Uley South groundwater model
Model scenarios 2024

Department for Environment and Water
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DEW Technical report 2024/6

Government of South Australia
Department for Environment and Water

Department for Environment and Water

Government of South Australia

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81-95 Waymouth St, ADELAIDE SA 5000

Telephone +61 (8) 8463 6946

Facsimile +61 (8) 8463 6999

ABN 36702093234

www.environment.sa.gov.au

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Acknowledgement of Country

We acknowledge and respect the Traditional Custodians whose ancestral lands we live and work upon and we pay our respects to their Elders past and present.

We acknowledge and respect their deep spiritual connection and the relationship that Aboriginal and Torres Strait Islanders people have to Country.

We also pay our respects to the cultural authority of Aboriginal and Torres Strait Islander people and their nations in South Australia, as well as those across Australia.

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Summary

The Uley South groundwater model (DEW 2020a) has been updated with pumping data to January 2024. The model has been used to run two scenarios requested by SA Water to test the impact on groundwater levels from pumping 5.5 GL/y under two different recharge scenarios.

Scenario A simulates average recharge for the past 20 years projected into the future. Scenario B simulates low recharge observed from 2018–20 projected into the future with additional declines in recharge associated with climate change impacts based on the RCP8.5 projection to 2050.

Scenario A shows some stabilisation in groundwater at current levels, while scenario B shows declines in groundwater level into the future. Both scenarios result in some landward movement of the freshwater-seawater interface. In scenario B the modelled seawater interface toe position is ~625 m from pumping wells at the year 2050.

1 Introduction

The Uley South Basin is the primary source for municipal water supply on the Eyre Peninsula. Concern over declining groundwater levels and increasing salinity in recent years has raised the risk profile in this basin. This has occurred in the context of groundwater extraction for public supply reducing (e.g., Lincoln Basin, Wanilla Basin) or ceasing (e.g., Robinson Basin) from other small groundwater basins across Eyre Peninsula over time due to increasing salinity.

The status of the Uley South groundwater resource has been reported as 'average' for 2022/23 based on measured groundwater levels. The length of monitoring record among those wells ranges from 14 to 63 years. In 2022/23, the groundwater levels observed in 51% of the monitoring wells were in the mid-range of observations in their monitoring records (32% of wells report below average levels). However, over the past 20 years, groundwater levels in the Uley South aquifer have remained within less than 1 metre of a critical minimum level (DEW 2024b).

SA Water collaborated with the Department for Environment and Water (DEW) to develop a groundwater flow model for the Uley South Basin to understand current resource trends and assess future risks (DEW, 2020a). In addition to simulating groundwater flow, the model simulates the position and movement of the seawater interface with the SWI2 package (Bakker et al 2013). The SWI2 package assumes a sharp interface between seawater and freshwater, and hence does not account for diffusion and dispersion.

This model has since been updated several times to include new metered pumping data and recharge information and run additional scenarios (DEW 2020b; DEW 2021a,b; DEW 2023a,b). These scenarios have tested multiple pumping configurations, pumping rates and assumptions regarding future rainfall and recharge. Results have shown that reduction in pumping to 3.5 GL/y mitigates the risk on seawater intrusion into the future, compared to continued pumping of 5 G/y or increased pumping. This includes scenarios in which recharge is low and continues to decline in line with RCP8.5 climate projections. The seawater interface may continue to move inland as recharge declines regardless of reduced pumping and ongoing monitoring will be required to assess risks into the future.

This technical memo documents two scenarios requested by SA Water in February 2024 which investigate the impact of extraction of 5.5 GL/y under two different sets of recharge assumptions.

2 Modelling approach

All details regarding the conceptualisation, construction and calibration of the Uley South groundwater model can be found in DEW (2020a) with subsequent scenario reports (DEW, 2020b; DEW, 2021a, b; DEW, 2023a, b). As part of this work, the model has been updated to January 2024 with pumping data provided by SA Water. In doing so, a post audit, similar to that described in DEW (2024a), was run by importing new groundwater level observation data into the model and assessing model performance. These two scenarios are run based on requests from SA Water with scenario details in Table 2.1. Both scenarios are run from 2024–2050.

Scenario	Pumping	Recharge
A	Pumping at 5.5 GL/y	Recharge based on long term average for the 20-year period 2004-2023
B	Pumping at 5.5 GL/y	Recharge based dry conditions 2018-2020 with climate change impacts based on RCP8.5 projection

Table 2.1. Model scenarios

2.1 Model inputs

2.1.1 Recharge

Recharge rates for the two scenarios are shown in Figure 2.1. In scenario A, recharge is based on the average recharge over the 20-year period 2004–23 which continues, unchanged, into the future. In scenario B, recharge is based on the average for 2018–20 (a period of low recharge) and declines into the future based on rainfall projections for the Eyre Peninsula under climate change projections considering the RCP8.5 emissions pathway. The projections in rainfall are applied to recharge volumes using a scaling factor approach in the same way as described in DEW (2023b).

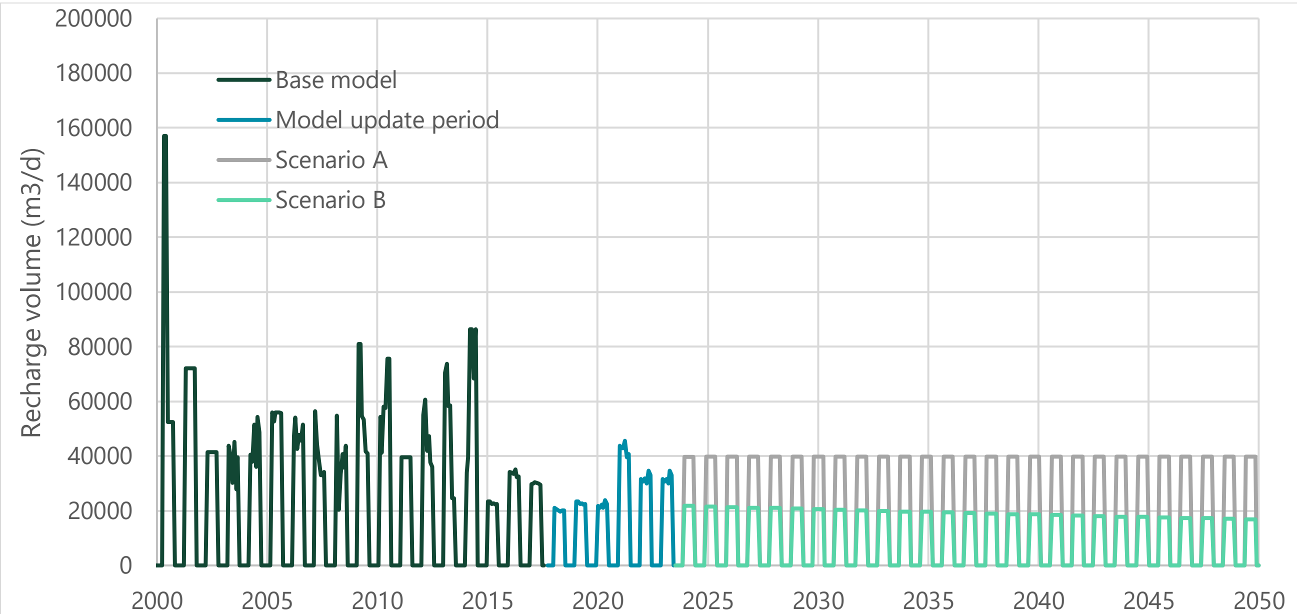


Figure 2.1. Modelled recharge rates for the baseline model (from 2000 onwards) and the scenarios

2.1.2 Pumping

Pumping rates for individual wells for the scenarios are based on metered rates scaled up to achieve an overall pumping volume of 5.5 GL/y. As part of the model's requirements it is assumed that all pumps are operating all year in the model with pumping varying seasonally based on metered data from previous years (e.g., generally higher pumping in summer, lower pumping in winter). Modelled monthly pumping volumes for individual wells are provided in Appendix A.

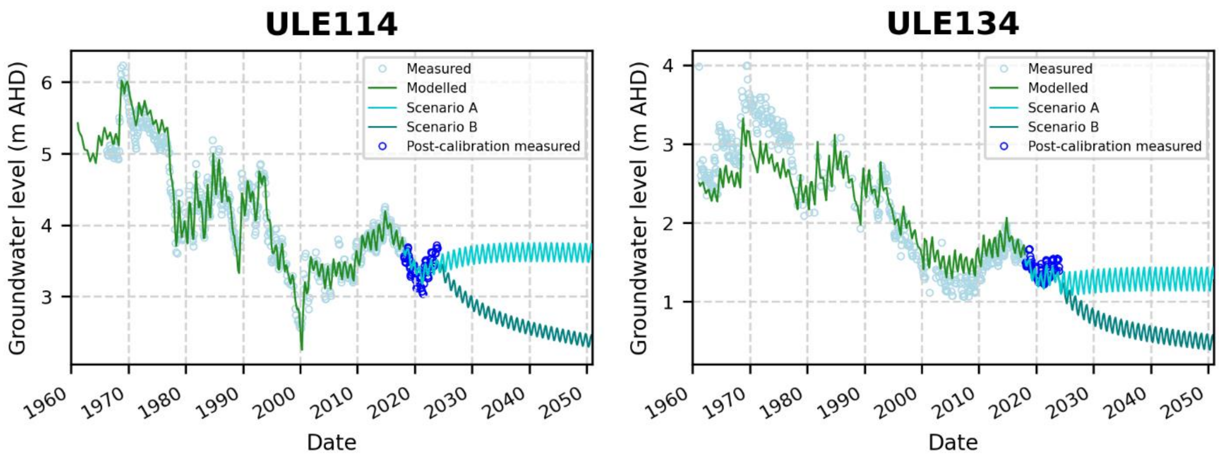
3 Results

Results for the model post-audit are given in Table 3.1. The results are similar to those reported in DEW (2024a) with the model performing well, statistically, for the post-calibration period. More importantly, the modelled groundwater levels compare well with measured levels and trends (Figure 3.1). Groundwater level measurements from 2018 onwards are represented as 'post-calibration' measurements in Figure 3.1.

Model	Root mean squared error (m)	Scaled root mean square error (%)
Original calibration	0.62	1.7
Post-audit (DEW, 2024)	0.27	0.88
Post-audit, this study	0.28	0.92

Table 3.1. Model post-audit results

Modelled groundwater levels for Scenario A show that groundwater levels show a small amount of recovery in some areas (ULE114) or stabilise at current levels (ULE134, Figure 3.1, see Figure 3.3 for map of observation well locations) and remain consistent into the future as recharge is repeated as would be expected. Recovery is also observed near inland extraction wells where pumping volumes have changed, e.g. ULE097 which is adjacent to town water supply well #12. Elsewhere though, such as in SLE074, adjacent to new supply wells from which extraction commenced in mid-2022, groundwater levels do not recover in Scenario A. In Scenario B, groundwater levels decline into the future as pumping remains at 5.5GL/y and recharge decreases. Groundwater levels generally decline below minimum levels observed historically by 2050. Modelled groundwater levels for other observation wells can be found in Appendix B.



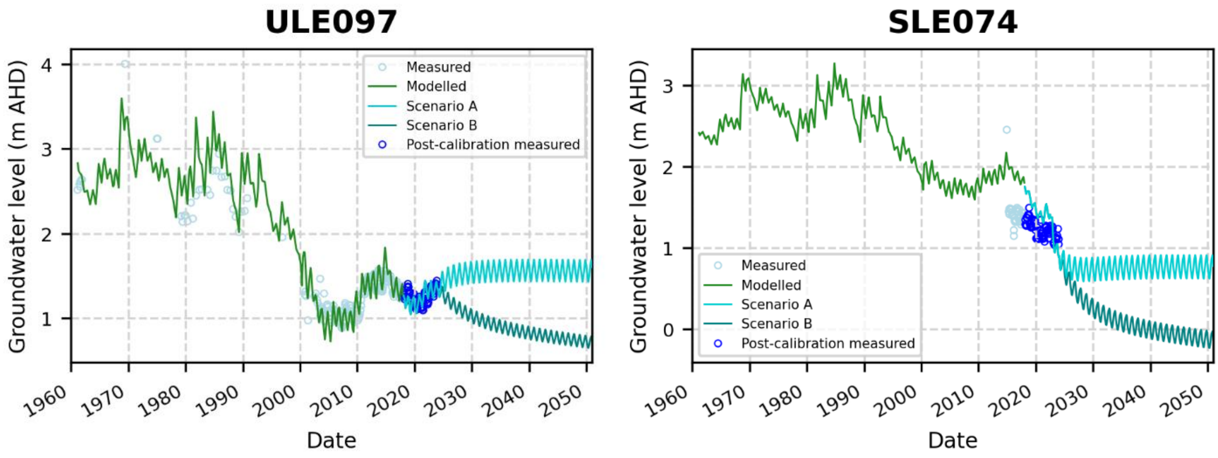


Figure 3.1. Measured vs modelled groundwater levels for Scenarios A and B at observation wells

Results from the SWI2 modelling show the seawater interface moves further inland for both scenarios. This can be seen as an increase in the elevation of the interface in monitoring wells close to the coast (Figure 3.2). The transition zone in Figure 3.2 refers to the depth over which a change from freshwater to seawater has been measured with salinity profiles in well SLE069. Scenario results also show a change in position of the toe of the seawater interface (Figure 3.3), where the toe is the location in which the interface intersects the base of the aquifer. Seawater intrusion is greater in scenario B with the modelled interface toe within 700 m of supply wells by 2050.

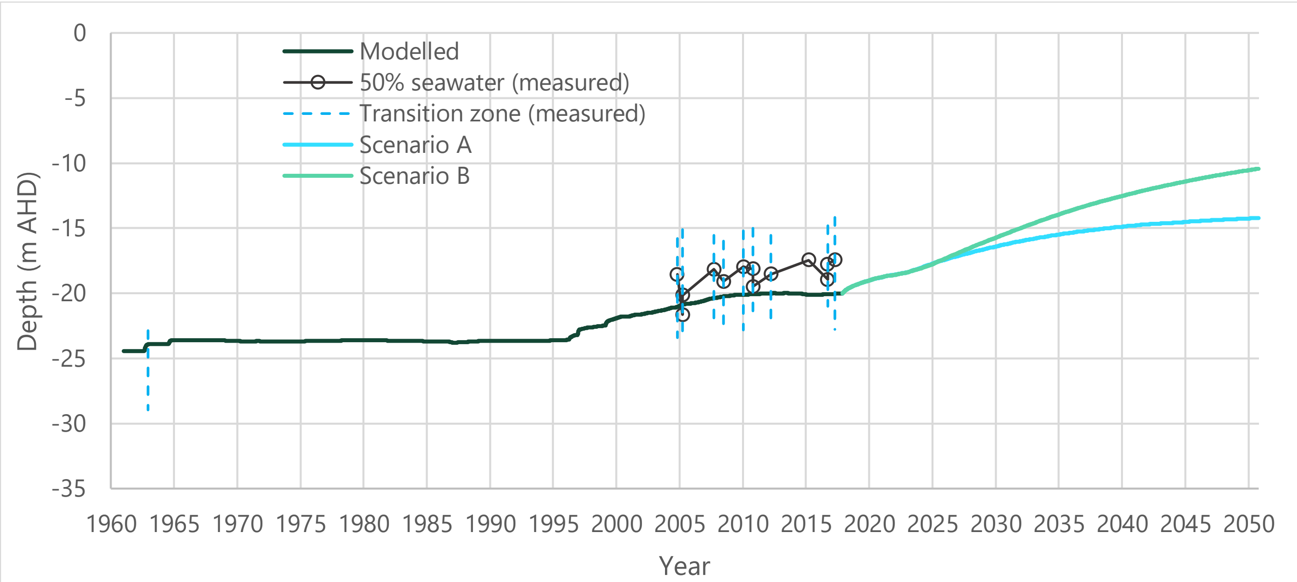


Figure 3.2. Measured and modelled seawater interface position at SLE069

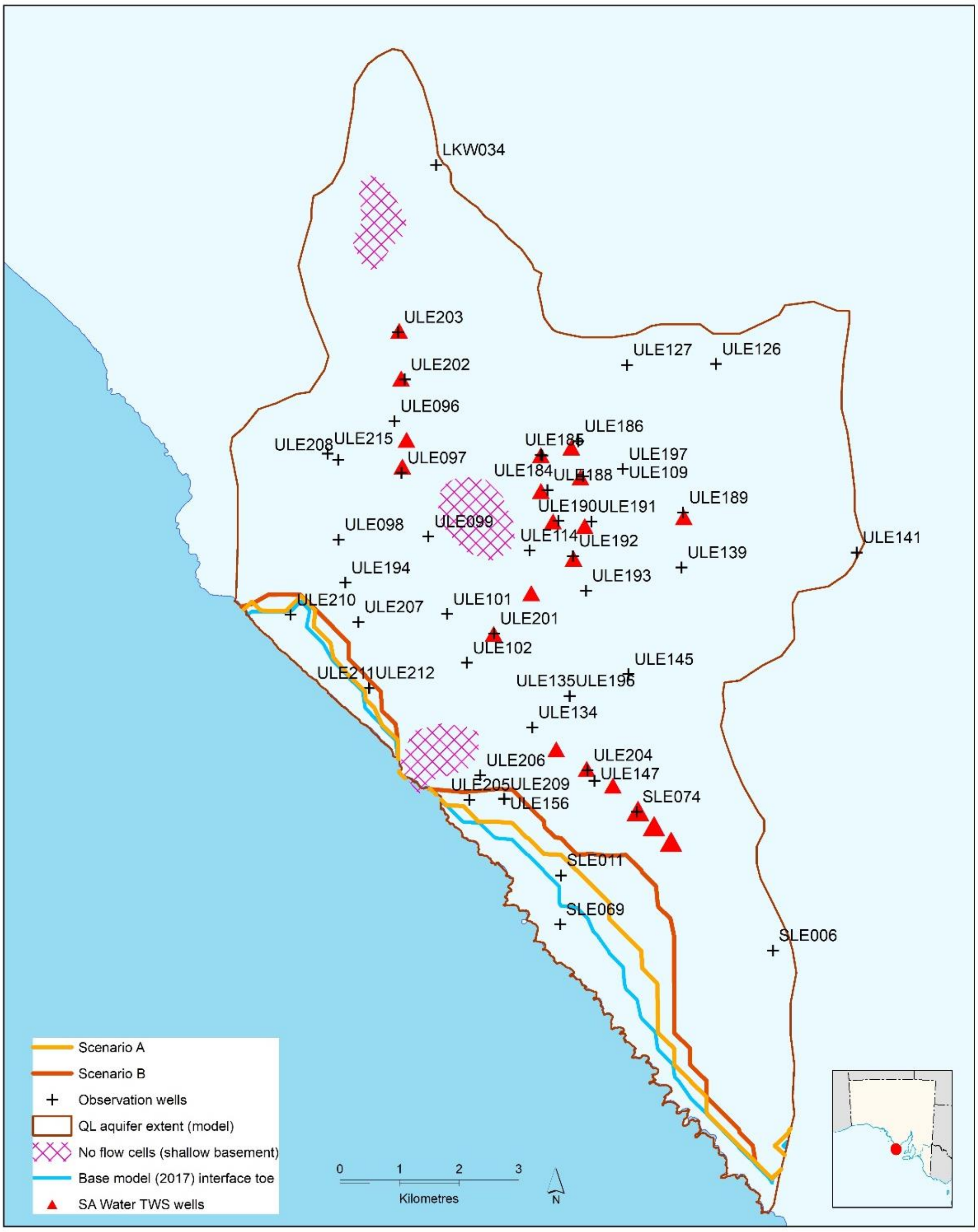


Figure 3.3. Modelled seawater interface toe location in the QL aquifer at 2050

4 Assumptions and limitations

Assumptions and limitations associated with the Uley South groundwater model have been reported previously (DEW, 2020a,b, 2021a,b). Relevant to the current scenarios, the following assumptions and limitations are acknowledged.

- The model has monthly stress periods; hence supply well pumping rates are constant for the month. In reality, pumps will come on and off during a month depending on demand and maintenance requirements.
- Simulation of the seawater interface with the SWI2 package (Bakker et al 2013) does not account for dispersive mixing of fresh and saline water or preferential flow pathways. Any preferential pathways would permit increased landward extension of the seawater interface. Therefore, results may underestimate impacts from the seawater intrusion and should be used as a guide only.

5 Conclusions and recommendations

The two model scenarios have been run to test the potential impact of pumping 5.5 GL/y from Uley South into the future under different recharge assumptions requested by SA Water.

Scenario A assumes average recharge from 2004-2023 continues into the future. Groundwater levels show general stabilisation over time under this scenario. Scenario B assumes that the low recharge observed from 2018–20 continues with further declines associated with climate change impacts using the RCP8.5 projection. Under this scenario groundwater levels declines below levels previously observed by 2050.

Both scenarios show inland movement of the freshwater-seawater interface with a greater ingress of seawater in Scenario B. Given that the freshwater-seawater interface moves inland under both scenarios, pumping rates at 5.5 GL/y should be considered highly problematic. Previous scenario modelling has shown that a reduction in pumping to 3.5 GL/y may mitigate this risk. As a consequence, the capacity of the resource to sustain 5.5 GL/y in the short term is highly dependent upon rainfall recharge and there is a need for an additional volume of climate-resilient water to augment supply to ensure water security and long-term groundwater resource sustainability in the region.

6 Appendices

A. Pumping volumes

Monthly pumping volumes for the scenarios presented here have been determined in a similar way to previous scenario reports. They are based on metered data reported by SA Water but with the data filled in such a way that all wells are operational in every month. Table A1 gives the monthly pumping volumes for each well in the model scenarios, where total extraction is 5.5 GL/y (5500 ML/y). Figure A1 shows the total monthly pumping volumes compared with metered data from recent years.

	Jan	Feb	March	April	May	Jun	July	August	Sept	October	Nov	December
TWS 9	30.24	25.43	28.79	24.08	21.26	15.54	13.12	12.32	14.64	15.87	17.81	29.20
TWS 10	52.93	44.50	50.39	42.13	37.21	27.19	22.97	21.56	25.62	27.78	31.16	51.10
TWS11	30.24	25.43	28.79	24.08	21.26	15.54	13.12	12.32	14.64	15.87	17.81	29.20
TWS12	15.12	12.71	14.40	12.04	10.63	7.77	6.56	6.16	7.32	7.94	8.90	14.60
TWS 13	22.68	19.07	21.60	18.06	15.95	11.65	9.84	9.24	10.98	11.90	13.35	21.90
TWS 15	39.32	33.06	37.43	31.30	27.64	20.20	17.06	16.02	19.03	20.64	23.15	37.96
TWS 16	39.32	33.06	37.43	31.30	27.64	20.20	17.06	16.02	19.03	20.64	23.15	37.96
TWS 17	37.81	31.78	35.99	30.09	26.58	19.42	16.41	15.40	18.30	19.84	22.26	36.50
TWS18	45.37	38.14	43.19	36.11	31.90	23.30	19.69	18.48	21.96	23.81	26.71	43.80
TWS19	37.81	31.78	35.99	30.09	26.58	19.42	16.41	15.40	18.30	19.84	22.26	36.50
TWS20	30.24	25.43	28.79	24.08	21.26	15.54	13.12	12.32	14.64	15.87	17.81	29.20
TWS21	22.68	19.07	21.60	18.06	15.95	11.65	9.84	9.24	10.98	11.90	13.35	21.90
TWS22	45.37	38.14	43.19	36.11	31.90	23.30	19.69	18.48	21.96	23.81	26.71	43.80
TWS23	22.68	19.07	21.60	18.06	15.95	11.65	9.84	9.24	10.98	11.90	13.35	21.90
TWS24	46.88	39.41	44.63	37.32	32.96	24.08	20.34	19.09	22.69	24.60	27.60	45.26
TWS 25	22.68	19.07	21.60	18.06	15.95	11.65	9.84	9.24	10.98	11.90	13.35	21.90
TWS 26	15.12	12.71	14.40	12.04	10.63	7.77	6.56	6.16	7.32	7.94	8.90	14.60
TWS27	37.81	31.78	35.99	30.09	26.58	19.42	16.41	15.40	18.30	19.84	22.26	36.50
TWS28	37.81	31.78	35.99	30.09	26.58	19.42	16.41	15.40	18.30	19.84	22.26	36.50
TWS29	37.81	31.78	35.99	30.09	26.58	19.42	16.41	15.40	18.30	19.84	22.26	36.50
Total	669.92	563.21	637.78	533.27	471.02	344.14	290.70	272.87	324.27	351.59	394.40	646.83

Table A1. Monthly pumping volumes (ML) for extraction wells in scenarios where total pumping = 5500 ML/y

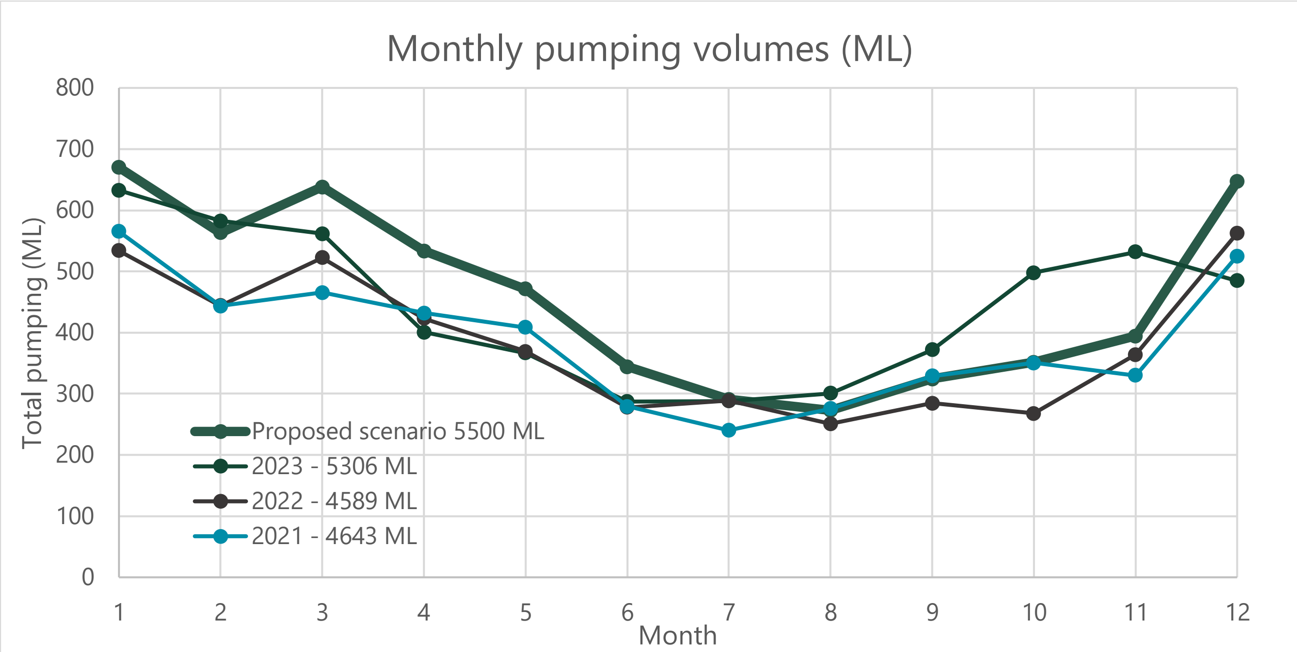
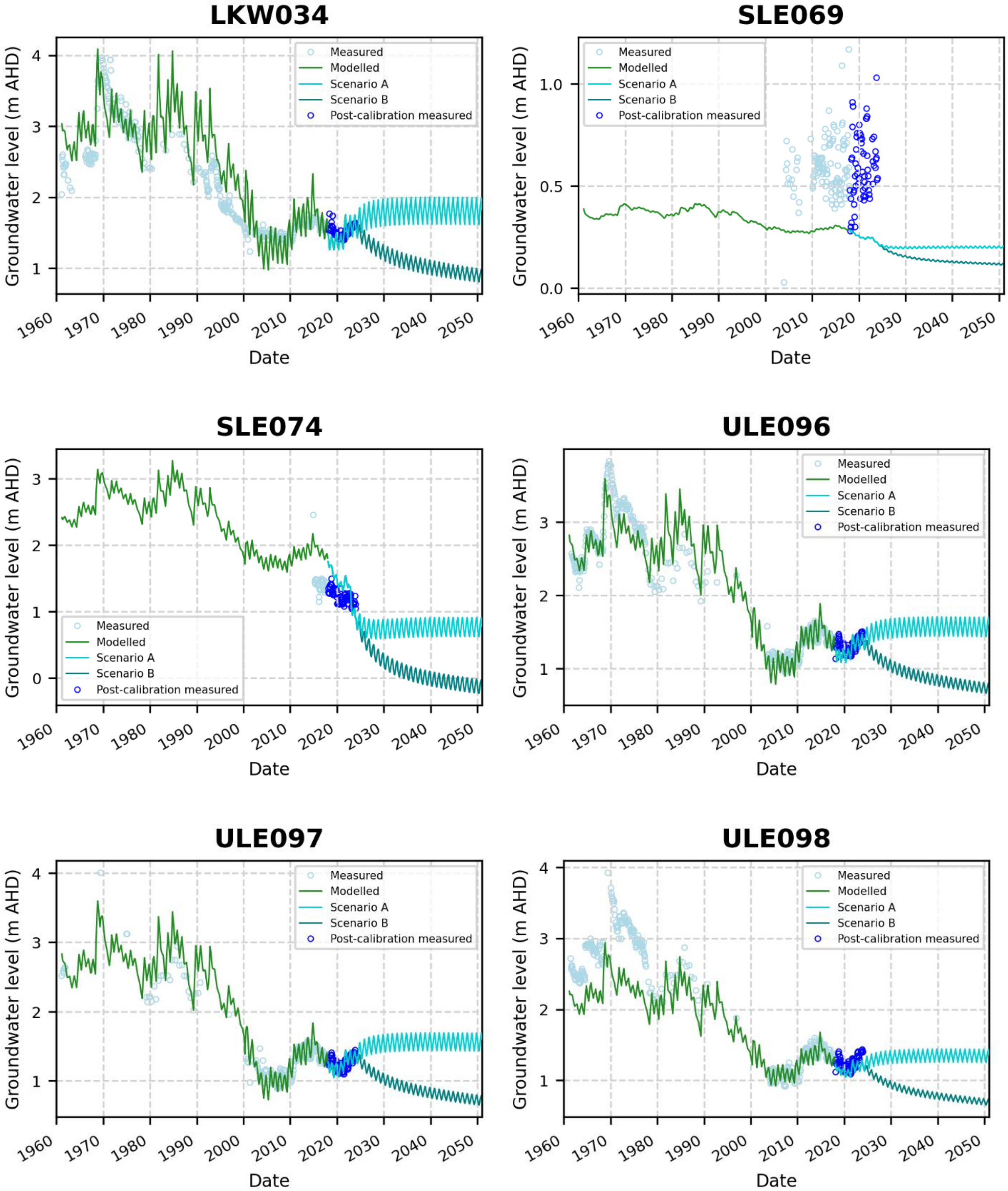
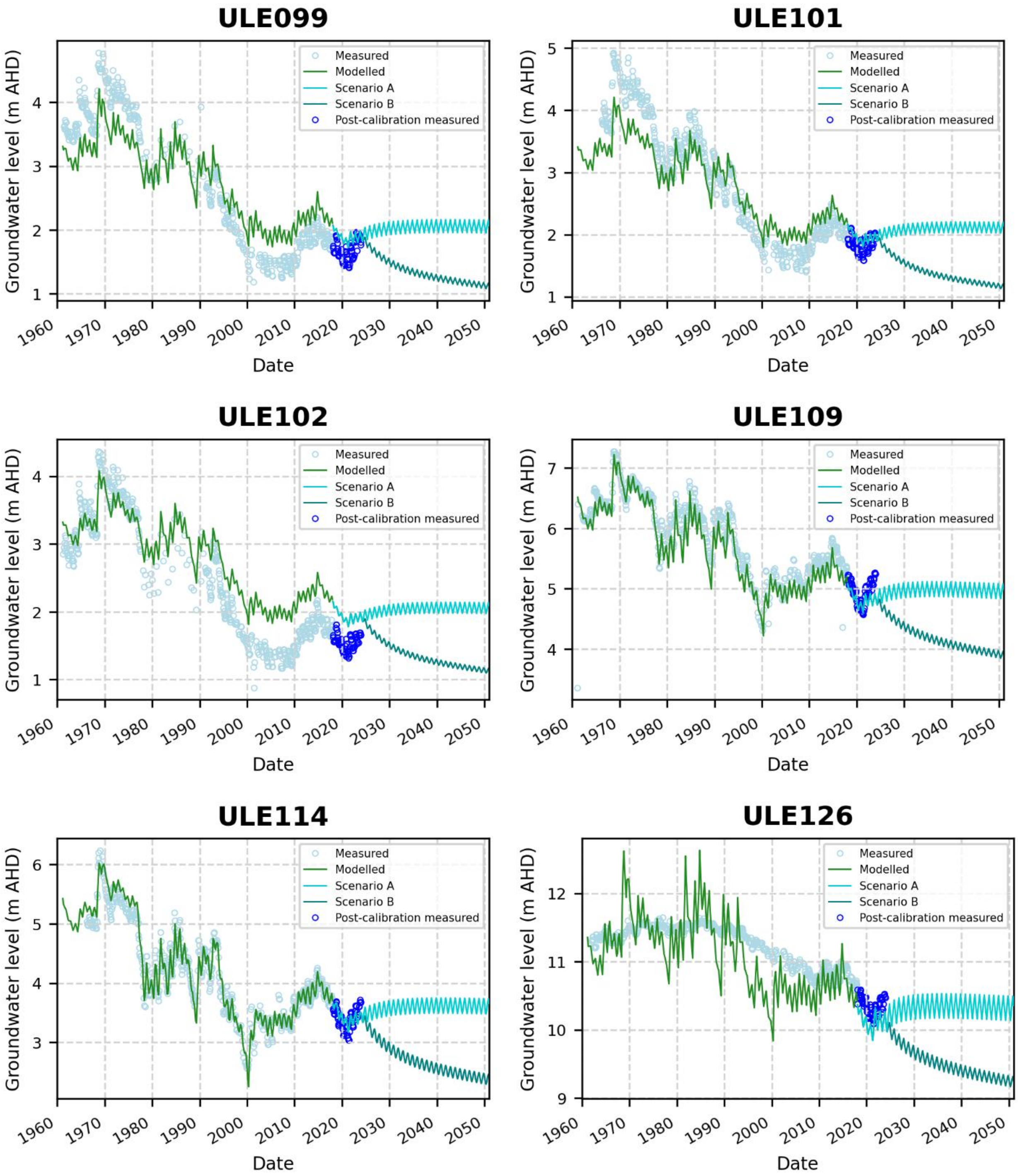
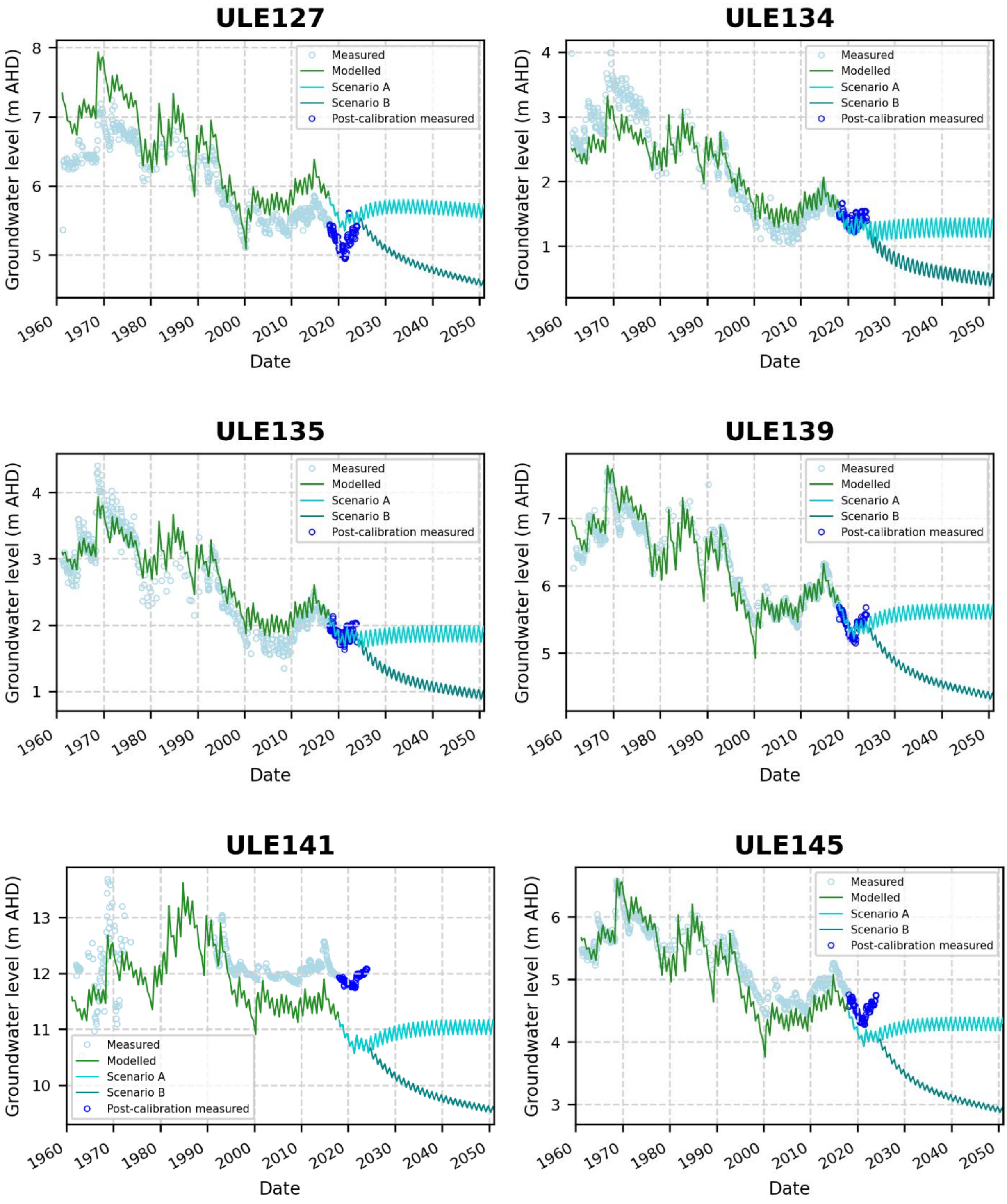


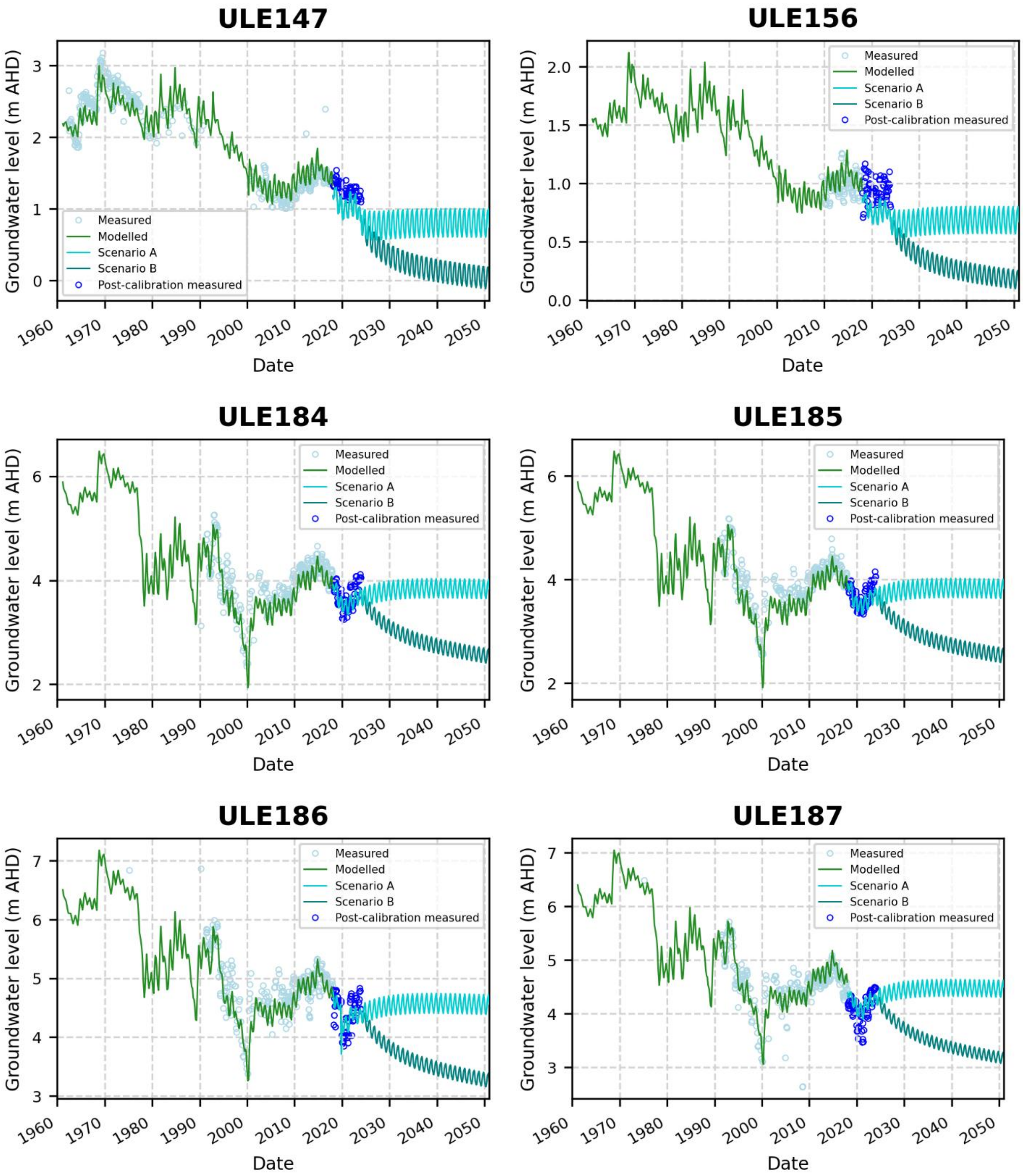
Figure A1. Total monthly extraction volumes for recent years and for the scenario

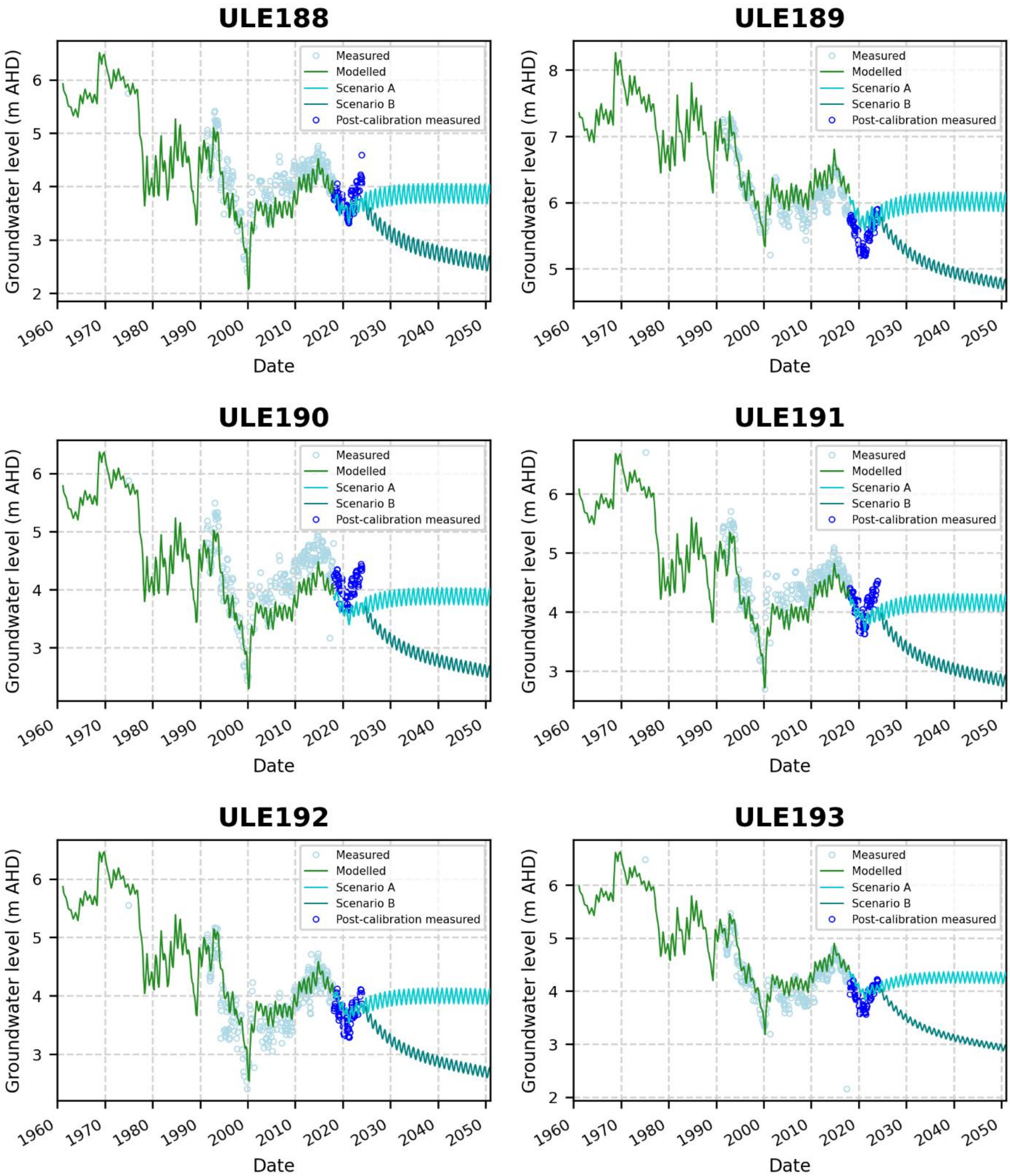
B. Modelled groundwater levels




ULE099
ULE101
ULE102
ULE109
ULE114
ULE126
Groundwater level (m AHD)
Date
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050


ULE127
ULE134
ULE135
ULE139
ULE141
ULE145
Groundwater level (m AHD)
Date
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured


ULE147
ULE156
ULE184
ULE185
ULE186
ULE187
Groundwater level (m AHD)
Date
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050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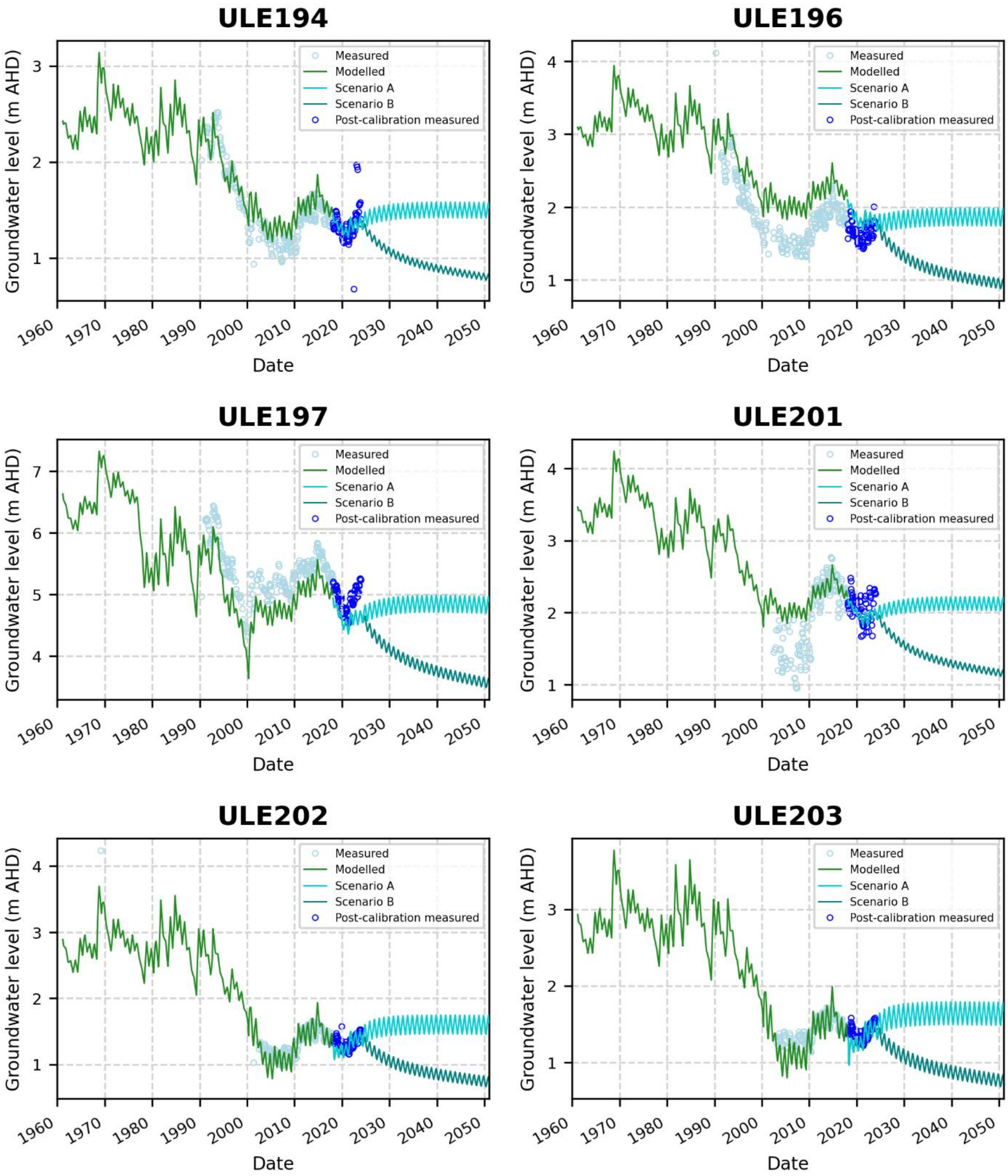
ULE189
ULE190
ULE191
ULE192
ULE193
Groundwater level (m AHD)
Date
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050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Groundwater level (m AHD)
Date
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured
ULE196
Groundwater level (m AHD)
Date
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured
ULE197
Groundwater level (m AHD)
Date
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured
ULE201
Groundwater level (m AHD)
Date
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured
ULE202
Groundwater level (m AHD)
Date
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured
ULE203
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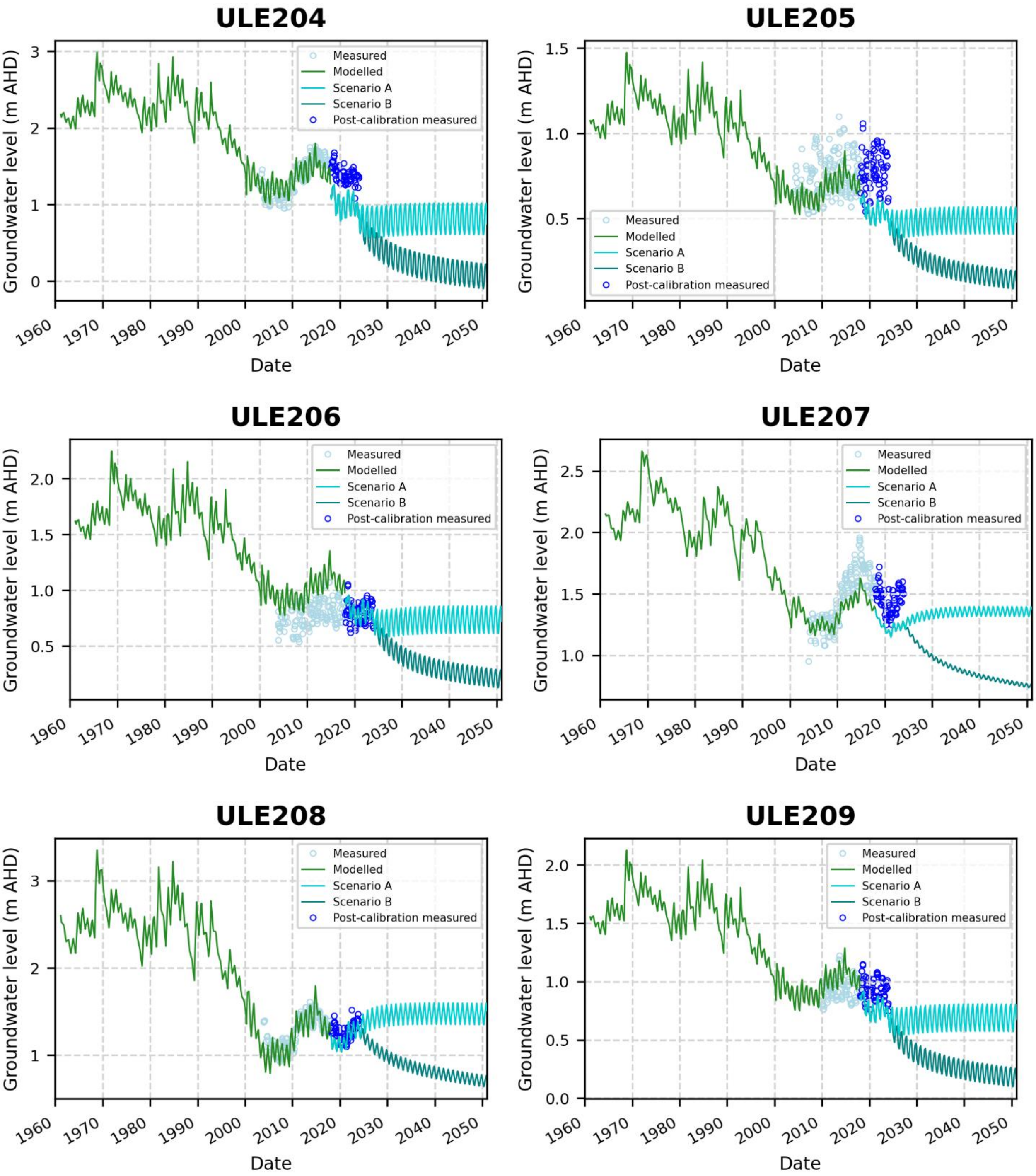
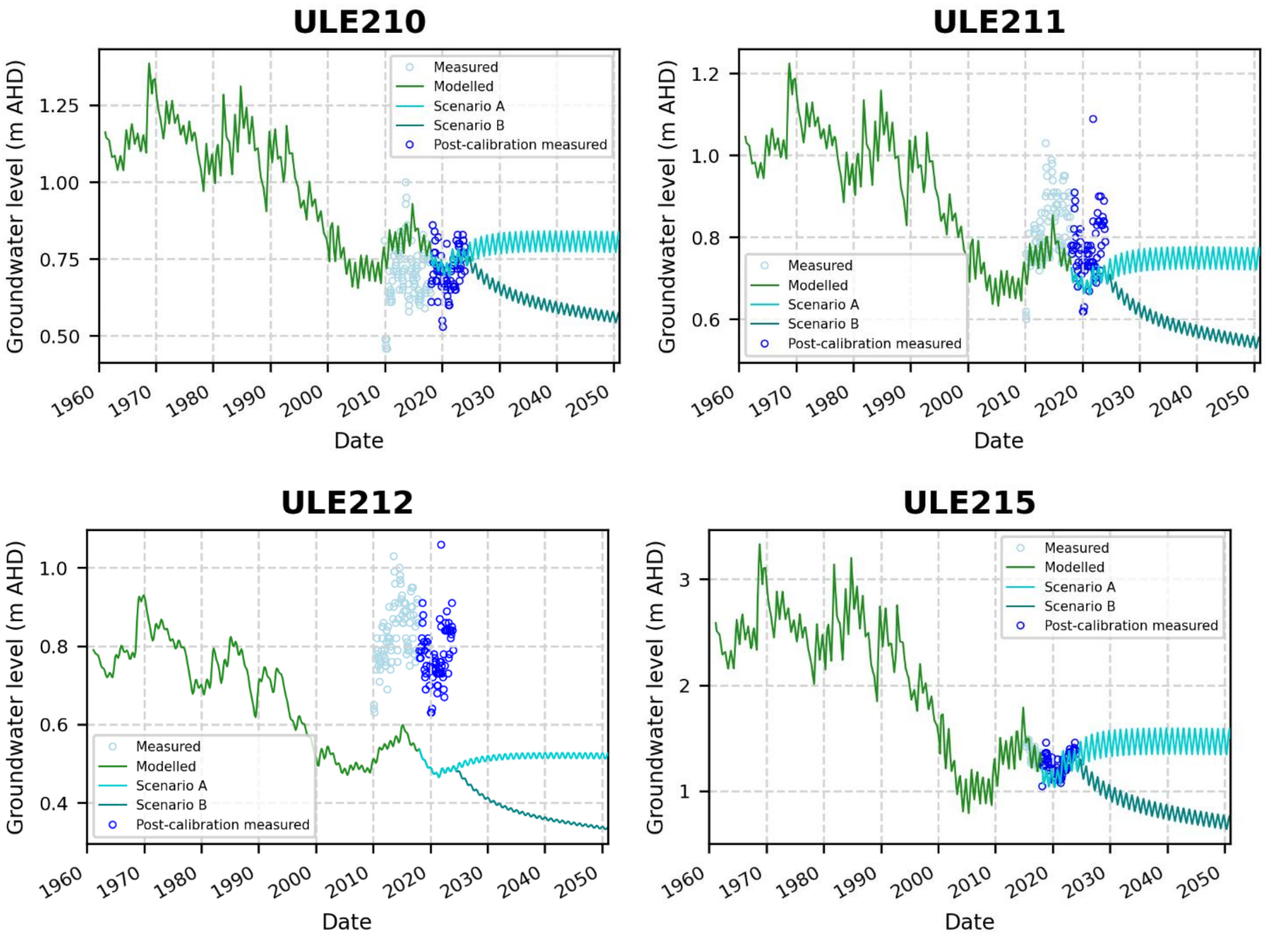
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured


ULE204
ULE205
ULE206
ULE207
ULE208
ULE209
Groundwater level (m AHD)
Date
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050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ULE211
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Date
Measured
Modelled
Scenario A
Scenario B
Post-calibration measured
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050

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