TECHNICAL MEMORANDUM

To	[redacted], Shire of Upper Gascoyne
From	[redacted]
Date	18/12/2024
Job Number	11974
Subject	Evaporation Pond Sizing Calculations

1 INTRODUCTION

The Shire of Upper Gascoyne (the Shire) engaged WML Consultants to provide the concept and detailed design for a proposed HDPE-lined evaporation pond at their Gascoyne Junction waste facility on Wansborough Rd. The evaporation pond is required to store brine wastewater from the proposed reverse osmosis (RO) plant which is part of a larger water harvesting process being set up by the Shire. This letter details the methods and assumptions used to design the pond, ensuring excess evaporation is achieved on an annual basis.

2 DESIGN METHODOLOGY

The detailed design sizing of the evaporation pond was undertaken in two stages. The initial stage was used to estimate the minimum floor area required to achieve a greater cumulative monthly evaporation than cumulative monthly inflow across a 12-month period. This assumed a rectangular evaporation pond with a 1.5 m high embankment, with inflow comprising the RO plant wastewater and rainfall captured within internal embankments. The 3D model was then designed with this minimum floor area to achieve a roughly neutral cut-to-fill volume to minimise the cost of earthworks. The evaporation/inflow balance was then recalculated using the 3D design areas to ensure that the annual average evaporation is larger than the yearly inflow volume.

3 INFLOW VOLUME

Inflow to the evaporation pond will mainly comprise the RO plant's brine wastewater, with rainfall also entering the pond across the floor and internal embankments. The evaporation pond was designed with a seasonal wastewater input volume of 60 m^3/day in the warmer months (October to March) and 30 m^3/day in the cooler months (April to September), which was provided as design inputs by the Shire based on maximum expected usage patterns. 60 m^3/day is the maximum wastewater production capacity of the RO plant, with current outputs expected to be between 43-50 m^3/day.

Average monthly rainfall data was obtained from the Bureau of Meteorology (Gascoyne Junction station 006022) to determine the approximate volume of rainfall entering the pond inside the internal crest. A pond floor area of 6,254 m^2 and a catchment area inside the crest of 9,299 m^2 were used. No design storm events (e.g. 0.2 EY) have been factored into the inflow calculations as the catchment area is relatively small, and inflow and evaporation have been designed on a monthly scale. A summary of the monthly wastewater and rainfall inflows is provided below in Table 1.

Table 1: Monthly design inflow volumes.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily wastewater volume (m^3)	60	60	60	30	30	30	30	30	30	60	60	60
Monthly wastewater volume (m^3)	1,860	1,680	1,860	900	930	900	930	930	900	1,860	1,800	1,860
Average monthly rainfall (mm)	23	31	30	14	28	31	26	12	3	5	3	4
Monthly rainfall volume (m^3)	215	287	274	129	257	289	245	110	27	42	32	36
Total monthly inflow (m^3)	2,075	1,967	2,134	1,029	1,187	1,189	1,175	1,040	927	1,902	1,832	1,896

4 EVAPORATION VOLUME

Evaporation was estimated from the Bureau of Meteorology's monthly evaporation maps, which provide evaporation estimates for all of Australia based on pan evaporation data collected between 1970-2005. The evaporation volume was determined by multiplying the monthly evaporation (mm) by the area at the base of the pond. The water level will fluctuate throughout the year, resulting in a potentially larger surface area for evaporation to occur, however, using the floor area is conservative as it is the smallest area available for evaporation to occur over. The Bureau of Meteorology's 2017 trend map shows that between 0-2.5 mm/10 years of additional evaporation has been recorded between 1970-2016. As this value is minimal, no additional climate change factors have been applied. The design monthly evaporation values are shown below in Table 2.

Table 2: Monthly design evaporation values.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average pan evaporation (mm)	360	310	300	225	160	115	120	155	205	280	365	355
Monthly evaporation volume (m^3)	2,251	1,939	1,876	1,407	1,001	719	750	969	1,282	1,751	2,283	2,220

To be conservative, no additional evaporation due to the effect of the black HDPE surface heating up the wastewater was applied, however, some studies have shown that the rate of evaporation can increase by approximately 20%.

5 EVAPORATION/INFLOW BALANCE

The cumulative monthly inflow and evaporation values can be seen below in Table 3, with Figure 1 showing the stored volume in the pond at the end of each month. It can be seen that at the end of the 12-month period, the expected evaporation for the 60/30 m^3/day seasonal production pattern is 96 m^3 greater than the expected inflow. The maximum required storage of 1,121 m^3 occurs in August. The available storage volume of the evaporation pond is over 18,800 m^3, allowing for storage from a significant rainfall event or the temporary increase in wastewater production over winter.

Table 3: Cumulative monthly design inflow and evaporation values.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cumulative inflow (m^3)	2,075	4,042	6,176	7,206	8,392	9,582	10,757	11,797	12,724	14,626	16,457	18,353
Cumulative evaporation (m^3)	2,251	4,190	6,066	7,474	8,474	9,193	9,944	10,913	12,195	13,946	16,229	18,449

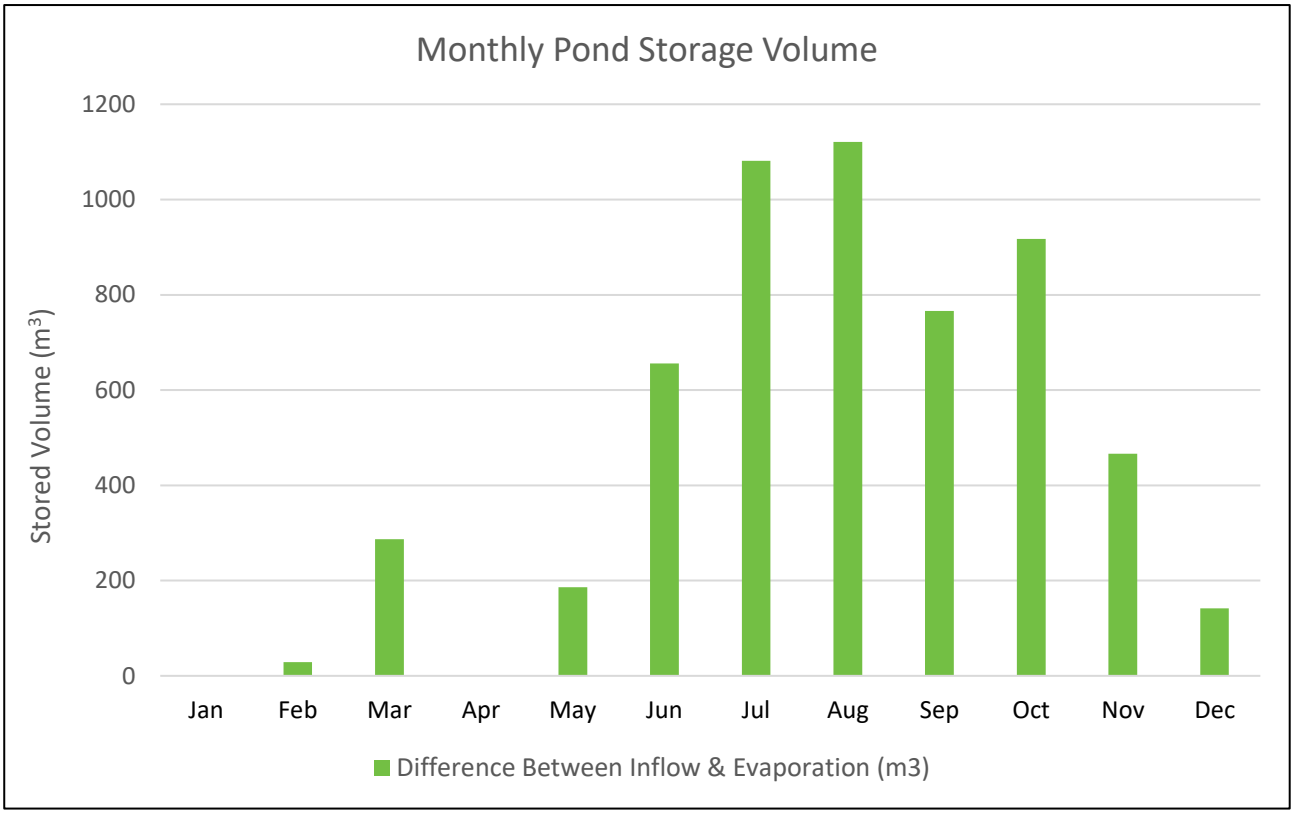

Figure 1: Monthly pond storage volume.

A spillway has been designed near the northwest corner to allow for controlled water discharge should the pond ever overtop. The existing surface at the northwest corner is one of the lowest points on the exterior of the dam, where water will flow towards the nearby overland flow path that leads to the Gascoyne River.

6 CONCLUSION

The Gascoyne Junction reverse osmosis wastewater evaporation pond has been designed and sized to ensure an excess evaporation potential is achieved across a 12-month period based on monthly inputs for inflow (RO plant wastewater and rainfall) and evaporation. Average monthly evaporation/rainfall data was sourced from the Bureau of Meteorology and a seasonal design inflow of 60 m^3/day during the warmer half of the year, and 30 m^3/day during the colder half of the year was provided by the Shire. Expected current peak inflows of between 43-50 m^3/day will result in a shallower volume of water being present for less of the year.

Yours faithfully,

[redacted]

Civil Engineer
Author

[redacted]

Senior Civil Engineer
Reviewer

For and on behalf of WML Consultants Pty Ltd