DEVELOPMENT AREA 19 (MURIEL COURT)

LOCAL WATER MANAGEMENT STRATEGY

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CITY OF COCKBURN

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STATEMENT OF LIMITATIONS

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This Local Water Management Strategy ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV.Australia Pty Ltd (ENV) ("scope of services"). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

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EXECUTIVE SUMMARY

This Local Water Management Strategy (LWMS) has been prepared to support the development of Development Area 19, also known as Muriel Court located in Cockburn Central.

The site has a total land area of approximately 79 ha and is located in the northwest corner of the intersection of North Lake Road and the Kwinana Freeway in Cockburn. The land is approximately 16 km South of Perth CBD.

The amended Structure Plan has been adopted by the City of Cockburn in July 2010 and Endorsed by the Western Australian Planning Commission in September 2010. Under *Better Urban Water Management (BUWM)* (WAPC 2008a), a LWMS is required to support the Structure Plan prior to subdivision and development of land zoned "Urban". As the Structure Plan has already been approved by the Western Australian Planning Commission, the LWMS is required to be approved by the Department of Water.

The objective of the LWMS is to ensure that sustainable management of the total water cycle at the Muriel Court development occurs through Water Sensitive Urban Design. This includes water conservation, wastewater management and recycling, stormwater management and groundwater management. These issues will be managed through incorporation of the design elements outlined below and detailed in Table A.

- Providing a drainage design that utilises detention bioretention areas and road reserves for stormwater quality and quantity management;
- Determining average annual maximum groundwater levels for the site;
- Providing fill for building pads to allow adequate clearance to groundwater for the onsite infiltration of lot stormwater runoff for up to the 100 year 24 hour ARI events;
- Ensuring that stormwater from the 1 year events is retained and infiltrated on site;
- Managing post development flows from the site in accordance with the District Water Management Strategy
- Ensuring that bioretention areas with a minimum area of 2% of the directly connected effective impervious area will be provided to maintain water quality;
- Sizing stormwater bioretention areas to manage stormwater runoff from the site.
- Ensuring sufficient public open space is available to meet Liveable Neighbourhood guidelines;
- Ensuring that contaminated sites, acid sulphate soils and disease, vector and nuisance insect management are considered in the design of the development; and

- Estimation of scheme and groundwater water consumption including water conservation strategies.

Table A: Design objectives and Design Elements for Muriel Court Development

BUWM Design Objective	Design Element
Water Conservation and Efficiency	Information on the use of rainwater tanks, grey water systems or other alternate water sources will be made available.
	Waterwise landscaping packages will be available for residential lots, including Waterwise plants, soil amendments to improve water and nutrient retention, minimal turf areas and water efficient irrigation.
	Rainwater tanks will be promoted for use for toilet flushing and washing machines.
Water Quantity Management	The drainage concept design includes infiltration bioretention areas, swale a proposed swale at Muriel Court and side entry pits and manholes with open bases and to increase infiltration locally.
	All stormwater from all lots is to be infiltrated on the lot for all events up to 100 year 24 hr ARI storm event. The 1 in 1 year ARI storm will be fully infiltrated on-site.
	On-site soakwells will be used for individual lots.
Water Quality Management	Installation of BMP structural controls to strip pollutants including Gross Pollutant Traps (GPTs), vegetated infiltration bioretention areas, vegetated swales and possibly rain gardens.
	The developer intends to incorporate 2% of the constructed impervious area as bio-retention areas.
	Soil amendments will be used in swales and bioretention areas and irrigated POS where required. Encouragement of soil amendments in residential lawns and gardens via Waterwise landscaping packages.
	The use of fertilisers in Public Open Space (POS) will be limited.

BUWM Design Objective	Design Element
Stormwater Quality Modelling Criteria	Stormwater quality modelling is not proposed for the site at this stage because currently there is no commercially available tool approved by the DoW to undertake such modelling for this area.
Disease Vector and Nuisance Insect Management	The system will be designed to ensure that detained immobile stormwater is fully infiltrated in a time period not exceeding 96 hours. Permanent water bodies are not proposed on the site.

The key design requirements for the detailed design of the Muriel Court LWMS and the critical control points that will be used to meet these requirements are listed in Table B. A summary of the drainage design details for the Muriel Court development are listed in Table C.

Table B: Requirements and Critical Control Points for the Muriel Court Development

Design Requirement	Critical Control Point
A target of less than 100 kL/p.year potable water use to be achieved. Water balance modelling indicates that 58 kL/a potable water use is possible.	Provision of water from the Water Service Provider and groundwater for irrigation, promotion of front yard Waterwise landscaping packages, promotion of rainwater tank provision education of ex-house & in-house Waterwise measures (Section 5.3).
Implementing a drainage design that ensures no flow off the site in the 1 in 1 year event from the development.	Drainage design which ensures storage and infiltration onsite for the 1 in 1 year event with the use of bioretention areas in POS, in combination with other BMPs (Section 6).
Base of bioretention areas to be set at Average Annual Maximum Groundwater Levels (AAMGLs).	Significant filling of the site will be required to maintain adequate separation between the potential AAMGL and the structures (Section 6.2, Section 7.2).

Design Requirement	Critical Control Point
At least 1.5 m of clearance from lot levels to Average Annual Maximum Groundwater Levels (AAMGLs) is available.	Fill levels have been calculated to ensure sufficient clearance from the site's calculated potential AAMGL of (Section 7.2).
Availability of water source for landscaping.	Water from the superficial aquifer will be used for POS irrigation. The City of Cockburn intends to apply for a licence to abstract up to 33 ML/a from the superficial aquifer. The Department of Water advises that this water is currently available for allocation (Section 5.4).

Table C: Summary of Drainage Concept Design

	Catchment		
	Northern	Western	South Eastern
Base Invert Level for Bioretention Area(mAHD)	22.5	22.5	24
Site Average Annual Maximum Groundwater Level (mAHD)	22.5	22.5	24
Equivalent Impervious Area (ha)	10.9	5.0	2.3
Maximum Storage Volume - 1 in 10 ARI (m^3)	5481	1702	1284
Maximum Storage Volume - 1 in 100 ARI (m^3)	9226	2795	1943

1 INTRODUCTION

This Local Water Management Strategy (LWMS) has been prepared to support the Structure Plan (SP) for Development Area 19 (Muriel Court) in the City of Cockburn. The Structure Plan and the LWMS has been prepared by the City under the City of Cockburn's Town Planning Scheme No.3 to support a mixture of residential and commercial land uses.

Area 19 is located within the City of Cockburn, approximately 16km south of the Perth Central Business District and 10km south east of Fremantle. The site is bound by Kwinana Freeway, Kentucky Court, North Lake Road, Semple Court and Verna Court, as shown in Figure 1, and covers an area of approximately 78ha.

The site is comprised of 86 semi-rural/residential lots generally ranging in size of 5,000m^2 to 2ha and commercial lots. The established residential suburb of South Lake is immediately west of the site and continues around to the north of the site, north of Berrigan Drive. Land ownership within the site is fragmented.

The current land use is described as semi-rural/residential, with dwellings surrounded by cleared paddocks and pockets of existing vegetation and dampland areas scattered throughout. The site generally has a very gentle grade down towards the west, with some slightly higher and lower lying areas. The total catchment currently discharges stormwater informally into Yangebup Lake located to the west of the site.

1.1 TOTAL WATER CYCLE MANAGEMENT – PRINCIPLES AND OBJECTIVES

The objective of this LWMS is to establish a development that manages the total water cycle in a sustainable manner. The objectives of total water cycle management, as described by the Draft Water Resources State Planning Policy (WAPC, 2004) are to:

- Take into account total water cycle management and water-sensitive urban design principles and ensure that the development is consistent with current best management practices and best planning practices for the sustainable use of water resources, particularly stormwater.

- Seek to achieve no net difference in water quality and quantity, such that post-development water quality and quantity conditions are equal to or better than pre-development conditions.

- Promote management of the urban water cycle as a single system in which all urban water flows are recognised as a potential resource and where the interconnectedness of water supply, stormwater, wastewater, flooding, water quality, waterways, estuaries and coastal waters is recognised.

- Maximise the opportunities for compliance with best practice stormwater management, including retention of stormwater on site/at the source.

- Promote use of water conservation mechanisms that increase the efficiency of the use of water, including stormwater.

- Incorporate the re-use and recycling of water, particularly stormwater and grey water, consistent with state water strategy recycling objectives. Alternative water sources should be considered where appropriate.

- Promote the retention and use of local native vegetation in developments to minimise water use and maximise filtration, particularly where landscaping is proposed.

1.2 PLANNING BACKGROUND

1.2.1 Metropolitan Region Scheme

The site is zoned 'Urban' under the Metropolitan Region Scheme.

1.2.2 Town Planning Scheme

The site is predominantly zoned 'Development' under the City of Cockburn Town Planning Scheme No. 3, with areas adjacent to North Lake Road being zoned 'Mixed Business'.

2 PROPOSED DEVELOPMENT

2.1 KEY ELEMENTS OF THE STRUCTURE PLAN

The amended Structure Plan has been adopted by the City of Cockburn in July 2010 and Endorsed by the Western Australian Planning Commission in September 2010. The Structure Plan for Development Area 19 proposes a range of densities to provide a variety of housing types. This includes densities of R20, R25, R40, R60, R80 and R160. In general, the higher densities have been provided within the walkable catchment of the train station, along proposed bus routes and around areas of Public Open Space (POS). Lower densities have also been incorporated to provide a suitable land use transition and provide a variety of housing types.

The plan also entails a strip of mixed use lots fronting North Lake Road, which forms the site's southern boundary. Three Public Open Space (POS) areas have been incorporated into the Structure Plan and the existing Church and Child Care Centre are to remain, as shown.

To ensure suitable density targets are achieved, the City's Town Planning Scheme (within the DA 19 provisions) requires all subdivision and development to achieve at least 75% of the nominated density. Applying the minimum 75% density requirement will ensure that a minimum gross residential density of 31.8 dwellings per hectare is achieved over the entire structure plan area. Within the 800m walkable catchment a minimum gross residential density of 77.8 dwellings will be achieved. This is well in excess of the gross residential target density of 40 dwellings per hectare for the 800m walkable catchment nominated under the Liveable Neighbourhoods guidelines.

The Structure Plan (modified February 2010) shows proposed zoning and POS locations and is reproduced as Figure 2 in this LWMS.

2.2 DISTRICT WATER MANAGEMENT STRATEGY

The *City of Cockburn Development Area 19: District Water Management Strategy* (the DWMS) was prepared for the site by Cardno BSD in 2008. The District Water Management Strategy was based on the *Cockburn Central and Solomon Road Development Areas Arterial Drainage Scheme Review* (the ADSR) undertaken by David Wills and Associates (DWA) (2005), which investigates drainage in the broader Cockburn Central Area and sets design criteria for stormwater flows.

The ADSR sets out a drainage philosophy based on maximising the recharge of the groundwater at the source point and using fill where required to encourage this. (DWA, 2005). The subject site is divided into three catchments for drainage purposes, being a northern catchment, western catchment and south eastern catchment (DWA 2005). The ADSR also sets out Design Regional Control Groundwater Levels (DRCGLs) to be used in determining the base levels for bioretention areas (DWA, 2005).

The DWMS builds on the ADSR to set out criteria for flows from bioretention areas and earthworks levels. These criteria have been used to inform the Design Criteria shown in Section 3 and the parameters and levels used in the drainage design outlined in Sections 6 and 7.

The one main change from the DWMS and ADSR has been the placement of the bottom of the bioretention areas. The DWMS and ADSR recommend that the base of the bioretention areas be set 0.5 m below the DRCL, forming a bioretention area that may be wet for several months over winter (Cardno BSD, 2008, DWA, 2005). Based on discussions with the City of Cockburn, this report proposes that bioretention area base levels be set at AAMGL to reduce the period over which bioretention areas are inundated.

2.3 ENVIRONMENTAL REPORTS

The environmental reports undertaken to support the Structure Plan are:

- *Limited Preliminary Site Inspection* by Ace Environmental (2008); and
- *Geotechnical Investigation Report* by Brown Geotechnical and Environmental Geotechnical, Ref 06036.01, May 2007)

3 PRE-DEVELOPMENT ENVIRONMENT

3.1 TOPOGRAPHY

The site is generally slightly undulating, with heights ranging from 22 m AHD near the corner of Semple Court with North Lake Road, 23m AHD at the corner of Semple Court with Verna Court, 25m AHD in the north east and south east corners of the site to 26 m AHD to the north of the east end of Muriel Court (Figure 13).

3.2 GEOLOGY AND SOILS

Geology and soils of the site were assessed by Brown Geotechnical and Environmental (2007), who installed 34 test pits on the site (Appendix A).

The soils of the site are medium-grained grey sands of the Bassendean formation with approximately 0.2 to 0.5 m of dark grey fine to medium grained sandy topsoil (BGE, 2007). Coffee rock was found at a depth of 1.6 to 2 m in two of the test pits. Uncontrolled fill was observed in nine of the 34 test pits. The uncontrolled fill was generally sands, often containing gravel or limestone associated with road base materials.

3.2.1 Acid Sulphate Soils

The site is mapped as generally having a moderate to low risk of Acid Sulphate Soils (WAPC, 2004) (Figure 4). The exception to this is the area associated with the wetland in the south-east corner of the site, which is mapped as having a high risk of Acid Sulphate Soils (Figure 4). Preliminary investigations by Brown Geotechnical and Environmental (2007) (Appendix A) indicated limited potential for acid sulphate soils within the site, however it was indicated that more detailed testing would be required in areas adjacent to the high risk area.

3.2.2 Contaminated Sites

A preliminary assessment for contaminated sites was undertaken by Ace Environmental (2008) (Appendix B). The assessment indicated a number of properties within the site as being potential contaminated sites and requiring further investigation due to current or former potentially contaminating activities such as nurseries or poultry farms, or evidence of fuel storage on the site (Figure 5). Additional details on this matter can be found in Appendix B.

3.3 SURFACE WATER

The site is within the South Jandakot Drainage Area, and is in the catchment of Lake Yangebup. Because the previous development in Area 19 has been predominantly of a rural residential nature, the site lacks formal drainage infrastructure, except for the major roads.

The drainage for the Cockburn Central area was assessed by David Wills for the City of Cockburn in the *Cockburn Central and Solomon Road Development Areas Arterial Drainage Scheme Review* (David Wills and Associates, 2005). The ADSR report considered that the drainage systems significant to the Area 19 site were:

- Open drain along North Lake Road (North Lake Road Drain) which discharges into Yangebup Lake;
- Open drain along southern end of Semple Court (Anning Park) feeding the North Lake Road drain;
- 'Lakelands' flood storage reserve serving the South Lake residential development;
- 450mm diameter pipeline on Berrigan Drive feeding into 'Lakelands'; and
- Wetlands to the south of North Lake Road receiving local drainage (Figure 6).

The above drainage features were identified in the ADSR report for possible integration into the future development.

There are no permanent surface water features within the site boundaries.

3.4 GROUNDWATER

Hydrologically, the site is located between the Jandakot Public Drinking Water Source Area (PDWSA) and Lake Yangebup, which is part of the Beeliar chain of wetlands. Groundwater flow in the area is in a generally westerly to north-westerly, towards the Beeliar Wetlands (Perth Groundwater Atlas, 2nd edition, DoE, 2004). Depth to maximum groundwater levels on the site is generally less than 2 metres (Perth Groundwater Atlas, 1st edition, WRC, 1997).

Because of the site's location between two areas of hydrological interest, there are ten long term Department of Water monitoring bores in the superficial aquifer within two kilometres of the site, seven of which have been monitored since the 1970's. There is also a long term surface water monitoring point in the Tea Tree Close Wetland, immediately to the south of the site (Figure 4). As such, it is considered that the hydrology of the broader area is well understood.

Based on this information, permission was given by the Department of Water for the Local Water Management Strategy to be prepared on the basis of six months' groundwater monitoring data (Appendix C). The Department has also agreed that six months' groundwater monitoring data is adequate for the preparation of an Urban Water Management Plan in this area (Appendix C).

3.4.1 Groundwater Levels and Flow Direction

Groundwater levels on the site were measured between August 2009 and January 2010 by Cardno BSD. Average Annual Maximum Groundwater Levels were then determined

through reference to DoW bore 3157, located approximately 300 m south of the site (Figure 4). This was compared to the maximum recorded groundwater levels in the local bores dated 22/9/2009. AAMGL was determined for the site by selecting a date for which a water level reading was recorded for DoW bore 3157 (22 September 2009) and subtracting the level from the calculated AAMGL (value of -0.099). The difference was used by adding it to the calculated water levels recorded for the site bores on that same day to obtain an estimate for AAMGL for the site bores (Appendix G).

The AAMGL on the site varied from 20.58 m AHD at MC5 in the south-west corner of the site to 23.99 m AHD at MW6 in the south east of the site (Figure 4). Depth to groundwater varied from being above the ground surface in the wetland area in the south-east of the site to greater than 2.6m in much of the north-west of the site to above 4.4m in the north-east. It appears that North Lake Road Drain acts as a groundwater control mechanism.

The AAMGL contours on the site are higher than the DRCGL levels quoted in the DWMS (Cardno BSD, 2008) and the ADSR (DWA, 2005). The separation ranges from approximately 1m higher along the western boundary to being within approximately 0.3m along the eastern boundary.

An 18month monitoring program of groundwater levels to assist in refining the estimated maximum groundwater level is ongoing and due for completion in early 2011.

3.4.2 Groundwater Quality

Groundwater quality was monitored by Cardno BSD on two occasions in August and November 2009 for pH, electrical conductivity and nutrients. Analysis for heavy metals was also undertaken in August 2009.

The groundwater was slightly acidic, with average pH values between 5.4 and 6.7, as is common within Bassendean Sand profiles (Table 1, Figure 7). The total phosphorus levels were slightly elevated, with the average value of four wells exceeding the Healthy Rivers Action Plan Long Term Target of 0.1 mg/L (Table 1, Figure 7)). The total nitrogen exceeded the Healthy Rivers Action Plan Long Term Target of 1 mg/L at five bores (Table 1, Figure 7). In ENV's experience such nitrogen and phosphorus levels are similar to other Bassendean Sand sites with a history of extensive agriculture.

Table 1: Average Groundwater Quality Results for pH, Electrical Conductivity and Nutrients (Average of August 2009 and November 2009 results).

	pH	EC mS/cm	Total P mg/L	Ortho-P mg/L	Total N mg/L	NOx-N mg/L	NH4_N mg/L	TKN mg/L
MC1	5.9	0.11	0.03	0.02	1.05	0.17	0.14	0.90
MC2	5.4	0.28	0.67	0.08	8.80	1.19	0.08	7.65
MC3	6.6	0.56	0.35	0.33	2.05	0.02	0.11	2.05
MC4	6.5	0.40	0.05	0.04	1.40	0.02	0.40	1.35
MC5	5.6	0.84	0.82	0.77	5.00	0.17	0.28	4.85
MC6	6.7	0.59	0.11	0.06	0.95	0.12	0.11	0.85
Site Average	6.1	0.46	0.34	0.22	3.21	0.28	0.18	2.94
Healthy Rivers Action Plan Long Term Target			0.1		1.0			
Healthy Rivers Action Plan Short Term Target			0.2		2.0			

Table 2: Groundwater Quality Results for Heavy Metals (August 2009).

	Arsenic mg/L	Cadmium mg/L	Chromium mg/L	Copper mg/L	Lead mg/L	Nickel mg/L	Zinc mg/L	Mercury mg/L
MC1	<0.001	0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
MC2	0.001	<0.0001	0.006	0.008	0.003	0.006	**0.034**	<0.0001
MC3	0.002	<0.0001	<0.001	0.001	<0.001	<0.001	<0.005	<0.0001
MC4	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
MC5	0.001	<0.0001	<0.001	0.001	<0.001	0.002	**0.011**	<0.0001
MC6	<0.001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.0001
Freshwater Aquatic Ecosystems	0.024	0.0002	0.01			0.011	0.008	

Metals concentrations on the site generally met the NHMRC Freshwater Aquatic Ecosystems guidelines (Table 2). The only exception to this was zinc at MC2 and MC5, which was slightly elevated.

3.5 VEGETATION

A preliminary assessment of vegetation quality was undertaken by the City, including a site survey in winter 2007. The report recommended areas of vegetation for retention (Appendix D). Discussions with the City indicate that they consider the vegetation in the south-eastern wetland to be of most importance. The City's assessment was of a preliminary nature and was not undertaken in Spring, additional botanical work may be required prior to subdivision to determine whether Declared Rare Flora or Threatened Ecological Communities are present on the site.

3.6 WETLANDS

The site does not contain Conservation or Resource Enhancement Category wetlands (Figure 5).

3.7 SUMMARY OF SITE CONSTRAINTS

The primary environmental constraints of the site are:

- Low depth to groundwater in the south-eastern part of the site
- Need to manage acid sulphate soils during development, and
- Potentially contaminated sites (Figure 5)

3.8 WORK REQUIRED AT THE SUBDIVISION STAGE

Additional environmental work may be required by the Western Australian Planning Commission at the subdivision stage as a condition of subdivision. This work may include:

- Acid Sulphate Soils Investigations where sites have been identified in Figure 4 as being at risk;
- Dewatering Management Plans
- Review of subsoil drainage requirements

4 DESIGN CRITERIA

These criteria are based on *Better Urban Water Management* (WAPC, 2008a) and Cardno's *Development Area 19 District Water Management Strategy,* which covers the site (Cardno BSD, (2008)).

4.1 WATER CONSERVATION

Principle

No potable water should be used outside of homes and buildings with the use of water to be as efficient as possible (WAPC, 2008a).

Design Objectives

Consumption target for potable water of 100 kL/person/year (State Water Plan Target), including not more than 40-60 kL/person/year scheme water (WAPC 2008a).

Site Response

The development will aim to use best practice to achieve efficient use of scheme water and to minimise using scheme water outside of the house and meet the 100 kL/person/year target.

4.2 WATER QUANTITY MANAGEMENT

Principle and Criteria

Based on the DWMS predevelopment flow estimates, the peak discharge into the North Lake Road open drain from the bioretention area or swales is to be set at a maximum 8L/s/impervious ha for the peak of the 5 year ARI event and 9.6L/s/impervious ha for the peak of the 100 year ARI event (Cardno BSD, 2008). No peak discharge was prescribed in the DWMS for the Northern Catchment.

Site Response

The drainage strategy for the site will comply with the guidelines set in the DWMS.

4.3 WATER QUALITY MANAGEMENT

These criteria are intended to apply to run-off from impervious areas and should be met in addition to the groundwater design objectives.

Principle

Maintain surface and groundwater quality at pre-development levels (winter concentrations) and, if possible, improve the quality of water leaving the development area to maintain and restore ecological systems in the sub-catchment in which the development is located (WAPC 2008a).

Criteria

Contaminated Sites – To be managed in accordance with the Contaminated Sites Act 2003.

All other Land – If the pollutant outputs from the development (measured or modelled concentrations) exceed catchment ambient conditions, the proponent shall achieve water quality improvements in the development area or, alternatively, arrange equivalent water quality improvement offsets inside the catchment. If these conditions have not been determined, the development should meet relevant water quality guidelines stipulated in the National Water Quality Management Strategy (ARMCANZ & ANZECC 2000) (WAPC 2008a).

Site Response/Commitment

The development proposes to use Best Management Practices in line with the Stormwater Management Manual (DoW, 2004-2007) to manage water quality on the site. The site is considered to be unlikely to be contaminated based on the land use history of being largely vegetated. As such, contaminated sites guidelines do not apply.

4.4 STORMWATER QUALITY MODELLING CRITERIA

Principle

If it is proposed to use a stormwater modelling tool to demonstrate compliance with design objectives, the following design modelling parameters are recommended.

As compared to a development that does not actively manage stormwater quality:

- *At least 80% reduction in the average annual load of total suspended solids;*
- *At least 60% reduction in the average annual load of total phosphorus;*
- *At least 45% reduction in the average annual load of total nitrogen; and*
- *At least 70% reduction in the average annual load of gross pollutants* (WAPC, 2008a).

Site Response/Commitment

Stormwater quality modelling is not proposed for the site at this stage because currently there is no commercially available tool in Western Australia approved by the DoW to undertake such modelling. Instead, bioretention areas with a minimum area of 2% of the directly connected effective impervious area will be provided to maintain water quality.

4.5 DISEASE VECTOR AND NUISANCE INSECT MANAGEMENT

Principle

To reduce health risks from mosquitoes, retention and detention treatments should be designed to ensure that between the months of November and May, detained immobile stormwater is fully infiltrated in a time period not exceeding 96 hours.

*Permanent water bodies are discouraged, but where accepted by DoW, must be designed to maximise predation of mosquito larvae by native fauna to the satisfaction of the local government on advice of the Departments of Water and Health (*WAPC, 2008a).

Site Response/Commitment

The system has been designed to ensure that detained immobile stormwater is fully infiltrated in a time period not exceeding 96 hours between November and May.

The base of the bioretention areas will be set at AAMGL to reduce ponding from November to May.

Permanent water bodies are not proposed for this site.

5 WATER CONSERVATION

5.1 PROPOSED STRATEGIES

Water use for garden irrigation accounts for approximately 50% of domestic potable water use in Perth (Coghlan and Loh, 2003). Because of the high density nature of the development, the areas of garden will be quite low. This results in a low usage of potable water within the area. However, the use of waterwise plantings and water efficient appliances will still need to be encouraged in this area to achieve the modelled outcome.

5.2 WATER BALANCE MODELLING

5.2.1 Pre-development Water Balance

In the pre-development scenario, it is assumed that 25% of rainfall becomes recharge to groundwater and surface water systems (Davidson, 1995). Rainfall data was taken from the Bureau of Meteorology site Jandakot for the years (1972 – 2009). Based on an average annual rainfall of 832.2mm, the total annual recharge for the site is 164 ML/yr For details of this calculation refer to Appendix E.

5.2.2 Post-development Water Balance

In the post-development scenario, the total recharge is 408 ML/yr, an increase of 250% on the pre-development scenario. This increase is primarily due to the increase in hard surfaces caused by development which increases runoff and infiltration and reduces evapotransipration. Without large areas of vegetation to transpire the water, this increase is inevitable in developments with medium to high densities. The following information was used in determining the water balance. For details of this calculation refer to Appendix E.

- Land areas are as provided by City of Cockburn, 17/11/2009;
- Local Centre is assumed to be commercial;
- Estimated area of garden = 65% of OS area for low density;
- Estimated area of garden = 45% of OS area for med density;
- Estimated area of garden = 30% of OS area for high density;
- Persons per house from Water Corporation (2008) quoting ABS (2006);
- No lot drainage and no sub-surface drainage;
- Rain on Hard Surfaces is 4.5% Evap, 95.5% storm water (WAWA, 1987);

- Rain and irrigation has a 17.5% surface loss; and
- Verge has been calculated as a scaled average based on average verge length per block and total verge area based on road reserve

5.3 DOMESTIC WATER CONSUMPTION

5.3.1 Estimated Water Consumption

Water consumption was calculated for the development using residential water use figures from a range of sources (Coghlan and Loh 2003, GHD 2005, Water Corporation 2008). The calculated potable water consumption was approximately 58 kL/person/year with rainwater tanks (for toilet flushing) connected to an estimated 20% of the low and medium density homes only. This is below the 100 kL/person/year recommended in the State Water Strategy and within the Better Urban Water Management Plan target range of 40 – 60 kL/person/year. The low potable water consumption reflects the fact that the development is predominantly of a high density, with approximately 60% of the dwellings being zoned R80 or greater. This higher density means that less water is used outside the home than would otherwise be the case because there is very little garden area. Information regarding estimated water consumption is given in Table 3.

Table 3: Estimated annual potable water consumption with rainwater tanks

Density Type	Usage Area	Volume Per Resident (L)	Annual Usage (kL/resident/yr)	Total Usage (kL/year)
Low (R20,R25)	In-house	92	34	30,101
	Ex-house	93	34	30,570
	Total	185	68	60,671
Medium (R40,R60)	In-house	93	34	39,729
	Ex-house	89	32	38,001
	Total	182	66	77,730
High (R80,R160)	In-house	116	42	147,893
	Ex-house	31	11	40,034
	Total	148	54	187,927
			In-house	217,722
			Ex-house	108,605
			Total	326,328

Average scheme water usage (kL/yr/resident)	58.76

Note: In-house potable water use is less for the low and medium density homes due to the use of rainwater as a substitute source. Total in-house water use is the same for all densities.

5.3.2 Water Efficiency Measures

The development will be expected to comply with waterwise principles and this has been assumed in the domestic water consumption modelling. The City of Cockburn encourages the use of waterwise landscaping and rainwater tanks in this development however these practices are difficult to enforce. It is assumed that there will be a certain level of voluntary uptake particularly within the lower density areas however

this level cannot be quantified. Further investigation into the use of residential rainwater tanks will occur at the UWMP stage.

5.4 PUBLIC OPEN SPACE

The development allows for a total of 6.34ha of Public Open Space. Assuming that 70% of the POS is irrigated at the DoW's accepted rate of 7500 kL/ha/yr, this will require a total of 33 ML/year.

The site is located in the Cockburn Groundwater Area and the Kogalup Groundwater Sub-area. The Department of Water indicates that the superficial aquifer in the area is currently 87% allocated and over 600,000 kL/year is available (as of October 2010). As such, it is considered that adequate ground water is available for irrigation of public open space in the area if no other allocations are made.

POS landscaping within the site will be undertaken by the City of Cockburn, as part of the Developer Contributions Scheme (DCA). POS will be developed as the land is subdivided. Water use in public open space will be minimised where possible through the use of hard surfaces and low water use plants where appropriate.

An indicative landscape plan for the POS areas is provided (Figure 12).

5.5 COMMERCIAL WATER CONSUMPTION

The commercial areas within the development are zoned 'mixed business' which can include light and service industrial, wholesaling, showrooms, trade and professional services. Because of the range of possible uses, it is difficult to determine the potable water use of such a section. However, the proposed land uses are very unlikely to individually consume above 20,000 kL/year or 55 kL/day of potable water. From July 2009, businesses consuming above this amount must develop and implement Water Efficiency Management Plans (WEMP) to help reduce their water use (Government of Western Australia, 2007).

Small to medium businesses are not required to have a WEMP. A simple way of ensuring that small businesses are water efficient would be to ensure that new commercial buildings meet standard water efficiency requirements in a similar manner to new homes, based on 5 Star Plus and the Federal Government's NABERS scheme for water and energy efficiency in office and hotel buildings. These water efficiency options will be recommended but not mandated.

Commercial reuse of rainwater for toilet flushing and cooling towers is also considered to be an option. Such systems do not require a special license or treatment, but must be approved by the Department of Health. At present none of these measures will be mandated for the commercial areas of the development, but will be recommended by the developer.

5.6 POTABLE WATER SUPPLY

A servicing report for the site was prepared by Cardno BSD (2008) (Appendix F). While potable water is currently available in the area, the current water mains are not considered adequate to cope with the proposed lot yield (Cardno BSD, 2008). This report recommends an extension from the existing 400 mm potable water pipe within the Beeliar Road site, approximately 550 m south of the site (Cardno BSD, 2008).

Further details for the provision of potable water services will be outlined at the subdivision stage.

5.7 WASTEWATER

The site is currently not connected to the Water Corporation Wastewater system. Wastewater services are available in the North Lake Road Reserve and at the corner of Semple Court and Berrigan Drive (Cardno BSD, 2008) (Figure 6). These pipes are considered to have adequate capacity to service the site (Cardno BSD, 2008).

Arrangements will need to be made for provision of reticulated wastewater systems at the subdivision stage.

5.8 MATTERS TO BE ADDRESSED AT THE SUBDIVISION STAGE

The Urban Water Management Plan should:

- *Confirmation of groundwater allocation for POS and response in terms of landscaping design;*
- *Undertake subdivision-level water balances based on the groundwater allocation;*
- *Provide further details on water conservation measures in-house and ex-house to be implemented at the site;*
- *Provide information on the use of rainwater tanks, grey water systems or other alternate water sources used*
- *Details of waterwise landscaping packages to be provided to households;*
- *Ensure that remnant vegetation of significance is clearly identified and retained*

6 STORMWATER MANAGEMENT STRATEGY

6.1 DESIGN PRINCIPLES AND GENERAL POINTS

The District Water Management Strategy (DWMS) (Cardno BSD, 2008) outlined the principles by which the stormwater management of the Development Area 19 (Muriel Court) is to be achieved. This report divides Development Area 19 into three sub-catchments (Figure 3 of DWMS), each with its own bioretention areas and draining to different outfalls. These sub-catchments (and associated bioretention areas) were labelled Northern, Western and South Eastern catchment areas and bioretention areas and these labels have been adopted in this report.

Each bioretention area has an outflow pipe connecting it to existing infrastructure external to the site. A representation of these pipes can be seen in Figures 8 to 11. The Northern catchment drains northward to connect with existing infrastructure at Berrigan Drive before out-falling to Lakelands Reserve. The Western catchment connects to the Anning Park drain and the South Eastern catchment drains southward to connect to the North Lake Road drain. Storm water from both the Western and South Eastern catchments finally outfalls at Yangebup Lake.

Drainage to the bioretention areas for smaller events will be through the drainage network whereas larger events will utilise overland flow paths. Flood protection will be achieved in the development through detaining the 1 in 100 year ARI event to pre-development flow rates through the use of stormwater bioretention areas. This is required by the DoW and is articulated in BUWM. Sizing of the bioretention areas is predominantly to provide flood protection both within the development and to the downstream catchment.

Protection of ecological assets is specified within the DWMS through infiltration of the 1 in 1 year ARI event. This infiltration area is shown in each sub-catchment in dark green in Figures 8 to 11. The infiltration of stormwater up to the 1 in 1 year ARI event has been allowed for in the design of the bioretention areas by placing the upstream invert of the outflow pipe (the bioretention area end) at a height above the volume required to store the 1 in 1 year ARI event. Street side entry pits and gullies will be bottomless to increase infiltration.

As per discussion with the City of Cockburn during project meetings, the bases of the bioretention areas have been set at AAMGL. It is understood that the department of water recommends a 300mm clearance from the base of the bioretention areas to groundwater level however due to the limitations on the site, specifically limited stormwater storage areas within the POS, the level was set to AAMGL. The City of Cockburn will design and manage the POS throughout the life of the development and will take appropriate action to address any issues that may arise from the above approach.

The City of Cockburn has advised that they will not allow lot connections for any lots with the Muriel Court development and that all lots manage stormwater through the use of soakwells and storages for up to 1 in 100 year events. All runoff into the drains and bioretention areas will therefore be from the roads and Public Open Spaces only up to the 1 in 100 year event.

For the purposes of this report North Lake Rd Drain is assumed to remain as an open drain, as indicated in discussions with the City of Cockburn. The City of Cockburn has also indicated that Anning Park will be upgraded to a piped drain in the short term. This infrastructure is outside the Structure Plan boundary.

6.2 PROPOSED DRAINAGE DESIGN

The Muriel Court development area and surrounding contributing catchments were modelled using XPSTORM software. The following assumptions and input parameters were used in the model. Some of these have been modified from the requirements outlined in the DWMS with the changes proposed by the City of Cockburn during project management meetings.

- all storm water from storm event sizes up to and including the 1 in 100 year 24 hour event are retained on lots for all lot types including mixed business;
- all storm water runoff (from roads and POS only) for 1 year ARI 1 hour storms is to be retained within the bioretention areas with a maximum water level of no greater than 0.3m;
- the runoff coefficient for road reserve areas is 90%;
- the runoff coefficient for POS areas is 10%;
- the slope for roads was assumed to 0.005;
- the slope for POS was assumed to be 0.002; and
- the DWMS provided an Intensity Frequency Duration (IFD) table for the Cockburn Area. A different IFD table for rainfall was obtained from the Bureau of Meteorology specific to the Muriel Court site and was used rather than the more general DWMS IFD table.

6.2.1 Bioretention Areas

The locations of the three bioretention areas have been determined in the DWMS as being within the POS area of each catchment area in the development area. The exact locations and shape of the bioretention areas within the POS will be designed in detail by the City of Cockburn.

The three bioretention areas were designed based on critical storms events and the resulting inflows from the contributing catchments. The base of the bioretention area is set at estimated AAMGL as advised by the City of Cockburn.

For each catchment, the roads surrounding the POS areas are required to be 1.2m above AAMGL (the base of the bioretention areas) (Table 8). For the Western and South Eastern catchment the flooded areas were determined by setting the depth of flooding for the 100 year event to less than 1.2m. For the Northern catchment the depth of flooding for the 1:100yr ARI 72 hr event is 1.4m. For this catchment the surrounding roads have been set a minimum of 1.7m above AAMGL.

A square bioretention area shape was modelled due to the simplicity it afforded and it is understood that this will not be the final shape of the bioretention area. The lowest part of the bioretention area has vertical walls of height 300mm. This area fully contains the 1 year ARI event and allows full recharge of this storm water.

The flood storage volumes and areas calculated using the XPSTORM model are detailed in Table 4. Surface areas indicated in Table 4 are indicative only and will depend upon the final shape of the bioretention area.

Bioretention area outflow pipe inverts are set at 300mm above the base of the bioretention areas so that all storm water entering the bioretention areas is retained and infiltrated for the 1 year 1 hour ARI event. Each bioretention area has been designed with one 300mm outflow pipe to limit the flow rate from the bioretention area to achieve the 1 in 100 year ARI pre-development.

Figures showing bioretention area sizing for a specific flood events are

- 100 Year Flood Event Plan - Figure 8.
- 10 Year Flood Event Plan - Figure 9.
- 5 Year Flood Event Plan - Figure 10.
- 1 Year Flood Event Plan - Figure 11.

The areas required to determine the POS credits are given below.

- The total structure plan area = 67.09 ha
- Deductions = 3.62 ha
- Gross subdivisible area = 63.48 ha
- Public Open Space @10 per cent = 6.347 ha
- Public open space above 1:1 ARI = 6.347 ha
- Drainage - up to 1:1 ARI (no credit) = 0.713 ha

- Total POS /drainage required = 7.060 ha
- Total POS/drainage shown on Structure Plan = 7.060 ha

From Table 4,

- Total submerged area for 1:1 yr event = 0.94 ha
- Total submerged area for 1:5 yr event = 1.04 ha

Under the current design, the inundated area for the 1:1 ARI event (0.94ha) is larger than that permitted under the Liveable Neighbourhoods guidelines (0.713ha). It is proposed that a portion of the volume of stormwater produced by a 1:1 year event will be infiltrated using shallow underground drainage galleries (such as an Atlantis stormwater harvesting tank), within the POS, reducing the area of inundation to comply with the guidelines.

The underground drainage galleries will be designed to be hydraulically connected to the inundation areas and will have the same inverts (at or above the AAMGL). Storm water in the galleries will drain into the surrounding soil and will not be stored. They will be located around the perimeter of the basins within the POS in the areas that have a suitable separation to ground water to cover the galleries with soil. Stormwater for events larger than 1 in 1 year ARI will initially fill the inundation areas, then the galleries and then additional water will leave the site through the controlled outlets. The detailed design and location of the galleries will be determined by the City when they design and construct the POS areas and will be presented within future urban water management plans.

Table 4: **Bioretention Area Data**

	Northern	Western	SthEastern
Estimated AAMGL (mAHD)	22.5	22.5	24
Base Area (ha)	0.45	0.21	0.17
Bioretention area Invert Level (mAHD)	22.5	22.5	24
Outlet pipe US invert (mAHD)	22.8	22.8	24.3
Outlet Pipe Diameter (mm)	1x300	1x300	1x300
Outlet pipe slope (%)	0.333	0.333	0.333
1 Year ARI : 1hr			
Top Water Level (mAHD)	22.8	22.8	24.3
Top Water Level Area (ha)	0.45	0.27	0.22
Max Volume (m^3)	1337	613	506
Peak Outflow (m^3/s)	0	0	0
1 Year ARI : Critical			
Critical Duration (hr)	72	72	72
Top Water Level (mAHD)	23.0	23.0	24.5
Top Water Level Area (ha)	0.50	0.24	0.19
Runoff Volume (m^3)	2567	1051	818
Peak Outflow (m^3/s)	0.047	0.031	0.028
5 Year ARI : Critical			
Critical Duration (hr)	72	72	72
Top Water Level (mAHD)	23.4	23.1	24.6
Top Water Level Area (ha)	0.57	0.26	0.21
Max Volume (m^3)	4600	1416	1100
Peak Outflow (m^3/s)	0.054	0.054	0.047
10 Year ARI : Critical			
Critical Duration (hr)	72	72	72
Top Water Level (mAHD)	23.6	23.24	24.7
Top Water Level Area (ha)	0.61	0.27	0.22
Max Volume (m^3)	5481	1702	1284
Peak Outflow (m^3/s)	0.056	0.055	0.048
100 Year ARI : Critical			
Critical Duration (hr)	72	72	72
Top Water Level (mAHD)	23.9	23.6	25.0
Top Water Level Area (ha)	n/a*	n/a*	n/a*
Max Volume (m^3)	15309	4584	4368
Peak Outflow (m^3/s)	0.060	0.064	0.055

* Top water level areas for 100 year events are not provided as they will greatly depend on the shape of the bioretention areas. The top water level areas for the lesser events are provided as a guide only.

6.2.2 Conveyance from the Site

Stormwater into the bioretention areas will be from road runoff and from POS runoff only. Open bottomed side entry pits will be used to convey road runoff into the bioretention areas.

Conveyance from the site is by means of a 300mm outflow pipe from each of the bioretention areas with the upstream inverts set at 300mm above the base of the bioretention areas. These pipes connect to existing stormwater infrastructure at different locations external to the Muriel Court site. These pipe details are shown in Table 4.

Northern Catchment

The northern catchment bioretention area outflow pipe is proposed to drain north across Verna Court to Berrigan Drive. From there the storm water drains west to join with existing storm water infrastructure at the corner of Semple Court and Berrigan Drive. This existing infrastructure drains westward for approximately 450m before crossing Berrigan Drive and discharging into Lakelands Reserve. The City of Cockburn is satisfied that there is sufficient capacity with Lakelands Reserve to manage this stormwater.

Western Catchment

The Western catchment bioretention area outflow pipe is proposed to drain west and connect to the existing Anning Park drain at the north east corner of the park. The City of Cockburn advises that this drain will be upgraded to a piped system and so a piped system was used for Anning Park in the stormwater modelling.

South Eastern Catchment

The South Eastern catchment is proposed to drain south to North Lake Road, approximately 300m east of Poletti Road and connect with existing storm water infrastructure. This infrastructure drains west along the southern side of North Lake Road before crossing over North Lake Road at Semple Court and into Anning Park. At Thomas Street the storm water then crosses back over North Lake Road before outfalling at Yangebup Lake. Figures 8 to 11 show the flow paths of the modelled network.

A maximum outflow rate was specified by the DWMS for the 5 year and for 100 year ARI events from the south eastern and western catchments (Section 4.5 of DWMS). Table 5 outlines the maximum flows determined from the DWMS compared to the modelled flow rates. No maximum flow rate was specified for the Northern catchment.

Table 5: Actual and Allowable Maximum Outflow rates (m^3/s)

		North	Western	South Eastern
5 Year ARI	Peak Outflow (m^3/s)	0.054	0.054	0.047
	DWMS max allowable	n/a	.076	0.084
100 Year ARI	Peak Outflow (m^3/s)	0.060	0.064	0.055
	DWMS max allowable	n/a	0.091	0.101

6.2.3 Flood Protection

All stormwater for up to a 1:100 year ARI 72 hour event is expected to be detained within the bioretention areas and therefore there should be no overland flow paths out of the bioretention areas for floods up to the 1 in 100 year ARI event.

A minimum freeboard of 0.3m is required between peak flood level and minimum habitable floor levels.

6.2.4 Stormwater Treatment within the Road Reserve

Due to the narrowness of road reserves in the area and the high density nature of the proposed development, the City of Cockburn believes that the only suitable location of swales is Muriel Court, east of the realigned Semple Court. The use of tree pit rain gardens and permeable pavement to increase infiltration within the road reserve will be encouraged. Open bottomed manholes should be used where adequate clearance to groundwater exists.

This information should be read in conjunction with Table 8 in Section 7.2 which outlines the separation requirements as part of the groundwater management strategy.

6.2.5 Lot Drainage

The City of Cockburn requires all lots, including the mixed business precinct , to store all stormwater up to the 1 in 100 year ARI 24 hr event on site (as per the City Of Cockburn On Site Drainage Requirements (Residential/Industrial/Subdivisions) (undated)). These requirements provide guidance on sizing of onsite storage, either through soak wells, drainage sumps or other approved methods and the volume and area required.

- For the R20-R60 and the Mixed Business (Non-Residential) areas the finished lot levels need to be 1.5m above the AAMGL.
- For the R80 and R160 areas (including the Mixed Business – Office/ Residential R160 area) the finished lot levels need to be 2.8m above the AAMGL.

This information should be read in conjunction with Table 8 in Section 7.2 which outlines the separation requirements as part of the groundwater management strategy.

6.3 STORMWATER QUALITY

Management of stormwater quality relies on the use of both structural and non-structural best management practices (BMPs) as specified in the Stormwater Management Manual (DoW, 2004-2007).

In terms of structural BMPs, the development complies with the Department of Water's recommendation that an equivalent of 2% of the directly connected impervious area be allowed as vegetated infiltration area to remove nutrients from groundwater. This area will be vegetated with native vegetation and provided within the bioretention areas in the POS.

The total directly connected impervious area for the development for events less than 1 in 100 year ARI is given below in Table 6. 2% of the directly connected impervious area is 0.40 ha.

Table 6: Directly Connected Impervious Area

	Total Directly Connected Area (ha)	Directly Connected Impervious Area (ha)
Northern		
Road (0.9)	11.7	10.5
POS (0.1)	3.3	0.3
Total	**15.0**	**10.9**
Western		
Road (0.9)	5.4	4.9
POS (0.1)	1.7	0.2
Total	**7.1**	**5.0**
South Eastern		
Road (0.9)	4.4	4.0
POS (0.1)	2.0	0.2
Total	**6.4**	**4.2**
Total Area	**28.6**	**20.1**

The bioretention areas are expected to remove pollutants including suspended solids, nutrients, sediments and heavy metals to standards summarised in Table 7. The subsoil drain is surrounded by a mixture of blue metal and cracked pea gravel (laterite) which has a strong ability to bind phosphorus.

Table 7: Typical Annual Pollutant Load Removal Efficiencies (Source: Stormwater Management Manual (DoW, 2004-2007)

Pollutant	Expected Removal
Litter	>90%
Total Nitrogen	25-40%
Total Phosphorus	30-50%
Coarse Sediment	>90%
Heavy Metals	20-60%

The use of tree pit rain gardens and permeable pavement to increase infiltration within the road reserve will be encouraged.

If fill is required beyond the standard cut to fill within the site, fill should be yellow sand with a phosphorus retention index (PRI) greater than 15.

6.3.1 Non-structural BMPs

The primary source of nutrients in residential developments is the fertiliser applied to the lawns and gardens of properties and POS areas. However, as the proposed development is of a higher density nature, areas of lawn and garden beds will be generally low, and as such fertiliser use by householders is not expected to be high.

The following non-structural BMPs are recommended for this site:

- Use of fertiliser within POS to be limited; and
- Buyers should be provided with information regarding minimising fertiliser use at the point of sale.

6.4 IMPACT ON WATER DEPENDANT ECOSYSTEMS

There are no priority wetlands within or adjacent to the site. There is some priority vegetation in the south east catchment. Detail is provided in Appendix D.

6.5 DISEASE VECTOR AND NUISANCE INSECT MANAGEMENT

No artificial water bodies are being constructed as part of this development. As such, the potential for midge and mosquito breeding on the site is low.

Between November and May, the predominant mosquito breeding season, groundwater levels will be below the base of the proposed bioretention areas not providing suitable conditions for breeding.

When groundwater levels are at AAMGL in winter, temperatures are usually low enough to substantially extend the breeding cycle of mosquitoes exposing them to the risk of the water drying out, killing the eggs and larvae before the breeding cycle is complete (DoH, 2004).

6.6 MATTERS TO BE ADDRESSED AT THE SUBDIVISION STAGE

- *Provision of a detailed drainage plan for the subdivision area including swales, rain gardens and confirmation of sizing and location of structures;*
- *Details of landscaping for swales, rain gardens and bioretention areas;*
- *Confirmation of finished lot levels;*
- *Identify monitoring locations, analytes and frequency for post-development monitoring; and*
- *Identify contingency action plan and trigger values for post development monitoring.*

7 GROUNDWATER MANAGEMENT STRATEGY

7.1 GROUNDWATER MANAGEMENT

The site currently has groundwater levels close to the surface with some surface expressions. Fill will be required to ensure suitable separation between groundwater levels and infrastructure. In addition, fill will be required to ensure sufficient separation to allow for storm water from the lots to be infiltrated on site through the use of soak wells or other sub surface drainage device.

It is expected that up to approximately 33 ML/year of ground water may be required to maintain the POS. This water will be extracted from the superficial aquifer.

Subsoil drainage will be required under the conditions outlined in Table 8, and will be set at AAMGL to maintain the predevelopment AAMGL level. The subsoil drains will be connected to the main drainage lines which will have free draining outlets into the bioretention areas for treatment.

7.2 GROUNDWATER LEVELS AND FILL

Fill requirements have been based on the requirements of the DWMS and the City's *Guidelines and Standards for the Design, Construction and Handover of Subdivision within the Municipality* (2009) and are summarised in the table below.

Table 8: Design Parameters for Lot Levels

	Mixed Business	Urban
Minimum Lot Level	1.2 m above AAMGL, but minimum 1.5 m preferred	1.5 m above AAMGL
Minimum Stormwater Disposal within lot	All to be disposed on site via soakwells (1 in 100 yr 24 hour event)	All to be disposed on site via soakwells (1 in 100 yr 24 hour event)
Lot subsoil drainage required when…	Lot level less than 1.5 m above AAMGL or where lot requires fill to meet minimum clearance	Lot level less than 1.5 m above AAMGL or where lot requires fill to meet minimum clearance
Minimum Road Centreline Level	1.2 m above AAMGL	1.2 m above AAMGL
Road subsoil drainage to be required when…	Road centreline is less than 1.5 m above AAMGL	Road centreline is less than 1.7 m above AAMGL
Open bottomed bioretention areas within road reserve may be considered when.	Road centreline is more than 1.7 m above AAMGL	Road centreline is more than 1.7 m above AAMGL

The guidance in the DWMS was based on the DRCGL (design regional control groundwater level). As the DRCGL is lower than the AAMGL on this site, the AAMGL has been used as the groundwater control level. This is in line with the City of Cockburn's requirement that groundwater levels are not to be controlled to below the AAMGL (City of Cockburn, 2009).

Soil permeability tests are to be taken on site and used to determine the spacing of subsoil drainage lines. Data from such tests and the calculations are to be submitted (City of Cockburn, 2009).

7.3 IMPACT ON WATER DEPENDANT ECOSYSTEMS

The site does not contain water dependant ecosystems. There are water dependant ecosystems to the south east and the west of the site however the development is not expected to have an impact on these systems.

7.4 GROUNDWATER QUALITY

Groundwater quality will be maintained through the use of BMPs to manage stormwater quality prior to infiltration where ever possible and the minimisation of fertiliser use as per Section 6.3.

7.5 ACID SULPHATE SOILS MANAGEMENT

The site includes areas of high risk of acid sulphate soils (ASS) (Appendix A). Developments that contain or are adjacent to high risk areas shall undertake Department of Environment and Conservation compliant investigations to determine the presence of ASS on their sites. Where ASS is present, Dewatering Management Plans shall be required at the UWMP stage.

7.6 WORK REQUIRED AT THE UWMP STAGE

Work required at the UWMP includes:

- Preparation of drainage design and earthworks levels for the subject site, including subsoil drainage design where required; and
- Management of Potential Acid Sulphate Soils where appropriate.

8 SUBDIVISION AND URBAN WATER MANAGEMENT PLANS

An Urban Water Management Plan will be required at the point of subdivision to confirm compliance of the development with the Local Water Management Strategy. The Department of Water has agreed that the groundwater monitoring results presented in the Local Water Management Strategy are adequate to support an Urban Water Management Plan in this case (Department of Water, letter dated 19 January 2010).

8.1 ENVIRONMENTAL ISSUES

Additional environmental work may be required by the Western Australian Planning Commission at the subdivision stage as a condition of subdivision. This work may include:

- *Acid sulphate soils investigations where sites have been identified as being at risk (Figure 4);*
- *Contaminated site management plan where sites potentially contaminated sites have been identified (Figure 5);*
- *Dewatering management plans;*
- *Ensure that remnant vegetation of significance is clearly identified and retained; and*
- *Identify contingency action plan and trigger values for post development monitoring (refer Table 10).*

8.2 WATER CONSERVATION

The Urban Water Management Plan should:

- *Provide information on the use of rainwater tanks, grey water systems or other alternate water sources used;*
- *Details of any waterwise landscaping packages to be provided to households; and*
- *Provide further details on any other water conservation measures in-house and ex-house to be implemented at the site.*

8.3 STORMWATER MANAGEMENT

The Urban Water Management Plan should include:

- *Details of landscaping for swales, rain gardens and bioretention areas;*

- *Confirmation of finished lot levels;*
- *Provision of a detailed drainage plan for the subdivision area including swales, rain gardens and* bioretention areas *and confirmation of sizing and location of structures;*
- *A detailed drainage plan which should include consideration of upstream catchments; and*
- *Preparation of drainage design and earthworks levels for the subject site, including subsoil drainage design where required.*

8.4 GROUNDWATER MANAGEMENT

The Urban Water Management Plan should include:

- *Confirmation of groundwater allocation for POS and response in terms of landscaping design;*
- *Undertake subdivision-level water balances based on the groundwater allocation;*
- *Identify monitoring locations, analytes and frequency for post-development monitoring;*
- *Contingency planning for post-development monitoring;*
- *Management of Potential Acid Sulphate Soils where appropriate(Figure 4);*
- *Preparation of drainage design and earthworks levels for the subject site, including subsoil drainage design where required; and*
- *Provide and implementation plan which includes monitoring, construction, contingency, roles and responsibilities.*

9 IMPLEMENTATION

9.1 ROLES & RESPONSIBILITIES

Table 9: Implementation Plan

Item	Responsibility for Scheme Development	Interim Maintenance (first two years)	Long-term Maintenance
Waterwise fittings and rainwater tanks	Developer to encourage and provide guidance. Residents to construct their own systems.	Residents	Residents
Swales and drainage system within the road reserve, including subsoil drainage	Developer	Developer for 12 months as per City requirements.	City of Cockburn
Public Open Space	City of Cockburn	City of Cockburn	City of Cockburn
Monitoring of the development and contingency responses	Developer. The City of Cockburn will oversee the monitoring and coordinate reporting.	Developer for two years following practical completion of each stage of development.	Holder of groundwater license for monitoring in compliance with license conditions.

9.2 POST- DEVELOPMENT MONITORING

A detailed post-development monitoring program and contingency plan should be developed for the subdivision by the developer and submitted to the City of Cockburn before any works are commenced. These programs should be inline with the LWMS.

Post-development monitoring for each stage will include monthly measurements of ground water and surface water levels (where surface water is present) and quarterly sampling for pH, electrical conductivity, redox potential, total nitrogen, ammonia, heavy metals, Kjeldahl nitrogen, nitrate/nitrite, total phosphorus and phosphate in groundwater for which trigger levels and resulting actions are outlined in Table 10. This monitoring will be undertaken for two years following the practical completion of each stage.

Monitoring shall be undertaken at the pre-development bores and at each bioretention area (Figure 7). In addition to the predevelopment bores, a monitoring bore shall be

installed at the east end of Muriel Court adjacent to the freeway (MC7 on Figure 7). Where pre-development bores are destroyed during construction, replacement bores of a similar depth shall be installed and monitored after development.

Surface water monitoring shall be undertaken in each main bioretention area, using monthly grab samples taken when water is present.

Table 10: Parameters, Tests and Actions Associated with Monitoring

Parameter	Test	Trigger	Action
Groundwater Levels and Quality	Groundwater level and water quality from pre-development bores, sampled quarterly	Increase in Total Phosphorus and Total Nitrogen concentration compared to pre-development baseline for two successive events (refer Table 1). Increase in groundwater level over two successive winters from predevelopment levels.	Responsible body to investigate reasons for any change. If intervention is required, this shall be undertaken prior to the following winter.
Surface water quality	Surface water quality - opportunistic event based sampling at least 4 times per year.	Increase in Total Phosphorus and Total Nitrogen concentration compared to pre-development baseline for two successive events.	Responsible body to investigate reasons for any change. If intervention is required, this shall be undertaken prior to the following winter.

The contingency response to the monitoring program will be detailed in each UWMP. It will likely include trigger levels and action levels in the groundwater levels and wetlands that will require investigation and responsive actions. There will also be water quality criteria to be addressed.

9.3 REPORTING

Reporting will be co-ordinated by the developer and submitted to City of Cockburn and DoW for review. The reports will compare the monitoring results with the target design criteria and performance objectives and determine what, if any, further actions may be

necessary. Reports will also provide ongoing assessment of the suitability of existing monitoring and reporting frequencies. Assessment of performance compliance against water quality criteria will require careful consideration to account for inter-seasonal and inter-annual variability, and also take into account both surface and groundwater quality function of historical land use practices not only within the development area, but over the entire upstream catchment.

Reports will be prepared on an annual basis, and cover the calendar year. Developers may choose to co-operate and issue joint reports.

9.4 CONTINGENCY PLAN

If baseline groundwater quality values (Table 1) are exceeded for two successive events, then steps will be taken as follows:

- Re-sample the affected bores/surface water location to confirm the result;
- If the result is consistent, determine a cause through inspection (e.g. is there a blockage in the system, are the subsoil drains working correctly);
- Undertake maintenance or mitigation measures if required.

Results from the affected area should be watched closely in subsequent monitoring events, to determine if the management measures have been effective.

Given that the majority of increase in nutrient levels is expected from household fertiliser applications, household education programs could be considered a potential mitigation strategy should nutrient levels be seen to increase.

If sustained ponding is noted during the groundwater and surface water monitoring program, then this will be referred to the entity managing the asset at the time. It will trigger an investigation into the cause of the sustained ponding and an engineering remedy will likely ensue. This is a responsibility link between the water quality monitoring program and the hydraulic maintenance program.

10 REFERENCES

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FIGURES

PRINTED: Wed 13 Oct 10

DRAWN: TE 21-09-09 AUTHOR: MD 21-09-09

09-181-f1.dgn

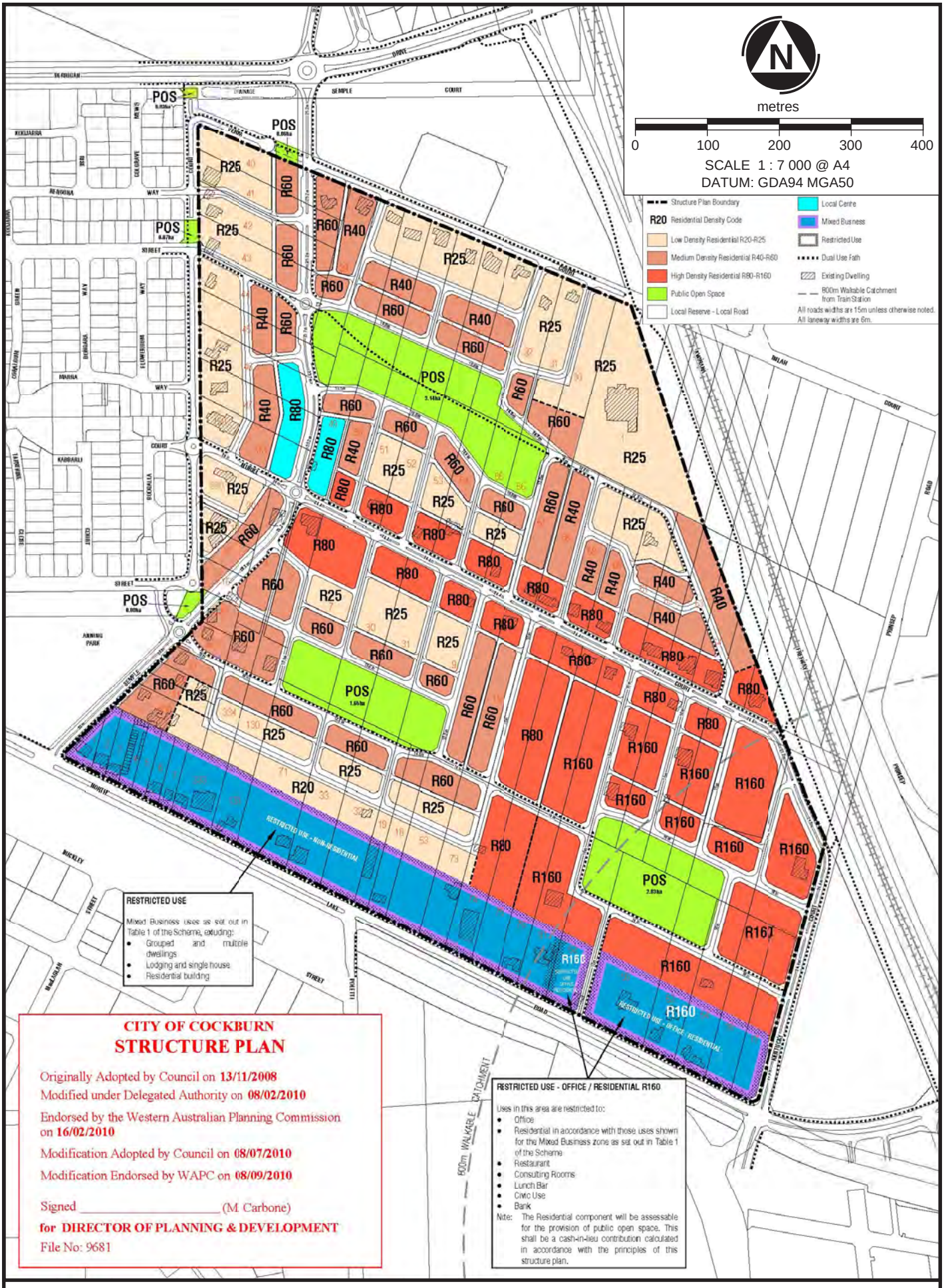
City of Cockburn
AREA 19 MURIEL COURT, COCKBURN CENTRAL
LOCAL WATER MANAGEMENT STRATEGY

SITE PLAN

FIGURE 1

Bore locations supplied by Department of Water, 7/09/2009

env Australia



PRINTED: Wed 13 Oct 10

AUTHOR: MD 1-01-10

DRAWN: TE 1-01-10

09-181-f2.dgn

City of Cockburn
AREA 19 MURIEL COURT, COCKBURN CENTRAL
LOCAL WATER MANAGEMENT STRATEGY
STRUCTURE PLAN
FIGURE 2

SOURCE: City of Cockburn 19_Muriel Court_DSP_10ModifiedJul2010A3

env Australia

PRINTED: Thu 14 Oct 10

metres

0 10 20 30 40 50

SCALE 1 : 6 000 @ A3
DATUM: GDA49 MGA50

LEGEND

- Area 19 Boundary
- Cadastral Boundary
- 25 Topographical Contour (1.0m interval)

Berrigan Drive
Verna Court
Semple Court
Muriel Court
KWINANA FREEWAY
North Lake Road
Kentucky Court
Tea Tree Close
COCKBURN CENTRAL

Aerial supplied by Langate

09-181-f3.dgn DRAWN: TE 27-01-10 AUTHOR: MD 27-01-10

City of Cockburn
AREA 19 MURIEL COURT, COCKBURN CENTRAL
LOCAL WATER MANAGEMENT STRATEGY
SITE CONDITIONS
FIGURE 3

env Australia

PRINTED: Wed 13 Oct 10

Berrigan Drive

Verna Court

Semple Court

Muriel Court

Kentucky Court

Tea Tree Close

North Lake Road

KWINANA FREEWAY

COCKBURN CENTRAL

MODERATE TO LOW ASS

HIGH RISK ASS

MC1 MC2 MC3 MC4 MC5 MC6

3196 13686 3157

TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP11 TP12 TP13 TP14 TP15 TP16 TP17 TP18 TP19 TP20 TP21 TP22 TP23 TP24 TP25 TP26 TP27 TP28 TP29 TP30 TP31 TP32 TP33 TP34

P1 P2 P3 P4 P5 P6 P7 P8 P9 P10 P11 P12 P13 P14 P15 P16 P17 P18 P19 P20 P21 P22 P23 P24 P25 P26 P27 P28 P29

metres

0 50 100 150 200 250

SCALE 1 : 6 000 @ A3

DATUM: GDA49 MGA50

LEGEND

- Area 19 Boundary
- Cadastral Boundary
- Topographical Contour (0.5m interval)
- DOW Groundwater bore
- DOW Surface water monitoring point
- Monitoring bore LWMS
- Test Pit Location
- Perth Sand Penetrometer Test Location

ACID SULFATE SOILS

HIGH ASS — High risk of actual acid sulfate soil (AASS) & potential acid sulfate soil (PASS) <3m from surface

MOD. ASS — Moderate to low risk of AASS and PASS occuring generally at depths of >3m

LOW ASS — Low to no risk of AASS and PASS occuring generally at depths of >3m (Not Applicable to this figure)

Source: DPI, 10-2-2005
Mapped Scale 1:200 000, Accurate up to 1:25 000
Indicative at 1 : 6 000

GEOLOGY

- Fill observed at depth <2.7m
- Coffee rock observed at < 2.7m
- Bassendean sand

Aerial supplied by Langate
Geomorphic Wetlands supplied by DOE, 2004

City of Cockburn
AREA 19 MURIEL COURT, COCKBURN CENTRAL
LOCAL WATER MANAGEMENT STRATEGY
GEOTECHNICAL
FIGURE 4

env Australia

09-181-f4.dgn DRAWN: TE 1-02-09 AUTHOR: MD 1-02-09

PRINTED: Wed 13 Oct 10

N

metres

0 10 20 30 40 50

SCALE 1 : 1 000
DATUM: GDA49 MGA50

LEGEND

- Area 19 Boundary
- Geomorphic Wetlands
  - Conservation Category Wetland
  - Resource Enhancement Wetland
  - Multiple Use Wetland
- Potentially Contaminated Sites (as per ACE Environmental Report)

Berrigan Drive
Verna Court
Semple Court
Muriel Court
KWINANA FREEWAY
North Lake Road
Kentucky Court
Tea Tree Close
COCKBURN CENTRAL

Aerial supplied by Langate
Geomorphic Wetlands supplied by DOE, 2004

City of Cockburn
AREA 19 MURIEL COURT, COCKBURN CENTRAL
LOCAL WATER MANAGEMENT STRATEGY
ENVIRONMENTAL
FIGURE 5

env Australia

09-181-f5.dgn DRAWN: TE 1-02-09 AUTHOR: MD 1-02-09

PRINTED: Thu 14 Oct 10

N

metres

0 10 20 30 40 50

SCALE 1 : 10 000@A3
DATUM: GDA49 MGA 50

LEGEND

- Area 19 Boundary
- Drainage location
- Flow direction

Lakelands

Berrigan Drive Drain

Berrigan Drive

Verna Court

Semple Court

Semple Court Drain

Muriel Court

KWINANA FREEWAY

North Lake Road

Anning Park

Buckley Street Basin

Yangebup Lake

North Lake Road Drain

North Lake Road Rerserve

Buckley Street

Kentucky Court

Tea Tree Close

Poletti Road

Beeliar Drive

Hammond Road

Beeliar Lake

Aerial supplied by Landgate

09-181-f6.dgn DRAWN: TE 24-06-10 AUTHOR: MD 24-06-10

City of Cockburn
AREA 19 MURIEL COURT, COCKBURN CENTRAL
LOCAL WATER MANAGEMENT STRATEGY

EXISTING SURFACE DRAINAGE

FIGURE 6

env Australia

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Berrigan Drive

Verna Court

Semple Court

Muriel Court

North Lake Road

Kentucky Court

Tea Tree Close

KWINANA FREEWAY

COCKBURN CENTRAL

MC1	
pH	5.9
EC	0.11
Total P	0.03
Total N	1.05

MC2	
pH	5.4
EC	0.28
Total P	0.665
Total N	2.05

MC3	
pH	6.6
EC	0.56
Total P	0.345
Total N	2.05

MC4	
pH	6.5
EC	0.40
Total P	0.05
Total N	1.4

MC5	
pH	5.6
EC	0.84
Total P	0.82
Total N	5.0

MC6	
pH	6.7
EC	0.59
Total P	0.11
Total N	0.95

MC1 21.548

MC2 23.032

MC3 21.818

MC4 23.705

MC5 20.575

MC6 23.988

MC7

N

metres

0 60 120 180 240 300

SCALE 1 : 6 000 @ A3

DATUM: GDA49 MGA50

LEGEND

- Area 19 Boundary
- Cadastral Boundary
- 25 Topographical Contour (1.0m interval)
- MC1 Monitoring bore LWMS
- MC7 Additional Post Development Monitoring Bore
- 21.818 AAMGL (m AHD)
- 21 AAMGL Contour (m AHD)
- Groundwater Flow Direction

Depth to Groundwater

- Above Surface
- 0 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 2m
- >2m

- Greater than short term value HRAP target + TN=2mg/L & TP=0.2mg/L
- Greater than long term value HRAP target + TN=1mg/L & TP=0.1mg/L

Aerial supplied by Langate

09-181-f7.dgn DRAWN: TE 24-05-10 AUTHOR: MD 24-05-10

City of Cockburn

AREA 19 MURIEL COURT, COCKBURN CENTRAL

LOCAL WATER MANAGEMENT STRATEGY

GROUNDWATER PLAN

FIGURE 7

env Australia

PRINTED: Mon 06 Dec 10

Lakelands Reserve

Berrigan Drive

Verna Court

Semple Court

NORTHERN CATCHMENT

Top water level 23.9m AHD
Storage volume 15309m 3

WESTERN CATCHMENT

Top water level 23.6m AHD
Storage volume 4584m 3

To Lake Yangebup

Outfalls

Anning Park

North Lake Road

Buckley St Basin

WESTERN CATCHMENT

Muriel Court

KWINANA FREEWAY

SOUTH - EASTERN CATCHMENT

Top water level 25.0m AHD
Storage volume 4368m 3

North Lake Road Drain

Kentucky Court

Tea Tree Close

Poletti Road

N

metres

0 60 120 180 240 300

SCALE 1 : 6 000
DATUM: GDA49 MGA50

LEGEND

- Area 19 Boundary
- Cadastral Boundary
- Catchment Area
- Public open space
- Inundation area
- Flow Path
- Stormwater Infrastructure

09-181-f8.dgn DRAWN: TE 23-06-10 AUTHOR: JH 23-06-10

City of Cockburn
AREA 19 MURIEL COURT, COCKBURN CENTRAL
LOCAL WATER MANAGEMENT STRATEGY
100 YEAR FLOOD EVENT PLAN
FIGURE 8

env Australia

PRINTED: Mon 06 Dec 10

Lakelands Reserve

Berrigan Drive

Semple Court

NORTHERN CATCHMENT

NORTHERN CATCHMENT
Top water level 23.6m AHD
Storage volume 6100m^3
Top water level area 5481m^2

WESTERN CATCHMENT
Top water level 23.24m AHD
Storage volume 1702m^3
Top water level area 2700m^2

WESTERN CATCHMENT

Muriel Court

KWINANA FREEWAY

To Lake Yangebup

Anning Park

Outfalls

North Lake Road

Buckley St Basin

SOUTH - EASTERN CATCHMENT

SOUTH - EASTERN CATCHMENT
Top water level 24.7m AHD
Storage volume 2200m^3
Top water level area 1284m^2

North Lake Road Drain

Poletti Road

COCKBURN CENTRAL

N

metres

0 60 120 180 240 300

SCALE 1 : 6 000
DATUM: GDA49 MGA50

LEGEND

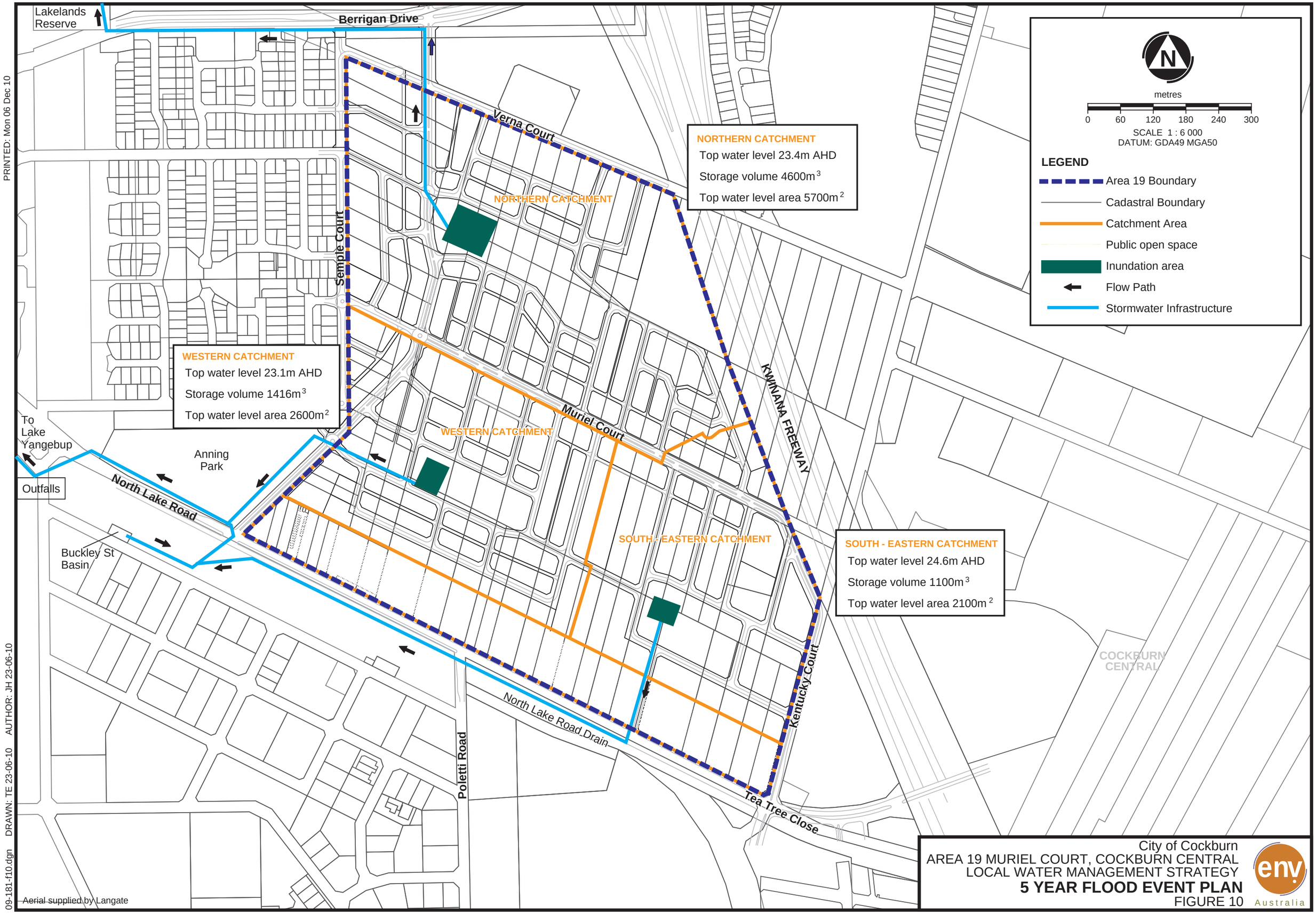
- Area 19 Boundary
- Cadastral Boundary
- Catchment Area
- Public open space
- Inundation area
- Flow Path
- Stormwater Infrastructure

09-181-f9.dgn DRAWN: TE 23-06-10 AUTHOR: JH 23-06-10

Aerial supplied by Langate

City of Cockburn
AREA 19 MURIEL COURT, COCKBURN CENTRAL
LOCAL WATER MANAGEMENT STRATEGY
10 YEAR FLOOD EVENT PLAN
FIGURE 9

env Australia



City of Cockburn
AREA 19 MURIEL COURT, COCKBURN CENTRAL
LOCAL WATER MANAGEMENT STRATEGY
5 YEAR FLOOD EVENT PLAN
FIGURE 10

env Australia

PRINTED: Mon 06 Dec 10

Lakelands Reserve

Berrigan Drive

Verna Court

Semple Court

NORTHERN CATCHMENT

NORTHERN CATCHMENT
Top water level 23.0m AHD
Storage volume 2567m^3
Top water level area 5000m^2

WESTERN CATCHMENT
Top water level 23.0m AHD
Storage volume 1051m^3
Top water level area 2400m^2

To Lake Yangebup

Outfalls

Anning Park

North Lake Road

Buckley St Basin

WESTERN CATCHMENT

Muriel Court

KWINANA FREEWAY

SOUTH - EASTERN CATCHMENT

SOUTH - EASTERN CATCHMENT
Top water level 24.5m AHD
Storage volume 818m^3
Top water level area 1900m^2

North Lake Road Drain

Poletti Road

Kentucky Court

Tea Tree Close

COCKBURN CENTRAL

N

metres

0 60 120 180 240 300

SCALE 1 : 6 000
DATUM: GDA49 MGA50

LEGEND

- Area 19 Boundary
- Cadastral Boundary
- Catchment Area
- Public open space
- Inundation area
- Flow Path
- Stormwater Infrastructure

AUTHOR: JH 23-06-10

DRAWN: TE 23-06-10

09-181-f11.dgn

Aerial supplied by Langate

City of Cockburn
AREA 19 MURIEL COURT, COCKBURN CENTRAL
LOCAL WATER MANAGEMENT STRATEGY
1 YEAR FLOOD EVENT PLAN
FIGURE 11

env Australia

PRINTED: Fri 22 Jul 11

Notes:
- tree value and quality to be assessed onsite at POS design stage, to confirm if retention is suitable,
- existing grass trees to be removed & relocated prior to earthworks,
- no separation between 1:5 and 1:100 storage,
- 1:5 event overtops 1:1,
- maximum depth 1:1 -- 500mm
  1:5 -- 800mm
  1:100 -- 1500mm

Biofiltration area
1:1 event storage
TWL 23.0
volume 922m3
area 1,844m2
@0.5 depth
base 22.50

1:1 event storage - underground
volume 129m3
area 556m2

Retaining walls
around 1:1 event

retained vegetation at
existing RL 23.00 approx

note: requires detailed examination if seperation between 1:5 and 1:100 event storage is required

1:100 event storage
TWL 23.6
volume 4,584m3
area 5,953m2
base 22.80
@0.77 depth
Increase depth to 0.9
for surface area of 5,093m2

1:5 event storage
adjust level to 22.70 from 23.10 ADH
volume 1,416m3
area 2,600m2
@0.5 depth

muriel court

landscape sketch plan

Catchment 1 - Western POS

city of cockburn 5 July 2011 Scale 1:2000 at A4

emerge ASSOCIATES
Integrated Science & Design

09-181-f12a.dgn DRAWN: TE 14-10-10 AUTHOR: JH 14-10-10

Notes:
- tree value and quality to be assessed onsite at POS design stage, to confirm if retention is suitable,
- existing grass trees to be removed & relocated prior to earthworks,
- no separation between 1:5 and 1:100 storage,
- 1:5 event overtops 1:1,
- maximum depth 1:1 -- 500mm
  1:5 -- 800mm
  1:100 -- 1500mm

muriel court

landscape sketch plan

Catchment 2 - Northern POS

city of cockburn 5 July 2011 Scale 1:2000 at A4

emerge ASSOCIATES
Integrated Science & Design

LANDSCAPE - PRELIMINARY LANDSCAPE PLAN

FIGURE 12b

env Australia

PRINTED: Fri 22 Jul 11

09-181-f12b.ddn DRAWN: TE 14-10-10 AUTHOR: JH 14-10-10

Notes:
- tree value and quality to be assessed onsite at POS design stage, to confirm if retention is suitable,
- existing grass trees to be removed & relocated prior to earthworks,
- no separation between 1:5 and 1:100 storage,
- 1:5 event overtops 1:1,
- maximum depth 1:1 -- 500mm
  1:5 -- 800mm
  1:100 -- 1500mm

muriel court

landscape sketch plan

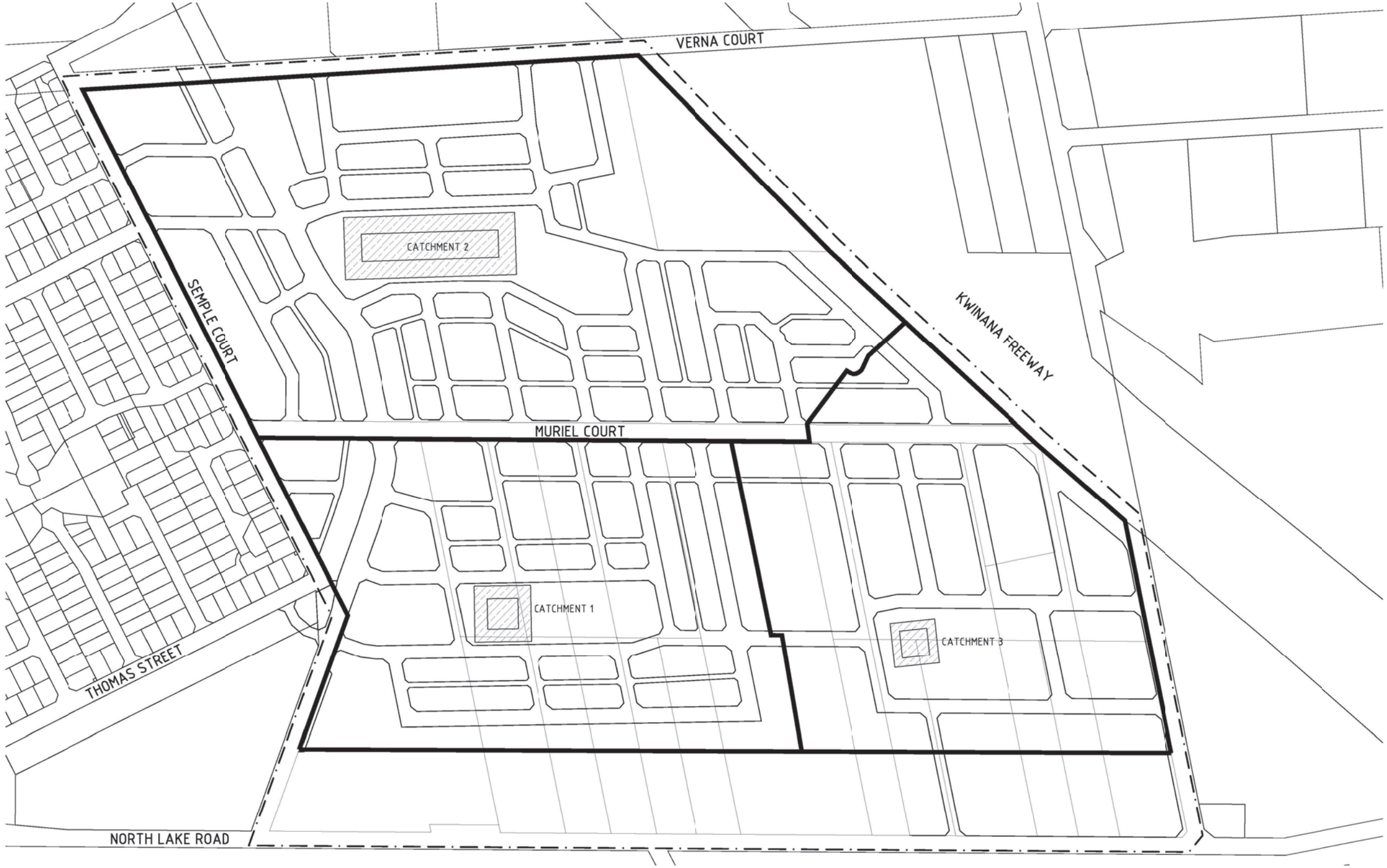
Catchment 3 - South-Eastern POS

city of cockburn 5 July 2011 Scale 1:2000 at A4

emerge ASSOCIATES Integrated Science & Design

PRINTED: Fri 22 Jul 11

09-181-f12c.dgn DRAWN: TE 14-10-10 AUTHOR: JH 14-10-10



LEGEND:

(EXISTING)

CONTOURS —245.0—

(PROPOSED)

CATCHMENT AREAS

EXTENT OF SITE

DESIGN LEVEL CONTOURS —245.0—

CUT AREA

FILL AREA

BASIN

DESIGN PAD LEVEL 25.60

DESIGN ROAD LEVEL 24.70

DIRECTION OF FLOW

LIST OF DRAWINGS

12233-01	OVERALL LAYOUT PLAN
12233-02	EARTHWORKS PLAN
12233-03	NATURAL SURFACE AND GROUND WATER LEVEL PLAN
12233-04	DESIGN LEVELS AND GROUND WATER LEVEL PLAN
12233-05	DRAINAGE CATCHMENT 1-DESIGN LEVELS
12233-06	CATCHMENT 1 CROSS-SECTIONS
12233-07	DRAINAGE CATCHMENT 2-DESIGN LEVELS
12233-08	CATCHMENT 2 CROSS-SECTIONS SHEET 1
12233-09	CATCHMENT 2 CROSS-SECTIONS SHEET 2
12233-10	DRAINAGE CATCHMENT 3-DESIGN LEVELS
12233-11	CATCHMENT 3 CROSS-SECTIONS

NOTES :

1. TOP SOIL IS TO BE STOCK PILED ON SITE AND RESPREAD AROUND THE VERGES ON COMPLETION OF EARTHWORKS TO BATTERS
2. CONTRACTOR TO MAINTAIN ACCESS TO EXISTING LOTS AT ALL TIMES DURING CONSTRUCTION

EARTHWORKS NOTES

1. STRIP TOPSOIL AND STOCKPILE.
2. PROOF ROLL AREAS TO BE FILLED.
3. IMPORT AND PLACE CLEAN SAND FILL AND COMPACT IN LAYERS OF 300 (COMPACTING FILL).
4. REPLACE TOPSOIL AND FINAL GRADE.
5. STABILISE SITE WITH HYDOMULCH.

SERVICES AND RESTORATION:

1. SERVICES MARKED ON THIS DRAWING ARE APPROXIMATE AND ARE UNCONFIRMED.
2. LOCATE ALL SERVICES WITHIN THE VICINITY OF WORKS PRIOR TO COMMENCEMENT. CONTACT 1100
3. IN THE EVENT THAT SERVICES MAY HAVE TO BE FOUND, ARRANGE A SITE MEETING WITH THE AUTHORITY CONCERNED, LOCATE AND PROTECT SERVICES TO THE SATISFACTION OF BOTH PARTIES.
4. ALL PUBLIC AND PRIVATE PROPERTY WITHIN THE ROAD RESERVE AND LOTS MUST BE REINSTATED TO ORIGINAL CONDITION OR BETTER IF INTERFERED WITH DURING THE WORKS.

DIAL BEFORE YOU DIG

ENGINEERING - OVERALL PLAN

FIGURE 13

REVISION	DESCRIPTION	DESIGN PR	DRAWN JB	CHECKED MD	DATE
A	INITIAL DRAWING				

McDowall Affleck

DESIGNERS | PROJECT MANAGERS | CONSTRUCTORS

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THIS IS ISSUED FOR

INFORMATION
COMMENT
APPROVAL
TENDER
CONSTRUCTION

DO NOT USE FOR ANY PURPOSE OTHER THAN THAT INDICATED

SCALE: 1:2500 SHEET SIZE: A1

DATUM: -

ALL DIMENSIONS IN MILLIMETRES DO NOT SCALE

CLIENT: ENV AUSTRALIA PTY LTD.

PROJECT: MURIEL COURT LWMS COCKBURN CENTRAL

TITLE: OVERALL LAYOUT PLAN

DRAWING NUMBER: 12233-01

REVISION: A

PRINTED: Tue 30 Nov 10

VERNA COURT

SEMPLE COURT

KWINANA FREEWAY

MURIEL COURT

THOMAS STREET

NORTH LAKE ROAD

EARTHWORK VOLUMES

CUT	20,486 m³
FILL	1,224,694 m³
EXCESS FILL OVER CUT	1,204,208 m³

ENGINEERING - EARTHWORKS PLAN

FIGURE 14

REVISION	DESCRIPTION	DESIGN	DRAWN	CHECKED	DATE
B	LEGEND ALTERED	PR	EA	MD	30.11.2010
A	INITIAL DRAWING	PR	JB	MD	

McDowall Affleck

DESIGNERS | PROJECT MANAGERS | CONSTRUCTORS

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THIS IS ISSUED FOR

INFORMATION
COMMENT
APPROVAL
TENDER
CONSTRUCTION

DO NOT USE FOR ANY PURPOSE OTHER THAN THAT INDICATED

SCALE: 1:2000 | SHEET SIZE: A1

DATUM: -

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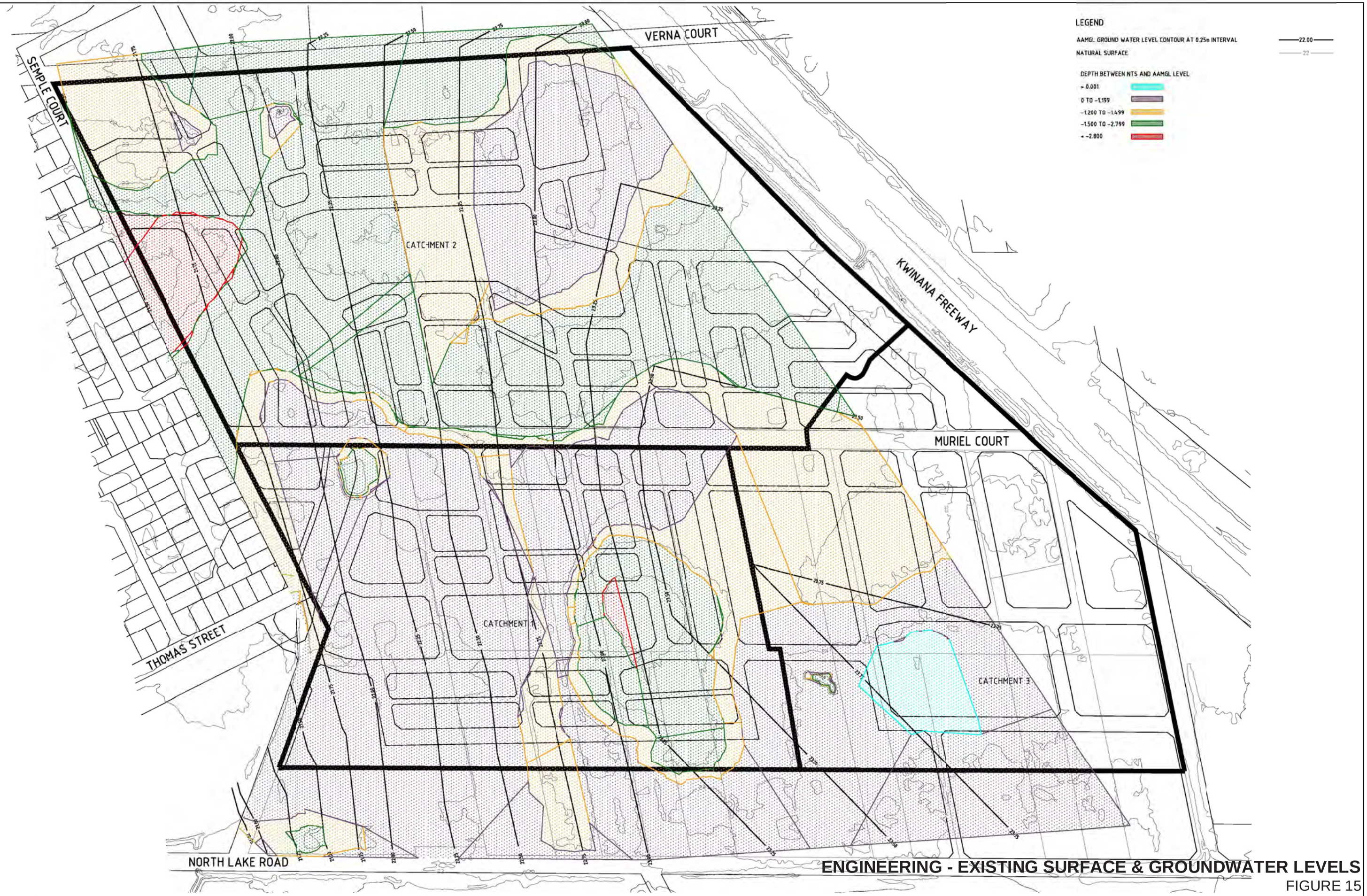
PROJECT: MURIEL COURT LWMS COCKBURN CENTRAL

TITLE: EARTHWORKS PLAN

DRAWING NUMBER: 12233-02

REVISION: B

09-181-f14.dgn DRAWN: TE 14-10-10 AUTHOR: JH 14-10-10



ENGINEERING - EXISTING SURFACE & GROUNDWATER LEVELS

FIGURE 15

REVISION	DESCRIPTION	DESIGN	DRAWN	CHECKED	DATE
B	LEGEND ALTERED	PR	EA	MD	30.11.2010
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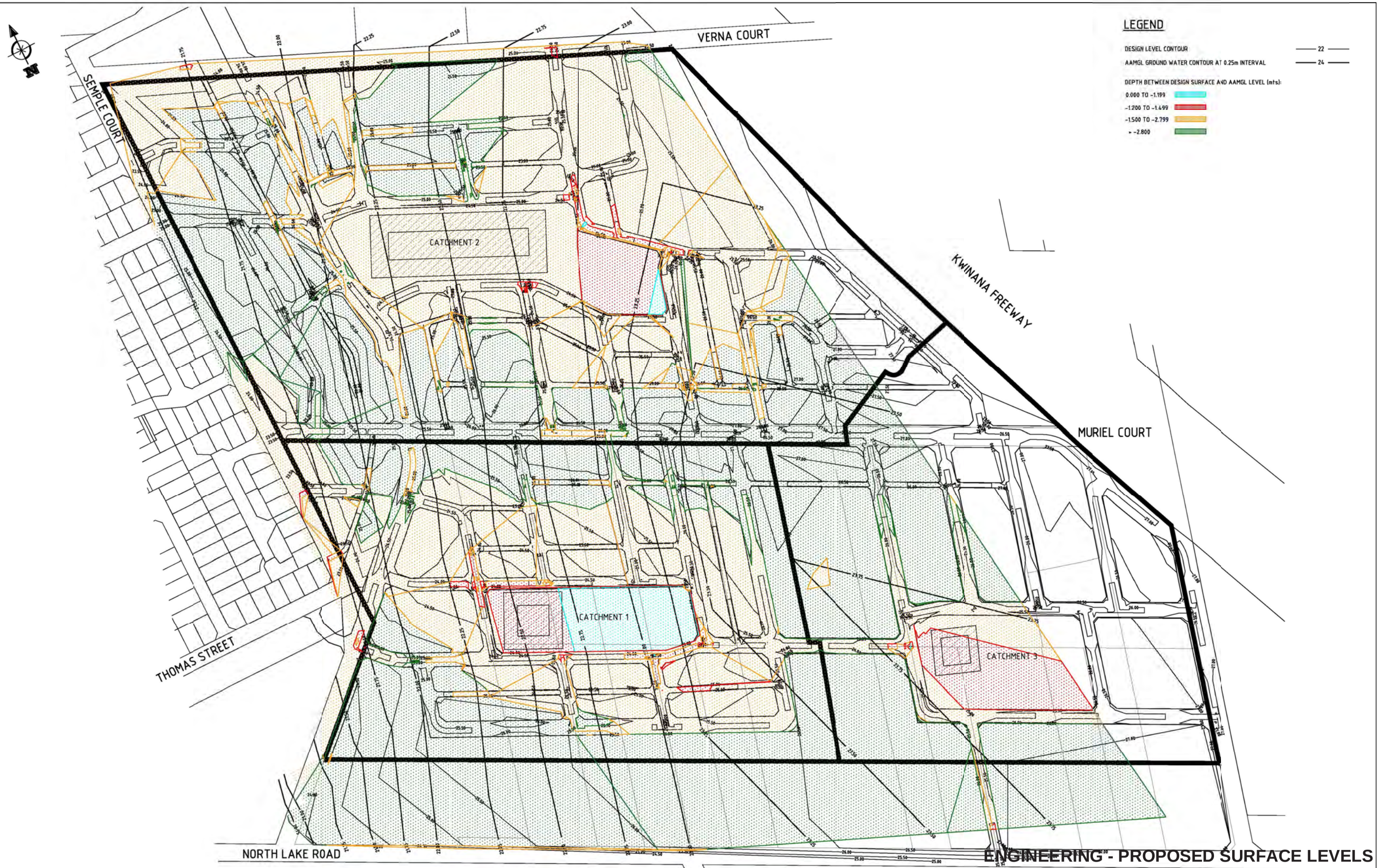
PROJECT: MURIEL COURT LWMS COCKBURN CENTRAL
TITLE: NATURAL SURFACE AND GROUND WATER LEVEL PLAN
DRAWING NUMBER: 12233-03
REVISION: B



ENGINEERING"- PROPOSED SURFACE LEVELS

FIGURE 16

REVISION	DESCRIPTION	DESIGN	DRAWN	CHECKED	DATE
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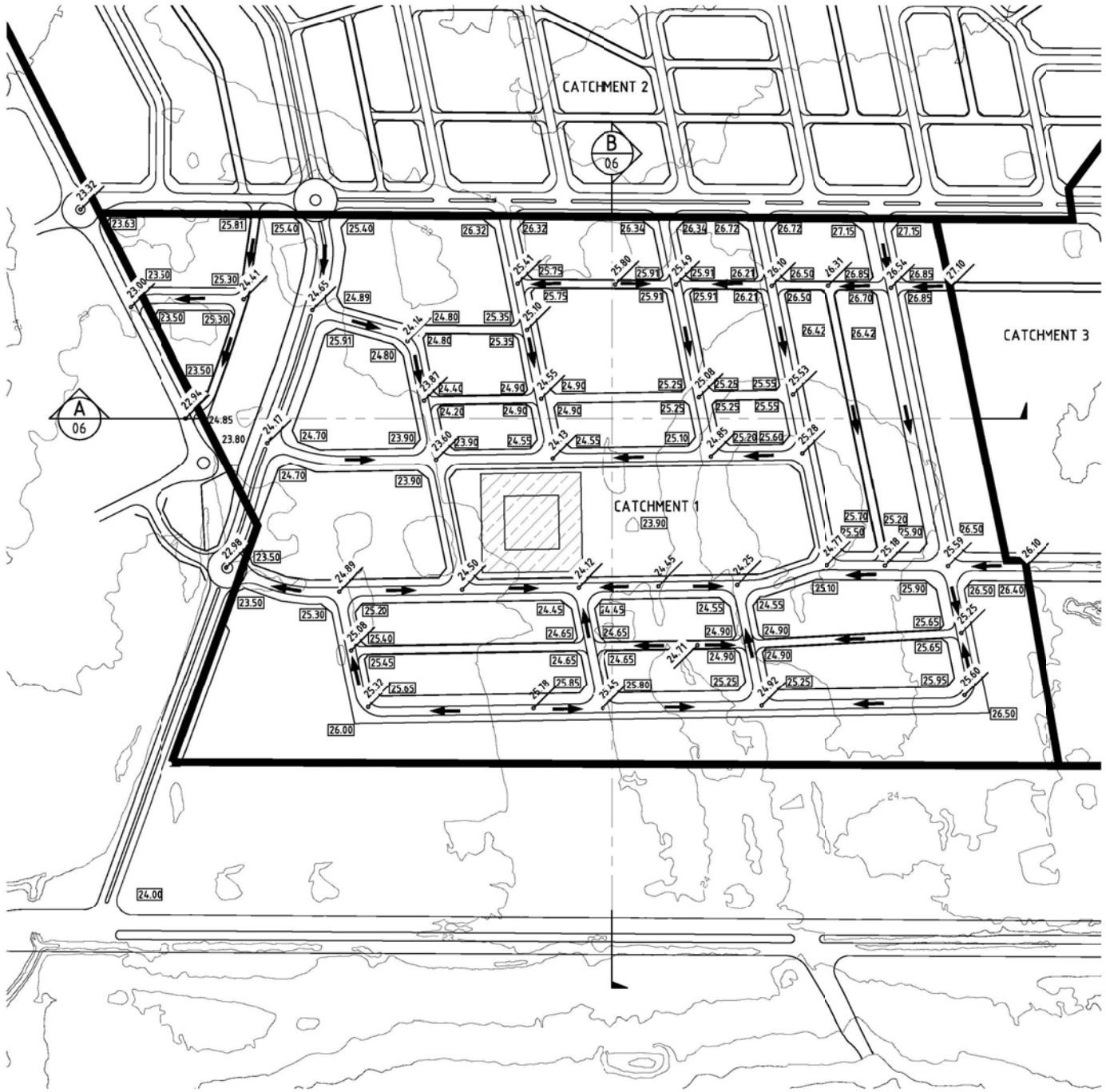
TITLE: DESIGN LEVELS AND GROUND WATER LEVEL PLAN
DRAWING NUMBER: 12233-04
REVISION: B



ENGINEERING - DRAINAGE CATCHMENT 1 DESIGN LEVELS

FIGURE 17

REVISION	DESCRIPTION	DESIGN	DRAWN	CHECKED	DATE
A	INTIAL DRAWING	PR	JB	MD	11.10.2010

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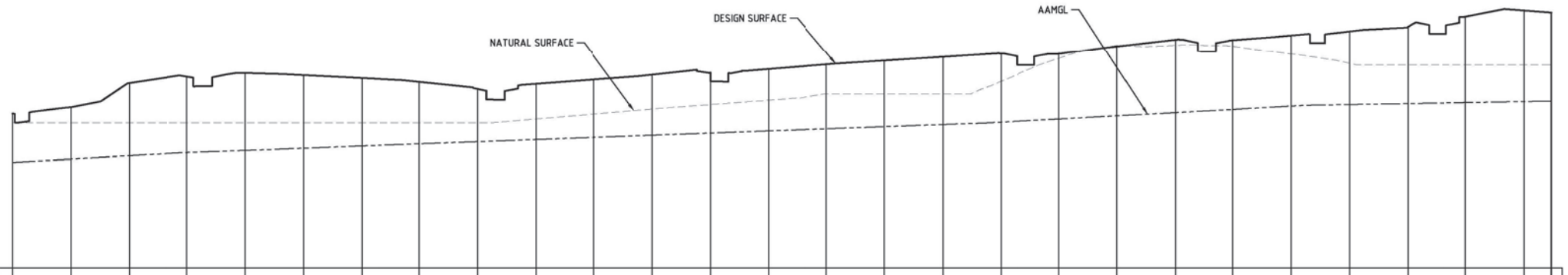
PROJECT: MURIEL COURT LWMS COCKBURN CENTRAL

TITLE: DRAINAGE CATCHMENT 1 DESIGN LEVELS

DRAWING NUMBER: 12233-05

REVISION: A

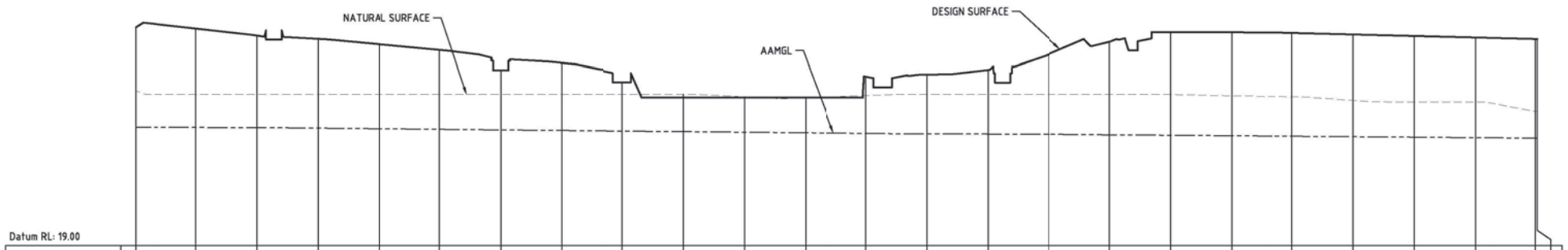
PRINTED: Tue 30 Nov 10
09-181-f17.dgn DRAWN: TE 14-10-10 AUTHOR: JH 14-10-10



Datum RL: 18.00

DESIGN SURFACE	23.32		23.54		24.36		24.59		24.72		24.64		24.54		24.41		24.16		24.35		24.49		24.66		24.73		24.86		25.02		25.15		25.28		25.39		25.39		25.65		25.88		25.87		26.03		26.17		26.33		26.68		26.90		26.83	
DEPTH	1.66		1.77		2.48		2.61		2.67		2.52		2.34		2.13		1.81		1.92		1.99		2.08		2.08		2.14		2.22		2.28		2.34		2.37		2.25		2.41		2.53		2.41		2.46		2.54		2.67		2.99		3.17		3.08	
NATURAL SURFACE	23.00		23.00		23.00		23.00		23.00		23.00		23.00		23.00		23.00		23.13		23.30		23.47		23.63		23.78		24.00		24.00		24.00		24.43		25.23		25.68		25.70		25.66		25.38		25.05		25.00		25.00		25.40		25.40	
GROUND WATER LEVEL	21.66		21.77		21.87		21.98		22.05		22.13		22.21		22.28		22.35		22.43		22.50		22.57		22.65		22.72		22.80		22.87		22.94		23.02		23.13		23.24		23.35		23.46		23.58		23.63		23.66		23.70		23.73		23.75	
CHAINAGE	0.00		20.00		40.00		60.00		80.00		100.00		120.00		140.00		160.00		180.00		200.00		220.00		240.00		260.00		280.00		300.00		320.00		340.00		360.00		380.00		400.00		420.00		440.00		460.00		480.00		500.00		520.00		529.27	

SECTION A
H 1:1000 V 1:100
05



Datum RL: 19.00

DESIGN SURFACE	26.18		26.14		25.91		25.80		25.63		25.44		24.79		25.02		24.40		23.90		23.90		23.90		24.59		24.65		24.80		25.30		25.71		26.02		26.02		26.00		25.95		25.90		25.85		25.80		25.80	
DEPTH	3.26		3.22		3.00		2.91		2.75		2.59		1.95		2.20		1.60		1.12		1.14		1.16		1.86		1.94		2.10		2.61		3.03		3.36		3.37		3.37		3.34		3.30		3.27		3.23		3.23	
NATURAL SURFACE	24.12		24.00		24.00		24.00		24.00		24.00		24.00		24.00		24.00		24.00		23.93		23.89		23.97		24.00		24.00		24.00		24.00		24.00		23.96		23.93		23.81		23.75		23.75		23.45		23.44	
GROUND WATER LEVEL	22.93		22.92		22.91		22.90		22.88		22.86		22.84		22.82		22.80		22.78		22.75		22.74		22.72		22.71		22.70		22.69		22.68		22.66		22.65		22.63		22.61		22.60		22.59		22.57		22.57	
CHAINAGE	0.00		20.00		40.00		60.00		80.00		100.00		120.00		140.00		160.00		180.00		200.00		220.00		240.00		260.00		280.00		300.00		320.00		340.00		360.00		380.00		400.00		420.00		440.00		460.00		460.61			

SECTION B
H 1:1000 V 1:100
05

ENGINEERING - DRAINAGE CATCHMENT 1 SECTIONS PLAN

FIGURE 18

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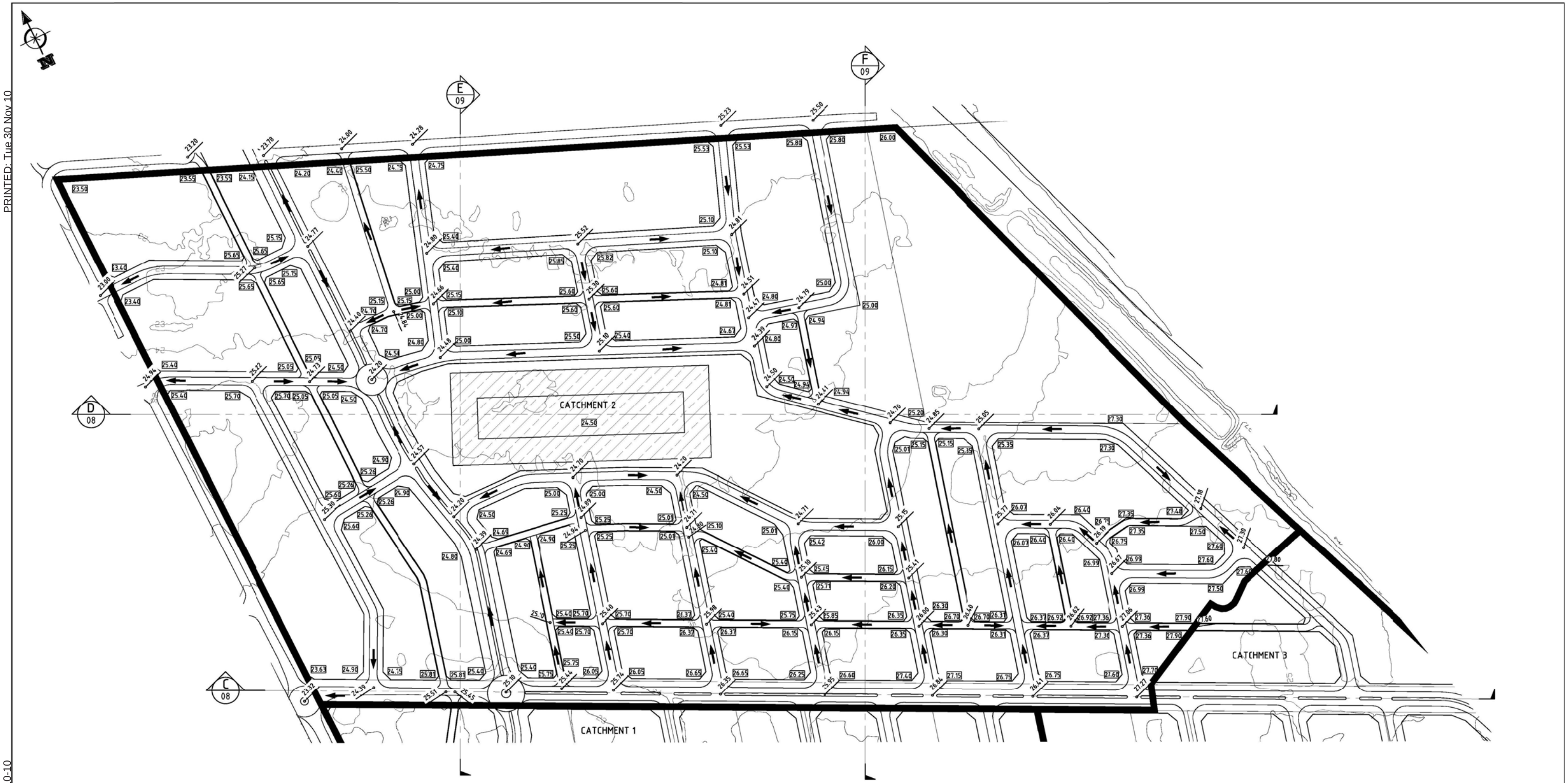
TITLE: CATCHMENT 1 CROSS-SECTIONS
DRAWING NUMBER: 12233-06
REVISION: B



ENGINEERING - DRAINAGE CATCHMENT 2 DESIGN LEVELS

FIGURE 19

REVISION	DESCRIPTION	DESIGN	DRAWN	CHECKED	DATE
A	INITIAL DRAWING	PR	JB	MD	11.10.2010

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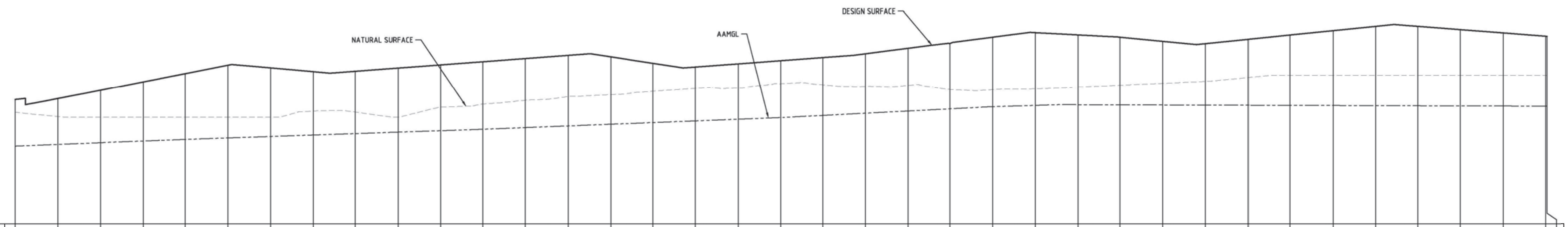
CLIENT: ENV AUSTRALIA PTY LTD.
PROJECT: MURIEL COURT LWMS COCKBURN CENTRAL
TITLE: DRAINAGE CATCHMENT 2 DESIGN LEVELS
DRAWING NUMBER: 12233-07
REVISION: A

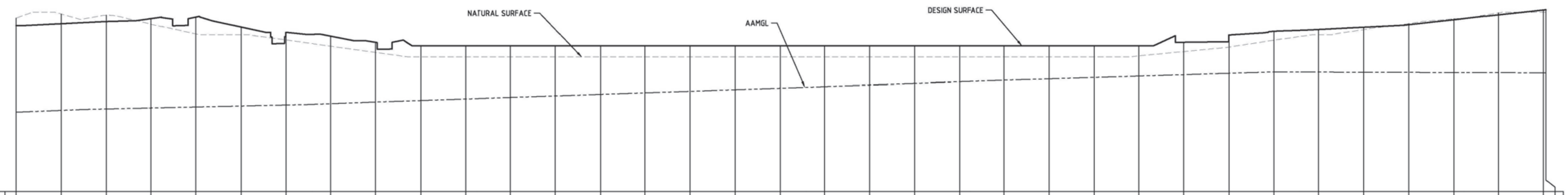
09-181-f20.dgn DRAWN: TE 14-10-10 AUTHOR: JH 14-10-10 PRINTED: Tue 30 Nov 10



Datum RL: 18.00

CHAINAGE	GROUND WATER LEVEL	NATURAL SURFACE	DEPTH	DESIGN SURFACE
0.00	21.64	23.24	2.21	23.85
20.00	21.72	23.04	2.17	23.89
40.00	21.80	23.00	2.49	24.29
60.00	21.88	23.00	2.80	24.68
80.00	21.96	23.00	3.12	25.08
100.00	22.03	23.00	3.45	25.47
120.00	22.10	23.00	3.25	25.35
140.00	22.16	23.30	3.01	25.17
160.00	22.23	23.25	2.96	25.19
180.00	22.30	23.00	3.04	25.34
200.00	22.37	23.48	3.12	25.49
220.00	22.44	23.63	3.20	25.64
240.00	22.51	23.81	3.28	25.79
260.00	22.59	23.98	3.35	25.94
280.00	22.67	24.07	3.20	25.87
300.00	22.75	24.24	2.81	25.57
320.00	22.83	24.37	2.56	25.39
340.00	22.91	24.39	2.63	25.54
360.00	22.99	24.60	2.70	25.69
380.00	23.09	24.55	2.74	25.84
400.00	23.20	24.47	2.82	26.02
420.00	23.30	24.52	2.98	26.28
440.00	23.40	24.32	3.10	26.50
460.00	23.50	24.31	3.29	26.80
480.00	23.57	24.35	3.45	27.01
500.00	23.60	24.44	3.31	26.91
520.00	23.59	24.53	3.21	26.80
540.00	23.58	24.62	3.02	26.60
560.00	23.58	24.71	2.92	26.49
580.00	23.57	24.89	3.13	26.70
600.00	23.57	25.00	3.34	26.90
620.00	23.56	25.00	3.55	27.11
640.00	23.55	25.00	3.76	27.31
660.00	23.55	25.00	3.77	27.31
680.00	23.54	25.00	3.62	27.16
700.00	23.53	25.00	3.47	27.00
720.00	23.53	25.00	3.32	26.85
720.61	23.53	25.00	3.32	26.84

SECTION C 07
H 1:1000 V 1:100



Datum RL: 18.00

CHAINAGE	GROUND WATER LEVEL	NATURAL SURFACE	DEPTH	DESIGN SURFACE
0.00	21.56	25.74	3.84	25.40
20.00	21.64	25.92	3.84	25.49
40.00	21.70	25.87	3.88	25.59
60.00	21.75	25.47	3.97	25.72
80.00	21.79	25.03	3.99	25.78
100.00	21.84	25.00	3.50	25.34
120.00	21.88	24.76	3.22	25.10
140.00	21.94	24.48	2.99	24.93
160.00	22.01	24.21	2.64	24.65
180.00	22.08	24.00	2.42	24.50
200.00	22.15	24.00	2.35	24.50
220.00	22.22	24.00	2.28	24.50
240.00	22.29	24.00	2.21	24.50
260.00	22.36	24.00	2.14	24.50
280.00	22.42	24.00	2.08	24.50
300.00	22.49	24.00	2.01	24.50
320.00	22.56	24.00	1.94	24.50
340.00	22.63	24.00	1.87	24.50
360.00	22.70	24.00	1.80	24.50
380.00	22.77	24.00	1.73	24.50
400.00	22.83	24.00	1.67	24.50
420.00	22.90	24.00	1.60	24.50
440.00	22.97	24.00	1.53	24.50
460.00	23.03	24.00	1.47	24.50
480.00	23.09	24.00	1.41	24.50
500.00	23.15	24.05	1.35	24.50
520.00	23.21	24.24	1.44	24.66
540.00	23.28	24.44	1.71	24.98
560.00	23.33	24.75	1.81	25.15
580.00	23.33	25.00	1.90	25.23
600.00	23.32	25.22	2.01	25.33
620.00	23.31	25.49	2.13	25.44
640.00	23.31	25.70	2.36	25.66
660.00	23.30	25.97	2.58	25.88
680.00	23.30	26.00	2.81	26.10
681.17	23.30	26.00	2.82	26.11

SECTION D 07
H 1:1000 V 1:100

ENGINEERING - DRAINAGE CATCHMENT 2 SECTIONS PLAN 1

FIGURE 20

REVISION	DESCRIPTION	DESIGN	DRAWN	CHECKED	DATE
B	AAMGL NOTED	PR	EA	MD	30.11.2010
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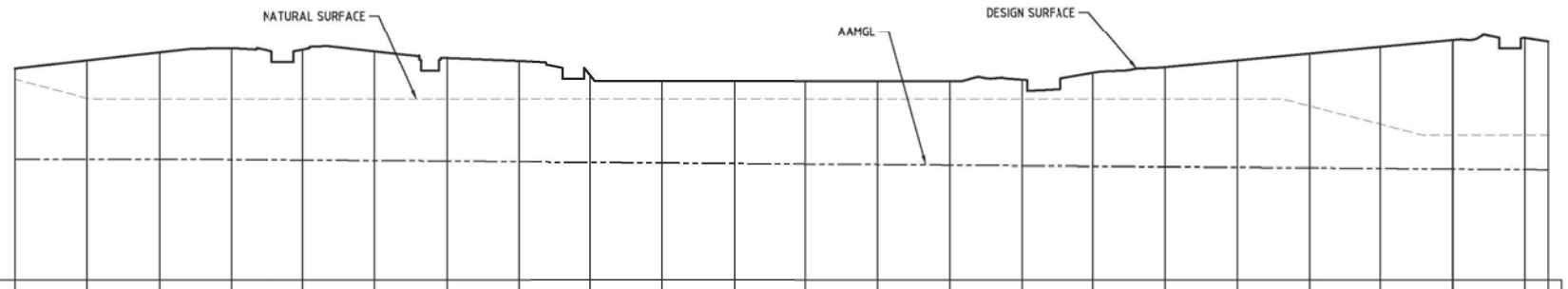
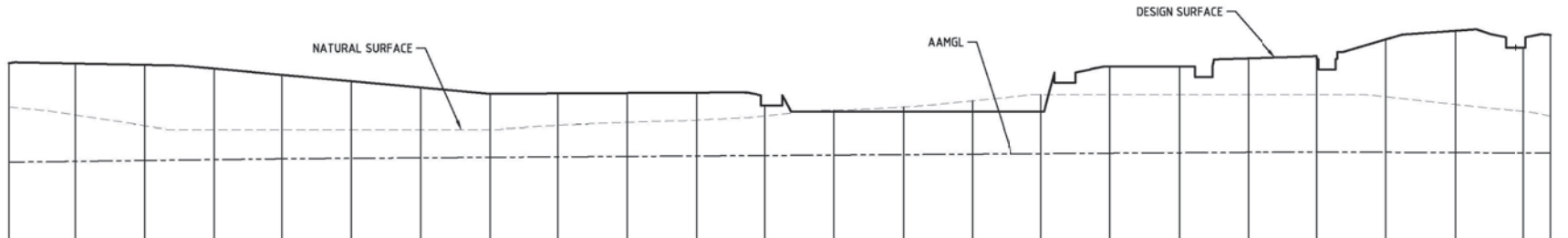
TITLE: CATCHMENT 2 CROSS-SECTIONS SHEET 1
DRAWING NUMBER: 12233-08
REVISION: B



Datum RL: 19.00

DESIGN SURFACE	24.85	25.07	25.30	25.41	25.38	25.33	25.14	25.06	24.67	24.50	24.50	24.50	24.50	24.50	24.50	24.54	24.73	24.89	25.08	25.27	25.46	25.64	25.70	25.61					
DEPTH	2.52	2.75	2.97	3.09	3.07	3.04	2.86	2.79	2.42	2.26	2.28	2.29	2.31	2.32	2.37	2.58	2.75	2.95	3.16	3.36	3.56	3.63	3.54						
NATURAL SURFACE	24.55	24.03	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	23.81	23.30	23.00	23.00	23.00						
GROUND WATER LEVEL	22.33	22.33	22.33	22.32	22.31	22.29	22.28	22.26	22.25	22.24	22.22	22.21	22.19	22.18	22.17	22.15	22.14	22.12	22.11	22.10	22.08	22.07	22.06						
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	300.00	320.00	340.00	360.00	380.00	400.00	420.00	426.42						

SECTION E
H 1:1000 V 1:100 (07)



Datum RL: 20.00

DESIGN SURFACE	25.91	25.90	25.86	25.75	25.57	25.38	25.20	25.02	25.03	25.04	25.05	24.67	24.50	24.50	24.50	24.50	25.18	25.46	26.05	26.11	26.59	26.84	26.36	26.72					
DEPTH	2.84	2.81	2.74	2.61	2.40	2.21	2.01	1.82	1.81	1.81	1.81	1.42	1.23	1.22	1.20	1.19	2.46	2.12	2.70	2.75	3.24	3.50	3.03	3.40					
NATURAL SURFACE	24.64	24.40	24.10	24.00	24.00	24.00	24.00	24.00	24.12	24.19	24.25	24.37	24.54	24.63	24.81	25.00	25.00	25.00	25.00	25.00	24.93	24.71	24.51	24.37					
GROUND WATER LEVEL	23.06	23.09	23.11	23.14	23.16	23.18	23.19	23.20	23.22	23.23	23.24	23.26	23.27	23.28	23.30	23.31	23.32	23.34	23.35	23.36	23.35	23.34	23.33	23.33					
CHAINAGE	0.83	21.00	40.00	61.00	81.00	101.00	121.00	141.00	161.00	181.00	201.00	221.00	241.00	261.00	281.00	301.00	321.00	341.00	361.00	381.00	401.00	421.00	441.00	447.93					

SECTION F
H 1:1000 V 1:100 (07)

ENGINEERING - DRAINAGE CATCHMENT 2 SECTIONS PLAN 2

FIGURE 21

REVISION	DESCRIPTION	DESIGN	DRAWN	CHECKED	DATE
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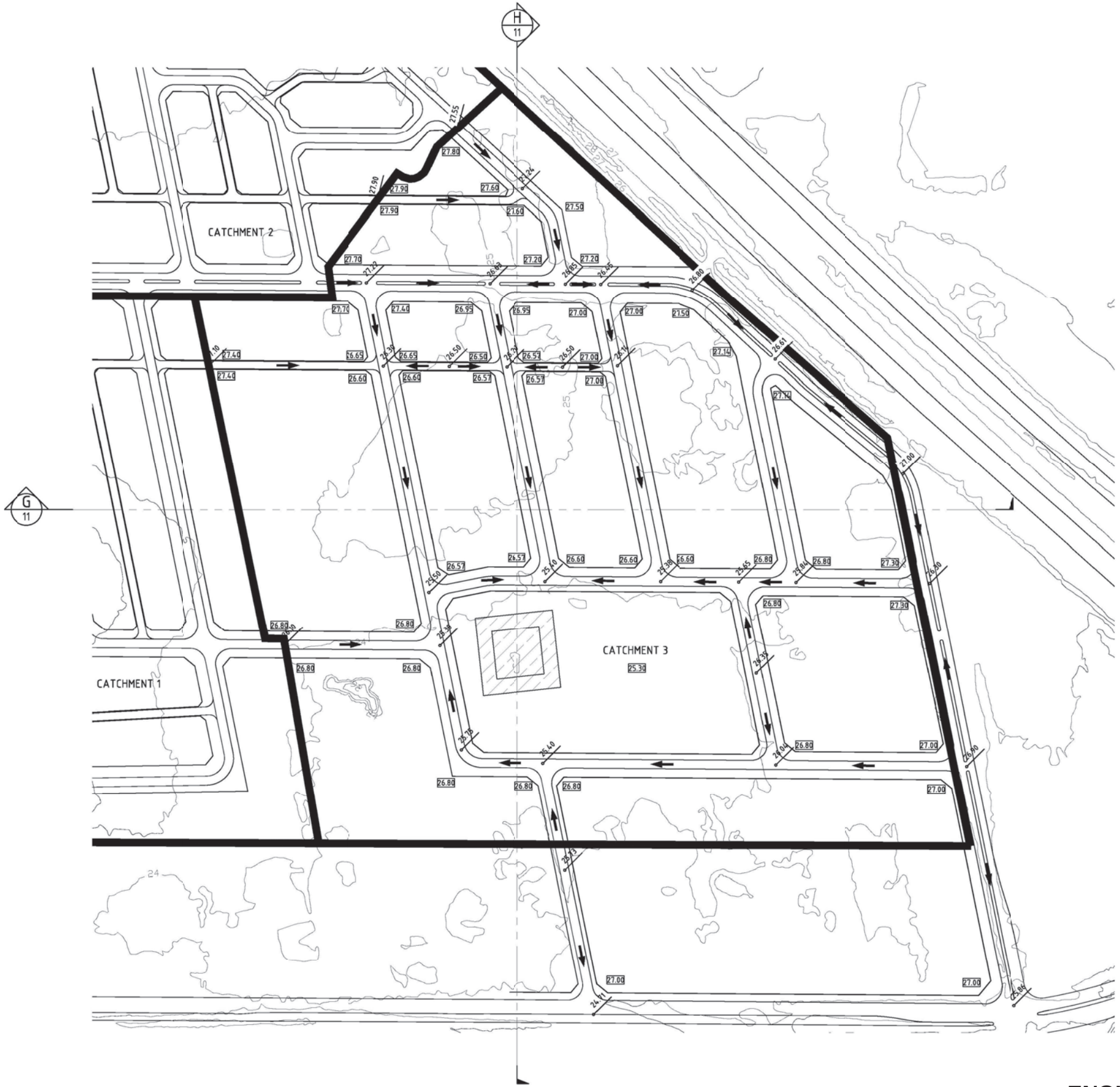
DRAWING NUMBER: 12233-09
REVISION: B



ENGINEERING - DRAINAGE CATCHMENT 3 DESIGN LEVELS

FIGURE 22

REVISION	DESCRIPTION	DESIGN	DRAWN	CHECKED	DATE
A	INITIAL DRAWING	PR	JB	MD	11.10.2010

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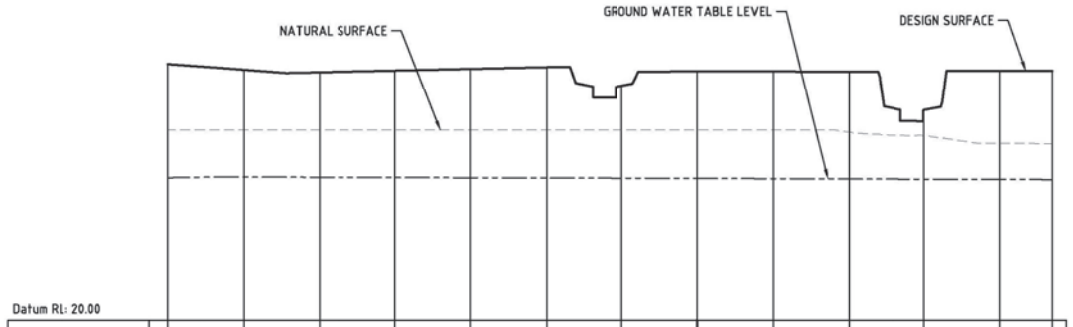
TITLE: DRAINAGE CATCHMENT 3 DESIGN LEVELS
DRAWING NUMBER: 12233-10
REVISION: A



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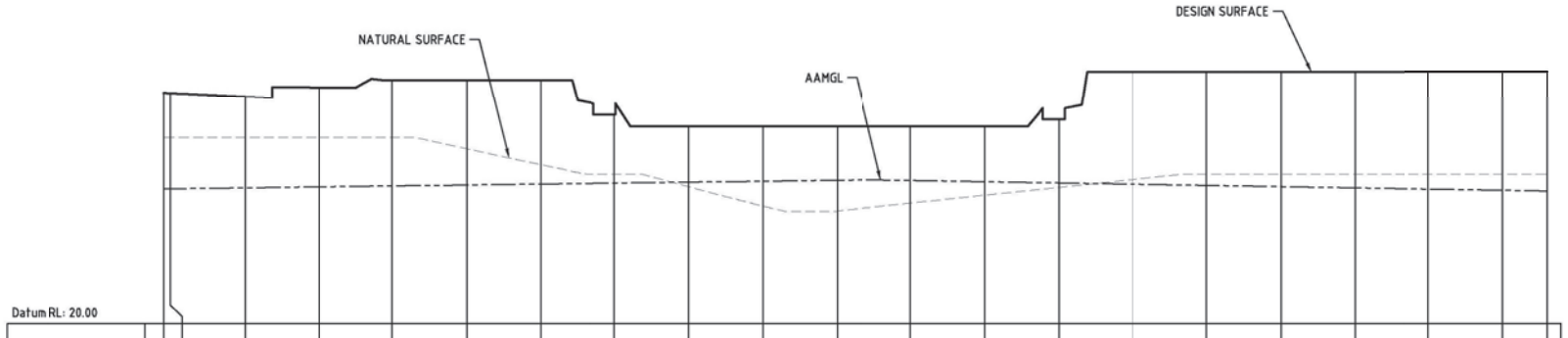
NATURAL SURFACE	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	24.94	24.85	24.64	24.64	
GROUND WATER LEVEL	23.73	23.76	23.75	23.74	23.74	23.73	23.72	23.72	23.71	23.70	23.70	23.69	23.69	
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	233.72	

SECTION G
H 1:1000 V 1:100 10



Datum RL: 20.00

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DEPTH	2.62	2.61	2.48	2.71	2.88	2.86	2.83	1.86	1.51	1.48	1.46	1.46	1.50	1.73	3.06	3.10	3.13	3.16	3.20	3.23	3.25			
NATURAL SURFACE	25.00	25.00	25.00	25.00	25.00	24.69	24.26	24.00	23.67	23.15	23.01	23.23	23.44	23.65	23.86	24.00	24.00	24.00	24.00	24.00	24.00			
GROUND WATER LEVEL	23.61	23.61	23.64	23.66	23.69	23.71	23.74	23.77	23.79	23.82	23.84	23.84	23.80	23.77	23.74	23.70	23.67	23.64	23.60	23.57	23.55			
CHAINAGE	198.16	200.00	220.00	240.00	260.00	280.00	300.00	320.00	340.00	360.00	380.00	400.00	420.00	440.00	460.00	480.00	500.00	520.00	540.00	560.00	571.92			

SECTION H
H 1:1000 V 1:100 10

ENGINEERING - DRAINAGE CATCHMENT 3 SECTIONS PLAN

FIGURE 23

REVISION	DESCRIPTION	DESIGN	DRAWN	CHECKED	DATE
B	AAMGL NOTED	PR	EA	MD	30.11.2010
A	INITIAL DRAWING	PR	JB	MD	

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PROJECT: MURIEL COURT LWMS COCKBURN CENTRAL
TITLE: CATCHMENT 3 CROSS-SECTIONS
DRAWING NUMBER: 12233-11
REVISION: B

APPENDIX A

GEOTECHNICAL INVESTIGATION REPORT

DISTRICT STRUCTURE PLAN
DEVELOPMENT AREA 19
CITY OF COCKBURN
WESTERN AUSTRALIA

GEOTECHNICAL
AND
ACID SULPHATE SOIL ASSESSMENT

MAY 2007
Ref: 06036.01

FOR
KOLTASZ SMITH

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CONDITIONS RELATING TO THIS REPORT

1. This report has been prepared for the sole use of the City of Cockburn. It has been issued in accordance with the agreed terms and scope detailed in the proposal for the investigation. No responsibility or liability to any third party is accepted for any damages arising out of the use of this report.

2. This report has been prepared by suitably qualified and experienced personnel for the purposes stated herein. Every care is taken with the report as it relates to interpretation of sub-surface conditions, discussion of findings and recommendations given. No responsibility for the consequences of extrapolation by others is accepted by the company.

3. Findings and conclusions produced in the report are based on the investigation of the sub-surface through isolated locations. Conditions between investigated sites are based on extrapolation, interpretation and professional estimates. Unexpected variations in ground conditions often occur which cannot always be anticipated. The conclusions and recommendations in the report were considered accurate at the time of issue and based on certain assumptions at the time. Conditions and assumptions change with time and may affect the accuracy of the report.

4. Certain content within this report is based on information provided by the client and/or other parties and the accuracy of this information cannot be guaranteed.

5. These conditions must be read as part of the report and must be reproduced with all future copies.

6. The recommendations of this report should be considered a starting point. Recommendations should be continuously reviewed during the earthworks stage as sub-surface information and results from monitoring become available. It is strongly recommended that the Company be retained to provide consultancy and/or inspections during the earthwork stages.

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1 Introduction

A District Structure Plan (DSP) is currently being prepared for the City of Cockburn's Development Area 19, Jandakot. As part of the DSP a geotechnical and acid sulphate soil assessment is required. Brown Geotechnical & Environmental was commissioned by Koltasz Smith (Project Engineers) on behalf of associated land owners to undertake the assessment. This report presents the results of the assessment.

The terms of reference for the assessment were outlined in Brown Geotechnical and Environmental's proposal dated 4 August 2006. Instructions to proceed with the investigation were received from the Koltasz Smith on 4 October 2006.

Details and plans for the development area, survey plans and contact details for individual Lot owners were supplied through Koltasz Smith.

2 Site Location

Development Area 19 lies at the northwest corner of the intersection of North Lake Road and the Kwinana Freeway. The land is approximately 16km south of the Perth central business district and approximately 10km southeast of Fremantle, within the City of Cockburn. The land adjoins the predominantly developed suburb of South Lake to the west along Semple Court, abuts the Kwinana Freeway to the east, and is bounded by Verna Court to the north and North Lake Road to the south.

3 Site Details and Background

The area has previously been used for a mixture of rural lifestyle, horse agistment and similar related activities. Some light industrial and commercial activities have also been present in the area. Immediately to the west there is history of market gardens.

The area is characterized by low density housing surrounded by grassed paddocks and occasional trees. An area of very dense trees is present towards the south eastern corner and past aerial photographs show groundwater in a small lake bed within this area. During the investigation this area was dry; however a depression with old reeds was evident, though inaccessible to the excavator.

The site area is generally level at approximately 24m AHD with high points to approximately 27m AHD in the central south and northeast.

4 Geology and Environmental Studies

The Environmental Geology sheet for the area **[2]** indicates the site to be underlain by Thin Bassendean Sands over the Guildford Formation (consisting of silts and clays) in the north and south, with Bassendean Sands running west to east through the centre. A pocket of Swamp deposits consisting of silty sand is present towards the south eastern corner.

The Perth Groundwater Atlas **[3]** shows the maximum historical groundwater level to be approximately 23m AHD.

The City of Cockburn, Arterial Drainage Scheme Review Nov 2005 **[4]** show design regional groundwater levels to range from 23.5m AHD in the east of the development area to 20m AHD in the west. The hydraulic gradient is therefore to the west.

The WAPC Bulletin No.64 May 2007 – *Acid Sulphate Soils, Central Perth Metro Area* **[5]** shows the potential for Acid Sulphate Soils (ASS) over the majority of the site to be medium to low. The exception to this is towards the south eastern corner where high risk soils are indicated and are likely to be associated with the swamp deposits show on the geological map.

5 Objectives

It was essential that the geotechnical and acid sulphate soil assessment methodology for the development area was consistent with the requirements for a Structure Plan as detailed in the Town Planning Scheme and WAPC Guidelines for the Preparation of Local Structural Plans in Urban Release Areas (June 1992).

The following issues will therefore be addressed in this report:

- Subsurface conditions.
- Present site classifications in accordance with AS 2870-1996 **[1]**.
- Earthwork required to obtain site classifications suitable for the development of the area.
- The suitability of soils within the area to be used as borrow material for residential or industrial land fill.
- Groundwater levels.
- Drainage and soil permeability issues.
- Public Open Spaces.
- Design CBR's for road pavement design.
- Potential acid sulphate soil issues.

6 Methodology and Scope of Works

To enable an assessment of the geotechnical issues highlighted in Section 5, it was proposed to carry out a limited test pitting exercise across the whole development area. Perth sand penetrometer testing would also be carried out to determine the relative density of sands and current groundwater levels would be recorded in test pits. Selected soil samples would be collected for field descriptions and laboratory testing.

It was also proposed to use the test pitting exercise to assess the extent of the high risk ASS in the south eastern corner of the site. An increased density of test pits would be required in this area. ASS field testing would be carried out on samples from test pits in this area at selected depths.

The fieldwork would be followed by laboratory testing to determine relevant geotechnical properties of the soils and potential ASS risk.

7 Fieldwork and Laboratory Testing

7.1 Investigation Fieldwork

The fieldwork was undertaken during the period from 15 March 2007 to 23 March 2007. Thirty-four test pits were excavated across the site using a 5 tonne excavator. The test pits were extended to a maximum depth of 2.7m. Occasionally test pits were terminated early due to the test pit walls collapsing or where refusal in very dense material was encountered. Perth sand penetrometer (PSP) tests were carried out to determine relative density of the soils at thirty locations. Soil samples were obtained from the test pits for field descriptions, ASS field testing, geotechnical and ASS laboratory testing. Groundwater levels were recorded where encountered.

The original grid system envisaged proved impossible to implement due to site access problems with the high number Lots owners involved. Test pits were located on accessible Lots and an acceptable coverage of the development area was attained. Access into the dense area of trees in the southern corner of the site proved impossible due to the dense vegetation and owner access issues.

Test pit and PSP locations are shown in Figure 1, with test pit logs enclosed in Appendix A and PSP plots in Appendix B.

7.2 ASS Field Testing

Thirty-six soil samples were selected for preliminary ASS testing. Field tests were carried out on all the samples and included the initial pH of the soil (pH_F) and pH after oxidation by hydrogen peroxide (pH_{FOX}), in accordance with the DoE's 'Identification and Investigation of Acid Sulphate Soils and Groundwater' **[6]** and 'Guidelines for Sampling and Analysis of Lowland Acid Sulphate Soils in Queensland' **[7]**. ASS field test results are presented in Appendix D.

7.3 Laboratory Testing

Soil samples were delivered to Western Geotechnics Group laboratories for particle size distributions determinations, percent fines determinations and organic contents. Soil samples were also delivered to ALS Environmental for ASS laboratory testing. The geotechnical laboratory test certificates are presented in Appendix C and ASS laboratory test certificates in Appendix D.

8 Results

8.1 Subsurface Conditions

Subsurface conditions encountered in the test pits and inferred from laboratory testing and penetrometer test results are described as follows:

8.1.1 Fill

Fill was encountered in TP1, 2, 17, 22, 23, 25, 29, 30 and 31. The majority of the fill material encountered consisted of reworked or imported sand often containing gravel of limestone associated with old road base. The depth of fill extended to approximately 0.5m. In TP29 fill

was encountered to 1m depth and consisted of household rubbish and building materials in a sandy matrix.

8.1.2 Topsoil

Topsoil was encountered in seventeen of the test pits and generally consisted of dark grey, fine and medium grained sand with rootlets and occasional roots. The thickness of the topsoil varied from 0.2m to 0.5m.

8.1.3 Sand

Medium grained, grey sand with a trace of silt was encountered below the topsoil or fill in all test pits. The sand extended beyond the base of all test pits. The sand from TP25 and 28 contained traces of organic material, with laboratory results indicating low values of up to 0.85%.

The relative density of the sand was generally medium dense, becoming dense below approximately 1.5m depth. In TP19, 20, 24, 27 and 32 the sand was dense throughout. In TP23, 26 and 33 sands were loose to 1m depth.

The test pits walls were generally stable, only occasionally collapsing in looser sands above approximately 1.5m depth as the excavations deepened.

8.1.4 Coffee Rock

Very dense (weakly cemented), brown sand, colloquially named coffee rock, was encountered in TP14 and TP15 below 1.6m and 2.0m depth respectively. The 5 tonne excavator refused in the material at approximately 2.2m depth.

8.1.5 Groundwater

Groundwater was encountered in a number of the test pits. Groundwater depths and reduced levels are shown in Table 1. Ground levels have been taken from survey plans provided.

Table 1 - Groundwater Depth

Location	Groundwater Depth (m BGL)	Ground Level (m AHD)	Groundwater Level (m AHD)
TP17	2.4	25.0	22.6
TP20	2.2	23.6	21.4
TP27	2.4	24.8	22.4
TP28	2.5	24.0	21.5
TP29	2.1	23.8	21.7
TP30	2.3	24.0	21.7
TP31	2.1	24.5	22.4
TP32	2.3	24.8	22.5
TP33	2.0	23.8	21.8
TP34	2.1	22.8	20.7

The maximum groundwater level encountered was 22.6m AHD (2.4m bgl) in the north east corner of the site (TP17). The minimum depth to groundwater encountered was 2.0m (21.8m AHD) in the west of the site (TP33).

8.2 Test Results

8.2.1 Geotechnical Laboratory Test Results

Laboratory test results are summarised in Table 2.

Table 2 – Geotechnical Laboratory Test Results

Test Pit No.	Depth (m)	Organic Content (%)	Particle Size Distribution					USC
			Fines (%)	Sand (%)			Gravel (%)	
				fine	medium	coarse		
TP5	0.5 – 1.5	-	2	6	75	17	0	SP
TP7	1.3 – 2.5	-	2	10	75	13	0	SP
TP11	0.5 – 1.5	-	1	-	-	-	-	SP
TP13	0.5 – 1.5	-	1	-	-	-	-	SP
TP15	0.5 – 1.5	-	2	16	76	6	0	SP
TP17	0.9 – 2.0	-	0	9	78	13	0	SP
TP20	0.5 – 1.5	-	2	12	80	6	0	SP
TP22	1.5 – 2.5	-	1	5	78	16	0	SP
TP28	0.5 – 1.5	0.8	3	11	75	11	0	SP

Sands tested were poorly graded with low fines content. Organic contents were low.

8.2.2 Acid Sulphate Soil Test Results

ASS field test results are summarised in Table 3.

Table 3 – Acid Sulphate Soil Field Test Results

Test Pit No	Depth (m)	pH_F (field)	pH_{FOX} (post oxidation)	Reaction Strength
TP1	0.5	6.9	5.1	Moderate
TP1	1.5	7.2	5.5	Slight
TP1	2.5	6.9	5.0	Slight*
TP2	0.5	6.8	4.9	Slight
TP2	1.5	7.2	5.2	Slight
TP2	2.5	7.1	5.0	Slight
TP3	0.5	6.7	4.2	Slight
TP3	1.5	6.6	4.5	Slight*
TP3	2.5	7.1	5.2	Slight
TP4	0.5	7.0	3.8	Slight
TP4	1.5	5.8	3.8	Slight*
TP4	2.5	6.2	4.8	Slight
TP5	0.5	6.3	4.7	Slight
TP5	1.5	6.2	4.7	Slight
TP5	2.5	6.5	4.9	Slight
TP9	0.5	6.8	4.9	Slight
TP9	1.5	6.9	4.7	Slight
TP9	2.5	6.8	4.9	Slight
TP26	0.5	6.2	4.6	Slight
TP26	1.5	6.2	4.5	Slight*
TP26	2.5	6.3	4.6	Slight
TP27	0.5	6.0	4.8	Slight
TP27	1.5	6.3	4.8	Slight*
TP27	2.5	6.0	5.9	Slight
TP28	0.5	6.1	5.0	Slight
TP28	1.5	6.2	4.8	Slight
TP28	2.5	6.3	4.9	Slight
TP29	0.5	7.9	4.9	Slight
TP29	1.5	7.7	5.2	Slight
TP29	2.5	7.3	4.6	Strong*
TP30	0.5	7.3	4.3	Moderate*
TP30	1.5	6.8	4.7	Slight
TP30	2.5	6.8	4.6	Slight
TP31	0.5	7.0	4.5	Moderate*
TP31	1.5	7.0	5.0	Slight
TP31	2.5	7.0	5.1	Slight*
TP32	0.5	6.1	2.9	Moderate*
TP32	1.5	6.3	4.1	Slight*
TP32	2.5	5.9	4.2	Slight

* Selected for laboratory testing.

The field results show the actual pH_F of the soil to be non-acidic i.e. generally pH_F >6. The pH_{FOX} results however indicated that some soils in the vicinity of the high risk area may become acidic if oxidised, with pH_{FOX} of 2.9 in TP32 and 3.8 in TP4. These samples and samples showing volatile reactions were sent for confirmatory laboratory analysis to confirm sulphitic content.

ASS laboratory test results are summarised in Table 4.

Table 4 – Acid Sulphate Soil Laboratory Test Results

	Sample		TP1	TP3	TP4	TP4	TP26	TP27	TP29	TP30	TP31	TP31	TP32	TP32
	Depth		0.25	1.5	1.5	2.5	1.5	1.5	2.5	0.5	0.5	2.5	0.5	1.5
Analyte grouping / Analyte	**Units**	**LOR**												
EA033-A: Actual Acidity														
pH KCl (23A)	pH Unit	0.1	6.5	6.2	5.4	6.6	6.4	6.2	6.6	6.7	6.9	6.2	4.9	5.8
Titratable Actual Acidity (23F)	mole H+ / t	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity	% pyrite S	.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
Potential Acidity														
Chromium Reducible Sulfur (22B)	% S	0.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
acidity - Chromium Reducible Sulfur	mole H+ / t	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
EA033-E: Acid Base Accounting														
ANC Fineness Factor	---	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	% S	0.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02	<.02
Net Acidity (acidity units)	mole H+ / t	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

All results are below critical threshold limits (see Appendix E).

9 Analysis and Discussion

9.1 Subsurface Conditions

Evidence from the limited test pitting exercise has shown the whole of Development Area 19 to be underlain by medium grained, grey sand to a depth of at least 2m. This formation is consistent with the Bassendean Sands shown on the geological map for the area **[2]**.

The laboratory test results show the sand to have a low fines content (approximately 2%) and a zero gravel content. In-situ penetrometer testing has shown the density of the sand to be generally medium dense, becoming dense below approximately 1.5m depth. Some tests indicated loose sand to approximately 1m depth; however these areas appear to be sporadic across the site. The sand was usually overlain by a thin layer of sandy topsoil.

The geology map for the area indicates the Guildford Formation, consisting of silt and clay deposits, to be present in the northern and southern areas of the site. No evidence of these deposits was uncovered during the investigation.

Pockets of fill were identified during the test pitting exercise and appear to occur randomly across the site. It should be noted that the majority of test pits were located in areas easily accessible to the excavator, such as paddocks or in areas where disruption to occupiers or land owners would be minimised. The test pit positions would therefore not necessarily be located in areas where fill would be expected.

The fill encountered should be suitable for foundation support, however screening to remove deleterious material may be required in some areas. The detailed geotechnical investigations for future individual developments will be able to identify suspect fill areas.

9.2 Site Classification

Future Site Classifications for the area, in accordance with AS 2870 – 1996 **[1]**, are likely to be Site Class 'A'. This assumes the underlying sand identified during this investigation is consistent across the whole site. Detailed geotechnical investigations for future individual developments within the area will be required to confirm site classifications.

9.3 Earthwork Requirements

The majority of the earthworks envisaged as part of any future development will be associated with removal of topsoil, trees, old buildings and associated fill materials. Proof compacting of surface sand will be required, and any filling with imported sands to bring future site developments up to formation levels (see Section 9.6) will require compaction to relevant residential or industrial standards.

9.4 Borrow Materials

The grain size, low fines content and free draining nature of in-situ sands underlying the development area make them suitable for use as imported fill material for residential and industrial building developments.

9.5 Groundwater

The maximum groundwater level encountered during the investigation was 22.6m AHD in the north eastern corner of the site. This was at a depth of 2.4m below existing ground level. The minimum depth to groundwater encountered was 2.0m (21.8m AHD) towards the western boundary of the site.

The City of Cockburn, Arterial Drainage Scheme Review Nov 2005 **[4]** show design regional groundwater levels to vary from 23.5m AHD in the east of the development area to 20m AHD in the west. The hydraulic gradient therefore being to the west.

It appears from the above study, that the design regional groundwater levels will be closest to the existing ground level in the south eastern corner of the site at approximately 23.5m AHD (1.5m below existing ground level).

9.6 Soil Permeability and Drainage

The grain size, low fines content and free draining nature of in-situ sands underlying the development area make them suitable for the use of soakwells in future developments. It is estimated, based on particle size distribution analysis from laboratory test results, that a permeability value approximating to $1x10^{-4}$m/sec would be appropriate for soakwell design. However, as with all geotechnical assumptions within this report, a full geotechnical investigation will be required for each future development to confirm these values.

It is not envisaged that existing ground levels would require raising for site drainage using soakwells. The approximate depth to the design regional groundwater levels is 1.5m.

9.7 Public Open Spaces

The Structure Plan for development areas requires the provision of Public Open Spaces (POS). POS areas often contain lakes both ornamental and for drainage related issues. The free draining nature of the in-situ soils may require the provision of an impermeable lining for the lakes to prevent drying out in times of low groundwater levels.

9.8 CBR for Road Pavement Design

The in-situ sand appears to be consistent across the site. With surface sands compacted to a minimum of 98% SMDD at optimum moisture content, a design CBR of approximately 12% should be appropriate for future road pavement designs **[8]**. Further geotechnical investigations will be required to confirm this value.

9.9 Acid Sulphate Soils

The WAPC Bulletin No.64 May 2007 – *Acid Sulphate Soils, Central Perth Metro Area* **[5]** indicates the potential for acid sulphate generating soils within the development area to be mostly moderate to low. The exception is a pocket of potentially high risk soil towards the south eastern corner.

Moderate to low risk ASS zones require a full ASS investigation if soils are to be disturbed below a depth of 3m or below the groundwater level. High risk ASS zones require detailed ASS investigations if soils are to be disturbed below the existing ground level.

Test pitting was carried out in the vicinity of the south western corner of the development area in order to determine the extent of the high risk soils. Samples taken were field tested for actual pH (pH_F) and pH after oxidation with hydrogen peroxide (pH_{FOX}) which gives an indication of potential acidity should the soils be excavated and exposed to air. Further confirmatory testing was carried out in the laboratory. Samples could not be obtained from the very centre of the high risk hotspot, a small dried up lake area within dense vegetation.

Laboratory results revealed that some sands within the high risk ASS area contained existing acidity, however no potential acidity was identified. Sands containing existing acidity may require remediation during earthworks. This would consist of blending the sands with lime to neutralise the acidity. The extent of any remediation would be confirmed during detailed ASS investigation as part of future developments.

Based on the preliminary acid sulphate assessments, it can be concluded that the sand surrounding the dense vegetated areas denoted as high risk may contain some existing acidity but no potential acidity (refer Figure 3). It should be assumed that high risk soils exist in the centre of the area where the old lake existed.

Detailed ASS investigations will be required for all future developments in the area denoted as high risk by the WAPC Bulletin No.64. It is likely however that these investigations will show little or no potential acidity within the soils, except in the vicinity of the old lake.

If potential ASS soils are identified as part of these detailed investigations, ASS Management Plans will be required to treat acid generating soils. Dewatering Management Plans will also be required if excavations are to extend below groundwater level.

BROWN GEOTECHNICAL & ENVIRONMENTAL

Ken Brown

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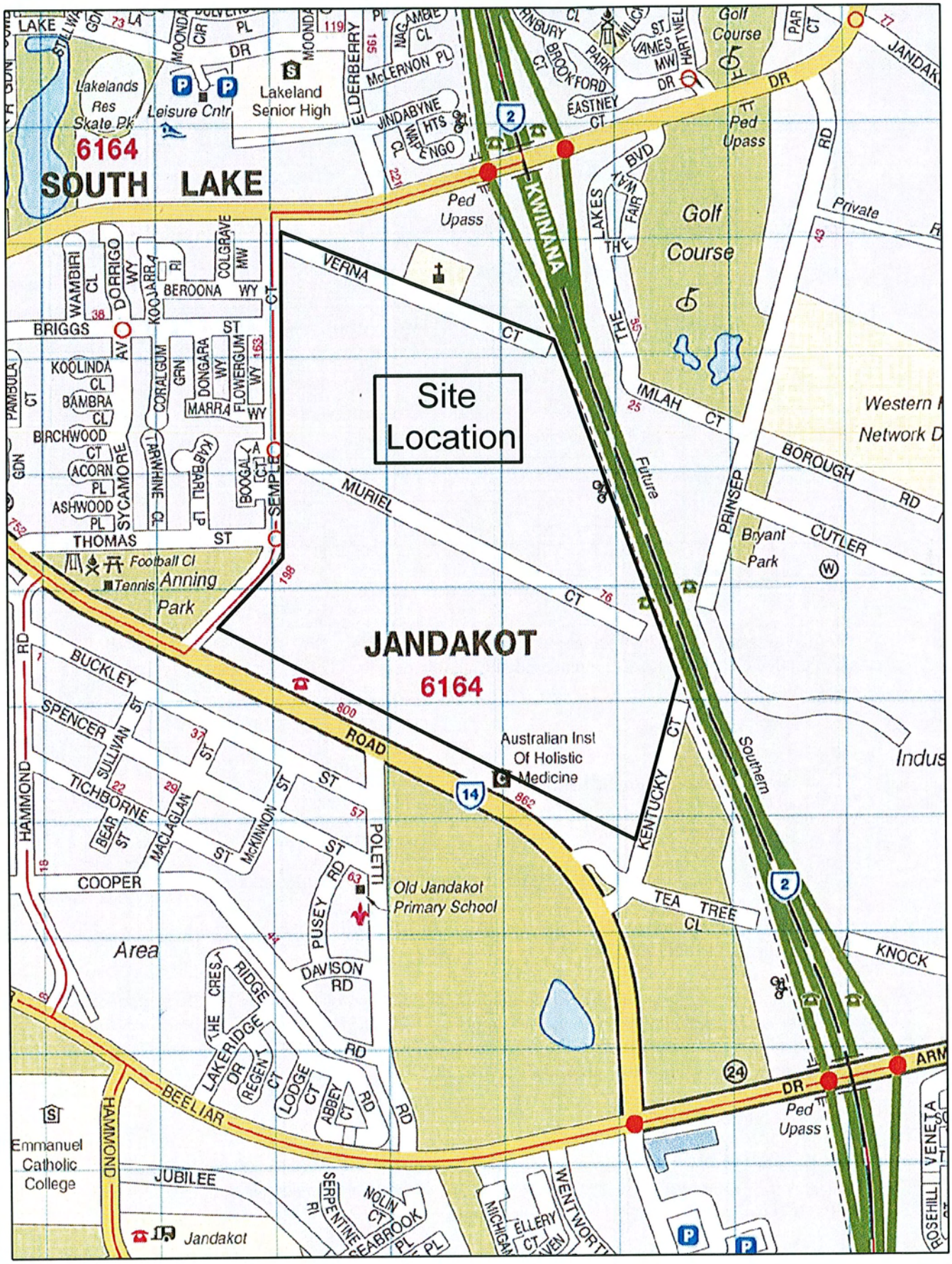
[6] DoE (2004). Identification and Investigation of Acid Sulphate Soils (August).

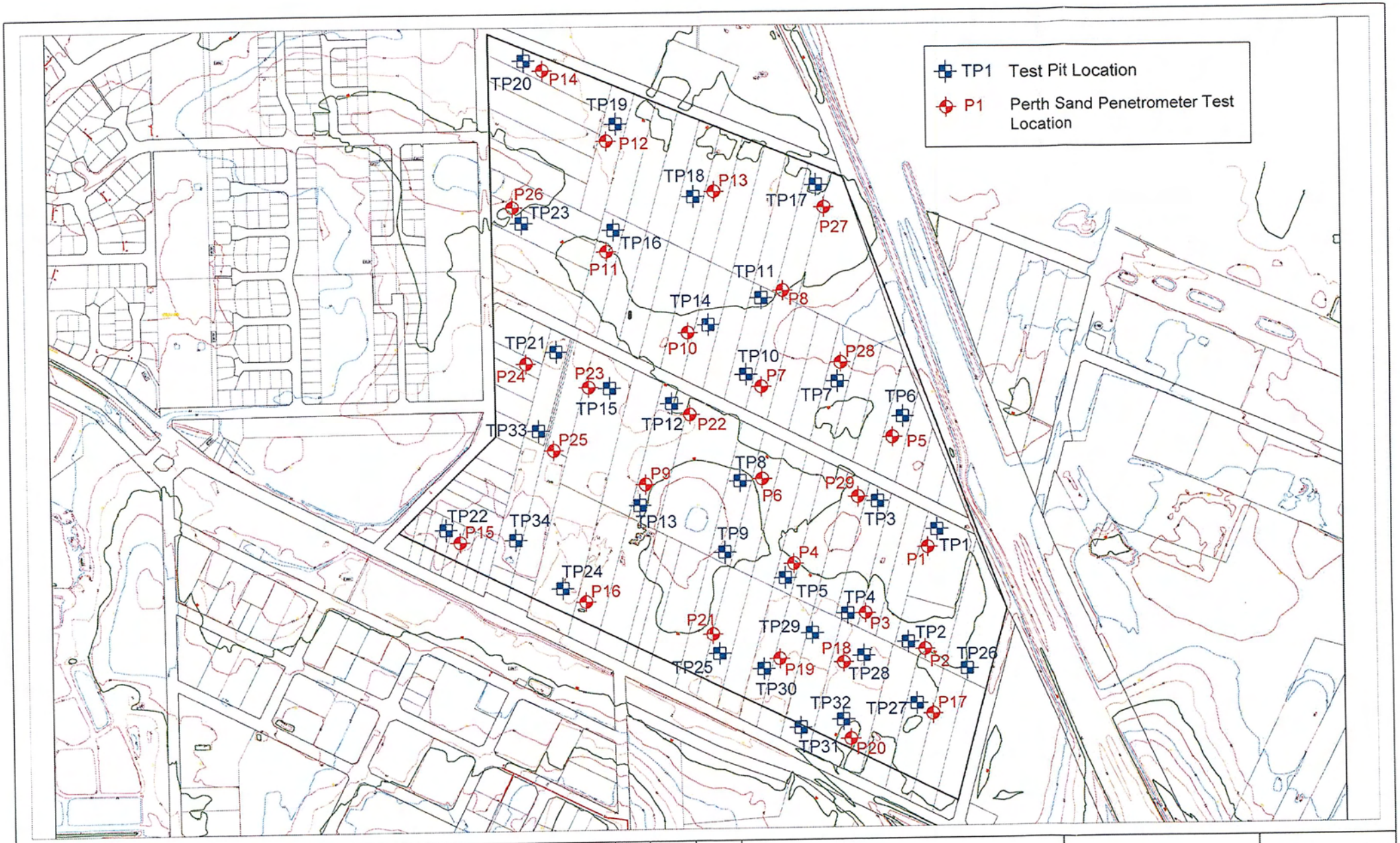
[7] CR Ahern et al (1998). Guidelines for Sampling and Analysis of Lowland Acid Sulphate Soils in Queensland 1998 (October).

[8] Main Roads Western Australia (April 2004); Engineering Road Note No 9. Procedure for Thickness Design of Flexible Pavements.

FIGURES



Brown Geotechnical & Environmental	Date	Description	Drawn	Checked	Approved	LOCATION PLAN	CLIENT	Drawing No. 06036.01
Suite 4, 47 Monash Avenue Como WA6152 Tel: (08) 9368 2615 Email: bge@acidss.com.au	01.05.07	Location Plan	TW	KIB				Scale: NTS
						DEVELOPMENT AREA 19 JANDAKOT	KOLTASZ SMITH	Sheet Size: A4
								Job No. 06036.01
								FIGURE 1



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Email: bge@acidss.com.au

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10.05.07	Test Location Plan	TW	KB	

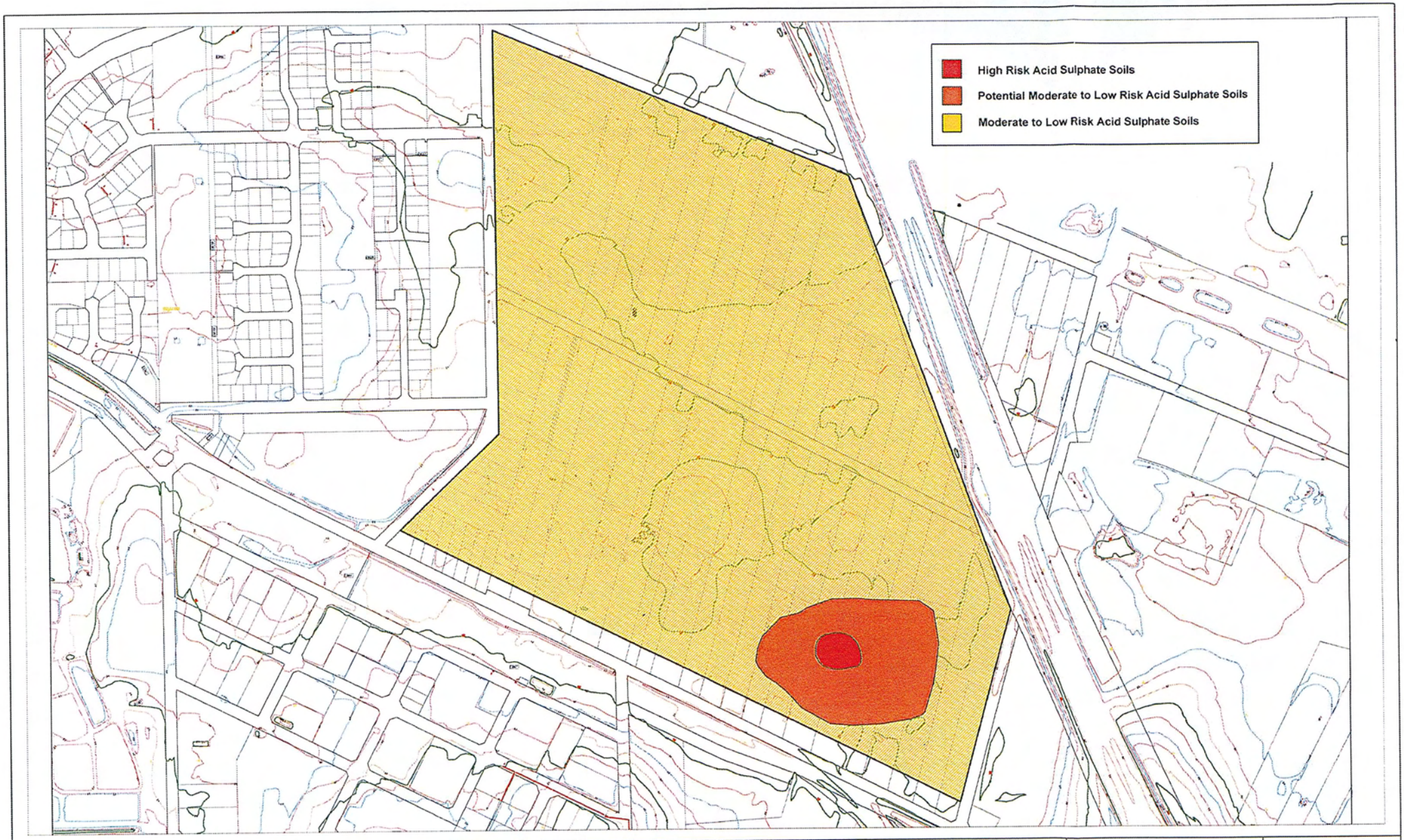
TEST LOCATION PLAN

DEVELOPMENT AREA 19 (MURIEL COURT)
JANDAKOT

CLIENT

KOLTASZ SMITH

Drawing No. 07036.02
Scale: NTS
Sheet Size: A4
Job No: J07036.01
FIGURE 2



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10.05.07	Test Location Plan	TW	KB	

POTENTIAL ACID SULPHATE SOIL ZONES

DEVELOPMENT AREA 19 (MURIEL COURT)
JANDAKOT

CLIENT

KOLTASZ SMITH

Drawing No. 07036.03
Scale: NTS
Sheet Size: A4
Job No: J07036.01
FIGURE 3

APPENDIX A

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP1

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 25.6 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.854064E 32.119052S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		25.5			FILL	FILL: Light brown, coarse sandy gravel and limestone road base		
							pH_F=6.9% pH_{FOX}=5.1%	
					SP	SAND: Medium dense, medium, dark grey, trace silt, moist, roots to 1.2m		
			0.5					
		25.0						
			1.0					
	Not Encounterd	24.5					pH_F=7.2% pH_{FOX}=5.5%	
			1.5			dense below 1.5m		
		24.0						
			2.0				pH_F=6.9% pH_{FOX}=5.0%	
		23.5						
			2.5			Borehole TP1 terminated at 2.5m		
		23.0						
			3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP2

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 24.8 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.853531E 32.120831S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		24.5	0		FILL	FILL: Sandy gravel, coarse, light brown, road base, trace limestone		
					SP	SAND: Medium dense, medium, light grey, trace silt, moist	pH_F=6.8% pH_{FOX}=4.9%	
			0.5					
		24.0						
			1.0					
	Not Encounterd					dense below 1.2m		
		23.5				collapse below 1.3m	pH_F=7.2% pH_{FOX}=5.2%	
			1.5					
		23.0						
			2.0					
		22.5					pH_F=7.1% pH_{FOX}=5.0%	
			2.5			Borehole TP2 terminated at 2.5m		
		22.0						
			3.0					

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP3

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 25.3 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.853048E 32.118670S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		25.0	0			TOPSOIL: Medium dense, medium, dark grey, with many rootlets to 1.1m		
			0.5			SAND: Medium dense, medium, grey, moist	pH_F=6.7% pH_{FOX}=4.2%	
	Not Encounterd	24.5	1.0				pH_F=6.6% pH_{FOX}=4.5%	
		24.0	1.5			dense below 1.5m		
		23.5	2.0				pH_F=7.1% pH_{FOX}=5.2%	
		23.0	2.5					
		22.5	3.0			Borehole TP3 terminated at 2.5m		

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP4

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 24 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.852489E 32.120323S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Medium dense, fine to medium, black, trace rootlets		
					SP	SAND: Medium dense, medium, dark grey, trace silt, moist, roots to 1.7m	pH_F=7.0% pH_{FOX}=3.8%	
		23.5	0.5					
						dense below 0.9m		
	Not Encounterd	23.0	1.0				pH_F=5.8% pH_{FOX}=3.8%	
		22.5	1.5					
		22.0	2.0				pH_F=6.2% pH_{FOX}=4.8%	
		21.5	2.5			Borehole TP4 terminated at 2.5m		
		21.0	3.0					

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP5

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 **COMPLETED** 15/3/07
R.L. SURFACE 24.7 **DATUM** m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- **BEARING** ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.851294E 32.119890S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW **CHECKED BY** KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		24.5				TOPSOIL: Medium dense, medium, dark grey, rootlets, dry		
			0.5		SP	SAND: Medium dense, medium, light grey, moist	pH_F=6.3% pH_{FOX}=4.7%	
		24.0					Fines=2% Sand=98% Gravel=0%	
	Not Encounterd		1.0			dense below 0.9m		
		23.5					pH_F=6.2% pH_{FOX}=4.7%	
			1.5					
		23.0						
			2.0					
		22.5					pH_F=6.5% pH_{FOX}=4.9%	
			2.5			Borehole TP5 terminated at 2.5m		
		22.0						
			3.0					

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP6

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 25.4 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 116.853454E 32.117476S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		25.0	0.0			TOPSOIL: Medium dense, medium, dark grey, rootlets, dry		
	Not Encounterd		0.5		SP	SAND: Medium dense, medium, grey, trace silt, moist		
		24.5	1.0			dense below 1.2m		
		24.0	1.5					
		23.5	2.0					
		23.0	2.5			Borehole TP6 terminated at 2.5m		
		22.5	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP7

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 25.5 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.852336E 32.116866S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Medium dense, fine to medium, dark grey, rootlets, dry		
		25.0	0.5			SAND: Medium dense, medium, light grey, trace silt, moist		
	Not Encounterd	24.5	1.0			dense below 1.2m		
		24.0	1.5				Fines=2% Sand=98% Gravel=0%	
		23.5	2.0					
		23.0	2.5					
						Borehole TP7 terminated at 2.5m		
		22.5	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP8

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 25 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.850684E 32.118188S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Medium dense, medium, grey, trace rootlets, dry		
	Not Encounterd	24.5	0.5		SP	SAND: Medium dense, medium, light grey, trace silt, moist		
		24.0	1.0					
		23.5	1.5			Collapse below 1.8m		
		23.0	2.0			dense below 2.4m		
		22.5	2.5			Borehole TP8 terminated at 2.5m		
		22.0	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP9

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 25.7 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.850252E 32.119153S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encounterd	25.5	0		SP	SAND: Medium dense, medium, grey, trace silt, dry		
						light grey below 0.2m	pH_F=6.8% pH_{FOX}=4.9%	
		25.0	0.5			moist below 0.7m		
		24.5	1.0			dense below 1.2m	pH_F=6.9% pH_{FOX}=4.7%	
		24.0	1.5					
		23.5	2.0				pH_F=6.8% pH_{FOX}=4.7%	
		23.0	2.5			Borehole TP9 terminated at 2.5m		
			3.0					

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP10

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 25.6 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.851142E 32.116866S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encounterd	25.5				TOPSOIL: Medium dense, medium, grey, trace rootlets, dry		
					SP	SAND: Medium dense, medium, light grey, trace silt, moist		
			0.5					
		25.0						
			1.0					
		24.5						
			1.5					
		24.0						
			2.0					
		23.5				dense below 2.1m		
						Borehole TP10 terminated at 2.3m		
			2.5					
		23.0						
			3.0					

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP11

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07 R.L. SURFACE 25.1 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator TEST PIT LOCATION 115.851447E 32.115748S MGA
TEST PIT SIZE 0.5m x 1m LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		25.0	0.0			TOPSOIL: Medium dense, medium, dark grey, rootlets, dry		
	Not Encounterd	24.5	0.5			SAND: Medium dense, medium, light grey, trace silt, moist	Fines=1%	
		24.0	1.0			dense below 1.2m		
		23.5	1.5					
		23.0	2.0					
		22.5	2.5			Borehole TP11 terminated at 2.5m		
			3.0					

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP12

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 24.8 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.849439E 32.117146S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		24.5	0.0			TOPSOIL: Medium dense, medium, dark grey, rootlets, dry		
			0.5		SP	SAND: Medium dense, medium, grey, trace silt, moist		
		24.0						
			1.0					
	Not Encounterd	23.5				wet below 1.5m		
			1.5			collpase below 1.5m		
						brown below 1.6m		
		23.0				dense below 1.8m		
			2.0					
		22.5						
			2.5			Borehole TP12 terminated at 2.5m		
		22.0						
			3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP13

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 24.5 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.848906E 32.118569S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encounterd	24.0	0.5		SP	SAND: Medium dense, medium, grey, trace silt, roots to 0.5m, dry		
						dense and moist below 0.6m		
		23.5	1.0				Fines=1%	
		23.0	1.5					
		22.5	2.0					
		22.0	2.5					
						Borehole TP13 terminated at 2.5m		
		21.5	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP14

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 25 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.850024E 32.116053S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Medium dense, fine, grey, trace rootlets, dry		
					SP	SAND: Medium dense, medium, light grey, trace silt, moist		
		24.5	0.5					
	Not Encounterd	24.0	1.0			dense below 1.2m		
		23.5	1.5					
						COFFEE ROCK: Very dense, medium, brown sand, moist (weakly cemented)		
		23.0	2.0					
						Refusal Borehole TP14 terminated at 2.3m		
		22.5	2.5					
		22.0	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP15

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07 R.L. SURFACE 24 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator TEST PIT LOCATION 115.848346E 32.116714S MGA
TEST PIT SIZE 0.5m x 1m LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Medium dense, medium, dark grey, rootlets, dry		
	Not Encountered	23.5	0.5		SP	SAND: Medium dense, medium, grey, trace silt, moist		
		23.0	1.0			dense below 1.2m	Fines=2% Sand=98% Gravel=0%	
		22.5	1.5					
		22.0	2.0			COFFEE ROCK: Very dense, medium, brown sand, moist (weakly cemented)		
		21.5	2.5			Refusal Borehole TP15 terminated at 2.2m		
		21.0	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP16

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 15/3/07 COMPLETED 15/3/07
R.L. SURFACE 24.7 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.848372E 32.114503S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encounterd	24.5	0.5		SP	SAND: Medium dense, medium, light grey, rootlets to 0.8m, dry		
		24.0				dense below 0.6m		
		23.5	1.0					
		23.0	1.5					
		22.5	2.0					
			2.5			Borehole TP16 terminated at 2.5m		
		22.0						
			3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP17

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 16/3/07 COMPLETED 16/3/07
R.L. SURFACE 25 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.852108E 32.113766S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						FILL: Medium dense, fine to medium, light brown, sand, dry		
		24.5	0.5		SP	SAND: Medium dense, medium, dark grey, trace silt, moist		
						trace roots at 0.9m		
		24.0	1.0			dense below 1.2m		
							Fines=0% Sand=100% Gravel=0%	
		23.5	1.5					
		23.0	2.0					
	▼ 2.4m	22.5	2.5			Borehole TP17 terminated at 2.4m		
		22.0	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP18

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 16/3/07 COMPLETED 16/3/07
R.L. SURFACE 24.3 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.849871E 32.113740S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encounterd	24.0	0.5			SAND: Medium dense, medium, grey, trace silt, dry		
		23.5	1.0			dense below 0.9m		
		23.0	1.5			moist below 1.2m		
		22.5	2.0					
		22.0	2.5			Borehole TP18 terminated at 2.5m		
		21.5	3.0					

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP19

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 16/3/07 COMPLETED 16/3/07
R.L. SURFACE 24 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.484999E 32.112800S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encounterd	23.5	0.5		SP	SAND: Dense, fine to medium, grey, trace silt, dry, with rootlets		
						medium grained below 0.5m		
						moist below 0.8m		
		23.0	1.0					
						light grey, moist below 1.2m		
		22.5	1.5					
		22.0	2.0					
		21.5	2.5					
		21.0	3.0			Borehole TP19 terminated at 2.7m		

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP20

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 16/3/07 COMPLETED 16/3/07 R.L. SURFACE 23.6 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator TEST PIT LOCATION 115.846517E 32.111606S MGA
TEST PIT SIZE 0.5m x 1m LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		23.5	0.5			SAND: Dense, medium, grey, trace silt, rootlets to 0.5m, moist		
		23.0	1.0				Fines=2% Sand=98% Gravel=0%	
		22.5	1.5					
		22.0	2.0					
	▼ 2.2m	21.5	2.5					
		21.0	3.0			Borehole TP20 terminated at 2.7m		

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP21

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 16/3/07 COMPLETED 16/3/07
R.L. SURFACE 24 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.847305E 32.116205S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						TOPSOIL: Medium dense, medium, grey, dry with rootlets		
					SP	SAND: Medium dense, medium, grey, trace silt, moist		
	Not Encounterd	23.5	0.5					
		23.0	1.0					
						Collapse above 1.4m		
		22.5	1.5			dense below 1.5m		
		22.0	2.0					
						Borehole TP21 terminated at 2.2m		
		21.5	2.5					
		21.0	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP22

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 16/3/07 COMPLETED 16/3/07
R.L. SURFACE 22 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.845246E 32.119026S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		21.5	0.5			FILL: Medium dense, fine to medium, grey, sand, trace limestone		
	Not Encounterd	21.0	1.0			TOPSOIL: Medium dense, medium, dark grey, rootlets, moist Collapse above 1.3m		
		20.5	1.5		SP	SAND: Dense, medium, grey, trace silt, moist	Fines=1% Sand=99% Gravel=0%	
		20.0	2.0					
		19.5	2.5			Borehole TP22 terminated at 2.5m		
		19.0	3.0					

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP23

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 16/3/07 COMPLETED 16/3/07
R.L. SURFACE 24.7 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.846695E 32.114223S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		24.5	0			FILL: Medium dense, fine to medium, red sand, rootlets to 0.2m, dry		
						FILL: Medium dense, fine to medium, light brown, trace limestone, dry		
	Not Encounterd				SP	SAND: Loose, medium, grey, trace silt, dry		
			0.5					
		24.0						
						medium dense and moist below 0.9m		
			1.0					
		23.5						
			1.5					
		23.0						
						dense below 1.8m		
			2.0					
		22.5						
			2.5			Borehole TP23 terminated at 2.5m		
		22.0						
			3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP24

CLIENT City of Cockburn

PROJECT NAME District Structurial Plan - Development Area 19

PROJECT NUMBER J06036.01

PROJECT LOCATION Jandakot

DATE STARTED 16/3/07 COMPLETED 16/3/07

R.L. SURFACE 24 DATUM m AHD

EXCAVATION CONTRACTOR Burke Contracting

SLOPE --- BEARING ---

EQUIPMENT 5 Tonne Mini Excavator

TEST PIT LOCATION 115.847254E 32.120170S MGA

TEST PIT SIZE 0.5m x 1m

LOGGED BY TW CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encounterd	23.5	0.5		SP	SAND: Dense, medium, grey, dry, roots to 1m		
		23.0	1.0			moist below 1.0m		
		22.5	1.5					
		22.0	2.0					
		21.5	2.5					
		21.0	3.0			Borehole TP24 terminated at 2.7m		

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP25

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 23/3/07 COMPLETED 23/3/07
R.L. SURFACE 24.4 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.850024E 32.121263S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		24.0	0.0			FILL: Medium dense, medium, brown, sand, rootlets		
	Not Encounterd				SP	SAND: Medium dense, medium, dark grey, moist		
		23.5	0.5					
			1.0			peaty between 1.1m and 1.3m		
		23.0						
			1.5			dense below 1.5m		
		22.5						
			2.0					
		22.0				Borehole TP25 terminated at 2.2m		
			2.5					
		21.5						
			3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP26

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 23/3/07 COMPLETED 23/3/07
R.L. SURFACE 25.2 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.854573E 32.121212S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encounterd	25.0	0.0		SP	SAND: Loose, coarse, dark grey, moist, roots to 1m		
							pH_F=6.2% pH_{FOX}=4.6%	
		24.5	0.5					
			1.0			medium dense and medium grained below 1.0m		
		24.0					pH_F=6.2% pH_{FOX}=4.5%	
			1.5					
		23.5				dense below 1.8m		
			2.0					
		23.0					pH_F=6.3% pH_{FOX}=4.6%	
			2.5			Collapse Borehole TP26 terminated at 2.5m		
		22.5	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE
Brown Geotechnical & Environmental

TEST PIT NUMBER TP27

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 23/3/07 COMPLETED 23/3/07
R.L. SURFACE 24.8 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.853709E 32.121949S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		24.5	0.5		SP	SAND: Dense, fine to medium, grey, moist, trace rootlets	pH_F=6.0% pH_{FOX}=4.8%	
		24.0	1.0					
		23.5	1.5			brown below 1.6m	pH_F=6.2% pH_{FOX}=4.5%	
	▼ 2.4m	23.0	2.0					
		22.5	2.5				pH_F=6.3% pH_{FOX}=4.6%	
		22.0	3.0			Borehole TP27 terminated at 2.5m		

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP28

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 23/3/07 COMPLETED 23/3/07
R.L. SURFACE 24 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.852641E 32.121085S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
					SP	SAND: Medium dense, medium, grey, locally brown, trace silt, trace organics, moist		
							pH_F=6.1% pH_{FOX}=5.0%	
		23.5	0.5					
							Organic Content=0.84%	
		23.0	1.0			dense below 1.0m		
							pH_F=6.2% pH_{FOX}=4.8%	
		22.5	1.5			brown and wet below 1.6m		
		22.0	2.0					
							pH_F=6.3% pH_{FOX}=4.9%	
	▼ 2.5m	21.5	2.5			Borehole TP28 terminated at 2.5m		
		21.0	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP29

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 23/3/07 COMPLETED 23/3/07 R.L. SURFACE 23.8 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator TEST PIT LOCATION 115.851879E 32.120780S MGA
TEST PIT SIZE 0.5m x 1m LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		23.5	0.5			FILL: Fine to medium, grey, rocks, rubbish, pipe, in a sandy matrix	pH_F=7.9% pH_{FOX}=4.9%	
		23.0	1.0		SP	SAND: Medium dense, medium, grey, trace silt, moist yellow below 0.7m	pH_F=7.7% pH_{FOX}=5.2%	
	▼ 2.1m	22.5	1.5					
		22.0	2.0				pH_F=7.3% pH_{FOX}=4.6%	
		21.5	2.5					
		21.0	3.0			Borehole TP29 terminated at 2.5m		

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP30

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 23/3/07 COMPLETED 23/3/07
R.L. SURFACE 24 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.850811E 32.121440S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
					FILL	FILL: Medium dense, medium, yellow and grey sand, trace rootlets	pH_F=7.3% pH_{FOX}=4.3%	
		23.5	0.5			TOPSOIL: Fine to medium, dark grey, sand, with rootlets		
		23.0	1.0		SP	SAND: Dense, medium, grey, trace silt, moist	pH_F=6.8% pH_{FOX}=4.7%	
		22.5	1.5					
		22.0	2.0				pH_F=6.8% pH_{FOX}=4.6%	
	▼ 2.3m	21.5	2.5					
						Borehole TP30 terminated at 2.5m		
		21.0	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP31

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 23/3/07 **COMPLETED** 23/3/07 **R.L. SURFACE** 24.5 **DATUM** m AHD
EXCAVATION CONTRACTOR Burke Contracting **SLOPE** --- **BEARING** ---
EQUIPMENT 5 Tonne Mini Excavator **TEST PIT LOCATION** 115.851472E 32.122355S MGA
TEST PIT SIZE 0.5m x 1m **LOGGED BY** TW **CHECKED BY** KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
						FILL: Fine to medium, yellow, sand, trace rootlets	pH_F=7.0% pH_{FOX}=4.5%	
		24.0	0.5			TOPSOIL: Fine to medium, dark grey, sand, trace rootlets		
					SP	SAND: Medium dense, medium, grey, moist		
		23.5	1.0					
						brown and wet below 1.35m	pH_F=7.0% pH_{FOX}=5.0%	
		23.0	1.5					
	▼ 2.1m	22.5	2.0				pH_F=7.0% pH_{FOX}=5.1%	
		22.0	2.5			Borehole TP31 terminated at 2.5m		
		21.5	3.0					

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP32

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 23/3/07 COMPLETED 23/3/07
R.L. SURFACE 24.8 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.852235E 32.122203S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		24.5	0.0			TOPSOIL: Fine to medium, dark grey sand, trace rootlets	pH_F=6.1% pH_{FOX}=2.9%	
		24.0	0.5		SP	SAND: Dense, medium, light grey, trace silt, moist		
		23.5	1.0			collapse above 1.2m brown and wet below 1.3m	pH_F=6.3% pH_{FOX}=4.1%	
		23.0	1.5					
	▼ 2.3m	22.5	2.0				pH_F=5.9% pH_{FOX}=4.2%	
		22.0	2.5			Borehole TP32 terminated at 2.5m		
			3.0					

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP33

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 23/3/07 COMPLETED 23/3/07
R.L. SURFACE 23.8 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting
SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator
TEST PIT LOCATION 115.846949E 32.117527S MGA
TEST PIT SIZE 0.5m x 1m
LOGGED BY TW CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		23.5	0.5		SP	SAND: Loose, coarse, dark grey, moist	pH_F=7.9% pH_{FOX}=4.9%	
		23.0	1.0			medium dense and medium grained below 1.0m		
		22.5	1.5				pH_F=7.7% pH_{FOX}=5.2%	
		22.0	2.0			Collapse above 2.2m		
	▼ 2.0m	21.5	2.5				pH_F=7.3% pH_{FOX}=4.6%	
						Borehole TP33 terminated at 2.5m		
		21.0	3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

BGE

Brown Geotechnical & Environmental

TEST PIT NUMBER TP34

CLIENT City of Cockburn
PROJECT NAME District Structurial Plan - Development Area 19
PROJECT NUMBER J06036.01
PROJECT LOCATION Jandakot

DATE STARTED 23/3/07 COMPLETED 23/3/07 R.L. SURFACE 22.8 DATUM m AHD
EXCAVATION CONTRACTOR Burke Contracting SLOPE --- BEARING ---
EQUIPMENT 5 Tonne Mini Excavator TEST PIT LOCATION 115.846440E 32.118975S MGA
TEST PIT SIZE 0.5m x 1m LOGGED BY TW CHECKED BY KB
NOTES

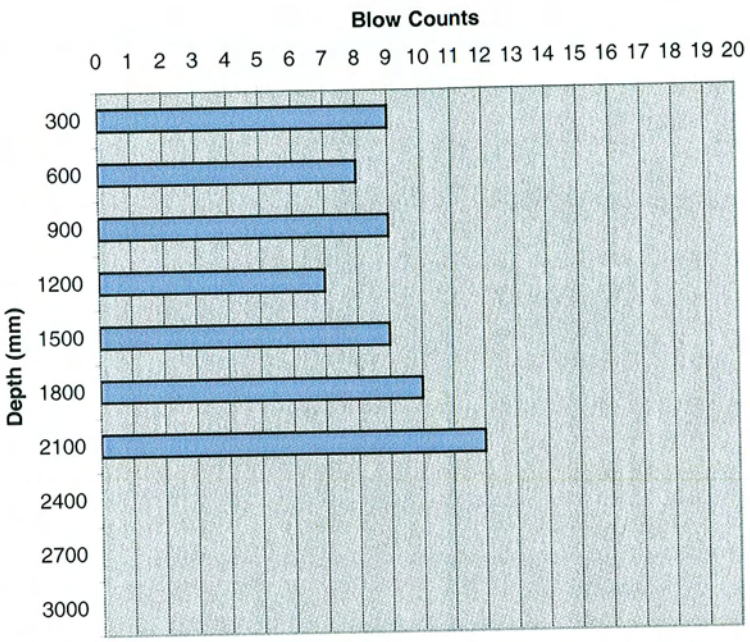
Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
		22.5	0			TOPSOIL: Medium dense, medium, dark grey, dry	pH_F=7.9% pH_{FOX}=4.9%	
			0.5		SP	SAND: Medium dense, medium, grey, trace silt, moist		
		22.0						
			1.0					
		21.5					pH_F=7.7% pH_{FOX}=5.2%	
			1.5					
		21.0						
			2.0					
	▼ 2.1m							
		20.5					pH_F=7.3% pH_{FOX}=4.6%	
			2.5					
						Borehole TP34 terminated at 2.5m		
		20.0						
			3.0					

BOREHOLE / TEST PIT LOGS.GPJ GINT AUSTRALIA.GDT 23/1/08

APPENDIX B

Depth (mm)	Blow Counts
300	9
600	8
900	9
1200	7
1500	9
1800	10
2100	12
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 1

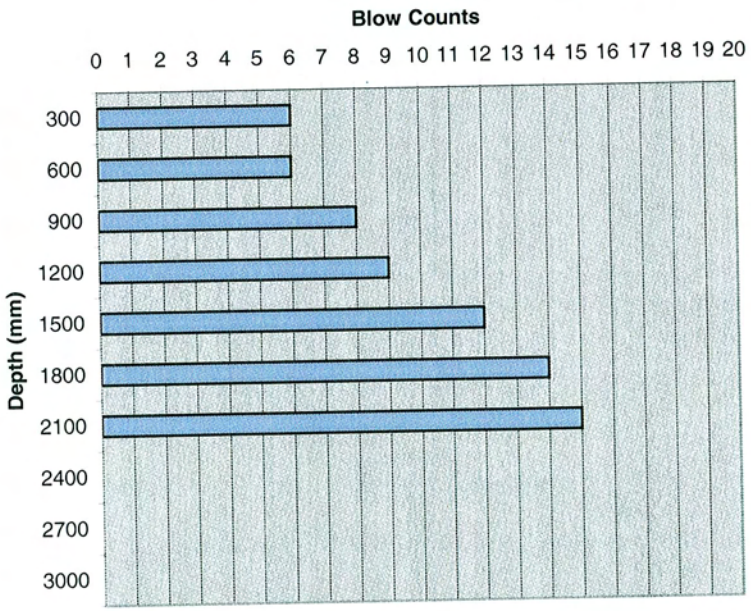


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	6
600	6
900	8
1200	9
1500	12
1800	14
2100	15
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 2

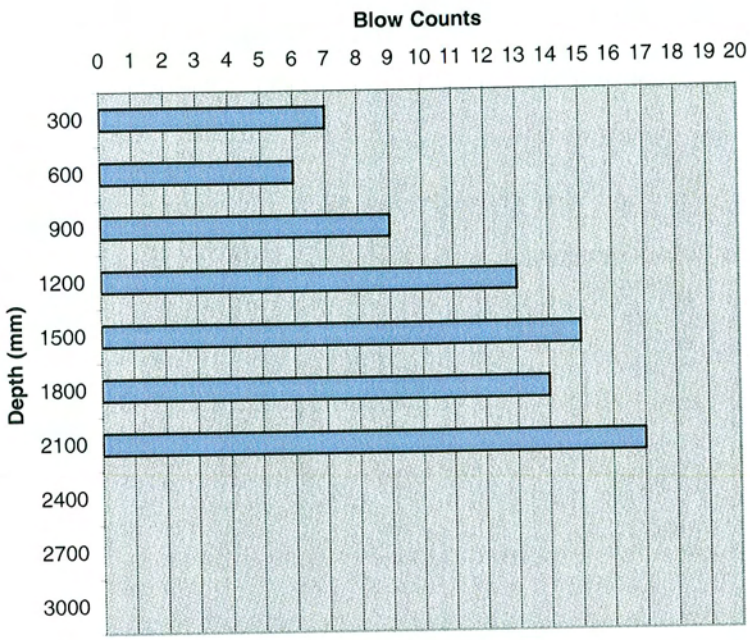


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	7
600	6
900	9
1200	13
1500	15
1800	14
2100	17
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 3

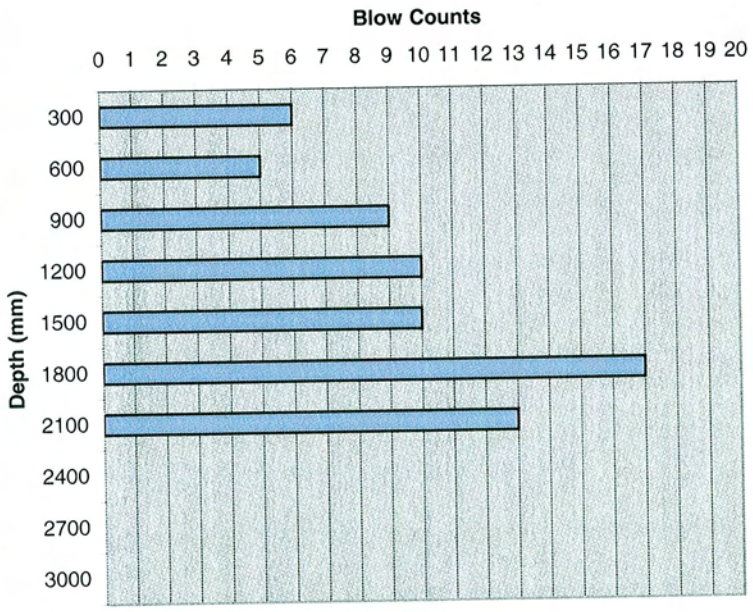


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	6
600	5
900	9
1200	10
1500	10
1800	17
2100	13
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 4

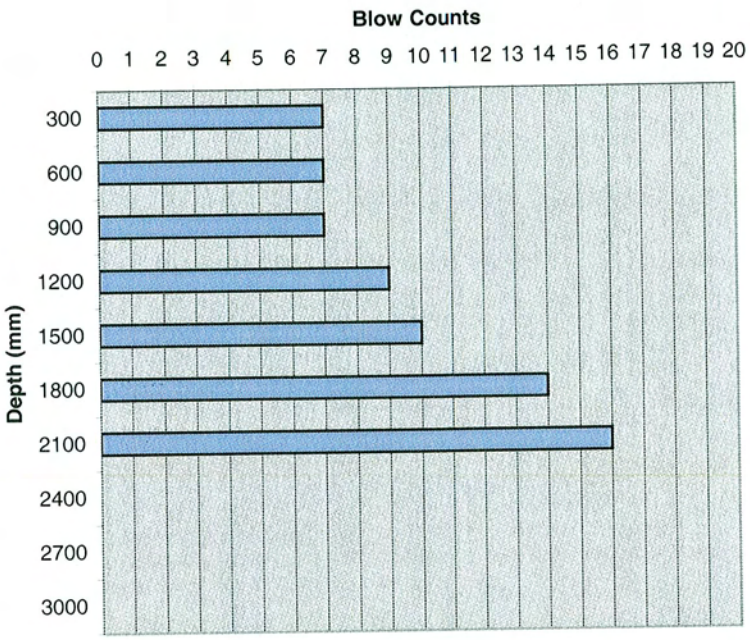


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	7
600	7
900	7
1200	9
1500	10
1800	14
2100	16
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 5

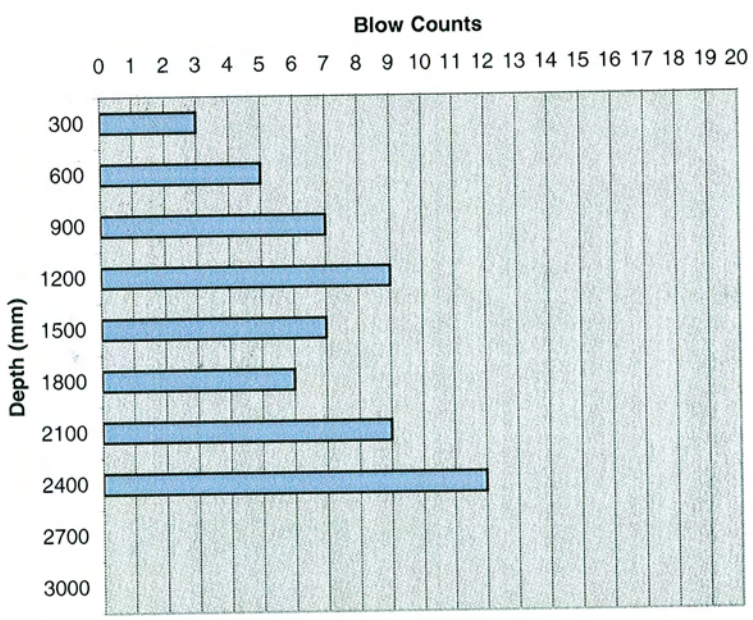


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	3
600	5
900	7
1200	9
1500	7
1800	6
2100	9
2400	12
2700	
3000	

Perth Sand Penetrometer Results - Test 6

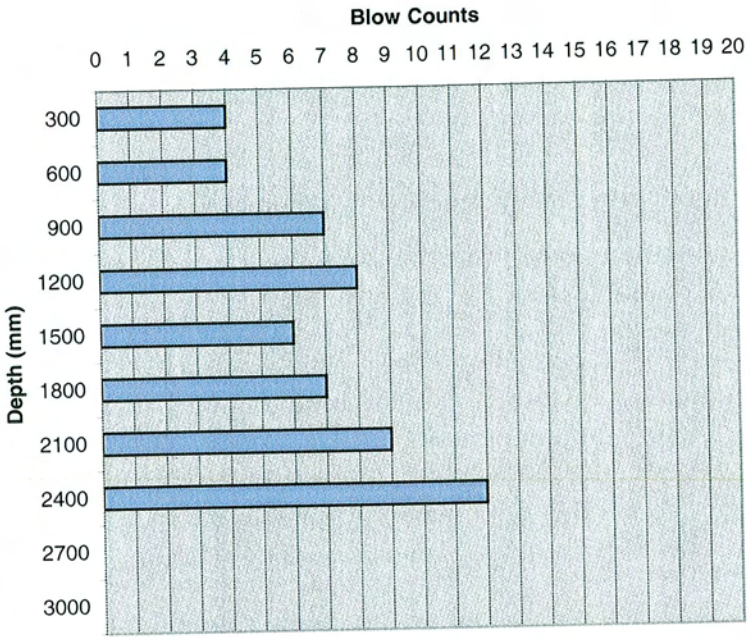


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	4
600	4
900	7
1200	8
1500	6
1800	7
2100	9
2400	12
2700	
3000	

Perth Sand Penetrometer Results - Test 7

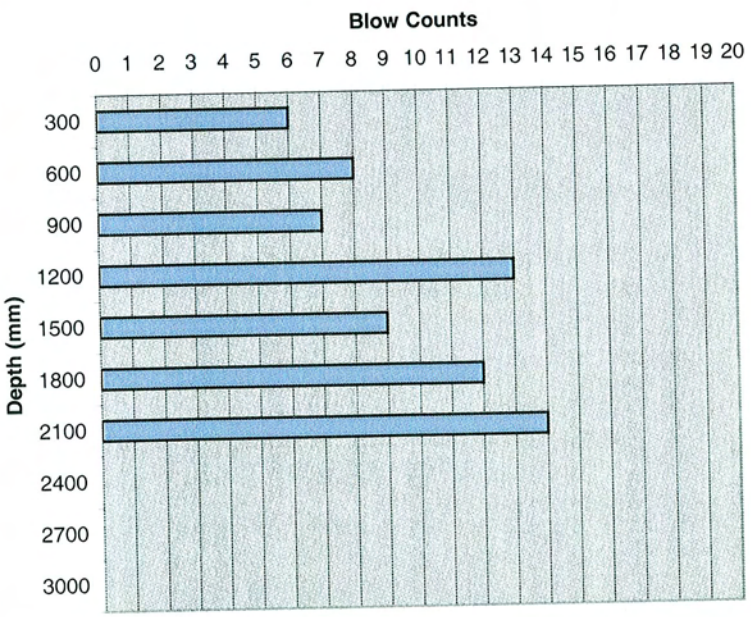


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	6
600	8
900	7
1200	13
1500	9
1800	12
2100	14
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 8

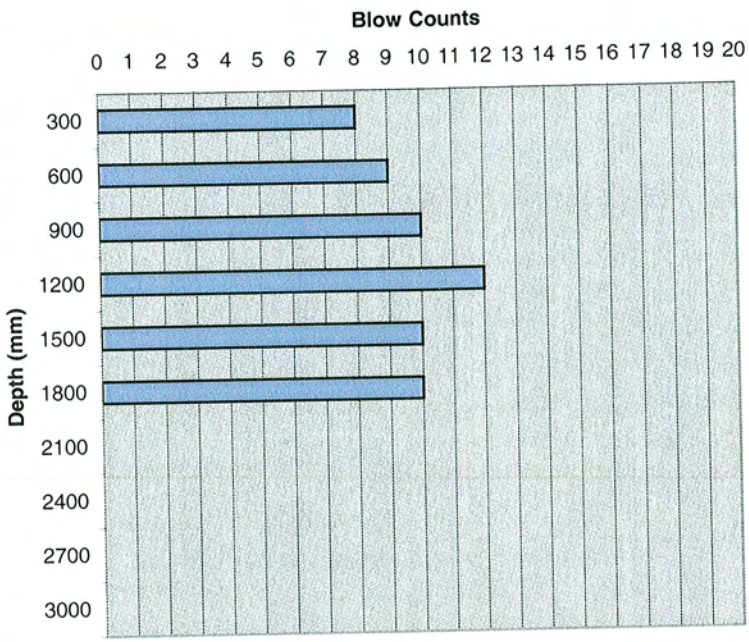


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	8
600	9
900	10
1200	12
1500	10
1800	10
2100	
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 9

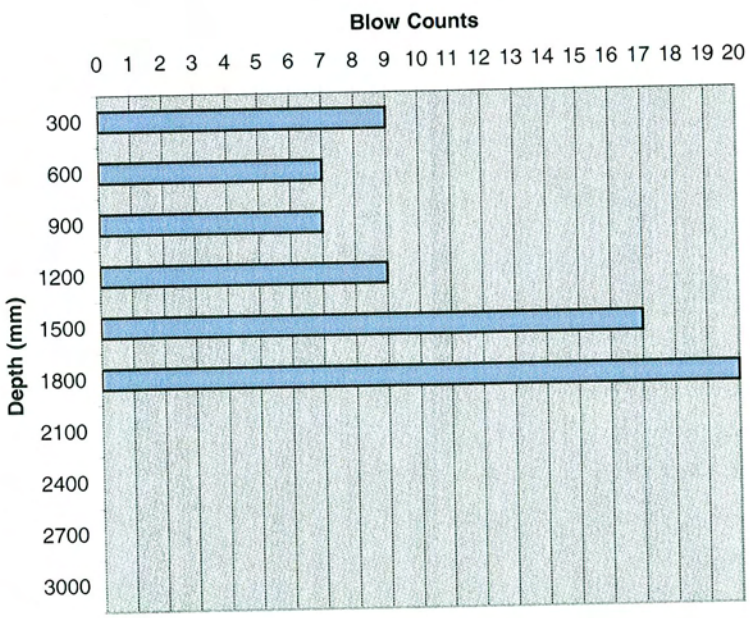


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	9
600	7
900	7
1200	9
1500	17
1800	20
2100	
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 10

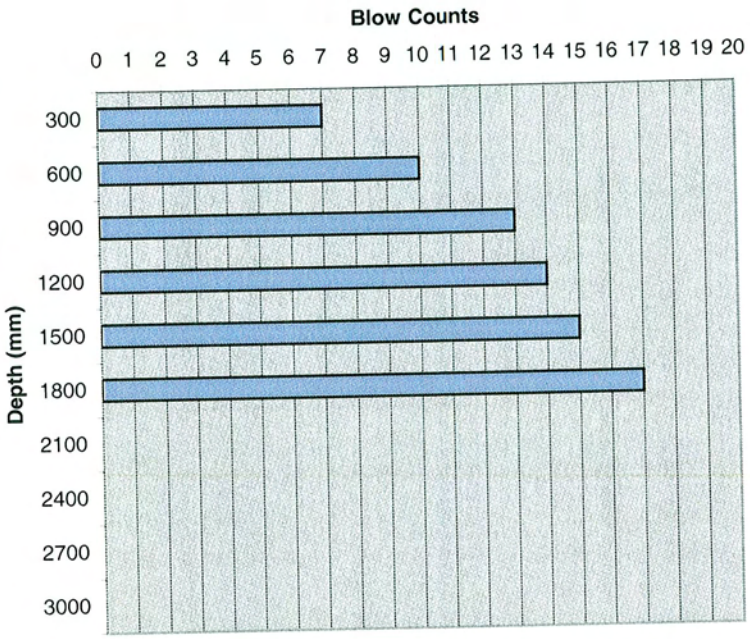


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	7
600	10
900	13
1200	14
1500	15
1800	17
2100	
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 11

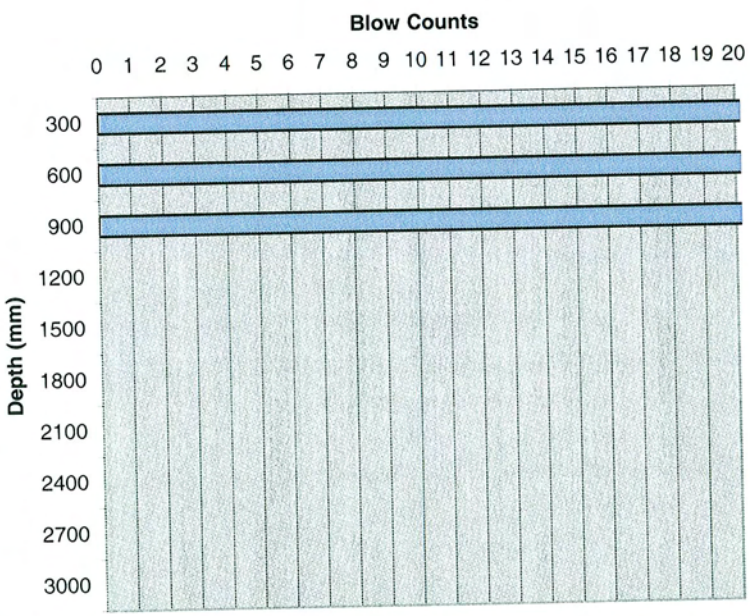


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	22
600	24
900	24
1200	
1500	
1800	
2100	
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 12

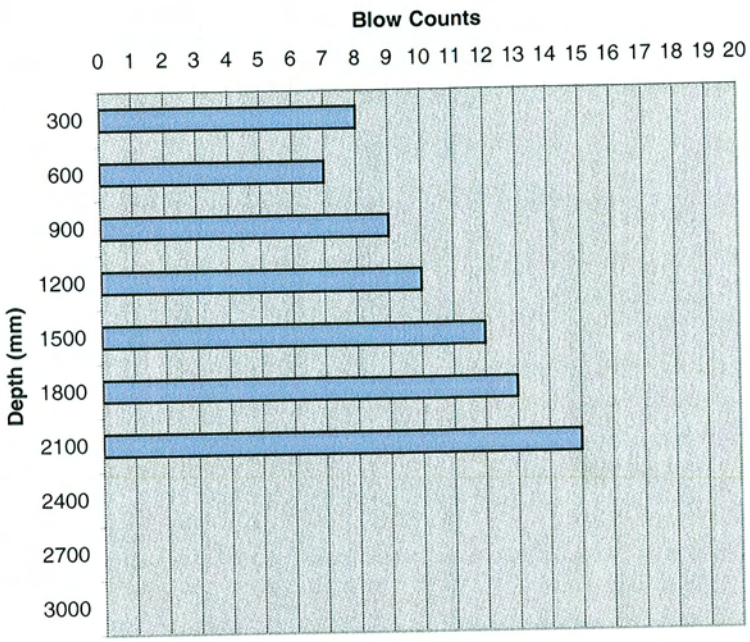


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	8
600	7
900	9
1200	10
1500	12
1800	13
2100	15
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 13

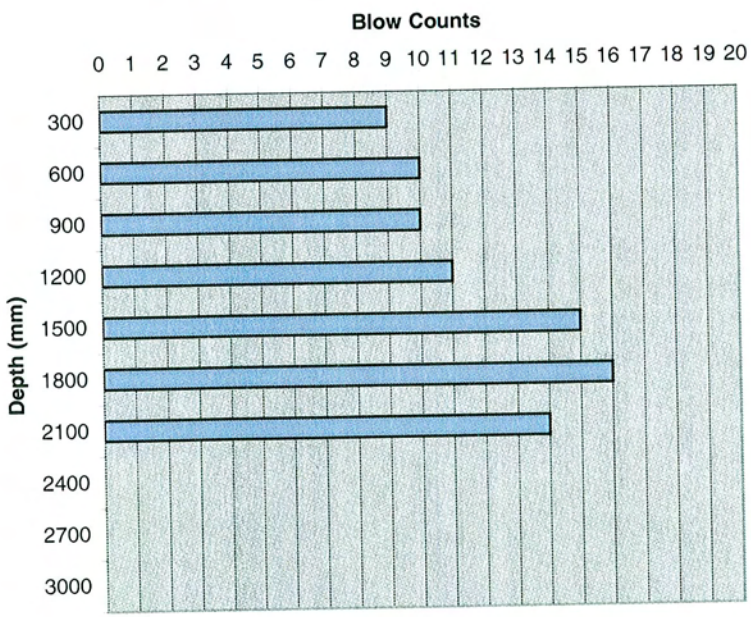


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	9
600	10
900	10
1200	11
1500	15
1800	16
2100	14
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 14

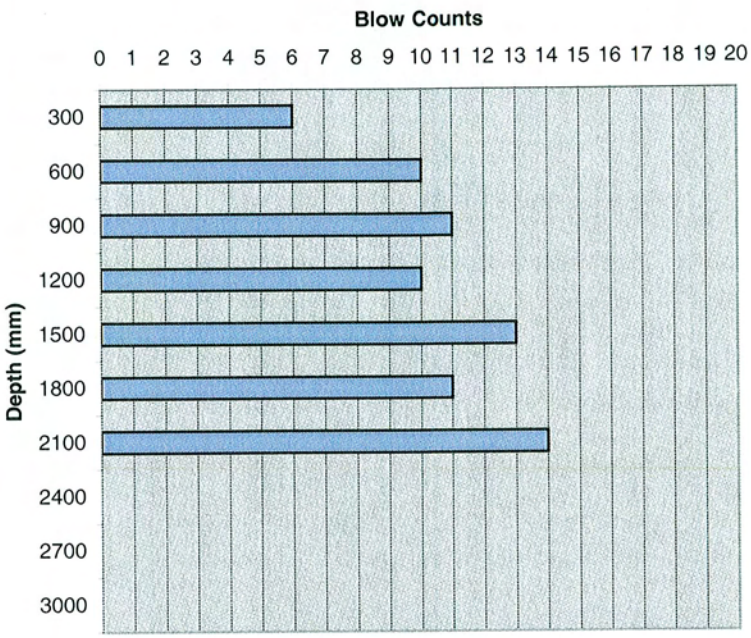


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	6
600	10
900	11
1200	10
1500	13
1800	11
2100	14
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 15

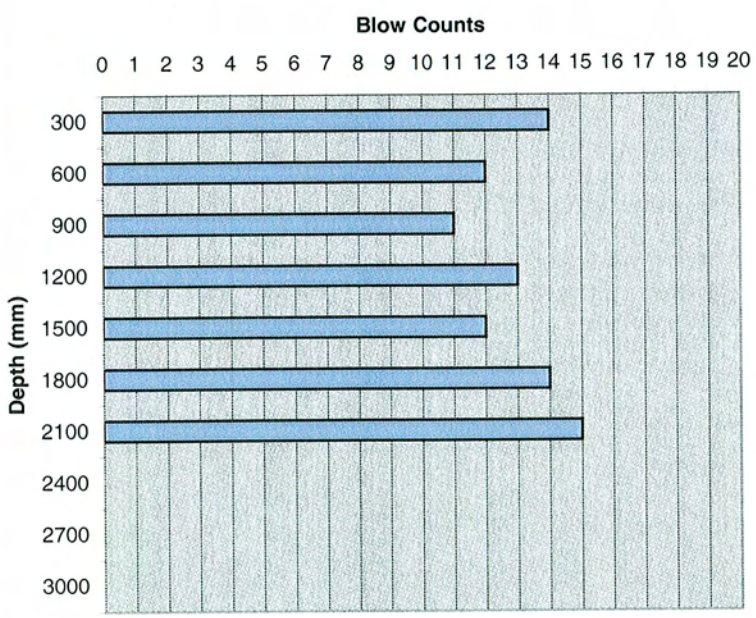


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	14
600	12
900	11
1200	13
1500	12
1800	14
2100	15
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 16

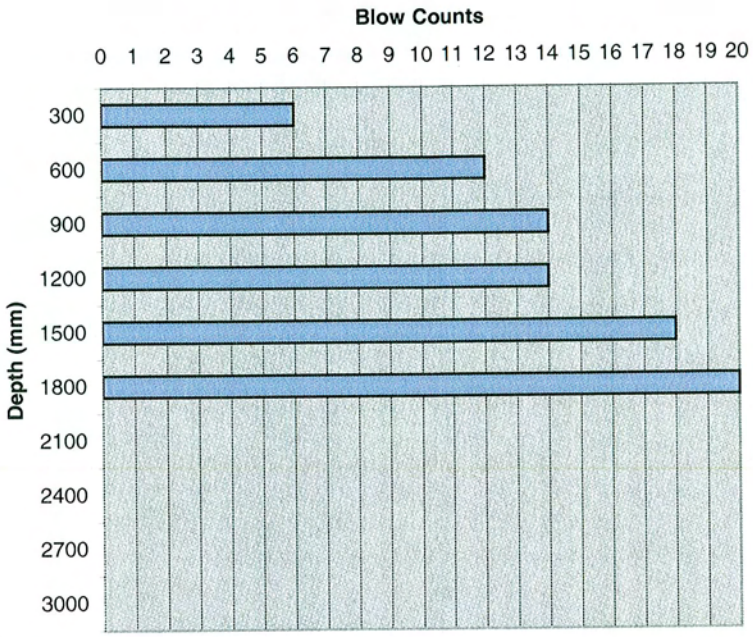


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	6
600	12
900	14
1200	14
1500	18
1800	20
2100	
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 17

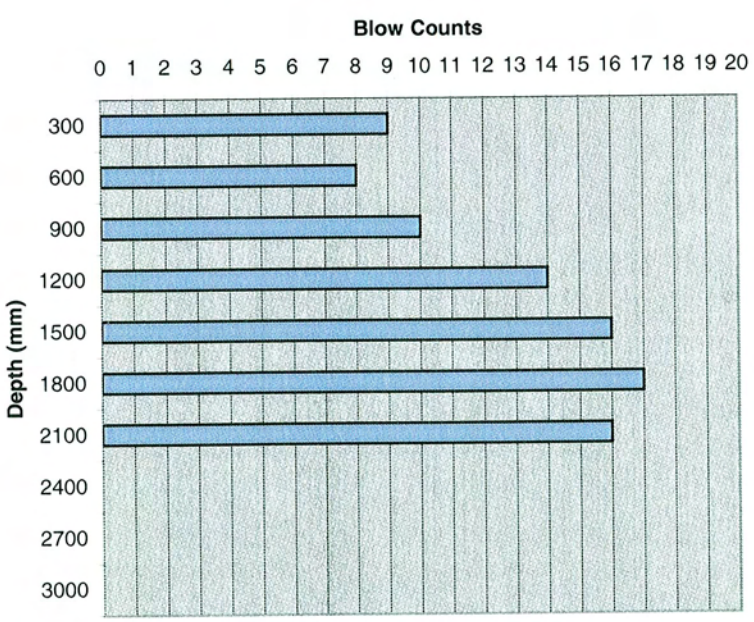


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	9
600	8
900	10
1200	14
1500	16
1800	17
2100	16
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 18

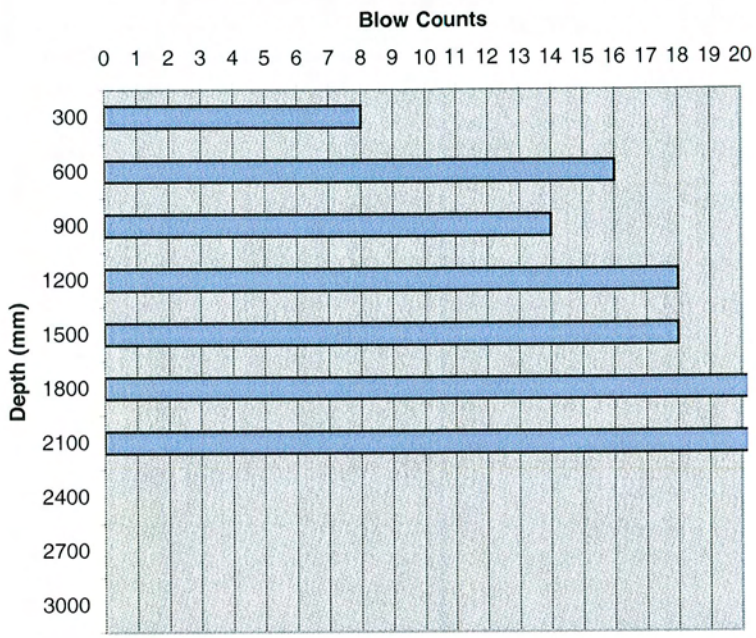


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	8
600	16
900	14
1200	18
1500	18
1800	22
2100	24
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 19

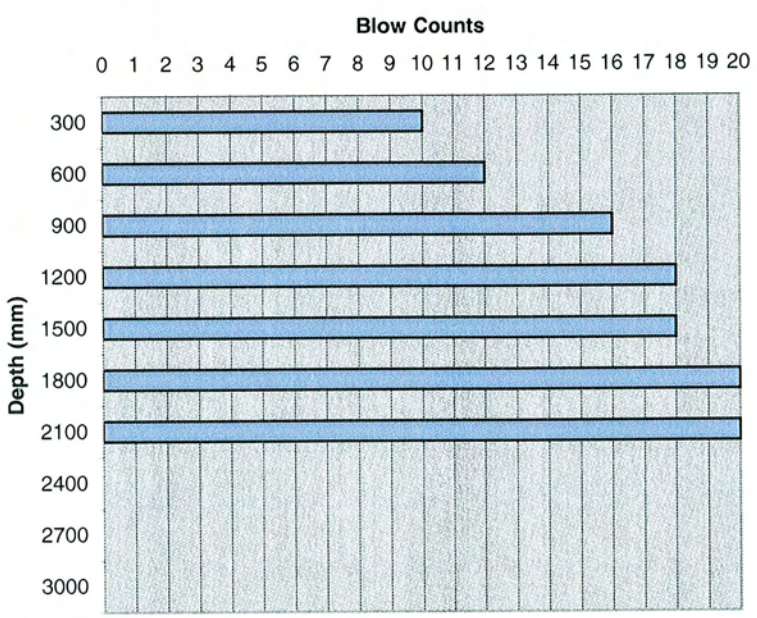


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	10
600	12
900	16
1200	18
1500	18
1800	20
2100	20
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 20

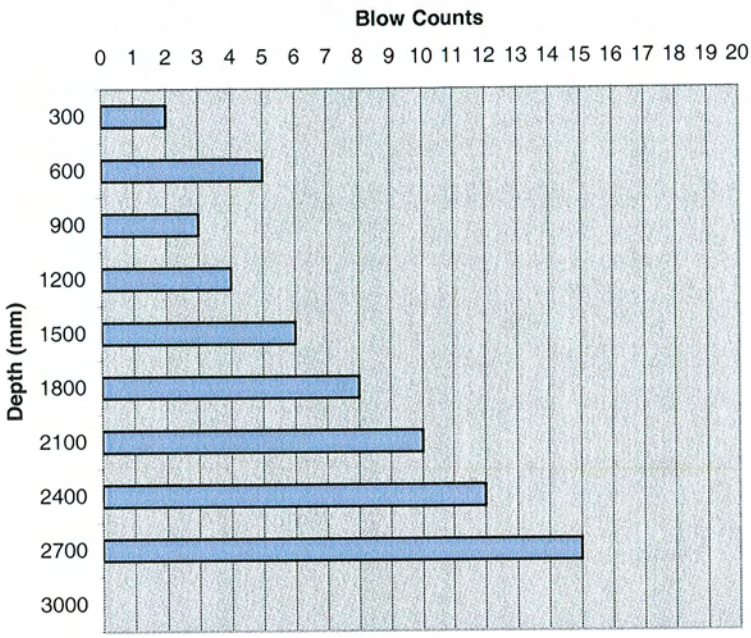


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	2
600	5
900	3
1200	4
1500	6
1800	8
2100	10
2400	12
2700	15
3000	

Perth Sand Penetrometer Results - Test 21

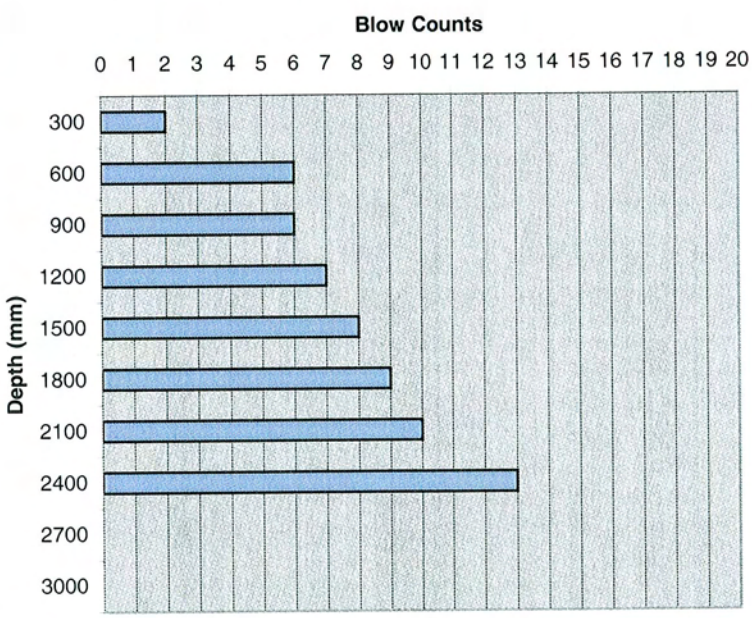


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	2
600	6
900	6
1200	7
1500	8
1800	9
2100	10
2400	13
2700	
3000	

Perth Sand Penetrometer Results - Test 22

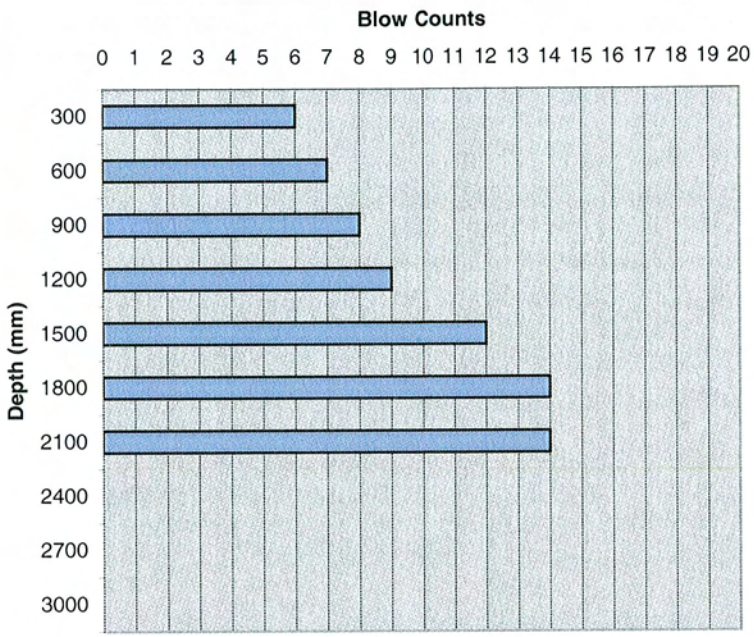


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	6
600	7
900	8
1200	9
1500	12
1800	14
2100	14
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 23

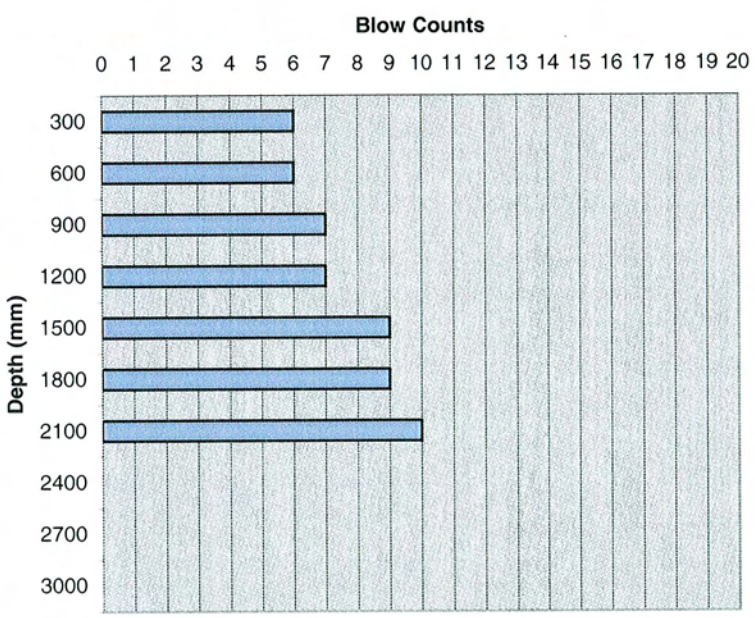


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	6
600	6
900	7
1200	7
1500	9
1800	9
2100	10
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 24

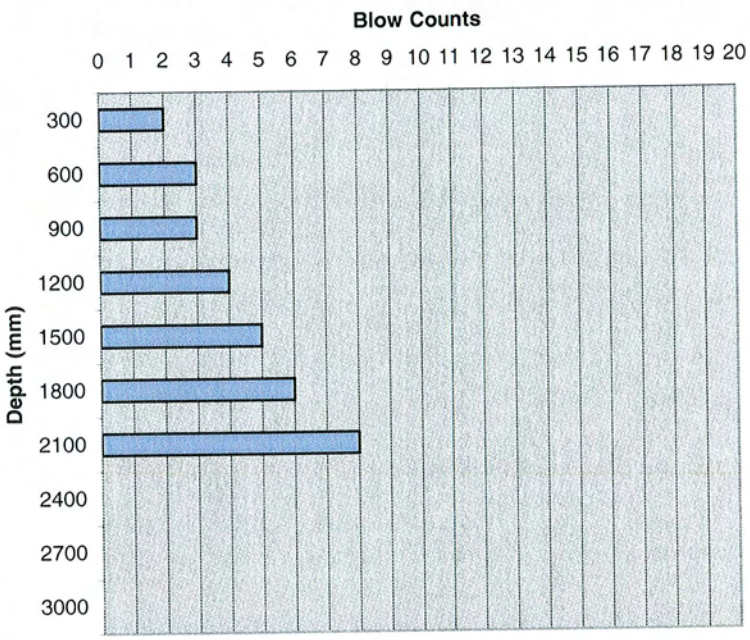


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	2
600	3
900	3
1200	4
1500	5
1800	6
2100	8
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 25

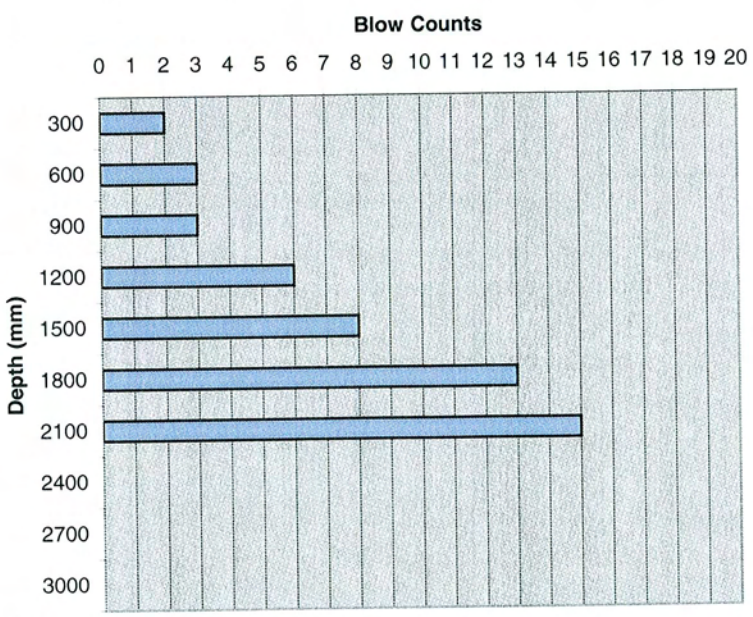


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	2
600	3
900	3
1200	6
1500	8
1800	13
2100	15
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 26

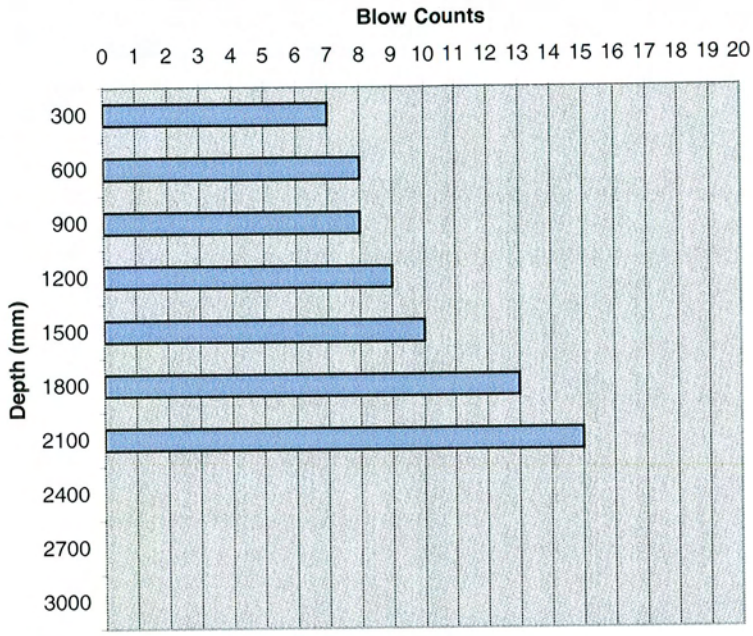


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	7
600	8
900	8
1200	9
1500	10
1800	13
2100	15
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 27

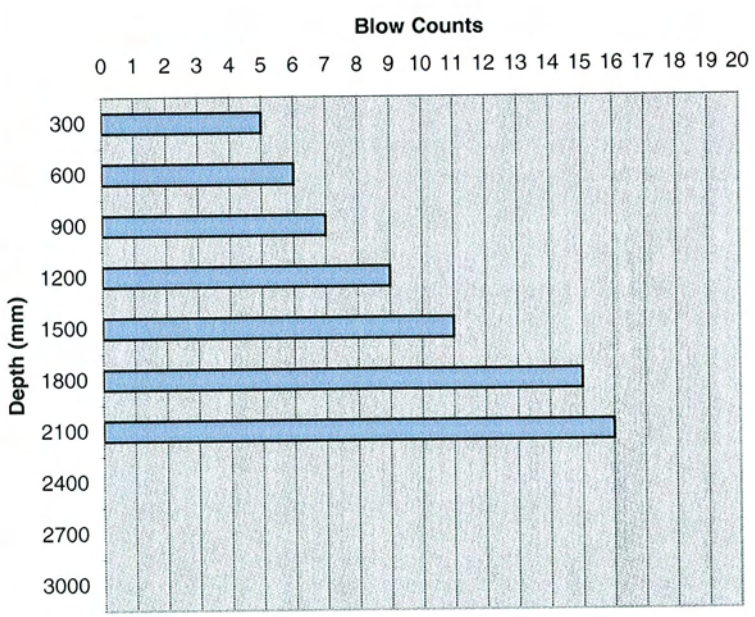


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	5
600	6
900	7
1200	9
1500	11
1800	15
2100	16
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 28

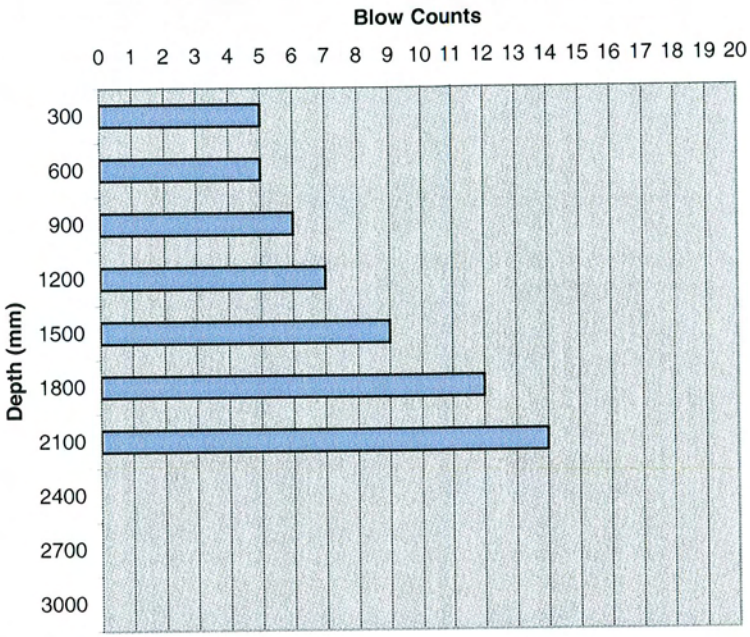


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth (mm)	Blow Counts
300	5
600	5
900	6
1200	7
1500	9
1800	12
2100	14
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 29

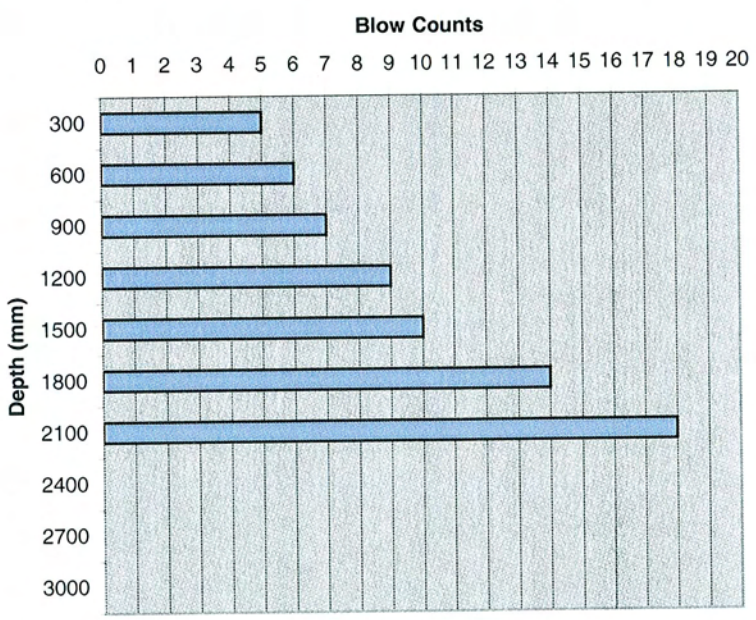


Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

Depth	Blow Counts
300	5
600	6
900	7
1200	9
1500	10
1800	14
2100	18
2400	
2700	
3000	

Perth Sand Penetrometer Results - Test 30



Job Name: Area 19 Northlake Road, Jandakot **Job No**: J06036.01

Date: 15/03/2007

APPENDIX C

Western Geotechnics Group
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

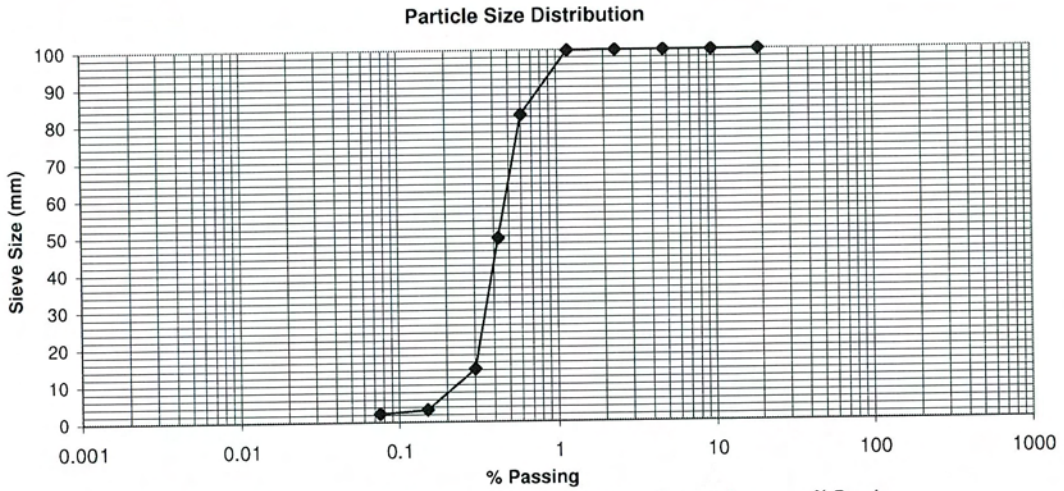
perth@westerngeo.com.au
ABN 91105324436
ph: 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

Client:	Brown Geotechnical & Environmental Pty Ltd	Client Job No.:	J06036/1
Project:	Muriel Court (Area 19)	Test Date:	28/03/07
Location:	Jandakot	WG Job No.:	07-01-175
Sample No.:		Lab No.:	07-WG-710
Sample ID.:	TP5	Depth:	0.5 - 1.5m

METHOD FOR DETERMINATION OF PARTICLE SIZE DISTRIBUTION

-acc to AS 1289.3.6.1



Sieve Size (mm)	% Passing	Sieve Size (mm)	% Passing
		2.36	100
		1.18	100
		0.600	83
		0.425	49
19.0	100	0.300	14
9.5	100	0.150	3
4.75	100	0.075	2

Notes:
Sample supplied by client

Certificate No.:07-WG-710 / S301

Approved Signatory: (Mark Matthews) **Date:** 12/04/2007

This document is issued in accordance with NATA's accreditation requirements

Accreditation No. 2418

SN 2411

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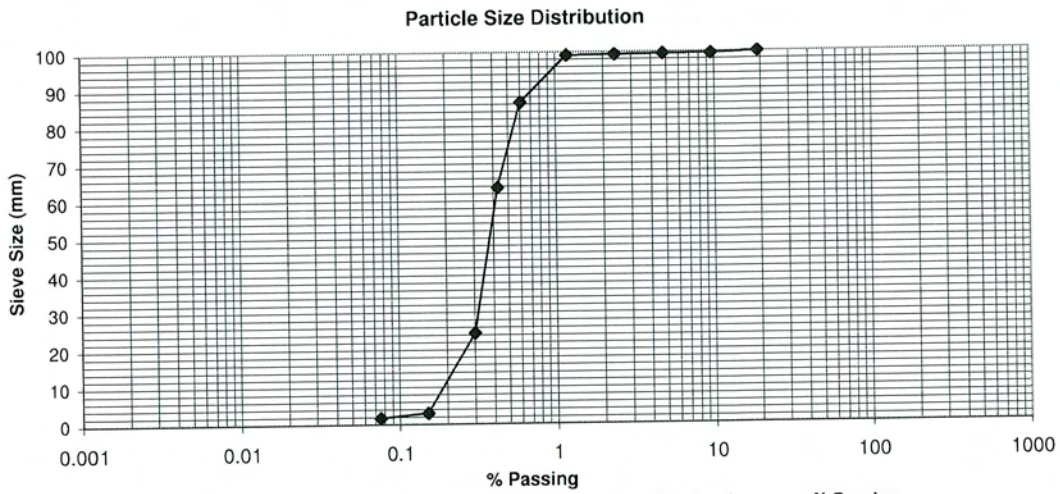
fx: (08) 9458 3700

TEST CERTIFICATE

Client:	Brown Geotechnical & Environmental Pty Ltd	Client Job No.:	J06036/1
Project:	Muriel Court (Area 19)	Test Date:	29/03/07
Location:	Jandakot	WG Job No.:	07-01-175
Sample No.:		Lab No.:	07-WG-718
Sample ID.:	TP7	Depth:	1.3 - 2.5m

METHOD FOR DETERMINATION OF PARTICLE SIZE DISTRIBUTION

-acc to AS 1289.3.6.1



Sieve Size (mm)	% Passing	Sieve Size (mm)	% Passing
		2.36	99
		1.18	99
		0.600	87
		0.425	64
19.0	100	0.300	24
9.5	100	0.150	3
4.75	99	0.075	2

Notes:
Sample supplied by client

Certificate No.:07-WG-718 / S301

Approved Signatory: (Mark Matthews) **Date:** 12/04/2007

This document is issued in accordance with NATA's accreditation requirements

Accreditation No. 2418

SN 2411

Western Geotechnics Group
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TEST CERTIFICATE

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ph: 1300 781 744
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Client:	Brown Geotechnical & Environmental Pty Ltd	Client Job No:	J06036/1
Project:	Muriel Court (Area 19)	Order No:	
Location:	Jandakot	Tested Date:	12/04/2007
Sample No:	07-WG-711	WG Job Number:	07-01-175
Sample ID:	TP11 0.5 - 1.5m	Lab:	Welshpool

PSD: PERCENT FINES <0.075MM

AS1289.3.6.1 (% Fines)

Part	Method	
Material Finer than 75µm (%)		1

Notes:

Note: Sample supplied by client

Approved Signatory: (M.Matthews) Date: 12/04/2007

ilac-MRA NATA

Accreditation No.: 2418

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Client:	Brown Geotechnical & Environmental Pty Ltd	Client Job No:	J06036/1
Project:	Muriel Court (Area 19)	Order No:	
Location:	Jandakot	Tested Date:	12/04/2007
Sample No:	07-WG-712	WG Job Number:	07-01-175
Sample ID:	TP13 0.5 - 1.5m	Lab:	Welshpool

PSD: PERCENT FINES <0.075MM

AS1289.3.6.1 (% Fines)

Part	Method	
Material Finer than 75µm (%)		1

Notes:

Note: Sample supplied by client

Approved Signatory: (M.Matthews) Date: 12/04/2007

ilac-MRA NATA

This document is issued in accordance with NATA's accreditation requirements

Accreditation No.: 2418

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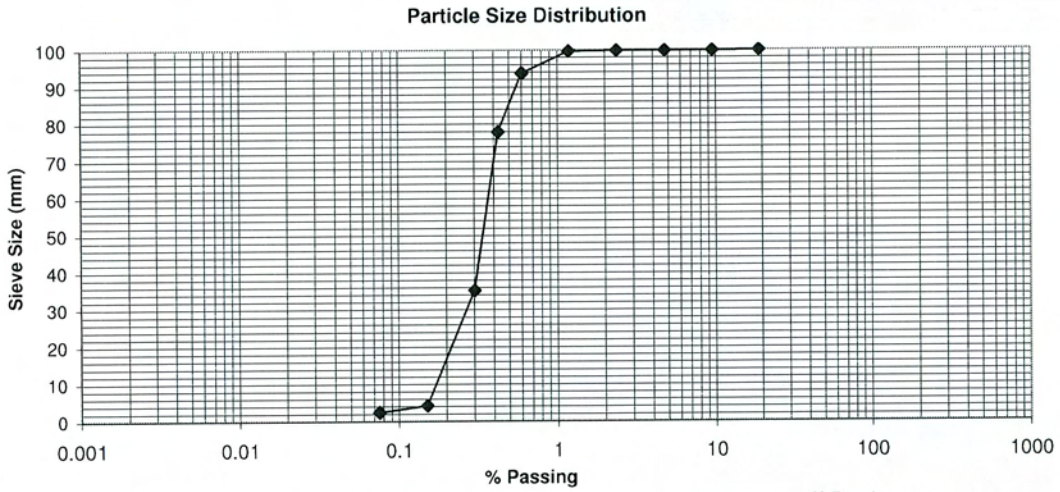
TEST CERTIFICATE

Client:	Brown Geotechnical & Environmental Pty Ltd	Client Job No.:	J06036/1
Project:	Muriel Court (Area 19)	Test Date:	29/03/07
Location:	Jandakot	WG Job No.:	07-01-175
Sample No.:		Lab No.:	07-WG-713
Sample ID.:	TP15	Depth:	0.5 - 1.5m

METHOD FOR DETERMINATION OF PARTICLE SIZE DISTRIBUTION

-acc to AS 1289.3.6.1



Sieve Size (mm)	% Passing	Sieve Size (mm)	% Passing
		2.36	100
		1.18	100
		0.600	94
		0.425	78
19.0	100	0.300	35
9.5	100	0.150	4
4.75	100	0.075	2

Notes:
Sample supplied by client

Certificate No.:07-WG-713 / S301

Approved Signatory: (Mark Matthews) **Date:** 12/04/2007

ilac-MRA NATA Accreditation No. 2418

This document is issued in accordance with NATA's accreditation requirements

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Western Geotechnics Group
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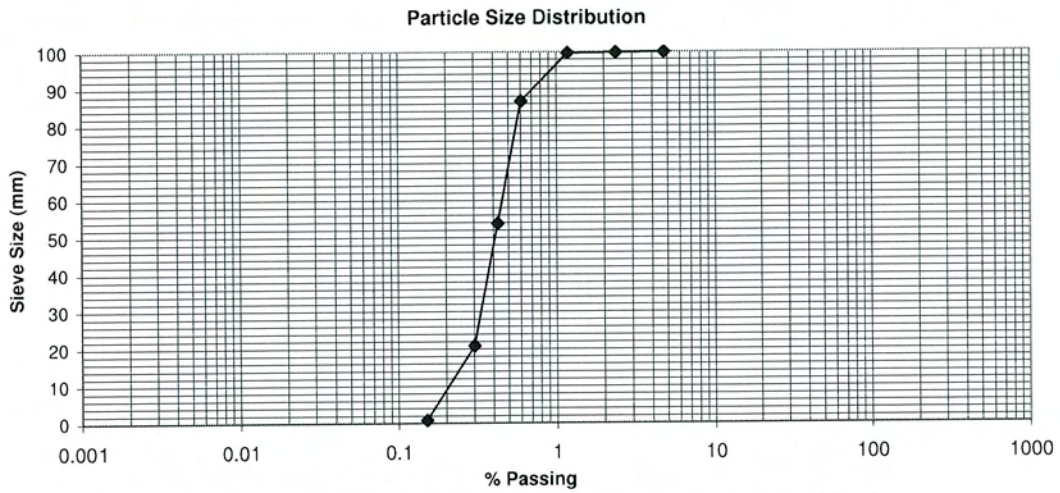
fx: (08) 9458 3700

TEST CERTIFICATE

Client:	Brown Geotechnical & Environmental Pty Ltd	Client Job No.:	J06036/1
Project:	Muriel Court (Area 19)	Test Date:	29/03/07
Location:	Jandakot	WG Job No.:	07-01-175
Sample No.:		Lab No.:	07-WG-714
Sample ID.:	TP17	Depth:	0.9 - 2.0

METHOD FOR DETERMINATION OF PARTICLE SIZE DISTRIBUTION

-acc to AS 1289.3.6.1



Sieve Size (mm)	% Passing	Sieve Size (mm)	% Passing
		2.36	100
		1.18	100
		0.600	87
		0.425	54
		0.300	21
		0.150	1
4.75	100	0.075	0

Notes:
Sample supplied by client

Certificate No.:07-WG-714 / S301

Approved Signatory: (Mark Matthews) **Date:** 12/04/2007

ilac-MRA NATA Accreditation No. 2418

This document is issued in accordance with NATA's accreditation requirements

SN 2411

Western Geotechnics Group
PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

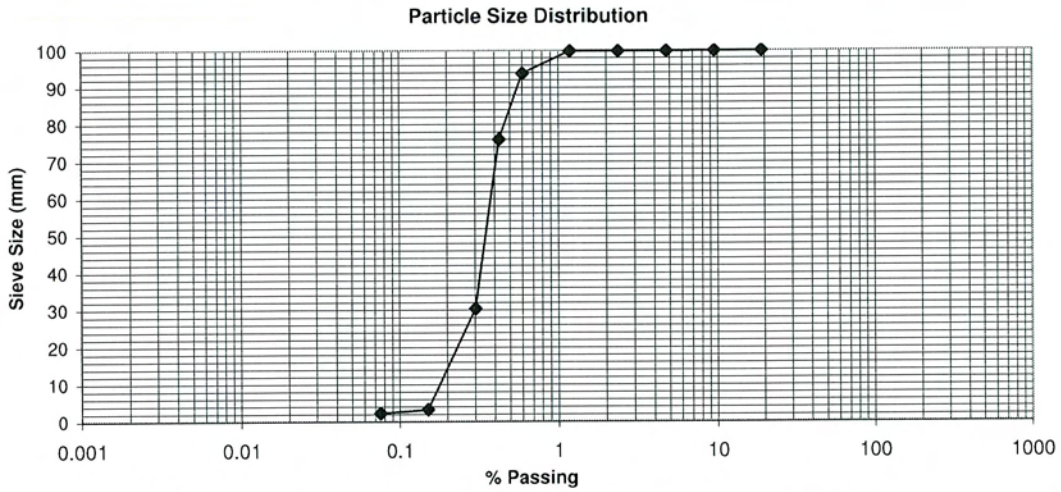
perth@westerngeo.com.au
ABN 91105324436
ph: 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

Client:	Brown Geotechnical & Environmental Pty Ltd	Client Job No.:	J06036/1
Project:	Muriel Court (Area 19)	Test Date:	29/03/07
Location:	Jandakot	WG Job No.:	07-01-175
Sample No.:		Lab No.:	07-WG-715
Sample ID.:	TP20	Depth:	0.5 - 1.5m

METHOD FOR DETERMINATION OF PARTICLE SIZE DISTRIBUTION

-acc to AS 1289.3.6.1



Sieve Size (mm)	% Passing	Sieve Size (mm)	% Passing
		2.36	100
		1.18	100
		0.600	94
		0.425	76
19.0	100	0.300	30
9.5	100	0.150	3
4.75	100	0.075	2

Notes:
Sample supplied by client

Certificate No.:07-WG-715 / S301

Approved Signatory: (Mark Matthews) **Date:** 12/04/2007

ilac-MRA NATA Accreditation No. 2418

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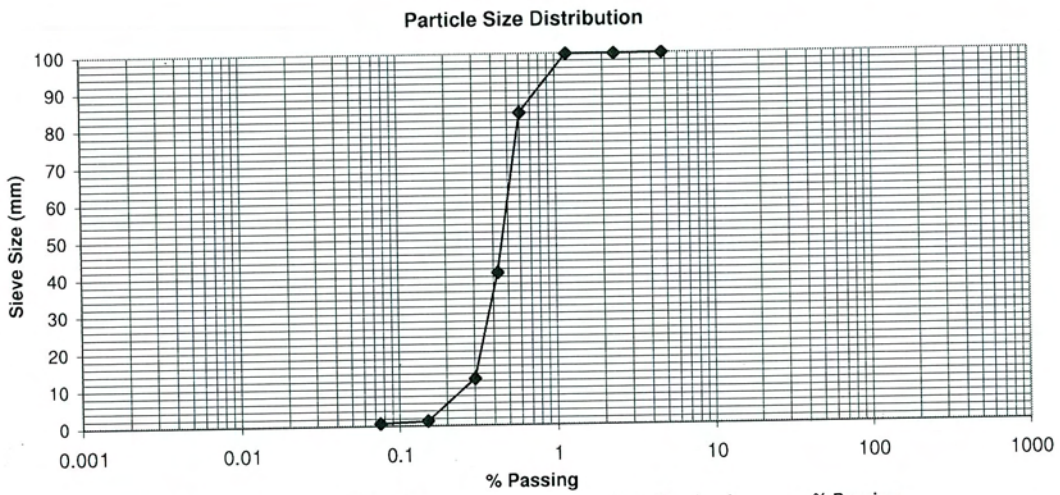
fx: (08) 9458 3700

TEST CERTIFICATE

Client:	Brown Geotechnical & Environmental Pty Ltd	Client Job No.:	J06036/1
Project:	Muriel Court (Area 19)	Test Date:	30/03/07
Location:	Jandakot	WG Job No.:	07-01-175
Sample No.:		Lab No.:	07-WG-716
Sample ID.:	TP22	Depth:	1.5 - 2.5m

METHOD FOR DETERMINATION OF PARTICLE SIZE DISTRIBUTION

-acc to AS 1289.3.6.1



Sieve Size (mm)	% Passing	Sieve Size (mm)	% Passing
		2.36	100
		1.18	100
		0.600	84
		0.425	41
		0.300	13
		0.150	1
4.75	100	0.075	1

Notes:
Sample supplied by client

Certificate No.:07-WG-716 / S301

Approved Signatory: (Mark Matthews) Date: 12/04/2007

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Accreditation No. 2418

SN 2411

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PO Box 219 Bentley WA 6982
36 Railway Parade
Welshpool WA 6106

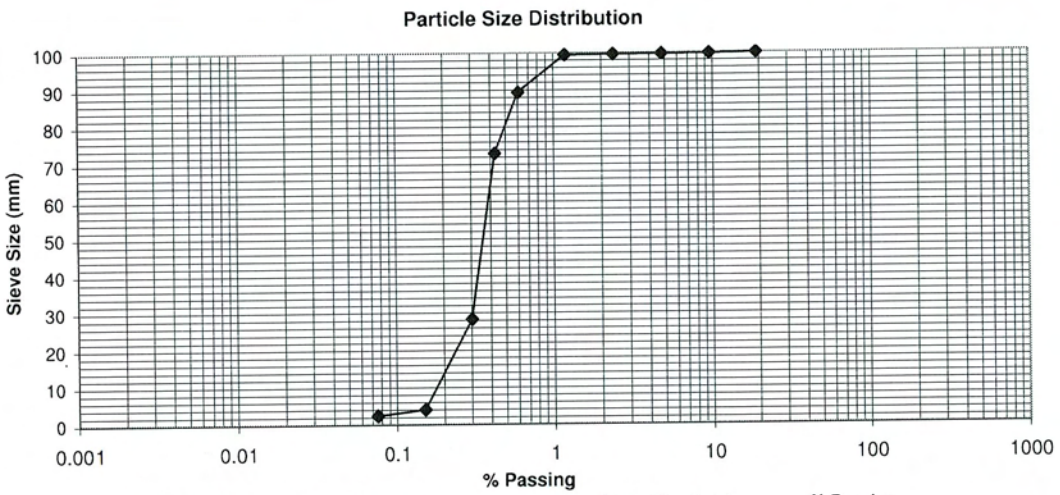
perth@westerngeo.com.au
ABN 91105324436
ph: 1300 781 744
fx: (08) 9458 3700

TEST CERTIFICATE

Client:	Brown Geotechnical & Environmental Pty Ltd	Client Job No.:	J06036/1
Project:	Muriel Court (Area 19)	Test Date:	28/03/07
Location:	Jandakot	WG Job No.:	07-01-175
Sample No.:		Lab No.:	07-WG-717
Sample ID.:	TP28	Depth:	0.5 - 1.5m

METHOD FOR DETERMINATION OF PARTICLE SIZE DISTRIBUTION

-acc to AS 1289.3.6.1



Sieve Size (mm)	% Passing	Sieve Size (mm)	% Passing
		2.36	100
		1.18	99
		0.600	89
		0.425	73
19.0	100	0.300	28
9.5	100	0.150	4
4.75	100	0.075	3

Notes:
Sample supplied by client

Certificate No.:07-WG-717 / S301

Approved Signatory: (Mark Matthews) **Date:** 12/04/2007

ilac-MRA NATA Accreditation No. 2418

This document is issued in accordance with NATA's accreditation requirements

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Western geotechnics Group

TEST CERTIFICATE

CLIENT: Brown Geotechnical & Enviromental Pty Ltd
PROJECT: Muriel Court (Area 19)
LOCATION: Jandakot

JOB NO.: 07-01-175
CLIENT JOB NO.: J06036/1
DATE TESTED: 30/03/2007

Lab Ref No.: 07-WG-717
Sample Id:
Sample No.: TP28 – 0.5 - 1.5m
Description:

ORGANIC MATTER CONTENT - FURNACE METHOD

- according to ASTM D 2974, Part 9, Method C

Organic Content (%):	**0.84**

Note:

Certificate No.: WG717

Approved Signatory :_ (M.Matthews) **Date : 12/04/2007**

QMS.Forms.Soils.WG086.01.C

APPENDIX D

Acid Sulphate Soil Field Test Results

Test Pit No	Depth (m)	pH_F (field)	pH_{FOX} (post oxidation)	Reaction Strength
TP1	0.5	6.9	5.1	Moderate
TP1	1.5	7.2	5.5	Slight
TP1	2.5	6.9	5.0	Slight*
TP2	0.5	6.8	4.9	Slight
TP2	1.5	7.2	5.2	Slight
TP2	2.5	7.1	5.0	Slight
TP3	0.5	6.7	4.2	Slight
TP3	1.5	6.6	4.5	Slight*
TP3	2.5	7.1	5.2	Slight
TP4	0.5	7.0	3.8	Slight
TP4	1.5	5.8	3.8	Slight*
TP4	2.5	6.2	4.8	Slight
TP5	0.5	6.3	4.7	Slight
TP5	1.5	6.2	4.7	Slight
TP5	2.5	6.5	4.9	Slight
TP9	0.5	6.8	4.9	Slight
TP9	1.5	6.9	4.7	Slight
TP9	2.5	6.8	4.9	Slight
TP26	0.5	6.2	4.6	Slight
TP26	1.5	6.2	4.5	Slight*
TP26	2.5	6.3	4.6	Slight
TP27	0.5	6.0	4.8	Slight
TP27	1.5	6.3	4.8	Slight*
TP27	2.5	6.0	5.9	Slight
TP28	0.5	6.1	5.0	Slight
TP28	1.5	6.2	4.8	Slight
TP28	2.5	6.3	4.9	Slight
TP29	0.5	7.9	4.9	Slight
TP29	1.5	7.7	5.2	Slight
TP29	2.5	7.3	4.6	Strong*
TP30	0.5	7.3	4.3	Moderate*
TP30	1.5	6.8	4.7	Slight
TP30	2.5	6.8	4.6	Slight
TP31	0.5	7.0	4.5	Moderate*
TP31	1.5	7.0	5.0	Slight
TP31	2.5	7.0	5.1	Slight*
TP32	0.5	6.1	2.9	Moderate*
TP32	1.5	6.3	4.1	Slight*
TP32	2.5	5.9	4.2	Slight

* Selected for laboratory testing.

ALS Environmental

11/F, Chung Shun Knitting Centre
1-3 Wing Yip St, Kwai Chung
Tel : (852) 2610 1044
Fax : (852) 2610 2021
Email: alshk@hknet.com

SAMPLE SUBMISSION FORM

Please Note : The following information is required to expedite sample analysis. Please complete all the necessary details and return this form with your samples.

CLIENT DETAILS:
Company Name: Brown Geotechnical & Environmental

Client Contact Name: Ken Brown Date: 05/04/07

Postal Address: POBox 4000, Victotia Park WA6979

Email: bge@acidss.com.au

Phone: 9368 2615 Fax: 9367 7409

CLIENT ORDER No : J06036.01/2 ALS QUOTATION NUMBER : PEN/063/06

PROJECT NAME: Area 19, Muriel Court, Jandakot

SECONDARY CONTACT
Name :
Address:
Phone :

Environmental Division
Perth
Work Order
EP0701409

Telephone : 61-8-9209 7655

(office use only)
Batch No: EP0701409
Date Received: 5/4/07
Total No Samples: #13

Luke Jones
5/4/07 16:30

SAMPLE ANALYTIC

Lab ID (office use only)	Sample ID.	Matrix	Sampling Date/Time	Analysis Required
1	TP1 – 2.5m EP07012007003	Soil	15/03/07	ASS Chromium Suite
2	TP3 – 1.5m EP07012007008	Soil	15/03/07	ASS Chromium Suite
3	TP4 – 1.5m EP07012007011	Soil	15/03/07	ASS Chromium Suite
4	TP4 – 2.5m EP07012007012	Soil	15/03/07	ASS Chromium Suite
5	TP26 – 1.5m EP07012007020	Soil	15/03/07	ASS Chromium Suite
6	TP27 – 1.5m EP07012007023	Soil	15/03/07	ASS Chromium Suite
7	TP29 – 2.5m EP07012007027	Soil	15/03/07	ASS Chromium Suite
8	TP30 – 0.5m EP07012007028	Soil	15/03/07	ASS Chromium Suite
9	TP31 – 0.5m EP07012007031	Soil	15/03/07	ASS Chromium Suite

(CONTINUED OVERLEAF)

SAMPLE ANALYTICAL REQUIREMENTS (continued) :

(office use only)
Batch No:

Lab ID (office use only)	Sample ID.	Matrix	Sampling Date/Time	Analysis Required
10	TP31 – 2.5m EP07012007033	Soil	15/03/07	ASS Chromium Suite
11	TP32 – 0.5m EP07012007034	Soil	15/03/07	ASS Chromium Suite
12	TP32 – 1.5m EP07012007035	Soil	15/03/07	ASS Chromium Suite
13	QA1	Soil	15/03/07	ASS Chromium Suite
	Soil samples retained by ALS			

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CERTIFICATE OF ANALYSIS

Client	: BROWN GEOTECHNICAL AND ENVIRONMENTAL	Laboratory	: Environmental Division Perth	Page	: 1 of 6
Contact	: MR KEN BROWN	Contact	: Michael Sharp	Work Order	: EP0701409
Address	: SUITE 4 / 47 MONASH AVENUE COMO WA AUSTRALIA 6152	Address	: 10 Hod Way Malaga WA Australia 6090		
E-mail	: kenbrown@acidss.com.au	E-mail	: Michael.Sharp@alsenviro.com		
Telephone	: 93682615	Telephone	: 61-8-9209 7655		
Facsimile	: - Not provided -	Facsimile	: 61-8-9209 7600		
Project	: J06036.01 2 Ex EP0701207	Quote number	: PEN-063-06	Date received	: 5 Apr 2007
Order number	: - Not provided -			Date issued	: 17 Apr 2007
C-O-C number	: - Not provided -			No. of samples	- Received : 13
Site	: Area 19, Muriel Court, Janakot				Analysed : 13

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NATA Accredited Laboratory 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Position	Department
Stacey Hawkins	Instrument Chemist	Perth Inorganics - NATA 825 (15847 - Perth)

ALS Environmental

Comments

This report for the ALSE reference EP0701409 supersedes any previous reports with this reference. Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- **Analytical Results for Samples Submitted**
- **Surrogate Recovery Data**

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

Specific comments for Work Order **EP0701409**

Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Retained Acidity not required because pH KCl greater than or equal to 4.5

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: TP1 2.5	TP3 1.5	TP4 1.5	TP4 2.5	TP26 1.5
Sample Matrix Type / Description:				SOIL	SOIL	SOIL	SOIL	SOIL
Sample Date / Time:				15 Mar 2007 15:00	15 Mar 2007 15:00	15 Mar 2007 15:00	15 Mar 2007 15:00	15 Mar 2007 15:00
Laboratory Sample ID:				EP0701409-001	EP0701409-002	EP0701409-003	EP0701409-004	EP0701409-005
EA033-A: Actual Acidity								
pH KCl (23A)		0.1	pH Unit	6.5	6.2	5.4	6.6	6.4
Titratable Actual Acidity (23F)		2	mole H+ / t	<2	2	10	<2	2
sulfidic - Titratable Actual Acidity (s-23F)		0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)		10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)		0.01	% CaCO3	----	----	----	<0.01	----
acidity - Acid Neutralising Capacity (a-19A1)		10	mole H+ / t	----	----	----	<10	----
sulfidic - Acid Neutralising Capacity (s-19A1)		0.01	% pyrite S	----	----	----	<0.01	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor		0.5		1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)		10	mole H+ / t	<10	<10	11	<10	<10
Liming Rate		1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)		10	mole H+ / t	<10	<10	11	<10	<10
Liming Rate excluding ANC		1	kg CaCO3/t	<1	<1	<1	<1	<1

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID : TP27 1.5	TP29 2.5	TP30 0.5	TP31 0.5	TP31 2.5
			Sample Matrix Type / Description :	SOIL	SOIL	SOIL	SOIL	SOIL
			Sample Date / Time :	15 Mar 2007 15:00	15 Mar 2007 15:00	15 Mar 2007 15:00	15 Mar 2007 15:00	15 Mar 2007 15:00
			Laboratory Sample ID :	EP0701409-006	EP0701409-007	EP0701409-008	EP0701409-009	EP0701409-010
EA033-A: Actual Acidity								
pH KCl (23A)		0.1	pH Unit	6.2	6.6	6.7	6.9	6.2
Titratable Actual Acidity (23F)		2	mole H+ / t	2	<2	<2	<2	2
sulfidic - Titratable Actual Acidity (s-23F)		0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
acidity - Chromium Reducible Sulfur (a-22B)		10	mole H+ / t	<10	<10	<10	<10	<10
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A1)		0.01	% CaCO3	----	0.06	0.24	0.30	----
acidity - Acid Neutralising Capacity (a-19A1)		10	mole H+ / t	----	11	48	61	----
sulfidic - Acid Neutralising Capacity (s-19A1)		0.01	% pyrite S	----	0.02	0.08	0.10	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor		0.5		1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)		10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate		1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)		0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity excluding ANC (acidity units)		10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate excluding ANC		1	kg CaCO3/t	<1	<1	<1	<1	<1

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	Client Sample ID: TP32 0.5	TP32 1.5	QA1		
Sample Matrix Type / Description:				SOIL	SOIL	SOIL		
Sample Date / Time:				15 Mar 2007 15:00	15 Mar 2007 15:00	15 Mar 2007 15:00		
Laboratory Sample ID:				EP0701409-011	EP0701409-012	EP0701409-013		
EA033-A: Actual Acidity								
pH KCl (23A)		0.1	pH Unit	4.9	5.8	5.9		
Titratable Actual Acidity (23F)		2	mole H+ / t	5	2	2		
sulfidic - Titratable Actual Acidity (s-23F)		0.02	% pyrite S	<0.02	<0.02	<0.02		
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)		0.02	% S	<0.02	<0.02	<0.02		
acidity - Chromium Reducible Sulfur (a-22B)		10	mole H+ / t	<10	<10	<10		
EA033-E: Acid Base Accounting								
ANC Fineness Factor		0.5		1.5	1.5	1.5		
Net Acidity (sulfur units)		0.02	% S	<0.02	<0.02	<0.02		
Net Acidity (acidity units)		10	mole H+ / t	<10	<10	<10		
Liming Rate		1	kg CaCO3/t	<1	<1	<1		
Net Acidity excluding ANC (sulfur units)		0.02	% S	<0.02	<0.02	<0.02		
Net Acidity excluding ANC (acidity units)		10	mole H+ / t	<10	<10	<10		
Liming Rate excluding ANC		1	kg CaCO3/t	<1	<1	<1		

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Surrogate Control Limits

- **No surrogates present on this report.**

ALS Environmental

QUALITY CONTROL REPORT

Client	:	**BROWN GEOTECHNICAL AND ENVIRO**	**Laboratory**	: Environmental Division Perth	**Page**	:	**1 of 5**
Contact	:	MR KEN BROWN	**Contact**	: Michael Sharp			
Address	:	SUITE 4 / 47 MONASH AVENUE COMO WA AUSTRALIA 6152	**Address**	: 10 Hod Way Malaga WA Australia 6090	**Work order**	:	**EP0701409**
					Amendment No.	:	
Project	:	J06036.01 2 Ex EP0701207	**Quote number**	: PEN-063-06	**Date received**	:	**5 Apr 2007**
Order number	:	- Not provided -			**Date issued**	:	**17 Apr 2007**
C-O-C number	:	- Not provided -					
Site	:	Area 19, Muriel Court, Janakot					
E-mail	:	kenbrown@acidss.com.au	**E-mail**	: Michael.Sharp@alsenviro.com	**No. of samples**		
Telephone	:	93682615	**Telephone**	: 61-8-9209 7655	**Received**	:	13
Facsimile	:	- Not provided -	**Facsimile**	: 61-8-9209 7600	**Analysed**	:	13

This final report for the ALSE work order reference EP0701409 supersedes any previous reports with this reference.

Results apply to the samples as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- Matrix Spikes (MS); Recovery and Acceptance Limits

Work order specific comments

Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Retained Acidity not required because pH KCl greater than or equal to 4.5

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NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory - 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IED 17025

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Stacey Hawkins	Perth Inorganics - NATA 825 (15847 - Perth)

Quality Control Report - Laboratory Duplicates (DUP)

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** = *Limit of Reporting,* ***RPD*** = *Relative Percent Difference.*
* Indicates failed QC. The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Laboratory Duplicates (DUP) Report

Matrix Type: SOIL

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EA033-A: Actual Acidity						
EA033-A: Actual Acidity - (QC Lot: 389856)				**pH Unit**	**pH Unit**	**%**
EP0701409-001	TP1 - 2.5	pH KCl (23A)	0.1 pH Unit	6.5	6.5	0.0
		Titratable Actual Acidity (23F)	2 mole H+ / t	<2	<2	0.0
		sulfidic - Titratable Actual Acidity (s-23F)	0.02 % pyrite S	<0.02	<0.02	0.0
EP0701409-011	TP32 - 0.5	pH KCl (23A)	0.1 pH Unit	4.9	5.5	11.1
		Titratable Actual Acidity (23F)	2 mole H+ / t	5	4	28.4
		sulfidic - Titratable Actual Acidity (s-23F)	0.02 % pyrite S	<0.02	<0.02	0.0
EA033-B: Potential Acidity						
EA033-B: Potential Acidity - (QC Lot: 389856)				**% S**	**% S**	**%**
EP0701409-001	TP1 - 2.5	Chromium Reducible Sulfur (22B)	0.02 % S	<0.02	<0.02	0.0
		Acidity - Chromium Reducible Sulfur (a-22B)	10 mole H+ / t	<10	<10	0.0
EP0701409-011	TP32 - 0.5	Chromium Reducible Sulfur (22B)	0.02 % S	<0.02	<0.02	0.0
		Acidity - Chromium Reducible Sulfur (a-22B)	10 mole H+ / t	<10	<10	0.0
EA033-E: Acid Base Accounting						
EA033-E: Acid Base Accounting - (QC Lot: 389856)						**%**
EP0701409-001	TP1 - 2.5	ANC Fineness Factor		1.5	1.5	0.0
		Net Acidity (sulfur units)	0.02 % S	<0.02	<0.02	0.0
		Net Acidity (acidity units)	10 mole H+ / t	<10	<10	0.0
		Liming Rate	1 kg CaCO3/t	<1	<1	0.0
		Net Acidity excluding ANC (sulfur units)	0.02 % S	<0.02	<0.02	0.0
		Net Acidity excluding ANC (acidity units)	10 mole H+ / t	<10	<10	0.0
		Liming Rate excluding ANC	1 kg CaCO3/t	<1	<1	0.0
EP0701409-011	TP32 - 0.5	ANC Fineness Factor		1.5	1.5	0.0
		Net Acidity (sulfur units)	0.02 % S	<0.02	<0.02	0.0
		Net Acidity (acidity units)	10 mole H+ / t	<10	<10	0.0
		Liming Rate	1 kg CaCO3/t	<1	<1	0.0

Matrix Type: SOIL

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EA033-E: Acid Base Accounting - continued						
EA033-E: Acid Base Accounting - (QC Lot: 389856) - continued				**% S**	**% S**	**%**
EP0701409-011	TP32 - 0.5	Net Acidity excluding ANC (sulfur units)	0.02 % S	<0.02	<0.02	0.0
		Net Acidity excluding ANC (acidity units)	10 mole H+ / t	<10	<10	0.0
		Liming Rate excluding ANC	1 kg CaCO3/t	<1	<1	0.0

Quality Control Report - Method Blank (MB) and Laboratory Control Samples (LCS)

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of actual laboratory data. Flagged outliers on control limits for inorganics tests may be within the NEPM specified data quality objective of recoveries in the range of 70 to 130%. Where this occurs, no corrective action is taken. Abbreviations: LOR = Limit of reporting.

Matrix Type: SOIL

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	*LOR*	*Method blank result*	*Actual Results*		*Recovery Limits*	
			Spike concentration	*Spike Recovery*	*Dynamic Recovery Limits*	
				LCS	*Low*	*High*
EA033-A: Actual Acidity						
EA033-A: Actual Acidity - (QC Lot: 389856)		pH Unit	pH Unit	%	%	%
pH KCl (23A)	0.1 pH Unit	<0.1	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	0.02 % pyrite S	<0.02	----	----	----	----
Titratable Actual Acidity (23F)	2 mole H+ / t	<2	----	----	----	----
EA033-B: Potential Acidity						
EA033-B: Potential Acidity - (QC Lot: 389856)		mole H+ / t	mole H+ / t	%	%	%
Acidity - Chromium Reducible Sulfur (a-22B)	10 mole H+ / t	<10	----	----	----	----
Chromium Reducible Sulfur (22B)	0.02 % S	<0.02	----	----	----	----
EA033-E: Acid Base Accounting						
EA033-E: Acid Base Accounting - (QC Lot: 389856)				%	%	%
ANC Fineness Factor		<0.5	----	----	----	----
Liming Rate	1 kg CaCO3/t	<1	----	----	----	----
Net Acidity (acidity units)	10 mole H+ / t	<10	----	----	----	----
Net Acidity (sulfur units)	0.02 % S	<0.02	----	----	----	----

ALS Environmental

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** *= Limit of Reporting,* ***RPD*** *= Relative Percent Difference.*

* Indicates failed QC

Matrix Spike (MS) Report

					Actual Results		Recovery Limits	
					Sample Result	Spike Recovery	Static Limits	
Analyte name	Laboratory Sample ID	Client Sample ID	LOR	Spike Concentration		MS	Low	High
- (QC Lot:)						%	%	%

- **No Matrix Spike (MS) carried out on this Work Order.**

ALS Environmental

INTERPRETIVE QUALITY CONTROL REPORT

Client	:	**BROWN GEOTECHNICAL AND ENVIRONMENTAL**	**Laboratory**	:	Environmental Division Perth	**Page**	: **1 of 5**
Contact	:	MR KEN BROWN	**Contact**	:	Michael Sharp		
Address	:	SUITE 4 / 47 MONASH AVENUE COMO WA AUSTRALIA 6152	**Address**	:	10 Hod Way Malaga WA Australia 6090	**Work order**	: **EP0701409**
						Amendment No.	:
Project	:	J06036.01 2 Ex EP0701207	**Quote number**	:	PEN-063-06	**Date received**	: 5 Apr 2007
Order number	:	- Not provided -				**Date issued**	: 17 Apr 2007
C-O-C number	:	- Not provided -					
Site	:	Area 19, Muriel Court, Janakot					
E-mail	:	kenbrown@acidss.com.au	**E-mail**	:	Michael.Sharp@alsenviro.com	**No. of samples**	
Telephone	:	93682615	**Telephone**	:	61-8-9209 7655	**Received**	: 13
Facsimile	:	- Not provided -	**Facsimile**	:	61-8-9209 7600	**Analysed**	: 13

This Interpretive Quality Control Report was issued on 17 Apr 2007 for the ALS work order reference EP0701409 and supersedes any previous reports with this reference.
This report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Type Frequency Compliance
- Summary of all Quality Control Outliers
- Brief Method Summaries

Interpretive Quality Control Report - Analysis Holding Time

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the sample aliquot was taken. Elapsed time to analysis represents time from sampling where no extraction / digestion is involved or time from extraction / digestion where this is present. For composite samples, sampling date/time is taken as that of the oldest sample contributing to that composite. Sample date/time for laboratory produced leaches are taken from the completion date/time of the leaching process. Outliers for holding time are based on USEPA SW846, APHA, AS and NEPM (1999). Failed outliers, refer to the 'Summary of Outliers'.

Matrix Type: SOIL

Analysis Holding Time and Preservation

Method / Container / Client Sample ID(s)	Date Sampled	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
EA033: Chromium Suite for Acid Sulphate Soils							
80* dried soil TP1 - 2.5, TP3 - 1.5, TP4 - 1.5, TP4 - 2.5, TP26 - 1.5, TP27 - 1.5, TP29 - 2.5, TP30 - 0.5, TP31 - 0.5, TP31 - 2.5, TP32 - 0.5, TP32 - 1.5, QA1	**15 Mar 2007**	**13 Apr 2007**	14 Mar 2008	Pass	**16 Apr 2007**	12 Jul 2007	Pass

Interpretive Quality Control Report - Frequency of Quality Control Samples

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which this work order was processed. Actual rate should be greater than or equal to the expected rate.

Frequency of Quality Control Samples

Matrix Type: SOIL

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
EA033: Chromium Suite for Acid Sulphate Soils	2	13	15.4	10.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Laboratory Control Samples (LCS)					
EA033: Chromium Suite for Acid Sulphate Soils	1	13	7.7	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Method Blanks (MB)					
EA033: Chromium Suite for Acid Sulphate Soils	1	13	7.7	5.0	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

Interpretive Quality Control Report - Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged on the 'Quality Control Report'. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). Flagged outliers on control limits for inorganics tests may be within the NEPM specified data quality objective of recoveries in the range of 70 to 130%. Where this occurs, no corrective action is taken. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot.

Non-surrogates

- **For all matrices, no RPD recovery outliers occur for the duplicate analysis.**
- **For all matrices, no method blank result outliers occur.**
- **For all matrices, no laboratory spike recoveries breaches occur.**
- **For all matrices, no matrix spike recoveries breaches occur.**

Surrogates

- **For all matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time

The following report highlights outliers within this 'Interpretive Quality Control Report - Analysis Holding Time'.

- **No holding time outliers occur.**

Outliers : Frequency of Quality Control Samples

The following report highlights outliers within this 'Interpretive Quality Control Report - Frequency of Quality Control Samples'.

- **No frequency outliers occur.**

Method Reference Summary

The analytical procedures used by ALS Environmental are based on established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house procedure are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

Matrix Type: SOIL

Preparation Methods

EN020PR : Drying at 85 degrees, bagging and labelling (ASS) - In house

Analytical Methods

EA033 : Chromium Suite for Acid Sulphate Soils - Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.

APPENDIX E

APPENDIX E

Soil Assessment Criteria

Western Australia's Draft Acid Sulphate Soil Guidelines (2006) have established action criteria for the assessment of the environmental risk of acid sulphate soils. The action criteria are based on the sum of existing plus, potential acidity, calculated as equivalent sulphur (e.g. s-TAA + S_{CR} in %S units) or equivalent acidity (e.g. TAA + TPA in mol H^+/tonne). The highest laboratory result was used to assess against the action criteria.

As clay content tends to influence the soils natural pH buffering capacity, the action criteria are grouped by three broad texture categories – coarse, medium and fine. The criteria are used to define when acid sulphate soils disturbed at a site will need to be treated and managed. The Table below summarises the action criteria.

Texture based acid sulphate soils action criteria

Type of Material		Action Criteria if <1,000 tonnes of material is disturbed		Action Criteria if >1,000 tonnes of material is disturbed	
Texture Range	**Approx. Clay Content**	**Equivalent Sulphur (%)**	**Equivalent Acidity (mol H^+/tonne)**	**Equivalent Sulphur**	**Equivalent Acidity (mol H^+/tonne)**
Coarse – sands to loamy sands	≤ 5%	0.03	18.7	0.03	18.7
Medium – sandy loams to light clays	5 – 40%	0.06	37.4	0.03	18.7
Fine – medium to heavy clays and silty clays	≥ 40%	0.1	64.8	0.03	18.7

In addition to the action criteria, the guidelines define indicator pH values for field pH (pH_F) and field peroxide pH (pH_{FOX}) to assist with identifying likely acid generating soils. The pH indicator values are defined as:

- $pH_F \leq 4$ (when pH >4 but<5 may indicate some existing acidity); and
- pH_{FOX} <3 or a much lower pH_{FOX} than pH_F (greater than 1 pH unit change).

APPENDIX B

LIMITED PRELIMINARY SITE INVESTIGATION

ACE ENVIRONMENTAL

DISTRICT STRUCTURE PLAN
DEVELOPMENT AREA 19
CITY OF COCKBURN

WESTERN AUSTRALIA

LIMITED PRELIMINARY SITE ASSESSMENT

FOR
CITY OF COCKBURN

JANUARY 2008
Ref: J07030.01

Ace Environmental Pty Ltd
Shop 17, 2 South Western Highway, Armadale WA 6112
Tel (08) 9497 5000; Fax (08) 9497 5111

ABN: 15 125 509 775

CONDITIONS RELATING TO THIS REPORT

1. This report has been prepared for the sole use of the City of Cockburn. It has been issued in accordance with the agreed terms and scope detailed in the proposal for the investigation. No responsibility or liability to any third party is accepted for any damages arising out of the use of this report.

2. This report has been prepared by suitably qualified and experienced personnel for the purposes stated herein. Every care is taken with the report as it relates to interpretation of sub-surface conditions, discussion of findings and recommendations given. No responsibility for the consequences of extrapolation by others is accepted by the company.

3. Findings and conclusions produced in the report are based on the investigation of the sub-surface through isolated locations. Conditions between investigated sites are based on extrapolation, interpretation and professional estimates. Unexpected variations in ground conditions often occur which cannot always be anticipated. The conclusions and recommendations in the report were considered accurate at the time of issue and based on certain assumptions at the time. Conditions and assumptions change with time and may affect the accuracy of the report.

4. Certain content within this report is based on information provided by the client and/or other parties and the accuracy of this information cannot be guaranteed.

5. These conditions must be read as part of the report and must be reproduced with all future copies.

6. The recommendations of this report should be considered a starting point. Recommendations should be continuously reviewed during the earthworks stage as sub-surface information and results from monitoring become available. It is strongly recommended that the Company be retained to provide consultancy and/or inspections during the earthwork stages.

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1 Introduction

In August 2007, Ace Environmental Pty Limited (Ace) was commissioned by Koltasz Smith on behalf of the City of Cockburn to undertake a Limited Preliminary Site Investigation (PSI) of Development Area 19, Jandakot, Western Australia (the site). Brown Geotechnical and Environmental Pty Limited (BGE) was initially commissioned to undertake the PSI in October 2006, but were not able to complete the investigation. This report includes the findings and data collected during both investigations.

A site locality map is presented in **Figure 1** and detailed site layout maps are included in **Figures 2** and **3**.

This report summarises the findings of the limited PSI conducted at the site from the 26 to 30 March and 31 October 2007 to provide an assessment of the human health and environmental risks associated with the site from past and current activities.

1.1 Objectives

The objective of the scope of work was to provide the client with the results of the desktop study enabling them to have a better understanding of the environmental issues that may need addressing during the development stage.

1.2 Scope of Work

As detailed in BGE's and Ace's proposal dated 4 August 2006 and 6 August 2007, respectively, the following scope of works was undertaken:

- Site inspection
- Collection and review of historical information
- Assessment of the potential contamination status of the site
- Preparation of a report that provides recommendations for any further investigations if potentially contaminating activities are identified.

2 Methodology

A limited PSI was undertaken to identify past and present potentially contaminating land use and to determine whether a detailed soil sampling program is required. The following activities were undertaken as part of the PSI:

- Site inspection encompassing interviews with available personnel, identifying neighbouring land use and a site walkover by qualified personnel
- Review of current and historical aerial photography from the Department of Land Information (DOLI)
- Determine likely groundwater elevations and quality near the site including a search of DEC AQWA database bore data
- Review of geological data to determine the topography and geology of the area
- Review of the City of Cockburn's Planning, Health and Environment Departmental records.
- Review of the WAPC Planning Bulletin 64 to determine ASS classification.
- Installation of 6 groundwater monitoring bores to depths of approximately 3 to 4 metres below ground level enabling the bores to be screened from above the watertable to the end of the hole.
- Collection of one groundwater sample from each well and measurement of groundwater level, field pH, conductivity and dissolved oxygen one week after installation.
- Laboratory analysis of 7 groundwater samples (including 1 QA/QC sample) by a NATA accredited laboratory for low level OC/OPs and heavy metals (As, Cd, Hg, Cu, Cr, Ni, Pb and Zn), total petroleum hydrocarbons (TPH) and benzene, toluene, ethyl benzene and xylenes (BTEX).
- Preparation of a report detailing the results of the limited PSI investigation.

3 Site Description

Development Area 19 is approximately 79 ha in size and lies at the northwest corner of the intersection of North Lake Road and the Kwinana Freeway. The land is approximately 16 km south of the Perth central business district and approximately 10 km southeast of Fremantle, within the City of Cockburn. The land adjoins the predominantly developed suburb of South Lake to the west along Semple Court, abuts the Kwinana Freeway to the east, and is bounded by Verna Court to the north and North Lake Road to the south.

The area has previously been used for a mixture of rural lifestyle, horse agistment and similar related activities. Some light industrial and commercial activities have also been present in the area. Immediately to the west there is history of market gardens.

Development Area 19 encompasses 95 Lots including Lots 1, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39 and 40 Verna Court; Lots 11, 12, 13, 14, 15, 16, 17, 18, 41, 42, 43, 44, 45, 46, 47 and 500 Semple Court; Lots 1, 2, 3, 7, 9, 10, 11, 12, 13, 15, 20, 21, 30, 31, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 80, 100(1), 100(2), 101, 102, 130, 200 and 201 Muriel Court; Lots 16, 17, 53, 54 and 55 Tea Tree Close; Lots 1, 2, 3, 4, 5, 6, 7, 8, 18, 19, 32, 33, 50, 52, 53, 71, 73, 74, 75, 76, 81 and 131 North Lake Road and Lot 411 Kentucky Court.

3.1 Site Inspection

Lot 1 Verna Court
A partially completed large building is situated in the middle of the Lot. Some building debris, fill and stockpiles were observed.

Lot 30 Verna Court
Rubbish was seen at the roadside (Verna Court) and rear of the Lot and a stockpile at the front of the Lot containing bricks and rubble.

Lot 31 Verna Court
Horses and stables and fenced off paddocks

Lot 32 Verna Court
Rubbish including an old battery and paint tins were observed at the rear of the Lot.

Lot 33 Verna Court
A residential dwelling is located at the front of the Lot and goats on bare land were observed at the rear of the Lot.

Lot 34 Verna Court
An old greenhouse is located on the Lot and some sheep.

Lot 35 Verna Court
Junk and rubbish including old tyres and sand was observed on the Lot.

Lot 36 Verna Court
Stockpiles and potentially contaminated fill was observed at the front of the Lot and old vehicles and piles of rubbish were scattered around the Lot.

Lot 37 Verna Court
An old car and piles of rubbish were observed on the Lot.

Lot 38 Verna Court
Disused stables and sheds

Lot 39 Verna Court
There is development occurring at the front of the Lot and some excavation in the middle of the Lot, which contained some rubbish. Potentially uncontrolled fill may have been brought onto the Lot. Some scrub at the rear of the Lot.

Lot 40 Verna Court
Some irrigation risers and an old shed.

Lot 11 Semple Court
A residential dwelling is located on the Lot and signs of possible market gardening/nursery activities in the past.

Lot 12 Semple Court
A residential dwelling

Lot 13 Semple Court
The Lot contains irrigation risers and sheds.

Lot 14 Semple Court
Large amounts of stockpiles (sand)

Lot 15 Semple Court
Lots of junk including old oil drums

Lot 16 Semple Court
A shed and some rubbish was observed on the Lot

Lot 17 Semple Court
The Lot contained a residential dwelling, sheds and some garden.

Lot 18 Semple Court
A residential dwelling – some rubbish around the Lot.

Lot 41 Semple Court
Some old irrigation risers, sheds, junk and old cars were observed.

Lot 42 Semple Court
Some old irrigation risers, a shed and bricks in a hollow at the rear of the Lot were observed.

Lot 43 Semple Court
An old shed and dead trees were observed.

Lot 44 Semple Court
Irrigation risers and horses were observed on the Lot.

Lot 45 Semple Court
A derelict house was located at the front of the Lot and a concrete pad and old sheds were observed at the rear of the Lot.

Lot 46 Semple Court
Old cars and stockpiles, old batteries and oil/paint drums were observed around the Lot.

Lot 47 Semple Court
A workshop was located on the Lot and piles of rubbish, bricks, timber, old vehicles, oil drums and tyres.

Lot 500 Semple Court
An operational garden centre with a "Dutch Windmill" was observed.

Lot 1 Muriel Court
A residential dwelling was located at the front of the Lot with sheds and horses at the rear.

Lot 2 Muriel Court
A residential dwelling was located at the front of the Lot and grape vines and fruit trees at the rear and a large shed.

Lot 3 Muriel Court
A residential dwelling was located at the front of the Lot and grape vines at the rear with irrigation.

Lot 7 Muriel Court
A residential dwelling was located at the front of the Lot and horses, sheds and stables at the rear.

Lot 9 Muriel Court
A residential dwelling is located at the front of the Lot and scrub at the rear of the Lot.

Lot 10 Muriel Court
A residential dwelling is located at the front of the Lot and scrub at the rear of the Lot.

Lot 11 Muriel Court
A residential dwelling is located at the front of the Lot and trees and vacant land at the rear.

Lot 12 Muriel Court
Scrub at the front of the Lot

Lot 13 Muriel Court
A residential dwelling is located at the front of the Lot and what appeared to be an asbestos fence was observed.

Lot 15 Muriel Court
Lot 15 had old buildings and piles of rubbish, debris and irrigation – potential that welding was undertaken in the past.

Lot 20 Muriel Court
A residential dwelling is located at the front of the Lot.

Lot 21 Muriel Court
Residential dwelling with irrigation risers for trees, some rubbish and a pile of old steel which were not considered potentially contaminating.

Lot 30 Muriel Court
A residential dwelling is located at the front of the Lot and piles of rubbish, tyres and fill were observed at the rear of the Lot.

Lot 31 Muriel Court
A residential dwelling is located at the front of the Lot and old sheds, fences and trees were observed at the rear.

Lot 48 Muriel Court
A day care centre was located on the corner and piles of sand and fill were observed around the Lot.

Lot 49 Muriel Court
A residential dwelling is located at the front of the Lot and sheds and old cars at the rear.

Lot 50 Muriel Court
A residential dwelling is located at the front of the Lot and old sheds, fruit trees and irrigation at the rear.

Lot 51 Muriel Court
A residential dwelling is located at the front of the Lot and sheds and greenhouse at the rear.

Lot 52 Muriel Court
A residential dwelling and shed is located at the front of the Lot and a field was observed at the rear of the Lot.

Lot 53 Muriel Court
A residential dwelling is located at the front of the Lot and a shed, rubbish and scrub at the rear.

Lot 54 Muriel Court
Vacant land with a few trees.

Lot 55 Muriel Court
A residential dwelling is located at the front of the Lot and irrigation and an old vegetable patch at the rear.

Lot 56 Muriel Court
A residential dwelling is located at the front of the Lot and sheds and piles of rubbish at the rear.

Lot 57 Muriel Court
No site access

Lot 58 Muriel Court
A residential dwelling is located at the front of the Lot and some old tyres, sheds, scrub and horses at the rear.

Lot 59 Muriel Court
A residential dwelling is located at the front of the Lot and an old car, stables, horses and batteries and tyres were observed at the rear of the Lot.

Lot 60 Muriel Court
A residential dwelling is located at the front of the Lot and scrub at the rear with a shed and some rubbish, which did not appear to be potentially contaminating.

Lot 61 Muriel Court
A residential dwelling is located at the rear of the Lot as well as a workshop. The site had old oil drums, some junk, rubble, fill and bricks.

Lot 62 Muriel Court
A residential dwelling is located at the front of the Lot and a shed at the rear full of rubbish, lots of old vehicles, piles of rubbish, a large number of blue drums and horses and goats were also observed.

Lot 63 Muriel Court
A residential dwelling is located at the front of the Lot with a workshop at the back. Two above ground fuel storage tanks were found on the site with obvious signs of fuel leakage. Other observations were a fuel truck at the Lot, oil drums, containers, old vehicles, rubbish and a pile of old batteries.

Lot 64 Muriel Court
A residential dwelling is located at the front of the Lot and at the rear was a large shed, sheep, irrigation and a large stockpile of sand overgrown with grass.

Lot 65 Muriel Court
Vacant land with trees and sheds. Bricks and rubbish including roofing material that could be potentially asbestos material were observed around the Lot.

Lot 80 Muriel Court
No site access

Lot 100 Muriel Court
A residential dwelling was at the front of the Lot, which had irrigation for lawn and trees. Part of the site at the back of the Lot had been cleared – stockpiles of soil and vegetation were still present.

Lot 101 Muriel Court
A residential dwelling was at the front of the Lot. At the side and back of the Lot were an old car wreck, workshop, old tyres, car parts, oil drums, and a pile of sand. Some oil staining was observed.

Lot 102 Muriel Court
Vacant land with scrub

Lot 130 Muriel Court
A paddock with a horse and irrigation was observed on the Lot.

Lot 200 Muriel Court
No site access

Lot 201 Muriel Court
A residential dwelling is located at the front of the Lot and sheds and an old car were at the rear.

Lot 16 Tea tree Close
Horse paddocks with irrigation were observed on the Lot.

Lot 17 Tea Tree Close
Horse paddocks with irrigation were observed on the Lot.

Lot 53 Tea Tree Close
Two Residential dwellings were located at the front of the Lot.

Lot 54 Tea Tree Close
It was in the past an operational nursery. The Lot contained stockpiles, old cars and left over plants.

Lot 55 Tea Tree Close
A veterinary clinic was located at the front and fibre cable optics are in the vicinity of the Lot.

Lot 1 North Lake Road
A hire firm (Delta Handy Hire) is located on the Lot and a workshop is at the rear – possible fuel storage on the Lot.

Lot 2 North Lake Road
No access to Lot - residential

Lot 3 North Lake Road
No access to Lot - residential

Lot 4 North Lake Road
No access to Lot - residential

Lot 5 North Lake Road
Piles of sand were observed on the Lot and it is being used as a building site for storage units.

Lot 6 North Lake Road
Residential dwelling

Lot 7 North Lake Road
A residential dwelling is located at the front of the Lot and sheds at the rear.

Lot 8 North Lake Road
A residential dwelling is located at the front of the Lot and sheds at the rear.

Lot 18 North Lake Road
A residential dwelling is located at the front of Lot and scrub and rubbish was observed at the rear of the Lot.

Lot 19 North Lake Road
Pete's Discount Salvage and Hardware is located on this Lot. A large workshop and storage shed was observed and some rubbish was at the rear of the Lot.

Lot 32 North Lake Road
His and Hers Home Garden Supplies is located on the Lot. It consisted of sand, dirt and gravel storage, large shed, house and a rubbish tip was observed at the rear of the Lot.

Lot 33 North Lake Road
Two residential dwellings were observed at the front of the Lot and at the rear were trees, irrigation risers and a shipping container.

Lot 50 North Lake Road
A liquor store is located on this Lot and there is some shipping containers at the rear of the Lot.

Lot 52 North Lake Road
A residential dwelling is located at the front of the Lot and scrub and grass and a large pile of rubbish was observed at the rear of the Lot.

Lot 53 North Lake Road
Two residential dwellings are located at the front of the Lot.

Lot 71 North Lake Road
A large residential dwelling is located at the front of the Lot and a vegetable garden, sheep, turkeys, some rubbish and sea containers were observed at the rear of the Lot.

Lot 73 North Lake Road
A residential dwelling and paddock are located at the front of the Lot and a nursery is located at the rear – some chemical storage on the Lot.

Lot 74 North Lake Road
A medical centre is located at the front and at the rear is an old house, sheds, greenhouse and stockpiles, piles of rocks and pushed up mounds of soil and vegetation.

Lot 75 North Lake Road
It appears to be used as a place to park large trailers and shipping containers. Piles of rubbish, a large shed/workshop, stable, rubbles and a house that is being demolished was observed on the Lot. Also observed were a truck wash area and some oil staining.

Lot 76 North Lake Road
A residential dwelling is located at the front of the Lot and horses at the rear.

Lot 81 North Lake Road
The Australian Institute of Holistic Medicine is located on this Lot. There is two main buildings at the front and a car park at the rear of the Lot.

Lot 131 North Lake Road
A mechanic is located on this Lot. The Lot contains a mechanical workshop and previously had working underground fuel storage tanks (USTs), which are still in the ground beneath the Lot. LPG storage tanks were also observed on the Lot.

Lot 411 Kentucky Court
Horses and stables and fenced off paddocks.

Site photographs taken during the site inspection are included in **Appendix A**.

3.2 Neighbouring Land Use

Land use in the vicinity of the site includes:

North: church, bus depot and undeveloped land
East: Kwinana freeway
South: vacant land; South-east: undeveloped land and Cockburn central town centre
West: residential subdivision; South-west: industrial area

3.3 Zoning and Proposed Land Use

The zoning for the site is Development Area 19; split zoning: mixed business/development. The proposed land use is for a low-high density residential subdivision.

4 Site History

4.1 Council or Local Government Records

The City of Cockburn found no records relating to current or historical environmental health issues; complaints, cleanup notices, buried waste or applications of fuel tanks for Lots 10, 15, 21, 60, 61, 63, 100, 101, 102 Muriel Court, Lots 16 and 17 Tea Tree Close and 411 Kentucky Court. A copy of the letter is included in **Appendix B.** Records for the remaining Lots were not accessed for this PSI.

4.2 Freedom of Information Searches

Records obtained from the Department of Water under the freedom of Information (FOI) Act are included in **Appendix C**. A summary of the information collected is outlined below:

Department of Water

The Department of Water conducted a thorough search and confirmed that they had no documents relating to the properties. The site is located within a proclaimed groundwater area and a proclaimed surface water area (Murray River Catchment) and licenses would be required to take water.

4.3 Historical Aerial Photography Review

Historical aerial photos are shown in **Appendix D** and summarised in **Table 4.1**.

Table 4.1 Aerial Photography Review

Date	Observation
	Limit of DOLI supplied aerial photography
17/12/2005- colour	**Lot 15** ▪ Mostly vacant lot, old shed pad, small shed and trees bordering lot **Surrounds** ▪ North- Residential house and workshop, Kwinana freeway ▪ East- see lot 411 ▪ South- see lot 102 ▪ West- see lot 101 **Lot 16** ▪ Stables and paddocks bordered by trees **Surrounds** ▪ North- see lot 411 ▪ East- see lot 17 ▪ South- Vacant land and cleared land for development ▪ West- commercial buildings front of lot, residential house in middle of lot, nursery plants across rest of lot **Lot 17** ▪ Paddocks bordered by trees **Surrounds** ▪ North- see lot 411 ▪ East- Vacant scrub land, Kwinana freeway ▪ South- Vacant land and cleared land for development ▪ West- see lot 16 **Lot 21** ▪ Building front of lot, remainder grass and vegetation with bush at back of lot **Surrounds** ▪ North- Several buildings front of lot with swimming pool, more

	buildings on lot some grass/ vegetation ▪ East- see lot 100 ▪ South- large industrial building front of lot with car park, bushland at back of lot ▪ West- residential property middle of lot, large shed at rear, remainder grass and bushland **Lot 100** ▪ Building middle of lot, remainder grass and vegetation **Surrounds** ▪ North- large residential building front of lot, small shed remainder grass and vegetation ▪ East- see lot 101 ▪ South- large commercial building front of lot with car park, bushland at back of lot ▪ West- see lot 21 **Lot 101** ▪ No land development, grass and vegetation comprise lot **Surrounds** ▪ North- vacant lot, front of lot sandy, remainder grass and vegetation ▪ East- see lot 15 ▪ South- large commercial building front of lot with car park, bushland at back of lot ▪ West- see lot 100 **Lot 102** ▪ No land development, grass and bushland covers lot **Surrounds** ▪ North- see lot 15 ▪ East- see lot 411 ▪ South- commercial building and residential at front of lots, nursery and vacant bush land at back of lots ▪ West- see lot 101 **Lot 411** ▪ Several buildings between middle and back of lot, remainder grass and vegetation, with a tree border **Surrounds** ▪ North- Kwinana Freeway, large commercial buildings ▪ East- grass and bushland, no evidence of development ▪ South- see lot 16 and 17 Tea Tree CL ▪ West- see lot 15 and 102 **Lot 10** ▪ Front of lot has several buildings, back of lot cleared, trees bordering the west edge **Surrounds** ▪ North- several residential buildings front of lot, remainder grass and vegetation ▪ East- vacant lot, no signs of development ▪ South- several industrial buildings, market gardening takes up majority of lot ▪ West- several residential buildings front of lot, remainder grass and vegetation **Lot 60** ▪ Residential house, with swimming pool, remainder bushland **Surrounds** ▪ North- large industrial building, remainder of lot cleared ▪ East- see lot 61 ▪ South- residential building front of lot, remainder grass and vegetation West- residential building front of lot, track at rear with grass and vegetation **Lot 61** ▪ Residential house at rear of site, trees across rest

	Surrounds ▪ North- large industrial building, remainder of lot cleared ▪ East- residential building front of lot, track back of lot, remainder grass and vegetation ▪ South- residential building front of lot, remainder grass and vegetation ▪ West- see lot 60 **Lot 63** ▪ Residential house and swimming pool front of lot, sheds, parking area, grass and trees on boundaries **Surrounds** ▪ North- Freeway ▪ East- building front of lot, remainder grass and vegetation ▪ South- large residential building middle of lot, remainder grass and vegetation ▪ West- residential building front of lot, track back of lot remainder grass and vegetation **Lot 54** ▪ Commercial nursery with many buildings **Surrounds** ▪ South- Vacant land **Lot 53** ▪ Front of site buildings, back of site bush **Surrounds** ▪ South - Vacant land **Lot 55** ▪ Front partially cleared, large car park, commercial development, remainder grass and vegitation **Surrounds** ▪ South- Vacant land **Lot 52** ▪ Front of lot buildings, remainder of lot grass and bushland towards back **Surrounds** ▪ South- Vacant land **Lot 81** ▪ Car park at front of lot and several buildings, car park at back of lot, remainder grass and vegetation **Surrounds** ▪ South- Vacant land **Lot 76** ▪ One building front of site, grass and vegetation remainder **Surrounds** ▪ South- Vacant land **Lot 75** ▪ Car park and buildings towards centre of site, remainder grass and vegetation **Surrounds** ▪ South- Vacant land **Lot 74** ▪ Large building and car park front of land, bush back section of site **Surrounds** ▪ South- Vacant land **Lot 73** ▪ Front of site grass and vegetation and a car park, Buildings centre of site, Possible market gardening at rear of site delineated by lines **Surrounds** ▪ South- Vacant land

	Lot 53 ▪ Front of site cleared land, small building centre of site, shrub land towards back of site **Surrounds** ▪ South- Vacant land **Lot 18** ▪ Building front of site, remainder cleared land and vegetation **Surrounds** ▪ South- Vacant land **Lot 19** ▪ Cleared land, small building middle of site **Surrounds** ▪ South- Vacant land **Lot 32** ▪ Car park front of site, buildings middle of site, grass and vegetation back of site **Surrounds** ▪ South- Vacant land **Lot 33** ▪ Buildings front of site, land cleared, trees bordering back of site **Surrounds** ▪ South- Vacant land **Lot 71** ▪ Buildings front right corner, remainder of land cleared, trees neighbouring back of lot **Surrounds** ▪ South- Vacant lot **Lot 131** ▪ Building at front of site, remainder of site grass and lots of trees **Surrounds** ▪ South- Vacant lot **Lot 50** ▪ Land cleared with large building and car park taking up majority of lot **Surrounds** ▪ South- Vacant lot **Lot 8** ▪ Building front of lot, small building centre of lot remainder grass and vegetation **Surrounds** ▪ South- Vacant lot **Lot 7** ▪ Several small buildings front have of lot, remainder grass and vegetation **Surrounds** ▪ South- Vacant lot **Lot 6** ▪ Small buildings towards front of lot, remainder grass and vegetation **Surrounds** ▪ South- Vacant lot **Lot 5** ▪ Most of land cleared except for a few trees around edge of property **Surrounds** ▪ South- Vacant land **Lot 4** ▪ Land cleared, no vegetation or grass **Surrounds** ▪ South- Vacant lot

	Lot 3 ▪ Residential Building front of lot, remainder grass and vegetation **Surrounds** ▪ South- Vacant lot **Lot 2** ▪ Building front and centre of lot, remainder grass and vegetation **Surrounds** ▪ South- Vacant lot ▪ West- Bushland and grass, no signs of development **Lot 1** ▪ Land cleared, car park and large building at front of lot **Surrounds** ▪ South- Vacant Lot ▪ West- Bushland and grass, no signs of development **Lot 130** ▪ No signs of development, lot consists of grass and vegetation **Surrounds** ▪ South- Lot 131, East- Lot 71, West- Lot 3, North- Lot 2 **Lot 3** ▪ No signs of development, Lot consists of grass and vegetation **Surrounds** ▪ South- Lot 50, East lot 130, North- lot 1, West- Lot 8, 500, 11, 12 ,13, 14, 15 **Lot 500** ▪ Nursery back of site, front of site buildings and vegetation **Surrounds** ▪ West- Bushland and grass, no signs of development **Lot 11** ▪ Front of lot cleared, back of land building with grass and vegetation **Surrounds** ▪ West- Bushland and grass, no signs of development **Lot 12** ▪ Two residential buildings towards centre of lot, remainder grass and trees bordering lot **Surrounds** ▪ West- Bushland and grass, no signs of development **Lot 13** ▪ Buildings at the front and back of lot, remainder grass with trees bordering lot **Surrounds** ▪ West- Bushland and grass, no signs of development **Lot 14** ▪ South side of lot cleared, North side of lot has a building and grass with trees bordering the lot **Surrounds** ▪ West- grass and bushland, no signs of development **Lot 15** ▪ Front of lot residential building, remainder of lot covered in grass and some bushland **Surrounds** ▪ West- grass and bushland, no signs of development **Lot 16** ▪ One building front of lot, remainder covered in bushland **Surrounds** ▪ West- grass and bushland no signs of development, South Lake road **Lot 17** ▪ Several buildings north west side of property, remainder cleared land with grass and vegetation

	Surrounds ▪ West- Residential subdivision **Lot 18** ▪ Several buildings front the front to the middle of the lot, remainder grass with a tree border on the north side **Surrounds** ▪ Residential subdivision **Lot 200** ▪ Several buildings on centre of lot and a swimming pool, remainder of lot trees and vegetation **Surrounds** ▪ West- Residential subdivision ▪ North- See lot 48 **Lot 201** ▪ Building on south side of lot, remainder grass with trees bordering entire lot **Surrounds** ▪ North- See lot 48 **Lot 1** ▪ Building front of lot, remainder grass and vegetation **Surrounds** ▪ North- see lot 48 **Lot 2** ▪ Buildings front of site, orchard through middle of lot, rest grass and vegetation **Surrounds** ▪ North- See lot 49 **Lot 7** ▪ Buildings back of lot and middle of lot, remainder grass and trees with more trees to the back of the lot **Surrounds** ▪ North- See lots 50 and 51 **Lot 30** ▪ Building front of lot with a swimming pool on the east side, remainder grass and vegetation **Surrounds** ▪ North- See lot 52 **Lot 31** ▪ Building front of lot, remainder grass and vegetation **Surrounds** ▪ North- See lots 53 and 54 **Lot 9** ▪ Front of lot has a few small buildings, the remainder is grass and vegetation **Surrounds** ▪ North- see lots 54,55,56 **Lot 10** ▪ Front of lot has several buildings, back of lot cleared, trees bordering the west edge **Surrounds** ▪ North- See lot 57 **Lot 11** ▪ No evidence of land development, Land cleared with some grass and vegetation **Surrounds** ▪ North- See lot 58 **Lot 12** ▪ Small building front of lot and Several buildings towards back of lot, remainder grass and vegetation **Surrounds**

	▪ North- See lot 59 **Lot 13** ▪ Building and bushland front of lot, centre of lot cleared land and grass, back of lot bush **Surrounds** ▪ North- See lot 60 **Lot 80** ▪ Two buildings front of lot, remainder grass and vegetation **Surrounds** ▪ North- See lot 61 **Lot 20** ▪ Building middle and back of lot, remainder grass with trees bordering **Surrounds** ▪ North- See lot 62 **Lot 65** ▪ Vacant lot with some trees **Surrounds** ▪ North- Freeway **Lot 64** ▪ Residential house, small shed, grass and some trees **Surrounds** ▪ North- Freeway **Lot 62** ▪ Residential house, parking, horse track at rear of site **Surrounds** ▪ North- Freeway **Lot 59** ▪ Residential house, trees and track at rear **Lot 58** ▪ Residential, grass and trees at rear **Lot 57** ▪ Residential house, small sheds, grass **Lot 56** ▪ Residential house, small sheds, possible small orchard in middle of site, scrub at rear **Lot 55** ▪ Vacant land, grass some trees **Lot 54** ▪ Residential house, one shed, trees **Lot 53** ▪ Residential house, two sheds, scrub **Lot 52** ▪ Residential house, shed, large cleared pad, grass **Lot 51** ▪ Residential house, large sheds, possible greenhouses, grass **Lot 50** ▪ Residential house, small sheds, small orchard, grass **Lot 49** ▪ Residential house, shed, grass **Lot 48** ▪ Vacant land, grass **Surrounds** ▪ West- new subdivision **Lot 47** ▪ Residential house, large shed, fenced paddocks at rear of site **Surrounds** ▪ West- new subdivision **Lot 46** ▪ Residential house, shed, trees

	Surrounds ▪ West- new subdivision **Lot 45** ▪ Two sheds, vacant land and track **Surrounds** ▪ West- new subdivision **Lot 44** ▪ Residential house, trees and track **Surrounds** ▪ West- new subdivision **Lot 43** ▪ Residential house, trees and track **Surrounds** ▪ West- new subdivision **Lot 42** ▪ Residential house, significant amount of trees front of property, back of property grass **Surrounds** ▪ West- new subdivision **Lot 41** ▪ Two buildings front of site, car park and tress with grass remainder of lot **Surrounds** ▪ West- new subdivision **Lot 40** ▪ West side of lot grass with tree border, east side corner residential house with a swimming pool **Surrounds** ▪ North- large block of land, majority grass and vegetation with industrial buildings and car park **Lot 39** ▪ Vacant block of land with no signs of development **Surrounds** ▪ North- large block of land, majority grass and vegetation with industrial buildings and car park **Lot 38** ▪ Several buildings at front of lot, remainder grass with significant amount of bushland **Surrounds** ▪ North- large block of land, majority grass and vegetation with industrial buildings and car park **Lot 37** ▪ Building at front of property, remainder bushland **Surrounds** ▪ North- large block of land, majority grass and vegetation with industrial buildings and car park **Lot 36** ▪ Several buildings towards front of property with a swimming pool, remainder grass and vegetation **Surrounds** ▪ North- large block of land, majority grass and vegetation with industrial buildings and car park **Lot 35** ▪ Residential building at front of lot, remainder grass and vegetation **Surrounds** ▪ North- large block of land, majority grass and vegetation with industrial buildings and car park **Lot 34** ▪ Residential building and tress front of lot, back half of lot grass

	with one tree **Surrounds** ▪ North- large block of land, majority grass and vegetation with industrial buildings and car park **Lot 33** ▪ Residential building and trees front of lot, remainder grass and vegetation **Lot 32** ▪ Residential building front of lot, remainder grass and bushland **Surrounds** ▪ North- large block of land, majority grass and vegetation with industrial buildings and car park **Lot 31** ▪ Residential building front of lot, remainder grass and vegetation **Surrounds** ▪ North- large block of land, majority grass and vegetation with industrial buildings and car park **Lot 30** ▪ Residential building and trees front of lot, remainder of lot cleared **Surrounds** ▪ North- large block of land, majority grass and vegetation with industrial buildings and car park **Lot 1** ▪ Large industrial building with track, remainder of grass and vegetation **Surrounds** North- large block of land, majority grass and vegetation with industrial buildings and car park
06/01/1995- colour	**Lot 15** ▪ Residential house and sheds, trees bordering lot **Surrounds** ▪ North- Small vacant lot with trees ▪ East- see lot 411 ▪ South- see lot 102 ▪ West- see lot 101 **Lot 16** ▪ Stables and paddocks bordered by trees **Surrounds** ▪ North- see lot 411 ▪ East- see lot 17 ▪ South- Vacant scrubland ▪ West- commercial buildings front of lot, residential house in middle of lot, nursery plants across rest of lot **Lot 17** ▪ Paddocks bordered by trees **Surrounds** ▪ North- see lot 411 ▪ East- Vacant scrub land, Kwinnana freeway ▪ South- Vacant land and cleared land for development ▪ West- see lot 16 **Lot 21** ▪ Building front of lot, remainder grass and vegetation with bush at back of lot **Surrounds** ▪ North- Several buildings front of lot with swimming pool, more buildings on lot some grass/ vegetation ▪ East- see lot 100 ▪ South- large industrial building front of lot with car park, bushland at back of lot

- West- residential property middle of lot, large shed at rear, remainder grass and bushland

Lot 100

- Building middle of lot, remainder grass and vegetation

Surrounds

- North- large residential building front of lot, small shed remainder grass and vegetation
- East- see lot 101
- South- large commercial building front of lot with car park, bushland at back of lot
- West- see lot 21

Lot 101

- No land development, grass and vegetation comprise lot

Surrounds

- North- vacant lot, front of lot sandy, remainder grass and vegetation
- East- see lot 15
- South- large commercial building front of lot with car park, bushland at back of lot
- West- see lot 100

Lot 102

- No land development, grass and bushland covers lot

Surrounds

- North- see lot 15
- East- see lot 411
- South- commercial building and residential at front of lots, nursery and vacant bush land at back of lots
- West- see lot 101

Lot 411

- Several buildings between middle and back of lot, remainder grass and vegetation, with a tree border

Surrounds

- North- Kwinana Freeway, large commercial buildings
- East- grass and bushland, no evidence of development
- South- see lot 16 and 17 Tea Tree CL
- West- see lot 15 and 102

Lot 10

- Building front of lot, remainder of lot cleared with track, some vegetation

Surrounds

- North- Several buildings front of lot, remainder grass and vegetation
- East- Vacant lot with track around sides
- South- Industrial buildings, nursery

West- Back of lot grass and bushland, front of lot residential building and orchard

Lot 60

- Small residential building front of lot with swimming pool, remainder bush and grass

Surrounds

- North- Bushland, no signs of development
- East- See lot 61
- South- Small residential property front of lot, remainder grass and vegetation
- West- Residential building front of lot, track through middle of lot, remainder grass and vegetation

Lot 61

- Residential building back of lot, remainder grass and vegetation- trees bordering, driveway down centre

Surrounds

- North- Bushland, vacant lot with no signs of development

	▪ East- Small residential building front of lot, cleared land with track round the lot ▪ South- Residential building centre of lot, remainder grass and vegetation with tree border ▪ West- see lot 60 **Lot 63** ▪ Buildings front of lot with swimming pool, remainder of lot cleared **Surrounds** ▪ North- Kwinana Freeway ▪ East- Residential building front of lot, remainder of lot cleared with some vegetation ▪ South- Residential property front of lot, remainder grass and vegetation, bushland towards back ▪ West- Small residential building front of lot, cleared land with track.
20/04/1985 Colour	**Lot 15** ▪ No border between lot 100, 101, 15, 102- large grass oval, several buildings with garden borders/ decorative gardens to eastern side of property **Surrounds** ▪ North- two lots- residential property at front remainder grass and bushland, eastern lot has a track ▪ East- see lot 411 ▪ South- joined to lot 102 ▪ West-joined to lot 101 **Lot 16** ▪ Vacant lot with no signs of development **Surrounds** ▪ North- see lot 411 ▪ East- Kentucky CT, bushland no signs of development ▪ South- Tea Tree CL, bushland no signs of development ▪ West- see lot 17 **Lot 17** ▪ Vacant lot with no signs of development **Surrounds** ▪ North- see lot 411 ▪ East- see lot 16 ▪ South- Tea Tree CL- bushland, no signs of development ▪ West- residential building middle of lot, several buildings front of lot remainder grass and vegetation **Lot 21** ▪ Residential building front of lot, remainder grass and vegetation **Surrounds** ▪ North- Residential building front of lot, remainder grass and vegetation ▪ East- see lot 100 ▪ South- Several buildings front of lot, remainder grass, bushland at back of lot ▪ West- Residential building front of lot with swimming pool, remainder grass/ vegetation with a track **Lot 100** ▪ No border between lot 100, 101, 15, 102 large grass oval, several buildings with garden borders/ decorative gardens to eastern side of property **Surrounds** ▪ North- Residential building front of lot, remainder grass and vegetation ▪ East- Joined with lot 101, 15, 102 ▪ South- Industrial building, car park and swimming pool front of lot, remainder grass and bushland ▪ West- see lot 21

	Lot 101 ▪ No border between lot 100, 101, 15, 102- large grass oval, several buildings with garden borders/ decorative gardens to eastern side of property **Surrounds** ▪ North- Vacant lot, no signs of development ▪ East- joined to lot 15 ▪ South- - Industrial building, car park and swimming pool front of lot, remainder grass and bushland ▪ West- Joined with lot 100 **Lot 102** ▪ No border between lot 100, 101, 15, 102- large grass oval, several buildings with garden borders/ decorative gardens to eastern side of property **Surrounds** ▪ North- Joined to lot 15 ▪ East see lot 411 ▪ South- two residential properties, eastern lot several buildings remainder grass and bushland, western ▪ West- residential building front of lot, remainder lot cleared with some bushland at the back **Lot 411** ▪ Split into two properties, eastern lot- residential building middle of lot, remainder grass and vegetation, western lot- vacant block of land with grass and vegetation and track round the sides **Surrounds** ▪ North- Two properties, one vacant lot, western lot- residential building remainder grass and vegetation ▪ East- Kentucky CT, bushland no signs of development ▪ South- see lots 16 and 17 Tear Tree CL ▪ West- see lot 102, 15, 101, 100 **Lot 10** ▪ Building front of lot, remainder grass and vegetation, track around sides of property **Surrounds** ▪ North- Several buildings front of lot, remainder grass and vegetation, dense bushland at back ▪ East- Vacant land, no signs of development ▪ South- Two buildings, remainder grass and vegetation ▪ West- Residential building front of lot, evidence of orchard, remainder of lot bushland **Lot 60** ▪ Small residential building front of lot with swimming pool, remainder bushland **Surrounds** ▪ North- Vacant lot, no signs of development ▪ East- See lot 61 ▪ South- Small residential building with swimming pool front of lot, remainder vegetation- track around side ▪ West- Small building front of lot, remainder grass and vegetation, track around sides **Lot 61** ▪ Small residential building with swimming pool back of lot, remainder bushland with driveway through the middle **Surrounds** ▪ North- Front of lot building and swimming pool, grass and vegetation remainder of lot cleared ▪ East- Residential building front of lot, remainder grass with track around sides ▪ South- Residential building front of lot, remainder grass and

	vegetation ▪ West- See lot 60 **Lot 63** ▪ Residential building front of lot with swimming pool, remainder grass and vegetation, dense bush at back **Surrounds** ▪ North- Kwinana freeway no longer passes through top of lot, Lot 90- grass and vegetation, residential building front of lot ▪ East- Residential building front of lot, remainder grass and vegetation ▪ South- Residential building front of lot, remainder grass and vegetation ▪ West- Residential building front of lot, remainder grass with track around sides
11/06/1975 B&W	**Lot 15** ▪ No distinctive boundaries between lot 100,101,15 and 102, large track around outside, some decorative garden layout left side of lot **Surrounds** ▪ North- several buildings front of lot, remainder grass / vegetation with small lake and back of lot ▪ East- see lot 411 ▪ South- joined with lot 102 ▪ West- joined with lot 101 **Lot 16** ▪ Building front of lot, remainder cleared with some grass and vegetation **Surrounds** ▪ North- see lot 411 ▪ East- Kentucky CT, bushland, no signs of development ▪ South- Tea Tree CL, bushland, no signs of development ▪ West- see lot 17 **Lot 17** ▪ Vacant block of land with no signs of development, small lake middle of lot? **Surrounds** ▪ North- see lot 411 ▪ East- see lot 16 ▪ South- Tea Tree CL- bushland, with no signs of development ▪ West- vacant block of land, with what looks like sheep **Lot 21** ▪ Vacant block of land with no signs of development **Surrounds** ▪ North- Vacant block of land, bushland, no signs of development ▪ East- see lot 100 ▪ South- Large building and car park front of lot, remainder grass and vegetation ▪ West- no distinctive border with lot 20, grass and bushland, vacant land **Lot 100** ▪ No distinctive boundaries between lot 100,101,15 and 102, large track around outside, some decorartive garden layout left side of lot **Surrounds** ▪ North- Residential building front of lot, remainder grass and bushland with a track to back ▪ East- joined with lot 101 ▪ South- Large building and car park front of lot, remainder grass and vegetation ▪ West- see lot 21 **Lot 101** ▪ No distinctive boundaries between lot 100,101,15 and 102, large

track around outside, some decorative garden layout left side of lot

Surrounds

- North- Vacant lot of land with no signs of development
- East- Joined with lot 15/21
- South- Vacant block of land, with what looks like sheep?
- West- joined with lot 100

Lot 102

- No distinctive boundaries between lot 100,101,15 and 102, large track around outside, some decorative garden layout left side of lot

Surrounds

- North- Joined with lot 15
- East- see lot 411
- South- vacant block of land, remains of lake
- West- joined with lot 101

Lot 411

- Several buildings back of lot with car park, remainder grass and vegetation

Surrounds

- North- Two lots- western lot- several buildings front of lot, remainder grass and vegetation, eastern lot- vacant lot with no signs of development
- East- Kentucky CT, Bushland no signs of development
- South- see lot 16 and 17 Tea Tree CL
- West- see lot 102 and15

Lot 10

- Residential property front of lot, remainder grass and vegetation- back of lot cleared

Surrounds

- North- Vacant lot, no signs of development
- East- vacant lot, bushland front of lot, back of lot slightly cleared with track
- South- Several buildings centre of lot, remainder grass and vegetation

West- several buildings front of lot, remainder bushland

Lot 60

- Residential buildings front of lot, middle cleared, remainder bushland

Surrounds

- North- Vacant lot, no signs of development- bushland
- East- See lot 61
- South- Residential building front of lot, remainder grass and vegetation
- West- Vacant lot, no signs of development, some land cleared

Lot 61

- Vacant lot, no signs of development, track through middle of property

Surrounds

- North-Vacant lot, no signs of development- bushland
- East- Residential property back of lot, remainder bushland
- South- Residential building front of lot, remainder grass and vegetation, with track around sides
- West- See lot 60

Lot 63

- Front of lot cleared, remainder bushland

Surrounds

- North- Residential property front of lot, remainder grass and vegetation
- East- Residential property front of lot, remainder bushland with a track
- South- Vacant lot with no signs of development
- West- Residential property back of lot, remainder bushland

11/03/1965– B&W	**Lot 15** ▪ No distinctions between lot 100, 101, 15 and 102, track around land, no signs of development **Surrounds** ▪ North- small residential property middle of lot, remainder grass and vegetation ▪ East- see lot 411 ▪ South- joined lot 102 ▪ West- joined with lot 101 **Lot 16** ▪ Native vegetation with swamplands **Surrounds** ▪ North- see lot 411 ▪ East- Kentucky CT- swamp and bushland ▪ South- Tea Tree CL, Cleared lot, no signs of development ▪ West- joined to lot 17 **Lot 17** ▪ Native vegetation with swamplands **Surrounds** ▪ North- see lot 411 ▪ East- joined with lot 16 ▪ South- Tea Tree CL, cleared lot, no signs of development, evidence of swamp further south east ▪ West- vacant lot, native vegetation with swamp **Lot 21** ▪ Vacant block of land, merged with lot 20, no signs of development **Surrounds** ▪ North- vacant land, with no signs of development ▪ East- see lot 100 ▪ South- vacant land, with no signs of development ▪ West- vacant land, with no signs of development **Lot 100** ▪ No distinctions between lot 100, 101, 15 and 102, track around land, no signs of development **Surrounds** ▪ North- vacant lot, no signs of development ▪ East- joined with lot 101 ▪ South- vacant lot, no signs of development ▪ West- see lot 21 **Lot 101** ▪ No distinctions between lot 100, 101, 15 and 102, track around land, no signs of development **Surrounds** ▪ North- vacant lot no signs of development ▪ East- joined with lot 15 ▪ South- vacant lot, no signs of development ▪ West- joined with lot 100 **Lot 102** ▪ No distinctions between lot 100, 101, 15 and 102, track around land, no signs of development **Surrounds** ▪ North-joined with lot 15 ▪ East- see lot 411 ▪ South- vacant lot, no signs of development ▪ West- joined with lot 101 **Lot 411 Kentucky CT** ▪ Vacant lot with no signs of development, small lake middle of lot bordering lot 15 **Surrounds** ▪ North- vacant lot, no signs of development

	▪ East- scrubland no signs of development ▪ South- see lot 16, 17 ▪ West- see lot 102, 15 **Lot 10** ▪ Small residential building front of lot, remainder bushland **Surrounds** ▪ North- Several buildings front of lot, driveway down side, remainder grass and vegetation ▪ East- residential building front of lot, remainder bushland ▪ South- Industrial and small building centre of lot, remainder of lot cleared with some vegetation ▪ West- Vacant lot, no signs of development **Lot 60** ▪ Residential building front of lot, remainder cleared with some vegetation **Surrounds** ▪ North, East, South, West – Bushland, no signs of development **Lot 61** ▪ Bushland, no signs of development **Surrounds** ▪ North- bushland, no signs of development ▪ East- bushland, no signs of development ▪ South- bushland, no signs of development ▪ West- See lot 60 **Lot 63** ▪ Bushland, no signs of development **Surrounds** ▪ North/ East/ South/ West- Bushland, no signs of development
06/11/1953– B&W	**Lot 15** ▪ No distinction between lot 100, 101, 15 and 102, vacant block of land, no signs of development, lack bordering eastern side **Surrounds** ▪ North- small residential building middle of lot, remainder of lot cleared with some grass and vegetation ▪ East- see lot 411 ▪ South- joined with lot 15 ▪ West- joined with lot 101 **Lot 16** ▪ Swamplands, edge of lake on border, no distinction between lot 16 and 17 **Surrounds** ▪ North- see lot 411 ▪ East- scrubland, no signs of development ▪ South- vacant land, no signs of development ▪ West- lake and native vegetation **Lot 17** ▪ Swamplands, edge of lake on border, no distinction between lot 16 and 17 **Surrounds** ▪ North- see lot 411 ▪ East- joined with lot 16 ▪ South- Tea Tree CL, vacant land, no signs of development ▪ West- lake and native vegetation **Lot 21** ▪ Vacant block of land with no signs of development **Surrounds** ▪ North- vacant block of land with no signs of development ▪ East- see lot 100 ▪ South- vacant block of land, lake at back of lot ▪ West- vacant block of land no signs of development

	Lot 100 ▪ No distinction between lot 100, 101, 15 and 102, vacant block of land, no signs of development **Surrounds** ▪ North- vacant block of land, no signs of development ▪ East- joined with lot 101 ▪ South- vacant block of land, swamp at back of lot ▪ West- see lot 21 **Lot 101** ▪ No distinction between lot 100, 101, 15 and 102, vacant block of land, no signs of development, lack bordering eastern side **Surrounds** ▪ North- vacant block of land, no signs of development ▪ East- joined with lot 15 and 102 ▪ South- vacant block of land, swamp at back of lot ▪ West- joined with lot 100 **Lot 102** ▪ No distinction between lot 100, 101, 15 and 102, vacant block of land, no signs of development, lack bordering eastern side **Surrounds** ▪ North- joined with lot 15 ▪ East- see lot 411 ▪ South- vacant block of land with swamp at back of lot ▪ West- joined with lot 101 **Lot 411** ▪ Vacant block of land, swamp bordering lot 15, mostly cleared **Surrounds** ▪ North- vacant block of land, with no signs of development ▪ East- scrubland, no signs of development ▪ South- see lot 16 and 17 ▪ West- see lot 102 **Lot 10** ▪ Bushland, no signs of development **Surrounds** ▪ North- bushland, no signs of development ▪ East- bushland, no signs of development ▪ South- Several buildings centre of lot, remainder grass and vegetation ▪ West- bushland, no signs of development **Lot 60** ▪ Residential building middle of lot **Surrounds** ▪ North/ East/ South/ West- bushland, no signs of development **Lot 61** ▪ Bushland, no signs of development **Surrounds** ▪ North/ East/ South/ West- bushland, no signs of development **Lot 63** ▪ Bushland, no signs of development **Surrounds** ▪ North/ East/ South/ West- bushland, no signs of development

5 Environmental Settings

5.1 Topography

The site is predominantly flat at a height of approximately 25 m above Australian Height Datum (AHD) increasing to approximately 27 m AHD in the central south and north east of the site (DoE, 2005).

5.2 Geology

Based on the hydrogeology and Groundwater Resources of the Perth Region Western Australia, surface geology of the site comprises Quaternary aged Bassendean Sand. Underlying this unit at depth is Kardinya member of the Osborne Formation a Cretaceous aged formation of Sandstones and Shales.

The Bassendean Sand Formation which is present over most of the central Perth region unconformably overlies the Cretaceous and Tertiary strata and inter-fingers to the east with the Guildford Clay, which both unconformably overlie the Kardinya member of the Osborne Formation. The stratigraphic relationships of the Bassendean Sand with the Guildford Clay and Gnangara Sand indicate that the formation was deposited under changing and perhaps alternating fluvial, estuarine and shallow-marine environments.

5.3 Acid Sulphate Soils

The Quarternary sands beneath the majority of the site have moderate to low risk of acid generation. Soils containing peat in the south eastern corner of the site have high risk of acid generation, which is likely to be associated with the swamp deposits shown on the geological map (http:/www.wrc.wa.gov.au/infocentre/atlas/atlas_html/, accessed 27/06/07).

5.4 Surface Hydrology

No surface water bodies were identified within 500 m of the site. The nearest water bodies to the site are Yangebup Lake and Kogolup Lake, which are approximately 1.5 km to the west and southwest of the site, respectively. There are also other unnamed lakes and swamps in the area.

5.5 Hydrogeology

The Perth Groundwater Atlas shows the watertable to be at approximately 23 m AHD at the site, with a groundwater flow to the west.

Water bearing layers and aquifers potentially occurring beneath the site is the superficial aquifer – Jandakot Mound, which has a maximum saturated thickness of approximately 40 m with total dissolved solids of 250-1000 mg/L. The groundwater has potential potable use and the flow direction should be to the west. Based on the depth to groundwater, the vulnerability of contamination to groundwater beneath the site is high.

5.6 Groundwater Resources and Beneficial Uses

Land use in the general area surrounding the site includes residential/semi rural, vacant land, grazing of horses, nurseries and commercial buildings and the Kwinana Freeway is adjacent to the site.

A bore search identified 27 registered bores and 167 registered bores located within 1 and 2 km of the site, respectively. The recorded purpose of registered bores included monitoring, observation, investigation, production, irrigation, livestock and domestic/household.

With respect to the use of groundwater beneath the site the Department of Health (DoH) considers it an unsafe practice to drink or swim in untreated groundwater as experience has shown the groundwater may contain microbiological and chemical contamination. Groundwater should always be tested, assessed by an experienced person and then treated appropriately to ensure that it is safe for the intended use.

Based on a TDS value of 250-1000 mg/L the most beneficial use of groundwater beneath the site is for drinking purposes. However, as discussed above, the use of untreated groundwater beneath the site for drinking water purposes is not advised.

5.7 Groundwater Quality

Groundwater quality for the south east portion of the site was obtained from the groundwater investigation undertaken on the site by Ace Environmental in October 2007. A summary of the findings is outlined below:

- The depth to shallow groundwater within monitoring wells across the site ranged from 1.413 to 2.775 m below top of casing. Based on gauging and surveying of wells, the inferred hydraulic gradient is flowing to the west.
- Measured pH values ranged from 5.88 to 6.45
- Electrical conductivity readings ranged from 375 to 1390 µS/cm (hence approximately 259 to 959 mg/L TDS), thereby indicating that groundwater is suitable for drinking water purposes.
- Dissolved oxygen (DO) levels ranged from 1.47 to 2.15 mg/L.
- Redox potential values ranged from -139 to -10 mV.

An additional groundwater investigation needs to be undertaken for the entire site as the groundwater investigation undertaken was only for the south east portion of the site encompassing Lots 10, 15, 21, 60, 61, 63, 100, 101 and 102 Muriel Court, Lots 16 and 17 Tea Tree Close and Lot 411 Kentucky Court. The results should not be extrapolated to include the entire site as potentially contaminating activities including the storage of underground fuel tanks were found on other Lots.

Analytical results and the methodology used for the groundwater investigation have been included in this report for reference only.

6 Methodology

6.1 Groundwater Methodology

Field activities conducted as part of the groundwater assessment program were undertaken on 27 March and 31 October 2007. Field activities are summarised in **Table 6.1** and grid references of the groundwater monitoring bores are included in **Table 6.2**. Groundwater bore logs and gauging sheets are included in **Appendices E** and **F**, respectively.

Table 6.1 Summary of Groundwater Assessment

Activity	Location	Details
Clearance of underground services	MB01 to MB06 inclusive	Service Location survey by MP Electrolocation
Well construction and installation	MB01 to MB06 inclusive	Wells were constructed with 50 mm, class 18, uPVC threaded screen and casing in accordance with BGE well construction procedures.
Well development	MB01 to MB06 inclusive	Wells were purged of 5 well volumes or until bailed dry upon completion of construction
Well gauging	MB01 to MB06 inclusive	Wells were gauged for the presence of phase separated hydrocarbons and standing water levels using oil/water interface probe, which was decontaminated in between each measurement. Field measurements of pH, temperature, dissolved oxygen, redox and EC were taken every 12 L or until the parameters stabilised.
Sampling method	MB01 to MB06 inclusive	Disposable bailers were used to obtain the groundwater samples. A base volatile valve was not used to prevent agitation as it was not deemed necessary since Ace do not invert the bailer when collecting groundwater samples. The sample is collected from the bottom of the bailer, which minimises agitation.
Decontamination procedure	MB01 to MB06 inclusive	New disposable gloves and new strings were used for each well to avoid the risk of cross contamination
Sample preservation	MB01 to MB06 inclusive	Samples were collected in laboratory supplied bottles and immediately stored in an insulated esky chilled with ice bricks upon sampling until transit to the laboratory

Table 6.2 Grid Reference of Groundwater Bores

GW Bore	Grid Reference
MB01	115.854985E; 32.120901S
MB02	115.853617E; 32.123196S
MB03	115.852894E; 32.118617S
MB04	115.852417E; 32.117212S
MB05	115.853599E; 32.117722S
MB06	115.850562E; 32.118043S

7 Environmental Investigation Levels

Groundwater investigation levels adopted for this PSI are based on *Table 3, Assessment Levels for Water* (DoE, November 2003).

The highest potential beneficial use of groundwater of the superficial aquifer beneath the site is for drinking water purposes as total dissolved solids were approximately 259 to 959 mg/L. The WA Drinking Water guidelines have been adopted and the Long-term Irrigation guidelines adopted in the absence of Drinking Water guidelines. No marine water ecosystems have been identified within 1 km of the site.

The investigation levels adopted for assessing the contamination status of groundwater at the site are provided in **Table 7.1**.

Table 7.1 Groundwater Investigation Levels

Analytical Groupings	Analyte	Drinking Water (µg/L)	Long-Term Irrigation (µg//L)	Adopted Guideline (µg/L)
OC/OPs	Aldrin	0.3	-	**0.3**
	Dieldrin	0.3	-	**0.3**
	Chlordane	1	-	**1**
	DDT	20	-	**20**
	Chlorpyrifos	30	-	**30**
	Diazinon	3	-	**3**
Metals	Lead (mg/L)	0.01	2.0	**0.01**
	Arsenic (mg/L)	0.007	0.1	**0.007**
	Cadmium (mg/L)	0.002	0.01	**0.002**
	Chromium (mg/L)	-	0.1	**0.1**
	Copper (mg/L)	2.0	0.2	**0.2**
	Mercury (mg/L)	0.001	0.002	**0.001**
	Nickel (mg/L)	0.02	0.2	**0.02**
	Zinc (mg/L)	3.0	2.0	**3.0**
TPH, BTEX	$C_6 - C_9$	-	-	-
	$C_{10} - C_{14}$	-	-	-
	$C_{15} - C_{28}$	-	-	-
	$C_{29} - C_{36}$	-	-	-
	Benzene	1	-	**1**
	Toluene	800	-	**800**
	Ethylbenzene	300	-	**300**
	Xylenes	600	-	**600**

Notes:

- No investigation level available

8 Results and Discussion

8.1 Groundwater Analytical Results

The number of groundwater samples analysed, analytes tested for, minimum/maximum constituent concentrations and samples that exceeded the investigation levels are detailed in **Table 8.1**. Tables of groundwater analytical results, copies of laboratory certificates and signed chain of custody documents are included in **Appendices G** and **H**, respectively.

Table 8.1 Summary of Groundwater Analytical Results

Number of Samples Analysed	Analyte	Min Conc. (µg/L)	Max Conc. (µg/L)	Samples Exceeding Investigation Levels
6	Aldrin	<0.010	<0.010	None
6	Dieldrin	<0.010	<0.010	None
6	Chlordane	<0.010	<0.010	None
6	DDT	<0.010	<0.010	None
6	Chlorpyrifos	<0.050	<0.050	None
6	Diazinon	<0.10	<0.10	None
6	Lead (mg/L)	<0.001	0.003	None
6	Arsenic (mg/L)	<0.001	0.003	None
6	Cadmium (mg/L)	0.0001	0.0004	None
6	Chromium (mg/L)	<0.001	<0.001	None
6	Copper (mg/L)	<0.001	0.003	None
6	Mercury (mg/L)	<0.0001	<0.0001	None
6	Nickel (mg/L)	0.001	0.006	None
6	Zinc (mg/L)	0.014	0.024	None
6	TPH $C_6 - C_9$	<20	<20	None
6	TPH $C_{10} - C_{14}$	<50	60	None
6	TPH $C_{15} - C_{28}$	<100	400	None
6	TPH $C_{29} - C_{36}$	<50	100	None
6	Benzene	<1	<1	None
6	Toluene	<2	<2	None
6	Ethylbenzene	<2	<2	None
6	Xylenes	<2	<2	None

Field gauging results of the groundwater, with the exception of MB01 did not suggest the presence of phase separated hydrocarbons and the water appeared to be free of sheen.

OC/OPs, metals and BTEX were either reported at below the laboratory detection limits or at concentrations less than the WA Drinking Water and Long Term Irrigation Guidelines for all groundwater samples. TPH was reported above laboratory detection in MB01, but not in any of the other monitoring bores. Western Australia does not currently have guidelines for TPH in water and hence the Dutch guidelines are typically referred to when assessing TPH impacts in groundwater. The concentrations of TPH found in MB01 were well below the Dutch guidelines.

8.2 QA/QC and Analytical Data Validation

8.2.1 Field Method Validation

Field methodologies were consistent with Ace's field procedures and are summarised in **Table 8.2**.

Table 8.2 Field Method Validation

QA/QC Requirement	Yes/No	Comments
Sampling equipment properly decontaminated	Yes	None
Sample preservation following collection in the field	Yes	None
Sufficient field QA/QC samples collected	Yes	None
Samples delivered to laboratory within holding times	Yes	None
Review of field quality control (QC) sample results	Yes	None
Other anomalies	No	None

8.2.2 Analytical Data Validation

Relative percentage differences (RPD) calculations for the inter-laboratory field duplicates are shown in **Table 8.3** and analytical data validation interpretations are summarised in **Table 8.4**.

Table 8.3 Relative Percentage Difference

Sample Number	QA Type	Aldrin	Dieldrin	Chlordane	Heptachlor	As
MB01	Primary	<0.010	<0.010	<0.010	<0.005	<0.001
QA1	Split sample	<0.010	<0.010	<0.010	<0.005	<0.001
RDP (%)		na	na	na	na	na

Sample Number	QA Type	Hg	Cd	Cr	Pb	Zn	Cu	Ni
MB01	Primary	<0.0001	0.0002	<0.001	<0.001	0.023	<0.001	0.001
QA1	Split sample	<0.0001	0.0002	<0.001	<0.001	0.027	0.002	0.002
RPD (%)		na	na	na	na	16	66	66

Sample Number	QA Type	Benzene	Toluene	Ethylbenzene	meta-& para-Xylene	ortho-Xylene
MB01	Primary	<1	<2	<2	<2	<2
QA1	Split sample	<1	<2	<2	<2	<2
RPD (%)		na	na	na	na	na

Sample Number	QA Type TPH fraction	C_6-C_9	C_{10}-C_{14}	C_{15}-C_{28}	C_{29}-C_{36}
MB01	Primary	<20	60	400	100
QA1	Split sample	<20	100	600	140
RPD (%)		na	50	40	33

RPD Relative Percentage Difference
na Not applicable as primary and/or QC sample are less than Practical Quantitation Limits

Table 8.4 Analytical Data Validation

QA/QC Requirement	Yes/No	Comments
Holding times	Yes	None
Laboratory accreditation	Yes	None
Sample preservation methods	Yes	None
Review of laboratory quality control results	Yes	None
Required analytical detection limits met	Yes	None

It is considered that the accuracy and precision of the groundwater data, implied from the field QA/QC information available for this project are of sufficient standard and that the analytical results can be used as a basis for interpretation.

9 Conclusion

Within the limitations of the scope of works, Ace has concluded that:

- The PSI established that farming, poultry farming and a mechanical workshop with an underground fuel storage tank were the only potentially contaminating activities occurring in the proposed development area. However, a site inspection across the entire area found a large amount of materials that are considered potentially contaminating. These included piles of rubbish and uncontrolled Fill, car wrecks, workshops, old tyres, oil drums, signs of oil staining and fuel leakages and piles of batteries.

Based on the information available and within the limitations of the PSI, Ace recommends that Detailed Site Investigations be carried out prior to subdivision and development occurring and site remediation/validation be implemented as required. In addition, Ace did not identify any environmental issues with the exception of the underground fuel storage tank that would prevent the proposed development area from being classified suitable for residential development. Removal of the tank would eliminate the potential risk to human health and the environment and hence make the site suitable for residential development.

ACE ENVIRONMENTAL

GINA PEMBERTON
MANAGING DIRECTOR

10 References

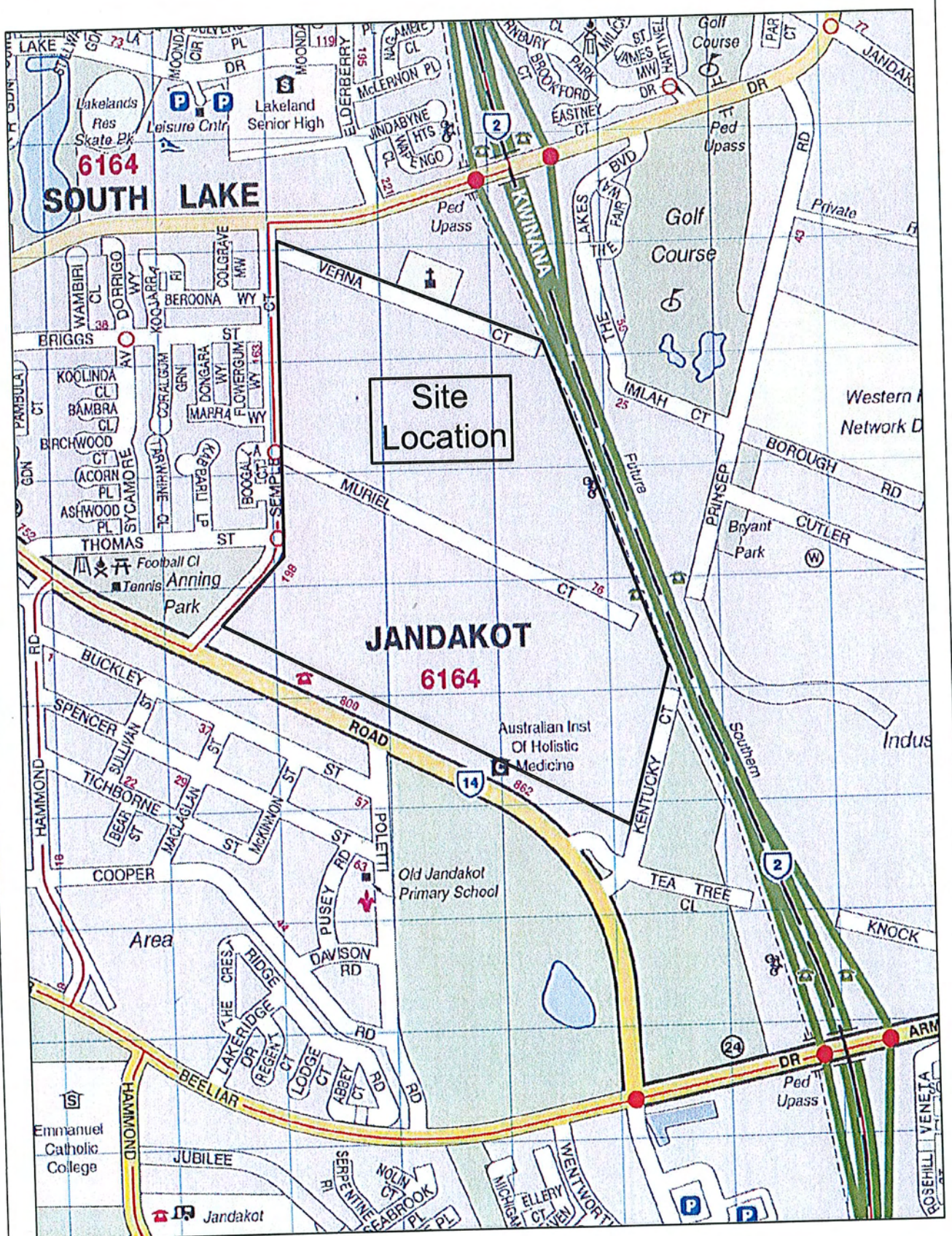
DoE and WAPC (Nov 2003). Planning Bulletin No.64. Central Metropolitan Region Scheme Acid Sulphate Soils.

Department of Water (2006): www.environmental.wa.gov.au

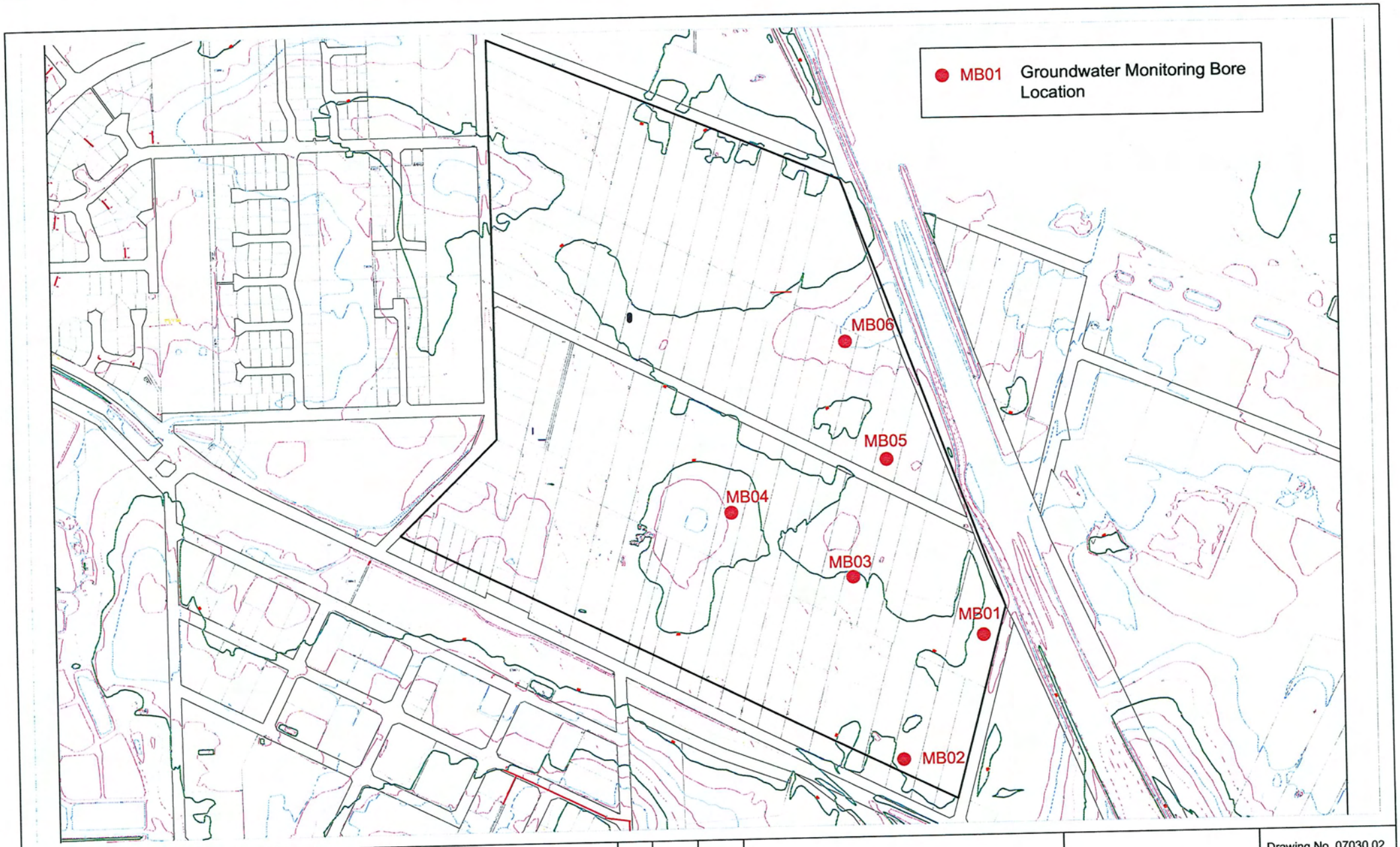
Department of Environment. December 2001. Contaminated Sites Management Series. Contaminated Sites Technical Guidelines.

Department of Environment. 2004. Perth Groundwater Atlas (2nd ed).

FIGURES



Ace Environmental Pty Limited Shop 17/2 South Western Hwy Armadale WA6112 Tel: (08) 9497 5000 Email: gina@aceenvironmental.com.au	Date	Description	Drawn	Checked	Approved	LOCATION PLAN	CLIENT	Drawing No. 07030.01
	21.06.07	Location Plan	HC	GP				Scale: NTS
						DEVELOPMENT AREA 19 JANDAKOT	KOLTASZ SMITH	Sheet Size: A4
								Job No. J07030.01
								FIGURE 1



Ace Environmental
Shop 17/2 South Western Hwy
Armadale WA 61112
Tel: 08 9497 5000
Email: gina@aceenvironmental.com.au

Date	Description	Drawn	Checked	Approved
21.06.07	Bore Location Plan	HC	GP	

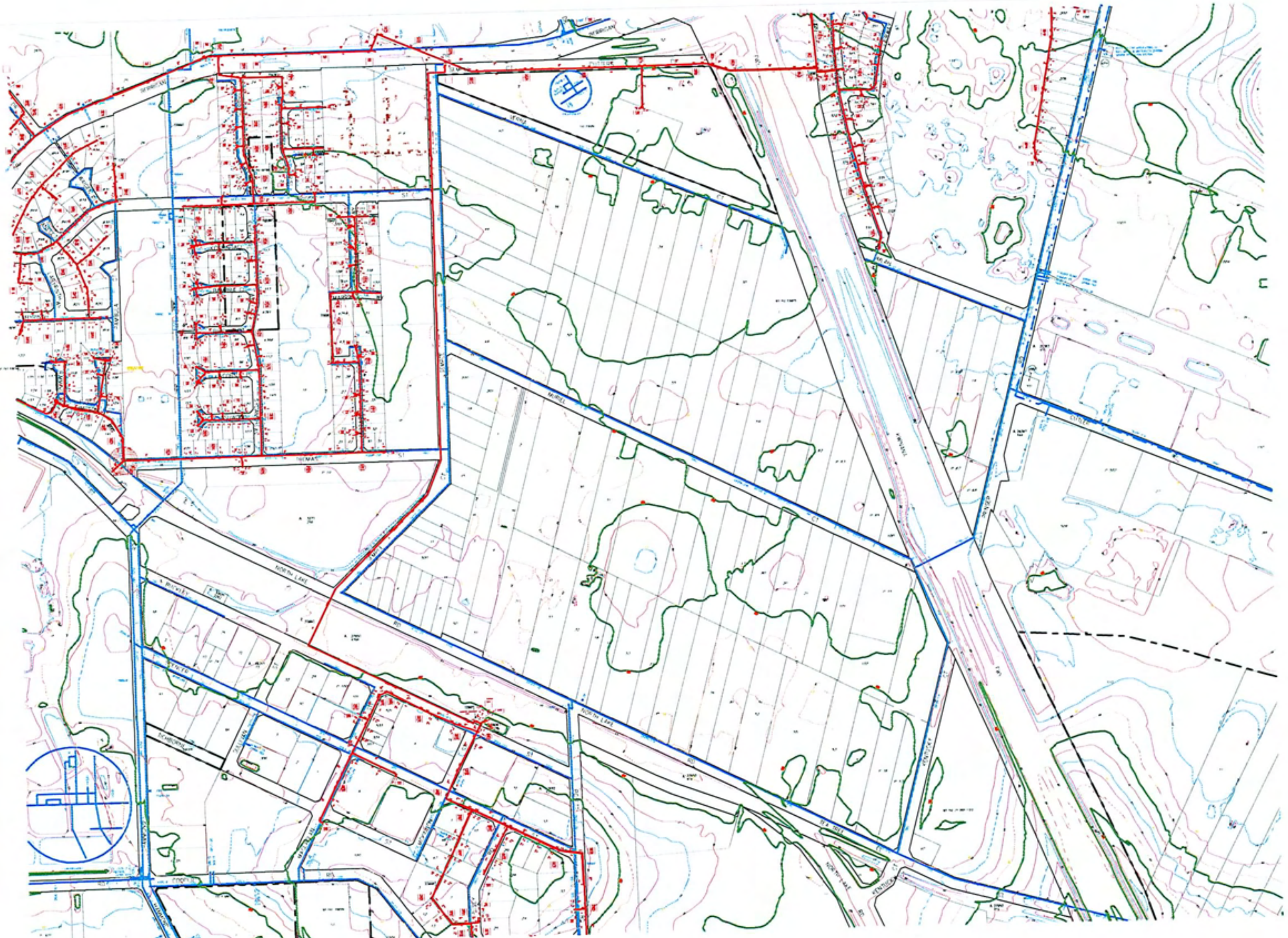
BORE LOCATION PLAN

DEVELOPMENT AREA 19 (MURIEL COURT)
JANDAKOT

CLIENT

KOLTASZ SMITH

Drawing No. 07030.02
Scale: NTS
Sheet Size: A4
Job No: J07030.01
FIGURE 2



Height Datum : AHD Coordinate System : MGA94

The Water Corporation has taken due care in the preparation of this data, but accepts no responsibility for any inaccuracy of facility, cadastral or contour information provided, nor inappropriate use of this information. If any inaccuracy is found with the facility information, please contact Facilities Mapping Information Section on (08) 9420 2068. If any inaccuracy is found with the cadastral or contour information, please contact DOLA to request source data.

APPENDIX A

Site Photograph: Lot 411 Kentucky Court, Jandakot.

Site Photograph: Lots 16 and 17 Tea Tree Close, Jandakot.

Site Photograph: Lot 102 Muriel Court, Jandakot.

Site Photograph: Lot 15 Muriel Court, Jandakot.

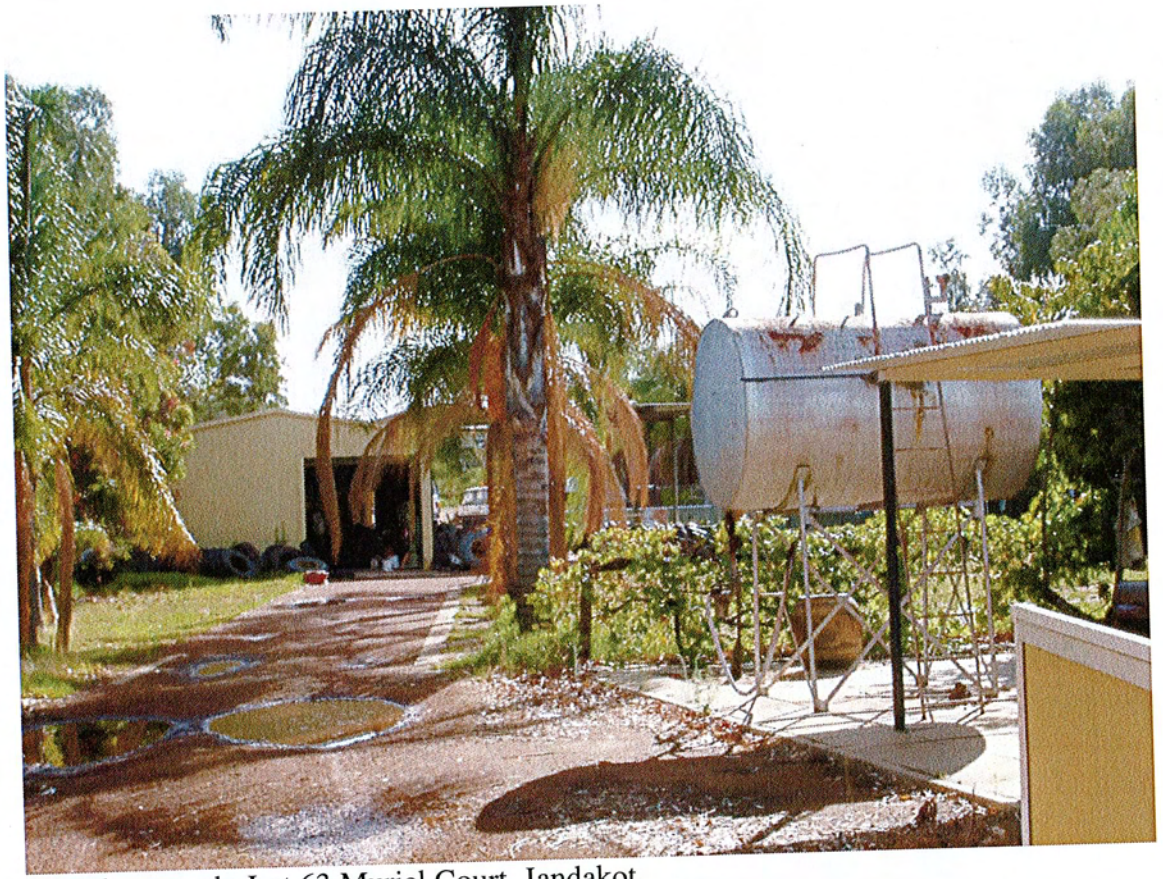
Site Photograph: Lot 101 Muriel Court, Jandakot.

Site Photograph: Lot 100 Muriel Court, Jandakot.

Site Photograph: Lot 21 Muriel Court, Jandakot.

Site Photograph: Lot 10 Muriel Court, Jandakot.

Site Photograph: Lot 61 Muriel Court, Jandakot.



Site Photograph: Lot 63 Muriel Court, Jandakot.

Site Photograph: Lot 63 Muriel Court, Jandakot.

APPENDIX B

City of **Cockburn**
ABN: 27 471 341 209
PO Box 1215, Bibra Lake DC,
Western Australia 6965

9 Coleville Crescent, Spearwood,
Western Australia 6163

Telephone (08) 9411 3444
Facsimile (08) 9411 3416

Wetlands to waves

Direct Indial: 9411 3589
Ref: 6003

19 January 2007

Attention: Gina Pemberton
Brown Geotechnical & Environmental
4/47 Monash Avenue
COMO WA 6152

RE: HEALTH SEARCH – LOTS 411, 102, 15, 101, 100, 21, 16, 17, 60, 61, 63 & 10 MURIEL COURT - JANDAKOT

Please be advised that your request for a search on the above properties with respect to current & historical environmental health issues; records of complaints, cleanup notices, buried waste, applications for installation of fuel tanks etc. has been completed. No issues were found in this regard.

Should you have any further queries, please contact Health Services on 9411 3589.

G Taylor

Gail Taylor
Health Services Clerical Officer

APPENDIX C

Department of Water
Government of Western Australia

FOI Ref number: DOW LR 30

FOI Coordinator: Gérard Fabien

Contact Number: 08 6364 6489

Ms Gina Pemberton
Brown Geotechnical and Environmental
4/47 Monash Avenue
COMO WA 6152

Dear Ms Pemberton

FREEDOM OF INFORMATION (FOI) APPLICATION NO: DOW LR 30
PROPERTY: AREA 19 NORTHLAKE ROAD, JANDAKOT

This letter refers to your FOI application requesting information about the above-mentioned premises.

The Department has conducted searches of relevant databases, using the description of the Properties contained in your application, and no documents have been located.

Please note there are one licence issued under the *Metropolitan Water Sewerage Supply and Drainage Act 1909* and not the *Rights in Water and Irrigation Act 1914 (RIWI Act)* this Property. The Property is located in a proclaimed groundwater area under the *RIWI Act* where groundwater from non artesian aquifer systems cannot be taken without a 5c licence to take water. Additional information relating to licensing is available on the Department's website at http://portal.water.wa.gov.au/portal/page/portal/LicensingWaterIndustryServices

The Property is located within a proclaimed surface water area (Murray River Catchment) under the *RIWI Act* hence licences/permits for surface water is also required, however GIS Viewer does not show a watercourse on the property.

If you wish to contest the decision in regard to access to the documents, you have a right to have the decision reviewed. Details of the review process are set out in the attached extract from the Act.

Yours sincerely

Gérard Fabien
FOI COORDINATOR
GOVERNMENT RELATIONS BRANCH

22 February 2007

Enc

168 St Georges Terrace Perth Western Australia 6000
PO Box K822 Perth Western Australia 6842
Telephone (08) 6364 7600 Facsimile (08) 6364 7601
www.water.wa.gov.au

APPENDIX D

Aerial Photograph: Area 19, Jandakot; 3 February 1948.

Aerial Photograph: Area 19, Jandakot; 6 November 1953.

Aerial Photograph: Area 19, Jandakot; 11 March 1965.

Aerial Photograph: Area 19, Jandakot; 11 June 1975.

Aerial Photograph: Area 19, Jandakot; 20 April 1985.

Aerial Photograph: Area 19, Jandakot; 6 January 1995.

Aerial Photograph: Area 19, Jandakot; 17 December 2005.

APPENDIX E

BOREHOLE NUMBER MB01

Ace Environmental Pty Ltd

CLIENT Landowner group 2

PROJECT NAME Development Area 19

PROJECT NUMBER J07030

PROJECT LOCATION Jandakot

DATE STARTED 4/4/07 COMPLETED 4/4/07

R.L. SURFACE ___ DATUM ___

DRILLING CONTRACTOR G.S Drilling

SLOPE 90° BEARING ---

EQUIPMENT Drilling Rig

HOLE LOCATION 115 854985E 32 120901S MGA

HOLE SIZE 100mm

LOGGED BY TW CHECKED BY GP

NOTES ___

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
			0.5		SP	SAND: Loose, coarse, dark grey, moist, roots to 1m		
			1.0			medium dense and medium grained below 1.0m		
			1.5					
			2.0			dense below 1.8m		
	▼		2.5			pale grey, wet below 2.5m		
			3.0					
			3.5					
			4.0					
			4.5			Borehole MB01 terminated at 4.5m		
			5.0					
			5.5					

BOREHOLE / TEST PIT LOGS.GPJ GINT STD AUSTRALIA.GDT 20/1/08

BOREHOLE NUMBER MB02

Ace Environmental Pty Ltd

CLIENT Landowner group 2
PROJECT NAME Development Area 19
PROJECT NUMBER J07030
PROJECT LOCATION Jandakot

DATE STARTED 4/4/07 COMPLETED 4/4/07
R.L. SURFACE
DATUM
DRILLING CONTRACTOR G S Drilling
SLOPE 90°
BEARING ---
EQUIPMENT Drilling Rig
HOLE LOCATION 115.853617E 32.123196S MGA
HOLE SIZE 100mm
LOGGED BY TW
CHECKED BY GP
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
			0.5		SP	SAND: Dense, fine to medium, grey, moist, trace rootlets		
			1.0					
			1.5			brown below 1.6m		
	▼		2.0			grey brown, wet below 2.0m		
			2.5					
			3.0					
			3.5					
			4.0			Borehole MB02 terminated at 4m		
			4.5					
			5.0					
			5.5					

BOREHOLE NUMBER MB03

Ace Ace Environmental Pty Ltd

CLIENT Landowner group 2
PROJECT NAME Development Area 19
PROJECT NUMBER J07030
PROJECT LOCATION Jandakot

DATE STARTED 4/4/07 COMPLETED 4/4/07
R.L. SURFACE
DATUM
DRILLING CONTRACTOR G.S Drilling
SLOPE 90°
BEARING ---
EQUIPMENT Drilling Rig
HOLE LOCATION 115.852894E 32.118617S MGA
HOLE SIZE 100mm
LOGGED BY TW
CHECKED BY GP
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
			0			TOPSOIL: Medium dense, medium, dark grey with many rootlets to 1.1m		
			0.5			SAND: Medium dense, medium grained, grey, moist		
			1.0					
			1.5			dense below 1.5m		
			2.0					
			2.5					
			3.0			paler grey, wet below 3.0m		
	▼		3.5					
			4.0					
			4.5					
			5.0					
			5.5			Borehole MB03 terminated at 5.5m		

BOREHOLE NUMBER MB04

Ace | Ace Environmental Pty Ltd

CLIENT Landowner group 2 | PROJECT NAME Development Area 19

PROJECT NUMBER J07030 | PROJECT LOCATION Jandakot

DATE STARTED 4/4/07 | COMPLETED 4/4/07 | R.L. SURFACE | DATUM

DRILLING CONTRACTOR G.S Drilling | SLOPE 90° | BEARING ---

EQUIPMENT Drilling Rig | HOLE LOCATION 115.852417E 32.117212S MGA

HOLE SIZE 100mm | LOGGED BY TW | CHECKED BY GP

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
			0.0			TOPSOIL. Medium dense, fine to medium, dark grey rootlets, dry		
			0.5			SAND: Medium dense, medium grained, light grey trace silt, moist		
			1.0			dense below 1.2m		
			1.5					
			2.0					
			2.5					
	▼		3.0			paler grey, wet below 2.8m		
			3.5					
			4.0					
			4.5					
			5.0			Borehole MB04 terminated at 5m		
			5.5					

BOREHOLE NUMBER MB05

Ace Environmental Pty Ltd

CLIENT Landowner group 2

PROJECT NAME Development Area 19

PROJECT NUMBER J07030

PROJECT LOCATION Jandakot

DATE STARTED 4/4/07 COMPLETED 4/4/07

R.L. SURFACE ____ DATUM ____

DRILLING CONTRACTOR G.S Drilling

SLOPE 90° BEARING ---

EQUIPMENT Drilling Rig

HOLE LOCATION 116.853599E 32.117122S MGA

HOLE SIZE 100mm

LOGGED BY TW CHECKED BY GP

NOTES ____

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
			0			TOPSOIL. Medium dense, medium, dark grey, rootlets, dry		
					SP	SAND: Medium dense, medium grained, grey, trace silt, moist		
			0.5					
			1.0			dense below 1 2m		
			1.5					
			2.0					
			2.5					
			3.0					
	▼					pale grey, wet below 3 3m		
			3.5					
			4.0					
			4.5					
			5.0					
			5.5			Borehole MB05 terminated at 5 5m		

BOREHOLE / TEST PIT LOGS GPJ GINT STD AUSTRALIA GDT 20/1/08

BOREHOLE NUMBER MB06

Ace Environmental Pty Ltd

CLIENT Landowner group 2
PROJECT NAME Development Area 19
PROJECT NUMBER J07030
PROJECT LOCATION Jandakot
DATE STARTED 4/4/07 COMPLETED 4/4/07
R.L. SURFACE
DATUM
SLOPE 90°
BEARING ---
DRILLING CONTRACTOR G S Drilling
HOLE LOCATION 115.850562E 32.118043S MGA
EQUIPMENT Drilling Rig
LOGGED BY TW
CHECKED BY GP
HOLE SIZE 100mm
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
			0.0			TOPSOIL. Medium dense, medium grained, grey, trace rootlets, dry		
			0.5		SP	SAND. Medium dense, medium grained, light grey, trace silt, moist		
			1.0					
			1.5					
			2.0					
			2.5			dense below 2.4m		
			3.0					
	▼		3.5			paler grey, wet below 3.4m		
			4.0					
			4.5					
			5.0					
			5.5			Borehole MB06 terminated at 5.5m		

Groundwater Field Parameters

Job Number: J07030 **Sampling Point:** MB01

Project: Area 19	**Purging Date:** 31 Oct 2007
Site Location: Jandakot	**Sampling Date:** 31 Oct 2007
MGA Grid Coordinates (WGS 84)	Well depth from TOC (m): 4.50
	Depth to groundwater from TOC (m): 1.906
Easting	Depth to be purged (m): 2.5
Northing	

Purging Information

Purge 5 casing volumes or until dry

1 casing volume = 2L/m for wells of 50mm ID

1 casing volume = 8 L/m for wells of 100mm ID

Method pump type: subm ○ bailer ✓ GrundfosMP1 ○	One purge volume: 5 litres
Tubing material: HDPE ○ PVC ✓ S/Steel ○	No. of times purged: 5
Start time (2400hr):	Total purge volume: 25 litres

Field Results While Purging

	pH	Conductivity (mS.cm)	Redox (mV)	DO (ppm)	Temp. °C
After 1 purge volume	5.91	390	-132	2.04	19.1
After 4 purge volumes	5.90	363	-131	2.27	18.9
After 5 purge volumes	5.96	375	-126	2.15	20.7
Extra if required					
Extra if required					

Measurements for pH should be within 0.1 pH units and measurements for conductivity, salinity and dissolved oxygen should be within 10% and temperature within 0.5 °C before the well is sampled

Are the field results acceptable to allow sampling? (circle one) Yes No (No: suspend additional purge data)

Sampling Details

Method pump type: waterra ○ bailer ✓ GrundfosMP1 ○	
Tubing material: HDPE ○ PVC ✓ S/Steel ○	
Is there a hydrocarbon sheen? Yes (No)	
Odour: a slight hydrocarbon odour	
Colour:	
Turbidity: L M H	

Analysis Required (tick if yes)

TPH	Ammonia
BTEx	SVOCs
VOCs	Other
Cyanide	Other
PAHs	Other
Metals (see dustpan form for list)	

Weather Conditions

Rain	Temperature °C	Cloud cover	%

Other comments and observations:

Sampler's name: Gina Pemberton Signature: Gina Pemberton

APPENDIX F

Groundwater Field Parameters

Job Number: J07030 **Sampling Point:** MB02

Project: Area 19	**Purging Date:** 31/10/07
Site Location: Jandakot	**Sampling Date:** 31/10/07
MGA Grid Coordinates (WGS 84)	Well depth from TOC (m): 4m
	Depth to groundwater from TOC (m): 2.701
Easting	Depth to be purged (m): 1.5
Northing	

Purging Information

Purge 5 casing volumes or until dry

1 casing volume = 2L/m for wells of 50mm ID

1 casing volume = 8 L/m for wells of 100mm ID

Method pump/type submersible ○ bailer ✓ GrundfosMP1 ○	One purge volume 3 litres
Tubing material HDPE ○ PVC ✓ S.Steel ○	No. of times purged 5
Start time (2400hr):	Total purge volume 15 litres

Field Results While Purging

	pH	Conductivity (mS.cm)	Redox (mV)	DO (ppm)	Temp. °C
After 1 purge volume	5.70	1375	-106	2.23	19.8
After 4 purge volumes	5.80	1388	-121	2.20	19.8
After 5 purge volumes	5.78	1390	-122	2.09	19.9
Extra if required					
Extra if required					

Measurements for pH should be within 0.1 pH units and measurements for conductivity, salinity and dissolved oxygen should be within 10% and temperature within 0.5 °C before the well is sampled.

Are the field results acceptable to allow sampling? (circle one) (Yes) No (If No, append additional purge data.)

Sampling Details

Method pump/type Mastersa ○ bailer ✓ GrundfosMP ○	
Tubing material HDPE ○ PVC ✓ S.Steel ○	
Is there a hydrocarbon sheen? Yes (No)	
Odour no smell	
Colour	
Turbidity L M H	

Analysis Required (tick if yes)

TPH	Ammonia
BTEX	S.VOCs
VOCs	Other
Cyanide	Other
PAHs	Other
Metals (see bottle form for list)	

Weather Conditions

Rain	Temperature °C	Cloud cover	%

Other comments and observations:

Sampled by name: Gina Pemberton Signature: Gina Pemberton

Groundwater Field Parameters

Job Number: J07030 **Sampling Point:** MB03

Project: Area 19	**Purging Date:** 31/10/07
Site Location: Jandakot	**Sampling Date:** 31/10/07
MGA Grid Coordinates (WGS 84	Well depth from TOC (m): 5.5
Easting:	Depth to groundwater from TOC (m): 2.514
Northing:	Depth to be purged (m): 2

Purging Information

Purge 5 casing volumes or until dry
1 casing volume = 2L/m for wells of 50mm ID
1 casing volume = 8 L/m for wells of 100mm ID

Method pump/type submers ○ bailer ✓ GrundfosMP1 ○	One purge volume 4 litres
Tubing material HDPE ○ PVC ✓ S/Steel ○	No. of times purged 5
Start time (2400hr):	Total purge volume 20 litres

Field Results While Purging

	pH	Conductivity (mS.cm)	Redox (mV)	DO (ppm)	Temp. °C
After 1 purge volume	6.48	972	-140	1.87	19.9
After 4 purge volumes	6.46	993	-137	2.06	19.6
After 5 purge volumes	6.45	936	-139	1.94	20.1
Extra if required					
Extra if required					

Measurements for pH should be within 0.1 pH units and measurements for conductivity, salinity, and dissolved oxygen should be within 10% and temperature within 0.5 °C before the well is sampled.

Are the field results acceptable to allow sampling? (circle one) (Yes) No (No, append additional purge data)

Sampling Details

Method pump/type submers ○ bailer ✓ GrundfosMP ○
Tubing material HDPE ○ PVC ✓ S/Steel ○
Is there any hydrocarbon sheen? Yes (No)
Odour no smell
Odour
Turbidity L M H

Analysis Required (tick if yes)

TPH	Ammonia
BTEX	SVOCs
VOCs	Oil
Cyanide	Other
PAHs	Other
Metals (see dustpan form for list)	

Weather Conditions

Rain Temperature °C Cloud cover %

General comments and observations

Sampler's name: Gina Pemberton Signature: Gina Pemberton

Groundwater Field Parameters

Job Number: J07030 **Sampling Point:** MB04

Project: Area 19	**Purging Date:** 31/10/07
Site Location: Jandakot	**Sampling Date:** 31/10/07
MGA Grid Coordinates (WGS 84)	Well depth from TOC (m) 5m
Easting	Depth to groundwater from TOC (m) 2.190
Northing	Depth to be purged (m) 3

Purging Information

Purge 5 casing volumes or until 'dry'
1 casing volume = 2L/m for wells of 50mm ID
1 casing volume = 8 L/m for wells of 100mm ID

Method pump type submO bailer ✓ GrundfosMP1 O	One purge volume 6 litres
Tubing material HDPE O PVC ✓ S/Steel O	No. of times purged 5
Start time (2400hr)	Total purge volume 30 litres

Field Results While Purging

	pH	Conductivity (mS.cm)	Redox (mV)	DO (ppm)	Temp. °C
After 1 purge volume	5.94	279	-128	2.16	19.5
After 4 purge volumes	5.91	390	-126	1.88	21.0
After 5 purge volumes	5.92	391	-128	1.74	20.9
Extra if required					
Extra if required					

Measurements for pH should be within 0.1 pH units and measurements for conductivity, salinity, and dissolved oxygen should be within 10% and temperature within 0.5 °C before the well is sampled

Are the field results acceptable to allow sampling? (circle one) (Yes) No *No, append additional purge data

Sampling Details

Method pump type Mat'ls O bailer ✓ GrundfosMP1 O
Tubing material HDPE O PVC ✓ S/Stee O
Smells and dissolved oxygen? Yes (No)
Odour no smell
Colour
Turbidity L M H

Analysis Required (tick if yes)

TPH	Ammonia
BTEX	SVOCs
VOCs	Other
Cyanide	Other
PAHs	Other
Metals (see dustbox form for list)	

Weather Conditions

Rain Temperature °C Cloud cover %

Other comments and observations

Sampled by name Gina Pemberton Signature Gina Pemberton

Groundwater Field Parameters

Job Number: J07030 **Sampling Point:** MB05

Project: Area 19	**Purging Date:** 31/10/07
Site Location: Jandakot	**Sampling Date:** 31/10/07
MGA Grid Coordinates (WGS 84	Well depth from TOC (m) 5.5
Easting	Depth to groundwater from TOC (m) 2.775
Northing	Depth to be purged (m) 2

Purging Information

Purge 5 casing volumes or until dry

1 casing volume = 2L/m for wells of 50mm I.D

1 casing volume = 8 L/m for wells of 100mm I.D

Method pump/bailer submersible ○ bailer ✓ GrundfosMP1 ○	One purge volume 4 litres
Tubing material HDPE ○ PVC ✓ SiSteel ○	No. of times purged 5
Start time (2400hrs)	Total purge volume 20 litres

Field Results While Purging

	pH	Conductivity (mS.cm)	Redox (mV)	DO (ppm)	Temp. °C
After 1 purge volume	6.05	394	-55	2.08	21.0
After 4 purge volumes	5.92	388	-65	1.90	20.6
After 5 purge volumes	5.88	383	-94	1.42	21.6
Extra if required					
Extra if required					

Measurements for pH should be within 0.1 pH units and measurements for conductivity, salinity and dissolved oxygen should be within 10% and temperature within 0.5 °C before the well is sampled

Are the field results acceptable to allow sampling? (circle one) (Yes) No (You should add additional purge data)

Sampling Details

Method pump/bailer waterra ○ bailer ✓ GrundfosMP ○	
Tubing material HDPE ○ PVC ✓ SiSteel ○	
Is there a hydrocarbon sheen? Yes (No)	
Odour no smell	
Colour	
Turbidity L M H	

Analysis Required (tick if yes)

TPH	Ammonia
BTEX	SVOCs
VOCs	Br
Cyanide	Other
PAHs	Other
Metals (see custody form for list)	

Weather Conditions

Rain Temperature °C Cloud cover %

Other comments and observations

Sampler's name Gina Pemberton Signature Gina Pemberton

Groundwater Field Parameters

Job Number: J07030 **Sampling Point:** MB06

Project: Area 19	**Purging Date:** 31/10/07
Site Location: Jandakot	**Sampling Date:** 31/10/07
MGA Grid Coordinates (WGS 84	Well depth from TOC (m) 5.5
Easting	Depth to groundwater from TOC (m) 1.413
Northing	Depth to be purged (m) 4

Purging Information

Purge 5 casing volumes or until dry

1 casing volume = 2L/m for wells of 50mm ID

1 casing volume = 8 L/m for wells of 100mm ID

Method pump/type submersible ○ bailer ✓ GrundfosMP1 ○	One purge volume 8 litres
Tubing material HDPE ○ PVC ✓ S.Steel ○	No. of times purged 5
Start time (2400hr)	Total purge volume 40 litres

Field Results While Purging

	pH	Conductivity (mS.cm)	Redox (mV)	DO (ppm)	Temp. °C
After 1 purge volume	6.06	450	79	2.34	18.3
After 4 purge volumes	5.47	362	20	1.93	18.8
After 5 purge volumes	5.95	464	-8	1.70	18.9
Extra if required	5.95	465	-10	1.62	18.9
Extra if required					

Measurements for pH should be within 0.1 pH units and measurements for conductivity, salinity, and dissolved oxygen should be within 10% and temperature within 0.5 °C before the well is sampled

Are the field results acceptable to allow sampling? please circle (Yes) No (No: record additional purge data)

Sampling Details

Method pump/type submersible ○ bailer ✓ GrundfosMP1 ○

Tubing material HDPE ○ PVC ✓ S.Steel ○

Is there a hydrocarbon sheen? Yes (No)

Odour no smell

Odour

Turbidity - M H

Analysis Required (tick if yes)

TPH	Ammonia
BTEX	SVOCs
VOCs	Other
Cyanide	Other
PAHs	Other
Metals (see custody form for list)	

Weather Conditions

Rain Temperature °C Cloud cover %

Other comments and observations

Sampler's name Gina Pemberton Signature Gina Pemberton

APPENDIX G

Table 1 – Groundwater Analytical Results: Dissolved Metals

Sample Identification Number	Sample Date	QA Sample Type	Metals							
			Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Mercury
Units			mg/L							
Assessment Criteria										
Adopted Investigation Levels			0.1	0.01	0.1	0.2	2.0	0.2	2.0	0.002
Analytical Results										
MB01	31/10/2007		<0.001	0.0002	<0.001	<0.001	<0.001	0.001	0.023	<0.0001
MB02	31/10/2007		0.003	0.0002	<0.001	0.003	0.001	0.006	0.006	<0.0001
MB03	31/10/2007		0.002	0.0001	<0.001	0.002	<0.001	0.001	0.017	<0.0001
MB04	31/10/2007		<0.001	0.0002	<0.001	0.003	0.003	0.002	0.020	<0.0001
MB05	31/10/2007		<0.001	0.0004	<0.001	0.002	<0.001	0.002	0.019	<0.0001
MB06	31/10/2007		0.002	0.0002	<0.001	<0.001	<0.001	0.002	0.014	<0.0001

Table 2 – Total Petroleum Hydrocarbons and BTEX

Sample Name	Sample Date	Total Petroleum Hydrocarbons & BTEX								
		C6 – C9 Fraction	C10 – C14 Fraction	C15 – C28 Fraction	C29 – C36 Fraction	Benzene	Toluene	Ethylbenzene	Meta- & para-Xylene	Ortho-Xylene
MB01	31/10/2007	<20	60	400	100	<1	<2	<2	<2	<2
MB02	31/10/2007	<20	<50	<100	70	<1	<2	<2	<2	<2
MB03	31/10/2007	<20	<50	<100	<50	<1	<2	<2	<2	<2
MB04	31/10/2007	<20	<50	<100	<50	<1	<2	<2	<2	<2
MB05	31/10/2007	<20	<50	<100	<50	<1	<2	<2	<2	<2
MB06	31/10/2007	<20	<50	<100	<50	<1	<2	<2	<2	<2

Table 3a – Groundwater Analytical Results: Organophosphorus Pesticides (Ultra-trace)

Sample Name	Sample Date	Organochlorine Pesticides (µg/L)											
		Bromophos-ethyl	Carbophenothion	Chlorfenvinphos	Chlorpyrifos	Chlorpyrifos-methyl	Demeton-S-methyl	Diazinon	Dichlorvos	Dimenthoate	Ethion	Fenamiphos	Fenthion
MB01	31/10/2007	<0.10	<0.10	<0.10	<0.050	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
MB02	31/10/2007	<0.10	<0.10	<0.10	<0.050	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
MB03	31/10/2007	<0.10	<0.10	<0.10	<0.050	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
MB04	31/10/2007	<0.10	<0.10	<0.10	<0.050	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
MB05	31/10/2007	<0.10	<0.10	<0.10	<0.050	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
MB06	31/10/2007	<0.10	<0.10	<0.10	<0.050	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Table 3b – Groundwater Analytical Results: Organophosphorus Pesticides (Ultra-trace)

Sample Name	Sample Date	Organochlorine Pesticides (µg/L)						
		Malathion	Azinphos Methyl	Monocrotophos	Parathion	Parathion-methyl	Pirimphos-ethyl	Prothiofos
MB01	31/10/2007	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
MB02	31/10/2007	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
MB03	31/10/2007	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
MB04	31/10/2007	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
MB05	31/10/2007	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
MB06	31/10/2007	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Table 5 – Groundwater Analytical Results: Organochlorine Pesticides - Water

	Sample Name					
	MB01	MB02	MB03	MB04	MB05	MB06
	Sample Date					
	31/10/2007	31/10/2007	31/10/2007	31/10/2007	31/10/2007	31/10/2007
Organochlorine Pesticides (µg/L)						
Aldrin	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-BHC	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
beta-BHC	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
delta-BHC	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4.4' – DDD	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4.4' – DDE	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
4.4' – DDT	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
DDT (total)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Dieldrin	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-Endosulfan	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
beta-Endosulfan	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endosulfan sulfate	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endosulfan	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin aldehyde	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin ketone	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Heptachlor	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Heptachlor epoxide	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Hexachlorobenzene (HCB)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
gamma-BHC	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Methoxychlor	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
cis-Chlordane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
trans-Chlordane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Total Chlordane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

APPENDIX H

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EP0705200**	Page	: 1 of 8
Client	: **ACE ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MS GINA PEMBERTON	Contact	: Michael Sharp
Address	: SHOP 17/2 SOUTH WESTERN HIGHWAY ARMADALE WA AUSTRALIA 6112	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: gina@aceenvironmental.com.au	E-mail	: Shaun.Crabb@alsenviro.com
Telephone	: +61 08 9497 5000	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: J07030	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 02-NOV-2007
C-O-C number	: ----	Issue Date	: 21-NOV-2007
Sampler	: G.P	No. of samples received	: 7
Site	: ----	No. of samples analysed	: 7
Quote number	: EN-062-07		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ashwini Sharma	Inorganics Co-ordinator	Inorganics
Celine Conceicao	Spectroscopist	Inorganics
PHALAK INTHAKESONE	Organics Co-ordinator	Organics
Shuk Hui Li	Senior Chemist - Organics	Perth Organics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes.

Key : CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID	MB01	MB02	MB03	MB04	MB05
				Client sampling date / time	31-OCT-2007 15:00	31-OCT-2007 15:00	31-OCT-2007 15:00	31-OCT-2007 15:00	31-OCT-2007 15:00
					EP0705200-001	EP0705200-002	EP0705200-003	EP0705200-004	EP0705200-005
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	0.003	0.002	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		0.0002	0.0002	0.0001	0.0002	0.0004
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	0.003	0.002	0.003	0.002
Lead	7439-92-1	0.001	mg/L		<0.001	0.001	<0.001	0.003	<0.001
Nickel	7440-02-0	0.001	mg/L		0.001	0.006	0.001	0.002	0.002
Zinc	7440-66-6	0.005	mg/L		0.023	0.024	0.017	0.020	0.019
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	---	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	---	50	µg/L		60	<50	<50	<50	<50
C15 - C28 Fraction	---	100	µg/L		400	<100	<100	<100	<100
C29 - C36 Fraction	---	50	µg/L		100	70	<50	<50	<50
EP080: BTEX									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
EP130A: Organophosphorus Pesticides (Ultra-trace)									
Bromophos-ethyl	4824-78-6	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Carbophenothion	786-19-6	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Chlorfenvinphos (Z)	470-90-8	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Chlorpyrifos	2921-88-2	0.050	µg/L		<0.050	<0.050	<0.050	<0.050	<0.050
Chlorpyrifos-methyl	5598-13-0	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Demeton-S-methyl	919-86-8	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Diazinon	333-41-5	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Dichlorvos	62-73-7	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Dimethoate	60-51-5	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Ethion	563-12-2	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Fenamiphos	22224-92-6	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Fenthion	55-38-9	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Malathion	121-75-5	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Azinphos Methyl	86-50-0	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Monocrotophos	6923-22-4	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Parathion	56-38-2	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10
Parathion-methyl	298-00-0	0.10	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: MB01	MB02	MB03	MB04	MB05
				Client sampling date / time: 31-OCT-2007 15:00	31-OCT-2007 15:00	31-OCT-2007 15:00	31-OCT-2007 15:00	31-OCT-2007 15:00
				EP0705200-001	EP0705200-002	EP0705200-003	EP0705200-004	EP0705200-005
EP130A: Organophosphorus Pesticides (Ultra-trace) - Continued								
Pirimphos-ethyl	23505-41-1	0.10	µg/L	<0.10	<0.10	<0.10	<0.10	<0.10
Prothiofos	34643-46-4	0.10	µg/L	<0.10	<0.10	<0.10	<0.10	<0.10
EP131A: Organochlorine Pesticides								
Aldrin	309-00-2	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-BHC	319-84-6	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
beta-BHC	319-85-7	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
delta-BHC	319-86-8	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
4.4'-DDD	72-54-8	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
4.4'-DDE	72-55-9	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
4.4'-DDT	50-29-3	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
^ DDT (total)	---	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Dieldrin	60-57-1	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
alpha-Endosulfan	959-98-8	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
beta-Endosulfan	33213-65-9	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Endosulfan sulfate	1031-07-8	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
^ Endosulfan (sum)	115-29-7	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin	72-20-8	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin aldehyde	7421-93-4	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Endrin ketone	53494-70-5	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Heptachlor	76-44-8	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Heptachlor epoxide	1024-57-3	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Hexachlorobenzene (HCB)	118-74-1	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
gamma-BHC	58-89-9	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
Methoxychlor	72-43-5	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
cis-Chlordane	5103-71-9	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
trans-Chlordane	5103-74-2	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
^ Total Chlordane (sum)	---	0.010	µg/L	<0.010	<0.010	<0.010	<0.010	<0.010
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	106	104	103	110	105
Toluene-D8	2037-26-5	0.1	%	103	104	103	101	102
4-Bromofluorobenzene	460-00-4	0.1	%	92.9	92.8	95.9	88.9	93.8
EP130S: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.1	%	111	94.2	72.4	59.1	65.4
EP131S: OC Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.1	%	68.4	75.9	55.6	54.4	77.6

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: MB06	QA1	----	----	----
				Client sampling date / time: 31-OCT-2007 15:00	31-OCT-2007 15:00	---	---	---
				EP0705200-006	EP0705200-007	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	**0.002**	<0.001	---	---	---
Cadmium	7440-43-9	0.0001	mg/L	**0.0002**	**0.0002**	---	---	---
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	---	---	---
Copper	7440-50-8	0.001	mg/L	<0.001	**0.002**	---	---	---
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	---	---	---
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.002**	---	---	---
Zinc	7440-66-6	0.005	mg/L	**0.014**	**0.027**	---	---	---
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	---	---	---
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	---	20	µg/L	<20	<20	---	---	---
C10 - C14 Fraction	---	50	µg/L	<50	**100**	---	---	---
C15 - C28 Fraction	---	100	µg/L	<100	**600**	---	---	---
C29 - C36 Fraction	---	50	µg/L	<50	**140**	---	---	---
EP080: BTEX								
Benzene	71-43-2	1	µg/L	<1	<1	---	---	---
Toluene	108-88-3	2	µg/L	<2	<2	---	---	---
Ethylbenzene	100-41-4	2	µg/L	<2	<2	---	---	---
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	---	---	---
ortho-Xylene	95-47-6	2	µg/L	<2	<2	---	---	---
EP130A: Organophosphorus Pesticides (Ultra-trace)								
Bromophos-ethyl	4824-78-6	0.10	µg/L	<0.10	<0.10	---	---	---
Carbophenothion	786-19-6	0.10	µg/L	<0.10	<0.10	---	---	---
Chlorfenvinphos (Z)	470-90-8	0.10	µg/L	<0.10	<0.10	---	---	---
Chlorpyrifos	2921-88-2	0.050	µg/L	<0.050	<0.050	---	---	---
Chlorpyrifos-methyl	5598-13-0	0.10	µg/L	<0.10	<0.10	---	---	---
Demeton-S-methyl	919-86-8	0.10	µg/L	<0.10	<0.10	---	---	---
Diazinon	333-41-5	0.10	µg/L	<0.10	<0.10	---	---	---
Dichlorvos	62-73-7	0.10	µg/L	<0.10	<0.10	---	---	---
Dimethoate	60-51-5	0.10	µg/L	<0.10	<0.10	---	---	---
Ethion	563-12-2	0.10	µg/L	<0.10	<0.10	---	---	---
Fenamiphos	22224-92-6	0.10	µg/L	<0.10	<0.10	---	---	---
Fenthion	55-38-9	0.10	µg/L	<0.10	<0.10	---	---	---
Malathion	121-75-5	0.10	µg/L	<0.10	<0.10	---	---	---
Azinphos Methyl	86-50-0	0.10	µg/L	<0.10	<0.10	---	---	---
Monocrotophos	6923-22-4	0.10	µg/L	<0.10	<0.10	---	---	---
Parathion	56-38-2	0.10	µg/L	<0.10	<0.10	---	---	---
Parathion-methyl	298-00-0	0.10	µg/L	<0.10	<0.10	---	---	---

Analytical Results

Sub-Matrix: **WATER**

Compound	CAS Number	LOR	Unit	Client sample ID: MB06	QA1	----	----	----
				Client sampling date / time: 31-OCT-2007 15:00	31-OCT-2007 15:00	---	---	---
				EP0705200-006	EP0705200-007	----	----	----
EP130A: Organophosphorus Pesticides (Ultra-trace) - Continued								
Pirimphos-ethyl	23505-41-1	0.10	µg/L	<0.10	<0.10	---	---	---
Prothiofos	34643-46-4	0.10	µg/L	<0.10	<0.10	---	---	---
EP131A: Organochlorine Pesticides								
Aldrin	309-00-2	0.010	µg/L	<0.010	<0.010	---	---	---
alpha-BHC	319-84-6	0.010	µg/L	<0.010	<0.010	---	---	---
beta-BHC	319-85-7	0.010	µg/L	<0.010	<0.010	---	---	---
delta-BHC	319-86-8	0.010	µg/L	<0.010	<0.010	---	---	---
4.4'-DDD	72-54-8	0.010	µg/L	<0.010	<0.010	---	---	---
4.4'-DDE	72-55-9	0.010	µg/L	<0.010	<0.010	---	---	---
4.4'-DDT	50-29-3	0.010	µg/L	<0.010	<0.010	---	---	---
^ DDT (total)	---	0.010	µg/L	<0.010	<0.010	---	---	---
Dieldrin	60-57-1	0.010	µg/L	<0.010	<0.010	---	---	---
alpha-Endosulfan	959-98-8	0.010	µg/L	<0.010	<0.010	---	---	---
beta-Endosulfan	33213-65-9	0.010	µg/L	<0.010	<0.010	---	---	---
Endosulfan sulfate	1031-07-8	0.010	µg/L	<0.010	<0.010	---	---	---
^ Endosulfan (sum)	115-29-7	0.010	µg/L	<0.010	<0.010	---	---	---
Endrin	72-20-8	0.010	µg/L	<0.010	<0.010	---	---	---
Endrin aldehyde	7421-93-4	0.010	µg/L	<0.010	<0.010	---	---	---
Endrin ketone	53494-70-5	0.010	µg/L	<0.010	<0.010	---	---	---
Heptachlor	76-44-8	0.005	µg/L	<0.005	<0.005	---	---	---
Heptachlor epoxide	1024-57-3	0.010	µg/L	<0.010	<0.010	---	---	---
Hexachlorobenzene (HCB)	118-74-1	0.010	µg/L	<0.010	<0.010	---	---	---
gamma-BHC	58-89-9	0.010	µg/L	<0.010	<0.010	---	---	---
Methoxychlor	72-43-5	0.010	µg/L	<0.010	<0.010	---	---	---
cis-Chlordane	5103-71-9	0.010	µg/L	<0.010	<0.010	---	---	---
trans-Chlordane	5103-74-2	0.010	µg/L	<0.010	<0.010	---	---	---
^ Total Chlordane (sum)	---	0.010	µg/L	<0.010	<0.010	---	---	---
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**111**	**108**	---	---	---
Toluene-D8	2037-26-5	0.1	%	**103**	**105**	---	---	---
4-Bromofluorobenzene	460-00-4	0.1	%	**92.4**	**94.5**	---	---	---
EP130S: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.1	%	**62.6**	**45.9**	---	---	---
EP131S: OC Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.1	%	**69.1**	**58.7**	---	---	---

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1,2-Dichloroethane-D4	17060-07-0	70.0	130
Toluene-D8	2037-26-5	70.0	130
4-Bromofluorobenzene	460-00-4	70.0	130
EP130S: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	32	136.4
EP131S: OC Pesticide Surrogate			
Dibromo-DDE	21655-73-2	10	136

ALS Laboratory Group
ANALYTICAL CHEMISTRY & TESTING SERVICES

Environmental Division

QUALITY CONTROL REPORT

Work Order	: **EP0705200**	Page	: 1 of 9
Client	: **ACE ENVIRONMENTAL PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MS GINA PEMBERTON	Contact	: Michael Sharp
Address	: SHOP 17/2 SOUTH WESTERN HIGHWAY ARMADALE WA AUSTRALIA 6112	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: gina@aceenvironmental.com.au	E-mail	: Shaun.Crabb@alsenviro.com
Telephone	: +61 08 9497 5000	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: J07030	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 02-NOV-2007
Sampler	: G.P	Issue Date	: 21-NOV-2007
Order number	: ----		
		No. of samples received	: 7
Quote number	: EN-062-07	No. of samples analysed	: 7

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ashwini Sharma	Inorganics Co-ordinator	Inorganics
Celine Conceicao	Spectroscopist	Inorganics
PHALAK INTHAKESONE	Organics Co-ordinator	Organics
Shuk Hui Li	Senior Chemist - Organics	Perth Organics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been preformed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insuffient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = Chemistry Abstract Services number
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting. Result < 10 times LOR:- No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:- 0% - 20%.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020F: Dissolved Metals by ICP-MS (QC Lot: 531440)									
EP0705200-001		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0002	0.0001	0.0	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.001	0.0	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.001	0.001	0.0	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.023	0.023	0.0	No Limit
EP0705201-004		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EG020A-F: Copper	7440-50-8	0.001	mg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EG020A-F: Lead	7439-92-1	0.001	mg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	Anonymous	Anonymous	Anonymous	Anonymous
EG035F: Dissolved Mercury by FIMS (QC Lot: 528260)									
EB0712792-013		EG035F: Mercury	7439-97-6	0.0001	mg/L	Anonymous	Anonymous	Anonymous	Anonymous
EP0705200-006		EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 528877)									
EP0705030-001		EP071: C10 - C14 Fraction	---	50	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EP071: C15 - C28 Fraction	---	100	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EP071: C29 - C36 Fraction	---	50	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 533833)									
EP0705167-001		EP080: C6 - C9 Fraction	---	20	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
EP0705171-005		EP080: C6 - C9 Fraction	---	20	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
EP080: BTEX (QC Lot: 533833)									
EP0705167-001		EP080: Benzene	71-43-2	1	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EP080: Toluene	108-88-3	2	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EP080: Ethylbenzene	100-41-4	2	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EP080: ortho-Xylene	95-47-6	2	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
EP0705171-005		EP080: Benzene	71-43-2	1	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EP080: Toluene	108-88-3	2	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EP080: Ethylbenzene	100-41-4	2	µg/L	Anonymous	Anonymous	Anonymous	Anonymous

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP080: BTEX (QC Lot: 533833) - continued									
EP0705171-005		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	Anonymous	Anonymous	Anonymous	Anonymous
		EP080: ortho-Xylene	95-47-6	2	µg/L	Anonymous	Anonymous	Anonymous	Anonymous

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

		Method Blank (MB) Report			Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 531440)								
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	114	70	130
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	98.7	70	130
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	107	70	130
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	97.7	70	130
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	104	70	130
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	99.8	70	130
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	103	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 528260)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.010 mg/L	106	80.5	117
EP080/071: Total Petroleum Hydrocarbons (QCLot: 528877)								
EP071: C10 - C14 Fraction	---	50	µg/L	<50	400 µg/L	70.6	44.5	122
EP071: C15 - C28 Fraction	---	100	µg/L	<100	400 µg/L	89.0	55.1	143
EP071: C29 - C36 Fraction	---	50	µg/L	<50	400 µg/L	88.8	53.6	128
EP080/071: Total Petroleum Hydrocarbons (QCLot: 533833)								
EP080: C6 - C9 Fraction	---	20	µg/L	<20	320 µg/L	108	74.2	142
EP080: BTEX (QCLot: 533833)								
EP080: Benzene	71-43-2	1	µg/L	<1	20 µg/L	97.5	72.6	122
EP080: Toluene	108-88-3	2	µg/L	<2	20 µg/L	98.6	71.1	123
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	20 µg/L	98.0	71.9	121
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	40 µg/L	94.0	72.3	122
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	20 µg/L	97.8	72.3	121
EP130A: Organophosphorus Pesticides (Ultra-trace) (QCLot: 528413)								
EP130: Bromophos-ethyl	4824-78-6	0.10	µg/L	<0.10	1.0 µg/L	78.2	35.4	143
EP130: Carbophenothion	786-19-6	0.10	µg/L	<0.10	1.0 µg/L	77.5	5.13	171
EP130: Chlorfenvinphos (Z)	470-90-8	0.10	µg/L	<0.10	0.9 µg/L	86.1	44.6	155
EP130: Chlorpyrifos	2921-88-2	0.050	µg/L	<0.050	1.0 µg/L	82.5	38.5	145
EP130: Chlorpyrifos-methyl	5598-13-0	0.10	µg/L	<0.10	1.0 µg/L	86.1	40.3	135
EP130: Demeton-S-methyl	919-86-8	0.10	µg/L	<0.10	1.0 µg/L	83.3	20.7	178
EP130: Diazinon	333-41-5	0.10	µg/L	<0.10	1.0 µg/L	84.6	38.7	146
EP130: Dichlorvos	62-73-7	0.10	µg/L	<0.10	1.0 µg/L	97.7	18.4	151

Sub-Matrix: **WATER**

Method: Compound	CAS Number	Method Blank (MB) Report			Laboratory Control Spike (LCS) Report			
		LOR	Unit	Result	Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
						LCS	Low	High
EP130A: Organophosphorus Pesticides (Ultra-trace) (QCLot: 528413) - continued								
EP130: Dimethoate	60-51-5	0.10	µg/L	<0.10	1.0 µg/L	71.9	27.4	131
EP130: Ethion	563-12-2	0.10	µg/L	<0.10	1.0 µg/L	77.0	36.1	147
EP130: Fenamiphos	22224-92-6	0.10	µg/L	<0.10	1.0 µg/L	62.6	4.43	168
EP130: Fenthion	55-38-9	0.10	µg/L	<0.10	1.0 µg/L	82.1	23.2	145
EP130: Malathion	121-75-5	0.10	µg/L	<0.10	1.0 µg/L	82.2	40.7	136
EP130: Azinphos Methyl	86-50-0	0.10	µg/L	<0.10	1.0 µg/L	75.5	1.35	163
EP130: Monocrotophos	6923-22-4	0.10	µg/L	<0.10	1.0 µg/L	12.0	10	86.3
EP130: Parathion	56-38-2	0.10	µg/L	<0.10	1.0 µg/L	83.8	35.5	141
EP130: Parathion-methyl	298-00-0	0.10	µg/L	<0.10	1.0 µg/L	87.0	31.1	144
EP130: Pirimphos-ethyl	23505-41-1	0.10	µg/L	<0.10	1.0 µg/L	72.2	38.9	142
EP130: Prothiofos	34643-46-4	0.10	µg/L	<0.10	1.0 µg/L	80.0	40	138
EP131A: Organochlorine Pesticides (QCLot: 528412)								
EP131A: Aldrin	309-00-2	0.010	µg/L	<0.010	0.1 µg/L	78.3	35.8	139
EP131A: alpha-BHC	319-84-6	0.010	µg/L	<0.010	0.1 µg/L	64.0	19.7	153
EP131A: beta-BHC	319-85-7	0.010	µg/L	<0.010	0.1 µg/L	80.8	43.8	136
EP131A: delta-BHC	319-86-8	0.010	µg/L	<0.010	0.1 µg/L	78.6	37.4	144
EP131A: 4.4'-DDD	72-54-8	0.010	µg/L	<0.010	0.1 µg/L	85.0	37.5	145
EP131A: 4.4'-DDE	72-55-9	0.010	µg/L	<0.010	0.1 µg/L	81.5	30.5	146
EP131A: 4.4'-DDT	50-29-3	0.010	µg/L	<0.010	0.1 µg/L	86.8	31	151
EP131A: DDT (total)	---	0.010	µg/L	<0.010	---	---	---	---
EP131A: Dieldrin	60-57-1	0.010	µg/L	<0.010	0.1 µg/L	87.2	34.4	145
EP131A: alpha-Endosulfan	959-98-8	0.010	µg/L	<0.010	0.1 µg/L	76.5	30.2	141
EP131A: beta-Endosulfan	33213-65-9	0.010	µg/L	<0.010	0.1 µg/L	91.9	30.3	148
EP131A: Endosulfan sulfate	1031-07-8	0.010	µg/L	<0.010	0.1 µg/L	83.6	19.1	150
EP131A: Endosulfan (sum)	115-29-7	0.010	µg/L	<0.010	---	---	---	---
EP131A: Endrin	72-20-8	0.010	µg/L	<0.010	0.1 µg/L	105	13	165
EP131A: Endrin aldehyde	7421-93-4	0.010	µg/L	<0.010	0.1 µg/L	74.9	28.3	134
EP131A: Endrin ketone	53494-70-5	0.010	µg/L	<0.010	0.1 µg/L	76.1	15.1	146
EP131A: Heptachlor	76-44-8	0.005	µg/L	<0.005	0.1 µg/L	76.4	33.2	148
EP131A: Heptachlor epoxide	1024-57-3	0.010	µg/L	<0.010	0.1 µg/L	74.6	36	143
EP131A: Hexachlorobenzene (HCB)	118-74-1	0.010	µg/L	<0.010	0.1 µg/L	62.6	14	146
EP131A: gamma-BHC	58-89-9	0.010	µg/L	<0.010	0.1 µg/L	67.2	27.2	147
EP131A: Methoxychlor	72-43-5	0.010	µg/L	<0.010	0.1 µg/L	82.6	34.4	150
EP131A: cis-Chlordane	5103-71-9	0.010	µg/L	<0.010	0.1 µg/L	78.6	15.4	152

Sub-Matrix: **WATER**

Method: Compound	CAS Number	Method Blank (MB) Report			Laboratory Control Spike (LCS) Report			
		LOR	Unit	Result	Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
						LCS	Low	High
EP131A: Organochlorine Pesticides (QCLot: 528412) - continued								
EP131A: trans-Chlordane	5103-74-2	0.010	µg/L	<0.010	0.1 µg/L	81.0	45.1	140
EP131A: Total Chlordane (sum)	---	0.010	µg/L	<0.010	---	---	---	---

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	Spike Recovery (%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 531440)							
EP0705200-001	MB01	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	108	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	101	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	106	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	101	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	104	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	99.0	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	103	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 528260)							
EB0712792-013	Anonymous	EG035F: Mercury	7439-97-6	Anonymous	Anonymous	Anonymous	Anonymous
EP080/071: Total Petroleum Hydrocarbons (QCLot: 533833)							
EP0705167-006	Anonymous	EP080: C6 - C9 Fraction	---	Anonymous	Anonymous	Anonymous	Anonymous
EP080: BTEX (QCLot: 533833)							
EP0705167-006	Anonymous	EP080: Benzene	71-43-2	Anonymous	Anonymous	Anonymous	Anonymous
		EP080: Toluene	108-88-3	Anonymous	Anonymous	Anonymous	Anonymous

Environmental Division

INTERPRETIVE QUALITY CONTROL REPORT

Work Order	: **EP0705200**	Page	: 1 of 6
Client	: ACE ENVIRONMENTAL PTY LTD	Laboratory	: Environmental Division Perth
Contact	: MS GINA PEMBERTON	Contact	: Michael Sharp
Address	: SHOP 17/2 SOUTH WESTERN HIGHWAY ARMADALE WA AUSTRALIA 6112	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: gina@aceenvironmental.com.au	E-mail	: Shaun.Crabb@alsenviro.com
Telephone	: +61 08 9497 5000	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: J07030	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Site	: ----		
C-O-C number	: ----	Date Samples Received	: 02-NOV-2007
Sampler	: G.P	Issue Date	: 21-NOV-2007
Order number	: ----		
		No. of samples received	: 7
Quote number	: EN-062-07	No. of samples analysed	: 7

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Interpretive Quality Control Report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Parameter Frequency Compliance
- Brief Method Summaries
- Summary of Outliers

Analysis Holding Time Compliance

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and precludes subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the analysis aliquot was taken. Elapsed period to analysis represents number of days from sampling where no extraction / digestion is involved or period from extraction / digestion where this is present. For composite samples, sampling date is assumed to be that of the oldest sample contributing to the composite. Sample date for laboratory produced leachates is assumed as the completion date of the leaching process. Outliers for holding time are based on USEPA SW 846, APHA, AS and NEPM (1999). A listing of breaches is provided in the Summary of Outliers.

Holding times for leachate methods (excluding elutriates) vary according to the analytes being determined on the resulting solution. For non-volatile analytes, the holding time compliance assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These soil holding times are: Organics (14 days); Mercury (28 days) & other metals (180 days). A recorded breach therefore does not guarantee a breach for all non-volatile parameters.

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Filtered; Lab-acidified MB01, MB02, MB03, MB04, MB05, MB06, QA1	**31-OCT-2007**	---	---	---	**12-NOV-2007**	28-APR-2008	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Filtered; Lab-acidified MB01, MB02, MB03, MB04, MB05, MB06, QA1	**31-OCT-2007**	---	---	---	**12-NOV-2007**	28-NOV-2007	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved MB01, MB02, MB03, MB04, MB05, MB06, QA1	**31-OCT-2007**	**07-NOV-2007**	07-NOV-2007	✓	**08-NOV-2007**	18-DEC-2007	✓
Amber VOC Vial - HCl or NaHSO4 MB01, MB02, MB03, MB04, MB05, MB06, QA1	**31-OCT-2007**	---	---	---	**14-NOV-2007**	14-NOV-2007	✓
EP080: BTEX							
Amber VOC Vial - HCl or NaHSO4 MB01, MB02, MB03, MB04, MB05, MB06, QA1	**31-OCT-2007**	---	---	---	**14-NOV-2007**	14-NOV-2007	✓

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP130A: Organophosphorus Pesticides (Ultra-trace)							
Amber Glass Bottle - Unpreserved							
MB01, MB02, MB03, MB04, MB05, MB06, QA1	**31-OCT-2007**	**07-NOV-2007**	07-NOV-2007	✓	**13-NOV-2007**	18-DEC-2007	✓
EP131A: Organochlorine Pesticides							
Amber Glass Bottle - Unpreserved							
MB01, MB02, MB03, MB04, MB05, MB06, QA1	**31-OCT-2007**	**07-NOV-2007**	07-NOV-2007	✓	**13-NOV-2007**	18-DEC-2007	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(where) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Matrix: **WATER**

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
Analytical Methods		QC	Regular	Actual	Expected	Evaluation	
Laboratory Duplicates (DUP)							
Dissolved Mercury by FIMS	EG035F	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH - Semivolatile Fraction	EP071	1	19	5.3	10.0	×	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH Volatiles/BTEX	EP080	2	20	10.0	10.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Dissolved Mercury by FIMS	EG035F	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Organochlorine Pesticides (Ultra-trace)	EP131A	1	11	9.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Organophosphorus Pesticides (Ultra-trace)	EP130	1	8	12.5	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH - Semivolatile Fraction	EP071	1	19	5.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH Volatiles/BTEX	EP080	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Dissolved Mercury by FIMS	EG035F	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Organochlorine Pesticides (Ultra-trace)	EP131A	1	11	9.1	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Organophosphorus Pesticides (Ultra-trace)	EP130	1	8	12.5	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH - Semivolatile Fraction	EP071	1	19	5.3	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
TPH Volatiles/BTEX	EP080	1	20	5.0	5.0	✓	NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Dissolved Mercury by FIMS	EG035F	1	20	5.0	5.0	✓	ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	5.0	5.0	✓	ALS QCS3 requirement
TPH Volatiles/BTEX	EP080	1	20	5.0	5.0	✓	ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	(APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	AS 3550, APHA 21st ed. 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
TPH - Semivolatile Fraction	EP071	WATER	USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
TPH Volatiles/BTEX	EP080	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Organophosphorus Pesticides (Ultra-trace)	EP130	WATER	USEPA Method 3640 (GPC cleanup), 8141 (GC/FPD - Capillary Column) This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)
Organochlorine Pesticides (Ultra-trace)	EP131A	WATER	USEPA Method 3640 (GPC cleanup),3620 (Florisil), 8081/8082 (GC/uECD/uECD). This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	USEPA SW 846 - 3510B 500 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2). ALS default excludes sediment which may be resident in the container.
Sep. Funnel Extraction of Liquids (Ultra-trace pesticides.)	ORG14-UTP	WATER	USEPA 3510 Samples are extracted into dichloromethane, concentrated and exchanged into an apporpriate solvent for GPC and florisil cleanup as required. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2). ALS default excludes sediment which may be resident in the container.

Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged in the Quality Control (QC) Report. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). This report displays QC Outliers (breaches) only.

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

- **For all matrices, no Method Blank value outliers occur.**
- **For all matrices, no Duplicate outliers occur.**
- **For all matrices, no Laboratory Control outliers occur.**
- **For all matrices, no Matrix Spike outliers occur.**

Regular Sample Surrogates

- **For all regular sample matrices, no surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

This report displays Holding Time breaches only. Only the respective Extraction / Preparation and/or Analysis component is/are displayed.

- **No Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

The following report highlights breaches in the Frequency of Quality Control Samples.

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
TPH - Semivolatile Fraction	1	19	5.3	10.0	NEPM 1999 Schedule B(3) and ALS QCS3 requirement

CHAIN OF CUSTODY DOCUMENTATION

CLIENT: Ace Environmental P/L
ADDRESS / OFFICE: Shop 17/2 South Western Highway, Armadale
PROJECT MANAGER (PM): Gina Pemberton
PROJECT ID: J07030
SITE:
P.O. NO:
RESULTS REQUIRED (Date): 5 days
QUOTE NO: EN/062/07

SAMPLER: G. Pemberton
MOBILE: 0439 948 545
PHONE: (08) 94975000
EMAIL REPORT TO: gina@aceenvironmental.com.au
EMAIL INVOICE TO (if different to report): Same as above

Australian Laboratory Services Pty Ltd

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: Yes No N/A
SAMPLE TEMPERATURE
CHILLED: Yes No

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL

ANALYSIS REQUIRED including SUITES (note - suite codes must be listed to attract suite prices)

Notes e.g. Highly contaminated samples
e.g. "High PAHs expected"
Extra volume for QC or trace LORs etc

ALS ID	SAMPLE ID	MATRIX	DATE	Time	Container Type / Code	Total bottles	W-5	W-5 ultra trace OC/OPs
1	MB01	W	31/10			5	✓	✓
2	MB02	↓	↓			↓	✓	✓
3	MB03						✓	✓
4	MB04						✓	✓
5	MB05						✓	✓
6	MB06						✓	✓
7	QA1						✓	✓

Environmental Division
Perth
Work Order
EP0705200

Telephone : +61-8-9209 7655

NB: Std 8 HMs in W-5, please do dissolved metals only. Not field filtered.

RELINQUISHED BY
Name: G. Pemberton
Of: Ace
Name
Of
Date: 2/11/07
Time: 1:00PM
Date
Time

RECEIVED BY
Name: Mike Jones
Of: ALSE
Name:
Of
Date: 2/11/07
Time: 13:32
Date
Time

METHOD OF SHIPMENT
Con' Note No:
Transport Co

Water Container Codes: P = Unpreserved Plastic, N = Nitric Preserved Plastic, ORC = Nitric Preserved ORC, SH = Sodium Hydroxide/Cd Preserved, S = Sodium Hydroxide Preserved Plastic, AG = Amber Glass Unpreserved,
V = VOA Vial HCl Preserved, VS = VOA Vial Sulphuric Preserved, SG = Sulfuric Preserved Amber Glass, H = HCl preserved Plastic, HS = HCl preserved Speciation bottle, SP = Sulfuric Preserved Plastic, F = Formaldehyde Preserved Glass,
Z = Zinc Acetate Preserved Bottle, E = EDTA Preserved Bottles, ST = Sterile Bottle, ASS = Plastic Bag for Acid Sulphate Soils, B = Unpreserved Bag

AUSTRALIAN LABORATORY SERVICES P/L

APPENDIX C

DEPARTMENT OF WATER CORRESPONDENCE

Government of **Western Australia**
Department of **Water**

looking after all our water needs

Your ref: 09.181 L001
Our ref: RF2130
Enquiries: Brett Dunn

6 October 2009

RECEIVED
9 OCT 2009
BY:.....

ENV Australia
PO Box 7480
PERTH WA 6850

Attn: Margaret Dunlop

Dear Margaret,

RE: PROPOSED HYDROLOGICAL MONITORING TO INFORM LOCAL WATER MANAGEMENT STRATEGY - DEVELOPMENT AREA 19, MURIEL COURT, COCKBURN

Thank you for you correspondence dated 2nd October 2009, regarding proposed hydrological monitoring to inform a Local Water Management Strategy (LWMS) for the abovementioned site.

Specifically, this proposal proposes to determine groundwater levels for the site based on 6 months site specific monitoring data (inclusive of a winter) and correlated to Department of Water's (DoW's) long term bore datasets to inform the LWMS. Monitoring will continue through the structure planning process and a minimum of 18 months site specific data will be collected to refine the estimated Maximum Groundwater Level (MGL).

The DoW wishes to advise it is satisfied with the above approach to inform the future LWMS.

If you wish to discuss the above please contact the DoW's Mandurah Office on (08) 9550 4222.

Yours Sincerely

For Adrian Parker
Program Manager – Urban Water Management
Kwinana Peel Region

Kwinana Peel Region
107 Breakwater Parade Mandurah Ocean Marina Mandurah Western Australia 6210
PO Box 332 Mandurah Western Australia 6210
Telephone (08) 9550 4222 Facsimile (08) 9581 4560
www.water.wa.gov.au
wa.gov.au

APPENDIX D

PRELIMINARY VEGETATION REPORT

City of Cockburn

Memorandum

To: **Allen Blood**

From: **Dave Bright**

Date: 1 November 2007

Re: **Vegetation Assessment of Muriel Court**

==========

Allen

All lots covered by the Muriel Court Structure Plan were desk-top assessed for remnant vegetation. This was followed by an on-ground vegetation survey, conducted during the period mid July to end of August 2007.

Whilst there were many lots that supported isolated native trees, only three areas contained remnant vegetation of any significance:

- Area 1 - Lot 39 Verna Court
- Area 2 - Lots 53, 54 and 56 Muriel Court
- Area 3 – Lots 80, 20, 21, 100, 101 and 102 Muriel Court, Lots 52, and 81 North Lake Road, Lots 53, 54, and 55 Tea Tree Close, and Lot 35 Kentucky Court

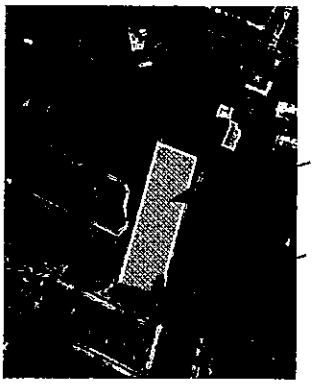
Area 1

The bushland on Lot 39 Verna Court is generally in poor to very poor condition. The original vegetation would probably have been Grasstree heathland, Xanthorrhoea preissii, with occasional Coastal Blackbutt, Eucalyptus todtiana and WA Christmas

Trees, Nuytsia floribunda. There are two small areas of slightly better ('fair') quality bushland at the southern end of the lot. It is recommended that the larger area be preserved although considerable weed control and some revegetation work will be required.

'Poor' condition bushland

'Fair' condition bushland



Has some ecological value but considerable weed control/reveg work is required

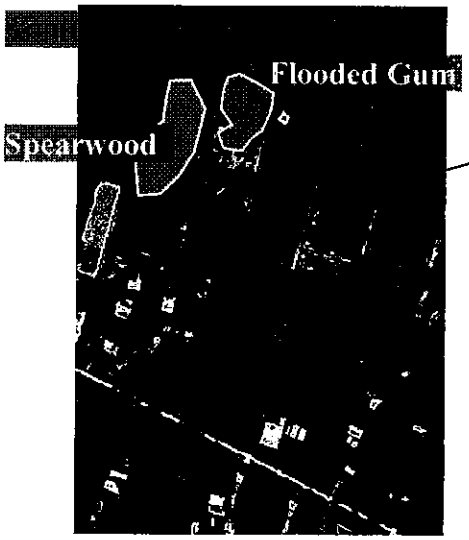
Recommend preserving although some weed control/reveg work is required

Area 2

The bushland on Lot 53 Muriel Court is a monoculture of Spearwood, *Kunzea glabrescens* with two Stout Paperbarks along the northern boundary. Whilst the core is in very good condition, the firebreaks are very wide and weedy. It has some ecological value and the Spearwood is fairly easy to restore, however there are better areas worth preserving.

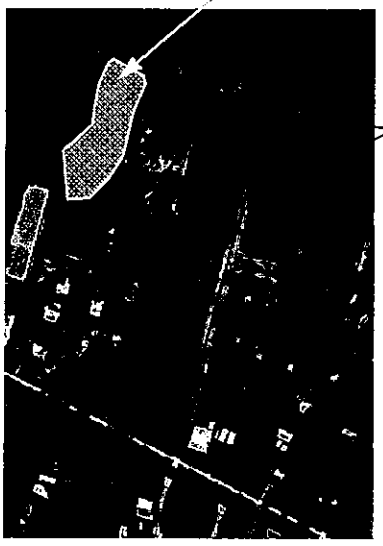
Lot 54 Muriel Court supports a monoculture of Flooded Gums, *Eucalyptus rudis,* comprising a stand of mature specimens near the northern boundary with saplings of several ages to the south. I consider these are worth preserving.

Lot 56 Muriel Court supports Heathland with Holly Banksia, *Banksia ilicifolia*. It has the highest diversity of all the remnants. I strongly recommend preserving this although some weed control/reveg work is required.



Very high diversity remnant

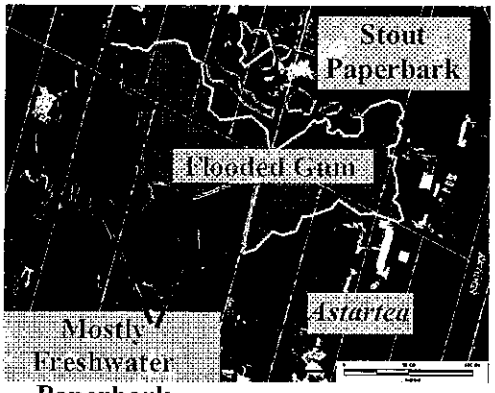
Has some ecological value however there are better areas worth preserving

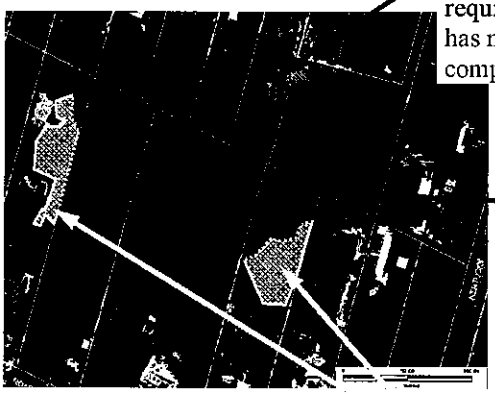


Strongly recommend preserving although some weed control/ reveg work is required

Area 3

Lots 80, 20, 21, 100, 101 and 102 Muriel Court, Lots 52, and 81 North Lake Road, Lots 53, 54, and 55 Tea Tree Close, and Lot 35 Kentucky Court support a large wetland remnant in 'fair' to 'good' condition. The wetland exhibits a degree of 'zoning', with Stout Paperbarks, *Melaleuca preissiana*, along the north western edge, Flooded Gum, *Eucalyptus rudis*, in the core and mostly Freshwater Paperbarks, *Melaleuca raphiophylla,* in the south eastern corner. There is very little native understorey; it having been replaced by grass (predominantly Kikuyu) and Arum Lily. Sydney Golden Wattle, *Acacia longifolia,* is the major woody weed.





Summary

It is recommended that priority be given to preserving the remnant bushland on Lots 54 and 56 Muriel Court, and the wetland remnant centred on Lot 52 North Lake Road and Lots 55 and 53 Tea Tree Close.

APPENDIX E

POST DEVELOPMENT WATER BALANCE

Muriel Court Water Balance Summary

Pre-Development	Drainage and Infiltration (ML/yr)
Pre Development	**164**

Post-Development	Drainage and Infiltration (ML/yr)
R20 Houses	10.06
R25 Houses	64.33
R40 Houses	26.60
R60 Houses	46.32
R80 Houses	43.74
R160 Apartment Blocks	55.77
Commercial	69.74
Irrigated POS	21.37
Non-irrigated POS	0.00
Roads and verges	147.27
POS and apartment block irrigation (from bores)	-77.18
Total recharge to groundwater and drains	**408.03**

% increase of recharge	**248.98**

Assumptions

Land areas are as provided by City of Cockburn, 17/11/2009
Local Centre is assumed to be commercial
Estimated area of garden = 65% of OS area for low density
Estimated area of garden = 45% of OS area for med density
Estimated area of garden = 30% of OS area for high density
Persons per house from Water Corporation (2007) quoting ABS (2001)
No lot drainage and no sub-surface drainage
Rain on Hard Surfaces is 4.5% Evap, 95.5% stormwater (WAWA, 1987)
Rain and irrigation has a 17.5% surface loss
Verge has been calculated as a scaled average based on average verge length per block and total verge area based on road reserve
References to GHD (2005) are to *Non-potable Water Use: Guidelines for developers and their consultants* (draft)
References to Water Authority of Western Australia (1987) are to *Perth Urban Water Balance Study: Volume 2 - Data Collection & Analysis Techniques*
References to Water Corporation (2007) are to *Water Supply Consumption Tool*
References to Davidson (1995) are to *Hydrogeology and Groundwater Resources of the Perth Region Western Australia*

Residential Density	Lot Density Code	Area (ha)	Area %	Number of Houses/Units	Persons per house	Avg Lot size (m^2)	Min % open space (OS)	Min area OS on average block (m^2)	Estimated area of house (m^2)	Estimated area of Hardstand (m^2)	Estimated area of Garden (m^2)	Total Hard surfaces (Ha)	Total Hard surfaces - not roof (Ha)
Low	R20	1.63	3.7	33	2.79	500	50	250	250	88	163	1.11	0.29
Low	R25	10.55	23.6	301	2.79	350	50	175	175	61	114	7.11	1.84
Medium	R40	4.10	9.2	186	1.73	220	45	99	121	54	45	3.26	1.01
Medium	R60	8.57	20.8	476	1.73	180	45	81	99	45	36	6.83	2.12
High	R80	6.92	17.1	554	1.48	125	60	75	50	53	23	5.68	2.91
High	R160	8.83	25.6	1413	1.48	63	60	38	25	26	11	7.24	3.71
Total (where applicable)		40.60	100.0	2963								31.24	11.88

Rainfall as per Jandakot, 1972 - 2009, Evaporation as per Medina 1983 -2009

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Totals*
Monthly Rainfall (mm)	14.2	17.3	15.7	43.1	108.3	163.8	180.3	126.4	86.1	47.7	29.5	9.7	832.2
Monthly Evaporation (mm)	260.4	221.2	192.2	117	74.4	54	55.8	71.3	96	145.7	195	241.8	1724.8
Rainfall - Evaporation (mm)	-246	-204	-177	-74	34	110	125	55	-10	-98	-166	-232	-883

Commercial	Lot Area (m^2)	Roof Area (m^2)	Garden (m^2)	Hardstand (m^2)
Commercial	96,200	76,960	9,620	9,620
Total Commercial	**96,200**	**76,960**	**9,620**	**9,620**

Other	ha	m^2	
Irrigated POS	6.820	68,200	
Bush and Wetland	0	0	
Total POS	6.820	68,200	
Road Reserve	21.730	217,300	
Road Reserve as Road	15.646	156,456	
Road Reserve as verge	6.084	60,844	28% of road reserve from WAPC road design criteria
School	0.000	0	
Total Area	78.770	787,700	

Number of dwellings	2963

Pre-clearing water balance

Bushland, assuming 25% of rainfall becomes recharge (as per Davidson, 1995)

Total rainfall for site	655,524	kL/yr for site
Total flow to groundwater and drains	163,881	kL/yr for site
	164	ML/yr for site

Total Recharge to groundwater from R20 Households Irrigation and Household runoff.

Assumes that household irrigation includes non-swale verges, calculated as per assumptions sheet
Epot=0.7*Pan Evaporation

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*	
A	Monthly Rainfall (mm)	14.2	17.3	15.7	43.1	108.3	163.8	180.3	126.4	86.1	47.7	29.5	9.7	842.1	
B	Monthly Evaporation (mm)	260.4	221.2	192.2	117.0	74.4	54.0	55.8	71.3	96.0	145.7	195.0	241.8	1724.8	
C	Evap-Trans (mm)	182.3	154.8	134.5	81.9	52.1	37.8	39.1	49.9	67.2	102.0	136.5	169.3	1207.4	
D	GHD (2005)- gives ratios over an annual basis (ex-house Single) (L/house/day)	911	911	841	561	280	140	35	35	70	351	771	911	484.75	
D	Irrigation in this subdivision (L/house/day)	611	611	564	376	188	94	23	23	47	235	517	611	325.00	Garden Irrigation of 2L per m2 per day (Water Corporation, 2007)
E	Irrigation kL/house/month	18.93	17.10	17.48	11.28	5.82	2.82	0.73	0.73	1.41	7.30	15.51	18.93	118.03	
F	Garden Rainfall (kL/house/month)	2.31	2.81	2.55	7.00	17.60	26.62	29.30	20.54	13.99	7.75	4.79	1.58	136.84	
G	Roof splash (10% of rain falling on roofs)	0.36	0.43	0.39	1.08	2.71	4.10	4.51	3.16	2.15	1.19	0.74	0.24	21.05	
H	Paving runoff	1.19	1.45	1.31	3.60	9.05	13.69	15.07	10.56	7.19	3.99	2.47	0.81	70.37	
I	Total input to gardens	22.78	21.79	21.73	22.97	35.18	47.22	49.60	34.99	24.75	20.22	23.50	21.56	346.30	
J	Surface evaporation and interception losses	3.99	3.81	3.80	4.02	6.16	8.26	8.68	6.12	4.33	3.54	4.11	3.77	60.60	
K	Total input - surface evap	18.80	17.98	17.93	18.95	29.02	38.95	40.92	28.87	20.42	16.69	19.39	17.79	285.69	
L	Potential Evap for area	29.62	25.16	21.86	13.31	8.46	6.14	6.35	8.11	10.92	16.57	22.18	27.50	196.20	
M	Total input - potential evap	-10.82	-7.18	-3.93	5.64	20.56	32.81	34.57	20.76	9.50	0.11	-2.79	-9.71	89.50	
N	Therefore infiltration to groundwater from gardens(kL/house)	0.00	0.00	0.00	5.64	20.56	32.81	34.57	20.76	9.50	0.11	0.00	0.00	123.94	
O	**TOTAL GARDEN INFILTRATION FOR R20 LOTS**	0	0	0	186	678	1083	1141	685	313	4	0	0	**4090**	
P	Water to soakwells or drains from roof (kL/house/month)	3.1	3.7	3.4	9.3	23.3	35.2	38.7	27.2	18.5	10.2	6.3	2.1	180.95	Assumes paving runoff flows to garden rather than drains
P1	Wastewater infiltrated on site (kL/house/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	houses not on septics therefore n/a
Q	**TOTAL SOAKWELL OR DRAIN INFILTRATION FOR R20 LOTS (kL)**	101	123	111	306	768	1161	1278	896	611	338	209	69	**5971**	
R	**Total Irrigation Water Use for R20 Lots (kL)**	625	564	577	372	192	93	24	24	46	241	512	625	**3895**	

Total Recharge to groundwater from R25 Households Irrigation and Household runoff. Excludes Swales

Assumes that household irrigation includes non-swale verges, calculated as per assumptions sheet
Epot=0.7*Pan Evaporation

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*	
A	Monthly Rainfall (mm)	14.2	17.3	15.7	43.1	108.3	163.8	180.3	126.4	86.1	47.7	29.5	9.7	842.1	
B	Monthly Evaporation (mm)	260.4	221.2	192.2	117.0	74.4	54.0	55.8	71.3	96.0	145.7	195.0	241.8	1724.8	
C	Evap-Trans (mm)	182.3	154.8	134.5	81.9	52.1	37.8	39.1	49.9	67.2	102.0	136.5	169.3	1207.4	
D	GHD (2005)- gives ratios over an annual basis (ex-house Single) (L/house/day)	911	911	841	561	280	140	35	35	70	351	771	911	484.75	
D	Irrigation in this subdivision (L/house/day)	428	428	395	263	131	66	16	16	33	165	362	428	227.50	Garden Irrigation of 2L per m2 per day (Water Corporation, 2007)
E	Irrigation kL/house/month	13.25	13.25	12.24	8.16	4.07	2.04	0.51	0.51	1.02	5.11	11.22	13.25	84.63	
F	Garden Rainfall (kL/house/month)	1.62	1.97	1.79	4.90	12.32	18.63	20.51	14.38	9.79	5.43	3.36	1.10	95.79	
G	Roof splash (10% of rain falling on roofs)	0.25	0.30	0.27	0.75	1.90	2.87	3.16	2.21	1.51	0.83	0.52	0.17	14.74	
H	Paving runoff	0.83	1.01	0.92	2.52	6.33	9.58	10.55	7.39	5.04	2.79	1.73	0.57	49.26	
I	Total input to gardens	15.95	16.54	15.21	16.34	24.62	33.12	34.72	24.49	17.36	14.16	16.81	15.09	244.41	
J	Surface evaporation and interception losses	2.79	2.89	2.66	2.86	4.31	5.80	6.08	4.29	3.04	2.48	2.94	2.64	42.77	
K	Total input - surface evap	13.16	13.64	12.55	13.48	20.31	27.32	28.64	20.21	14.32	11.68	13.87	12.45	201.64	
L	Potential Evap for area	20.73	17.61	15.30	9.32	5.92	4.30	4.44	5.68	7.64	11.60	15.53	19.25	137.34	
M	Total input - potential evap	-7.58	-3.97	-2.75	4.16	14.39	23.02	24.20	14.53	6.67	0.08	-1.65	-6.80	64.30	
N	Therefore infiltration to groundwater from gardens(kL/house)	0.00	0.00	0.00	4.16	14.39	23.02	24.20	14.53	6.67	0.08	0.00	0.00	87.06	
O	**TOTAL GARDEN INFILTRATION FOR R20 LOTS**	0	0	0	1253	4331	6930	7284	4373	2009	24	0	0	**26,205**	
P	Water to soakwells or drains from roof (kL/house/month)	2.1	2.6	2.4	6.5	16.3	24.6	27.1	19.0	13.0	7.2	4.4	1.5	126.66	Assumes paving runoff flows to garden rather than drains
P1	Wastewater infiltrated on site (kL/house/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	houses not on septics therefore n/a
Q	**TOTAL SOAKWELL OR DRAIN INFILTRATION FOR R25 LOTS (kL)**	643	783	711	1951	4903	7416	8163	5723	3898	2160	1336	439	**38,125**	
R	**Total Irrigation Water Use for R25 Lots (kL)**	3989	3989	3683	2457	1226	613	153	153	307	1537	3376	3989	**25,474**	

Total Recharge to groundwater from R40 Households Irrigation and Household runoff. Excludes Swales

Assumes that household irrigation includes non-swale verges, calculated as per assumptions sheet
Epot=0.7*Pan Evaporation

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*	
A	Monthly Rainfall (mm)	14.2	17.3	15.7	43.1	108.3	163.8	180.3	126.4	86.1	47.7	29.5	9.7	842.1	
B	Monthly Evaporation (mm)	260.4	221.2	192.2	117.0	74.4	54.0	55.8	71.3	96.0	145.7	195.0	241.8	1724.8	
C	Evap-Trans (mm)	182.3	154.8	134.5	81.9	52.1	37.8	39.1	49.9	67.2	102.0	136.5	169.3	1207.4	
D	GHD (2005)- gives ratios over an annual basis (ex-house Single) (L/house/day)	911	911	841	561	280	140	35	35	70	351	771	911	484.75	
D	Irrigation in this subdivision (L/house/day)	167	167	155	103	51	26	6	6	13	65	142	167	89.10	Garden Irrigation of 2L per m2 per day (Water Corporation, 2007)
E	Irrigation kL/house/month	5.19	4.69	4.79	3.09	1.60	0.77	0.20	0.20	0.39	2.00	4.25	5.19	32.36	
F	Garden Rainfall (kL/house/month)	0.63	0.77	0.70	1.92	4.82	7.30	8.03	5.63	3.84	2.13	1.31	0.43	37.52	
G	Roof splash (10% of rain falling on roofs)	0.17	0.21	0.19	0.52	1.31	1.98	2.18	1.53	1.04	0.58	0.36	0.12	10.19	
H	Paving runoff	0.74	0.90	0.82	2.24	5.63	8.52	9.38	6.57	4.48	2.48	1.53	0.50	43.79	
I	Total input to gardens	6.73	6.57	6.50	7.78	13.36	18.57	19.79	13.93	9.74	7.18	7.46	6.24	123.85	
J	Surface evaporation and interception losses	1.18	1.15	1.14	1.36	2.34	3.25	3.46	2.44	1.70	1.26	1.30	1.09	21.67	
K	Total input - surface evap	5.56	5.42	5.36	6.42	11.02	15.32	16.33	11.49	8.04	5.93	6.15	5.15	102.18	
L	Potential Evap for area	8.12	6.90	5.99	3.65	2.32	1.68	1.74	2.22	2.99	4.54	6.08	7.54	53.79	
M	Total input - potential evap	-2.57	-1.48	-0.63	2.77	8.70	13.64	14.59	9.27	5.04	1.38	0.07	-2.39	48.39	
N	Therefore infiltration to groundwater from gardens(kL/house)	0.00	0.00	0.00	2.77	8.70	13.64	14.59	9.27	5.04	1.38	0.07	0.00	55.46	
O	**TOTAL GARDEN INFILTRATION FOR R40 LOTS**	0	0	0	515	1619	2536	2713	1724	938	257	13	0	**10,315**	
P	Water to soakwells or drains from roof (kL/house/month)	1.5	1.8	1.6	4.5	11.3	17.0	18.8	13.1	9.0	5.0	3.1	1.0	87.58	Assumes paving runoff flows to garden rather than drains
P1	Wastewater infiltrated on site (kL/house/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	houses not on septics therefore n/a
Q	**TOTAL SOAKWELL OR DRAIN INFILTRATION FOR R40 LOTS (kL)**	275	335	304	834	2095	3169	3488	2445	1666	923	571	188	**16,290**	
R	**Total Irrigation Water Use for R40 Lots (kL)**	966	872	891	575	297	144	37	37	72	372	791	966	**6,019**	

Total Recharge to groundwater from R60 Households Irrigation and Household runoff

Assumes that household irrigation includes non-swale verges, calculated as per assumptions sheet
Epot=0.7*Pan Evaporation

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*	
A	Monthly Rainfall (mm)	14.2	17.3	15.7	43.1	108.3	163.8	180.3	126.4	86.1	47.7	29.5	9.7	842.1	
B	Monthly Evaporation (mm)	260.4	221.2	192.2	117.0	74.4	54.0	55.8	71.3	96.0	145.7	195.0	241.8	1724.8	
C	Evap-Trans (mm)	182.3	154.8	134.5	81.9	52.1	37.8	39.1	49.9	67.2	102.0	136.5	169.3	1207.4	
D	GHD (2005)- gives ratios over an annual basis (ex-house Single) (L/house/day)	911	911	841	561	280	140	35	35	70	351	771	911	484.75	
D	Irrigation in this subdivision (L/house/day)	137	137	126	84	42	21	5	5	11	53	116	137	72.90	Garden Irrigation of 2L per m2 per day (Water Corporation, 2007)
E	Irrigation kL/house/month	4.25	3.84	3.92	2.53	1.31	0.63	0.16	0.16	0.32	1.64	3.48	4.25	26.48	
F	Garden Rainfall (kL/house/month)	0.52	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	6.37	
G	Roof splash (10% of rain falling on roofs)	0.14	0.17	0.16	0.43	1.07	1.62	1.78	1.25	0.85	0.47	0.29	0.10	8.34	
H	Paving runoff	0.60	0.74	0.67	1.83	4.61	6.97	7.67	5.38	3.66	2.03	1.26	0.41	35.83	
I	Total input to gardens	5.51	5.28	5.28	5.32	7.52	9.75	10.15	7.32	5.36	4.67	5.56	5.29	77.01	
J	Surface evaporation and interception losses	0.96	0.92	0.92	0.93	1.32	1.71	1.78	1.28	0.94	0.82	0.97	0.93	13.48	
K	Total input - surface evap	4.55	4.35	4.35	4.39	6.20	8.05	8.37	6.04	4.42	3.85	4.59	4.36	63.53	
L	Potential Evap for area	6.64	5.64	4.90	2.99	1.90	1.38	1.42	1.82	2.45	3.72	4.98	6.17	44.01	
M	Total input - potential evap	-2.10	-1.29	-0.55	1.41	4.30	6.67	6.95	4.22	1.98	0.14	-0.39	-1.81	19.53	
N	Therefore infiltration to groundwater from gardens(kL/house)	0.00	0.00	0.00	1.41	4.30	6.67	6.95	4.22	1.98	0.14	0.00	0.00	25.66	
O	**TOTAL GARDEN INFILTRATION FOR R60 LOTS**	0	0	0	670	2048	3175	3309	2010	940	64	0	0	**12,217**	
P	Water to soakwells or drains from roof (kL/house/month)	1.2	1.5	1.3	3.7	9.2	13.9	15.3	10.8	7.3	4.1	2.5	0.8	71.65	Assumes paving runoff flows to garden rather than drains
P1	Wastewater infiltrated on site (kL/house/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	houses not on septics therefore n/a
Q	**TOTAL SOAKWELL OR DRAIN INFILTRATION FOR R60 LOTS (kL)**	575	701	636	1746	4386	6634	7303	5120	3487	1932	1195	393	**34,108**	
R	**Total Irrigation Water Use for R60 Lots (kL)**	2022	1826	1866	1205	621	301	78	78	150	779	1656	2022	**12,603**	

Total Recharge to groundwater from R80 Households Irrigation and Household runoff.

Assumes that household irrigation includes non-swale verges, calculated as per assumptions sheet
Epot=0.7*Pan Evaporation

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*	
A	Monthly Rainfall (mm)	14.2	17.3	15.7	43.1	108.3	163.8	180.3	126.4	86.1	47.7	29.5	9.7	842.1	
B	Monthly Evaporation (mm)	260.4	221.2	192.2	117.0	74.4	54.0	55.8	71.3	96.0	145.7	195.0	241.8	1724.8	
C	Evap-Trans (mm)	182.3	154.8	134.5	81.9	52.1	37.8	39.1	49.9	67.2	102.0	136.5	169.3	1207.4	
D	GHD (2005)- gives ratios over an annual basis (ex-house Single) (L/house/day)	911	911	841	561	280	140	35	35	70	351	771	911	484.75	
D	Irrigation in this subdivision (L/house/day)	85	85	78	52	26	13	3	3	6	33	72	85	45.00	Garden Irrigation of 2L per m2 per day (Water Corporation, 2007)
E	Irrigation kL/house/month	2.62	2.37	2.42	1.56	0.81	0.39	0.10	0.10	0.19	1.01	2.15	2.62	16.34	
F	Garden Rainfall (kL/house/month)	0.32	0.39	0.35	0.97	2.44	3.69	4.06	2.84	1.94	1.07	0.66	0.22	18.95	
G	Roof splash (10% of rain falling on roofs)	0.07	0.09	0.08	0.22	0.54	0.82	0.90	0.63	0.43	0.24	0.15	0.05	4.21	
H	Paving runoff	0.71	0.87	0.79	2.16	5.43	8.21	9.04	6.34	4.32	2.39	1.48	0.49	42.22	
I	Total input to gardens	3.72	3.71	3.64	4.91	9.21	13.11	14.10	9.91	6.88	4.71	4.44	3.37	81.72	
J	Surface evaporation and interception losses	0.65	0.65	0.64	0.86	1.61	2.29	2.47	1.73	1.20	0.82	0.78	0.59	14.30	
K	Total input - surface evap	3.07	3.06	3.00	4.05	7.60	10.81	11.63	8.18	5.68	3.89	3.66	2.78	67.42	
L	Potential Evap for area	4.10	3.48	3.03	1.84	1.17	0.85	0.88	1.12	1.51	2.29	3.07	3.81	27.17	
M	Total input - potential evap	-1.03	-0.42	-0.02	2.21	6.43	9.96	10.75	7.06	4.16	1.59	0.59	-1.02	40.25	
N	Therefore infiltration to groundwater from gardens(kL/house)	0.00	0.00	0.00	2.21	6.43	9.96	10.75	7.06	4.16	1.59	0.59	0.00	42.76	
O	**TOTAL GARDEN INFILTRATION FOR R80 LOTS**	0	0	0	1223	3562	5519	5957	3909	2307	883	327	0	**23,686**	
P	Water to soakwells or drains from roof (kL/house/month)	0.6	0.7	0.7	1.9	4.7	7.0	7.7	5.4	3.7	2.0	1.3	0.4	36.19	Assumes paving runoff flows to garden rather than drains
P1	Wastewater infiltrated on site (kL/house/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	houses not on septics therefore n/a
Q	**TOTAL SOAKWELL OR DRAIN INFILTRATION FOR R80 LOTS (kL)**	338	412	374	1026	2578	3900	4293	3009	2050	1136	702	231	**20,049**	
R	**Total Irrigation Water Use for R80 Lots (kL)**	1452	1312	1341	866	446	216	56	56	108	560	1190	1452	**9,054**	

Total Recharge to groundwater from R160 Households Irrigation and Household runoff.

Assumes that household irrigation includes non-swale verges, calculated as per assumptions sheet
Epot=0.7*Pan Evaporation

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*	
A	Monthly Rainfall (mm)	14.2	17.3	15.7	43.1	108.3	163.8	180.3	126.4	86.1	47.7	29.5	9.7	842.1	
B	Monthly Evaporation (mm)	260.4	221.2	192.2	117.0	74.4	54.0	55.8	71.3	96.0	145.7	195.0	241.8	1724.8	
C	Evap-Trans (mm)	182.3	154.8	134.5	81.9	52.1	37.8	39.1	49.9	67.2	102.0	136.5	169.3	1207.4	
D	GHD (2005)- gives ratios over an annual basis (ex-house Single) (L/house/day)	911	911	841	561	280	140	35	35	70	351	771	911	484.75	
D	Irrigation in this subdivision (L/house/day)	42	42	39	26	13	6	2	2	3	16	36	42	22.50	Garden Irrigation of 2L per m2 per day (Water Corporation, 2007)
E	Irrigation kL/house/month	1.31	1.18	1.21	0.78	0.40	0.19	0.05	0.05	0.10	0.51	1.07	1.31	8.17	
F	Garden Rainfall (kL/house/month)	0.16	0.19	0.18	0.48	1.22	1.84	2.03	1.42	0.97	0.54	0.33	0.11	9.47	
G	Roof splash (10% of rain falling on roofs)	0.04	0.04	0.04	0.11	0.27	0.41	0.45	0.32	0.22	0.12	0.07	0.02	2.11	
H	Paving runoff	0.36	0.43	0.39	1.08	2.71	4.11	4.52	3.17	2.16	1.20	0.74	0.24	21.11	
I	Total input to gardens	1.86	1.86	1.82	2.45	4.61	6.55	7.05	4.96	3.44	2.36	2.22	1.69	40.86	
J	Surface evaporation and interception losses	0.33	0.32	0.32	0.43	0.81	1.15	1.23	0.87	0.60	0.41	0.39	0.30	7.15	
K	Total input - surface evap	1.54	1.53	1.50	2.02	3.80	5.41	5.82	4.09	2.84	1.94	1.83	1.39	33.71	
L	Potential Evap for area	2.05	1.74	1.51	0.92	0.59	0.43	0.44	0.56	0.76	1.15	1.54	1.90	13.58	
M	Total input - potential evap	-0.51	-0.21	-0.01	1.10	3.21	4.98	5.38	3.53	2.08	0.80	0.29	-0.51	20.13	
N	Therefore infiltration to groundwater from gardens(kL/house)	0.00	0.00	0.00	1.10	3.21	4.98	5.38	3.53	2.08	0.80	0.29	0.00	21.38	
O	**TOTAL GARDEN INFILTRATION FOR R160 LOTS**	0	0	0	1559	4543	7039	7597	4985	2942	1126	417	0	**30,206**	
P	Water to soakwells or drains from roof (kL/house/month)	0.3	0.4	0.3	0.9	2.3	3.5	3.9	2.7	1.9	1.0	0.6	0.2	18.09	Assumes paving runoff flows to garden rather than drains
P1	Wastewater infiltrated on site (kL/house/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	houses not on septics therefore n/a
Q	**TOTAL SOAKWELL OR DRAIN INFILTRATION FOR R160 LOTS (kL)**	431	525	477	1,309	3,288	4,973	5,474	3,838	2,614	1,448	896	295	**25,568**	
R	**Total Irrigation Water Use for R160 LOTS (kL)**	1,852	1,673	1,710	1,104	569	275	71	71	138	714	1,517	1,852	**11,546**	

Total Recharge to groundwater from Commerical areas

Includes both irrigation and rainfall
It is assumed that total commercial consumption is 0.800 kL/m^{2}GLA/year (Water Corporation, 2007)
Roof area is assumed to be equivalent to GLA.
Irrigation for the commercial area is 5% of total consumption (Water Corporation, 2007)
Epot=0.7*Pan Evaporation

Assumes that household irrigation includes non-swale verges, calculated as per assumptions sheet
A Epot=0.7*Pan Evaporation
B

D		*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*
E	Monthly Rainfall (mm)	14.6	17.7	15.1	42.9	108.7	163.8	180.3	126.4	86.1	47.7	29.4	10.0	842.7
F	Monthly Evaporation (mm)	260.4	221.2	192.2	117.0	74.4	54.0	55.8	71.3	96.0	145.7	195.0	241.8	1724.8
G	Evap-Trans (mm)	182.3	154.8	134.5	81.9	52.1	37.8	39.1	49.9	67.2	102.0	136.5	169.3	1207.4
H	GHD (2005)- gives ratios over an annual basis (ex-house Single) (L/house/day)	911	911	841	561	280	140	35	35	70	351	771	911	484.75
I	Irrigation in this subdivision (L/day)	36158	36158	33380	22266	11113	5557	1389	1389	2778	13931	30601	36158	19240.00
J	Irrigation kL/house/month	1120.90	1120.90	1034.77	690.26	344.51	172.26	43.06	43.06	86.13	431.87	948.64	1120.90	7157.28
K	Garden Rainfall (kL/house/month)	140.45	170.27	145.26	412.70	1045.69	1575.76	1734.49	1215.97	828.28	458.87	282.83	96.20	8106.77
L	Roof splash (10% of rain falling on roofs)	112.36	136.22	116.21	330.16	836.56	1260.60	1387.59	972.77	662.63	367.10	226.26	76.96	6485.42
M	Paving runoff	134.13	162.61	138.73	394.13	998.64	1504.85	1656.43	1161.25	791.01	438.22	270.10	91.87	7741.97
N	Total input to gardens	1507.85	1590.01	1434.97	1827.24	3225.40	4513.46	4821.57	3393.06	2368.05	1696.07	1727.84	1385.93	29491.44
O	Surface evaporation and interception losses	263.87	278.25	251.12	319.77	564.45	789.86	843.78	593.78	414.41	296.81	302.37	242.54	5161.00
P	Total input - surface evap	1243.97	1311.75	1183.85	1507.47	2660.96	3723.61	3977.80	2799.27	1953.64	1399.26	1425.46	1143.39	24330.44
Q	Potential Evap for area	1753.53	1489.56	1294.27	787.88	501.01	363.64	375.76	480.13	646.46	981.14	1313.13	1628.28	11614.80
	Total input - potential evap	-509.56	-177.81	-110.42	719.60	2159.95	3359.97	3602.04	2319.14	1307.17	418.11	112.33	-484.89	12715.64
	Therefore infiltration to groundwater from gardens(kL/house)	0.00	0.00	0.00	719.60	2159.95	3359.97	3602.04	2319.14	1307.17	418.11	112.33	0.00	13998.32
	TOTAL GARDEN INFILTRATION FOR COMMERCIAL LOTS	0	0	0	720	2160	3360	3602	2319	1307	418	112	0	**13,998**
	Water to soakwells or drains from roof (kL/house/month)	965.7	1170.8	998.8	2837.7	7190.2	10834.9	11926.3	8361.0	5695.3	3155.2	1944.7	661.5	55742.18
	Wastewater infiltrated on site (kL/house/month)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
	TOTAL SOAKWELL OR DRAIN INFILTRATION FOR COMMERCIAL LOTS (kL)	965.7	1,171	999	2,838	7,190	10,835	11,926	8,361	5,695	3,155	1,945	661	**55,742**
	Total Irrigation Water Use for Commercial Lots (kL)	1120.9	1,121	1,035	690	345	172	43	43	86	432	949	1,121	**7,157**

Total Recharge to groundwater from Irrigated POS

Includes both irrigation and rainfall
Epot=0.7*Pan Evaporation
Assume that 30% is shrubs, rest is irrigated lawn

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*
A	Monthly Rainfall	14.2	17.3	15.7	43.1	108.3	163.8	180.3	126.4	86.1	47.7	29.5	9.7	842.1
B	Monthly Evaporation	260.4	221.2	192.2	117.0	74.4	54.0	55.8	71.3	96.0	145.7	195.0	241.8	1724.8
C	Evapotranspiration (assume 70% of Evaporation)	182.3	154.8	134.5	81.9	52.1	37.8	39.1	49.9	67.2	102.0	136.5	169.3	1207.4
D	Irrigating at ET rate for Grass as per DoE/SRT 2004 (kL/ha/d) when evap exceeds rainfall	58.80	55.30	43.40	27.30	0.00	0.00	0.00	0.00	0.00	32.90	45.50	54.60	317.8
E	Shrub Irrig (kL/d/ha) from GHD (2005)	34	33	21	9	0	0	0	0	0	9	15	31	152
	Average volume per ha assuming 30% shrubs (kl/d/ha)	51.36	48.61	36.68	21.81	0.00	0.00	0.00	0.00	0.00	25.73	36.35	47.52	268.06
F	Average volume per ha assuming 30% shrubs (kl/month/ha)	1592.16	1361.08	1137.08	654.30	0.00	0.00	0.00	0.00	0.00	797.63	1090.50	1473.12	8105.87
	For Total Irrigated POS													
G	Monthly irrigation (kL/month)	10,859	9,283	7,755	4,462	0	0	0	0	0	5,440	7,437	10,047	55,282
H	Rainfall (kL/month)	968	1,180	1,071	2,939	7,386	11,171	12,296	8,620	5,872	3,253	2,012	662	57,431
I	Total input (kL/month)	11,827	10,462	8,826	7,402	7,386	11,171	12,296	8,620	5,872	8,693	9,449	10,708	112,713
J	Surface evaporation and interception losses	2,070	1,831	1,544	1,295	1,293	1,955	2,152	1,509	1,028	1,521	1,654	1,874	19,725
K	Total input - surface evap	9,757	8,632	7,281	6,106	6,093	9,216	10,145	7,112	4,844	7,172	7,796	8,834	92,988
L	Evapotranspiration for area	12,431	10,560	9,176	5,586	3,552	2,578	2,664	3,404	4,583	6,956	9,309	11,544	82,342
M	Total input - evapotranspiration	-2,674	-1,929	-1,894	521	2,542	6,638	7,481	3,708	261	216	-1,514	-2,709	10,646
N	**Therefore infiltration to groundwater from irrigated POS (kL/month)**	0	0	0	521	2,542	6,638	7,481	3,708	261	216	0	0	**21,367**

Non-irrigated POS

0.00 % of development area

Therefore 24.76% of predevelopment recharge

0.00 ML/yr

Total Recharge from roads and verges

Assumes no irrigation of these areas
Epot=0.7*Pan Evaporation

Pavement

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*
Monthly Rainfall	14.2	17.3	15.7	43.1	108.3	163.8	180.3	126.4	86.1	47.7	29.5	9.7	842.1
Monthly Evaporation	260	221	192	117	74	54	56	71	96	146	195	242	1724.8
Evap-Trans	182.3	154.8	134.5	81.9	52.1	37.8	39.1	49.9	67.2	102.0	136.5	169.3	1207.4
Rainfall falling on roads (kL)	2,222	2,707	2,456	6,743	16,944	25,627	28,209	19,776	13,471	7,463	4,615	1,518	131,752
Evaporation losses (kL)	100	122	111	303	762	1,153	1,269	890	606	336	208	68	5,929
Runoff from roads (kL)	2,122	2,585	2,346	6,440	16,182	24,474	26,940	18,886	12,865	7,127	4,408	1,449	125,823
Rain falling on drainage structures (kL)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interception losses (kL)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Evapotranspiration (kL)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total rainfall on roads, minus total losses (kL)	2,122	2,585	2,346	6,440	16,182	24,474	26,940	18,886	12,865	7,127	4,408	1,449	125,823
Therefore water losses from roads (kL/month)	2,122	2,585	2,346	6,440	16,182	24,474	26,940	18,886	12,865	7,127	4,408	1,449	**125,823**

Includes both irrigation and rainfall
Epot=0.7*Pan Evaporation
Assume all verges are lawn
Assume all verge is irrigated at POS rates

	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Total*
Monthly Rainfall	14.2	17.3	15.7	43.1	108.3	163.8	180.3	126.4	86.1	47.7	29.5	9.7	842.1
Monthly Evaporation	260.4	221.2	192.2	117.0	74.4	54.0	55.8	71.3	96.0	145.7	195.0	241.8	1724.8
Evapotranspiration (assume 70% of Evaporation)	182.3	154.8	134.5	81.9	52.1	37.8	39.1	49.9	67.2	102.0	136.5	169.3	1207.4
Irrigating at ET rate for Grass as per DoE/SRT 2004 (kL/ha/d) when evap exceeds rainfall	58.80	55.30	43.40	27.30	0.00	0.00	0.00	0.00	0.00	32.90	45.50	54.60	317.8
Average volume per ha/month	1822.80	1714.30	1345.40	846.30	0.00	0.00	0.00	0.00	0.00	1019.90	1410.50	1692.60	9851.8
For Total Irrigated verge													
Monthly irrigation (kL/month)	11,091	10,430	8,186	5,149	0	0	0	0	0	6,205	8,582	10,298	59,942
Rainfall (kL/month)	864	1,053	955	2,622	6,589	9,966	10,970	7,691	5,239	2,902	1,795	590	51,237
Total input (kL/month)	11,955	11,483	9,141	7,772	6,589	9,966	10,970	7,691	5,239	9,108	10,377	10,889	111,179
Surface evaporation and interception losses	2,092	2,010	1,600	1,360	1,153	1,744	1,920	1,346	917	1,594	1,816	1,906	19,456
Total input - surface evap	9,863	9,474	7,541	6,412	5,436	8,222	9,050	6,345	4,322	7,514	8,561	8,983	91,723
Evapotranspiration for area	11,091	9,421	8,186	4,983	3,169	2,300	2,377	3,037	4,089	6,205	8,305	10,298	73,461
Total input - evapotranspiration	-1,228	52	-644	1,428	2,268	5,922	6,674	3,308	233	1,308	256	-1,315	
Therefore infiltration to groundwater from irrigated POS (kL/month)	0	52	0	1,428	2,268	5,922	6,674	3,308	233	1,308	256	0	**21,450**

APPENDIX F

SERVICING REPORT

Cardno BSD

Shaping the Future

CITY OF COCKBURN
DEVELOPMENT AREA NO.19
SERVICING REPORT (VERSION 2)

22 January 2008
Job No. E07007

City of Cockburn

Cardno BSD Pty Ltd

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Document Control

Version	Date	Author		Reviewer	
		Name	Initials	Name	Initials
1	25 June 2007	Wayne Burns		Jeremy Cordina	
2	22 January 2008	Wayne Burns		Wayne Burns	

DEVELOPMENT AREA 19 –SERVICING REPORT (VERSION 1)

TABLE OF CONTENTS

APPENDICES

EXECUTIVE SUMMARY

This Servicing Report has been prepared by Cardno BSD for Koltasz Smith, Town Planning Consultants to further the development of the Area 19 District Structure Plan, to be submitted to and approved by the City of Cockburn and Western Australian Planning Commission.

The report identifies the existing service lines associated with various services necessary to the provided for the future development of the land in an urban form.

This report constitutes Version 2 of the report which is a revision of the report which was first prepared and submitted on the 25 June 2007. The revised version provides further information and clarification of details which were unavailable at the time the initial version was produced.

1. INTRODUCTION

1.1 Background

Koltasz Smith and Associates are currently preparing a District Structure Plan (DSP) for the area depicted as Development Area No.19 under the City of Cockburn's Town Planning Scheme No.3. As part of the preparation of the DSP, details for the future servicing of the site are required. To this end, Cardno BSD have been commissioned by Koltasz Smith on behalf of the City of Cockburn and associated landowners to undertake investigations on the servicing requirements to facilitate the preparation of the DSP and ultimately the lands development. This report represents the findings of these investigations.

1.2 Site location

Development Area 19 is located within the City of Cockburn, approximately 16km south of the Perth Central Business District and 10km south east of Fremantle. The site is bounded by the Kwinana Freeway road reservation to the east, North Lake Road to the south, Semple Court to the west and Verna Court to the north. The established residential suburb of South Lake abuts the site west of Semple Court.

1.3 Site Description

The site is comprised of some 86 properties, with the majority of these being between 5,000m^2 to 2.0ha in area. The properties are largely occupied by semi-rural/residential uses, with dwellings surrounded by paddocks and pockets of existing vegetation and dampland areas scattered throughout.

2. WATER SUPPLY

2.1 Servicing Strategy

Preliminary advice from the Water Corporation has indicated that existing 150mm dia water reticulation mains are located directly south (North Lake Rd) and east (Kentucky Ct) of the site, however these mains have insufficient capacity to service the lot yields which are expected to be generated from the development of the site. In this regard, a 400mm dia steel water distribution main exists approximately 550 metres south of the site, within the Beeliar road reserve, which is large enough to be able to service the site.

The location of these existing Water Mains is indicated on the drawings found under Appendix B.

In order to connect the site to this main, an extension would be required to be made, which would most likely be located within the North Lake road reserve and connect to the site via the Kentucky road reserve, as shown in the drawing found within Appendix C.

2.2 Cost Implications

The total cost of extending the 400mm dia water distribution main is estimated to be in the order of $550,000. This extension will constitute a pre-funded item for which the capital expenditure of constructing the main would be refunded to developers over a timeframe, which would be negotiated with the water Corporation. The cost of providing the extension would not constitute an item under any future cost contributions scheme and would be a cost which the Water Corporation would require initial subdividers/developers within the site to take on.

Standard headworks contributions will be required to be paid by developers on a per lot basis, currently headworks costs for this location are being charged at a rate of $3,183 per lot.

3. WASTEWATER

3.1 Servicing Strategy

3.1.1 Existing Services

The Water Corporation have advised that a 600mm dia sewer main is currently being constructed within the North Lake road reserve, which abuts the mixed use zone that forms the southern boundary of Development Area No.19. Construction of this main is expected to be completed within the second half of 2007 and will provide sufficient capacity to service the sites wastewater disposal requirements.

Furthermore, a 225mm dia sewer main currently extends adjacent to Berrigan Drive, which connects to Semple Court at the sites northwestern corner. Both sewer mains connect back to the Water Corporation's Jandakot Pump Station No.1 located on Barrine Gardens in South Lake.

The Water Corporation's wastewater planning for the region is attached under Appendix C.

3.1.2 Proposed Connection

Given the proximity of wastewater mains with sufficient capacity to service the site, connection to the regional reticulated wastewater system would be able to be made by connecting to the existing mains that lie adjacent to the site.

3.2 Cost Implications

Given the above, pre-funded capital connections costs will be able to be maintained to a minimum, however, developers will be required to cover the cost of reticulation systems within land holdings and standard headworks contributions will be required to be paid on a per lot basis.

Headworks costs within this location are currently being charged at a rate of $1,469 per lot.

4. ROADWORKS

4.1 Road Upgrades

The road network proposed within the Draft DSP requires the construction and modification of roads, which are considered to provide benefit to the entire development area as opposed to only those new lots abutting them. In this regard, some of the roads proposed are internal within the plan and provide a direct benefit to the land in terms of facilitating for traffic and providing access to future lots. Other roadworks are external from the site and are necessary to facilitate the proposed design.

These roadworks are as follows:-

- The upgrade of Muriel Ct and Kentucky Court to the standard of a Neighbourhood Connector A as described in Liveable Neighbourhoods;
- The upgrade of the southern portion of Semple Court (approx 250m) to the standard of an Integrator B as described in Liveable Neighbourhoods;
- The construction of a realigned northern portion of Semple Court (apprx 850m) to the standard of an Integrator B as described in Liveable Neighbourhoods;
- The realignment and construction of the southern portion of Elderberry Drive, to the standards of the existing road (10m wide pavement);
- The construction of signalised traffic intersections at the junction of Berrigan and Elderberry Drive, Semple Court and North Lake Drive and Kentucky Court and North Lake Drive.
- The upgrade of North Lake Road to a dual carriageway with central median strip and dual use path.

4.2 Cost Implications

The table below provides estimated construction costs for the various works described above. In considering the costs provided below it should be noted that the figures provided have been prepared on current construction rates, without the benefit of any initial engineering investigations or detailed design. Accordingly these costs do not account for any required earthworks or road level changes, road drainage costs, the relocation, raising or lowering of existing services or site remediation costs.

Development Area 19 - Regional Roadworks		
Item	**Total Cost**	**Difference**
Standard Access Road		
Internal Roads		
New Semple Ct (850m) - Constructed to Integraor B standard and includes 2 roundabouts and paved median	$800,000	$450,000
Old Semple Ct (250m) - Constructed to Integrator B standard and includes the demolition and removal of the existing road surface	$230,000	$135,000
Muriel/Kentucky Ct (1375m) - Constructed to Neighbourhood Connector A standard and includes the demolition and removal of the existing road surface	$1,200,000	$680,000

External Roads		
Eldeberry Drive (250m) - Constructed to the stanards of the existing road and includes terminating Culs-de-sac	$260,000	
Berrigan Drive Intersection - Traffic signal controlled intersection, including civil works and traffic management during construction	$480,000	
Semple Ct Intersection - Traffic signal controlled intersection, including civil works and traffic management during construction	$430,000	
Kentucky Ct Intersection - Traffic signal controlled intersection, including civil works and traffic management during construction	$430,000	
Modifications to Semple Ct - Includes the demolition and removal of existing pavement and kerbing and installation of new pavement and kerbing.	$65,000	

Costs for internal roads indicate not only the final estimated total for construction of the road but also the difference in cost due to the roads regional function. In this regard items such as the additional pavement area, kerbing and median strip paving requirements constitute the difference in cost in comparison to if the road was constructed to an access road standard. In considering these items for any cost contribution scheme, it is there fore reasonable that the refund to affected landowners comprise this difference only rather than any contributions scheme being utilised to fully fund the cost of roads.

With respect to external roadworks, no land within the development area benefits directly from these works but rather there is an overall benefit to the development area in facilitating the proposed design, accordingly it is considered that any cost contributions scheme covering these items should apportion the cost of works out amongst units on a pro-rata basis.

Further to the above, it should be noted that with respect to the upgrade works to North Lake Road, units created from within the development area are considered to represent only a portion of users benefiting from its upgrade and therefore any contributions towards improvements to this road, should be relative to the percentage patronage of the road resulting from the development of the site.

5. STORMWATER

5.1 Cockburn Central & Solomon Road Development Areas – Arterial Drainage Scheme Review

Prior to the preparation of the Development Area 19 District Structure Plan commencing, the City of Cockburn commissioned David Wills and Associates (DWA), to undertake a study of the subject site and surrounding lands titled the Cockburn Central & Solomon Road Development Areas – Arterial Drainage Scheme Review (ADSR), to assist in resolving technical issues associated with the provision of an integrated stormwater drainage system, to facilitate the anticipated future development of the site and surrounding areas.

The study separates its study area into 8 'sub-catchment areas' of which the subject site comprises areas 4, 5 and 6 as shown in Appendix 4 attached. The study proposes a strategy 'to formalise the drainage flow paths into Lake Yangebup, whilst maximising infiltration and implementing sound water resource management principles to assist in improving water quality discharging to Lake Yangebup.'

The study also recommends a suitable groundwater control level be adopted which can be maintained by way of groundwater control basins or subsoil drainage which then flow to Yangebup Lake.

5.2 Development Area 19 Local Water Management Strategy

The Local Water Management Strategy (LWMS) was prepared by Cardno BSD to develop a strategy for stormwater management that closely follows the principals of the DWA Arterial Drainage Scheme Review, relevant to the District Structure Plan proposed.

Sub-catchment areas provided in the ADSR report were altered only slightly for the LWMS to suit the proposed District Structure Plan for Development Area 19. Based upon the altered catchment areas and proposed zoning of the District Structure Plan, approximate volumes of runoff were determined for each catchment area to provide a better understanding of the likely best method of stormwater management.

As design levels are yet to be determined for Development Area 19, a detailed recommended strategy was not provided. However, available options and recommendations for stormwater management were provided.

5.3 Proposed Stormwater Infrastructure

Stormwater infrastructure for the development on a regional scale would require:-

- The upgrading of both the existing Semple Court and North Lake Road open drain to a landscaped channel;
- The extension of the existing 450mm diameter pipe under Berrigan Drive to connect Development Area 19 up to '*Lakelands*', groundwater collection and compensating basins/swales;
- A subsoil drainage network required to assist in setting the regional groundwater control level; and
- Outlet pipes within basins in POS to discharge to the regional network.

5.4 Cost Implications

The table below provides estimated construction costs for the various stormwater treatment works described above. In considering the costs provided below it should be noted that the figures provided have been prepared on current construction rates, without the benefit of any initial engineering investigations or detailed design. Accordingly these costs do not account for any required earthworks, fill or level changes, road drainage costs, the relocation, raising or lowering of existing services or site remediation costs.

Development Area 19 - Regional Stormwater Works	
Item	**Total Cost**
External Infrastructure	
New Semple Ct Open Drain (3000sq.m) - Constructed to North Lake Road Open Drain with Landscaping and Landscaping Features	$150,000
North Lake Road Landscaped Channel (20000sq.m) - Constructed from Kentucky Ct to Lake Yangebup with Landscaping and Landscaping Features	$1,000,000
Berrigan Drive Pipeline Extension (350m) - Constructed from site to Berrigan Dr with associated connections and road crossings	$110,000
Internal Infrastructure	
Groundwater Collection and Compensating Basins (6000sq.m) - Constructed within POS to included some landscaping	$72,000
Basin Discharge Pipework (1850m) - 300mmdia pipeline from basins to regional network, including trenching	$140,000
Subsoil Drainage (2050m) - Subsoil drainge to control groundwater level throughout major roads and POS where no Groundwater Collection Basin	$175,000

With respect to the above stormwater drainage costs, all lots within the development area are considered to benefit equally from the completion of these works and accordingly it is considered that any cost contributions scheme covering these items should apportion the cost of works out amongst units on a pro-rata basis

6. GAS SUPPLY

6.1 Servicing Strategy

6.1.1 Existing Services

The drawing provided under Appendix 5 indicates the location of current gas mains existing within the land and surrounding area. In this regard, the red lines depict high pressure gas transmission lines, which are accessible to the site from its southern (North Lake Rd) and eastern (Kentucky Ct) boundaries. The green lines depict medium pressure gas transmission lines, which traverse the site within the Muriel Court road reserve and are also accessible to the site from its western (Semple Court) and northern (Verna Ct) boundaries.

6.1.2 Proposed Services

Whilst gas services will be able to be connected to the site via the existing service lines detailed above, Alinta has advised that it is difficult to determine if the existing infrastructure has the capacity to service the area without any knowledge of timing or staging of the development, however it is likely that some reinforcement of the existing network will be required if the entire site was to be developed in the near future.

6.2 Cost Implications

Any reinforcement of the existing service network would require capital contributions from developers, however, given that the need or extent of any upgrades is at this stage unknown, the costs of strengthening the service are unable to be determined.

7. POWER SUPPLY

Based on the Current Western Power network within the area, servicing the sites power requirements will involve the following:

Existing Transmission Towers of 330kV and 132kV remain in a corridor to the south of the subdivision, which will not impact on the lots facing North Lake Rd, the easement, however will have a visual impact on the Mixed Use Business lots, unless North Lake Rd is realigned in which case new easement requirements may apply.

A high Voltage 22kV cable is currently installed on the north side of North Lake Rd, which appears to be a dedicated feeder from APM Zone Substation, and may not be available for supply to this area.

Other High Voltage aerials exist around the proposed area, which would indicate that some small stage development could occur without significant infrastructure being needed prior to any residential lots being released.

However, in order for the total area to be completed and based on the R codes supplied, a new High Voltage feeder would be required from APM Zone substation to supply the total demand. The funding for this would be on a full cost basis and implemented on the current Western Power Economic System Pool, where the Developer pays a per kVA system charge on the residential lots which in turn allows Western Power to credit the high voltage costs back to the Developer via the HV system pool.

At present commercial and industrial lots are not included in the System Pool, so are at full cost to the Developer unless they are included with a residential stage and the residential load is greater than the commercial load.

With this in mind it would be expected to start initial development in the residential area.

Current costs per lot for materials for residential lots are in the order of $4,200 per lot. Costs for commercial lots are in the order of $10-12k per lot.

8. TELECOMMUNICATIONS

8.1 Servicing Strategy

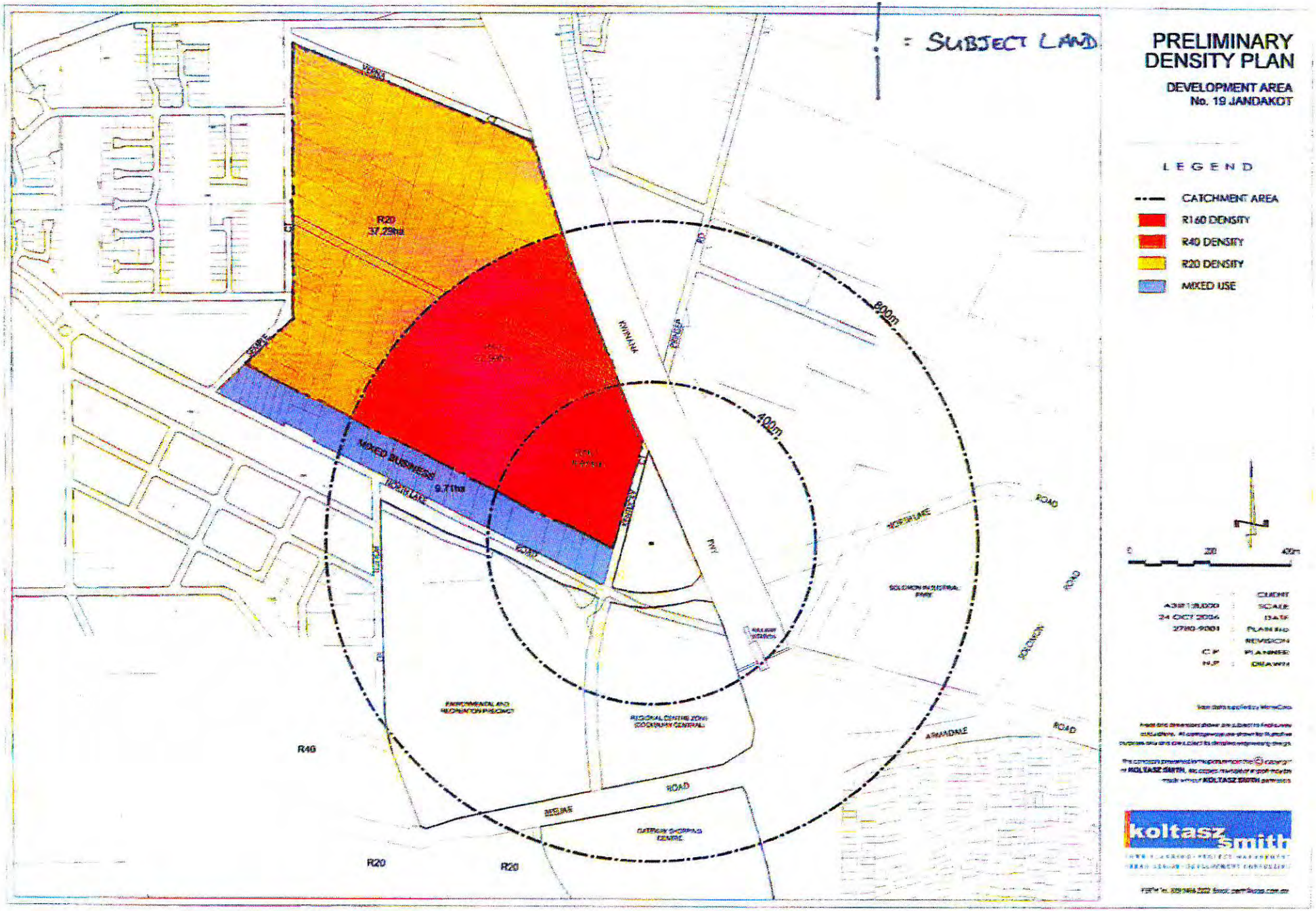
Telstra have provided advice indicating that they could provide telecommunications services to dwellings within the development, which includes the following: -

- Up to 4 telephone services to each dwelling;
- High speed internet service 10 & 20Mbps (scaleable up to 100Mpbs);
- Foxtel digital subscription TV service;
- Digital free to air television service (providing a desirable 'clean roof' development); and
- Next G (3G) mobile coverage.

Telstra have indicated the cost for connection of the above services would be at $3,150 per dwelling, which is a cost, which would be taken on by developers at construction. No regional connection costs would apply at a district structure planning level.

APPENDIX A

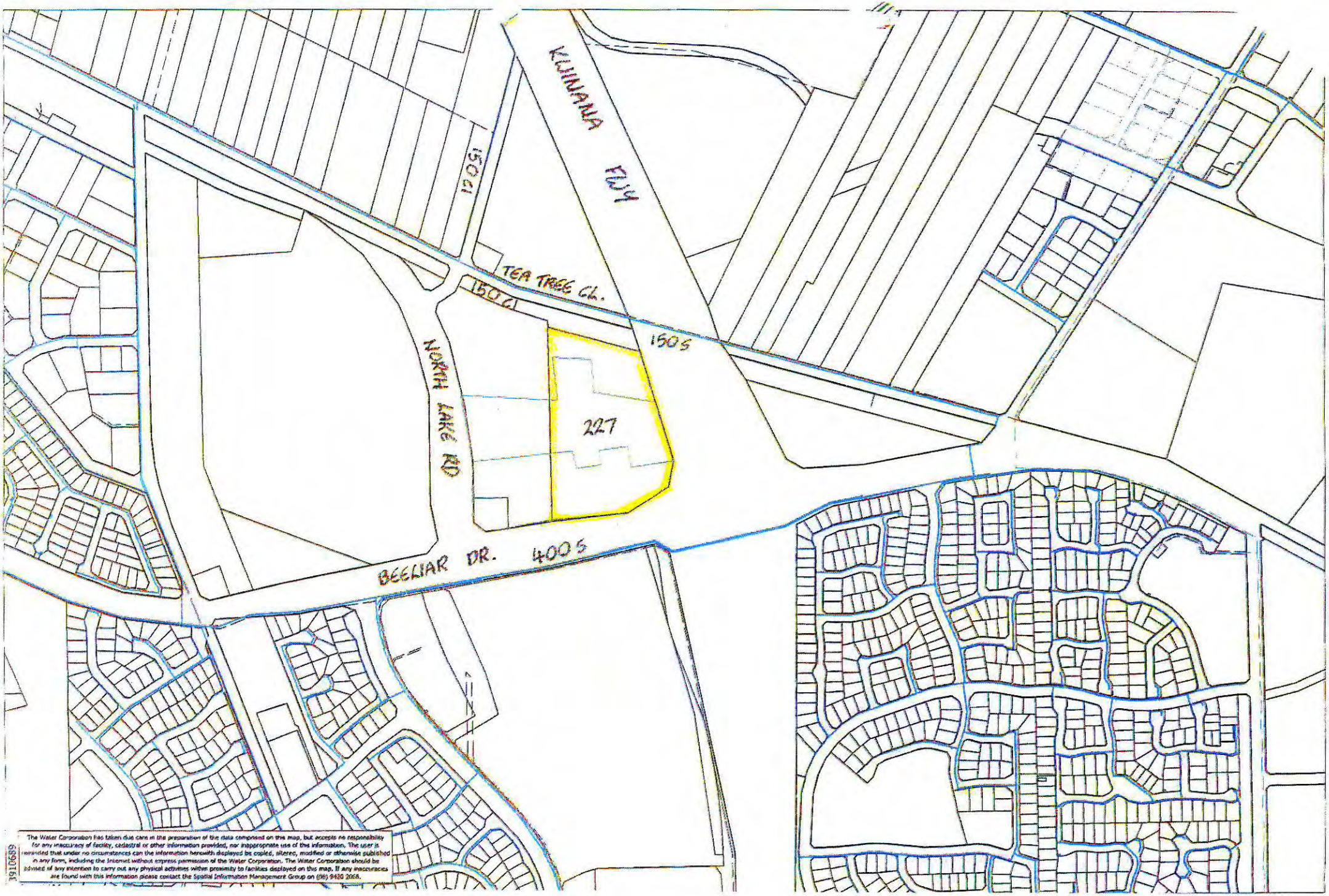
Locality Plan

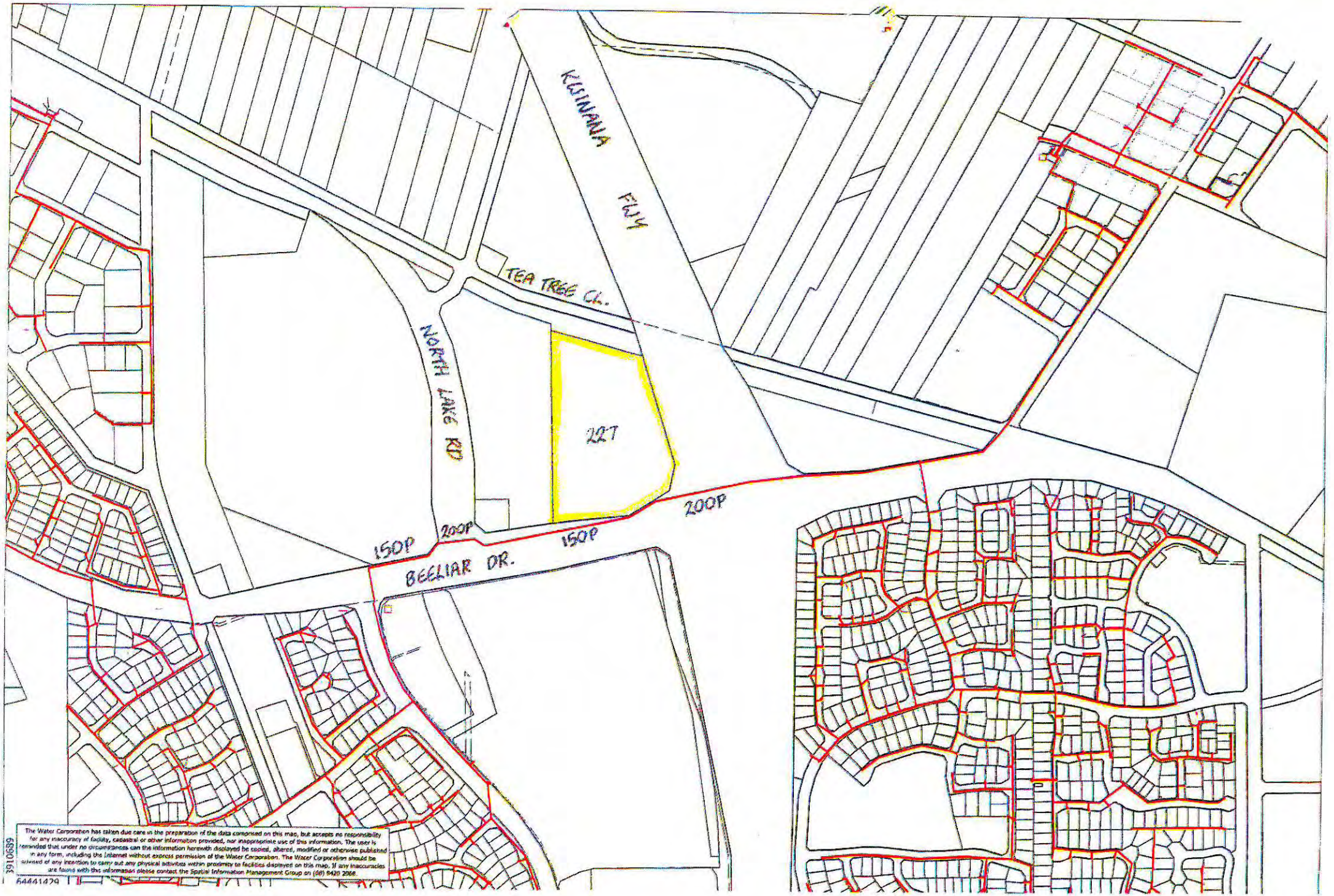

= SUBJECT LAND
PRELIMINARY DENSITY PLAN
DEVELOPMENT AREA No. 19 JANDAKOT
LEGEND
CATCHMENT AREA
R160 DENSITY
R40 DENSITY
R20 DENSITY
MIXED USE
R20 37.29ha
MIXED BUSINESS 9.71ha
800m
400m
R40
R20
R20
ROAD
ARMADALE
koltasz smith

APPENDIX B

Water Corporation Existing Water Supply Mains

TAR... EN... - E...TIN... WA... M...S

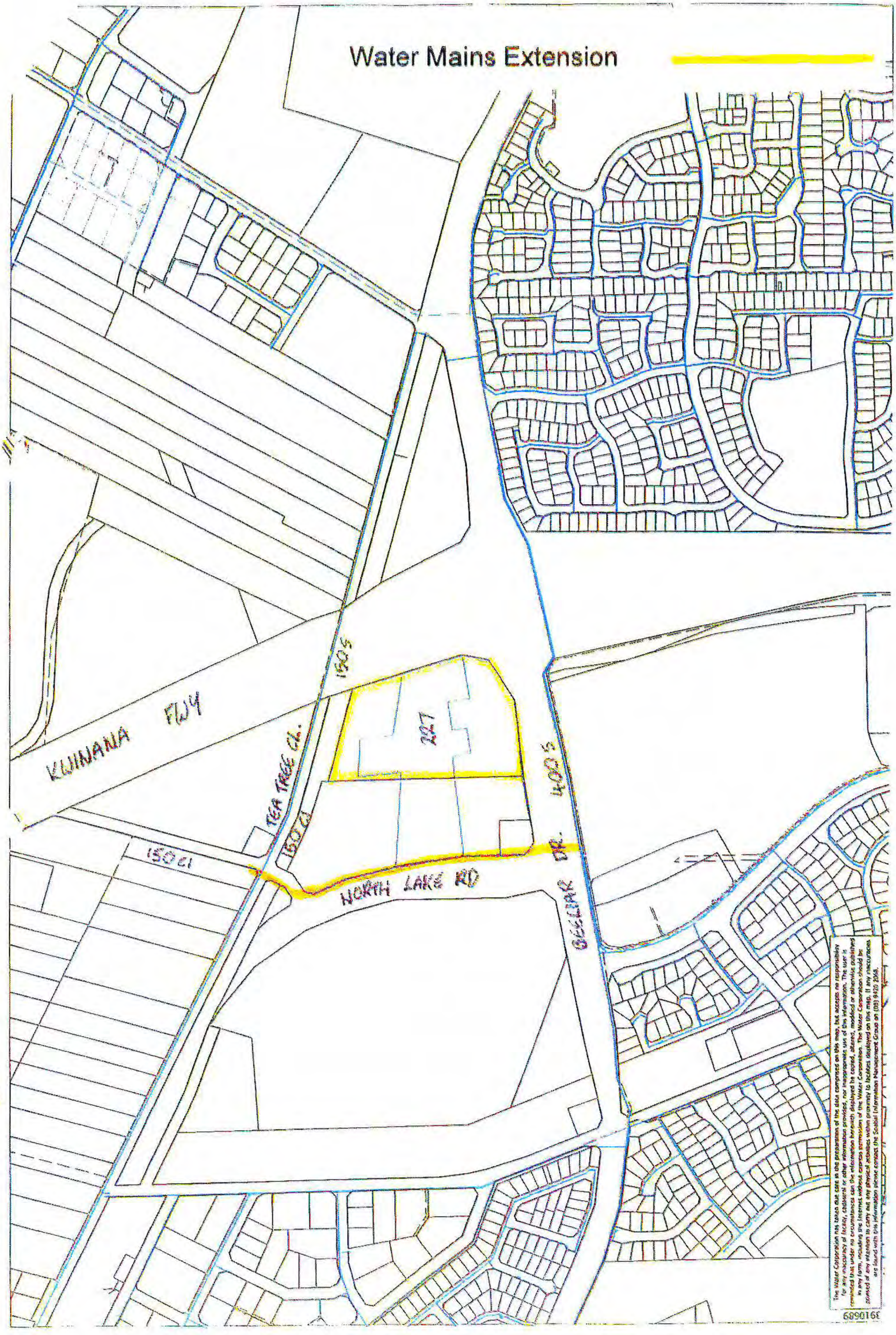




APPENDIX C

Proposed Water Distribution Main

Water Mains Extension



APPENDIX D

Water Corporation Wastewater Planning

ATTACHMENT 3 –
PROPOSED SEWER MAINS
& LOCATION OF
SANDAKOT PUMP
STATION (PS) No.1

JANDAKOT
SD036

CATCHMENT 'R8425 - 013'
SEWER DESIGN FLOW - 3.1L/s

CATCHMENT 'R8430 - 036'
SEWER DESIGN FLOW - 7.9L/s

CATCHMENT 'R8626 - 036'
SEWER DESIGN FLOW - 4.7L/s

CATCHMENT 'R1562 - 036'
SEWER DESIGN FLOW - 2.2L/s

CATCHMENT 'R3650 - 036'
SEWER DESIGN FLOW - 1.2L/s

CATCHMENT 'T9950 - 036'
SEWER DESIGN FLOW - 10.2L/s

CATCHMENT 'S0691 - 036'
SEWER DESIGN FLOW - 3.8L/s

CATCHMENT 'W5247 - 036'
SEWER DESIGN FLOW - 4.7L/s

CATCHMENT 'V4715 - 036'
SEWER DESIGN FLOW - 14.5L/s

CATCHMENT '193 - 036'
SEWER DESIGN FLOW - 1.7L/s

CATCHMENT '181 - 036'
SEWER DESIGN FLOW - 4.5L/s

CATCHMENT '182 - 036'
SEWER DESIGN FLOW - 3.0L/s

CATCHMENT '177 - 036'
SEWER DESIGN FLOW - 5.3L/s

CATCHMENT '174 - 036'
SEWER DESIGN FLOW - 6.5L/s

CATCHMENT '168 - 036'
SEWER DESIGN FLOW - 3.6L/s

CATCHMENT '172 - 036'
SEWER DESIGN FLOW - 16.7L/s

CATCHMENT 'AA4010 - 036'
SEWER DESIGN FLOW - 4.3L/s

CATCHMENT '170 - 036'
SEWER DESIGN FLOW - 6.4L/s

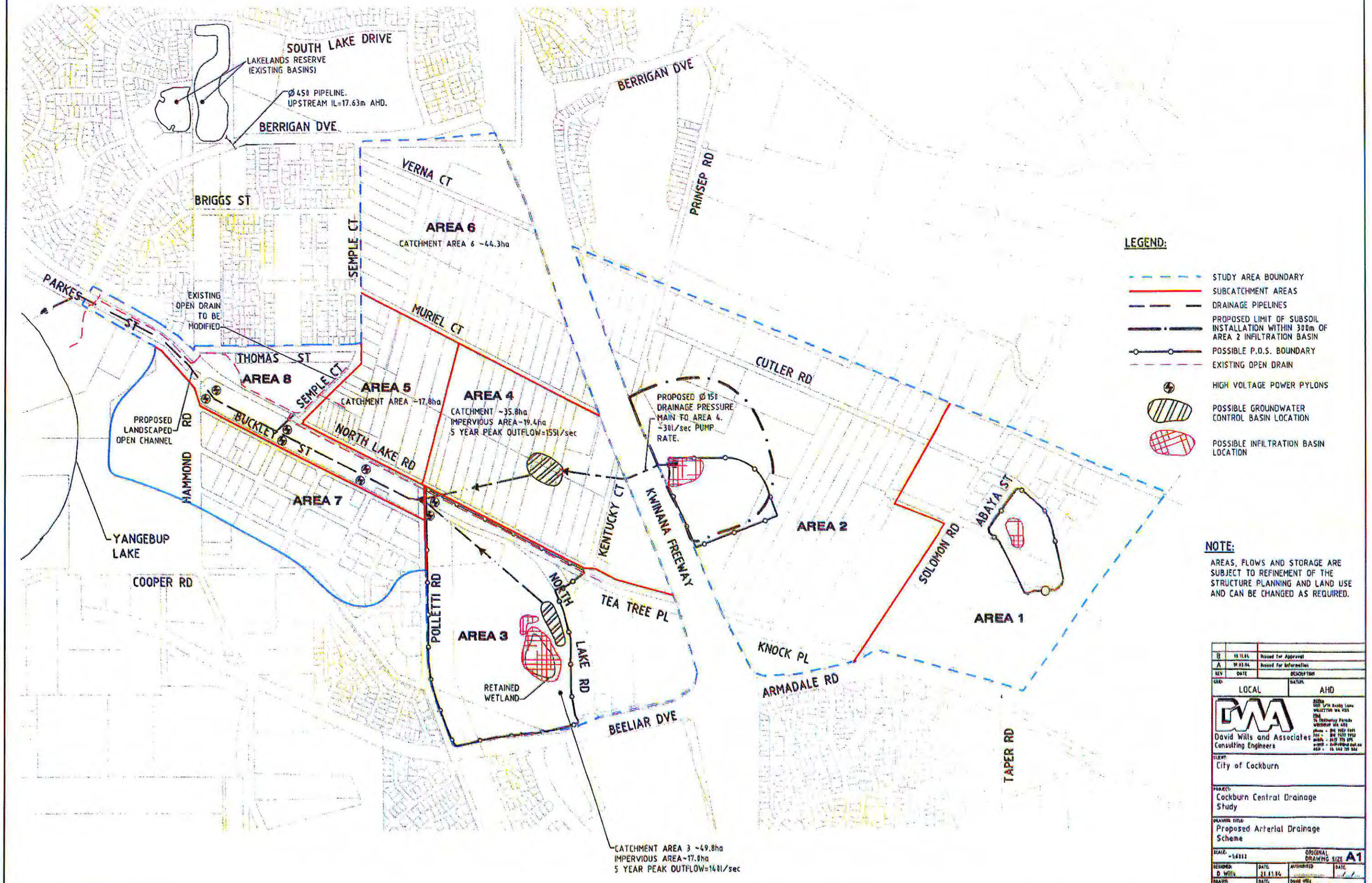
P.S. TO BE GRADED OUT

P.S. TO BE GRADED OUT

'RINTING AND IS SUBJECT TO ONGOING REVIEW
RACY OF DATA SUPPLIED BY EXTERNAL AGENCIES.

APPENDIX E

Proposed Arterial Drainage Scheme


SOUTH LAKE DRIVE
LAKELANDS RESERVE (EXISTING BASINS)
Ø450 PIPELINE. UPSTREAM IL=17.63m AHD.
BERRIGAN DVE
BERRIGAN DVE
PRINSEP RD
VERNA CT
BRIGGS ST
SEMPLE CT
AREA 6
CATCHMENT AREA 6 ~44.3ha
PARKES ST
EXISTING OPEN DRAIN TO BE MODIFIED
MURIEL CT
CUTLER RD
THOMAS ST
AREA 8
SEMPLE CT
AREA 5
CATCHMENT AREA ~17.6ha
AREA 4
CATCHMENT ~35.8ha
IMPERVIOUS AREA~19.4ha
5 YEAR PEAK OUTFLOW=155l/sec
PROPOSED Ø150 DRAINAGE PRESSURE MAIN TO AREA 4. ~30l/sec PUMP RATE.
PROPOSED LANDSCAPED OPEN CHANNEL
BUCKLEY ST
NORTH LAKE RD
HAMMOND RD
AREA 7
KENTUCKY CT
KWINANA FREEWAY
AREA 2
SOLOMON RD
ABAYA ST
YANGEBUP LAKE
COOPER RD
POLLETTI RD
NORTH LAKE RD
TEA TREE PL
AREA 3
AREA 1
KNOCK PL
ARMADALE RD
RETAINED WETLAND
BEELIAR DVE
TAPER RD
CATCHMENT AREA 3 ~49.8ha
IMPERVIOUS AREA~17.0ha
5 YEAR PEAK OUTFLOW=140l/sec
LEGEND:
STUDY AREA BOUNDARY
SUBCATCHMENT AREAS
DRAINAGE PIPELINES
PROPOSED LIMIT OF SUBSOIL INSTALLATION WITHIN 300m OF AREA 2 INFILTRATION BASIN
POSSIBLE P.O.S. BOUNDARY
EXISTING OPEN DRAIN
HIGH VOLTAGE POWER PYLONS
POSSIBLE GROUNDWATER CONTROL BASIN LOCATION
POSSIBLE INFILTRATION BASIN LOCATION
NOTE:
AREAS, FLOWS AND STORAGE ARE SUBJECT TO REFINEMENT OF THE STRUCTURE PLANNING AND LAND USE AND CAN BE CHANGED AS REQUIRED.
B 19.10.04 Issued for Approval
A 19.03.04 Issued for Information
REV DATE DESCRIPTION
GRID: LOCAL DATUM: AHD
David Wills and Associates Consulting Engineers
CLIENT: City of Cockburn
PROJECT: Cockburn Central Drainage Study
DRAWING TITLE: Proposed Arterial Drainage Scheme
SCALE: 1:6000 ORIGINAL DRAWING SIZE: A1
DESIGNED: D Wills DATE: 23.11.04
DRAWN: J Eagle DATE: 23.11.04
AUTHORISED: David Wills DATE:
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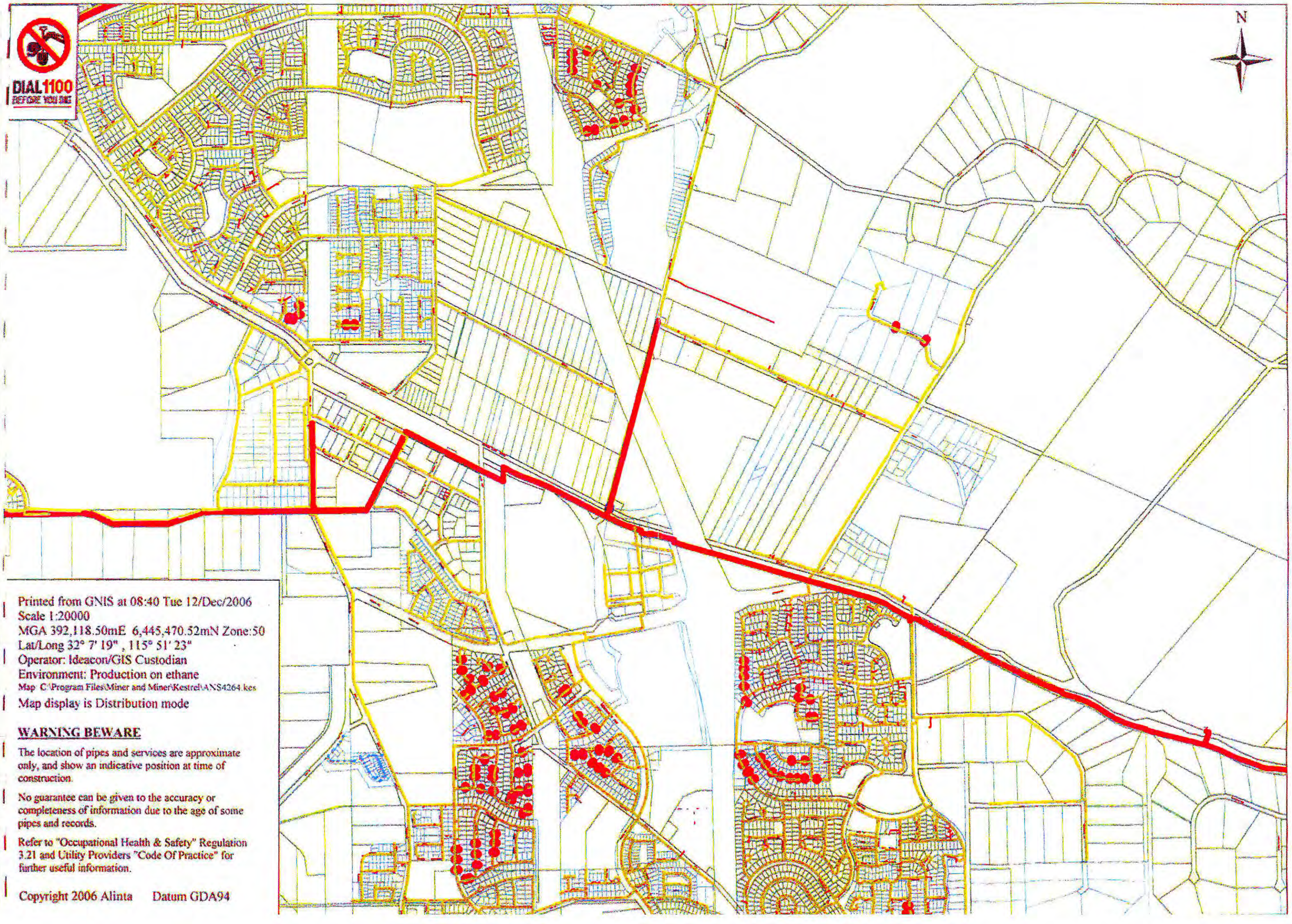
JOB NUMBER: 03080
DWG No: C04
REV No: B

APPENDIX F

Existing Gas Mains



Printed from GNIS at 08:40 Tue 12/Dec/2006
Scale 1:20000
MGA 392,118.50mE 6,445,470.52mN Zone:50
Lat/Long 32° 7' 19" , 115° 51' 23"
Operator: Ideacon/GIS Custodian
Environment: Production on ethane
Map C:\Program Files\Miner and Miner\Kestrel\ANS4264.kes
Map display is Distribution mode

WARNING BEWARE

The location of pipes and services are approximate only, and show an indicative position at time of construction.

No guarantee can be given to the accuracy or completeness of information due to the age of some pipes and records.

Refer to "Occupational Health & Safety" Regulation 3.21 and Utility Providers "Code Of Practice" for further useful information.

 Datum GDA94

APPENDIX G

CALCULATION OF AAMGL

Bore 3157

Date	mAHD	Years Max
6/06/1975	21.940	
11/07/1975	22.110	
13/08/1975	22.710	
8/09/1975	22.790	
14/10/1975	22.710	
12/11/1975	22.620	22.79
15/03/1976	22.040	
23/04/1976	21.790	
13/05/1976	21.730	
11/06/1976	21.730	
14/07/1976	21.810	
21/09/1976	22.240	22.24
7/09/1981	22.490	
21/10/1981	22.470	22.47
19/03/1985	21.890	
19/03/1985	21.890	
9/04/1985	21.860	
9/04/1985	21.860	
16/07/1985	22.060	
12/08/1985	22.350	
9/09/1985	22.520	
14/10/1985	22.510	
13/11/1985	22.400	
11/12/1985	22.290	22.52
30/01/1986	22.010	
19/02/1986	21.900	
18/03/1986	21.830	
10/04/1986	21.900	
12/05/1986	21.630	
16/06/1986	21.730	
14/07/1986	22.090	
13/08/1986	22.630	
16/09/1986	22.850	
22/10/1986	22.750	
18/11/1986	22.630	
18/12/1986	22.450	22.85
28/01/1987	22.200	
26/02/1987	22.030	
16/03/1987	21.930	
13/04/1987	21.850	
13/05/1987	21.900	
10/06/1987	21.930	
15/07/1987	22.270	
13/08/1987	22.680	
7/09/1987	22.730	
19/10/1987	22.680	
12/11/1987	22.590	
14/12/1987	22.450	22.73
28/01/1988	22.230	
25/02/1988	22.020	
14/03/1988	21.920	
27/04/1988	21.755	
17/05/1988	21.870	
13/06/1988	22.140	
22/07/1988	22.590	
18/08/1988	22.960	
14/09/1988	22.900	
26/10/1988	22.860	
22/11/1988	22.795	
9/12/1988	22.670	22.96
17/01/1989	22.440	
10/02/1989	22.290	
27/02/1989	22.250	
23/03/1989	22.070	
19/04/1989	21.950	
20/04/1989	21.940	
20/04/1989	21.940	
20/04/1989	21.940	
29/05/1989	21.990	
30/06/1989	22.030	
24/07/1989	22.140	
29/08/1989	22.590	
22/09/1989	22.660	
19/10/1989	22.630	
27/11/1989	22.450	22.66
4/01/1990	22.310	
23/01/1990	22.230	
15/02/1990	22.090	
12/03/1990	21.980	
9/04/1990	21.890	
10/05/1990	21.870	
9/06/1990	21.840	
9/07/1990	21.910	
14/08/1990	22.210	
7/09/1990	22.310	
9/10/1990	22.270	
12/11/1990	22.170	
3/12/1990	22.100	22.31

Date	mAHD	Years Max
4/01/1991	21.970	
14/02/1991	21.740	
11/03/1991	21.630	
3/04/1991	21.500	
21/05/1991	21.430	
12/06/1991	21.580	
11/07/1991	22.060	
5/08/1991	22.410	
16/09/1991	22.620	
7/10/1991	22.640	
12/11/1991	22.520	
9/12/1991	22.460	22.64
7/01/1992	22.340	
6/02/1992	22.180	
9/03/1992	22.500	
1/04/1992	22.460	
19/05/1992	22.310	
10/06/1992	22.300	
13/07/1992	22.650	
12/08/1992	22.800	
3/09/1992	22.930	
10/09/1992	22.960	
7/10/1992	22.940	
9/11/1992	22.790	
2/12/1992	22.730	22.96
7/01/1993	22.600	
3/02/1993	22.440	
4/03/1993	22.270	
2/04/1993	22.120	
4/05/1993	22.010	
3/06/1993	22.020	
7/07/1993	22.150	
10/08/1993	22.360	
6/09/1993	22.550	
12/10/1993	22.690	
4/11/1993	22.590	
6/12/1993	22.480	22.69
7/01/1994	22.310	
4/02/1994	22.150	
4/03/1994	22.030	
7/04/1994	21.820	
4/05/1994	21.680	
7/06/1994	21.810	
5/07/1994	22.170	
9/08/1994	22.710	
8/09/1994	22.800	
7/10/1994	22.740	
7/11/1994	22.620	
5/12/1994	22.560	22.8
6/01/1995	22.340	
6/02/1995	22.110	
28/02/1995	21.980	
3/04/1995	21.790	
5/05/1995	21.640	
12/06/1995	21.840	
5/07/1995	21.910	
8/08/1995	22.390	
8/09/1995	22.590	
5/10/1995	22.540	
13/11/1995	22.570	22.59
9/01/1996	22.340	
13/02/1996	22.080	
7/03/1996	21.960	
4/04/1996	21.800	
13/05/1996	21.630	
11/06/1996	21.550	
2/07/1996	21.880	
9/08/1996	22.400	
12/09/1996	22.590	
3/10/1996	22.710	
7/11/1996	22.630	
3/12/1996	22.540	22.71
3/01/1997	22.380	
5/02/1997	22.160	
4/03/1997	22.000	
2/04/1997	21.900	
13/05/1997	21.710	
4/06/1997	21.830	
1/07/1997	21.900	
5/08/1997	22.010	
2/09/1997	22.290	
1/10/1997	22.380	
4/11/1997	22.280	
1/12/1997	22.160	22.38

Date	mAHD	Years Max
6/01/1998	21.970	
2/02/1998	21.820	
4/03/1998	21.650	
31/03/1998	21.590	
4/05/1998	21.460	
3/06/1998	21.450	
1/07/1998	21.650	
5/08/1998	21.820	
2/09/1998	22.050	
1/10/1998	22.230	
27/10/1998	22.220	
26/11/1998	22.100	22.23
6/01/1999	21.910	
3/02/1999	21.780	
4/03/1999	21.650	
8/04/1999	21.490	
4/05/1999	21.390	
4/06/1999	21.450	
30/06/1999	21.610	
23/07/1999	21.820	
7/09/1999	22.160	
5/10/1999	22.390	
29/10/1999	22.480	
3/12/1999	22.340	22.48
6/01/2000	22.160	
1/02/2000	22.250	
29/02/2000	22.060	
30/03/2000	21.920	
1/05/2000	21.850	
1/06/2000	21.800	
4/07/2000	22.180	
1/08/2000	22.610	
31/08/2000	22.770	
29/09/2000	22.720	
1/11/2000	22.600	
6/12/2000	22.450	22.77
3/01/2001	22.310	
31/01/2001	22.140	
7/03/2001	21.940	
30/03/2001	21.810	
30/04/2001	21.670	
31/05/2001	21.770	
27/06/2001	21.820	
27/07/2001	22.080	
29/08/2001	22.470	
14/09/2001	22.570	
28/09/2001	22.610	
17/10/2001	22.610	
26/10/2001	22.660	
4/12/2001	22.480	22.66
3/01/2002	22.320	
31/01/2002	22.170	
27/02/2002	22.000	
3/04/2002	21.800	
24/04/2002	21.840	
29/05/2002	21.730	
27/06/2002	22.010	
25/07/2002	22.300	
22/08/2002	22.410	
26/09/2002	22.500	
29/10/2002	22.380	
4/12/2002	22.670	
31/12/2002	22.120	22.5
30/01/2003	21.910	
26/02/2003	21.780	
26/03/2003	21.630	
1/05/2003	21.580	
28/05/2003	21.640	
25/06/2003	21.710	
30/07/2003	22.310	
27/08/2003	22.630	
1/10/2003	22.720	
30/10/2003	22.580	
28/11/2003	22.480	22.72
6/01/2004	22.280	
29/01/2004	22.140	
26/02/2004	21.980	
25/03/2004	21.820	
23/04/2004	21.670	
21/05/2004	21.720	
30/06/2004	21.910	
29/07/2004	22.080	
31/08/2004	22.430	
28/09/2004	22.460	
26/10/2004	22.420	
23/11/2004	22.320	
21/12/2004	22.220	22.46

Date	mAHD	Years Max
25/01/2005	22.030	
22/02/2005	21.890	
22/03/2005	21.750	
19/04/2005	21.690	
17/05/2005	21.250	
14/06/2005	22.420	
26/07/2005	22.850	
23/08/2005	22.930	
29/09/2005	22.980	
26/10/2005	22.890	
30/11/2005	22.760	
21/12/2005	22.660	22.98
30/01/2006	22.510	
22/02/2006	22.410	
29/03/2006	22.210	
27/04/2006	22.160	
26/05/2006	22.040	
28/06/2006	21.970	
26/07/2006	22.520	
29/08/2006	22.320	
28/09/2006	22.300	
26/10/2006	22.210	
29/11/2006	22.080	
18/12/2006	22.010	22.32
12/01/2007	21.910	
14/02/2007	21.750	
15/03/2007	21.610	
16/04/2007	21.500	
11/05/2007	21.440	
12/06/2007	21.380	
11/07/2007	21.670	
8/08/2007	22.010	
13/09/2007	22.310	
5/10/2007	22.390	
7/11/2007	22.360	
5/12/2007	22.230	22.39
9/01/2008	22.080	
7/02/2008	21.920	
19/03/2008	21.760	
8/04/2008	21.830	
5/05/2008	21.750	
5/06/2008	21.920	
2/07/2008	22.180	
14/08/2008	22.730	
3/09/2008	22.680	
16/10/2008	22.660	
11/11/2008	22.680	
9/12/2008	22.610	22.73
14/01/2009	22.450	
12/02/2009	22.280	
12/03/2009	22.140	
9/04/2009	21.990	
14/05/2009	21.820	
10/06/2009	21.810	
9/07/2009	22.100	
14/08/2009	22.450	
8/09/2009	22.690	
8/10/2009	22.720	
4/11/2009	22.580	
3/12/2009	22.490	22.72
8/01/2010	22.290	

3157 AAMGL	**22.61**

Calculation of AAMGL

Calculated AAMGL for 3157	22.61	mAHD
Measured Level (22/9/2009)	22.72	mAHD
Difference between calculated and measured	-0.10	mAHD

22/09/2009		**calculated AAMGL**
	(mAHD)	(mAHD)
MC1	21.647	**21.55**
MC2	23.131	**23.03**
MC3	21.914	**21.81**
MC4	23.804	**23.70**
MC5	20.674	**20.57**
MC6	24.087	**23.99**
DoW 3157	**22.715**	**22.61**