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District/Local Water Management Strategy (October, 2013)

REPORT

**NOVALEE NOMINEES PTY LTD AND
ESTATES 77 PTY LTD
LOTS 635, 739 AND 740 BALDIVIS ROAD,
BALDIVIS**

**DISTRICT AND LOCAL WATER MANAGEMENT
STRATEGY**

OCTOBER 2013



DEVELOPMENT
ENGINEERING
CONSULTANTS

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Revision	Description	Checked	Approved	Date
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LOTS 635, 739 AND 740 BALDIVIS ROAD, BALDIVIS

DISTRICT AND LOCAL WATER MANAGEMENT STRATEGY (LWMS)

Executive Summary

Estate Scale

- A lineal open space is proposed as part of the structure plan, which will provide opportunities for soakage at source via lineal swales.
- Swales will be constructed in discrete areas of POS to cater for the major and minor storms. Swale areas will be designed to ensure the major storm is retained on site.
- Information Packages will be provided to all lot purchasers to: (a) Fully inform lot owners of the requirement to install a 1500mm diameter by 1200 deep soakwell prior to an outflow connection to the drainage system; (b) To encourage the use of rainwater tanks; (c) To utilise water efficient devices & appliances throughout their homes; and (d) To maximise the use Water & Nutrient-wise plants, and minimise the use of lawns.

Access Street Scale

- All piped drainage systems will be designed to accommodate the 1 in 5 year ARI event.
- Where possible piped drainage will be excluded in preference of swale drains and overland flow.

Allotment Scale

- All lot owners will be encouraged to install rainwater tanks plumbed into their homes for household use in order to assist to contain the 1 year - 1 hour ARI event on-site in lieu of soakwells.
- All lots are required to install the equivalent of 2 by 1500mm by 1200mm deep soakwells to hold the relevant storm events on site.

Public Open Space Areas

- All swale basins constructed within a POS area will be designed to infiltrate all storms up to and including the 100 year ARI.

1 Introduction

This LWMS report has been prepared as a stand-alone document to support the Local Structure Plan for Lots 635, 739 and 740 Baldivis Road, Baldivis and will be used to guide the design and construction of the proposed drainage solutions for subdivision within the area.

The location of the site is shown in Appendix A, together with an aerial photograph of the existing site.

The site is located on the western side of Baldivis Road immediately west of the intersection between Serpentine Road and Baldivis Road.

1.1 *Drainage / Water Management Principles and Design Objectives*

The following water sensitive design criteria, principles & objectives are to be pursued &/or implemented as part of the proposed development:

- *Water Conservation & Water Efficiency*

Objective: To minimise the use of scheme water outside of the home and to use water as efficiently as possible - both within & outside of the home.

Objective: All lot purchasers will be encouraged to install rain water tanks plumbed into their home; to use water efficient devices & appliances throughout their homes and to plant “Water-wise” & “Nutrient-wise” gardens.

- *Water Quantity Management*

Principle: To ensure that post-development discharge is retained on site.

Objective: All allotments to be a minimum of 0.5m above the 1 in 100 year flood level.

Objective: Retention basins to be provided to ensure that 1 in 100 year storm is disposed on sit via infiltration.

- *Water Quality Management*

Principle: To improve the overall surface & groundwater quality of the water leaving the estate and if possible improve the quality of water leaving the development.

Objective: Ensure that surface water is routed to swale basins and retained on site.

1.2 *Planning Background*

The subject land forms the Lot 635, 739 and 740 Baldivis Road a portion of which proposes the amendment of the land from “Urban deferred” to Urban under the Local Town Planning Scheme. There are some complexities with this as portions of the land are zoned residential under the Council scheme, but “Urban Deferred” under the metropolitan regional scheme.

The remainder requires structure plan approval as it is already zoned. The Structure Plan requires the preparation and approval of this document prior to subdivision approval.

The proposed structure plan and relevant zonings are detailed in Appendix A.

2 Proposed Development

2.1 Key Elements of the Local Structure Plan (LSP)

The site is located within the suburb of Baldvis within the City of Rockingham and covers an area of approximately 80ha of undeveloped land. The site is located west of Baldvis Road where it intersects with Serpentine Road and south of the existing Highbury Park Development essentially bounded by the existing development (to the north), the existing sand quarry immediately north of Sixty eight road (to the south), Baldvis Road (to the east) and Smirk Road to the west.

The development proposal consists of approximately 850 single residential allotments averaging around 500 square metres in area, an aged persons site, 4 group housing sites and a primary school site.

A large easement traverses the site ranging from 150 to 350m west of Baldvis Road. This easement contains a significant Water Corporation distribution main, the APT Dongara Gas pipeline and provision for a future pipeline for Alcoa. The easement is approximately 63.5m wide and is proposed to be incorporated within POS.

2.2 Previous Land Use

The land is currently undeveloped and has been mostly cleared. The land was previously used for farming and rural pursuits.

2.3 Finished Lot Levels

Finished Lot levels will be set using on the basis that they are a minimum of 0.5m above 100 year TWL of Drainage basins and that they are set such that major storm will flood into POS in lieu of flooding the lots.

Further criteria is that Lots are to be at least 1.2m above AAMGL, although the groundwater is well below surface levels.

3 Design Criteria

The drainage requirements for developments within this area are controlled by the requirements of the City of Rockingham, which are outlined below.

Item	Description	Requirement	Source / Comment
1	Water Quality	1 in 1 years 1 hour storm to be Retained on site	DoW requirements
2	ARI for pipe design	1 in 5 years	Standard Council requirement
3	ARI for compensating basin design	1 in 100 years without outflow from site	Standard Council requirement – No predevelopment flows currently exit the site.
4	Flow rates	No Post development flow permitted	Per Water Corporation requirement for the Mundijong Drainage District ²
5	Min. lot freeboard	0.5m above basin 1 in 100 year flood level 0.3m above 100 Year HGL in Road System	Standard Council requirement developments
6	Basin Criteria Side slopes – In POS	Max. 1 in 6	Standard Council requirement



Item	Description	Requirement	Source / Comment
7	Run-off coefficients	0.80 – for road reserves 0 – For Urban Residential Allotments 0. – Developed Rural Areas/POS	Per Council requirements – allowance for Lots and POS in Road allowances

4 Pre-development Environment

4.1 Topography and Landform

The site rises steeply from RL5.00m AHD on the south eastern side of the site on Baldivis Road to a ridge that runs north/south approximately in the centre of the site at approximately RL39m AHD at the top. The site then falls west to a valley line in the north eastern corner of the site at approximately RL15m AHD.

4.2 Soil Characteristics

The Perth Environmental Geology Mapping (Gozzard JR 1983 Rockingham Part Sheets 2033 II and 2133 III)¹ indicates that part of the site area consists of two major soil types as outlined below:

- Eastern Lower areas abutting Baldivis Road - defined as Bassendean Sand of eolian origin, light grey at surface and yellow at depth. It is noted as being well drained above the water table.
- Western Portion of Site - defined as sand derived from Tamala Limestone of residual origin. It is noted to be a good groundwater recharge area and the soils are recognized as having some ability to attenuate pollutants due to small clay content.

In essence the site consists of well graded sands of high permeability meaning that soakage will be effective on the site.

The Western Australian Planning Commission Planning Bulletin 64 identifies the western portion of the subject site as having low to no risk of acid sulfate soils and potential acid sulfate soils occurring generally at depths greater than 3m. The remainder of the site indicates as having no known risk of acid sulphate soils occurring.

4.3 Geotechnical

Given the homogeneous sand on the site and excavations in the peripheral areas to the site being consistent with the environmental mapping, no geotechnical investigations have been undertaken on the site.

It is proposed that further investigations will be undertaken as part of the Urban Water Management Plan for the area to confirm the soil profile of the area.

The developers of the land have farmed the site for many years and are familiar with the soil types across the land.

4.4 Groundwater Aspects

Groundwater bores have been established across the site which are shown in Appendix A. The levels were measured in early October 2009 to provide an initial insight into the level regime across the site and the comparison with the maximum levels estimated by the DoW regional mapping.

The measured results indicate a level ranging from a peak of around RL3.5mAHD on the south eastern side of the site grading north and west to a level of around RL2.5mAHD on the northern corner of the site and RL2.0mAHD on the western side of the site. This is slightly different from the Department of Water 2004 Groundwater Atlas⁵ that indicates a mounding of groundwater at around RL4.0mAHD to the west of the site, grading east to around RL2.1mAHD at Baldivis Road.

The base data from the DoW bores was south and the peripheral bore locations are plotted on the plan in Appendix D. The DoW records also included measurements taken in October 2009 and in the main extended as far back as 1975. The AAMGL for each bore location was calculated and the difference was calculated between the AAMGL and the measured level as at October 2009. The median difference was calculated to be around 0.34m higher than the level measured as at October 2009. As a result, the site measured levels in October 2009, were increased by 0.38m to arrive at the AAMGL levels plotted on the Plan in Appendix B.

It is clear that the groundwater levels are well below the existing and proposed levels of the site.

Based on the bore records, it appears that the bore hole on Baldivis Road represents water perching on the subsurface impervious layers rather than an unconfined groundwater surface level. Soil profile details have been gleaned from bore hole construction logs for each of the bores established across the site which are included in Appendix D. While all bores indicated a consistent porous soil profile, bore S1 indicated a darker brown finer soil at approximately 3.5m depth which indicates perching and possibly the interface between the “Baldivis Flats” catchment which drains east to the Peel Main Drain and the groundwater catchment that drains west. In reality, the discrepancy of this groundwater level is largely academic as the existing and proposed levels of the site will be well above the groundwater levels.

4.5 Surface Water Aspects

4.5.1 General

As shown in Appendix B, the current site is divided into five major catchments being west, north, east and south of the natural ridge through the site, with the catchment east of the ridge being split north east and south east. The soil is very permeable and in the rare event that runoff occurs, each catchments will drain to suitable low areas and infiltrate.

The majority of the site is very steep, with average grades on the hill sides being around 10% meaning that apart from infiltration during the rainfall event, any collected run-off will need to reach flatter terrain for sufficient depth and capacity to be available for infiltration to occur.

The western portion of the site falls within the Water Corporations “Rural” Mundijong Drainage District. East of Baldivis Road, this permits a maximum outflow from areas to be either 2.5l/s/ha or 5.0l/s/ha depending on the soil classification of “sand” or “clay”. The area of this site, being west of Baldivis Road had no defined allowance. Given the permeable soil conditions and the location of isolated low areas throughout the catchments, this makes logical sense and as a result, drainage facilities within this development have been designed to hold all events up to 1 in 100 year storm without outflow.

4.5.2 Predevelopment Ground Water Monitoring

Monitoring bores have been installed over the site, one in each corner and a number of bores around the existing houses on Lots 739 and 740. Initial background water quality records have been undertaken by RPS Bowman Bishaw Gorham in October of 2009. The initial results are included in Appendix D.

The baseline results indicate that in general the water is suitable for irrigation and the water is generally within environmental guidelines, apart from Bore BS3 which is the house bore for Lot 739 which appears to be abnormally high in Nitrogen. Bores BS5 and BS6 are also quite high.

Historically, these areas of Lot 739 were used for intensive agriculture including a piggery and poultry farm. As can be seen from the test results, the bore records immediately adjacent to these previous uses indicate high levels of nitrogen, but these concentrations decrease as the distance from the use increases.

The monitoring results measured to date are incorporated within Appendix D, but the key parameters are included within Table 3.1 and 3.2 below.

Table 3.1 – Groundwater Depth Results

Bore	BS1	BS2	BS3	BS4	BS5	BS6	BS7
RL Surface	6.193	22.929	25.580	11.358	24.609	16.576	22.469
	Groundwater Level (mAHD)						
Oct 2009	3.474	2.208	2.191	2.485	2.230	2.081	2.011
Depth	2.719	20.721	23.389	8.873	22.379	14.495	20.458
Nov 2009	3.272	2.227	2.313	2.542	2.310	2.095	2.015



Table 3.2 – Groundwater Quality test results

Sample ID	Date	Trigger	Nutrients					
			Total P	Reactive P	Total N	TKN	NH ₄ -N	NO _x -N
		LOR	0.01	0.01	0.1	0.1	0.01	0.01
		Refer Below	0.8-12 ¹	0.03 ²	5 ¹	NG	0.04 ²	0.1 ²
		LIWG	NG	NG	NG	NG	NG	NG
BS1	5/10/2009		0.20	0.01	1.9	1.8	0.5	0.09
BS2	5/10/2009		0.08	0.04	1.3	1	<0.2	0.34
BS3	5/10/2009		0.12	<0.01	15	1	0.7	14
BS4	5/10/2009		0.21	<0.01	0.3	<0.2	<0.2	0.16
BS5	5/10/2009		0.10	<0.01	8.7	<0.2	<0.2	8.7
BS6	5/10/2009		0.19	0.04	4.1	<0.2	<0.2	4.1
BS7	5/10/2009		0.11	0.01	0.6	0.5	0.3	0.12

1. Irrigation Guidelines ANZECC/ARMCANZ 2000, Chapter 9
2. Values for Wetland environments - Table 3.3.6 ANZECC/ARMCANZ 2000 Freshwater and Marine WQ Guidelines Chapter 3

As outlined in Table 3.1 monitoring has only recently commenced, with the next round of testing scheduled for after commencement of development, being generally in accord with the programme outlined in Section 9.1.

4.6 Environmental Assets and Water-Dependent Ecosystems

There are no conservation category wetlands in the area, with the closest wetlands being immediately west of Eighty Road some 3km west of the subject land.

4.7 Existing Infrastructure and Design Constraints

Sufficient capacity is available in the adjoining development to service the development of the subject land. There will be some major service infrastructure extensions required to facilitate the development of the land primarily a water service extension along Baldivis Road from the north.

The western portion of the site is proposed to be sewer into existing infrastructure to the west of the site; however a new permanent sewerage pumping station will be required to be constructed east of Baldivis Road which will be subject to further investigations and discussions with the Water Corporation.

The primary constraint on the site is the steep terrain, which limits the use of soakage in isolated locations throughout the site, other than through the use of baseless manholes.

5 Water Sustainability Initiatives

5.1 General

The current state government requirement to increase the efficiency of water use in new developments to a target of less than 100kl per person per year is proposed to be implemented within the development.

This is proposed to be achieved by:

- Increased water efficiency in the household by encouraging the use of waterwise appliances through regulation and financial incentives.
- Encouragement of the use of rainwater tanks to supplement scheme water for irrigation.
- The use of low water requirement plants and minimizing turf areas for gardens and POS areas

5.2 Individual Lot Owner Initiatives

Water conservation will be encouraged by the developer through the promotion of native, water-wise gardens and water efficient household devices & appliances. All requirements for the purchaser will be outlined in their purchase contract and associated information handouts. .

The information will also outline the case for all lot owners to use rainwater tanks plumbed into their homes to assist with the retention of the 1 in 1 year ARI event.

5.3 Estate Public Open Space (POS) Initiatives

5.3.1 Aims

The drainage impacts of the POS will be managed to ensure that:

- The maximum depth of water within drainage basins during a 100 year storm is limited to 1.5m.
- Subsurface storage will be provided on site to ensure for low ARI rainfall events the water will remain below the surface and any silt will remain below the surface.
- Flush kerbs will be constructed abutting POS areas with either direct run-off for infiltration in lower areas or with swales for infiltration/conveyance to drainage basin areas.

Any proposed landscaping development of the POS areas will address the following objectives:

- Minimising irrigation & fertiliser demands via appropriate species selection
- Managing fertiliser application to minimise impacts on water quality.
- Weed Management
- Fauna Protection

5.3.2 General POS initiatives

The treatment of the POS areas will typically consist of grassed areas with designated areas of native planting and mulching. All areas will be designed to minimise

irrigation requirements with predominantly native plantings incorporated into the landscape design and the use of low water requirement grasses such as kikuyu.

A Public Open Space Management Plan (POSMP) will be prepared in accordance the Department of Water's (DoW) and City of Rockingham requirements which will address the objectives outlines in Section 5.3.1.

5.3.3 Irrigation

1) Water Sources and required Allocations:

The current lot owners have a licence to take 99,900kL water on a licence that expires 2015. All water uses for the existing site are extracted from that bore which is a reliable source of water. Once development occurs, it is proposed that the existing bore licences will be altered to utilise the allocation for irrigation of POS areas.

For the POS irrigation the overall water use is limited to a maximum of 7500kl per hectare per annum in accord with the Department of Water requirements. Given that the total area to be irrigated over the total development is approximately 12.20ha requiring an annual bore yield of some 91,500kL per annum, this means that the existing allocation will be sufficient for the development of the POS areas.

It will be necessary to seek an amendment to the existing bore licence(s) for irrigation requirements. Additional allocations to that required for the development will be retained for future use.

Standard conditions require irrigation usage to be metered monthly and submitted annually in accord with DoW requirements.

2) Programming and Irrigation Minimisation.

Establishment irrigation for street trees and native POS planting areas is expected to be used for a period of between 2 and 3 years after planting then disconnected.

Typically, watering will start with 10mm three times / day for initial establishment over a period of around 1 month, depending on the weather and the time of the year. This should then be reduced to 10mm once/day for a period of around 2 months - dependant on the time of year. The watering is then reduced to 10mm applied 2 to 3 times a week.

Irrigation should be programmed and maintained to minimise the water used across the site, with the following mechanisms to minimise water use.

- The system should be checked regularly to detect faults and ensure water is being used effectively and efficiently.
- In general the system should be checked at a frequency of
 - November to April - Once per fortnight.
 - May to October - Once a month.
- All sprinklers should be checked to fully pop-up and retract, bubblers and that nozzles are free of blockages and sprinklers are providing adequate coverage. Particular attention should be paid to irrigation of transplanted mature trees and street trees to ensure they are receiving adequate water.

- The watering regime for planted areas should reflect the plants needs in accordance with the plant type and natural rainfall, in accordance with the Water Corporation's "Water-wise" guidelines. Watering should be monitored throughout the year and adjusted accordingly to ensure appropriate watering. Watering should only take place within the hours stipulated by the Water Corporation (Currently 6.00pm to 9.00am).

The Irrigation Schedule is expected to be as follows (based on landscape hydrozones):

- Turf should be separated from shrubbery and turf and shrubbery should be supplied by different stations of irrigation and scheduled separately.
- Areas of turf subject to lower wear in sheltered environments &/or are not in visually prominent positions should be scheduled to receive a lesser amount of irrigation than areas of turf that are subject to high levels of wear, in exposed environments &/or in visually prominent locations;
- Low Water use plants should be scheduled to receive a lesser amount of water than areas of higher water use; and,
- Irrigation should be progressively withdrawn from areas of native shrubbery.

As part of the landscape works, the topsoil in the landscaped areas will be improved to ensure free drainage and nutrient retention properties prior to planting.

6 Stormwater Management Strategy

6.1 Pre-Development Hydrology

As outlined in Section 4, the site consists of sand with excellent soakage characteristics and is generally very steep with most portions of the site grading at around 10%.

Based on the fact that little or no run-off occurs from the site and all rainfall is infiltrated, it has been assumed that there is no predevelopment flow from the site. A plan detailing the predevelopment catchment boundaries is shown in Appendix B.

Each of the catchments grades to natural isolated low areas and infiltrates as follows:

- Western Catchment drains to a low point in the north western corner of the site (Level of Low Point RL15.00mAHD)
- Southern Catchment drains to a low point in the centre of the site on the southern boundary (Level of Low Point RL21.00mAHD)
- Northern Catchment drains to a low point in the centre of the site in the abutting land on the northern boundary of the site (Level of Low Point RL17.00mAHD)
- The Eastern Portion of the Site essentially grades towards Baldivis Road without an isolated low point. From inspection of the site, there are no culverted crossings of the road and it appears that all rainfall infiltrates prior to run-off. In the event that run-off did follow the road grade, the road falls from RL10.0mAHD on the northern Boundary of the Site to around RL5.50mAHD on the South Western Corner of the site.

6.2 Pre- & Post- Development Hydrology

The drainage strategy is proposed to infiltrate all stormwater on site as close to the source as possible. The underlying soils are deemed to be appropriate for uptake of nutrients meaning that the soakage of the water will provide sufficient opportunities for nutrient uptake.

The site is proposed to be divided into five major catchments as per the natural catchment. A plan detailing the catchment boundaries and proposed drainage basins is shown in Appendix B.

Due to the steep slopes on the site, the benefit and logistics of installing small retention basins across the site are marginal and difficult. Soakage at source will be employed for all allotments without outflow. Planning of the site has utilised lineal open space, particularly abutting the service easement and in various other locations on the site which lends itself to use of flush kerbing which allows road water to run off and infiltrate. This can be either used in conjunction with swales or simply allowing run-off into POS areas where they are lower than roadways and lots.

All basins will be constructed as shallow swales within POS areas. Water will be drained into the POS areas to soakwells in the base which will provide below ground storage to maximize the function of the POS during lower ARI rainfall events. GPT's will be constructed at entry to the POS soakage areas to ensure that all litter and sediment is contained for easy cleaning.

The areas required to contain flows from the post development catchments areas are summarised in Table 6.1 - Refer also to Appendices B and C for the catchment plan and detailed calculations:

Table 6.1 – Drainage Basin Areas/Catchments and Areas affected by Drainage

Basin Description	Impervious Catchment (Ha)	Storage provided (100Yr)	Storage provided (5Yr)	Storage provided (1Yr)	Site Area Required (100Yr)(m ²)	Site Area Required (5Yr) (m ²)	Site Area Required (1Yr) (m ²)
Catchment 1(South Eastern)	6.70	5,750	1,990	1,150	5,580	4,370	4,050
Catchment 2A (North Eastern)	1.36	700	570	290	1,200	1,090	860
Catchment 3 (Northern)	2.64	2,120	835	450	2,170	1,910	1,820
Catchment 4 (Southern)	2.06	1,920	750	280	2,210	1,940	1,290
Catchment 5 (Western)	8.51	8,060	3,200	1,610	6,800	5,240	4,670
Total	21.27	18,550	7,345	3,780	17,960	14,550	12,690

6.3 1 in 1 year ARI event

6.3.1 General

The 1 in 1 year event is typically seen as the storm where most nutrients and particulate matter is generated from.

It is proposed that the 1 in 1 year ARI 1 hour storm will be retained on site without outflow in accordance with DoW requirements. This is proposed to be undertaken at the various levels as outlined in the following sections.

6.3.2 Lots:

Lots will either retain water on site in rainwater tanks in conjunction with soakwells or install soakwells to infiltrate water to ensure no outflow into the street drainage system. It has been assumed that all Lots will be fitted with at least 2 by 1500 diameter by 1.2m deep soakwells to achieve full retention of the 1 in 1 year 1 hour storm. The use of these soakwells will also ensure any overflow from major events will infiltrate in garden areas prior to reaching the street drainage system.

6.3.3 Streets:

The 1 in 1 year 1 hour storm for roadways, will be contained within swales in POS and in the end of line swales/soakage basins.

Drainage pits will be laid with open bases to permit soakage for small rainfall events thereby encouraging further soakage “at source”. The baseless pits will cater for around 1.5-2.0mm of rainfall.

Where possible, overland flow will be employed in lieu of piped drains. Where roads are constructed adjacent to open space and opportunities for soakage are available, flush kerbs will be used in conjunction with swale drainage in lieu of a piped drainage system.

The remainder of the 1 in 1 year 1 hour event will be contained within the soakage basin without overflow to any surrounding POS areas.

Soakwells and below ground storage will be installed in the basin, thereby ensuring that stormwater will be contained below ground for lower ARI rainfall events, thereby maximizing the usability of the swales.

A GPT will be installed prior to any inflow from the piped drainage system into the drainage basin to limit the siltation of the basin.

6.3.4 Lineal Open Space:

All roadway flow where roads abut POS will be directed to the POS areas using flush kerbs. This will encourage soakage at source. In general this will be where roads are slightly higher than POS areas. Where roads are level with POS areas swales will be employed.

If POS areas are significantly higher than roadways, the use of swales will not be employed.

6.3.5 Detention Basins

Beyond the measures employed in baseless pits and lineal swales, the remainder of the 1 in 1 year 1 hour storm will be retained within the detention basin areas. The drainage basins will retain the water until it infiltrates.

6.3.6 Non structural measures

Non structural measures will also be employed to reduce the sources of nutrients. These measures involve providing advice to lot purchasers and stakeholders to reduce nutrient sources from the application of garden fertilisers and eroded particulate matter particularly from the new urban areas during the housing construction phase and in establishment of gardens.

Minimisation of nutrient loading can obviously be achieved through:

- Education of local residents and Council maintenance personnel; and
- By implementing frequent street and storm water maintenance programs – particularly during housing construction.
- By planting and using appropriate native species.

6.4 1 in 5 year ARI event

All piped drainage systems will be designed to accommodate the 1 in 5 year ARI event, without any inundation of roadways.

6.5 1 in 100 year ARI event

For the major event, flows in excess of the 5 year storm will surcharge and run overland. All roads within the estate will be designed to accommodate and direct extreme event flows towards each POS and compensating basin. The land will be divided into the same catchment areas as detailed in the post development plan as Appendix B.

6.6 Finished Lot Levels (Relative to the 1 in 100 year flood levels)

As outlined in Section 2.3, the land is proposed to be filled a minimum of 500mm above the top water level of drainage basins. In all cases, lots will be set to ensure conveyance for major storms will be along the roadways without flooding homes.

6.7 POS Credits

As outlined in the LSP document all POS credit calculations have been based upon current “Liveable Neighbourhood” policy guidelines - where 100% of the area covered by the 1 in 1 year event of each compensating basin is typically not included as a “usable” POS area. The 1 in 5 Year event is designated as a restricted area normally attracting a 100% credit for the area between the 1 Year and the 5 year ARI levels provided this comprises less than 20% of the total POS allocation.

The affected areas of the drainage basins are detailed in Table 6.1.

6.8 Best Management Practices Water Quality Targets

The DoW’s Stormwater Manual provides guidelines and information on best management practices that may be applied at land development and construction sites to improve stormwater management and environmental performance.

Poorly managed land development sites can often be a major source of stormwater pollution. Certain construction activities can allow pollutants to be transported (via existing stormwater systems or over-land flow) to adjoining receiving water bodies.

The major source of pollutants from construction activities in this instance will potentially be from:

- Eroded materials in the interim period between opening up the surface of the site and implementing the drainage management measures.
- Litter & waste storage areas- that allow materials to be blown by wind or washed away by rainfall into existing stormwater systems.
- Wash-down areas– poor practices can allow materials to enter stormwater systems.
- Placement & storage of delivered products- particularly sand and soil stockpiles where such materials may be tracked by vehicles onto roads, or blown, or washed on to roads which then get into existing stormwater systems.
- Dewatering activities– which can cause sedimentation of downstream water bodies.

Consequently no construction activities will commence on the site until an appropriate approved Environmental Management Plan (EMP) is prepared that fully addresses:

- litter and waste management practices (non-hazardous & hazardous materials);
- vehicle & equipment washing-down practices;
- water conservation practices;
- product placement & storage practices;
- dewatering activities (if applicable); and
- Any other practices that may adversely impact upon receiving water bodies.

This will be prepared by the contractor undertaking the civil works on the subdivision together with the engineering consultant.

The Best Management measures proposed for this area are proposed to be:

- Non Structural Measures to be implemented reduce applied nutrient loading.
- On Site Retention of 1 in 1 year 1 hour ARI Storm.

Research has indicated that this approach will achieve reductions of at least 80% of total suspended solids; 60% of total phosphorus; 45% of total nitrogen & 70% of gross pollutants compared to a conventional drainage system.

7 Groundwater Management Strategy

7.1 Groundwater Level Management

Groundwater levels for the site location are plotted on the site plan in Appendix B. In general the levels are many metres below the site levels with the exception of the eastern side of the site. Development levels in that location are set at around RL7.50 minimum which is well above the measured groundwater level RL3.5mAHD.

The critical point in this location is the base of the drainage basin which is proposed at RL4.3mAHD. Despite this being some 0.8m above the measured levels, it is still well above the regional estimated peak groundwater levels, meaning that the POS area will always be dry.

There is no further need for controls of groundwater levels and all drainage pipework will be laid well above the controlled groundwater levels.

7.2 Actions to Address Acid Sulphate Soils or Contamination

The ASS mapping for the area indicates that there is a low to medium chance of ASS soils being present on the site.

RPS has reviewed the site for ASS and further detailed investigations have been undertaken. The test results indicate that no ASS will be encountered in association with the works, in particular where the works are above the groundwater levels.

In the event that dewatering is required testing of the groundwater discharge will be required to ensure that pH and Total Acidity levels are within acceptable guideline limits, to ensure that ASS management measures can be employed if required.

All dewatering discharge will be infiltrated.

8 The next stage – Subdivisions and Urban Water management Plans

The structure plan area is under the ownership of two developers, which simplifies the physical implementation of the proposals. An Urban Water Management Plan (UWMP) will be required for the subdivision proposal, but will generally fit within the framework of this Local Water Management Strategy.

The amendment of current groundwater licence (Ref Section 5.3.3) will be either finalised or substantially progressed prior to the submission of future Urban Water management Plans.

The UWMP will build on the concepts of this report providing ongoing monitoring results and addressing the following major points:

- Further detail in the design of the detention basins.
- Further detail in landscape proposals.
- Additional environmental test data and geotechnical investigations.

Once this data is received, the approach outlined herein will be reviewed with detailed work required to:

- Finalise the design of the swales in the POS.
- Detail the Drainage basins including the various inlet configurations and edge treatments to ensure the overall functional and aesthetic outcomes are satisfactory.
- Review the drainage calculations relative to final planning proposals for the site to ensure that the land use assumptions within the drainage calculations herein are consistent.

9 Monitoring

9.1 General

The prime concern for the nutrients emanating from the development is the health of the subsurface environment. As a result it is proposed to monitor the nutrient levels using the existing groundwater bores as shown in the plan in Appendix B.

Water will be sampled quarterly, typically in January, March, July and September.

The monitoring is proposed to be carried out for two years following completion of the last Stage of civil construction or until hand over of the POS to the City of Rockingham, whichever occurs first.

Hand over to the City of Rockingham will occur two years after completion of establishment works. In the interim period, the developers will accept responsibility for the maintenance and monitoring of the landscaping and monitoring works.

The level will be measured and samples will be sent to a NATA registered laboratory to undertake the following tests:

Total Phosphorous	TP
Total Nitrogen	
Filterable Reactive Phosphorous	
Nitrate and Nitrite	NO _x
Ammonia-Nitrogen	NH ₃
Total Kjeldahl Nitrogen	TKN
Salinity	EC or TDS
pH	

An annual report will be submitted to the City of Rockingham and the DoW until hand over. Annual Reports will be provided each December commencing in the first December after the first stage of the development is completed.

In the event that a sample exceeds the predevelopment environment by over 10%, sampling frequency will be increased to monthly to assess the reasoning behind the difference. Once this has been established and the matter resolved to the satisfaction of Council and DoW, quarterly sampling will be reintroduced.

10 Implementation

10.1 Commitments

The developers are committed to

- 1) Physical Outcomes – To be undertaken at the time of construction.
 - Ensuring that all storm water drainage from the estate is infiltrated on site.

2) Non Structural – To be undertaken as part of sales documentation, by providing Information Packages to all lot purchasers to:

- Fully inform lot owners of the requirement to install a minimum of two 1500mm diameter by 1200mm deep soakwell prior to outflow into the drainage system in the event a rainwater tank is not installed or a single soakwell if a rainwater tank is used.
- To encourage the use of rainwater tanks (plumbed into their homes); and
- To utilise water efficient devices & appliances throughout their homes, and to encourage all purchasers to install Water & Nutrient-wise plants.

3) Further investigation and reporting:

- Prepare Urban Water Management plans to support further detailed subdivision planning.
- Undertake further monitoring of groundwater.
 - Pre- Development – from present until commencement of subdivision works.
 - Post Development – until two years following the final stage of the development
- Undertake further geotechnical investigations.

10.2 Contingency Measures

The results will be compared between the initial results to those measured each year.

In the event that any of the indicators from the sampling exceeds the initial measurements by 10% for two consecutive samples, Council and DoW will be notified and the matter will be investigated at the developers cost.

The possible contingency measures are as follows:

1. Reduction in irrigation or fertiliser use in key areas and review of timing.
2. Soil amendment in high nutrient areas
3. Increased planting of water and nutrient thirsty plants in groundwater recharge areas.

The measures employed and the timing will be resolved at the time with the DoW and Council.

10.3 Maintenance Schedules (Incl. Roles & Responsibilities)

Maintenance schedules and arrangements will be resolved as part of the Urban Water Management planning and will be dependant on the detailed design and operation of the mechanisms required. As a brief summary, table 10.1 has been included to provide guidelines for likely maintenance responsibilities.

Table 10.1 – Proposed Maintenance Programme for the development

#	Drainage Element:	Possible Maintenance and Inspection Frequency:	Responsibility:
1	Rainwater tank(s); trapped underground soakage / connection pit(s)	Annually inspection & clean-out (as necessary) – just prior to winter rains	Lot Owner



#	Drainage Element:	Possible Maintenance and Inspection Frequency:	Responsibility:
2	Swale Areas, table drains and detention basins	<u>During developer maintenance period:</u> Inspect, clean-out & maintain plants ~fortnightly intervals (depending on loading) – as part of POS maintenance works <u>After developer maintenance period:</u> Inspect, clean-out & maintain plants (as required) as part of standard Council POS maintenance program	Developer Council
3	Drainage culverts, standard table drains, pipes and pits	<u>During developer maintenance period:</u> Inspect, clean-out & maintain structures annually – just prior to winter (& then again in Aug / Sept if necessary) <u>After developer maintenance period:</u> Inspect, clean-out & maintain structures at least annually – just prior to winter – but inspection frequency will need to be higher during home construction phase	Developer Council
4	Trapped Pits and GPT's	<u>During developer maintenance period:</u> Inspect, clean-out & maintain pits tri-annually – just prior to winter & then around June / July & again in Oct / Nov for the first two years <u>After developer maintenance period:</u> Inspect, clean-out & maintain pits tri-annually – just prior to winter & then around June / Aug – but inspection frequency will need to be higher during home construction phase.	Developer
5	Base of compensating basins	Initial formal inspection & assessment of performance of bases (say) at around year 3 & then every 5 – 10 years.	Council

10.4 Funding

The cost for the implementation of the capital water management measures will be borne by the developers. Maintenance and monitoring costs will be borne by the developers for the periods as outlined in the maintenance schedule table in section 10.3 above.

10.5 Review

Following the approval of this document, it is not expected that the LWMS for this development will need to be reviewed as this forms the broad structure of the approach for the drainage in the area.

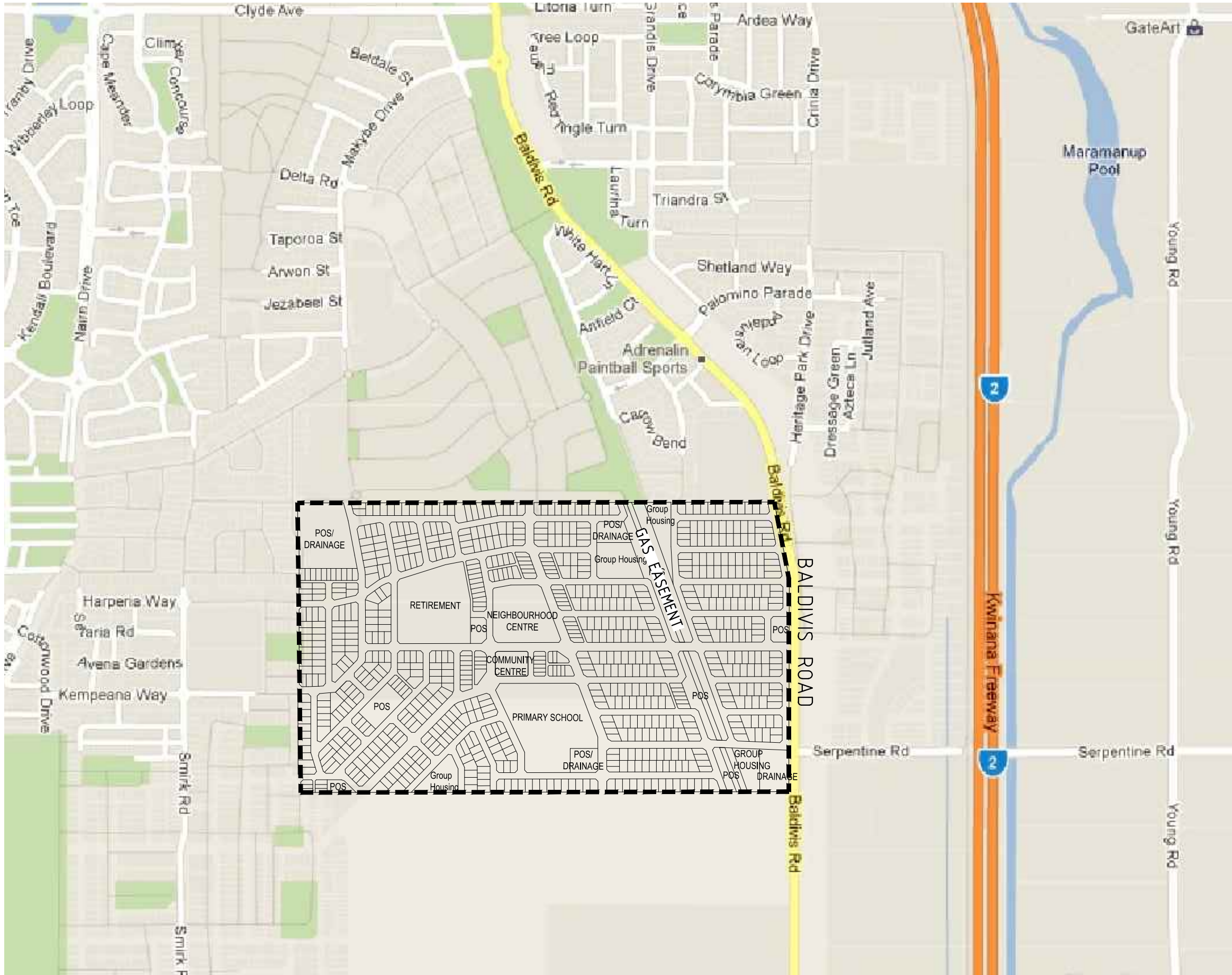
In general minor amendments can be made, provided they meet the outcomes sought within this report. In the event that the management measures used within the state have significantly changed or the first subdivision application following the expiration of 4 years from the first subdivision approval whichever is the later, the measures used for management of stormwater should be reviewed.

11 References:

1. Environmental Geology Mapping - Part Sheets 2033 II and 2133 III, Gozzard JR 1983
2. Mundijong Drainage District – Rural Drainage Criteria, Water Corporation May, 2000
3. Australian Rainfall and Run-off A Guide to Flood Estimation Volume 1, Institute of Engineers, 1987
4. Perth Groundwater Atlas, Waters and Rivers Commission, October 1997.

5. Perth Groundwater Atlas (Edition 4), Department of Environment, 2004

APPENDIX A – REGIONAL CONTEXT PLAN, AERIAL PHOTO OF SITE AND PROPOSED STRUCTURE PLAN



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B	06/09/11	WJB	LOT LAYOUT AMENDED
A	2/12/09	JEG	INITIAL ISSUE
No.	DATE	BY	REVISION

CLIENT:	
NOVALEE NOMINEES PTY LTD	
ESTATES 77 PTY LTD	
SRA	SRA

	DEVELOPMENT
	ENGINEERING
	CONSULTANTS

SUITE 3, 123A COLIN ST, WEST PERTH, 6005 WESTERN AUSTRALIA Ph: (08) 9481 1900 Fax: (08) 9481 1700

PROJECT:	LOTS 635, 739 & 740
	BALDIVIS ROAD
	BALDIVIS
	W.A.P.C. No. -

DRAWING:	LOCALITY PLAN
SCALE	1:5000
DATE	2/12/09
PROJECT NUMBER	PRO519 D01

DRAWN	JEG	CHECK	SRA	REV No.	B
DESIGNED	JEG	APPROVED	SRA		
S:\PROPOSALS\PRO519\DRAWINGS\PRO519 D01.dwg 25/10/2011					



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ESTATES 77 PTY LTD



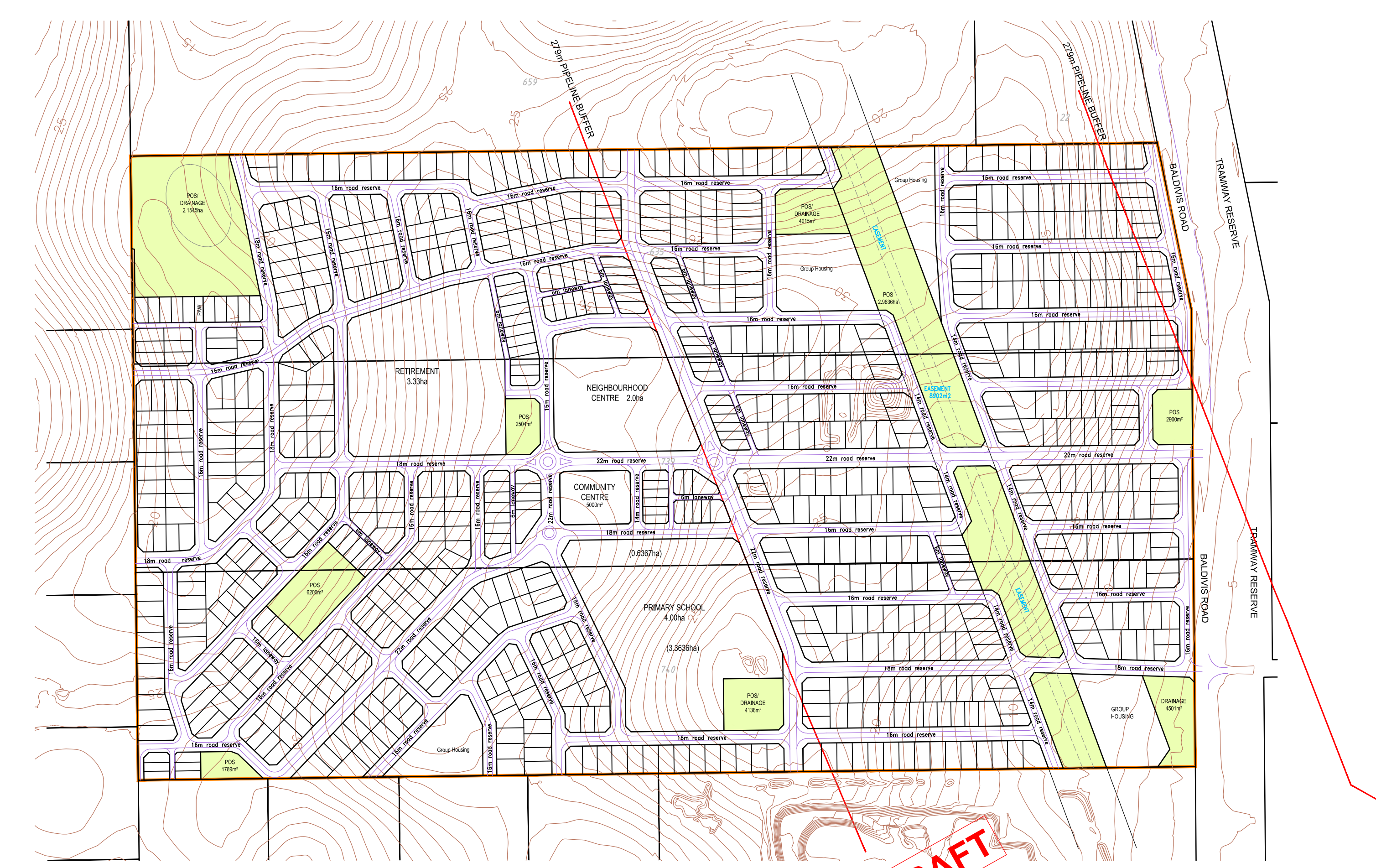
SUITE 3, 123A COLIN ST,
WEST PERTH, 6005
WESTERN AUSTRALIA
Ph: (08) 9481 1900
Fax: (08) 9481 1700

SUBJECT: **LOTS 635, 739 & 740**
BALDIVIS ROAD
BALDIVIS

AERIAL PHOTO

SCALE 1:2000	DRAWN JEG	CHECK SRA	REV No.
DATE 2/12/09	DESIGNED JEG	APPROVED SRA	C
PROJECT NUMBER PRO519 D02			

CAD DRAWING DO NOT MANUALLY ALTER



DRAFT STRUCTURE PLAN

Lots 635, 739 + 740 Baldvis Road
Baldvis

Lot	POS / Drainage / P.S. / Comm. Centre
635 (north)	4.0485 ha
739 (middle)	2.9739 ha
740 (south)	6.0909 ha
Total 13.1133 ha	

DRAFT

P

M

L

K

J

I

Based on rev M, Rev O & P superceded

Mods to school site, 16 to 18m road

Redesign/ Relocate PS

Redesign of western entry point

Various redesign

Relocation of Retirement

110728

110310

110310

101216

101112

101021

SB

SJ

LI

SB

LI

LI

DP

LI

LI

LI

LI

DP

DRAWING NUMBER

UD1 102

REFERENCE NUMBER

CGC BAL

0

80

160m

REV

P

ISSUE

DESCRIPTION

YYMMDD

DRAWN

APPVD

Issued for design intent only.
All areas and dimensions are
subject to detail design + survey.

SCALE 1:4000
SHEET A3

robertsday

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Western Australia 6004 AUSTRALIA

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APPENDIX B – DRAINAGE CATCHMENT PLANS

- **Pre-development catchment plan**
- **Post development catchment plan with flow directions,
bore locations and proposed drainage basins**

BASIN 3 DETAILS	
CATCHMENT AIMP	2.64Ha
BASE R.L.	20.50m
100yr VOLUME	2142m ³ (R.L.2160)
100yr TWL AREA	2176m ²
5yr VOLUME	835m ³ (R.L.20.96)
5yr TWL AREA	1909m ²
1yr VOLUME	444m ³ (R.L.20.75)
1yr TWL AREA	1824m ²

BASIN 3 DETAILS	
CATCHMENT AIMP	2.64Ha
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100yr TWL AREA	2176m ²
5yr VOLUME	835m ³ (R.L.20.96)
5yr TWL AREA	1909m ²
1yr VOLUME	444m ³ (R.L.20.75)
1yr TWL AREA	1824m ²

CATCHMENT AREA

FINISHED SURFACE CONTOURS

WATER CONTOURS

DRAINAGE BASIN

MONITORING BORE

DEPTH

NAME

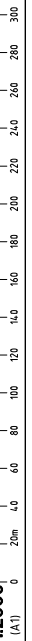
SURFACE LEVEL

23

2.90

B51

RL6.193



CATCHMENT Aimp	2 06Ha
BASE R.L.	22 00m
100yr VOLUME	1920m ³ (R.L.23.20)
100yr TWL AREA	2207m ²
5yr VOLUME	747m ³ (R.L.22.59)
5yr TWL AREA	1536m ²
1yr VOLUME	379m ³ (R.L.22.33)
1yr TWL AREA	1248m ²

CATCHMENT Aimp	2 06Ha
BASE R.L.	22 00m
100yr VOLUME	1920m ³ (R.L.23.20)
100yr TWL AREA	2207m ²
5yr VOLUME	747m ³ (R.L.22.59)
5yr TWL AREA	1536m ²
1yr VOLUME	379m ³ (R.L.22.33)
1yr TWL AREA	1248m ²

BASIN 2 DETAILS	
CATCHMENT Aimp	1.36Ha
BASE R.L.	19.00m
10yr VOLUME	699m ³ (R.L.19.82)
10yr TWL AREA	1198m ²
5yr VOLUME	562m ³ (R.L.19.70)
5yr TWL AREA	1089m ²
1yr VOLUME	291m ³ (R.L.19.42)
1yr TWL AREA	853m ²

BASIN 2 DETAILS	
CATCHMENT Aimp	1.36Ha
BASE R.L.	19.00m
10yr VOLUME	699m ³ (R.L.19.82)
10yr TWL AREA	1198m ²
5yr VOLUME	562m ³ (R.L.19.70)
5yr TWL AREA	1089m ²
1yr VOLUME	291m ³ (R.L.19.42)
1yr TWL AREA	853m ²

BASIN 1 DETAILS	
CATCHMENT Aimp	6.05Ha
BASE R.L.	4.30m
100yr VOLUME	5741m ³ (R.L.5.55)
100yr TWL AREA	5673m ²
5yr VOLUME	1986m ³ (R.L.4.80)
5yr TWL AREA	4368m ²
1yr VOLUME	1145m ³ (R.L.4.60)
1yr TWL AREA	4047m ²

BASIN 1 DETAILS	
CATCHMENT Aimp	6.05Ha
BASE R.L.	4.30m
100yr VOLUME	5741m ³ (R.L.5.55)
100yr TWL AREA	5673m ²
5yr VOLUME	1986m ³ (R.L.4.80)
5yr TWL AREA	4368m ²
1yr VOLUME	1145m ³ (R.L.4.60)
1yr TWL AREA	4047m ²

APPENDIX C – DRAINAGE CALCULATIONS

- End of Line Drainage Basin size calculations for 1 in 1 year 1 in 5 year and 1 in 100 Yr Storms

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 1 - Main Basin

Data to be Input

Rainfall ARI (Years)	1	Overflow from	Basin 2A	685
1 in 1 Year Impervious Catchment(Ha)	6.05			
Required Storage(1 in 1Yr 1 Hr)(m ³)	931			
Available Storage(m ³)	984			
Soakage Outflow(l/s/m ²)	0.013			
Allowable Outflow (l/s) (10 year)	-			

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	6.93	0	16.1511	3.6869	0.5	27.27
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	0.80	0.80	0.62	1.00	
Run-Off Co-efficient(Cy)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	5.55	0.00	0.00	0.00	0.50	6.05

0.22 Effective C

Data From A, R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	² ₁	20.6	0	-
Map 2	² ₁₂	4.5	18	0
Map 3	² ₇₂	1.3	18	0
Map 4	⁵⁰ ₁	35.5	16	0
Map 5	⁵⁰ ₁₂	7	15	0
Map 6	⁵⁰ ₇₂	2.1	14	0
Map 7	G	0.68	12.5	0
Map 8	F2	4.82	6	0
Map 9	F50	17		69,316

Road Catchment Area:

Net Storage

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	(After Soakage)	Time of Water in Basin(hrs)
20	0.33	29.76	500	600	0.50	46.68	56.02024555	544	3.6
30	0.50	23.61	396	714	0.50	46.68	84.03036832	630	4.2
45	0.75	18.45	310	837	0.50	46.68	126.0455525	711	5.0
60	1.00	15.38	258	930	0.50	46.68	168.0607366	762	5.5
120	2.00	10.76	181	1300	1.50	46.76	336.6908199	964	7.7
240	4.00	6.92	116	1674	2.50	46.84	674.5203329	999	9.9
480	8.00	4.45	75	2154	3.50	46.92	1351.318052	803	12.8
960	16.00	2.79	47	2699	4.50	47.00	2707.190877	-8	16.0
2880	48.00	1.34	22	3879	5.50	47.08	8135.236948	-4256	22.9
4320	72.00	0.99	17	4292	6.50	47.16	12223.3519	-7932	25.3

Drainage Basin Dimensions:

Side Slopes 1: Length(m) Breadth(m)
6 78 46

RL(Base) 4.3

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
4.3	0	3588	14352	0	0	0	Static Water Level
4.55	0.25	3969	15105	944	944	0	1 in 1 year 1 Hour
4.56	0.26	3985	15135	984	322	40	1 in 1 year
4.79	0.49	4352	15845	1942	1942	998	5 Year Storage
4.88	0.58	4499	16127	2341	2341	1396	10 Year Storage
5.55	1.25	5673	18297	5741	5741	4797	100 Year Storage
5.9	1.6	6337	19482	7842	7842	6898	

Development Engineering Consultants - Drainage Basin Spreadsheet

**Project: Lots 635, 739 and 740 Baldivis Road
Baldivis**



Location: Catchment 1 - Main Basin

Data to be Input

Rainfall ARI (Years)	5	Overflow from	Basin 2A	685
1 in 1 Year Impervious Catchment(Ha)	6.05			
Required Storage(1 in 1Yr 1 Hr)(m ³)	931			
Available Storage(m ³)	1947			
Soakage Outflow(l/s/m ²)	0.013			
Allowable Outflow (l/s) (10 year)	-			

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	6.93	0	16.1511	3.6869	0.5	27.27
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	0.95	0.95	0.91	1.00	
Run-Off Co-efficient(Cy)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	5.55	0.00	0.00	0.00	0.50	6.05

0.22 Effective C

Data From A, R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	² ₁ ₁	20.6	20	0
Map 2	² ₁ ₂	4.5	18	0
Map 3	² ₁ ₂	1.3	18	0
Map 4	⁵⁰ ₁ ₁	35.5	16	0
Map 5	⁵⁰ ₁ ₂	7	15	0
Map 6	⁵⁰ ₁ ₂	2.1	14	0
Map 7	G	0.68	12.5	0
Map 8	F2	4.82	6	0
Map 9	F50	17		
				69,316

Road Catchment Area:

Net Storage

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	(After Soakage)	Time of Water in Basin(hrs)
20	0.33	50.06	841	1009	0.50	46.68	56.02024555	953	6.0
30	0.50	39.10	657	1182	0.50	46.68	84.03036832	1098	7.0
45	0.75	30.05	505	1362	0.50	46.68	126.0455525	1236	8.1
60	1.00	24.74	415	1495	0.50	46.68	168.0607366	1327	8.9
120	2.00	17.26	290	2086	1.50	46.76	336.6908199	1750	12.4
240	4.00	10.84	182	2622	2.50	46.84	674.5203329	1947	15.5
480	8.00	6.81	114	3294	3.50	46.92	1351.318052	1943	19.5
960	16.00	4.45	75	4306	4.50	47.00	2707.190877	1599	25.4
2880	48.00	2.08	35	6048	5.50	47.08	8135.236948	-2088	35.7
4320	72.00	1.52	26	6627	6.50	47.16	12223.3519	-5596	39.0

Drainage Basin Dimensions:

Side Slopes 1: Length(m) Breadth(m)
6 78 46

RL(Base) 4.3

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
4.3	0	3588	14352	0	0	0	Static Water Level
4.55	0.25	3969	15105	944	944	0	1 in 1 year 1 Hour
4.56	0.26	3985	15135	984	322	40	1 in 1 year
4.79	0.49	4352	15845	1942	1942	998	5 Year Storage
4.88	0.58	4499	16127	2341	2341	1396	10 Year Storage
5.55	1.25	5673	18297	5741	5741	4797	100 Year Storage
5.9	1.6	6337	19482	7842	7842	6898	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 1 - Main Basin

Data to be Input

Rainfall ARI (Years)	100	Overflow from	Basin 2A	685
1 in 1 Year Impervious Catchment(Ha)	6.05			
Required Storage(1 in 1Yr 1 Hr)(m ³)	931			
Available Storage(m ³)	5741			
Soakage Outflow(l/s/m ²)	0.013			
Allowable Outflow (l/s) (10 year)	-			

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	6.93	0	16.1511	3.6869	0.5	27.27
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	1.20	1.20	1.41	1.00	
Run-Off Co-efficient(Cy)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	5.55	0.00	0.00	0.00	0.50	6.05

0.22 Effective C

Data From A, R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	² ₁	20.6	20	0
Map 2	² ₁₂	4.5	18	0
Map 3	² ₇₂	1.3	18	0
Map 4	⁵⁰ ₁	35.5	16	0
Map 5	⁵⁰ ₁₂	7	15	0
Map 6	⁵⁰ ₇₂	2.1	14	0
Map 7	G	0.68	12.5	0
Map 8	F2	4.82	6	0
Map 9	F50	17		
				69,316

Road Catchment Area:

Net Storage

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	(After Soakage)	Time of Water in Basin(hrs)
20	0.33	98.74	1658	1990	0.50	46.68	56.02024555	1934	11.8
30	0.50	75.22	1263	2274	0.50	46.68	84.03036832	2189	13.5
45	0.75	56.30	945	2552	0.50	46.68	126.0455525	2426	15.2
60	1.00	45.44	763	2747	0.50	46.68	168.0607366	2579	16.3
120	2.00	31.59	530	3819	1.50	46.76	336.6908199	3483	22.7
240	4.00	19.11	321	4622	2.50	46.84	674.5203329	3948	27.4
480	8.00	11.56	194	5592	3.50	46.92	1351.318052	4240	33.1
960	16.00	8.08	136	7813	4.50	47.00	2707.190877	5106	46.2
2880	48.00	3.65	61	10581	5.50	47.08	8135.236948	2446	62.4
4320	72.00	2.62	44	11422	6.50	47.16	12223.3519	-801	67.3

Drainage Basin Dimensions:

Side Slopes 1: Length(m) Breadth(m)
6 78 46

RL(Base) 4.3

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
4.3	0	3588	14352	0	0	0	Static Water Level
4.55	0.25	3969	15105	944	944	0	1 in 1 year 1 Hour
4.56	0.26	3985	15135	984	322	40	1 in 1 year
4.79	0.49	4352	15845	1942	1942	998	5 Year Storage
4.88	0.58	4499	16127	2341	2341	1396	10 Year Storage
5.55	1.25	5673	18297	5741	5741	4797	100 Year Storage
5.9	1.6	6337	19482	7842	7842	6898	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 2 - Basin 2A

Data to be Input

Rainfall ARI (Years)	1
1 in 1 Year Impervious Catchment(Ha)	1.36
Required Storage(1 in 1Yr 1 Hr)(m ³)	209
Available Storage(m ³)	279
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	1.51	0	3.2858	0.231	0.15	5.17
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	0.80	0.80	0.62	1.00	
Run-Off Co-efficient(C _y)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	1.21	0.00	0.00	0.00	0.15	1.36

0.26 Effective C

Data From A₁R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	2 ₁₁	20.6	22	0
Map 2	2 ₁₁₂	4.5	20	0
Map 3	2 ₁₇₂	1.3	18	0
Map 4	50 ₁₁	35.5	16	0
Map 5	50 ₁₁₂	7	15	0
Map 6	50 ₁₇₂	2.1	14	0
Map 7	G	0.68	12.5	0
Map 8	F2	4.82	6	0
Map 9	F50	17		15,067

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	29.76	112	134	0.60	7.07	8.480934657	126	5.3	0	0
30	0.50	23.61	89	160	0.60	7.07	12.72140199	147	6.3	0	0
45	0.75	18.45	69	188	0.60	7.07	19.08210298	169	7.4	0	0
60	1.00	15.38	58	208	0.60	7.07	25.44280397	183	8.2	0	0
120	2.00	10.76	40	292	0.60	7.07	50.88560794	241	11.5	0	0
240	4.00	6.92	26	375	0.60	7.07	101.7712159	274	14.8	0	0
480	8.00	4.45	17	483	0.60	7.07	203.5424318	279	19.0	0	0
960	16.00	2.79	11	605	0.60	7.07	407.0848635	198	23.8	0	0
2880	48.00	1.34	5	870	0.60	7.07	1221.254591	-352	34.2	0	0
4320	72.00	0.99	4	962	0.60	7.07	1831.881886	-870	37.8	0	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m)	Breadth(m)
6	45
19	12
RL(Base)	

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
19	0	540	2160	0	0	0	Static Water Level
19.32	0.32	774	2613	209	209	0	1 in 1 year 1 Hour
19.42	0.42	853	2760	291	322	81	1 in 1 year
19.7	0.7	1089	3188	562	562	353	5 Year Storage
19.82	0.82	1198	3379	699	699	490	10 Year Storage
20.3	1.3	1673	4182	1385	1385	1176	100 Year Storage
20.5	1.5	1890	4536	1742	1742	1532	

685 Flow to Basin 1

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 2 - Basin 2A

Data to be Input

Rainfall ARI (Years)	5
1 in 1 Year Impervious Catchment(Ha)	1.36
Required Storage(1 in 1Yr 1 Hr)(m ³)	209
Available Storage(m ³)	562
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	1.51	0	3.2858	0.231	0.15	5.17
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	0.95	0.95	0.91	1.00	
Run-Off Co-efficient(Cy)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	1.21	0.00	0.00	0.00	0.15	1.36

0.26 Effective C

Data From A,R & R Volume 2

Location	Perth WA	Road Catchment Area: RR Width(m)	Length(m)	Area (Total)
Map 1	2 ₁₁	20.6	22	0
Map 2	2 ₁₁₂	4.5	20	0
Map 3	2 ₁₇₂	1.3	18	0
Map 4	50 ₁₁	35.5	16	0
Map 5	50 ₁₁₂	7	15	0
Map 6	50 ₁₇₂	2.1	14	0
Map 7	G	0.68	12.5	0
Map 8	F2	4.82	6	0
Map 9	F50	17		15,067

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	50.06	188	226	0.60	7.07	8.480934657	218	8.9	0	0
30	0.50	39.10	147	265	0.60	7.07	12.72140199	252	10.4	0	0
45	0.75	30.05	113	305	0.60	7.07	19.08210298	286	12.0	0	0
60	1.00	24.74	93	335	0.60	7.07	25.44280397	310	13.2	0	0
120	2.00	17.26	65	468	0.60	7.07	50.88560794	417	18.4	0	0
240	4.00	10.84	41	588	0.60	7.07	101.7712159	486	23.1	0	0
480	8.00	6.81	26	739	0.60	7.07	203.5424318	535	29.0	0	0
960	16.00	4.45	17	965	0.60	7.07	407.0848635	558	37.9	0	0
2880	48.00	2.08	8	1356	0.60	7.07	1221.254591	135	53.3	0	0
4320	72.00	1.52	6	1486	0.60	7.07	1831.881886	-346	58.4	0	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m)	Breadth(m)
6	45
19	12
RL(Base)	

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
19	0	540	2160	0	0	0	Static Water Level
19.32	0.32	774	2613	209	209	0	1 in 1 year 1 Hour
19.42	0.42	853	2760	291	322	81	1 in 1 year
19.7	0.7	1089	3188	562	562	353	5 Year Storage
19.82	0.82	1198	3379	699	699	490	10 Year Storage
20.3	1.3	1673	4182	1385	1385	1176	100 Year Storage
20.5	1.5	1890	4536	1742	1742	1532	

685 Flow to Basin 1

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 2 - Basin 2A

Data to be Input

Rainfall ARI (Years)	100
1 in 1 Year Impervious Catchment(Ha)	1.36
Required Storage(1 in 1Yr 1 Hr)(m ³)	209
Available Storage(m ³)	700
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	1.51	0	3.2858	0.231	0.15	5.17
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	1.20	1.20	1.41	1.00	
Run-Off Co-efficient(C _y)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	1.21	0.00	0.00	0.00	0.15	1.36

0.26 Effective C

Data From A_r & R Volume 2

Location	Perth WA	Road Catchment Area: RR Width(m)	Length(m)	Area (Total)
Map 1	² I ₁	20.6	22	0
Map 2	² I ₁₂	4.5	20	0
Map 3	² I ₇₂	1.3	18	0
Map 4	⁵⁰ I ₁	35.5	16	0
Map 5	⁵⁰ I ₁₂	7	15	0
Map 6	⁵⁰ I ₇₂	2.1	14	0
Map 7	G	0.68	12.5	0
Map 8	F2	4.82	6	0
Map 9	F50	17		15,067

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	98.74	372	446	0.60	7.07	8.480934657	438	17.5	0	0
30	0.50	75.22	283	510	0.60	7.07	12.72140199	497	20.0	0	0
45	0.75	56.30	212	572	0.60	7.07	19.08210298	553	22.5	0	0
60	1.00	45.44	171	616	0.60	7.07	25.44280397	590	24.2	0	0
120	2.00	31.59	119	856	0.60	7.07	50.88560794	805	33.7	105	15
240	4.00	19.11	72	1036	0.60	7.07	101.7712159	935	40.7	235	16
480	8.00	11.56	44	1254	0.60	7.07	203.5424318	1050	49.3	350	12
960	16.00	8.08	30	1752	0.60	7.07	407.0848635	1345	68.8	645	11
2880	48.00	3.65	14	2372	0.60	7.07	1221.254591	1151	93.2	451	3
4320	72.00	2.62	10	2561	0.60	7.07	1831.881886	729	100.7	29	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m)	Breadth(m)
6	45
19	12
RL(Base)	

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
19	0	540	2160	0	0	0	Static Water Level
19.32	0.32	774	2613	209	209	0	1 in 1 year 1 Hour
19.42	0.42	853	2760	291	322	81	1 in 1 year
19.7	0.7	1089	3188	562	562	353	5 Year Storage
19.82	0.82	1198	3379	699	699	490	10 Year Storage
20.3	1.3	1673	4182	1385	1385	1176	100 Year Storage
20.5	1.5	1890	4536	1742	1742	1532	

685 Flow to Basin 1

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 3 - Basin 3

Data to be Input

Rainfall ARI (Years)	1
1 in 1 Year Impervious Catchment(Ha)	2.64
Required Storage(1 in 1Yr 1 Hr)(m ³)	407
Available Storage(m ³)	444
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	3.11	0	8.1178	0.8939	0.15	12.28
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	0.80	0.80	0.62	1.00	
Run-Off Co-efficient(Cy)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	2.49	0.00	0.00	0.00	0.15	2.64

0.22 Effective C

Data From A,R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	2 ₁₁	20.6	22	0
Map 2	2 ₁₂	4.5	20	155
Map 3	2 ₁₇₂	1.3	18	0
Map 4	50 ₁₁	35.5	16	730
Map 5	50 ₁₂	7	15	0
Map 6	50 ₁₇₂	2.1	14	0
Map 7	G	0.68	12.5	0
Map 8	F2	4.82	6	65
Map 9	F50	17		
				31,144

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	29.76	218	262	0.60	22.44	26.9309296	235	3.2	0	0
30	0.50	23.61	173	312	0.60	22.44	40.39639439	271	3.9	0	0
45	0.75	18.45	135	366	0.60	22.44	60.59459159	305	4.5	0	0
60	1.00	15.38	113	406	0.60	22.44	80.79278879	325	5.0	0	0
120	2.00	10.76	79	568	0.60	22.44	161.5855776	407	7.0	0	0
240	4.00	6.92	51	731	0.60	22.44	323.1711552	408	9.1	0	0
480	8.00	4.45	33	941	0.60	22.44	646.3423103	295	11.6	0	0
960	16.00	2.79	20	1179	0.60	22.44	1292.684621	-113	14.6	0	0
2880	48.00	1.34	10	1695	0.60	22.44	3878.053862	-2183	21.0	0	0
4320	72.00	0.99	7	1875	0.60	22.44	5817.080793	-3942	23.2	0	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m)	Breadth(m)
2	75
20.5	23
RL(Base)	

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
20.5	0	1725	6900	0	0	0	Static Water Level
20.73	0.23	1816	7081	407	407	0	1 in 1 year 1 Hour
20.75	0.25	1824	7097	444	322	36	1 in 1 year
20.96	0.46	1909	7264	835	835	428	5 Year Storage
21.03	0.53	1937	7320	970	970	563	10 Year Storage
21.59	1.09	2171	7774	2120	2120	1713	100 Year Storage
22	1.5	2349	8112	3047	3047	2639	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 3 - Basin 3

Data to be Input

Rainfall ARI (Years)	5
1 in 1 Year Impervious Catchment(Ha)	2.64
Required Storage(1 in 1Yr 1 Hr)(m ³)	407
Available Storage(m ³)	835
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	3.11	0	8.1178	0.8939	0.15	12.28
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	0.95	0.95	0.91	1.00	
Run-Off Co-efficient(C _y)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	2.49	0.00	0.00	0.00	0.15	2.64

0.22 Effective C

Data From A_r & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	2 ₁₁	20.6	22	0
Map 2	2 ₁₂	4.5	20	155
Map 3	2 ₁₂	1.3	18	0
Map 4	50 ₁₁	35.5	16	730
Map 5	50 ₁₂	7	15	0
Map 6	50 ₁₂	2.1	14	0
Map 7	G	0.68	12.5	0
Map 8	F2	4.82	6	65
Map 9	F50	17		
				31,144

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	50.06	367	441	0.60	22.44	26.9309296	414	5.5	0	0
30	0.50	39.10	287	516	0.60	22.44	40.39639439	476	6.4	0	0
45	0.75	30.05	220	595	0.60	22.44	60.59459159	535	7.4	0	0
60	1.00	24.74	181	653	0.60	22.44	80.79278879	573	8.1	0	0
120	2.00	17.26	127	912	0.60	22.44	161.5855776	750	11.3	0	0
240	4.00	10.84	80	1146	0.60	22.44	323.1711552	822	14.2	0	0
480	8.00	6.81	50	1439	0.60	22.44	646.3423103	793	17.8	0	0
960	16.00	4.45	33	1882	0.60	22.44	1292.684621	589	23.3	0	0
2880	48.00	2.08	15	2643	0.60	22.44	3878.053862	-1236	32.7	0	0
4320	72.00	1.52	11	2896	0.60	22.44	5817.080793	-2921	35.8	0	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m)	Breadth(m)
2	75
20.5	23
RL(Base)	

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
20.5	0	1725	6900	0	0	0	Static Water Level
20.73	0.23	1816	7081	407	407	0	1 in 1 year 1 Hour
20.75	0.25	1824	7097	444	322	36	1 in 1 year
20.96	0.46	1909	7264	835	835	428	5 Year Storage
21.03	0.53	1937	7320	970	970	563	10 Year Storage
21.59	1.09	2171	7774	2120	2120	1713	100 Year Storage
22	1.5	2349	8112	3047	3047	2639	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 3 - Basin 3

Data to be Input

Rainfall ARI (Years)	100
1 in 1 Year Impervious Catchment(Ha)	2.64
Required Storage(1 in 1Yr 1 Hr)(m ³)	407
Available Storage(m ³)	2130
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	3.11	0	8.1178	0.8939	0.15	12.28
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	1.20	1.20	1.41	1.00	
Run-Off Co-efficient(Cy)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	2.49	0.00	0.00	0.00	0.15	2.64

0.22 Effective C

Data From A₁R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	2 ₁₁	20.6	22	0
Map 2	2 ₁₁₂	4.5	20	155
Map 3	2 ₁₇₂	1.3	18	0
Map 4	50 ₁₁	35.5	16	730
Map 5	50 ₁₁₂	7	15	0
Map 6	50 ₁₇₂	2.1	14	0
Map 7	G	0.68	12.5	0
Map 8	F2	4.82	6	65
Map 9	F50	17		
				31,144

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	98.74	724	869	0.60	22.44	26.9309296	842	10.8	0	0
30	0.50	75.22	552	993	0.60	22.44	40.39639439	953	12.3	0	0
45	0.75	56.30	413	1115	0.60	22.44	60.59459159	1055	13.8	0	0
60	1.00	45.44	333	1200	0.60	22.44	80.79278879	1119	14.9	0	0
120	2.00	31.59	232	1669	0.60	22.44	161.5855776	1507	20.7	0	0
240	4.00	19.11	140	2020	0.60	22.44	323.1711552	1696	25.0	0	0
480	8.00	11.56	85	2443	0.60	22.44	646.3423103	1797	30.2	0	0
960	16.00	8.08	59	3414	0.60	22.44	1292.684621	2121	42.3	0	0
2880	48.00	3.65	27	4623	0.60	22.44	3878.053862	745	57.2	0	0
4320	72.00	2.62	19	4991	0.60	22.44	5817.080793	-826	61.8	0	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m)	Breadth(m)
2	75
20.5	23
RL(Base)	

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
20.5	0	1725	6900	0	0	0	Static Water Level
20.73	0.23	1816	7081	407	407	0	1 in 1 year 1 Hour
20.75	0.25	1824	7097	444	322	36	1 in 1 year
20.96	0.46	1909	7264	835	835	428	5 Year Storage
21.03	0.53	1937	7320	970	970	563	10 Year Storage
21.59	1.09	2171	7774	2120	2120	1713	100 Year Storage
22	1.5	2349	8112	3047	3047	2639	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 4 - Basin 4

Data to be Input

Rainfall ARI (Years)	1
1 in 1 Year Impervious Catchment(Ha)	2.06
Required Storage(1 in 1Yr 1 Hr)(m ³)	318
Available Storage(m ³)	379
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	2.08	0	6.3173	0.0171	0.4	8.81
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	0.80	0.80	0.62	1.00	
Run-Off Co-efficient(C _y)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	1.66	0.00	0.00	0.00	0.40	2.06

0.23 Effective C

* Includes Primary School Site

Data From A, R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	² I ₁	20.6	0	-
Map 2	² I ₁₂	4.5	0	-
Map 3	² I ₇₂	1.3	0	-
Map 4	⁵⁰ I ₁	35.5	0	-
Map 5	⁵⁰ I ₁₂	7	0	-
Map 6	⁵⁰ I ₇₂	2.1	0	-
Map 7	G	0.68	0	-
Map 8	F2	4.82	0	-
Map 9	F50	17		20,778

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	29.76	170	205	0.60	13.20	15.84413466	189	4.3	0	0
30	0.50	23.61	135	243	0.60	13.20	23.76620199	220	5.1	0	0
45	0.75	18.45	106	285	0.60	13.20	35.64930298	250	6.0	0	0
60	1.00	15.38	88	317	0.60	13.20	47.53240397	270	6.7	0	0
120	2.00	10.76	62	444	0.60	13.20	95.06480794	349	9.3	0	0
240	4.00	6.92	40	571	0.60	13.20	190.1296159	381	12.0	2	0
480	8.00	4.45	26	735	0.60	13.20	380.2592318	355	15.5	0	0
960	16.00	2.79	16	921	0.60	13.20	760.5184635	160	19.4	0	0
2880	48.00	1.34	8	1323	0.60	13.20	2281.555391	-958	27.8	0	0
4320	72.00	0.99	6	1464	0.60	13.20	3422.333086	-1958	30.8	0	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m) Breadth(m)

RL(Base) 22

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
22	0	1012	4048	0	0	0	Static Water Level
22.28	0.28	1248	4510	316	316	0	1 in 1 year 1 Hour
22.33	0.33	1293	4594	379	379	64	1 in 1 year
22.59	0.59	1536	5047	747	747	431	5 Year Storage
22.69	0.69	1635	5226	905	905	590	10 Year Storage
23.22	1.22	2207	6224	1920	1920	1604	100 Year Storage
23.3	1.3	2301	6382	2100	2100	1785	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 4 - Basin 4

Data to be Input

Rainfall ARI (Years)	5
1 in 1 Year Impervious Catchment(Ha)	2.06
Required Storage(1 in 1Yr 1 Hr)(m ³)	318
Available Storage(m ³)	747
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	2.08	0	6.3173	0.0171	0.4	8.81
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	0.95	0.95	0.91	1.00	
Run-Off Co-efficient(C _y)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	1.66	0.00	0.00	0.00	0.40	2.06

0.23 Effective C

* Includes Primary School Site

Data From A, R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	² I ₁	20.6	0	-
Map 2	² I ₁₂	4.5	0	-
Map 3	² I ₇₂	1.3	0	-
Map 4	⁵⁰ I ₁	35.5	0	-
Map 5	⁵⁰ I ₁₂	7	0	-
Map 6	⁵⁰ I ₇₂	2.1	0	-
Map 7	G	0.68	0	-
Map 8	F2	4.82	0	-
Map 9	F50	17		20,778

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	50.06	287	344	0.60	13.20	15.84413466	328	7.2	0	0
30	0.50	39.10	224	403	0.60	13.20	23.76620199	379	8.5	0	0
45	0.75	30.05	172	465	0.60	13.20	35.64930298	429	9.8	0	0
60	1.00	24.74	142	510	0.60	13.20	47.53240397	463	10.7	0	0
120	2.00	17.26	99	712	0.60	13.20	95.06480794	617	15.0	0	0
240	4.00	10.84	62	894	0.60	13.20	190.1296159	704	18.8	0	0
480	8.00	6.81	39	1124	0.60	13.20	380.2592318	743	23.6	0	0
960	16.00	4.45	26	1469	0.60	13.20	760.5184635	708	30.9	0	0
2880	48.00	2.08	12	2063	0.60	13.20	2281.555391	-219	43.4	0	0
4320	72.00	1.52	9	2261	0.60	13.20	3422.333086	-1162	47.6	0	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m) Breadth(m)
6 23 44

RL(Base) 22

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
22	0	1012	4048	0	0	0	Static Water Level
22.28	0.28	1248	4510	316	316	0	1 in 1 year 1 Hour
22.33	0.33	1293	4594	379	379	64	1 in 1 year
22.59	0.59	1536	5047	747	747	431	5 Year Storage
22.69	0.69	1635	5226	905	905	590	10 Year Storage
23.22	1.22	2207	6224	1920	1920	1604	100 Year Storage
23.3	1.3	2301	6382	2100	2100	1785	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 4 - Basin 4

Data to be Input

Rainfall ARI (Years)	100
1 in 1 Year Impervious Catchment(Ha)	2.06
Required Storage(1 in 1Yr 1 Hr)(m ³)	318
Available Storage(m ³)	1906
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	2.08	0	6.3173	0.0171	0.4	8.81
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	1.20	1.20	1.41	1.00	
Run-Off Co-efficient(C _y)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	1.66	0.00	0.00	0.00	0.40	2.06

0.23 Effective C

* Includes Primary School Site

Data From A, R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	² I ₁	20.6	0	-
Map 2	² I ₁₂	4.5	0	-
Map 3	² I ₇₂	1.3	0	-
Map 4	⁵⁰ I ₁	35.5	0	-
Map 5	⁵⁰ I ₁₂	7	0	-
Map 6	⁵⁰ I ₇₂	2.1	0	-
Map 7	G	0.68	0	-
Map 8	F2	4.82	0	-
Map 9	F50	17		20,778

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	98.74	566	679	0.60	13.20	15.84413466	663	14.3	0	0
30	0.50	75.22	431	776	0.60	13.20	23.76620199	752	16.3	0	0
45	0.75	56.30	322	871	0.60	13.20	35.64930298	835	18.3	0	0
60	1.00	45.44	260	937	0.60	13.20	47.53240397	889	19.7	0	0
120	2.00	31.59	181	1303	0.60	13.20	95.06480794	1208	27.4	0	0
240	4.00	19.11	109	1577	0.60	13.20	190.1296159	1387	33.2	0	0
480	8.00	11.56	66	1907	0.60	13.20	380.2592318	1527	40.1	0	0
960	16.00	8.08	46	2665	0.60	13.20	760.5184635	1905	56.1	0	0
2880	48.00	3.65	21	3610	0.60	13.20	2281.555391	1328	75.9	0	0
4320	72.00	2.62	15	3897	0.60	13.20	3422.333086	474	82.0	0	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m) Breadth(m)

RL(Base) 22

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
22	0	1012	4048	0	0	0	Static Water Level
22.28	0.28	1248	4510	316	316	0	1 in 1 year 1 Hour
22.33	0.33	1293	4594	379	379	64	1 in 1 year
22.59	0.59	1536	5047	747	747	431	5 Year Storage
22.69	0.69	1635	5226	905	905	590	10 Year Storage
23.22	1.22	2207	6224	1920	1920	1604	100 Year Storage
23.3	1.3	2301	6382	2100	2100	1785	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 5 - Basin 5

Data to be Input

Rainfall ARI (Years)	1
1 in 1 Year Impervious Catchment(Ha)	8.51
Required Storage(1 in 1Yr 1 Hr)(m ³)	1310
Available Storage(m ³)	1612
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	10.01	0	22.7127	3.2036	0.5	36.42
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	0.80	0.80	0.62	1.00	
Run-Off Co-efficient(C _y)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	8.01	0.00	0.00	0.00	0.50	8.51

0.23 Effective C

* Includes Primary School Site

Data From A, R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	² I ₁	20.6	0	-
Map 2	² I ₁₂	4.5	0	-
Map 3	² I ₇₂	1.3	0	-
Map 4	⁵⁰ I ₁	35.5	0	-
Map 5	⁵⁰ I ₁₂	7	0	-
Map 6	⁵⁰ I ₇₂	2.1	0	-
Map 7	G	0.68	0	-
Map 8	F2	4.82	0	-
Map 9	F50	17		100,085

Road Catchment Area:

Net Storage

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	29.76	703	844	0.60	52.70	63.23693466	781	4.4	0	0
30	0.50	23.61	558	1004	0.60	52.70	94.85540199	909	5.3	0	0
45	0.75	18.45	436	1177	0.60	52.70	142.283103	1035	6.2	0	0
60	1.00	15.38	363	1308	0.60	52.70	189.710804	1119	6.9	0	0
120	2.00	10.76	254	1830	0.60	52.70	379.4216079	1450	9.6	0	0
240	4.00	6.92	164	2355	0.60	52.70	758.8432159	1597	12.4	0	0
480	8.00	4.45	105	3031	0.60	52.70	1517.686432	1513	16.0	0	0
960	16.00	2.79	66	3798	0.60	52.70	3035.372864	762	20.0	0	0
2880	48.00	1.34	32	5458	0.60	52.70	9106.118591	-3648	28.8	0	0
4320	72.00	0.99	23	6039	0.60	52.70	13659.17789	-7620	31.8	0	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m)	Breadth(m)
6	90
14.5	45

RL(Base) 14.5

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
14.5	0	4050	16200	0	0	0	Static Water Level
14.81	0.31	4566	17218	1335	1335	0	1 in 1 year 1 Hour
14.87	0.37	4669	17419	1612	1612	277	1 in 1 year
15.19	0.69	5236	18504	3196	3196	1861	5 Year Storage
15.31	0.81	5457	18919	3837	3837	2503	10 Year Storage
16	1.5	6804	21384	8060	8060	6725	100 Year Storage
16.5	2	7866	23256	11724	11724	10389	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 5 - Basin 5

Data to be Input

Rainfall ARI (Years)	5
1 in 1 Year Impervious Catchment(Ha)	8.51
Required Storage(1 in 1Yr 1 Hr)(m ³)	1310
Available Storage(m ³)	3196
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	10.01	0	22.7127	3.2036	0.5	36.42
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	0.95	0.95	0.91	1.00	
Run-Off Co-efficient(C _y)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	8.01	0.00	0.00	0.00	0.50	8.51

0.23 Effective C

* Includes Primary School Site

Data From A, R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	² I ₁	20.6	0	-
Map 2	² I ₁₂	4.5	0	-
Map 3	² I ₇₂	1.3	0	-
Map 4	⁵⁰ I ₁	35.5	0	-
Map 5	⁵⁰ I ₁₂	7	0	-
Map 6	⁵⁰ I ₇₂	2.1	0	-
Map 7	G	0.68	0	-
Map 8	F2	4.82	0	-
Map 9	F50	17		100,085

Road Catchment Area:

Net Storage

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	50.06	1183	1420	0.60	52.70	63.23693466	1356	7.5	0	0
30	0.50	39.10	924	1663	0.60	52.70	94.85540199	1568	8.8	0	0
45	0.75	30.05	710	1917	0.60	52.70	142.283103	1775	10.1	0	0
60	1.00	24.74	584	2104	0.60	52.70	189.710804	1914	11.1	0	0
120	2.00	17.26	408	2936	0.60	52.70	379.4216079	2556	15.5	0	0
240	4.00	10.84	256	3690	0.60	52.70	758.8432159	2931	19.4	0	0
480	8.00	6.81	161	4635	0.60	52.70	1517.686432	3117	24.4	0	0
960	16.00	4.45	105	6059	0.60	52.70	3035.372864	3024	31.9	0	0
2880	48.00	2.08	49	8510	0.60	52.70	9106.118591	-596	44.9	0	0
4320	72.00	1.52	36	9326	0.60	52.70	13659.17789	-4333	49.2	0	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m)	Breadth(m)
6	90
14.5	45

RL(Base) 14.5

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
14.5	0	4050	16200	0	0	0	Static Water Level
14.81	0.31	4566	17218	1335	1335	0	1 in 1 year 1 Hour
14.87	0.37	4669	17419	1612	1612	277	1 in 1 year
15.19	0.69	5236	18504	3196	3196	1861	5 Year Storage
15.31	0.81	5457	18919	3837	3837	2503	10 Year Storage
16	1.5	6804	21384	8060	8060	6725	100 Year Storage
16.5	2	7866	23256	11724	11724	10389	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road
Baldivis



Location: Catchment 5 - Basin 5

Data to be Input

Rainfall ARI (Years)	100
1 in 1 Year Impervious Catchment(Ha)	8.51
Required Storage(1 in 1Yr 1 Hr)(m ³)	1310
Available Storage(m ³)	8060
Soakage Outflow(l/s/m ²)	0.013
Allowable Outflow (l/s) (10 year)	-

Catchment Details	Roads	Lots (Connected)	Lots (Unconnected)	POS*	Basin Area	Total
Gross Catchment Area	10.01	0	22.7127	3.2036	0.5	36.42
Run-Off Co-efficient(C ₁₀)	0.80		0.00	0	1.00	
ARI Multiplier	1.00	1.20	1.20	1.41	1.00	
Run-Off Co-efficient(C _y)	0.80	0.00	0.00	0.00	1.00	
Impervious Area(Ha)	8.01	0.00	0.00	0.00	0.50	8.51

0.23 Effective C

* Includes Primary School Site

Data From A, R & R Volume 2

Location	Perth WA	RR Width(m)	Length(m)	Area (Total)
Map 1	² I ₁	20.6	0	-
Map 2	² I ₁₂	4.5	0	-
Map 3	² I ₇₂	1.3	0	-
Map 4	⁵⁰ I ₁	35.5	0	-
Map 5	⁵⁰ I ₁₂	7	0	-
Map 6	⁵⁰ I ₇₂	2.1	0	-
Map 7	G	0.68	0	-
Map 8	F2	4.82	0	-
Map 9	F50	17	0	-
				100,085

Road Catchment Area:

Net Storage

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Preliminary Height(m)	Q out (Soakage)(l/s)	V out (Soakage)	Net Storage (After Soakage)	Time of Water in Basin(hrs)	V out (Req'd)	Q out(l/s)
20	0.33	98.74	2333	2800	0.60	52.70	63.23693466	2737	14.8	0	0
30	0.50	75.22	1777	3199	0.60	52.70	94.85540199	3104	16.9	0	0
45	0.75	56.30	1330	3592	0.60	52.70	142.283103	3449	18.9	0	0
60	1.00	45.44	1074	3865	0.60	52.70	189.710804	3676	20.4	0	0
120	2.00	31.59	746	5374	0.60	52.70	379.4216079	4995	28.3	0	0
240	4.00	19.11	452	6504	0.60	52.70	758.8432159	5745	34.3	0	0
480	8.00	11.56	273	7868	0.60	52.70	1517.686432	6351	41.5	0	0
960	16.00	8.08	191	10995	0.60	52.70	3035.372864	7959	58.0	0	0
2880	48.00	3.65	86	14890	0.60	52.70	9106.118591	5783	78.5	0	0
4320	72.00	2.62	62	16073	0.60	52.70	13659.17789	2414	84.7	0	0

Drainage Basin Dimensions:

Side Slopes 1: Length(m) Breadth(m)
6 90 45

RL(Base) 14.5

TWL(mAHD)	Height(m)	A(TWL)	Average Area	Vol(m ³)	Treatment Storage above LWL	Detention Storage above LWL	The Designated Height allows Storage for
14.5	0	4050	16200	0	0	0	Static Water Level
14.81	0.31	4566	17218	1335	1335	0	1 in 1 year 1 Hour
14.87	0.37	4669	17419	1612	1612	277	1 in 1 year
15.19	0.69	5236	18504	3196	3196	1861	5 Year Storage
15.31	0.81	5457	18919	3837	3837	2503	10 Year Storage
16	1.5	6804	21384	8060	8060	6725	100 Year Storage
16.5	2	7866	23256	11724	11724	10389	

Development Engineering Consultants - Drainage Basin Spreadsheet

Project: Lots 635, 739 and 740 Baldivis Road

Location: Soakwell Design



Data to be Input

Rainfall ARI (Years)	100		
Standard Lot Area	500	sqm	
Run-off Coefficient	0.45		
Impervious Area(Ha):	0.023	Storage Above Ground	
Area above Ground inundated to 0.05m Deep (between Front of House and verge)	45.00	0.05	2.25
Storage provided manholes and pipe	-		
Number of Soakwells	2.00		
Diameter of Soakwells	1.50		
Depth of Each Soakwell	1.20		
Storage required Soakwells	4.24		
Storage Provided	6.49		
Soakage Rate (l/s/m2)	0.02		

Data From A,R & R Volume 2

Location	Perth WA
Map 1 ² I ₁	20.6
Map 2 ² I ₁₂	4.5
Map 3 ² I ₇₂	1.3
Map 4 ⁵⁰ I ₁	35.5
Map 5 ⁵⁰ I ₁₂	7
Map 6 ⁵⁰ I ₇₂	2.1
Map 7 G	0.68
Map 8 F2	4.82
Map 9 F50	17

Tc(mins)	Tc(hrs)	I(mm/hr)	Q(l/s)	Total V in	Q out (Soakage)(l/s)	V out	Net Storage	Vout (Required)	Q out(l/s)	Effective Run-off C
40	0.667	61.34	3.83	9.200604072	1.16	2.787690212	6.41291386	-	0.00	0.00
50	0.833	52.08	3.26	9.76591451	1.16	3.484612765	6.281301745	-	0.00	0.00
60	1.000	45.44	2.84	10.22344662	1.16	4.181535318	6.041911303	-	0.00	0.00
70	1.167	46.33	2.90	12.1604876	1.16	4.878457871	7.282029728	0.79	0.19	0.03
120	2.000	31.59	1.97	14.21516802	1.16	8.363070637	5.852097388	-	0.00	0.00
240	4.000	19.11	1.19	17.20301635	1.16	16.72614127	0.476875075	-	0.00	0.00
480	8.000	11.56	0.72	20.81122435	1.16	33.45228255	-12.6410582	-	0.00	0.00
960	16.000	8.08	0.50	29.07997162	1.16	66.90456509	-37.82459347	-	0.00	0.00
1440	24.000	6.08	0.38	32.82690588	1.16	100.3568476	-67.52994176	-	0.00	0.00
2880	48.000	3.65	0.23	39.38207864	1.16	200.7136953	-161.3316166	-	0.00	0.00
4320	72.000	2.62	0.16	42.51284291	1.16	301.0705429	-258.5577	-	0.00	0.00

APPENDIX D – WATER QUALITY MONITORING
-RPS Reporting
-Location Map of Peripheral DoW Bores

RPS Environmental
 ARL Lab No: 24441-24450
 13 November 2009

Nutrients

Date Prepared 6/10/2009
 Date Analysed 09/10/2009, 12/10/2009, 15/10/2009, 16/10/2009

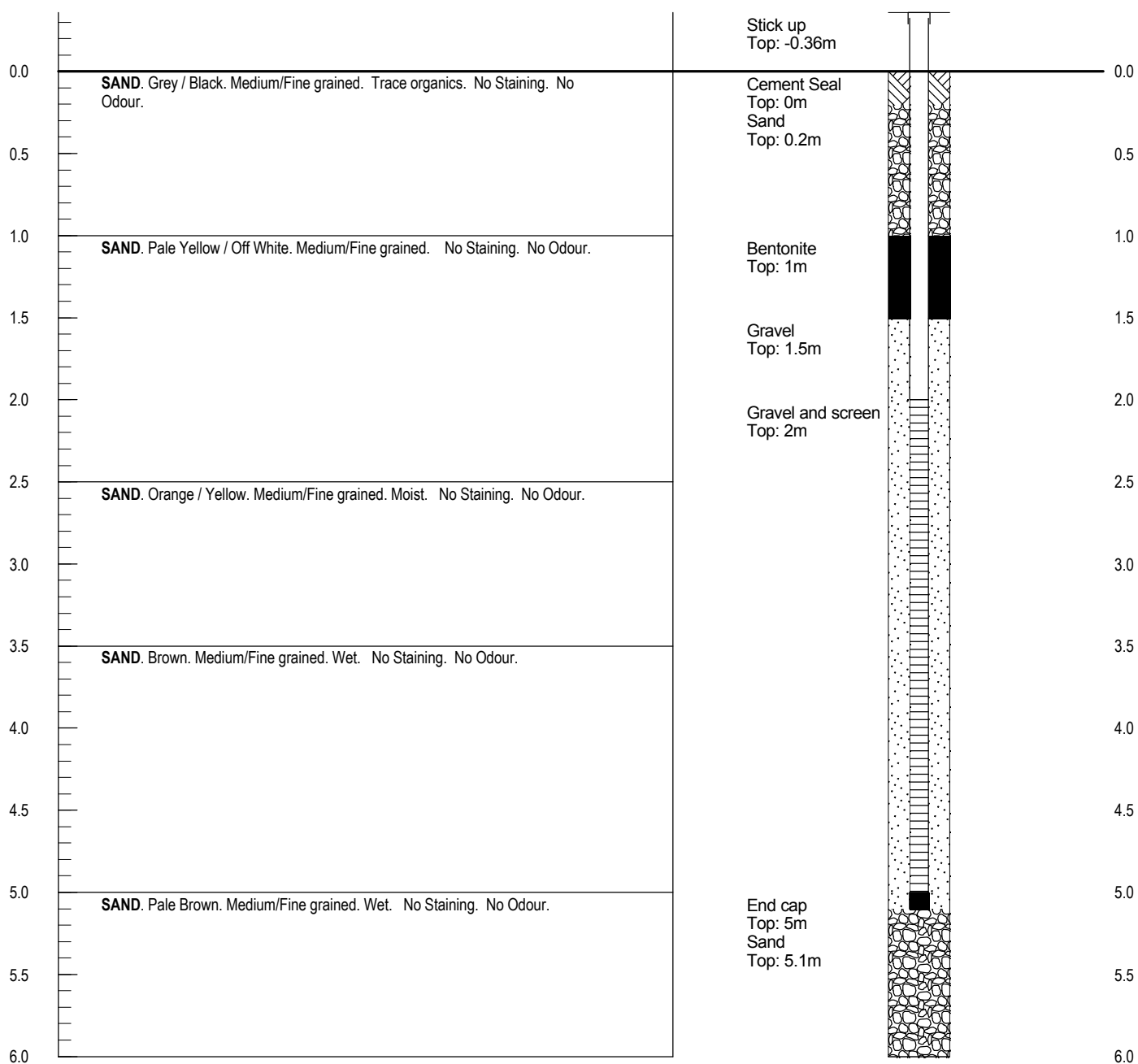
ARL Lab No	Method Detection Limit	24441	24442	24443	24444	24445	24446	24447	24448	24449
Sample Marks		BS-1	BS-2	BS-3	BS-4	BS-5	BS-6	BS-7	BS-R	BS-Z
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Ammonia-N	0.2	0.5	< 0.2	0.7	< 0.2	< 0.2	< 0.2	0.3	< 0.2	< 0.2
NOx-N	0.01	0.09	0.34	14	0.16	8.7	4.1	0.12	< 0.01	0.16
Total Kjeldahl Nitrogen	0.2	1.8	1.0	1.0	< 0.2	< 0.2	< 0.2	0.5	< 0.2	< 0.2
Total Nitrogen	0.2	1.9	1.3	15	0.3	8.7	4.1	0.6	< 0.2	0.4
Reactive Phosphorus	0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01	0.04	0.01	< 0.01	0.02
Total Phosphorus	0.01	0.20	0.08	0.12	0.21	0.10	0.19	0.11	< 0.01	0.25

BOREHOLE CONSTRUCTION LOG

PROJECT NUMBER: C09367			WEATHER:	
BOREHOLE NUMBER: BS-1			DRILLING METHOD: Sonic	
SITE:		LOCATION:		TOTAL DEPTH: 6 m
EAST:	389828	NORTH:	6419503	TOP of COLLAR RL: mAHD
DATE BEGUN:	1/09/2009	DATE COMPLETED:	1/09/2009	STATIC WATER LEVEL:
SCIENTIST: GH			CASE DIAMETER: 50 mm	PVC CLASS: 18
DRILLING COMPANY: Strataprobe			LOCKABLE BORE: Yes	
DRILLER: John			SHEET: 1 of 1	

LITHOLOGY DESCRIPTION

BORE INSTALLATION

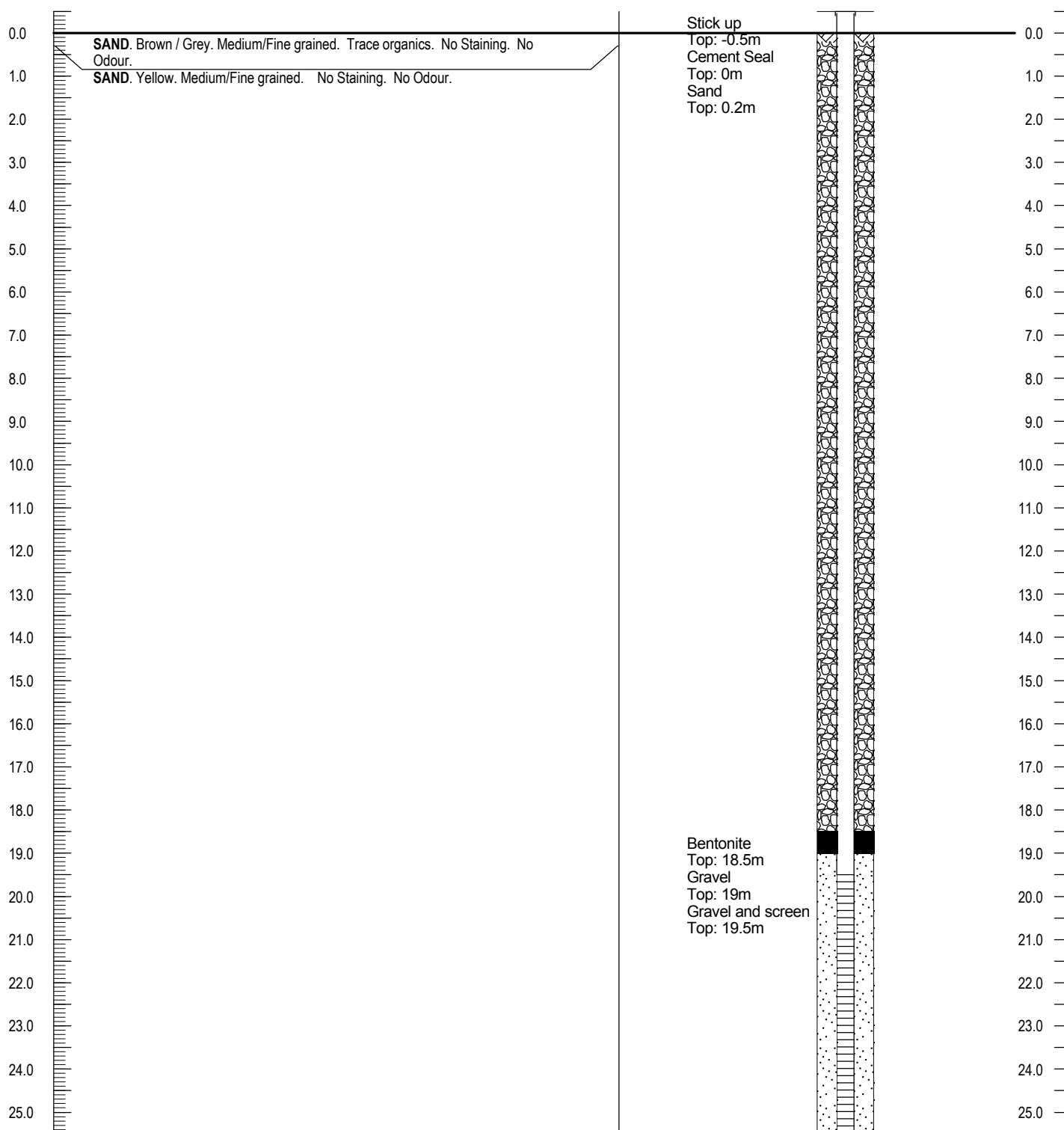


BOREHOLE CONSTRUCTION LOG

PROJECT NUMBER: C09367			WEATHER:	
BOREHOLE NUMBER: BS-2			DRILLING METHOD: Sonic/ solid stem auger	
SITE:		LOCATION:		TOTAL DEPTH: 25.5 m
EAST:	389471	NORTH:	6419583	TOP of COLLAR RL: mAHD
DATE BEGUN:	2/09/2009	DATE COMPLETED:	10/09/2009	STATIC WATER LEVEL:
SCIENTIST: GH			CASE DIAMETER: 50 mm	PVC CLASS: 18
DRILLING COMPANY: Strataprobe			LOCKABLE BORE: Yes	
DRILLER: John			SHEET: 1 of 1	

LITHOLOGY DESCRIPTION

BORE INSTALLATION

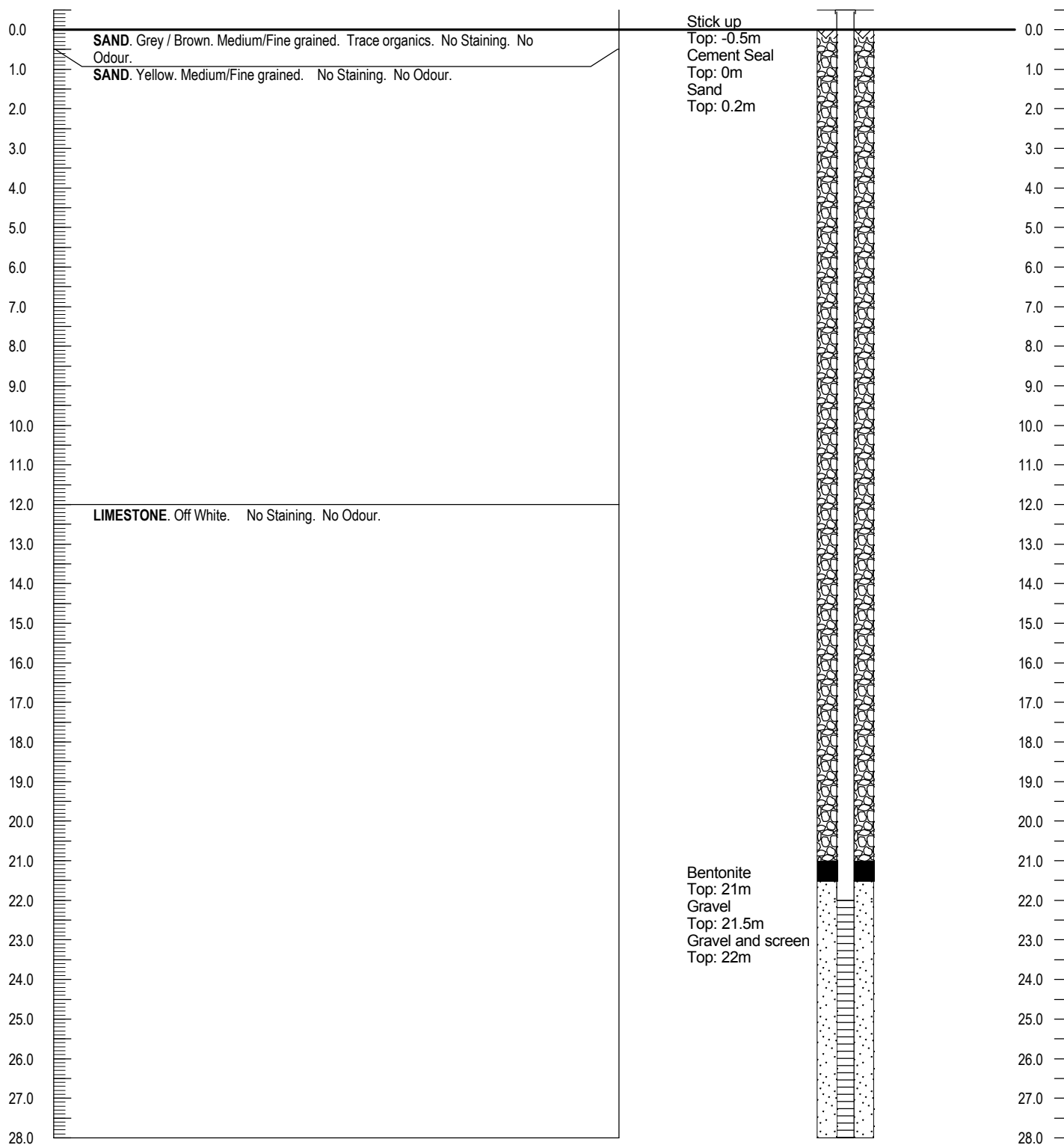


BOREHOLE CONSTRUCTION LOG

PROJECT NUMBER: C09367			WEATHER:	
BOREHOLE NUMBER: BS-3			DRILLING METHOD: Rotary air blast/ Solid stem auger	
SITE:		LOCATION:		TOTAL DEPTH: 28 m
EAST:	389483	NORTH:	6419730	TOP of COLLAR RL: mAHD
DATE BEGUN:	2/09/2009	DATE COMPLETED:	10/09/2009	STATIC WATER LEVEL:
SCIENTIST: GH			CASE DIAMETER: 50 mm	PVC CLASS: 18
DRILLING COMPANY: Strataprobe			LOCKABLE BORE: Yes	
DRILLER: John			SHEET: 1 of 1	

LITHOLOGY DESCRIPTION

BORE INSTALLATION

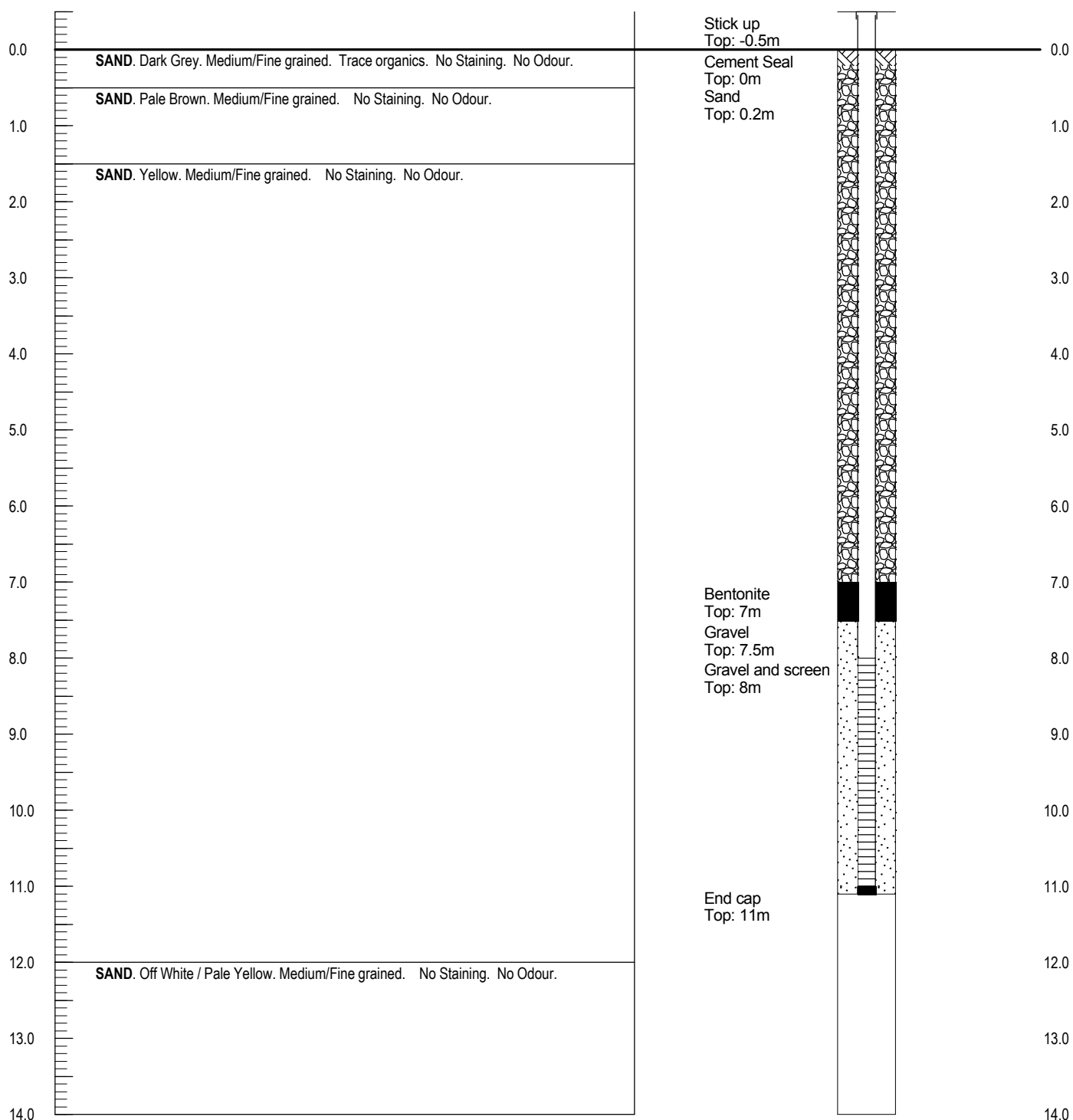


BOREHOLE CONSTRUCTION LOG

PROJECT NUMBER: C09367			WEATHER:	
BOREHOLE NUMBER: BS-4			DRILLING METHOD: Solid Stemmed Auger/ Sonic	
SITE:		LOCATION:		TOTAL DEPTH: 14 m
EAST:	389803	NORTH:	6420140	TOP of COLLAR RL: mAHD
DATE BEGUN:	3/09/2009	DATE COMPLETED:	3/09/2009	STATIC WATER LEVEL:
SCIENTIST: GH			CASE DIAMETER: 50 mm	PVC CLASS: 18
DRILLING COMPANY: Strataprobe			LOCKABLE BORE: Yes	
DRILLER: John			SHEET: 1 of 1	

LITHOLOGY DESCRIPTION

BORE INSTALLATION

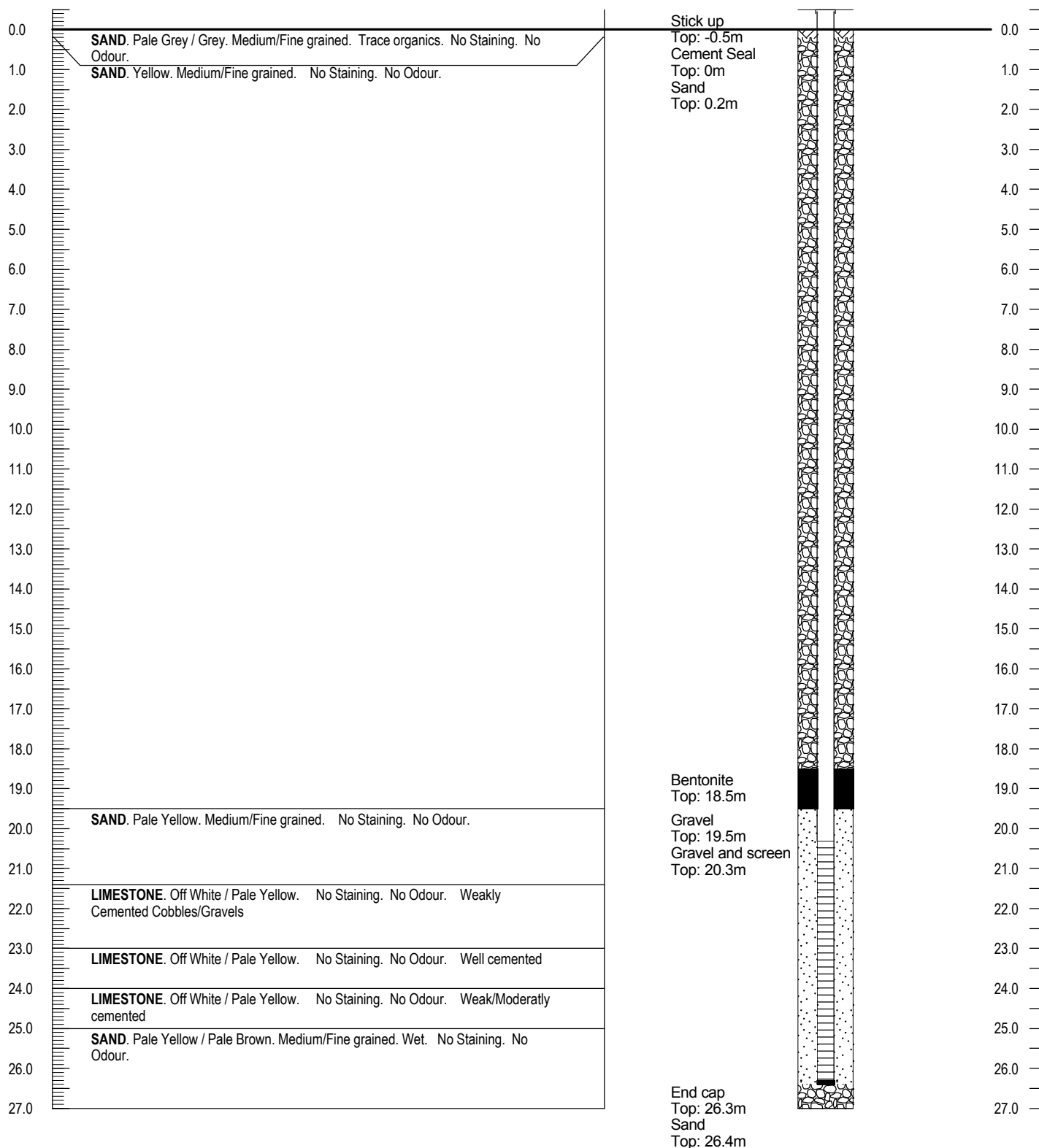


BOREHOLE CONSTRUCTION LOG

PROJECT NUMBER: C09367			WEATHER:	
BOREHOLE NUMBER: BS-5			DRILLING METHOD: Air Core	
SITE:		LOCATION:		TOTAL DEPTH: 27 m
EAST:	389529	NORTH:	6419875	TOP of COLLAR RL: mAHD
DATE BEGUN:	4/09/2009	DATE COMPLETED:	4/09/2009	STATIC WATER LEVEL:
SCIENTIST: GH			CASE DIAMETER: 50 mm	PVC CLASS: 18
DRILLING COMPANY: Proline			LOCKABLE BORE: Yes	
DRILLER: Stuart			SHEET: 1 of 1	

LITHOLOGY DESCRIPTION

BORE INSTALLATION

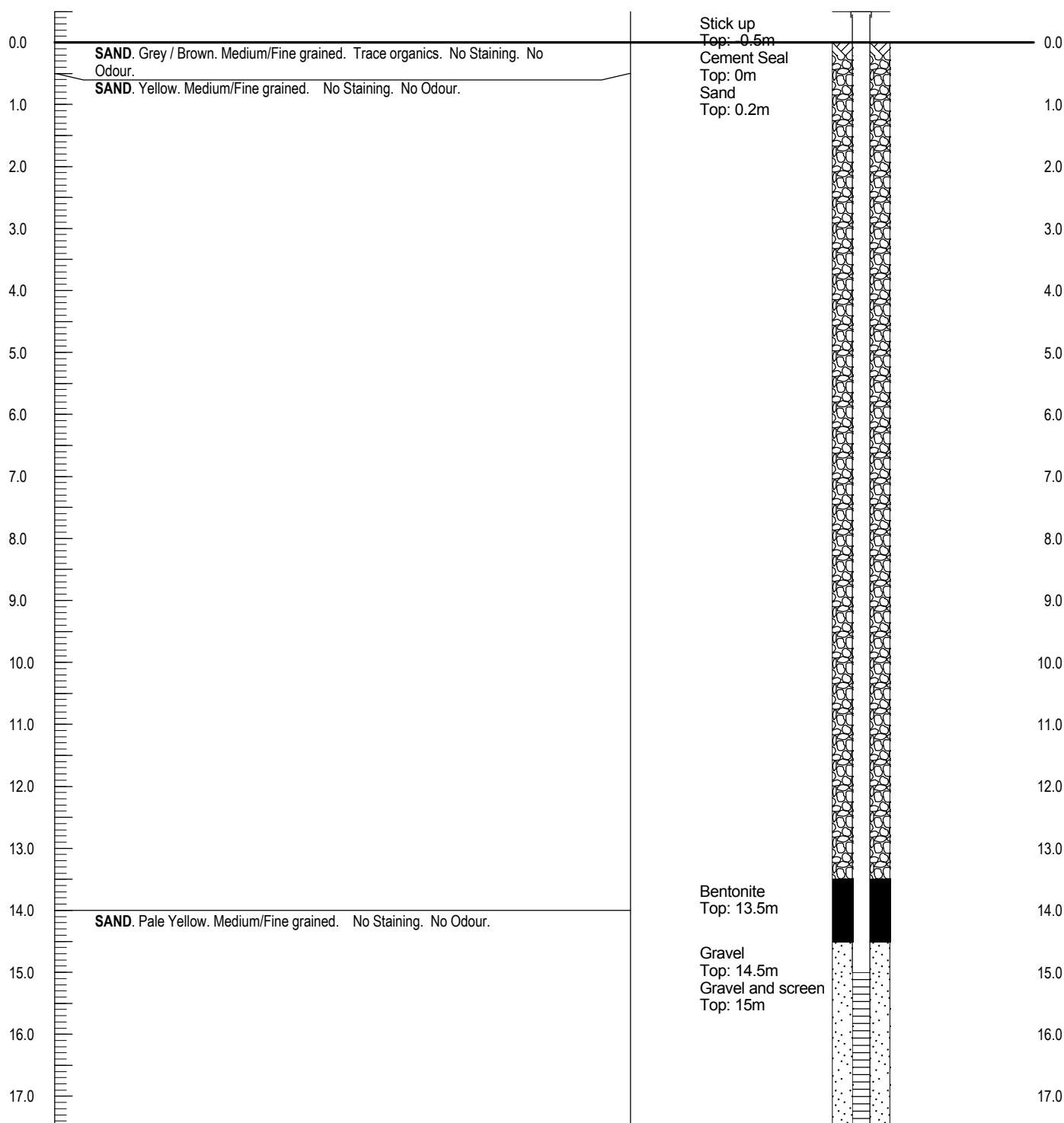


BOREHOLE CONSTRUCTION LOG

PROJECT NUMBER: C09367			WEATHER:	
BOREHOLE NUMBER: BS-6			DRILLING METHOD: Sonic	
SITE:		LOCATION:		TOTAL DEPTH: 17.5 m
EAST:	388642	NORTH:	6420139	TOP of COLLAR RL: mAHD
DATE BEGUN:	18/09/2009	DATE COMPLETED:	18/09/2009	STATIC WATER LEVEL:
SCIENTIST: GH			CASE DIAMETER: 50 mm	PVC CLASS: 18
DRILLING COMPANY: Strataprobe			LOCKABLE BORE: Yes	
DRILLER: John			SHEET: 1 of 1	

LITHOLOGY DESCRIPTION

BORE INSTALLATION

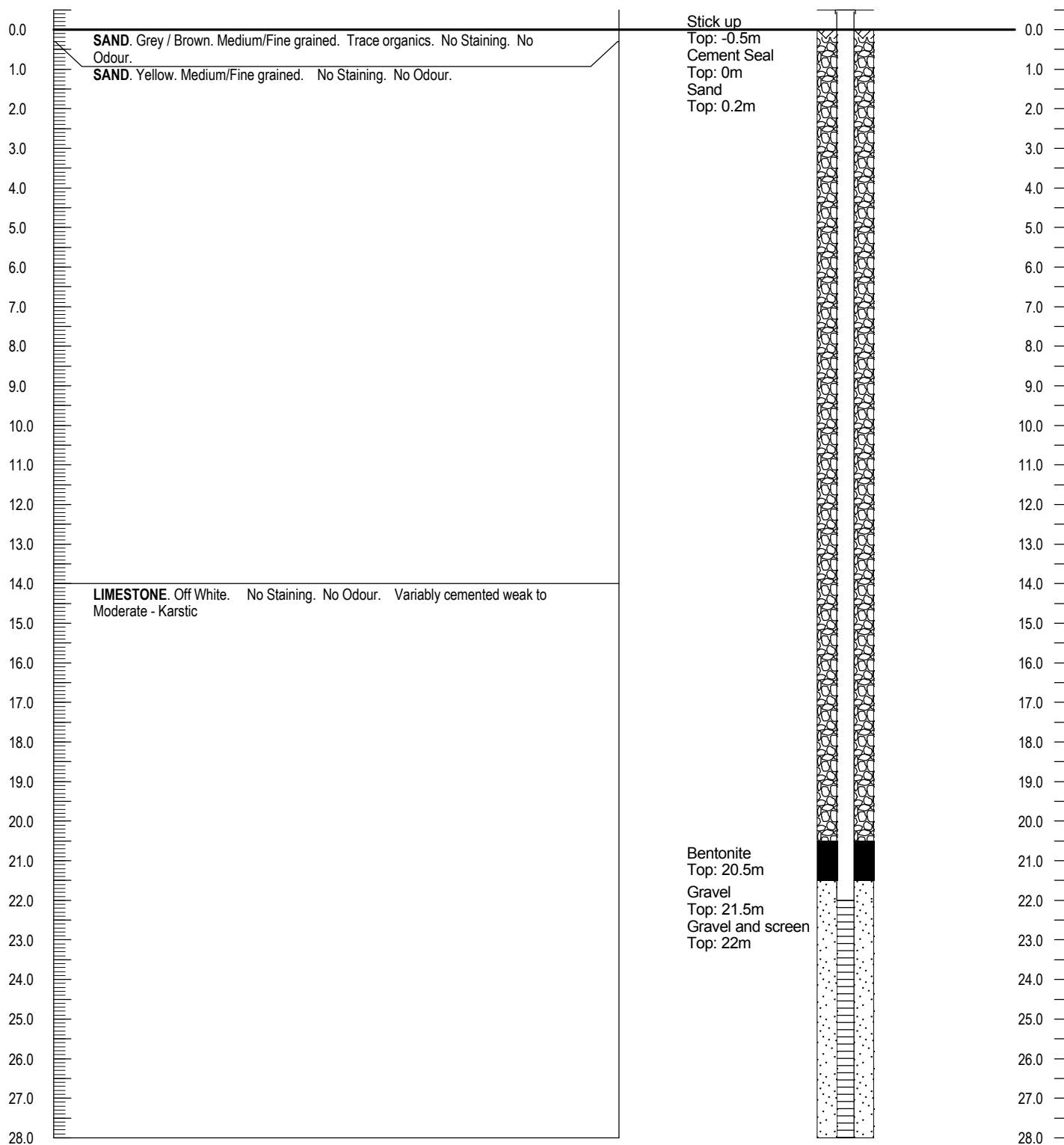


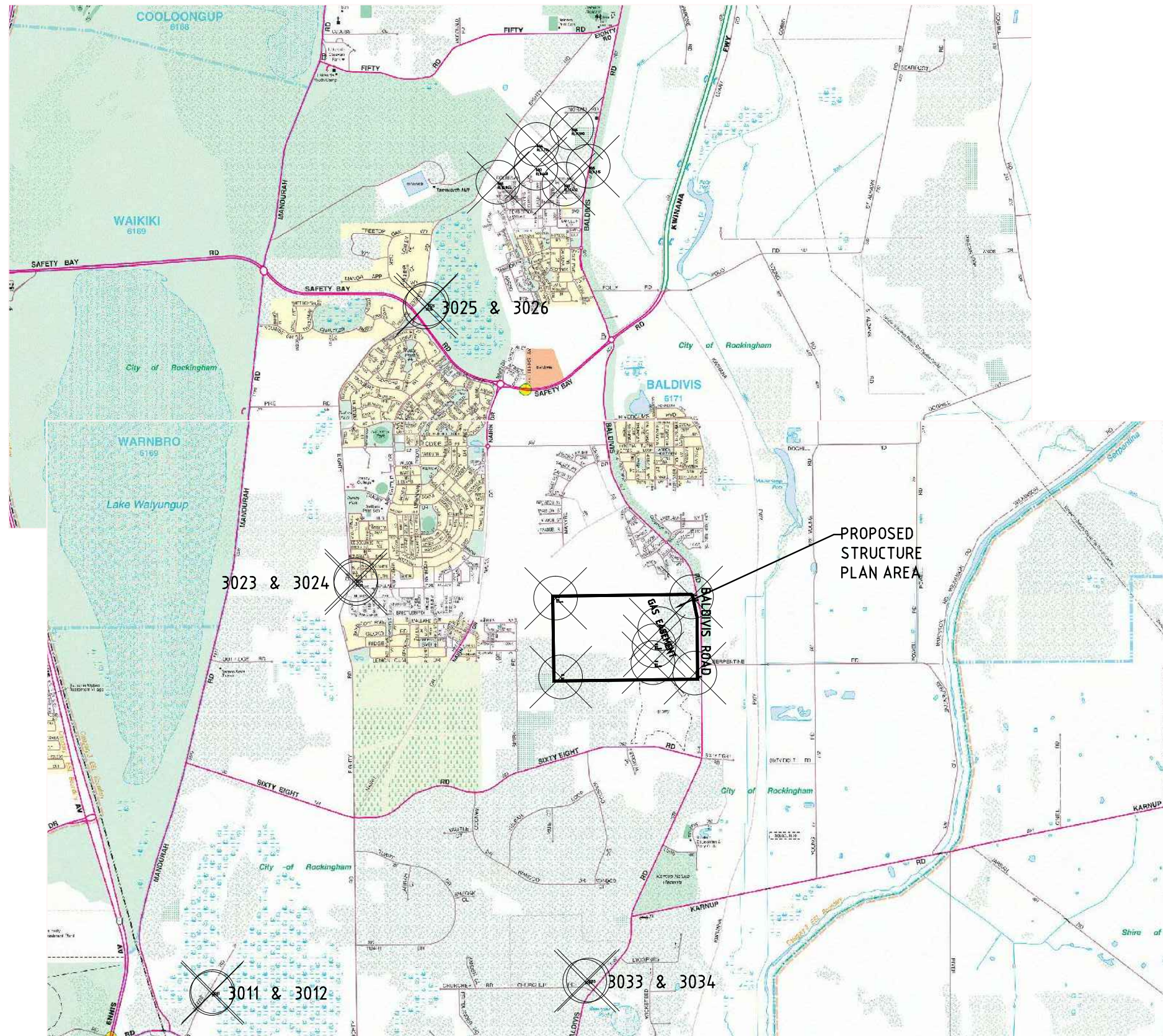
BOREHOLE CONSTRUCTION LOG

PROJECT NUMBER: C09367			WEATHER:	
BOREHOLE NUMBER: BS-7			DRILLING METHOD: Mud Rotary	
SITE:		LOCATION:		TOTAL DEPTH: 28 m
EAST:	388681	NORTH:	6419468	TOP of COLLAR RL: mAHD
DATE BEGUN:	11/09/2009	DATE COMPLETED:	11/09/2009	STATIC WATER LEVEL:
SCIENTIST: GH			CASE DIAMETER: 50 mm	PVC CLASS: 18
DRILLING COMPANY: Strataprobe			LOCKABLE BORE: Yes	
DRILLER: John			SHEET: 1 of 1	

LITHOLOGY DESCRIPTION


BORE INSTALLATION





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No.	DATE	BY	REVISION
A	2/12/09	JEG	INITIAL ISSUE

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Fax: (08) 9481 1700

PROJECT:	LOTS 635, 739 & 740 BALDIVIS ROAD BALDIVIS
W.A.P.C. No.	-

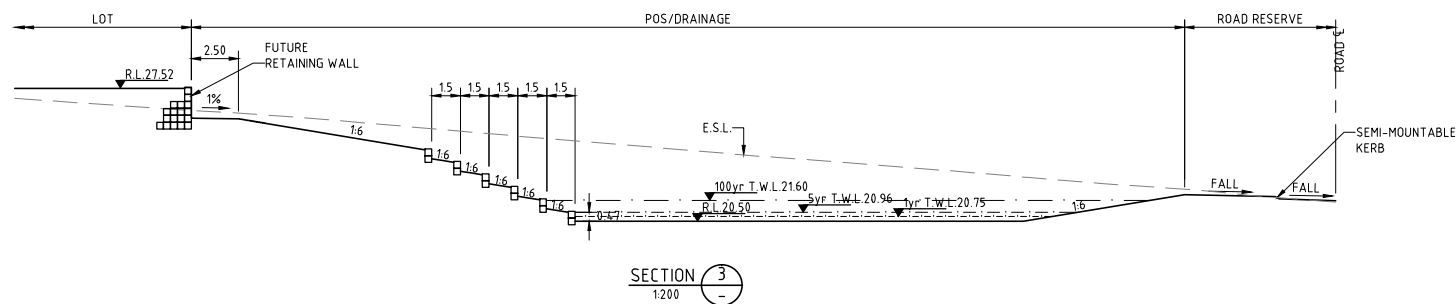
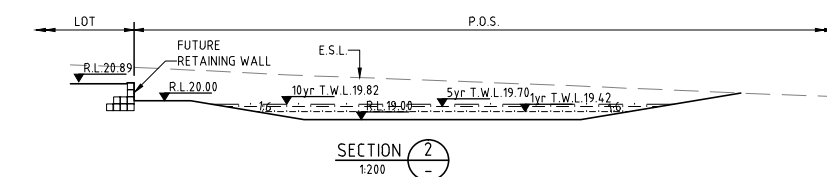
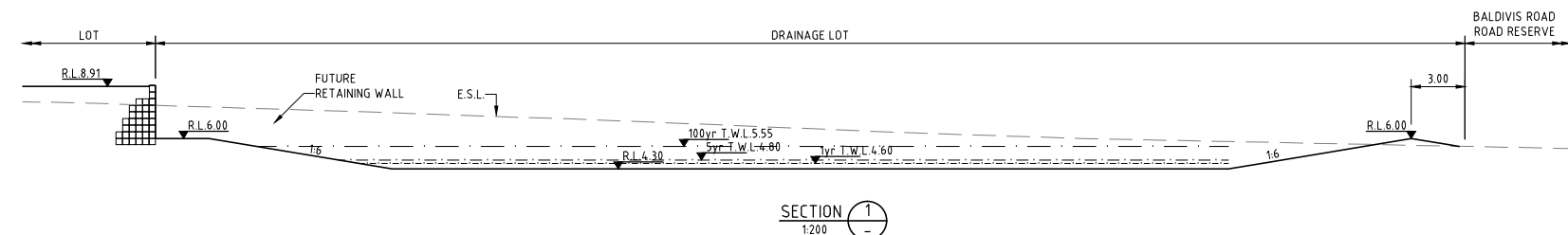
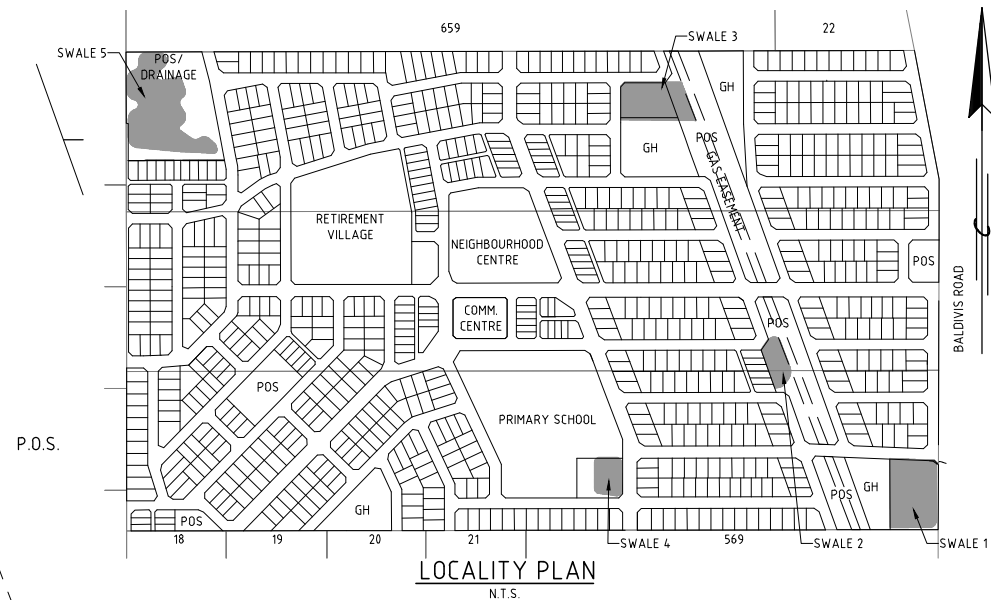
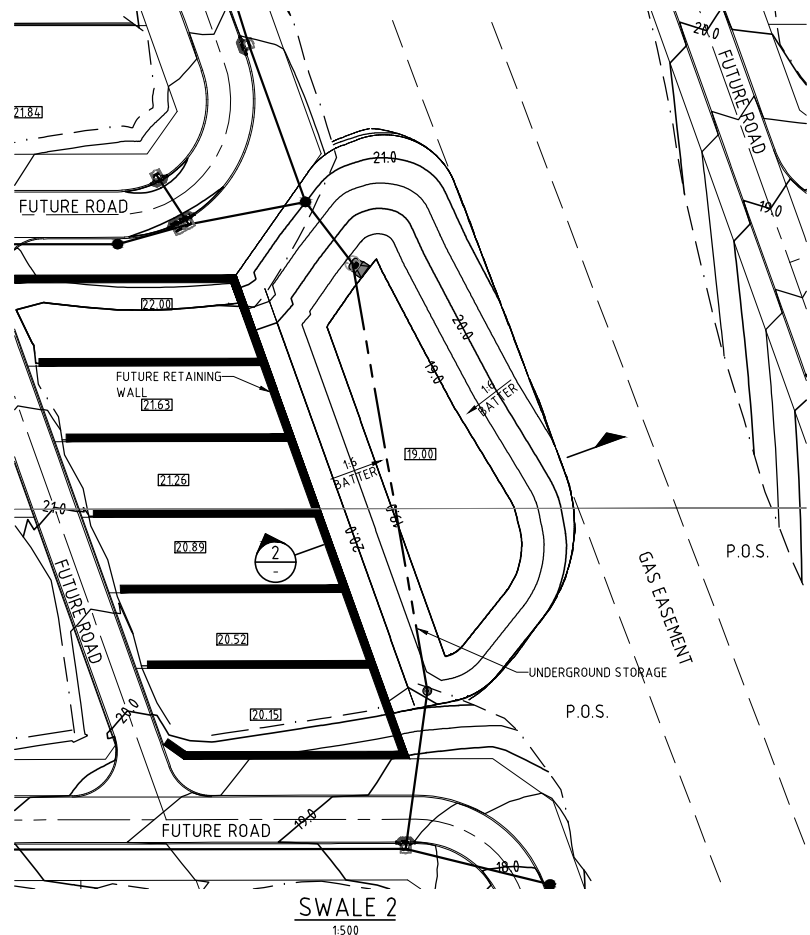
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DESIGNED	JEG
CHECK	SRA
APPROVED	SRA
PROJECT NUMBER	PRO519 D-06

REV No.	A
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APPENDIX E – DETAILS OF DRAINAGE BASINS

D-05 Drainage Swale Details Sheet 1 of 2

D-06 Drainage Swale Details Sheet 2 of 2

[illegible]

CLIENT: **NOVALEE NOMINEES PTY LTD**
ESTATES 77 PTY LTD



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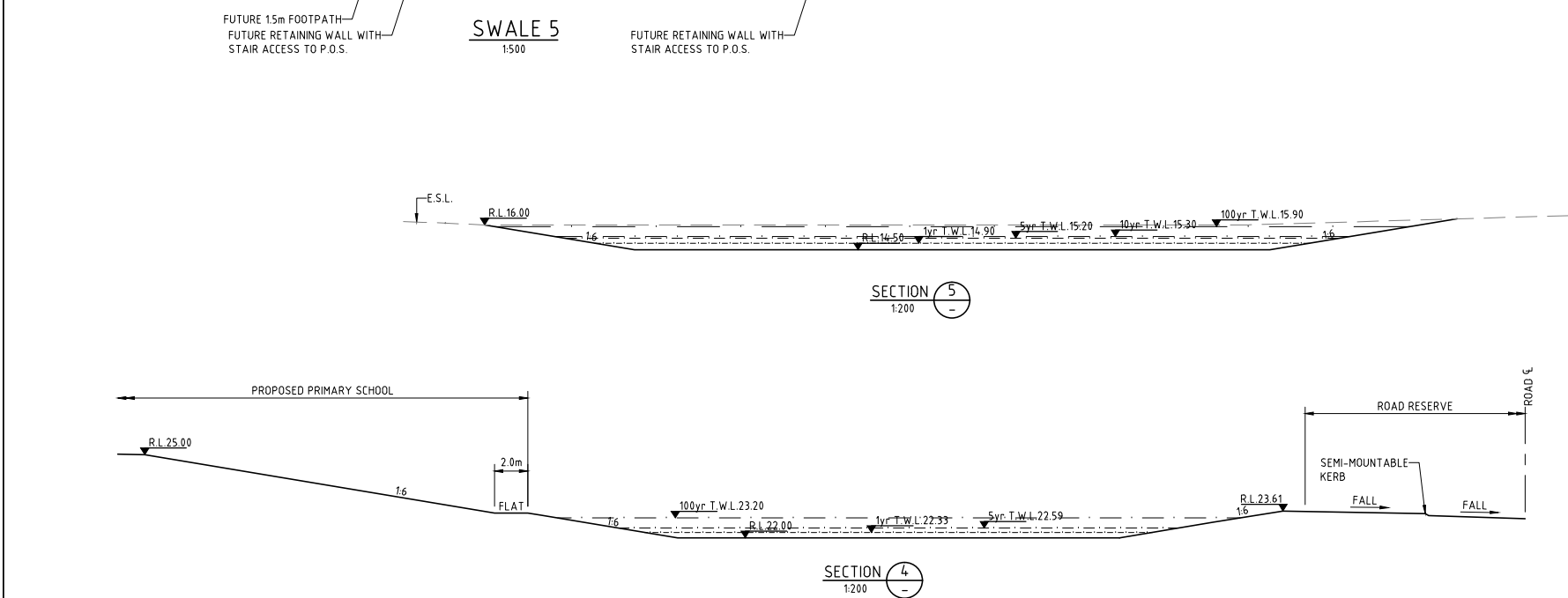
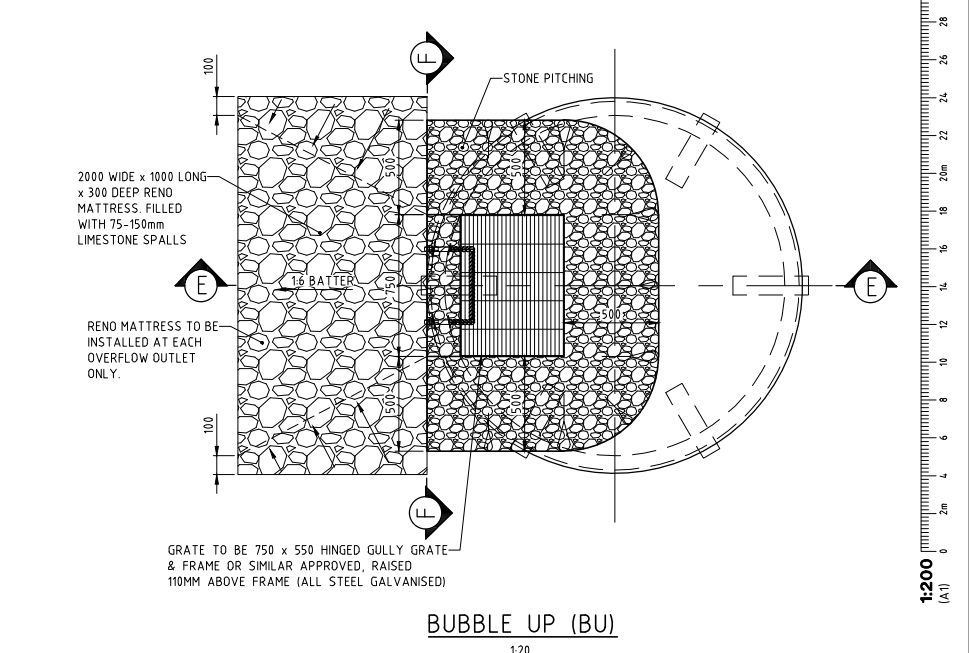
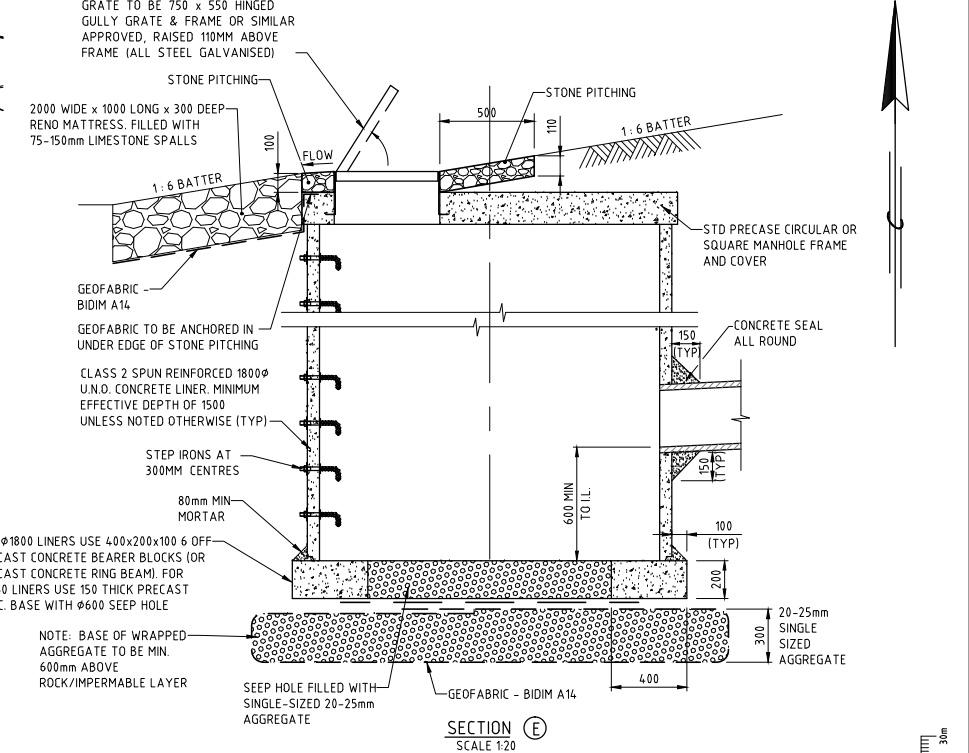
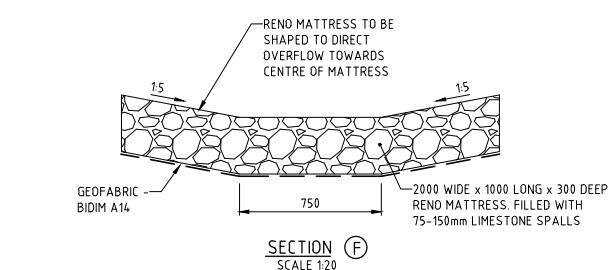
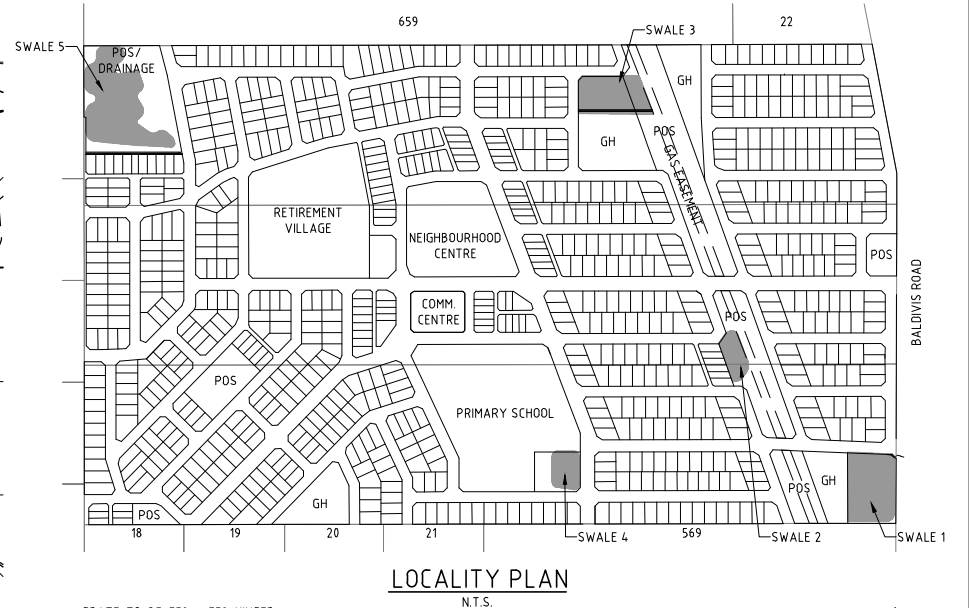
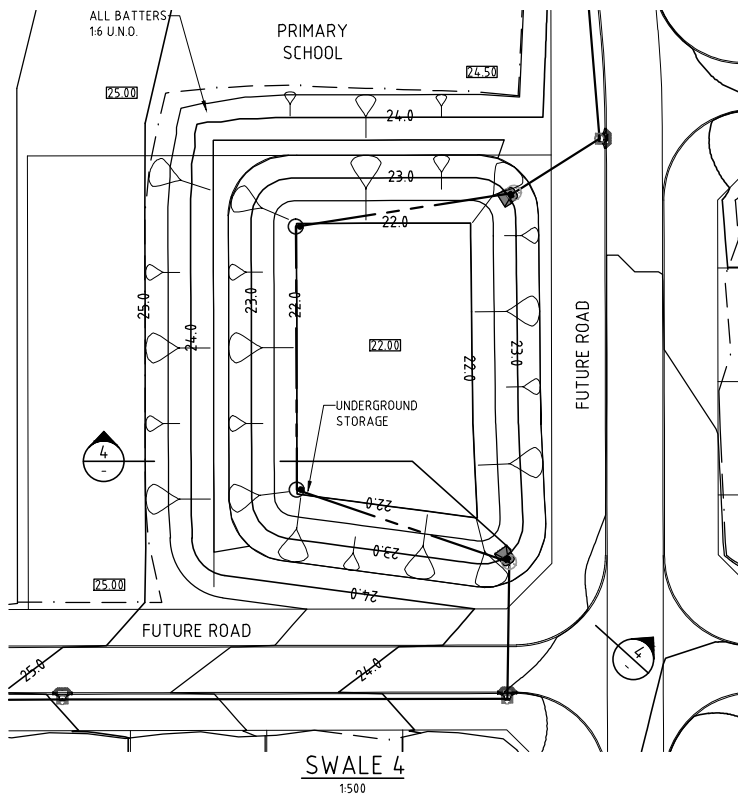
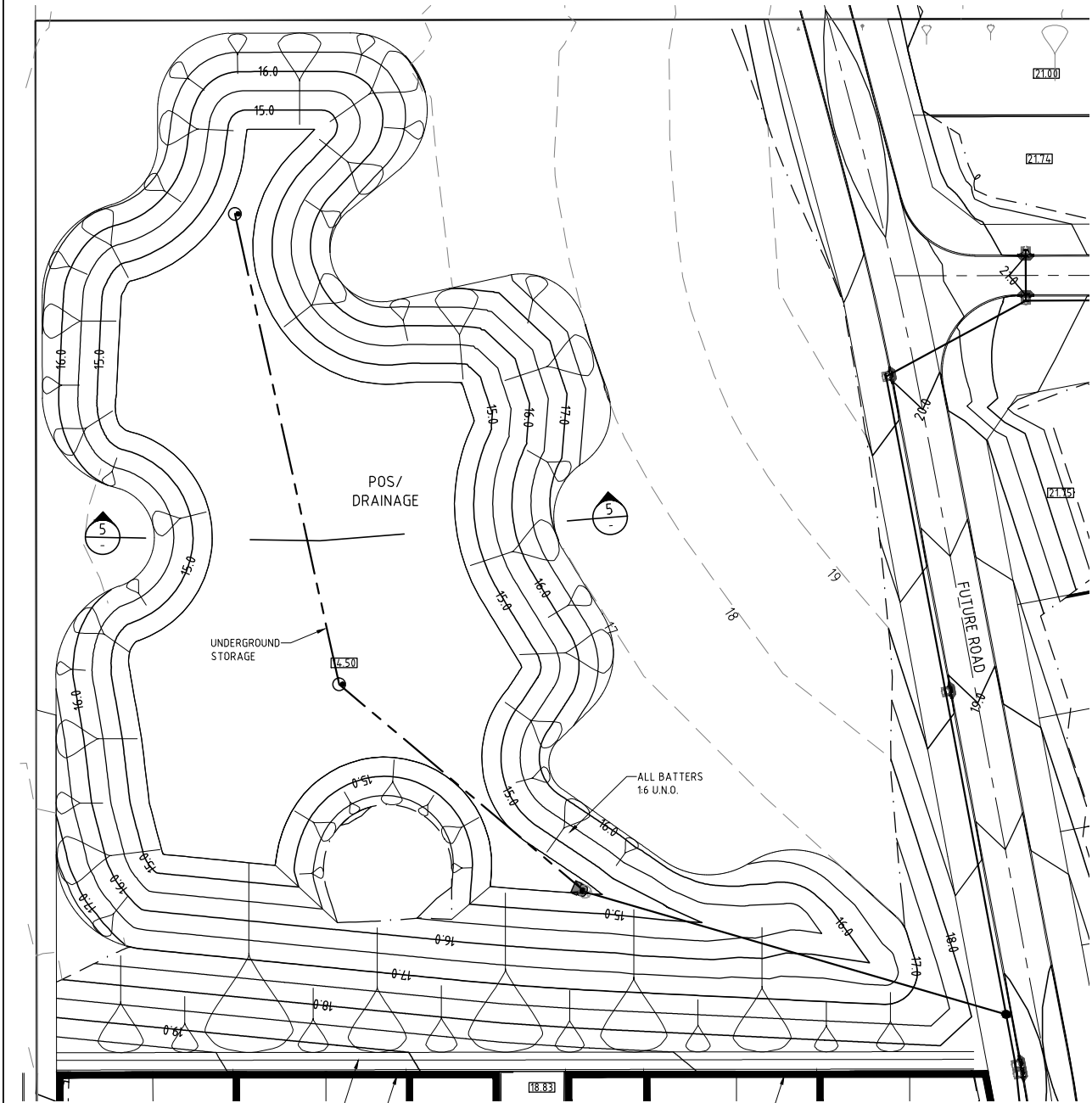
SUITE 3, 123A COLIN ST,
WEST PERTH, 6005
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Fax: (08) 9481 1700

PROJECT: **LOTS 635, 739 & 740
BALDIVIS ROAD
BALDIVIS**

DRAWING:
DRAINAGE SWALE DETAILS
SHEET 1 OF 2

CAD DRAWING DO NOT MANUALLY ALTER

SCALE	DRAWN	CHECK	REV No
AS SHOWN	WJB	SRA	A
DATE	DESIGNED	APPROVED	
08/09/11	WJB	SRA	
PROJECT NUMBER			
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No				SRA				W.A.P.C. No. -				CAD DRAWING DO NOT MANUALLY ALTER				S:\PROPOSALS\PRO519\DRAWINGS\PRO519 D06.dwg				25/10/2011			

