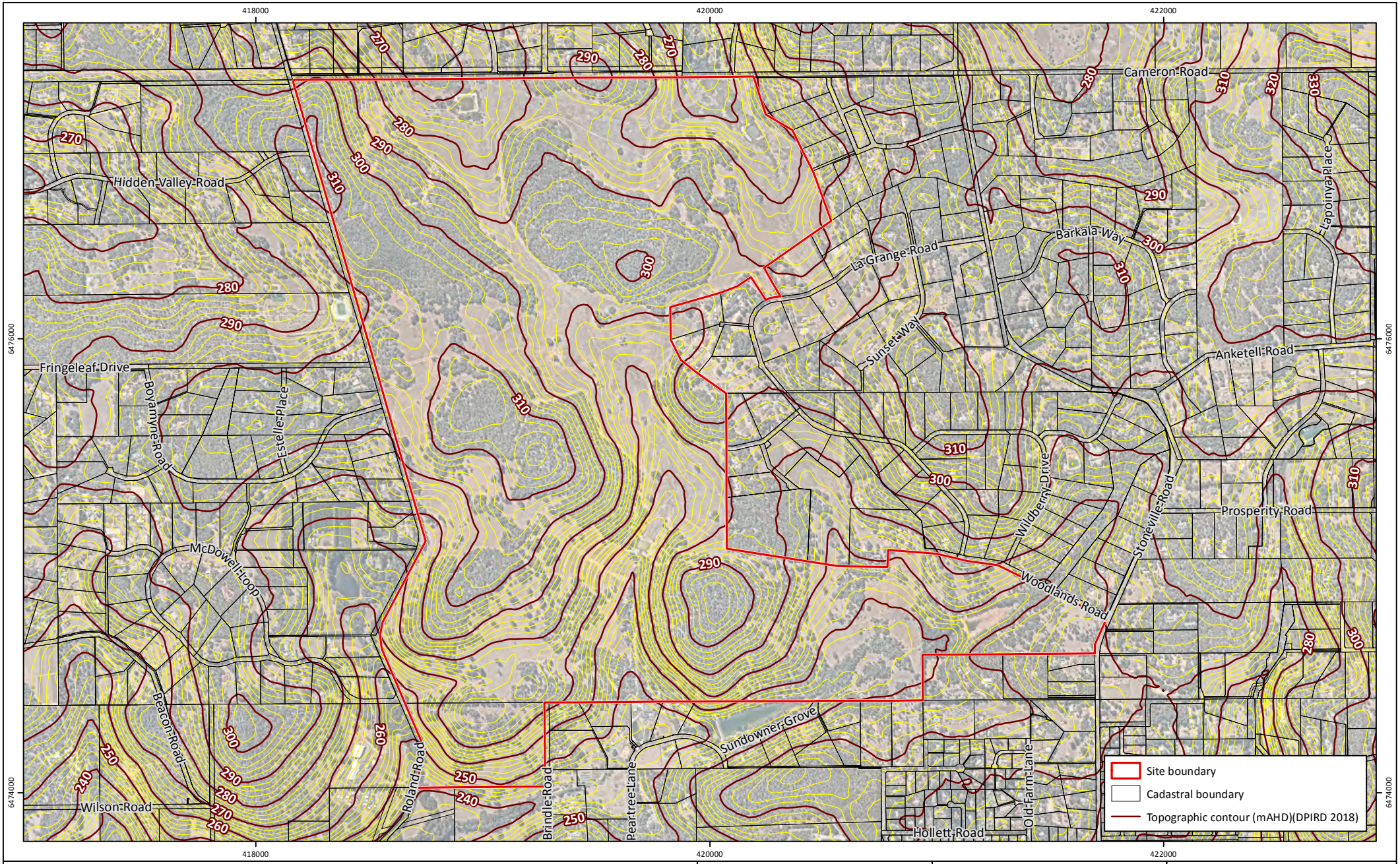

Figure 2: Topography

Project:	Local Water Management Strategy North Stoneville SP34
Client:	Satterley

Plan Number:
EP17-013(01)--F04a

Drawn:	KNM
Date:	31/05/2019
Checked:	MGB
Approved:	DPC
Date:	31/05/2019

N

0 200 400 600
Metres

Scale: 1:22,000@A4

GDA 1994 MGA Zone 50

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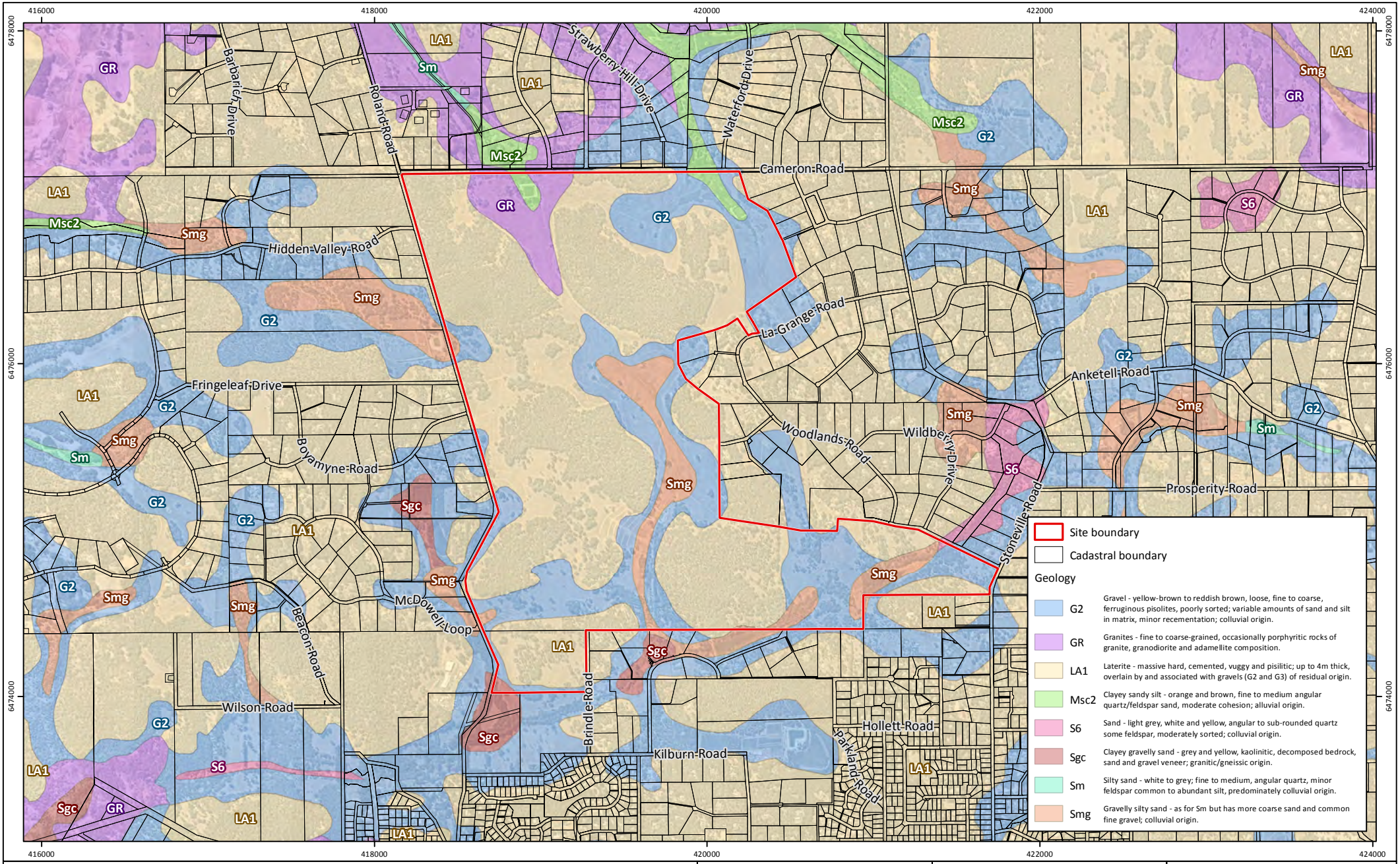

Figure 3: Geological Mapping

Project: Local Water Management Strategy
North Stoneville SP34

Client: Satterley

Plan Number:
EP17-013(01)--F05a

Drawn:	KNM
Date:	31/05/2019
Checked:	MGB
Approved:	DPC
Date:	31/05/2019

N

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Metres

Scale: 1:30,000@A4

GDA 1994 MGA Zone 50

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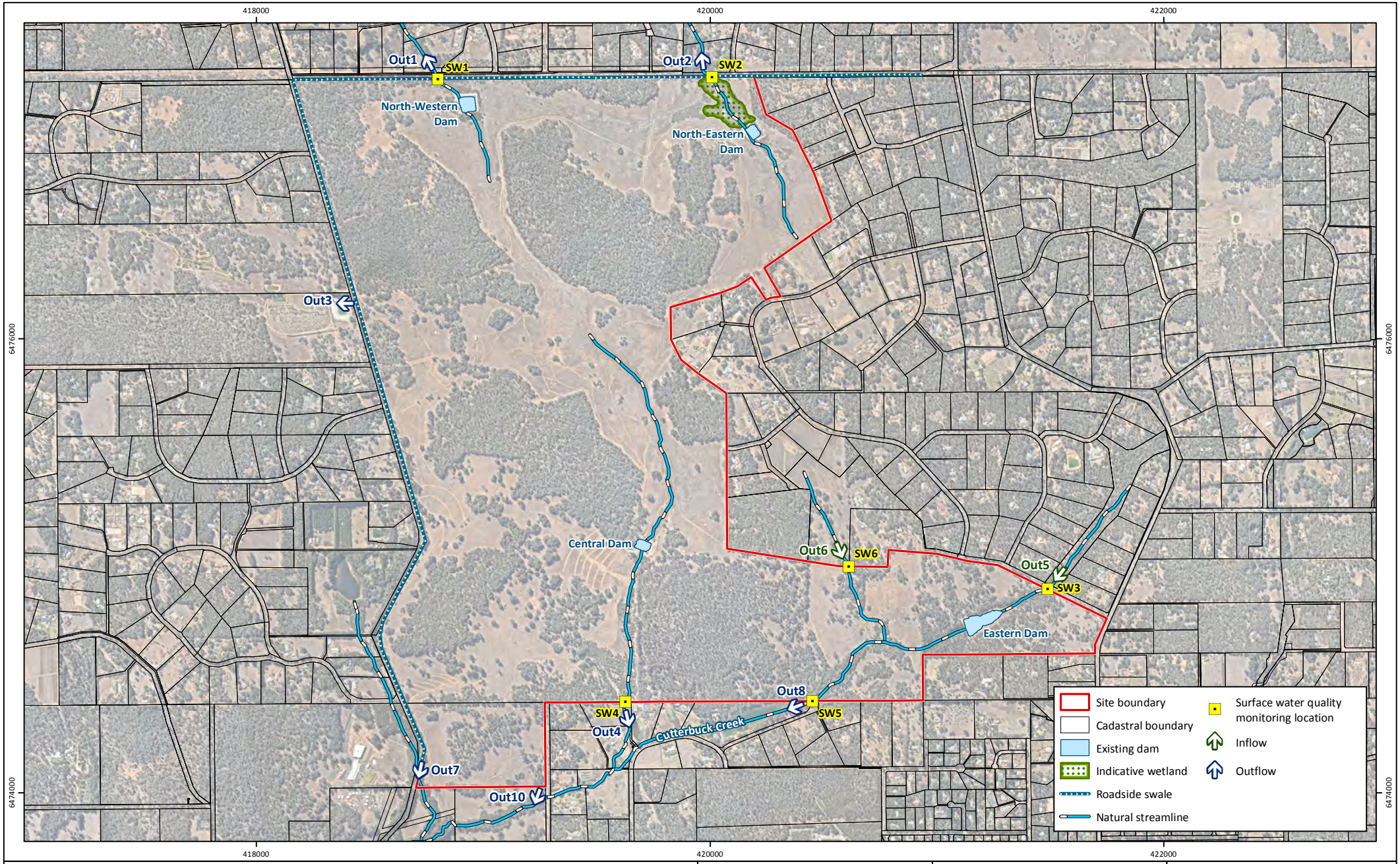

Figure 4: Hydrological Features

Project: Local Water Management Strategy
North Stoneville SP34

Client: Satterley

Plan Number:
EP17-013(01)--F06a

Drawn:	KNM
Date:	31/05/2019
Checked:	MGB
Approved:	DPC
Date:	31/05/2019

N

0 200 400 600
Metres

Scale: 1:22,000@A4

GDA 1994 MGA Zone 50

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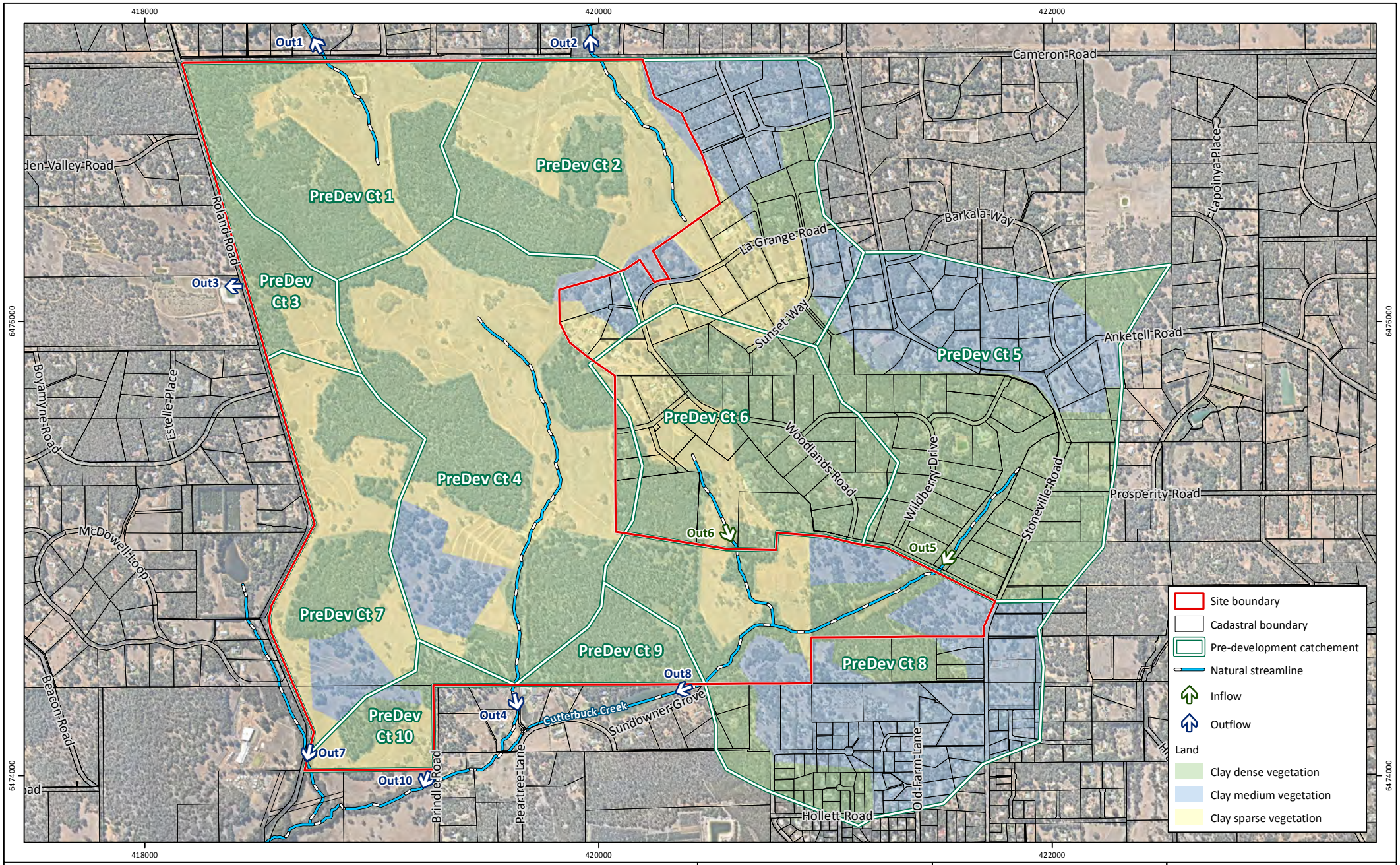

Figure 5: Pre-development Catchments and Land Uses

Project:	Local Water Management Strategy North Stoneville SP34
Client:	Satterley

Plan Number:
EP17-013(01)--F07a

Drawn:	KNM
Date:	31/05/2019
Checked:	MGB
Approved:	DPC
Date:	31/05/2019

Scale: 1:22,000@A4

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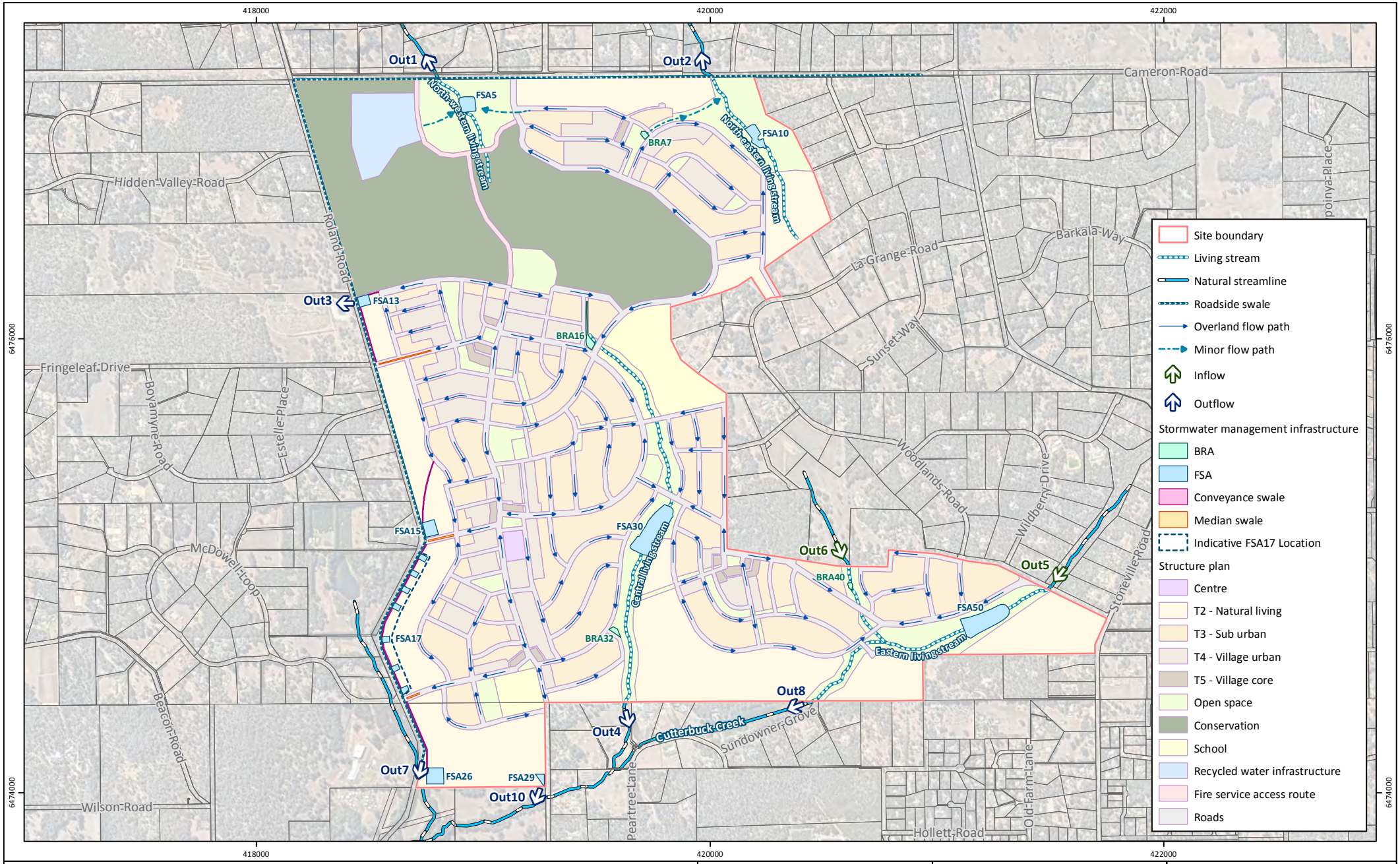

Figure 6: Stormwater Management Plan

Project:	Local Water Management Strategy North Stoneville SP34
Client:	Satterley

Plan Number:
EP17-013(01)--F08a

Drawn:	KNM
Date:	31/05/2019
Checked:	MGB
Approved:	DPC
Date:	31/05/2019

N

0 200 400 600
Metres

Scale: 1:22,000@A4

GDA 1994 MGA Zone 50

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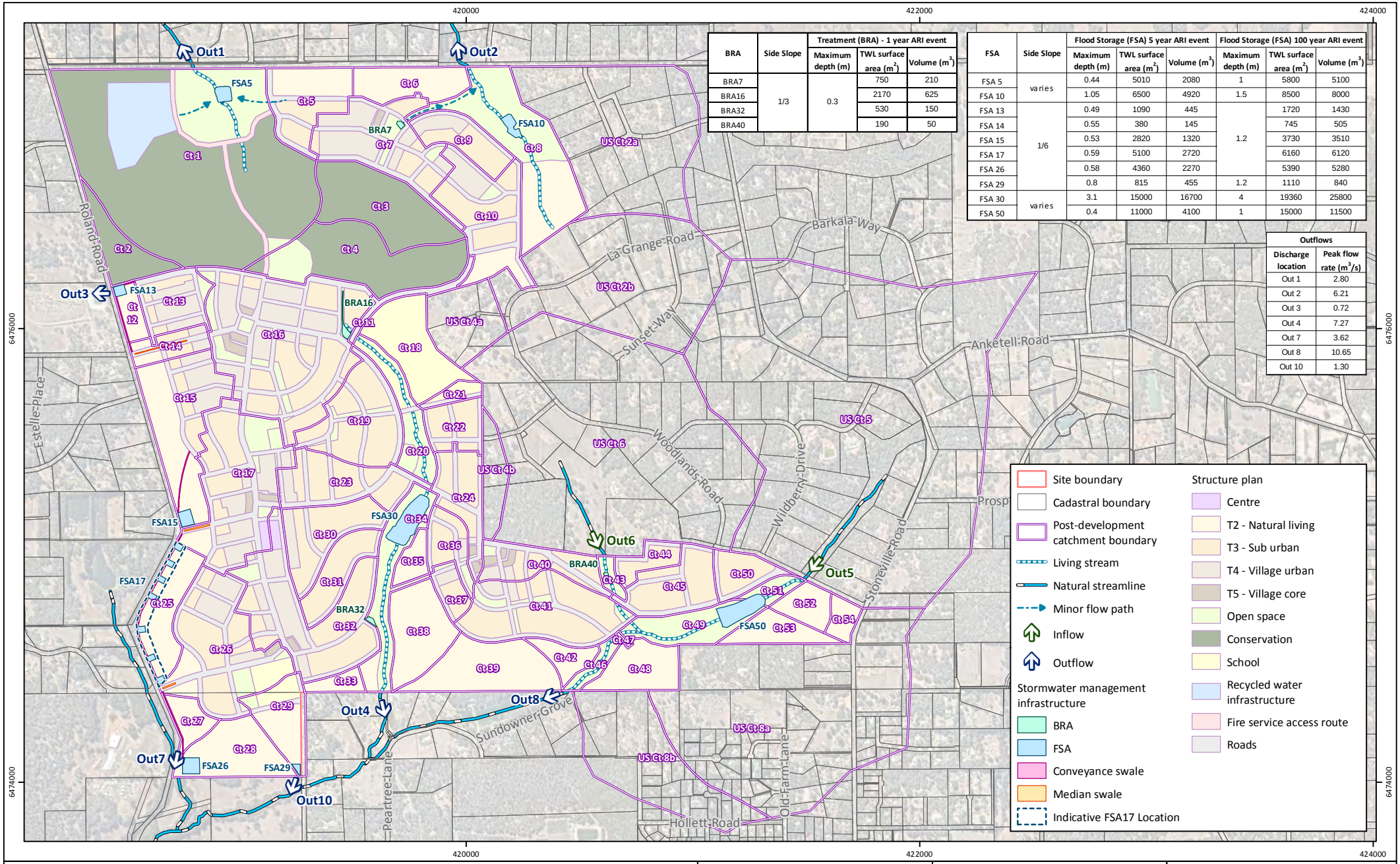
While Emerge Associates makes every attempt to ensure the accuracy and completeness of data, Emerge accepts no responsibility for externally sourced data used



BRA	Side Slope	Treatment (BRA) - 1 year ARI event		
		Maximum depth (m)	TWL surface area (m^2)	Volume (m^3)
BRA7	1/3	0.3	750	210
BRA16			2170	625
BRA32			530	150
BRA40			190	50

FSA	Side Slope	Flood Storage (FSA) 5 year ARI event			Flood Storage (FSA) 100 year ARI event		
		Maximum depth (m)	TWL surface area (m^2)	Volume (m^3)	Maximum depth (m)	TWL surface area (m^2)	Volume (m^3)
FSA 5	varies	0.44	5010	2080	1	5800	5100
FSA 10		1.05	6500	4920	1.5	8500	8000
FSA 13	1/6	0.49	1090	445	1.2	1720	1430
FSA 14		0.55	380	145		745	505
FSA 15		0.53	2820	1320		3730	3510
FSA 17		0.59	5100	2720		6160	6120
FSA 26		0.58	4360	2270		5390	5280
FSA 29		0.8	815	455	1.2	1110	840
FSA 30	varies	3.1	15000	16700	4	19360	25800
FSA 50		0.4	11000	4100	1	15000	11500

Outflows	
Discharge location	Peak flow rate (m^3/s)
Out 1	2.80
Out 2	6.21
Out 3	0.72
Out 4	7.27
Out 7	3.62
Out 8	10.65
Out 10	1.30

Figure 7: Post-development Catchments, Detention Storage and Discharge Characteristics

Project: Local Water Management Strategy
North Stoneville SP34
Client: Satterley

Plan Number:
EP17-013(01)--F09a
Drawn: KNM
Date: 04/06/2019
Checked: MGB
Approved: DPC
Date: 04/06/2019

N

0 200 400 600
Metres
Scale: 1:22,000@A4
GDA 1994 MGA Zone 50

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Appendix A

North Stoneville SP34

SATTERLEY

NORTH STONEVILLE STRUCTURE PLAN

SIZE A4_ 1:20000

0 metres 200 400 600 800 1000

RD great places

N

LEGEND

- Structure Plan Boundary

Reserves

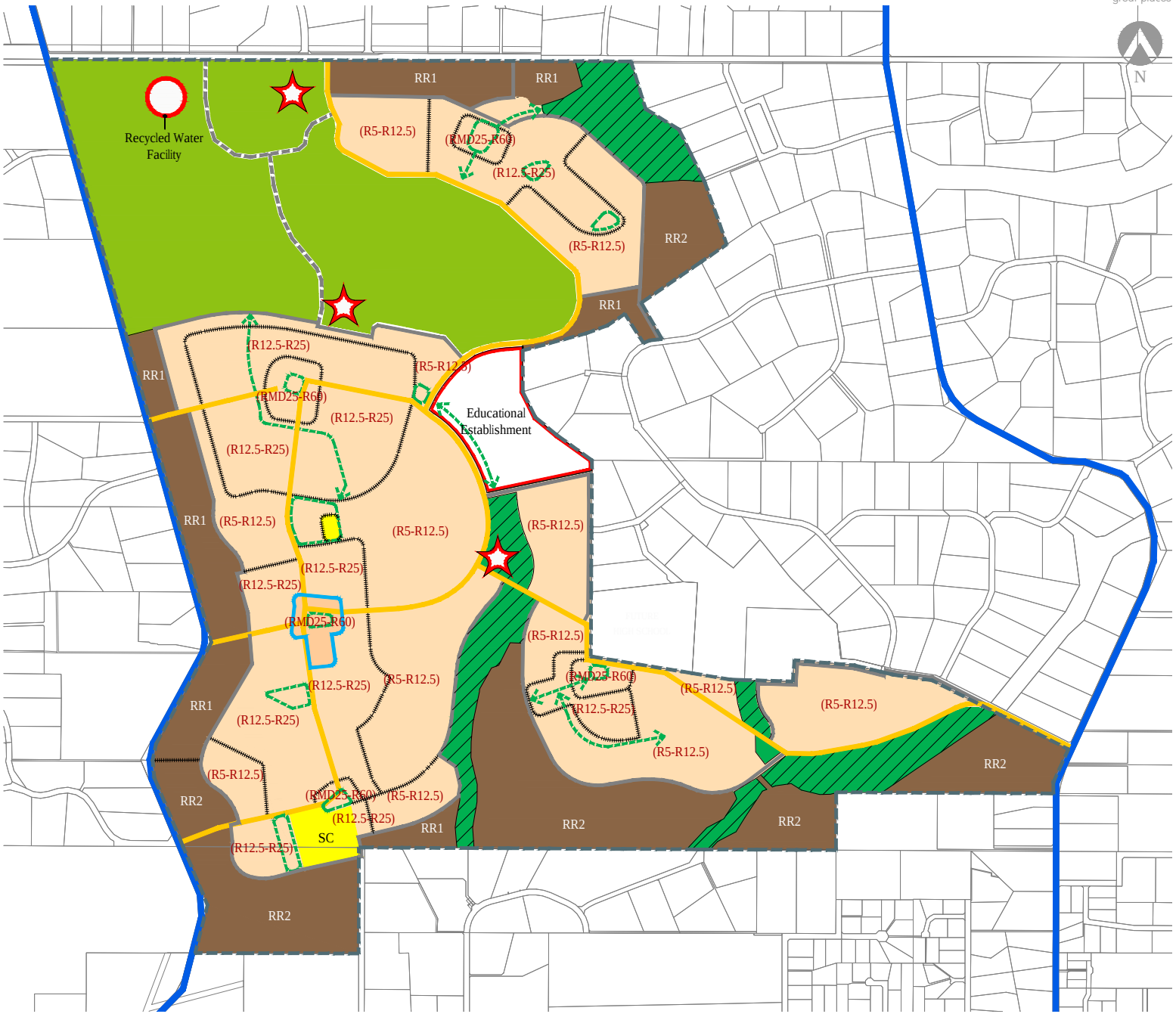
- Conservation / Recreation
- Important Local Roads
- Public Purposes
- SC — Public Purposes: School
- Recreation

Zones

- Residential
- Rural Residential
- Special Use
- Local Centre

Other

- Connector Road
- Perimeter Road (Bushfire)
- Fire Service Access Route
- (R5-R12.5) R Codes
- Suggested Recreation Reserve Location
- Green Link
- Potential Special Use Location
- Recycled Water Facility (preferred location)



REF NO.	DRAW NO.	REV.
SAT STO	RD1 300	I

Appendix B

Geotechnical Investigations

Report on

PRELIMINARY GEOTECHNICAL STUDY
PROPOSED STONEVILLE PROJECT
LOT 48 ROLAND ROAD, STONEVILLE

Submitted to:
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J1701008 001 R Rev0

05 April 2017

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APPENDIX A: PHOTOGRAPHS

APPENDIX B: TEST PIT REPORTS

APPENDIX C: DYNAMIC CONE PENETROMETER TEST RESULTS

APPENDIX D: LABORATORY TEST RESULTS

APPENDIX E: CSIRO PAMPHLET

APPENDIX F: UNDERSTANDING YOUR REPORT

1. INTRODUCTION

This report presents the outcomes of the preliminary geotechnical study conducted by Galt Geotechnics (Galt) for the proposed Stoneville residential project at Lot 48 Roland Road, Stoneville ("the site"). The location of the site relative to the surrounding area is shown on Figure 1, Site and Location Plan.

The study was authorised by Grant Wilkins from Satterley Property Group in a signed Client Authorisation Form dated 22 December 2016.

The recommendations given herein are subject to review and confirmation following detailed geotechnical investigations prior to detailed design.

2. SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The site is irregular in shape and covers a total plan area of about 540 ha. It is bounded by Cameron Road to the north, Roland Road to the west and rural-residential type properties to the east and south.

Based on our discussions with the project team and the information provided, we understand that

- the site will be divided into between 1,200 and 1,700 lots over 3 Precincts;
- an on-site package treatment plant, storage tanks and dam are proposed to handle the disposal of wastewater; and
- it is likely potable water will be extended to the site.

Historical photographs (see Figure 2, Historical Aerial Imagery) show that the site was largely covered in dense bushland until about 1965. Some large parts of the site were cleared between 1965 and 1979 and a few small dams were constructed near the corners of the site. From this time, the site remains relatively unchanged to date.

At the time of our investigation, the site comprised a combination of large open areas, sparsely covered in grass and isolated trees, and other large areas with spreads of mature trees. We understand that the areas of dense vegetation may not be developed. We also note that:

- There are outcrops and scattered cobbles and boulders of very well cemented Laterite over most of the site.
- There are isolated tree stumps and large buried roots.
- There is an existing water-course aligned north-south through the centre of the site.

Published contour maps (Landgate 5 m scale contour maps) show that the surface elevation ranges from about RL 260 m to RL 314 m AHD across the site. There are three notable high parts of the site near the centre with maximum elevations of about RL 298 m to RL 314 m AHD. The surface generally falls from these high points towards the north-west, south-west and south-east corners of the site and the water-course at the centre of the site. Published contours have been presented on Figure 1 for reference.

We assume that the structures to be built on the site will be single or double storey masonry brick or steel framed, supported on shallow footings and ground slabs.

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ABN: 64 625 054 729

3. OBJECTIVES

The objectives of the preliminary study were to:

- assess subsurface soil and groundwater conditions across the site;
- identify areas of rock and hard digging to assist with planning the lot layout, road layout, road vertical design, deep sewer design and subdivision design;
- provide preliminary site classifications in accordance with AS 2870 and provide earthworks and ground improvement strategies that may lead to a different (better) classification;
- recommend the thickness of sand pads to be placed over various parts of the site to obtain a range of lot site classifications,
- advise if the sites of proposed water supply tanks and water recycling tanks (two sites, each about 1 ha) are likely to be suitable;
- recommend pavement thickness for proposed roads.

4. FIELDWORK

The fieldwork was carried out over the period 1 to 17 February 2017 and comprised:

- a drive-over survey of the site, including taking of photographs and noting surface features;
- excavation of test pits at 100 locations (TP1 to TP100), extending to depths ranging from 0 m to 2.5 m;
- testing with a dynamic cone penetrometer (DCP) adjacent to each test pit extending to depths ranging from shallow refusal to 1.0 m; and
- collection of samples for inspection and geotechnical laboratory testing.

General

Test locations were selected by a senior geotechnical engineer from Galt in consultation with the project design team. The tests were positioned by a geotechnical engineer from Galt relative to surrounding site features and using a handheld GPS accurate to about 5 m in the horizontal plane. The engineer conducted the drive-over survey, observed the test pitting, logged the soils encountered in the test pits, performed the DCP tests and collected representative soil samples for inspection and geotechnical laboratory testing.

Test locations are shown on Figure 1, Site and Location Plan.

Test Pits

Test pits were excavated using a 28.5 tonne, Samsung SE280 LC-2 excavator equipped with a 0.6 m wide, tiger toothed bucket. The excavator was supplied and operated by ANH Contracting. Test pit reports are presented in Appendix B, Test Pit Reports, along with a method of soil and rock description, cementation classification and a list of explanatory notes and abbreviations used in the reports.

Details of the test pits are presented in Table A1: Summary of Test Pits located at the end of the text.

Dynamic Cone Penetrometer Tests

DCP tests were conducted in accordance with AS1289.6.3.2. The DCP test results are presented in Appendix C, Dynamic Cone Penetrometer Test Results.

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5. LABORATORY TEST RESULTS

Laboratory testing was conducted by Liquid Labs WA in their NATA accredited laboratory. The testing comprised determination of:

- particle size distribution on 12 samples;
- Atterberg limits and linear shrinkage on 8 samples;
- shrink-swell index on 2 samples;
- Emerson class number on 2 samples;
- dry density-moisture content relationship using:
  - Modified compactive effort on 3 samples;
  - Standard compactive effort on 1 sample; and
- 4 day soaked California bearing ratio (CBR) on 4 remoulded samples.

The laboratory test results are presented in Appendix D, Laboratory Test Results along with the test methods followed. A summary of the laboratory test results is presented in Table 1: Summary of Laboratory Test Results.

Table 1: Summary of Laboratory Test Results

Test Name	Sample depth (m)	USC	% Gravel	% Sand	% Fines	LL (%)	PI (%)	LS (%)	I_{ss}	SMDD (t/m³)	MMDD (t/m³)	OMC	CBR	ECN
TP08	0 – 0.6	SM	24	55	21	-	-	-	-	-	2.04	9.6	40	-
TP43	0 – 0.4	GP/GM	49	39	12	-	-	-	-	-	2.23	8.7	35	-
TP54	1 – 2	SC/CH	3	48	49	60	36	10.5	-	-	-	-	-	-
TP61	0 – 1	GP/GM	65	28	7	-	-	-	-	-	2.22	9.7	50	-
TP71	0.9 – 1.7	CH	-	48	52	55	30	9	-	-	-	-	-	-
TP73	1.7 – 2.07	SC/CH	6	48	48	57	31	7	0.6	-	-	-	-	-
TP84	1.2 – 1.46	CH	3	33	64	68	36	7	0.4	-	-	-	-	-
TP94	0 – 0.5	GP	62	33	5	-	-	-	-	-	-	-	-	-
TP95	0.2 – 1.1	GC	3	66	31	28	13	5	-	1.94	-	11.4	9	-
TP95	1.1 – 2	CH	14	36	50	67	39	10.5	-	-	-	-	-	-
TP98	2.1 – 2.9	SC/CH	4	48	48	60	37	11	-	-	-	-	-	6
TP100	1 – 1.5	SC	22	42	36	42	18	5.5	-	-	-	-	-	6

Notes: USC: Unified soils classification LL: Liquid Limit PI: Plasticity Index LS: Linear Shrinkage
Iss: Shrink-swell Index MMDD: Modified Maximum Dry Density OMC: Optimum Moisture Content
CBR: 4 day soaked California Bearing Ratio, sample compacted to 95 % MMDD/SMDD, 4.5 kg surcharge
ECN: Emerson Class Number

6. SITE CONDITIONS

6.1 Geology

The Mundaring sheet of the 1:50,000 scale Environmental Geology series map indicates that the site is predominantly underlain by massive, cemented Laterite. This is typically overlain by a variable thickness of pisolitic gravel.

There is also an isolated area of granite shown on the northern part of the site and narrow zones of colluvium present along and near the Clutterbuck Creek alignment.

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The geological units are described as follows:

- GRAVEL – yellow-brown to reddish brown, loose, fine to coarse, ferruginous pisolites, poorly sorted; variable amounts of sand and silt in matrix, minor re-cementation, colluvial origin;
- GRANITES – fine to coarse-grained, occasionally porphyritic rocks of granite, granodiorite and adamellite composition;
- LATERITE – massive, hard, cemented, vuggy and pisolitic; up to 4 m thick, overlain by and associated with gravels of residual origin
- GRAVELLY SILTY SAND – white to grey, fine to coarse grained, angular quartz, minor feldspar, common to abundant silt and common fine gravel; colluvial origin

The findings of the investigation are generally consistent with the geological mapping.

The soils generally comprise a variety of lateritised soils and cemented materials that transition into clayey soils at depth. Significant portions of the site are underlain by very well cemented Hardpan Laterite.

Note: The term "Laterite" broadly refers to soil and rock strength materials which are rich in iron and aluminium. In our report, we have typically used the term "Hardpan Laterite" or "hardpan" to refer to the upper cemented zone of Laterite that has rock strength characteristics.

6.2 Subsurface Conditions

TOPSOIL AND VEGETATION

Generally, the topsoil over the entire site comprises a minor proportion of fine organics. The main variable is the proportion of buried roots associated with densely vegetated parts and partially cleared vegetation.

The open areas of the site typically have a sparse cover of grass and isolated trees. Occasional tree stumps and large buried roots were noted in these areas. Historical aerial imagery shows that significant portions of these areas were previously covered with dense vegetation that was later cleared. Based on our investigation, it appears that some of the buried tree roots were not removed.

In the densely vegetated areas of the site, there are a significant proportion of large buried roots associated with the mature trees.

SHALLOW VERY WELL CEMENTED HARDPAN LATERITE

Shallow, very well cemented, Hardpan Laterite (hardpan) is present over most of the site. The entire area of Precinct 1 and significant portions of both Precincts 2 and 3 appear to be underlain by this cemented material.

It is noted that the shallow areas of very well cemented Hardpan Laterite often coincide with:

- the higher-lying parts of the site;
- the densely vegetated parts of the site; and
- areas with hardpan outcrops and loosely scattered cobbles and boulders on the surface.

We have mapped the approximate depth to cemented hardpan across the site based on the depth to hardpan recorded in each test pit. This information is presented on Figure 3, Depth of Hardpan Laterite. In view of the wide spacing of the test pits, we consider the accuracy of the contours to be relatively limited.

The typical soil profile comprises:

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- Silty SAND to Sandy GRAVEL with occasional LATERITE COBBLES & BOULDERS: predominantly comprising fine to medium grained pisolitic gravel and medium grained sand, variable proportion of very well cemented Laterite cobbles and boulders, 5% to 20% non-plastic fines, typically very loose to loose, extending to depths ranging from 0.1 m to 2.1 m (often less than 1.0 m thick); overlying
- HARDPAN LATERITE: very well iron cemented, typically medium to high strength, massive, comprising gravel sized ferruginous cemented pisolites and sand sized quartz grains.

NOTE: Refer to test pit reports in Appendix B, Test Pit Reports for stratigraphy and detailed soil descriptions.

Excavation of the very well cemented hardpan was conducted with a 28-tonne excavator equipped with a 0.6 m tiger toothed bucket. Typically, penetration of about 0.2 m to 0.5 m deep was achieved after about 10 to 15 minutes of excavation. We were generally unable to expose the soils below the cemented hardpan.

VARIABLY CEMENTED HARDPAN LATERITE AND LATERITIC COBBLES/BOULDERS

There are profiles of variably cemented hardpan (broadly weakly to moderately cemented comprising some very well cemented particles) and Lateritic COBBLES & BOULDERS present over some portions of the site. These were noted in the following areas:

- Northern part of Precinct 1 (extending over an area with dimensions of about 900 m by 400 m from the northern boundary).
- Western and eastern parts of Precinct 3.
- Western part of proposed dam site.

A very broad description of the stratigraphy is as follows:

- Silty SAND to Sandy GRAVEL AND/OR LATERITE COBBLES & BOULDERS; overlying
- Variably Cemented HARDPAN LATERITE: weakly to moderately cemented mass comprising very well cemented cobble and boulders sized particles; overlying
- Clayey SAND to Sandy CLAY: often comprising high plasticity fines, variable proportions of quartz sand grains and ferruginised gravel.

Note: Please refer to the test pit reports for details of the stratigraphy and characteristics of each soil type at each test location.

HIGH PLASTICITY CLAYEY SOILS

The following parts of the site are underlain by high plasticity clayey soils:

- The south-west corner of Precinct 1 (localised area)
- The north-western part and eastern corner (localised area) of Precinct 2.
- The western and eastern parts of Precinct 3.
- The proposed dam site.

Areas of shallow clayey soils sometimes coincide with variably cemented hardpan and Lateritic cobbles and boulders described above.

6.3 Groundwater

The groundwater information published in the Perth Groundwater Atlas does not extend to the site. However, based on the elevation of the site and our experience in the area of the Mundaring Hills, we expect that the static groundwater

table is well below the current ground surface. Notwithstanding this, we note that shallow perched groundwater can develop on top of the cemented Laterite and/or clayey soils during the wetter times of the year.

Groundwater was encountered in 11 of the 100 test pits, at the following locations, depths and observed rates of seepage from the sidewall of the test pits:

- TP07: 1.1 m – Slow inflow
- TP12: 2.5 m – Slow inflow
- TP13: 2.5 m – Strong inflow
- TP59: 2.8 m – Strong inflow
- TP79: 2.0 m – Strong inflow
- TP80: 1.5 m – Slow inflow
- TP82: 1.0 m – Very strong inflow
- TP85: 1.8 m – Very strong inflow
- TP95: 2.8 m – Slow inflow
- TP99: 1.0 m – Moderate inflow
- TP100: 2.2 m – Slow inflow

7. PRELIMINARY GEOTECHNICAL ASSESSMENT

7.1 General

The following sections present a preliminary assessment of a number of geotechnical factors that will influence residential development of the site. These recommendations are based on a broad geotechnical study that is not adequate for detailed design. Further investigation is required to confirm the recommendations below and provide a suitable geotechnical model for completing the civil design.

7.2 Suitability for Development and Potential Construction Issues

We consider that the site is geotechnically capable of supporting residential development.

There are, however, geotechnical concerns particularly with the presence of shallow very well cemented Hardpan Laterite that will influence the earth-working and residential development of the site. These issues are discussed below:

Exposure of High Plasticity Clayey Soils

Where penetration through weaker Hardpan Laterite was possible, the underlying material typically comprises high plasticity clayey soils. The hardpan layer forms a cemented and impermeable barrier on top of the clayey soils. As such, the hardpan prevents rainfall perching on and softening the clayey soils. Exposure of the clayey soils to storm-water/groundwater will:

- potentially influence the strength of the ground to support residential structures and pavements;
- expose the soil to increased moisture variations and seasonal shrink swell movements (which would adversely influence the site classification); and
- cause heaving and rutting of the subgrade if the soils become saturated and are trafficked.

It is therefore recommended that:

- excavations into the clayey soils are limited and site surface levels are raised rather than lowered to improve the drainage conditions; and

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- earthworks are carried out in the summer months (to limit exposure to rainfall) even though earthworks in summer have their own issues such as dust control and rapid drying out of soils.

Limited Characterisation of Hardpan Laterite

Given that shallow refusal typically occurred on the Hardpan Laterite (often at depths less than 1 m), there is still uncertainty on:

- the thickness of the Hardpan Laterite;
- the strength and excavatability of the Hardpan Laterite at depth;
- the soils underlying the Hardpan Laterite (although very limited exposure of the underlying soils shows that they may comprise high plasticity clayey soils).

The above may present issues with earthworks, particularly where excavation into the Hardpan Laterite is required to install services (particularly deeper services such as gravity sewers). It also means that the site classification for residential lots cannot be confirmed for significant portions of the site. We recommend that this issue is addressed with further investigation with the appropriate equipment – refer to Section 7.10.

Shallow Lateritic Boulders and Deep Loose Soils

The in-situ pisolitic gravelly soils are typically very loose to loose and often contain cobble and boulder sized Lateritic particles. We recommend the following treatment of loose soils and oversize particles during the earthworks:

- Deep loose gravelly soils must be over-excavated (by ~1 m) and replaced in compacted layers to ensure a minimum 1.5 m of compacted gravelly soil is present below house pads.
- When backfilling, particles larger than 200 mm in diameter must be removed.

7.3 Site Classification

We have considered the site classifications for the site in accordance with AS2870 (2011) "Residential Slabs and Footings. We have conducted a broad assessment of the site classifications assuming our recommended site preparation guidelines in Section 7.5 are followed.

Precinct 1

Precinct 1 is mainly underlain by very well cemented hardpan, except the north-eastern part which comprises some variably cemented hardpan, deep gravels and Laterite cobbles and boulders.

We are unable to confirm the site classification for most of Precinct 1 due to shallow refusal on Hardpan Laterite. However, it can be expected that either a "Class S" or "Class A" should be possible with conventional site preparation and making up any required thickness of inert material with approved structural fill. Where there is at least 1.8 m of laterite or inert soil above the clayey strata, no fill would be required to achieve a "Class A".

The site classification for the north-eastern part of Precinct 1, (where target depth was achieved in most instances) has been assessed as equivalent to "Class S" due to the presence of loose gravelly soils above the Hardpan Laterite (noted to be very loose to loose to depths of up to 1.5 m). A "Class A" could be achieved by over-excavating the loose soils, compacting the exposed base, and backfilling in controlled layers with approved compacted granular fill.

Precinct 2

The north-western portion of Precinct 2 in its current condition can typically be classified as "Class S" or "Class M" due to the deep zones of loose granular soils and shallow, occasionally soft, medium to high plasticity clayey soils. This

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portion of Precinct 2 could potentially be improved to either a "Class S" or "Class A", with over-excavation and replacement of loose/soft materials with approved compacted fill and by raising the surface with inert granular fill.

The central and south-eastern half of Precinct 2 is typically underlain by shallow Hardpan Laterite. Similar to Precinct 1, further investigation is required to confirm the site classifications in this area; however it can be expected that sufficient thicknesses of hardpan would result in either a "Class S" or "Class A" site classification. Placement and compaction of approved structural fill could readily improve the site classification in these areas if required.

Precinct 3

Precinct 3 is typically underlain by shallow Hardpan Laterite, however there are low parts of this Precinct to the west and east that contain clayey soils at shallow depth.

We expect that either a "Class S" or "Class A" would be applicable with suitable site preparation as per Precincts 1 and 2.

The areas of shallow clayey soils would be classified as "Class S" or "Class M" depending on the depth of reactive clayey soils and loose/soft soils. These can be improved to either a "Class S" or "Class A" by over-excavation and replacement of loose/soft soils with approved structural fill and achieving the minimum required thickness of inert material above the clayey soils.

Improvement in Site Classification

The following site classifications can be expected with the following thicknesses of inert material:

- "Class A" with a minimum 1.8 m inert material above any reactive soils.
- "Class S" with a minimum 0.5 m inert material above any reactive soils.

This assumes that there are no significant depths of loose or soft soil underlying the inert material. The in-situ gravelly soils (Silty Gravelly SAND to GRAVEL), Hardpan Laterite and sand, may be used to make up the required thickness of inert material.

The density of deep profiles of loose soils (such as the in-situ gravels) will need to be improved to a suitable density to achieve the desired site classification. Alternatively, the soil can be replaced with approved compacted fill to a depth of at least 1.5 m below finished lots to achieve the desired site classification.

We refer you to the CSIRO's pamphlet BTF18-2011: Foundation Maintenance and Footing Performance: A Homeowner's Guide. This provides practical advice to reduce the risk of future heave moments. A copy of this pamphlet is presented in Appendix E.

7.4 Drainage and Dewatering

Due to the relatively impermeable nature of the shallow Hardpan Laterite and underlying clayey subsurface soils, storm-water may pond at shallow depth during the wetter times of the year. This may cause difficulties during construction including:

- heaving and rutting of saturated clayey soils when they are exposed and trafficked; and
- softening of exposed clayey soils when water is allowed to pond at the base of excavations.

As an additional measure, we also recommend that site levels are raised with free draining, inert granular material above the Hardpan Laterite to promote drainage. Subsoil drains may also be used to facilitate drainage away from structures. However, we note that this method of drainage will not be as effective as elevating the lots with free draining

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sand fill above the Hardpan Laterite.

Groundwater was encountered in 11 of the 100 test pits at depths ranging from 1.0 m to 2.8 m, typically on the lower parts of the site. Given that our study was conducted in summer, it is expected that the groundwater will rise during the wetter times of the year. We expect that some dewatering will be required (particularly during the wetter times of the year) for excavations that extend into the Hardpan Laterite and/or clayey soils. We consider the dewatering will be readily managed by shaping the excavations to a perimeter drain and/or sump and removing the water with a pump.

7.5 Site Preparation

7.5.1 General

The site preparation measures outlined below are aimed to provide preliminary guidance on the improvement of the site in preparation for construction of residential structures and pavements. The site preparation is not required below undeveloped parts of the lots and/or landscaped areas such as public open space (unless hard landscaping features such as retaining walls, shade structures and/or pedestrian bridges are proposed).

As discussed in Section 0, we recommend that surface levels are generally raised rather than lowered over the hardpan layer to avoid exposing any clayey soils and to limit the earthworks preparation required. Notwithstanding this recommendation, we have provided site preparation guidelines in both areas of excavation and fill, with particular notes on the treatment of hardpan layers.

In Areas of Excavation

- Remove vegetation including grubbing out of roots. In general, a topsoil strip should not be required, unless significant organic matter is noted. Locally deeper excavations may be required to remove tree roots. These excavations must be backfilled with approved compacted fill.
- In areas of Shallow Hardpan Laterite, excavate to a depth of at least 0.6 m below design level and stockpile for later re-use as fill.
    - Gravelly/Sandy soils and Variably Cemented Laterite may be excavated and re-used as structural fill provided that they are first processed to remove larger particles – Refer to Section 7.7.
    - Very well cemented Hardpan Laterite will need to first be ripped with a large bull dozer (probably D9 or larger) to facilitate excavation. Depending on the strength of the cemented material, it may be crushed down to size and re-used as fill.
    - The excavated hardpan will need to be inspected by a geotechnical engineer prior to fill placement.
- In areas where gravel is exposed, over-excavate the surface to a depth of at least 0.6 m below finished lots level and compact the exposed base to the minimum density specified in Section 7.6.
- Further excavation and replacement of loose soils or particles larger than 200 mm will be required where the minimum density cannot be achieved. This will need to be confirmed by inspection prior to fill placement.
- Place and compact approved sand/gravelly fill in layers no greater than 0.3 m loose thickness. A minimum 0.6 m compacted thickness of approved fill must be present above any hardpan layers.

In Areas of Fill

- Remove vegetation including grubbing out of roots. In general, a topsoil strip should not be required, unless significant organic matter is noted. Locally deeper excavations may be required to remove tree roots. These excavations must be backfilled with approved compacted fill.
- Excavation of oversize particles (larger than 200 mm) and/or loose soils is required where less than 0.6 m of fill is proposed. Inspection of the base is required to determine whether further excavation of oversized particles is required. Excavation into the Hardpan Laterite is not required unless only for service trenches.
- Moisture condition and compact the in-situ soils to achieve the level of compaction specified in Section 7.6.

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- Over-excavation and replacement of loose soils or particles larger than 200 mm will be required where the minimum density cannot be achieved. This will need to be confirmed by inspection prior to fill placement.
- Place and compact approved sand/gravelly fill in layers no greater than 0.3 m loose thickness. Each layer must be compacted to achieve the minimum level of compaction specified in Section 7.6.
- A minimum 0.6 m thickness of approved compacted fill is required above any Hardpan Laterite.

NOTE: The purpose of 0.6 m thickness of approved compacted fill above the hardpan is to provide the residential builders with a sufficient thickness of soil to readily allow for shallow footing and slab excavations and installation of services with conventional earthmoving equipment (such as a 1.5 tonne mini-excavator). Note that the specified thickness of fill is not intended to improve the site classification. If excavation into the hardpan does not present an issue, the minimum thickness of fill is not required, however reference must be made to foundation preparation on Hardpan Laterite below.

Foundation preparation on Hardpan Laterite

Excavation into Hardpan Laterite is likely to lead to the formation of irregularities and undulations in the surface including the creation of high and low points. Careful excavation will be required to minimise undulations in the surface particularly below footings and slabs. Where holes have formed below footings, they must be backfilled with lean mix concrete to produce a level base. Holes and undulations in fill areas may be carefully backfilled with approved, compacted structural fill.

7.6 Compaction

In-situ granular soils and approved granular fill must be moisture conditioned to within 2% of optimum moisture content (OMC) and compacted using suitable compaction equipment to achieve a dry density ratio (DDR) of at least 95% MMDD (maximum modified dry density) as determined in accordance with AS 1289 5.2.1.

Given the in-situ gravelly and silty/clayey soils present we recommend the use of a large pad-foot roller as this will assist in crushing down weaker cemented particles and will promote kneading and mixture of silty/clayey soils. It should be noted that smooth drum rollers can cause laminations of silty/clayey soils which can promote water ingress. Use of such rollers on clayey soils should be limited to smoothing of the finished surface of lots or subgrades.

Compaction control of gravelly soils (containing >15% gravel) and clayey soils (>5 % fines) must be conducted by a NATA accredited soils laboratory with a nuclear density gauge (NDG) in accordance with AS1289.5.8.1.

We do not recommend the re-use of the in-situ clayey soils as general or structural fill. However, we note that limited filling with clayey materials may be required (in place of granular fill) to backfill excavations/depressions formed in the in-situ clayey soils. This is to prevent water infiltrating through sand backfill and ponding within excavations/depressions in the clayey subgrade. The presence of water in any excavations/depressions can be expected to soften the underlying clayey ground. Where clayey fill is used, it must be compacted to a minimum dry density ratio of at least 95% SMDD (standard maximum dry density) as determined in accordance with AS1289.5.1.1.

Typically for a project of this size, the following compaction testing is required:

- on each lift of fill at the rate of 1 test per 500 m^3 (or 1 test per 1,000 m^2 layer);
- at 15 m centres along retaining wall foundations; and
- at 20 m intervals along pavement centre-lines.

To reduce the level of compaction control testing required, we would recommend development of a method specification. This could be achieved by conducting NDG testing on trial areas of compacted fill materials to determine the minimum number of passes required to achieve the required DDR. Geotechnical inspection of these trials could

also be carried out to assess the surface deformation during compaction and recommend a suitable number of passes with the proposed compaction equipment.

Given the gravelly nature of the in-situ soils it is unlikely that a Perth sand penetrometer or a dynamic cone penetrometer will be appropriate for use in this project unless an imported sand fill is used to raise site levels. We may provide recommendations for use of a penetrometer when the soils are considered appropriate for this method of compaction control.

Over-excavation and replacement of loose materials must be done where the minimum dry density ratio cannot be achieved.

Fill must be placed in horizontal layers of not greater than 300 mm loose thickness. Each layer must be compacted by suitable compaction equipment, and carefully controlled to ensure even compaction over the full area and depth of each layer.

7.7 Approved Fill

Imported granular fill must comply with the material requirements as stated in AS 3798 (2007), "Guidelines on Earthworks for Commercial and Residential Developments".

The in-situ gravelly soils (Silty Gravelly SAND to GRAVEL) are considered appropriate for re-use as inert structural fill.

Hardpan Laterite may potentially be crushed down to produce a material suitable for bulk fill and possibly as base-course fill for pavements. Further investigation and trials are required to assess the strength of the cemented Laterite and the best approach to producing an appropriate fill material.

Excavation into the in-situ silty/clayey soils (containing more than 20% fines) and/or re-use of such material is not recommended as:

- exposing the clayey soil to the elements may result in saturation and softening of the soils;
- the clayey soils will be difficult to traffic when saturated;
- the material will likely be difficult to moisture condition and compact; and
- there may be adverse implications on site classification and drainage if used in place of free draining inert granular fill.

The in-situ clayey soil should only be re-used where backfilling of excavations into similar clayey ground is required.

If there is any doubt regarding the suitability of fill material, a geotechnical engineer must be engaged to inspect and approve the potential fill.

7.8 Excavations and Slopes

Test pits were excavated using a 28.5 tonne Samsung SE280 LC-2 excavator equipped with a 0.6 m tiger toothed bucket. Based on our observations we note that:

- Excavation into the shallow very well iron cemented Hardpan Laterite was very difficult. Penetration of about 0.2 m to 0.5 m depth into this layer was achieved over a period of about 10 to 15 minutes of excavation.
- Excavations into the variably cemented Hardpan Laterite (variable iron cementation) and Lateritic cobbles and boulders were achieved with reasonable productivity. The weakly cemented and desiccated clayey soils at depth were excavated with relative ease.
- Excavation of the upper gravelly and clayey soils was readily achieved.

Given the size of the proposed development, we note that bulk excavation into the shallow very well cemented Laterite will likely be required. Based on our preliminary investigation, we expect that:

- Bulk excavation of Hardpan Laterite will first require ripping of the surface with a large bulldozer (probably a D9 or larger) equipped with a single tine ripper to achieve productive excavation.
- Excavation of deep trenches (for gravity sewers or similar) will require the use of a large excavator equipped with a hydraulic rock breaker.

We recommend that further investigation is carried out to trial the excavatability of the Hardpan Laterite. This is further discussed in Section 7.10.

Excavation into the variable cemented Hardpan Laterite (overall weakly to well cemented) and Lateritic cobbles and boulders is expected to require the use of a large excavator (20 tonne or larger) equipped with a rock bucket. Ripping this material with a bulldozer (D9) is likely to assist in achieving productive excavation.

Excavation of the in-situ gravelly and silty/clayey soils should be readily achieved with a 10 tonne or larger excavator. A larger excavator equipped with a rock bucket may be required in desiccated and hard clayey soils during summer.

7.9 Flexible Pavements

7.9.1 Subgrades

The in-situ gravelly soils (Silty Gravelly SAND to GRAVEL) will provide a relatively strong subgrade when compacted for construction of pavements. However, the in-situ silty and clayey soils will exhibit poor subgrade performance if they become saturated. It is therefore essential that pavement subgrades are properly drained to minimise softening and associated poor pavement performance.

To establish appropriate subgrade design CBR values for pavement design, we arranged 4 soaked CBR tests on the typical subgrade soils. The results of the laboratory testing indicate the following CBR values:

- TP8: 0 – 0.6 m: Silty Sandy GRAVEL: CBR @ 95% MMDD = 35%
- TP43: 0 – 0.4 m: Silty Gravelly SAND: CBR @ 95% MMDD = 40%
- TP61: 0 – 1.0 m: Sandy GRAVEL: CBR @ 95% MMDD = 50%
- TP95: 0.2 – 1.1 m: Clayey SAND: CBR @ 95% SMDD = 9%

On the basis of the above, we recommend that pavement subgrades are formed with a minimum 0.6 m compacted thickness of in-situ or site derived gravelly fill (Silty Gravelly SAND to Sandy GRAVEL) above the in-situ clayey soils or Hardpan Laterite. Provided this is done, and our recommended site preparation guidelines in Section 7.5 are followed, we consider that a subgrade CBR of 15% is appropriate for flexible pavement design.

7.9.2 Shire of Mundaring Guidelines

Based on our discussions with the Shire of Mundaring (SoM) Engineering Officer, we understand that the SoM does not provide a standard specification for pavement thickness design for urban roads in new residential developments. Notwithstanding this, we understand that a typically pavement design that is accepted in the Mundaring catchment area comprises:

- Wearing course comprising a 30 mm layer of Asphaltic Concrete.
- Primer seal between the wearing course and base-course layers.
- Base-course comprising a minimum 200 mm layer of Crushed Ferricrete/Hardpan Laterite.

We assume that this typical pavement detail is based on a pavement constructed on a compacted sand subgrade (assume minimum CBR 10%). On this basis, it would be necessary to ensure that a minimum 0.6 m compacted thickness of site derived gravelly fill is present below any pavements to achieve an adequate subgrade CBR for pavement construction.

Should the above mentioned pavement design be adopted it must be first confirmed and approved by the SoM.

7.9.3 Recommended Pavement Thickness for Preliminary Design

Austroads (2012)[1] provide empirical design charts for the design of granular pavements with thin bituminous surfacings. The recommended pavement thicknesses are based on the design traffic (expressed as design equivalent standard axles – DESA) and the design subgrade CBR.

We are not aware of any published information on typical urban traffic volumes for new residential developments in the Mundaring catchment area. In the absence of such information, we have referred to Austroads (2012) for indicative design traffic values for lightly trafficked urban streets. To account for temporary heavy vehicle loads during construction, we have referred to the indicative design traffic for "Local access roads in an industrial area" and note that a DESA of 3 x 10^5 is recommended for a pavement design life of 40 years.

On this basis, we have determined the following minimum pavement thicknesses based on the Austroads (2012) design charts.

Table 2: Recommended Pavement Thicknesses in accordance with Austroads (2012) Empirical Design Charts

Pavement Detail	Design CBR	DESA	Minimum Thickness of granular layers[1] (mm)	Minimum thickness of base-course layers[2] (mm)
General	15	3 x 10^5	175	110
Roundabouts or small radius curves		9 x 10^5	200	135

Notes:
1. Granular layers are defined as both base-course and sub-base materials.
2. Sub-base must have a minimum CBR of 30% when compacted.
3. Base-course must have a minimum CBR of 80% when compacted.
4. The DESA is multiplied by 3 at roundabouts and small radius curves to account for increased damage from turning vehicles.
5. Pavement design life of 40 years and wearing course design life of 15 years have been assumed in this assessment.

We consider that a suitable wearing course layer would comprise a 30-mm thick layer of AC10 dense graded asphalt over the base-course. The recommendations in Austroads (2012) indicate that this asphalt layer may be assumed to make up the required thickness of granular layers, but not the base-course.

On this basis, we consider that a suitable pavement design in accordance with Austroads (2012) may comprise the following profile:

- Wearing course comprising a 30-mm layer of AC10, dense graded asphalt.
- Application of a primer seal between the wearing course and base-course layers.
- Base-course comprising Crushed Ferricrete/Hardpan Laterite at the following thicknesses:

[1] Austroads (2012) Guide to Pavement Technology, Part 2: Pavement Structural Design

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- a minimum 150 m along general pavement sections.
- a minimum 175 m at roundabouts or small radius curves.

Notes:

1. The recommended pavement thicknesses are provided as preliminary recommendations only and do not constitute a pavement design. These recommendations must be reviewed and approved by the pavement designers and SoM.
2. Due to the limited sub-base thickness required (65 mm), we consider it impractical to include a separate layer of sub-base material above the subgrade. This is largely due to the difficulty that the civil contractor would face ensuring the design thickness of sub-base material is maintained over the subgrade prior to placement of base-course.
3. Specification of fill properties (grading, particle strength, density) is beyond the scope of these recommendations.

7.10 Proposed Stormwater and Effluent Retention

We understand that dams are proposed near the northern site boundary for retention of storm-water and/or treated sewage effluent. The approximate location of the proposed dam site is shown on Figure 1.

We expect that construction of the dam/s will be carried out as follows:

- excavation of a square/rectangular dam below ground surface; and
- construction of above ground embankments using the excavated soils around the periphery of the excavation to form sidewalls for the dam and increase the capacity.

This appears consistent with the method of construction used for a number of existing dams on the site. The embankments of the existing dams comprise clayey soils and appear have been constructed in a controlled manner and are showing no significant signs of distress (i.e. no significant signs of instability, rilling/erosion or shrink swell movements).

In summary, the subsurface conditions at the proposed dam site comprise:

<u>Eastern side of Existing Dam (TP99 & TP100)</u>

- Silty SAND or Sandy GRAVEL: typically extending to depths ranging to 0.5 m to 0.7 m; overlying
- Clayey SAND: comprising 20% to 40% low to medium plasticity fines becoming high plasticity with depth, extending to depths ranging from 1.6 m to 2.8 m; overlying
- Clayey SAND/Sandy CLAY (SC/CH): comprising high plasticity fines and variable sand content, extending to the maximum investigated depth of 2.8 m.

<u>Western side of Existing Dam (TP97 & TP98)</u>

- SAND/Silty SAND or Silty/Clayey Sandy GRAVEL: extending from ground surface to depths ranging from 0.7 m to 0.9 m; overlying
- HARPDAN LATERITE (very low to low strength) OR LATERTIC BOULDERS AND COBBLES: extending to depths ranging from 2.1 m to 2.4 m; overlying
- Clayey SAND/ Sandy CLAY: comprising high plasticity fines and variable sand content, extending to the maximum investigated depth of 2.8 m.

We have conducted laboratory testing of the typical in-situ clayey soils at the proposed dam site to assess the suitability of the in-situ material for construction of the dam sidewalls. The following table presents a summary of the laboratory test results of the in-situ clayey soils at the proposed dam site.

Table 3: Laboratory Test Results of In-situ Soils at Proposed Dam Site

Test Name	Depth (m)	Soil Description	USCS	Emerson Class Number	Plasticity Index	Linear Shrinkage (%)
TP98	2.1 – 2.9	Clayey SAND/Sandy CLAY	SC/CH	6	37	11.0
TP100	1.0 – 1.5	Sandy CLAY	SC	6	18	5.5

Based on our experience, typical soil characteristics that are desirable for dam construction comprise include materials that:

- Have a fines content greater than 30%.
- Exhibit low slaking and dispersion.
- Low linear shrinkage;
- Low permeability

In summary, we consider that the in-situ clayey sand and sandy clays at the proposed dam site are generally consistent with the recommendations above and will provide a good source of material for constructing the dam. Notwithstanding this, earthworks with clayey soils, particularly those of high plasticity, are often problematic as the materials are difficult to moisture conditions and compact.

It is therefore essential that the clayey soils are moisture conditioned to within 2% of optimum moisture content. This will probably require wetting, curing (possibly for a few days) and mixing of the clayey soils prior to use.

Clayey soils must be compacted in layer no greater than 0.25 m loose thickness to achieve a minimum DDR of 95% SMMDD. Given that the clayey soils are moderately to highly reactive it is also important that the soils are protected from any significant moisture changes otherwise they will be allowed to shrink and swell. This is typically achieved by placing and compacting a protective layer of sandy gravel (such as that at the proposed dam site) over the clayey soils.

The above advice is provided as general recommendations only and will need to be confirmed once more information regarding the proposed dam design becomes available. We can provide further design assistance if required.

8. FURTHER INVESTIGATION

This preliminary geotechnical study was aimed to broadly assess the subsurface conditions across the site, particularly those that may adversely impact on development of the site as a residential subdivision. One such impediment to residential development is the presence of shallow Hardpan Laterite. The presence of Hardpan Laterite caused shallow test pit refusal and limited our assessment of the subsurface conditions over large portions of the site.

On the basis of the above, we recommend that further investigation is carried out, with particularly emphasis on:

- Assessing the strength, and excavatability of the Hardpan Laterite.
  - We recommend that this is assessed by conducting ripping trials with a large bulldozer (say D9 or larger) equipped with a single tine ripper.
- Assessing the thickness of the Hardpan Laterite and the subsurface soils below to provide appropriate site classification/s and site preparation procedures for development.
  - We recommend that air core drilling is carried out to assess the full subsurface profile over areas of shallow Hardpan Laterite.

9. CLOSURE

We draw your attention to Appendix F of this report, "Understanding Your Report". The information provided within is intended to inform you as to what your realistic expectations of this report should be. Guidance is also provided on how to minimise risks associated with ground-works for this project. This information is provided not to reduce the level of responsibility accepted by Galt, but to ensure that all parties who rely on this report are aware of the responsibilities each assumes in so doing.

GALT GEOTECHNICS PTY LTD

Fred Davenport CPEng

Geotechnical Engineer

Harry Chambers

Geotechnical Engineer

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Table A1: Summary of Test Pits

Coordinates (PCG)		Test Name	Test Depth (m)	Approximate Elevation (m AHD)	Depth of Groundwater (m)	Depth of Hardpan Laterite (m)	Reason for Termination	Stratigraphy
Eastings (m)	Northings (m)							
80807.63	275074.84	TP1	1.0	305	NE	0.6	Refusal	Gravelly Silty SAND AND BOULDERS over HARDPAN LATERITE
80656.22	274926.92	TP2	2.9	305	NE	1.5	Target depth	Gravelly Silty SAND over GRAVEL over HARDPAN LATERITE
80819.96	274925.88	TP3	1.2	305	NE	1.0	Refusal	Gravelly Silty SAND over GRAVEL over HARDPAN LATERITE
80959.48	274927.13	TP4	2.7	305	NE	1.2	Target depth	Gravelly Silty SAND over HARDPAN LATERITE
81106.87	274935.89	TP5	2.5	300	NE	2.1	Target depth	Gravelly Silty SAND over GRAVEL over HARDPAN LATERITE
81254.99	274933.22	TP6	2.9	293	NE	-	Target depth	Silty SAND over SAND over Gravelly SAND, COBBLES AND BOULDERS
81404.14	274926.23	TP7	1.5	290	1.1	1.1	Refusal	Silty SAND over Silty Sandy GRAVEL over HARDPAN LATERITE
80662.09	274788.2	TP8	1.0	305	NE	0.9	Refusal	Sandy Silty GRAVEL over GRAVEL over HARDPAN LATERITE
80817.27	274786.95	TP9	1.0	309	NE	0.8	Refusal	Gravelly Silty SAND AND BOULDERS over HARDPAN LATERITE
80953.35	274778.56	TP10	2.7	308	NE	-	Target depth	Gravelly Silty SAND over GRAVEL AND GRAVEL/COBBLES
81106.41	274782.86	TP11	2.4	301	NE	1.1	Slow excavation	Gravelly Silty SAND over Silty Sandy GRAVEL over HARDPAN LATERITE
81255.76	274781.31	TP12	2.5	294	2.5	1.0	Target depth	Silty SAND over HARDPAN LATERITE
81405.55	274771.31	TP13	2.8	288	2.5	1.5	Target depth	Silty SAND over HARDPAN LATERITE
80808.97	274639.17	TP14	3.0	310	NE	-	Target depth	Gravelly Silty SAND over Clayey Sandy GRAVEL, COBBLES AND BOULDERS
80955.96	274639.39	TP15	0.7	310	NE	0.65	Refusal	SAND/LATERITE BOULDERS over HARDPAN LATERITE
81110.31	274635.04	TP16	1.0	307	NE	1.0	Refusal	Sandy GRAVEL/Gravelly SAND and LATERITE BOULDERS
81252.65	274632.72	TP17	1.0	299	NE	0.7	Refusal	Sandy GRAVEL over HARDPAN LATERITE
81400.61	274640.14	TP18	0.8	292	NE	0.8	Refusal	Sandy GRAVEL over HARDPAN LATERITE
81551.35	274629.38	TP19	1.0	283	NE	0.7	Refusal	Sandy GRAVEL over HARDPAN LATERITE
80801.61	274487.83	TP20	0.5	310	NE	0.2	Refusal	SAND/Gravelly SAND over HARDPAN LATERITE
80957.22	274493.13	TP21	0.4	310	NE	0.2	Refusal	SAND over HARDPAN LATERITE
81105.51	274485.47	TP22	0.9	310	NE	0.9	Refusal	Gravelly SAND and LATERITE BOULDERS
81255.98	274480.36	TP23	0.3	310	NE	0.2	Refusal	SAND/Silty SAND over HARDPAN LATERITE
81398.05	274485.25	TP24	1.0	299	NE	0.9	Refusal	SAND and LATERITE BOULDERS over HARDPAN LATERITE
81552.99	274485.99	TP25	0.5	285	NE	0.3	Refusal	GRAVEL over HARDPAN LATERITE
80956.19	274338.23	TP26	1.3	307	NE	1.1	Refusal	SAND/Silty SAND over Gravelly SAND/Sandy GRAVEL over HARDPAN LATERITE
81102.69	274336.12	TP27	2.9	310	NE	-	Target depth	Gravelly SAND over GRAVEL over Clayey GRAVEL
81253.55	274336.88	TP28	0.7	310	NE	0.5	Refusal	SAND/Gravelly SAND over HARDPAN LATERITE
81395.41	274332.12	TP29	0.7	306	NE	0.5	Refusal	SAND/Silty SAND over HARDPAN LATERITE
81544.48	274334.88	TP30	0.2	292	NE	0.2	Refusal	SAND/Silty SAND over HARDPAN LATERITE
80950.08	274193.09	TP31	0.8	302	NE	0.7	Refusal	SAND/Gravelly SAND over HARDPAN LATERITE
81108.78	274190.29	TP32	0.9	309	NE	0.7	Refusal	SAND/Silty SAND over HARDPAN LATERITE
81250.06	274183.64	TP33	1.2	307	NE	0.8	Refusal	Sandy GRAVEL over HARDPAN LATERITE
81399.81	274189.06	TP34	0.25	303	NE	0.2	Refusal	Gravelly SAND/Sandy GRAVEL
81546.96	274184.51	TP35	0.2	292	NE	0.2	Refusal	SAND/Silty SAND
80951.31	274041.39	TP36	0.8	300	NE	0.4	Refusal	Sandy GRAVEL over HARDPAN LATERITE
81098.37	274035.96	TP37	2.3	303	NE	0.7	Slow excavation	Sandy GRAVEL over HARDPDAN LATERITE over cemented/uncemented Clayey SAND
81246.77	274033.96	TP38	0.5	299	NE	0.3	Refusal	SAND/Gravelly SAND over HARDPAN LATERITE

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Coordinates (PCG)		Test Name	Test Depth (m)	Approximate Elevation (m AHD)	Depth of Groundwater (m)	Depth of Hardpan Laterite (m)	Reason for Termination	Stratigraphy
Eastings (m)	Northings (m)							
81397.42	274029.73	TP39	0.5	291	NE	0.1	Refusal	Gravelly SAND over HARDPAN LATERITE
80949.37	273895.03	TP40	0.8	300	NE	0.55	Refusal	Sandy GRAVEL over HARDPAN LATERITE
81093.85	273885.39	TP41	0.15	300	NE	0.1	Refusal	Gravelly SAND over HARDPAN LATERITE
81245.67	273888.81	TP42	0.5	293	NE	0.3	Refusal	Gravelly Silty SAND over HARDPAN LATERITE
81397.18	273887.02	TP43	1.6	280	NE	1.3	Refusal	Gravelly SAND over GRAVEL over HARDPAN LATERITE
80798.72	273744.34	TP44	0.7	0	NE	0.3	Refusal	Sandy GRAVEL over HARDPAN LATERITE
80941.07	273750.02	TP45	0.5	299	NE	0.3	Refusal	Gravelly SAND over HARDPAN LATERITE
81095.22	273742.01	TP46	0.9	293	NE	0.6	Refusal	Sandy GRAVEL AND LATERITIC BOULDERS over HARDPAN LATERITE
81246.44	273741.55	TP47	0.5	286	NE	0.2	Refusal	Gravelly SAND over HARDPAN LATERITE
81385	273742.24	TP48	1.0	277	NE	0.5	Refusal	Gravelly SAND over Sandy GRAVEL over HARDPAN LATERITE
80799.19	273587	TP49	0.4	292	NE	0.3	Refusal	Silty SAND AND LATERITIC BOULDERS over HARDPAN LATERITE
80941.63	273590.56	TP50	0.4	288	NE	0.1	Refusal	Gravelly Silty SAND over HARDPAN LATERITE
81096.75	273590.42	TP51	1.35	283	NE	0.7	Refusal	Silty SAND over Sandy GRAVEL over HARDPAN LATERITE
81235.04	273600.32	TP52	0.2	282	NE	0.1	Refusal	Gravelly Silty SAND over HARDPAN LATERITE
81392.28	273585.87	TP53	1.2	269	NE	1.0	Refusal	Sandy GRAVEL/GRAVEL over HARDPAN LATERITE
80790.62	273441.21	TP54	2.8	276	NE	2.8	Target depth	Silty SAND over Sandy GRAVEL AND BOULDERS over Clayey SAND
81237.68	273444.85	TP55	1.1	274	NE	1.0	Refusal	GRAVEL over HARDPAN LATERITE
81392.15	273448.04	TP56	1.15	265	NE	1.0	Refusal	GRAVEL over HARDPAN LATERITE
81836.4	274557.97	TP57	2.5	289	NE	0.6	Target depth	GRAVEL over HARDPAN LATERITE over Clayey SAND/Sandy CLAY
81976.44	274393.53	TP58	1.5	284	NE	1.4	Refusal	Silty SAND over GRAVEL and COBBLES over HARDPAN LATERITE
81890.17	274257.3	TP59	2.9	274	2.8	-	Target depth	Silty SAND/Gravelly Silty SAND over HARDPAN LATERITE over Clayey SAND
82004.5	274165.69	TP60	2.9	278	NE	-	Target depth	Silty SAND over Sandy GRAVEL/GRAVEL over Clayey SAND/Sandy CLAY
81943.52	274035.92	TP61	2.5	276	NE	-	Target depth	GRAVEL, possible transition into HARDPAN LATERITE
82027.57	273975.56	TP62	1.3	282	NE	0.9	Refusal	Silty Sandy GRAVEL over HARPDAN LATERITE
81841.04	273916.37	TP63	2.9	280	NE	-	Target depth	Silty Sandy GRAVEL over Weakly Cemented Clayey SAND over Clayey SAND
82021.22	273850.94	TP64	2.9	290	NE	-	Target depth	Silty/Clayey Sandy GRAVEL over Sandy CLAY/CLAY
81810.82	273723.85	TP65	2.6	286	NE	0.8	Target depth	Gravelly SAND over HARDPAN LATERITE
82119.58	273587.06	TP66	0.8	288	NE	0.3	Refusal	Sandy GRAVEL over HARDPAN LATERITE
82204.85	273799.69	TP67	1.5	285	NE	1.2	Refusal	Sandy GRAVEL over HARDPAN LATERITE
82402.88	273814.71	TP68	2.7	274	NE	0.8	Target depth	Silty SAND over Silty Sandy GRAVEL over Weakly Cemented Clayey SAND over Clayey SAND/Sandy CLAY
82441.64	273562.87	TP69	1.5	263	NE	1.3	Refusal	GRAVEL over HARDPAN LATERITE
82499.22	273693.76	TP70	2.8	265	NE	1.0	Target depth	Clayey SAND over GRAVEL over HARDPAN LATERITE over Gravelly CLAY
82665.11	273778.39	TP71	2.9	264	NE	-	Target depth	Clayey SAND over Clayey SAND/Sandy CLAY
82601.75	273599.74	TP72	2.6	260	NE	-	Target depth	Clayey SAND over GRAVEL over Gravelly Sandy CLAY
82773.2	273605.51	TP73	2.8	260	NE	-	Target depth	Silty SAND over GRAVEL & COBBLES and Clayey SAND/Gravelly Clayey SAND
82809.82	273869.52	TP74	2.6	272	NE	-	Target depth	Silty SAND over GRAVEL, COBBLES & BOULDERS over Clayey SAND/Sandy CLAY
82875.32	273756.65	TP75	1.2	267	NE	1.0	Refusal	Sandy GRAVEL over HARDPAN LATERITE
83027.73	273824.8	TP76	0.5	282	NE	0.3	Refusal	Silty Sandy GRAVEL over HARDPAN LATERITE

Coordinates (PCG)		Test Name	Test Depth (m)	Approximate Elevation (m AHD)	Depth of Groundwater (m)	Depth of Hardpan Laterite (m)	Reason for Termination	Stratigraphy
Eastings (m)	Northings (m)							
83275.94	273758.02	TP77	1.2	272	NE	1.0	Refusal	Silty Sandy GRAVEL over HARDPAN LATERITE
81597.55	273769.31	TP78	1.5	260	NE	1.0	Slow excavation	Silty SAND over Gravelly Silty SAND over HARDPAN LATERITE
81793.28	274145.27	TP79	2.7	270	2	-	Target depth	Silty/Clayey SAND over Clayey SAND, Gravelly Clayey SAND and Sandy CLAY/CLAY
81751.19	274855.85	TP80	2.0	285	1.5	1.2	Refusal	SAND/Silty SAND over HARDPAN LATERITE
81027.4	275510.3	TP81	1.2	283	NE	0.9	Refusal	SAND/Silty SAND over Silty/Clayey SAND over HARDPAN LATERITE
82310.62	275355.43	TP82	1.3	282	1.0	1.1	Refusal	Silty SAND over Clayey SAND over HARDPAN LATERITE
81274.36	275856.28	TP83	2.6	283	NE	-	Target depth	SAND over Sandy GRAVEL, Silty SAND and Sandy CLAY
81447.08	275844.01	TP84	2.7	284	NE	-	Target depth	SAND, LATERITE COBBLES AND BOULDERS over SAND/Clayey SAND and Sandy CLAY
81634.12	275781.44	TP85	2.6	279	1.8	-	Target depth	SAND over Clayey SAND
81832.33	275811.11	TP86	2.8	274	NE	-	Target depth	Gravelly Clayey SAND over Sandy CLAY
81446.5	275685.33	TP87	3.0	285	NE	-	Target depth	Silty/Clayey SAND over Clayey Sandy GRAVEL and CLAY
81611.87	275625.17	TP88	2.0	282	NE	2.0	Refusal	Silty/Clayey SAND over LATERITE GRAVEL AND COBBLES
81750.62	275680.85	TP89	0.6	280	NE	0.5	Refusal	Gravelly SAND over HARDPAN LATERITE
81901.87	275679.16	TP90	0.6	283	NE	0.6	Refusal	Gravelly SAND
82048.95	275673.93	TP91	1.7	280	NE	1.7	Refusal	Gravelly SAND and LATERITE BOULDERS
81749.49	275532.59	TP92	0.6	286	NE	0.6	Refusal	SAND/Gravelly SAND
81902.46	275534.55	TP93	1.1	290	NE	1.1	Refusal	Gravelly SAND/Sandy GRAVEL and LATERITE BOULDERS
82044.06	275530.79	TP94	0.7	285	NE	0.5	Refusal	Sandy GRAVEL over HARDPAN LATERITE
82208.26	275522.74	TP95	2.9	279	2.8	-	Target depth	Silty SAND over Clayey SAND over Clayey SAND/Sandy CLAY & LATERITE BOULDERS
82056.82	275371.52	TP96	0.2	289	NE	0.2	Refusal	SAND/Gravelly SAND
80809.7	275925	TP97	2.7	268	NE	-	Target depth	SAND/Silty SAND over LATERITE BOULDERS AND COBBLES
80837.15	275828.22	TP98	2.8	273	NE	0.9	Target depth	Silty/Clayey Sandy GRAVEL over HARDPAN LATERITE over Clayey SAND/Sandy CLAY
80968.92	275830.26	TP99	2.8	273	1.0	-	Target depth	Silty/Clayey SAND over Clayey SAND/Sandy CLAY
80988.05	275930.89	TP100	2.8	272	2.2	-	Target depth	Silty SAND over Sandy GRAVEL over Clayey SAND

Notes: 1 – Coordinates are provided using the Perth Coastal Grid (PCG94) projection system.
1 – Ground elevations have been approximated using the 5-m scale contour mapping presented on the Landgate online aerial imagery.
2 – NE – Not encountered.
3 – Depth of Hardpan Laterite refers to the approximate depth to the surface of well to very well cemented Hardpan. These depths do not take into account weaker and variably cemented hardpan or other layers comprising LATERITEGRAVEL, COBBLES OR BOULDERS.
4 – Refusal occurred on inferred, very well cemented Hardpan Laterite.

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Figures

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Legend

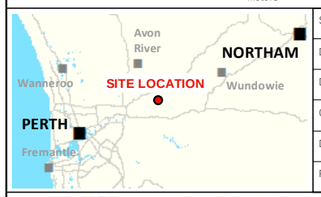
- Test Pit
- Site Boundary

NOTES: Approximate ground elevation contours (RL m AHD) as shown on Landgate online aerial imagery.

N

0 200 400 600 800 1000

Meters



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DRAWN	DAC
DATE DRAWN	31/03/2017
CHECKED	HWC
DATE CHECKED	31/03/2017
PROJECTION	GDA 1994 MGA Zone 50

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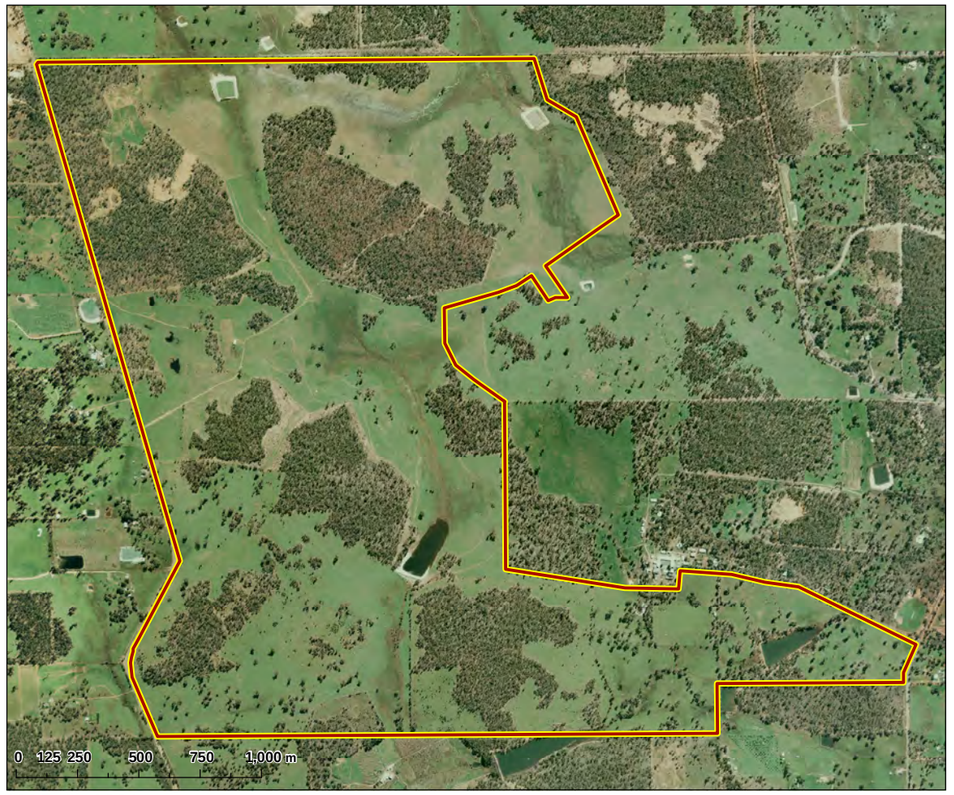
CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	SITE AND LOCATION PLAN
Job No	J1701008
Fig No	FIGURE 1
Rev	**A**

MAP 1 - 1965

MAP 2 - 1974

MAP 3 - 1979



MAP 4 - 1981

LEGEND

Site Boundary

N

0 380 760 1140 1520 1900

Meters

SCALE	1:25,000 (A3)
DRAWN	DAC
DATE DRAWN	14/02/2017
CHECKED	HWC
DATE CHECKED	14/02/2017
PROJECTION	GDA 1994 MGA Zone 50

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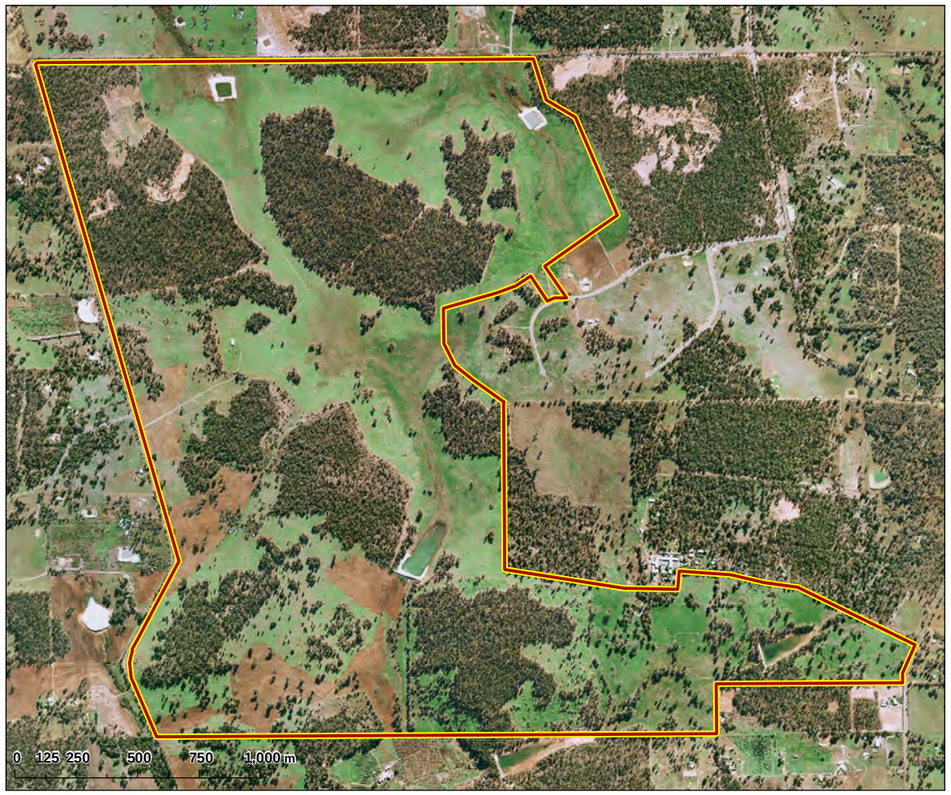
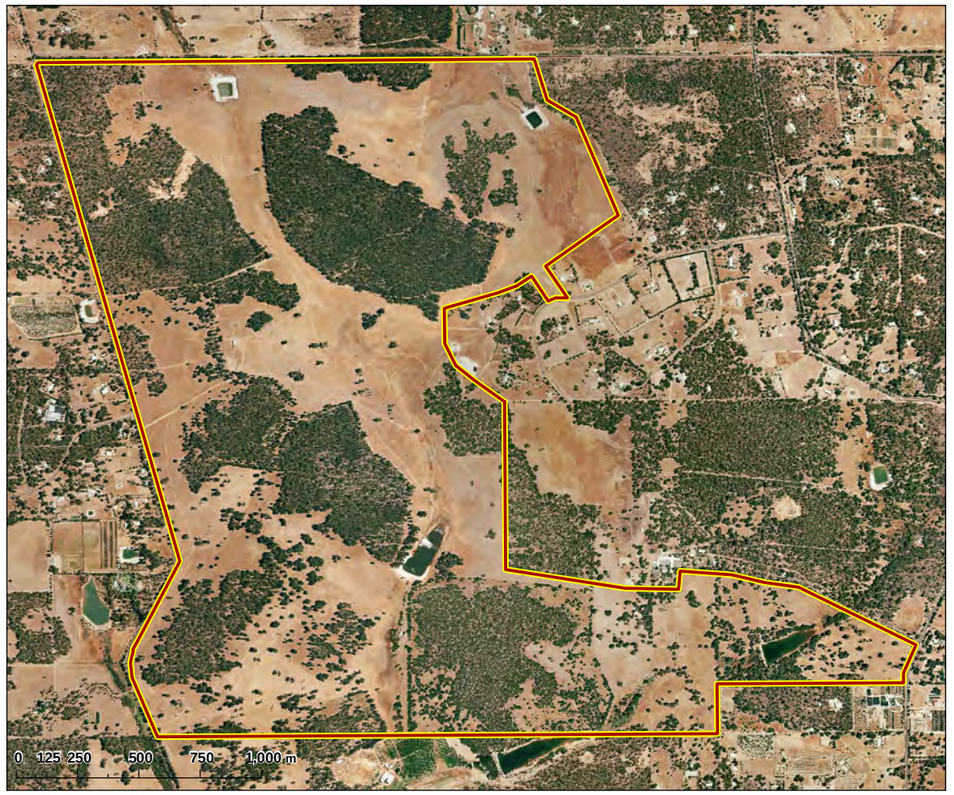
CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (1965 - 1981)

Job No	Fig No	Rev
J1701008	FIGURE 2A	**A**

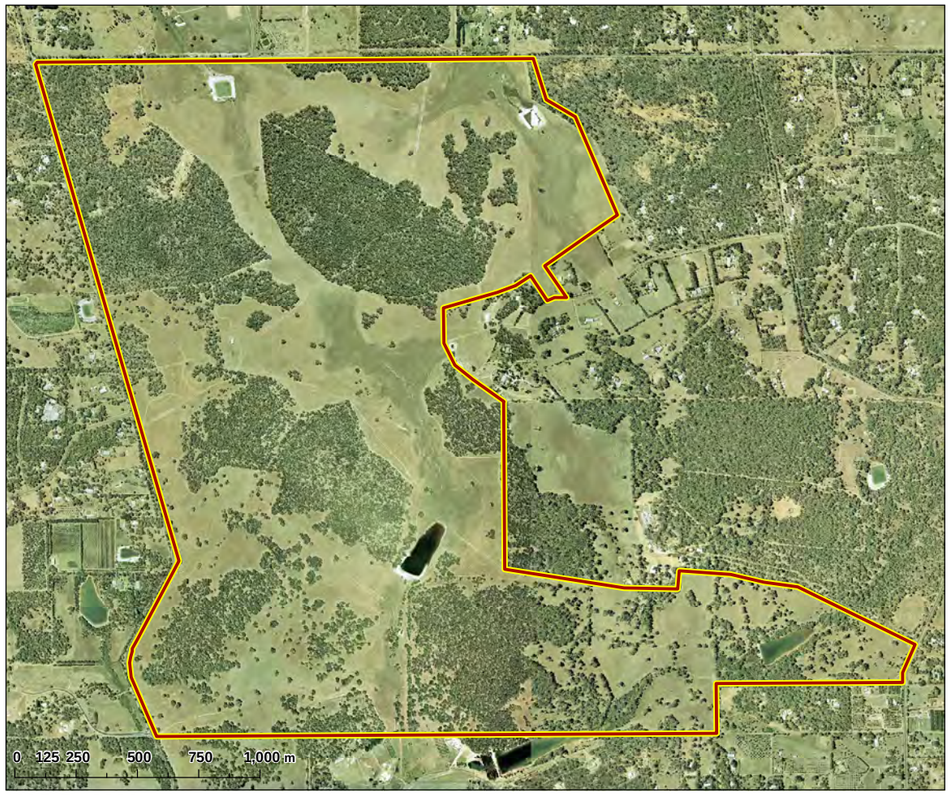
O:\Jobs\2017\J1701008 - C&W SI Stoneville\09 GIS\04 MXD\Aerial\J1701008-A001.mxd (damonclark) 14/02/2017 10:33:42 AM



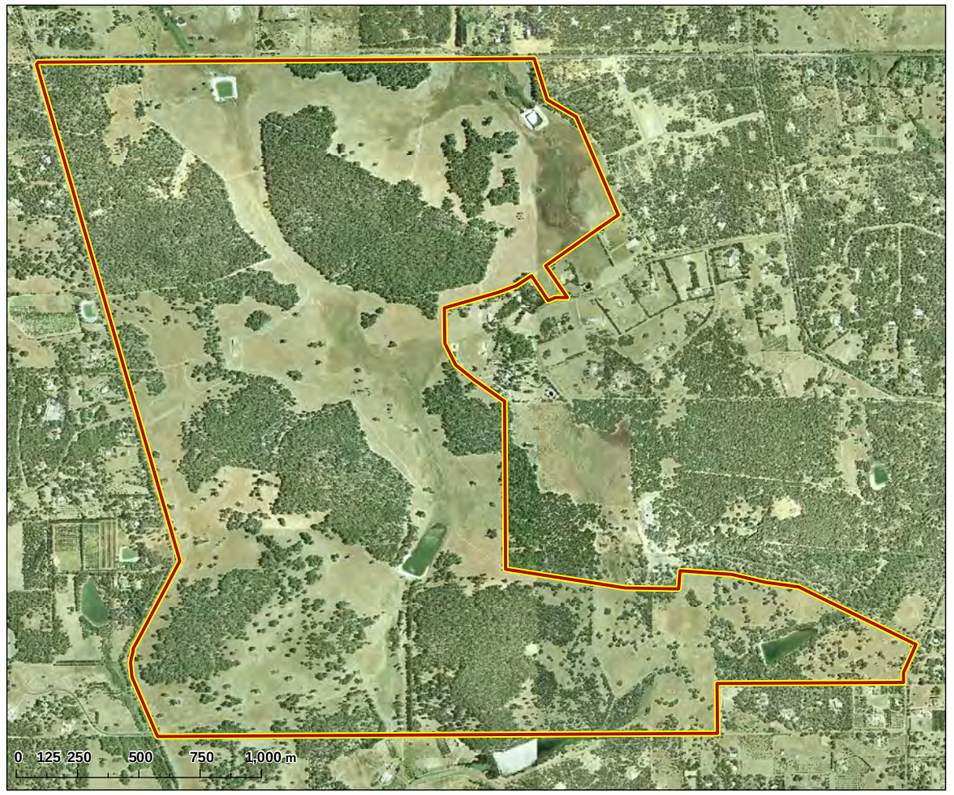
MAP 5 - 1985



MAP 6 - 1995



MAP 7 - 2000



MAP 8 - 2001

LEGEND

Site Boundary

N

0 380 760 1140 1520 1900

Meters

SCALE	1:25,000 (A3)
DRAWN	DAC
DATE DRAWN	14/02/2017
CHECKED	HWC
DATE CHECKED	14/02/2017
PROJECTION	GDA 1994 MGA Zone 50

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CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (1985 - 2001)

Job No	Fig No	Rev
J1701008	FIGURE 2B	**A**

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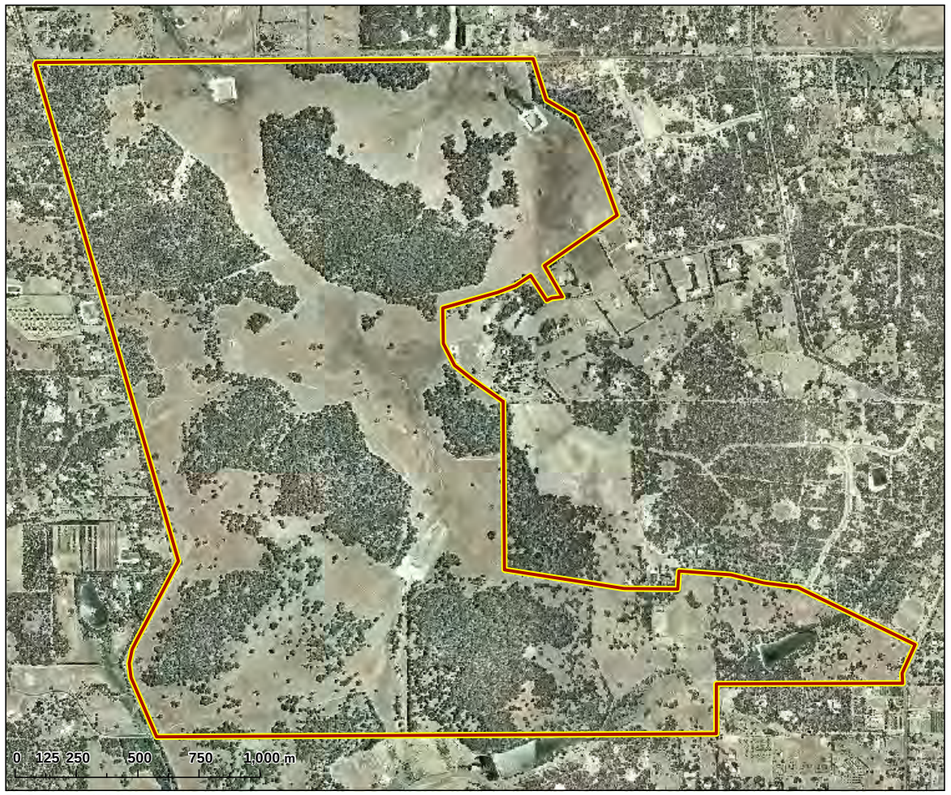
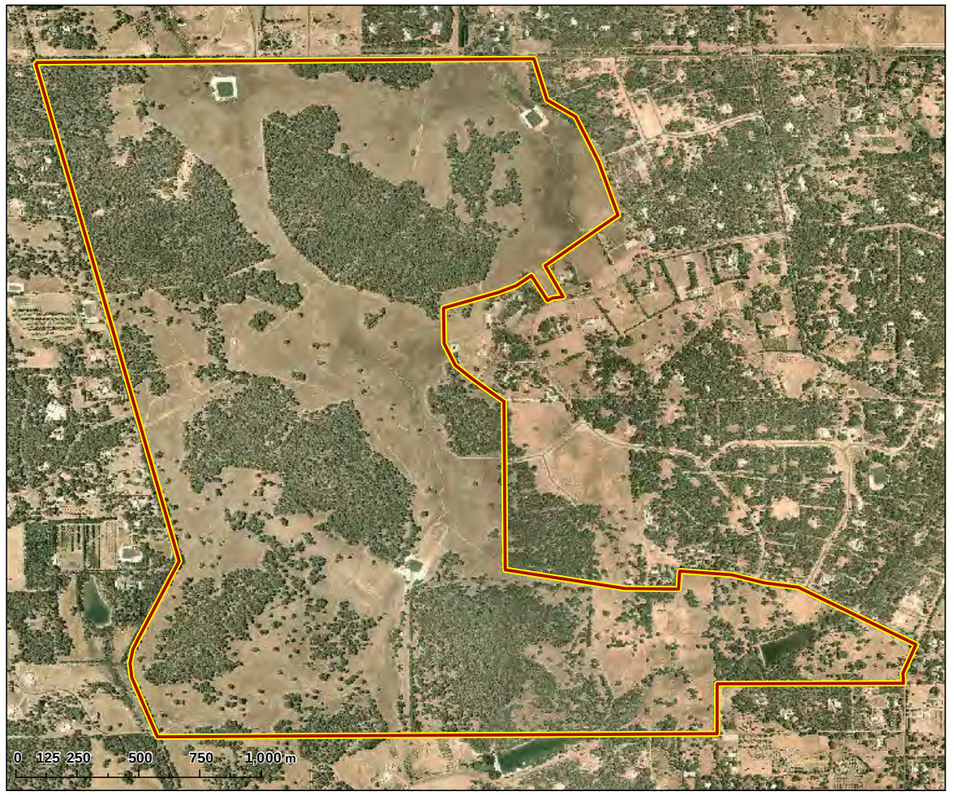
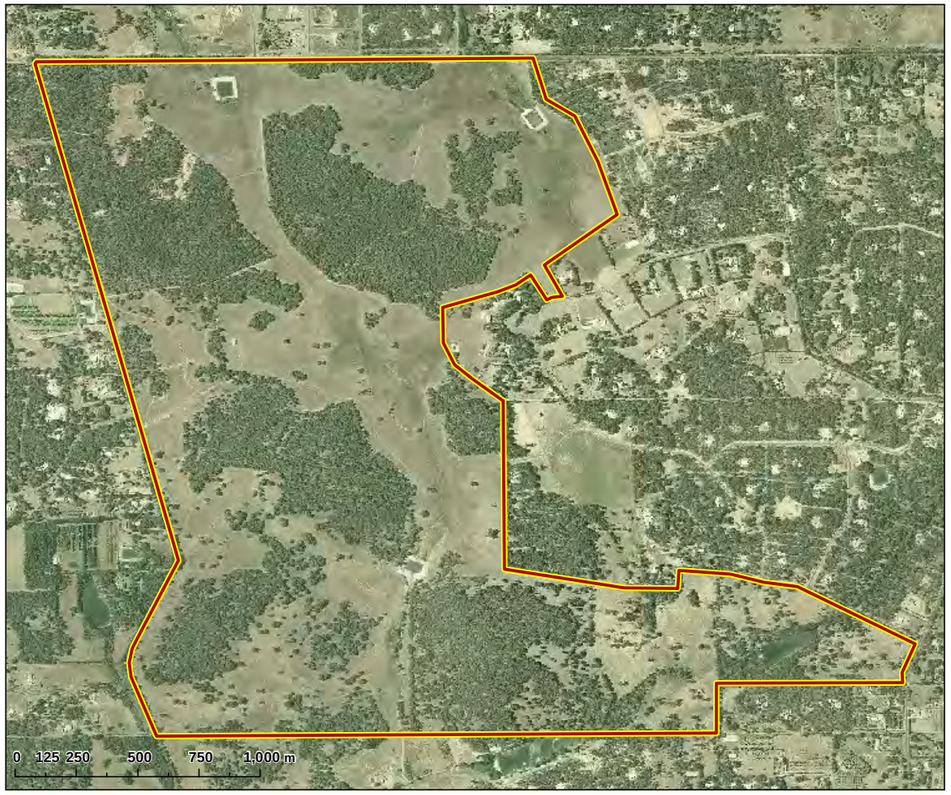


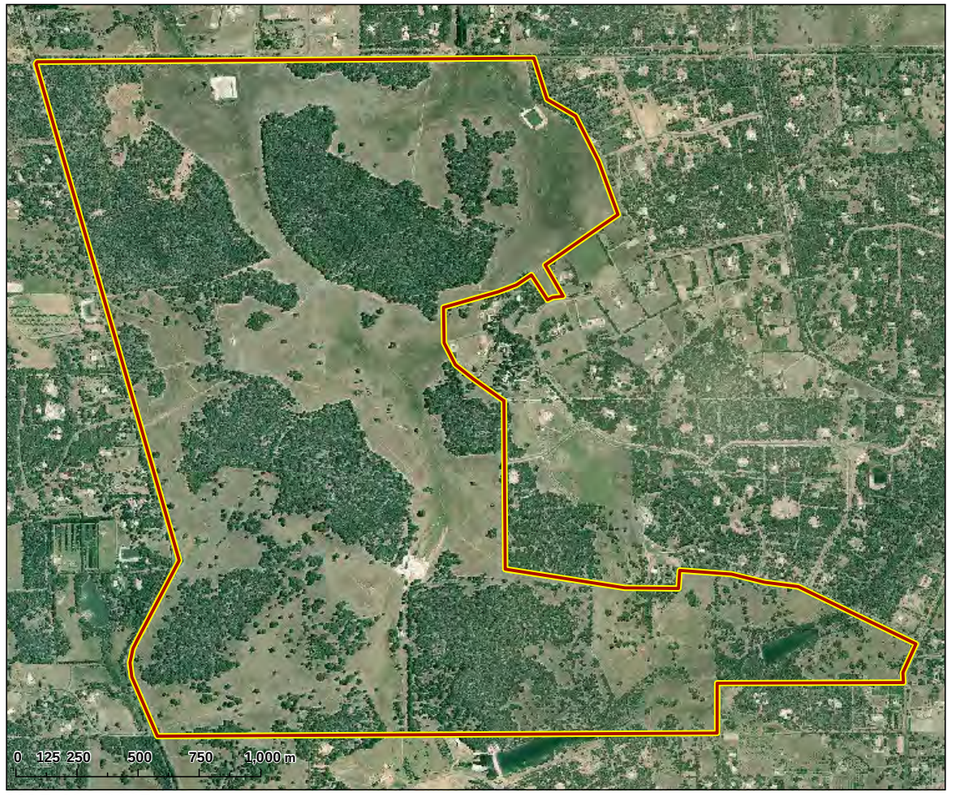
MAP 9 - 2002



MAP 10 - 2003



MAP 11 - 2004



MAP 12 - 2005

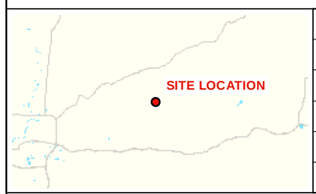
LEGEND

Site Boundary

N

0 380 760 1140 1520 1900

Meters



SCALE	1:25,000 (A3)
DRAWN	DAC
DATE DRAWN	14/02/2017
CHECKED	HWC
DATE CHECKED	14/02/2017
PROJECTION	GDA 1994 MGA Zone 50

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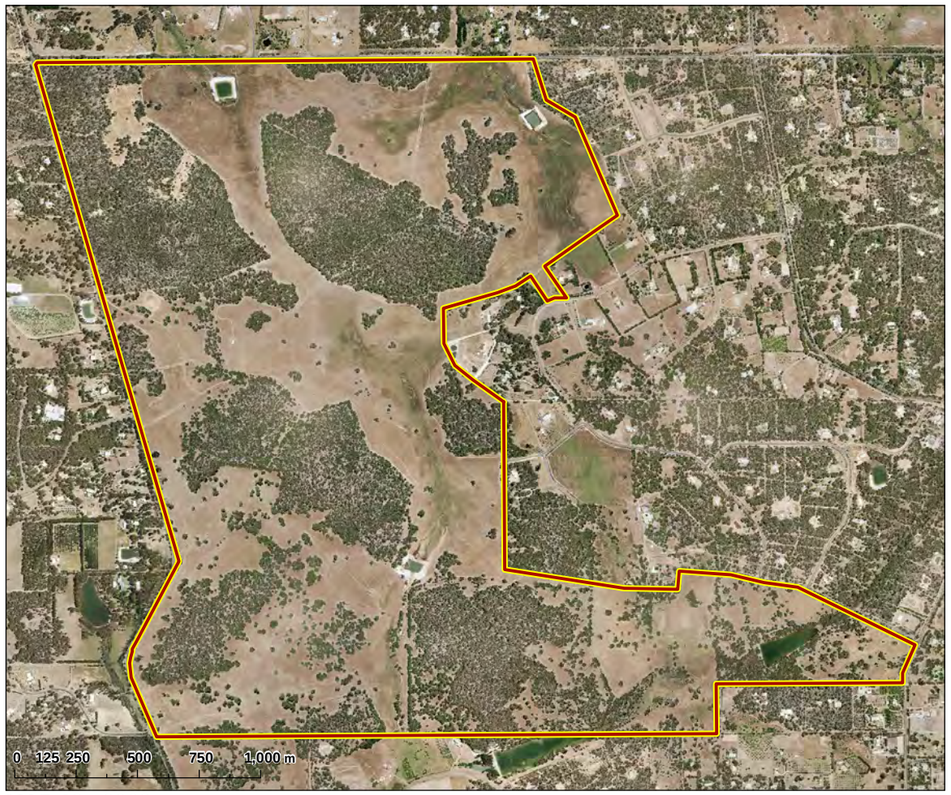
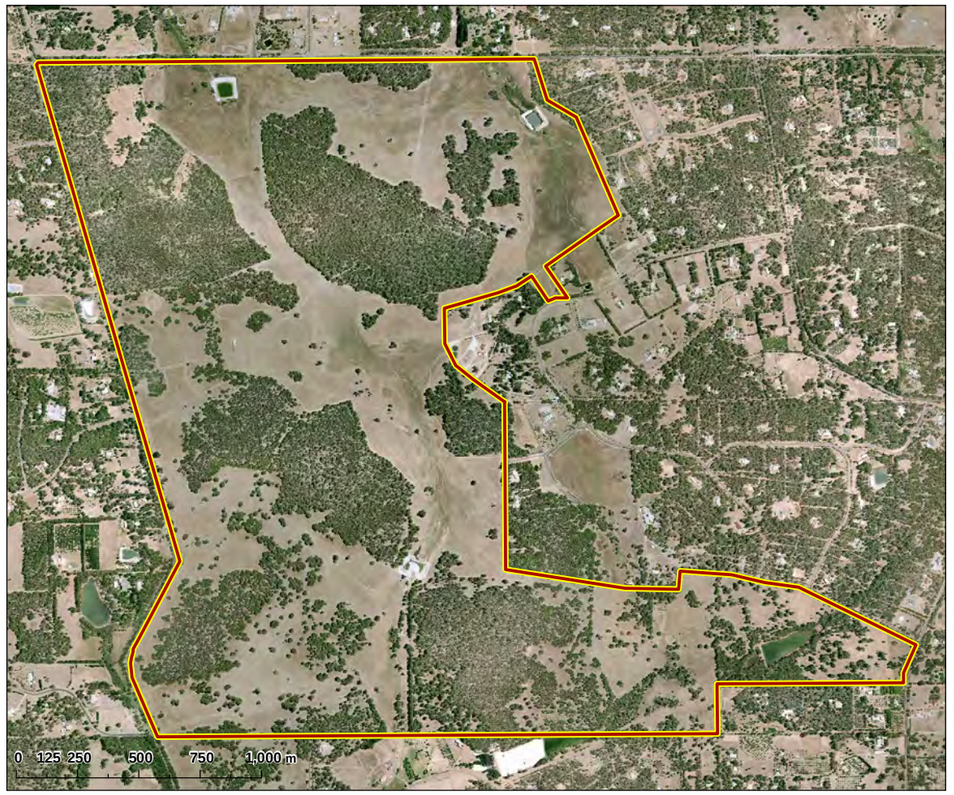
CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (2002 - 2005)

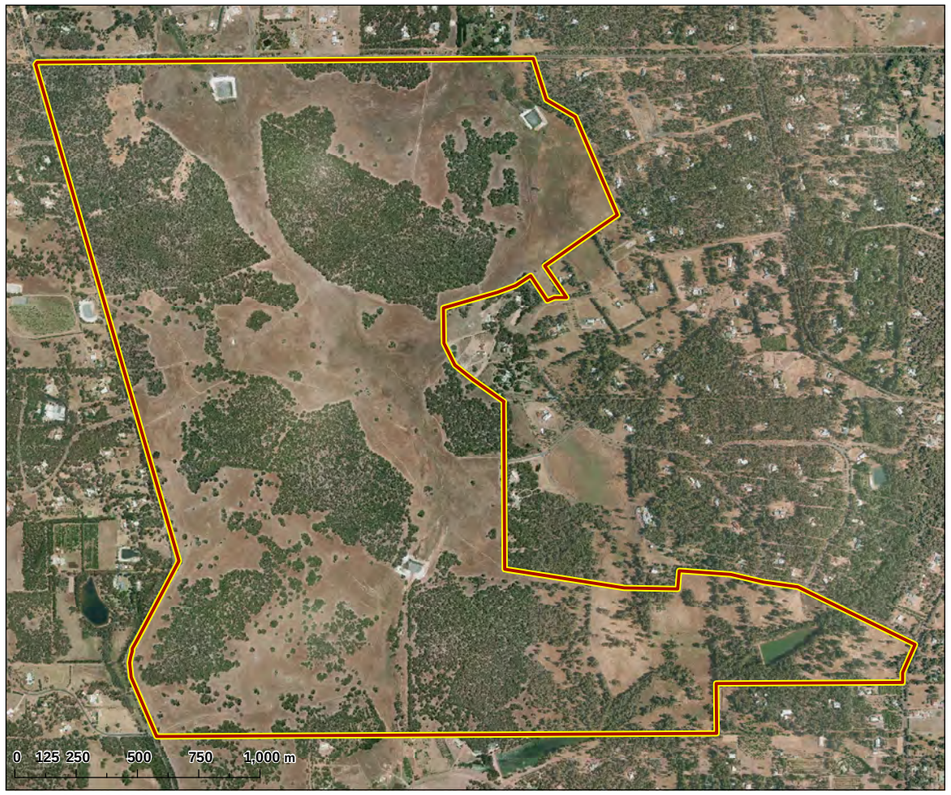
Job No	Fig No	Rev
J1701008	FIGURE 2C	**A**



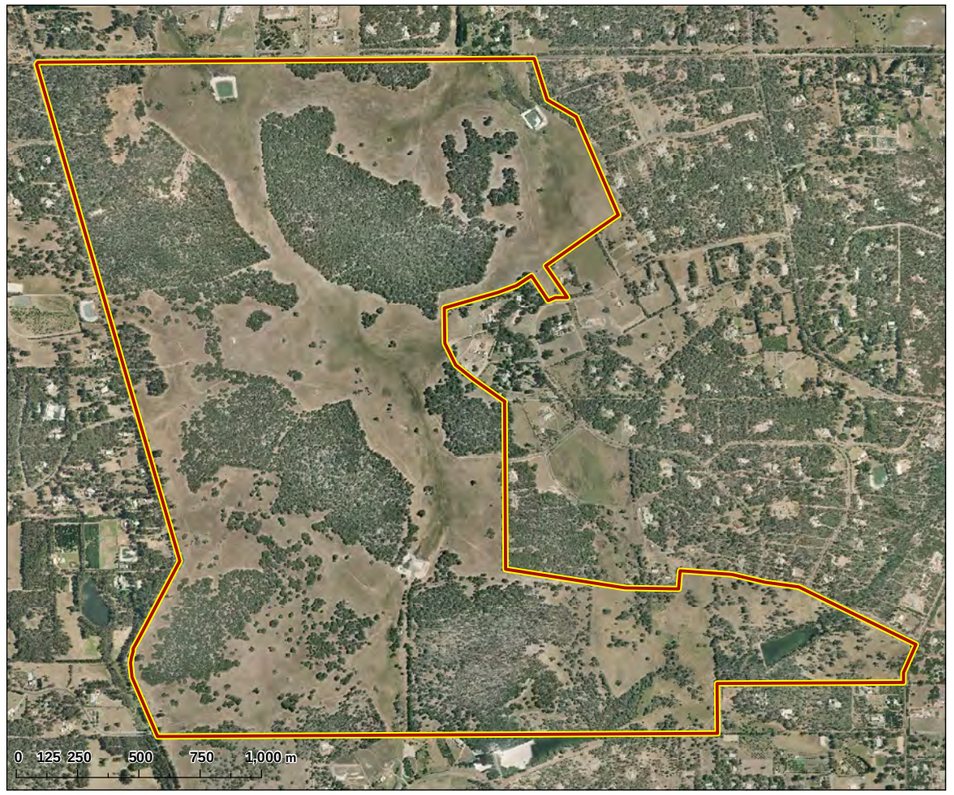
MAP 13 - 2008



MAP 14 - 2007



MAP 15 - 2008



MAP 16 - 2009

LEGEND

Site Boundary

N

0 380 760 1140 1520 1900

Meters

SCALE	1:25,000 (A3)
DRAWN	DAC
DATE DRAWN	14/02/2017
CHECKED	HWC
DATE CHECKED	14/02/2017
PROJECTION	GDA 1994 MGA Zone 50

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CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (2008 - 2009)

Job No	Fig No	Rev
J1701008	FIGURE 2D	**A**

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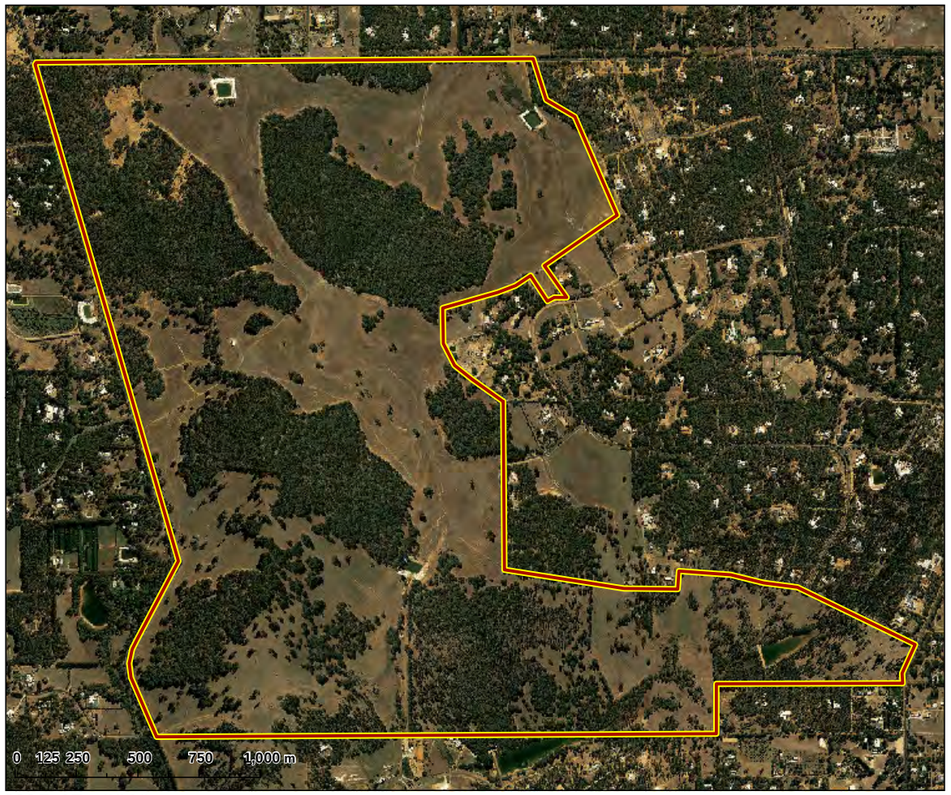
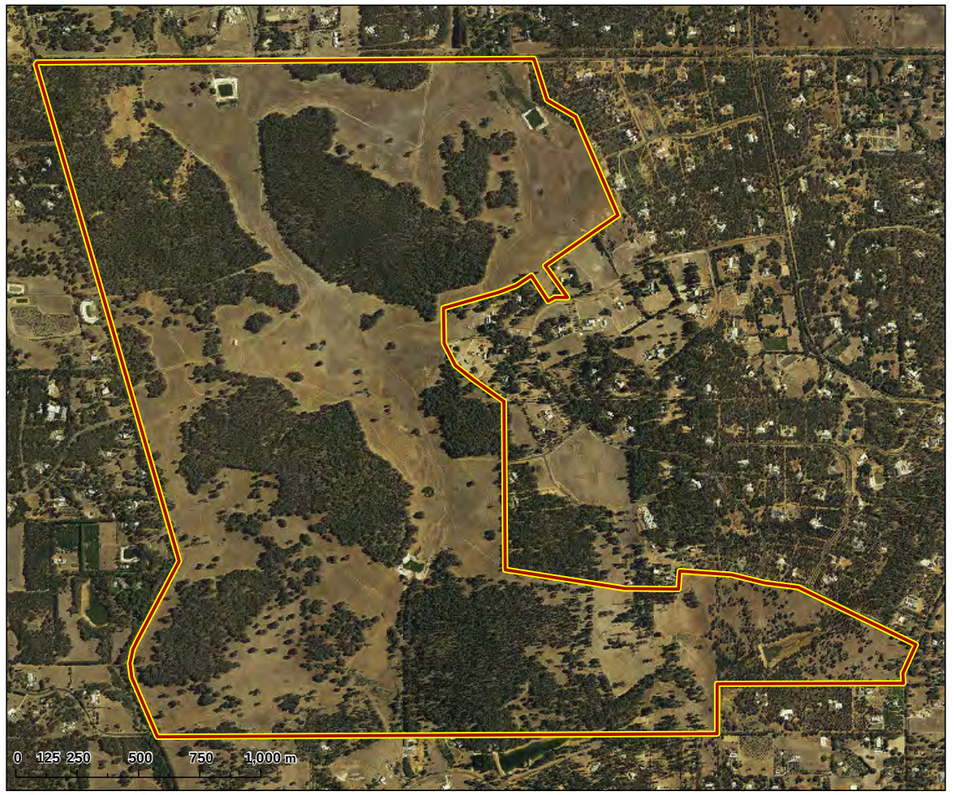
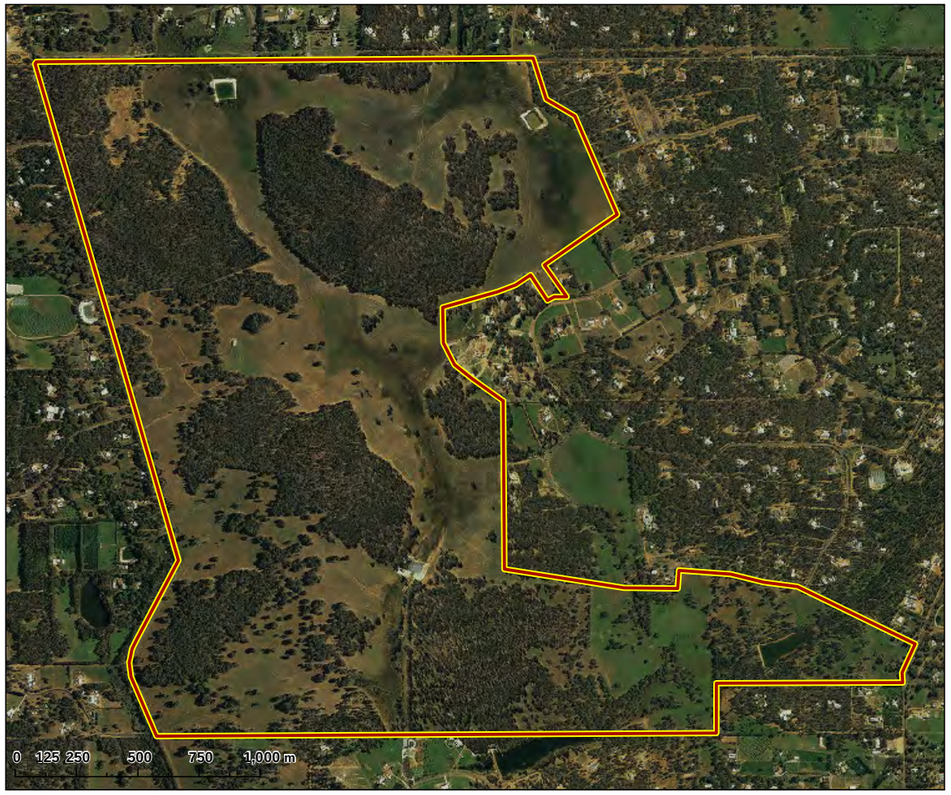


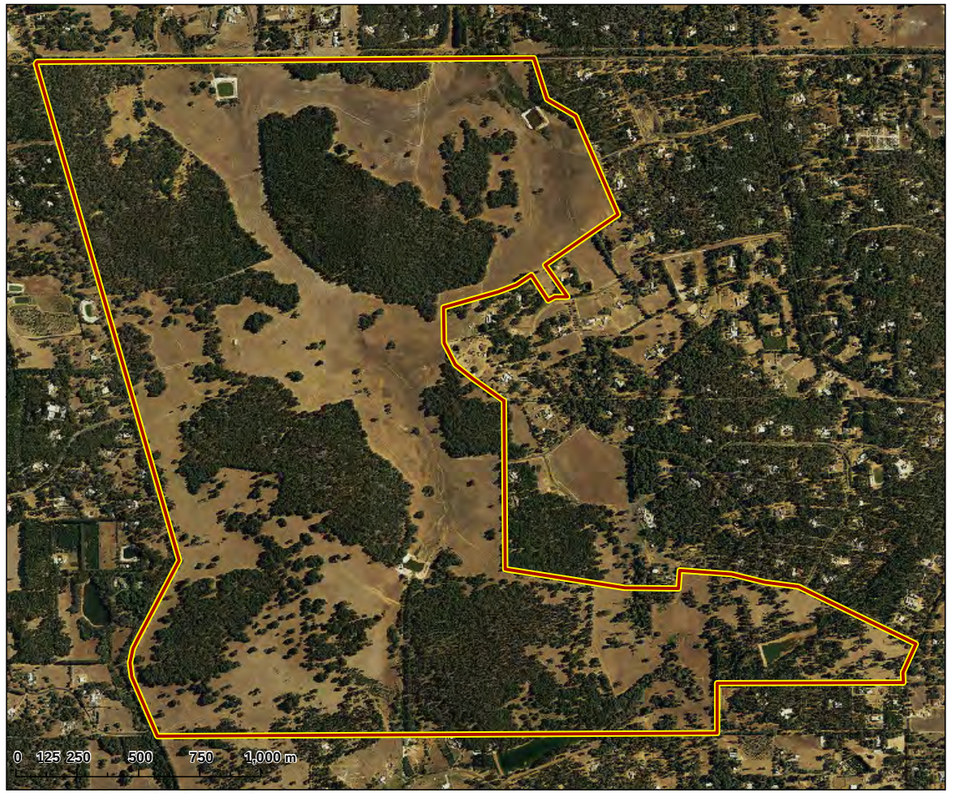
MAP 17 - 2010



MAP 18 - 2011(March)



MAP 19 - 2011(August)



MAP 20 - 2012(February)

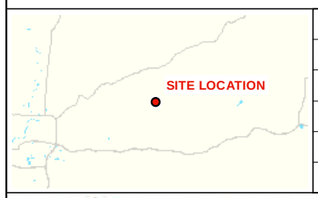
LEGEND

Site Boundary

N

0 390 780 1170 1560 1950

Meters



SCALE	1:25,000 (A3)
DRAWN	DAC
DATE DRAWN	14/02/2017
CHECKED	HWC
DATE CHECKED	14/02/2017
PROJECTION	GDA 1994 MGA Zone 50

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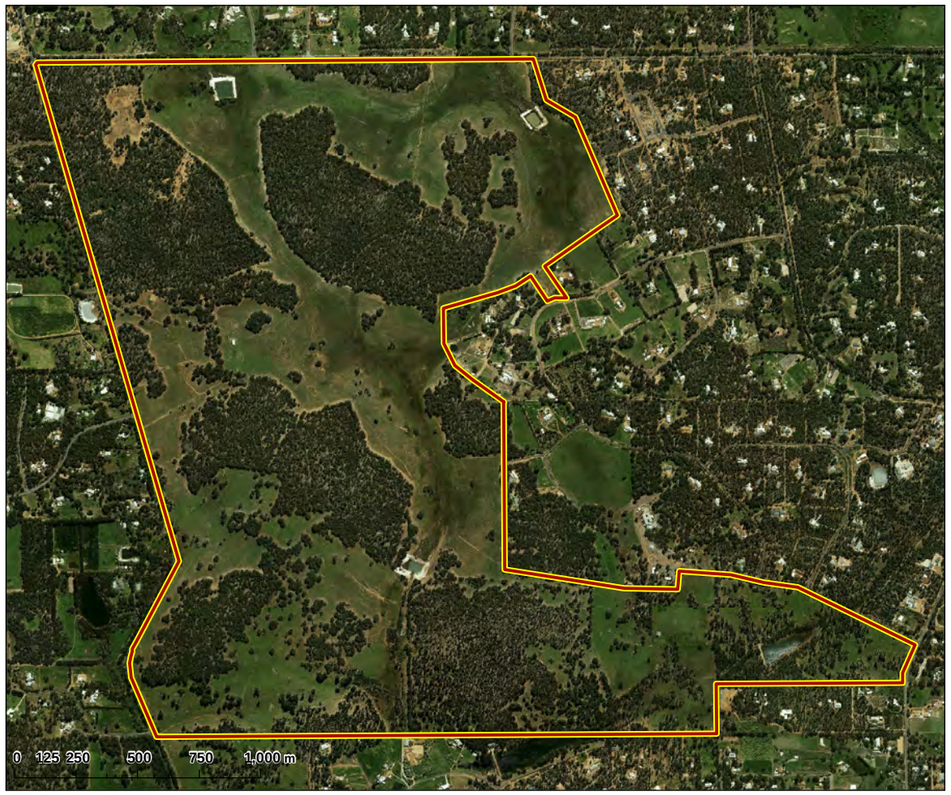
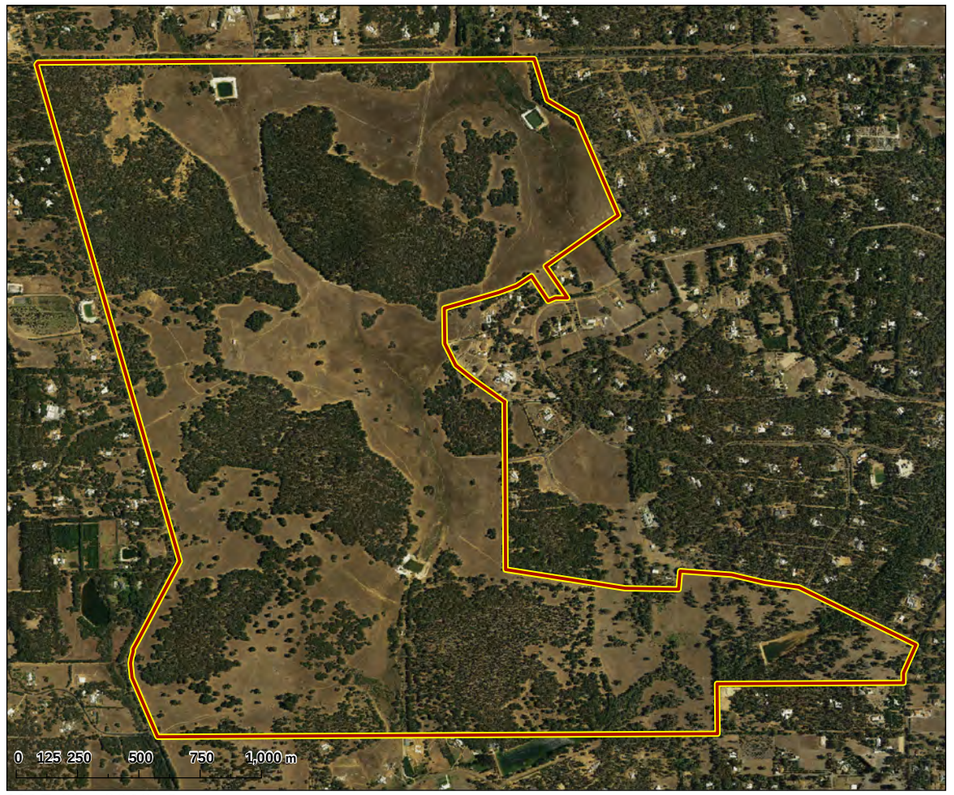
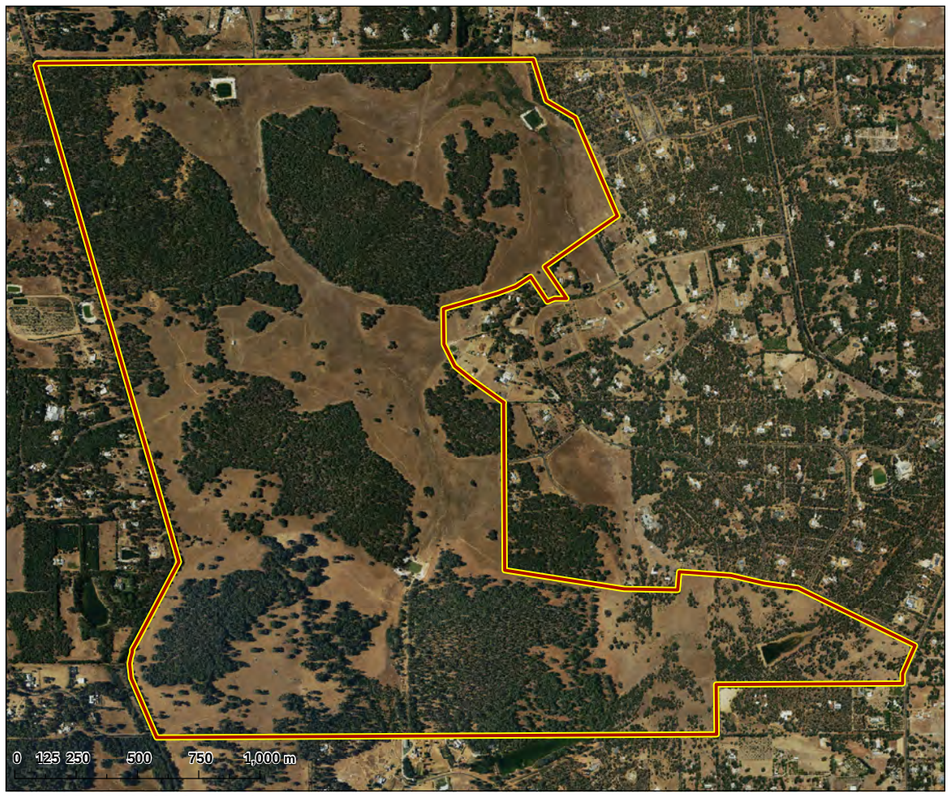
CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (2011(MARCH) - 2012(FEBRUARY))
Job No	J1701008
Fig No	FIGURE 2E
Rev	**A**



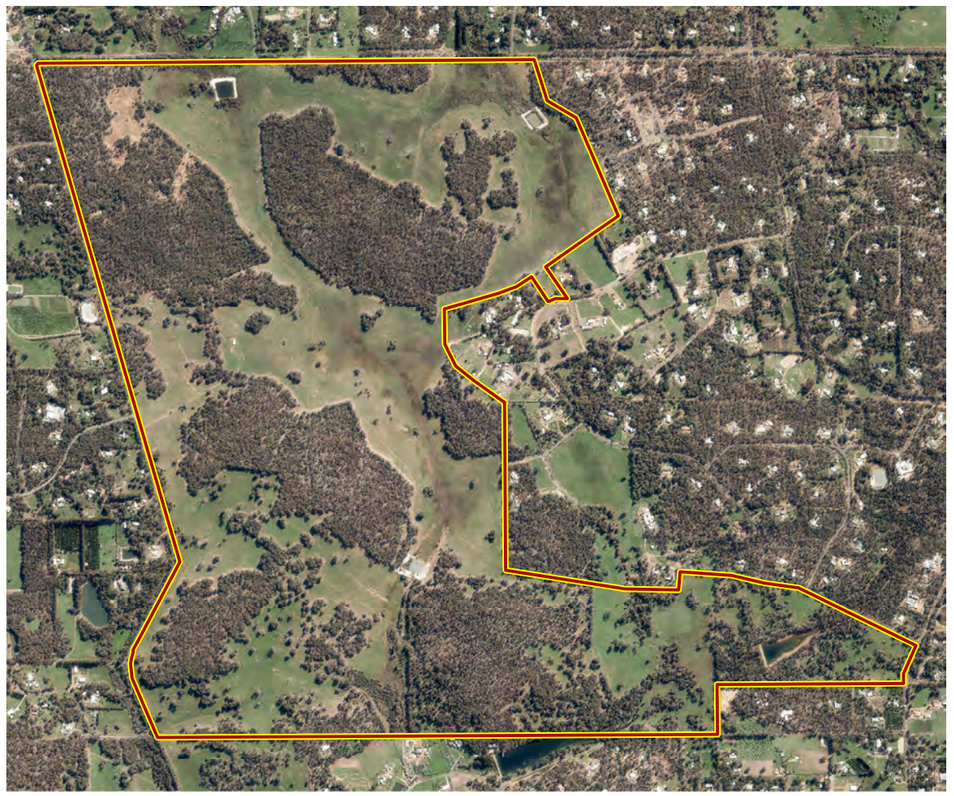
MAP 21 - 2012 (September)



MAP 22 - 2013 (January)



MAP 23 - 2014(February)



MAP 4 - 2014 (August)

LEGEND

Site Boundary

N

0 380 760 1140 1520 1900

Meters

SCALE	1:25,000	(A3)
DRAWN	DAC	
DATE DRAWN	14/02/2017	
CHECKED	HWC	
DATE CHECKED	14/02/2017	
PROJECTION	GDA 1994 MGA Zone 50	

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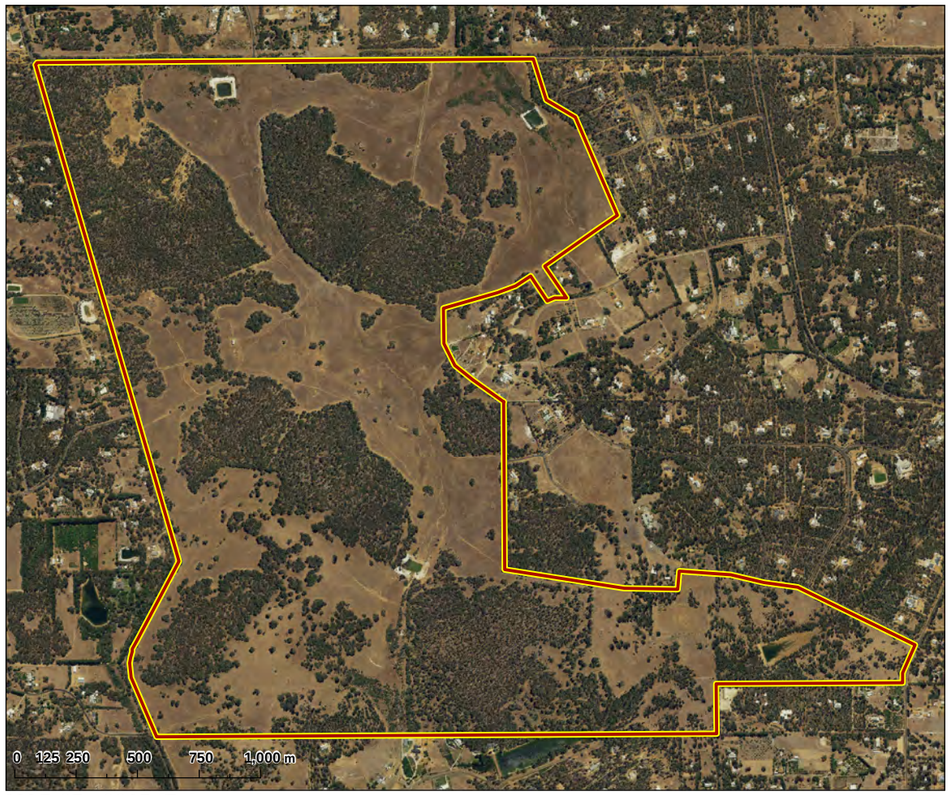
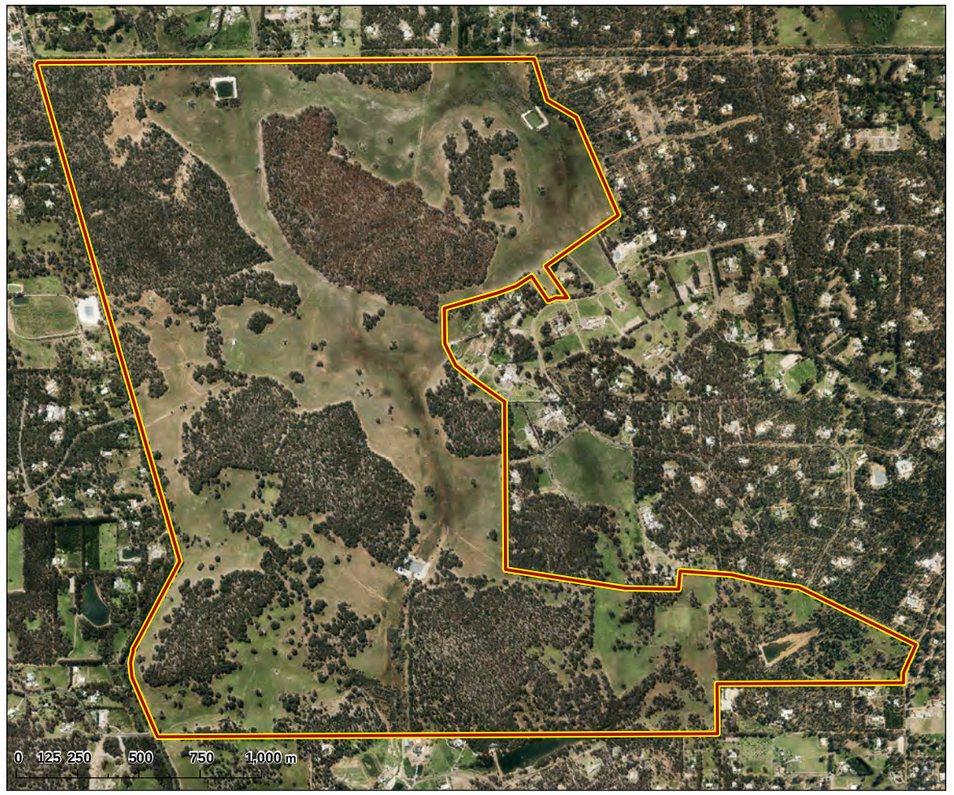
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (2012 (SEPTEMBER) - 2014 (AUGUST))

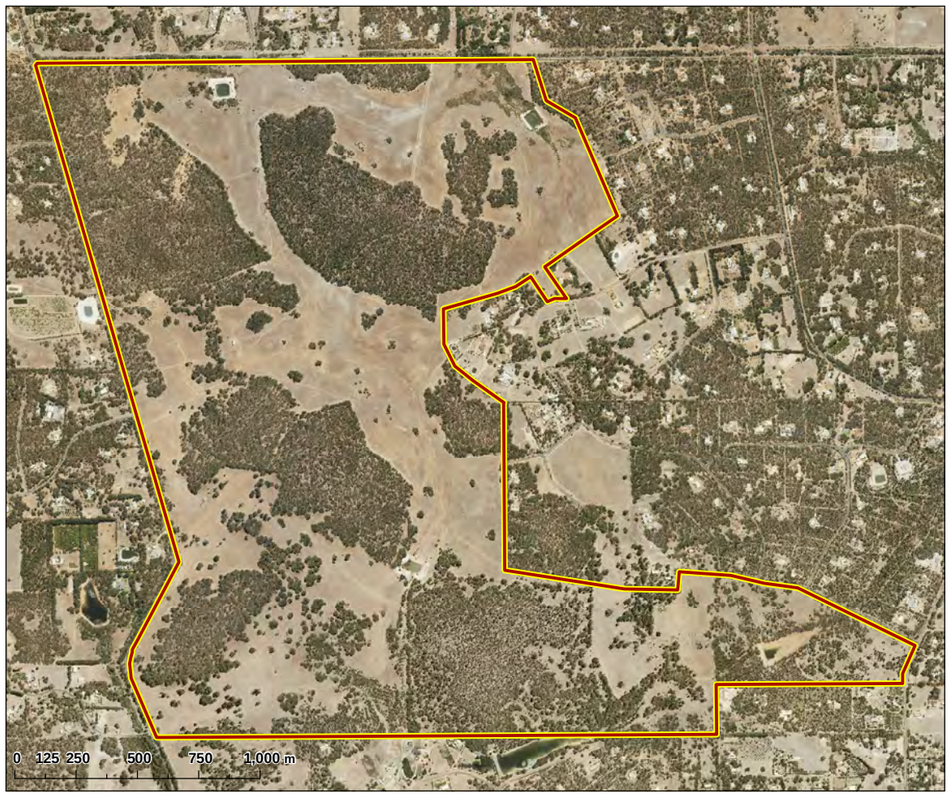
Job No	Fig No	Rev
J1701008	FIGURE 2F	**A**



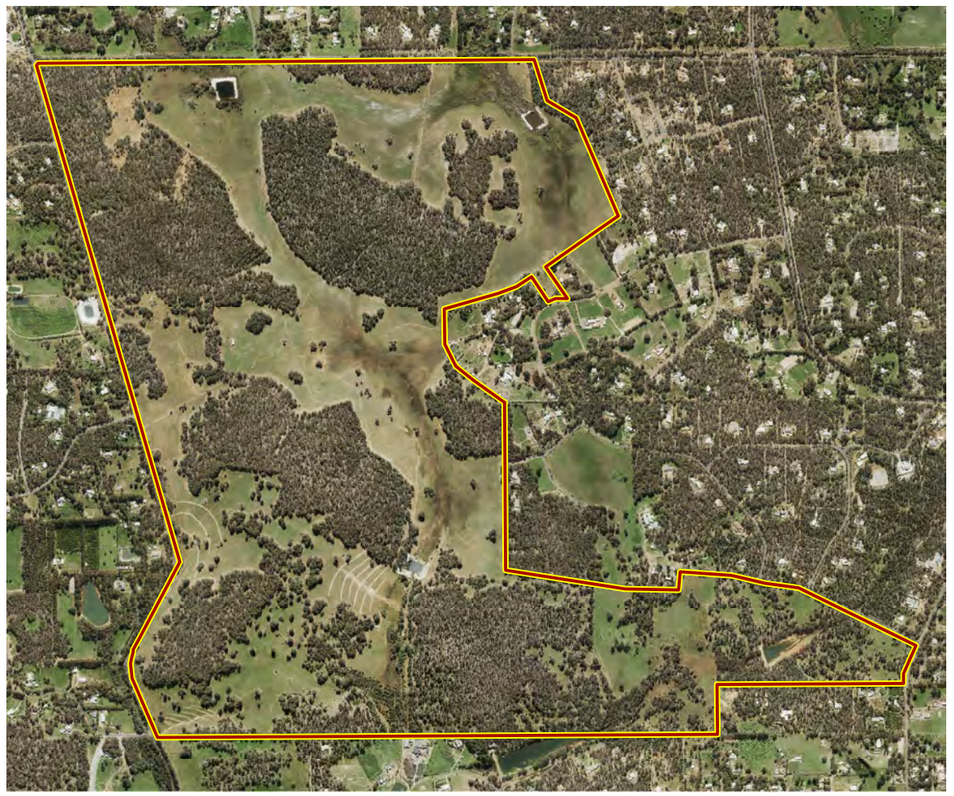
MAP 25 - 2015 (February)



MAP 26 - 2015 (September)



MAP 27 - 2016 (February)



MAP 28 - 2016 (August)

LEGEND

Site Boundary

N

0 380 760 1140 1520 1900

Meters

SCALE	1:25,000	(A3)
DRAWN	DAC	
DATE DRAWN	14/02/2017	
CHECKED	HWC	
DATE CHECKED	14/02/2017	
PROJECTION	GDA 1994 MGA Zone 50	

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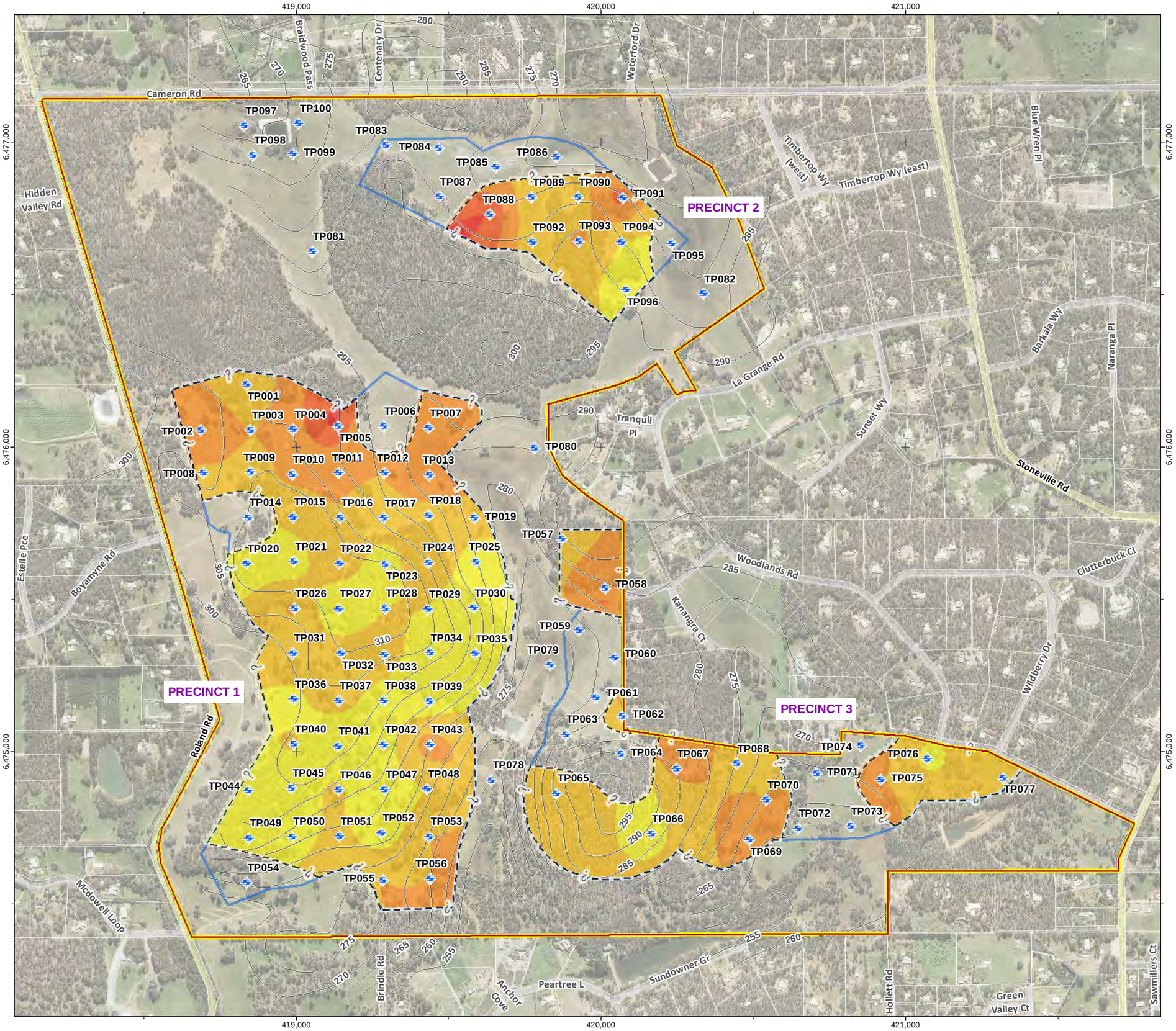
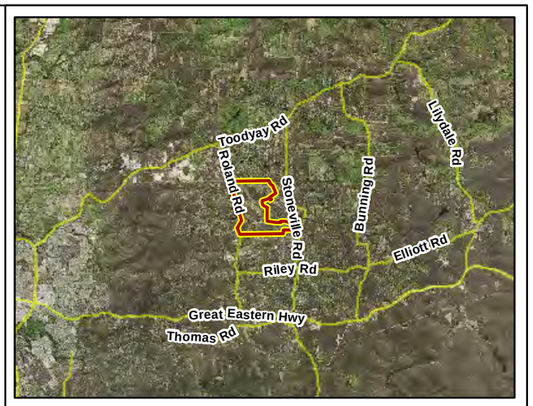
CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (2015 (FEBRUARY) - 2016 (AUGUST))

Job No	Fig No	Rev
J1701008	FIGURE 2G	**A**





Legend

- Test Pit
- Site Boundary

DEPTH TO HARDPAN LATERITE	
Range	Colour
0.00 - 0.50	
0.50 - 1.00	
1.00 - 1.50	
1.50 - 2.00	
2.00 - 2.10	

NOTES: Depth to Hardpan Laterite refers to the broadly approximated depth to well to very well cemented Hardpan Laterite. The approximated depths do not take into account areas comprising shallow Lateritic GRAVEL, COBBLES OR BOULDERS. The accuracy of this mapping is limited by the number of test pits and the variability of the Hardpan Laterite profile.

N

0 200 400 600 800 1000
Meters

SCALE	1:12,500 (A3)
DRAWN	DAC
DATE DRAWN	30/03/2017
CHECKED	HWC
DATE CHECKED	30/03/2017
PROJECTION	GDA 1994 MGA Zone 50

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CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	DEPTH TO HARDPAN LATERITE
Job No	J1701008
Fig No	FIGURE 3
Rev	**A**

O:\Jobs\2017\J1701008 - C&W SI Stoneville\09 GIS\04 MXD\J1701008-003.mxd (DamonClark) 30/03/2017 2:49:38 PM

Appendix A: Photographs

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ABN: 64 625 054 729

Photograph 1: Test pit excavation on north-west corner of Precinct 1

Photograph 2: Typical Lateritic Boulders and Shallow Hardpan Laterite on north-western part of Precinct 1

Photograph 3: Open area on the eastern part of Precinct 1

Photograph 4: Typical Shallow Hardpan Laterite

Photograph 5: Typical surface conditions over Precinct 3

Photograph 6: Typically clayey soils (extremely weathered granitic rock) encountered in Precinct 3

Photograph 7: Dam on the southern part of Precinct 1

Photograph 8: Dam near the south-east corner of Precinct 3

Photograph 9: Outcrops and scattered cobbles and boulders of Cemented Laterite over southern part of Precinct 1

Photograph 10: Water-course on south-eastern part of Precinct 1

Appendix B: Test Pit Reports

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METHOD OF SOIL DESCRIPTION
BOREHOLE AND TEST PIT REPORTS

GRAPHIC LOG & UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) SYMBOLS

Graphic	USCS	Soil Name
		FILL (various types)
		COBBLES
		BOULDERS
	GP	GRAVEL (poorly graded)
	GW	GRAVEL (well graded)
	GC	Clayey GRAVEL
	SP	SAND (poorly graded)
	SW	SAND (well graded)
	SC	Clayey SAND

Graphic	USCS	Soil Name
	SM	Silty SAND
	ML	SILT (low liquid limit)
	MH	SILT (high liquid limit)
	CL	CLAY (low plasticity)
	CI	CLAY (medium plasticity)
	CH	CLAY (high plasticity)
	OL	Organic SILT (low liquid limit)
	OH	Organic SILT (high liquid limit)
	Pt	PEAT

RESISTANCE TO EXCAVATION

Symbol	Term	Description
VE	Very easy	All resistances are relative to the selected method of excavation
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

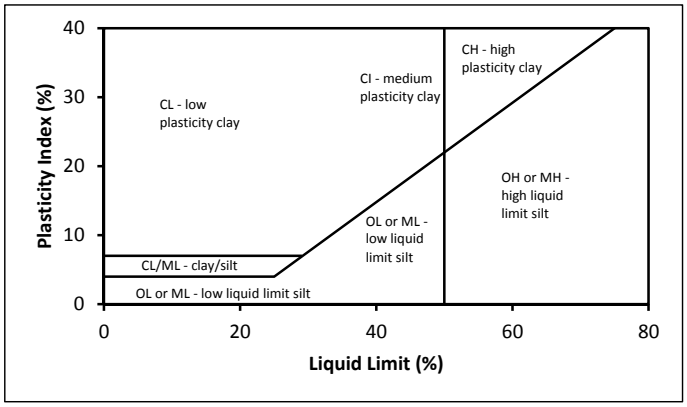
SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726-1993, Appendix A. Material properties are assessed in the field by visual/tactile methods in combination with field testing techniques (where used).

PARTICLE SIZE

Soil Name		Particle Size (mm)
BOULDERS		>200
COBBLES		63 to 200
GRAVEL	Coarse	20 to 63
	Medium	6 to 20
	Fine	2 to 6
SAND	Coarse	0.6 to 2.0
	Medium	0.2 to 0.6
	Fine	0.075 to 0.2
FINES	SILT	0.002 to 0.075
	CLAY	<0.002

PLASTICITY PROPERTIES



MOISTURE CONDITION

AS1726-1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726-1993 and HB160-2006

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N"	DCP blows per 100 mm
VS	Very Soft	0 to 12	0 to 2	<1
S	Soft	12 to 25	2 to 4	<1
F	Firm	25 to 50	4 to 8	1 to 2
St	Stiff	50 to 100	8 to 15	3 to 4
VSt	Very Stiff	100 to 200	15 to 30	5 to 10
H	Hard	>200	>30	>10

Symbol	Term	Density Index (%)	SPT "N"	DCP blows per 100 mm	PSP Blows per 300 mm
VL	Very Loose	<15	0 to 4	<1	0 to 2
L	Loose	15 to 35	4 to 10	1 to 2	2 to 6
MD	Medium Dense	35 to 65	10 to 30	2 to 3	6 to 8
D	Dense	65 to 85	30 to 50	4 to 8	8 to 15
VD	Very Dense	>85	>50	>8	>15

Note: PSP correlations only valid to 450 mm depth

Consistency and density may also be inferred from excavation performance and material behaviour.

ROCK STRENGTH, WEATHERING AND DEFECTS

STRENGTH

SYMBOL	STRENGTH	PLI, $I_{s(50)}$	Typical UCS	TYPICAL DESCRIPTORS
EL	Extremely Low	≤0.03	≤0.7	Easily remoulded by hand to form a soil
VL	Very Low	0.03-0.1	0.7-2.4	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; too hard to cut triaxial samples by hand. Pieces up to 30 mm thick can be broken by finger pressure
L	Low	0.1-0.3	2.4-7	Easily scored with a knife; indentations 1-3 mm show in the specimen with firm blows of the pick point; has dull thud under hammer. A piece of core 150 mm long x 50 mm dameter may be broken by hand. Sharp edges of core may be friable and break during handling
M	Medium	0.3-1.0	7-24	Readily scored with a knife; a piece of core 150 mm long x 50 mm diameter can be broken by hand with difficulty
H	High	1.0-3.0	24-70	A piece of core 150 mm long x 50 mm diameter cannot be broken by hand but can be broken by a pick with a single blow; rock rings under hammer
VH	Very High	3.0-10.0	70-240	Hand specimen breaks with pick after more than 1 blow; rock rings under hammer
EH	Extremely High	≥10.0	≥240	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer

PLI: Point Load Index (MPa) UCS: Uniaxial Compressive Strength (MPa)
Note: Rock strength is defined in accordance with PLI. The relationship between PLI and UCS varies depending on rock type, weathering, etc. UCS is typically 24 x $I_{s(50)}$ (may range from 10-30 x $I_{s(50)}$ but possibly lower for carbonate rocks)

WEATHERING

SYMBOL	TERM	TYPICAL DESCRIPTORS
RS	Residual Soil	Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; the soil has not been significantly transported.
EW	Extremely Weathered	The rock has weathered to such an extent that it has 'soil' properties i.e. it either disintegrates or can be remoulded in water. Fabric of original rock still evident.
HW	Highly Weathered	Rock strength is changed by weathering. The whole of the rock mass is discoloured, usually by iron staining or bleaching such that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to deposition of weathering products in pores.
MW	Moderately Weathered	The whole of the rock mass is discoloured, usually by iron staining or bleaching such that the colour of the original rock is not recognisable.
SW	Slightly Weathered	Rock is slightly discoloured but shows little or no change of strength from fresh rock
Fr	Fresh	Rock shows no sign of decomposition or staining

Note: The terms HW and MW are not used by AS 1726. The standard uses the term Distinctly Weathered instead to cover this range of weathering.

ROCK DEFECTS

SYMBOL	DESCRIPTION	COATING / INFILLING		ROUGHNESS		PLANARITY	
J	Joint	Cn	Clean	Sl	Slickensided	Pl	Planar
B	Bedding	St	Stained	Sm	Smooth	Cr	Curved
F	Foliation	Vn	Veneer	Ro	Rough	Un	Undulating
C	Contact	Ct	Coating	VR	Very rough	St	Stepped
Cl	Cleavage					Ir	Irregular
SZ	Shear Zone						
V	Vein						
IS	Infilled seam						
DI	Drilling induced break						

CORE RUN DETAILS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
TCR	Total Core Recovery	RQD	Rock Quality Designation	TOR	Top of Run
SCR	Solid Core Recovery			BOR	Bottom of Run

METHOD OF CEMENTATION CLASSIFICATION
BOREHOLE AND TEST PIT REPORTS

Cementation Classification System For Cemented Granular Materials

Cementation Classification	Description
Uncemented	No cementation present
Very weakly Cemented	Near uncemented sand
Weakly Cemented	Very low strength rock, fragments can be crushed between fingers
Moderately Cemented	Low strength rock, easily scratched, generally friable, rock core can be broken by hand
Well Cemented	Medium strength rock, can be scratched with thumbnail, requires substantial hand effort to break core
Very well cemented	Typically high strength rock, cannot be scratched easily, core can be broken with blow from hammer

EXPLANATORY NOTES TO BE READ WITH BOREHOLE AND TEST PIT REPORTS

METHOD OF DRILLING OR EXCAVATION

AC	Air Core	E	Excavator	PQ3	PQ3 Core Barrel
AD/T	Auger Drilling with TC-Bit	EH	Excavator with Hammer	PT	Push Tube
AD/V	Auger Drilling with V-Bit	HA	Hand Auger	R	Ripper
AT	Air Track	HMLC	HMLC Core Barrel	RR	Rock Roller
B	Bulldozer Blade	HQ3	HQ3 Core Barrel	SON	Sonic Rig
BH	Backhoe Bucket	N	Natural Exposure	SPT	Driven SPT
CT	Cable Tool	NMLC	NMLC Core Barrel	WB	Washbore
DT	Diatube	PP	Push Probe	X	Existing Excavation

SUPPORT

T	Timbering

PENETRATION EFFORT (RELATIVE TO THE EQUIPMENT USED)

VE	Very Easy	E	Easy	F	Firm
H	Hard	VH	Very Hard		

WATER

►	Water Inflow	▼	Water Level
◄	Water Loss (complete)		
◁	Water Loss (partial)		

SAMPLING AND TESTING

B	Bulk Disturbed Sample	P	Piston Sample
BLK	Block Sample	PBT	Plate Bearing Test
C	Core Sample	U	Undisturbed Push-in Sample
CBR	CBR Mould Sample		U50: 50 mm diameter
D	Small Disturbed Sample	SPT	Standard Penetration Test
ES	Environmental Soil Sample		Example: 3, 4, 5 N=9
EW	Environmental Water Sample		3,4,5: Blows per 150 mm
G	Gas Sample		N=9: Blows per 300 mm after
HP	Hand Penetrometer		150 mm seating interval
LB	Large Bulk Disturbed Sample	VS	Vane Shear; P = Peak
M	Mazier Type Sample		R = Remoulded (kPa)
MC	Moisture Content Sample	W	Water Sample

ROCK CORE RECOVERY

TCR = Total Core Recovery (%) $= \frac{CRL}{TCL} \times 100$

SCR = Solid Core Recovery (%) $= \frac{CCR}{TCL} \times 100$

RQD = Rock Quality Designation (%) $= \frac{ALC>100}{TCL} \times 100$

TCL	Length of Core Run
CRL	Recovered Length of Core
CCR	Total Length of Cylindrical Pieces of Core Recovered
ALC>100	Total Length of Axial Lengths of Core Greater than 100 mm Long

TEST PIT: TP01

Job Number:	J1701008	**Easting:**	80808 m	**Contractor:**	ANH Contracting	**Date:**	01/02/2017
Client:	Cossill & Webley	**Northing:**	275075 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Gravelly Silty SAND: medium grained, dark brown becoming orange brown, with approximately 30-40% fine sub-angular to rounded gravel, with approximately 20% non-plastic fines, trace roots up to 20 mm diameter to 0.5 m depth, isolated hardpan laterite boulders, low strength, up to 1.0 m long, to 1.0 m depth	M	L	Depth of soil varies from 0.6 m to 1.0 m
			0.5									
	VH		1.0						HARDPAN LATERITE: very high strength, moderately weathered, pale grey mottled orange-brown and dark red, sand sized quartz fragments, inferred laterised residual granite			
			1.5						Hole terminated at 1.00 m Refusal on hardpan LATERITE Groundwater not encountered			
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									
			5.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP02

Job Number:	J1701008	**Easting:**	80656 m	**Contractor:**	ANH Contracting	**Date:**	01/02/2017
Client:	Cossill & Webley	**Northing:**	274927 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0 – 0.5					SM	Gravelly Silty SAND: medium grained, dark brown becoming orange-brown, with approximately 30-40% fine grained, sub-angular to rounded gravel, with approximately 20% non-plastic fines, trace rootlets to 0.1 m depth	M	MD	
			0.5 – 1.0					GP-GM	GRAVEL: fine grained, occasionally medium to coarse grained, pale brown, with approximately 10-20% medium sand, with some non-plastic fines		L	
	H		1.0 – 2.5						HARDPAN LATERITE: low strength, very well iron cemented, variably mottled pale grey, dark red-brown and orange-brown, gravel size pisolites and sand/gravel size quartz, isolated zones of pale grey quartz sand/gravel, inferred laterised residual granite			
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP03

Job Number:	J1701008	**Easting:**	80820 m	**Contractor:**	ANH Contracting	**Date:**	01/02/2017
Client:	Cossill & Webley	**Northing:**	274926 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0 – 0.5					SM	Gravelly Silty SAND: medium grained, dark brown becoming orange brown, with approximately 30-40% fine to medium grained gravel, with approximately 20% non-plastic fines, trace rootlets to 0.1 m depth, gravel content increasing with depth	M	MD	
			0.5 – 1.0					GP-GM	GRAVEL: fine to medium grained, sub-angular to rounded, pale brown, with approximately 10-20% medium grained sand, with some non-plastic fines			
	VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled pale grey, gravel sized pisolites, sand/gravel sized quartz, inferred laterised residual granite			
			1.5 – 3.0						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP04

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Job Number:	J1701008	**Easting:**	80959 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274927 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E-VH		0.0					SM	Gravelly Silty SAND: medium grained, dark brown becoming orange-brown, with approximately 30-40% iron cemented gravel, with approximately 20% non-plastic fines, trace rootlets to 0.1 m	M	L - MD	Depth of soil varies from 0.3 m to 1.2 m
			0.5									
			1.0						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown, mottled yellow-brown and orange, gravel sized pisolites, sand sized quartz			
	F		1.5						Becoming very low strength, weakly cemented, friable, yellow-brown mottled dark red-brown, sand sized quartz, excavated as well cemented gravel and cobbles, fine grained gravel and medium to coarse grained sand HARDPAN LATERITE: very low strength, generally weakly cemented, friable, yellow-brown mottled dark red-brown, sand sized quartz, excavated as well cemented gravel and cobbles, fine grained gravel and medium to coarse grained sand Becoming very low strength, weakly cemented, friable, yellow-brown mottled dark red-brown, sand sized quartz, excavated as well cemented gravel and cobbles, fine grained gravel and medium to coarse grained sand			
			2.0									
			2.5									
			3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP05

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Job Number:	J1701008	**Easting:**	81107 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274936 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0					SM	Gravelly Silty SAND and LATERITE BOULDERS: medium grained, dark brown becoming orange-brown, with approximately 30% fine and medium grained gravel, with approximately 20% non-plastic fines, contains very well cemented LATERITE BOULDERS up to 1.5 m in diameter	M	L	Depth of soil varies from 0.6 m to 1.5 m
			0.5		B(TP05-01)			GP	GRAVEL: fine to coarse grained ferruginous pisolitic gravel, yellow-brown to pale brown, with some medium grained sand, trace fines, trace cobbles up to 150 mm in diameter		L - MD	
	E		1.0									
			1.5						Yellow-brown, with some low plasticity fines			
			2.0						HARDPAN LATERITE: very low to low strength, well iron cemented, pale grey mottled dark red-brown and orange-brown			
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP06

Job Number:	J1701008	**Easting:**	81255 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274933 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained quartz sand, dark brown to 0.1 m becoming orange-brown, with approximately 20% non-plastic fines, some fine grained gravel	D - M	VL	
			0.5					SP-SM	SAND: medium to coarse grained quartz sand, yellow brown, with some fine grained gravel, some non-plastic fines			
			1.0					SP	Gravelly SAND: medium to coarse grained quartz sand, pale grey, with approximately 30-40% medium to coarse grained, low strength, very well iron cemented gravel, cobbles and boulders of HARDPAN LATERITE, up to 0.3 m in size		L	
			1.5									
			2.0									
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP07

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Job Number:	J1701008	**Easting:**	81404 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274926 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, brown, trace rootlets to 0.1 m, with approximately 30% non-plastic fines, trace fine to coarse grained gravel			
			0.5					GM	Silty Sandy GRAVEL: fine to coarse grained iron cemented gravel, yellow-brown, with approximately 30% medium to coarse grained sand, with approximately 10-15% non-plastic fines	M	L	
	VH	Slow inflow	1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled orange-brown, gravel sized pisolites			
			1.5						Hole terminated at 1.50 m Refusal on hardpan laterite Groundwater encountered at 1.1 m			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP08

Job Number:	J1701008	**Easting:**	80662 m	**Contractor:**	ANH Contracting	**Date:**	01/02/2017
Client:	Cossill & Webley	**Northing:**	274788 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0		B(TP08-01)			SM	Gravelly Silty SAND: medium grained, dark brown becoming orange-brown, with approximately 30-40% fine to coarse grained pisolitic gravel, with approximately 15-20% non-plastic fines, trace rootlets to 0.1 m	M	L	
			0.5					GP	GRAVEL: medium grained, rounded, pisolitic gravel, pale brown, trace sand			
	VH		1.0						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled pale grey and orange-brown, gravel sized pisolites, sand sized quartz			
			1.5						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP09

Job Number:	J1701008	**Easting:**	80817 m	**Contractor:**	ANH Contracting	**Date:**	01/02/2017
Client:	Cossill & Webley	**Northing:**	274787 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0 – 0.5						HARDPAN LATERITE and Gravelly Silty SAND: Laterite excavated as very well cemented boulders up to 1.2 m in size, Gravelly Silty SAND is medium grained, dark brown becoming orange-brown, with approximately 30-40% fine grained gravel, with approximately 20% non-plastic fines, trace roots	M		
	VH		0.5 – 1.0						HARDPAN LATERITE: high strength, very well iron cemented, gravel sized pisolites, sand and gravel sized quartz, inferred laterised residual granite			
			1.0						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP10

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Job Number:	J1701008	**Easting:**	80953 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274779 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0		B(TP10-01)			SM	Gravelly Silty SAND: medium grained, dark brown becoming orange-brown, with approximately 30-40% fine grained gravel, with approximately 20-30% non-plastic fines, trace rootlets to 0.1 m	M	VL	
			0.5		B(TP10-02)			GP	GRAVEL: fine to medium grained ferruginous pisolitic, pale brown, with some medium grained sand, trace fines			
	E		1.0						GRAVEL and COBBLES: weakly cemented, excavated as fine to coarse grained lateritic gravel and cobbles, containing gravel sized pisolitic and sand sized quartz, very well cemented, cobbles up to 200 mm diameter, pale yellow-brown, with some medium grained sand, trace fines			
			1.5									
			2.0					GP	Gravel and cobbles becoming weakly cemented and very low strength, quartz component increasing, friable			
			2.5									
			3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP11

Job Number:	J1701008	**Easting:**	81106 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274783 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0					SM	Gravelly Silty SAND: medium grained, dark brown, with approximately 30-40% fine grained gravel, with approximately 20% non-plastic fines, trace rootlets to 0.1 m	M	L - MD	
			0.5					GM	Silty Sandy GRAVEL: fine and occasionally medium grained iron cemented, with approximately 30-40% medium grained sand, with approximately 20% non-plastic fines		L	
	H		1.0						HARDPAN LATERITE: low strength, very well iron cemented, dark red-brown mottled yellow-brown and orange-brown, gravel sized ferruginous pisolites, sand sized quartz, with zones of Silty Sandy GRAVEL			
	F-H		1.5						Very low strength, moderately to well cemented, yellow-brown			
			2.0									
			2.5						Hole terminated at 2.40 m Stopped due to slow excavation Groundwater not encountered			
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP12

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Job Number:	J1701008	**Easting:**	81256 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274781 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0 – 0.5					SM	Silty SAND: medium to coarse grained, brown, with approximately 20-30% non-plastic fines, with some fine iron cemented gravel, trace rootlets, ranging from 1.0 m to 1.3 m in thickness	M	L - MD / VL	
E	H		1.0 – 2.5						HARDPAN LATERITE: typically low strength, very well iron cemented, variably mottled dark red-brown, orange-brown and pale grey, pale grey zones are friable, pisolitic, sand sized quartz			
		▼	2.5 – 3.0						Hole terminated at 2.50 m Target depth Groundwater encountered at 2.5 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP13

Job Number:	J1701008	**Easting:**	81406 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274771 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown to 0.1 m, becoming orange-brown, with approximately 20% non-plastic fines, trace rootlets to 0.1 m, trace fine grained gravel	M	L	
			0.5						Yellow-brown, trace fine to coarse grained gravel			
			1.0									
	H		1.5						HARDPAN LATERITE: low strength, very well iron cemented, dark red-brown mottled yellow-brown and pale grey, gravel sized ferruginous pisolites, sand sized quartz with zones of pale grey sand			
			2.0									
		Strong Inflow	2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater encountered at 2.5 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP14

Job Number:	J1701008	**Easting:**	80809 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274639 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0					SM	Gravelly Silty SAND and HARDPAN LATERITE BOULDERS: medium grained sand, fine grained ferruginous pisolitic gravel, becoming medium grained with depth, dark brown to 0.1 m becoming orange-brown, with approximately 20% non-plastic fines, very well cemented HARDPAN LATERITE BOULDERS up to 1.5 m in size, trace rootlets to 0.1 m	M		Density could not be assessed
			0.5									
			1.0					GC	Clayey Sandy GRAVEL and HARDPAN LATERITE COBBLES and BOULDERS: fine to coarse grained iron cemented gravel, yellow-brown, with approximately 30% fine to coarse grained sand, with approximately 15% low plasticity fines, very well cemented HARDPAN LATERITE COBBLES and BOULDERS			
			1.5									
			2.0									
			2.5									
			3.0						Hole terminated at 3.00 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP15

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Job Number:	J1701008	**Easting:**	80956 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274639 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0					SP-SM	SAND: medium to coarse grained, dark grey-brown becoming brown, with some fine to medium grained pisolitic gravel, with some non-plastic fines, isolated very well cemented LATERITE BOULDERS, trace large roots	D - M	L	
	VH		0.5						HARDPAN LATERITE: medium strength, very well iron cemented yellow-brown mottled orange and red-brown, ferruginous pisolites, minor carbonate cementation			
			1.0						Hole terminated at 0.70 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP16

Job Number:	J1701008	**Easting:**	81110 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274635 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0					SP-GP	Sandy GRAVEL/Gravelly SAND and LATERITE BOULDERS: medium to coarse grained sand, fine to medium grained pisolitic gravel, dark grey-brown becoming orange-brown, with some non-plastic fines trace large roots to 0.5 m, very well cemented LATERITE BOULDERS	D - M	L	
			0.5									
			1.0						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP17

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Job Number:	J1701008	**Easting:**	81253 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274633 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.1 m becoming brown and pale brown, with approximately 30 to 40% medium to coarse grained sand, with some non-plastic fines	M	L	
	H-VH		0.5						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolitic sand sized quartz			
			1.0						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP18

Job Number:	J1701008	**Easting:**	81401 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274640 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					GP	Sandy GRAVEL: fine to medium grained, sub-angular to rounded, pisolitic gravel, dark grey to 0.1 m, becoming pale brown, with approximately 30-40% medium to coarse grained sand	M	L - MD	
			1.0 – 1.5 – 2.0 – 2.5 – 3.0						Hole terminated at 0.80 m Refusal on high strength HARDPAN LATERITE Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP19

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Job Number:	J1701008	**Easting:**	81551 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274629 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark brown to 0.1 m becoming yellow-brown, with approximately 30 to 40% medium to coarse grained sand,with some non-plastic fines, trace cobbles, trace rootlets to 0.1 m	M	L - MD	
	H-VH		0.5						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized pisolites, sand sized quartz			
			1.0						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP20

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Job Number:	J1701008	**Easting:**	80802 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274488 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F		0.0					SP-SM	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown becoming grey-brown, with approximately 30% fine grained pisolitic gravel, with some non-plastic fines	D	L	Average depth of Gravelly SAND varies between 0.1 m and 0.3 m Numerous laterite outcrops at surface
	VH								HARDPAN LATERITE: medium strength, very well iron cemented, yellow-brown mottled dark red-brown, ferruginous pisolites, minor carbonate cementation			
			0.5						Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP21

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Job Number:	J1701008	**Easting:**	80957 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274493 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VH		0.0					SP-SM	SAND: medium to coarse grained, grey-brown, with some fine grained pisolitic gravel, with some non-plastic fines	D - M	L	Numerous laterite outcrops exposed at surface
									HARDPAN LATERITE: medium strength, very well iron cemented, yellow-brown mottled dark red-brown and orange-brown, ferruginous pisolites, sand sized quartz			
			0.5						Hole terminated at 0.40 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP22

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Job Number:	J1701008	**Easting:**	81106 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274485 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VH		0.0 – 0.5					SP	Gravelly SAND and LATERITE BOULDERS: medium to coarse grained, grey-brown becoming brown, with approximately 30% fine grained pisolitic gravel, very well cemented LATERITE BOULDERS up to 1.2 m in size, trace large roots	D - M	L	
			1.0						Hole terminated at 0.90 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP23

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Job Number:	J1701008	**Easting:**	81256 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274480 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, grey-brown, with approximately 10-15% non-plastic fines, with some fine to coarse grained gravel, trace rootlets and roots	D - M	L	
	VH								HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown, ferruginous pisolites			
			0.5						Hole terminated at 0.30 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP24

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Job Number:	J1701008	**Easting:**	81398 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274485 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0 – 0.5					SP	SAND and LATERITE BOULDERS: medium to coarse grained sand, grey-brown, with some fine to coarse grained gravel, very well cemented LATERITE BOULDERS up to 1.2 m in size, trace large roots to 0.7 m	D - M	L	
			1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, ferruginous pisolites			
			1.5 – 2.0 – 2.5 – 3.0						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP25

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Job Number:	J1701008	**Easting:**	81553 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274486 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP	GRAVEL: fine to medium grained, sub-rounded to sub-rounded, pisolitic, dark brown to 0.1 m becoming pale brown, with some medium to coarse grained sand, trace non-plastic fines, trace rootlets to 0.1 m	M	MD	
	VH		0.5						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized pisolites			
									Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP26

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Job Number:	J1701008	**Easting:**	80956 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274338 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, dark grey-brown, with approximately 10-15% non-plastic fines, with some fine to coarse grained pisolitic gravel, trace roots, isolated very well cemented LATERITE BOULDERS	D - M	L	
			0.5					SP-GP	Gravelly SAND/Sandy GRAVEL: fine to medium grained pisolitic gravel, medium to coarse grained sand, with some non-plastic fines, isolated very well cemented LATERITE BOULDERS			
	VH		1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown, ferruginous pisolites			
			1.5						Hole terminated at 1.30 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP27

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Job Number:	J1701008	**Easting:**	81103 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274336 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					SP-SM	Gravelly SAND: medium to coarse grained, grey-brown, with approximately 40-50% fine to medium grained pisolitic gravel, with some non-plasticity fines, trace large roots, isolated very well cemented LATERITE BOULDERS		L	
	E-F		0.5 – 2.0					GP-GC	GRAVEL: fine to coarse grained, very well cemented lateritic, yellow-brown and red-brown, with some medium to coarse grained sand, with some medium plasticity fines	D	MD	
			2.0 – 2.5					GC	Clayey GRAVEL: fine to coarse grained, very well cemented lateritic, with approximately 20-30% medium plasticity fines, with some medium to coarse grained sand	M		
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP28

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Job Number:	J1701008	**Easting:**	81254 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274337 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown becoming brown, with approximately 30% fine to medium grained pisolitic gravel, with some non-plastic fines, trace to some large roots	D - M	L	Average depth of Gravelly SAND recorded; depth varies from 0.3 m to 0.7 m
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled orange-brown			
			1.0						Hole terminated at 0.70 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP29

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Job Number:	J1701008	**Easting:**	81395 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274332 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, grey-brown, with approximately 10-15% non-plastic fines, with some fine grained pisolitic gravel, trace to some rootlets and roots	D - M	L	Average depth recorded; depth of Gravel varies from 0.3 m to 0.7 m
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, ferruginous pisolites			
									Hole terminated at 0.70 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP30

Job Number:	J1701008	**Easting:**	81544 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274335 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, grey-brown, with approximately 10-15% non-plastic fines, with some fine to medium grained pisolitic gravel	D - M	L	Average depth of Gravel recorded; depth varies from 0.1 m to 0.4 m. Numerous laterite outcrops exposed.
									Hole terminated at 0.20 m Refusal on hardpan laterite Groundwater not encountered			
			0.5									
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP31

Job Number:	J1701008	**Easting:**	80950 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274193 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0 – 0.5					SP	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown to 0.2 m, becoming orange-brown, with approximately 30% fine to medium grained pisolitic gravel, isolated very well cemented LATERITE BOULDERS	D - M	L	
	VH		0.5 – 1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown, ferruginous pisolites, sand sized quartz			
			1.0						Hole terminated at 0.80 m Refusal on hardpan laterite Groundwater not encountered			
			1.5 – 2.0 – 2.5 – 3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP32

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Job Number:	J1701008	**Easting:**	81109 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274190 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, dark grey-brown becoming brown, with approximately 10-15% non-plastic fines, with some fine to medium grained pisolitic gravel, isolated very well cemented LATERITE BOULDERS, trace to some large roots	D - M	L	Average depth of gravel recorded depth varies between 0.5 m and 1.0 m. Numerous laterite outcrops at surface.
			0.5									
	VH								HARDPAN LATERITE: medium strength, very well iron cemented, yellow-brown mottled orange-brown and dark red-brown, gravel sized pisolites			
			1.0						Hole terminated at 0.90 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP33

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Job Number:	J1701008	**Easting:**	81250 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274184 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.2 m becoming brown to orange-brown, with some non-plastic fines, with approximately 30 to 40% medium to coarse grained sand, trace roots to 1.0 m, isolated very well cemented LATERITE BOULDERS	D - M		Average depth of gravel recorded. Depth of gravel varies between 0.6 m and 1.0 m. Numerous laterite outcrops exposed at surface.
	H-VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, yellow-brown mottled dark red-brown, ferruginous pisolites, isolated zones of weaker cementation			
			1.5						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP34

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Job Number:	J1701008	**Easting:**	81400 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274189 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E VH		0.0					SP-GP	Gravelly SAND/Sandy GRAVEL: fine to medium grained pisolitic gravel, medium to coarse grained sand, dark grey-brown becoming grey-brown, with some fines	D - M	L	
									HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown, ferruginous pisolites			
			0.5						Hole terminated at 0.25 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP35

Job Number:	J1701008	**Easting:**	81547 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274185 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, grey-brown, with approximately 10-15% non-plastic fines, trace rootlets and small roots	D - M	L	
									Hole terminated at 0.20 m Refusal on hardpan laterite Groundwater not encountered			
			0.5									
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP36

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Job Number:	J1701008	**Easting:**	80951 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274041 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown becoming brown, with approximately 40 to 50% medium to coarse grained sand, with some non-plastic fines, isolated boulders of very well cemented LATERITE	D - M	L	Numerous laterite outcrops at surface
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown, ferruginous pisolites			
			1.0						Hole terminated at 0.80 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP37

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Job Number:	J1701008	**Easting:**	81098 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	274036 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to coarse grained pisolitic gravel, dark grey-brown to 0.2 m becoming pale brown, with approximately 30 to 40% medium to coarse grained sand, with some non-plastic fines, isolated very well iron cemented boulders up to 0.3 m in size	D	L - MD	
			0.5									
	H		1.0						HARDPAN LATERITE: low strength, well iron cemented, mottled yellow-brown, orange-brown and dark red-brown, gravel sized pisolites			
			1.5						Becoming variably cemented and friable, with clayey zones, transitioning into desiccated Clayey SAND			
			2.0									
			2.5						Hole terminated at 2.30 m Stopped due to slow excavated through cemented clayey soils Groundwater not encountered			
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP38

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Job Number:	J1701008	**Easting:**	81247 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	274034 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0					SP	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown becoming brown, with approximately 20 to 40% fine to coarse grained pisolitic gravel, isolated very well cemented LATERITE BOULDERS extending to 0.3 m to 0.5 m depth	M	L	
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
									Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP39

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Job Number:	J1701008	**Easting:**	81397 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	274030 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	Gravelly SAND: medium to coarse grained, dark grey-brown becoming pale brown, with approximately 30-40% fine to medium grained pisolitic gravel	D - M	L	
	VH								HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites and sand sized quartz			
			0.5						Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP40

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Job Number:	J1701008	**Easting:**	80949 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	273895 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.3 m becoming pale brown, with approximately 30 to 40% medium to coarse grained sand, with some non-plastic fines, trace to some roots and rootlets to 0.5 m	D - M	L	Average depth of gravel recorded depth varies from 0.3 m to 0.8 m. Numerous laterite outcrops at surface.
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red mottled yellow-brown and orange-brown, ferruginous pisolites			
			1.0						Hole terminated at 0.80 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP41

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Job Number:	J1701008	**Easting:**	81094 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273885 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VH		0.0					SP	Gravelly SAND: medium to coarse grained, grey-brown, with approximately 30-40% fine to medium grained pisolitic gravel, trace roots and rootlets	M		Numerous laterite outcrops at surface.
									HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites, sand sized quartz			
			0.5						Hole terminated at 0.15 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP42

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Job Number:	J1701008	**Easting:**	81246 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273889 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F		0.0					SM	Gravelly Silty SAND: medium to coarse grained, dark grey, with approximately 30-40% fine grained pisolitic gravel, with some roots and rootlets, trace very well iron cemented LATERITE BOULDERS	M	L	
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
									Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP43

Job Number:	J1701008	**Easting:**	81397 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273887 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP43-01)			SP	Silty Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey brown, approximately 20-40% medium to coarse grained sand, trace rootlets and roots	D		
			0.5					GP-GM	GRAVEL: fine to medium grained pisolitic gravel, pale brown to orange-brown, with some non-plastic fines	M	L	
	VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled yellow-brown and orange-brown, gravel sized ferruginous pisolites			
			1.5						Hole terminated at 1.60 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP44

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	80799 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	273744 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown becoming brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, trace to some rootlets and roots	D - M	L	
	H-VH		0.5						HARDPAN LATERITE: low to medium strength, very well iron cemented, yellow-brown mottled dark red-brown, ferruginous pisolites, isolated zones of weaker cementation			
			1.0						Hole terminated at 0.70 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP45

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Job Number:	J1701008	**Easting:**	80941 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273750 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F		0.0					SP-SM	Gravelly SAND: medium to coarse grained, dark grey-brown becoming pale brown, with approximately 30-40% fine to medium grained pisolitic gravel, with some non-plastic fines, trace very well cemented LATERITE BOULDERS	M	L	Numerous laterite outcrops exposed.
	VH		0.5						HARDPAN LATERITE: medium strength, very well iron cemented, mottled yellow-brown, orange-brown and dark red-brown, sand sized quartz			
									Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP46

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Job Number:	J1701008	**Easting:**	81095 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273742 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0					GP-GM	Sandy GRAVEL and LATERITE BOULDERS: fine to medium grained pisolitic gravel, dark grey-brown to 0.1 m becoming pale brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, very well iron cemented LATERITE BOULDERS up to 0.35 m in size	D - M	L - MD	Depth of soil varies from 0.5 m to 0.7 m
	VH		0.5						HARDPAN LATERITE: typically medium strength, very well iron cemented with some occasionally moderately cemented zones, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
			1.0						Hole terminated at 0.90 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP47

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Job Number:	J1701008	**Easting:**	81246 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273742 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	Gravelly SAND: medium to coarse grained, dark grey-brown, with approximately 30-40% fine to medium grained pisolitic gravel, with some non-plastic fines, trace roots	D - M	L	Depth of gravelly sand varies from 0.2 m to 0.4 m
	VH								HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled orange-brown and yellow-brown, gravel sized ferruginous pisolites			
			0.5						Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP48

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Job Number:	J1701008	**Easting:**	81385 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273742 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F		0.0					SP-SM	Gravelly SAND: medium to coarse grained, dark grey-brown becoming pale brown and orange-brown, with approximately 30-40% fine to medium grained pisolitic gravel, with some non-plastic fines, trace very well iron cemented LATERITE BOULDERS	M	L	Depth of soil varies from 0.5 m to 1.0 m
			0.5					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, orange-brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, trace roots			
	H-VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
									Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP49

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Job Number:	J1701008	**Easting:**	80799 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273587 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0					SM	Silty SAND and LATERITE BOULDERS: medium to coarse grained, dark grey-brown becoming brown, with approximately 15% non-plastic fines, with some fine to medium grained pisolitic gravel, high strength, very well iron cemented LATERITE BOULDERS, trace roots	M	L	Numerous laterite outcrops exposed.
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown and orange-brown, gravel sized ferruginous pisolites, sand sized quartz			
			1.0						Hole terminated at 0.40 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP50

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Job Number:	J1701008	**Easting:**	80942 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273591 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E VH		0.0					SM	Gravelly Silty SAND: medium to coarse grained, dark grey-brown becoming orange-brown, with approximately 30-40% fine to medium grained pisolitic gravel, with approximately 15% non-plastic fines, trace rootlets	D	L	Numerous laterite outcrops exposed Depth of soil varies from 0.1 m to 0.4 m
			0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous cemented pisolites			
			1.0						Hole terminated at 0.40 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP51

Job Number:	J1701008	**Easting:**	81097 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273590 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 15-20% non-plastic fines, with some fine to medium grained pisolitic gravel, trace small roots	D	L - MD	
			0.5					GP	Sandy GRAVEL: fine to medium grained pisolitic gravel, pale brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines			
	H-VH		1.0						HARDPAN LATERITE: typically medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown and orange-brown, with occasional moderately cemented zones, gravel sized ferruginous pisolites			
			1.5						Hole terminated at 1.35 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP52

Job Number:	J1701008	**Easting:**	81235 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273600 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VH		0.0					SM	Gravelly Silty SAND: medium to coarse grained, dark grey-brown, with approximately 30-40% fine to medium grained pisolitic gravel, with approximately 15% non-plastic fines, trace roots	D	L	Numerous laterite outcrops exposed.
									HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous cemented pisolites, sand sized quartz			
			0.5						Hole terminated at 0.20 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP53

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Job Number:	J1701008	**Easting:**	81392 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273586 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.2 m becoming pale brown, with approximately 30 to 40% medium to coarse grained sand, trace roots	D - M	VL	
			0.5					GP-GM	GRAVEL: fine to medium grained pisolitic gravel, pale brown, with some non-plastic fines, trace roots to 0.5 m		L - MD	
	VH		1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous cemented pisolites, sand sized quartz			
			1.5						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP54

Job Number:	J1701008	**Easting:**	80791 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273441 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 15% non-plastic fines, with some fine to medium grained pisolitic gravel, trace roots up to 40 mm in diameter		L	
			0.5					GP-GM	Sandy GRAVEL and BOULDERS: fine to medium grained pisolitic gravel, pale brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, trace roots to 0.5 m, low strength boulders up to 0.3 m in size		MD	
	F		1.0		B(TP54-01)			SC-CH	Clayey SAND / Sandy CLAY: fine to coarse grained quartz sand, orange-brown mottled pale grey and red-brown, with approximately 30-50% high plasticity fines	M	H	
			1.5						Slickensided in parts			
	F-H		2.0									
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP55

Job Number:	J1701008	**Easting:**	81238 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273445 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP55-01)			GP-GM	GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.5 m becoming pale brown, with some medium to coarse grained sand, with some non-plastic fines, trace roots to 0.5 m Trace medium to coarse grained sand	D	L - MD	
	VH		1.0						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown and orange-brown, gravel sized ferruginous cemented pisolites, sand sized quartz Hole terminated at 1.10 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP56

Job Number:	J1701008	**Easting:**	81392 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273448 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					GP-GM	GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.7 m becoming pale brown, with some medium to coarse grained sand, with some non-plastic fines, trace roots (typically 10 mm) to 0.5 m	D - M	L - MD	
	VH		1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous cemented pisolites, sand sized quartz			
			1.5 – 3.0						Hole terminated at 1.15 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP57

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81836 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274558 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	GRAVEL: fine to medium grained pisolitic gravel, dark brown to 0.1 m becoming pale brown, with some medium to coarse grained sand, with some non-plastic fines, trace rootlets to 0.1 m, trace roots up to 40 mm in diameter	M	L	
	F-H		0.5						HARDPAN LATERITE: very low strength, weakly to moderately cemented, orange-brown mottled dark red-brown and pale grey, ~~friable, excavated as low plasticity Clayey GRAVEL with low plasticity~~ fines Pale grey mottled orange-brown and dark red-brown, transitioning into desiccated Clayey SAND/Sandy CLAY at depth			
			1.0									
			1.5									
			2.0									
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP58

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81976 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274394 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					SM	Silty SAND: medium to coarse grained, dark grey-brown to 0.1 m, becoming pale brown, with approximately 20% non-plastic fines, with some fine gravel	M	L	
	F		0.5 – 1.0					GP-GM	GRAVEL and COBBLES: medium to coarse grained lateritic gravel and cobbles, with some medium to coarse grained sand, with some non-plastic fines		L - MD	
	VH		1.0 – 1.5						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown			
			1.5 – 2.0						Hole terminated at 1.50 m Refusal on hardpan laterite Groundwater not encountered			
			2.0 – 2.5									
			2.5 – 3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP59

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81890 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274257 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND/Gravelly Silty SAND: medium to coarse grained, dark grey-brown to 0.1 m, becoming orange-brown, with approximately 30% non-plastic fines, with approximately 20-40% fine to medium grained gravel	M	L	
			0.5								MD	
	H		1.0						HARDPAN LATERITE: low strength, well iron cemented, dark red-brown and yellow-brown, gravel sized pisolites, sand sized quartz			
			1.5					SC	Clayey SAND: medium to coarse grained quartz, off-white mottled dark red-brown and orange-brown, with approximately 40% high plasticity fines, isolated sandier zones,possibly extremely weathered granitic rock		St	
		Slow inflow	2.0									
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater encountered at 2.8 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP60

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	82005 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274166 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown to 0.1 m, becoming orange-brown, with some non-plastic fines, with some fine to medium grained pisolitic gravel	M	L	
			0.5					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, with approximately 30% medium to coarse grained sand, with some non-plastic fines			
	F-H		1.0					GP-GM	GRAVEL: fine to coarse grained weakly cemented lateritic gravel, pale grey and brown, with some medium to coarse grained sand, with some non-plastic fines Coarse grained lateritic gravel and cobbles, pale grey mottled yellow-brown and dark red-brown		L - MD	
			1.5									
			2.0					SC-CI	Clayey SAND/Sandy CLAY: pale grey mottled yellow-brown, medium plasticity			
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP61

Job Number:	J1701008	**Easting:**	81944 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	274036 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0		B(TP61-01)			GP-GM	GRAVEL: fine grained pisolitic gravel (becoming coarser with depth), dark grey-brown to 0.1 m, becoming pale brown, with some medium to coarse grained sand, with some non-plastic fines, isolated large roots up to 0.1 m in diameter in upper 0.5 m	M	VL	
			0.5									
			1.0									
	F		1.5						Inclusions of medium to coarse grained gravel and cobbles		L	
	H-VH		2.0						Becoming pale grey mottled dark red-brown, inferred transition into HARDPAN LATERITE			
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP62

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	82028 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273976 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E-F		0.0 – 0.5					GM	Silty Sandy GRAVEL: fine to medium grained lateritic gravel, dark grey-brown to 0.2 m, becoming pale brown, with approximately 40% medium to coarse grained sand, with approximately 15% non-plastic fines, trace rootlets to 0.2 m, trace roots up to 30 mm diameter to 0.6 m	M	L	Laterite outcrops exposed
	H-VH		0.5 – 1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown			
			1.0 – 1.5						Hole terminated at 1.30 m Refusal on hardpan laterite Groundwater not encountered			
			1.5 – 2.0									
			2.0 – 2.5									
			2.5 – 3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP63

Job Number:	J1701008	**Easting:**	81841 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273916 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GM	Silty Sandy GRAVEL: fine grained lateritic gravel, becoming medium to coarse grained with depth, dark grey to 0.2 m, becoming pale brown, with approximately 30-40% medium to coarse grained sand, with approximately 15% non-plastic fines, trace roots up to 30 mm in diameter	M	L	
			0.5									
	F		1.0					SC	Clayey SAND: weakly cemented, yellow-brown mottled dark red-brown, excavated as weakly to moderately cemented, fine to coarse grained gravel and cobbles, friable, becoming clayier with depth	D	H	
			1.5					SC	Clayey SAND: fine to coarse grained quartz sand, pale grey mottled yellow-brown, with approximately 30% non-plastic to low plasticity fines, desiccated and hard			
			2.0									
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP64

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Job Number:	J1701008	**Easting:**	82021 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273851 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GM	Silty Sandy GRAVEL: fine to medium grained lateritic gravel, dark grey-brown to 0.2 m, becoming pale brown, with approximately 30-40% medium to coarse grained sand, with approximately 15% non-plastic fines, trace roots	D - M	VL	
			0.5					GC	Clayey Sandy GRAVEL: fine to coarse grained, well cemented lateritic gravel, orange-brown, with approximately 30-40% medium to coarse grained sand, with approximately 20% low plasticity fines			
			1.0									
			1.5					CH	Sandy CLAY/CLAY: high plasticity, pale brown mottled yellow-brown and dark red-brown, with approximately 30% fine to medium grained sand, trace gravel	D	H	
			2.0									
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP65

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Job Number:	J1701008	**Easting:**	81811 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273724 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					SP-SM	Gravelly SAND: medium to coarse grained, pale brown, with approximately 30-40% fine to medium grained lateritic gravel, with some non-plastic fines, isolated very well iron cemented LATERITE BOULDERS up to about 2 m in size, trace roots and rootlets	D	L - MD	
	H		0.5 – 1.0						HARDPAN LATERITE: low strength, well iron cemented, mottled yellow-brown, orange-brown and red-brown			
	F		1.0 – 2.5					SC	Gravelly Clayey SAND: paler in colour, becoming gradually friable and uncemented, transitioning into desiccated, medium plasticity	D	H	
			2.5 – 3.0						Hole terminated at 2.60 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP66

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Job Number:	J1701008	**Easting:**	82120 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	273587 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0					GP-GM	Sandy GRAVEL: fine grained pisolitic gravel, dark grey-brown becoming brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, isolated high strength LATERITE BOULDERS up to 1.5 m in size	M	L	Numerous laterite outcrops exposed at surface
			0.5						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, ferruginous gravel sized pisolites			
			1.0						Hole terminated at 0.80 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP67

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Job Number:	J1701008	**Easting:**	82205 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273800 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine grained pisolitic gravel, becoming medium grained with depth, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines		L	
			0.5							D - M		
	F								Medium to coarse grained gravel, yellow-brown		L - MD	
			1.0									
	H-VH								HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, sand sized quartz			
			1.5						Hole terminated at 1.50 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP68

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Job Number:	J1701008	**Easting:**	82403 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273815 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 15% non-plastic fines, with some fine to coarse grained lateritic gravel, trace small roots to 0.2 m	D - M	L	
			0.5					GM	Silty Sandy GRAVEL: fine to medium grained lateritic gravel, brown, with approximately 30-40% medium to coarse grained sand, with approximately 15% non-plastic fines			
	F-H		1.0					SC	Clayey SAND: weakly cemented, yellow-brown mottled pale grey and dark red-brown, friable, workable into low plasticity Clayey SAND, becoming uncemented and clayier with depth	D	H	
			1.5									
			2.0					SC-CI	Clayey SAND/Sandy CLAY: medium plasticity fines, fine to coarse grained quartz sand, pale grey mottled yellow			
			2.5									
			3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP69

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Job Number:	J1701008	**Easting:**	82442 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273563 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.1 m, becoming pale brown, with some medium to coarse grained sand, with some non-plastic fines, trace large roots to 0.5 m	D - M	L	
	VH		1.5						HARDPAN LATERITE: medium strength, very well iron cemented, yellow-brown mottled dark red-brown, ferruginous gravel sized pisolites			
									Hole terminated at 1.50 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP70

Job Number:	J1701008	**Easting:**	82499 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273694 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP70-01)			SC	Clayey SAND: medium to coarse grained, dark grey-brown, with approximately 20-30% low plasticity fines, with some fine to ~~medium grained pisolitic gravel, trace rootlets~~ Brown, no rootlets	M	L	
	F		0.5					GP-GM	GRAVEL: medium grained pisolitic gravel, pale brown, with some medium to coarse grained sand, with some non-plastic fines	D		
	VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, pale grey mottled orange-brown and dark red-brown			
			1.5						Becoming uncemented, transitioning into high plasticity Gravelly CLAY			
	F-H		2.0					CH	Gravelly CLAY: high plasticity, pale grey mottled dark red-brown, with approximately 30-40% fine to coarse grained, very well iron cemented gravel, with some sand		H	
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP71

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Job Number:	J1701008	**Easting:**	82665 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273778 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SC	Clayey SAND: medium to coarse grained, brown, with approximately 20-30% non-plastic to low plasticity fines	M	L - MD	
			0.5						Orange-brown, with approximately 20-30% low plasticity fines			
	F		1.0		B(TP71-01)			CH-SC	Clayey SAND/Sandy CLAY: high plasticity fines, medium to coarse grained quartz sand, off-white mottled yellow-brown and red-brown, isolated sandier zones		St	
			1.5						Becoming off-white, sand content increasing			
			2.0									
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP72

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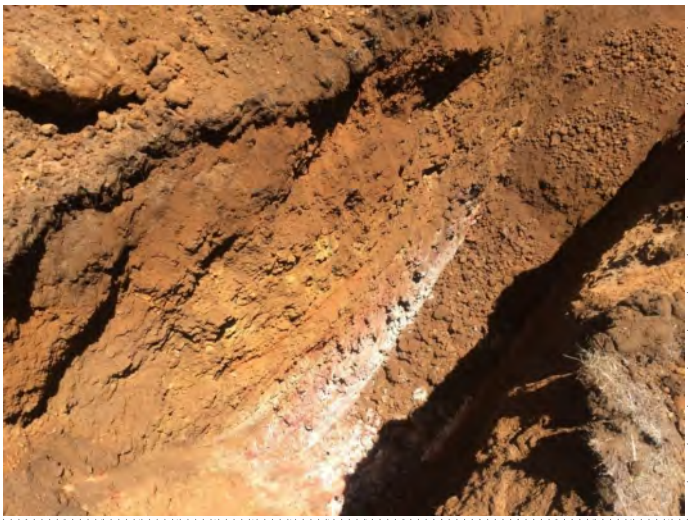
Job Number:	J1701008	**Easting:**	82602 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273600 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SC	Clayey SAND: medium to coarse grained, dark grey-brown to 0.2 m, becoming brown, with approximately 20-30% low plasticity fines, with some fine to medium grained pisolitic gravel	M	MD	
	F-H		0.5					GP-GM	GRAVEL: fine to coarse grained, well cemented lateritic gravel and cobbles, with some medium to coarse grained brown sand, with some low plasticity fines, with isolated weakly cemented zones			
	F		1.0					CH	Gravelly Sandy CLAY: variable proportion of medium to coarse grained quartz sand, fine to coarse grained iron cemented gravel, high plasticity fines, mottled off-white and dark red-brown	M - W		
			1.5									
			2.0									
			2.5						Hole terminated at 2.60 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP73

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Job Number:	J1701008	**Easting:**	82773 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273606 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium grained, dark grey-brown, with approximately 20-30% non-plastic fines	M	L	
			0.5						Yellow-brown			
	F		1.0					GP	GRAVEL and COBBLES: very well iron cemented, coarse grained lateritic gravel and cobbles in a matrix of medium to coarse grained quartz sand, pale grey mottled orange-brown and red-brown			
			1.5		B(TP73-01)			SC	Clayey SAND/Gravelly Clayey SAND: medium to coarse grained quartz sand, with approximately 30-40% high plasticity fines, variably iron cemented, medium to coarse grained gravel	M - W	H	
			2.0									
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP74

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	82810 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273870 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					SM	Silty SAND: medium grained, dark grey-brown to 0.2 m, becoming brown, with approximately 20-30% non-plastic fines, trace fine grained pisolitic gravel, isolated gravelly zones at depth	M	L	
	H		0.5 – 1.5						LATERITE GRAVEL, COBBLES and BOULDERS: high strength, very well iron cemented, dark red-brown mottled orange-brown, in a matrix of brown Silty SAND as described above			
	F		1.5 – 2.5					SC-CH	Clayey SAND/Sandy CLAY: high plasticity fines, medium to coarse grained quartz sand, off-white, variable sand content	M - W	St	
			2.5 – 3.0						Hole terminated at 2.60 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP75

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Job Number:	J1701008	**Easting:**	82875 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273757 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					GP-GM	Sandy GRAVEL: fine grained pisolitic gravel,dark brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, trace rootlets and small roots Pale brown, no organics	D	L	
	VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown and yellow-brown			
			1.5 – 3.0						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP76

Job Number:	J1701008	**Easting:**	83028 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273825 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GM	Silty Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown becoming brown, with approximately 30-40% medium to coarse grained sand, with approximately 15% non-plastic fines, isolated very well cemented LATERITE BOULDERS	D	L	Laterite outcrops exposed at surface
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown and yellow-brown, gravel sized ferruginous pisolites			
									Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP77

Job Number:	J1701008	**Easting:**	83276 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273758 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5		B(TP77-01)			GM	Silty Sandy GRAVEL: fine grained pisolitic gravel, dark grey-brown to 0.1 m, becoming orange-brown, with approximately 30-40% medium to coarse grained sand, with approximately 15% non-plastic fines, trace rootlets to 0.1 m	M	L	
	VH		0.5 – 1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
			1.0 – 1.5						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			
			1.5 – 2.0									
			2.0 – 2.5									
			2.5 – 3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP78

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Job Number:	J1701008	**Easting:**	81598 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273769 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, grey-brown to 0.2 m, becoming orange-brown, with approximately 20% non-plastic fines, trace fine grained gravel, gravel content increasing with depth, trace roots up to 20 mm in diameter	D - M	VL	
			0.5					SM	Gravelly Silty SAND: medium to coarse grained, orange brown and pale brown, approximately 30-40% fine to medium grained gravel, with occasional coarse gravel and cobbles			
	VH		1.0						HARDPAN LATERITE: generally very well iron cemented, medium strength, with occasional moderately cemented zones, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
			1.5						Hole terminated at 1.50 m Stopped due to slow excavation through hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP79

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Job Number:	J1701008	**Easting:**	81793 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274145 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	Strong inflow	0.0		B(TP79-01)			SM-SC	Silty/Clayey SAND: fine to coarse grained, orange-brown, with approximately 20% non-plastic to low plasticity fines, trace rootlets to 0.1 m	M	F	
			0.5					SC	Clayey SAND: fine to coarse grained, yellow-brown, with approximately 40% low plasticity fines, trace fine grained angular gravel, gravel content increasing with depth			
			1.0		B(TP79-02)			SC	Gravelly Clayey SAND: yellow-brown, with approximately 30-40% low to medium plasticity fines, with approximately 30-40% fine to coarse grained lateritic gravel			
			1.5		B(TP79-03)			CH	Sandy CLAY/CLAY: high plasticity, pale grey mottled dark red-brown, with approximately 20-40% fine to coarse grained sand, trace fine to coarse grained gravel including quartz and occasional iron cemented zones, striated, slickensided, inferred extremely weathered granitic rock	M - W	St	
			2.0									
			2.5									
			3.0						Hole terminated at 2.70 m Target depth Groundwater encountered at 2 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP80

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Job Number:	J1701008	**Easting:**	81751 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274856 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	Slow inflow	0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, dark grey, with approximately 10-15% non-plastic fines, trace rootlets	M	L	
			0.5					SM	Silty SAND: medium to coarse grained, orange-brown, with approximately 20% non-plastic fines			
	H		1.0						HARDPAN LATERITE: low strength, well iron cemented, yellow-brown mottled orange-brown and dark red-brown, sand sized quartz			
			1.5									
			2.0						Hole terminated at 2.00 m Refusal on hardpan laterite Groundwater encountered at 1.5 m			
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP81

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81027 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275510 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 30% non-plastic fines, trace rootlets	D	S	
			0.5					SM-SC	Silty/Clayey SAND: medium to coarse grained, yellow-brown, with approximately 30% non-plastic to low plasticity fines	D - M		
	H-VH		1.0						HARDPAN LATERITE: low to medium strength, very well iron cemented, dark red-brown mottled yellow-brown			
			1.5						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP82

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	82311 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275355 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E		Very strong inflow	0.0					SM	Silty SAND: medium to coarse grained, dark grey, with approximately 20-30% non-plastic fines	M	VS	
			0.5					SC	Clayey SAND: medium to coarse grained, pale brown and orange-brown, with approximately 30-40% low plasticity fines, trace iron cemented gravel	W		
			1.0						HARDPAN LATERITE: medium strength, orange-brown mottled dark red-brown			
			1.5						Hole terminated at 1.30 m Refusal on hardpan laterite Groundwater encountered at 1 m			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP83

Job Number:	J1701008	**Easting:**	81274 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275856 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND: medium to coarse grained, dark grey-brown, with some non-plastic fines, trace rootlets	D - M	VL	
			0.5					GP-GM	Sandy GRAVEL: fine to coarse grained pisolitic gravel, pale brown to orange-brown, with approximately 30 to 40% medium to coarse grained quartz sand, with some non-plastic fines		L	
			1.0					SM	Silty SAND: medium to coarse grained quartz sand, orange-brown, with approximately 15% non-plastic fines, weakly cemented cobbles		MD	
			2.0					CH	Sandy CLAY: high plasticity, pale grey mottled dark red-brown, with approximately 30-40% medium to coarse grained sand, slickensided, with cemented zones		H	
			2.5									
			3.0						Hole terminated at 2.60 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP84

Job Number:	J1701008	**Easting:**	81447 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275844 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F		0.0					SP	SAND, LATERITE COBBLES and BOULDERS: medium to coarse grained, angular quartz sand, grey, very well iron cemented cobbles and boulders	D - M	L	
			0.5					SP-SC	SAND/Clayey SAND: medium to coarse grained, angular quartz sand, off-white mottled orange, with approximately 10-15% medium plasticity fines, variably iron cemented gravel and cobbles			
			1.0		B(TP84-01)			CH	Sandy CLAY: high plasticity, grey mottled orange, variable quartz sand content, slickensided, striated, blocky			
			1.5						Pale grey mottled dark red brown	M	VSt - H	
			2.0									
			2.5									
			3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP85

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Job Number:	J1701008	**Easting:**	81634 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275781 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE	Very strong inflow	0.0					SP	SAND: medium to coarse grained, angular, off-white	M	L - MD	
			0.5									
			1.0						Pale yellow-brown, with weakly iron cemented cobbles		VL	
			1.5									
			2.0					SC	Clayey SAND: medium to coarse grained, yellow-brown, with approximately 20% low plasticity fines, with weakly iron cemented zones			
			2.5									
			3.0						Hole terminated at 2.60 m Target depth Groundwater encountered at 1.8 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP86

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Job Number:	J1701008	**Easting:**	81832 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275811 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SC	Gravelly Clayey SAND: medium to coarse grained, brown and orange-brown, with approximately 30-40% medium plasticity fines, with approximately 30-40% fine to coarse grained iron cemented gravel	M - W	S	
	F		0.5					CH	Sandy CLAY: high plasticity, off-white, 30-40% medium to coarse grained quartz sand and fine grained gravel	M	St - VSt	
			1.0									
			1.5									
			2.0									
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP87

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81447 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275685 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 20-30% non-plastic fines, trace rootlets	D - M	L - MD	
			0.5					SM	Gravelly Silty SAND: medium to coarse grained, brown, with approximately 30-40% fine to medium grained gravel, with some non-plastic fines			
								SC	Clayey SAND: medium to coarse grained, orange-brown, with approximately 30-40% low plasticity fines	M	St	
	F		1.0					GC	Clayey Sandy GRAVEL: fine to medium grained iron cemented gravel, weakly cemented as cobbles, pale grey and orange-brown, with approximately 30% medium to coarse grained sand, with approximately 15% low plasticity fines		MD	
			1.5									
			2.0					CH	CLAY: high plasticity, off-white mottled orange and dark red-brown, with some medium to coarse grained sand, striated, slickensided, blocky		VSt	
			2.5									
			3.0						Hole terminated at 3.00 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP88

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81612 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275625 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 20-30% non-plastic fines, trace rootlets	D - M	F	
			0.5					SM-SC	Silty/Clayey SAND: medium to coarse grained, yellow-brown, with approximately 20-30% non-plastic to low plasticity fines, becoming coarser grained and less clayey with depth	M		
	H		1.0					GP	LATERITE GRAVEL and COBBLES: medium to coarse grained, very well iron cemented lateritic gravel and cobbles, dark red-brown mottled pale grey and orange-brown, with some quartz sand, trace fines			
			1.5									
			2.0						Hole terminated at 2.00 m Refusal on cemented gravel and cobbles Groundwater not encountered			
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP89

Job Number:	J1701008	**Easting:**	81751 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275681 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	Gravelly SAND: medium to coarse grained, dark grey-brown becoming brown, with approximately 30% fine to medium grained pisolitic gravel, with some non-plastic fines, isolated very well cemented LATERITE BOULDERS, trace rootlets to 0.2 m	D - M	L	
	VH		0.5						HARDPAN LATERITE: low to medium strength, very well cemented, yellow-brown mottled dark red-brown, ferruginous pisolites			
			1.0						Hole terminated at 0.60 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP90

Job Number:	J1701008	**Easting:**	81902 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275679 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					SP-SM	Gravelly SAND: medium to coarse grained, dark grey-brown becoming grey-brown, with approximately 30-40% fine to medium grained pisolitic gravel, with some non-plastic fines, with large roots	D - M	L	
			1.0 – 3.0						Hole terminated at 0.60 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP91

Job Number:	J1701008	**Easting:**	82049 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275674 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0 – 1.5					SP	Gravelly SAND and LATERITE BOULDERS: medium to coarse grained, grey-brown to 0.2 m, becoming orange-brown, with approximately 30-40% fine to medium grained pisolitic gravel, very well cemented LATERITE BOULDERS up to 1.5 m in size, trace to some roots and rootlets to 0.2 m, isolated large roots to 1.0 m	M	MD	
			1.5 – 3.0						Hole terminated at 1.70 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP92

Job Number:	J1701008	**Easting:**	81749 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275533 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					SP-SM	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown, with some fine grained pisolitic gravel, with some non-plastic fines, isolated very well cemented LATERITE COBBLES and BOULDERS	D - M	L	
			0.5 – 3.0						Hole terminated at 0.60 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP93

Job Number:	J1701008	**Easting:**	81902 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275535 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0					SP-GP	Gravelly SAND/Sandy GRAVEL and LATERITE BOULDERS: medium to coarse grained sand, fine to medium grained pisolitic gravel, with some non-plastic fines, with very well cemented LATERITE BOULDERS up to 1.5 m in size, with large diameter roots	D	L	
			0.5						No roots			
			1.0						Hole terminated at 1.10 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP94

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Job Number:	J1701008	**Easting:**	82044 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275531 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP94-01)			GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown becoming grey-brown, approximately 40% medium to coarse grained sand, with some non-plastic fines	D - M	VL	Average depth of Gravelly SAND recorded; varies from 0.4 m to 0.7 m
	VH		0.5						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled yellow-brown, ferruginous pisolites			
			1.0						Hole terminated at 0.70 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP95

Job Number:	J1701008	**Easting:**	82208 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275523 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	Slow inflow	0.0		B(TP95-01)			SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 20-30% non-plastic fines, with very large diameter roots	M	VS	
			0.5					SC	Clayey SAND: medium to coarse grained, orange-brown, with approximately 30-40% low plasticity fines, with very large diameter roots to 0.9 m			
			1.0		B(TP95-02)							
	F-H		1.5					SC-CH	Clayey SAND / Sandy CLAY and LATERITE BOULDERS: medium to coarse grained, high plasticity fines, pale blue-grey mottled orange and dark red-brown, very well iron cemented LATERITE BOULDERS	W	St	
			2.0									
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater encountered at 2.8 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/04/2017 16:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP96

Job Number:	J1701008	**Easting:**	82057 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275372 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VH		0.0					SP-SM	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown and grey-brown, with approximately 30% fine to medium grained pisolitic gravel, with some non-plastic fines, trace rootlets	D	L	Average depth of Gravelly SAND varies between 0.1 m and 0.3 m Numerous laterite outcrops at surface
			0.5						Hole terminated at 0.20 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/04/2017 16:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP97

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	80810 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275925 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, dark grey-brown, with some fine grained gravel, trace rootlets	D	L	
	F-H		0.5						LATERITE BOULDERS and COBBLES: fine to coarse grained, very well iron cemented gravel and cobbles, orange-brown, with some medium to coarse grained sand, with some non-plastic fines	D - M	MD	
			1.0									
			1.5						Dark red-brown mottled pale grey and orange, becoming weakly cemented and friable, transitioning into underlying layer			
			2.0									
	F		2.5					SC	Clayey SAND: medium to coarse grained quartz sand, off-white, with approximately 30% high plasticity fines	M	H	
			3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/04/2017 16:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP98

Job Number:	J1701008	**Easting:**	80837 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275828 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0					GM	Silty Sandy GRAVEL; fine to medium grained pisolitic gravel, dark grey-brown, with approximately 20-40% medium to coarse grained sand, with approximately 15-20% non-plastic fines	D - M	L	
			0.5					GC	Clayey Sandy GRAVEL: fine to medium grained pisolitic gravel, orange-brown, with approximately 30-40% medium to coarse grained sand, with approximately 15-20% low plasticity fines			
	H		1.0						HARDPAN LATERITE: very low to low strength, well iron cemented, pale grey mottled orange and dark red-brown			
			1.5						Becoming uncemented, transitioning into underlying layer			
	F		2.0		B(TP98-01)			SC-CH	Clayey SAND/Sandy CLAY: high plasticity, medium to coarse grained quartz sand, off-white mottled dark red-brown, highly variable sand content, occasional weakly iron cemented lenses	M	H	
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/04/2017 16:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP99

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	80969 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275830 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	Moderate inflow	0.0					SM	Silty SAND: medium to coarse grained, grey-brown, with approximately 30-40% non-plastic fines, trace rootlets	D - M	VD	
			0.5					SC	Clayey SAND: medium to coarse grained, orange-brown, with approximately 30-40% low to medium plasticity fines		F	
			1.0					SC	Gravelly Clayey SAND: medium to coarse grained quartz sand, pale grey mottled orange, with approximately 20% low to medium plasticity fines, with approximately 30% very well iron cemented gravel and cobbles		St	
	F		1.5					SC-CH	Clayey SAND/Sandy CLAY: high plasticity, medium to coarse grained quartz sand, off-white, highly variable sand content, occasional weakly iron cemented lenses	M	H	
			2.0									
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater encountered at 1 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/04/2017 16:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP100

Job Number:	J1701008	**Easting:**	80988 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275931 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 20% non-plastic fines, trace rootlets	D	L	
			0.5					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, brown, with approximately 20-40% medium to coarse grained quartz sand, with some non-plastic fines	D - M		
								SC	Isolated orange-brown Clayey SAND layer			
	F		1.0		B(TP100-01)			SC	Clayey SAND: medium to coarse grained, pale grey mottled orange-brown, with approximately 30-40% medium plasticity fines	M	VSt	
			1.5									
			2.0						Pale blue-grey mottled dark red-brown, well iron cemented lenses			
		Slow inflow	2.5						Pale blue-grey, with approximately 30% medium plasticity fines			
			3.0						Hole terminated at 2.80 m Target depth Groundwater encountered at 2.2 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/04/2017 16:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

Appendix C: Dynamic Cone Penetrometer Test Results

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4/15 Walters Drive OSBORNE PARK WA 6017
ABN: 64 625 054 729

DYNAMIC CONE PENETROMETER RECORD SHEET

AS 1298.6.3.2

Client:	Satterley Property Group	**Job No:**	J1701008
Project:	Proposed Stoneville Residential Project	**Date:**	Various
Location:	Lot 48 Roland Road, Stoneville	**Engineer:**	HWC

Location:	TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	1	5	5	3	2	2	2	2
200-300	1	6	4	2	2	0	2	2
300-400	HB	7	5	3	2	1	1	2
400-500		5	5	4	4	1	2	2
500-600		5	5	4	5	1	3	2
600-700		4	HB	5	10	1	11R	2
700-800		3		5	10	1		2
800-900		3		5	11HB	2		1
900-1000		3		3		2		3

Location:	TP9	TP10	TP11	TP12	TP13	TP14	TP15	TP16
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	HB	4	3	4	2	HB	2	HB
200-300		3	4	3	1		1	
300-400		1	8	2	1		3	
400-500		1	3	1	1		2HB	
500-600		0	4	1	1			
600-700		0	3	1	3			
700-800		1	1	0	6			
800-900		1	1	2	HB			
900-1000		1	3HB	3				

Location:	TP17	TP18	TP19	TP20	TP21	TP22	TP23	TP24
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	2	3	5	HB	HB	HB	1	HB
200-300	2	2	2				HB	
300-400	1	2	2					
400-500	3	1	5					
500-600	8HB	2	9HB					
600-700		4						
700-800		7						
800-900		6						
900-1000		15R						

Dynamic Cone Penetrometer tests done in accordance with AS 1289.6.3.2

R: Refusal HB: Hammer-bounce

DYNAMIC CONE PENETROMETER RECORD SHEET

AS 1298.6.3.2

Client:	Satterley Property Group	**Job No:**	J1701008
Project:	Proposed Stoneville Residential Project	**Date:**	Various
Location:	Lot 48 Roland Road, Stoneville	**Engineer:**	HWC

Location:	TP25	TP26	TP27	TP28	TP29	TP30	TP31	TP32
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	3	3	2	1	1	2HB	1	1
200-300	2	2	2HB	7	1HB		1	0
300-400	5HB	1		5			2	1
400-500		0		5HB			2	1
500-600		2					HB	2
600-700		5						3
700-800		6						6
800-900		3						4
900-1000		6						6

Location:	TP33	TP34	TP35	TP36	TP37	TP38	TP39	TP40
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	2	2	1	2	3	HB	HB	2
200-300	1	1	1	2	6			2
300-400	1	2HB	2	1	5			2
400-500	1		2	2	9			2
500-600	1		5HB	3HB	10R			2HB
600-700	0							
700-800	2HB							
800-900								
900-1000								

Location:	TP41	TP42	TP43	TP44	TP45	TP46	TP47	TP48
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	2HB	1	2	3HB	HB	2	2HB	3
200-300		3	2			4HB		HB
300-400		4HB	1					
400-500			2					
500-600			1					
600-700			2					
700-800			2					
800-900			1					
900-1000			2					

Dynamic Cone Penetrometer tests done in accordance with AS 1289.6.3.2

R: Refusal HB: Hammer-bounce

DYNAMIC CONE PENETROMETER RECORD SHEET

AS 1298.6.3.2

Client:	Satterley Property Group	**Job No:**	J1701008
Project:	Proposed Stoneville Residential Project	**Date:**	Various
Location:	Lot 48 Roland Road, Stoneville	**Engineer:**	HWC

Location:	TP49	TP50	TP51	TP52	TP53	TP54	TP55	TP56
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	HB	2	2	HB	1	2	2	3
200-300		1	2		1	2	3	3
300-400		2HB	2		3	2	3	2
400-500			2		2	5	3	3
500-600			3		5	9	3	2
600-700			4		5	8	3	3
700-800			3HB		6	10R	4	4
800-900					5		4	10R
900-1000					8		4	

Location:	TP57	TP58	TP59	TP60	TP61	TP62	TP63	TP64
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	2	1	2	1	1	2	2	1
200-300	1	1	1	1	1	4HB	2	1
300-400	1	1	0	1	1		2	0
400-500	2	1	4	1	0		1	1
500-600	3	3	6	2	1		2	1
600-700	3	4	11	2	2		10R	1
700-800	10	5	5	2	2			10R
800-900	15	5	4	12	2			
900-1000	11R	10R	4		2			

Location:	TP65	TP66	TP67	TP68	TP69	TP70	TP71	TP72
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	2	2	2	2	2	2	5	2
200-300	1	1	1	2	1	1	2	2
300-400	3	2	0	1	1	0	3	2
400-500	4	4	1	1	0	2	1	2
500-600	6	10R	2	2	1	3	1	3
600-700	7		3	2	3	7	1	3
700-800	7		5	7	3	10R	4	5
800-900	10R		5	10R	1		10R	8
900-1000			7		2			8

Dynamic Cone Penetrometer tests done in accordance with AS 1289.6.3.2

R: Refusal HB: Hammer-bounce

DYNAMIC CONE PENETROMETER RECORD SHEET

AS 1298.6.3.2

Client:	Satterley Property Group	**Job No:**	J1701008
Project:	Proposed Stoneville Residential Project	**Date:**	Various
Location:	Lot 48 Roland Road, Stoneville	**Engineer:**	HWC

Location:	TP73	TP74	TP75	TP76	TP77	TP78	TP79	TP80
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	2	2	1	2	2	1	3	1
200-300	1	1	2	1	2	1	1	2
300-400	1	1	1	2HB	2	1	2	1
400-500	1	4	1		2	0	4	1
500-600	2	4	2		2	1	5	1
600-700	1	8HB	1		7	4	2	1
700-800	0		2		5	HB	3	2
800-900	1		5		5		8	1
900-1000	3		10R		7HB		10R	2

Location:	TP81	TP82	TP83	TP84	TP85	TP86	TP87	TP88
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	1	1	1	2HB	2	2	2	3
200-300	1	0	0		2	1	2	4
300-400	1	0	0		2	1	1	3
400-500	1	1	2		3	1	1	1
500-600	1	0	4		2	2	3	1
600-700	0	1	5		2	4	4	2
700-800	1	0	5		1	3	6	2
800-900	3HB	1	10R		1	4	4	2
900-1000		2			1	6	7	5HB

Location:	TP89	TP90	TP91	TP92	TP93	TP94	TP95	TP96
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET	SET	SET	SET	SET
100-200	HB	2	HB	HB	HB	1	1	1
200-300		1				1	0	4HB
300-400		4				0	0	
400-500		7				1	1	
500-600		HB				1	0	
600-700						0	1	
700-800						2	0	
800-900						1	1	
900-1000							2	

Dynamic Cone Penetrometer tests done in accordance with AS 1289.6.3.2

R: Refusal HB: Hammer-bounce

DYNAMIC CONE PENETROMETER RECORD SHEET

AS 1298.6.3.2

Client:	Satterley Property Group	**Job No:**	J1701008
Project:	Proposed Stoneville Residential Project	**Date:**	Various
Location:	Lot 48 Roland Road, Stoneville	**Engineer:**	HWC

Location:	TP97	TP98	TP99	TP100				
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100	SET	SET	SET	SET				
100-200	1	2	1	2				
200-300	1	1	0	1				
300-400	1	1	1	1				
400-500	3	3HB	0	2				
500-600	4HB		1	2				
600-700			2	2				
700-800			1	2				
800-900			3	5				
900-1000			2	5				

Location:								
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100								
100-200								
200-300								
300-400								
400-500								
500-600								
600-700								
700-800								
800-900								
900-1000								

Location:								
Depth (mm)	**N° of Penetrometer Blows per 100 mm Depth Interval**							
0-100								
100-200								
200-300								
300-400								
400-500								
500-600								
600-700								
700-800								
800-900								
900-1000								

Dynamic Cone Penetrometer tests done in accordance with AS 1289.6.3.2

R: Refusal HB: Hammer-bounce

Appendix D: Laboratory Test Results

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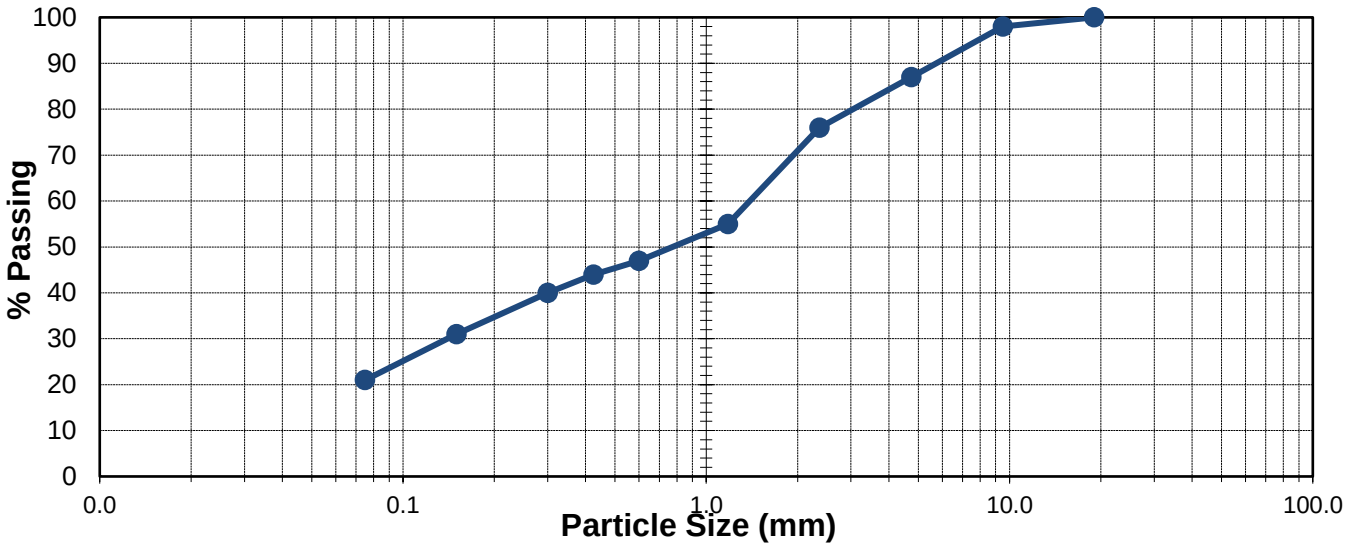
ABN: 64 625 054 729

LIQUIDLABSWA
CONSTRUCTION MATERIALS TESTING LABORATORY
UNIT 4, 96 BRIGG ST, WELSHPOOL, WA 6106 LIQUIDLABSWA.COM.AU

Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/380_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/380
Sample ID:	TP08 0.0-0.6m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	**AS 1289.3.6.1**
Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	98
4.75	87
2.36	76
1.18	55
0.600	47
0.425	44
0.300	40
0.150	31
0.075	21

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

Comments:

NATA
WORLD RECOGNISED ACCREDITATION

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Approved Signature:

Name: Matt van Herk
Function Laboratory Manager
Date: 02-March-2017

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CONSTRUCTION MATERIALS TESTING LABORATORY
UNIT 4, 96 BRIGG ST, WELSHPOOL, WA 6106 LIQUIDLABSWA.COM.AU

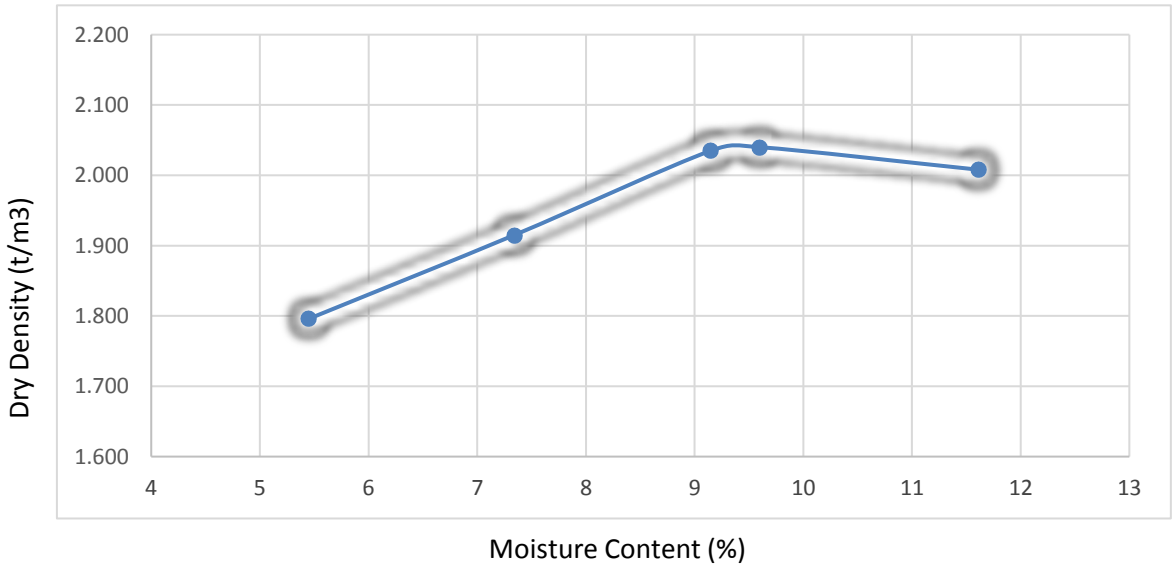
Modified Maximum Dry Density Test Report — Test Method: AS 1289.5.2.1

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project	**Report No:**	LLS17/380_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/380
Sample ID:	TP08 0.0-0.6m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received

Modified Maximum Dry Density	2.040	t/m^3
Optimum Moisture Content	9.6	%
Curing Period	6	hrs
Percent Retained +19.0mm	0	%

Moisture	5.5	7.3	9.2	9.6	11.6
Dry Density	1.796	1.915	2.035	2.040	2.008



Client Address: 4/15 Walters Dr, Osborne Park, WA 6017

Comments:

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Function: Laboratory Manager
Date: 02-March-2017

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California Bearing Ratio Test Report — Test Method: AS 1289.6.1.1

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project	**Report No:**	LLS17/380_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/380
Sample ID:	TP08 0.0-0.6m	**Issue Date:**	08-March-2017

Sampling Procedure: Tested as Received

Maximum Dry Density (t/m^3):	**2.040**	**Conditions at Test**	
Optimum Moisture Content (%):	**9.6**		
Desired Conditions:	**95/100**	Soaking Period (Days):	**4**
		Surcharge (kg):	**4.5**
Compactive Effort		Entire Moisure Content (%):	**12.0**
		Entire Moisture Ratio (%):	**125.0**
Mass of Hammer (kg):	**4.9**	Top 30mm Moisture Content (%):	**11.8**
Number of layers:	**5**	Top 30mm Moisture Ratio (%):	**123.0**
Number of blows/layer:	**17**	Swell (%):	**0.0**
		CBR at 2.5mm Penetration (%):	**40**
Conditions after Compaction			
		Conditions after Soaking	
Dry Density (t/m^3):	**1.938**		
Moisture Content (%):	**9.8**	Dry Density (t/m^3):	**1.938**
Density Ratio (%):	**95.0**	Moisture Content (%):	**13.4**
Moisture Ratio (%):	**102.0**	Dry Density Ratio (%):	**95.0**
Soaked/Unsoaked:	**Soaked**	Moisture Ratio (%):	**139.0**

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

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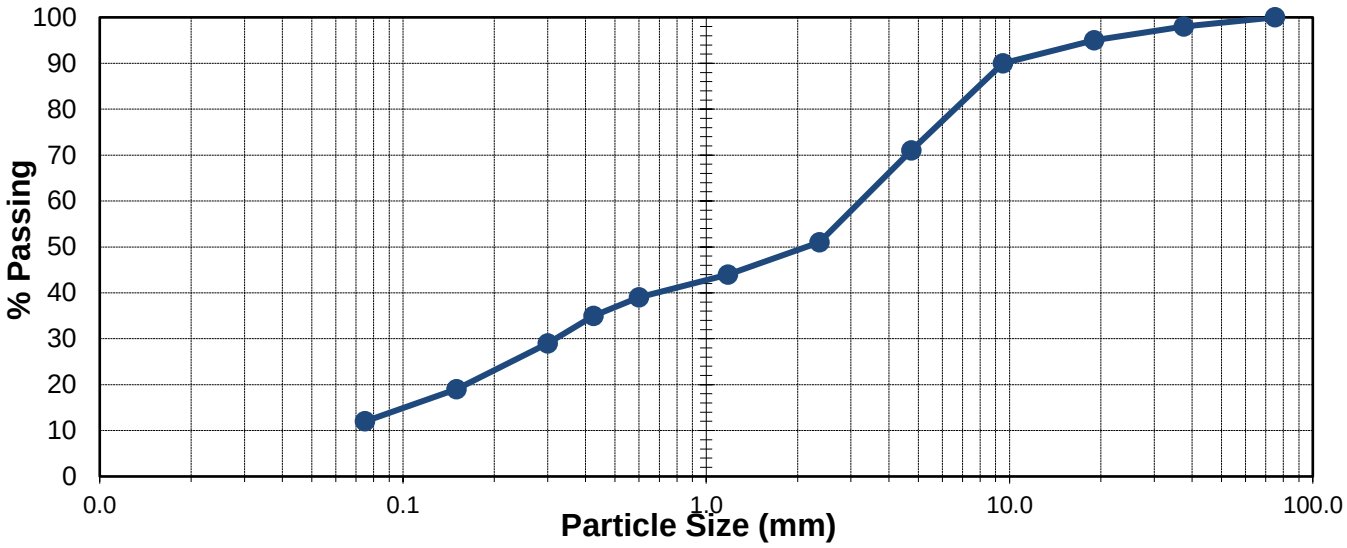
Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/385_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/385
Sample ID:	TP43 0.0-0.4m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	**AS 1289.3.6.1**
Sieve Size (mm)	% Passing
75.0	100
37.5	98
19.0	95
9.5	90
4.75	71
2.36	51
1.18	44
0.600	39
0.425	35
0.300	29
0.150	19
0.075	12

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

Comments:

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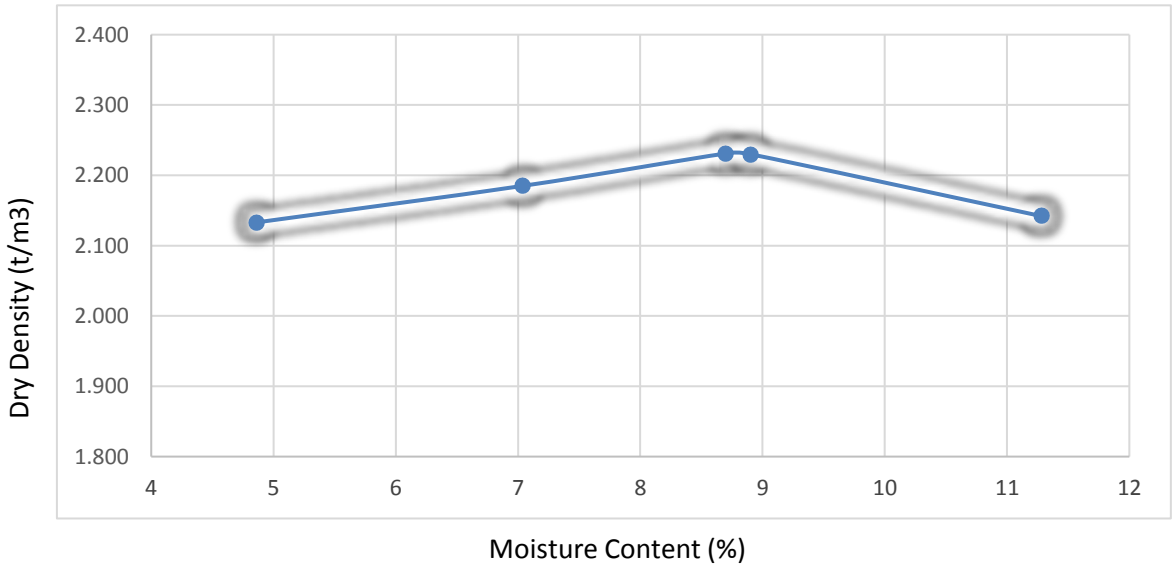
Modified Maximum Dry Density Test Report — Test Method: AS 1289.5.2.1

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project	**Report No:**	LLS17/385_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/385
Sample ID:	TP43 0.0-0.4m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received

Modified Maximum Dry Density	2.231	t/m^3
Optimum Moisture Content	8.7	%
Curing Period	15	hrs
Percent Retained +19.0mm	0	%

Moisture	4.9	7.0	8.7	8.9	11.3
Dry Density	2.133	2.185	2.231	2.230	2.142



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California Bearing Ratio Test Report — Test Method: AS 1289.6.1.1

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project	**Report No:**	LLS17/385_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/385
Sample ID:	TP43 0.0-0.4m	**Issue Date:**	08-March-2017

Sampling Procedure: Tested as Received

Maximum Dry Density (t/m^3):	**2.231**	**Conditions at Test**	
Optimum Moisture Content (%):	**8.7**		
Desired Conditions:	**95/100**	Soaking Period (Days):	**4**
		Surcharge (kg):	**4.5**
Compactive Effort		Entire Moisure Content (%):	**9.6**
		Entire Moisture Ratio (%):	**110.0**
Mass of Hammer (kg):	**4.9**	Top 30mm Moisture Content (%):	**10.1**
Number of layers:	**5**	Top 30mm Moisture Ratio (%):	**116.5**
Number of blows/layer:	**19**	Swell (%):	**0.0**
		CBR at 5.0mm Penetration (%):	**35**
Conditions after Compaction			
		Conditions after Soaking	
Dry Density (t/m^3):	**2.123**		
Moisture Content (%):	**8.6**	Dry Density (t/m^3):	**2.123**
Density Ratio (%):	**95.0**	Moisture Content (%):	**11.3**
Moisture Ratio (%):	**99.0**	Dry Density Ratio (%):	**95.0**
Soaked/Unsoaked:	**Soaked**	Moisture Ratio (%):	**129.5**

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

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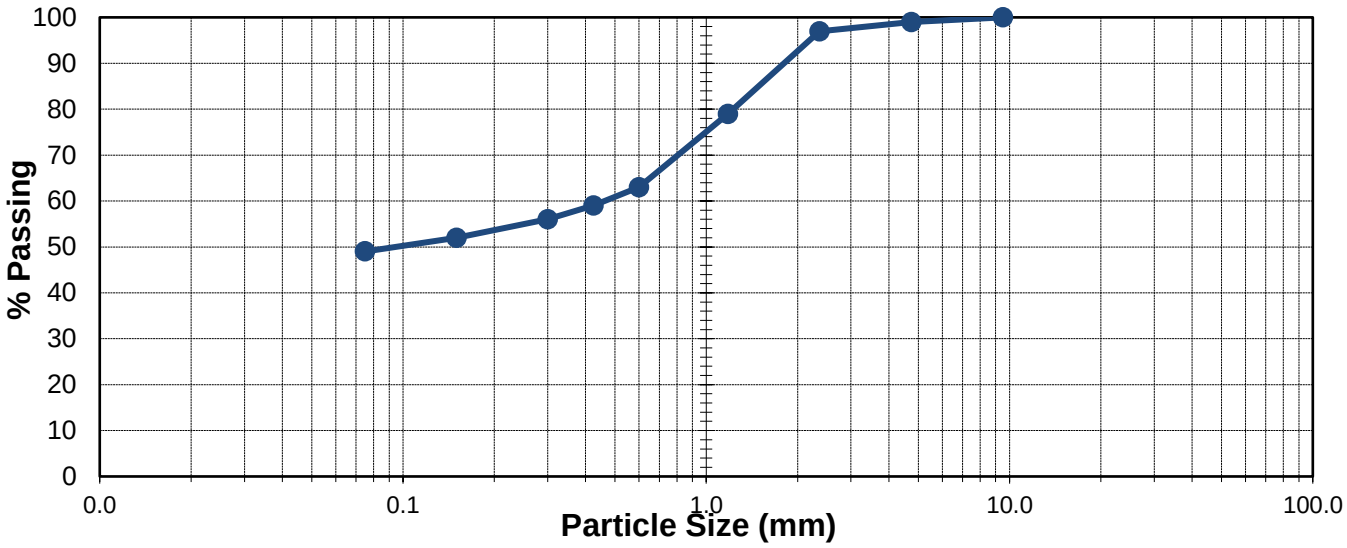
Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/384_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/384
Sample ID:	TP54 1.0-2.0m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	AS 1289.3.6.1
Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	99
2.36	97
1.18	79
0.600	63
0.425	59
0.300	56
0.150	52
0.075	49

Atterberg Limits Tests AS 1289		
Liquid Limit 3.1.1	60	%
Plastic Limit 3.2.1	24	%
Plasticity Index 3.3.1	36	%
Linear Shrinkage 3.4.1	10.5	%
Cracked	☐	
Curled	☑	

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

Comments:

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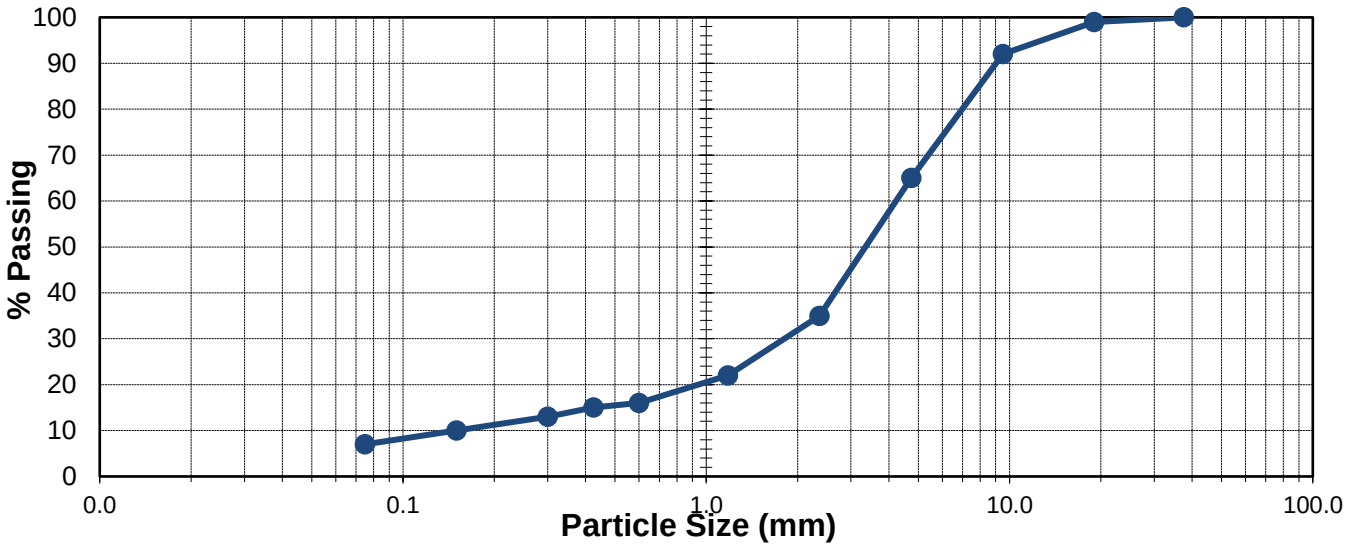
Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/383_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/383
Sample ID:	TP61 0.0-1.0m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	**AS 1289.3.6.1**
Sieve Size (mm)	% Passing
75.0	
37.5	100
19.0	99
9.5	92
4.75	65
2.36	35
1.18	22
0.600	16
0.425	15
0.300	13
0.150	10
0.075	7

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

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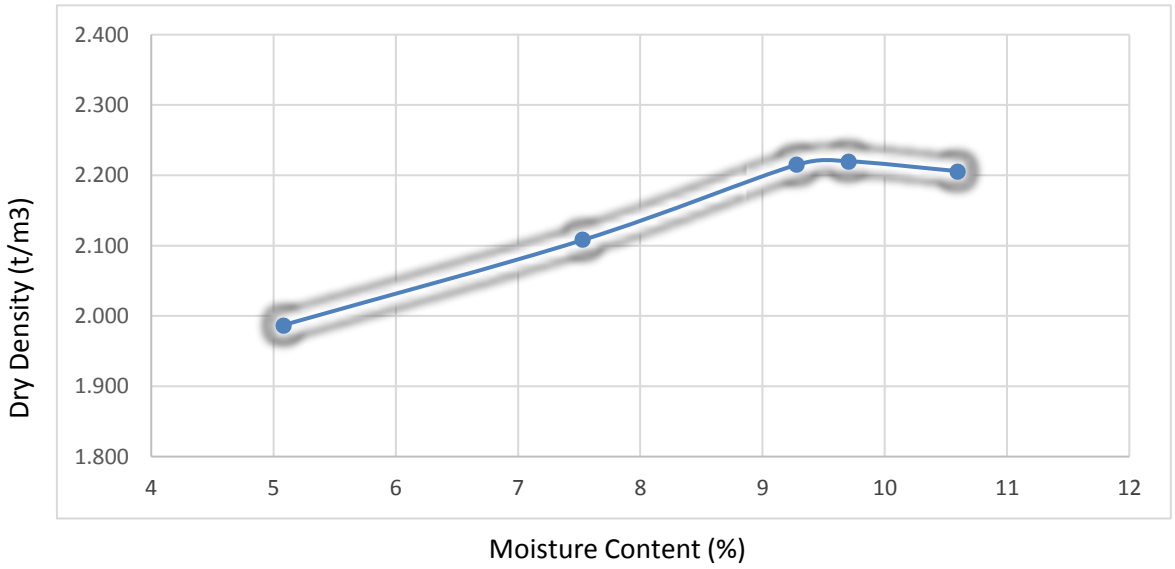
Modified Maximum Dry Density Test Report — Test Method: AS 1289.5.2.1

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project	**Report No:**	LLS17/383_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/383
Sample ID:	TP61 0.0-1.0m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received

Modified Maximum Dry Density	2.220	t/m^3
Optimum Moisture Content	9.7	%
Curing Period	15	hrs
Percent Retained +19.0mm	0	%

Moisture	5.1	7.5	9.3	9.7	10.6
Dry Density	1.987	2.108	2.215	2.220	2.206



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California Bearing Ratio Test Report

Test Method: AS 1289.6.1.1

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project	**Report No:**	LLS17/383_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/383
Sample ID:	TP61 0.0-1.0m	**Issue Date:**	08-March-2017

Sampling Procedure: Tested as Received

Maximum Dry Density (t/m^3):	**2.220**	**Conditions at Test**	
Optimum Moisture Content (%):	**9.7**		
Desired Conditions:	**95/100**	Soaking Period (Days):	**4**
		Surcharge (kg):	**4.5**
Compactive Effort		Entire Moisure Content (%):	**10.2**
		Entire Moisture Ratio (%):	**105.5**
Mass of Hammer (kg):	**4.9**	Top 30mm Moisture Content (%):	**10.4**
Number of layers:	**5**	Top 30mm Moisture Ratio (%):	**107.0**
Number of blows/layer:	**20**	Swell (%):	**0.0**
		CBR at 5.0mm Penetration (%):	**50**
Conditions after Compaction			
		Conditions after Soaking	
Dry Density (t/m^3):	**2.113**		
Moisture Content (%):	**9.5**	Dry Density (t/m^3):	**2.113**
Density Ratio (%):	**95.0**	Moisture Content (%):	**12.6**
Moisture Ratio (%):	**97.5**	Dry Density Ratio (%):	**95.0**
Soaked/Unsoaked:	**Soaked**	Moisture Ratio (%):	**130.0**

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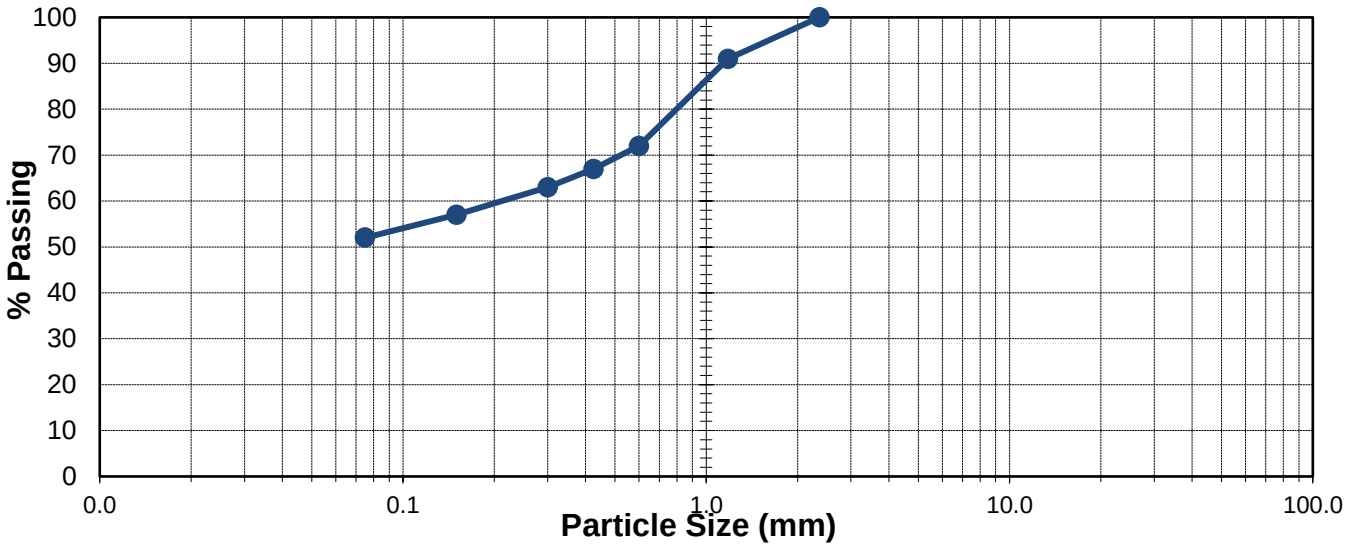
Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/382_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/382
Sample ID:	TP71 0.9-1.7m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	**AS 1289.3.6.1**
Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	100
1.18	91
0.600	72
0.425	67
0.300	63
0.150	57
0.075	52

Atterberg Limits Tests
AS 1289

Liquid Limit 3.1.1	**55**	%
Plastic Limit 3.2.1	**25**	%
Plasticity Index 3.3.1	**30**	%
Linear Shrinkage 3.4.1	**9.0**	%
Cracked	☐	
Curled	☐	

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

Comments:

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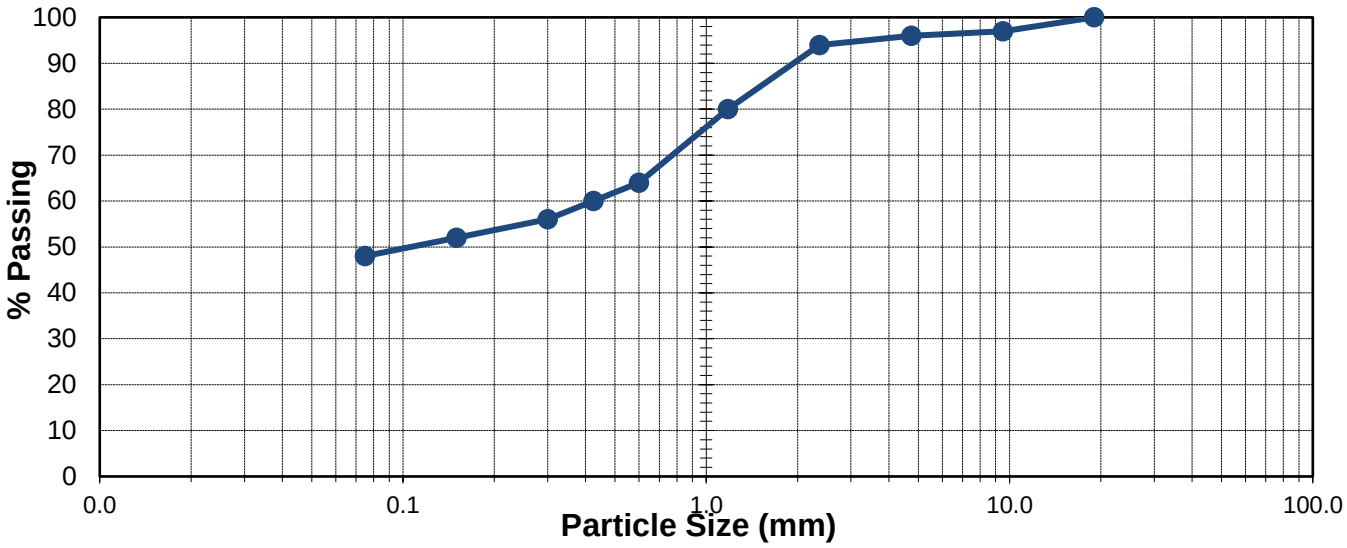
Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/381_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/381
Sample ID:	TP73 1.7-2.07m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	AS 1289.3.6.1
Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	100
9.5	97
4.75	96
2.36	94
1.18	80
0.600	64
0.425	60
0.300	56
0.150	52
0.075	48

Atterberg Limits Tests AS 1289		
Liquid Limit 3.1.1	57	%
Plastic Limit 3.2.1	26	%
Plasticity Index 3.3.1	31	%
Linear Shrinkage 3.4.1	7.0	%
Cracked	☐	
Curled	☐	

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

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Shrink Swell Index Test Report		**Test Method:**	**$_1$ AS 1289.7.1.1**
Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project	**Report No:**	LLS17/381 _1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/381
Sample ID:	TP73 1.7-2.07m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received

Soil Description:	Orange/White Silty Clay
Sample Type:	55mm Triaxial Tube sample (Remoulded)

Swell Specimen

Moisture Content - Initial (%)	14.8	Moisture Content - Final (%)	21.1
Dry Density - Initial (t/m3)	1.74	Estimated Inert Inclusions(%)	4

Shrink Specimen

Moisture Content - Initial (%)	15.5	Length/Diameter Ratio	2.3
Extent of Crumbling	Nil	Extent of Cracking	Nil

Shrinkage Strain (%)	0.7	Shrink Swell Index I_{ss}	0.6
Swell Strain (%)	0.8		

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

Comments: $_1$ Shrink Swell Index not covered under scope of accreditation

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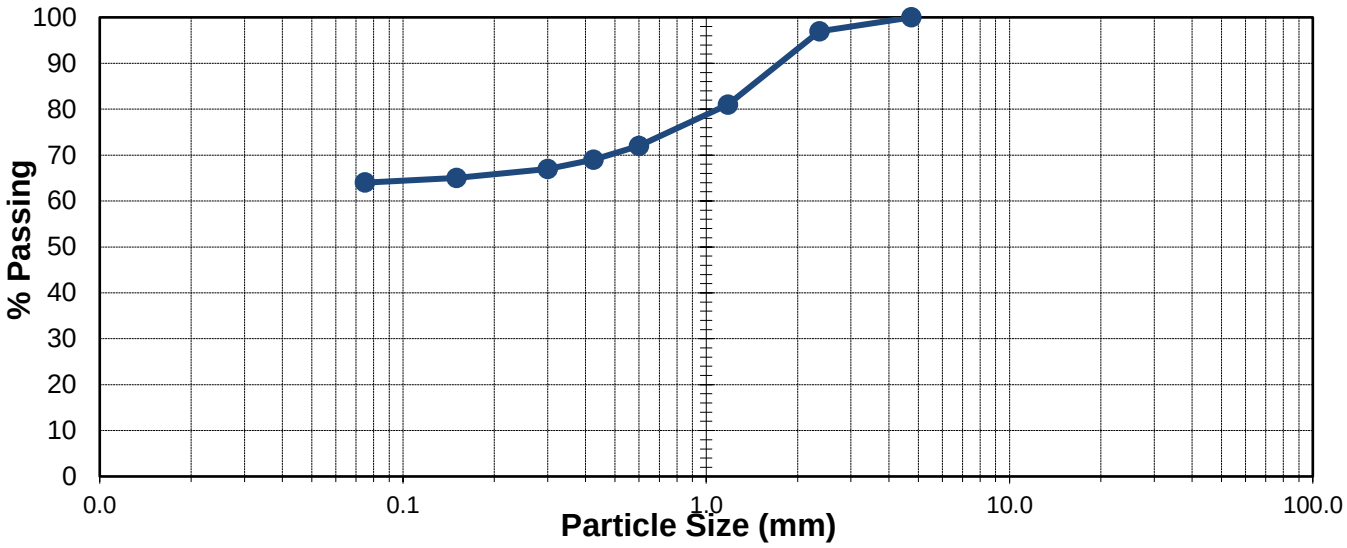
Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/386_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/386
Sample ID:	TP84 1.2-1.46m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	**AS 1289.3.6.1**
Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	97
1.18	81
0.600	72
0.425	69
0.300	67
0.150	65
0.075	64

Atterberg Limits Tests
AS 1289

Liquid Limit 3.1.1	**68**	%
Plastic Limit 3.2.1	**32**	%
Plasticity Index 3.3.1	**36**	%
Linear Shrinkage 3.4.1	**7.0**	%
Cracked	☐	
Curled	☐	

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

Comments:

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Shrink Swell Index Test Report		**Test Method:**	**$_1$ AS 1289.7.1.1**
Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project	**Report No:**	LLS17/386 _1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/386
Sample ID:	TP84 1.2-1.46m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received

Soil Description:	White Orange Silty Clay
Sample Type:	55mm Triaxial Tube sample (Remoulded)

Swell Specimen

Moisture Content - Initial (%)	18.4	Moisture Content - Final (%)	22.9
Dry Density - Initial (t/m3)	1.59	Estimated Inert Inclusions(%)	0

Shrink Specimen

Moisture Content - Initial (%)	18.6	Length/Diameter Ratio	2.3
Extent of Crumbling	Nil	Extent of Cracking	Nil

Shrinkage Strain (%)	0.8	Shrink Swell Index I_{ss}	0.4
Swell Strain (%)	0.0		

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

Comments: $_1$ Shrink Swell Index not covered under scope of accreditation

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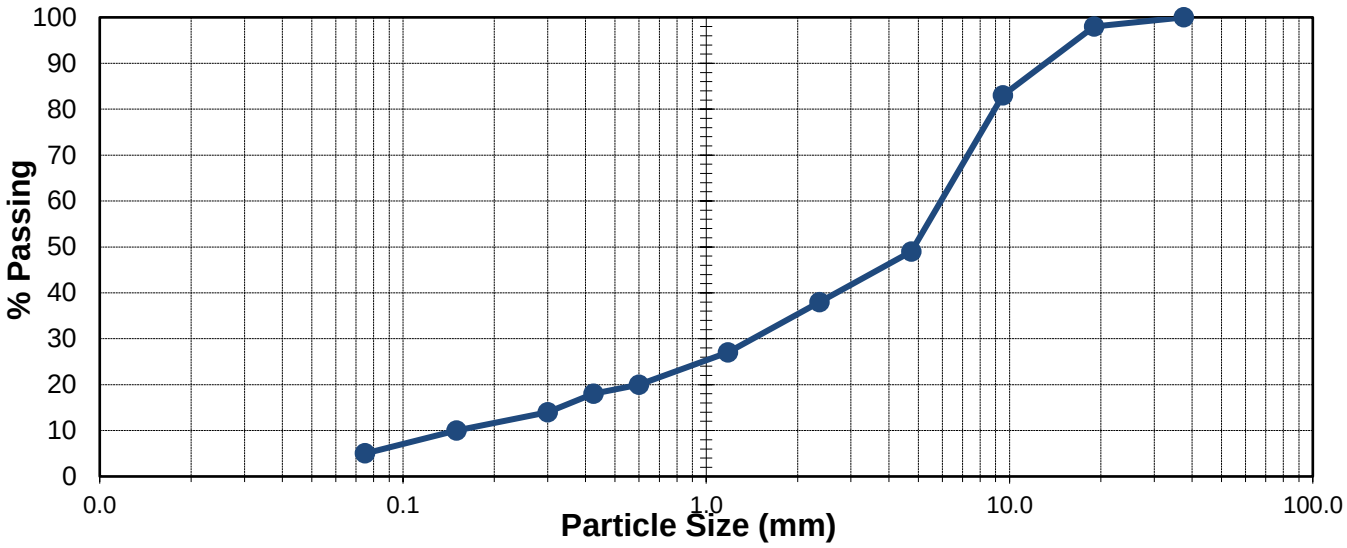
Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/391_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/391
Sample ID:	TP94/1 0.0-0.5m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	**AS 1289.3.6.1**
Sieve Size (mm)	% Passing
75.0	
37.5	100
19.0	98
9.5	83
4.75	49
2.36	38
1.18	27
0.600	20
0.425	18
0.300	14
0.150	10
0.075	5

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

Comments:

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Name: Matt van Herk
Function Laboratory Manager
Date: 02-March-2017

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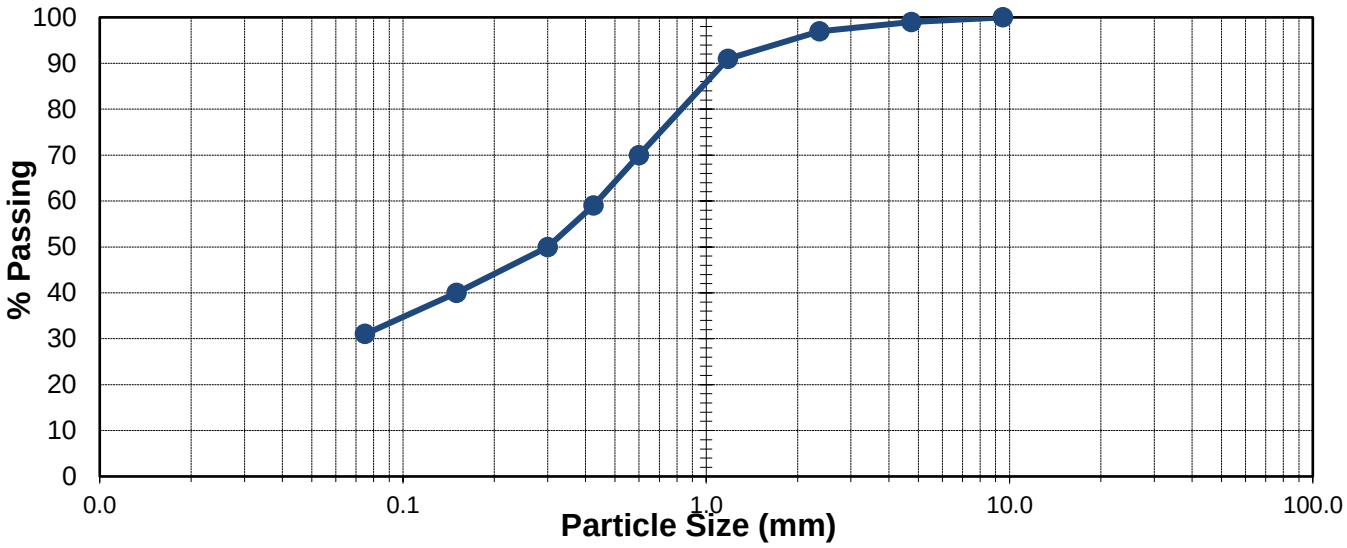
Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/389_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/389
Sample ID:	TP95/1 0.2-1.1m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	AS 1289.3.6.1
Sieve Size (mm)	% Passing
75.0	
37.5	
19.0	
9.5	100
4.75	99
2.36	97
1.18	91
0.600	70
0.425	59
0.300	50
0.150	40
0.075	31

Atterberg Limits Tests AS 1289		
Liquid Limit 3.1.1	28	%
Plastic Limit 3.2.1	15	%
Plasticity Index 3.3.1	13	%
Linear Shrinkage 3.4.1	5.0	%
Cracked	☑	
Curled	☐	

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

Comments:

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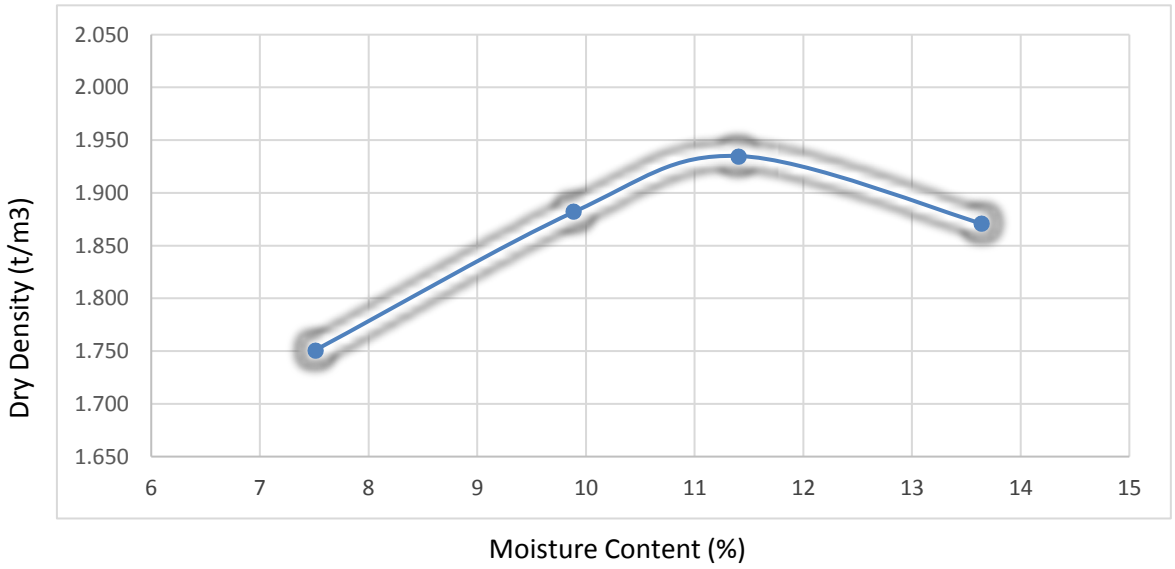
Standard Maximum Dry Density Test Report — Test Method: AS 1289.5.1.1

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project	**Report No:**	LLS17/389_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/389
Sample ID:	TP95/1 0.2-1.1m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received

Standard Maximum Dry Density	1.935	t/m^3
Optimum Moisture Content	11.4	%
Curing Period	15	hrs
Percent Retained +19.0mm	0	%

Moisture	7.5	9.9	11.4	13.6	
Dry Density	1.751	1.882	1.935	1.871	



Client Address: 4/15 Walters Dr, Osborne Park, WA 6017

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Date: 02-March-2017

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California Bearing Ratio Test Report

Test Method: AS 1289.6.1.1

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project	**Report No:**	LLS17/389_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/389
Sample ID:	TP95/1 0.2-1.1m	**Issue Date:**	08-March-2017

Sampling Procedure: Tested as Received

Standard Maximum Dry Density (t/m^3):	**1.935**	**Conditions at Test**	
Optimum Moisture Content (%):	**11.4**		
Desired Conditions:	**95/100**	Soaking Period (Days):	**4**
		Surcharge (kg):	**4.5**
Compactive Effort		Entire Moisure Content (%):	**13.4**
		Entire Moisture Ratio (%):	**117.0**
Mass of Hammer (kg):	**2.7**	Top 30mm Moisture Content (%):	**14.7**
Number of layers:	**3**	Top 30mm Moisture Ratio (%):	**129.0**
Number of blows/layer:	**15**	Swell (%):	**0.0**
		CBR at 5.0mm Penetration (%):	**9**
Conditions after Compaction			
		Conditions after Soaking	
Dry Density (t/m^3):	**1.837**		
Moisture Content (%):	**11.5**	Dry Density (t/m^3):	**1.837**
Density Ratio (%):	**95.0**	Moisture Content (%):	**14.9**
Moisture Ratio (%):	**101.0**	Dry Density Ratio (%):	**95.0**
Soaked/Unsoaked:	**Soaked**	Moisture Ratio (%):	**131.0**

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

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Date: 08-March-2017

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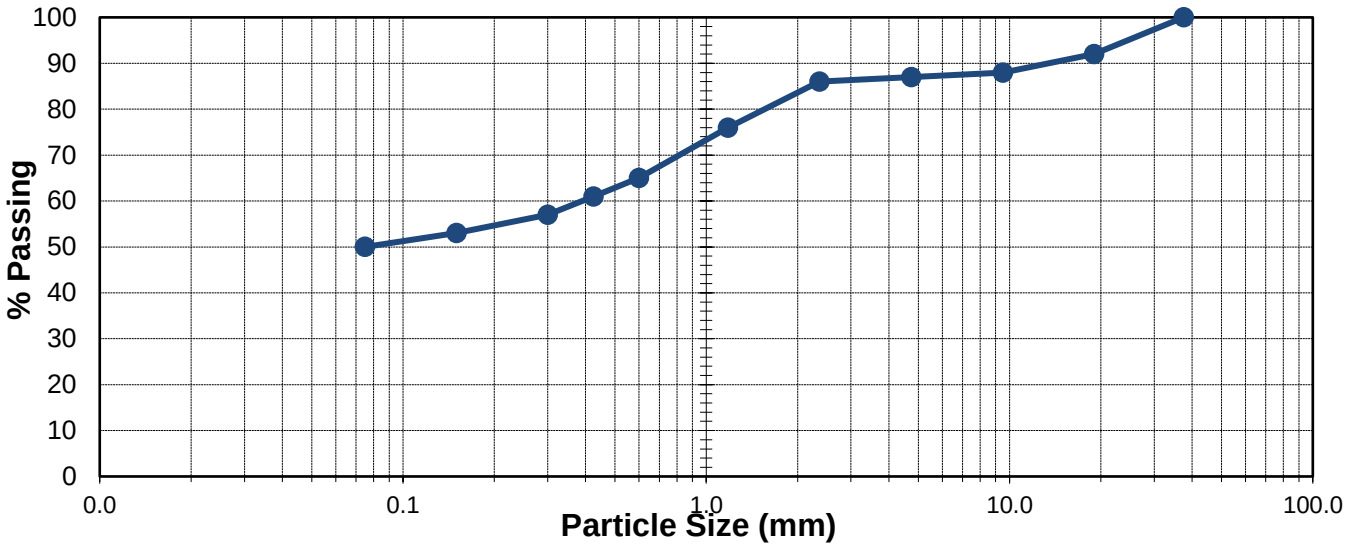
Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/390_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/390
Sample ID:	TP95/2 1.1-2.0m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	AS 1289.3.6.1
Sieve Size (mm)	% Passing
75.0	
37.5	100
19.0	92
9.5	88
4.75	87
2.36	86
1.18	76
0.600	65
0.425	61
0.300	57
0.150	53
0.075	50

Atterberg Limits Tests AS 1289		
Liquid Limit 3.1.1	67	%
Plastic Limit 3.2.1	28	%
Plasticity Index 3.3.1	39	%
Linear Shrinkage 3.4.1	10.5	%
Cracked	☑	
Curled	☐	

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

Comments:

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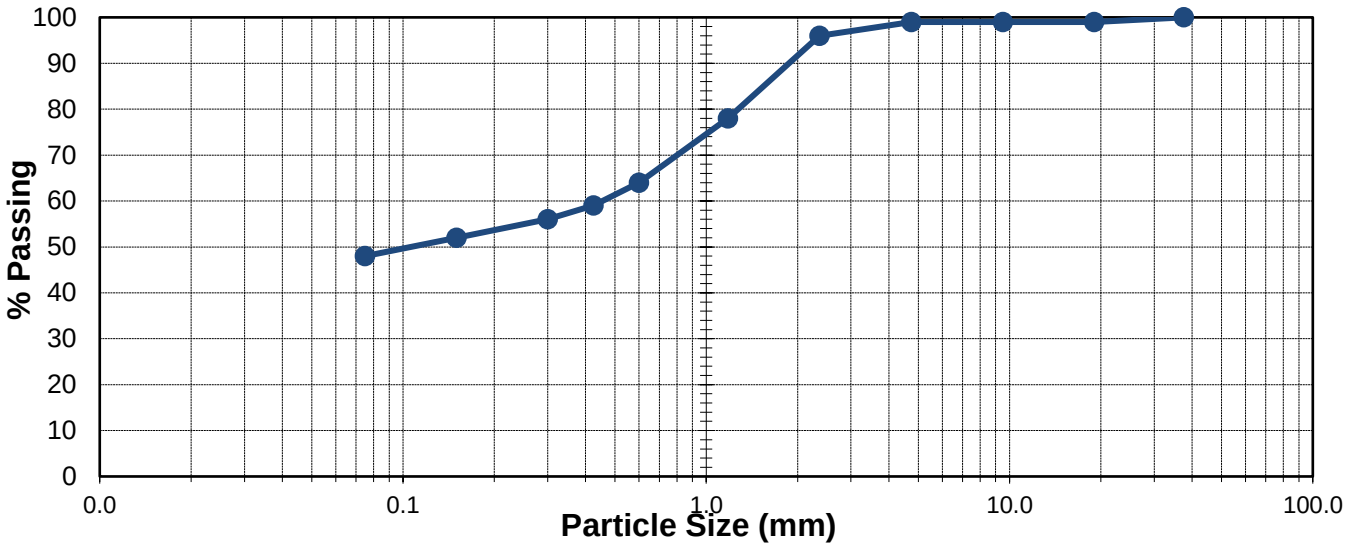
Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/388_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/388
Sample ID:	TP98 2.1-2.9m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	AS 1289.3.6.1
Sieve Size (mm)	% Passing
75.0	
37.5	100
19.0	99
9.5	99
4.75	99
2.36	96
1.18	78
0.600	64
0.425	59
0.300	56
0.150	52
0.075	48

Atterberg Limits Tests AS 1289		
Liquid Limit 3.1.1	60	%
Plastic Limit 3.2.1	23	%
Plasticity Index 3.3.1	37	%
Linear Shrinkage 3.4.1	11.0	%
Cracked	☑	
Curled	☑	

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

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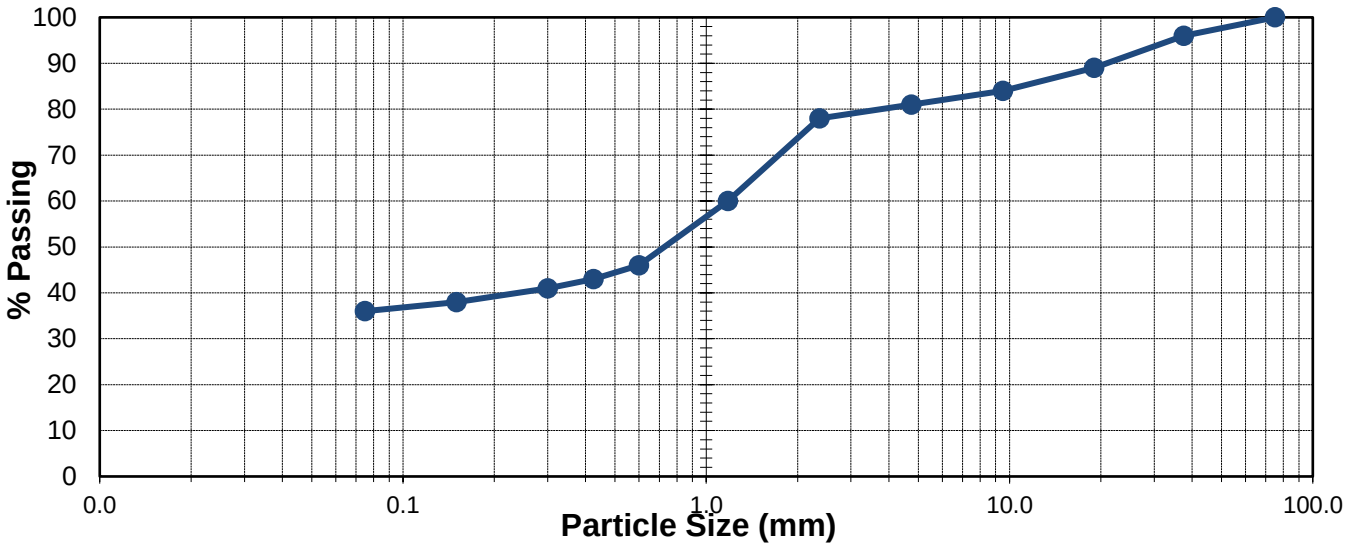
Particle Size Distribution Test Report

Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/387_1
Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/387
Sample ID:	TP100 1.0-1.5m	**Issue Date:**	02-March-2017

Sampling Procedure: Tested as Received



SIEVE ANALYSIS	AS 1289.3.6.1
Sieve Size (mm)	% Passing
75.0	100
37.5	96
19.0	89
9.5	84
4.75	81
2.36	78
1.18	60
0.600	46
0.425	43
0.300	41
0.150	38
0.075	36

Atterberg Limits Tests
AS 1289

Liquid Limit 3.1.1	**42**	%
Plastic Limit 3.2.1	**24**	%
Plasticity Index 3.3.1	**18**	%
Linear Shrinkage 3.4.1	**5.5**	%
Cracked	☑	
Curled	☑	

Client Address: 4/15 Walters Dr, Osborne Park WA 6017

Comments:

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Date: 02-March-2017

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Emerson Class Number Test Report		**Test Method: AS 1289.3.8.1**	
Client:	Galt Geotechnics	**Ticket No:**	S330
Project:	Proposed Stoneville Residential Project (J1701008)	**Report No:**	LLS17/387-388_1
Project Location:	Lot 48 Roland Road, Stoneville	**Sample No:**	LLS17/387-388
Sample Identification:	See below	**Issue Date:**	2/03/2017
Sampling Procedure:	Tested as received		

Sample Number	Sample ID	Date Tested	Emerson Class Number
LLS17/387	TP100 1.0-1.5m	1/03/2017	**6**
LLS17/388	TP98 2.1-2.9m	1/03/2017	**6**

Client Address: 4/15 Walters Dr, Osborne Park, WA 6017

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Name: Matt van Herk
Function: Laboratory Manager
Date: 02-March-2017

Appendix E: CSIRO Pamphlet

www.galtgeo.com.au
4/15 Walters Drive OSBORNE PARK WA 6017
ABN: 64 625 054 729

Foundation Maintenance and Footing Performance:
A Homeowner's Guide

PUBLISHING

BTF 18-2011 replaces Information Sheet 10/91

Buildings can and often do move. This movement can be up, down, lateral or rotational. The fundamental cause of movement in buildings can usually be related to one or more problems in the foundation soil. It is important for the homeowner to identify the soil type in order to ascertain the measures that should be put in place in order to ensure that problems in the foundation soil can be prevented, thus protecting against building movement.

This Building Technology File is designed to identify causes of soil-related building movement, and to suggest methods of prevention of resultant cracking in buildings.

Soil Types

The types of soils usually present under the topsoil in land zoned for residential buildings can be split into two approximate groups – granular and clay. Quite often, foundation soil is a mixture of both types. The general problems associated with soils having granular content are usually caused by erosion. Clay soils are subject to saturation and swell/shrink problems.

Classifications for a given area can generally be obtained by application to the local authority, but these are sometimes unreliable and if there is doubt, a geotechnical report should be commissioned. As most buildings suffering movement problems are founded on clay soils, there is an emphasis on classification of soils according to the amount of swell and shrinkage they experience with variations of water content. The table below is Table 2.1 from AS 2870-2011, the Residential Slab and Footing Code.

Causes of Movement

Settlement due to construction

There are two types of settlement that occur as a result of construction:

- Immediate settlement occurs when a building is first placed on its foundation soil, as a result of compaction of the soil under the weight of the structure. The cohesive quality of clay soil mitigates against this, but granular (particularly sandy) soil is susceptible.
- Consolidation settlement is a feature of clay soil and may take place because of the expulsion of moisture from the soil or because of the soil's lack of resistance to local compressive or shear stresses. This will usually take place during the first few months after construction, but has been known to take many years in exceptional cases.

These problems are the province of the builder and should be taken into consideration as part of the preparation of the site for construction. Building Technology File 19 (BTF 19) deals with these problems.

Erosion

All soils are prone to erosion, but sandy soil is particularly susceptible to being washed away. Even clay with a sand component of say 10% or more can suffer from erosion.

Saturation

This is particularly a problem in clay soils. Saturation creates a bog-like suspension of the soil that causes it to lose virtually all of its bearing capacity. To a lesser degree, sand is affected by saturation because saturated sand may undergo a reduction in volume, particularly imported sand fill for bedding and blinding layers. However, this usually occurs as immediate settlement and should normally be the province of the builder.

Seasonal swelling and shrinkage of soil

All clays react to the presence of water by slowly absorbing it, making the soil increase in volume (see table below). The degree of increase varies considerably between different clays, as does the degree of decrease during the subsequent drying out caused by fair weather periods. Because of the low absorption and expulsion rate, this phenomenon will not usually be noticeable unless there are prolonged rainy or dry periods, usually of weeks or months, depending on the land and soil characteristics.

The swelling of soil creates an upward force on the footings of the building, and shrinkage creates subsidence that takes away the support needed by the footing to retain equilibrium.

Shear failure

This phenomenon occurs when the foundation soil does not have sufficient strength to support the weight of the footing. There are two major post-construction causes:

- Significant load increase.
- Reduction of lateral support of the soil under the footing due to erosion or excavation.

In clay soil, shear failure can be caused by saturation of the soil adjacent to or under the footing.

GENERAL DEFINITIONS OF SITE CLASSES

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes
M	Moderately reactive clay or silt sites, which may experience moderate ground movement from moisture changes
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes
H2	Highly reactive clay sites, which may experience very high ground movement from moisture changes
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes

Notes

1. Where controlled fill has been used, the site may be classified A to E according to the type of fill used.
2. Filled sites. Class P is used for sites which include soft fills, such as clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soil subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise.
3. Where deep-seated moisture changes exist on sites at depths of 3 m or greater, further classification is needed for Classes M to E (M-D, H1-D, H2-D and E-D).

Tree root growth
Trees and shrubs that are allowed to grow in the vicinity of footings can cause foundation soil movement in two ways:

- Roots that grow under footings may increase in cross-sectional size, exerting upward pressure on footings.
- Roots in the vicinity of footings will absorb much of the moisture in the foundation soil, causing shrinkage or subsidence.

Unevenness of Movement

The types of ground movement described above usually occur unevenly throughout the building's foundation soil. Settlement due to construction tends to be uneven because of:

- Differing compaction of foundation soil prior to construction.
- Differing moisture content of foundation soil prior to construction.

Movement due to non-construction causes is usually more uneven still. Erosion can undermine a footing that traverses the flow or can create the conditions for shear failure by eroding soil adjacent to a footing that runs in the same direction as the flow.

Saturation of clay foundation soil may occur where subfloor walls create a dam that makes water pond. It can also occur wherever there is a source of water near footings in clay soil. This leads to a severe reduction in the strength of the soil which may create local shear failure.

Seasonal swelling and shrinkage of clay soil affects the perimeter of the building first, then gradually spreads to the interior. The swelling process will usually begin at the uphill extreme of the building, or on the weather side where the land is flat. Swelling gradually reaches the interior soil as absorption continues. Shrinkage usually begins where the sun's heat is greatest.

Effects of Uneven Soil Movement on Structures

Erosion and saturation
Erosion removes the support from under footings, tending to create subsidence of the part of the structure under which it occurs. Brickwork walls will resist the stress created by this removal of support by bridging the gap or cantilevering until the bricks or the mortar bedding fail. Older masonry has little resistance. Evidence of failure varies according to circumstances and symptoms may include:

- Step cracking in the mortar beds in the body of the wall or above/below openings such as doors or windows.
- Vertical cracking in the bricks (usually but not necessarily in line with the vertical beds or perpends).

Isolated piers affected by erosion or saturation of foundations will eventually lose contact with the bearers they support and may tilt or fall over. The floors that have lost this support will become bouncy, sometimes rattling ornaments etc.

Seasonal swelling/shrinkage in clay
Swelling foundation soil due to rainy periods first lifts the most exposed extremities of the footing system, then the remainder of the perimeter footings while gradually permeating inside the building footprint to lift internal footings. This swelling first tends to create a dish effect, because the external footings are pushed higher than the internal ones.

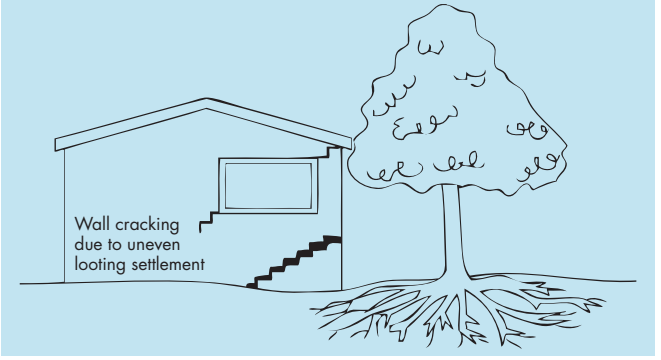
The first noticeable symptom may be that the floor appears slightly dished. This is often accompanied by some doors binding on the floor or the door head, together with some cracking of cornice mitres. In buildings with timber flooring supported by bearers and joists, the floor can be bouncy. Externally there may be visible dishing of the hip or ridge lines.

As the moisture absorption process completes its journey to the innermost areas of the building, the internal footings will rise. If the spread of moisture is roughly even, it may be that the symptoms will temporarily disappear, but it is more likely that swelling will be uneven, creating a difference rather than a disappearance in symptoms. In buildings with timber flooring supported by bearers and joists, the isolated piers will rise more easily than the strip footings or piers under walls, creating noticeable doming of flooring.

As the weather pattern changes and the soil begins to dry out, the external footings will be first affected, beginning with the locations where the sun's effect is strongest. This has the effect of lowering the external footings. The doming is accentuated and cracking reduces or disappears where it occurred because of dishing, but other cracks open up. The roof lines may become convex.

Doming and dishing are also affected by weather in other ways. In areas where warm, wet summers and cooler dry winters prevail, water migration tends to be toward the interior and doming will be accentuated, whereas where summers are dry and winters are cold and wet, migration tends to be toward the exterior and the underlying propensity is toward dishing.

Trees can cause shrinkage and damage



Movement caused by tree roots
In general, growing roots will exert an upward pressure on footings, whereas soil subject to drying because of tree or shrub roots will tend to remove support from under footings by inducing shrinkage.

Complications caused by the structure itself
Most forces that the soil causes to be exerted on structures are vertical – i.e. either up or down. However, because these forces are seldom spread evenly around the footings, and because the building resists uneven movement because of its rigidity, forces are exerted from one part of the building to another. The net result of all these forces is usually rotational. This resultant force often complicates the diagnosis because the visible symptoms do not simply reflect the original cause. A common symptom is binding of doors on the vertical member of the frame.

Effects on full masonry structures
Brickwork will resist cracking where it can. It will attempt to span areas that lose support because of subsided foundations or raised points. It is therefore usual to see cracking at weak points, such as openings for windows or doors.

In the event of construction settlement, cracking will usually remain unchanged after the process of settlement has ceased.

With local shear or erosion, cracking will usually continue to develop until the original cause has been remedied, or until the subsidence has completely neutralised the affected portion of footing and the structure has stabilised on other footings that remain effective.

In the case of swell/shrink effects, the brickwork will in some cases return to its original position after completion of a cycle, however it is more likely that the rotational effect will not be exactly reversed, and it is also usual that brickwork will settle in its new position and will resist the forces trying to return it to its original position. This means that in a case where swelling takes place after construction and cracking occurs, the cracking is likely to at least partly remain after the shrink segment of the cycle is complete. Thus, each time the cycle is repeated, the likelihood is that the cracking will become wider until the sections of brickwork become virtually independent.

With repeated cycles, once the cracking is established, if there is no other complication, it is normal for the incidence of cracking to stabilise, as the building has the articulation it needs to cope with the problem. This is by no means always the case, however, and monitoring of cracks in walls and floors should always be treated seriously.

Upheaval caused by growth of tree roots under footings is not a simple vertical shear stress. There is a tendency for the root to also exert lateral forces that attempt to separate sections of brickwork after initial cracking has occurred.

The normal structural arrangement is that the inner leaf of brickwork in the external walls and at least some of the internal walls (depending on the roof type) comprise the load-bearing structure on which any upper floors, ceilings and the roof are supported. In these cases, it is internally visible cracking that should be the main focus of attention, however there are a few examples of dwellings whose external leaf of masonry plays some supporting role, so this should be checked if there is any doubt. In any case, externally visible cracking is important as a guide to stresses on the structure generally, and it should also be remembered that the external walls must be capable of supporting themselves.

Effects on framed structures
Timber or steel framed buildings are less likely to exhibit cracking due to swell/shrink than masonry buildings because of their flexibility. Also, the doming/dishing effects tend to be lower because of the lighter weight of walls. The main risks to framed buildings are encountered because of the isolated pier footings used under walls. Where erosion or saturation causes a footing to fall away, this can double the span which a wall must bridge. This additional stress can create cracking in wall linings, particularly where there is a weak point in the structure caused by a door or window opening. It is, however, unlikely that framed structures will be so stressed as to suffer serious damage without first exhibiting some or all of the above symptoms for a considerable period. The same warning period should apply in the case of upheaval. It should be noted, however, that where framed buildings are supported by strip footings there is only one leaf of brickwork and therefore the externally visible walls are the supporting structure for the building. In this case, the subfloor masonry walls can be expected to behave as full brickwork walls.

Effects on brick veneer structures
Because the load-bearing structure of a brick veneer building is the frame that makes up the interior leaf of the external walls plus perhaps the internal walls, depending on the type of roof, the building can be expected to behave as a framed structure, except that the external masonry will behave in a similar way to the external leaf of a full masonry structure.

Water Service and Drainage

Where a water service pipe, a sewer or stormwater drainage pipe is in the vicinity of a building, a water leak can cause erosion, swelling or saturation of susceptible soil. Even a minuscule leak can be enough to saturate a clay foundation. A leaking tap near a building can have the same effect. In addition, trenches containing pipes can become watercourses even though backfilled, particularly where broken rubble is used as fill. Water that runs along these trenches can be responsible for serious erosion, interstrata seepage into subfloor areas and saturation.

Pipe leakage and trench water flows also encourage tree and shrub roots to the source of water, complicating and exacerbating the problem. Poor roof plumbing can result in large volumes of rainwater being concentrated in a small area of soil:

- Incorrect falls in roof guttering may result in overflows, as may gutters blocked with leaves etc.
- Corroded guttering or downpipes can spill water to ground.
- Downpipes not positively connected to a proper stormwater collection system will direct a concentration of water to soil that is directly adjacent to footings, sometimes causing large-scale problems such as erosion, saturation and migration of water under the building.

Seriousness of Cracking

In general, most cracking found in masonry walls is a cosmetic nuisance only and can be kept in repair or even ignored. The table below is a reproduction of Table C1 of AS 2870-2011.

AS 2870-2011 also publishes figures relating to cracking in concrete floors, however because wall cracking will usually reach the critical point significantly earlier than cracking in slabs, this table is not reproduced here.

Prevention/Cure

Plumbing
Where building movement is caused by water service, roof plumbing, sewer or stormwater failure, the remedy is to repair the problem. It is prudent, however, to consider also rerouting pipes away from the building where possible, and relocating taps to positions where any leakage will not direct water to the building vicinity. Even where gully traps are present, there is sometimes sufficient spill to create erosion or saturation, particularly in modern installations using smaller diameter PVC fixtures. Indeed, some gully traps are not situated directly under the taps that are installed to charge them, with the result that water from the tap may enter the backfilled trench that houses the sewer piping. If the trench has been poorly backfilled, the water will either pond or flow along the bottom of the trench. As these trenches usually run alongside the footings and can be at a similar depth, it is not hard to see how any water that is thus directed into a trench can easily affect the foundation's ability to support footings or even gain entry to the subfloor area.

Ground drainage
In all soils there is the capacity for water to travel on the surface and below it. Surface water flows can be established by inspection during and after heavy or prolonged rain. If necessary, a grated drain system connected to the stormwater collection system is usually an easy solution.

It is, however, sometimes necessary when attempting to prevent water migration that testing be carried out to establish watertable height and subsoil water flows. This subject is referred to in BTF 19 and may properly be regarded as an area for an expert consultant.

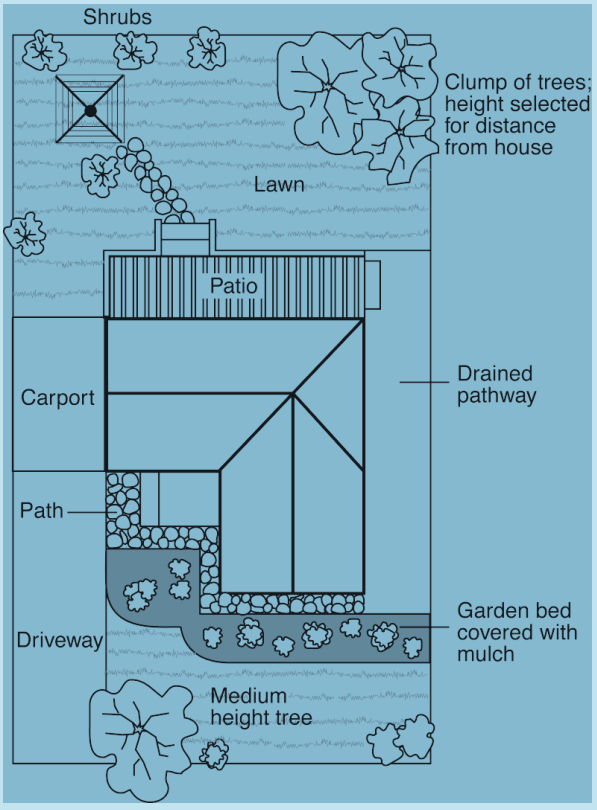
Protection of the building perimeter
It is essential to remember that the soil that affects footings extends well beyond the actual building line. Watering of garden plants, shrubs and trees causes some of the most serious water problems.

For this reason, particularly where problems exist or are likely to occur, it is recommended that an apron of paving be installed around as much of the building perimeter as necessary. This paving should

CLASSIFICATION OF DAMAGE WITH REFERENCE TO WALLS

Description of typical damage and required repair	Approximate crack width limit (see Note 3)	Damage category
Hairline cracks	<0.1 mm	0
Fine cracks which do not need repair	<1 mm	1
Cracks noticeable but easily filled. Doors and windows stick slightly.	<5 mm	2
Cracks can be repaired and possibly a small amount of wall will need to be replaced. Doors and windows stick. Service pipes can fracture. Weathertightness often impaired.	5–15 mm (or a number of cracks 3 mm or more in one group)	3
Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Window and door frames distort. Walls lean or bulge noticeably, some loss of bearing in beams. Service pipes disrupted.	15–25 mm but also depends on number of cracks	4

Gardens for a reactive site



extend outwards a minimum of 900 mm (more in highly reactive soil) and should have a minimum fall away from the building of 1:60. The finished paving should be no less than 100 mm below brick vent bases.

It is prudent to relocate drainage pipes away from this paving, if possible, to avoid complications from future leakage. If this is not practical, earthenware pipes should be replaced by PVC and backfilling should be of the same soil type as the surrounding soil and compacted to the same density.

Except in areas where freezing of water is an issue, it is wise to remove taps in the building area and relocate them well away from the building – preferably not uphill from it (see BTF 19).

It may be desirable to install a grated drain at the outside edge of the paving on the uphill side of the building. If subsoil drainage is needed this can be installed under the surface drain.

Condensation

In buildings with a subfloor void such as where bearers and joists support flooring, insufficient ventilation creates ideal conditions for condensation, particularly where there is little clearance between the floor and the ground. Condensation adds to the moisture already present in the subfloor and significantly slows the process of drying out. Installation of an adequate subfloor ventilation system, either natural or mechanical, is desirable.

Warning: Although this Building Technology File deals with cracking in buildings, it should be said that subfloor moisture can result in the development of other problems, notably:

- Water that is transmitted into masonry, metal or timber building elements causes damage and/or decay to those elements.
- High subfloor humidity and moisture content create an ideal environment for various pests, including termites and spiders.
- Where high moisture levels are transmitted to the flooring and walls, an increase in the dust mite count can ensue within the living areas. Dust mites, as well as dampness in general, can be a health hazard to inhabitants, particularly those who are abnormally susceptible to respiratory ailments.

The garden

The ideal vegetation layout is to have lawn or plants that require only light watering immediately adjacent to the drainage or paving edge, then more demanding plants, shrubs and trees spread out in that order.

Overwatering due to misuse of automatic watering systems is a common cause of saturation and water migration under footings. If it is necessary to use these systems, it is important to remove garden beds to a completely safe distance from buildings.

Existing trees

Where a tree is causing a problem of soil drying or there is the existence or threat of upheaval of footings, if the offending roots are subsidiary and their removal will not significantly damage the tree, they should be severed and a concrete or metal barrier placed vertically in the soil to prevent future root growth in the direction of the building. If it is not possible to remove the relevant roots without damage to the tree, an application to remove the tree should be made to the local authority. A prudent plan is to transplant likely offenders before they become a problem.

Information on trees, plants and shrubs

State departments overseeing agriculture can give information regarding root patterns, volume of water needed and safe distance from buildings of most species. Botanic gardens are also sources of information. For information on plant roots and drains, see Building Technology File 17.

Excavation

Excavation around footings must be properly engineered. Soil supporting footings can only be safely excavated at an angle that allows the soil under the footing to remain stable. This angle is called the angle of repose (or friction) and varies significantly between soil types and conditions. Removal of soil within the angle of repose will cause subsidence.

Remediation

Where erosion has occurred that has washed away soil adjacent to footings, soil of the same classification should be introduced and compacted to the same density. Where footings have been undermined, augmentation or other specialist work may be required. Remediation of footings and foundations is generally the realm of a specialist consultant.

Where isolated footings rise and fall because of swell/shrink effect, the homeowner may be tempted to alleviate floor bounce by filling the gap that has appeared between the bearer and the pier with blocking. The danger here is that when the next swell segment of the cycle occurs, the extra blocking will push the floor up into an accentuated dome and may also cause local shear failure in the soil. If it is necessary to use blocking, it should be by a pair of fine wedges and monitoring should be carried out fortnightly.

This BTF was prepared by John Lewer FAIB, MIAMA, Partner, Construction Diagnosis.

The information in this and other issues in the series was derived from various sources and was believed to be correct when published.

The information is advisory. It is provided in good faith and not claimed to be an exhaustive treatment of the relevant subject.

Further professional advice needs to be obtained before taking any action based on the information provided.

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Appendix F: Understanding Your Report

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UNDERSTANDING YOUR REPORT

GALT FORM PMP11 Rev2

1. EXPECTATIONS OF THE REPORT

This document has been prepared to clarify what is and is not provided in your report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with the conditions on site.

Geotechnical engineering and environmental science are less exact than other engineering and scientific disciplines. We include this information to help you understand where our responsibilities begin and end. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of projects and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- the project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the project team. Furthermore, we recommend that we be able to review work produced by other members of the project team that relies on information provided in our report.

3. SOIL LOGS

Our reports often include logs of intrusive and non-intrusive investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party because of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

5. CHANGE IN SUBSURFACE CONDITIONS

The recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including anthropogenic events (such as construction or contaminating activities on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

6. SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use professional judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from professional judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

7. ENVIRONMENTAL AND GEOTECHNICAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not addressed in geotechnical reports. Similarly, geotechnical issues are not addressed in environmental reports. The investigation techniques used for geotechnical investigations can differ from those used for environmental investigations. It is the client's responsibility to satisfy themselves that geotechnical and environmental considerations have been taken into account for the site.

Report on

SUPPLEMENTARY GEOTECHNICAL STUDY
PROPOSED STONEVILLE PROJECT
LOT 48 ROLAND ROAD, STONEVILLE

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J1701008 002 R Rev1

14 July 2017

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APPENDIX E: UNDERSTANDING YOUR REPORT

1. INTRODUCTION

This report presents the outcomes of the supplementary geotechnical study conducted by Galt Geotechnics (Galt) for the proposed Stoneville residential project at Lot 48 Roland Road, Stoneville ("the site"). The location of the site relative to the surrounding area is shown on Figure 1, Site and Location Plan.

The supplementary study was authorised by Grant Wilkins from Satterley Property Group in a signed Client Authorisation Form dated 16 May 2017.

This study supplements the findings of our original geotechnical investigation (refer report J1701008 001 R Rev0 dated 5 Aril 2017).

2. SITE DESCRIPTION

The site is irregular in shape and covers a total plan area of about 540 ha. It is bounded by Cameron Road to the north, Roland Road to the west and rural-residential type properties to the east and south.

Historical photographs (see Figure 2, Historical Aerial Imagery) show that the site was largely covered in dense bushland until about 1965. Some large parts of the site were cleared between 1965 and 1979 and a few small dams were constructed near the corners of the site. From this time, the site remained relatively unchanged to date.

At the time of our studies, the site comprised a combination of large open areas, sparsely covered in grass and isolated trees, and other large areas with spreads of mature trees. We understand that the areas of dense vegetation (trees) may not be developed. We also note that:

- There are outcrops and scattered cobbles and boulders of very well cemented Laterite over most of the site.
- There are isolated tree stumps and large buried roots.
- There is an existing water-course aligned north-south through the centre of the site.

The supplied survey plan and published contour maps (Landgate 5 m scale contour maps) show that the surface elevation ranges from about RL 260 m to RL 315 m AHD across the site. There are three notable high parts of the site near the centre with maximum elevations of about RL 298 m to RL 314 m AHD. The surface generally falls from these high points towards the north-west, south-west and south-east corners of the site and the water-course at the centre of the site. The 5 m scale contours have been presented on Figure 1 for reference.

3. PROPOSED DEVELOPMENT

Based on the information provided, we understand that the site is proposed for a residential project comprising a development of about 1,200 to 1,700 lots over 3 Precincts. We understand that it is currently proposed to initiate the project with a two stage development over a relatively small area on the southern part of Precinct 1. We understand that this will include:

- Stage 1
  - 6 to 8 home display village.
  - Sales Centre.
  - Cottage Lots
- Stage 2
  - Development of larger sized lots than Stage 1.
  - Construction of lots down the slope into the valley.

A copy of the preliminary concept plans and drawings provided are presented in Appendix A, Project Drawings.

We assume that the structures to be built on the site will be single or double storey masonry brick or steel framed, supported on shallow footings and ground slabs.

We understand that a hydrological assessment is being conducted for a preliminary recycled waste-water facility (PRWF) near the north-west corner of the site. The information provided shows that:

- The proposed PRWF will cover an area with approximate dimensions of about 300 m by 300 m (about 9 hectares) that is upslope from the existing dam near the northern boundary.
- The recycled water plant (RWP) area will be located on the northern part of the PWRF. This will be located on a levelled pad with plan dimensions of about 140 m by 120 m at an elevation of RL 282 m AHD. Earthworks for this pad will therefore require excavation of up to about 8 m at the south-west corner and fill placement of about 1 m to 2 m at the north-east corner to form a level pad at design level. Proposed cut volume is 29,500 m^3 and proposed fill volume is 4,200 m^3.
- The holding dam will be located on the southern part of the PRWF with an option to construct near the centre. The dam will be about 120 m by 120 m in plan with a proposed dam base at RL 293 m AHD. The peripheral embankments of the dam will be constructed to an elevation of RL 300 m AHD, with sides battered to a slope angle of 1V:3H. The proposed storage volume is shown as 40,000 m^3 with expected cut volumes ranging from 11,500 m^3 to 14,100 m^3 and expected fill volumes ranging from 36,300 m^3 to 41,500 m^3 for both options.
- Recycled wastewater from the PWRF is proposed for re-use as irrigation water in areas of Public Open Space (POS).

A preliminary drawing of the proposed PRWF is included in Appendix A.

4. PREVIOUS STUDY AND PURPOSE OF SUPPLEMENTARY STUDY

Galt conducted a preliminary geotechnical study across the site in February 2017 the results of which were presented in report J1701008 001 R Rev0 dated 5 April 2017. Fieldwork comprised excavation of 101 test pits using a 28 tonne tracked excavator equipped with a rock bucket. Shallow, very well cemented, Hardpan Laterite (hardpan) was found over most of the site which caused excavation refusal at shallow depth.

Test pit reports from this study are presented in Appendix B, Previous Test Pit Reports along with a method of soil description and cementation classification and a list of explanatory notes and abbreviations used in the reports. Summary details of the test pits are also included in Appendix B for reference. Also included are Figures from our preliminary study including the approximate depth to Hardpan as shown on Figure 3.

Based on the results of the preliminary study, the project team decided that further geotechnical investigation and assessment is required in the shallow hardpan areas of the site to provide sufficient information to complete the civil design.

5. SCOPE OF WORK AND OBJECTIVES

On the basis of the above, the scope of work and objectives of the supplementary study were to:

- Conduct ripping trials with a large bulldozer equipped with a single tine to assess:
  - The bulk excavatability of the in-situ hardpan laterite and the associated influence on cut to fill earthworks;
  - The excavatability of the in-situ soils/hardpan layers for installation of services if the roads are constructed in areas cut into the shallow hardpan laterite.

- Conduct excavatability assessments using a large excavator equipped with a rock breaker and another excavator for removal of hardpan spoil and deeper excavation to assess:
  - The excavatability of the hardpan laterite for cut to fill earthworks for a single residential lot.
  - The thickness of the hardpan layers and the nature of the underlying soils.
  - The suitability of the ground for installation of buried services, sewer tanks and soak-wells.
- Conduct a preliminary assessment of the soil parameters for on-site disposal of recycled wastewater by way of irrigation.

6. FIELDWORK

The fieldwork for the supplementary study was carried out over the period 29 to 31 May 2017 and comprised:

- Mobilisation/Demobilisation of the following plant to and from the site:
  - 47.9 tonne bulldozer equipped with a single tine ripper;
  - 30 tonne excavator equipped with a hydraulic rock breaker.
  - 30 tonne excavator equipped with a 1.2 m wide rock bucket.

- Trial ripping with a CAT D9T bulldozer over a period of 2 days on 4 trial areas (BT1 to BT4) in open areas of the site underlain by very well cemented shallow hardpan. The ripping trials extended to depths ranging from 0.5 m to 2.5 m.

- Rock breaker trial excavations over a period of 2 days at 13 locations within readily accessible and open areas of the site underlain by very well cemented shallow hardpan, including:
  - 10 locations (RBT07, RBT09, RBT17, RBT25, RBT31, RBT33, RBT39, RBT47, RBT50 & RBT55) within Precinct 1, extending to depths ranging from 1.0 m to 3.3 m;
  - 3 locations (RBT90, RBT92 & RBT96) within Precinct 2, extending to depths ranging from 1.4 m to 2.8 m.

The fieldwork was conducted by a geotechnical engineer and senior geotechnical engineer from Galt. The test locations and trial areas were selected and positioned relative to surrounding site features. The engineers observed the excavation and ripping trials, assessed the excavatability and strength of the ground and logged the materials where appropriate.

Summary details of the rock breaker trial excavations and bulldozer trials are presented in Table 1. Test locations are shown on Figure 1 and Figures 3 to 5. Photographs taken during the trials are presented in Appendix C, Photographs.

Table 1: Summary of BT Ripping and RBT Excavations

Test Location	Test Depth (m)	Depth to Hardpan (m)	Thickness of Hardpan (m)	Reason for Termination	Stratigraphy
BT1	0.5	NE	NE	Target depth	Gravelly SAND
BT2	1.0	NE	NE	Target depth	Gravelly SAND & LATERITE BOULDERS
BT3	~2.5	0-0.5	1.5-2.0	Target depth	Gravelly SAND over HARDPAN LATERITE over Clayey SAND
BT4	~2.0	0 – 0.5	> 2.0	Target depth	Sandy GRAVEL & LATERITE BOULDERS over HARDPAN LATERITE
RBT07	1.7	0.6	0.9	Target depth	Sandy GRAVEL over HARDPAN LATERITE over Clayey SAND/Sandy CLAY

Test Location	Test Depth (m)	Depth to Hardpan (m)	Thickness of Hardpan (m)	Reason for Termination	Stratigraphy
RBT09	3.2	NE	NE	Target depth	Gravelly SAND over Clayey GRAVEL
RBT17	1.0	0.2	> 0.8	Target depth	Gravelly SAND/Sandy GRAVEL over HARDPAN LATERITE
RBT25	2.7	NE	NE	Target depth	Gravelly SAND over LATERITE BOULDERS & COBBLES
RBT31	3.3	NE	NE	Target depth	Gravelly SAND over Clayey GRAVEL
RBT33	3.0	0.3	2.2	Target depth	Gravelly SAND over HARDPAN LATERITE
RBT39	3.0	0.2	2.1	Target depth	Gravelly SAND over HARDPAN LATERITE
RBT47	2.0	0.6	> 1.4	Target depth	Gravelly SAND over HARDPAN LATERITE
RBT50	3.2	0.0	2.8	Target depth	HARDPAN LATERITE
RBT55	3.2	1.2	> 2.0	Target depth	GRAVEL over HARDPAN LATERITE
RBT90	2.8	0.6	1.2-2.1	Target depth	Sandy GRAVEL over HARDPAN LATERITE over Clayey SAND
RBT92	1.9	NE	NE	Target depth	Sandy GRAVEL over LATERITE BOULDERS & COBBLES over Clayey SAND
RBT96	1.4	0.15	> 1.15	Target depth	Sandy GRAVEL over HARDPAN LATERITE

Note: NE – Not encountered

7. GEOLOGY

The Mundaring sheet of the 1:50,000 scale Environmental Geology series map indicates that the site is predominantly underlain by massive, cemented Laterite. This is typically overlain by a variable thickness of pisolitic gravel.

There is also an isolated area of granite shown on the northern part of the site and narrow zones of colluvium present along and near the Clutterbuck Creek alignment.

The geological units are described as follows:

- GRAVEL – yellow-brown to reddish brown, loose, fine to coarse, ferruginous pisolites, poorly sorted; variable amounts of sand and silt in matrix, minor re-cementation, colluvial origin;
- GRANITES – fine to coarse-grained, occasionally porphyritic rocks of granite, granodiorite and adamellite composition;
- LATERITE – massive, hard, cemented, vuggy and pisolitic; up to 4 m thick, overlain by and associated with gravels of residual origin
- GRAVELLY SILTY SAND – white to grey, fine to coarse grained, angular quartz, minor feldspar, common to abundant silt and common fine gravel; colluvial origin

The findings of the preliminary study generally shows that shallow, very well cemented, Hardpan Laterite (hardpan) is present over most of the site. The entire area of Precinct 1 and significant portions of both Precincts 2 and 3 appear to be underlain by this cemented material.

Note: The term "Laterite" broadly refers to soil and rock strength materials which are rich in iron and aluminium. In our report, we have typically used the term "Hardpan Laterite" or "hardpan" to refer to the upper cemented zone of Laterite that has rock strength characteristics.

8. ROCK BREAKER TRIAL EXCAVATIONS

Rock breaker trial (RBT) excavations were carried out on 30 and 31 May 2017 using a 30 tonne Volvo EC300DL equipped with a hydraulic rock breaker and another equipped with a 1.2 m wide rock bucket. The excavation procedure involved

- Excavation to the surface of the hardpan (if present).
- Penetrating and breaking down the hardpan using a 30-tonne excavator fitted with a hydraulic rock breaker.
- Excavating the broken-down hardpan with the other 30-tonne excavator fitted with a rock bucket.
- Repetition of the above procedure until the desired thickness of hardpan is excavated and/or until the soils underlying the hardpan are exposed.

RBT test pits reports are presented in Appendix D, RBT Test Pit Reports. The method of soil description, cementation classification and a list explanatory notes and abbreviations used in the reports are presented in Appendix B.

The typical profile encountered in the areas of very well cemented, massive, shallow hardpan can be described as follows:

- Gravelly SAND/Sandy GRAVEL/GRAVEL: fine to coarse grained sand, fine to medium pisolitic gravel, dark grey brown typically becoming pale brown, yellow brown or orange brown, typically dry and loose, trace very well cemented cobbles and boulders, present from ground surface and extending to depths ranging from 0.15 m to 1.2 m; overlying

- HARDPAN LATERITE: very well iron cemented, massive, typically dark red brown variably mottled yellow brown and off-white, becoming yellow brown and weakly to well cemented at depths ranging from 1.8 m to 2.8 m, present from ground surface and extending to investigated depths ranging from 1.0 m to 3.3 m; overlying

- Clayey SAND/Sandy CLAY (SC-CI): fine to coarse grained sand, between 15% to 50% low to medium plasticity fines, either mottled red-brown and yellow brown or off-white and yellow brown, varying between laterised clayey soils and extremely weathered granitic rock, present from depths as shallow as 1.5 m and extending to a depth of up to 2.8 m.

The approximate rates of Hardpan penetration are presented in Table 2: Summary of Hardpan Excavation Rates.

Table 2: Summary of Hardpan Excavation Rates

Test Location	Test Pit Depth (m)	Thickness of Hardpan Excavated (m)	Duration of Excavation (mins)	Rate of Hardpan Excavation (m^3/hr)
RBT07	1.7	0.9	20	21.6
RBT17	1.0	0.8	45	9.6
RBT25	2.7	2.4[2]	60	19.2
RBT39	3.0	2.8	50	26.9
RBT50	3.2	3.2	90	19.2
RBT55	3.2	2	45	21.4
RBT90	2.8	2.1	120	9.5
RBT92	1.9	0.9[2]	20	21.6
RBT96	1.4	1.25	75	8

Notes: 1. Approximate plan dimensions of excavations were 2 m by 4 m

2. Excavation into very well cemented Laterite Boulders/Cobbles rather than massive Hardpan

There are variabilities in the cemented Hardpan Laterite that were encountered in 4 of the 13 RBT excavations (RBT9, RBT25, RBT31 and RBT92). The soil profiles encountered in these test pits included thick layers of LATERITE BOULDERS & COBBLES in a matrix of sand/gravel and Ferruginous Clayey GRAVEL below the upper gravelly soils. Typically, these occur near the boundary of the inferred massive shallow hardpan areas, outside the areas of dense vegetation. For further details refer to the RBT Test Pit reports in Appendix D.

9. BULLDOZER TRIAL RIPPING

Trial ripping was carried out on 31 May and 1 June 2017 using a 47.9 tonne Caterpillar D9T bulldozer equipped with a single tine ripper. The trial ripping was carried out on 4 trial areas (BT1 to BT4), measuring approximately 25 m by 25 m in plan area. The outcomes of the trial ripping on each area are discussed below:

Trial Area 1

Trial Area 1 is located near the centre of Precinct 2, west of an area of dense vegetation.

The bulldozer lowered the tine into the ground to a depth of about 0.5 m and progressively ripped the ground over a number of parallel, straight passes over the full width and length of the trial area. The bulldozer tine easily penetrated and loosened the in-situ soils to a depth of 0.5 m over the full extent of the trial area. The exposed soils typically comprised gravelly sand. Due to the absence of shallow hardpan, the trial area was moved to another trial location.

Trial Area 2

Trial Area 2 is near the centre of Precinct 2, about 200 m north-east of Trial Area 1 and at the north-west corner of an area of dense vegetation. The ground is sloped and falls to the north and there are boulder sized Hardpan outcrops exposed on the surface.

Cross ripping was conducted to a depth of about 1.0 m in this area. The cross ripping procedure generally involved:

- Lowering the tine onto the rock and/or into the soil.
- Ripping in a straight path along the full length of the trial area.
- Conducting a number of parallel ripping passes as described above, over the full width of the trial area.
- Cross ripping the ground by repeating the first 3 steps above perpendicular to the initial ripping alignment.
- Once a sufficient amount of ground/rock is broken and/or disturbed, push the spoil to the side of the trial area and repeat the cross-ripping procedure.

The tine easily penetrated and loosened the ground to disturb LATERITE BOULDERS & COBBLES up to 1.5 m in size in a matrix of Gravelly SAND and Sandy GRAVEL. The boulders were noted to:

- contain a high proportion of pisoids;
- be typically, moderately to well cemented and of very low to low strength
- be less iron indurated than the typical very well cemented Hardpan present across the site.

Due to the inconsistency of the Hardpan in this area, the trial area was moved to another location where massive very well cemented is present.

Trial Area 3

Trial Area 3 is located near the south-east corner of Precinct 2 to the south-east of an area of dense vegetation. There are a number of boulder sized Hardpan outcrops exposed across the surface.

Cross ripping of the upper 0.5 m of soil showed that the upper profile typically comprises very well cemented LATERITE BOULDERS in a matrix of Gravelly SAND.

The upper layer of boulders and gravelly sand were removed to expose very well cemented, dark red brown, iron indurated, massive Hardpan. Penetration of this layer with the bulldozer tine was very difficult and often little penetration was achieved. The tine simply skimmed over the surface and chipped off small cobble and boulders sized fragments of Hardpan from the surface. It was possible in some locations to penetrate isolated weaker and less iron indurated zones of the Hardpan. The tine was then able to get underneath the very well cemented zones sometimes leading to easier excavation of the Hardpan. However, in general, due to the consistency of the very well cemented zones around the weaker Hardpan, it was not possible to effectively loosen the stronger Hardpan from the sides.

Cross ripping of the Hardpan continued over a period of about 4 to 5 hours until the cemented layer was eventually penetrated to expose clayey sand (extremely weathered granitic rock). It appears that the lower part of the Hardpan is generally weaker with localised very well cemented zones. Once an opening into the Hardpan was formed, it was possible to continue breaking down the cemented material from the sides of the opening with a significant increase in productivity.

Trial Area 4

Trial Area 4 is located near the southern end of Precinct 1 between areas of dense vegetation. There are significant amounts of Hardpan outcrop exposed across the surface in this area.

Cross ripping of the upper 0.5 m, disturbed a 0.5 m layer of very well cemented LATERITE BOULDERS in a matrix of Gravelly SAND. This layer was easily disturbed and pushed to the side with the bulldozer front blade.

Below the boulders an undulating profile of Hardpan comprising two peaks of very well cemented (inferred medium to high strength), dark red brown, iron indurated Hardpan were encountered on the northern and southern parts of the trial area and a slightly weaker cemented (inferred low strength), yellow brown, pisolitic Hardpan at the centre.

Ripping of the heavily iron indurated zones of Hardpan was very difficult and often involved the tine skimming over the surface and chipping off small cobble and boulder sized fragments. It was very difficult to achieve any reasonable penetration through these areas over a period of about 4 to 5 hours of ripping.

Ripping of the central zone was possible to a depth of about 2 m below the surrounding area over a period of about 4 to 5 hours (noting that this area was not strictly targeted). However, it was not possible to break down the highly iron indurated zones of Hardpan surrounding the area to the north and south.

10. SUPPLEMENTARY GEOTECHNICAL ASSESSMENT

10.1 Characterisation of Hardpan Laterite

The rock breaker trial excavations and bulldozer ripping trials targeted areas of shallow very well cemented Hardpan across the site that were previously identified during the preliminary study.

In summary, the results of the trials have shown that:

- The areas of shallow Hardpan, typically comprise:
  - a thin layer of gravelly sand to sandy gravel with variable boulder sized inclusions;
  - a dark-red brown, very well cemented, iron indurated layer of Hardpan (inferred medium to high strength and locally higher) ranging from 1.0 m to 2.5 m in thickness (probably on average 2 m);
  - a yellow-brown, moderately to well cemented (inferred very low to low strength) layer of Hardpan, that appears to become weaker with depth, the thickness has not been confirmed;
  - underlying clayey soils ranging from laterised residual granitic rock to extremely weathered granitic rock.
- The dark red brown, iron indurated Hardpan is typically massive and contains a very limited proportion of weaker zones to exploit using conventional earthmoving plant.
- The iron indurated layer is very well cemented and of inferred medium to high strength.
- The ripping trials with the 47.9 tonne Caterpillar D9T bulldozer equipped with a single tine ripper achieved penetration through the iron indurated Hardpan ranging between 1 m and 2 m depth over a plan area with dimensions of about 25 m by 25 m for a period of 4 to 5 hours cross ripping.
- The rock breaker trial excavations conducted with two, 30 tonne excavators equipped with a hydraulic rock breaker and rock bucket achieved penetration rates ranging from about 8 m^3/hr to 27 m^3/hr in the iron indurated Hardpan over a plan area of about 2 m by 4 m.

The above profile is expected to be reasonably consistent in areas of dense vegetation, particularly over the central parts of Precincts 1 and 2 and the western part of Precinct 3. However, this should be confirmed with further investigation and/or inspection during trial works/earthworks.

There are occasional variations in the Hardpan Laterite, which include profiles of Laterite boulders and cobbles in a matrix of gravelly soil and variability cemented and ferruginous Clayey GRAVEL. These appear to be transitioning zones in the Hardpan which extend from the elevated, densely vegetated areas of the site to the low-lying areas.

10.2 Options for Excavation and Development

The results of our supplementary investigation show that the Hardpan is very well cemented and will be difficult to remove by way of bulk excavation using conventional earthmoving methods.

It is therefore strongly recommended that excavations into the Hardpan are limited where possible and surface levels for residential lots are raised rather than lowered over the Hardpan. We recommend the following options are considered for development of the site and treatment/excavation of shallow Hardpan.

Limit filling to building envelopes

It may be possible to reduce the volumes of fill required for residential lots by limiting fill placement to nominated building envelopes for the structures and providing suitable retention as required. Excavations for service installation within the Hardpan would require the use of rock breakers or a trencher/s.

Engineer structures to accommodate the slopes

Residential structures may be engineered to accommodate the natural slopes of the site. This may be achieved by constructing the house on piers rather than using conventional filling and retaining methods. Excavations for service installation within the Hardpan would require the use of rock breakers or trenchers.

Rock Trenching for Service Installation

Excavations of trenches in the Hardpan for service installation may be achieved using rock trenching equipment. Typically, this involves using a heavy weight machine (> 50 tonne) equipped with a wide cutting chain lined with teeth.

We have discussed the capabilities of rock trenching machines with an experienced pipeline construction and installation contractor. We understand that they have undertaken trenching in a similar geological setting of Hardpan Laterite to the north-east of the site in the Wundowie area. We understand the following excavation productivity was recorded using their 75 tonne Tesmec TRS1300 Super rock trenching machine:

- Excavation productivity of 5 m/hour was recorded for a 0.9 m wide and 1.5 m deep trench within massive, iron indurated Hardpan. This approximately equates to an excavation rate of 6.75 m^3/hour.
- Excavation productivity of 19 m/hour was recorded for a 0.9 m wide and 1.5 m deep trench through areas of weaker Hardpan and Laterite Boulders. This approximately equates to an excavation rate of 25.7 m^3/hour.

Based on our discussions, we also understand that important factors which would influence the efficiency of rock trenching include:

- The width of the trenches - The productivity of rock trenching is strongly influenced by the required width of the trench. The width should be limited where possible.
- Machine weights - It is essential that the machine has sufficient weight to remain stable during excavation and limit the wear and tear on the cutting chain. Additional weights can be used to stabilise the machine if required.
- Installation of services in common trenches to limit the excavation required.
- The consistency of the Hardpan - The productivity of excavation is strongly influenced by weaker zones in the rock. These can be exploited by the cutting chain to increase productivity.
- Servicing and maintenance requirements - Daily servicing and maintenance is required depending on the wear and tear on the cutting chain.

We can provide details of a suitable contractor that can provide further assistance and advice regarding their trenching capabilities.

Blasting

We have discussed the option of blasting to break down the Hardpan with a Perth based blasting consultant. Based on our discussions, we understand that the limiting factor with blasting the Hardpan is that soils/uncemented zones (particularly the softer underlying clayey soils) and variably dense zones in the Hardpan will attenuate the energy and reduce efficiency (i.e. variably dense or soft zones will absorb the blast energy).

On this basis, it is recommended to limit the blasting of Hardpan to well defined zones of very well cemented Hardpan that cannot be removed by typical excavation/trenching equipment. We can provide details of a consultant who may provide further direction regarding this option and advise on suitable blasting contractors.

Trialling larger earthmoving equipment

The use of larger earthmoving equipment may achieve a higher productivity of excavation in the Hardpan. It is noted that a 105 tonne D11 bulldozer can apply approximately double the penetration load and break-out force using a single tine ripper compared to the 47.9 tonne D9T bulldozer used during the trials.

However, we note that there is a limited availability of large bulldozers and excavators in Perth as most plant of this size is based on mine sites. If required, we can further explore the availability of such earthmoving plant in Perth and the associated costs.

10.3 Site Classification

Based on the findings of the supplementary investigation, we have conducted a preliminary assessment of the site classification in accordance with AS2870 (2011) "Residential Slabs and Footings" for the areas of shallow very well cemented Hardpan.

We consider that a "Class A" site classification is appropriate in the areas of shallow Hardpan provided that:

- A minimum 1.8 m thickness of inert material (gravelly sand/sandy gravel, Hardpan Laterite) is present above any reactive clayey soils – it appears that the minimum thickness of inert material is present across the majority of the shallow Hardpan areas provided that site levels are not lowered.
- The site preparation requirements guidelines in our preliminary geotechnical report (J1701008 001 R Rev0) are followed.

Should lowering of site levels be required to level the lots and/or recover site derived fill materials, it is likely that the site classification would change to a "Class S" subject to a minimum 0.5 m cover of inert material above the reactive clayey soils. Further investigation and confirmation of fill thicknesses and soil profiles is required to estimate characteristic surface movements to optimise the footing and slab design for Class S lots.

10.4 Potential Borrow Materials

We understand that it is proposed to source fill materials from site where possible. Due to the presence of the shallow Hardpan, the availability of excavatable site-derived fill materials is somewhat limited. Crushing and screening may be considered to produce relatively high quality granular fill. Trials would be required to confirm if this was economically possible. This is discussed further in the following sections.

Based on the information gained from our preliminary and supplementary investigations, we have conducted a very broad delineation of the soil types and zones across the site. The plan extent of the soil zones described below is mapped on Figure 5, Preliminary Borrow Assessment. The approximate thicknesses of fill materials available are discussed below.

In summary, we consider the site can be broadly characterised as follows:

Zone A – Deep gravelly soils, Laterite Boulders/Cobbles and low strength Hardpan

- These areas are expected to have the greatest volume of in-situ gravelly sand/sandy gravel.
- The finer gravelly soils are typically present in the upper 1.0 m and 1.5 m, however occasionally extend to greater depths (up to 3 m).
- Laterite boulders/cobbles and low strength Hardpan are typically present from depths of about 1.0 m to 3.0 m. However, there are areas where this material is present from ground surface.
- Laterite boulders/cobbles and excavated low strength Hardpan can probably be crushed and screened and re-incorporated into the finer gravelly sand/sandy gravel for re-use as structural fill. Ideally, the maximum particle size should be limited to 200 mm and the larger particles must be suitably blended into the sand/gravel to ensure there are no significant voids or loose zones when compacted. This can be assessed during compaction trials.
- Larger particles may be used in bulk fill / rock fill applications.

- Without crushing and screening, the materials may not comply with select fill requirements such as retaining wall backfill and/or trench backfill. In this instance, it will be necessary to import suitable fill materials.

Zone B - Thin gravelly soils over very well cemented Hardpan

- These areas are typically characterised by boulder sized outcrops of Hardpan at the surface. The surface of the Hardpan typically undulates and has a covering of gravelly sand/sandy gravel soil up to 1 m in thickness (probably on average about 0.5 m thick). There are variable inclusions of Laterite Boulders in this upper profile that would need to be crushed down to a suitable size prior to re-use as fill as noted above.
- On average, we expect that about 0.5 m of fine gravelly fill can be recovered from these areas. Any foundations located directly on Hardpan will need to take into account the site preparation guidelines provided in our preliminary geotechnical report.

Zone C - Undesirable borrow materials – Variable clayey soils with a limited cover of inert granular material

These areas of the site typically comprise variable thicknesses of inert to low plasticity soils (including sand, silty/clayey sand and other gravelly soils) over high plasticity clayey soils. We do not recommend that borrow materials are sourced from these areas as:

- Any clayey soils sourced from these areas will be difficult to moisture condition and compact and may adversely influence the site classification for residential lots
- Reducing the thickness of inert materials above the shallow high plasticity clayey soil will adversely influence the site classification.
- Exposure of clayey soils may allow stormwater to perch on top, leading to saturation and softening of the in-situ soils.

10.5 Preliminary Waste-Water Recycling Facility

10.5.1 Treatment Plant and Holding Dams

The main purpose of the rock breaker trial excavations was to target, delineate and profile areas of shallow, very well cemented Hardpan across the site. Due to the thickness and strength of the Hardpan, the productivity of the rock breaking and excavation was low and the number of trial excavations was limited.

We also note that the area for the proposed preliminary waste-water recycling facility (PWRF) treatment plant and holdings dams was enclosed within a perimeter fence that prevented suitable access for our machinery.

Due to the above, our preliminary assessment of the proposed PWRF has been limited to a walkover of the area.

Based on our walkover, we provide the following comments:

- The proposed PWRF site is generally open and clear around the centre, however becomes densely vegetated to the south over the footprint of the proposed holding dams.
- The exposed ground across the open areas generally comprises gravelly soils. It is possible there is Hardpan present below which is variably cemented/uncemented and excavatable with a large excavator (30 tonne or larger with a rock bucket). However, it is expected that deep excavations will intersect extremely weathered granitic rock, that becomes progressively less weathered and stronger with depth.
- Boulder sized outcrops of very well cemented Hardpan Laterite were noted in the areas of dense vegetation to the south. It is therefore possible that more competent and massive Hardpan Laterite is present in this area that would require the use of rock breaking equipment during excavation.

- We recommend that any gravelly sand/sandy gravel fill sourced from the excavations for the holding dams is used to form a structural pad for construction of the treatment plant and/or to improve the foundations of the dam embankments.

10.5.2 Preliminary Assessment of Soil Parameters for Effluent Disposal

We understand that recycled waste-water from the PWRF will be directed to the proposed areas of POS and used as irrigation water. We understand that the preliminary design requires details of the soil parameters in the areas of POS.

The approximate locations of proposed areas of POS as shown on the project drawings is presented on Figure 5, Proposed POS and Drainage Areas.

The preliminary information presented in Table 3 and Table 4 is broadly inferred from the test pit and laboratory data obtained from our preliminary geotechnical study. Soil descriptions and layer thicknesses for the various soil types are presented in the test pit reports presented in Appendix B. Should further information be required, it will be necessary to conduct a targeted investigation that would probably involve:

- Drilling of boreholes using air coring techniques or similar.
- Sampling and laboratory testing of representative soil types.
- Constant head permeability testing using a Guelph permeameter at each location.

Table 3: Summary of Soil Conditions in POS Areas

Residential Precinct	Type of POS	Location	Test Pit References	Typical Stratigraphy
Precinct 1	T1 – Natural Living	North	TP01, TP03	Gravelly Silty SAND to GRAVEL; over HARDPAN LATERITE
	T1 – Natural Living	Near Centre	TP15, TP21, TP22 TP26, TP27, TP28	SAND/Gravelly SAND, GRAVEL, SAND/Silty SAND Gravelly SAND & LATERITE BOULDERS; over HARDPAN LATERITE
	T2 – Semi-Rural	North	TP09, TP10, TP11	Gravelly Silty SAND to GRAVEL & COBBLES OR HARDPAN LATERITE
	T2 – Semi-Rural	East	TP29, TP30, TP34, TP35	SAND/Silty SAND to Gravelly SAND/Sandy GRAVEL; over HARDPAN LATERITE
	T3 – Sub-Urban	North-east	TP12, TP13, TP18	Silty SAND or Sandy GRAVEL; over HARDPAN LATERITE
	T3 – Sub-Urban	South-west	TP40, TP41, TP45, TP46	Gravelly SAND to Sandy GRAVEL & BOULDERS; over HARDPAN LATERITE
Precinct 2	T3 – Sub-Urban	Near Centre	TP85, TP88, TP89	SAND, Silty/Clayey SAND, Gravelly SAND & BOULDERS; over HARDPAN LATERITE

Residential Precinct	Type of POS	Location	Test Pit References	Typical Stratigraphy
Water-course between Precinct 2 and 3	T1-Natural Living		TP78, TP79	Silty/Clayey SAND to Gravelly Silty/Clayey SAND (> 30% fines); over HARDPAN LATERITE
Precinct 3	T1 – Natural Living	Near Centre	TP70	Clayey SAND; over GRAVEL; over HARDPAN LATERITE; over Gravelly CLAY;
		South-east of Precinct 3	TP72, TP73	Clayey SAND/Silty SAND; over GRAVEL; over Clayey SAND to Gravelly CLAY
	T3 – Sub-Urban	Western part of Precinct 3	TP64, TP65	Gravelly SAND to Clayey Sandy GRAVEL; over Sandy CLAY/CLAY

Table 4: Preliminary Soil Parameters for Irrigation Model

Soil Types	Bulk Density (t/m^3)	Fines Content (%)	Saturated Permeability (m/day)	
			Compacted[1]	In-situ
Silty SAND to Sandy GRAVEL	1.9 – 2.2	< 15	0.1 – 1.0	1.0 – 5.0
Silty/Clayey SAND, Clayey GRAVEL 15-30% fines	1.9 – 2.2	15 – 30	9×10^{-4}	9×10^{-4}
Clayey SAND, Clayey GRAVEL, Sandy CLAY, Gravelly CLAY, CLAY > 30% fines	1.9 – 2.2	> 30	9×10^{-5}	9×10^{-5}
HARDPAN LATERITE	2.2	-	-	impermeable

Note: 1. Fines refer to particles less than 0.075 mm in size

2. Soil parameters are based on our experience with the soil types and the available laboratory data

11. CLOSURE

We draw your attention to Appendix E of this report, "Understanding Your Report". The information provided within is intended to inform you as to what your realistic expectations of this report should be. Guidance is also provided on how to minimise risks associated with ground-works for this project. This information is provided not to reduce the level of responsibility accepted by Galt, but to ensure that all parties who rely on this report are aware of the responsibilities each assumes in so doing.

GALT GEOTECHNICS PTY LTD

Fred Davenport CPEng

Geotechnical Engineer

Harry Chambers

Geotechnical Engineer

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Figures

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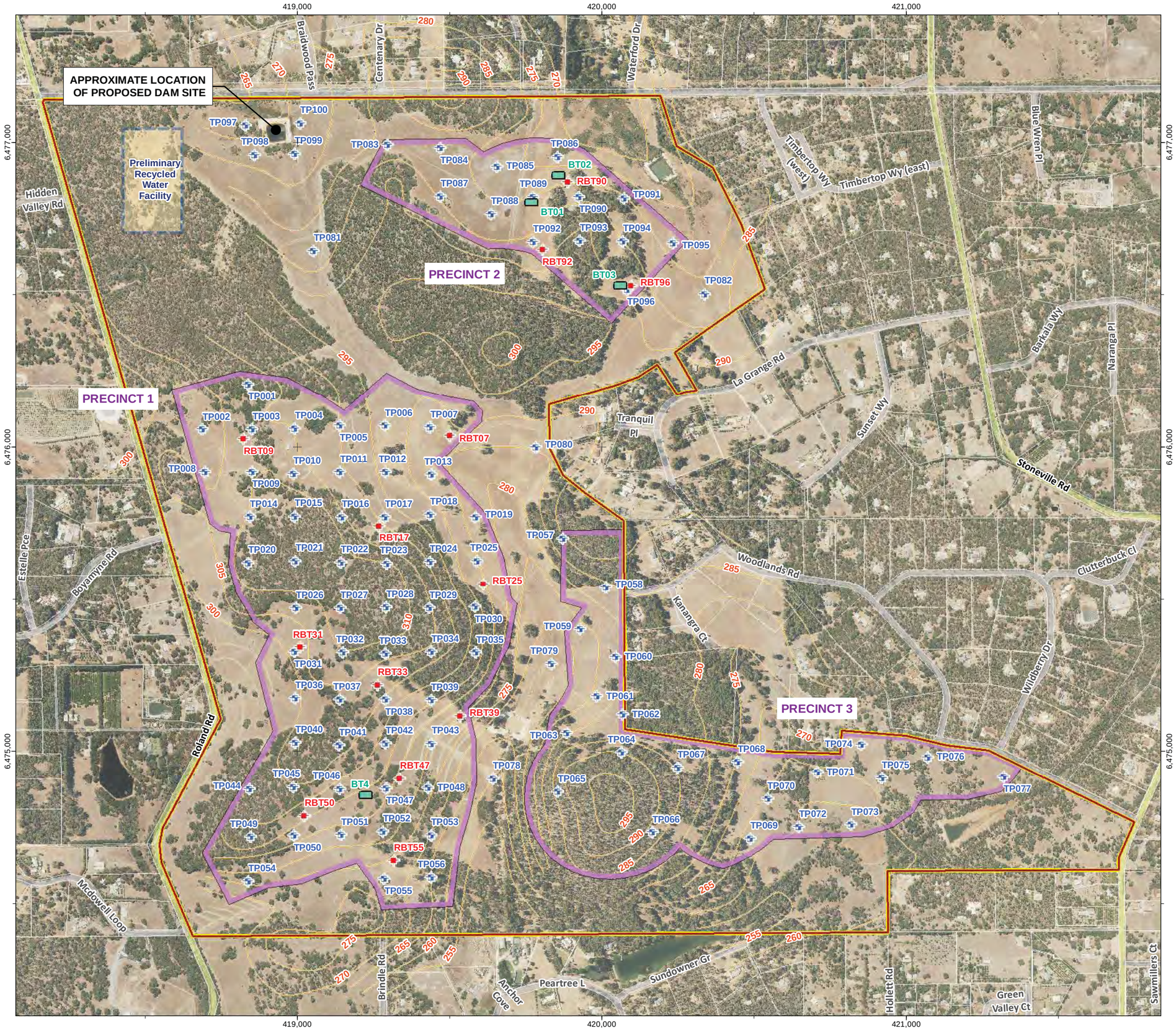

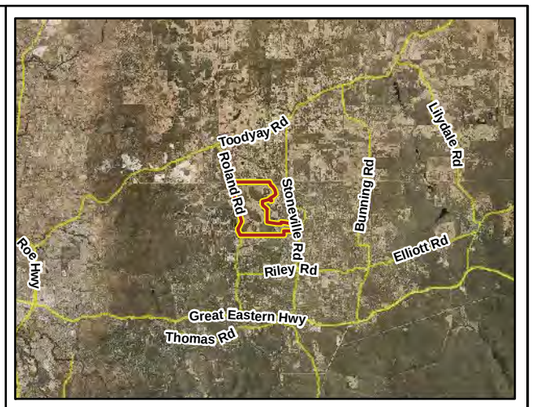

Legend

- Site Boundary

Excavation and Ripping Trials - May/June 2017

- Rock breaker trial pits
- Bulldozer trial areas

Preliminary Geotechnical Investigation – February 2017

- Test Pit

NOTES: Approximate ground elevation contours (RL m AHD) as shown on Landgate online aerial imagery.

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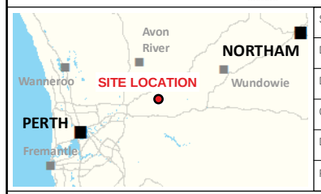

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CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	SITE AND LOCATION PLAN
Job No	J1701008-002
Fig No	FIGURE 1
Rev	**A**

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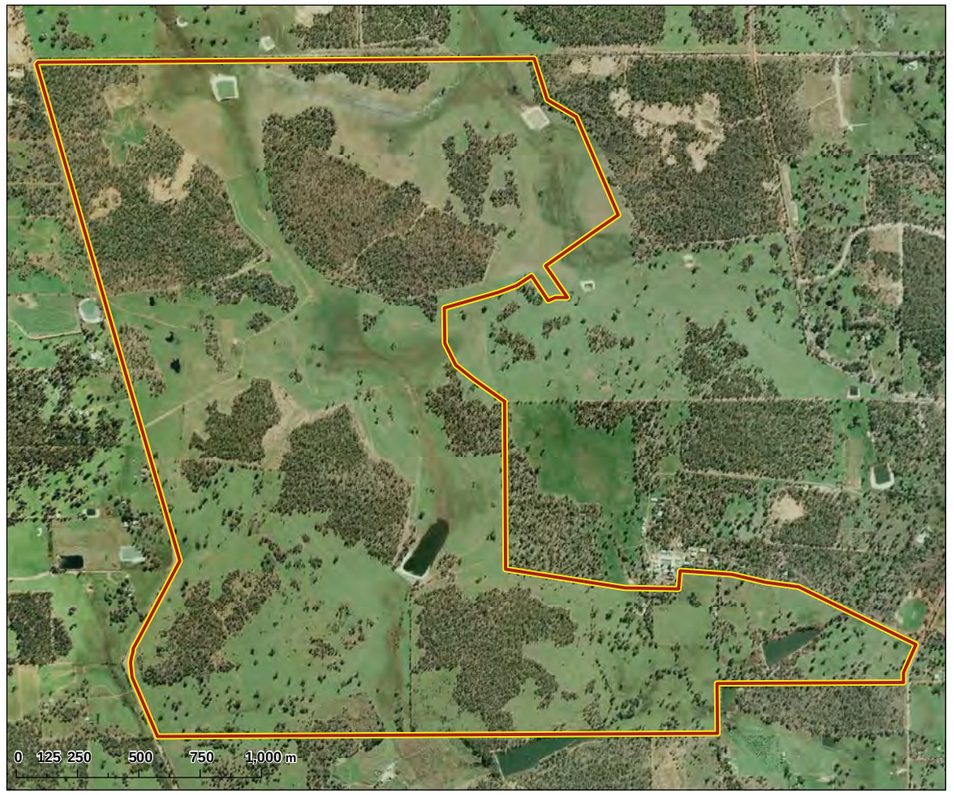
MAP 1 - 1965

MAP 2 - 1974

MAP 3 - 1979



MAP 4 - 1981

LEGEND

Site Boundary

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DATE CHECKED	14/02/2017
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CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (1965 - 1981)

Job No	Fig No	Rev
J1701008	FIGURE 2A	**A**

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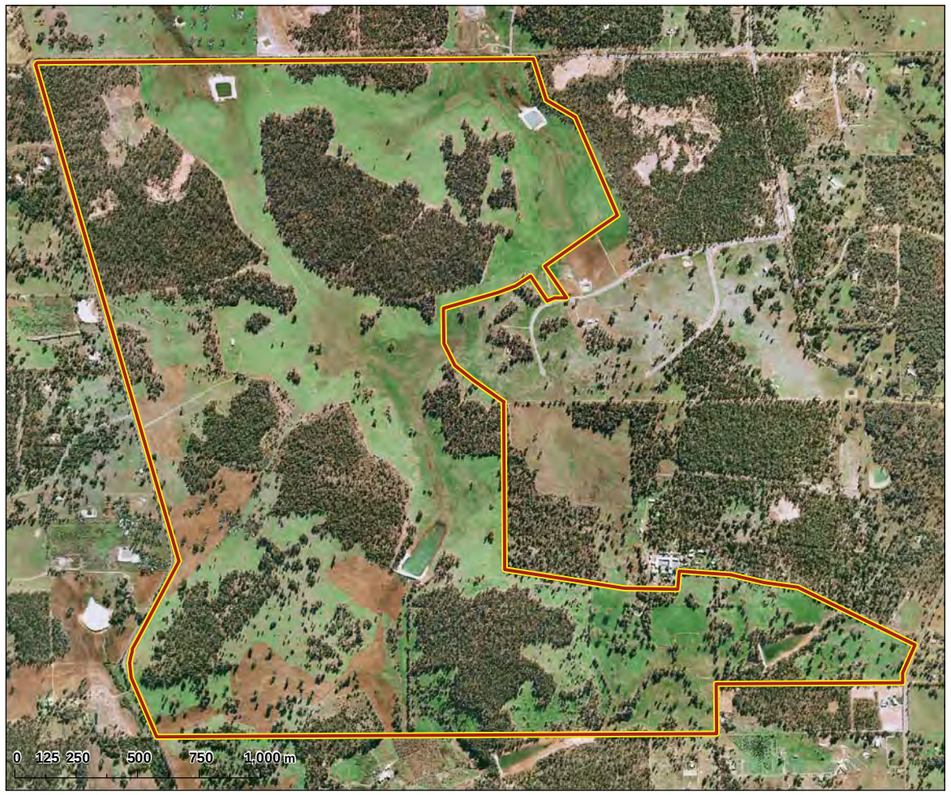
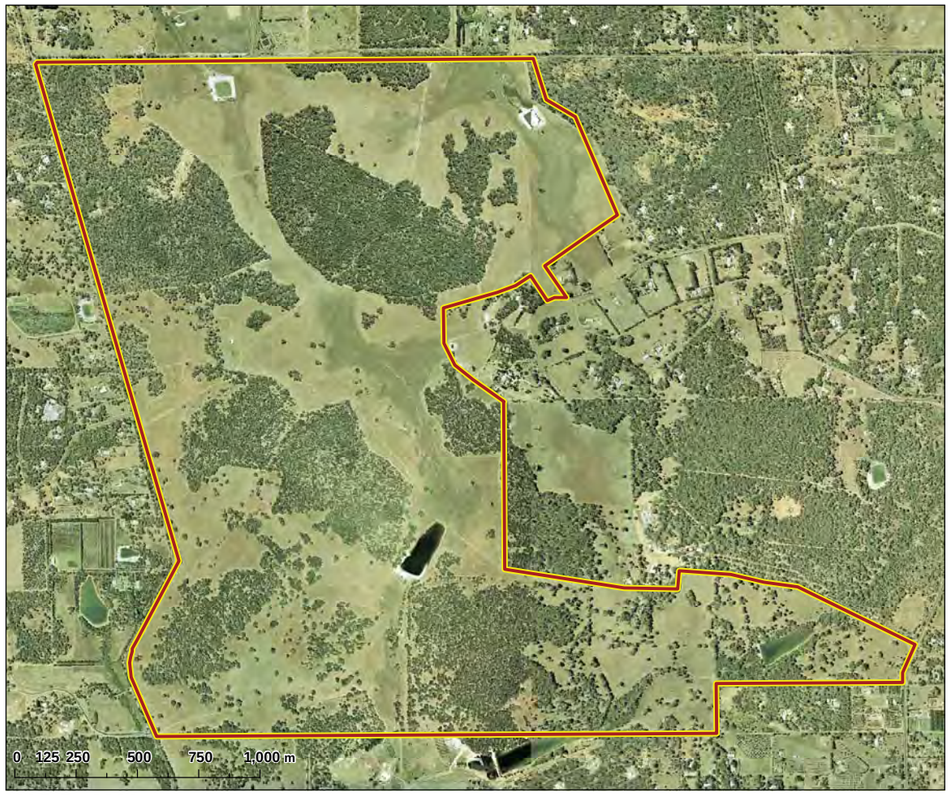
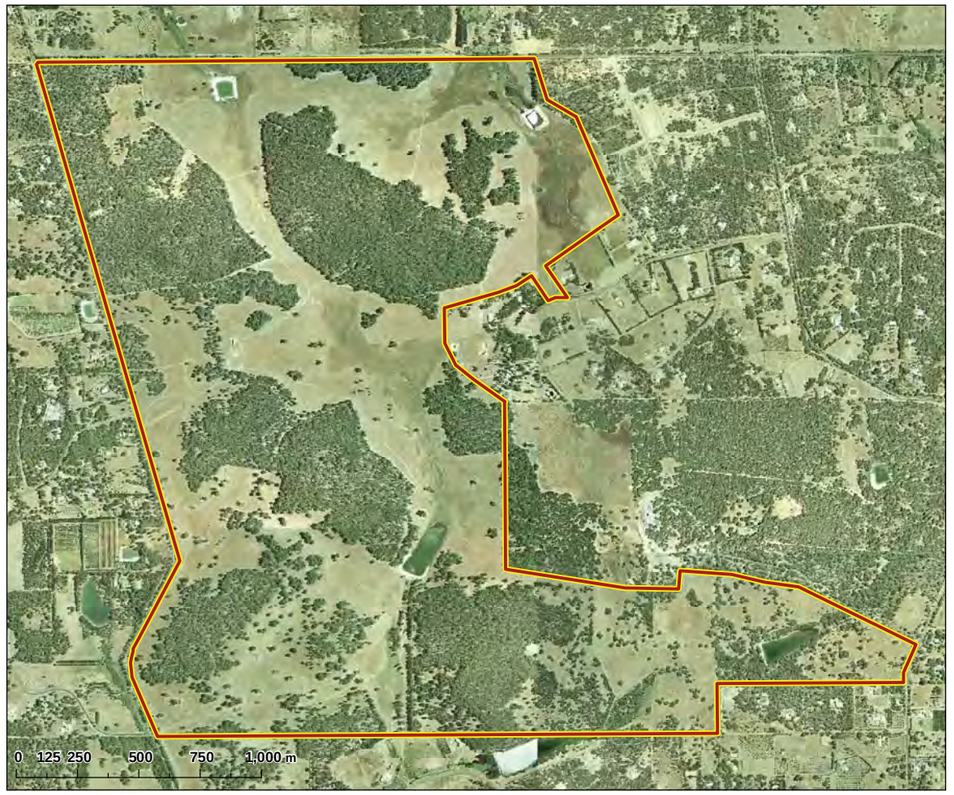


MAP 5 - 1985

MAP 6 - 1995



MAP 7 - 2000



MAP 8 - 2001

LEGEND

Site Boundary

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DATE DRAWN	14/02/2017
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DATE CHECKED	14/02/2017
PROJECTION	GDA 1994 MGA Zone 50

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CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (1985 - 2001)
Job No	J1701008
Fig No	FIGURE 2B
Rev	**A**

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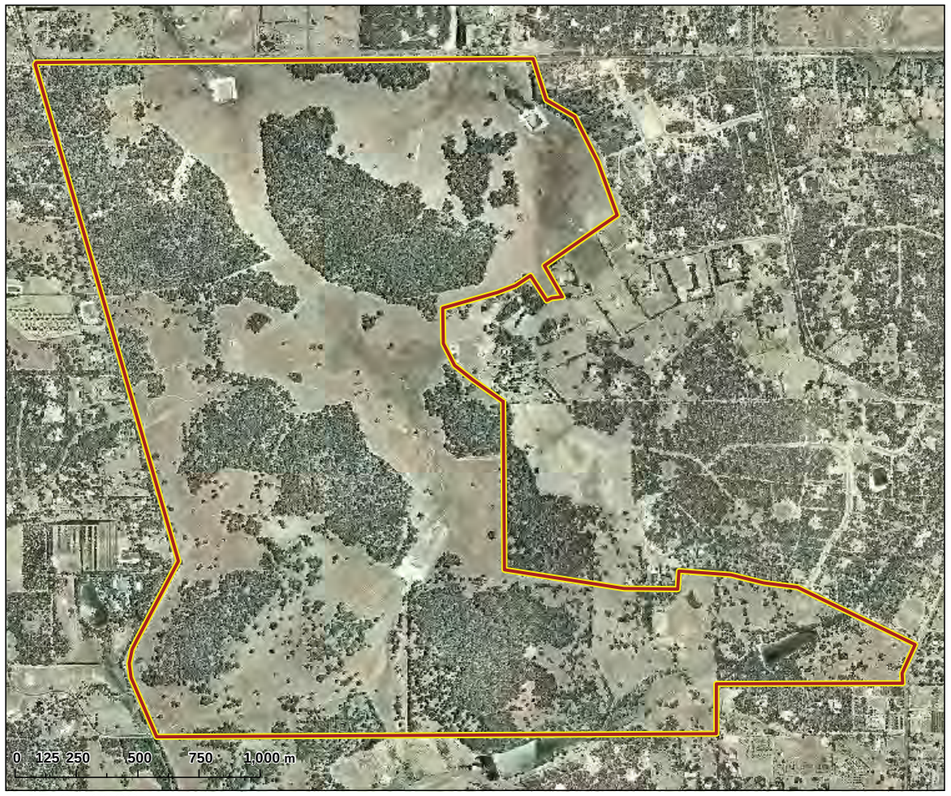
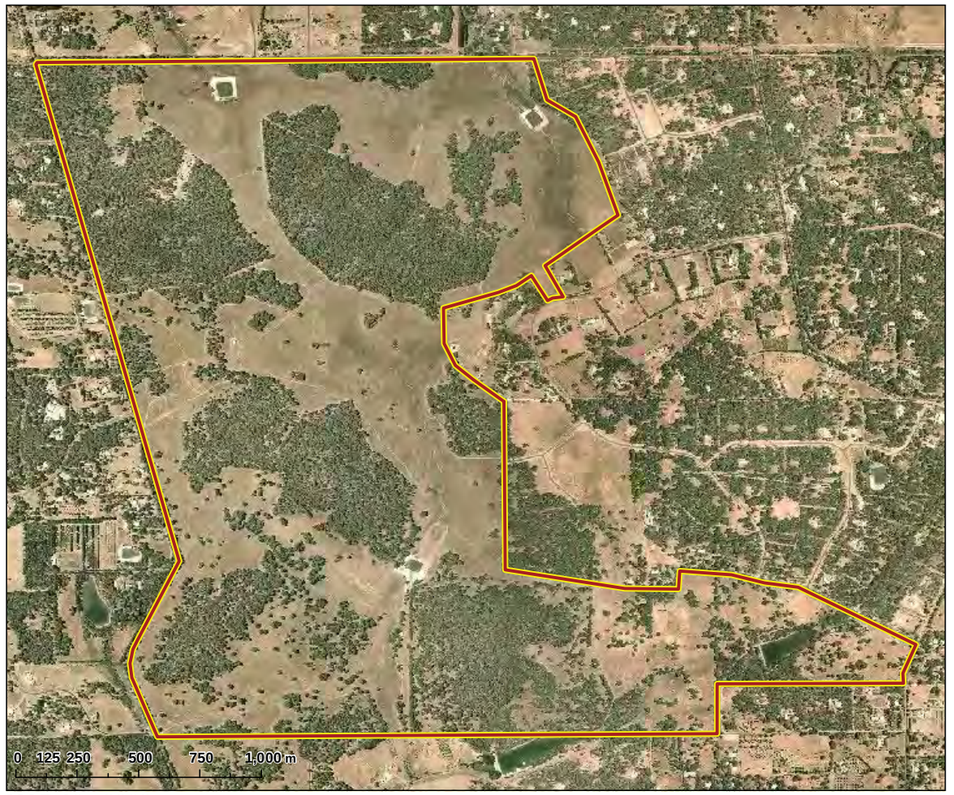


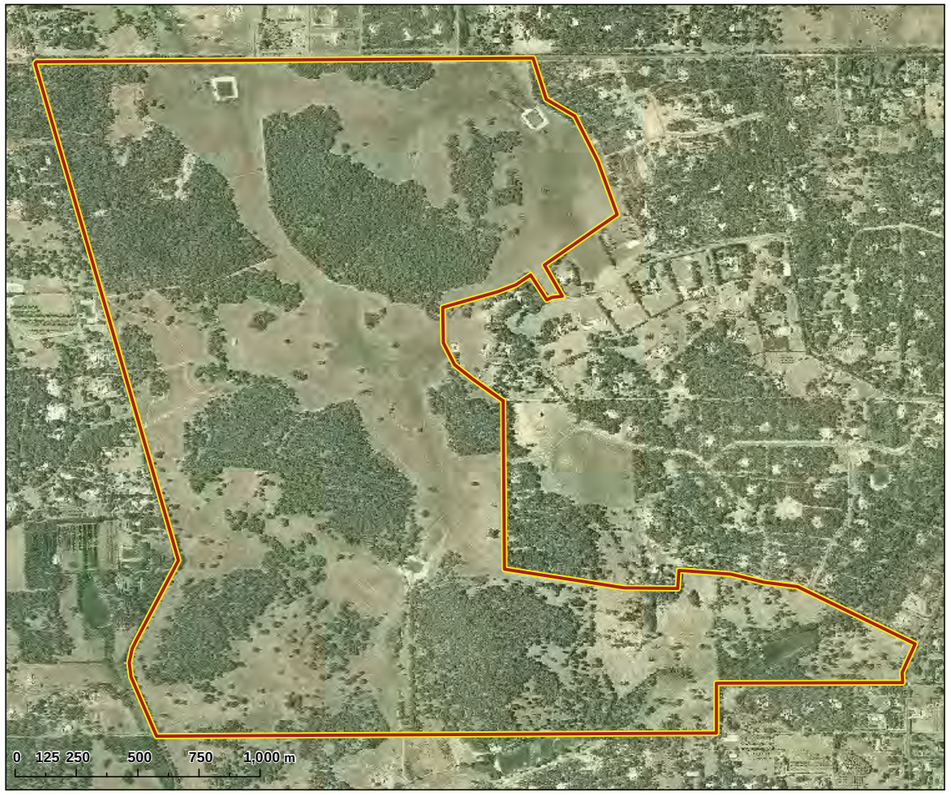
MAP 9 - 2002



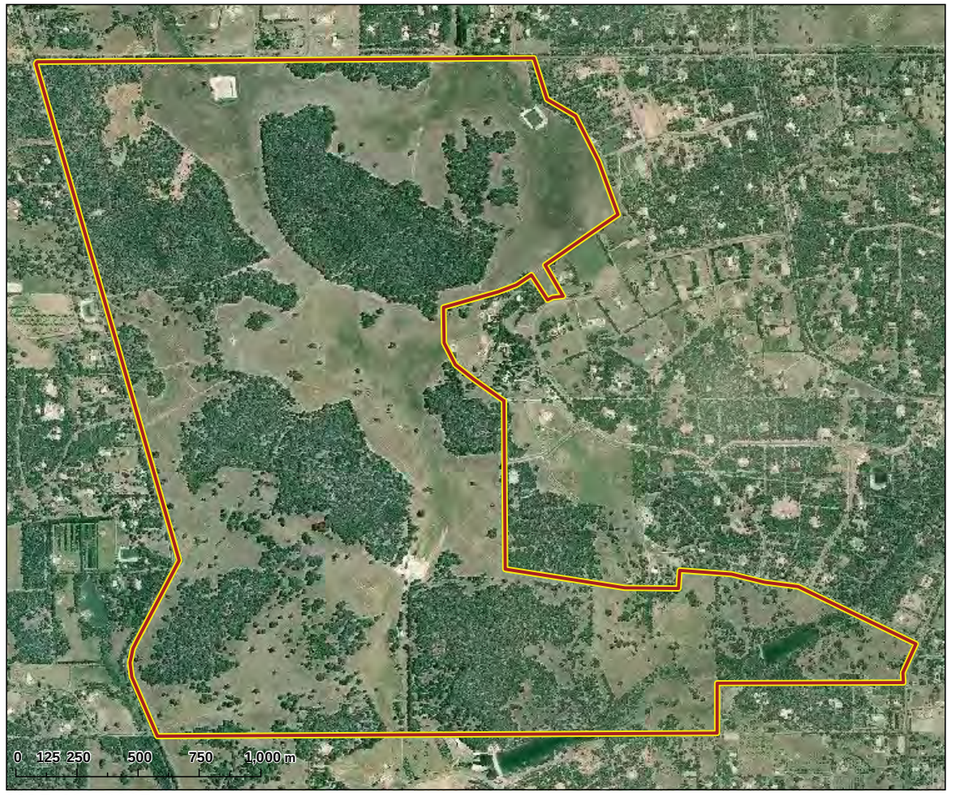
MAP 10 - 2003

LEGEND

Site Boundary



MAP 11 - 2004



MAP 12 - 2005

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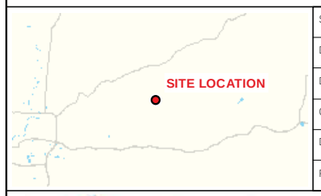

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PROJECTION	GDA 1994 MGA Zone 50

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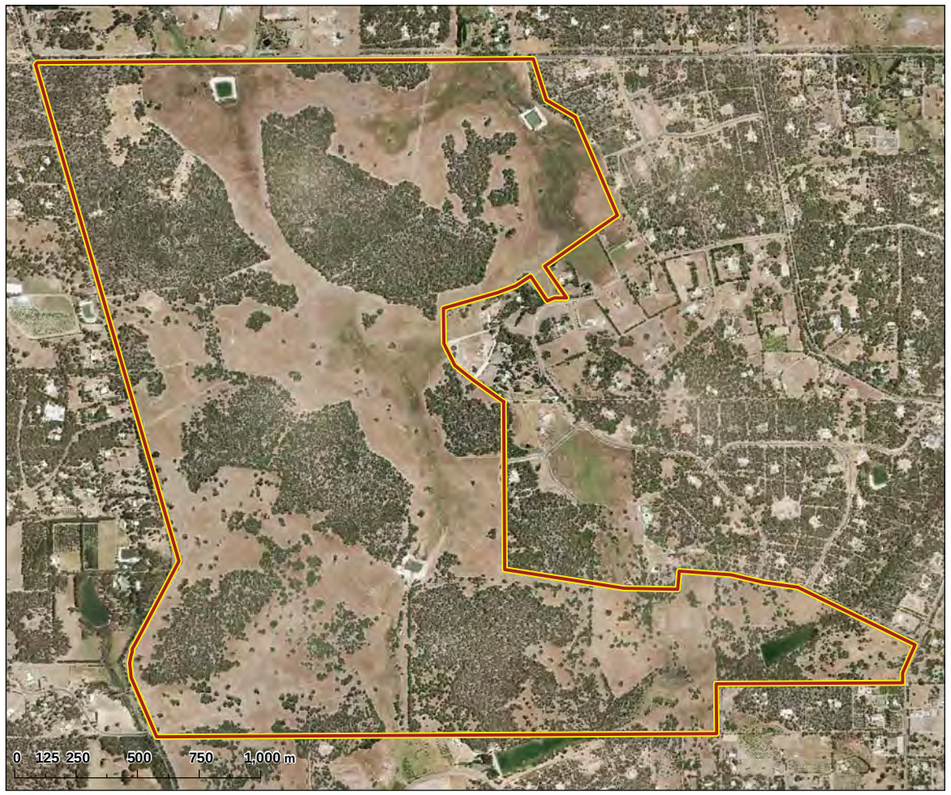
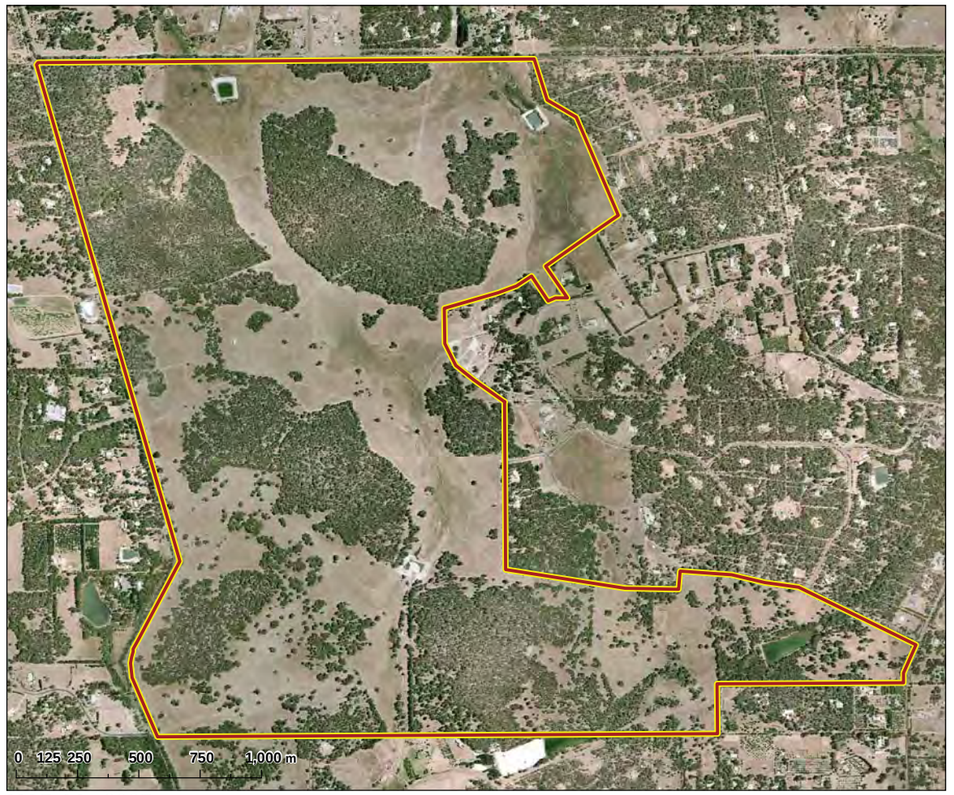
CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (2002 - 2005)

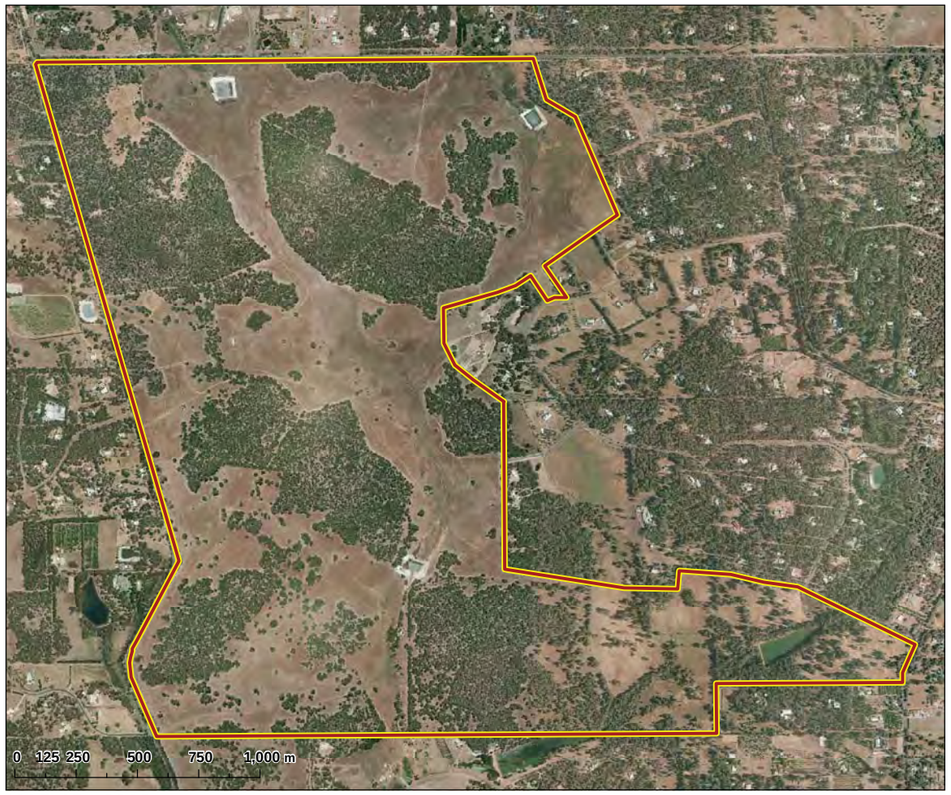
Job No	Fig No	Rev
J1701008	FIGURE 2C	**A**



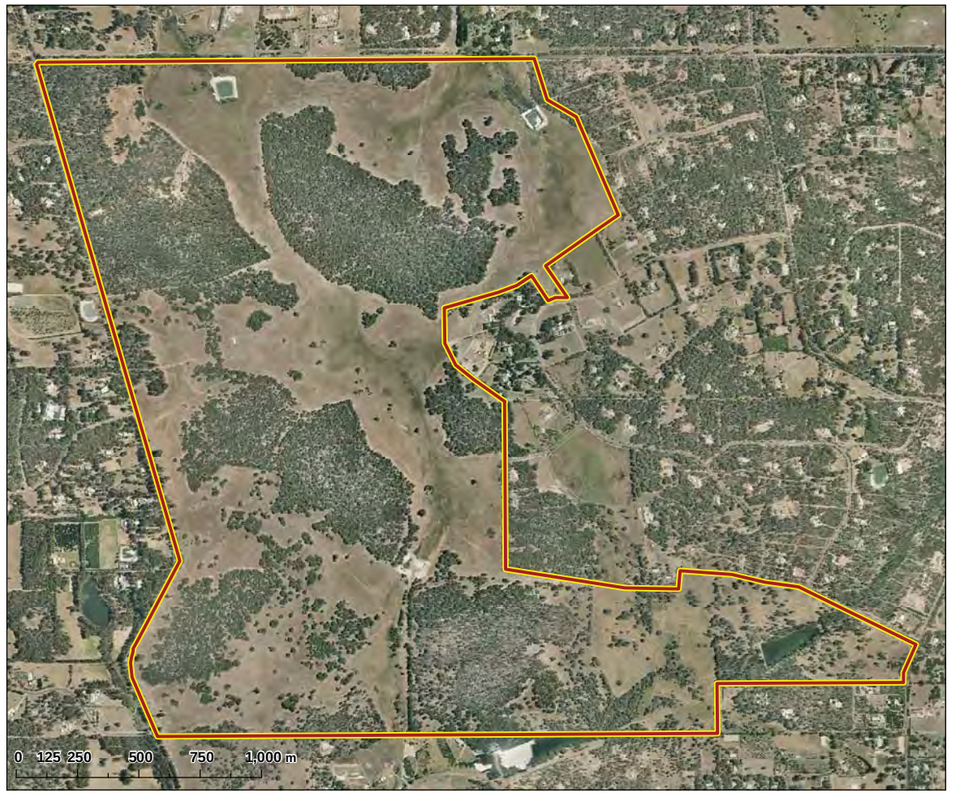
MAP 13 - 2008



MAP 14 - 2007



MAP 15 - 2008



MAP 16 - 2009

LEGEND

Site Boundary

N

0 380 760 1140 1520 1900

Meters

SCALE	1:25,000	(A3)
DRAWN	DAC	
DATE DRAWN	14/02/2017	
CHECKED	HWC	
DATE CHECKED	14/02/2017	
PROJECTION	GDA 1994 MGA Zone 50	

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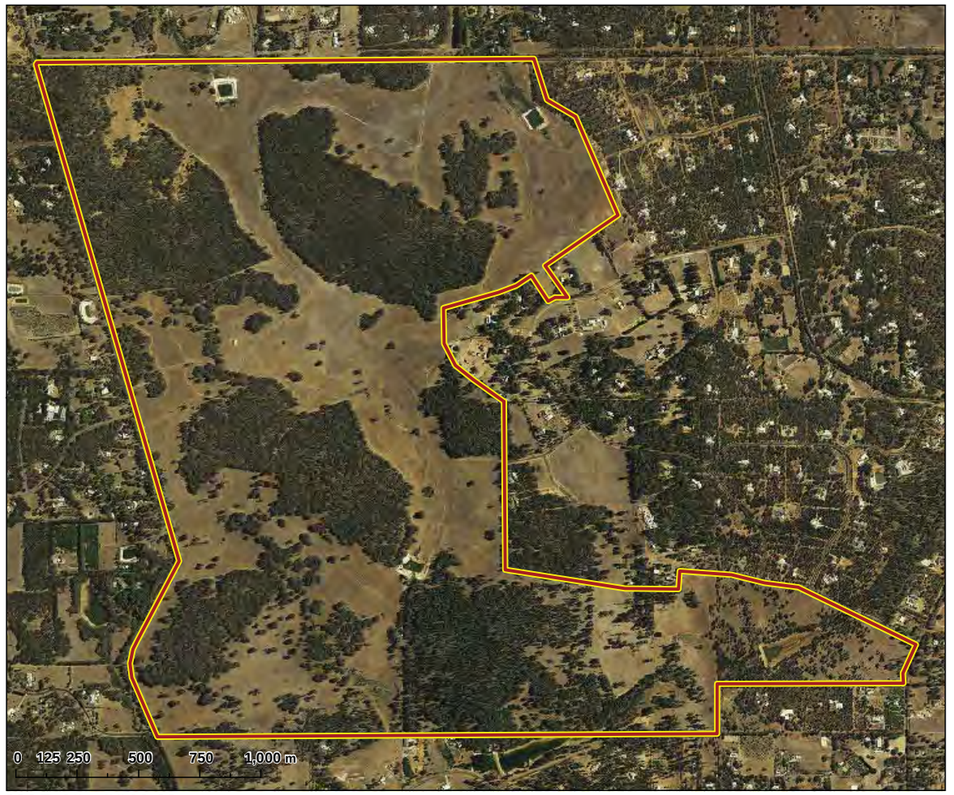
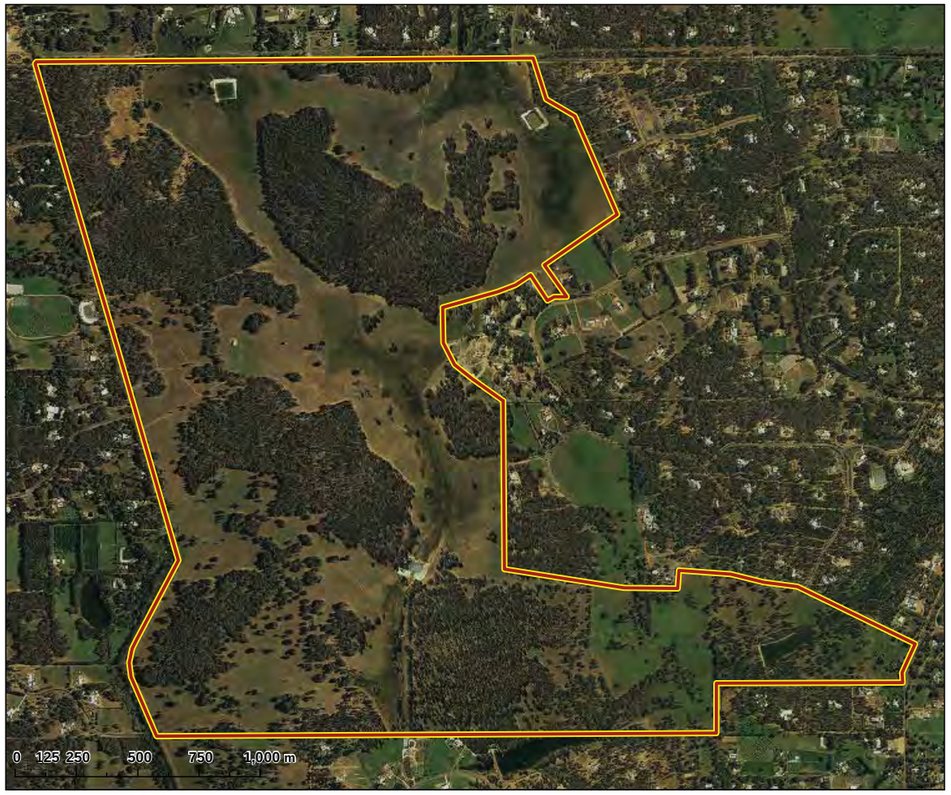
CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (2008 - 2009)

Job No	Fig No	Rev
J1701008	FIGURE 2D	**A**

MAP 17 - 2010



MAP 18 - 2011(March)



MAP 19 - 2011(August)

MAP 20 - 2012(February)

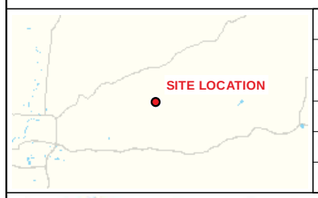
LEGEND

Site Boundary

N

0 390 780 1170 1560 1950

Meters



SCALE	1:25,000	(A3)
DRAWN	DAC	
DATE DRAWN	14/02/2017	
CHECKED	HWC	
DATE CHECKED	14/02/2017	
PROJECTION	GDA 1994 MGA Zone 50	

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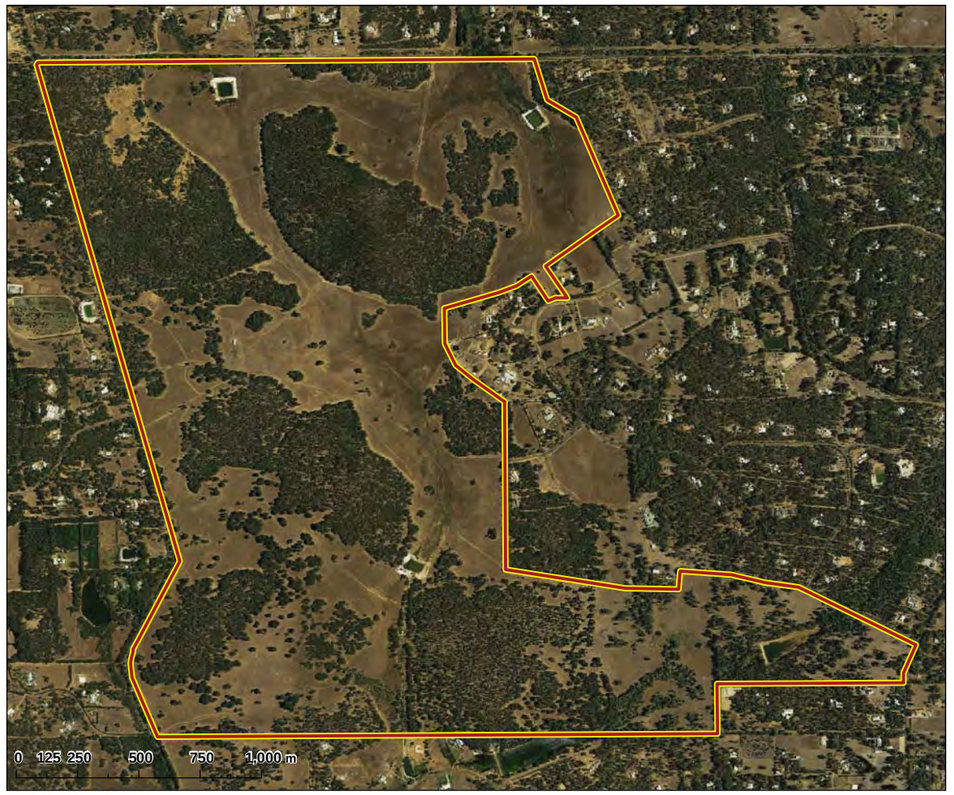
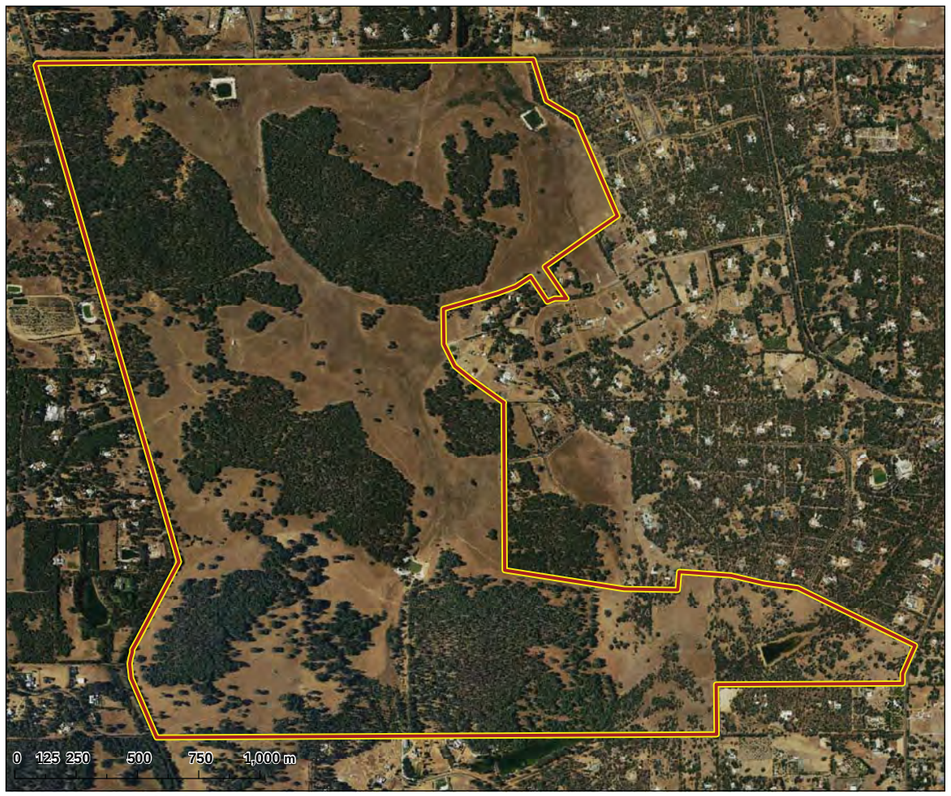
CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (2011(MARCH) - 2012(FEBRUARY))
Job No	J1701008
Fig No	FIGURE 2E
Rev	**A**

MAP 21 - 2012 (September)



MAP 22 - 2013 (January)



MAP 23 - 2014(February)

MAP 4 - 2014 (August)

LEGEND

Site Boundary

N

0 380 760 1140 1520 1900

Meters

SCALE	1:25,000	(A3)
DRAWN	DAC	
DATE DRAWN	14/02/2017	
CHECKED	HWC	
DATE CHECKED	14/02/2017	
PROJECTION	GDA 1994 MGA Zone 50	

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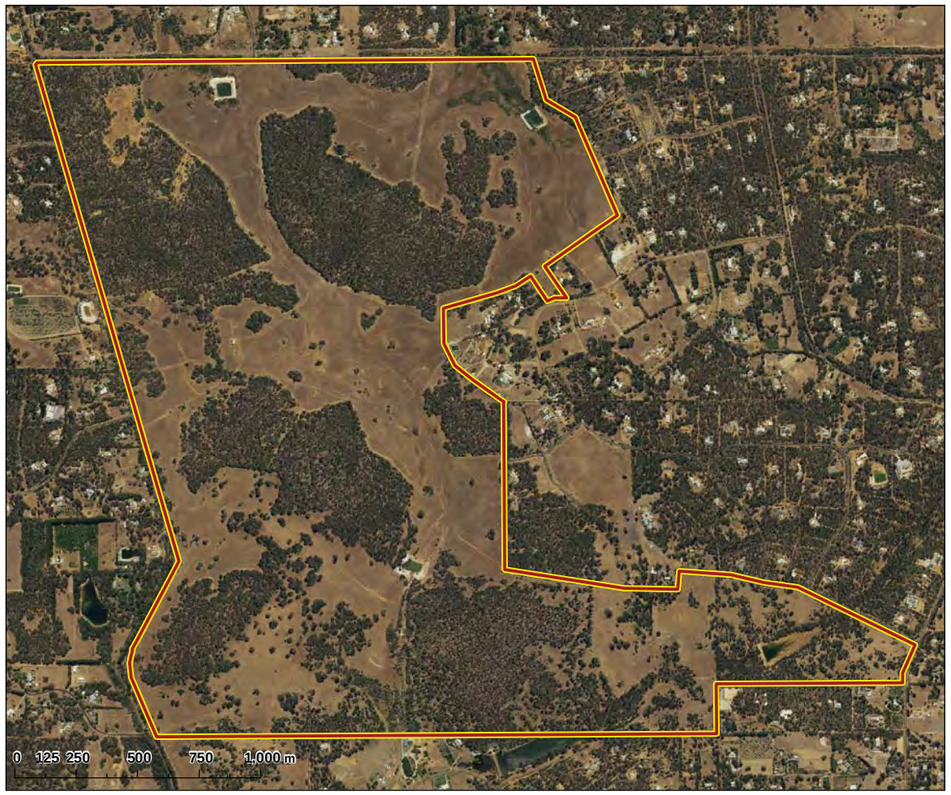
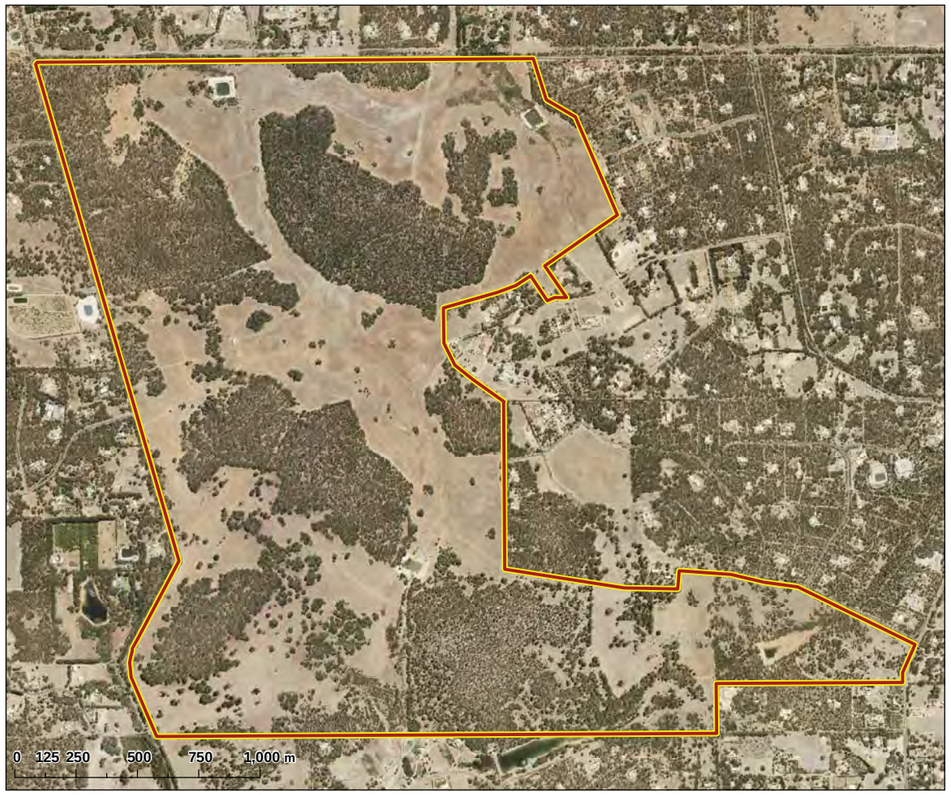
CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (2012 (SEPTEMBER) - 2014 (AUGUST))

Job No	Fig No	Rev
J1701008	FIGURE 2F	**A**



MAP 25 - 2015 (February)

MAP 26 - 2015 (September)



MAP 27 - 2016 (February)

MAP 28 - 2016 (August)

LEGEND

Site Boundary

N

0 380 760 1140 1520 1900

Meters

SCALE	1:25,000	(A3)
DRAWN	DAC	
DATE DRAWN	14/02/2017	
CHECKED	HWC	
DATE CHECKED	14/02/2017	
PROJECTION	GDA 1994 MGA Zone 50	

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CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	HISTORICAL AERIAL IMAGERY (2015 (FEBRUARY) - 2016 (AUGUST))

Job No	Fig No	Rev
J1701008	FIGURE 2G	**A**

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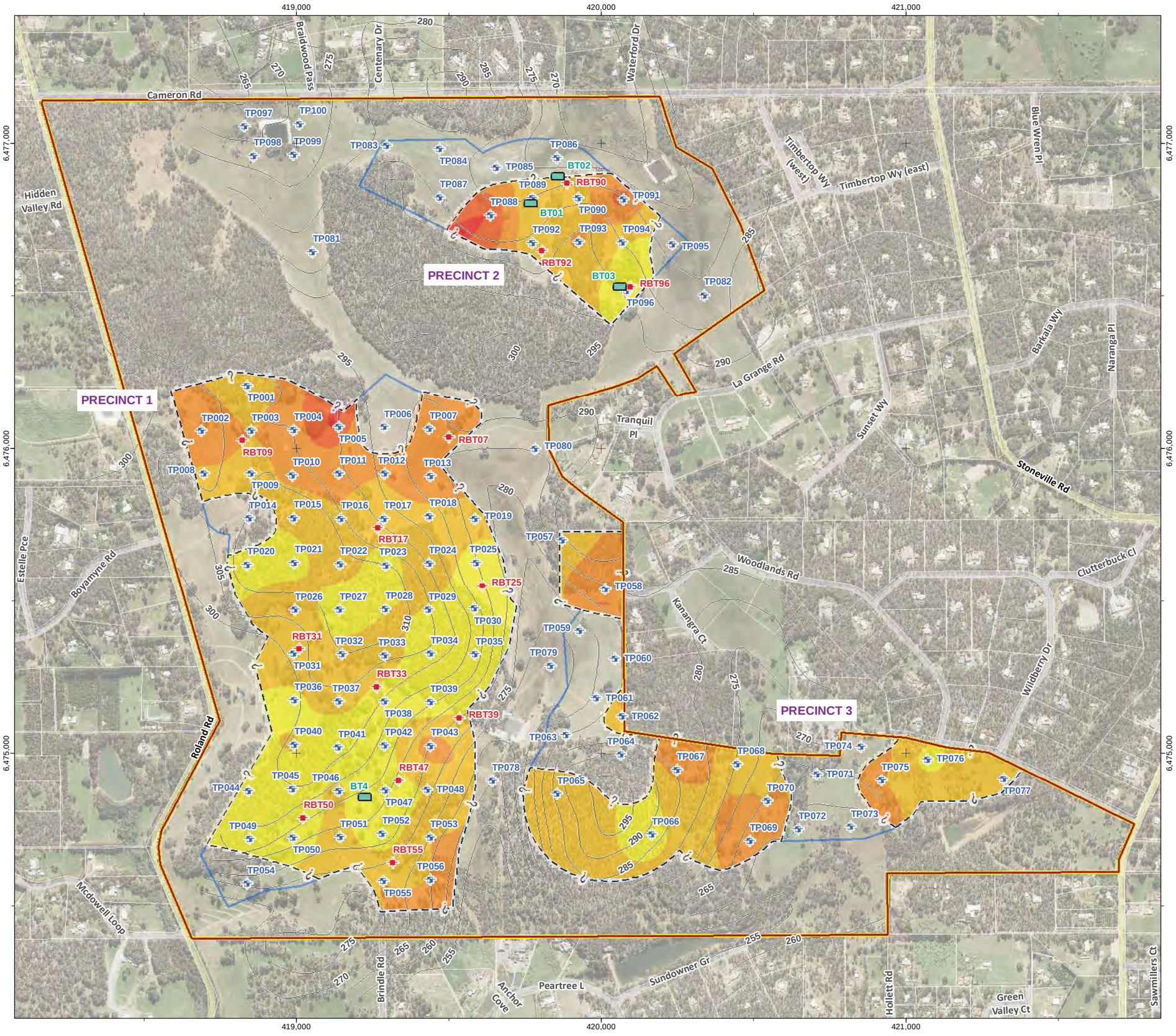

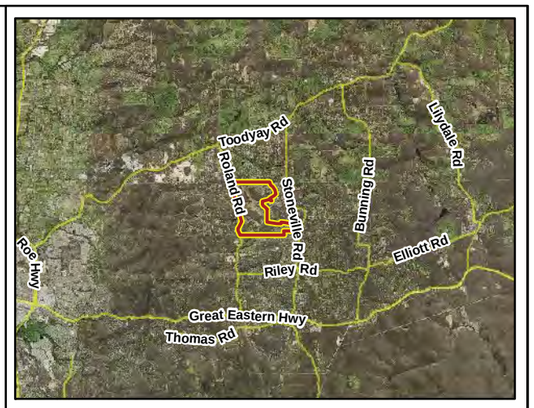

Legend

Site Boundary

DEPTH TO HARDPAN LATERITE	
Range	Colour
0.00 - 0.50	
0.50 - 1.00	
1.00 - 1.50	
1.50 - 2.00	
2.00 - 2.10	

NOTES: Depth to Hardpan Laterite refers to the broadly approximated depth to well to very well cemented Hardpan Laterite. The approximated depths do not take into account areas comprising shallow Lateritic GRAVEL, COBBLES OR BOULDERS. The accuracy of this mapping is limited by the number of test pits and the variability of the Hardpan Laterite profile.

N

0 200 400 600 800 1000

Meters

SCALE	1:12,500 (A3)
DRAWN	DAC
DATE DRAWN	22/06/2017
CHECKED	HWC
DATE CHECKED	30/03/2017
PROJECTION	GDA 1994 MGA Zone 50

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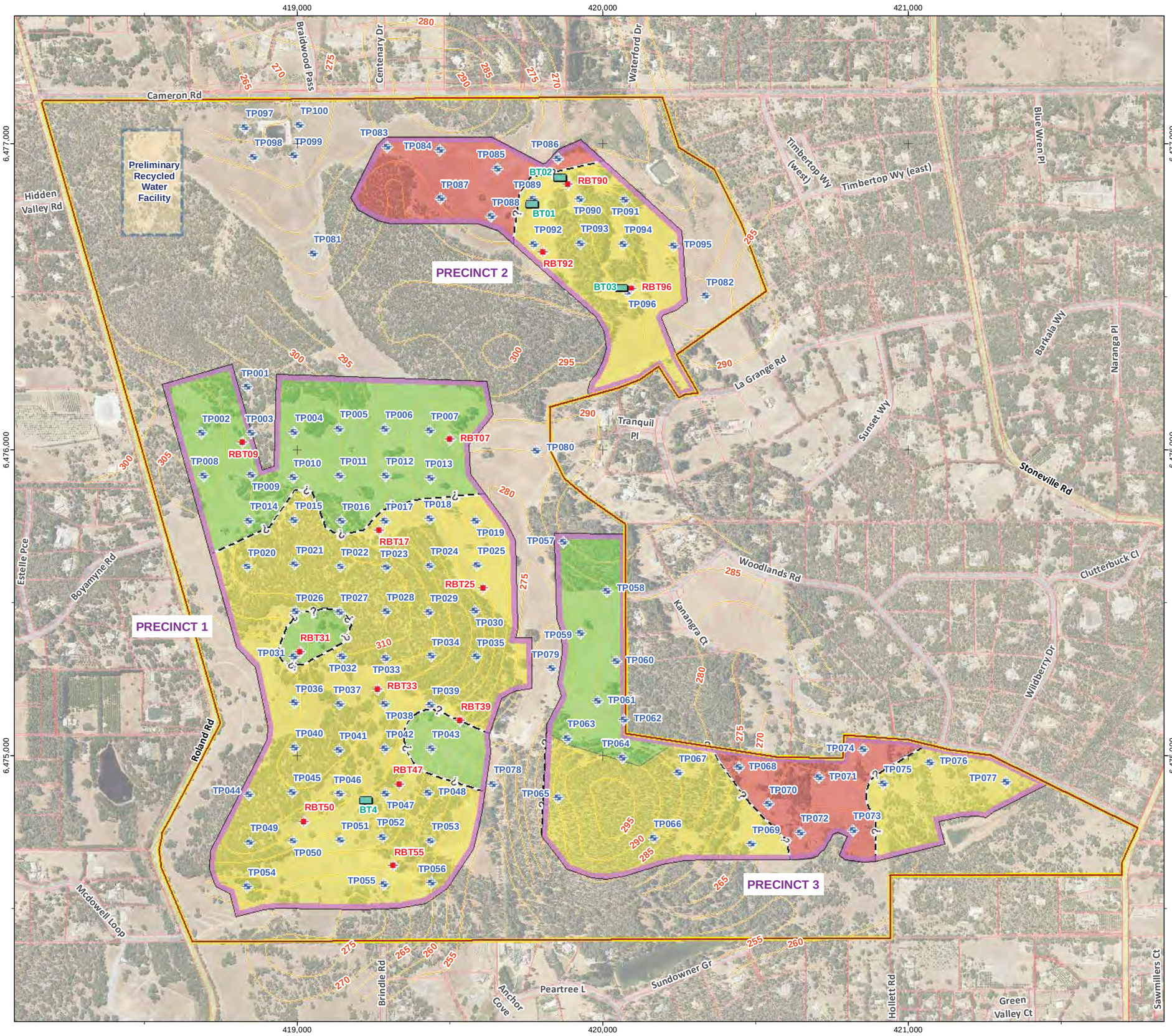
CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	DEPTH TO HARDPAN LATERITE
Job No	J1701008
Fig No	FIGURE 3
Rev	**A**



Legend

- Site Boundary

Excavation and Ripping Trials - May/June 2017

- Rock breaker trial pits
- Bulldozer trial areas

Preliminary Geotechnical Investigation – February 2017

- Test Pit
- Zone A - Deepest profiles of predominantly gravelly soils and excavatable Hardpan ranging between 1 m to 3 m in thickness - excavatable Hardpan present on northern part of Precinct 1
- Zone B - Thin layer of gravelly soils (0 m to 1 m thickness - on average about 0.5 m) over very well cemented Hardpan
- Zone C - Undesirable borrow materials - variable clayey soils with a limited cover of inert granular material

NOTES: Approximate ground elevation contours (RL m AHD) as shown on Landgate online aerial imagery.

N

0 200 400 600 800 1000
Meters

SCALE	1:12,500	(A3)
DRAWN	DAC	
DATE DRAWN	5/07/2017	
CHECKED	HWC	
DATE CHECKED	22/06/2017	
PROJECTION	GDA 1994 MGA Zone 50	

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CLIENT	**SATTERLEY PROPERTY GROUP**
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	PRELIMINARY BORROW ASSESSMENT
Job No	J1701008-002
Fig No	FIGURE 4
Rev	**A**

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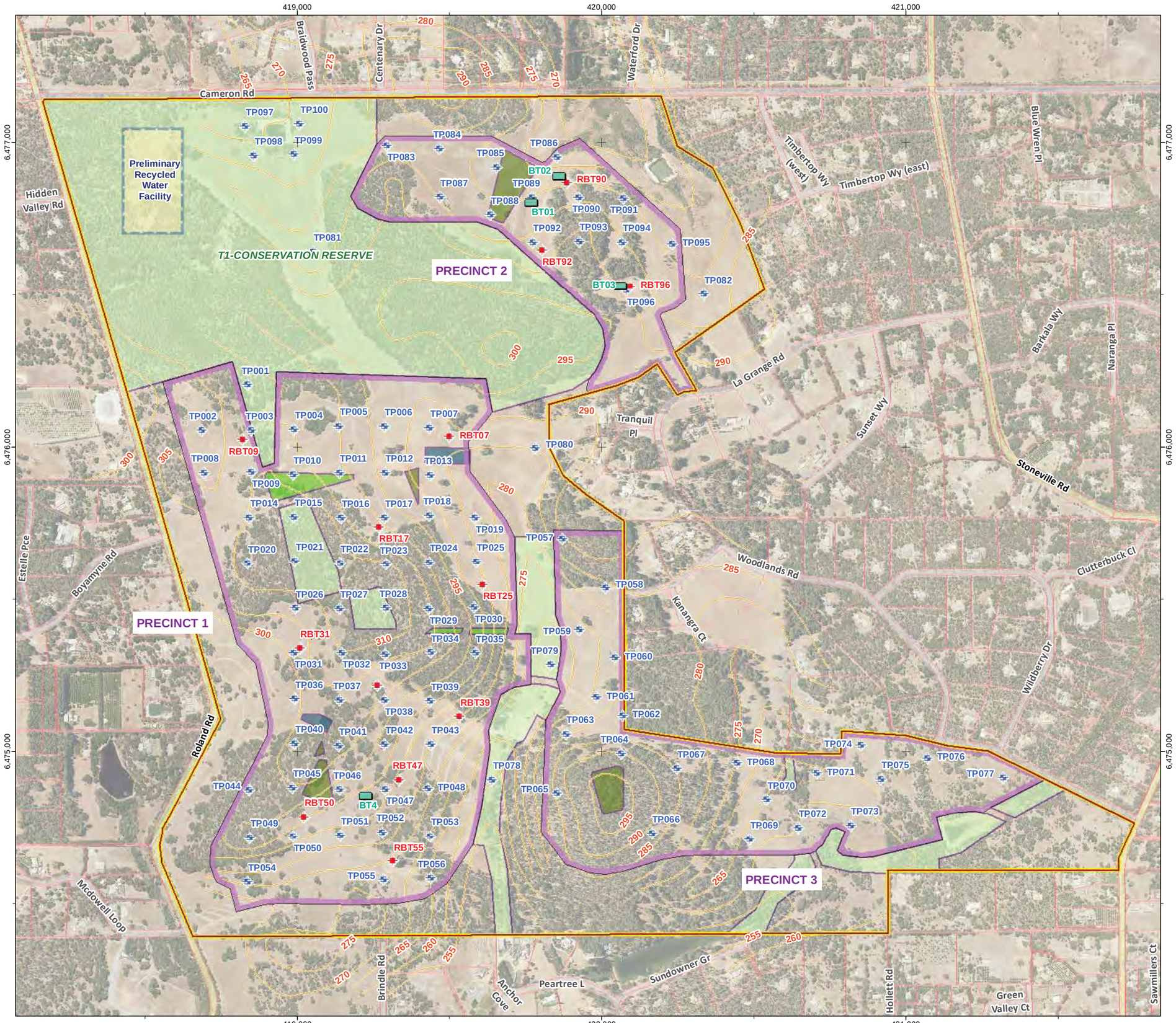


Legend

- Site Boundary

Excavation and Ripping Trials - May/June 2017

- Rock breaker trial pits
- Bulldozer trial areas

Preliminary Geotechnical Investigation – February 2017

- Test Pit

Open Space

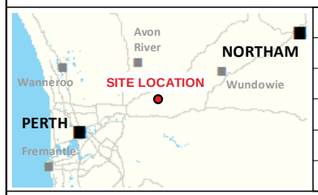
- T1 - Natural Living
- T2 - Semi-Rural
- T3 - Sub-Urban
- T4 - Village Core

NOTES: Approximate ground elevation contours (RL m AHD) as shown on Landgate online aerial imagery.

N

0 200 400 600 800 1000

Meters



SCALE	1:12,500 (A3)
DRAWN	DAC
DATE DRAWN	5/07/2017
CHECKED	HWC
DATE CHECKED	22/06/2017
PROJECTION	GDA 1994 MGA Zone 50

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CLIENT	SATTERLEY PROPERTY GROUP
PROJECT	PROPOSED STONEVILLE PROJECT
LOCATION	LOT 48 ROLAND ROAD STONEVILLE
TITLE	PROPOSED PUBLIC OPEN SPACE AND DRAINAGE AREAS
Job No	J1701008-002
Fig No	FIGURE 5
Rev	A

O:\Jobs\2017\J1701008 - C&W SI Stoneville\09 GIS\04 MXD\002\J1701008-02-005.mxd (damonclark) 5/07/2017 4:38:59 PM

Appendix A: Project Drawings

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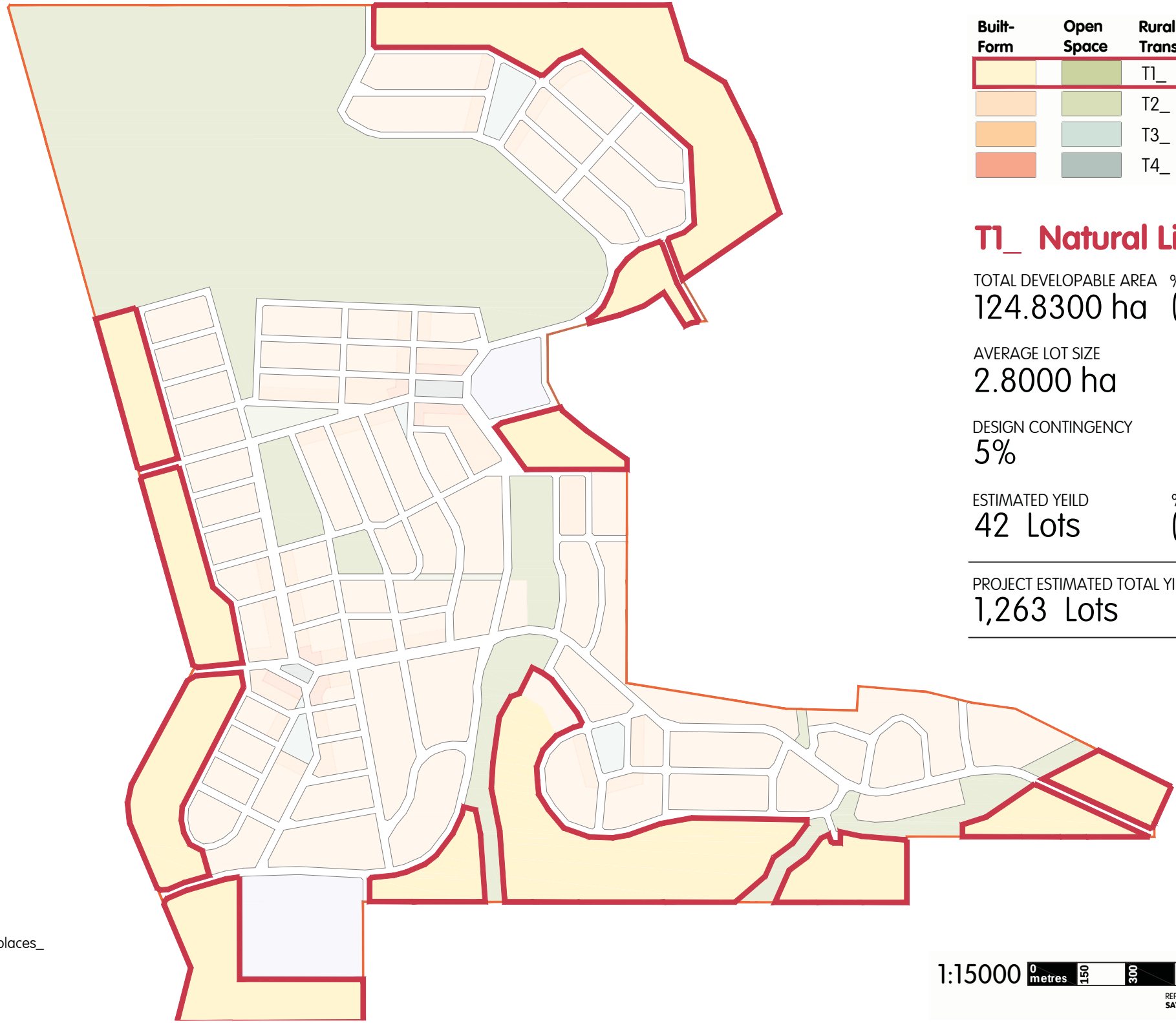
4/15 Walters Drive OSBORNE PARK WA 6017
ABN: 64 625 054 729



N

Built-Form	Open Space	Rural - Urban Transect
		T1_ Natural Living
		T2_ Semi-Rural
		T3_ Sub-Urban
		T4_ Village Core

T1_ Natural Living

TOTAL DEVELOPABLE AREA
124.8300 ha

% of TOTAL AREA
(41.7%)

AVERAGE LOT SIZE
2.8000 ha

DESIGN CONTINGENCY
5%

ESTIMATED YEILD
42 Lots

% OF TOTAL YIELD
(3.4%)

PROJECT ESTIMATED TOTAL YIELD
1,263 Lots

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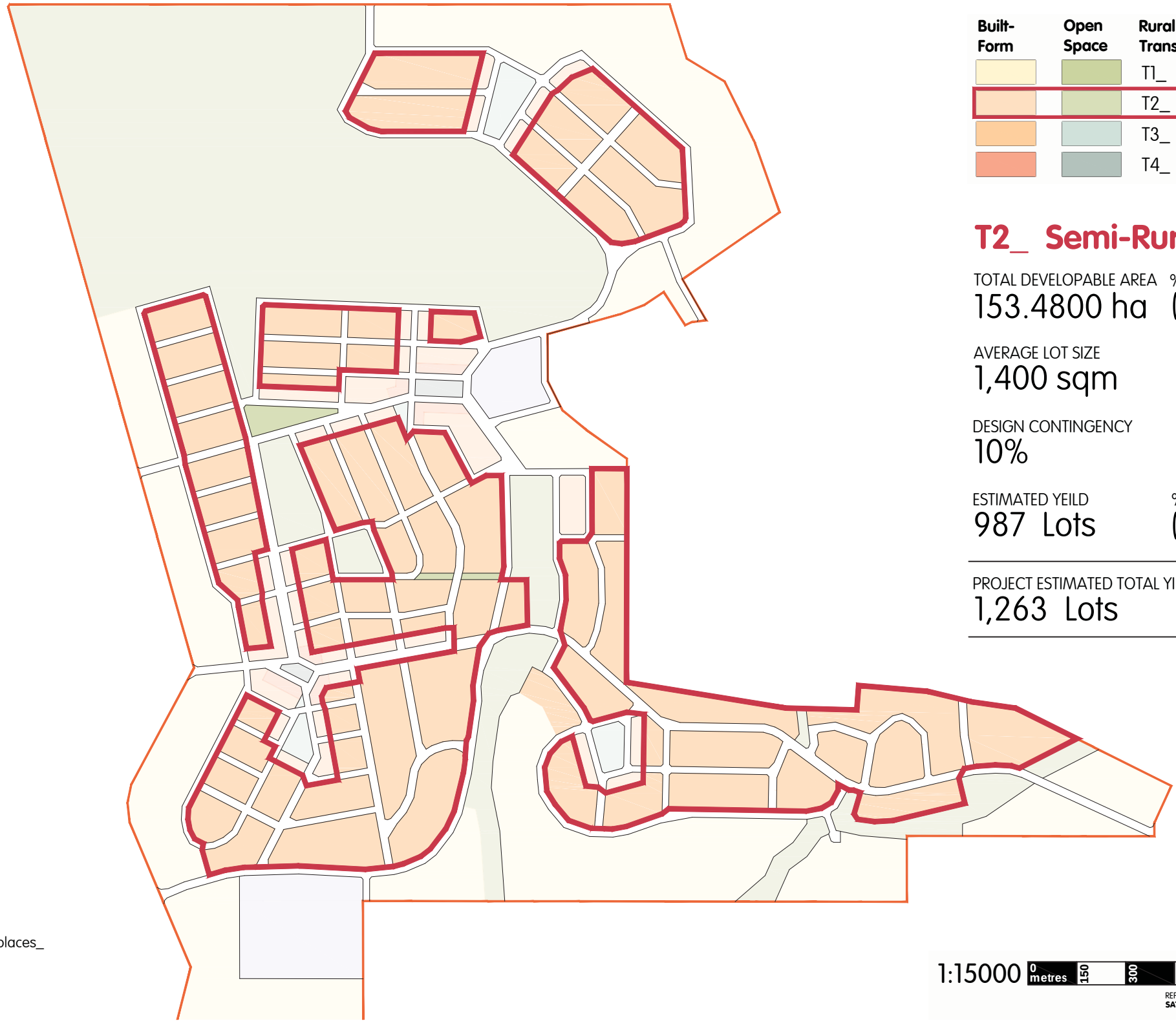
Stoneville

1:15000

0 metres 150 300 450 600 750

REF NO. SAT STO | DRAW NO. RD1 100 | REV. E



N

Built-Form	Open Space	Rural - Urban Transect
		T1_ Natural Living
		T2_ Semi-Rural
		T3_ Sub-Urban
		T4_ Village Core

T2_ Semi-Rural

TOTAL DEVELOPABLE AREA
153.4800 ha

% of TOTAL AREA
(51.2%)

AVERAGE LOT SIZE
1,400 sqm

DESIGN CONTINGENCY
10%

ESTIMATED YEILD
987 Lots

% OF TOTAL YIELD
(78.1%)

PROJECT ESTIMATED TOTAL YIELD
1,263 Lots

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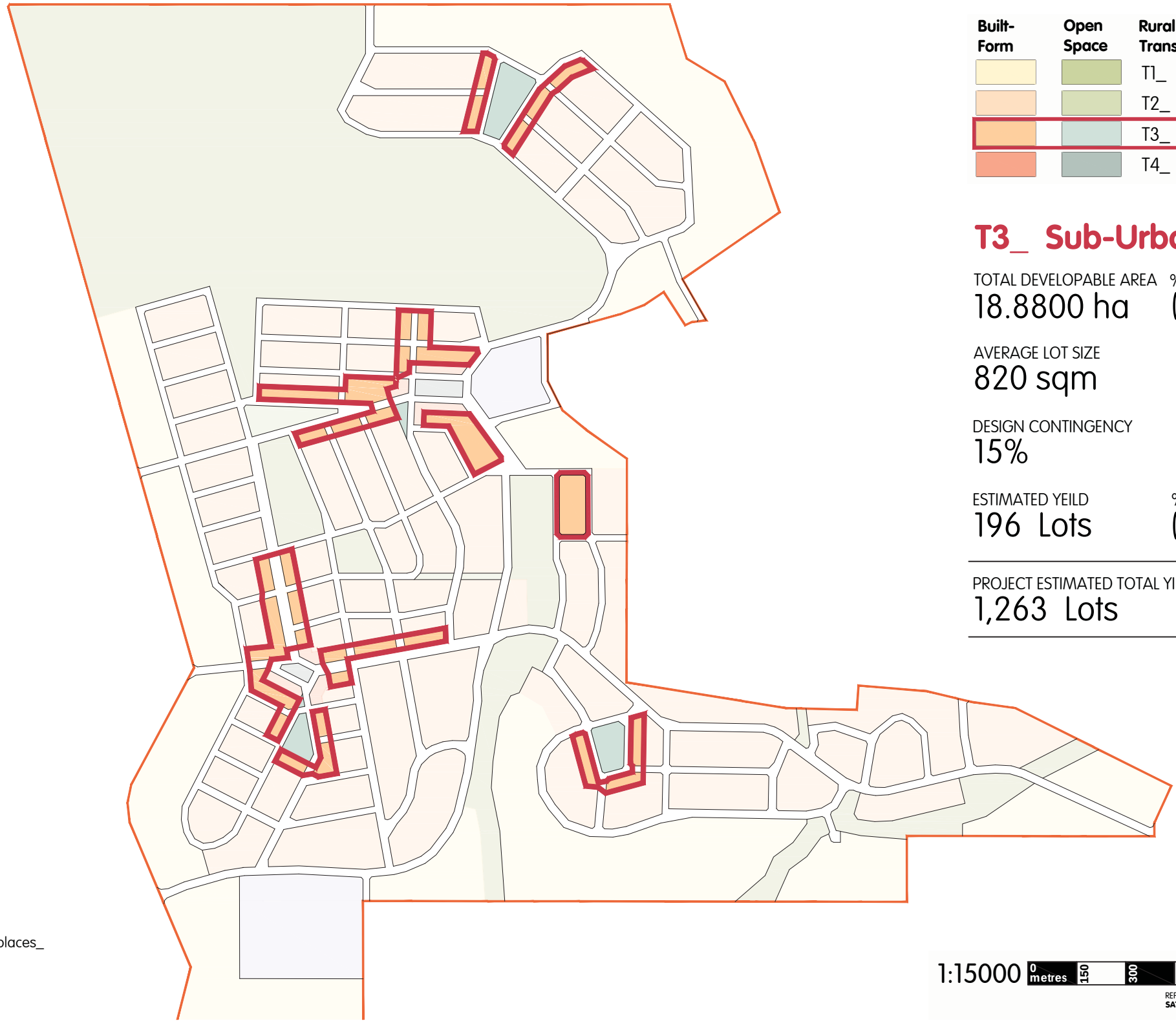
Stoneville

1:15000

0 metres 150 300 450 600 750

REF NO. SAT STO | DRAW NO. RD1 100 | REV. E



N

Built-Form	Open Space	Rural - Urban Transect
		T1_ Natural Living
		T2_ Semi-Rural
		T3_ Sub-Urban
		T4_ Village Core

T3_ Sub-Urban

TOTAL DEVELOPABLE AREA
18.8800 ha

% of TOTAL AREA
(6.3%)

AVERAGE LOT SIZE
820 sqm

DESIGN CONTINGENCY
15%

ESTIMATED YEILD
196 Lots

% OF TOTAL YIELD
(15.5%)

PROJECT ESTIMATED TOTAL YIELD
1,263 Lots

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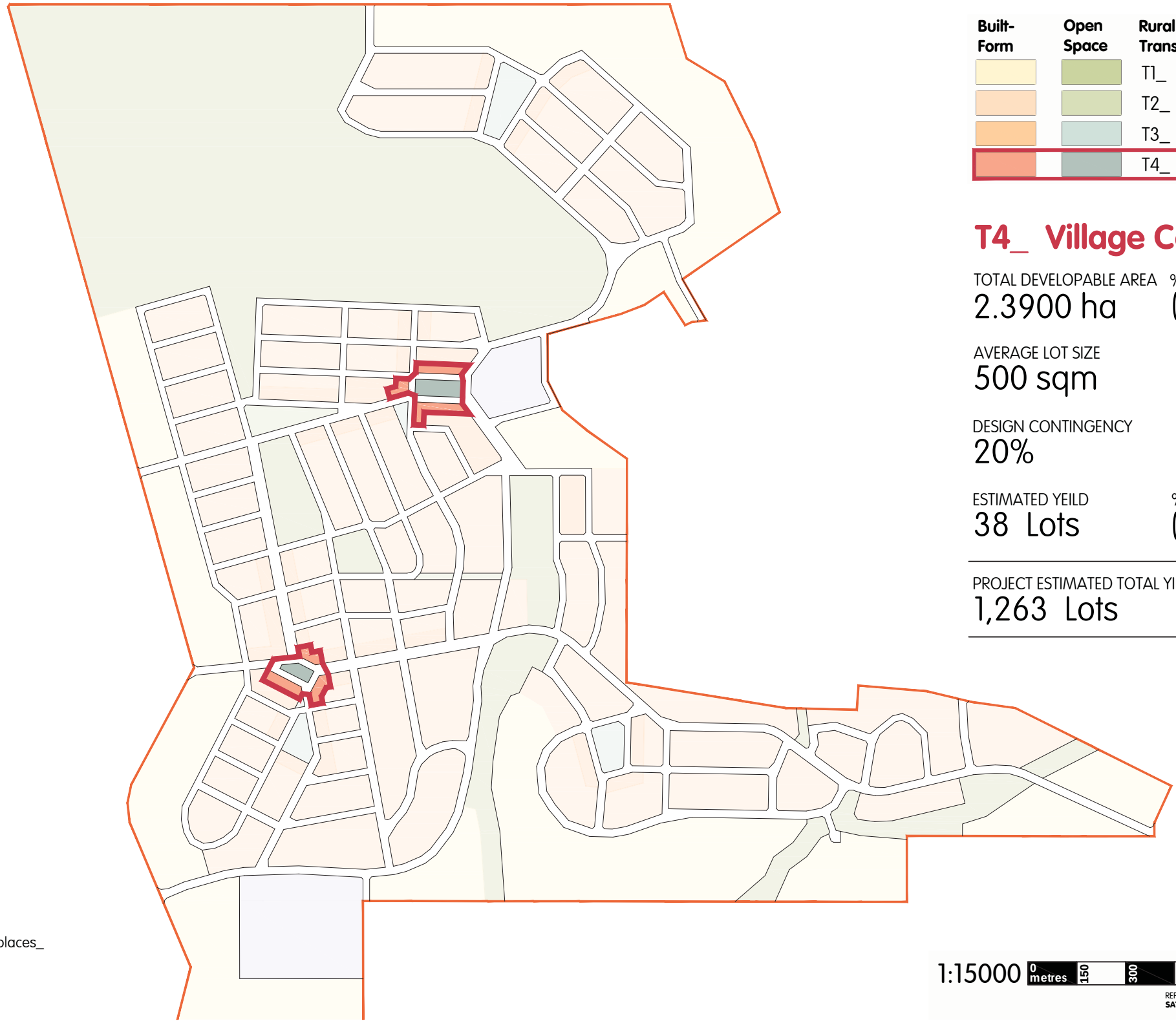
Stoneville

1:15000

0 metres 150 300 450 600 750

REF NO. SAT STO | DRAW NO. RD1 100 | REV. E



N

Built-Form	Open Space	Rural - Urban Transect
		T1_ Natural Living
		T2_ Semi-Rural
		T3_ Sub-Urban
		T4_ Village Core

T4_ Village Core

TOTAL DEVELOPABLE AREA
2.3900 ha

% of TOTAL AREA
(0.8%)

AVERAGE LOT SIZE
500 sqm

DESIGN CONTINGENCY
20%

ESTIMATED YEILD
38 Lots

% OF TOTAL YIELD
(3.0%)

PROJECT ESTIMATED TOTAL YIELD
1,263 Lots

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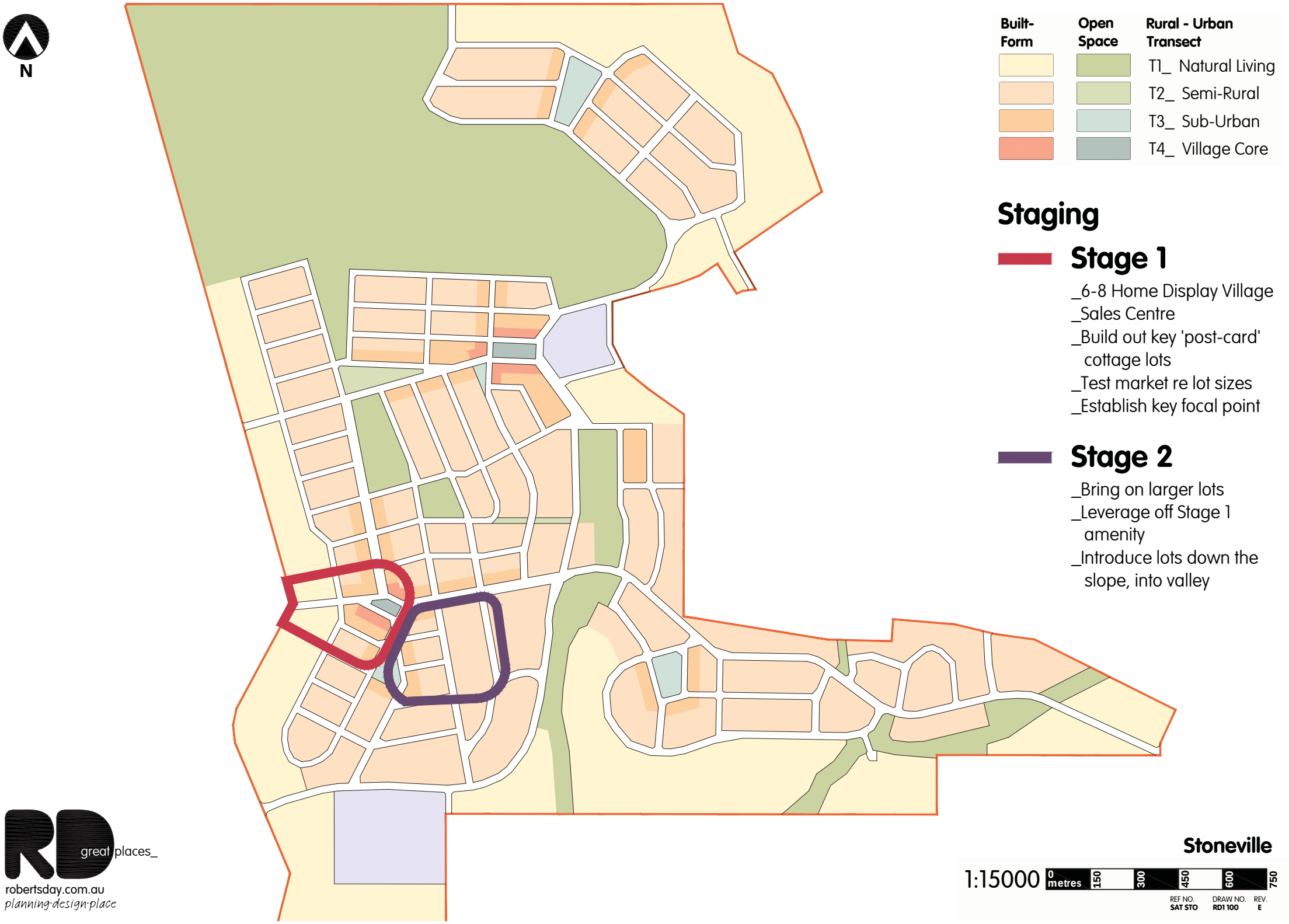
Stoneville

1:15000 0 metres 150 300 450 600 750

REF NO. SAT STO | DRAW NO. RD1 100 | REV. E


N
Built-Form
Open Space
Rural - Urban Transect
T1_ Natural Living
T2_ Semi-Rural
T3_ Sub-Urban
T4_ Village Core
Staging
Stage 1
_6-8 Home Display Village
_Sales Centre
_Build out key 'post-card' cottage lots
_Test market re lot sizes
_Establish key focal point
Stage 2
_Bring on larger lots
_Leverage off Stage 1 amenity
_Introduce lots down the slope, into valley
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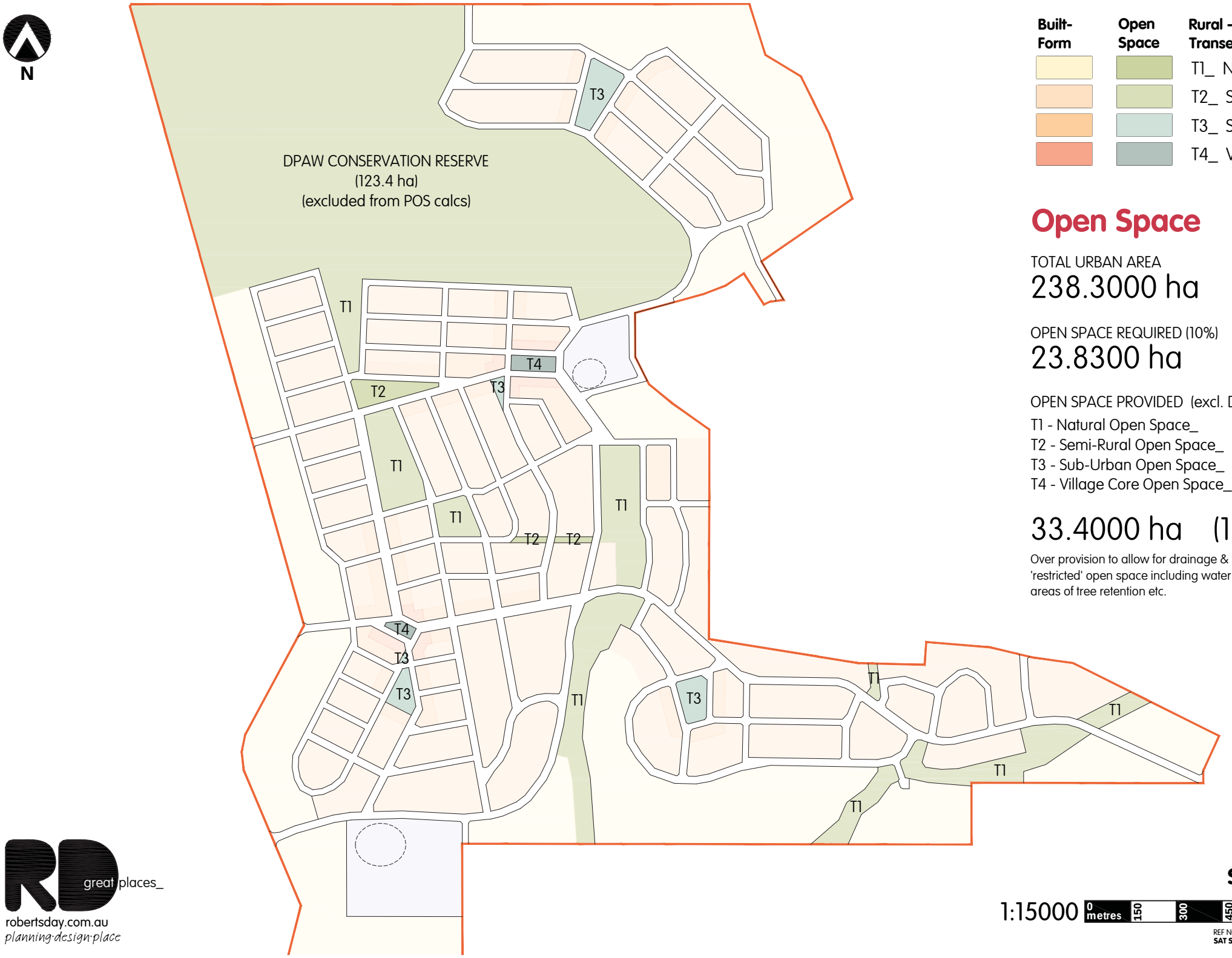
Stoneville
1:15000
0 metres
150
300
450
600
750
REF NO. SAT STO
DRAW NO. RD1 100
REV. E



Built-Form	Open Space	Rural - Urban Transect
		T1_ Natural Living
		T2_ Semi-Rural
		T3_ Sub-Urban
		T4_ Village Core

Open Space

TOTAL URBAN AREA
238.3000 ha

OPEN SPACE REQUIRED (10%)
23.8300 ha

OPEN SPACE PROVIDED (excl. DPAW Reserve)

T1 - Natural Open Space_	26.6 ha
T2 - Semi-Rural Open Space_	1.5 ha
T3 - Sub-Urban Open Space_	4.3 ha
T4 - Village Core Open Space_	1.0 ha

33.4000 ha (14.0%)

Over provision to allow for drainage & high use of 'restricted' open space including water courses, large areas of tree retention etc.

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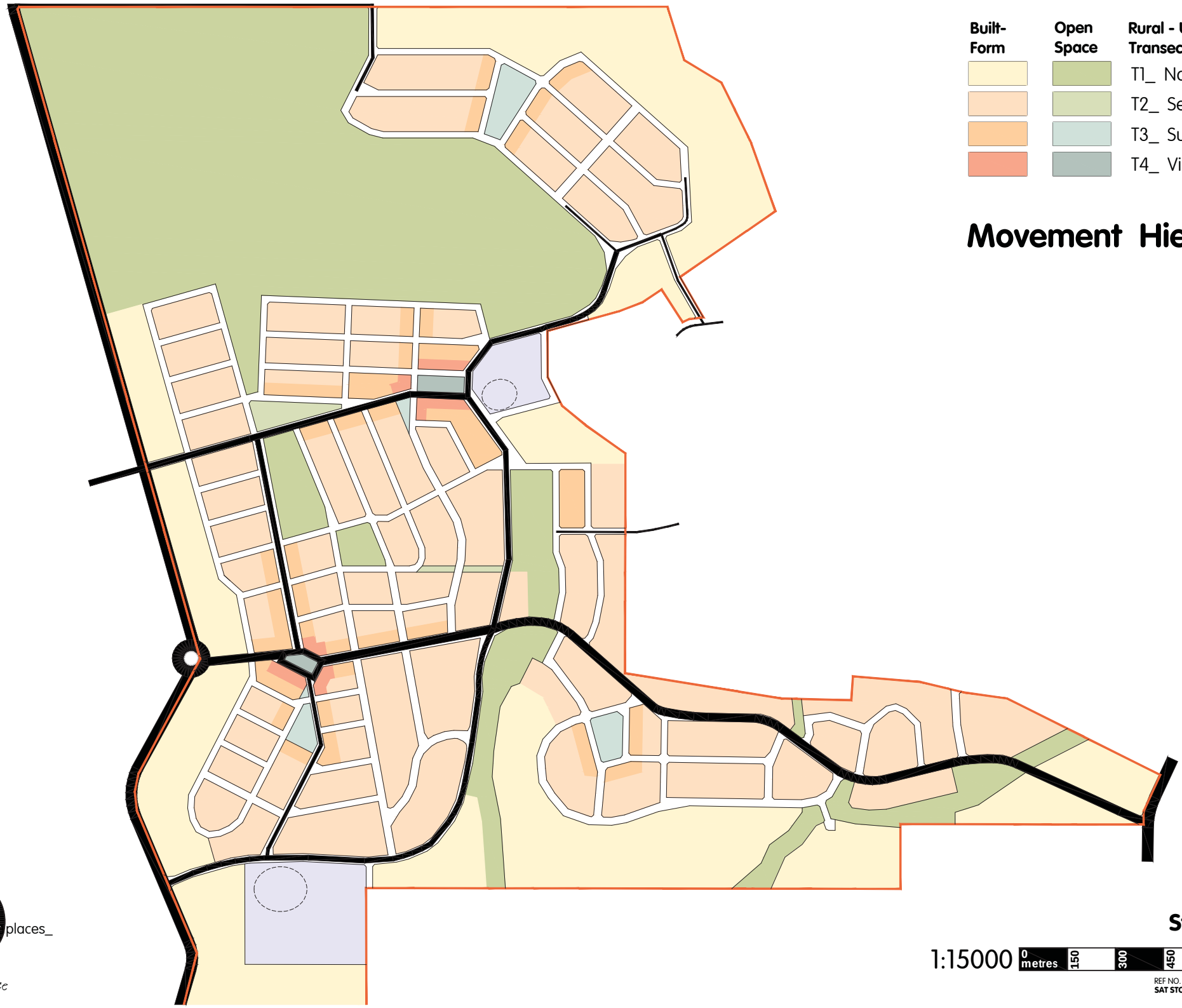
Stoneville

1:15000 0 metres 150 300 450 600 750

REF NO. SAT STO | DRAW NO. RD1 100 | REV. E


N
Built-Form
Open Space
Rural - Urban Transect
T1_ Natural Living
T2_ Semi-Rural
T3_ Sub-Urban
T4_ Village Core
Movement Hierarchy
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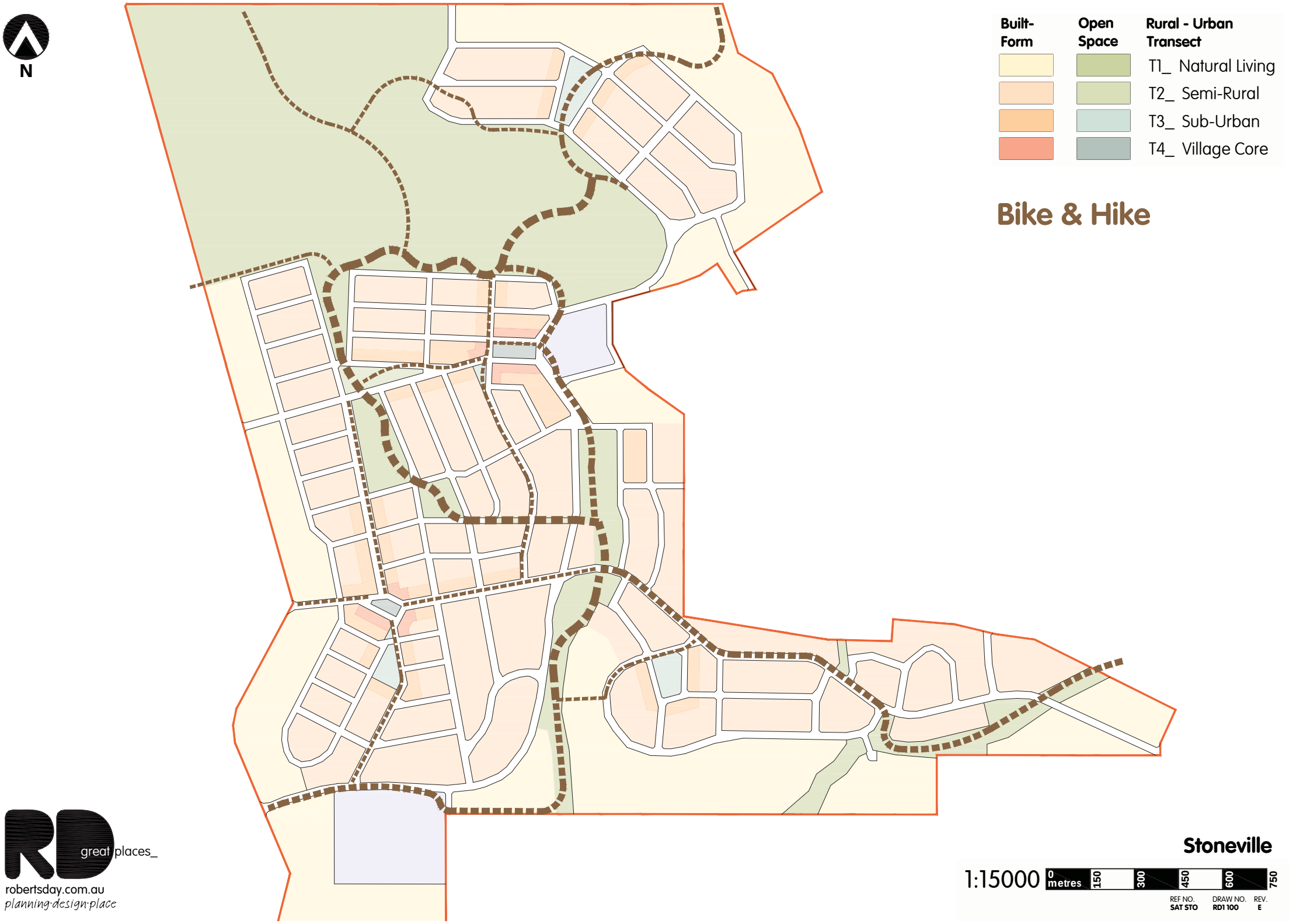
Stoneville
1:15000
0 metres
150
300
450
600
750
REF NO. SAT STO
DRAW NO. RD1 100
REV. E


N
Built-Form
Open Space
Rural - Urban Transect
T1_ Natural Living
T2_ Semi-Rural
T3_ Sub-Urban
T4_ Village Core
Bike & Hike
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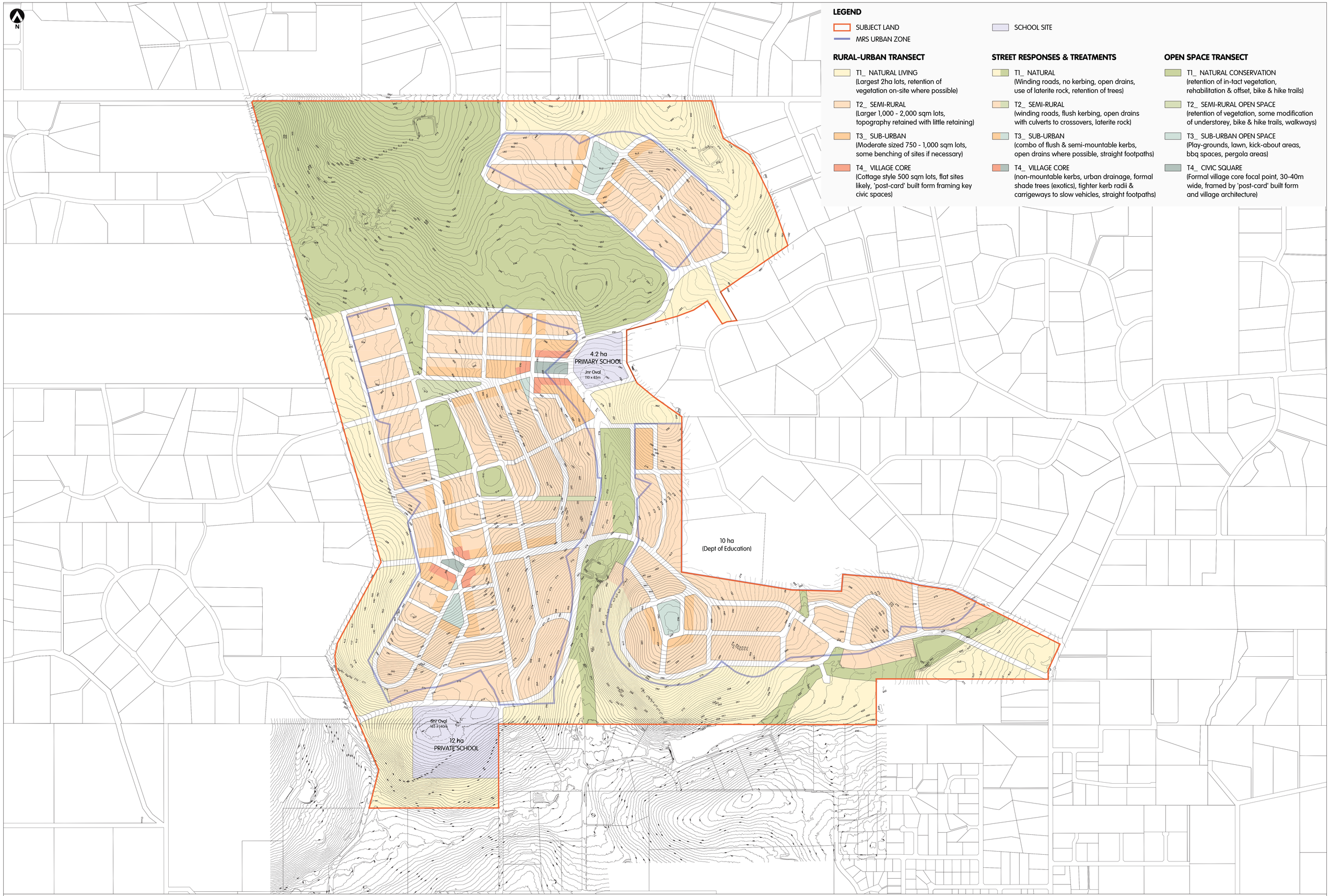
Stoneville
1:15000
0 metres
150
300
450
600
750
REF NO. SAT STO
DRAW NO. RD1 100
REV. E



LEGEND

- SUBJECT LAND
- MRS URBAN ZONE
- SCHOOL SITE

RURAL-URBAN TRANSECT

- T1_ NATURAL LIVING (Largest 2ha lots, retention of vegetation on-site where possible)
- T2_ SEMI-RURAL (Larger 1,000 - 2,000 sqm lots, topography retained with little retaining)
- T3_ SUB-URBAN (Moderate sized 750 - 1,000 sqm lots, some benching of sites if necessary)
- T4_ VILLAGE CORE (Cottage style 500 sqm lots, flat sites likely, 'post-card' built form framing key civic spaces)

STREET RESPONSES & TREATMENTS

- T1_ NATURAL (Winding roads, no kerbing, open drains, use of laterite rock, retention of trees)
- T2_ SEMI-RURAL (winding roads, flush kerbing, open drains with culverts to crossovers, laterite rock)
- T3_ SUB-URBAN (combo of flush & semi-mountable kerbs, open drains where possible, straight footpaths)
- T4_ VILLAGE CORE (non-mountable kerbs, urban drainage, formal shade trees (exotics), tighter kerb radii & carrigeways to slow vehicles, straight footpaths)

OPEN SPACE TRANSECT

- T1_ NATURAL CONSERVATION (retention of in-tact vegetation, rehabilitation & offset, bike & hike trails)
- T2_ SEMI-RURAL OPEN SPACE (retention of vegetation, some modification of understorey, bike & hike trails, walkways)
- T3_ SUB-URBAN OPEN SPACE (Play-grounds, lawn, kick-about areas, bbq spaces, pergola areas)
- T4_ CIVIC SQUARE (Formal village core focal point, 30-40m wide, framed by 'post-card' built form and village architecture)

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DRAFT

SIZE A0
1:5000 at metres 0 100 200 300 400 500

REV	DESCRIPTION	YYMMDD	DRAWN	APP'D
E	WORKSHOP #3 CHANGES	170504	ED	DC
D	ADD LEGEND	170424	ED	DC
C	LARGER CELLS	170413	ED	PC
B	REVISED CONCEPT	170413	ED	PC
A	CONCEPT	170317	ED	RD

Concept Plan
Stoneville Townsite
Shire of Mundaring

REF NO. **SAT STO** DRAW NO. **RD1 100** REV. **E**

DISCLAIMER: ISSUED FOR DESIGN INTENT ONLY. ALL AREAS AND DIMENSIONS ARE SUBJECT TO DETAIL DESIGN AND SURVEY

CAMERON ROAD

ROLAND ROAD

STONEVILLE ROAD

1 IN 2 CUT BATTER

1 IN 2 FILL BATTER

RECYCLED WATER PLANT AREA

VOLUMES FROM 12d MODEL
CUT = 29,500m²
FILL = 4,200m²

FLAT PAD RL 282.0m

1 IN 3 FILL BATTER

DAM CREST RL 300.0m

DAM BASE RL 293.0m

VOLUMES FROM 12d MODEL
CUT = 11,500m²
FILL = 41,500m²
STORAGE VOLUME = 40,000m³

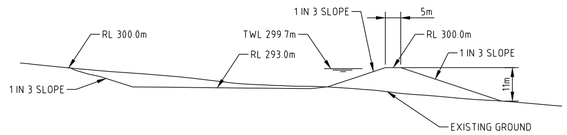
DAM BASE RL 293.0m

1 IN 3 FILL BATTER

VOLUMES FROM 12d MODEL
CUT = 14,100m²
FILL = 36,300m²
STORAGE VOLUME = 40,000m³

DAM CREST RL 300.0m

A
-



SECTION A
1:1000

0m 20 40 60m
1:1000

REV	DATE	DRN	CKD	APP	AMENDMENT
B	22.05.17	AAD	TB		FUTURE SECOND DAM ADDED
A	18.05.17	AAD	TB	T. BOEKEMAN	ISSUED FOR INFORMATION

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CLIENT: SATTERLEY

APPROVED: TROY BOEKEMAN 18.05.17

DESIGNED: AAD

SCALE: 1:1000

PROJECT: STONEVILLE

TITLE: PRELIMINARY RECYCLED WATER FACILITY

WAPC No.: WAPC No.

DRAWING No.: 6198-00-SK6

REVISION: B

ORIGINAL SIZE: A1

P:\6198 Stoneville\6198-00\Acad\6198-00-SK6.dwg, 22/05/2017 4:08:11 PM, aarond, Digital Signing PDF.pc3, 1:1, - CW Reference

Appendix B: Previous Test Pit Reports

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ABN: 64 625 054 729

Table A1: Summary of Test Pits

Coordinates (PCG)		Test Name	Test Depth (m)	Approximate Elevation (m AHD)	Depth of Groundwater (m)	Depth of Hardpan Laterite (m)	Reason for Termination	Stratigraphy
Eastings (m)	Northings (m)							
80807.63	275074.84	TP1	1.0	305	NE	0.6	Refusal	Gravelly Silty SAND AND BOULDERS over HARDPAN LATERITE
80656.22	274926.92	TP2	2.9	305	NE	1.5	Target depth	Gravelly Silty SAND over GRAVEL over HARDPAN LATERITE
80819.96	274925.88	TP3	1.2	305	NE	1.0	Refusal	Gravelly Silty SAND over GRAVEL over HARDPAN LATERITE
80959.48	274927.13	TP4	2.7	305	NE	1.2	Target depth	Gravelly Silty SAND over HARDPAN LATERITE
81106.87	274935.89	TP5	2.5	300	NE	2.1	Target depth	Gravelly Silty SAND over GRAVEL over HARDPAN LATERITE
81254.99	274933.22	TP6	2.9	293	NE	-	Target depth	Silty SAND over SAND over Gravelly SAND, COBBLES AND BOULDERS
81404.14	274926.23	TP7	1.5	290	1.1	1.1	Refusal	Silty SAND over Silty Sandy GRAVEL over HARDPAN LATERITE
80662.09	274788.2	TP8	1.0	305	NE	0.9	Refusal	Sandy Silty GRAVEL over GRAVEL over HARDPAN LATERITE
80817.27	274786.95	TP9	1.0	309	NE	0.8	Refusal	Gravelly Silty SAND AND BOULDERS over HARDPAN LATERITE
80953.35	274778.56	TP10	2.7	308	NE	-	Target depth	Gravelly Silty SAND over GRAVEL AND GRAVEL/COBBLES
81106.41	274782.86	TP11	2.4	301	NE	1.1	Slow excavation	Gravelly Silty SAND over Silty Sandy GRAVEL over HARDPAN LATERITE
81255.76	274781.31	TP12	2.5	294	2.5	1.0	Target depth	Silty SAND over HARDPAN LATERITE
81405.55	274771.31	TP13	2.8	288	2.5	1.5	Target depth	Silty SAND over HARDPAN LATERITE
80808.97	274639.17	TP14	3.0	310	NE	-	Target depth	Gravelly Silty SAND over Clayey Sandy GRAVEL, COBBLES AND BOULDERS
80955.96	274639.39	TP15	0.7	310	NE	0.65	Refusal	SAND/LATERITE BOULDERS over HARDPAN LATERITE
81110.31	274635.04	TP16	1.0	307	NE	1.0	Refusal	Sandy GRAVEL/Gravelly SAND and LATERITE BOULDERS
81252.65	274632.72	TP17	1.0	299	NE	0.7	Refusal	Sandy GRAVEL over HARDPAN LATERITE
81400.61	274640.14	TP18	0.8	292	NE	0.8	Refusal	Sandy GRAVEL over HARDPAN LATERITE
81551.35	274629.38	TP19	1.0	283	NE	0.7	Refusal	Sandy GRAVEL over HARDPAN LATERITE
80801.61	274487.83	TP20	0.5	310	NE	0.2	Refusal	SAND/Gravelly SAND over HARDPAN LATERITE
80957.22	274493.13	TP21	0.4	310	NE	0.2	Refusal	SAND over HARDPAN LATERITE
81105.51	274485.47	TP22	0.9	310	NE	0.9	Refusal	Gravelly SAND and LATERITE BOULDERS
81255.98	274480.36	TP23	0.3	310	NE	0.2	Refusal	SAND/Silty SAND over HARDPAN LATERITE
81398.05	274485.25	TP24	1.0	299	NE	0.9	Refusal	SAND and LATERITE BOULDERS over HARDPAN LATERITE
81552.99	274485.99	TP25	0.5	285	NE	0.3	Refusal	GRAVEL over HARDPAN LATERITE
80956.19	274338.23	TP26	1.3	307	NE	1.1	Refusal	SAND/Silty SAND over Gravelly SAND/Sandy GRAVEL over HARDPAN LATERITE
81102.69	274336.12	TP27	2.9	310	NE	-	Target depth	Gravelly SAND over GRAVEL over Clayey GRAVEL
81253.55	274336.88	TP28	0.7	310	NE	0.5	Refusal	SAND/Gravelly SAND over HARDPAN LATERITE
81395.41	274332.12	TP29	0.7	306	NE	0.5	Refusal	SAND/Silty SAND over HARDPAN LATERITE
81544.48	274334.88	TP30	0.2	292	NE	0.2	Refusal	SAND/Silty SAND over HARDPAN LATERITE
80950.08	274193.09	TP31	0.8	302	NE	0.7	Refusal	SAND/Gravelly SAND over HARDPAN LATERITE
81108.78	274190.29	TP32	0.9	309	NE	0.7	Refusal	SAND/Silty SAND over HARDPAN LATERITE
81250.06	274183.64	TP33	1.2	307	NE	0.8	Refusal	Sandy GRAVEL over HARDPAN LATERITE
81399.81	274189.06	TP34	0.25	303	NE	0.2	Refusal	Gravelly SAND/Sandy GRAVEL
81546.96	274184.51	TP35	0.2	292	NE	0.2	Refusal	SAND/Silty SAND
80951.31	274041.39	TP36	0.8	300	NE	0.4	Refusal	Sandy GRAVEL over HARDPAN LATERITE
81098.37	274035.96	TP37	2.3	303	NE	0.7	Slow excavation	Sandy GRAVEL over HARDPDAN LATERITE over cemented/uncemented Clayey SAND
81246.77	274033.96	TP38	0.5	299	NE	0.3	Refusal	SAND/Gravelly SAND over HARDPAN LATERITE

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Coordinates (PCG)		Test Name	Test Depth (m)	Approximate Elevation (m AHD)	Depth of Groundwater (m)	Depth of Hardpan Laterite (m)	Reason for Termination	Stratigraphy
Eastings (m)	Northings (m)							
81397.42	274029.73	TP39	0.5	291	NE	0.1	Refusal	Gravelly SAND over HARDPAN LATERITE
80949.37	273895.03	TP40	0.8	300	NE	0.55	Refusal	Sandy GRAVEL over HARDPAN LATERITE
81093.85	273885.39	TP41	0.15	300	NE	0.1	Refusal	Gravelly SAND over HARDPAN LATERITE
81245.67	273888.81	TP42	0.5	293	NE	0.3	Refusal	Gravelly Silty SAND over HARDPAN LATERITE
81397.18	273887.02	TP43	1.6	280	NE	1.3	Refusal	Gravelly SAND over GRAVEL over HARDPAN LATERITE
80798.72	273744.34	TP44	0.7	0	NE	0.3	Refusal	Sandy GRAVEL over HARDPAN LATERITE
80941.07	273750.02	TP45	0.5	299	NE	0.3	Refusal	Gravelly SAND over HARDPAN LATERITE
81095.22	273742.01	TP46	0.9	293	NE	0.6	Refusal	Sandy GRAVEL AND LATERITIC BOULDERS over HARDPAN LATERITE
81246.44	273741.55	TP47	0.5	286	NE	0.2	Refusal	Gravelly SAND over HARDPAN LATERITE
81385	273742.24	TP48	1.0	277	NE	0.5	Refusal	Gravelly SAND over Sandy GRAVEL over HARDPAN LATERITE
80799.19	273587	TP49	0.4	292	NE	0.3	Refusal	Silty SAND AND LATERITIC BOULDERS over HARDPAN LATERITE
80941.63	273590.56	TP50	0.4	288	NE	0.1	Refusal	Gravelly Silty SAND over HARDPAN LATERITE
81096.75	273590.42	TP51	1.35	283	NE	0.7	Refusal	Silty SAND over Sandy GRAVEL over HARDPAN LATERITE
81235.04	273600.32	TP52	0.2	282	NE	0.1	Refusal	Gravelly Silty SAND over HARDPAN LATERITE
81392.28	273585.87	TP53	1.2	269	NE	1.0	Refusal	Sandy GRAVEL/GRAVEL over HARDPAN LATERITE
80790.62	273441.21	TP54	2.8	276	NE	2.8	Target depth	Silty SAND over Sandy GRAVEL AND BOULDERS over Clayey SAND
81237.68	273444.85	TP55	1.1	274	NE	1.0	Refusal	GRAVEL over HARDPAN LATERITE
81392.15	273448.04	TP56	1.15	265	NE	1.0	Refusal	GRAVEL over HARDPAN LATERITE
81836.4	274557.97	TP57	2.5	289	NE	0.6	Target depth	GRAVEL over HARDPAN LATERITE over Clayey SAND/Sandy CLAY
81976.44	274393.53	TP58	1.5	284	NE	1.4	Refusal	Silty SAND over GRAVEL and COBBLES over HARDPAN LATERITE
81890.17	274257.3	TP59	2.9	274	2.8	-	Target depth	Silty SAND/Gravelly Silty SAND over HARDPAN LATERITE over Clayey SAND
82004.5	274165.69	TP60	2.9	278	NE	-	Target depth	Silty SAND over Sandy GRAVEL/GRAVEL over Clayey SAND/Sandy CLAY
81943.52	274035.92	TP61	2.5	276	NE	-	Target depth	GRAVEL, possible transition into HARDPAN LATERITE
82027.57	273975.56	TP62	1.3	282	NE	0.9	Refusal	Silty Sandy GRAVEL over HARPDAN LATERITE
81841.04	273916.37	TP63	2.9	280	NE	-	Target depth	Silty Sandy GRAVEL over Weakly Cemented Clayey SAND over Clayey SAND
82021.22	273850.94	TP64	2.9	290	NE	-	Target depth	Silty/Clayey Sandy GRAVEL over Sandy CLAY/CLAY
81810.82	273723.85	TP65	2.6	286	NE	0.8	Target depth	Gravelly SAND over HARDPAN LATERITE
82119.58	273587.06	TP66	0.8	288	NE	0.3	Refusal	Sandy GRAVEL over HARDPAN LATERITE
82204.85	273799.69	TP67	1.5	285	NE	1.2	Refusal	Sandy GRAVEL over HARDPAN LATERITE
82402.88	273814.71	TP68	2.7	274	NE	0.8	Target depth	Silty SAND over Silty Sandy GRAVEL over Weakly Cemented Clayey SAND over Clayey SAND/Sandy CLAY
82441.64	273562.87	TP69	1.5	263	NE	1.3	Refusal	GRAVEL over HARDPAN LATERITE
82499.22	273693.76	TP70	2.8	265	NE	1.0	Target depth	Clayey SAND over GRAVEL over HARDPAN LATERITE over Gravelly CLAY
82665.11	273778.39	TP71	2.9	264	NE	-	Target depth	Clayey SAND over Clayey SAND/Sandy CLAY
82601.75	273599.74	TP72	2.6	260	NE	-	Target depth	Clayey SAND over GRAVEL over Gravelly Sandy CLAY
82773.2	273605.51	TP73	2.8	260	NE	-	Target depth	Silty SAND over GRAVEL & COBBLES and Clayey SAND/Gravelly Clayey SAND
82809.82	273869.52	TP74	2.6	272	NE	-	Target depth	Silty SAND over GRAVEL, COBBLES & BOULDERS over Clayey SAND/Sandy CLAY
82875.32	273756.65	TP75	1.2	267	NE	1.0	Refusal	Sandy GRAVEL over HARDPAN LATERITE
83027.73	273824.8	TP76	0.5	282	NE	0.3	Refusal	Silty Sandy GRAVEL over HARDPAN LATERITE

Coordinates (PCG)		Test Name	Test Depth (m)	Approximate Elevation (m AHD)	Depth of Groundwater (m)	Depth of Hardpan Laterite (m)	Reason for Termination	Stratigraphy
Eastings (m)	Northings (m)							
83275.94	273758.02	TP77	1.2	272	NE	1.0	Refusal	Silty Sandy GRAVEL over HARDPAN LATERITE
81597.55	273769.31	TP78	1.5	260	NE	1.0	Slow excavation	Silty SAND over Gravelly Silty SAND over HARDPAN LATERITE
81793.28	274145.27	TP79	2.7	270	2	-	Target depth	Silty/Clayey SAND over Clayey SAND, Gravelly Clayey SAND and Sandy CLAY/CLAY
81751.19	274855.85	TP80	2.0	285	1.5	1.2	Refusal	SAND/Silty SAND over HARDPAN LATERITE
81027.4	275510.3	TP81	1.2	283	NE	0.9	Refusal	SAND/Silty SAND over Silty/Clayey SAND over HARDPAN LATERITE
82310.62	275355.43	TP82	1.3	282	1.0	1.1	Refusal	Silty SAND over Clayey SAND over HARDPAN LATERITE
81274.36	275856.28	TP83	2.6	283	NE	-	Target depth	SAND over Sandy GRAVEL, Silty SAND and Sandy CLAY
81447.08	275844.01	TP84	2.7	284	NE	-	Target depth	SAND, LATERITE COBBLES AND BOULDERS over SAND/Clayey SAND and Sandy CLAY
81634.12	275781.44	TP85	2.6	279	1.8	-	Target depth	SAND over Clayey SAND
81832.33	275811.11	TP86	2.8	274	NE	-	Target depth	Gravelly Clayey SAND over Sandy CLAY
81446.5	275685.33	TP87	3.0	285	NE	-	Target depth	Silty/Clayey SAND over Clayey Sandy GRAVEL and CLAY
81611.87	275625.17	TP88	2.0	282	NE	2.0	Refusal	Silty/Clayey SAND over LATERITE GRAVEL AND COBBLES
81750.62	275680.85	TP89	0.6	280	NE	0.5	Refusal	Gravelly SAND over HARDPAN LATERITE
81901.87	275679.16	TP90	0.6	283	NE	0.6	Refusal	Gravelly SAND
82048.95	275673.93	TP91	1.7	280	NE	1.7	Refusal	Gravelly SAND and LATERITE BOULDERS
81749.49	275532.59	TP92	0.6	286	NE	0.6	Refusal	SAND/Gravelly SAND
81902.46	275534.55	TP93	1.1	290	NE	1.1	Refusal	Gravelly SAND/Sandy GRAVEL and LATERITE BOULDERS
82044.06	275530.79	TP94	0.7	285	NE	0.5	Refusal	Sandy GRAVEL over HARDPAN LATERITE
82208.26	275522.74	TP95	2.9	279	2.8	-	Target depth	Silty SAND over Clayey SAND over Clayey SAND/Sandy CLAY & LATERITE BOULDERS
82056.82	275371.52	TP96	0.2	289	NE	0.2	Refusal	SAND/Gravelly SAND
80809.7	275925	TP97	2.7	268	NE	-	Target depth	SAND/Silty SAND over LATERITE BOULDERS AND COBBLES
80837.15	275828.22	TP98	2.8	273	NE	0.9	Target depth	Silty/Clayey Sandy GRAVEL over HARDPAN LATERITE over Clayey SAND/Sandy CLAY
80968.92	275830.26	TP99	2.8	273	1.0	-	Target depth	Silty/Clayey SAND over Clayey SAND/Sandy CLAY
80988.05	275930.89	TP100	2.8	272	2.2	-	Target depth	Silty SAND over Sandy GRAVEL over Clayey SAND

Notes: 1 – Coordinates are provided using the Perth Coastal Grid (PCG94) projection system.
1 – Ground elevations have been approximated using the 5-m scale contour mapping presented on the Landgate online aerial imagery.
2 – NE – Not encountered.
3 – Depth of Hardpan Laterite refers to the approximate depth to the surface of well to very well cemented Hardpan. These depths do not take into account weaker and variably cemented hardpan or other layers comprising LATERITEGRAVEL, COBBLES OR BOULDERS.
4 – Refusal occurred on inferred, very well cemented Hardpan Laterite.

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METHOD OF SOIL DESCRIPTION
BOREHOLE AND TEST PIT REPORTS

GRAPHIC LOG & UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) SYMBOLS

Graphic	USCS	Soil Name
		FILL (various types)
		COBBLES
		BOULDERS
	GP	GRAVEL (poorly graded)
	GW	GRAVEL (well graded)
	GC	Clayey GRAVEL
	SP	SAND (poorly graded)
	SW	SAND (well graded)
	SC	Clayey SAND

Graphic	USCS	Soil Name
	SM	Silty SAND
	ML	SILT (low liquid limit)
	MH	SILT (high liquid limit)
	CL	CLAY (low plasticity)
	CI	CLAY (medium plasticity)
	CH	CLAY (high plasticity)
	OL	Organic SILT (low liquid limit)
	OH	Organic SILT (high liquid limit)
	Pt	PEAT

RESISTANCE TO EXCAVATION

Symbol	Term	Description
VE	Very easy	All resistances are relative to the selected method of excavation
E	Easy	
F	Firm	
H	Hard	
VH	Very hard	

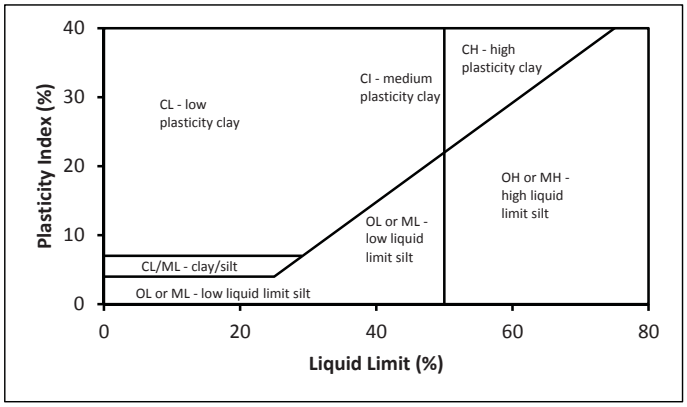
SOIL CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil descriptions are based on AS1726-1993, Appendix A. Material properties are assessed in the field by visual/tactile methods in combination with field testing techniques (where used).

PARTICLE SIZE

Soil Name		Particle Size (mm)
BOULDERS		>200
COBBLES		63 to 200
GRAVEL	Coarse	20 to 63
	Medium	6 to 20
	Fine	2 to 6
SAND	Coarse	0.6 to 2.0
	Medium	0.2 to 0.6
	Fine	0.075 to 0.2
FINES	SILT	0.002 to 0.075
	CLAY	<0.002

PLASTICITY PROPERTIES



MOISTURE CONDITION

AS1726-1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays and silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition and may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726-1993 and HB160-2006

Symbol	Term	Undrained Shear Strength (kPa)	SPT "N"	DCP blows per 100 mm
VS	Very Soft	0 to 12	0 to 2	<1
S	Soft	12 to 25	2 to 4	<1
F	Firm	25 to 50	4 to 8	1 to 2
St	Stiff	50 to 100	8 to 15	3 to 4
VSt	Very Stiff	100 to 200	15 to 30	5 to 10
H	Hard	>200	>30	>10

Symbol	Term	Density Index (%)	SPT "N"	DCP blows per 100 mm	PSP Blows per 300 mm
VL	Very Loose	<15	0 to 4	<1	0 to 2
L	Loose	15 to 35	4 to 10	1 to 2	2 to 6
MD	Medium Dense	35 to 65	10 to 30	2 to 3	6 to 8
D	Dense	65 to 85	30 to 50	4 to 8	8 to 15
VD	Very Dense	>85	>50	>8	>15

Note: PSP correlations only valid to 450 mm depth

Consistency and density may also be inferred from excavation performance and material behaviour.

ROCK STRENGTH, WEATHERING AND DEFECTS

STRENGTH

SYMBOL	STRENGTH	PLI, $I_{s(50)}$	Typical UCS	TYPICAL DESCRIPTORS
EL	Extremely Low	≤0.03	≤0.7	Easily remoulded by hand to form a soil
VL	Very Low	0.03-0.1	0.7-2.4	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; too hard to cut triaxial samples by hand. Pieces up to 30 mm thick can be broken by finger pressure
L	Low	0.1-0.3	2.4-7	Easily scored with a knife; indentations 1-3 mm show in the specimen with firm blows of the pick point; has dull thud under hammer. A piece of core 150 mm long x 50 mm dameter may be broken by hand. Sharp edges of core may be friable and break during handling
M	Medium	0.3-1.0	7-24	Readily scored with a knife; a piece of core 150 mm long x 50 mm diameter can be broken by hand with difficulty
H	High	1.0-3.0	24-70	A piece of core 150 mm long x 50 mm diameter cannot be broken by hand but can be broken by a pick with a single blow; rock rings under hammer
VH	Very High	3.0-10.0	70-240	Hand specimen breaks with pick after more than 1 blow; rock rings under hammer
EH	Extremely High	≥10.0	≥240	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer

PLI: Point Load Index (MPa) UCS: Uniaxial Compressive Strength (MPa)
Note: Rock strength is defined in accordance with PLI. The relationship between PLI and UCS varies depending on rock type, weathering, etc. UCS is typically 24 x $I_{s(50)}$ (may range from 10-30 x $I_{s(50)}$ but possibly lower for carbonate rocks)

WEATHERING

SYMBOL	TERM	TYPICAL DESCRIPTORS
RS	Residual Soil	Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; the soil has not been significantly transported.
EW	Extremely Weathered	The rock has weathered to such an extent that it has 'soil' properties i.e. it either disintegrates or can be remoulded in water. Fabric of original rock still evident.
HW	Highly Weathered	Rock strength is changed by weathering. The whole of the rock mass is discoloured, usually by iron staining or bleaching such that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to deposition of weathering products in pores.
MW	Moderately Weathered	The whole of the rock mass is discoloured, usually by iron staining or bleaching such that the colour of the original rock is not recognisable.
SW	Slightly Weathered	Rock is slightly discoloured but shows little or no change of strength from fresh rock
Fr	Fresh	Rock shows no sign of decomposition or staining

Note: The terms HW and MW are not used by AS 1726. The standard uses the term Distinctly Weathered instead to cover this range of weathering.

ROCK DEFECTS

SYMBOL	DESCRIPTION	COATING / INFILLING		ROUGHNESS		PLANARITY	
J	Joint	Cn	Clean	Sl	Slickensided	Pl	Planar
B	Bedding	St	Stained	Sm	Smooth	Cr	Curved
F	Foliation	Vn	Veneer	Ro	Rough	Un	Undulating
C	Contact	Ct	Coating	VR	Very rough	St	Stepped
Cl	Cleavage					Ir	Irregular
SZ	Shear Zone						
V	Vein						
IS	Infilled seam						
DI	Drilling induced break						

CORE RUN DETAILS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
TCR	Total Core Recovery	RQD	Rock Quality Designation	TOR	Top of Run
SCR	Solid Core Recovery			BOR	Bottom of Run

EXPLANATORY NOTES TO BE READ WITH BOREHOLE AND TEST PIT REPORTS

METHOD OF DRILLING OR EXCAVATION

AC	Air Core	E	Excavator	PQ3	PQ3 Core Barrel
AD/T	Auger Drilling with TC-Bit	EH	Excavator with Hammer	PT	Push Tube
AD/V	Auger Drilling with V-Bit	HA	Hand Auger	R	Ripper
AT	Air Track	HMLC	HMLC Core Barrel	RR	Rock Roller
B	Bulldozer Blade	HQ3	HQ3 Core Barrel	SON	Sonic Rig
BH	Backhoe Bucket	N	Natural Exposure	SPT	Driven SPT
CT	Cable Tool	NMLC	NMLC Core Barrel	WB	Washbore
DT	Diatube	PP	Push Probe	X	Existing Excavation

SUPPORT

T	Timbering

PENETRATION EFFORT (RELATIVE TO THE EQUIPMENT USED)

VE	Very Easy	E	Easy	F	Firm
H	Hard	VH	Very Hard		

WATER

►	Water Inflow	▼	Water Level
◄	Water Loss (complete)		
◁	Water Loss (partial)		

SAMPLING AND TESTING

B	Bulk Disturbed Sample	P	Piston Sample
BLK	Block Sample	PBT	Plate Bearing Test
C	Core Sample	U	Undisturbed Push-in Sample
CBR	CBR Mould Sample		U50: 50 mm diameter
D	Small Disturbed Sample	SPT	Standard Penetration Test
ES	Environmental Soil Sample		Example: 3, 4, 5 N=9
EW	Environmental Water Sample		3,4,5: Blows per 150 mm
G	Gas Sample		N=9: Blows per 300 mm after
HP	Hand Penetrometer		150 mm seating interval
LB	Large Bulk Disturbed Sample	VS	Vane Shear; P = Peak
M	Mazier Type Sample		R = Remoulded (kPa)
MC	Moisture Content Sample	W	Water Sample

ROCK CORE RECOVERY

TCR = Total Core Recovery (%) $= \frac{CRL}{TCL} \times 100$

SCR = Solid Core Recovery (%) $= \frac{CCR}{TCL} \times 100$

RQD = Rock Quality Designation (%) $= \frac{ALC>100}{TCL} \times 100$

TCL	Length of Core Run
CRL	Recovered Length of Core
CCR	Total Length of Cylindrical Pieces of Core Recovered
ALC>100	Total Length of Axial Lengths of Core Greater than 100 mm Long

METHOD OF CEMENTATION CLASSIFICATION
BOREHOLE AND TEST PIT REPORTS

Cementation Classification System For Cemented Granular Materials

Cementation Classification	Description
Uncemented	No cementation present
Very weakly Cemented	Near uncemented sand
Weakly Cemented	Very low strength rock, fragments can be crushed between fingers
Moderately Cemented	Low strength rock, easily scratched, generally friable, rock core can be broken by hand
Well Cemented	Medium strength rock, can be scratched with thumbnail, requires substantial hand effort to break core
Very well cemented	Typically high strength rock, cannot be scratched easily, core can be broken with blow from hammer

TEST PIT: TP01

Job Number:	J1701008	**Easting:**	80808 m	**Contractor:**	ANH Contracting	**Date:**	01/02/2017
Client:	Cossill & Webley	**Northing:**	275075 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Gravelly Silty SAND: medium grained, dark brown becoming orange brown, with approximately 30-40% fine sub-angular to rounded gravel, with approximately 20% non-plastic fines, trace roots up to 20 mm diameter to 0.5 m depth, isolated hardpan laterite boulders, low strength, up to 1.0 m long, to 1.0 m depth	M	L	Depth of soil varies from 0.6 m to 1.0 m
			0.5									
	VH		1.0						HARDPAN LATERITE: very high strength, moderately weathered, pale grey mottled orange-brown and dark red, sand sized quartz fragments, inferred laterised residual granite			
			1.5						Hole terminated at 1.00 m Refusal on hardpan LATERITE Groundwater not encountered			
			2.0									
			2.5									
			3.0									
			3.5									
			4.0									
			4.5									
			5.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP02

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	80656 m	**Contractor:**	ANH Contracting	**Date:**	01/02/2017
Client:	Cossill & Webley	**Northing:**	274927 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0 – 0.5					SM	Gravelly Silty SAND: medium grained, dark brown becoming orange-brown, with approximately 30-40% fine grained, sub-angular to rounded gravel, with approximately 20% non-plastic fines, trace rootlets to 0.1 m depth	M	MD	
			0.5 – 1.0					GP-GM	GRAVEL: fine grained, occasionally medium to coarse grained, pale brown, with approximately 10-20% medium sand, with some non-plastic fines		L	
	H		1.0 – 2.5						HARDPAN LATERITE: low strength, very well iron cemented, variably mottled pale grey, dark red-brown and orange-brown, gravel size pisolites and sand/gravel size quartz, isolated zones of pale grey quartz sand/gravel, inferred laterised residual granite			
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP03

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	80820 m	**Contractor:**	ANH Contracting	**Date:**	01/02/2017
Client:	Cossill & Webley	**Northing:**	274926 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0 – 0.5					SM	Gravelly Silty SAND: medium grained, dark brown becoming orange brown, with approximately 30-40% fine to medium grained gravel, with approximately 20% non-plastic fines, trace rootlets to 0.1 m depth, gravel content increasing with depth	M	MD	
			0.5 – 1.0					GP-GM	GRAVEL: fine to medium grained, sub-angular to rounded, pale brown, with approximately 10-20% medium grained sand, with some non-plastic fines			
	VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled pale grey, gravel sized pisolites, sand/gravel sized quartz, inferred laterised residual granite			
			1.5 – 3.0						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP04

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	80959 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274927 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E-VH		0.0 – 0.5					SM	Gravelly Silty SAND: medium grained, dark brown becoming orange-brown, with approximately 30-40% iron cemented gravel, with approximately 20% non-plastic fines, trace rootlets to 0.1 m	M	L - MD	Depth of soil varies from 0.3 m to 1.2 m
E	F		0.5 – 2.5						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown, mottled yellow-brown and orange, gravel sized pisolites, sand sized quartz Becoming very low strength, weakly cemented, friable, yellow-brown mottled dark red-brown, sand sized quartz, excavated as well cemented gravel and cobbles, fine grained gravel and medium to coarse grained sand HARDPAN LATERITE: very low strength, generally weakly cemented, friable, yellow-brown mottled dark red-brown, sand sized quartz, excavated as well cemented gravel and cobbles, fine grained gravel and medium to coarse grained sand Becoming very low strength, weakly cemented, friable, yellow-brown mottled dark red-brown, sand sized quartz, excavated as well cemented gravel and cobbles, fine grained gravel and medium to coarse grained sand			
			2.5 – 3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP05

Job Number:	J1701008	**Easting:**	81107 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274936 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0					SM	Gravelly Silty SAND and LATERITE BOULDERS: medium grained, dark brown becoming orange-brown, with approximately 30% fine and medium grained gravel, with approximately 20% non-plastic fines, contains very well cemented LATERITE BOULDERS up to 1.5 m in diameter	M	L	Depth of soil varies from 0.6 m to 1.5 m
			0.5		B(TP05-01)			GP	GRAVEL: fine to coarse grained ferruginous pisolitic gravel, yellow-brown to pale brown, with some medium grained sand, trace fines, trace cobbles up to 150 mm in diameter		L - MD	
	E		1.0									
			1.5						Yellow-brown, with some low plasticity fines			
			2.0						HARDPAN LATERITE: very low to low strength, well iron cemented, pale grey mottled dark red-brown and orange-brown			
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP06

Job Number:	J1701008	**Easting:**	81255 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274933 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained quartz sand, dark brown to 0.1 m becoming orange-brown, with approximately 20% non-plastic fines, some fine grained gravel	D - M	VL	
			0.5					SP-SM	SAND: medium to coarse grained quartz sand, yellow brown, with some fine grained gravel, some non-plastic fines			
			1.0									
			1.5					SP	Gravelly SAND: medium to coarse grained quartz sand, pale grey, with approximately 30-40% medium to coarse grained, low strength, very well iron cemented gravel, cobbles and boulders of HARDPAN LATERITE, up to 0.3 m in size		L	
			2.0									
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP07

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81404 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274926 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, brown, trace rootlets to 0.1 m, with approximately 30% non-plastic fines, trace fine to coarse grained gravel			
			0.5					GM	Silty Sandy GRAVEL: fine to coarse grained iron cemented gravel, yellow-brown, with approximately 30% medium to coarse grained sand, with approximately 10-15% non-plastic fines	M	L	
	VH	Slow inflow	1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled orange-brown, gravel sized pisolites			
			1.5						Hole terminated at 1.50 m Refusal on hardpan laterite Groundwater encountered at 1.1 m			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP08

Job Number:	J1701008	**Easting:**	80662 m	**Contractor:**	ANH Contracting	**Date:**	01/02/2017
Client:	Cossill & Webley	**Northing:**	274788 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0		B(TP08-01)			SM	Gravelly Silty SAND: medium grained, dark brown becoming orange-brown, with approximately 30-40% fine to coarse grained pisolitic gravel, with approximately 15-20% non-plastic fines, trace rootlets to 0.1 m	M	L	
			0.5					GP	GRAVEL: medium grained, rounded, pisolitic gravel, pale brown, trace sand			
	VH		1.0						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled pale grey and orange-brown, gravel sized pisolites, sand sized quartz			
			1.5						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP09

Job Number:	J1701008	**Easting:**	80817 m	**Contractor:**	ANH Contracting	**Date:**	01/02/2017
Client:	Cossill & Webley	**Northing:**	274787 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0 – 0.5						HARDPAN LATERITE and Gravelly Silty SAND: Laterite excavated as very well cemented boulders up to 1.2 m in size, Gravelly Silty SAND is medium grained, dark brown becoming orange-brown, with approximately 30-40% fine grained gravel, with approximately 20% non-plastic fines, trace roots	M		
	VH		0.5 – 1.0						HARDPAN LATERITE: high strength, very well iron cemented, gravel sized pisolites, sand and gravel sized quartz, inferred laterised residual granite			
			1.0 – 1.5 – 2.0 – 2.5 – 3.0						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP10

Job Number:	J1701008	**Easting:**	80953 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274779 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0		B(TP10-01)			SM	Gravelly Silty SAND: medium grained, dark brown becoming orange-brown, with approximately 30-40% fine grained gravel, with approximately 20-30% non-plastic fines, trace rootlets to 0.1 m	M	VL	
			0.5		B(TP10-02)			GP	GRAVEL: fine to medium grained ferruginous pisolitic, pale brown, with some medium grained sand, trace fines			
	E		1.0						GRAVEL and COBBLES: weakly cemented, excavated as fine to coarse grained lateritic gravel and cobbles, containing gravel sized pisolitic and sand sized quartz, very well cemented, cobbles up to 200 mm diameter, pale yellow-brown, with some medium grained sand, trace fines			
			1.5									
			2.0					GP	Gravel and cobbles becoming weakly cemented and very low strength, quartz component increasing, friable			
			2.5									
			3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP11

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Job Number:	J1701008	**Easting:**	81106 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274783 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0 – 0.5					SM	Gravelly Silty SAND: medium grained, dark brown, with approximately 30-40% fine grained gravel, with approximately 20% non-plastic fines, trace rootlets to 0.1 m	M	L - MD	
			0.5 – 1.0					GM	Silty Sandy GRAVEL: fine and occasionally medium grained iron cemented, with approximately 30-40% medium grained sand, with approximately 20% non-plastic fines		L	
	H		1.0 – 1.5						HARDPAN LATERITE: low strength, very well iron cemented, dark red-brown mottled yellow-brown and orange-brown, gravel sized ferruginous pisolites, sand sized quartz, with zones of Silty Sandy GRAVEL			
	F-H		1.5 – 2.0						Very low strength, moderately to well cemented, yellow-brown			
			2.0 – 2.5						Hole terminated at 2.40 m Stopped due to slow excavation Groundwater not encountered			
			2.5 – 3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP12

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Job Number:	J1701008	**Easting:**	81256 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274781 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0 – 0.5					SM	Silty SAND: medium to coarse grained, brown, with approximately 20-30% non-plastic fines, with some fine iron cemented gravel, trace rootlets, ranging from 1.0 m to 1.3 m in thickness	M	L - MD	
											VL	
	H		1.0 – 2.5						HARDPAN LATERITE: typically low strength, very well iron cemented, variably mottled dark red-brown, orange-brown and pale grey, pale grey zones are friable, pisolitic, sand sized quartz			
		▼	2.5						Hole terminated at 2.50 m Target depth Groundwater encountered at 2.5 m			
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP13

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81406 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274771 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown to 0.1 m, becoming orange-brown, with approximately 20% non-plastic fines, trace rootlets to 0.1 m, trace fine grained gravel	M	L	
			0.5									
			1.0						Yellow-brown, trace fine to coarse grained gravel			
	H		1.5						HARDPAN LATERITE: low strength, very well iron cemented, dark red-brown mottled yellow-brown and pale grey, gravel sized ferruginous pisolites, sand sized quartz with zones of pale grey sand			
			2.0									
		Strong Inflow	2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater encountered at 2.5 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP14

Job Number:	J1701008	**Easting:**	80809 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274639 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0					SM	Gravelly Silty SAND and HARDPAN LATERITE BOULDERS: medium grained sand, fine grained ferruginous pisolitic gravel, becoming medium grained with depth, dark brown to 0.1 m becoming orange-brown, with approximately 20% non-plastic fines, very well cemented HARDPAN LATERITE BOULDERS up to 1.5 m in size, trace rootlets to 0.1 m	M		Density could not be assessed
			0.5									
			1.0					GC	Clayey Sandy GRAVEL and HARDPAN LATERITE COBBLES and BOULDERS: fine to coarse grained iron cemented gravel, yellow-brown, with approximately 30% fine to coarse grained sand, with approximately 15% low plasticity fines, very well cemented HARDPAN LATERITE COBBLES and BOULDERS			
			1.5									
			2.0									
			2.5									
			3.0						Hole terminated at 3.00 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP15

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Job Number:	J1701008	**Easting:**	80956 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274639 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0					SP-SM	SAND: medium to coarse grained, dark grey-brown becoming brown, with some fine to medium grained pisolitic gravel, with some non-plastic fines, isolated very well cemented LATERITE BOULDERS, trace large roots	D - M	L	
	VH		0.5						HARDPAN LATERITE: medium strength, very well iron cemented yellow-brown mottled orange and red-brown, ferruginous pisolites, minor carbonate cementation			
			1.0						Hole terminated at 0.70 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP16

Job Number:	J1701008	**Easting:**	81110 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274635 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0 – 0.5					SP-GP	Sandy GRAVEL/Gravelly SAND and LATERITE BOULDERS: medium to coarse grained sand, fine to medium grained pisolitic gravel, dark grey-brown becoming orange-brown, with some non-plastic fines trace large roots to 0.5 m, very well cemented LATERITE BOULDERS	D - M	L	
			1.0						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP17

Job Number:	J1701008	**Easting:**	81253 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274633 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.1 m becoming brown and pale brown, with approximately 30 to 40% medium to coarse grained sand, with some non-plastic fines	M	L	
	H-VH		0.5						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolitic sand sized quartz			
			1.0						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP18

Job Number:	J1701008	**Easting:**	81401 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274640 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					GP	Sandy GRAVEL: fine to medium grained, sub-angular to rounded, pisolitic gravel, dark grey to 0.1 m, becoming pale brown, with approximately 30-40% medium to coarse grained sand	M	L - MD	
			1.0 – 1.5 – 2.0 – 2.5 – 3.0						Hole terminated at 0.80 m Refusal on high strength HARDPAN LATERITE Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP19

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Job Number:	J1701008	**Easting:**	81551 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274629 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark brown to 0.1 m becoming yellow-brown, with approximately 30 to 40% medium to coarse grained sand,with some non-plastic fines, trace cobbles, trace rootlets to 0.1 m	M	L - MD	
			0.5									
	H-VH								HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized pisolites, sand sized quartz			
			1.0						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP20

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Job Number:	J1701008	**Easting:**	80802 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274488 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F		0.0					SP-SM	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown becoming grey-brown, with approximately 30% fine grained pisolitic gravel, with some non-plastic fines	D	L	Average depth of Gravelly SAND varies between 0.1 m and 0.3 m Numerous laterite outcrops at surface
	VH								HARDPAN LATERITE: medium strength, very well iron cemented, yellow-brown mottled dark red-brown, ferruginous pisolites, minor carbonate cementation			
			0.5						Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP21

Job Number:	J1701008	**Easting:**	80957 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274493 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VH		0.0					SP-SM	SAND: medium to coarse grained, grey-brown, with some fine grained pisolitic gravel, with some non-plastic fines	D - M	L	Numerous laterite outcrops exposed at surface
									HARDPAN LATERITE: medium strength, very well iron cemented, yellow-brown mottled dark red-brown and orange-brown, ferruginous pisolites, sand sized quartz			
			0.5						Hole terminated at 0.40 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP22

Job Number:	J1701008	**Easting:**	81106 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274485 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VH		0.0 – 0.5					SP	Gravelly SAND and LATERITE BOULDERS: medium to coarse grained, grey-brown becoming brown, with approximately 30% fine grained pisolitic gravel, very well cemented LATERITE BOULDERS up to 1.2 m in size, trace large roots	D - M	L	
			1.0 – 3.0						Hole terminated at 0.90 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP23

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Job Number:	J1701008	**Easting:**	81256 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274480 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, grey-brown, with approximately 10-15% non-plastic fines, with some fine to coarse grained gravel, trace rootlets and roots	D - M	L	
	VH								HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown, ferruginous pisolites			
			0.5						Hole terminated at 0.30 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP24

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Job Number:	J1701008	**Easting:**	81398 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274485 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0 – 0.5					SP	SAND and LATERITE BOULDERS: medium to coarse grained sand, grey-brown, with some fine to coarse grained gravel, very well cemented LATERITE BOULDERS up to 1.2 m in size, trace large roots to 0.7 m	D - M	L	
			1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, ferruginous pisolites			
			1.5						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP25

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Job Number:	J1701008	**Easting:**	81553 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274486 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP	GRAVEL: fine to medium grained, sub-rounded to sub-rounded, pisolitic, dark brown to 0.1 m becoming pale brown, with some medium to coarse grained sand, trace non-plastic fines, trace rootlets to 0.1 m	M	MD	
	VH		0.5						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized pisolites			
									Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP26

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Job Number:	J1701008	**Easting:**	80956 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274338 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, dark grey-brown, with approximately 10-15% non-plastic fines, with some fine to coarse grained pisolitic gravel, trace roots, isolated very well cemented LATERITE BOULDERS	D - M	L	
			0.5					SP-GP	Gravelly SAND/Sandy GRAVEL: fine to medium grained pisolitic gravel, medium to coarse grained sand, with some non-plastic fines, isolated very well cemented LATERITE BOULDERS			
	VH		1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown, ferruginous pisolites			
			1.5						Hole terminated at 1.30 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP27

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Job Number:	J1701008	**Easting:**	81103 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274336 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	Gravelly SAND: medium to coarse grained, grey-brown, with approximately 40-50% fine to medium grained pisolitic gravel, with some non-plasticity fines, trace large roots, isolated very well cemented LATERITE BOULDERS	D	L	
			0.5									
	E-F		1.0					GP-GC	GRAVEL: fine to coarse grained, very well cemented lateritic, yellow-brown and red-brown, with some medium to coarse grained sand, with some medium plasticity fines		MD	
			1.5									
			2.0					GC	Clayey GRAVEL: fine to coarse grained, very well cemented lateritic, with approximately 20-30% medium plasticity fines, with some medium to coarse grained sand	M		
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP28

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Job Number:	J1701008	**Easting:**	81254 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274337 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown becoming brown, with approximately 30% fine to medium grained pisolitic gravel, with some non-plastic fines, trace to some large roots	D - M	L	Average depth of Gravelly SAND recorded; depth varies from 0.3 m to 0.7 m
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled orange-brown			
			1.0						Hole terminated at 0.70 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP29

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Job Number:	J1701008	**Easting:**	81395 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274332 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, grey-brown, with approximately 10-15% non-plastic fines, with some fine grained pisolitic gravel, trace to some rootlets and roots	D - M	L	Average depth recorded; depth of Gravel varies from 0.3 m to 0.7 m
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, ferruginous pisolites			
			1.0						Hole terminated at 0.70 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP30

Job Number:	J1701008	**Easting:**	81544 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274335 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, grey-brown, with approximately 10-15% non-plastic fines, with some fine to medium grained pisolitic gravel	D - M	L	Average depth of Gravel recorded; depth varies from 0.1 m to 0.4 m. Numerous laterite outcrops exposed.
									Hole terminated at 0.20 m Refusal on hardpan laterite Groundwater not encountered			
			0.5									
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP31

Job Number:	J1701008	**Easting:**	80950 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274193 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
	E		0.0 – 0.5					SP	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown to 0.2 m, becoming orange-brown, with approximately 30% fine to medium grained pisolitic gravel, isolated very well cemented LATERITE BOULDERS	D - M	L	
	VH		0.5 – 1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown, ferruginous pisolites, sand sized quartz			
			1.0 – 1.5 – 2.0 – 2.5 – 3.0						Hole terminated at 0.80 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP32

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Job Number:	J1701008	**Easting:**	81109 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274190 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					SP-SM	SAND/Silty SAND: medium to coarse grained, dark grey-brown becoming brown, with approximately 10-15% non-plastic fines, with some fine to medium grained pisolitic gravel, isolated very well cemented LATERITE BOULDERS, trace to some large roots	D - M	L	Average depth of gravel recorded depth varies between 0.5 m and 1.0 m. Numerous laterite outcrops at surface.
	VH		0.5 – 1.0						HARDPAN LATERITE: medium strength, very well iron cemented, yellow-brown mottled orange-brown and dark red-brown, gravel sized pisolites			
			1.0						Hole terminated at 0.90 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	81250 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274184 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.2 m becoming brown to orange-brown, with some non-plastic fines, with approximately 30 to 40% medium to coarse grained sand, trace roots to 1.0 m, isolated very well cemented LATERITE BOULDERS	D - M		Average depth of gravel recorded. Depth of gravel varies between 0.6 m and 1.0 m. Numerous laterite outcrops exposed at surface.
	H-VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, yellow-brown mottled dark red-brown, ferruginous pisolites, isolated zones of weaker cementation			
			1.5						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	81400 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274189 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E VH		0.0					SP-GP	Gravelly SAND/Sandy GRAVEL: fine to medium grained pisolitic gravel, medium to coarse grained sand, dark grey-brown becoming grey-brown, with some fines	D - M	L	
									HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown, ferruginous pisolites			
			0.5						Hole terminated at 0.25 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	81547 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274185 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, grey-brown, with approximately 10-15% non-plastic fines, trace rootlets and small roots	D - M	L	
									Hole terminated at 0.20 m Refusal on hardpan laterite Groundwater not encountered			
			0.5									
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	80951 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274041 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown becoming brown, with approximately 40 to 50% medium to coarse grained sand, with some non-plastic fines, isolated boulders of very well cemented LATERITE	D - M	L	Numerous laterite outcrops at surface
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown, ferruginous pisolites			
			1.0						Hole terminated at 0.80 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	81098 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	274036 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to coarse grained pisolitic gravel, dark grey-brown to 0.2 m becoming pale brown, with approximately 30 to 40% medium to coarse grained sand, with some non-plastic fines, isolated very well iron cemented boulders up to 0.3 m in size	D	L - MD	
			0.5									
	H		1.0						HARDPAN LATERITE: low strength, well iron cemented, mottled yellow-brown, orange-brown and dark red-brown, gravel sized pisolites			
			1.5						Becoming variably cemented and friable, with clayey zones, transitioning into desiccated Clayey SAND			
			2.0									
			2.5						Hole terminated at 2.30 m Stopped due to slow excavated through cemented clayey soils Groundwater not encountered			
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	81247 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	274034 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0					SP	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown becoming brown, with approximately 20 to 40% fine to coarse grained pisolitic gravel, isolated very well cemented LATERITE BOULDERS extending to 0.3 m to 0.5 m depth	M	L	
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
									Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP39

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Job Number:	J1701008	**Easting:**	81397 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	274030 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	Gravelly SAND: medium to coarse grained, dark grey-brown becoming pale brown, with approximately 30-40% fine to medium grained pisolitic gravel	D - M	L	
	VH								HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites and sand sized quartz			
			0.5						Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP40

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	80949 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	273895 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.3 m becoming pale brown, with approximately 30 to 40% medium to coarse grained sand, with some non-plastic fines, trace to some roots and rootlets to 0.5 m	D - M	L	Average depth of gravel recorded depth varies from 0.3 m to 0.8 m. Numerous laterite outcrops at surface.
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red mottled yellow-brown and orange-brown, ferruginous pisolites			
			1.0						Hole terminated at 0.80 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP41

Job Number:	J1701008	**Easting:**	81094 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273885 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VH		0.0					SP	Gravelly SAND: medium to coarse grained, grey-brown, with approximately 30-40% fine to medium grained pisolitic gravel, trace roots and rootlets	M		Numerous laterite outcrops at surface.
									HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites, sand sized quartz			
			0.5						Hole terminated at 0.15 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP42

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Job Number:	J1701008	**Easting:**	81246 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273889 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F		0.0					SM	Gravelly Silty SAND: medium to coarse grained, dark grey, with approximately 30-40% fine grained pisolitic gravel, with some roots and rootlets, trace very well iron cemented LATERITE BOULDERS	M	L	
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
			1.0						Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP43

Job Number:	J1701008	**Easting:**	81397 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273887 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP43-01)			SP	Silty Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey brown, approximately 20-40% medium to coarse grained sand, trace rootlets and roots	D		
			0.5					GP-GM	GRAVEL: fine to medium grained pisolitic gravel, pale brown to orange-brown, with some non-plastic fines	M	L	
	VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled yellow-brown and orange-brown, gravel sized ferruginous pisolites			
			1.5						Hole terminated at 1.60 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP44

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Job Number:	J1701008	**Easting:**	80799 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	273744 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown becoming brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, trace to some rootlets and roots	D - M	L	
	H-VH		0.5						HARDPAN LATERITE: low to medium strength, very well iron cemented, yellow-brown mottled dark red-brown, ferruginous pisolites, isolated zones of weaker cementation			
			1.0						Hole terminated at 0.70 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP45

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	80941 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273750 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F		0.0					SP-SM	Gravelly SAND: medium to coarse grained, dark grey-brown becoming pale brown, with approximately 30-40% fine to medium grained pisolitic gravel, with some non-plastic fines, trace very well cemented LATERITE BOULDERS	M	L	Numerous laterite outcrops exposed.
	VH		0.5						HARDPAN LATERITE: medium strength, very well iron cemented, mottled yellow-brown, orange-brown and dark red-brown, sand sized quartz			
									Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP46

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81095 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273742 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0					GP-GM	Sandy GRAVEL and LATERITE BOULDERS: fine to medium grained pisolitic gravel, dark grey-brown to 0.1 m becoming pale brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, very well iron cemented LATERITE BOULDERS up to 0.35 m in size	D - M	L - MD	Depth of soil varies from 0.5 m to 0.7 m
	VH		0.5						HARDPAN LATERITE: typically medium strength, very well iron cemented with some occasionally moderately cemented zones, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
			1.0						Hole terminated at 0.90 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP47

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81246 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273742 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	Gravelly SAND: medium to coarse grained, dark grey-brown, with approximately 30-40% fine to medium grained pisolitic gravel, with some non-plastic fines, trace roots	D - M	L	Depth of gravelly sand varies from 0.2 m to 0.4 m
	VH								HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled orange-brown and yellow-brown, gravel sized ferruginous pisolites			
			0.5						Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP48

Job Number:	J1701008	**Easting:**	81385 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273742 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F		0.0					SP-SM	Gravelly SAND: medium to coarse grained, dark grey-brown becoming pale brown and orange-brown, with approximately 30-40% fine to medium grained pisolitic gravel, with some non-plastic fines, trace very well iron cemented LATERITE BOULDERS	M	L	Depth of soil varies from 0.5 m to 1.0 m
			0.5					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, orange-brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, trace roots			
	H-VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
			1.5						Hole terminated at 1.00 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP49

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Job Number:	J1701008	**Easting:**	80799 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273587 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0					SM	Silty SAND and LATERITE BOULDERS: medium to coarse grained, dark grey-brown becoming brown, with approximately 15% non-plastic fines, with some fine to medium grained pisolitic gravel, high strength, very well iron cemented LATERITE BOULDERS, trace roots	M	L	Numerous laterite outcrops exposed.
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown and orange-brown, gravel sized ferruginous pisolites, sand sized quartz			
			1.0						Hole terminated at 0.40 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP50

Job Number:	J1701008	**Easting:**	80942 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273591 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E VH		0.0					SM	Gravelly Silty SAND: medium to coarse grained, dark grey-brown becoming orange-brown, with approximately 30-40% fine to medium grained pisolitic gravel, with approximately 15% non-plastic fines, trace rootlets	D	L	Numerous laterite outcrops exposed Depth of soil varies from 0.1 m to 0.4 m
			0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous cemented pisolites			
			1.0						Hole terminated at 0.40 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP51

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Job Number:	J1701008	**Easting:**	81097 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273590 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 15-20% non-plastic fines, with some fine to medium grained pisolitic gravel, trace small roots	D	L - MD	
			0.5					GP	Sandy GRAVEL: fine to medium grained pisolitic gravel, pale brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines			
	H-VH		1.0						HARDPAN LATERITE: typically medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown and orange-brown, with occasional moderately cemented zones, gravel sized ferruginous pisolites			
			1.5						Hole terminated at 1.35 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP52

Job Number:	J1701008	**Easting:**	81235 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273600 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VH		0.0					SM	Gravelly Silty SAND: medium to coarse grained, dark grey-brown, with approximately 30-40% fine to medium grained pisolitic gravel, with approximately 15% non-plastic fines, trace roots	D	L	Numerous laterite outcrops exposed.
									HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous cemented pisolites, sand sized quartz			
			0.5						Hole terminated at 0.20 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP53

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Job Number:	J1701008	**Easting:**	81392 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273586 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					GP	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.2 m becoming pale brown, with approximately 30 to 40% medium to coarse grained sand, trace roots	D - M	VL	
			0.5 – 1.0					GP-GM	GRAVEL: fine to medium grained pisolitic gravel, pale brown, with some non-plastic fines, trace roots to 0.5 m		L - MD	
	VH		1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous cemented pisolites, sand sized quartz			
			1.5 – 3.0						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP54

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Job Number:	J1701008	**Easting:**	80791 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273441 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 15% non-plastic fines, with some fine to medium grained pisolitic gravel, trace roots up to 40 mm in diameter		L	
			0.5					GP-GM	Sandy GRAVEL and BOULDERS: fine to medium grained pisolitic gravel, pale brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, trace roots to 0.5 m, low strength boulders up to 0.3 m in size		MD	
	F		1.0		B(TP54-01)			SC-CH	Clayey SAND / Sandy CLAY: fine to coarse grained quartz sand, orange-brown mottled pale grey and red-brown, with approximately 30-50% high plasticity fines	M	H	
			1.5						Slickensided in parts			
	F-H		2.0									
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP55

Job Number:	J1701008	**Easting:**	81238 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273445 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP55-01)			GP-GM	GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.5 m becoming pale brown, with some medium to coarse grained sand, with some non-plastic fines, trace roots to 0.5 m Trace medium to coarse grained sand	D	L - MD	
	VH		1.0						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown and orange-brown, gravel sized ferruginous cemented pisolites, sand sized quartz Hole terminated at 1.10 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP56

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Job Number:	J1701008	**Easting:**	81392 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273448 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					GP-GM	GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.7 m becoming pale brown, with some medium to coarse grained sand, with some non-plastic fines, trace roots (typically 10 mm) to 0.5 m	D - M	L - MD	
	VH		1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous cemented pisolites, sand sized quartz			
			1.15						Hole terminated at 1.15 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	81836 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274558 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	GRAVEL: fine to medium grained pisolitic gravel, dark brown to 0.1 m becoming pale brown, with some medium to coarse grained sand, with some non-plastic fines, trace rootlets to 0.1 m, trace roots up to 40 mm in diameter	M	L	
	F-H		0.5						HARDPAN LATERITE: very low strength, weakly to moderately cemented, orange-brown mottled dark red-brown and pale grey, ~~friable, excavated as low plasticity Clayey GRAVEL with low plasticity~~ fines Pale grey mottled orange-brown and dark red-brown, transitioning into desiccated Clayey SAND/Sandy CLAY at depth			
			1.0									
			1.5									
			2.0									
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	81976 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274394 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					SM	Silty SAND: medium to coarse grained, dark grey-brown to 0.1 m, becoming pale brown, with approximately 20% non-plastic fines, with some fine gravel	M	L	
	F		0.5 – 1.0					GP-GM	GRAVEL and COBBLES: medium to coarse grained lateritic gravel and cobbles, with some medium to coarse grained sand, with some non-plastic fines		L - MD	
	VH		1.0 – 1.5						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown			
			1.5 – 2.0						Hole terminated at 1.50 m Refusal on hardpan laterite Groundwater not encountered			
			2.0 – 2.5									
			2.5 – 3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP59

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Job Number:	J1701008	**Easting:**	81890 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274257 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	Slow inflow	0.0					SM	Silty SAND/Gravelly Silty SAND: medium to coarse grained, dark grey-brown to 0.1 m, becoming orange-brown, with approximately 30% non-plastic fines, with approximately 20-40% fine to medium grained gravel	M	L MD	
	H		1.0						HARDPAN LATERITE: low strength, well iron cemented, dark red-brown and yellow-brown, gravel sized pisolites, sand sized quartz			
			1.5					SC	Clayey SAND: medium to coarse grained quartz, off-white mottled dark red-brown and orange-brown, with approximately 40% high plasticity fines, isolated sandier zones,possibly extremely weathered granitic rock		St	
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater encountered at 2.8 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	82005 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274166 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown to 0.1 m, becoming orange-brown, with some non-plastic fines, with some fine to medium grained pisolitic gravel	M	L	
			0.5					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, with approximately 30% medium to coarse grained sand, with some non-plastic fines			
	F-H		1.0					GP-GM	GRAVEL: fine to coarse grained weakly cemented lateritic gravel, pale grey and brown, with some medium to coarse grained sand, with some non-plastic fines Coarse grained lateritic gravel and cobbles, pale grey mottled yellow-brown and dark red-brown		L - MD	
			1.5									
			2.0					SC-CI	Clayey SAND/Sandy CLAY: pale grey mottled yellow-brown, medium plasticity			
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	81944 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	274036 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0		B(TP61-01)			GP-GM	GRAVEL: fine grained pisolitic gravel (becoming coarser with depth), dark grey-brown to 0.1 m, becoming pale brown, with some medium to coarse grained sand, with some non-plastic fines, isolated large roots up to 0.1 m in diameter in upper 0.5 m	M	VL	
			0.5									
			1.0								L	
	F		1.5						Inclusions of medium to coarse grained gravel and cobbles			
	H-VH		2.0						Becoming pale grey mottled dark red-brown, inferred transition into HARDPAN LATERITE			
			2.5						Hole terminated at 2.50 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP62

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Job Number:	J1701008	**Easting:**	82028 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273976 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E-F		0.0 – 0.5					GM	Silty Sandy GRAVEL: fine to medium grained lateritic gravel, dark grey-brown to 0.2 m, becoming pale brown, with approximately 40% medium to coarse grained sand, with approximately 15% non-plastic fines, trace rootlets to 0.2 m, trace roots up to 30 mm diameter to 0.6 m	M	L	Laterite outcrops exposed
	H-VH		0.5 – 1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown			
			1.0 – 1.5						Hole terminated at 1.30 m Refusal on hardpan laterite Groundwater not encountered			
			1.5 – 2.0									
			2.0 – 2.5									
			2.5 – 3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	81841 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273916 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GM	Silty Sandy GRAVEL: fine grained lateritic gravel, becoming medium to coarse grained with depth, dark grey to 0.2 m, becoming pale brown, with approximately 30-40% medium to coarse grained sand, with approximately 15% non-plastic fines, trace roots up to 30 mm in diameter	M	L	
			0.5									
	F		1.0					SC	Clayey SAND: weakly cemented, yellow-brown mottled dark red-brown, excavated as weakly to moderately cemented, fine to coarse grained gravel and cobbles, friable, becoming clayier with depth	D	H	
			1.5						Clayey SAND: fine to coarse grained quartz sand, pale grey mottled yellow-brown, with approximately 30% non-plastic to low plasticity fines, desiccated and hard			
			2.0					SC				
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	82021 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273851 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GM	Silty Sandy GRAVEL: fine to medium grained lateritic gravel, dark grey-brown to 0.2 m, becoming pale brown, with approximately 30-40% medium to coarse grained sand, with approximately 15% non-plastic fines, trace roots	D - M	VL	
			0.5					GC	Clayey Sandy GRAVEL: fine to coarse grained, well cemented lateritic gravel, orange-brown, with approximately 30-40% medium to coarse grained sand, with approximately 20% low plasticity fines			
			1.0									
			1.5					CH	Sandy CLAY/CLAY: high plasticity, pale brown mottled yellow-brown and dark red-brown, with approximately 30% fine to medium grained sand, trace gravel	D	H	
			2.0									
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	81811 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273724 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					SP-SM	Gravelly SAND: medium to coarse grained, pale brown, with approximately 30-40% fine to medium grained lateritic gravel, with some non-plastic fines, isolated very well iron cemented LATERITE BOULDERS up to about 2 m in size, trace roots and rootlets	D	L - MD	
	H		0.5 – 1.0						HARDPAN LATERITE: low strength, well iron cemented, mottled yellow-brown, orange-brown and red-brown			
	F		1.0 – 2.5					SC	Gravelly Clayey SAND: paler in colour, becoming gradually friable and uncemented, transitioning into desiccated, medium plasticity	D	H	
			2.5 – 3.0						Hole terminated at 2.60 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	82120 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	273587 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0					GP-GM	Sandy GRAVEL: fine grained pisolitic gravel, dark grey-brown becoming brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, isolated high strength LATERITE BOULDERS up to 1.5 m in size	M	L	Numerous laterite outcrops exposed at surface
			0.5						HARDPAN LATERITE: high strength, very well iron cemented, dark red-brown mottled yellow-brown, ferruginous gravel sized pisolites			
			1.0						Hole terminated at 0.80 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP67

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Job Number:	J1701008	**Easting:**	82205 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273800 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine grained pisolitic gravel, becoming medium grained with depth, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines		L	
			0.5							D - M		
	F								Medium to coarse grained gravel, yellow-brown		L - MD	
			1.0									
	H-VH								HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, sand sized quartz			
			1.5						Hole terminated at 1.50 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP68

Job Number:	J1701008	**Easting:**	82403 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273815 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 15% non-plastic fines, with some fine to coarse grained lateritic gravel, trace small roots to 0.2 m	D - M	L	
			0.5					GM	Silty Sandy GRAVEL: fine to medium grained lateritic gravel, brown, with approximately 30-40% medium to coarse grained sand, with approximately 15% non-plastic fines			
	F-H		1.0					SC	Clayey SAND: weakly cemented, yellow-brown mottled pale grey and dark red-brown, friable, workable into low plasticity Clayey SAND, becoming uncemented and clayier with depth	D	H	
			1.5									
			2.0					SC-CI	Clayey SAND/Sandy CLAY: medium plasticity fines, fine to coarse grained quartz sand, pale grey mottled yellow			
			2.5									
			3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP69

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Job Number:	J1701008	**Easting:**	82442 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273563 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown to 0.1 m, becoming pale brown, with some medium to coarse grained sand, with some non-plastic fines, trace large roots to 0.5 m	D - M	L	
	VH		1.5						HARDPAN LATERITE: medium strength, very well iron cemented, yellow-brown mottled dark red-brown, ferruginous gravel sized pisolites			
									Hole terminated at 1.50 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP70

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Job Number:	J1701008	**Easting:**	82499 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273694 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP70-01)			SC	Clayey SAND: medium to coarse grained, dark grey-brown, with approximately 20-30% low plasticity fines, with some fine to ~~medium grained pisolitic gravel, trace rootlets~~ Brown, no rootlets	M	L	
	F		0.5					GP-GM	GRAVEL: medium grained pisolitic gravel, pale brown, with some medium to coarse grained sand, with some non-plastic fines			
	VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, pale grey mottled orange-brown and dark red-brown			
			1.5						Becoming uncemented, transitioning into high plasticity Gravelly CLAY	D		
	F-H		2.0					CH	Gravelly CLAY: high plasticity, pale grey mottled dark red-brown, with approximately 30-40% fine to coarse grained, very well iron cemented gravel, with some sand		H	
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Job Number:	J1701008	**Easting:**	82665 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273778 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SC	Clayey SAND: medium to coarse grained, brown, with approximately 20-30% non-plastic to low plasticity fines	M	L - MD	
			0.5						Orange-brown, with approximately 20-30% low plasticity fines			
	F		1.0		B(TP71-01)			CH-SC	Clayey SAND/Sandy CLAY: high plasticity fines, medium to coarse grained quartz sand, off-white mottled yellow-brown and red-brown, isolated sandier zones		St	
			1.5						Becoming off-white, sand content increasing			
			2.0									
			2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP72

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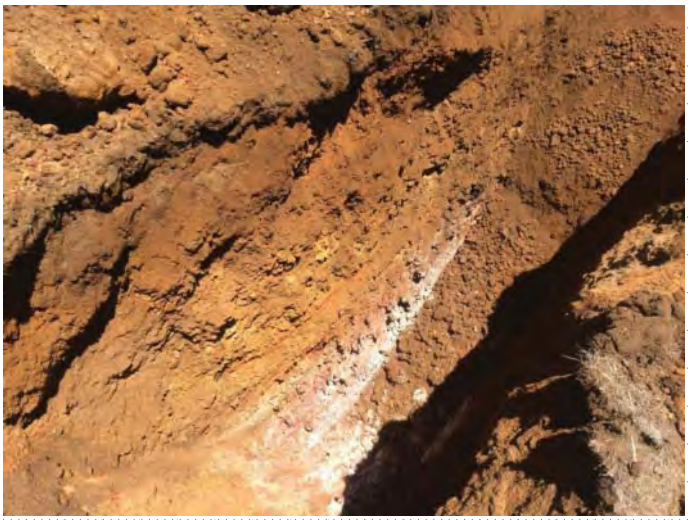
Job Number:	J1701008	**Easting:**	82602 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273600 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SC	Clayey SAND: medium to coarse grained, dark grey-brown to 0.2 m, becoming brown, with approximately 20-30% low plasticity fines, with some fine to medium grained pisolitic gravel	M	MD	
	F-H		0.5					GP-GM	GRAVEL: fine to coarse grained, well cemented lateritic gravel and cobbles, with some medium to coarse grained brown sand, with some low plasticity fines, with isolated weakly cemented zones			
	F		1.0					CH	Gravelly Sandy CLAY: variable proportion of medium to coarse grained quartz sand, fine to coarse grained iron cemented gravel, high plasticity fines, mottled off-white and dark red-brown	M - W		
			1.5									
			2.0									
			2.5						Hole terminated at 2.60 m Target depth Groundwater not encountered			
			3.0									

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP73

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Job Number:	J1701008	**Easting:**	82773 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273606 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium grained, dark grey-brown, with approximately 20-30% non-plastic fines	M	L	
			0.5						Yellow-brown			
	F		1.0					GP	GRAVEL and COBBLES: very well iron cemented, coarse grained lateritic gravel and cobbles in a matrix of medium to coarse grained quartz sand, pale grey mottled orange-brown and red-brown			
			1.5		B(TP73-01)			SC	Clayey SAND/Gravelly Clayey SAND: medium to coarse grained quartz sand, with approximately 30-40% high plasticity fines, variably iron cemented, medium to coarse grained gravel	M - W	H	
			2.0									
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP74

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Job Number:	J1701008	**Easting:**	82810 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273870 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium grained, dark grey-brown to 0.2 m, becoming brown, with approximately 20-30% non-plastic fines, trace fine grained pisolitic gravel, isolated gravelly zones at depth	M	L	
	H		0.5						LATERITE GRAVEL, COBBLES and BOULDERS: high strength, very well iron cemented, dark red-brown mottled orange-brown, in a matrix of brown Silty SAND as described above			
	F		1.0					SC-CH	Clayey SAND/Sandy CLAY: high plasticity fines, medium to coarse grained quartz sand, off-white, variable sand content	M - W	St	
			1.5									
			2.0									
			2.5									
			3.0						Hole terminated at 2.60 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP75

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Job Number:	J1701008	**Easting:**	82875 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273757 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GP-GM	Sandy GRAVEL: fine grained pisolitic gravel,dark brown, with approximately 30-40% medium to coarse grained sand, with some non-plastic fines, trace rootlets and small roots	D	L	
			0.5						Pale brown, no organics			
	VH		1.0						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown and yellow-brown			
			1.5						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP76

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Job Number:	J1701008	**Easting:**	83028 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273825 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					GM	Silty Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown becoming brown, with approximately 30-40% medium to coarse grained sand, with approximately 15% non-plastic fines, isolated very well cemented LATERITE BOULDERS	D	L	Laterite outcrops exposed at surface
	VH		0.5						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown and yellow-brown, gravel sized ferruginous pisolites			
									Hole terminated at 0.50 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP77

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Job Number:	J1701008	**Easting:**	83276 m	**Contractor:**	ANH Contracting	**Date:**	03/02/2017
Client:	Cossill & Webley	**Northing:**	273758 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5		B(TP77-01)			GM	Silty Sandy GRAVEL: fine grained pisolitic gravel, dark grey-brown to 0.1 m, becoming orange-brown, with approximately 30-40% medium to coarse grained sand, with approximately 15% non-plastic fines, trace rootlets to 0.1 m	M	L	
	VH		0.5 – 1.0						HARDPAN LATERITE: medium to high strength, very well iron cemented, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
			1.0 – 1.5						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			
			1.5 – 2.0									
			2.0 – 2.5									
			2.5 – 3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP78

Job Number:	J1701008	**Easting:**	81598 m	**Contractor:**	ANH Contracting	**Date:**	08/02/2017
Client:	Cossill & Webley	**Northing:**	273769 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, grey-brown to 0.2 m, becoming orange-brown, with approximately 20% non-plastic fines, trace fine grained gravel, gravel content increasing with depth, trace roots up to 20 mm in diameter	D - M	VL	
			0.5					SM	Gravelly Silty SAND: medium to coarse grained, orange brown and pale brown, approximately 30-40% fine to medium grained gravel, with occasional coarse gravel and cobbles			
	VH		1.0						HARDPAN LATERITE: generally very well iron cemented, medium strength, with occasional moderately cemented zones, dark red-brown mottled yellow-brown, gravel sized ferruginous pisolites			
			1.5						Hole terminated at 1.50 m Stopped due to slow excavation through hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP79

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Job Number:	J1701008	**Easting:**	81793 m	**Contractor:**	ANH Contracting	**Date:**	02/02/2017
Client:	Cossill & Webley	**Northing:**	274145 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	Strong inflow	0.0		B(TP79-01)			SM-SC	Silty/Clayey SAND: fine to coarse grained, orange-brown, with approximately 20% non-plastic to low plasticity fines, trace rootlets to 0.1 m	M	F	
			0.5					SC	Clayey SAND: fine to coarse grained, yellow-brown, with approximately 40% low plasticity fines, trace fine grained angular gravel, gravel content increasing with depth			
			1.0		B(TP79-02)			SC	Gravelly Clayey SAND: yellow-brown, with approximately 30-40% low to medium plasticity fines, with approximately 30-40% fine to coarse grained lateritic gravel	M - W		
			1.5		B(TP79-03)			CH	Sandy CLAY/CLAY: high plasticity, pale grey mottled dark red-brown, with approximately 20-40% fine to coarse grained sand, trace fine to coarse grained gravel including quartz and occasional iron cemented zones, striated, slickensided, inferred extremely weathered granitic rock		St	
			2.0									
			2.5									
			3.0						Hole terminated at 2.70 m Target depth Groundwater encountered at 2 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP80

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81751 m	**Contractor:**	ANH Contracting	**Date:**	16/02/2017
Client:	Cossill & Webley	**Northing:**	274856 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, dark grey, with approximately 10-15% non-plastic fines, trace rootlets	M	L	
			0.5					SM	Silty SAND: medium to coarse grained, orange-brown, with approximately 20% non-plastic fines			
			1.0									
	H	Slow inflow	1.5						HARDPAN LATERITE: low strength, well iron cemented, yellow-brown mottled orange-brown and dark red-brown, sand sized quartz			
			2.0						Hole terminated at 2.00 m Refusal on hardpan laterite Groundwater encountered at 1.5 m			
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP81

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81027 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275510 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 30% non-plastic fines, trace rootlets	D	S	
			0.5					SM-SC	Silty/Clayey SAND: medium to coarse grained, yellow-brown, with approximately 30% non-plastic to low plasticity fines	D - M		
	H-VH		1.0						HARDPAN LATERITE: low to medium strength, very well iron cemented, dark red-brown mottled yellow-brown			
			1.5						Hole terminated at 1.20 m Refusal on hardpan laterite Groundwater not encountered			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP82

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	82311 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275355 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E		Very strong inflow	0.0					SM	Silty SAND: medium to coarse grained, dark grey, with approximately 20-30% non-plastic fines	M	VS	
			0.5					SC	Clayey SAND: medium to coarse grained, pale brown and orange-brown, with approximately 30-40% low plasticity fines, trace iron cemented gravel	W		
			1.0						HARDPAN LATERITE: medium strength, orange-brown mottled dark red-brown			
			1.5						Hole terminated at 1.30 m Refusal on hardpan laterite Groundwater encountered at 1 m			
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP83

Job Number:	J1701008	**Easting:**	81274 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275856 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND: medium to coarse grained, dark grey-brown, with some non-plastic fines, trace rootlets	D - M	VL	
			0.5					GP-GM	Sandy GRAVEL: fine to coarse grained pisolitic gravel, pale brown to orange-brown, with approximately 30 to 40% medium to coarse grained quartz sand, with some non-plastic fines		L	
			1.0					SM	Silty SAND: medium to coarse grained quartz sand, orange-brown, with approximately 15% non-plastic fines, weakly cemented cobbles		MD	
			2.0					CH	Sandy CLAY: high plasticity, pale grey mottled dark red-brown, with approximately 30-40% medium to coarse grained sand, slickensided, with cemented zones		H	
			2.5									
			3.0						Hole terminated at 2.60 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP84

Job Number:	J1701008	**Easting:**	81447 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275844 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F		0.0					SP	SAND, LATERITE COBBLES and BOULDERS: medium to coarse grained, angular quartz sand, grey, very well iron cemented cobbles and boulders	D - M	L	
			0.5					SP-SC	SAND/Clayey SAND: medium to coarse grained, angular quartz sand, off-white mottled orange, with approximately 10-15% medium plasticity fines, variably iron cemented gravel and cobbles			
			1.0		B(TP84-01)			CH	Sandy CLAY: high plasticity, grey mottled orange, variable quartz sand content, slickensided, striated, blocky			
			1.5						Pale grey mottled dark red brown	M	VSt - H	
			2.0									
			2.5									
			3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP85

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81634 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275781 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE	Very strong inflow	0.0					SP	SAND: medium to coarse grained, angular, off-white	M	L - MD	
			0.5									
			1.0						Pale yellow-brown, with weakly iron cemented cobbles		VL	
			1.5									
			2.0					SC	Clayey SAND: medium to coarse grained, yellow-brown, with approximately 20% low plasticity fines, with weakly iron cemented zones			
			2.5									
			3.0						Hole terminated at 2.60 m Target depth Groundwater encountered at 1.8 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP86

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Job Number:	J1701008	**Easting:**	81832 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275811 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SC	Gravelly Clayey SAND: medium to coarse grained, brown and orange-brown, with approximately 30-40% medium plasticity fines, with approximately 30-40% fine to coarse grained iron cemented gravel	M - W	S	
	F		0.5					CH	Sandy CLAY: high plasticity, off-white, 30-40% medium to coarse grained quartz sand and fine grained gravel	M	St - VSt	
			1.0									
			1.5									
			2.0									
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP87

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81447 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275685 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 20-30% non-plastic fines, trace rootlets	D - M	L - MD	
			0.5					SM	Gravelly Silty SAND: medium to coarse grained, brown, with approximately 30-40% fine to medium grained gravel, with some non-plastic fines			
			1.0					SC	Clayey SAND: medium to coarse grained, orange-brown, with approximately 30-40% low plasticity fines	M	St	
	F		1.5					GC	Clayey Sandy GRAVEL: fine to medium grained iron cemented gravel, weakly cemented as cobbles, pale grey and orange-brown, with approximately 30% medium to coarse grained sand, with approximately 15% low plasticity fines		MD	
			2.0					CH	CLAY: high plasticity, off-white mottled orange and dark red-brown, with some medium to coarse grained sand, striated, slickensided, blocky		VSt	
			2.5									
			3.0						Hole terminated at 3.00 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP88

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	81612 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275625 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 20-30% non-plastic fines, trace rootlets	D - M	F	
			0.5					SM-SC	Silty/Clayey SAND: medium to coarse grained, yellow-brown, with approximately 20-30% non-plastic to low plasticity fines, becoming coarser grained and less clayey with depth	M		
	H		1.0					GP	LATERITE GRAVEL and COBBLES: medium to coarse grained, very well iron cemented lateritic gravel and cobbles, dark red-brown mottled pale grey and orange-brown, with some quartz sand, trace fines			
			1.5									
			2.0						Hole terminated at 2.00 m Refusal on cemented gravel and cobbles Groundwater not encountered			
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP89

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Job Number:	J1701008	**Easting:**	81751 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275681 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP	Gravelly SAND: medium to coarse grained, dark grey-brown becoming brown, with approximately 30% fine to medium grained pisolitic gravel, with some non-plastic fines, isolated very well cemented LATERITE BOULDERS, trace rootlets to 0.2 m	D - M	L	
	VH		0.5						HARDPAN LATERITE: low to medium strength, very well cemented, yellow-brown mottled dark red-brown, ferruginous pisolites			
			1.0						Hole terminated at 0.60 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP90

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Job Number:	J1701008	**Easting:**	81902 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275679 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					SP-SM	Gravelly SAND: medium to coarse grained, dark grey-brown becoming grey-brown, with approximately 30-40% fine to medium grained pisolitic gravel, with some non-plastic fines, with large roots	D - M	L	
			1.0 – 3.0						Hole terminated at 0.60 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP91

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Job Number:	J1701008	**Easting:**	82049 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275674 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	H		0.0 – 1.5					SP	Gravelly SAND and LATERITE BOULDERS: medium to coarse grained, grey-brown to 0.2 m, becoming orange-brown, with approximately 30-40% fine to medium grained pisolitic gravel, very well cemented LATERITE BOULDERS up to 1.5 m in size, trace to some roots and rootlets to 0.2 m, isolated large roots to 1.0 m	M	MD	
			1.5 – 3.0						Hole terminated at 1.70 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP92

Job Number:	J1701008	**Easting:**	81749 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275533 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0 – 0.5					SP-SM	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown, with some fine grained pisolitic gravel, with some non-plastic fines, isolated very well cemented LATERITE COBBLES and BOULDERS	D - M	L	
			0.5 – 3.0						Hole terminated at 0.60 m Refusal on hardpan laterite Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP93

Job Number:	J1701008	**Easting:**	81902 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275535 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	F-H		0.0					SP-GP	Gravelly SAND/Sandy GRAVEL and LATERITE BOULDERS: medium to coarse grained sand, fine to medium grained pisolitic gravel, with some non-plastic fines, with very well cemented LATERITE BOULDERS up to 1.5 m in size, with large diameter roots	D	L	
			0.5						No roots			
			1.0						Hole terminated at 1.10 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/04/2017 16:13 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: TP94

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	82044 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275531 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94		LC-2	**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0		B(TP94-01)			GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, dark grey-brown becoming grey-brown, approximately 40% medium to coarse grained sand, with some non-plastic fines	D - M	VL	Average depth of Gravelly SAND recorded; varies from 0.4 m to 0.7 m
	VH		0.5						HARDPAN LATERITE: medium strength, very well iron cemented, dark red-brown mottled yellow-brown, ferruginous pisolites			
			1.0						Hole terminated at 0.70 m Refusal on hardpan laterite Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP95

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	82208 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275523 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 20-30% non-plastic fines, with very large diameter roots			
					B(TP95-01)			SC	Clayey SAND: medium to coarse grained, orange-brown, with approximately 30-40% low plasticity fines, with very large diameter roots to 0.9 m	M	VS	
			0.5									
			1.0		B(TP95-02)							
	F-H		1.5					SC-CH	Clayey SAND / Sandy CLAY and LATERITE BOULDERS: medium to coarse grained, high plasticity fines, pale blue-grey mottled orange and dark red-brown, very well iron cemented LATERITE BOULDERS	W	St	
			2.0									
		Slow inflow	2.5									
			3.0						Hole terminated at 2.90 m Target depth Groundwater encountered at 2.8 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP96

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	82057 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275372 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VH		0.0					SP-SM	SAND/Gravelly SAND: medium to coarse grained, dark grey-brown and grey-brown, with approximately 30% fine to medium grained pisolitic gravel, with some non-plastic fines, trace rootlets	D	L	Average depth of Gravelly SAND varies between 0.1 m and 0.3 m Numerous laterite outcrops at surface
			0.5						Hole terminated at 0.20 m Refusal on hardpan laterite Groundwater not encountered			
			1.0									
			1.5									
			2.0									
			2.5									
			3.0									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP97

Job Number:	J1701008	**Easting:**	80810 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275925 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SP-SM	SAND/Silty SAND: medium to coarse grained, dark grey-brown, with some fine grained gravel, trace rootlets	D	L	
	F-H		0.5						LATERITE BOULDERS and COBBLES: fine to coarse grained, very well iron cemented gravel and cobbles, orange-brown, with some medium to coarse grained sand, with some non-plastic fines	D - M	MD	
			1.0									
			1.5						Dark red-brown mottled pale grey and orange, becoming weakly cemented and friable, transitioning into underlying layer			
			2.0									
	F		2.5					SC	Clayey SAND: medium to coarse grained quartz sand, off-white, with approximately 30% high plasticity fines	M	H	
			3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP98

Job Number:	J1701008	**Easting:**	80837 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275828 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	VE		0.0					GM	Silty Sandy GRAVEL; fine to medium grained pisolitic gravel, dark grey-brown, with approximately 20-40% medium to coarse grained sand, with approximately 15-20% non-plastic fines	D - M	L	
			0.5					GC	Clayey Sandy GRAVEL: fine to medium grained pisolitic gravel, orange-brown, with approximately 30-40% medium to coarse grained sand, with approximately 15-20% low plasticity fines			
	H		1.0						HARDPAN LATERITE: very low to low strength, well iron cemented, pale grey mottled orange and dark red-brown			
			1.5						Becoming uncemented, transitioning into underlying layer			
	F		2.0		B(TP98-01)			SC-CH	Clayey SAND/Sandy CLAY: high plasticity, medium to coarse grained quartz sand, off-white mottled dark red-brown, highly variable sand content, occasional weakly iron cemented lenses	M	H	
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP99

Sheet 1 OF 1

Job Number:	J1701008	**Easting:**	80969 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275830 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E	Moderate inflow	0.0					SM	Silty SAND: medium to coarse grained, grey-brown, with approximately 30-40% non-plastic fines, trace rootlets	D - M	VD	
			0.5					SC	Clayey SAND: medium to coarse grained, orange-brown, with approximately 30-40% low to medium plasticity fines		F	
			1.0					SC	Gravelly Clayey SAND: medium to coarse grained quartz sand, pale grey mottled orange, with approximately 20% low to medium plasticity fines, with approximately 30% very well iron cemented gravel and cobbles		St	
	F		1.5					SC-CH	Clayey SAND/Sandy CLAY: high plasticity, medium to coarse grained quartz sand, off-white, highly variable sand content, occasional weakly iron cemented lenses	M	H	
			2.0									
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater encountered at 1 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: TP100

Job Number:	J1701008	**Easting:**	80988 m	**Contractor:**	ANH Contracting	**Date:**	17/02/2017
Client:	Cossill & Webley	**Northing:**	275931 m	**Machine:**	Samsung SE280	**Logged:**	HWC
Project:	Proposed Residential Development	**Datum:**	PCG94	LC-2		**Checked Date:**	29/03/2017
Location:	Lot 48 Roland Road, Stoneville			**Operator:**	Neil	**Checked By:**	FAD
				Bucket:	0.6 m rock		

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E	E		0.0					SM	Silty SAND: medium to coarse grained, dark grey-brown, with approximately 20% non-plastic fines, trace rootlets	D	L	
			0.5					GP-GM	Sandy GRAVEL: fine to medium grained pisolitic gravel, brown, with approximately 20-40% medium to coarse grained quartz sand, with some non-plastic fines	D - M		
								SC	Isolated orange-brown Clayey SAND layer			
	F		1.0		B(TP100-01)			SC	Clayey SAND: medium to coarse grained, pale grey mottled orange-brown, with approximately 30-40% medium plasticity fines	M	VSt	
			1.5						Pale blue-grey mottled dark red-brown, well iron cemented lenses			
		Slow inflow	2.0						Pale blue-grey, with approximately 30% medium plasticity fines			
			2.5									
			3.0						Hole terminated at 2.80 m Target depth Groundwater encountered at 2.2 m			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Appendix C: Photographs

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4/15 Walters Drive OSBORNE PARK WA 6017
ABN: 64 625 054 729

Photograph 1: Typical rock breaking through near surface Hardpan

Photograph 2: Excavation of broken Hardpan

Photograph 3: Typical Hardpan profile after rock breaking and excavation

Photograph 4: Rock breaking through Hardpan boulders

Photograph 5: Typical profile of Hardpan boulders and less massive zones

Photograph 6: Trial ripping over Trial Area 1 – Not considered typical of shallow Hardpan

Photograph 7: Trial ripping over Trial Area 2 – typical of Hardpan Boulders with limited iron induration

Photograph 8: Start of trial ripping over Trial Area 3

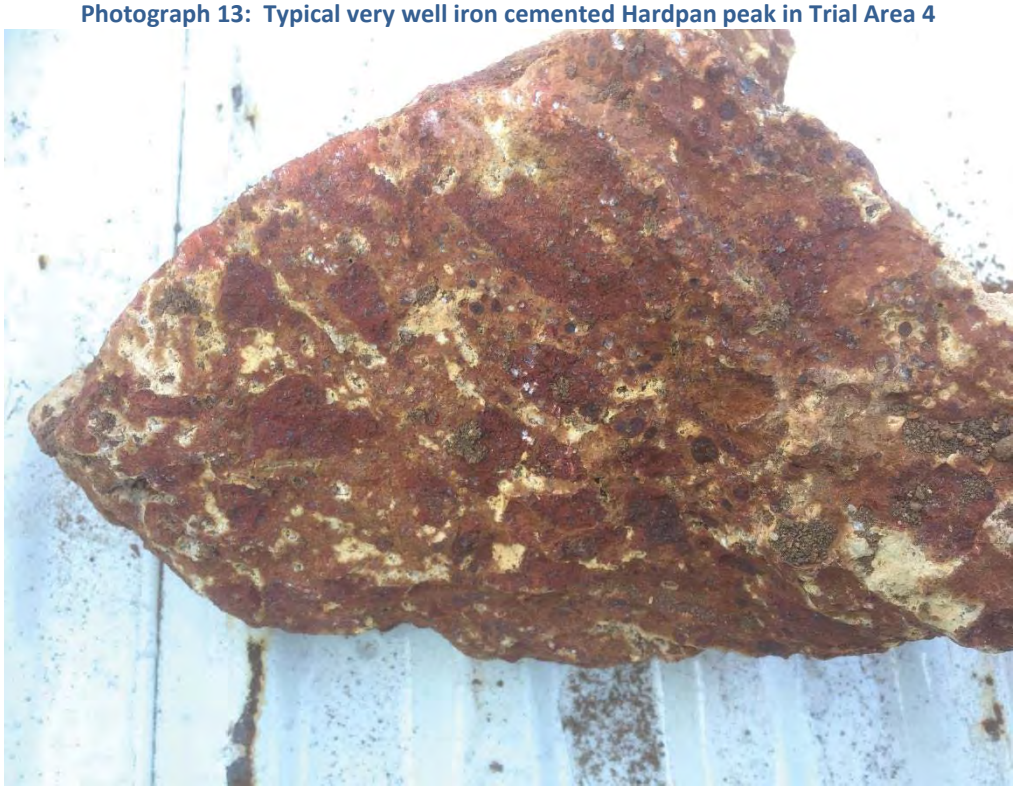
Photograph 9: Typical very well cemented Hardpan exposed in Trial Area 3

Photograph 10: Progressive ripping in Trial Area 3

Photograph 11: Clayey sand (Extremely Weathered Granitic Rock) exposed below Hardpan in Trial Area 3

Photograph 12: Trial ripping in Trial Area 4

Photograph 13: Typical very well iron cemented Hardpan peak in Trial Area 4



Photograph 14: Typical iron indurated Hardpan (very well cemented)

Photograph 15: Trial Area 4 after one day's ripping

Photograph 16: Less cemented Hardpan present between very well iron cemented peaks of Hardpan in Trial Area 4

Photograph 17: Central and Northern part of PRWF

Photograph 18: Hardpan outcrops in vegetated area of PWRF to the south

Appendix D: RBT Test Pit Reports

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4/15 Walters Drive OSBORNE PARK WA 6017
ABN: 64 625 054 729

TEST PIT: RBT07

Sheet 1 OF 1

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	30/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	FAD
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					GP	Sandy GRAVEL: fine to medium pisolitic gravel, yellow brown, with cobble and boulder sized inclusions, colluvium	D	L - MD	
			0.5						HARDPAN LATERITE: very well iron cmented, massive, dark red-brown			Approximately 20 mins to penetrate Hardpan with rock breaker
			1.0									
			1.5					SC-CI	Clayey SAND / Sandy CLAY: fine to coarse grained sand, low to medium plasticity fines, mottled yellow-brown and red-brown	M	St	
			2.0						Hole terminated at 1.70 m Target depth Groundwater not encountered			
			2.5									
			3.0									
			3.5									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: RBT09

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	31/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	NC
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					SP	Gravelly SAND: fine to coarse grained, yellow brown and orange brown, approximately 30-40% fine to medium grained pisolitic gravel, trace very well cemented boulders	D	L	
			1.5					GC	Clayey GRAVEL: fine to coarse grained variably iron cemented gravel and cobbles, mottled off-white and dark brown, with occasional friable and medium to high plasticity clayey zones		D	
			3.0						Hole terminated at 3.20 m Target depth Groundwater not encountered			
			3.5									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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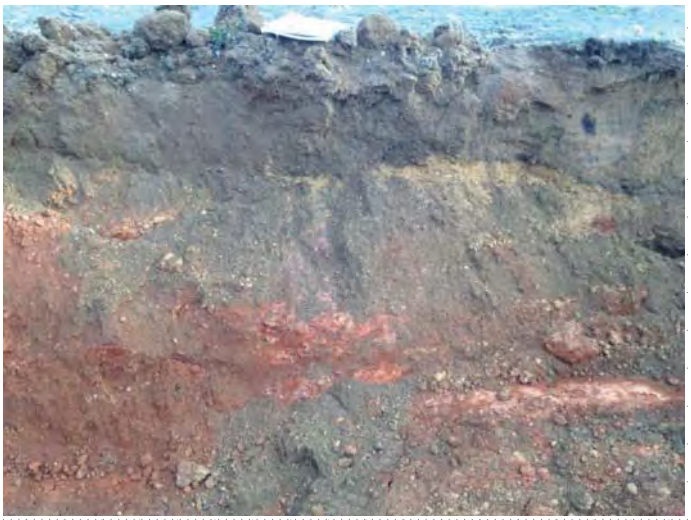
TEST PIT: RBT17

Sheet 1 OF 1

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	30/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	FAD
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					SP-GP	Gravelly SAND / Sandy GRAVEL: fine to coarse grained sand, fine to medium pisolitic gravel, dark grey-brown, becoming yellow brown	D	L	Approximately 45 mins to penetrate 0.8 m into Hardpan with rock breaker
			0.5						HARDPAN LATERITE: very well iron cemented, massive, brown mottled yellow brown and grey-green, with occasional pockets of gravel			
			1.0						Hole terminated at 1.00 m Target depth Groundwater not encountered			
			1.5									
			2.0									
			2.5									
			3.0									
			3.5									

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: RBT25

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	30/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	FAD
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					SP	Gravelly SAND: fine to coarse grained, dark grey, approximately 30-40% fine to medium pisolitic gravel	D	L	
			0.5						LATERITE BOULDERS & COBBLES: in a matrix of Sandy GRAVEL: fine to medium pisolitic gravel, very well cemented cobbles and boulders, yellow brown, becoming cemented with depth		D	Approximately 60 mins to penetrate 2.4 m through Boulders and Cobbles with rock breaker
			1.0									
			1.5									
			2.0									
			2.5									
			3.0						Hole terminated at 2.70 m Target depth Groundwater not encountered			
			3.5									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/07/2017 10:48 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: RBT31

Sheet 1 OF 1

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	31/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	NC
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					SP-SM	Gravelly SAND: fine to coarse grained, yellow brown to orange brown, approximately 30-40% fine to medium grained pisolitic gravel, with some non-plastic fines	D - M	L	
			1.5					GC	Clayey GRAVEL: fine to coarse grained variable iron cemented gravel and cobbles, mottled dark brown and off-white, with occasional friable and medium to high plasticity Clayey zones, cementation reducing with depth	D	D	
			3.5						Hole terminated at 3.30 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/07/2017 10:48 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: RBT33

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	31/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	NC
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					SP	Gravelly SAND: fine to coarse grained, pale brown to orange-brown, approximately 30-40% fine to medium pisolitic gravel	D	L	
			0.5						HARDPAN LATERITE: very well iron cemented, dark red brown, mottled yellow-brown and off-white			
			1.0									
			1.5									
			2.0									
			2.5						Becoming yellow-brown, moderately cemented			
			3.0						Hole terminated at 3.00 m Target depth Groundwater not encountered			
			3.5									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: RBT39

Sheet 1 OF 1

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	31/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	NC
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					SP	Gravelly SAND: fine to coarse grained, pale brown, approximately 30-40% fine to medium pisolitic gravel	D - M	L	
									HARDPAN LATERITE: very well iron cemented, massive, dark red brown, mottled yellow-brown and off-white			Approximately 50 mins to penetrate Hardpan with rock breaker
			0.5									
			1.0						Transitioning into very well cemented boulders with interconnected weak to well cemented zones			
			1.5									
			2.0						Becoming yellow-brown, weakly to moderately cemented, transitioning into clayey soil			
			2.5									
			3.0						Hole terminated at 3.00 m Target depth Groundwater not encountered			
			3.5									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/07/2017 10:48 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: RBT47

Sheet 1 OF 1

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	31/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	NC
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					SP-SM	Gravelly SAND: fine to coarse grained, pale brown, approximately 30-40% fine to medium grained pisolitic gravel	D	L	Depth of gravelly sand varies from 0.2 to 1.0 m
			0.5						HARDPAN LATERITE: very well iron cemented, massive, dark red-brown, occasionally mottled yellow brown and off-white			
			1.0									
			1.5									
			2.0						Hole terminated at 2.00 m Stopped due to slow penetration through Hardpan Groundwater not encountered			
			2.5									
			3.0									
			3.5									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/07/2017 10:48 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: RBT50

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	31/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	NC
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description				
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0						HARDPAN LATERITE: very well iron cemented, massive, dark red brown, mottled orange-brown and yellow brown, variable thin layer of Gravelly SAND above			Approximately 90 mins to penetrate Hardpan with rock breaker
			0.5									
			1.0									
			1.5									
			2.0									
			2.5									
			3.0						Becoming yellow-brown, variable uncemented with well cemented gravels and cobbles			
			3.5						Hole terminated at 3.20 m Target depth Groundwater not encountered			

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: RBT55

Sheet 1 OF 1

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	31/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	NC
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					GP-GM	GRAVEL: fine to medium pisolitic gravel, pale brown, with some fine to coarse grained sand, trace cobbles and boulders	D	L - MD	
			1.0						HARDPAN LATERITE: very well iron cemented, massive, dark red-brown, with adjacent zones of GRAVEL extending to a depth of up to 2.5 m			Approximately 45 mins to penetrate 2 m of Hardpan with rock breaker
			3.0						Hole terminated at 3.20 m Target depth Groundwater not encountered			
			3.5									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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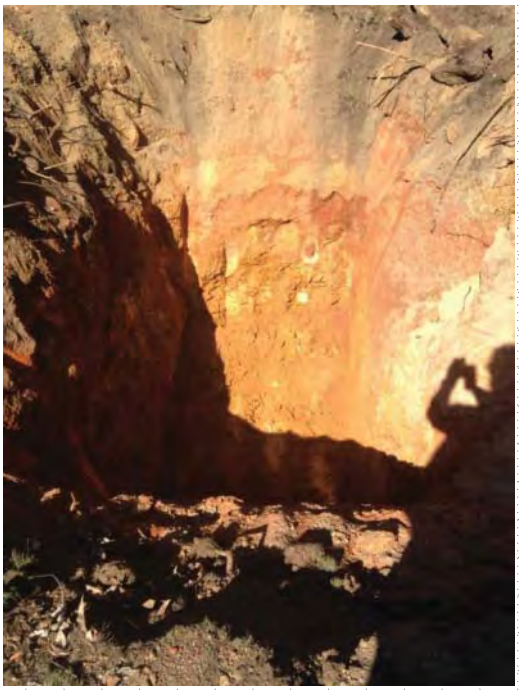
TEST PIT: RBT90

Sheet 1 OF 1

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	30/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	FAD
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					GP	Sandy GRAVEL: fine to medium grained pisolitic gravel, yellow brown	D	L	
			0.5						HARDPAN LATERITE: very well iron cemented, dark red brown, massive, vesicular			Approximately 120 mins to penetrate Hardpan with rock breaker
			1.0									
			1.5									
			2.0						Well cemented, yellow-brown cementation decreasing with depth			
			2.5					SC	Clayey SAND: fine to coarse grained, red-brown, low to medium plasticity fines	M	MD - St	
			3.0						Hole terminated at 2.80 m Target depth Groundwater not encountered			
			3.5									

Sketch & Other Observations



Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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TEST PIT: RBT92

Sheet 1 OF 1

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	30/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	FAD
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					GP	Sandy GRAVEL: fine to medium gravel, red-brown		L	
			0.5									
			1.0						LATERITE BOULDERS & COBBLES: in a Sandy GRAVEL matrix: fine to medium pisolitic gravel, very well cemented cobbles and boulders	D	D	Approximately 20 mins to penetrate through Boulders and Cobbles with rock breaker
			1.5					SC	Clayey SAND: fine to coarse grained, grey mottled yellow-brown, approximately 15-20% low plasticity fines, extremely weathered granitic rock	M	MD - D	
			2.0						Hole terminated at 1.90 m Target depth Groundwater not encountered			
			2.5									
			3.0									
			3.5									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

GALT LIB 1.01.GLB Log GG_EXCAVATION J1701008.GPJ <<DrawingFile>> 05/07/2017 10:48 8.30.003 Datgel DGD, CPT, Photo, Monitoring Tools | Lib: GALT 1.01 2013-02-21 Prj: GALT 1.01 2013-02-21

TEST PIT: RBT96

Sheet 1 OF 1

Job Number:	J1701008	**Contractor:**	Tracc Civil	**Date:**	30/05/2017
Client:	Satterley Property Group	**Machine:**	Volvo EC300D x 2	**Logged:**	FAD
Project:	Proposed Stoneville Project	**Operator:**	Neil / Tremain	**Checked Date:**	05/07/2017
Location:	Lot 48 Roland Road, Stoneville	**Bucket:**	1.2 m rock	**Checked By:**	HWC

Excavation					Sampling		Field Material Description					
METHOD	EXCAVATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USCS SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION	MOISTURE CONDITION	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
E/EH			0.0					GP	Sandy GRAVEL: fine to medium pisolitic gravel, yellow brown	D	L	
			0.5						HARDPAN LATERITE: very well iron cemented, massive, dark red brown mottled yellow brown			Approximately 75 mins to penetrate 1.25 m of Hardpan with rock breaker
			1.0									
			1.5						Hole terminated at 1.40 m Target depth Groundwater not encountered			
			2.0									
			2.5									
			3.0									
			3.5									

Sketch & Other Observations

Comments:

See Explanatory Notes and Method of Soil Description sheets for details of abbreviations and basis of descriptions

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Appendix E: Understanding Your Report

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ABN: 64 625 054 729

UNDERSTANDING YOUR REPORT

GALT FORM PMP11 Rev2

1. EXPECTATIONS OF THE REPORT

This document has been prepared to clarify what is and is not provided in your report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with the conditions on site.

Geotechnical engineering and environmental science are less exact than other engineering and scientific disciplines. We include this information to help you understand where our responsibilities begin and end. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of projects and we can help you to manage your risk.

2. THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- the project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the project team. Furthermore, we recommend that we be able to review work produced by other members of the project team that relies on information provided in our report.

3. SOIL LOGS

Our reports often include logs of intrusive and non-intrusive investigation techniques. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

4. THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party because of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

5. CHANGE IN SUBSURFACE CONDITIONS

The recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including anthropogenic events (such as construction or contaminating activities on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

6. SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use professional judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from professional judgement and opinion.

The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

7. ENVIRONMENTAL AND GEOTECHNICAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not addressed in geotechnical reports. Similarly, geotechnical issues are not addressed in environmental reports. The investigation techniques used for geotechnical investigations can differ from those used for environmental investigations. It is the client's responsibility to satisfy themselves that geotechnical and environmental considerations have been taken into account for the site.

Appendix C

Foreshore Assessment Report

FORESHORE AREA REPORT – STONEVILLE STRUCTURE PLAN

1.1 Purpose of foreshore area report

The Stoneville site contains five watercourses, three of which originate within the site. Clutterbuck Creek and a minor tributary pass through the site conveying upstream catchment runoff, eventually discharging to Jane Brook downstream of the site. Most of the watercourse areas are in highly degraded condition, however provide some measure of hydrological function.

This foreshore area report describes a biophysical assessment conducted to determine the following:

- The foreshore area required to protect the values of Clutterbuck Creek and the onsite waterways
- Whether any of the eroded valley floors should be considered waterways, which will then require consideration of a foreshore area/setback.

The location and extent of any foreshore area should align with the structure plan (SP) layout wherever possible. This will ensure that the SP accommodates appropriate foreshore areas within the land planning process. For example, by locating foreshore areas within public open space (POS) or a foreshore reserve (DoW 2012).

1.2 Policy context

Government policy and guidance relating to foreshore areas is primarily administered by Department of Water and Environmental Regulation (DWER). A number of guidance documents assist with the determination of foreshore areas. These documents include:

- *Operation Policy 4.3: Identifying and establishing waterways foreshore areas* (DoW 2012)
- *Guidance Note 6: Identifying and establishing waterways foreshore areas* (DoW 2013)
- *Water Note 23: Determining foreshore reserves* (WRC 2001).

Operational Policy 4.3: Identifying and establishing waterways foreshore areas (DoW 2012) outlines the processes for identifying and managing foreshore areas to ensure that environmental, social and economic values associated with waterways and adjoining lands are maintained. DoW (2013) recommend that the key document to assist in the identification of foreshore areas is *Water Note 23: Determining foreshore reserves* (WRC 2001).

2 BIOPHYSICAL ASSESSMENT

The following biophysical factors require consideration when identifying a foreshore area (WRC 2001):

- Geological features and landforms that influence the waterway.
- Soils, including those associated with riparian vegetation and those prone to erosion.
- Waterways, flood prone land and areas subject to channel changes.
- Riparian vegetation associated with the waterway.
- Function of the foreshore.
- Aquatic and riparian fauna habitat.
- Areas that may be harmed by land use pressures.
- Adjacent archaeological and ethnographic sites.

2.1 Climate

The site experiences a 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 1,079 mm on average annually with approximately half of the rainfall received between June and August (BoM 2018). The region experiences rainfall (>1 mm) on 87 days annually (on average) (BoM 2018).

2.2 Geomorphology, topography and soils

2.2.1 Geomorphology

The site occurs on the Darling Plateau, which is the geomorphic unit that characterises "the hills" region to the east of the Swan Coastal Plain (Gozzard 2007). The bedrocks of the plateau are overlain with lateritic materials and associated sands and gravels, which are the product of granite and dolerite erosion. The Darling Plateau has been deeply eroded by stream action which has led to the creation of the characteristic hills and valleys, which predominantly flow east to west towards the scarp.

2.2.2 Topography

The site is characterised by undulating topography with a prominent valley running laterally through the site. Topographic contours indicate that the site ranges from 247 metres Australian height datum (m AHD) to 316 m AHD. The highest point within the site is located on a crest within a section of remnant vegetation toward the centre of the site. The lowest point is located at the discharge of the central streamline on the southern boundary. Slope varies within the site to a maximum gradient of 15 %. The flattest areas within the site are generally located at higher elevations on saddles, ridgelines and crests.

The streamlines are incised to some measure, however the upper reaches of the streamlines which originate within site are poorly defined and are effectively valley floors. The lower sections of streamlines where they discharge from the site are evidenced by mildly incised channels 0.5 to 1.0m deep, or low-lying areas with no defined channel and culverted flow under boundary roads.

2.2.3 Soils

The site lies within the "surface of planation and lateric uplands" (Dp), and "narrow, shallow valley floors" (Fv), geological classifications (Smurthwaite 1986).

Regional geological mapping indicates that ground conditions throughout the site are largely comprised of laterite (LA1), which is known to exhibit poor drainage, low permeability and can be difficult to excavate. Laterites are hard and cemented up to 4 m thick, with an overlying layer of Gravel.

Streamline banks, lower lying areas and valleys throughout the site are generally underlain by sand and silt (G2) and fine to coarse grained granites (GR). Gravelly silty sand (Smg), white to grey in colour with fine gravel and common clay underlay streamlines.

Recent Geotechnical investigations at the site (Galt Geotechnics 2017) confirm that the site is underlain by materials consistent with the regional mapping, including:

- Gravelly sand/sandy gravel/gravel: fine to coarse grained sand, fine to medium pisolitic gravel, dark grey brown typically becoming pale brown, yellow brown or orange brown, typically dry and loose, trace very well cemented cobbles and boulders, present from ground surface and extending to depths ranging from 0.15 m to 1.2 m;
- Hardpan laterite: very well iron cemented, massive, typically dark red brown variably mottled yellow brown and off-white, becoming yellow brown and weakly to well cemented at depths

ranging from 1.8 m to 2.8 m, present from ground surface and extending to investigated depths ranging from 1.0 m to 3.3 m;

- Clayey sand/sandy clay (SC-CI): fine to coarse grained sand, between 15% to 50% low to medium plasticity fines, either mottled red-brown and yellow brown or off-white and yellow brown, varying between laterised clayey soils and extremely weathered granitic rock, present from depths as shallow as 1.5 m and extending to a depth of up to 2.8 m.

2.3 Historical land use

Approximately half of the site has historically been cleared for agricultural/grazing purposes, including the majority of streamline areas. Large sections of discontinuous remnant vegetation have been retained throughout the site.

Historical aerials show that the southern section of the site was partially cleared and the two dams/lakes along the southern site boundary were constructed prior to 1965 (earliest available imagery). The northern section of the site was cleared and the three significant dams constructed between 1965 and 1974. There have been no significant clearing activities observed within the site since 1974.

Between February and September of 2016 contour bunds were installed in three areas to the south west of the site, presumably to control erosion.

2.4 Waterways, drains and wetlands

2.5 Wetlands

There are no mapped geomorphic wetlands located within the site. There is however one location within the site that exhibits wetland-like characteristics. This area is located immediately downstream of the north-eastern dam. The location of the 'wetland' area within the site is shown on Figure 4 of the LWMS.

2.6 Surface water

2.6.1 Streamlines

The majority of the site is underlain by low permeability soils and an undulating topography grading towards shallow valleys. During rainfall events, runoff from the surrounding catchments are concentrated within streamlines. Clutterbuck Creek flows through the eastern portion of the site, and the main central catchment discharges to this Creek south of the site. Clutterbuck Creek is a tributary of Jane Brook and those catchments which discharge northwards eventually discharge to Susannah Brook. There are four main streamlines present within the site, all of which have had surface water capture dams constructed in the past (these are detailed in **Section 2.6.3**).

The locations of streamlines and site discharges is shown in Figure 4 of the LWMS.

2.6.2 Roadside swales

Roadside swales are present along the majority of the western and northern boundaries (Roland Road and Cameron Road respectively).

The roadside swale adjacent to Roland Road is located on the eastern side of the road and is conveyed under Roland Road via culverts. Topography grades from east to west in the vicinity of the Roland Road swale and runoff from the western facing portion of the site contributes runoff to the

swale. Roland Road swale flows are concentrated and discharged southwards, towards Clutterbuck Creek (a tributary of Jane Brook) (at discharge location Out 7) or locally to a dam west of the site (discharge location Out 3).

The roadside swale within the site and adjacent to Cameron Road is located to the south of the road. The eastern section of the swale conveys runoff from the site towards a localised streamline which discharges under Cameron Road via a 900 mm culvert (discharge location Out 1). The western section of the swale directs flow from the site and an upstream catchment towards the low-lying wetland area and culvert (discharge location Out 2), which ultimately discharges to Susannah Brook. The locations of roadside swales and discharge locations are shown in Figure 4 of the LWMS.

2.6.3 Dams

Surface runoff storage dams have historically been constructed within natural streamlines and would have historically served as a water source for agricultural uses. The four main dams are described in detail in the LWMS (Section 3.5) and are shown in Figure 4 of the LWMS.

In addition to the main dams, there is a minor dam which intersects a streamline entering the site from the north.

Discharge from dams is conveyed offsite via incised streamlines which ultimately discharge into either Clutterbuck Creek (a tributary of Jane Brook) to the south or Susannah Brook to the north.

2.6.4 Pre-development surface runoff modelling

The pre-development environment within the site has been modelled using XPSWMM. The modelling and results are discussed in Section 3.5.4 of the LWMS. Detailed modelling assumptions are provided in the Modelling Assumptions Report which is provided in the LWMS (Appendix C).

Pre-development modelling has identified flood widths within representative cross sections throughout streamlines within the site. The cross sections were derived from topographical survey and channel measurements during site inspections by Emerge Associates. A number of cross sections were assessed within each streamline to allow for changes in hydrology (e.g. additional streamline flows, major changes in topography, contributing catchments, etc.).

The results of the modelling and cross-sectional analysis indicated that frequent event flows are predominantly contained within incised channels. The flooded width exceeded the incised channel width in locations where the conveyance capacity of the channel was exceeded, or a defined channel was absent, which lead to wider flooding. This occurred on the two northern discharging streamlines. Where wider flooding occurred, the flood width was estimated through interpolation between cross sections, as dictated by topography.

The estimated flooding extent within streamlines in the frequent event is shown in **Figure 1**.

2.7 Groundwater

The low permeability of underlying laterite soils exhibit poor drainage and act as an aquiclude. There is therefore not expected to be any substantial and/or connected aquifers within the site. It is possible that there may be fractured rock aquifers at some locations, however there is no evidence onsite of this occurring. Groundwater is not expected to significantly recharge an aquifer beneath the site, and therefore the quality of any limited groundwater contributions are therefore not relevant to the ongoing management of the site.

Runoff from rainfall events is conveyed as sheetflow over the steeply sloped terrain towards low lying areas and streamlines, resulting in localised inundation and increased streamflow. It is likely that there would be seasonal saturation of the shallow clayey soil profile, and that the moisture in this shallow layer would migrate to the lower parts of the site. This is evidenced by the vegetation that is sustained in the low points (valleys) of the site.

2.8 Flora and vegetation

The areas of intact vegetation found over the majority of the site can be described as comprising a woodland to open forest of *Corymbia calophylla* (marri) and *Eucalyptus marginata* (jarrah) over grass/forbland of pasture weeds. Where this vegetation occurs within or close to waterways, a sparse to closed shrubland of *Taxandria linearifolia* was noted to occur underneath the canopy.

Parkland cleared areas with scattered native and planted trees over isolated native shrubs over a closed grassland of pasture weeds are also present throughout the site.

Vegetation within and surrounding the two northern waterways tended to comprise a tall open to closed shrubland of *T. linearifolia*, *Astartea scoparia* and *Melaleuca* spp. over forbland of pasture weeds (or layer absent). Some patches of planted **Eucalyptus* spp. were also present, particularly to the south of the man-made dam near the north western waterway.

The vegetation was present in 'good' to 'completely degraded' condition according to the Keighery (1994) vegetation condition assessment scheme.

The portions of vegetation that are directly associated with the waterways are shown on **Figure 2**.

2.9 Heritage

2.9.1 Aboriginal heritage

S18 Approval under the Aboriginal Heritage Act 1972 has been provided for the development to proceed. The approval specifies that the waterways need to be provided within a 60 m corridor. A site inspection was undertaken to determine the point at which the shallow sheet flow within valleys was discernable as a channelized flow to determine the beginning of the streamline. The location was recorded using a GPS and used as the uppermost part of the 'streamline'.

3 FORESHORE AREA DETERMINATION AND PROTECTION MEASURES

A waterway is defined as '*any river, creek, stream or brook, including its floodplain and estuary. This includes systems that flow permanently, for part of the year or occasionally; and parts of the waterway that have been artificially modified*' (DoW 2012).

The foreshore area is defined as '*the land that adjoins or directly influences a waterway. It is the area of transition between the edge of the waterway and the furthest extent of riparian vegetation, the floodplain and riverine landforms, or a negotiated area endorsed*' DWER (DoW 2012).

The results of the desktop study, hydrological modelling, and site visits has allowed identification of the waterway, and associated foreshore areas, across the site.

Minor eroded channels which are the upstream portions of streamlines within the site have low biophysical values. Consequently, these do not specifically need to be protected by a foreshore area. Their current hydrological functions (i.e. the conveyance of runoff) can be achieved through appropriate design of the SP. Notwithstanding that a foreshore area is not required for these portions, are still included within a 60 m corridor to meet the S18 approval requirements and these areas will therefore be protected.

The existing dams within the site are not necessary to protect the values of the waterways. While these will be retained within the 60 m corridor, they do not require a setback purely for hydraulic purposes. It is noted however that there is some measure of vegetation around these, and the vegetation should be considered as necessary to protect the overall values of the waterways.

The portions of the waterways which have trees and understorey vegetation immediately adjacent to the incised streamlines are not necessarily species typically associated with streamlines. These trees/vegetation are currently providing a stabilisation/erosion protection function and therefore retention of these would be necessary to protect the values of the waterway, however only to the extent that frequent event flooding would intersect these. The streamlines which convey Clutterbuck Creek and its tributaries have very little understorey.

The low lying areas adjacent to the two northern streamlines have some measure of understorey and riparian or wetland vegetation, and this should be retained.

The foreshore area and any area that could be considered as a 'foreshore reserve' should be considered to be the sum of:

- The extent of frequent event flooding within and adjacent to the streamlines
- The presence of trees and vegetation immediately adjacent to the dams/storage areas
- The extent of wetland/riparian vegetation adjacent to the streamlines
- Existing trees/vegetation adjacent to Clutterbuck Creek and its tributaries, to the extent that these are intersected by frequent event flooding
- An additional 10 m from the outermost of the above features to allow for side slope integration and management access. It is noted that where maintenance access and topographical integration can be addressed in an alternative manner this requirement would not be relevant.

The extent of the recommended 'foreshore reserve' area is shown spatially in **Figure 3**.

4 CONCLUSIONS

The biophysical factors and hydrological inputs have been assessed, and this allows determination of an appropriate foreshore area, as shown in **Figure 3**. This should be incorporated within POS/conservation areas wherever possible, however where it is not possible to do so an alternate approach could be taken which minimises the extent of clearing and which addresses maintenance access and topographical integration with the surrounding areas.

General References

Department of Water (DoW) 2012, *Operational policy 4.3: Identifying and establishing waterways foreshore areas*, Perth.

Department of Water (DoW) 2013, *Guidance Note 6: Identifying and establishing waterways foreshore areas*, Perth, Western Australia.

Gozzard, J. R. 2007, *Geology and Landforms of the Perth Region*, Geological Survey of Western Australia, Perth.

Keighery, B. 1994, *Bushland Plant Survey: A guide to plant community survey for the community*, Wildflower Society of WA (Inc), Nedlands.

Smurthwaite, A. J. 1986, *Mundaring Part Sheets 2134 II and 2134 III*, Perth Metropolitan Region, Environmental Geology Series, Geological Survey of Western Australia, Perth.

Water and Rivers Commission (WRC) 2001, *Water Note 23: Determining Foreshore Reserves*, East Perth.

Online References

Bureau of Meteorology (BoM) 2018, Climate Data Online, viewed 3rd September 2018, Available from: <http://www.bom.gov.au/climate/data/>.

Department of Aboriginal Affairs (DAA) 2018, *Aboriginal Heritage Enquiry System*, viewed 23 April 2018, <http://maps.dia.wa.gov.au/AHIS2/>.

Department of Biodiversity, Conservation and Attractions (DBCA) 2018, *Geomorphic Wetland Database – Swan Coastal Plain (DBCA-019)*, viewed 3 September 2018, Available from: <https://catalogue.data.wa.gov.au/dataset/geomorphic-wetlands-swan-coastal-plain>.

Department of Water and Environmental Regulation (DWER) 2018, *Perth Groundwater Map database*, viewed 23 April 2018 <http://www.water.wa.gov.au/maps-and-data/maps/perth-groundwater-atlas >.

Landgate 2015, *WA Atlas*, viewed 16 June 2015, <https://www2.landgate.wa.gov.au/bmvf/app/waatlas/>.

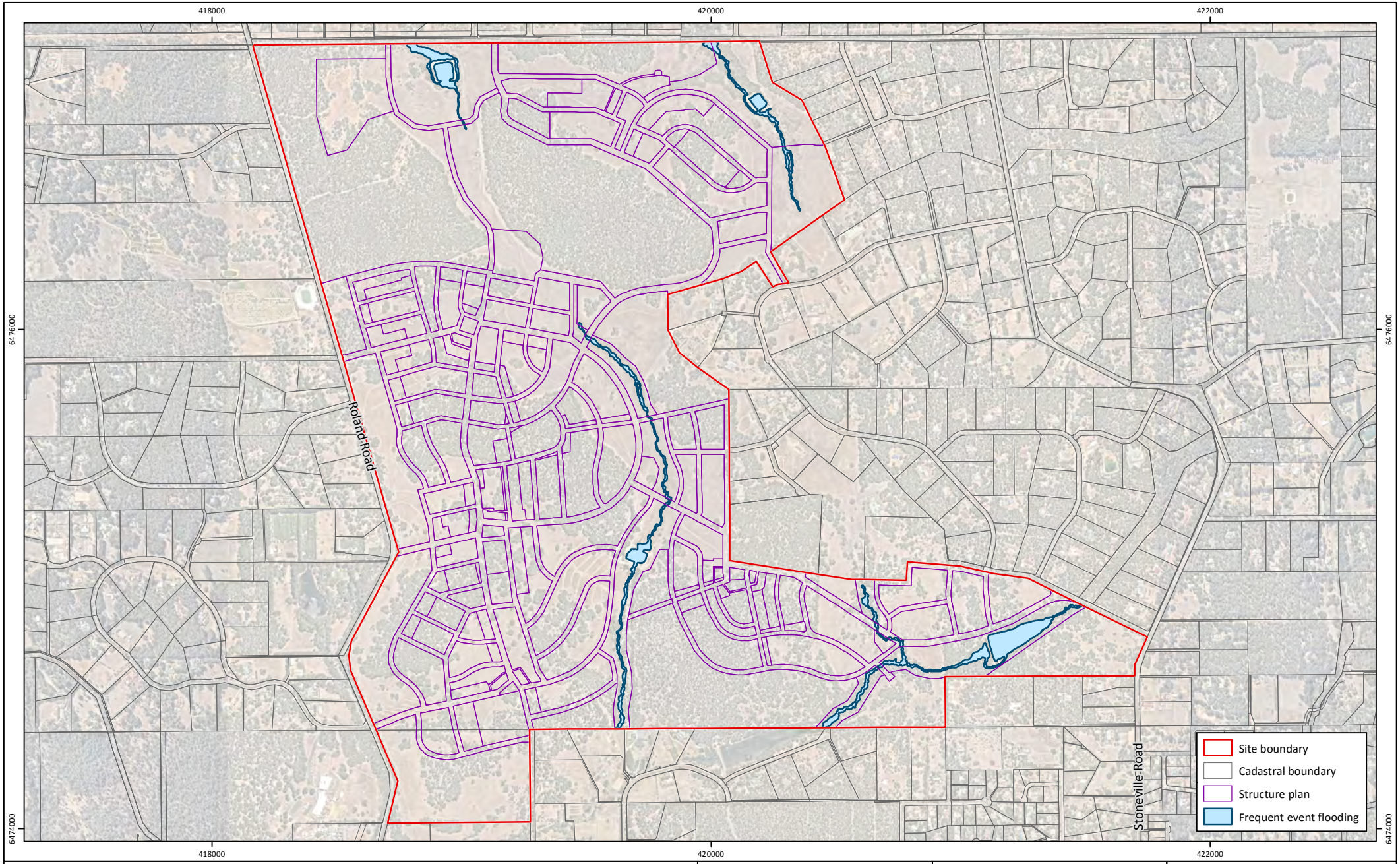

Figure 1: Frequent Event Flooding

Project: Stoneville Structure Plan Support

Client: Satterley

Plan Number:
EP17-013(07)--F13

Drawn:	KNM
Date:	11/06/2019
Checked:	MGB
Approved:	DPC
Date:	11/06/2019

N

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Metres

Scale: 1:20,000@A4

GDA 1994 MGA Zone 50

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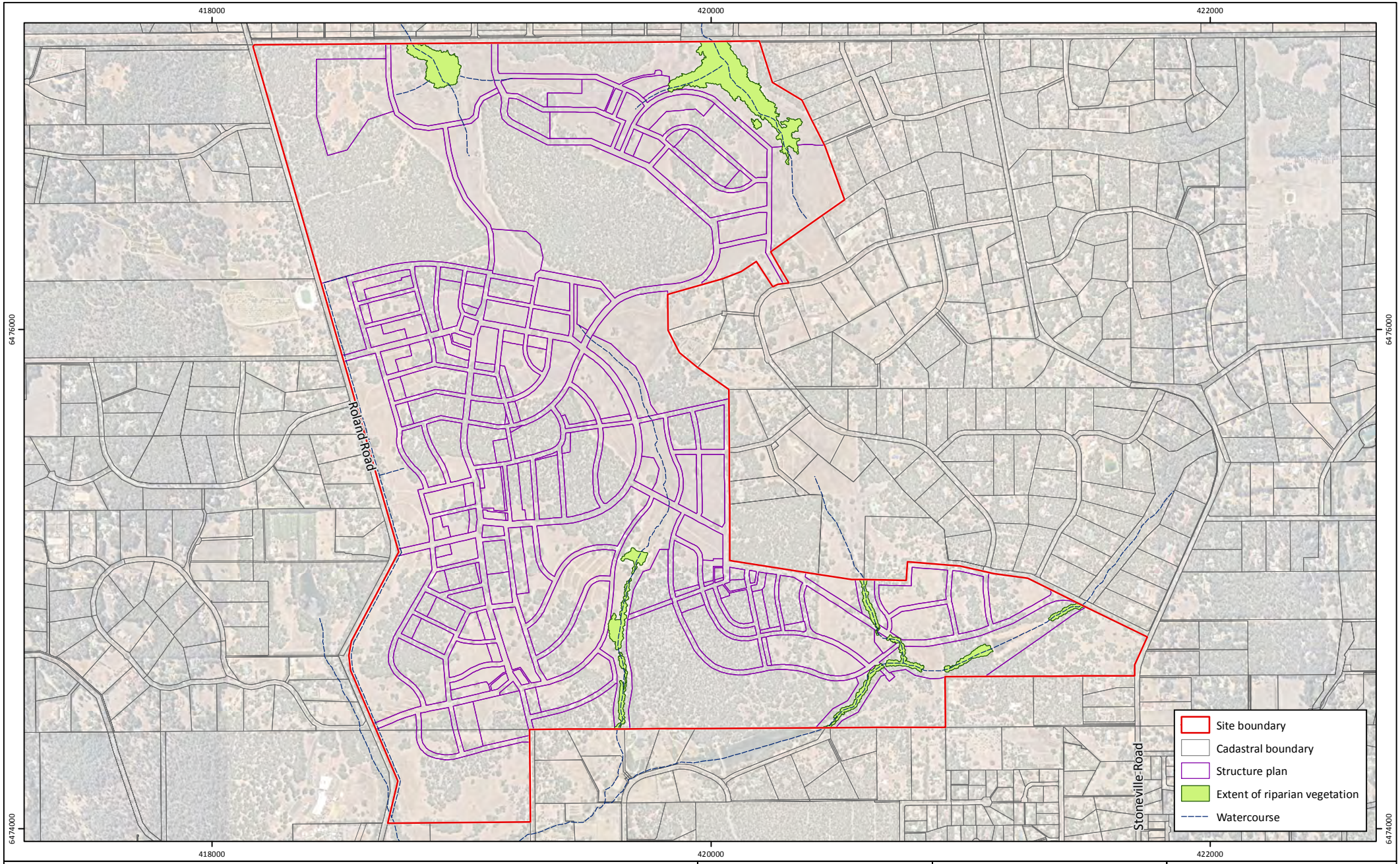

Figure 2: Extent of Riparian Vegetation

Project: Stoneville Structure Plan Support

Client: Satterley

Plan Number:
EP17-013(07)--F14

Drawn:	KNM
Date:	11/06/2019
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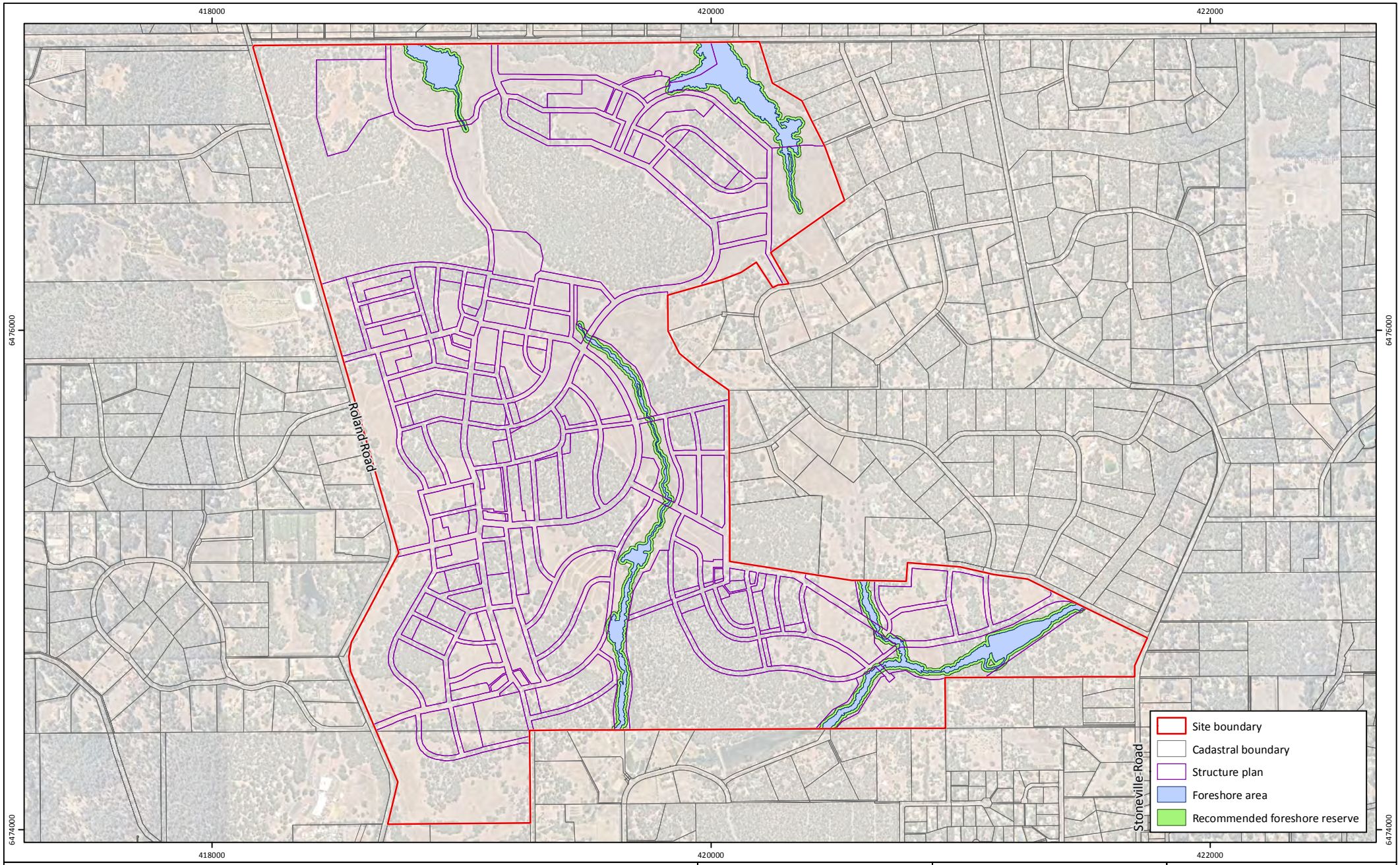

Figure 3: Identified Foreshore Areas

Project: Stoneville Structure Plan Support

Client: Satterley

Plan Number:
EP17-013(07)--F15a

Drawn:	KNM
Date:	17/06/2019
Checked:	MGB
Approved:	DPC
Date:	17/06/2019

N

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Metres

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Appendix D

Modelling Assumptions Report

North Stoneville SP34 Structure Plan Support

Modelling Assumptions Report

Project No: EP17-013(02)

Prepared for Satterley
November, 2018

Document Control

Doc name:	North Stoneville SP34 Structure Plan Support Modelling Assumptions Report				
Doc no.:	**EP17-013(02)--013**				
Version	**Date**	**Author**		**Reviewer**	
1	November 2018	Marley Butler	MGB	David Coremans	DPC
	To support North Stoneville LWMS				

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1 Introduction

Emerge Associates have been engaged to prepare a Local Water Management Strategy, to support structure planning of North Stoneville SP34, in Stoneville Western Australia. This modelling assumptions report has been prepared to support the *North Stoneville SP34 Local Water Management Strategy* (LWMS) (Emerge Associates 2018)

XPSWMM hydrologic and hydraulic modelling software has been used to model the existing site and proposed development to identify the peak flows leaving the site and inform the proposed drainage designs for the site. XPWMM software utilises the *Australian Rainfall and Runoff* (AR&R) (Ball J *et al.* 2016) flood estimation methodology and Bureau of Meteorology (BoM) *Intensity-Frequency-Duration* (IFD) rainfall estimates which are based on long term historical records across multiple monitoring locations. The use of hydrological modelling, incorporating long term rainfall record patterns, is considered best practice for drainage design.

1.1 Modelling Assumptions

The hydrologic component of the XPSWMM model uses the Laurenson 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 and regional topographical data.
- Infiltration rates and percentage imperviousness have been selected based on experience with model preparation for similar soil conditions, SP34 footprint and average lot sizes, calibrated data from a similar, nearby development area and regional geological mapping.

Runoff from each sub-catchment is routed through the catchment using the hydraulic component of XPSWMM. Generally, assumptions associated with the hydraulic component of the model include:

- Virtual links (i.e. purely for model construction, not equivalent to flow path onsite) between nodes within a sub-catchment are given nominal lengths and slopes; typically 10-20 m in length with slopes of 5 – 10% to minimise the lag time of conveying the water from a sub-catchment node to a ‘storage’ node, a ‘dummy intermediate’ node or a conduit/link. In certain scenarios virtual links were required to have slightly different characteristics as dictated by natural terrain.
- Considering the scale of the site and the early stage of planning, links between sub-catchment storages are given nominal lengths and slopes with a suitable roughness representative of road surfaces for the purposes of conceptual conveyance.
- Artificial channels are designed with a width of 5 m, roughness of 0.014 (Manning’s n) and are trapezoidal in shape. This allows for easy conveyance and represents concrete pipes and road surfaces within the model.
- Natural streamlines were represented by trapezoids with roughness, gradient and cross sections chosen to be representative of the streamline as determined by aerial photography and topography.
- Where relevant, median swales, bio-retention areas (BRAs), and flood storage areas (FSAs) are modelled as nodal-reservoirs with no infiltration.

2 Pre-development Model

2.1 Pre-development catchments

The pre-development catchment areas have been informed by:

- Topographical contours (regional 2 m contours)
- Existing roadside drainage
- Existing surface water features and streamline discharge locations.

Three pre-development land use types were identified using aerial photography and the extent of vegetation cover. Soil/ground conditions were generally consistent across the site, and are characterised by impervious clay and laterite at or close to the surface.

The pre-development model uses an "initial loss - continual loss" infiltration model. Land use loss assumptions were converted from calibrated loss assumptions of the same land types from a characteristically similar site.

Land use types and loss parameters are shown in **Table 1**, with total and segmented catchment areas shown in **Table 2.**

Table 1: North Stoneville pre-development land uses and loss parameters

Land type	Initial loss (mm)	Continual loss (mm)	Roughness (Manning's n)
Clay Sparse Vegetation	5	3.8	0.1
Clay Medium Vegetation	7	6.8	0.12
Clay Dense Vegetation	12	10.5	0.2

Table 2: North Stoneville pre-development catchment areas

Catchment	Slope	Area (ha)			
		Total area	Clay sparse	Clay medium	Clay dense
1	0.04	88.748	29.994	-	58.753
2	0.03	168.022	73.080	46.167	48.775
3	0.02	21.974	8.108	-	13.866
4	0.06	186.895	75.924	23.979	86.992
5	0.03	160.020	-	56.607	103.414
6	0.04	98.781	31.197	-	67.584
7	0.06	75.622	36.086	10.048	29.488
8	0.03	164.172	15.130	85.727	63.314
9	0.065	18.945	-	-	18.945
10	0.07	20.716	8.647	1.263	10.806

2.2 Pre-development flow paths

Flow paths and discharge locations have been identified through review of topographical contours and aerial imagery, topographical survey and through site visits by Emerge Associates hydrologists. Inflows from upstream catchments have been assumed to concentrate at the point at which the contributing streamline enters the site. Natural streamlines conveying flows from upstream catchments were designed with representative physical characteristics as discussed in **Section 1.1**. No streamlines were modelled for upstream contributing catchments. These catchments used the Laurenson method of runoff routing within XPSWMM to concentrate flows at discharge locations.

2.3 Critical duration analysis

A critical duration peak flow analysis was carried out for the 20% AEP (5 year ARI) and 1% AEP (100 year ARI) events with durations ranging from 15 minutes to 3 days. The pre-development critical durations for each discharge location for both the 20% and 1% AEP events are summarised below in **Table 3**.

Table 3: Pre-development critical duration flow analysis

Discharge location	Contributing pre-development catchments	Critical duration (mins) (1% AEP)	Critical duration (mins) (20% AEP)
Ct1	1	360	1,440
Ct2	2	360	2,280
Ct3	3	360	1440
Ct4	4	360	360
Ct5	5	360	360
Ct6	6	360	1,440
Ct7	7	360	1,440
Ct8	8	360	360
Ct9	9	360	1,440
Ct10	10	720	720
Dummy out	5, 6, 8	360	360

3 Post-development Model

3.1 Post-development catchments

The post-development catchment areas within the site were informed by:

- Topographical contours (surveyed 25 cm contours within the site and regional 2 m contours)
- North Stoneville Structure Plan 34 revision K
- Road layout and flow directions provided by civil engineers
- Existing roadside drainage
- Existing surface water features and streamline discharge locations.

A summary of the catchment areas are provided in **Appendix A**.

3.2 Post-development land uses and loss assumptions

The post-development model uses an "initial loss - continual loss" infiltration model.

Land use assumptions for post-development catchments were informed by:

- North Stoneville Structure Plan 34 revision K
- Topographical contours (surveyed 25 cm contours within the site and regional 2 m contours)
- Regional geological mapping
- Site visits by Emerge Associates hydrologists
- Preliminary civil design details.

The loss assumptions used were predominantly based upon the following assumptions:

- Lot assumptions
  - Lot areas that would remain largely unchanged in the post development environment (T1,T2, T3 the school lot and the wastewater treatment lot) were split into their underlying pre-development land uses.
  - Higher density lots that would be earthworked (T4, T5 and Centre) have higher loss parameters to represent imported fill and ripping of underlying soils (designated 'HD' in-model).
  - Open spaces assumed a clay sparse vegetation density land use.
  - A percentage of impervious area was deducted from each land use area to represent housing, paths and driveways for development lots. Percentage imperviousness was calculated by assuming a nominal lot impervious area of 300 m^2 for T2, T3, T4 and T5 lots, 6,000 m^2 for the wastewater treatment facility (based on available footprint plans) and 3 ha total impervious area for the combined school sites.
- Road reserves
  - Road reserves assumed a 60% impervious area.
  - There will be no infiltration on roads, pavements and driveways. There will however be some minor absorption storage loss which is accounted for in the initial loss value.
  - Road verge will assume similar loss characteristics to medium vegetated areas, but with a smoother roughness coefficient.

- No infiltration is assumed to occur within stormwater management features due to the largely impervious underlying ground conditions.
- Volumes leaving the system through evapotranspiration were assumed to be negligible when compared to the total runoff volume and in the timeframe of a storm event since the duration of model run was short, and there would be little/no transpiration when air moisture levels are close to saturation, therefore XPSWMM default evapotranspiration assumptions are used.

A summary of the land uses allocated to structure plan lot types and associated land use loss assumptions are provided in **Table 4** and **Table 5** respectively.

Table 4: Land use distribution and imperviousness (Structure Plan allocation)

Land Type (structure plan)	Land use loss assumption allocation	Average lot impervious area (m^2)	Average Lot size (m^2)	% impervious
Road reserve	Split into road surface and verge	-	-	60
Open space	Clay Sparse Vegetation	-	-	0
Conservation (T1)	Split into existing pre-development land uses	-	-	0
T2	Split into existing pre-development land uses	300	22,000	1.4
T3	Split into existing pre-development land uses	300	1,400	21.4
T4	HD	300	820	36.6
T5	HD	300	500	60.0
School	Split into existing pre-development land uses	30000	-	16.4
Wastewater	Split into existing pre-development land uses	6000	-	5.8
Centre	HD	1.0867	-	95

Road reserve is assumed to be constituted of 60% road surface and 40% road verge.

Table 5: Land use loss assumptions

Land Type		Initial loss (mm)	Continual loss (mm/hr)	Manning's number (n)
Road surface		0.5	0	0.01
Road verge		7	6.8	0.05
HD		20	3.8	0.035
Lot Impervious		1	0.1	0.014
Pre-development	Clay Sparse Vegetation	5	3.8	0.1
	Clay Medium Vegetation	7	6.8	0.12
	Clay Dense vegetation	12	10.5	0.2

3.3 Critical duration analysis

A critical duration peak flow and peak stage analysis was carried out for the 20% AEP (5 year ARI) and 1% AEP (100 year ARI) events with durations ranging from 15 minutes to 3 days. The pre-development critical durations for each discharge location and each FSA for both the 20% and 1% AEP events are summarised in **Table 6** and **Table 7**.

Table 6: Critical duration discharge flow analysis

Discharge location	Critical Duration (20% AEP)	Critical Duration (1% AEP)
Out 1	1440	360
Out 2	720	360
Out 3	1440	360
Out 4	720	360
Out 5	Inflow	
Out 6	Inflow	
Out 7	720	360
Out 8	360	360
Out 9	1440	360
Out 10	720	60

Table 7: Critical duration FSA stage analysis

FSA		Critical Durations (20% AEP)	Critical Duration (1% AEP)	Discharge location
FSA 13		360	360	Out 3
FSA 14		720	360	
FSA 15		1,440	360	Out 7
FSA 17		2,880	360	
FSA 26		360	360	
FSA 29		720	360	Out 10
Dams	FSA 5	1440	360	Out 1
	FSA 10	720	360	Out 2
	FSA 30	1440	360	Out 4
	FSA 50	360	360	Out 8

4 References

Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M and I, T. 2016, *Australian Rainfall and Runoff: A Guide to Flood Estimation*, Commonwealth of Australia (Geoscience Australia), Canberra.

Emerge Associates, 2018, *North Stoneville SP34 Local Water Management Strategy,* report prepared for Satterley, Subiaco.

Appendices:

Post-development spatial, land use and slope catchment breakdown

Post development catchment	Land use	Area (ha)	Average slope (%)
Ct 1	Clay dense	51.559	6.2
Ct 1	Clay sparse	24.876	5.6
Ct 1	Impervious	0.600	10.0
Ct 1	Clay sparse	2.688	5.4
Ct 10	Clay dense	1.657	3.1
Ct 10	Clay med	1.410	3.7
Ct 10	Clay sparse	5.594	4.4
Ct 10	HD	1.361	4.3
Ct 10	Impervious	1.892	10.0
Ct 10	Road	2.924	4.4
Ct 11	Road	2.246	4.4
Ct 12	Clay dense	3.404	4.6
Ct 12	Clay sparse	0.160	2.8
Ct 12	Impervious	0.051	10.0
Ct 13	Clay dense	0.405	3.3
Ct 13	Clay sparse	0.758	3.2
Ct 13	HD	1.662	2.6
Ct 13	Impervious	1.276	10.0
Ct 13	Road	1.727	2.6
Ct 14	Clay dense	0.937	3.1
Ct 14	Clay sparse	0.544	2.5
Ct 14	HD	0.845	4.0
Ct 14	Impervious	0.598	10.0
Ct 14	Road	1.092	2.7
Ct 15	Clay dense	1.217	7.1
Ct 15	Clay sparse	10.244	5.2
Ct 15	HD	2.278	3.3
Ct 15	Impervious	1.927	10.0
Ct 15	Road	1.826	4.9
Ct 16	Clay dense	5.493	5.8
Ct 16	Clay sparse	8.289	5.2
Ct 16	HD	6.364	4.5
Ct 16	Impervious	6.704	10.0
Ct 16	Road	11.439	4.6
Ct 17	Clay dense	2.956	6.1
Ct 17	Clay sparse	6.190	5.0
Ct 17	HD	3.563	4.4
Ct 17	Impervious	4.168	10.0
Ct 17	Road	6.383	5.1
Ct 18	Clay dense	3.820	8.5
Ct 18	Clay med	0.115	3.9
Ct 18	Clay sparse	5.063	4.8
Ct 18	Impervious	1.765	10.0
Ct 19	Clay dense	4.123	10.4
Ct 19	Clay sparse	4.330	8.9
Ct 19	Impervious	2.082	10.0
Ct 19	Road	3.530	8.1
Ct 2	Clay dense	5.858	4.2
Ct 20	Clay dense	0.025	10.4
Ct 20	Clay sparse	6.019	5.3
Ct 20	Impervious	0.461	10.0
Ct 20	Road	0.181	6.8
Ct 21	Clay dense	0.751	7.4
Ct 21	Clay sparse	0.253	5.7
Ct 21	Impervious	0.197	10.0
Ct 21	Road	0.563	9.2
Ct 22	Clay dense	2.391	9.2
Ct 22	Clay sparse	0.562	5.9
Ct 22	Impervious	0.804	10.0
Ct 22	Road	1.565	7.6
Ct 23	Clay dense	5.090	9.2
Ct 23	Clay sparse	0.543	7.4
Ct 23	HD	0.384	5.5
Ct 23	Impervious	1.719	10.0
Ct 23	Road	3.563	8.7
Ct 24	Clay sparse	3.356	5.8
Ct 24	HD	0.303	7.6
Ct 24	Impervious	1.198	10.0
Ct 24	Road	2.796	5.6
Ct 25	Clay dense	4.114	11.5
Ct 25	Clay med	0.133	12.8
Ct 25	Clay sparse	4.498	12.0
Ct 25	Impervious	0.124	10.0
Ct 26	Clay dense	2.823	8.7

Post development catchment	Land use	Area (ha)	Average slope (%)
Ct 26	Clay med	4.209	9.4
Ct 26	Clay sparse	3.520	5.8
Ct 26	HD	2.316	5.6
Ct 26	Impervious	3.188	10.0
Ct 26	Road	5.371	7.8
Ct 27	Clay dense	0.106	12.1
Ct 27	Clay med	1.453	12.5
Ct 27	Clay sparse	1.808	13.5
Ct 27	Impervious	0.048	10.0
Ct 28	Clay dense	3.282	13.0
Ct 28	Clay sparse	6.000	11.5
Ct 28	Impervious	0.132	10.0
Ct 29	Clay dense	1.751	8.4
Ct 29	Clay med	0.546	4.8
Ct 29	Clay sparse	2.858	10.4
Ct 29	Impervious	0.349	10.0
Ct 29	Road	1.346	8.1
Ct 3	Clay dense	13.377	3.8
Ct 3	Clay sparse	1.553	5.7
Ct 30	Clay dense	1.873	11.5
Ct 30	Clay med	2.127	8.9
Ct 30	Clay sparse	1.862	9.6
Ct 30	HD	0.440	7.2
Ct 30	Impervious	1.850	10.0
Ct 30	Road	1.664	10.3
Ct 31	Clay dense	0.060	13.0
Ct 31	Clay med	2.294	9.0
Ct 31	Clay sparse	1.828	10.4
Ct 31	Impervious	1.139	10.0
Ct 31	Road	1.141	10.1
Ct 32	Clay dense	1.305	9.5
Ct 32	Clay med	2.626	10.0
Ct 32	Clay sparse	3.401	6.6
Ct 32	HD	4.155	6.3
Ct 32	Impervious	4.776	10.0
Ct 32	Road	5.948	6.8
Ct 33	Clay dense	1.974	10.1
Ct 33	Impervious	0.028	10.0
Ct 34	Clay dense	1.622	6.7
Ct 34	Clay sparse	9.621	8.9
Ct 34	Impervious	0.030	10.0
Ct 35	Clay dense	2.271	14.9
Ct 35	Clay sparse	0.116	12.5
Ct 35	Impervious	0.034	10.0
Ct 36	Clay dense	0.833	11.5
Ct 36	Clay sparse	1.483	7.1
Ct 36	HD	0.300	10.4
Ct 36	Impervious	0.682	10.0
Ct 36	Road	1.433	9.6
Ct 37	Clay dense	1.173	6.3
Ct 37	Clay sparse	0.207	9.6
Ct 37	HD	0.319	6.4
Ct 37	Impervious	0.504	10.0
Ct 37	Road	0.650	9.5
Ct 38	Clay dense	9.280	13.6
Ct 38	Impervious	0.569	10.0
Ct 39	Clay dense	11.669	11.6
Ct 39	Impervious	0.354	10.0
Ct 4	Clay dense	15.693	3.8
Ct 4	Clay med	0.279	3.2
Ct 4	Clay sparse	3.797	3.4
Ct 4	Road	0.190	6.9
Ct 40	Clay dense	1.723	5.4
Ct 40	Clay sparse	1.202	7.2
Ct 40	HD	0.776	6.8
Ct 40	Impervious	1.435	10.0
Ct 40	Road	2.362	5.4
Ct 41	Clay dense	5.936	8.4
Ct 41	Clay sparse	4.647	5.2
Ct 41	HD	0.595	6.1
Ct 41	Impervious	2.793	10.0
Ct 41	Road	4.062	6.9
Ct 42	Clay dense	2.857	6.8
Ct 42	Clay sparse	0.106	2.0
Ct 42	Impervious	0.042	10.0
Ct 43	Clay sparse	1.308	5.4
Ct 44	Clay dense	0.416	6.0
Ct 44	Clay med	0.098	7.7

Post development catchment	Land use	Area (ha)	Average slope (%)
Ct 44	Clay sparse	1.267	5.5
Ct 44	Impervious	0.485	10.0
Ct 44	Road	0.987	6.4
Ct 45	Clay dense	0.664	7.7
Ct 45	Clay med	1.944	7.6
Ct 45	Clay sparse	2.487	5.2
Ct 45	Impervious	1.387	10.0
Ct 45	Road	2.726	5.9
Ct 46	Clay sparse	1.963	3.7
Ct 47	Road	0.182	2.4
Ct 48	Clay dense	1.571	4.5
Ct 48	Clay med	4.764	2.9
Ct 48	Clay sparse	0.500	2.3
Ct 48	Impervious	0.097	10.0
Ct 49	Clay sparse	7.435	6.1
Ct 5	Clay dense	3.043	4.8
Ct 5	Clay sparse	1.901	3.9
Ct 5	Impervious	0.579	10.0
Ct 5	Road	2.115	4.2
Ct 50	Clay dense	0.179	7.8
Ct 50	Clay med	2.673	7.8
Ct 50	Impervious	0.776	10.0
Ct 50	Road	1.065	7.6
Ct 51	Clay sparse	1.714	5.0
Ct 52	Clay dense	0.625	6.0
Ct 52	Clay med	2.340	5.0
Ct 52	Impervious	0.042	10.0
Ct 52	Road	0.876	5.2
Ct 53	Clay dense	2.184	5.2
Ct 53	Clay med	2.517	3.5
Ct 53	Impervious	0.067	10.0
Ct 54	Clay med	1.809	2.1
Ct 54	Impervious	0.026	10.0
Ct 54	Road	0.317	0.5
Ct 6	Clay dense	3.128	6.1
Ct 6	Clay sparse	3.857	5.7
Ct 6	Impervious	0.099	10.0
Ct 7	Clay dense	1.140	4.4
Ct 7	Clay sparse	5.858	3.9

Post development catchment	Land use	Area (ha)	Average slope (%)
Ct 7	HD	1.919	3.8
Ct 7	Impervious	2.739	10.0
Ct 7	Road	5.105	4.2
Ct 8	Clay med	0.316	6.4
Ct 8	Clay sparse	20.009	5.6
Ct 8	Impervious	0.120	10.0
Ct 9	Clay dense	2.217	7.4
Ct 9	Clay sparse	1.030	7.2
Ct 9	HD	0.760	10.3
Ct 9	Impervious	1.323	10.0
Ct 9	Road	1.085	8.4
US Ct 2a	Clay dense	8.574	4.4
US Ct 2a	Clay med	31.132	4.4
US Ct 2a	Clay sparse	0.794	4.4
US Ct 2b	Clay dense	7.144	4.4
US Ct 2b	Clay med	11.476	4.4
US Ct 2b	Clay sparse	24.130	4.4
US Ct 4a	Clay dense	0.176	6.9
US Ct 4a	Clay med	5.175	6.9
US Ct 4a	Clay sparse	4.026	6.9
US Ct 4b	Clay dense	4.794	6.9
US Ct 4b	Clay sparse	0.010	6.9
US Ct 5	Clay dense	103.440	4.2
US Ct 5	Clay med	56.644	4.2
US Ct 6	Clay dense	67.557	5.3
US Ct 6	Clay med	0.024	5.3
US Ct 6	Clay sparse	30.482	5.3
US Ct 8a	Clay dense	11.352	4.1
US Ct 8a	Clay med	58.969	4.1
US Ct 8a	Clay sparse	0.037	4.1
US Ct 8b	Clay dense	16.483	4.1
US Ct 8b	Clay med	6.665	4.1

Appendix E

Surface Water Quality Monitoring Results

Surfacewater Monitoring Results 2017-2018

		Field						Inorganics	Nutrients							
		pH (field)	EC (field)	DO	DO (saturated)	Redox (field)	Temperature	TSS	NH3 as N	NO2- as N	NO3- as N	NOx	TKN	TN	Reactive P as P	TP
		pH units	µS/cm	mg/L	%	mV	oC	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Site Code	**Date of Sampling**															
SW1	14/07/2017	7.23	1380	4.22	40.5	183	13.2	-	0.02	<0.01	0.15	0.15	0.1	0.2	<0.01	0.02
SW1	30/08/2017	6.44	717	7.75	76.1	48.5	14.4	-	0.02	<0.01	0.04	0.04	0.1	0.1	<0.01	0.02
SW1	14/09/2017	6.41	740	5.67	57	94.7	15.6	5	0.03	<0.01	<0.01	<0.01	0.1	0.1	<0.01	0.01
SW1	5/07/2018	5.15	824	8.81	82.1	74.9	12.1	-	0.01	<0.01	1.86	1.86	0.6	2.5	<0.01	<0.01
SW1	26/07/2018	5.98	590	8.16	82.1	53.3	15.6	-	0.01	<0.01	1.47	1.47	0.4	1.9	<0.01	<0.01
SW2	14/07/2017	7.83	818	7.91	78.5	153	15	-	<0.01	<0.01	0.5	0.5	0.2	0.7	<0.01	0.04
SW2	30/08/2017	6.41	463	7.86	78.2	46	15.2	-	0.02	<0.01	0.92	0.92	0.3	1.2	<0.01	0.01
SW2	14/09/2017	6.71	399	6.21	63.2	69	16.3	<5	0.03	<0.01	0.76	0.76	0.2	1	<0.01	0.01
SW2	5/07/2018	5.66	428	10.4	97.6	58	12.5	-	0.02	<0.01	5.05	5.05	<0.5	5	<0.01	<0.05
SW2	26/07/2018	6.22	346	8.15	81.1	44	15	-	0.03	<0.01	3.16	3.16	0.6	3.8	<0.01	<0.02
SW3	14/09/2017	6.37	435	6.64	69.2	96	17.6	<5	0.03	<0.01	<0.01	<0.01	0.1	0.1	<0.01	<0.01
SW3	26/07/2018	5.56	307	7.78	76.2	74	14.5	-	0.01	<0.01	0.08	0.08	0.1	0.2	<0.01	<0.01
SW3	30/08/2018	6.43	419	8.43	85.4	54	15.9	-	<0.01	<0.01	0.02	0.02	<0.1	<0.1	<0.01	<0.01
SW4	14/07/2017	7.38	405	7.38	80.5	195	15	-	0.01	<0.01	3.64	3.64	0.4	4	<0.01	<0.02
SW4	30/08/2017	6.53	254	6.53	88.9	49	16.5	-	<0.01	0.01	2.5	2.51	0.2	2.7	<0.01	<0.02
SW4	14/09/2017	6.91	267	6.91	103.1	87	18.7	<5	0.03	<0.01	2.64	2.64	0.3	2.9	<0.01	0.04
SW4	5/07/2018	5.31	323	5.31	96.5	65	12.3	-	0.03	<0.01	4.3	4.3	0.5	4.8	<0.01	<0.02
SW4	26/07/2018	6.21	251	6.21	86.4	64	-	-	0.03	<0.01	3.33	3.33	0.6	3.9	<0.01	0.09
SW5	30/08/2017	6.45	388	9.73	100	56	16.8	-	0.01	0.03	1.57	1.6	0.4	2	<0.01	<0.01
SW5	14/09/2017	6.35	396	7.39	76.6	97	17.2	<5	0.02	<0.01	1.39	1.39	0.3	1.7	<0.01	0.02
SW5	5/07/2018	5.3	335	8.17	78.9	69	12.7	-	0.01	<0.01	3.85	3.85	0.7	4.6	<0.01	0.03
SW5	26/07/2018	5.61	339	7.49	73.4	70	14.5	-	0.01	<0.01	4.7	4.7	0.6	5.3	<0.01	<0.02
SW6	26/07/2018	5.55	226	7.38	71.3	74	13.7	-	0.02	<0.01	6.64	6.64	1.6	8.2	<0.01	<0.05
Minimum Concentration		5.15	226	4.22	40.5	44	12.1	<5	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.01	<0.01
Maximum Concentration		7.83	1380	10.4	103.1	195	18.7	5	0.03	0.03	6.64	6.64	1.6	8.2	<0.01	0.09
Average Concentration		6.3	480	7.4	79	81	15	3	0.018	0.0063	2.1	2.1	0.38	2.5	0.005	0.018
Median Concentration		6.37	399	7.49	78.9	69	15	2.5	0.02	0.005	1.57	1.6	0.3	2	0.005	0.01
Standard Deviation		0.69	265	1.4	14	41	1.8	1.1	0.0095	0.0053	1.9	1.9	0.33	2.2	0	0.019

Appendix F

Landscape Concepts

LEGEND

- RETAINED VEGETATION OR LANDFORM INTEGRATED INTO OPEN SPACE
- EXISTING HERITAGE SITE TO BE PROTECTED
- EXISTING CREEKLINE & BUFFER
- PROPOSED IRRIGATED POS AREAS
- PROPOSED IRRIGATED KEY STREETSCAPES
- PROPOSED IRRIGATED SECONDARY STREETSCAPES ESTABLISHMENT IRRIGATION (2YRS)
- PROPOSED DRAINAGE AREAS ESTABLISHMENT IRRIGATION (2YRS)
- PROPOSED LOW FUEL ZONES, MANAGED REHAB PLANTING, LOW HEIGHT AT MATURITY NON-IRRIGATED

POS TYPOLOGIES

HA
High Level ACTIVE: Manicured POS with irrigated turf kick-about areas and/or ovals used for sports. Irrigated native and exotic (hardy) garden beds and shade trees of larger stature. Circulating paths, feature walls, shade structures & park furniture provide passive recreation with play equipment and potential art or sculpture located at key nodes. These spaces are commonly located within schools, special use community sites or large areas of dedicated POS.

H
High Level: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.

M
Medium Level: Manicured POS with a parkland setting including irrigated turf pockets, native garden beds and new trees integrated with existing trees, vegetation and landform. Circulating paths, some walls, smaller or low-key shade structures & park furniture. The areas are generally the connecting greenlink portions of POS evident through the centre of the site.

L-M
Low-Medium Level: Some seasonally irrigated turf, temporary irrigated garden beds and new tree planting integrated with rehabilitation planting, retained vegetation and landform. Walking trails, signage, resting nodes with park furniture and potential bike trails are proposed. Spaces generally include some drainage function.

L
Low Level: Retention of existing vegetation and landform to the majority of the site. Some manicured buffer landscape treatments with minimal turf & temporary irrigation works to native garden beds. Walking paths and rest points to be provided

Creek line Corridor: Retention of existing vegetation and water bodies including creeks and dams where possible.
New drainage basins and manicured buffer landscape treatments with turf & temporary irrigation works to native garden beds. Walking trails, signage, resting nodes with park furniture and potential bike trails are proposed.

NORTH STONEVILLE TOWNSITE

LANDSCAPE MASTERPLAN
NOVEMBER 2018

JOB NO. 1612601
1:6000 @ A1

M1.101

0 60 120 240 360 600m

REV B

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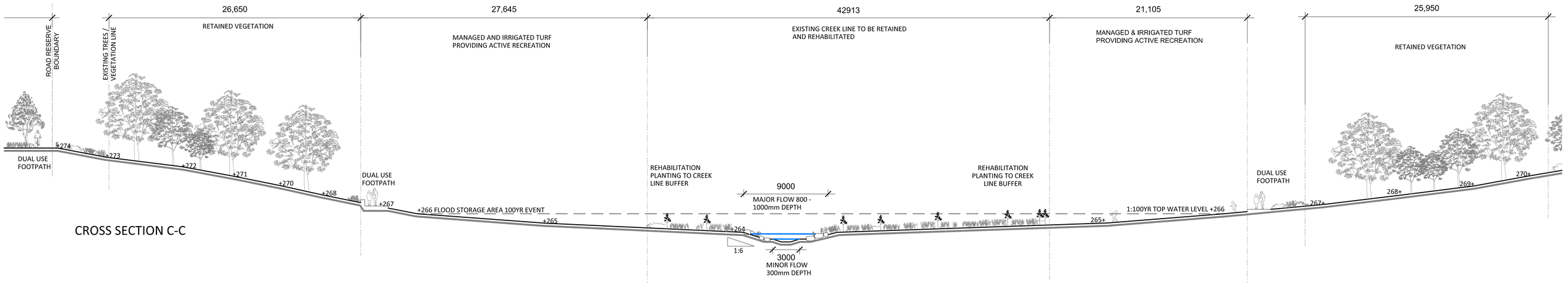

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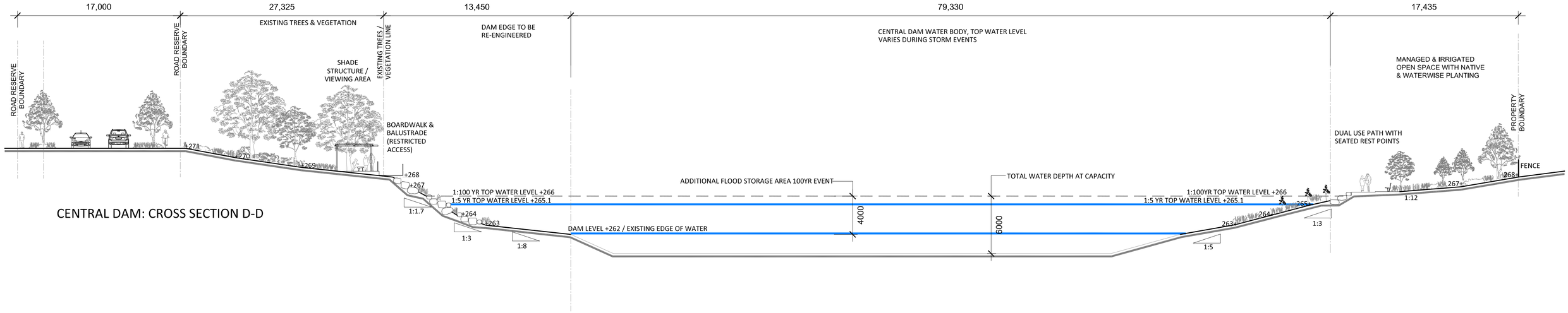

CENTRAL DAM: CROSS SECTION D-D

NORTH STONEVILLE TOWNSITE

PREPARED FOR SATTERLEY PROPERTY GROUP

CENTRAL DAM POS: CROSS SECTIONS (CONCEPT)

JOB NO. 1612602 C1.102 REV B NOV 2018

1:200 @ A1

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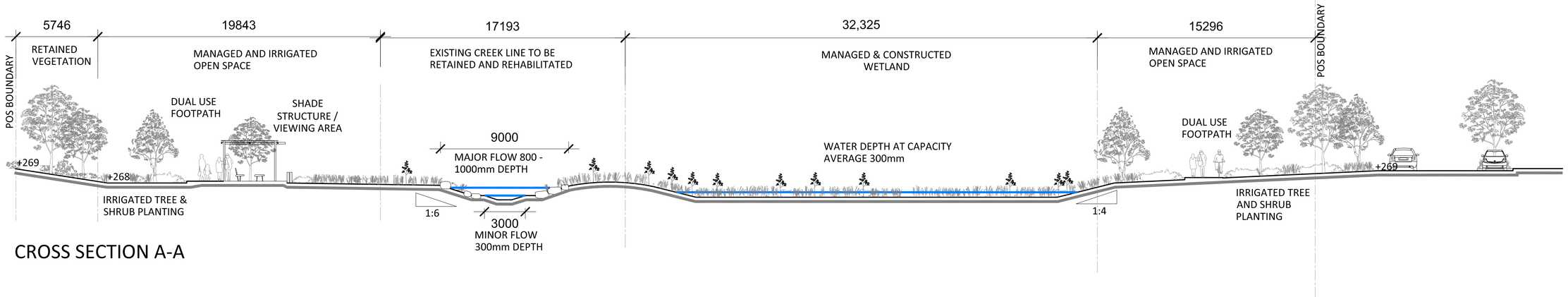
PLAN \ E

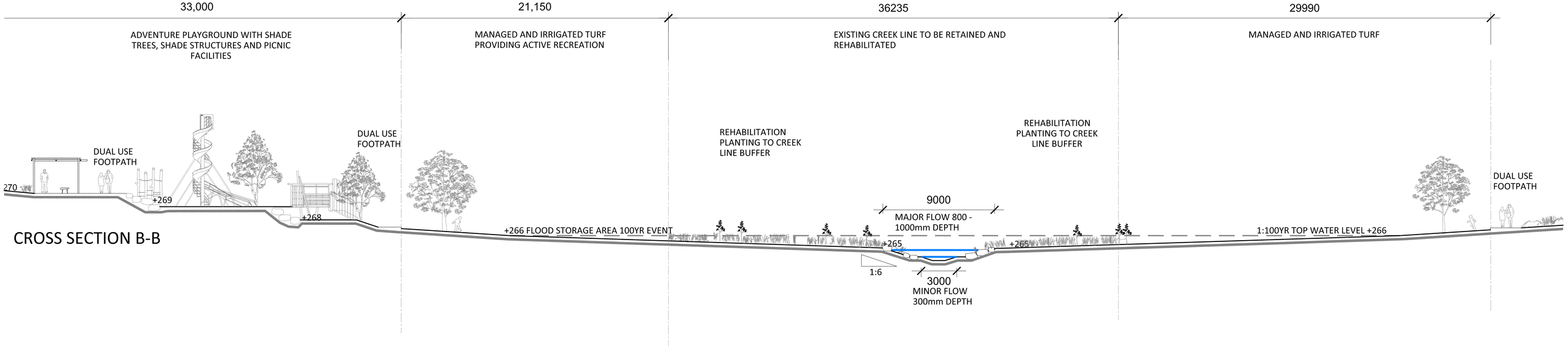
FILE LOCATION: L:\PROJECTS\2016 PROJECTS\16126 NORTH STONEVILLE TOWN SITE\1612602\PROJECT\P5 DRAWINGS\CONCEPTS\ACAD\1612602 C1.101 DAM CROSS SECTIONS.DWG

PLOTTED BY: KDAWSON

PLOT DATE: 19/11/2018 4:21:38 PM



CROSS SECTION A-A



CROSS SECTION B-B

NORTH STONEVILLE TOWNSITE

PREPARED FOR SATTERLEY PROPERTY GROUP

CENTRAL DAM POS: CROSS SECTIONS (CONCEPT)

JOB NO. 1612602 C1.101 REV B NOV 2018

1:150 @ A1

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NORTH STONEVILLE TOWNSITE

SATTERLEY PROPERTY GROUP
DRAWING [1612601 C101] REVISION [B]

1612601
REV D

IRRIGATION CALCULATIONS

DWER LAND USE CLASSIFICATION					NATURE AREAS (M2)	IMPERVIOUS AREAS (M2)	NATIVE GARDEN (M2)		RECREATION AREAS, (RED HIGHLIGHTED ARE SPORTS GROUNDS M2)	ASSUME 50% NATIVE GARDEN AND 50% NON NATIVE GARDEN (M2)	NATIVE GARDEN (M2)		SPORT GROUNDS KL
POS AREA	TYPOLOGY / CLASSIFICATION	LOT AREA M2	VERGE AREA M2 (8%-10%)	TOTAL AREA M2	RETAINED VEGETATION, LANDFORM OR CREEKLINE M2 (NON IRRIGATED)	HARD WORKS M2	LOW FUEL ZONE, DRAINAGE BASIN OR OTHER NON IRRIGATED AREA M2		PERMANENT TURF IRRIGATION M2	PERMANENT TREE & SHRUB IRRIGATION M2	TEMPORARY (2yr) ESTABLISHMENT IRRIGATION M2	PERMANENT PASSIVE AREAS: ALLOCATION kl/Ha/Yr (@ 6,750kl/ha/yr)	PERMANENT ACTIVE AREAS: ALLOCATION kl/Ha/Yr (@ 7,500kl/ha/yr)
1	**Low-Medium Level:** Some seasonally irrigated turf, temporary irrigated garden beds and new tree planting integrated with rehabilitation planting, retained vegetation and landform. Walking trails, signage, resting nodes with park furniture and potential bike trails are proposed. Spaces generally include some drainage function.	118,915	9,513.20	**128,428**	47,500	6,421	39,840		**13,866.72**	10,400	10,400	**16,380**	-
2	**High Level ACTIVE**: Manicured POS with irrigated turf kick-about areas and / or ovals used for sports. Irrigated native and exotic (hardy) garden beds and shade trees of larger stature. Circulating paths, feature walls, shade structures & park furniture provide passive recreation with play equipment and potential art or sculpture located at key nodes.	10,920	1,092	**12,012**	-	1,201	420		**6,234.23**	4,156		**2,805.40**	**4,675.67**
3	**Low Level:** Retention of existing vegetation and landform to the majority of the site. Some manicured buffer landscape treatments with minimal turf & temporary irrigation works to native garden beds. Walking paths and rest points to be provided	3,440	344	**3,784**	1,930	378	132		**537**	806	-	**906.63**	-
4	**Low Level:** Retention of existing vegetation and landform to the majority of the site. Some manicured buffer landscape treatments with minimal turf & temporary irrigation works to native garden beds. Walking paths and rest points to be provided	3,935	394	**4,329**	1,930	433	151		**725.66**	544	544	**857.19**	-
5A	**Low Level:** Retention of existing vegetation and landform to the majority of the site. Some manicured buffer landscape treatments with minimal turf & temporary irrigation works to native garden beds. Walking paths and rest points to be provided	116,785	9,342.80	**126,128**	116,785	6,306	3,036		-	-	-	-	-
5B	**Low Level:** Retention of existing vegetation and landform to the majority of the site. Some manicured buffer landscape treatments with minimal turf & temporary irrigation works to native garden beds. Walking paths and rest points to be provided	463,660	37,093	**500,753**	438,590	5,008	57,155		-		-	-	-
5C	**Low-Medium Level:** Some seasonally irrigated turf, temporary irrigated garden beds and new tree planting integrated with rehabilitation planting, retained vegetation and landform. Walking trails, signage, resting nodes with park furniture and potential bike trails are proposed. Spaces generally include some drainage function.	481,120	38,490	**519,610**	374,800	5,196	87,710		**7,786**	22,059	22,059	**20,145**	-
6	**Medium Level**: Manicured POS with a parkland setting including irrigated turf pockets, native garden beds and new trees integrated with existing trees, vegetation and landform. Circulating paths, some walls, smaller or low-key shade structures & park furniture. The areas are generally the connecting greenlink portions of POS evident through the centre of the site.	4,855	486	**5,341**	-	801	2,135		**721.33**	1,683	-	**1,623**	-

7	**High Level ACTIVE**: Manicured POS with irrigated turf kick-about areas and / or ovals used for sports. Irrigated native and exotic (hardy) garden beds and shade trees of larger stature. Circulating paths, feature walls, shade structures & park furniture provide passive recreation with play equipment and potential art or sculpture located at key nodes. These spaces are commonly located with schools, special use community sites or large areas of dedicated POS.	14,320	1,432	**15,752**	3,245	1,575	788		5,072	2,536	2,536	1,712	3,804
8	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	3,600	360	**3,960**	-	594	198		**950.40**	2,218	-	**2,138**	
9	**Medium Level**: Manicured POS with a parkland setting including irrigated turf pockets, native garden beds and new trees integrated with existing trees, vegetation and landform. Circulating paths, some walls, smaller or low-key shade structures & park furniture. The areas are generally the connecting greenlink portions of POS evident through the centre of the site.	7,525	753	**8,278**	3,575	828	414		**1,038**	1,211	1,211	**1,518**	
10	**Medium Level**: Manicured POS with a parkland setting including irrigated native garden beds and new trees integrated with existing trees, vegetation and landform. Circulating paths, some walls, smaller or low-key shade structures & park furniture. The areas are generally the connecting greenlink portions of POS evident through the centre of the site.	2,405	241	**2,646**	1,235	265	265		**-**	881	-	**595**	
11	**Medium Level**: Manicured POS with a parkland setting including irrigated native garden beds and new trees integrated with existing trees, vegetation and landform. Circulating paths, some walls, smaller or low-key shade structures & park furniture. The areas are generally the connecting greenlink portions of POS evident through the centre of the site.	3,735	374	**4,109**	1,420	411	205		**-**	2,072		**1,399**	
12	**Medium Level**: Manicured POS with a parkland setting including irrigated native garden beds and new trees integrated with existing trees, vegetation and landform. Circulating paths, some walls, smaller or low-key shade structures & park furniture. The areas are generally the connecting greenlink portions of POS evident through the centre of the site.	2,530	253	**2,783**	1,015	556.60	139		-	1,072		**724**	
13 & 14	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	945	95	**1,040**	-	103.95	104		**249**	582	-	**561**	
15	**High Level ACTIVE**: Manicured POS with irrigated turf kick-about areas and / or ovals used for sports. Irrigated native and exotic (hardy) garden beds and shade trees of larger stature. Circulating paths, feature walls, shade structures & park furniture provide passive recreation with play equipment and potential art or sculpture located at key nodes. These spaces are commonly located with schools, special use community sites or large areas of dedicated POS.	23,365	2,337	**25,702**	5,075	2,570	6,685		**7,960**	3,411	-	**2,303**	**5,969.92**
16	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	2,675	268	**2,943**	-	441.38	147		**1,177.00**	1,177	-	**1,589**	
17	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	2,560	256	**2,816**	-	422.40	141		**901.12**	1,352	-	**1,521**	

18	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	765	77	**842**	-	168.30	42		**315.56**	316	-	**426**	
19	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	2,105	211	**2,316**	-	463.10	116		**694.65**	1,042	-	**1,172**	
20	**Low-Medium Level:** Some seasonally irrigated turf, temporary irrigated garden beds and new tree planting integrated with rehabilitation planting, retained vegetation and landform. Walking trails, signage, resting nodes with park furniture and potential bike trails are proposed. Spaces generally include some drainage function. Creek line Corridor: Retention of existing vegetation and water bodies including creeks and dams where possible. New drainage basins and manicured buffer landscape treatments with turf & temporary irrigation works to native garden beds. Walking trails, signage, resting nodes with park furniture and potential bike trails are proposed.	36,965	3,697	**40,662**	1,645	4,066.15	8,380		**10,628.14**	7,971	7,971	**12,554**	
21	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	1,620	162	**1,782**	-	356.40	178		**498.96**	-	748	**337**	
22	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	1,570	157	**1,727**	-	345.40	86		**518.10**	777	-	**874**	
23	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	270	27	**297**	-	59.40	15		**89.10**	134	-	**150**	
24	**Medium Level**: Manicured POS with a parkland setting including irrigated turf pockets, native garden beds and new trees integrated with existing trees, vegetation and landform. Circulating paths, some walls, smaller or low-key shade structures & park furniture. The areas are generally the connecting greenlink portions of POS evident through the centre of the site.	3,835	384	**4,219**	1,560	421.85	211		**810.29**	-	1,215	**547**	
25	**Medium Level**: Manicured POS with a parkland setting including irrigated turf pockets, native garden beds and new trees integrated with existing trees, vegetation and landform. Circulating paths, some walls, smaller or low-key shade structures & park furniture. The areas are generally the connecting greenlink portions of POS evident through the centre of the site.	940	94	**1,034**	-	103.40	52		**351.56**	264	264	**415**	
26	**Medium Level**: Manicured POS with a parkland setting including irrigated turf pockets, native garden beds and new trees integrated with existing trees, vegetation and landform. Circulating paths, some walls, smaller or low-key shade structures & park furniture. The areas are generally the connecting greenlink portions of POS evident through the centre of the site.	7,920	792	**8,712**	3,350	871.20	436		**1,622.08**	2,433	- 0	**2,737**	

27	**High Level ACTIVE**: Manicured POS with irrigated turf kick-about areas and / or ovals used for sports. Irrigated native and exotic (hardy) garden beds and shade trees of larger stature. Circulating paths, feature walls, shade structures & park furniture provide passive recreation with play equipment and potential art or sculpture located at key nodes. These spaces are commonly located with schools, special use community sites or large areas of dedicated POS. Creek line Corridor: Retention of existing vegetation and water bodies including creeks and dams where possible. New drainage basins and manicured buffer landscape treatments with turf & temporary irrigation works to native garden beds. Walking trails, signage, resting nodes with park furniture and potential bike trails are proposed.	90,760	9,076	**99,836**	31,430	9,983.60	13,535		**17,954.96**	**13,466**	**13,466**	**9,089.70**	**13,466**
28	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	2,005	201	**2,206**	-	330.83	110		**705.76**	**1,059**	-	**1,191**	
29 & 30	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	910	91	**1,001**	-	150.15	50		**320.32**	**480**	-	**541**	
31	**Medium Level**: Manicured POS with a parkland setting including irrigated turf pockets, native garden beds and new trees integrated with existing trees, vegetation and landform. Circulating paths, some walls, smaller or low-key shade structures & park furniture. The areas are generally the connecting greenlink portions of POS evident through the centre of the site.	2,460	246	**2,706**	950	405.90	135		**485.92**	**729**	-	**820**	
32	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	1,975	198	**2,173**	-	325.88	109		**695.20**	**1,043**	-	**1,173**	
33	**High Level ACTIVE**: Manicured POS with irrigated turf kick-about areas and / or ovals used for sports. Irrigated native and exotic (hardy) garden beds and shade trees of larger stature. Circulating paths, feature walls, shade structures & park furniture provide passive recreation with play equipment and potential art or sculpture located at key nodes. These spaces are commonly located with schools, special use community sites or large areas of dedicated POS.	23,965	2,397	**26,362**	2,045	2,636.15	1,216		**13,301.94**	**7,163**	-	**4,834.74**	**9,976**
34	**Medium Level**: Manicured POS with a parkland setting including irrigated turf pockets, native garden beds and new trees integrated with existing trees, vegetation and landform. Circulating paths, some walls, smaller or low-key shade structures & park furniture. The areas are generally the connecting greenlink portions of POS evident through the centre of the site.	10,065	1,007	**11,072**	4,040	1,660.73	554		**1,926.88**	**1,445**	**1,445**	**2,276**	
35	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	1,285	129	**1,414**	-	212.03	141		**318.04**	**371**	**371**	**465**	
36	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	2,045	205	**2,250**	-	337.43	225		**506.14**	**590**	**590**	**740**	

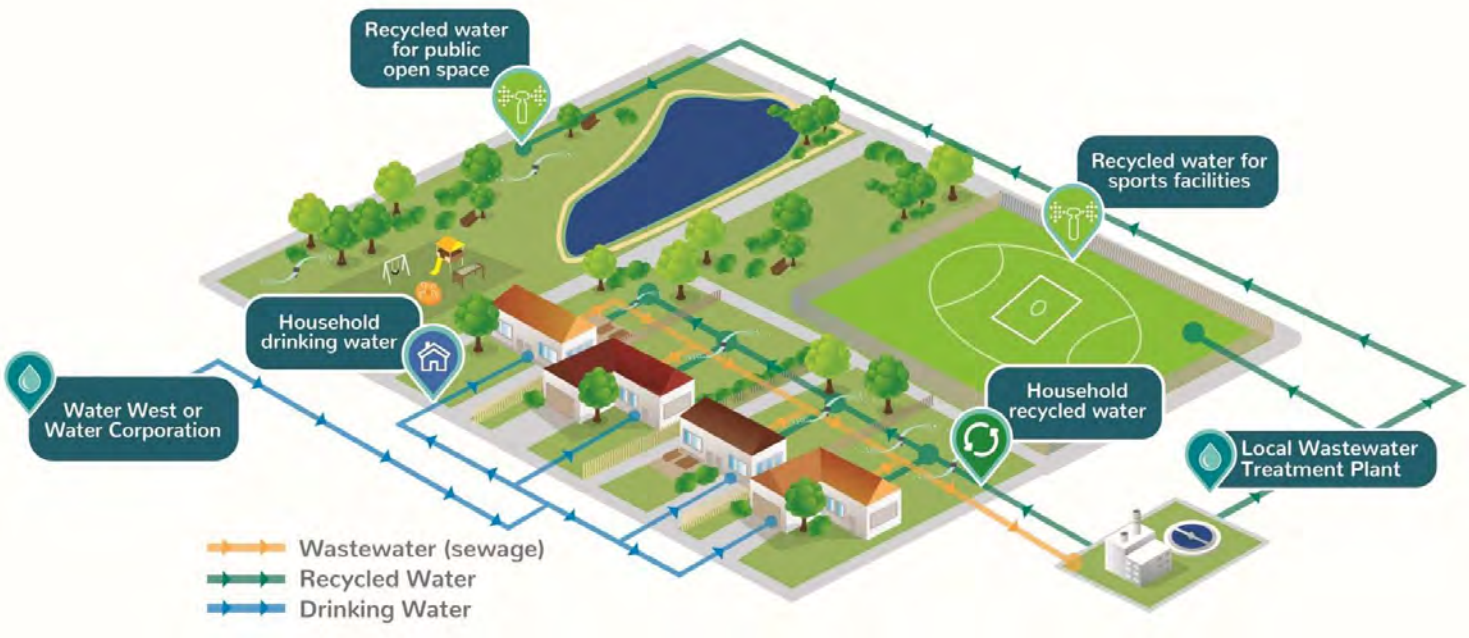
37	**High Level**: Significant areas of hardstand, irrigated turf and large trees with some irrigated native and exotic (hardy) garden beds. Shade structures or arbors, park furniture, and incidental play or sculptures considered at key focal points. Commonly seen in town centre locations or adjacent key community facilities.	2,615	262	**2,877**	-	431.48	144		**690.36**	805	805	**1,010**	
38	**Low-Medium Level:** Some seasonally irrigated turf, temporary irrigated garden beds and new tree planting integrated with rehabilitation planting, retained vegetation and landform. Walking trails, signage, resting nodes with park furniture and potential bike trails are proposed. Spaces generally include some drainage function.	12,995	1,040	**14,035**	5,800	1,403.46	4,760		-	2,071	-	**1,398.02**	
39	**Low Level:** Retention of existing vegetation and landform to the majority of the site. Some manicured buffer landscape treatments with minimal turf & temporary irrigation works to native garden beds. Walking paths and rest points to be provided	4,100	410	**4,510**	495	451.00	226		**1,001.55**	1,168	1,168	**1,465**	
40	**Low Level:** Retention of existing vegetation and landform to the majority of the site. Some manicured buffer landscape treatments with minimal turf & temporary irrigation works to native garden beds. Walking paths and rest points to be provided	19,725	1,973	**21,698**	19,195	2,169.75	1,085		-	- 376	- 376	- **254**	
41	**High Level ACTIVE**: Manicured POS with irrigated turf kick-about areas and / or ovals used for sports. Irrigated native and exotic (hardy) garden beds and shade trees of larger stature. Circulating paths, feature walls, shade structures & park furniture provide passive recreation with play equipment and potential art or sculpture located at key nodes. These spaces are commonly located with schools, special use community sites or large areas of dedicated POS. Creek line Corridor: Retention of existing vegetation and water bodies including creeks and dams where possible. New drainage basins and manicured buffer landscape treatments with turf & temporary irrigation works to native garden beds. Walking trails, signage, resting nodes with park furniture and potential bike trails are proposed.	95,435	7,635	**103,070**	43,210	10,306.98	3,092		**20,907.33**	25,553	- 0	**17,248.54**	**15,680**
OTHER													
SPECIAL SITE	**High Level::** Possible Community Facility such as Cidery. Irrigated turf, garden beds & trees with paths and park furniture.	8,753	700	**9,453**	1,645	105.04	473		**3,615.27**	3,615	-	**2,440.31**	**2,711**
ANG-SCH	**Medium - High Level**: Senior School oval retained Additional 1.Ha general landscape treatments for school interior included.	31,400	-	**31,400**					**25,400.00**	6,000		**4,050**	**19,050.00**
ROLAND RD STREETSCAPE	**Key Streets, High Level** : Retained Trees, possible verge swale Irrigated garden beds and large trees planted.	-	7,295	**7,295**	1,440	729.50	365		-	2,380.38	2,380	**1,607**	
STREETSCAPES	**Key Streets, High Level** : Boulevard treatments with hard treatments, Irrigated turf, garden beds, large trees.	-	63,550	**63,550**	-	6,355	6,355		**15,252.00**	20,972	9,744	**36,223.50**	
STREETSCAPES	**Secondary Streets, Medium Level** : Temporary Irrigated garden beds, 100Ltr trees.	-	50,020	**50,020**	-	5,002	5,002		-		37,015	**-**	
ENTRY AREAS	**High Level** : Signage and Sculpture with temporary Irrigated turf, garden beds, large trees.	-	-	**-**	-	-	-		**-**	-	5,790	**-**	
	SUB TOTAL	**1,633,773**	**255,149**	**1,888,922**	1,113,905	83,364	246,758		**165,829**	157,633	119,350	**162,309**	**75,334**
	SUB TOTAL (Ha)	**163.38**	**25.51**	**188.89**	111.4	8.3	24.7		**16.6**	15.8	11.93		
	SUB TOTAL (ML)										119	**162**	**75**

Appendix G

Stoneville Wastewater Servicing Concept Design Assessment

NORTH STONEVILLE WASTEWATER SERVICING

CONCEPT DESIGN ASSESSMENT



Prepared for

Satterley Property Group

May 2019

PROPRIETARY AND CONFIDENTIAL INFORMATION

The attached document contains proprietary and confidential information and is submitted under a confidential relationship for the purpose defined below.

Purpose: *This document has been prepared to assist in the preliminary assessment of the viability of a wastewater recycling scheme by Water West for the North Stoneville development*.

By accepting this document, the recipient agrees:

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This report has been prepared in consultation with Permeate Partners

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1 EXECUTIVE SUMMARY

The purpose of this report has been to further develop the wastewater servicing scheme for the proposed subdivision of Lot 48 Stoneville Road and Lot 1 Roland Road in Stoneville. The key findings of the investigations undertaken by Water West are presented below.

- The optimal approach to ensure the North Stoneville project can be serviced with or without the inclusion of the potential subdivision of the new Parkerville townsite is to construct one (1) recycled water plant (RWP) in a staged manner which enables the RWP to be expanded if Parkerville proceeds, without materially impacting on the cost of construction or operation of the overall RWP scheme for the North Stoneville project as a discrete, or stand-alone, concept.
- The preferred location of the RWP and storage dams is in the north-west of the estate, with direct access from Cameron Road.
- Management of the recycled water produced via the RWP from the collection of wastewater from each of the North Stoneville and Parkerville subdivisions should be undertaken on-site within each of the North Stoneville and Parkerville estates, with the volume of recycled water to be managed (i.e. storage and disposal) within each estate being proportional to the wastewater generated by each estate.
- There is sufficient recycled water generated by the North Stoneville estate across the year to meet the irrigation requirements for the proposed open space areas within the North Stoneville estate.
- Storage of recycled water will be required in winter in order to meet the “summer” irrigation demands of the open space areas.
- Management agreements will be required between Water West and the relevant party responsible for managing the open space (e.g. public open space, school ovals, wetland) to ensure the recycled water is irrigated as required by Water West in order to maintain the integrity of the water balance.

2 INTRODUCTION

Satterley Property Group proposes to undertake subdivision of Lot 48 Stoneville Road and Lot 1 Roland Road, Stoneville, in partnership with the land's owner, the Perth Diocesan Trust and together, the "Developer".

The land is zoned Urban under the Metropolitan Region Scheme and requires further planning approvals in the form of a Structure Plan and Subdivision, prior to creation of first lot Titles which is anticipated to occur in early 2020.

The key constraint to previously obtaining planning approvals for the subdivision of the land was the absence of a wastewater servicing solution. Satterley Property Group has engaged Water West to address wastewater servicing of the land and Water West's previous desktop investigations of the proposed project indicated that Water West could deliver a solution that was technically and commercially feasible.

The servicing approach previously identified by Water West is still considered to be the optimal solution for the proposed subdivision and is based on the on-site tertiary treatment of wastewater (via a recycled water plant – "RWP") and the re-use of recycled water to meet irrigation demand.

This report has expanded upon the previous preliminary investigations undertaken by Water West, by considering in significant detail the water balance for the project based on the current subdivision concept of ~1,400 residential plus commercial uses and two (2) schools. The water balance has been used to develop a number of scenarios for managing the recycled water generated by the RWP, including irrigation of open space and storage.

The results of the above are presented in the following sections of this report and are intended to form the basis for progressing to the next stage of detailed design, approvals, construction and the final commercial agreement between Water West and the Developer.

Figure 1 – North Stoneville Aerial

3 INCLUSION OF PARKERVILLE SUBDIVISION

Previous discussions have been undertaken with Satterley Property Group regarding the opportunities/issues of including the future Parkerville estate in the concept planning for the North Stoneville estate.

There is uncertainty at this time as to whether the Parkerville estate will proceed and if so, the timing of subdivision commencement and how many lots would be created per year.

Water West's view is that should both projects proceed, operational optimisation would be achieved through one (1) RWP only.

Consequently, the approach taken for this report has been to develop a wastewater scheme that focuses on North Stoneville only, but which makes allowance for the inclusion of Parkerville, without additional cost or land-take for the North Stoneville project.

The design philosophy adopted has therefore been:

- Only one (1) RWP is constructed and that this is at North Stoneville
- The RWP be designed to enable construction in three (3) stages (treatment plant only), with two (2) stages dedicated to North Stoneville and one (1) stage to Parkerville
- Winter surplus recycled water generated by the Parkerville estate be stored in dams on the Parkerville estate and/or otherwise disposed of within the Parkerville estate
- Raw sewage and recycled water conveyance pipes be constructed between the Parkerville estate and the RWP at North Stoneville, the costs of which will be the subject of a commercial agreement between the Parkerville developer and Water West

4 North Stoneville Estate Development Assumptions

The findings outlined in this report are based on the lot yield, lot size and public open space assumptions adopted from the North Stoneville Masterplan prepared by Roberts Day Group and dated 15 November 2018.

The Masterplan is included as Figure 2 on the following page. The Plan E irrigation plan is included as Figures 3 on the following pages.

Commentary regarding the Parkerville estate is provided elsewhere in this report; for relevance, a lot yield of 750 lots was adopted and no assumptions have been made as to the area proposed for public open space within the estate nor to available areas for excess recycled water storage or disposal.

4.1 Residential Lot Yield

Table 1 summarises the residential lot yield and lot type assumptions:

Table 1 - Lot Yield and Type

Lot Type	Lot Size Range	Number of Lots
T1	> 2.0ha	60
T2	800m^2-2,000m^2	1,100
T3	350m^2-800m^2	200
T4	<350m^2	50
Total		1,410

An assumption of 2.8 persons per dwelling has been adopted in the report and it is assumed that all lots are single-dwelling lots.

4.2 Open Space Irrigation Area

Irrigation of open space areas with recycled water has been assumed to occur in various locations throughout the estate in accordance with the Plan E POS Typologies plan contained in Figure 3.

The total irrigation area is 34ha.

The water balance has assumed an average irrigation rate across the 34ha, although it is anticipated that some open spaces such as playing fields will have higher irrigation rates than other open spaces. Given the estate will be developed on a stage-by-stage basis over ~15 years, there will be an opportunity to massage the storage and delivery of the water balance in accordance with more detailed irrigation planning as the subdivision of the estate progresses.

Earlier versions of the North Stoneville Masterplan proposed less POS available for irrigation (now 34ha) which in turn required a different approach to managing the annual water balance for the site; specifically a portion of residential lots being provided an allocation of recycled water for outside irrigation and the concept of sending a small amount of recycled water to a constructed wetland once a year every 3 to 5 years depending on seasonal/rainfall variations. Given the POS available for irrigation has now been increased to 34ha, no recycled water will be provided for residential irrigation and no recycled water will be sent to a constructed wetland. All of the recycled water will be solely used for POS irrigation.

Figure 2 – North Stoneville Masterplan

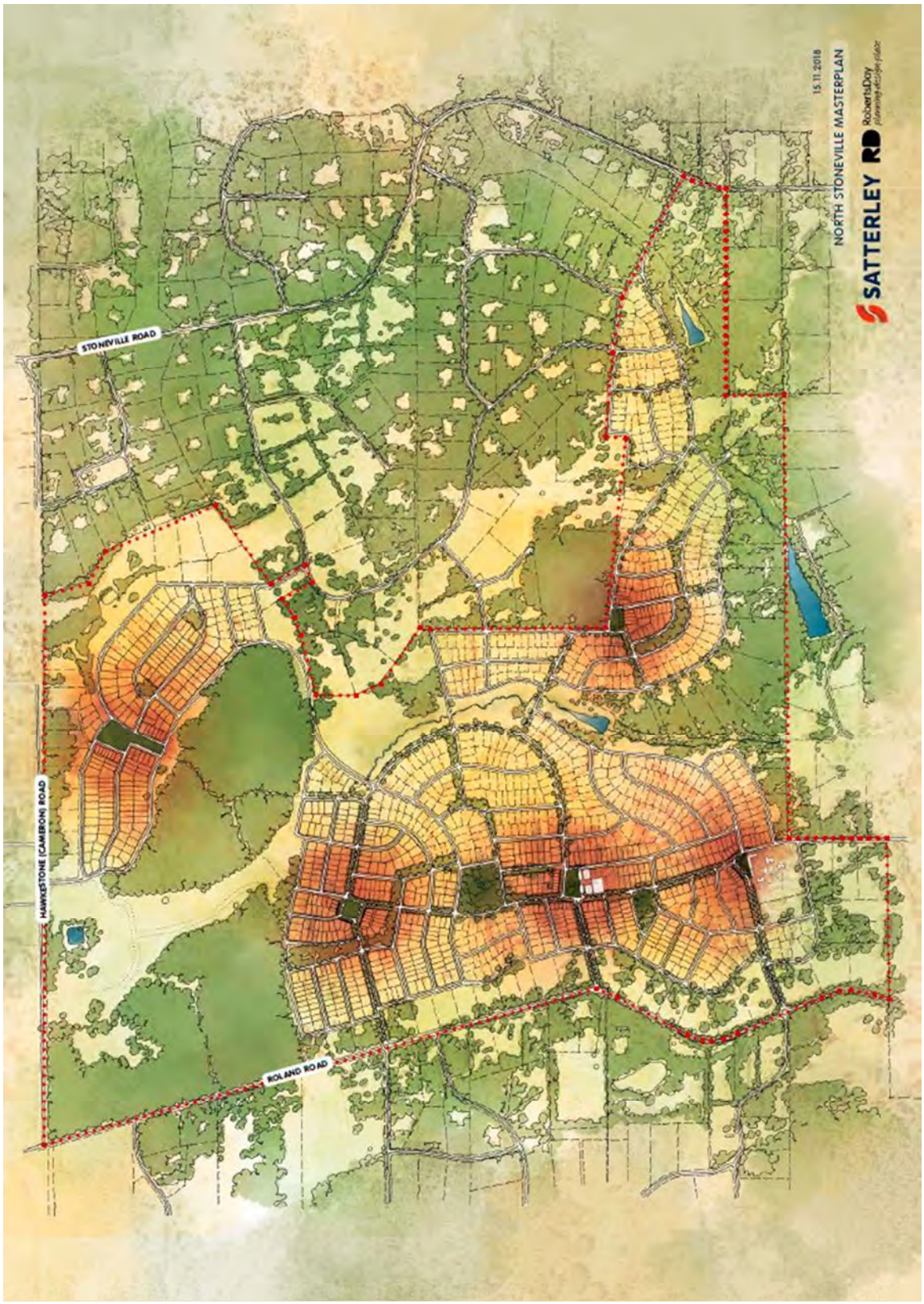
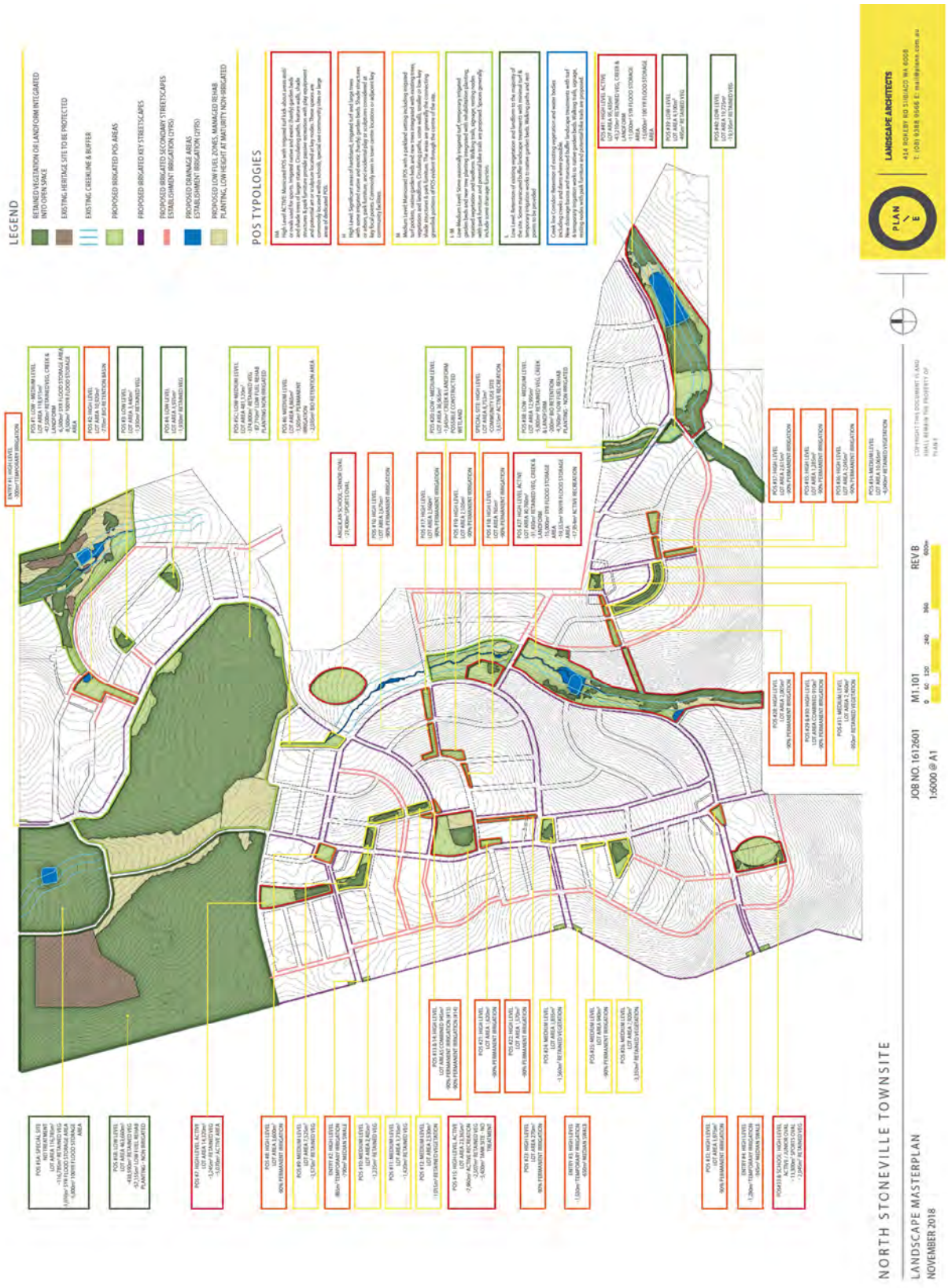


Figure 3 – Landscape POS Typologies



5 WATER BALANCE AND RECYCLED WATER MANAGEMENT

5.1 Overview

Preparing the water balance for the project was the essential first step to determine:

1) the design requirements for the RWP; and,
2) the amount of recycled water available for POS irrigation within the estate.

Specifically, the assumptions and findings of the water balance, which are detailed below, have driven the key design elements of:

- RWP site area requirements;
- RWP technology sizings (e.g. number of membranes, size of concrete bioreactor, etc.);
- open space irrigation rates; and
- size of winter surplus storage dams;

The water balance is sensitive to the driving assumptions of how many lots are being serviced and how many persons per lot (or, per dwelling - ppd) will be characteristic of the estate; number of persons drives the wastewater generated (the water balance is based on 165 litres/person/day of wastewater generated).

The analysis has been undertaken on the assumption of 2.8ppd and ~1,400 lots for the North Stoneville estate. The assumed lot yield for the Parkerville estate is 750 lots.

The water balance is also sensitive to soil composition and annual rainfall assumptions as both these assumptions drive how much water can be applied to public open space, other open space and/or passed through a wetland; there is a limitation as to the quantity of nutrients that can be sent to the "receiving environment", therefore either volume of recycled water irrigated is set at a maximum or the quality (nutrient "loading") of recycled water is amended (via further treatment).

Notwithstanding the assumptions detailed above, there will be an opportunity to analyse real data (e.g. actual household size and irrigation demand) once the subdivision of the estate is underway and adjust future RWP staging/capacity, storage and irrigation areas accordingly. Similarly, capacity/irrigation can also be adjusted to cater for a revised lot yield of approximately +10% with certain operational attenuations to the plant operation.

The information and the assumptions used to prepare the water balance are detailed in 2.

Table 2 – Water balance assumptions

Parameter	Unit	Value	Comment
Stoneville number of lots	-	1410	Information provided by Developer
Parkerville number of lots	-	750	Information provided by Developer
Equivalent persons per lot	EP/Lot	2.8	Accepted standard based on similar communities
Sewage flow	L/EP/day	165	Accepted standard based on similar communities.
POS Irrigation Area	Ha	32.4	Irrigable area in community nominated by the Developer
Design Peak Daily Flow (PDF)	ML/day	N/A	Dictated by the approach for sewer extraction. Design will allow for short periods of higher flow to accommodate fluctuations in demand or process upsets.

Irrigation rate – Active POS	ML/Ha/yr	7.5	Irrigation rates supplied by Plan E
Irrigation rate – Passive POS	ML/Ha/yr	6.75	Irrigation rates supplied by Plan E

When the North Stoneville estate is fully developed, the RWP will generate 237ML of recycled water per year. The open space layout within the Masterplan has been designed to absorb 237ML of irrigation water at standard irrigation rates.

Given irrigation demand is not constant across all months, 84ML of storage in dams (recycled water dams) will be provided to cater for lower irrigation demand in cooler/wetter months (e.g. winter) and higher irrigation demand in warmer/drier months (e.g. summer). Irrigation of POS will gradually draw down on this 84ML storage volume across spring, summer and autumn.

Two recycled water dams will be constructed (total 84ML). The second recycled water dam will not be constructed until the townsite has reached approximately 50% subdivision; if it has become apparent during the early stages of subdivision and operation of the first recycled water dam that volume/storage requirements are greater than currently forecast, the design of the second dam can be revised to cater for an increased volume. Additionally, once the second dam is completed and the subdivision of the townsite has reached – or is close to reaching – full completion and further storage is deemed necessary, the site has sufficient land area available for additional storage to be constructed.

The water balance of the recycled water will be managed across the irrigation season (generally September to May) to ensure required irrigation rates are met (e.g. December to March are forecast to require higher irrigation rates than the "shoulder" seasons). If, by March/April, there is a higher volume of recycled water remaining in the storage dams than forecast, scheduled irrigation rates during these months (and into May) can be adjusted to ensure the remaining recycled water levels of the dams are sufficiently low to cater for winter collection and storage (when there is little to no irrigation demand). The volume of recycled water being stored/irrigated on an annual basis does not change.

The water balance has been completed for the North Stoneville development only. The results can be assumed to be proportional for Parkerville. As previously noted, the preferred approach where the RWP is sized to cater for the Parkerville estate is for Parkerville to undertake all of its recycled water management on its own site – i.e. be it 3rd pipe, winter storage dams, constructed wetland or a combination of these.

6 RECYCLED WATER PLANT

All wastewater produced from the North Stoneville estate will be processed through an on-site recycled water treatment plant (RWP). The recycled water produced by the RWP will be treated to a fit-for-purpose standard that will facilitate re-use within the estate for irrigation of public open space.

6.1 Location and Access

The RWP will be located in the north-west of the estate, in line with direction from Satterley Property Group. The overall layout and location of the RWP is shown in Figure 5 on the following page.

This location is the site of a former quarry and has been significantly cleared of vegetation. Some additional clearing of vegetation will be required.

Access to the RWP is proposed to be from Cameron Road and will be via a sealed access road which utilises the alignment of the access track which was previously cleared for the quarry operations. Operational vehicle movements to/from the RWP will therefore be discrete from the estate. Investigations with the Shire as to approval for access to Cameron Road have not been undertaken at this stage.

The boundaries of the RWP site have not been defined, however a fenced site area which incorporates the key design elements of the RWP as depicted in 5 will be required.

6.2 Tenure

The Department of Health (DoH) will require that the RWP is ultimately located on a separate freehold-titled lot which is owned by and under the control of Water West. The DoH might permit the RWP to be initially located on a defined parcel of land with leasing arrangements that provide indefinite control over - and access to - the land in favour of Water West, however this would likely only be accepted as an interim measure.

Water West recommends that a separate lot for the RWP site be created as part of the stage 1 subdivision of the estate.

Figure 4 – Pitt Town RWP, Sydney

Figure 5 – RWP & Storage Dams Site Arrangement and Access

Prepared by Permeate Partners

6.3 Design Philosophy

The RWP will be a tertiary-treatment facility utilising membrane technology and biological processes, typically referred to as a membrane bio-reactor (MBR) and similar to the facilities viewed by the North Stoneville project team at Pitt Town and Pennant Hills golf course in Sydney.

Storage of winter surplus recycled water is required, with storage in two lined dams sited adjacent to the RWP. .

6.4 Capacity and Staging

The RWP will be designed to service the current forecast flows of ~650kL/day generated by the North Stoneville project, with the option to further expand capacity by ~350kL/day to cater for the Parkerville estate in the event the Parkerville project proceeds.

Given the total wastewater generation of both projects approximates to a split of two-thirds (2/3) for North Stoneville and one-third (1/3) for Parkerville, the RWP will be designed to enable construction in three stages (or modules). This allows for three scenarios:

1) Parkerville never proceeds, or proceeds but with its own RWP – only stages 1 and 2 of the RWP are constructed;
2) Parkerville proceeds, but only after North Stoneville is fully subdivided – stage 3 of the RWP is constructed when needed;
3) Parkerville proceeds concurrently with North Stoneville –stage 3 is constructed when the combined wastewater generation from both estates reaches the treatment capacity for stages 1 and 2.

There will be initial works that will need to be undertaken irrespective of whether stage 3 is constructed; these include civil works for the RWP site area, services (power and water), RWP building and control room and access (to both Cameron Road and around the RWP).

6.5 Layout

The proposed location of the plant has been selected in consultation with the project team. The concept design has been developed to optimise the footprint of the overall plant whilst ensuring the plant is accessible and maintainable.

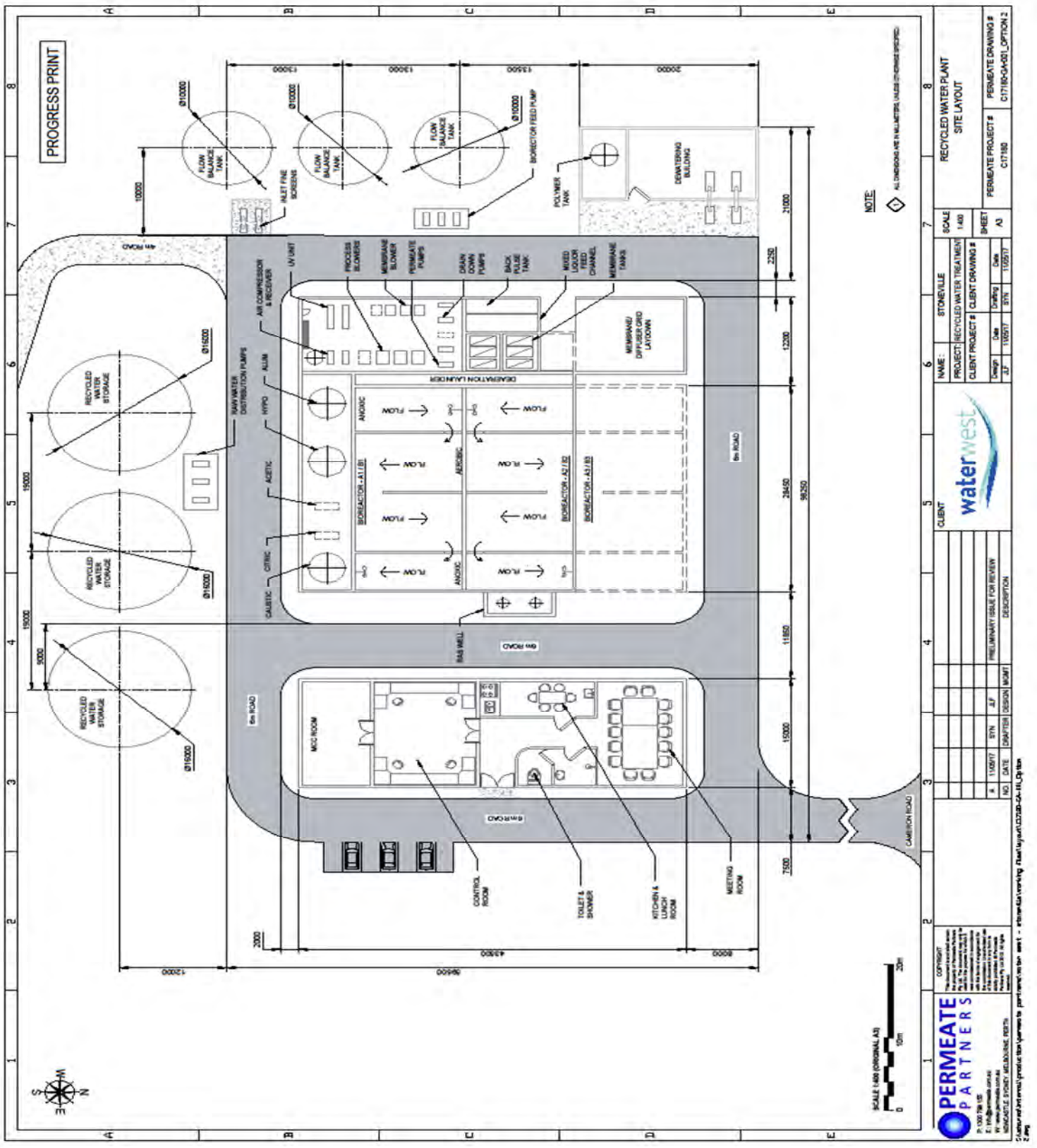
The land proposed for the RWP slopes from RL 300m AHD at the south-west corner to RL 280m AHD at the north-east corner. The RWP will be located on a levelled pad with plan dimensions of approximately 140m by 120m. Earthworks for this pad will therefore require excavation of up to 10m at the western end and fill placement of 1m to 2m at the north-east corner to form a level pad at design level. Estimated volume of cut is 14,100 bcm and the estimated volume of fill is 36,300 bcm.

The proposed RWP layout is shown in Figure 6.

As detailed in section 6, the majority of the RWP elements are designed for construction in three (3) stages – e.g. recycled water storage tanks, bioreactor, membrane units, flow balance tanks.

Elements such as control room, hardstand (access/parking) and building which need to be constructed at the commencement of the scheme, will be required irrespective of a two (2) stage RWP or a three (3) stage RWP (noting there may be some extra costs for these elements by initially designing for three stages, though these are not overly material in the context of the overall RWP design costs.

Figure 6 – RWP Plant Concept Layout



6.6 Flowsheet

The flowsheet for the proposed RWP is summarised below.

6.6.1 *Inlet Fine Screens*

All incoming sewage will pass through a set of fine screens with an aperture size of 2mm or less. This removes solids and inorganic matter from the waste stream and provides protection for the down-stream membranes. The screens are installed as duty/standby. The fine screens are connected to the odour scrubber for treatment of foul air.

The screened sewage is discharged to a Flow Balance Tank (FBT).

The screenings are discharged to a waste bin for disposal off-site

6.6.2 *Flow Balance Tank*

The FBT receives screened sewage and buffers the diurnal flows from the community to provide a relatively steady flow to the treatment plant. The FBT also provides a storage buffer should there be a reason to temporarily stop any downstream process. The FBT is equipped with a mixer to ensure the sewage stays mixed and any solids stay in suspension. From the FBT, the screened sewage is pumped to the biological reactor (bioreactor).

6.6.3 *Biological Reactor*

The bioreactor consists of a biological nutrient removal activated sludge process. The movement of the wastewater between anoxic and aerobic zones enables nitrogen and BOD (biochemical oxygen demand) reduction. Coagulant is added to assist in the removal of phosphorous.

Figure 7 - Bioreactor during commissioning

6.6.4 *Anoxic Zone*

Raw sewage combines with the return activated sludge in the deaeration launder before entering the anoxic zone. An internal recycle also returns sewage from the end of the aerobic zone to the start of the anoxic zone. Mixers are installed in the anoxic zone to suspend the solids and provide good contact between the incoming wastewater and the mixed liquor. The anoxic zone is baffled to ensure a plug flow through the bioreactor.

6.6.5 *Aerobic Zone*

The mixed liquor from the anoxic zone overflows into the aerobic zone. The aerobic zone is aerated with fine bubble diffusers installed in the base of the bioreactor. Similar to the anoxic zone the aerobic zone is baffled to encourage plug flow through the zone. The mixed liquor from the aerobic zone is either returned to the start of

the anoxic zone via the internal recycle, or overflows into the RAS (return activated sludge) well, where it is pumped to the membrane tanks.

To ensure the treated wastewater quality is achieved, key process indicators for the biological reactor such as flow, dissolved oxygen (DO), mixed liquor suspended solids (MLSS) and pH are continuously monitored.

6.6.6 *Membrane Filtration*

Membrane filtration will be used to separate the treated wastewater from the MLSS. The small pore size of the membrane results in the rejection of solids and pathogens at the membrane surface whilst treated water passes through.

Membrane permeability is maintained by:

- Aeration at the base of the membranes to dislodge solids from the membrane surface.
- Periodic relaxing and/or backpulsing of the membranes.
- Periodic chemical cleaning of the membranes.

The permeate pump operates based on biological reactor level and directs filtered water to the chlorine contact tank via the Ultra Violet (UV) disinfection units. The mixed liquor from the membrane tank is returned to the deaeration launder via an overflow. To ensure membrane filtration performance is maintained, key process indicators such as flow, trans-membrane pressure (and permeability) and permeate turbidity are continuously monitored.

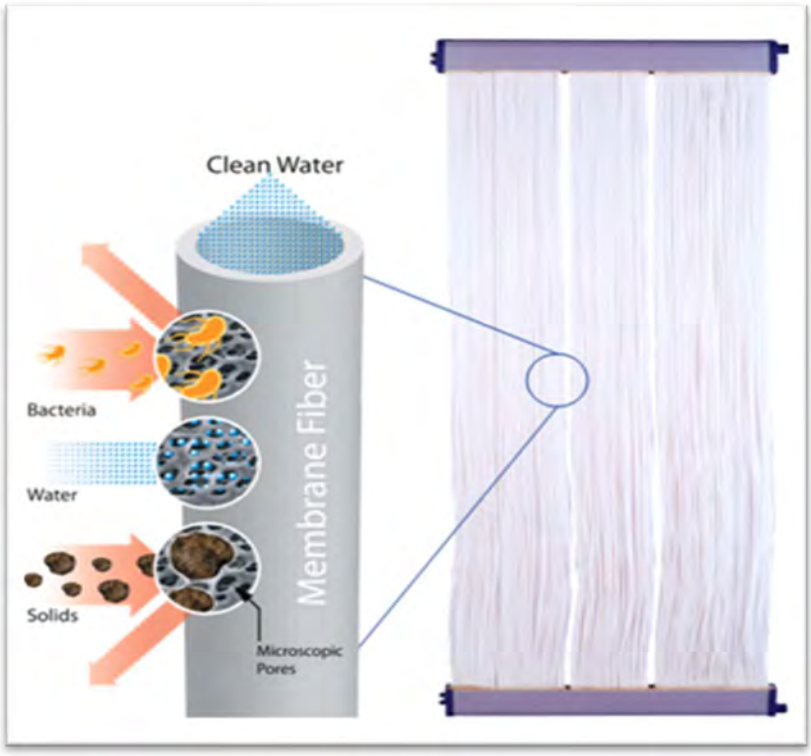


Figure 8 – Membrane Process

6.6.7 *UV Disinfection*

Permeate from the membranes is pumped directly through a UV system to provide an additional disinfection barrier. UV light inactivates pathogens by disrupting their genetic information and rendering them harmless. The UV disinfection system will be installed N+1 to match the plant capacity. UV transmissivity and intensity are continuously measured online to ensure the appropriate dosage is applied.

6.6.8 *Chlorination*

The permeate from the UV system is discharged to the chlorine contact tank where it is dosed with sodium hypochlorite to provide chlorine disinfection. The chlorine contact tank is baffled to ensure plug flow and the appropriate contact time is achieved. Treated water from the discharge of the chlorine contact tank is then pumped to the recycled water storage tanks.

Instrumentation installed at the end of the chlorine contact tank measures the residual free chlorine and controls the dosing rate of the pumps. Dosing pumps for the chlorine contact tank are installed N+1.

6.6.9 *Chemical Storage and Dosing*

Various chemicals are typically required for sewage treatment, recycled water production and cleaning. These chemicals will be stored in appropriately sized tanks, taking into consideration the chemical type and consumption rates. The tanks along with the associated chemical dosing pumps will be located within separate bunded areas. The chemicals that are included in the base case design are described in the table below:

Table 3 – Chemical type and purpose

Chemical	Purpose
Alum	Used as a coagulant to precipitate phosphorous
Sodium Hypochlorite	Used for the final disinfection of the treated recycled water and for membrane cleaning
Citric Acid	Used for membrane cleaning
Sodium Hydroxide	Used to control pH in the biological process

The chemical storage tanks and dosing pumps are designed and bunded in accordance with AS3780. Storage capacity is designed for a nominal 30 days storage. Dosing pumps are installed N+1.

6.6.10 *Odour Scrubbing*

Biofiltration-based odour scrubbing systems are proposed to treat foul air from the inlet screens and the plant sump.

The biofilters are packed with customised media to biologically oxidise the odorous gases in the foul air stream and achieve an H_2S removal efficiency of >99%. Mist sprays in the biofilter ensure the correct level of humidity is achieved at all times within the system.

6.6.11 *Recycled Water Storage and Distribution*

The recycled water storage tanks (as opposed to the storage dams) provide a buffer between the recycled water production and recycled water supply to the community.

A distribution pump set has been included for distribution of the recycled water to the network. Distribution pumps are installed in an N+1 configuration.

Figure 9 – Recycled water storage tanks at Pennant Hills, Sydney

The storage tanks are included for storage of excess recycled water during periods where the production of recycled water is greater than the demand. A pump station has been included to transfer the water from the dam back to the RWP for re-processing prior to distribution.

6.6.12 *Sludge Dewatering*

Waste activated sludge (WAS) from the RWP will be dewatered for disposal. The dry solids are disposed off-site whilst the centrate is returned to the process. A centrifuge system with accompanying polymer dosing system has been included in the concept design.

6.7 Storage Dams

The water balance for the North Stoneville project reveals that there will be a need to store recycled water over winter to meet irrigation requirements for public open space in spring, summer and autumn.

The minimum storage requirement to meet POS irrigation demand is estimated at 84ML.

Figure 10 – Aerial view of Royal Melbourne Golf Course 40ML Recycled Water Storage Dam

Water West considers the optimal location for the storage dams is adjacent to the RWP, on the site of the former quarry.

Figure 5 details the proposed location of the storage dams and presents a design based on two (2) dams of ~40ML in size. The final dam configuration – and the storage options discussed in this report – may vary in design/size from the notional layouts presented in Figure 5.

The dams will be lined with high-density polyethelyne (HDPE) which has high durability and is highly resistant to UV exposure and penetration. Whilst no compromise of the integrity of the liners is anticipated, it is worth noting that the water levels will have real-time water level moniors installed as part of standard operations to assist with the POS irrigation regime and therefore any irregularity in water level changes will be quickly identified, allowing short-term remediation of a breach to the integrity of the liners.

Reconfiguration of storage design has been discussed in section 5.1.

Figure 11 – Ground view of Royal Melbourne Golf Course 40ML Recycled Water Storage Dam

6.8 Raw Sewage Characteristics

For the infrastructure design, the raw sewage characteristics have been assumed to align with typical residential sewage characteristics. The design range for the sewage characteristics are summarised in Table 4 below.

Table 4 – Raw sewage characteristics

Parameter	Unit	Value
5-day Biological Oxygen Demand (BOD_5)	g/person/day[1]	75
	mg/L	307
Total suspended solids (TSS)	g/person/day[1]	75
	mg/L	307
Total Nitrogen (TN)	g/person/day[1]	19
	mg/L	78
Total Phosphorous (TP)	g/person/day[1]	4
	mg/L	16
Total dissolved solids (TDS)	mg/L	<2,000mg/L
pH	-	6.0 to 9.0

6.9 Treated Water Characteristics

The treated water characteristics are presented in *Table 5*.

Table 5 – Treated water characteristics

Parameter	Unit	State	National	Design
5-day Biological Oxygen Demand (BOD_5)	mg/L	<10	-	<10
Total suspended solids (TSS)	mg/L	<10	-	<10
Total Nitrogen (TN)	mg/L	-	-	15
Total Phosphorous (TP)	mg/L	-	-	3-5
pH	-	6.5-8.5	-	6.5-8.5
E.coli	cfu/100mL	<1	<1	<1
Clostridium perfringens	cfu/100mL	<1	-	<1
Somatic coliphage	pfu/100mL	<1	-	<1
Log removal - Bacteria	-	-	≥5	≥5
Log removal – Protozoa & Helminths	-	-	≥5	≥5
Log removal - Viruses	-	-	≥6.5	≥6.5
Free chlorine residual	mg/L	0.2-2.0	-	-
Turbidity	NTU	<2 95%ile <5 100%ile	-	<0.3
Alkalinity	mg/L	-	-	<50

6.10 Temporary/Interim RWP

Water West initially considered the option of a temporary RWP for the first stages of the estate however given the proposed lot creation rate, the limitations on the capacity of a temporary RWP would have required construction of the permanent RWP within three (3) to four (4) years of the creation of the Stage 1 subdivision of the estate. The benefit from deferring capital expenditure on the permanent RWP for this period of time was not considered to outweigh the additional capital expenditure required for the temporary RWP.

If a temporary RWP was to be pursued, the optimal location would have been on the same site as a subsequent permanent RWP. There would therefore be works common to both the temporary and permanent plants, notably access, site works and wastewater/recycled water pumps/distribution, thereby requiring some of the capital expenditure required for the permanent RWP to be undertaken in any event.

7 SEWER AND RECYCLED WATER RETICULATION NETWORKS

7.1 Sewer Reticulation Network

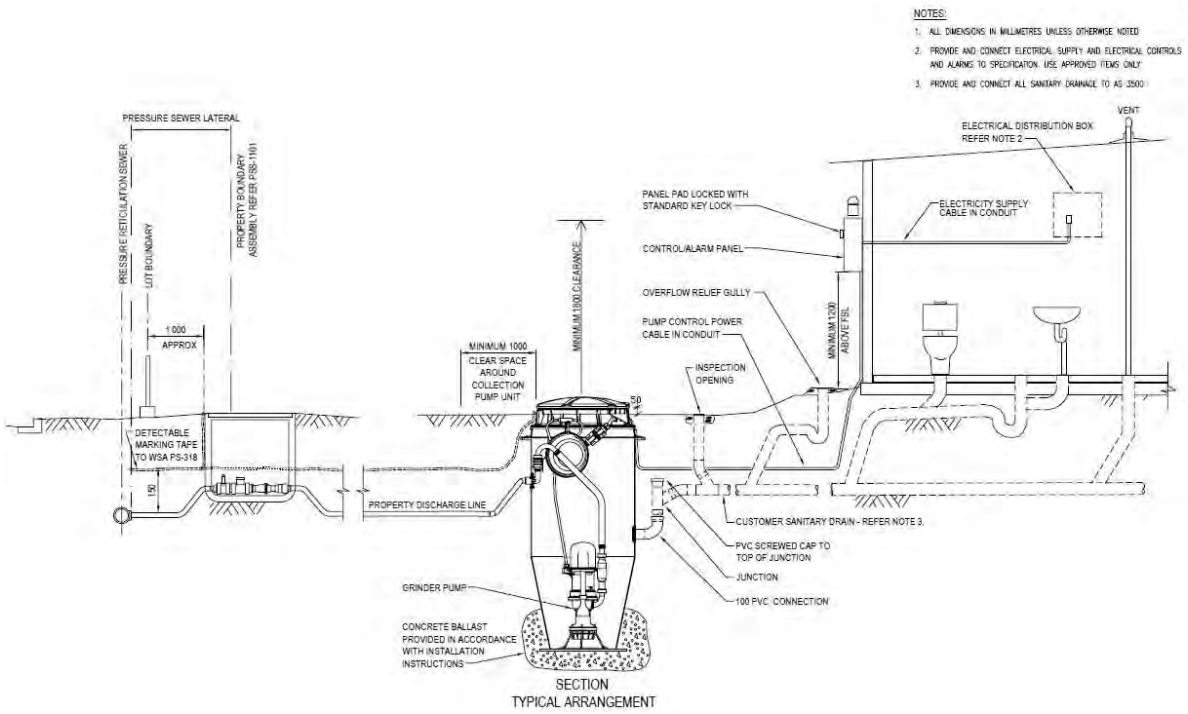
Pressure sewer is the preferred option for North Stoneville given the unknown, though likely significant, amount of rock that may be encountered if deep trenching of a gravity system was undertaken.

A pressure sewer system will provide the following benefits to the North Stoneville project:

- can be constructed at a consistent depth below the finished subdivision level, thereby eliminating deep trenching;
- avoids wet weather infiltration reducing overall hydraulic treatment capacity requirements, thereby also minimising the potential for excess sewage and / or recycled water during wet weather events;
- assists in minimising contamination risks through improved contaminant traceability back to the lot owner;
- enables tracking of individual household sewer production via system telemetry.

Most conventional wastewater treatment facilities have an option to bypass raw sewage during extreme wet weather events directly to the point of discharge (i.e. river or ocean). Given the North Stoneville project needs to be self-contained in terms of treated wastewater (recycled water) management, it is best if extreme wet weather flows are avoided as these are likely to directly add to the costs of the storage dams (greater storage area required) and/or alternative disposal mechanisms such as a constructed wetland or subsurface irrigation.

Figure 12 - PSS On-property Typical Arrangement (Extracted from WSA-07, drawing PSS - 1101)



Water West will ultimately own and maintain the sewer reticulation network. Water West and the Developer will need to confirm the approach for handover of the asset; this detail can be further discussed during the structure planning phase of the project.

7.2 Recycled Water Reticulation Network

A distribution network for the recycled water will be required in selected parts of the estate.

It has been assumed that recycled water will be provided to selected public open space and school ovals.

A distribution system inclusive of pipes and booster pumps will need to be constructed between the RWP and these locations. Given the conceptual stage of the design and project decision making process, Water West has not undertaken an analysis of infrastructure requirements, alignments or costs. This will need to be undertaken during the structure planning phase of the project and will be reliant on inputs from the project engineer, landscape architect and possibly the irrigation consultant.

The Developer will be responsible for the design, construction and delivery cost of the recycled water network.

Water West will ultimately own and maintain the sewer reticulation network.

8 RECYCLED WATER DISPOSAL – OPEN SPACE AND ENVIRONMENTAL

Disposal of the recycled water produced by the RWP is an essential component of the overall wastewater scheme and must be carefully managed to ensure the water balance is maintained across the year. Whilst there is some leeway in the design of the scheme to allow for monthly and seasonal variances, it is essential to the integrity of the scheme that the nominated disposal areas take the recycled water when required.

Given these areas will be located on land which will likely not be under the ownership of Water West, appropriate management agreements will need to be in place to ensure Water West has the ability to manage recycled water disposal as required. Further consideration of the form of these agreements will need to be undertaken during the structure planning process.

Further discussion in regard to the identified options for recycled water disposal is provided in the following sections.

8.1 Public Open Space and School Ovals

The assumptions as to how much public open space and school ovals will be available for irrigation was detailed in section 5. There will be the opportunity to adjust the water balance storage approach as the estate is progressively subdivided.

Given establishment of public open space per subdivision stage will typically precede recycled water availability (i.e. wastewater flows from lots will be required to generate the recycled water), consideration could be given to pumping water from the existing farm dam at Cameron Road (which is not lined and loses its volume through seepage across summer) and storing this in the lined RWP storage dams, thereby increasing the volume of water available for public open space establishment (and civil works dust suppression). The storage dams will have excess capacity until the estate is fully built out.

Water West understands the Developer will be responsible for establishment of the public open space and for the initial years of maintenance and that after an agreed time period, maintenance of the public open space will pass to the Shire.

The design of the irrigation system (e.g. surface or subsurface) should be determined during the structure planning phase in collaboration between Water West and the project team. The system will need to be designed to ensure low maintenance/replacement requirements whilst also providing a high level of reliability for irrigation of recycled water when required.

The cost for installation and maintenance of the irrigation system in the public open space will be by the Developer as per standard industry practice and future maintenance will be the responsibility of the Shire of Mundaring. The cost for installation and ongoing maintenance of the school ovals will be by the relevant school authority.

Appropriate management arrangements between Water West and the party responsible for managing the public open space and the school ovals will be required. This may include, but not be limited to, the ability for Water West to irrigate these areas, within reason, as required by Water West in order to manage the estate water balance across the year.

The volume usage charge to the Developer (and eventually the Shire of Mundaring) for non-potable water provided by Water West to irrigate the public open space areas would typically be $1.00/kL, However, specific to the North Stoneville project and business case, Water West proposes offering a rebate to this charge to effect a net cost of $0.00/kL to the Developer and Shire. A charge of $1.00/kL will apply to all non-potable supplied to the primary and secondary schools in the development.

9 SCHEME INFRASTRUCTURE MANAGEMENT AND RESPONSIBILITY MATRIX

The following table provides an overview of management and responsibility for various infrastructure components of the scheme. The designations do not necessarily imply cost responsibility.

Table 6 – Scheme Infrastructure Management and Responsibility Matrix

		Approvals	Construction/ Installation	Ownership	Ultimate Operation/ Maintenance
RWP Core	RWP Site	Water West	Water West	Water West	Water West
	RWP	Water West	Water West	Water West	Water West
	Storage Dams	Water West	Water West	Water West	Water West
RW Disposal	Public Open Space	Developer	Developer	Council	Council**
	School Ovals	School	School	School	School**
Residential 3rd Pipe	Subdivision Network	Developer	Developer	Water West	Water West
	Lot Meters	Lot Owner	Water West	Water West	Water West
	Internal Lot Plumbing/Irrigation	Lot Owner	Lot Owner	Lot Owner	Lot Owner
Wastewater	Subdivision Network	Developer	Developer	Water West	Water West
	Meter (if PSS)	Lot Owner	Water West	Water West	Water West
	Tank/Pump (if PSS)	Lot Owner	Lot Owner	Lot Owner	Lot Owner
	Internal Lot/Dwelling Plumbing	Lot Owner	Lot Owner	Lot Owner	Lot Owner

** Management agreement required with Water West

Appendix H

Interim Position Statement: Constructed Lakes - Audit

Interim Position Statement Constructed Lakes Audit

Interim position requirements	Emerge Associates response
Land use planning for drainage and water management	
Has the constructed lake been approved in regional or district planning?	The retained dams (i.e. constructed lakes) are existing surface water features.
Is the constructed lake clearly indicated on the local structure plan, subdivision application and subdivision plan?	The retained dams are shown within the LWMS and SP34.
General requirements	
If the constructed lake is proposed solely for irrigation storage, has the developer or landowner demonstrated why alternatives such as groundwater bores or tanks, are not viable options?	Retained dams will be used as they are existing, and they will initially be used for irrigation storage.
If the constructed lake is proposed as a component of the stormwater management system, is it consistent with the *Decision Process for Stormwater Management in WA*	The retained dams form an integral part of the stormwater management strategy as they provide detention storage for a significant proportion of site runoff. The stormwater management design criteria and objectives (see Section 4.3 of the LWMS) have been informed by, and align with those presented in the *Decision Process for Stormwater Management in WA* (DWER 2017).
If the constructed lake is proposed as a component of the stormwater management system, does the design demonstrate how the constructed lake will provide stormwater management benefits?	The retained dams will provide detention storage for site runoff, thereby maintaining pre-development hydrological characteristics (peak flow rates) and protecting downstream environments. Stormwater management within the large, existing storages maximises the amenity that can be achieved within the development while demonstrating site-specific design responses in line with best practise WSUD principles. It will also minimise the extent of clearing and earthworks required.
Has the developer or landowner demonstrated consideration of the local conditions when deciding whether the lake will be lined or unlined?	The dams are already constructed from local low permeability clay materials.
Water use efficiency	
Does the design minimise surface area and use other design methods to reduce water loss through evaporation?	As the dams have previously been established, existing vegetation is able to be retained which will provide initial protection from some degree of solar irradiance. The dams intersect the existing streams within the site. The dams will tie into the landscaping of the living streams and will provide an attractive community feature. This will involve revegetation of banks which will provide further sun protection and reduce evaporation.
Has a water balance calculation been provided, which demonstrates that the net loss of water will be acceptable?	On-site investigations and review of aerial imagery have determined that the dams remain inundated throughout the year. The dams are intended to be solely recharged by stormwater (as is the current regime) and will therefore have no impact on water usage.
If the constructed lake is proposed for the purpose of irrigation storage, has the developer or landowner	The use of the dams for irrigation storage is a temporary measure and will only be required for construction and

demonstrated that landscaping has been designed to minimise the amount of water required for irrigation.	initial development stages. A long term analysis of long term water uses is not relevant to the retention of the dams.
If the constructed lake is proposed for the purpose of irrigation storage, has the developer or landowner demonstrated that the volume of water in the constructed lake is consistent with the irrigation requirements?	The use of the dams for irrigation storage is a temporary measure and will only be required for construction and initial development stages. A long term analysis of long term water uses is not relevant to the retention of the dams.
If required, has the developer or landowner applied for a *Rights in Water and Irrigation* (RIWI) Act 1914 licence?	DWER have advised that a licence under the RIWI Act will not be required.
Protection of natural wetlands, waterways and other water dependent ecosystems	
Will the proposal impact on natural wetlands, waterways and other water dependent ecosystems located near to, or downstream of, the constructed lake?	The dams are pre-existing. However, all dams will need to be configured with the appropriate outlet required to provide stormwater management and some may require repair. Hydrological modelling has been undertaken to determine that the reconfiguration of dam outlets and some minor adjustments would provide the required detention storage, thereby maintaining pre-development peak flow rates and protecting receiving environments.
Have adequate wetland buffer areas and waterway foreshore areas been designated to protect any wetlands and waterways located adjacent to, or downstream of, the constructed lake?	A foreshore assessment report (FAR) has been prepared by Emerge for all streamlines within the site (see **Appendix C** of the LWMS). This assessment includes consideration of the dams, which are on-line and are therefore inherently included in the waterways. The FAR has determined the appropriate foreshore area in consideration of riparian and wetland vegetation.
Has maintenance of the hydrologic regimes of nearby and downstream wetlands, waterways and other water dependent ecosystems been adequately considered?	Hydrological modelling has been undertaken to determine that the reconfiguration of dam outlets and some minor adjustments will provide the required detention storage to maintain the existing hydrological regime and will mitigate any potential impacts to receiving environments.
Does the proposal avoid modifications to Conservation and Resource Enhancement management category wetlands?	There are no mapped geomorphic wetlands located within the site. Riparian and wetland-like areas have been identified in the FAR and will be protected within foreshore reserves.
If it is proposed to modify a Multiple Use management category wetland, has the Department of Environment and Conservation granted approval (i.e. based on the merits of the proposal)?	There are no mapped geomorphic wetlands located within the site. Riparian and wetland-like areas have been identified in the FAR and will be protected within foreshore reserves.
If required, has the developer or landowner applied for a RIWI Act permit?	N/A
If required, has a RIWI Act licence been granted, or is it likely to be granted?	N/A
Does the proposal avoid directly connecting the constructed lake to natural wetlands and waterways (e.g. via pipes, constructed channels or drains)?	The retained dams are currently situated within existing streamlines and low-lying areas and are therefore inherently connected to and integrated within existing streamlines and wetland-like areas. The existing hydrological regime will be largely maintained; some repair and configuration of dam outlets will be required to ensure that additional runoff attributable to urban development will not impact receiving environments. This will not require any major alteration of the hydrological regime nor

	additional connection to or disconnection from wetlands or waterways.
Algal and aquatic weed blooms	
Has the developer or landowner demonstrated (e.g. by modelling) that the turnover (i.e. rate of water exchange) and circulation of the constructed lake will be adequate to significantly minimise the risk of algal and aquatic weed blooms?	The dams are existing and therefore new habitat that could be susceptible to algal blooms is not being created. Notwithstanding, the design and maintenance of the dams will retain the significant depth (limiting temperature rises) pre-treatment of runoff to remove nutrients (via the WSUD measures proposed) and ongoing management would include aeration and manual removal if necessary.
Has the developer or landowner demonstrated that the water quality will not contribute to algal and aquatic weed blooms?	The dams are existing and therefore new habitat that could be susceptible to algal blooms is not being created.
Has the developer or landowner used appropriate non-structural and structural methods to maintain or treat water quality?	Yes. The LWMS proposes structural and non-structural methods to be utilised for mitigation of pollutant loading (see Section 7). Proposed structural measures include bio-retention areas (BRAs), tree pits, vegetated swales and living streams (these are discussed in detail in Section 7.2 of the LWMS).
Acid sulfate soils and iron monosulfides	
Has the developer or landowner identified whether there is a risk of acid sulfate soils (ASS) being present?	Preliminary and supplementary geotechnical investigations undertaken by Galt Geotechnics (2017) did not encounter ASS. There is no known risk of ASS occurring within 3 m of the natural soil in the surrounding area, including the John Forrest National Park, and it is therefore inferred that the site will contain a similarly low level of ASS risk. Furthermore, the features in question are pre-existing and will not require dewatering.
If ASS have been identified, are the proposed management practices consistent with relevant guidelines in the DEC's ASS Guidelines Series?	N/A
Is appropriate management proposed to minimise the risk of iron monosulfides forming in the sediments of drainage systems?	The dams are existing and therefore new areas where MBO could occur are not being created. Notwithstanding, the design and maintenance of the dams will retain the significant depth and side slopes will be revegetated to promote stabilisation and aeration (via root contact).
Has the developer or landowner demonstrated that inflow water quality (i.e. sulfate and ferrous iron) will not contribute to the formation of iron monosulfides?	The dams are existing and if MBO was going to form under the site conditions this would already have occurred if it were going to (and it has not).
Other issues considered, but not the specific responsibility of the Department (e.g. on-going maintenance, life-cycle costs, mosquitoes and midges)	
Has the developer or landowner adequately considered the requirements for on-going maintenance?	Yes. Amalgamation of stormwater detention storage within the retained dams will significantly reduce the maintenance requirement for drainage infrastructure within the site. On-going maintenance requirements have been considered and are discussed in Section 10 of the LWMS, and will be further detailed in the future UWMP.
Has the developer or landowner adequately considered the life-cycle cost of maintenance and retrofitting or replacement, including all associated infrastructure?	Yes. The landscape designs that will be developed in close consultation with the Shire will allow a more detailed analysis of future maintenance costs. These will be provided to the Shire at the appropriate time in the future.

Has the developer or landowner proposed to avoid using algicides and algistats or using them only where appropriate, for the management of algal and aquatic weed blooms?	Yes, and the approach to this will be documented in future more detailed management plans (e.g. UWMP)
Has the local government provided support for the proposal?	Yes, the Shire is supportive of SP34
Has the developer or landowner demonstrated that the design and management of the proposed constructed lake will minimise the risk of mosquitoes and midges?	The dams are existing and therefore new habitat that could provide mosquito habitat is not being created. Notwithstanding, the design and maintenance of the dams will retain the significant depth and will limit the extent of emergent vegetation in shallow water. The orientation of the dams cannot be changed as they are existing. Ongoing management of the dams and surrounds will include consideration of mosquito habitat and where relevant may include monitoring of mosquito larvae and appropriate response.

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ASSOCIATES