Archaeo-Environments Pty Ltd
heritage soils and landscape

Bennett Road Development Plan
Gisborne South

LAND CAPABILITY & STORM WATER REVIEW

Land Capability Assessor
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LAND CAPABILITY AND STORM WATER REPORT
Bennett Road Development Plan, Gisborne South

ABOUT THE AUTHORS

Dr Chris Day DPhil, MIFA Director, Archaeo-Environments Ltd
Chris has over 35 years experience in geology, geomorphology, soils and heritage work which included 12 years in Bendigo and Benalla with DSE. This included management of catchment and salinity research teams and soil and soil permeability (recharge) mapping as a basis for Dryland Salinity Management Plans across the Avoca, Loddon, Campaspe and Goulburn Broken Catchments.

Larry White B Agr Sc., $CPSS_3$, CPAg, CENVP
Larry has over 45 years of experience in land and soils management with preparation of land capability assessment and land management plans throughout Victoria since 1990.
Larry has held senior research positions with Victorian Land Protection and Department of Conservation as well as EPA and Golder Associates. Larry has prepared over 500 land capability and land management plans, VCAT hearings and consulting work with various Shires throughout Victoria

1 INTRODUCTION

A land capability and storm water review has been commissioned by various landowners for a Development Plan for 130ha at Bennett Road, Gisborne. The land is subject to Macedon Ranges Planning Scheme Development Plan Overlay 18 (DPO18) and also the Rural Living Zone Schedule 2 under the recent C110 Planning Scheme Amendment. A Development Plan is required and will provide an overview document for a future planning permit application.

The land is not within a Declared Water Supply Catchment. The aim of this report is to identify the various issues which will inform sub-division and a planning permit application to Macedon Ranges Shire Council.

1.1 SCOPE OF WORKS

The land capability and storm water review will include a summary of potential site issues relevant to local planning requirements as follows :

> To demonstrate the capacity of infrastructure to service the proposed lot density of the development ; retain waste water on site; treat, retard and reduce stormwater; and reduce any impacts on soil and water downstream of the development

The scoping study is conservative, aimed at the protection of environmental and human health. It is not intended to support a particular proposal, but rather to describe the existing land parcels and suggest how adverse environmental impacts of the proposal may be minimised. Field work was conducted on March 24, 2018.

2.0 DATA SCOPE AND LIMITATIONS

The land planning assessment has been prepared by Dr. Chris Day (Archaeo-Environments Ltd) and Larry White (Paladin White Pty Ltd). Mapping and assessment has been conducted at a scale of 1 : 2500 and provides a guide and professional overview of site conditions. Terrain mapping, soil properties, climatic and botanical data are based on reconnaissance field-work and regional data sources for the purpose of reasonable and relevant estimates. As physical conditions, soils and local hydrology may vary over time, the overview assessment on which estimates are made in this report are limited to 18 months. This assessment is sufficient for a broad assessment within DPO18. The report should be used within the scope and scale of the brief and not for detailed design or property layout works or for any development beyond those of the brief. The scope of the Development Plans and more detailed assessment would occur at the time of development of the future lots. The report and recommendations therein are to be used to provide guidance toward - but do not guarantee – planning permission. It is not to be used, in full or in part, by any other party without written permission from the author.

3 LOCATION AND PROPERTY BACKGROUND

3.1 LOCATION

The subject block is composed of 6 properties. The site occupies approximately 130ha in and around Bennett Rd Gisborne. Located within Macedon Ranges Planning Scheme Development Plan Overlay (DPO18) and Rural Living Zone Schedule 2 under the recent C110 Planning Scheme Amendment. Both the Zone and DPO refer to a minimum lot size of 2ha.

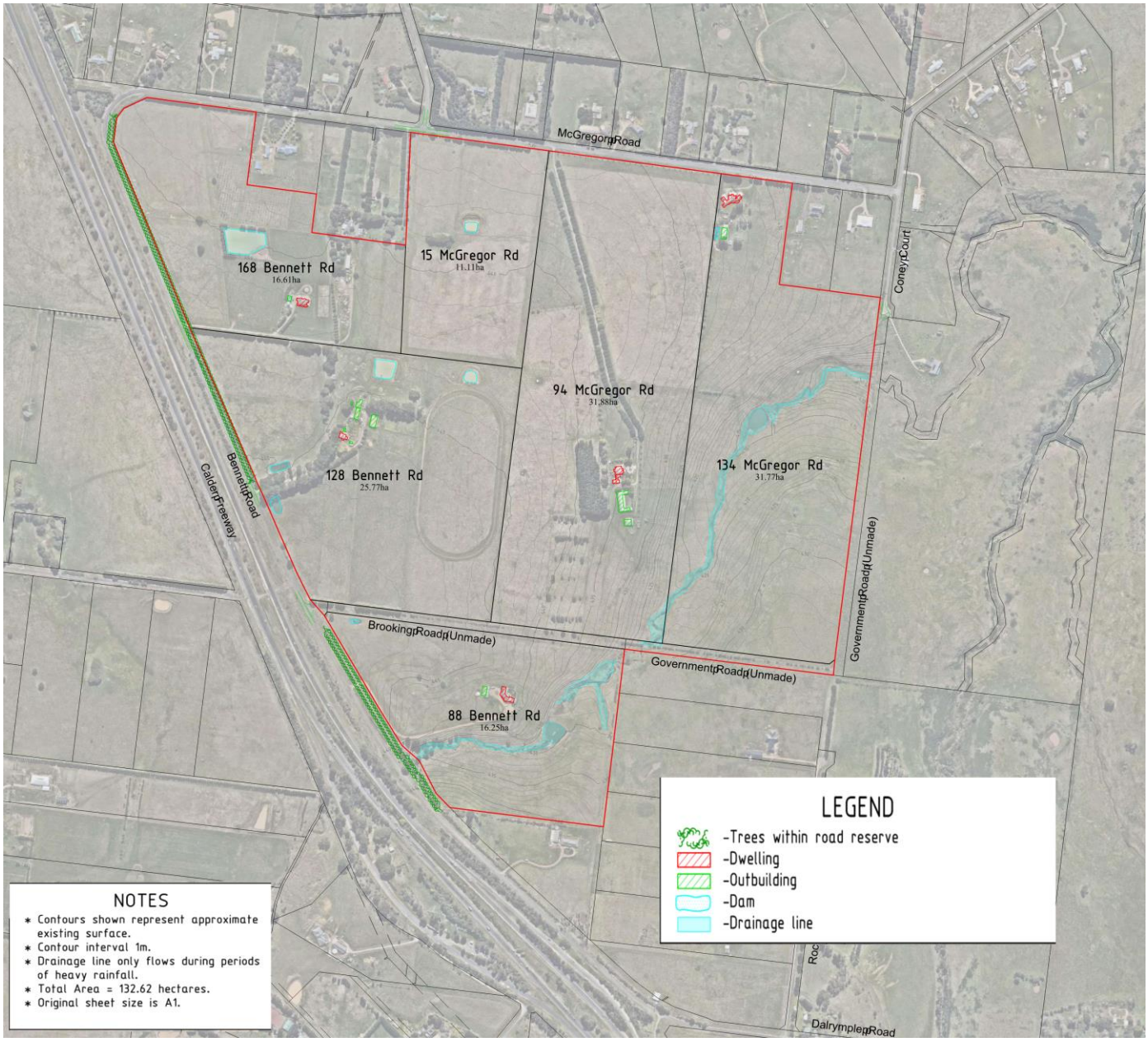

Fig 1 Location Map : Aerial view (courtesy : Terraco Ltd)

3.2 GENERAL SETTING/SITE CONDITION

The property is characterised by a broad and open volcanic plain which includes an incised waterway across the south-west. The block has been almost entirely cleared of native vegetation, with minor clumps of eucalypts (predominantly grey box) and tree plantations, with the main vegetation existing as exotic plantings as driveway avenues and some cypress windbreaks and boundary plantings. There are 10 dams which are for the most part across gentle drainage depressions. The property is fenced throughout with a range of horse property and lifestyle properties.

3.3 USE OF ADJOINING LAND

The subject property is bounded to the west by Bennett Road and the Calder Freeway to the west, McGregor Road to the north and Dalrymple Road to the south with developed blocks to the north and sloping terrain toward Jacksons Creek to the east.

3.4 FACILITIES/INFRASTRUCTURE

3.4.1 Mains Power

Mains power will be available to properties within the site.

3.4.2 Water

Reticulated potable water will be connected to the development area.

3.4.3 Bores and Dams

There are no bores onsite. There are 10 dams on the property. A series of stand-alone dams are situated across the open plain with two dams located across the waterway (Djirri Djirri Creek) to the east. These two dams will be removed under development plans. It is expected that other dams will be seasonal or have minimal volumes in the summer. At the time of inspection most of the dams were essentially dry.

3.4.4 Watertable depth

No groundwater bores were observed on the block. Registered bores are located within 200m of the site boundary to the north and south. Reference was made to the VVS (Visualising Victorias Groundwater) website which interpolates regional bore data. On this basis the watertable depth across the development area varies between 10 and 30m with watertable depth becoming shallower toward the north-west. Groundwater salinity varies between 1-3500mgl and is classed as (b) level beneficial use. On the basis of the VVG website, watertable depth will not be at high risk from effluent disposal across the development area.

3.4.5 Climate

Average annual rainfall is in the order of 750-800mm. A one-in-ten year rain is ~750mm. Average estimated annual evapo-transpiration is in the order of ~1350mm. Evaporation may exceed rainfall for 8 months (September to April) in an “average” year and these dry months may be challenging for agricultural production. The district can experience significant variations in rainfall and temperature and can have very cool winters & warm to hot and windy summers (which can

have implications for vegetation establishment).

3.5 TOPOGRAPHY AND DRAINAGE

The land encompasses a gently undulating volcanic terrain which falls toward the north and north-east. Water flow and local drainage is predominantly toward an incised waterway (Djirri Djirri Creek) which extends across the south-east corner of the property. Otherwise drainage across the property is via very gentle drainage swales and undefined drainage depressions. There is rock outcrop along the edge of low escarpments above the main drainage line to the east as well as within a stoney rise in the south-east part of the block.

Land form and soil description is based on field inspection and reference to the report : A Study of the Land in the Catchments to the North of Melbourne (Jeffrey P J 1981) SCA. Fig 2 shows general landform and land units across the development area.

Five main land units have been mapped across the development area.

LU 1 Open plain
LU2 Gentle-moderate slopes
LU3 Steep slopes
LU4 Valley floor
LU5 Stoney rise (o/c)

3.6 SOILS-LANDFORMS and WASTE WATER MANAGEMENT

Geology across the development area has been described in Section 3.5 as undulating volcanic terrain. The pattern of soils across this landscape reflects soil development across the large and predominant volcanic plain land unit with smaller soil units within valley edge and drainage features to the east of the property. Soils have been mapped for each land unit as follows :

LAND UNIT 1

Land Unit 1 is the predominant land type occupying the majority (73%) of the development area. Soils are typically deep volcanic silty clay (Plate 1) with soil profile described in Table 1 below

Soil profile
Yellow-grey sodic duplex soils, coarse structure clay loam
Moderate-low permeability – 5-10cm/day
Soil depth 1-1.5m deep.
Land Capability Rating Fair
Design loading rate (DLR) 2.5L/m^2/day
Constraints : Localised area of flat-gentle slopes, poor drainage or floaters will require site by site investigation.

Summary (on-site WW disposal):
Soils across land unit 1 would present generally suitable conditions for effluent disposal with estimated waste water envelopes at 300-450m^2 in area for 3-5 bedroom dwellings. At individual 2ha block level some localised conditions may require lot by lot assessment and design subject to location of building envelopes etc..

Plate 1 Typical deep yellow-grey clay loam across land unit 1

Plate 2 View to south across land unit 1 and location of auger hole

LAND UNIT 2

Land unit 2 occupies (16%) gentle-moderate slopes along Djirri Djirri Creek to the east of the development area. Soils are typically reddish-brown volcanic silty clay, stoney in part (Plate 1) with soil profile described :

Soil profile

Reddish-brown duplex soils, coarse structure clay loam. Some basalt floaters within the profile.
Moderate-low permeability – 5-10cm/day
Soil depth 0.5-0.8m deep.
Land Capability Rating Fair
Design loading rate (DLR) 3L/m^2/day
Constraints : Localised areas of shallow soils and stoney subsoils will require site by site investigation.

Summary (on site WW disposal) :

Soils across land unit 2 would present generally suitable conditions for effluent disposal with estimated waste water envelopes at 300-400m^2 in area for 3-5 bedroom dwellings. At individual 2ha block level some localised conditions may require lot by lot assessment.

Plate 3 View to south across mid-slope soil exposure

Plate 4 View to north-east across Land Unit 2

LAND UNIT 3

Land unit 3 occupies 2% of the development area, small areas of steep and stoney ground (2%) commonly along the edge of Djirri Djirri Creek across the eastern part of the development area. Soils are typically shallow reddish-brown clay loam with common basalt outcrop (Plate 1) with soil profile described :

Soil profile

Reddish-brown duplex soils, coarse structure clay loam. Common basalt floaters and outcrop within the profile.
Moderate permeability – 10-30cm/day
Soil depth 0.2 – 0.8m deep.

Land Capability Rating Very poor
Design loading rate (DLR) 3L/m^2/day
Constraints : Common areas of bedrock outcrop and shallow stoney subsoils.

Summary (on site WW disposal):
Soils across land unit 3 would present poor conditions for effluent disposal with waste water disposal considered high risk in this area. These areas will be included within the drainage line reserve and will therefore be exempt from development.

Plate 5 View to south across Land unit 3 (to north of Djirri Djirri Creek).

LAND UNIT 4

Land unit 4 occupies 6% and includes Djirri Djirri Creek and surrounding low slopes to the eastern part of the development area. Soils are typically dark grey-black uniform clay soils of low permeability with soil profile described :

Soil profile
Dark grey-black clay soils with heavy clay subsoils.
Low permeability – 1-10mm/day
Soil depth 1.0 – 1.5m deep.
Land Capability Rating Very poor
Design loading rate (DLR) 2L/m^2/day
Constraints : Common areas of waterlogging and poor drainages.

Summary (on site WW disposal):
Soils across land unit 4 would present poor conditions for effluent disposal with estimated waste water envelopes at 450-550m^2 in area for 3-5 bedroom dwellings. Heavy clay soils and occasional waterlogging risk may require additional management measures. Much of Land Unit 4 lies within the drainage line reserve and will be exempt from development.

Plate 6 Soil profile (Land Unit 4) showing deep clay subsoil.

Plate 7 View to south-east across land unit 4.

LAND UNIT 5

Land unit 5 (5%) is located on a gentle hillcrest in the south-east part of the development area. Bedrock outcrop is high in this area with shallow stoney soils. Soils are typically dark grey-black uniform clay soils of low permeability with soil profile described :

<u>Soil profile</u>
Dark grey-black clay soils with heavy clay subsoils.
Low permeability – 1-10mm/day
Soil depth 1.0 – 1.5m deep.
Land Capability Rating Very poor
Design loading rate (DLR) 2L/m^2/day
Constraints : Common areas of waterlogging and poor drainage.

Summary (on site WW disposal):

Soils across land unit 5 would present poor conditions for effluent disposal with likely additional management design and estimated waste water envelopes at 450-550m^2 in area for 3-5 bedroom dwellings. Presence of bedrock outcrop would require careful design of WW envelope and additional excavation work or adoption of secondary treatment and subsurface irrigation for example. However the large size (2ha) of lots within Land unit 5 would be expected to include parts of Land unit 2 which provides suitable conditions for waste water disposal.

Plate 8 View to south across land unit 5 showing common bedrock outcrop

3.7 SETBACKS

A 60m waste water envelope setback from the (non-potable) waterway (Djirri Djirri Creek) across the eastern part of the development area is shown in Fig 2 and is in accord with Table 5 (EPA Septic Code 2016) with use of a primary system. As the development area is not part of a declared water supply catchment final setback requirements will be subject to advice from MRSC with possible referral to Western Water. The EPA Code (2016) also allows a 30m setback with use of a secondary system. A 30m setback is recommended around isolated dams should they be retained. The dams located along Djirri Djirri Creek will be decommissioned.

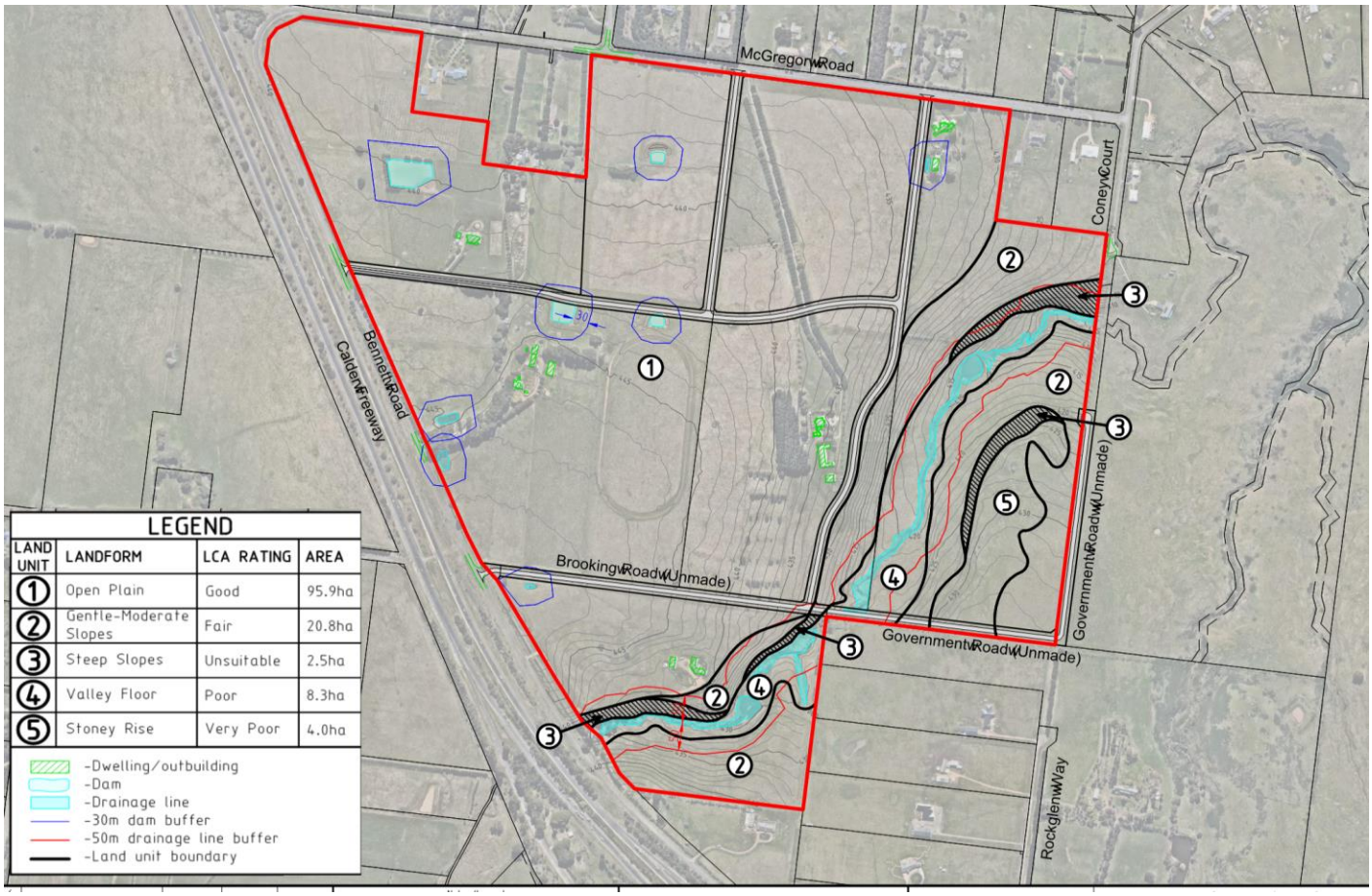

Fig 2 Land Unit Map (Courtesy Terraco Ltd)

4.0 WASTE WATER MANAGEMENT – LAND CAPABILITY

A summary of soil and environmental properties across the subject property is described in Section 3 above. It is expected that there would be few constraints to wastewater disposal across the majority (73%) of the subject property. Djirri Djirri Creek and areas of rock outcrop to the east of the development area include some areas which will constrain waste water disposal. The concept plan specifies a maximum of 6 lots in this area and subject to detailed assessment under subdivision application. The EPA Septic Code (2016) recommends setbacks from waterways and features and this will include a 60m buffer of the waterway and 30m from various scattered dams in accord with Table 5 (EPA Septic Code 2016).

For each subdivision application for the land an effluent envelope or treatment area must be designated and shown on the proposed lots. The envelopes shall be at least 60 metres or greater from the watercourse top of bank, and created on the plan of subdivision as a restriction or as agreed with the Responsible Authority. EPAs Code of Practice – Onsite Wastewater Management determines septic field setbacks required from waterways, at 60 metres for a primary treatment system and 30 metres for a secondary treatment system.

4.1 LAND CAPABILITY SUMMARY TABLE

Table 1 presents a summary of landform, soil and land capability values across the development area with suggested constraints and WW management for planned 2ha lot development. The summary of information is in general compliance with the EPA Septic Code and general MAV standards.

Table 1 Land capability summary

Land Unit	Landform	Area (ha)	Soil type	Slope %	Percolation (est) cm/day	LCA rating	On site WW comment (2ha lots)
1	Open Plain	73	Yellow-grey clay loam	0-2	5-10	Good	Few constraints. Subject to individual assessment.
2	Gentle-Mod plain	16	Reddish-brown silty clay (floaters)	7-10	10-20	Fair	Few constraints. Subject to individual assessment
3	Steep slopes	2	Reddish brown clay and common bedrock outcrop	12-25	20-50	Very poor	Highly constrained. No development likely
4	Valley floor	6	Dark grey-black heavy clay	1-3	0.5-1.0	Poor	Heavy soils and low permeability. Some waterlogging risk. Most of the area within 60m buffer.
5	Stoney rise	3	Shallow stoney soil and bedrock outcrop	2-4	20-50	Very Poor – additional WW management required.	Constrained by bedrock outcrop. Secondary treatment and additional excavation work necessary.

4.2 EXAMPLE OF SIZING OF WASTE WATER ENVELOPE (CASE STUDY)

While the sizing of waste water envelopes on individual lots is beyond the scope of this study, an indicative sizing of a WWE is summarised below. There are commonly two methods for assigning the size of WWEs which incorporate (i) design loading rates which use soil permeability and daily effluent volumes and (ii) a water-nitrogen balance.

An example of sizing of waste water envelopes across 2ha lots for Land Unit 1 which occupies the largest part of the development area uses an assumption of a 4 bedroom dwelling and 750 litres/day effluent volumes and adoption of a conventional trench septic system.

4.2.1 Waste water envelope – land application

(i) DESIGN LOADING RATE

The critical time for wastewater application will be during the winter period. Based upon the estimated household discharge for a 4BR house (up to 750L/day) and with an application rate (DLR) of 3.0L/m^2/day (based on low-moderate percolation rates on deep volcanic sub-soils onto a series of raised, disposal areas (garden or treed), there would be a requirement for an area of 250m^2 to address the wastewater disposal needs for any new dwelling on this property. It is expected that this estimate of WWE area would be increased to 300m2 to provide an additional buffer. It is expected that within Land Unit 1 that there would be ample room for design of a waste water field of these dimensions within the 2ha lots across the development area.

A conventional trench system of 120-150m would appear to be sufficient to carry the hydraulic load from the new dwelling. Layout design may vary, with 3 trenches (such as 40-50m long, 70cm wide and 60cm deep) with appropriate setbacks. Other configurations may suit, subject to individual site conditions, owner preference, site design and plumbing contractor advice.

(ii) WATER – NITROGEN BALANCE

A water-nitrogen balance using various rainfall, environmental and effluent volumes has been generated for proposed discharge from a 4 bedroom dwelling (Table 1 below)

As a general guide to sizing waste water envelopes within the 2ha lots the following water-nitrogen balance has incorporated various parameters (rainfall Macedon station, estimated discharge from a 4br home, evapotranspiration and nitrogen factors). The water-nitrogen balance incorporates rainfall and evapotranspiration data and various soil properties.

TABLE 2 Water – nitrogen balance assuming 4br dwelling on Land Unit 1.

(Template supplied courtesy P Williams)

Paul Williams & Associates Pty Ltd CD00002

WATER/NITROGEN BALANCE (20/30/10): With no wet month storage.

Rainfall Station: Macedon Forestry/ Evaporation Station: Malmsbury

Location: LAURISTON
Date: #####
Client: Chris Day

ITEM	UNIT	#	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Days in month:		D	31	28	31	30	31	30	31	31	30	31	30	31
Evaporation (Mean)	mm	A	205	176	124	75	47	27	27	43	66	105	126	152
Mean Rainfall	mm	B1	79	98	91	104	139	139	132	138	129	125	114	108
Effective rainfall	mm	B2	71	88	82	94	125	125	119	124	116	113	103	97
Peak seepage Loss[1]	mm	B3	171	154	171	165	171	165	171	171	165	171	165	171
Evapotranspiration(IXA)	mm	C1	92	79	56	34	21	12	12	19	30	47	57	68
Waste Loading(C1+B3-B2)	mm	C2	192	145	144	105	67	52	64	66	79	105	119	142
Net evaporation from lagoons (10(0.8A-B1xlagoon area(ha)))	L	NL	0	0	0	0	0	0	0	0	0	0	0	0
Volume of Wastewater	L	E	23250	21000	23250	22500	23250	22500	23250	23250	22500	23250	22500	23250
Total Irrigation Water(E-NL)/G	mm	F	66	60	66	64	66	64	66	66	64	66	64	66
Irrigation Area(E/C2)annual.	m^2	G												
Surcharge	mm	H	-125	-85	-78	-41	0	12	3	1	-14	-39	-55	-75
Actual seepage loss	mm	J	45	69	93	124	170	177	173	171	151	132	110	95
Direct Crop Coefficient:		I	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Rainfall Retained: 90	%	K	1. Seepage loss (peak) equals deep seepage plus lateral flow: 5.4mm (<10% ksat)											
Lagoon Area: 0	ha	L	CROP FACTOR											
Wastewater(Irrigation): 750	L	M	0.7	0.7	0.7	0.6	0.5	0.45	0.4	0.45	0.55	0.65	0.7	0.7
Seepage Loss (Peak): 5.5	mm	N	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Irrig'n Area(No storage): 350	m^2	P2	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Application Rate: 3.0	mm	Q	1	1	1	1	1	1	1	1	1	1	1	1
Nitrogen in Effluent: 30	mg/L	R	NITROGEN UPTAKE:											
Denitrification Rate: 20	%	S												
Plant Uptake: 220	kg/ha/y	T												
Average daily seepage: 4.1	mm	U												
Annual N load: 6.57	kg/yr	V												
Area for N uptake: 299	m^2	W												
Application Rate: 2.5	mm	X												
Irrig'n Area (adjusted for slope) 420	m^2	Z												
Application Rate (Design): 1.8	mm	Z1												

Species:	Kg/ha.yr	pH	Species:	Kg/ha.yr	pH	Species:	Kg/ha.yr
Ryegrass	200	5.6-8.5	Bent grass	170	5.6-6.9	Grapes	200
Eucalyptus	90	5.6-6.9	Couch grass	280	6.1-6.9	Lemons	90
Lucerne	220	6.1-7.9	Clover	180	6.1-6.9	C cunn'a	220
Tall fescue	150-320	6.1-6.9	Buffalo (soft)	150-320	5.5-7.5	P radiata	150
Rye/clover	220		Sorghum	90	5.6-6.9	Poplars	115

1.2 x hydraulic area (10% to 20% slope)

Based on Water-Nitrogen Balance Calculations shown above which assume 600L/day waste water use and effective rainfall, evapotranspiration and soil seepage parameters, the irrigation area (no wet month storage) = **350m^2**

NOMINATED WW APPLICATION AREA

(i) According to DLR estimates cited above, the estimated irrigation area = 250m2 upgraded to 300m^2.

(ii) According to Water - Nitrogen Balance* above the estimated irrigation area (no storage) = 350m^2

*This value is highly dependent on (conservative) soil percolation estimates and an overestimate of monthly rainfall.

Accounting for both methods of WWE approximation, the more conservative estimate from the Water Balance indicates the area required for land application (350m^2).

4.2.3 Conventional Waste Water System (example)

A conventional system is a passive system, which does not require connection to electricity. If carefully located, installed and routinely inspected there should be a low risk of failure or break down. A conventional system can also be used for intermittent occupancy patterns.

Treatment

- Treatment should be via a septic tank having an EPA Certificate of Approval and with fittings meeting Australian Standards AS1546.
- The tank should be inspected annually and pumped out every three years or earlier if required. Pump outs should be reported to Council.

Disposal Field

- Disposal field will be designed within the 2ha lot area according to various setback requirements and individual site design.
- The chosen disposal field should be planted out in the early stages of development to allow establishment of vegetation such as trees and shrubs.
- Beds could be built up with mulch to a depth of at least 100mm.
- Vegetation across the WWE will assist with water and nutrient uptake.

4.2.4 General waste water management per 2ha lot

Local soils across Land Unit 1 are deep and relatively well-drained.
The WWE should be re-vegetated with shrubs and trees to enhance transpiration and maximize soil-water storage, particularly during winter months. .
To ensure the viability of the vegetation on a disposal field, it may occasionally be necessary for supplementary watering in very dry times.
The active disposal field should be restricted from access by vehicles, children, pets and visitors.
New owner/occupants should be made familiar with management and permit requirements
If there are plans for house extensions, the wastewater management program should be reviewed by Council.

5.0 SUMMARY

It is emphasised that the development area is not part of a declared water supply catchment. Given proposed 2ha lot size it is expected that building and waste water envelopes could be assigned to adequately managed waste water disposal. There may be localised constraints which would be identified at individual lot resolution. On this basis, waste water could be retained and treated on site.

Areas where land is steep, mainly within the 60m drainage line buffer, will not require WW service. Land Unit 4 and Land Unit 5 will be constrained by poor soils and rock outcrop with a lesser yield as indicated in the concept plan.

An example of sizing of waste water envelope and waste water management across Land Unit 1 is presented above.

For each subdivision application for the land an effluent envelope or treatment area must be designated and shown on the proposed lots. The envelopes shall be at least 60 metres or greater from the watercourse top of bank, and created on the plan of subdivision as a restriction or as agreed with the Responsible Authority. EPAs Code of Practice – Onsite Wastewater Management determines septic field setbacks required from waterways, at 60 metres for a primary treatment system and 30 metres for a secondary treatment system.

6.0 STORM-WATER ASSESSMENT AND RECOMMENDATIONS

INTRODUCTION

The storm water assessment aims at identifying land constraints associated with the development area and to recommend management programs to address these constraints and thereby reduce the environmental impact of the proposed changed land use. Emphasis of the assessment is on internal management of storm water within the individual lots.

The emphasis is on soil-water management issues as follows :

- *Management of soil and water impacts so that the water quality of Jacksons Creek is not affected.*
- *The capacity of all drainage infrastructure to service the development.*
- *The methods for the treatment and retardation of all stormwater.*
- *The methods for sediment control*

6.1 DRAINAGE INFRASTRUCTURE and STORMWATER MANAGEMENT

The development property is not connected to sewer. A land capability assessment above has identified general land units within which waste water disposal is suitable or constrained. Within a minimum 2ha lot size, the proposed residential dwellings will be designed to harvest rainwater to water tanks. Engineering design plans will include retarding and management of runoff from driveways and paved surfaces. Rain water that is not

harvested from the dwelling and sheds as well as rain water from access roads etc shall be retarded on site to maintain flow at current conditions.

At an individual lot level, it is expected that rain water runoff from dwellings and shedding would be managed to reduce run-off and retain rain water on site. It is recommended that each block will be landscaped and planted to reduce/retard run-off.

6.2 STORM WATER MANAGEMENT RECOMMENDATIONS

The assessed environmental risk indicates that residential development on this land will need moderate management programs in place to address Storm water management on the property.

A) Design of drainage areas : driveways, paved area to mitigate off-site drainage.

B) Harvesting of rainwater from dwelling and sheds to large water tanks as well as retarding basins

C) Construction of contour banks to mitigate run-off where necessary

D) Establishment of tree/vegetation belts to minimise risk of overland flow.

E) Sediment control

6.3 DRAINAGE DESIGN

The development will include approximately 50x 2ha blocks which will be large enough to incorporate storm water management measures for dwellings and garage/outbuildings with access driveway and internal paths.

Recommendations

Engineering design to manage/reduce run-off from driveways and paved areas. Potential design might include direction of excess runoff toward either a sump or area of tree planting aimed at reducing ponding / mitigating off-site runoff.

6.4 STORM WATER AND HARVESTING RAINWATER

Recommendations

Stormwater will be harvested to large rainwater tanks. Overflow pipes will be directed toward treed areas or off-site drainage to avoid ponding.

6.5 SOIL EROSION AND SEDIMENT MANAGEMENT

ROADS and ACCESS

Access to the proposed dwellings will be via new driveways and upgraded access roads. It is expected that new access roads or driveways will need to be constructed and maintained to prevent erosion.

Recommendations

- *Drainage of new driveways should be designed to accommodate heavy and potentially erosive rainfall events. This would include effective grading and use of concrete and gravel batters designed to avoid gullying during storm events.*
- *Track runoff should be very carefully controlled, with well formed and maintained drainage structures (eg table drains, under road drainage etc*
- *Erosion management measures would include establishment of vegetation or geotextile along the exposed edges of the driveway.*
- *It is a general recommendation that future plans for access road throughout the block recognize soil erosion risk and implement measures to avoid soil exposure.*
- *During short-term construction works for any dwelling, impacts on shallow soils should be minimized.*

6.6 SOIL EROSION/SEDIMENT CONTROL MANAGEMENT

Local volcanic soils have an organic topsoil which can be susceptible to erosion when exposed. Local areas of poor drainage within each lot could be drained/vegetated to avoid ponding. Overall erosion risk is however low across the development area block. Soils are of low-moderate erosion risk following construction of the new driveway and other earthworks allied with development of the new dwelling.

Recommendations

- *During house, shed and infrastructure works, minimize soil exposure and potential soil erosion during wet periods by staged works and use of gravel cover where necessary.*
- *Establishment of contour tree planting to minimize overland flow*
- *Construction of a dam in suitable part of the property could be used to harvest stormwater and site drainage.*
- *Construction and maintenance of any access roads should be designed for optimal drainage with stone/gravel cover to reduce erosion risk.*
- *.Maintain vegetative cover over undeveloped parts of the property - avoid areas of exposed soil.*
- *Minimize "off-track" use of vehicles (including motor bikes) on the property.*
- *Sediment from driveways and exposed areas should be minimize by the above soil management measures. Construction of a sediment/sump (subject to engineering design) could be constructed to retard sediment on-site for potential redistribution.*

Fig 3 presents a conceptual land management plan for management and mitigation of storm water, sediment and erosion control across a typical residential property.

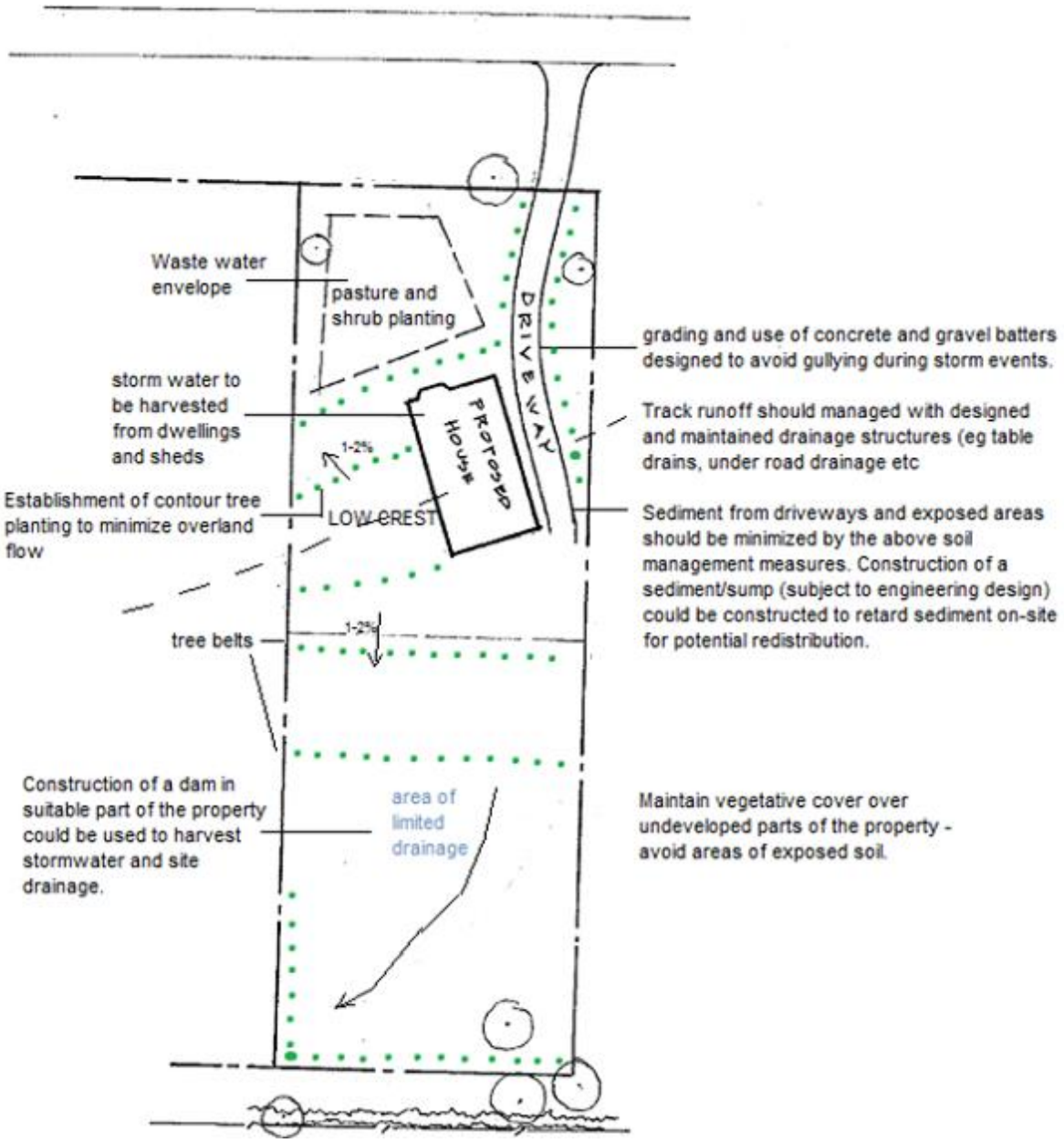

Fig 3 Storm water management map of typical 2ha lot within development area showing location of proposed dwelling (BE) and waste water envelope WWE with general land and storm water management recommendations.

APPENDIX A
LIMITATIONS

This report is solely for the use of the Client (various owner-landholders) and any reliance of this report by third parties shall be at such party's sole risk and may not contain sufficient information for purposes of other parties or for other uses. This report shall only be presented in full and may not be used to support any other objective than those set out in the report, except where written approval with comments are provided by Archaeo-Environments Pty Ltd.

This document is not intended to reduce the level of responsibility accepted by Archaeo-Environments Pty Ltd but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.
This report has been prepared for the specific purpose outlined in the proposal and no responsibility is accepted for the use of this document, in whole or part, in other purposes or contexts.

The scope and period of services are as described in the proposal. Conditions may exist which were undetectable given the limited nature of the enquiry AE ltd was engaged to assess with respect to the site. Conditions may vary between sample sites, with special conditions within the study area not revealed by the assessment and which have therefore not been accounted for in the report. Additional studies and actions may therefore be required.

It is recognised that time affects the information and assessment provided in this report. The opinions of AE Ltd are based on information current at the time the report was produced. It is understood that the services provided by AE Ltd lead to opinions based on the actual conditions of the study area at the time the study area was visited. These opinions cannot be used to assess effects of any subsequent changes in the quality of the site or its surroundings or any laws and regulations.

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