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DATE:	9 August 2019
TO:	Brian Cole
	Whitehaven Coal Limited
FROM:	Tingting Liu and Dr Noel Merrick
RE:	Vickery Extension Project Groundwater Sensitivity Analysis
OUR REF:	Report HS2019/34

1 INTRODUCTION

The Whitehaven Coal Ltd (Whitehaven) Vickery Extension Project is located within the Gunnedah Basin Coalfield and involves extension of open cut mining operations and installation of a borefield. The groundwater assessment for the Vickery Extension Project was completed by HydroSimulations (now part of SLR) in August 2018. SLR were engaged by Whitehaven to assist in the preparation of Response to Submissions (RTS) for the Project. This memo presents results from additional modelling conducted using the existing Vickery Extension Project groundwater model (HydroSimulations 2018)[1]. This includes additional work for the sensitivity analysis, borefield modelling and post closure modelling (fully backfilled design).

2 SENSITIVITY ANALYSIS

Comments from the DPE Independent Expert outlined that the sensitivity analysis undertaken for the Vickery Extension Project should be updated to include additional parameters, as only vertical hydraulic conductivity was undertaken at that time (although more extensive sensitivity analysis had been presented in a previous report). In line with the recommendations, a staged approach has been followed to initially test the calibration sensitivity to changes in parameters to then determine the minimum effort approach to uncertainty analysis. This memo presents the calibration sensitivity results for the Vickery Extension Project.

[1] HydroSimulations, 2018, Vickery Extension Project Groundwater Assessment, in Whitehaven Coal *Vickery Extension Project Environmental Impact Statement,* Appendix A Groundwater Assessment

2.1 Methodology

A sensitivity analysis was carried out to assess the response of the model to varying input parameters. The objective of the sensitivity analysis was to rank the input parameters in terms of their influence on the predicted results. The model parameters were adjusted to encompass the range of likely uncertainty in key parameters. This was achieved by changing and assessing the following:

- ±1 order of magnitude change in horizontal hydraulic conductivity (Kh) of all geological units (excluding spoil);
- ±1 order of magnitude change in vertical hydraulic conductivity (Kv) of all geological units (excluding spoil);
- ±1 order of magnitude change in storage coefficient (S) of all geological units (excluding spoil);
- factor of ±3 change in specific yield (Sy) of all geological units (excluding spoil); and
- factor of ±3 change in recharge (Rch) of all geological units (excluding spoil).

2.2 Results

Table 2-1 shows the calibration statistics for the base-case model and various sensitivity scenarios. The results presented include the normally distributed error between the modelled and measured water levels, presented as root mean square (*RMS*) as well as the scaled RMS (*SRMS*) that accounts for the total measured head change across the model domain. The *SRMS change* represents the difference in SRMS for the different scenarios when compared to the base-case model.

Table 2-1 Calibration sensitivity statistics

Run ID	Scenario	RMS (m)	SRMS (%)	SRMS change (%)
Base	Base-case	3.91	5.24	-
Kh+	Hydraulic conductivity (horizontal) + 1 OM	6.19	8.29	158%
Kh-	Hydraulic conductivity (horizontal) – 1 OM	5.78	7.75	148%
Kv+	Hydraulic conductivity (vertical) + 1 OM	4.12	5.53	106%
Kv-	Hydraulic conductivity (vertical) – 1 OM	3.73	5.00	95%
S+	Storage Coefficient +1 OM (upper bound 1 x 10^{-4})	3.98	5.34	102%
S-	Storage Coefficient -1 OM (upper bound 1 x 10^{-4})	4.00	5.37	102%
Sy-	Specific yield / Factor of 3	4.08	5.47	104%
Sy+	Specific yield x Factor of 3	3.12	5.12	98%
Rch+	Recharge x Factor of 3	4.99	6.70	128%
Rch-	Recharge / Factor of 3	3.64	4.88	93%

As shown in **Table 2-1** each model scenario resulted in similar RMS and SRMS results, with most results within ± 10 % of the base-case model. A change in horizontal hydraulic conductivity recorded the greatest reduction in calibration performance, with the base-case model having the best performance. The calibration performance improved slightly with a decrease in vertical hydraulic conductivity, increase in specific yield and reduction in recharge.

Table 2-2 presents the difference in observed and modelled water levels (residuals) averaged over the calibration period from 2006 to 2011. The table presents selected bores within the area of potential impact that were discussed by the DPE Independent Expert and selected bores within alluvium near the Project. On each row, the scenario with the best performance is highlighted.

Table 2-2 Calibration sensitivity average residuals

Bore ID	Layer	Base	Kh+	Kh-	Kv+	Kv-	S+	S-	Sy+	Sy-	Rch+	Rch-
GW031856	1 (Qa)	-14.6	**-3.1**	-22.7	-14.5	-14.9	-14.6	-14.6	-14.6	-14.6	-20.0	-10.9
GW036462_1	1 (Qa)	5.2	7.4	**0.9**	5.3	5.2	5.3	5.3	5.6	5.0	3.7	5.8
GW036484_1	1 (Qa)	-6.5	**-3.7**	-12.6	-6.5	-6.4	-6.4	-6.4	-6.1	-6.6	-8.3	-5.7
MP-2	1	5.9	15.7	-7.6	6.7	4.8	5.9	5.9	6.0	6.0	**1.0**	10.8
MW1	9	-5.1	13.3	-8.0	-5.8	-3.6	-5.0	-5.0	-5.0	-5.1	-9.0	**-0.8**
MW3	1	-6.7	13.0	-8.9	-7.0	-6.5	-6.7	-6.6	-6.7	-6.7	-11.1	**0.7**
MW6	2	-9.4	12.0	-11.8	-9.6	-8.1	-9.4	-9.1	-9.5	-9.4	-15.6	**-1.4**
VNW223	2	7.5	10.1	5.3	7.6	8.1	8.6	8.8	10.0	**4.2**	6.4	7.9
WB-10	1	5.9	7.6	**2.0**	5.9	5.7	5.9	5.9	6.2	5.5	4.3	6.4
WB-12	1	6.4	8.7	**1.0**	6.4	6.2	6.4	6.4	6.8	6.0	4.6	7.0
WB-3	1	6.7	16.3	6.5	8.0	4.8	6.7	7.1	6.8	6.7	**4.5**	9.3
WB-5	2	11.3	18.5	10.5	13.5	9.0	11.3	12.0	11.6	11.2	**8.5**	13.2
WB-7	3	**-0.4**	11.5	-13.8	-0.7	-0.7	-0.4	1.9	-0.4	-0.4	-5.9	2.6
GW_10	1	-3.0	1.4	-14.7	-2.9	-2.4	-3.0	-3.0	-2.8	-3.2	-9.0	**-0.5**
GW_11	1	**1.2**	2.9	-4.1	1.2	1.2	1.2	1.2	1.4	1.2	-1.2	2.4
GW_2	1	1.1	2.7	-4.1	1.1	**1.0**	1.1	1.1	1.2	**1.0**	-1.6	2.3
GW_4	1	-4.3	**-1.8**	-11.2	-4.3	-4.4	-4.3	-4.3	-4.2	-4.4	-8.0	-2.6
GW_5	1	-1.6	1.3	-8.5	-1.6	-1.7	-1.6	-1.6	-1.6	-1.7	-5.4	**0.3**
GW_7	1	-3.4	1.6	-4.8	-3.7	-4.1	-3.4	-3.4	-3.3	-3.5	-5.9	**-1.4**
GW_9	1	1.1	7.7	-1.4	2.8	1.1	1.3	1.1	1.9	**0.8**	-3.0	4.3

The average bore residuals presented in **Table 2-2** display that changes in vertical hydraulic conductivity, storativity and specific yield generally had little to no influence on the residuals for the selected bores. The greatest improvement in residuals is visible for some of the selected bores due to changes in horizontal hydraulic conductivity and recharge. However, no single variation consistently improves all results. In addition, these bores represent only a subset of bores within the model, and as discussed earlier, changes in horizontal hydraulic conductivity and increased recharge resulted in a decrease in the overall model performance (i.e. SRMS).

Overall, the calibration performance improved slightly with a decrease in vertical hydraulic conductivity, increase in specific yield and reduction in recharge. The predicted groundwater levels for each of the observation bores based on the sensitivity runs for Kv-, Sy+ and Rch- were extracted and presented in **Attachment A**. The location of the bores is shown in **Figure 1**, annotated to show bores within alluvium and hardrock. The hydrographs for Sy+ show negligible change in predicted levels for most bores, with the exception of some bores at Canyon Coal Mine, with the change resulting in over prediction of heads in the coal measures (VNW222) and more variability in levels in the alluvium (VNW221 and VNW223). This response may relate more to localised conditions as it is not consistent with results for other alluvial bores.

The hydrographs also show that a reduction in recharge and Kv generally reduces predicted groundwater levels, particularly for the alluvial bores as is expected. This will reduce the level of saturated thickness predicted in the model. The model predictions in alluvium are shown where saturated alluvium is present. Therefore, the basecase results provide a more conservative estimate of predicted drawdown in alluvium compared to if recharge and Kv was reduced.

2.3 Discussion

Sensitivity analysis was undertaken on the five defined parameters, through the simulation of 10 model scenarios with parameters modified from the base-case throughout the calibration period (2006-2011). The simulation results indicate that the model is most sensitive to changes in horizontal hydraulic conductivity. Both increased and decreased horizontal conductivity scenarios recorded the greatest decrease in calibration performance and variation in bore residuals. The calibration performance improved slightly with a decrease in vertical hydraulic conductivity, increase in specific yield and reduction in recharge. Further review of the predicted change in water levels over time indicates the reduction in Kv and recharge reduces the predicted saturated thickness of alluvium in some areas. The model values for Kv and recharge therefore provide a more conservative estimate of potential impacts, as they show a larger saturated extent and larger potential area for drawdown.

3 POST CLOSURE MODELLING

The Vickery Extension Project included a proposed partially backfilled design for the post closure landform. The following sections present the methodology and results for updates to the post closure modelling

3.1 Methodology

The fully backfilled design (no void) was replicated by applying spoil properties to the whole Vickery Project area, consistent with properties applied for the Vickery Extension Project. The purpose of the modelling is to show whether a backfilled void would remain as a groundwater sink, as was previously demonstrated for the partial backfill design where a void lake would be allowed to develop. If the backfilled pit were not to remain as a sink, there would be potential water quality effects from migration of groundwater off-site.

3.2 Results – Fully Backfilled Scenario

Figure 2 and **Figure 3** show the predicted water table contours at the end of Vickery mining (mine year 25, stress period 111) and at the end of 100 years recovery for fully backfilled, respectively. The lowest water table level is about 50 mAHD at the end of mining and rising to 267 mAHD after 100 years post-mining. The water table around the mining footprint is about 210 mAHD at the end of mining and 265 mAHD at the end of 100 years recovery. Due to the potential for higher rainfall recharge over the extent of pit backfill, the water table in a fully backfilled pit would eventually establish at a higher level than surrounding groundwater levels, thereby allowing slow groundwater discharge off-site.

Figure 4 shows the predicted hydrograph on a monitoring well located in the centre of the area mined in the last year of mining. The water level more than fully recovers after 20 years of post-mining. This supports the earlier observation that a fully backfilled pit would become a groundwater source rather than a groundwater sink.

3.3 Discussion

Numerical groundwater modelling of the fully backfilled final void design was conducted using the existing groundwater model. No significant cumulative effect is evident. The model predicts that with the fully backfilled option, groundwater levels will recover back above pre-mining levels and the mine area will act as a groundwater source to the surrounding strata in the Upper Namoi alluvium. Groundwater levels show flow from the backfilled pit area, with a steeper hydraulic gradient towards the alluvium to the north and south of the Project area rather than the west and east. Although groundwater would discharge off-site in the case of complete backfilling, it would not have the high salinity of water in a void lake if backfilling were not to occur. In the latter case, the pit would continue to act as a groundwater sink.

4 REFERENCES

HydroSimulations (2018) Vickery Extension Project – Groundwater Assessment. Report prepared for Whitehaven Coal Limited.

Figures

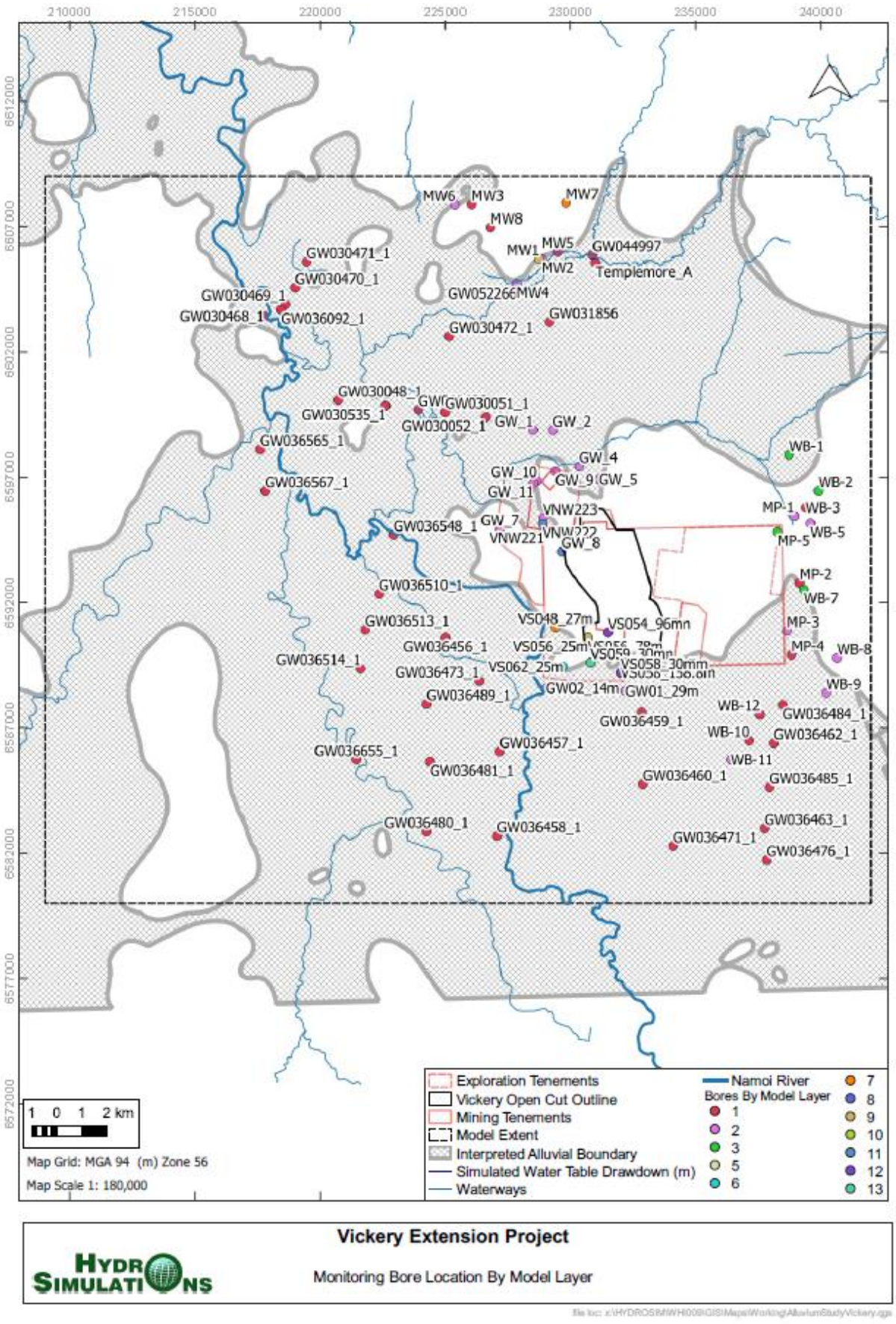


Figure 1 **Model Observation Points**

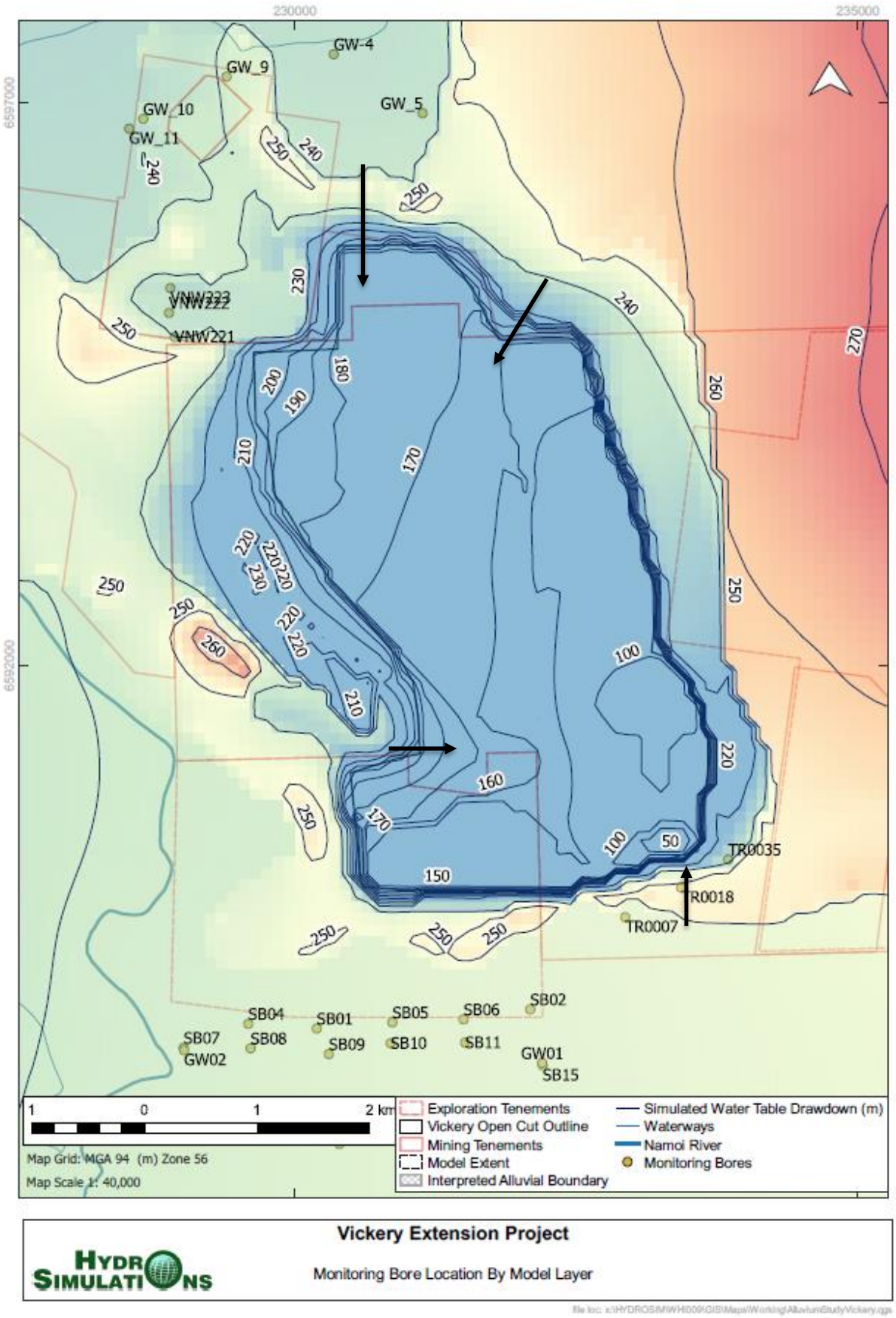


Figure 2 Simulated Water Table (mAHD) at the end of Vickery Mining (Stress Period 111) for Fully Backfilled Void

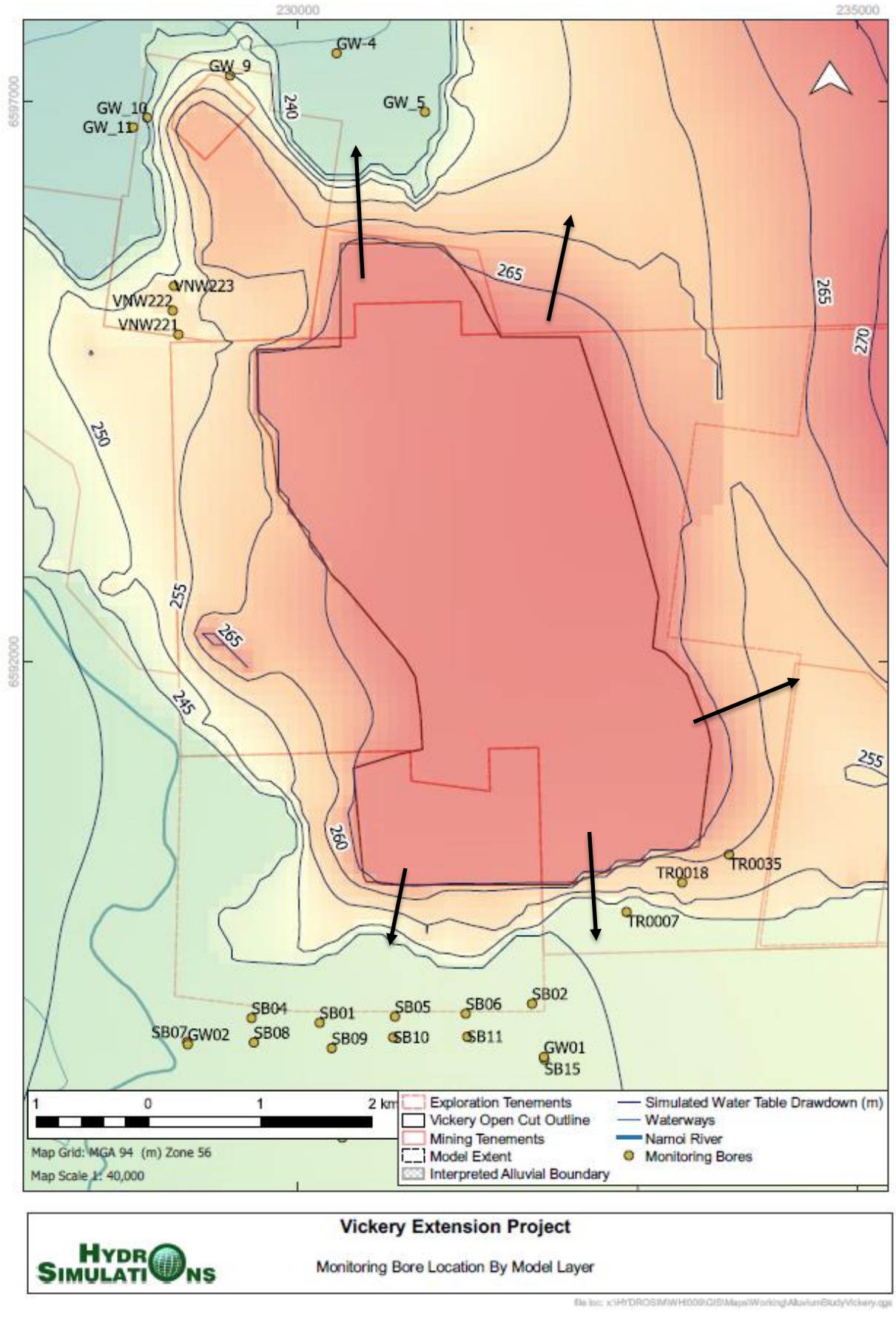


Figure 3 Simulated Water Table (mAHD) at the end of 100 Years Recovery for Fully Backfilled Void

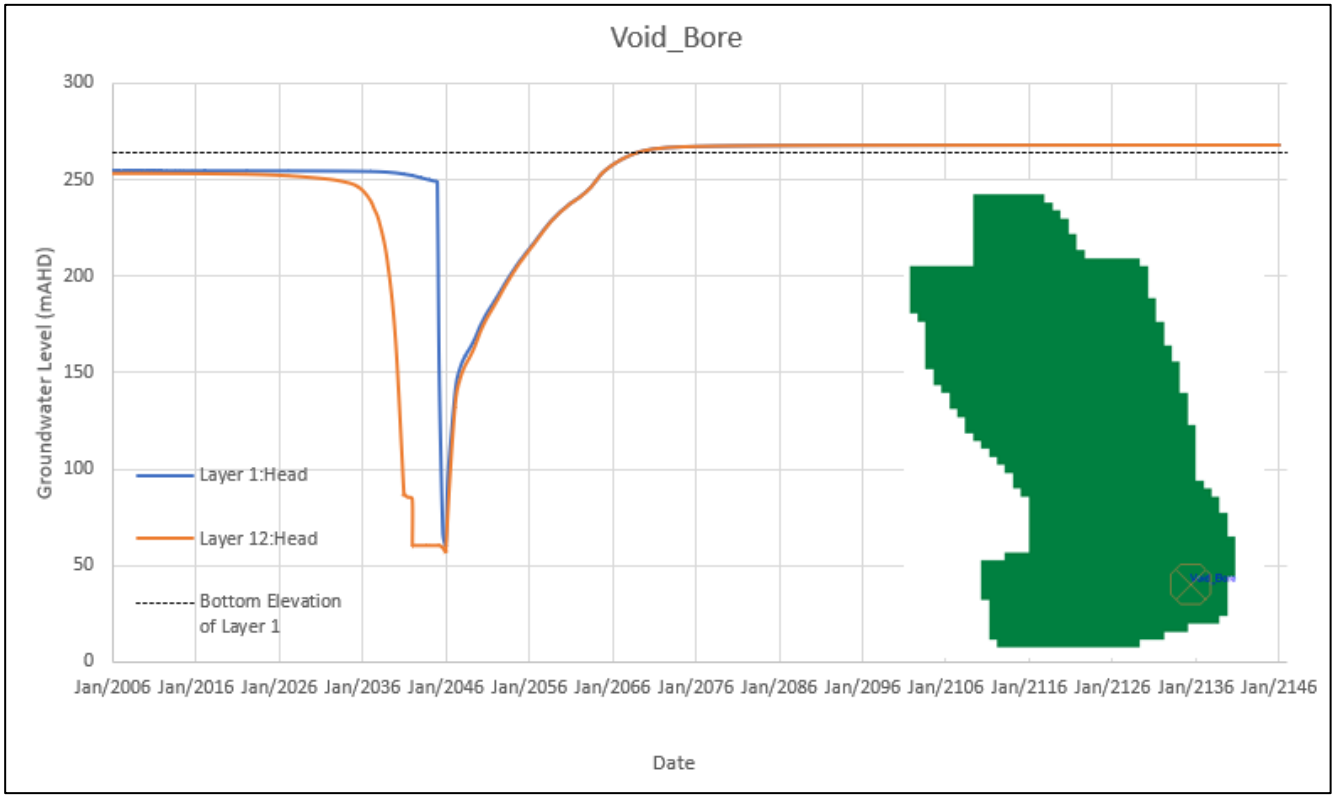
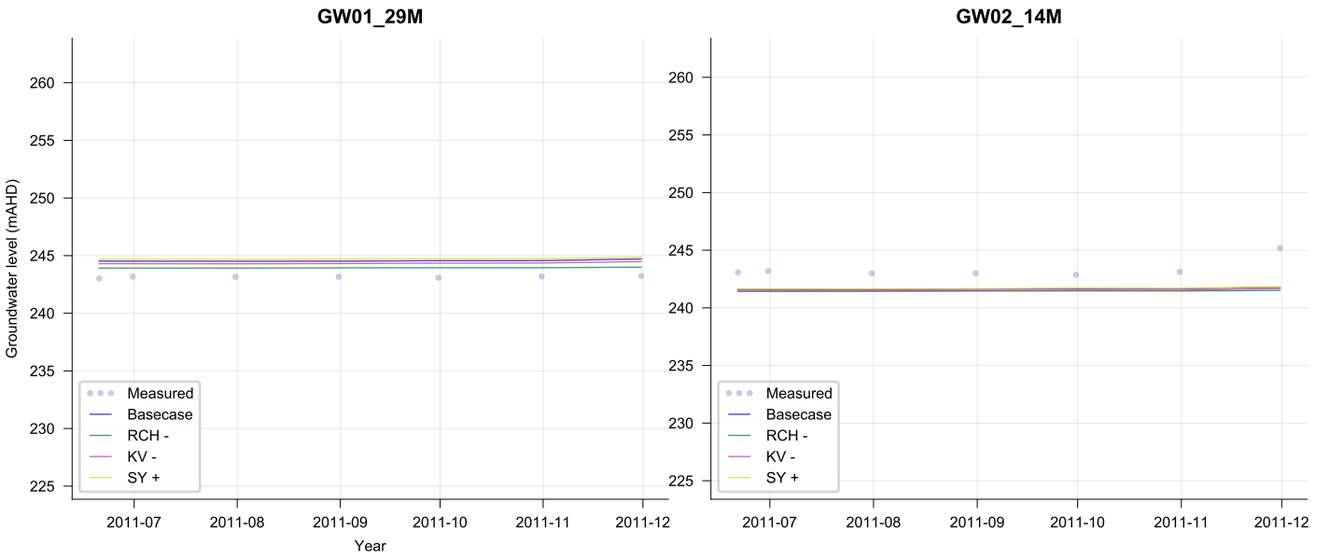


Figure 4 Predicted Void Water Level Hydrograph (no Void)

Attachment A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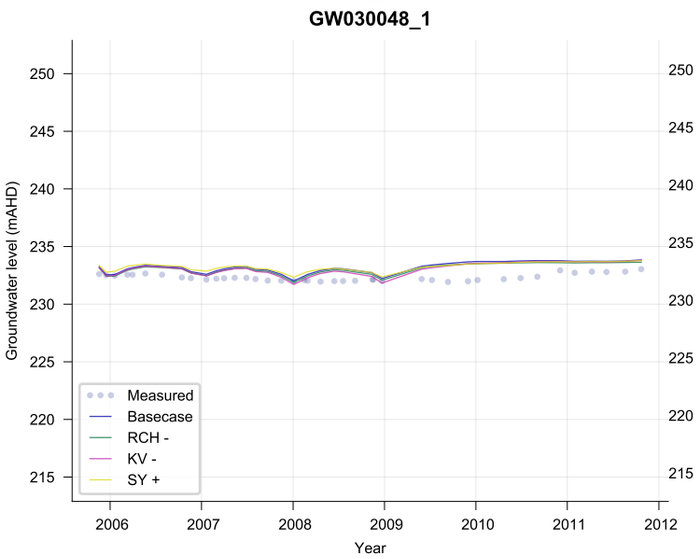
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

GW02_14M
Measured
Basecase
RCH -
KV -
SY +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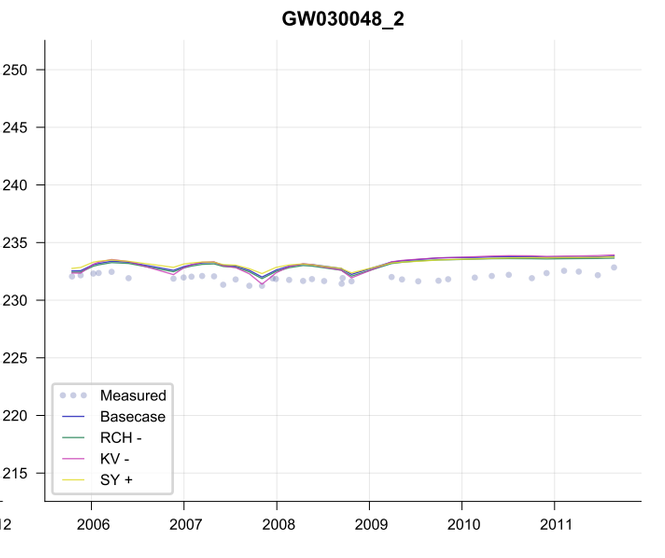
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +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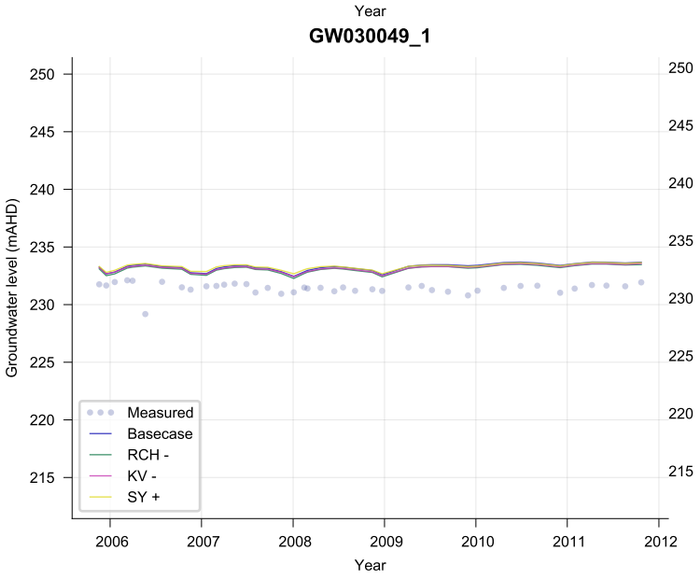
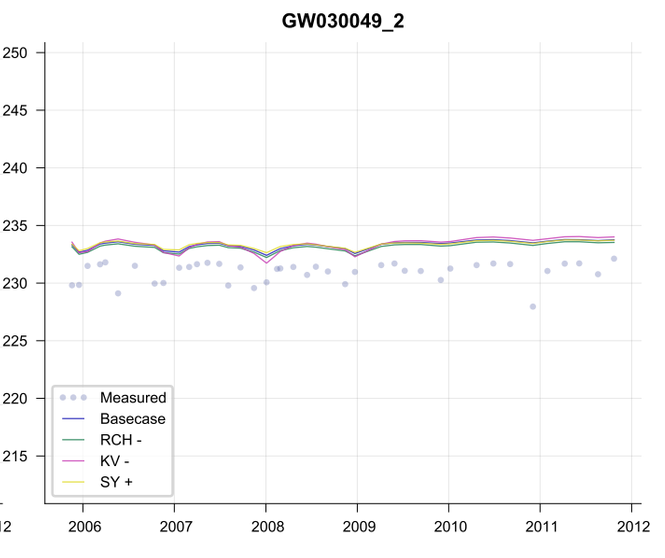
Measured
Basecase
RCH -
KV -
SY +


GW030049_1
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +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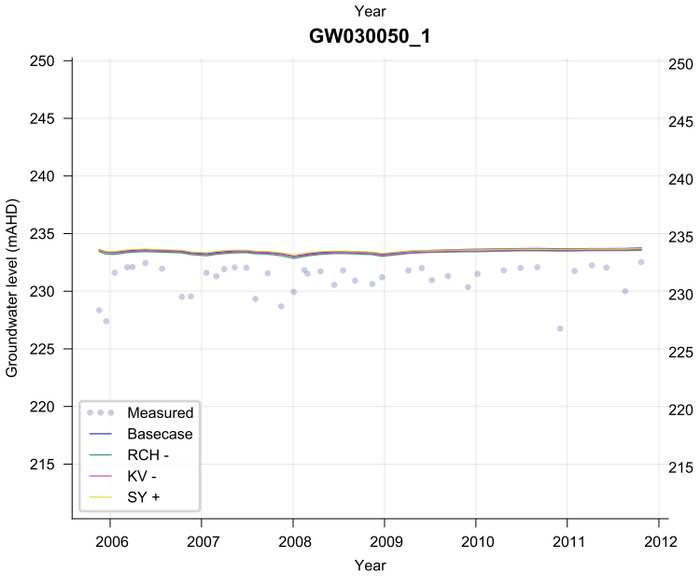
Measured
Basecase
RCH -
KV -
SY +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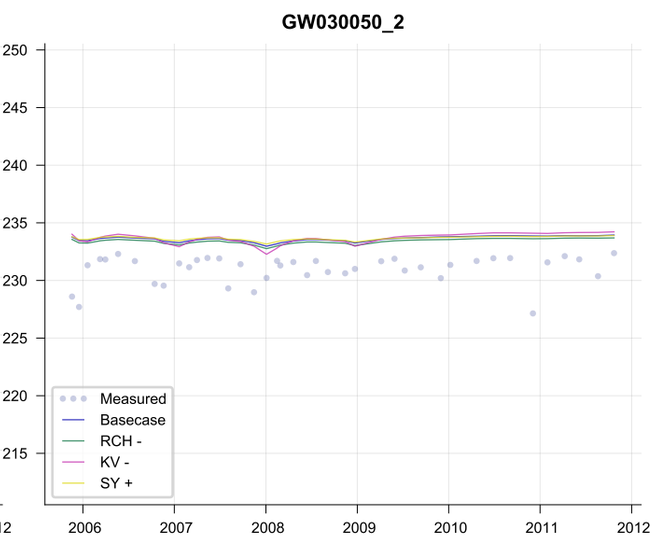
Year
Measured
Basecase
RCH -
KV -
SY +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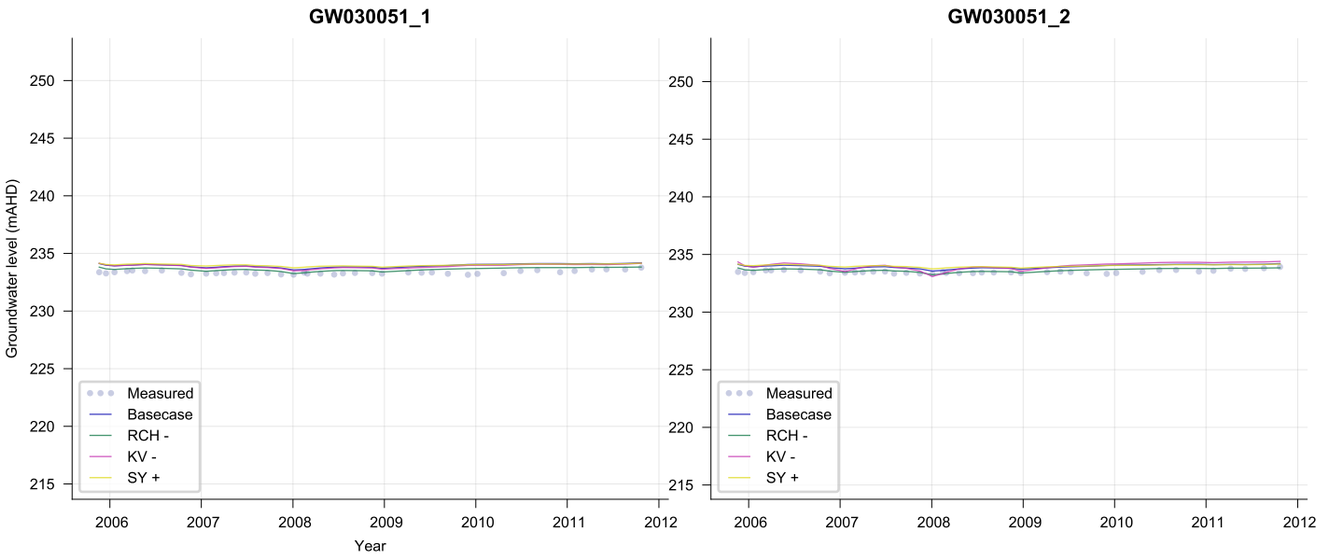
Measured
Basecase
RCH -
KV -
SY +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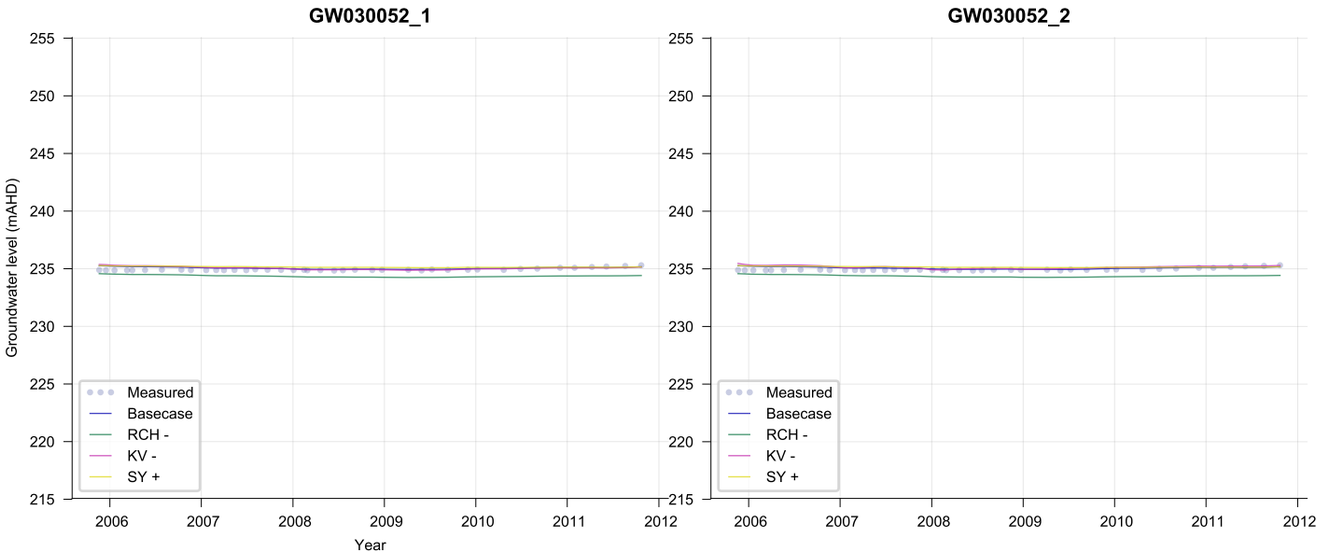
Measured
Basecase
RCH -
KV -
SY +

GW030051_2
Measured
Basecase
RCH -
KV -
SY +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Year
Measured
Basecase
RCH -
KV -
SY +

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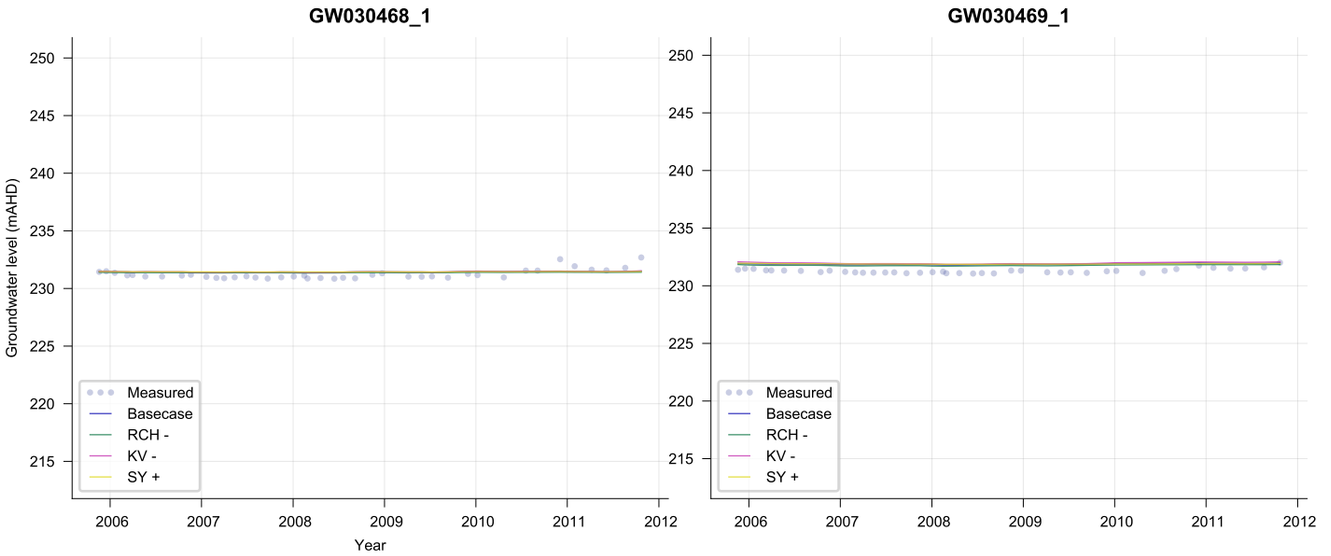
Measured
Basecase
RCH -
KV -
SY +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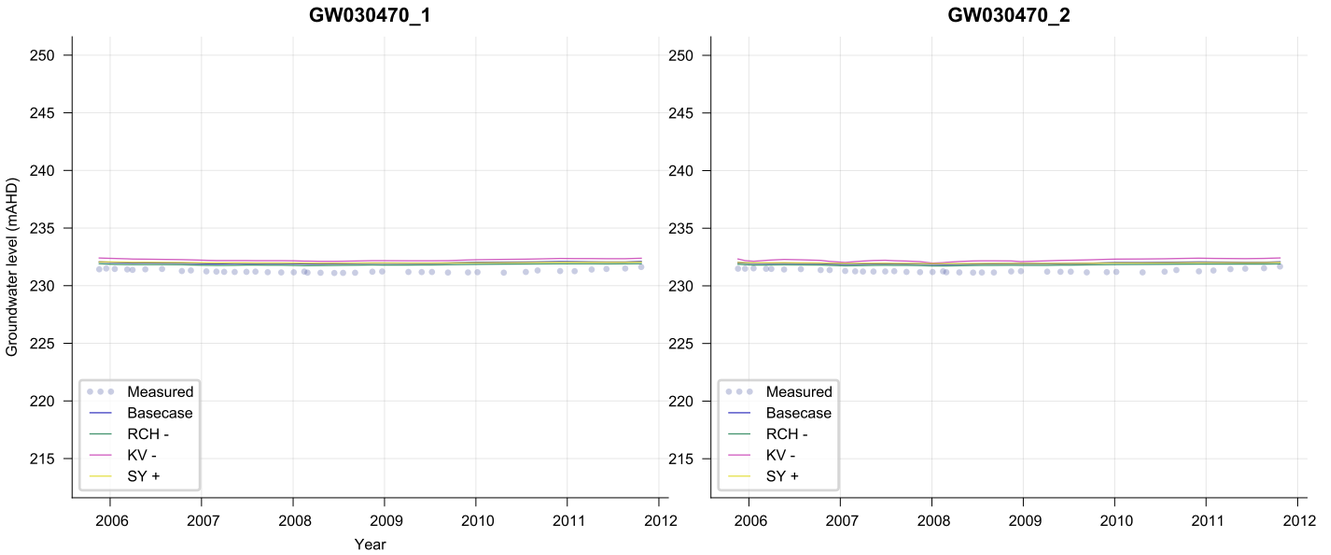
Year
Measured
Basecase
RCH -
KV -
SY +

GW030469_1
Measured
Basecase
RCH -
KV -
SY +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Measured
Basecase
RCH -
KV -
SY +

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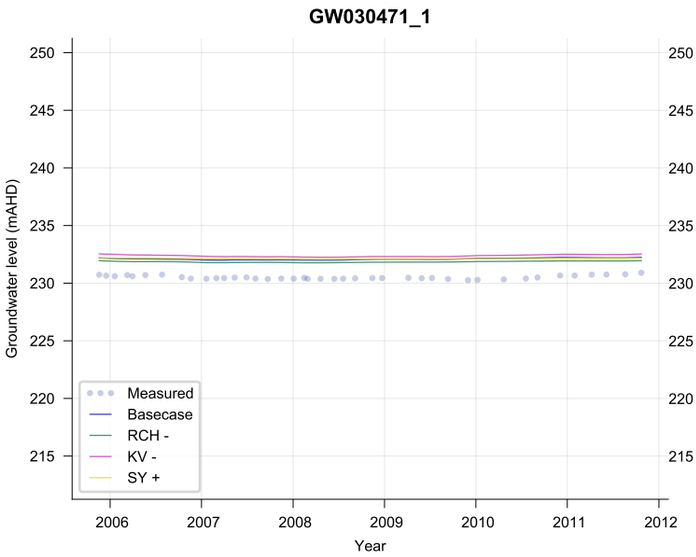
Basecase
RCH -
KV -
SY +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Year
Measured
Basecase
RCH -
KV -
SY +


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KV -
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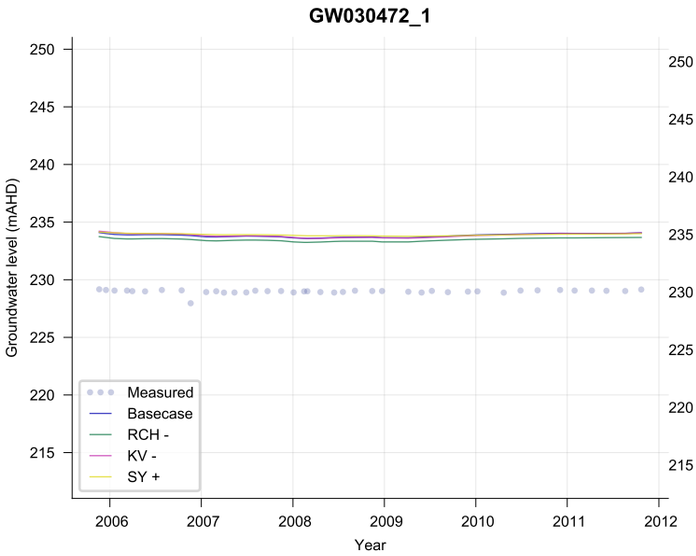
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KV -
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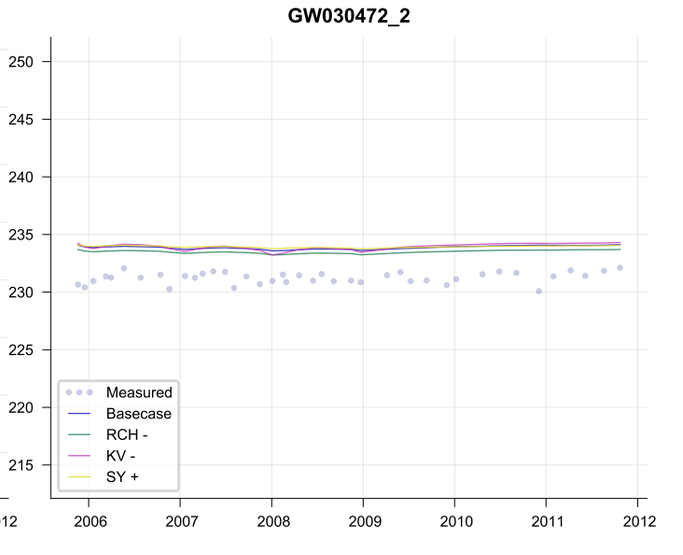
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KV -
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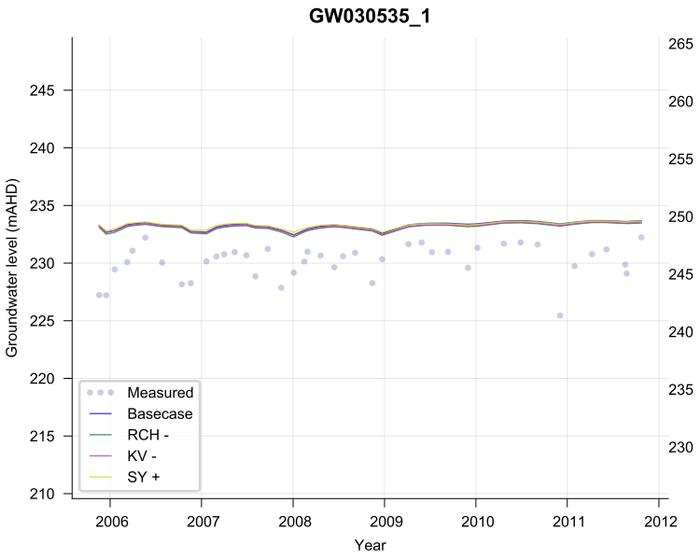
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Year
Measured
Basecase
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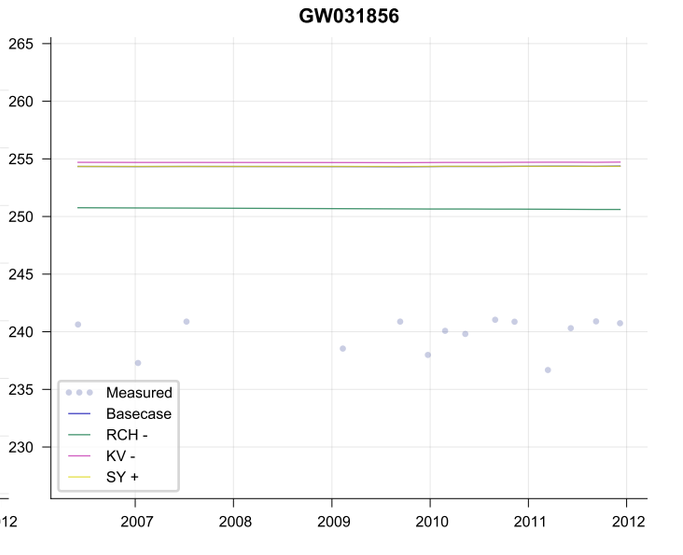
KV -
SY +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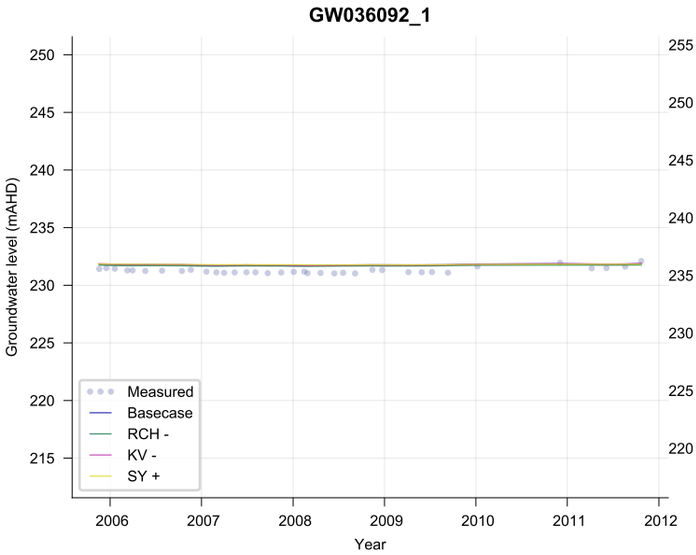
KV -
SY +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Basecase
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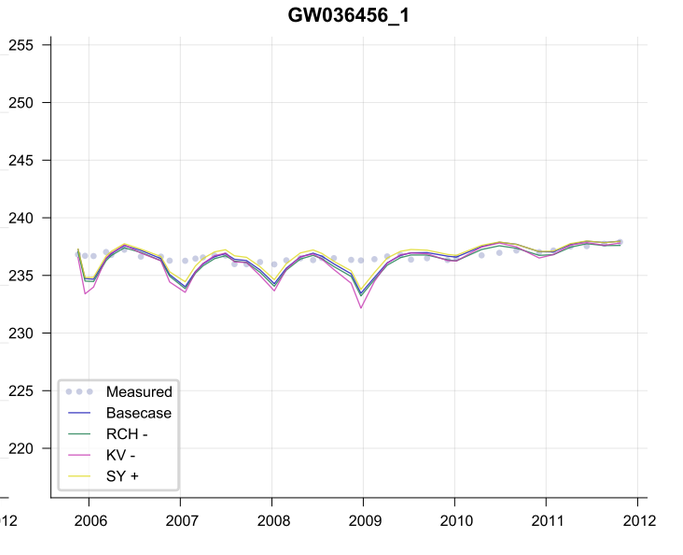
SY +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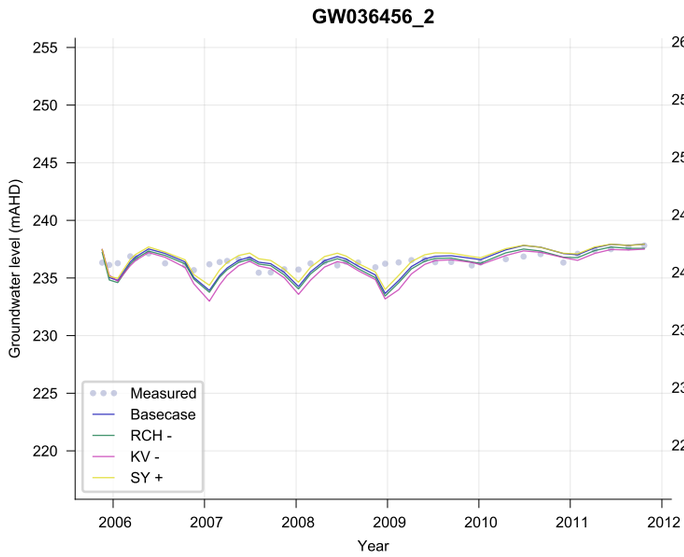
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Measured
Basecase
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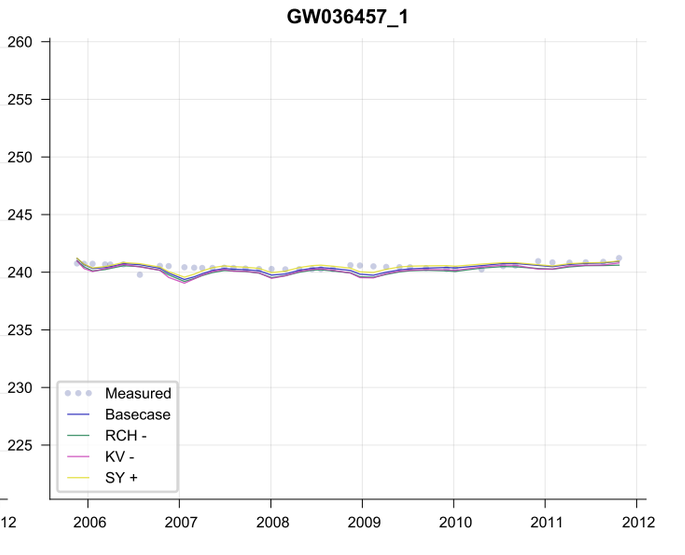
KV -
SY +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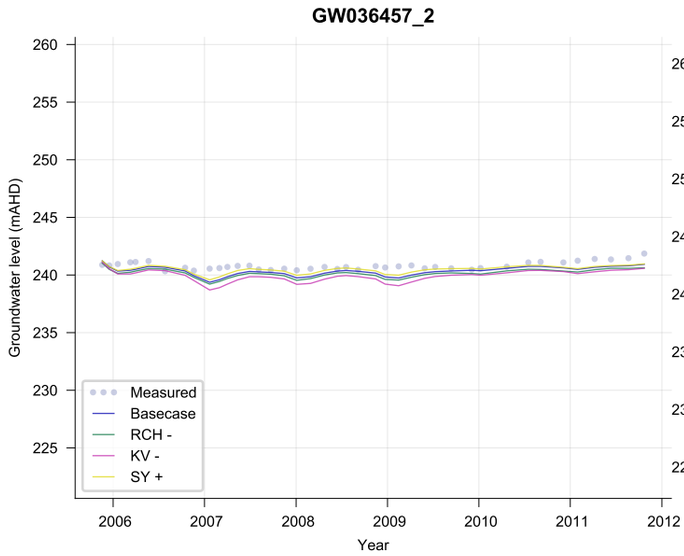
KV -
SY +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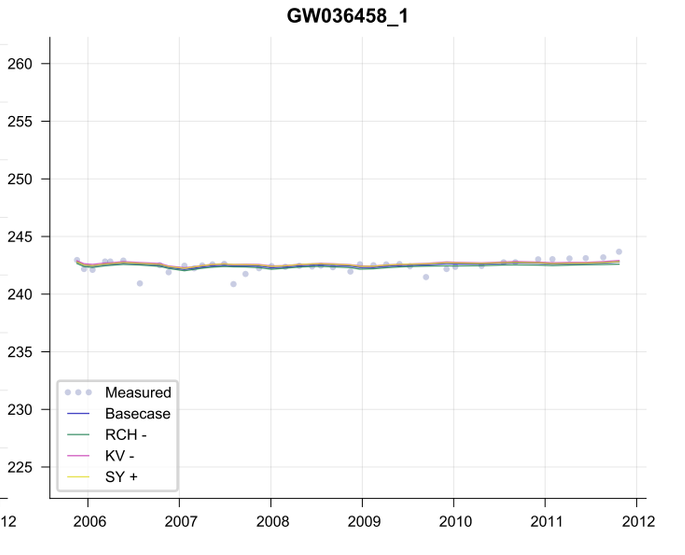
Year
Measured
Basecase
RCH -
KV -
SY +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Basecase
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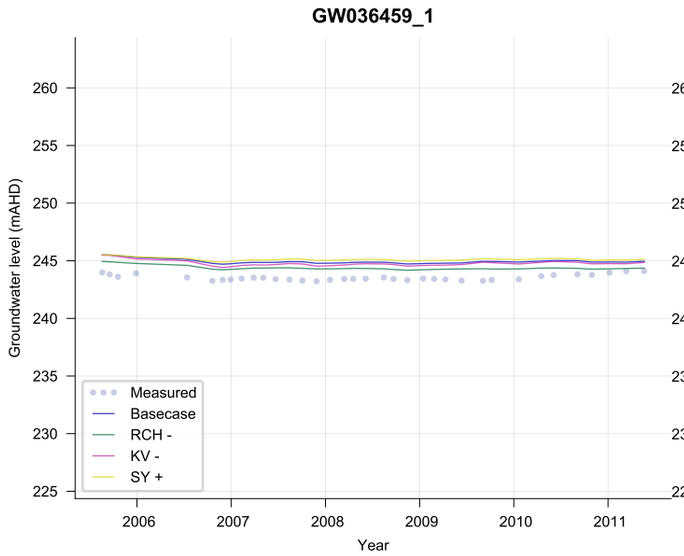
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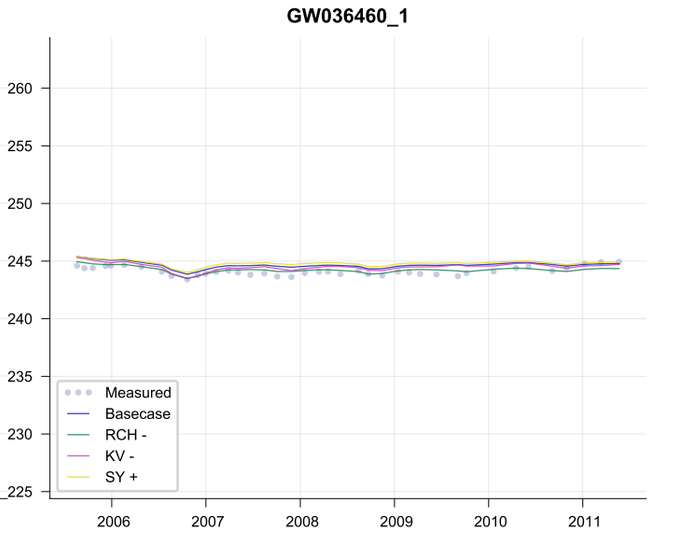
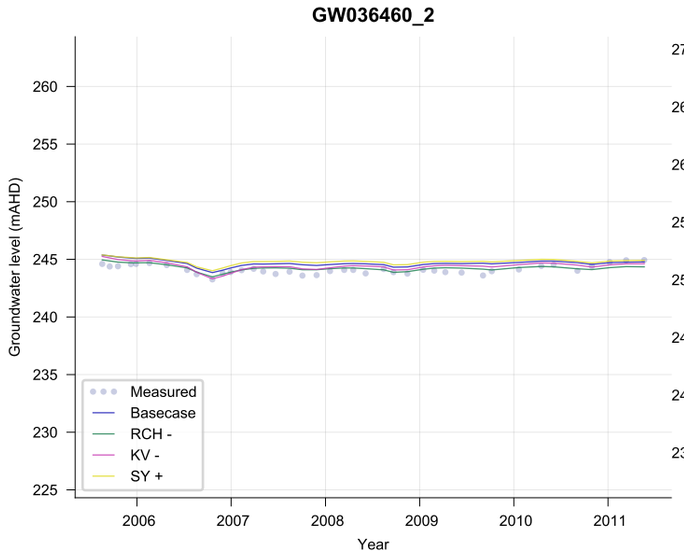
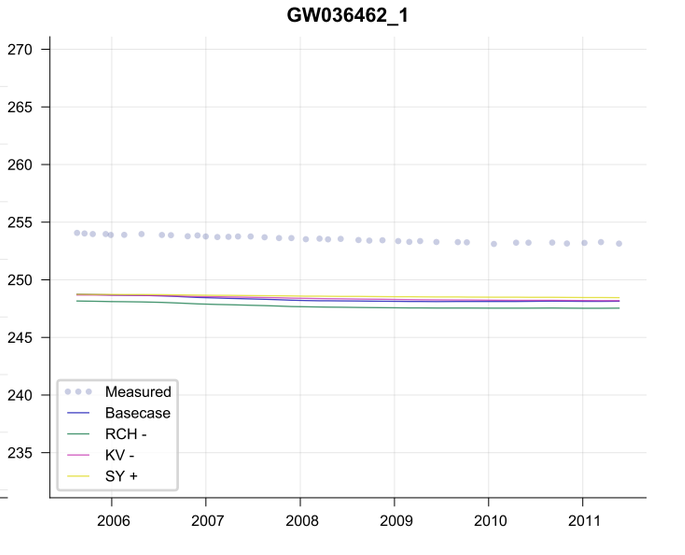
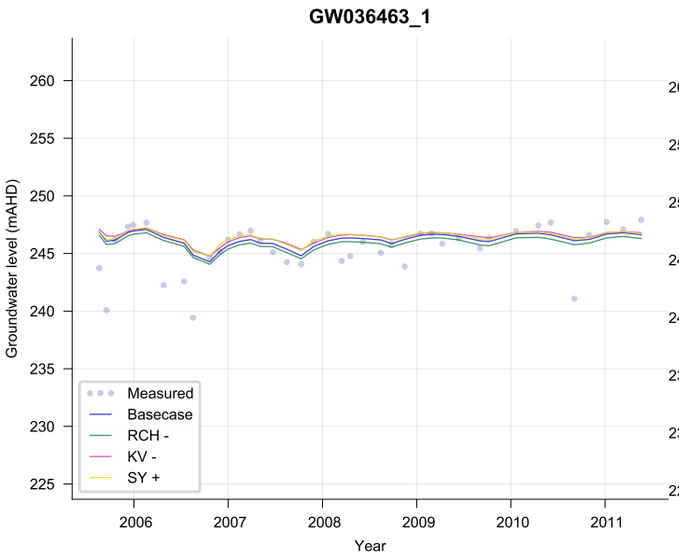
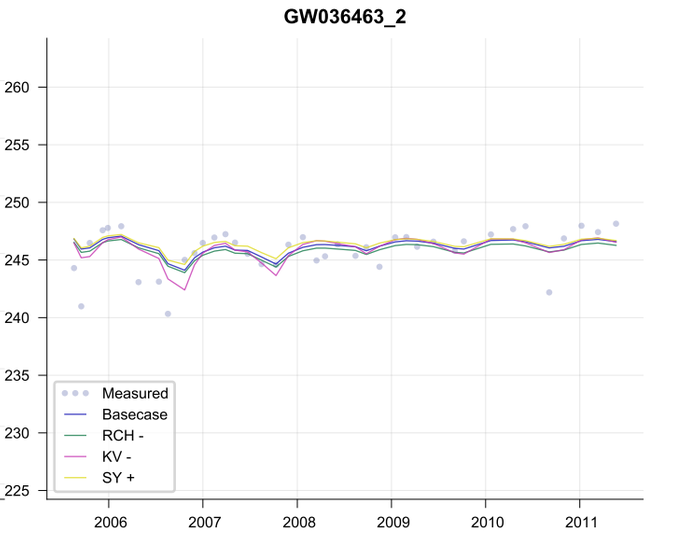
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

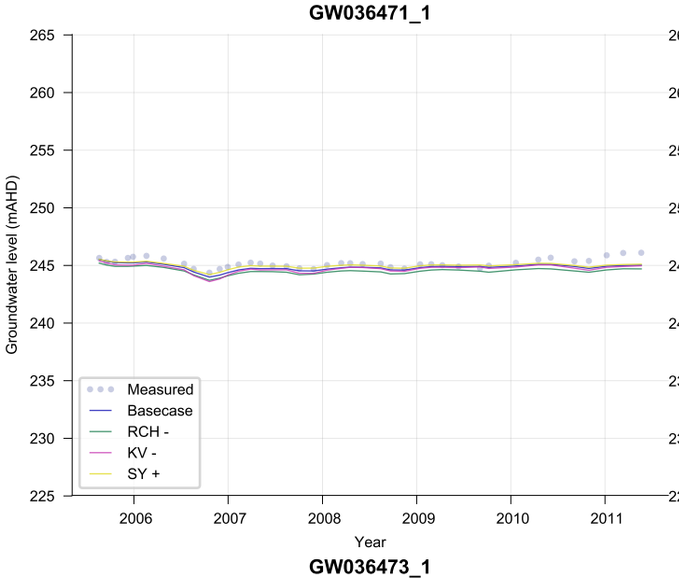

GW036460_1
Measured
Basecase
RCH -
KV -
SY +

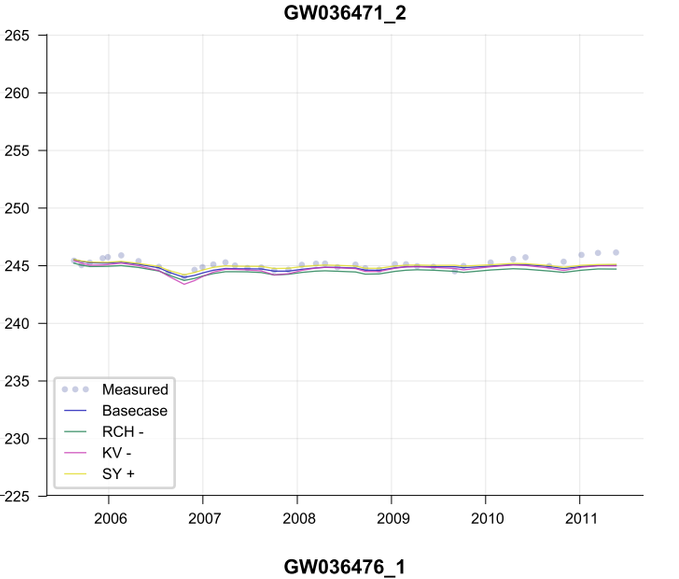

GW036460_2
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

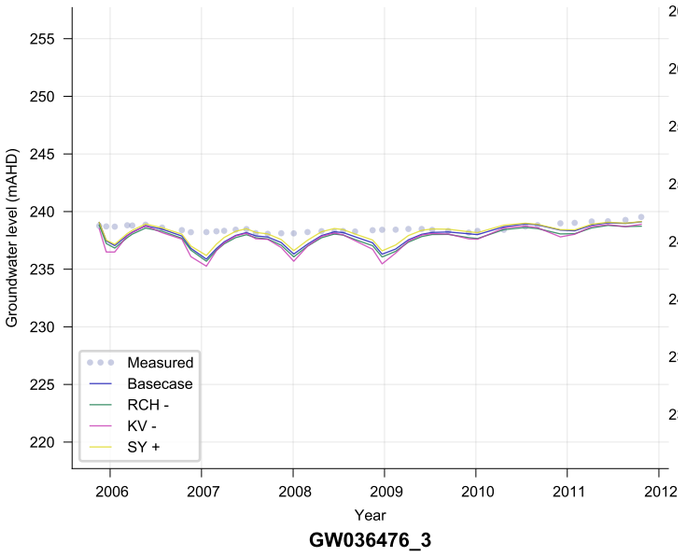

GW036462_1
Measured
Basecase
RCH -
KV -
SY +

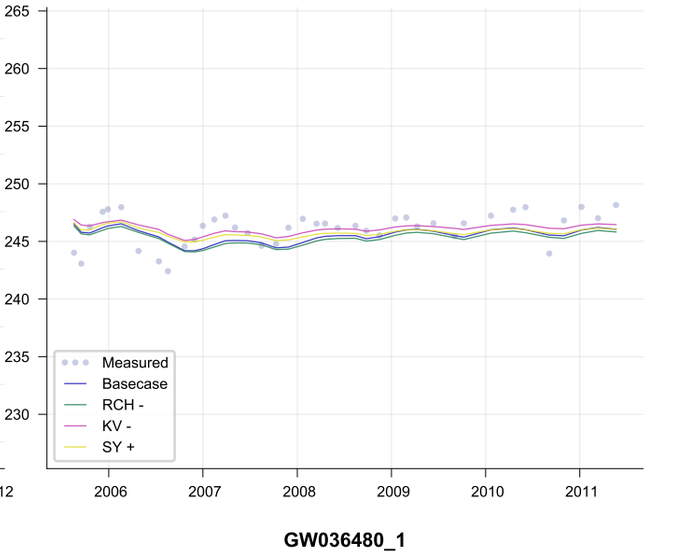

GW036463_1
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

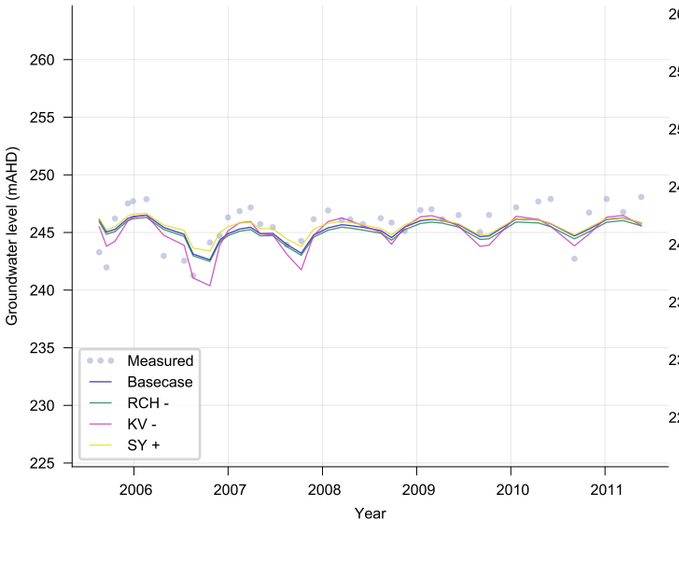

GW036463_2
Measured
Basecase
RCH -
KV -
SY +

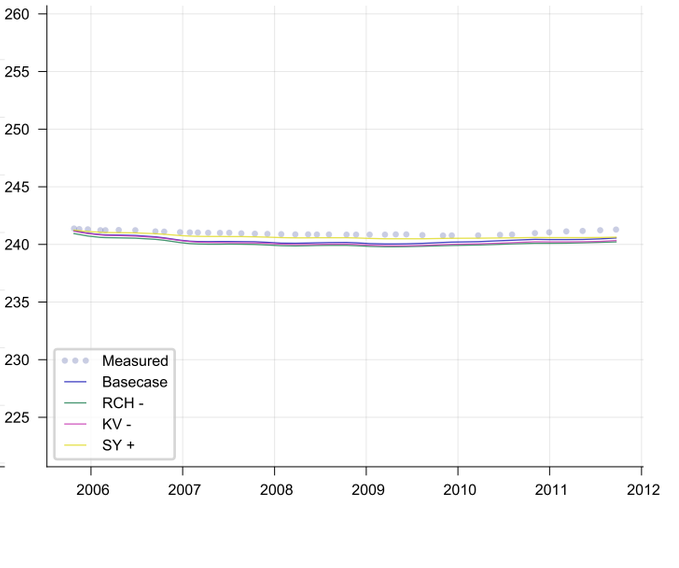

GW036471_1
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

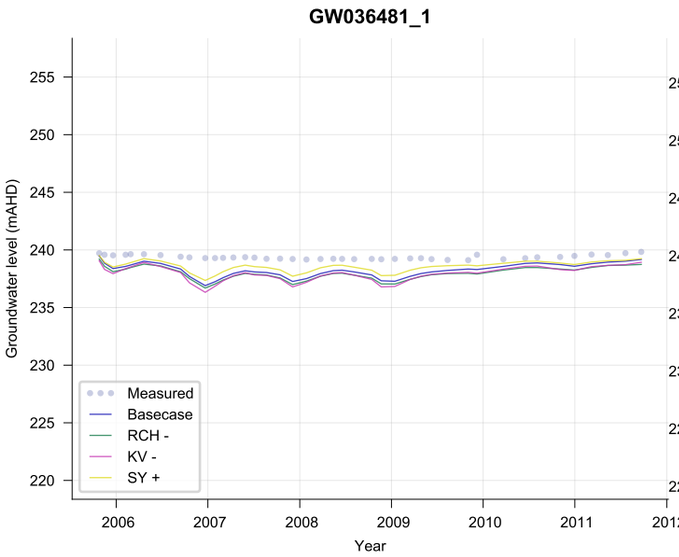

GW036471_2
Measured
Basecase
RCH -
KV -
SY +

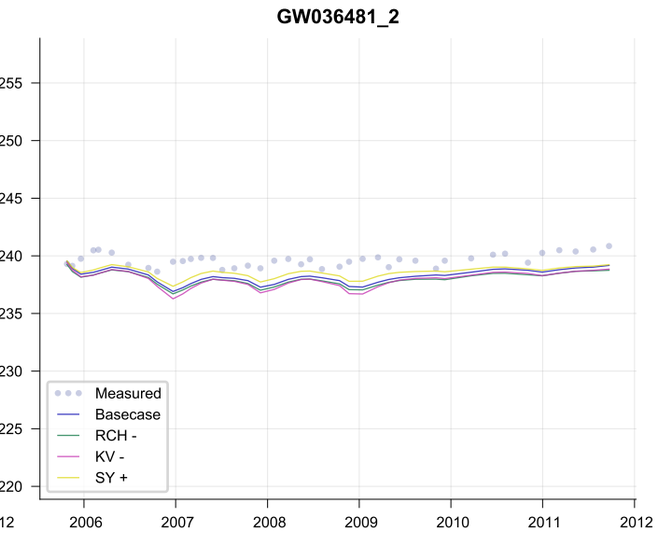

GW036473_1
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

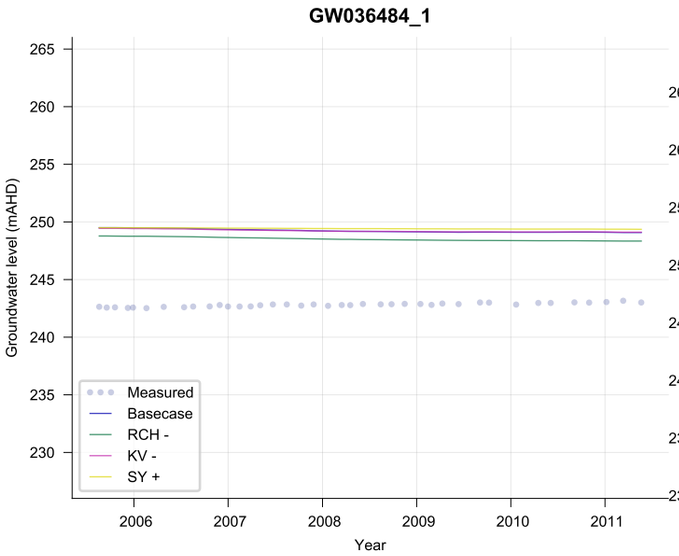

GW036476_1
Measured
Basecase
RCH -
KV -
SY +

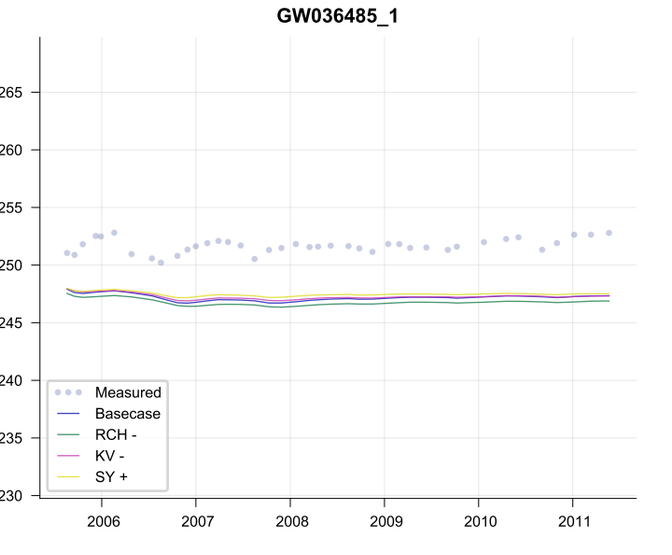

GW036476_3
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

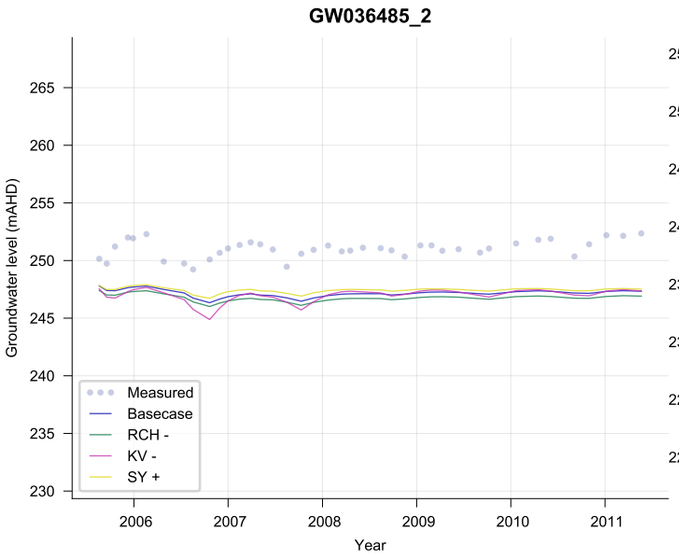

GW036480_1
Measured
Basecase
RCH -
KV -
SY +

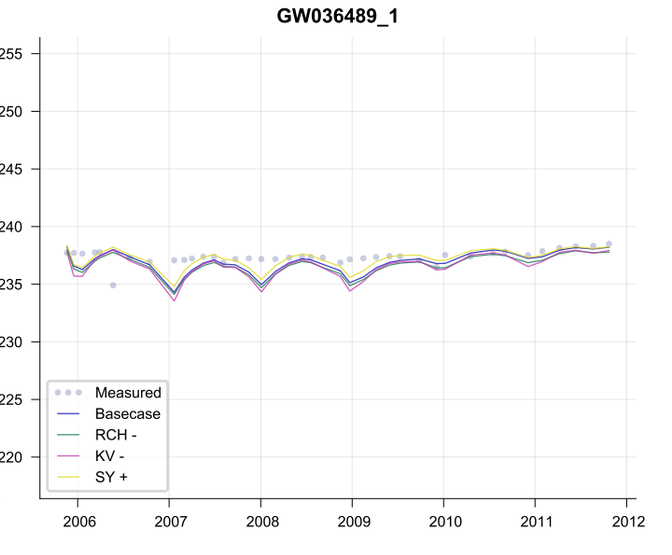

GW036481_1
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

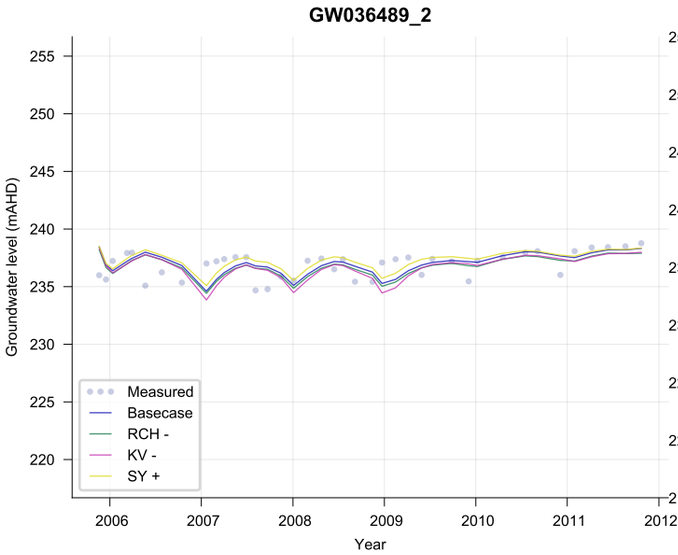

GW036481_2
Measured
Basecase
RCH -
KV -
SY +

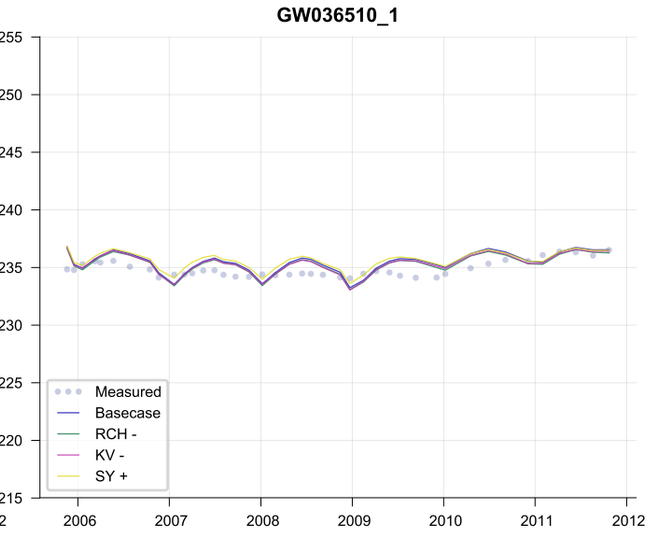

GW036484_1
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

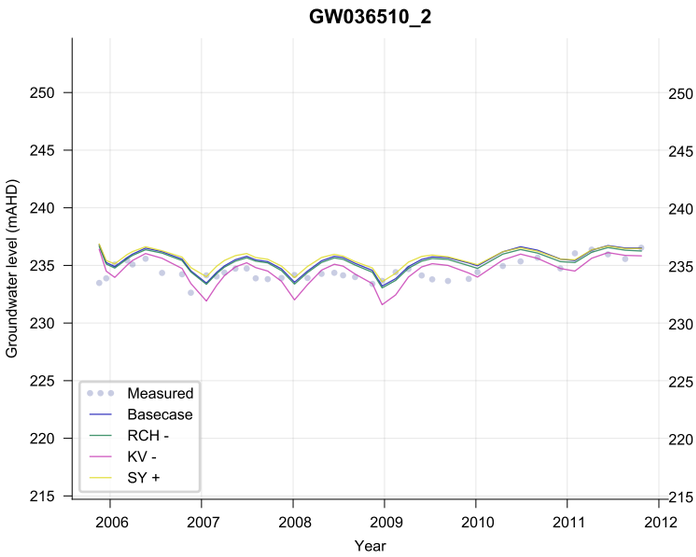

GW036485_1
Measured
Basecase
RCH -
KV -
SY +

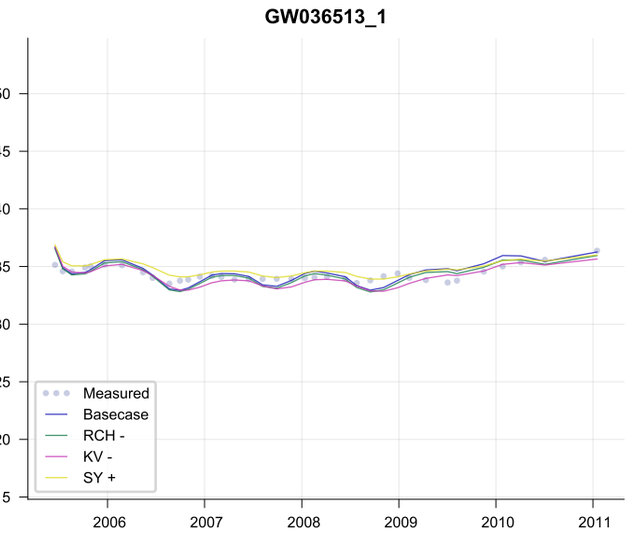

GW036485_2
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

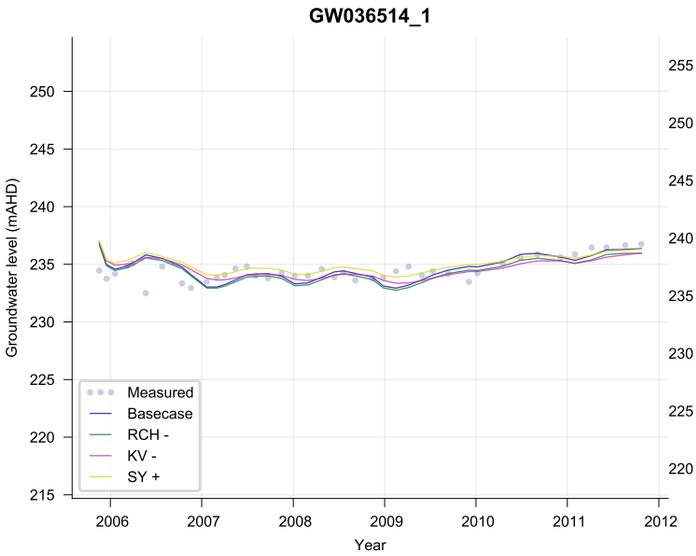

GW036489_1
Measured
Basecase
RCH -
KV -
SY +

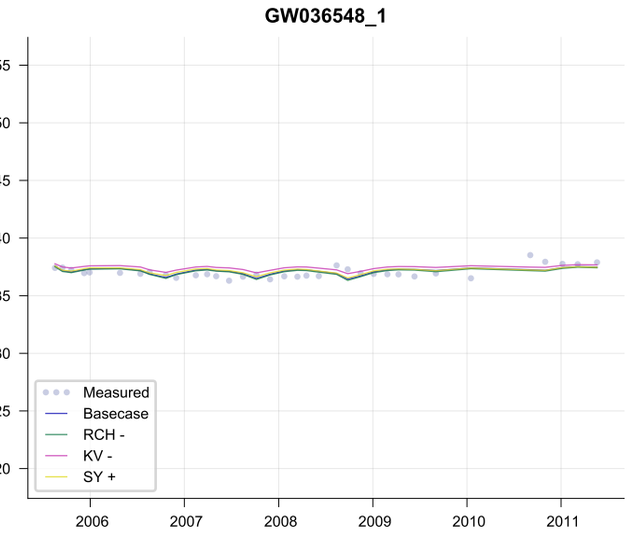

GW036489_2
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

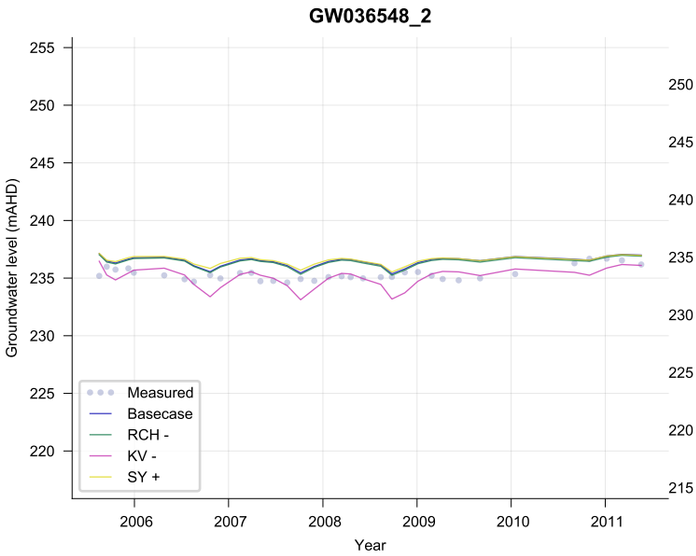

GW036510_1
Measured
Basecase
RCH -
KV -
SY +

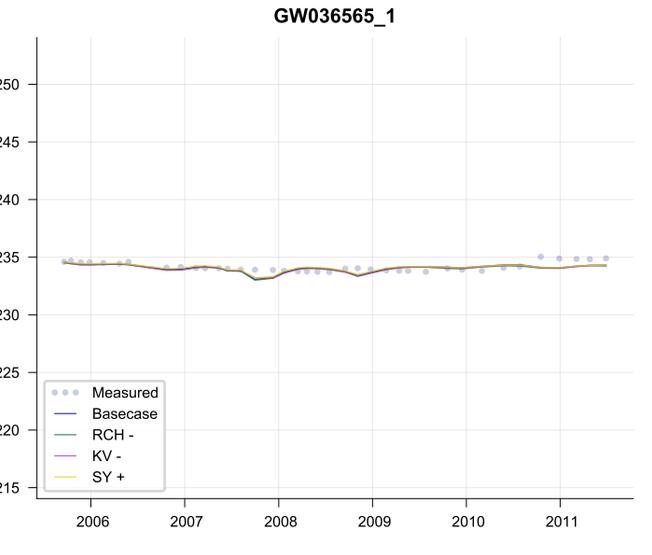

GW036510_2
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

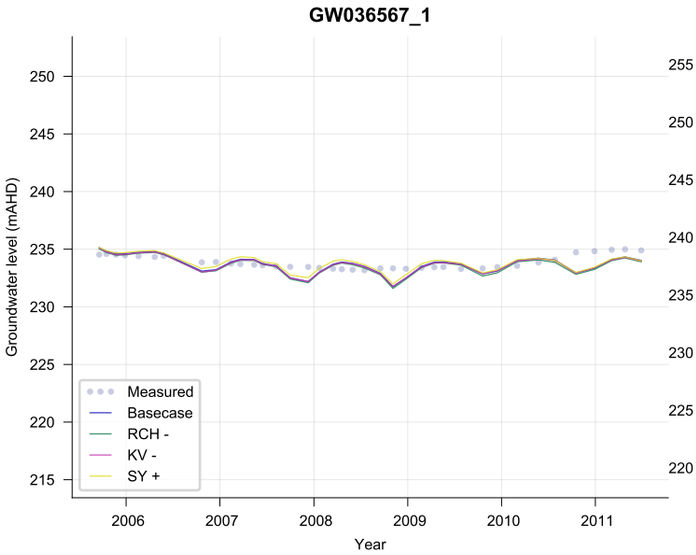

GW036513_1
Measured
Basecase
RCH -
KV -
SY +

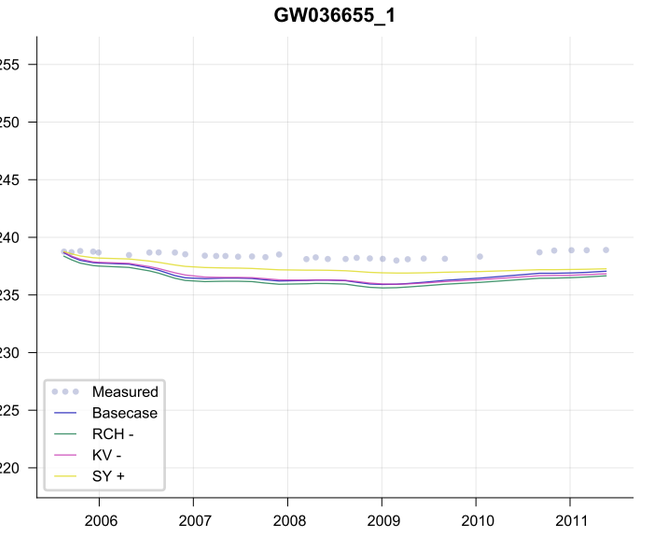

GW036514_1
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

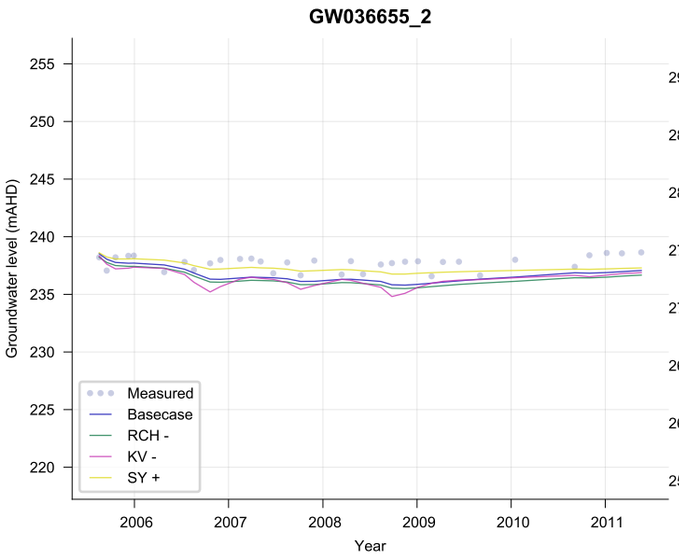

GW036548_1
Measured
Basecase
RCH -
KV -
SY +

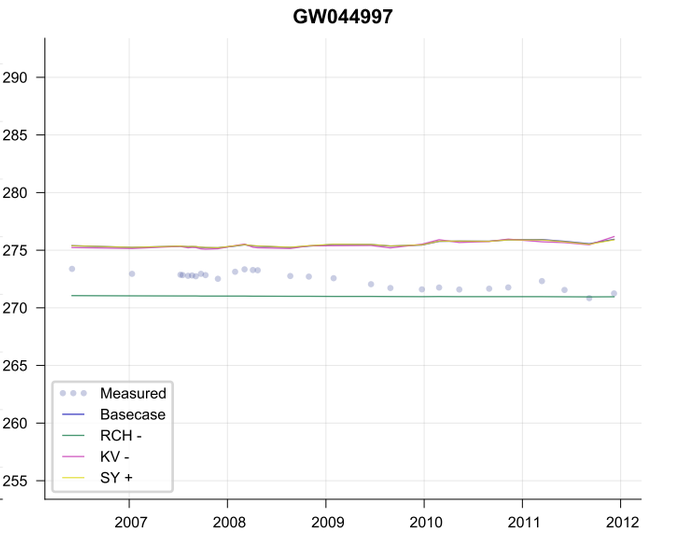

GW036548_2
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

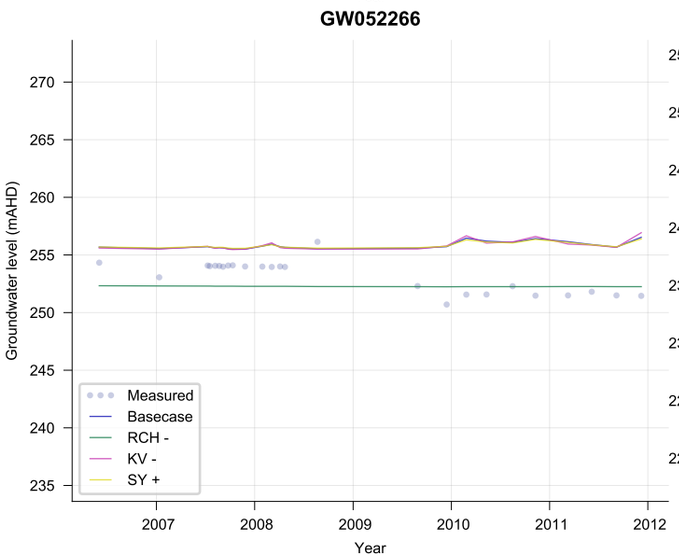

GW036565_1
Measured
Basecase
RCH -
KV -
SY +

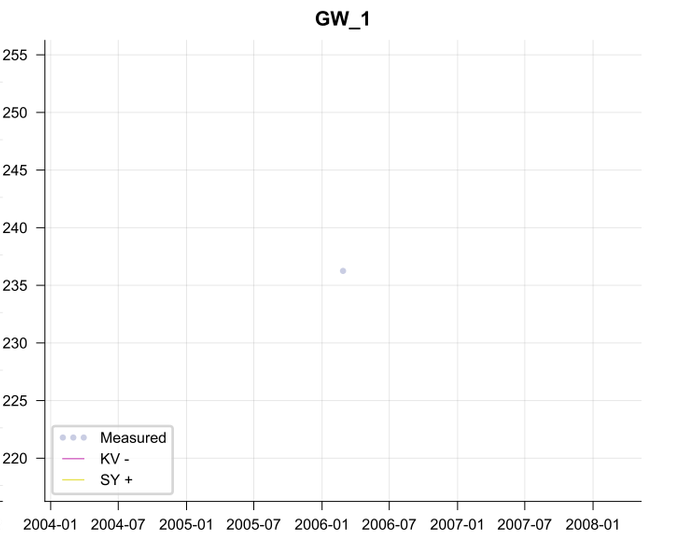

GW036567_1
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

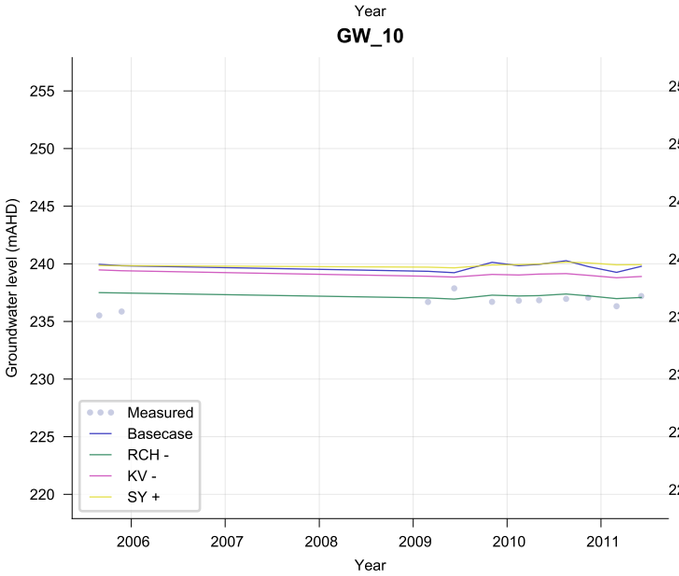

GW036655_1
Measured
Basecase
RCH -
KV -
SY +

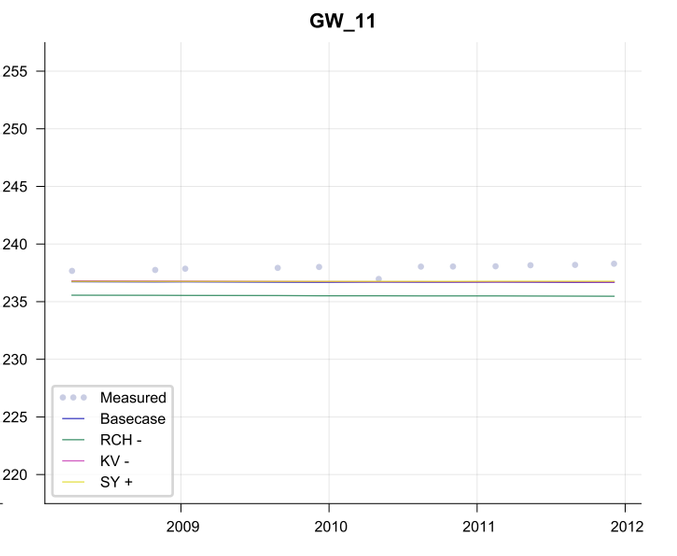

GW036655_2
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

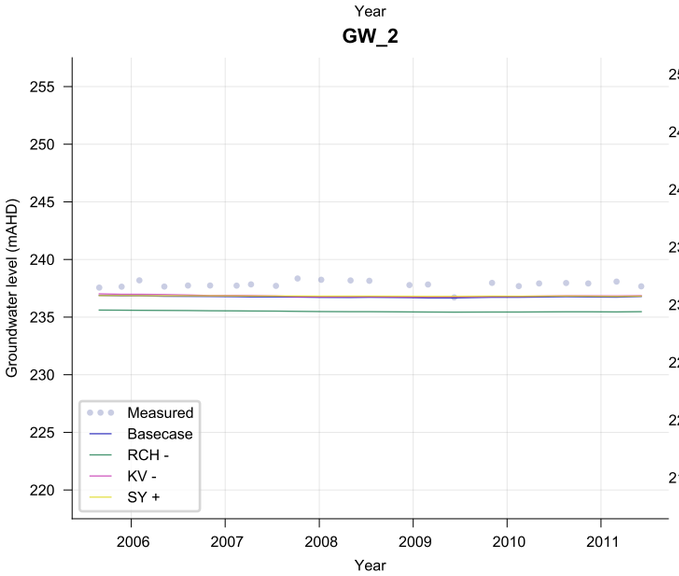

GW044997
Measured
Basecase
RCH -
KV -
SY +

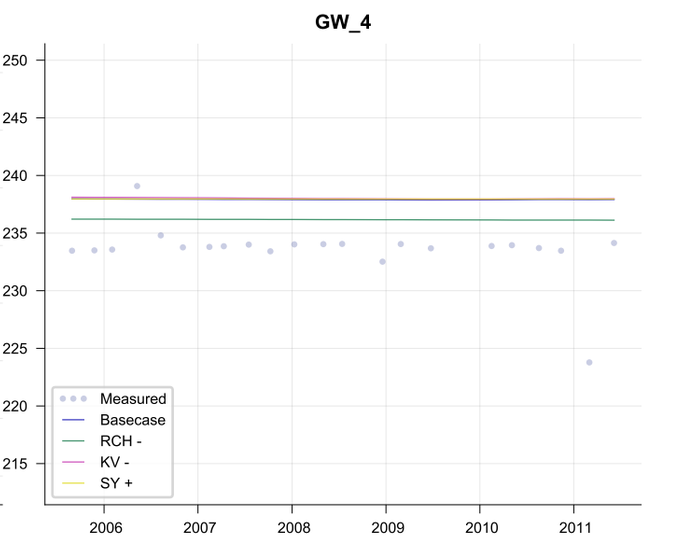

GW052266
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

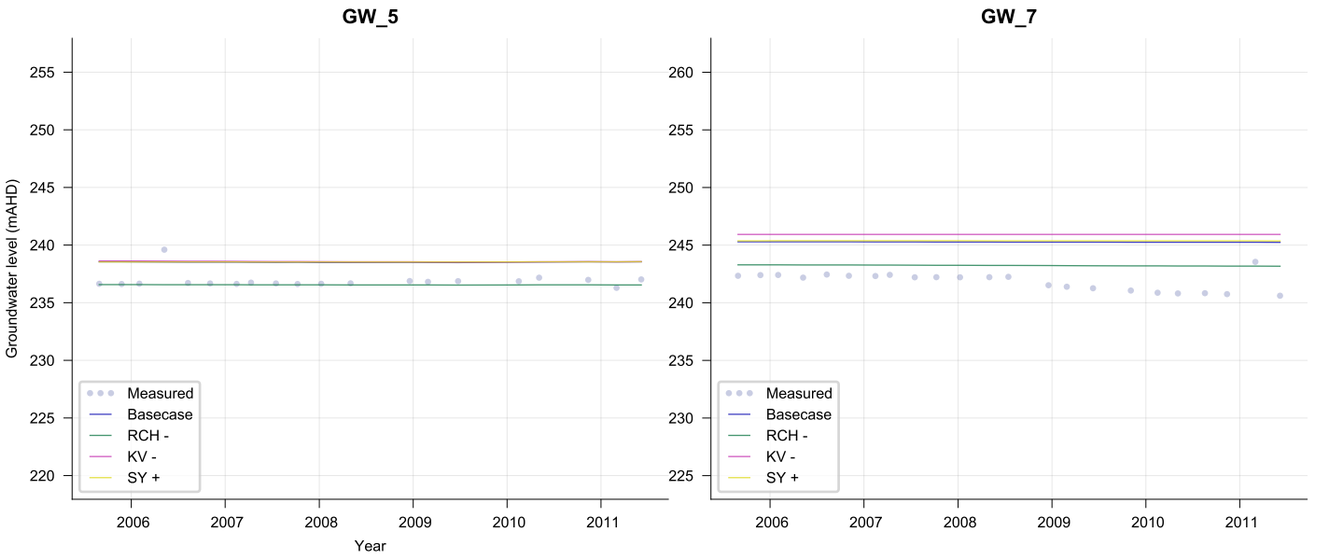

GW_1
Measured
KV -
SY +


GW_10
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

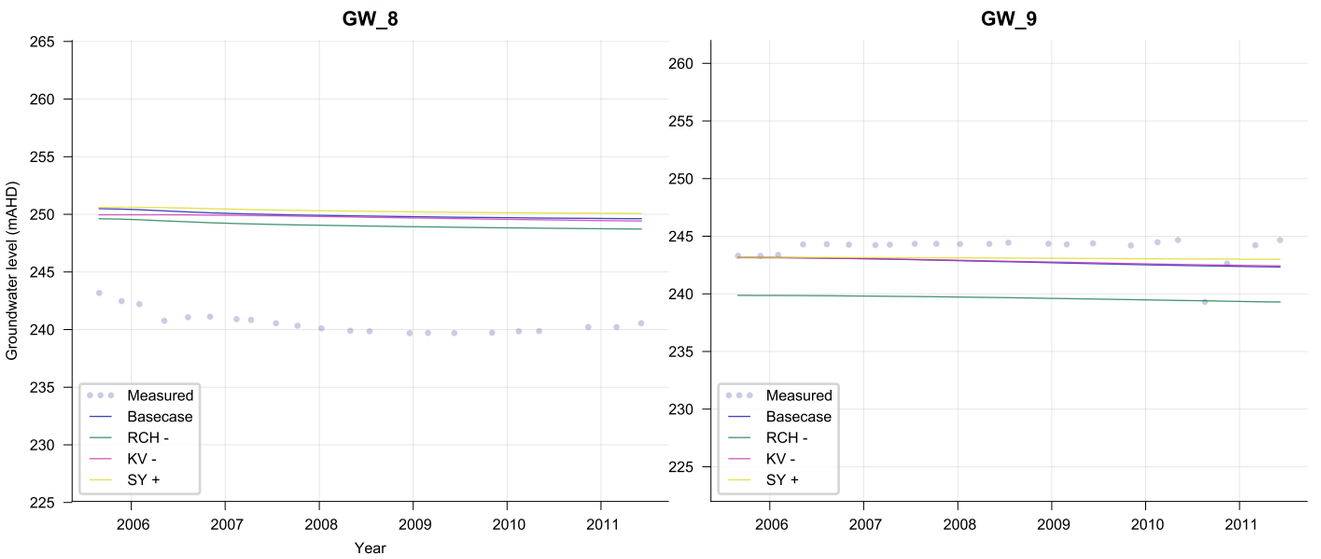

GW_11
Measured
Basecase
RCH -
KV -
SY +


GW_2
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

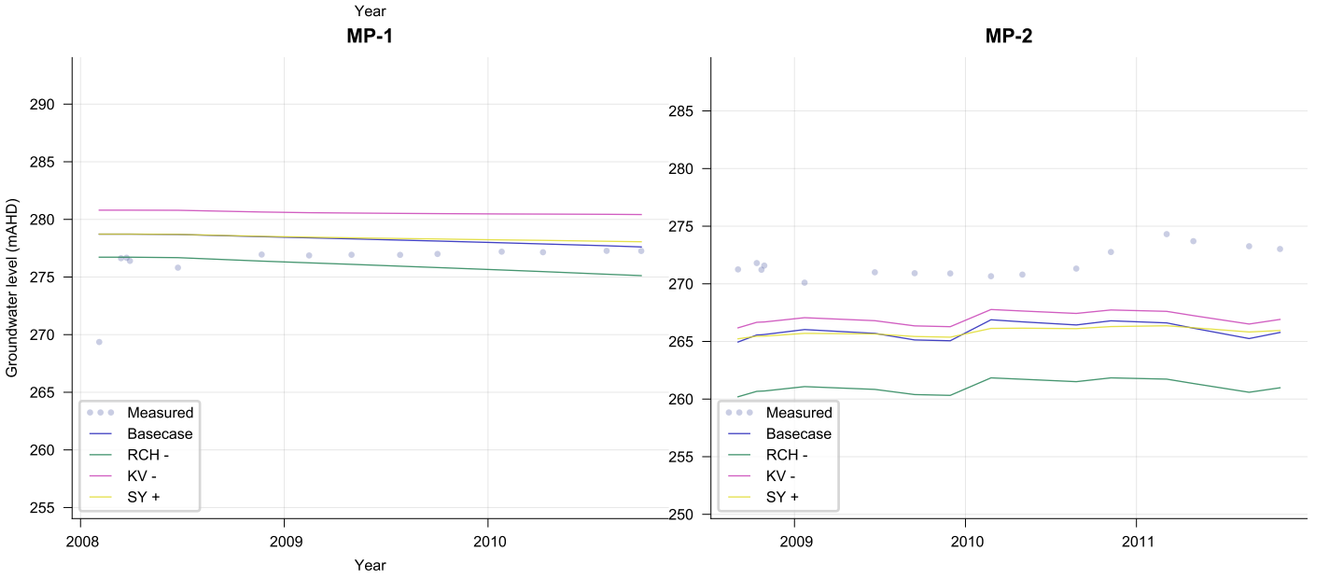

GW_4
Measured
Basecase
RCH -
KV -
SY +


GW_5
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

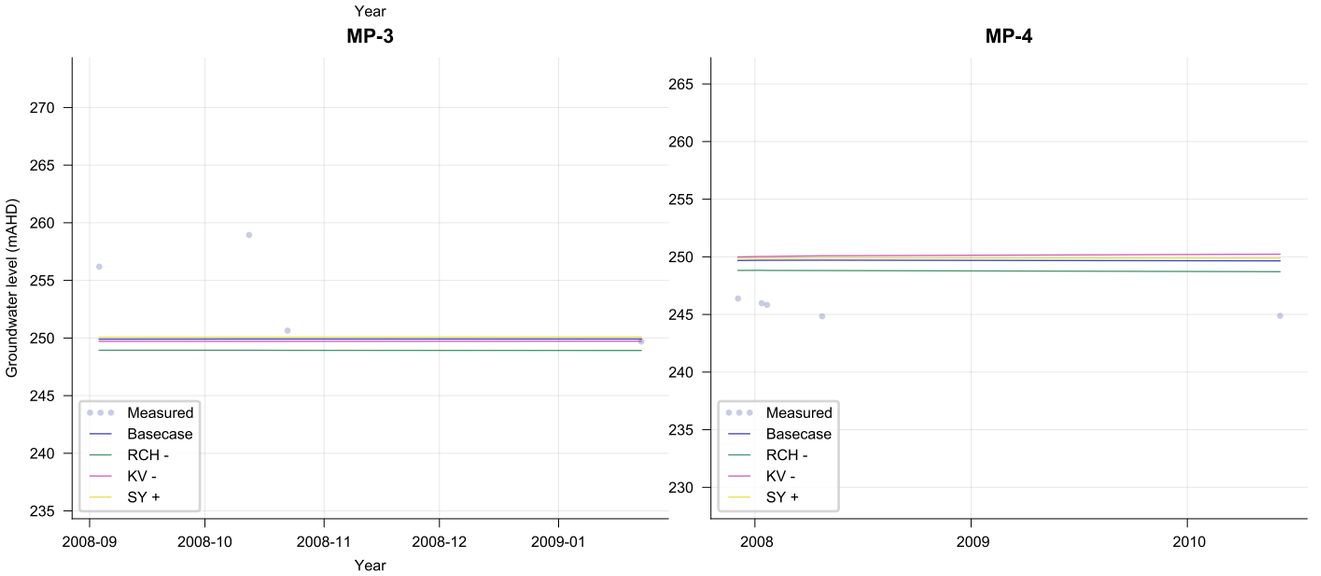
GW_7
Measured
Basecase
RCH -
KV -
SY +


GW_8
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

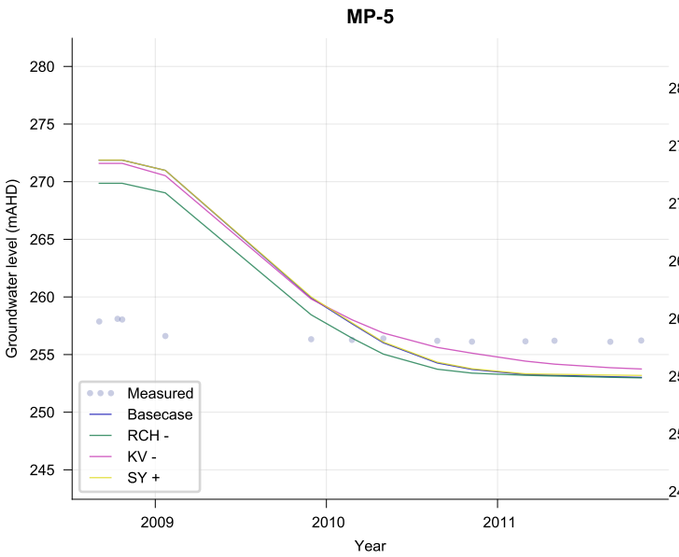
GW_9
Measured
Basecase
RCH -
KV -
SY +

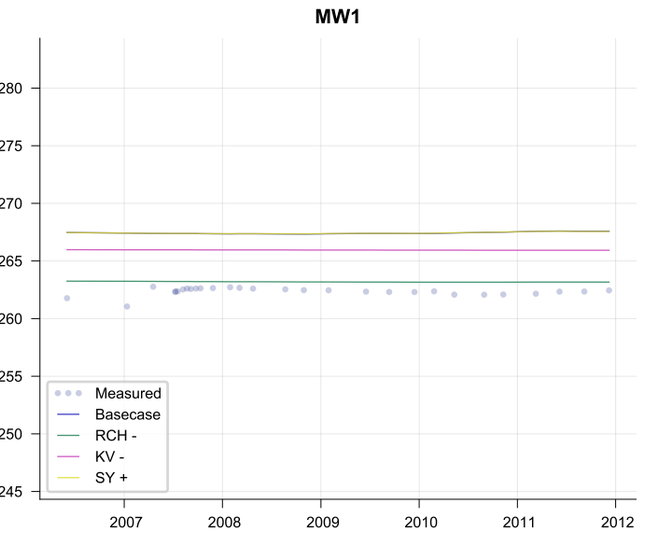

MP-1
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

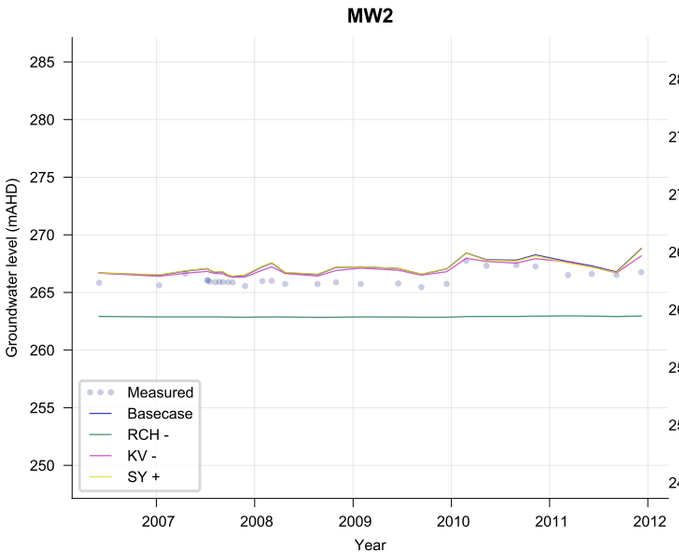
MP-2
Measured
Basecase
RCH -
KV -
SY +

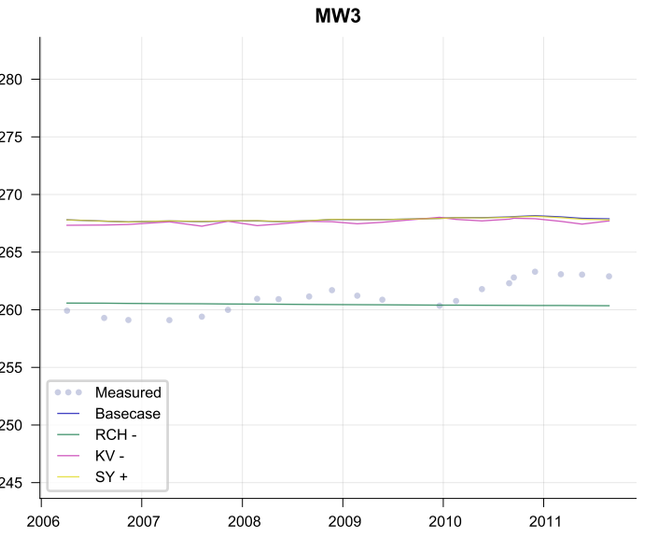

MP-3
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

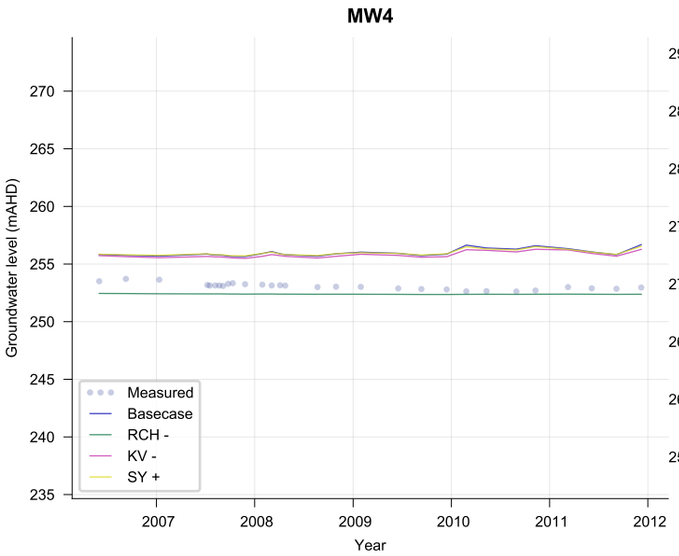
MP-4
Measured
Basecase
RCH -
KV -
SY +

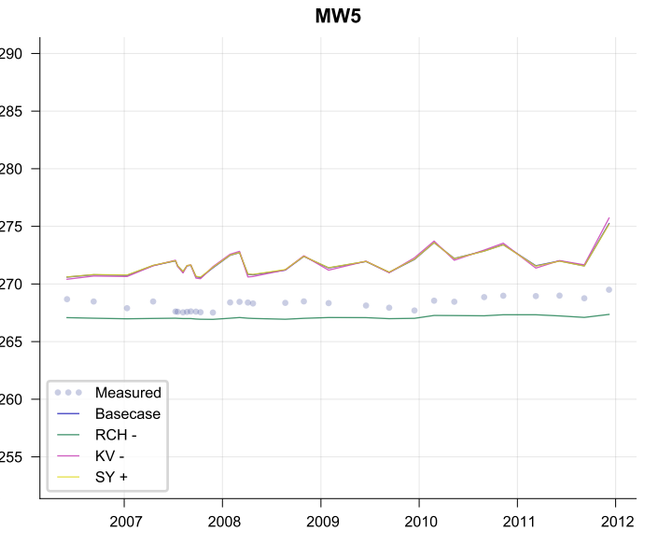

MP-5
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

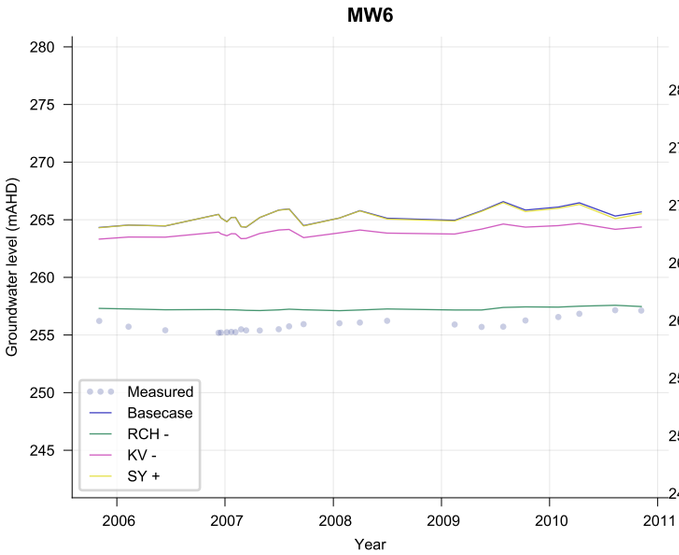

MW1
Measured
Basecase
RCH -
KV -
SY +

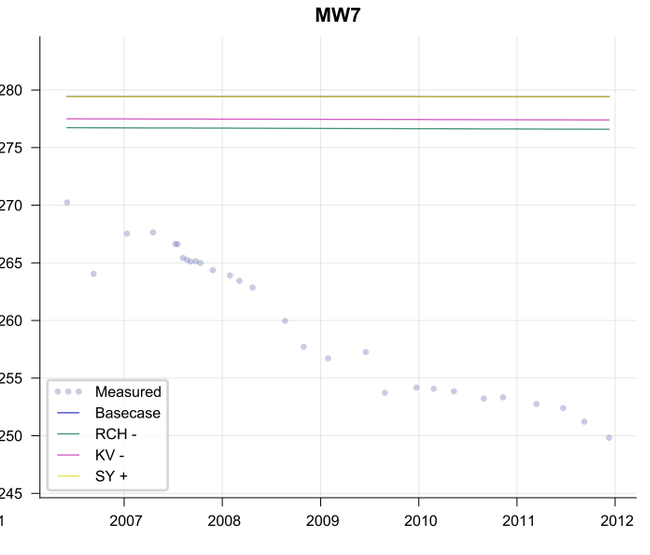

MW2
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

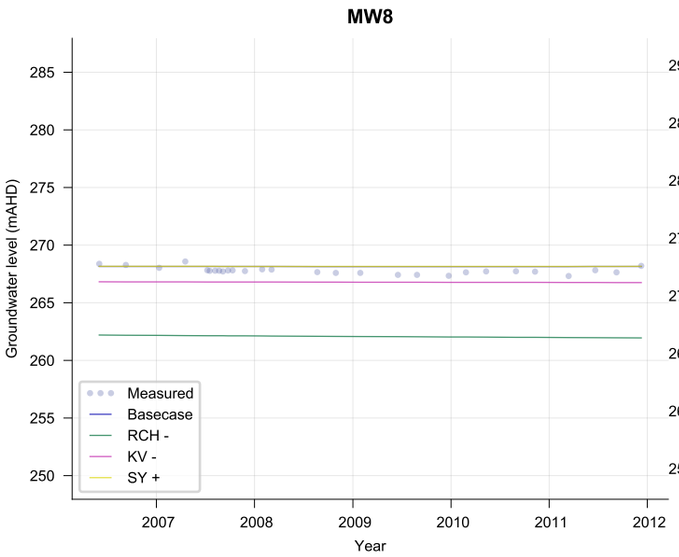

MW3
Measured
Basecase
RCH -
KV -
SY +

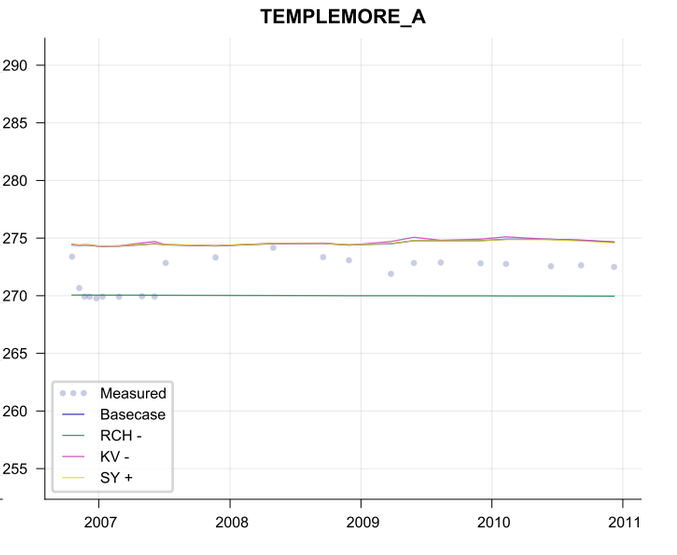

MW4
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

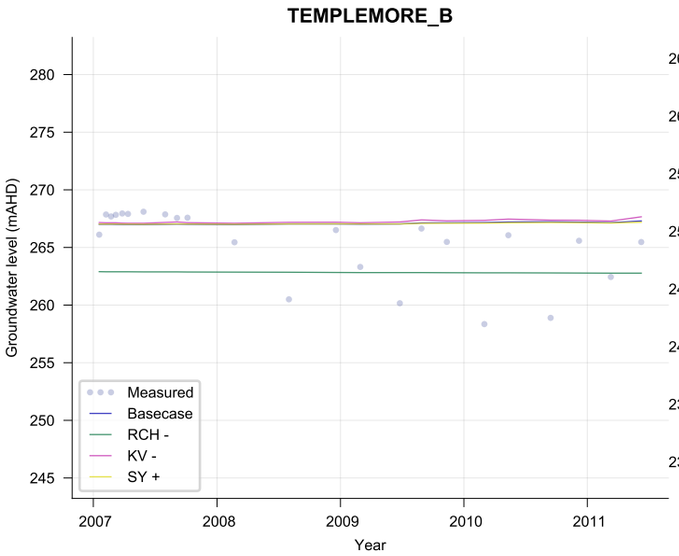

MW5
Measured
Basecase
RCH -
KV -
SY +

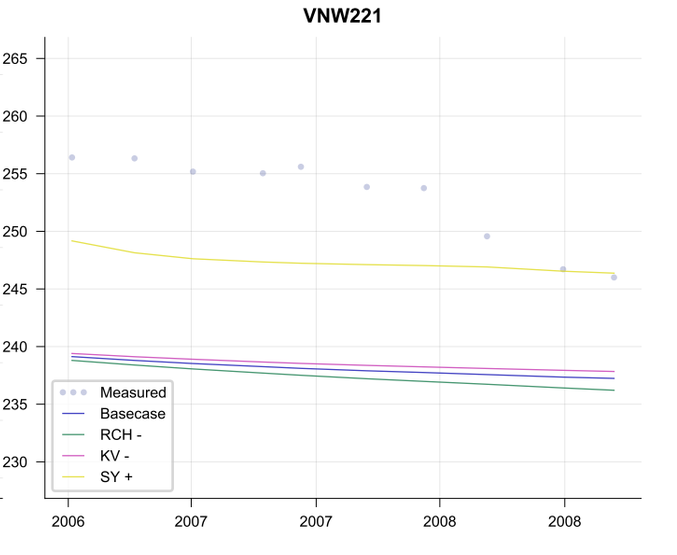

MW6
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

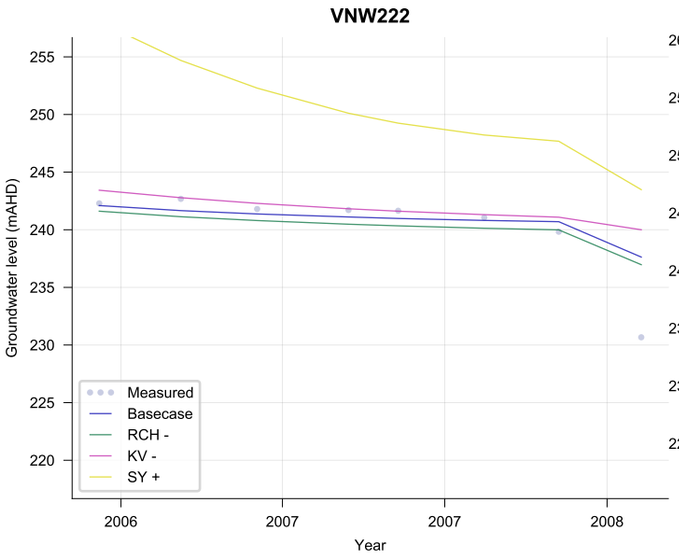

MW7
Measured
Basecase
RCH -
KV -
SY +

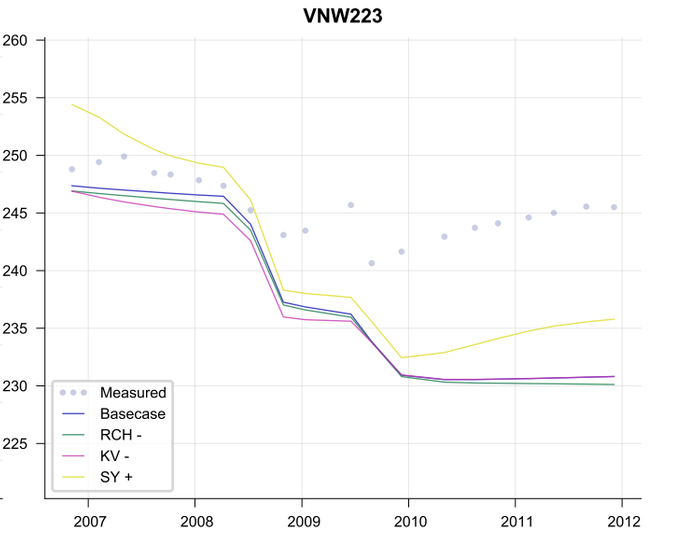

MW8
Groundwater level (mAHD)
285
280
275
270
265
260
255
250
2007
2008
2009
2010
2011
2012
Year
Measured
Basecase
RCH -
KV -
SY +

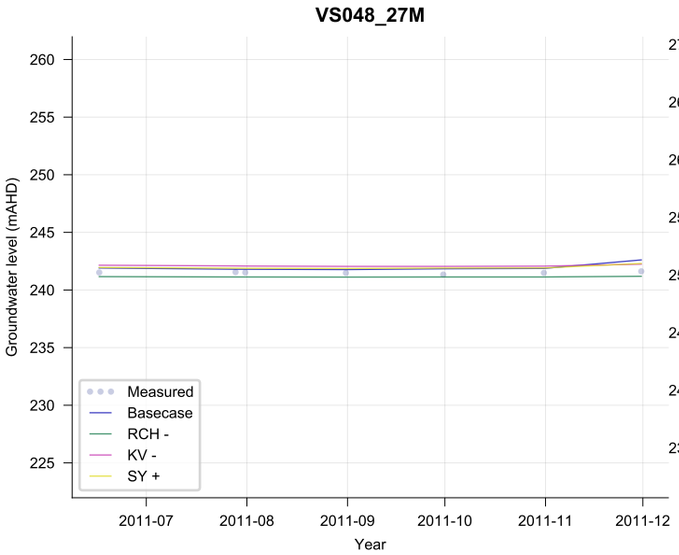

TEMPLEMORE_A
290
285
280
275
270
265
260
255
2007
2008
2009
2010
2011
Measured
Basecase
RCH -
KV -
SY +

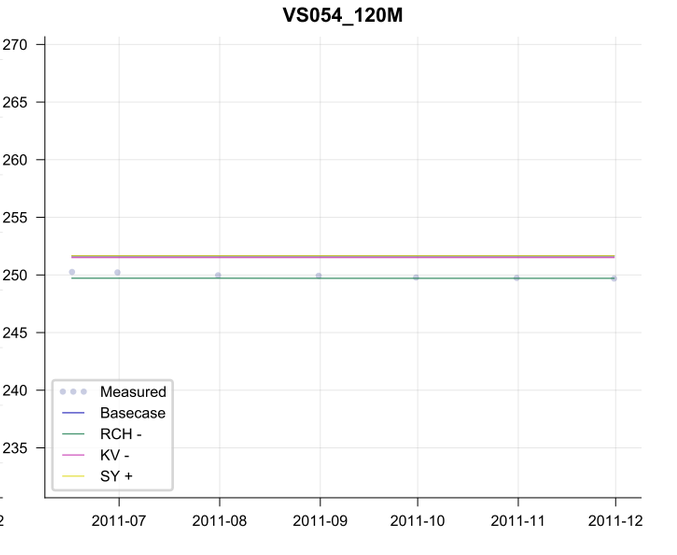

TEMPLEMORE_B
Groundwater level (mAHD)
280
275
270
265
260
255
250
245
2007
2008
2009
2010
2011
Year
Measured
Basecase
RCH -
KV -
SY +

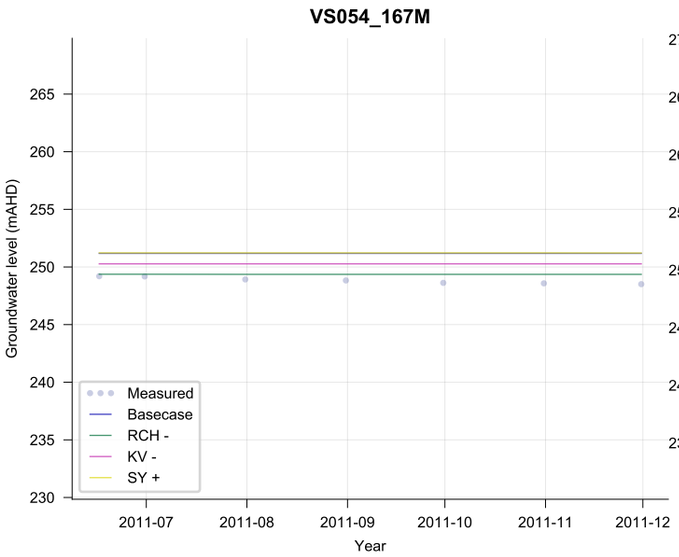

VNW221
265
260
255
250
245
240
235
230
2006
2007
2007
2008
2008
Measured
Basecase
RCH -
KV -
SY +

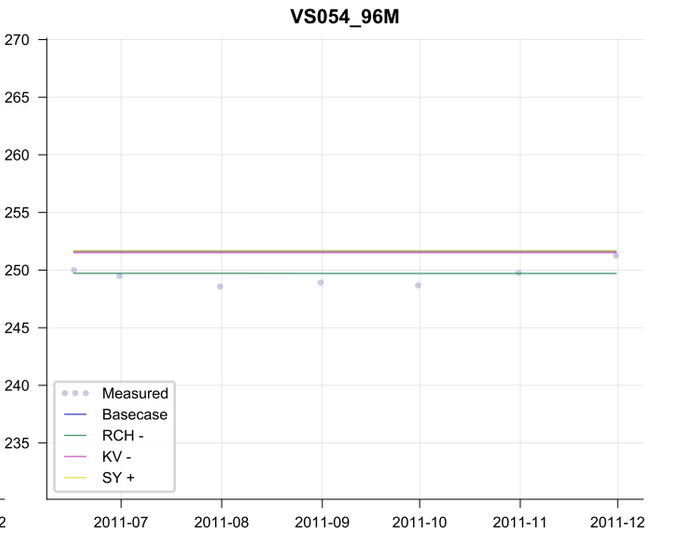

VNW222
Groundwater level (mAHD)
255
250
245
240
235
230
225
220
2006
2007
2007
2008
Year
Measured
Basecase
RCH -
KV -
SY +

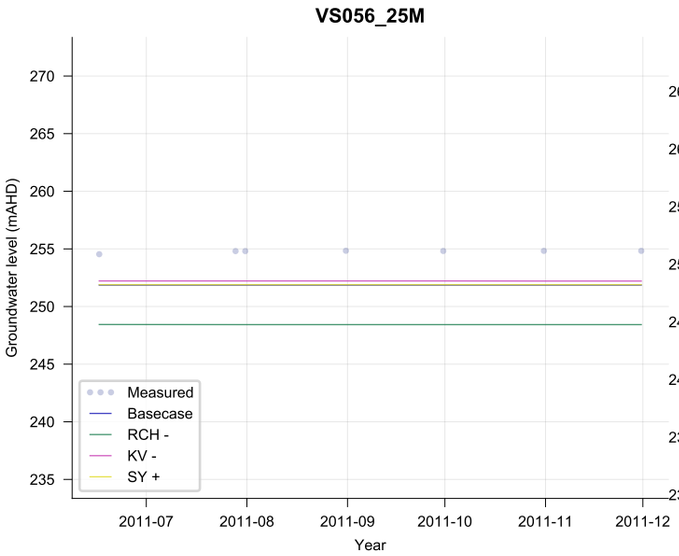

VNW223
260
255
250
245
240
235
230
225
2007
2008
2009
2010
2011
2012
Measured
Basecase
RCH -
KV -
SY +

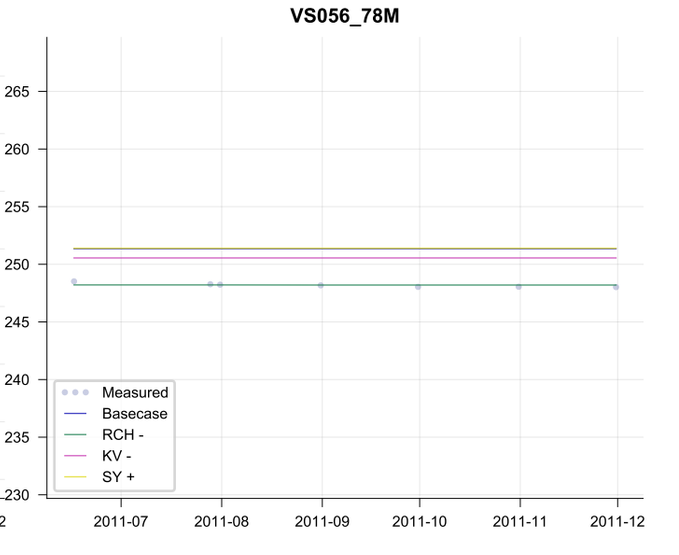

VS048_27M
Groundwater level (mAHD)
260
255
250
245
240
235
230
225
2011-07
2011-08
2011-09
2011-10
2011-11
2011-12
Year
Measured
Basecase
RCH -
KV -
SY +

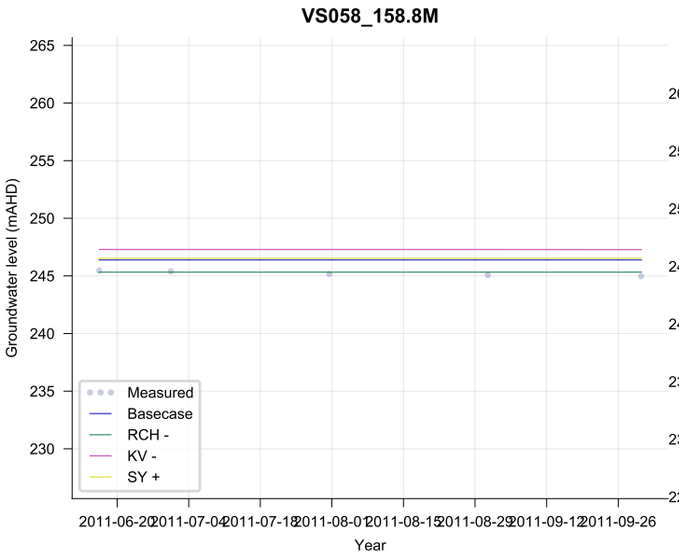

VS054_120M
270
265
260
255
250
245
240
235
2011-07
2011-08
2011-09
2011-10
2011-11
2011-12
Measured
Basecase
RCH -
KV -
SY +

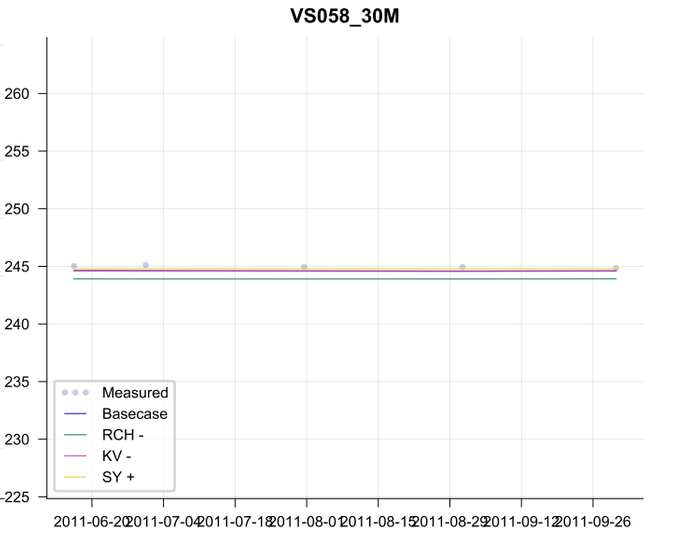

VS054_167M
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

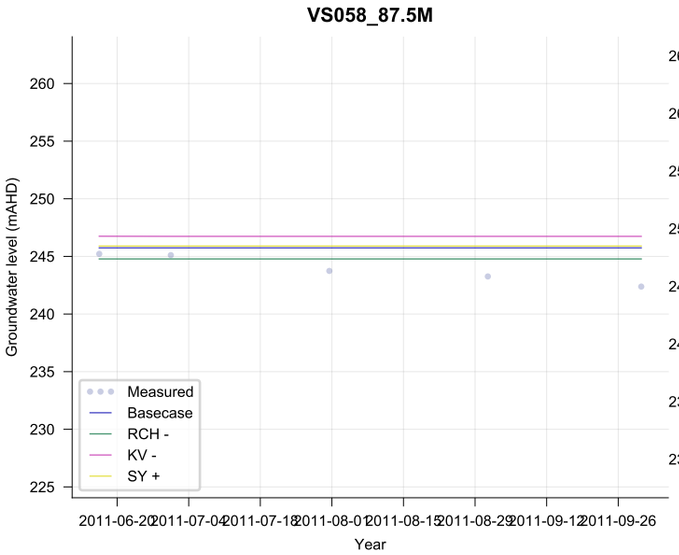

VS054_96M
Measured
Basecase
RCH -
KV -
SY +

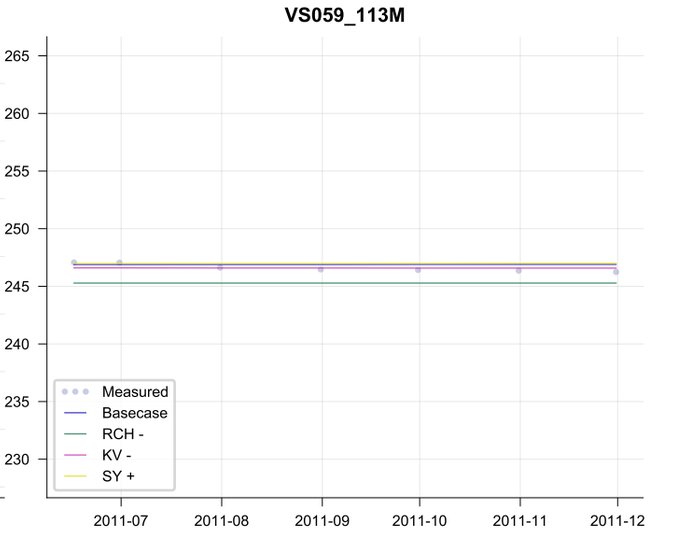

VS056_25M
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

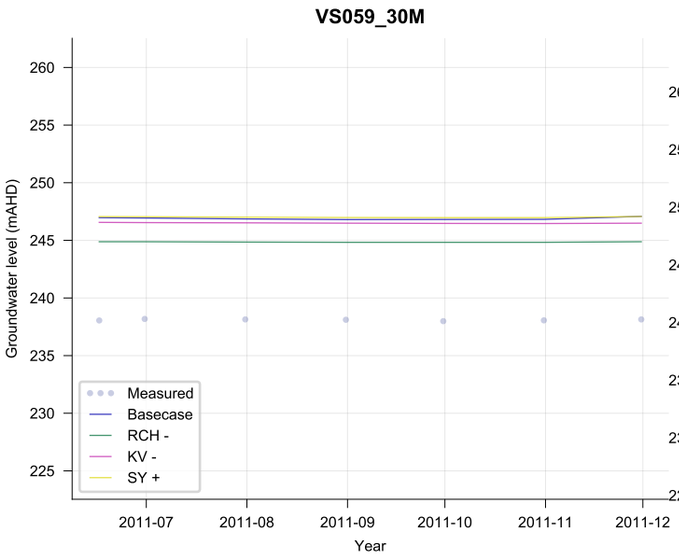

VS056_78M
Measured
Basecase
RCH -
KV -
SY +

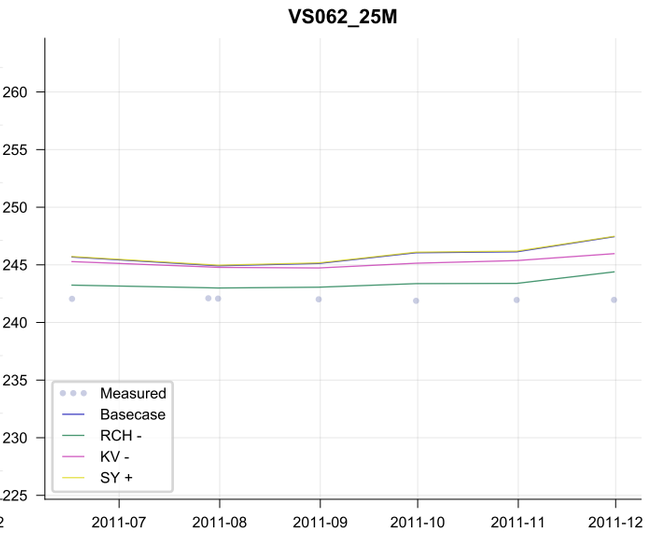

VS058_158.8M
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

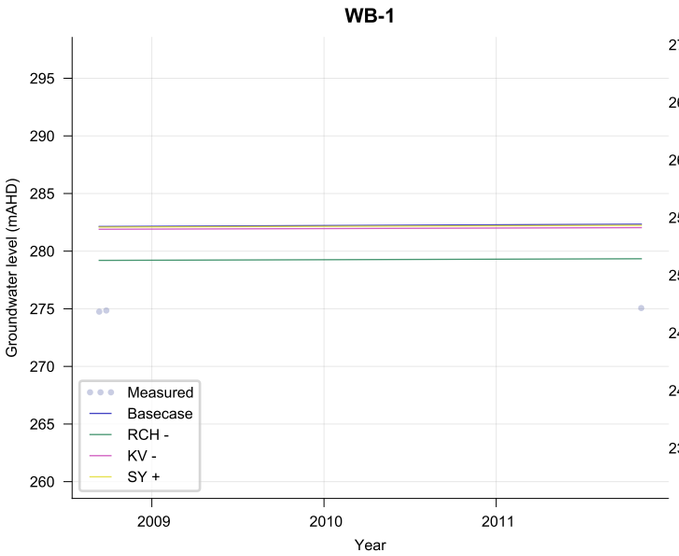

VS058_30M
Measured
Basecase
RCH -
KV -
SY +

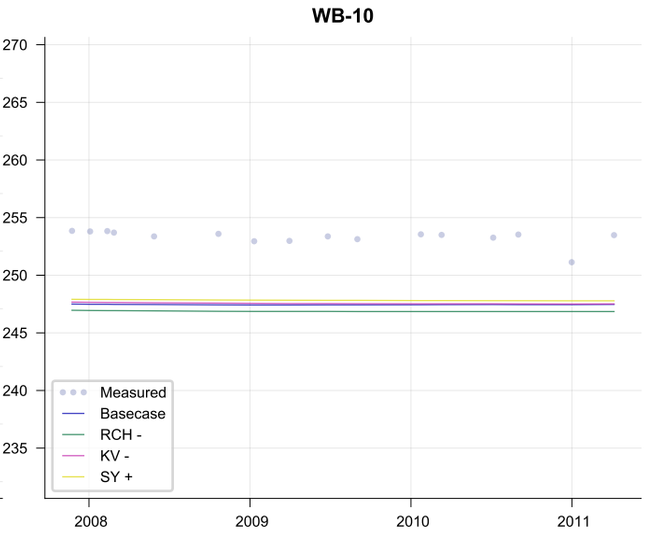

VS058_87.5M
Groundwater level (mAHD)
Year
Measured
Basecase
RCH -
KV -
SY +

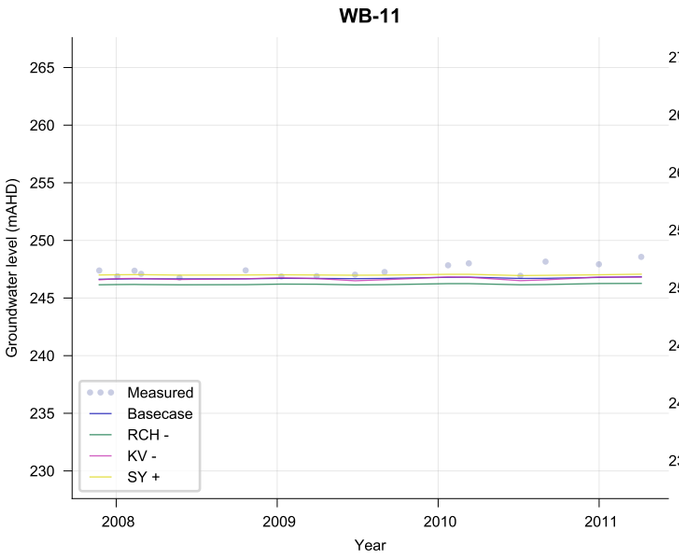

VS059_113M
Measured
Basecase
RCH -
KV -
SY +

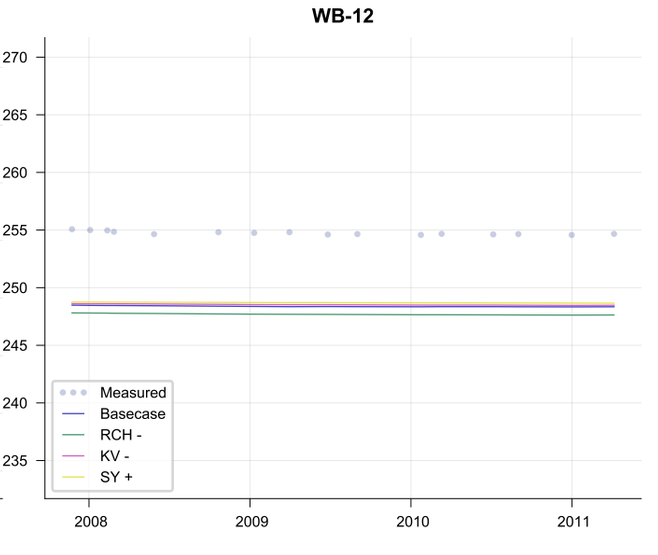

VS059_30M
Groundwater level (mAHD)
260
255
250
245
240
235
230
225
2011-07
2011-08
2011-09
2011-10
2011-11
2011-12
Year
Measured
Basecase
RCH -
KV -
SY +

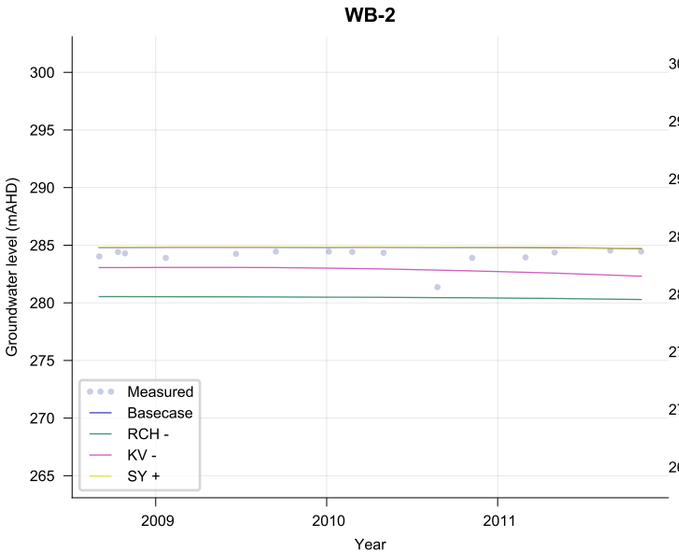

VS062_25M
260
255
250
245
240
235
230
225
2011-07
2011-08
2011-09
2011-10
2011-11
2011-12
Measured
Basecase
RCH -
KV -
SY +

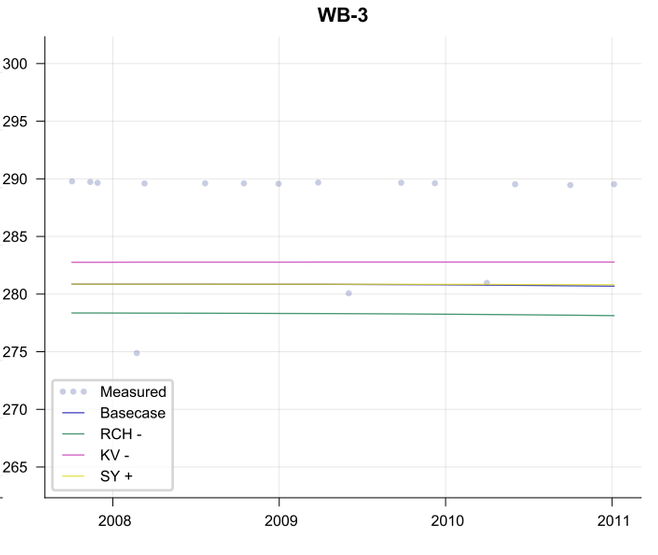

WB-1
Groundwater level (mAHD)
295
290
285
280
275
270
265
260
2009
2010
2011
Year
Measured
Basecase
RCH -
KV -
SY +


WB-10
270
265
260
255
250
245
240
235
2008
2009
2010
2011
Measured
Basecase
RCH -
KV -
SY +


WB-11
Groundwater level (mAHD)
265
260
255
250
245
240
235
230
2008
2009
2010
2011
Year
Measured
Basecase
RCH -
KV -
SY +


WB-12
270
265
260
255
250
245
240
235
2008
2009
2010
2011
Measured
Basecase
RCH -
KV -
SY +


WB-2
Groundwater level (mAHD)
300
295
290
285
280
275
270
265
2009
2010
2011
Year
Measured
Basecase
RCH -
KV -
SY +


WB-3
300
295
290
285
280
275
270
265
2008
2009
2010
2011
Measured
Basecase
RCH -
KV -
SY +