Technical Memorandum

July 6, 2023

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From	Elizabeth Saunders	**Project No.**	12604929
Project Name	Eastern Catchments Study		
Subject	Saltwater Gully Dam - Preliminary Water Balance Results		

1. Introduction

A water balance model was developed to represent the Eastern Catchments study area at Talison's Greenbushes mine site to predict water and key Contaminants of Particular Concern (CoPC) trends over the mine life and post-closure. The model incorporates the expansion of S1 and S8 WRLs, the new Saltwater Gully Dam and re-use of TSF1.

In addition to the water balance, the model also performs a mass balance of four CoPCs, namely lithium, arsenic, sulphate, and nitrate. The mass balance assumes that the CoPCs are conservative substances that do not decay over time or react with the other substances (i.e., only subject to concentration or dilution). All water storages are assumed to be well mixed and always contain a homogenous mixture (i.e., stratification not considered).

1.1 Purpose of this Memorandum

This Technical Memorandum is provided as an interim communication and is provided to foster discussion in relation to the operation of Saltwater Gully Dam. It should not be relied upon in any way or for any purpose.

The memorandum provides an overview of the operating rules applied in the water balance model for SWG dam and preliminary results.

All other details pertaining to the model build and operation are not included in this memorandum and will instead be detailed in the Eastern Catchments Risk assessment. This includes but isn't limited to model calibration, water quality parameters and assumptions, and groundwater configuration.

1.2 Scope and Limitations

This technical memorandum has been prepared by GHD for Talison Lithium Pty Ltd. It is not prepared as, and is not represented to be, a deliverable suitable for reliance by any person for any purpose. It is not intended for circulation or incorporation into other documents. The matters discussed in this memorandum are limited to those specifically detailed in the memorandum and are subject to any limitations or assumptions specially set out.

2. Model Schematic

The water balance model represents the catchment of Hester Brook and the new SWG dam. The following two scenarios are incorporated into the model:

– **Baseline** scenario: existing site/ operations and the existing approved expansion of Floyds WRL (S1)
– **Development** scenario: full development with combination of the existing approved expansion of Floyds WRL (S1), the proposed S8 WRL and SWG Dam.

The catchments and reporting locations (i.e., where results have been extracted) for the baseline and development scenario are shown in **Figure 2.2**. The SWG Dam water balance schematic is shown in **Figure 2.1**, which applies to the development scenario only.

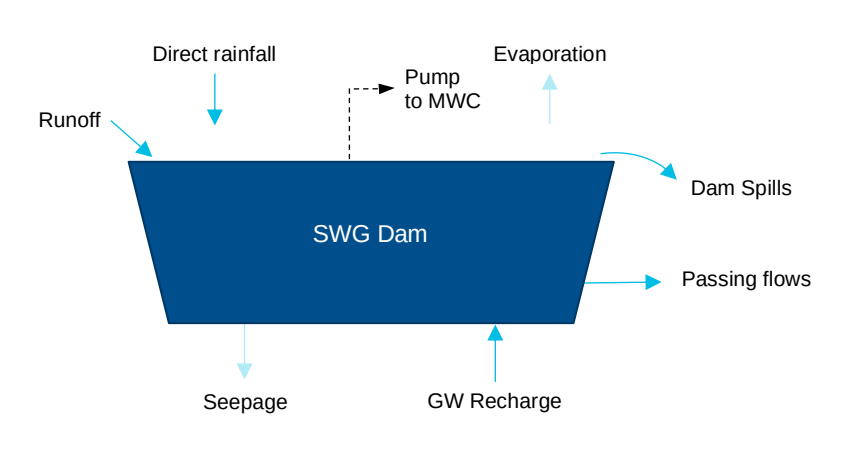

Figure 2.1 SWG Dam schematic

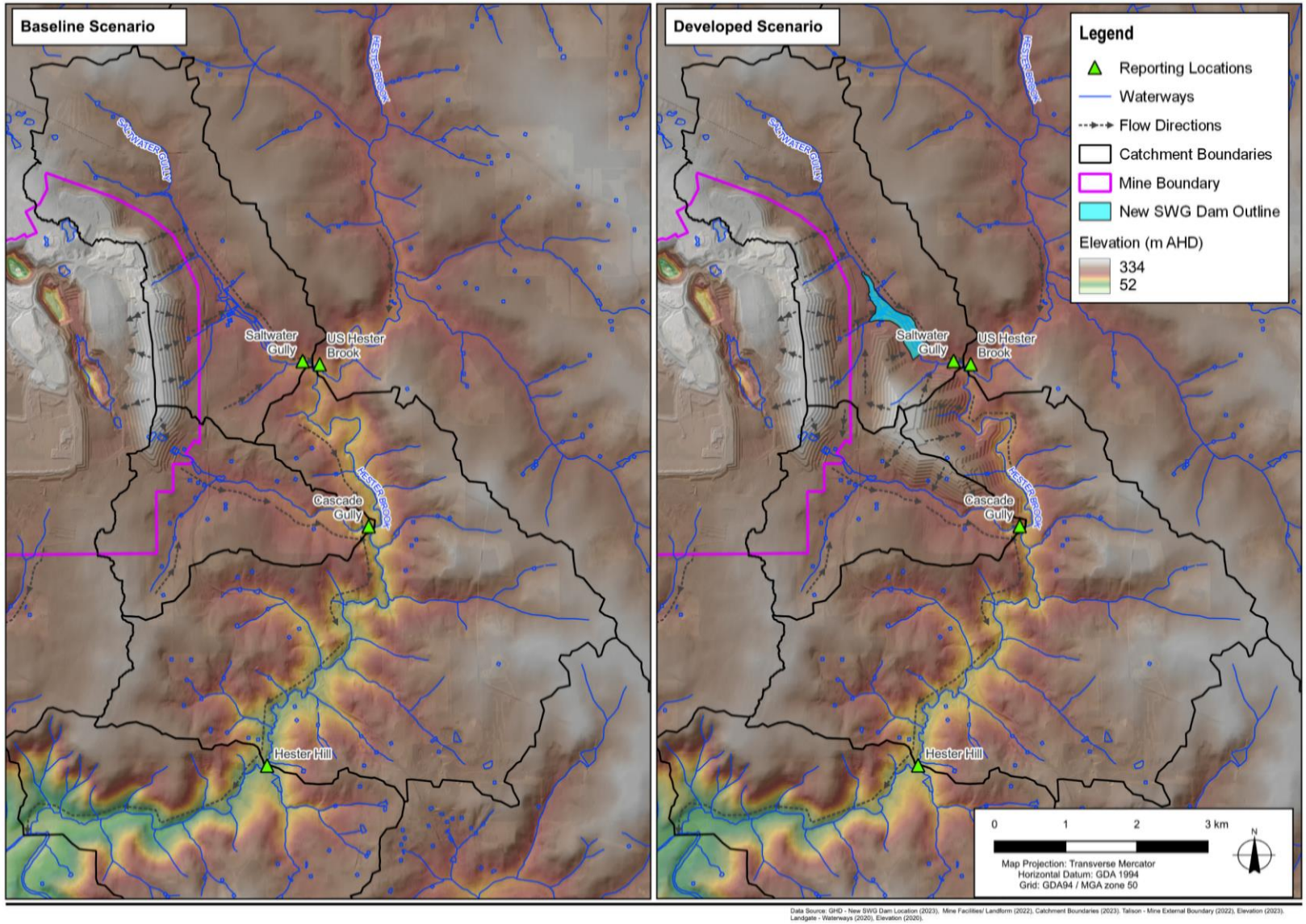

Figure 2.2 Water balance model catchments and reporting locations

This Technical Memorandum is provided as an interim output under our agreement with Talison Lithium Pty Ltd. It is provided to foster discussion in relation to technical matters associated with the project and should not be relied upon in any way.

3. Saltwater Gully (SWG) Dam Configuration

3.1 Rating Curves

The storage characteristics of the new SWG dam is configured in the model with a rating curve which was defined using 5 m contour data from Landgate (2020). The stage-storage and stage-area curves are provided in **Figure 3.1** and **Figure 3.2** respectively.

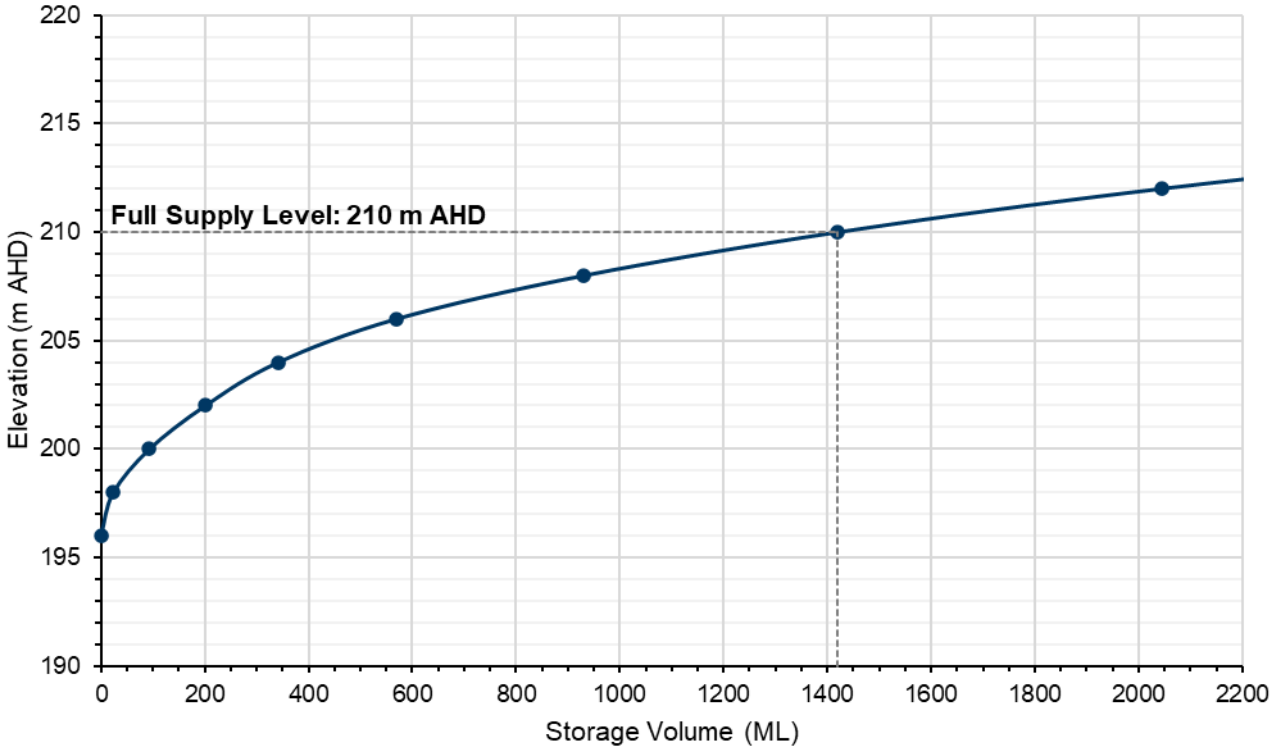

Figure 3.1 SWG Dam – Stage-storage curve

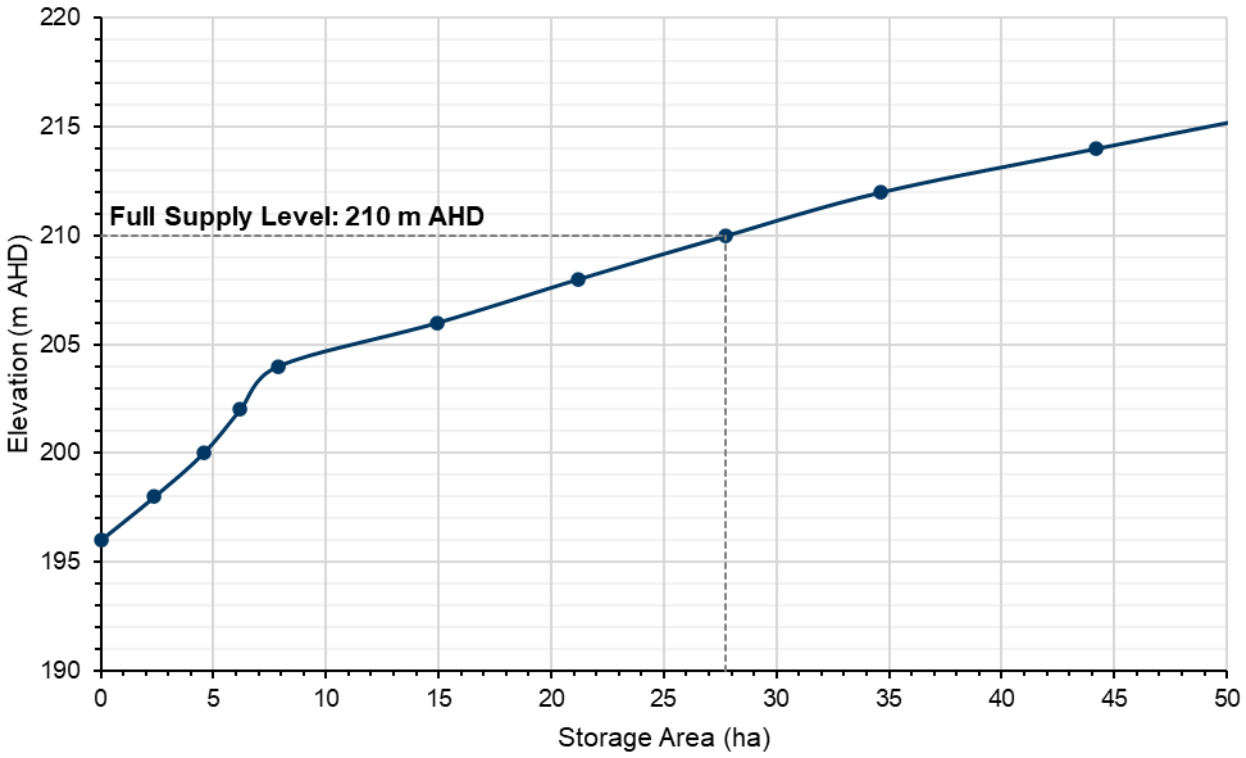

Figure 3.2 SWG Dam – Stage-area curve

3.2 Operating Rules

The operating rules configured in the model for SWG dam were informed by the following:

– Maintaining a nominal Low Operating Level (LOL) of 200.9 m AHD, which equates to 10% of the total storage volume. This level was adopted to ensure adequate depth and volume for pumping requirements and to achieve sufficient dilution for water quality purposes.

– Passing flow requirements, which are designed to maintain downstream waterway health. These releases are designed to mimic the existing flow patterns of the waterway by passing a portion of inflows into the new dam, downstream. The flows were iterated until downstream water quality requirements were achieved.

The SWG dam operating rules are detailed in **Table 3.1**.

Table 3.1 SWG Dam Operating Rules

Outflow destination	Transfer start trigger	Transfer stop trigger	Maximum transfer rate (m^3/s)	Notes
Mine Water Circuit (MWC)	SWG > LOL	SWG <= LOL	600	A nominal pump rate was selected based on larger pump capacities used in MWC[1].
Receiving environment (Saltwater Gully)	Runoff > 0 m^3/s	Runoff = 0 m^3/s	20% * runoff inflow	Refer Section 4.1.5 for sensitivity testing results on this operating rule.

[1] It is assumed that there are no storage constraints in the MWEC to receiving this water.

4. Preliminary Results

4.1.1 Model Scenarios

The following two scenarios were simulated using the model:

- **Baseline** scenario: existing site/ operations and the existing approved expansion of Floyds WRL (S1)
- **Development** scenario: full development with combination of the existing approved expansion of Floyds WRL (S1), the proposed S8 WRL and SWG Dam.

The water balance model was simulated over a 40-year period from January 2023 and extends 20 years post mine closure, which is expected to occur in 2043. The model was simulated 500 times with each simulation adopting a unique climate sequence (of rainfall and evaporation) that was sampled from historical climate records.

The simulated water levels, spills, seepage rates, and CoPC concentrations, are presented in following sub-section.

4.1.2 Interpreting Results

As noted above, the model is simulated 500 times with each simulation adopting a unique climate sequence. Each simulation is equally likely and represents one possible path the system could follow through time based on the unique sampled climate sequence. The results of each simulation are assembled into probability distributions of possible outcomes.

The results are therefore represented as probability distributions opposed to a single value. By way of example the 10^{th} percentile result represents the value at which 10% of the modelled outputs were less than this value. Similarly, the 90^{th} percentile represents the value at which 90% of the modelled outputs were less than this value.

It's important to note that the percentile results do not directly relate to a "wet" or "dry" climate sequences (i.e. 90^{th} percentile does not correspond to a "wet" climate and the 10^{th} percentile does not correspond to a "dry" climate). For example, a 90^{th} percentile water volume would relate to a wetter period, but a 90^{th} percentile CoPC concentration would relate to a dryer period, when there is less dilution.

4.1.3 SWG Dam Results

The simulated daily water levels, volume, spill events and seepage flows in SWG Dam are presented in **Figure 4.1**, **Figure 4.2**, **Figure 4.3**, **Figure 4.4** respectively. **Figure 4.5** to **Figure 4.8** provide the simulated CoPC concentrations in SWG dam.

The simulation results indicate the following:

- The median volume in SWG fluctuates seasonally between ~140 ML (LOL) and ~380 ML. In the dryer months between November and April, the volume is maintained just below the LOL volume and unable to transfer the 600 m^3/hr each day.
- Spills typically occur in the winter months and the probability of spilling on a given winter day is typically less than 10%.
- The establishment of S8 WRL in 2023 results in a minimal rise in simulated CoPC concentrations. This can be attributed to the majority of the S8 WRL catchment being downstream of the dam, thereby limiting the occurrence of a significant spike in CoPC concentrations.

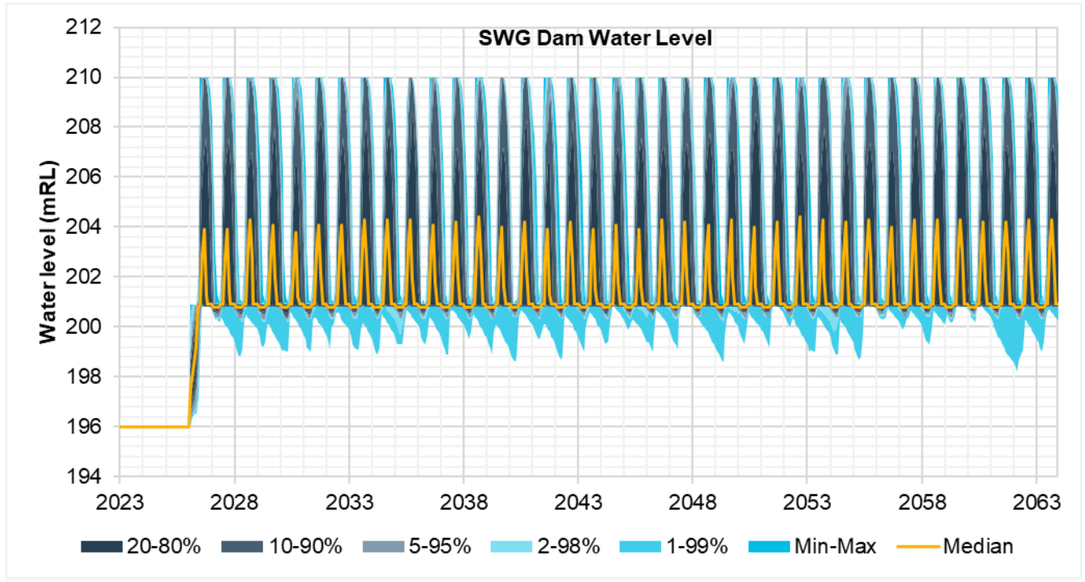

Figure 4.1 Simulated daily water levels in SWG Dam

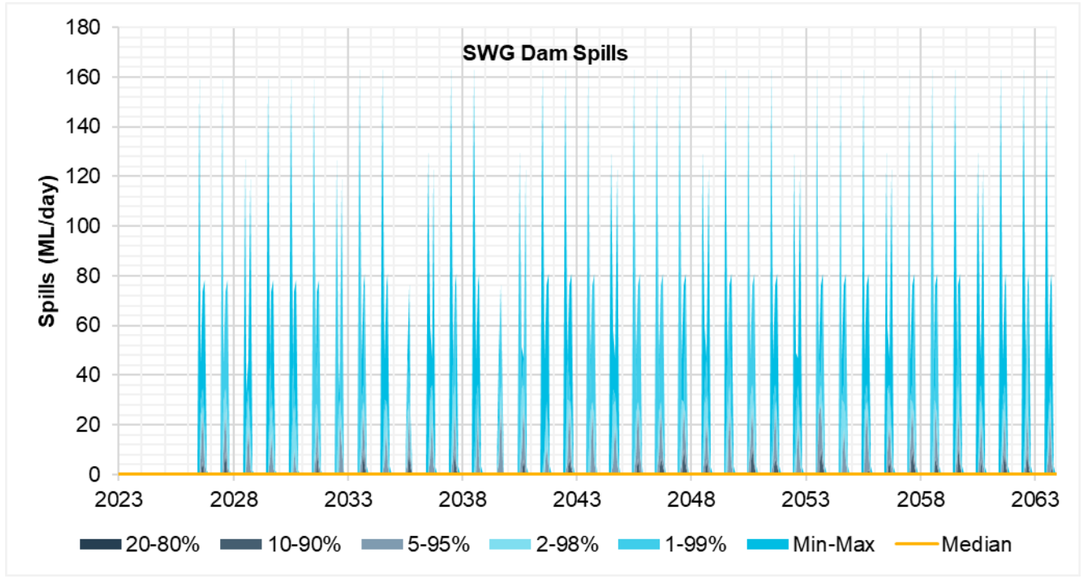

Figure 4.3 Simulated daily spills from SWG Dam

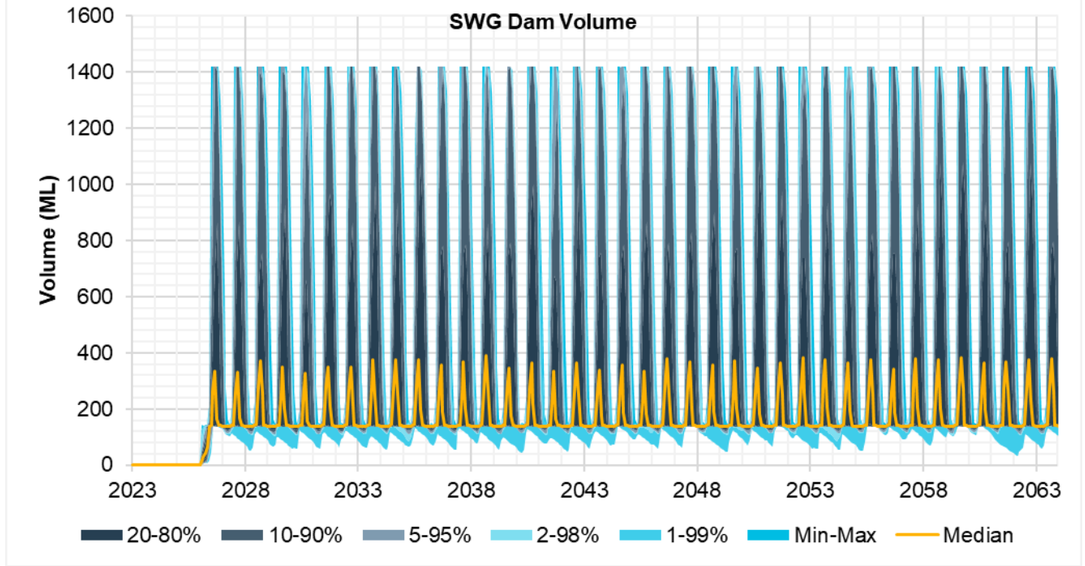

Figure 4.2 Simulated daily water volumes in SWG Dam

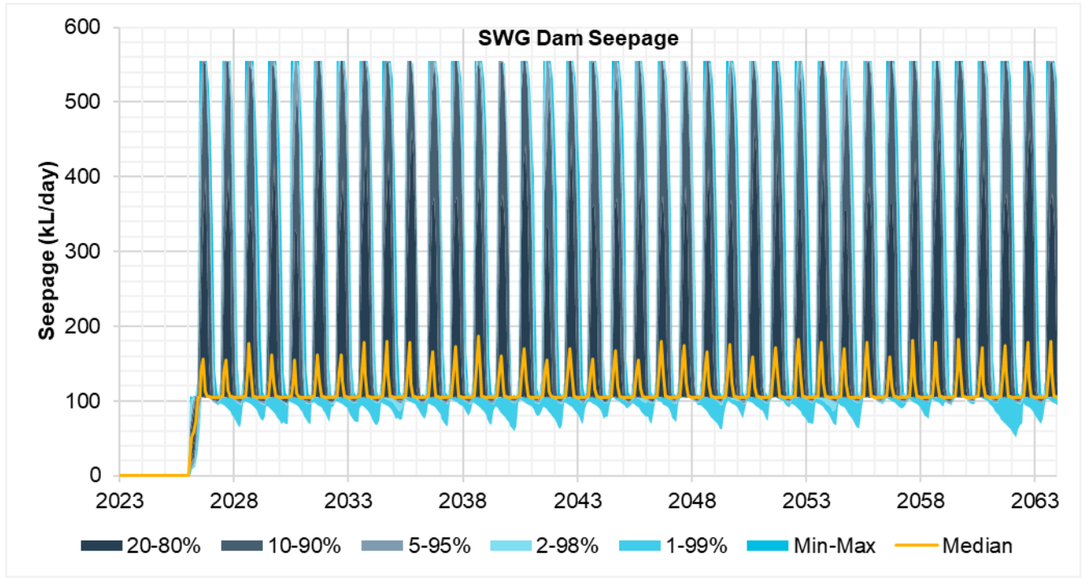

Figure 4.4 Simulated daily seepage flows from SWG dam

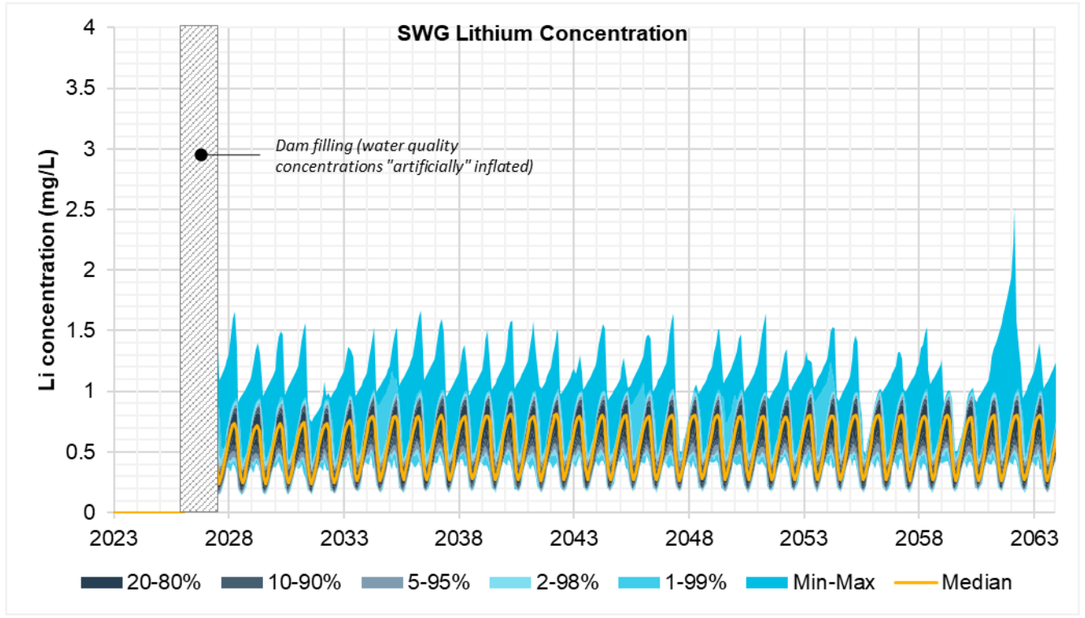

Figure 4.5 Simulated lithium concentrations in SWG Dam

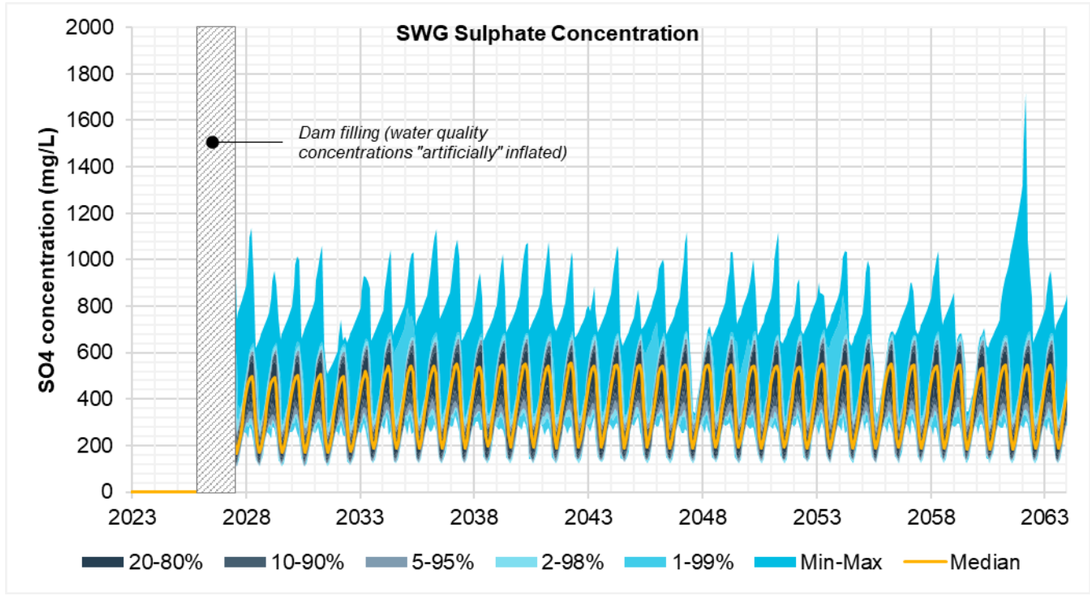

Figure 4.7 Simulated sulphate concentrations in SWG Dam

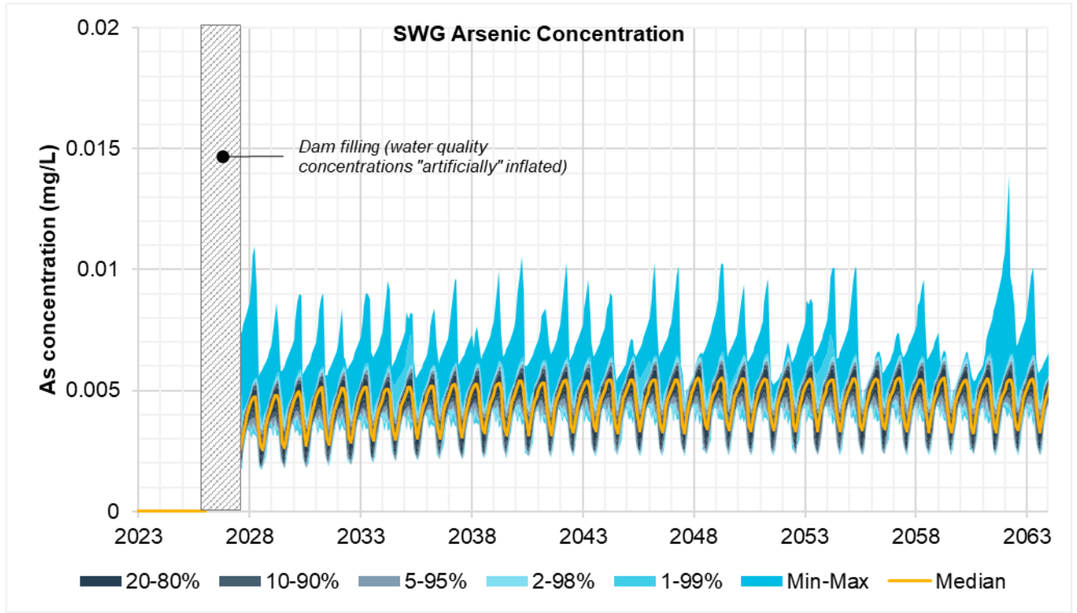

Figure 4.6 Simulated arsenic concentrations in SWG Dam

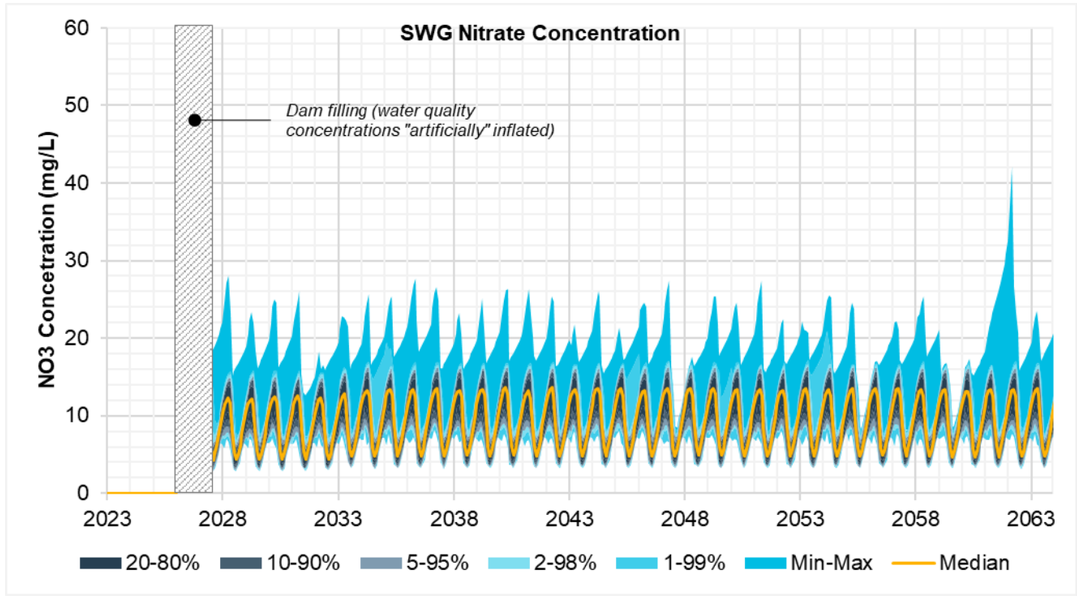

Figure 4.8 Simulated nitrate concentration in SWG Dam

4.1.4 Receiving Catchment Results

Simulated daily streamflow at the reporting locations in the model are provided in Figure 4.9 to Figure 4.16 for the baseline and developed scenarios.

A statistical summary of the simulated CoPC concentrations for the model period (2023 to 2063) is provided in **Table 4.1** and depicted graphically in **Figure 4.17** to **Figure 4.20**.

The results indicate the following:

– The simulated volume of water discharging Saltwater Gully into Hester Brook reduces by ~80% once the new SWG dam is constructed, which is consistent with the passing flows being 20% of all inflows. This results in a negligible change in the simulated streamflow at Hester Hill as Saltwater Gully only comprises 7% of the total Hester Brook catchment.

– The establishment of S8 WRL results in a worsening of CoPC concentrations at Saltwater Gully outlet and Cascade Gully outlet. At Hester Hill, there is only a slight increase in the CoPC concentrations as there is significant dilution from non-disturbed catchment flows.

– Although SWG dam helps dilute the water discharged from the S1 WRL, the majority of the S8 WRL catchment is positioned downstream of the dam. Consequently, the dilution effect at the Saltwater Gully outlet from the S8 WRL is minimal.

– The baseline CoPC concentrations will differ from the monitored water quality data due to the following reasons:

  - Limitations of the model: CoPCs are assumed to be conservative substances that do not decay over or react with other substances. In the model they are only subject to concentration or dilution.
  - Monitoring of CoPCs in the catchment only occurs when there is sufficient flow. The modelled results are based on a range of flows and due to dilution and concentration will vary significantly depending on the volume of water in the creeks (e.g., concentrations inflated at very low flows).

– For this reason, the emphasis should be on the concentration difference between baseline and developed, rather than the specific concentration values.

Table 4.1 Statistics of simulated CoPCs from 2023 to 2063

Location	Saltwater Gully Outlet		Cascade Gully Outlet		Hester Brook (U/S SWG)		Hester Hill	
Statistic	**Baseline**	**Developed**	**Baseline**	**Developed**	**Baseline**	**Developed**	**Baseline**	**Developed**
Lithium concentration (mg/L)								
Minimum	1.33	1.70	0.04	0.09	0.00	0.00	0.02	0.02
5%	1.51	2.07	0.21	0.35	0.00	0.00	0.07	0.07
20%	1.68	2.35	0.59	0.69	0.00	0.00	0.32	0.42
50%	1.83	2.60	0.79	0.87	0.00	0.00	0.50	0.63
80%	1.95	2.75	0.95	1.03	0.00	0.00	0.65	0.78
95%	2.02	2.81	1.08	1.11	0.00	0.00	0.75	0.93
Maximum	2.33	3.00	1.10	1.12	0.00	0.00	1.06	1.08
Arsenic concentration (mg/L)								
Minimum	0.006	0.038	0.001	0.002	0.000	0.000	0.000	0.000
5%	0.007	0.042	0.001	0.003	0.000	0.000	0.000	0.001
20%	0.008	0.045	0.003	0.004	0.000	0.000	0.001	0.002
50%	0.008	0.048	0.003	0.004	0.000	0.000	0.002	0.003
80%	0.009	0.049	0.004	0.005	0.000	0.000	0.003	0.004

Location	Saltwater Gully Outlet		Cascade Gully Outlet		Hester Brook (U/S SWG)		Hester Hill	
95%	0.009	0.050	0.004	0.005	0.000	0.000	0.003	0.005
Maximum	0.011	0.050	0.005	0.005	0.000	0.000	0.004	0.005
Sulphate concentration (mg/L)								
Minimum	919	1168	45	77	15	15	30	28
5%	1033	1416	158	250	16	16	64	63
20%	1147	1605	410	475	16	16	225	288
50%	1247	1768	537	592	16	16	344	422
80%	1324	1869	649	699	16	16	440	522
95%	1375	1915	734	752	16	16	510	619
Maximum	1584	2041	748	760	16	16	719	727
Nitrate concentration (mg/L)								
Minimum	23.1	29.3	1.4	2.2	0.7	0.7	1.0	1.0
5%	25.9	35.4	4.1	6.3	0.7	0.7	1.8	1.8
20%	28.6	40.0	10.2	11.8	0.7	0.7	5.7	7.2
50%	31.0	44.0	13.2	14.6	0.7	0.7	8.5	10.4
80%	32.9	46.4	15.9	17.1	0.7	0.7	10.8	12.8
95%	34.1	47.5	18.0	18.4	0.7	0.7	12.5	15.2
Maximum	39.2	50.6	18.3	18.6	0.7	0.7	17.6	17.8

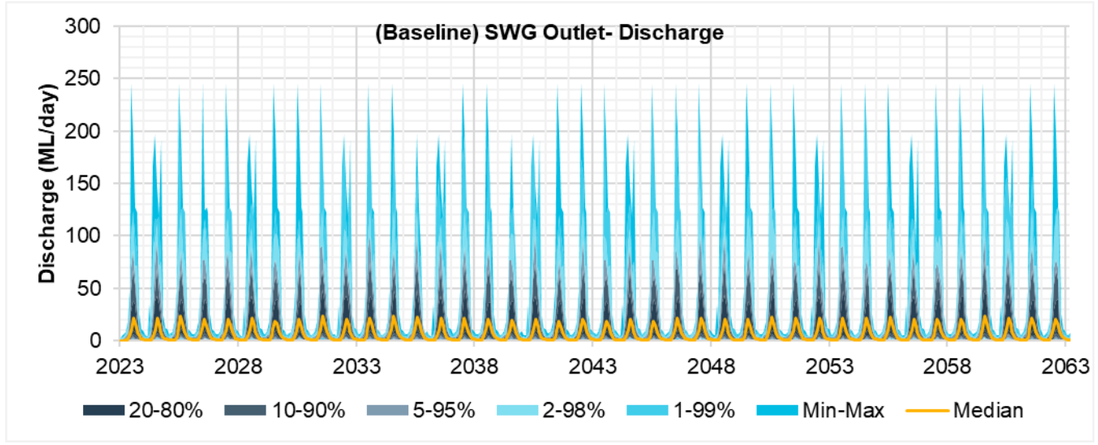

Figure 4.9 Simulated daily streamflow at Saltwater Gully outlet – Baseline scenario

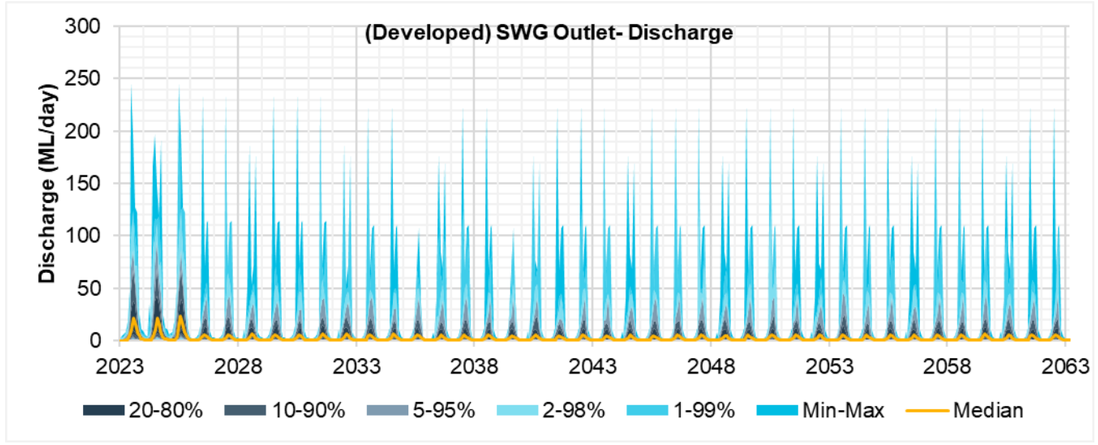

Figure 4.12 Simulated daily streamflow at Saltwater Gully outlet – Developed scenario

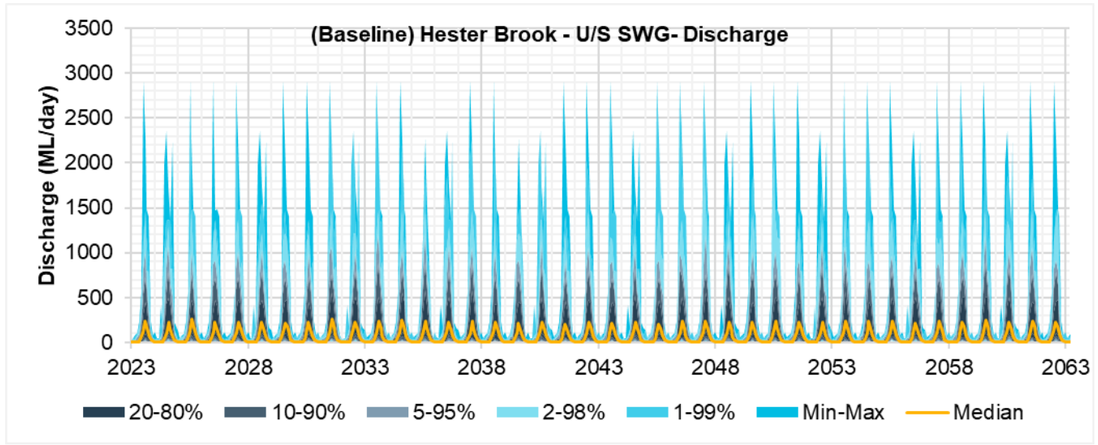

Figure 4.10 Simulated daily streamflow at Hester Brook, upstream of Saltwater Gully confluence – Baseline scenario

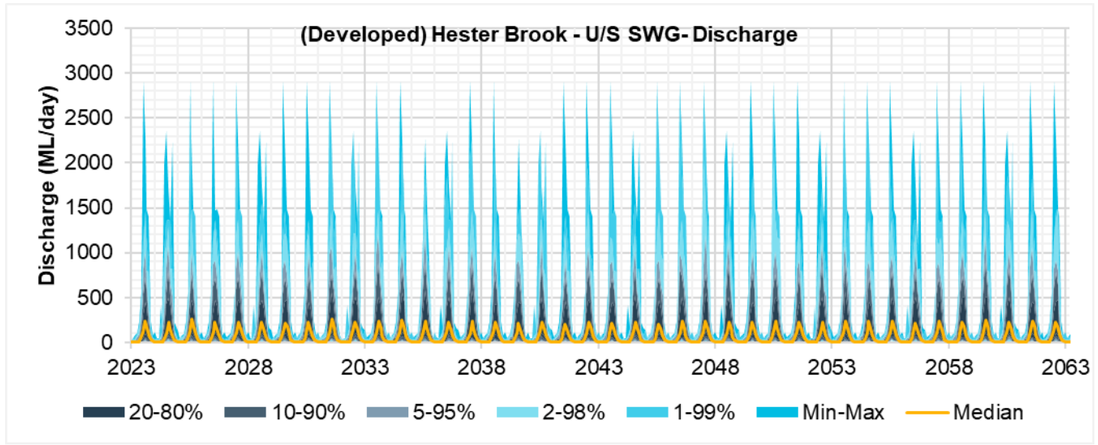

Figure 4.13 Simulate daily streamflow at Hester Brook, upstream of confluence with Saltwater Gully – Developed scenario

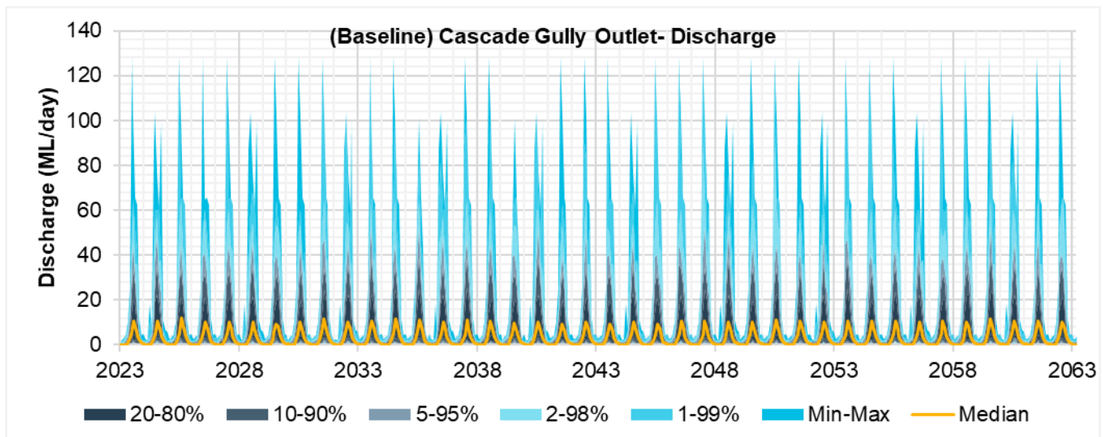

Figure 4.11 Simulated daily streamflow at Cascade Gully outlet (confluence with Hester Brook) – Baseline scenario

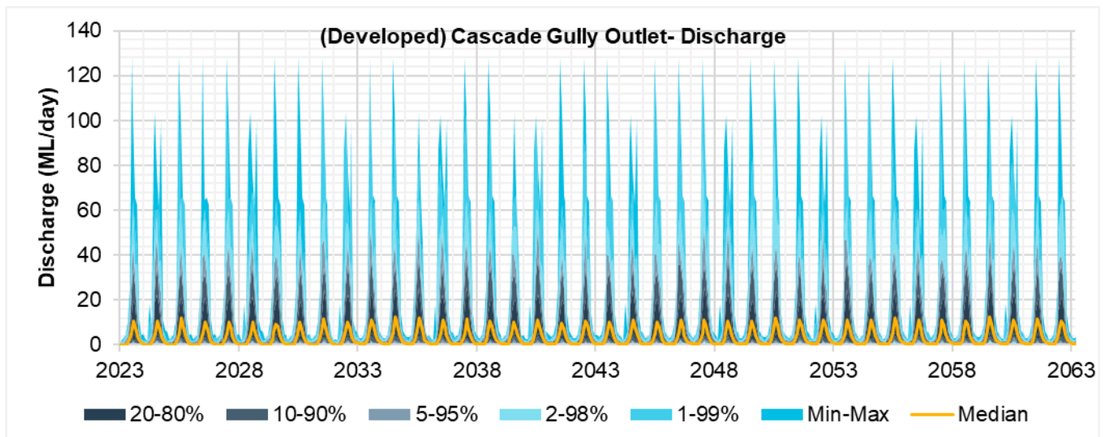

Figure 4.14 Simulated daily streamflow at Cascade Gully outlet (confluence with Hester Brook) – Developed scenario

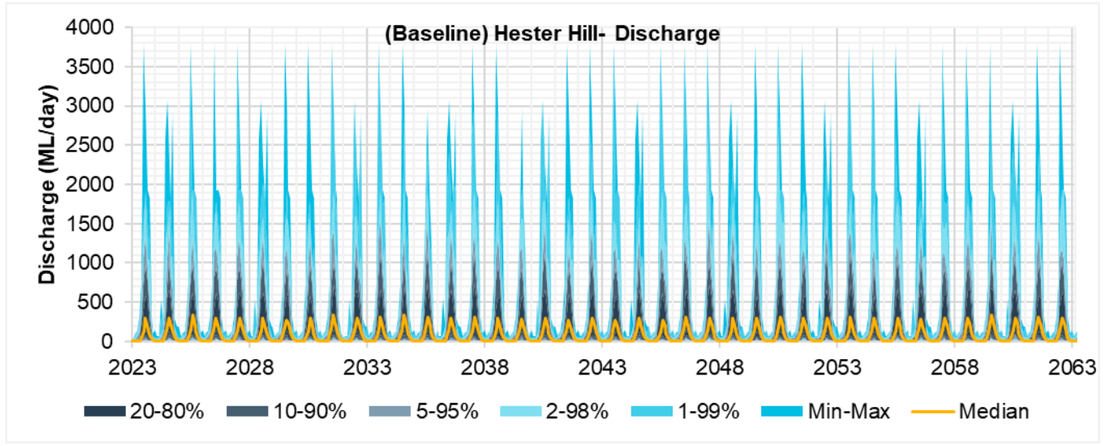

Figure 4.15 Daily streamflow at Hester Hill – Baseline scenario

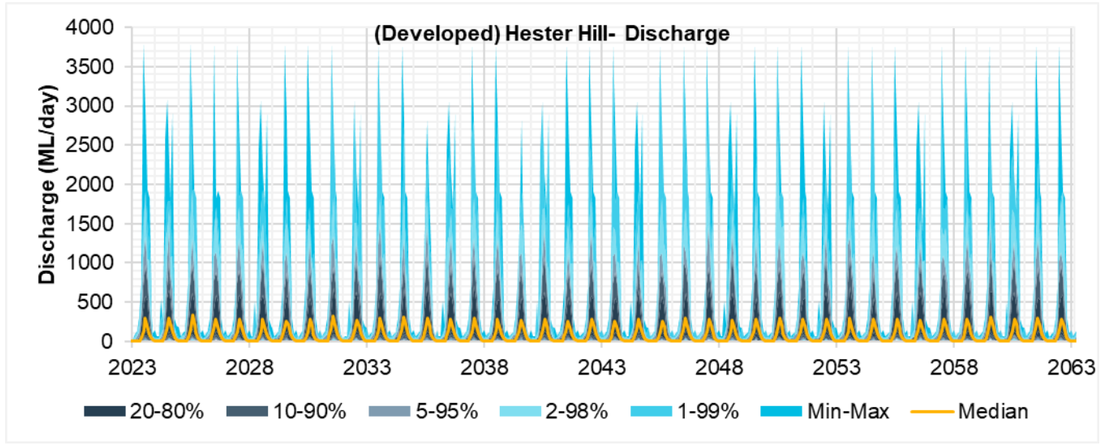

Figure 4.16 Daily streamflow at Hester Hill – Developed scenario

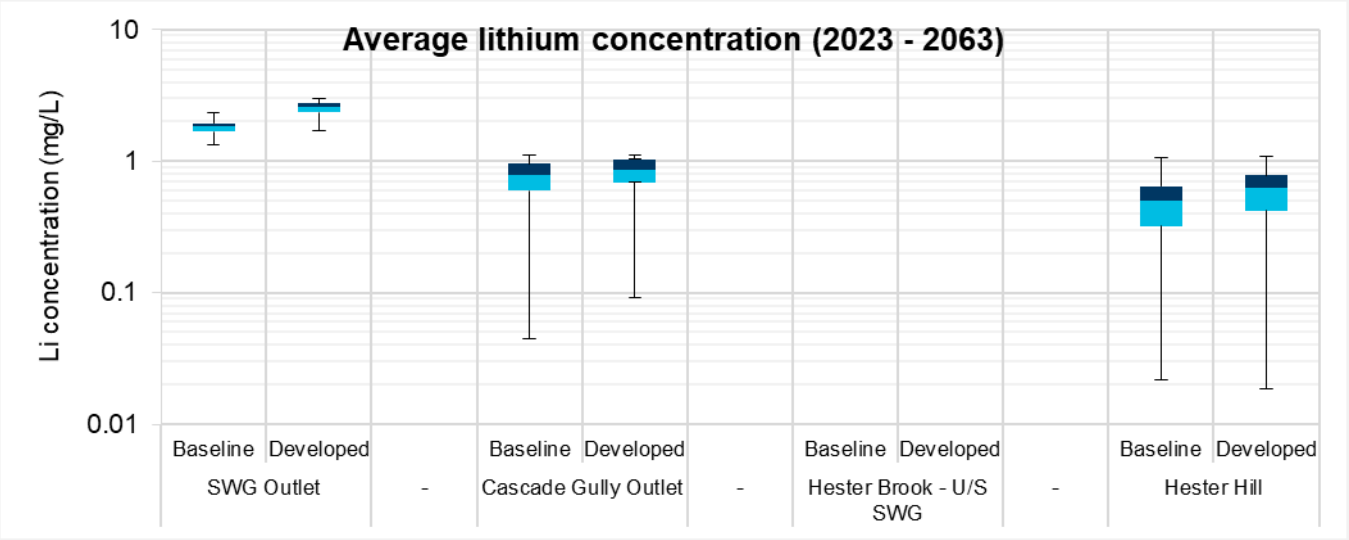

Figure 4.17 *Range of simulated arsenic concentrations*

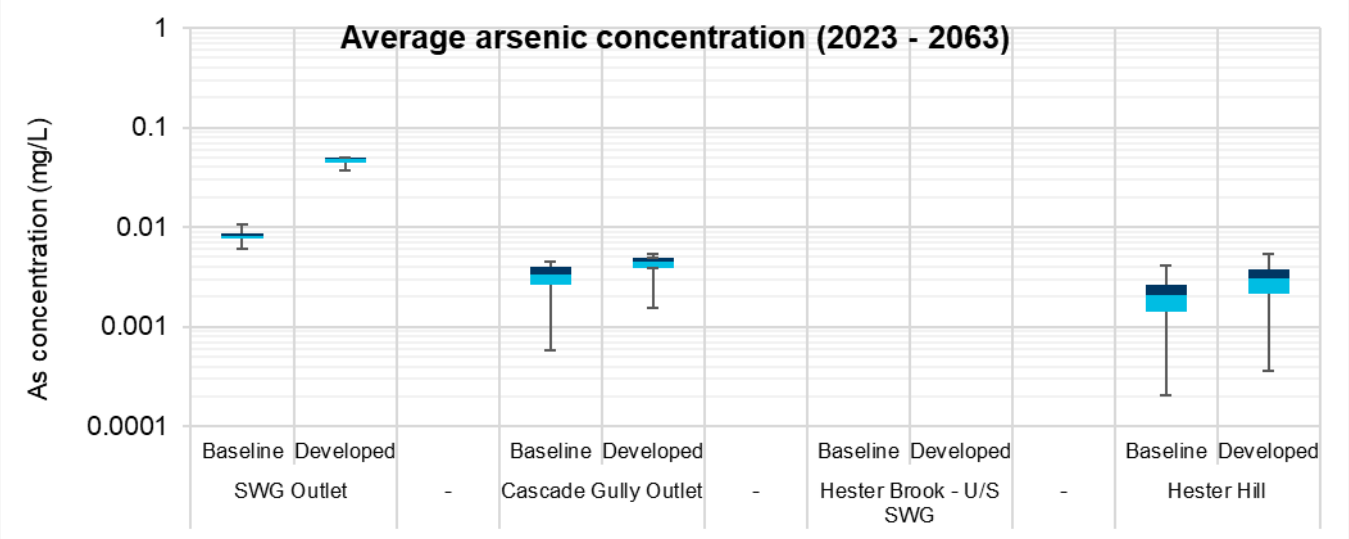

Figure 4.18 *Range of simulated arsenic concentrations*

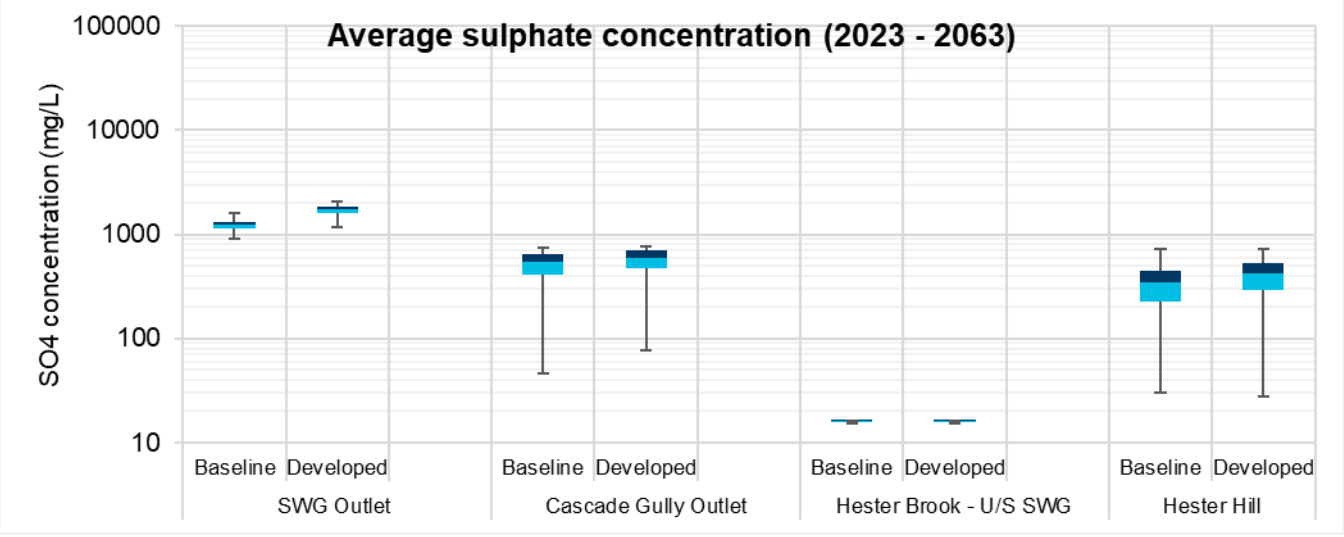

Figure 4.19 *Range of simulated sulphate concentrations*

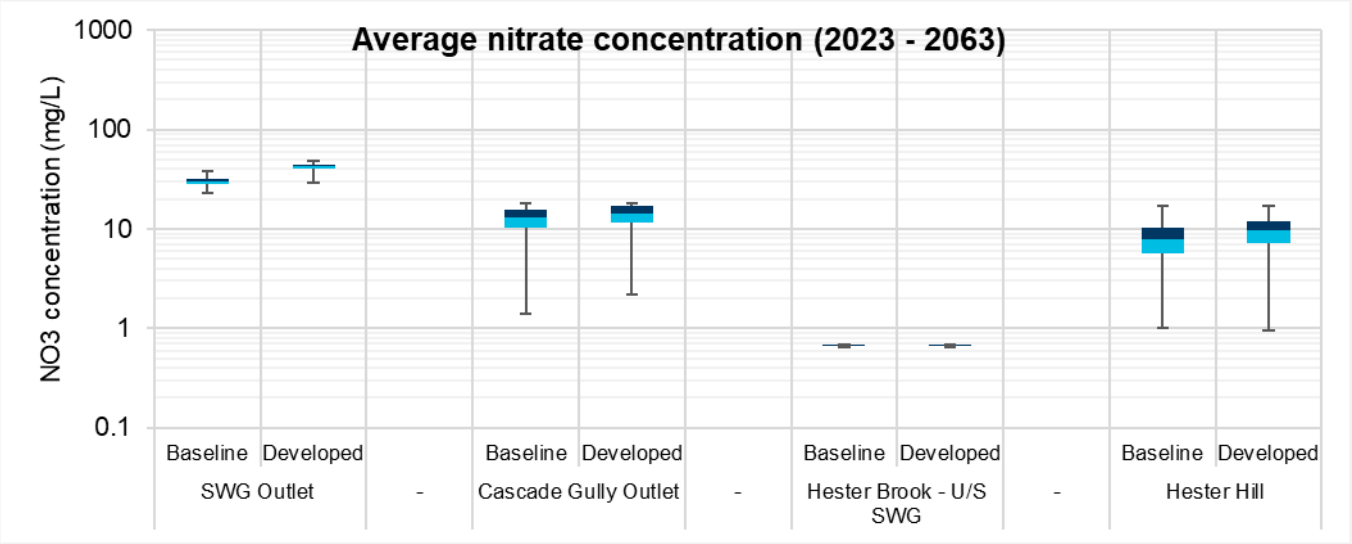

Figure 4.20 ***Range of simulated nitrate concentrations***

4.1.5 Sensitivity Test – Passing Flows

A sensitivity test was undertaken to determine how changing flow requirements at SWG impacts water levels in the dam and flow and CoPC concentrations in the downstream waterways.

The following sensitivity runs were undertaken:

– 10% of inflows
– 50% of inflows
– 20% of inflows (adopted case)

The impact was assessed using the 50th percentile (median) results from the model for:

– Simulated daily water levels and lithium concentrations in the SWG dam (**Figure 4.21** and **Figure 4.24**)
– Simulated daily discharges and lithium concentrations at Saltwater Gully outlet (**Figure 4.22** and **Figure 4.25**)
– Simulated daily discharges and lithium concentrations at Hester Hill (**Figure 4.23** and **Figure 4.26**)

The results indicate the following:

– The passing flow requirements have a negligible impact on the simulated discharge volumes and lithium concentrations at Hester Hill.
– A passing flow requirement of 50% significantly reduces the available water in SWG dam for transfer to the MWC in the median case and increases the lithium concentrations discharging Saltwater Gully outlet.
– Whilst a passing flow requirement of 10% increases the available water volume in SWG dam for transfer to the MWC, it will increase the spill risk on a given winter day from less than 10% to 15%.

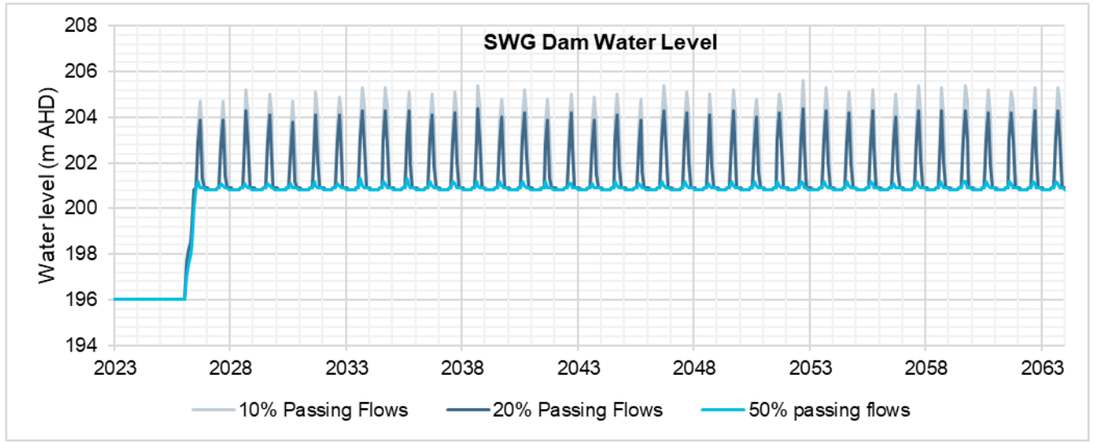

Figure 4.21 Simulated water level in SWG Dam under different passing flow requirements (median result)

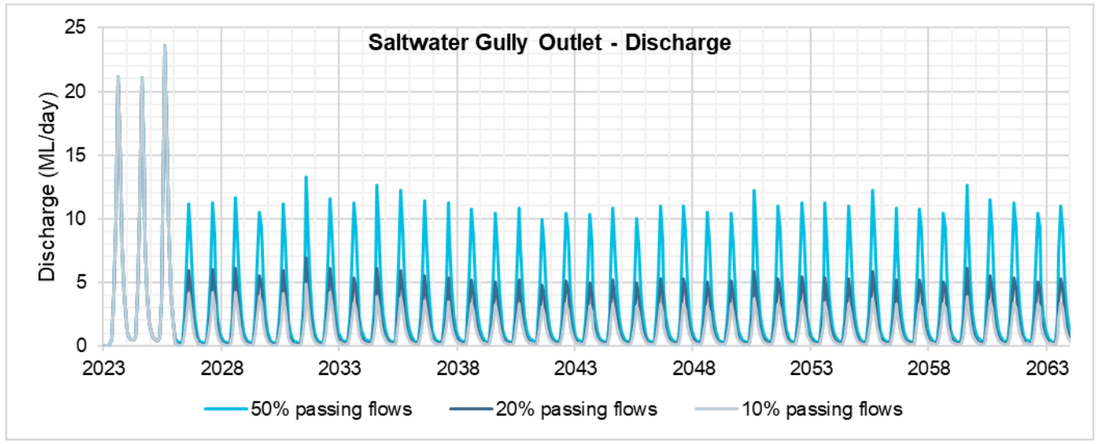

Figure 4.22 Simulated streamflow at Saltwater Gully outlet under different passing flow requirements (median result)

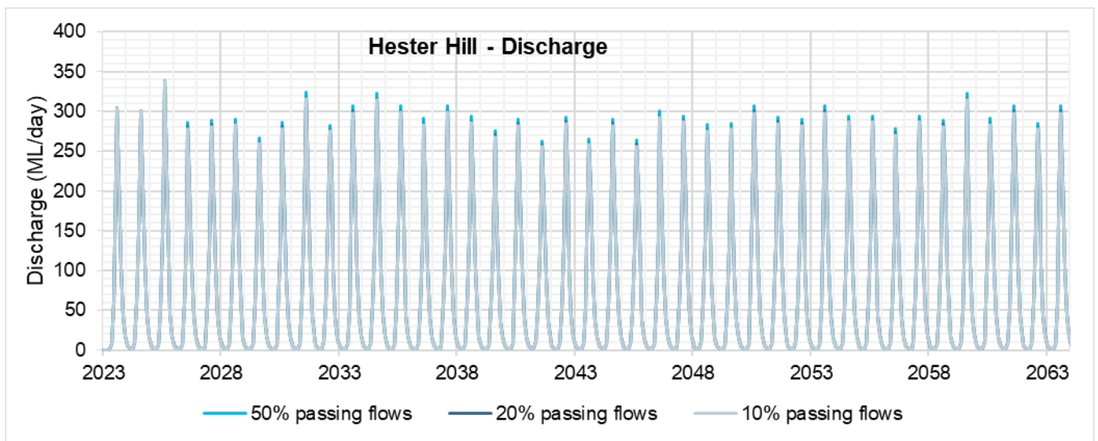

Figure 4.23 Simulated streamflow Hester Hill under different passing flow requirements (median result)

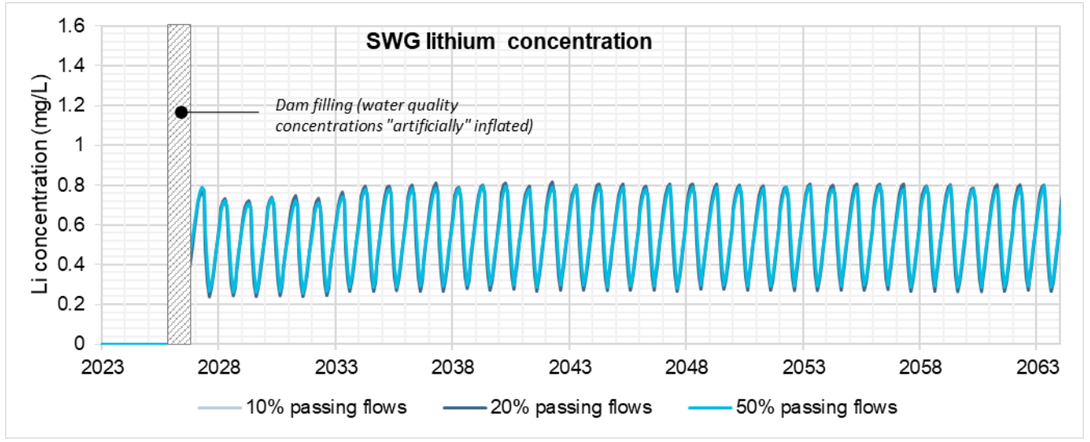

Figure 4.24 Simulated lithium concentration in SWG dam under different passing flow requirements (median result)

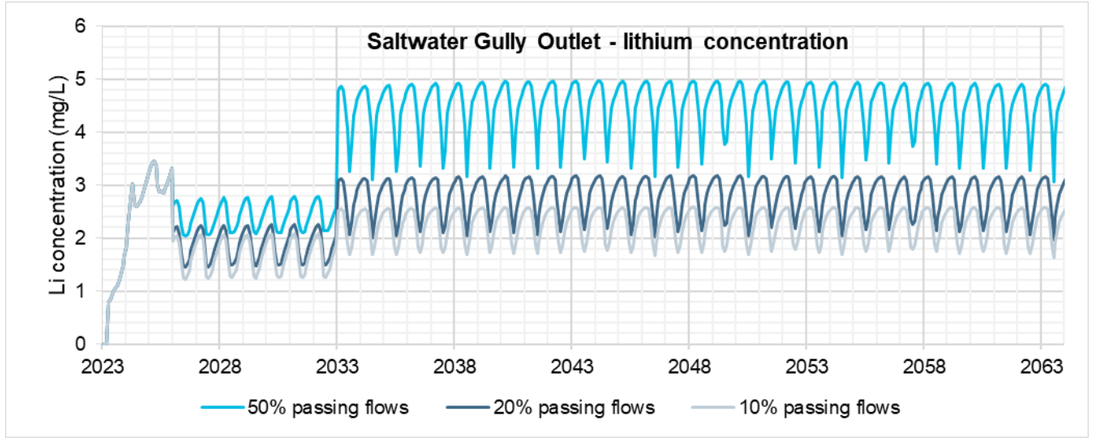

Figure 4.25 Simulated lithium concentrations at Saltwater Gully outlet under different passing flow requirements (median result)

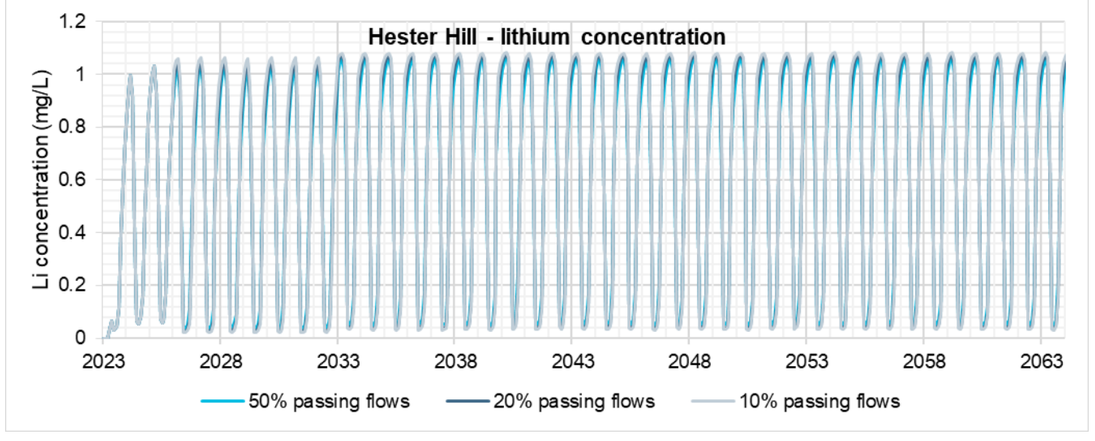

Figure 4.26 Simulated lithium concentrations at Hester Hill under different passing flow requirements (median result)