TALLANGATTA FARM
LOTS 50 AND 1456 GREAT NORTHERN HIGHWAY, MUCHEA

LOCAL WATER MANAGEMENT STRATEGY

Prepared for

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Draft Report No. J20008b
11 March 2021

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1.0 INTRODUCTION

1.1 Background

Tallangatta Farm (Lots 50 and 1456 Great Northern Highway, Muchea) is located on the corner of Muchea East Road and Great Northern Highway, Muchea. Tallangatta Beef Pty Ltd, the owner of Tallangatta Farm), has applied to the Shire of Chittering for the property to be rezoned from Agricultural Resource to General Industry. The *Muchea Industrial Park Structure Plan* (MIPSP) shows Tallangatta as part of Precinct 2 (General Industry Core) of the Muchea Industrial Park. Figure 1 shows the location of the site within the draft Muchea Industrial Park Structure Plan area.

The total area of Tallangatta is 213 hectares. Figure 2 shows the boundaries of the site. Figure 3 shows a preliminary conceptual plan of subdivision.

The Local Structure Plan for Tallangatta has been submitted to the Department of Planning, Lands & Heritage and the Shire of Chittering, and is currently being considered by these agencies.

1.2 Previous Studies

1.2.1 Water Management Strategy – Muchea Employment Node

A Water Management Strategy (WMS) was prepared by Connell Wagner in 2008 in support of the District Structure Plan for the Muchea Employment Node. The WMS documented the existing environment of the MEN in broad terms, including soils and geology, topography, hydrology, vegetation and land uses. The WMS examined:

- the possible impacts of development on surface water and groundwater
- water demand and supply options;
- wastewater treatment and disposal, including leach drains, evaporation ponds and reuse.

The WMS recommended, among other things:

- Groundwater monitoring over at least two winter seasons should be undertaken to provide information on groundwater levels and quality.

- The preferred method of effluent disposal, based on desktop studies, was treatment by Aerobic Treatment Units (ATU) followed by disposal in evaporation ponds.

- Development should be set back from waterways in accordance with Water and Rivers Commission Note 23: *Determining Foreshore Reserves* (2001), with a default minimum setback of 30m.

- Stormwater runoff from lots and roads should be managed by infiltration and detention so that the runoff from a 1-year 1-hour storm is retained and infiltrated, and that peak flows from critical storms up to 100-year ARI are limited to pre-development rates.

- Water sensitive urban design measures should be implemented to meet catchment water quality targets as set out in the Swan-Canning Water Quality Improvement Plan (2009).

1.2.2 Regional Water Management Strategy – Muchea

The Muchea Regional Water Management Strategy (RWMS) was prepared by Emerge Associates for the Department of Planning, Lands & Heritage in 2019. The RWMS deals with the entire Muchea Employment Node, covering an area of 6,580 hectares.

The RWMS identifies environmental values, documents the hydrological regime and identifies requirements for wastewater management. The RWMS recommends further assessments prior to development including geotechnical, flora and fauna, wetlands, waterways, land capability and flooding.

1.3 Relevant Guidelines and Policies

1.3.1 State Planning Policy 2.9

State Planning Policy 2.9: *Water Resources* (WAPC, 2006) lists the following key principles for total water cycle management:

- Consideration of all water sources (including wastewater) in water planning, maximising the value of water resources.

- Integration of water and land use planning.

- Sustainable and equitable use of all water sources, having consideration of the needs of all water users including the community, industry and the environment.

- Integration of water use and natural water processes.

- A whole-of-catchment integration of natural resource use and management.

SPP 2.9 also lists the following general objectives for water-sensitive urban design:

- to manage a water regime;

- to maintain and, where possible, enhance water quality;

- to encourage water conservation;

- to enhance water-related environmental values; and
- to enhance water-related recreational and cultural values.

Element 5 of *Liveable Neighbourhoods* Edition 3 (WAPC, 2004) identifies specific objectives and requirements for Urban Water Management. These are based on Best Planning Practices which are defined as the best practical approach for achieving water resource management objectives within an urban framework.

1.3.2 Better Urban Water Management

Better Urban Water Management (WAPC, 2008) sets out the following objectives for water sensitive urban design:

Water Conservation

- Consumption of 100kL/pp/yr including less than 40-60 kL/p/yr scheme water.

Water Quantity

- Ecological Protection – Maintain pre-development flow rates and volumes for the 1 year ARI event. Maintain or restore desirable environmental flows and/or hydrological cycles.
- Flood Management – Maintain pre-development flow rates and volumes for the 100 year ARI event.

Water Quality

- Maintain pre-development nutrient outputs (if known) or meet relevant water quality guidelines (e.g. ANZECC & ARMCANZ, 2000).
- Treat all runoff in the drainage network prior to discharge consistent with the Stormwater Management Manual.
- As compared to a development that does not actively manage stormwater quality, achieve:
    - at least 80% reduction of Total Suspended Solids;
    - at least 60% reduction of Total Phosphorus;
    - at least 45% reduction of Total Nitrogen; and
    - at least 70% reduction of gross pollutants.

Mosquitoes and Midges

- Design detention structures so that, between the months of November and May, stormwater is fully infiltrated within 96 hours.

- Design permanent water bodies (where accepted by DWER) to maximise predation of mosquito larvae by native fauna.

1.3.3 Shire of Chittering Local Planning Scheme No. 6

"The following development requirements shall apply to the development and subdivision of land within industrial zones and to industrial land uses –

(a) the effect on the environment by means of discharge of pollutants or contaminants into the air, ground and water be avoided, or managed within acceptable limits;

(b) where an on-site wastewater disposal system is proposed –

  i. land capability assessment may be required to demonstrate the capability of the site to manage wastewater and the suitability of the proposed system;
  ii. the use of fill and drains to achieve the required separation from groundwater is to be limited; and
  iii. a suitable and unencumbered land application area is to be set aside to distribute treated sewage, where required;

(c) within sewerage sensitive areas secondary treatment systems with nutrient removal are to be utilised;

(d) notwithstanding any other provisions of this scheme, industrial development not connected to reticulated sewerage (for treatment on-site or off-site) is to be restricted to 'dry industry' being land uses that intend to dispose of wastewater on site to the environment of a kind and volume ordinarily discharged from a habitable building at a daily volume of less than 540 litres per 1,000m^2 of the site area [R10 equivalent];

(e) where trade waste is to be managed and/or disposed of on-site or off-site the associated risks must be identified and addressed, including the vulnerability of the receiving environment where relevant;

The Scheme shows Tallangatta as part of a Water Prone Area (Ellen Brook Palusplain), within which the following special provisions apply:

"5.3.3 Planning Requirements

The local government will impose conditions on any Development approval relating to -

a) the construction and occupation of any dwelling or outbuilding;

b) the type of effluent disposal system used in this area shall be high performance with bacterial and nutrient stripping capabilities to the specifications of local government and the Health Department and shall be located in a position determined by local government.;

c) minimum floor levels for any building above the highest known water levels;

d) any land use that may contribute to the degradation of the surface or sub-surface water quality.

e) no development other than for conservation purposes will be permitted within 30 metres of any natural water body; AMD 21 GG 3/4/09

f) damming, draining or other developments which may alter the natural flow of surface water will not be permitted unless such works are part of an approved Catchment Management Plan."

Schedule 11 of the Scheme contains the following provisions that apply to the Muchea Industrial Park:

"2.2 Environmental Management Plans

The following Environmental Management Plans shall be prepared and used to inform the design and proposed subdivision and development within the Structure Plan area. They shall be submitted as an additional detail of a Structure Plan unless otherwise determined by the Western Australian Planning Commission.

2.2.1 Local Water Management Strategy

The developer shall submit to the Local Authority a Local Water Management Strategy (LWMS) for approval as an additional detail of a Structure Plan pursuant to clause 5.19 in order to ensure that surface and ground waters are managed with the aim of maintaining the natural water balance. The Local Authority must notify and consult with the authority responsible for water and the environment on the proposed strategy in advertising the Local Structure Plan(s) pursuant to Part 4 of the deemed provisions.

The LWMS shall be prepared in accordance with Better Urban Water Management or its successor document.

The Structure Plan design shall respond to the LWMS required by 2.2.1 and shall be implemented to the satisfaction of the Local Authority, having regard to any advice from the Department of Water."

1.3.4 <u>Government Sewerage Policy</u>

The Government Sewerage Policy (2019) requires that all new subdivision and development should be deep-sewered unless it is exempt for one of several reasons. For exempt developments, the policy establishes minimum site capability requirements and, where appropriate, density limits. In these cases, on-site effluent disposal may be approved where the responsible authority is satisfied that:

- each lot is capable of accommodating on-site sewage disposal without endangering public health or the environment; and
- the minimum site requirements for on-site sewage disposal as set out in the Policy can be met.

The Policy designates certain areas as Sewage Sensitive Areas (SSAs), including land:

- within the coastal catchment of the Swan Estuary; and
- within 1km upgradient or 250m downgradient (or overall 1km where the groundwater gradient is unknown) of a significant wetland.

Additional restrictions and requirements apply to on-site effluent disposal in SSAs, including:

- a minimum lot size of one hectare (unless exempted on a case-by-case basis);
- minimum vertical separation of 1.5m from the discharge point of effluent disposal systems to the highest groundwater table level; and
- secondary effluent treatment systems with nutrient removal.

The Policy shows all of Tallangatta except for about 6ha in the north-east corner within an SSA associated with the Ellen Brook catchment. The remaining 6ha is shown within an SSA associated with a significant wetland. Figure 3 shows the mapped SSAs.

The SSA mapping associated with the wetland is considered to be erroneous. The wetland in question (a Conservation category dampland) is located more than 300m upgradient of the site and is maintained by surface flow and/or locally perched groundwater (the mapped permanent groundwater table is 45-50m below the ground surface), so there is no possibility of groundwater flow from the site to the wetland. This matter is examined further in Section 4.1.

1.3.5 DoW Operational Policy 4.3: Identifying and Establishing Waterways Foreshore Areas

DoW Operational Policy 4.3 was published in 2012 and sets out the Department of Water’s policy on defining and protecting foreshore reserves. It is intended to apply to all natural waterways within development areas. The policy sets out procedures for identifying, delineating and protecting foreshore areas.

The procedure may vary depending on the size and nature of the waterway and the nature of the proposed adjacent development. The policy provides for standard or nominal foreshore widths to be employed in some cases, such as small subdivisions and/or minor tributary creeks where the waterway is adequately protected and the proposed development poses an insignificant additional risk to the waterway.

1.3.6 DoW Interim Guideline: Developing a Local Water Management Strategy

The DoW LWMS guideline was published in 2008 and sets out the DoW's preferred format and content for LWMS documents. The guideline expands on the LWMS guidance provided in *Better Urban Water Management* (2008).

This LWMS has been prepared in accordance with the principles set out in the DoW guideline. Appendix A shows a completed checklist from the DWER guideline.

1.4 Scope of the LWMS

The scope of this LWMS is to:

- Document the existing environment on the site, in relation to soils, drainage, erosion, watercourses, groundwater and water-dependent ecosystems.
- Briefly describe the proposed development in relation to water management.
- Examine the capability of the site for on-site effluent disposal.
- Address relevant regulatory requirements and design criteria for water harvesting, setbacks to watercourses, groundwater management and drainage.
- Describe the strategies to be implemented for water conservation, watercourse protection, groundwater management and stormwater drainage.
- Outline the proposed monitoring program.
- Outline what is to be addressed in future Urban Water Management Plans.

1.5 Design Objectives

Table 1.1 summarises the water-related design objectives for Tallangatta and the means by which they will be achieved in the LWMS and subsequent management plans.

Table 1.1 Design Objectives

Design Aspect	*Design Objective*	*How Objective is to be Achieved*
Water Conservation	Ensure efficient and sustainable use of water resources	Only low water use industries permitted in Precinct 2. Use water efficient fixtures. Limit wastewater generation to 5.4 KL/ha/day. Use non-potable water for irrigation. Purchase groundwater licence(s) from existing holders within or outside the project area. Use water-efficient native species for landscaping. Irrigate landscape plantings only for 2 years.
Groundwater Management	Minimise impacts on groundwater level and flows Minimise impacts on groundwater quality	Subsoil drains set at or above pre-existing AAMGL, with fill used to provide additional clearance if required. Finished floor levels of habitable buildings set at least 0.5m above controlled groundwater level. Treat runoff from minor storms in bioretention basins and swales. Minimise fertiliser and chemical use in landscaping areas. Use nutrient-removing alternative secondary systems for effluent disposal.
Surface Water Management	Minimise impacts on surface water flow rates, volumes and quality	Retain and infiltrate runoff from 1-year ARI 1-hour storms in bioretention basins and swales. Detain runoff from larger storms and control release from lots and overall site to pre-development flow rates. Convey existing flows through the site in stream reserves or roadside swales at pre-development rates. Set effluent disposal facilities at least 100m back from natural waterways. Sweep streets regularly to remove accumulated contaminants.

2.0 EXISTING ENVIRONMENT

2.1 Rainfall

Muchea, like the rest of the greater Perth region, has a strongly seasonal rainfall, with most of the annual rain falling between May and September in association with winter cold fronts. Occasional heavy falls may occur from summer thunderstorms. The long-term average annual rainfall for Pearce RAAF Base (located 6.5km south of the site) is 679.7mm, of which 77% falls between the months of May and September.

Figure 4 shows a rainfall occurrence chart for Pearce RAAF. Table 2.1 shows rainfall intensity, frequency and duration for Muchea.

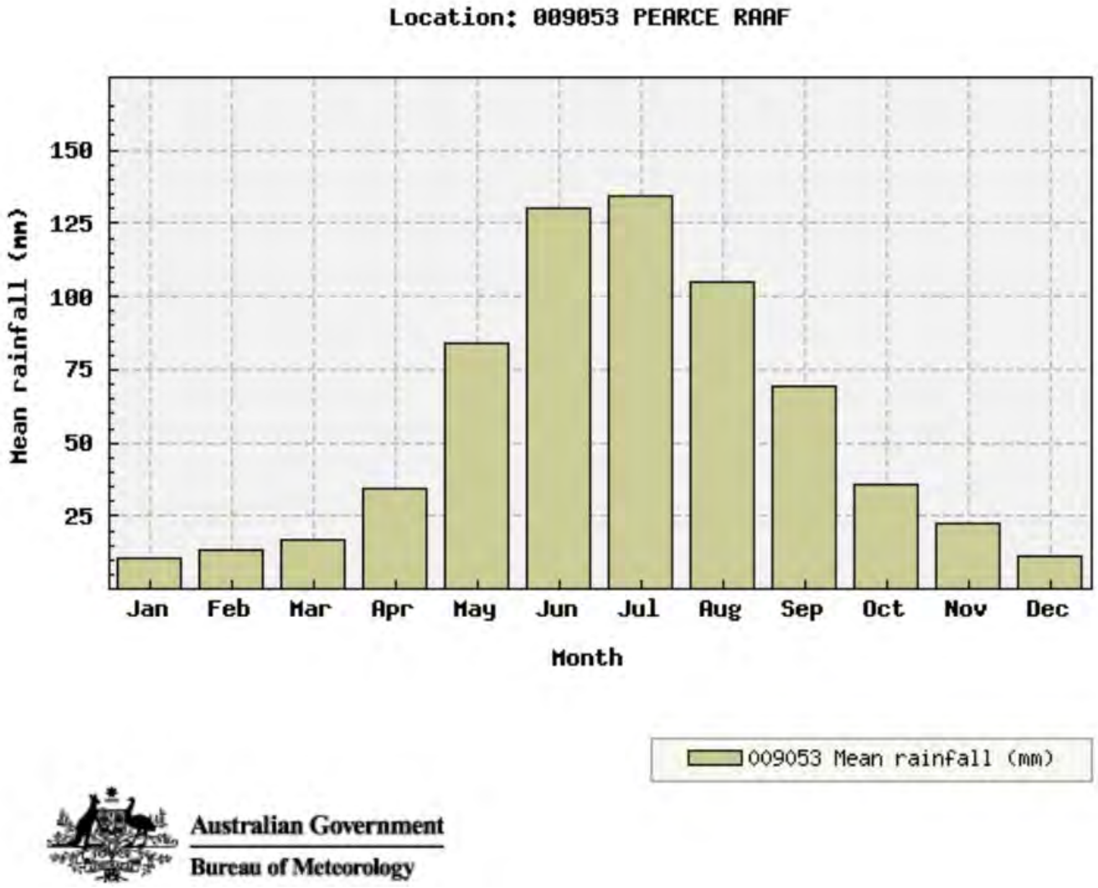
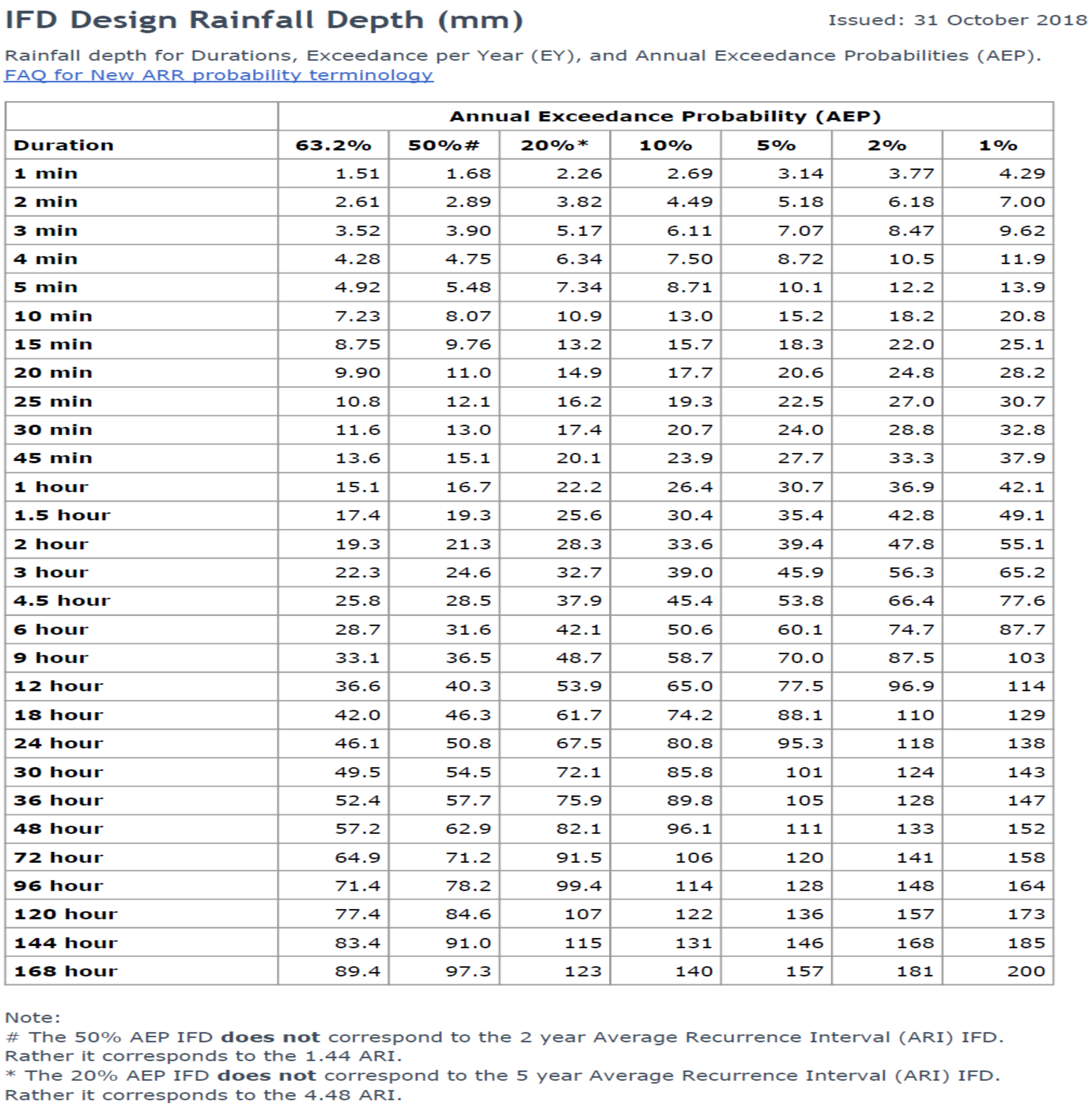


Figure 4 **Pearce RAAF Mean Rainfall**



IFD Design Rainfall Depth (mm) Issued: 31 October 2018

Rainfall depth for Durations, Exceedance per Year (EY), and Annual Exceedance Probabilities (AEP).
FAQ for New ARR probability terminology

	Annual Exceedance Probability (AEP)						
Duration	**63.2%**	**50%#**	**20%***	**10%**	**5%**	**2%**	**1%**
1 min	1.51	1.68	2.26	2.69	3.14	3.77	4.29
2 min	2.61	2.89	3.82	4.49	5.18	6.18	7.00
3 min	3.52	3.90	5.17	6.11	7.07	8.47	9.62
4 min	4.28	4.75	6.34	7.50	8.72	10.5	11.9
5 min	4.92	5.48	7.34	8.71	10.1	12.2	13.9
10 min	7.23	8.07	10.9	13.0	15.2	18.2	20.8
15 min	8.75	9.76	13.2	15.7	18.3	22.0	25.1
20 min	9.90	11.0	14.9	17.7	20.6	24.8	28.2
25 min	10.8	12.1	16.2	19.3	22.5	27.0	30.7
30 min	11.6	13.0	17.4	20.7	24.0	28.8	32.8
45 min	13.6	15.1	20.1	23.9	27.7	33.3	37.9
1 hour	15.1	16.7	22.2	26.4	30.7	36.9	42.1
1.5 hour	17.4	19.3	25.6	30.4	35.4	42.8	49.1
2 hour	19.3	21.3	28.3	33.6	39.4	47.8	55.1
3 hour	22.3	24.6	32.7	39.0	45.9	56.3	65.2
4.5 hour	25.8	28.5	37.9	45.4	53.8	66.4	77.6
6 hour	28.7	31.6	42.1	50.6	60.1	74.7	87.7
9 hour	33.1	36.5	48.7	58.7	70.0	87.5	103
12 hour	36.6	40.3	53.9	65.0	77.5	96.9	114
18 hour	42.0	46.3	61.7	74.2	88.1	110	129
24 hour	46.1	50.8	67.5	80.8	95.3	118	138
30 hour	49.5	54.5	72.1	85.8	101	124	143
36 hour	52.4	57.7	75.9	89.8	105	128	147
48 hour	57.2	62.9	82.1	96.1	111	133	152
72 hour	64.9	71.2	91.5	106	120	141	158
96 hour	71.4	78.2	99.4	114	128	148	164
120 hour	77.4	84.6	107	122	136	157	173
144 hour	83.4	91.0	115	131	146	168	185
168 hour	89.4	97.3	123	140	157	181	200

Note:
\# The 50% AEP IFD **does not** correspond to the 2 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 1.44 ARI.
* The 20% AEP IFD **does not** correspond to the 5 year Average Recurrence Interval (ARI) IFD. Rather it corresponds to the 4.48 ARI.

Table 2.1 Rainfall Intensity for Muchea

2.2 Physiography

2.2.1 Topography

Tallangatta is located on the western footslopes of the Gingin Scarp, just west of the Darling Fault. The site slopes generally westward from a high point of 93m AHD in the north-east to a low of 53m AHD at the north-west corner. The gradient averages about 2.5%. The steepest slopes are in the north-east, reaching up to 10% in places. Figure 5 shows the topography.

2.2.2 Geology, Landforms and Soils

Most of Tallangatta is mapped by the GSWA (Gozzard, 1982) as Guildford Formation (Qpa), with soils consisting of pebbly silt (Mgs_1). This unit is described as having generally low permeability and shallow groundwater, with a low to moderate capability for effluent and drainage disposal. The foundation stability may vary, with differential settling possible in clayey areas. Sand pads are generally necessary for foundations.

The eastern part of the property is mapped as Colluvium (Qc), with soils of medium to coarse grained brown sand (S_5) and sandy silt (Msg). The S_5 soil type has high permeability and generally high capability for drainage and effluent disposal. The Msg type has low permeability and consequently low suitability for effluent disposal. Both soil types provide good foundations when compacted.

A small area in the north-east of the property is mapped as Leederville Formation (Klb), with soils derived from siltstone (ST_1). This unit is described as moderately stable but prone to weathering when disturbed, with low permeability making it of low suitability for drainage or effluent disposal.

Figure 5 shows the GSWA mapping. Drilling at nine locations across the site in June 2017 (Figure 5) generally confirmed the GSWA mapping. Soil logs from the drilling are attached in Appendix B.

2.2.3 Soil Permeability

The permeability of the site soils will vary depending on the clay content. Test pumping during sampling of the on-site bores indicated hydraulic conductivities in the subsoil (1-5 m bgl) ranging from about 0.06 m/day to 0.42 m/day. The permeability of the top 2m of the soil profile is expected to be higher.

Brown Geotechnical carried out falling-head permeability tests at three locations at 0.5-1m depth across the property (Figure 5) in 2020. The tests returned estimated permeabilities ranging from 8.5×10^{-5} m/day in dense gravelly sandy clay to 53 m/day in sandy gravel. The geotechnical report is attached in Appendix C.

For preliminary drainage and effluent design purposes, a conservative permeability of 1 m/day has been assumed. Constant-head permeability tests in accordance with the method set out in Australian Standard AS1547:2012: – *On-site Domestic Wastewater Management* will be undertaken prior to subdivision.

2.2.4 Acid Sulphate Soils

The DBCA maps the site as Low to Nil risk of Acid Sulphate Soils (ASS). The nearest mapped High ASS risk area is a palusplain about 1.6km to the south.

Bore sampling in August 2020 found no indicators of potential or actual ASS in the groundwater. No further investigation of ASS is considered to be necessary.

2.2.5 Phosphorus Retention Index

Previous experience has shown that the gravelly and silty clay soils of the Guildford Formation and other alluvial and colluvial soils generally have moderate to high PRI.

PRI is a measure of the ability of a soil to adsorb and retain phosphorus from solution. A high PRI indicates that a soil is unlikely to leach phosphorus to the water table. Typical ranges for PRI values in soils are as follows:

PRI Range	*Rating*	*Typical soils*
0 – 0.5	Very Low	Bassendean Sand
2 – 4	Low – Moderate	Karrakatta Sands
5 – 12	Moderate – High	Cottesloe Sands
12 – 20	High	Crushed Limestone, Limesand
20 – 1000+	Very High	Clay

The DWER recommends a minimum PRI of 15 for soils beneath infiltration basins and swales. The site soils are expected to meet or exceed this requirement. PRI testing of soils beneath proposed infiltration basins will be undertaken before subdivision.

2.3 Hydrology

2.3.1 Groundwater

Groundwater flows from east to west beneath the site at a gradient of between 0.01 and 0.02. The low permeability of the soil profile means that groundwater throughflow would be very low.

Regional mapping by the DWER shows superficial groundwater present at minimum elevations of 48m to 55m AHD. Figure 6 shows the DWER contours.

Groundwater measurements in nine bores in and around the site on 21 August 2020 (Figure 6), during a drier than average winter, gave the water depths and levels shown in Table 2.2. Groundwater measurements collected from the site since 2017 are detailed in Appendix D.

Simultaneous measurements of DWER bores located 1,400m south (Swan GWA 2-98) and 40m north (Gnangara Monitoring GD20) enabled Average Annual Maximum (AAMGL) and Maximum (MGL) groundwater levels at the site to be calculated. Figure 6 shows the calculated AAMGL and depth to AAMGL contours across the site. Figure 7 shows the hydrographs of the DWER bores.

Table 2.2 shows that the groundwater levels measured in August 2020 were about 0.4m below the AAMGL. The winter of 2020 was drier than average, and the levels measured on 21 August are considered to approximate the peak for the year.

Figure 6 shows that the AAMGL is within one metre of the ground surface in parts of the west, south and north-west of the site. The AAMGL is predicted to intersect the ground surface in small areas in the west, south and north-east.

Filling and/or subsoil drainage is likely to be necessary in areas of the site where the depth to groundwater is less than 1.5m in order to provide groundwater clearance for roads, buildings and effluent disposal. The requirement for filling will depend on the size of the lots and the uses to which they are put. Most of the site has sufficient slope and depth to groundwater that subsoil drainage alone may be sufficient to create the necessary groundwater clearance for building, effluent disposal and drainage.

Table 2.2 Groundwater Depths and Levels 21 August 2020

Bore (Figure 6)	*Depth (mbgl)*	*Level (m AHD)*	*AAMGL (m AHD)*	*MGL (m AHD)*	*Depth to AAMGL (m)*	*Depth to MGL (m)*
TB1	4.64	60.61	61.037	61.617	4.213	3.633
TB2	2.95	82.05	82.477	83.057	2.523	1.943
TB3	0.7	79.85	80.277	80.857	0.273	-0.307
TB4	0.41	54.39	54.817	55.397	-0.017	-0.597
TB5	>3.45	<63.55				
TB6	0.37	53.63	54.057	54.637	-0.057	-0.637
TB7	1.14	57.26	57.687	58.267	0.713	0.133
TB8	1.11	64.14	64.567	65.147	0.683	0.103
TB9	0.56	74.24	74.667	75.247	0.133	-0.447
MB1	0.285	51.305	51.732	52.312	-0.142	-0.722
MB3	1.59	50.99	51.417	51.997	1.163	0.583
MB5	0.77	56.02	56.447	57.027	0.343	-0.237
WB2	>4.98	<65.89				
GD20	0.88	60.6	59.85	61.35	1.63	0.13
2-98	2.117	56.173	56.6	57.18	1.69	1.11

2.3.2 Surface Water

A significant creek flows from east to west along the northern edge of the property. Two smaller drains flow across the site near the southern boundary. All of the watercourses are seasonal or ephemeral. The remainder of the property would drain by sheet flow during heavy rainfall. Figure 8 shows the drainage lines and their catchments.

The northern creekline is a natural waterway, incised at the eastern side of the property but flatter and shallower at the western side. The depth of the creek channel is estimated at 1m in the east and 0.5m at the west, with a width of 5-10m. The creek drains an upstream catchment of about 360ha and an additional catchment of 250ha within the property.

Historical Landgate aerial photography shows that the middle drainage line is an artificial drain, constructed between 1965 and 1977. It is shallow and slightly incised, about 0.5m deep and 8-10m wide. It has an upstream catchment of about 38ha and an internal catchment of another 30ha.

The southernmost drainage line is also a constructed drain, dating from between 1977 and 1979. It is slightly incised, about 0.5m deep with a width ranging from 4-8m in the east to 12m in the west. It drains an upstream catchment of about 117ha and an internal catchment of another 3ha.

All drainage from the site flows eventually into Ellen Brook, the major drainage feature of the region. The Ellen Brook catchment is the largest sub-catchment of the Swan-Canning River system, contributing 6% of the total annual flow, and is the largest single contributor of nutrients to the system (WA Govt, 2011).

Ellen Brook has a surface catchment of 715km^2 (WRC, 2012). The Brook rises as Chandala Brook about 22km north-northwest of the site. The Brook is seasonal, flowing generally between May and November with an annual flow ranging from 2.1 to 48.6 GL (SRT, 2009).

Table 2.3 summarises estimated 100-year ARI (average recurrence interval) flows under current conditions in the three drainage lines, calculated using the Rational Method (Institute of Engineers Australia, 1987). A runoff coefficient of 0.3 for the 100-year storm was assumed for all catchments. Table 2.3 also shows estimated water depths, widths and flow velocities in the watercourses at the upstream and downstream ends of the site, calculated with Manning's open channel flow formula (Fang, 2002), using a roughness coefficient (Manning's *n*) of 0.03.

Table 2.3 100-year ARI Flows in Existing Watercourses

Drainage Line		*North*	*Middle*	*South*
Upstream Catchment (ha)		360	38	117
100-yr ARI Flow (m^3/sec)		7.04	1.21	3.9
Water Depth (m)	*Upstream*	0.7	0.2	0.5
	Mid-point	0.8	-	-
	Downstream	0.4	0.2	0.5
Top Water Width (m)	*Upstream*	4.6	9.4	8.2
	Mid-point	6.9	-	-
	Downstream	28	11	11
Flow Velocity (m/sec)	*Upstream*	3.5	1.0	1.5
	Mid-point	2.0	-	-
	Downstream	1.1	1.1	1.1

The flow calculations in Table 2.3 suggest that the northern creek is likely to overtop its banks at its western end during a 100-year storm, creating flooding to about 15m each side of the creek. The eastern part of the northern creek, and the two southern drainage lines, appear unlikely to overtop in a 100-year storm.

The flow velocity in the eastern part of the northern creek is relatively high and may cause scouring of the creek bed in a 100-year storm. Given that a storm of this size may not have occurred since the creekline and its catchment were cleared for farming, such an event may alter the shape of the watercourse. Some protection works (such as revegetation, riffling and barriers) may be necessary to reduce the risk of this occurring. Given the relatively steep topography in the vicinity of the creekline, any scouring is likely to result in minor straightening of the watercourse rather than any major change in its alignment.

The calculations shown in Table 2.3 are preliminary and based on desktop estimates of channel morphology and catchment characteristics. They should not be used for design purposes.

2.4 Water Resources

2.4.1 Groundwater

Tallangatta is within the Eclipse Hill Subarea of the Gingin Groundwater Area (GWA) for the superficial and surficial aquifers, the Southern Scarp sub-area for the semi-confined (Mirrabooka) aquifer, the Cowalla sub-area for the confined Leederville-Parmelia aquifer and the Chandala sub-area for the Yarragadee aquifer. Groundwater allocations within the GWA are managed under the Gingin Groundwater Areas Allocation Plan (DoW, 2015).

Under the plan (as of 2015), the Eclipse Hill (superficial), Southern Scarp (Mirrabooka) and Cowalla (Leederville) sub-areas are over-allocated and no new allocations are available.

The Gingin Groundwater Allocation Plan shows that the Eclipse Hill Subarea has a total allocable resource of 1,050 ML/a in the superficial and 3,000 ML/a in the surficial aquifer. The DWER has advised (M. Ong, 2017 pers. comm.) that the superficial aquifer resource is fully allocated but 1,600 ML/a is available for allocation in the surficial aquifer.

In the deeper confined aquifers, the Leederville aquifer (Cowalla Subarea) has a total of 17,617 ML/a, which is fully allocated, and the Yarragadee aquifer (Chandala Subarea) has 1,050 ML/a, of which 194 ML/a is available for allocation.

2.4.2 Surface Water

The three drainage lines that flow across Tallangatta have a combined upstream catchment of approximately 515 hectares. Using the average annual rainfall of 653mm for Pearce RAAF Base (BoM, 2017) and an overall catchment runoff coefficient of 5% (CSIRO, 2009), it can be estimated that an average of approximately 168 ML/a of surface flow may be available for capture and use.

This may be augmented by the capture and storage of stormwater from within the developed industrial area. Using the same average rainfall and an overall post-development runoff coefficient of 20%, the industrial area could yield approximately another 278 ML/a.

Capture and storage of surface runoff at this scale is problematic for several reasons:

- The quantity available is variable, with annual rainfall at Pearce RAAF having been recorded as low as 50% of the mean.
- Storage of the water would require deep ponds covering several hectares.
- Unless the ponds were covered, a substantial portion (average 2m depth each year) of the stored water would be lost to evaporation.
- Captured surface water, particularly stormwater from streets, would be unsuitable for potable use.

For these reasons, capture of surface water, while possibly feasible in particular circumstances, is unlikely to be a viable water supply option for the whole estate.

2.5 Water Quality

2.5.1 Groundwater

Groundwater samples were collected from the nine on-site bores in August 2017. The samples show that the groundwater quality across the site is generally moderate, with some notable features:

- Nitrogen (both total and NO_X) levels were elevated across most of the site, particularly in Bore TB1 in the centre of the property. This is probably due largely to the high density of cattle then being stocked on the property. Nitrogen levels are expected to decline once cattle are removed from the property.
- Bore TB3 is quite saline (Conductivity 12 mS/cm = 7,200 mg/L) as well as being very acidic (ph 3.7, Total Acidity 96) and high in some metals (aluminium, potassium, iron, lead and zinc). These are consistent with its origin as seepage from clay and siltstone. The sulphate level is also elevated, although the low sulphate/chloride ratio (0.09) and the elevation and soil type suggests that these characteristics are not indicative of the presence of ASS.
- Dissolved phosphorus levels were low across the site.

Table 2.4 shows the groundwater quality data from August 2017.

2.5.2 Surface Water

Surface water samples were collected from six locations (three inflowing, three outflowing) in August 2017 (Figure 8). The results show that the surface flows into and out of the site are generally of similar and moderate quality. The water in the northern creek has elevated salinity, but shows little of the high acidity found in the adjacent Bore TB3. Water flowing from the east in the vicinity of the Midland Brick quarry had very low pH but only moderate acidity.

Table 2.5 shows the surface water data from August 2017.

Table 2.4 Groundwater Quality 17/8/2017

(see Figure 6 for bore locations)

	Parameter	Unit	Aquatic Ecosystems[a]	Irrigation Water[b]	*TB1*	*TB2*	*TB3*	*TB4*	*TB5*	*TB6*	*TB7*	*TB8*	*TB9*
Nutrients	Total Nitrogen	mg/L	1.2	5	**19**	0.9	**9.5**	**5.3**	**2**	**2.3**	0.6	1.2	**6.2**
	NOx	mg/L	0.15	ng	**19**	**0.72**	0.15	**3.7**	**1.4**	**1.2**	**0.18**	**0.25**	**3.8**
	Total Kjeldahl Nitrogen	mg/L	ng	ng	<0.2	0.2	9.4	1.6	0.6	1.1	0.4	1	2.4
	Total Phosphorus	mg/L	0.065	0.05	**0.89**	**0.09**	**0.54**	**0.49**	**0.43**	**0.48**	0.04	**0.3**	**3.5**
	Reactive Phosphorus	mg/L	0.04	ng	0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Physical	pH		6.5-8.0	6-8.5	**5.9**	6.8	**3.7**	6.8	6.5	7.3	6.6	7	7.4
	Conductivity	mS/cm	0.12-0.3	1.3	**1**	**0.53**	**12**	**2.2**	0.29	**0.7**	**0.49**	**0.55**	**0.63**
	Salinity (from EC)	mg/L	72-180	780	**600**	**318**	**7200**	**1320**	174	**420**	**294**	**330**	**378**
	Acidity	mg/L	40[c]	ng	19	5	**96**	<5	13	9	19	7	7
	Alkalinity	mg/L	ng	ng	10	28	<5	21	22	100	50	38	67
	Acidity:Alkalinity Ratio		1[c]	ng	**1.90**	0.18	**>19.2**	<0.24	0.59	0.09	0.38	0.18	0.10
	Hardness	mg/L	ng	60-350	95	64	1310	208	27	56	59	63	48
	Sulphate	mg/L	ng	ng	60	26	310	29	18	66	17	40	23
	Chloride	mg/L	ng	350	240	150	3600	690	94	110	100	110	130
	SO_4:Cl Ratio		0.5	ng	0.25	0.17	0.09	0.04	0.19	**0.60**	0.17	0.36	0.18
Major Ions	Calcium	mg/L	ng	ng	5	6	30	9	4.2	5.8	5.6	9.1	7.2
	Sodium	mg/L	ng	230	130	61	2100	350	36	110	54	60	80
	Potassium	mg/L	ng	ng	0.2	0.4	60	0.6	1.2	<0.1	0.9	3.8	6.6
	Magnesium	mg/L	ng	ng	20	12	300	45	4	10	11	9.9	7.2
	Iron	mg/L	ng	10	0.26	0.09	2.4	0.3	0.07	0.36	0.04	0.02	0.16

Notes

ng denotes "no guideline". na denotes "not analysed"

a. ANZECC (2000) Aquatic Ecosystem trigger values (Nutrient, pH and Conductivity are for lowland rivers; Dissolved Metals are for freshwater ecosystems 90% species protection)

b. ANZECC (2000) Irrigation trigger values (long-term irrigation up to 100 years)

c. DEC(20__) oxidation indicator triggers for ASS-affected groundwater.

d. ANZECC (2000) Irrigation trigger values for pasture and fodder for grazing animals except pigs and dairy animals.

Dissolved Metals	Aluminium	mg/L	0.08	5	**1.7**	**0.3**	**9.2**	**1.1**	**0.2**	**0.8**	<0.1	<0.1	**0.3**	
	Arsenic (III & V)	mg/L	0.136	0.1	<0.002	<0.002	0.002	0.001	<0.002	0.001	<0.002	<0.002	<0.002	
	Cadmium	mg/L	0.0004	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
	Chromium (VI)	mg/L	0.006	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
	Copper	mg/L	0.0018	0.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	Mercury	mg/L	0.0019	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
	Nickel	mg/L	0.013	0.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	Lead	mg/L	0.0056	2	<0.01	<0.01	**0.02**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	Zinc	mg/L	0.015	2	**0.08**	<0.01	**0.04**	**0.02**	<0.01	0.01	0.01	<0.01	<0.01	

Table 2.5 Surface Water Quality 17/8/2017
(see Figure 8 for sample locations)

	Parameter	Unit	Aquatic Ecosystems[a]	Irrigation Water[b]	TS1 (inflow)	TS2 (outflow)	TS4 (outflow)	TS5 (outflow)	TS6 (inflow)	TS7 (inflow)
Nutrients	Total Nitrogen	mg/L	1.2	5	0.8	0.9	**3.5**	1.1	**3.8**	0.2
	NOx	mg/L	0.15	ng	0.01	0.1	**0.81**	<0.01	**0.93**	<0.01
	Total Kjeldahl Nitrogen	mg/L	ng	ng	0.8	0.8	2.7	1.1	2.9	0.2
	Total Phosphorus	mg/L	0.065	0.05	**0.09**	**0.1**	**0.16**	**0.08**	**0.08**	**0.09**
	Reactive Phosphorus	mg/L	0.04	ng	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Physical	pH		6.5-8.0	6-8.5	**6.3**	**6.1**	**9.3**	7.5	**10.4**	**3.8**
	Conductivity	mS/cm	0.12-0.3	1.3	**3.2**	**3.3**	**0.95**	**1**	**1**	**2.2**
	Salinity (from EC)	mg/L	72-180	780	**1920**	**1980**	**570**	**600**	**600**	**1320**
	Acidity	mg/L	40[c]	ng	6	<5	<5	<5	<5	27
	Alkalinity	mg/L	ng	ng	10	<5	100	11	130	<5
	Acidity:Alkalinity Ratio		1[c]	ng	0.60	-	<0.02	<0.45	<0.04	**>5.4**
	Hardness	mg/L	ng	60-350	353	382	94	90	76	145
	Sulphate	mg/L	ng	ng	52	62	98	55	110	170
	Chloride	mg/L	ng	350	890	980	190	290	220	570
	SO_4:Cl Ratio		0.5	ng	0.06	0.06	**0.52**	0.19	0.50	0.30
Major Ions	Calcium	mg/L	ng	ng	16	16	28	8.2	24	3.8
	Sodium	mg/L	ng	230	540	630	110	120	120	330
	Potassium	mg/L	ng	ng	14	16	27	7.4	28	5.6
	Magnesium	mg/L	ng	ng	76	83	5.9	17	4	33
	Iron	mg/L	ng	10	0.1	0.1	0.07	0.05	<0.01	2.8

Notes

ng denotes "no guideline". na denotes "not analysed"

a. ANZECC (2000) Aquatic Ecosystem trigger values (Nutrient, pH and Conductivity are for lowland rivers; Dissolved Metals are for freshwater ecosystems 90% species protection)

b. ANZECC (2000) Irrigation trigger values (long-term irrigation up to 100 years)

c. DEC(20__) oxidation indicator triggers for ASS-affected groundwater.

d. ANZECC (2000) Irrigation trigger values for pasture and fodder for grazing animals except pigs and dairy animals.

Dissolved Metals	Aluminium	mg/L	0.08	5	<0.1	<0.1	<0.1	<0.1	<0.1	**1.2**	
	Arsenic (III & V)	mg/L	0.136	0.1	0.002	0.002	0.002	<0.002	0.002	<0.002	
	Cadmium	mg/L	0.0004	0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
	Chromium (VI)	mg/L	0.006	0.1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
	Copper	mg/L	0.0018	0.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	Mercury	mg/L	0.0019	0.002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
	Nickel	mg/L	0.013	0.2	<0.01	<0.01	<0.01	<0.01	<0.01	**0.02**	
	Lead	mg/L	0.0056	2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	Zinc	mg/L	0.015	2	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	

2.6 Wetlands

The north-west and north-east corners of Tallangatta are mapped as Multiple Use palusplain (seasonally waterlogged plain) by the DBCA. Palusplain also covers an extensive area west of the property in the floodplain of Ellen Brook. Figure 8 shows the mapped wetlands.

Multiple Use category wetlands are degraded and are regarded by the DBCA as developable, provided that the hydrological functions (mainly drainage) of the wetland are maintained or replicated.

No other wetlands are present on or immediately downstream of the property.

2.7 Vegetation

Tallangatta is cleared except for a number of scattered paddock trees (some apparently planted) and a small group of denser trees around the creekline in the north-east corner. The paddock trees are mostly located in the northern two-thirds of the property, with the southern third being almost entirely cleared.

The paddock trees appear to be mostly mature Marri and Wandoo, with some large specimens up to 15-20 tall. Flooded Gums are present near the creekline in the north-east corner of the property.

The DPAW database show no recorded rare or priority flora or threatened ecological communities on the property. Given the degree of clearing, it is unlikely that any rare or threatened species or communities would be present.

There is no riverine, riparian or wetland-dependent vegetation present on the property.

2.8 Fauna

The largely cleared project area offers little habitat for native fauna, apart from disturbance-tolerant species such as kangaroos (which may graze in the paddocks from refuges to the east) and birds which might nest in some trees.

There are no riverine, riparian or wetland habitats present on the property.

2.9 Land Uses and Potential Contamination

Historical Landgate aerial photography shows that Tallangatta has been cleared and used primarily for broadacre farming since before 1965. The photographs show stock pens (possibly for pigs or poultry) near the farmhouse in the centre of the property between 1965 and about 2000; however this use appears to have been small-scale and essentially domestic. Residual contamination from pesticides such as dieldrin could be present around the site of the stock pens.

Between 2004 and 2011 the property was used as an intensive live cattle export depot. Between about 2006 and 2010, manure from the feedlot operation was stockpiled in windrows about 250m east of the cattle handling sheds in the middle of the property. When the feedlot operation ended the stockpiled compost was removed from the site.

Intensive agriculture is regarded as a potentially contaminating land use by the Department of Environmental Regulation (DER, 2004); however, the agricultural chemicals available for use since 2004 do not include many of the chemicals often responsible for persistent soil contamination, such as organochlorine pesticides.

Feedlots are potential sources of soil and groundwater contamination by nutrients (nitrogen and phosphorus), organic matter and pathogens (particularly faecal bacteria). All of these contaminants are mobile and/or short-lived, and are not likely to result in persistent soil or groundwater contamination or to pose a long-term risk to health.

The DWER Contaminated Sites Database shows no records of contamination on or near Tallangatta. A desktop study carried out by Connell Wagner in 2007 for the Muchea Employment Node Structure Plan identified a number of sites of possible contamination in the greater Employment Node; it is unknown whether any of these were in Tallangatta. The Structure Plan recommended that a detailed contamination study, involving a site history and possibly soil sampling, be undertaken to investigate the sites identified by Connell Wagner and any others subsequently identified.

Given the previous land uses on Tallangatta, it is expected that any contamination found by the detailed study will be low-level, localised and readily remediated to a level suitable for industrial use.

3.0 WATER USE SUSTAINABILITY

3.1 Water Supply

Water will be required for both potable and non-potable purposes. The water requirement for the fully developed project area is unknown. Calculations based on a study carried out by GHD for the Karratha Gap Industrial Estate suggest that approximately 4 KL/ha/day will be required for both potable and non-potable uses. Over the 213ha of the site (assuming 80% developable land), this equates to a total water demand of approximately 250ML/yr. This is less than the volume available in the surficial aquifer, but water from this source is unlikely to be suitable for potable use and the available yield may vary from place to place. The presence of existing bores and windmills on Tallangatta indicates that water is available in at least some parts of the property.

The Leederville aquifer is likely to be the preferred source for potable supply due to its generally higher quality and lower risk of contamination. Non-potable groundwater demand is likely to be limited to landscape irrigation, as industries within this precinct will be restricted to those with low water usage.

Potable water will be supplied to the project area by a licensed water provider. A proposed water project for the Lower Chittering Valley is currently in development by Aqua Ferre Pty Ltd, which includes construction of a water treatment facility on Lot 2 Reserve Rd, Chittering. Aqua Ferre is in the process of applying for a Water Service Provider's Licence from the Economic Regulation Authority (ERA). Aqua Ferre has confirmed that it has the capacity within its proposed licence to supply Muchea Industrial Park with potable water. Discussions with Aqua Ferre are ongoing. A letter from Aqua Ferre confirming this understanding is attached in Appendix E.

For non-potable uses, purchase of water entitlements from existing licensed users within or outside of the project area is likely to be necessary. The landowners will negotiate with existing licence holders within and outside of the project area with a view to purchasing an existing groundwater allocation, and will submit a groundwater licence application to the DWER in due course.

3.2 Water Efficiency Measures

Precinct 2 of the MIP will be designed as a low-water-use precinct. Only industries with low water consumption will be permitted in this precinct. This is driven largely by the hydrology of the site and its proximity to Ellen Brook, which demands that wastewater disposal be minimised.

Potable water use within the project area will be limited to consumption for domestic use in toilets, bathrooms and kitchens. The Shire of Chittering Town Planning Scheme No. 6 limits wastewater generation in industrial zones to 5,400 litres per hectare per day.

Groundwater will be used mainly for irrigation of landscape plantings and swales. These areas will be irrigated only during the establishment stage (one or two years). The Landscape Master Plan estimates total plantings of 40ha of sedges, shrubs and trees within the project area.

The water demand for irrigation in a given year will depend on the staging of subdivision and development. If the project area were developed over ten years, the demand for irrigation water (at the DWER’s default rate of 4,500 KL/ha/yr) over that ten year period would be in the order of 18 ML/yr, decreasing in subsequent years.

4.0 LAND CAPABILITY FOR ON-SITE EFFLUENT DISPOSAL

4.1 Published Land Capability Ratings and Constraints

Extrapolation of mapping by the Department of Agriculture (King & Wells, 1990) suggests that the western part of Tallangatta would be mapped as Guildford Formation (Gf2): “Plain with imperfectly drained yellow duplex soils with sand to sandy loam topsoil”, and the eastern part as Reagan (Re2): “Gentle slopes with deep, well drained brownish or earthy sands situated below Re1”. King & Wells (1990) rated the capability of these landform types for on-site effluent disposal as follows:

Landform	*Capability*	*Limiting Factor(s)*
Gf2	Fair	Microbial purification ability, soil absorption ability
Re2	High	None

The limitations on the capability of the Gf2 landform unit relate to the imperfect drainage of the unit due to its silty soils and sometimes occurrence of clay horizons. The drilling carried out in June 2017 showed that the soils on the site possessed a sandy or gravelly loam profile to at least 1.5m depth, suggesting that they were well drained. Permeability measurements by Bayley Environmental Services in 2017 and Brown Geotechnical in 2020 returned permeabilities in the top 5m of the soil profile between 8.6×10^{-4} and 53 m/day. These results suggest that the permeability of the Gf2 soils on the site poses no significant constraint to effluent disposal.

The Government Sewerage Policy maps most of the project area as being within a Sewage Sensitive Area (SSA) due to its location within the catchment of the Swan-Canning Estuary and/or within 1km of significant wetlands. The Policy places additional site requirements in terms of groundwater clearance and lot density on effluent disposal within SSAs, including a lower lot size limit of 1ha. Figure 3 shows the SSA boundaries over the subject land.

The north-eastern part of Tallangatta is mapped as SSA by the GSP under the category of land “…within one kilometre up-groundwater-gradient and 250 metres down-groundwater-gradient of a significant wetland; or where the groundwater gradient is unknown or seasonably variable within one kilometre of the significant wetland…”. Closer inspection shows that the wetland in question in this case, a Conservation Category dampland located 315m east of the project area, is upgradient of the site and maintained by surface water inflow from further upgradient. There appears to be no way that effluent disposal at the site could affect this dampland, and therefore the SSA mapping in this case is considered invalid. The GSP allows for SSA mapping to be refined through site-specific investigations as in this case.

4.2 Soil Permeability

Australian Standard AS1947:2012 recommends a minimum hydraulic conductivity of 0.06m/day for on-site effluent disposal without special design. The testing method set out in the *Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974* implies a minimum conductivity of 0.11m/day without specific approval by the Director-General of Public Health. Permeabilities of this order are generally found in weakly structured or massive clays.

Permeability measurements by Bayley Environmental Services in 2017 and Brown Geotechnical in 2020 returned permeabilities in the top 5m of the soil profile of $8.6x10^{-4}$ to 53 m/day.

Constant-head permeability tests in accordance with the method set out in Australian Standard AS1547:2012: – *On-site Domestic Wastewater Management* will be undertaken prior to subdivision.

4.3 Phosphorus Retention Index

The Health Department's draft *Code of Practice for Onsite Sewage Management* (2012) recommends a PRI of at least 20 for soils beneath effluent irrigation areas.

Previous experience has shown that the gravelly and silty clay soils of the Guildford Formation and other alluvial and colluvial soils generally have moderate to high PRI.

PRI testing of soils beneath proposed infiltration basins will be undertaken before subdivision. The soils will be modified by the importation of high-PRI fill if necessary to achieve an overall PRI of at least 20, in line with the Health Department's draft Code of Practice (2012).

4.4 Depth to Groundwater

The Government Sewerage Policy (GSP) (WA Govt, 2019) requires that land used for effluent disposal in sewage sensitive areas must have a minimum clearance of 1.5m from the effluent discharge point (e.g. base of leach drain or ATU drip lines) to the highest groundwater level. Under the Policy, the required clearance can be achieved by filling but not by drainage. Outside of sewage sensitive areas, the minimum groundwater clearance requirement for loams and heavy soils is 0.6m.

The groundwater measurements and modelling carried out in August 2020 indicate that the average annual maximum groundwater level (AAMGL) is within 1.5m of the ground surface in the south, west and north-east of the project area (Figure 6). Filling of effluent disposal sites will be required in these areas to permit on-site effluent disposal in accordance with the GSP.

Where filling is used to achieve the necessary groundwater clearance, subsoil drains will be installed at the AAMGL to minimise groundwater rise into the fill. Because drainage is not being used to create the required clearance, this is believed to comply with the GSP.

4.5 Slope

The Government Sewerage Policy prohibits on-site effluent disposal on land with a slope of more than 1 in 5 (20%), in order to prevent runoff of effluent.

The slope of the subject land is mostly less than 5% and does exceed 10%. Effluent disposal on the site is therefore unconstrained by slope.

4.6 Watercourse Setbacks

The Department of Water & Environmental Regulation (DWER, 2016) recommends that effluent disposal systems should be located at least 100m from waterways and wetlands. The Government Sewerage Policy requires a 100m setback from waterways, significant wetlands and drains discharging directly into waterways or significant wetlands without treatment.

For the purposes of these requirements, "waterway" is defined as a natural watercourse as defined in the *Rights in Water and Irrigation Act 1914*. Based on site inspections and historical aerial photography as described in Section 2.3.2, the northern creekline is a natural waterway, while the middle and southernmost drainage lines are artificial drains.

Under the structure plan for Tallangatta, the northern creekline will be retained in its current alignment within a POS reserve that extends between 30m and 150m from the creekline. All effluent disposal areas will be set back at least 100m from this creekline.

The middle and southern existing drainage lines will be realigned into roadside bioretention swales, where dense vegetation will treat the water flowing down the drains to reduce flow velocities and remove suspended sediments, nutrients and other contaminants.

The Government Sewerage Policy provides that reduced setbacks from drains may be allowed where it can be demonstrated that the reduced setbacks will not have a significant impact on the environment or public health. In this case, setbacks of less than 100m from bioretention swales are considered acceptable and necessary because:

- all effluent disposal will be by means of alternative effluent disposal systems with nutrient removal capability (Section 4.7);

- the clayey soils and high PRI of the site (Section 2.2.5) mean that leachate emanating from the effluent disposal systems will be of high quality;
- the water in the roadside swales will be treated by infiltration, vegetation uptake and soil adsorption before it reaches any downstream water body; and
- imposing a requirement for 100m setbacks would severely constrain and in some cases prevent the siting of effluent disposal systems on lots

A setback of 6m from subsoil drains is considered necessary and justified because:

- the subsoil drains will be located upslope of the effluent disposal fields (Section 4.8) and will drain only clean groundwater that has been filtered through the soil profile;
- all effluent disposal will be by means of alternative effluent disposal systems with nutrient removal capability (Section 4.7);
- the drained water will be treated by infiltration and vegetation uptake within the roadside swales before being released to downstream watercourses (Section 5.5.2);
- a greater separation would reduce the effectiveness of the subsoil drains in limiting groundwater rise within the effluent disposal areas; and
- the clayey soils and high PRI of the site (Section 2.2.5) mean that the drained water will be of high quality.

The differing sized lots within the subject site will offer a range of options for siting of development elements and effluent disposal systems within each lot. At the time of subdivision and development approval, the siting of individual effluent disposal systems will be subject to review and approval by the Shire of Chittering and other agencies.

It is concluded that the proposed system of effluent disposal in the project area will pose minimal risk to the environment or public health and will meet all setback requirements set out in current government policies.

4.7 System Selection and Location

All effluent generated within the subdivision will be treated and disposed by means of individual on-site effluent disposal systems. All lots in low-lying areas where the AAMGL is less than 1.5m below the natural ground surface will be required to employ nutrient-attenuating secondary treatment systems such as aerobic treatment units (ATUs) with high-PRI irrigation areas or modified leach drain systems (e.g. Filtrex). Lots in higher areas or with deeper groundwater may employ conventional septic systems and leach drains.

ATU irrigation areas will be filled to approximately 2m above the AAMGL in order to provide 1.5m clearance from the AAMGL to the effluent drip lines as required under the Government Sewerage Policy (2019), allowing for 0.3m groundwater mounding and 0.2m soil cover over the drip lines. Fill used for this purpose will be either sourced from on site or imported. The soil will be tested and modified if necessary to confirm a PRI of at least 20.

The ATU irrigation area or leach drain length on each lot will be sized to suit the expected population of the lot. As a rough rule of thumb, each full-time employee on site will require approximately 23m^2 of effluent irrigation area or 4.4m of leach drain. Treated ATU effluent may be disposed of via leach drains, which may reduce the area required for disposal by up to two thirds at the cost of a greater height of fill.

The effluent disposal requirements of each lot will vary depending on the soil profile, groundwater depth and expected site population. Site testing on each lot prior to development will be required to determine the optimum location and type of effluent disposal system.

4.8 Subsoil Drainage

Where fill is used to raise pads for effluent disposal, subsoil drains will be placed upslope of the filled pad to prevent groundwater rise into the fill. The drains will be placed at least 6m upslope from the drip lines or leach drains. The drains will be set with their inverts at or above the AAMGL and will discharge via free-draining outlets into the roadside swales, where the water will be further treated by infiltration and vegetation uptake within the swales. Because the water will be draining from high-PRI soil (see Section 2.2.5), it will be of high quality.

5.0 STORMWATER MANAGEMENT STRATEGY

5.1 Principles and Objectives

The stormwater management strategy aims to comply with the principles and objectives for stormwater management identified in the *Stormwater Management Manual for WA* (DoW, 2004) and *Better Urban Water Management* (WAPC, 2008).

Nutrient concentrations and loads in water leaving the site will be managed to comply with the targets of the draft *Swan Canning Water Quality Improvement Plan* (SRT, 2009) for the Ellen Brook catchment, as follows:

- Winter median TP concentration: 0.1 mg/L
- Winter median TN concentration: 1.0 mg/L
- Annual TP yield: 0.03 kg/ha
- Annual TN yield: 0.31 kg/ha.

5.2 Drainage Management System

The drainage system will be designed to maintain surface flow rates and volumes within and from the developed site at their pre-development levels. The drainage design presented here is conceptual and will be refined in the detailed subdivision designs. Figure 9 shows an overview of the conceptual drainage design.

The priorities for managing the various sizes of storm event will be:

- 1 year ARI Infiltrate all flows as close to the source as possible. Maintain pre-development flow rates and volumes. Minimise export of nutrients and sediments.

- 5 year ARI Detain water prior to discharge. Maintain pre-development flow rates and volumes. Maintain amenity and serviceability. Prevent scouring and damage.

- 100 year ARI Maintain pre-development flow rates and volumes. Prevent flooding and damage.

5.2.1 Through Drainage

The existing creekline entering at the north-east of the property will be retained in its current alignment and protected within a POS reserve. The two artificial drainage lines that enter towards the south-east corner of the property will be realigned into roadside bioretention swales.

The swales will be sized to accommodate the flow from a 100-year ARI critical storm from both the upstream and internal catchments. A series of low weirs within the swales will capture and infiltrate road runoff from storms up to 1-year ARI 1-hour. The inverts of the swales will be at or above the AAMGL.

The swales will be configured as living streams and densely planted with sedges and shrubs to slow the water flow and help to remove sediments and nutrients from the water.

5.2.2 Lot Drainage

Runoff from roofs, paved surfaces and hardstand areas within private lots from storms up to 1-year ARI 1-hour duration (about 15mm) will be retained and infiltrated within each lot in soakwells, swales, basins and/or landscaping areas. For preliminary design purposes it has been assumed that all parts of the lots except for landscaping and effluent irrigation areas will be developed to hardstand, internal roads or buildings. These will be subject to detailed design on individual lots.

The in-lot drainage structures will also be sized to capture the excess runoff from roofs, paved surfaces and hardstand areas from critical storms up to 100-year ARI. In most cases the critical storm (that producing the highest flow rate) will be of less than fifteen minutes' duration, and the volume of flow will be less than that from the 1-year 1-hour storm.

All runoff from within each lot will be directed to the bioretention/detention basin. Overflows from the basins will run into the roadside bioretention swales, either directly or, for those lots that do not have a downslope road frontage, via drainage easements.

The management of excess runoff from each lot will vary depending on the situation of the lot. In general:

- On lots that front a public road on the downslope side, the part of the lot near the road will be filled as necessary to raise its level above the outer embankment of the roadside swale and allow overflow drainage to flow into the roadside swale. The height of filling will generally be between 0m and 0.8m. Depending on the slope of the lot, the filling will extend between about 10m and 90m from the lot boundary. This filling will be carried out by the subdivider/developer during the construction of the roads.

  The internal basin will be located in the fill and will capture the 1-year 1-hour storm runoff and excess flow from critical storms up to 100-year ARI, and will overflow into the roadside swale.

  Figure 10 shows a conceptual layout and profile of a typical lot in this situation.

- On lots that adjoin another lot on the downslope side (i.e. that do not have a downslope road frontage), the in-lot basin will overflow via a bund or swale along the downslope lot boundaries to the nearest roadside swale. Where the flow needs to cross another lot before reaching the road reserve, an easement nominally 10m wide will be created in favour of the Shire of Chittering. Swales and/or bunds may be created within the easements as necessary to direct the overflow. These swales and bunds will be constructed by the developer at the time of creation of the lots. Figure 9 shows the conceptual layout of the drainage easements. Figure 10 shows a conceptual layout of a typical lot of this type.

5.2.3 Internal Road Drainage

Runoff from public roads from up to the 1-year ARI 1-hour storm will be retained and infiltrated in roadside bioretention swales. The inverts of the swales will be at or above the AAMGL. Figure 9 shows the preliminary layout of the roadside swale network.

The swales will be constructed with low internal weirs set at a height that captures the 1-year 1-hour storm. In preliminary drainage calculations (Appendix F), the swales have been set at 0.5m to 0.8m deep with base width of 3m to 5m, side slopes of 1 in 3 and with 0.3m high internal weirs. The weirs may incorporate underdrains to promote infiltration of the 1-year flows.

The configuration of the swales and internal weirs will be subject to detailed design prior to subdivision, including:

- the height of the swale inverts at or above the AAMGL;
- the depth and width of the swales;
- the height of the internal weirs;
- the composition of the swale floors, designed to maximise nutrient uptake;
- planting of the swales with dense sedges and shrubs to maximise nutrient uptake; and
- the possible inclusion of underdrains within the swales to promote infiltration of 1-year ARI flows.

Figure 11 shows conceptual profiles of the roadside swales.

5.2.4 Major Storm Drainage

Road runoff and lot overflows from larger storms will overtop the weirs and flow along the swales to the western boundary, where it will enter the roadside drains and culverts on Great Northern Highway. The peak flow rate of drainage out of the site will be controlled to be no greater than that existing before development.

Figure 9 shows the overall drainage layout and the 100-year ARI flow paths. Table 5.1 summarises the 100-year flows in the swales. The flow calculations are detailed in Appendix F.

The drainage from the site flows beneath Great Northern Highway via eleven culverts, as shown on Figure 9. These were constructed in the context of a rural setting, in which culverts may be designed to allow some ponding upstream on adjacent land during major storms.

Survey of the culverts adjacent to the site, coupled with data provided by Main Roads WA from its IRIS database, enabled the flow capacities of the culverts to be calculated using Manning's Open Channel Flow Formula. The calculations show that, assuming overall peak flow rates following development are controlled to be no greater than the pre-development flows, the combined capacity of the culverts is more than double the expected 100-year peak flow from the project area and upstream.

In the centre of the site (culverts CH35.41 to CH36.12), the predicted peak flow rate exceeds the instantaneous capacity of the culverts by approximately 40%. In this section, the existing roadside drain on Great Northern Highway appears to sufficient capacity to store the excess flow without backing up into the project area. If further detailed design calculations show that additional storage is necessary, the Public Open Space area adjacent to the boundary, measuring approximately 0.87ha, may be configured as a flood storage area. Table 5.2 shows the culvert flow calculations.

Table 5.1 Preliminary Swale Sizing – 100 yr ARI Critical Storm

Swale Segment (Figure 9)	*Contributing Segments*	*Contributing Lots*	*Contributing Upstream Catchments*	*Total Cumulative Peak Flow (L/s)*[1]	*Long Slope*[2]	*Swale Base Width (m)*	*Swale Depth (m)*	*Height Over 0.3m Weir (m)*[4]
A1	A1-A5	10-16, 42-49n	46U,47U,49U,49NU	2892.34	0.0179	5	0.6	0.28
A2	A2	10-13		501.31	0.0066	4	0.5	0.15
A3	A3	43		273.18	0.0044	3	0.5	0.13
A4	A4	46	46U	1230.24	0.0140	2	0.6	0.25
A5	A5	47-49N	46U,47U,48U,49NU	1748.01	0.0086	3.5	0.6	0.30
A6	A6			245.51	0.0190	4	0.5	0.07
B1	B1			163.29	0.0182	2	0.5	0.07
C1	C1	22		1946.20	0.0185	3	0.6	0.27
C2	C2	23,24		2121.04	0.0016	4.5	0.8	0.48
C3	C3,C4	20,21,32-41		1610.66	0.0071	3.5	0.6	0.30
C4	C4	33-41		1415.40	0.0079	3	0.6	0.29
D1	D1-D5	25-30,49S-51,54,55	49SU,50U,51U,DRU	1430.40	0.0172	3	0.6	0.26
D2	D2-D5	26,27,49S-51,54,55	49SU,50U,51U,DRU	1390.13	0.0209	4	0.5	0.20
D3	D3-D5	49S-51,54,55	49SU,50U,51U,DRU	1600.45	0.0080	3.5	0.6	0.29
D4	D4,D5	49S-51	49SU,50U,51U,DRU	2892.34	0.0179	5	0.6	0.28
D5	D5	49S-51	49SU,50U,51U,DRU	501.31	0.0066	4	0.5	0.15

1. Based on runoff coefficient for the 100-year ARI storm of 0.85 and 100% development of lots to hardstand.
2. Based on existing topography; this may change with filling and levelling of lots and road reserves.
3. Calculated using Manning's Open Channel Flow Formula (Fang, 2000) for a trapezoidal channel with 1:3 side slopes and Manning's *n* of 0.04.

Table 5.2 100yr ARI Culvert Flows

Culvert(s) Figure 9)	*No. & Size*	*Length (m)*	*Slope*	*Total Capacity (m^3/s)[1]*	*100 yr Flow (m^3/s)[2]*	*Storage Required (m^3)[3]*	*GNH Drain Volume (m^3)[4]*
CH36.64	5 x 1.2 x 0.5	17.3	0.0068	7618	6788	0	1089
CH36.43	1 x 0.9 x 0.45	14.8	0.0142				
CH36.12	1 x 0.6	17.2	0.0152	3584	4986	1893	2750
CH35.98	2 x 0.5	14.8	0.0172				
CH35.92	1 x 0.6	14.8	0.0110				
CH35.73	1 x 0.9 x 0.6	16	0.0086				
CH35.58	1 x 0.45	16	0.0088				
CH35.41	1 x 0.45	16	0.0025				
CH35.23	5 x 1.2 x 0.75	20.8	0.0057	12898	1630	0	1191
CH35.02	2 x 1.2 x 0.45	25.6	0.0092				
CH34.79	4 x 1.2 x 0.75	25.6	0.0094	10487	3630	0	30

1. Calculated by Manning's Open Channel Flow Equation as set out in Fang (2000) using pipe roughness coefficient of 0.016 (wet-cast concrete).
2. Calculated by Rational Method using runoff coefficients of 0.85 for road reserves and lots, 0.35 for upstream catchments and POS.
3. Calculated by modified COPAS Equation.
4. Calculated from length of drain within segment, 4m base width and 1:3 side slopes.

5.3 Surface Water Quality Management

The drainage system will be designed to maximise on-site retention of nitrogen, phosphorus, sediments and other contaminants. This will be achieved by:

- Retaining and infiltrating all lot runoff from storms up to 1-year ARI in bioretention basins within the lots.

- Retaining and infiltrating all road runoff from storms up to 1-year ARI 1-hour duration (estimated by the DWER to carry more than 99% of total flows and nutrients) in vegetated bioretention swales with a minimum soil PRI of 15.

- Conveying all runoff from storms between 1-year and 100-year ARI in densely vegetated bioretention swales to allow suspended particles to be filtered out.

5.4 Maintenance

The drainage system has been designed to require minimal maintenance. The following will be required to ensure that the system continues to function as designed:

- Regular cleaning of side entry and junction pits, inlet pits and small culverts. More frequent (perhaps annual)cleaning may be required during the construction phase.

- Tending and maintenance of swales and other vegetated drainage features to remove litter, control weeds and encourage the growth of native species.

- Pruning, mulching or removal of vegetation in swales as necessary to maintain ground fuel loads below 8 tonnes/ha.

6.0 GROUNDWATER MANAGEMENT STRATEGY

6.1 Groundwater Levels

The drainage system for the site is designed to minimise changes to the existing groundwater regime. Roadside swales and subsoil drains will be set with their inverts at or above the AAMGL. Subsoil drainage within lots will be limited to filled areas used for buildings or effluent disposal.

6.2 Subsoil Drainage

Subsoil drainage will be employed within some lots where necessary to maintain existing maximum groundwater levels beneath building pads and effluent disposal areas. Subsoil drains may also be employed within road reserves to prevent groundwater rise from damaging the road base and pavement.

All subsoil drains will be set with their invert at or above the AAMGL. Therefore, changes to the groundwater hydrology of the site will be minimal. The subsoil drains will discharge into roadside swales via free-draining outlets.

6.3 Groundwater Quality

The sampling undertaken to date indicates that the groundwater beneath the site contains low to moderate concentrations phosphorus but elevated levels of nitrogen. This is to be expected given the nature of the soils and the land use history of the site.

The relationship between nutrient inputs and exports is complex, especially in the case of phosphorus, which travels through the soil profile as a “front” in a complex series of adsorption and desorption reactions. Nitrogen is subject to denitrification and mineralisation in the soil and groundwater. As a result, nutrient exports from the site at present will be a reflection of nutrient inputs over the last several decades, modified by soil hydrology and nutrient retention capacity.

The aim of nutrient management will be to limit nutrient inputs to the site so that nutrient outputs are minimised. As an industrial precinct, the area of fertilised gardens and lawns will be small. Landscaping areas including street trees, swales and vegetation buffers will be established with minimal fertilisers and irrigation.

Measures available to minimise nutrient inputs and exports in the development will include:

- regular street sweeping to remove accumulated contaminants; and
- selection of native species with low water and fertiliser requirements for public open space and landscape areas.

7.0 LANDSCAPING STRATEGY

Landscaping of the site will focus on the use of species with low water demand. Planting areas will include bioretention swales and basins, landscape buffers (to a minimum of 10% of the area of each lot) and street trees. The plantings will not be irrigated after the establishment phase. No turf grass will be planted.

The plantings in swales, basins and effluent irrigation areas will include a high proportion of species recommended in the Monash University (2014) *Vegetation Guidelines for Stormwater Biofilters in the South-West of Western Australia*.

Fertiliser use will be minimal. New tube stock plantings will be fertilised with slow-release nitrogen and phosphorus tablets on establishment and thereafter will be unfertilised.

The bioretention basins and swales will be densely planted with inundation-tolerant species including sedges and low shrubs in order to stabilise the basins and maximise their ability to take up nitrogen from the water.

The total area to be planted is approximately 40 hectares. If all of this area were planted simultaneously during the establishment phase, approximately 180 ML of water would be required to irrigate the new plantings for the first year. As the project area is likely to be developed in a number of stages, the requirement for irrigation water is likely to be spread out over a number of years, with only a small part of the total demand being required in any one year.

The density of planting will be controlled to keep flammable ground fuel loads below 8 tonnes/ha, in accordance with the Bushfire Hazard Assessment (Eco logical Australia, 2020).

Figure 12 shows the conceptual landscaping strategy. The landscaping strategy is described in more detail in the Landscape Master Plan (BES, 2021).

8.0 MONITORING

Baseline water quality results for the site are shown in Tables 2.4 and 2.5. Groundwater levels and quality will continue to be monitored and compared against baseline levels and relevant guidelines. Water quality in surface drains will be monitored upstream and downstream of the project area to determine what (if any) impacts the development may be having on the watercourses.

Water quality sampling will be conducted nominally once a year in late winter. Detailed water monitoring and response procedures will be developed as part of the Urban Water Management Plans to be prepared for each stage of subdivision.

9.0 IMPLEMENTATION AND FURTHER MANAGEMENT PLANS

Further planning and subdivision of the subject land will be carried out in accordance with the general water management principles set out in this LWMS. Subdivision of lots in the structure plan area may be carried out by individual owners as they see fit, in accordance with the framework of the LWMS.

An Urban Water Management Plan (UWMP) will be prepared as a condition of subdivision approval for each stage of subdivision. The UWMP will present the detailed design of the stormwater drainage system within that stage.

The developer of each stage of subdivision will maintain the drainage system, landscaped areas and water monitoring program within that stage until two years after that stage of subdivision is completed. At the end of that time the responsibility for monitoring and management will be handed over to the Shire of Chittering.

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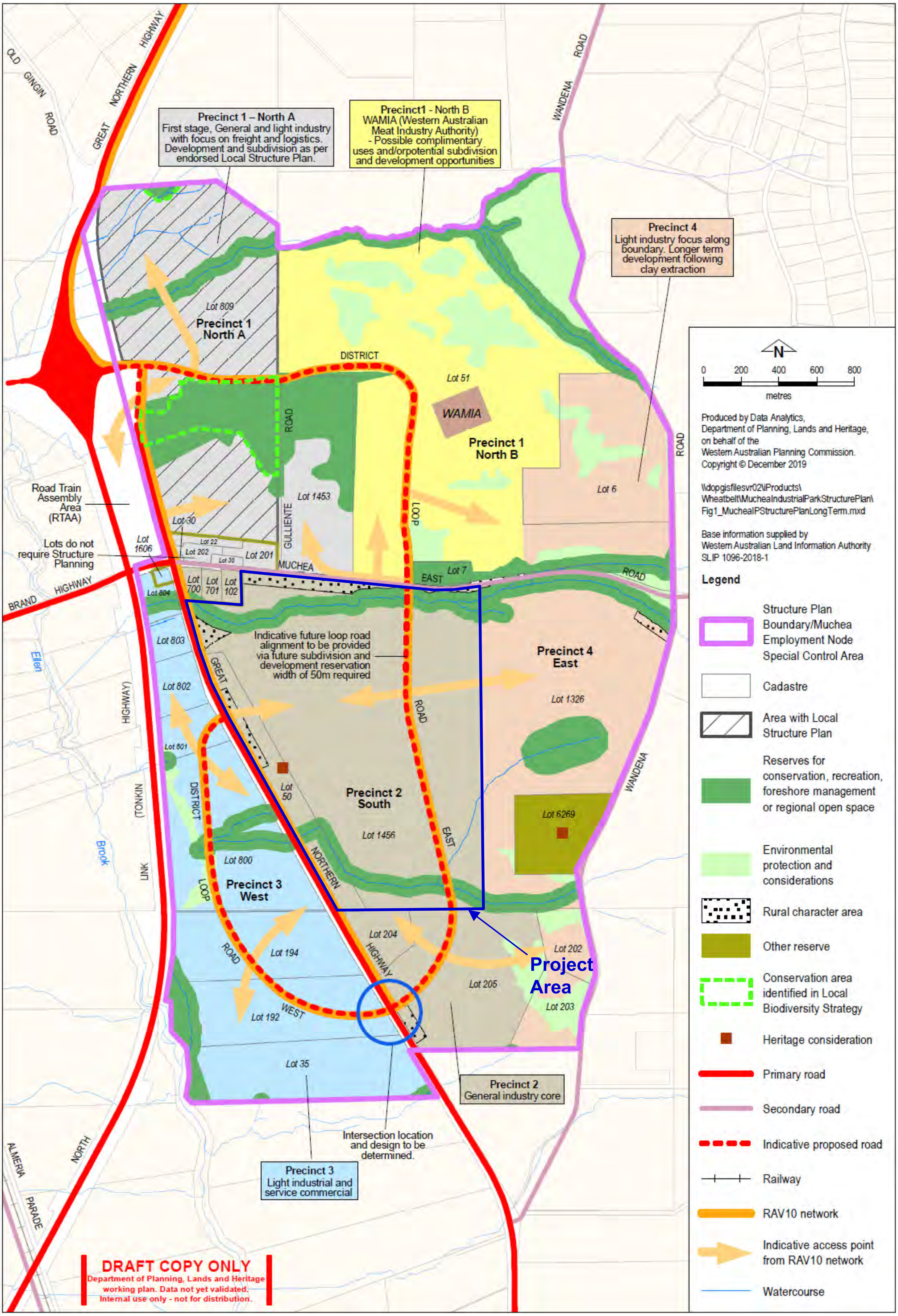
Figures



Source: WAPC, 2019

Figure 1

DRAFT MUCHEA INDUSTRIAL PARK STRUCTURE PLAN

Figure 2

THE SITE AND SURROUNDINGS

Image source: Google 2018

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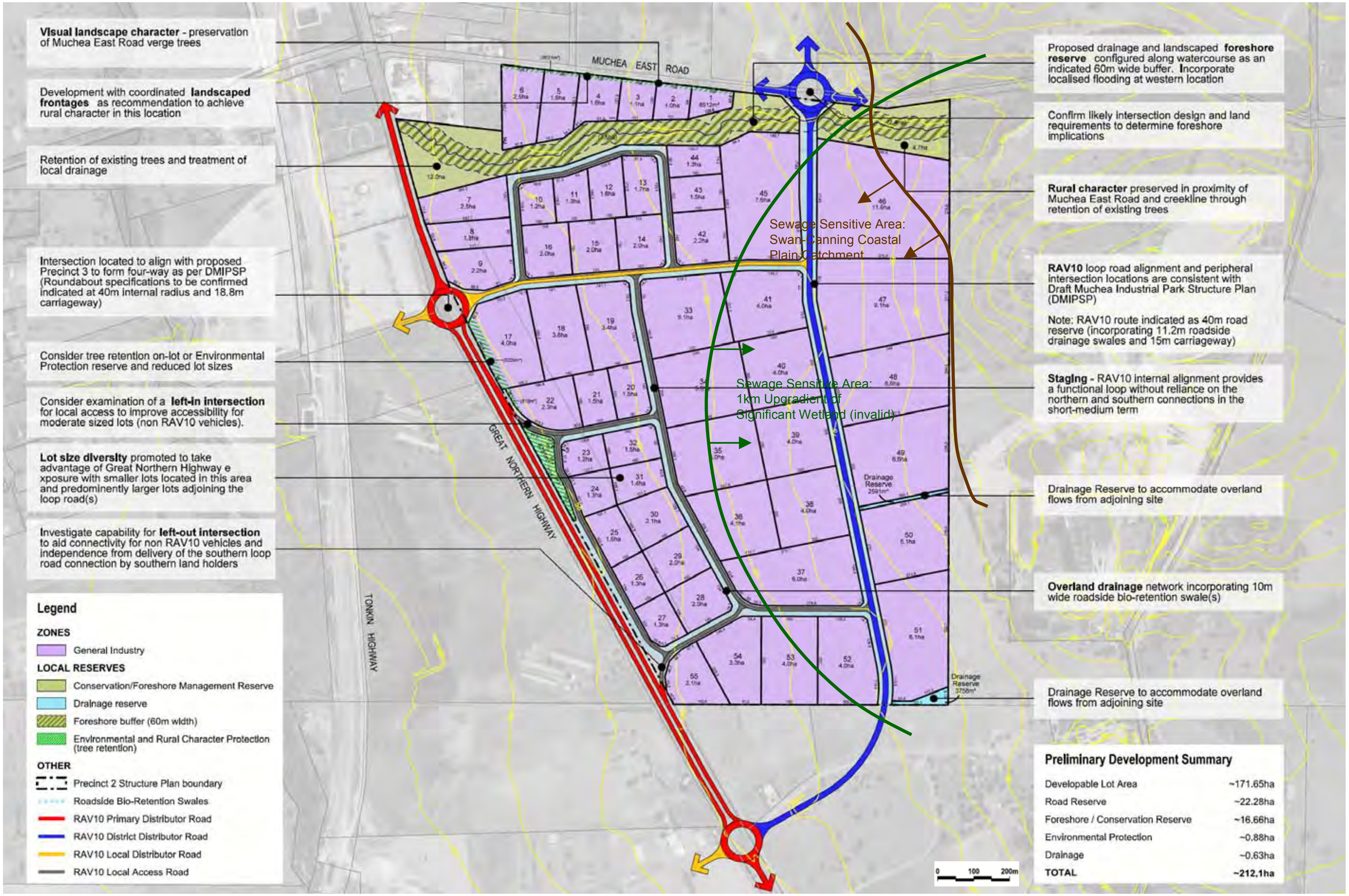

Visual landscape character - preservation of Muchea East Road verge trees

Development with coordinated **landscaped frontages** as recommendation to achieve rural character in this location

Retention of existing trees and treatment of local drainage

Intersection located to align with proposed Precinct 3 to form four-way as per DMIPSP (Roundabout specifications to be confirmed indicated at 40m internal radius and 18.8m carriageway)

Consider tree retention on-lot or Environmental Protection reserve and reduced lot sizes

Consider examination of a **left-in intersection** for local access to improve accessibility for moderate sized lots (non RAV10 vehicles).

Lot size diversity promoted to take advantage of Great Northern Highway e xposure with smaller lots located in this area and predominently larger lots adjoining the loop road(s)

Investigate capability for **left-out intersection** to aid connectivity for non RAV10 vehicles and independence from delivery of the southern loop road connection by southern land holders

Proposed drainage and landscaped **foreshore reserve** configured along watercourse as an indicated 60m wide buffer. Incorporate localised flooding at western location

Confirm likely intersection design and land requirements to determine foreshore implications

Rural character preserved in proximity of Muchea East Road and creekline through retention of existing trees

RAV10 loop road alignment and peripheral intersection locations are consistent with Draft Muchea Industrial Park Structure Plan (DMIPSP)

Note: RAV10 route indicated as 40m road reserve (incorporating 11.2m roadside drainage swales and 15m carriageway)

Staging - RAV10 internal alignment provides a functional loop without reliance on the northern and southern connections in the short-medium term

Drainage Reserve to accommodate overland flows from adjoining site

Overland drainage network incorporating 10m wide roadside bio-retention swale(s)

Drainage Reserve to accommodate overland flows from adjoining site

Legend

ZONES

- 🟪 General Industry

LOCAL RESERVES

- 🟩 Conservation/Foreshore Management Reserve
- 🟦 Drainage reserve
- ▨ Foreshore buffer (60m width)
- ▨ Environmental and Rural Character Protection (tree retention)

OTHER

- Precinct 2 Structure Plan boundary
- Roadside Bio-Retention Swales
- RAV10 Primary Distributor Road
- RAV10 District Distributor Road
- RAV10 Local Distributor Road
- RAV10 Local Access Road

Preliminary Development Summary

Developable Lot Area	~171.65ha
Road Reserve	~22.28ha
Foreshore / Conservation Reserve	~16.66ha
Environmental Protection	~0.88ha
Drainage	~0.63ha
TOTAL	**~212.1ha**

Figure 3

PROPOSED PLAN OF SUBDIVISION

Taylor Burrell Barnett

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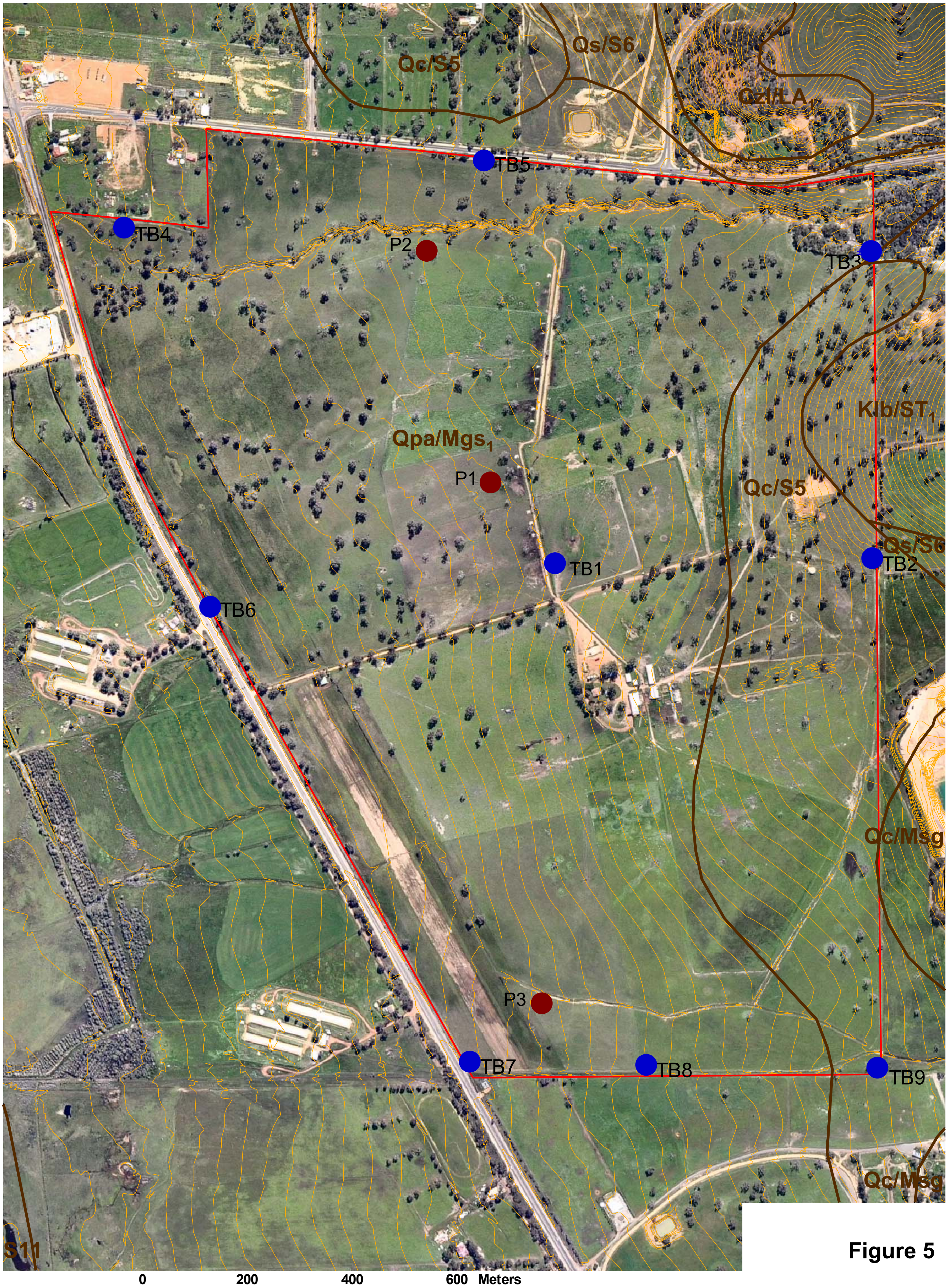

🟥	Site boundary
●	Borehole
●	Permeability Test (Brown Geotechnical, 2020)
—	1m Topographic contour (m AHD)
—	Geological boundary

Figure 5

PHYSIOGRAPHY

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Figure 6

GROUNDWATER HYDROLOGY

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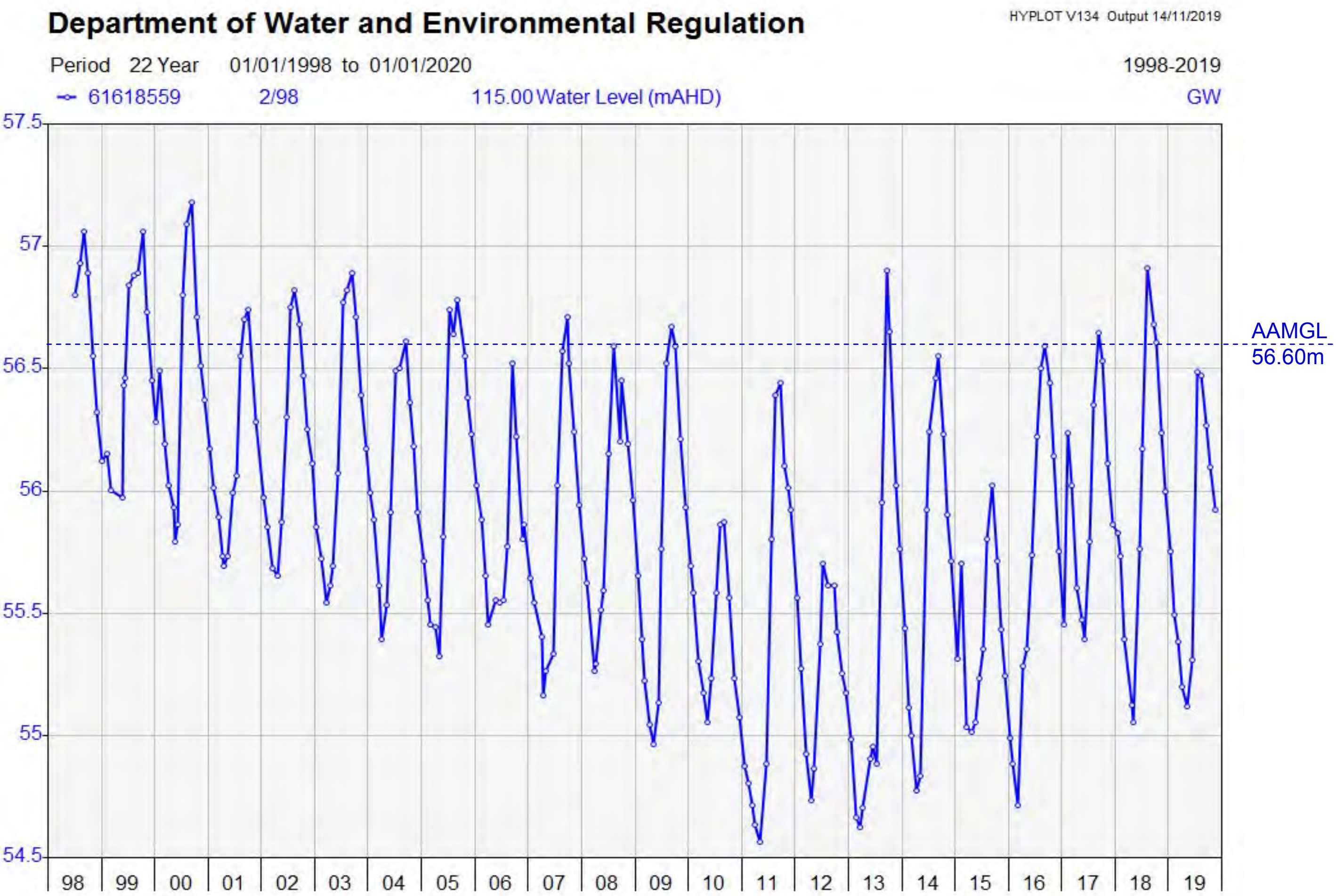

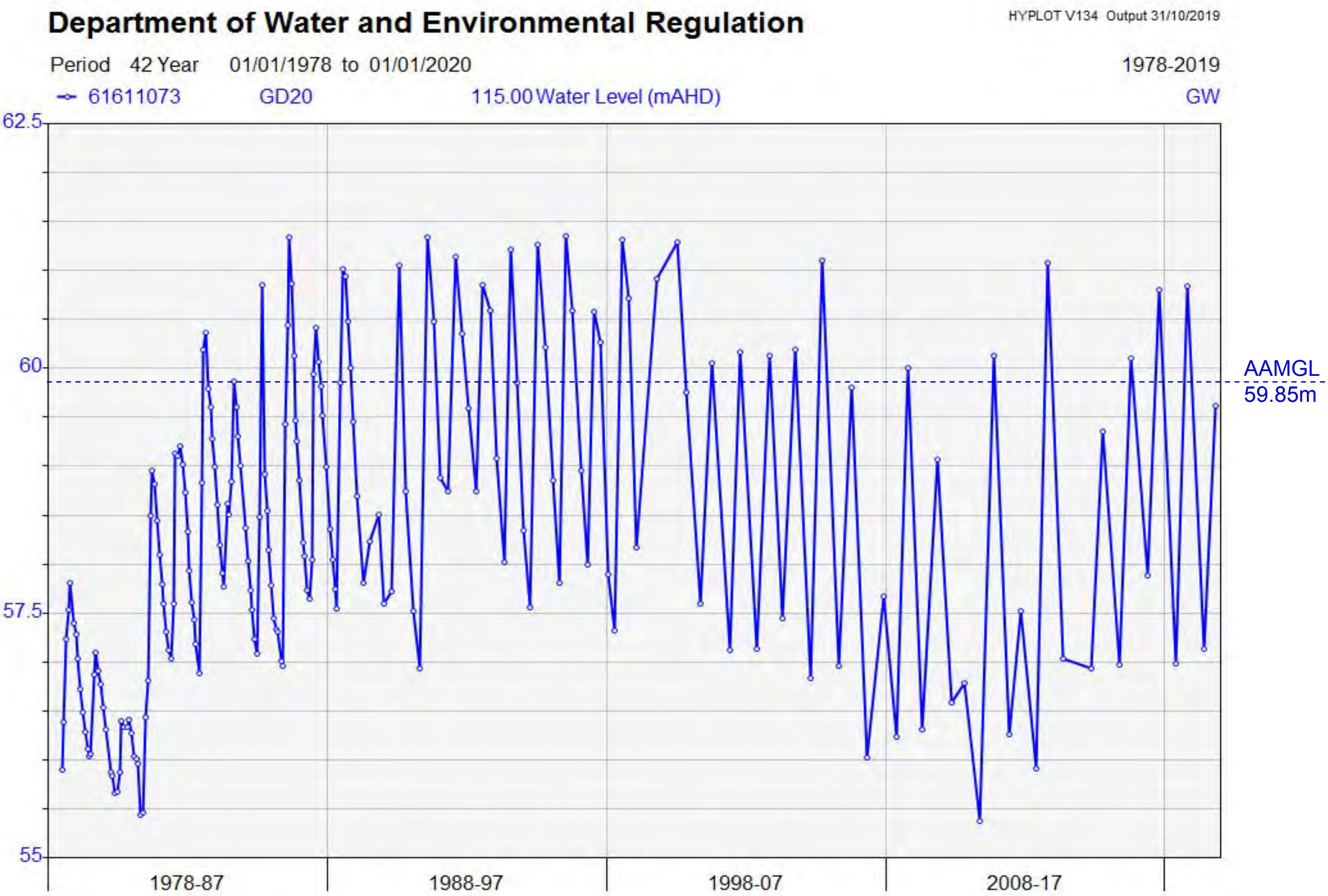

Figure 7

DWER BORE HYDROGRAPHS

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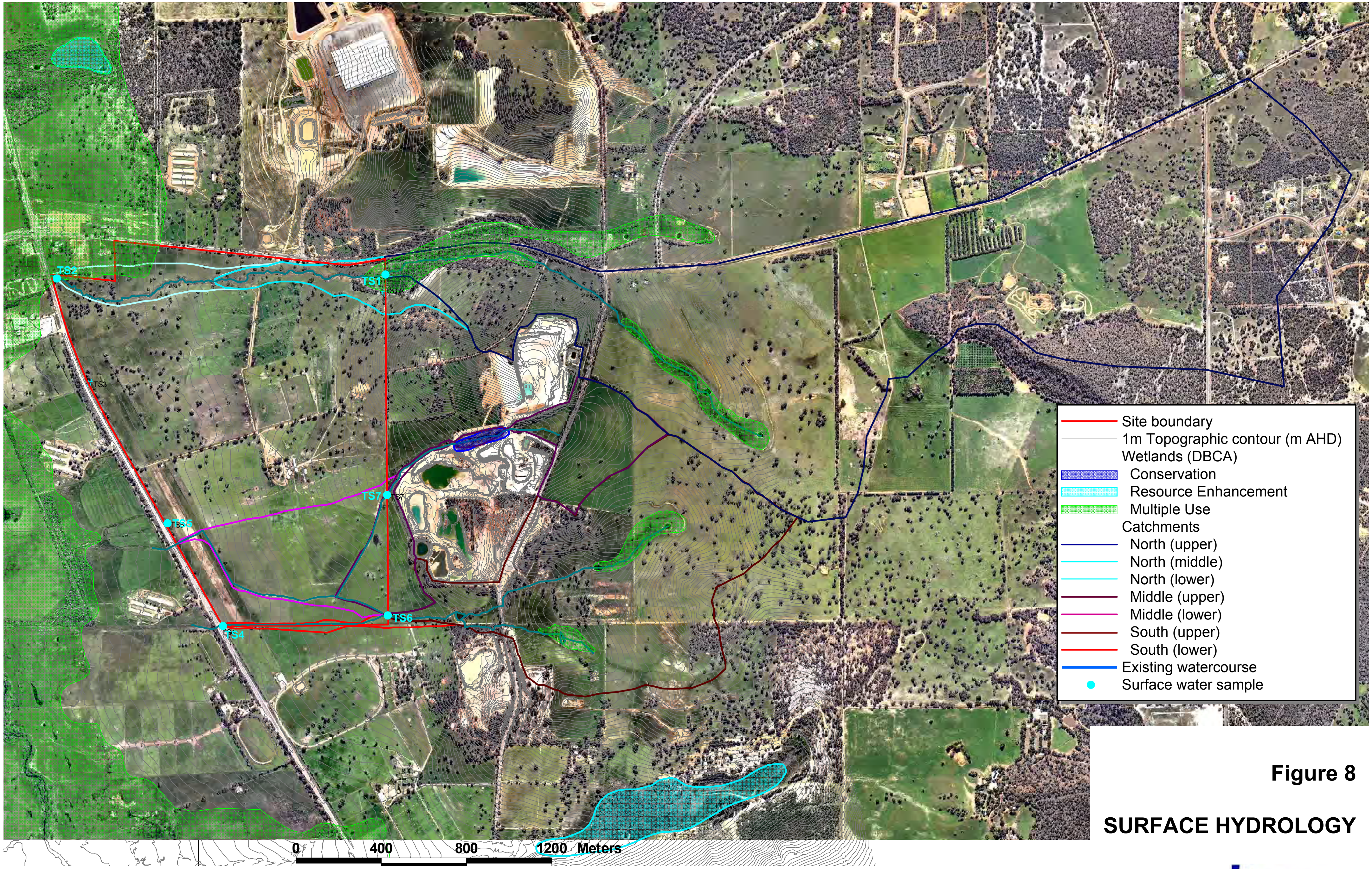

Figure 8

SURFACE HYDROLOGY

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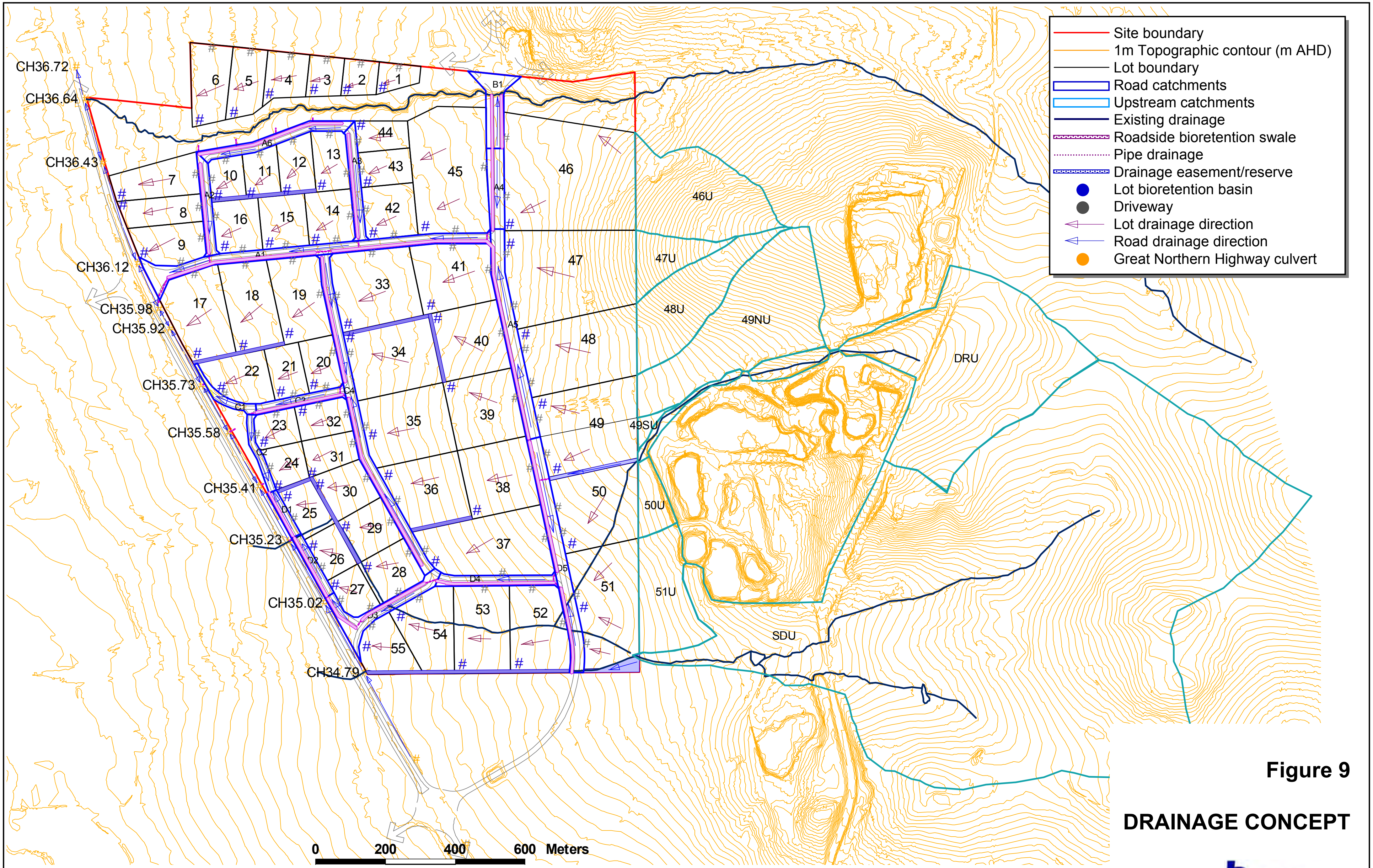

Figure 9

DRAINAGE CONCEPT

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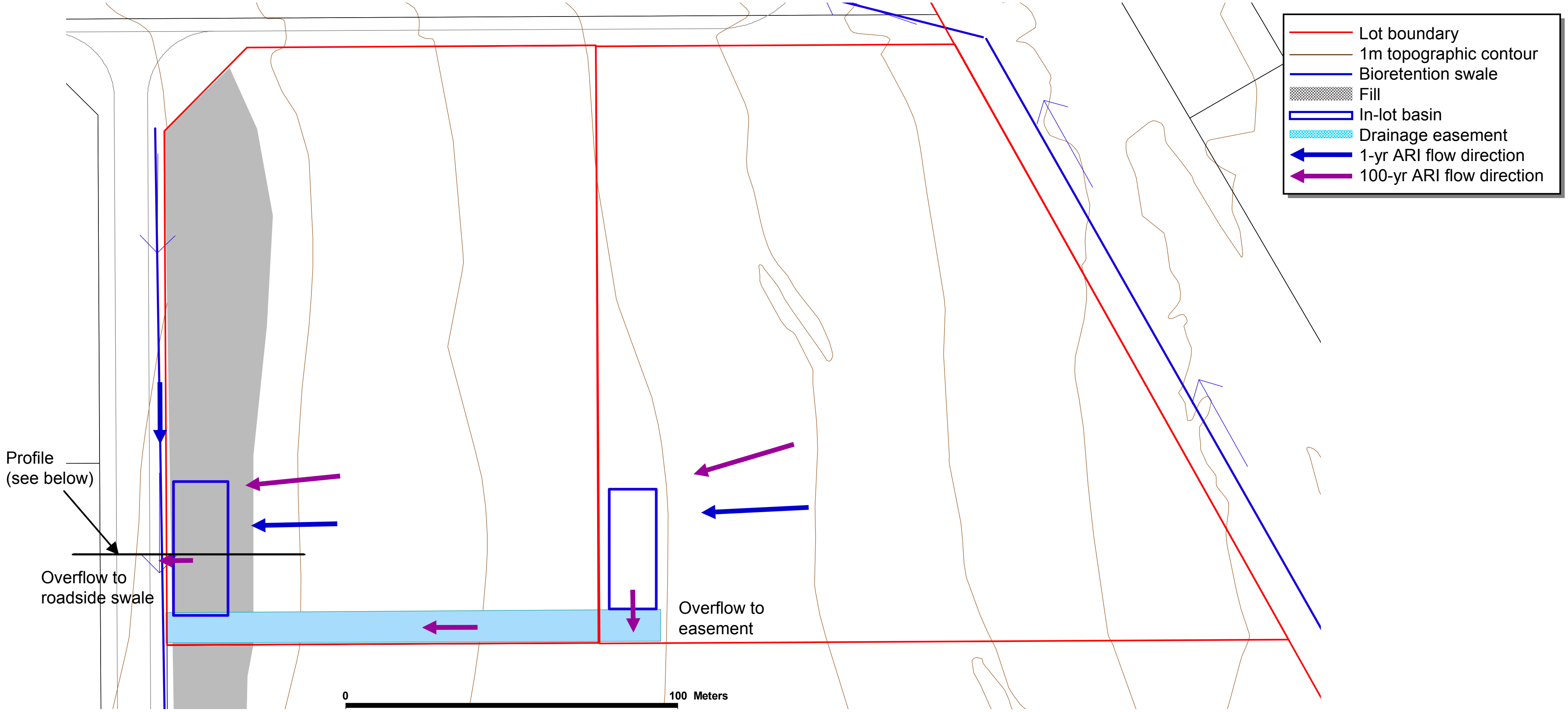

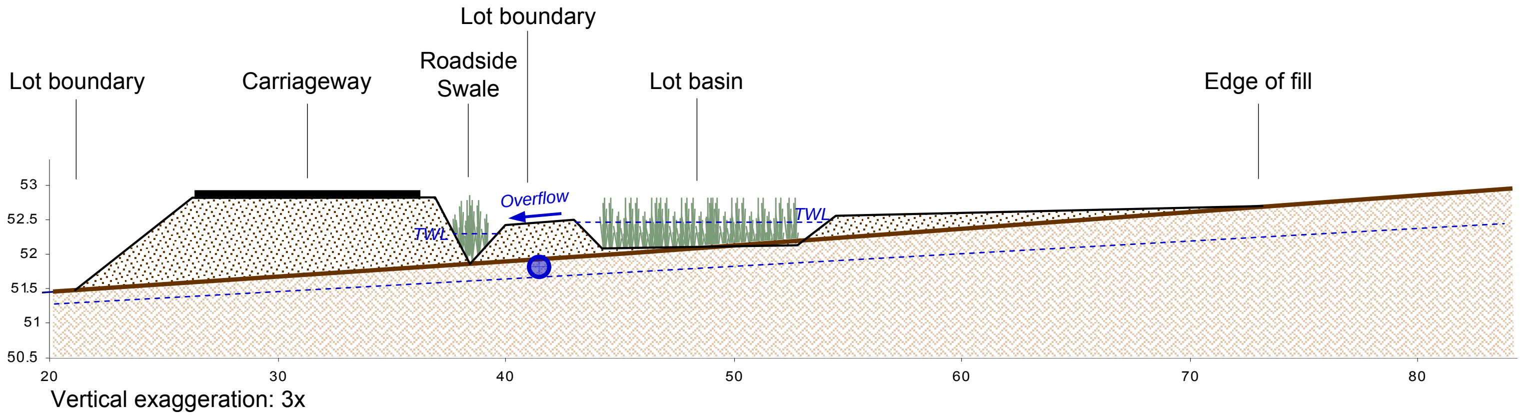

Figure 10

LOT DRAINAGE EXAMPLES

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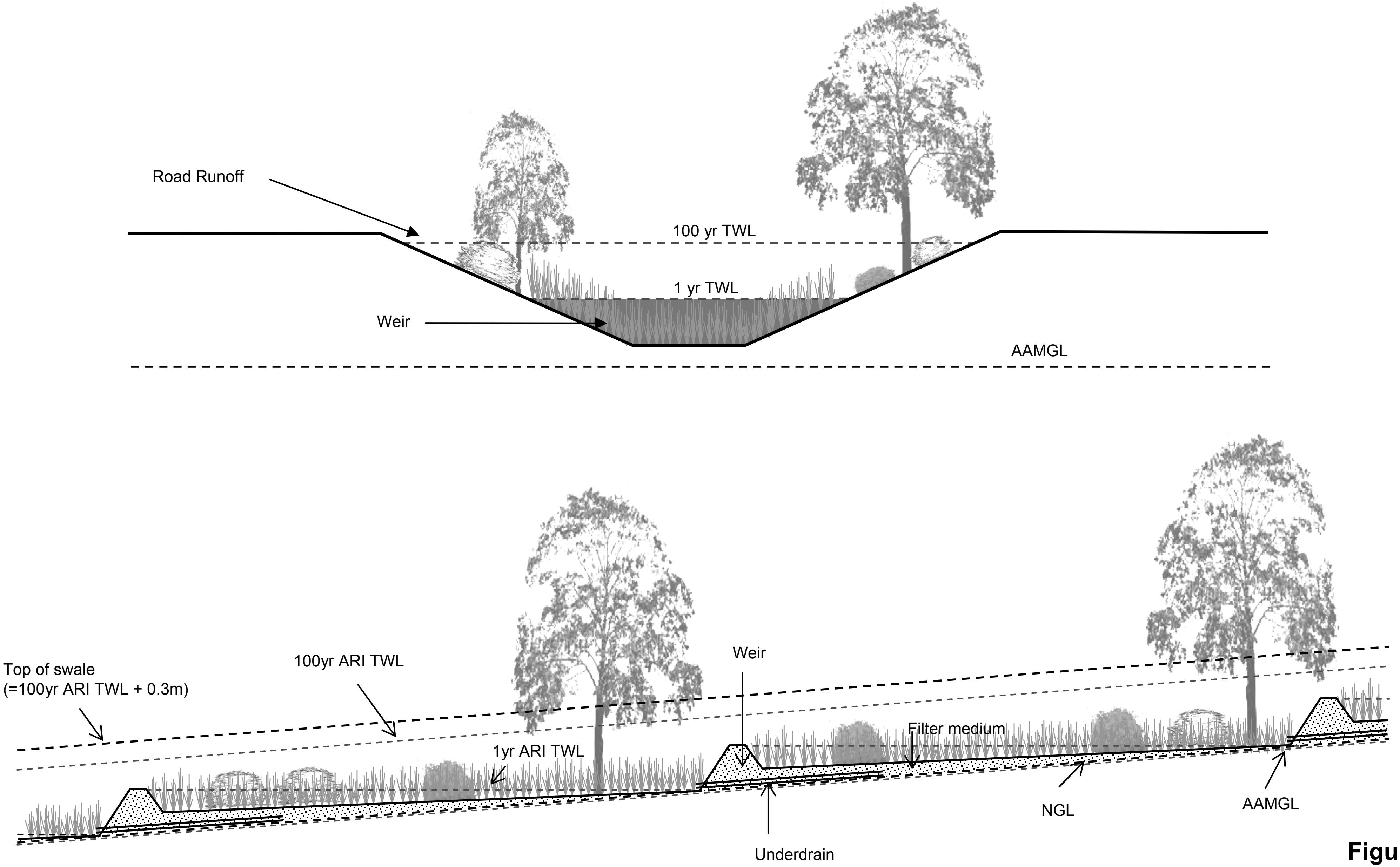

Figure 11

CONCEPTUAL SWALE PROFILES

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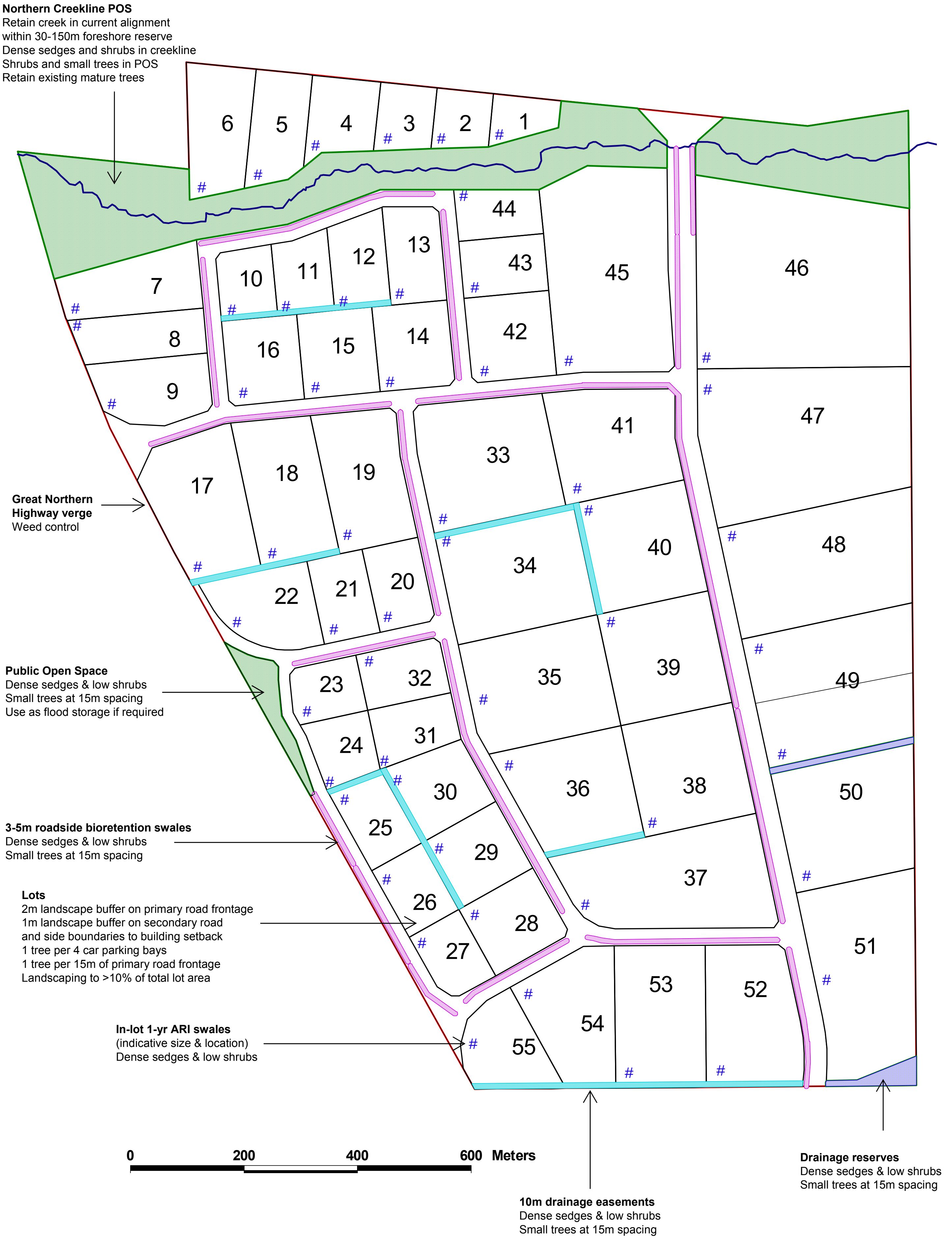

Northern Creekline POS
Retain creek in current alignment
within 30-150m foreshore reserve
Dense sedges and shrubs in creekline
Shrubs and small trees in POS
Retain existing mature trees

Great Northern Highway verge
Weed control

Public Open Space
Dense sedges & low shrubs
Small trees at 15m spacing
Use as flood storage if required

3-5m roadside bioretention swales
Dense sedges & low shrubs
Small trees at 15m spacing

Lots
2m landscape buffer on primary road frontage
1m landscape buffer on secondary road
and side boundaries to building setback
1 tree per 4 car parking bays
1 tree per 15m of primary road frontage
Landscaping to >10% of total lot area

In-lot 1-yr ARI swales
(indicative size & location)
Dense sedges & low shrubs

10m drainage easements
Dense sedges & low shrubs
Small trees at 15m spacing

Drainage reserves
Dense sedges & low shrubs
Small trees at 15m spacing

Figure 12

LANDSCAPE MASTER PLAN

bayley environmental services

Appendix A

DWER LWMS Checklist

Appendix 2 Local water management strategy checklist

Local water management strategy item	Deliverable	☑	Notes
Executive summary			
Summary of the development design strategy, outlining how the design objectives are proposed to be met	Table 1: Design elements and requirements for best management practices and critical control points	☑	Page 8
Introduction			
Total water-cycle management – principles and objectives Planning background Previous studies		☑	Section 1
Proposed development			
Structure plan, zoning and land use Key landscape features Previous land use	Site context plan Structure plan	☑ ☑	Figures 1-3 Section 2
Landscape – proposed public open space areas, public open space credits, water source, bore(s), lake details, irrigation areas (if applicable)	Landscape plan	☑	Sections 3, 7
Design criteria			
Agreed design objectives and source of objectives		☑	Section 1.5 Table 1.1
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		☑	Section 2
Site conditions – existing topography/contours, aerial photo underlay, major physical features	Site condition plan	☑	Section 2
Geotechnical – topography, soils including acid sulfate soils and infiltration capacity, test pit locations	Geotechnical plan	☑	Section 2 Appendix C
Environmental – areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental plan plus supporting data where appropriate	☑	Section 2
Surface water – topography, 100-year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface-water plan	☑	Section 2
Groundwater – topography, pre-development groundwater levels and water quality, test bore locations	Groundwater plan plus site investigations	☑	Section 2

Local water management strategy item	**Deliverable**	**☑**	**Notes**
Water sustainability initiatives			
Water efficiency measures – private and public open spaces including method of enforcement		☑	Section 3
Water supply (fit-for-purpose) strategy, agreed actions and implementation		☑	Section 3
Wastewater management		☑	Section 4
Stormwater management strategy			
Flood protection – peak flow rates, volumes and top water levels at control points, 100-year flowpaths and100-year detention storage areas	100-year-event plan Long section of critical points	☑ ☑	Section 5
Manage serviceability – storage and retention required for the critical 5-year ARI storm events Minor roads should be passable in the 5-year ARI event	5-year-event plan	☑	Section 5
Protect ecology – detention areas for the 1-year 1-hour ARI event, areas for water quality treatment and types of agreed structural and non-structural best management practices and treatment trains (including indicative locations). Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1-year-event plan Typical cross sections	☑ ☑	Section 5
Groundwater management strategy			
Post-development groundwater levels, existing and likely final surface levels, outlet controls, and subsoil drain areas/exclusion zones	Groundwater/subsoil plan	☑	Section 6
Actions to address acid sulfate soils or contamination		☑	Sections 2.2.4 and 2.9
The next stage – subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required before detailed design.		☑	Section 9
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		☑	Section 8
Implementation			
Developer commitments		☑	Section 9
Roles, responsibilities, funding for		☑	Section 9

Local water management strategy item	Deliverable	☑	Notes
implementation			
Review		☑	Section 9

Appendix B

Soil Logs

SOIL PROFILE LOG

PROJECT NUMBER:	J20008
SITE ID:	TB1
EASTING:	405754
NORTHING:	6505172
METHOD:	Auger rig
TOTAL DEPTH (mbgl):	6
REFUSAL (Y/N):	N
DATE:	13/06/2017
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0.5	Brown gravelly sand		
1 - 1.5	Orange gravelly loam		
2	Orange-brown clay-loam		
2.5	Orange-brown loamy clay		
3	Red-brown loamy clay		
3.5 - 5	Pink clay		
5.5 - 6	Red clay		

SOIL PROFILE LOG

PROJECT NUMBER:	J20008
SITE ID:	TB2
EASTING:	406361
NORTHING:	6505180
METHOD:	Auger rig
TOTAL DEPTH (mbgl):	6
REFUSAL (Y/N):	N
DATE:	13/06/2017
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0.5 - 2	Orange slightly clayey sand		
2.5	Orange-brown gravelly loam		
3	Orange-brown gravelly clay-loam		
3.5 - 4	Red-brown loamy clay		
4.5	Red gravelly loamy clay		
5-Jun	Red loamy clay		

SOIL PROFILE LOG

PROJECT NUMBER:	J20008
SITE ID:	TB3
EASTING:	406340
NORTHING:	6505764
METHOD:	Auger rig
TOTAL DEPTH (mbgl):	2
REFUSAL (Y/N):	Y
DATE:	13/06/2017
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0.5	Grey sand		
1	Grey-brown sand, damp		
1.5	Brown slightly gravelly sand, damp		
2	Red-brown gravelly clay		
2.4	Refusal on granite(?)		

SOIL PROFILE LOG

PROJECT NUMBER:	J20008
SITE ID:	TB4
EASTING:	404938
NORTHING:	6505808
METHOD:	Auger rig
TOTAL DEPTH (mbgl):	4
REFUSAL (Y/N):	n
DATE:	13/06/2017
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0.5	Grey-brown gravelly sand		
1	Orange gravelly sand		
1.5	Orange gravelly loamy sand		
2	Orange loamy clay		
2.5 - 3	Orange-brown/grey mottled well structured clay		
3.5	Pink-brown hard clay, dry		
4	Pink hard clay, dry		

SOIL PROFILE LOG

PROJECT NUMBER:	J20008
SITE ID:	TB5
EASTING:	405623
NORTHING:	6505941
METHOD:	Auger rig
TOTAL DEPTH (mbgl):	4
REFUSAL (Y/N):	N
DATE:	13/06/2017
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0.5	Brown gravelly sand		
1	Orange-brown sandy gravel		
1.5	Orange-yellow gravelly loamy sand		
2 - 2.5	Orange-yellow sandy clay		
3	Orange-brown sandy clay		
3.5 - 4	Yellow-brown sandy clay		

SOIL PROFILE LOG

PROJECT NUMBER:	J20008
SITE ID:	TB6
EASTING:	405100
NORTHING:	6505093
METHOD:	Auger rig
TOTAL DEPTH (mbgl):	4
REFUSAL (Y/N):	N
DATE:	13/06/2017
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0.5	Brown gravelly sand		
1 - 1.5	Orange-brown gravelly loam		
2	Orange-brown gravelly loamy clay		
2.5	Red-brown moderately structured gravelly clay		
3	Red-yellow-brown well structured gravelly clay, damp		
3.5	Red-brown/grey mottled clay		
4	Red clay, dry		

SOIL PROFILE LOG

PROJECT NUMBER:	J20008
SITE ID:	TB7
EASTING:	405596
NORTHING:	6504222
METHOD:	Auger rig
TOTAL DEPTH (mbgl):	4
REFUSAL (Y/N):	N
DATE:	13/06/2017
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0.5	Pale brown gravelly sand		
1	Yellow-brown gravelly sandy loam		
1.5	Yellow-brown gravelly loamy clay		
2	Brown gravelly loamy clay		
2.5 - 3	Red-brown slightly mottled gravelly clay		
3.5 - 4	Red/orange/grey slightly mottled gritty clay		

SOIL PROFILE LOG

PROJECT NUMBER:	J20008
SITE ID:	TB8
EASTING:	405932
NORTHING:	6504216
METHOD:	Auger rig
TOTAL DEPTH (mbgl):	4
REFUSAL (Y/N):	N
DATE:	13/06/2017
DEPTH TO WATER (mbgl)	_

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0.5 - 1	Yellow-brown gravelly sand		
1.5	Orange-brown gravelly loam		
2	Orange-brown gravelly clay-loam		
2.5 - 4	Red-brown sandy loamy clay		

SOIL PROFILE LOG

PROJECT NUMBER:	J20008
SITE ID:	TB9
EASTING:	406375
NORTHING:	6504202
METHOD:	Auger rig
TOTAL DEPTH (mbgl):	3
REFUSAL (Y/N):	N
DATE:	13/06/2017
DEPTH TO WATER (mbgl)	-

SOIL PROFILE		SAMPLE DATA	
DEPTH (m)	SOIL DESCRIPTION	SAMPLE ID	INTERVAL (m)
0.5	Yellow-brown slightly gravelly silty sand		
1 - 1.5	Yellow-brown sandy loam with occasional gravel		
2	Brown slightly gravelly clay-loam		
2.5 - 3	Red-brown silty clay, dry & very hard		

Appendix C

Geotechnical Report
(Brown Geotechnical, 2021)

PRELIMINARY GEOTECHNICAL INVESTIGATION

For Local Structure Plan

LOTS 50 and M1456
GREAT NORTHERN HIGHWAY
MUCHEA
WESTERN AUSTRALIA

DECEMBER 2020
Ref: 20049

FOR
Tallangatta Beef Pty Ltd
c/- iParks Property Group Pty

Brown Geotechnical

CONDITIONS RELATING TO THIS REPORT

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

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

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

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

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

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

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1 Introduction

In November 2020 Brown Geotechnical was commissioned by iParks Property Group on behalf of the client – Tallangatta Beef Pty Ltd to undertake a preliminary geotechnical investigation for the development of a Local Structure Plan at Lots 50 and M1456 Great Northern Highway, Muchea (the site), refer Figure 1. This report presents the results of the investigation conducted at the site. The fieldwork was carried out over the 19th and 20th November 2020. Details of the site were supplied by planners iParks Property Group Pty.

Note: It should be noted that this is a preliminary geotechnical investigation for the development of a Local Structure Plan. In portions of the site where soils are non-homogenous, or where boundaries lines are drawn on Figures, for example between zones of different soil types or site classification, additional investigation should be undertaken. The conclusions in this report are based on limited sampling and testing, and should be used as starting point for further detailed investigations as the project proceeds.

2 Brief

The brief discussed with the planners required the report to address:

- Subsurface conditions.
- An estimate of existing soil classification in accordance with AS2870 (2011).
- Any earthworks required to obtain a classification suitable for development including estimated additional fill thickness requirements.
- The presents of uncontrolled fill.
- Estimated CBR for road pavement design.
- Suitability of existing soils for use in the development.
- An assessment of acid sulphate soil issues
- Estimated site permeability and likely drainage issues.

3 Desk Studies

The site covers approximately 213ha and consists of large fenced paddocks. The paddocks are mostly grass covered with some areas of trees. A small creek runs east west across the north of the site. The depth varies from 0.5m to 1m.

The geological map for the area indicates the majority of the site to be underlain by the Guildford Formation consisting of clay, sand, silt and gravels. Quartz sand is noted in the centre and along the eastern boundary, with lateritic gravels towards the north eastern corner.

The Perth Groundwater Map indicates the historical maximum groundwater level to be about 50m AHD, approximately 8m below ground level. It is understood that pre-development groundwater monitoring is to be carried out on the site by others.

The acid sulphate soil risk map for the area, indicates soils to be in the No Known Risk category.

The site rises eastwards from approx. 50m along the Great Northern Highway to 93m AHD in the north east. Some steeper slopes rise in the north east, likely associated with the outcropping laterite deposits noted on the geological map.

4 Fieldwork and Laboratory Testing

4.1 Scope of Work

As detailed in the Brown Geotechnical proposal, the following scope of work was undertaken:

- A desk study to determine likely soil types below the site.
- Follow-up fieldwork including a walk-over survey to determine any obvious geological features, hazards and ASS indicators.
- Test holes excavated at approximate 200m centres to confirm soil type identified in the desk study. Some areas allowed limited access, however enough information was collected for the preliminary report.
- Limited soil sampling was carried out for laboratory analysis to determine soil classification and geotechnical properties.
- Laboratory testing included: particle size distribution, Atterberg Limits, percent fines content and organic content.
- In the absence of any high-risk ASS indicators, no preliminary acid sulphate soil testing was required as initially indicated in the proposal.
- Organic content determination was carried out for potential blending ratios of topsoil with clean sand fill for use in the future development.
- Permeability testing was carried out typical soil types encountered for site drainage information.

Test locations are shown on Figure 1, with test hole logs enclosed in Appendix A and penetrometer plots in Appendix B.

4.2 Laboratory Testing

Soil samples were delivered to the NATA accredited Western Geotechnical Laboratory Services for geotechnical testing. The laboratory test certificates are presented in Appendix C.

5 Geotechnical Results

5.1 Subsurface Condition

Subsurface conditions encountered in the test holes and inferred from laboratory test results and PSP plots are described as follows:

5.1.1 Topsoil and Fill

Test holes encountered topsoil consisting of grey silty sand with organics, locally with rootlets. The topsoil varied in thickness from 0.1m to 0.15m, the average across the site being 0.1m.

No uncontrolled fill was encountered in test holes and there were no obvious signs of old structures, foundations or infill areas within the paddocks.

5.1.2 Sand with Silt

Fine to medium grained, sand with low to moderate silt content was encountered in all test holes below the topsoil in the central and north western portion of the site (refer Figure 2). Penetrometer tests show the material to be medium dense. The thickness varied from approximately 0.3m to 0.5m.

The sand extends to greater depths in the north eastern portion of the site, locally >2m and at one locality on the western boundary (refer Figure 2).

5.1.3 Sandy Gravel

Fine to medium grained, gravel with sand was encountered in all test holes below the topsoil in the southern portion of the site (refer Figure 2). Penetrometer tests show the material to be medium dense to dense. The thickness varied from approximately 0.1m to 0.55m.

5.1.4 Laterite (Cemented Sandy Gravel)

A very dense, often cemented, sandy gravel or Laterite was encountered at the surface in TH15 and TH16 on the eastern boundary. The excavator refused in the material at about 0.6m.

5.1.5 Gravelly Sand with Clay

Very dense, fine to medium grained sandy gravel with clay was encountered below the silty sand and sandy gravel areas of the site. The material was occasionally present at the surface in the center of the site in the vicinity of TH7, 11 and 12. Test results show the material to have a moderate fines content, intermediate to low plasticity with a low expansive nature. The material often became hard after about 1m due to pockets of iron rich cementation resulting in slow excavation and often caused refusal of the 5 tonne excavator.

5.1.6 Groundwater

No groundwater was not encountered in test holes. The Perth Groundwater Map indicates the historical maximum groundwater levels to be about 50m AHD, approximately 8m below ground level.

5.2 Laboratory Test Results

Laboratory test results are summarized in Table 1

Table 1 – Classification Test Results

Test Hole No.	Depth (m)	LL (%)	PL (%)	PI (%)	Particle Size Distribution			Organic (%)
					Fines (%)	Sand (%)	Gravel(%)	
TH01	0.2-0.5	NP	NP	NP	13	79	8	
TH06	1.5-2.0	31	13	21	27			
TH14	0.1							5.8
TH14	1.0-1.5	NP	NP	NP	22	71	7	
TH19	0.3-0.8				4	26	70	
TH19	1.0-1.5	28	14	14	19			
TH21	1.5-1.9	35	16	19	24			
TH29	0.1-0.5	NP	NP	NP	5	27	68	
TH29	0.5-1.1	23	17	6				
TH37	1.2-1.6	31	14	17	21			

*Non-plastic

5.3 Soil Permeability

Permeability test results are summarized in Table 2.

Table 2 – Permeability Test Results

Test Location	Testing Material	In-situ Permeability Test Result (m/s)	Drainage Characteristics
P1 (TH12)	Very dense gravelly sand with clay	*$1x10^{-9}$m/s	Poor
P2 (TH01)	Medium dense sand with silt	$5x10^{-4}$m/s	Moderate to Good
P3 (TH19)	Medium dense sandy gravel with silt	$6x10^{-4}$m/s	Moderate to Good

*Estimated: Minimal Soakage

6 Analysis and Conclusions

6.1 Subsurface Conditions (refer Figure 2)

The topsoil has an average thickness of 0.1m. Once the grass and roots are removed the topsoil will be relatively low in organic content. Testing a typical sample gave an organic content of 5.8%. It should be suitable for use as engineering fill when screened and blended with clean sand fill at a ratio of approximately 1:3 (screened topsoil : clean sand). Further testing following screening could bring the ratio down to 1:2 or 1:1 for some portions of the site.

Below the topsoil, much of the site is covered by 0.3-0.5m of granular soils with a moderate silt content (sand and gravels). These soils are non-cohesive, relatively free draining with moderate to good drainage characteristics.

These sand and gravels are underlain by a clayey subgrade across the majority of the site, except for the north east area. The soil is a very dense gravel with clay. The clayey subgrade extends to at least 2.0m. The soils have a moderate to low plastic fines content, an intermediate to low plasticity and a low expansive nature. The drainage in the clayey soil is poor. The material often becomes hard with iron cementation below about 1m which caused refusal of the 5 tonne excavator in most holes.

The north eastern area consists of deeper sands, with hard lateritic soils on the eastern boundary which caused refusal of the 5 tonne excavator close to the surface.

No uncontrolled fill was encountered in test holes.

With respect to the desk study and geological information obtained prior to the fieldwork, it appears that the sands discussed are not as extensive as anticipated, confined only to the north east area. The remainder of the site is underlain by the Guildford Formation as suggested, with the laterite deposits to the east.

6.2 Groundwater

No groundwater was not encountered in test holes. The Perth Groundwater Map indicates the historical maximum groundwater levels to be about 50m AHD, approximately 8m below ground level. It is likely that in times of heavy rainfall, the granular soils above of the clayey subgrade will saturate resulting in a perched water table. The soils would then likely drain towards the creek; or the deeper sand deposits from the raised lateritic area.

6.3 Site Classification and Fill Requirements

Based on this preliminary geotechnical investigation, test hole spacing and limited testing, the classification for the site in accordance with AS 2870 – 2011 can be divided in to two classes. The portion underlain by a clayey subgrade with moderate to low plastic fines content, low plasticity and low expansive nature has an existing classification of Class ‘S’. The portion underlain by deeper sand and laterite has an existing classification of Class ‘A’ (refer Figure 2 and Table 3).

To obtain a site classification of Class 'A' in all areas, additional sand fill will be required. A total of 1.8m of granular material will be required above the clayey subgrade. The approximate thickness of additional fill varies from 0.2m to 1.8m and is shown on Figure 2.

Further investigation will be required to determine the exact boundaries between the site classification zones for specific Lots, and the amount of sand fill required could vary.

Table 3 – Definition of Site Classifications (Australian Standard AS2870-2011)

Class	Foundation
A	Most sand and rock sites with little or no ground movement from moisture changes
S	Slightly reactive clay sites with only slight ground movement for moisture changes (y_s<20mm).
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes (y_s 20-40mm).
H1	Highly reactive clay site, which can experience moderate to high ground movement from moisture changes (y_s 40-60mm)
H2	Highly reactive clay site, which can experience high ground movement from moisture changes (y_s 60-75mm)
E	Extremely reactive sites, which can experience extreme ground movement from moisture changes (y_s>75mm)
P	Sites which include: soft soils, such as soft clays or silts or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise

y_s: Characteristic Surface Movement

6.4 Earthworks

6.4.1 Introduction

All earthworks should be undertaken in accordance with AS3798-1996 “Guidelines on earthworks for commercial and residential developments”. This section should act as a guide to likely earthwork requirements for the site, pending a detailed investigation.

6.4.2 Topsoil and Fill Management

A thin layer of topsoil is present across the site. It is not suitable for foundation support and should be removed along with trees and roots then replaced with clean sand fill. The topsoil may be used in landscaping following the removal of any tree roots, unless screened and blended as described below. A geotechnical inspection will be required to confirm topsoil stripping.

6.4.1 Blending of Topsoil for use as Engineering Fill

Topsoil in most areas of the site appears to be of lower quality i.e. lower in organic and fines content. An option would be to blend the screened topsoil with clean sand fill to reduce the organic and fines content to acceptable levels for use in residential or commercial development. Limited testing on non-screened topsoil, but with grass and roots removed, suggest a ratio of approximately 1:3 (screened topsoil : clean sand) to be appropriate. Further testing following screening could bring the ration down to 1:2 or 1:1 for portions of the site.

Ongoing tests for organic and fines content would be required post screening and on the blended soil to confirm suitability for use in the development.

6.4.2 Proof Rolling

Following the removal of topsoil, prior to footing placement or placing any additional fill on site, the surface should be proof rolled to achieve at least 95% SMDD for residential and 98% SMDD for commercial developments.

6.4.3 Imported Fill Material

Any sand fill imported to obtain site formation levels should be compacted in layers not more than 300mm thick to at least 95% SMDD for residential and 98% SMDD for commercial developments. In-situ density tests should be carried out to calibrate a PSP to specific densities of the compacted material to check fill compaction. Moisture conditioning (wetting) of the sand may to be required to optimise compaction. Imported sand should ideally contain less than 5% non-plastic fines to maintain good drainage conditions.

Following excavation for foundations, the bases of pad and strip footings should also be compacted to achieve at least 95% SMDD for residential and 98% SMDD for commercial developments.

6.4.4 Earthwork Inspections

A geotechnical engineer should inspect the site following the removal of vegetation, trees, roots and unsuitable materials, and to confirm the compaction of the subsurface following proof rolling. Inspections and auditing of the earthworks should be carried out by the geotechnical engineer to enable confirmation of the final site classification.

6.5 Suitability of In-situ Soils as Engineering Fill

The majority of the in-situ sands, particularly in the central and north area, contain a moderate fines content but zero plasticity. The soils will be suitable for use as engineering fill in the future development but have a reduced permeability due to the raised silt content. Blending with clean sand fill would reduce the fines content and increase drainage potential.

The sandy gravel with clay could also be blended with clean sand to reduce the fines. The material may be appropriate as a base layer above the existing clayey subgrade if major earthworks are required and removal of the existing granular soils is necessary.

6.6 Design CBR

Assuming the subgrade material below the road pavement or car park areas will be the natural in-situ near surface sand, a design CBR of 20 is suitable pavement design. Pavements founded on the sandy gravels could have a higher CBR of at least 30. Pavements founded within imported sand fill will require CBR testing during earthworks.

6.7 Retaining Wall Parameters

The site is gently sloping to the west and some retaining maybe required in the development. The following retaining wall parameters have been based on a compacted dense sand soil with $\phi=40^o$.

γ=19 kN/m^3
Ko=0.36
Ka=0.22
Kp=4.6

The parameters detailed above assume design of the retaining structure and compaction of the foundations are in accordance with AS 4678-2002, and that backfill material is composed of clean cohesionless sand.

6.8 Acid Sulphate Soils

The acid sulphate soil risk map for the area indicate soils below the site to be in the No Known Risk category. The walkover survey and descriptions from test holes indicated no soils associated with high-risk ASS.

6.9 Site Permeability and Drainage Recommendations

The near surface sand and gravels contain moderate fines, zero plasticity and are free draining. The drainage condition within the sands prior to proof rolling is moderate to good. Permeability of approx. 5x10^{-4}m/s was recorded. Permeability of the underlying clayey subgrade was poor.

For soakwell installation, additional sand fill may be required in some areas, especially where the clayey subgrade approaches the existing surface. A suitably designed drainage system would allow for the use of soakwells if sufficient height, say at least 1.2m, is obtained above the clayey subgrade and the groundwater. Further permeability testing and groundwater monitoring is recommended as part of the detailed geotechnical investigation to refine these observations.

If clean fill sand is to be imported on to the site to raise site formation levels, permeability can vary depending on the source, and could vary between 1x10^{-3} and a 1x10^{-5} m/s based on observed results on typical Perth fill sands.

Permeability and drainage conditions may be reduced during earthworks due to compaction of in-situ and imported sands. Over compaction during earthworks can seriously reduce soil permeability. It is recommended that further permeability testing be carried out following earthworks to confirm parameters used during drainage design.

BROWN GEOTECHNICAL

Ferry Haryono
Senior Geotechnical Engineer

Reviewed by
Ken Brown
Senior Geotechnical Engineer

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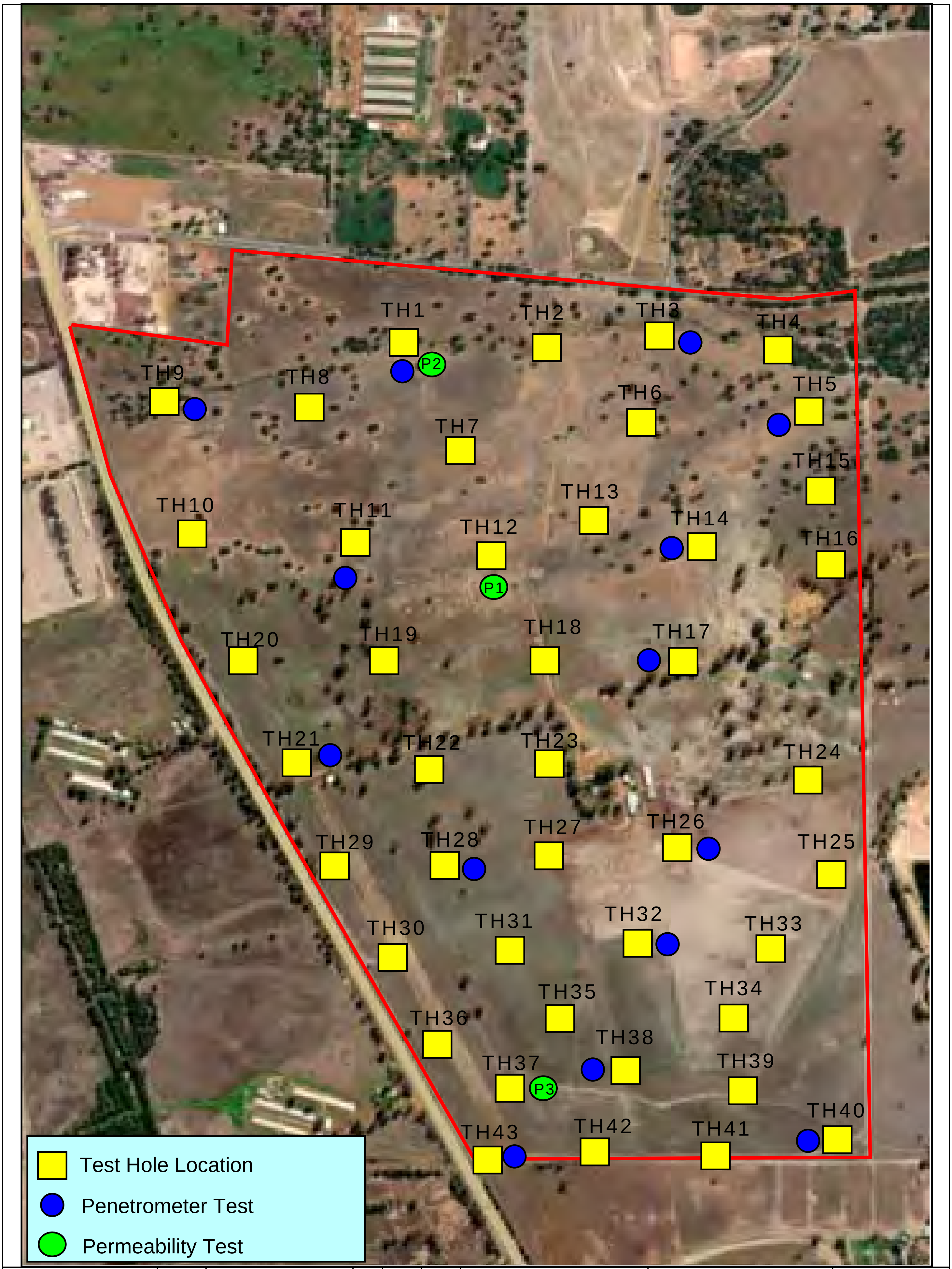
2. Geological Survey of Western Australia. 1:50,000 Environmental Geology Series, Perth.
3. Department of Water. *Perth Groundwater Map*
4. Standards Australia AS3798-2011. “Guidelines on earthworks for commercial and residential developments”.
5. Standards Australia AS 4678-2002. Earth-Retaining Structures.

FIGURES



BG
Brown
Geotechnical

Date	Description	Drawn	Checked	Approved
21.11.2020	Test Location Plan	kb	fh	kb

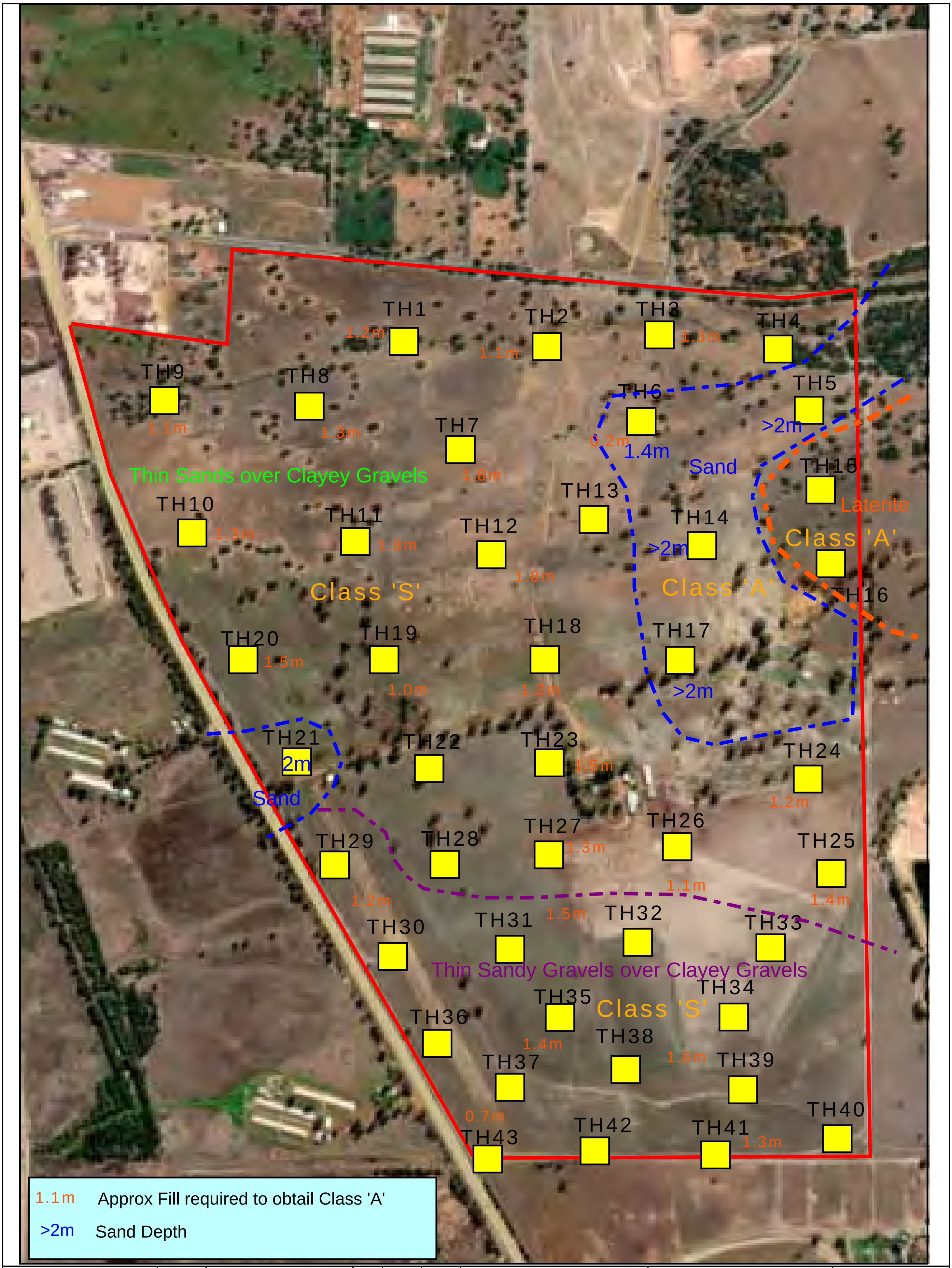
TEST LOCATION PLAN

LOTS 50 AND M1456
GREAT NORTHERN HIGHWAY
MUCHEA

CLIENT

Tallangatta Beef Pty Ltd

Drawing No. 20049 Fig1
Scale: NTS
Sheet Size: A4
Job No. 20049
FIGURE 1



BG
Brown
Geotechnical

Date	Description	Drawn	Checked	Approved
21.11.2020	Test Location Plan	kb	fh	kb

Subsoil Conditions

LOTS 50 AND M1456
GREAT NORTHERN HIGHWAY
MUCHEA

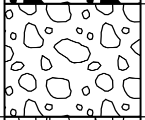
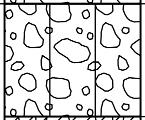
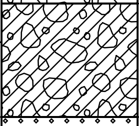
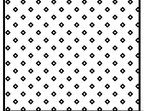
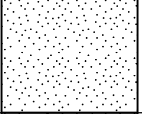
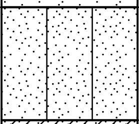
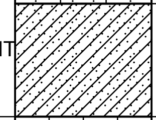
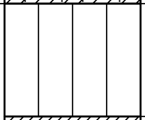
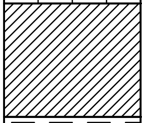
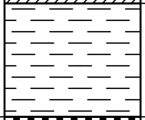
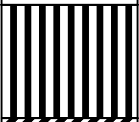
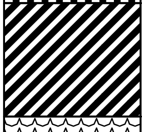
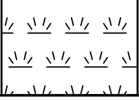
CLIENT

Tallangatta Beef Pty Ltd

Drawing No. 20049 Fig2
Scale: NTS
Sheet Size: A4
Job No. 20049
FIGURE 2

APPENDIX A

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

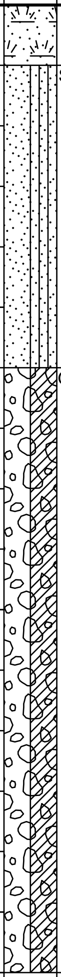
BG Brown Geotechnical

BOREHOLE NUMBER TH01

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405491 6504955
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry	Fines=8% Sand=79% Gravel=13%	
			1.0 1.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			2.0 2.5			REFUSAL Borehole TH01 terminated at 1.6m		

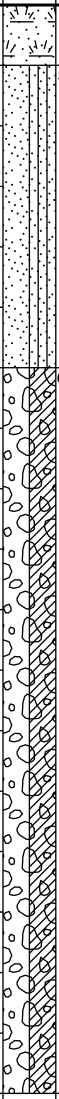
BG Brown Geotechnical

BOREHOLE NUMBER TH02

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405738 6505809
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			1.0 1.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			2.0 2.5			REFUSAL Borehole TH02 terminated at 1.8m		

BG Brown Geotechnical

BOREHOLE NUMBER TH03

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

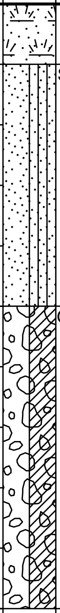
HOLE LOCATION 405992 6505834

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			1.0		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			1.5 2.0 2.5			REFUSAL Borehole TH03 terminated at 1m		

BG Brown Geotechnical

BOREHOLE NUMBER TH04

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

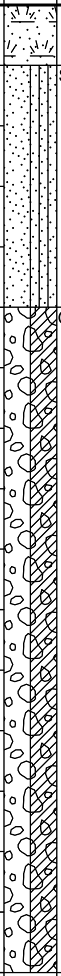
HOLE LOCATION 406198 6505805

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES



Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			1.0 1.5					
			2.0 2.5			REFUSAL Borehole TH04 terminated at 1.6m		

Brown Geotechnical

BOREHOLE NUMBER TH05

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 406306 6505635
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5 1.0 1.5 2.0		SP-SM	SAND: Medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			2.5			Borehole TH05 terminated at 2m		

BG Brown Geotechnical

BOREHOLE NUMBER TH06

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 406306 6505635
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5 1.0		SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			1.5 2.0		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry	LL=34 PL=13 Fines=27% LS=6%	
			2.5			Borehole TH06 terminated at 2m		

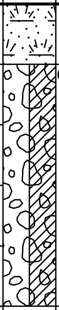
BG Brown Geotechnical

BOREHOLE NUMBER TH07

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405567 6505550
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH07 terminated at 0.5m		

BG Brown Geotechnical

BOREHOLE NUMBER TH08

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

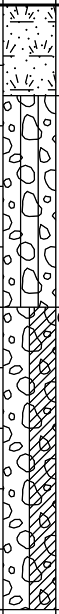
HOLE LOCATION 405251 6505641

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		GM	GRAVELLY SAND:Medium dense, fine to medium grained, grey, with silt, dry		
			1.0		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			1.5 2.0 2.5			REFUSAL Borehole TH08 terminated at 1m		

BG Brown Geotechnical

BOREHOLE NUMBER TH09

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

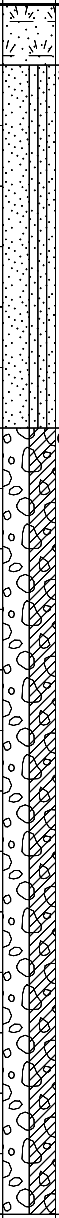
HOLE LOCATION 404995 6505634

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			1.0 1.5 2.0		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			2.5			Borehole TH09 terminated at 2m		

BG Brown Geotechnical

BOREHOLE NUMBER TH10

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

HOLE LOCATION 405083 6505388

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH10 terminated at 0.9m		

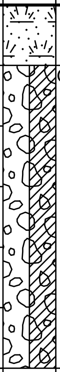
BG Brown Geotechnical

BOREHOLE NUMBER TH11

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405447 6505378
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH11 terminated at 0.6m		

BG Brown Geotechnical

BOREHOLE NUMBER TH12

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

HOLE LOCATION 405709 6505396

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH12 terminated at 0.5m		

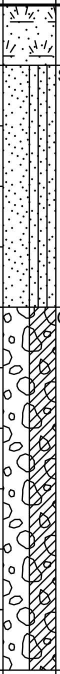
BG Brown Geotechnical

BOREHOLE NUMBER TH13

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 406306 6505635
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					SP-SM	SAND: Loose to medium dense, fine to medium grained, yellowish brown & grey, with silt, trace gravel, dry		
			0.5 1.0		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			1.5 2.0 2.5			REFUSAL Borehole TH13 terminated at 1.1m		

BOREHOLE NUMBER TH14

PAGE 1 OF 1

BG Brown Geotechnical

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

HOLE LOCATION 406082 6505424

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		SP-SM	SAND: Medium dense, fine to medium grained, yellowish brown & grey, with silt and gravel, dry		
			1.0				Fines=22% Sand= 71% Gravel=7%	
			1.5					
			2.0			Borehole TH14 terminated at 2m		
			2.5					

BOREHOLE NUMBER TH15

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

HOLE LOCATION 406323 6505444

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		GPS	GRAVELLY SAND / LATERITE: Very dense (cemented), fine to coarse, brown, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH15 terminated at 0.6m		

BG Brown Geotechnical

BOREHOLE NUMBER TH16

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

HOLE LOCATION 406312 6505233

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		GPS	GRAVELLY SAND / LATERITE: Very dense (cemented), fine to coarse, brown, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH16 terminated at 0.8m		

BOREHOLE NUMBER TH17

PAGE 1 OF 1

BG Brown Geotechnical

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

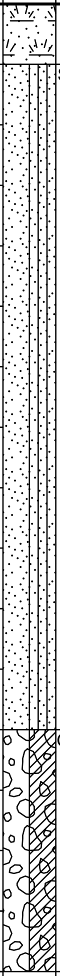
HOLE LOCATION 406063 6505177

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES



Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5 1.0		SP-SM	SAND: Loose to medium dense, fine to coarse grained, grey, with silt, trace gravel, dry		
			1.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			2.0 2.5			REFUSAL Borehole TH17 terminated at 1.6m		

BG Brown Geotechnical

BOREHOLE NUMBER TH18

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

HOLE LOCATION 405768 6505169

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					SP-SM	SAND: Loose to medium dense, fine to coarse grained, grey, with silt, trace gravel, dry		
			0.5 1.0 1.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			2.0 2.5			REFUSAL Borehole TH18 terminated at 1.6m		

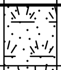
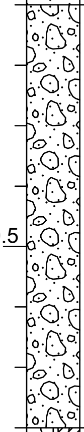
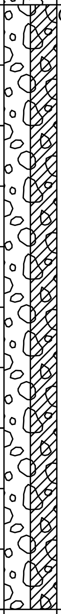
BG Brown Geotechnical

BOREHOLE NUMBER TH19

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405463 6505127
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		GPS	SANDY GRAVEL: Medium dense to dense, fine to coarse grained, grey, trace silt, dry	Fines=4% Sand=26% Gravel=70%	
			1.0 1.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry	LL=28 PL=14 Fines=19% LS=4%	
			2.0 2.5			REFUSAL Borehole TH19 terminated at 1.8m		

BG Brown Geotechnical

BOREHOLE NUMBER TH20

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 20/10/20 **COMPLETED** 20/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

HOLE LOCATION 405178 6505190

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					GPS	SANDY GRAVEL: Medium dense to dense, fine to coarse grained, grey, trace silt, dry		
			0.5 1.0 1.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			2.0 2.5			REFUSAL Borehole TH20 terminated at 1.6m		

BOREHOLE NUMBER TH21

PAGE 1 OF 1

BG Brown Geotechnical

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

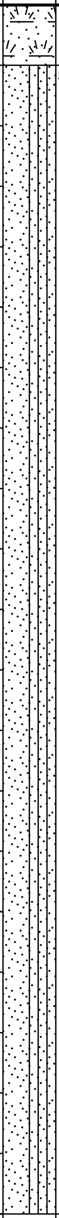
HOLE LOCATION 405246 6504978

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					SP-SM	SAND: Medium dense, fine to coarse grained, yellowish brown & grey, with silt, trace gravel, dry		
			0.5					
			1.0					
			1.5			with some clay below 1.5m	LL=35 PL=16 Fines=24% LS=6%	
			2.0			Borehole TH21 terminated at 2m		
			2.5					

BG Brown Geotechnical

BOREHOLE NUMBER TH22

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

HOLE LOCATION 405246 6504978

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			1.0 1.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			2.0 2.5			REFUSAL Borehole TH22 terminated at 1.9m		

BOREHOLE NUMBER TH23

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

HOLE LOCATION 405762 405762

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH23 terminated at 0.8m		

BOREHOLE NUMBER TH24

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

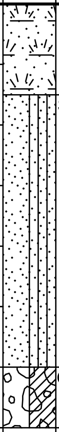
HOLE LOCATION 406273 6504973

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
					GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
						REFUSAL Borehole TH24 terminated at 0.7m		
			1.0					
			1.5					
			2.0					
			2.5					

BG Brown Geotechnical

BOREHOLE NUMBER TH25

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

HOLE LOCATION 406284 6504795

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH25 terminated at 0.7m		

BG Brown Geotechnical

BOREHOLE NUMBER TH26

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

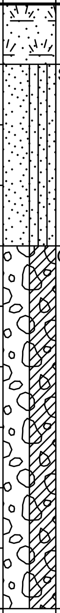
HOLE LOCATION 405946 6504827

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			0.5 1.0		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.5 2.0 2.5			REFUSAL Borehole TH26 terminated at 1m		

BG Brown Geotechnical

BOREHOLE NUMBER TH27

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405784 6504955
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt, trace gravel, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH27 terminated at 0.7m		

BG Brown Geotechnical

BOREHOLE NUMBER TH28

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20
COMPLETED 21/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405541 6504777
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered			▨		TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5	▨	SP-SM	SAND: Loose to medium dense, fine to medium grained, grey, with silt and gravel, dry		
			1.0	▨	GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.5 2.0 2.5			REFUSAL Borehole TH28 terminated at 1m		

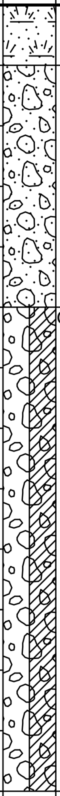
BG Brown Geotechnical

BOREHOLE NUMBER TH29

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405342 6504804
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES



Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					GPS	SANDY GRAVEL: Medium dense, fine to medium grained, grey, with silt, dry	Fines=5% Sand=27% Gravel=68%	
			0.5 1.0		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry	LL=23 PL=17 LS=2%	
			1.5 2.0 2.5			REFUSAL Borehole TH29 terminated at 1.3m		

BG Brown Geotechnical

BOREHOLE NUMBER TH30

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20

COMPLETED 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

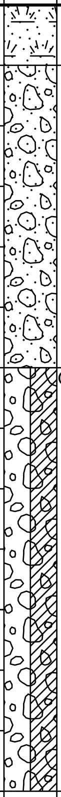
HOLE LOCATION 405416 6504605

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES



Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		GPS	SANDY GRAVEL: Medium dense, fine to medium grained, grey, with silt, dry		
			1.0		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown, dry		
			1.5 2.0 2.5			REFUSAL Borehole TH30 terminated at 1.3m		

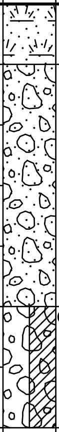
BG Brown Geotechnical

BOREHOLE NUMBER TH31

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20
COMPLETED 21/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405570 6504604
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES



Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					GPS	SANDY GRAVEL: Medium dense, fine to medium grained, grey, with silt, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
						REFUSAL Borehole TH31 terminated at 0.7m		
			1.0					
			1.5					
			2.0					
			2.5					

BOREHOLE NUMBER TH32

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

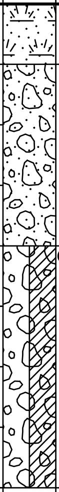
HOLE LOCATION 405859 6504616

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					GPS	SANDY GRAVEL: Medium dense, fine to medium grained, grey, with silt, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.0			REFUSAL Borehole TH32 terminated at 0.8m		
			1.5					
			2.0					
			2.5					

BG Brown Geotechnical

BOREHOLE NUMBER TH33

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20

COMPLETED 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

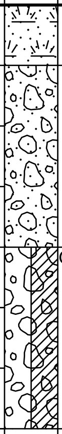
HOLE LOCATION 405984 6504614

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					GPS	SANDY GRAVEL: Medium dense, fine to medium grained, grey, with silt, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH33 terminated at 0.7m		

BG Brown Geotechnical

BOREHOLE NUMBER TH34

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

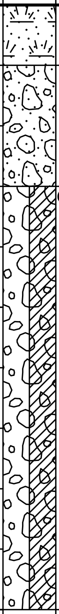
HOLE LOCATION 406020 6504417

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					GPS	SANDY GRAVEL: Medium dense, fine to medium grained, grey, with silt, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH34 terminated at 1m		

BOREHOLE NUMBER TH35

BG Brown Geotechnical

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

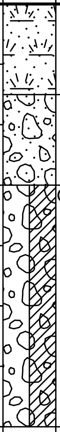
DATE STARTED 21/10/20 **COMPLETED** 21/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405736 6504450
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					GPS	SANDY GRAVEL: Medium dense, fine to medium grained, grey, with silt, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH35 terminated at 0.9m		

BOREHOLE NUMBER TH36

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20
COMPLETED 21/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405519 6504466
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					GPS	SANDY GRAVEL: Medium dense, fine to medium grained, grey, with silt, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH36 terminated at 0.7m		

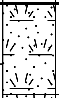
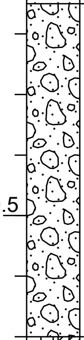
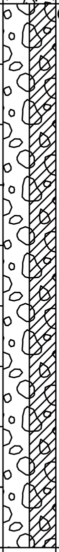
BG Brown Geotechnical

BOREHOLE NUMBER TH37

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20
COMPLETED 21/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405588 6504333
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		GPS	SANDY GRAVEL: Medium dense, fine to medium grained, grey, with silt, dry		
			1.0 1.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry	LL=31 PL=14 Fines=21% LS=6%	
			2.0 2.5			REFUSAL Borehole TH37 terminated at 1.6m		

BOREHOLE NUMBER TH38

PAGE 1 OF 1

BG Brown Geotechnical

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405777 6504329
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					GPS	SANDY GRAVEL: Medium dense, fine to medium grained, grey, with silt, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH38 terminated at 0.7m		

BOREHOLE NUMBER TH39

PAGE 1 OF 1

BG Brown Geotechnical

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20

COMPLETED 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

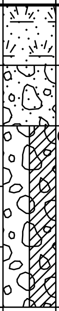
HOLE LOCATION 406096 6504327

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					GPS	SANDY GRAVEL: Dense, fine to medium grained, grey, with silt, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH39 terminated at 0.5m		

BG Brown Geotechnical

BOREHOLE NUMBER TH40

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

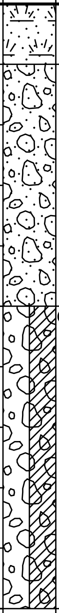
HOLE LOCATION 406357 6504220

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
					GPS	SANDY GRAVEL: Dense, fine to medium grained, grey, with silt, dry		
			0.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.0 1.5 2.0 2.5			REFUSAL Borehole TH40 terminated at 1m		

BG Brown Geotechnical

BOREHOLE NUMBER TH41

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

HOLE LOCATION 406108 6504220

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5		GPS	SANDY GRAVEL: Dense, fine to medium grained, grey, with silt, dry		
			1.0 1.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			2.0 2.5			REFUSAL Borehole TH41 terminated at 1.6m		

BG Brown Geotechnical

BOREHOLE NUMBER TH42

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd
PROJECT NAME LOTS 50 and M1456
PROJECT NUMBER 20049
PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20
R.L. SURFACE
DATUM
DRILLING CONTRACTOR
SLOPE 90°
BEARING ---
EQUIPMENT 5 tonne excavator
HOLE LOCATION 405842 6504214
HOLE SIZE 0.5mx1.5m
LOGGED BY FH
CHECKED BY KB
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered			▨		TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5	▨	GPS	SANDY GRAVEL: Dense, fine to medium grained, grey, with silt, dry		
			1.0	▨	GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			1.5 2.0 2.5			REFUSAL Borehole TH42 terminated at 1.3m		

BOREHOLE NUMBER TH43

PAGE 1 OF 1

CLIENT Tallangatta Beef Pty Ltd

PROJECT NAME LOTS 50 and M1456

PROJECT NUMBER 20049

PROJECT LOCATION MUCHEA

DATE STARTED 21/10/20 **COMPLETED** 21/10/20

R.L. SURFACE

DATUM

DRILLING CONTRACTOR

SLOPE 90°

BEARING ---

EQUIPMENT 5 tonne excavator

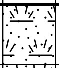
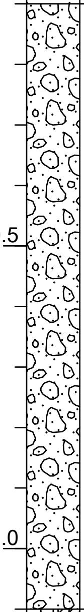
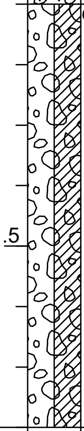
HOLE LOCATION 405652 6504213

HOLE SIZE 0.5mx1.5m

LOGGED BY FH

CHECKED BY KB

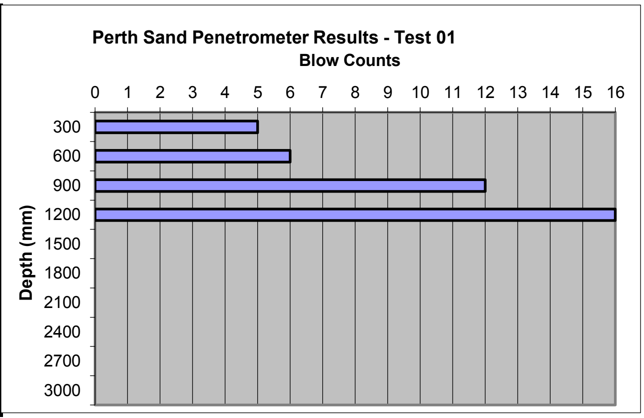
NOTES

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Additional Observations
	Not Encountered					TOPSOIL: Loose, dark grey, silty sand with rootlets		
			0.5 1.0		GPS	SANDY GRAVEL: Dense, fine to medium grained, grey, with silt, dry		
			1.5		GP-GC	GRAVELLY SAND with CLAY: Very dense, fine to coarse, yellowish brown & grey, dry		
			2.0 2.5			REFUSAL Borehole TH43 terminated at 1.8m		

APPENDIX B

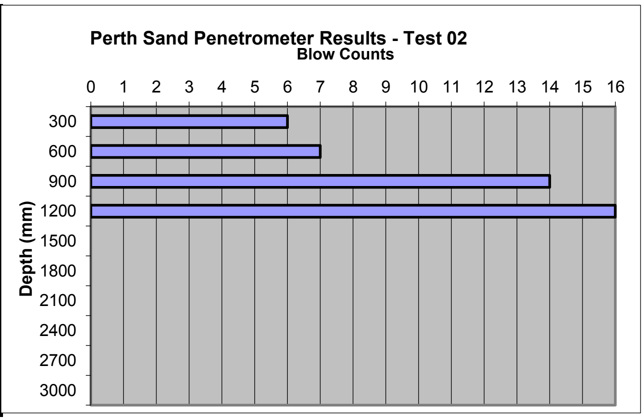
Perth Sand Penetrometer Test Plots

Depth (mm)	Blow Counts
300	5
600	6
900	12
1200	16
1500	
1800	
2100	
2400	
2700	
3000	



Job Name: Lot 50 &
M1456
Muchae
Job No: 20049
Date: 20/11/2020
Location: TH01

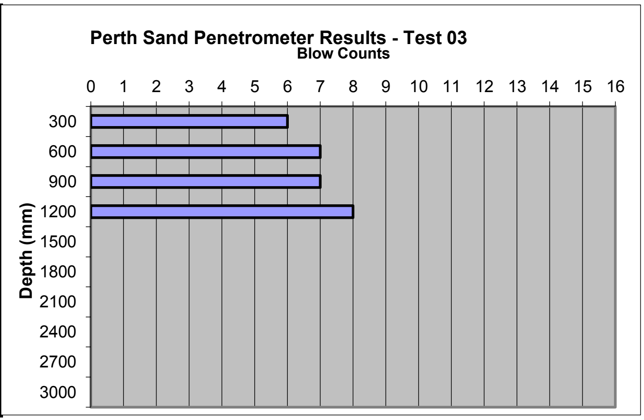
Depth (mm)	Blow Counts
300	6
600	7
900	14
1200	16
1500	
1800	
2100	
2400	
2700	
3000	



Job Name: Lot 50 &
M1456

Job No: 20049
Date: 20/11/2020
Location: TH03

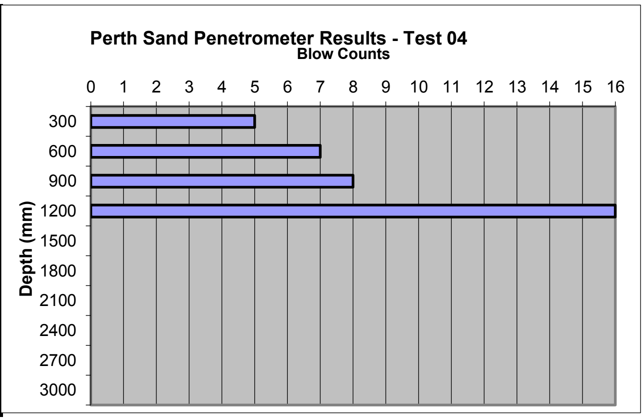
Depth (mm)	Blow Counts
300	6
600	7
900	7
1200	8
1500	
1800	
2100	
2400	
2700	
3000	



Job Name: Lot 50 &
M1456

Job No: 20049
Date: 20/11/2020
Location: TH05

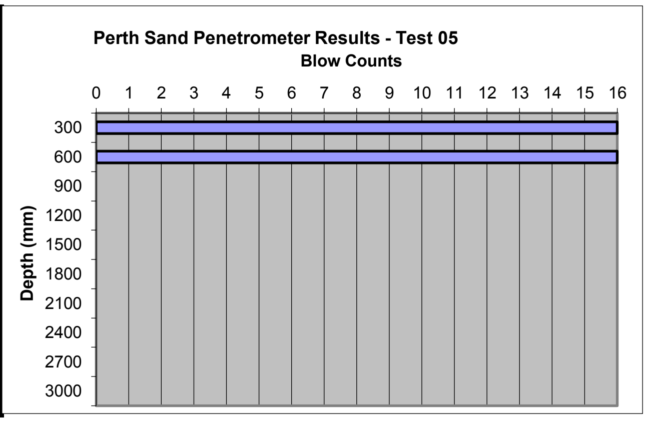
Depth (mm)	Blow Counts
300	5
600	7
900	8
1200	16
1500	
1800	
2100	
2400	
2700	
3000	



Job Name: Lot 50 &
M1456

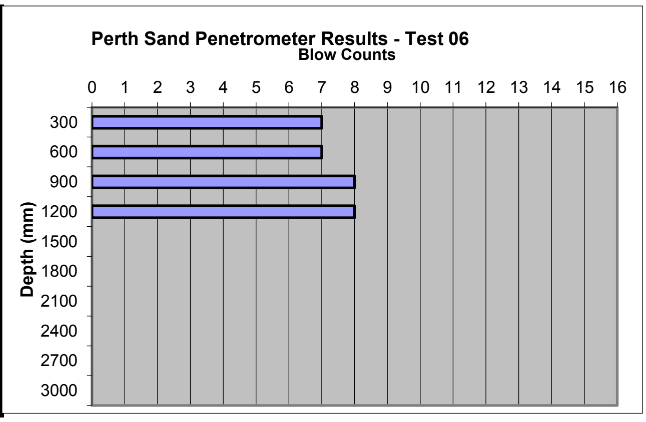
Job No: 20049
Date: 20/11/2020
Location: TH09

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



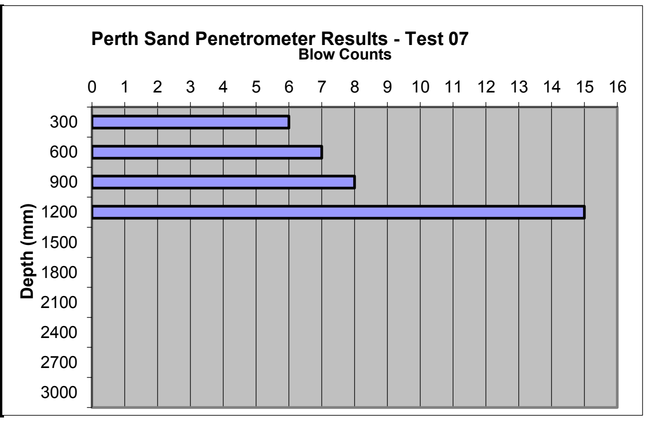
Job Name: Lot 50 &
M1456
Muchae
Job No: 20049
Date: 20/11/2020
Location: TH11

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



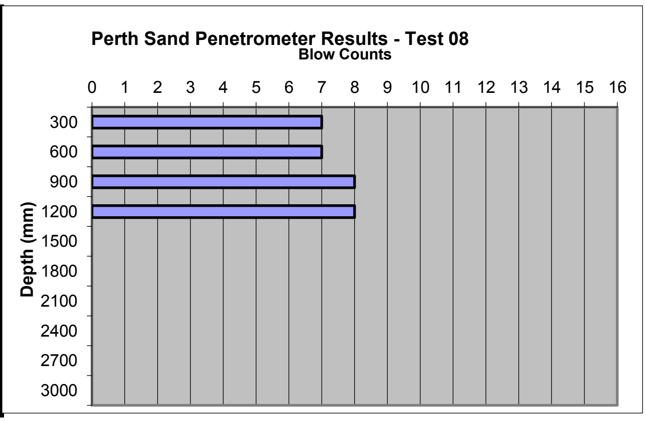
Job Name: Lot 50 &
M1456
Muchae
Job No: 20049
Date: 20/11/2020
Location: TH14

Depth (mm)	Blow Counts
300	6
600	7
900	8
1200	15
1500	
1800	
2100	
2400	
2700	
3000	



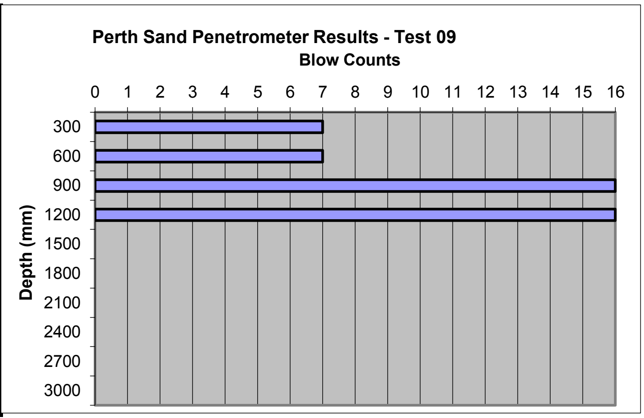
Job Name: Lot 50 &
M1456
Muchae
Job No: 20049
Date: 20/11/2020
Location: TH17

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



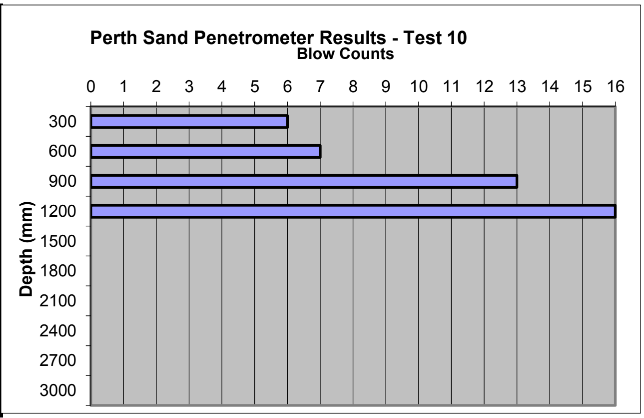
Job Name: Lot 50 &
M1456
Muchae
Job No: 20049
Date: 20/11/2020
Location: TH21

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



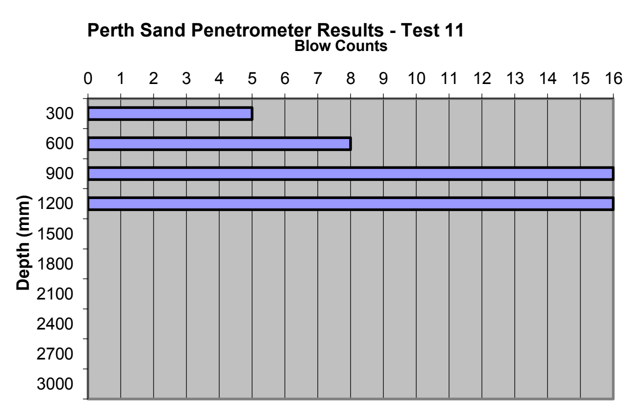
Job Name: Lot 50 &
M1456
Muchae
Job No: 20049
Date: 20/11/2020
Location: TH26

Depth (mm)	Blow Counts
300	6
600	7
900	13
1200	16
1500	
1800	
2100	
2400	
2700	
3000	



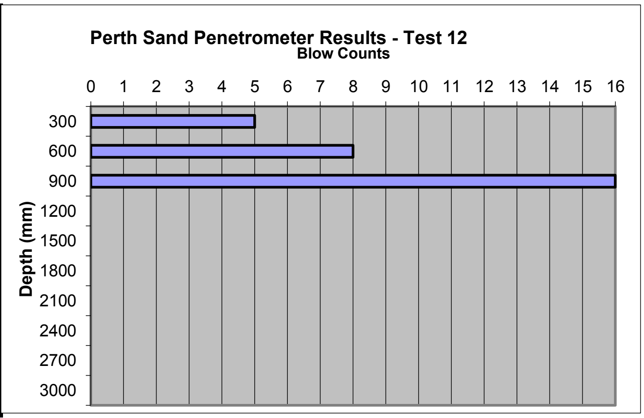
Job Name: Lot 50 &
M1456
Muchae
Job No: 20049
Date: 20/11/2020
Location: TH28

Depth (mm)	Blow Counts
300	5
600	8
900	16
1200	16
1500	
1800	
2100	
2400	
2700	
3000	



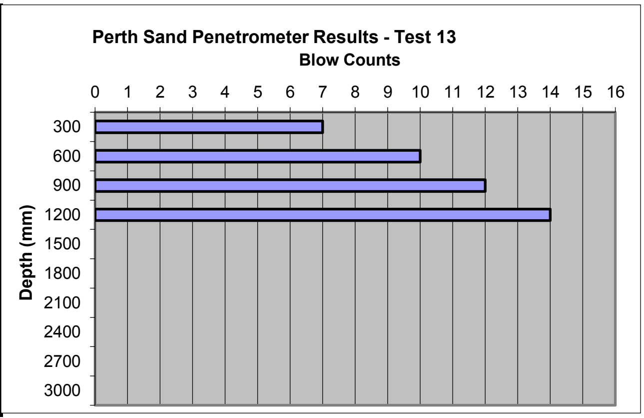
Job Name: Lot 50 &
M1456
Muchae
Job No: 20049
Date: 20/11/2020
Location: TH32

Depth (mm)	Blow Counts
300	5
600	8
900	16
1200	
1500	
1800	
2100	
2400	
2700	
3000	



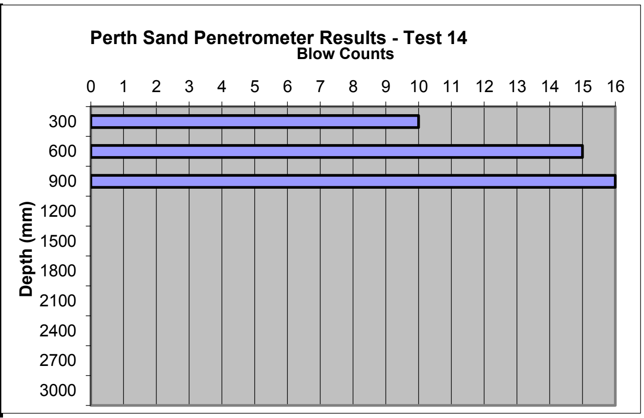
Job Name: Lot 50 &
M1456
Muchae
Job No: 20049
Date: 20/11/2020
Location: TH38

Depth (mm)	Blow Counts
300	7
600	10
900	12
1200	14
1500	
1800	
2100	
2400	
2700	
3000	



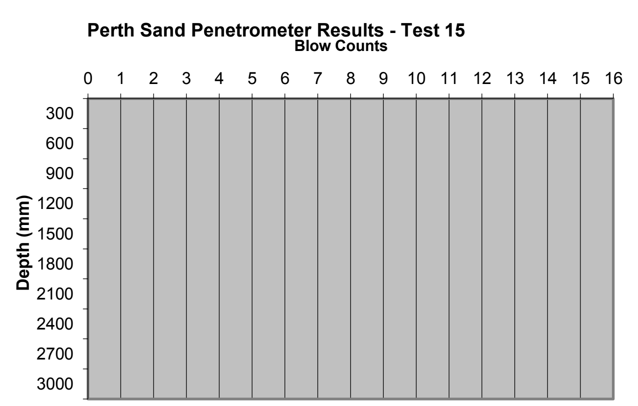
Job Name: Lot 50 &
M1456
Muchae
Job No: 20049
Date: 20/11/2020
Location: TH40

Depth (mm)	Blow Counts
300	10
600	15
900	16
1200	
1500	
1800	
2100	
2400	
2700	
3000	



Job Name: Lot 50 &
M1456
Muchae
Job No: 20049
Date: 20/11/2020
Location: TH43

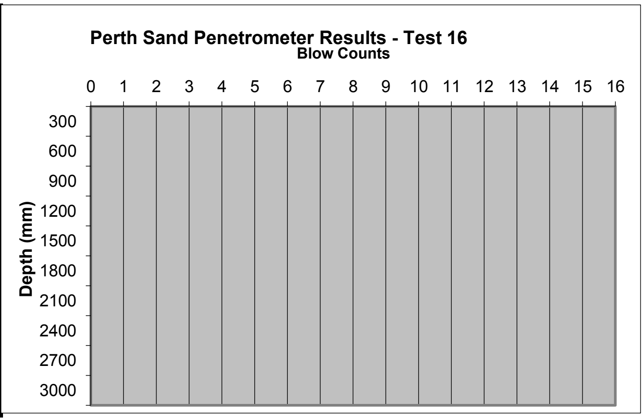
Depth (mm)	Blow Counts
300	
600	
900	
1200	
1500	
1800	
2100	
2400	
2700	
3000	



Job Name:

Job No:
Date:
Location:

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



Job Name:

Job No:
Date:
Location:

APPENDIX C

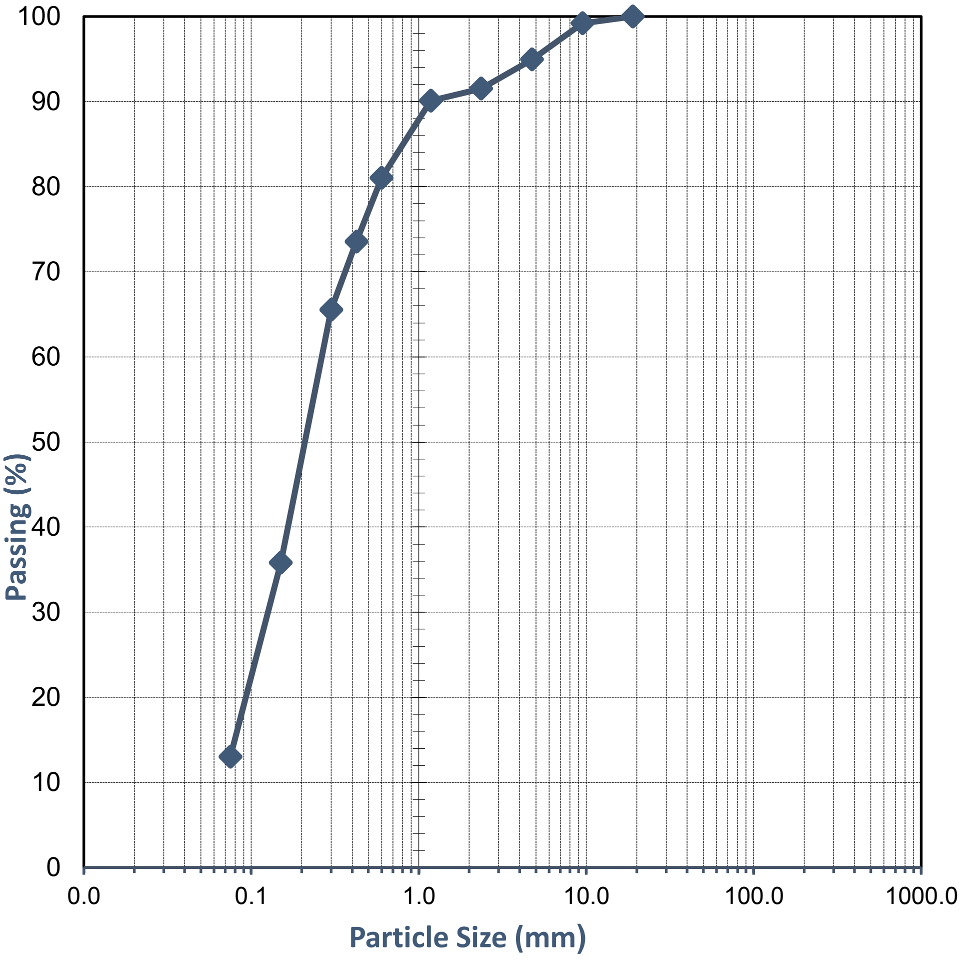
TEST REPORT - AS 1289.3.6.1

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9800_1_PSD
Project:	Tallangatta	*Sample No.*	WG20/9800
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH1 0.2-0.5m	*Date Tested:*	28-29/10/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	100
9.5	99
4.75	95
2.36	92
1.18	90
0.600	81
0.425	74
0.300	66
0.150	36
0.075	13



Comments:

Approved Signatory:

Name: Brooke Elliott

Date: 30-October-2020

Accreditation No. 20599
Accredited for compliance with ISO/IEC 17025 - Testing

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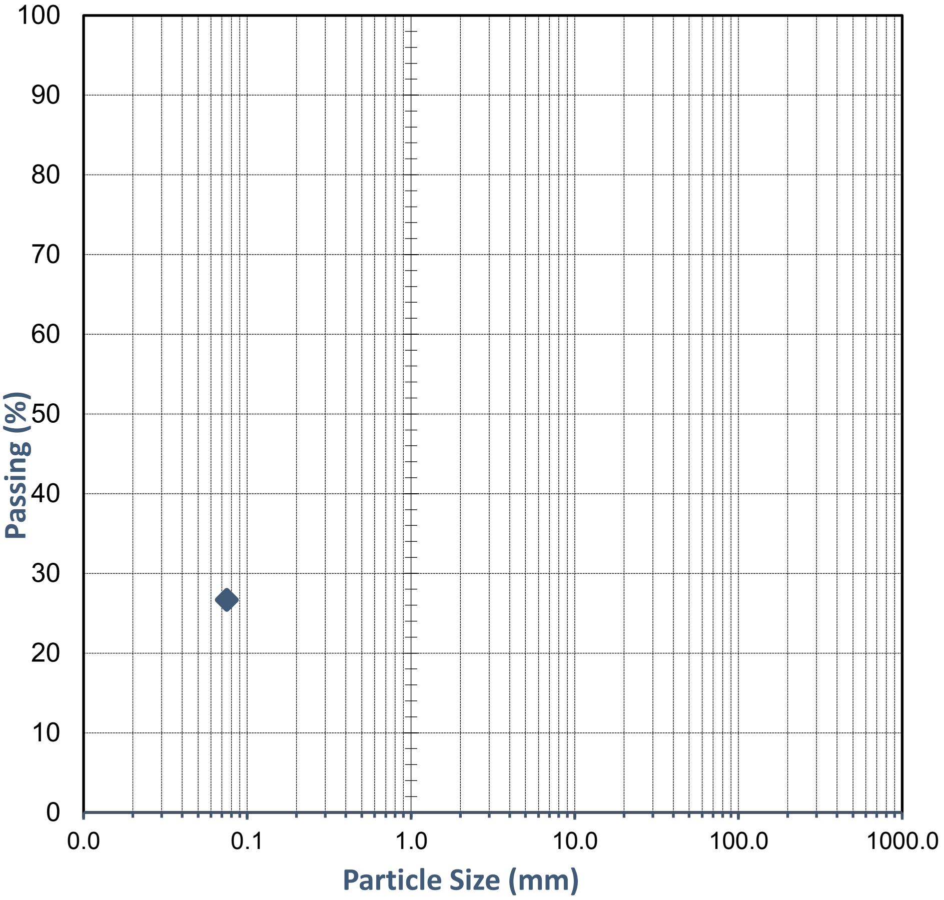
TEST REPORT - AS 1289.3.6.1 (% Fines)

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9801_1_%FINES
Project:	Tallangatta	*Sample No.*	WG20/9801
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH6 1.5-2.0m	*Date Tested:*	28-29/10/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	
1.18	
0.600	
0.425	
0.300	
0.150	
0.075	27



Comments: Clients request for the % Fines of Material passing 0.075mm only.

Approved Signatory:

Name: Brooke Elliott

Date: 30-October-2020

NATA
WORLD RECOGNISED ACCREDITATION

Accreditation No. 20599
Accredited for compliance
with ISO/IEC 17025 - Testing

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WESTERN GEOTECHNICAL
& Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9801_1_PI
Project:	Tallangatta	*Sample No.*	WG20/9801
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH6 1.5-2.0m	*Date Tested:*	29-10-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50^{o}C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**34**
AS 1289.3.2.1	**Plastic Limit (%)**	**13**
AS 1289.3.3.1	**Plasticity Index (%)**	**21**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**6.5**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**Cracked, Curled**

Comments:

Approved Signatory:

Name: Brooke Elliott
Date: 02-November-2020

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TEST REPORT - ASTM D2974-14 (Test Method C)

Client:	Brown Geotechnical	*Ticket No.*	S1фну
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/фулл_1_ORG
Project:	Tallangatta	*Sample No.*	WG20/9802-1
Location:	Muchae	*Date Sampled:*	2л-мл-2020
Sample Identification:	TH14 0.1m	*Date Tested:*	ну-мл-2020

TEST RESULTS - Organic Content

Sampling Method:	**Sampled by Client, Tested as Received**
Testing Completed By:	**KT**
Furnace Temperature (^oC):	**440**

Sample Number	Sample Identification	Ash Content (%)	Organic Content (%)
WG20/9802-1	S1	94.2	5.8
0	0	#DIV/0!	#DIV/0!
0	0	#DIV/0!	#DIV/0!
0	0	#DIV/0!	#DIV/0!
0	0	#DIV/0!	#DIV/0!
0	0	#DIV/0!	#DIV/0!
0	0	#DIV/0!	#DIV/0!
0	0	#DIV/0!	#DIV/0!
0	0	#DIV/0!	#DIV/0!

Comments:

Approved Signatory:

Name: Brooke Elliott

Date:30-October-2020

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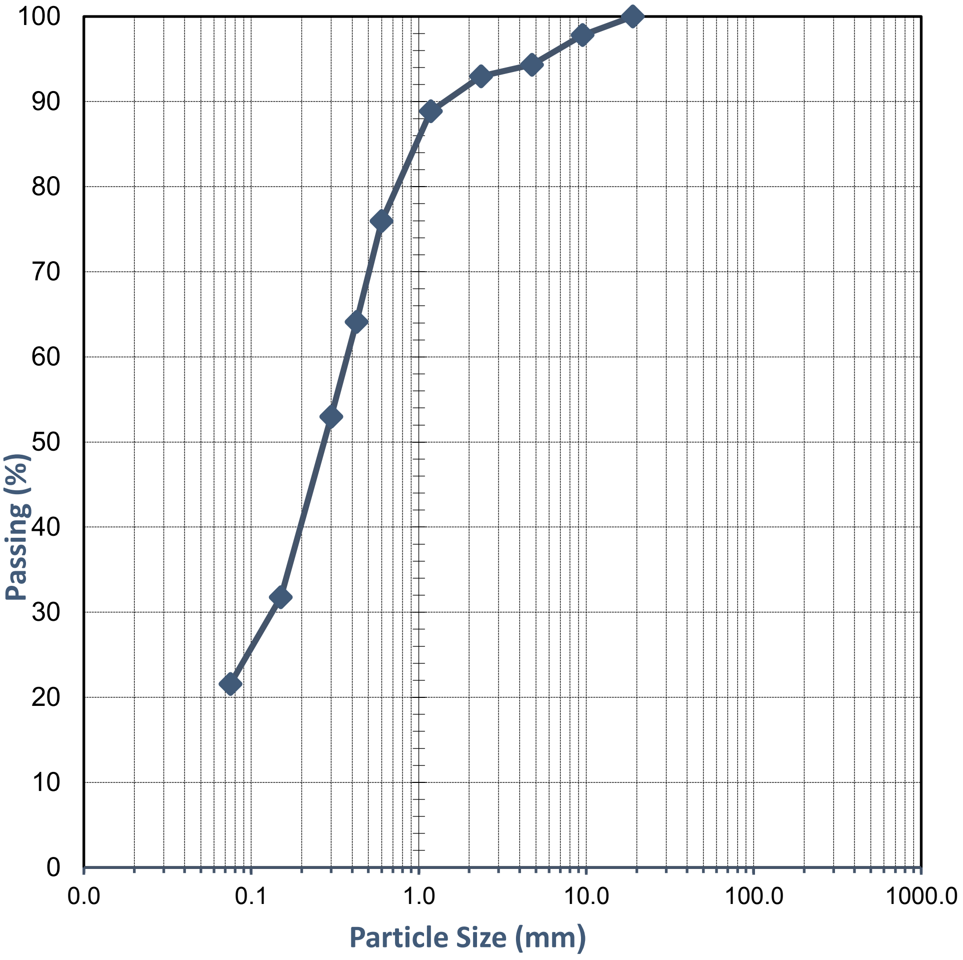
TEST REPORT - AS 1289.3.6.1

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9802_1_PSD
Project:	Tallangatta	*Sample No.*	WG20/9802
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH14 1.0-1.5m	*Date Tested:*	28-29/10/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	100
9.5	98
4.75	94
2.36	93
1.18	89
0.600	76
0.425	64
0.300	53
0.150	32
0.075	22



Comments:

Approved Signatory:

Name: Brooke Elliott
Date: 30-October-2020

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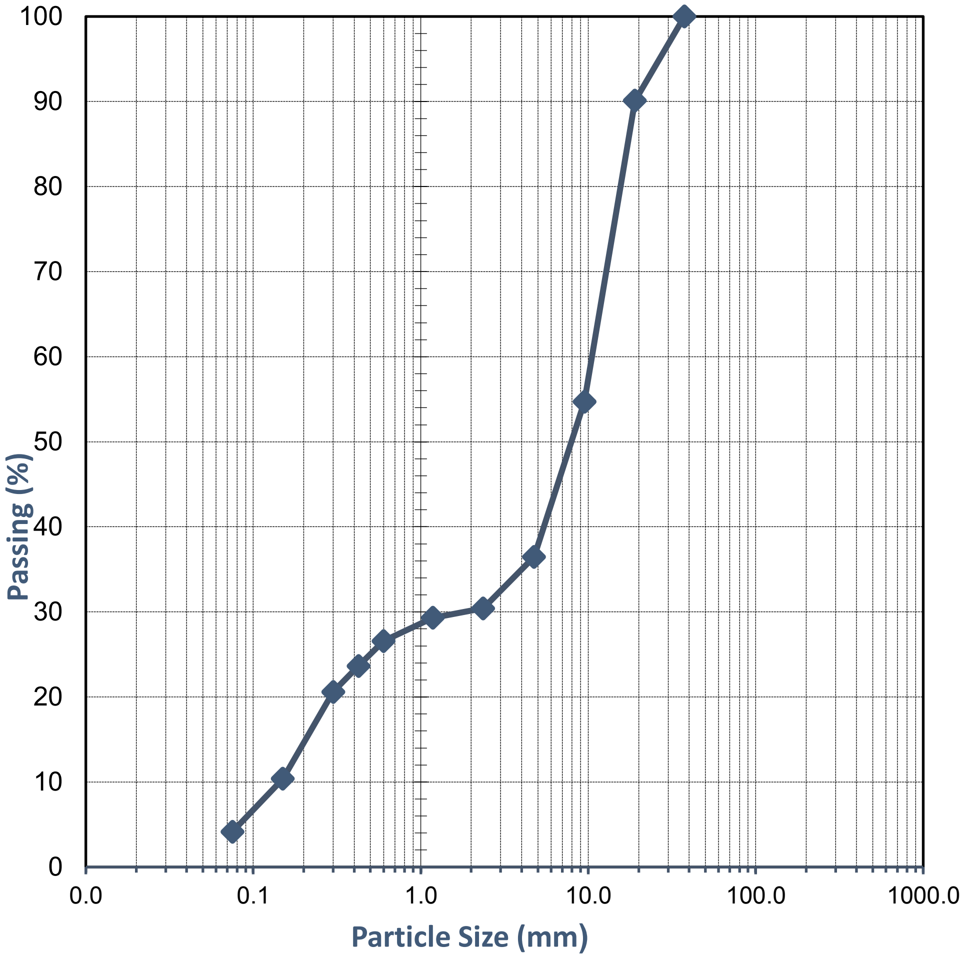
TEST REPORT - AS 1289.3.6.1

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9803_1_PSD
Project:	Tallangatta	*Sample No.*	WG20/9803
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	Th19 0.3-0.8m	*Date Tested:*	28-29/10/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	100
19.0	90
9.5	55
4.75	36
2.36	30
1.18	29
0.600	27
0.425	24
0.300	21
0.150	10
0.075	4



Comments:

Approved Signatory: B Elliott

Name: Brooke Elliott

Date: 30-October-2020

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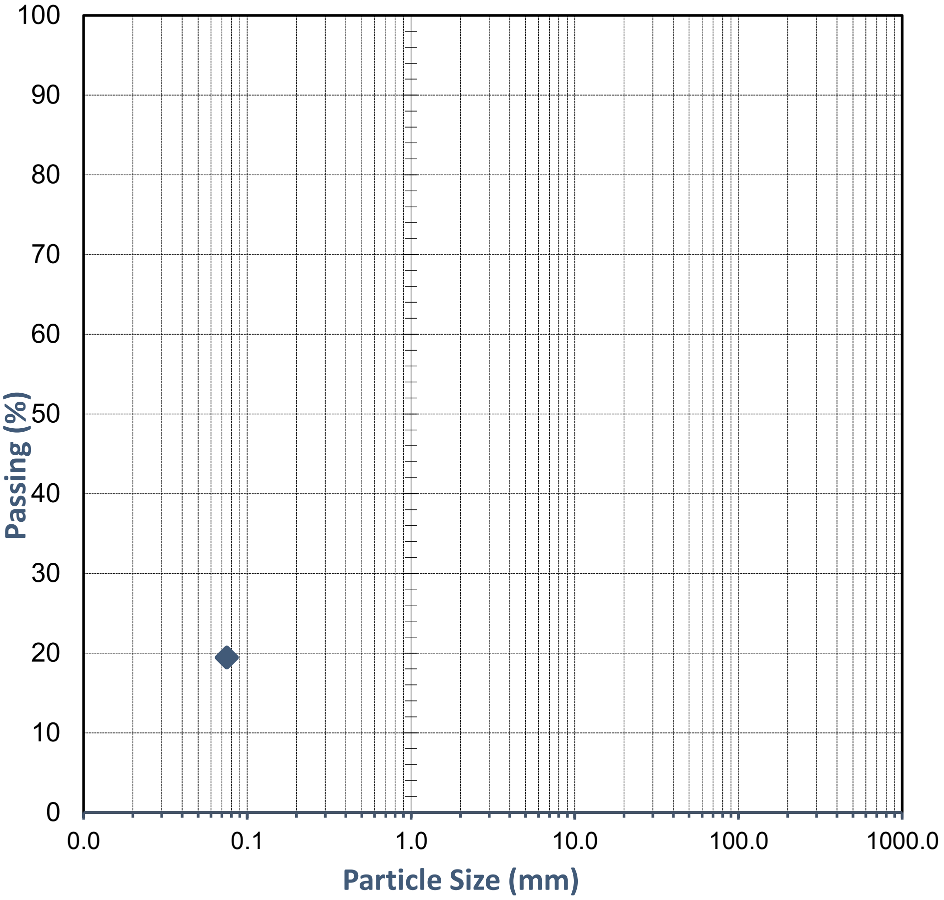
TEST REPORT - AS 1289.3.6.1 (% Fines)

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9804_1_%FINES
Project:	Tallangatta	*Sample No.*	WG20/9804
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH19 1.0-1.5m	*Date Tested:*	28-29/10/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	
1.18	
0.600	
0.425	
0.300	
0.150	
0.075	19



Comments: Clients request for the % Fines of Material passing 0.075mm only.

Approved Signatory:

Name: Brooke Elliott

Date: 02-November-2020

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TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9804_1_PI
Project:	Tallangatta	*Sample No.*	WG20/9804
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH19 1.0-1.5m	*Date Tested:*	29-10-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50^{o}C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**28**
AS 1289.3.2.1	**Plastic Limit (%)**	**14**
AS 1289.3.3.1	**Plasticity Index (%)**	**14**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**4.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**-**

Comments:

Approved Signatory:

Name: Brooke Elliott
Date: 02-November-2020

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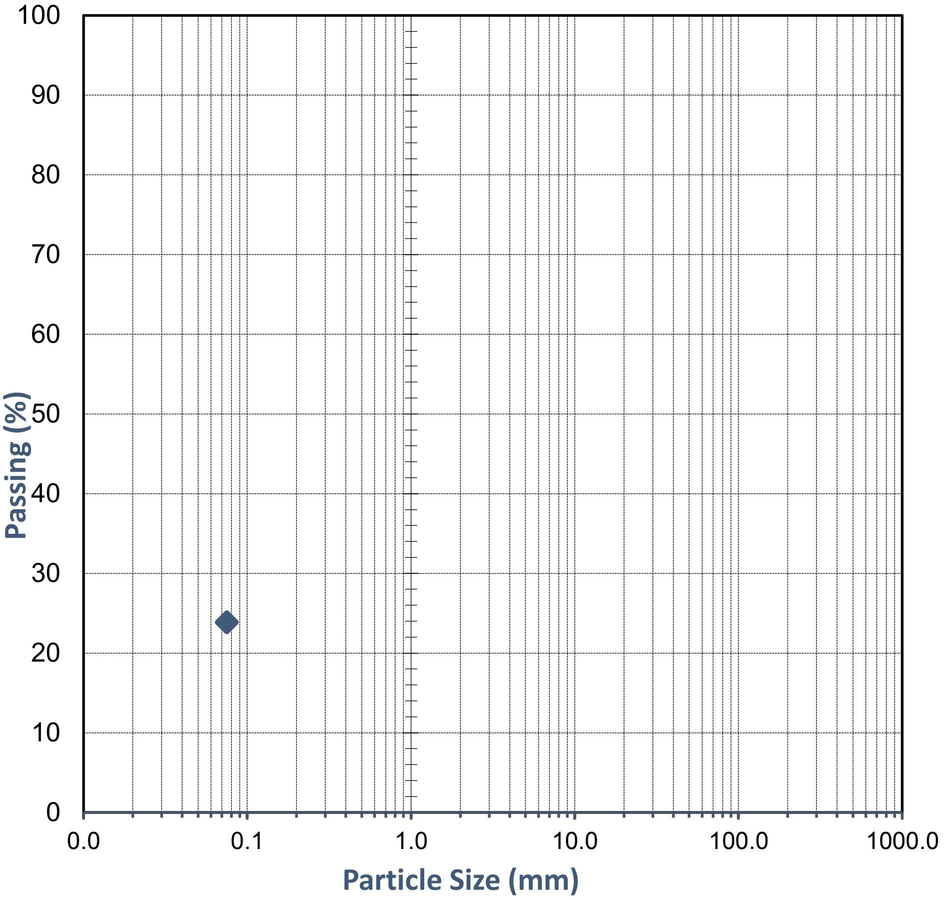
TEST REPORT - AS 1289.3.6.1 (% Fines)

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9805_1_%FINES
Project:	Tallangatta	*Sample No.*	WG20/9805
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH21 1.5-1.9m	*Date Tested:*	28-29/10/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	
1.18	
0.600	
0.425	
0.300	
0.150	
0.075	24



Comments: Clients request for the % Fines of Material passing 0.075mm only.

Approved Signatory:

Name: Brooke Elliott
Date: 30-October-2020

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TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9805_1_PI
Project:	Tallangatta	*Sample No.*	WG20/9805
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH21 1.5-1.9m	*Date Tested:*	29-10-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50^{o}C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**35**
AS 1289.3.2.1	**Plastic Limit (%)**	**16**
AS 1289.3.3.1	**Plasticity Index (%)**	**19**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**6.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**Cracked**

Comments:

Approved Signatory:

Name: Brooke Elliott
Date: 02-November-2020

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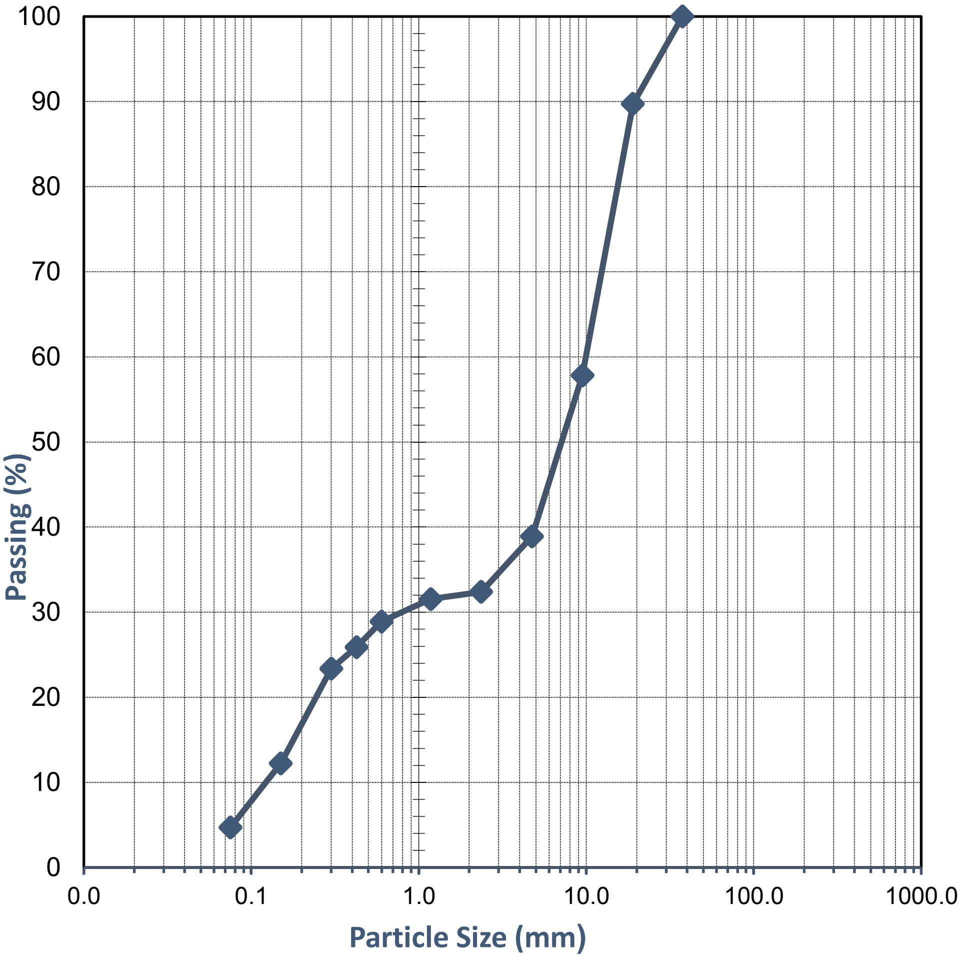
TEST REPORT - AS 1289.1.1*,3.6.1

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9806_1_PSD
Project:	Tallangatta	*Sample No.*	WG20/9806
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH29 0.1-0.5m	*Date Tested:*	28-10-2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: **Sampled by Client, Tested as Received**

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	100
19.0	90
9.5	58
4.75	39
2.36	32
1.18	32
0.600	29
0.425	26
0.300	23
0.150	12
0.075	5



*Comments: *AS 1289.1.1- Deviation from standard: Insufficient sample according to test method requirements. NATA accreditation does not cover the performance of this service.*

Approved Signatory:

Name: Brooke Elliott

Date: 30-October-2020

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TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9807_1_PI
Project:	Tallangatta	*Sample No.*	WG20/9807
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH29 0.5-1.1m	*Date Tested:*	29-10-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50^{o}C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**23**
AS 1289.3.2.1	**Plastic Limit (%)**	**17**
AS 1289.3.3.1	**Plasticity Index (%)**	**6**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**2.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**Cracked**

Comments:

Approved Signatory:

Name: Brooke Elliott
Date: 02-November-2020

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WESTERN GEOTECHNICAL
& Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

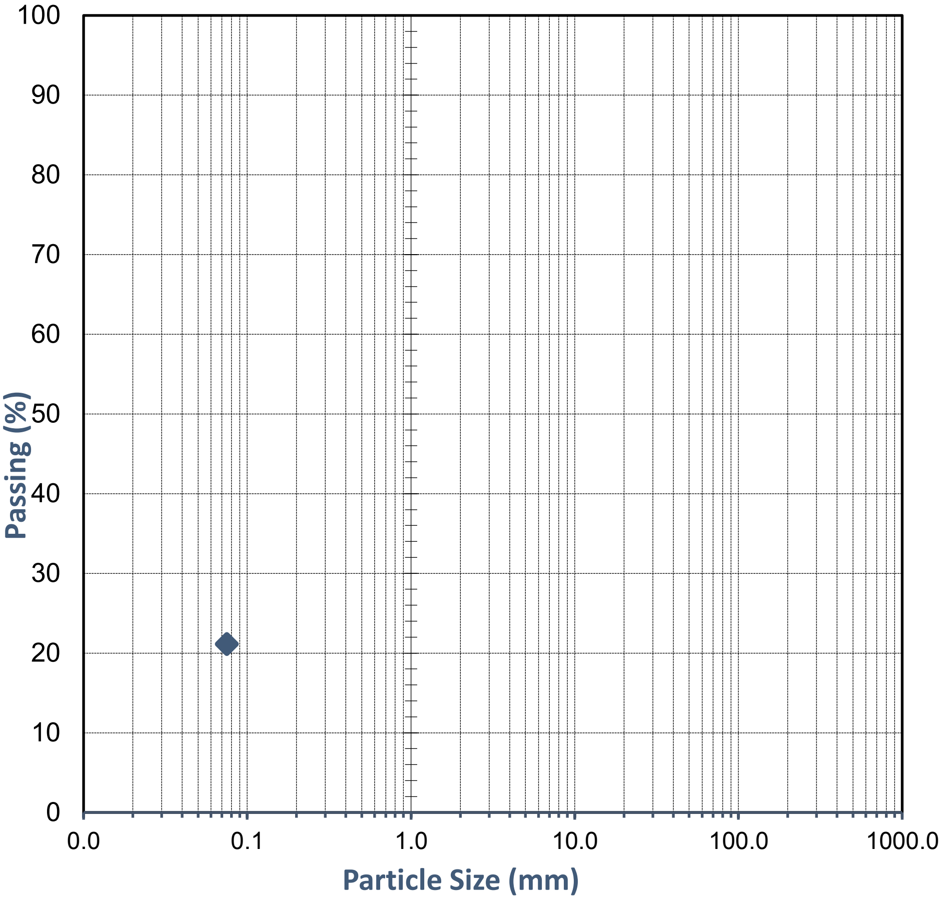
TEST REPORT - AS 1289.3.6.1 (% Fines)

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9808_1_%FINES
Project:	Tallangatta	*Sample No.*	WG20/9808
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH37 1.2-1.6m	*Date Tested:*	28-29/10/2020

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
75.0	
37.5	
19.0	
9.5	
4.75	
2.36	
1.18	
0.600	
0.425	
0.300	
0.150	
0.075	21



Comments: Clients request for the % Fines of Material passing 0.075mm only.

Approved Signatory:

Name: Brooke Elliott

Date: 30-October-2020

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WESTERN GEOTECHNICAL
& Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Brown Geotechnical	*Ticket No.*	S1928
Client Address:	PO Box 278 Como, WA, 6952	*Report No.*	WG20/9808_1_PI
Project:	Tallangatta	*Sample No.*	WG20/9808
Location:	Muchae	*Date Sampled:*	20-10-2020
Sample Identification:	TH37 1.2-1.6m	*Date Tested:*	29-10-2020

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50^{o}C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**31**
AS 1289.3.2.1	**Plastic Limit (%)**	**14**
AS 1289.3.3.1	**Plasticity Index (%)**	**17**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**6.5**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**-**

Comments:

Approved Signatory:

Name: Brooke Elliott
Date: 02-November-2020

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Appendix D

Groundwater Measurements

TALLANGATTA BORES
STATIC DATA

Bore	Easting	Northing	Install Date	RLT (mAHD)	RLG (mAHD)	Total Depth (mbtoc)	Stickup (magl)	Total Depth (mbgl)
TB1	405754	6505172	13/06/2017	65.91	65.25	5.9	0.66	5.24
TB2	406361	6505180	13/06/2017	85.62	85	6.03	0.62	5.41
TB3	406340	6505764	13/06/2017	81.08	80.55	2.2	0.53	1.67
TB4	404938	6505808	13/06/2017	55.5	54.8	4.32	0.7	6.91
TB5	405623	6505941	13/06/2017	67.69	67	4.16	0.69	3.47
TB6	405100	6505093	13/06/2017	54.61	54	4.63	0.61	4.02
TB7	405596	6504222	13/06/2017	59.09	58.4	5.24	0.69	4.55
TB8	405932	6504216	13/06/2017	65.84	65.25	4.76	0.59	4.17
TB9	406375	6504202	13/06/2017	75.48	74.8	3.61	0.68	2.93
GD20	405300	6506021	uk	62.09	61.48	19.51	0.61	18.9
2-98	406399	6502795	uk	58.893	58.29	18.603	0.603	18

TALLANGATTA BORES
DEPTHS TO WATER

	DEPTH TO WATER (mbgl)						
Bore	**17/08/2017**	**12/01/2018**	**18/10/2018**	**30/05/2019**	**21/08/2020**	**9/09/2020**	**2/10/2020**
TB1	2.4		0.6		4.64		>5.18
TB2	1.51		1.38		2.95		2.95
TB3	0.35		0.61		0.7		0.94
TB4	0.22		0.83		0.41		1.09
TB5	0.61		0.76		>3.45		>3.45
TB6	0.28		0.66		0.37	0.45	0.83
TB7	0.82		1.2		1.14		1.3
TB8	0.44		1.02		1.11		2.22
TB9	0.26		0.82		0.56		1.02
GD20	0.19				0.88		1.48
2-98	1.49				2.117		2.267

TALLANGATTA BORES
WATER LEVELS

	WATER LEVEL (m AHD)						
Bore	**17/08/2017**	**12/01/2018**	**18/10/2018**	**30/05/2019**	**21/08/2020**	**9/09/2020**	**2/10/2020**
TB1	62.85		64.67		60.61		<60.07
TB2	83.49		83.66		82.05		82.05
TB3	80.2		79.92		79.85		79.61
TB4	54.58		54		54.39		53.71
TB5	66.39		66.24		<63.55		<63.55
TB6	53.72		53.34		53.63	53.55	53.17
TB7	57.58		57.23		57.26		57.1
TB8	64.81		64.22		64.14		63.03
TB9	74.54		73.97		74.24		73.78
GD20	61.29		60.91		60.6		60
2-98	56.793		56.623		56.173		56.023

TALLANGATTA BORES
AAMGL and MGL
from 21/8/20 measurements

Bore	**AAMGL (mAHD)**	**MGL (mAHD)**	**DTAAMGL (m)**	**DTMGL (m)**
TB1	61.037	61.617	4.213	3.633
TB2	82.477	83.057	2.523	1.943
TB3	80.277	80.857	0.273	-0.307
TB4	54.817	55.397	-0.017	-0.597
TB5				
TB6	54.057	54.637	-0.057	-0.637
TB7	57.687	58.267	0.713	0.133
TB8	64.567	65.147	0.683	0.103
TB9	74.667	75.247	0.133	-0.447
GD20	59.85	61.35	1.63	0.13
2-98	56.6	57.18	1.69	1.11

Appendix E

Letter from Aqua Ferre Pty Ltd

AQUA FERRE PTY LTD

ACN 121 146 772
PO Box 1982 West Perth WA 6872
Level 1, 5 Ord Street West Perth WA 6005
Tel: 08 9282 5400
Fax: 08 9282 5484

29 January 2018

Tom Carmody
Director and Licensee
Tomahawk Property on behalf of the Muchea Employment Node Precinct 3 Landowner Group
8/355 Stirling Highway
Claremont WA 6010

Dear Mr Carmody

Muchea Employment Node Precinct 3 Landowner Group

I refer to your enquiries to Aqua Ferre Pty Ltd (Aqua Ferre) regarding the availability of water and the potential future supply of water, within the Muchea region.

You have advised that you represent a number of landowners with properties on Great Northern Highway and Brand Highway in Muchea (collectively described as the Muchea Employment Node Precinct 3 Landowner Group or more generally the landowner group).

On behalf of the landowner group you have requested information from Aqua Ferre in support of two planning documents:

- Shire of Chittering Town Planning Scheme No 6 Amendment No.67 - Rezoning Lots M1601, 800-804, 192, 194 and 35 Great Northern Highway, Muchea from 'Agricultural Resource' zone to 'Industrial Development' zone, and amending the Scheme Maps accordingly; and
- Precinct 3 Muchea Industrial Park Structure Plan.

In particular you have sought information regarding Aqua Ferre's water entitlements, the prospect that some of Aqua Ferre's water entitlement may be allocated to the landowner group properties, and whether the water can be practically supplied from Aqua Ferre's operations to the landowner group properties.

1 MEN & Precinct 3

The Muchea Employment Node Structure Plan (MENSP) was adopted by the WAPC in August 2011, and provides a 20-year planning framework for industrial development within the Shire of Chittering. We understand that the MENSP is currently under review and a revised document is expected to be released during 2019.

You have advised that the subject land is located within Precinct 3, which forms the eastern portion of the MENSP, to the west of Great Northern Highway (GNH).

Precinct 3 of the Muchea Employment Node (more recently referred to as the Muchea Industrial Park (MIP)) ('the Structure Plan area') is approximately 185ha in area and located to the south east of the townsite of Muchea. Precinct 3 is triangular in shape and extends in a lineal pattern from Brand Highway in the north, along Great Northern Highway (GNH) in the east, to the southern boundary of the Shire of Chittering, and along the Perth-Darwin Highway (PDNH) to the west, which is currently under construction.

Figure 1 below shows the proposed Precinct 3 development boundaries (Urbis 2019, LPS Amendment, Muchea Employment Node, DWG-11).

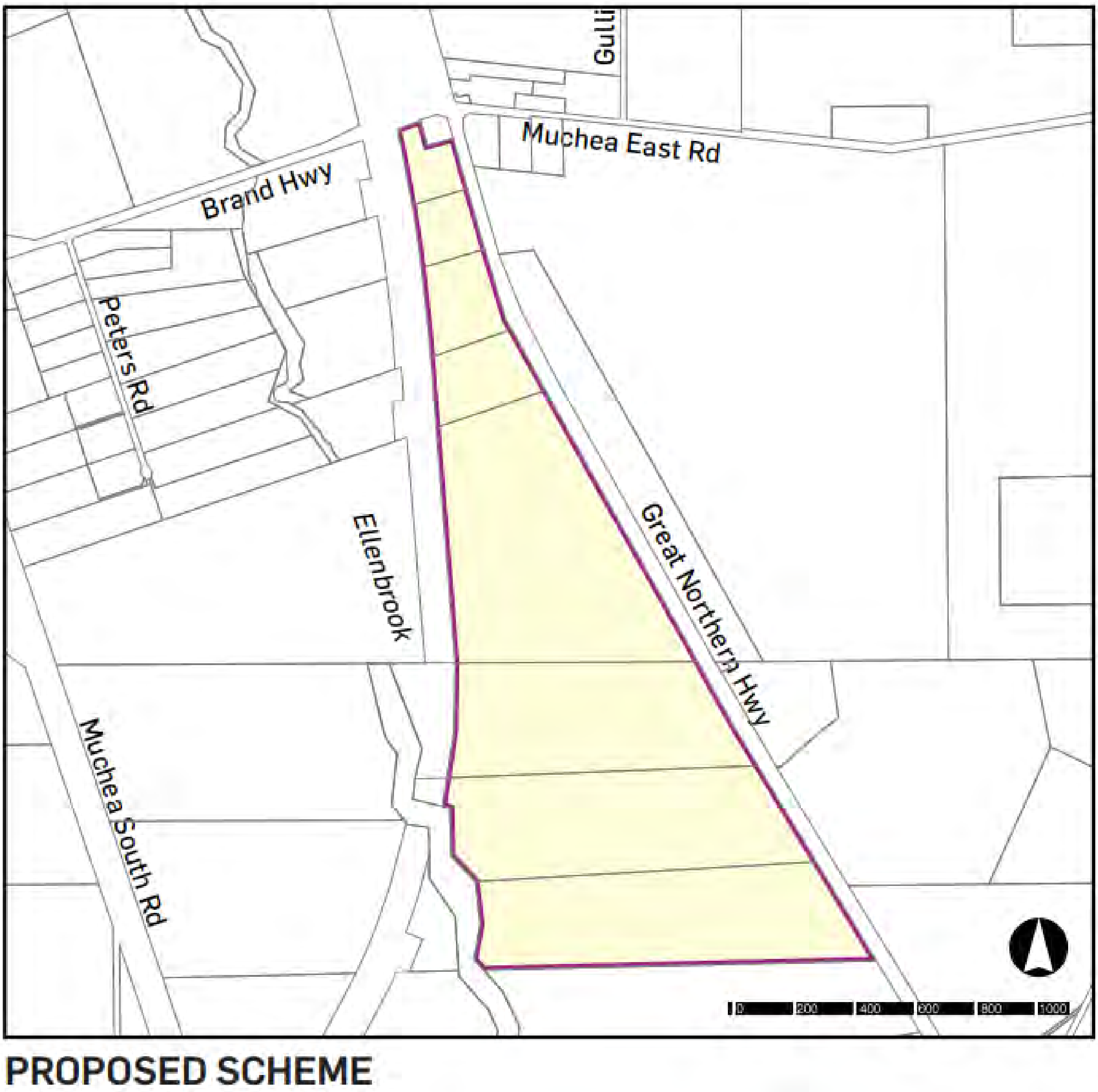


Figure 1 Proposed Precinct 3 development

Urbis[1] have indicated that the land has largely been historically cleared for agricultural purposes and contains stands of large, mature trees with degraded understorey, and a number of rural drainage lines.

---

[1] Urbis Pty Ltd 2019, Precinct 3, Muchea Industrial Park, Structure Plan, Draft January 2019

You have advised that the Structure Plan[2] will provide approximately 51 lots of approximately 1.3ha to 7.6ha providing flexibility for a range of industrial uses, expected to be primarily transport logistics related.

We understand that the Structure Plan is being progressed concurrently with Amendment No.67 to LPS6 which proposes to rezone the land from ‘Agricultural Resource Zone’ to the ‘Industrial Development’ zone, to introduce land use permissibility for Precinct 3; clarify requirements for the preparation of Management Plans, and introduce provisions relating to provision of reticulated water and construction of the loop road.

2 Aqua Ferre

Aqua Ferre was established to be an independent water service provider following approaches by property development groups seeking water services in the Chittering/Muchea region. Aqua Ferre is proposing to build and operate a potable water supply system at Reserve Road, Chittering (as shown in Figure 2).

The proposed water treatment plant (WTP) would be operated as a constant flow rate to promote a stable process with the intention of producing reliable potable water that meets the Australian Drinking Water Guidelines.

Figure 2 below broadly shows the Precinct 3 development (outlined in red) to the south of Harvis' proposed MEN (Phase 1) development (outlined in yellow) and Aqua Ferre's proposed water facility to the north.

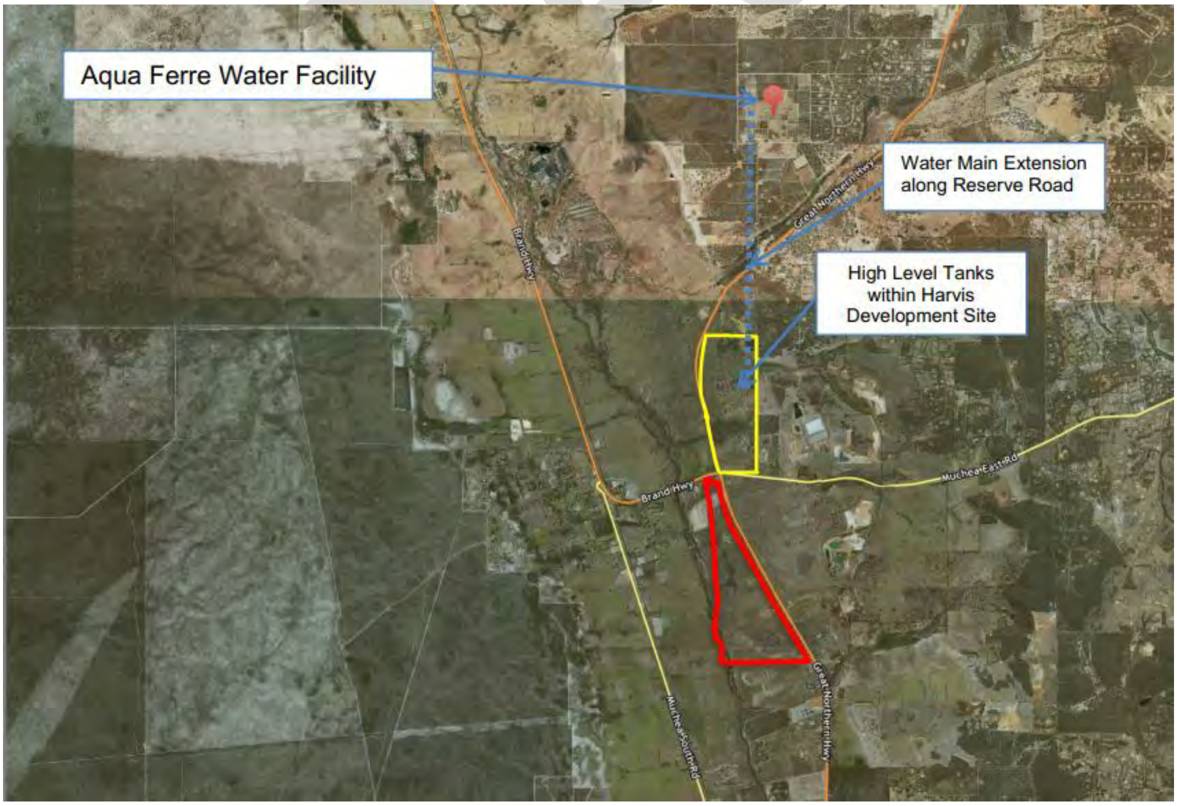


Figure 2 Development boundaries

---

[2] Urbis Pty Ltd 2019, Precinct 3, Muchea Industrial Park, Structure Plan, Draft January 2019

2.1 Water Entitlement

The Reserve Road (Chittering) property currently has a total water entitlement or allocation (licence to abstract water from an artesian aquifer) of 288,800 kL per annum. The developer of the Reserve Road residential development, Riverside, has transferred the Water Licence GWL 59907(3) to the Water Corporation to enable the licence to be changed from an agricultural extraction to public water supply. It is intended that this water entitlement will be transferred to Aqua Ferre when a water service licence has been granted.

Aqua Ferre has similar entitlement rights to a further 362,900 kL per annum licence, originally GWL 102502(4) which is now part of GWL 65011.

In total, it is intended that Aqua Ferre will have access to 651,700 kL of water per annum.

There is an existing production bore located within the proposed Reserve Road development that was previously used for wildflower irrigation, where the proposed potable WTP would be located.

2.2 Existing water supply commitments

Aqua Ferre intends supplying approximately 153 ML of treated potable water to the residential development at Reserve Road, Chittering, and to a commercial/industrial development at the adjacent MEN (northern Precinct 1 only). It is intended that a further 75 ML will be set aside for future demand across these two developments.

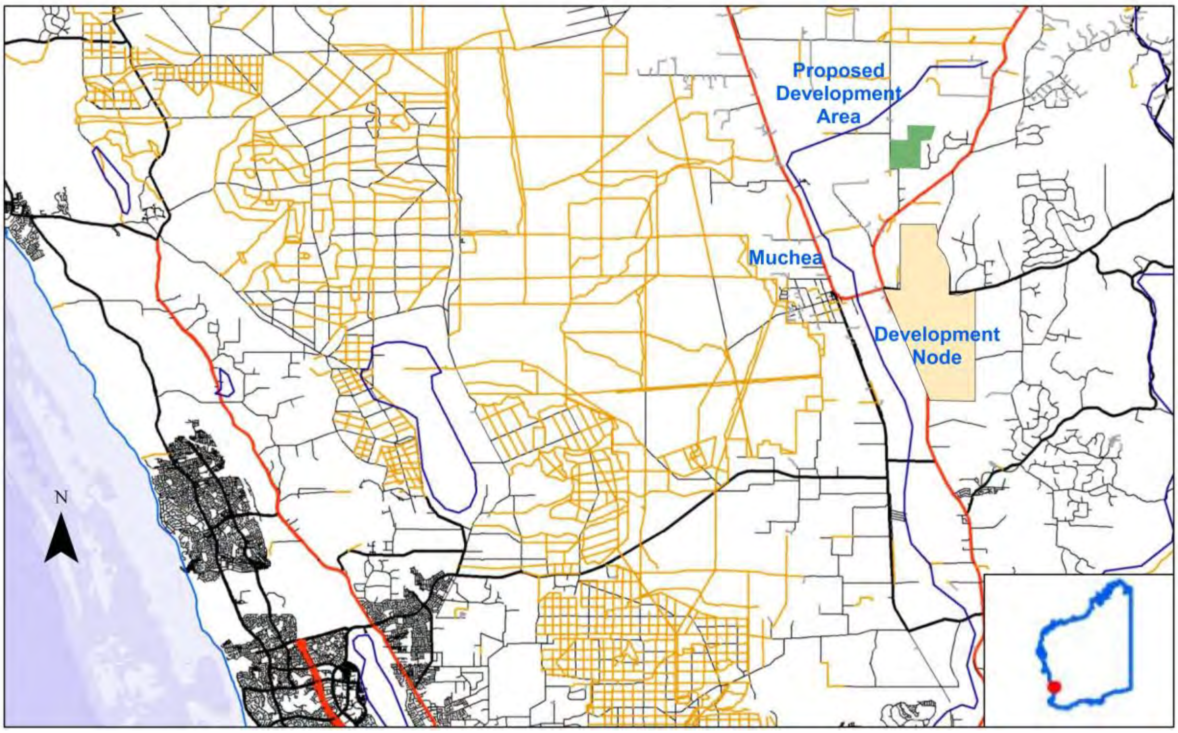


Figure 3 Location of Reserve Road residential development and MEN

The new Reserve Road rural living allotment development is located 8km north east of the Muchea town site and 80km north of the Perth central business district. It is also in close proximity (4km) to the proposed MEN on the eastern side of Great Northern Highway. The development is in accordance with the Shire of Chittering's planning scheme (2004). The Reserve Road development covers an area of approximately 160 hectares and involves the creation of approximately 245 rural residential allotments in progressive stages. It is a requirement of the development approval that potable reticulated water is available.

Figure 4 Contour map (5m contour lines) of the Harvis MEN development showing ephemeral swale

Phase 1 of the MEN development is being undertaken by development group Harvis Capital Pty Ltd (Harvis). The Harvis development is located on the northern end of the proposed MEN. The site is slightly undulating with an ephemeral swale running through the development (Figure 4). The development is well placed and has been planned around the proposed Perth Darwin Highway.

It is the intention of the MEN development that these lots also have a reticulated water resource. Currently, the area does not have a public water supply scheme. Aqua Ferre is finalising documentation to allow the Economic Regulation Authority Western Australia to consider an application for a water services licence.

It is proposed that the water supply for the Harvis MEN development will have a standalone delivery and network system, to ensure that the demand of both systems can meet peak demand and firefighting requirements.

After treatment, it is intended that the water required for the Harvis MEN site will be delivered to a 500kL holding tank with aeration. Water would be reticulated to customers using a standard, continually pressurised water reticulation network. The piping would follow the general topography and alignment of the development streets and will have 600mm coverage.

3 Precinct 3 water requirement

You have advised that the intention is that the land the subject of the Structure Plan would be serviced with reticulated water provided by a licensed water provider.

The total area of supply is for an industrial development totalling approximately 185 hectares. No indication of staging of development has been provided at this point.

Estimated annual water usage has been provided (based on preliminary modelling by Cossill & Webley) as 203ML per annum on a net area of 139 hectares (after allowing for a 25% reduction in land area calculation to accommodate roads/drainage). The proposed system has been modelled at 4kL/day per hectare based on advice from Cossill & Webley of studies of similar industry types and uses. It is noted that this compares to the Water Corporation design standard for industrial land of approximately 17 kL/ha/day.

Based on your advice of estimated water usage, Aqua Ferre would have capacity under its entitlements to meet the demand of the subject land. This is not an undertaking to commit an allocation of water, or to supply water, to the Muchea Employment Node Precinct 3 Landowner Group. Any such arrangements would be the subject to future commercial negotiation, agreement on terms including pricing and remaining water availability under Aqua Ferre's entitlements.

4 Supply assessment

Aqua Ferre has conducted a preliminary desktop assessment of the potential supply route from its planned water treatment plant at Reserve Road to the proposed Precinct 3 development via Harvis' phase 1 MEN development. This represents a distance of approximately 3.5 kilometres.

The assessment did not highlight any major engineering impediments to the provision of water to the proposed development. (This is not to say, however, that any impediments would not become apparent on more detailed analysis.)

Any proposal for supply would be inclusive of the requirements of:

- Water Corporation Design Standard DS 63 – Water Reticulation Standard Design and Construction Requirements for Water Reticulation Systems or Water Reticulation Systems up to DN250
- DFES requirements for firefighting services
- Hydraulic modelling using EPANET 2 for system hydraulics.

Hydraulic modelling would require topographical mapping at 0.5m.

Additionally, there would be a requirement for a water reserve for tanks, pumps, sumps, generator and chlorination which would need to be met by the subject landowners' group.

5 Disclaimer

This report is dated 29 January 2019 and incorporates information available to Aqua Ferre up to that date only. It excludes consideration of any information arising, or event occurring, after that date which may impact opinions expressed or statements made by Aqua Ferre in this report.

Aqua Ferre has prepared this report on the instructions, and for the sole benefit, of Tomahawk Property (Instructing Party), for inclusion within a rezoning application and Structure Plan as described in paragraph 3 of this letter (Purpose) and not for any other purpose or use. To the extent permitted by applicable law, Aqua Ferre expressly disclaims all liability, whether direct or indirect:

- to the Instructing Party, which may arise in connection with any reliance or purported reliance on this report for any purpose other than the Purpose, and
- to any other person, which may arise in connection with any reliance or purported reliance on this report for any purpose whatsoever (including the Purpose).

All statements and opinions contained in or associated with this report are made on the basis of information supplied to Aqua Ferre as at the date of this report, and upon which Aqua Ferre has relied. To the extent permitted by applicable law, Aqua Ferre expressly disclaims any liability, whether direct or indirect, which may arise in connection with any errors or omissions in this report arising from information provided to Aqua Ferre by the Instructing Party or by any other person.

Achievement of any proposed or intended events or circumstances described in this report will depend, among other things, on the actions of others, over which Aqua Ferre has no control. To the extent permitted by applicable law, Aqua Ferre expressly disclaims any liability, whether direct or indirect, which may arise in connection with the delay in, or failure to occur of, any proposed or intended events or circumstances described in this report.

Yours sincerely

Peter Fogarty
Director

Appendix F

Flow Calculations

LOTS - 1 YEAR ARI 1 HOUR

Rainfall Intensity i (mm/h)	15.1	(1yr, 1hr Storm)
Runoff Coefficient Lots	0.8	
Permeability k (m/hr)	0.0417	

Segment	Lot(s)	Lot Area (m2)	Ai (m2)	Q (L/s)	Vinflow (m3)
A1					
	14	20000	16000	67	242
	15	20000	16000	67	242
	16	20000	16000	67	242
	42	22000	17600	74	266
	45	76000	60800	255	919
A2				0	0
	10	12000	9600	40	145
	11	13000	10400	44	157
	12	16000	12800	54	193
	13	17000	13600	57	206
A3				0	0
	43	15000	12000	50	181
	44	13000	10400	44	157
A4				0	0
	46	116000	92800	390	1402
A5				0	0
	47	91000	72800	306	1100
	48	66000	52800	222	798
	49N	33000	26400	111	399
B1				0	0
C1				0	0
	22	23000	18400	77	278
C2				0	0
	23	12000	9600	40	145
	24	13000	10400	44	157
C3				0	0
	20	15000	12000	50	181
	21	15000	12000	50	181
	32	15000	12000	50	181
C4				0	0
	33	51000	40800	171	617
	34	50000	40000	168	604
	35	50000	40000	168	604
	36	41000	32800	138	496
	37	60000	48000	201	725
	38	40000	32000	134	484
	39	40000	32000	134	484
	40	40000	32000	134	484
	41	40000	32000	134	484
D1				0	0
	25	16000	12800	54	193
	28	20000	16000	67	242
	29	20000	16000	67	242
	30	21000	16800	71	254
	31	14000	11200	47	169
D2				0	0
	26	13000	10400	44	157
	27	13000	10400	44	157
D3				0	0
	54	33000	26400	111	399
	55	21000	16800	71	254
D4					
D5					
	49S	33000	26400	111	399
	50	51000	40800	171	617
	51	61000	48800	205	737
Others					
	1	8512	6810	29	103
	2	10000	8000	34	121
	3	11000	8800	37	133
	4	16000	12800	54	193
	5	19000	15200	64	230
	6	25000	20000	84	302
	7	25000	20000	84	302
	8	18000	14400	60	218
	9	22000	17600	74	266
	17	40000	32000	134	484
	18	36000	28800	121	435
	19	34000	27200	114	411
	52	40000	32000	134	484
	53	40000	32000	134	484

Basin Sizing	Depth	Slope 1:x	Base Width	Base Length	Top Width (m)	Top Length (m)	Volume	Effective Volume	Surface Area (m2)	Volume check
A1										
14	0.5	4	20	20	24	24	243	263	576	ok
15	0.5	4	20	20	24	24	243	263	576	ok
16	0.5	4	20	20	24	24	243	263	576	ok
42	0.5	4	21	21	25	25	265	287	625	ok
45	0.5	4	40	40	44	44	883	956	1936	ok
A2										
10	0.5	4	15	15	19	19	145	157	361	ok
11	0.5	4	15	15	19	19	145	157	361	ok
12	0.5	4	17	17	21	21	181	196	441	ok
13	0.5	4	18	18	22	22	201	217	484	ok
A3										
43	0.5	4	17	17	21	21	181	196	441	ok
44	0.5	4	15	15	19	19	145	157	361	ok
A4										
46	0.5	4	49	49	53	53	1301	1410	2809	ok
A5										
47	0.5	4	44	44	48	48	1059	1147	2304	ok
48	0.5	4	37	37	41	41	761	825	1681	ok
49N	0.5	4	29	29	33	33	481	521	1089	ok
A6										
B1										
C1										
22	0.5	4	21	21	25	25	265	287	625	ok
C2										
23	0.5	4	15	15	19	19	145	157	361	ok
24	0.5	4	15	15	19	19	145	157	361	ok
C3										
20	0.5	4	17	17	21	21	181	196	441	ok
21	0.5	4	17	17	21	21	181	196	441	ok
32	0.5	4	17	17	21	21	181	196	441	ok
C4										
33	0.5	4	32	32	36	36	579	627	1296	ok
34	0.5	4	32	32	36	36	579	627	1296	ok
35	0.5	4	32	32	36	36	579	627	1296	ok
36	0.5	4	29	29	33	33	481	521	1089	ok
37	0.5	4	35	35	39	39	685	742	1521	ok
38	0.5	4	28	28	32	32	451	488	1024	ok
39	0.5	4	28	28	32	32	451	488	1024	ok
40	0.5	4	28	28	32	32	451	488	1024	ok
41	0.5	4	28	28	32	32	451	488	1024	ok
D1										
25	0.5	4	17	17	21	21	181	196	441	ok
28	0.5	4	20	20	24	24	243	263	576	ok
29	0.5	4	20	20	24	24	243	263	576	ok
30	0.5	4	20	20	24	24	243	263	576	ok
31	0.5	4	16	16	20	20	163	176	400	ok
D2										
26	0.5	4	15	15	19	19	145	157	361	ok
27	0.5	4	15	15	19	19	145	157	361	ok
D3										
54	0.5	4	26	26	30	30	393	425	900	ok
55	0.5	4	20	20	24	24	243	263	576	ok
D4										
D5										
49S	0.5	4	26	26	30	30	393	425	900	ok
50	0.5	4	32	32	36	36	579	627	1296	ok
51	0.5	4	35	35	39	39	685	742	1521	ok
Others										
1	0.5	4	12	12	16	16	99	107	256	ok
2	0.5	4	13	13	17	17	113	123	289	ok
3	0.5	4	14	14	18	18	129	139	324	ok
4	0.5	4	17	17	21	21	181	196	441	ok
5	0.5	4	19	19	23	23	221	240	529	ok
6	0.5	4	22	22	26	26	289	313	676	ok
7	0.5	4	22	22	26	26	289	313	676	ok
8	0.5	4	19	19	23	23	221	240	529	ok
9	0.5	4	21	21	25	25	265	287	625	ok
17	0.5	4	28	28	32	32	451	488	1024	ok
18	0.5	4	27	27	31	31	421	456	961	ok
19	0.5	4	26	26	30	30	393	425	900	ok
52	0.5	4	28	28	32	32	451	488	1024	ok
53	0.5	4	28	28	32	32	451	488	1024	ok

1 YEAR ARI 1 HOUR FLOWS - ROADS

Rainfall Intensity i (mm/h)	15.1	(1yr, 1hr Storm)
Runoff Coefficient Road Reserves	0.8	
Runoff Coefficient Swale	1	
Runoff Coefficient Lots	0	
Runoff Coefficient OS	0	
Permeability k (m/hr)	**0.0417**	
Driveway Width (m)	10.0	
Swale Side Slope (1/x)	3.00	

Segment	Road Reserve (m2)	Swale Length (m)	Swale Depth (m)	Weir Height (m)	Swale Base Width (m)	Swale Top Width (m)	Swale Area (m2)	Lots (m2)	POS (m2)	Ai	Segment Peak Flow (L/s)	Segment 1 hr Flow (m3)
A1	32745	870	0.6	0.3	5	8.60	7482	0	0	27692	116	418.5
A2	8531	256	0.5	0.3	4	7.00	1792	0	0	7183	30	108.6
A3	9956	295	0.5	0.3	3	6.00	1770	0	0	8319	35	125.7
A4	10792	229	0.6	0.3	2	5.60	1282	0	0	8890	37	134.3
A5	24409	583	0.6	0.3	3.5	7.10	4139	0	0	20355	85	307.6
A6	13299	420	0.5	0.3	4	7.00	2940	0	0	11227	47	169.7
B1	13269	296	0.5	0.3	2	5.00	1480	0	0	10911	46	164.9
C3	7868	249	0.6	0.3	3	6.60	1643	0	0	6623	28	100.1
C4	29301	885	0.8	0.3	4.5	9.30	8231	0	0	25087	105	379.1
D1	4310	141	0.6	0.3	3.5	7.10	1001	0	0	3648	15	55.1
D2	5856	189	0.6	0.3	3	6.60	1247	0	0	4934	21	74.6
D3	15265	326	0.6	0.3	3	6.60	2152	0	0	12642	53	191.1
D4	10526	335	0.5	0.3	4	7.00	2345	0	0	8890	37	134.3
D5	27241	623	0.6	0.3	3.5	7.10	4423	0	0	22677	95	342.7

Trapezoidal Swales

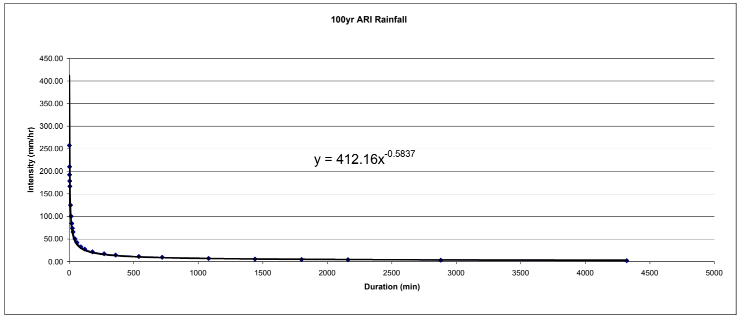
Swale Segment	No. Driveways	No. Weirs	Length	Weir Spacing (m)	Long Slope	Max U/S Reach (m)	Upstream Ht (m)	1 hr Inflow per Weir (m3)	Storage per Weir (m3)	Total Storage (m3)	Effective Storage per Weir (m3)	Effective Total Storage (m3)	Volume Check
A1	5	65	870	13	0.0179	12.6	0.1	6.44	12.55	816.05	15.66	1017.58	ok
A2	3	4	256	64	0.0066	45.5	0.0	27.14	22.27	89.09	29.42	117.70	ok
A3	2	5	295	59	0.0044	55.0	0.1	25.14	33.33	166.67	42.11	210.53	ok
A4	1	17	229	13	0.014	12.9	0.1	7.90	7.08	120.29	8.69	147.73	ok
A5	3	23	583	25	0.0086	24.0	0.1	13.37	18.87	433.99	23.32	536.39	ok
A6	0	19	420	22	0.019	15.8	0.0	8.93	7.74	147.00	10.22	194.20	ok
B1	1	26	296	11	0.0182	11.0	0.1	6.34	5.67	147.41	7.03	182.68	ok
C3	2	13	249	19	0.0185	16.2	0.0	7.70	6.32	82.22	8.34	108.36	ok
C4	7	5	885	177	0.0016	163.0	0.0	75.82	127.28	636.39	160.49	802.46	ok
D1	0	3	141	47	0.0071	42.3	0.0	18.38	18.59	55.77	24.54	73.61	ok
D2	0	5	189	38	0.0079	37.8	0.0	14.91	15.67	78.36	20.39	101.93	ok
D3	2	26	326	13	0.0172	11.8	0.1	7.35	8.26	214.64	10.19	265.06	ok
D4	2	19	335	18	0.0209	14.4	0.0	7.07	7.03	133.64	9.29	176.55	ok
D5	3	20	623	31	0.008	29.7	0.1	17.14	20.80	416.01	26.20	524.01	ok

100 YEAR ARI DRAINAGE PROPERTIES - LOTS

Segment	Lot(s)	AREAS (m2)			TIME OF CONCENTRATION PRE-DEVELOPMENT					TIME OF CONCENTRATION POST-DEVELOPMENT					CRITICAL STORM INTENSITY (mm/h)	
		Area (m2)	Effective Area (m2)		Longest Path (m)	RL Top (mAHD)	RL Bottom (mAHD)	Slope (m/km)	TC (min)	Longest Path (m)	RL Top (mAHD)	RL Bottom (mAHD)	Slope (m/km)	TC (min)	Pre-Dev	Post-Dev
			Pre	Post												
A1																
	14	20000	7000	17000	200	65	60.6	22.00	10.3	200	65	60.6	22.00	9.4	105.8	111.5
	15	20000	7000	17000	200	62	59	15.00	11.1	200	62	59	15.00	10.1	101.2	106.6
	16	20000	7000	17000	193	59.8	57.4	12.44	11.1	193	59.8	57.4	12.44	10.2	101.1	106.5
	42	22000	7700	18700	204	67.5	64.5	14.71	11.2	204	67.5	64.5	14.71	10.3	100.4	105.7
	45	76000	26600	64600	410	72.6	67	13.66	20.3	410	72.6	67	13.66	18.5	71.2	75.0
A2																
	10	12000	4200	10200	162	60	58.2	11.11	10.0	162	60	58.2	11.11	9.2	107.3	113.0
	11	13000	4550	11050	177	62	59.4	14.69	10.3	177	62	59.4	14.69	9.4	105.7	111.4
	12	16000	5600	13600	198	64	61	15.15	11.2	198	64	61	15.15	10.2	100.6	106.0
	13	17000	5950	14450	189	65.5	63	13.23	10.9	189	65.5	63	13.23	10.0	102.1	107.5
A3																
	43	15000	5250	12750	179	68.1	65.4	15.08	10.2	179	68.1	65.4	15.08	9.3	106.3	111.9
	44	13000	4550	11050	175	68.6	66	14.86	10.1	175	68.6	66	14.86	9.3	106.6	112.3
A4																
	46	116000	40600	98600	466	82	71	23.61	19.8	466	82	71	23.61	18.1	72.2	76.0
A5																
	47	91000	31850	77350	430	89.7	70.9	43.72	16.5	430	89.7	70.9	43.72	15.1	80.1	84.4
	48	66000	23100	56100	366	84.5	72.2	33.61	15.3	366	84.5	72.2	33.61	14.0	83.8	88.3
	49N	33000	11550	28050	305	83.9	75.4	27.87	14.2	305	83.9	75.4	27.87	13.0	87.6	92.2
A6																
B1																
C1																
	22	23000	8050	19550	179	57.2	54	17.88	9.4	179	57.2	54	17.88	8.6	111.1	117.0
C2																
	23	12000	4200	10200	156	57.4	55.3	13.46	9.3	156	57.4	55.3	13.46	8.5	112.2	118.1
	24	13000	4550	11050	158	57.2	54.9	14.56	9.2	158	57.2	54.9	14.56	8.4	112.9	118.9
C3																
	20	15000	5250	12750	179	60	58.2	10.06	11.1	179	60	58.2	10.06	10.1	101.3	106.7
	21	15000	5250	12750	179	58.7	56.7	11.17	10.8	179	58.7	56.7	11.17	9.9	102.6	108.1
	32	15000	5250	12750	179	60.5	57.5	16.76	10.0	179	60.5	57.5	16.76	9.1	107.6	113.3
C4																
	33	51000	17850	43350	309	66	60.5	17.80	15.1	309	66	60.5	17.80	13.8	84.6	89.1
	34	50000	17500	42500	317	67.6	60.5	22.40	14.8	317	67.6	60.5	22.40	13.5	85.5	90.1
	35	50000	17500	42500	249	69	61.5	30.12	11.0	249	69	61.5	30.12	10.0	101.9	107.3
	36	41000	14350	34850	309	68	61.5	21.04	14.9	309	68	61.5	21.04	13.6	85.2	89.7
	37	60000	21000	51000	354	74	63.5	29.66	15.3	354	74	63.5	29.66	14.0	83.7	88.2
	38	40000	14000	34000	282	74.7	68.1	23.40	13.3	282	74.7	68.1	23.40	12.2	90.8	95.7
	39	40000	14000	34000	283	74.8	67.7	25.09	13.2	283	74.8	67.7	25.09	12.1	91.4	96.3
	40	40000	14000	34000	282	73	65.6	26.24	13.0	282	73	65.6	26.24	11.9	92.1	97.0
	41	40000	14000	34000	273	69.8	65.5	15.75	14.0	273	69.8	65.5	15.75	12.8	88.4	93.1
D1																
	25	16000	5600	13600	190	57	54.8	11.58	11.3	190	57	54.8	11.58	10.4	99.9	105.2
	28	20000	7000	17000	193	62	58.2	19.69	10.1	193	62	58.2	19.69	9.3	106.7	112.3
	29	20000	7000	17000	200	62.3	57	26.50	9.9	200	62.3	57	26.50	9.1	108.2	113.9
	30	21000	7350	17850	210	61	56.7	20.48	10.9	210	61	56.7	20.48	10.0	102.3	107.7
	31	14000	4900	11900	182	60.5	57.3	17.58	10.1	182	60.5	57.3	17.58	9.3	106.7	112.4
D2																
	26	13000	4550	11050	165	58	55.3	16.36	9.4	165	58	55.3	16.36	8.6	111.6	117.5
	27	13000	4550	11050	163	59.6	56.8	17.18	9.2	163	59.6	56.8	17.18	8.4	113.0	119.0
D3																
	54	33000	11550	28050	254	63.5	60	13.78	13.6	254	63.5	60	13.78	12.5	89.8	94.5
	55	21000	7350	17850	202	61.5	58.5	14.85	11.2	202	61.5	58.5	14.85	10.2	100.8	106.2
D4																
D5																
	49S	33000	11550	28050	301	83.8	75.5	27.57	14.0	301	83.8	75.5	27.57	12.9	88.1	92.8
	50	51000	17850	43350	333	82	72.5	28.53	14.8	333	82	72.5	28.53	13.5	85.6	90.1
	51	61000	21350	51850	268	78.4	70.3	30.22	11.5	268	78.4	70.3	30.22	10.6	98.8	104.1
Others																
	1	8512	2979	7235	152	69.5	67.4	13.82	9.3	152	69.5	67.4	13.82	8.5	111.9	117.9
	2	10000	3500	8500	144	67.3	65.7	11.11	9.1	144	67.3	65.7	11.11	8.3	113.7	119.7
	3	11000	3850	9350	157	65.5	63.8	10.83	9.9	157	65.5	63.8	10.83	9.0	108.4	114.1
	4	16000	5600	13600	200	64	61.5	12.50	11.8	200	64	61.5	12.50	10.8	97.8	103.0
	5	19000	6650	16150	231	61.6	59.5	9.09	14.2	231	61.6	59.5	9.09	13.0	87.5	92.2
	6	25000	8750	21250	257	60	57.8	8.56	15.6	257	60	57.8	8.56	14.3	83.0	87.4
	7	25000	8750	21250	267	58	54	14.98	14.5	267	58	54	14.98	13.2	86.6	91.2
	8	18000	6300	15300	253	57.5	54	13.83	14.4	253	57.5	54	13.83	13.2	86.9	91.5
	9	22000	7700	18700	207	57.4	54	16.43	11.2	207	57.4	54	16.43	10.2	100.8	106.2
	17	40000	14000	34000	291	57.2	54	11.00	16.0	291	57.2	54	11.00	14.7	81.7	86.0
	18	36000	12600	30600	285	58.3	55.5	9.82	16.2	285	58.3	55.5	9.82	14.8	81.1	85.4
	19	34000	11900	28900	267	61	58.2	10.49	15.1	267	61	58.2	10.49	13.8	84.6	89.1
	52	40000	14000	34000	276	70	66.5	12.68	14.8	276	70	66.5	12.68	13.5	85.6	90.2
	53	40000	14000	34000	296	67.5	63.5	13.51	15.6	296	67.5	63.5	13.51	14.3	82.8	87.2

Runoff Coefficients	
Cleared Upland	0.35
Hardstand	0.85

Event	Duration (mins)	Intensity (mm/hr)
1 min	1	257.40
2 min	2	210.00
3 min	3	192.40
4 min	4	178.50
5 min	5	166.80
10 min	10	124.80
15 min	15	100.40
20 min	20	84.60
25 min	25	73.68
30 min	30	65.60
45 min	45	50.53
1 hr	60	42.10
1.5 hr	90	32.73
2 hr	120	27.55
3 hr	180	21.73
4.5 hr	270	17.24
6 hr	360	14.62
9 hr	540	11.44
12 hr	720	9.50
18 hr	1080	7.17
24 hr	1440	5.75
30 hr	1800	4.77
36 hr	2160	4.08
48 hr	2880	3.17
72 hr	4320	2.19



100 YEAR ARI FLOWS - LOTS

Storm Duration (mins)	A1																			
	14				15				16				42				45			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	205.81	1215.50	1009.69	-35.80	196.81	1215.50	1018.69	-39.27	196.60	1215.50	1018.90	-39.35	214.70	1337.05	1122.35	-43.92	525.97	4618.90	4092.93	-272.88
2	205.81	991.67	785.85	2.36	196.81	991.67	794.85	-0.63	196.60	991.67	795.07	-0.70	214.70	1090.83	876.13	-1.32	525.97	3768.33	3242.37	-114.33
3	205.81	908.56	702.74	36.75	196.81	908.56	711.74	34.28	196.60	908.56	711.96	34.21	214.70	999.41	784.71	37.18	525.97	3452.51	2926.55	30.83
4	205.81	842.92	637.10	65.21	196.81	842.92	646.10	63.25	196.60	842.92	646.32	63.20	214.70	927.21	712.51	69.15	525.97	3203.08	2677.12	153.50
5	205.81	787.67	581.85	88.85	196.81	787.67	590.85	87.40	196.60	787.67	591.07	87.36	214.70	866.43	651.73	95.82	525.97	2993.13	2467.17	257.88
10	205.81	589.33	383.52	154.61	196.81	589.33	392.52	155.73	196.60	589.33	392.74	155.75	214.70	648.27	433.56	171.49	525.97	2239.47	1713.50	580.43
15	205.81	474.11	268.30	175.81	196.81	474.11	277.30	179.51	196.60	474.11	277.51	179.59	214.70	521.52	306.82	198.16	525.97	1801.62	1275.66	733.82
20	205.81	399.50	193.69	176.17	196.81	399.50	202.69	182.45	196.60	399.50	202.90	182.60	214.70	439.45	224.75	201.91	525.97	1518.10	992.13	808.19
25	205.81	347.93	142.12	165.79	196.81	347.93	151.12	174.65	196.60	347.93	151.34	174.86	214.70	382.73	168.02	193.85	525.97	1322.15	796.18	841.94
30	205.81	309.78	103.97	148.20	196.81	309.78	112.97	159.66	196.60	309.78	113.18	159.93	214.70	340.76	126.05	177.86	525.97	1177.16	651.19	848.48
45	205.81	238.63	32.82	72.65	196.81	238.63	41.82	91.92	196.60	238.63	42.03	92.37	214.70	262.49	47.79	104.90	525.97	906.79	380.83	782.51
60	205.81	198.81	-7.01	-21.13	196.81	198.81	1.99	5.97	196.60	198.81	2.21	6.62	214.70	218.69	3.98	11.93	525.97	755.46	229.50	648.45
90	205.81	154.57	-51.24	-238.22	196.81	154.57	-42.24	-195.36	196.60	154.57	-42.02	-194.33	214.70	170.03	-44.67	-206.40	525.97	587.38	61.42	270.47
120	205.81	130.10	-75.71	-477.62	196.81	130.10	-66.72	-418.92	196.60	130.10	-66.50	-417.52	214.70	143.11	-71.60	-449.18	525.97	494.37	-31.60	-190.10
180	205.81	102.63	-103.18	-997.72	196.81	102.63	-94.18	-907.25	196.60	102.63	-93.97	-905.09	214.70	112.89	-101.81	-980.02	525.97	389.99	-135.97	-1264.52
270	205.81	81.43	-124.38	-1837.73	196.81	81.43	-115.38	-1699.44	196.60	81.43	-115.16	-1696.14	214.70	89.58	-125.13	-1841.91	525.97	309.44	-216.52	-3098.29
360	205.81	69.02	-136.79	-2724.70	196.81	69.02	-127.79	-2538.48	196.60	69.02	-127.57	-2534.03	214.70	75.93	-138.78	-2755.32	525.97	262.29	-263.68	-5107.26
540	205.81	54.04	-151.77	-4591.47	196.81	54.04	-142.77	-4309.28	196.60	54.04	-142.55	-4302.53	214.70	59.45	-155.26	-4684.11	525.97	205.36	-320.60	-9474.10
720	205.81	44.86	-160.95	-6536.80	196.81	44.86	-151.95	-6158.57	196.60	44.86	-151.74	-6149.52	214.70	49.35	-165.36	-6699.21	525.97	170.47	-355.49	-14137.23
1080	205.81	33.84	-171.97	-10554.03	196.81	33.84	-162.97	-9983.62	196.60	33.84	-162.75	-9969.98	214.70	37.23	-177.48	-10868.53	525.97	128.60	-397.36	-23941.36
1440	205.81	27.15	-178.66	-14672.72	196.81	27.15	-169.66	-13910.14	196.60	27.15	-169.44	-13891.90	214.70	29.87	-184.83	-15149.47	525.97	103.18	-422.79	-34131.26
1800	205.81	22.51	-183.30	-18851.83	196.81	22.51	-174.30	-17897.18	196.60	22.51	-174.09	-17874.34	214.70	24.76	-189.94	-19496.99	525.97	85.54	-440.43	-44553.86
2160	205.81	19.28	-186.53	-23051.83	196.81	19.28	-177.53	-21905.06	196.60	19.28	-177.31	-21877.62	214.70	21.21	-193.49	-23867.43	525.97	73.27	-452.69	-55054.25
2880	205.81	14.95	-190.86	-31499.41	196.81	14.95	-181.86	-29968.44	196.60	14.95	-181.64	-29931.81	214.70	16.45	-198.25	-32660.71	525.97	56.82	-469.14	-76237.24
4320	205.81	10.36	-195.45	-48472.06	196.81	10.36	-186.45	-46172.57	196.60	10.36	-186.23	-46117.55	214.70	11.40	-203.30	-50332.33	525.97	39.38	-486.59	-118893.80
Volume check				ok				ok				ok				ok				ok

Storm Duration (mins)	A2															
	10				11				12				13			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	125.16	729.30	604.14	-20.87	133.65	790.08	656.43	-23.32	156.51	972.40	815.89	-31.79	168.78	1033.18	864.40	-32.78
2	125.16	595.00	469.84	1.93	133.65	644.58	510.94	1.49	156.51	793.33	636.82	-0.83	168.78	842.92	674.14	-0.02
3	125.16	545.13	419.98	22.48	133.65	590.56	456.92	23.85	156.51	726.84	570.33	27.15	168.78	772.27	603.49	29.57
4	125.16	505.75	380.59	39.45	133.65	547.90	414.25	42.36	156.51	674.33	517.82	50.38	168.78	716.48	547.70	54.11
5	125.16	472.60	347.44	53.54	133.65	511.98	378.34	57.73	156.51	630.13	473.62	69.75	168.78	669.52	500.74	74.55
10	125.16	353.60	228.44	92.52	133.65	383.07	249.42	100.51	156.51	471.47	314.96	124.68	168.78	500.93	332.16	132.21
15	125.16	284.47	159.31	104.76	133.65	308.17	174.53	114.33	156.51	379.29	222.78	143.97	168.78	402.99	234.22	151.99
20	125.16	239.70	114.54	104.50	133.65	259.68	126.03	114.61	156.51	319.60	163.09	146.60	168.78	339.58	170.80	154.07
25	125.16	208.76	83.60	97.79	133.65	226.16	92.51	107.90	156.51	278.35	121.84	140.63	168.78	295.74	126.97	147.01
30	125.16	185.87	60.71	86.76	133.65	201.36	67.71	96.50	156.51	247.82	91.31	128.90	168.78	263.31	94.53	133.84
45	125.16	143.18	18.02	39.98	133.65	155.11	21.46	47.51	156.51	190.90	34.39	75.52	168.78	202.84	34.06	74.97
60	125.16	119.28	-5.87	-17.75	133.65	129.22	-4.42	-13.34	156.51	159.04	2.53	7.59	168.78	168.98	0.21	0.62
90	125.16	92.74	-32.41	-150.93	133.65	100.47	-33.17	-154.21	156.51	123.66	-32.85	-151.83	168.78	131.39	-37.39	-173.12
120	125.16	78.06	-47.10	-297.51	133.65	84.56	-49.08	-309.59	156.51	104.08	-52.43	-329.03	168.78	110.58	-58.20	-365.76
180	125.16	61.58	-63.58	-615.47	133.65	66.71	-66.94	-647.18	156.51	82.10	-74.41	-716.38	168.78	87.24	-81.54	-786.09
270	125.16	48.86	-76.30	-1128.36	133.65	52.93	-80.71	-1192.49	156.51	65.15	-91.36	-1345.14	168.78	69.22	-99.56	-1467.36
360	125.16	41.41	-83.74	-1669.43	133.65	44.87	-88.78	-1768.31	156.51	55.22	-101.29	-2011.37	168.78	58.67	-110.11	-2188.46
540	125.16	32.43	-92.73	-2807.32	133.65	35.13	-98.52	-2980.30	156.51	43.23	-113.28	-3417.99	168.78	45.94	-122.84	-3709.51
720	125.16	26.92	-98.24	-3992.34	133.65	29.16	-104.49	-4243.35	156.51	35.89	-120.62	-4887.40	168.78	38.13	-130.65	-5297.28
1080	125.16	20.31	-104.85	-6438.36	133.65	22.00	-111.65	-6851.72	156.51	27.07	-129.44	-7927.38	168.78	28.77	-140.01	-8580.34
1440	125.16	16.29	-108.87	-8945.25	133.65	17.65	-116.00	-9526.05	156.51	21.72	-134.79	-11048.54	168.78	23.08	-145.70	-11949.64
1800	125.16	13.51	-111.65	-11488.38	133.65	14.63	-119.01	-12239.64	156.51	18.01	-138.50	-14218.12	168.78	19.13	-149.65	-15370.37
2160	125.16	11.57	-113.59	-14044.05	133.65	12.53	-121.11	-14966.82	156.51	15.43	-141.08	-17404.37	168.78	16.39	-152.39	-18808.83
2880	125.16	8.97	-116.19	-19183.93	133.65	9.72	-123.93	-20452.09	156.51	11.96	-144.55	-23814.97	168.78	12.71	-156.07	-25726.20
4320	125.16	6.22	-118.94	-29510.20	133.65	6.74	-126.91	-31473.01	156.51	8.29	-148.22	-36698.05	168.78	8.81	-159.97	-39626.74
Volume check				ok				ok				ok				ok

Storm Duration (mins)	A3								A4			
	43				44				46			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	154.96	911.63	756.66	-26.63	134.71	790.08	655.36	-22.93	813.96	7049.90	6235.94	-408.01
2	154.96	743.75	588.79	1.96	134.71	644.58	509.87	1.83	813.96	5751.67	4937.70	-166.60
3	154.96	681.42	526.45	27.72	134.71	590.56	455.85	24.13	813.96	5269.62	4455.66	54.34
4	154.96	632.19	477.23	49.03	134.71	547.90	413.18	42.57	813.96	4888.92	4074.95	240.95
5	154.96	590.75	435.79	66.72	134.71	511.98	377.27	57.88	813.96	4568.47	3754.50	399.64
10	154.96	442.00	287.04	115.87	134.71	383.07	248.35	100.36	813.96	3418.13	2604.17	888.81
15	154.96	355.58	200.62	131.60	134.71	308.17	173.46	113.87	813.96	2749.84	1935.88	1119.78
20	154.96	299.63	144.66	131.70	134.71	259.68	124.96	113.84	813.96	2317.10	1503.14	1230.13
25	154.96	260.95	105.99	123.74	134.71	226.16	91.44	106.82	813.96	2018.01	1204.05	1278.48
30	154.96	232.33	77.37	110.37	134.71	201.36	66.64	95.12	813.96	1796.71	982.75	1285.28
45	154.96	178.97	24.01	53.19	134.71	155.11	20.40	45.20	813.96	1384.05	570.09	1175.02
60	154.96	149.10	-5.86	-17.68	134.71	129.22	-5.49	-16.57	813.96	1153.07	339.11	960.74
90	154.96	115.93	-39.03	-181.55	134.71	100.47	-34.24	-159.32	813.96	896.53	82.57	364.43
120	154.96	97.57	-57.39	-362.16	134.71	84.56	-50.15	-316.58	813.96	754.56	-59.40	-358.06
180	154.96	76.97	-77.99	-754.36	134.71	66.71	-68.00	-657.94	813.96	595.25	-218.71	-2037.17
270	154.96	61.07	-93.89	-1387.58	134.71	52.93	-81.78	-1208.93	813.96	472.31	-341.66	-4895.17
360	154.96	51.77	-103.19	-2056.02	134.71	44.87	-89.85	-1790.44	813.96	400.33	-413.63	-8020.73
540	154.96	40.53	-114.43	-3462.53	134.71	35.13	-99.59	-3013.82	813.96	313.45	-500.51	-14804.60
720	154.96	33.65	-121.32	-4927.96	134.71	29.16	-105.55	-4288.27	813.96	260.19	-553.77	-22040.80
1080	154.96	25.38	-129.58	-7953.76	134.71	22.00	-112.72	-6919.46	813.96	196.29	-617.67	-37242.74
1440	154.96	20.36	-134.60	-11055.65	134.71	17.65	-117.06	-9616.59	813.96	157.49	-656.48	-53033.50
1800	154.96	16.88	-138.08	-14202.86	134.71	14.63	-120.08	-12352.98	813.96	130.55	-683.41	-69179.25
2160	154.96	14.46	-140.50	-17365.73	134.71	12.53	-122.18	-15102.96	813.96	111.84	-702.12	-85443.83
2880	154.96	11.22	-143.75	-23727.17	134.71	9.72	-124.99	-20633.85	813.96	86.73	-727.23	-118251.02
4320	154.96	7.77	-147.19	-36508.16	134.71	6.74	-127.98	-31745.99	813.96	60.10	-753.86	-184309.11
Volume check				ok				ok				ok

	A5												C1			
Storm Duration (mins)	47				48				49N				22			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	709.03	5530.53	4821.49	-271.94	537.70	4011.15	3473.45	-183.25	404.60	2888.03	2483.43	-122.35	248.49	1397.83	1149.33	-37.00
2	709.03	4512.08	3803.05	-86.24	537.70	3272.50	2734.80	-49.80	404.60	2356.20	1951.60	-27.18	248.49	1140.42	891.93	6.24
3	709.03	4133.93	3424.90	83.13	537.70	2998.23	2460.54	71.72	404.60	2158.73	1754.13	59.32	248.49	1044.84	796.35	45.12
4	709.03	3835.27	3126.24	225.54	537.70	2781.63	2243.93	173.68	404.60	2002.77	1598.17	131.75	248.49	969.35	720.86	77.17
5	709.03	3583.88	2874.85	346.05	537.70	2599.30	2061.60	259.75	404.60	1871.50	1466.90	192.73	248.49	905.82	657.33	103.68
10	709.03	2681.47	1972.44	709.92	537.70	1944.80	1407.10	517.02	404.60	1400.26	995.66	373.01	248.49	677.73	429.24	175.92
15	709.03	2157.21	1448.18	871.18	537.70	1564.57	1026.87	627.33	404.60	1126.49	721.89	447.48	248.49	545.23	296.74	196.92
20	709.03	1817.73	1108.69	937.78	537.70	1318.35	780.65	668.96	404.60	949.21	544.61	472.48	248.49	459.43	210.93	193.95
25	709.03	1583.10	874.07	955.66	537.70	1148.18	610.48	675.24	404.60	826.69	422.09	472.02	248.49	400.12	151.63	178.61
30	709.03	1409.49	700.46	940.90	537.70	1022.27	484.57	657.83	404.60	736.03	331.43	454.48	248.49	356.24	107.75	154.98
45	709.03	1085.76	376.73	793.81	537.70	787.48	249.78	530.95	404.60	566.98	162.38	348.06	248.49	274.42	25.93	57.84
60	709.03	904.57	195.53	564.77	537.70	656.06	118.36	344.50	404.60	472.36	67.76	198.68	248.49	228.63	-19.86	-60.31
90	709.03	703.31	-5.72	-25.65	537.70	510.09	-27.60	-124.58	404.60	367.27	-37.33	-169.51	248.49	177.76	-70.73	-330.67
120	709.03	591.94	-117.09	-715.70	537.70	429.32	-108.38	-666.13	404.60	309.11	-95.49	-590.03	248.49	149.61	-98.88	-626.76
180	709.03	466.96	-242.07	-2280.59	537.70	338.68	-199.02	-1883.62	404.60	243.85	-160.75	-1528.09	248.49	118.02	-130.47	-1266.58
270	709.03	370.52	-338.51	-4895.77	537.70	268.73	-268.97	-3904.62	404.60	193.48	-211.12	-3075.77	248.49	93.65	-154.84	-2295.38
360	709.03	314.06	-394.98	-7721.82	537.70	227.78	-309.92	-6078.88	404.60	164.00	-240.60	-4734.01	248.49	79.38	-169.11	-3378.30
540	709.03	245.90	-463.13	-13793.03	537.70	178.34	-359.35	-10731.72	404.60	128.41	-276.19	-8269.89	248.49	62.15	-186.34	-5651.05
720	709.03	204.12	-504.91	-20219.78	537.70	148.04	-389.65	-15642.64	404.60	106.59	-298.01	-11991.74	248.49	51.59	-196.90	-8014.24
1080	709.03	153.98	-555.05	-33646.52	537.70	111.68	-426.02	-25880.54	404.60	80.41	-324.19	-19735.21	248.49	38.92	-209.57	-12886.29
1440	709.03	123.55	-585.49	-47535.10	537.70	89.60	-448.09	-36453.37	404.60	64.52	-340.08	-27719.83	248.49	31.23	-217.27	-17875.01
1800	709.03	102.42	-606.61	-61701.23	537.70	74.28	-463.42	-47227.22	404.60	53.48	-351.12	-35848.95	248.49	25.89	-222.61	-22933.10
2160	709.03	87.73	-621.30	-75961.06	537.70	63.63	-474.06	-58069.17	404.60	45.82	-358.78	-44027.22	248.49	22.17	-226.32	-28015.27
2880	709.03	68.04	-640.99	-104698.41	537.70	49.35	-488.35	-79910.83	404.60	35.53	-369.07	-60497.25	248.49	17.20	-231.29	-38234.27
4320	709.03	47.15	-661.88	-162522.37	537.70	34.20	-503.50	-123847.82	404.60	24.62	-379.98	-93620.23	248.49	11.92	-236.57	-58761.55
Volume check				ok				ok				ok				ok

	C2								C3											
Storm Duration (mins)	23				24				20				21				32			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	130.84	729.30	598.46	-18.91	142.65	790.08	647.42	-20.19	147.80	911.63	763.83	-29.37	149.63	911.63	762.00	-28.65	156.88	911.63	754.75	-25.93
2	130.84	595.00	464.16	3.59	142.65	644.58	501.93	4.14	147.80	743.75	595.95	-0.41	149.63	743.75	594.12	0.22	156.88	743.75	586.87	2.55
3	130.84	545.13	414.29	23.81	142.65	590.56	447.91	25.99	147.80	681.42	533.62	25.76	149.63	681.42	531.79	26.29	156.88	681.42	524.54	28.20
4	130.84	505.75	374.91	40.46	142.65	547.90	405.24	43.98	147.80	632.19	484.39	47.48	149.63	632.19	482.56	47.90	156.88	632.19	475.31	49.40
5	130.84	472.60	341.76	54.22	142.65	511.98	369.33	58.83	147.80	590.75	442.95	65.59	149.63	590.75	441.12	65.90	156.88	590.75	433.87	66.99
10	130.84	353.60	222.76	91.57	142.65	383.07	240.41	99.04	147.80	442.00	294.20	116.78	149.63	442.00	292.37	116.57	156.88	442.00	285.12	115.58
15	130.84	284.47	153.62	102.19	142.65	308.17	165.52	110.28	147.80	355.58	207.79	134.56	149.63	355.58	205.96	133.83	156.88	355.58	198.70	130.77
20	130.84	239.70	108.86	100.29	142.65	259.68	117.02	107.96	147.80	299.63	151.83	136.71	149.63	299.63	150.00	135.46	156.88	299.63	142.75	130.31
25	130.84	208.76	77.92	91.94	142.65	226.16	83.50	98.66	147.80	260.95	113.15	130.81	149.63	260.95	111.32	129.03	156.88	260.95	104.07	121.80
30	130.84	185.87	55.02	79.27	142.65	201.36	58.70	84.66	147.80	232.33	84.54	119.51	149.63	232.33	82.71	117.20	156.88	232.33	75.45	107.88
45	130.84	143.18	12.33	27.55	142.65	155.11	12.46	27.85	147.80	178.97	31.17	68.54	149.63	178.97	29.35	64.64	156.88	178.97	22.09	49.03
60	130.84	119.28	-11.56	-35.14	142.65	129.22	-13.43	-40.86	147.80	149.10	1.31	3.92	149.63	149.10	-0.52	-1.57	156.88	149.10	-7.78	-23.51
90	130.84	92.74	-38.10	-178.29	142.65	100.47	-42.18	-197.53	147.80	115.93	-31.87	-147.41	149.63	115.93	-33.70	-156.10	156.88	115.93	-40.95	-190.74
120	130.84	78.06	-52.79	-334.88	142.65	84.56	-58.09	-368.76	147.80	97.57	-50.22	-315.42	149.63	97.57	-52.05	-327.32	156.88	97.57	-59.31	-374.72
180	130.84	61.58	-69.27	-672.93	142.65	66.71	-75.94	-738.18	147.80	76.97	-70.83	-682.33	149.63	76.97	-72.65	-700.69	156.88	76.97	-79.91	-773.70
270	130.84	48.86	-81.98	-1216.06	142.65	52.93	-89.72	-1331.39	147.80	61.07	-86.72	-1277.47	149.63	61.07	-88.55	-1305.55	156.88	61.07	-95.81	-1417.11
360	130.84	41.41	-89.43	-1787.43	142.65	44.87	-97.79	-1955.20	147.80	51.77	-96.03	-1907.75	149.63	51.77	-97.86	-1945.57	156.88	51.77	-105.11	-2095.76
540	130.84	32.43	-98.42	-2985.98	142.65	35.13	-107.52	-3263.30	147.80	40.53	-107.27	-3237.86	149.63	40.53	-109.09	-3295.19	156.88	40.53	-116.35	-3522.73
720	130.84	26.92	-103.93	-4231.72	142.65	29.16	-113.49	-4622.52	147.80	33.65	-114.15	-4626.84	149.63	33.65	-115.98	-4703.68	156.88	33.65	-123.23	-5008.64
1080	130.84	20.31	-110.54	-6799.22	142.65	22.00	-120.66	-7423.33	147.80	25.38	-122.42	-7499.65	149.63	25.38	-124.24	-7615.54	156.88	25.38	-131.50	-8075.40
1440	130.84	16.29	-114.55	-9427.59	142.65	17.65	-125.00	-10290.09	147.80	20.36	-127.43	-10448.56	149.63	20.36	-129.26	-10603.51	156.88	20.36	-136.51	-11218.26
1800	130.84	13.51	-117.34	-12092.14	142.65	14.63	-128.02	-13196.02	147.80	16.88	-130.92	-13442.86	149.63	16.88	-132.74	-13636.84	156.88	16.88	-140.00	-14406.40
2160	130.84	11.57	-119.27	-14769.26	142.65	12.53	-130.12	-16115.59	147.80	14.46	-133.34	-16452.79	149.63	14.46	-135.16	-16685.81	156.88	14.46	-142.42	-17610.23
2880	130.84	8.97	-121.87	-20152.01	142.65	9.72	-132.93	-21985.60	147.80	11.22	-136.58	-22508.36	149.63	11.22	-138.41	-22819.47	156.88	11.22	-145.66	-24053.56
4320	130.84	6.22	-124.63	-30964.11	142.65	6.74	-135.92	-33776.10	147.80	7.77	-140.03	-34677.54	149.63	7.77	-141.85	-35144.83	156.88	7.77	-149.11	-36998.37
Volume check				ok				ok				ok				ok				ok

	C4																			
Storm Duration (mins)	33				34				35				36				37			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	419.49	3099.53	2680.04	-139.34	415.71	3038.75	2623.04	-134.13	495.47	3038.75	2543.28	-96.79	339.52	2491.78	2152.25	-110.74	488.48	3646.50	3158.02	-166.78
2	419.49	2528.75	2109.26	-36.42	415.71	2479.17	2063.46	-33.47	495.47	2479.17	1983.70	-0.38	339.52	2032.92	1693.39	-28.12	488.48	2975.00	2486.52	-45.45
3	419.49	2316.82	1897.33	57.25	415.71	2271.39	1855.68	58.12	495.47	2271.39	1775.92	86.69	339.52	1862.54	1523.01	47.05	488.48	2725.67	2237.19	65.04
4	419.49	2149.44	1729.95	135.81	415.71	2107.29	1691.58	134.89	495.47	2107.29	1611.82	158.92	339.52	1727.98	1388.45	110.08	488.48	2528.75	2040.27	157.76
5	419.49	2008.55	1589.06	202.10	415.71	1969.17	1553.46	199.62	495.47	1969.17	1473.70	219.11	339.52	1614.72	1275.19	163.24	488.48	2363.00	1874.52	236.02
10	419.49	1502.80	1083.31	399.76	415.71	1473.33	1057.63	392.15	495.47	1473.33	977.87	388.95	339.52	1208.13	868.61	321.50	488.48	1768.00	1279.52	470.00
15	419.49	1208.98	789.49	483.87	415.71	1185.28	769.57	473.34	495.47	1185.28	689.81	447.41	339.52	971.93	632.40	388.46	488.48	1422.33	933.85	570.37
20	419.49	1018.73	599.24	514.90	415.71	998.75	583.04	502.50	495.47	998.75	503.28	453.78	339.52	818.98	479.45	412.76	488.48	1198.50	710.02	608.32
25	419.49	887.23	467.74	518.61	415.71	869.83	454.13	504.87	495.47	869.83	374.37	433.30	339.52	713.26	373.74	415.09	488.48	1043.80	555.32	614.12
30	419.49	789.93	370.44	504.02	415.71	774.44	358.74	489.29	495.47	774.44	278.98	394.82	339.52	635.04	295.52	402.70	488.48	929.33	440.85	598.39
45	419.49	608.51	189.02	402.52	415.71	596.57	180.87	385.95	495.47	596.57	101.11	222.49	339.52	489.19	149.67	319.13	488.48	715.89	227.41	483.33
60	419.49	506.95	87.47	254.99	415.71	497.01	81.31	237.45	495.47	497.01	1.55	4.64	339.52	407.55	68.03	198.54	488.48	596.42	107.94	314.12
90	419.49	394.16	-25.32	-114.45	415.71	386.44	-29.27	-132.49	495.47	386.44	-109.03	-504.70	339.52	316.88	-22.65	-102.45	488.48	463.72	-24.76	-111.73
120	419.49	331.75	-87.74	-539.93	415.71	325.24	-90.47	-557.42	495.47	325.24	-170.22	-1069.66	339.52	266.70	-72.82	-448.51	488.48	390.29	-98.19	-603.47
180	419.49	261.71	-157.78	-1494.78	415.71	256.57	-159.13	-1509.19	495.47	256.57	-238.89	-2302.61	339.52	210.39	-129.13	-1224.19	488.48	307.89	-180.59	-1709.10
270	419.49	207.65	-211.84	-3077.64	415.71	203.58	-212.13	-3084.58	495.47	203.58	-291.89	-4301.35	339.52	166.94	-172.59	-2508.81	488.48	244.30	-244.18	-3544.60
360	419.49	176.01	-243.48	-4778.98	415.71	172.56	-243.15	-4776.18	495.47	172.56	-322.91	-6417.24	339.52	141.50	-198.03	-3888.72	488.48	207.07	-281.41	-5519.42
540	419.49	137.81	-281.68	-8416.88	415.71	135.11	-280.60	-8390.06	495.47	135.11	-360.36	-10880.89	339.52	110.79	-228.74	-6837.66	488.48	162.13	-326.35	-9745.72
720	419.49	114.40	-305.09	-12254.25	415.71	112.15	-303.56	-12199.53	495.47	112.15	-383.31	-15540.78	339.52	91.97	-247.56	-9946.98	488.48	134.58	-353.90	-14206.63
1080	419.49	86.30	-333.19	-20250.52	415.71	84.61	-331.10	-20133.77	495.47	84.61	-410.86	-25176.79	339.52	69.38	-270.15	-16424.14	488.48	101.53	-386.95	-23506.69
1440	419.49	69.24	-350.25	-28505.61	415.71	67.88	-347.83	-28321.75	495.47	67.88	-427.59	-35066.47	339.52	55.66	-283.86	-23109.36	488.48	81.46	-407.02	-33111.23
1800	419.49	57.40	-362.09	-36915.98	415.71	56.27	-359.44	-36661.90	495.47	56.27	-439.19	-45107.40	339.52	46.14	-293.38	-29919.38	488.48	67.53	-420.95	-42898.51
2160	419.49	49.17	-370.32	-45379.00	415.71	48.21	-367.50	-45053.69	495.47	48.21	-447.26	-55200.45	339.52	39.53	-300.00	-36771.75	488.48	57.85	-430.63	-52747.71
2880	419.49	38.13	-381.36	-62426.91	415.71	37.38	-378.32	-61956.75	495.47	37.38	-458.08	-75505.60	339.52	30.66	-308.87	-50574.45	488.48	44.86	-443.62	-72589.51
4320	419.49	26.42	-393.06	-96718.82	415.71	25.91	-389.80	-95955.18	495.47	25.91	-469.56	-116309.37	339.52	21.24	-318.28	-78337.52	488.48	31.09	-457.39	-112503.74
Volume check				ok				ok				ok				ok				ok

Storm Duration (mins)	C4															
	38				39				40				41			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	353.27	2431.00	2077.73	-96.51	355.41	2431.00	2075.59	-95.46	358.02	2431.00	2072.98	-94.20	343.76	2431.00	2087.24	-101.32
2	353.27	1983.33	1630.06	-17.08	355.41	1983.33	1627.92	-16.14	358.02	1983.33	1625.31	-15.02	343.76	1983.33	1639.57	-21.38
3	353.27	1817.11	1463.84	55.02	355.41	1817.11	1461.70	55.84	358.02	1817.11	1459.09	56.81	343.76	1817.11	1473.35	51.25
4	353.27	1685.83	1332.56	115.26	355.41	1685.83	1330.42	115.96	358.02	1685.83	1327.81	116.78	343.76	1685.83	1342.07	112.04
5	353.27	1575.33	1222.06	165.87	355.41	1575.33	1219.92	166.44	358.02	1575.33	1217.31	167.12	343.76	1575.33	1231.57	163.18
10	353.27	1178.67	825.39	314.02	355.41	1178.67	823.25	313.98	358.02	1178.67	820.64	313.92	343.76	1178.67	834.91	314.03
15	353.27	948.22	594.95	373.09	355.41	948.22	592.81	372.44	358.02	948.22	590.20	371.64	343.76	948.22	604.46	375.81
20	353.27	799.00	445.73	390.51	355.41	799.00	443.59	389.25	358.02	799.00	440.98	387.70	343.76	799.00	455.24	395.95
25	353.27	695.87	342.59	386.49	355.41	695.87	340.45	384.62	358.02	695.87	337.84	382.32	343.76	695.87	352.11	394.65
30	353.27	619.56	266.28	368.09	355.41	619.56	264.14	365.60	358.02	619.56	261.53	362.56	343.76	619.56	275.80	378.97
45	353.27	477.26	123.99	267.54	355.41	477.26	121.85	263.20	358.02	477.26	119.24	257.90	343.76	477.26	133.50	286.64
60	353.27	397.61	44.34	130.76	355.41	397.61	42.20	124.56	358.02	397.61	39.59	117.00	343.76	397.61	53.85	158.13
90	353.27	309.15	-44.12	-201.33	355.41	309.15	-46.27	-211.27	358.02	309.15	-48.87	-223.40	343.76	309.15	-34.61	-157.35
120	353.27	260.19	-93.08	-577.59	355.41	260.19	-95.22	-591.29	358.02	260.19	-97.83	-607.98	343.76	260.19	-83.56	-516.92
180	353.27	205.26	-148.01	-1411.93	355.41	205.26	-150.15	-1433.18	358.02	205.26	-152.76	-1459.07	343.76	205.26	-138.50	-1317.75
270	353.27	162.86	-190.41	-2782.06	355.41	162.86	-192.55	-2814.68	358.02	162.86	-195.16	-2854.40	343.76	162.86	-180.89	-2637.41
360	353.27	138.05	-215.23	-4245.41	355.41	138.05	-217.37	-4289.42	358.02	138.05	-219.98	-4343.02	343.76	138.05	-205.71	-4050.17
540	353.27	108.09	-245.19	-7356.99	355.41	108.09	-247.33	-7423.81	358.02	108.09	-249.94	-7505.19	343.76	108.09	-235.67	-7060.43
720	353.27	89.72	-263.55	-10625.20	355.41	89.72	-265.69	-10714.87	358.02	89.72	-268.30	-10824.04	343.76	89.72	-254.04	-10227.26
1080	353.27	67.69	-285.59	-17414.14	355.41	67.69	-287.73	-17549.49	358.02	67.69	-290.34	-17714.30	343.76	67.69	-276.07	-16813.28
1440	353.27	54.31	-298.97	-24406.04	355.41	54.31	-301.11	-24587.09	358.02	54.31	-303.72	-24807.53	343.76	54.31	-289.45	-23602.29
1800	353.27	45.02	-308.25	-31519.43	355.41	45.02	-310.40	-31746.15	358.02	45.02	-313.00	-32022.18	343.76	45.02	-298.74	-30512.90
2160	353.27	38.56	-314.71	-38674.27	355.41	38.56	-316.85	-38946.66	358.02	38.56	-319.46	-39278.32	343.76	38.56	-305.19	-37464.89
2880	353.27	29.91	-323.36	-53079.40	355.41	29.91	-325.51	-53443.15	358.02	29.91	-328.11	-53886.02	343.76	29.91	-313.85	-51464.40
4320	353.27	20.73	-332.55	-82043.83	355.41	20.73	-334.69	-82590.31	358.02	20.73	-337.30	-83255.66	343.76	20.73	-323.03	-79617.42
Volume check				ok				ok				ok				ok

Storm Duration (mins)	D1																			
	25				28				29				30				31			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	155.37	972.40	817.03	-81.28	207.43	1215.50	1008.07	-95.69	210.33	1215.50	1005.17	-94.47	208.88	1276.28	1067.40	-104.39	145.23	850.85	705.62	-24.63
2	155.37	793.33	637.96	-39.52	207.43	991.67	784.24	-44.19	210.33	991.67	781.33	-43.13	208.88	1041.25	832.37	-49.84	145.23	694.17	548.93	2.02
3	155.37	726.84	571.48	-7.48	207.43	908.56	701.12	-4.90	210.33	908.56	698.22	-4.01	208.88	953.98	745.11	-8.08	145.23	635.99	490.75	26.02
4	155.37	674.33	518.96	18.96	207.43	842.92	635.49	27.40	210.33	842.92	632.58	28.13	208.88	885.06	676.19	26.35	145.23	590.04	444.81	45.88
5	155.37	630.13	474.76	41.06	207.43	787.67	580.24	54.26	210.33	787.67	577.33	54.83	208.88	827.05	618.17	55.07	145.23	551.37	406.13	62.36
10	155.37	471.47	316.10	29.97	207.43	589.33	381.90	39.80	210.33	589.33	379.00	40.23	208.88	618.80	409.92	40.29	145.23	412.53	267.30	108.06
15	155.37	379.29	223.92	77.24	207.43	474.11	266.68	95.11	210.33	474.11	263.78	94.71	208.88	497.82	288.94	100.92	145.23	331.88	186.64	122.57
20	155.37	319.60	164.23	98.10	207.43	399.50	192.07	117.39	210.33	399.50	189.17	116.16	208.88	419.48	210.60	126.87	145.23	279.65	134.42	122.48
25	155.37	278.35	122.98	104.83	207.43	347.93	140.50	122.01	210.33	347.93	137.60	119.94	208.88	365.33	156.45	134.29	145.23	243.55	98.32	114.88
30	155.37	247.82	92.45	102.59	207.43	309.78	102.35	115.40	210.33	309.78	99.45	112.49	208.88	325.27	116.39	129.92	145.23	216.84	71.61	102.23
45	155.37	190.90	35.53	45.96	207.43	238.63	31.20	41.07	210.33	238.63	28.30	37.39	208.88	250.56	41.68	54.27	145.23	167.04	21.81	48.34
60	155.37	159.04	3.68	7.69	207.43	198.81	-8.63	-18.28	210.33	198.81	-11.53	-24.50	208.88	208.75	-0.13	-0.27	145.23	139.16	-6.07	-18.33
90	155.37	123.66	-31.71	-89.35	207.43	154.57	-52.86	-150.83	210.33	154.57	-55.76	-159.52	208.88	162.30	-46.57	-131.85	145.23	108.20	-37.03	-172.34
120	155.37	104.08	-51.29	-229.30	207.43	130.10	-77.33	-349.02	210.33	130.10	-80.23	-362.81	208.88	136.60	-72.27	-324.24	145.23	91.07	-54.17	-341.97
180	155.37	82.10	-73.27	-441.18	207.43	102.63	-104.80	-636.75	210.33	102.63	-107.70	-655.57	208.88	107.76	-101.12	-610.91	145.23	71.84	-73.39	-710.16
270	155.37	65.15	-90.22	-840.43	207.43	81.43	-126.00	-1182.27	210.33	81.43	-128.90	-1211.29	208.88	85.50	-123.37	-1152.32	145.23	57.00	-88.23	-1304.37
360	155.37	55.22	-100.15	-1446.98	207.43	69.02	-138.41	-2010.86	210.33	69.02	-141.31	-2055.32	208.88	72.47	-136.40	-1974.79	145.23	48.32	-96.92	-1931.46
540	155.37	43.23	-112.13	-2171.19	207.43	54.04	-153.39	-2985.72	210.33	54.04	-156.29	-3045.46	208.88	56.75	-152.13	-2951.40	145.23	37.83	-107.40	-3250.64
720	155.37	35.89	-119.48	-3549.09	207.43	44.86	-162.57	-4849.17	210.33	44.86	-165.47	-4939.88	208.88	47.10	-161.77	-4812.75	145.23	31.40	-113.83	-4624.82
1080	155.37	27.07	-128.29	-5083.92	207.43	33.84	-173.59	-6907.24	210.33	33.84	-176.49	-7028.58	208.88	35.53	-173.34	-6879.48	145.23	23.69	-121.54	-7461.79
1440	155.37	21.72	-133.65	-8065.11	207.43	27.15	-180.28	-10916.03	210.33	27.15	-183.18	-11099.32	208.88	28.51	-180.37	-10898.07	145.23	19.01	-126.23	-10369.79
1800	155.37	18.01	-137.36	-11130.10	207.43	22.51	-184.92	-15029.42	210.33	22.51	-187.82	-15274.63	208.88	23.63	-185.24	-15026.58	145.23	15.76	-129.48	-13320.06
2160	155.37	15.43	-139.94	-14236.23	207.43	19.28	-188.15	-19194.31	210.33	19.28	-191.05	-19501.46	208.88	20.25	-188.63	-19209.12	145.23	13.50	-131.74	-16284.97
2880	155.37	11.96	-143.41	-17425.74	207.43	14.95	-192.48	-23460.05	210.33	14.95	-195.38	-23828.41	208.88	15.70	-193.17	-23499.82	145.23	10.47	-134.77	-22248.09
4320	155.37	8.29	-147.08	-23698.91	207.43	10.36	-197.07	-31859.36	210.33	10.36	-199.97	-32350.19	208.88	10.88	-198.00	-31942.32	145.23	7.25	-137.98	-34228.57
Volume check				ok				ok				ok				ok				ok

Storm Duration (mins)	D2								D3							
	26				27				54				55			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	141.00	790.08	649.07	-20.73	142.82	790.08	647.26	-20.13	287.96	2005.58	1717.61	-81.36	205.80	1276.28	1070.47	-41.57
2	141.00	644.58	503.58	3.68	142.82	644.58	501.77	4.18	287.96	1636.25	1348.29	-15.64	205.80	1041.25	835.45	-0.96
3	141.00	590.56	449.56	25.62	142.82	590.56	447.75	26.02	287.96	1499.12	1211.15	44.04	205.80	953.98	748.18	35.74
4	141.00	547.90	406.89	43.71	142.82	547.90	405.08	44.00	287.96	1390.81	1102.85	93.93	205.80	885.06	679.26	66.21
5	141.00	511.98	370.98	58.66	142.82	511.98	369.17	58.85	287.96	1299.65	1011.69	135.88	205.80	827.05	621.25	91.62
10	141.00	383.07	242.07	99.34	142.82	383.07	240.25	99.01	287.96	972.40	684.44	259.10	205.80	618.80	413.00	163.61
15	141.00	308.17	167.17	111.05	142.82	308.17	165.36	110.20	287.96	782.28	494.32	308.82	205.80	497.82	292.01	188.82
20	141.00	259.68	118.67	109.21	142.82	259.68	116.86	107.84	287.96	659.18	371.21	324.19	205.80	419.48	213.67	192.15
25	141.00	226.16	85.16	100.38	142.82	226.16	83.34	98.49	287.96	574.09	286.13	321.87	205.80	365.33	159.53	184.21
30	141.00	201.36	60.35	86.86	142.82	201.36	58.54	84.44	287.96	511.13	223.17	307.69	205.80	325.27	119.46	168.70
45	141.00	155.11	14.11	31.48	142.82	155.11	12.29	27.49	287.96	393.74	105.77	227.74	205.80	250.56	44.76	98.31
60	141.00	129.22	-11.78	-35.78	142.82	129.22	-13.59	-41.36	287.96	328.03	40.07	117.93	205.80	208.75	2.94	8.82
90	141.00	100.47	-40.53	-189.55	142.82	100.47	-42.34	-198.32	287.96	255.05	-32.92	-149.96	205.80	162.30	-43.50	-201.09
120	141.00	84.56	-56.44	-357.87	142.82	84.56	-58.25	-369.83	287.96	214.66	-73.30	-454.25	205.80	136.60	-69.20	-434.34
180	141.00	66.71	-74.29	-721.46	142.82	66.71	-76.11	-739.83	287.96	169.34	-118.63	-1130.31	205.80	107.76	-98.04	-944.09
270	141.00	52.93	-88.07	-1305.88	142.82	52.93	-89.89	-1333.90	287.96	134.36	-153.60	-2242.17	205.80	85.50	-120.30	-1771.37
360	141.00	44.87	-96.14	-1920.89	142.82	44.87	-97.95	-1958.59	287.96	113.89	-174.08	-3430.90	205.80	72.47	-133.33	-2647.84
540	141.00	35.13	-105.87	-3211.36	142.82	35.13	-107.69	-3268.42	287.96	89.17	-198.79	-5960.83	205.80	56.75	-149.06	-4498.12
720	141.00	29.16	-111.84	-4552.95	142.82	29.16	-113.66	-4629.39	287.96	74.02	-213.94	-8619.96	205.80	47.10	-158.70	-6430.80
1080	141.00	22.00	-119.00	-7318.46	142.82	22.00	-120.82	-7433.68	287.96	55.84	-232.12	-14146.49	205.80	35.53	-170.27	-10428.96
1440	141.00	17.65	-123.35	-10149.92	142.82	17.65	-125.17	-10303.92	287.96	44.80	-243.16	-19840.47	205.80	28.51	-177.29	-14533.66
1800	141.00	14.63	-126.37	-13020.58	142.82	14.63	-128.18	-13213.33	287.96	37.14	-250.82	-25634.72	205.80	23.63	-182.17	-18701.91
2160	141.00	12.53	-128.47	-15904.86	142.82	12.53	-130.28	-16136.38	287.96	31.82	-256.15	-31463.14	205.80	20.25	-185.56	-22892.04
2880	141.00	9.72	-131.28	-21704.31	142.82	9.72	-133.10	-22013.35	287.96	24.67	-263.29	-43198.76	205.80	15.70	-190.10	-31322.31
4320	141.00	6.74	-134.27	-33353.67	142.82	6.74	-136.08	-33817.78	287.96	17.10	-270.87	-66797.13	205.80	10.88	-194.92	-48264.07
Volume check				ok				ok				ok				ok

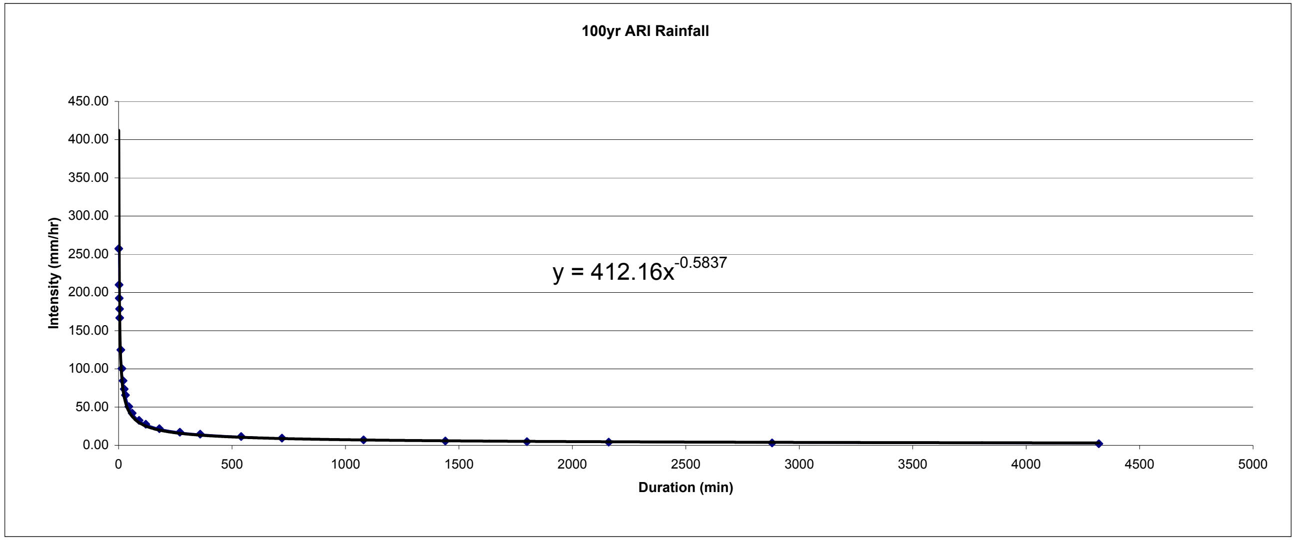
	D5											
Storm Duration (mins)	49S				50				51			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	282.79	2005.58	1722.78	-84.01	424.30	3099.53	2675.22	-136.66	586.07	3707.28	3121.21	-125.61
2	282.79	1636.25	1353.46	-18.02	424.30	2528.75	2104.45	-34.00	586.07	3024.58	2438.51	-7.00
3	282.79	1499.12	1216.32	41.95	424.30	2316.82	1892.51	59.40	586.07	2771.09	2185.03	100.27
4	282.79	1390.81	1108.02	92.14	424.30	2149.44	1725.14	137.69	586.07	2570.90	1984.83	189.44
5	282.79	1299.65	1016.86	134.39	424.30	2008.55	1584.25	203.70	586.07	2402.38	1816.31	263.92
10	282.79	972.40	689.61	259.07	424.30	1502.80	1078.50	400.00	586.07	1797.47	1211.40	476.38
15	282.79	782.28	499.49	310.26	424.30	1208.98	784.68	482.74	586.07	1446.04	859.97	552.96
20	282.79	659.18	376.38	327.11	424.30	1018.73	594.42	512.41	586.07	1218.48	632.41	566.00
25	282.79	574.09	291.30	326.26	424.30	887.23	462.93	514.74	586.07	1061.20	475.13	546.30
30	282.79	511.13	228.34	313.56	424.30	789.93	365.63	498.77	586.07	944.82	358.75	504.64
45	282.79	393.74	110.94	238.09	424.30	608.51	184.20	393.12	586.07	727.82	141.75	310.35
60	282.79	328.03	45.23	132.76	424.30	506.95	82.65	241.41	586.07	606.36	20.29	60.60
90	282.79	255.05	-27.75	-126.11	424.30	394.16	-30.14	-136.42	586.07	471.45	-114.62	-528.59
120	282.79	214.66	-68.13	-421.33	424.30	331.75	-92.55	-570.33	586.07	396.80	-189.27	-1185.49
180	282.79	169.34	-113.46	-1079.18	424.30	261.71	-162.60	-1542.13	586.07	313.02	-273.05	-2624.75
270	282.79	134.36	-148.43	-2163.62	424.30	207.65	-216.65	-3150.51	586.07	248.37	-337.70	-4965.46
360	282.79	113.89	-168.91	-3324.87	424.30	176.01	-248.29	-4877.43	586.07	210.52	-375.55	-7448.89
540	282.79	89.17	-193.62	-5799.75	424.30	137.81	-286.49	-8566.57	586.07	164.83	-421.24	-12698.36
720	282.79	74.02	-208.77	-8403.80	424.30	114.40	-309.91	-12455.21	586.07	136.83	-449.24	-18187.10
1080	282.79	55.84	-226.95	-13820.08	424.30	86.30	-338.00	-20554.11	586.07	103.22	-482.85	-29550.18
1440	282.79	44.80	-237.99	-19403.83	424.30	69.24	-355.06	-28911.81	586.07	82.82	-503.25	-41222.75
1800	282.79	37.14	-245.65	-25087.90	424.30	57.40	-366.90	-37424.73	586.07	68.65	-517.42	-53080.05
2160	282.79	31.82	-250.98	-30806.12	424.30	49.17	-375.13	-45990.33	586.07	58.81	-527.26	-65000.84
2880	282.79	24.67	-258.12	-42321.35	424.30	38.13	-386.17	-63243.38	586.07	45.61	-540.46	-88987.73
4320	282.79	17.10	-265.70	-65478.88	424.30	26.42	-397.88	-97945.65	586.07	31.61	-554.46	-137197.31
Volume check				ok				ok				ok

100 YEAR ARI DRAINAGE PROPERTIES - UPSTREAM CATCHMENTS

Catchment	AREAS (m2)			TIME OF CONCENTRATION PRE-DEVELOPMENT					TIME OF CONCENTRATION POST-DEVELOPMENT					CRITICAL STORM INTENSITY (mm/h)	
	Area (m2)	Effective Area (m2)		Longest Path (m)	RL Top (mAHD)	RL Bottom (mAHD)	Slope (m/km)	TC (min)	Longest Path (m)	RL Top (mAHD)	RL Bottom (mAHD)	Slope (m/km)	TC (min)	Pre-Dev	Post-Dev
		Pre	Post												
46U	85334	29867	29867	200	65	60.6	22.00	8.9	200	65	60.6	22.00	8.9	115.2	115.2
47U	25256	8840	8840	200	62	59	15.00	10.8	200	62	59	15.00	10.8	102.6	102.6
48U	63701	22295	22295	193	59.8	57.4	12.44	9.9	193	59.8	57.4	12.44	9.9	108.2	108.2
49NU	127362	44577	44577	204	67.5	64.5	14.71	9.4	204	67.5	64.5	14.71	9.4	111.2	111.2
49SU	4097	1434	1434	410	72.6	67	13.66	27.1	410	72.6	67	13.66	27.1	60.0	60.0
DRU	241611	84564	84564	162	60	58.2	11.11	7.4	162	60	58.2	11.11	7.4	127.8	127.8
50U	16395	5738	5738	177	62	59.4	14.69	10.0	177	62	59.4	14.69	10.0	107.2	107.2
51U	51525	18034	18034	198	64	61	15.15	10.0	198	64	61	15.15	10.0	107.7	107.7
SDU	1174437	411053	411053	2014	145	74.5	35.00	62.7	2014	145	74.5	35.00	62.7	36.8	36.8

Runoff Coefficients	
Cleared Upland	0.35
Hardstand	0.85

Event	Duration (mins)	Intensity (mm/hr)
1 min	1	257.40
2 min	2	210.00
3 min	3	192.40
4 min	4	178.50
5 min	5	166.80
10 min	10	124.80
15 min	15	100.40
20 min	20	84.60
25 min	25	73.68
30 min	30	65.60
45 min	45	50.53
1 hr	60	42.10
1.5 hr	90	32.73
2 hr	120	27.55
3 hr	180	21.73
4.5 hr	270	17.24
6 hr	360	14.62
9 hr	540	11.44
12 hr	720	9.50
18 hr	1080	7.17
24 hr	1440	5.75
30 hr	1800	4.77
36 hr	2160	4.08
48 hr	2880	3.17
72 hr	4320	2.19



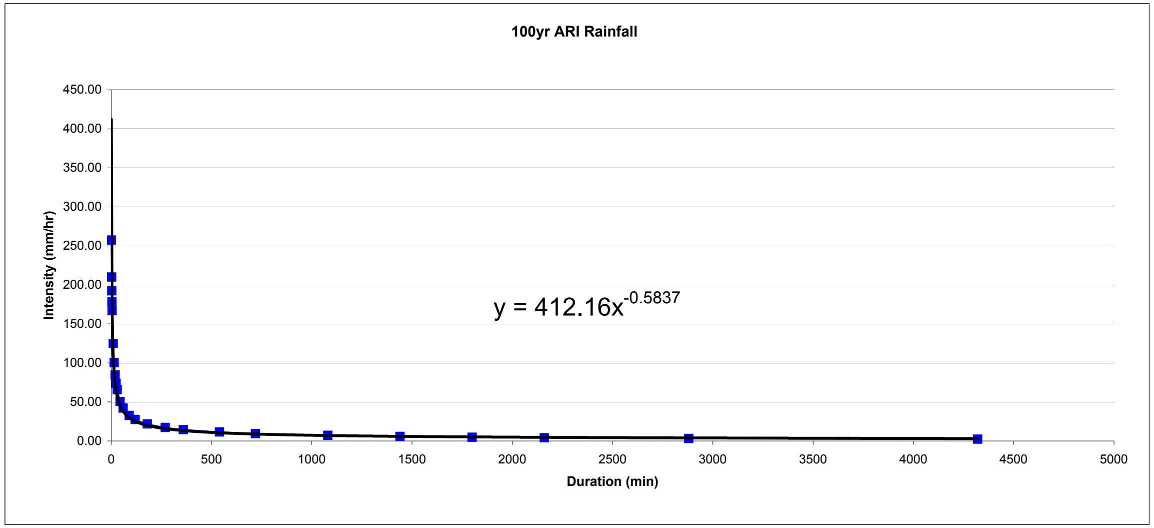
100 YEAR ARI DRAINAGE PROPERTIES - ROADS

CATCHMENT	AREAS (m2)					EFFECTIVE AREAS (m2)		TIME OF CONCENTRATION PRE DEVELOPMENT					TIME OF CONCENTRATION POST-DEVELOPMENT					CRITICAL STORM INTENSITY (mm/h)	
	Road Reserve (m2)	Swale	Lots (m2)	POS (m2)	Total	Pre	Post	Longest Path (m)	RL Top (mAHD)	RL Bottom (mAHD)	Slope (m/km)	TC (mln)	Longest Path (m)	RL Top (mAHD)	RL Bottom (mAHD)	Slope	TC (mln)	Pre-Dev	Post-Dev
A1	32745	870	0	0	33615	11765	27964	989	70	54	16.18	51.3	989	70	54	16.18	47.0	44.0	46.5
A2	8531	256	0	0	8787	3075	7290	290	58.5	56.8	5.86	21.1	290	58.5	56.8	5.86	19.3	77.0	81.3
A3	9956	295	0	0	10251	3588	8507	340	66	64	5.88	24.3	340	66	64	5.88	22.3	70.4	74.3
A4	10792	229	0	0	11021	3857	9208	231	73.7	70.4	14.29	13.7	231	73.7	70.4	14.29	12.6	100.7	106.4
A5	24409	583	0	0	24992	8747	20835	612	75	70	8.17	37.5	612	75	70	8.17	34.3	53.6	56.6
A6	13299	420	0	0	13719	4802	11367	500	66	58	16.00	28.4	500	66	58	16.00	26.1	63.8	67.3
B1	13269	296	0	0	13565	4748	11323	213	73	72	4.69	15.5	213	73	72	4.69	14.2	93.4	98.6
C1	4400	0	0	0	4400	1540	3740	183	55.7	54	9.29	13.0	183	55.7	54	9.29	11.9	104.3	110.3
C2	4813	0	0	0	4813	1685	4091	233	55.5	54.5	4.29	19.1	233	55.5	54.5	4.29	17.5	81.8	86.5
C3	7868	249	0	0	8117	2841	6725	258	60.4	55.7	18.22	15.1	258	60.4	55.7	18.22	13.8	95.1	100.3
C4	29301	885	0	0	30186	10565	25039	570	63	60.5	4.39	38.8	570	63	60.5	4.39	35.6	52.5	55.4
D1	4310	141	0	1	4452	1558	3685	145	55.5	54	10.34	10.1	145	55.5	54	10.34	9.2	122.4	129.2
D2	5856	189	0	2	6047	2116	5006	195	57	55.5	7.69	13.9	195	57	55.5	7.69	12.8	99.8	105.4
D3	15265	326	0	0	15591	5457	13024	402	63.2	56.8	15.92	22.6	402	63.2	56.8	15.92	20.7	73.7	77.8
D4	10526	335	0	0	10861	3801	8997	338	70.5	63.2	21.60	18.5	338	70.5	63.2	21.60	17.0	83.5	88.1
D5	27241	623	0	0	27864	9752	23248	407	75	70.5	11.06	23.2	407	75	70.5	11.06	21.3	72.5	76.5

Runoff Coefficients	**Pre-Dev**	**Post-Dev**
Roads	0.35	0.85
Swales/Basins	0.35	1
Lots	0.35	0
OS	0.35	0

Rainfall IFD

Event	**Duration (mins)**	**Intensity (mm/hr)**
1 min	1	257.40
2 min	2	210.00
3 min	3	192.40
4 min	4	178.50
5 min	5	166.80
10 min	10	124.80
15 min	15	100.40
20 min	20	84.60
25 min	25	73.68
30 min	30	65.60
45 min	45	50.53
1 hr	60	42.10
1.5 hr	90	32.73
2 hr	120	27.55
3 hr	180	21.73
4.5 hr	270	17.24
6 hr	360	14.62
9 hr	540	11.44
12 hr	720	9.50
18 hr	1080	7.17
24 hr	1440	5.75
30 hr	1800	4.77
36 hr	2160	4.08
48 hr	2880	3.17
72 hr	4320	2.19



100 YEAR ARI FLOWS - ROADS

Storage Duration (mins)	A1				A2				A3				A4				A5				A6			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	143.93	1999.41	1855.48	-265.41	65.77	521.22	455.44	-39.29	70.15	608.24	538.09	-50.69	107.95	658.34	550.39	-35.09	130.31	1489.71	1359.40	-163.47	85.10	812.75	727.66	-75.47
2	143.93	1631.22	1487.29	-191.67	65.77	425.24	359.46	-21.31	70.15	496.23	426.09	-29.40	107.95	537.11	429.16	-13.60	130.31	1215.38	1085.07	-109.52	85.10	663.08	577.99	-46.63
3	143.93	1494.51	1350.58	-123.76	65.77	389.60	323.82	-5.08	70.15	454.64	384.50	-10.11	107.95	492.09	384.14	5.54	130.31	1113.52	983.21	-60.12	85.10	607.51	522.42	-20.39
4	143.93	1386.54	1242.60	-65.60	65.77	361.45	295.68	8.60	70.15	421.80	351.65	6.20	107.95	456.54	348.59	21.45	130.31	1033.07	902.77	-17.98	85.10	563.62	478.53	1.87
5	143.93	1295.65	1151.72	-15.35	65.77	337.76	271.98	20.21	70.15	394.15	324.01	20.10	107.95	426.62	318.67	34.74	130.31	965.36	835.05	18.24	85.10	526.68	441.58	20.91
10	143.93	969.41	825.48	149.60	65.77	252.71	186.94	55.77	70.15	294.90	224.76	63.37	107.95	319.20	211.24	72.83	130.31	722.28	591.98	135.11	85.10	394.06	308.97	81.05
15	143.93	779.88	635.95	241.31	65.77	203.30	137.53	72.21	70.15	237.25	167.10	84.33	107.95	256.79	148.84	86.73	130.31	581.07	450.76	197.38	85.10	317.02	231.92	111.38
20	143.93	657.15	513.22	298.81	65.77	171.31	105.53	79.68	70.15	199.91	129.77	94.84	107.95	216.38	108.43	89.29	130.31	489.62	359.32	234.13	85.10	267.13	182.03	127.76
25	143.93	572.32	428.39	338.72	65.77	149.20	83.42	82.51	70.15	174.11	103.96	99.94	107.95	188.45	80.50	85.94	130.31	426.43	296.12	257.71	85.10	232.65	147.55	136.93
30	143.93	509.56	365.63	366.84	65.77	132.84	67.06	82.22	70.15	155.01	84.87	101.41	107.95	167.78	59.83	78.64	130.31	379.66	249.36	272.48	85.10	207.13	122.04	141.27
45	143.93	392.53	248.60	414.10	65.77	102.33	36.55	71.46	70.15	119.41	49.27	94.32	107.95	129.25	21.30	44.08	130.31	292.46	162.16	288.94	85.10	159.56	74.47	138.96
60	143.93	327.02	183.09	431.83	65.77	85.25	19.48	52.69	70.15	99.48	29.34	77.96	107.95	107.68	-0.27	-0.78	130.31	243.65	113.35	283.14	85.10	132.93	47.84	124.33
90	143.93	254.26	110.33	419.63	65.77	66.28	0.51	2.16	70.15	77.35	7.20	30.17	107.95	83.72	-24.23	-107.26	130.31	189.45	59.14	235.53	85.10	103.36	18.26	75.10
120	143.93	214.00	70.07	371.57	65.77	55.79	-9.99	-58.26	70.15	65.10	-5.04	-29.05	107.95	70.46	-37.49	-226.56	130.31	159.45	29.14	160.74	85.10	86.99	1.90	10.75
180	143.93	168.82	24.89	208.93	65.77	44.01	-21.77	-197.37	70.15	51.36	-18.79	-168.61	107.95	55.59	-52.36	-488.78	130.31	125.78	-4.52	-39.20	85.10	68.62	-16.47	-145.95
270	143.93	133.95	-9.98	-131.46	65.77	34.92	-30.86	-432.50	70.15	40.75	-29.40	-408.56	107.95	44.11	-63.84	-916.35	130.31	99.80	-30.50	-412.09	85.10	54.45	-30.65	-421.56
360	143.93	113.54	-30.39	-547.83	65.77	29.60	-36.18	-688.24	70.15	34.54	-35.61	-672.39	107.95	37.38	-70.57	-1370.43	130.31	84.59	-45.71	-842.27	85.10	46.15	-38.94	-728.88
540	143.93	88.90	-55.03	-1531.80	65.77	23.17	-42.60	-1240.11	70.15	27.04	-43.10	-1247.01	107.95	29.27	-78.68	-2330.21	130.31	66.24	-64.07	-1816.16	85.10	36.14	-48.96	-1405.99
720	143.93	73.79	-70.14	-2644.13	65.77	19.24	-46.54	-1826.00	70.15	22.45	-47.70	-1861.21	107.95	24.30	-83.65	-3333.28	130.31	54.98	-75.32	-2886.15	85.10	30.00	-55.10	-2135.84
1080	143.93	55.67	-88.26	-5075.80	65.77	14.51	-51.26	-3052.51	70.15	16.93	-53.21	-3153.32	107.95	18.33	-89.62	-5409.04	130.31	41.48	-88.83	-5181.04	85.10	22.63	-62.47	-3680.49
1440	143.93	44.66	-99.27	-7674.46	65.77	11.64	-54.13	-4322.50	70.15	13.59	-56.56	-4496.17	107.95	14.71	-93.24	-7539.68	130.31	33.28	-97.03	-7600.29	85.10	18.16	-66.94	-5292.96
1800	143.93	37.03	-106.91	-10373.69	65.77	9.65	-56.12	-5617.94	70.15	11.26	-58.88	-5868.88	107.95	12.19	-95.76	-9701.99	130.31	27.59	-102.72	-10093.83	85.10	15.05	-70.04	-6945.52
2160	143.93	31.72	-112.21	-13106.67	65.77	8.27	-57.51	-6922.57	70.15	9.65	-60.50	-7252.24	107.95	10.44	-97.51	-11876.15	130.31	23.63	-106.67	-12612.85	85.10	12.89	-72.20	-8612.21
2880	143.93	24.60	-119.33	-18651.45	65.77	6.41	-59.36	-9552.02	70.15	7.48	-62.66	-10042.60	107.95	8.10	-99.85	-16249.78	130.31	18.33	-111.98	-17709.31	85.10	10.00	-75.10	-11977.27
4320	143.93	17.05	-126.89	-29866.96	65.77	4.44	-61.33	-14844.75	70.15	5.19	-64.96	-15662.57	107.95	5.61	-102.34	-25040.32	130.31	12.70	-117.61	-27996.91	85.10	6.93	-78.17	-18759.58
Volume check				ok				ok				ok				ok				ok				ok

Storage Duration (mins)	B1				C1				C2				C3				C4			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	123.17	809.60	686.42	-47.75	44.61	267.41	222.80	-13.14	38.27	292.51	254.24	-19.68	75.02	480.85	405.83	-28.11	154.02	1790.26	1636.24	-202.22
2	123.17	660.51	537.34	-20.85	44.61	218.17	173.55	-4.48	38.27	238.64	200.37	-9.70	75.02	392.30	317.28	-12.20	154.02	1460.59	1306.56	-137.22
3	123.17	605.15	481.98	3.21	44.61	199.88	155.27	3.24	38.27	218.64	180.37	-0.69	75.02	359.42	284.40	2.01	154.02	1338.17	1184.15	-77.69
4	123.17	561.43	438.26	23.30	44.61	185.44	140.83	9.64	38.27	202.85	164.58	6.89	75.02	333.46	258.44	13.85	154.02	1241.50	1087.48	-26.90
5	123.17	524.63	401.46	40.17	44.61	173.29	128.67	14.98	38.27	189.55	151.28	13.31	75.02	311.60	236.58	23.78	154.02	1160.12	1006.10	16.80
10	123.17	392.53	269.36	89.64	44.61	129.65	85.04	30.16	38.27	141.82	103.55	32.79	75.02	233.14	158.12	52.71	154.02	868.00	713.98	158.04
15	123.17	315.79	192.61	109.37	44.61	104.30	59.69	35.52	38.27	114.09	75.82	41.53	75.02	187.56	112.54	63.99	154.02	698.30	544.28	233.67
20	123.17	266.09	142.92	115.16	44.61	87.89	43.28	36.27	38.27	96.14	57.87	45.25	75.02	158.04	83.02	66.97	154.02	588.41	434.39	278.63
25	123.17	231.75	108.57	113.71	44.61	76.55	31.93	34.63	38.27	83.73	45.46	46.37	75.02	137.64	62.62	65.65	154.02	512.46	358.44	307.77
30	123.17	206.33	83.16	107.41	44.61	68.15	23.54	31.38	38.27	74.55	36.28	45.74	75.02	122.55	47.53	61.44	154.02	456.26	302.24	326.31
45	123.17	158.94	35.77	72.97	44.61	52.50	7.89	16.51	38.27	57.43	19.15	38.31	75.02	94.40	19.38	39.57	154.02	351.47	197.45	348.47
60	123.17	132.42	9.24	25.95	44.61	43.74	-0.88	-2.52	38.27	47.84	9.57	26.41	75.02	78.65	3.63	10.19	154.02	292.81	138.79	343.86
90	123.17	102.96	-20.22	-88.58	44.61	34.01	-10.61	-47.35	38.27	37.20	-1.07	-4.64	75.02	61.15	-13.87	-60.80	154.02	227.67	73.64	291.37
120	123.17	86.65	-36.52	-218.74	44.61	28.62	-15.99	-97.37	38.27	31.31	-6.96	-41.21	75.02	51.47	-23.55	-141.13	154.02	191.61	37.59	206.19
180	123.17	68.36	-54.82	-507.90	44.61	22.58	-22.03	-206.93	38.27	24.70	-13.57	-124.52	75.02	40.60	-34.42	-319.03	154.02	151.16	-2.86	-24.69
270	123.17	54.24	-68.93	-983.43	44.61	17.92	-26.70	-385.10	38.27	19.60	-18.68	-264.25	75.02	32.21	-42.80	-610.84	154.02	119.94	-34.08	-458.74
360	123.17	45.97	-77.20	-1491.37	44.61	15.19	-29.43	-573.99	38.27	16.61	-21.66	-415.49	75.02	27.31	-47.71	-922.00	154.02	101.66	-52.36	-961.69
540	123.17	36.00	-87.18	-2570.51	44.61	11.89	-32.72	-972.69	38.27	13.01	-25.27	-740.58	75.02	21.38	-53.64	-1581.97	154.02	79.60	-74.42	-2104.00
720	123.17	29.88	-93.29	-3702.76	44.61	9.87	-34.74	-1388.94	38.27	10.80	-27.48	-1084.72	75.02	17.75	-57.27	-2273.56	154.02	66.07	-87.95	-3361.83
1080	123.17	22.54	-100.63	-6052.68	44.61	7.45	-37.17	-2249.66	38.27	8.14	-30.13	-1803.65	75.02	13.39	-61.63	-3707.54	154.02	49.85	-104.18	-6063.66
1440	123.17	18.09	-105.09	-8470.10	44.61	5.97	-38.64	-3132.68	38.27	6.53	-31.74	-2546.99	75.02	10.74	-64.28	-5181.62	154.02	39.99	-114.03	-8914.95
1800	123.17	14.99	-108.18	-10926.66	44.61	4.95	-39.66	-4028.61	38.27	5.42	-32.86	-3304.67	75.02	8.90	-66.11	-6678.85	154.02	33.15	-120.87	-11855.48
2160	123.17	12.84	-110.33	-13397.69	44.61	4.24	-40.37	-4929.34	38.27	4.64	-33.63	-4067.48	75.02	7.63	-67.39	-8184.72	154.02	28.40	-125.62	-14826.65
2880	123.17	9.96	-113.21	-18370.96	44.61	3.29	-41.32	-6741.08	38.27	3.60	-34.67	-5604.45	75.02	5.92	-69.10	-11214.96	154.02	22.02	-132.00	-20839.19
4320	123.17	6.90	-116.27	-28370.50	44.61	2.28	-42.33	-10382.08	38.27	2.49	-35.78	-8697.30	75.02	4.10	-70.92	-17307.02	154.02	15.26	-138.76	-32978.07
Volume check				ok												ok				ok

Storm Duration (mins)	D1				D2				D3				D4				D5			
	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)	Pre-Dev Flow (l/s)	Post-Dev Flow (l/s)	Excess Flow (l/s)	Storage (m3)
1	52.99	263.45	210.46	-10.82	58.70	357.93	299.23	-19.65	111.73	931.23	819.50	-72.90	88.15	643.31	555.16	-44.21	196.30	1662.25	1465.96	-132.92
2	52.99	214.94	161.94	-2.68	58.70	292.01	233.32	-7.94	111.73	759.74	648.01	-40.55	88.15	524.85	436.70	-22.34	196.30	1356.15	1159.85	-75.02
3	52.99	196.92	143.93	4.46	58.70	267.54	208.84	2.48	111.73	696.07	584.34	-11.26	88.15	480.86	392.71	-2.68	196.30	1242.49	1046.20	-22.57
4	52.99	182.70	129.70	10.29	58.70	248.21	189.52	11.14	111.73	645.78	534.05	13.46	88.15	446.12	357.97	13.83	196.30	1152.73	956.43	21.74
5	52.99	170.72	117.73	15.08	58.70	231.94	173.25	18.37	111.73	603.45	491.72	34.49	88.15	416.88	328.73	27.78	196.30	1077.17	880.88	59.45
10	52.99	127.73	74.74	27.67	58.70	173.54	114.84	39.14	111.73	451.50	339.78	99.48	88.15	311.91	223.76	69.81	196.30	805.94	609.65	176.34
15	52.99	102.76	49.77	30.58	58.70	139.61	80.91	46.75	111.73	363.23	251.50	130.31	88.15	250.93	162.78	88.23	196.30	648.37	452.07	232.24
20	52.99	86.59	33.60	28.93	58.70	117.64	58.94	48.19	111.73	306.07	194.34	145.13	88.15	211.44	123.29	95.57	196.30	546.34	350.04	259.58
25	52.99	75.41	22.42	24.90	58.70	102.46	43.76	46.43	111.73	266.56	154.83	151.68	88.15	184.15	96.00	97.17	196.30	475.82	279.52	272.15
30	52.99	67.14	14.15	19.28	58.70	91.22	32.52	42.50	111.73	237.33	125.60	152.67	88.15	163.95	75.80	94.91	196.30	423.64	227.34	274.81
45	52.99	51.72	-1.27	-2.71	58.70	70.27	11.57	23.84	111.73	182.82	71.09	138.01	88.15	126.30	38.15	75.86	196.30	326.34	130.04	251.31
60	52.99	43.09	-9.90	-28.91	58.70	58.54	-0.15	-0.44	111.73	152.31	40.58	109.14	88.15	105.22	17.07	46.88	196.30	271.88	75.58	202.46
90	52.99	33.50	-19.49	-88.18	58.70	45.52	-13.18	-58.14	111.73	118.42	6.70	28.31	88.15	81.81	-6.34	-27.28	196.30	211.39	15.09	63.61
120	52.99	28.20	-24.80	-152.72	58.70	38.31	-20.39	-122.85	111.73	99.67	-12.06	-70.03	88.15	68.85	-19.29	-113.75	196.30	177.91	-18.38	-106.47
180	52.99	22.24	-30.75	-291.52	58.70	30.22	-28.48	-265.15	111.73	78.63	-33.10	-299.10	88.15	54.32	-33.83	-309.44	196.30	140.35	-55.95	-504.37
270	52.99	17.65	-35.34	-513.80	58.70	23.98	-34.72	-497.29	111.73	62.39	-49.34	-689.62	88.15	43.10	-45.05	-635.93	196.30	111.36	-84.93	-1184.91
360	52.99	14.96	-38.03	-746.91	58.70	20.33	-38.37	-743.89	111.73	52.88	-58.85	-1116.75	88.15	36.53	-51.62	-988.03	196.30	94.39	-101.90	-1930.74
540	52.99	11.71	-41.28	-1234.05	58.70	15.91	-42.78	-1265.22	111.73	41.40	-70.32	-2042.91	88.15	28.60	-59.55	-1742.30	196.30	73.91	-122.39	-3550.67
720	52.99	9.72	-43.27	-1738.67	58.70	13.21	-45.49	-1810.11	111.73	34.37	-77.36	-3029.70	88.15	23.74	-64.41	-2538.69	196.30	61.35	-134.95	-5278.78
1080	52.99	7.34	-45.66	-2775.99	58.70	9.97	-48.73	-2937.79	111.73	25.93	-85.80	-5100.85	88.15	17.91	-70.24	-4199.17	196.30	46.28	-150.01	-8909.14
1440	52.99	5.89	-47.11	-3835.25	58.70	8.00	-50.70	-4095.30	111.73	20.80	-90.93	-7249.70	88.15	14.37	-73.78	-5913.31	196.30	37.13	-159.16	-12678.19
1800	52.99	4.88	-48.11	-4906.97	58.70	6.63	-52.07	-5269.98	111.73	17.24	-94.48	-9444.22	88.15	11.91	-76.24	-7658.68	196.30	30.78	-165.51	-16528.81
2160	52.99	4.18	-48.81	-5983.55	58.70	5.68	-53.02	-6451.14	111.73	14.77	-96.96	-11655.06	88.15	10.21	-77.94	-9415.49	196.30	26.37	-169.93	-20408.54
2880	52.99	3.24	-49.75	-8146.73	58.70	4.40	-54.29	-8827.18	111.73	11.46	-100.27	-16112.92	88.15	7.91	-80.24	-12953.95	196.30	20.45	-175.85	-28232.60
4320	52.99	2.25	-50.75	-12490.68	58.70	3.05	-55.64	-13602.85	111.73	7.94	-103.79	-25088.77	88.15	5.48	-82.67	-20072.82	196.30	14.17	-182.12	-43987.99
Volume check				ok				ok				ok				ok				ok

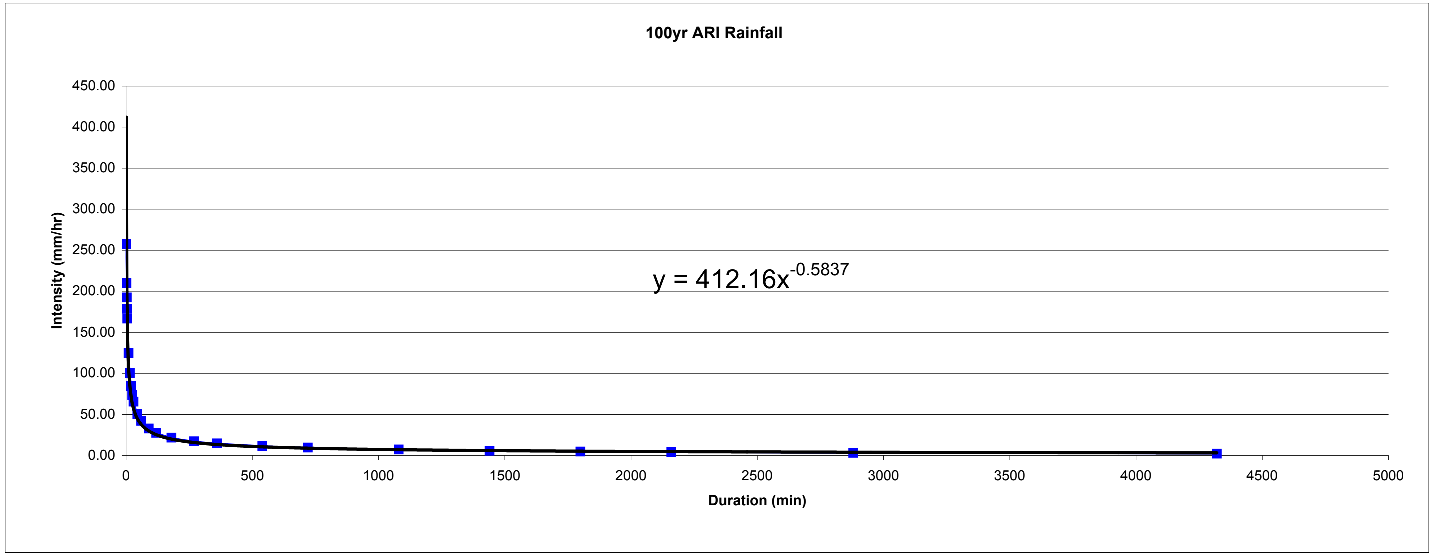
COMBINED 100 YEAR ARI DRAINAGE PROPERTIES

CATCHMENT				CUMULATIVE EFFECTIVE AREAS (m2)			TIME OF CONCENTRATION					CRITICAL STORM INTENSITY (mm/h)
	Contibuting Segments	Contributing Lots	Contributing Upstream Catchments	Road	Lots	Upstream	Longest Path (m)	RL Top (mAHD)	RL Bottom (mAHD)	Slope	TC (mln)	Pre-Dev
A1	A1-A5	10-16, 42-49n	46U,47U,49U,49NU	31033	192500	105579	2463	126	54	29.23	81.3	31.6
A2	A2	10-13		3075	20300	0	290	58.5	57	5.17	17.6	77.2
A3	A3	43		3588	9800	0	350	68	64	11.43	19.2	73.5
A4	A4	46	46U	3857	40600	29867	836	123	70.5	62.80	27.5	59.6
A5	A5	47-49N	46U,47U,48U,49NU	8747	66500	75712	1493	126	70	37.51	50.7	41.7
A6	A6			13299	0	0	453	66	58	17.66	22.8	66.5
B1	B1			4748	0	0	149	73.5	70	23.49	7.8	123.8
C1	C1	22		14946	0	0	1387	75	54	15.14	71.1	34.2
C2	C2	23,24		1685	8750	0	304	57	55	6.58	19.1	73.7
C3	C3,C4	20,21,32-41		2841	159950	0	1204	75	55.5	16.20	48.0	43.0
C4	C4	33-41		10565	144200	0	939	75	60.5	15.44	38.0	49.3
D1	D1-D5	25-30,49S-51,54,55	49SU,50U,51U,DRU	1558	110600	109770	3125	125	54	22.72	112.8	26.1
D2	D2-D5	26,27,49S-51,54,55	49SU,50U,51U,DRU	2116	78750	109770	2980	125	55	23.49	108.5	26.7
D3	D3-D5	49S-51,54,55	49SU,50U,51U,DRU	5457	69650	109770	2789	125	57	24.38	101.1	27.9
D4	D4,D5	49S-51	49SU,50U,51U,DRU	3801	50750	109770	2394	125	63	25.90	86.8	30.5
D5	D5	49S-51	49SU,50U,51U,DRU	9752	50750	109770	2022	125	70.5	26.95	72.4	33.8

Runoff Coefficients	Pre-Dev	Post-Dev
Roads	0.35	0.85
Swales/Basins	0.35	0
Lots	0.35	0
OS	0.35	0
Cleared Upland	0.35	0.35

Rainfall IFD

Event	Duration (mins)	Intensity (mm/hr)
1 min	1	257.40
2 min	2	210.00
3 min	3	192.40
4 min	4	178.50
5 min	5	166.80
10 min	10	124.80
15 min	15	100.40
20 min	20	84.60
25 min	25	73.68
30 min	30	65.60
45 min	45	50.53
1 hr	60	42.10
1.5 hr	90	32.73
2 hr	120	27.55
3 hr	180	21.73
4.5 hr	270	17.24
6 hr	360	14.62
9 hr	540	11.44
12 hr	720	9.50
18 hr	1080	7.17
24 hr	1440	5.75
30 hr	1800	4.77
36 hr	2160	4.08
48 hr	2880	3.17
72 hr	4320	2.19



COMBINED 100 YEAR ARI FLOWS

Segment	Contributing Segments	Contributing Lots	Contributing Upstream Catchments	Total Cum Peak Flow (L/s)	Long Slope	Swale Base Width (m)	Swale Depth (m)	Height Over Weir (m)
A1	A1-A5	10-16, 42-49n	46U,47U,49U,49NU	2892.34	0.0179	5	0.6	0.28
A2	A2	10-13		501.31	0.0066	4	0.5	0.15
A3	A3	43		273.18	0.0044	3	0.5	0.13
A4	A4	46	46U	1230.24	0.0140	2	0.6	0.25
A5	A5	47-49N	47U,48U,49NU	1748.01	0.0086	3.5	0.6	0.30
A6	A6			245.51	0.0190	4	0.5	0.07
B1	B1			163.29	0.0182	2	0.5	0.07
C3	C3,C4	20,21,32-41		1946.20	0.0185	3	0.6	0.27
C4	C4	33-41		2121.04	0.0016	4.5	0.8	0.48
D1	D1-D5	25-30,49S-51,54,55	49SU,50U,51U,DRU	1610.66	0.0071	3.5	0.6	0.30
D2	D2-D5	26,27,49S-51,54,55	49SU,50U,51U,DRU	1415.40	0.0079	3	0.6	0.29
D3	D3-D5	49S-51,54,55	49SU,50U,51U,DRU	1430.40	0.0172	3	0.6	0.26
D4	D4,D5	49S-51	49SU,50U,51U,DRU	1390.13	0.0209	4	0.5	0.20
D5	D5	49S-51	49SU,50U,51U,DRU	1600.45	0.0080	3.5	0.6	0.29

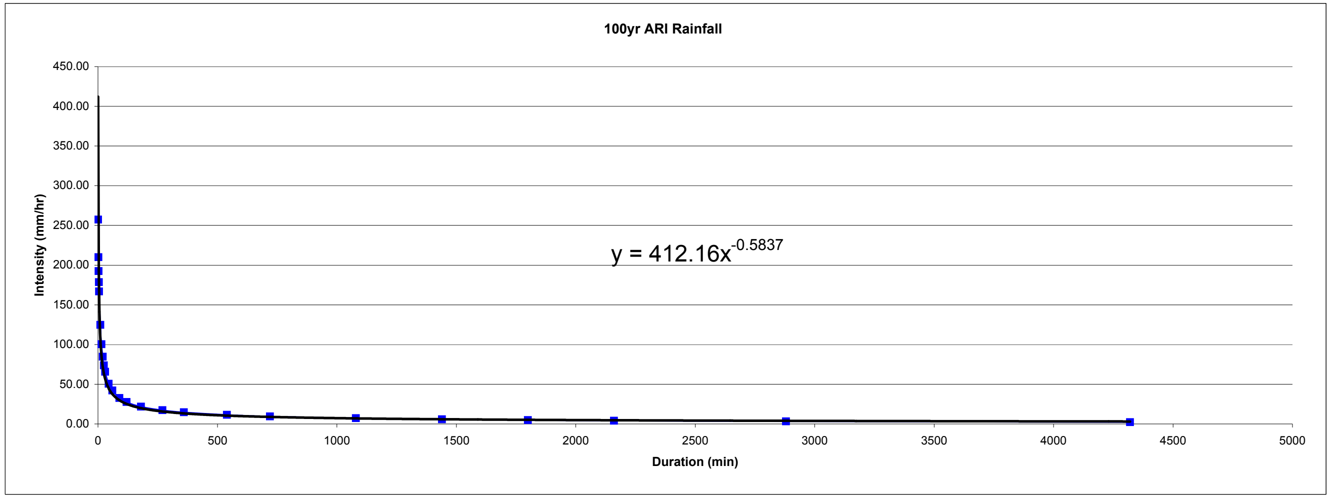
GNH CULVERT 100 YEAR ARI DRAINAGE PROPERTIES

CATCHMENT					EFFECTIVE AREAS (m2)							TIME OF CONCENTRATION					CRITICAL STORM INTENSITY (mm/h)
Group	**Culverts**	**Contibuting Segments**	**Contributing Lots**	**Contributing Upstream Catchments**	**Lots**	**Road Reserve**	**Swales/ Drainage**	**POS**	**Upstream Forested**	**Upstream Cleared**	**Total**	**Longest Path (m)**	**RL Top (mAHD)**	**RL Bottom (mAHD)**	**Slope**	**TC (mIn)**	**Pre-Dev**
A	CH36.64 CH36.43	A6, B1	1-8,44	POS, NDU	50929	9299	251	58193	147021	1012858	1278551	6514	235	53	27.94	192.7	19.1
B	CH36.12 CH35.98 CH35.92 CH35.73 CH35.58 CH35.41	A1-A5,C1-C4,D1	9-25, 28-43,45-49N	POS, 46U-49NU	404269	47994	1228	3074		105579	562143	2540	126	54	28.35	80.0	31.9
C	CH35.23 CH35.02	D2-D5	26,27,49S-51,54,55, DR	49SU-51U, DRU	78750	20611	516			109770	209646	2800	125	56.7	24.39	100.3	28.0
D	CH34.79		52,53	DR, SDU	28000		1318			411053	440371	2850	145	58.5	30.35	90.7	29.7

Runoff Coefficients	**Pre-Dev**	**Post-Dev**
Roads	0.35	0.85
Swales/Basins	0.35	0
Lots	0.35	0.85
POS	0.35	0.35
Cleared Upstram	0.35	0.35
Forested Upstream	0.2	0.2

Rainfall IFD

Event	**Duration (mins)**	**Intensity (mm/hr)**
1 min	1	257.40
2 min	2	210.00
3 min	3	192.40
4 min	4	178.50
5 min	5	166.80
10 min	10	124.80
15 min	15	100.40
20 min	20	84.60
25 min	25	73.68
30 min	30	65.60
45 min	45	50.53
1 hr	60	42.10
1.5 hr	90	32.73
2 hr	120	27.55
3 hr	180	21.73
4.5 hr	270	17.24
6 hr	360	14.62
9 hr	540	11.44
12 hr	720	9.50
18 hr	1080	7.17
24 hr	1440	5.75
30 hr	1800	4.77
36 hr	2160	4.08
48 hr	2880	3.17
72 hr	4320	2.19



100 yr CULVERT FLOWS

Culvert Properties							Catchment Properties			Post Development (=Pre Development) Flows			Storage	
Group	Culverts	No. & Size	Length	Slope	Max Flow (m3/s)	Total Capacity (L/s)	100 yr Total Effective Area (m2)	100 yr Critical Storm Intensity (mm/hr)	100 yr TC (min)	100yr Flow (L/s)	GNH Swale Length (m)	GNH Swale Volume (m3)	Storage Required (m3)	Volume Check
A	CH36.64	5 x 1.2 x 0.5	17.3	0.0068	6.5025	7618.3	1278551	19	193	6788.06	396.00	1089.00	0.00	ok
	CH36.43	1 x 0.9 x 0.45	14.8	0.0142	1.1158									
B	CH36.12	1 x 0.6	17.2	0.0152	0.6258	3583.9	562143	32	80	4986.14	1000.00	2750.00	1892.96	ok
	CH35.98	2 x 0.5	14.8	0.0172	0.8202									
	CH35.92	1 x 0.6	14.8	0.0110	0.5324									
	CH35.73	1 x 0.9 x 0.6	16	0.0086	1.2656									
	CH35.58	1 x 0.45	16	0.0088	0.2217									
	CH35.41	1 x 0.45	16	0.0025	0.1182									
C	CH35.23	5 x 1.2 x 0.75	20.8	0.0057	10.28	12898	209646	28	100	1630.10	433.00	1190.75	0.00	ok
	CH35.02	2 x 1.2 x 0.45	25.6	0.0092	2.618									
D	CH34.79	4 x 1.2 x 0.75	25.6	0.0094	10.4872	10487.2	440371	30	91	3630.26	11.00	30.25	0.00	ok

GNH Swale Dimensions

Base width (m)	4
Depth (m)	0.5
Side slope	3