Australasian Groundwater & Environmental Consultants

Report on

GS40 Peel Valley Alluvium Stage 5

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Australasian Groundwater and Environmental Consultants Pty Ltd

GS40 – Peel Valley Alluvium

Stage 5 – Assessment through multiple lines of evidence

The Peel Valley Alluvium (GS40) is located within the Namoi catchment in northwestern New South Wales and consists of an unconfined alluvial aquifer system hydraulically connected to the Peel River, a tributary of the Namoi River (Figure 1; Crosbie et al., 2023; O'Rourke, 2010). Groundwater entitlements are densely distributed across most of GS40 and are constrained to the narrow alluvial branches of this unit (Figure 1). GS40 spans approximately 186 km², with a Sustainable Diversion Limit (SDL) of 9.34 GL/year and a long-term average recharge estimate of 2.89 GL/year (recharge estimates vary; refer to Table 1). Between 2013 and 2023, average annual groundwater extraction was 5.71 GL/year, representing almost two times the estimated recharge and 61% of the SDL (Figure 2). Groundwater use supports irrigation and stock and domestic supplies, and supplements surface water supply during years of below-average rainfall (Figure 2). Long-term climate observations show a relatively persistent below-average rainfall signal for the 2011–2020 period and a reverse signal post-2020 (Figure 3). GS40 shows a semi-arid to dry sub-humid climate since at least the 1980s based on the precipitation-to-evaporation ratio (Figure 3).

The water table is generally between 5 m and 10 m below the ground surface, though some areas are within the top 5 m below surface (Figure 4a), particularly in the Dungowan Creek and Duncans Creek zones (which are the two alluvial branches southeast of Nemingha; Figure 1). Groundwater flows from southeast to northwest and south to north along the alluvial valleys (Figure 4b). Long-term (1974-2024) and short-term (2012-2024) median groundwater levels show spatial agreement and are contained within a well-defined multi-decadal fluctuation zone that is only several metres thick (Figure 5). In several most areas of GS40, there is minimal discrepancy between the elevation of the long-term and short-term median groundwater levels, suggesting that groundwater levels have been stable over the last decade. Water quality is generally fresh, with salinity below 1,500 mg/L (equivalent to 2239 µS/cm) (Figure 6; MDBA, 2020). Water level trends vary spatially but show a small number of bores with gently declining trends over the long-term (since the 1970s and 1980s) in the central zone (Figure 7; Figure 9). Short-term trends (Figure 10) are all either stable, increasing, or not statistically significant (i.e. none of the 44 bores with short-term data show decreasing trends; Table 1), and there is a marked recovery post-2020 observed in many bores (Figure 7). The understanding of temporal salinity trends is limited due to poor data availability (Figure 8).

MDBA (2020) previously reported diffuse recharge for GS40 as 22.90 GL/year; this was based on WAVES modelling and included diffuse recharge only (excluding flood and in-stream recharge). More recently, estimates from other sources are lower: 2.89 GL/year (Stage 2; derived from chloride mass balance work of Lee *et al*., 2024) and 4.16 GL/year (MD-SY2 project WAVES modelling of diffuse recharge; Crosbie et al., 2025). Table 1 shows a storage-to-recharge ratio (S/R) of 67 using the MD-SY2 estimate of recharge and the RRAM estimate of storage, suggesting low buffering capacity and high vulnerability to short-term climate variability (S/R is within the "high responsiveness" bracket[1] defined in Rojas et al., 2022). The high extraction-to-recharge (E/R) ratio (1.96) and high SDL-to-recharge (SDL/R) ratio (3.24) suggest that there is pressure on the productive base.

[1] S/R ratio: High responsiveness: 29 to 111.
Medium responsiveness: 11 to 333.
Low responsiveness: >333.

Despite this pressure in GS40, the productive base shows negligible signs of stress in the short term, and only mild signs in the long term (Table 1; Figure 9; Figure 10). Statistically significant ($\alpha=0.05$) declines over the long-term (1974–2024) were observed in nine of the 45 bores with suitable records (Table 1), and all but one of these trends are mild (less than -0.1 m/year; Figure 9). The short-term records show a widespread lack of statistically significant trends and there are no bores with declining records (Figure 10). The short-term recovery period follows a period of close-to-average and below-average rainfall (prior to 2020, Figure 3) and is associated with a substantial reduction in annual take and an increase in rainfall post-2020 (Figure 2). This pattern indicates a dynamic and responsive system, and aligns well with the concept that suitability of take from the aquifer is influenced by seasonal recharge variability (NSW DoI, 2019). Short-term groundwater level recovery is likely to positively affect surface water connectivity, as the catchment is classified as mostly 'losing connected' during 2000-2019 by Crosbie et al. (2023). Despite this classification, groundwater discharge maintains baseflow in surface water bodies where the Peel Valley alluvium narrows, particularly at the lower end of the valley. Therefore, groundwater-dependent ecosystems (GDEs), such as riparian woodlands and wetland ecosystems (NSW DoI, 2019), may also be impacted by groundwater level changes.

Stage 4 of this BPR technical groundwater review provided a quantitative assessment of resource condition indicators within a 5 km buffer around extraction points (asset area). Long-term groundwater level declines were observed in only 5% of the productive base asset area, 6% of the river connectivity asset area, and 5% of the GDE asset area (Table 2). In the short-term, these percentages decreased to 0% in all cases (Table 2). Approximately 50% of each ESLT asset area showed improving water level conditions in the long-term, increasing by one or two percent in the short-term (Table 2), suggesting partial recovery or stabilisation (Figure 11). Levels of uncertainty, as indicated by areas with insufficient data to inform temporal trends, have remained relatively similar between the long- and short-term periods (Figure 11). The exception is the water quality (salinity) ESLT, where the long-term and short-term conditions both indicate there are insufficient data to determine temporal trends.

The NSW state-based risk assessment (NSW DoI, 2019) assigns variable risk ratings across ESLT values. For the productive base, most risk factors are rated high to medium. High risks include: groundwater take (licenced or basic rights) causing local drawdown that reduces groundwater access; climate change reducing recharge and groundwater availability; and increases in irrigation efficiency reducing recharge. Limits on trade and the location and rate of extraction, reserving water above the LTAAEL for the environment, plus monitoring of water levels, are key management controls. The risk to the structural integrity of the groundwater system was rated as medium (with low likelihood). Regarding river connectivity, there is a high risk of groundwater take causing local drawdown that impacts instream ecological values, and a high risk of climate change reducing recharge and thus impacting instream ecological values. The risk to GDEs from climate change reducing groundwater recharge is high, and that of groundwater extraction (which causes local drawdown) is medium (NSW DoI, 2019). The risk of groundwater extraction inducing connection with poor quality groundwater is medium (with low likelihood), and the risk of poor quality groundwater impacting GDEs and instream ecological values (qualitatively assessed) is low. Data availability is extensive for water levels, but more limited for water quality, contributing to residual uncertainty in the risk profile.

Future projections from the MD-SY2 project suggest that diffuse recharge in GS40 may increase by 2050 due to more intense rainfall events (Crosbie et al., 2025). In contrast, overbank flood recharge and in-stream recharge are projected to decline by 19.7% and 8.4% relative to current conditions, respectively (Crosbie et al., 2025), potentially reducing (localised) episodic recharge and groundwater availability during dry periods. These opposing trends introduce uncertainty regarding net future recharge in GS40. Stage 6 of this BPR technical groundwater review found that the future area of drawdown (Area of Influence, AoI[2]) is projected to expand slightly under climate change scenarios, with the median future AoI (P50) marginally exceeding the present AoI, indicating potential increases in deteriorating areas (Figure 12). The SDL/R ratio is also projected to increase marginally, indicating that the rate of replenishment for the resource may change in the future. The Stage 6 assessment classified the pressure from future climate change on GS40 groundwater resources as high to very high (based on long-term and short-term water level evidence).

[2] Area of influence is defined as the area impacted by drawdown caused by groundwater extraction. For the quantitative assessment of Stage 4, this is equivalent to the percentage asset area showing a deteriorating resource condition, which is a statistically significant declining trend in groundwater level.

Overall, groundwater level trends suggest stable conditions across ESLT values in GS40, with no declining trends observed over the short-term period. The recent resource condition is mainly a response to changes since about 2020, with sequential wet years and reduced groundwater extraction. Uncertainty in salinity trends is high, with 100% of the asset area classified as insufficient data to inform temporal trends, and moderate concerns for groundwater quality. The water level trends confirm the sensitive nature of the unit to its net fluxes, as storage is relatively small compared to recharge, which is highly variable. Current extraction remains below the SDL, but is possibly twice the volume of recharge. In addition, recharge estimates for GS40 vary, with some being lower than the SDL. Therefore, the impacts of full SDL utilisation have not yet been realised. Although no signs of stress are present in recent groundwater level trends, GS40 is susceptible to pressures, and the state-based risk assessment supports this concern, highlighting several high risks to productive base, river connectivity, and GDEs based on increased take and climate change. Climate projections indicate reduced episodic (localised) recharge from floodplain processes and overall the pressure from climate change is assessed as high or very high. Collectively, the analysis suggests low to moderate pressure on the productive base of GS40, but with very high sensitivity to future climatic variability.

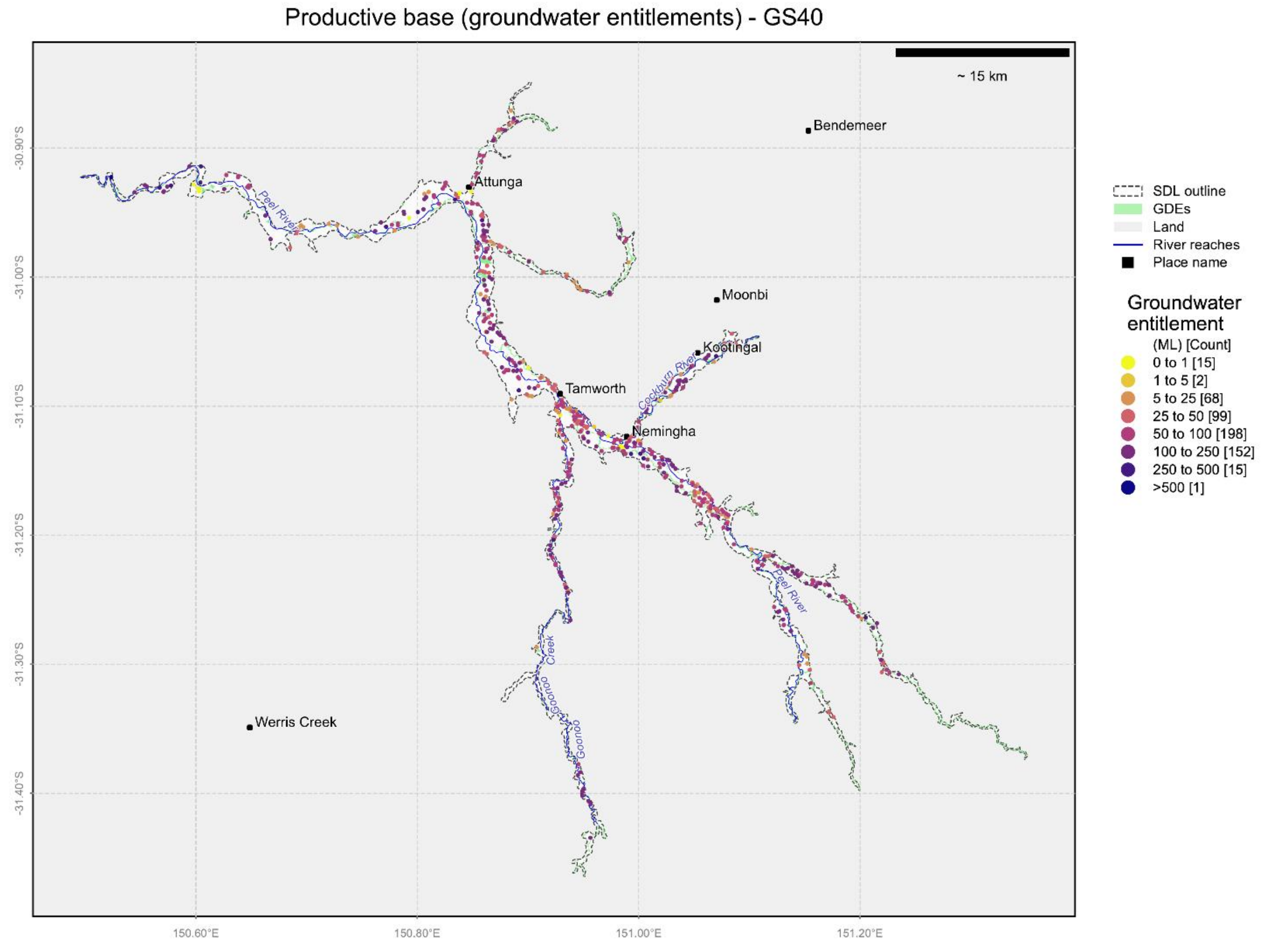


Figure 1 Productive base (groundwater entitlements)

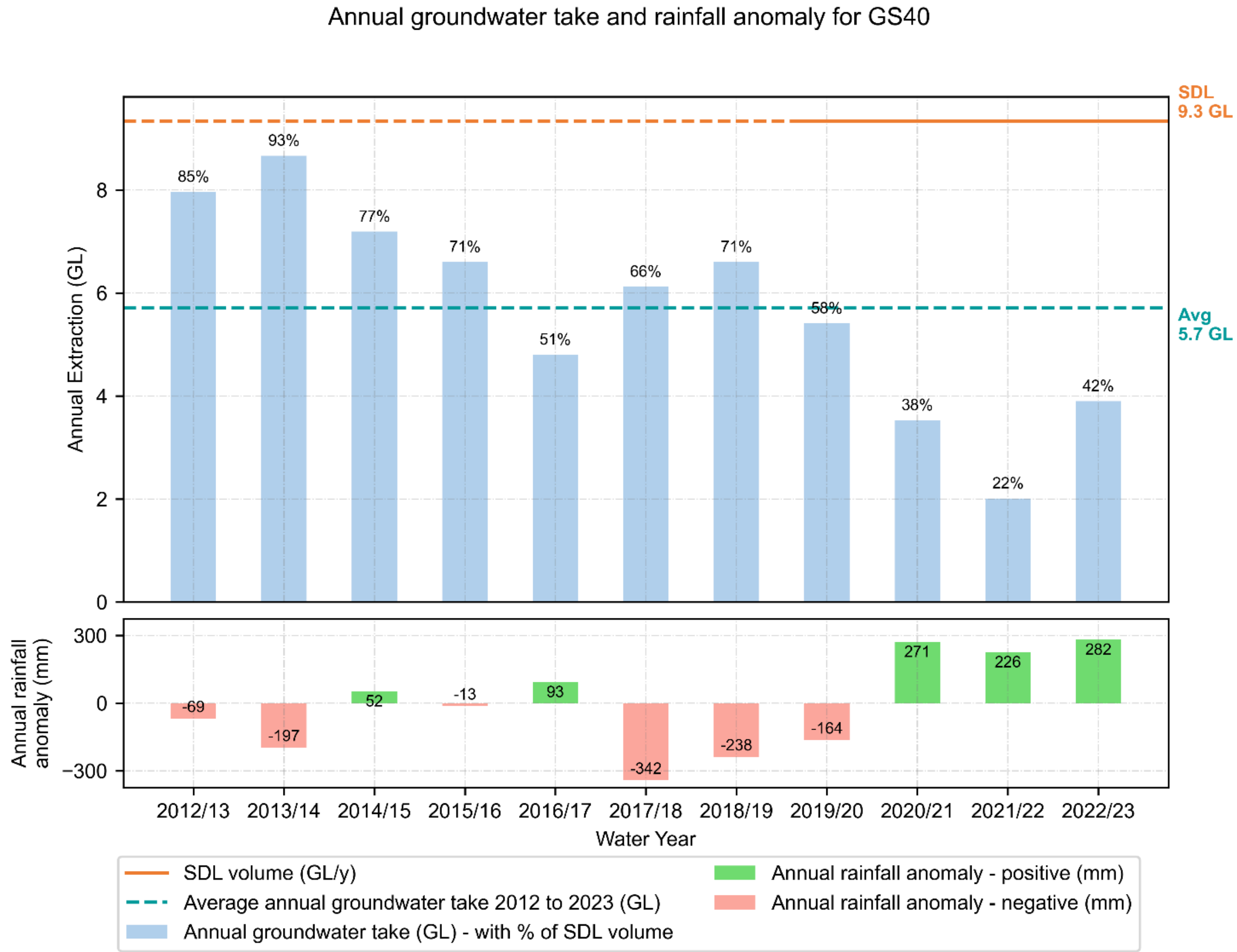


Figure 2 Groundwater take in the SDL since 2012

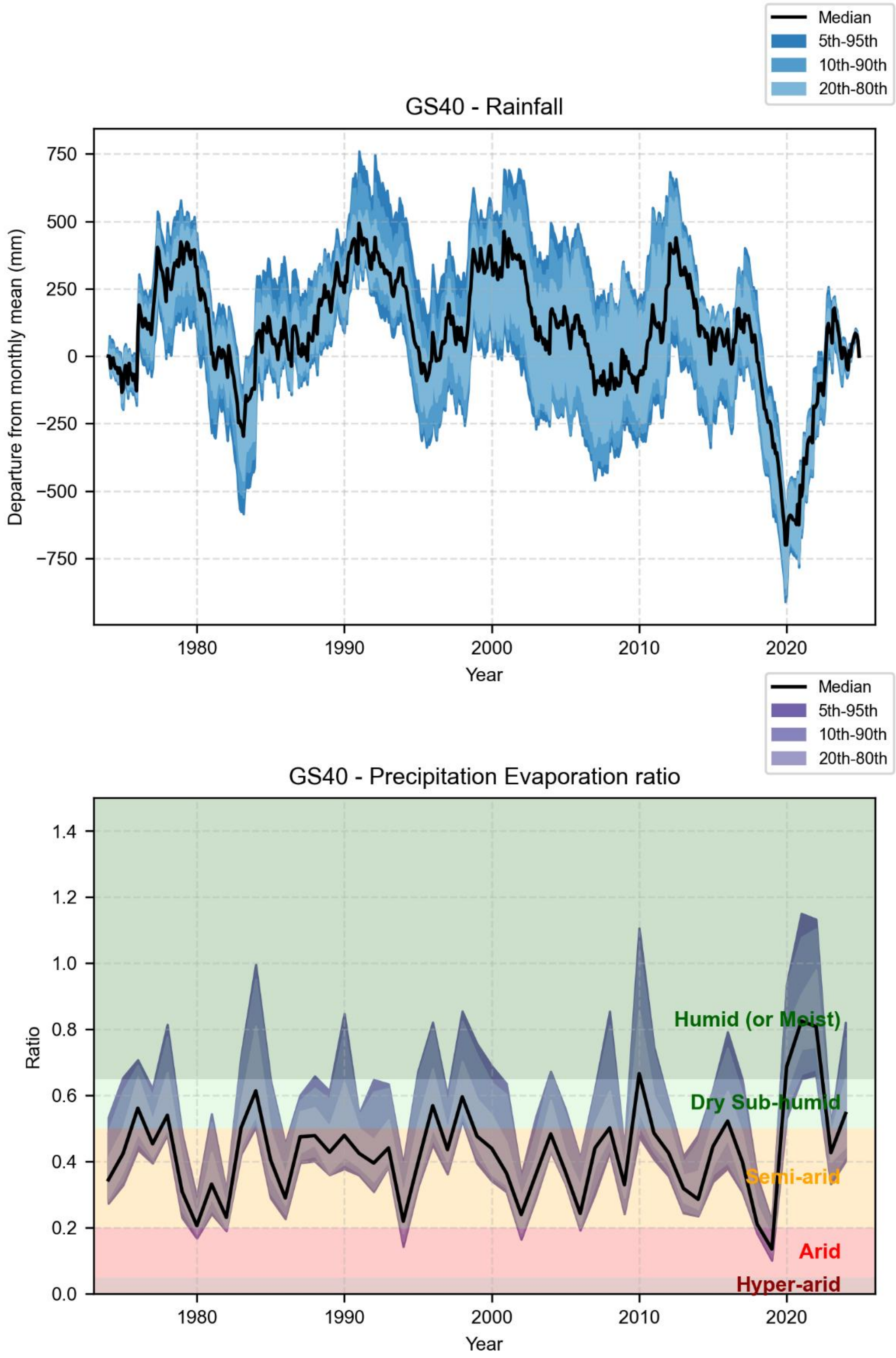
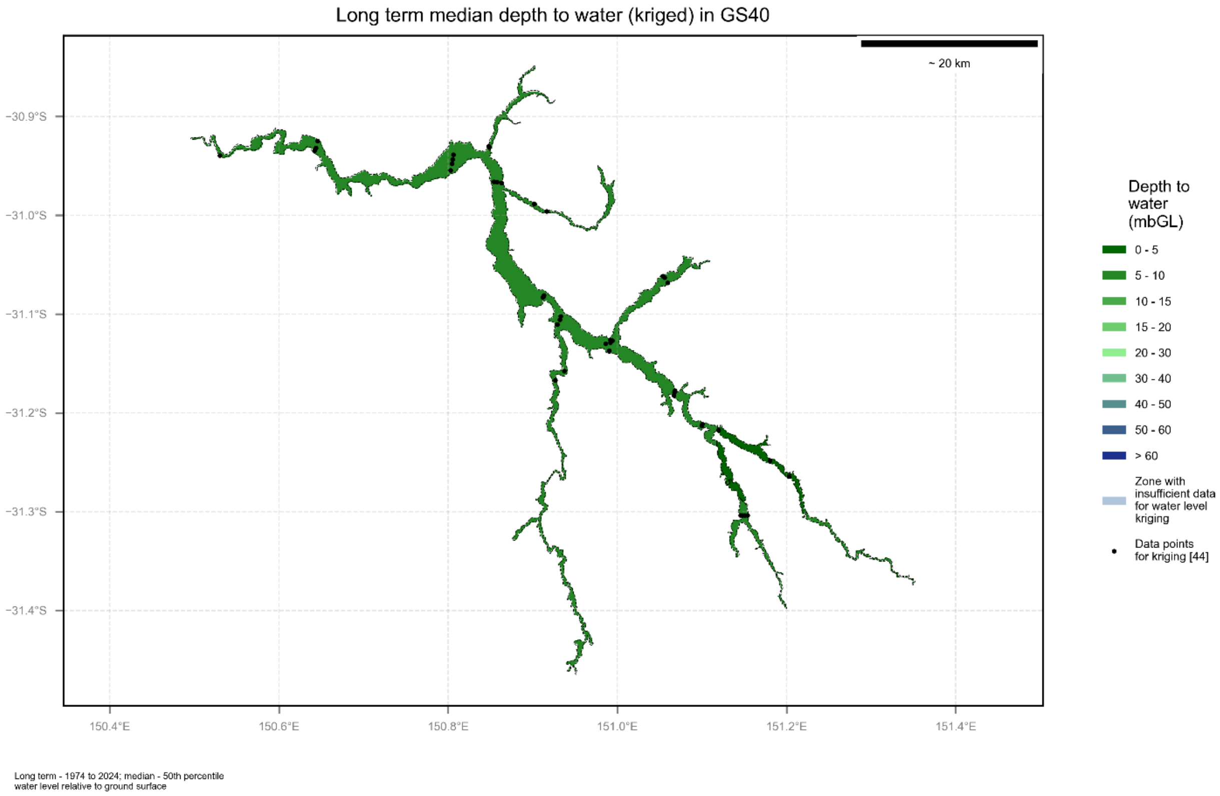
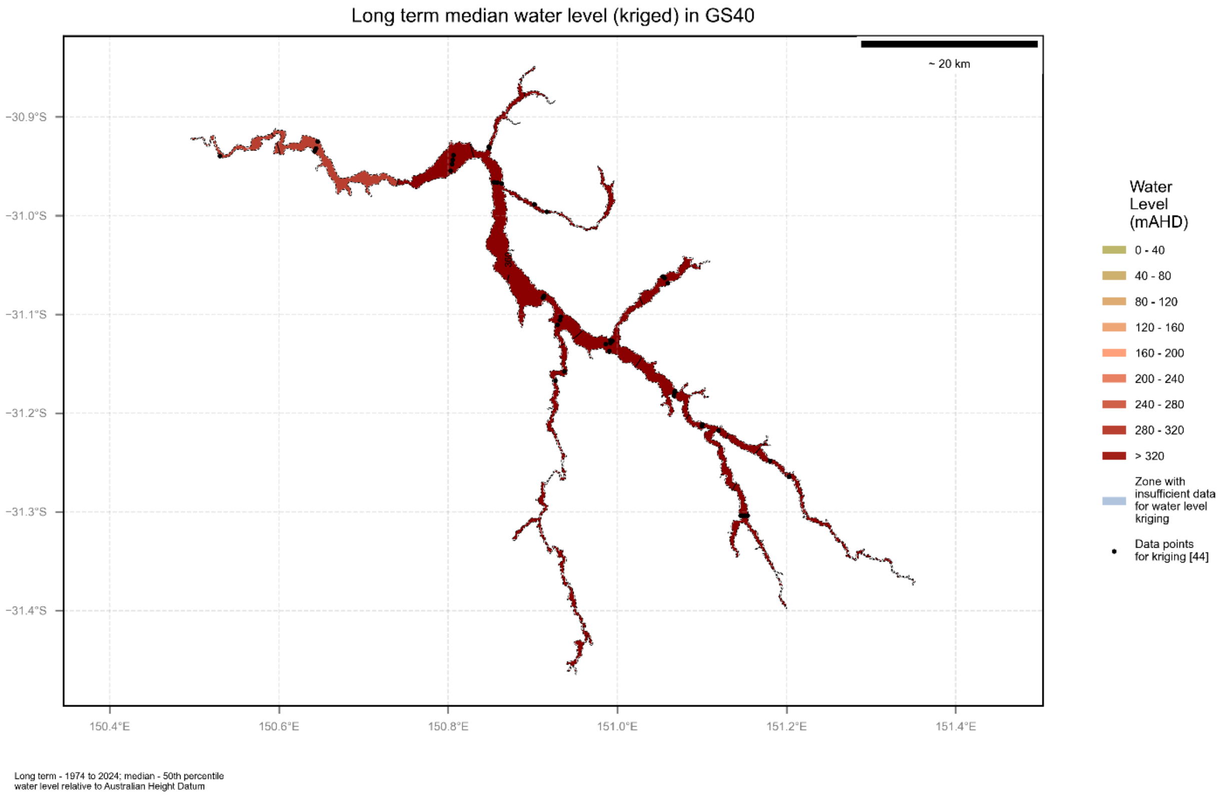


Figure 3 Historical climate trends

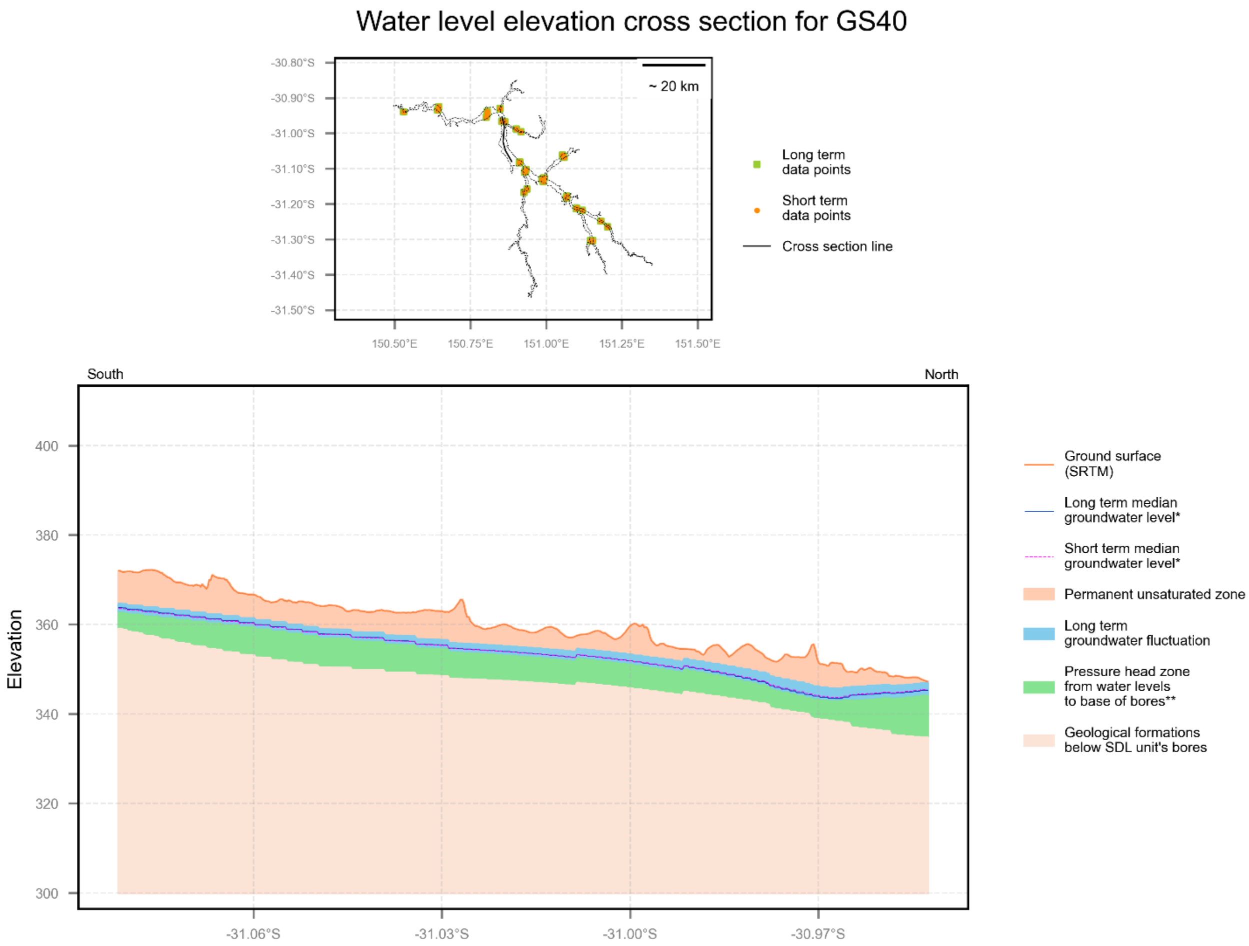


(a)



(b)

Figure 4 Long-term median (a) depth to water and (b) water level elevation



*Long term - 1974 to 2024; Short term - 2012 to 2024; median - 50th percentile

***This cross-section is a scaled representation of bore data specific to the SDL resource unit.*
The data are temporally and spatially aggregated, resulting in some smoothing of the representation of water levels and aquifer formations that is different from the detail of reality.
The blue zone represents the long term fluctuation in groundwater levels, as indicated by the 5th and 95th percentiles of groundwater levels from 1974 to 2024.
The green pressure head zone may be representative of the total available drawdown (TAD), as it shows the water column in bores of the SDL resource unit (measured as the difference between the long-term 5th percentile groundwater level and the base of the bores of the SDL resource unit).
This cross-section is for interpretation purposes only and should not be used for planning or compliance purposes.

Figure 5 South to north distribution of water levels in the SDL resource unit

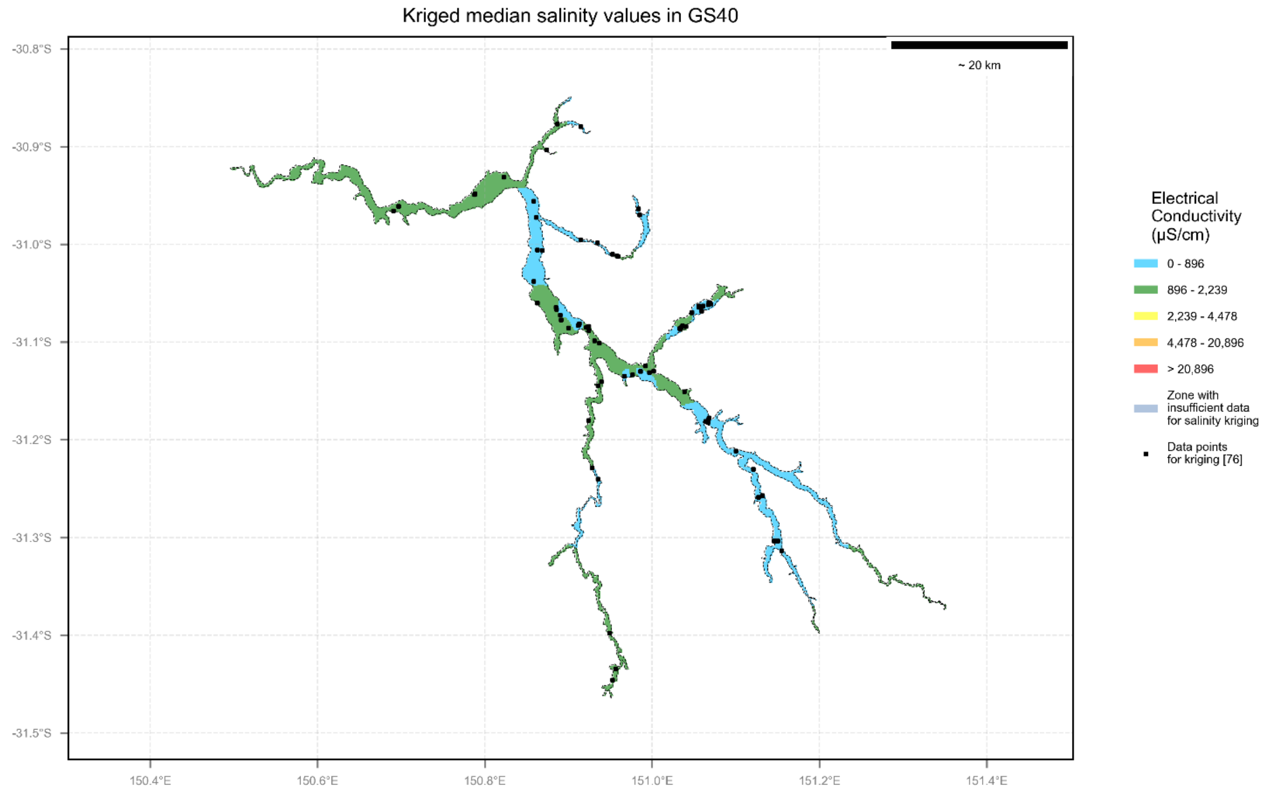


Figure 6 Groundwater salinity distribution

Table 1 Table of groundwater metadata for the SDL resource unit

Parameter	Unit	Long-term (1974 to 2024)	Short-term (2012 to 2024)	SDL resource unit data
SDL volume	GL/y	-	-	9.34
SDL resource unit area	km²	-	-	186
Average annual take (2013 to 2023)	GL/y	-	-	5.71
Number of groundwater entitlement bores	-	-	-	550
SDL resource unit storage estimate*	GL	-	-	277
Recharge estimate (SY1)	GL/y	-	-	22.90
Recharge estimate (Stage 2)	GL/y	-	-	2.89
Diffuse recharge estimate (SY2 - WAVES)	GL/y	-	-	4.16
Extraction/SDL (E/SDL) (Stage 2 result)	-	-	-	0.61
SDL/Recharge (SDL/R) (Stage 2 result)	-	-	-	3.24
SDL/Recharge (SDL/R) (SY2 or modelled recharge)	-	-	-	2.24
Storage/Stage 2 Recharge (S/R)	-	-	-	96
Storage/SY2 or modelled Recharge (S/R)	-	-	-	67
Number of bores in the SDL unit	-	1,232	1,232	-
Number of bores for water level trend analysis	-	46	44	-
Number of bores for water level trend with sufficient data	-	45	43	-
Number of bores with decreasing water level trend	-	9	0	-
Number of bores with increasing water level trend	-	6	3	-
Number of bores with no statistically significant water level trend	-	30	40	-
Mean water level trend magnitude	m/y	0.01	0.07	-
Minimum water level trend magnitude	m/y	-0.34	0.0	-
5%ile water level trend magnitude	m/y	-0.02	0.01	-
10%ile water level trend magnitude	m/y	-0.01	0.03	-
50%ile water level trend magnitude	m/y	0.01	0.07	-
90%ile water level trend magnitude	m/y	0.05	0.13	-
95%ile water level trend magnitude	m/y	0.06	0.14	-
Maximum water level trend magnitude	m/y	0.07	0.2	-
Number of bores for salinity trend analysis	-	80	N/A	-
Number of bores for salinity trend with sufficient data	-	0	N/A	-
Number of bores with decreasing salinity trend	-	0	N/A	-
Number of bores with increasing salinity trend	-	0	N/A	-
Number of bores with no statistically significant salinity trend	-	0	N/A	-
Mean salinity trend magnitude	µS/cm/y	N/A	N/A	-
Minimum salinity trend magnitude	µS/cm/y	N/A	N/A	-
5%ile salinity trend magnitude	µS/cm/y	N/A	N/A	-
10%ile salinity trend magnitude	µS/cm/y	N/A	N/A	-
50%ile salinity trend magnitude	µS/cm/y	N/A	N/A	-
90%ile salinity trend magnitude	µS/cm/y	N/A	N/A	-
95%ile salinity trend magnitude	µS/cm/y	N/A	N/A	-
Maximum salinity trend magnitude	µS/cm/y	N/A	N/A	-

Note: *Groundwater resource storage estimate source: RRAM.

Table 2 Table of results from spatial analysis of RCI trends in ESLT asset areas

ESLT Value	Asset area (m2)	Long-term				Short term			
		Proportion of asset area with improving/ stable RCI trends	Proportion of asset area with deteriorating RCI trends	Proportion of asset area with uncertain RCI trends	Trend grouping	Proportion of asset area with improving/ stable RCI trends	Proportion of asset area with deteriorating RCI trends	Proportion of asset area with uncertain RCI trends	Trend grouping
Productive base	1,887,345,659	47%	5%	47%	Variable trends	49%	0%	51%	Insufficient data
GDEs	1,860,694,344	48%	5%	47%	Variable trends	49%	0%	51%	Insufficient data
River connectivity	1,572,633,840	50%	6%	44%	Improving / stable trends	51%	0%	49%	Improving / stable trends
Water quality	1,887,345,659	0%	0%	100%	Insufficient data	0%	0%	100%	Insufficient data

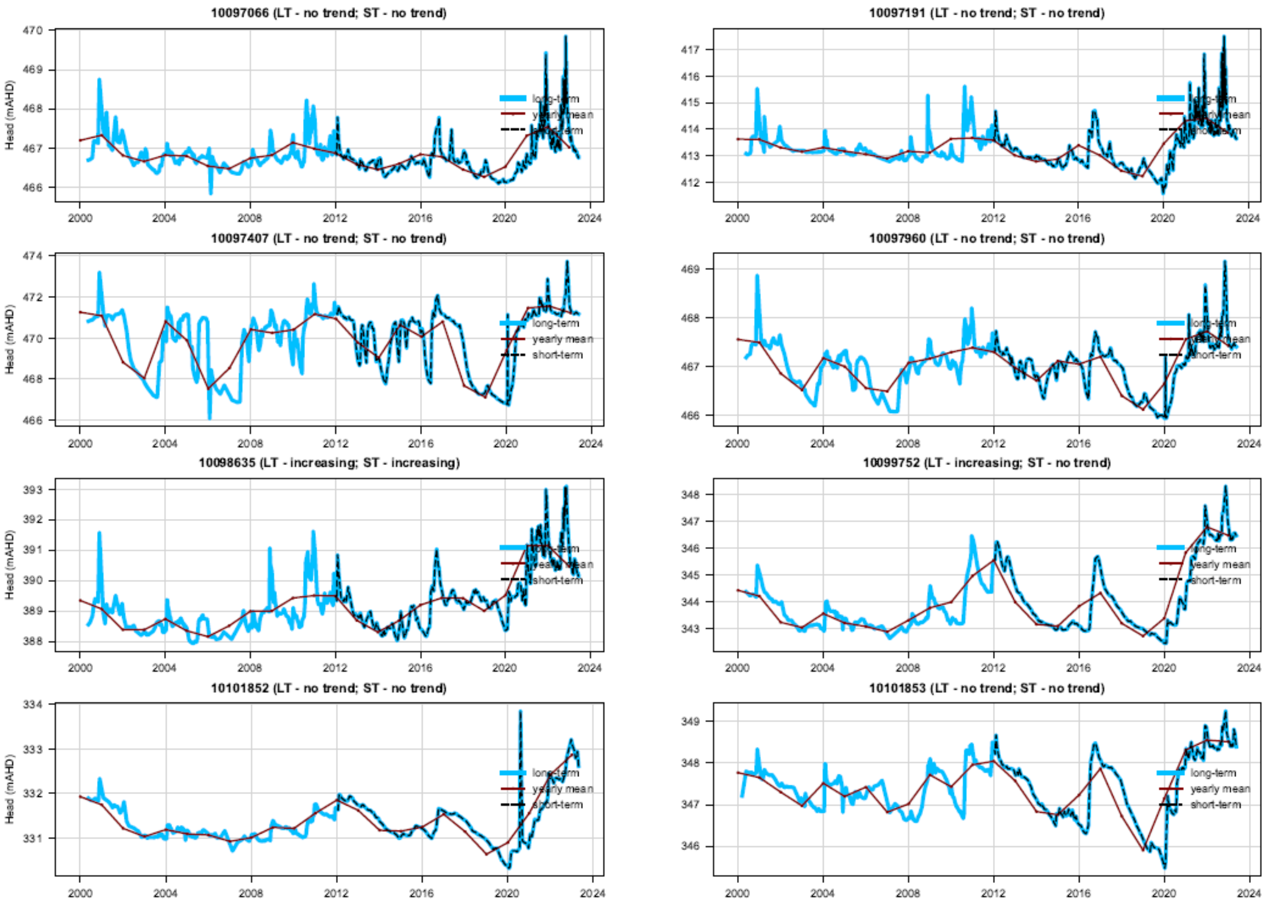


Figure 7 Representative groundwater hydrographs for the SDL resource unit

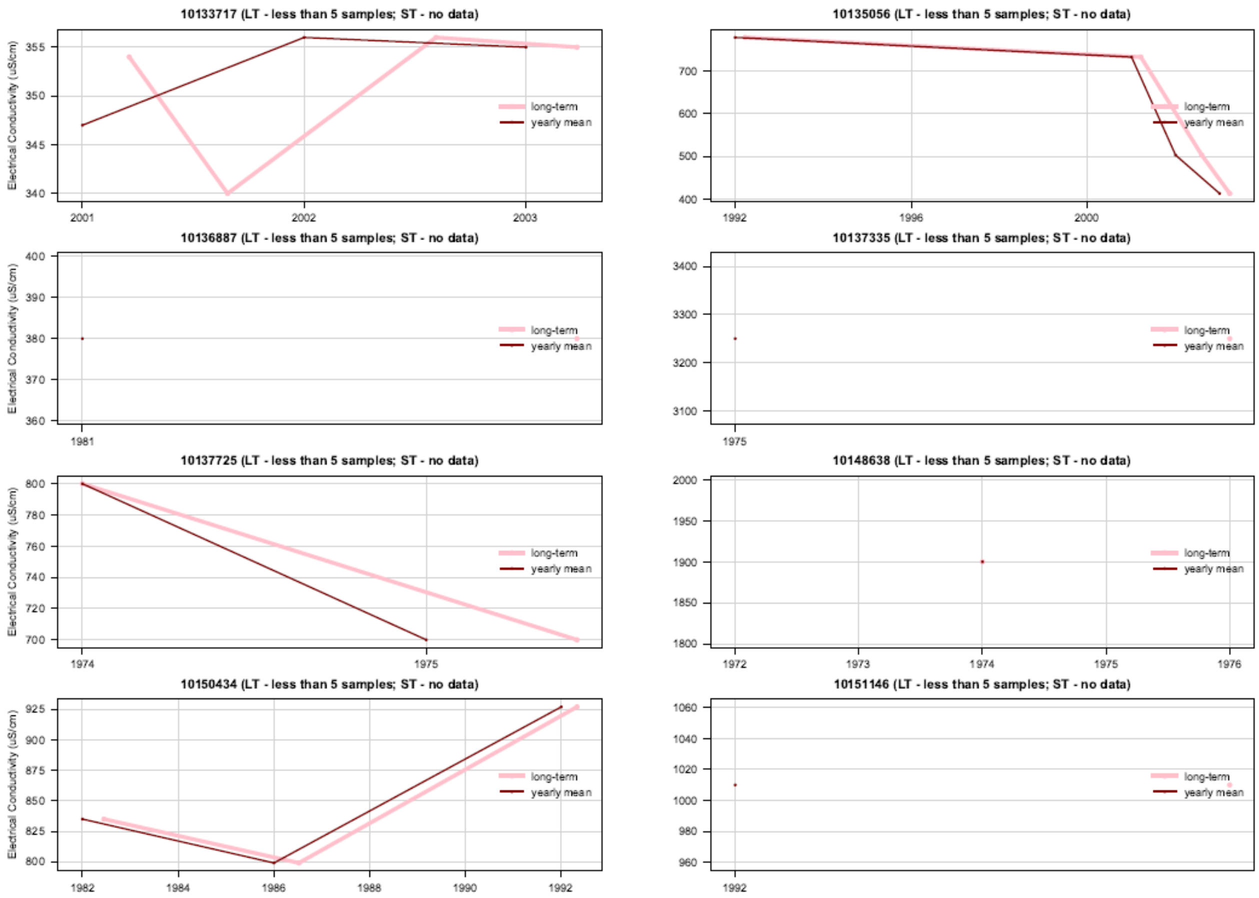
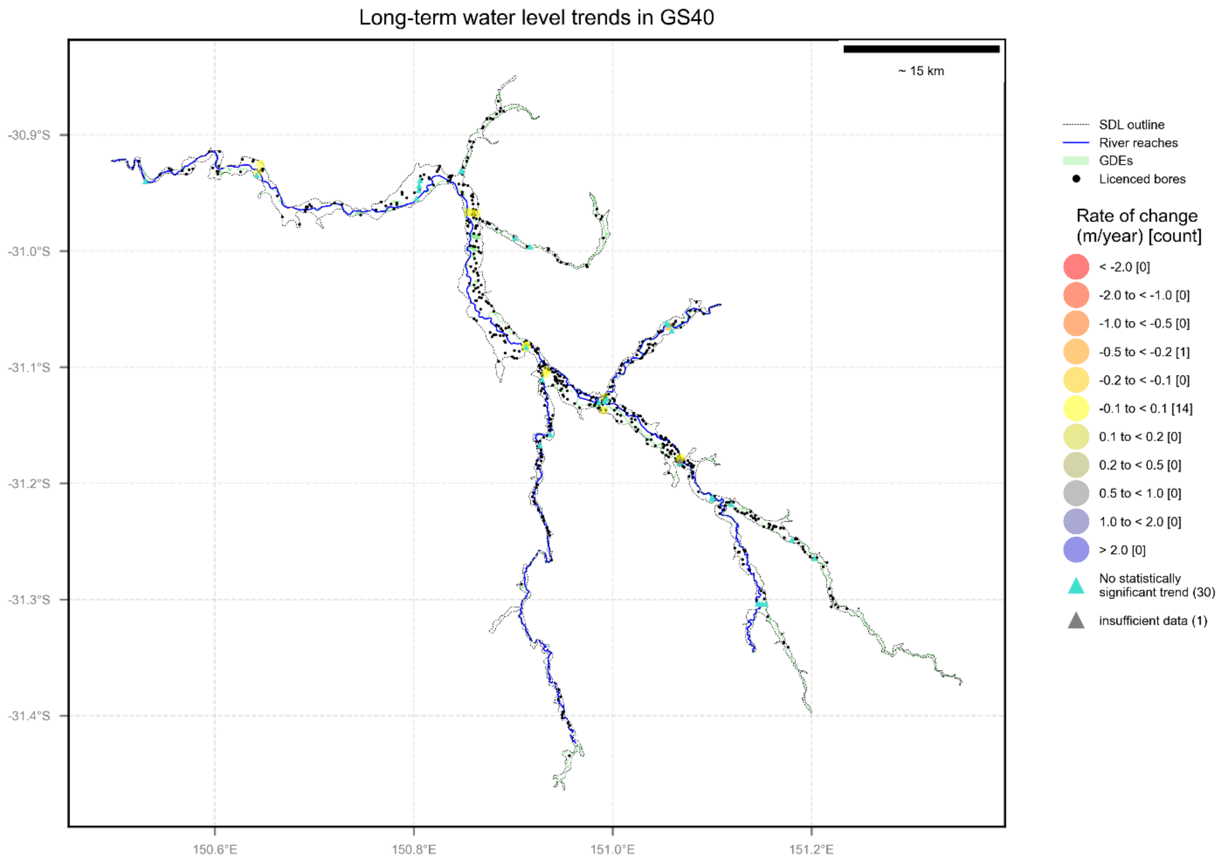
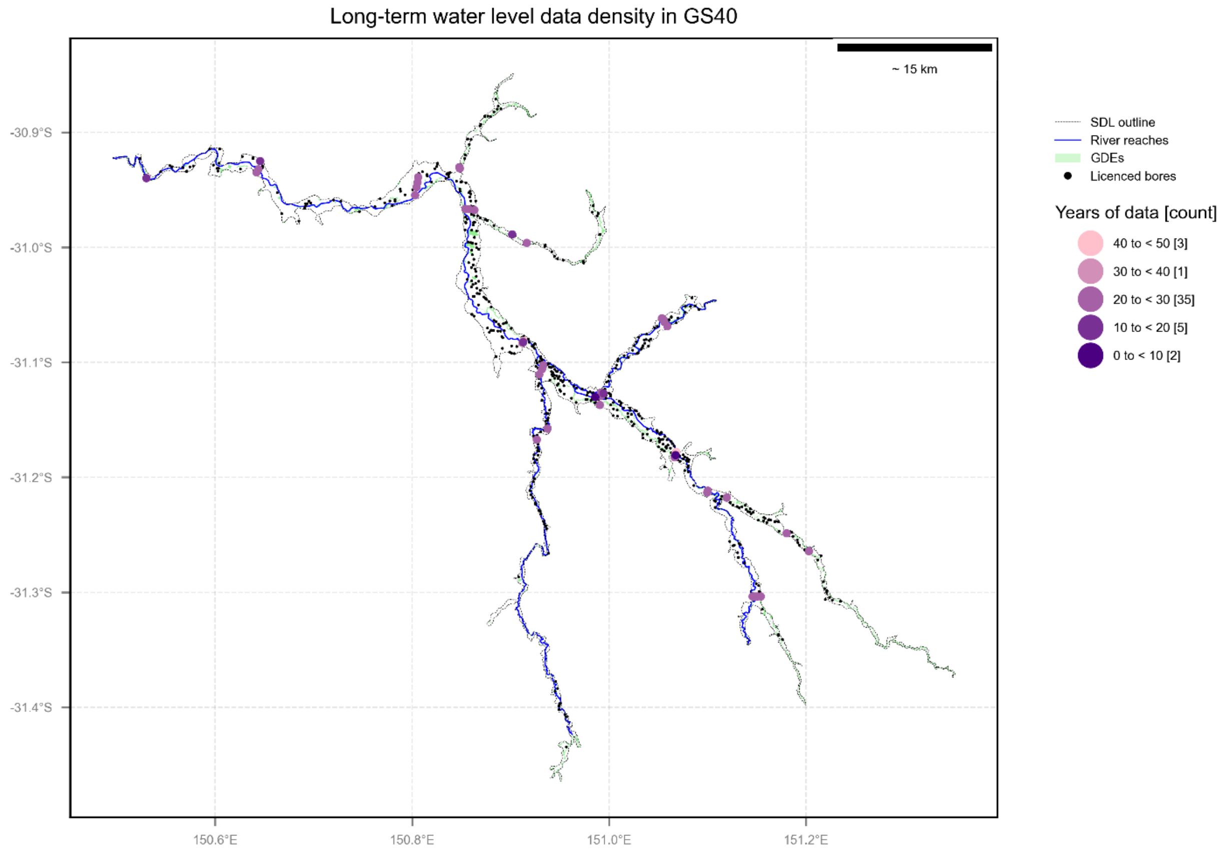


Figure 8 Representative groundwater salinity time series for the SDL resource unit

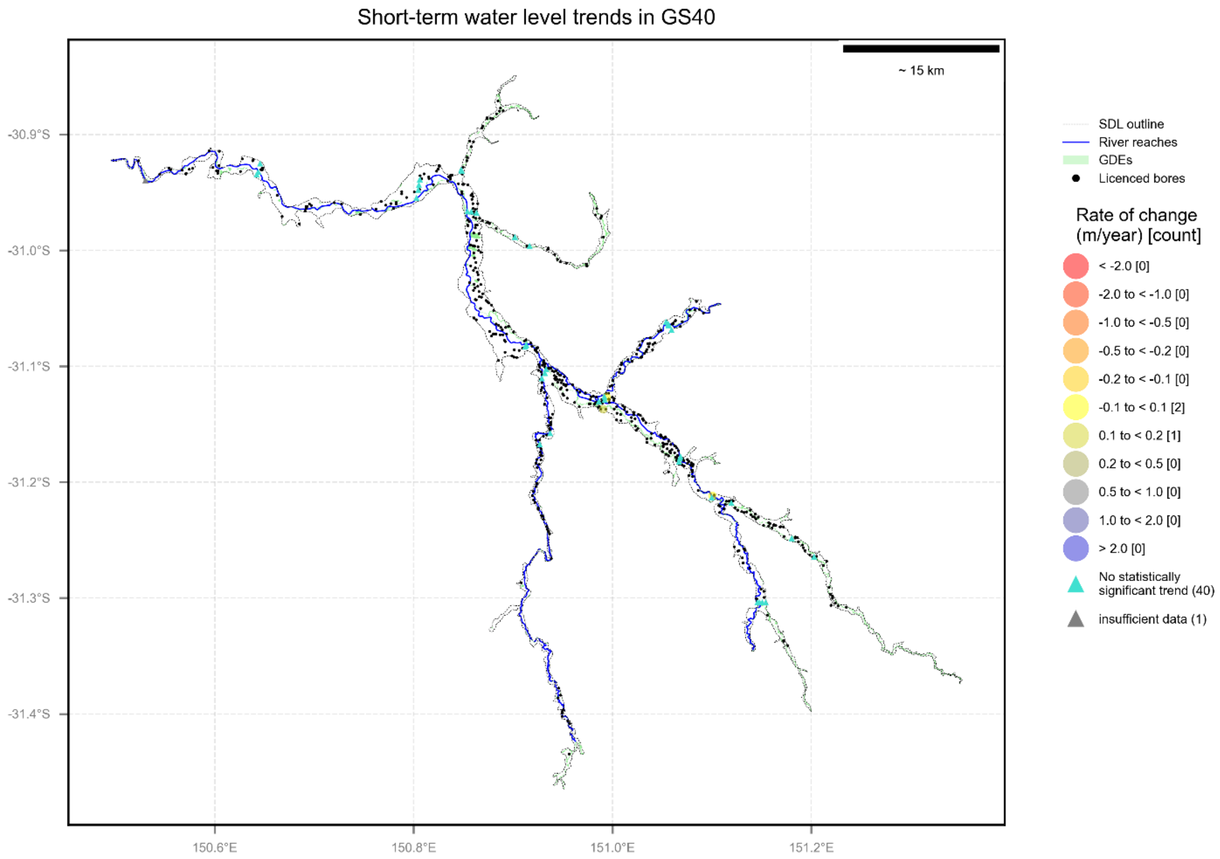


a)

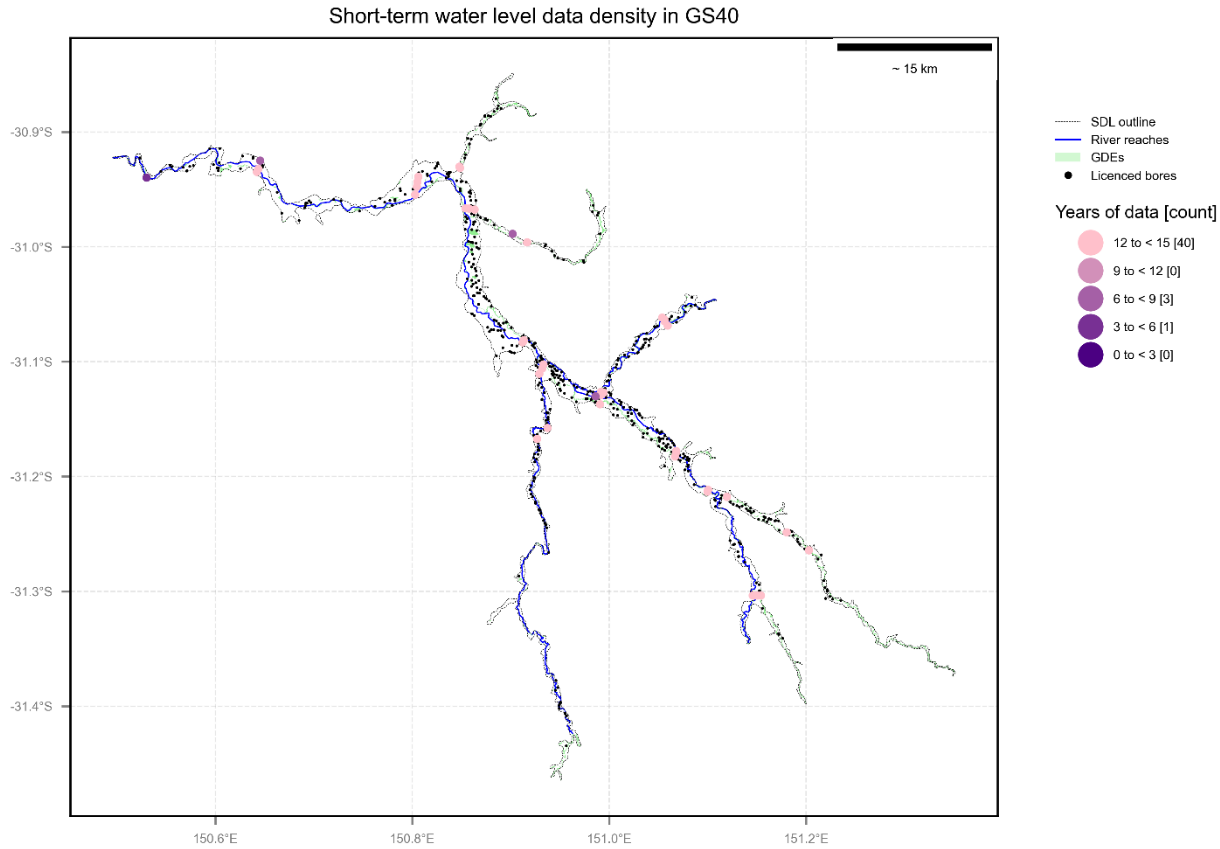


b)

Figure 9 Long-term (1974 to 2024) groundwater level trends (a) and data availability (b)



a)



b)

Figure 10 Short-term (2012 to 2024) groundwater level trends (a) and data availability (b)

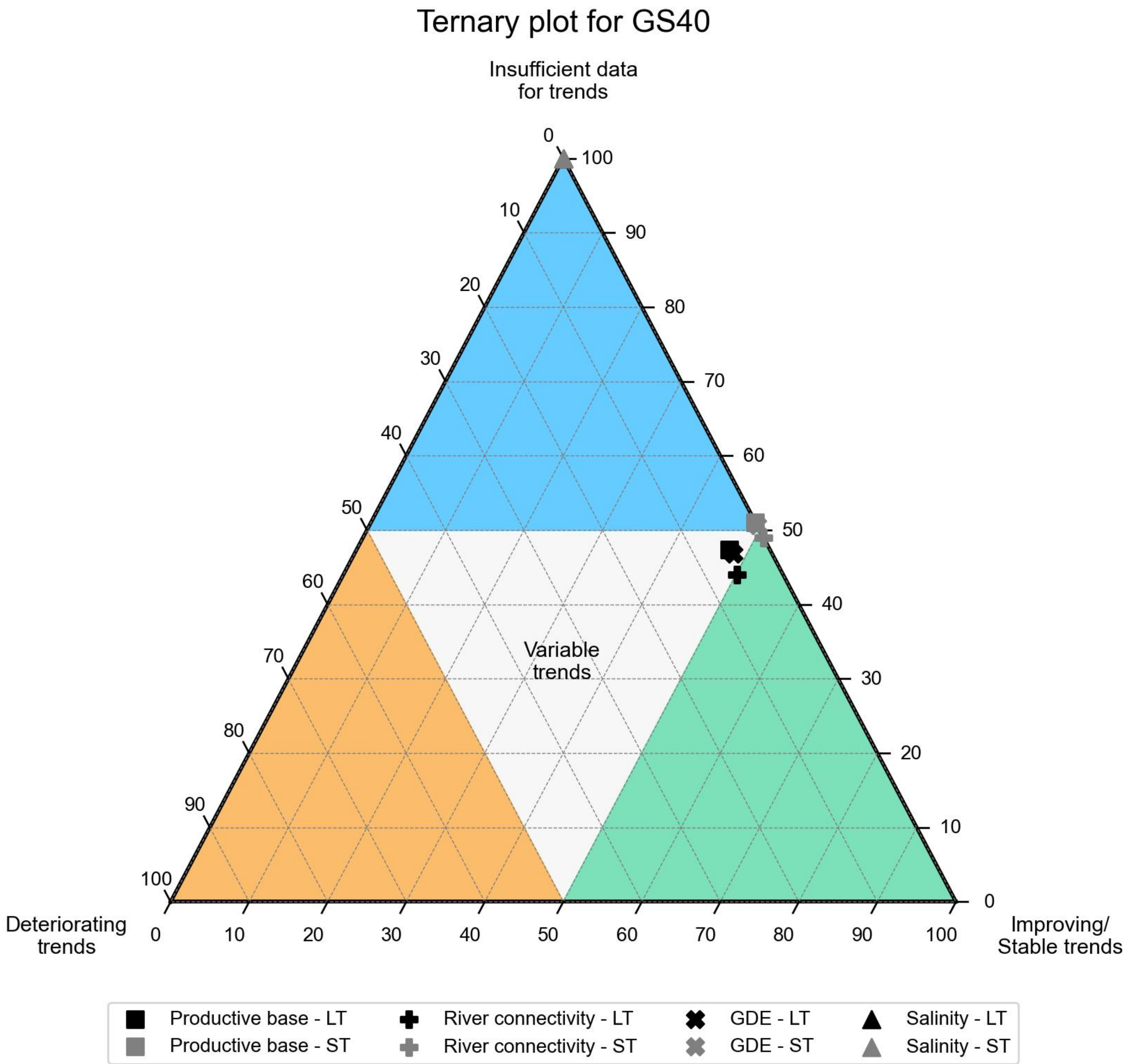


Figure 11 Stage 4 assessment outcome: trends in resource condition indicators for ESLT values

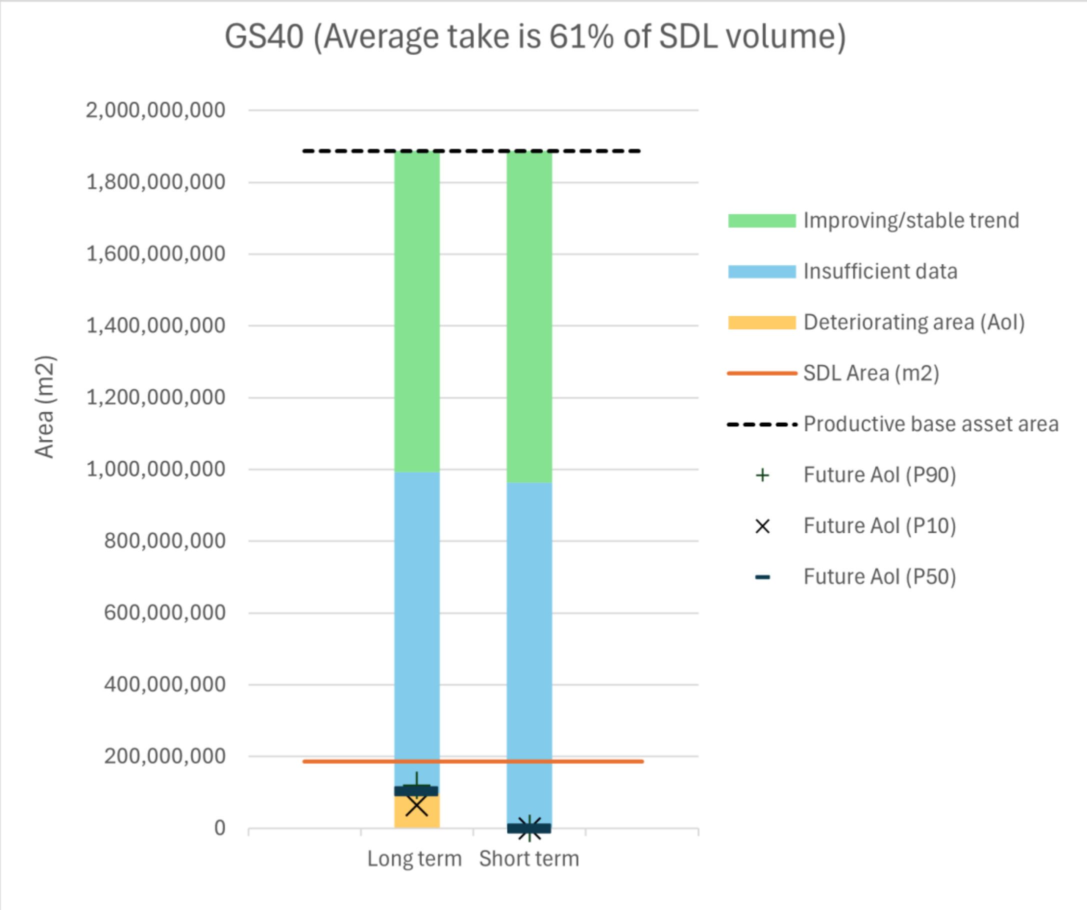


Figure 12 Estimates for change in area of influence (AoI) due to climate change

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