Application for Licence

Part V Division 3 of the *Environmental Protection Act 1986*

Licence Number	L7413/1998/10
Applicant	Cretta Pty Ltd
ACN	008 870 166
File number	DER6824/1 APP-0026028
Premises	Howard Park Wines 137 Fifty One Road COWARAMUP 6284 Legal description - Lots 22 and 23 on Plan 98345 As defined by the premises map attached to the issued licence
Date of report	20/02/2025
Decision	Licence granted

Caron Goodbourn
Manager, Process Industries
an Officer Delegated under section 20 of the *Environmental Protection Act 1986* (WA)

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1. Decision summary

This decision report documents the assessment of potential risks to the environment and public health from emissions and discharges during the operation of a wine production facility at Howard Park Wines, 137 Fifty-One Road Cowaramup (premises, Howard Park). As a result of this licence renewal application assessment, replacement licence L7413/1998/10 has been granted with conditions.

2. Scope of assessment

2.1 Regulatory framework

In completing the assessment documented in this decision report, the Department of Water and Environmental Regulation (the department; DWER) has considered and given due regard to its regulatory framework and relevant policy documents which are available at DWER Regulatory documents | Western Australian Government.

2.2 Application summary and overview of premises

On 15 December 2023, the applicant (Cretta Pty Ltd, licence holder) submitted a licence renewal application to the department under section 57 of the *Environmental Protection Act 1986* (EP Act).

The application seeks to renew licence L7413/1998/9 relating to beverage production (wine) and irrigating beverage production wastewater to land. The application is supported by two nutrient irrigation management plans and a geotechnical report for the evaporation pond and marc pad.

The previous licence L7413/1998/9 relates to Category 25 – Beverage production with a discharge of wastewater onto land with a design or production capacity of 3200 kilolitres of wine produced per year.

The application has been assessed in accordance with the *Guideline: Risk Assessments* (DWER 2020).

2.2.1 Background

The premises is approximately 4.4 km northwest of the of the Cowaramup town centre.

The premises was first issued with a licence (L06630/1) in March 2000. Existing licence L7413/1998/9 expires on 23 February 2025. The prescribed premises consists of two properties, Lots 22 and 23 both owned by the applicant.

- Lot 22 on Plan 98345 contains the winery and wastewater treatment plant (WWTP)
- Lot 23 on Plan 98345 contains the marc pad, wastewater irrigation areas and wastewater evaporation pond.

The review of the licence against the application supporting documentation suggests that changes to the wastewater disposal area and to the evaporation pond have been made, but not through a licence amendment or works approval application. (see section 3.1)

2.3 Overview of Operations

The following outlines the key infrastructure and operations of the winery, WWTP, wastewater disposal and organic solids management within the premises. This information has been sourced from the applicant, the application supporting documentation and annual environmental reports.

2.3.1 Winery

The licence holder's previous licence (issued in 2014) has an approved production capacity of 3,200

kL of wine per annual period with approximately 15kL/day of wastewater treated by the on-site WWTP.

Delegated Officer summary: The department is assessing wastewater emissions based on an estimated annual wine production of up to 3,200 kL, with an average wastewater-to-wine ratio of 3:1 (excluding stormwater).

The produced wine is stored and aged within the premises before being bottled. Bottling occurs within the same process building that is also used as a cellar door. Liquid wastewater is generated from winery activities consisting of crushing, pressing, cleaning, racking, transfers, filtration, and bottling. Wastewater is collected within a drainage system within the processing and bottling areas and are connected to the wastewater treatment plant (WWTP) via 4 collection concrete sumps.

The winery consists of:

- 2 grape crusher/destemmers
- 5 grape presses
- 47 red fermenters with a total capacity of 700 tonnes
- 213 wine storage tanks with a total capacity of 5.7 ML
- Wine barrels
- Chilling system
- 3 heat exchangers
- Assorted pumps, hoses, filters, and fittings
- Bottling facility
- 4 collection concrete sumps and pumps (2 x 5 kL, 1 x 1kL and 1 x 0.5 kL capacity sumps)

2.3.2 Winery wastewater treatment plant (WWTP)

The WWTP is located on the eastern side of the winery building. The WWTP includes the following in order of flow pathway (Figure 1):

- 5 kL fibreglass primary receival tank with sump pump
- 5 kL concrete storage sump with a pump and solids screen
- 20 kL fibreglass primary settling tank (PS1)
- 2x 50 kL polyethylene primary settling tanks (PS2 and PS3)
- 170 kL concrete untreated storage tank
- 2x 210 kL lined steel untreated storage tanks
- 4x 50 kL polyethylene untreated storage tanks
- Control shed with pumps and two blowers
- 170 kL concrete batch reactor aeration tank (SBR1)
- 340 kL concrete batch reactor aeration tank (SBR2)
- 2x 20 kL fibreglass waste activated sludge aeration tanks
- Stainless-steel clarifier tank (7 kL)
- 20 kL fibreglass treated wastewater tank
- 5 kL fibreglass thicken sludge tank

Untreated wastewater is screened for large solids and settled in primary storage tanks (total capacity 120 kL); water overflows to the untreated storage tanks storage (790 kL total capacity 100 kL less than calculated by the applicant). Accumulated solids are periodically removed from the primary and untreated storage tanks.

Wastewater stored in untreated wastewater storage tanks is processed via two batch reactors/ aeration tanks (SBRs) in a sequence batch reactor process. Aeration rates and timing is automatic and determined by continuous dissolved oxygen measurement to ensure bacteria present in the activated sludge receives sufficient oxygen to process the batch. Clear supernatant is decanted from the surface of the SBRs and transferred to the treated wastewater tank. Accumulated activated sludge levels in the aeration tank(s) are monitored and discharged to the waste activated sludge aeration tanks (40 kL total capacity) when required. The sludge is then pumped into a clarifier by pump operated by a float switch. The clarifier dewaters the sludge, periodically gravity feeding the settled sludge via an actuator valve in the base of the clarifier. Clear supernatant overflows to a sump and pumped back to storage tanks for treatment.

The WWTP has a maximum processing capacity of 90kL of wastewater per day. Tanks are monitored daily to monitor overflow.

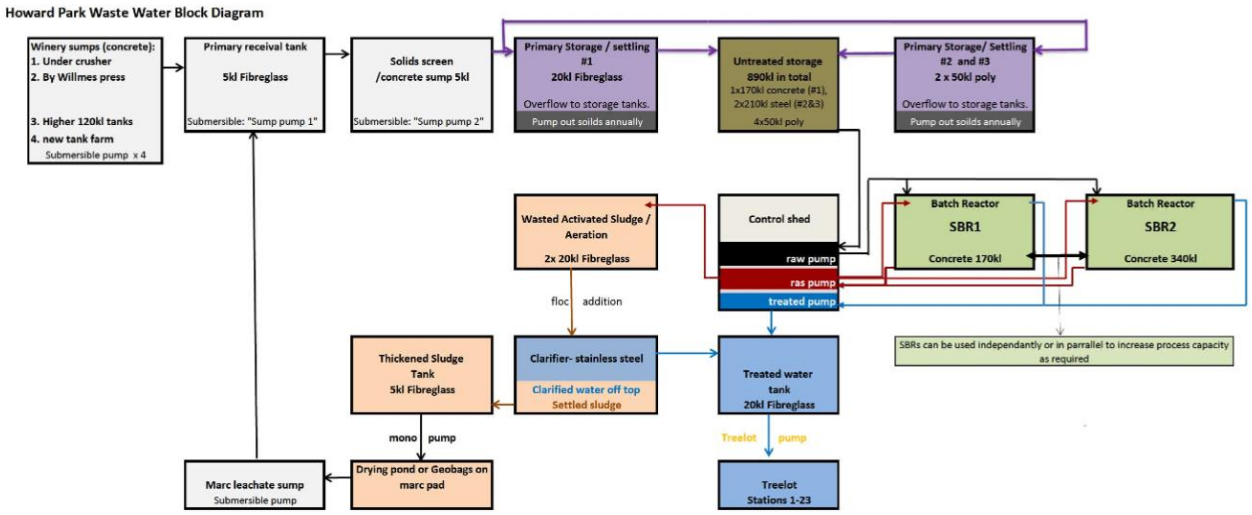

Figure 1: Wastewater treatment plant flow chart provided by the applicant.

2.3.3 Treated wastewater disposal (irrigation and evaporation).

The applicant provided two nutrient irrigation management plans (NIMP's). One on 15 December 2023 (Howard Park Wines, 2023) and the second on 21 June 2024 (Emerge Associates, 2024) they stated the following:

The main discharge from the premises is treated wastewater discharged to land to a dedicated ~1.15 ha tree lot divided into 23 sections (stations) or directed to an evaporation holding pond of unspecified size and freeboard. Each station is monitored and irrigated on a rotational basis to prevent waterlogging of the soil.

Based on data submitted during reporting periods 2020 to 2024, during the vintage period (Feb – April), treated wastewater discharge averages 31kL/day. Outside of the vintage period, an average of 15kL/day is discharged (average approx. discharge of 7.4ML of treated wastewater per annum). Irrigation is administered daily via flood and sprinkler irrigation over a mixed species tree lot. The treated wastewater stored in the WWTP 20 kL treated wastewater storage tank is activated via a float switch to ensure the tank does not overtop. During winter treated wastewater is diverted to the evaporation holding pond when soil moisture in the tree lot is saturated.

The trees in the tree lot were planted in 2001. Trees in sections 7 - 17 were harvested and in 2023

section 7 - 10 was replaced with Boronia and Banksia species. The treelots are bunded by earthen bunds preventing any surface runoff.

In the AER report and NIMP the applicant supplied discharge rates for the periods of 2022 – 2024. The following was noted.

- A total of ~1.9 ML of wastewater was irrigated to the evaporation pond (09 June – 01 September) and 5.8 ML of waster irrigated to land for period in the 2022 – 2023 period. In 2023 – 2024 4.7 ML of wastewater was irrigated to land with an unknown quantity sent to the evaporation pond.
- Wastewater was irrigated for 12 months of the year (either to the treelot or evaporation holding pond).
- Highest average daily irrigation was 53.69 kL (March).
- Lowest daily average irrigation was 7.312 kL (October).

2.3.4 Specifications of the marc pad and evaporation pond and solids management.

Evaporation pond

In a geotechnical report submitted to the department on 24 June 2024 (L&MGSPL 2024), the marc pad and evaporation pond were tested for its level of permeability. Four sample locations were taken in both the marc pad and evaporation pond. From the report it's deemed that of the sampled points the soil liner properties are suitable to meet requirements in order to reduce risk (DoW 2013).

The report was reviewed by comparison with a guidance document that has been published by the Institution of Professional Engineers of New Zealand (IPENZ, 2017), which is the most comprehensive guidance available in Australasia for the construction and management of agricultural wastewater storage ponds.

The suite of geotechnical tests that were carried out by L&MGSPL on soil materials from the evaporation pond is suitable and is consistent with the testing recommended in the IPENZ guidance document. Additionally, the results of the tested parameters generally fall within the range of soil properties that are suitable in the IPENZ guidance document for the construction of a compacted clay liner to minimise the rate of seepage from the pond.

The main limitation of the geotechnical testing is that it was undertaken more than 20 years after the evaporation pond was constructed using a "cut and fill" methodology. By contrast, the IPENZ guidance indicated that the geotechnical testing should be undertaken during the construction of the liner.

Based on the information provided, it is unlikely that the liner of the evaporation pond was constructed in the recommended manner or is of a suitable thickness to minimise the seepage rate of stored wastewater. This is particularly the case for the western margin of the pond, which was constructed at a later date to the main body of the pond to increase its overall storage capacity.

<u>Recommended measures to improve the management of the evaporation pond</u>

Based on the information that has been provided in the previous section, and on photos of the evaporation pond that were provided in the geotechnical report, the following measures are recommended to improve the management of the pond:

(i) Provision of a gravel cover to protect the liner from damage.

The photos that were provided suggest that some gulley erosion is taking place on the walls of the evaporation pond. Consequently, it is recommended that a layer of gravel is added to the walls and base of the pond to protect the liner.

(ii) Periodically assess the seepage rate of the pond using "Pond Drop" tests

Given that there is currently a large degree of uncertainty about how thick the compacted clay liner

is, there is a significant risk that the rate of seepage from the evaporation pond would be much greater than had it been constructed in a suitable manner, and where the liner had the minimum recommended thickness of 450 mm.

For example, if the maximum water depth in the pond were to be 2.0 metres, the expected seepage rate from the pond under these conditions would be expected to be 0.47 mm/day, which is equivalent to a total loss of water from the full basal area of the pond of about 0.96 m^3/day. If the measured rate of seepage were found to be much greater than this figure, the applicant should either be required to carry out a risk assessment to demonstrate that the measured seepage rate would be unlikely to cause significant environmental harm, or to reduce the rate of seepage by lowering the maximum water level in the pond.

Delegated Officer summary: Considering the above and that the main limitation of the geotechnical testing is that it was undertaken more than 20 years after the evaporation pond was constructed using a "cut and fill" methodology, the Delegated Officer has added regulatory controls to the licence that limits volumes of wastewater to prevent the irrigation area from being hydraulically overloaded during the remaining irrigation months; and

The Delegated Officer has also determined to require the installation of a monitoring well between the evaporation pond and the boundary of the premises (the pond is positioned very close to the premises boundary) to pick up any potential leakage from the pond into groundwater before the groundwater moves across the premises boundary.

Marc pad

Solid organic waste consisting of grape marc, WWTP dewatered sludges, sediments from the evaporation pond and winery screenings is transferred to a clay lined bunded hardstand (marc pad).

The application stated that 'sludge removed from the WWTP is pumped into geobags placed on the marc pad'. When dry, the sludge solids are removed from the geobags and added to the grape marc stockpile on the marc pad for aging. Further to this the licence holder has stated in a response to the 2020-2021 AER that composting occurs off premises, but has not indicated where the composting occurs

Leachate and stormwater falling on the marc pad drains to and is collected by a sump that is pumped to the 5kL primary receival tank of the WWTP.

The application was not supported by a water balance that identified all sources and volumes of water entering the WWTP and evaporation pond, and that justifies that there is adequate storage capacity in the evaporation pond over the 4 wet winter months when irrigation is not possible. It has also been considered that in the Cowaramup locality, rainfall exceeds evaporation for over 5 months of the year.

Delegated Officer summary: Considering the above the Delegated Officer has also determined to require the installation of a monitoring well down hydraulic gradient of the marc pad to pick up any potential leakage from the operation of the pad and sump.

3. Legislative context and other approvals

3.1 Environmental Protection Act 1986 (EP Act) - compliance

DWER maintain an Incident Compliance Management System (ICMS) database for all reported incidents and compliance matters. Table 1 lists the incidents and non-compliances for licence L7413/1998/(1-9) that have been recorded for the licence held by licence holder Cretta Pty Ltd.

Exceedances of annual phosphorus loading limits have been an issue over the last 5 years. With the department sending the licence holder a review of the AACR and AER for reporting period 2022-2021. The department concerns noted the high concentrations of phosphorous, BOD and TDS in the treated wastewater, the process of composting and leachate management. The licence holder

responded to this review providing information on soil and water sampling, composting, leachate management and the irrigation area. The applicant has indicated that measures are now in place to remove settled solids from the primary storage tanks, and this has resulted in a reduction of accumulated and bound phosphorus.

Prescribed premises, restrictions as to changes to etc

Under section 53 of the EP Act, the occupier of a prescribed premises commits an offence, if they make any changes to the method of operation or process, or construct, install or alter any equipment on the premises for the storage, handling or treatment or discharge of waste or constructs, relocates or alters any discharge pipe or channel through which waste is or may be discharged into the environment, unless he does so in accordance with a works approval or licence.

It would appear that changes to waste handling equipment have been made that have not been assessed and authorised through a licence or works approval.

For this reason, a number of regulatory controls have been imposed on the licence that are related to these potentially unauthorised changes.

Table 1: Summary of recent incidents and compliance matters 2009 – 2024.

ICMS number	Date reported	Incident / compliance matters
70927 66480	4/08/2023 8/08/2022	Licence holder reported, N1 notification of condition breach of annual phosphorus loading limit.
62819	26/03/2021	Licence holder reported, N1 notification of condition breach of phosphorus and BOD loading limit.
31632	31/01/2014	The licence holder did not by 1 January in each year (2014) provide to the CEO an Annual Audit Compliance Report in the form in attachment 2 to their licence. A review of the AACR noted that the report was received on 31 January 2014.
31631	02/01/2014	A review of the AER for the 2012/13 reporting period noted non-compliance to condition 9. The licence holder did not provide the Director, by 1 January in each year (2014), an annual environmental report. A review of the AER noted that the report was received on 02 January 2014.
26861, 26860, 26857, 26856	23/11/2012	A site inspection on 23/11/2012 noted a non-compliance with Condition W5(b)(iii). BOD exceeded 30 kg/ha/day.
16756	18/11/2009	Environmental Field Notice (EFN) number 2872 was issued stating the following "In breach of the provisions of Section 50 of the Environmental Protection Act 1986 and hereby requested to do the following 17:00 on 18/11/09. 1. • Ensure that the marc pad leachate recovery sump pump is fully operational to prevent any further discharge of leachate into the environment. • Submit written notification outlining compliance with point 1 of this notice." Submitted AER late.

3.2 Other legislative approvals

3.2.1 Rights to Water and Irrigation Act 1914 (RIWI)

Cretta Pty Ltd holds surface water licence SWL167280, to take 86 ML of water per year from the Wilyabrup, Busselton Coast Surface Water Area for the purposes of horticulture on Lots 22 and 23 on Plan 98345 and Lot 210 on Plan 55675, with the location of the water source on Lot 210.

The Applicant has indicated that water for the processing and washdown of the winery is sourced from rainwater collected in storage tanks and from dams within the property authorised by water licence SWL167280.

4. Monitoring data review

4.1.1 Existing wastewater quality

Howard Park have provided wastewater quality data within their AERs. Data from July 2017 to June 2024 is listed in Appendix 2 representing the last 7 years of wastewater quality data. The average and highest and lowest values are presented in Table 2. The wastewater data was not accompanied by laboratory analysis sheets therefore the data is unverified. Samples are taken from the treated wastewater storage tank and are considered representative of the water quality of irrigated wastewater.

Table 2: Wastewater quality (supplied by the applicant)

Wastewater quality- date range: July 2017 to June 2024							
	BOD mg/L	**EC mS/m**	**TDS mg/L**	**TN mg/L**	**TP mg/L**	**TSS mg/L**	**pH**
Average	222	210	1691	10.69	7.45	222	7.8
Highest	4140	586	3800	71	59	1500	8.6
Lowest	1	67.2	580	0.66	0.51	2	5.8
Typical average of raw winery wastewater[1]	8,858	192.5		110	52	760	5
ANZECC 2000 – Primary Industries[2]	<15		1425[4]	25 – 125[3]	0.8 - 12[3]		6-9

[1]Mosse K.P.M., Patti A.F., Christen E.W., Cavagnaro T.R. 2011 *Review: Winery wastewater quality and treatment options in Australia Vol 17, 111 – 122*. Australian Journal of Grape and Wine Research. Available at: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1755-0238.2011.00132.x

[2] National Water Quality Management Strategy Paper No. 4 – Australian and New Zealand Guidelines for Fresh and Marine Water Quality, *Volume 3 Primary Industries*, 2000, ANZECC and ARMCANZ (ANZECC 2000).

[3] ANZECC 2000, values are for short term irrigation and requires site specific assessment of soil properties and plant uptake to determine actual value.

[4]DPIRD 2019, *Water salinity and plant irrigation*. Lower threshold of approximate concentration of TDS that would be considered "salty".

Biological oxygen demand

The National Water Quality Management Strategy guidelines for sewerage systems and effluent management (NWQMS) recommends that for primary treatment systems, typical biological oxygen demand (BOD) ranges for treated effluent should range between 120 - 250 mg/L. Wastewater from the existing treatment system at the premises is typically within this range apart from 17 incidents which exceeded the upper value (20 % of data), where BOD was reported as high as 4140 mg/L on March 2021.

Nutrient levels

Nutrients including total nitrogen and total phosphorus were generally within reported levels for effluent management recommendations for primary treated systems under the NWQMS. It is noted that in the past 2 years total phosphorus was 36 mg/L in December 2023 and 28 mg/L in January 2024 and January 2023.

pH

The pH of the wastewater was consistently within ANZECC 2000 - Primary Industries for irrigation quality. Two consecutive events within 4 years of data were below the recommended levels (5.8 pH in February and March 2021).

Total dissolved solids / electrical conductivity

The electrical conductivity (EC) and total dissolved solids (TDS) of the wastewater were consistently within DPIRDs (2022) irrigation categories of moderately salty (456 – 1425 mg/L as TDS and 80 - 250 mS/m as EC) to salty (1425 – 2850 mg/L as TDS and 250 – 500 mS/m as EC). Noting January 2023 sample was 3,750 mg/L. Where irrigation of total dissolved solids (TDS) above 1425 mg/L will result in a minimum 25% yield loss, which increases with the increase in salts within the wastewater.

It is noted that EC and TDS levels are extrinsically linked. TDS measures breakdown of arrange of dissolved substances whilst EC measures ion concentration. TDS was consistently within ANZECC 2000 - Primary Industries for irrigation quality. One event (March 2021) within 6 years of data was above the recommended levels.

However, EC fluctuated from freshwater to salty, indicating that factors like chemicals in washdown water and vintage processing stages may be impacting on salt levels within the WWTP with potential long-term impacts to plant and soil health.

Delegated Officer summary: It's noted that potassium in wastewater has not been sampled. Potassium is a byproduct of winery wastewater and can be high. Irrigation of wastewater high in potassium will affect soil structure reducing hydraulic conductivity. For this reason, the Delegated Officer has determined to include potassium sampling in the wastewater monitoring program.

Furthermore, sodium adsorption ratio (SAR) and ions for sodium, calcium and magnesium will be sampled twice a year in the wastewater sampling program, to monitor for potential sodicity impacts. Emission limits for SAR in irrigated wastewater (SAR:EC relationship for prediction of soil structure). These limits will protect healthy soil structure and prevent soil ESP increasing.

The Delegated Officer has determined that the installation of monitoring wells and the monitoring of groundwater will be added to the licence due to the historically high levels of phosphorus loading of the irrigation area, and to determine if any leakage is occurring from the evaporation pond and marc pad.

4.1.2 Nutrient uptake by mixed tree lot - NIMP

In the NIMPs submitted by the applicant a nutrient balance was included on the uptake of nitrogen and phosphorous by the trees and soil. The desktop NIMP claimed that adequate amount of phosphorous and nitrogen were able to be taken up by the mixed tree lot. The Delegated Officer noted the following about the NIMP:

- The nitrogen and phosphorous uptake were taken from a study which was conducted on the uptake of seedlings. Although it took a conservative approach of this uptake it is not a reflection of the proposed practice of coppicing on which little information was provided.
- The calculations did not consider the density of trees in the irrigation lot.
- The values used for soil uptake of nitrogen and phosphorus were taken from a study on the southwest of Western Australia and used in the NIMP as a generic soil uptake value. The values used do not factor in any site soil specific factors which may influence the uptake of nutrients by soil.
- Did not consider the amount of total phosphorous already accumulated in the soils
- The NIMP used an annual wastewater value of 7264 kL which is not reflective of a worst-case scenario of wastewater generation at peak production.
- That groundwater monitoring was taken outside the premises boundary nearby to surface water bodies and may not provide an accurate representation of potential pollution being caused by treated wastewater irrigation.

Delegated Officer summary: The information included in the NIMP is insufficient in providing evidence of nutrient export by the mature bluegum tree lot. The calculated nutrient export rates are 82.52 kg/ha per annual period for nitrogen and 6.28 kg/ha per annual period for phosphorous, calculations are summarised in Appendix 3.

For nutrients to be removed from the site, the requirement for the licence holder to submit a coppicing plan will be added to the licence.

4.1.3 Water balance for evaporation pond

In the applicants NIMP (Emerge Associates, 2024) the applicant proposes to irrigate all effluent during the winter months (June to September) to the evaporation pond. The water balance provided by the applicant focused on irrigation to the land application area and did not account for the change in irrigation point to the evaporation pond.

Calculations undertaken by the Delegated Officer summarised in Appendix 4 shows that under a scenario at maximum theoretical production and during a high rainfall year (2021) that the pond could exceed carrying capacity by up to 889 kL.

4.1.4 Soil monitoring

As part of the current licence the licence holder is required to monitor soil every second year in summer within the existing licence within the irrigated treelot at two depths (S1 at 0-100 mm depth and S2 at 100-200 mm depth).

Table 3 outlines the soil data over three sampling events in January 2019, 2021, and 2023 taken from the licence holders submitted AERs. It is noted that the data provided by the licence holder was not accompanied by laboratory data analysis sheets thus the data is unverified.

Table 3: Soil data (retrieved from licence holder)

Date	Site reference	Depth	pH	EC	Na	Ca	Mg	SAR
		mm		µS/cm	mg/kg	mg/kg	mg/kg	
18/01/2019	S1	0 - 100	8.5	200	750	2100	360	4
	S2	100 - 200	8.5	140	540	1700	320	3
13/01/2021	S1	0 -100	8.5	200	290	19	3	16
	S2	100 - 200	8.5	140	120	6	1	13
11/01/2023	S1	0 - 100	7.9	210	13	<10	<10	2
	S2	100 - 200	8.2	140	<10	<10	<10	1

Sodium adsorption ratio (SAR) relates to the amount of sodium relative to calcium and magnesium ions in soil. A soil SAR value below 3 is generally considered optimum for healthy plant growth. When SAR applied to land is greater than >9 the soil is at high risk of becoming sodic (DPI, 2016). Sodic soils cause particles to repel each other preventing the formation of soil aggregates, resulting in poor filtration, poor aeration, reduced nutrient uptake and poor growth of plants.

It is notes that soil results in 2021 indicate that the soils were sodic, indicating that irrigation during this period would not have infiltrated but runoff over the surface. Rainfall leaching excess salts and ions would have assisted in reducing soil SAR levels in 2023. It's noted that pH level varied by 0.6 units on the surface.

Delegated Officer summary: The wastewater quality is moderately salty wastewater, the soil monitoring SAR results and pH changes and has determined to update the existing soil monitoring program to include:

- soil sampling with increased parameters (total nitrogen, total available nitrogen, total phosphorus, total available phosphorus (Colwell), potassium, sodicity (exchangeable sodium percentage (ESP)), and phosphorous retention index;

- revised soil monitoring to Australian Standards (AS 4482.1) using surface composite sample (0-20 cm), and deeper composite sample of each major soil horizon 20 – 50 cm below ground,

The nature of the wastewater is generally salty and unless treated appropriately salts can buildup in the soil and can cause significant degradation to soil biology and chemistry. Monitoring soil and wastewater can ensure proactive management actions can be undertaken by the licence holder to ensure dispersive soils are not caused by long-term irrigation activities.

4.1.5 Soil geotechnical report and nutrient balance.

During the 21-day comment period the applicant submitted a geotechnical report of the soil in the licences land application area (Western Geotechnical & Laboratory Services 2024) and recommendations made by the applicant's consultant based off soil sampling results and updated nutrient loading and water balance calculations (Emerge Associates 2025a; Emerge Associates 2025b). A total of 8 auger holes were dug across the irrigation area to a depth of 1m when possible. From the results of the soil testing and nutrient balance the delegate Officer notes the following with further information below on phosphorous, nitrogen and potassium:

- Phosphorous loading was found to significantly elevated in all the tested soil samples, being the highest in the topsoil (0-10cm range) then decreasing deeper in the soil profile, with the highest phosphorous concentration being 650 mg/kg at soil sample site BH2 (0-10cm).
- Soil samples are to be considered sodic due to high exchangeable sodium percentage (ESP) and low EC values with the highest value being 31% (BH2 1m). Only one soil sample (BH1 0-10cm) was below the ESP threshold of 6%, above this threshold soil the risk of soil dispersion may begin (DPIRD 2022).

Delegate Officer summary: The licence holder must apply gypsum to the soil in the land application area to prevent the occurrence of dispersive soils.

- Significant range of soil pH ($CaCl_2$) extraction, ranging from 5.1 to 8.1.

Phosphorous

The applicant's consultant has correctly indicated that the bulk of the ferruginous soil materials in profiles beneath the wastewater irrigation area are likely to have a high capacity for adsorbing phosphorus. Consequently, if these materials were present in an ideal soil profile where water flow were only to take place vertically through matrix-flow (*i.e.*, via a uniform wetting front through a perfectly homogenous porous medium), there would be a low risk that significant amounts of phosphorus would be released to offsite environmental receptors. Under these conditions, the US EPA suggests that a typical wastewater irrigation system will saturate about a 0.3 metre thickness of a soil profile with phosphorus every ten years (US EPA, 2006).

However, these conditions do not exist in duplex soils such as those that occur beneath much of the Howard Park winery. The characteristics of water flow in these types of soils are described below.

The region is underlain by granitic gneisses of Proterozoic age that comprise bedrock in the area, and form part of the Leeuwin Complex (Wilde and Nelson, 2001). The fresh bedrock is covered by a lateritic weathered profile that is typically 5-15 metres thick. The dominant soil-type that has formed within the weathered profile in the area is a duplex-type (or "texture-contrast") soil profile known as the Forest Grove soil-type (Tille *et al*., 2020). Profiles in this soil-type usually contain an upper horizon that consists of silt- to sand-sized ferruginous materials with variable amounts of lateritic pisolites. This horizon typically has a thickness of 0.5-1.5 metres and is underlain by clays that have a much lower hydraulic conductivity.

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However, these conditions do not exist in duplex soils such as those that occur beneath much of the Howard Park winery. The characteristics of water flow in these types of soils are described below.

In duplex soils (which are common in the southern part of WA), water flow from infiltrating rainfall or irrigation water may be rapidly transmitted vertically through the shallow permeable soil horizon. This often takes place through macropores, which form preferred flow pathways through the shallow soil horizon. This infiltrated water will then accumulate on the surface of the underlying low-permeability horizon. Then, depending on the degree of land slope and the rate of water infiltration, water will also begin to flow laterally on this boundary (see *e.g*., McGuire *et al*., 2024). In situations where bedrock is present at shallow depth, some water flow often takes place through macropores in the clayey horizon and accumulates on the surface of fresh bedrock (Hardie *et al*., 2012).

This subsurface lateral flow of water on sloping surfaces in a permeable horizon above a low permeability surface in a soil is often called “interflow”, “throughflow” or “subsurface runoff” (Hardie *et al*., 2012; McGuire *et al*., 2024). Under natural conditions, these lateral subsurface flow events may only take place for a few days after heavy rainfall events in winter months. However, beneath areas where the water balance has been disrupted by land clearing and irrigation, these flow events may persist for several weeks during the winter months (McGuire *et al*., 2024).

Investigations that have been carried out on a catchment underlain by duplex soils in Albany (McKergow *et al*., 2006a) indicated that soil interflow was the main source of water discharge through the riparian zone at the bottom of the catchment to a stream. Soil interflow was also found to be the dominant source of nutrients that were discharged from the catchment to the stream (McKergow *et al*., 2006b). It is likely that the Howard Park winery catchment would behave in a similar manner.

Phosphorus is usually considered to have a low mobility in soils, as inorganic chemical forms of this nutrient are typically strongly adsorbed to iron and aluminum oxyhydroxide and clay minerals within the soil profile. Consequently, there is generally a limited opportunity for this nutrient to be transported in soluble form in soils, unless sorption sites on these minerals have become fully saturated. In soils that contain large amounts of ferruginous minerals, such as the soils at the Howard Park winery, it could take many decades for adsorption sites within the soil profile to become saturated. This is likely to be the case for the Howard Park winery site, despite the observation that the current P application rate in wastewater is up to a factor of ten higher than the capacity of the most sensitive horizon in the soil profile.

However, there is increasing evidence that significant amounts of phosphorus can be transported in soil interflow in Western Australia as fine colloids (<0.2 µm in size), even when soluble forms of this nutrient are absent (Sharma *et al*., 2017). The study by Sharma *et al*. (2017) also indicated that the transport of colloidal forms of phosphorus increased as the P loading to soils increased. This study found that with a phosphorus loading rate to soils of about 40 kg/ha, up to about 2.6 kg/ha of phosphorus could be released in the form of colloidal particles into soil interflow.

Recent research (Adediran *et al*., 2021) has indicated that phosphorus in the fine colloids that are leached from the soil surface is mostly bound up with organic matter. The formation and leaching of these phosphorus-bearing colloids are also likely to increase as the humic content of soils increases (Wang *et al*., 2024).

The statement by the applicant’s consultant that soils beneath the irrigation area have essentially an infinite capacity for adsorbing phosphorus is not correct. Information provided by the US EPA (US EPA, 2006) has indicated that all wastewater irrigation schemes have a finite lifespan, which is limited by the capacity of the underlying soils to adsorb phosphorus.

The US EPA has indicated that typically, a phosphorus saturation front extends downwards through soils at a rate of about 30 cm every ten years beneath wastewater irrigation areas (US EPA, 2006).

When the entire soil profile above the water table has become saturated with phosphorus, the site is no longer suitable for wastewater irrigation.

Duplex soils, such as those that underlie the Howard Park winery, are especially problematic for wastewater irrigation. This is because some phosphorus can be episodically transported from wastewater irrigation schemes on duplex soils before adsorption sites in these soils have become saturated with this nutrient. This can take place because seasonal interflow events in permeable horizons in these soils are able to transport some phosphorus in colloidal form to offsite receptors. Recent research has suggested that the amount of colloidal phosphorus that can be transported in seasonal interflow will increase with increasing phosphorus application rates to these soils, and with the accumulation of organic matter in the irrigated soils.

This component of phosphorus discharge is currently not accounted for in wastewater irrigation schemes that are sited on duplex soils.

Delegated Officer Summary: Due to the risk of phosphorous leaching through the soil to groundwater, phosphorous loading has been conditioned in the licence at 40 kg/ha/year. This loading rate is based off the most limiting soil profile (BH4) and nutrient export of blue gums.

Nitrogen

Like phosphorus, it is likely that seasonal soil interflow would be the most significant pathway for the export of nitrogen from the wastewater irrigation area. A preliminary nutrient balance suggests that the uptake of nitrogen by vegetation in the area is in approximate balance with the application rate of this nutrient in wastewater. However, it is considered to be likely that some of the nitrogen stored in the soil profile would be lost in interflow during the winter months when the rate of vegetation uptake is lowest, and when sufficient infiltration is present to transport the nitrogen below the root zone in the irrigation area.

There is currently insufficient information available to quantify the likely rate of transport of nitrogen in interflow from the irrigation area.

Delegated Officer Summary: Due to the potential risk the licence will be conditioned with a nitrogen loading rate of 160 kg/ha/year based off the applicant's nutrient export calculations of blue gums. It's noted that the tonnage of blue gums harvested used in the nutrient export calculations included leaf litter, the licence will be conditioned to manage leaf litter in the land application area.

Potassium

The nutrient balance relied upon a potassium (K) concentration of 20 mg/L (estimate). The Australian Winery guidelines (Day et al. 2011) indicate a K concentration ranging from 80 to 180 mg/L (vintage) and 40 to 340 mg/L (non-vintage). K is generally not removed by wastewater treatment processes. The K estimate made in the nutrient balance is potentially an under-estimation. K concentrations in the soil also indicate excessive loading within the soil, with some profiles having a disproportionate amount of exchangeable K outside the preferred percentage of 2-6% when compared to CEC (NSW DPI 2004). More information is required on the K concentration in the winery wastewater and uptake by blue gums.

Water Balance

Based off the updated water balance calculations provided by the applicant's consultant it claims that the land application area has sufficient area for the hydraulic load and the evaporation pond is a sufficient size to prevent overfill. Assumptions made by the applicant are summarised and comments by the delegated officer in **bold**:

- Soil infiltration rate was calculated at 0.39 m/day (390 mm/day). **It's noted that there was high variation in what was provided in the soil permeability data. The topsoil sample (25 cm) had an average permeability of 522.42 mm/day ranging from 0.24 mm/day to 686.88 mm/day and below soil sample (50 cm) an average permeability of 57.48 ranging from 0.72 mm/day to 336 mm/day.**

- Evaporation from the marc pad and hardstand was included as outputs in the land application area water balance and evaporation of the marc pad in the evaporation pond water balance. **Although precipitation and evaporation will occur in these areas of the premises, it's noted that evaporation for these areas cannot exceed the amount of precipitation that occurs.**
- Treated wastewater was sent to the evaporation pond in months June, July and August. **It's noted that in the month of May precipitation exceeds evaporation, this month should be included in which treated wastewater is sent to the evaporation pond.**
- The WWTP was included as storage during in months June, July and August as additional storage to the evaporation pond with a total of 780 kL being included as storage (maximum capacity of the WWTP is 790 kL). **The WWTP may act as a buffer for exceeding capacity for the evaporation pond, based off calculations provided in the applicant's water balance the total amount of inputs to the evaporation pond equals 2453 kL which is within 4 kL of the ponds estimated carrying capacity of 2457 kL.**

Delegated Officer Summary: Based on the calculations provided in the water balance and the assumptions made summarised above the water balance has been recalculated to determine maximum monthly hydraulic loading to the land application area (Appendix 5). The results of these calculations have been included in the licence as a maximum treated wastewater loading limit. Additionally it's noted that as evaporation pond storage may exceed capacity the applicant should consider installing more storage and expanding the irrigation area.

5. Risk assessment

The department assesses the risks of emissions from prescribed premises and identifies the potential source, pathway and impact to receptors in accordance with the *Guideline: Risk Assessments* (DWER 2020).

To establish a risk event there must be an emission, a receptor which may be exposed to that emission through an identified actual or likely pathway, and a potential adverse effect to the receptor from exposure to that emission.

5.1 Source-pathways and receptors

5.1.1 Emissions and controls

The key emissions and associated actual or likely pathway during premises operation which have been considered in this decision report are detailed in Table 4 below. Table 4 also details the control measures the applicant has proposed in the to assist in controlling these emissions, where necessary.

Table 4: Proposed applicant controls

Emission	**Sources**	**Potential pathways**	**Proposed applicant derived controls** (from submitted application supporting documentation)
Operation			
Nutrient and chemical laden wastewater generated from processing and cleaning of the alcoholic / nonalcoholic beverage manufacturing	Wine and beverage manufacturing and packaging	Infiltration through soils and overland runoff.	All wastewater is directed to the WWTP. Operations within an enclosed building. Production limited to not more than 3200kL/wine per year.

Emission	Sources	Potential pathways	Proposed applicant derived controls (from submitted application supporting documentation)
equipment and packaging			
Nutrient laden solids and leachate from marc/lees prior to spreading on site or removal offsite.	Management of winery beverage solid waste (marc and WWTP sludges)		All leachate is collected in sump and pumped to WWTP. Solids are composted. Compost not applied within 50 metres to an external boundary or watercourse/wetland. Sludge solids are pumped to geobags on the marc pad hardstand, for drying and added to grape marc to be composted. Any accumulated heavy solids in the primary storage/settling tanks are periodically removed from the bottom of these tanks
Odour from wastewater processing and storage.	Management of alcohol manufacturing wastewater	Air / wind	Aeration by the SBRs
Spills, leaks and overtopping of wastewater containments with nutrient laden wastewater and sludge processed through the WWTP and evaporation pond		Infiltration through soils and overland runoff.	Treated wastewater tank and clarifier has float switch to activate irrigation to ensure no overtopping. 900 kL of untreated storage, with 200 kL used as a contingency (4 days of inflow during vintage) in a breakdown. Vegetation or floating debris is prevented from growing in WWTP. Wastewater tanks are fitted with overflow pipes that direct excess wastewater back to storage.
Nutrient rich wastewater to land	Onsite disposal of treated wastewater via irrigation to land	Infiltration through soils and overland runoff.	Removal of settled soils in the primary holding tanks to reduce wastewater phosphorus levels. Irrigate to treelot on a rotational basis. Soil and irrigated wastewater monitoring. Tree's will be coppiced for nutrient removal.
Wastewater to land with excessive hydraulic loading			All treated wastewater diverted to evaporative pond in winter months (June, July and August) and will not be irrigated to land. Treelot is bunded. Land application area will be visually inspected during vintage for waterlogging.
Containment of treated wastewater in the	Treated wastewater irrigated to	Infiltration through soils and overland	A pump is available to pump wastewater back to the WWTP to avoid exceeding the

Emission	Sources	Potential pathways	Proposed applicant derived controls (from submitted application supporting documentation)
evaporation pond	the evaporation pond during the winter months	runoff.	capacity in the evaporation pond. Freeboard is maintained in the evaporation pond by being maintained within 500 kL of capacity. The evaporation pond is emptied of sediments every third year to prevent sediment build up.

5.1.2 Receptors

In accordance with the *Guideline: Risk Assessment* (DWER 2020), the Delegated Officer has excluded the applicant's employees, visitors, and contractors from its assessment. Protection of these parties often involves different exposure risks and prevention strategies and is provided for under other state legislation.

Table 5 below provides a summary of potential human and environmental receptors that may be impacted because of activities upon or emission and discharges from the prescribed premises *(Guideline: Environmental Siting* (DWER 2020)).

Table 5: Sensitive human and environmental receptors and distance from prescribed activity

Human receptors	Distance from prescribed activity
Residential Premises	720 m north of winery/WWTP 805 m east – southeast of the winery/WWTP. 840 m south of the winery/WWTP 970 m northeast of the winery/WWTP 1 km north-northwest of the winery/WWTP 1.1 km west of the winery/WWTP
Twinwood Winery	788 m east of the WWTP/winery
Environmental receptors	**Distance from prescribed activity**
Wilyabrup Brook – Proclaimed surface water area under the Rights to Water and Irrigation Act 1914 (RIWI)	476 m northeast of the land application area.
Underlying groundwater (non-potable purposes) Busselton Capel, Cape to Cape North, Combined Leeuwin Surficial/Fractured Rock - RIWI	Seasonal groundwater within ~2 metres of the surface (based on April 2023 Aerial soaks internal DWER spatial data).
Surrounding dams on nearby premises	45m east of land application area. 300m northeast of land application area 180m southeast of land application area.

5.2 Risk ratings

Risk ratings have been assessed in accordance with the *Guideline: Risk Assessments* (DWER 2020) for each identified emission source and considers potential source-pathway and receptor linkages as identified in Section 5.1. Where linkages are in-complete they have not been considered further in the risk assessment.

Where the applicant has proposed mitigation measures/controls (as detailed in Section 5.1), these have been considered when determining the final risk rating. Where the Delegated Officer considers the applicant's proposed controls to be critical to maintaining an acceptable level of risk, these will be incorporated into the licence as regulatory controls.

Additional regulatory controls may be imposed where the applicant's controls are not deemed sufficient. Where this is the case the need for additional controls will be documented and justified in Table 6.

Licence L7413/1998/10 that accompanies this decision report authorises emissions associated with the operation of the premises i.e. wine manufacturing and irrigation to land with treated wastewater.

The conditions in the issued licence, as outlined in Table 6 have been determined in accordance with *Guidance Statement: Setting Conditions* (DER 2015).

Table 6: Risk assessment of potential emissions and discharges from the premises during operation.

Risk Event					Risk rating C = consequence L = likelihood	Justification for additional regulatory controls	Regulatory controls conditioned in the licence
Source/ Activities	**Potential emissions**	**Potential pathways and impact**	**Receptors**	**Applicant controls**			
Operation							
Treatment and storage of winery wastewater	Odour	Air/wind dispersal affects the health and amenity of receptors.	Residential premises in all directions between 720 to 1,100 m from the winery and WWTP/irrigation areas	Applicant controls specified in Table …	Onsite impacts: minimal C = Slight The risk event will probably not occur in most circumstances. L = Rare **Low Risk**	The wastewater undergoes organic removal through aeration and treatment and most wastewater tanks are closed reducing their exposure to air. The Delegated Officer considers the risk as **low** with the licence holders controls as sufficient in managing the risk.	Applicant controls conditioned
	Nutrient and salt-laden wastewater processed through the WWTP	Overtopping, spills and leaks of tanks and pipes cause contamination of soil, groundwater, and surface water.			Onsite impacts: minimal C = Slight The risk event will probably not occur in most circumstances. L = Rare **Low Risk**	The applicant has a series of impermeable tanks in the WWTP plant which provides a sufficient amount storage in the wastewater treatment plant to avoiding overtopping (1480 kL in total). Although majority of wastewater is produced over the vintage period, this occurs during summer which will allow for the wastewater to be irrigated to land during this period which will decrease the overall wastewater in the WWTP during this time. The Delegated Officer considers the risk as **low** with the licence holders controls as sufficient in managing the risk.	No additional controls.
Irrigation of treated wastewater to land application area consisting of mixed tree species.	Nutrient and salt-rich wastewater to the irrigation area.	The discharge of treated wastewater to land through irrigation has potential to contaminate soils, groundwater, and surface water.	Proclaimed Wilyabrup Creek 476 m northeast of the winery. Proclaimed seasonal groundwater within 2 m of the surface.		Onsite impacts mid-level. Offsite impacts low-level. C = Moderate The risk event will probably occur in most circumstances. L = Likely **High Risk**	The Delegated Officer notes that the treated wastewater being irrigated to land has in previous annual periods exceeded licence loading limits for BOD and phosphorous and has had high salt content. Additionally based off information sent by the applicant the area covered by sprinklers is smaller than the area conditioned in the licence. The Delegated Officer has reviewed the treated wastewater data submitted in AERs and determined that historical nutrient and exceeding ANZECC 2000 guidance limits which may be degrading soil and plants. Review of the nutrient balance based on the NIMP submitted by the applicant indicated there was a lack of information to determine the nutrient offtake within the irrigation area. The applicant will continue with planted mixed tree species which have little nutrient uptake. Given the high nutrient and salt content, the lack of a clear NIMP, distance from groundwater, the licence holder's previous compliance to the existing licence and the controls proposed by the applicant that the risk of treated wastewater irrigation to land is catergorised as **high**. The Delegated Officer has determined to add additional regulatory controls for the monitoring and reporting of emissions, staged emission limits and soil and groundwater monitoring to the licence. The Delegated Officer also determines that current licence emission loading rates will be amended according to soil quality and nutrient offtake.	**Condition 2, Table 2:** Installation requirements of monitoring wells. **Condition 5, Table 3:** Additional parameters for emission limits of EC and SAR:EC and change of nitrogen and phosphorous loading rates. **Condition 7:** Coppicing plan **Condition 8, Table 5:** Additional parameters added to emissions and discharge monitoring of potassium and SAR. **Condition 9, Table 6:** Additional parameters added to soil monitoring of total nitrogen, total available nitrogen, total phosphorous, total available phosphorous, phosphorus retention index, total dissolved salts, exchangeable sodium percentage, and potassium. Alternating soil sampling locations. **Condition 10, Table 7:** Added the monitoring of groundwater with the parameters of standing water level, pH, electrical conductivity, total nitrogen, total phosphorous, total dissolved salts.
	Wastewater to land with excessive hydraulic loading				Onsite impacts: mid-level Offsite impacts: low level C = Moderate The risk event will	The applicant proposes to irrigate to the currently licensed irrigation lot of mixed trees. Due to the premises being located in an area of high rainfall the Delegated Officer considers the risk as **medium** and has placed controls on the irrigation of treated wastewater to land in order to prevent irrigation occurring on soil which has exceeded it's hydraulic capacity.	**Condition 1, Table 1, Item 6:** Operational requirements fot the land application area. **Condition 6:** Hydraulic loading limits

Risk Event					Risk rating C = consequence L = likelihood	Justification for additional regulatory controls	Regulatory controls conditioned in the licence
Source/ Activities	**Potential emissions**	**Potential pathways and impact**	**Receptors**	**Applicant controls**			
			Proclaimed Wilyabrup Creek 476 m northeast of the winery. Proclaimed seasonal groundwater within 2 m of the surface.		probably not occur in most circumstances. L = Unlikely **Medium Risk**		
Containment of treated wastewater and solids	Nutrient and salt-rich wastewater discharged to the evaporation pond.	Overtopping or seepage of treated wastewater which may contaminate soil.			Onsite impacts: mid-level Offsite impacts: low level C = Moderate The risk event will probably not occur in most circumstances. L = Unlikely **Medium Risk**	The applicant provided a geotech report for the evaporation pond's permeability. The Delegated Officer notes that the new section of the evaporation pond was not sampled due to there being water in that area of the pond. Due to absence of permeability testing in the new section the Delegated Officer considers the risk as **medium**. To reduce the risk of infiltration of treated wastewater to soil and groundwater the Delegated Officer has imposed a limit on the hydraulic loading.	**Condition 1, Table 1, Item 4:** Treated wastewater storage.
	Nutrient laden solids and leachate from marcs, lees, and sludges.	Direct discharge to land and seepage / infiltration causing contamination of the soil, groundwater, and surface water.			Onsite impacts: mid-level Offsite impacts: low level C = Moderate The risk event will probably not occur in most circumstances. L = Unlikely **Medium Risk**	Winery solid waste is placed and stored on a bunded marc pad. In the current licence the solid waste is considered compost, which the applicant has not demonstrated how the solid wastes will be converted into a compost. Leachate from the marc pad is collected in the leachate sump and pumped back to the WWTP. It's also noted that no testing of the leachate sump liner was conducted. The Delegated Officer considers the risk of leachate runoff as **medium.** To prevent the buildup of leachate on the marc pad, the Delegated Officer has determined to add additional regulatory controls for the removal of solid wastes by the end of vintage (April) and for the removal of solids offsite. As the licence holder has not included any information on the process of compost creation.	**Condition 1, Table 1, Item 5:** Operational requirements for the marc pad. Removal of the word "compost" from the licence.

Note 1: Consequence ratings, likelihood ratings and risk descriptions are detailed in the *Guideline: Risk assessments* (DWER 2020).

Note 2: Proposed applicant controls are depicted by standard text. **Bold and underline text** depicts additional regulatory controls imposed by department.

6. Consultation

Table 7 provides a summary of the consultation undertaken by the department.

Table 7: Consultation

Consultation method	Comments received	Department's response
Application advertised on the department's website on 14 August 2024.	None received	N/A
Local Government Authority advised of proposal on 15 August 2024.	The Shire of Augusta replied on 19 August 2024 stating that the Shire's Environmental Health Department does not have any objection to this renewal application and that no complaints or concerns to the premises has been found on record.	N/A
DWER seeked advice from DPIRD to the nutrient and water balance in the NIMP on 30 September 2024.	DPIRD replied on 01 October 2024 advising of the complexity of blue gum nutrient uptake, that DPIRD recommends an annual crop when calculating nutrient balance for assurance that nutrients are being adsorbed within that annual period. DPIRD followed up with an additional email on 15 October 2024 with a review of the water balance and nutrient balance noting the following: • Water balance for the land application area was fine. • Evaporation pond calculations needed to focus on the ponds area not volume. • Unclear on how P uptake was calculated. Noting the lack of information on the depth of P saturation over time. • The absence of environmental triggers and actions for monitoring. • Literature pointed at the majority of phosphorous accumulation occurring in the soil opposed to tree biomass. Which is consistent with the NIMP. • Growth rate and yield are highly variable. Also provided were blue gum nutrient coppicing calculations (Mendham et al., 2014).	The department agreed with their use of the Mendham et al. 2014 paper and has been used in this report.
Applicant was provided with a draft licence and decision report on 5/12/2024	The applicant provided a response on 9/12/2024, 29/01/2025, 03/02/2025 and 4/02/2025 also providing a soil sampling geotechnical report (Western Geotechnical and Laboratory Services, 2024) and comments on the soil quality, a water balance, nutrient and organic loading calculations and comments on the draft licence and decision report.	Refer to Appendix 1 for Delegated Officers response.

7. Decision

Based on the assessment in this decision report, the Delegated Officer has determined to issue the renewed licence L7413/1998/10 with additional regulatory controls This determination was based off the following:

- The applicant's submission of a NIMP for nutrient uptake and water balance and the updated information on soil quality and nutrient and water balance.
- Operational requirements for the storage (evaporation pond) and irrigation of treated wastewater to the land application area.
- Water balance calculations giving hydraulic loading limits to the land application area.
- No treated wastewater can be irrigated to the land application area during the wet months (precipitation exceeds evaporation) and must be sent to the evaporation pond.

The Delegated Officer has proposed the following revised and/or additional regulatory controls in the renewed licence:

- Revised emission loading limits for total nitrogen and total phosphorous.
- Additional parameters to discharge monitoring.
- Additional parameters to soil monitoring and changing of soil sampling locations.
- Addition of the requirement to install and monitoring groundwater wells.
- Revised reporting requirements.

In reviewing the licence, the Delegated Officer has updated the format of the licence to include the relevant infrastructure associated with the winery, wastewater treatment plant, evaporation pond, marc pad and piping not previously included in the licence. Additionally, the land application area has been updated to reflect current practices and controls.

The Delegated Officer is satisfied that with the above controls added to the licence that the overall risk of the wineries operations is low and prevents adverse impacts to public health and the environment.

It's recommended that the licence holder should investigate expanding the wastewater irrigation area/s to vines if no pastured areas are available. As the licence holder irrigates to a small stand of blue gums, which has limited nutrient uptake, a new or expanded land application area will decrease risk by providing more nutrient uptake and allow for more hydraulic loading (given appropriate crop selection and area).

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Appendix 1: Summary of applicant's comments on risk assessment and draft conditions

Condition (description) / Section	Summary of applicant's comment	Department's response
Licence		
Assessed production capacity and condition 1	The volume of wine produced on site be re-instated to 3,200 kL/year based on the water balance (which has considered a conservative wastewater volume) being able to be adequately managed onsite.	The Delegated Officer has reviewed the applicants updated water balance and considers it insufficient in justifying the low risk of a 3,200 kL/year production. The Delegated Officer has determined in order to reduce risk, impose a limit on the amount of annual wastewater irrigation according to the Delegated Officers updated water balance calculations (Appendix 5).
Condition 2, Table 1 (infrastructure table)	i. Item 2 (c): Removal of this requirement as all tanks are monitored daily. All tanks have plumbed in overflow pipes that directs water back to storage tanks if required. Overflowing of tanks is not possible. ii. Item 3 (c): Applicant is actively managing the buildup of sediments within the WWTP to manage phosphorus the build up of sediments within the evaporation pond will reduce. Recommend to change this to a visual inspection basis with the removal of sediments occurring with the build up of more than 20mm of sediments before removal. This will assist in not damaging the liner is sediments have not built up to enough of a depth within the proposed 3 year period. iii. Item 5 (a): The marc pad is connected to the WWTP to allow the collection and treatment of this water, suggest the addition of dewatering of sludge be allowed for this item as well. iv. Item 6 i.: Amend wording as treelot is only blue gums. v. Item 6 (e) and (g): conditions are similar and could be combined.	i. The Delegated Officer notes this was an applicant derived control taken from the applicants supporting information, it's agreed that the risk is low and the condition has been amended removing the mention of daily inspection, with the condition for the licence holder to ensure no overtopping occurs. ii. Amended this condition according to the applicants recommendation. iii. Amended the condition removing "dewatered" from "dewatered WWTP sludge". iv. Wording amended according to recommendation. v. Conditions combined.
Condition 3	The applicant request for standards in which the evaporation pond is to be tested.	The Delegated Officer has removed the condition for a drop test based on risk being lowered due to the presence of a monitoring well and hydraulic loading limits.

Condition (description) / Section	Summary of applicant's comment	Department's response
Condition 5, 6 & 7	Installation of monitoring wells is acknowledged but communications with the DWER Regional Hydrogeologist has confirmed lower requirements than what is specified is appropriate (email attached). Table 2 should be updated to align with the requirement of WQPN 30 with the recommended locations to align with those given by DWER's regional hydrogeologist.	Noted, but will not change condition or align it with the requirements of WQPN 30. The two locations proposed by the regional hydrogeologist are currently included in the licence with the third based off the Delegated Officers assessment of risk.
Condition 8 (emission limits)	i. Removal of electrical conductivity (EC) as an emission limit as the comparison of SAR:EC is more important that EC on its own. Assuming this has been added do to impacts of vegetation growth and nutrient uptake but site specific soil testing within the treelots does not support a limit on nutrient uptake or vegetation growth. ii. Removal of emission values nitrogen and phosphorus limits from the licence based on the results of the nutrient balance and site testing which indicate: • Low risk of nutrients building up within the soil profile from long term wastewater discharge within the site. • Site soils and vegetation are adequately managing nitrogen within the site based on site soil testing and outcomes of the nutrient balance. • Site soils and vegetation are adequately managing phosphorus within the site based on site soil testing and outcomes of the nutrient balance. • The volume of wastewater required to begin reaching levels that would present a risk to the environment are beyond the current capacity of the WWTP (3,800 kL/year). An assessment on the output of 11,400 kL (31300 L/day) of wastewater was undertaken and found: a) Minimum area required for N management = 9,952 m2 b) Minimum area required for P management = 1,384 m2 c) Minimum area required for K management = 1,058 m2 d) Minimum area required for BOD management = 3,827 m2.	i. The Delegated Officer rejects the removal of EC as an emission limit value, justification for EC as a parameter is specified in section 4.1.1 of the decision report. ii. The Delegated Officer rejects the removal of the nitrogen and phosphorous limits see section 4.1.5 for explanation. The Delegated Officer has amended loading rates to 160 kg/ha/year for nitrogen and 40 kg/ha/year for phosphorus.
Condition 9 (staged emission limits)	Removal of the staged emission reduction for the site as there is no evidence (based on site soil testing and the outcomes of the nutrient balance) for the applicant to be encumbered within addition emission limits.	The Delegated Officer notes that due to the applicant providing adequate soil testing results during the 21 day period the Delegated Officer has agreed to remove the stagged emission limits.
Condition 10	Simplification of this condition based on the outcomes of the site specific soil testing.	The Delegated Officer notes the applicant's amendment to

Condition (description) / Section	Summary of applicant's comment	Department's response
(coppicing management plan)	Recommend this condition be changed to 'Maintenance of vegetation cover within the tree lots via to ensure the optimal growth and nutrient uptake of vegetation is maintained'.	condition but rejects the applicants recommendation as vague and as outlined in the decision report that blue gums must be coppiced to ensure nutrient removal from the site.
Condition 12, Table 6 (soil sampling)	i. Land application areas recommend shifting to a composite shallow soil profile sample only (no deeper profile) based on the site specific testing undertaken which indicated the shallow soil profile has the most infiltration capacity and will be where the majority of nutrients will be managed within the soil profile. ii. Parameters: removal of phosphorus retention index (PRI) as this has been identified by the current soil testing undertaken.	i. The Delegated Officer has not amended the soil sampling requirements based on the applicant's comment noting the high variation of nutrient concentration (particularly in nitrogen and phosphorous) in the soil samples from the surface soil sample (10 cm) and sample taken below (50 cm). To provide a holistic representation of soil quality a composite for both surface and deep soil must be analysed. The Delegated Officer has amended depth requirements from 20 – 80 cm to 20 – 50 cm based on the soil sample data submitted with the applicant's comments. ii. The Delegated Officer notes the soil testing provided and the PRI results, the Delegated Officer agrees that although the PRI values are high in samples, PRI must still be sampled in order to confirm that the soil is still able to retain the phosphorus in the future.
Condition 13 (groundwater monitoring)	Addition of text to allow a missed sample if the bore is dry. Applicant will be required a re-attempt to sample but if dry again then this will be deemed adequate.	The Delegated Officer agrees with the applicant and a note has been added to the condition.
Condition 14 (d) (NATA accreditation)	The applicant requested that analytes sodium, magnesium, calcium and SAR have non-NATA laboratory analysis permitted stating the following as reasoning: • The local laboratory (Vintessential Laboratories) has NATA accreditation for all analytes listed in the licence except for sodium, magnesium, calcium and SAR. The laboratory Technical Manager & WA State Manager advised (Sept 2024): • We perform water metals analysis by Atomic Absorption Spectrometry, and whilst we are only NATA accredited for Copper analysis in wine by AAS, we follow similar procedures for all of our AAS analysis. • All the standards used are traceable to NIST as required by NATA, we use only high-purity reagent grade chemicals, and we use quality controls which are traceable to NIST. As samples are kept cool before analysis this prevents any bacterial activity, and samples are acidified upon receival to stabilise them and prevent precipitation.	The Delegated Officer agrees with the applicant reasoning for non-NATA accreditation for parameters relating to SAR. A note has been added to the licence conditions allowing non-NATA analysis. If the licence holder is to change the laboratory in which SAR analytes are sent for

Condition (description) / Section	Summary of applicant's comment	Department's response
	• Transport of samples to Perth would lead to an increase in time before this stabilisation step, and that analysis (or at least the acidification) of water as soon as possible after sampling would lead to the most accurate results. • Given that sodium, magnesium, calcium and SAR are general indicators of water quality and are not analytes being measured at trace concentrations against a limit, along with the information provided by the laboratory, we request that the DWER licence allows use of the local laboratory with non-NATA accredited method for these analytes.	
Condition 15 (monthly sampling)	21 days can be problematic if there are issues with the sampling and a resampling is required the lab availability for testing (noting that the lab only accepts samples for BOD analysis on Wed, Thurs & Friday. Public holidays also delay when the lab will accept a sample which can cause issues with the 21 days requirement. Request that this is changes to 15 days to simplify this process and allow the proponent to adequately meet this requirement.	The Delegated Officer has amended the 21 day between sampling condition to 15 days.
Condition 19 (notification of leaks or spills)	Can the definition of a spill please be clarified? Spills are referenced in Condition 19 and in the AER reporting requirements, there can be minor leaks or spills that are on concrete areas or can be cleaned up or have no impact due to small volumes – do these need to be reported? Can this condition be removed from the licence as there is already an obligation under the EP act to notify the DWER of spills that may have the potential to impact the environment – under Section 72 of the act – so why does it need to be replicated in the licence (redundant).	The Delegated Officer has included a definition in the licence, as this condition is standard on recent winery licences and will remain on the licence.
Decision Report		
Section 2.3.3	1.9 ML of wastewater is sent to the evaporation pond not 2 ML.	The Delegated Officer has amended the statement.
Section 2.3.4	i. The requirements for the investigation of the liner in the evaporation pond was based on the request to meet DWER WQPN 27 Liners for pollutants, using engineered soils from the letter received on the 13/2/2024. Why has this requirement now changed to IPENZ guidance document. Can DWER please confirm if assessment for liners has been undertaken as per this document? Has this methodology for assessment been used within Western Australia for the development of evaporation ponds/liner material assessment? Was this method (or an earlier version) available at the time of construction of the evaporation pond? If not, then why is this being stated in the	i. In section 2.3.4 referenced by the applicant the Delegated Officer does not make reference to WQPN 27 in relation to the construction specifications of the evaporation pond. It's however noted in the section that of the sampling points conducted in the geological report that they did meet liner specifications. Reference to WQPN 27 has been added intext for clarity. The Delegated Officer can reference any relevant current guidelines which may

Condition (description) / Section	Summary of applicant's comment	Department's response
	decision report? From research version 1 of this document was first developed in 2011. Why is WQPN 27 not being referenced here? ii. Can clarification be provided regarding the pond leak test and how this is to be demonstrated to the satisfaction of DWER? Pond drop tests can only be undertaken during construction so how is this an applicable requirement for any pond that has already been constructed? Available testing within the evaporation pond suggests a low permeability rate has been achieved (10^{-9} m/s). Further, the evaporation pond is located upgradient of the irrigation area (treelots) which show no indication that groundwater contamination via groundwater seepage is occurring over the 20 years of site operations. Groundwater is assumed to follow the topography of the site which, at this location of the site, occurs in an east to west direction (towards the irrigation areas). To address this pond would a drop test of the existing evaporation pond considered appropriate to determine the seepage of the current liner with the results of this provided to DWER?	assist in identifying risk associated with the liner. In this case the reference used (IPENZ 2017) was from an internal review used in relation to the recently constructed section of the evaporation pond which was not sampled in the geotechnical report as this section of the pond was considered high risk due to lack of information. ii. The Delegated Officer has removed the condition for a drop test based on risk being lowered due to the presence of a monitoring well and hydraulic loading limits.
Section 3.1	Clarify statement that submission of AER was 'submitted late over the years'. AER have been submitted in time for at least the last 10 years.	The Delegated Officer agrees and has removed this statement from the decision report.
Section 3.2.1	This item has been addressed separately via communications with Julian Woodward (DWER) on 6/3/2024 that no amendment to the existing licence is required to include wine manufacturing activities. This should be removed from the decision report.	The Delegated Officer notes the clarification on surface water licence SWL167280, the section is still included in the decision report with the text amended to only include information included in the water licence.

Appendix 2: Licence holders wastewater quality data

Date	Volume	EC	pH	TDS	TSS	TN	TP	BOD
Unit	kL	mS/m		mg/L	mg/L	mg/L	mg/L	mg/L
26/07/2017	730.933	127.4	7.3	1200	380	2.2	4.8	242
24/08/2017	449.139	74.1	7.7	2300	390	10	1.8	247
29/09/2017	413.41	186.8	7.4	1900	350	7.8	2	255
26/10/2017	476.83	181.1	7.8	1200	350	6.8	3	274
24/11/2017	323.833	187	7	740	140	3	4	206
15/12/2017	402.813	176.8	7.5	1500	110	2.8	5.6	14
24/01/2018	393.575	118.4	8	840	83	9.9	6.1	8
23/02/2018	548.798	122	7.8	850	200	15	3.4	436
29/03/2018	1,732.28	353	7.7	3800	270	9.4	3.9	13
27/04/2018	774.222	174.2	7.7	1100	310	20	2.2	488
31/05/2018	390.431	187.2	8.1	1200	22	3.8	3.2	61
28/06/2018	1,001.25	92.7	7.9	580	460	3.9	3.2	140
26/07/2018	443.264	150.1	7.8	740	1300	20	3.8	214
24/08/2018	367.748	205	8.1	1200	1500	18	4.8	284
27/09/2018	188.347	190.7	7.2	970	700	25	50	238
25/10/2018	694.051	146	7.8	1500	200	8.4	4.7	808
29/11/2018	316.168	120.3	7.1	920	420	18	3.2	229
14/12/2018	318.082	164.2	7.5	1400	81	6.4	2.8	181
25/01/2019	558.05	184	7.7	1200	25	4.6	5	13
28/02/2019	596.723	90.5	7.6	650	260	16	2.1	72
28/03/2019	1,116.50	113.9	6.2	1100	100	7	1.9	838
1/05/2019	995.328	132.6	7.6	820	140	6.2	2	140
23/05/2019	644.979	178.6	7.3	1300	250	6.4	5.2	166
28/06/2019	669.865	156.6	8.2	1000	650	17	7.3	96
19/07/2019	382.702	113.1	7.9	820	850	28	4.9	203
22/08/2019	396.358	111.2	7.8	700	1000	7.6	4.2	212
26/09/2019	237.005	104.6	7.2	960	570	19	3.3	344
24/10/2019	557.654	67.2	7.5	880	550	14	3	178
22/11/2019	282.586	181.8	7	1200	1100	22	59	264
13/12/2019	332.77	203	7.9	1400	65	20	21	25
30/01/2020	197.233	213	8.2	1400	16	46	20	14
28/02/2020	1299.968	189.9	7.3	1500	200	9.3	1.6	1112
27/03/2020	1105.8	218	8.2	1500	31	4.1	3.3	92
30/04/2020	555.221	211	8.4	1700	7	7	4	9
29/05/2020	512.728	185.7	8.1	1100	350	19	10	137
25/06/2020	538.946	220	8.4	1600	120	10	7.6	58
31/07/2020	645.105	249	8.5	1900	170	6.9	11	15
28/08/2020	566.789	194	8.3	1400	160	7	10	14
25/09/2020	357.565	199.9	7.9	1500	67	5.3	6	55
29/10/2020	422.502	241	8.2	2100	500	16	4.9	89

Licence: L7413/1998/10

Date	Volume	EC	pH	TDS	TSS	TN	TP	BOD
Unit	kL	mS/m		mg/L	mg/L	mg/L	mg/L	mg/L
26/11/2020	474.7	200	8.2	1300	200	7.1	4.7	11
11/12/2020	376.093	154.6	8.4	1000	220	9.7	1.8	11
28/01/2021	258.064	110	7.5	1200	250	22	9.1	110
26/02/2021	678.922	127.8	5.8	1200	150	10	6.5	908
26/03/2021	760.128	250	5.8	3100	210	11	5.6	4140
29/04/2021	1,200.95	173.8	7.1	1500	570	20	5.2	792
3/06/2021	872.678	190.1	7.3	1700	240	12	8.1	504
25/06/2021	737.592	191	8.2	2200	130	6.7	5.8	688
23/07/2021	863.646	168.2	7.6	1400	120	4.4	9.5	199
27/08/2021	277.651	209	6.9	2100	88	6.3	8.1	476
30/09/2021	405.911	193	8	1800	60	5.5	4.8	520
21/10/2021	602.019	192	8.2	2100	53	6.1	4.8	169
25/11/2021	430.807	211	8.1	1800	19	2.8	2.8	55
17/12/2021	545.822	237	8.6	2000	14	1.4	2.9	6
27/01/2022	478.944	236	8.5	1700	16	25	14	42
27/02/2022	615.201	188.8	8.2	1400	7	0.66	3.2	12
24/03/2022	1,519.79	215	8.3	2100	95	3.4	1.2	141
28/04/2022	841.671	234	8.3	1500	810	17	5.3	151
26/05/2022	618.84	177	8.4	1600	53	3.2	4.5	12
26/06/2022	557.317	237	8.1	2100	420	7.2	7.1	128
28/07/2022	563.151	193	8.4	1700	48	9.6	5.2	102
1/09/2022	537.182	194	7.9	1700	120	6.9	3.6	82
29/09/2022	352.562	173	7.6	1900	4	1.3	6.3	227
28/10/2022	549.479	241	8	2100	22	3.3	0.89	118
2/12/2022	448.099	215	8.2	1900	28	6.9	4.4	58
5/01/2023	786.599	586	8.4	2200	6	18	8.7	82
31/01/2023	477.754	255	8.4	2100	2	35	28	56
23/02/2023	468.836	209	7.7	1600	7	71	13	7
30/03/2023	1,304.74	249	7.9	2000	50	4.2	1.9	118
27/04/2023	1,090.12	286	8	2300	6	1.4	1.9	10
25/05/2023	766.739	226	7.8	2200	6	2.3	5.2	9
29/06/2023	676.789	244	7.6	1500	8	1.8	8.6	10
27/07/2023	0	257	7.6	2300	14	3.4	6.3	19
24/08/2023	0	251	7.7	1900	14	6.4	0.71	15
28/09/2023	423.127	245	7.7	2100	14	3.6	0.51	9
9/11/2023	308.038	331	7.9	2800	6	2.3	1.6	4
30/11/2023	340.74	345	7.9	2800	7	1.9	2	11
15/12/2023	141.448	354	7.6	3200	9	32	36	9
25/01/2024	318.228	358	7.9	3100	34	3.5	28	6
22/02/2024	1330.219	321	7.9	2900	9	0.9	2.9	8
21/03/2024	854.729	366	8	2700	5	1.3	5.5	11
26/04/2024	471.938	424	7.9	3100	11	4.4	16	6

Date	Volume	EC	pH	TDS	TSS	TN	TP	BOD
Unit	**kL**	**mS/m**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
31/05/2024	581.927	416	8.1	3300	21	3.5	4.6	1
27/06/2024	0	288	7.9	2200	19	2.9	9.5	99
Average		**209.98**	**7.79**	**1691.31**	**221.93**	**10.69**	**7.45**	**221.86**
Median		**193.5**	**7.9**	**1550**	**105**	**6.95**	**4.8**	**97.5**

Appendix 3: Nutrient offtake calculations for emission loading.

Below are the calculations for the nutrient uptake of *Eucalyptus globulus*. Values used in calculations were retrieved from Medham et al. 2014.

	Nitrogen	Phosphorous
Formula	Nutrient offtake = a verage annual total yield * nutrient content	
Average annual total yield (t-DM/year)[1]	30 * 0.8 = 24	
Nutrient content (kg/t-DM)[2]	6.57	0.5
Nutrient offtake (kg/ha/year)	**158**	**12**

[1] calculated as an average annual yield over the trial period -20% as a conservative approach due to lack of site-specific soil information and coppicing plan.

[2] calculated as an average nutrient content from values in Table 3 (Medham et al. 2014).

Appendix 4: Water balance for the evaporation pond.

Below are the results of a basic water balance calculation on months where precipitation exceeded evaporation using weather data provided by the applicant retrieved from BOM, weather station 009936 in 2021 (BOM, 2024; BOM, n.d.) and a conservative effluent irrigation rate as a daily average effluent irrigation rate at maximum theoretical production (3200 kL of wine). Red indicates months where inputs exceed maximum evaporation pond storage of 2457.6 kL (exceeded by 889.89 kL in September).

Values in red represent

Parameter	Units	May	Jun	Jul	Aug	Sep
Days in month	days	31	30	31	31	30
Effluent irrigation rate	kL/day	22.19	22.19	22.19	22.19	22.19
Inputs						
Precipitation	mm	203.20	165.50	251.80	224.80	92.40
Precipitation in pond[1]	kL	416.15	338.94	515.69	460.39	189.24
Effluent irrigation	kL	0.00	665.70	687.89	687.89	0.00
Total input	kL	416.15	1004.64	1203.58	1148.28	189.24
Outputs						
Evaporation	mm	65.00	50.00	50.00	60.00	75.00
Evaporation from pond[1]	kL	133.12	102.40	102.40	122.88	153.60
Total output	kL	133.12	102.40	102.40	122.88	153.60
Net change (inputs - outputs)	kL	283.03	902.24	1101.18	1025.40	35.64

Cumulative storage required	kL	283.03	1185.28	2286.45	3311.85	3347.49

1 pond parameters calculated as (precipitation or evaporation) * pond area (m^2) / 1000.

Appendix 5: Land application area water balance

Water balance calculations for the land application area to determine hydraulic loading.

Location :	Howard Park Wines
Land Application Area:	Land Application Area (L1,L2 and L3)
Rainfall Station (monthly mean value)	Cowaramup 2021 rainfall year (BOM number: 009936)
Evapotranspiration data (monthly mean value)	Site-specific Potential Evapotranspiration (PET) data for a short crop from BOM

Key

	Input required
	Calculations
	Output value

Design Wastewater Flow	Q	l/day	35164.8
		ML/year	9.6
		ML/ha/year	8.3
Design Irrigation Rate (DIR) (from Table M1 AS/NZ 1547)	DIR	mm/day	3.5
Run-off coefficient - determined based on Site and Soil Evaluation and run-off co-efficient table	RC		0.00
Nominated Land Application Area	LAA	m^2	**11500**
		ha	**1.150**

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
Days in Month	D	Input data	days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation (average)	P	Input data	mm/month	2.4	81.84	58	92.7	203.2	165.5	251.8	224.8	92.4	123	17	4.4	1317
Wastewater generated (KL/month)	P	Input data	KL/month	1090.1	984.6	1090.1	1054.9	1090.1	0.0	0.0	0.0	1054.9	1090.1	1054.9	1090.1	9600
Inputs																
Precipitation infiltrating	PI	P x (1 - RC)	mm/month	2.4	81.8	58.0	92.7	203.2	165.5	251.8	224.8	92.4	123.0	17.0	4.4	1317.0
Wastewater Irrigation	WI	(Q x D)/LAA	mm/month	94.8	85.6	94.8	91.7	94.8	0.0	0.0	0.0	91.7	94.8	91.7	94.8	834.8
Inputs	I	PI + WI	mm/month	97.2	167.5	152.8	184.4	298.0	165.5	251.8	224.8	184.1	217.8	108.7	99.2	2151.8
Outputs																
Evapotranspiration (PET)	ET	-	mm/month	200.4	170.5	143.8	93.2	67.0	53.5	55.8	67.7	83.0	115.3	145.7	183.6	1379.5
Percolation (potential)	B	R/7 x DIR	mm/month	108.5	98.0	108.5	105.0	108.5	105.0	108.5	108.5	105.0	108.5	105.0	108.5	1277.5
Outputs (potenial)	O	ET + B	mm/month	308.9	268.5	252.3	198.2	175.5	158.5	164.3	176.2	188.0	223.8	250.7	292.1	2657.0
Storage																
Storage indicator (positive value = storage required)		I - O	mm/month	-211.7	-101.0	-99.5	-13.8	122.5	7.0	87.5	48.6	-3.9	-6.0	-142.0	-192.9	-
Cumulative wastewater generated that is required to be stored. Note: Rain is not stored			mm/month	0.0	0.0	0.0	0.0	94.8	94.8	94.8	94.8	0.0	0.0	0.0	0.0	-
Cumulative Storage volume - accounting for commencement of irrigation			mm	0.0	0.0	0.0	0.0	94.8	94.8	94.8	94.8	90.9	0.0	0.0	0.0	-

STORAGE REQUIRED FOR NOMINATED AREA TO ACHIEVE HYDRAULIC LOADING LIMITS			m^3 or KL	**1090.1**

Hydraulic Loading Limit (KL/month)			KL	3525	2147	2234	1213	0	0	0	0	1099	1159	2688	3309	