South Walker Creek Mulgrave Resource Access: Stage 2C (MRA2C)

EPBC 2017-7957

Appendix J:
Final Void Water Balance Modelling Summary

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(Alluvium 2018)

1 Conditions of the final void post closure

1.1 Final Void water balance modelling

An assessment of the water balance and water quality conditions in the final void likely to remain in F pit has been examined through hydrologic modelling. A water balance model was created by considering rainfall, evaporation, contributing catchment area and hydrogeologic characteristics of the area.

Conceptually, we considered the final pit void as being a local sink pit lake as per the following conceptual diagram. This was based on the likely final landform, current groundwater levels and the results of the water balance modelling

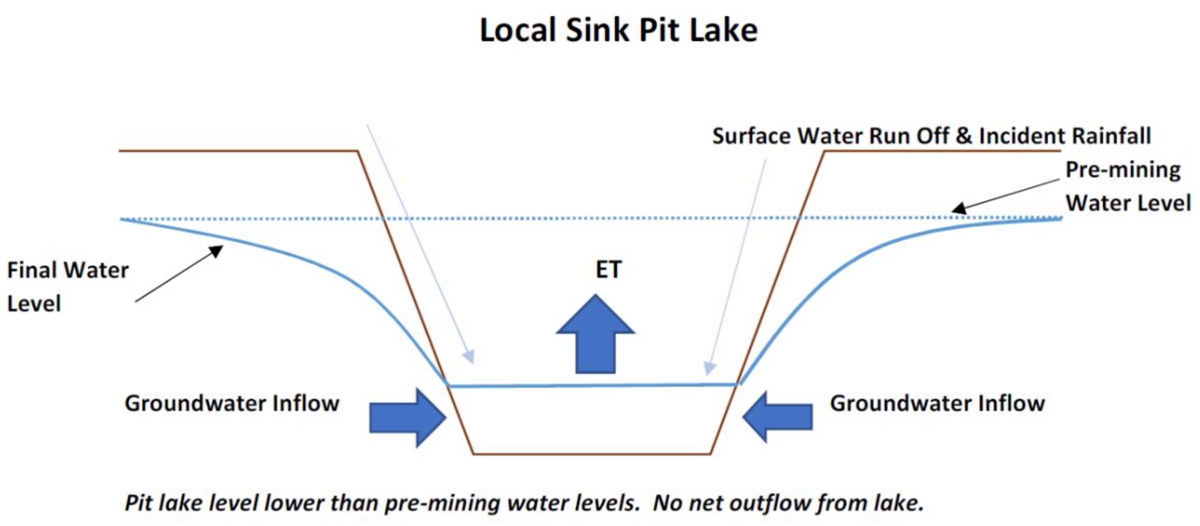

Figure 1. Local Sink Pit Lake Conceptual Model

In undertaking this assessment, the assumption is that the current disturbance areas are indicative of the final form of the site, albeit with rehabilitation and some internal reconfiguration of the drainage. Ultimately, the form of the final void post mining is therefore likely to be similar to the existing void, accordingly the characteristics of the existing void and surrounding catchment has been used to develop the model.

Using the Conceptual Model outlined above, the model was developed to account for the following water balances sources and sinks as shown in Figure 2 below.

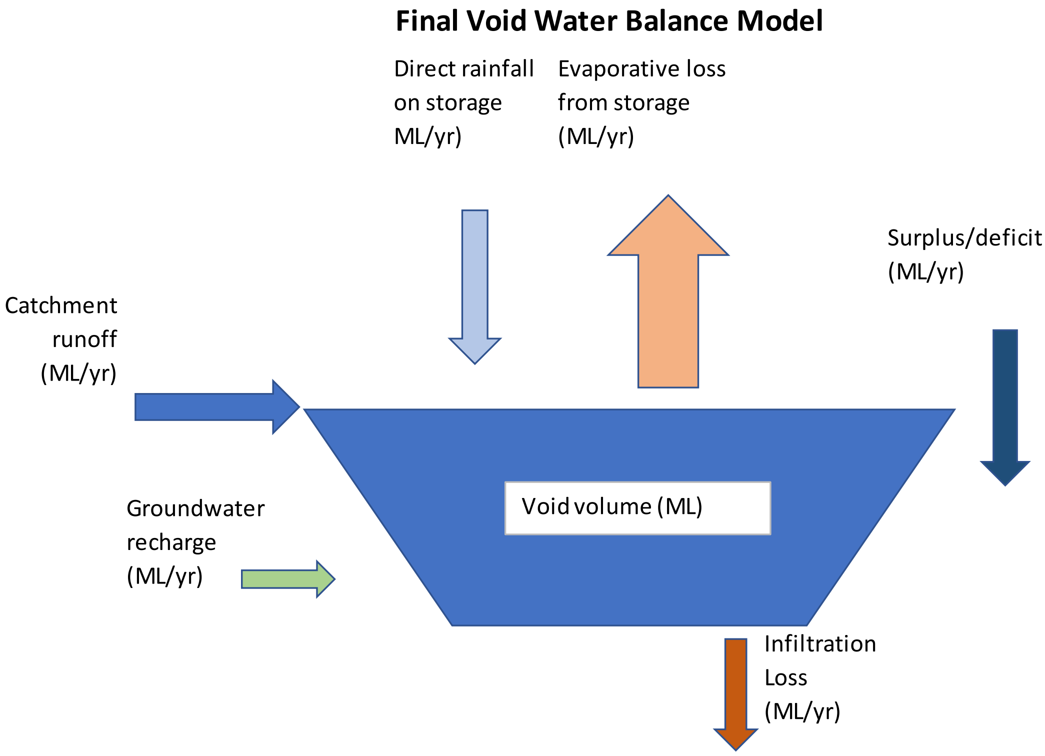

Figure 2. *Water balance model representation*

The model was developed with the following inputs:

- Daily rainfall - Nebo Station 033054 from 01/01/1900 – 31/12/2017
- Mean monthly pan evaporation – Nebo Station 33054
- F Pit Catchment area – 54.23 ha (measured through GIS of final proposed pit area)
- F Pit final void area – 13.45 ha (measured through GIS based on existing pit area to void area ratio)
- Volumetric runoff coefficient for surface waters 0.35
- Depth 175m (from Golders 2018)
- Recharge rate 0.5% of rainfall (from Golders 2018)

The model uses the inputs noted above to calculate inflows from surface and groundwaters and subtract losses through evaporation and leakage/exfiltration. This is done on a daily timestep over the time period selected. Nebo station climatic data was used as it was the longest continuous record available closest to the subject site. This climate is indicative of that at South Walker Creek and shows the significant surplus of evaporation over rainfall that is characteristic of the area. It is likely that the rainfall is a slight overestimation of rainfall at the SWC site given the strong east/west rainfall gradient, but this would also provide a conservative estimate of the likely changes in water volumes over time.

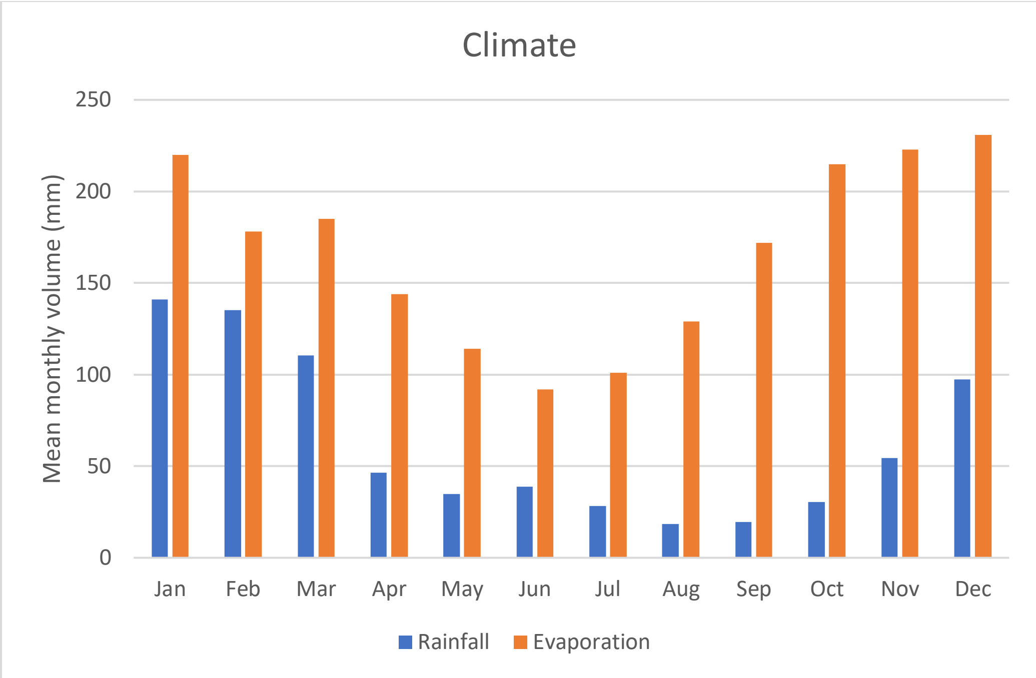

Figure 3. Mean monthly values for rainfall and evaporation at Nebo (033054)

To simulate the impacts on water quality, the salt concentration was derived by accounting for the initial salt concentration in the void, a runoff salt concentration, recharge salt concentration and salt from direct rainfall. The values chosen were relatively arbitrary but set to typical conditions noted in runoff studies (Duncan 1999, Fletcher et al 2004) and from previous modelling (ACARP 2017). These parameters were set as per the following:

- Rainfall salt concentration – 10mg/L (typical rainfall total dissolved salts are <10mg/L)
- Runoff salt concentration – 100 mg/L (surface runoff total dissolved salts are between 50-100mg/L)
- Recharge salt concentration – 5,000 mg/L (a conservative estimate based on local groundwater conditions)
- Initial void salt concentration – 1,000 mg/L (arbitrary, simply used as a starting point)

The model was run over the 117 year climatic period available to gauge the trends of water balance and water quality from these ranges of inputs. It was assumed that the pit would be full at the commencement of the analysis to view the overall trend in the results. Given that the workings are likely to be active immediately prior to closure, this is a conservative assumption, as the void would likely be dry, but this wouldn't show trends easily. The results are presented graphically below.

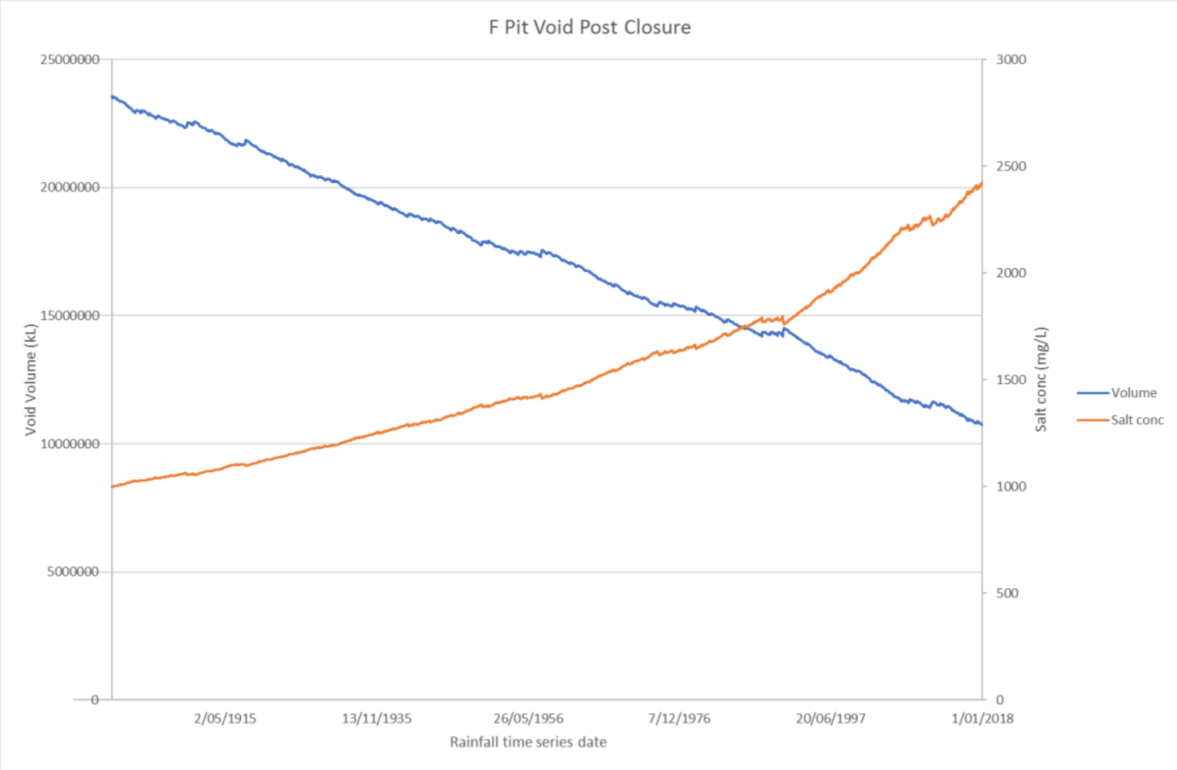

Figure 4. Water balance and salt concentration for simulation of F Pit void post closure

This shows that over the period modelled, the general trend is for the water volume to reduce to less than 50% of the current volume, with a consequential increase in salinity to an end concentration of 2.5 times the existing concentration. This is expected given that the evaporation rate is significantly greater than the rainfall rate, such that even with recharge, the inflows never exceed the losses from the system and it is therefore expected that the final void, if similar in characteristics to the current F pit void in area, depth and contributing catchment, will never overtop, but continue to concentrate salt and other associated water quality criteria.

Using the representation given in Figure 2 earlier, the actual volumetric change for each of the sources and sinks in the model are shown in Figure 3 below. The volumes are presented on a mean annual basis, where the results of the model were compiled and averaged over the entire climatic period. The size of the arrows approximately indicates the scale of the source or sink in terms of volumetric change, with the surplus/deficit showing the mean annual water balance results.

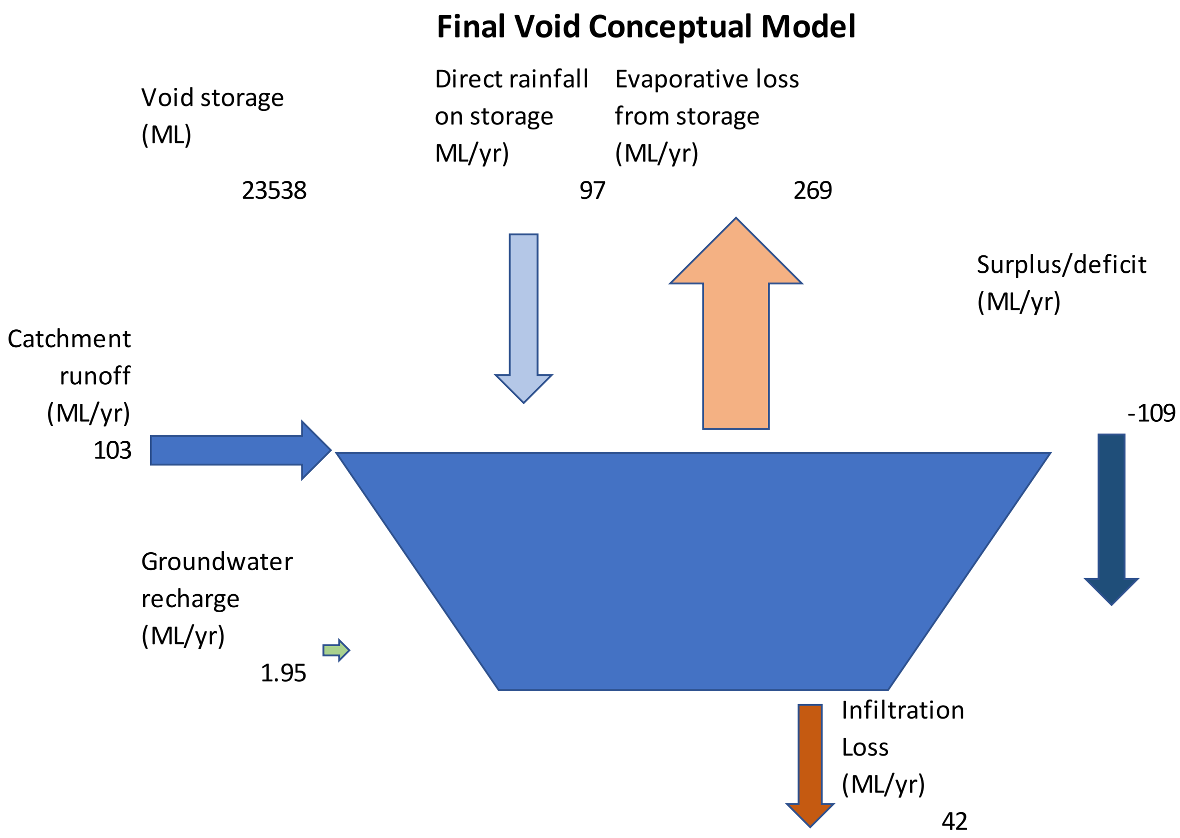

Figure 5. *Final water balance volumetric change (mean annual change)*

To also understand volumetric changes if the starting point was an empty pit void (no water at commencement of the water balance), a further model run was examined with 0ML volume. This shows that the pit continually dries out. The salt concentration is not reported on this graph as when the model indicates an empty void, the salt concentration is unrealistically high (i.e. zero volume divided by salt load means infinite concentration).

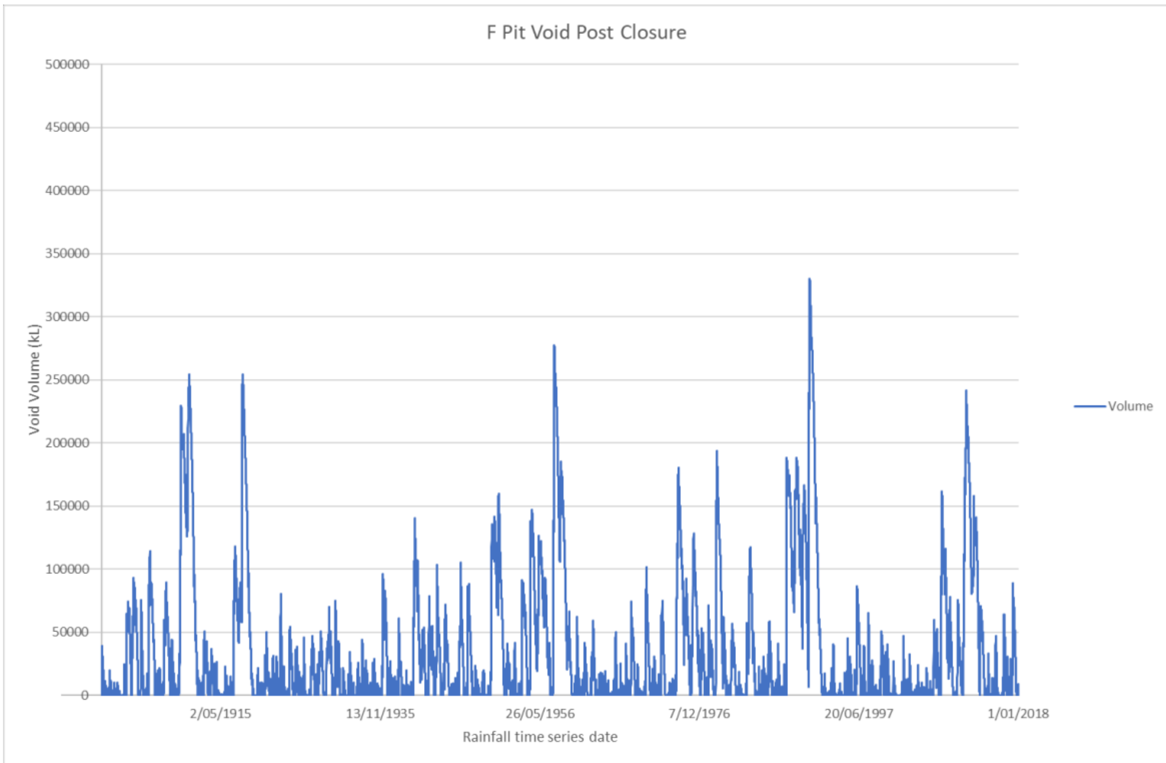

Figure 6. *Pit volumes from an empty void starting point.*

Sensitivity analysis was also undertaken to investigate the reasonable range of parameters around both hydrology and water quality to see which parameters may have the greatest influence on void conditons. Each parameter set was varied within a range of plausible values. The results of this analysis are presented below:

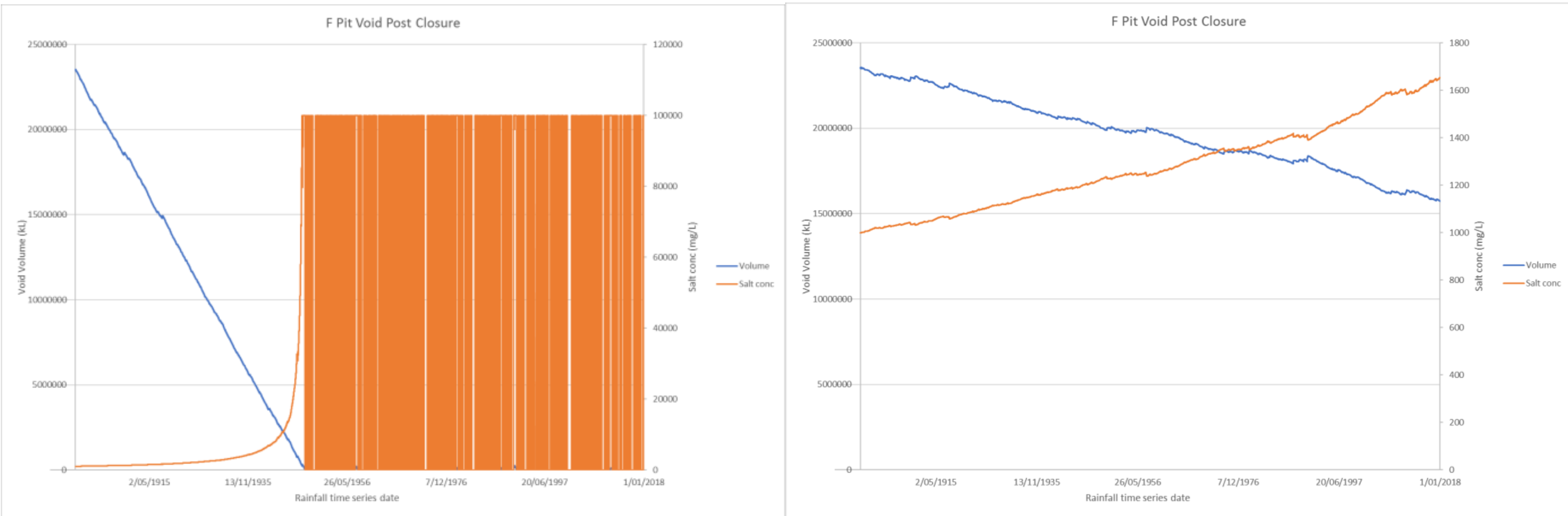

Figure 7. Infiltration rate (varied 1 order of magnitude)

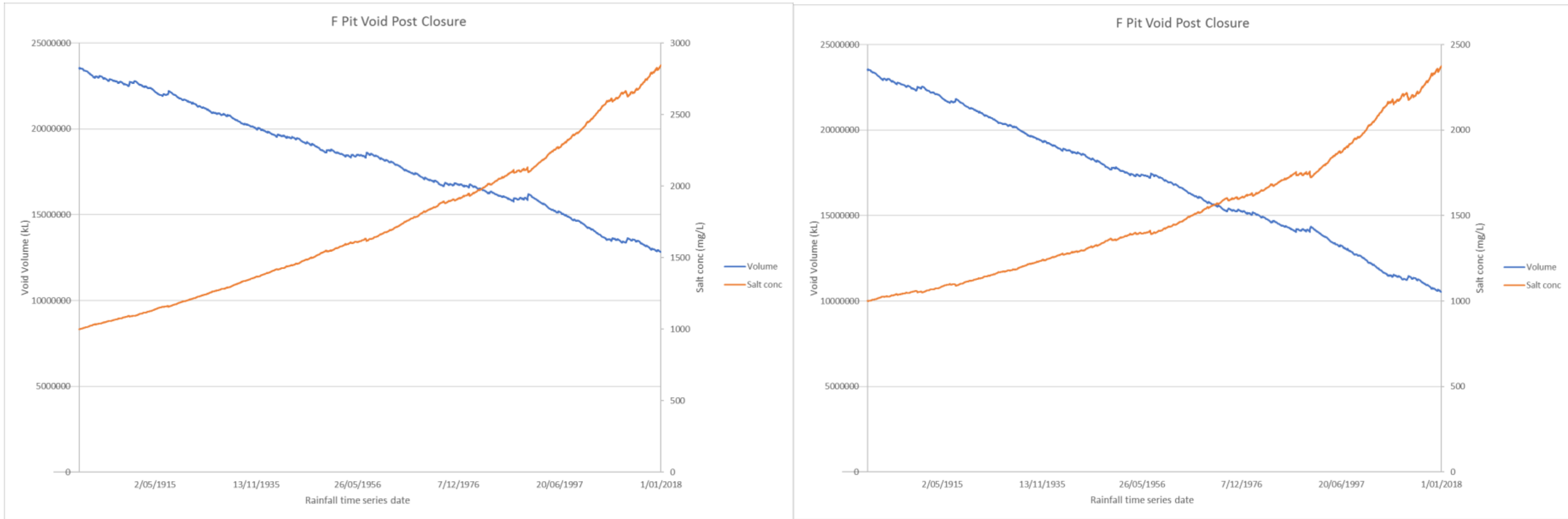

Figure 8. Recharge rate (varied 1 order of magnitude)

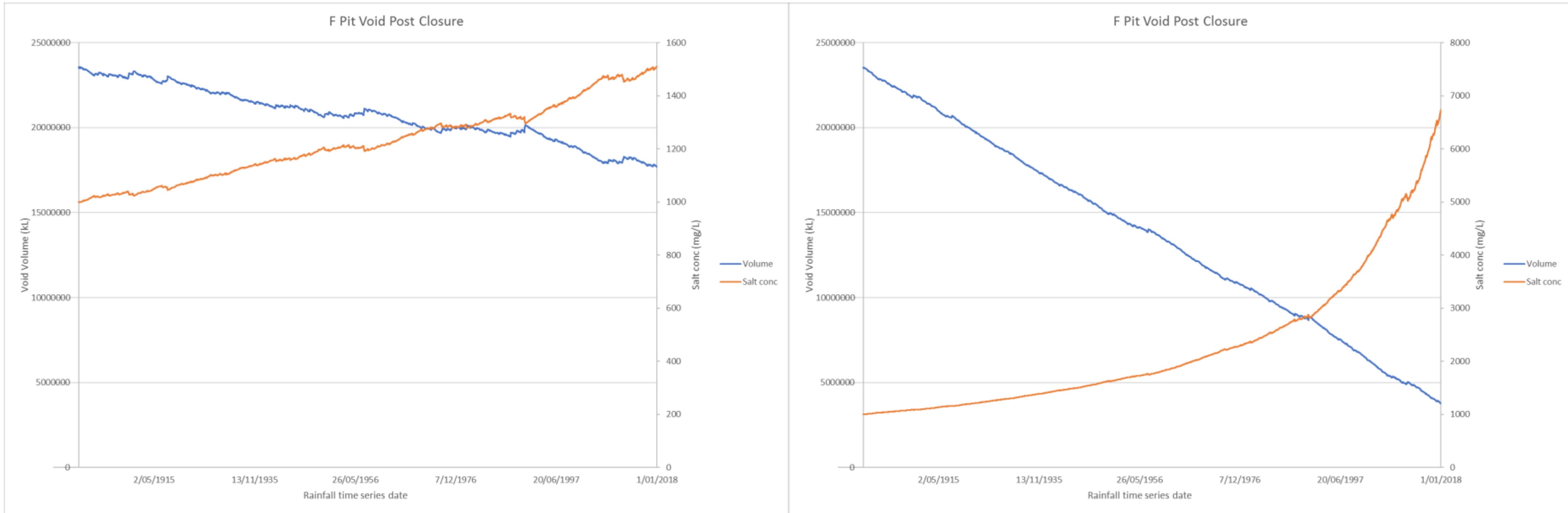

Figure 9. Runoff coefficient (0.55 – 0.15)

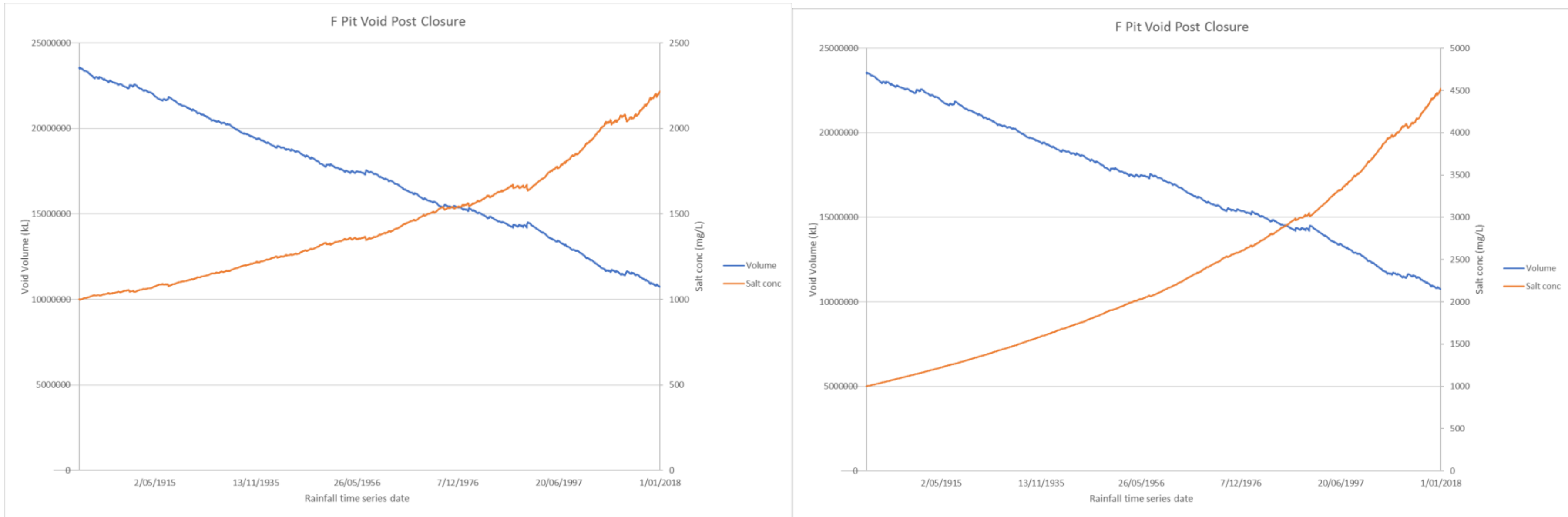

Figure 10. Inflow salt concentrations (1 order of magnitude)

This analysis shows is that the results are relatively insensitive to recharge rate, and salt concentrations, with some sensitivity to runoff coefficients and high sensitivity to leakage/infiltration loss. In all cases however, the model shows a decreasing trend in volume and increasing trend in salt concentration, suggesting that the likely condition of the void post closure is that volumes are not ever likely to overtop but water quality concentrations will increase over time. This means that the default condition of the final void is one that would tend to dry out or be completely dry most of the time, depending on the starting level of the void. Further modelling of the final configuration would be needed to confirm this, but it is highly likely that these conditions would be indicative of most final configurations.

A further variation was conducted to examine the impacts of additional catchment area on the void water balance and water quality. This is shown in the figure below.

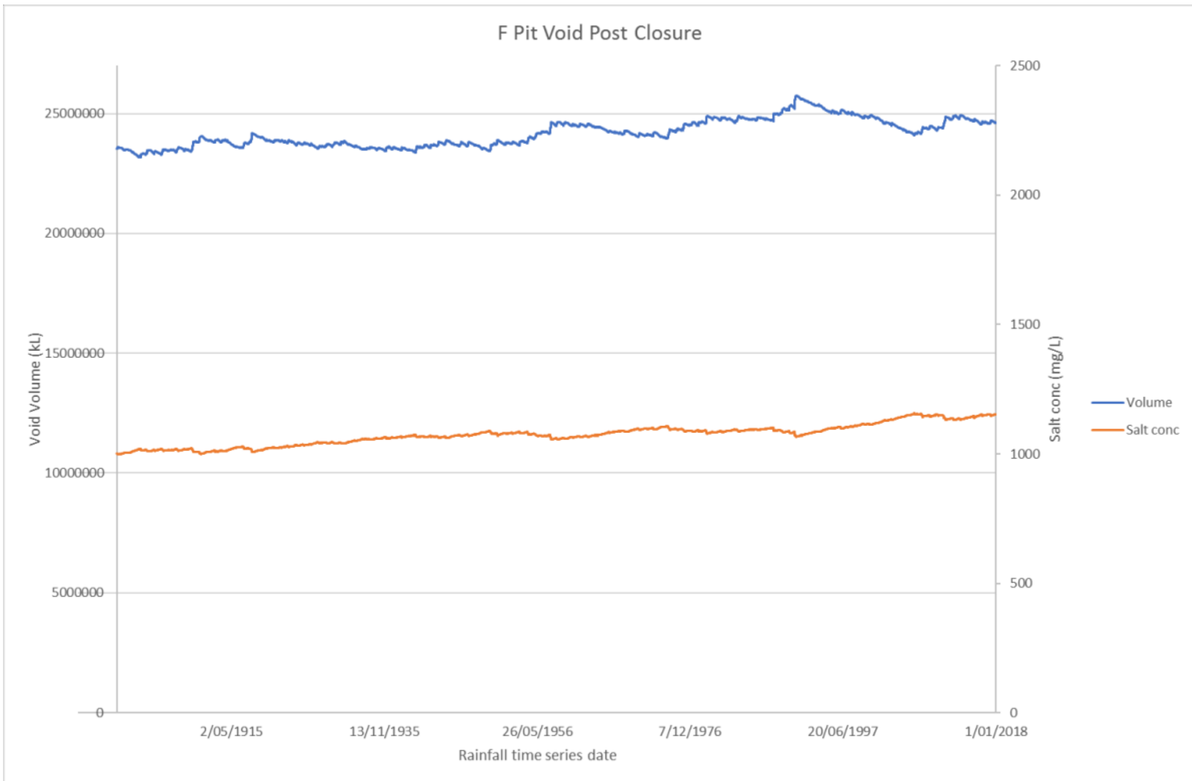

Figure 11. Increased surface water catchment area (100ha rather than 54.23ha)

This result shows that it may be possible to achieve a relatively stable waterbody by increasing the catchment area to void area ratio, but this is based on the assumption of a full void at the time of closure. This is typical of most waterbodies in that there is an optimal size (depending on climate) where inflows can match losses and outflows to achieve consistent volumes and levels. From this, we can therefore anticipate that the final void post closure can be designed to achieve a relatively stable form if the configuration is cognisant of the relationship of runoff and evaporation on the water balance and water quality of the waterbody.

All of this analysis shows that the catchment area draining to the final void is one of the most influential factors on whether a waterbody would exist post closure, as all modelling demonstrates that the most likely scenario is a void where the losses significantly exceed the inflows and hence the system would tend to dryness or be completely dry if the starting condition was also an empty void.

1.2 Final void configuration

Final void would be relinquished in a safe, stable, and sustainable manner, in accordance with Queensland Govt requirements. The high wall would be battered back to a safe angle and the high wall and end walls would include a berm and trench design for safety purposes.

Where beneficial use to post-mining land use is not viable, storage structures would be decommissioned so as to minimise post-mining management requirements. Decommissioning would be in accordance with standard industry practice and legislative requirements. Within this, dams would have mud removed, walls breached and recontoured to a safe grade.