



Lot 1507 Eighty Road, Baldivis
Local Structure Plan



APPENDIX J

LOCAL WATER MANAGEMENT STRATEGY



PARKLAND HEIGHTS

LOT 1507 EIGHTY ROAD BALDIVIS

LOCAL WATER MANAGEMENT STRATEGY



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LOT 1507 EIGHTY ROAD BALDIVIS

LOCAL WATER MANAGEMENT STRATEGY

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STATEMENT OF LIMITATIONS

Scope of Services

This environmental site assessment report (“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.

Reliance on Data

In preparing the report, ENV has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report (“the data”). Except as otherwise stated in the report, ENV has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (“conclusions”) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. ENV will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to ENV.

Environmental Conclusions

In accordance with the scope of services, ENV has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions. Also it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

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Other Limitations

ENV will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

The scope of services did not include any assessment of the title to or ownership of the properties, buildings and structures referred to in the report nor the application or interpretation of laws in the jurisdiction in which those properties, buildings and structures are located.

EXECUTIVE SUMMARY

This report has been prepared by ENV. Australia Pty Ltd to support the submission of a revised version of a Local Structure Plan for the land located in Lot 1507 Eighty Rd, Baldivis. This site is owned by Rockingham Park Pty Ltd and is also known as Parkland Heights.

Under *Better Urban Water Management (BUWM)* (WAPC 2008a), a Local Water Management Strategy (LWMS) is required to support the Local Structure Plan prior to subdivision and development of land zoned Urban. The BUWM sets out the requirements for a LWMS, which must be approved by the Western Australian Planning Commission on advice of the Department of Water as part of the Local Structure Plan Approval.

The objective of the Local Water Management Strategy (LWMS) is to ensure that sustainable management of the total water cycle at Parkland Heights, Lot 1507 Eighty Rd, Baldivis occurs through Water Sensitive Urban Design. This includes water conservation, stormwater management and groundwater management. Rockingham Park Pty Ltd aims to manage these issues at the site through the following initiatives:

Water Conservation

- Participating in the Urban Development Institute of Australia's EnviroDevelopment program to achieve a maximum potable water usage of 80 kL/person/year and meet the EnviroDevelopment target of a 20% reduction in scheme water use;
 1. Behaviour change of householders, encouraging water conservation through education packages and the construction of a Waterwise Display Village (The Behaviour Change Program).
 2. Providing waterwise front gardens to all homes in Parkland Heights
- Providing Waterwise landscaping for Public Open Space (POS) that includes waterwise plants, soil amendments to improve water and nutrient retention, minimising turf areas and water efficient irrigation; and
- Using groundwater to irrigate POS.

Stormwater Management

- Implementing a drainage design that ensures pre-development discharge rates in the event of a 1 in 100 year ARI event will be maintained through storage and infiltration on site; and
- Maximising infiltration by developing swales and rain gardens in road reserves where possible, planted with native vegetation to encourage nutrient and

suspended solids uptake and removal prior to infiltration. Open based manholes will also be used to maximise infiltration. Infiltration basins in Public Open Space will manage larger events.

Groundwater Management

- Recognising the issue of groundwater availability and planning low water use POS.

This LWMS demonstrates that Parkland Heights, Lot 1507 Eighty Rd, Baldivis can be developed without significant constraints. The outstanding issues can be resolved at the Urban Water Management Plan stage to create a development that meets the goals and ideals of *Better Urban Water Management*.

1 INTRODUCTION

This report has been prepared to support the submission of a Local Structure Plan for Lot 1507 Eighty Road, Baldivis. The study area is approximately 40 km kilometres south of Perth in the City of Rockingham (Figure 1). The site is situated on the Spearwood Dunes system on the Swan Coastal Plain. It was cleared in the 1960's and has since been operated as an agroforestry plantation (Figure 1). It is bound by existing and approved residential housing to the north and east of the site respectively, Eighty Road to the west and Sixty-Eight Road immediately south. The total area of the site is approximately 120 hectares.

Under *Better Urban Water Management* (BUWM) (WAPC, 2008a) and *Planning Bulletin 92* (WAPC, 2008b) a Local Water Management Strategy (LWMS) is required to support a Local Structure Plan (LSP). An amended LSP is being prepared to expand the area within the existing LSP at Lot 1507 Eighty Road to include land on the east side of Nairn Drive (Figure 2). The LWMS provides strategic information regarding the management of water in the development while outlining and demonstrating the feasibility of the proposed drainage design. This work is then refined and details confirmed at the Subdivision Stage through Urban Water Management Plans for each subdivision application area. *BUWM* and the document *Interim: Developing a Local Water Management Strategy* (DoW, 2008) set out the requirements for a LWMS. The agency responsible for the approval of the LWMS is the Western Australian Planning Commission (WAPC) on advice of the Department of Water (WAPC, 2008b).

1.1 Total Water Cycle Management – Principles and Objectives

The process of managing the total water cycle in an urban scenario is referred to as Water Sensitive Urban Design (WSUD). A Local Water Management Strategy seeks to support WSUD by assisting to design, develop and maintain urban water systems that are sensitive to the total water cycle. The principles of WSUD as outlined in the *Better Urban Water Management* (BUWM) (WAPC, 2008a) have been used here. These principles are to:

- Protect natural systems – protect and enhance natural water systems and their hydrological regimes in urban developments;
- Integrate stormwater treatment into the landscape – use stormwater in the landscape by incorporating multiple use corridors that maximise the visual and recreational amenity of developments;
- Protect water quality – protect the water quality draining from urban development and minimise outputs of phosphorus and nitrogen and other pollutants;
- Manage run-off and peak flows – reduce peak flows from urban developments by using local detention measures and minimising impervious areas; and

- Add value while minimising development costs – minimise the drainage infrastructure cost of development.

1.2 Planning Background

1.2.1 Metropolitan Region Scheme

The site is situated in the South-West Corridor of the Perth Metropolitan Region. The land is zoned Urban under the Metropolitan Region Scheme (MRS) and is included within Category A1 of the South West Corridors Structure Plan, being land assessed as having no constraints to urban development.

1.2.2 City of Rockingham District Zoning Scheme (Town Planning Scheme No. 2)

Under the City of Rockingham District Zoning Scheme (Town Planning Scheme No. 2) the site is zoned Development.

1.2.3 Baldivis South District Structure Plan

The Baldivis South District Structure Plan (DSP) was prepared for the site by the City of Rockingham in 2004. A District Water Management Strategy (DWMS) was not developed as part of the DSP.

1.3 Previous Studies

Previous studies into land and water management at the subject site include:

- Lot 1507 Eighty Road Baldivis, Geotechnical Investigation Report, Prepared for Summit Homes Group (Sinclair Knight Merz, 2009);
- Preliminary Acid Sulphate Soils Investigation Lot 1507 Sixty Eight Road, Baldivis WA, Prepared for Rockingham Park Pty Ltd (ENV, 2009a);
- Environmental Preliminary Site Investigation Lot 1507 Sixty Eight Road, Baldivis WA, Prepared for Rockingham Park Pty Ltd (ENV, 2009b);
- Flora and Vegetation of Lot 1507 Sixty-Eight and Eighty Roads, Baldivis, Prepared for Rockingham Park Pty Ltd (ENV, 2009c);
- Lot 1507 Sixty-Eight Road, Baldivis Black Cockatoo Assessment, Prepared for Rockingham Park Pty Ltd (ENV, 2010);
- Parkland Heights, Lot 1507 Sixty-Eight Road Baldivis, Environmental Assessment, Prepared for Rockingham Park Pty Ltd (ENV, 2011a); and
- Parkland Heights Acid Sulfate Soils Dewatering Management Plan, Prepared for Rockingham Park Pty Ltd (ENV, 2011b).

2 PROPOSED DEVELOPMENT

2.1 KEY POINTS OF STRUCTURE PLAN

The Local Structure Plan (LSP) presents a predominantly low and medium residential development forming a community with a range of densities (R15 – R60) including single and grouped dwellings. The site is divided east and west by Nairn Drive, a major road in the South Baldivis traffic network (Figure 2).

Within the residential areas, provisions have been made for 20 areas of Public Open Space (POS) for both drainage and amenity purposes. Provision has also been made for a primary school located in the area east of Nairn Drive. Community and recreation facilities and a local centre are also included within the LSP to enhance community amenity within the development (Figure 2). A staging plan is provided in Figure 7.

A focus on preserving and reinforcing existing positive site characteristics will be implemented through the proposed landscape treatment of the site. POS have been planned to incorporate significant existing trees along Eighty Road both pines and eucalypts) where possible. The existing vegetation will provide the foundation and structure for new tree planting, which will include eucalypts and pines, as well as deciduous trees in key areas to reference the semi-rural character of the area.

2.2 ENVIRONMENTAL REPORT AND MANAGEMENT PLAN

An Environmental Assessment of Lot 1507 Eighty Road, Baldivis was undertaken by ENV Australia and included in the Local Structure Plan (ENV, 2011a). The report is based on work done for the site in the preparation of the Local Structure Plan, including a desktop study, a flora and vegetation survey and an acid sulfate soils investigation, carried out by ENV Australia. The report presents opportunities and constraints for development of the site and recommendations for environmental management of the site related to the proposed development (ENV, 2011a).

3 DESIGN CRITERIA

The principles, design objectives and criteria shown here are from *Better Urban Water Management (BUWM)* (WAPC, 2008a). Quotes from BUWM are shown in italics.

3.1 WATER CONSERVATION - AND EFFICIENCY

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 of 100 kL/person/year (State Water Plan Target).

Site Response

The development will aim to achieve the target of a maximum scheme water usage of 80 kL/person/year through Rockingham Park's participation in the UDIA EnviroDevelopment program and the expected uptake of groundwater for POS and residential irrigation. The Water Corporation's latest potable water use study 'Perth's Residential Water Use Study 2008/2009' (Water Corporation, 2010) found that the average potable water consumption rate was 106 kL/person/year. Water efficiency programs will be developed to target behaviour change of householders and promote the use of non-potable water sources to minimise potable water use both in-house and ex-house. This will be modelled in the display village. All homes will have water wise front garden landscapes in order to assist in meeting the EnviroDevelopment target of a 20% reduction in potable water use.

3.2 WATER QUANTITY MANAGEMENT

Principle

Post-development annual discharge volume and peak flows will be maintained relative to pre-development conditions, unless otherwise established through determination of Ecological Water Requirements for sensitive environments (WAPC, 2008a).

Criteria

Ecological Protection - *For the critical one-year average recurrence interval (ARI) event, the post-development discharge volume and peak flow rates shall be maintained relative to pre-development conditions in all parts of the catchment. Where there are identified impacts on significant ecosystems, maintain or restore desirable environmental flows and/or hydrological cycles as specified by the DoW.*

Flood Management - *Manage the catchment run-off for up to the 1 in 100 year ARI event in the development area to pre-development peak flows, unless otherwise indicated in*

an approved strategy or as negotiated with the relevant drainage service provider (WAPC 2008a).

Site Response

The drainage strategy for the site is based on detention of stormwater on-site to maintain pre-development discharge rates in events up to the 1 in 100 year ARI. Run-off from 1 in 1 year ARI events will be infiltrated on site.

3.3 WATER QUALITY MANAGEMENT

These 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, predominantly nutrients. The site is considered to be unlikely to be contaminated based on the land use history of being largely vegetated (ENV, 2008b). As such, contaminated sites guidelines do not apply.

Bio-retention structures with an area equivalent to 2% of the directly connected constructed impervious area will be provided as close to source as possible and practical.

3.4 STORMWATER 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.

3.5 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.

Permanent water bodies are not proposed for this site.

4 PRE-DEVELOPMENT ENVIRONMENT

4.1 TOPOGRAPHY

The site is composed of remnant bushland and pine plantation and is situated at an elevation of 4 - 42 m AHD (Figure 3). The site is undulating, but generally slopes overall from the south-east to north-west, with the lowest point of the site on the western border. There are also two lower points in the centre of the site with heights of 10 – 11 m AHD (Figure 3).

4.2 SOILS AND GEOLOGY

Regional geological information was obtained from the Geological Survey of WA 1:50,000 Environmental Geology Series which describes the geology at and surrounding the site (Gozzard, 1986) (Figure 4). Only one geological unit was identified at the site:

- S7 SAND – (Sand derived from Tamala limestone) pale yellowish brown, medium to coarse-grained, sub-angular to well-rounded quartz, trace of feldspar, shell debris, variably lithified, surface kankar, of eolian origin.

This soil unit is also known as 'Spearwood Sand'. This classification is generally consistent with the geotechnical work undertaken by SKM (2009). ENV (2009a) also recorded the presence of a layer of clayey sand at a depth of 1.7 m at groundwater bore MW1 located in the north-western corner of the site (Figure 8, Appendix C of ENV, 2009a). As this layer was not reported in any other surveys, it is assumed that this layer is isolated to a small area near this bore only.

The physical properties of the site geology are described as follows (GSWA, 1980):

- High permeability;
- Low to medium slope stability; and
- Moderate ease of excavation.

A geotechnical report of the site (SKM, 2009) summaries permeability testing and geological results obtained at three test pits across the site (Figure 3). Soils within the site were found to consist predominantly of sand with a hydraulic conductivity between 4.3 – 5.9 m/day and of moderate to good drainage characteristics (SKM, 2009).

4.2.1 Acid Sulfate Soils

An Acid Sulfate Soils (ASS) Investigation was undertaken on the site by ENV in 2009 (ENV, 2009a). The investigation indicated that the site was generally at a low risk of ASS, in line with the ASS risk mapping of the site (Figure 4). Only one soil sample showed evidence of ASS. This was found at MW1 in the north-west of the site at a

depth of 2.25 m (Figure 8, Appendix C of ENV, 2009a). This may be due to its proximity to a high risk ASS area associated with an adjacent wetland (identified in Section 4.3).

Should future excavation works involve the disturbance of soil at or near the water table and groundwater in the north-western vicinity of the site, further localised investigation is recommended and it may trigger some management specific to this corner of the site.

4.2.2 Phosphorus Retention Index

Phosphorus Retention Index (PRI) was measured at four groundwater bores at the site during installation. The PRI results are presented in Table 1 below.

Table 1: Phosphorus Retention Index Test Results

| Location | PRI |
|----------|-----|
| MW1 | 0 |
| MW2 | 4.2 |
| MW4 | 1.1 |
| MW5 | 6 |

According to Allen and Jeffery (1990), soils with PRIs of less than 2 may be classified as very weakly adsorbing or desorbing of phosphorus and PRIs between 2-5 as weakly adsorbing of phosphorus. This indicates that the soils at the site have a low natural nutrient retention property with respect to phosphorus.

With the exception of soil at bore MW5 (PRI = 6), the PRI results are generally below the usual range expected for a Spearwood Sand of 5 -20 (Allen and Jeffrey, 1990). This may be due in part to the use of the site as a pine plantation, which may have enhanced leaching of the surface soils. Observations of adjacent sites indicate that the soils become a darker yellow or orange colour at depth, suggesting that more iron oxides are present at depth. This may imply an increase in PRI with depth (Bolland, Allen and Barrow, 2003).

4.2.3 Contaminated Sites Assessment

ENV has undertaken an Environmental Preliminary Site Investigation (PSI) of the site (ENV, 2009b). Searches indicated that the site was not subject to any specific land use prior to 1963 (ENV, 2009b). Aerial photographs of the site before 1963 confirm this and show surrounding areas consist entirely of bushland (ENV, 2009b). Early stages of land cultivation to the east and west of the site are observable in aerial photographs taken in

1963 (ENV, 2009b). The site was cultivated for forestry product purposes at some stage between 1963 and 1974 (ENV, 2009b). There is no indication that the site was utilised for any other land use between 1973 and 2000 (ENV, 2009b). The Forest Products Commission began harvesting the pine trees at the site between 2001 and 2004 (ENV, 2009b).

No record of the site was found on the Department of Environment and Conservation Contaminated Sites Database at the time of the investigation (ENV, 2009b). It was therefore considered that a Detailed Site Investigation (DSI) was not required (ENV, 2009b).

4.3 SURFACE WATER QUANTITY AND QUALITY

The site is located within the Peel-Harvey catchment. There are no ephemeral or permanent surface water bodies located within the site. The nearest wetlands to the site are Outridge Swamp, located 80 m west of the site and Lake Walyungup, located 1.7 km north-west of the site.

There are no drainage lines within the site due to the high permeability of the Spearwood Sands at the site, as described in Section 3.2. The site is therefore dominated by infiltration with little to no surface run-off except during extreme storm events.

4.4 GROUNDWATER QUANTITY AND QUALITY

ENV installed five groundwater monitoring bores at the site using air and mud rotary methods in October 2009 (Appendix A). Four Department of Water (DoW) groundwater bores have also been included in the groundwater monitoring program at the site (Table 2). ENV undertook pre-development groundwater level and quality monitoring for the period of October 2009 to March 2011. Groundwater levels have currently been measured during 12 events and five sets of water samples have been collected and analysed.

4.4.1 Groundwater Levels

The five ENV bores and four DoW bores located on or near the site have been monitored monthly since 28 October 2009 until most recently on 11 November 2010 (Figure 6). The groundwater levels measured in the DoW bores since installation in 1975 were also reviewed to provide maximum and minimum groundwater levels (Appendix B). Groundwater levels have been measured for at least two winters in 2009 and 2010.

The Annual Average Maximum Groundwater Levels (AAMGLs) on the site were calculated from levels measured in October 2009 and varied from 2.41 mAHD in MW1 in the north-west to 1.50 mAHD at MW5 in the south. Depth to AAMGLs varied between

8.65 m Below Ground Level (BGL) at MW4 in the south-west, to 1.67 mBGL at MW3 in the west (Table 2). MW3 is located in one of the lowest areas of the site. On many areas of the site the depth to AAMGLs exceeds 20 m (Figure 6). Groundwater contour mapping is presented in Figure 6.

The minimum groundwater levels measured on-site varied from 1.6 mAHD (January 2010) at MW1 in the north-east to 0.35 mAHD (May 2010) at MW5 in the south of the site. Full monitoring records may be found in Appendix C.

The regional flow direction shown in the Second Edition of the Perth Groundwater Atlas (DoE, 2004) is south-west towards Lake Walyungup. This direction is consistent with groundwater levels measured by ENV, which indicate a clear south-westerly flow direction towards Lake Walyungup, as well as a general southerly direction (Figure 6).

Table 2: AAMGLs at or near Lot 1507 Eighty Rd, Baldivis Groundwater Bores

| Bore | Annual Average Maximum Groundwater Levels (mAHD) | Depth to AAMGLs (mBGL) |
|----------|--|------------------------|
| MW1 | 2.41 | 1.87 |
| MW2 | 2.38 | 5.81 |
| MW3 | 2.35 | 1.67 |
| MW4 | 2.34 | 8.65 |
| MW5 | 1.50 | 5.46 |
| DoW 3011 | 2.25 | 4.51 |
| DoW 3012 | 2.23 | 4.53 |
| DoW 3033 | 2.35 | 8.37 |
| DoW 3034 | 2.35 | 11.51 |

Figure 6 also shows bores F and G. These bores were initially installed to record upstream groundwater levels and quality at the site. These bores however were dry at 21m and advise from the DoW in 2009 was that they therefore did not need to be monitored.

4.4.2 Groundwater Quality

The groundwater quality monitoring program included the measurements of physical parameters of acidity and electrical conductivity, measurements of total and components of nitrogen and phosphorus and a suite of heavy metals, detailed below. No groundwater quality data is available for bore MW2 because it has been blocked since October 2009, thus not allowing bailers to reach groundwater for sampling. The

thinner water level probes were still able to move freely through the bore however, and measure water levels at MW2.

Physical parameter measurements were taken using hand-held water quality meters in collected groundwater samples. Groundwater samples were purged and collected using bailers and analysed at National Association of Testing Authorities (NATA)-accredited laboratory MPL Laboratories, Myaree.

Physical Parameters

pH was found to be generally stable and neutral in all bores located within the site (Table 3 and Figure 6). Electrical conductivity (EC) levels measured in groundwater were found to be similar and of freshwater quality in all bores. Full physical parameter results may be found in Appendix C.

Table 3: Groundwater Physical Parameter Results

| Bore | pH | | | Mean EC (mS/cm) | Calculated TDS (mg/L) ¹ |
|------|------|---------|---------|-----------------|------------------------------------|
| | Mean | Minimum | Maximum | | |
| MW1 | 5.53 | 5.35 | 5.7 | 0.67 | 335 |
| MW3 | 6.37 | 6.16 | 6.68 | 0.45 | 227 |
| MW4 | 7.52 | 7.39 | 7.66 | 0.75 | 377 |
| MW5 | 6.43 | 6.13 | 6.82 | 0.58 | 288 |

¹TDS (Total Dissolved Solids) calculated from EC assuming pure NaCl and conversion factor of 500

Nutrient Concentrations

Groundwater at the site was generally found to have levels of Total Phosphorus (TP) exceeding the Long Term Swan-Canning Cleanup Program (SCCP) target of 0.1 mg/L (SRT, 1999) with mean TP concentrations varying between 0.11 and 0.48 mg/L (Table 4 and Figure 6). However, PO₄ concentrations at all bores were negligible and only bore MW4 was found to minimally exceed detection limits, which suggests that phosphorus in groundwater at the site exists predominantly in a particulate form.

Total Nitrogen (TN) concentrations exceeded the long-term SCCP target of 1 mg/L at all bores except for MW5. TN concentrations in MW1 were also found to equal or exceed the ANZECC Fresh Water Quality guidelines level of 1.2 mg/L (Table 4 and Figure 6). Full nutrient results may be found in Appendix C. Given a breakdown of nitrogen in groundwater in Table 4, the predominant form is organic (Kjeldahl) nitrogen (TKN).

Table 4: Mean Groundwater Nutrient Results

| Monitoring Location | Total P mg/L | PO4 mg/L | Total N mg/L | NO3-N mg/L | NH3-N mg/L | TKN mg/L |
|------------------------------------|-----------------|-------------|-----------------|---------------|---------------|-------------|
| MW1 | 0.22 | <0.005 | 3.35 | 0.13 | 0.46 | 3.25 |
| MW3 | 0.48 | <0.005 | 1.09 | 0.01 | 0.16 | 1.09 |
| MW4 | 0.24 | 0.0058 | 1.00 | 0.20 | 0.04 | 0.79 |
| MW5 | 0.11 | <0.005 | 0.93 | 0.13 | 0.05 | 0.79 |
| SCCP long-term Target ¹ | 0.1 | - | 1 | - | - | - |
| ANZECC Guidelines ² | 0.065 | 0.04 | 1.2 | 0.15 | - | - |

¹SRT (2003)²ANZECC & ARMCANZ (2000). Guidelines are for slightly disturbed ecosystems in south-west Australia.

Heavy Metal Concentrations

Groundwater samples were analysed for a suite of heavy metals listed in Table 5 below. Mean Chromium (Cr), Copper (Cu) and Zinc (Zn) concentrations exceeded ANZECC Fresh Water Quality guidelines levels (95% level of protection) in bores. Mean Cadmium (Cd) concentrations exceeded ANZECC Fresh Water Quality guidelines (95% level of protection) in all bores except MW1, however, MW1 was also the only bore where mean Arsenic (As) and Nickel (Ni) concentrations did exceed the guidelines. Mean Lead (Pb) concentrations exceeded ANZECC Fresh Water Quality guidelines (95% level of protection) in two of the four bores sampled, MW1 and MW5.

Given that the detection limit for Mercury (Hg) analysis (<0.0001 mg/L) was greater than the ANZECC guideline level (0.00006 mg/L), it is not possible to determine whether the ANZECC guideline level (95% level of protection) was exceeded. However, Hg mean concentrations were found to be below detection limits in all bores sampled.

Table 5: Mean Groundwater Metals Results

| Bore | As (mg/L) | Cd (mg/L) | Cr (mg/L) | Cu (mg/L) | Pb (mg/L) | Ni (mg/L) | Zn (mg/L) | Hg (mg/L) |
|---|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| MW1 | 0.024 | 0.0001 | 0.046 | 0.01 | 0.01 | 0.02 | 0.07 | <0.0001 |
| MW3 | 0.015 | 0.0008 6 | 0.024 | 0.003 | 0.0026 | 0.003 2 | 0.032 | <0.0001 |
| MW4 | 0.002 | 0.0008 6 | 0.003 | 0.0046 | 0.0016 | 0.004 2 | 0.024 | <0.0001 |
| MW5 | 0.01 | 0.0008 6 | 0.038 | 0.006 | 0.0078 | 0.004 2 | 0.13 | <0.0001 |
| ANZECC Guideline ¹ (mg/L) | 0.024 | 0.0002 | 0.001 | 0.0014 | 0.0034 | 0.011 | 0.008 | 0.00006 |

¹ANZECC & ARMCANZ (2000). Guidelines are trigger values for freshwater with 95% level of protection.

4.5 ENVIRONMENTAL ASSETS

This section represents a brief summary of the environmental assets and water dependent ecosystems on the site. Further information on the species and management of flora and fauna on the site can be found in *Flora and Vegetation of Lot 1507 Sixty-Eight and Eighty Roads, Baldivis* (ENV, 2009c), which also accompanies the Local Structure Plan.

4.5.1 Vegetation Type and Condition

The site does not appear to be constrained in terms of floristic attributes. The vegetation over most of the site is cleared with no good quality remnant vegetation of significance.

Twenty-two families, 35 genera and 40 taxa (18 of which were introduced) were found during the survey. None of these are listed as significant species.

The site contains one main vegetation unit - Open Woodland of *Eucalyptus gomphocephala*, *Eucalyptus marginata* and **Pinus pinaster* over *Acacia saligna*, *Jacksonia furcellata* and *Xanthorrhoea preissii* over weeds. There are no flora species or vegetation communities of significance on the site. There are no areas of vegetation or particular trees that should be retained in planning urban development for the site and no particular requirements for management have been identified.

4.5.2 Water Dependiant Ecosystems

There are no wetlands, springs or other water dependant ecosystems located within the site. A Conservation Category Wetland (CCW) and Multiple Use Wetland (UFI 6394),

Outridge Swamp, is located approximately 80 m to the west of the site (Figure 5). Another CCW Wetland (UFI 13083), Stakehill Swamp, is located further west, approximately 600 m of the site. The local groundwater flow direction at the site is partially south-west and may have some influence on the wetlands located directly west of the site.

5 WATER SUSTAINABILITY

5.1 INTRODUCTION

This section provides a summary of water conservation measures that will be undertaken at Lot 1507 Eighty Road, Baldivis. Water conservation criteria for Water Sensitive Urban Design (WSUD) in BUWM (WAPC, 2008) provide a consumption target of 100 kL/person/year. At a minimum, the development at Lot 1507 Eighty Road, Baldivis aims to meet the State Water Plan target of 100 kL/person/year. However, a greater goal of achieving a 20% reduction in potable water use will be implemented through Rockingham Park's participation in the UDIA EnviroDevelopment program. Additional savings will be achieved through use of residential bores for garden irrigation and commercial bores for POS irrigation.

The Water Corporation's latest potable water use study 'Perth's Residential Water Use Study 2008/2009' (Water Corporation, 2010) found that the average potable water consumption rate was 106 kL/person/year whereas the State Water Plan states a target of 100kL/p/a. Therefore, to meet the EnviroDevelopment potable water reduction target of 20%, a maximum usage of 80 kL/person/year of potable water is required. The water sustainability initiatives to meet this target are addressed below.

This section also addresses the provision of water for the irrigation within the development of areas of Public Open Space (POS), the proposed primary school and the servicing of potable water and wastewater supplies and sources. Water conservation issues are summarised and matters to be addressed at subdivision are presented.

5.2 WATER CONSERVATION STRATEGY

Rockingham Park Pty Ltd is seeking certification of sustainability initiatives undertaken at its Lot 1507 Eighty Rd development through the UDIA EnviroDevelopment program, including those specifically targeting water conservation under the Water Element of the program.

The EnviroDevelopment program seeks to raise the level of sustainable urban land development in WA and provides awards across six elements where it can be verified that sustainability benchmarks will be achieved. These elements include water conservation through the reduction of potable water consumption, as well as protecting ecosystems, reducing waste and increasing recycling, reducing energy use, using environmentally responsible materials in development and encouraging sustainable community amenities and behaviour.

To achieve water conservation at Lot 1507 Eighty Rd, the following EnviroDevelopment principles will be implemented:

- Reduction of overall potable water use by more than 20% through water efficiency measures; and

- Use of alternate water sources.

Support will also be provided to residents to educate them on how to minimise their water use. Sustainability Information Packages (SIPs) will be provided by Rockingham Park to homeowners as an educational tool on water conservation, reducing fertiliser use and other sustainability initiatives, as well as stipulating requirements on the built form of each lot. Education will also be promoted through the construction of a Waterwise Display Village designed to display and endorse waterwise practices both inside and outside the house. In addition to participating in the EnviroDevelopment program, Rockingham Park Pty Ltd is also investigating a Waterwise Land Development accreditation from the Water Corporation to demonstrate their commitment to water conservation.

The Water Corporation Waterwise criteria to be investigated for Lot 1507 Eighty Rd include:

- Addressing water efficiency and water conservation within the Entry Statement and Public Open Spaces;
- Addressing water efficiency and water conservation through innovation in all major buildings within the development;
- Including specific clauses that reflect water efficiency and water conservation within the general conditions of sale, in relation to both private and public buildings and building of display villages; and
- Educating the community on water efficiency and water conservation.

5.2.1 Water Efficiency Measures

Approximately half of all household water use is for maintaining gardens, therefore minimising water demand for landscaping is an essential water conservation measure for residential areas (Water Corporation, 2010). Ex-house irrigation controls can be easily implemented through the developer provided landscaping packages.

Rockingham Park will commit to implementing its goal of reducing overall potable water use by more than 20% through offering waterwise front garden landscaping to all homes in the development. In addition programs will be implemented to support residents to use less water through behavioural changes.

Note that residential bore water use has not been included in these calculations and the uptake off this alternate water source would reduce the scheme water use significantly further.

In addition to these options, it will be incentivised through the associated rebate packages to plumb homes for provisional connection to rainwater and grey water reuse schemes (as per the earlier proposed Five Star Plus Stage Two program).

It is intended that waterwise landscaping packages through Waterwise landscaping incentive packages by Planet Landscapes will be provided by Rockingham Park as part of each lot sale. These packages will include the use of soil amendments (such as mulch or clayey/loamy soils to improve water and nutrient retention), waterwise plants (with native options), paving or mulched surfaces and minimising turf areas, based upon individual garden requirements of the landowner.

In addition to these water efficiency measures aimed at the household scale, waterwise landscape design will also be undertaken for all POS and streetscapes. POS and streetscape design will also include the use of soil amendments, waterwise plants with native options, paving or mulched surfaces and minimal turf areas where practical.

5.2.2 Potential Alternate Water Sources

Rockingham Park will also commit to implementing its goal of reducing overall potable water use through the provision of a combination of the following water efficiency measures implemented in POS, as well as in-house and ex-house in individual houses:

- The use of **groundwater** for irrigation of POS and streetscapes.
- Consideration of the use of **grey water**: home grey water reuse systems on all 'traditional' lots (R20 and R40) and group housing lots (from bathrooms only) for irrigation of perennial garden beds, where garden areas are large enough to meet Department of Health standards.
- Consideration of the use of **rainwater**: rainwater harvesting tanks (minimum of 2000L) on all houses where roof areas are large enough to be plumbed in to supplement toilets and laundry water use. These systems will be promoted for use from the Stage 1 Display Village.

A preliminary water balance (Appendix F) has been completed for each of these individual options to determine how much water will be saved at the development if any of these are implemented. The cost-benefit aspects of these alternative water source options will also be considered at the subdivision stage of the development.

5.2.3 Education Strategies

Marketing and educational tools are important in encouraging the behaviour change of future landowners. The installation of waterwise fittings by landowners, further to those required for Stage 1 of the Five Star Plus scheme, may reduce water usage by up to 25% (Water Corporation, 2008). Sustainability Information Packages (SIPs) provided by Rockingham Park will be designed to ensure that landowners are aware of all

possible water conservation measures and how best to apply them. The packages will be distributed individually and will be supported by free community workshops and householder consultations on waterwise design.

SIPs will comprise information on, but will not be limited to, advice on the following:

- Changing personal and family water use behaviour, both in-house and ex-house;
- Using Water Efficiency Labelling and Standards (WELS) to choose fixtures with greater than four stars for tap fittings and three stars for shower heads, as well as advice about choosing flow regulators, low flow dual flush toilet, washing machines and relevant rebates available from the State Government;
- Water efficiency measures for ex-house use, including how to operate waterwise irrigation systems, frequency and timing of irrigation, landscaping packages and timing and the use of pool covers;
- Rainwater tanks, requirements, information about installation of tanks, switching systems and plumbing to toilets and/or laundry and relevant rebates; and
- Greywater systems, including requirements, approved products, regulatory approvals, installation of infrastructure for irrigation and relevant rebates.

Rockingham Park Pty Ltd plans to build a Waterwise Display Village that meets Water Corporation standard (Water Corporation, 2007) for viewing by potential and new landowners. The Display Village will be designed to display and promote waterwise practices both inside and outside the house. Sustainability Information Packages (SIP) and tours of the Display Village will be provided to explain waterwise measures, such as waterwise fittings, appliances, landscaping and irrigation. Features are expected to include rainwater tanks and connections, water efficient taps and shower heads in kitchens and bathrooms and mulching, waterwise plants, turf, soil amendments and irrigation controllers in the garden.

Rockingham Park Pty Ltd is investigating obtaining a Waterwise Land Development accreditation from the Water Corporation to demonstrate their commitment to water conservation. This accreditation is obtained by submitting an application to the Water Corporation specifying that water conservation targets have been met for POS, water efficient methods have been addressed in public and private buildings (including the display village) and that the community will be educated on water conservation via methods such as literature (SIPs).

5.3 PROJECTED POTABLE WATER CONSUMPTION

- The 80 kL/person/year EnviroDevelopment target (Section 5.1) can be achieved as shown in Appendix F. These calculations are determined from the current water yields calculated from given lot yields, based on Water Corporation Waterwise

Calculator assumptions, take-up rates of water efficiency packages and dwelling statistics. It is estimated that a typical resident living in Lot 1507 Eight Road, Baldivis will potentially use less than 80 kL/year on average of scheme water.

The water sustainability initiatives will save 26% volume of scheme water, based on current Water Corporation figures, and meet BUWM design criteria. It will also meet EnviroDevelopment criteria for the Water Element of a 20% reduction of potable water. Full potable demand calculations may be found in Appendix F.

5.4 PUBLIC OPEN SPACE (POS) IRRIGATION

Rockingham Park Pty Ltd has been issued groundwater allocations by the Department of Water (DoW) to irrigate POS and verge streetscapes at a rate of 7,500 kL/ha/year, as required by the DoW (WAWA, 1990). This irrigation rate requires a total allocation of 97 ML/year. A licence for 37 ML/year from the Leederville aquifer and 60 ML/year from the superficial aquifer has been acquired by Rockingham Park (Appendix G) and comes from an 80ML/year allocation that is shared with Lot 1507 Eighty Rd and another site owned by Rockingham Park. This will need to be amended in the future.

Rockingham Park Pty Ltd recognises the importance of conserving groundwater resources in the Jandakot area and has planned for the use of a water minimising landscape design. The groundwater allocation will be sufficient to ensure the irrigation of POS within the Lot 1507 Eighty Rd, Baldivis development through the use of minimal turf, soil amendments, waterwise plants and water-efficient irrigation. Appendix D contains information demonstrating the breakdown of water use for the POS areas until 2025.

5.5 PRIMARY SCHOOL IRRIGATION

A site for a primary school has been identified in the Local Structure Plan (Figure 2) with an approximate area of 4Ha. Of this area 1Ha will be used as a sports oval requiring non-potable water for irrigation of the turf. The DoW's recommended irrigation application rate for active POS is 10000 kL/ha/a. Therefore the required water to irrigate just the oval is 10000 kL/a. Additional irrigable areas of the school grounds will require additional water. As the ground water in this sub area is fully allocated, a groundwater licence to irrigate the primary school grounds cannot be given at this time. Options to source the required irrigation water for the Primary School shall be investigated as part of the Urban Water Management Plan (UWMP) and will include:

- Purchasing or leasing of a ground water allocation from a third party if available. This may be a private or public entity;
- Applying for a groundwater allocation from the DoW that may become available from recouped water entitlements;

- Using recycled water whether it be an onsite system, sewer mining, grey water reuse or a combination of these;
- Supplementing of any of the above systems with rainwater or stormwater harvesting;
- A combination of the above.

The UWMP shall present a feasibility study of the proposed options and identify the proposed supply option or options.

5.6 WATER BALANCE

An increase in recharge volume of approximately 270% is estimated post-development as shown in Appendix E. The pre-development recharge is estimated at 113 ML/year. Water balance calculations indicate that approximately 306 ML/yr additional recharge will occur on site once developed (Appendix E).

5.7 POTABLE WATER SERVICING

The site falls within the Tamworth tank water reticulation area. Water supply to the eastern part of the site is currently limited until the existing DN500 water distribution main in Nairn Drive has been extended south to the existing DN250 reticulation main at The Ridge Boulevard. This work is currently under way. The DN400 water main is proposed to be progressively extended southwards along Nairn Drive as a Water Corporation pre-funded capital works item as the development front moves southwards along Nairn Drive.

There is an existing DN300 water main located on the eastern side of Eighty Road that will also need to be extended southwards as a Water Corporation pre-funded capital works item along the front of the site to service the site from the west. The distribution mains in Nairn Drive and Eighty Road will be linked by reticulation-sized mains through the development road network as the development front moves ahead.

The Water Corporation has advised that land above the 30 metre contour is unable to be supplied by the Corporation and local boosting of water supply may be required. As shown in the Preliminary Earthworks Plan (Appendix H), none of the landholding will fall above the RL30 contour.

5.8 WASTEWATER SERVICING

Water Corporation waste water planning shows two future Waste Water Pump Stations (WWPSs) and Pressure Mains (PMs) located within the site: Baldivis WWPS “K” and Baldivis South WWPS “N”.

The initial stages of the development are proposed in the north-west corner of the site fronting Eighty Road. The Baldivis South WWPS “K” would need to be constructed as

part of any first stage of development for the landholding as the Water Corporation policy is not to allow tankering. No details of the sewerage outfall could be confirmed at the time of writing this report. It is expected that the outfall would be, at least in the short-term, into an existing 225 mm gravity sewer located to the north, near the intersection of Nairn Drive and Territory Crescent.

The Water Corporation waste water planning shows 2 Waste Water Pumping Stations (WWPS) and Pressure Mains (PMs), being Baldivis South WWPS “K” and Baldivis South WWPS “N” located within the landholding.

The initial stages of the development are proposed in the northwest corner of the landholding fronting Eighty Road. The Baldivis South WWPS “K” would need to be constructed as part of any first stage of development for the landholding as the Water Corporation policy is not to allow tankering. The WWPS is a Type 40 permanent station and will be located on the eastern side of Eighty Road next to a future POS area. The outfall is to be as per Option B (Refer Appendix J) and eventually moving into the ultimate as Option C.

The WWPS, and the ultimate pressure main (PM) if it forms part of the ultimate sewerage infrastructure, are capital works items for the Water Corporation, and as such the costs are funded by the developer and reimbursed by the Water Corporation according to a formula based on the number of lots titled compared to the number of lots calculated by the Water Corporation to justify the capital works expenditure. The agreement is formalised through a Customer Constructed Works Agreement (CCWA). Only permanent infrastructure falls within the CCWA as being reimbursable by the Water Corporation to the Developer.

It is expected that the initial pressure main construction (Option B and C) will not be capital works items.

If the WWPS and the PM form part of the ultimate sewerage infrastructure, then they will be capital works items owned by the Water Corporation. In this case the costs are funded by the developer and reimbursed by the Water Corporation according to a formula based on the number of lots titled compared to the number of lots calculated by the Water Corporation to justify the capital works expenditure. The agreement is formalised through a Customer Constructed Works Agreement (CCWA). Only permanent infrastructure falls within the CCWA as being reimbursable by the Water Corporation to the developer.

It is recommended that the CCWA takes into account an agreed discharge factor from an agreed percentage of individual household grey water reuse systems to be permanently implemented and operated. It is expected that this will be less than the actual number installed due to a lack of maintenance, shutdown and failure to replace systems by some householders at the end of their useful life.

5.9 MATTERS TO BE ADDRESSED AT THE SUBDIVISION STAGE

Matters to be addressed at the subdivision stage in the Urban Water Management Plan(s) (UWMPs) where relevant are:

- Finalise details of landscaping design in terms of confirmed groundwater allocation;
- Undertake subdivision level water balances based on the groundwater allocation;
- Final decision on water sustainability initiatives to be implemented at the site based on current investigations;
- Refine expected percentage uptake of rainwater and greywater reuse systems to be implemented and include at UWMP level water balance calculations;
- Finalise details to be included in the Sustainability Information Package; and
- Provide relevant design detail for the primary school irrigation water source including demonstration that any required licences for groundwater supply (if this is the preferred option) are substantially progressed.

6 STORMWATER MANAGEMENT STRATEGY

The stormwater management strategy for the site is based on infiltration of stormwater to maintain pre-development flows, while maintaining water quality. A variety of structural and non-structural Best Management Practices (BMPs) are proposed to achieve this, including swales and rain gardens in road reserves and POS, side entry and other drainage pits with open bases and infiltration basins. Swales, rather than pipes, may be used for conveyance where possible.

A Drainage Concept Plan for the site developed by Serling Consulting engineers is included in Appendix I.

6.1 STORMWATER QUANTITY

6.1.1 Stormwater Management in Road Reserves

Stormwater within road reserves will be collected via swales or conventional gully pits depending on the steepness of the landform and adjacent land uses. The pits will have open bases to increase soakage from the system. Swales, rain gardens and underground soakage systems will be used where feasible to manage more frequent rainfall events and increase infiltration through the drainage network.

Swales and road reserve rain gardens will be installed in median strips on the major road, Nairn Drive, and in road reserves adjacent to Public Open Space where space is available, as shown in the Drainage Concept Plans in Appendix I. These structures will generally contain native vegetation, although grass may be used on the edges of Public Open Space where this is more appropriate to the development. Where feasible, the use of swales rather than pipes for conveyance will be considered.

Swales are generally only suitable for areas where the slope is less than about 4% (Engineers Australia, 2006). Road reserve widths are also a potential constraint for the use of swales and rain gardens. Road reserves that may be appropriate for the use of swales have been identified and are shown on the Drainage Concept Plan (Appendix I).

Intermittent rain gardens within the widened road reserve of Nairn Drive may also be utilised. These will be designed to retain nutrients while infiltrating stormwater and use appropriate native vegetation. An example of a rain garden is shown in Plate 1. Potential rain garden locations are presented in Appendix I.

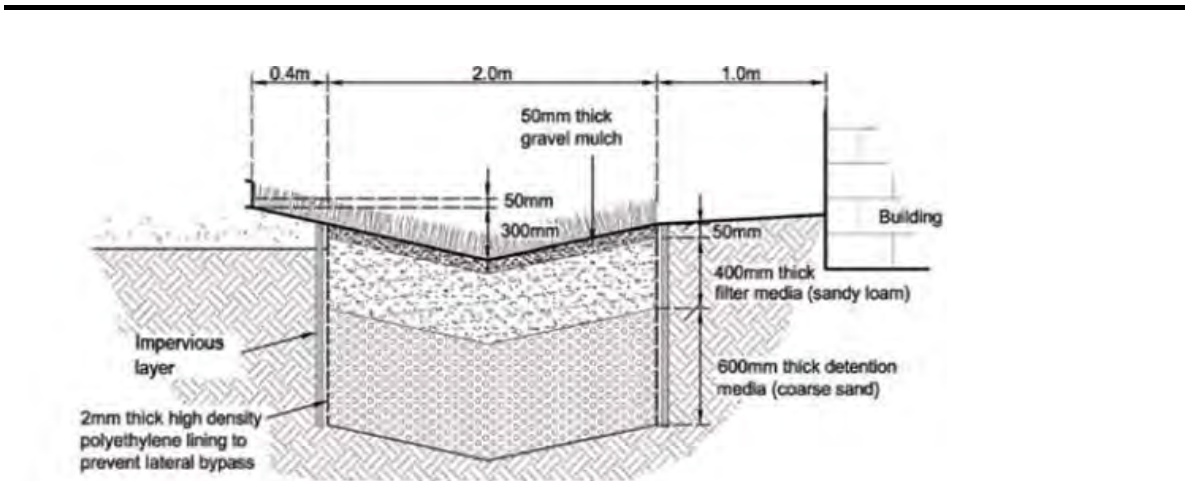


Plate 1: Example of a rain garden design (from DoW, 2008). Note that the rain gardens will not be located adjacent to buildings.

The site will utilise open-based drainage pits to increase infiltration throughout the drainage network. Soakage pits may be used in road verges where road reserve widths and service alignments permit.

The use of permeable paving will be considered for rear lane access in addition to parking areas and within the activity centres. The City of Rockingham will be consulted to determine suitability of permeable paving. Consideration will be given to non-central road alignments for better facilitation of swales and rain gardens, and to appropriate road reserve widths for infiltration within road reserves at a UWMP stage.

Major flow paths will be provided along road reserves for the 1 in 100 year flow (Appendix I). Peak flows for the 1 in 100 year ARI event will discharge the site by overland flow in the north-western corner of the site.

6.1.2 Flood Management in Public Open Space

The development has been divided into ten catchments for flood management purposes (Appendix I and Table 6) based on approximate topographic catchments. The catchment areas vary from 1.10 ha to 6.32 ha (Table 6). Areas of Public Open Space have been allocated for drainage in each catchment. The basins have been designed to cater for the 1 in 100 year ARI events and to allow approximately 12340m³ of storage in all of the ten catchments. The basin areas have been designed upon the basis that a maximum area of 25% of POS is inundated during a 1 in 10 year ARI storm event, as per City of Rockingham standards. The infiltration rate upon which the drainage concept plan is based is 3 m/day.

Table 6: Catchment areas for 1 in 100 year ARI peak volumes and approximate basin areas for each catchment at Parkland Heights

| Catchment No. | Catchment Area (ha) | Impervious Area (ha) | 1 in 100 year ARI Peak Volume (m ³) | Basin Area (m ²) (based on the base area requirement for 1 in 100 Year ARI event) | | | |
|---------------|---------------------|----------------------|---|---|------------------|-----------------|-----------------|
| | | | | 1 in 100 Year ARI | 1 in 10 Year ARI | 1 in 5 Year ARI | 1 in 1 Year ARI |
| B1 | 3.77 | 3.39 | 1,700 | 2,495 | 2,159 | 2,085 | 1,878 |
| B2 | 6.32 | 5.69 | 2,350 | 3,365 | 2,977 | 2,893 | 2,654 |
| B3 | 5.09 | 4.58 | 2,100 | 2,227 | 1,839 | 1,755 | 1,508 |
| B4 | 2.06 | 1.85 | 1,050 | 1,546 | 1,265 | 1,206 | 1,043 |
| B5 | 3.03 | 2.48 | 1,290 | 2,095 | 1759 | 1,673 | 1,414 |
| B6 | 1.27 | 1.14 | 860 | 2,119 | 1,840 | 1,795 | 1,732 |
| B7 | 1.89 | 1.7 | 380 | 935 | 902 | 878 | 798 |
| B8 | 1.1 | 0.99 | 310 | 942 | 836 | 810 | 750 |
| B9 | 3.43 | 3.09 | 1,480 | 2,501 | 2,180 | 2,112 | 1,924 |
| B10 | 2.12 | 1.91 | 820 | 1,245 | 1,012 | 961 | 814 |

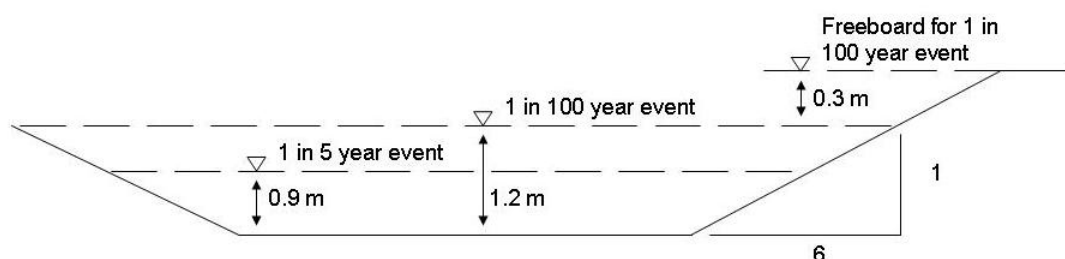


Plate 2: Conceptual design of drainage structure. Design will be optimised and improved at subdivision stage to decrease area of inundation in smaller events and maximise POS useability. Base area will depend on volume required.

The total area of inundation in a 1 in 5 year ARI event is 1.62 ha within Public Open Space. This area represents the storage for the whole 1 in 5 year event, without allowances for losses through drainage pits and swales. This is seen as a maximum allowable area for inundation and efforts will be made to reduce this area by maximising infiltration within the road reserve.

The area of inundation in a 1 in 100 year ARI event is estimated at 1.95 ha. This area is outlined in Appendix I. The areas are shown to indicate the total area of inundation. The basins themselves shall be shaped and located to maximise the useability of the Public Open Space while maintaining acceptable depths of inundation.

6.1.3 Lot Stormwater Management

The drainage from lots will be managed on the lots through the use of soakwells or similar structures. Soils within the site consist predominantly of sand with a given hydraulic conductivity between 4.3 – 5.9 m/day and of moderate to good drainage characteristics (SKM, 2009), which is considered suitable.

Lots will not be provided with a direct connection to the road drainage system.

A minimum freeboard of 0.3 m will be provided between the 1 in 100 year water level and minimum habitable floor levels.

6.2 STORMWATER QUALITY

The development will use a mixture of structural and non-structural controls to manage stormwater quality, in line with the DoW's *Stormwater Management Manual* (2004-7).

Stormwater quality on the site will be maintained through the use of Best Management Practices including swales, rain gardens and infiltrating basins to remove nutrients and sediments. These structures will be planted with native vegetation to encourage nutrient and suspended solids uptake and removal prior to infiltration. The structures will be sized to meet the DoW requirement that an equivalent of 2% of the effective impervious area will be bioretention structures to maintain water quality (DoW, 2008c). Gross pollutant traps will also be used prior to discharge to basins or Public Open Space.

A package of information provided to landowners at settlement of their property will include information on reducing fertiliser use and other water conservation and environmental management measures.

6.3 IMPACT ON WATER DEPENDANT ECOSYSTEMS

There are no water dependant ecosystems (WDEs) within the site. The closest wetland, Outridge Swamp, is 80 m to the west of the site and the associated 50 m buffer zone is still 30 m away from the site.

6.4 MATTERS TO BE ADDRESSED AT THE SUBDIVISION STAGE

Matters to be addressed at the subdivision stage in the Urban Water Management Plan(s) (UWMPs) are:

- Provision of a detailed drainage design and planning for the subdivision area including underground soakage systems, swales and rain gardens and confirmation of sizing and location of structures, road alignments and road reserves; and
- Details of landscaping for swales, rain gardens and basins.

7 GROUNDWATER MANAGEMENT STRATEGY

7.1 GROUNDWATER QUANTITY

Because of the significant depth to groundwater over the site, depth to groundwater is not considered to be a significant constraint to development on this site. Subsoil drainage is not proposed on this site.

Fill will not be required on this site to manage groundwater levels, except possibly in isolated areas around POS and other low points.

7.2 IMPACT ON WATER DEPENDANT ECOSYSTEMS

There are no wetlands or groundwater dependent vegetation within the site as outlined in Section 4.5.2. The closest wetland, Outridge Swamp, is 80 m to the west of the site. Groundwater flow direction at the site is partially due south-west and not directly in the path of the wetland. Any changes to the groundwater regime will be managed to ensure there is minimal impact upon this wetland.

7.3 GROUNDWATER QUALITY

Nutrient concentrations entering groundwater will be reduced through the use of a mixture of structural and non-structural Best Management Practices including:

- Swales, rain gardens and basins with native vegetation in frequently inundated areas and amended fill to strip nutrients prior to infiltration;
- Soil amendments in all POS and landscaping packages to retain phosphorus and water;
- Limiting the use of fertilisers in POS through householder education and control of POS; and
- Provision of education to householders on fertilise wise gardening through Sustainability Information Packages.

7.4 MATTERS TO BE ADDRESSED AT THE SUBDIVISION STAGE

Matters to be addressed at the subdivision stage in the Urban Water Management Plan(s) (UWMPs) are:

- Confirmation of finished lot levels; and
- Further details of landscaping and Sustainability Information Packages to be provided to householders.

8 MATTERS TO BE ADDRESSED AT THE SUBDIVISION STAGE

The following section summarises all matters presented in this report that have to be addressed at the subdivision stage in the Urban Water Management Plan(s) (UWMPs).

These are:

- Finalise details of landscaping design in terms of confirmed groundwater allocation;
- Undertake subdivision level water balances based on the groundwater allocation;
- Finalise decisions on water sustainability initiatives to be implemented at the site based on current investigations;
- Undertake cost-benefit analyses of alternate water source options;
- Determine expected percentage uptake of rainwater and greywater reuse systems to be implemented and include at UWMP level water balance calculations;
- Provision of a detailed drainage design and planning for the subdivision area including underground soakage systems, swales and rain gardens and confirmation of sizing and location of structures, road alignments and road reserves;
- Provision of details of landscaping for swales, rain gardens and basins;
- Confirmation of finished lot levels; and
- Finalise details of landscaping and Sustainability Information Packages to be provided to householders.

9 MONITORING

9.1 PROGRAM FOR UWMP PREPARATION

Eighteen months of groundwater monitoring has been completed at Lot 1507 Eighty Rd, Baldivis. The full set of monitoring data acquired will be used to provide a baseline for post-development groundwater quality and levels.

This information will be provided as part of the first UWMP.

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 Rockingham 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 7. This monitoring will be undertaken for two years following the practical completion of each stage.

Monitoring shall be undertaken at the pre-development bores (Figure 6) excepting bores F and G. Where pre-development bores are destroyed during construction, replacement bores of a similar depth shall be installed and monitored after development.

Table 7: 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. |

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.

10 IMPLEMENTATION

10.1 ROLES AND RESPONSIBILITIES

| Item | Scheme Development | Interim Maintenance (Minimum of two years) | Long-term Maintenance |
|--|--------------------|--|--|
| Waterwise Efficiency Packages | Developer | Residents and strata companies. | Residents and strata companies. |
| Sustainability Information packages | Developer | Developer | Council |
| Swales, raingardens and drainage system | Developer | Developer for at least 2 years as per Council requirements | Council |
| Public Open Space | Developer | Developer for at least 2 years as per Council requirements | Council |
| Monitoring of the development | Developer | Developer for three years post-development, including one year following the completion of the majority (80%) of the development | Developer for monitoring in compliance with groundwater licensing conditions. Council for other items. |

10.2 FUNDING

No external funding is being sought for this project.

10.3 REVIEW

Rockingham Park Pty Ltd expects that development of Lot 1507 Eighty Rd, Baldivis will occur over a number of years. Water management ‘best practice’ procedures will likely vary during the development timeframe. If there is a need to change, then proposed practices may need to be modified in the future to comply with improvements in understanding or design. Rockingham Park Pty Ltd proposes to address any identified and agreed modifications through the preparation and implementation of UWMPs.

11 CONCLUSIONS

The objective of the Local Water Management Strategy (LWMS) is to ensure that sustainable management of the total water cycle at Parkland Heights, Lot 1507 Eighty Rd, Baldivis occurs through Water Sensitive Urban Design. This includes water conservation, stormwater management and groundwater management. Rockingham Park Pty Ltd aims to manage these issues at the site through the following initiatives:

Water Conservation

- Participating in the EnviroDevelopment program to achieve a maximum potable water usage of 80 kL/per/year and meet both the State Water Target and EnviroDevelopment target of a 20% reduction in scheme water use;
- Providing Waterwise landscaping for Public Open Space (POS) that includes waterwise plants, soil amendments to improve water and nutrient retention, minimising turf areas and water efficient irrigation;
- Investigating the possibility of using an alternative water source to irrigate POS;

Stormwater Management

- Implementing a drainage design that ensures pre-development discharge rates in the event of a 1 in 100 year ARI event will be maintained through storage and infiltration on site; and
- Maximising infiltration by developing swales and rain gardens in road reserves where possible, planted with native vegetation to encourage nutrient and suspended solids uptake and removal prior to infiltration. Open based manholes will also be used to maximise infiltration. Infiltration basins in Public Open Space will manage larger events.

Groundwater Management

- Recognising the issue of groundwater availability and planning low water use POS.

This LWMS demonstrates that Parkland Heights, Lot 1507 Eighty Rd, Baldivis can be developed without significant constraints. The outstanding issues can be resolved at the Urban Water Management Plan stage to create a development that meets the goals and ideals of *Better Urban Water Management*.

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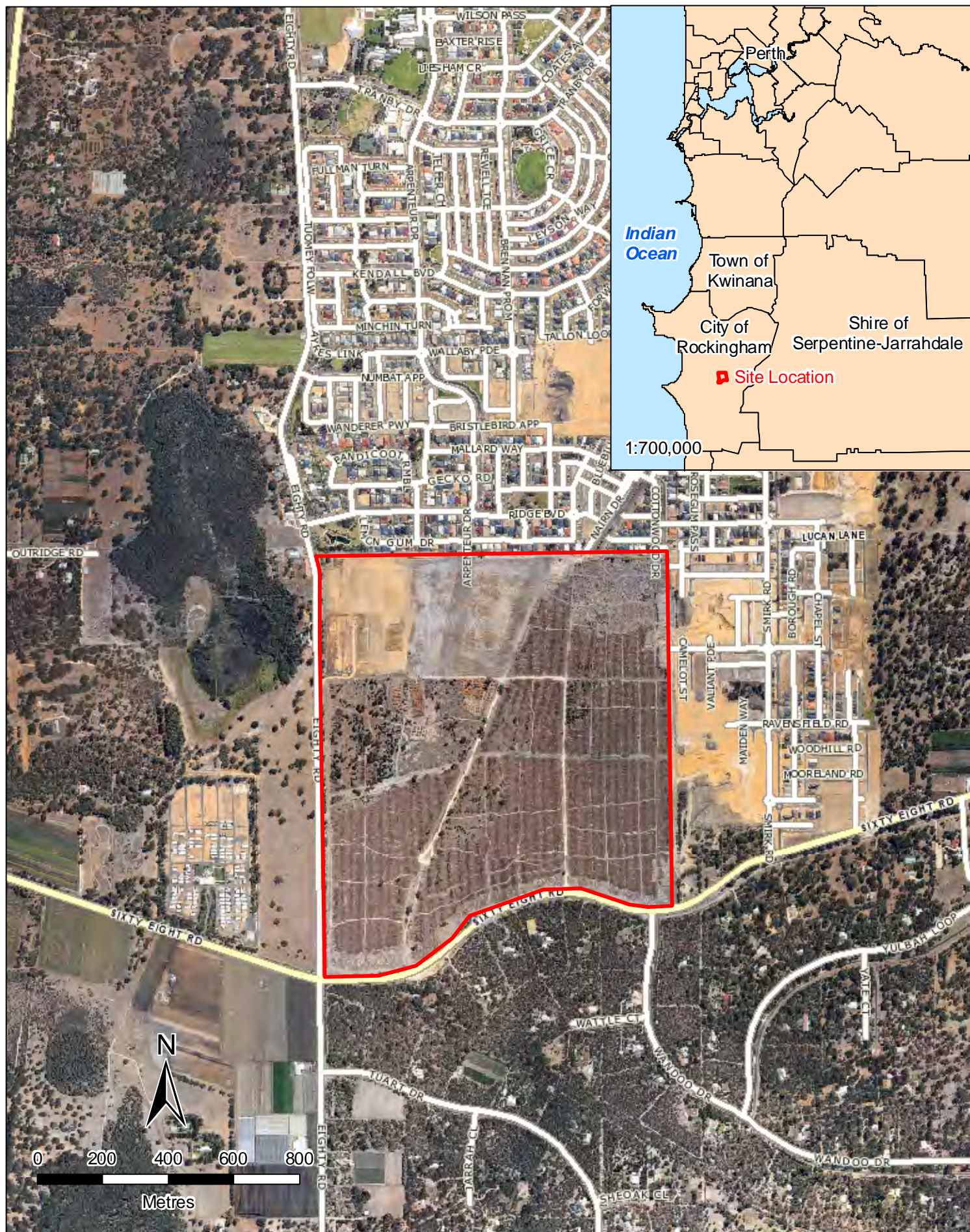
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FIGURES



CLIENT
 Rockingham Park
AUTHOR:
 J Hunt
SCALE
 1:15,000@ A4
DRAWN
 T Ellis
PROJECTION
 GDA94 MGA50

JOB NO.
 J100378
DATE
 6-12-2011

Site Context Plan

Lot 1507 Eighty Road, Baldvis
 Local Water
 Mangement Strategy

FIGURE
1



Source: Taylor Burrell Barnett, 14-11-2011



CLIENT

Rockingham Park

AUTHOR:

J Hunt

SCALE

1:7000 @ A4

DRAWN

T Ellis

PROJECTION

N/A

JOB NO.

J100378

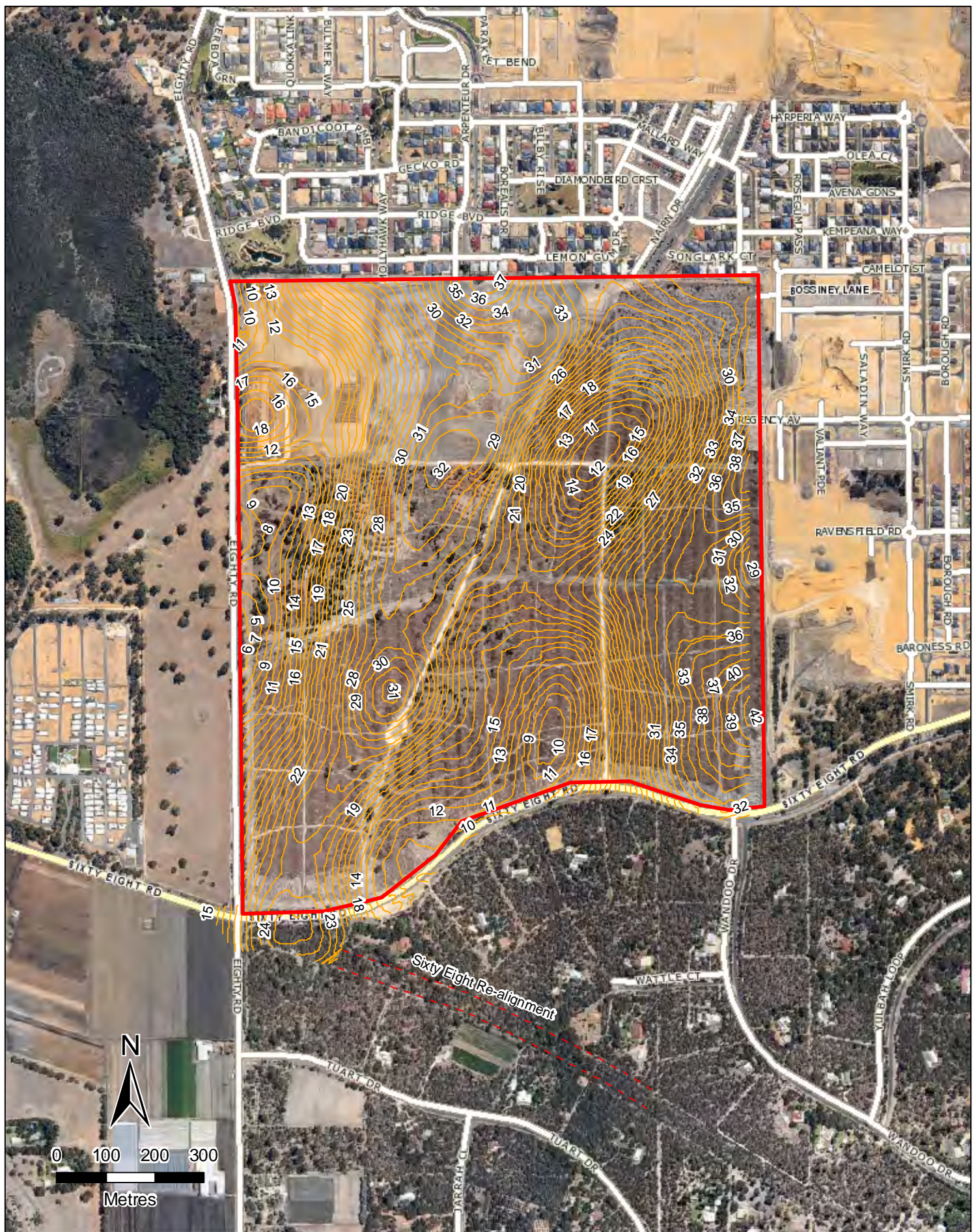
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6-12-2011

Site Structure Plan

Lot 1507 Eighty Road, Baldivis
Local Water
Mangement Strategy

FIGURE 2



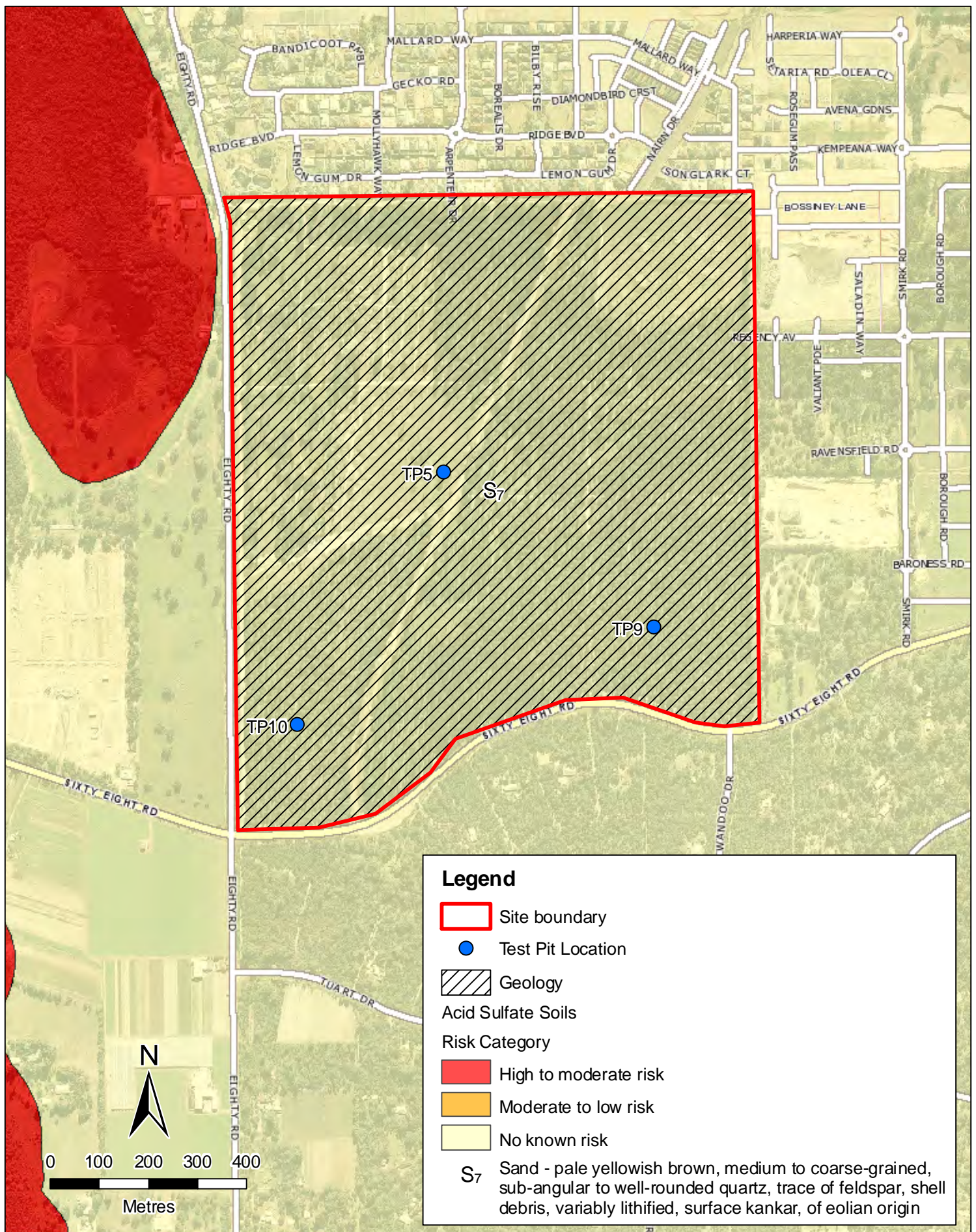
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 Rockingham Park
AUTHOR:
 J Hunt
SCALE
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JOB NO.
 J100378
DATE
 6-12-2011

Site Condition Plan

Lot 1507 Eighty Road, Baldvis
 Local Water
 Mangement Strategy

FIGURE
3



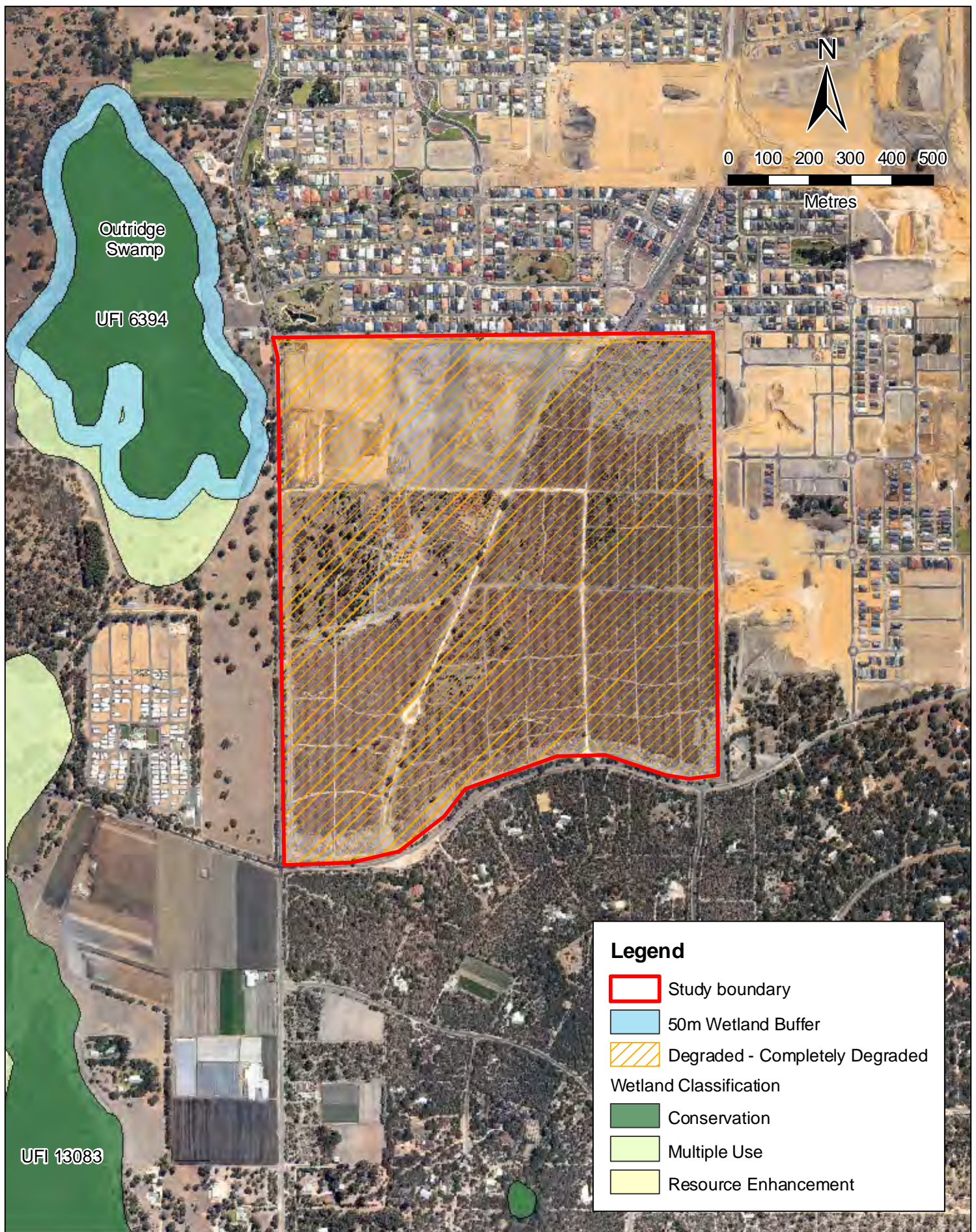
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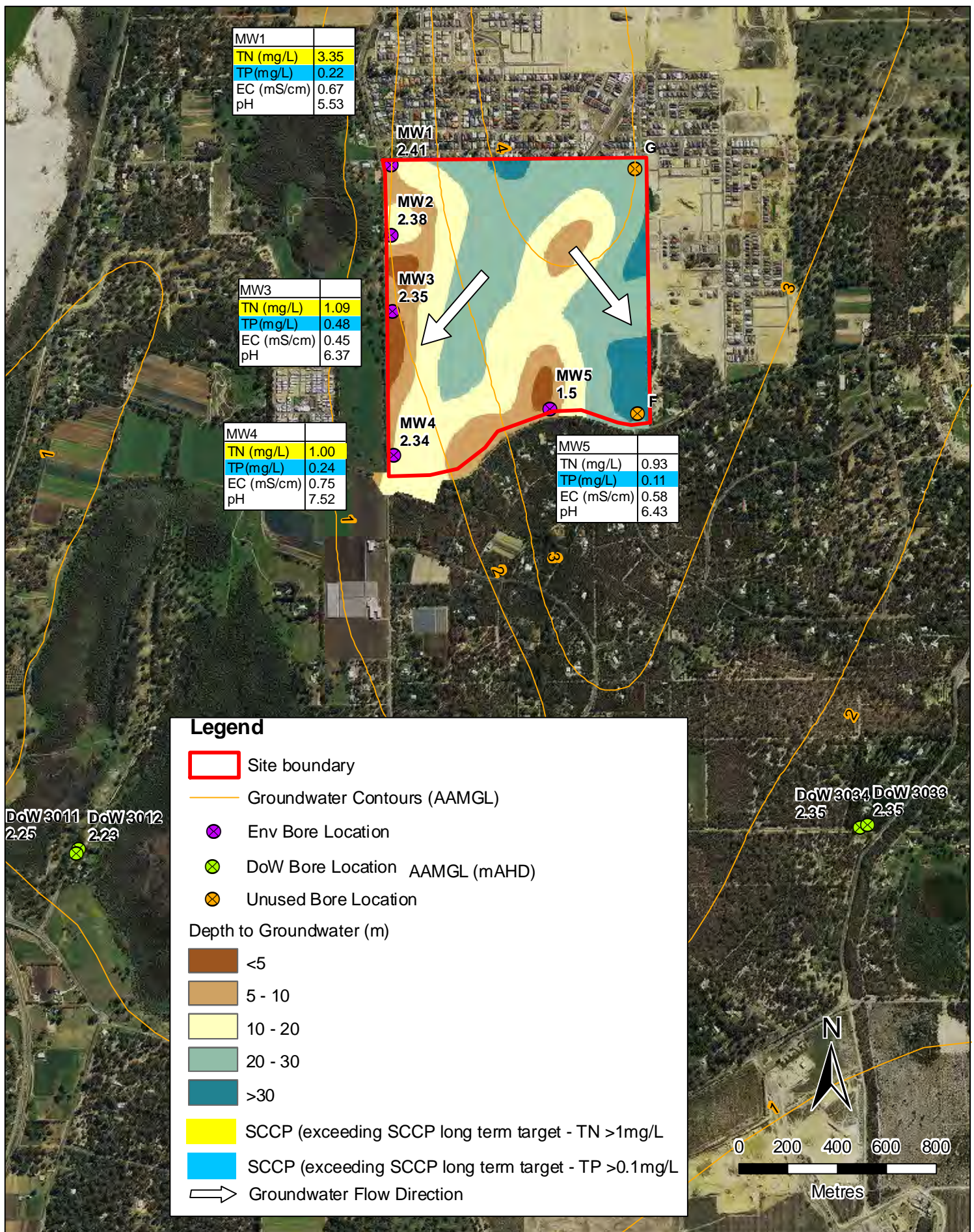
JOB NO.
 J100378
DATE
 6-12-2011

DRAWN
 T Ellis
PROJECTION

Geotechnical Plan

Lot 1507 Eighty Road, Baldi
 Local Water
 Management Strategy







Indicative Staging Plan

LOT 1507, BALDIVIS
A ROCKINGHAM PARK PTY LTD PROJECT

plan: 00/075/032B
date: 22/11/2011
projection: PCG 94

designed: DR
checked: BDM
drawn: BR

scale: 1:2500@A1 | 1:2000@A0
0 50 100m



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APPENDIX A

BORE LOGS

Project: Parkland Heights
Job No: 09.207
Date Logged: 21-Oct-09
Installation Method: Air Rotary

Installation Method: Air Rotary

NOTE:

| | |
|---|---------------------|
|  | Monitor Well Screen |
|  | Gravel Pack |
|  | Bentonite Layer |
|  | Sand Fill |
|  | Cement Grout |

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.






Client: Rockingham Park
 Logged By: PA
 Drilled By: Landcare Drilling
 Monitoring Bore No: MB2

Project: Parkland Heights
 Job No: 09.207
 Date Logged: 21-Oct-09
 Installation Method: Air Core

386985E, 6419281N

| Depth BGL (m) | Sample Taken | Monitor Well Log | Profile | Lithology | Field Rank | Observations (PID in ppm _v VOC) |
|---------------------|-----------------|------------------------|------------|--|---------------|---|
| | | | | blue riser | | |
| | | | 0 - 0.25 | TOPSOIL - SAND, black | | organic matter |
| | | | 0.25 - 0.5 | SAND, tan brown, medium grain size, poorly sorted | | dry |
| | | | 0.5 - 1 | SAND, brown, medium grain size, moderately sorted | | dry quartz sand light tan parts |
| 1.0 | | | 1 - 2.5 | SAND, yellow/orange, medium grain size, moderately sorted | | dry white quartz elements, very orange colour |
| 2.0 | | | | | | |
| | | | 2.5 - 6 | SAND, yellow/orange, medium grain size, moderately sorted | | damp very slight clay stain |
| 3.0 | | | | | | |
| 4.0 | | | | | | |
| 5.0 | | | | | | |
| | | | | | | slightly lighter at 5.4 mbgl |

NOTE:

-  Monitor Well Screen
-  Gravel Pack
-  Bentonite Layer
-  Sand Fill
-  Cement Grout

Initial water table at time drilling









ENV. Australia
 Level 7
 182 St Georges Terrace
 Perth, WA, 6000.

Project: Parkland Heights
Job No: 09.207
Date Logged: 21-Oct-09
Installation Method: Air Core

Installation Method: Air Core

NOTE:

| | | |
|---|---------------------|---|
|  | Monitor Well Screen | <p>Initial water table at time drilling</p>  |
|  | Gravel Pack | |
|  | Bentonite Layer | |
|  | Sand Fill | |
|  | Cement Grout | |

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

Project: Parkland Heights
Job No: 09.207
Date Logged: 21-Oct-09
Drilling Method: Air core, mud rotary

Installation Method: Air core, mud rotary

182 St Georges Terrace
Perth, WA, 6000.

Project: Parkland Heights
Job No: 09.207
Date Logged: 22/10/09
Installation Method: Air and Mud rotary

387632E, 6418582N

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

182 St Georges Terrace
Perth, WA, 6000.

Project: Parkland Heights
Job No: 09.207
Date Logged: 22/10/09
Installation Method: Air and Mud rotary

387632E, 6418582N

ENV. Australia
Level 7
182 St Georges Terrace
Perth, WA, 6000.

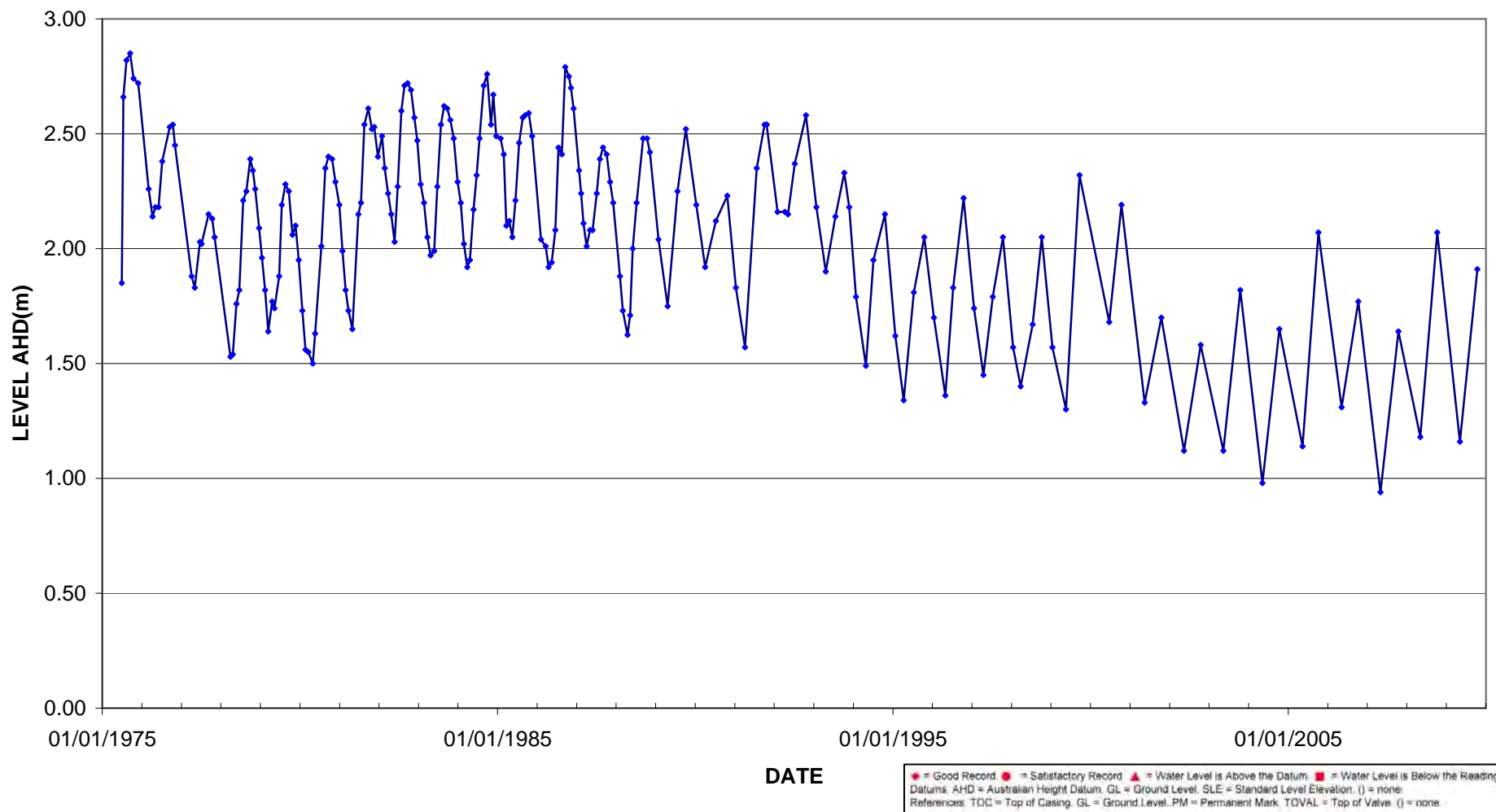
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Perth, WA, 6000.

APPENDIX B

DOW GROUNDWATER DATA

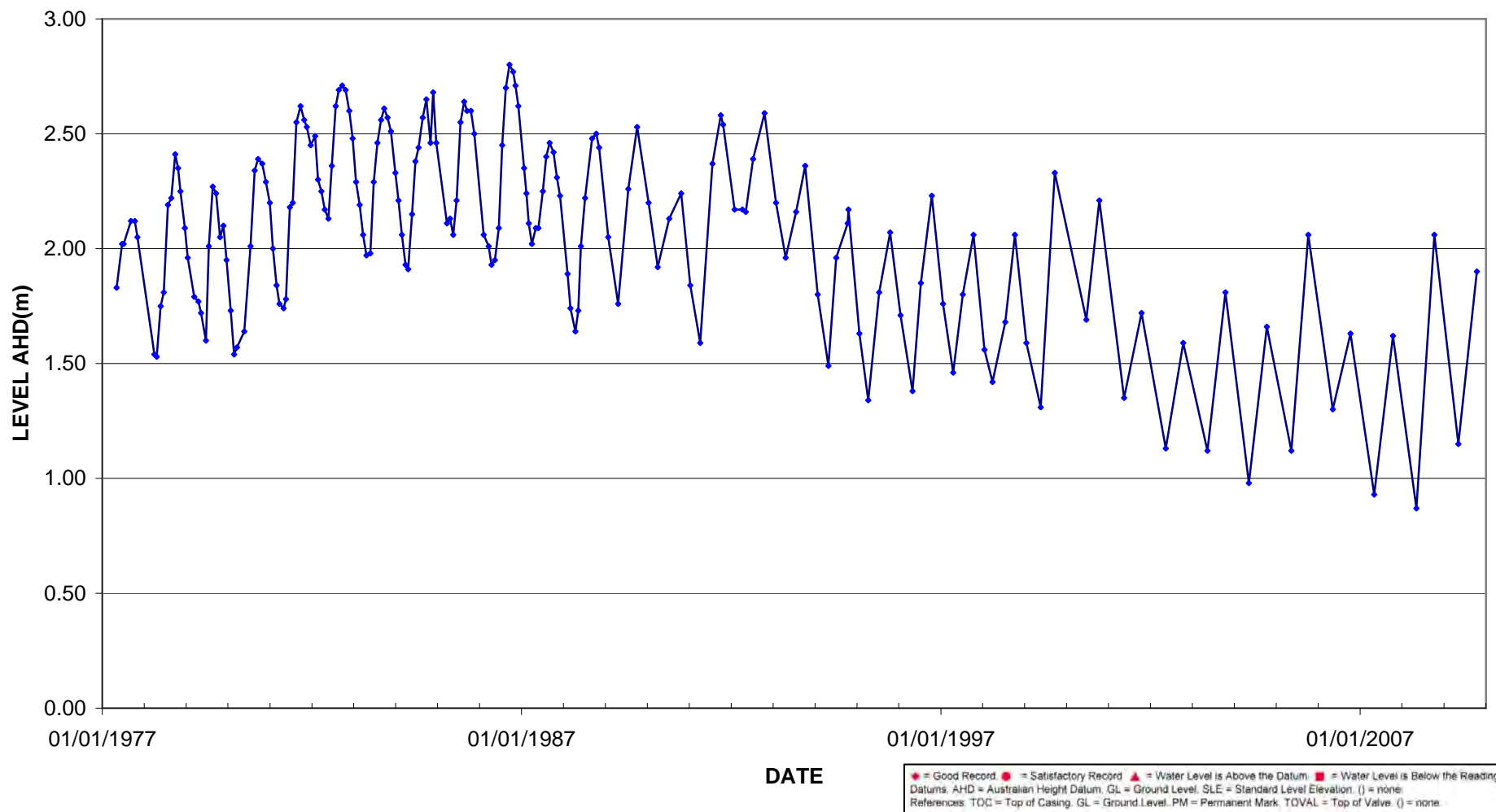
61410049 LAKE THOMSON T430 (O)

Easting = 385714.00 Northing = 6416781.00 Zone = 50 TOC = 7.17m AHD WIN SITE ID = 3011



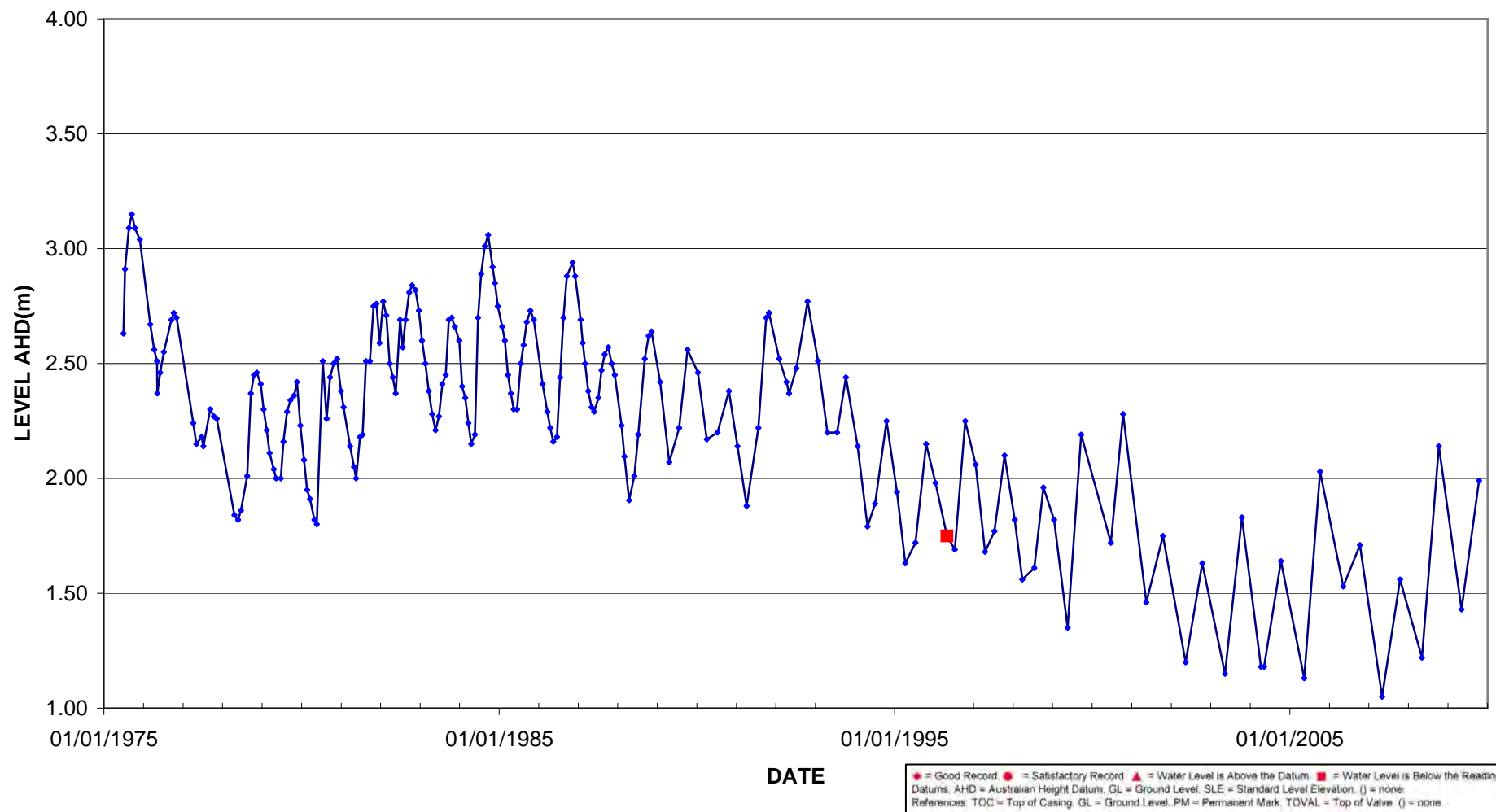
61410050 LAKE THOMSON T430 (I)

Easting = 385704.00 Northing = 6416765.00 Zone = 50 TOC = 7.46m AHD WIN SITE ID = 3012



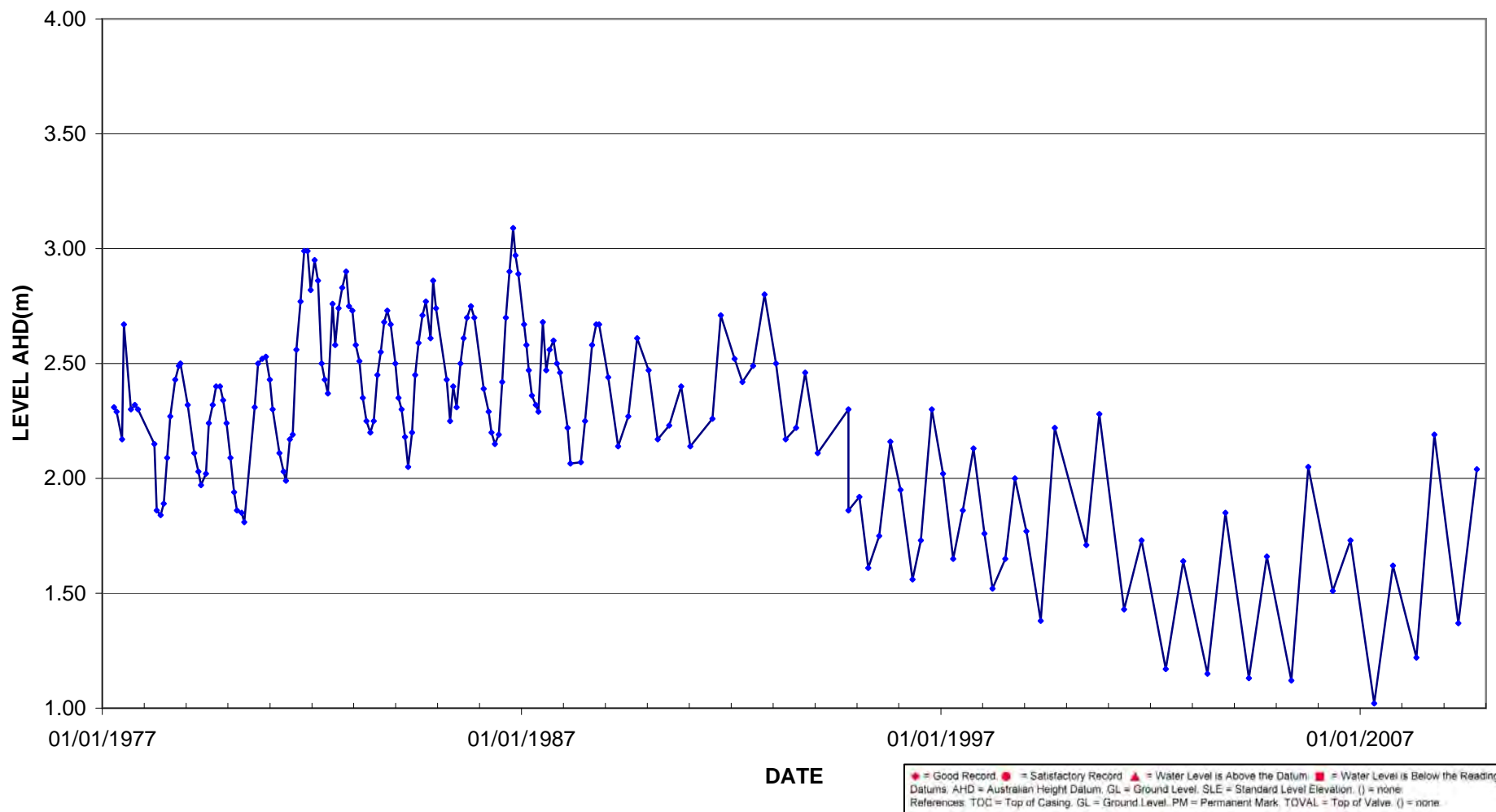
61410071 LAKE THOMSON T440

Easting = 388918.00 Northing = 6416879.00 Zone = 50 TOC = 10.9mAHD WIN SITE ID = 3033



61410072 LAKE THOMSON T441

Easting = 388889.00 Northing = 6416870.00 Zone = 50 TOC = 14.15mAHD WIN SITE ID = 3034



APPENDIX C

MONITORING RECORDS

Parkland Heights - Lot 1507 Eighty Road - Baldivis

| pH | | | | | | |
|-----|------------|------------|------------|-----------|------------|------|
| | 28/10/2009 | 21/01/2010 | 21/04/2010 | 7/07/2010 | 11/10/2010 | MEAN |
| MB1 | 5.7 | 5.35 | dry | dry | dry | 5.53 |
| MB2 | blocked | | | | | |
| MB3 | 6.68 | 6.5 | 6.16 | 6.29 | 6.22 | 6.37 |
| MB4 | 7.66 | 7.5 | 7.5 | 7.39 | 7.56 | 7.52 |
| MB5 | 6.82 | 6.16 | 6.13 | 6.61 | 6.45 | 6.43 |

| EC (mS) | | | | | | |
|---------|------------|------------|------------|-----------|------------|------|
| | 28/10/2009 | 21/01/2010 | 21/04/2010 | 7/07/2010 | 11/10/2010 | MEAN |
| MB1 | 0.71 | 0.63 | dry | dry | dry | 0.67 |
| MB2 | Blocked | | | | | |
| MB3 | 0.47 | 0.46 | 0.47 | 0.45 | 0.42 | 0.45 |
| MB4 | 1.13 | 0.73 | 0.67 | 0.71 | 0.53 | 0.75 |
| MB5 | 0.61 | 0.52 | 0.61 | 0.69 | 0.45 | 0.58 |

Parkland Heights - Lot 1507 Eighty Road - Baldivis

DoW Bore 3012

| | | | |
|----------|------------|-------|-------|
| 12:00:00 | 22/04/1983 | 1.970 | |
| 12:00:00 | 25/05/1983 | 1.980 | |
| 12:00:00 | 24/06/1983 | 2.290 | |
| 12:00:00 | 26/07/1983 | 2.460 | |
| 12:00:00 | 25/08/1983 | 2.560 | |
| 12:00:00 | 23/09/1983 | 2.610 | |
| 12:00:00 | 21/10/1983 | 2.570 | |
| 12:00:00 | 21/11/1983 | 2.510 | |
| 12:00:00 | 29/12/1983 | 2.330 | 2.610 |
| 12:00:00 | 25/01/1984 | 2.210 | |
| 12:00:00 | 23/02/1984 | 2.060 | |
| 12:00:00 | 26/03/1984 | 1.930 | |
| 12:00:00 | 18/04/1984 | 1.910 | |
| 12:00:00 | 22/05/1984 | 2.150 | |
| 12:00:00 | 20/06/1984 | 2.380 | |
| 12:00:00 | 18/07/1984 | 2.440 | |
| 12:00:00 | 24/08/1984 | 2.570 | |
| 12:00:00 | 24/09/1984 | 2.650 | |
| 12:00:00 | 31/10/1984 | 2.460 | |
| 12:00:00 | 21/11/1984 | 2.680 | |
| 12:00:00 | 19/12/1984 | 2.460 | 2.680 |
| 12:00:00 | 22/03/1985 | 2.110 | |
| 12:00:00 | 18/04/1985 | 2.130 | |
| 12:00:00 | 16/05/1985 | 2.060 | |
| 12:00:00 | 14/06/1985 | 2.210 | |
| 12:00:00 | 18/07/1985 | 2.550 | |
| 12:00:00 | 20/08/1985 | 2.640 | |
| 12:00:00 | 12/09/1985 | 2.600 | |
| 12:00:00 | 16/10/1985 | 2.600 | |
| 12:00:00 | 15/11/1985 | 2.500 | 2.640 |
| 15:06:00 | 05/02/1986 | 2.060 | |
| 10:44:00 | 20/03/1986 | 2.010 | |
| 10:31:00 | 15/04/1986 | 1.930 | |
| 10:12:00 | 14/05/1986 | 1.950 | |
| 11:07:00 | 18/06/1986 | 2.090 | |
| 10:23:00 | 16/07/1986 | 2.450 | |
| 10:41:00 | 18/08/1986 | 2.700 | |
| 10:03:00 | 18/09/1986 | 2.800 | |
| 10:24:00 | 20/10/1986 | 2.770 | |
| 09:27:00 | 10/11/1986 | 2.710 | |
| 09:35:00 | 03/12/1986 | 2.620 | 2.800 |
| 09:18:00 | 23/01/1987 | 2.350 | |
| 09:47:00 | 12/02/1987 | 2.240 | |
| 10:26:00 | 04/03/1987 | 2.110 | |
| 09:36:00 | 02/04/1987 | 2.020 | |
| 09:21:00 | 05/05/1987 | 2.090 | |
| 09:43:00 | 28/05/1987 | 2.090 | |
| 08:58:00 | 06/07/1987 | 2.250 | |
| 09:38:00 | 04/08/1987 | 2.400 | |
| 09:11:00 | 02/09/1987 | 2.460 | |
| 13:24:00 | 06/10/1987 | 2.420 | |
| 09:15:00 | 05/11/1987 | 2.310 | |
| 11:13:00 | 03/12/1987 | 2.230 | 2.460 |
| 09:34:00 | 05/02/1988 | 1.890 | |
| 09:40:00 | 03/03/1988 | 1.740 | |
| 10:01:00 | 15/04/1988 | 1.640 | |
| 09:27:00 | 09/05/1988 | 1.730 | |
| 09:06:00 | 01/06/1988 | 2.010 | |
| 09:40:00 | 07/07/1988 | 2.220 | |
| 09:33:00 | 06/09/1988 | 2.480 | |
| 09:41:00 | 12/10/1988 | 2.500 | |
| 09:47:00 | 07/11/1988 | 2.440 | 2.500 |
| 09:36:00 | 25/01/1989 | 2.050 | |
| 09:59:00 | 21/04/1989 | 1.760 | |
| 11:32:00 | 20/07/1989 | 2.260 | |
| 10:00:00 | 05/10/1989 | 2.530 | 2.530 |
| 13:04:00 | 11/01/1990 | 2.200 | |
| 10:49:00 | 02/04/1990 | 1.920 | |
| 13:01:00 | 10/07/1990 | 2.130 | |
| 11:46:00 | 23/10/1990 | 2.240 | 2.240 |

| | | | |
|----------|------------|-------|-------|
| 10:52:00 | 10/01/1991 | 1.840 | |
| 10:24:00 | 06/04/1991 | 1.590 | |
| 10:01:00 | 23/07/1991 | 2.370 | |
| 10:41:00 | 02/10/1991 | 2.580 | |
| 14:43:00 | 23/10/1991 | 2.540 | 2.580 |
| 14:34:00 | 31/01/1992 | 2.170 | |
| 10:17:00 | 07/04/1992 | 2.170 | |
| 14:07:00 | 07/05/1992 | 2.160 | |
| 12:12:00 | 09/07/1992 | 2.390 | |
| 12:13:00 | 19/10/1992 | 2.590 | 2.590 |
| 11:30:00 | 25/01/1993 | 2.200 | |
| 11:28:00 | 20/04/1993 | 1.960 | |
| 09:27:00 | 19/07/1993 | 2.160 | |
| 10:15:00 | 08/10/1993 | 2.360 | 2.360 |
| 10:33:00 | 24/01/1994 | 1.800 | |
| 12:39:00 | 27/04/1994 | 1.490 | |
| 10:16:00 | 05/07/1994 | 1.960 | |
| 15:45:00 | 11/10/1994 | 2.110 | |
| 12:37:00 | 18/10/1994 | 2.170 | 2.170 |
| 11:22:00 | 23/01/1995 | 1.630 | |
| 09:50:00 | 10/04/1995 | 1.340 | |
| 13:15:00 | 14/07/1995 | 1.810 | |
| 11:47:00 | 17/10/1995 | 2.070 | 2.070 |
| 09:17:00 | 15/01/1996 | 1.710 | |
| 10:17:00 | 30/04/1996 | 1.380 | |
| 11:17:00 | 11/07/1996 | 1.850 | |
| 09:57:00 | 14/10/1996 | 2.230 | 2.230 |
| 10:50:00 | 20/01/1997 | 1.760 | |
| 08:49:00 | 17/04/1997 | 1.460 | |
| 09:23:00 | 11/07/1997 | 1.800 | |
| 09:35:00 | 13/10/1997 | 2.060 | 2.060 |
| 09:22:00 | 15/01/1998 | 1.560 | |
| 09:10:00 | 26/03/1998 | 1.420 | |
| 11:14:00 | 15/07/1998 | 1.680 | |
| 10:53:00 | 07/10/1998 | 2.060 | 2.060 |
| 09:30:00 | 15/01/1999 | 1.590 | |
| 10:19:00 | 20/05/1999 | 1.310 | |
| 09:37:00 | 21/09/1999 | 2.330 | 2.330 |
| 10:18:00 | 21/06/2000 | 1.690 | |
| 09:33:00 | 12/10/2000 | 2.210 | 2.210 |
| 09:22:00 | 16/05/2001 | 1.350 | |
| 09:06:00 | 16/10/2001 | 1.720 | 1.720 |
| 09:17:00 | 13/05/2002 | 1.130 | |
| 09:13:00 | 14/10/2002 | 1.590 | 1.590 |
| 09:06:00 | 13/05/2003 | 1.120 | |
| 13:15:00 | 15/10/2003 | 1.810 | 1.810 |
| 10:44:00 | 07/05/2004 | 0.980 | |
| 09:53:00 | 11/10/2004 | 1.660 | 1.660 |
| 10:22:00 | 13/05/2005 | 1.120 | |
| 09:18:00 | 06/10/2005 | 2.060 | 2.060 |
| 09:35:00 | 08/05/2006 | 1.300 | |
| 09:29:00 | 09/10/2006 | 1.630 | 1.630 |
| 08:59:00 | 03/05/2007 | 0.930 | |
| 09:14:00 | 15/10/2007 | 1.620 | 1.620 |
| 10:24:00 | 06/05/2008 | 0.870 | |
| 09:12:00 | 09/10/2008 | 2.060 | 2.060 |
| 09:49:00 | 06/05/2009 | 1.150 | |
| 12:27:00 | 15/10/2009 | 1.900 | 1.900 |

Average = 2.233

DoW Bore 3011

Levels in mAHD

| | |
|---------------------|-------|
| 00:00:00 30/06/1975 | 1.850 |
| 12:00:00 14/07/1975 | 2.660 |
| 12:00:00 13/08/1975 | 2.820 |
| 12:00:00 15/09/1975 | 2.850 |
| 12:00:00 17/10/1975 | 2.740 |
| 12:00:00 28/11/1975 | 2.720 |
| 2.850 | |
| 12:00:00 05/03/1976 | 2.260 |
| 12:00:00 08/04/1976 | 2.140 |
| 12:00:00 05/05/1976 | 2.180 |
| 12:00:00 04/06/1976 | 2.180 |
| 12:00:00 07/07/1976 | 2.380 |
| 12:00:00 15/09/1976 | 2.530 |
| 12:00:00 13/10/1976 | 2.540 |
| 12:00:00 02/11/1976 | 2.450 |
| 2.540 | |
| 12:00:00 05/04/1977 | 1.880 |
| 12:00:00 05/05/1977 | 1.830 |
| 12:00:00 21/06/1977 | 2.030 |
| 12:00:00 06/07/1977 | 2.020 |
| 12:00:00 08/09/1977 | 2.150 |
| 12:00:00 12/10/1977 | 2.130 |
| 12:00:00 04/11/1977 | 2.050 |
| 2.150 | |
| 12:00:00 30/03/1978 | 1.530 |
| 12:00:00 20/04/1978 | 1.540 |
| 12:00:00 24/05/1978 | 1.760 |
| 12:00:00 19/06/1978 | 1.820 |
| 12:00:00 26/07/1978 | 2.210 |
| 12:00:00 24/08/1978 | 2.250 |
| 12:00:00 29/09/1978 | 2.390 |
| 12:00:00 23/10/1978 | 2.340 |
| 12:00:00 13/11/1978 | 2.260 |
| 12:00:00 20/12/1978 | 2.090 |
| 2.390 | |
| 12:00:00 15/01/1979 | 1.960 |
| 12:00:00 14/02/1979 | 1.820 |
| 12:00:00 13/03/1979 | 1.640 |
| 12:00:00 18/04/1979 | 1.770 |
| 12:00:00 10/05/1979 | 1.740 |
| 12:00:00 22/06/1979 | 1.880 |
| 12:00:00 17/07/1979 | 2.190 |
| 12:00:00 21/08/1979 | 2.280 |
| 12:00:00 19/09/1979 | 2.250 |
| 12:00:00 23/10/1979 | 2.060 |
| 12:00:00 22/11/1979 | 2.100 |
| 12:00:00 20/12/1979 | 1.950 |
| 2.280 | |
| 12:00:00 24/01/1980 | 1.730 |
| 12:00:00 22/02/1980 | 1.560 |
| 12:00:00 19/03/1980 | 1.550 |
| 12:00:00 28/04/1980 | 1.500 |
| 12:00:00 21/05/1980 | 1.630 |
| 12:00:00 16/07/1980 | 2.010 |
| 12:00:00 21/08/1980 | 2.350 |
| 12:00:00 19/09/1980 | 2.400 |
| 12:00:00 24/10/1980 | 2.390 |
| 12:00:00 25/11/1980 | 2.290 |
| 12:00:00 29/12/1980 | 2.190 |
| 2.400 | |
| 12:00:00 27/01/1981 | 1.990 |
| 12:00:00 26/02/1981 | 1.820 |
| 12:00:00 24/03/1981 | 1.730 |
| 12:00:00 30/04/1981 | 1.650 |
| 12:00:00 23/06/1981 | 2.150 |
| 12:00:00 17/07/1981 | 2.200 |
| 12:00:00 19/08/1981 | 2.540 |
| 12:00:00 24/09/1981 | 2.610 |
| 12:00:00 26/10/1981 | 2.520 |
| 12:00:00 17/11/1981 | 2.530 |
| 12:00:00 21/12/1981 | 2.400 |
| 2.610 | |
| 12:00:00 29/01/1982 | 2.490 |
| 12:00:00 23/02/1982 | 2.350 |
| 12:00:00 25/03/1982 | 2.240 |

| | observed WL (mAHD) | calculated AAMGL (mAHD) | GL (mAHD) | GL - AAMGL (m) |
|-----------------|--|----------------------------|--------------|-------------------|
| | 28/10/2009 | | | |
| MW1 | 2.009 | 2.423 | 4.281 | 1.858 |
| MW2 | 1.98 | 2.394 | 8.195 | 5.801 |
| MW3 | 1.942 | 2.356 | 4.012 | 1.656 |
| MW4 | 1.938 | 2.352 | 10.988 | 8.636 |
| MW5 | 1.094 | 1.508 | 6.954 | 5.446 |
| DoW 3011 | 1.845 | 2.259 | 6.76 | 4.501 |
| | Max | | 2.423 | |
| | Min | | 1.508 | |
| | | | | 0.414 |
| | difference between observed & calculated | | | |

| | | |
|---------------------|-------|-------|
| 12:00:00 22/04/1982 | 2.150 | |
| 12:00:00 24/05/1982 | 2.030 | |
| 12:00:00 23/06/1982 | 2.270 | |
| 12:00:00 27/07/1982 | 2.600 | |
| 12:00:00 23/08/1982 | 2.710 | |
| 12:00:00 22/09/1982 | 2.720 | |
| 12:00:00 22/10/1982 | 2.690 | |
| 12:00:00 23/11/1982 | 2.570 | |
| 12:00:00 21/12/1982 | 2.470 | 2.720 |
| 12:00:00 20/01/1983 | 2.280 | |
| 12:00:00 21/02/1983 | 2.200 | |
| 12:00:00 23/03/1983 | 2.050 | |
| 12:00:00 22/04/1983 | 1.970 | |
| 12:00:00 25/05/1983 | 1.990 | |
| 12:00:00 24/06/1983 | 2.270 | |
| 12:00:00 26/07/1983 | 2.540 | |
| 12:00:00 25/08/1983 | 2.620 | |
| 12:00:00 23/09/1983 | 2.610 | |
| 12:00:00 21/10/1983 | 2.560 | |
| 12:00:00 21/11/1983 | 2.480 | |
| 12:00:00 29/12/1983 | 2.290 | 2.620 |
| 12:00:00 25/01/1984 | 2.200 | |
| 12:00:00 23/02/1984 | 2.020 | |
| 12:00:00 26/03/1984 | 1.920 | |
| 12:00:00 18/04/1984 | 1.950 | |
| 12:00:00 22/05/1984 | 2.170 | |
| 12:00:00 20/06/1984 | 2.320 | |
| 12:00:00 18/07/1984 | 2.480 | |
| 12:00:00 24/08/1984 | 2.710 | |
| 12:00:00 24/09/1984 | 2.760 | |
| 12:00:00 31/10/1984 | 2.540 | |
| 12:00:00 21/11/1984 | 2.670 | |
| 12:00:00 19/12/1984 | 2.490 | 2.760 |
| 12:00:00 29/01/1985 | 2.480 | |
| 12:00:00 25/02/1985 | 2.410 | |
| 12:00:00 22/03/1985 | 2.100 | |
| 12:00:00 18/04/1985 | 2.120 | |
| 12:00:00 16/05/1985 | 2.050 | |
| 12:00:00 14/06/1985 | 2.210 | |
| 12:00:00 18/07/1985 | 2.460 | |
| 12:00:00 20/08/1985 | 2.570 | |
| 12:00:00 12/09/1985 | 2.580 | |
| 12:00:00 16/10/1985 | 2.590 | |
| 12:00:00 15/11/1985 | 2.490 | 2.590 |
| 15:09:00 05/02/1986 | 2.040 | |
| 10:47:00 20/03/1986 | 2.010 | |
| 10:38:00 15/04/1986 | 1.920 | |
| 10:16:00 14/05/1986 | 1.940 | |
| 11:13:00 18/06/1986 | 2.080 | |
| 10:27:00 16/07/1986 | 2.440 | |
| 10:36:00 18/08/1986 | 2.410 | |
| 10:08:00 18/09/1986 | 2.790 | |
| 10:28:00 20/10/1986 | 2.750 | |
| 09:31:00 10/11/1986 | 2.700 | |
| 09:38:00 03/12/1986 | 2.610 | 2.790 |
| 09:20:00 23/01/1987 | 2.340 | |
| 09:45:00 12/02/1987 | 2.240 | |
| 10:30:00 04/03/1987 | 2.110 | |
| 09:39:00 02/04/1987 | 2.010 | |
| 09:23:00 05/05/1987 | 2.080 | |
| 09:55:00 28/05/1987 | 2.080 | |
| 09:01:00 06/07/1987 | 2.240 | |
| 09:41:00 04/08/1987 | 2.390 | |
| 09:13:00 02/09/1987 | 2.440 | |
| 13:28:00 06/10/1987 | 2.410 | |
| 09:18:00 05/11/1987 | 2.290 | |
| 11:09:00 03/12/1987 | 2.200 | 2.440 |
| 09:37:00 05/02/1988 | 1.880 | |
| 09:42:00 03/03/1988 | 1.730 | |
| 10:04:00 15/04/1988 | 1.625 | |
| 09:30:00 09/05/1988 | 1.710 | |
| 09:08:00 01/06/1988 | 2.000 | |
| 09:42:00 07/07/1988 | 2.200 | |
| 09:36:00 06/09/1988 | 2.480 | |

| | | | |
|----------|------------|-------|-------|
| 09:48:00 | 12/10/1988 | 2.480 | |
| 09:50:00 | 07/11/1988 | 2.420 | 2.480 |
| 09:38:00 | 25/01/1989 | 2.040 | |
| 10:01:00 | 21/04/1989 | 1.750 | |
| 11:34:00 | 20/07/1989 | 2.250 | |
| 10:08:00 | 05/10/1989 | 2.520 | 2.520 |
| 12:50:00 | 11/01/1990 | 2.190 | |
| 10:46:00 | 02/04/1990 | 1.920 | |
| 13:06:00 | 10/07/1990 | 2.120 | |
| 11:23:00 | 23/10/1990 | 2.230 | 2.230 |
| 10:56:00 | 10/01/1991 | 1.830 | |
| 10:27:00 | 06/04/1991 | 1.570 | |
| 09:59:00 | 23/07/1991 | 2.350 | |
| 10:32:00 | 02/10/1991 | 2.540 | |
| 12:33:00 | 23/10/1991 | 2.540 | |
| 13:10:00 | 23/10/1991 | 2.540 | 2.540 |
| 14:28:00 | 31/01/1992 | 2.160 | |
| 10:14:00 | 07/04/1992 | 2.160 | |
| 14:42:00 | 07/05/1992 | 2.150 | |
| 12:17:00 | 09/07/1992 | 2.370 | |
| 12:08:00 | 19/10/1992 | 2.580 | 2.580 |
| 11:24:00 | 25/01/1993 | 2.180 | |
| 11:26:00 | 20/04/1993 | 1.900 | |
| 09:32:00 | 19/07/1993 | 2.140 | |
| 10:18:00 | 08/10/1993 | 2.330 | |
| 00:00:00 | 24/11/1993 | 2.180 | 2.330 |
| 10:35:00 | 24/01/1994 | 1.790 | |
| 12:44:00 | 27/04/1994 | 1.490 | |
| 10:19:00 | 05/07/1994 | 1.950 | |
| 12:35:00 | 18/10/1994 | 2.150 | 2.150 |
| 11:20:00 | 23/01/1995 | 1.620 | |
| 09:45:00 | 10/04/1995 | 1.340 | |
| 13:10:00 | 14/07/1995 | 1.810 | |
| 11:45:00 | 17/10/1995 | 2.050 | 2.050 |
| 09:15:00 | 15/01/1996 | 1.700 | |
| 10:15:00 | 30/04/1996 | 1.360 | |
| 11:15:00 | 11/07/1996 | 1.830 | |
| 09:55:00 | 14/10/1996 | 2.220 | 2.220 |
| 10:52:00 | 20/01/1997 | 1.740 | |
| 08:45:00 | 17/04/1997 | 1.450 | |
| 09:20:00 | 11/07/1997 | 1.790 | |
| 09:30:00 | 13/10/1997 | 2.050 | 2.050 |
| 09:20:00 | 15/01/1998 | 1.570 | |
| 09:08:00 | 26/03/1998 | 1.400 | |
| 11:12:00 | 15/07/1998 | 1.670 | |
| 10:51:00 | 07/10/1998 | 2.050 | 2.050 |
| 09:28:00 | 15/01/1999 | 1.570 | |
| 10:17:00 | 20/05/1999 | 1.300 | |
| 09:34:00 | 21/09/1999 | 2.320 | 2.320 |
| 10:16:00 | 21/06/2000 | 1.680 | |
| 09:31:00 | 12/10/2000 | 2.190 | 2.190 |
| 09:20:00 | 16/05/2001 | 1.330 | |
| 09:03:00 | 16/10/2001 | 1.700 | 1.700 |
| 09:15:00 | 13/05/2002 | 1.120 | |
| 09:11:00 | 14/10/2002 | 1.580 | 1.580 |
| 09:04:00 | 13/05/2003 | 1.120 | |
| 13:11:00 | 15/10/2003 | 1.820 | 1.820 |
| 10:42:00 | 07/05/2004 | 0.980 | |
| 09:51:00 | 11/10/2004 | 1.650 | 1.650 |
| 10:20:00 | 13/05/2005 | 1.140 | |
| 09:16:00 | 06/10/2005 | 2.070 | 2.070 |
| 09:33:00 | 08/05/2006 | 1.310 | |
| 09:27:00 | 09/10/2006 | 1.770 | 1.770 |
| 08:57:00 | 03/05/2007 | 0.940 | |
| 09:11:00 | 15/10/2007 | 1.640 | 1.640 |
| 10:21:00 | 06/05/2008 | 1.180 | |
| 09:09:00 | 09/10/2008 | 2.070 | 2.070 |
| 08:47:00 | 06/05/2009 | 1.160 | |
| 12:22:00 | 15/10/2009 | 1.910 | 1.910 |

Average = 2.259

DoW Bore 3033

Levels in mAHD

| | | |
|---------------------|-------|-------|
| 00:00:00 30/06/1975 | 2.630 | |
| 12:00:00 14/07/1975 | 2.910 | |
| 12:00:00 19/08/1975 | 3.090 | |
| 12:00:00 15/09/1975 | 3.150 | |
| 12:00:00 15/10/1975 | 3.090 | |
| 12:00:00 28/11/1975 | 3.040 | 3.150 |
| 12:00:00 05/03/1976 | 2.670 | |
| 12:00:00 08/04/1976 | 2.560 | |
| 12:00:00 05/05/1976 | 2.510 | |
| 12:00:00 07/05/1976 | 2.370 | |
| 12:00:00 04/06/1976 | 2.460 | |
| 12:00:00 08/07/1976 | 2.550 | |
| 12:00:00 15/09/1976 | 2.690 | |
| 12:00:00 06/10/1976 | 2.720 | |
| 12:00:00 02/11/1976 | 2.700 | 2.720 |
| 12:00:00 05/04/1977 | 2.240 | |
| 12:00:00 05/05/1977 | 2.150 | |
| 12:00:00 21/06/1977 | 2.180 | |
| 12:00:00 07/07/1977 | 2.140 | |
| 12:00:00 08/09/1977 | 2.300 | |
| 12:00:00 12/10/1977 | 2.270 | |
| 12:00:00 07/11/1977 | 2.260 | 2.300 |
| 12:00:00 20/04/1978 | 1.840 | |
| 12:00:00 24/05/1978 | 1.820 | |
| 12:00:00 19/06/1978 | 1.860 | |
| 12:00:00 16/08/1978 | 2.010 | |
| 12:00:00 19/09/1978 | 2.370 | |
| 12:00:00 19/10/1978 | 2.450 | |
| 12:00:00 13/11/1978 | 2.460 | |
| 12:00:00 20/12/1978 | 2.410 | 2.460 |
| 12:00:00 15/01/1979 | 2.300 | |
| 12:00:00 14/02/1979 | 2.210 | |
| 12:00:00 12/03/1979 | 2.110 | |
| 12:00:00 18/04/1979 | 2.040 | |
| 12:00:00 11/05/1979 | 2.000 | |
| 12:00:00 22/06/1979 | 2.000 | |
| 12:00:00 17/07/1979 | 2.160 | |
| 12:00:00 21/08/1979 | 2.290 | |
| 12:00:00 19/09/1979 | 2.340 | |
| 12:00:00 23/10/1979 | 2.360 | |
| 12:00:00 19/11/1979 | 2.420 | |
| 12:00:00 20/12/1979 | 2.230 | 2.420 |
| 12:00:00 23/01/1980 | 2.080 | |
| 12:00:00 22/02/1980 | 1.950 | |
| 12:00:00 19/03/1980 | 1.910 | |
| 12:00:00 28/04/1980 | 1.820 | |
| 12:00:00 21/05/1980 | 1.800 | |
| 12:00:00 15/07/1980 | 2.510 | |
| 12:00:00 20/08/1980 | 2.260 | |
| 12:00:00 19/09/1980 | 2.440 | |
| 12:00:00 24/10/1980 | 2.500 | |
| 12:00:00 25/11/1980 | 2.520 | |
| 12:00:00 29/12/1980 | 2.380 | 2.520 |
| 12:00:00 23/01/1981 | 2.310 | |
| 12:00:00 24/03/1981 | 2.140 | |
| 12:00:00 30/04/1981 | 2.050 | |
| 12:00:00 19/05/1981 | 2.000 | |
| 12:00:00 23/06/1981 | 2.180 | |
| 12:00:00 17/07/1981 | 2.190 | |
| 12:00:00 19/08/1981 | 2.510 | |
| 12:00:00 23/09/1981 | 2.510 | |
| 12:00:00 26/10/1981 | 2.750 | |
| 12:00:00 23/11/1981 | 2.760 | |
| 12:00:00 21/12/1981 | 2.590 | 2.760 |
| 12:00:00 25/01/1982 | 2.770 | |
| 12:00:00 22/02/1982 | 2.710 | |
| 12:00:00 26/03/1982 | 2.500 | |

| | observed WL (mAHD) | calculated AAMGL (mAHD) | GL (mAHD) | GL - AAMGL (m) |
|-----------------|-----------------------|----------------------------|--------------|-------------------|
| | 25/11/2009 | | | |
| MW1 | 1.941 | 2.335 | 4.281 | 1.946 |
| MW2 | 1.895 | 2.289 | 8.195 | 5.906 |
| MW3 | 1.87 | 2.264 | 4.012 | 1.748 |
| MW4 | 1.85 | 2.244 | 10.988 | 8.744 |
| MW5 | 1.036 | 1.430 | 6.954 | 5.524 |
| DoW 3033 | 1.95 | 2.344 | 6.76 | 4.416 |

Max 2.335
Min 1.430

0.394

difference between observed & calculated

| | | |
|---------------------|-------|-------|
| 12:00:00 22/04/1982 | 2.440 | |
| 12:00:00 20/05/1982 | 2.370 | |
| 12:00:00 30/06/1982 | 2.690 | |
| 12:00:00 23/07/1982 | 2.570 | |
| 12:00:00 19/08/1982 | 2.690 | |
| 12:00:00 21/09/1982 | 2.810 | |
| 12:00:00 19/10/1982 | 2.840 | |
| 12:00:00 19/11/1982 | 2.820 | |
| 12:00:00 20/12/1982 | 2.730 | 2.840 |
| 12:00:00 17/01/1983 | 2.600 | |
| 12:00:00 18/02/1983 | 2.500 | |
| 12:00:00 21/03/1983 | 2.380 | |
| 12:00:00 21/04/1983 | 2.280 | |
| 12:00:00 24/05/1983 | 2.210 | |
| 12:00:00 23/06/1983 | 2.270 | |
| 12:00:00 25/07/1983 | 2.410 | |
| 12:00:00 24/08/1983 | 2.450 | |
| 12:00:00 22/09/1983 | 2.690 | |
| 12:00:00 20/10/1983 | 2.700 | |
| 12:00:00 18/11/1983 | 2.660 | |
| 12:00:00 28/12/1983 | 2.600 | 2.700 |
| 12:00:00 24/01/1984 | 2.400 | |
| 12:00:00 22/02/1984 | 2.350 | |
| 12:00:00 22/03/1984 | 2.240 | |
| 12:00:00 17/04/1984 | 2.150 | |
| 12:00:00 21/05/1984 | 2.190 | |
| 12:00:00 19/06/1984 | 2.700 | |
| 12:00:00 17/07/1984 | 2.890 | |
| 12:00:00 21/08/1984 | 3.010 | |
| 12:00:00 20/09/1984 | 3.060 | |
| 12:00:00 31/10/1984 | 2.920 | |
| 12:00:00 21/11/1984 | 2.850 | |
| 12:00:00 18/12/1984 | 2.750 | 3.060 |
| 12:00:00 29/01/1985 | 2.660 | |
| 12:00:00 21/02/1985 | 2.600 | |
| 12:00:00 21/03/1985 | 2.450 | |
| 12:00:00 18/04/1985 | 2.370 | |
| 12:00:00 15/05/1985 | 2.300 | |
| 12:00:00 14/06/1985 | 2.300 | |
| 12:00:00 18/07/1985 | 2.500 | |
| 12:00:00 14/08/1985 | 2.580 | |
| 12:00:00 12/09/1985 | 2.680 | |
| 12:00:00 16/10/1985 | 2.730 | |
| 12:00:00 15/11/1985 | 2.690 | 2.730 |
| 14:47:00 05/02/1986 | 2.410 | |
| 11:22:00 20/03/1986 | 2.290 | |
| 11:42:00 15/04/1986 | 2.220 | |
| 10:59:00 14/05/1986 | 2.160 | |
| 12:32:00 18/06/1986 | 2.180 | |
| 11:06:00 16/07/1986 | 2.440 | |
| 11:20:00 18/08/1986 | 2.700 | |
| 10:54:00 18/09/1986 | 2.880 | |
| 10:35:00 10/11/1986 | 2.940 | |
| 10:11:00 03/12/1986 | 2.880 | 2.940 |
| 09:57:00 23/01/1987 | 2.690 | |
| 10:20:00 12/02/1987 | 2.590 | |
| 11:13:00 04/03/1987 | 2.500 | |
| 10:17:00 02/04/1987 | 2.380 | |
| 10:00:00 05/05/1987 | 2.310 | |
| 10:28:00 28/05/1987 | 2.290 | |
| 10:15:00 06/07/1987 | 2.350 | |
| 10:16:00 04/08/1987 | 2.470 | |
| 09:44:00 02/09/1987 | 2.540 | |
| 14:06:00 06/10/1987 | 2.570 | |
| 10:05:00 05/11/1987 | 2.500 | |
| 13:30:00 03/12/1987 | 2.450 | 2.690 |
| 10:09:00 05/02/1988 | 2.230 | |
| 10:20:00 03/03/1988 | 2.095 | |
| 10:49:00 15/04/1988 | 1.905 | |
| 09:51:00 01/06/1988 | 2.010 | |
| 10:28:00 07/07/1988 | 2.190 | |
| 10:22:00 06/09/1988 | 2.520 | |
| 10:42:00 12/10/1988 | 2.620 | |

| | | |
|---------------------|-------|-------|
| 10:22:00 07/11/1988 | 2.640 | 2.640 |
| 10:09:00 25/01/1989 | 2.420 | 2.560 |
| 10:42:00 21/04/1989 | 2.070 | |
| 12:05:00 20/07/1989 | 2.220 | |
| 11:05:00 05/10/1989 | 2.560 | |
| 13:58:00 11/01/1990 | 2.460 | 2.460 |
| 11:33:00 02/04/1990 | 2.170 | |
| 13:51:00 10/07/1990 | 2.200 | |
| 12:48:00 23/10/1990 | 2.380 | |
| 11:29:00 10/01/1991 | 2.140 | 2.770 |
| 11:03:00 06/04/1991 | 1.880 | |
| 10:56:00 23/07/1991 | 2.220 | |
| 11:15:00 02/10/1991 | 2.700 | |
| 12:21:00 29/10/1991 | 2.720 | |
| 13:29:00 29/10/1991 | 2.720 | |
| 13:36:00 31/01/1992 | 2.520 | |
| 11:30:00 08/04/1992 | 2.420 | |
| 14:05:00 01/05/1992 | 2.370 | |
| 13:42:00 09/07/1992 | 2.480 | |
| 12:53:00 19/10/1992 | 2.770 | |
| 12:55:00 25/01/1993 | 2.510 | 2.510 |
| 12:12:00 20/04/1993 | 2.200 | |
| 10:30:00 19/07/1993 | 2.200 | |
| 10:57:00 08/10/1993 | 2.440 | |
| 11:15:00 24/01/1994 | 2.140 | 2.250 |
| 13:24:00 27/04/1994 | 1.790 | |
| 11:40:00 05/07/1994 | 1.890 | |
| 13:08:00 18/10/1994 | 2.250 | |
| 12:43:00 23/01/1995 | 1.940 | 2.150 |
| 11:00:00 10/04/1995 | 1.630 | |
| 14:10:00 14/07/1995 | 1.720 | |
| 09:22:00 19/10/1995 | 2.150 | |
| 09:55:00 15/01/1996 | 1.980 | 2.250 |
| 10:52:00 30/04/1996 | 1.750 | |
| 11:50:00 11/07/1996 | 1.690 | |
| 10:37:00 14/10/1996 | 2.250 | |
| 11:20:00 20/01/1997 | 2.060 | 2.100 |
| 09:50:00 17/04/1997 | 1.680 | |
| 09:50:00 11/07/1997 | 1.770 | |
| 10:30:00 13/10/1997 | 2.100 | |
| 09:55:00 15/01/1998 | 1.820 | 1.960 |
| 09:53:00 26/03/1998 | 1.560 | |
| 11:42:00 15/07/1998 | 1.610 | |
| 10:27:00 07/10/1998 | 1.960 | |
| 10:00:00 15/01/1999 | 1.820 | 2.190 |
| 11:05:00 20/05/1999 | 1.350 | |
| 10:30:00 21/09/1999 | 2.190 | |
| 10:54:00 21/06/2000 | 1.720 | |
| 10:00:00 12/10/2000 | 2.280 | 2.280 |
| 10:00:00 16/05/2001 | 1.460 | 1.750 |
| 09:44:00 16/10/2001 | 1.750 | |
| 09:50:00 13/05/2002 | 1.200 | 1.630 |
| 09:43:00 14/10/2002 | 1.630 | |
| 09:40:00 13/05/2003 | 1.150 | 1.830 |
| 13:54:00 15/10/2003 | 1.830 | |
| 09:24:00 07/04/2004 | 1.180 | 1.640 |
| 11:22:00 07/05/2004 | 1.180 | |
| 10:43:00 11/10/2004 | 1.640 | |
| 10:53:00 13/05/2005 | 1.130 | 2.030 |
| 09:50:00 06/10/2005 | 2.030 | |
| 10:22:00 08/05/2006 | 1.530 | 1.710 |
| 10:16:00 09/10/2006 | 1.710 | |
| 09:28:00 03/05/2007 | 1.050 | 1.560 |
| 09:40:00 15/10/2007 | 1.560 | |
| 10:46:00 06/05/2008 | 1.220 | 2.140 |
| 09:37:00 09/10/2008 | 2.140 | |
| 09:12:00 06/05/2009 | 1.430 | 1.990 |
| 13:01:00 15/10/2009 | 1.990 | |

Average = 2.344

DoW Bore 3034

Levels in mAHD

| | |
|---------------------|-------|
| 12:00:00 13/04/1977 | 2.310 |
| 12:00:00 05/05/1977 | 2.290 |
| 12:00:00 21/06/1977 | 2.170 |
| 12:00:00 07/07/1977 | 2.670 |
| 12:00:00 08/09/1977 | 2.300 |
| 12:00:00 12/10/1977 | 2.320 |
| 12:00:00 07/11/1977 | 2.300 |
| <hr/> | |
| 12:00:00 30/03/1978 | 2.150 |
| 12:00:00 20/04/1978 | 1.860 |
| 12:00:00 24/05/1978 | 1.840 |
| 12:00:00 19/06/1978 | 1.890 |
| 12:00:00 20/07/1978 | 2.090 |
| 12:00:00 16/08/1978 | 2.270 |
| 12:00:00 29/09/1978 | 2.430 |
| 12:00:00 29/10/1978 | 2.490 |
| 12:00:00 13/11/1978 | 2.500 |
| <hr/> | |
| 12:00:00 15/01/1979 | 2.320 |
| 12:00:00 13/03/1979 | 2.110 |
| 12:00:00 18/04/1979 | 2.030 |
| 12:00:00 11/05/1979 | 1.970 |
| 12:00:00 22/06/1979 | 2.020 |
| 12:00:00 17/07/1979 | 2.240 |
| 12:00:00 21/08/1979 | 2.320 |
| 12:00:00 19/09/1979 | 2.400 |
| 12:00:00 23/10/1979 | 2.400 |
| 12:00:00 19/11/1979 | 2.340 |
| 12:00:00 20/12/1979 | 2.240 |
| <hr/> | |
| 12:00:00 23/01/1980 | 2.090 |
| 12:00:00 22/02/1980 | 1.940 |
| 12:00:00 19/03/1980 | 1.860 |
| 12:00:00 28/04/1980 | 1.850 |
| 12:00:00 21/05/1980 | 1.810 |
| 12:00:00 20/08/1980 | 2.310 |
| 12:00:00 19/09/1980 | 2.500 |
| 12:00:00 24/10/1980 | 2.520 |
| 12:00:00 25/11/1980 | 2.530 |
| 12:00:00 29/12/1980 | 2.430 |
| <hr/> | |
| 12:00:00 23/01/1981 | 2.300 |
| 12:00:00 24/03/1981 | 2.110 |
| 12:00:00 30/04/1981 | 2.030 |
| 12:00:00 19/05/1981 | 1.990 |
| 12:00:00 23/06/1981 | 2.170 |
| 12:00:00 17/07/1981 | 2.190 |
| 12:00:00 19/08/1981 | 2.560 |
| 12:00:00 23/09/1981 | 2.770 |
| 12:00:00 26/10/1981 | 2.990 |
| 12:00:00 23/11/1981 | 2.990 |
| 12:00:00 21/12/1981 | 2.820 |
| <hr/> | |
| 12:00:00 25/01/1982 | 2.950 |
| 12:00:00 22/02/1982 | 2.860 |
| 12:00:00 26/03/1982 | 2.500 |
| 12:00:00 22/04/1982 | 2.430 |
| 12:00:00 20/05/1982 | 2.370 |
| 12:00:00 30/06/1982 | 2.760 |
| 12:00:00 23/07/1982 | 2.580 |
| 12:00:00 20/08/1982 | 2.740 |
| 12:00:00 21/09/1982 | 2.830 |
| 12:00:00 25/10/1982 | 2.900 |
| 12:00:00 19/11/1982 | 2.750 |
| 12:00:00 20/12/1982 | 2.730 |
| <hr/> | |
| 12:00:00 17/01/1983 | 2.580 |
| 12:00:00 18/02/1983 | 2.510 |
| 12:00:00 21/03/1983 | 2.350 |
| 12:00:00 21/04/1983 | 2.250 |
| 12:00:00 24/05/1983 | 2.200 |
| 12:00:00 23/06/1983 | 2.250 |

| | observed WL (mAHD) | calculated AAMGL (mAHD) | GL (mAHD) | GL - AAMGL (m) |
|-----------------|-----------------------|----------------------------|--------------|-------------------|
| | 25/11/2009 | | | |
| MW1 | 1.941 | 2.354 | 4.281 | 1.927 |
| MW2 | 1.895 | 2.308 | 8.195 | 5.887 |
| MW3 | 1.87 | 2.283 | 4.012 | 1.729 |
| MW4 | 1.85 | 2.263 | 10.988 | 8.725 |
| MW5 | 1.036 | 1.449 | 6.954 | 5.505 |
| DoW 3034 | 1.945 | 2.358 | 6.76 | 4.402 |

| | |
|-----|-------|
| Max | 2.354 |
| Min | 1.449 |

0.413
difference between observed & calculated

| | | |
|---------------------|-------|-------|
| 12:00:00 25/07/1983 | 2.450 | |
| 12:00:00 24/08/1983 | 2.550 | |
| 12:00:00 22/09/1983 | 2.680 | |
| 12:00:00 20/10/1983 | 2.730 | |
| 12:00:00 18/11/1983 | 2.670 | |
| 12:00:00 28/12/1983 | 2.500 | 2.730 |
| 12:00:00 24/01/1984 | 2.350 | |
| 12:00:00 22/02/1984 | 2.300 | |
| 12:00:00 22/03/1984 | 2.180 | |
| 12:00:00 17/04/1984 | 2.050 | |
| 12:00:00 21/05/1984 | 2.200 | |
| 12:00:00 19/06/1984 | 2.450 | |
| 12:00:00 17/07/1984 | 2.590 | |
| 12:00:00 21/08/1984 | 2.710 | |
| 12:00:00 20/09/1984 | 2.770 | |
| 12:00:00 31/10/1984 | 2.610 | |
| 12:00:00 21/11/1984 | 2.860 | |
| 12:00:00 18/12/1984 | 2.740 | 2.860 |
| 12:00:00 21/03/1985 | 2.430 | |
| 12:00:00 18/04/1985 | 2.250 | |
| 12:00:00 15/05/1985 | 2.400 | |
| 12:00:00 14/06/1985 | 2.310 | |
| 12:00:00 18/07/1985 | 2.500 | |
| 12:00:00 14/08/1985 | 2.610 | |
| 12:00:00 12/09/1985 | 2.700 | |
| 12:00:00 16/10/1985 | 2.750 | |
| 12:00:00 15/11/1985 | 2.700 | 2.750 |
| 14:45:00 05/02/1986 | 2.390 | |
| 11:18:00 20/03/1986 | 2.290 | |
| 11:52:00 15/04/1986 | 2.200 | |
| 10:55:00 14/05/1986 | 2.150 | |
| 12:44:00 18/06/1986 | 2.190 | |
| 11:11:00 16/07/1986 | 2.420 | |
| 11:27:00 18/08/1986 | 2.700 | |
| 10:50:00 18/09/1986 | 2.900 | |
| 10:54:00 20/10/1986 | 3.090 | |
| 10:30:00 10/11/1986 | 2.970 | |
| 10:08:00 03/12/1986 | 2.890 | 3.090 |
| 09:54:00 23/01/1987 | 2.670 | |
| 10:18:00 12/02/1987 | 2.580 | |
| 11:16:00 04/03/1987 | 2.470 | |
| 10:20:00 02/04/1987 | 2.360 | |
| 10:05:00 05/05/1987 | 2.320 | |
| 10:31:00 28/05/1987 | 2.290 | |
| 10:18:00 06/07/1987 | 2.680 | |
| 10:19:00 04/08/1987 | 2.470 | |
| 09:46:00 02/09/1987 | 2.560 | |
| 14:12:00 06/10/1987 | 2.600 | |
| 10:09:00 05/11/1987 | 2.500 | |
| 13:33:00 03/12/1987 | 2.460 | 2.680 |
| 10:11:00 05/02/1988 | 2.220 | |
| 10:15:00 03/03/1988 | 2.065 | |
| 09:59:00 01/06/1988 | 2.070 | |
| 10:23:00 07/07/1988 | 2.250 | |
| 10:20:00 06/09/1988 | 2.580 | |
| 10:49:00 12/10/1988 | 2.670 | |
| 10:26:00 07/11/1988 | 2.670 | 2.670 |
| 10:13:00 25/01/1989 | 2.440 | |
| 10:45:00 21/04/1989 | 2.140 | |
| 12:09:00 20/07/1989 | 2.270 | |
| 11:14:00 05/10/1989 | 2.610 | 2.610 |
| 13:40:00 11/01/1990 | 2.470 | |
| 11:29:00 02/04/1990 | 2.170 | |
| 13:55:00 10/07/1990 | 2.230 | |
| 12:41:00 23/10/1990 | 2.400 | 2.470 |
| 11:43:00 10/01/1991 | 2.140 | |
| 10:51:00 23/07/1991 | 2.260 | |
| 11:17:00 02/10/1991 | 2.710 | 2.710 |
| 13:27:00 31/01/1992 | 2.520 | |
| 11:34:00 08/04/1992 | 2.420 | |
| 13:48:00 09/07/1992 | 2.490 | |
| 12:47:00 19/10/1992 | 2.800 | 2.800 |

| | | |
|---------------------|-------|-------|
| 13:00:00 25/01/1993 | 2.500 | |
| 12:15:00 20/04/1993 | 2.170 | |
| 10:23:00 19/07/1993 | 2.220 | |
| 10:53:00 08/10/1993 | 2.460 | 2.500 |
| 11:17:00 24/01/1994 | 2.110 | |
| 13:04:00 18/10/1994 | 2.300 | |
| 15:30:00 19/10/1994 | 1.860 | 2.300 |
| 12:45:00 23/01/1995 | 1.920 | |
| 10:55:00 10/04/1995 | 1.610 | |
| 14:05:00 14/07/1995 | 1.750 | |
| 09:20:00 19/10/1995 | 2.160 | 2.160 |
| 09:50:00 15/01/1996 | 1.950 | |
| 10:50:00 30/04/1996 | 1.560 | |
| 11:52:00 11/07/1996 | 1.730 | |
| 10:35:00 14/10/1996 | 2.300 | 2.300 |
| 11:15:00 20/01/1997 | 2.020 | |
| 09:35:00 17/04/1997 | 1.650 | |
| 09:55:00 11/07/1997 | 1.860 | |
| 10:25:00 13/10/1997 | 2.130 | 2.130 |
| 09:50:00 15/01/1998 | 1.760 | |
| 09:50:00 26/03/1998 | 1.520 | |
| 11:40:00 15/07/1998 | 1.650 | |
| 10:25:00 07/10/1998 | 2.000 | 2.000 |
| 09:58:00 15/01/1999 | 1.770 | |
| 10:59:00 20/05/1999 | 1.380 | |
| 10:26:00 21/09/1999 | 2.220 | 2.220 |
| 10:50:00 21/06/2000 | 1.710 | |
| 09:58:00 12/10/2000 | 2.280 | 2.280 |
| 09:57:00 16/05/2001 | 1.430 | |
| 09:40:00 16/10/2001 | 1.730 | 1.730 |
| 09:47:00 13/05/2002 | 1.170 | |
| 09:49:00 14/10/2002 | 1.640 | 1.640 |
| 09:37:00 13/05/2003 | 1.150 | |
| 13:57:00 15/10/2003 | 1.850 | 1.850 |
| 11:25:00 07/05/2004 | 1.130 | |
| 10:39:00 11/10/2004 | 1.660 | 1.660 |
| 10:50:00 13/05/2005 | 1.120 | |
| 09:48:00 06/10/2005 | 2.050 | 2.050 |
| 10:19:00 08/05/2006 | 1.510 | |
| 10:13:00 09/10/2006 | 1.730 | 1.730 |
| 09:25:00 03/05/2007 | 1.020 | |
| 09:45:00 15/10/2007 | 1.620 | 1.620 |
| 10:49:00 06/05/2008 | 1.220 | |
| 09:35:00 09/10/2008 | 2.190 | 2.190 |
| 09:09:00 06/05/2009 | 1.370 | |
| 13:01:00 15/10/2009 | 2.040 | 2.040 |

Average = 2.358

APPENDIX D

GROUND WATER USAGE

Project: HERITAGE PARK IRRIGATION REQUIREMENTS per STAGE AND YEAR
PRELIMINARY MAY 2011

7500kL/hect/ann

Includes: - POS incl. verges associated with POS

Does not include: - Verges

POS not completed within this stage

Assume 70% irrigation requirements following completion of 2 year maintenance period (with exception of POS F - full irrigation requirements)

POS within 2 year maintenance period (assume full irrigation requirements during this time)

POS Partially completed within Stage (assume full irrigation requirements for completed POS)

POS Fully completed within Stage (assume full irrigation requirements)

| YEAR | | | | | | STAGE NUMBER AND COMPLETION DATE (APPROXIMATE) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------------------------|---------------|-------------------------|------------------------|-------|-------|--|----------|------------|----------|------------|----------|------------|----------|------------|----------|------------|----------|------------|----------|------------|----------|------------|----------|------------|----------|------------|----------|------------|----------|------------|----------|------------|----------|------------|
| | | | | | | 2011 | | 2012 | | 2013 | | 2014 | | 2015 | | 2016 | | 2017 | | 2018 | | 2019 | | 2020 | | 2021 | | 2022 | | 2023 | | 2024 | | 2025 |
| | | | | | | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half | 2nd Half | First Half |
| POS Area | Water/year kL | Water/yr in maintenance | Water/yr ongoing | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| STAGE | | 100% usage | 70% usage (excl POS F) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5A | 1ST HALF 2011 | 7,825 | 4,049 | 4,049 | 2,835 | 2,025 | 2,025 | 2,025 | 2,025 | 2,025 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | 1,417 | | | | |
| 5B | 1ST HALF 2012 | 0 | 0 | 0 | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1B | 1ST HALF 2012 | 960 | 612 | 612 | 428 | 306 | 306 | 306 | 306 | 306 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | 214 | | | | |
| TOTAL WATER (KL) PER YEAR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| HERITAGE PARK | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Project: HERITAGE PARK AND PARKLAND HEIGHTS IRRIGATION REQUIREMENTS per STAGE AND YEAR
PRELIMINARY MAY 2011

7500kL/hect/ann

Includes: - POS incl. verges associated with POS
- Greenlinks

Does not include: - Verges

POS not completed within this stage

Assume 70% irrigation requirements following completion of 2 year maintenance period (with exception of POS F - full irrigation requirements)
 POS within 2 year maintenance period (assume full irrigation requirements during this time)
 POS Partially completed within Stage (assume full irrigation requirements for completed POS)
 POS Fully completed within Stage (assume full irrigation requirements)

| YEAR | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| TOTAL WATER (kL) PARKLAND HEIGHTS + HERITAGE PARK PER YEAR | 10,264 | 17,090 | 58,759 | 55,271 | 59,071 | 58,795 | 56,411 | 65,069 | 64,886 | 69,384 | 72,951 | 72,059 | 78,065 | 79,285 | 39,642 |

| Date: 15/06/2011 | | | | | |
|--|--------------------|-------------------------------|--|--------------------------------------|--------------------------------|
| Project: Lot 1507 Parkland Heights | | | | | |
| Year | Construction Stage | Approximate Stage Finish Date | Water Usage | Required Construction Water (kL) | Required Irrigation Water (kL) |
| 2011 | 1 | September | Construction Water/ Irrigation | 30,000 | 6,500 |
| 2012 | 2 | August | Construction Water/ Irrigation | 30,000 | 13,000 |
| 2013 | 3 | August | Construction Water/ Irrigation | 40,000 | 55,000 |
| 2014 | Sand Mining | Continuous | Construction Water/ Irrigation | 40,000 | 55,000 |
| 2015 | 4 | February | Construction Water/ Irrigation | 40,000 | 56,000 |
| 2016 | 5 | February | Construction Water/ Irrigation | 60,000 | 56,000 |
| 2017 | 6 | June | Construction Water/ Irrigation | 60,000 | 56,000 |
| 2018 | 7 | June | Construction Water/ Irrigation | 40,000 | 62,000 |
| 2019 | Sand Mining | Continuous | Construction Water/ Irrigation | 40,000 | 62,000 |
| 2020 | 8 | June | Construction Water/ Irrigation | 40,000 | 67,000 |
| 2021 | 9A | June | Construction Water/ Irrigation | 50,000 | 70,000 |
| 2022 | 9B | June | Construction Water/ Irrigation | 50,000 | 70,000 |
| 2023 | 10A | June | Construction Water/ Irrigation | 50,000 | 75,000 |
| 2024 | 10B | June | Construction Water/ Irrigation | 50,000 | 77,000 |
| 2025 | 11 | June | Construction Water/ Irrigation | 30,000 | 77,000 |
| Project: Heritage Park | | | | | |
| Year | Construction Stage | Approximate Stage Finish Date | Water Usage | Required Construction Water (kL) | Required Irrigation Water (kL) |
| 2011 | 5A | July | Construction Water/ Irrigation | 20000 | 23,000 |
| 2012 | 5B & 1B | July | Construction Water/ Irrigation | 25000 | 23,000 |
| 2013 | POS Only | | Irrigation | - | 23,000 |
| 2014 | POS Only | | Irrigation | - | 23,000 |
| 2015 | POS Only | | Irrigation | - | 23,000 |
| 2016 | POS Only | | Irrigation | - | 23,000 |
| 2017 | POS Only | | Irrigation | - | 23,000 |
| 2018 | POS Only | | Irrigation | - | 23,000 |
| 2019 | POS Only | | Irrigation | - | 23,000 |
| 2020 | POS Only | | Irrigation | - | 23,000 |
| 2021 | POS Only | | Irrigation | - | 23,000 |
| 2022 | POS Only | | Irrigation | - | 23,000 |
| 2023 | POS Only | | Irrigation | - | 23,000 |
| 2024 | POS Only | | Irrigation | - | 23,000 |
| 2025 | POS Only | | Irrigation | - | 23,000 |
| Summary: Parkland Heights & Heritage Park | | | | | |
| Year | | | Total Required Construction Water (kL) | Total Required Irrigation Water (kL) | |
| 2011 | | | 50,000 | 29,500 | |
| 2012 | | | 55,000 | 36,000 | |
| 2013 | | | 40,000 | 78,000 | |
| 2014 | | | 40,000 | 78,000 | |
| 2015 | | | 40,000 | 79,000 | |
| 2016 | | | 60,000 | 79,000 | |
| 2017 | | | 60,000 | 79,000 | |
| 2018 | | | 40,000 | 85,000 | |
| 2019 | | | 40,000 | 85,000 | |
| 2020 | | | 40,000 | 90,000 | |
| 2021 | | | 50,000 | 93,000 | |
| 2022 | | | 50,000 | 93,000 | |
| 2023 | | | 50,000 | 98,000 | |
| 2024 | | | 50,000 | 100,000 | |

APPENDIX E

WATER BALANCE CALCULATIONS

Parkland Heights LWMS

| Pre-Development | Drainage and Infiltration (ML/yr) |
|------------------------|--|
| Pre Development | 112.83 |

| Post-Development | Drainage and Infiltration (ML/yr) |
|-------------------------|--|
|-------------------------|--|

| Groundwater Input | |
|---|---------------|
| R15 Houses | 5.71 |
| R20 Houses | 191.64 |
| R25 Houses | 6.94 |
| R30 Houses | 55.91 |
| R40 Houses | 26.34 |
| R50 Houses | 0.00 |
| R60 Houses | 19.27 |
| Non Residential recharge from rainfall & irrigation | 48.60 |
| POS recharge from rainfall & irrigation | 19.36 |
| Drainage areas and roads | 164.54 |
| Total Input | 538.31 |

| Groundwater Extraction | |
|--|----------------|
| R15 Houses | -1.20 |
| R20 Houses | -46.36 |
| R25 Houses | -1.19 |
| R30 Houses | -12.37 |
| R40 Houses | 0.00 |
| R50 Houses | 0.00 |
| R60 Houses | 0.00 |
| Groundwater for non-residential irrigation | -14.70 |
| Groundwater for POS irrigation | -44.39 |
| Total Extraction | -120.21 |

| | |
|--|---------------|
| Total recharge to groundwater and drainage leaving site | 418.10 |
|--|---------------|

| | |
|--------------------------------------|---------------|
| Extra volume recharge/outflow | 305.28 |
|--------------------------------------|---------------|

| | |
|---------------------------------------|-------------|
| % increase of recharge/outflow | 271% |
|---------------------------------------|-------------|

APPENDIX F

POTABLE DEMAND CALCULATIONS

Appendix F - Potable Calculator

| Standard Water Use data | | R15 | R20 | R25 | R30 | R40 | R60 | Total |
|-------------------------|-----------|------|--------|------|-------|-------|-------|--------|
| Number of dwellings | | 19 | 696 | 27 | 302 | 170 | 190 | 1404 |
| Number of people/hh | | 4 | 3 | 3 | 2 | 1.5 | 1.5 | 2.41 |
| Number of people | | 76 | 2088 | 81 | 604 | 255 | 285 | 3389 |
| Irrigable area/ lot | m2 | 280 | 208 | 208 | 110 | 50 | 35 | |
| Irrigation rates | kL/ha/a | 7500 | 7500 | 7500 | 7500 | 7500 | 7500 | |
| Irrigation rates | kL/m2/a | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | |
| Indoor | kL/hh/a | 224 | 168 | 168 | 112 | 84 | 84 | |
| Outdoor | kL/hh/a | 210 | 156 | 156 | 82.5 | 37.5 | 26.3 | |
| Total Water use | kL/hh/a | 434 | 324 | 324 | 194.5 | 121.5 | 110 | 244 |
| Total Water use | kL/zone/a | 8246 | 225504 | 8748 | 58739 | 20655 | 20948 | 342840 |
| Total Water use | kL/p/a | 109 | 108 | 108 | 97 | 81 | 74 | 101 |

| | | | | | | | | | | |
|------------------------------|---|-----|-----|-----|----|----|----|---------------|---------|---|
| Residential bore takeup rate | % | 20% | 20% | 20% | 0% | 0% | 0% | Total Savings | | |
| | | | | | | | | kL/dev/a | kL/hh/a | % |

| | | | | | | | | | | | |
|----|---|-----------|------|--------|------|------|------|------|-------|------|-------|
| P1 | Eco water saver- Rainwater indoors | | | | | | | | | | |
| | Package takeup rate | 1% | 1% | 1% | 0% | 0% | 0% | | | | |
| | Savings | kL/hh/a | 26 | 21 | 21 | 16 | 15 | 15 | | | |
| | Total package savings | kL/zone/a | 4.94 | 146.16 | 5.67 | 0 | 0 | 0 | 157 | 0.1 | 0% |
| P2 | Eco water recycler - Greywater + ww garden (backyard) | | | | | | | | | | |
| | Package takeup rate (not including those in P3) | 0% | 0% | 0% | 0% | 0% | 0% | | | | |
| | % of total homes with both bore and package | 0% | 0% | 0% | 0% | 0% | 0% | | | | |
| | Greywater | | | | | | | | | | |
| | Greywater produced | kL/hh/a | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | Required Greywater area (35mm/wk) | m2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Scheme water saved | kL/hh/a | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Scheme water saved | kL/zone/a | 0 | 0 | 0 | 0 | 0 | 0 | | | |
| | Waterwise garden usage | | | | | | | | | | |
| | Waterwise garden savings | kL/hh/a | 42.0 | 31.2 | 31.2 | 16.5 | 7.5 | 5.3 | | | |
| | Waterwise garden savings | kL/zone/a | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | | |
| | Total package savings | kL/zone/a | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0% |
| | Savings from bore | kL/zone/a | 798 | 21715 | 842 | 0 | 0 | 0 | 23356 | 17 | 6.8% |
| | Savings from bore & package | kL/zone/a | 798 | 21715 | 842 | 0 | 0 | 0 | 23356 | 16.6 | 6.8% |
| P3 | Eco waterwise landscape (frontyard) | | | | | | | | | | |
| | Package takeup rate (not including those with P2) | 100% | 100% | 100% | 100% | 0% | 0% | | | | |
| | % of total homes with both bore and package | 0% | 0% | 0% | 0% | 0% | 0% | | | | |
| | Scheme water savings | kL/hh/a | 42 | 31.2 | 31.2 | 16.5 | 7.5 | 5.25 | | | |
| | Total package scheme water savings | kL/zone/a | 798 | 21715 | 842 | 4983 | 0 | 0 | 28339 | 20.2 | 8.3% |
| | Savings from bore | kL/zone/a | 798 | 21715 | 842 | 0 | 0 | 0 | 23356 | 16.6 | 6.8% |
| | Savings from bore & package | kL/zone/a | 1596 | 43430 | 1685 | 4983 | 0 | 0 | 51694 | 36.8 | 15.1% |
| P4 | Indoor Eco water saver (Internal appliance upgrade) | | | | | | | | | | |
| | Package takeup rate | 0% | 0% | 0% | 0% | 0% | 0% | | | | |
| | Savings | kL/hh/a | 46.6 | 35.0 | 35.0 | 23.3 | 17.5 | 17.5 | | | |
| | Total package savings | kL/zone/a | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0 | 0.0% |
| P5 | Behaviour change program | | | | | | | | | | |
| | Package takeup rate | 30% | 30% | 30% | 30% | 30% | 30% | | | | |
| | Savings | kL/hh/a | 65.1 | 48.6 | 48.6 | 29.2 | 18.2 | 16.5 | | | |
| | Total package savings | kL/zone/a | 371 | 10148 | 394 | 2643 | 929 | 943 | 15428 | 11.0 | 4.5% |

| | | | | | | | | | | |
|--------------------------------|-----------|------|-------|------|------|-----|-----|-------|------|-------|
| Total packages savings | kL/zone/a | 1174 | 32009 | 1242 | 7626 | 929 | 943 | 43923 | 31.3 | 12.8% |
| Total Residential Bore savings | kL/zone/a | 1596 | 43430 | 1685 | 0 | 0 | 0 | 46711 | 33.3 | 13.6% |

| | kL/hh/a | L/hh/d | kL/p/a | L/p/d |
|---|---------|--------|--------|-------|
| Standard Total Water Use | 247 | 677 | 102.3 | 280 |
| Estimated Total Water Savings from Packages | 31.3 | 86 | 13.0 | 36 |
| Estimated Total Water Savings from Bore | 33.3 | 91 | 13.8 | 38 |
| Expected Total Water Scheme Water Use | 182 | 500 | 75.6 | 207 |
| % reduction | 26% | 26% | 26% | 26% |

Packages Summary (averaged over whole development)

| | Total saving | | | |
|---|--------------|--------|-----|--|
| | kL/hh/a | kL/p/a | % | |
| Eco water saver- Rainwater indoors | 0.1 | 0.0 | 0% | toilet and w/m only assuming a 3star w/m assumes WW garden saves 40% of rear garden use assumes WW garden saves 40% of front garden use 4.5/3 toilet, 7.5L/min shower, tap restrictors Assumes 15% reduction |
| Eco water recycler - Greywater + ww garden | 0.0 | 0.0 | 0% | |
| Eco waterwise landscape | 20.2 | 8.4 | 8% | |
| Indoor Eco water saver (Internal appliance upgrade) | 0.0 | 0.0 | 0% | |
| Behaviour change program | 11.0 | 4.6 | 5% | |
| Residential bore water savings | 33.3 | 4.6 | 14% | |
| Total | 31 | 13 | 26% | |

APPENDIX G

GROUNDWATER LICENCES



Your ref: GWL 169700 (3)
Our ref: RF 7769
Enquiries: Lorna Aylward 9550 4217

Rockingham Park Pty Ltd
PO Box 7197
CLOISTERS SQUARE WA 6850

Dear Licensee

Re: Issue of a Licence to Take Water – GWL 169700 (3)
Property: Lot 9002 on Plan 61888-Volume/Folio 2715/142- Lot 9002 Baldivis-Heritage Park
Lot 182 on Plan 55259 on Plan 55259-Volume/Folio Lr3147/627-Lot 182 Baldivis-Heritage Park

Please find enclosed your *Licence to Take Water*, issued under section 5C of the *Rights in Water and Irrigation Act 1914*. This licence entitles you to take water, subject to certain terms, conditions or restrictions. It does not absolve the licensee from responsibility for compliance with the requirements of all Commonwealth and State legislation.

It is important that you read the conditions of your licence carefully. If you do not understand your licence, please contact the Department as soon as possible, as there are penalties for failing to comply with all of your licence conditions.

Under Section 26GG(2) of the *Rights in Water and Irrigation Act 1914*, you have a right to apply to the State Administrative Tribunal to request a written statement of reasons for the period for which the licence is granted or for a review of any term, condition or restriction included in the licence. You have 28 days from the date you received this letter to request that the decision be reviewed

For further information please contact the State Administrative Tribunal:

State Administrative Tribunal
12 St Georges Terrace
PERTH WA 6000

GPO Box U1991
PERTH WA 6845

Telephone: (08) 9219 3111
Toll-free: 1300 306 017
Facsimile: (08) 9325 5099
www.sat.justice.wa.gov.au

If you wish to continue taking water after this *Licence to Take Water* expires, it is your responsibility to apply to the Department of Water for its renewal. If this licence expires and you have not applied to renew it, then the taking of water must cease, or you will be in breach of the *Rights in Water and Irrigation Act 1914*. It is suggested that an application for renewal be made at least one month in advance of the *Licence to Take Water* expiry date.

Should legal access to the land cease, for example you decide to sell your property, before the *Licence to Take Water* expiry date, you are required to inform the Department using Form 6 - Notice that Licence Holder is not or may not be Eligible to Hold a Licence and return the enclosed licence within 30 days. Failure to comply is a breach of the *Rights in Water and Irrigation Act 1914*.

You may apply to amend or transfer the *Licence to Take Water* at any time. The Department may also amend, suspend or cancel this licence in certain circumstances. For further information, please refer to the Frequently Asked Questions (FAQ's) on the Departments website <http://www.water.wa.gov.au>

Please note that the Department maintains a 'Water Register' containing information on Western Australia's water availability and licensing details. An extract of this licence has been placed on the register and can be viewed online at; <http://www.water.wa.gov.au>.

If you have any queries relating to the above matter, please contact me on 9550 4217

Yours faithfully



Lorna Aylward
Natural Resource Management Officer
Department of Water
Kwinana Peel Regional office

24 August 2011

Encl. GWL 169700 (3)



LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

| | | | |
|-------------------------------|--|--|----------|
| Licensee(s) | Rockingham Park Pty Ltd | | |
| Description of Water Resource | Stakehill Perth - Superficial Swan | Annual Water Entitlement | 27450 kL |
| Location of Water Source | Lot 182 On Plan 55259 - Volume/Folio Lr3147/627 - Lot 182 Baldivis - Heritage Park | | |
| Authorised Activities | Taking of water for | Location of Activity | |
| | Irrigation of up to 0 ha of public open space | Lot 9002 On Plan 61888 - Volume/Folio 2715/142 - Lot 9002 Baldivis - Heritage Park | |
| | Irrigation of up to 6.87 ha of public open space | Lot 182 On Plan 55259 - Volume/Folio Lr3147/627 - Lot 182 Baldivis - Heritage Park | |
| Duration of Licence | From 18 August 2011 to 18 July 2013 | | |

This Licence is subject to the following terms, conditions and restrictions:

- 1 Approval by the Department of Water is to be obtained prior to the construction of additional and replacement wells and the modification or refurbishment of existing wells.
- 2 That should the licensee's draw adversely affect the aquifer or other users in the area, the Department of Water may reduce the amount that may be drawn.
- 3 The licensee shall not use water for public open space between 9 am and 6 pm except for the establishment of newly planted areas. For newly planted areas water may be used within these hours for a period of up to 28 consecutive days, commencing from the date of planting.
- 4 The annual water year for water taken under this licence is defined as 12:00 pm at 1 July to 12:00 pm at 1 July twelve months later.
- 5 The licensee must take and record the reading from each meter required under this licence at the beginning and another at the end of the water year defined on this licence.
- 6 In addition to taking and recording the reading(s) at the beginning and the end of the water year, the licensee must, as close as practicable to the end of each month (other than the month in which the water year ends), take and record the reading from each meter required under this licence.
- 7 All meter readings must be recorded on the "Meter Water Use Card".
- 8 The completed Meter Water Use Card must be returned to the Department of Water by 14 July.
- 9 The licensee must not, in any water year, take more water than the annual water entitlement specified in this licence.
- 10 The licensee must notify the Department of Water in writing of any water meter malfunction within seven days of the malfunction being noticed.
- 11 That the licensee shall have the irrigation project completed by 27 August 2011.

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000



LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

This Licence is subject to the following terms, conditions and restrictions:

- 12 The licensee must obtain authorisation from the Department of Water before removing, replacing or interfering with any meter required under this licence.
- 13 The licensee must ensure the installed meter(s) accuracy is maintained to within plus or minus 5% of the volume metered, in field conditions.
- 14 Between 1 June and 31 August in any year, the licence-holder must not water a lawn, garden, or grass-covered area ("turf") by reticulation, provided always that this restriction shall not apply to watering with a hand held hose; or watering, by way of reticulation: newly planted areas for a period of up to 28 days from the date of planting; for renovating turf; or for maintenance of reticulation systems.

End of terms, conditions and restrictions



Your ref: GWL 164680 (4)

Our ref: RF7769

Enquiries: Lorna Aylward (08) 9550 4217

Neil Teo
Dynamic Planning & Developments
PO Box 525
NORTH PERTH WA 6906

On behalf of Rockingham Park Pty Ltd

Dear Mr Teo

Re: Issue of a Licence to Take Water – GWL 164680 (4)
Property: Lot 1507 on Plan 194627-Volume/Folio Lr3115/948-Lot 1507 Baldivis-Parkland Estate
Lot 9003 on Plan 61899-Volume/Folio 2748/284-Lot 9003 Baldivis –Heritage Park

Please find enclosed your *Licence to Take Water*, issued under section 5C of the *Rights in Water and Irrigation Act 1914*. This licence entitles you to take water, subject to certain terms, conditions or restrictions. It does not absolve the licensee from responsibility for compliance with the requirements of all Commonwealth and State legislation.

It is important that you read the conditions of your licence carefully. If you do not understand your licence, please contact the Department as soon as possible, as there are penalties for failing to comply with all of your licence conditions.

Under Section 26GG(2) of the *Rights in Water and Irrigation Act 1914*, you have a right to apply to the State Administrative Tribunal to request a written statement of reasons for the period for which the licence is granted or for a review of any term, condition or restriction included in the licence. You have 28 days from the date you received this letter to request that the decision be reviewed

For further information please contact the State Administrative Tribunal:

State Administrative Tribunal
12 St Georges Terrace
PERTH WA 6000

GPO Box U1991
PERTH WA 6845

Telephone: (08) 9219 3111
Toll-free: 1300 306 017
Facsimile: (08) 9325 5099
www.sat.justice.wa.gov.au

This licence is due to expire on 25 August 2013. If you wish to continue taking water after this *Licence to Take Water* expires, it is your responsibility to apply to the Department of Water for its renewal. If this licence expires and you have not applied to renew it, then the taking of water must cease, or you will be in breach of *the Rights in Water and Irrigation Act 1914*. It is suggested that an application for renewal be made at least one month in advance of the *Licence to Take Water* expiry date.

Should legal access to the land cease, for example you decide to sell your property, before the *Licence to Take Water* expiry date, you are required to inform the Department using Form 6 - Notice that Licence Holder is not or may not be Eligible to Hold a Licence and return the enclosed licence within 30 days. Failure to comply is a breach of the *Rights in Water and Irrigation Act 1914*.

You may apply to amend or transfer the *Licence to Take Water* at any time. The Department may also amend, suspend or cancel this licence in certain circumstances. For further information, please refer to the Frequently Asked Questions (FAQ's) on the Departments website <http://www.water.wa.gov.au>

The Department of Water would like to inform you that your licence has been re-issued for a 1 year period only, it includes a development condition stating that you must have at least 50% of the irrigation project completed within the term of the licence otherwise the water entitlement will be reduced in line with the Department of Water's Statewide policy on unused water entitlements.

Please note that the Department maintains a 'Water Register' containing information on Western Australia's water availability and licensing details. An extract of this licence has been placed on the register and can be viewed online at; <http://www.water.wa.gov.au>.

If you have any queries relating to the above matter, please contact me on (08) 9550 4217

Yours sincerely



Lorna Aylward
Natural Resource Management Officer
Department of Water
Kwinana Peel Region

31 August 2011

Encl. GWL 164680 (4)



LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

| | | | |
|-------------------------------|--|--|----------|
| Licensee(s) | Rockingham Park Pty Ltd | | |
| Description of Water Resource | Stakehill Perth - Superficial Swan | Annual Water Entitlement | 80000 kL |
| Location of Water Source | Lot 1507 On Plan 194627 - Volume/Folio Lr3115/948 - Lot 1507 Baldivis - Parkland Heights Lot 9003 On Plan 61899 - Volume/Folio 2748/284 - Lot 9003 Baldivis - Heritage Park | | |
| Authorised Activities | Taking of water for | Location of Activity | |
| | Dust suppression for earthworks and construction purposes Earthwork and construction purposes | Lot 1507 On Plan 194627 - Volume/Folio Lr3115/948 - Lot 1507 Baldivis - Parkland Heights | |
| | Dust suppression for earthworks and construction purposes Earthwork and construction purposes | | |
| | Dust suppression for earthworks and construction purposes Earthwork and construction purposes | Lot 9003 On Plan 61899 - Volume/Folio 2748/284 - Lot 9003 Baldivis - Heritage Park | |
| Duration of Licence | From 26 August 2011 to 25 August 2013 | | |

This Licence is subject to the following terms, conditions and restrictions:

- 1 That should the licensee's draw adversely affect the aquifer or other users in the area, the Department of Water may reduce the amount that may be drawn.
- 2 Approval by the Department of Water is to be obtained prior to the construction of additional and replacement wells and the modification or refurbishment of existing wells.
- 3 The annual water year for water taken under this licence is defined as 12:00 pm at 1 July to 12:00 pm at 30 June twelve months later.
- 4 The licensee must take and record the reading from each meter required under this licence at the beginning and another at the end of the water year defined on this licence.
- 5 In addition to taking and recording the reading(s) at the beginning and the end of the water year, the licensee must, as close as practicable to the end of each month (other than the month in which the water year ends), take and record the reading from each meter required under this licence.
- 6 All meter readings must be recorded on the "Meter Water Use Card".
- 7 The licensee must not, in any water year, take more water than the annual water entitlement specified in this licence.
- 8 The licensee must ensure the installed meter(s) accuracy is maintained to within plus or minus 5% of the volume metered, in field conditions.

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000



LICENCE TO TAKE WATER

Granted by the Minister under section 5C of the Rights in Water and Irrigation Act 1914

This Licence is subject to the following terms, conditions and restrictions:

- 9 The licensee must notify the Department of Water in writing of any water meter malfunction within seven days of the malfunction being noticed.
- 10 The licensee must submit to the Department of Water the recorded meter readings and the volume of water taken within the water year by 14 July.
- 11 The licensee must install a cumulative water meter of a type approved under the Rights in Water and Irrigation (Approved Meters) Order 2009 to each water draw point under this licence.

End of terms, conditions and restrictions

APPENDIX H

PRELIMINARY EARTHWORKS PLAN

1. DRAWING FOR INFORMATION ONLY. FOR DETAILED DESIGN INFORMATION REFER TO STAGE SPECIFIC DRAWINGS AND SPECIFICATION.

1.40
PRELIMINARY DESIGN FINISHED SURFACE CONTOUR (1.0m INTERVAL)
LIMIT OF WORKS BOUNDARY

CHECK PRINT
Apr 20, 2011

- ☐ DRAFTING CHECK
 - ☐ DESIGN CHECK
 - ☐ CLIENT REVIEW
 - ☐ APPROVED BY
ENGINEER

PRELIMINARY OVERALL EARTHWORKS PLAN

Serling Consulting (WA) Pty Ltd
ACN: 136 628 058

SPRING CONSULTING

UNIT 210/296 SAGOROUGH BEACH ROAD
OSBORNE PARK WA 6017
Telephone (08) 9202 8740
Facsimile (08) 9202 8749

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INNOVATIVE ENGINEERING SOLUTIONS

ROCKINGHAM PARK

LOT 1507 - BALDIVIS - PARKLAND HEIGHTS

| | |
|-----------|----------------|
| R JONG | DRAFTING CHECK |
|-----------|----------------|

| | |
|----------|---------------|
| RED JONG | DESIGN REVIEW |
|----------|---------------|

APPROVED
PROJECT DIRECTOR

SHEET
A1

| | |
|--------|--|
| DATUM | |
| A.H.D. | |

WAPC No. _____
SCALE _____

1.1000

| | |
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| | |
| | 7 |

PROJECT No. 5700

1020

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| D | 010 |
|---|-----|

DRAWING | 01

| | |
|-----|--|
| No. | |
|-----|--|

, INDICATES A COPY OF AN ORIGINAL SIGNED DRAWING

APPENDIX I

DRAINAGE CONCEPT PLANS



DESIGN ASSUMPTIONS

- WHERE SUBDIVISION LAYOUT NOT AVAILABLE IMPERVIOUS AREA EQUALS 25% OF TOTAL CATCHMENT AREA.
- INFILTRATION AREA IS ESTIMATED AT 25% OF ALL
 - POS
 - ROAD / MEDIAN AREA WITHIN CATCHMENT
 - BELOW GROUND INFILTRATION NETWORK AREA

LEGEND

- GENERALISED DRAINAGE FLOW DIRECTION
- EXTENT OF SITE CATCHMENT BOUNDARY
- DRAINAGE SUB CATCHMENT BOUNDARY
- PROPOSED SURFACE CONTOUR
- PROPOSED PUBLIC OPEN SPACE
- PROPOSED SWALES / BELOW GROUND INFILTRATION SYSTEM
- DENOTES DRAINAGE INFILTRATION BASIN. SHAPE TO BE DETERMINED AT DETAIL DESIGN
- DENOTES 1 in 1 STORM TWL
- DENOTES 1 in 5 STORM TWL
- DENOTES 1 in 10 STORM TWL
- DENOTES 1 in 100 STORM TWL

AREAS AND STORAGE 1 IN 1 STORM

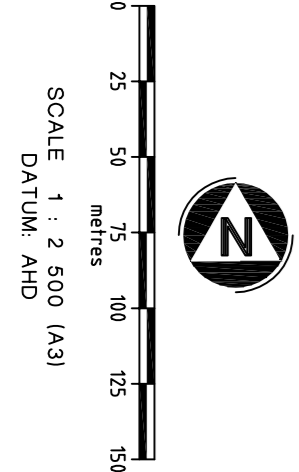
| SWALE | CATCHMENT | IMPERVIOUS AREA | INFILTRATION RATE | SWALE AREA | STORM VOLUME |
|-------|-----------|-----------------|-------------------|--------------------|-------------------|
| 1 | 1.33 ha | 1.20 ha | 3.0m/DAY | 54.6m ² | 70m ³ |
| 2 | 1.89 ha | 1.70 ha | 3.0m/DAY | 902m ² | 110m ³ |
| 3 | 2.17 ha | 1.95 ha | 3.0m/DAY | 800m ² | 150m ³ |
| 4 | 1.73 ha | 1.56 ha | 3.0m/DAY | 551m ² | 100m ³ |
| 5 | 0.99 ha | 0.89 ha | 3.0m/DAY | 4.62m ² | 50m ³ |

| BASIN | CATCHMENT AREA | IMPERVIOUS AREA | INFILTRATION RATE | BASIN AREA | STORM VOLUME |
|-------|----------------|-----------------|-------------------|--------------------|-------------------|
| B1 | 3.77 ha | 3.39 ha | 3.0m/DAY | 1878m ² | 300m ³ |
| B2 | 6.32 ha | 5.69 ha | 3.0m/DAY | 2654m ² | 470m ³ |
| B3 | 5.09 ha | 4.58 ha | 3.0m/DAY | 1508m ² | 560m ³ |
| B4 | 2.06 ha | 1.85 ha | 3.0m/DAY | 1043m ² | 170m ³ |
| B5 | 2.75 ha | 2.48 ha | 3.0m/DAY | 1414m ² | 140m ³ |
| B6 | 1.27 ha | 1.14 ha | 3.0m/DAY | 1732m ² | 10m ³ |
| B7 | 1.89 ha | 1.70 ha | 3.0m/DAY | 798m ² | 140m ³ |
| B8 | 1.10 ha | 0.99 ha | 3.0m/DAY | 750m ² | 60m ³ |
| B9 | 3.43 ha | 3.09 ha | 3.0m/DAY | 1924m ² | 260m ³ |
| B10 | 2.12 ha | 1.91 ha | 3.0m/DAY | 814m ² | 200m ³ |

09.078

Serling Consulting
INNOVATIVE ENGINEERING SOLUTIONS

Serling Consulting (WA) Pty Ltd
 UNIT 210/268 SPAREBORN BEACH ROAD
 SPAREBORN BEACH, WEST AUSTRALIA 6163
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 Email: info@serlingconsulting.com.au
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PARKLAND HEIGHTS
 LOT 1507 EIGHTY ROAD, BALDIVIS
 LOCAL WATER MANAGEMENT STRATEGY
 DRAINAGE CATCHMENT PLAN - 1 IN 1YR STORM EVENT
 FIGURE 1





DESIGN ASSUMPTIONS

- WHERE SUBDIVISION LAYOUT NOT AVAILABLE IMPERVIOUS AREA EQUALS 25% OF TOTAL CATCHMENT AREA.
- INFILTRATION AREA IS ESTIMATED AT 25% OF ALL
 - POS
 - ROAD / MEDIAN AREA WITHIN CATCHMENT
 - BELOW GROUND INFILTRATION NETWORK AREA

LEGEND

- GENERALISED DRAINAGE FLOW DIRECTION
- EXTENT OF SITE CATCHMENT BOUNDARY
- DRAINAGE SUB CATCHMENT BOUNDARY
- PROPOSED SURFACE CONTOUR
- PROPOSED PUBLIC OPEN SPACE
- PROPOSED BELOW GROUND INFILTRATION STORAGE
- DENOTES DRAINAGE INFILTRATION BASIN. SHAPE TO BE DETERMINED AT DETAIL DESIGN
- DENOTES 1 in 1 STORM TWL
- DENOTES 1 in 5 STORM TWL
- DENOTES 1 in 10 STORM TWL
- DENOTES 1 in 100 STORM TWL

AREAS AND STORAGE 1 IN 5 STORM

| SWALE | CATCHMENT AREA | IMPERVIOUS AREA | INFILTRATION RATE | SWALE AREA | STORM VOLUME |
|-------|----------------|-----------------|-------------------|--------------------|-------------------|
| 1 | 1.33 ha | 1.20 ha | 3.0m/DAY | 691m ² | 120m ³ |
| 2 | 1.89 ha | 1.70 ha | 3.0m/DAY | 1232m ² | 190m ³ |
| 3 | 2.17 ha | 1.95 ha | 3.0m/DAY | 1000m ² | 250m ³ |
| 4 | 1.73 ha | 1.56 ha | 3.0m/DAY | 755m ² | 180m ³ |
| 5 | 0.99 ha | 0.89 ha | 3.0m/DAY | 573m ² | 80m ³ |

| BASIN | CATCHMENT AREA | IMPERVIOUS AREA | INFILTRATION RATE | BASIN AREA | STORM VOLUME |
|-------|----------------|-----------------|-------------------|--------------------|---------------------|
| B1 | 3.77 ha | 3.39 ha | 3.0m/DAY | 2085m ² | 74.0m ³ |
| B2 | 6.32 ha | 5.69 ha | 3.0m/DAY | 2893m ² | 107.0m ³ |
| B3 | 5.09 ha | 4.58 ha | 3.0m/DAY | 1755m ² | 105.0m ³ |
| B4 | 2.06 ha | 1.85 ha | 3.0m/DAY | 1206m ² | 43.0m ³ |
| B5 | 2.75 ha | 2.48 ha | 3.0m/DAY | 1673m ² | 44.0m ³ |
| B6 | 1.27 ha | 1.14 ha | 3.0m/DAY | 1795m ² | 14.0m ³ |
| B7 | 1.89 ha | 1.70 ha | 3.0m/DAY | 878m ² | 27.0m ³ |
| B8 | 1.10 ha | 0.99 ha | 3.0m/DAY | 810m ² | 13.0m ³ |
| B9 | 3.43 ha | 3.09 ha | 3.0m/DAY | 2112m ² | 65.0m ³ |
| B10 | 2.12 ha | 1.91 ha | 3.0m/DAY | 961m ² | 4.0m ³ |

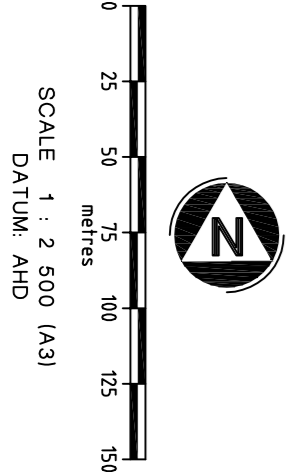
09.078

SERLING CONSULTING

INNOVATIVE ENGINEERING SOLUTIONS

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PARKLAND HEIGHTS
 LOT 1507 EIGHTY ROAD, BALDIVIS
 LOCAL WATER MANAGEMENT STRATEGY
 DRAINAGE CATCHMENT PLAN - 1 IN 5YR STORM EVENT
 FIGURE 2





DESIGN ASSUMPTIONS

- WHERE SUBDIVISION LAYOUT NOT AVAILABLE IMPERVIOUS AREA EQUALS 25% OF TOTAL CATCHMENT AREA.
- INFILTRATION AREA IS ESTIMATED AT 25% OF ALL
 - POS
 - ROAD / MEDIAN AREA WITHIN CATCHMENT
 - BELOW GROUND INFILTRATION NETWORK AREA

LEGEND

GENERALISED DRAINAGE FLOW DIRECTION

EXTENT OF SITE CATCHMENT BOUNDARY

DRAINAGE SUB CATCHMENT BOUNDARY

PROPOSED SURFACE CONTOUR

PROPOSED PUBLIC OPEN SPACE

PROPOSED BELOW GROUND INFILTRATION STORAGE

DENOTES DRAINAGE INFILTRATION BASIN. SHAPE TO BE DETERMINED AT DETAIL DESIGN

DENOTES 1 in 1 STORM TWL

DENOTES 1 in 5 STORM TWL

DENOTES 1 in 10 STORM TWL

DENOTES 1 in 100 STORM TWL

AREAS AND STORAGE 1 IN 10 STORM

| SWALE | CATCHMENT AREA | IMPERVIOUS AREA | INFILTRATION RATE | SWALE AREA | STORM VOLUME |
|-------|----------------|-----------------|-------------------|--------------------|-------------------|
| 1 | 1.33 ha | 1.20 ha | 3.0m/DAY | 737m ² | 130m ³ |
| 2 | 1.89 ha | 1.70 ha | 3.0m/DAY | 1335m ² | 220m ³ |
| 3 | 2.17 ha | 1.95 ha | 3.0m/DAY | 1060m ² | 280m ³ |
| 4 | 1.73 ha | 1.56 ha | 3.0m/DAY | 819m ² | 210m ³ |
| 5 | 0.99 ha | 0.89 ha | 3.0m/DAY | 607m ² | 90m ³ |

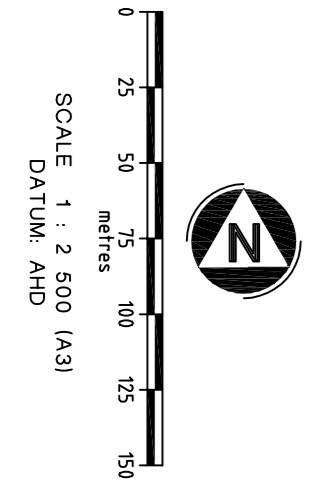
| BASIN | CATCHMENT AREA | IMPERVIOUS AREA | INFILTRATION RATE | BASIN AREA | STORM VOLUME |
|-------|----------------|-----------------|-------------------|--------------------|--------------------|
| B1 | 3.77 ha | 3.39 ha | 3.0m/DAY | 2159m ² | 910m ³ |
| B2 | 6.32 ha | 5.69 ha | 3.0m/DAY | 2977m ² | 1290m ³ |
| B3 | 5.09 ha | 4.58 ha | 3.0m/DAY | 1839m ² | 1230m ³ |
| B4 | 2.06 ha | 1.85 ha | 3.0m/DAY | 1265m ² | 530m ³ |
| B5 | 2.75 ha | 2.48 ha | 3.0m/DAY | 1759m ² | 570m ³ |
| B6 | 1.27 ha | 1.14 ha | 3.0m/DAY | 1840m ² | 230m ³ |
| B7 | 1.89 ha | 1.70 ha | 3.0m/DAY | 902m ² | 320m ³ |
| B8 | 1.10 ha | 0.99 ha | 3.0m/DAY | 836m ² | 170m ³ |
| B9 | 3.43 ha | 3.09 ha | 3.0m/DAY | 2180m ² | 790m ³ |
| B10 | 2.12 ha | 1.91 ha | 3.0m/DAY | 1012m ² | 480m ³ |

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OVERLAND FLOW
FOR 1 IN 100 YEAR
STORM EVENT

EIGHTY ROAD

ARPENTEUR DRIVE

MAIRN DRIVE

SIXTY EIGHT
ROAD

DESIGN ASSUMPTIONS

- WHERE SUBDIVISION LAYOUT NOT AVAILABLE IMPERVIOUS AREA EQUALS 25% OF TOTAL CATCHMENT AREA.
- INFILTRATION AREA IS ESTIMATED AT 25% OF ALL
 - POS
 - ROAD / MEDIAN AREA WITHIN CATCHMENT
 - BELOW GROUND INFILTRATION NETWORK AREA

LEGEND

- GENERALISED DRAINAGE FLOW DIRECTION
- EXTENT OF SITE CATCHMENT BOUNDARY
- DRAINAGE SUB CATCHMENT BOUNDARY
- PROPOSED SURFACE CONTOUR
- PROPOSED PUBLIC OPEN SPACE
- PROPOSED BELOW GROUND INFILTRATION STORAGE
- DENOTES DRAINAGE INFILTRATION BASIN. SHAPE TO BE DETERMINED AT DETAIL DESIGN
- DENOTES 1 in 1 STORM TWL
- DENOTES 1 in 5 STORM TWL
- DENOTES 1 in 10 STORM TWL
- DENOTES 1 in 100 STORM TWL

AREAS AND STORAGE 1 IN 100 STORM

| SWALE | CATCHMENT AREA | IMPERVIOUS AREA | INFILTRATION RATE | SWALE AREA | STORM VOLUME |
|-------|----------------|-----------------|-------------------|--------------------|-------------------|
| 1 | 1.33 ha | 1.20 ha | 3.0m/DAY | 879m ² | 180m ³ |
| 2 | 1.89 ha | 1.70 ha | 3.0m/DAY | 1678m ² | 310m ³ |
| 3 | 2.17 ha | 1.95 ha | 3.0m/DAY | 1300m ² | 400m ³ |
| 4 | 1.73 ha | 1.56 ha | 3.0m/DAY | 1020m ² | 300m ³ |
| 5 | 0.99 ha | 0.89 ha | 3.0m/DAY | 711m ² | 130m ³ |

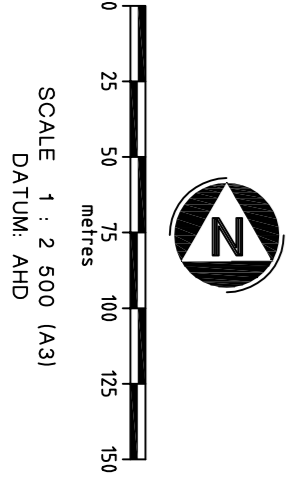
| BASIN | CATCHMENT AREA | IMPERVIOUS AREA | INFILTRATION RATE | BASIN AREA | STORM VOLUME |
|-------|----------------|-----------------|-------------------|--------------------|--------------------|
| B1 | 3.77 ha | 3.39 ha | 3.0m/DAY | 2495m ² | 1700m ³ |
| B2 | 6.32 ha | 5.69 ha | 3.0m/DAY | 3365m ² | 2350m ³ |
| B3 | 5.09 ha | 4.58 ha | 3.0m/DAY | 2227m ² | 2100m ³ |
| B4 | 2.06 ha | 1.85 ha | 3.0m/DAY | 1546m ² | 1050m ³ |
| B5 | 2.75 ha | 2.48 ha | 3.0m/DAY | 2095m ² | 1180m ³ |
| B6 | 1.27 ha | 1.14 ha | 3.0m/DAY | 2119m ² | 860m ³ |
| B7 | 1.89 ha | 1.70 ha | 3.0m/DAY | 935m ² | 360m ³ |
| B8 | 1.10 ha | 0.99 ha | 3.0m/DAY | 942m ² | 310m ³ |
| B9 | 3.43 ha | 3.09 ha | 3.0m/DAY | 2501m ² | 1480m ³ |
| B10 | 2.12 ha | 1.91 ha | 3.0m/DAY | 1245m ² | 820m ³ |

09.078



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PARKLAND HEIGHTS
LOT 1507 EIGHTY ROAD, BALDIVIS
LOCAL WATER MANAGEMENT STRATEGY
DRAINAGE CATCHMENT PLAN - 1 IN 100YR STORM EVENT
FIGURE 4



APPENDIX J

SEWER SERVICING OPTION

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Email: admin@serling.co.au
Web: www.serlingconsulting.com.au

Mr John Giacchetta
Development Services Branch
Water Corporation
PO Box 100
LEEDERVILLE, WA 6902



3 February 2011

*L01 WdT WaterCorporation WWPS options 110203
SC00102.011*

Dear John,

**LOT 1507: BALDIVIS SOUTH WWPS K
WAPC No.: 143012 / 139379**

WWPS Pressure Main Options Evaluation

Following a number of meetings towards the end of last year, we would like to confirm the status of our assessment for the proposed Type 40 Wastewater Pumping Station (WWPS) requirements and investigation of the proposed options for the temporary pressure main discharge path and location.

Background

Serling Consulting (WA) Pty Ltd (Serling) has used current Water Corporation Sewer planning and current development structure plan for the project to investigate options for the WWPS and pressure main.

The WWPS is a Type 40 permanent station with catchment as discussed below. It will be located on the eastern side of Eighty Road next to a future POS area.

Previous meetings confirmed that the pressure main options for this WWPS are all temporary and our assessment indicates that there are significant hydraulic, operations and construction cost differences between the possible options. We have evaluated these options for comments and direction before we can finalise the actual pumping station report. Pump duties and details for example will vary significantly depending on the option taken.

This options evaluation includes detail calculations for every option and these will be discussed in the following sections.

Catchment Plan

The catchment plan is attached as Annexure 1, Plan 1-1.

Calculations for the temporary pressure main have been based on an initial gross catchment area of 38 ha (19.1 + 4.75 + 14.7) which will cover the first 4 – 5 stages of the proposed Parkland Heights development (equal to at least 4 – 5 years construction timeframe depending on the number of lots developed per year) and it also includes the existing aged care group housing site, that is currently discharging into AC 5638 via a private pressure main.

The 38 ha is about 30% of the ultimate catchment area for this WWPS.

WWPS Site Layout

The proposed pumping station is located within a future POS, south of stage 1, with the access road to the station being constructed off a future internal road within the development. The attached site plan, see Annexure 2, demonstrates the turning movement and site boundary required to cater for the Type 40 arrangement and 3 hours of emergency storage pipe network.

The total area of the pump station site is approximately 40.5m x 22.5m and consideration for a combination of lot & easement boundaries are being reviewed.

Option A: Discharge into existing AC 5638 in Eighty Road – Preferred

Plan 1-2 showing the proposed layout and long section, as well as detail calculations, are included in Annexure 3.

This option will result in cutting into the existing 70mm private sewer pressure main in Eighty Road and redirect into a new discharge that gravity feeds into the proposed WWPS. The proposed pressure main from the pump station will then be installed along Eighty Road (915m) to discharge into the existing discharge chamber AC 5638 with the pipework between AC5638 & AB4398 to be upgraded to DN225. Key issues to note about this option are the following: (Refer to the calculation table in Annexure 3 for details)

1. In principle it will increase an existing discharge arrangement currently with the private pumping station from existing pumping rate of 3 l/sec to 11 l/sec (approximately peak flow of 8.3l/s)
2. Minimum temporary infrastructure required.
3. Much lower pump head requirements when compared to the other options, resulting in a more efficient and lower maintenance pump system.
4. Pressure main can be 100P-12 and further reduction in Duty Head Required if approval to use PE pipe. (Refer calculations for both the PVC and PE options in Annexure 3)
5. Construction along existing road reserve within the design parameters of 1.0m to 2.5m cover as specified in the Manual.
6. Redirects existing private station flows into the ultimate pumping station minimising future works in upgrades.

Option B: Discharge into existing pressure main at existing AC 5694

Plan 1-3 showing the proposed layout and long section, as well as detail calculations, are included in Annexure 4.

For this option, sewer will be pumped from the proposed pumping station through a 1,360m pressure main to an existing Water Corporation pressure main in the Nairn Drive area that discharges into existing access chamber AB5694. The pumping system will have to be synchronised with the Cottonwood Drive temporary pumping station. Key issues to note about this option are the following: (Refer to the calculation table in Annexure 4 for details)

1. Pump head requirements are relatively high as a result of the static head requirements.
2. Most of the route not subdivided or earthworked, so risk with alignment and levels. Excavations of over 6.0m for a pressure main to accommodate the ultimate future design levels.
3. A 150mm pressure main is required to reduce the pump head requirements and the minimum pumping rate required is 15l/s to provide the minimum velocity acceptable.
4. Due to the higher pumping rate and the low initial expected peak flows from the catchment, septic sewer is likely to occur within the station and the pressure main not being turned sufficiently.

Option C: Discharge into existing AC5237 – DN300 gravity main

Plan 1-4 showing the proposed layout, as well as detail calculations, are included in Annexure 5.

This option is along the same route as Option B, but discharges 2,150m from the pumping station into an existing DN300 (AC 5237) gravity main. Key issues to note about this option are the following: (Also refer to the calculation table in Annexure 5).

1. Pump head requirements are relatively high as a result of the static head requirements.
2. Most of the route not subdivided or earthworked, so risk with alignment and levels. Excavations of over 6.0m for a pressure main to accommodate the ultimate future design levels.
3. The pressure main & gravity main route also crosses unplanned private land with uncertainty about approvals and conditions or finished surface levels.
4. A significant section is along an existing, recently constructed road, which will require to be bored in order to not impact on the road and footpaths.
5. A 150mm pressure main is required to reduce the pump head requirements, and the minimum pumping rate required is 15l/s to provide the minimum velocity acceptable.
6. This option involves the construction of over 2km of temporary sewer pressure main and 350m of DN225 gravity main installed at steep grades (approximately 1 in 20) in order to connect into the existing DN300 invert levels.
7. Due to the higher **pumping** rate and the low initial expected peak flows from the catchment, septic sewer is likely to occur within the station and the pressure main not being turned sufficiently

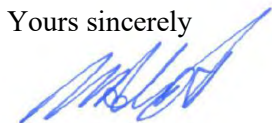
Further important issues are the following:

- The Developer will install the permanent rising main as stages develop, so there will be no issue with installation of sewer in new subdivision areas.
- Should the temporary system down Eighty Road be used (Option A) and in the event that the permanent pumping outlet to the East along Sixty Eight Road is not available when the temporary system reaches capacity, there is still the option to construct Options B or C with less risk, as the road reserves and levels will be established by that time.

Based on the comparison of options, we propose to use Option A as the most efficient and cost effective solution when considering maintenance and capital cost. It also provides flexibility should the permanent solution not be in place 5 or more years in the future. It will be appreciated if Water Corporation can investigate the downstream capacities and alternatives for Option A.

Your earliest attention to this application would be appreciated. Should you have any queries, please contact the undersigned.

Yours sincerely



WILLEM DU TOIT

Executive Engineer

Phone: 08 9202 8743
Fax: 08 9202 8701
Mobile: 0438 966 086
E-mail: wdutoit@serling.com.au

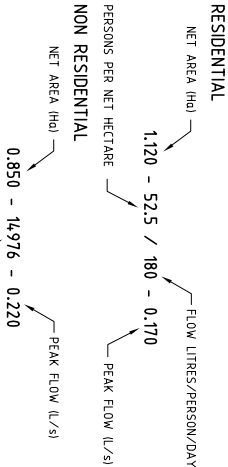
ANNEXURE 1

Catchment Plan

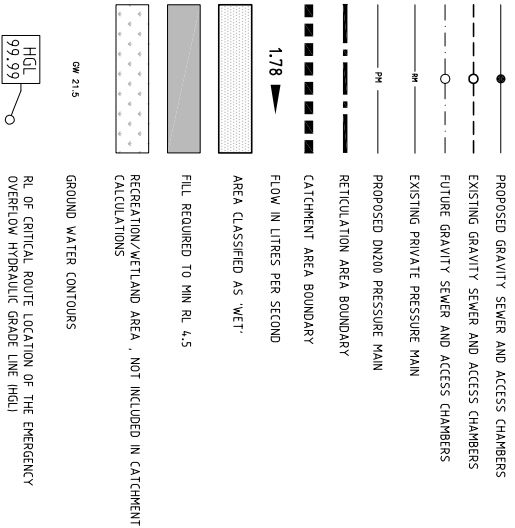
NOTES

1. LOCAL AUTHORITY : CITY OF ROCKINGHAM
2. ESTIMATED GROUND WATER LEVEL: REFER AAMGL CONTOURS
3. THIS RETICULATION AREA IS CLASSIFIED 'WET & DRY' IN ACCORDANCE WITH THE WATER CORPORATION WASTEWATER MANUAL VOL. 1 UNLESS NOTED OTHERWISE.
4. EXISTING SURFACE LEVELS DETERMINED FROM MAPS AERIAL AND GROUND SURVEYS.
5. ALL PIPE SIZES IN MILLIMETRES (DIA 150 UNO.O.I. ALL DISTANCES AND LEVELS IN METRES.
6. CADASTRAL BOUNDARIES DERIVED FROM MAPS PRECAL. EXISTING BOUNDARIES AND PLANNERS INFORMATION WHICH MAY BE SUBJECT TO FURTHER CHANGES.

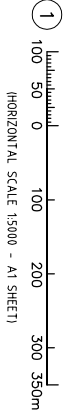
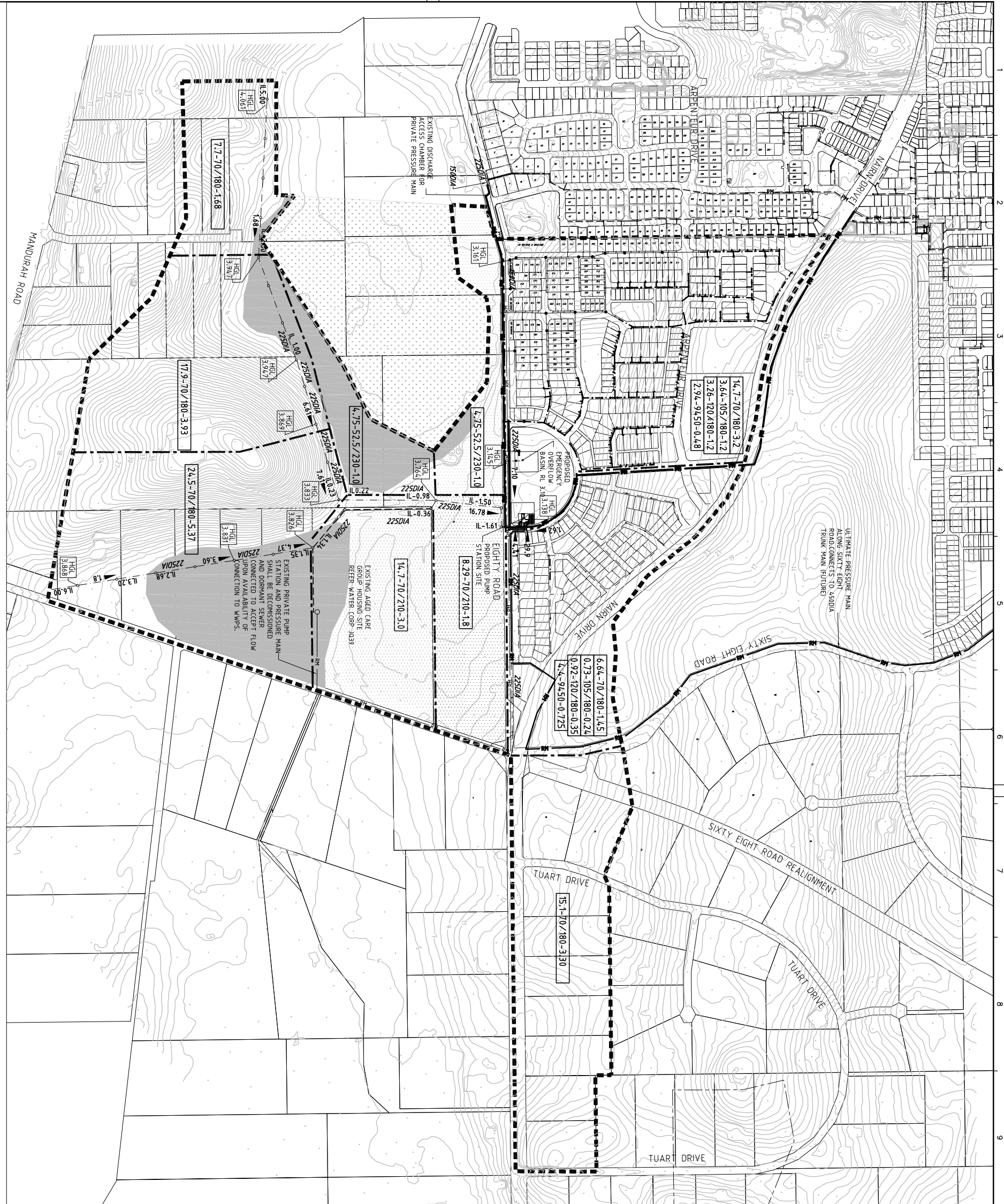
DESIGN DATA NOTATION



LEGEND



| PARAMETER | INITIAL | ULTIMATE |
|--|--|--|
| GROSS CATCHMENT AREA: | 39.2 | 134.9 |
| MAXIMUM INFLOW TO PUMPING STATION: | 6.1 | 29.9 |
| EXTERNAL CATCHMENTS (PEAK): | 3 | .. |
| PUMPING RATE REQUIRED | 11.1 | 39.77 |
| DESIGN PUMPS OPERATIONAL PUMPING FLOW | CUT-IN | CUT-IN |
| STORAGE VOLUME OF WET WELL BETWEEN CUT OUT-AT LEVEL (RL-4.05) AND ULTIMATE DUTY OUT-IN LEVEL (RL--2.25) | RL -3.55 | RL -2.25 |
| TOTAL 3HR STORAGE VOLUME REQUIRED | 98.280m ³ | 322.920m ³ |
| TOTAL STORAGE VOLUME IN THE SYSTEM (PIPEWORK, ACCESS CHAMBERS, MAINTENANCE SHAFTS & WET WELL) | 46.120m ³ | 111.948m ³ |
| TOTAL STORAGE VOLUME IN THE STORAGE TANKS. | 55.881m ³ Therefore we require 9 tanks. | 223.526m ³ Therefore we require 36 tanks. |
| STORAGE TIME IN SEWERAGE SYSTEM AT ULTIMATE GRAVITY SEWER DESIGN | HIGH LEVEL | HIGH LEVEL |
| CONDITIONING BETWEEN HIGH LEVEL ALARM LEVEL AND INVERT LEVEL (RL. 3.10) OF EMERGENCY OVERFLOW PIPE (OVERFLOW TO ENVIRONMENT) | RL -3.25 | RL -1.95 |



SC - REVISION RECORD

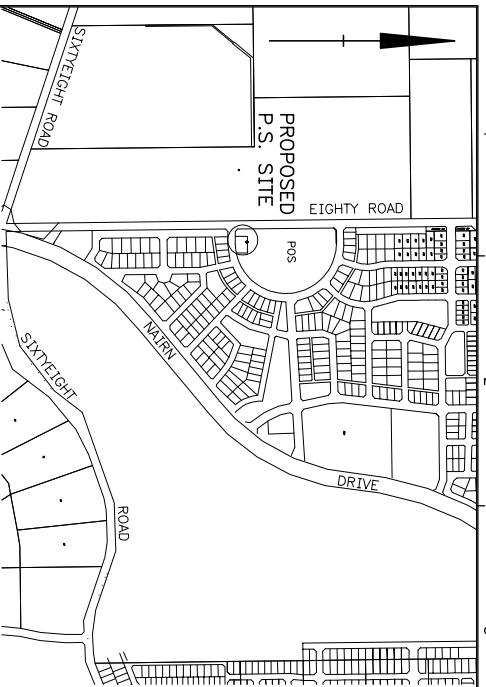
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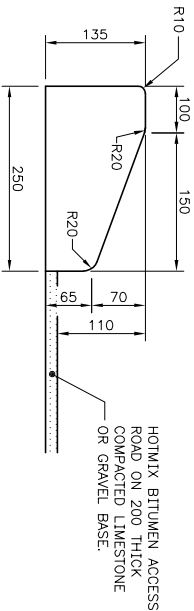
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| ISSUE | DATE | GRID | REVISION | DRN | REC | APPD | SURVEY BOOKS | VERTICAL DATUM | DES. CALC | DES. CHD | DES. REF | DES. CHD | NORTH POINT | CONSULTANT PROJECT MANAGER | CONSULTANT PROJECT DIRECTOR | FILE | PLAN | 1-1 | CAD | ISSUE | WF |
| 89 | | | | | | | | | | | | | | | | | | | | | |
| 810 | | | | | | | | | | | | | | | | | | | | | |

ANNEXURE 2

Preliminary Site Plan



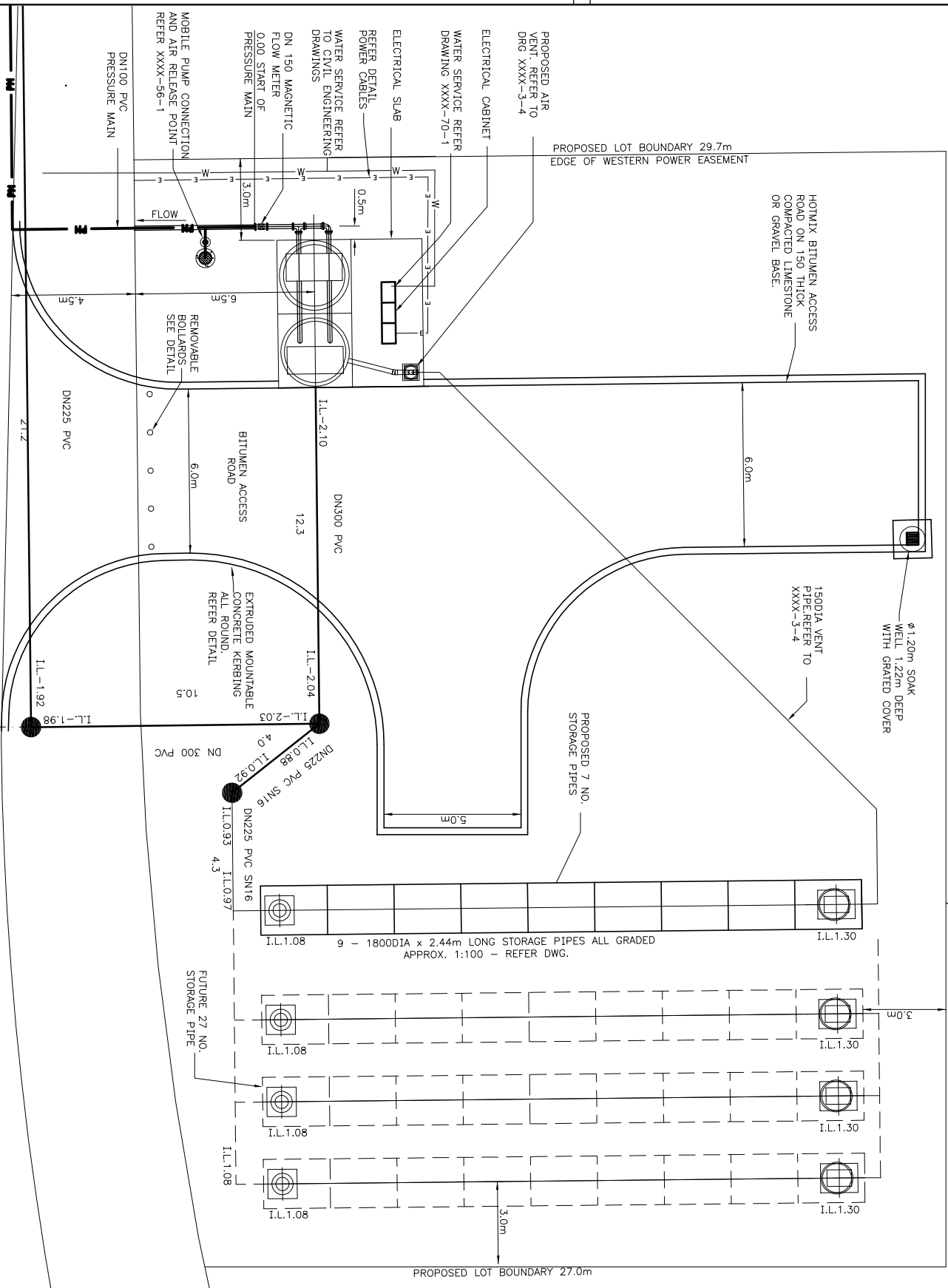
LOCALITY PLAN
SCALE: DIAGRAMMATIC



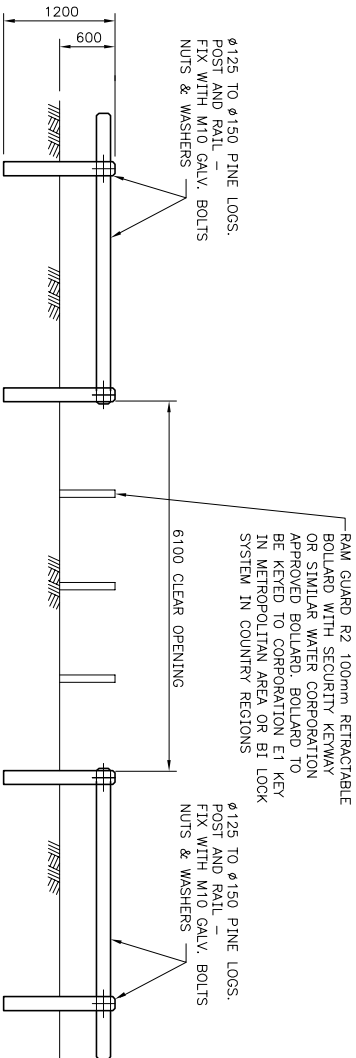
KERB DETAIL
SCALE: ②

SITE BOUNDARY DEFINITION
OR FENCING SHALL COMPLY
WITH THE REQUIREMENTS OF
THE LOCAL AUTHORITY

PROPOSED LOT BOUNDARY 40.5m



SITE PLAN
SCALE: ①



RETRACTABLE BOLLARDS AND PINE POST AND RAIL BARRIER
SCALE: DIAGRAMMATIC

CAUTION:
COMMUNICATION – CABLES MAY HAVE BEEN RECENTLY INSTALLED. PHONE *Input* FOR ON SITE LOCATION.
POWER – EXISTING POWER SERVICES MAY BE AFFECTED ON *Input* SIDE OF *Input* AVE./ST./RD. CONTACT *Input* ON *Input* PRIOR TO WORK COMMENCEMENT.
GAS – EXISTING GAS SERVICES MAY BE AFFECTED ON *Input* SIDE OF *Input* AVE./ST./RD. CONTACT *Input* ON *Input* PRIOR TO WORK COMMENCEMENT.

- GENERAL NOTES**
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS SHOWN OTHERWISE.
 2. SIGNAGE TO BE PROVIDED ACCORDING TO SECTION 4 CLAUSE 4.4.9 OF THE WASTEWATER STANDARD DS 51. SIGNAGE TO BE ATTACHED TO R.P.Z BACKFLOW PREVENTION CABINET UNLESS IT CANNOT BE VIEWED FROM ROAD. IN THIS CASE IT SHOULD BE ATTACHED TO THE MOST APPROPRIATE CABINET.

LEGEND

WATER CORPORATION FREEHOLD LAND OR RESERVE SHOWN:

Pumping Station Site Area, Location and Arrangements For Title Transfer To Water Corporation Shall Be Subject To Agreement Prior To Commencement Of Detailed Design Work

EXISTING SURFACE LEVEL SHOWN 9.8^8
PROPOSED SURFACE LEVEL SHOWN 99.99

REFERENCE DRAWINGS

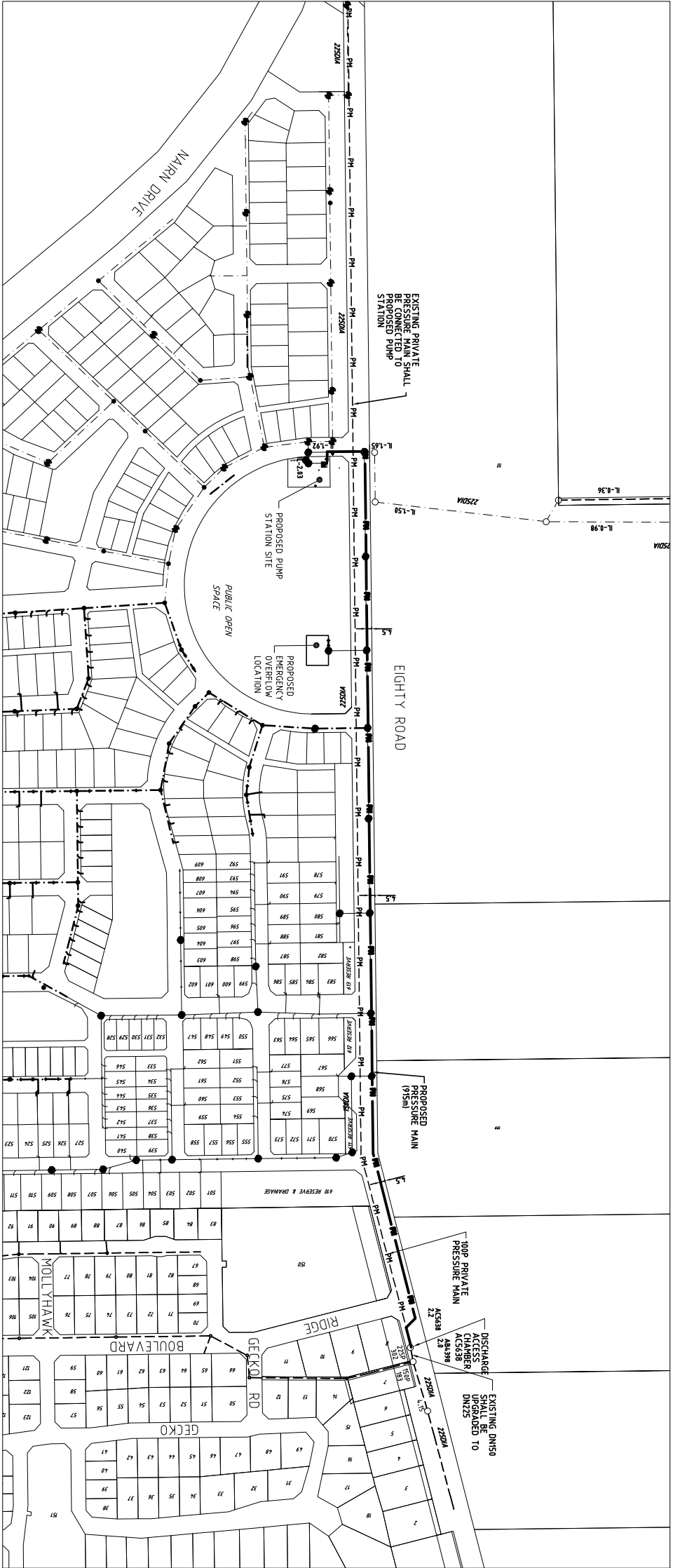
Example Drawing List Only – Modify to Suit Pump Station Type.

- XXXX-5-1 EMERGENCY STORAGE TANK DETAILS
- XXXX-5-3 EMERGENCY OVERFLOW DETAILS
- XXXX-10-1,2 GENERAL ARRANGEMENT NOS. 1 & 2
- XXXX-10-5 STRUCTURAL DETAILS – PRECAST COMPONENTS
- XXXX-10-6 PRECAST SLABS AND COVERS
- XXXX-10-7 ELECTRICAL SLAB DETAILS
- XXXX-10-8 VALVE, CONTROL AND ALARM HOLE COVERS
- XXXX-10-9 MISCELLANEOUS STEEL FABRICATION DETAILS
- XXXX-10-10 LADDER, PUMP RAIL & PIPE SUPPORT DETAIL
- XXXX-10-11 LIFT LIFT & LAMPARD DETAILS
- XXXX-10-12 R.P.Z BACKFLOW PREVENTION DEVICE

| | | | | | | | | | | | | | |
|--------------|--|----------------|--|-----------|--|-------------|--|----------------------|--|---|--|----------|--|
| SURVEY BOOKS | | VERTICAL DATUM | | DES. CALC | | NORTH POINT | | RECOMMENDED | | WASTEWATER – EXAMPLE DRAWING | | ORIGINAL | |
| AHD | | COORDINATE SYS | | DES. CHD | | P. ALBARKIS | | SUPERVISING ENGINEER | | BALDWIN SOUTH PUMPING STATION K EIGHTY ROAD | | SHEET | |
| NONE | | N/A | | N/A | | N/A | | APPROVED | | TYPE 40 PUMPING STATION – WITH VALVE P/T | | FILE | |
| DES. REF | | DES. CHD | | DES. CHD | | DES. CHD | | MANAGER I.D. BRANCH | | PROJECT | | PLAN | |
| N/A | | N/A | | N/A | | N/A | | PROJECT | | Input | | C | |
| DATE | | GRID | | DRN | | REC | | APD | | ISSUE | | A1 | |
| 810 | | 810 | | 810 | | 810 | | 810 | | 810 | | 810 | |

ANNEXURE 3

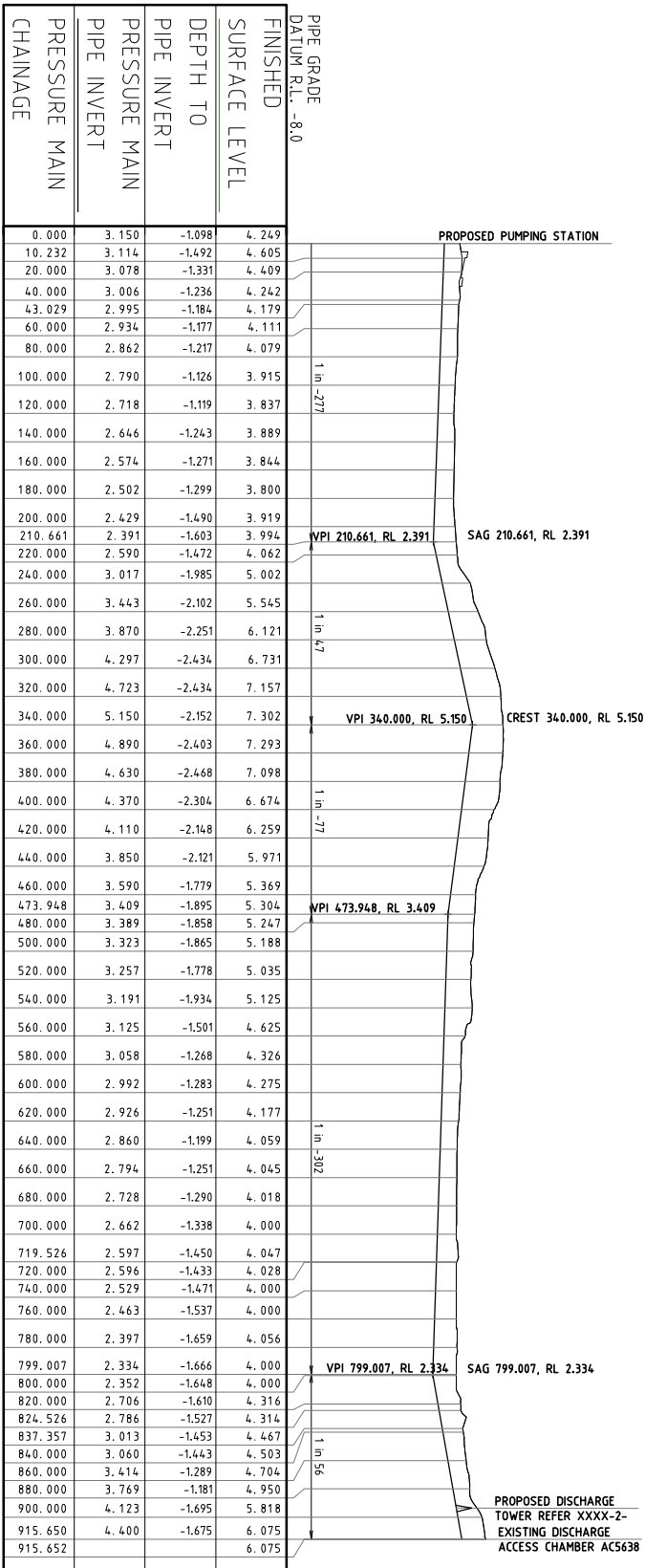
Option A Layout and calculations



SITE PLAN

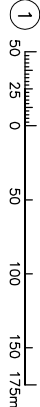
- NOTES**
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 6. CADASTRAL BOUNDARIES DERIVED FROM MAPS PREC.A. EXISTING BOUNDARIES AND PLANNERS INFORMATION WHICH MAY BE SUBJECT TO FURTHER CHANGES.

- LEGEND**
- PROPOSED GRAVITY SEWER AND ACCESS CHAMBERS
 - EXISTING GRAVITY SEWER AND ACCESS CHAMBERS
 - FUTURE GRAVITY SEWER AND ACCESS CHAMBERS
 - EXISTING PRIVATE PRESSURE MAIN
 - PROPOSED PRESSURE MAIN
 - GROUND WATER CONTOURS



PRESSURE MAIN PROFILE - OPTION A

SCALE HORIZ 1 : 2500 metres
VERT 1 : 250 metres



HORIZONTAL SCALE 1:2500 - A1 SHEET

SC - REVISION RECORD

| No | DATE | REVISION | BY | APP'D |
|----|------|----------|----|-------|
| 1 | | | | |

SC DRG No. WC090004-PS-1-2

| | | | | | | | | | | | | | | | | | | | | | | |
|-------|------|------|----------|-----|-----|------|--------------|----------------|-----------|------------|-------------|--------------------|-------------|----------------------------|----------|-----------------------------|------|------|-----|-----|-------|---------------------|
| ISSUE | DATE | GRID | REVISION | DRN | REC | APPD | SURVEY BOOKS | VERTICAL DATUM | DES. CALC | P. ALLEMAN | NORTH POINT | SEALING CONSULTING | RECOMMENDED | CONSULTANT PROJECT MANAGER | APPROVED | CONSULTANT PROJECT DIRECTOR | FILE | PLAN | 1-2 | CAD | ISSUE | ORIGINAL SHEET SIZE |
| 810 | | | | | | | | | | | | | | | | | | | | | | A1 |

Option A - Eighty Road Existing AC 5638 - PVC Pressure Main

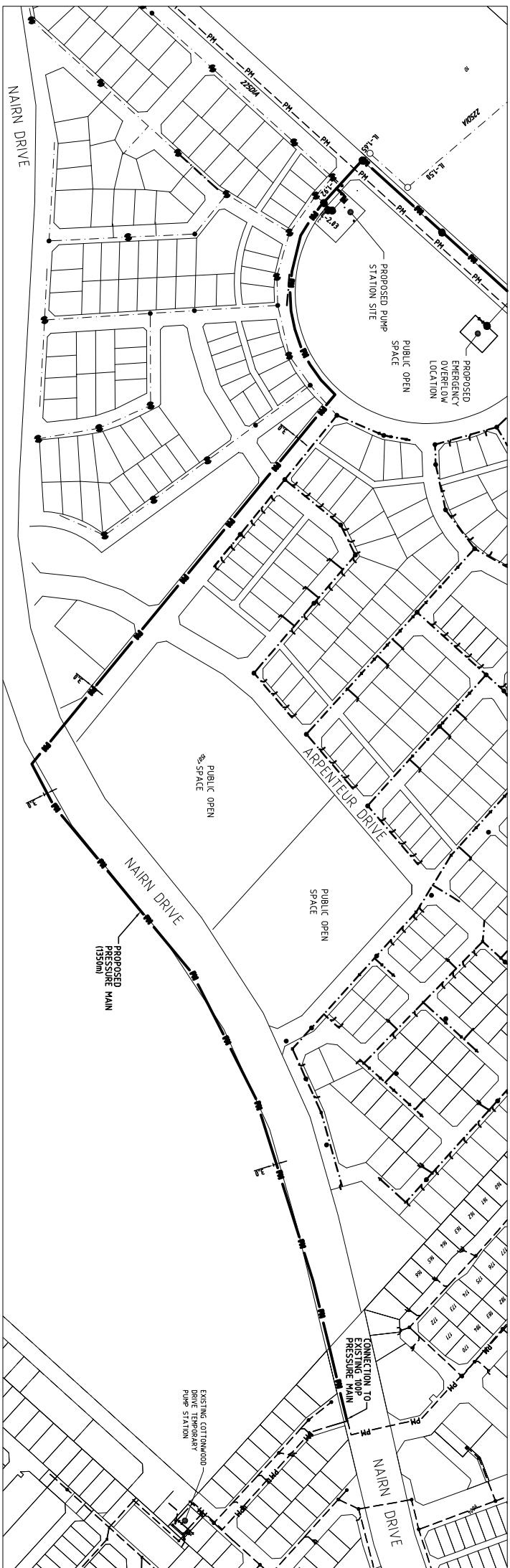
| | <i>Initial</i> | <i>Ultimate</i> | |
|--|----------------|-----------------|-----------|
| Max PUMP HEAD | 29.8 | 44.5 | m |
| PIPE DIAMETER | 100 | 225 | mm |
| Friction Head | 20.0 | 11.4 | m |
| Pumping Rate | 11.1 | 39.8 | L/s |
| Start of Pressure Main Level | 3.15 | 3.15 | RL |
| Internal Pump Station Pipework Diameter | 200 | 200 | mm |
| Internal Pump Station Pipework Length | 62 | 62 | m |
| Internal Pump Equivalent length Factor | 0.0 | 2.5 | |
| Pressure Main Nominal Diameter | 100 | 225 | mm |
| • Pipe Class to AS1477 | 12 | 12 | |
| • Pipe Internal Diameter | 108.5 | 233.7 | mm |
| • Pipe Length Actual | 915 | 2200 | m |
| • Pipe Velocity | 1.20 | 0.93 | m/s |
| Equivalent Length | 915.0 | 2354.4 | m |
| Colebrook-White k = 0.6 , f | 0.0322 | 0.0259 | |
| Hydraulic Gradient | 0.022 | 0.005 | m/m |
| Max Static Head | 9.8 | 33.1 | m |
| Min Static Head | 2.6 | 25.9 | m |
| Pump Duty Cut-out Level | -4.05 | -4.05 | RL |
| IL Discharge / Pressure Main Highest Point | 5.65 | 29.00 | RL |
| Emergency Overflow Level | 3.10 | 3.10 | RL |

Option A - Eighty Road Existing AC 5638 - PE Pressure Main

| | <i>PE140</i> | <i>PE160</i> | |
|--|--------------|--------------|-----------|
| Max PUMP HEAD | 22.9 | 16.3 | m |
| PIPE DIAMETER | 140 | 160 | mm |
| Friction Head | 13.1 | 6.5 | m |
| Pumping Rate | 11.1 | 11.1 | L/s |
| Start of Pressure Main Level | 3.15 | 3.15 | RL |
| Internal Pump Station Pipework Diameter | 200 | 200 | mm |
| Internal Pump Station Pipework Length | 62 | 62 | m |
| Internal Pump Equivalent length Factor | 1.0 | 1.0 | |
| Pressure Main Nominal Diameter | 140 | 160 | mm |
| • Pipe Class | 12.5 | 12.5 | |
| • Pipe Internal Diameter | 119 | 136 | mm |
| • Pipe Length Actual | 915 | 915 | m |
| • Pipe Velocity | 1.00 | 0.77 | m/s |
| Equivalent Length | 976.8 | 976.8 | m |
| Colebrook-White k = 0.6 , f | 0.0315 | 0.0305 | |
| Hydraulic Gradient | 0.013 | 0.007 | m/m |
| Max Static Head | 9.8 | 9.8 | m |
| Min Static Head | 2.6 | 2.6 | m |
| Pump Duty Cut-out Level | -4.05 | -4.05 | RL |
| IL Discharge / Pressure Main Highest Point | 5.65 | 5.65 | RL |
| Emergency Overflow Level | 3.10 | 3.10 | RL |

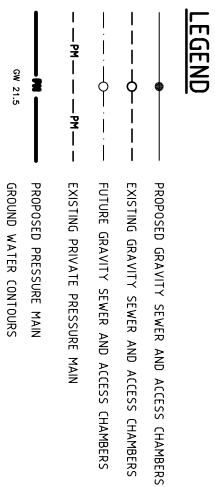
ANNEXURE 4

Option B Layout and calculations



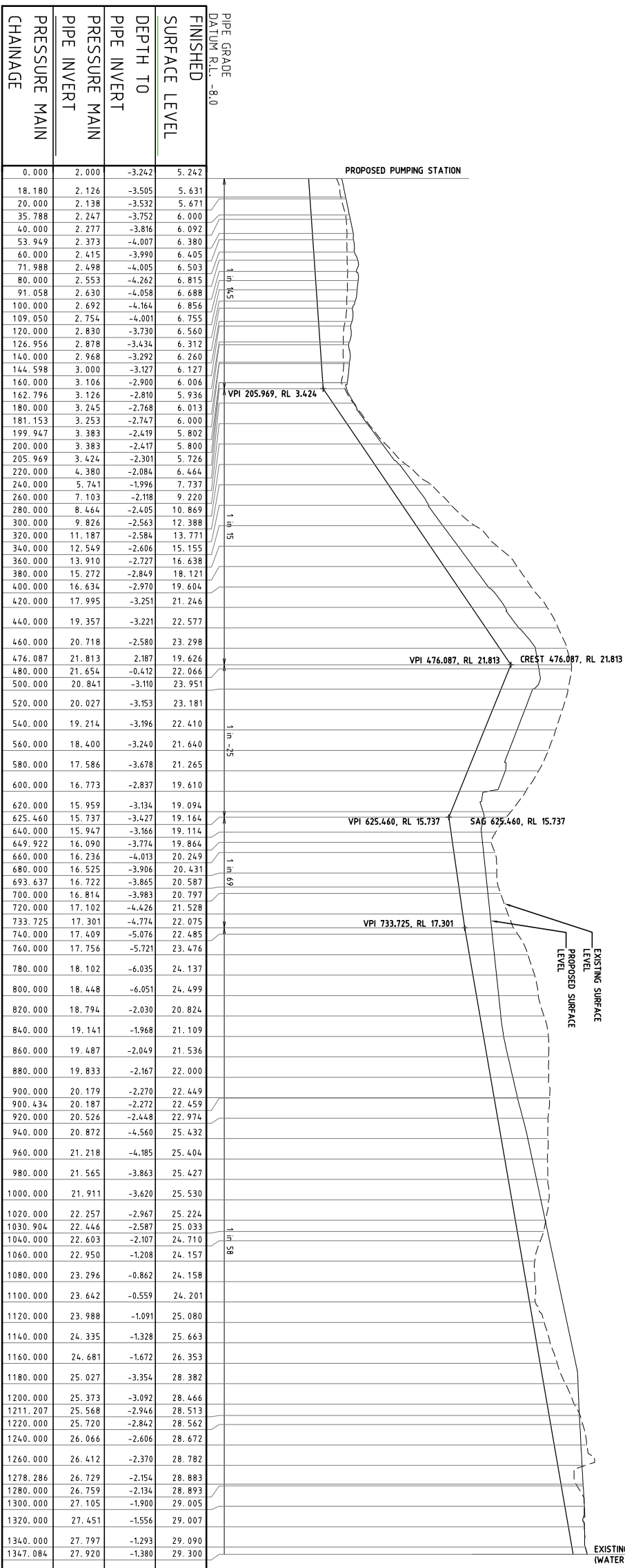
SITE PLAN

SCALE 1:2500



NOTES

1. LOCAL AUTHORITY - CITY OF ROCKINGHAM
2. ESTIMATED GROUND WATER LEVEL: REFER AAKM1 CONTOURS
3. THIS RETICULATION AREA IS CLASSIFIED 'WET & DRY' IN ACCORDANCE WITH THE WATER CORPORAION WASTEWATER MANUAL VOL. 1 UNLESS NOTED OTHERWISE.
4. EXISTING SURFACE LEVELS DETERMINED FROM MAPS AERIAL AND GROUND SURVEYS.
5. ALL PIPE SIZES IN MILLIMETRES (IDA 150 U.N.O.I, ALL DISTANCES AND LEVELS IN METRES).
6. CADASTRAL BOUNDARIES DERIVED FROM MAPS PRECAT, EXISTING BOUNDARIES AND PLANNERS INFORMATION WHICH MAY BE SUBJECT TO FURTHER CHANGES.



PRESSURE MAIN PROFILE - OPTION B

SCALE HORIZ 1 : 2500 metres

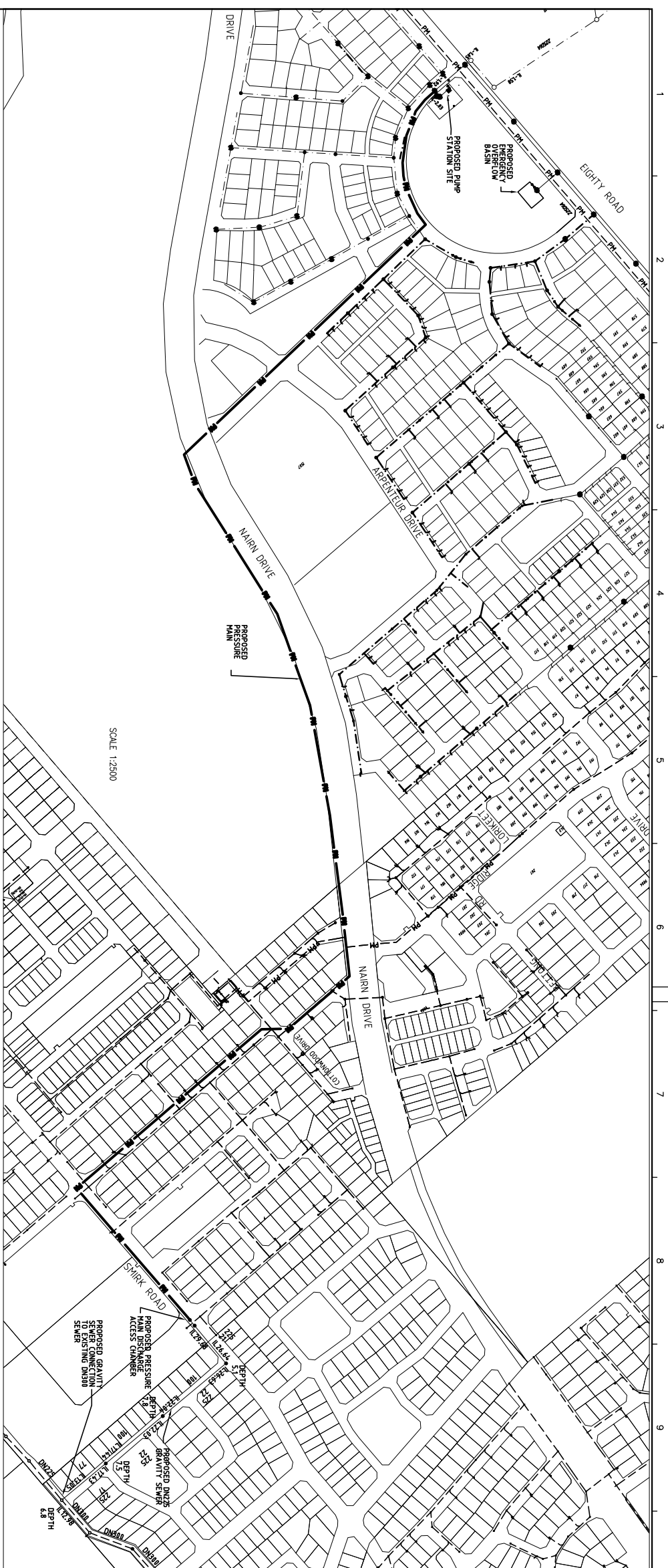
VERT 1 : 250 metres

Option B - Discharge into existing PM & Existing AB5694

| | <i>Initial</i> | <i>Ultimate</i> | |
|--|----------------|-----------------|-----------|
| Max PUMP HEAD | 59.1 | 44.5 | m |
| PIPE DIAMETER | 150 | 225 | mm |
| Friction Head | 20.0 | 11.4 | m |
| Pumping Rate % Ratio | | 100.00% | |
| Pumping Rate | 15.1 | 39.8 | L/s |
| Start of Pressure Main Level | 3.15 | 3.15 | RL |
| Internal Pump Station Pipework Diameter | 200 | 200 | mm |
| Internal Pump Station Pipework Length | 62 | 62 | m |
| Internal Pump Equivalent length Factor | 1.0 | 2.5 | |
| Pressure Main Nominal Diameter | 150 | 225 | mm |
| • Pipe Class to AS1477 | 12 | 12 | |
| • Pipe Internal Diameter | 158 | 234 | mm |
| • Pipe Length Actual | 1360 | 2200 | m |
| • Pipe Velocity | 0.77 | 0.93 | m/s |
| Equivalent Length | 1421.8 | 2354.4 | m |
| Colebrook-White k = 0.6 , f | 0.0291 | 0.0259 | |
| Hydraulic Gradient | 0.006 | 0.005 | m/m |
| Pressure Main Nominal Diameter - Existing | 100 | | mm |
| • Pipe Class to AS1477 | 12 | | |
| • Pipe Internal Diameter | 108.5 | | mm |
| • Pipe Length Actual | 300 | | m |
| • Pipe Velocity | 1.63 | | m/s |
| Colebrook-White k = 0.6 , f | 0.0320 | | |
| Hydraulic Gradient | 0.040 | | m/m |
| Max Static Head | 39.1 | 33.1 | m |
| Min Static Head | 31.9 | 25.9 | m |
| Pump Duty Cut-out Level | -4.05 | -4.05 | RL |
| IL Discharge / Pressure Main Highest Point | 35.00 | 29.00 | RL |
| Emergency Overflow Level | 3.10 | 3.10 | RL |

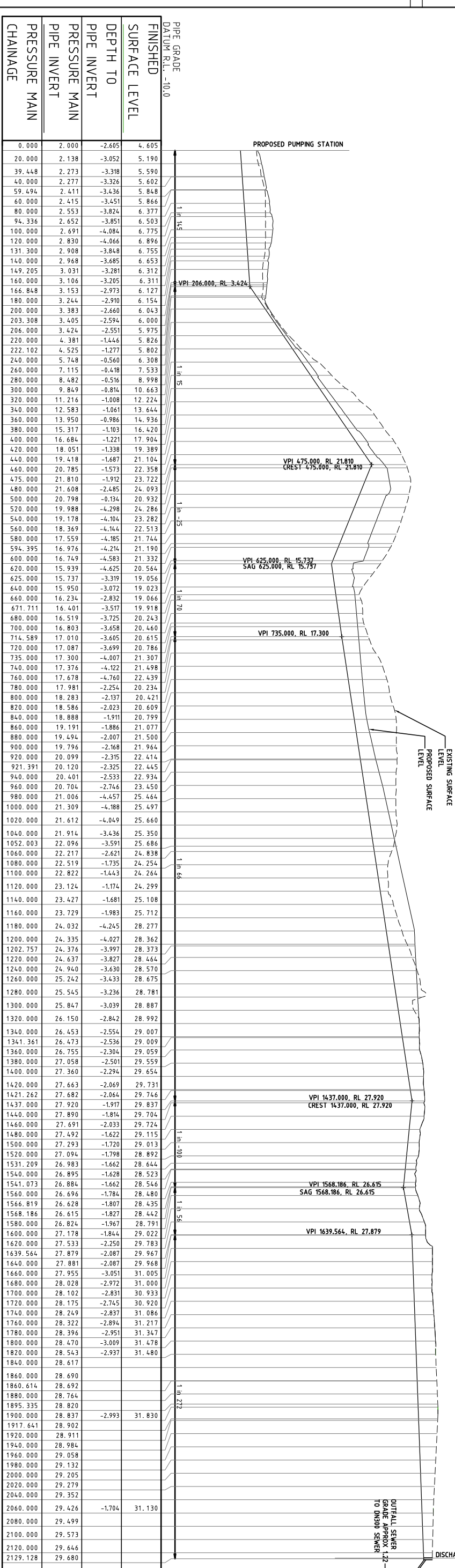
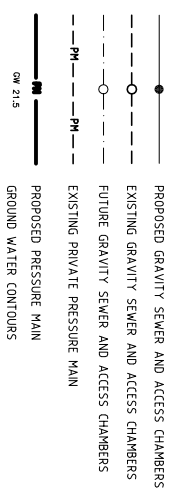
ANNEXURE 5

Option C Layout and calculations



- ## NOTES
1. LOCAL AUTHORITY : CITY OF BIRMINGHAM
 2. ESTIMATED GROUND WATER LEVEL REFER AMGL CONTOURS
 3. THIS REPLETION AREA IS CLASSIFIED 'WET & DRY' IN ACCORDANCE WITH THE WATER CORPORATION WASTEWATER MANUAL VOL. 1 UNLESS NOTED OTHERWISE.
 4. EXISTING SURFACE LEVELS DETERMINED FROM MAPS AERIAL AND GROUND SURVEYS.
 5. ALL PIPE SIZES IN MILLIMETRES (DIA 150 U.N.O.), ALL DISTANCES AND LEVELS IN METRES.
 6. CADASTRAL BOUNDARIES DERIVED FROM MAPS PRECALCULATED EXISTING BOUNDARIES AND PLANNERS' INFORMATION WHICH MAY BE SUBJECT TO FURTHER CHANGES.

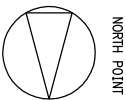
LEGEND



PRESSURE MAIN PROFILE - OPTION C

SCALE HORIZ 1 : 3000 metres
VERT 1 : 300 metres

SITE PLAN



Serfling Consulting (WA) Pty Ltd
ACN: 136 628 058
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OSBORNE PARK WA 6017
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| |
|-----------------------------|
| RECOMMENDED |
| CONSULTANT PROJECT MANAGER |
| APPROVED |
| CONSULTANT PROJECT DIRECTOR |



| | |
|---------|------|
| FILE | PLAN |
| PROJECT | 1-4 |

ORIGINAL
SHEET
SIZE
A1

Option C - Discharge into Existing AC5237 - DN300 Gravity Main

| | <i>Initial</i> | <i>Ultimate</i> | |
|--|----------------|-----------------|-----------|
| Max PUMP HEAD | 60.0 | 44.5 | m |
| PIPE DIAMETER | 150 | 225 | mm |
| Friction Head | 24.4 | 11.4 | m |
| Pumping Rate % Ratio | | 100.00% | |
| Pumping Rate | 15.1 | 39.8 | L/s |
| Start of Pressure Main Level | 3.15 | 3.15 | RL |
| Internal Pump Station Pipework Diameter | 200 | 200 | mm |
| Internal Pump Station Pipework Length | 62 | 62 | m |
| Internal Pump Equivalent length Factor | 1.0 | 2.5 | |
| Pressure Main Nominal Diameter | 150 | 225 | mm |
| • Pipe Class to AS1477 | 12 | 12 | |
| • Pipe Internal Diameter | 158 | 234 | mm |
| • Pipe Length Actual | 2150 | 2200 | m |
| • Pipe Velocity | 0.77 | 0.93 | m/s |
| Equivalent Length | 2211.8 | 2354.4 | m |
| Colebrook-White k = 0.6 , f | 0.0291 | 0.0259 | |
| Hydraulic Gradient | 0.006 | 0.005 | m/m |
| Pressure Main Nominal Diameter - Existing | 100 | | mm |
| • Pipe Class to AS1477 | 12 | | |
| • Pipe Internal Diameter | 108.5 | | mm |
| • Pipe Length Actual | 300 | | m |
| • Pipe Velocity | 1.63 | | m/s |
| Colebrook-White k = 0.6 , f | 0.0320 | | |
| Hydraulic Gradient | 0.040 | | m/m |
| Max Static Head | 35.6 | 33.1 | m |
| Min Static Head | 28.4 | 25.9 | m |
| Pump Duty Cut-out Level | -4.05 | -4.05 | RL |
| IL Discharge / Pressure Main Highest Point | 31.50 | 29.00 | RL |
| Emergency Overflow Level | 3.10 | 3.10 | RL |