Crighton Properties Pty Ltd

Concept Integrated Water Cycle Management Strategy (Revised) Riverside, Tea Gardens, NSW



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PROJECT MANAGEMENT



P0902346JR08V02 January 2013

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Concept Integrated Water Cycle Management Strategy (Revised), Riverside, Tea Gardens, NSW P0902346JR08V02 - January, 2013

Executive Summary

Overview

This report has been prepared to support a Concept Proposal Application under Part 3a of the EP&A Act (1979) for the Riverside Development at Tea Gardens, NSW. It presents a revised approach to the management of ground and surface waters in response to a long history of consultation with State and Local Government agencies.

Specifically, the strategy has been revised to address concerns expressed by the NSW Department of Planning and Infrastructure (DoPI), NSW Office of Water (NOW) and Great Lakes Council over the previously prepared strategy by Cardno (2012).

Site Hydrology – Drainage and Flood Management

A drainage and flood study (Tattersall Lander P/L, 2012) was completed to investigate impacts of the proposed development, adjacent properties and downstream receiving environments. Detailed flood modelling concludes:

- Provision of storage and low flow discharge structures ensure environmental flows into the wetland buffer are maintained.
- Proposed level spreader ensures the development will not increase flow velocities during rare events.
- Existing flood levels remain unaffected.
- All lots remain flood free to the design 100yr event as a result of provision of floodways and site filling.
- The safety of future residents is catered for in the peak PMF event.

Water Quality

Detailed water quality modelling has been undertaken in accordance with Sydney Metro CMA 'Draft NSW MUSIC Modelling Guidelines' (2010) to determine treatment measures required to achieve a Neutral or Beneficial Effect (NorBE) for post development water quality conditions, as well as satisfying Great Lakes Council Draft DCP (2012) Chapter 11 (previously DCP 54) requirements.

Treatment measures include a combination of 'at source' (bioretention swales, buffers) and end of line (constructed wetlands) structures (where needed) to achieve these objectives. Water quality modelling concludes:

- NorBE test is satisfied.
- WSUD, including distributed and 'at-source' management measures will be effective in mitigating against any water quality impacts on receiving wetlands, river and groundwater system.



Groundwater

The groundwater assessment quantifies existing groundwater conditions and potential hydrologic and water quality impacts on adjacent SEPP 14 wetlands. A conceptual groundwater management plan has been prepared to outline potential risks resulting from the development on the aquifer and risk management methodology.

Outcomes from the groundwater assessment conclude that the proposed development will result in:

- No discernible impact from the proposed development on SEPP 14 wetland groundwater levels and water budgets
- No discernible impact on water quality and levels in existing brackish lake (J Lake)
- NorBE on groundwater resources for the site and surrounding areas.
- Largely unchanged groundwater regime from existing conditions. This is due to the distributed WSUD approach to water quality management and recharge where possible in the catchment.



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1 Introduction

1.1 Background

This concept integrated water cycle management strategy (IWCMS or the 'strategy') has been prepared by Martens & Associates to support a Concept Proposal Application under Part 3a of the EP&A Act (1979) for the Riverside Development at Tea Gardens NSW. The report presents a revised approach to the management of ground water and surface waters on the site in response to a long history of consultation with State and Local Government agencies.

Specifically, the strategy has been revised to address concerns expressed by the NSW Department of Planning and Infrastructure (DoPI), NSW Office of Water (NOW) and Great Lakes Council over the previously prepared strategy by Cardno (2012).

The revised strategy has been formulated with the principle objective of ensuring Neutral or Beneficial Effect (NorBE) from the development on receiving groundwater and surface water systems to protect receiving waters and critical ecosystems including groundwater dependant ecosystems (GDEs). The strategy focuses on the use of 'at source' (i.e. 'distributed') stormwater treatment measures allowing preservation (to the extent possible) of existing ground water recharge mechanisms and surface water hydrology, such that there would be no significant impact on receiving waters and adjoining GDEs.

1.2 Site Development History

The following overviews of the history of the Riverside at Tea Gardens site and project description are drawn from ERM, 2011.

In 1991 Crighton Properties bought the 230 hectare site currently known as 'Riverside at Tea Gardens' (formerly 'Myall Quays') which lies immediately to the west of the Myall River and to the east of Myall Road (the main road linking Tea Gardens / Hawks Nest with the Pacific Highway). The location of the Riverside at Tea Gardens site is shown as Attachment 1A.

The Riverside at Tea Gardens Estate is currently being developed and comprises a range of residential, retail/commercial, recreation and tourist development. The part of the site remaining to be developed and covered by the concept plan comprises Lot 40 and Lot 10 DP270100.



An Environmental Assessment Report was prepared and placed on public exhibition for a period of 30 days from 19 February 2009 to 20 March 2009.

The Department of Planning and Infrastructure (DoPI) appointed an Independent Hearing and Assessment Panel (IHAP), which was subsequently modified to a Planning and Assessment Commission (PAC), to undertake an expert review of the proposed development. The terms of reference of the PAC were focused on the review on two main areas: the ecological constraints of the site and the hydrological issues associated with groundwater, the SEPP 14 wetland and flooding.

In a letter dated 22 October 2009, the DoPI raised a number of concerns regarding the concept plan and project application including that the proponent had not adequately established that the surface and groundwater flows to the adjoining SEPP 14 Wetland would remain unaltered.

Prior to the Minister for Planning making a determination on the concept plan and project application Crighton Properties withdrew the application. The application was withdrawn to enable additional information and studies to be undertaken to address issues raised by the PAC, DoPI and other government agencies. These additional investigations resulted in the preparation of the *Integrated Water Management Main Report* (Cardno, December 2011). This report accompanied a revised concept plan application which was exhibited from 8 February to 9 March 2012.

In response to exhibition of the revised concept plan, Council, DoPl and NOW provided comments on the report and subsequent meetings were held between the Applicant and the agencies. Significantly, the major outcome of the 15th June 2012 meeting between the Applicant, NOW and the DoPl, was that a revised strategy should be formulated to:

- Remove proposed freshwater ponds/ window lakes from the stormwater treatment train.
- Establish a new system of water quality management focusing on the use of 'at source' bio-filtration measures to achieve water quality targets.
- Utilise opportunities for 'at source' ground water recharge in conjunction with bio-filters (ensure sufficient treatment of surface waters prior to contact with groundwater) to preserve (as far as possible) groundwater recharge patterns across the development site.



• Maintain existing surface water hydrology, including flows, discharge patterns and outlet locations (as far as possible) to receiving environments.

1.3 Site Description

The Riverside at Tea Gardens site is bounded by Myall River to the east and Myall Road to the west (Attachment 1A). The Shearwater Residential Estate lies to the north of the site and residential development of Tea Gardens is to the south. The site has approximately a one kilometre frontage to Myall Road and two kilometre frontage to the Myall River. State Environmental Planning Policy No. 14 – Coastal Wetlands (SEPP 14) applies to wetlands within a portion of the eastern boundary of the site adjacent to the Myall River. These wetlands have been clearly identified along with a buffer to the wetlands and zoned accordingly when the site was rezoned in 2000. The remainder of the site is available for urban development and zoned accordingly.

The site is flat with generally sandy soils. There is a slight fall to the south east. The site ranges in height from approximately 0.6m Australian Height Datum (AHD) (along the foreshore of the Myall River) to 20m AHD (at the northern end of the site adjacent to Shearwater Estate). However, most of the site varies in height from between 1.6m AHD to 5.0m AHD.

The majority of the site was previously used for a pine plantation and has been substantially cleared of native vegetation. Some scattered isolated occurrences of both pines and natives currently exist on the site. The current land use on the site is cattle grazing.

1.4 **Project Description**

The Riverside at Tea Gardens site is already zoned 2(f) – Mixed Residential – Commercial for urban development. The concept plan for the development of the Riverside at Tea Gardens site consists of a residential / mixed use precinct proposed for the majority of the site and a tourist and larger lot component located in the NE corner of the site. Substantial areas of the 2(f) zoned land are proposed to be protected and enhanced as open space / wildlife movement corridors, over and above those already protected within the 7(a) and 7(b) zones.

The current proposal differs from that previously lodged with the DoPI in several key respects. Changes have been made to address concerns raised by the PAC and DoPI. Key changes include the following:



- i) Residential development of the site now focused over a much smaller development footprint, including the potential to create approximately 945 dwellings comprising 880 residential (variety of lots), 50 lodges and 15 houses in a Tourist Precinct.
- ii) A biodiversity offsetting package is proposed which will consist of both on-site and off-site offsets as part of an offsetting package.
- iii) A new water cycle management strategy as documented within this study.

The amended development concept plan is provided in Attachment 1B, while the diagrammatic stormwater concept plan is given in Attachment 1A.

1.5 Previous Investigations

A number of studies have been previously undertaken at the site in respect of water cycle management. These have been broadly summarised by Cardno in the IWMM report (2011). This study does not intend to further review or summarise previous works, apart from utilising historic groundwater and water quality data as summarised within the relevant study element of this report, as the water cycle management strategy has been completely revised.

1.6 Past Comments on Water Cycle Management

Over the past 4-5 years, a number of comments have been raised by various agencies, Council and their representatives. The following sections broadly summarise these comments:

1.6.1 NSW Planning & Assessment Commission (PAC)

In summary, PAC majority report (2009) noted three key areas requiring further resolution in regards to hydrological impacts of the proposed project in its 2009 form.

- i) Baseline groundwater information was lacking.
- ii) Proposed stormwater management approach was strongly opposed by all key government agencies and Council. Principally regarding extensive interception of groundwater aquifers, direct injection of untreated stormwater into groundwater, expansion of saline lake and access to the Myall River, and potential impacts on the SEPP 14 wetland and its adjacent buffer.



iii) Flooding under climate change scenarios has not been adequately addressed.

1.6.2 NSW Department of Planning

The DoPI utilises BMT WBM as their peer reviewer for the surface water and groundwater management aspects of the project.

BMT WBM (2012) review, undertaken as commissioned by DoPI in respect of the revised concept plan application which contained the Cardno (2011) report, produced the following recommendations:

Recommendation 1

It is recommended that the pond and lake systems be removed from the development proposal or at the very least, considered as receiving environments and not part of the water quality treatment system.

Recommendation 2

If freshwater lake systems are deemed a necessary part of the development, suitable treatment measures should be put in place for their protection, and a more sophisticated assessment of their performance be undertaken. If lakes are deemed necessary, they should be assessed independently of the treatment train and considered only as receiving waters.

Recommendation 3

Revise the existing and developed case MUSIC models to be consistent with the NSW MUSIC Modelling Guidelines.

Recommendation 4

Revise the existing and developed case MUSIC models to have parameters which are both justified and consistent with the NSW MUSIC modelling guidelines.

Recommendation 5 The deep seepage parameter should not be used in any MUSIC models of the site.

Recommendation 6

The groundwater contributions of the site, using the outputs of the MUSIC model and other models, need to be better assessed to quantify the hydrologic and water quality impacts on the adjacent SEPP 14 wetlands.

Recommendation 7

Appropriate parameters to represent nutrients likely to be present in rainfall are to be used where direct rainfall onto lakes are being modelled.

Recommendation 8

Revise the existing case MUSIC model source nodes to better reflect both the "agricultural" and "forested" conditions of the existing site and to include specific nodes reflecting the commercial areas in the existing site.

Recommendation 9

Clarify the WBD nodes and whether the existing commercial areas have been properly accounted for in the future case model.



Recommendation 10

Use a sub-daily timestep through both the existing and developed case models, either 6 or 12 minute.

Recommendation 11

The model warmup should be turned on in any future models of the site, or the first year of results not included in the analysis of model outputs.

Recommendation 12

Wetland nodes, where used, should be configured both within the model and in design drawings to contain a high flow bypass, and a sediment forebay to remove coarse sediment. Also the configuration of the wetlands should be revised so as to provide reasonable (24-48 hour) detention times and consistent extended detention depths.

Recommendation 13

Any measures included in the water quality management regime should be designed such that treatment occurs prior to any interaction with the groundwater.

Recommendation 14

Reconfigure the swale nodes to be consistent with the NSW guidelines.

Recommendation 15

The treatment system should be revised (using revised MUSIC models) to achieve NorBE prior to any discharge to receiving waters including any proposed freshwater lakes and the existing saline lake.

Recommendation 16

It is recommended that an approach which treats and then infiltrates surface water, and reuses as much surface water as possible through rainwater and stormwater harvesting would be a far better approach for the site. Such a system would use biofiltration systems designed to infiltrate to the shallow groundwater, distributed throughout the development, perhaps coupled to well-designed wetlands that had provision for stormwater harvesting. This approach would be far more consistent with a WSUD philosophy and also result in better outcomes for the SEPP 14 wetlands, but at a reduced capital and operational cost to the developer. This obviously has not been assessed as part of this review but suggested as a possible revised treatment system.

Recommendation 17

Assessment of both the surface and groundwater impacts to the SEPP 14 wetlands be considered in further revisions of the Integrated Water Management Plan with a view to minimising hydrologic changes consistent with the requirements of the SEPP 14 and the Great Lakes Council DCP 54 Water Sensitive Design.

The recommendations, together with comments received from the various other State agencies and Council resulted in a change of strategy, the basis of this report. In formulating the revised strategy, Martens & Associates have liaised closely with BMT WBM, the outcomes of which are discussed further Section 1.7.



1.6.3 NSW Office of Water

NOW review of the Cardno (2011) report concluded that it did not support the strategy as it did not reflect the PAC recommendations and more specifically:

- Construction of "window lakes".
- Extension of the existing brackish lake.
- Use of the existing brackish lake as a water quality management device (sediment and nutrient sink).
- Increasing the connection between lake and Myall River.
- Potential activation of Potential Acid Sulphate Soils (PASS) due to lake construction activities.
- Lowering of groundwater levels as a result of lake construction.

1.6.4 Great Lakes Council

In their comments relating to Cardno (2011) report, Council, have noted that they are unable to comment on water quality modelling in qualified detail as it normally relies on the assistance of experts in that field (normally BMT WBM). General comments/concerns raised by Council include:

- MUSIC model software and model assumptions may not be consistent with current modelling guidelines.
- The model may be yielding an inaccurate assessment of the proposed scheme performance (in particular overstating predevelopment nutrient exports and understating post development nutrient exports which could understate the need for water quality performance).
- There is an overreliance on treatment by the existing brackish lake system to achieve water quality objectives. This reliance would be better placed upon primary treatment measures located closer to the source of pollutants.
- Reliance on the brackish lakes has potential for impact upon the (currently) efficient operation of the existing system, which could have impacts upon the recreational, health amenity values of this waterway.



1.7 Revised Strategy Formulation

Martens & Associates prepared a "MA Concept Outline of Revised Water Management Strategy, Riverside, Tea Gardens, NSW" in July 2012. The report reviewed past correspondence from various surface water management proposals for the development and provided recommendations for an amended water management strategy for the current development.

BMT WBM were engaged by DPI to review the recommendations. Overall, their findings were supportive of the revised strategy and specific details regarding the proposed objectives were noted. Importantly, it was recommended that:

".... biofilters which discharge into the underlying sand dominated regions of the site be maximised to ensure sufficient treatment of surface water occurs before infiltration into groundwater. This may be in conflict with the Office of Water's requirements to line all systems, however it is felt that using biofilters should be sufficient to protect groundwater quality, though this will need to be confirmed through modelling."

The use of biofilters to enable "at-source" recharge across the site to maintain (as far as practical) existing groundwater regimes formed a key element of the revised strategy presented in this report.

NOW also provided comment on the concept outline and were generally supportive of the revised strategy. They suggested recharge beds specifically designed to discharge to the groundwater may lead to difficulties in achieving NorBE objectives. This consideration has been resolved by ensuring sufficient treatment is provided within biofilters prior to groundwater recharge. It is discussed further in the water quality section of this report.

1.8 Strategy Elements

Elements forming part of the revised integrated strategy include:

i) Site hydrology – drainage and flood management

An updated stormwater drainage concept plan and supporting hydrological model including flood assessment has been developed by Tattersall Lander Pty Ltd.

The concept drainage plan was developed in coordination with the water quality and groundwater management strategies. Key to this was the preservation of surface water hydrology on



receiving environments including the adjacent SEPP 14 Wetlands.

As part of the works, Tattersall Lander prepared a detailed postdevelopment site terrain or 'surface' which was used for water quality and groundwater modelling.

The scope of the flood study was formulated from feedback received from various agencies including DoPI, Council (and BMT WBM) and OEH.

ii) Surface water quality

A revised stormwater management system has been formulated by Martens & Associates using current best practice WSUD philosophies for water quality tailored to the site. This includes compliance with:

- Great Lakes Council Draft DCP (2012) Chapter 11 (previously DCP 54) requirements.
- DoPI's peer reviewer feedback (BMT WBM). Council also utilise BMT WBM as peer reviewers.
- NOW feedback.
- Draft NSW MUSIC Modelling Guidelines (BMT WBM, 2010).

The revised water quality management concept relies on "atsource" treatment structures and elimination of proposed "window lakes" and is integrated with groundwater and surface water management strategies for the development.

iii) Groundwater

An updated groundwater model and groundwater management strategy has been formulated by Martens & Associates. The revised model utilises additional groundwater data, including increased data coverage, and addresses concerns raised by various assessment agencies.

The groundwater management strategy integrates closely with the stormwater management strategy utilising 'at source' recharge mechanisms to ensure NorBE impacts on groundwater patterns and conditions particularly in relation to impact on critical receiving waters and GDEs.



2 Site Hydrology – Drainage and Flood Management

2.1 Overview

Tattersall Lander P/L (2012) have completed a concept drainage layout design and flood assessment (Attachment 5) to investigate the impacts of flooding on the proposed development, adjacent properties and downstream receiving environments. It has been completed in accordance with Great Lakes Council requirements and the Floodplain Management Manual (NSW Government, 2005).

2.2 Site Hydrology Objectives

The objectives of the flood study were to:

- 1. Determine appropriate floodway designs, and the required fill levels within the proposed development.
- 2. Design a drainage system to mitigate any potential post development impacts on receiving downstream environments.
- 3. Assess the impact of the proposed development on adjacent development and environmental lands.

2.3 Conclusions

Tattersall Lander study demonstrates that the proposed The development will not have an adverse impact on flood behaviour on or around the site. Specifically it concludes:

- The combination of provided storage and low flow discharge 1 structures ensure environmental flows into the wetland buffer area are maintained once the site is developed.
- 2 The proposed level spreader designed for high flow discharge ensures the development will not result in an increase in flow velocities during rare events that would otherwise cause damage to downstream environments.
- 3 Existing flood levels remain unaffected by the proposal.
- 4 Proposed filling works plus floodway capacities ensure all lots remain flood free to the design 100yr event.
- 5 The proposed development design caters for the safety of future residents in the peak PMF event.



3 Water Quality Management

3.1 Overview

This water quality assessment determines treatment measures required to achieve adopted water quality objectives thereby protecting downstream receiving environments.

This assessment allows for a general specification of water quality structures, and will require refinement at detailed design stage.

3.2 Water Quality Objectives

Chapter 11 of Great Lakes Council's Draft Development Control Plan (DCP) 2012 requires the following water quality performance targets be achieved for development of greenfields sites within their LGA:

- 90% reduction of gross pollutants (GPs) relative to pollution generation from development without treatment.
- Neutral or Beneficial Effect of total suspended solids (TSS).
- Neutral or Beneficial Effect of total phosphorus (TP).
- Neutral or Beneficial Effect of total nitrogen (TN).

The draft DCP 2012 defines 'Neutral or Beneficial Effect' (NorBE) as 'loads of pollutants from future development must be equivalent to or less than land use prior to development'.

The draft DCP (2012) also requires stormwater management to incorporate the principles of Water Sensitive Urban Design (WSUD) whereby treatment structures form a 'treatment train' rather than single 'end of line' structures.

3.3 Reference Documents

Table 1 provides a summary of relevant past documentation and how these have been utilised in preparation of this assessment.



 Table 1: Reference documentation summary

Document	Comment
BMT WBM (2010) 'Draft NSW MUSIC Modelling Guidelines' prepared for Sydney Metropolitan CMA	These guidelines were recommended by BMT WBM (2012) to be used for water quality modelling for the proposed development. As such, this revised assessment has been prepared in accordance with these guidelines.
BMT WBM (June, 2012) 'Review of Water Quality Management for the Proposed Riverside at Tea Gardens Development – Final Report'	Review of previous surface water management assessment undertaken on behalf of NSW Department of Planning for the proposed development
Martens and Associates (2012) 'Concept Outline of Revised Water Management Strategy; Riverside, Tea Gardens, NSW'	Prepared to provide a review of correspondence relating to previous surface water management proposals for the development and to provide recommendations for an amended water management strategy. Forms the basis for this assessment.
BMT WBM (July, 2012) 'Riverside at Tea Gardens Residential Subdivision Revised Concept Plan'	A review of Martens and Associates (2012) concept outline for water management at the site. Provides additional recommendations to BMT WBM (June, 2012).

3.4 Modelling Aims

For the purposes of water quality modelling, 4 receiving environments were noted as being potentially affected by development at the site:

- 1. Myall Creek
- 2. SEPP 14 wetlands
- 3. Existing 'J' Lake
- 4. Site groundwater system and groundwater dependant ecosystems (GDEs)

The groundwater element is considered in Section 4. Given the existing site has a number of drainage outlets into the wetlands, the wetlands were further spilt into 3 separate receiving 'nodes' ('Wetland 1', 'Wetland 2' and 'Wetland 3')to ensure water quality compliance along its entire length.

The aim of this assessment is therefore to achieve the water quality objectives for each of the 5 identified downstream surface water receiving environments.

Receiving environments ('nodes') are shown in Attachment 3A (Figure 1 and 2) and Attachment 3C.



3.5 Modelling Methodology

3.5.1 Overview

The Model for Urban Stormwater Improvement Conceptualisation (*MUSIC*, Version 5.1) developed by the CRC for Catchment Hydrology was utilised to evaluate pre and post development pollutant loads from the site.

The following modelling scenarios were considered:

- 1. <u>Pre Development</u> the existing site was modelled to determine baseline pollutant generation rates for TSS, TN and TP.
- 2. <u>Post Development (untreated)</u> the developed site was modelled without water quality structures to determine baseline gross pollutant generation rates.
- 3. <u>Post Development (treated)</u> the developed site was modelled with water quality structures included to achieve adopted objectives for nutrients and gross pollutants.

Pre and post development (with treatment nodes) MUSIC model layouts are provided in Attachment 3A.

3.5.2 Climate Data

Base rainfall data was sourced from Williamtown RAAF from 1997 – 2007. In accordance with BMT WBM (June, 2012) the rainfall data file was adjusted using Hawks Nest data to make an allowance for the increased rainfall experienced at the site. The conversion factor between the annual averages for the 2 stations was calculated to be 1.2 (i.e. Hawks Nest rainfall data approximately 120% higher than Williamtown RAAF at the time of analysis).

Average monthly areal potential evapotranspiration (PET) was sourced from 'Climatic Atlas of Australia – Evapotranspiration' (Bureau of Meteorology, 2001). Inputs are summarised in Table 2.



Table 2: PET inputs - Hawks Nest (BOM, 2001).

Month	PET (mm)
January	180
February	135
March	135
April	90
Мау	70
June	50
July	50
August	70
September	95
October	135
November	150
December	175

A 6 minute timestep was adopted for the water quality analysis.

3.5.3 Model Input Parameters

Input parameters for pre and post development MUSIC modelling are in accordance with SMCMA (2010) MUSIC modelling guidelines and based on development design by Tattersall Lander P/L and recommendations within BMT WBM reviews (June and July, 2012).

A summary of input parameters and their source is provided in Attachment 3B.

- 3.5.4 Catchment Areas
 - 3.5.4.1 Pre Development

Pre development catchment areas were identified based on the following process:

• Upslope catchments affecting the site were provided by Tattersall Lander P/L.



- SEPP14 wetland buffer area was calculated based on aerial photography interpretation and site investigations.
- The site was split into 5 catchments based on site hydrology, recent site aerial and 0.1m contours. The 5 catchments were directed into 5 separate receiving environments ("receiving nodes"):
 - J Lake
 - Wetland 3 (southern extent of SEPP 14 wetland)
 - Wetland 2 (middle of SEPP 14 wetland)
 - Wetland 1 (northern extent of SEPP 14 wetland)
 - Myall Creek
- Catchments land use was defined as 'forest' or 'agricultural' source nodes based on aerial interpretation and detailed site investigations (inspections, walkovers and geotechnical testing).
- Each catchment was split into subcatchments based on soil type(s) within upper 0.5m of the ground surface (Attachment 3C) to dictate pervious input parameters (Attachment 3D). Soil types were based on the findings of intrusive geotechnical testing (49 boreholes) undertaken by Coffey (2008) and Martens and Associates (2009 and 2012). Site testing plan is provided in Attachment 3H.
- \circ $\,$ Across the site seven soil landscape were identified :
 - Sandy clay
 - Clayey sand
 - Clayey sand overlying sandy clay
 - Sand overlying sandy clay
 - Loamy sand
 - Loamy sand overlying sand
 - Sandy clay overlying clay

Borelogs are provided in Attachment 3I.



- Soil landscape for upslope catchments was taken to be sandy clay loam based on the Port Stephens Soil Landscapes 1:100 000 sheet (Department of Land and Water Conservation, 1995).
- Soil landscape for wetland buffer areas was assumed to be clayey sand.

3.5.4.2 Post Development

Post development catchment areas were defined based on the following process:

- Upslope areas affecting the site and wetland buffer areas remained consistent with the pre development model.
- The site was split into 5 catchments to be consistent with the pre development model and to allow assessment of water quality impacts at discrete receiving environments. However, due to proposed site drainage, sub catchment areas differed somewhat from the pre development model. Total modelled site catchment area is consistent with pre development (Attachment 3D).
- Proposed residential/development areas within each catchment were split into smaller subcatchments by Tattersall Lander according to proposed site drainage.
- Individual sub-catchments were further split into roof, road, bioretention swale and residential areas ('nodes') by Tattersall Lander (Attachment 3D). 'Residential' nodes included driveway, footpath and pervious lot areas (such as landscaping and lawns).
- Proposed floodway areas were calculated based on proposed development layout provided by Tattersall Lander. These areas were assigned the 'urban' node.
- The 'Myall Creek' catchment floodway includes re-forested corridor 20m wide and 330m long leading down to the proposed wetland (Section 3.6.2) and the discharge point into Myall Creek.
- Re-forestation areas were calculated based on proposed development layout provided by Tattersall Lander. Reforestation areas include both areas to be planted out (i.e. actively revegetated) and areas to remain undeveloped that are assumed will regenerate naturally once agricultural practices cease. These areas were assigned the 'forest' node.



- Based on advice from the Client, we understand the majority of the site is to be filled by varying amounts to achieve flood levels. We understand soil type for the post developed site is 100mm loamy sand topsoil overlying sand. This soil type was utilised for pervious input parameters for all post development source nodes within the development footprint (Attachment 3D).
- Upslope areas, wetland buffers and onsite retained forest areas had soil landscapes properties consistent with the pre development model.

3.6 Treatment Train Philosophy

The preferred stormwater treatment strategy for the site is based on the principles of WSUD. It utilises 'at source' controls and some end of line structures (where required) to provide a treatment train that ensures treatment objectives are satisfied and the integrity of downstream receiving environments are maintained. Individual stormwater quality improvement devices (SQIDs) are outlined in the following sub sections. A conceptual layout of the proposed treatment train is provided in Attachment 3E.

3.6.1 Bioretention Swales

Road side bioretention swales ('bioswales') are proposed to provide 'at source' treatment of developed areas. Approximately 2% in standard residential streets and up to 4-5% in areas of open space will be utilised for bioswales to achieve water quality outcomes.

Bioswales provide treatment through media filtration, biological uptake of nutrients, evapotranspiration and detention. Although infiltration is also a feature of these structures that provides treatment, this feature has been set to 0mm/hr to ensure sufficient water quality treatment is provided prior to infiltration in an effort to protect downslope receiving environments that are reliant on groundwater quality (Section 3.7).

On advice from BMT WBM (October 3, 2012) the highflow bypass was set to 100m³/s (i.e. all flow is directed to the bioswales) to allow the bioswales to also act as gross pollutant traps (GPTs). Maintenance of the bioswales will therefore require regular removal of gross pollutants captured.

Bioswale input parameters are provided in Attachment 3B. Proposed bioswale design is provided in Attachment 3F.



3.6.2 Buffer Areas

Buffer areas have been utilised in:

- The northern precinct to treat runoff from road areas
- In the eco-resort to treat runoff from the service road and pool decking.
- To treat runoff prior to collection and treatment in bioswales.
 Buffer areas will take the form of 1m wide grass strips that runoff will sheet flow over.

3.6.3 Wetland

A wetland is required within the 'Myall Creek' catchment (the proposed northern precinct) to reduce nitrogen and phosphorus levels prior to discharge into Myall Creek. Modelling indicates the following preliminary specifications are required to achieve water quality objectives:

- Surface area of 4, 468 m²
- Batter slopes of 1(V):3(H)
- Extended detention depth of 0.35m
- Total depth of 0.75m
- Permanent pool volume of 668 m³
- 0 mm/hr exfiltration (i.e. the wetland will be lined)
- Outlet pipe diameter of 85mm and overflow weir width of 3.0m (preliminary design factors)

The wetland shall be located offline to the east of the main northern precinct development footprint (Attachment 3A). A highflow bypass channel shall be located within the northern precinct floodway to carry flows exceeding 0.7 m³/s (the peak Q_{3mth} inflow into the floodway as provided by Tattersall Lander P/L) through the floodway and directly to Myall Creek.



3.7 MUSIC Model Run Types ('Modes')

The post development model was run in two 'modes'

Mode 1: Infiltration capacity of bioswales was 'switched off' by setting exfiltration to 0mm/hr. This mode was used for water quality assessment.

Mode 2: infiltration capacity of bioswales was 'switched on' by setting exfiltration rate to a suitable value. This mode was used to determine site water balances.

3.8 MUSIC Results

3.8.1 Suspended Solids and Nutrient Loads

Modelling results achieved are summarised in Table 3. These demonstrate that the WSUD approach results in the NorBE test being satisfied.

Receiving Environment	Parameter	Pre Development (kg/y)	Post Development (kg/y)	Achieved Reduction (%)	Complies (Y/N)
	TSS	4570	2240	51	Y
Myall Creek	TP	17.1	16.7	2	Y
	TN	181.0	155	14	Y
	TSS	3650	1310	64	Y
Wetland 1	TP	12.9	9.74	24	Y
	TN	123.0	75.9	38	Y
	TSS	54000	25600	53	Y
Wetland 2	TP	207.0	106	49	Y
	TN	1360	826	39	Y
	TSS	8860	3800	57	Y
Wetland 3	TP	36.7	29.50	20	Y
	TN	242.0	209	14	Y
J Lake	TSS	3750.0	811	78	Y
JEako	TP	15.9	9.88	38	Y

Table 3: MUSIC results - NorBE assessment.



Concept Integrated Water Cycle Management Strategy (Revised),

Riverside, Tea Gardens, NSW

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	TN	104.0	70.40	32	Y
	TSS	66600.0	33700	49	Y
Total	TP	260.0	172	34	Y
	TN	1710.0	1340	22	Y

3.8.2 Gross Pollutant Loads

Table 4 provides an assessment of the treatment train effectiveness for gross pollutant loads generated from the site. This demonstrates that pollutant load reductions are met.

Receiving Environment	Untreated (kg/yr)	Treated (kg/yr)	Achieved Reduction (%)	Complies (Y/N)
Myall Creek	2190	31	99	Y
Wetland 1	1000	0	100	Y
Wetland 2	6350	140	98	Y
Wetland 3	3040	53.3	98	Y
J Lake	1000	0	100	Y
Total	13 580	224.3	98	Y

 Table 4: MUSIC results - treatment train effectiveness - gross pollutants.

3.8.3 Nutrient Concentrations In Treated Stormwater

Table 5 provides median concentrations of nutrients in stormwater following treatment. These are used for comparison to existing groundwater quality data at the site.



Table 5: Nutrient concentrations.

Receiving Environment	TSS (mg/L)	TP (mg/L)	TN (mg/L)
Myall Creek	5.81	0.0604	0.600
Wetland 1	2.92	0.084	0.572
Wetland 2	6.38	0.097	0.598
Wetland 3	6.59	0.104	0.641
J Lake	2.80	0.107	0.600

3.8.4 Conclusion

The proposed treatment train achieves site water quality objectives outlined in Section 3.2 and will have a beneficial impact on stormwater quality discharging to downstream sensitive receiving environments.

Treatment devices assumed no infiltration (despite this occurring in reality) to ensure water quality targets were being achieved prior to any infiltration into the groundwater table. The proposed treatment train therefore also protects the integrity of the groundwater quality, which downstream SEPP 14 wetland environments rely on.

3.9 Groundwater Recharge Assessment

Using the MUSIC node water balance feature, the following factors were extracted:

- 1. Total rainfall inflow
- 2. Evapotranspiration loss
- 3. Baseflow losses for source nodes
- 4. Infiltration loss for treatment nodes
- 5. Total storm outflow

In order to estimate the volume of water which could conceivably *reach* the groundwater system, the following method was used to estimate areal 'net infiltration' rates:

Net infiltration rate = (Source node baseflow + treatment node infiltration)/(total source and treatment node area)



Whilst the above method may result in some overestimation of infiltration, it provides a convenient means of comparing infiltration rates between different parts of the study area. We note that MUSIC is not a distributed groundwater model and not capable of the same level of modelling sophistication as MODFLOW.

The above approach therefore provides a means of scaling MUSIC model outcomes to the calibrated MODFLOW recharge rates for existing conditions. The same scaling factor can then be used to estimate MODFLOW recharge rates under developed conditions using MUSIC model water balance results data for developed conditions.

Section 4 covers the above in more detail.

3.10 Compliance with BMT WBM Recommendations

BMT WBM's (June, 2012) review of previously undertaken stormwater management assessment provides a number of recommendations for improving water quality modelling, producing a model consistent with modelling guidelines and creating a management system which protects downstream receiving environments. Demonstration of this revised assessment's consistency with this review is provided in Table 6.



Table 6: Compliance with BMT WBM (2012)

Element	Recommendation	Comment
Model setup	Revise the existing and development case MUSIC model to be consistent with NSW MUSIC Modelling Guidelines.	As shown in Attachment 3B, MUSIC modelling is consistent with the guidelines.
	Revise the existing and development case to have parameters which are both justified and consistent with NSW MUSIC Modelling Guidelines.	As shown in Attachment 3B, MUSIC modelling is consistent with the guidelines. Each input parameter has been justified.
	Revise the existing MUSIC model source nodes to better reflect both the 'agricultural' and 'forested' conditions of the existing site and to include specific nodes reflecting the commercial areas in the existing site.	Aerial interpretation and site investigations have beer utilised to delineate between forest and agricultural areas both on the site and in upslope catchments. No commercial areas occur onsite.
	Clarify the WBD nodes.	This has been removed from modelling.
	Use a sub-daily timestep through both the existing and developed case models, either 6 or 12 minute.	1997 – 2007 6 minute pluviograph rainfall data from Williamtown RAAF was utilised for MUSIC modelling. Rainfall data was adjusted using Hawks Nest data to account for increased rainfall at the site compared with Williamtown.
	The model warmup should be turned on, or the first year of results not included in the analysis of model outputs.	The 'catchment warmup' feature was switched on fo MUSIC modelling.
nput parameters	The deep seepage parameter should not be used in MUSIC modelling.	Daily Deep Seepage Rates (DSR) for all source nodes has been set to 0% in accordance with Table 3-8 of the NSW Music Modelling Guidelines.
	Appropriate parameters to represent nutrients likely to be present in rainfall are to be used where direct rainfall onto lakes are modelled.	Lakes have been removed from the proposed development.



Element	Recommendation	Comment
	Wetland nodes, where used, should be configured to contain high flow bypass, sediment forebay to remove coarse sediment and reasonable detention times (24 – 48hrs) and detention depths.	The Myall Creek wetland has been designed with a high flow bypass (equivalent to Q_{3mth} of flow entering floodway) and sediment inlet pond in accordance with NSW Music Modelling Guidelines. Detention time is 42 hrs and extended detention depth is 0.35m (total depth 0.75m).
	Reconfigure swale nodes to be consistent with NSW guidelines.	No swales are proposed in the treatment train.
Proposed treatment train	Pond and lake system be removed from the development or considered as receiving environments and not part of the water quality treatment system.	Previous pond and window lakes have been removed from the stormwater management system.
	If freshwater lakes are deemed necessary, treatment measures shall be put in place for their protection. They should be considered receiving waters and independent of the treatment train.	Freshwater lakes have been removed from the proposed development.
	The treatment system should be revised to achieve NorBE prior to any discharge to receiving waters.	As shown in Table 3, NorBE is achieved by the proposed treatment train prior to any discharge/infiltration into receiving environments.



Element	Recommendation	Comment
	An approach which treats and then infiltrates surface water, and reuses as much surface water as possible through rainwater and stormwater harvesting would be a far better approach.	The proposed treatment train treats stormwater prior to any infiltration (Table 3). We understand the developer has an agreement with Midcoast Water to use treated effluent from the Hawkes Nest STP for external uses (such as irrigation) at the site. No additional reuse/stormwater harvesting is therefore proposed.
Reporting	Assessment of both the surface and groundwater impacts to the SEPP 14 wetlands be considered in revisions of the Integrated Water Management Plan with a view to minimise hydrological changes.	Groundwater infiltration and recharge rates have been calculated for the pre and post development site using MUSIC modelling. This information has been used to calibrate detailed groundwater modelling (Section 4.4) and assess the impacts to the SEPP 14 wetlands.
		Water quality modelling suggests the proposed treatment train will result in a neutral or beneficial impact on water quality of surface water. This will assist in protecting downstream environments including the SEPP 14 wetlands.

3.11 Conclusions and Recommendations

The revised stormwater management system and MUSIC model is consistent with both the NSW MUSIC modelling guidelines (BMT WBM 2010) and the BMT WBM reviews (June and July, 2012). Results of MUSIC modelling indicate that water quality objectives will be met by the proposed stormwater treatment train.

The proposed management system is consistent with the principles of Water Sensitive Urban Design (WSUD) as the proposed treatment strategy utilises 'at source' controls and a 'treatment train' rather than relying solely on large end of line structures. This approach is considered the most appropriate for the site and will provide the best outcome for receiving environments

We note that further refinement of the model at the detailed design stage may alter the sizes of proposed treatment structures.



4 Groundwater Assessment

4.1 Overview

As part of the revision of the integrated water cycle management strategy, the previous groundwater assessment has been fully revised to address the following:

- PAC (2009):
 - Lack of baseline groundwater information.
 - Inappropriate use of a steady state model instead of transient model and poor calibration of the model.
 - Potential for saline intrusion from the existing detention lake.
 - Assessment of groundwater flux at shoreline to assess potential impacts to tidal wetland ecosystem.
- NoW submission to DoPI (2012)
 - Use of a steady state model rather than a dynamic model incorporating a representative period of climatic variability.
 - Underestimation of the effect of the averaging of drawdown over time (it believes this average drawdown will then be compounded by natural fluctuations rather than offset by them).
- DoPI (BMT WBM (2012) review) recommended:
 - Groundwater contributions of the site be better assessed to quantify hydrologic and water quality impacts on adjacent wetlands.
 - Implementation of biofiltration systems to promote 'at source' recharge of treated stormwater to groundwater throughout the development (and assessment of resulting surface and groundwater impacts on the SEPP 14 wetlands).

The revised groundwater assessment has included:

1. Review of site previous hydrogeological investigations and collation of key data.



- 2. Collection of additional site groundwater data including:
 - Groundwater level measurement at existing site bores and at newly installed bores in areas lacking data coverage.
 - Groundwater quality sampling.
 - Soil permeability testing.
- 3. Revision of numerical groundwater models for the existing and developed site conditions incorporating:
 - Additional collected groundwater data.
 - Revised strategy of 'at source' recharge for the developed site model.

4.2 Groundwater Objectives

The principle objectives of the strategy with regard to groundwater are:

- 1. <u>Preserve Water Quality</u> Existing groundwater quality to be preserved or improved.
- 2. <u>Preserve Groundwater Levels</u> Ensure groundwater levels critical for GDEs (i.e. SEPP 14 wetland) are not disturbed.
- 3. <u>Preserve Flow Patterns and Water Balance</u> Maintain existing groundwater flow patterns and flow budgets to critical ecosystems (SEPP 14 wetlands and the existing saltwater (J) lake).

4.3 Existing Groundwater Conditions

4.3.1 Conceptualisation of Aquifer System

Groundwater is confined within a shallow to medium depth marine sand deposit (with some areas of clay deposit) that sits at or above sea level and adjoins a bed rock controlled hill in the north and north west of the site. The aquifer is bounded by Myall River to the east and Port Stephens associated bays and creeks to the south/west.

Water table depths are frequently shallow and typically less than 1-2m below existing ground level. Groundwater depth variation is minimal spatially across the majority of the site in response to minimum site grades. Water levels within the aquifer are significantly dependent on



incident rainfall and sea level rather than other catchment processes such as run-on.

A number of existing small incised man-made channels drain surface water and intermittent shallow groundwater to the lower lying heath and wetland areas to the site's east.

4.3.2 Available Data

4.3.2.1 Previous investigations

This assessment draws from a number of previous groundwater investigations conducted on the site. More specifically, groundwater level data, water quality results and geotechnical information has been utilised from:

- Coffey Partners International (February, 1996), Myall Quays Development Groundwater and Surface Water Study.
- Coffey Geotechnics (October, 2007), Groundwater Assessment Riverside Development, Tea Gardens.
- Martens & Associates (December, 2011) Preliminary Hydrogeological Study and Concept Groundwater Management Plan, Riverside, Tea Gardens, NSW.

4.3.2.2 Additional Investigations

Additional site investigations were conducted for this assessment in early $(3^{rd} - 4^{th})$ and late $(25^{th} - 26^{th})$ September 2012. These included:

- Installation of three new GMBs (GMB201, GMB202 and 203).
- Groundwater level measurement at all existing site bores and at newly installed bores.
- Groundwater quality sampling (GMB3, GMB4, GMB5, GMB6, GMB7, GMB8, GMB9, GMB10, GMB25, Lake, GMB201, GMB202 and GMB 203).
- Hydraulic conductivity testing at all existing site bores and at newly installed bores.

4.3.2.3 Site Groundwater Monitoring Bores (GMBs)

A total of 19 GMBs exist across the site including three recently constructed bores (GMB201, GMB202 and GMB203) and 16 remaining



bores from previous investigations. Bore locations are indicated on Figure 3 (Attachment 4A).

4.3.2.4 Geotechnical

Aquifer material generally comprises fine to medium grained sands with some cemented layers (coffee rock). However, variations in soil landscape (Section 3.5.4) do exist across the site resulting in variations in hydraulic conductivity and recharge capacity.

4.3.2.5 Hydraulic Conductivity

In-situ Hydraulic conductivity (K) testing (Table 7) was undertaken in September 2012 utilising single bore slug tests (Hvorslev method, 1981) on all existing site bores. Calculation sheets are provided in Attachment 4D. The site was categorised into zones of equivalent hydraulic conductivity for groundwater modelling purposes (Figure 16, Attachment 4A).



GMB	K (m/d)	K Zone (Figure 16)	Adopted K (m/d)
GMB1Aa	6.5	1	4.5
GMB3	11.7	2	10
GMB4	13.1	2	10
GMB5	18.4	5	16
GMB6	17.0	5	16
GMB7	4.4	1	4.5
GMB8	3.5	1	4.5
GMB9	4.5	1	4.5
GMB10	16.6	5	16
GMB11	3.1	1	4.5
GMB12	4.8	1	4.5
GMB21	9.8	2	10
GMB22	6.7	2	10
GMB23	8.6	2	10
GMB24	8.9	2	10
GMB25	3.6	7	3.5
GMB201	4.8	1	4.5
GMB202	16.3	5	16
GMB203	4.0	1	4.5

 Table 7: Measured in-situ hydraulic conductivity.

4.3.2.6 Specific Yield

Specific Yield (S_y) is likely to be of the order of 0.1 to 0.15 based on review of Coffey (February, 1996) and our experience with similar aquifers.



4.3.2.7 Water Level Data

Historical groundwater level measurements at established GMBs are collated in Attachment 4B. The data includes a long history of instantaneous dipped levels and also some periods of continuous monitoring with data loggers. It is considered that the data set is satisfactory for the purposes of steady groundwater modelling for the concept stage assessment.

Continuous monitoring undertaken in July 2009 is presented in Figure 4 (Attachment 4A) to illustrate response to tidal and rainfall variation.

The following comments are made based on review of site groundwater level data:

- 1. Groundwater levels are generally shallow.
- 2. Groundwater resurfaced at times at GMBs 7 and 23 during the Martens and Associates (July, 2009) continuous data logging period.
- 3. Short-term groundwater level fluctuations are typically <1m and can occur within hours of heavy rainfall.
- 4. Lake levels are consistently lower than groundwater levels suggesting that groundwater discharges to the lake in the vicinity of the existing GMBs. Discharge of groundwater to the lake is expected to occur around the majority of the lake based on likely groundwater gradients.
- 5. Groundwater response to rainfall is shown to be rapid, occurring within 1-2 days of incident rainfall. Groundwater responses appear more substantial at higher ground elevations.

4.3.2.8 Groundwater Quality

Historical groundwater quality data at established GMBs are collated in Attachment 4C and summarised in Table 8 with site data grouped and compared against lake data.



Analyte	Site GMB Median ¹	Site GMB Mean ¹	Lake Median ^{1,2}
рН	5.6	5.6	6.1
TDS (mg/L)	200	1653	5565
Chloride (mg/L)	65	847	2919
Sulphate (mg/L)	16	125	431
Magnesium (mg/L)	6.1	60.2	181.5
Calcium (mg/L)	3.6	19.7	59.0
EC (us/cm)	264	2151	7091
TN (mg/L)	2.5	46.6	0.7
TP (mg/L)	0.41	4.35	0.07

Notes:

 $^{\rm l.}$ Laboratory detection limit used where result below detection limit. $^{\rm 2}$ Median and Mean results equal as based on 2 data points

Continuous monitoring of groundwater and lake EC concentrations was undertaken concurrently with groundwater level monitoring by Martens and Associates (July, 2009) for GMB 1A, 2A, 25 and 26 (lake). Results are summarised in Table 9 and plotted in Figure 5 (Attachment 4A). Results indicate saline/brackish lake water does not migrate from lake to local groundwater system. This is expected given the groundwater gradient is towards the lake.

Table 9: Summar	y of continuous	groundwater EC	(µS/cm)	monitoring.
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GMB	1A ¹	2A ¹	25 ¹	26 (lake) 1
Mean	255	155	229	10285
Minimum	240	140	180	7830
Maximum	260	150	380	13150
Range	20	10	200	5320

Notes:

 $^{\rm L}$ Martens and Associates (July, 2009) continuous data logging (04/06/2009 to 06/07/2009) at 0.5 hr logging frequency.



The following comments are made based on review of site groundwater quality data:

- 1. Groundwater quality is not of sufficient standard to satisfy potable use requirements in accordance with Australian Drinking Water Guidelines (NHMRC, 2004), primarily on the basis of acid levels, variable salinity and elevated concentrations of a range of analytes (Martens and Associates, April, 2009).
- 2. The most significant beneficial uses for groundwater in some locations of the site are for irrigation and ecosystem maintenance (Coffey, October, 2007).
- 3. Median EC and TDS concentrations within the lake are higher than in GMBs and are indicative of saline water. This is expected as the lake's drain invert level is approximately 0.66 mAHD (Coffey, October, 2007). Based on review of Fort Denison tidal data such an elevation can be expected to be breached by tides approximately 25 days per year.
- 4. Median EC and TDS concentrations within GMBs are indicative of fresh water.
- 5. Monitoring data indicates that lake nutrient concentrations are lower than those observed in nearby GMBs.

4.3.2.9 Summary

GMB coverage and the extensive historical levels data record are considered well suited for the purposes of groundwater modelling for concept stage assessment.



4.4 Groundwater Modelling

4.4.1 Steady state or Transient Modelling

Based on our review of groundwater data, we are of the view that a steady state modelling approach is appropriate to the concept phase application because:

- Groundwater is consistently high.
- Response to rainfall is rapid and in the range of 0.5-2 days therefore a transient model would require a similar time step. We do not consider this adds much to the analysis.

In balancing the two approaches of steady state as opposed to transient, we have undertaken analysis for both the mean rainfall conditions as well as 'wet' year conditions (refer to Section 4.4.4). 'Dry' year conditions were not analysed because it was considered irrelevant to operation of the drainage system since removal of the window lakes from the proposal meant that there is no risk of groundwater 'flow reversal'.

4.4.2 Modelling Approach

A series of preliminary steady state groundwater models have been developed to assess the likely changes of the proposed development on existing groundwater levels, flow patterns and water balances on receiving environments. Modelling works extended a concept model previously prepared by Coffey (October, 2007 and August, 2009) and Martens & Associates (December, 2011) and incorporated the following major developments:

- Additional GMB calibration data additional groundwater levels for all site GMBs;
- Additional GMBs (GMB201, GMB202 and GMB203) extended GMB coverage to include the Monkey Jacket area, improving spatial calibration.
- Establishment of hydraulic conductivity zones based on field testing results.
- Revised recharge zones based on land form, drainage pattern and soil types and iteratively adjusted during model calibration.
- Inclusion of drainage cells with calculated drainage conductance to better reflect existing site drainage features.



- Addition of 'mean' and 'wet' year scenarios.
- Addition of sea level rise scenario.
- Developed site model established utilising developed site terrain and recharge rates adjusted according to stormwater modelling (MUSIC) water balance results.

The following models were developed.

- <u>M0</u>: <u>Calibration model Existing terrain and conditions</u> Using available site geotechnical data and GMB level data, a calibrated single layer steady state model was developed.
- <u>M1a:</u> Existing terrain, mean rainfall conditions Recharge zone values derived in M0 factored to account for difference between average rainfall experienced during groundwater level data collection and mean rainfall conditions experienced on site.
- <u>M1b:</u> Existing terrain, wet rainfall conditions As per M1a with recharge values factored for wet conditions.
- <u>M1c</u>: <u>Existing terrain, mean rainfall conditions, sea level rise</u> As per M1a with boundary conditions changed to reflect potential climate change induced sea level rise of 0.9m (increased from 0.045m AHD to 0.9m AHD).
- <u>M1d:</u> Existing terrain, wet rainfall conditions, sea level rise As per M1b with sea level rise boundary conditions.
- <u>M2a</u>: <u>Developed terrain, mean rainfall conditions</u> M1a terrain replaced with developed site terrain including proposed drainage systems. Recharge zone values adjusted with "MUSIC to MODFLOW" conversion factor.
- <u>M2b</u>: <u>Developed terrain, wet rainfall conditions</u> As per M2a with additional adjustment of recharge values for wet conditions.
- M2c: Developed terrain, mean rainfall conditions, sea level rise As per M2a with boundary conditions changed to reflect potential climate change induced sea level rise of 0.9m (increased from 0.045m AHD to 0.9m AHD).
- <u>M2d</u>: <u>Developed terrain, wet rainfall conditions, sea level rise</u> As per M2b with sea level rise boundary conditions.



4.4.3 Model Setup

Modelling was undertaken with Visual Modflow Version 4.6.0.161 utilising single layer, steady state modelling and with background (constant) properties as summarised in Table 10.

 Table 10: Summary of groundwater model properties.

Property	Value/Detail	Comment
Grid cell size	25m x 25m	-
Existing Terrain	DTM from Tattersall Lander	06.11.2012
Developed Terrain	DTM from Tattersall Lander	14.11.2012
Cell Base	DTM produced from rock level contours	Coffey (2007)
Head observation wells	Mean GMB observations from data record for 19 GMBs	Attachment 4B
Boundary Conditions	Constant Head: Myall River = 0.045m AHD J Lake = 0.7m AHD Monkey Jacket upper slopes = 4.45-4.6m	-
Boundary Conditions – Sea Level Rise	Constant Head: Myall River = 0.9m AHD J Lake = 0.9m AHD Monkey Jacket Upper slopes = 4.45-4.6m	Myall River and J Lake constant head heights increased to 0.9m (DECCW, 2009, benchmark for sea level rise planning = 0.9 by 2100).
Water Balance Zones	Refer to Figure 15 (Attachment 4A)	Assigned to existing condition and developed condition models to allow comparison of water movement between zones and total zone budgets between models.
Hydraulic Conductivity – K	Refer to Figure 16 (Attachment 4A)	Site divided into K zones based on field K testing results.



4.4.4 Existing Conditions Modelling

4.4.4.1 Calibration Model

A calibration model (M0) was developed to establish base recharge values for existing site conditions and involved:

- Definition of hydraulic conductivity (K) zones across the site based on field testing results (Figure 16, Attachment 4A; Attachment 4D).
- Definition of recharge zones across the site based on site landform, vegetation type and drainage conditions (Figure 17, Attachment 4A).
- Calibration of head equipotentials against observed heads (at GMBs) by iterative adjustment of recharge zones values whilst keeping K values constant. Calibrated recharge values are summarised in Table 11.

Calibration results are depicted in Figure 6 (Attachment 4A) showing a normalised RMS of 4.27%, comparing favourably with the typical industry accepted upper threshold of 10%. A calibrated residual mean of -0.066m indicates suitable prediction of mean groundwater head.

4.4.4.2 Mean and Wet Year

'Mean' and 'wet' year versions of the existing conditions groundwater model (M1a and M1b respectively) were developed as follows:

- Assessment of average monthly rainfall experienced during site observations (R_{obs}). Average monthly rainfall was used rather than average annual rainfall due to the lack of complete annual groundwater monitoring records.
- Assessment of 'mean' (R_{mean}) and 'wet' (R_{wet}) (90th percentile) average monthly rainfall for the site based on rainfall records (Nelson Bay BOM Station Number 61054).
- Calculation of recharge adjustment factors by the following method:

'Mean' = R_{mean} / R_{obs}

'Wet' = R_{wet} / R_{obs}

• Calculation of 'mean' and 'wet' year recharge values (Table 12) for use in the model scenarios by multiplying calibrated recharge values by the adjustment factors (Table 11).



Table 11: 'Mean' and 'Wet' year recharge adjustment factors.

	Robs	R _{mean}	Rwet
Rainfall mm/month	104.2	112.4	158.1
Recharge Adjustment Factor	1	1.08	1.52

Table 12: Summary of adopted recharge values (existing site conditions).

	Recharge rate (mm/year)			
Zone	Calibrated Model	Mean Year	Wet Year	
Industrial	40	43	61	
Residential	100	108	152	
Quarry	40	43	61	
Coastal saltmarsh/mangrove	40	43	61	
Dense heath/wetland	80	86	121	
Forested slopes	70	75	106	
Cleared clay soils	30	32	46	
Cleared poorly drained	150	162	228	
Cleared sandy soils	250	270	379	

4.4.5 Developed Conditions Model

4.4.5.1 Terrain file and Drains

The concept design surface DTM (from Tattersalls Lander) was utilised in the developed conditions modelling. The DTM incorporated drain invert levels including the invert of proposed roadside biofilters. This is an important consideration as it allowed evaluation of groundwater levels against drainage structures function to ensure structures are not "drowned out" and that stormwater treatment within biofilters is undertaken prior to interception of groundwater.

Drain layout is depicted in Figure 15, Attachment 4A.



4.4.5.2 Recharge Adjustment and Zonation

Recharge rates derived in calibrating the existing conditions model were compared against infiltration rates derived from water quality (MUSIC) modelling (Section 3.9).

Developed condition recharge rates were developed based on the outcomes of MUSIC modelling. MUSIC water balance results provided values for 'infiltration losses'. These were compared to the calibrated recharge rates for the 'mean' groundwater level model. A direct adoption of MUSIC infiltration rates could not be used as the 2 models use different algorithms to model groundwater (MODFLOW is a distributed model).

MUSIC to MODFLOW recharge conversion factors were then calculated by dividing the MODFLOW recharge rate for a particular recharge zone by the MUSIC derived infiltration rates for the equivalent site location. Conversion factors were determined for all recharge zones.

As the majority of the site shall be filled with loamy sands overlying sand loams (Section 3.5.4), the recharge factor determined for the pre development area comprising similar soil conditions of loamy sand over sandy loam profile was deemed appropriate to utilise across the total developable site footprint. This factor was calculated to be 0.5 (MODFLOW recharge rate of 250mm/yr divided by MUSIC infiltration rate of approximately 500mm/yr).

Similar results were achieved for the proposed revegetated slope and revegetated low lying areas of the site, thus a conversion factor of 0.5 was applied uniformly across the total area of the site to be developed or rehabilitated. Conversions rates were not applied to areas of the site remaining unchanged as a result of the development such as the dense heath/wetland area, coastal saltmarsh and forested slopes west of the site.

The conversion factor was applied to post development MUSIC water balance figures to derive relative recharge values for the MODFLOW developed model (Table 13). Recharge zones were also redefined into five new zones to reflect developed conditions including residential areas, eco-tourism area, revegetated low lying area and revegetated slopes (Figure 17, Attachment 4A).



Area	Description	MUSIC Infiltration (mm/yr)	Conversion Factor	MODFLOW Recharge (mm/yr)
A	Residential (Main)	292	0.5	146
В	Residential (Monkey Jacket)	302	0.5	151
С	Eco-tourism	403	0.5	202
D	Revegetated Low Lying	524	0.5	262
E	Revegetated Slopes	320	0.5	64

Table 13: MUSIC to MODFLOW Recharge conversion for developed conditions.

4.4.6 Modelling Results

4.4.6.1 Head Equipotential Plots

Head equipotentials plots are presented in Figures 7-10 (Attachment 4A). These represent groundwater contours at a 0.1m contour interval.

4.4.6.2 Drawdown Comparisons

Drawdown comparisons (Figures 11-14) present the difference in groundwater levels between model scenarios as drawdown contours (0.05m interval).

Effect of development - no sea level rise

Figure 11 demonstrates that under mean rainfall conditions, proposed development will have insignificant effects on groundwater across the majority of the site, including within and adjacent to all wetland areas (GDEs) south of the Monkey Jacket area. However, groundwater levels primarily in the more undulating areas in the site's west will be reduced. This is as a result of design surface interception with groundwater particularly west of GMB9 and GMB201 (Monkey Jacket area) and at the upper ends of the main drainage line near GMB7 and GMB11.

Effect of development – with sea level rise

Figure 13 demonstrates very similar results to Figure 11, demonstrating that sea level rise has no discernible impact on the relationship between the developed site groundwater levels and the existing site's groundwater levels.

Effect of 'wet' year

Figure 12 demonstrates minor water table rises within the upper areas of the site under 'wet' conditions compared to 'mean' conditions for



the developed site without sea level rise. There is no discernible difference in the eastern (GDE) areas of the site.

Effect of sea level rise

Figure 14 demonstrates that sea level has an effect on groundwater levels in the eastern (GDE) parts of the site but no significant effect in the higher areas in the site's west.

4.4.6.3 Water Balance to Receiving Environments

A water balance assessment was conducted for:

- 1 Myall Creek catchment area
- 2 Rehabilitation and SEPP 14 wetland area
- 3 J lake

Total in-flow to these areas (sum of groundwater and drain contributions) was determined (Table 14). Results indicate:

- Water balances to the rehabilitation area and SEPP 14 wetland are maintained.
- Discharges to Myall Creek will increase. This is primarily due to increased drain flows which shall be discharged directly to the Myall River (following proposed water quality wetland treatment) and will not impact on GDEs.

Table 14: Water balance summaries.

	Exi	sting Condition	ons	Dev	eloped Cond	itions	Differ	ence
	Flow In	Upslope Drains	Total flow In	Flow In	Upslope Drains	Total flow In	Total f	low in
Receiving Node	(m³/day)	(m³/day)	(m³/day)	(m³/day)	(m³/day)	(m³/day)	m³/day	%
Myall Creek	97.0	0.0	97.0	86.7	293.2	379.9	282.9	292%
Rehab Area & SEPP 14 Wetland	484.2	614.8	1099.0	327.5	739.0	1066.5	-32.6	-3%
J Lake	491.7	0.0	491.7	468.1	0.0	468.1	-23.6	-5%



4.4.6.4 Groundwater Interception Plot

A comparison of the concept design surface DTM and the M2a surface is presented in Figure 18. This indicates design surface areas (developed site contours) that intercept the modelled groundwater level (M2a) under mean rainfall conditions. Red and pink coloured areas indicate groundwater being intercepted. <u>We note that the</u> <u>design surface DTM is based on drain invert levels including the invert of</u> <u>proposed roadside biofilters as opposed to finished ground surface</u> <u>levels in these areas.</u>

The main areas where interception would occur are within the Western Branch and Monkey Jacket drainage corridors. Other areas of likely interception include the higher western slopes of the Monkey Jacket area and the invert level of roadside biofilters in a number of locations across the site.

Concept results indicate interception over the majority of depicted interception areas is typically less than 0.1m. More detailed design and modelling at the DA stage may void these minor interceptions altogether.

More significant interception occurs within the Monkey Jacket higher slope areas where approximately 1.5m interception is indicated. This would result in local lowering of the groundwater within this immediate area through subsurface road drainage. The drawdown plots suggest the spatial influence of the drawdown is relatively focused and does not extend to influence downslope wetland areas. This area of the site is not flanked by GDE's. In reality, a very minor area of the development site (approximately 1%) is affected by this. We would recommend that design levels within this area could be re-evaluated at a more detailed design stage in the project, with further consideration to water table levels, supported with additional data.

Modelling results suggests that the extent of groundwater interception likely as a result of the proposed design levels will have negligible impact on GDE's. We therefore recommend that this finding bear no real significance on concept approval of the proposal. If deemed by authorities to be an issue, the areas of groundwater interception can be managed in either one of two ways in moving forward with the future design stages of the development: The management options include:

1 Minor amendments to the design levels in the affected areas of the site during more detailed design stage of the application (DA stage). It is appreciated that raising levels in stormwater storage and receiving areas of the site may result in



considerable overall volumes (and hence expense) of fill being required extending to other areas requiring fall to allow drainage.

2 Acceptance that a slight lowering of the groundwater will occur in the areas of interception. Groundwater modelling suggests that slight lowering the groundwater table in such areas will have negligible impact on levels within the surrounding GDE areas.

Both options could be supported by additional geotechnical/groundwater investigations if deemed required particularly in the Monkey Jacket area of the site where current modelling has relied on one piezometer. Greater coverage should be included to allow more detailed assessment, to accompany a DA application for that area.

4.4.7 Transient Groundwater Levels

The modelling undertaken has provided a range of mean groundwater level scenarios. We make the following specific comments in relation to transient or 'day to day' groundwater level variations.

- 1. On a daily basis, groundwater levels may fluctuate considerably across the site in response to incident rainfall. During periods of heavy rainfall, for example, groundwater can locally rise within a few hours in the order of 0.1-0.5 m (depending on location). This groundwater response is generally short lived due to the sandy permeable nature of the aquifer.
- 2. In some locations within the development site (under the preliminary proposed developed terrain surface) surface drains and inverts of some road side swales may capture a small proportion of these intermittently high groundwater levels.
- 3. We note that the site already maintains a number of drainage channels which achieve the same effect as that described above (i.e. they remove the higher groundwater levels to surface drains). However, these are generally at a lower level than that to be constructed for the developed site.
- 4. It is our view that whilst drain interception of intermittently elevated groundwater levels is not ideal, that the placement of fill at the site and broadly higher elevation of the proposed site drainage system compared with the existing conditions, will not result in any significant change to the capture of higher



groundwater levels at the critical ecosystem boundaries than is presently the case.

4.4.8 Uncertainty Analysis and Model Limitations

In accordance with Australian groundwater modelling guidelines (June, 2012), the model is considered to generally represent a 'Class 2' model confidence-level classification.

A 'Class 2' classification is justified on the basis of the following:

- Geotechnical and groundwater data coverage are high for the entire model domain.
- The conceptual model is relatively simple and therefore inherently exhibits a relatively lower degree of uncertainty compared to other more complex hydrogeological systems.
- Digital elevation models (DEM) for terrain surfaces are high quality.
- Model is a steady state and single layer.

Model limitations:

- Temporal head data coverage is considered reasonable but insufficient to permit transient calibration verification. We do not consider this a significant limitation as discussed in Section 4.4.1.
- Dry-cells developed in the model within the higher slopes of the northern site area (west of GMB201). This is considered to be an effect of relatively sharp ground steepening area and was offset by assigning constant head boundary conditions in this area. Lack of variation in head equipotentials in the area for the various model scenarios is a consequence. We do not consider this a significant limitation as:
 - 1) GMB data in this area allows confidence in the assigning of constant head values in this area.
 - 2) This area is not adjacent to critical receiving waters or GDEs.

In spite of these limitations the model's target confidence level is deemed fit for purposes of concept stage assessment.



4.5 Effects of Development on Groundwater

4.5.1 Groundwater Levels

From groundwater modelling results it is concluded that the proposed development would result in no discernible impact on groundwater levels within or adjacent to the critical ecosystems (i.e. SEPP 14 wetland and J lake) of the site. The development's impact on groundwater would be limited to the higher western portions of the site and the Monkey Jacket area with the zone of impact being relatively confined and not extending to downslope critical ecosystems.

4.5.2 Water Balance to Wetland

The water balance analysis demonstrates that existing groundwater flow patterns and water budgets to critical ecosystems (SEPP 14 wetlands and J lake) are maintained for the proposed development.

4.5.3 Groundwater Quality

Water quality modelling results (Section 3.7) demonstrates that proposed surface water treatment strategy will produce concentrations of key pollutants (TP and TN) that are considerably below existing groundwater concentrations found on site (Table 15). Hence, a NorBE groundwater quality result is achieved.

Table 15: Comparison of water que	uality modelling results with existing groundwater quality.
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Pollutant	Stormwater Pollutant Concentration ¹	Existing Groundwater ¹
TP mg/L	0.084	0.41
TN mg/L	0.082	2.5

Notes:

^{1.} Median values (see Table 8).



4.6 Preliminary Concept Groundwater Management Plan

4.6.1 Overview

This preliminary concept groundwater management plan provides advice on the following:

- 1. Existing aquifer characteristics
- 2. Potential aquifer risks
- 3. Risk management objectives
- 4. Risk management methods
- 5. Further investigation requirements
- 4.6.2 General Aquifer Characteristics

Based on preliminary investigations and modelling of the aquifer, the following characteristics define the Riverside site aquifer:

- 1. The aquifer is sand-dominated, of a relatively low gradient and highly permeable.
- 2. The groundwater system is coupled with the Port Stephens estuary/Myall River and is responsive to tidal fluctuations.
- 3. The aquifer is highly responsive to recharge events. Reasonably rapid groundwater level fluctuations of the order of 500 mm to 1000 mm can occur in response to rainfall.
- 4. Aquifer recharge is local and is predominantly controlled by incident rainfall.
- 5. Based on available groundwater quality data, groundwater is likely to be of a low-value resource due to TDS, pH, chloride, sodium and ammonia concentrations which exceed Australian Drinking Water Guidelines (NHRMC, 2004).



4.6.3 Primary Risk Identification

The following broad scale potential risks are identified in association with the release of urban land.

- 1. Untreated stormwater discharge to groundwater resulting in groundwater contamination.
- 2. Changes to groundwater level which come about through modifications to surface infiltration and recharge properties at the site.
- 3. Changes to groundwater flow direction which come about through modifications to surface infiltration and recharge properties at the site.
- 4. Significant modifications to groundwater flow budgets to GDEs and receiving waters.
- 5. Locally increasing groundwater levels though excessive recharge resulting in surface water losses from the groundwater system.

4.6.4 Risk Management Objectives

On the basis of identified risks, the following risk management objectives are provided:

- 1. Development is to be undertaken in such a way so as to ensure that groundwater table drawdown is minimised.
- 2. Development should not result in a degradation of the existing aquifer water quality.
- 3. Development should not significantly alter the flow directions of ground water at the site.
- 4. Development water and groundwater management strategies should be integrate and ensure surface water and groundwater systems are managed such that the integrity of GDEs is preserved or enhanced.



4.6.5 Risk Management Methods

The following methods are provided in order that the risk management objectives can be met:

- 1. All stormwater management systems treat stormwater to a level equal to or better than existing groundwater quality prior to discharge to any groundwater body.
- 2. No direct permanent connection to groundwater.
- 3. Minimised (as far as practical) exposure of groundwater to surface water systems.
- 4. Recharge treated stormwater throughout the site in such a way so as to enable distributed recharge rather than single point recharge. This ensures that groundwater flow gradients, levels and directions are maintained at/close to pre-development levels. It is noted that that current proposal features a recharge swale that buffers the SEPP 14 wetland.
- 4.6.6 Groundwater pH Management

Existing groundwater pH levels at the site are variable and may typically range between say 5.0 and 6.5 depending on specific location, local soil and geology, and antecedent rainfall conditions. Samples from GMB returned the lowest pH value of 3.99.

Rainfall pH levels for coastal NSW are generally acidic due to the disassociation of CO_2 to form carbonic acid and may range between say 5.5 and 7.0. Lower levels [to say pH of 4.5] can be experienced in coastal areas near larger urban centres or closer to industrial centres (such as Newcastle in the case of this site) (Bridgman, 1989).

Contrasting the depressed pH of rainfall, urban runoff, notably from concrete and other pavement surfaces, has the potential to maintain a slightly elevated pH of say 6.5 – 7.5. In the case of this development, we do not expect any changes to background groundwater pH levels at the fringing wetlands for the following reasons:

- 1. There will be minimal concrete pavements / surfaces within the development relative to other surfaces (ie. pervious surfaces and roofs) and therefore limited potential for significant production of alkaline urban runoff.
- 2. Rainwater will remain the primary source of acidity within urban runoff and there will continue to be significant opportunity within the



development footprint and within the proposed surface drainage system for contact between rainwater and *in-situ* soil prior to percolation to the groundwater system.

- 3. Local soils within and adjoining the fringing wetlands have a significant capacity to maintain stable pH levels given the high levels of organic matter and buffering capacity of local soils (Murphy, 1995).
- 4.6.7 Recycled Water Usage

We provide the following preliminary comments in relation to the risks that any potential irrigation of recycled water over the site would pose.

- Indicative nutrient concentrations in recycled water would be 6 mg/L TN and 2.2 mg/L TP. These values are comparable to existing groundwater conditions, particularly nitrogen levels. We note there may be scope to reduce these concentrations with additional water treatment.
- 2. On the basis that lots will be of the order of 600 m² with irrigated garden beds and/or lawns being in approximately 200 m², a maximum of some 90-100 KL/ET/year (say 100 KL/dwelling/year) of recycled water could be expected to be used for outdoor purposes (assuming a total water consumption rate of 210 KL/ET/year).
- 3. Irrigation nutrient loads to the yard areas will therefore be of the order of 0.60 kg/year TN and 0.22 kg/year TP. It is important to note that these loads would be irrigated during dry times and generally onto unsaturated soils and not directly into the groundwater system. During times of high groundwater, there would be no need to provide additional irrigation water. Risks of direct recharge are therefore negligible.
- 4. Broad acre nutrient consumption rates for lawns and landscaped gardens are of the order of 200 kg/ha/year and 15 kg/ha/year phosphorus. On this basis, demand for nutrients in irrigated yard and landscaped areas will be of the order of 4 kg/year TN and 0.3 kg/year TP.
- 5. The above demonstrates that demand for nutrients in garden areas alone far outstrips that which can be supplied by the recycled water. In the case of nitrogen, demand is 660 % of expected supply, and in the case of phosphorus, demand is 136 % of expected supply. In the case of phosphorus, these preliminary estimates do not account for the significant sorption of phosphorous that would occur within soils.



- 6. The preliminary calculations are conservative as they do not account for the opportunity for nutrient uptake in areas outside those being irrigated, nor do they account for nutrient transformation which will occur within the unsaturated and saturated portions of the soil (e.g. denitrification losses).
- 4.6.8 Beneficial Use of Site Groundwater Resource

The proposed development, together with the integrated water management strategy in place will have NorBE on the potential for beneficial use of the site's groundwater resource given the findings of NorBE on surface water and groundwater assessments determined in this study.

It is noted from Section 4.3.2 that existing groundwater quality is not suited for potable use.

Potential risk from future domestic use of groundwater for irrigation has not been assessed in detail but there is no likely need for such use given the agreement in place with Midcoast Water for the re-use of recycled water for irrigation on individual lots and in public spaces throughout the development.

Any proposed extraction point for irrigation would require conditional licence approval from the NSW Office of Water and be subject to similar rigorous impact assessment on GDEs.

Use of groundwater for GDE maintenance represents the most suitable potential use of the site's groundwater resource.



4.7 Compliance with Previous Review Feedback

 Table 16: Compliance with Review Feedback

Assessor	Issue	Comment
PAC (2009)	Lack of baseline groundwater information.	Addressed: Additional information gathered and utilised – Additional GW level recordings, GMB locations, hydraulic conductivity assessment (Section 4.3.2)
	Inappropriate use of a steady state model instead of transient model and poor calibration of the model.	Addressed : Steady state justified (Section 4.4.1); improved and appropriate Model calibration results (Section4.4.4);
	Potential for saline intrusion from the existing detention lake.	Addressed: Drawdown risk eliminated by revision of water cycle management strategy including removal of window lakes. No likelihood of flow reversal from the J lake (Section 4.4.1);
	Assessment of groundwater flux at shoreline to assess potential impacts to tidal wetland ecosystem.	Not applicable : tidal wetland ecosystem groundwater flux totally dependent on tidal fluctuations. Removed from any conceivable impact from development given distance from development to natural shoreline ecosystem and no discernible impact shown groundwater levels and flow balances on other side of wetland closets to development.
Now (2012)	Use of a steady state model rather than a dynamic model incorporating a representative period of climatic variability	Addressed: Steady state justified, climate variability incorporated with 'wet' and 'mean' year modelling (Section 4.4.1);
	Underestimation of the effect of the averaging of drawdown over time (it believes this average drawdown will then be compounded by natural fluctuations rather than offset by them)	Addressed: Model calibration improved (Section4.4.4); Climate variability incorporated into modelling (Section 4.4.1).
DoPI (2012)	Groundwater contributions of the site be better assessed to quantify hydrologic and water quality impacts on adjacent wetlands.	Addressed: Totally revised model, improved data, calibration, climate variability incorporation.
	Implementation of biofiltration systems to promote 'at source' recharge of treated stormwater to groundwater throughout the development (and assessment of resulting surface and groundwater impacts on the SEPP 14 wetlands).	Addressed : Totally revised WSUD approach incorporating biofilters for water quality treatment and 'at source' recharge to maintain groundwater regimes and minimise risk of impacts on GDEs.



5 Conclusions and Recommendations

This report presents a revised approach to the management of ground and surface waters associated with the development of land at the "Riverside" site at Tea Gardens, NSW from cattle grazing to residential and tourism purposes. It has been prepared to support a Concept Proposal Application under Part 3a of the EP&A Act (1979).

The revised strategy has been carefully formulated from a long history of consultation with State and Local Government agencies and specifically addresses concerns expressed by the NSW Department of Planning and Infrastructure (DoPI), NSW Office of Water (NOW) and Great Lakes Council over the previously prepared strategy by Cardno (2012).

The revised strategy has been formulated with the principle objective of ensuring Neutral or Beneficial Effect (NorBE) from the development on receiving groundwater and surface water systems to protect receiving waters and critical ecosystems including groundwater dependant ecosystems (GDEs). The strategy focuses on the use of 'at source' (i.e. 'distributed') stormwater treatment measures allowing preservation (to the extent possible) of existing ground water recharge mechanisms and surface water hydrology, such that there would be no significant impact on receiving waters and adjoining GDEs.

5.1 General Conclusions

Concluding remarks for three main elements that form part of the integrated strategy are summarised as follows:

i) Site hydrology – drainage and flood management

Undertaken by Tattersall Lander Pty Ltd, the updated stormwater drainage concept plan and supporting hydrological model including flood assessment was developed in coordination with the water quality and groundwater management strategies.

The assessment demonstrates that the proposed development will not have an adverse impact on flood behaviour on or around the site. Specifically it concludes:

• The combination of provided storage and low flow discharge structures ensure environmental flows into the wetland buffer area are maintained once the site is developed.



- The proposed level spreader designed for high flow discharge ensures the development will not result in an increase in flow velocities during rare events that would otherwise cause damage to downstream environments.
- Existing flood levels remain unaffected by the proposal.
- Proposed filling works plus floodway capacities ensure all lots remain flood free to the design 100yr event.
- The proposed development design caters for the safety of future residents in the peak PMF event.

ii) Surface water quality

The revised stormwater management system, formulated by Martens & Associates, uses current best practice WSUD philosophies for water quality tailored to the site. The revised surface water quality management concept relies on "atsource" treatment structures and elimination of proposed "window lakes" and is integrated with groundwater and surface water management strategies for the development.

Detailed water quality modelling has been undertaken in accordance with Sydney Metro CMA 'Draft NSW MUSIC Modelling Guidelines' (2010) to determine treatment measures required to achieve a Neutral or Beneficial Effect (NorBE) for post development water quality conditions, as well as satisfying Great Lakes Council Draft DCP (2012) Chapter 11 (previously DCP 54) requirements.

Treatment measures include a combination of 'at source' (bioretention swales, buffers) and end of line (constructed wetlands) structures (where needed) to achieve these objectives. Water quality modelling concludes:

- NorBE test is satisfied.
- WSUD, including distributed and 'at-source' management measures will be effective in mitigating against any water quality impacts on receiving wetlands, river and groundwater system.

iii) Groundwater

The revised groundwater model and groundwater management strategy, formulated by Martens & Associates, utilises additional



groundwater data, including increased data coverage, and address' concerns raised by various assessment agencies.

The groundwater management strategy integrates closely with the stormwater management strategy utilising 'at source' recharge mechanisms to ensure NorBE impacts on groundwater patterns and conditions particularly in relation to impact on critical receiving waters and GDEs.

Groundwater assessment outcomes conclude:

- Modelling shows minor areas of groundwater interception within the development footprint. However, no discernible impact from the proposed development is likely on SEPP 14 wetland groundwater levels and water budgets.
- No discernible impact on water quality and levels in existing brackish lake (J Lake).
- NorBE on groundwater resources for the site and surrounding areas.
- Largely unchanged groundwater regime from existing conditions. This is due to the distributed WSUD approach to water quality management and recharge where possible in the catchment.

5.2 Recommended Commitments

The following recommendations are made for developer commitments in progression of the project.

Detailed design for the development shall be consistent with the integrated approach to water cycle management as outlined in this strategy. Additionally, it shall include provision for ongoing monitoring and reporting to ensure water cycle management objectives are being met.

Recommended commitments include:

i) Site hydrology – drainage and flood management

 Proposed drainage storages, low flow discharge structures and level spreaders shall be designed and constructed to ensure environmental flows into the wetland buffer area are maintained to predevelopment conditions and will not result in a significant increase in flow velocities during rare events



that would otherwise cause damage to downstream environments.

- The proposed development including filling works will ensure all lots remain flood free to the design 100yr event and that existing flood levels (including for neighbouring areas) remain unaffected by the development.
- The proposed development design will cater for the safety of future residents in all reasonably considered flooding scenarios including the peak PMF event.

ii) Surface water quality

- The proposed stormwater treatment train shall be implemented at the site to ensure that water quality objectives are met.
- Proposed treatment train is to combine 'at source' and end of line controls in accordance with principles of Water Sensitive Urban Design and to avoid reliance on large end of line structures.
- The development shall have a neutral or beneficial effect on water quality in order to protect receiving environments, including SEPP14 wetlands, existing brackish lake, Myall Creek and the groundwater table.

i) Groundwater

- Proposed 'at source' water quality treatment mechanisms incorporate groundwater recharge mechanisms are to ensure distributed recharge and NorBE impacts on groundwater patterns and conditions across the development site.
- Proposed development is to have no significant impact on SEPP 14 wetland groundwater levels and water budgets.
- Proposed development to have no significant impact on water quality and levels in existing brackish lake (J Lake).
- Proposed development to be designed so that minimal groundwater interception will occur. Any areas of interception are to be approved in consultation and subject to approval of NOW (and any other relevant Government agencies).



6 References

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- BMT WBM (2012), Review of Water Quality Management for the Proposed Riverside at Tea Gardens Development; Final Report.
- Bureau of Meteorology (2001), Climatic Atlas of Australia Evapotranspiration.
- Cardno (2011), Riverside at Tea Gardens, Integrated Water Cycle Management Strategy and Sewerage Servicing, Final, November.
- Coffey Partners International (February, 1996), Myall Quays Development Groundwater and Surface Water Study.
- Coffey Geotechnics (October, 2007), Groundwater Assessment Riverside Development, Tea Gardens.
- ERM (November, 2012), Riverside at Tea Gardens Preferred Project Report.

Great Lakes Council (2012), Draft Development Control Plan

- Landcom (2004), Soils and Construction 'Managing Urban Stormwater'.
- Martens & Associates (December, 2011), Preliminary Hydrogeological Study and Concept Groundwater Management Plan, Riverside, Tea Gardens, NSW.
- Murphy, C. L. (1995), Soil Landscapes of the Port Stephens 1:100 000 Sheet, Soil Conservation Service of NSW.
- NHMRC (2004), Australian Drinking Water Guidelines.

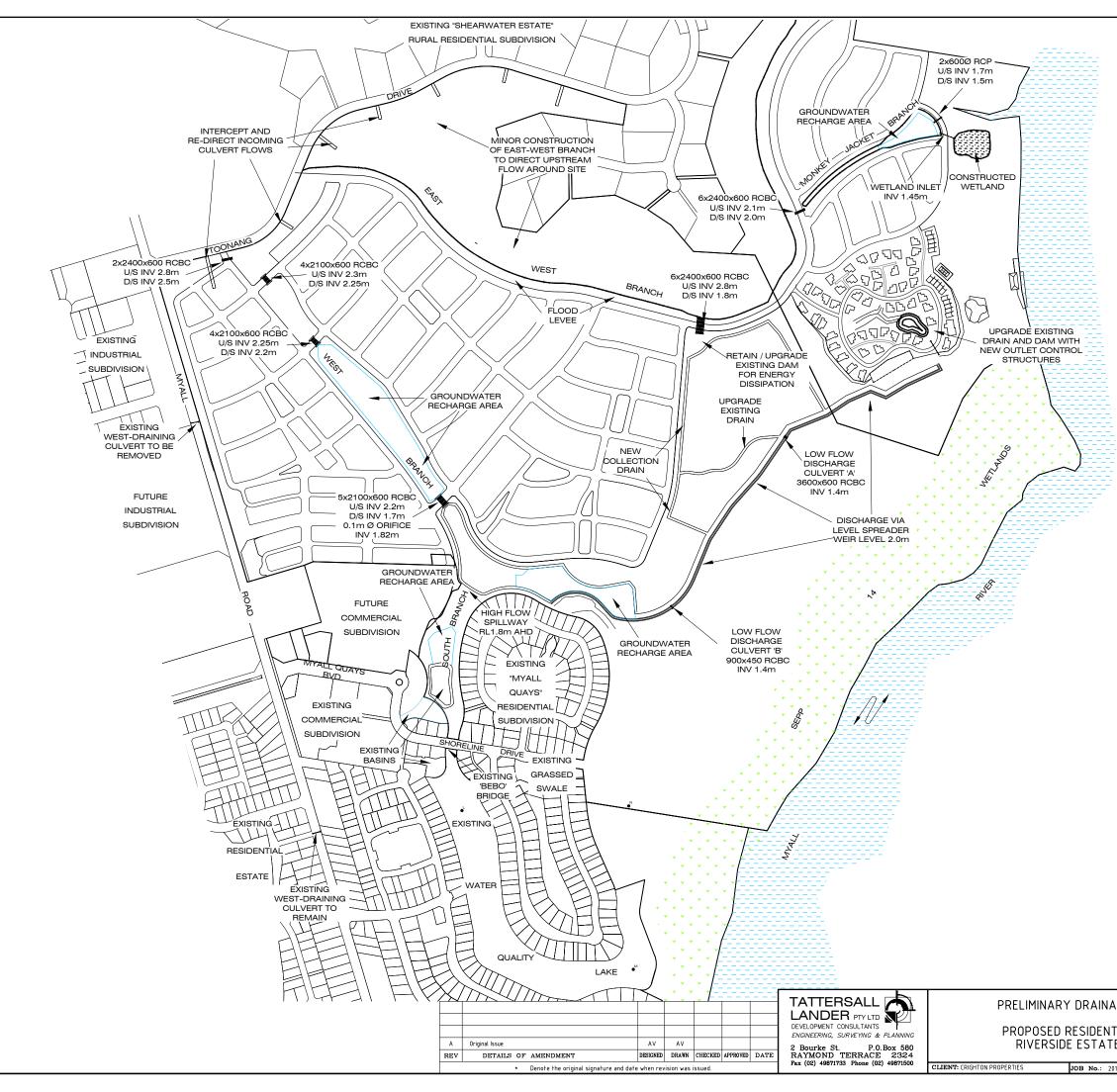
NSW DECCW (2009), Sea Level Rise Policy Statement.

Sydney Metropolitan Catchment Management Authority (SMCMA) (2010), Draft NSW MUSIC Modelling Guidelines.



7 Attachment 1A – Preliminary Drainage Details Plan







Ľ	20	40	\$	80m	
1: 4000)	for	A1	Size	Plot

GE DESIGN DETAILS TAL DEVELOPMENT E, TEA GARDENS		COUNCIL GREAT LAKES	2120014	
		PARISH	SHEET SIZE	A1
		SCALE 1:4000	SHEE1 16	Г No.
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1479	COMPUTER FILE : S:\projects\Myall Quays\dwg\STG9\Riverside DA Inundation Plans.dwg			

8 Attachment 1B – Amended Concept Development Plan





Extent of concept plan area 'Riverside' at Tea Gardens. Conservation Conservation Existing Lakes Existing Lakes Dopen Space / Water Management Low Density Residential Low - Medium Density Residential Home business Public Woodland Park for Active Recreation Future precinct Facilities	ept plan area 'Riverside' at Tea	222.5 Ha % 6.7 Ha 15.4 Ha 64.8 Ha	100 % 52.2% 3.0 % 6.9 % 29.1 %	780 Dw
Conservation Existing Lakes Deen Space / Water Management Cow Density Residential Low - Medium Density Residential Home business Eco Lodge / Tourist Accomodation Foreshore Precinct Public Woodland Park for Active R Future precinct Facilities	s Water Management Residential	16.1 Ha 5.7 Ha 5.4 Ha 34.8 Ha	52.2% 3.0 % 6.9 % 29.1 %	780 Dw
Existing Lakes Existing Lakes Deen Space / Water Management Low Density Residential Low - Medium Density Residential Home business Foreshore Precinct Public Woodland Park for Active R Future precinct Facilities		5.7 Ha 5.4 Ha 54.8 Ha	3.0% 6.9% 29.1%	780 Dw
Existing Lakes Open Space / Water Management Open Space / Water Management Low Density Residential Low - Medium Density Residential Home business Foreshore Precinct Public Woodland Park for Active R Future precinct Facilities		6.7 Ha 15.4 Ha 14.8 Ha	3.0% 6.9% 29.1%	780 Dw
Open Space / Water Management Low Density Residential Low - Medium Density Residential Home business Eco Lodge / Tourist Accomodation Foreshore Precinct Public Woodland Park for Active R Future precinct Facilities		5.4 Ha 54.8 Ha	6.9 % 29.1 %	780 Dw
Open Space / Water Management Low Density Residential Low - Medium Density Residential Home business Eco Lodge / Tourist Accomodation Foreshore Precinct Public Woodland Park for Active R Future precinct Facilities		5.4 Ha 34.8 Ha	6.9 % 29.1 %	780 Dw
Low Density Residential Low - Medium Density Residential Home business Eco Lodge / Tourist Accomodation Foreshore Precinct Public Woodland Park for Active R Future precinct Facilities	esidential	34.8 Ha	29.1 %	780 Dw
Low Density Residential Low - Medium Density Residential Home business Eco Lodge / Tourist Accomodation Foreshore Precinct Public Woodland Park for Active R Future precinct Facilities	esidential	34.8 Ha	29.1 %	780 Dw
Low - Medium Density Residentia Home business Eco Lodge / Tourist Accomodation Foreshore Precinct Public Woodland Park for Active R Future precinct Facilities	ensity Residential			
Low - Medium Density Residential Home business Eco Lodge / Tourist Accomodation Foreshore Precinct Public Woodland Park for Active R Future precinct Facilities	ensity Residential			
Eco Lodge / Tourist Accomodation Foreshore Precinct Public Woodland Park for Active R Future precinct Facilities	usiness	7.7 На	3.5 %	100 Dw
Eco Lodge / Tourist Accomodation Foreshore Precinct Public Woodland Park for Active R Future precinct Facilities				
Public Woodland Park for Active R Future precinct Facilities		10.4 Ha	4.7 %	65 Dw
Public Woodland Park for Active R Future precinct Facilities				
Future precinct Facilities	Public Woodland Park for Active Recreation	1.4 Ha	0.6 %	
)	precinct Facilities			
Existing house.	house.			
Location of known midden & buffer.	n of known midden & buffer.			
• • • • Existing drain outlet to Myall River.	drain outlet to Myall River.			
Contract of this application) (Not part of this application)	bing Town Centre			
E Future connecting road	connecting road			



CRIGHTON PROPERTIES REVISION 0

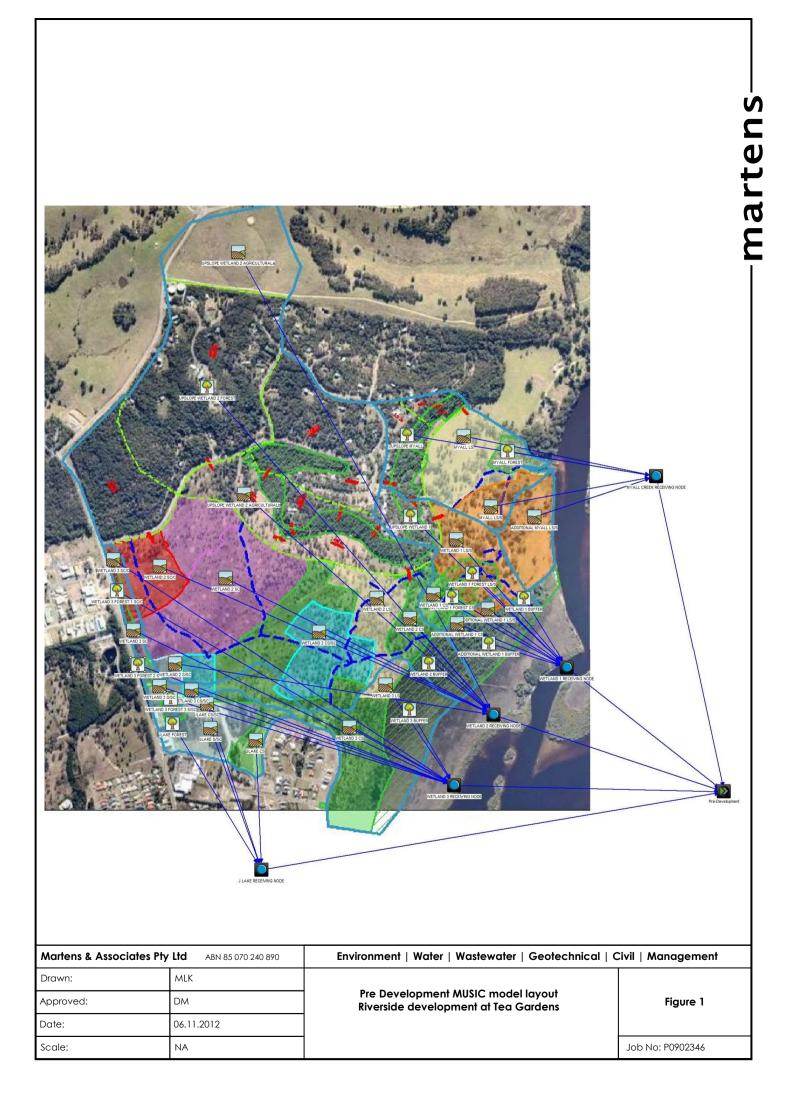
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 Part 3a Submission to N.S.W. D.O.P.

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 October 2012
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 R.C

9 Attachment 3A – Pre and Post Development MUSIC layouts





Martens & Associates Pty Ltd ABN 85 070 240 890 Environment Water Wastewater Geotechnical Civil Management Drawn: MLK Approved: DM Date: 07.11.2012 Post Development MUSIC model layout Riverside development at Tea Gardens Idea National Process				
Drawn: MLK Approved: DM Date: 07.11.2012 Post Development MUSIC model layout Riverside development at Tea Gardens Figure 2	Martens & Associates Ptv	2 Ltd ABN 85 070 240 890	Environment Water Wastewater Geotechnical 0	Civil Manaaement
Approved: DM Post Development MUSIC model layout Riverside development at Tea Gardens Figure 2 Date: 07.11.2012 Image: Control of the second sec				
Date: 07.11.2012			Post Development MUSIC model layout	Figure 2
			kiversiae aevelopment at lea Gardens	
	Scale:	NA		Job No: P0902346

10 Attachment 3B – MUSIC Input Parameters



Attachment 3B: MUSIC modelling input parameter values and source.

Element	Factor	Input	Source
Element Setup		Input Rainfall: Hawks Nest adjusted Williamtown RAAF 6min pluvio 1/1/1997 - 31/12/2006 PET: Monthly averages as per BOM 'Climatic Atlas of Australia'	Source WBM (2012a) requires Williamtown to be used with a 6min timestep. WBM (2010) MUSIC guidelines suggests 1/1/2002 - 31/12/2006 is used for this climate file in Table 3- 1. Discussion with T. Weber (Sept 4, 2012) confirmed the climate file should also include 5 years prior to 2002 (i.e. 1/1/1997 - 31/12/2006). PET as per advice from T Weber on Oct 3, 2012.
	Node Type	The existing site will be a mixture of agricultual and forested nodes, depending on location across the site. Proposed will be a mixture of roof, road and residential nodes plus forest for reforestation areas and agricultural for pre=post areas.	As recommended in WBM (2012a)
	Roof Area	Roof area assumed to be 40% of total lot area in accordance with Great Lakes requirement for floor space ratio.	Area supplied by Tattersall Lander.
	Road Area	Based on proposed lot layout.	Area supplied by Tattersall Lander.
	Residential - Impervious area	Includes effective impervious area (EIA) only in accordance with WBM (2010). EIA for site (excluding roads and roofs which are modelled separately) are footpaths and the driveway area from road to front boundary.	EIA as per WBM (2010). Footpath and driveway area provided by Tattersall Lander
Source Nodes	Residential - Pervious area	Total lot area minus total roof. Includes driveway area on each lot as not considered EIA.	Area supplied by Tattersall Lander.
	Rainfall Threshold	Based on land use type or surface type	As recommended in WBM (2010) Table 3-6
	Pervious Area Parameters	 Existing site - based on soils within the top 0.5m of existing soil profile Catchment 1: SCC, FC and rainfall-runoff parameters based on WBM (2010) for sandy clay soils. Catchment 16: SSC, FC and rainfall runoff parameters based on a weighted average of values in WBM (2010) based on clayey sand (0.3m) overlying sand (0.2m). Proposed site - the site will be filled with sand and then 100mm of loamy sand growing media to achieve FFL's consistent with flood requirements. SCC, FC and rainfall-runoff parameters based on a weighted average of values in WBM (2010) for top 0.5m - where 0.4m is sand and 0.1m is loamy sand. 	Average soil properties based on WBM (2010) Table 3-7 and 3-8 and site geotechnical testing by Coffey (2008) and Martens (2009) of 49 boreholes.
	EMC's	As per WBM (2010)	WBM (2012b) requires that the proponent should use site calibrated parameters or the MUSIC guidelines. In the absense of site specific data we are using the EMCs specified within the WBM (2010) guidelines which are taken from Fletcher <i>et al</i> 2004.
	Estimation Method	Stochastically generated	As per WBM (2010) MUSIC modelling guidelines
	Low Flow By-Pass	0 m3/s	As per WBM (2010) MUSIC modelling guidelines
	High Flow Bypass	100 m3/s	As per advice from T Weber (October 3, 2012)
	Extended Detention depth	0.25m	Design of proposed swales. Design provided by Tattersall Lander (attached).
	Surface area	Surface area (combined surface area for subcatchment) at half the detention depth	As per WBM (2010) MUSIC modelling guidelines. Area provided by Tattersall Lander.
	Filter area	By design. Total area within subcatchment.	Design of proposed swales. Design provided by Tattersall Lander (attached).
	Unlined filter media	Equal to square root of surface area (actual) multiplied by 4	As per WBM (2010) MUSIC modelling guidelines
	Saturated Hydraulic Conductivity	180 mm/hr	MUSIC model help guidelines (ewater) recommend a hydraulic conductibity of 360 mm/hr be used for sands. 50% of this value has been used in modelling as a conservative estimate of realistic long-term hydraulic conductivity of system (ewater).
	Filter Depth	0.4m	Design of proposed swales. Design provided by Tattersall Lander (attached).
BioSwale	TN content of filter media	500 mg/kg	As per direction from T. Weber c/o Stuart Withington in correspondance dated
	Orthophosphate content of filter media	50 mg/kg	September 7, 2012.
	Exfiltration rate	0mm/hr	Although some exfiltration is expected, the system is being designed such that
			treatment occurs prior to surface water being lost to the system. A second model run with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be
	Is based lined?	Yes	with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment.
	Is based lined? Vegetation Properties	With effective nutrient removal plants	with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be
			with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment.
	Vegetation Properties Oveflow weir width Underdrain present	With effective nutrient removal plants Driveway is weir for each swale (3.5m). Total weir is used in	with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment. Landscaping of Bioswales will include deep rooted vegetation.
	Vegetation Properties Oveflow weir width Underdrain present	With effective nutrient removal plants Driveway is weir for each swale (3.5m). Total weir is used in modelling (i.e. 3.5 x number of swales).	 with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment. Landscaping of Bioswales will include deep rooted vegetation. Design of proposed swales. Design provided by Tattersall Lander (attached).
Buffer	Vegetation Properties Oveflow weir width Underdrain present Submerged zone with carbon present Percentage of upstream area buffered (%)	With effective nutrient removal plants Driveway is weir for each swale (3.5m). Total weir is used in modelling (i.e. 3.5 x number of swales). Yes No By design	 with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment. Landscaping of Bioswales will include deep rooted vegetation. Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines
Buffer	Vegetation Properties Oveflow weir width Underdrain present Submerged zone with carbon present Percentage of upstream area buffered (%) Buffer area (%)	With effective nutrient removal plants Driveway is weir for each swale (3.5m). Total weir is used in modelling (i.e. 3.5 x number of swales). Yes No By design By design	 with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment. Landscaping of Bioswales will include deep rooted vegetation. Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines
Buffer	Vegetation Properties Oveflow weir width Underdrain present Submerged zone with carbon present Percentage of upstream area buffered (%) Buffer area (%) Exfiltration rate	With effective nutrient removal plants Driveway is weir for each swale (3.5m). Total weir is used in modelling (i.e. 3.5 x number of swales). Yes No By design By design Omm/hr	 with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment. Landscaping of Bioswales will include deep rooted vegetation. Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Pesign of proposed swales. Design provided by Tattersall Lander (attached). Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines No infiltration assumed
Buffer	Vegetation Properties Oveflow weir width Underdrain present Submerged zone with carbon present Percentage of upstream area buffered (%) Buffer area (%) Exfiltration rate	With effective nutrient removal plants Driveway is weir for each swale (3.5m). Total weir is used in modelling (i.e. 3.5 x number of swales). Yes No By design By design Omm/hr 0 m3/s	 with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment. Landscaping of Bioswales will include deep rooted vegetation. Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines
Buffer	Vegetation Properties Oveflow weir width Underdrain present Submerged zone with carbon present Percentage of upstream area buffered (%) Buffer area (%) Exfiltration rate	With effective nutrient removal plants Driveway is weir for each swale (3.5m). Total weir is used in modelling (i.e. 3.5 x number of swales). Yes No By design By design Omm/hr 0 m3/s 50% of 1 year ABI based on total subcatchment area and AB&B	 with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment. Landscaping of Bioswales will include deep rooted vegetation. Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines No infiltration assumed As per WBM (2010) MUSIC modelling guidelines As per WBM (2010) MUSIC modelling guidelines
Buffer	Vegetation Properties Oveflow weir width Underdrain present Submerged zone with carbon present Percentage of upstream area buffered (%) Buffer area (%) Exfiltration rate Low Flow By-Pass High Flow Bypass	With effective nutrient removal plants Driveway is weir for each swale (3.5m). Total weir is used in modelling (i.e. 3.5 x number of swales). Yes No By design By design Omm/hr 0 m3/s 50% of 1 year ARI based on total subcatchment area and AR&R	 with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment. Landscaping of Bioswales will include deep rooted vegetation. Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Pesign of proposed swales. Design provided by Tattersall Lander (attached). Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines No infiltration assumed As per WBM (2010) MUSIC modelling guidelines
Buffer	Vegetation Properties Oveflow weir width Underdrain present Submerged zone with carbon present Percentage of upstream area buffered (%) Buffer area (%) Exfiltration rate Low Flow By-Pass High Flow Bypass Inlet pond Volume Surface area	With effective nutrient removal plants Driveway is weir for each swale (3.5m). Total weir is used in modelling (i.e. 3.5 x number of swales). Yes No By design By design Omm/hr 0 m3/s 50% of 1 year ARI based on total subcatchment area and AR&R results for Nelson Bay 0 m3 Surface area (4321 m2) at half the detention depth (0.05m)	 with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment. Landscaping of Bioswales will include deep rooted vegetation. Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines No infiltration assumed As per WBM (2010) MUSIC modelling guidelines Bioswales provide pre treatment include gross pollutant capture and so an inlet pond is not required as per WBM (2010) MUSIC modelling guidelines By design and as per WBM (2010) MUSIC modelling guidelines
Buffer Wetland	Vegetation Properties Oveflow weir width Underdrain present Submerged zone with carbon present Percentage of upstream area buffered (%) Buffer area (%) Exfiltration rate Low Flow By-Pass High Flow Bypass Inlet pond Volume Surface area	With effective nutrient removal plants Driveway is weir for each swale (3.5m). Total weir is used in modelling (i.e. 3.5 x number of swales). Yes No By design By design Omm/hr 0 m3/s 50% of 1 year ARI based on total subcatchment area and AR&R results for Nelson Bay 0 m3 Surface area (4321 m2) at half the detention depth (0.05m)	 with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment. Landscaping of Bioswales will include deep rooted vegetation. Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Pesign of proposed swales. Design provided by Tattersall Lander (attached). Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines No infiltration assumed As per WBM (2010) MUSIC modelling guidelines As per WBM (2010) MUSIC modelling guidelines Bioswales provide pre treatment include gross pollutant capture and so an inlet pond is not required as per WBM (2010) MUSIC modelling guidelines
	Vegetation Properties Oveflow weir width Underdrain present Submerged zone with carbon present Percentage of upstream area buffered (%) Buffer area (%) Exfiltration rate Low Flow By-Pass High Flow Bypass Inlet pond Volume Surface area Extended Detention depth	With effective nutrient removal plants Driveway is weir for each swale (3.5m). Total weir is used in modelling (i.e. 3.5 x number of swales). Yes No By design By design Omm/hr 0 m3/s 50% of 1 year ARI based on total subcatchment area and AR&R results for Nelson Bay 0 m3 Surface area (4321 m2) at half the detention depth (0.05m) 0.35m	 with exfiltration 'turned on' will be utilised to provide data for groundwater modelling. Although system will not be lined, system has been modelled to not allow water to be lost from the system prior to treatment. Landscaping of Bioswales will include deep rooted vegetation. Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Design of proposed swales. Design provided by Tattersall Lander (attached). Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines Provided by Tattersall Lander and as per WBM (2010) MUSIC modelling guidelines No infiltration assumed As per WBM (2010) MUSIC modelling guidelines Bioswales provide pre treatment include gross pollutant capture and so an inlet pond is not required as per WBM (2010) MUSIC modelling guidelines By design and as per WBM (2010) MUSIC modelling guidelines By design Based on a surface area of 3185 m2 at 0.4m depth (permanent pool depth). Volume



WBM (2012b) 'Riverside at Tea Gardens Residential Subdivision Revised Concept Plan'

11 Attachment 3C – Soil Landscapes Mapping



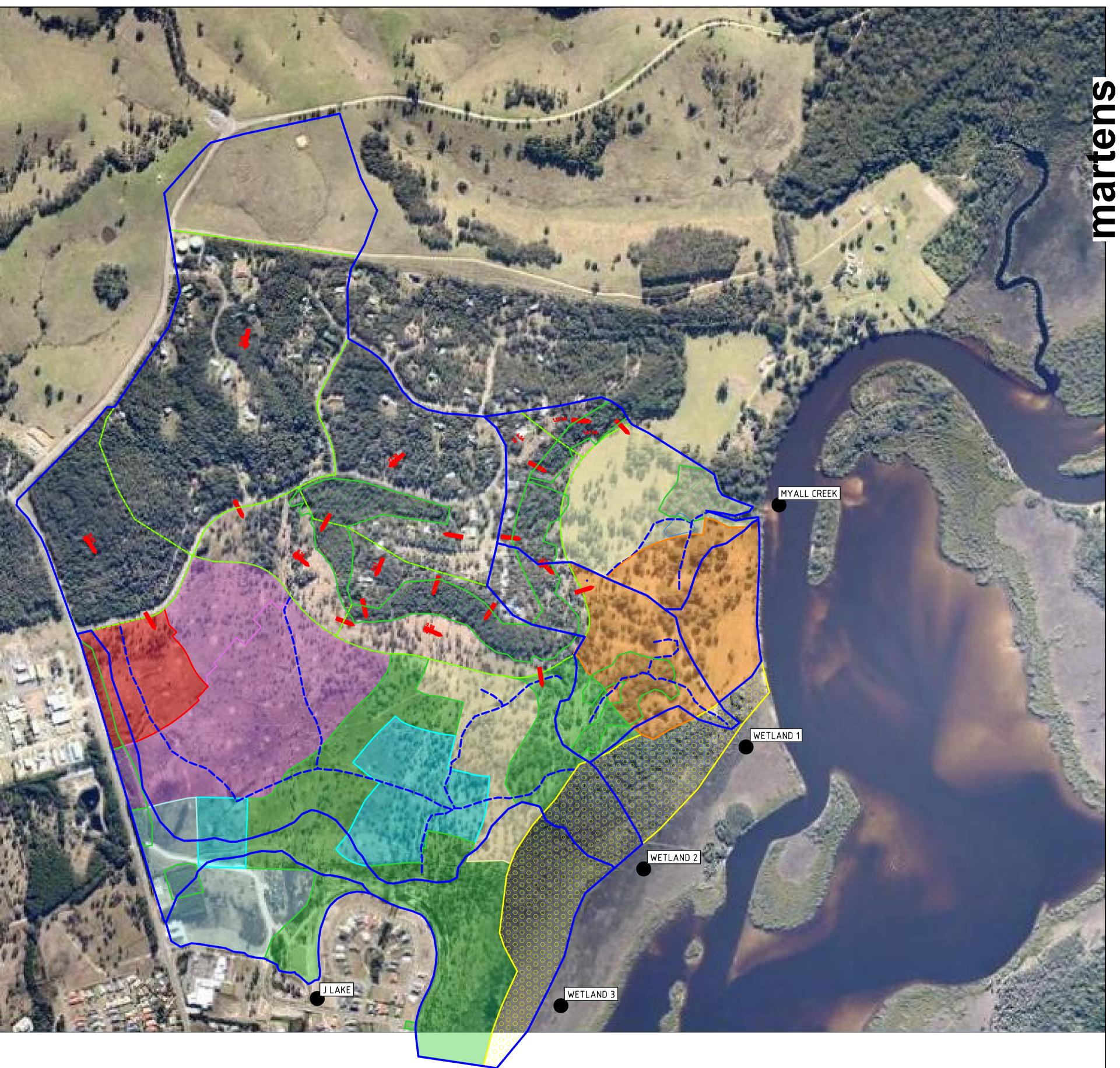
KEY



NOTE AERIAL SOURCE: TATTERSALL LANDER P/L

PAGE BAR SCALE UNITS – METRES SCALE – 1:6000 @ A1 1:12000 @ A3

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Martens & Associates Pt	y Ltd ABN 85 070 240 890	Environment W
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Date:	10.10.2012	
Scale @ A1:	1:6000	6/37 Leighton Place, Hornsby, N Email: <u>mail@mar</u>

Water | Wastewater | Geotechnical | Civil | Management

LANDSCAPES - EXISTING SITE EVELOPMENT AT TEA GARDENS, NSW

Drawing No./ID:

D100

Project:File:RevP0902346JD07V03A Revision:

12 Attachment 3D – Catchment Areas



PRE DEVELOPMENT CATCHMENT AREAS

											RVIOUS INPUT PARAM			
RECEIVING NODE	CATCHMENT ID	TOTAL AREA (HA)	IMPERVIOUS AREA (HA)	%	PERVIOUS AREA (HA)	%	EMC CATEGORY	SOIL TYPE	SSC	FC	INF A	INF B	DDR (%)	DBR (%)
	JLAKE FOREST	0.2		0%	0.2	100%	FOREST	SAND/SANDY CLAY	161.8	82	288	1.5	70	40
J-LAKE	JLAKE S/SC	6.97	0.45	6%	6.52	94%	AGRICULTURAL	SAND/SANDY CLAY	161.8	82	288	1.5	70	40
7-DAILE	JLAKE CS	3.66	0	0%	3.66	100%	AGRICULTURAL	CLAYEY SAND	107	75	250	1.3	60	45
	JLAKE CS/SC	0.27	0.09	33%	0.18	67%	AGRICULTURAL	CLAYEY SAND/SANDY CLAY	128	86.4	208	2.32	39	33
		11.1												
	MYALL FOREST	2.32	0	0%	2.32	100%	FOREST	LOAMY SAND	139	69	360	0.5	100	50
	MYALL LS/S	3.83	0	0%	3.83	100%	AGRICULTURAL	LOAMY SAND/SAND	168	73	360	0.5	100	50
MYALL CREEK	MYALL LS	9.73	0	0%	9.73	100%	AGRICULTURAL	LOAMY SAND	139	69	360	0.5	100	50
	UPSLOPE MYALL	9.14	0.914	10%	8.226	90%	FOREST	SANDY CLAY LOAM	108	73	250	1.3	60	45
	ADDITIONAL MYALL LS/S	7.47	0	0%	7.47	100%	AGRICULTURAL	LOAMY SAND/SAND	168	73	360	0.5	100	50
		32.5												
	WETLAND 1 FOREST LS/S	2.3	0	0%	2.3	100%	FOREST	LOAMY SAND/SAND	168	73	360	0.5	100	50
	WETLAND 1 FOREST CS	1.04	0	0%	1.04	100%	FOREST	CLAYEY SAND	107	75	250	1.3	60	45
	WETLAND 1 LS/S	7.28	0	0%	7.28	100%	AGRICULTURAL	LOAMY SAND/SAND	168	73	360	0.5	100	50
	WETLAND 1 CS	2.03	0	0%	2.03	100%	AGRICULTURAL	CLAYEY SAND	107	75	250	1.3	60	45
WETLAND 1	UPSLOPE WETLAND 1	4.8	0.48	10%	4.32	90%	FOREST	SANDY CLAY LOAM	108	73	250	1.3	60	45
	WETLAND 1 BUFFER	0.4	0	0%	0.4	100%	FOREST	CLAYEY SAND	107	75	250	1.3	60	45
	ADDITIONAL WETLAND 1 BUFFER	7.73	0	0%	7.73	100%	FOREST	CLAYEY SAND	107	75	250	1.3	60	45
	ADDITIONAL WETLAND 1 LS/S	0.69	0	0%	0.69	100%	AGRICULTURAL	LOAMY SAND/SAND	168	73	360	0.5	100	50
	ADDITIONAL WETLAND 1 CS	0.15	0	0%	0.15	100%	AGRICULTURAL	CLAYEY SAND	107	75	250	1.3	60	45
		26.4					-							
	UPSLOPE WETLAND 2 AGRICULTURAL	27.38	0.91	3%	26.47	97%	AGRICULTURAL	SANDY CLAY LOAM	108	73	250	1.3	60	45
	UPSLOPE WETLAND 2 FOREST	86.28	8.628	10%	77.652	90%	FOREST	SANDY CLAY LOAM	108	73	250	1.3	60	45
	WETLAND 2 SC/C	6.22	0	0%	6.22	100%	AGRICULTURAL	SANDY CLAY/CLAY	107.7	75.8	148.5	3.7	14.5	14.5
	WETLAND 2 SC	27.03	0	0%	27.03	100%	AGRICULTURAL	SANDY CLAY	142	94	180	3	25	25
WETLAND 2	WETLAND 2 S/SC	1.02	0	0%	1.02	100%	AGRICULTURAL	SAND/SANDY CLAY	161.8	82	288	1.5	70	40
	WETLAND 2 CS/SC	11.58	0	0%	11.58	100%	AGRICULTURAL	CLAYEY SAND/SANDY CLAY	128	86.4	208	2.32	39	33
	WETLAND 2 CS	15.96	0	0%	15.96	100%	AGRICULTURAL	CLAYEY SAND	107	75	250	1.3	60	45
	WETLAND 2 LS	7.09	0	0%	7.09	100%	AGRICULTURAL	LOAMY SAND	139	69	360	0.5	100	50
	WETLAND 2 BUFFER	4.12	0	0%	4.12	100%	FOREST	CLAYEY SAND	107	75	250	1.3	60	45
		186.7					-							
	WETLAND 3 FOREST 1	0.8	0	0%	0.8	100%	FOREST	SANDY CLAY/CLAY	107.7	75.8	148.5	3.7	14.5	14.5
	WETLAND 3 FOREST 2	0.77	0	0%	0.77	100%	FOREST	SANDY CLAY	142	94	180	3	25	25
	WETLAND 3 FOREST 3	0.96	0	0%	0.96	100%	FOREST	SAND/SANDY CLAY	161.8	82	288	1.5	70	40
	WETLAND 3 SC/C	1.07	0	0%	1.07	100%	AGRICULTURAL	SANDY CLAY/CLAY	107.7	75.8	148.5	3.7	14.5	14.5
WETLAND 3	WETLAND 3 SC	0.28	0	0%	0.28	100%	AGRICULTURAL	SANDY CLAY	142	94	180	3	25	25
	WETLAND 3 S/SC	1.88	0	0%	1.88	100%	AGRICULTURAL	SAND/SANDY CLAY	161.8	82	288	1.5	70	40
	WETLAND 3 CS/SC	1.03	0	0%	1.03	100%	AGRICULTURAL	CLAYEY SAND/SANDY CLAY	128	86.4	208	2.32	39	33
	WETLAND 3 CS	15.15	0	0%	15.15	100%	AGRICULTURAL	CLAYEY SAND	107	75	250	1.3	60	45
	WETLAND 3 LS	1.65	0	0%	1.65	100%	AGRICULTURAL	LOAMY SAND	139	69	360	0.5	100	50
	WETLAND 3 BUFFER	10.01	0	0%	10.01	100%	FOREST	CLAYEY SAND	107	75	250	1.3	60	45
		33.6						•						
	Total Catchment Area	290	ha											

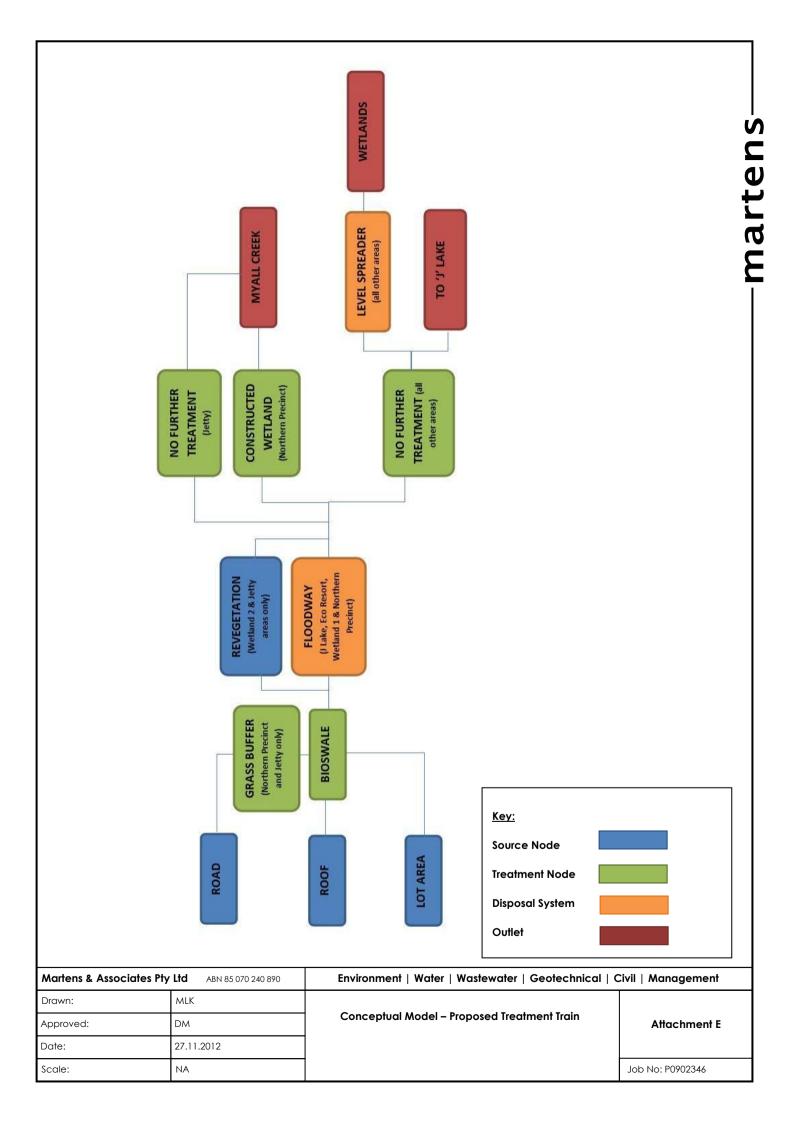
POST DEVELOPMENT CATCHMENT AREAS

NB ALL POST DEVELOPMENT CATCHMENTS ARE BOOMM LOAAN SAND/400MM SAND SOIL TYPE ALL OTHER CATCHMENTS ARE BASED ON PRE DEVELOPMENT SOIL TYPES

														PERVIOUS IN	PUT PARA	MTERS -ONL	Y APPLIES TO PRE	POST NODES A	ID UPSLOPE NO	2015
RECEIVING NODE	CATCHMENT	Total Area	Biofilter Area	1/2 DD Area.	Road Area	Driveway Area	Footpath Area	Lot Area	House Area	Residential Node	% Impervious (Res)	%Pervious (Res)	NODE	SOIL TYPE	SSC	FC	INFA	INFB	DDR (%)	
	JLAKE FLOODWAY	3.59		-,							18%		URBAN	LOAMY SAND/SAND	168	73	360	0.5	100	50
	10	3.97	0.	07 0.11	0.63	0.01	0.12	2.09	0.83	1.38	9%		ORDER	LOAMY SAND/SAND	168	73	360	0.5	100	50
JLAKE	10a	4.61	0,			0.04	0.07	2.45	0.98	1.58	7%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	103	4.01	05	0.08	1.15	0.04	0.07	2.43	0.58	1.50	175	23%		LOANT SHIND/SHIND	100	75	300	0.5	100	30
		3.76			0.50	0.05	0.40	1.52	0.64	1.00	1.54	85%		0.0000000000000000000000000000000000000	460		260	0.5	100	
	5	3.76	0.			0.05	0.12	1.53	0.61	1.09	15%			LOAMY SAND/SAND	168 168	73	360	0.5	100	50
	0																			
	1	3.67	0.			0.06	0.06	2.32	0.93	1.51	8%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	8	4.57	0.			0.07	0.14	2.49	1.00	1.70	12%			LOAMY SAND/SAND	168	73	360	0.5	100	50
Wetland 3	9	4.98	0.	12 0.18	1.20	0.00	0.10	2.41	0.96	1.55	6%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	WETLAND 3 AGRICULTURE	2.54									0%		AGRICULTURE	CLAYEY SAND	107	75	250	1.3	60	45
	WETLAND 3 REVEGETATION	5.88									0%		FOREST	CLAYEY SAND	107	75	250	1.3	60	45
	WETLAND 3 BUFFER	1.66									0%	100%	FOREST	CLAYEY SAND	107	75	250	1.3	60	45
	WETLAND 3 FLOODWAYS	8.96									3%	97%	URBAN							
	Total	39.95																		
	1	3.20	0.	0.12	0.61	0.05	0.05	2.05	0.82	1.33	7%	93%		LOAMY SAND/SAND	168	73	360	0.5	100	50
	2	2.09	0.	0.07	0.30	0.03	0.04	1.47	0.59	0.96	8%	92%		LOAMY SAND/SAND	168	73	360	0.5	100	50
	3	3.41	0.				0.05	2.02	0.81	1.31				LOAMY SAND/SAND	168	73	360	0.5	100	50
	4	2.28	0.			0.01	0.05	1.62	0.65	1.02	5%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	11	4.56	0.			0.08	0.10	3.03	1.21	2.00	9%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	12	4.14	0,			0.07		3.05	1.22		7%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	13	3.28	0.			0.06	0.07	2.04	0.82	1.35	10%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	14	3.78	0.			0.06	0.07	2.51	1.01	1.53	10%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	14	2.07	0.			0.04	0.07	1.46	0.58	0.95	8%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	15	3.57	0.			0.04	0.04	2.51	1.01	1.63	8%			LOAMY SAND/SAND	168	73	360	0.5	100	50
WETLAND 2	16	3.57	0.			0.05	0.06	2.51	0.83	1.63	8%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	17																			
	18	2.12	0.			0.03	0.04	1.16	0.46	0.77	9%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	19	3.33	0.	0.13	0.54	0.06	0.07	2.22	0.89	1.46	9%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	UPSLOPE WEST	13.87									3%		FOREST	SANDY CLAY LOAM	108	73	250	1.3	60	45
	UPSLOPE WETLAND 2 AG	15.57									6%		AGRICULTURE	SANDY CLAY LOAM	108	73	250	1.3	60	45
	UPSLOPE WETLAND 2 FOREST	84.22									10%		FOREST	SANDY CLAY LOAM	108	73	250	1.3	60	45
	WETLAND 2 REVEGETATION	11.10									0	100%	FOREST	LOAMY SAND/SAND	168	73	360	0.5	100	50
	WETLAND 2 BUFFER	12.48									0	100%	FOREST	CLAYEY SAND	107	75	250	1.3	60	45
	WETLAND 2 ADDITIONAL ROAD	0.49									100%	0%	ROAD	LOAMY SAND/SAND	168	73	360	0.5	100	50
	Total	179.2																		
	27	7.19	0.	13 0.23	0.30	0.12	0.72		1.47	5.19	16%	84%		OAMY SAND/SAND	168	73	360	0.5	100	50
	28a	1.52	0.	0.04	0.00	0.10			0.00	1.36	7%	93%		LOAMY SAND/SAND	168	73	360	0.5	100	50
	WETLAND 1 REVEGETATION	3.24									0	100%	FOREST	LOAMY SAND/SAND	168	73	360	0.5	100	50
WETLAND 1	WETLAND 1 BUFFER	0.40									0		FOREST	CLAYEY SAND	107	75	250	1.3	60	45
	ADDITIONAL WETLAND 1 BUFFER	7.73									0		FOREST	CLAYEY SAND	107	75	250	1.3	60	45
	WETLAND 1 NATURAL REVEG	1.32		-							0		FOREST	LOAMY SAND/SAND	168	73	360	0.5	100	50
	Total	21.4			1						0	100%	TONEST	LOANT JAND/JAND	100	13	300	0.5	100	50
	20	1.72	0.	0.07	0.44	0.03	0.05	0.95	0.38	0.65	12%	88%		LOAMY SAND/SAND	168	73	360	0.5	100	50
	20	1.72	0.			0.03	0.04	1.16	0.58	0.83	12%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	21	2.40	0.			0.03	0.04	1.16	0.46	1.20	10%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	22	2.40				0.04	0.04	1.87	0.75	1.20				LOAMY SAND/SAND	168	73	360	0.5		50
	23	2.56	0.								8%								100	
	24		0.			0.03	0.05	1.04	0.42	0.71	12%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	25	1.38	0.			0.03	0.03	0.89	0.36	0.59	10%			LOAMY SAND/SAND	168	73	360	0.5	100	50
	26	2.22	0.			0.03	0.06	1.24	0.50	0.84				LOAMY SAND/SAND	168	73	360	0.5	100	50
MYALL CREEK	28b	2.23	0.	0.06	0.19	0.00			0.06	1.92	0%			LOAMY SAND/SAND	168	73	360	0.5	100	50
Incen	MYALL UPSLOPE	14.29									10%		FOREST	SANDY CLAY LOAM	108	73	250	1.3	60	45
	MYALL FOREST	1.70									0%		FOREST	LOAMY SAND	139	69	360	0.5	100	50
	MYALL REVEGETATION	0.19									0%	100%	FOREST	LOAMY SAND/SAND	168	73	360	0.5	100	50
	MYALL NATURAL REVEGETATION	2.77									0%	100%	FOREST	LOAMY SAND/SAND	168	73	360	0.5	100	50
	MYALL FLOODWAY FOREST	0.66									0%	100%	FOREST	LOAMY SAND/SAND	168	73	360	0.5	100	50
	MYALL FLOODWAY	0.68									0%	100%	URBAN	LOAMY SAND/SAND	168	73	360	0.5	100	50
	MYALL WETLAND	0.447		1		1				1		1	WETLAND	1		-	1	1		1
	Total	37.1																		
		290 h																		

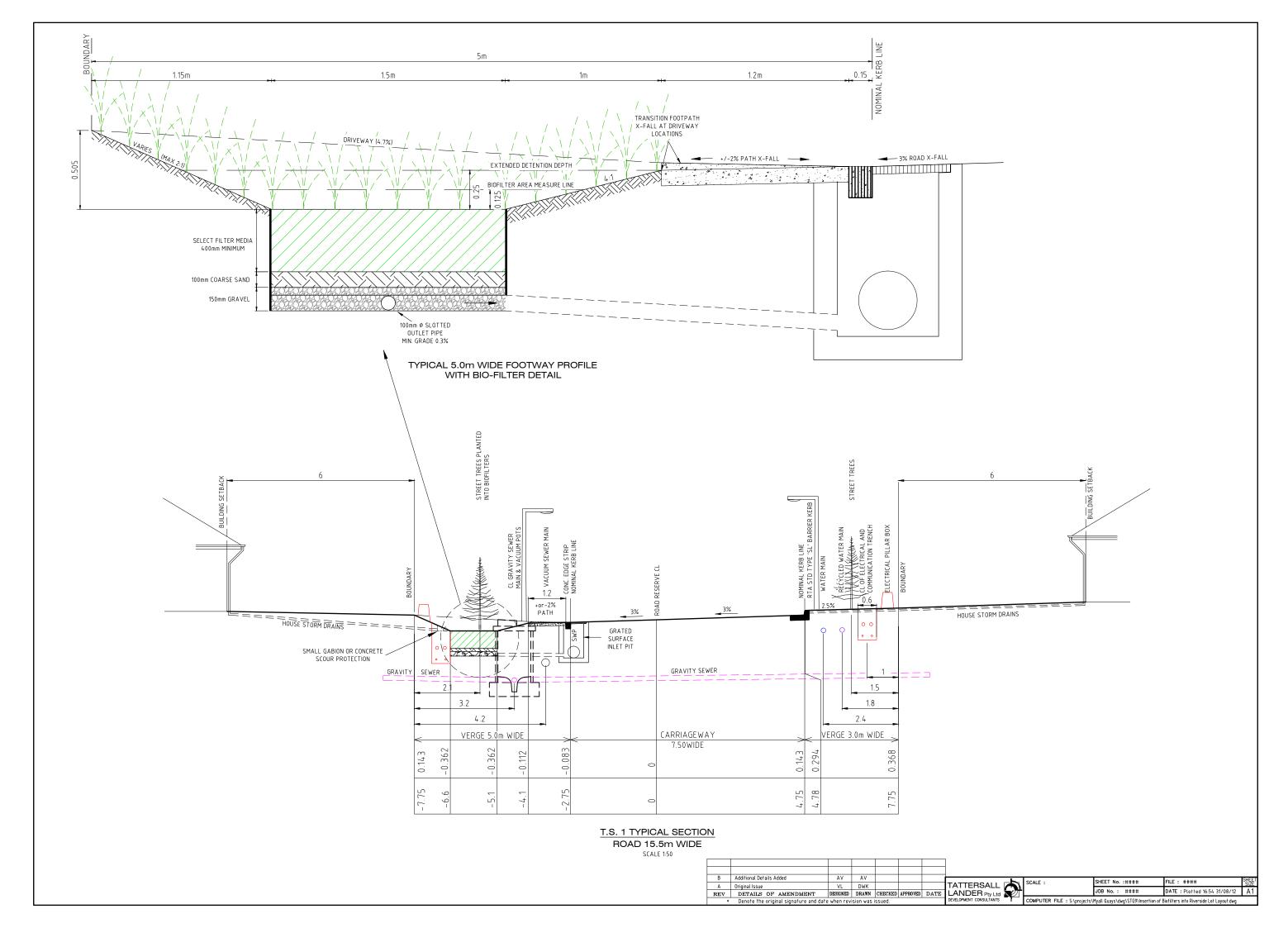
13 Attachment 3E – Conceptual Layout; Proposed Water Quality Treatment Train

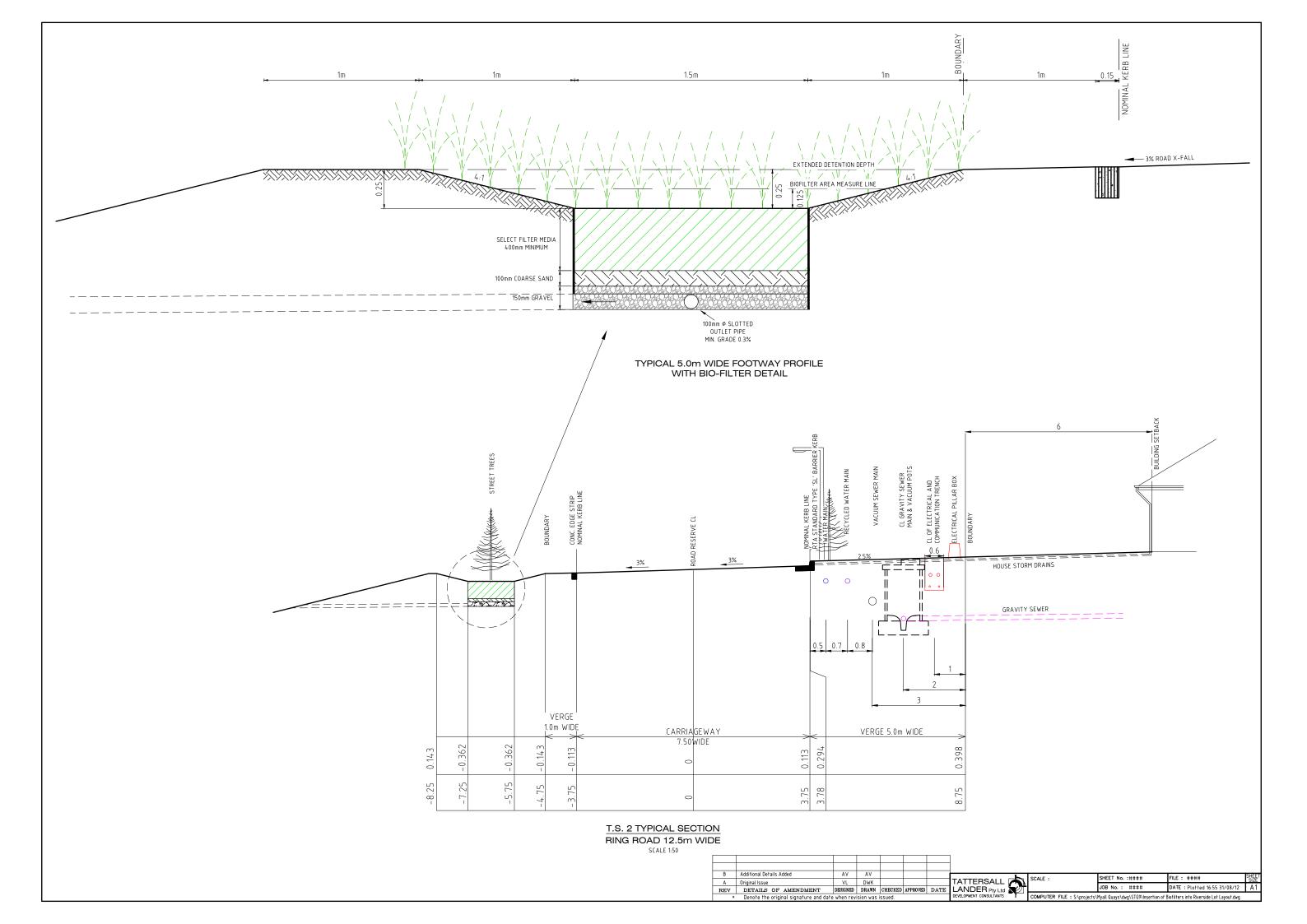




14 Attachment 3F - Proposed Bioswale Design







15 Attachment 3G – Pre and Post Development Recharge Rates; MUSIC Modelling



				ML/	yr .		
RECEIVING NODE	CATCHMENT ID	TOTAL AREA (HA)	RAINFALL	ET	BASEFLOW (SOURCE NODES) / INFILTRATION LOSS (TREATMENT NODES)	STORM FLOW	INFILTRATION RATE (mm/yr
	JLAKE FOREST	0.2	2.7	1.7	0.9	0.1	450
J-LAKE	JLAKE S/SC	6.97	95.8	57.6	30.9	7.3	443
	JLAKE CS	3.66	50.3	32.6	11	6.7	300
	JLAKE CS/SC	0.27	3.7	1.8	0.5	1.4	18
	MYALL FOREST	2.32	31.9	19.4	11.7	0.8	50-
	MYALL LS/S	3.83	52.6	31.5	20.7	0.4	54
MYALL CREEK	MYALL LS	9.73	133.7	81.2	49.1	3.4	50
	UPSLOPE MYALL	9.14	121.9	71.7	25.6	24.6	28
	ADDITIONAL MYALL LS/S	7.47	102.6	61.3	40.4	0.8	54
	WETLAND 1 FOREST LS/S	2.3	31.6	18.9	12.4	0.3	53
	WETLAND 1 FOREST CS	1.04	14.3	9.3	3.1	1.9	29
	WETLAND 1 LS/S	7.28	100	59.8	39.4	0.8	54
	WETLAND 1 CS	2.03	27.9	18.1	6.1	3.7	30
WETLAND 1	UPSLOPE WETLAND 1	4.8	66	38.8	13.8	13.3	28
	WETLAND 1 BUFFER	0.4	5.5	3.6	1.2	0.7	30
	ADDITIONAL WETLAND 1 BUFFER	7.73	106.2	68.9	23.2	14.1	30
	ADDITIONAL WETLAND 1 LS/S	0.69	9.5	5.7	3.7	0.1	53
	ADDITIONAL WETLAND 1 CS	0.15	27.9	18.1	6.1	3.7	40
	UPSLOPE WETLAND 2 AGRICULTURAL	27.38	213.9	130.7	46.8	36.4	17
	UPSLOPE WETLAND 2 FOREST	86.28	1185.5	697.4	248.5	239.6	28
	WETLAND 2 SC/C	6.22	85.5	55.7	3.5	23.6	5
	WETLAND 2 SC	27.03	371.4	250.8	55	65.5	20
WETLAND 2	WETLAND 2 S/SC	1.02	14	8.9	4.8	0.3	47
	WETLAND 2 CS/SC	11.58	159.1	105.8	35.2	18.1	30
	WETLAND 2 CS	15.96	219.3	142.3	47.9	29.1	30
	WETLAND 2 LS	7.09	97.4	59.1	35.8	2.5	50
	WETLAND 2 BUFFER	4.12	56.6	36.7	12.4	7.5	31
	WETLAND 3 FOREST 1	0.8	11	7.2	0.5	3.4	6
	WETLAND 3 FOREST 2	0.77	10.6	7.1	1.6	34	20
	WETLAND 3 FOREST 3	0.96	13.2	8.4	4.5	0.3	46
	WETLAND 3 SC/C	1.07	14.7	9.6	0.6	5.1	5
WETLAND 3	WETLAND 3 SC	0.28	3.8	2.6	0.6	0.7	21
WEILAND 3	WETLAND 3 S/SC	1.88	25.8	16.4	8.9	0.6	47
	WETLAND 3 CS/SC	1.03	14.2	9.4	3.1	1.6	30
	WETLAND 3 CS	15.15	208.2	135.1	45.4	27.7	29
	WETLAND 3 LS	1.65	22.7	13.8	8.3	0.6	50
	WETLAND 3 BUFFER	10.01	137.5	89.2	30	18.3	2

Infiltration = 180 mm/hr for sandy loams and sands INFILTRATION RATES PROPOSED - WATER BALANCE BY CATCHMENT AREA

				ML/yr BASEFLOW (SOURCE NODES) / INFILTRATION LOSS				
ECEIVING NODE	CATCHMENT ID JLAKE FLOODWAY	RAINFALL/INFLOW 49.3			STORM FLOW 0.4	AREA (HA) 3.59	%Impervious 18%	*INFILTRATION RATE (mm
	10 Residential 10 Bioswale	19 27.3	10.5	6.8 3.6	1.7 21.9			
JLAKE	10 Bioswaie					3.97	40%	
	10 10a Residential	21.7	12.2	7.9	1.6			
	10a bioswale 10a	36.6	1.5	6.7	28.4	4.61	49%	
	5 Residential	15	7.8		2.2			
	S Bioswale S	22.5	2.3	2.5	17.7	3.76	36%	
	6 Residential	23.1	12	7.7	3.4			
	6 Bioswale	31.3	2.3	4.2	24.8	3.93	47%	
	7 residential	20.7	11.5	7.5	1.7	3.53	477	
	7 Bioswale	29.3	3.1	2.3	23.9	3.67	46%	
Wetland 3	8 residential	23.4	12.5	8.1	2.8	3.07	40%	
wetland 3	8 Bioswale	35	5.8	0.2	29.1			
	8 9 residential	21.3	12.1	7.9	1.4	4.57	46%	
	9 Bioswale	36.7	3.3	3.7	29.8			
	9 WETLAND 2 AGRICULTURE	24.9	22.6	76	4.7	4.98	45% 0%	
	WETLAND 3 AGRICULTURE WETLAND 3 REVEGETATION	34.9 80.8	22.6 52.4	7.6 17.6	10.8	2.54 5.88	0%	
	WETLAND 3 BUFFER	22.8	14.8	5	3 4.4	1.66	0%	
	WETLAND 3 FLOODWAYS	123.1	71.7	47	4.4	8.96	3%	
	1 Residential	18.2	10.2	6.7	1.3			
	1 Bioswale	26.3	2	3.4	20.9	3.2	48%	
	1 2 Residential	13.2	7.3	4.8	1.1	3.2	48%	
	2 Bioswale	17.4	1.2	2.4	13.8	2.09	46%	-
	2 3 Residential	18	10	6.5	1.5	2.09	46%	
	3 Bioswale	26.6	2.1		21.2			
	3 4 Residential	14	8		0.8	3.41	45%	
	4 Bioswale	14 18.6	1.2	5.2 2.5	14.9			
	4					2.28	45%	
	11 Residential 11 Bioswale	27.5 38.5	15.1	9.8	2.6 30.5			
	11					4.56	48%	
	12 Residential 12 Bioswale	27.2 34.7	15.3	10	1.9 27.8		<u>.</u>	
	12		2			4.14	46%	1
	13 Residential	18.5	10.1		1.8			
	13 Bioswale 13	27.5	2	3.7	21.8	3.28	49%	
	14 Residential	22.5	12.5	8.2	1.8			
NETLAND 2	14 Bioswale 14	30.4	1.9	4.3	24.2	3.78	45%	
	14 15 Residential	13.1	7.3	4.7	1.1	3.78	45%	
	15 Bioswale	17.3	1.1	2.5	13.7			
	15 16 Residential	22.4	12.5	8.1	1.8	2.07	47%	
	16 Bioswale	30.6	1.5	5	24.1			
	16 17 Residential	18.8	10.3	6.7	1.8	3.57	48%	
	17 Residential 17 Bioswale	27.4	10.3	6.7	22.1			
	17					3.62	44%	
	18 Residential 18 Bioswale	10.6	5.8 4.6	3.8 0.2	1112			
	18					2.12	45%	
	19 Residential	20.1 27.5	11.1 2.1	7.2	1.8			
	19 Bioswale 19					3.33	47%	
	19 UPSLOPE WEST	190.6	119.6	43.1	27.9	3.33 13.87	3%	
	UPSLOPE WETLAND 2 AG UPSLOPE WETLAND 2 FOREST	213.9 1017.7	130.7 598.7	46.8 213.4	36.4 205.6	15.57 74.07	6% 10%	
	UPSLOPE WETLAND 2 REVEGETATION	167.8	108.2	39.1	20.5	12.21	0%	
	WETLAND 2 REVEGETATION WETLAND 2 BUFFER	152.5 171.5	91.2 111.3	60 37.4	1.3 22.8	11.1 12.48	0%	
	THE ISHING & DUFFER			37.4		12.48	0%	
	27 Residential	68.3	34.8	22.3	11.2			
	27 Bioswale 27	56.7	3.5	6.7	46.5	7.19	36%	
	WETLAND 1 REVEGETATION	44.5	26.6	17.5	0.4	3.24	0%	
VETLAND 1	WETLAND 1 BUFFER ADDITIONAL WETLAND 1 BUFFER	5.5 106.2	3.6	1.2 23.2	0.7	0.4	0%	
	WETLAND 1 NATURAL REVEG	18.1	10.8 11.2	7.1	0.2	1.32	0%	<u> </u>
	Residential 28A	18.7	11.2	7.4	0.2		-	
	28A Bioswale 28A	1.2	0.5	0	0.7	1.52	6%	
	20 Residential	8.9	4.8	3.1	1	-		
	20 Bioswale 20	14.6	1.2	2	11.4	1.72	53%	
	21 Residential	10.6	5.8	3.7	1.1	2.72	33%	
	21 Bioswale	16.2	1.5	1.9	12.8	1.97	49%	
	22 Residential	16.5	9.3	6	1.2	1.97	49%	
	22 Bioswale	20.4	1	3.3	16.1			
	22 23 Residential	16.4	9.1	5.9	1.4	2.4	45%	
	23 Bioswale	21.3	1.4	2.8	17.1			
	23 24 Residential	9.8	5.2	3.4	12	2.56	46%	
	24 Bioswale	9.8	5.2	3.4 1.8	12.2			
	24 25 Residential					1.9	49%	-
	25 Residential 25 Bioswale	8.1 11.4	4.4	2.9 1.3	0.8 9.1			
IYALL CREEK	25					1.38	47%	
	26 Residential	11.5	6.2	4	1.3		-	
	26 Bioswale 26	17.3	2.8		13.5	2.2	48%	
	28b Residential	26	15.5	10.2	0.2			
	288 Bioswale 288 Bioswale roof	10.4	0.2	0.6	9.6 0.6			
	299 Biopyrale road	2.2	0.8	0.2	1.3			L
	28b MYALL UPSLOPE					2.23	11%	-
	MYALL FOREST	196.3 23.4	115.5	41.2 8.6	39.6 0.6	14.29	10%	
	MYALL REVEGETATION	2.6	1.6	1	0	0.19	0%	
	MYALL NATURAL REVEGETATION MYALL FLOODWAY FOREST	38.1 9.1	22.7 5.4	15 3.6	0.3	2.77	0% 0%	
	MYALL FLOODWAY	9.1	5.4	3.6	0.1	0.66	0%	
	MYALL WETLAND	181.7	6.9		174.8			

* Net infiltration rate = (source node baseflow + treatment node infiltration) / area

16 Attachment 3H – Site Testing Plan



-0 2 II SI 4 R

martens

Martens & Associates Pty	Ltd ABN 85 070 240 890	Environment Water Wastewater Geotechnical C	Civil Management
Drawn:	MLK		
Approved:	DM	Site Testing Plan	Attachment H
Date:	29.11.2012		
Scale:	NA		Job No: P0902346

17 Attachment 3I – Borelogs



~	~	4	د	~ ` /)))		-tc	chnics					
C	C			ЗУ	100 F	Ę	JC	JIC	CHIICS		Ē	Excava	ation No.	TP 1
En	ıg	in	ee		-				avation			Sheet Project	: No:	1 of 1 GEOTSGTE20248AA
Clien				ΤΑΤ	TEF	RSAL	L SL	IRVE	YORS PTY LTD			Date st		4.4.2007
⊃rinc ⊃roje		:		RIV	FRS	INE F	=97/	TEI	PROJECT APPLICATION, TEA G				ompletec	a: 4.4.2007 CW
Fest j		ocat	ion:			TO F			NODEOT AT LICATION, TEA O			Checke	-	<i>Mi</i>
						Backho			Pit Orientation: Easting:	m			,	Surface: 2.586
excav					1.5m	long (Northing:	m	.		datu	am: AHD
			mo	rmation								ex x	tro-	
e l	N penetration	support	water	notes samples, tests, etc	RL	depth. metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics colour, secondary and minor components.		moisture condition	consistency/ density index	100 × pocket 200 × penetro- 300 × meter	structure and additional observations
BH		N		<u></u>	_2.5	-			TOPSOIL: SAND, fine to medium grained, dark brown with approximately 30% low plasticity fines 300mm of rootlets.	s, with	М			TOPSOIL .
				D	2.0	0. <u>5</u>		CI	Sandy CLAY: medium plasticity, dark brown-ora sand fine to medium grained.	nge,				
							,,,,,,	SP	SAND: fine to medium grained, pale grey-while.			VD		
				D	1.5	1. <u>0</u>			Dana sia asla ava basur					
					_1.0	_ 1. <u>5</u>			Becoming pale grey-brown.		w			
				D										
			7 8:54am		_0.5	2. <u>0</u>			Test pit TP 1 terminated at 1.9m					
			04-04-07			2.5								
SKE	ətch													
metho N BH B R E		existi backi	ng exi noe bu ozer b r		S pe 1 wa wa wa wa wa	iter water le	t io resista anging to efusal evel evel shown hflow	I	U ₅₀ undisturbed sample 50mm diameter U ₅₃ undisturbed sample 63mm diameter D disturbed sample S vane shear (kPa) Bs buik sample E environmental sample R refusal	oil desc pased on system noisture O dry M me W we Wp pla	y voist	dassifica		consistency/density Index VS very soft S soft F firm St stiff VSt very stiff H hard Fb triable VL very loose L loose MD medium dense D dense VD very dense

TESTPIT :

	/		⊂y	silte	2	,		chnics		Excava	ation No.	TP 2
Eng	ir	ne	ering	1 L	oq	- E	Exc	avation		Sheet		
lient:			-					YORS PTY LTD		Projec Date s		GEOTSGTE20248A. 4.4.2007
rincipal	:										ompleted	
roject:			RIVI	ERS	IDE E	ESTA	ATE	PROJECT APPLICATION, TEA GA	RDEN:		•	CW
est pit l	oca	tion:			TO F					Check		M
quipment					Backho			Pit Orientation: Easting:	m			. Surface: 2.433
xcavation				1.5m l	ong (Northing:	m		dati	um: AHĐ
	lon	info	rmation			mat		ubstance		- ×	t 6	
theurod 5 penetration 6	support	water	notes samples, tests, etc	RL 1	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture	consistency/ density index	100 x pocket 200 d penetro- 300 meter	structure and additional observations
Eo .	N							TOPSOIL: Silty Clayey SAND, fine to medium grained, dark brown with approximately 30% of low plasticity fines, with approximately 300mm of rootlef	S.			TOPSOIL
			D	_2.0	0. <u>5</u>		CI	Sandy CLAY: medium plasticity, dark brown-orange with some sand lenses.	e, M/W	/ St	×	
		9:13am	D	_1.5	 1. <u>0</u>						×	
		04-04-07 9:		_1.0	- - 1.5							
			D		-		SP	SAND: fine to medium grained, brown-dark grey.	W			Rapid inflow of groundwater and p collapsing below 1.7m depth.
	1			_0.5	2. <u>0</u>	• .•		Test pit TP 2 terminated at 1.9m				
					_							
				_0.0								
Sketch					2.5							<u> </u>
((6H 63 73	exist back build rippe	ing exi hoe bu ozer b		S	n <mark>a</mark>	o resista anging to efusal evel e shown		Uso undisturbed sample 50mm diameter soil Uss undisturbed sample 63mm diameter base D disturbed sample syste V vane shear (kPa)	sification s description ad on unified am sture dry moist wet plastic fin liquid limi	i d classifica		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense

C V04 5 0

co	ff	ev		Ç	geo	ote	chnics		_			
									E	Excava	tion No	р. ТР 3
Engir	ie	ering	j L	og	- E	Exc	avation		-	Sheet Project	No:	1 of 1 GEOTSGTE20248AA
Client:		ΤΑΤ	TEF	SAL	L SU	IRVE	YORS PTY LTD		E) Date st	arted:	4.4.2007
Principal:									0	Date co	omplete	ed: 4.4.2007
Project:		RIV	ERS	IDE I	ESTA	ATE I	PROJECT APPLICATION, TEA GA	RDE	ENS	.ogged	l by:	CW
Fest pit loca					IGUF	RE 1			C	Checke	- · ·	
quipment typ xcavation dir			4 WD I 1.5m I	3ackho ong (e 0.4m wi	ide	Pit Orientation: Easting: Northing:	m m				L. Surface: 2.571 itum: AHĐ
excavation	info		1		mate		ubstance					1
method 5 penetration support	water	notes samples, tests, etc	Ð	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.		moisture condition	consistency/ density index	100 x pocket 200 x penetro- 300 meter	
= 123 °		:	_2.5	lienes	<u>.</u> 13 3	00	TOPSOIL: Silty Clayey SAND, fine to coarse		м	00	6884	TOPSOIL
				0.5			grained, pale brown-brown, low plasticity fines with some rootlets to 300mm.					
		D	2.0	-		ŚĊ	Clayey SAND: fine to medium grained, orange-brown / pale brown, low plasticity fines.			VD		
						SP	SAND: fine to coarse grained to fine to medium grained, pale grey-white.		M/W			
		D	_1.5	1. <u>0</u>			- , .,					-
			1				Becoming pale brown-white.					
			_1.0	1. <u>5</u>								-
	-			-			Becoming white.					Rapid inflow of groundwater and pi collapsing below 1.7m depth.
	1-04-07	D					Test pit TP 3 terminated at 1.8m					
	8		_0.5	2. <u>0</u>								-
				_								
				_								
				2.5								
Sketch												
K exist 3H back 3 build R rippe	ing ex hoe b lozer b	bosure icavation ucket blade	S s per 1 2 wa wa	ter water is	t o resistar anging to efusal evel e shown hflow		U ₅₀ undisturbed sample 50mm diameter soil U ₆₃ undisturbed sample 63mm diameter base D disturbed sample syste V vane shear (kPa)	descrij ed on u tem isture dry mois wet plast	nified c	ibols and		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

U	1		Ξy	S	Ľ	<i>,</i>		chnics			E	Excava	ation N	o. 7	FP 4	
Eng	jir	e	erinç	j L	og	- F	Exc	avation				Sheet Project	t No:	1 of (1 GEOTSGTE	20248A
Client:			ΤΑΤ	TER	RSAL	LSU	JRVE	YORS PTY LTD			[Date s	tarted:	-	.4.2007	
Principa													omplet		.4.2007	
Project:								PROJECT APPLICA	TION, TEA (GARDI				C	CW 177	
Test pit					TO F Backho		RE 1	Pit Orientation;	Easting:		(Check	-	L. Surfa	<u>//</u>	
excavatio				1.5m l		0.4m w	ide	Fit Offentation.	Northing	m : m				.L. Suna atum:	ce: 2.260 AHD	
	tion	info	rmation			mat		ubstance								
method 5 T penetration	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	mater soil type: plasticity or pa colour, secondary and	rticle characteristic	2 5 , 3.	moisture condition	consistency/ density index	100 200 Appocket 300 benetro		structure a additional obse	
Ha	N					313		TOPSOIL: Silty CLAY, mediu grey-black, small percentage	m plasticity, dark		м		- 6 6 4	TOPS	50IL	
				_2.0				rootlets.		i serie						
													×			
			D	-	0. <u>5</u>		СН	CLAY: medium to high plasti	oity, dark grey.	P	vl>Wp	St	×			
			·	4.6									×			
				_1.5												
			Ď		1. <u>0</u>											
				_1.0												
		ε			1.5											
		12:12pm			_											
		5-04-07 1		_0.5	-								×××			
		05-0											x×x	Rapid	inflow of ground	water at
		>	D		2. <u>0</u>		SP	SAND: fine to coarse grained			w			2.0m	depth.	indian de
				0.0	-			Test pit TP 4 terminated at 2.	1m							
					-											
					2.5											
Sketch	1															
method					oport			notas samalas testa	i	elacois	ion	hola -	.d	1		ndor
netnod V K			osure cavation		shoring	N	nil	notes, samples, tests U _{so} undisturbed sample 5 U ₆₀ undisturbed sample 6	mm diameter	classificati soil descri based on ι	ption			VS S	isistency/density i very so soft	
A BH B	back	ng ext noe bu ozer bl	Joket	per	etration			D disturbed sample V vane shear (kPa)		system	eu C	,asonical		F St	son firm stiff	
R E	rippe exca	г			n	o resista anging to afusal	nce	Bs bulk sample E environmental sample		moisture D dry				VSI H		ff
				wat ▼	water le			R refusal		M mois W wet				Fb VL	friable very lo	ose
					on date water in						tic limit d limit			L MD		n dense
					water o										dense very de	inse

coffey	aeote	echnics		
concy	- 9		Excavation N	No. TP 5
Engineering	g Log - Exercised		Sheet Project No: Date started	1 of 1 GEOTSGTE20248AA 4.4.2007
Principal:			Date comple	ted: 4.4.2007
-		PROJECT APPLICATION, TEA	GARDENSLogged by:	CW
Test pit location: REP equipment type and model:	FER TO FIGURE 1	Pit Orientation: Easting	Checked by:	
excavation dimensions:	1.5m long 0.4m wide	Northin		R.L. Surface: 2.765 datum: AHD
excavation information	·····	substance		
bott pottan bottan	debth classification were blue generation ge	material soil type: plasticity or particle characteris colour, secondary and minor componer		· · · · · · · · · · · · · · · · · · ·
		TOPSOIL: SAND, fine to medium grained, da brown, with low plasticity fines, approximately fines with some rootlets to approximately 150 Sandy CLAY: medium plasticity, orange-brow sand fine to medium grained.	30% nm.	TOPSOIL
	2.0	SAND: fine to medium grained, pale grey-whit	e	
□ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □		Becoming pale grey-brown.		
	1.0 2.0	Test pit TP 5 terminated at 1.9m	w	Rapid groundwater inflow below 1.7m depth.
Sketch		l de la constante de la constante		<u>i I</u>
methodNnatural exposureXexisting excavationBHbackhoe bucketBbulkdozer bladeRripperEexcavator	support S shoring N nil penetration 1 2 3 4 no resistance ranging to vertusal water water level on date shown water outflow water outflow	notes, samples, tests Uso undisturbed sample 50mm diameter Uso undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	classification symbols and soil description based on unified classification system moisture D dry M moist W wet Wp plastic limit W, liquid limit	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

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	J		Cy		2	,		chnics		-	Excava	ation N	0.	TP 6	
Eng	ji	ne	erir	ıg L	_og	- E	Exc	avation			Sheet Project	t No:	1	of 1 GEOTSGTE20248	3 A .
lient:			T/	TTE	RSAL	LSU	IRVE	YORS PTY LTD			Date st	tarted:		5.4.2007	
rincipa	al:										Date co	•	ed:	5.4.2007	
roject:								PROJECT APPLICAT	ION, TEA GAR	RDENS	Logged	i by:		CW	
est pit					TO F		RE 1				Checke			///	
upmer cavatio			d model: ions:		Backho		ide	Pit Orientation:		m m			atum:	urface: 2.846 . AHD	
-	tio	n inf	ormatio					ubstance							
penetration	3	water	notes sample tests, e	is, tc	depth metres	graphic log	classification symbol	materia soil type: plasticity or part colour, secondary and m	icle characteristics,	moisture condition	consistency/ density index	200 A pocket 300 b pocket	-	structure and additional observations	
	~	1		_2.5	0.5			TOPSOIL: Silty SAND, fine to grey mottled white, with some 150mm.	nedium grained, dark rootlets and roots to	D		2	_	OPSOIL.	
			D	2.0	1.0		SM	Silty SAND: fine to medium gr cemented sand nodules.	aned, brown / red — –	- M	VD		IN	DURATED SAND?	_
		12:33pm		1.5	- - 1, <u>5</u>		SP .	SAND: fine to medium grained with some cemented sand noc	, pale brown-white ules.	—					
		▼ 05-04-07 1:		1.0	 2.0			Becoming pale grey-white. Lenses of cemented sand nod present.		w				ater visible. Pit collapsing due oundwater.	e to
				_0.5	- - 2.5			Test pit TP 6 terminated at 2.1	n						
Sketch	ŧ														
4	natural exposure S shoring N nil U existing excavation backhoe bucket penetration bulldozer blade 1 2 3 4 ripper excavator excavator			notes, samples, tests U _{so} undisturbed sample 50r U _{s3} undisturbed sample 63r D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	nm diameter soil de nm diameter system moistu D M W Wp		classificat		_	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense					

coffey	aeote	chnics			
coney	~ 9000		-	Excavation No.	TP 7
Engineering				Project No:	of 1 GEOTSGTE20248AA
	TERSALL SURVI	YORS PTY LID		Date started:	13.4.2007
Principal: Project: RIV		PROJECT APPLICATION		Date completed:	13.4.2007 JJT
-	ER TO FIGURE 1	FROJECT AFFEICATION		Cogged by:	Mu
equipment type and model:	ER TOTIGORE T	Pit Orientation:	Easting: m	R.L. Si	//// urface: 2.388
excavation dimensions:	m long m wide		Northing: m	datum:	
excavation information	1	substance			
b t t t t t t t t t t t t t		material soil type: plasticity or particle chu colour, secondary and minor co		consistency/ density index density index 200 Å pocket 200 å penetro 400 meter	structure and additional observations
	CH 	Sandy CLAY: high plasticity, dark bro to medium grained. Clayey SAND: fine to medium graine Hole terminated at 1.0m, hole collaps groundwater. Test pit TP 7 terminated at 1m	d, grey.		
Sketch method N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	support S shoring N nil penetration 1 2 3 4 ranging to ranging to refusal water water level on dale shown water inflow water outflow	notes, samples, tests U _{so} undisturbed sample 50mm dian D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal		classification	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb fnable VL very loose L loose MD medium dense D dense VD very dense

TAT RIVE on: REF	TERSALL ERSIDE ES ER TO FIG	SURVE STATE F GURE 1 e material s	Pit Orientation:	Easting:			No: arted: ompleted: t by:	of 1 GEOTSGTE20248AA 13.4.2007 13.4.2007 JJT
RIVE on: REF and model: nsions: r formation notes samples,	ERSIDE ES	STATE F GURE 1 e material s	PROJECT APPLICATIO	Easting:		Date co S Loggeo	ompleted: 1 by:	13.4.2007
on: REF and model: nsions: r nformation notes samples,	m long m wide	e material s	Pit Orientation:	Easting:		S Logged	i by:	
on: REF and model: nsions: r nformation notes samples,	m long m wide	e material s	Pit Orientation:	Easting:			-	557
and model: nsions: r nformation notes samples,	m long m wide	e material s	- -	•		OLICOV		HA0
nformation notes samples,		material s	ubstanca		m			urface: 3.184
notes samples,		1	uhetoneo	Northing:	m		datum	: AHD
samples,						. ×	6	
	depth RL metres	graphic log classification symbol	material soil type: plasticity or particle colour, secondary and min	or components.	moisture		100 x pocket 200 x pocket 300 b penetro- 400 meter	structure and additional observations
Not Measured	_3.0	SP	Clayey SAND: fine to medium gr	ained, błack,	M	D		
ZD	0. <u>5</u>							
	2.5	····		o dry to retrieve.				
	1.5							
	15 -							
	2.0							
	_1.0							
	2.5							
and support natural exposure existing excavation backhoe bucket hulidozer blade excavator excavator water support S shoring N nil penetration 1 2 3 4 no resistance ranging to water			diameter soi diameter bas sys mo D M	I descriptior sed on unified stem Jisture dry moist	-		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose	
	exposure excavation a bucket ar blade	exposure excavation a bucket ar blade or	exposure excavation b D 0.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2.5 2	D 0.5 2.5 - 1.0 - 1.0 - 1.5 - 1.5 - 1.6 - 2.0 - 1.5 - 1.6 - 2.0 - 1.5 - 2.0 - 1.1.5 - 2.0 - 1.1.5 - 2.0 - 2.10 - 2.25 - Prove the sample 50mm Up of sturbed sample 50mm Up of sturbed sample 60mm Up of sturbe	D 0.5 2.5 - 1.0 - 2.0 - 1.5 - 1.5 - 2.0 - 1.5 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.0 - 2.0 - 1.0 - 2.0 - 1.0 - 2.0 - 1.0 - 2.0 - 1.0 - 2.0 - 1.0 - 2.0 - 1.0 - 2.5 - 0 - 0 - 0 - 0 - 0 - 0 - </td <td>D 0.5 2.5 - 1.0 - 2.0 - 1.5 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.0 - 2.0 - 1.0 - 2.0 - 2.0 - 1.0 - 2.5 - 2.5 action in the state of the s</td> <td>D 0.5 2.5 Hole terminated at 0.6m, sand too dry to retrieve. Test pit TP 8 terminated at 0.6m 1.0 1.0 2.0 1.5 1.5 2.0 1.5 2.0 1.5 2.0 1.0 2.0 1.0 2.0 1.5 2.0 1.5 2.0 1.6 2.0 1.7 2.0 1.8 2.0 1.9 2.0 1.0 2.0 2.0 1.0 2.1 1.0 2.2.5 1.0</td> <td>D 0.5 2.5 </td>	D 0.5 2.5 - 1.0 - 2.0 - 1.5 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.5 - 2.0 - 1.0 - 2.0 - 1.0 - 2.0 - 2.0 - 1.0 - 2.5 - 2.5 action in the state of the s	D 0.5 2.5 Hole terminated at 0.6m, sand too dry to retrieve. Test pit TP 8 terminated at 0.6m 1.0 1.0 2.0 1.5 1.5 2.0 1.5 2.0 1.5 2.0 1.0 2.0 1.0 2.0 1.5 2.0 1.5 2.0 1.6 2.0 1.7 2.0 1.8 2.0 1.9 2.0 1.0 2.0 2.0 1.0 2.1 1.0 2.2.5 1.0	D 0.5 2.5

coff			neote	echnics				
COI	су	4894	9001			Excavati	ion No.	<i>TP</i> 9
Engine Client: Principal:				Cavation		Sheet Project M Date sta Date cor	No:	of 1 GEOTSGTE20248AA 4.4.2007 4.4.2007
Project:				PROJECT APPLICATION, TEA	GARDEN	S .ogged	by:	CW
Test pit locatio			FIGURE 1			Checked	-	<i>N//</i>
equipment type a excavation dimen		4WD Backhe 1.5m long	0.4m wide	Pit Orientation: Eastin North	-		R.L. S datum	Surface: 2.735 n: AHD
excavation in	formation	1		substance				
method 5 the penetration support	notes samples, tests, etc	depth RL metres		material soil type: plasticity or particle character colour, secondary and minor compone		LISI ISI	100 pocket 200 d penetro- 400 meter	structure and additional observations
T N	D	_2.5 0. <u>5</u>		TOPSOIL: Silty Clayey SAND, fine to mediu grained, dark grey, low plasticity fines, with s rootlets and thick roots to 100mm.	n M			OPSOIL
	D	_2.0	SC	Clayey SAND: fine to medium grained, dark brown-black, low plasticity fines with some b cemented sand nodules up to approximately diameter.	ack 0.13m	D/VD		
04-04-07 10-41-am		1.5 - 1.5 - 	SP	SAND: medium to coarse grained, pale grey Becoming pale grey-brown.	white.			Groundwater inflow below 1.8m
	D	2.0						lepth, -
		_0.5 -		Test pit TP 9 terminated at 2m				
X existing BH backhoe B buildoze		support S shoring penetratio 1 2 3 4		notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{es} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa)	classification sy soil description based on unified system			consistency/density index VS very soft S soft F firm St stiff
R ripper E excavato	or	water	ranging to refusal level te shown	Bs bulk sample E environmental sample R refusal	moisture D dry M moist W wet Wp plastic lim W _L liquid limit			VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

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U		/		ey	rfille.	2	,		chnics	E	Excava	ation N	0.	TP10
Er	ng	ir	e	ering	j L	.og	- E	Exc	avation		Sheet ^{>} roject	No:	1	of 1 GEOTSGTE20248AA
Clie	nt:			ΤΑΤ	TEF	RSAL	LSL	JRVE	YORS PTY LTD			larted:		4.4.2007
Prine	cipa	Ŀ								[Date co	omplet	ed:	4.4.2007
Proje	ect:			RIV	ERS	IDE I	EST	ATE I	PROJECT APPLICATION, TEA GARD	ENS	oggeo	l by:		CW
Test	t pit I	oca	tion:	REF	ER	TO F	IGU	RE 1			Checke	ed by:		MI.
	omen vatio				4WD 1.5m	Backho	e 0.4m w	údo	Pit Orientation: Easting: m					urface: 2.585
				rmation	1.011	iong i			Northing: m ubstance			ua	atum:	AHD
method	Denetration 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	100 A pocket 200 A pocket 300 b penetro-		structure and additional observations
BH		N			_2.5				TOPSOIL: Clayey SAND, fine to medium grained, brown, low plasticity fines, with some rootlets and roots (10-30mm thick) to approximately 450mm.	М				DPSOIL.
			п	D	2.0	0. <u>5</u>		ŚC	Clayey SAND: fine to medium grained, pale brown, with some cemented sand nodules, low plasticity fines.		MD			
			None Observed		_1.5	- - 1. <u>0</u>		SP	SAND: fine to medium grained, pale grey-white.		Ð			-
			-	D					:		VD			
					_1.0	1. <u>5</u> -				-			No	- o obvious groundwater level or
				D	_0.5	2. <u>0</u> _			One big, 0.7mm dia., cemented sand nodule. Test pit TP10 terminated at 1.9m	w			inf	low but pit collapsing.
						2.5								
Ske	etch													
metho N X BH B R E		existi backi bulldo rippe	atural exposure existing excavation packhoe bucket puldozer blade ipper excavator water water level on date shown				o resista anging to efusal	nce	notes, samples, tests classifica Uso undisturbed sample 50mm diameter soil desc Uso undisturbed sample 63mm diameter based on D disturbed sample system V vane shear (kPa) moisture E environmental sample D dy mo R refusal w wei	ription unified c			-	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose

TESTPIT 202

	FF	\sim) ا	neo	ר. רלב	chnics							
CU		ey	of the second	5	,					i	Excava	ation No.	TP11	
Engir	ıe	ering	g L	.og	- E	Exc	avation				Sheet Project		1 of 1 GEOTSGTE	20248AA
Client:		ΤΑΤ	TEF	RSAL	LSL	IRVE	YORS PTY LTD			[Date st	arted:	4.4.2007	
Principal:												ompleted		
Project:							PROJECT APPLICA	TION, TEA	GARD				CW Au	
Fest pit loca				TO F Backho		RE 1	Pit Orientation:	Easting		(Checke		Surface: 2.732	
excavation dir			1.5m		5 0.4m w	ide	Fit Offentation.	Northing				R.L.		
excavation	info	ormation	1		mat		ubstance		-	1	r .			
method 5 5 penetration subport	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	mate soil type: plasticity or pa colour, secondary and	article characterist		moisture condition	consistency/ density index	100 × pocket 200 v penetro- 400 meter	structure a additional obsei	
E N					<u> } </u>		TOPSOIL: Silty SAND, fine t grey-brown, low plasticity fine	o medium grained	1,	М		1004	TOPSOIL	
			_2.5		BIB	SC	Clayey SAND: fine to mediu grey-brown, low plasticity fine	m grained, pale			VD			
		D	-	0. <u>5</u>		SC	Clayey SAND: fine to mediu orange-brown, dark brown-b	m grained,						
			2.0	-	/ . /		with cemented sand nodules 0.13mm dia.	up to approximat	tely					-
			_2.0	-	/									-
				1. <u>0</u>	/	00	CAND. See to see as a second	1	_					-
		D	{	-		SP	SAND: fine to coarse graine	1, pale grey-brown	n.	w				-
			_1.5		· · · · ·									-
				1.5			Colour change.							-
														-
			_1.0											-
	15am	D		2.0			Test pit TP11 terminated at 1	1.9m						
	07 11:1			<u> </u>										
	04-04-07		_0.5											-
														-
Sketch	·			2.5										
X exist BH back B build R rippe	thod natural exposure existing excavation backhoe bucket buildozer blade ripper excavator water water water level on date shown water inflow		notes, samples, tests U ₅₀ undisturbed sample 5 D disturbed sample 6 D vane shear (kPa) Bs bulk sample E environmental sample R refusal	i3mm diameter	W we Wp pla	ription unified c			consistency/density in VS very so S soft F firm St stiff VSt very sti H hard Fb friable VL very bo L loose MD medium D dense	ff DSe n dense				

				<u> </u>		~			chnics		E	Excava	ition No.	TP12
Eng	gi	n	ee	ering	g L	.og	- E	Exc	avation			Sheet Project		1 of 1 GEOTSGTE20248A
ient:				TA	TTEF	RSAL	LSL	JRVE	YORS PTY LTD			Date st		4.4.2007
incip	al:										0	Date co	ompleted	± 4.4.2007
oject	:			RIV	'ERS	IDE I	EST	ATE I	PROJECT APPLICATION, TEA G	ARDI	ENS	oggeo	l by:	CW
est pil	t lo	cati	on:	REI	FER	TO F	IGUI	RE 1			(Checke	ed by:	M
				model:		Backho	e).4m w	ر. مام	Pit Orientation: Easting:	m				Surface: 3.126
cavati xcava				ms: rmation	1.5m	ong (ubstance	m			datu	m: AHD
benetration		support	water	notes samples tests, etc	:	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics colour, secondary and minor components.		moisture condition	consistency/ density index	o x pocket o d penetro- o meter	structure and additional observations
12	~	N	>		3.0	lineues	3 3	0 %	TOPSOIL: Silty Clayey SAND, fine to medium grained, dark grey, low plasticity fines, with some		M	0.0	100 200 300 400	TOPSOIL
									rootlets to approximately 350mm.	,				
						0. <u>5</u>	/	SC	Clayey SAND / Sandy CLAY: fine to medium grained, dark grey-brown, medium plasticity fines	s.		St	×	
			-	D	2.5	-		CL	Sandy CLAY: low to medium plasticity, orange-brown, sand fine to medium grained.					
					2.0	1. <u>0</u>		SP	SAND: fine to coarse grained, pale grey-white.			VD		
				Ð										
					_1.5	1. <u>5</u>			Becoming pale grey-brown.					
				D		2.0								
			11:30am		_1.0	-			Test pit TP12 terminated at 2m					
			04-04-07											
<u> </u> Sketc	<u> </u>		<u>8 </u>			2.5								
ethod ⊰	ex ba bu rip	natural exposure existing excavation backhoe bucket buildozer blade ripper excavator water excavator no resistance refusal water matural exposure solution refusal matural exposure solution motes, Uso Uso Uso Uso Uso Uso Uso Uso Uso Us				shoring	i o resista anging to	nce	Use undisturbed sample 50mm diameter s Usa undisturbed sample 63mm diameter b D disturbed sample s V vane shear (kPa) s Bs bulk sample n E environmental sample D		iption unified c		1	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose

TESTPIT 20246

ſ	20	f	f	ev		Ç	jeo	ote	chnics	<u> </u>				
				-						E	Excava	tion N	lo.	TP13
E	ng	in	e	ering	j L	.og	- E	Exc	avation		Sheet Project	No:	1	of 1 GEOTSGTE20248A
Clie	ent:			ΤΑΤ	TEF	RSAL	LSU	JRVE	YORS PTY LTD		Date st			4.4.2007
Prir	ncipal:									C	Date co	omplet	ted:	4.4.2007
Pro	ject:			RIVI	ERS	IDE I	EST	ATE I	PROJECT APPLICATION, TEA GARDE	ENSL	oggeo	l by:		CW
	st pit lo					TO F		RE 1	<u>, </u>	C	hecke	d by:		111
	ipment avation				4WD 1.5m	Backho	e).4m w	ide	Pit Orientation: Easting: m Northing: m				t.L. St atum:	urface: 2.825
				rmation	1.0111				ubstance					
method	 benetration 	support	water	notes samples, tests, etc	RL	depth metres.	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	100 pocket 200 d penetro- 300 b penetro-		structure and additional observations
BH					_2.5	0.5		-	TOPSOIL: Silty SAND, fine to medium grained, dark grey-black with some rootlets and roots (10-30mm thick).	D/M				DPSOIL
				D	2.0	1.0		SM	Silty SAND: dark brown-dark red, fine to medium grained, with cemented sand nodules to 0.16mm dia.	М	VD		B	ucket scraping on hard layer.
			04-04-07 11:51am	D	_1.5	1.5			Becoming brown-pale brown cemented nodules of sand still present.					
			▲ 04-(D	_1.0	2.0		- - -	Becoming dark brown-brown weakly cemented nodules present. Test pit TP13 terminated at 2m	w				
					_0.5	2.5						an and a second a se		
SI	ketch													
meti N BH B R E	n E E t	natural exposure existing excavation backhoe bucket bulldozer blade ripper excavator water water inflow water outflow					n o resista anging to efusal evel ≥ shown nflow	nce)		ption nified c				consistency/density index VS very soft S soft F firm Si stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

TESTPIT 2

COT	ey	- Office	g	le	ote	chnics	-	Excava	ation No.	TP14
	_					avation		Sheet Project		of 1 GEOTSGTE20248AA
Client:	ΤΑΤ	TERS	SALI	LSU	IRVE	YORS PTY LTD		Date st	larted:	4.4.2007
Principal:									ompleted:	
Project:						PROJECT APPLICATION, TEA GAR	DENS		i by:	CW
Fest pit location					RE 1	Production - Frankright		Checke		
equipment type an excavation dimens		4WD Ba		: .4m w	ide		n n		R.L. S	Surface: 2.760 n: AHD
excavation inf			Ĩ		erial s	ubstance			1	
method 8 penetration support water	notes samples, tests, etc	dı RL me	lepth etres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	100 A pocket 200 U penetro- 400 meter	structure and additional observations
		_2.5	 - - 0. <u>5</u>		СН	TOPSOIL: Silty CLAY, medium plasticity fines, brown with some rootlets approximately 400mm. CLAY: high plasticity, brown-dark brown.	_	VSt		OPSOIL
	D	2.0								
			<u>.</u>			Becoming dark grey-black with some mottled orange.			×	-
		_1.5				becoming dark grey-black with dome motiled orange.			××	
		_0.5	2. <u>0</u> _ _ _ 2.5			Test pit TP14 terminated at 1.8m				
Sketch										
method N natural ex K existing e B backhoe t B buildozer R ripper E excavator	xcavation bucket blade	1 2 3 water ↓ water	tration 3 4 ration	resistar nging to fusal vel shown		U _{so} undisturbed sample 50mm diameter soil de U _{so} undisturbed sample 63mm diameter based D disturbed sample system V vane shear (kPa) moistu E environmental sample D R refusal W V W		classificat		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense

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	ハ	J			₹y	455	٢	,00		chnics		E	Excava	tion I	No.	TP15
E	nç	gi	n	ee	ering	j L	.og	- [Exc	avation			Sheet Project	No;	1	i of 1 GEOTSGTE20248A
Clie	ent:				ΤΑΤ	TEF	RSAL	LSU	JRVE	YORS PTY LTD		ł	Date st	arted	:	4.4.2007
	ncipa												Date co	•	eted:	
	oject:									PROJECT APPLICATION, TEA (;ARDI			-		CW MM
	st pit						TO F Backho		RE 1	Pit Orientation: Easting:	m		Checke			Surface: 2.355
	avatio							о 0.4m v	/ide	Northing:	m				datun	
ex			n ir	for	mation	1		mat		ubstance				4		
mernoa	t benetration		Inddae	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristic colour, secondary and minor components		moisture condition	consistency/ density index	100 pocket 200 penetro-	a	structure and additional observations
	12	<u> </u>	1			_2.0	0.5			TOPSOIL: Silty (Clayey) SAND, fine to medium grained, dark grey-black, with some roots 10mn rootlets to approximately 400mm.		M		1	-	TOPSOIL
					D			17117	SP	SAND: fine to coarse grained, pale grey-brown, small percent of fines <20%.	·	M/W	D/VD			•
						_1.5	- - 1. <u>0</u>			Becoming pale grey mottled black and white.						
					D		-								F	Pit collapsing no groundwater
					D	-	1. <u>5</u>									bserved.
		Address of the Addres				_0.5	2.0			Pit collapsing. Test pit TP15 terminated at 1.7m						
						_0.0	2.5									
S	ketc	h														
net 1 3H 3	hod	natural exposure existing excavation S shoring N nil U _{so} un backhoe bucket penetration D dis bulldozer blade 1 2 3 4 V va ripper ranging to excavator Bs bull				Use undisturbed sample 50mm diameter Use undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	classificat solt descri based on u system noisture D dry M mois W wet Ny plas	iption unified o				consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose				

	ff,				עסו	ota	chnice							
CO		₹y		ر د	<i>j</i> c,		echnics		-	Excava	ition N	0.	TP16	,
	nee						avation			Sheet Project Date st			of 1 GEOTSGTE2024 4.4.2007	<u>8AA</u>
Principal:										Date co			4.4.2007	
Project:		RIVI	ERS	IDE I	EST	ATE I	PROJECT APPLICATION, TE	A GARI			•		CW	
Test pit loca	ation:	REF	ER	TO F	IGU	RE 1			(Checke	ed by:		MM?	
equipment typ	be and n	nodel:	4WD I	Backho	e		Pit Orientation: East	ing: m	}		R	L. Su	rface: 2.683	
excavation dir excavation			1.5m	ong (0.4m w		Norti	ning: m	1		d	atum:	AHD	
method 5 penetration support		notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characte colour, secondary and minor compor	istics, ents.	moisture condition	consistency/ density index	200 A pocket 300 B penetro-		structure and additional observations	,
				-		SP	TOPSOIL: Silty SAND, fine to medium grain grey-black mottled white, with some rootlets SAND: fine to medium grained, pale grey-b	s	M	D			DPSOIL	
		D	_2.0	0. <u>5</u> -						VD				-
	Ε	D	_1.5	1. <u>0</u>					M/W					-
	04-04-07 12:54pm			- - 1. <u>5</u>										
		D	_1.0			SP	SAND: fine to medium grained, dark grey-b	ack,	w					
			_0.5	2.0			cemented sand nodules, coffee rock. Pit collapsing. Test pit TP16 terminated at 1.8m							-
			_0.0	2.5								rand the first and with a set formula on the set of the set of		
Sketch							· · · · · ·							
X exist BH back B bullo R rippe	N natural exposure S shoring N nil X existing excavation Exposure S shoring N nil BH backhoe bucket penetration B bulldozer blade 1 2 3 4 R ripper ranging to				o resista anging to etusal evel e shown	nce	notes, samples, tests Uso undisturbed sample 50mm diameter Uso undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	soil des based o system moistum D da M m W w Wp pl	cation syr cription n unified of e ry noist ret lastic limit quid limit	dassificat			consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense	

coffey	option and a	chnics			
coney	- 900k	John 105	E	xcavation No.	TP17
Principal: Project: RIV Test pit location: REP equipment type and model:	TERSALL SURVI	EYORS PTY LTD PROJECT APPLICATION, TEA	P D GARDENS C : m	roject No: ate started: ate completed ogged by: hecked by:	CW Surface: 2.635
excavation information	·····	substance		. × 6	·····
poutseu poutseu 1 2 3				consistency/ density index 200 T pocket 300 b meter	structure and additional observations
H N	2.5	TOPSOIL: Sitty Clayey SAND, fine to medium grained, dark grey-black mottled white, low pla fines, with some rootlets.	sticity		TOPSOIL - - - -
D	2.0 0. <u>3 7717</u> SC - 2.0 SC - 5C - 5C	Sitty Clayey SAND: fine to medium grained, c brown / red, low to medium plasticity fines, wit cemented nodules of SAND. Clayey SAND: fine to medium grained, brown brown, low plasticity fines, with weakly cemen nodules of sand.	pale	VD	
▲05-04-07 10:53am	1.5 SP	SAND: fine to coarse grained, pale grey-pale Becoming grey-brown.	w		Rapid inflow of groundwater below 1.7m depth.
	2.0	Pit collapsing. Test pit TP17 terminated at 2m			
Sketch method N natural exposure X existing excavation BH backhoe bucket B bulldoer blade R ripper E excavator	support S shoring N nil penetration 1 2 3 4 no resistance ranging to ranging to water water level ✓ water level on date shown	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{so} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	classification symt soil description based on unified cla system moisture D dry M moist W wet Wp plastic limit W ₄ liquid limit		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense

Engineering Log - Excavation Sheet 1 of 1 Project No: GEOTSGTE2024 Client: TATTERSALL SURVEYORS PTY LTD Date started: 5.4.2007 Principal: Date completed: 5.4.2007 Project No: RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS.ogged by: CW rest pit location: REFER TO FIGURE 1 Checked by: quipment type and model: 4WD Backhoe Pit Orientation: Easting: m R.L. Surface: 2.302 xcavation dimensions: 1.5m long 0.4m wide Northing: m datum: AHD excavation linformation material substance material worthing: m datum: AHD material upper pasticity or particle characteristics, colour, secondary and minor components. worthing with additional observations additional observations	CO	f	F(ey		Ç	je	ote	chnics		Excav	ation No.	TP18
TattersALL SURVEYORS PTY LTD Date stanted: 5.4.2007 Traject Cale completed: 5.4.2007 Traject RVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENS, ogged by: CV Set pill location: REFER TO FIGURE 1 Checked by: Comparison: 15m log: material Comparison: CV Set pill location: Status Profession: Earling: material Comparison: Av0 Secondaria dimension: 15m log: Order oper plastopic organize characteristics, grant dimension: Earling: material Earling: material Earling: Status				-							Sheet		
	Client:	TATTERSALL SURVEYORS PTY LTD											
	Principal:											·	5 .4.2007
superformer type and model: 4WD Backbor Pt Orientation: Easing: n R.I. Eurise: 2.302 sequence information: Securities: 10 for long 0 dm wide sequence information: The material substance Securities: 10 for m	Project:		_						PROJECT APPLICATION, TEA GA	RDEN			CW MAA
Name Noting n Add Add Sector Table Table </td <td>•</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>RE 1</td> <td>Pit Orientation: Easting:</td> <td>m</td> <td>Check</td> <td></td> <td>Surface: 2.302</td>	•							RE 1	Pit Orientation: Easting:	m	Check		Surface: 2.302
Sign discription Sign discription </td <td>xcavation c</td> <td>lime</td> <td>ensio</td> <td>ons:</td> <td></td> <td></td> <td></td> <td>vide</td> <td>.</td> <td></td> <td></td> <td></td> <td></td>	xcavation c	lime	ensio	ons:				vide	.				
E I S RL <matrixe< th=""> B S Cookur secondary and minner components. E B S S 3 M -2.9 -3.5<td>_</td><td>on i</td><td>nfo</td><td>rmation</td><td>Т</td><td></td><td>ma</td><td>1</td><td>ubstance</td><td></td><td>_ ×</td><td></td><td></td></matrixe<>	_	on i	nfo	rmation	Т		ma	1	ubstance		_ ×		
Bit dial 1.0	2	support	water	samples,	RL		graphic log	classification symbol	soil type: plasticity or particle characteristics,	moisture	consistency/ density inde	kPa	structure and additional observations
National sequences Support N </td <td></td> <td>N</td> <td></td> <td></td> <td>_2.0</td> <td>1</td> <td></td> <td></td> <td>dark brown-black, sand fine to medium grained, with</td> <td></td> <td></td> <td></td> <td>TOPSOIL</td>		N			_2.0	1			dark brown-black, sand fine to medium grained, with				TOPSOIL
Interference 1.0 1.0 SP SAND: fine to coarsis grained, pale grey while. Image: space						0.5		СІ	CLAY: medium plasticity, dark grey mottled orange, with minor sand component approximately 10%.		VSt	- * -	
withod the spose Support Index spose Sand becoming indurated and dark brown / red. W withod 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.0 0.0 0.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.0 0.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 0.0 2.0 1.0 Pit collapsing due to inflow of groundwater, collapsing W 1.0 1				D		-		SC	Clayey SAND: fine to medium grained, grey, low plasticity fines.	-	D		
ethod to be on the serve to the serve					1.5		× • • • •	SP		-			
athod augront Sand becoming indurated and dark brown / red. W Image: second construction of the second consecond construction of the second construction o					_	I. <u>U</u> _							
ethod support Sand becoming indurated and dark brown / red. W W Image: Induced sequence of the se				0		-							
athrod asupport Sand becoming indurated and dark brown / red. W W Image:			0:35an			1. <u>5</u>							
sethod support Pit collapsing due to inflow of groundwater, collapsing Image: Collapsing due to inflow of groundwater, collapsing due to inflow and groundwater, collapsing due to inflow and groundwater, col		ľ	5-04-07			-			Sand becoming indurated and dark brown / red.	w	_		
wthod support Test pit TP18 terminated at 1.9m sketch 2.5 Sketch			ö 	D	0.5	-		ļ	Pit collapsing due to inflow of groundwater, collapsi	na			
ethod support notes, samples, tests sketch shoring N nil H backhob buckst penetration 12.3.4 no resistance ropper exclavator Water roging to model shown V van sharple R refusal W water V van sharple R refusal W wet V van sharple R refusal W wet V van sharple N moisture V very stift H hard V very stift R refusal						2.0			from sides.				
sketch netnod natural exposure existing excavation H support S shoring Light of penetration inducer blade ripper excavator notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{so} undisturbed sample 60mm diameter U _{so} undisturbed sample 60mm diameter U _{so} undisturbed sample 60mm diameter D v vane shear (kPa) Bs bulk sample R classification symbols and soli description based on unified dassification system consistency/density index VS M undisturbed sample 60mm diameter U _{so} undisturbed sample 60mm diameter D classification symbols and soli description based on unified dassification System VS very soft S M moresistance instiguto water water no resistance instiguto water moresistance registion R moresistance registion R very constitue VD VS very soft S M water moresistance instiguto on date shown refusal W VS very soft S S					_0.0								
ethod support notes, samples, tests classification symbols and solid description consistency/density index H backhose buckt S shoring N nil penetration U _{so} undisturbed sample 50mm diameter classification symbols and solid description vs very soft H backhose buckt 12/3/4 no resistance introjagi to resistance introjagi to resistance 0 disturbed sample 60mm diameter classification symbols and solid description vs very soft D disturbed sample D disturbed sample 60mm diameter back on unified classification system S soft V vare shear (KPa) Bis buck sample E moisture Vs very stift W vater vater refusal R refusal R refusal Vs very loose V very loose L loose Vs very loose L loose						2.5							
natural exposure existing excavation 1 S shoring N nil U _{so} undisturbed sample 50mm diameter U _{dso} soil description VS very soft 1 backhoe bucket buldozer blade ripper excavator penetration D disturbed sample 63mm diameter D soil description VS very soft 2 3 no resistance renging to water no resistance refusal no resistance refusal N nil U _{so} undisturbed sample 63mm diameter D soil description VS very soft Matter 2 3 no resistance refusal no resistance refusal Bs bulk sample moisture VS very stiff Matter water R refusal R refusal M moist Fb friable W water level on date shown no date shown ND medium dense MD medium dense	Sketch												
natural exposure existing excavation it S shoring N nil U ₅₀ undisturbed sample 50mm diameter U ₆₀ soil description VS very soft backhoe bucket buildozer blade ripper excavator penetration 1 2 3 4 roresistance radiging to water D disturbed sample 63mm diameter U ₆₀ soil description VS very soft buildozer blade ripper excavator no resistance radiging to refusal no resistance radiging to on date shown S bulk sample E moisture VS very soft water water ievel on date shown R refusal R refusal M moist Wy Iguid limit VD very lose W													
natural exposure existing excavation it S shoring N nil U ₅₀ undisturbed sample 50mm diameter U ₆₀ soil description VS very soft backhoe bucket buildozer blade ripper excavator penetration 1 2 3 4 roresistance radiging to water D disturbed sample 63mm diameter U ₆₀ soil description VS very soft buildozer blade ripper excavator no resistance radiging to refusal no resistance radiging to on date shown S bulk sample E moisture VS very soft water water ievel on date shown R refusal R refusal M moist Wy Iguid limit VD very lose W													
natural exposure existing excavation 1 S shoring N nil U ₅₀ undisturbed sample 50mm diameter U ₅₀ soil description VS very soft 1 backhoe bucket buildozer blade ripper excavator penetration 1 2.3.4 D disturbed sample values and sample soil description VS very soft 2 a no resistance ranging to water no resistance refusal no resistance refusal BS bulk sample moisture VS very stiff water water i refusal water i refusal R refusal R refusal M moist Fb friable W water i refusal m of ate shown no date shown K refusal MD medium dense													
water R refusal M moist Fb friable water level water level W wet VL very loose on date shown W Wp plastic limit L loose Wp Ilguid limit MD medium dense	na exi H ba bu rìp	istin Ickh Ildo: Iper	g exc oe bu zer bl	avation Icket	S pe	shoring netratior 2 3 4 n	1 10 resista	Ince	Uso undisturbed sample 50mm diameter soil Uso undisturbed sample 63mm diameter base D disturbed sample swyte V vane shear (kPa) syste Bs bulk sample mois	description ad on unifie am sture	Π		VS very soft S soft F firm St stiff VSt very stiff
• VE INSPORTO DECIDIO DECIDE	ex	cavi	alor		wa	ter water le	evel	1	R refusal M W Wp	moist wet plastic in			Fb friable VL very loose L loose

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] (ΞУ	78F	2	,		chnics	-	Excava	ation No		TP19
En	gi	n	ee	ering	y L	.og	- E	Exc	avation		Sheet Project	No:	1	of 1 GEOTSGTE20248A
lient:				TAT	TEF	RSAL	LSL	IRVE	YORS PTY LTD		Date st			4.4.2007
rincip	oai:										Date c	omplete	d:	4.4.2007
rojeci	t:			RIV	ERS	IDE I	ESTA	ATE I	PROJECT APPLICATION, TEA GAR	DENS	Logged	i by:		CW
est pi	it lo	cati	on:	REF	ER	TO F	IGUI	RE 1			Checke	ed by:		111
					4WD	Backho			Pit Orientation: Easting: n	n		R.L	Su	rface: 2.261
cavati xcav				ns: mation	1.5m	ong (0.4m w mat		ubstance Northing: n	n.		dat	um:	AHD
											ex /	r et		
t Denetration		support	water	notes samples, tests, etc		depth	graphic log	classification symbol	material soil type: plasticity or particle characteristics,	moisture condition	consistency/ density index	o ay pocket b ay pocket b a benetro-		structure and additional observations
12	23	ο N	3		RL	metres	5 17 17	ບທ່	colour, secondary and minor components. TOPSOIL: Clayey SAND, fine to medium grained,	E 8	οσ	\$385 \$	TC	PSOIL
									dark brown-black, tow plasticity fines with some rootlets.					
					2.0					_				
						0. <u>5</u>		СН	Sandy CLAY: medium to high plasticity, dark brown-black, sand fine to coarse grained.					
			-	D	-	-								
					_1.5	-								
			_			1. <u>0</u>								
			2:31pm	D				SP	Becoming dark grey-grey.	w	VD			
					_1.0			35	SAND: fine to coarse grained, pale grey-white.	vv			-	
			04-04-07			1. <u>5</u>								
			-											
				Ð	_0.5				Becoming pale brown / grey.					
						2.0			Pit collapsing due to groundwater. Test pit TP19 terminated at 1.8m					
	the second second					2.0								· · ·
					_0.0									
					Γ									
						2.5								
Sketo	ch				P	2.5								
ethod H	na ex ba rip	istin Ickho	g exc be bu ter bl		S pe	n n	n o resista anging to efusal evel		U _{so} undisturbed sample 50mm diameter soil de U _{ss} undisturbed sample 63mm diameter based D disturbed sample system V vane shear (kPa) moistu Bs bulk sample moistu E environmental sample D d R refusal M w		classifical			consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose

ooffou	acoto	obnice			
coffey	Geore	CHINCS	Excav	ation No.	TP20
Principal: Project: RI	TTERSALL SURVE		Date o GARDENS _L ogge	t No: started: completed:	of 1 <u>GEOTSGTE20248AA</u> 4.4.2007 4.4.2007 CW
equipment type and model:	4WD Backhoe	Pit Orientation: Easting	m	R.L. Si	urface: 2.255
excavation dimensions: excavation information	1.5m long 0.4m wide material s	Northing): m	datum:	: AHD
Jettor Jettor	nic log	material soil type: plasticity or particle characteristi colour, secondary and minor component		100 pocket 200 d penetro- 400 meter	structure and additional observations
Image: constraint of the second se	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	TOPSOIL: Silty Clayey SAND, fine to medium grained, dark grey-black mottled white, with so rootlets. Sandy CLAY: low plasticity, dark brown-red, sa fine to medium grained, trace of rootlets and cemented sand nodules. Sandy CLAY: low to medium plasticity, pale grey-pale brown mottled orange, sand fine to r grained. Becoming pale brown / grey. Pit collapsing due to groundwater. Test pit TP20 terminated at 1.7m	me D and M /		OPSOIL
Sketch method N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	support S shoring N nii penetration 1 2 3 4 ranging to refusal water water level on date shown water inflow water outflow	notes, samples, tests Uso undisturbed sample 50mm diameter Uso undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	classification symbols a soil description based on unified classific system moisture D dry M moist W wet Wp plastic limit W _L liquid limit		consistency/densify index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

)		чy	С.	ں ک	100		chnics		-	Excava	tion N	0.	TP21
Eng	ir	ie	ering	j L	og	- E	Exc	avation			Sheet Project	: No:	1	of 1 GEOTSGTE20248A
lient:			ΤΑΤ	TER	SAL	LSU	JRVE	YORS PTY LTD		[Date st	arted:		4.4.2007
rincipal	l:									(Date co	omplet	ed:	4.4.2007
roject:			RIVI	ERSI	IDE E	EST	ATE I	PROJECT APPLICATION, TEA	GARI	DENS	_oggeo	d by:		CW
est pit I	oca	tion:	REF	ER	TO F	IGU	RE 1			(Checke	ed by:		<u>////</u>
uipment 					Backho			Pit Orientation: Eastin						Inface: 2.675
cavation excavat			rmation	1.5m k	ong (0.4m w mat		ubstance	g: m	l 		da	atum:	AHD
penetration	support	water	notes samples, tests, etc		depth	graphic log	classification symbol	material soil type: plasticity or particle characteris	lics	moisture condition	consistency/ density index	a pocket benetro- meter		structure and additional observations
125	Ins N	wa		RL, r	netres	20	syr	colour, secondary and minor component TOPSOIL: Silty Clayey SAND, fine to mediun	its.	ÊÖ	der	30 2 Q		DPSOłL
			D	_2.5	0. <u>5</u>		SC	Clayey SAND: fine to medium grained, orang brown, low plasticity fines with so rootlets and some thick roots to 300mm. Clayey SAND: fine to medium grained, orang brown, low plasticity fines with some cemente sand nodules. SAND: fine to medium grained, pale grey-whi	ne e-pale d red		VD			
			D	_1.5	1.0 - - 1.5 -			Becoming pale brown-pale grey.						
		04-04-07	D	_0.5	 			Test pit TP21 terminated at 2m		W				apid groundwater inflow below 7m depth.
Sketch					2.5									
Н	od natural exposure existing excavation backhoe bucket buildozer blade nipper excavator water water level on date shown water outflow water outflow				thoring 3 4 retration 7 retr water let on date	t o resista anging to efusal evel evel e shown	nce	notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₆₅ undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	soil des based o system moistur D d M rr W w Wp p	cation syr cription in unified of re ry noist ret lastic limit quid limit				consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense

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coff	fov		ae	ote	chnics				
COI	су	100	90		or miles	-	Excava	ition No.	TP22
					avation		Sheet Project Date st	No:	1 of 1 GEOTSGTE20248AA 4.4.2007
Principal:	101	, E, (Q,						ompleted	
Project:	RIV	ERSID	E EST	ATE	PROJECT APPLICATION, TEA GAR	DENS	Logged	l by:	CW
Test pit locatio	on: REF	ER TO) FIGL	IRE 1			Checke	ed by:	M
equipment type a		4WD Bad	ckhoe			m		R.L.	Surface: 2.332
excavation dimention in excavation in		1.5m long	-		Northing:	m		datui	n: AHD
method benetration support	notes samples, টু tests, etc	de RL me	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	100 x pocket 200 x pocket 300 w penetro- 400 meter	structure and additional observations
E 123 0	-	_2.0			TOPSOIL: Sandy CLAY, low to medium plasticity, dark brown-black, sand fine to medium grained, with some rootlets.	D			TOPSOIL - - -
	D	1.5). <u>5 </u> (- -	Ci SM	CLAY: medium plasticity, dark brown-black, with some sand component approximately 30%. Silty SAND: fine to medium grained, brown-pale	— <mark>м</mark>	D		
	D		1. <u>0</u>		brown, with some cemented sand nodules.		VD		
		1.0		SP	SAND: fine to medium grained, pale grey-white.		-		
		F	2. <u>0</u> 		Pit collapsing due to groundwtaer inflow. Test pit TP22 terminated at 1.9m				
	04-07	_0.0							-
Sketch									
X existing		l <u> </u>	ration 4 no resis ranging	to	U ₅₀ undisturbed sample 50mm diameter undisturbed sample 63mm diameter D soil du based based V vane shear (kPa) Bs buik sample E environmental sample R refusal		classificat		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense

TESTPIT 20248AA

Form GEO 5.2 Issue 3 Rev.2

oof	F,	``		e r	ıص	ote	chnics					
COI	It	зу	Aller.	ں ب	je	ole	chnics		E	Excava	tion No.	TP23
	ee						avation		F	Sheet Project		1 of 1 GEOTSGTE20248AA
Client:		ΤΑΤ	TER	SAL	LSI	JRVE	YORS PTY LTD			Date st		5.4.2007 i: 5.4.2007
Principal: Project:		RIVE	RSI	IDE I	EST	ATF I	PROJECT APPLICATION, TEA	GARD			ompleted	CW
Test pit locati	on:	REF						0,11,21		Checke		IM
equipment type				Backho			Pit Orientation: Easting	g: m				Surface: 2.090
excavation dime			1.5m k	ong (0.4m v		Northin	ıg: m			datu	ım: AHD
d hetration ft		notes samples, tests, etc			graphic log	classification symbol	material		moisture condition	consistency/ density index	x pocket ⊌d penetro- meter	structure and additional observations
ق 123	water	10010, 010	RL r	depth netres	grap	clas sym	soil type: plasticity or particle characteris colour, secondary and minor componer	nts.		den	100 200 2 300 0	
Н			_2.0	-			TOPSOIL: Silty Clayey SAND, fine to medium grained, dark grey-black, low plasticity fines, v some rootlets to 300mm.		D			TOPSOIL
			_1.5	0. <u>5</u>		SC CL	Clayey SAND: fine to medium grained, dark grey-black, low to medium plasticity fines. Sandy CLAY: low to medium plasticity, pale b	prown /	M			
	erved I	D				SC SP	orange, sand fine to medium grained. Clayey SAND: fine to medium grained, pale g pale brown, low plasticity fines.	1		VD		
	None Observed			1. <u>0</u>			SAND: fine to coarse grained, pale grey-white	1.				
	Non	D	_1.0									
												- - -
			_0.5			•	Becoming grey / brown.	-	w			No visible water, but pit collapsing –
		D		2.0								
			_0.0	2.0		·	Test pit TP23 terminated at 2m					
				_								-
				2.5								-
Sketch			<u> </u>									
X existin BH backho B bulldoz R ripper	natural exposure S shoring N ni existing excavation backhoe bucket penetration buildozer blade 1234 paresistance					ance o	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{so} undisturbed sample 50mm diameter D disturbed sample 63mm diameter V vane shear (kPa) Bs bulk sample E environmental sample R refusal		ription unified o			consistency/density index VS very soft S soft F firm St stiff VSt very sliff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

		ev		ge	ote	chnics	Ē	xcava	tion No.	TP24
						avation	s	heet	1	of 1 GEOTSGTE20248A
lient:						YORS PTY LTD		roject ate st	No: arted:	5.4.2007
rincipal:							D	ate co	ompleted:	5.4.2007
roject:		RIV	ERSIDE	EST.	ATE I	PROJECT APPLICATION, TEA GARE	DENSL	oggeo	iby:	CW
est pit loc	ation:		ER TO						ed by:	M
quipment ty	rpe and	model:	4WD Backi	noe		Pit Orientation: Easting: m			R.L. S	Surface: 2.177
cavation d			1.5m long	0.4m v		Northing: m			datum	n: AHD
					1		T	ě ź	_ to tr	
penetration	support water	notes samples, tests, etc	dep RL metre		classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	100 A pocket 200 a penetro- 400 meter	structure and additional observations
12.5	N		I've meav		1	TOPSOIL: Sandy CLAY, low to medium plasticity, sand fine to medium grained, with some rootlets to	M		1 1	OPSOIL
			_2.0			100mm.			*	
		D	0.		CL	Sandy CLAY: low to medium plasticity, orange, sand fine to coarse grained.				
			_1.5		SP	SAND: fine to medium grained, pale grey-white mottled orange.	-	Ð		
]		nomed orange.		VD		
		D	1.0	4						
			_1.0	-	-					
	14am		1.5	<u>,</u>	- •					
	7 112		_0.5							
	05-04-07 11:44am			-						
	°	D	2.0	,	<u> </u>	Lenses of colour change to pale grey / brown, with some clay lenses.	W			
			_0.0	-		Pit collapsing from groundwater table. Test pit TP24 terminated at 2m				
			2.5	-						
Sketch										
nethod	natural exposure S shoring N nil Uso undisturbed sample 50mm diameter soil of						cation syn cription n unified c			consistency/density index VS very soft S soft

	~	` f	÷¢,	\sim		<u>م</u>	יסו	nte	chnics					
	C	J		ey	1999	Ĺ,	100	510	chnics		Excav	ation No.	TP25	
_	Enç	gin	e	ering	j L	og	- E	Exc	avation		Sheet Projec		1 of 1 GEOTSGTE	20248AA
-	Client:			ΤΑΤ	TER	SAL	LSU	JRVE	YORS PTY LTD		Date s	started:	5.4.2007	
	Principa	al:					_					completed		
	Project:								PROJECT APPLICATION, TEA	GARDE			CW Mha	
	Test pit				i	TO F Backho		RE 1	Pit Orientation: Easting	: m	Check	ed by:		
	excavatio				1.5m k		- 0.4m w	ide	Northin			datu		
F			info	rmation	1		mat	r	ubstance	1				
	method 1 2 penetration	5	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characterist colour, secondary and minor componen	ics. soit	condition condition consistency/ density index	100 × pocket 200 × pocket 300 v meter	structure a additional obse	
	BH	N			_2.5				TOPSOIL: Silty SAND, fine to medium grained grey mottled white with some rootlets and root (10mm) to 150mm. Silty SAND: fine to medium grained, dark grey	s	D M D		TOPSOIL	
				D	2.0	- - 1. <u>0</u>		· · ·	cemented nodules of SAND.		VD			
			05-04-07 11:08am		_1.0	- - 1. <u>5</u> -			100mm band of pale grey-pale brown and the becoming grey-brown weakly cemented sand nodules.	1	W		Rapid inflow of ground	- -
				D		2.0			Becoming dark brown / red weakly sand nodu Test pit TP25 terminated at 2m	es.			1.9m depth.	
					_0.5	2.5								۲ ۲ ۲
	method N X BH B R E	natu exist back nippe	ing ex hoe b ozer t	cavation ucket	S pe 1	shoring netratio 2 3 4 1 1 1 1 1 1 1 1 1 1 1 1 1	n no resista ranging t refusal level e showa	ance o	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{sa} undisturbed sample 60mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	soil descrip based on ur system moisture D dry M moist W wet	nified classific			stiff e oose um dense
Form GEO 5.2 Issue 3 Kev.	B R	bulld rippe	natural exposure existing excavation backhoe bucket bulldozer blade ripper excavator water water water level on date shown N nil U _{so} undisturbed sample 50mm diameter U _{so} undisturbed sample 63mm diameter backboe sample 63mm diameter U _{so} undisturbed sample 63mm diameter v vane shear (kPa) E environmental sample W water water level on date shown											St stiff VSt very s H hard Fb friable VL very I L loose MD media

a offer	S acoto	obnice			
coffey		CHINCS	Ex	cavation No.	TP26
Engineering	Log - Exc	avation		neet 1 oject No:	of 1 GEOTSGTE20248AA
Client: TAT	TERSALL SURVE	YORS PTY LTD	Da	ate started:	4.4.2007
Principal:				ate completed:	4.4.2007
-		PROJECT APPLICATION, TEA			CW
	ER TO FIGURE 1	Pit Orientation; Eastin		necked by:	//// 1 300
1.1. 3,	4WD Backhoe 1.5m long 0.4m wide	Pit Orientation: Eastin	-	R.L. Si datum:	
excavation information	material s	ubstance			
po tu tu tu tu tu tu tu tu tu tu	graphic log symbol symbol	material soil type: plasticity or particle characteri colour, secondary and minor compone	stics, nts.	consistency/ density index ¹⁰⁰ × pocket ²⁰⁰ v penetro- ³⁰⁰ meter	structure and additional observations
HI25 N	_1.5 _ {	TOPSOIL: Silty Sandy CLAY, medium plasti dark grey-black, sand fine to medium graine some rootlets to 100mm.	sity, M d, with		DPSOIL
D	0. <u>5</u>	SAND: fine to coarse grained, pale grey-whit	e.		-
	_1.0				
	1.0	Becoming pale brown / grey.			
	_0.5				
	1.5 · · · · · · · · · · · · · · · · · · ·	Pit collapsing due to groundwater. Test pit TP26 terminated at 1.5m			
	2.0				-
	0.5				-
	2.5				
Sketch					
method N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R ripper E excavator	support S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water water level on date shown water inflow water outflow	notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₈₃ undisturbed sample 63mm diameter D disturbed sample V vane shear (KPa) Bs bulk sample E environmental sample R refusal	classification symb soil description based on unified cla system D dry M moist W wet Wp plastic limit W_ liquid limit		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

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COL		Зy		ر د	JCI		chnics		Ē	Excava	ition No.	TP27
Engin		ering	J L	og	- [Exc	avation		F	Sheet Project	No:	1 of 1 GEOTSGTE20248AA
Client:		ΤΑΤ	TER	SAL	LS	JRVE	YORS PTY LTD			Date st		4.4.2007 4.4.2007
rincipal: roject:		RIVI	-RSI	DE P	=ST.	ATF I	PROJECT APPLICATION, TEA	GARD			ompleted	CW
est pit locat	ion:							. 6, 11 (2		Checke		MM.
quipment type			4WD B	ackho	e		Pit Orientation: Eastir	g: m			R.L.	Surface: 1.536
cavation dim			1.5m lo	ong (0.4m v mat		Northi ubstance	ng: m			datu	m: AHD
penetration penetration support	water	notes samples, tests, etc	RL n	depth	graphic log	classification symbol	material soil type: plasticity or particle characteri colour, secondary and minor compone	stics, nts	moisture condition	consistency/ density index	100 A pocket 200 A penetro- 300 b meter	structure and additional observations
= <u>123</u> ^ø	Λ	D	_1.0	0. <u>5</u>		SM	TOPSOIL: Silty (Clayey) SAND, fine to medi grained, dark grey-black, with some rootlets 200mm.	im to	D	VD	20	
	3:46pm	D	_0.5	- 1. <u>0</u> -		SP	with some cemented sand nodules. SAND: fine to coarse grained, brown / grey, small percent of fines approximately 20-30% clay lenses or nodules.	with				
	T 04-04-07 3:4	D	_0.0	- 1. <u>5</u> -			Becoming pale grey-white. Becoming pale grey / brown. Pit collapsing due to groundwater inflow.		M/W	-		
			0.5	2.0			Test pit TP27 terminated at 1.8m					
Sketch				2.5								
X existi BH back B bulld R rippe	natural exposure S shoring N ni existing excavation					ance to	notes, samples, tests U _{so} undisturbed sample 50mm diameter U ₆₃ undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	W we Wp pla	ription unified v	classifica		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very toose L loose MD medium dense D dense VD very dense

sue 3 Rav.2

L	バ	J		ey		2	ye		echnics		8	Excava	tion No.	TP28
									avation			Sheet Project	No:	1 of 1 GEOTSGTE20248A
Clie	ent:			T/	ATTE	RSA	LL S	URVE	YORS PTY LTD		[Date st	arted:	4.4.2007
Prin	ncipa	il:									ĩ	Date co	ompleted	i: 4.4.2007
Proj	ject:								PROJECT APPLICATION, TEA	GARDE	NS	oggeo	l by:	CW
	st pit							RE 1	Pit Orientation: Easting	m	(Checke		. Surface: 2.012
•	ipmen avatio	-		d model: ions:) Backh 1 Iong	0.4m •	wide	Pit Onentation. Easting Northing				datu	
exc		tio	n inf	ormatio	n		ma	1	ubstance				1	
method	penetration		support water	note sampli tests, i	es, etc	depi metre		classification symbol	material soil type: plasticity or particle characterist colour, secondary and minor componen	cs,	condition	consistency/ density index	100 A pocket 200 A penetro- 400 meter	structure and additional observations
ΗS	123	ĭ.	N						TOPSOIL: Silty SAND, fine to medium grained grey-black, with some rootlets.	1	D		4 3 5 7	TOPSOIL
					_1.	5 0.5			grey block, with come footied.					
000000000					_		<u> } </u>	SM	Silty SAND: fine to medium grained, dark		M	D		
									brown-black / red, cemented sand nodules.					
10000					1.	1.0								
							-							
			3:31pm					SP	SAND: fine to coarse grained, pale brown / gra	y	W			
			-07.3			5 1.5	-							
			04-04-07		0.		-	· .	Becoming brown / grey mottled orange.					
				D			-		Test pit TP28 terminated at 1.8m					
					_0.	2. <u>0</u>	-							
							-							
						2.5	-							
S	ketc	h												
met N BH R E	I natural exposure existing excavation H backhoe bucket bulldozer blade ripper excavator water ♥ wa				water water	ion	to	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{es} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal		nified	classifica		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb fnable VL very loose L loose MD medium dense	

~	_			~ ` <i>i</i>				ota	obnice					
U	;(ey	99F	ں ر	JC	Ule	chnics		Е	Excava	tion No.	TP29
Eı	ng	ii	ne	ering	j L	og	-	Exc	avation			Sheet Project		1 of 1 GEOTSGTE20248A
Clie	nt:			TAT	TER	SAL	LS	URVE	YORS PTY LTD		[Date st	arted:	5.4.2007
Prin	cipa	1:											ompleted	
-	ect:								PROJECT APPLICATION, TEA	I GARD				CW Mai
	-		ation			TO F		RE 1	Pit Orientation: Eastir		(Checke		
			nensi		1.5m).4m v	wide	North	-			datu	
exc		tior	n info	rmation	1		ma	-	ubstance					
method	5 penetration	cuonort	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteri colour, secondary and minor compone		moisture condition	consistency/ density index	100 × pocket 200 × pocket 300 № penetro- 400 meter	structure and additional observations
ц		Ň			_2.0	-			TOPSOIL: Silty SAND, fine to medium grain brown-black, with some rootlets.	ed, dark	D			TOPSOIL
					-	- 0. <u>5</u>		ļ	Silty SAND: fine to medium grianed, pale gr	ey / pale		D		
					1.5			sc	brown. Clayey SAND: fine to medium grained, pale low plasticity fines.		M			
						1. <u>0</u>								
			-	D	1.0									
						1.5	· · · ·	SP	SAND: fine to medium grained, pale grey-wi	īite.	W			
			:12pm	D	0.5		<u></u>	•	Pit collapsing. Test pit TP29 terminated at 1.7m					
			05-04-07 3		0.0	2.0							rega y propie pro pro provincio provi	
						-								:
SI	ketcł	n	<u> </u>	<u></u>	1	2.5			I					
neti ⟨ 3H 3 2	buildozer blade ripper excavator water				shoring 2 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4	n no resis anging refusal evel	to	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{sa} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	W we	ription unified	classifica		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very sose L loose	
						- on dat - water i water (nflow				uid limit			MD medium dense D dense VD very dense

TESTPIT 2

							chnics avation			Excava Sheet	ition No.	TP 3	30
Client:			-				YORS PTY LTD				arted:	5.4.2	0TSGTE20248 2007 2007
Principal: Project: Fest pit lo			ERSID ER TO				PROJECT APPLICATION, TEA GA	RDE	ens			: 5.4.1 CW	
equipment excavation excavati	type and dimensio	i model; ons:	4WD Bad	ickhoe	∋).4m wi	ide	Pit Orientation: Easting: Northing:	m m				. Surface:	1.159 AHD
nethod penetration	support water	notes samples, tests, etc	di RL me	lepth etres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.		moisture condition	consistency/ density index	100 × pocket 200 v pocket 300 v meter	addi	structure and tional observations
	2 s 05-04-07	D				SP	TOPSOIL: Sity Clayey SAND, fine to medium grained, dark grey-black mottled white, low plasticit fines, some rootlets 300mm and roots to 300mm. SAND: fine to coarse grained, pale grey-white. Becoming pale brown-grey. Becoming dark brown-red, with some cemented sa nodules. Pit collapsing. Test pit TP30 terminated at 1.7m	y	W	MD		at 0.3m, 8	ow of groundwater to g 05am, pit slowly from sides, organic
Xe BHb Bb Rp	natural exp existing ex packhoe b ulldozer b ipper excavator	cavation ucket	1 2 3 IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	oring tration 3 4 n r r r vater le	ı o resistaı anging to efusal	1	Uso undisturbed sample 50mm diameter soil Uss undisturbed sample 63mm diameter bas D disturbed sample syst V vane shear (kPa)	l descri ied on u tem isture dry moi: wet plas	iption unified (nbols ar		consiste VS S F St VSt H Fb VL L MD	ency/density index very soft soft firm stiff hard friable very loose loose medium dense

	U	T	T	ev	ø	<u> </u>	je	στε	chnics			Excava	tion N	lo.	TP31	
									avation		:	Sheet			of 1	
									YORS PTY LTD			Project			GEOTSGTE20248 5.4.2007	<u>3A/</u>
lient:				IAI	IER	SAL	LSU		TORSPITLID			Date st			5.4.2007	
rincip							-07	,				Date co	•	tea:		
rojeci									PROJECT APPLICATIO	N, TEA GAR			·		CW	
est pi						TO F		RE 1		Fastisa		Checke				
uipme cavat		•••			400D e 1.5m k	Backho ong i	e D.4m w	ide	Pit Orientation:	~	m m			k.∟. S latum	iurface: 0.732 n: AHD	
				rmation					ubstance							
penetration	perieuauon	support	ter	notes samples, tests, etc		depth	graphic log	classification symbol	material	haracteristics	moisture condition	consistency/ density index	a pocket d penetro-		structure and additional observations	
12		sup	water		RL I	metres	gra	syn	colour, secondary and minor	components.		<u>e</u> c	30 20 30 20			
		N			_0.5	0. <u>5</u>		SC	TOPSOIL: Silty Clayey SAND, fine grained, dark grey-black mottled w plasticity fines, with layer of mulch a 100mm. Clayey SAND: fine to medium grain pale brown, low plasticity fines.	nite, low to mediur and rootlets to	n <u>D</u> / M 	MD			OPSOIL (swampy area) orgai dour.	nic
				D	0.0				Becoming grey / brown.		w			v	ery slow inflow of groundwate	er.
			am 🖌	D		1. <u>0</u>		SP	SAND: fine to medium grained, dar	k brown-red,	_			8	apid inflow of groundwater.	
			05-04-07 8:29am		0.5	- - 1. <u>5</u>			indurated cemented sand nodules.					e en la constant de l		
			ł	D	1.0				Silty Gravelly SAND: fine to coarse grey-black, gravel fine to medium g							
						2.0			rounded-subrounded. Pit collapsing due to inflow of grour Test pit TP31 terminated at 1.8m							
					1.5											
						2.5							an i a fai a fai a fai			
															·	
H	nod natural exposure existing excavation backhoe bucket buildozer blade ripper excavator water water level water inflow water outflow					shoring 2 3 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1	n no resista anging to efusai evel evel e showr	ince)	notes, samples, tests Uso undisturbed sample 50mm c Uso undisturbed sample 63mm c D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	iameter soit di iameter based system D M W Wp		classifica			consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense	

TESTP

coffey	n aent	echnics		
coney	goor	Commos	Excavatio	on No. TP32
Engineerin	g Log - Ex	cavation	Sheet Project N	1 of 1 o: GEOTSGTE20248AA
Client: TA	TTERSALL SURV	EYORS PTY LTD	Date start	ted: 5.4.2007
Principal:			Date com	pleted: 5.4.2007
Project: RI	VERSIDE ESTATE	PROJECT APPLICATION, TE	A GARDENSLogged by	y: CW
Test pit location: RE	FER TO FIGURE	1	Checked	by:
equipment type and model:	4WD Backhoe	Pit Orientation: East	ing: m	R.L. Surface: 0,994
excavation dimensions: excavation information	1.5m long 0.4m wide	Norts	aing: m	datum: AHD
				, ό
potta under the sample sample tests, el	s, iic lo		istics, is point is in the second sec	수
H		TOPSOIL: Silty Clayey SAND, fine to mediu grained, dark grey-black mottled white, low fines, with some rootlets and roots (10mm)	plasticity	TOPSOIL (swampy area)
	_0.5 0.5	Clayey SAND: fine to coarse grained, pale brown, low plasticity fines maybe low perce fines approximately 30-40%.	grey-pale M D htage of	Some inflow of water.
8:47am	0.0 1.0	Becoming grey-brown, some presence of c sand nodules.	emented W	Moderate inflow of groundwater 8:47am.
05-04-07 8				
	0.5 1. <u>5</u>	Becoming grey mottled brown / orange and	presence	-
	1.0 2. <u>0</u>	of subrounded to rounded gravel (fine to me grained) less than 10mm size. Pit continually collapsed due to water table. Test pit TP32 terminated at 1.7m	dium	
	-1.5 2.5			-
Sketch				
method N natural exposure X existing excavation BH backhoe bucket B bulldozer blade R nipper E excavator	support S shoring N nil penetration 1 2 3 4 no resistance ranging to refusal water water levei on date shown water inflow water outflow	notes, samples, tests U _{so} undisturbed sample 50mm diameter U _{sa} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Ss bulk sample E environmental sample R refusal	classification symbols and soil description based on unified classification system moisture D dry M moist W wet Wp plastic limit W _L liquid limit	VSvery softSsoftFfirmStstiffVStvery stiffHhardFbfriableVLvery looseLlooseMDmedium denseDdenseVDvery dense

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CC)T		ey		Ć	jec	JIE	chnics		 E	Excava	tion N	0.	TP33
Eng	in	e	ering	յլ	.og	- E	Exc	avation			Sheet Project	No:	1	of 1 GEOTSGTE20248A
Client:			TAT	TER	RSAL	L SU	IRVE	YORS PTY LTD		۵	Date st	arted:		5.4.2007
Principal	l:									۵	Date co	mplet	ed:	5.4.2007
Project:			RIVI	ERS	IDE I	ESTA	ATE F	PROJECT APPLICATION, TEA G	ARDI	ENS	.ogged	by:		CW
Test pit I					TO F		RE 1			C	Checke	•		
equipment					Backho	е 0.4m w	ido	Pit Orientation: Easting: Northing:	m				:.L. Si atum:	urface: 0.923 : AHD
excavatior excavat				1.5m	iong .			ubstance	m				aun	
method 5 penetration	support	water	notes samples, tests, etc	RL	depth metres		classification symbol	material soil type: plasticity or particle characteristics colour, secondary and minor components.	s,	moisture condition	consistency/ density index	²⁰⁰ A pecket		structure and additional observations
드 123 표	N					1313		TOPSOIL: Silty Clayey SAND, fine to medium grained, dark grey-black mottled white, low plastic		D/M		- 36		OPSOIt. (swampy area)
				0.5	0. <u>5</u>		SC	fines, with some rootlets to 250mm. Clayey SAND: fine to coarse grained, pale grey-r brown.		М	D			
		7 8:56am	D	0.0	- - - 1.0_			Becoming grey / brown.	-	w				ery slow inflow of groundwater 56am, organic odour.
		05-04-07	D	0.5	- - 1.5									
				10	-									
			D		2.0		SP	SAND: fine to medium grained, dark brown-black some cemented nodules of sand.	ς, τ					
					-			Pit collapsing due to water table. Test pit TP33 terminated at 2m						
					-									
				1.5	2.5									
Skeich	Sketch													
Х ВН В		ng ex noe b ozer b		S pe 1	water I vater I on dat	n no resista ranging to refusal level e shown)	U _{so} undisturbed sample 50mm diameter sa U _{ss} undisturbed sample 63mm diameter b D disturbed sample 63mm diameter b V vane shear (kPa) sa Bs bulk sample m E environmental sample D R refusal M	A moi N wet Np plas	ription unified o	lassificat			consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

Form GEO 5.2 Issue 3 Rev.2

<image/> <image/>	Sheet 1 of 1												
Client: TATTERSALL SURVEYORS PTY LTD Principal: Project: RIVERSIDE ESTATE PROJECT APPLICATIO Test pit location: REFER TO FIGURE 1 equipment type and model: 4WD Backhoe Pit Orientation: excavation information material substance excavation information material substance tests, etc													
Principal: Project: RIVERSIDE ESTATE PROJECT APPLICATION Test pit location: REFER TO FIGURE 1 requipment type and model: 4WD Backhoe Pit Orientation: recavation dimensions: 1.5m long 0.4m wide excavation information material substance material substance material substance recavation information RL metres 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	Project No: GEOTSGTE2024 Date started: 5.4.2007												
Project: RUERSIDE ESTATE PROJECT APPLICATION Test pit location: REFER TO FIGURE 1 equipment type and model: 4WD Backhoe Pit Orientation: Torreaction information 0.4m wide excavation information 0.5m of the coarse grain gray-white, low plasticity fines. Pit slowly collapsing due to water the information 0.4m wide excavation information 0.	Date completed: 5.4.2007												
Test pit location: REFER TO FIGURE 1 quipment type and model: 4WD Backhoe Pit Orientation: xeavation dimensions: 1.5m long 0.4m wide excavation information material substance tests, etc 12.3 is tests, etc 12.3 is tests, etc 12.3 is tests, etc 12.5 is tests, etc 13.5 is tests,	·												
quipment type and model: 4WD Backhoe Pit Orientation: xxxxation dimensions: 1.5m long 0.4m wide excavation information material substance accavation information notes samples, tests, etc grained depth grained accavation information material substance accavation information material substance accavation information notes accavation information notes accavation information notes accavation information notes accos 0.5<	Checked by:												
Excavation information material substance and an analysis notes samples, tests, etc adeptitive of a strength of a st	Easting: m R.L. Surface: 0.893												
Open in otes samples, tests, etc notes samples, tests, etc open in tests, etc soil type: plasticity or particle colour, secondary and mino. 0 N N Image: tests, etc	Northing; m datum: AHD												
Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor N N Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State of the secondary and minor Image: State													
N TOPSOIL: Sity Clayey SAND, fine grained, dark grey-black mottled we plasticity fines. 0.5 0.5 0.5 SC Clayey SAND: fine to coarse grain grey-white, low plasticity fines. Becoming pale grey-pale brown. SP SAND: with some clayey lenses, figrained, low plasticity fines. 0.0 1.0 SC Clayey SAND: fine to coarse grain grained, low plasticity fines. 0.0 1.0 SC Clayey SAND: fine to coarse grain low to medium plasticity fines. 0.0 1.0 SC Clayey SAND: fine to coarse grain low to medium plasticity fines. Pit slowly collapsing due to water t -0.5 -0.5 1.5 -0.5 -0.5 -1.5 -0.5 -1.5 -0.5 -1.5 -0.5													
0.5 0.5 0.5 grey-white, low plasticity fines. 0.5 0.5 SAND: with some clayey lenses, figrained, low plasticity fines. 0.0 1.0 SC Clayey SAND: fine to coarse grain low to medium plasticity fines. 0.0 1.0 SC Clayey SAND: fine to coarse grain low to medium plasticity fines. 0.0 1.0 SC Clayey SAND: fine to coarse grain low to medium plasticity fines. 0.0 1.0 SC Clayey SAND: fine to coarse grain low to medium plasticity fines. 0.0 1.0 SC Clayey SAND: fine to coarse grain low to medium plasticity fines. 0.1.1 1.0 SC Clayey SAND: fine to coarse grain low to medium plasticity fines. 0.1.1 1.0 SC Clayey SAND: fine to medium graine red. 0.1.1 2.0 SM Silty SAND: fine to medium graine red. 1.1.0 2.0 SM Silty SAND: fine to groundwater. 1.1.1 1.1.5 1.1.5 1.1.5 1.1.1 1.1.5 1.1.5 1.1.5 1.1.1 1.1.5 1.1.5 1.1.5 1.1.1 1.1.5 1.1.5 1.1.5 1.1.5	to medium M TOPSOIL												
D SP SAND: with some clayey lenses, figrained, low plasticity fines. 0.0 1.0 SC Clayey SAND: fine to coarse grain low to medium plasticity fines. 0 0.0 1.0 SC Clayey SAND: fine to coarse grain low to medium plasticity fines. 0 0.0 1.5 Pit slowly collapsing due to water to reduce the state of the state	ed, pale												
0.0 0.0 0.0 0.0 1.0 SC Clayey SAND: fine to coarse grain low to medium plasticity fines. Pit slowly collapsing due to water t -0.5 1.5 -1.0 2.0 SM Silty SAND: fine to medium graine red. Pit collapsing due to groundwater. Test pit TP34 terminated at 2m	ne to medium M/W Very slow inflow of water, 9:13												
Pit slowly collapsing due to water t -0.5 1.5 -1.0 2.0 SM Silty SAND: fine to medium graine red. Pit collapsing due to water t Pit slowly collapsing due to water t Pit collapsing due to groundwater. Test pit TP34 terminated at 2m	ed, grey / brown, W MD												
-1.0 2.0 SM Silty SAND: fine to medium graine red. Pit collapsing due to groundwater. Test pit TP34 terminated at 2m	able.												
2.0 Silty SAND: fine to medium graine red. Pit collapsing due to groundwater. Test pit TP34 terminated at 2m	MD												
2.0 Silty SAND: fine to medium graine red. Pit collapsing due to groundwater. Test pit TP34 terminated at 2m													
L-1.5 2.5	d, dark brown /												
2.5													
ethod support notes, samples, tests natural exposure S shoring N nit U ₅₀ undisturbed sample 50mm existing excavation penetration U ₅₀ undisturbed sample 63mm H backhoe bucket penetration D disturbed sample buildozer blade 1 2 3 4 no resistance V vane shear (kPa) excavator moresistance refusal Bs bulk sample excavator water R refusal													

coffe	y 🐉	geote	chnics	6			Borehole No.	BH35
Enginee	ring Log	- Bor	ehole				Sheet Project No:	1 of 1 GEOTSGTE20248AA
Client:	TATTERSAL	L SURVE	YORS PTY L	TD		÷	Date started:	11.4.2007
Principal:							Date completed:	11.4.2007
Project:	RIVERSIDE	ESTATE F	PROJECT AF	PPLICATION	, TEA C	GARDEI	NS Logged by:	JJT
Borehole Location:	REFER TO F	GURE 1					Checked by:	1111
drill model and mountir	ng: MD20		Easting:		slope:	-90°	R.L. Su	~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~
hole diameter:	100 mm		Northing		bearing;		datum:	: AHD
drilling informatio	n	material su	Ibstance					
6							× + 6	

		diam					100 m	m			Northing	bearing:					datu	m: A	HÐ	
l	dri	lling	iņ	for	ma	lion			mat		ubstance									
	method	5 penetration	3	support	water	notes samples, tests, etc	RL	depth	graphic log	classification symbol	materi soil type: plasticity or par colour, secondary and ∂	ticle characteristic	CS, S.	moisture condition	consistency/ density index	100 × pocket 200 × pocket	a		cture and I observation	IS
	HF me		-	c†		SPT 2,2,3 N*=5 SPT 2,3,11 N*=14 SPT 6,4,12 N*=16	0 1 2 2 4 5			SP	colour, secondary and a SAND: fine to medium graine Borehole BH35 terminated at	minor components d, grey.	S.	¥ 8 W	S B	100	400			-
Form GEO 5.3 Issue 3 Rev.2	meth AS AD RR W CT HA DT B V T *bit s e.g.	nod	by s	aug rolle vas cab han diat blar V bi TC	er dr er/tric hbor le too d au ube ube ik bit t bit	e ol ger		ter 10/1/98	n no resista anging to efusai 3 water 1 3 water 1 a shown	ievel	notes, samples, tests U ₅₀ undisturbed sample 50 U ₆₃ undisturbed sample 60 D disturbed sample N standard penetration to N* SPT - sample recover Nc SPT with solid cone V vane shear (kPa) P pressuremeter Bs bulk sample E environmental sample R refusal	Omm diameter 3mm diameter est (SPT) ed		ription unified o				consistency/o VS F St VSt H Fb VL L MD D VD	density index very soft soft firm stiff very stiff hard friable very loose loose loose dense very dense	

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()(J		ey		Ļ	Jei	Ule	echnics		-	Boreho	le No.	BH	36
E	n	gi	ne	ering	зL	.og	- 	Bor	ehole			Sheet Project	No:	1 of GEC	1 DTSGTE20248AA
-	ent:								YORS PTY LTD			Date st			.2007
Pri	псір	al:									Ι	Date co	mpleted	1: 11.4	.2007
Pro	ojec	t:		RIV	ERS	IDE I	EST	ATE I	PROJECT APPLICATION, TE	A GARI	DENS	_oggeo	i by:	JJT	
Во	reho	ole L	ocati	on: REF	ER	TO F	GU	RE 1			(Checke	ed by:	Ťħ.	
				-	MD20				Easting: slope:	-90°			R.L	Surface:	2.361
_		mete g ini	r: forma		100 m	ım	mat	erial s	Northing bearin ubstance	g:			dati	ım:	AHD
	nenetration			notes samples, tests, etc			graphic log	classification symbol	material	· · · · ·	maisture condition	consistency/ density index	pocket penetro- meter		structure and ional observations
method	12		water		RL	depth metres	grap	clas sym	soil type: plasticity or particle characte colour, secondary and minor compon		mais conc	cons den:	kPa 9 8 8 9		
Η̈́Η					2	-	/	SC	Clayey SAND: fine to medium grained, blac low plasticity.	k, clay	м				
			.	SPT 4,4,5				SP	SAND: fine grained, white.		w	D			
				N*=9	-	<u>1</u> 	· · · ·	SP	SAND: fine to medium grained, black (coffe	e rock).					-
						-		SP	SAND: fine grained, white.						
						2									_
				SPT 2,9,11 N*=20	_0	-									
				N -20		_			Becoming grey.						
						3		•							
					-1							VĎ			
				SPT				•							
				6,13,24 N*≈37		4		1							
						<u> </u>		SP	SAND: fine to medium grained, black (coffe	e rock).					-
					2			-							
									Becoming softer.						
				SPT		5									
				6,9,23 N*=32	3	-									-
						_									
						6		,							_
					4	-	· · · · ·	-							
		SPT													
				N*=30	5	7	<u></u>		Borehole BH36 terminated at 7m	· · ·					
					_ `	-									-
met	nod				su	8 pport			notes, samples, tests	classific	ation syr	nbois an	d	consiste	ncy/density index
AS AD		;	auger c		M C	mud casing		i nìl	U _{so} undisturbed sample 50mm diameter U _{so} undisturbed sample 63mm diameter	soil des based o				VS S F	very soft soft
RR W Cĩ		,	roller/tri washbo cable to	re	per 1	netration	no resista	ance	D disturbed sample N standard penetration test (SPT) N* SPT - sample recovered	system moisture				F St VSt	firm stiff very stiff
HA DT		l	hand a diatube	uger	wa	iter	ranging to refusal	J	Nc SPT with solid cone V vane shear (kPa)	D di				H Fb	hard friable
B V		,	blank b V bit	it	T	10/1/90 on date	8 water e showr	level	P pressuremeter Bs bulk sample		astic limit				very loose loose
T *bit e.g.		n by s	TC bit uffix ADT		1 *	water i water o			E environmental sample R refusal	W _L lic	quid limit		-	MD D VD	medium dense dense very dense

BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

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_	ient:	-								YORS PTY LTD			Project Date st				<u>GEOT</u> 11.4.2	TSGTE202	248A/
	incip				141		(JAL						Date co			ed:	11.4.2		
	ojec				RIVE	ERS	IDE I	EST	ATE	PROJECT APPLICATION, TE	4 GARD						JJT		
	-		Loc	atio	n: REF					•			Checke				A M		
dri	ll mod	iei a	nd r	our	iting: I	MD20	I			Easting: slope:	-90°				R.	L. Su	rface:	Not Measure	d
	le dia rillin			mat		100 m	nm	mat	orial e	Northing bearing	g:				da	tum:		AHD	
F	-	č.			notes				1				ex x	et.	0				
method	1 2		support	water	samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle character colour, secondary and minor compon		moisture condition	consistency/ density index	100 pocket	Pa			tructure and onal observation	ons
뽀			C				_	/	sc	Clayey SAND: fine to medium grained, blac	k, clay	М							
									SP	SAND: fine to medium grained, white.			D						
			-	Y .	SPT 4,6,10 N*=16		_					w							
																			-
										Becoming dark brown, with some organic m	votorial								
										Becoming dark brown, with some organic in	alena),								
				F	SPT		2												-
					1,7,8 N*=15		-												
					3														
				3															-
													:						· ·
				SPT 6,18,R N*=R															
		*							SP	SAND: fine to medium grained, black (coffe	e rock).		VD			ĪN	DURATEL	SAND	
			ł																
		8		5						Becoming brown.									_
			ļ		SPT 5,7,R N*=R		_												
				}	N -N		1												
							6												_
		SPT -																	
			SPT 7 6,7,R N*=R 7				7												
Γ										Borehole BH37 terminated at 7m					T				
AS					support screwing* M mud N					notes, samples, tests U ₅₀ undisturbed sample 50mm diameter	classific soil desc	ription			_ []	1	VS	cy/density index very soft	1
AE RF W	२		roll	er dr er/tric hbor			casing netration 2 3 4	n		U ₆₃ undisturbed sample 63mm diameter D disturbed sample N standard penetration test (SPT)	based or system	unified	classifica	tion			S F St	soft firm stiff	
VV CT H/	ī		cab	nbor le toi d au	bl			no resista ranging te refusal	ince D	N standaro penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone	moisture D dr					1	VSt H	suir very stiff hard	
DT B			diai bla	ube 1k bit	-	wa	ater 10/1/9	8 water	level	V vane shear (kPa) P pressuremeter	M mi W we	oist et					Fb VL	friable very loose	
T	it shov	<i>n</i> Þ	V b TC	bit			on date - water i	e showr nflow	ı	Bs bulk sample E environmental sample R refusal		astic limit uid limit					L MD D	loose medium dei dense	nse
bi De.(ar D}	AD				water of										VD	very dense	

BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23,10.07

Enç lient: rincipa roject	gi al:						-										
lient: rincip: roject oreho	al:	in	ee						chnics			E	Boreho	le No.		BH38	
lient: rincip: roject oreho	al:			ring	I L	.og	- E	3or	rehole				Sheet Project	No:		1 of 1 GEOTSGT	E20248
roject oreho				-		-			YORS PTY LTD	· · · · · · · · ·			Date st			11.4.2007	
oreho												[Date co	mplet	ed:	11.4.2007	
	J.			RIV	ERS	IDE I	ESTA	ATE F	PROJECT APPL	ICATION, TE	A GARE	ENS	oggeo	by:		JJT	
ill mod	ne	Loc	atio	n: REF	ER	TO F	IGUI	RE 1				(Checke	ed by:		<u>MI</u>	
			nour	Ū	MD20				Easting:	slope:	-90°					Inface: 2.303	
le dian			rmat		100 m	Im	mate	erial s	Northing ubstance	bearing	g:			d	atum:	AHD	
benetration		support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	soil type: plasticity	naterial or particle character / and minor compon		moisture condition	consistency/ density index	100 pocket 200 pocket 300 penetro-		structure additional obs	
12	3	c	>		i nu	metres			TOPSOIL: Clayey SAN	•		м	00	288	. [PSOL	
				SPT 2,2,3 N*=5	_2	-		CL	Aclay low plasticity. Sandy CLAY: medium fine grained.	to high plasticity, gre	J y, sand	>Wp					
					- 1			CL	Sandy CLAY: low to me sand fine grained.	edium plasticity, dark	brown,						
			⊻														
				SPT		2						W					
				4,5,5 N*=10	Lo			sw	SAND: fine to medium	grained, grey.			Ď				
			ŀ			_											
						3											
					1	-	· · · ·										
			ŀ	SPT			· · · · ·		Becoming black.								
				12,18,23 N*=41		4											
					2	_											
			ŀ	SPT		5											
				4,8,11 N*=19	3												
						-	· · · ·										
						6							MD				
					4	-											
				SPT 4,8,8	1												
				4,5,5 N*=16		7			Perchala DU20 forming	lad at 7m							
					5	-			Borehole BH38 termina	icu al fill							
						8											
ethod		roller/tricone penet washbore 1 2 3 cable tool hand auger diatube water blank bit 10				pport mud casing 2 3 4 ater 10/1/9 on dat	n no resista anging to refusal 8 water e shown	level	U ₆₃ undisturbed sa D disturbed samp	ration test (SPT) ecovered cone a)	W we Wp pl	an unified of the second se	classifica			S soft F firm St stiff VSt very H hard Fb friat VL very L loos	soft stiff le loose e sium dense

BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23.10.07

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C)ر	J		e	y		5 C	jet	Jie	CHIICS		E	Excava	ition No.	TP39
E	nç	<u>ji</u>	ne	er	ing	j L	og	- E	Exc	avation			Sheet Project	No:	1 of 1 GEOTSGTE20248AA
Clie	ent:				ΤΑΤ	TER	SAL	L SL	IRVE	YORS PTY LTD		[Date st	arted:	1.6.2007
Prii	ncipa	al:												ompleted	
	oject:									PROJECT APPLICATION, TEA G	4RDI				RJP #//
	st pit			n: Id mod			TO F		RE 1	Pit Orientation: Easting:	m	(Checke	•	.Surface: 2.77
	avatio	-				2m lor		≠ 15m wi	de	Pit Orientation. Easting. Northing:	m			datu	
ex	_	-	n inf	orma	tion	1		mat		ubstance	T				
method	benetration		water	sar	otes nples, ts, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristics, colour, secondary and minor components.		moisture condition	consistency/ density index	100 × pocket 200 × penetro- 400 meter	structure and additional observations
ВН	12	<u> </u>	1					BIB		TOPSOIL: Sandy Silty CLAY, medium plasticity, dark grev, sand fine to medium grained.		М		-004	TOPSOIL Root affected.
					D	_2.5	- - 0. <u>5</u>		СН	CLAY: high plasticity, grey-brown and orange mottled, some sand.		>Wp	St	×	
					D	1.5	_ 1. <u>0</u> 		СН	CLAY: high plasticity, grey-grey-brown, some orange mottled with a trace of sand fine to mediur grained.	— — n			×	
		And a fatalistic prints for the second second			D		1. <u>5</u> –		SP	SAND: fine to medium grained, white / light grey-brown. Moderate groundwater inflow below 1.4m.		W			Pit collapsing below 1.4m, organic odour.
		A DAMAGNA DATA A DAMAGNA DATA A DAMAGNA DATA W				_1.0	_ 2. <u>0</u>			Test pit TP39 terminated at 1.7m					- - -
						0.5	2.5								
mer N BH B	thod	nal exi ba	sting e skhoe Idozer	excaval bucket	ion	S pe	netratior 2 3 4			U _{s0} undisturbed sample 50mm diameter so U _{s3} undisturbed sample 63mm diameter ba D disturbed sample sy V vane shear (kPa)	sil descr sed on stem	ription	nbols an classifica		consistency/density index VS very soft S soft F firm St suff
RE			natural exposure existing excavation backhoe bucket bulldozer blade ripper excavator water water water water					anging to efusat evel e shown	1	Bs bulk sample m E environmental sample D R refusal M W W W W	′ wet /p pla:	ist			VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

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CO		ey	Ŧ	ç	Jec	JIE	chnics			Excava	ition N	0.	TP40	
Engi	ne	ering	j L	.og	- E	Exc	avation			Sheet ² roject	No:	1	of 1 GEOTSGTE20248	AA
Client:		TAT	TEF	RSAL	LSL	IRVE	YORS PTY LTD			Date st			1.6.2007	
Principal:									ſ	Date co	omplet	ed:	1.6.2007	
Project:		RIV	ERS	IDE I	EST	ATE P	PROJECT APPLICATION, TE	A GARI	DENS	ogqeo	l by:		RJP	
Test pit loo	cation			TO F			,			Checke	-		1.HI	
equipment ty				Backho			Pit Orientation: Easti	ing: m			· · ·	L. Su	uface: 2.59	
excavation d	dimens	ions:	2m lo:	ng 0.4	45m wi	de	North	ning: m			da	atum:	AHD	
excavatio	on info	ormation	1		mat		ubstance					1		
method 5 5 penetration	support water	notes samples, tests, etc	RL	depth metres		classification symbol	material soil type: plasticity or particle character colour, secondary and minor compon		moisture condition	consistency/ density index	100 200 A pocket 300 b penetro-		structure and additional observations	
H	N		_2.5		<u>}</u> }		TOPSOIL: Silty Sandy CLAY, medium plast dark grey, sand fine to medium grained.	icity,	>Wp			ТС	DPSOIL Root affected.	-
		D		- - 0. <u>5</u>		СІ	Sandy CLAY: medium plasticity, grey-brow orange mottled, sand fine to medium graine			St	X			
			2.0	 1.0			Becoming grey-brown and sand content inc Sandy CLAY / Clayey SAND.	reasing to					·	-
		D	1.5	-		SP	SAND: fine to medium grained, grey-brown some clay.	with	w		×			-
	>	D	1.0	1. <u>5</u>		SP	SAND: fine to medium grained, light grey-br	own.					apid groundwater inflow below 4m. Organic odour.	'
			_0.5	2. <u>0</u>			Test pit TP40 terminated at 1.7m					a universita da sua carta de ante en ante en la contra de ante en la contra de		- -
				2.5								to the second statement of the		-
Sketch														
X ex BH ba B bu R rip	atural ex kisting e: ackhoe t Jildozer oper kcavator	kcavation bucket blade	S pe 1	iter water I on date	n no resista ranging to refusal evel e shown	•	notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₆₃ undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	soil dese based or system Moisture D dr M m W we Wp pl	n unified (e ry poist	dassifica		-	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense	

Form GEO 5.2 issue 3 Rev.2

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									avation		ę	Sheet		1 of 1
	-			-		-						Project		GEOTSGTE20248A
	ent:			ΤΑΤ	TEF	rsal	LSU	IRVE	YORS PTY LTD				tarted:	1.6.2007
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	oject: st pit l		tion			TO F			PROJECT APPLICATION, TEA	GARD			-	RJP Mu
	·					Backho			Pit Orientation: Easting:	m		Check	-	Surface: 3.63
	avatior				2m lor	ng 0.4	45m wi		Northing	j: m	-		datu	m: AHD
ex		tion	info	rmation			mat		ubstance			_ ×		
method	penetration	support	water	notes samples, tests, etc	RI	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteristic colour, secondary and minor components		moisture condition	consistency/ density index	6 A pocket 6 benetro- 8 meter	structure and additional observations
EH H	123	N	~			linettes		00	TOPSOIL: Sandy CLAY, medium plasticity,	.5.	м	00	40 300 300 10	TOPSOIL Root affected.
_					_3.5				grey-brown, sand fine to medium grained.					
						_		CI	Sandy CLAY: medium plasticity, light grey-brov and orange mottled, sand fine to medium grain		>Wp	St	-	
				D	-	0. <u>5</u>			and orange modica, some iste to modum grain	iou.			×	
					3.0	-			· · · · · · · · · · · · · · · · · · ·					
						-			Becoming light grey-light grey-brown and orang mottled.	ge			×	
						1.0			Sand content increasing light grey-brown and o					
				D	2.5				mottled.	sange				
						1.5								
				D	2.0			SP	SAND: fine to medium grained, light grey-brown some orange mottled, cemented.	n	м			
						-								
						2.0								
					_1.5	_								
			►-			_		SP	SAND: fine to medium grained, white-light		w			Slow groundwater inflow below
						25			grey-brown.					z.zm. Organic odour,
 	<u>ketch</u>			U	1	2.5			Test pit TP41 terminated at 2.5m	l				
D 2.5 SP SAND: tine to medium grained, while-light W Slow groundwater inflow below D 2.5 SP SAND: tine to medium grained, while-light W Slow groundwater inflow below														
met N BH R E		existi backi	ng ex hoe bi ozer b r		S : pei	ter water li	n o resista anging to efusal		U _{so} undisturbed sample 50mm diameter U _{es} undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal		ription unified of	classifica		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense

TESTPIT 20248AA L(

C	ノ)		сy	uși)	ر	500		chnics			Excava	ation No.	TP42
Ε	ng	in	e	ering	j L	.og	- E	Exc	avation			Sheet Projec	t No:	1 of 1 GEOTSGTE20248AA
Cli	ent:			ΤΑΤ	TEF	RSAL	LSU	IRVE	YORS PTY LTD				tarted:	1.6.2007
Pri	ncipal	:										Date c	omplete	d: 1.6.2007
Pro	oject:			RIVE	ERS	IDE I	ESTA	ATE I	PROJECT APPLICATION	, TEA GAF	RDENS	Logge	d by:	RJP
Tes	st pit I	oca	tion:	REF	ER	TO F	IGUI	RE 1				Check	ed by:	IIII
equ	ipment	t type	e and	I model:	4WD	Backho	e		Pit Orientation:	Easting:	m		R.L	. Surface: 2.82
	avatior cavat			ons: 2 rmation	2m lo	ng 0.4	45m wi mat		ubstance	Northing:	m		dati	um: AHD
									- 			iy/ lex	et o-	
method	penetration	support	water	notes samples tests, etc		depth	graphic log	classification symbol	material soil type: plasticity or particle c	aracteristics,	moisture condition	consistency/ density index	ady pocket benetro meter	structure and additional observations
вн ВН	123	ы N	Š		RL	metres	क 17117	රිගි	colour, secondary and minor TOPSOIL: Silty Sandy CLAY, low to	•	E S M	89	5 8 8 6	TOPSOIL Root affected.
۵						-			plasticity, sand fine to medium grain grey-brown.	ed, dark				
					_2.5	-	33	CI	Sandy CLAY: medium plasticity, gre		>Wp	St	-	
						0.5			orange mottled, sand fine to mediur	grained.			x	_
				D		-								
					2.0						_			
:						1.0		CI	Sandy CLAY: medium plasticity, gre some orange mottled, sand fine to r sand content increasing.	y-grey-brown iedium grained,				
				D	ļ	1. <u>0</u> _			·		_		×	-
						-		SP	SAND: fine to medium grained, whit).	W			Very slow water inflow below 1.1m.
					_1.5				Becoming grey-grey-brown, with a t	ace to some clay	ý.			
				D	1.5									-
									Test all TD40 terminated at 4 Zer					
					_1.0	-			Test pit TP42 terminated at 1.7m					
						2.0								-
						-								
					_0.5									
						2.5								
s	ketch	-1				1 2.0		-						,
me N	thod	natur	alex	osure	1	pport shoring	N	nil	notes, samples, tests U _{se} undisturbed sample 50mm di		fication sy escription	mbols ar	nd	consistency/density index VS very soft
X BH		existi backl	ing ex hoe b	cavation ucket	ре	netratio			U ₅₃ undisturbed sample 63mm di D disturbed sample		l on unified	classifica	ition	S soft F firm
B R		bullde rippe	ozer b r			234	to resista anging to	nce	V vane shear (kPa) Bs bulk sample	moist	ure			St stiff VSt very stiff
Е		exca	vator		wa wa	ater	efusal		E environmental sample R refusal	D M	dry moist			H hard Fb friable
					_	water le on date	evel e shown			W Wp W,	wet plastic limit liquid limit	t		VL very loose L loose MD medium dense
						- water i water c				v*.	aquin mint			D dense VD very dense

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CC	of	f	ev		Ç	geo	ote	chnics			=	ation No.	7040
								avation		ŝ	Sheet		TP43
Client:								YORS PTY LTD			Project	tarted:	GEOTSGTE20248A) 1.6.2007
Principal:			171	1 - 1								ompleted	
·	•		PI\/		י שחוי	FSTA		PROJECT APPLICATION				•	RJP
Project: Test pit lo		ion:			TO F			ROJECT AFFEICATION	, ILA GAN		Check	•	KSF KA
equipment					Backho			Pit Orientation:	Easting: r	n	SHECK		Surface: 4,75
excavation				2m lor		45m wi	de		-	n		datu	
excavati	ion	info	rmation	1		mat	1	ubstance		1	1		
method 5 7 penetration	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle ch colour, secondary and minor c	aracteristics, omponents.	moisture condition	consistency/ density index	100 A pocket 200 a penetro- 400 meter	structure and additional observations
Ξ.	123 i i i RL r N						SP	SAND: fine to medium grained, grey Becoming light grey-brown. SAND: fine to medium grained, grey orange mottled, trace to some clay. SAND: fine to medium grained, light some weakly cemented nodules, gre Test pit TP43 terminated at 1.85m	brown and				AEOLIAN Root affected to 0.15m.
X e BH b B b R n	existii backh	ng exc noe bu ozer b		S i		n o resista anging to efusal evel		notes, samples, tests U _{so} undisturbed sample 50mm dia U _{so} undisturbed sample 63mm dia D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	meter soll de meter based system moistu D M W Wp		dassifica		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense

	C					<u>-+-</u>	obnice					
COI		ey		Ĺ	jec	JIE	chnics		Ē	Excava	tion Ne	o. TP44
Engin	e	ering	j L	og	- E	Exc	avation			Sheet Project	No:	1 of 1 GEOTSGTE20248AA
Client:		ΤΑΤ	TEF	RSAL	L SI	IRVE	YORS PTY LTD			Date st		
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Project:		RIV	ERS	IDE I	ESTA	ATE F	PROJECT APPLICATION, TEA	I GARE	DENS	oggeo	l by:	RJP
Test pit locat	ion:	REF	ER	TO F	IGUI	RE 1			(Checke	ed by:	
equipment type				Backho			Pit Orientation: Eastin	5				RL, Surface; 4.46
excavation dim excavation			2m lor	1g 0.4	45m wi mat		ubstance	ing: m			da	atum: AHD
method 5 penetration support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle characteri colour, secondary and minor compone		moisture condition	consistency/ density index	100 × pocket 200 × pocket 300 v penetro-	
HB N						SP	SAND: fine to medium grained, dark grey-br		м		- 0.0.4	AEOLIAN Root affected to 0.3m.
		D	_4.0	0.5			Becoming light grey-brown.					
	None Observed			-		SP	SAND: fine to medium grained, dark brown, silt / Silty SAND.	some				
	Non	D	3.5	1. <u>0</u> –							anada da mumu da danat a sina di a da d	- -
		D	3.0	- 1. <u>5</u>			Becoming cleaner and less cemented, brow	n.			annora da Al Anan I an A Alan Anan a da Alan Anan a An	
			 				Test pit TP44 terminated at 1.8m					-
			_2.5	2. <u>0</u> –								
			_2.0	2.5								
Sketch												
	ng ex noe b ozer b r		s pe 1 wa	iter water	n no resista ranging to refusal level e showr inflow)	notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₆₃ undisturbed sample 63mm diameter D disturbed sample V vane shear (kPa) Bs bulk sample E environmental sample R refusal	soil des- based or system D dr M m W w Wp pl	n unified (dassifica		consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense

Form GEO 5.2 Issue 3 Rev.2

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Client	
Client:	

TATTERSALL SURVEYORS PTY LTD

Project No: Date started:

Borehole No.

Date completed:

Checked by:

Sheet

BH45 1 of 2

5.6.2007 5.6.2007

RJP

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GEOTSGTE20248AA

Principal: Project:

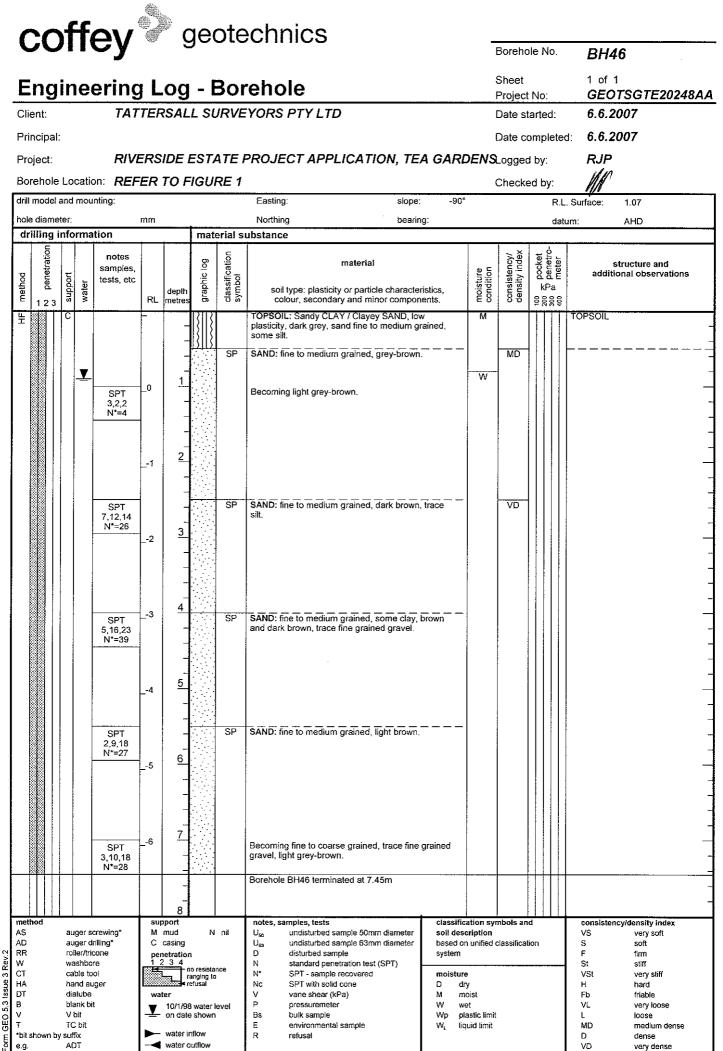
RIVERSIDE ESTATE PROJECT APPLICATION, TEA GARDENSLogged by:

Borehole Location: REFER TO FIGURE 1

drili	model	and	mou	nting:					Easting: slope:	-90°	3			R.i	L. Surface: 3,20
hole	e diame	eter:			mm		_		Northing bearin	g:				da	tum; AHD
dri	illing	info	orma	tion			mate	erial s	ubstance						
method	5 penetration	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle character colour, secondary and minor compon	istics, ents.	moisture condition	consistency/ density index	kF	300 b penetro- 400 meter	
堆		c			_3			SP	SAND: fine to medium grained, grey-brown		М	D		11	AEOLIAN SAND
				SPT 2,5,7 N*=12	_2	1			Becoming light grey-brown.						
	SPT 5.6,8 N*=14 		3			Becoming dark grey-brown.		W							
				3.15.21	1	4		SP	SAND: fine to coarse grained, dark brown, t gravel fine grained and silt.	race of		VD			
	隠し 3.15.21 - '		5			With a trace fine grained gravel.						20 blows for 100mm penetration.			
				SPT 8,18,21 N*=39	4	7_ - - - 8			Becoming fine to medium grained, light brow brown.	/n and					- 21 blows for 100mm penetration. - - - -
AS D RR W CT A T B V T	AD auger drilling* RR roller/tricone W washbore DT cable tool AA hand auger DT diatube B blank bit / V bit TC bit bit shown by suffix			M C per	boport mud casing netration 2 3 4 n 2 3 4 n ter 10/1/98	o resistar anging to efusal & water le & shown		notes, samples, tests U ₅₀ undisturbed sample 50mm diameter U ₅₀ undisturbed sample 63mm diameter D disturbed sample 63mm diameter D standard penetration test (SPT) N* SPT - sample recovered Nc SPT with solid cone V vane shear (kPa) P pressuremeter Bs bulk sample E environmental sample R refusal	soil des- based or system D dr M m W w Wp pl	n unified o	classificat		<u>.</u>	consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb friable VL very loose L loose MD medium dense D dense VD very dense	

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(][U			ЭУ	A	ç	JE	JIC	50111105		E	Boreho	le No).	BH45	
Е	n	ai	in	ee	erino	۶L	oa	- E	Bor	ehole			Sheet	NI			
_	ient:	-	_			-				YORS PTY LTD			Project Date st		:	GEOTSGTE20248 5.6.2007	SAA
Pri	incip	oal:										[Date co	mple	eted:	5.6.2007	
Pro	ojec	t:			RIVI	ERS	IDE I	ESTA	ATE I	PROJECT APPLICATION, T	EA GARDI	ENS	.ogged	by:		RJP	
Во	oreho	ole	Loc	catio	n: REF	ER	TO F	IGUI	RE 1			(Checke	d by	;	M	
	í moc e dia			mour	nting:	mm				Easting: slo Northing bea	e: -90° ring:					Surface: 3.20	
<u> </u>	rillin	g i		rma	tion			mate		ubstance					datum		
method	1 Depetration		support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material soil type: plasticity or particle charac colour, secondary and minor comp	teristics, onents.	moisture condition	consistency/ density index	100 A pocket	a	structure and additional observations	
Ŧ		Ť	С			5			SP	SAND: fine to coarse grained, dark brow gravel fine grained and silt. (continued)	1, trace of	w	Ď				
					SPT	-	-										
					5,13,17 N*=30		9										
						6											_
							-					-					
							10										
				-	SPT 1,6,15	-7	-										-
					N*=21					Borehole BH45 terminated at 10.45m							
							11										
						8											
				3m]▲			-										
				to 7			12										
		1		d back		9											-
				Collapsed back													
				8			13										
						10											
							-										
							14										-
						11	_										
							1 <u>5</u>										_
						12											
AS AD RR W CT HA DT B V T		hod support nd auger screwing* M mud N nil U, auger dilling* C casing U, roller/tricone penetration D washbore 1 2 3 4 no resistance cable tool nand auger refusal diatube water V blank bit V 10/1/98 water level V bit T c bit E							nce evel	P pressuremeter Bs bulk sample	moisture D dry M mois W wet Wp plas	iption unified o				consistency/density index VS very soft S soft F firm St stiff VSt very stiff H hard Fb finable VL very loose L loose MD medium dense D dense VD very dense	

BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23.10.07



BOREHOLE 20248AA LOGS.GPJ COFFEY.GDT 23,10,07

CL	IEN'	Т	С	righton	Proper	ties Pty	Ltd		COMMENCED	25.09.12		COMPLET	ED	25.09.12			REF	E	3H201	1
PR	OJE	СТ	H	ydroged	ological	Investig	jatio	n	LOGGED	NF		CHECKED	(GT/DM			Sheet '	_	-	•
SI			M	RD, Tea	1	ens, NSV	1		GEOLOGY	Marine Sands		VEGETAT		Sedges and	Grasses	3	PROJECT	r no . Po	902346	
				SIONS	Hydraulic A	Auger X 5.5m depth			EASTING NORTHING	NA		RL SURFA	CE ·				SLOPE	<5%		
				ION DA	1			MA				AGPEOT			SA	MPLIN	IG & TE			
						g	NO					×	X							
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L M PENETRATION H R R R	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, n particle characteristics, orga	PTION OF STF nottling, colour, pl anics, secondary ontamination, odo	asticity, rocks, oxi and minor compo	dation, nents,	CONSISTENCY	DENSITY INDEX	түре	DEPTH (M)		0.69m agl		DETAILS	Cover
v	Nil	N	м			× × ×	OL	ORGANIC SILT - Da		,		VS- S		D	0.0	2346/20	7		Concret	te, –
v	Nil	N	м	- - - - 1.0		 	CL	SANDY CLAY - Me grey, with some fine minor organic r Sand content	dium plastici to medium g matter prese	ty, grey brown grained sand nt (rootlets). with depth,	n to	St VSt St		D	0.3 0.6 0.8	2346/20 2346/20 2346/20	1/ 0.6	•	Bentonite	gl – Pipe
v	Nil	N	м	-			SP	Sand conte	ent increasing	1 >0.9m.	/			— —	1.1	2346/20 Hydrogen		NEE -	i <u>i i unibg</u> i	
-	<u> </u>	_	\vdash	1.3				SAND - Medium grai			^			- + -	1.4	odour pr 2346/20	esent.		<u> </u>	
v	Nil	N	M				SC	SANDY CLAY - Low dark brown, with s	ome medium SAND - Med	grained san	d	F- St					<u>4.0m</u> bg <u>l</u>		Sand	Screen - - - - - - - - - - - - - - - - - -
				5.5 6.0				Borehole terminated a	at 5.5m in org	anic clayey s	and.							1014		6.0
				rte Martens & Ass			ON LO		MARTENS & 6/37 Hornsby, none: (02) 9476	ACCOMPAN ASSOCIATES Leighton Place NSW 2077 Au 9999 Fax: (02 WEB: http://ww	PTY LTD stralia 9 9476 876	67	S AN			ine	erin oreh	-	og -	

CLII	ENT	Г	-	-	-	erties Pty			COMMENCED	25.09.12	COMPLETED	25.09.12			REF	Bł	1202
PRO		СТ	-			cal Investi	-	on	LOGGED	NF	CHECKED	GT/DM			Sheet 1		
SITI			M	IRD, 1		dens, NS	N		GEOLOGY EASTING	Marine Sands			nd Ferns	3	PROJECT	NO. P0902	2346
				SIONS		nØ X 7.0m dept	h		EASTING	NA	RL SURFACE	-			SLOPE	<5%	
								MA	TERIAL D			-	S	AMPLIN			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, orga		asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX TYPE	м				TAILS Well Cover
V	Nil	N	D	0.1			SP	LOAMY SAND -	Medium grai	ned, dark grey,		P_	0.0	2346/202	0.0	┥┟	$\overline{2}$ — —
v	Nil	N	D M	- - - - - - - - - - 0.85			SP	SAND - Medium grair	ned, pale grey ic matter pres	to grey, with some		L D					Concrete Back fill
v	Nil	N	м	1.0 - - - 1.8			()	SAND - Medium gra	iined, pale gr hell fragment			D		Hard panat coffee r	ration/ ock.		Bentonite Seal
v	Nil	N	м	<u>2.0</u> - 2.3			SP	SAND - Mediur dark orange brov roots an		d occasional							Sand Pack.
V NII N M Z Sc SAND - Medium									ned, pale brc	wn to grey brown, s present.		D	3.5	2346/202	(3.5		2.4m bgl UPVC Screen
				-				Borehole term	inated at 7.0	m in sand.							J
EQ				- - - - - - - - - - - - - - - - - - -	SUPPORT			MOISTURE PENE		SISTENCY DENSITY Very Soft VI Very Loc		NG & TESTIN	VG		netrometer	CLA	SSIFICATION
X BH HA PT A TC	Ex Bac Ex Hai Pus Au	kisting ckhoe cavat nd au sh tub iger igsten	e buck or ger e	vation	SH Shori SC Shoto RB Rock Nil No su	crete X No Bolts ⊻ Wa upport ← Wa ← Wa	t measu ater leve ater out ater infle	rred M Moist M MM. ⊧ W Wet H Hir Wp Plastic limit R Re Tow WI Liquid limit ww	oderate S gh F efusal St VSt H F	Very Soft VL Very Loc Soft L Loose Firm MD Medium I Stiff D Dense Very Stiff VD Very Den Hard Friable	B Buīk Dense U Und D Dist ise M Mois Ux Tube E Envir	er sample sample sturbed sample urbed sample ture content sample (x mi onmental sam	nle V D m) F nple V	 p Pocket pe S Standard /S Vane she DCP Dynami penetroi FD Field dens WS Water sat 	penetration te ar c cone meter sity		BOLS AND DESCRIPTIO USCS Agricultural
						EXCAVAT	ION L	OG TO BE READ IN CONJU			PORT NOTES	AND ABBR	EVIAT	IONS			
(r				ens	Pty. Ltd . 2012			6/37 Hornsby, 10ne: (02) 9476	ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 870 WEB: <u>http://www.marten</u>		E	Eng	gine Bo	ering reho	-	og -

СІ	IEN	т	С	righton	Proper	ties Pty	Ltd		COMMENCED	25.09.12	COMPLETE	D 25	.09.12			REF	E	3H203	
	ROJE	СТ	-		-	l Investiç		n	LOGGED	NF	CHECKED	-	T/DM			Sheet			
SI		NT	M	RD, Tea	Hydraulic	ens, NSW			GEOLOGY EASTING	Marine Sands	VEGETATION RL SURFAC	-	asses and	Ferns		PROJECT	NO . PO	902346	
				ISIONS	-	X 7.0m depth			NORTHING	NA	ASPECT	-				SLOPE	<5%	/6	
	EX	CA	VAT	ION DA	ГА			MA	L ATERIAL D	ATA				SA	MPLIN	IG & TE	STING	i	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	L M FENETRATION R R R R R	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STR nottling, colour, pl anics, secondary ontamination, odo	asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	түре	DEPTH (M)		WATEF		DETAILS	er
v	Nil	N	D	0.2			SP	LOAMY SAND - Medi				VL- L	D	0.0	2346/20	3/ 0.0		Concrete	-
v	Nil	N	м				sc	CLAYEY SAND - M grading to low pla	1edium grain	ed, dark brown,		L- MD	D	0.3	2346/20	 3/ 0.3	•	Bentonite Sea	
v	Nil	N	м	0.9		 	CL	SANDY CLAY -			+ +		Ď	1.0	2346/20	3/ 1.0		0.9m bgl	1.0
 	Nil	Y	w	<u>1.2</u> <u>-</u> <u>1.7</u> <u>-</u> <u>2.0</u> <u>-</u> <u>2.25</u> <u>-</u> <u>-</u> <u>3.0</u> <u>-</u> <u>-</u> <u>-</u> <u>-</u> <u>-</u>			SP	grey brown to da fine to mediuu SAND - Medium orange brown an shell fragm	m grained sa grained, dark	nd present / grey, mottled /n, with some			D	1.3	2346/20			Sand Pac	- - - 2 <u>.0</u> - - - - - - - - - - -
v	Nil	Y	w	- 4.0 			SP	SAND - Medium with some sł	grained, gre	y to dark grey, s present.						<u>4.5m bgl</u>		Well end plug.	4.0 5.0 6.0 7.0
				-		<u>anter de la constante de la cons</u>		Borehole term	inated at 7.0	m in sand.							1.361.47	<u>a d</u>	- 7.0
	K E BH Ba E Ex	atural xisting ackhoe kcavat	expos g exca e buck tor	ure SH vation SC et RE	JPPORT Shoring Shotcrete Rock Bo No suppo	lts <u>▼</u> Wat ort <u></u>	e obse measu er leve	MOISTURE PENE rved D Dry L Lo red M Moist M Mi i W Wet H Hi Wp Plastic limit R Re	TRATION CON w VS oderate S ph F fusal St	SISTENCY DENSITY Very Soft VL Very Loc Soft L Loose Firm MD Medium I Stiff D Dense	ose A A B B Dense U U D D	uger sar ulk samp ndisturb isturbed	ple led sample I sample	pp S VS	Standard S Vane sh CP Dynan	nic cone	test S	CLASSIFICATION YMBOLS AND IOIL DESCRIPTI YUSCS	
j	PT PU A Ai	and au Ish tub Jger	e			- ← Wat → Wat			н	Very Stiff VD Very Den Hard Friable	lse Μ.Μ. Ux.Τι	oisture o ube sam	content nple (x mm) ental sampl	FD	penetro Field der S Water si	ometer nsity		N Agricultural	
	FC Tu ∕ V-I	ngster	n Carb	ide Bit		-													
				rte	ns				MARTENS & 6/37 Hornsby, none: (02) 9476	ACCOMPANYING REF ASSOCIATES PTY LTD Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 870 WEB: http://www.marten	67	3 AND			jine	erin oreh	-	.og -	

СГ	IEN	Г	С	righton	Proper	ties Pty	Ltd		COMMENCED	25.09.12	COMPLET	ED 2	25.09.12			REF	BH204
PF	OJE	СТ	H	/drogec	logical	Investig	gatio	on	LOGGED	NF	CHECKED	(GT/DM			Sheet 1 o	
Sľ	ГЕ		М	RD, Tea	a Garde	ns, NSV	/		GEOLOGY	Marine Sands	VEGETATI	ON	Grasses and	l Ferns		PROJECT NO	P0902346
	JIPMEI				Hydraulic A				EASTING	NA	RL SURFA	CE	-				
EXC						(1.0m depth					ASPECT	-				SLOPE	<5%
_	EX			ON DA			z	IVI <i>F</i>	TERIAL DA					54		G & TEST	ING
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	M M H R E SISTANCE	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STR nottling, colour, pl anics, secondary a ntamination, odor	asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	A		TS AND DBSERVATIONS
v	Nil	N	М	- - - 0.3			SP	ORGANIC LOAM dark brown, black and		organic matter			D	0.1	2346/204	4/0.1	- - -
v	Nil	N	M	- - 0.5			SP	LOAMY SAND - N with mi	Medium grain nor fines pre		+		D	0.4	2346/204	¥/0.4	
v	Nil	N Y	W	 0.65 0.8			SP	ORGANIC LOAM dark brown to blac					D	0.6	2346/204	4/ 0.6	- - - -
v	Nil	N	м	- - 1.0			sc	CLAYEY SAND - M with minor sh	ledium grain Iell fragments	ed, pale brown, present.			D	0.9	2346/204	4/0.9	- - 1.0
				- - - - - - - - - - - - - - - - - - -				Borehole terminal									- - - - - - - - - - - - - - - - - - -
N E E F F	H Ba Ex A Ha T Pu	atural e xisting ckhoe cavato nd aug sh tub iger igsten	exposi excav bucke or ger e	ıre SH ration SC et RE Nil	IPPORT Shoring Shotcrete Rock Bol No suppo	ts ⊻ Wat ort ⊰ Wat → Wat	e obse measu er leve er outf er inflo	erved D Dry L Lo red M Moist M M Wet H Hit Wp Plastic limit R Re Now WI Liquid limit	w VS oderate S gh F ifusal St VSt H F	SISTENCY DENSITY Very Soft VL Very Lo Soft L Loose Firm MD Medium Stiff D Dense Very Stiff VD Very De Hard Friable	oose A A B B Dense U U D D nse M M Ux T E Er	uger s ulk sar Indistu isturbe loisturb ube sa nvironr	rbed sample ed sample e content ample (x mm mental samp	pi S D D D F D le V	Standard S Vane she CP Dynam penetro D Field der /S Water sa	nic cone ometer hisity	CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION Y USCS N Agricultural
Ļ					E	XCAVATI	ON LO	OG TO BE READ IN CONJU				S AN	ID ABBRE	VIATI	ONS		
		n	à	rte	ns	H 2012			6/37 Hornsby, 10ne: (02) 9476	ASSOCIATES PTY LTE Leighton Place NSW 2077 Australia 9999 Fax: (02) 9476 8 WEB: http://www.marte	767		E	ng	-	ering orehol	Log - le

CL	IEN	Г	С	righton	Prop	per	ties Pty	Ltd		COMMENCED	25.09.12		COMPLETE	D	25.09.12			REF	BH205	;
PR	OJE	СТ	H	ydrogeo	ologi	ical	Investig	gatio	on	LOGGED	NF		CHECKED		GT/DM			Sheet 1		
SI			M	RD, Tea	-		ns, NSV	V		GEOLOGY	Marine Sands		VEGETATI	-	Grasses and	l Ferns		PROJECT NO) . P0902346	
_	JIPMEI CAVAT		DIMEN	SIONS	Hydra 100m		Auger (1.0m depth			EASTING NORTHING	NA		RL SURFA	CE	-			SLOPE	<5%	
	EX	CA	/AT	ION DA	ГΑ				MA	ATERIAL DA	ТА					SA	MPLIN	G & TEST	ING	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)			GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STR mottling, colour, pla panics, secondary a ontamination, odou	asticity, rocks, oxidatio and minor components	ın, ۶,	CONSISTENCY	DENSITY INDEX	ТҮРЕ	DEPTH (M)	A		LTS AND OBSERVATIONS	6
v	Nil	Ν	м	- - 0.2				SP	ORGANIC LOAM dark grey, with so						D	0.0	2346/205	5/ 0.0		-
v	Nil	N	м	- - 0.5 - 0.6				SP	SAND - Mec	dium grained,	pale grey.				D	0.3	2346/205	5/ 0.3		- - - 0.5
v	Nil	N Y Y	M W W	- 0.7 - -				SP	SAND - Medium gr orange brown wi shell fragme		some minor)			D	0.7	2346/205	5/0.7		- - - - -
\vdash				1.0					Borehole term				-				1.0			
				- - - - - - - - - - - - - - - - - - -																- - - - - - - - - - - - - - - - - - -
N E E F A T	E: EH Ba E Ex A Ha T Pu	atural e kisting ckhoe cavate nd au sh tub iger igsten	exposi excar buck or ger e	ure S⊦ ∕ation SC et RE Nil	JPPOR Shot Rocl No s	ring tcrete k Bol	ts 👽 Wat	e obse measu ter leve ter out	erved D Dry L Lo Ired M Moist M M el W Wet H Hi Wp Plastic limit R Re flow WI Liquid limit	ow VS loderate S igh F efusal St VSt H	Soft L Lo Firm MD Me Stiff D De	IY ery Loose oose edium De ense ery Dense	e A A B B onse U U D D M M Ux Tr	uger s ulk sa ndistu isturb oistur ube s	& TESTIN sample mple urbed sample ed sample e content ample (x mm mental samp	p S V D	p Pocket p Standard S Vane sh CP Dynam penetro D Field der /S Water sa	ic cone meter isity	CLASSIFICATI SYMBOLS ANE SOIL DESCRIP Y USCS N Agricultur) TION
						E	XCAVATI	ON L	OG TO BE READ IN CONJU				RT NOTE	S AN	ID ABBRE	VIATI	ONS			
(rte			H 2012			6/37 Hornsby, hone: (02) 9476	ASSOCIATES PTY Leighton Place NSW 2077 Australi 9999 Fax: (02) 94 WEB: http://www.m	ia 76 8767			E	ng	-	ering reho	l Log - le	

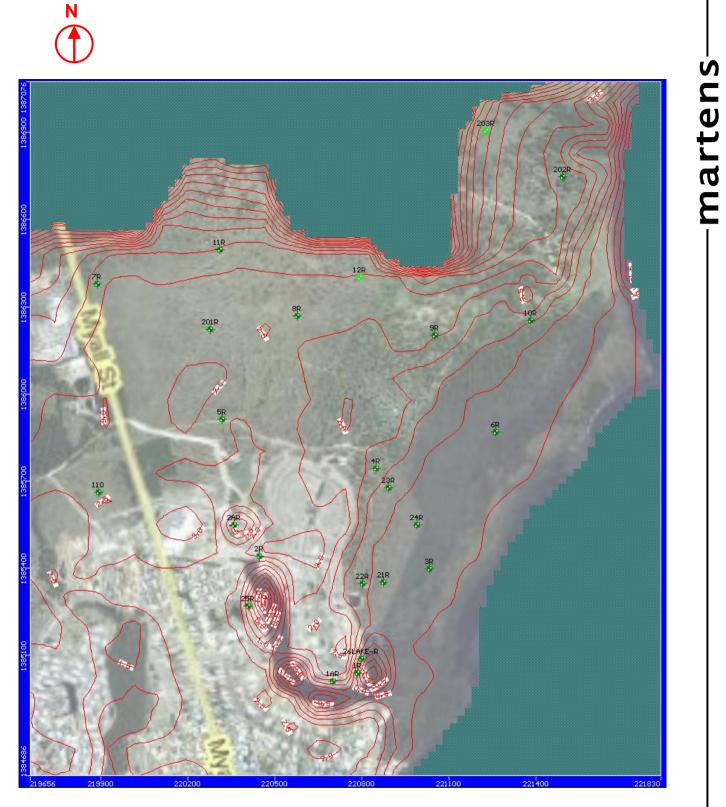
CLIENT		С	righton	Prope	rties Pty	Ltd		COMMENCED	COMPLET	ED	25.09.1	2			REF	BH20)6			
PROJECT			Н	ydroge	ologica	l Investig	gatio	on	LOGGED	CHECKED						Sheet 1				
			N	IRD, Te		ens, NSV	/		GEOLOGY	Marine Sands	VEGETATI	•	Grasses PROJECT NO. P0902346							
				ISIONS	Hydraulic	Auger X 1.0m depth			EASTING NORTHING	NA	RL SURFA	CE	-			SLOPE	<5%			
F	EXCAVATION DATA							MA			ASPECT				SA		G & TEST	1		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	M PENETRATION	GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STR nottling, colour, pl anics, secondary ontamination, odo	asticity, rocks, oxidation, and minor components,	CONSISTENCY	DENSITY INDEX		түре	DEPTH (M)		RESULTS AND ADDITIONAL OBSERVATIONS			
v	Nil	N	м				SP	ORGANIC LOAM dark brown, with so	IY SAND - Mo me fines and	edium grained, organic present.				D	0.1	2346/206	5/ 0.1		- - -	
v	Nil	N	м	0.5			SP	ORGANIC LOAMY SAI to black,	ND - Medium with some or					D	0.3	2346/206	¥0.3			
v	Nil	N Y	M W	0.7 - 0.8			SP	SAND - Med with	ium grained, minor organio					D	0.7	2346/206			-	
v	Nil	Y	w	- - 1.0			SP	LOAMY SAND parci	- Medium gra ally cemented							Hard pana coffee			- - 1.0	
	EQUI			- - - - - - - - - - - - - - - - - - -	UPPORT	WATER		Borehole term		n in sand.	SAM		3 & TES					CLASSIFICA	- - - - - - - - - - - - - - - - - - -	
	N N BH E E E HA F PT P A <i>F</i> TC Ti	latural Existing ackhoi xcava and au ush tub uger ungster	expos g exca e buck tor uger be	ure SI vation So et Ri	UPPORT H Shoring C Shotcre B Rock Bo il No supp	N Non te X Not olts ∏ Wat	e obsi measi er levi er out	erved D Dry L Lo Ired M Moist M M el W Wet H Hi Wp Plastic limit R Re flow WI Liquid limit	ow VS oderate S gh F efusal St VSt H	SISTENCY DENSITY Very Soft L Loose Firm MD Medium [Stiff D Dense Very Stiff VD Very Dens Hard Friable	se A A B B Dense U U D D se M M Ux T	uger : ulk sa Indistu isturb loisturb ube s	3 & TES sample urbed sample ved sample ample (x umental s	imple ple nt (mm)	S VS DC FC	Pocket pe Standard Vane she CP Dynam penetro Field der S Water sa	ic cone meter isity	SYMBOLS A	AND RIPTION	
	V V-Bit EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS MARTENS & ASSOCIATES PTY LTD 6/37 Leighton Place Hornsby, NSW 2077 Australia Phone: (02) 9476 8767 mail@martens.com.au WEB: http://www.martens.com.au																			

CLIENT		С	righton	Prope	rties Pty	Ltd		COMMENCED 25.09.12 COMPLETED				25.09.12		BH207				
PROJECT			-	-	-	al Investig	-	on				CHECKED		GT/DM			Sheet 1 o	
SI		MT	M	RD, Tea	Hydraulic	ens, NSV	V		GEOLOGY	Marine Sand	s	VEGETAT		Grasses			PROJECT NO.	P0902346
			DIMEN	SIONS	-	X 0.7m depth			NORTHING	NA		ASPECT	ACE	-			SLOPE	<5%
	EXCAVATION DATA							MA	ATERIAL D	ATA					S		G & TESTI	NG
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)		GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STF nottling, colour, p anics, secondary ontamination, odo	lasticity, rocks, and minor com	oxidation, ponents,	CONSISTENCY			TYPE DEPTH (M)		DDITIONAL C	TS AND DBSERVATIONS
v	Nil	N	D				SP	ORGANIC LOAM dark grey, with sc							D 0.0	2346/20		- - -
v	Nil	N N Y	D	- - - 0.5 - 0.6 - 0.7			SP	SAND - Med	lium grained,	pale grey.					D 0.3	3 2346/20	7/0.3	- - - 0 <u>.5</u> - - -
	K E BH Ba E Ex HA Ha PT Pu A Au FC Tur	atural e xisting ickhoe cavate ind au sh tub iger igsten	exposi excav bucke or ger e		PPORT I Shoring Shotre B Rock B No sup	te X Not olts ∏ Wat	e obse measu ter leve ter out	erved D Dry L Lo rred M Moist M M el W Wet H Hi Wp Plastic limit R Re Now WI Liquid limit	TRATION CON w VS oderate S ph F fusal St VSt	ISISTENCY Very Soft Soft Firm Stiff	DENSITY VL VeryLoo L Loose MD Medium I D Dense VD VeryDens	ose A B I Dense U D I se M M Ux	Auger Bulk sa Undist Disturt Noistu Tube s	G & TEST sample urbed sam ped sample ample (x i mental sa	nple le t mm)	pp Pocket p S Standard VS Vane sh DCP Dynan penetir FD Field dei WS Water si	l penetration test ear nic cone ometer nsity	
Ľ	/ V-6	Bit				EXCAVATI	ON L	OG TO BE READ IN CONJU			NYING REP		ES AI	ND ABB	REVIA	TIONS		
(EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS MARTENS & ASSOCIATES PTY LTD 6/37 Leighton Place Hornsby, NSW 2077 Australia Phone: (02) 9476 8767 mail@martens.com.au WEB: http://www.martens.com.au																	

CLIENT PROJECT		С	righton	Prope	rties Pty	Ltd		COMMENCED 25.09.12 COMPLETED					25.09.12 REF BH2					
		H	ydroged	ologica	I Investig	gatio	on	LOGGED	CHECKEE)	GT/DM			Sheet 1 of				
Sľ	ΓЕ		м	RD, Tea	a Garde	ens, NSV	v		GEOLOGY	Marine Sands	VEGETAT	ION	Grasses			PROJECT NO.	P0902346	
	JIPME				Hydraulic				EASTING	NA	RL SURFA	ACE	-					
EX				SIONS		X 1.0m depth			NORTHING	NA	ASPECT		-				<5%	
⊢	EX						7	M <i>A</i>	ATERIAL D					S		IG & TESTIN	NG	
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)		GRAPHIC LOG	CLASSIFICATION	Soil type, texture, structure, r particle characteristics, org	PTION OF STR mottling, colour, pl anics, secondary ontamination, odo	asticity, rocks, oxidation and minor components,	CONSISTENCY			DEPTH (M)			'S AND BSERVATIONS	
v	Nil	N	D	_ _ 			SP	ORGANIC LOAM dark grey, with sc						D 0.1				
v	Nil	N N Y	M W	- - - 0.5 - - 0.7 - -			SP	SAND - Med	lium grained,	pale grey.				٥. ס	4 2346/20	3/ 0.4	- - - - - - - - - - - - - - - - - - -	
⊢	-			1.0		<u>- 2000 (200</u>	1							-			1.0	
				-				Borehole term	inated at 1.0	m in sand.							-	
) E E	K E BH Ba E Ex HA Ha	MENT Atural et xisting cckhoe ccavate and au	expos exca buck or ger	ure SH vation SC et RE	IPPORT 4 Shoring 2 Shotcrei 3 Rock Bc No supp	te X Not olts ∏ Wat	e obse measu ter leve	erved D Dry L Lo nred M Moist M M el W Wet H Hin Wp Plastic limit R Re	ow VS oderate S gh F efusal St VSt	Soft L Loc	ry Loose A // ose B I dium Dense U nse D I y Dense M I	Auger Bulk sa Undist Disturt Moistu	3 & TEST sample imple urbed samp re content ample (x)	nple e	pp Pocket p S Standard VS Vane sh DCP Dynan Ppenetrr FD Field de	l penetration test ear nic cone ometer		
	Au CTur / V-I	uger ngsten Bit	Carbi	de Bit		→ Wat	er inflo	w	F	Friable	E E	nviron	imental sa	mple	WS Water s			
F						EXCAVATI	ON L	OG TO BE READ IN CONJU				ES AI	ND ABB	REVIA	TIONS			
	MARTENS & ASSOCIATES PTY LTD 6/37 Leighton Place Hornsby, NSW 2077 Australia Phone: (02) 9476 9999 Fax: (02) 9476 8767 mail@martens.com.au WEB: http://www.martens.com.au Borehole																	

18 Attachment 4A – Groundwater Assessment Figures

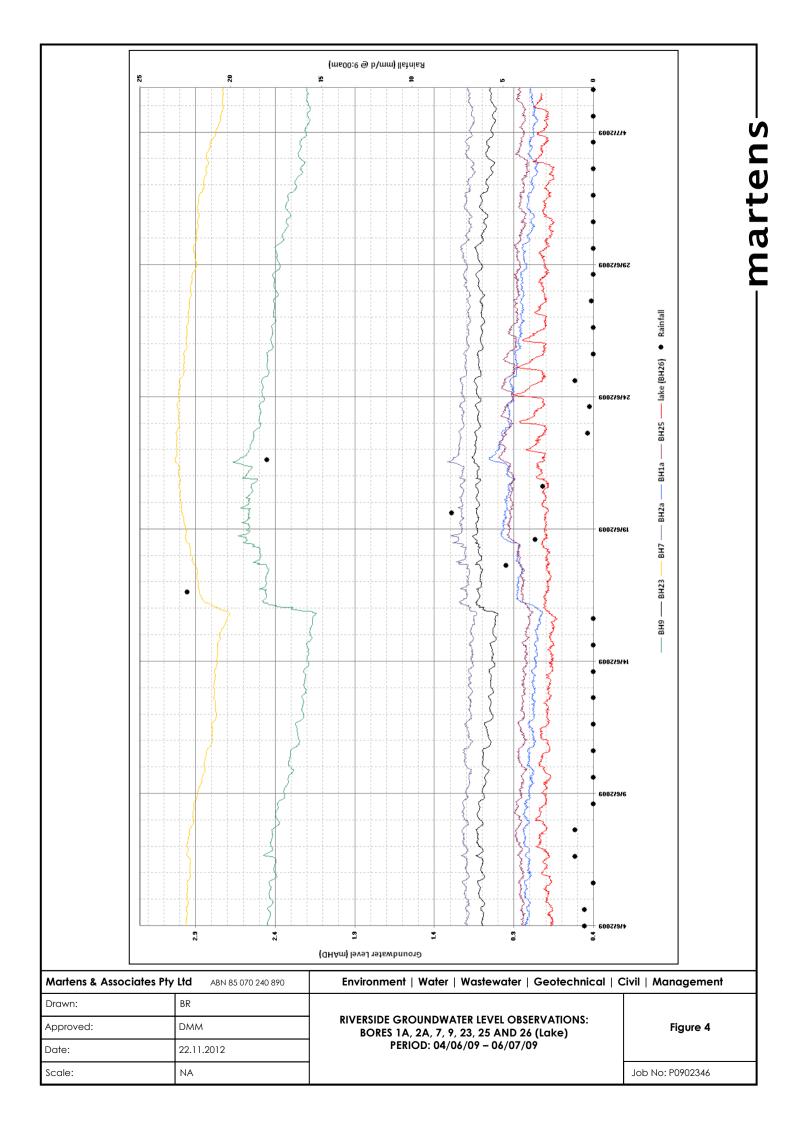


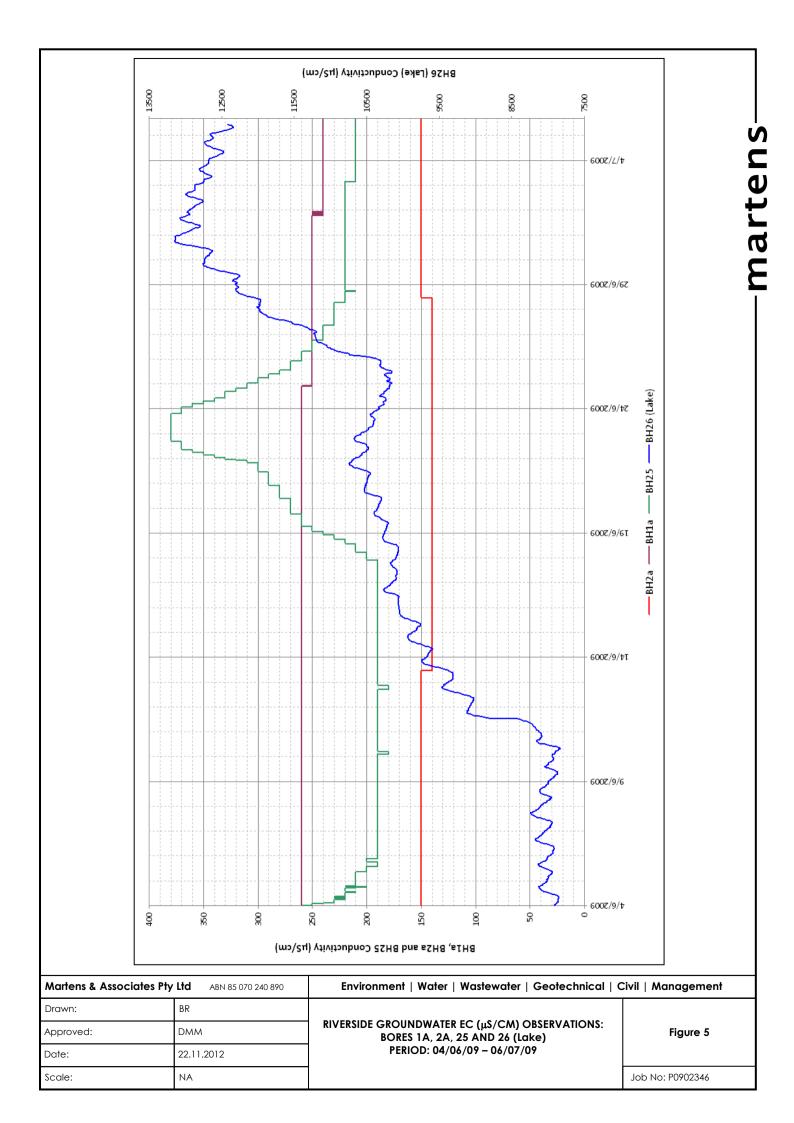


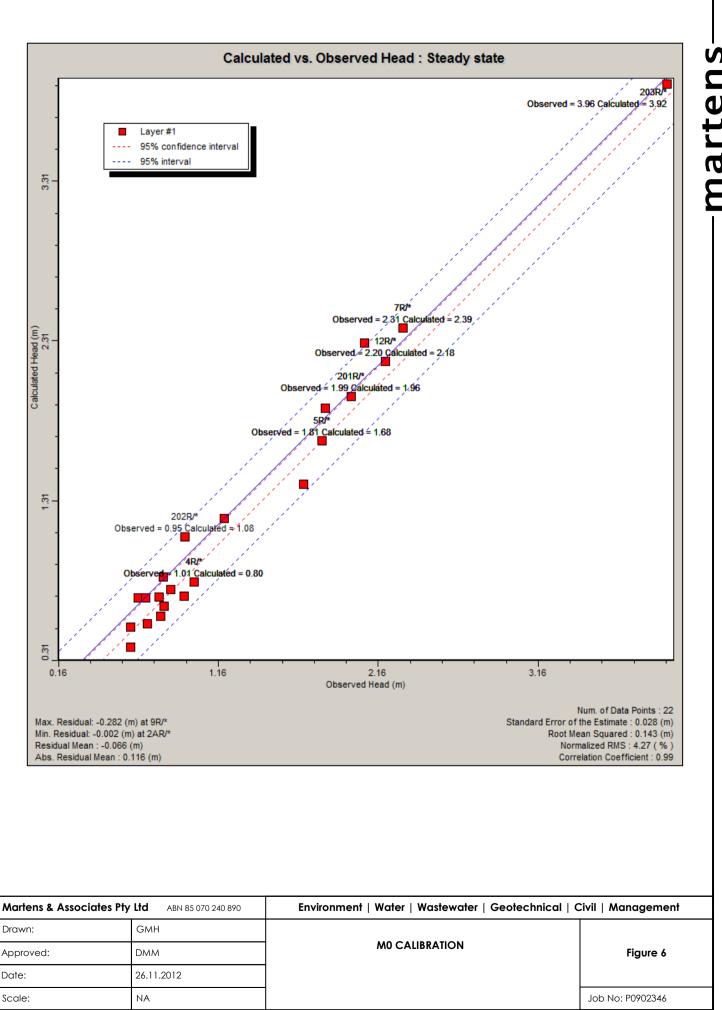
Note:

Image shows location of all installed GMBs to date (with a postfix of R). GMBs 1, 2, 2A and 26ILAKE are no longer available. GMB 201, 202 & 203 installed September 2012. GMB 110 forms part of groundwater model but not included in reporting.

Martens & Associates Pty	ABN 85 070 240 890	Environment Water Wastewater Geotechnical C	ivil Management		
Drawn:	GMH				
Approved:	DMM	SITE GROUNDWATER MONITORING BORES (GMBS) AND EXISTING SITE CONTOURS	Figure 3		
Date:	26.11.2012				
Scale:	NA		Job No: P0902346		







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