WATER RECYCLING and USE for MIXED USE DEVELOPMENT

SITE and SOIL EVALUATION for WASTE WATER RE-USE

5531 WEST SWAN ROAD, WEST City of Swan

Aulong Int'l (Australia) Pty Ltd

12 February 2022

WATER RECYCLING and USE
for MIXED USE DEVELOPMENT
INTENSIVE HORTICULTURE with TOURIST FACILITIES

SITE and SOIL EVALUATION for WASTE WATER RE-USE

5531 West Swan Road West Swan

Landform Research

Lindsay Stephens BSc (Geology), MSc (Plant Ecology)
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EXECUTIVE SUMMARY

This Water Recycling and Use Management Plan has been produced to document the methods by which water will be recovered and recycled to irrigate an Intensive perennial Jujube orchard at 5531 West Swan Road, West Swan.

5531 West Swan Road, West Swan is proposed to have an intensive agricultural land use, based on an orchard of Jujube with greenhouse grown mushrooms. Initially Shitake and Oyster mushrooms will be grown.

The re-use of waste water will integrate with water from an on site bore to provide the water for growth of the Jujube horticulture. Water for the Mushroom production will be scheme water and will not be included in this management plan. The mushrooms will be grown on specially prepared 'Logs" in a greenhouse facility, consisting of two greenhouses. Trials of the mushrooms have already been conducted in a warehouse in Canning Vale and have proved most successful.

Site preparation for the Jujube orchard is already in place with the excavation of holes to be prepared for installing the Jujube orchard plants.

A tourist facility consisting of accommodation and function centre/restaurant/café is proposed as ancillary to the intensive horticulture on 5531 West Swan Road, West Swan that is calculated to have a waste water volume of 7,940 Litres per day.

A Land Capability Report for the intensive land use has been prepared by Landform Research for the site and calculations show that there is sufficient water and soils to support horticulture or alternative land uses as proposed by the development.

Geotechnical Assessments have been conducted by Perth Geotechnics and their studies which are appended and this documentation is to form the Site and Soil Evaluation.

The studies show that the re-use of the water can be integrated into perennial Jujube Intensive Horticulture and partially substitute for water use from the on site bore and also partially substitute for nutrient requirements for the orchard, therefore reducing the potential for environmental impact in the local area.

Even though the calculated water volumes are 7,940 litres per day a 10,000 litre commercial Aquarius Waste Water recovery and treatment system (Aquarius 10KL O-2NR ATU see Figures 20 - 22) approved by the Department of Health WA is proposed with concrete tanks used. The system is designed to comply with AS/NZ 1546.3.

The irrigation Application Area has been assessed under AS/NZ 1547 and the *Government Sewerage Policy 2019*. The soils on site have been assessed by Perth Geotechnics, both for the development areas and the orchard. Copies of those site assessments are attached.

Water re-use is assessed by *Risk Assessment to Guidelines for the Non-potable Uses of Recycled Water in Western Australia*, Department of Health Western Australia

The soils are clay loams to light clays overlain by a sandy fill which enables a waste water irrigation rate of 3 litres/m^2.

A Stormwater Management Plan has been prepared by HyQualty Engineering.

The Development Application, which includes all planning information, is provided by Urbanista Planning.

- ***The waste water volumes are compatible with the irrigation requirements for the Jujube Orchard with some additional bore water likely to be required to top up the irrigation requirements.***

- ***The Irrigation Application Area is in excess of the required area based on the water loadings and has significantly greater setbacks and buffers than the required minima.***

- ***The Irrigation Application Area complies with the geotechnical requirements of AS/NZ 1547 and the Government Sewerage Policy.***

- ***Calculations of nutrients within the waste water demonstrate that the nutrients will substitute for some fertiliser applications on the Jujube orchard with some additional top ups required.***

CONTENTS

FIGURES

TABLES

1.0 INTRODUCTION

1.1 Background and Purpose

5531 West Swan Road West Swan is proposed to be intensive agriculture with an ancillary tourist facility consisting of accommodation and function centre/restaurant.

Lot 5531 is held by Jesuome Australia Pty Ltd.

The proposed intensive land use is to be implemented by Aulong Int'l (Australia) Pty Ltd, a wholesaler and importer of specialty and Asian food products.

Aulong Int'l (Australia) Pty Ltd operate from a wholesale warehouse at 20 Clipper Pde, Canning Vale WA, 6155. They are a successful business that not only supply the products but are actively researching the growth of specialty mushrooms at the Canning Vale site.

The landholder, Jesuome Australia Pty Ltd, and Aulong Int'l (Australia) Pty Ltd, share common directors.

1.2 Site Assessment - Methodology

Perth Geotechnics – Geotechnical study of the Development Area - 5 February 2021 – Attachment 1

A geotechnical report of the soils on the eastern part of the proposed development was completed by Perth Geotechnics 5 February 2021. That study covered the central and eastern portion of the site mainly where the built developments are to be located. The report mainly concentrated on the suitability of the soil conditions for those developments and demonstrates compliance.

The report is attached. (Attachment 1).

Perth Geotechnics sunk 8 soil auger holes, conducted two soil permeability tests, in addition to soil penetrometer and other soil parameter tests on the development site on 14 October 2021.

Perth Geotechnics – Geotechnical study and Permeability of the Intensive Horticulture Area – 14 October 2021 – Attachment 2

Further studies were completed by Perth Geotechnics by way of soil assessments and permeability field tests across the Irrigation Application Area conducted on 14 October 2021. Perth Geotechnics completed 6 soil permeability test holes and demonstrate compliance.

The report is attached. (Attachment 2)

Landform Research – Capability of Soils for Mixed Use Development – 14 February 2022 – Field data is attached at Attachment 3 and the whole report accompanies the planning application.

A land study of the site was conducted by Lindsay Stephens of Landform Research on 28 May 2021. Lindsay Stephens is very familiar with the local soils and has completed many land capability and geotechnical studies in the local soils and West Swan Area.

During the study by Landform Research on 28 May 2021, the ground of the western intensive agriculture section was assessed by soil auger holes and site mapping because that is where the orchard is proposed and that ground had not been previously assessed by Perth Geotechnics.

In the study the whole of the orchard and surrounding area was inspected. Five soil test holes were sunk to 1.2 metres to intersect the natural sand underlying the subsoil horizons using a long handled shovel as this is deemed suitable to determine the soil conditions for orchard growth.

Interpretation from aerial photography was also used, and ground photographs obtained.

The vegetation was reviewed to further add data to the soil information, based on species composition and distribution.

The Soil Test Hole data is provided at (Attachment 3).

Landform Research - Review of the excavated holes for planting – 21 November 2021

The site and Irrigation Land Application Area was inspected from a risk assessment perspective.

1.3 Site Description and Proposal

The site summary is taken from Urbanista Town Planning. The following Figures are taken from the Development Proposal.

> *The proposed development is located at No. 5531 (Lot 9) West Swan Road, West Swan. The subject site has a total land area of 18,388m2, with a frontage of 98.5m to West Swan Road, 65.93m to Fillip Way at the rear and a total depth of 237.64m.*
>
> *The agricultural use of the site will occupy approximately 8,300sqm of the site and is located at the rear half of the site. This area will be used as intensive orchards with two mushroom greenhouses located in the centre of the site.*
>
> *This open orchard is approximately 90m deep by 60m wide and will consist of approximately 600 initially and up to 1000 trees, spaced 2m apart across 30 rows orchard will be Jujube, (Chinese Dates) for sale to the Perth markets and to support the production and restaurant/café,.*
>
> *This land use also includes two mushroom greenhouses to initially grow Oyster and Shitake mushrooms. The largest mushroom greenhouse is 19.3m by 16m and will produce mushrooms in an area of up to 310sqm. The smaller mushroom greenhouse is just over 200sqm.*
>
> *The produce grown on site will be sorted/processed in the proposed warehouse located behind the existing dwelling. Separate rooms and sorting areas allow for this to be conducted as efficiently as possible and it is conveniently located in proximity to the restaurant.*

The agricultural use will employ three staff, and operate 10am to 5pm weekdays whilst also being able to respond as necessary to the seasonal demands and the stages of crop growth such as seeding or harvesting.

Site Integration

The various activities on site have been designed to integrate together.

The existing dwelling and shed will be retained, enhanced and incorporated into the proposed land uses.

Accommodation will be provided which will in turn support the restaurant/café, with the intensive agriculture from Mushrooms and Jujube Orchard.

There is a licensed bore on site with water allocation of 5,000 kL per year. To further enhance the agricultural viability of the intensive horticulture, treated waste water will be recovered and used to irrigate the perennial trees of the Jujube which will supply nutrients to the irrigated Jujube trees and in turn reduce the fertiliser requirements for the plants and minimise the risk of nutrient export from the site.

Mushrooms culture is selected because of the low water requirements, which will be from scheme water to minimise risk to production.

Mushrooms and Jujube do not require washing, therefore reducing water use on site.

As there are competing land uses on site, the various land uses are separated, a risk analysis completed and management proposed to minimise or negate the risk of contamination of crops, noise to the accommodation, and onsite use of insect control by implementing organic food production policies.

The hours of operation are to be regulated to minimise conflicts; for example the restaurant will be open during the day and only open at night for one off events such as weddings, when the chalets will be used by the guests.

The intensive horticulture landuses of mushrooms and jujube are low mechanical activities with low noise emissions, low potential for insect pests and require activities that will not impact on accommodation. The landuses are Predominantly Agriculture.

Agricultural - Intensive	8,500m^2	Primary Production and includes the below;
Incl. Orchard	*~5,800m^2*	*Primary Production – Fruit Trees*
Incl. Mushroom Greenhouses	*~510m^2*	*Primary Production – Mushrooms*
Incl. Warehouse	*~400m^2*	*Sorting / Processing of Produce*
Incl. Existing Shed	*~180m^2*	*Storage of tools and equipment*
Chalets or Cabins	6 chalets	75m^2 and 2 bedrooms each
Restaurant	294m^2	96-person maximum capacity
Single House (Existing)	220sqm	Retained Dwelling

Proposed Staging

Stage 1	Plant the intensive orchard and mushroom greenhouses
Stage 2	Installing the warehouse and the storeroom
Stage 3	Installing the restaurant and chalets with associated waste water recovery

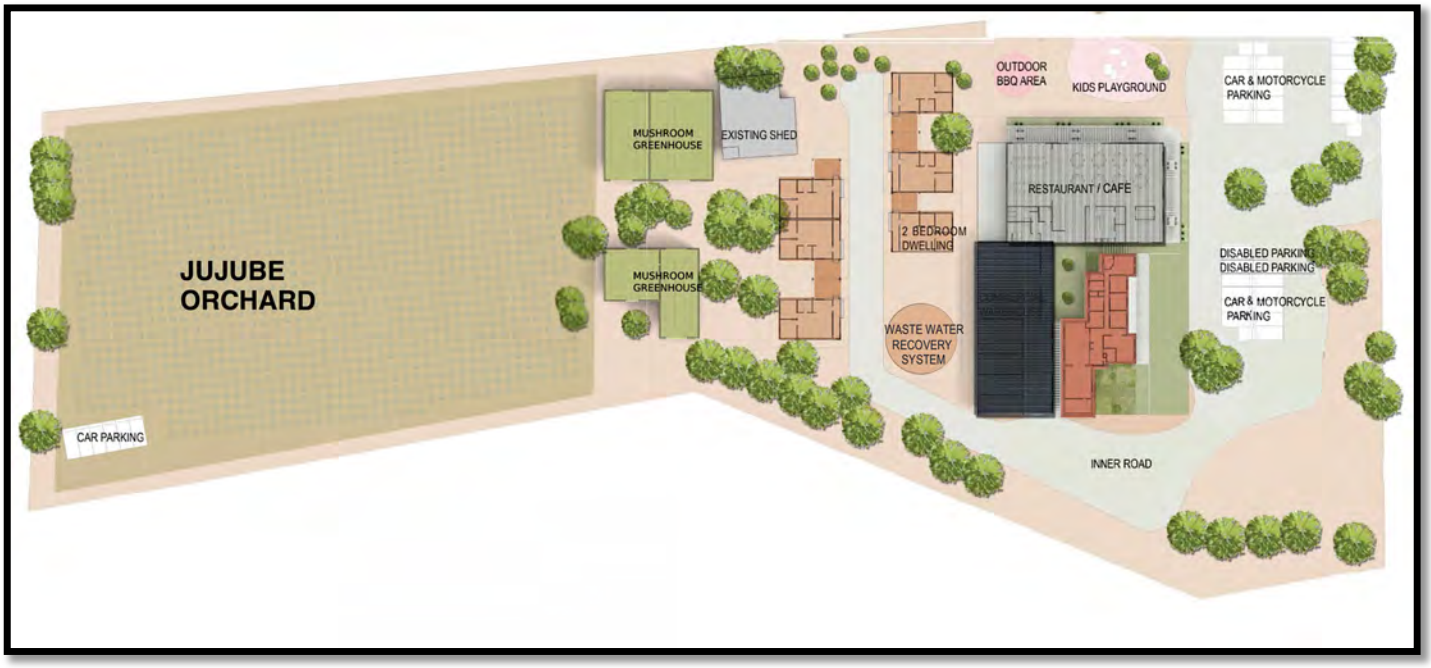

Figure 1: Concept development

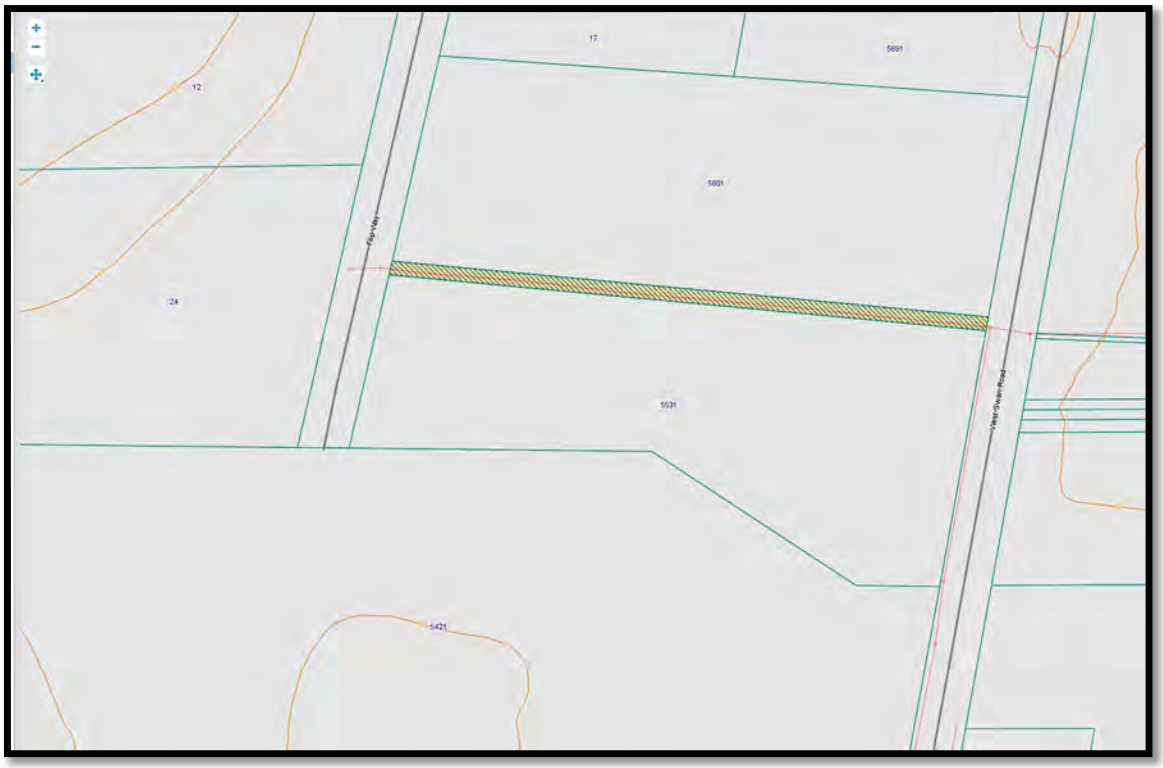

Figure 2: Contour elevations in 1 metre (AHD) City of Swan (IntraMap).

Compare with Figure 7, which uses a local datum, and Figure 7.

1.4 Statutory Requirements for the Reuse of Waste Water

A number of statutory provisions and Guidelines are in place for the safe disposal of waste water.

AS/NZ 1547, On-site domestic wastewater management

AS 1726 Geotechnical site investigations

Department of Health, ***Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units (ATU's).***

Department of Health, Specification for Aerobic Treatment Units (ATU'S) Serving Single Households *(Health Department)*

Government Sewerage Policy 2019

Health Act 1911

Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste Regulations 1974.

The Department of Health is charged with the protection and enhancement of the health and wellbeing of the WA community and therefore regulates the design, construction, connection, operation and maintenance of sewage in accordance with the Hea*lth Act 1911*.

The *Department of Health Guidelines for the Non-potable Uses of Recycled Water in Western Australia* provides a summary of the relevant statutory requirements and these are listed below.

For the purposes of the guidelines recycled water is considered to be sewage in accordance with *Section 3 of the Health Act 1911*.

The Department sets conditions of approval for recycling water schemes and the use of recycled water in Western Australia and all proposals must be approved by the Department.

The ***Health Act 1911*** contains a number of provisions that regulate the use of recycled water:

Section 98 – prohibits sewage being put anywhere unless it is authorised.
Section 107 – prohibits the use of any apparatus for the treatment of sewage unless approved by the Chief Health Officer.
Section 129 – prohibits the pollution of any water supply.

The ***Health Act 1911*** also contains a number of provisions that regulate the use of recycled water supplies:

Section 94 - prohibits chemical refuse or any waste that is injurious to health to be disposed in sewers or drains.
Section 98 – prohibits sewage being put anywhere unless it is authorised.
Section 107 – prohibits the use of any apparatus for the treatment of sewage unless approved by the Chief Health Officer.

Section 129 – prohibits the pollution of any water supply.

The ***Metropolitan Water Supply and Sewerage Act 1909*** contains a number of provisions that regulate the use of alternative water sources:

Section 54 – Only approved fittings may be used fit-for-purpose for the water supplied.
Section 55 – People supplied with water are required to keep their fittings in good repair.

The ***Metropolitan Water Supply, Sewerage and Drainage By-laws 1981*** contain details on several provisions for the supply of alternate water:

Section 3 - Protection of water against pollution.
Section 4 - Protection of catchment areas and water reserve.
Section 5 - Protection of public water supply areas and underground water pollution control areas.

The ***Water Services Licensing Act 1995*** contains a number of provisions that regulate the use of recycling water sources:

Section 18 – Requirement for licenses from the Economic Regulation Authority (ERA) to supply water.
Section 19 – Power to exempt people/incorporated bodies from licensing requirements.

The **Code of Practice for the Reuse of Greywater in WA 2010** sets out the minimum requirements for the reuse of greywater in WA on commercial premises reusing up to 5,000 L/day

There are **other government and non-government agencies** aside from the Department of Health that may have an interest or regulatory role in recycled water schemes. These can include (but are not limited to) the local government, the Department of Water, Environmental Regulation, Department of Planning, Land and Heritage, the Environmental Protection Agency and the Economic Regulation Authority and the City of Swan.

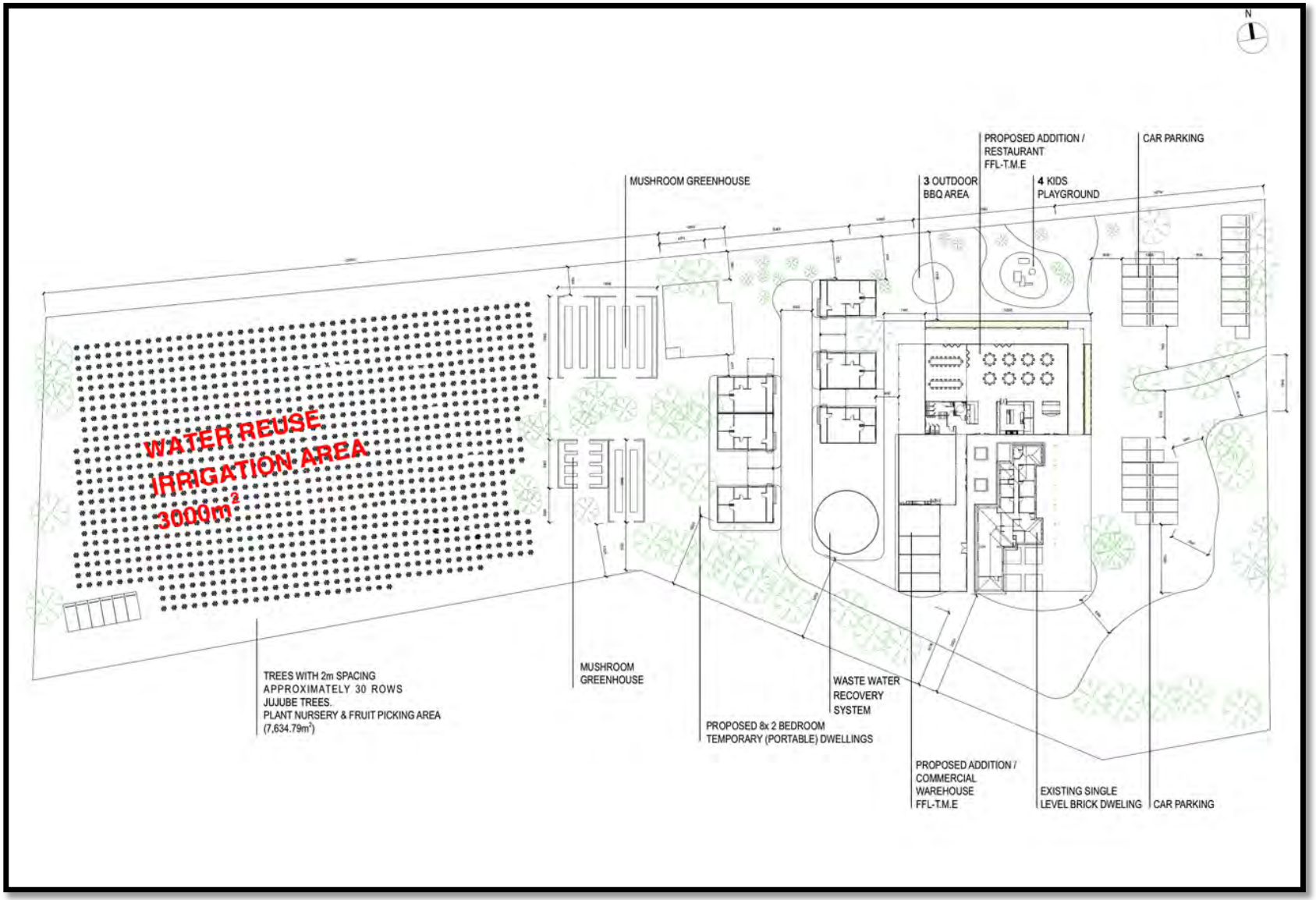

Figure 3: Concept development

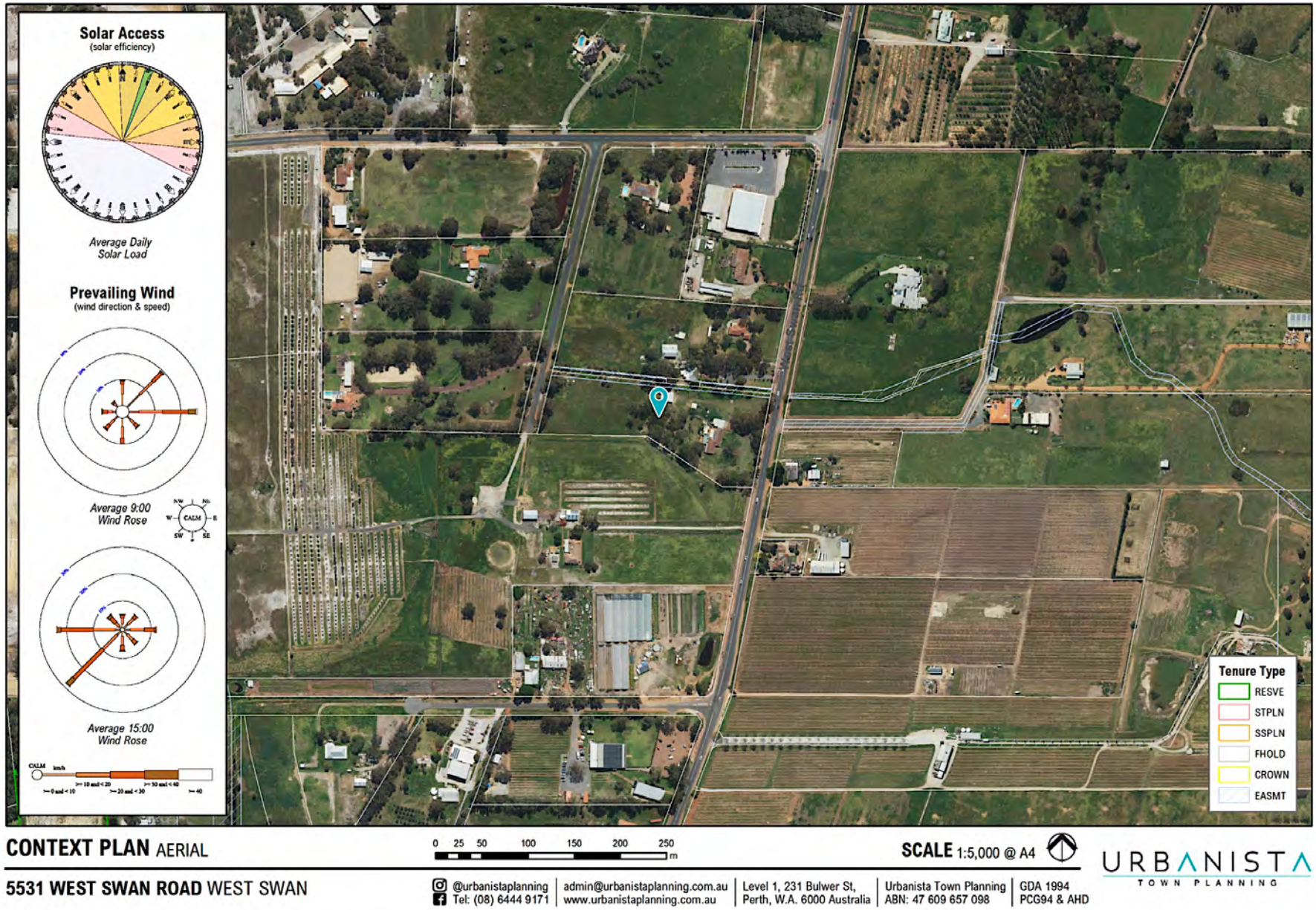

Figure 4: Subject land and surrounding land uses

Perth Geotechnics ABN: 78 532 814 778 19 Silkie Link, Southern River, WA 6110 Tel: 08 6396 2675; M: 0430 130 677 E: info@perthgeotechnics.com.au www.perthgeotechnics.com.au	**Project:** Geotechnical Investigation **Location:** 5531 West Swan Road, West Swan WA		**Site Plan:** Bore Hole (BH), Dynamic Cone Penetrometer (DCP) and Field Permeability Test (FPT) Locations
	Client: Hyqualty Group		
	Reference: GI83221PG	**Scale:** N.T.S.	**Drawing No:** 83221_Rev0
	Date: 04/02/2021	**Drawn By:** MH	

Figure 5: Soil test and permeability test holes - Perth Geotechnics (Fieldwork 14 October 2021)

Perth Geotechnics ABN: 78 532 814 778 19 Silkie Link, Southern River, WA 6110 Tel: 08 6396 2675; M: 0430 130 677 E: info@perthgeotechnics.com.au www.perthgeotechnics.com.au	**Project:** Permeability tests **Location:** 5531 West Swan Road, West Swan WA		**Site Plan:** Field Permeability Test (FPT) Locations
	Client: Hyqualty Construction		
	Reference: FPT128221PG	**Scale:** N.T.S.	**Drawing No:** 128221_Rev0
	Date: 19/10/2021	**Drawn By:** MH	

Figure 6: Soil test and permeability test holes - Perth Geotechnics (Fieldwork 14 October 2021)

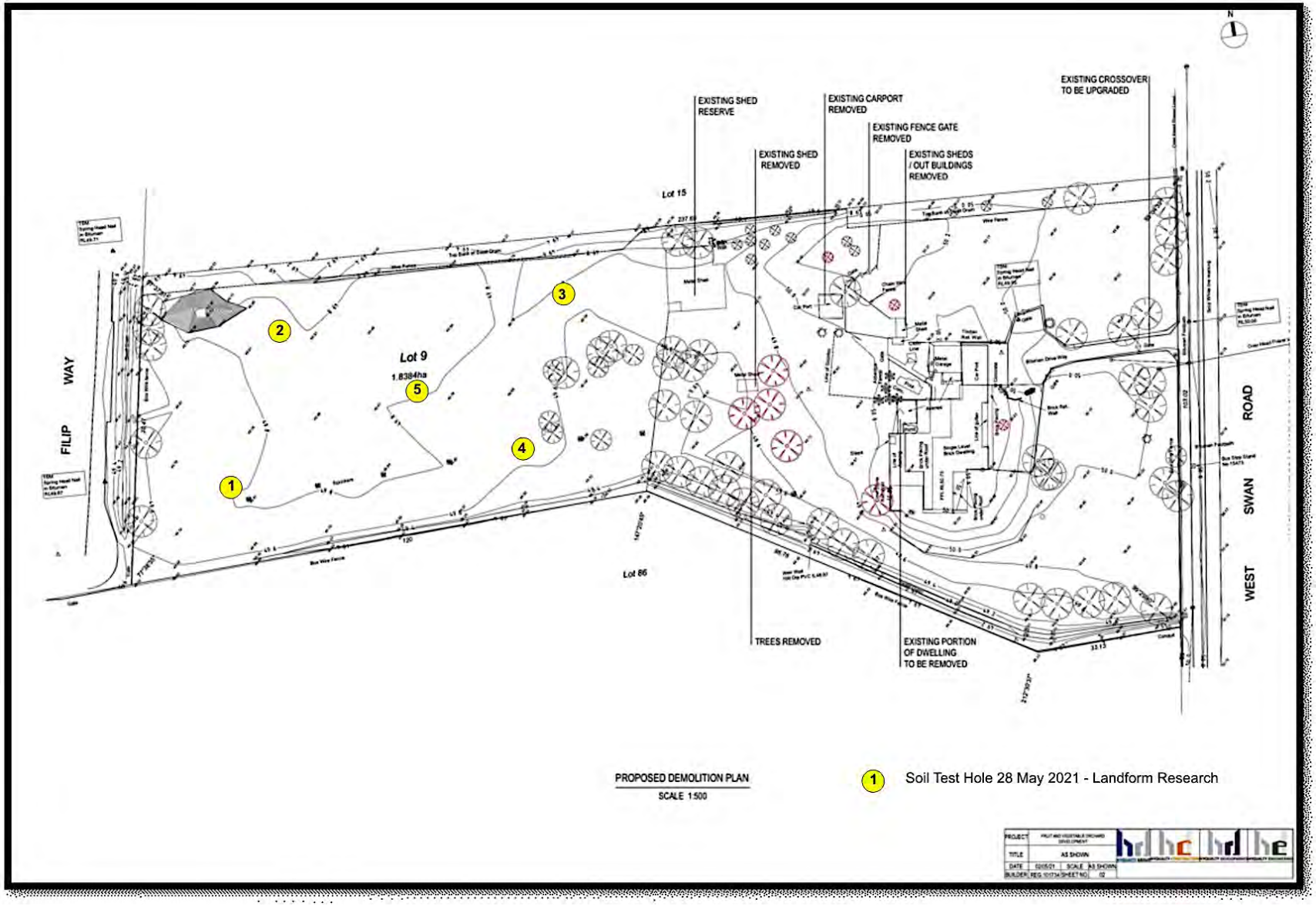

Figure 7: Contour Plan and Soil Test Holes. Note the Local datum. The land is at 17 metres AHD

Figure 8: Holes for the planting of Jujube sunk in July - August 2021

2.0 WEATHER CONDITIONS

2.1 Climate

The climate consists of warm to hot summers and mild wet winters. Climate averages are similar to the closest comprehensive recording station at Upper Swan, with the climate somewhere in between. The rainfall is similar for both stations at around 736 mm per year.

Average summer maximum is around 33 degrees Celcius with winter maxima of around 18 degrees Celcius. The mean winter minimum is around 7.0 degrees Celcius with frosts occurring on winter and spring mornings.

Wind directions are predominantly from the east in the mornings with increased velocity in summer, and south west to west in the afternoons, particularly in summer.

Other data on the attached graphs and figures from the Bureau of Meteorology (BOM) and Weather and Climate (Australia), show the suitability of the climate provided in the Swan Valley.

The data for soils and climate are summarised in Campbell Clause J, and G A Moore, 1991, *Land Capability Study for Horticulture in the Swan Valley,* DPIRD Land Resources Series No 6 and demonstrate the suitability of the valley for intensive horticulture.

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Monthly climate statistics

All years of record

About Climate statistics | Data file of statistics for this site (csv) | Site selection menu

Summary statistics UPPER SWAN RESEARCH STATION

A summary of the major climate statistics recorded at this site is provided below. There is also an extended table with more statistics available. More detailed data for individual sites is available.

Site information

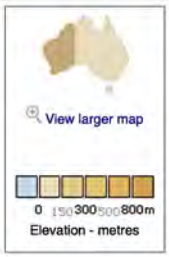
Site name: UPPER SWAN RESEARCH STATION
Site number: 009067
Latitude: 31.76 °S **Longitude:** 116.02 °E
Elevation: 15 m
Commenced: 1957 **Status:** Closed 04 Nov 1998
Latest available data: 31 Oct 1992

Additional information

Additional site information

Nearest alternative sites

1. 009053 PEARCE RAAF (9.9km)
2. 009022 GUILDFORD POST OFFICE (16.4km)
3. 009021 PERTH AIRPORT (19.4km)



View: Main statistics | All available | Period: Use all years of data | Text size: Normal | Large

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years		Plot	Map
Temperature																	
Mean maximum temperature (°C)	33.6	33.8	31.1	26.4	22.0	19.0	18.0	18.4	20.5	23.6	27.1	31.2	25.4	24	1965 1991		
Mean minimum temperature (°C)	15.0	16.2	14.3	11.5	9.4	8.3	7.6	6.8	7.5	8.6	10.8	13.0	10.8	24	1965 1991		
Rainfall																	
Mean rainfall (mm)	10.9	16.4	15.6	39.5	97.0	151.7	155.9	106.9	69.0	42.5	22.6	11.6	736.9	34	1957 1992		
Decile 5 (median) rainfall (mm)	2.3	7.6	7.8	38.8	90.6	154.0	150.6	106.6	65.4	38.2	13.8	9.0	732.7	35	1957 1992		
Mean number of days of rain ≥ 1 mm	1.4	1.5	2.1	4.7	8.1	10.6	12.6	10.5	7.7	5.4	3.3	1.8	69.7	33	1957 1992		
Other daily elements																	
Mean daily sunshine (hours)																	
Mean number of clear days	9.8	9.0	8.1	5.2	5.4	3.3	3.8	4.6	5.6	6.3	6.5	8.9	76.5	25	1965 1991		
Mean number of cloudy days	2.2	1.9	3.1	4.9	6.1	6.6	8.1	6.9	6.0	4.6	4.2	2.3	56.9	25	1965 1991		
9 am conditions																	
Mean 9am temperature (°C)	25.0	25.1	22.9	19.4	15.6	13.2	12.2	12.7	15.0	17.9	20.9	23.7	18.6	25	1965 1991		
Mean 9am relative humidity (%)	51	53	56	67	75	80	81	79	72	64	57	52	66	20	1965 1991		
Mean 9am wind speed (km/h)	15.2	15.1	14.4	11.2	8.3	7.2	7.6	8.5	9.8	12.7	13.7	13.7	11.4	16	1965 1991		
9am wind speed vs direction plot																	
3 pm conditions																	
Mean 3pm temperature (°C)	30.8	31.6	28.9	24.4	20.4	17.6	16.7	17.0	19.2	21.7	25.0	28.7	23.5	25	1965 1991		
Mean 3pm relative humidity (%)	38	38	39	52	57	65	64	61	58	54	47	40	51	21	1965 1991		
Mean 3pm wind speed (km/h)	15.5	14.2	14.5	12.2	9.7	9.5	9.2	11.3	12.7	14.0	16.8	16.1	13.0	13	1965 1991		
3pm wind speed vs direction plot																	

Figure 9: Climate data Upper Swan Research Station (BOM)

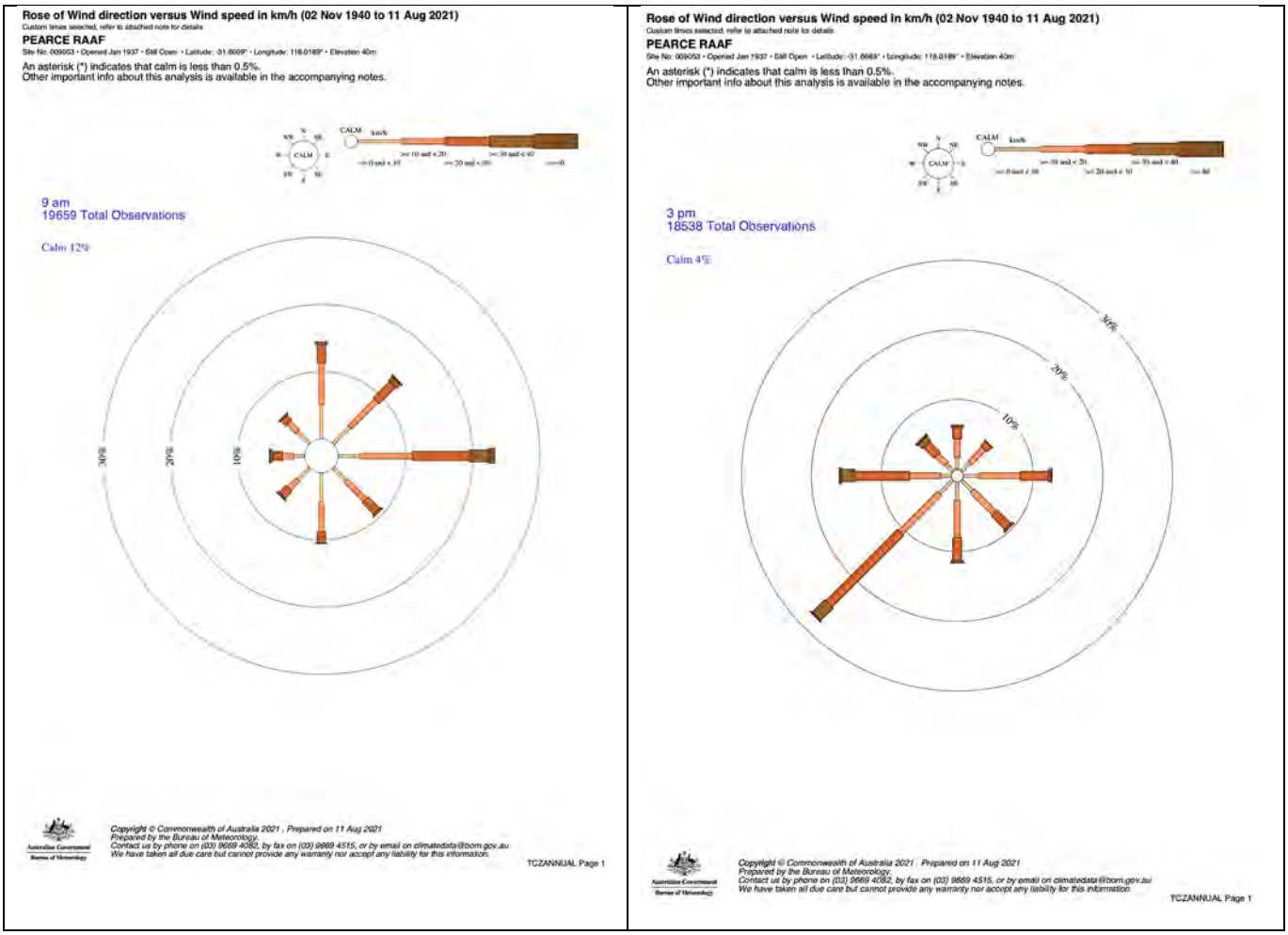


Figure 10 – Average yearly wind roses Upper Swan Research Station (BOM):

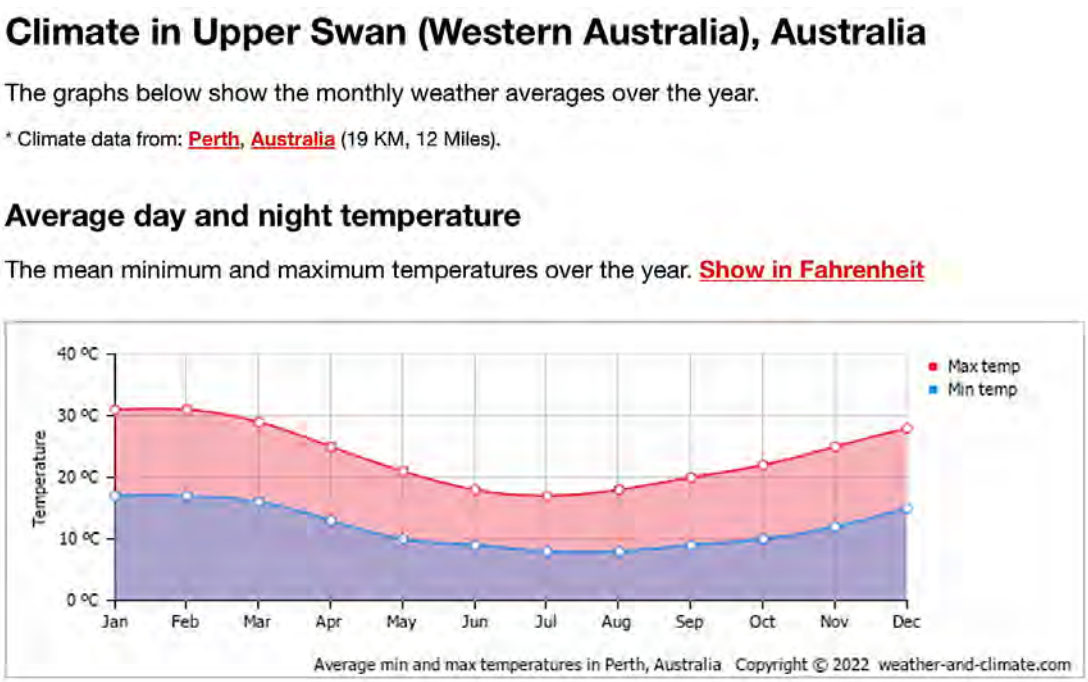
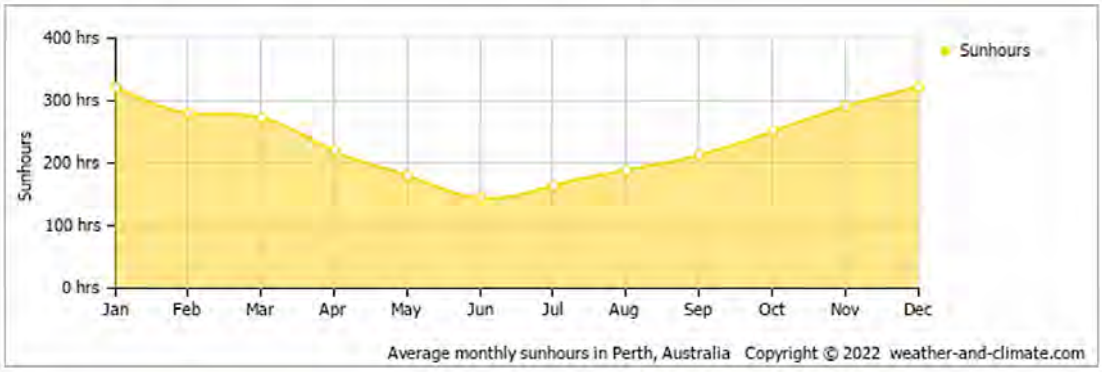


Figure 11: graphs of climate data Upper Swan (Weather and Climate - Australia)

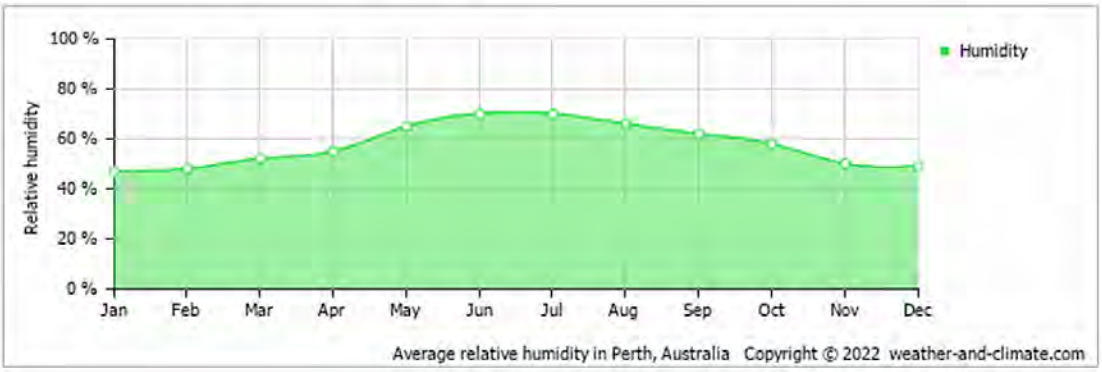
Monthly hours of sunshine

The average monthly total hours of sunshine over the year



Average humidity

The mean monthly relative humidity over the year



Average wind speed

The mean monthly wind speed over the year (in meters per second)

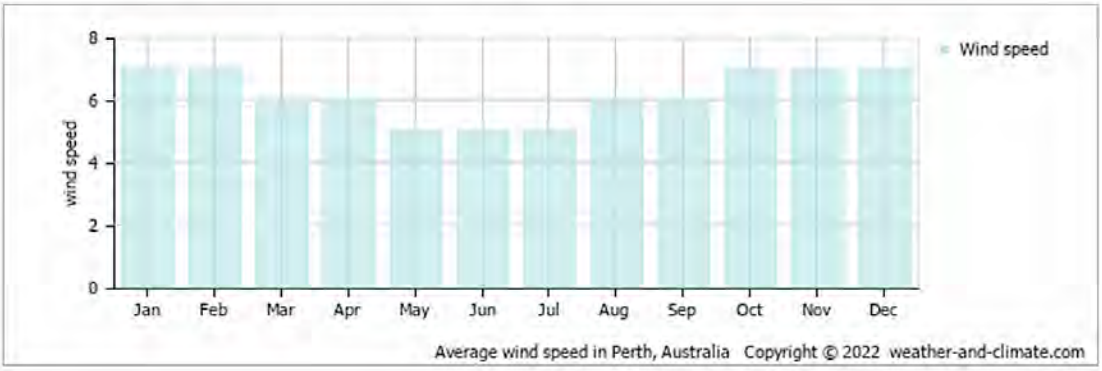
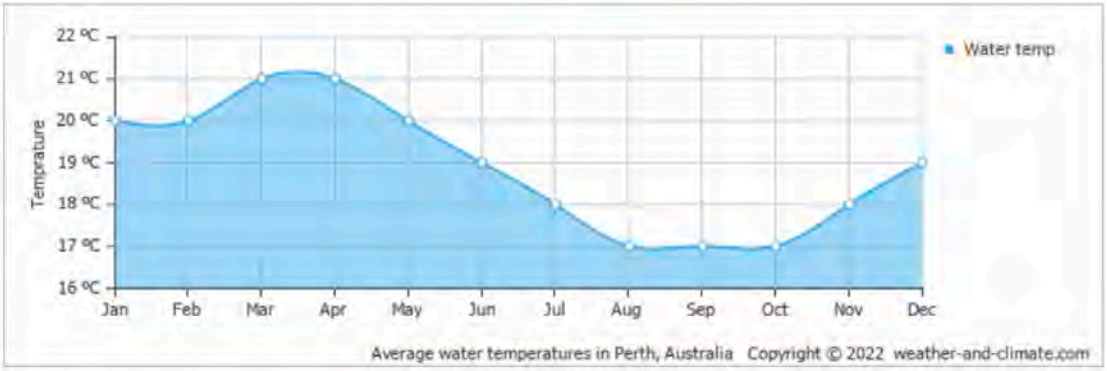


Figure 12: graphs of climate data Upper Swan (Weather and Climate - Australia)

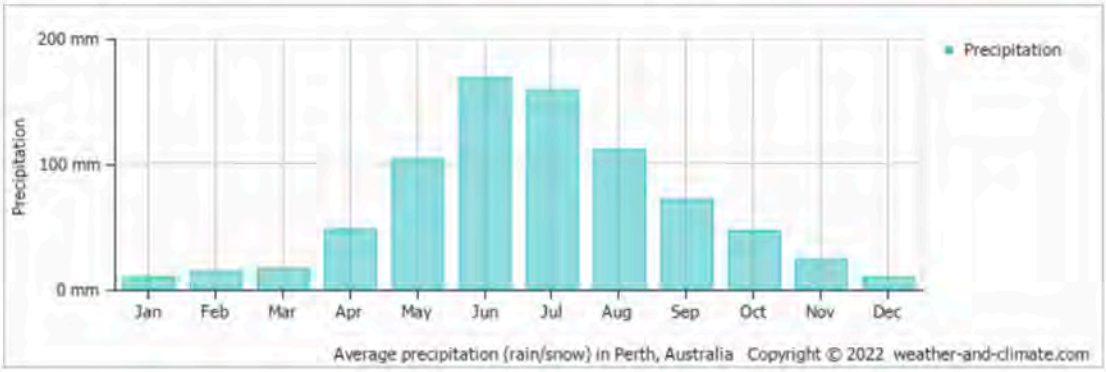
Average water temperature

The mean water temperature over the year. Show in Fahrenheit



Monthly precipitation

The mean monthly precipitation over the year, including rain, snow, hail etc. Show in Inches



Monthly rainy days

The average number of days each month with rain, snow, hail etc.

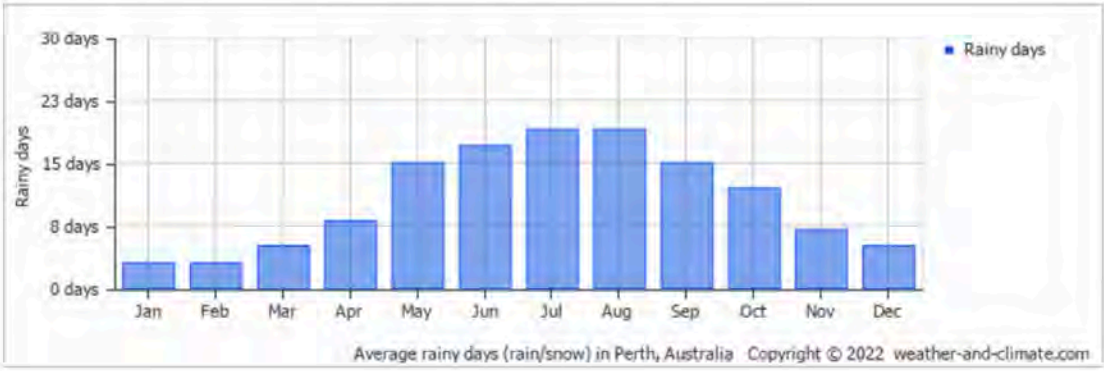


Figure 13: graphs of climate data Upper Swan (Weather and Climate - Australia)

3.0 REGOLITH AND SOIL ASSESSMENT

3.1 Geotechnical Studies

The geology, soils and hydrogeology of the development area and waste water disposal area were assessed by Western Geotechnics in;

> *Perth Geotechnics – Geotechnical study of the Development Area - 5 February 2021 – Attachment 1.*
>
> *Perth Geotechnics – Geotechnical study and Permeability of the Intensive Horticulture Area – 14 October 2021 – Attachment 2.*

In addition, the site was reviewed

Landform Research – Field assessment of Intensive Horticulture Area/Land Application Area – 28 May 2021- Attachment 3

Landform Research - Review of the excavated holes for planting – 21 November 2021

3.2 Geology and Geomorphology

The geology is mapped and summarised in the Perth 1 : 50 000 Perth Environmental Geology Series.

The site lies on the eastern side of the Swan Coastal Plain on sediments of the Perth Basin.

Perth Geotechnics listed the geology as;

> *A review of Environmental Geological Western Australia survey Map of Perth 1:50,000 (sheet 2034II and Part of 2034III and 2134III) revealed that the site is consisted of Pebbly Silt- strong brown silt with common, fine to occasionally coarse grained, sub rounded laterite quartz, heavily weathered granite pebble, some fine to medium grained quartz sand, of alluvial origin, Guildford formation (Qpa).*
>
> *Environmental Geological map of Perth also revealed that the site soil has low permeability, low corrosion potential, medium to high slope stability, medium to high bearing capacity. Near surface water table, prone to flooding, differential settlement of foundations may occur, unless built on columns or concrete rafts above 1 m or compacted sand, dispersive in places.*

Locally the soils are a mixture of alluvial sands, clay sands and sandy clays, normally with an overlying more sandy sequence of upper soil horizons. In some places an intermittent sheet of aeolian sand is present. The soils typically and geologically belong to the Guildford Formation.

A hole drilled for the Perth 1 : 50 000 Perth Environmental Geology is located at Fillip Way near the western edge of the subject land and shows 16 metres of (S8) sand.

The soil test holes on site however show some clay sands and sandy clays and as the site is near the boundary of the alluvial silts and sandy clays (Mgs1) of the Guildford Formation to the east it is likely that those materials underlay the site as evidenced from the soil test holes.

Elevation of the land is around 16.5 metres across Lot 5531 with the addition of some fill in the west and natural soils in the east. Figure 17. Compare Figure 17 to Figure 7 which uses a local datum and therefore the contours on the maps do not reflect AHD.

3.3 Regolith and Soils

Local soil mapping has been completed by the Department of Primary Industries and Rural Development; *Campbell Clause J, and G A Moore, 1991, Land Capability Study for Horticulture in the Swan Valley, DPIRD Land Resources Series No 6.*

All the above soil mapping was completed on the natural soils of the site, generally without drainage or fill and shows the subject land as being of aeolian sandy and miscellaneous soils.

The mapping is early and the naming of soil units has changed since that time. The site is shown as a small area of Valley Complex in the west and Karrakatta Sand on the remainder of the subject land. Karrakatta Sand is a yellow sand with the name now being restricted to yellow sand on limestone well to the west near the coast.

Figure 14: Site photograph of the orchard area/ land application area looking west. Note the existing pasture irrigation.

Site Investigation by Landform Research 28 May 2021 – Attachment 3

From a site examination by Landform Research some of the overlying sand is likely to be imported fill sand.

The soil test holes competed as part of this study show fill sand of 0.0 to 0.4 metres depth over earthy and loamy sands with a base of sandy clay. The overlying sand fill is sandy with pieces of pebble aggregate, brick and other inert materials.

In the north east in hole 2 there is sand to 1.2 metres which likely reflects a deepening overlaying sand layer to the west which matches the Perth 1 : 50 000 Perth Environmental Geology. Attachment 3.

This is reflected in the soil test holes, where the holes conducted by Perth Geotechnics bottomed in sand clay, whereas the soils of the proposed orchard are mostly earthy yellow sands, the earthy properties being due to a small portion of clay which adds significantly to the water and nutrient retention of the soils. Attachments 1 and 2.

Test Hole 4 bottomed in sandy clay at an elevation of 48.8 metres AHD metres suggesting that the sandy clay base is dipping west which matches the local drill hole for the Perth 1 : 50 000 Perth Environmental Geology.

The bore logs provided by Perth Geotechnical show sand over silty sand at 0.3 - 0.6 metres overlying sandy clay in the central and eastern parts of the lot, east from the proposed orchard. See Attachment 3.

Geotechnical Investigation by Perth Geotechnics 5 February 2021 – Attachment 1

Perth Geotechnics listed the soils as;

> *Environmental Geological map of Perth also revealed that the site soil has low permeability, low corrosion potential, medium to high slope stability, medium to high bearing capacity. Near surface water table, prone to flooding, differential settlement of foundations may occur, unless built on columns or concrete rafts above 1 m or compacted sand, dispersive in places.*
>
> *Six (6) Bore Holes (BH1 to BH6) were conducted at the site by using a hand auger to a depth of 1.0 m.*
>
> *Boreholes BH1 and BH6 revealed similar soil profile and consists of 0.0 - 0.7 m: SAND/Gravelly SAND- fine to medium grained, dark grey, grey, yellow, pale brown, brown, yellowish brown, dry to moist, with gravel up to 30 mm (FILL) 0.4 - 1.0 m: Sandy CLAY- medium plasticity, grey, brown, yellowish brow, moist, fine to medium grained sand.*
>
> *Groundwater table was not observed at any of the boreholes up to the investigation depth. BH1 to BH6 were terminated at the target depth of 1.0 m.*

The Geotechnical report for the waste water application area is provided at Attachment 2. Attachment 1 is the geotechnical report for the eastern portion of Lot 5531 for the proposed development but included some soil test holes.

Permeability Tests conducted by Perth Geotechnics 14 October 2021 – Attachment 2.

Six (6) Field permeability tests (FPT1 to FPT6) were conducting by using Guelph permeameter as per ASTM D 5126 – 90 at six locations. The tests were conducted at a depth of 1.0 m below ground level (bgl).

The Guelph Permeameter is a constant head device that operates on the Mariotte siphon principle. It provides a straightforward way of determining the field saturated hydraulic conductivity, matrix flux potential and the soil sorptivity in the field.

The Perth Geotechnics Permeability test report is presented in Attachment 2 and the summary Table below, which is taken from the Perth Geotechnics report.

Table 1: Permeability of the water application area soils

Permeability Test ID	Co-ordinates (GDA94)		Permeability Rate		Soil Description	Test Depth (m)
	Easting	Northing	cm/sec	m/day		
FPT1	404 150	6 475 907	7.3×10^{-4}	0.63	Sandy Clay	1.0
FPT2	404 102	6 475 908	7.5×10^{-4}	0.65	Sandy Clay	1.0
FPT3	404 066	6 475 910	9.3×10^{-4}	0.81	Sandy Clay	1.0
FPT4	404 064	6 475 871	7.8×10^{-4}	0.67	Sandy Clay	1.0
FPT5	404 095	6 475 876	6.7×10^{-4}	0.58	Sandy Clay	1.0
FPT6	404 135	6 475 873	7.5×10^{-4}	0.65	Sandy Clay	1.0

The coefficient of permeability or hydraulic conductivity of the site is varying from 0.58 to 0.81 m/day.

4.0 HYDROGEOLOGICAL ASSESSMENT

4.1 Surface Water.

There have been several site investigations during which the water and hydrology were reviewed.

- *Perth Geotechnics – Geotechnical study of the Development Area - 5 February 2021 (Attachment 1)*
- *Landform Research - Land Capability Study Intensive Horticulture Area – 12 February 2022 (Attachment 3 for soil data)*
- *Perth Geotechnics – Geotechnical study and Permeability of the Intensive Horticulture Area – 14 October 2021 (Attachment 2)*
- *Landform Research - Review of the excavated holes for planting – Field work 21 November 2021*

Even though the land was assessed in Ferbruary and October, by Perth Geotechnics, the availability of surface water can be determined from the location of the on site drains, remnant native and other plant and pasture species which have definite trends in winter wet areas, and examination of historic Google Earth Pro and Nearmap images.

There is no evidence of surface water laying on the subject land over the last ten years. The quality of the pasture and pasture growth over the years does not show any evidence of water logging and there is no current evidence on site.

Water is present in the bottom of the main northern drain in winter, and water was present in some years at lower elevation in the drain to the south east of the subject land as can be seen in the Figure below, which was taken in July 2009 prior to the land being filled.

That water appears likely to be temporarily perched on the less permeable subsoils of the Guildford Formation that occur in the east of the land and to the south. The water represents a temporary winter perched water table and not necessarily the water table.

Prior to sheeting with sand there were two small drains in the south feeding to a small east west drain in the south of Lot 5531.

Elevation of the land is around 16.5 metres AHD on the filled land of the Jujube Orchard, which is consistent with similar elevation on the eastern side of Lot 5531. The site mapping for the development uses a local datum and therefore the contours on the maps do not reflect AHD, therefore interpretations have to be made to convert the local datum to AHD. Figures 17 and 7.

City of Swan drainage shows the northern drain along the north side of the subject land draining east under West Swan Road to the Swan River.

When the planting holes were sunk in July – August 2021 a small temporary shallow pit was excavated along the southern portion of Lot 5531 and can be seen in Figure 8. The hole is shallow and the water lying in it at the time of the photo from August 2021 originates from recent rainfall at the time and inflow of surface water from the south, combined with the lower soil permeability of the underlying sandy clay soils which had permeabilities of 6.7 – 9.3 x 10^{-4} or 0.58 to 0.81 metres per day. Table 1.

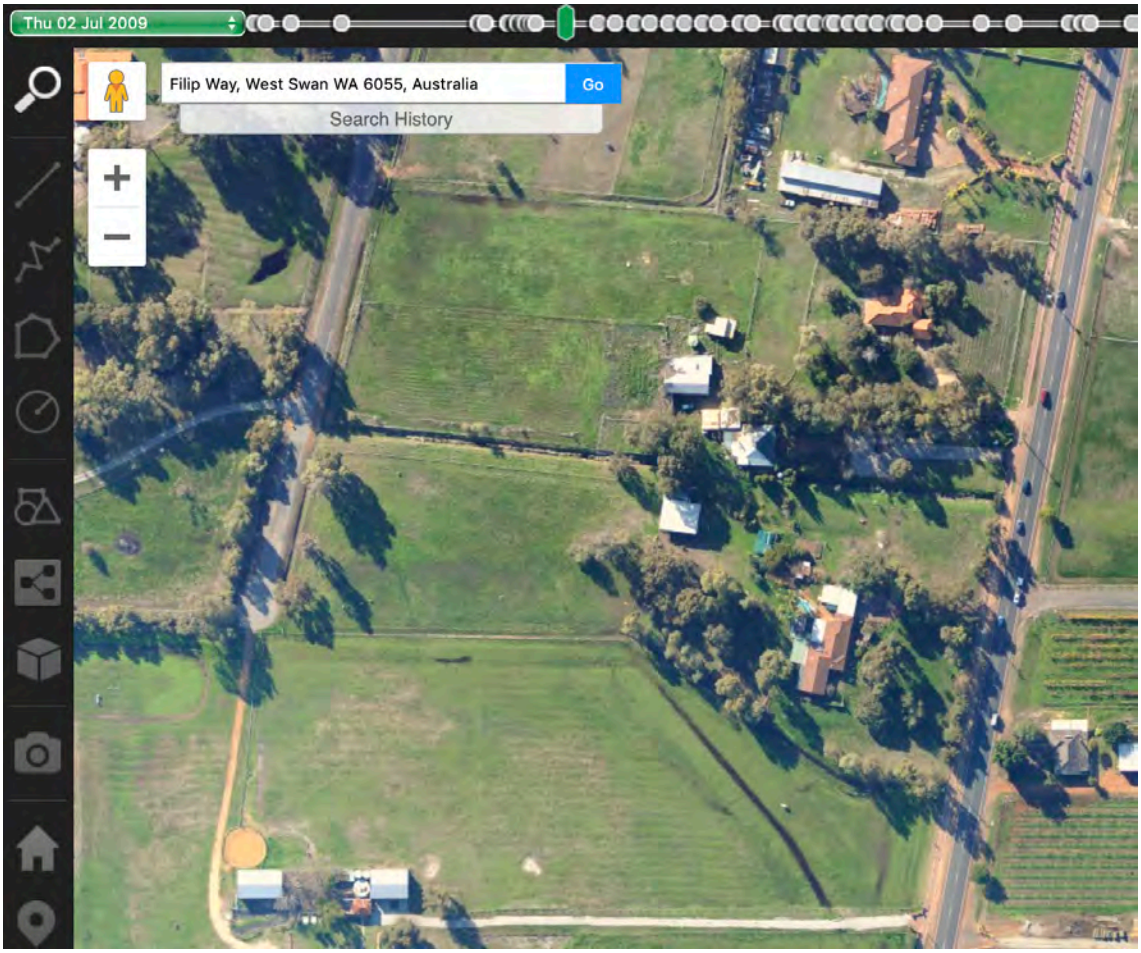


Figure 15: Drains present in winter 2009 prior to fill of the land (Nearmap)

Figure 16: northern drain from Fillip Road (Google Earth)

Soil Permeability

Perth Geotechnics found that the coefficient of permeability or hydraulic conductivity of the site is varying from 0.58 to 0.81 m/day. See Section 3.3 above and Attachments 2 and 1.

Salinity

Water is from precipitation and is fresh. There is a licensed bore on site (5,000 kL) with water suitable for horticulture.

Rivers, Wetlands and Streams

There are no rivers or streams on site although there are some surface drains, cut many years ago.

The main drain runs along the northern side of the subject land, and there are minor drains along the southern boundary and on the property to the south.

None of the drains have wetland vegetation.

Flood Risk

There is no potential for flooding as the land is slightly elevated above the surrounding lands. The surface has been filled by around 500 – 800 mm yellow sand fill and there is a drain extending east west along the northern side of Lot 5531. The drain varies from 1.5 to 2.0 metres below the elevation of the land on Lot 5531. Figure 16 and 17.

The are some lower elevations on the southern edge of Lot 5531.

Wetlands

There are no definitive wetlands on site as the land has been cleared, drained, filled and used for rural purposes.

4.2 Groundwater

Elevation of the land is around 16.5 metres across Lot 5531. Figure 17. Note that Figure 7 uses a local height datum and not AHD. The site mapping in Figure 7 for the development uses a local datum and therefore the contours on the maps do not reflect AHD.

Perth Geotechnics recorded;

> *Groundwater table was not observed at any of the borehole up to the investigation depth of 2.0 m below ground level.*
>
> *A review of the 'Online Perth Groundwater Atlas' of the Department of Water was carried out for this site. "Perth Groundwater Atlas" revealed that natural surface elevation is 15.5 m AHD and annual average groundwater table at 13.0 m AHD. That means depth of the groundwater table is approximately 2.5 m AHD from the ground level. The groundwater level contours are estimated based on the recorded groundwater levels measured in May of 2003 (end of summer). Therefore, accuracy of the data may vary.*

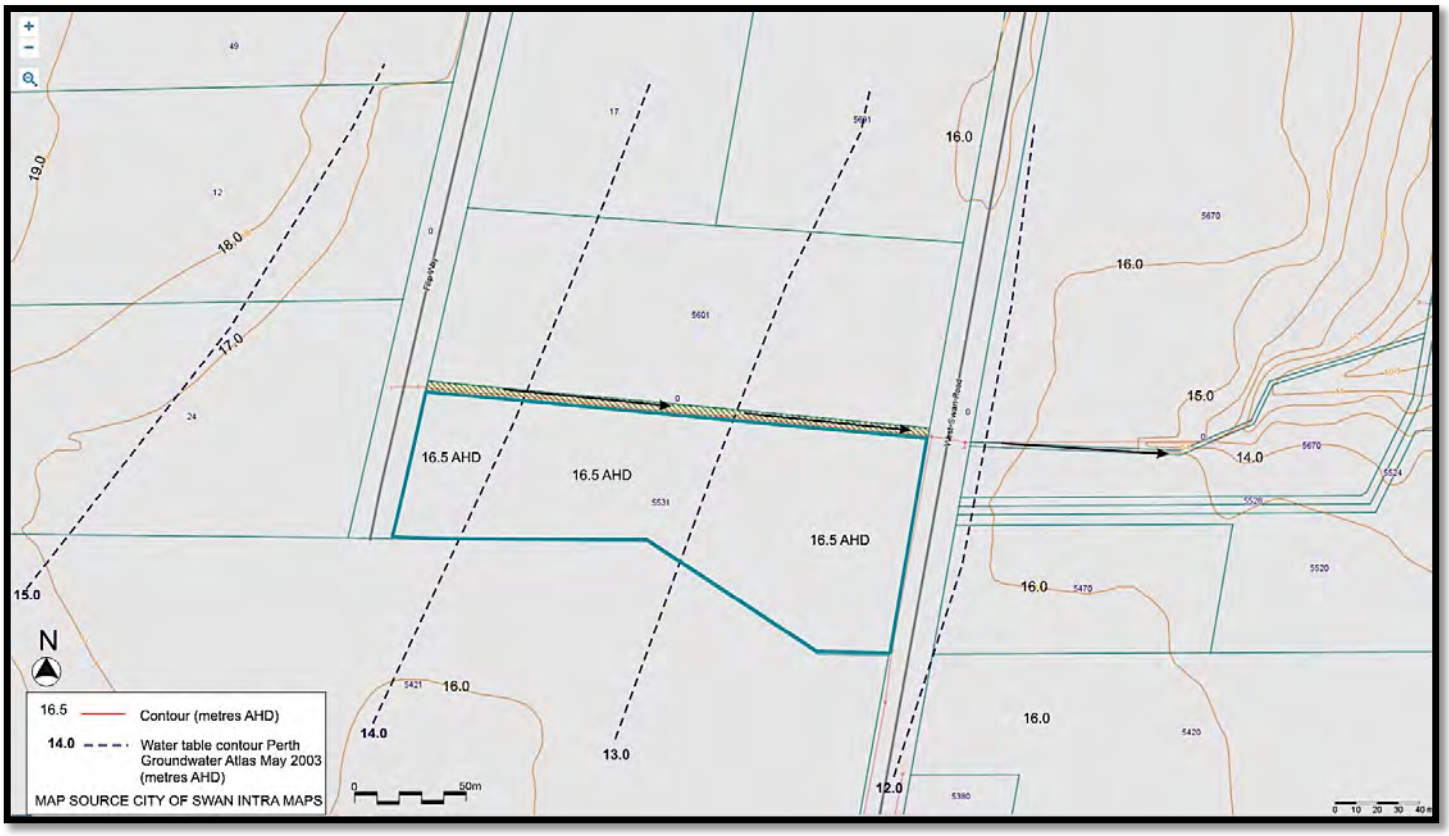


Figure 17: Water table contours May 2003 Perth Groundwater Atlas

The groundwater average depth is listed by Perth Geotechnics as 15.5 metres AHD which is different to the Perth Groundwater Atlas (data May 2003). Figure 17.

The Perth Groundwater Atlas May 2003 shows the water table dropping from 14.5 metres AHD in the north west corner of the lot down to 12.2 metres AHD at West Swan Road. With the land surface of 16.5 metres AHD for the filled land in the western half and the natural soils in the east, that provides for a separation of 2 plus metres on the western boundary of Lot 5531 increasing across the Jujube orchard and waste water disposal area and further increasing to 3 plus metres in the east of Lot 5531. See Figure 17 above.

- ***The separation to groundwater complies with the Guidelines with > 1.5 metres separation to the water table.***

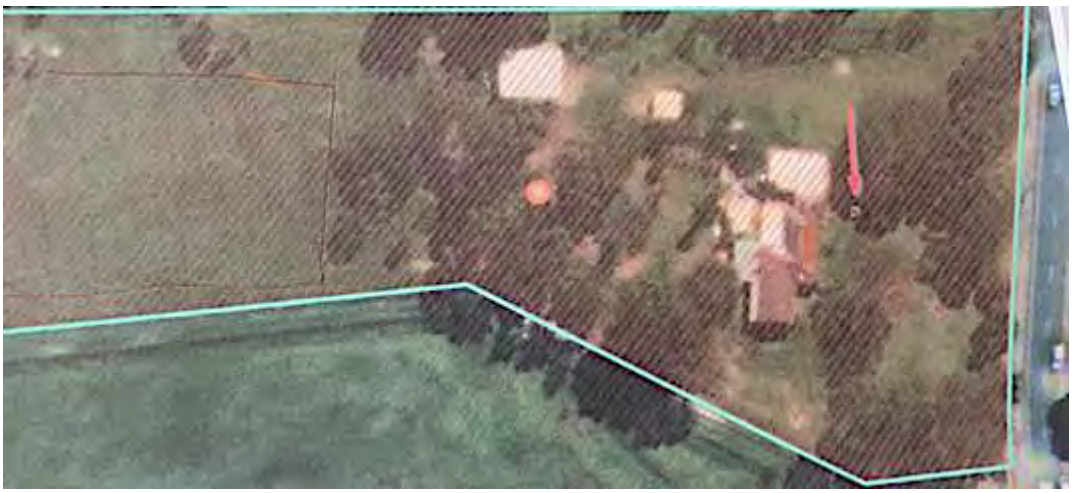
4.3 Water availability

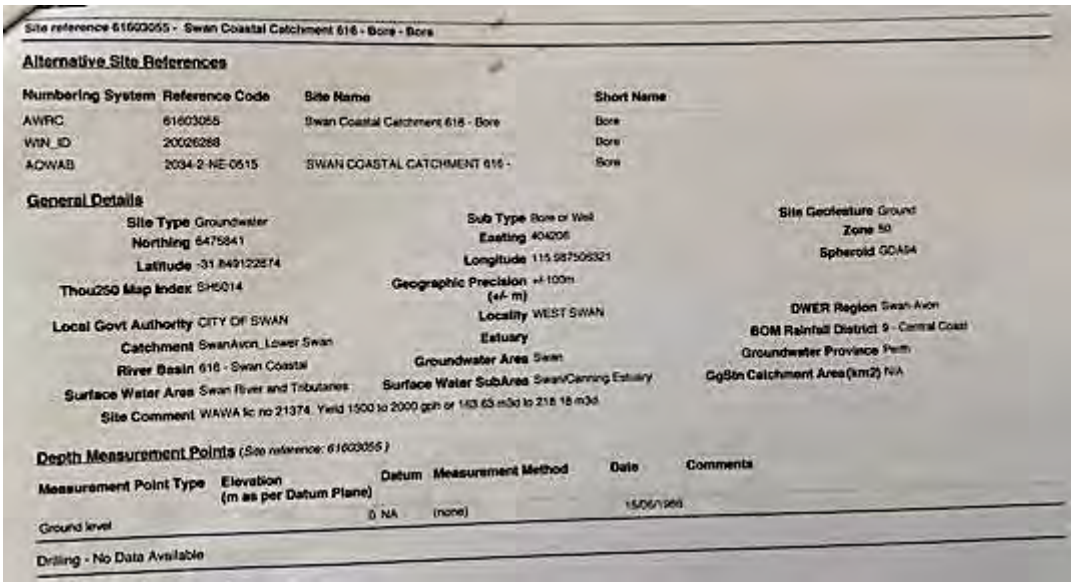
Surface Water Sources

There are no surface water sources of water.

Ground Water Sources - Bore

Groundwater is available and there is a licensed bore on site, licensed for 5,000 kL per year. The bore is located just east of the existing dwelling on Lot 5531.





Site reference 61603055 - Swan Coastal Catchment 616 - Bore - Bore

Alternative Site References

Numbering System	Reference Code	Site Name	Short Name
AWRC	61603055	Swan Coastal Catchment 616 - Bore	Bore
WIN_ID	20026288		Bore
AOWAB	2034-2-NE-0515	SWAN COASTAL CATCHMENT 616 -	Bore

General Details

Site Type Groundwater
Northing 6475841
Latitude -31.849122874
Thou250 Map Index SH5014
Local Govt Authority CITY OF SWAN
Catchment SwanAvon_Lower Swan
River Basin 616 - Swan Coastal
Surface Water Area Swan River and Tributaries
Sub Type Bore or Well
Easting 404206
Longitude 115.987506321
Geographic Precision (+/- m) +/-100m
Locality WEST SWAN
Estuary
Groundwater Area Swan
Surface Water SubArea Swan/Canning Estuary
Site Geofeature Ground
Zone 50
Spheroid GDA94
DWER Region Swan Avon
BOM Rainfall District 9 - Central Coast
Groundwater Province Perth
GgSbn Catchment Area(km2) N/A
Site Comment WAWA lic no 21374. Yield 1500 to 2000 gph or 163.65 m3d to 218.18 m3d

Depth Measurement Points (See reference: 61603055)

Measurement Point Type	Elevation (m as per Datum Plane)	Datum	Measurement Method	Date	Comments
Ground level	0	NA	(none)	15/06/1988	

Drilling - No Data Available

Figure 18: Details of the bore (arrowed)

Whether any additional allocations are available from an addition to the Water Licence or from trading or purchase of an additional allocation may affect the areas and types of land use.

Rain Water

It is possible to generate some additional water by the collection of rainwater, but generally this is not significant. For example a 200 m^2 roof area will generate around 140 kL water per year.

Scheme Water

Scheme water is available at site. It is assumed that sufficient availability can be used to supplement bore water.

It is proposed that the mushroom sticks will be misted with scheme water.

Recycled Water

It is proposed to re-use the waste water collected from the secondary treatment unit. That water will be recycled and used to irrigate the Jujube through subsurface irrigation. The volumes of waste water at maximum loadings are calculated as 7,940 litres/day.

The volume of water available will be determined by the number of land uses on site. Development will be progressive with the first activities being the orchard and mushroom greenhouses.

Types of land uses - requirements

The developments will be supplied with scheme water.

The Jujube orchard will utilise recovered waste water, backed up by bore water.

As noted above the volume of water available will be dependent on the number of land uses operating.

The first activities will be the orchard and mushroom greenhouses.

It is only when the restaurant/café and chalets are in operation that the volume of waste water will increase and be available for irrigating the jujube orchard. Prior to that time the orchard will be irrigated by bore water.

5.0 PROPOSED LAND USES – WATER MANAGEMENT

5.1 Proposed Land Uses

The proposed land uses are;

Agricultural - Intensive	8,500m^2	Primary Production and includes the below;
Incl. Orchard	*~5,800m^2*	*Primary Production – Fruit Trees*
Incl. Mushroom Greenhouses	*~510m^2*	*Primary Production – Mushrooms*
Incl. Warehouse	*~400m^2*	*Sorting / Processing of Produce*
Incl. Existing Shed	*~180m^2*	*Storage of tools and equipment*
Chalets or Cabins	6 chalets	75m^2 and 2 bedrooms each
Restaurant	294m^2	96-person maximum capacity
Single House (Existing)	220sqm	Retained Dwelling

5.2 Proposed Staging

Stage 1	Plant the intensive orchard and mushroom greenhouses
Stage 2	Installing the warehouse and the storeroom
Stage 3	Installing the restaurant and chalets with associated waste water recovery

5.3 Water Use - Loading

The water use/loadings are calculated at maximum rates according to AS/NZ 1547 and Department of Health Western Australia Guidelines as;

Chalets or Cabins	6 chalets	75m^2 and 2 bedrooms each Maximum loading 6 chalets x 4 persons x 150 L = 3,600 L/day
Restaurant	294m^2	96 person maximum capacity 96 persons x 30 L= 2,880 L/day 4 staff x 70 L = 280 L/day
Single House (Existing)	220sqm	Retained Dwelling 5 persons x 150 L = 900 L/day
Staff associated with horticulture		4 persons x 70 L = 280 L/day
TOTAL DAILY LOADING		**7,940 L/day**

Proposed Commercial ATU Aquarius O-2NR10KL with a capacity of 10,000 litres per day.

5.4 Requirements – Jujube Intensive Horticulture

Jujube Horticulture

The Department of Primary Industries and Regional Development has produced a summary of the industry for Jujube growing in Western Australia, that provides a good summary of the nature of the fruit, its growth habits and management and the uses and markets for the fruit. DPIRD 2020, Jujubes in Western Australia, DPLH Website. The website provides good documentation and includes the following introductory notes in italics.

Printed from The Chinese jujube (DPIRD 2020)

> *The Chinese jujube (Ziziphus jujuba Mill.) is one of the most important fruit crops in China and has been commonly used as a traditional Chinese medicine and food for thousands of years. The jujube is widely grown in China with cultivation records going back more than 3000 years and can also be found in neighbouring countries.*
>
> *The jujube is a medium-sized tree, growing 7–10 metres high. The tree has shiny deciduous foliage and produces a fruit that is known as a drupe.*
>
> *The fruit varies in size depending on the cultivar, and it has a thin, dark red skin surrounding a sweet, white flesh. The fruit is very nutritious with potassium, phosphorus, calcium and manganese being the major mineral components, as well as iron, sodium, zinc and copper.*
>
> *The jujube is a rich source of vitamin C and B-complex. The vitamin C content is higher than other fruits which are well known for high content such as oranges. The antioxidant capacity of fresh jujube is also relatively high compared with other vegetables and fruits.*
>
> *Jujube fruits are eaten fresh, dried or processed as 'Chinese dates' which have been used in confectionery such as breads, cake, candy, compote and jam.*
>
> *In Western Australia, jujubes are grown in the Perth Hills, the northern Rangelands, the South West and Great Southern regions. Jujubes are also grown in Victoria, South Australia New South Wales, Queensland and the Northern Territory.*
> *Small quantities of jujubes are sold at local markets and some Asian supermarkets in Perth.*
>
> *Western Australia's proximity to South East Asia and its counter-seasonal production to the northern hemisphere provides an opportunity to market product for the increasing demand, especially during festivals. Target markets include China, Singapore, Malaysia, Hong Kong and Taiwan.*
>
> *The jujube industry in Australia has potential to be a new profitable agricultural business to meet the requirements of domestic and overseas markets.*

Jujube are also grown as dense plantings in rows where with pruning heavy cropping can develop very quickly over a few years. For the intensive Jujube production on Lot 5531 the spacings are to be in rows 2 metres apart with 2 metre spacings and pruned to a height of 2 – 3 metres. Figure 8.

Climate and Nutrient Requirements

Printed from The Chinese jujube (DPIRD 2020)

Jujube trees have a lower water requirement and higher salt tolerance than most fruit crops. Under natural conditions the tree forms a deep and substantial taproot making it drought tolerant. Jujube trees grow best in climates with a long, hot, dry summer after adequate rain early in the season and cool temperatures during its dormancy. In Western Australia, jujubes are grown in areas with around 200–1000 mm annual rainfall.

Studies from China suggest the chilling requirement depends on the cultivar and can range from 775 to 1737 hours at less than 7.2°C. However, areas in WA where jujubes are grown are somewhat lower than this range, yet flowering and fruit set occurs. There is perhaps more to be understood regarding the true chilling requirement for Chinese jujubes under Australian climatic conditions but low to medium chill varieties would be best suited to WA.

Fruit set requires average daily temperatures above 20ºC. Fruit development requires average daily temperatures over 24–25ºC.

Jujubes grow well on a variety of soils. The tree prefers sandy loams or lighter soils but will grow on heavier clays. The jujube tree can tolerate saline, alkaline or slightly acidic soils but grows best in soil with pH 4.5–8.4.

Natural growing conditions of jujube in China

Condition	*Value*
Annual average temperature (ºC)	*5.5–22*
Average temperature of flower season (ºC)	*≥22–24*
Minimum temperature (ºC)	*≥ minus 38.2*
Frost-free period (days)	*≥100*
Annual rainfall (mm)	*87–2000*
Annual sunshine (hours)	*≥1100*
Soil depth (cm)	*≥30*
Soil pH	*4.5–8.4*
Soil NaCl (%)	*≤0.15*
Soil Na2CO3 (%)	*≤0.3*
Soil Na2SO4 (%)	*≤0.5*

DPIRD 2020 notes that;

Prior to planting, pits of 0.6–1m cubed are dug at appropriate distances depending on orchard density. The pits are filled with original soil mixed with manure, superphosphate and trace elements. Transplanting trees in the field is most successful just prior to bud burst.

Jujube orchards in WA will need a balanced nutrient program supplying nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg) and trace elements at rates depending on soil fertility, tree age and cropping levels. With deciduous orchards the best time to apply the main annual dressing of NPK is in early spring.

The site has already been prepared by drilling the holes in preparation for planting and shown by Figure 8.

5.5 Planting and Irrigation – Jujube Intensive Horticulture

Planting the Jujube Orchard

The agricultural use of the site will occupy approximately 8,300sqm of the site and will be located at the rear half of the site. Most of this area will be used as open orchards for Jujube production with two mushroom greenhouses located in the centre of the site.

The open orchard is approximately 90m deep by 60m wide and will consist of approximately 600 trees initially, spaced 2m apart across 30 rows. That equates to around 3,000 m^2.

It is proposed to add further trees to up to 1,000 trees on an area of around 5,000 m^2 later in the buffer areas and edges. Compare Figure 8 for the initial planting compared to Figure 3 which shows additional ground that can be planted.

For waste water re-use for irrigation an area of 3,000 m^2 will be set aside.

The proponent has already prepared planting sites across 3,000 m^2 of the orchard area with space for around 600 trees. The drilled planting holes can be seen in Figure 8.

Figure 19: Potted Jujube trees waiting to be sold (Source - Mid Valley Trees)

The Jubjube orchard will be planted in a similar manner.

Figure 20: Fruiting Jujube (Source – Flower Pictures)

Irrigation Requirements

For irrigation DPIRD 2020 notes;

Although jujube trees can survive with very little water, irrigation is an important factor to produce a good yield of quality jujubes. Irrigation scheduling has a direct impact on tree health and fruit yield, size and quality. Without correct scheduling an orchard is more susceptible to nutrient deficiencies, physiological disorders, pests and diseases.

Soil characteristics will influence the type and timing of your irrigation program. Moisture will drain towards the root zone and plant utilisation and water use efficiency will depend on how long it is held there.

The location has around 0.8 ha and 5,000 kL irrigation reliable rainfall of around 800 mm and with the nature of the soils, it is likely that alternative land uses will be based on irrigated agriculture.

The trees require approximately 3–8 megalitres per hectare (ML/ha or 3,000 – 8,000 kL per hectare) over the growing season, depending on site specific soil and climate.

For the currently prepared site of 3,000 m^2 the water use requirement will be 1, 000 – 2,400 kL per year, well within the capability of the bore allocation of 5,000 kL per year. Even with an expansion to 5,000 m^2 of planting the bore water requirement will be a maximum of 4,000 kL per year.

In addition the recovered waste water will be used for irrigation of the trees which will reduce the draw on the bore and reduce the amount of fertiliser requirement.

DPIRD notes that micro sprinklers are a good option for tree crops such as jujubes. They noted that compared to larger sprinklers they are efficient, saving water by only watering the ground under the trees and not the inter-rows. They work on lower pressure and are cheap to run. Trickle and drip irrigation are efficient, economical systems that are well suited to jujubes.

The proposed methods of irrigation will be in two sections depending on the source of the water.

As the waste water disposal area in the orchard will only be required when the restaurant and chalets are in use, initially only bore water will be used during the establishment of the orchard, and microsprays or drippers will be used.

During the later stages of development, when the restaurant/café and chalets are constructed, waste water will be used for irrigation to supplement the bore water and provide nutrients.

Water Volumes Available from Recovered Water

Whilst the maximum available water is 7,940 Litres per day, that volume of water is not likely to be available as the loadings will not be at peak. For example the loading for the chalets is likely to average 3 persons and not every night of the year. Similarly the restaurant/café will not be at capacity every day and as the development is constructed in stages the loadings and available recovered water will increase over a two year or longer time period.

For the soils on the Jujube orchard an Irrigation Application Area of 2,646 m^2 is required. An Application Area of 3,000 m^2 is provided which is excess of what is required. With 600 trees per 3,000 m^2 that equates to the Irrigation Application Area having 529 trees at the maximum development.

Even at full tourist loading the available waste water is anticipated to be around 50%– 60% of the maximum loading or around 4,500 L/day (4.5 kL/day) which is equivalent to 1,642.5 kL per year. That compares to the volume of waste water available under maximum loading of 2,898.1 kL per year.

That is, for the currently prepared site of 3,000 m^2 jujube horticulture, the water use requirement will be 1, 000 – 2,400 kL per year based on Jujube requirements which encompasses the range of waste water realistically available of 1,642.5 kL per year. At that volumes some additional top up irrigation from the bore will be required.

As irrigation is required mainly in Spring to Autumn inclusive the anticipated volume of recovered water will be able to supply the required irrigation requirements, with sufficient flexibility to use the bore to top up as necessary.

However even at the maximum design waste water loading of 2,898.1 kL per year that volume of water can be accommodated on the area of orchard allocated for Irrigation Application Area and would not be excessive to the Jujube.

Recovered water, which is excess of the plant requirements will add to the soil groundwater loadings and join the normal groundwater regime on the land with drainage to the natural and constructed drains. The setbacks of the orchard from the drains will provide sufficient detention time for treatment of the waste water by soil microorganisms.

At the maximum design waste water loading of 2,898.1 kL per year, a soil loading of 3 L/m^2 will result, which equates to 3 mm rainfall.

That is, even in winter if the recycled waste water is not required by the plants the addition to soil moisture is not significant at the equivalent of 3 additional mm of rainfall per day. Note that it anticipated that the loadings will not be at maximum every day and will build up over the staging of the development. Further it should be noted that the irrigation water will be added to only a small portion of Lot 5531.

Therefore a more realistic additional loading is equivalent to 2 additional mm of rainfall per day and even 1 mm precipitation equivalent in the early stages of the development.

- ***The anticipated volumes of waste water available for irrigation of Jujube is similar to or below the requirements for the orchard in the Application Area and will need topping up by bore water.***

- ***The application of waste water on Lot 5531 represents an insignificant amount of additional water to site of predicted equivalent to 1 mm rainfall daily.***

Application of Recovered Water

The use of recycled waste water is described in *Department of Health 2011, Guidelines for the Non-potable Uses of Recycled Water in Western Australia*. For recovered waste water the water is to be sourced from systems that feature secondary treatment and must only be used where there is a low risk of contamination.

For a perennial crop such as Jujube the waste water will be available through an underground delivery system with no water able to access the surface. The waste water reuse area will be dedicated to ensure there is no contact between the fruit and the water, the recycled water is not able to access the surface of the soils and there are restrictions to access, and management plans are in place. These are all proposed for the reuse of waste water and are described in the Risk Assessment for waste water re-use conducted to Department of Health Guidelines and included in the documentation for the Treatment of Waste Water.

There is also the potential for above ground sprinklers if required. Their use will require ozone treatment in the Aquarius ATU which is therefore considered in the review.

The timing of the irrigation will be developed to;

- Maintain adequate water during the year,
- Maintain normal and optimal growth patterns,
- Integrate with weather conditions,
- Integrate the recycled water to manage nutrient input to the plants based on soil, water and plant testing,

The proposed irrigation regime is consistent with DPIRD 2020 suggestions

A Risk Assessment for the Jujube Intensive Horticulture has been completed. Management is suggested to manage any risks and will be developed prior to commencement of the waste water system.

Nutrient Applications

It is anticipated that both recycled waste water and bore water will be used to manipulate the nutrient applications.

Aquarius waste water systems have been designed, and approved by the Department of Health WA to have a minimum of < 1 mg/L TP (phosphorus) and < 10 mg/L TN (nitrogen). Nitrogen is readily denitrified by soil microbial material in loam soils under anoxic conditions and taken up by plants.

For the maximum recycled water loading the Irrigation Application Area of 2,646 m^2 is required, which at the planting ratio equates to the irrigation of recovered water on 529 Jujube trees at maximum loadings or 2,898.1 kL per year / 529 trees = 5.47 kL per tree per year at maximum loading, which is not likely to be reached.

If maximum loading was reached and if the water contained the maximum permitted Nitrogen and Phosphorus the nutrient loading would be 1 mg/L TP x 1000 x 5.47 kL = 5,470 mg/P or 5.47 grams of TP per tree.

For nitrogen the maximum amount of nitrogen applied per tree is 54.7 grams TN per tree.

Those figures are within the realm of fertiliser requirements for each tree. Even so the total nutrient loadings are never likely to be reached and additional nutrients will need to be added especially as the Jujube are cropping trees and nutrients are removed annually through the fruit and prunings.

The nutrient levels in the recovered water therefore provide the ability to measure the actual loadings by analysis of the recycled water and then to calculate the amount of top up nutrients that are required.

That method ensures that there are no excess nutrients applied and that nutrient loss or export is unlikely.

Behaviour of Nutrients not utilised by Plants

- **Phosphorous**

Phosphorous is readily adsorbed onto clay and sesquioxides of the subsoils, loams and yellow sands. The soils on site, with their loam nature and increased clay content in the subsoils, have inherently high phosphate retention capability if the waste water enters those soil profiles.

Nutrient adsorbing waste water systems such as the Aquarius system utilise alum dosing to reduce phosphorus export.

Some indication of the improvements to the quality of the waste water leaving the waste water disposal area of nutrient adsorbing waste water systems in sites where phosphate retention is naturally low. The proposed ATU systems typically reduce the phosphorus by up to 98.55% phosphate adsorption with the Jujube orchard and then the loam – clay soil providing the remaining adsorption.

Phosphorus adsorption is dependent on the retention times within the soil to enable sufficient time for adsorption ono the clays and sesqioxides. The setbacks and buffer distances which relate to lateral soil moisture times provide sufficient time for this adsorption to occur, with the setbacks available being much greater than the minimum requirements.

The risk from phosphorous is therefore not regarded as a significant issue and there should be nil or minimum phosphorous added to the ground water.

- ***The amount of Total Phosphorus TP in the waste water will only form part of the nutrient requirements of the Jujube orchard. That combined with the soil characteristics will ensure no excess phosphorus export.***

- **Nitrogen**

Nitrogen is a prominent part of living matter and is constantly recycled through the organic matter and the atmosphere.

Nitrogen as ammonia in waste water is rapidly converted to nitrite and then nitrate under the influence of oxygen which occurs in the anaerobic tank followed by the aeration tank. The proposed Aquarius system is capable of removing 97.8% total nitrogen prior to release of water from the system.

Any nitrogenous products remaining in the irrigation water will be taken up by the Jujube orchard.

Soil microbes rapidly colonise the interface where waste water contacts the soil, with small amounts of organic matter at the interface providing the energy to sustain the microflora. Nitrates are normally removed by soil micro flora under anoxic conditions in the soils including leached white sands. The microflora remove the oxygen to leave nitrogen gas, which is lost to the atmosphere. Inorganic nitrogen can also attach to clay particles.

If any nitrogen remains it will be denitrified by bacteria under wet and anoxic soil conditions or lost through volatilisation of ammonia or the conversion of ammonia to soluble nitrogenous ions.

Nitrogen is also held within the soil organic matter and some ions are attached to clay particles. When organic matter breaks down or fertiliser is applied and not taken up by plants, nitrogen is converted to ammonia or rapidly converts to nitrite and then nitrate under the influence of oxygen.

Nitrogen loss relates to retention times within the soil and microbial activity so the water is retained in the soil for sufficient time for denitrification. The setbacks and buffer distances which relate to lateral soil moisture times provide sufficient time for this to occur, with the setbacks available being much greater than the minimum requirements.

Many studies, for example Dawes and Goonetilleke, 2001, have found that nitrogen is readily stripped from waste water released from a waste water disposal area. For example on a sloping sandy loam site in Brisbane the water entering the trenches had a concentration of 171 - 190 mg/L N but within 1 metre of the last trench the nitrogen concentration had dropped to 1.7 to 3.7 mg/L.

Gerritse et al, 1995, recorded a total of 140 mg/L nitrogen (NH4 - 100 mg/L and N02 - 40 mg/L), exiting a leach drain. After a travel distance through shallow soils of 1 metre this had dropped to between 20 and 100 mg/L, and by 3 metres the total nitrogen had dropped to 0.03 to 0.2 mg/L. When loaded with nitrogenous compounds the microflora of soils quickly adjusts to the loading, by increases in the number and type of bacteria.

Nitrogen loading is therefore not regarded as a significant issue for nutrient adsorbing waste water systems.

- ***The amount of Total Nitrogen TN in the waste water will only form part of the nutrient requirements of the Jujube orchard. That combined with the soil characteristics will ensure no excess nitrogen export.***

- **Microbial Purification**

Microbial material from stock or waste water systems can present a health hazard unless the material is deactivated by normal soil microbial organisms. Microbes could consist of thermotolerant bacteria, viruses and other organisms. For deactivation to occur sufficient dilution and retention time in the soils or other media are required which is completed in the design and operation of the Aquarius system with the anaerobic and aerobic tanks and bacterial breakdown of organic matter within the tanks.

The Department of Health, Specification for Aerobic Treatment Units (ATU'S) Serving Single Households (Health Department), shows that the average BOD released from a nutrient adsorbing system should be <20 mg/litre, prior to on ground disposal, < 30 mg/L suspended solids and < 10 *E.coli*/100 ml.

When below ground application of the reused waste water is used no additional sterilisation of the waste water is required. However if above ground irrigation is to be used the Aquarius system will be installed with an ozone treatment system to provide sterilisation and deactivation of microbial material.

Should any microbial material survive these processes the soil microbial activity will deactivate those organisms surviving the ATU unit. The organisms entering the Aquarius ATU unit are thermo tolerant and normally require body temperatures to survive or live.

The soil conditions are much colder and any such micro-organisms that survive the ATU and enter the soil will be attacked and deactivated by the soil microflora.

Again the setbacks and buffer distances relate to the retention times in the soils to enable deactivation of any microbial material from within the waste water. Those times relate to lateral soil moisture times and provide sufficient time for this to occur, with the setbacks available being much greater than the minimum requirements.

- ***The Treatment Provided by the Aquarius Commercial ATU O-2NR10KL provides for sufficient treatment of organic and microbial material and when combined with the treatment available in the natural soils will mitigate any microbial risks if the systems are correctly installed and maintained. The use of ozone treatment remains an additional means of sterilisation and management.***

Staging of the Intensive Horticulture and Tourist Development

As the first stage of the development is the planting of the Jujube orchard and establishing the mushroom greenhouses there will be no waste water available for re-use on site.

Mushroom production will use scheme water to minimise risk of cross contamination from waste water or the introduction of micro-organisms through the bore water.

Therefore in the initial growth stages of Jujube production bore water alone will be used for the irrigation of the production trees. During that time the existing waste water system attached to the current dwelling on site will remain operational.

It is anticipated that it will take around two years to progressively construct the chalets and the restaurant/café. Once constructed it is anticipated that there will be a lead in time for the tourist facilities to reach their maximum occupancy – activity. Even so it is likely that there will be only some times of the year of peak capacity when the maximum waste water recovery and re-use volumes will be available.

At other times the use and production of the volumes of waste water available is anticipated to be around 50% to 60% of maximum capacity. This is because the design of the systems are to maximum loadings which are not often likely to be reached, with the average chalet occupancy being 3 persons based on one or 2 couples per unit, the restaurant not operating every day or not to capacity on all days and the design loadings being based on the maximum water use which is not often reached for individual use.

Therefore the Jujube orchard will commence with using bore water and then over a period of 2 – 3 years recycled waste water will be available for irrigation. The waste water will progressively replace the bore water for irrigation and also the fertiliser application of phosphorus and nitrogen.

The holes for the initial planting of the Jujube orchard are already in place in preparation for planting. When recycled waste water becomes available it is be retrofitted as subsurface irrigation. Being subsurface there will be no need for sterilisation of that waste water. From the *Department of Health Guidelines for the Non-potable Uses of Recycled Water in Western Australia* the use of underground drippers for perennial horticulture orchard would fall under a "Low" Risk.

On the other hand if there are difficulties in retrofitting underground irrigation of the recycled waste water, a sprinkler irrigation system for the reuse of the waste water will be considered through the fitting of an ozone sterilisation unit to be added to the Aquarius waste water recovery and re-use system. Under the *Department of Health Guidelines for the Non-potable Uses of Recycled Water in Western Australia* the use of above ground sprinklers for perennial horticulture orchard would fall under a "Medium" Risk.

Retrofitting of above ground sprinklers and the ozone sterilisation system, combined with additional monitoring and biosecurity measures, will negate sterilisation of the waste water combined with additional biosecurity measures as outlined in Section 7.0 Risk Assessment.

- ***Staging of the development means that waste water will be progressively introduced as irrigation to the Jujube orchard over the first 2 – 3 years providing monitoring and updating as the developments, systems and waste water become available.***

6.0 PROPOSED WASTE WATER RECOVERY SYSTEM

6.1 Proposed Water Recovery System

Loading and Waste Water Unit

The proposed land uses provide for a maximum of 7,940 litres per day of waste water that can be recovered when the proposed development is constructed and at full loading.

Chalets or Cabins	6 chalets	75m^2 and 2 bedrooms each Maximum loading 6 chalets x 4 persons x 150 L = 3,600 L/day
Restaurant	294m^2	96 person maximum capacity 96 persons x 30 L= 2,880 L/day 4 staff x 70 L = 280 L/day
Single House (Existing)	220sqm	Retained Dwelling 5 persons x 150 L = 900 L/day
Staff associated with horticulture		4 persons x 70 L = 280 L/day
TOTAL DAILY LOADING		**7,940 L/day**

A Commercial ATU Aquarius O-2NR10KL with a capacity of 10,000 litres per day will be used.

As noted previously the maximum available water of 7,940 Litres per day is not likely to be available as the loadings will not be at peak. A waste water Application Area of 3,000 m^2 is provided, in excess f the required 2,646 m^2.

For example the loading for the chalets is likely to average 3 persons and not every night of the year. Similarly the restraurant/café will not be at capacity every day and as the development is constructed in stages the loadings and available recovered water will increase over a two year or longer time period.

All waste water will be directed to an Aquarius Commercial Waste Water System, capable of handling 10,000 litres of waste water per day.

Aquarius recommends the use of a 10,000 litre per day system because their smaller system has a capacity of 8,000 litres per day and the loading is close to that capacity. The system will be designed to AS/NZ 1646.3 and is approved by the Department of Health Western Australia.

Aquarius is a wholly owned Western Australian Company who operates from Osborne Park. The unit was chosen because of local manufacture, installation and maintenance which will make for a more efficient unit.

Details of the Proposed Treatment Unit

Considering the soils and depth to the water table, concrete strapped tanks are recommended and are proposed. See Figures 20, 21 and 22.

Table 2: Details of the Aquarius O-2NR 10kL

SPECIFICATION	EXPLANATION
Proposed System	Aquarius Commercial Alternative Treatment Unit. Aquarius O-2NR10KL with a capacity of 10,000 litres per day. Figures 20, 21 and 22.
Primary Tank	Retains the solids and uses aerobic and anaerobic bacteria to breakdown the BOD levels in the sewage. Tanks are proposed to be concrete strapped to better manage the soil conditions. Figure 20 and 22.
Secondary Tank	Additional treatment capacity. Retains the solids and uses aerobic and anaerobic bacteria to breakdown the BOD levels in the sewage.
Treatment Tank Aeration Chamber	Incorporates aeration to further break down BODs, and nitrates. Clarifying Chamber. Figure 20. The Clarifying Chamber provides a settling and clarifying period for the water prior to discharge. Discharge Chamber The Discharge chamber contains the Discharge Pump to pump the treated water out to irrigation or other disposal methods.
Alum Tank	Doses the Clarifying chamber of the Treatment tank with Alum. Alum acts as a flocculent to remove the nutrients and suspended solids and settle them to the bottom of the tank for further aerobic bacteria breakdown. Figure 20.
DoH WA ATU Water Quality Criteria	<20mg/L BOD <30mg/L suspended solids <10 E.coli/100ml >3mg/L Ozone concentration <1mg/L (98.5%) TP (% removal) <10mg/L (97.8%) TN (% removal)
Ozonation Pump	Ozone is a powerful disinfectant, many times more effective than chlorine and kills all bacteria. An Ozonation Pump is an additional option available to further increase the efficiency of the unit by sterilising the water to enable it to have even lower risk of microbial material. As the orchard is to be established as the first stage of the development, using recycled water to replace the bore water will be introduced progressively. The ozone unit will be used for any above ground application or waste water and as an additional biosecurity for below ground re-use of waste water.
Water irrigation Area	The area required at maximum loading is 2,646 m^2. A 3,000 m^2 Irrigation Application Area has been allocated to allow for the water disposal with further area available if required.

Water Re-use	The water will be used to irrigate Jujube orchard by underground drippers. This will ensure that there is no contamination of the fruit or surface soils by microbial materials. The water recovered will be used as the primary source of irrigation water for the Jujube intensive horticulture, a perennial fruit crop. Additional water for horticulture will be supplied by the existing bore on site. Nutrients within the recovered waste water will be regularly assessed and used as the primary source of nutrients for the Jujube horticulture. Additional nutrient will be added to the plants as required to top up the fertiliser to the optimum plant requirement.

- ***The design capacity of the Commercial ATU Aquarius O-2NR10KL is 20% in excess of the required waste water at maximum loading.***
- ***The waste water Application area is 11% larger than required and can be expanded if required.***

Buffers and Setbacks

Table 3: Setbacks and Buffers to waste water

BUFFER - SETBACK	REQUIRED	AVAILABLE - PROPOSED
Separation to Groundwater	0.6 metres – 1.5 metres for sewerage sensitive areas	The site is away from Sewerage sensitive areas which for the Swan Coastal Plain relate to areas where water can drain to estuaries. Perth Groundwater Atlas May 2003 shows the water table dropping from 15.5 metres AHD in the north west corner of the lot down to 12 metres AHD at West Swan Road. That provides for a separation of 1 plus metres on the western boundary of Lot 5531 increasing across the Jujube orchard and waste water disposal area and further increasing to 3.5 metres in the east of Lot 5531. That means that the separation to the water table is around 1.5 metres, increasing to the east of Lot 5531. The depth to groundwater can be checked from the drain along the north of the property where the water is present at the base of the drain and the drain is around 1.5 – 2 metres from the filled surface. In winter the drain has water only flowing in the base of the drain.
Distance to Bore - to land application area	30 metres	The bore is located at the eastern side of the existing dwelling at a distance of 100 metres.
Distance from boundaries	1.2 metres	15 metres in the north, 10 metres in the south
Distance from paths and access by guests	1.2 metres	5 metres separated by fences and signs for biosecurity.
Distance from watercourse	6.0 metres	15 metres to the drain in the north
Distance to mushroom	1.2 metres	25 metres with biosecurity measures in place

greenhouses		
Distance to nearest dwelling or accommodation	1.2 metres	130 metres to the nearest dwelling offsite. 50 metres to the chalets. 90 metres to restaurant/café.

- ***The buffers and setbacks available to the waste water disposal system and its Land Application Area are significantly greater than the required distances.***

7.0 RISK ASSESSMENT WASTE WATER REUSE

7.1 Risk Assessment for the Re-Use of Waste Water

The potential for land use conflicts on site is to:

- Other activities on site such as the Chalets, restaurant.

A risk management plan is prepared to address potential on site conflicts. This is a stand alone plan that will seek to manage potential conflicts between, for example noise and activity between intensive agriculture and chalet guests, biosecurity, contamination of fruit and produce, use of recovered waste water after the construction of the restaurant and chalets and other potential conflicts. See the separate Land Use Risk Management.

Under the *Department of Health Guidelines for the Non-potable Uses of Recycled Water in Western Australia* the use of recovered waste water for perennial horticulture orchard is reviewed by risk assessment.

In the Risk Assessment process all risk associated with the potential impacts of the intensive horticulture on land uses on Lot 5531 and the surrounding land uses are considered. Management procedures are provided to demonstrate the methods proposed to mitigate risks associated with the re-use of recycled waste water.

National Guidelines have been produced by the Environment Protection and Heritage Council, Natural Resources Management Ministerial Council and the Australian Health Ministers Conference to provide guidance on best practices for water recycling. The Guidelines provide for a 12 point program to manage the waste water re-use with the 12 points being listed in Table 4 .

As the development is to be staged, with the initial planting of the Jujube Orchard and establishment of the Mushroom Greenhouses at commencement and the later construction of the chalets and restaurant/café, the introduction of waste water for irrigation will not occur in the initial establishment of the intensive horticulture. Therefore it is appropriate for the management plan to manage risk to be a flexible document that will require updating during operation of the intensive horticulture as re-use or waste water is introduced.

The *Department of Health Guidelines for the Non-potable Uses of Recycled Water in Western Australia* provide for the development of a Hazard Analysis and Critical Control Points (HACCP) as a means of providing mitigation of risk.

A Management Plan developed along the Guidelines of the HACCP process is proposed, prior to the re-use of waste water for Intensive Horticulture on Lot 5531.

The Management Plan will update the Initial Risk Assessment developed in Table 6 to ensure all risks are recognised and managed. That process is like to require updating over the first few years of the establishment of the intensive horticulture as it moves to the re-use of recovered waste water and the proposed development integrates with the construction of the tourist facilities.

Table 4: 12 Elements Framework taken from the National Guidelines

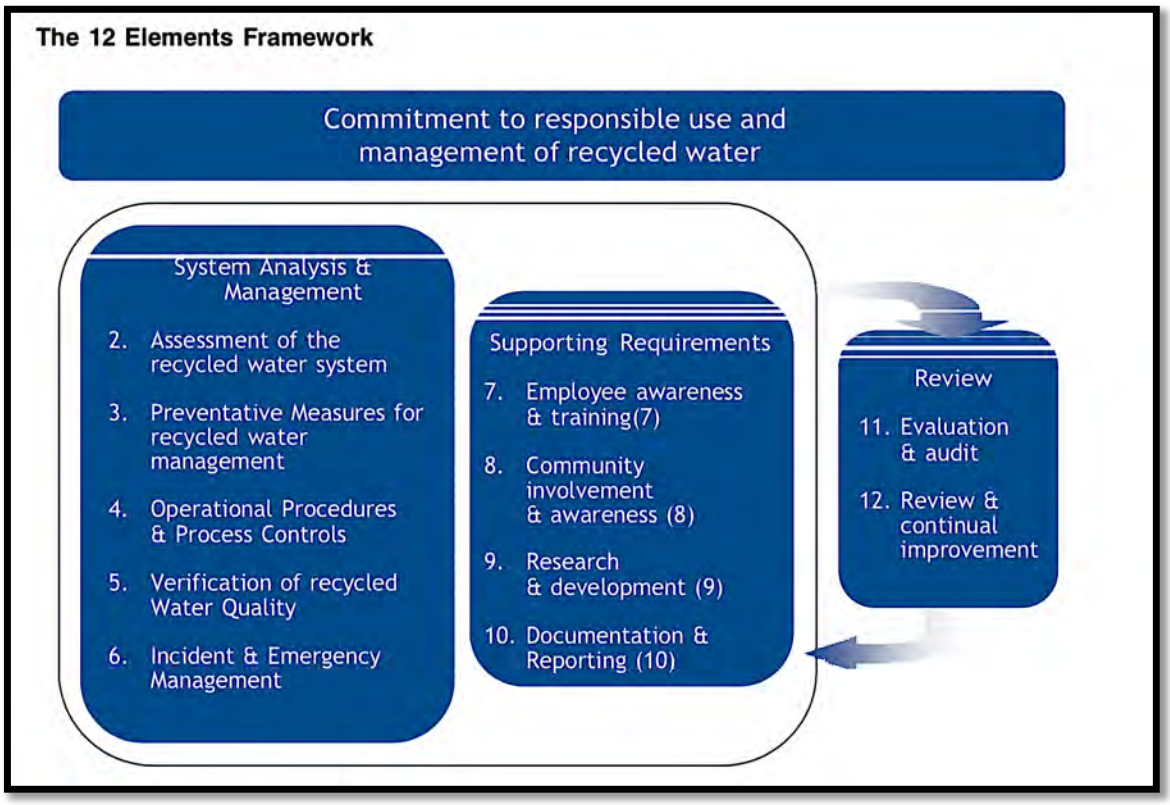
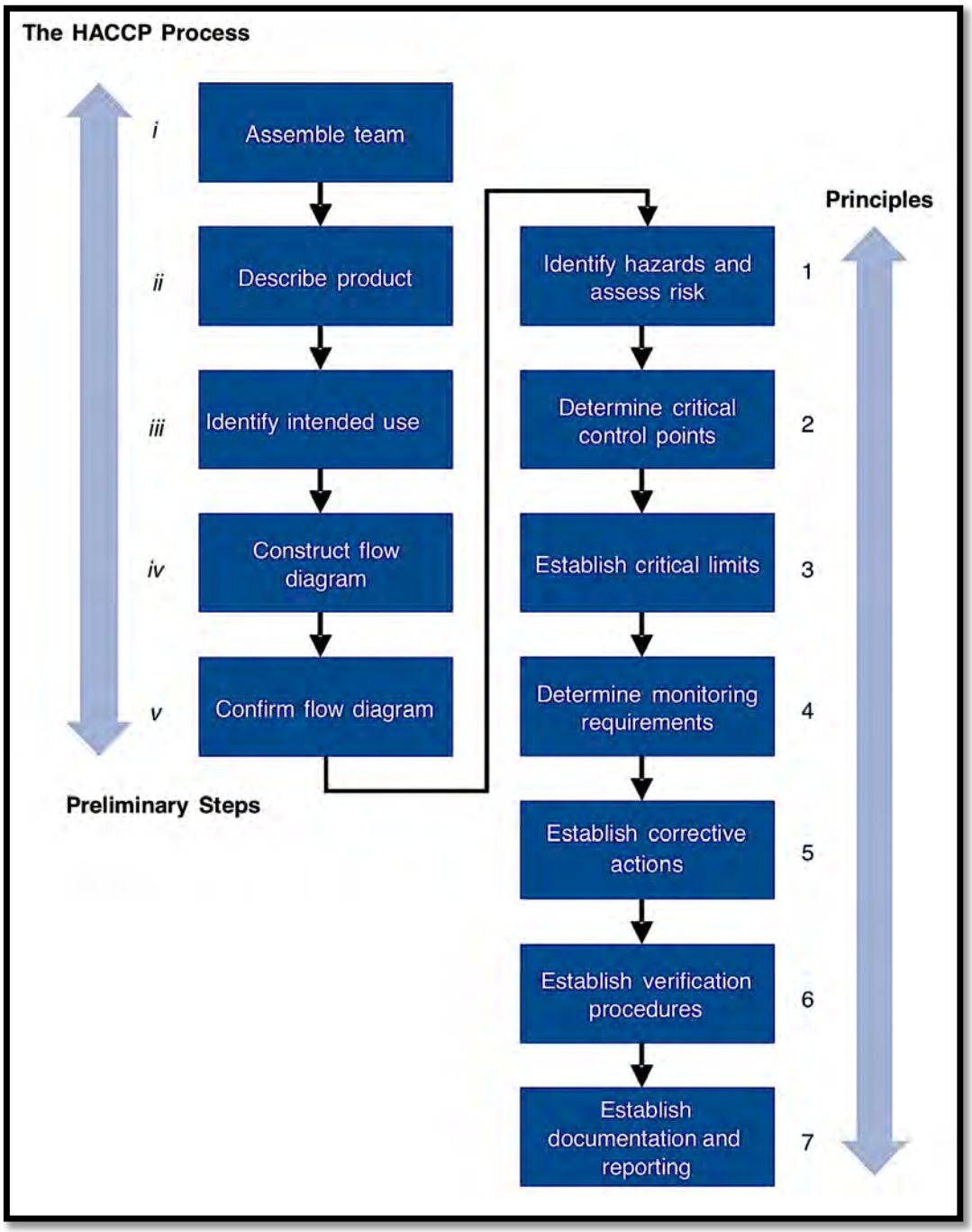


Table 5: HACCP process to provide guidance on the management of risk during operations



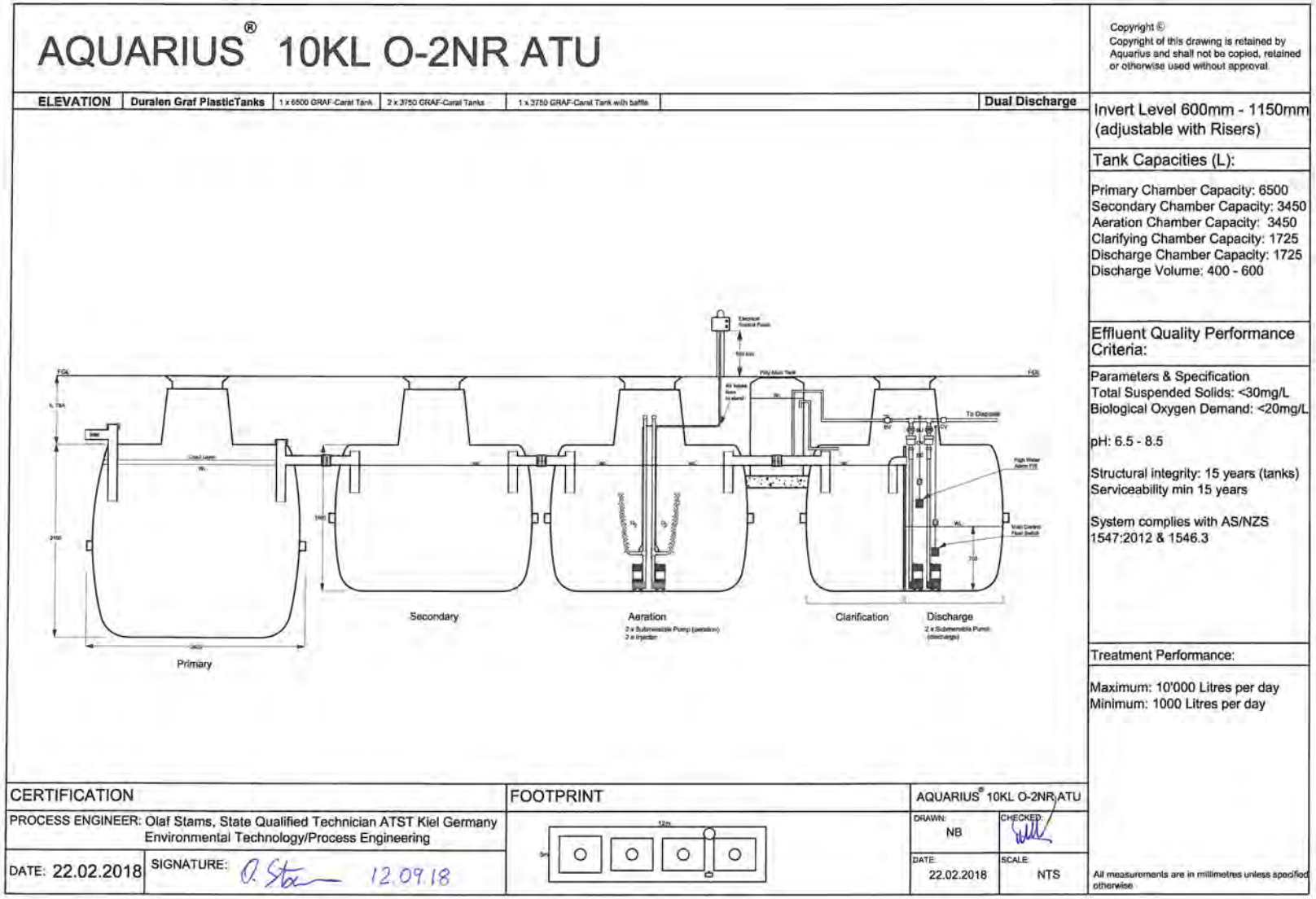


Figure 21: Aquarius 10K O-2NR ATU Approved Design

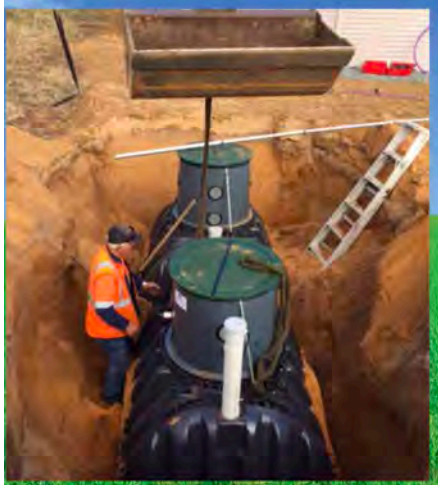
Introduction

Aquarius® Waste Water Systems is a privately owned Western Australian manufacturer of Wastewater Systems. We manufacture a comprehensive range of wastewater diversion systems, wastewater treatment systems and ancillary products, for both domestic and commercial applications.

All Aquarius® ATU systems are installed and serviced by our Approved Installers who are all Licensed Plumbing Companies. All installations must comply with state and local authority requirements.

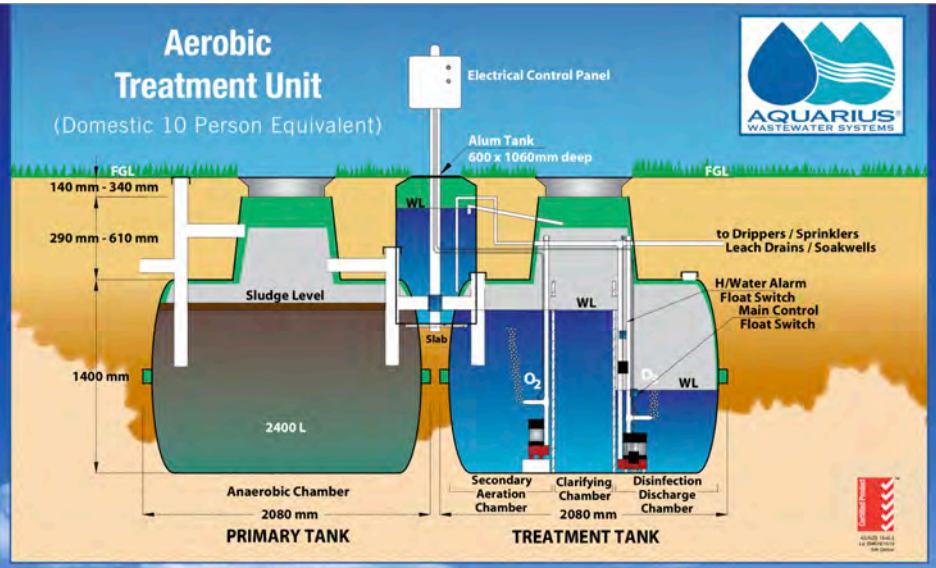
Caring for Our Environment

We live in a world where mankind is placing increasing pressures on our finite resources. The average Family dumps over 300,000 litres of recyclable water each year. The Aquarius® ATU recycles this water for sub-surface irrigation in your garden.



Aerobic Treatment Unit

(Domestic 10 Person Equivalent)



*Poly tank version shown. Also available in concrete tanks.

Aquarius® Alternative Treatment Units

The complete range of Aquarius® ATUs treat all the wastewater from the residential home or commercial site. The wastewater (from WC, kitchen, bathroom and laundry) is treated to current Department of Health WA Standards that allows it to be used for irrigation in garden beds, orchards, etc., or disposal into leach drains, soakwells and aquasafe drains. In addition the O-2 NR and O-3 models further treat the water to reduce phosphorous and nitrogen and these two ATU models are classified as **nutrient retentive** which is essential in water catchment areas, environmental sensitive areas and to comply with some local shire requirements.

The Aquarius® O-3 ATU we believe to be the most environmentally friendly ATU on the market by using Ozone as the final disinfection process. Ozone is many times more effective than chlorine and the by-product of Ozone is Oxygen.

Aquarius® Systems

1 – 5 Bedrooms	O-3 ATU	O-2 NR ATU	O-2 ATU
6 – 9 Bedrooms	O-3 4KL ATU	O-2 NR 4KL ATU	O-2 4KL ATU
Commercial	Aquarius® Standard or Custom Designed Commercial Systems Please speak to our Sales Consultant		

Specifications

	0-3	0-2 NR	0-2
System Features Poly/Duralen Plastic or Concrete Tank Construction	✓	✓	✓
Nutrient Retentive (Phosphorous reduction)	✓	✓	
Ozone Disinfection	✓		
Recycles all wastewater through irrigation into gardens, orchards, etc.	✓	✓	✓
Supplied complete with irrigation components, electrical components and pumps	✓	✓	✓
Footprint required approx 6m x 2.5m x 2m**	✓	✓	✓
Low Energy use	✓	✓	✓
Irrigation Area			
Above Ground Spray Irrigation	✓		
Sub-Surface Dripper Irrigation	✓	✓	✓
Irrigation area in sandy soil conditions –***150m²**	✓	✓	✓
Other Disposal Options Leach Drains / Soakwells / Aquasafe Drains	✓	✓	✓
Maintenance Service calls per year as per DoH WA requirements	2	2	2
Manufacturers Warranties			
Poly/Duralen Plastic Tanks 15 years	✓	✓	✓
Orange Pumps 1 year	✓	✓	✓
Irrigation and Electrical components 1 year	✓	✓	✓
Approvals Fully approved by the Department of Health	✓	✓	✓
Australian Standards approved AS/NZS 1546.3	✓	✓	✓
Why choose Aquarius Wholly owned West Australian Company	✓	✓	✓
Manufactured in Western Australia	✓	✓	✓
Extensive Support Network covering all of WA	✓	✓	✓
Local Agents fully trained and registered with Department of Health WA	✓	✓	✓

Subject to local authority approval.

Figure 22: Notes on the operation of the Aquarius Waste Water Treatment Systems.

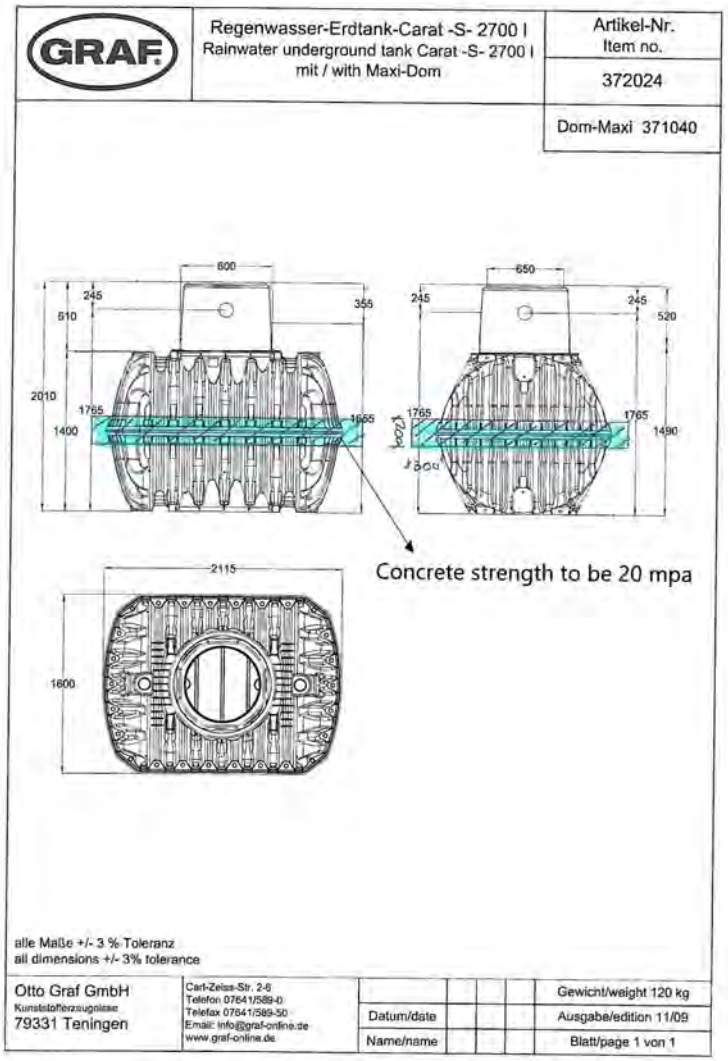


Figure 23: Concrete reinforcing to the tanks to stabilise them in the soil

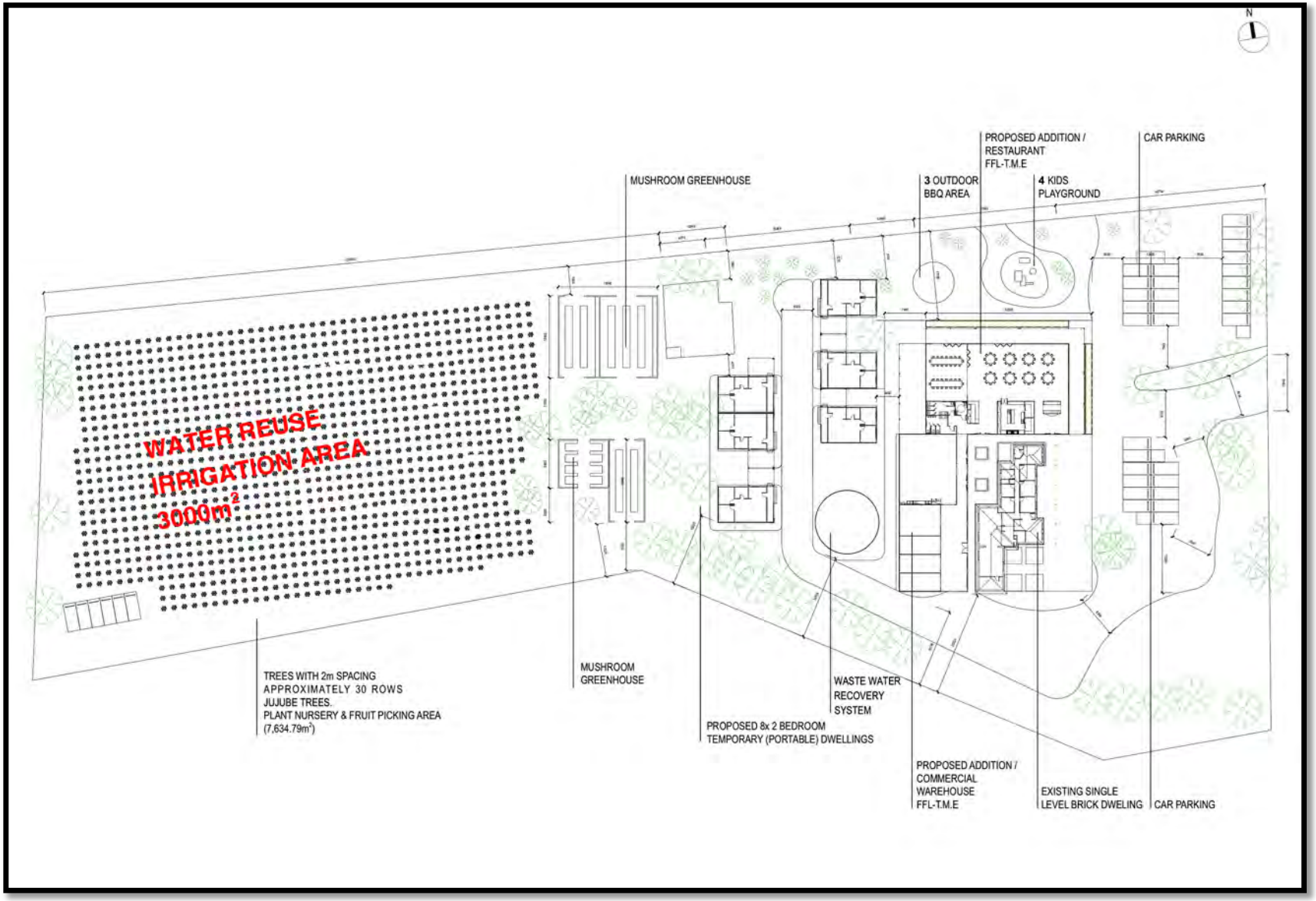


Figure 24: Water Reuse Irrigation Area

Table 6: Risk Assessment Table and Management

Factor	Potential Risk	Likelihood Consequence	Untreated Risk	Proposed Management	Likelihood Consequence	Treated Risk
General Risks - Amenity						
Amenity	Intensive horticulture may cause noise impacts	Unlikely Moderate	Medium	**Operations** The Mushroom Greenhouses and warehouse are closer to the chalets but are enclosed with walls, which will reduce noise carry. The activities are not mechanised with the staff accessing the greenhouses to maintain and harvest the mushrooms. Mechanical activity will be completed by battery operated facilities. The intensive horticulture of Jujube orchard is a perennial crop that requires harvesting for a period of a few weeks per year with pruning conducted over approximately one week and at other times of the year activities are minimal apart from monitoring and maintenance. Jujube are resistant to most insect pests and do not require frequent spraying. Treatment will be occasional organic spraying if required and baiting for fruit fly. Bird netting will be required. The warehouse where products are to be sorted will have the door facing away from sensitive premises or the doorway will be provided with noise screening panels to minimise noise carry. Operations will be timed to minimise impacts on the dwelling to the north and Chalet guests. **Acoustic Assessment** An Acoustic Assessment has been completed and is included in the Planning documentation. **External Dwellings** The closest dwelling is a single dwelling to the north at a distance of 130 metres from the intensive horticulture of Jujube orchard. **Chalets and Restaurant/Café** The Chalets are 50 metres away and the Restaurant/Café 90 metres from the intensive horticulture of Jujube orchard.	Unlikely Minor	Low
Spray Drift – Pest management	Sprays and pest management may impact on sensitive premises and the guests.	Unlikely Minor	Low	Brown spot of jujube, caused by the fungal pathogen *Nothophoma quercina* was recently detected in WA. No other significant diseases have been found in jujubes to date. Pests include rabbits, kangaroos and birds but these can be controlled by fencing or netting the orchard. The main pest is Fruit Fly, for which is baiting is propose and which which does not involve any offsite impacts. Medfly not only affects crop production, but limits access to interstate and overseas markets.	Rare Insignificant	Low

Factor	Potential Risk	Likelihood Consequence	Untreated Risk	Proposed Management	Likelihood Consequence	Treated Risk
				Three main control strategies for Fruit Fly available are: ➢ cover spraying ➢ bait or spot spraying ➢ lure and kill devices. The effectiveness of the baiting will be monitored with traps. If control is not sufficient bait and then spot spraying with organic or non harmful materials will be used. Cover spraying is not proposed. Fruit splitting is an issue for jujubes in Western Australia. It is a water-related physiological disorder and can ruin a large percentage of the crop in some years. The severity depends on water management throughout the growing season, rain around fruit maturation, and cultivar resistance. Maintaining soil moisture during the growing season will help reduce splitting but resistant varieties are the best option. **Bird control** Parrots are the most damaging pest to small and/or relatively isolated orchards. The rainbow lorikeet has also become a serious pest in some growing areas where it can pose an even greater threat to crops than the twenty-eight and red cap parrots. Bird control methods include: Exclusion netting: Although expensive (approximately $30 000/ha) this method will also alleviate the effects of extreme weather events such as hail storms and hot temperatures (sunburn). When assessing the advantage of netting as a means of bird control, the percentage of crop loss as well as the time spent controlling birds by other methods must be taken into account. Bird netting will be used for bird attacks, which is similar to netting that is used for grapes in the Swan Valley. **Warehouse Orientation** The warehouse where products are to be sorted will have the door facing away from sensitive premises or the doorway will be provided with noise screening panels to minimise noise carry. Operations will be timed to minimise impacts on the dwelling to the north and Chalet guests.		
Traffic	Traffic to the site may impact general amenity	Unlikely Minor	Low	**Traffic Assessment** A Traffic Assessment has been completed and is included in the Planning documentation.	Unlikely Minor	Low
Water Quality						

Factor	Potential Risk	Likelihood Consequence	Untreated Risk	Proposed Management	Likelihood Consequence	Treated Risk
Stormwater	Stormwater generated from hard surfaces may contribute to flooding	Unlikely Minor	Low	The only risk of flooding is onsite at the hard stand developments in the east. A Stormwater Management Plan has been prepared by HyQualty Engineering who have determined the storm frequency and generated water volumes. Stormwater will be fed to a detention basin in the north east of Lot 5531 from which excess water will be released to the drain along the northern side of Lot 5531. Any additional stormwater generated by the hard surfaces will help compensate for environmental water in a drying climate. The northern drain crosses under West Swan Road and drains across pasture to the Swan River	Rare Insignificant	Low
Groundwater separation	The groundwater separation may be insufficient under the proposed disposal area.	Unlikely Minor	Low	The current land surface of around 16.5 metres AHD. Figure 17 which should be compared to the local height datum used in Figure 7. The Perth Groundwater Atlas May 2003 shows the water table dropping from 15.5 metres AHD in the north west corner of the lot down to 12 metres AHD at West Swan Road. That provides for a separation of 1 plus metres on the western boundary of Lot 5531 increasing across the Jujube orchard and waste water disposal area and further increasing to 3.5 metres in the east of Lot 5531. Figure 7. In any case the groundwater does not intersect the land surface, but rather the maximum water table is around 1.5 metres below the surface. The drain along the northern side has water in winter but only on its base and is around 1.2 – 1.5 metres below the land surface of the orchard.	Rare Insignificant	Low
Groundwater Quality	Ground or surface water quality may be impacted.	Unlikely Minor	Low	**Staging of the Project** The project will be staged with the initial growth stages of Jujube production using bore water alone will be used for the irrigation of the production trees. During that time the existing waste water system attached to the current dwelling on site will remain operational. It is anticipated that it will take around two years to progressively construct the chalets and the restaurant/café. Once constructed it is anticipated that there will be a lead in time for the tourist facilities to reach their maximum occupancy – activity. Even so it is likely that there will be only some times of the year of peak capacity when the maximum waste water recovery and re-use volumes will be available. At other times the use and production of the volumes of waste water available is anticipated to be around 50% to 60% of maximum capacity. This is because the design of the systems are to maximum loadings which are not often likely to be reached, with the average chalet occupancy being 3 persons based on one or 2 couples per unit, the restaurant not operating every day or not to capacity on all days and the design loadings being based on the maximum water use not often reached for individual use. **Waste Water Volumes** All waste water volumes and calculations are conservative.	Rare Insignificant	Low

Factor	Potential Risk	Likelihood Consequence	Untreated Risk	Proposed Management	Likelihood Consequence	Treated Risk
				The waste treatment unit is a Aquarius Commercial ATU, Aquarius O-2NR10KL with a capacity of 10,000 litres per day, greater than the proposed water loading of 7,940 L/day. The use and production of the volumes of waste water available is anticipated to be around 50% to 60% of maximum capacity. This is because the design of the systems are to maximum loadings which are not often likely to be reached, with the average chalet occupancy being 3 persons based on one or 2 couples per unit, the restaurant not operating every day or not to capacity on all days and the design loadings being based on the maximum water use not often reached for individual use. The waste water application area has been assessed by Perth Geotechnics who determined the permeability of the underlying sandy clay layer. That permeability hass been used to size the application area to AS/NZ1547 and the Government Sewerage Policy 2019. **Buffers and Setbacks** The required application area is 2,640 m^2 with an area of 3,000 m^2 being allocated. The buffers and setbacks required for the installation of ATU's are available and well exceeded in all situations. See Groundwater Separation above. **Nutrient Calculations** The use of recycled waste water for irrigation of perennial horticulture will enable the dissolved phosphorus and nitrogen to be substituted for the addition of some fertiliser requirements for the plants. **Contamination** A Hazard Analysis and Critical Control Points (HACCP) to the Guidelines of the Department of Health will be prepared and operational prior to the use of recycled waste water for irrigation of the Jujube orchard.		
Biosecurity						
Pathogen biosecurity	There may be contamination between recycled water and crops	Unlikely Moderate	Medium	The Mushrooms will be grown in dedicated Mushroom Greenhouses, which will be isolated from the chalets and public areas by fences, signs and procedures. Mushrooms will be grown using scheme water to minimise any risk of cross contamination. The public will not be able access the Mushroom Greenhouses unless invited to do so, under strict hygiene conditions. Staff moving from the orchard to the mushroom greenhouses will be required to undergo foot and clothing sterlisation processes, depending on the levels of risk. For example walking in the orchard will provide a low risk for cross contamination, but undertaking work on the waste water recycling facilities	Unlikely Minor	Low

Factor	Potential Risk	Likelihood Consequence	Untreated Risk	Proposed Management	Likelihood Consequence	Treated Risk
				will carry a higher risk which will be treated accordingly. The public will be prevented from accessing the waste water recycling application area, by fences, gates and signage. A Hazard Analysis and Critical Control Points (HACCP) to the Guidelines of the Department of Health will be prepared and operational prior to the use of recycled waste water for irrigation of the Jujube orchard. A Stormwater Management Plan has been prepared by HyQualty Engineering who have determined the storm frequency and generated water volumes to minimise cross contamination.		
Public Health						
Public Health - Guests	The public may contact untreated waste water	Unlikely Minor	Low	The waste treatment unit proposed is a Aquarius Commercial ATU, Aquarius O-2NR10KL with a capacity of 10,000 litres per day, greater than the proposed water loading of 7,940 L/day. The system is approved by the Department of Health for installation. The proposed system complies with the setbacks and buffers and installation Guidelines for ATU waste water treatment units. The site has been assessed to AS/NZ1547 and the Government Sewerage Policy 2019 and complies with those Standards. Installation will be to the Department of Health, Code of Practice for the Design, Manufacture, Installation and Operation of Aerobic Treatment Units (ATU's).	Rare Insignificant	Low

RISK MATRIX			Effect / Consequence				
			1	2	3	4	5
Type			Insignificant	Minor	Moderate	Major	Severe
Environmental Impact			No discernible, adverse impact, individuals of species may be affected locally.	Discernible effect on the environment but no adverse impact, minor number of individuals of species may be affected locally	Minor adverse effect to the environment (including public amenity), moderate loss of individuals of species locally.	Moderate damage to ecosystem function, major loss of individuals of species locally, loss of public amenity.	Significant long-term damage/loss to ecosystem function, extinction of a species locally
Likelihood	A Almost Certain	Likely that the unwanted event could occur often (once per week) during the life of an individual item or system	Medium **11**	High **16**	High **20**	Very High **23**	Very High **25**
	B Likely	Likely that the unwanted event could occur several times per year during the life of an individual item or system.	Medium **7**	Medium **12**	High **17**	High **21**	Very High **24**
	C Possible	Likely that the unwanted event could occur sometime (once per year) during the life of an individual item or system.	Low **4**	Medium **8**	High **13**	High **18**	High **22**
	D Unlikely	Unlikely, but possible for the unwanted event to occur once in the life of an individual item or system.	Low **2**	Low **5**	Medium **9**	High **14**	High **19**
	E Rare	Highly unlikely that the unwanted event could ever occur in the life of an individual item or system.	Low **1**	Low **3**	Medium **6**	Medium **10**	High **15**

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