WASTEWATER TREATMENT PROPOSAL

90 WALNUT ROAD, BICKLEY WA 6076

DISTILLERY AND CAFÉ DEVELOPMENTY

PREPARED BY HB IZZETT

BSc (civil), MSc (wastewater)

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1 INTRODUCTION

The owner of HHH Distill Pty Ltd (t/a HHH Spirits), Hilton Izzett, wishes to develop a bigger distillery than the one currently on the property, and add a café. The café will produce a waste stream that is well understood and typically called sewage. The distillery will produce a waste stream that is less well understood in Western Australia and is characterised by a very high BOD and is defined in WA as 'trade waste'. The treatment of these two waste streams could theoretically be done together but there are no approved treatment systems in WA for such a blend.

This proposal looks at the treatment of the sewage using an approved ATU treatment system and an Upflow Anaerobic Sludge Bed Reactor (UASB) which has substantial research behind it and is ideally suited for high BOD waste streams.

2 WASTE CHARACTERISTICS

2.1 Sewage

The café and ablutions have an estimated waste flow based on the café's capacity of 50 patrons and 10 staff and 10 as a design contingency. The system loading rates are taken from the Supplement to Regulation 29 and Schedule 9 - Wastewater system loading rates of the Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974 (Regulations) for WA. With a total number of people at 70 and an average waste generation of 30l/person, the daily loading rate will be 2100 l/day.

The average BOD for sewage is around 470mg/l which means that the total daily BOD loading will be around 990g/day.

2.2 Trade Waste

The distillery will produce waste from 3 different processes:

- Wash run (this is the first whisky distillation) which produces 'pot ale' and is characterised by very high BOD;
- Spirit run (this is the second whisky distillation) which produces 'lees' and has a much lower BOD, but higher than sewage;
- Gin or vodka distillations which have very low BOD, but will be assessed as having the same as a spirit run to be conservative.

Information on BOD loading rates for pot ale and lees has been acquired from an article found in ACS Publications titled "Characterization of Pot Ale from a Scottish Malt Whisky Distillery and Potential Applications" (Link: https://pubs.acs.org/doi/10.1021/acsomega.9b04023). The calculations for the average daily loading rates are based on doing 3 whisky distillations per week and one gin/vodka distillation every 12 weeks.

The calculation of waste volumes from distillation are provided below:

Calculation of distillery waste						
Distillation Vol (L)	**ABV**	**Waste**	**# per week**	**Total waste**	**Ave waste per day**	**Comments**
900	8%	665.00	3	1995	285.00	Pot Ale
235	30%	144.00	3	432	62.00	Whisky Lees

300	50%	180.00	0.0833	14.994	2.00	Gin lees
				Total ave waste	**349.00**	

Adding cleaning water to the mix we get:

Distillery Waste Calculations			
Source	**Quant**	**Vol L/d**	**Total L/d**
Pot ale	1	285.00	285.00
Lees	1	62.00	62.00
Gin lees	1	2.00	2.00
Distillery cleaning water	1	80	80.00
TOTAL per day			**429.00**

Applying average BOD rates to each waste type we get:

BoD calculations			
Source	**Total L/d**	**BoD mg/L**	**BoD mg/d**
Pot ale	285	25,000	7,125,000
Whisky Lees	62	1,500	93,000
Gin lees	2	1,500	3,000
Distillery cleaning water	80	0	0
TOTAL per day	**429**		**7,221,000**
AVERAGE BoD mg/L	**16,832**		

3 WASTE TREATMENT SELECTION

3.1 Sewage Treatment

With the flow rate of sewage being 2,100 l/d the options for treatment by approved products is limited and only Taylex has a treatment system suitable, being the Taylex 5000 which is designed for the treatment of 5000 litres and a daily BOD loading of 2,330 g/d. This system more than twice the size required and provides plenty of capacity anomalies in flow.

3.2 Trade Waste Treatment

As mentioned above, the UASB reactor has been selected to treat the trade waste. Data for this selection was taken from a paper titled: “Grape wine distillery waste in UASB systems - Feasibility, alkalinity requirements and pH control” by RE Moosbrugger, MC Wentzel*, GA Ekama and GvR Marais, Department of Civil Engineering, University of Cape Town. The author of this proposal was doing research in the laboratory under Professor GA Ekama at the same time as RE Moosbruger and is familiar with his research.

The UASB has a number advantages for high BOD waste treatment:

- It can handle large fluctuations in BOD due to the pelletisation of the sludge which distributes the anaerobic bacteria evenly in the lower portion of the reactor, creating excellent contact time of influent with the bacteria;
- Anaerobic digestion creates alkalinity which stabilises the pH of the system, a very important consideration for a waste stream with a pH as low as 3.5;
- The system is simple and easy to operate with very low energy consumption;
- BOD reduction of the effluent is up to 94% with most of the processing taking place in the sludge bed which occupies the lower 50% of the reactor.

4 DESIGN OF TREATMENT PROCESS

4.1 Trade Waste Treatment

Since the treatment of sewage will be by an approved system, there is no need to discuss it in this proposal. The UASB has been designed based on parameters derived from Moosbrugger *et al* and the calculation of reactor sizing is given below:

Design Parameters				
Parameter	**Units**	**From**	**To**	**Design**
Hydraulic retention time	day	0.3	1	0.42
Upflow	m/hr	0.15	1.5	0.5
BOD dosing rate	mg/l	400	6000	1200
COD loading rate	kg/m3 sludge	2	20	9
BOD Loading rate	kg/m3 sludge	1.1	11	5

Calculated parameter	**Value**	**Units**
Ave BOD/day	16,832	mg/l
Ave flow/day	429	l/d
Total BOD	7,221,000	mg/d
Total BOD	7	kg/d
Diluted flow = dilution tank size	6018	l/d
Recycle ratio 1:	14	
Volume of reactor (litres	2528	litres
Flow	0.25	m^3/h
Area for design upflow (m2)	0.50	m^2
Diameter (m)	0.80	m
Height of reactor	5.04	m

A design based on these parameters will yield an effluent BOD of about 1,200 mg/l or better.

Traditionally, the UASB reactor is a single tank that is slender. However, the practicalities of this with small flows means that a tank with a diameter of, say, 0.8m, would have to be 5-6m high. Moosbrugger *et al* did experiments with 2 tanks in series with good results. For this proposal economic considerations are important and creating a UASB system with off the shelf products will keep the costs down while still maintaining the effectiveness of the treatment.

The design envisages using 'slim' water tanks with a diameter of 0.8m and a height of 2m. Three tanks in series will give the required volume for processing. On a large scale it is more expensive to do this, but on a small scale it is cheaper as there is no need to custom fabricate the tanks. It is a well known fact in waste treatment that multiple reactors in series produce better results than a single one, and accommodate anomalies in flow and concentration better too.

An important factor in the UASB treatment is the BOD to sludge volume ratio. In the experiments the sludge volume was kept constant by removing an amount every day. In this proposed design using 3 tanks in series, the volume of sludge can be manipulated very easily. By oversizing the dilution tank it also provides options to vary the dilution ratio if needs require. See appendix A for the PDF drawing.

The effluent and sludge waste from the UASB will be directed to the ATU. The UASB will produce an effluent of BOD = 1200 mg/l and with 430 litres effluent per day that equates to 516 g/day. The ATU has a capacity of 2330 g/day; the loading from sewage is 990 g/day, giving a total of just more than 1,500 g/day. This is still 800 g/day less than the capacity, leaving excess capacity of 800 g/day, or 34%.

The extra loading of the ATU from the UASB will assist the ATU in its performance, providing it with more carbon and nutrients, which it is notoriously short of.

4.2 Effluent Disposal

Using the Wastewater Calculator found on the Department of Health's website (https://www.health.wa.gov.au/~/media/Corp/Documents/Health-for/Water/Wastewater/Wastewater-Calulator.xlsm), and inputting data from the site conditions and the SSE, the effluent disposal system has been designed using a mound.

The disposal of effluent needs to be conducted 2m above the water table, which is 0.9m below ground level in the middle of winter at the proposed location (See drawing #A120 in the architect's package). The design drawing is attached at Appendix B.

4.3 Sludge Disposal

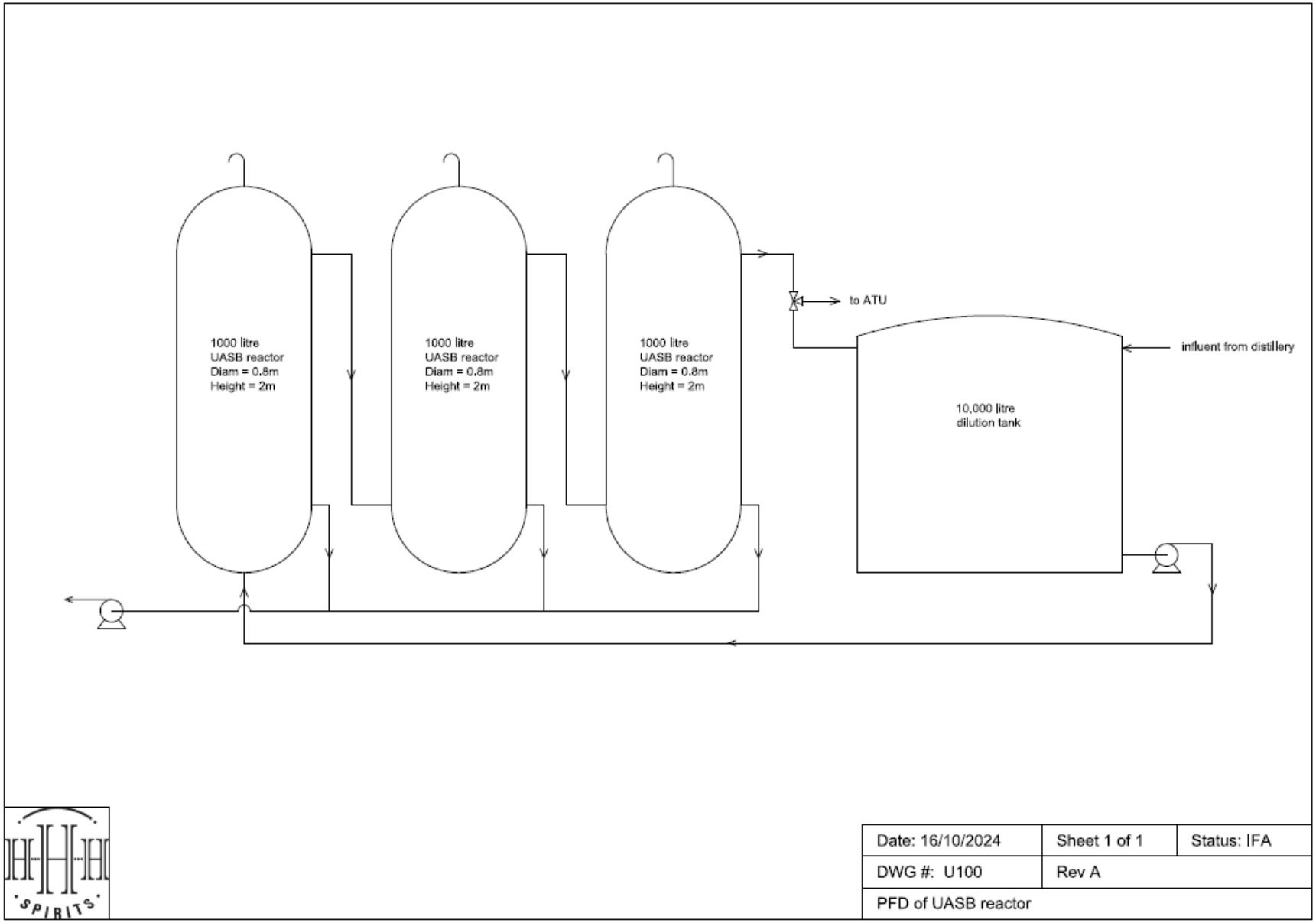
All the sludge from both the ATU and the UASB will end up in the anaerobic portion of the ATU and will accumulate over time. Generally, the anaerobic digestion will reduce the mass of solids by 60% through the generation of carbon dioxide and methane, so the accumulation of solids is much slower than the input. The sludge will be disposed by tanker at appropriate intervals as determined by personal doing the maintenance inspections on the ATU.

5 SUMMARY

Due to the two differing waste streams, it is proposed to use 2 treatments systems, an aerobic treatment unit for the café sewage and a UASB for the distillery waste. The effluent from the distillery waste will be transferred to the ATU which will enhance its performance.

Effluent from the ATU will be disposed of in a mound due the requirement of discharging 2m above the water table. Sludge disposal will be by tanker at appropriate intervals when the sludge level in the anaerobic digester of the ATU becomes too high.

A. PFD of UASB design



B. Effluent Disposal Mound

