ENGENY

MEMORANDUM

Project:	Spring Creek North Continuation Project Final Void Hydrology Assessment	Date:	6 October 2023
To:	Rolleston Open Cut	From:	Syed Ali, Aaron Baldwin
ATT:	Jeremy Duncan	CC:	Andrew Turnbull, Dave Moss
Subject:	Spring Creek North Continuation Project Final Void Assessment Summary		

INTRODUCTION

Rolleston Open Cut (ROC) commissioned Engeny to undertake a final void hydrology assessment to support the Spring Creek North Continuation Project (SCNCP) approvals process. This work has been completed in response to the Department of Environment and Science (DES) queries to the SCNCP Surface Water Assessment (Engeny, 2023) and SCNCP Groundwater Assessment (Umwelt, 2023). The scope involves development of a detailed water balance model of the SCNCP final voids to validate the findings documented in the SCNCP groundwater assessment (Umwelt, 2023) and an assessment of final void water quality post closure.

Objectives

The key objectives of this assessment are to address the queries from DES as outlined in Table 1.

Table 1: DES Queries for SCNCP Approval and Response Approach

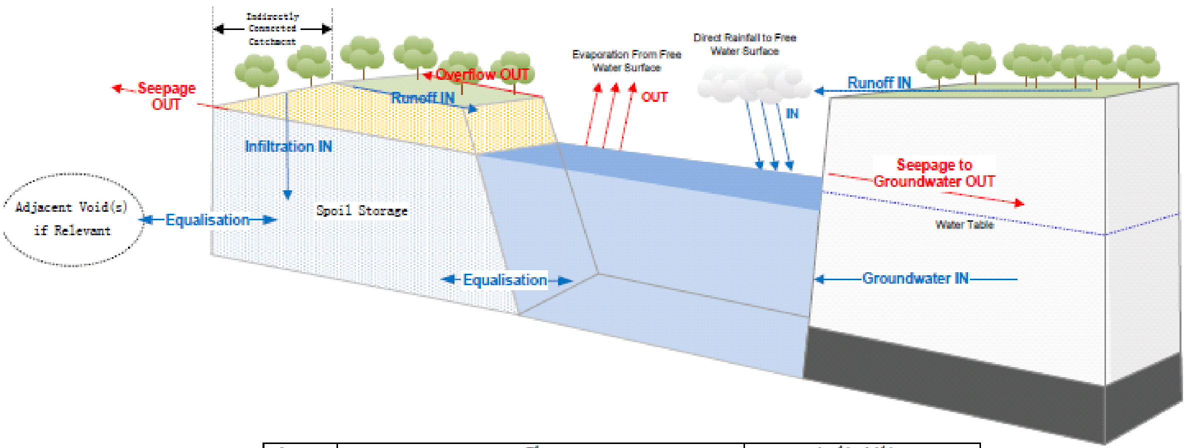
DES Query	Engeny Response Approach	Relevant Section
a) Appendix B, Section 5.5.1 states: "Recharge to the final voids was increased to 150% of annual rainfall to account for overland flow plus surface water diversion." However, it's unclear what surface water assessment was utilised to investigate and assess catchment size and run off to support the assumptions made.	• Review of the SCNCP final void configuration to determine the final drainage catchment/s. • Development of a water balance model to assess the void lake recovery and equilibrium status. • Validation of the assumption relating to final void recharge against the predicted void lake level results.	Results and Discussion, DES Query A
b) Section 5.3.10.2 of the supporting information document states: "Water quality within the final voids will change over time with groundwater inflows, spoil recharge and evaporative processes. However, as discussed in Section 5.3.5, unlike other areas in the Bowen Basin, groundwater within the Study area is generally of good quality, with fresh to brackish salinity. The periodic recharge events associated with La Niña episodes would also contribute fresh water." However, an assessment of final void water quality has not been provided.	• Use of the water balance model to assess the water quality within the final void.	Results and Discussion, DES Query B

METHODOLOGY

Conceptualisation

The conceptualisation of the SCNCP final void water balance is in accordance with the groundwater assessment (Umwelt, 2023) and is intended to validate surface water assumptions and predict long term final void water quality post closure. Figure 1 shows the water balance conceptual model used as the basis for this water balance model development and considers the following key water fluxes:

- Inflows:
  - Surface runoff from the void catchment – the surface drainage catchment is primarily rehabilitated spoil and minor undisturbed areas.
  - Direct rainfall on the void lake surface area.
  - Groundwater inflows to the void (if the void lake level is lower than the regional groundwater table).
  - Seepage through spoil from adjacent voids where relevant.
- Outflows:
  - Evaporative losses from the void lake surface area.
  - Groundwater outflows (if the void lake level is higher than the regional groundwater table).
  - Surface overflow if void storage capacity is exceeded.
  - Seepage through spoil to adjacent voids where relevant.



Aspect	Flux	Applicability
Input	Direct rainfall to water surface	All voids
	Runoff from connected catchment	All voids
	Infiltration from indirectly connected catchment	Void-specific
	Groundwater	Void-specific
	Equalisation through spoil from adjacent void(s)	Void-specific
Output	Evaporation	All voids
	Surface overflow	All Voids
	Seepage to groundwater	Void-specific
	Seepage via Spoil to receiving enviroment	All voids
	Equalisation through spoil from adjacent void(s)	Void-specific

Figure 1: Water Balance Conceptual Model

Approach and Assumptions

The SCNCP final landform includes partial backfill and rehabilitation of the mining pit to a stable grade which forms two final voids (Void 7 and Void 8) separated by rehabilitated backfilled spoil. It is proposed the final voids will not spill to the receiving environment or interact with the regional groundwater system to minimise the risk of potential impacts to environmental values. Where feasible, the final landform was shaped to direct drainage away from the final voids and includes external catchment diversion drains to reduce the volume of runoff reporting to the voids. Table 2 outlines the details and the assessment approach taken for SCNCP final void water balance assessment which was developed based on the conceptualisation presented in the groundwater assessment (Umwelt, 2023) and summarised in the previous section. The location and catchment reporting to the final voids is shown in Figure 2.

The water balance model was developed using the GoldSim software package. The water balance model utilises 133 years of daily rainfall and evaporation data obtained from SILO Data Drill (-24.40, 148.40) and was simulated on a daily timestep until both Void 7 and Void 8 reached equilibrium conditions. The runoff and water quality parameters were obtained from the existing operation water balance model for ROC, which is calibrated annually as part of the sites water management plan.

Table 2: SCNCP Details and Assessment Approach

Void	Assessment Approach
General	• Modelled as two voids (Void 7 and Void 8) which are hydraulically connected through spoil and seep between each other based on the water level difference between the voids.
Catchment Runoff and Direct Rainfall	• Catchment runoff is modelled using a daily Australian Water Balance Model (AWBM) for the catchment area reporting to each void which includes 277 ha for Void 7 and 354 ha for Void 8. • Direct rainfall (100% runoff) is modelled over the ponded void lake surface areas with daily rainfall.
Spoil Storage	• Allowance for water stored in the backfilled spoil areas with an assumed spoil porosity of 10%. The base of the void lakes are formed by approximately 100m of backfilled spoil above the base of the mining pit floor.
Groundwater Inflows	• Groundwater inflows were provided from the regional groundwater model (Umwelt, 2023) and includes flows from the basalt unit only (alluvium not relevant in the vicinity of Spring Creek North) (Umwelt, 2023) which is split evenly between Void 7 and Void 8 (0.48ML/d each, respectively).
Evaporation	• Lake evaporation is modelled over the ponded void lake surface areas using daily Moreton's Lake evaporation. For consistency with the groundwater assessment (Umwelt, 2023), the evaporation rate was reduced to 80% of Moreton's Lake evaporation to account for shadow cover.
Water Quality	• Groundwater inflow quality of 1,188µS/cm based on monitoring data as documented in Umwelt, 2023. • Surface runoff water quality of 547µS/cm based on the rehabilitated spoil catchment landuse.

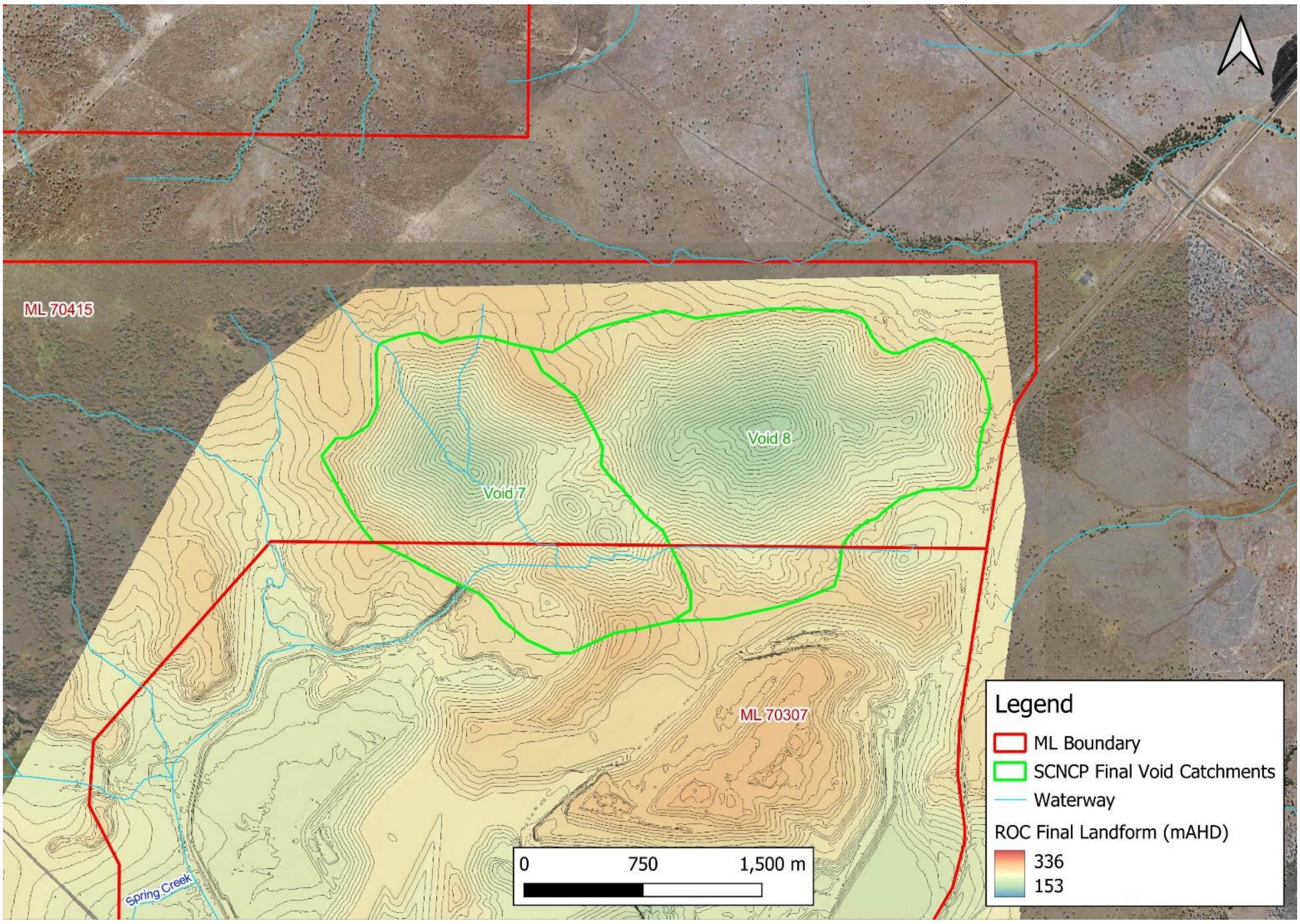


Figure 2: SCNCP Final Void Catchment Areas

Final Void Storage Characteristics

The final void storage characteristics are presented in Figure 3 and summarised in Table 3. The final voids are located approximately 100 m above the mining pit floor and the backfilled spoil will need to recover a significant amount of water storage before the void lakes will permanently hold water. The storage curves presented in Figure 3 are inclusive of surface storage volume and storage within the backfilled spoil based on the depth of the mining pit shell. The critical water levels are also presented in Table 3 and Figure 3.

Table 3: Important and Critical Water Levels

Storage Level Description	Void 7	Void 8
Base of Mining Pit: The base elevation at which the backfilled spoil will retain water.	106mAHD	
Base of Void: The base elevation of each final void and the level which water retained in the backfill spoil will need to exceed before water is retained by the pit lakes.	211mAHD	200mAHD
Critical RL 1 – Equilibrium levels determined in the groundwater assessment: the levels at which final voids will stabilise post mining and perform as sinks to groundwater (Umwelt, 2023)	230mAHD	225mAHD
Critical RL 2 - Spill Level: Elevation at which surface overflow to the receiving environment could occur i.e., the total storage capacity of the combined final voids is exceeded.	240mAHD	

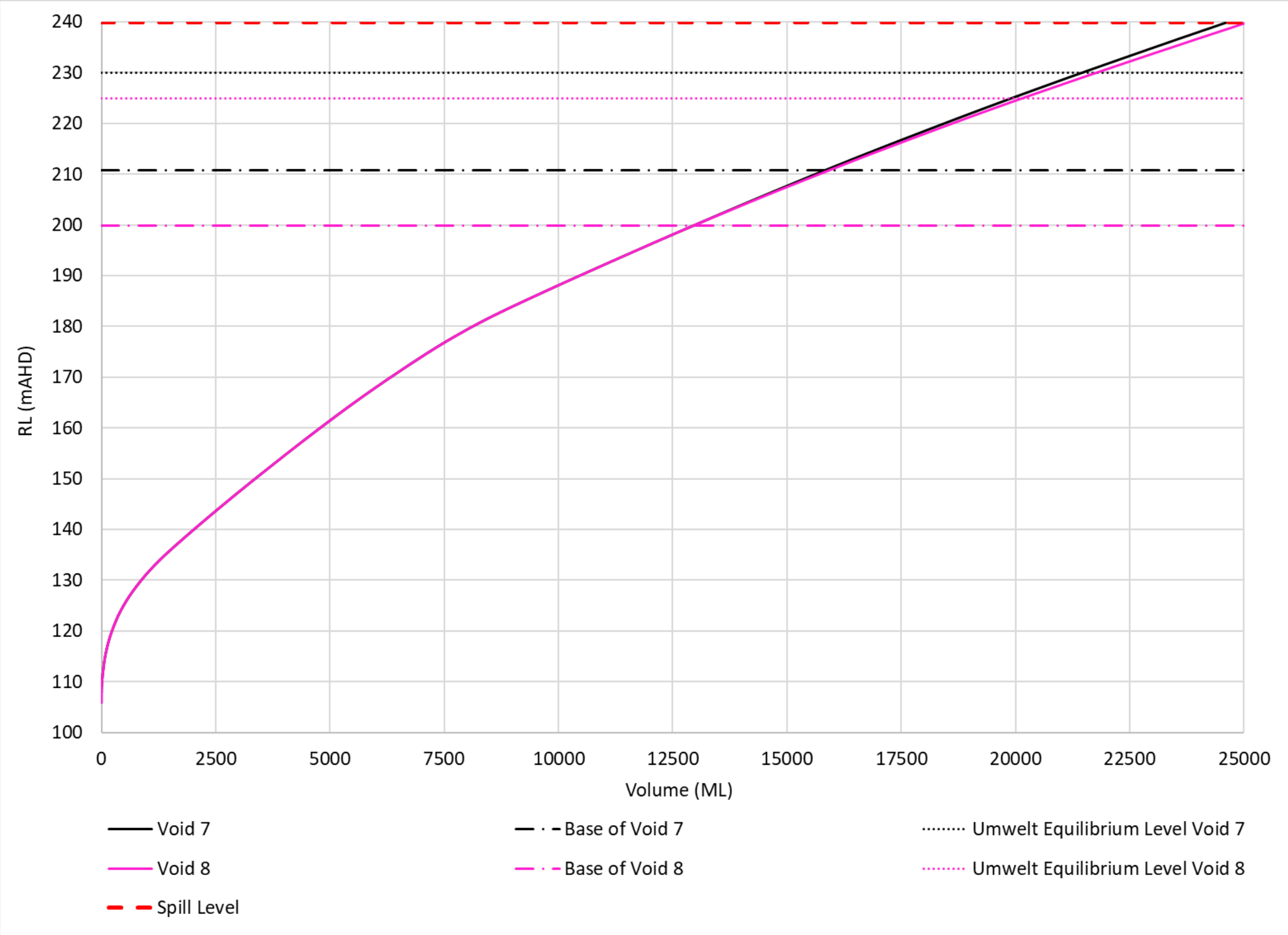


Figure 3: SCNCP Final Void Storage Curves

RESULTS AND DISCUSSION

The following sections present and discuss the results of the final void water balance model to address the DES queries to the SCNCP Surface Water Assessment (Engeny, 2023) and SCNCP Groundwater Assessment (Umwelt, 2023).

DES Query A

The void lake water balance model results for pit lake water level post mining are shown in Figure 4 and Figure 5 and indicate the following:

- The void lake equilibrium level in Void 7 is 220mAHD and 218mAHD in Void 8
- Following recovery of the pit lake level to equilibrium conditions the void lake level in Void 7 fluctuates between 218mAHD and 221mAHD and between 215mAHD and 224mAHD in Void 8.
- The void lake equilibrium level in Void 8 is lower (~2-3m) than in Void 7.
- Void 7 and Void 8 remain below the equilibrium levels determined in the groundwater assessment indicating the voids will perform as groundwater sinks.
- Under 95th percentile wet conditions, Void 7 and Void 8 will reach equilibrium at a similar rate.
- Under median climate conditions, equilibrium will be reach in approximately 80 years in Void 7 and 96 years in Void 8.

The final void water balance model provides a better representation of long-term pit lake levels and salinity compared to the groundwater model given the finer modelled timestep (daily) and consideration of climate variability. The groundwater model is primarily used to assess long-term groundwater interactions with the final voids. As a result, the water balance model has been used to validate the surface water inputs adopted in the groundwater model by comparing pit lake level recovery results. A comparison of the water balance and groundwater pit lake level results indicate:

- The base case equilibrium levels determined from the groundwater model in Void 7 (230mAHD) and Void 8 (225mAHD) were similar to those determined in this assessment (220mAHD and 218mAHD, for Void 7 and Void 8, respectively).
- The groundwater model predicted a lower equilibrium lake level in Void 8 compared to Void 7, which is consistent with this study.
- The time taken to reach equilibrium determined by the groundwater model was approximately 100 years which is similar to the modelled results in this study (80 years in Void 7 and 96 years in Void 8).
- Both assessments determined that Void 7 and Void 8 will perform as sinks to groundwater.
- Sensitivites presented in the groundwater assessment indicate that under all scenarios, Void 7 and Void 8 will perform as sinks to groundwater with sensitivity scenario results for Void 7 lake level between 210mAHD and 230mAHD and Void 8 lake level between 200mAHD and 225mAHD.
- The consistency between the water balance assessment results and the groundwater assessment results suggests the 150% factor applied to rainfall on the pit lake surface area to represent surface runoff in the groundwater model is valid.

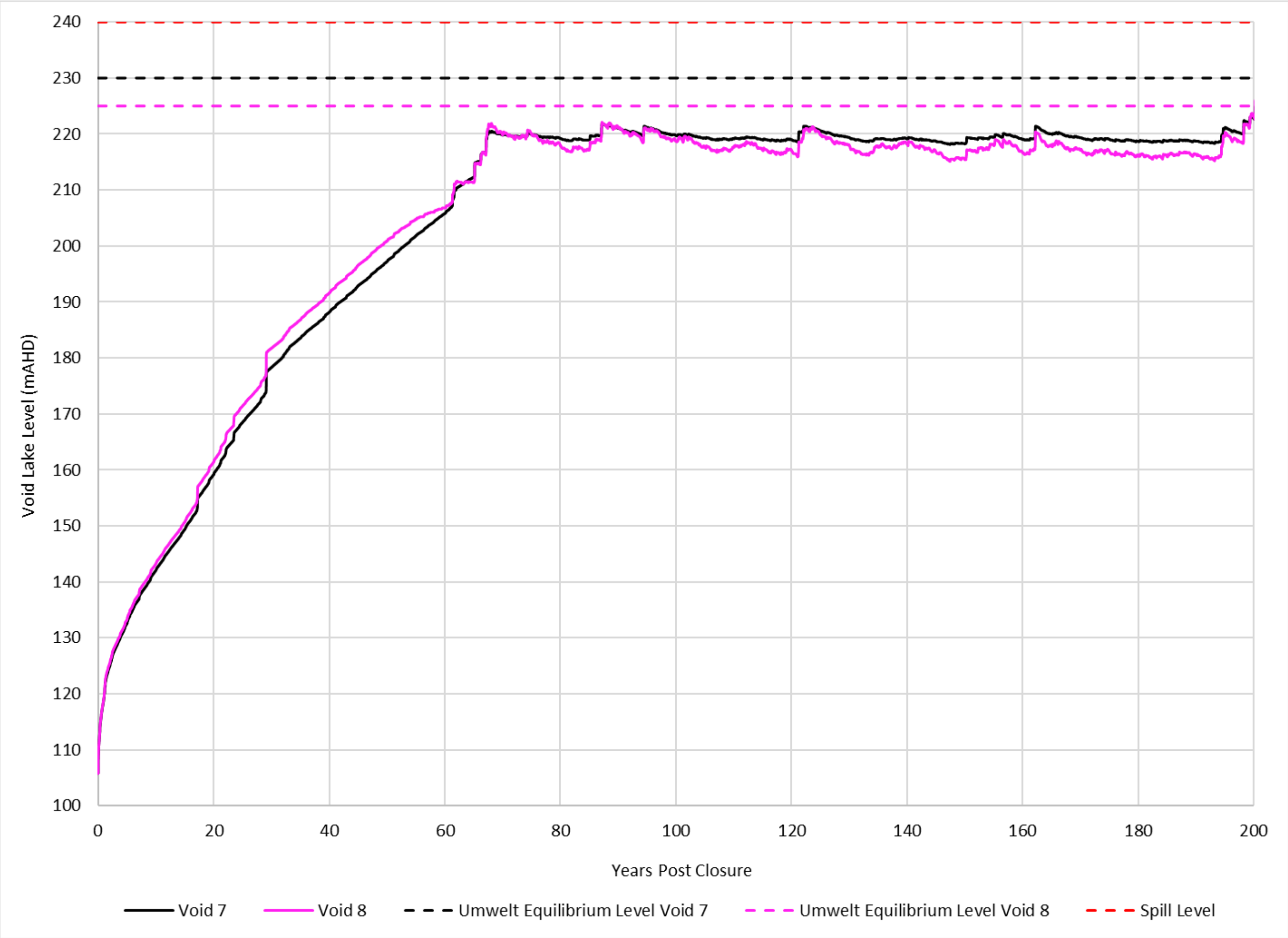


Figure 4: SCNCP Final Void Lake Levels

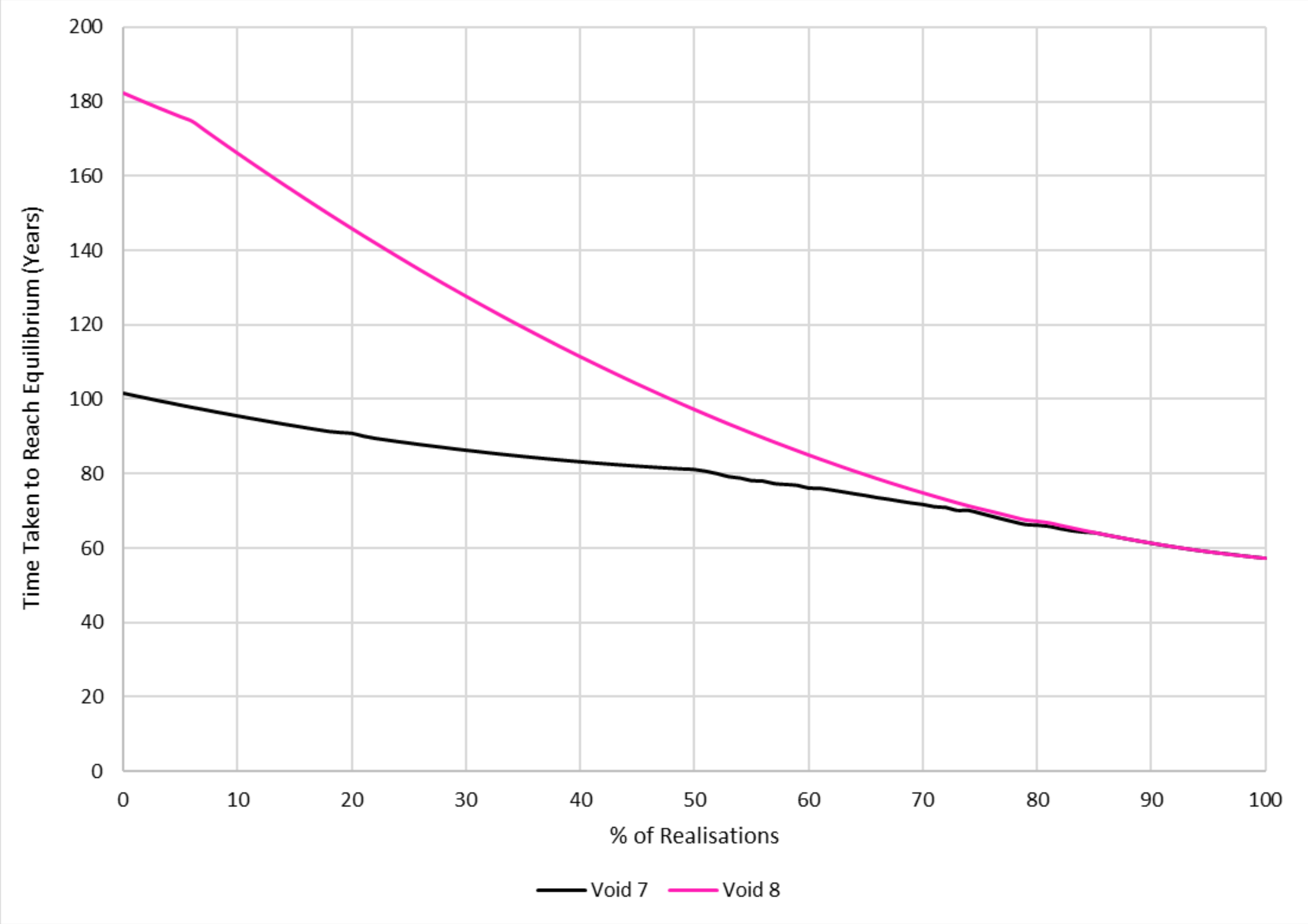


Figure 5: Time Taken to Reach Equilibrium in Void 7 and Void 8

DES Query B

The post mining void water quality was also assessed, results of which are shown in Figure 6. These results indicate that:

- The final void water quality remains fairly constant during the first 60 years which corresponds to the backfilled spoil filling period and is consistent with the regional groundwater quality with some minor dilution from surface runoff infiltration through the voids.
- Following the initial filling period of the backfilled spoil below the void lakes Void 8 has an increasing salinity trend due to seepage connectivity between Void 7 and Void 8.
- After 200 years post closure, the water quality within Void 7 and Void 8 will remain below the tolerance level for stock water for beef cattle of approximately 6,000µS/cm (ANZECC and ARMCANZ 2000 Volume 1: Chapter 4.3 Table 4.3.1) (DEHP, 2011).

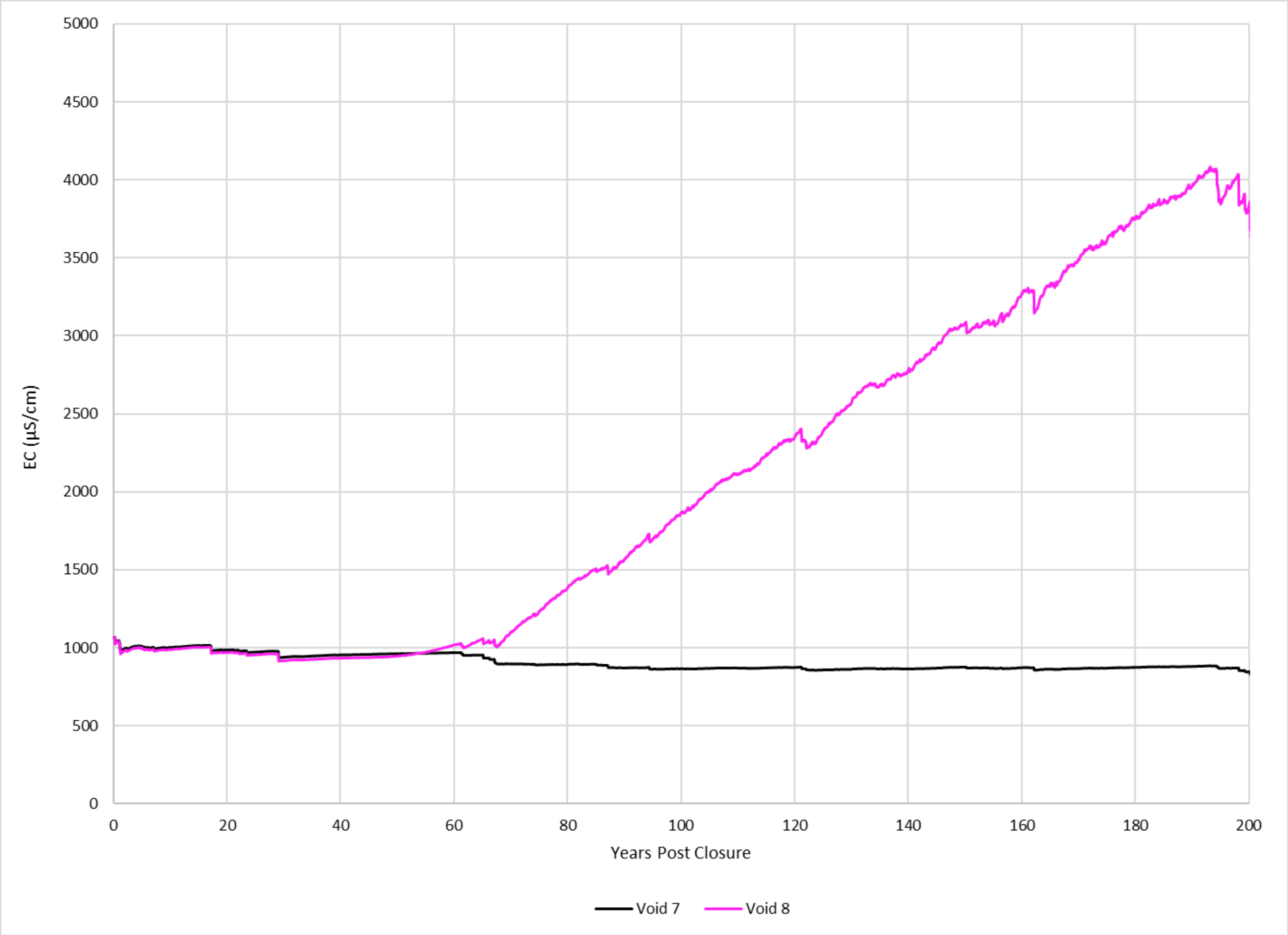


Figure 6: Spring Creek North Final Void Water Quality

REFERENCES

DEHP (2011). *Environmental Protection (Water) Policy 2009. Comet River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Comet River Sub-basin.* September 2011.

Engeny (2023). *Spring Creek North Surface Water Assessment.* QC1001_001-REP-001-3. January 2023.

Umwelt (2023). *Groundwater Impact Assessment, Spring Creek North Continuation Project.* 21834_R03_GWAssessment_Final_V3. April 2023.

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