APPENDIX A – ALLUVIAL DRILLING REPORT (ENRS, 2016)

ALLUVIAL DRILLING REPORT

Prepared For:	**Resource Strategies Pty Ltd on behalf of Whitehaven Coal Limited**
Project Number:	**ENRS0509**
Date:	**14th July 2016**

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1 x PDF	ENRS0509.r3_Vickery Extension_Alluvial Drilling Report (RES00746249)	Rev.3	14th Jul. 2016	Resource Strategies on behalf of Whitehaven Coal Limited.

EXECUTIVE SUMMARY

Environment & Natural Resource Solutions (ENRS Pty Ltd) were commissioned as independent hydrogeological consultants in February 2016 by Resource Strategies Pty Ltd on behalf of Whitehaven Coal Limited (the client) to supervise test drilling and construction of a series of monitoring bores to investigate the extent and nature of unconsolidated alluvial and colluvial deposits within the Vickery Extension Project area adjacent the Namoi River. ENRS understand the project is required to support assessments by HydroSimulations of the potential connection between shallow unconsolidated aquifers and the underlying Permian systems.

This report summarises the results of borehole drilling, geophysical wireline logging, monitoring bore construction, field observations and water quality analysis during one (1) Site mobilisation between the 6th and 16th of February 2016.

The objectives of the project were to:

- Conduct test drilling to investigate the depth and boundary of alluvial deposits, if any;
- Correlate drilling observations with previous TEM Geophysics survey; and
- Construct groundwater monitoring bores and conduct baseline water quality monitoring.

The scope of work for this groundwater investigation comprised the following tasks:

- ENRS hydrogeologist to supervise test drilling by client drilling contractor and review drill cuttings/chips logged by client geologist. Where drilling methods permit record the depth, yield and water quality of any aquifer intercepts;
- Compare drilling observations and wireline logging records in the field and prepare monitoring bore construction design. Position slotted casing adjacent alluvial aquifers or the primary coal seam, if present. Supervise construction by drilling contractor and record final installation details;
- Develop monitoring bores by airlifting with air compressor to remove any remnant drilling muds and sediment;
- Conduct groundwater sampling in monitoring bores to acquire representative grab samples with bailers 24 hours after development;
- Submit samples to NATA accredited laboratory for major chemistry and baseline analysis; and
- Compile investigation results and prepare drilling investigation report.

Based on the findings made during the scope of works the following conclusions and recommendations are provided:

- Drilling and borehole investigations were conducted between the 5th and 16th of February 2016 to further the delineation of alluvial deposits within the project area;

- Test drilling was undertaken at seven (7) pre-selected sites A1-A4, B, C, and D to groundtruth a recent TEM geophysical survey. Drill cuttings and wireline geophysical logs were definitive in identifying the presence of alluvial deposits at two (2) sites:
  - Site A1 alluvial clay and silt 0-6m. Dry with no groundwater;
  - Site A2-A4 no alluvium intersected. Thin clay deposits observed in A2 (0-6m) and A3 (0-3.5m) are consistent with colluvial deposits on the lower slopes of the surrounding landform;
  - ***Site B*** clayey ***alluvium*** with low groundwater yields ***0 - 20.5 m***;
  - Site C no alluvium intersected; and
  - ***Site D alluvium 0 - 57.25 m***.
- Monitoring bores were constructed by *Manion Drilling* licensed water bore drillers with screen positions designed by *ENRS* and *WHC* to target alluvial aquifers and the Cranleigh (CNW) coal seams where present. A nested piezometer was only installed at Site A1 as no coal measures were identified underlying the alluvial deposits at Site B and Site D; and
- The investigation program has met the project objectives supporting the delineation of an alluvial boundary between sites A1 and B as documented in the TEM survey report.

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1.0 INTRODUCTION

Environment & Natural Resource Solutions (ENRS Pty Ltd) were commissioned as independent hydrogeological consultants in February 2016 by Resource Strategies Pty Ltd on behalf of Whitehaven Coal Limited (the client) to supervise test drilling and construction of a series of monitoring bores to investigate the extent and nature of unconsolidated alluvial and colluvial deposits within the Vickery Extension Project area adjacent the Namoi River. ENRS understand the project is required to support assessments by HydroSimulations of the potential connection between shallow unconsolidated aquifers and the underlying Permian systems.

This report summarises the results of borehole drilling, geophysical wireline logging, monitoring bore construction, field observations and water quality analysis during one (1) Site mobilisation between the 6th and 16th of February 2016.

1.1 OBJECTIVES

The objectives of the project were to;

- Conduct test drilling to investigate the depth and boundary of alluvial deposits, if any;
- Correlate drilling observations with previous TEM Geophysics survey; and
- Construct groundwater monitoring bores and conduct baseline water quality monitoring.

1.2 SCOPE OF WORK

The scope of work for this groundwater investigation comprised the following tasks:

- ENRS hydrogeologist to supervise test drilling by client drilling contractor and review drill cuttings/chips logged by client geologist. Where drilling methods permit record the depth, yield and water quality of any aquifer intercepts;
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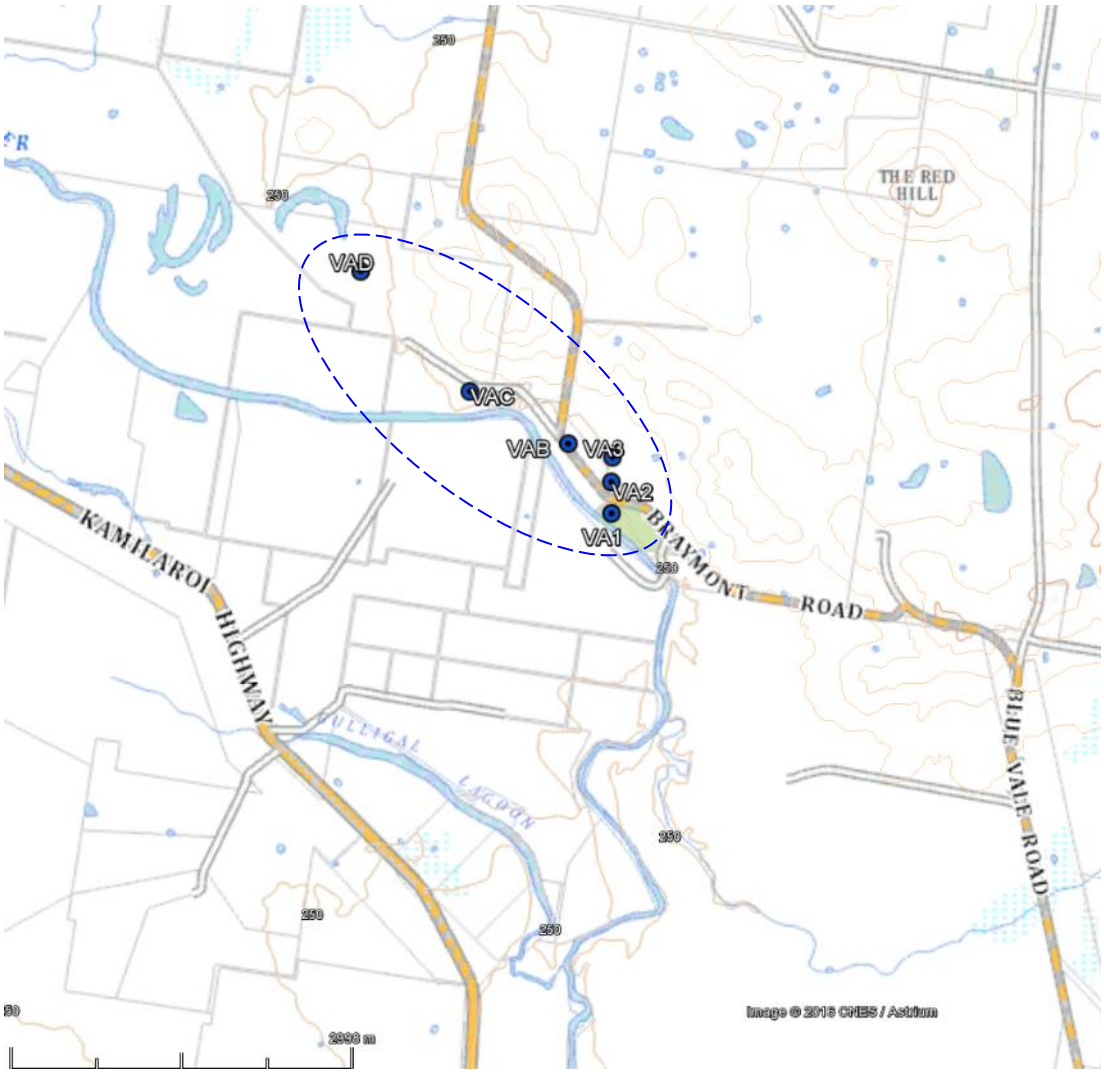
- Develop monitoring bores by airlifting with air compressor to remove any remnant drilling muds and sediment;
- Conduct groundwater sampling in monitoring bores to acquire representative grab samples with bailers 24 hours after development;
- Submit samples to NATA accredited laboratory for major chemistry and baseline analysis; and
- Compile investigation results and prepare drilling investigation report.

2.0 SITE DESCRIPTION

2.1 SITE LOCATION

The drilling investigation site is positioned on the northern side of the Namoi River on Braymont Road approximately 30 kilometres northwest of Gunnedah, as shown in **Figure 1**. ENRS understand borehole locations were pre-selected by the client, HydroSimulations and Resources Strategies to ground truth recent geophysics surveys and the published geology.

Figure 1 Site Location Map



Source: http://maps.six.nsw.gov.au/

2.2 GEOLOGY

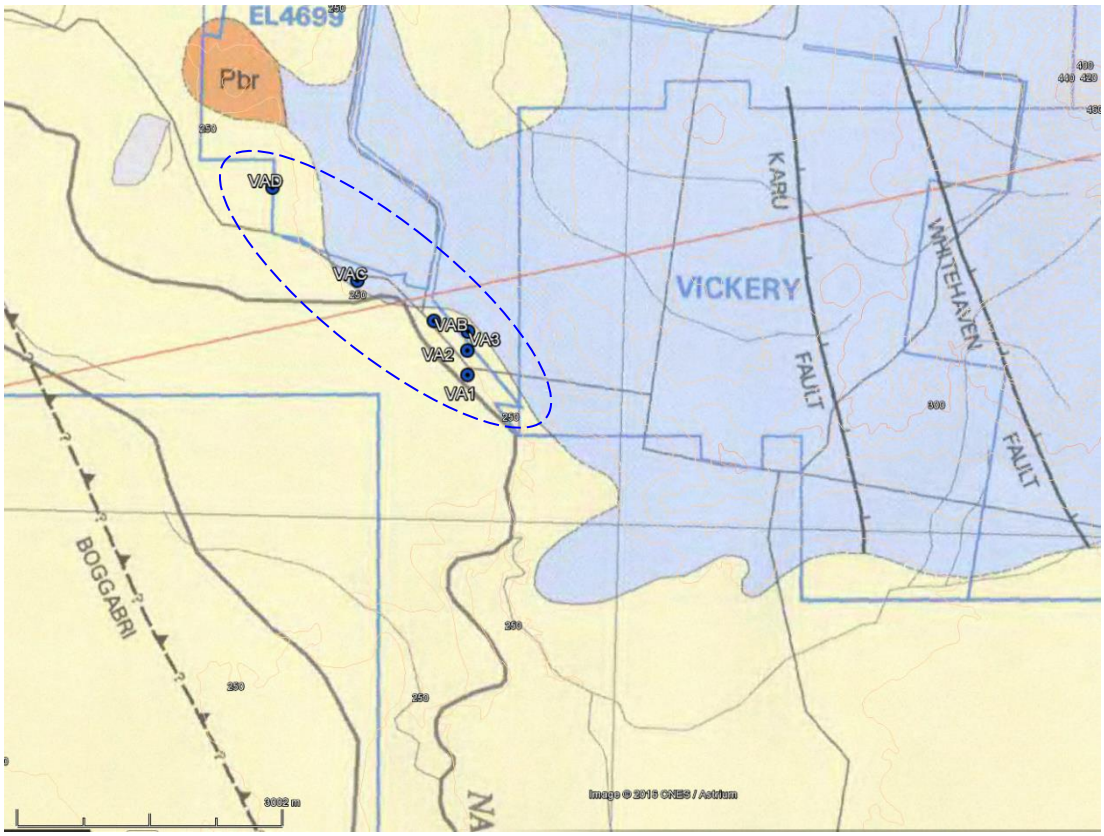
Review of the Gunnedah 1:100,000 series northern coalfield sheet (1998) indicates the bores are located near the margin of undifferentiated quaternary sediments and the Maules Creek formation with outcropping volcanics on the hill north of test bore site 'D'. These alluvial sediments associated with the Namoi River systems can be subdivided into:

- The uppermost Narrabri Formation which consists predominantly of clays with minor sand and gravel beds; and
- The underlying Gunnedah Formation which consists predominantly of gravel and sand with minor clay beds.

Table 1: Stratigraphic Formations

Period	Stratigraphy Formation	Symbol	Lithology
Quaternary	Undifferentiated Sediments -	**Qx**	Undifferentiated alluvial deposits includes Holocene alluvial channels and overbank deposits of sand, silt and clay. Generally does not include residual and veneer colluvial deposits.
Permian	Maules Creek Formation	**Pmx**	Basal carbonaceous claystone, pelletoidal clay sandstone, passing into fining-up cycles of sandstone, siltstone and coal. Conglomerate dominant towards top.
	Boggabri Volcanics	**Pbr**	Rhyolitic to dacitic lavas and ashflow tuffs with interbedded shale, rate trachyte and andesite.

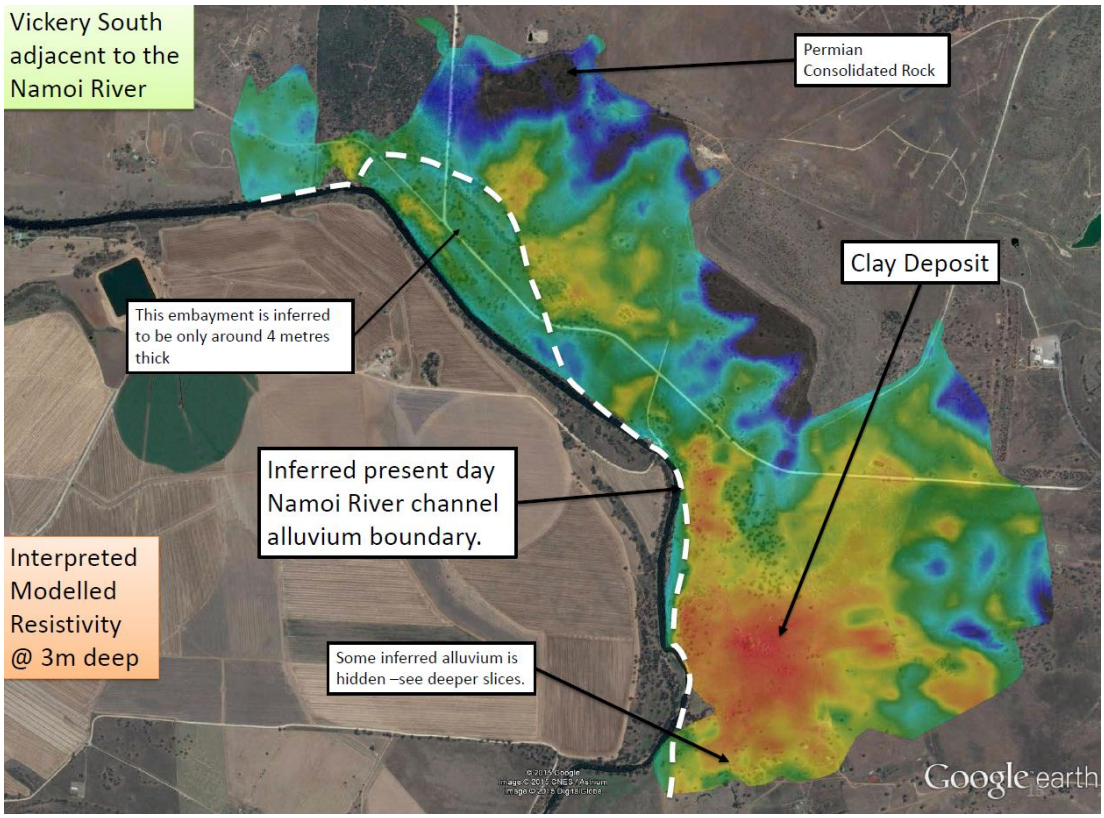
Figure 2 Site Geology



2.3 TEM GEOPHYSICS

A towed transient electromagnetic survey (AgTEM4) was conducted across the area in December 2015 by Ground Water Imaging Pty Ltd (GWI) (**Figure 3**). The survey results were interpreted and documented by Dr David Allen. The survey report provides an assessment of the location and thickness of alluvial deposits and hence potential distribution of unconfined groundwater resources. The reader is referred to the standalone survey report for further discussion of the survey results.

Figure 3 TEM Survey



3.0 PROJECT RESOURCES

3.1 PROJECT MANAGEMENT

The project was managed by Resource Strategies Pty Ltd in consultation with the client. Site inductions, drilling supervision, establishment and rehabilitation requirements were managed by the client.

3.2 DRILLING CONTRACTOR

The drilling contractor for the project was commissioned under separate contract by the client. Drilling and borehole construction was conducted by ***Manion Drilling*** with groundwater bore works supervised by a class 4 licensed water bore driller in accordance with DPI Water requirements.

3.3 GROUNDWATER CONSULTANT

Drilling and borehole construction was overseen by ENRS Hydrogeologist, Rohan Last. Rohan possesses more than ten years industry experience and holds a post graduate qualification in hydrogeology.

4.0 BORE LICENSING

ENRS understand drilling permits and groundwater licences were prepared and lodged by the client.

5.0 DRILLING METHODOLOGY

Test drilling was conducted using a multipurpose rig. Where practical the preferred method was to progress with ***rotary air*** which enables ready identification of aquifer intercepts and airlifting to measure yield and groundwater sample quality. Where necessary water may be injected to flush cuttings from the drill hole. Rotary air and water methods require relatively consolidated ground conditions to prevent hole collapse as the return water and air will erode the borehole. In the absence of suitable casing advance systems to stabilise the hole the multipurpose rig was adjusted to drill with ***rotary mud*** methods. Mud was recirculated through the borehole which slows the rate of recovery and adheres to the walls preventing collapse. Whilst mud drilling proved to be an effective method of maintaining a stable borehole in the alluvial test holes this method limited the collection of aquifer details. ENRS understand the drillers utilised a biodegradable mud commonly used for water bore drilling which is not expected to impact the long term monitoring results. Further interpretation of aquifer positions may be inferred from the geophysical logs and aquifer testing would be required to quantify potential yields and aquifer transmissivity. The following points summarise the investigation methodology:

1) Drill test hole to identify depth of target formations; (i) Alluvium, if any; Permian sequence; and Basement volcanics;
2) Collect bulk samples of drill cuttings at 1 metre (m) intervals or any significant change in stratigraphy. Compile chip trays for project records and document drill log in the field on designated field sheets. Photograph drill cuttings and daily site works;
3) Upon intersection of any water bearing zones, pause drilling, airlift the borehole to estimate the aquifer yield and obtain field measurements of salinity and pH (not possible with mud rotary drilling);
4) Geophysical logging in open holes or drill rods prior to construction or in completed boreholes pending ground conditions. Any potential variation in log response due to completed boreholes may be corrected during data processing; and

5) Construct deep nested piezometer with 6 m slotted casing positioned in the Cranleigh (CNW) coal seams which presents the primary resources for assessment. Construct with 50 millimetre (mm) PVC pressure pipe with bottom cap and slotted 6 m screen at base of bore. Install washed and graded gravel pack to approximately 1 m above the top of the screen. Set bentonite plug above the gravel and grout to the surface;

6) Where alluvium is identified, drill shallow alluvial bore within 5 metre radius. Construct shallow monitoring bore with 6 m slotted screen at the base of the alluvial deposits and surface bentonite seal as per deep borehole. Complete both bores surface concrete pads and lockable standpipes (or consider installing additional ~1.8 m standpipe for identification purposes if land is to be used for cropping);

7) Develop completed bores after grout has set with compressed air to remove at least three to five well volumes;

8) Collect representative water quality samples at least 24 hours after airlifting. Record field parameters EC, pH, DO, Eh, Temp, and submit samples to NATA laboratory for baseline testing of major ion and metals chemistry;

9) Survey final bore heads (top of internal PVC pipe and ground level immediately adjacent to the bore) to mAHD (to be completed by Client. Survey certificate shall be appended to this report); and

10) Establish program of regular monitoring to be confirmed by project manager (installation of loggers, groundwater sampling and laboratory analysis, aquifer testing).

6.0 DOWNHOLE GEOPHYSICS

A suite of downhole geophysical logs were acquired under separate contract by the client in test holes to support delineation of borehole stratigraphy and potential aquifer zones, composite log are provided in **Appendix A**. The following points summarise the key log forms:

- Caliper – measures the actual size of the bore and confirms borehole integrity. The Caliper tool data can be used to assess the borehole stability prior to construction, and confirm the position of fractures or structural features;
- Density – provides a measurement of bulk density of the formation. The effect of any drilling muds can be compensated for by using two detectors with Short Space (SS) and Long Space (LS) with differing spheres of detection. A Density Compensated Log (DCL) was reported for the site;
- Natural Gamma – discriminates between clayey, silty and ‘clean’ sediments from which the lithology can be determined. ‘Clean’ sediments are commonly associated with increased porosity and permeability;
- Neutron – measures the effect of the formation on neutrons emitted from a source. Useful for interpreting porosity. Typical sphere of investigation is several inches. Logs can be influenced by the presence of clay; and

- Resistivity – measures the electrical resistance of the formation, and provides an apparent resistance of any groundwater contained in the formation. Useful for interpreting lithology and porosity.

7.0 MONITORING BORE CONSTRUCTION

Monitoring bores were constructed by *Manion Drilling* licensed water bore drillers with design provided by ENRS Hydrogeologist, Rohan Last, in accordance with the minimum construction requirements for water bores in Australia (3rd ed. 2012).

The position of water entry zones was selected based on drilling observations and interpretation of wireline geophysical logs. The target aquifers for screening were:

- the base of any alluvium and unconsolidated materials; and
- the Cranleigh coal seams at the base of the Permian sequence (CNW).

Records of the borehole construction are documented in the Form A reports with a summary provided in **Table 4**. The bores were constructed with class 18 PVC pressure pipe with 6 m machine slotted casing at the base of the bores. The borehole annulus was filled with 5 mm graded gravel to above the screened zone. Bentonite seals were installed above and below the screened zone and near the surface. Bores were grouted at the surface with a steel monument stand.

8.0 GROUND SURVEY

Bore locations were recorded in the field by the client with a handheld GPS. The sites should be surveyed by a registered surveyor, with certificates attached to the report. Boreheads should be surveyed for elevations reported for the top of PVC casing inside the steel monuments and ground level.

9.0 HYDROGEOLOGY

The following sections outline the key observations and findings from the alluvium and groundwater investigation program.

9.1 AQUIFER INTERCEPTS & YIELD

Test drilling identified variable groundwater conditions in test bores. Where drilling was completed with rotary air methods, 'good' records of aquifer intercepts were obtained. However, where ground conditions required mud rotary methods, aquifer records were limited to observations of airlift yields during development in constructed monitoring bores.

Multiple aquifer zones were intersected in the Maules Creek sedimentary sequences with cumulative air lift yields estimated to be greater than 1 Litres Per Second (LPS) at Site's A1 and A3, whilst poor yields less than <1 LPS were noted at Site A2 and C.

Variable alluvial deposits were encountered at Sites B and D with yields controlled by clay content in sediments. Site B reported low air lift yields less than 1 LPS with a high clay content, whilst site D intersected larger gravel deposits providing an indicative yield greater than 1 LPS.

Aquifer records are summarised in **Table 4** with further assessment of aquifer intercepts supported by review of the borehole geophysics where the shape and response of the wireline log can provide an indication of the porosity and clay content and associated position of aquifers.

9.2 DEPTH TO WATER

The depth to water in the bores was measured on multiple occasions after drilling and development. A summary of field records is provided in **Table 2**.

Table 2: Water Level Records Post Development

Bore ID	Site	SWL mtoc (16/2/2016)	SWL mbgl (16/2/2016)
VNW392WBA	A1	6.67	6.12
VNW392WBB	A1	DRY	DRY
VNW391WBB	A2	8.245	7.695
VNW390WBA	A3	9.81	9.11
VNW389	A4	11.86	11.66
VNW395WBB	B	8.385	7.935
VNW393WBA	C	11.53	10.88
VNW394WBB	D	8.27	7.82

Note: SWL = Standing Water Level.

The water level data demonstrates a relatively high SWL. Further ground survey is required to translate levels into relative levels above the site datum and facilitate comparison of levels across the site. In general, the site is expected to present a minor hydraulic gradient similar to the site topography.

9.3 WATER QUALITY

Baseline water quality sampling was undertaken following purging and borehole stabilisation. Prior to sampling the depth to water was recorded and field measurements obtained using a calibrated TPS multi probe meter. A summary of field parameters is provided in **Table 3** with laboratory results collated in **Table 5**.

Table 3: Summary Field Water Quality

ID	Site	EC µS/cm	pH	FIELD REDOX mV	SHE mV	Temp °C
VNW392WBA	A1	3490	7.4	27	226	23.8
VNW392WBB	A1	-	-	DRY	DRY	DRY
VNW391WBB	A2	2550	7.32	-52	147	22.6
VNW390WBA	A3	2330	7.3	43	242	23.4
VNW389	A4	-	-	NA	NA	NA
VNW395WBB	B	2380	7.3	-232	-33	21.1
VNW393WBA	C	2840	8.07	-21	178	22.7
VNW394WBB	D	5720	7.59	-23	176	22.5

Note: µS/cm = microsiemens per centimetre; mV = millivolts; and °C = degrees Celsius.

Samples were stored on ice and submitted to ALS a NATA accredited laboratory, for analysis. Laboratory Certificates of Analysis (COA) are provided in **Appendix D**.The major ion chemistry was charted in Stiff and Piper diagrams to support an assessment of the degree of similarity between the aquifer chemistry.

The ***Stiff diagram*** (**Figure 4**) plots concentrations in milli-equivalent for cations on the left side of the diagram and anions on the right. Each ion is plotted as a point, and the points are connected to form a polygon. The ions are plotted in a consistent order (Na+K across from Cl; Ca across from HCO3 + CO3; Mg across from SO4) so that each polygon forms a unique signature for the water sample.

The ***Piper diagram*** (**Figure 5**) illustrates the relative concentrations of cations (left diagram) and anions (right diagram) in each sample. The cations are grouped into three (3) major divisions; Sodium (Na+) plus Potassium (K+); Calcium (Ca++); and Magnesium (Mg++). Whilst the Anions are similarly grouped into three major categories; Bicarbonate (HCO3-) plus Carbonate (CO3--); Sulfate (SO4--); and Chloride (Cl-).

Review of the major chemistry diagrams indicates groundwater samples distinct with some degree of similarity in the overall distribution of ions.

Figure 4 Stiff Diagram

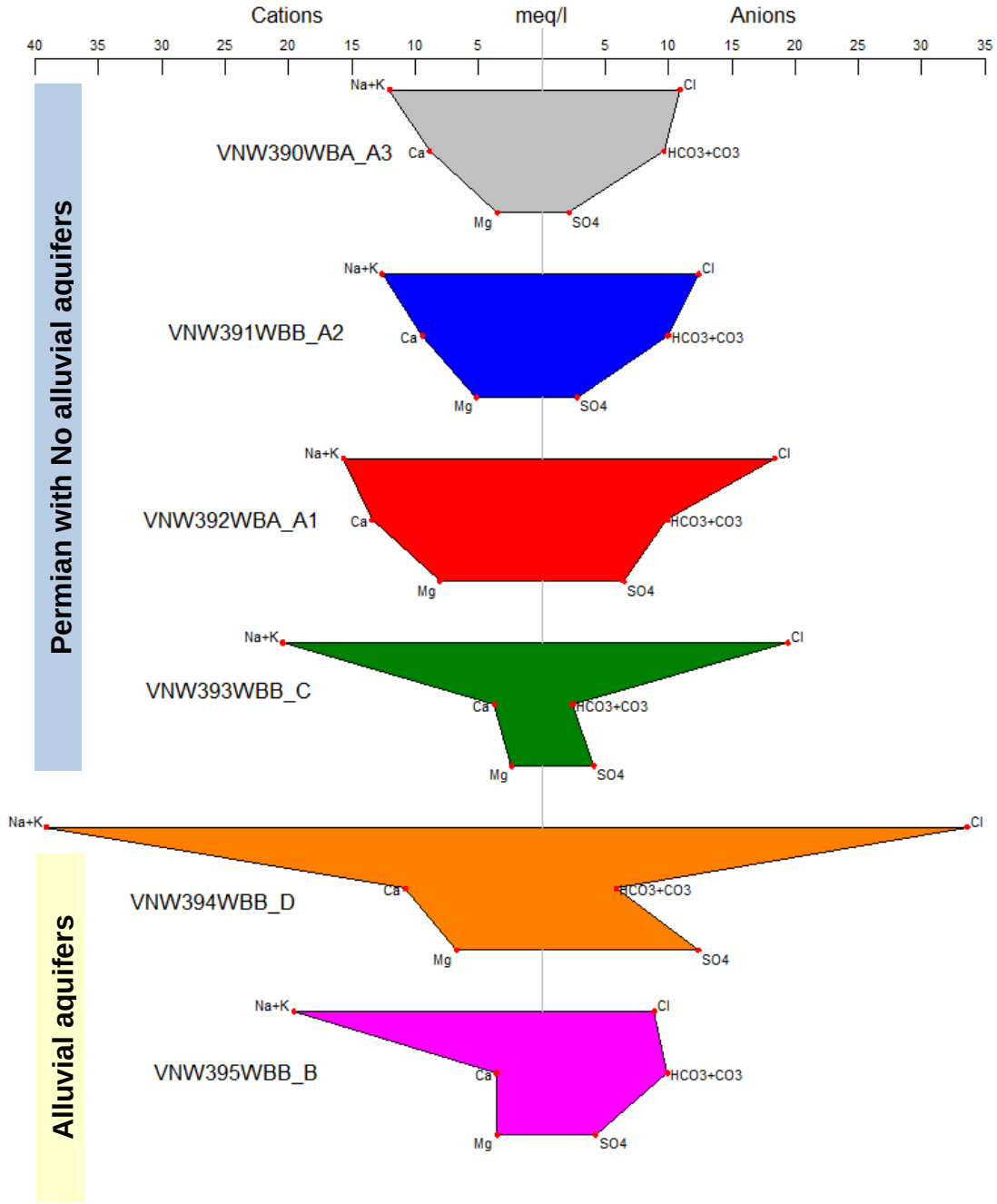
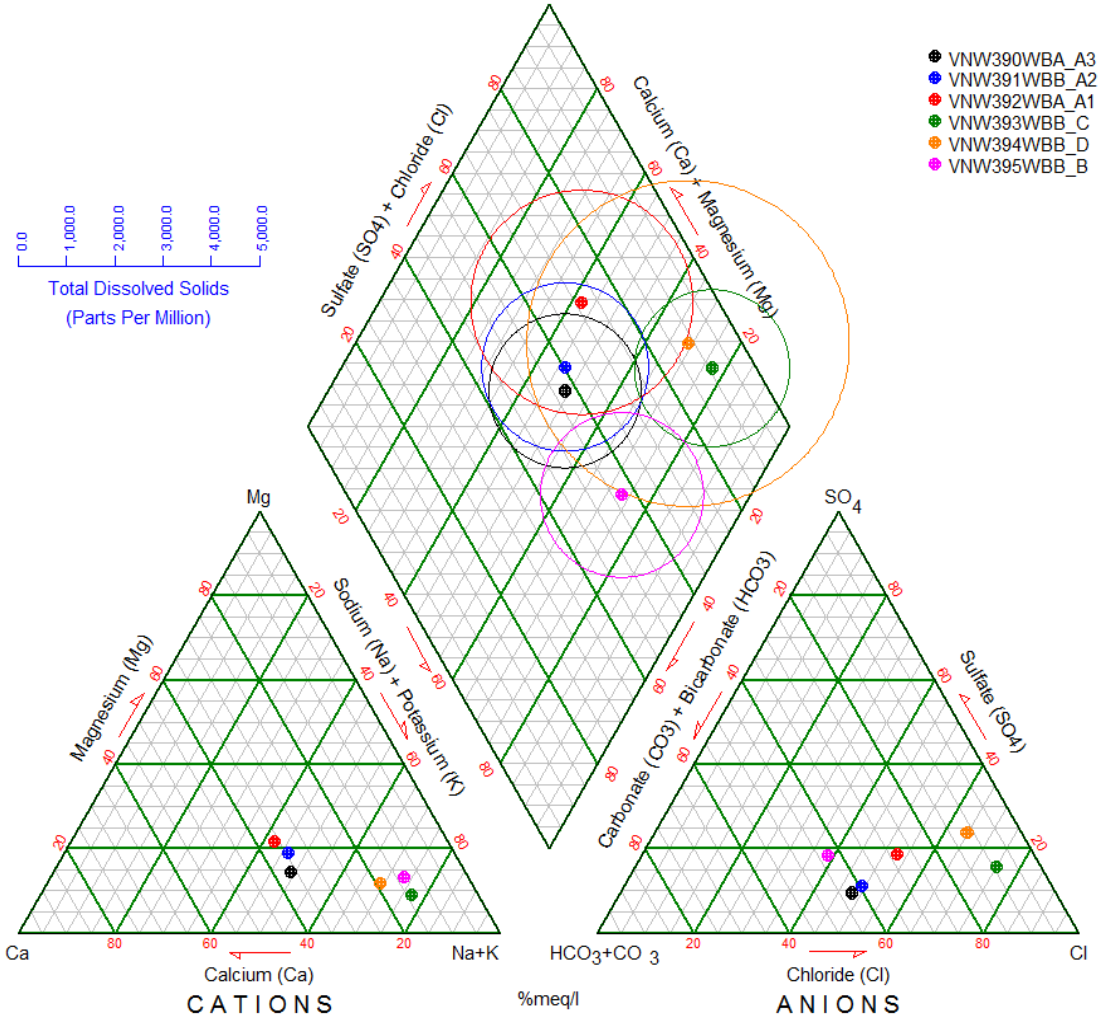


Figure 5 Piper Diagram



10.0 CONCLUSIONS & RECOMMENDATIONS

Based on the observations made during the scope of works the following conclusions and recommendations are provided:

- Drilling and borehole investigations were conducted between the 5th and 16th of February 2016 to further the delineation of alluvial deposits within the project area;
- Test drilling was undertaken at seven (7) pre-selected sites A1-A4, B, C, and D to groundtruth a recent TEM geophysical survey. Drill cuttings and wireline geophysical logs were definitive in identifying the presence of alluvial deposits at two (2) sites:
  - Site A1 alluvial clay and silt 0-6m. Dry with no groundwater;
  - Site A2-A4 no alluvium intersected. Thin clay deposits observed in A2 (0-6m) and A3 (0-3.5m) are consistent with colluvial deposits on the lower slopes of the surrounding landform;
  - ***Site B*** clayey ***alluvium*** with low groundwater yields ***0 - 20.5 m***;
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  - ***Site D alluvium 0 - 57.25 m***.
- Monitoring bores were constructed by *Manion Drilling* licensed water bore drillers with screen positions designed by *ENRS* and *WHC* to target alluvial aquifers and the Cranleigh (CNW) coal seams where present. A nested piezometer was only installed at Site A1 as no coal measures were identified underlying the alluvial deposits at Site B and Site D;
- Upon completion, monitoring bores were developed by airlifting and allowed to stabilise prior to sampling. Baseline water chemistry samples analysed by ALS report clear variation between alluvial and Permian aquifers;
- The investigation programme has met the project objectives supporting the delineation of an alluvial boundary between sites A1 and B as documented in the TEM survey report;
- ENRS recommend the boreheads be surveyed to relative levels to facilitate ongoing water level assessment. The bores may also be fitted with automated data loggers to compare the water level response to rainfall events between alluvial and Permian aquifers to consider the degree of connection with surface processes. Should the client require quantitative assessment of aquifer properties in the bores a program of falling head tests may be conducted to calculate hydraulic conductivity (K) values; and
- This report must be read in conjunction with the Statement of Limitations in Section 12.0.

11.0 REFERENCES

Australian Government National Water Commission (2012). Minimum Construction Requirements for Water Bores in Australia (third Edition).

Murray-Darling Basin Commission 1997, Murray-Darling Basin Groundwater Quality Sampling Guidelines, Technical Report No. 3, MDBC Groundwater Working Group, Commonwealth of Australia.

New South Wales Department of Industry Resources and Energy (1998). Gunnedah Coalfield (North) Regional 1:100,000 Geology Map.

Standards Australia 1998a, AS/NZS 5667.1:1998 Water quality sampling guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples

Standards Australia, New South Wales. 1998b, AS/NZS 5667.11:1998 Water Quality Sampling Guidance on Sampling of Groundwaters, Standards Australia, New South Wales.

12.0 LIMITATIONS

This report and the associated services performed by ENRS are in accordance with the scope of services set out in the contract between ENRS and the Client. The scope of services was defined by the requests of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to Site.

ENRS derived the data in this report primarily from visual inspections, and, limited sample collection and analysis made on the dates indicated. In preparing this report, ENRS has relied upon, and presumed accurate, certain information provided by government authorities, the Client and others identified herein. The report has been prepared on the basis that while ENRS believes all the information in it is deemed reliable and accurate at the time of preparing the report, it does not warrant its accuracy or completeness and to the full extent allowed by law excludes liability in contract, tort or otherwise, for any loss or damage sustained by the Client arising from or in connection with the supply or use of the whole or any part of the information in the report through any cause whatsoever.

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The data, findings, observations, conclusions and recommendations in the report are based solely upon the state of Site at the time of the investigation. The passage of time, manifestation of latent conditions or impacts of future events (e.g. changes in legislation, scientific knowledge, land uses, etc) may render the report inaccurate. In those circumstances, ENRS shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of the report.

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It is the responsibility of the Client to accept if the Client so chooses any recommendations contained within and implement them in an appropriate, suitable and timely manner.

FIGURES

Figure 6 Monitoring Bore Location Map

LEGEND

Historic Mining Area

Extension Project Components

Extent of Open Cut

Extent of Out of Pit Waste Rock Emplacement

Infrastructure Area

Drilling Site

Source: Orthophoto - Department of Land and Property Information, Aerial Photography Flown (July 2011); Department of Industry (2015)

WHITEHAVEN COAL

VICKERY EXTENSION PROJECT

Monitoring Bore Location Map

Figure 6

WHC-15-33_EIS GW AppA_201B

TABLES

BORE	SITE	East - GPS	North - not surveyed	RL_MAHD	DATE_CONSTRUCTED	DRILLED_DEPTH	METHOD	HOLE_DIAMETER_MM	GEOLOGY	CNW_TARGET_SEAM	AQUIFER_DEPTHS	ESTIMATED_YIELD	PIEZO_DEPTH_MBTOC	PIEZO_DEPTH_MBGL	50MM_PVC_CASING	SCREEN_0.5MM	SUMP	GRAVEL_A	BENTONITE_A	GRAVEL_B	BENTONITE_B	GROUT	PVC_CASING_STICKUP	SWL_MBTOC_16/2/2016	SWL_MBGL_16/2/2016	EC_µS/CM	PH	FIELD_REDOX_MV	CONVERTED_SHE_MV	TEMP
VNW392WBA	A1	228368	6591832	-	12-02-16	66.8	AIR_ROTARY	127	0-3 CLAY 3-6 SILT 6-60.75 PERMIAN 60.75-66 CLAYSTONE	57.59-59.75	10-11 ~0.1LPS 28-28.1 ~0.5LPS	~1.5LPS	61.2	60.65	+0.55-57.2	57.2-60.2	60.2-61.2	62.75-66	61.5-61.2	55.65-61.5	54.65-55.65	0-54.65	0.55	6.67	6.12	3490	7.4	27	226	23.8
VNW392WBB	A1	228368	6591828	-	08-02-16	6	AIR_ROTARY	127	0-3 CLAY 3-6 SILT	NONE	NONE	NA	5.97	5.52	+0.45-2.5	2.5-5.5	NONE	1.5-6.0	0.5-1.5	NA	NA	0-0.5	0.45	DRY	DRY			DRY	DRY	DRY
VNW391WBB	A2	228366	6592074	-	13-02-16	60.4	MUD_ROTARY	127	0-6 CLAY 6-58 PERMIAN 58-62.5 BASEMENT	51.25-53.47	0.9 MOISTURE 15 VERY MOIST >15 ND MUD	~0.1LPS	55.6	55.05	+0.55-51	51-54	54-55	55.55-60.4	54.6-55.55	54.6-50	49-50	0-49	0.55	8.245	7.695	2550	7.32	-52	147	22.6
VNW390WBA	A3	228378	6592280	-	14-02-16	60.5	AIR_ROTARY	127	0-4 CLAY 4-59 PERMIAN 59-60.5 BASEMENT	51.27-53.36	NA	>2LPS	54.03	53.33	+0.7-49.3	49.3-52.3	52.3-53.3	55.5-60.5	54.5-55.5	49-54.5	48-49	0-48	0.70	9.81	9.11	2330	7.3	43	242	23.4
VNW389	A4	228386	6592495	-	NONE	89	AIR_ROTARY	127	0-1 SILT 1-68 PERMIAN 68-70 BASEMENT	51.99-54.29	NA	NA	NOT CONSTRUCTED	NA	5.7	NA	NA	NA	NA	NA	NA	NA	0.2	11.86	11.66			NA	NA	NA
VNW395WBB	B	227966	6592439	-	12-02-16	21	MUD_ROTARY	127	0-5 CLAYEY SILT 5-6.84 SAND 6.84-10.32 GRAVEL 10.32-14.75 CLAY 14.75-20.5 GRAVEL 20.5-60 CONGLOMERATE (PERM) 60-63.5 CLAYSTONE	NONE	NA	<1LPS	20.98	20.53	+0.45-16.5	17.5-20.5	NONE	16.5-21	15.5-16.5	NA	NA	0-15.5	0.45	8.385	7.935	2380	7.3	-232	-33	21.1
VNW393WBA	C	227097	6592857	-	13-02-16	66.5	AIR_ROTARY	127	0-2.2 CLAY 2.2-58.96 PERMIAN 58.96-61.5 CLAYSTONE 61.5-66 BASEMENT VOLCANICS	55.62-56.43	36-63.1 ~0.1LPS 53-53.1 ~?	~0.7LPS	59.2	58.55	+0.65-54.5	54.5-57.5	57.5-58.5	60-66.5	58.5-60	53.5-58.5	52.5-53.5	0-52.5	0.65	11.53	10.88	2840	8.07	-21	178	22.7
VNW394WBB	D	226099	6593880	-	12-02-16	26	MUD_ROTARY	127	0-1 CLAY 1-9.5 SAND 9.5-57.25 CLAYEY GRAVEL 57.25-67 CLAYSTONE 67-69 BASEMENT VOLCANICS	NONE	>16	~1.5LPS	26.35	25.9	+0.45-22	22-25	25-26	19.8-26	18.7-19.8	NA	NA	0-18.7	0.45	8.27	7.82	5720	7.59	-23	176	22.5

TABLE 5: Total Groundwater Quality Monitoring Results
Resource Strategies - Vickery - March 2016

ENVIRONMENT & NATURAL RESOURCE SOLUTIONS

ANZECC 2000 -Trigger Values for Freshwater (Protection of 95% of Species)					-	-	-	-	-	-	-	-	-	-	-	-	-	0.7	6.5-8.0*	2,200	-	55	24 (As III)	370	0.2	1.0 (CrVI)	1.4	-	3.4	1900	0.6	11	11	0.05	8.0
ANZECC 2000 - Primary Industries Guidelines (Irrigation long-term Trigger Value)					-	-	460 (moderate)	-	-	-	-	-	-	700 (moderate)	-	-	-	1300 (low) 2900 (med)	-	5000	100	500	10	100	200	200	2000	200	2.0	200	20	-	2000
Service Station Guidelines (NSW EPA)					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.00	-	-	-	-	-	-
Australian Dringkling Water Guidelines (2011)				Health	-	-	-	-	-	-	-	-	500	-	-	50	-	-	-	-	-	-	10	4000	2.0	50	2000	-	10	500	1.0	20	10	100	-
				Aesthetic	-	-	180	-	-	-	-	-	250	250	-	-	6.5-8.5	-	600	200	-	-	-	-	1000	300	-	100	-	-	-	-	3000
Count	Lab Report.	Sample No.	Site ID	Date Sampled	Calcium - Dissolved	Potassium - Dissolved	Sodium - filterable	Magnesium	Hydroxide Alkalinity (OH-)	Bicarbonate Alkalinity	Carbonate Alkalinity as CaCO3	Total Alkalinity	Sulfate as SO4 - Turbidimetric	Chloride	Nitrite as N	Nitrate as N	pH - Lab	Electrical Conductivity - Lab	Total Dissolved Solids	Aluminium - Dissolved	Arsenic - Dissolved	Boron-Dissolved	Cadmium - Dissolved	Chromium - Dissolved	Copper - Dissolved	Iron - Dissolved	Lead - Dissolved	Manganese - Dissolved	Mercury - Dissolved	Nickel - Dissolved	Selenium - Dissolved	Silver - Dissolved	Zinc - Dissolved
				Units / Laboratory PQL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pH Units	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Count	Lab Report.	Sample ID		Sample Date	0.5	0.5	0.5	0.5	1	1	1	1	1	1	0.01	0.01	0.1	1	5	0.01	0.002	0.05	0.0001	0.001	0.001	0.05	0.001	0.001	0.0001	0.001	0.1	0.001	0.005
3	ES1603464003	VNW392WBA	A1	16-02-16	269	20	348	98	<1	605	<1	605	311	652	<0.01	<0.01	7.4	3490	2210	<0.01	<0.001	0.08	<0.0001	<0.001	<0.001	<0.05	<0.001	0.078	<0.0001	<0.001	<0.01	<0.001	0.009
2	ES1603464002	VNW391WBB	A2	16-02-16	189	14	282	63	<1	608	<1	608	134	439	<0.01	<0.01	7.32	2550	1440	<0.01	<0.001	0.1	<0.0001	<0.001	<0.001	0.05	<0.001	0.179	<0.0001	0.001	<0.01	<0.001	0.009
1	ES1603464001	VNW390WBA	A3	16-02-16	178	14	268	43	<1	588	<1	588	104	386	<0.01	<0.01	7.3	2330	1400	<0.01	0.002	0.1	<0.0001	<0.001	<0.001	<0.05	<0.001	0.054	<0.0001	0.003	<0.01	<0.001	0.014
6	ES1603464006	VNW395WBB	B	16-02-16	72	7	446	43	<1	605	<1	605	204	315	<0.01	0.04	7.3	2380	2810	0.06	0.002	0.25	<0.0001	<0.001	0.002	<0.05	<0.001	1.13	<0.0001	0.009	<0.01	<0.001	0.027
4	ES1603464004	VNW393WBB	C	16-02-16	75	12	463	29	<1	147	<1	147	197	688	<0.01	<0.01	8.07	2840	1660	0.01	0.001	0.05	<0.0001	0.018	<0.001	<0.05	<0.001	0.001	<0.0001	<0.001	<0.01	<0.001	<0.005
5	ES1603464005	VNW394WBB	D	16-02-16	216	14	891	82	<1	359	<1	359	593	1190	<0.01	<0.01	7.59	5720	3600	<0.01	0.001	0.12	<0.0001	<0.001	<0.001	<0.05	<0.001	1.24	<0.0001	0.007	<0.01	<0.001	0.127

Notes: * ANZECC 2000 - pH Upper and Lower Limit for NSW Lowland Rivers (Table 3.3.2).
Further assessment of heavy metals concentrations should include comparison against site specfic Hardness Modified Trigger Values (HMTV) - Table 3.4.3 ANZECC (2000)

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APPENDICES

Appendix A

Borehole Composite Logs

(note no logs recorded for bore Site A4 where no alluvium was observed)

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PLATE No:A1

LITHOLOGY LEGEND

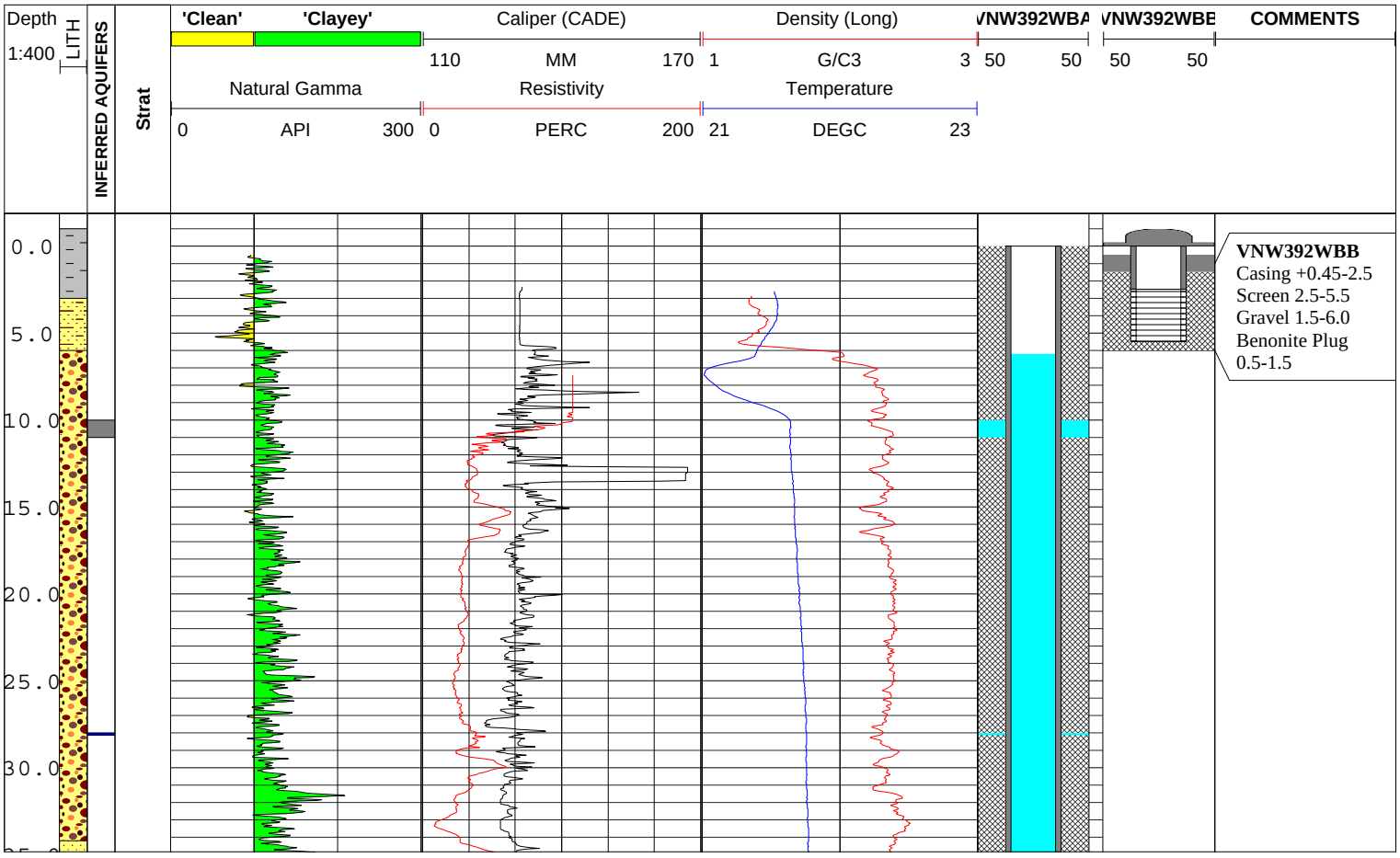
- Clay
- Silt
- Med Sand
- Conglomerate
- Coal

BORE NAME:

Site A1
Bore VNW392WBA

SUMMARY COMPOSITE LOG

Author: Rohan Last	**Date:** 12/2/2016	**Location - MGA Zone:** 55 J	**Fluid Type:** Water
WellCAD File No:	**Project:** ENRS509 Vickery	**Easting:** 228366	**Fluid Salinity:** 3490 uS/cm
Drilled Depth: 66.8m	**Client :** Whitehaven Coal Limited	**Northing:** -	**Fluid Level:** 6.12 mbgl (16/12/14)
Logged Depth:66m	**Drilled:** -	**Logged:** 12/02/16	**Tool:** Century (Ground Search)
Hole Size: 127mm	**Casing:** 50mm Cl18 PVC	**Notes:** +0.55m Casing stick up	



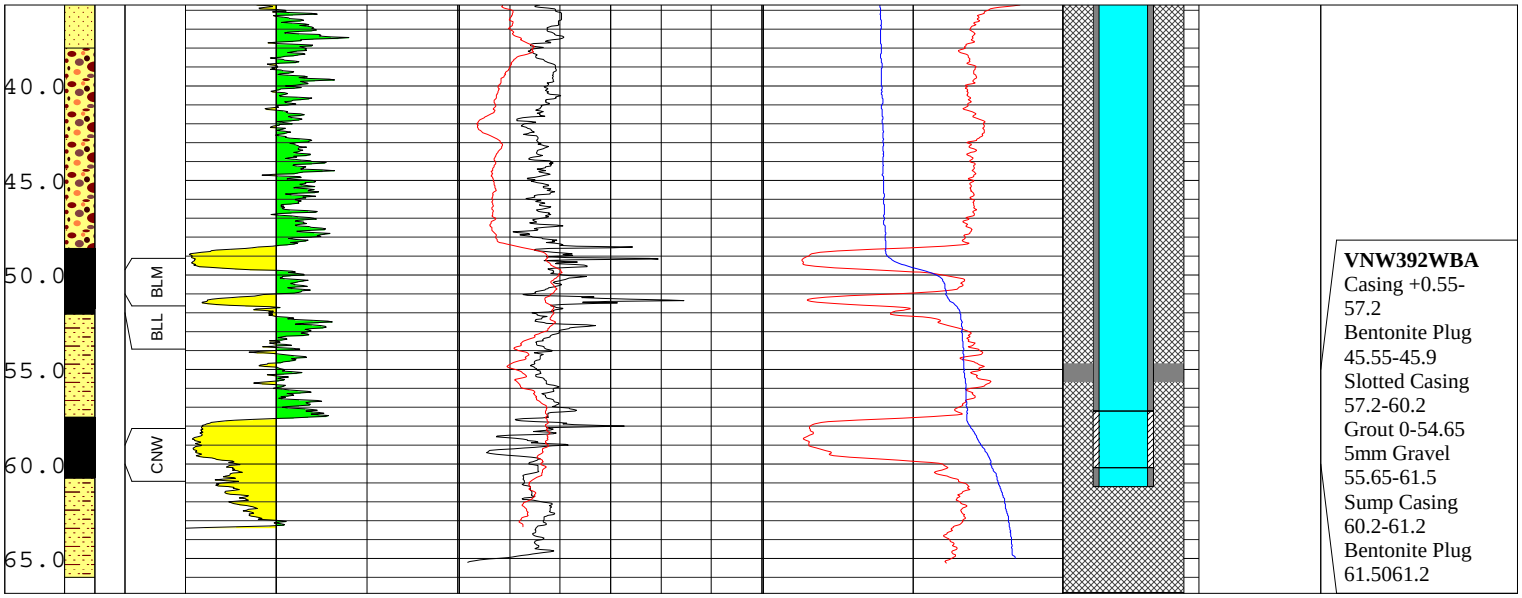

40.0
45.0
50.0
55.0
60.0
65.0
BLM
BLL
CNW
VNW392WBA
Casing +0.55-57.2
Bentonite Plug 45.55-45.9
Slotted Casing 57.2-60.2
Grout 0-54.65
5mm Gravel 55.65-61.5
Sump Casing 60.2-61.2
Bentonite Plug 61.5061.2

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PLATE No:A2

LITHOLOGY LEGEND

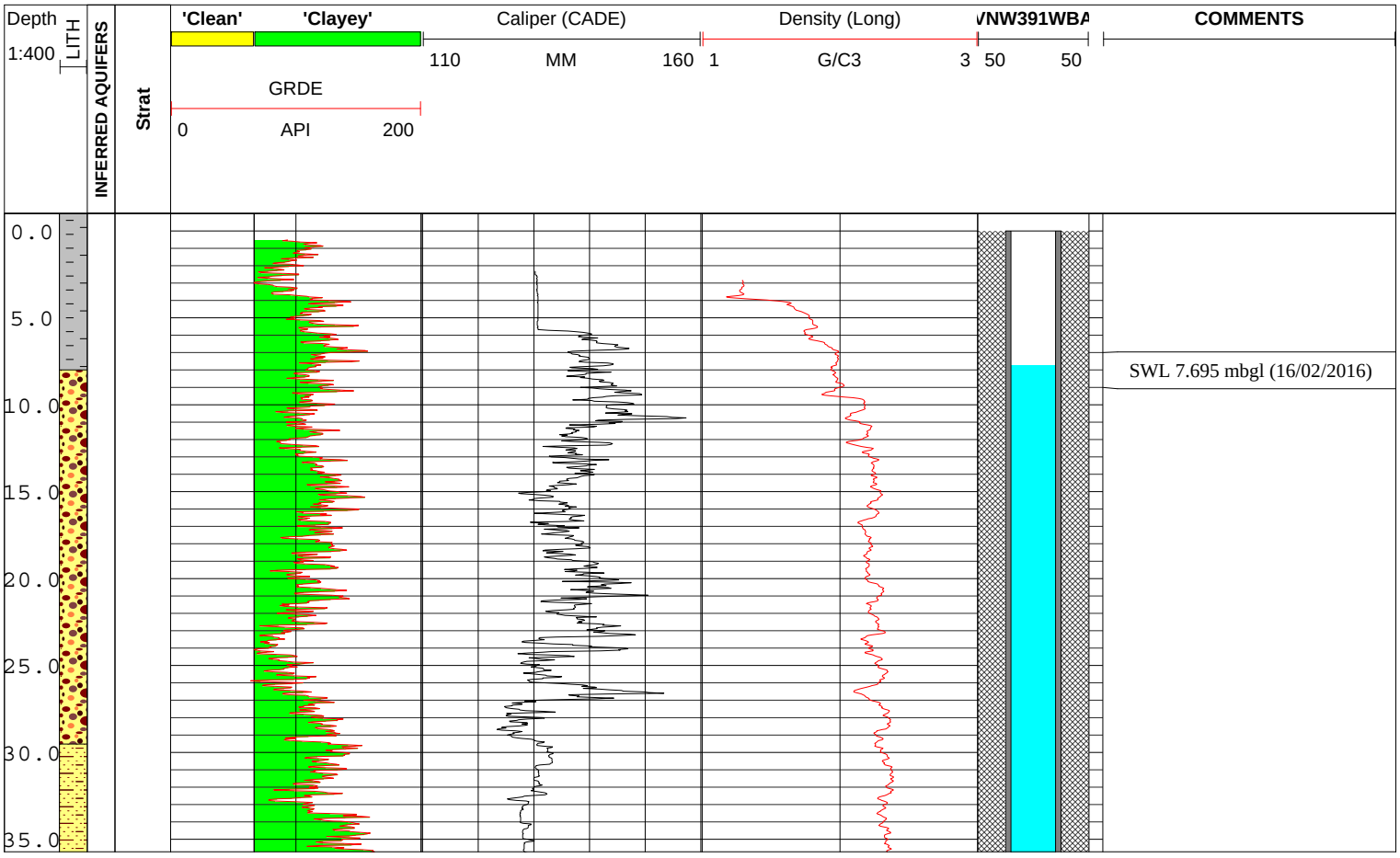
- Clay
- Silt
- Med Sand
- Conglomerate
- Coal

BORE NAME:

Site A2
Bore VNW391WBA

SUMMARY COMPOSITE LOG

Author: Rohan Last	**Date:** 13/2/2016	**Location - MGA Zone:** 55 J	**Fluid Type:** Water
WellCAD File No:	**Project:** ENRS509 Vickery	**Easting:** 228380	**Fluid Salinity:** - uS/cm
Drilled Depth: 60.4	**Client :** Whitehaven Coal Limited	**Northing:** 6592079	**Fluid Level:** 7.695 mbgl (16/12/16)
Logged Depth:60.4	**Drilled:** -	**Logged:** 13/02/16	**Tool:** Air Rotary
Hole Size: 127mm	**Casing:** 50mm Cl18 PVC	**Notes:** +0.55m Casing stick up	



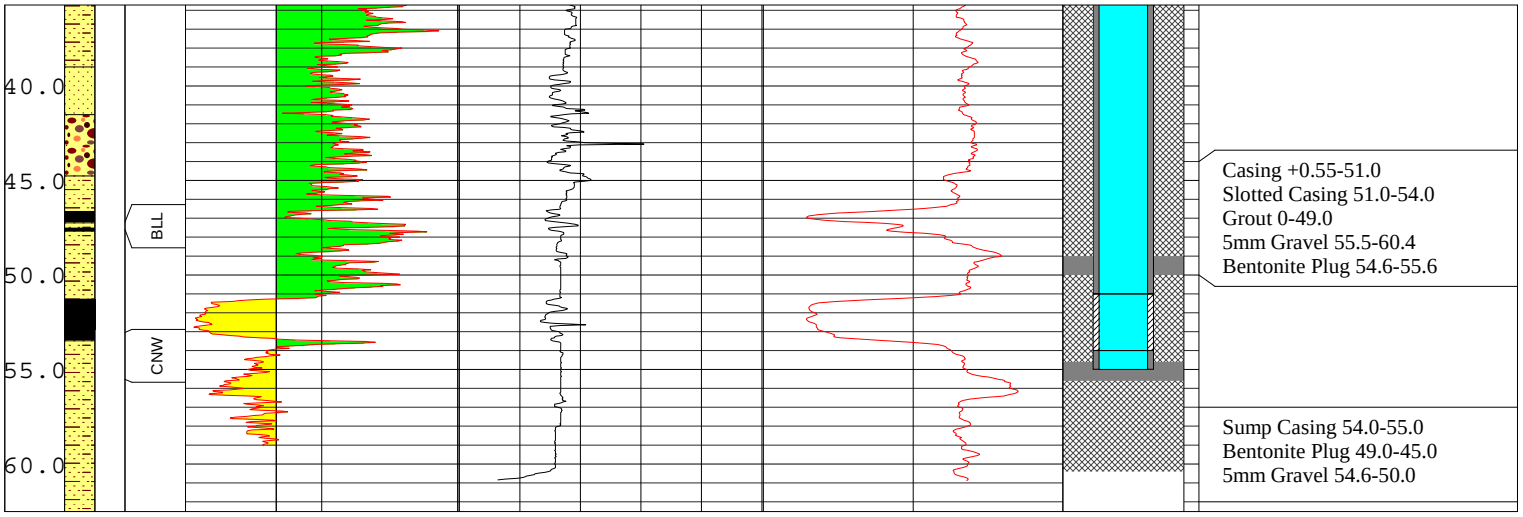

40.0
45.0
50.0
55.0
60.0
BLL
CNW
Casing +0.55-51.0
Slotted Casing 51.0-54.0
Grout 0-49.0
5mm Gravel 55.5-60.4
Bentonite Plug 54.6-55.6
Sump Casing 54.0-55.0
Bentonite Plug 49.0-45.0
5mm Gravel 54.6-50.0

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PLATE No:A3

LITHOLOGY LEGEND

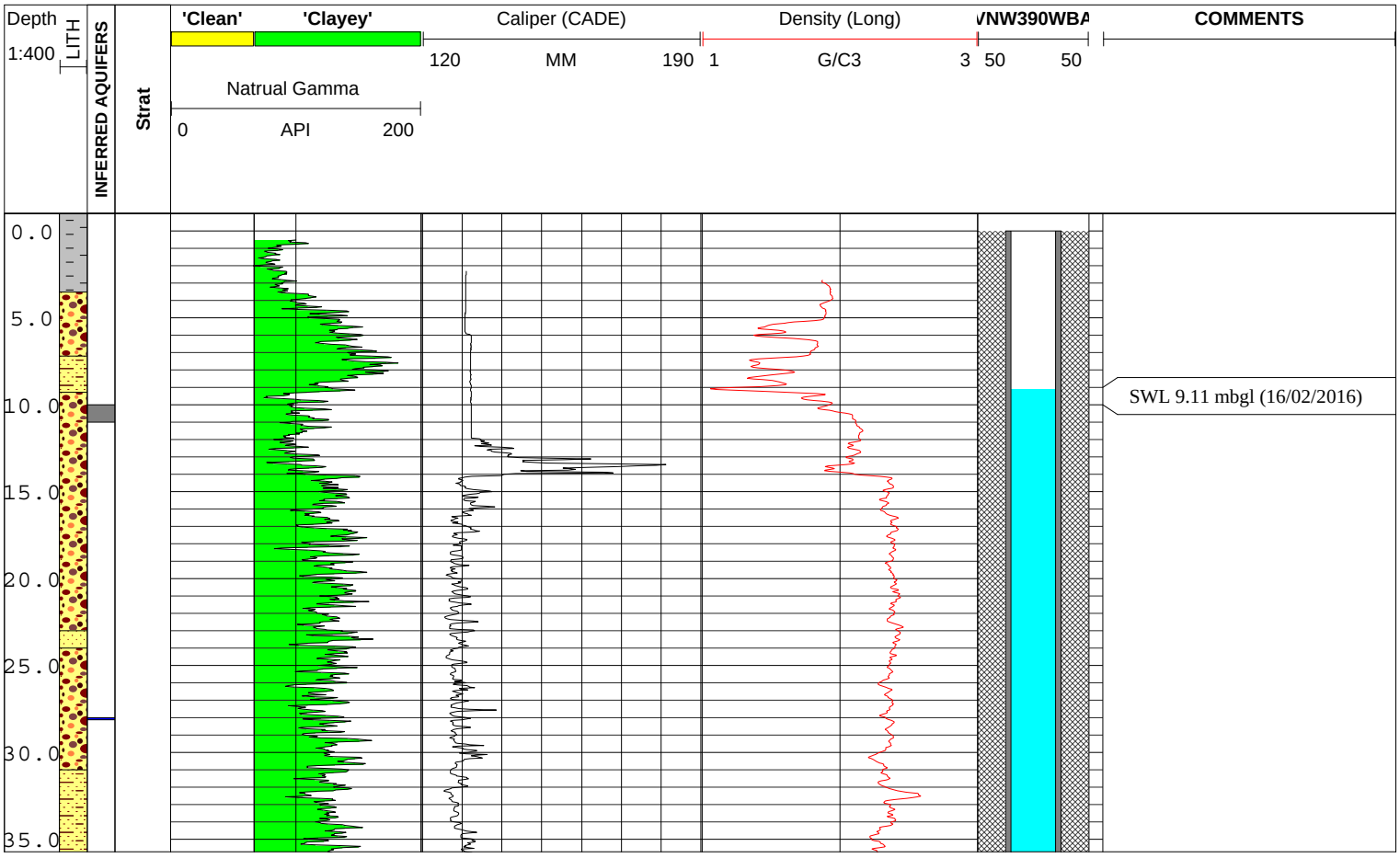
- Clay
- Silt
- Med Sand
- Claystone
- Conglomerate
- Coal

BORE NAME:

Site A3
Bore VNW390WBA

SUMMARY COMPOSITE LOG

Author: Rohan Last	**Date:** 14/2/2016	**Location - MGA Zone:** 55 J	**Fluid Type:** Water
WellCAD File No:	**Project:** ENRS509 Vickery	**Easting:** 228383	**Fluid Salinity:** 2330 uS/cm
Drilled Depth: 60.5	**Client :** Whitehaven Coal Limited	**Northing:** 6592293	**Fluid Level:** 9.11 mbgl (16/12/16)
Logged Depth:60.5	**Drilled:** -	**Logged:** 14/02/16	**Tool:** Air Rotary
Hole Size: 127mm	**Casing:** 50mm Cl18 PVC	**Notes:** +0.55m Casing stick up	



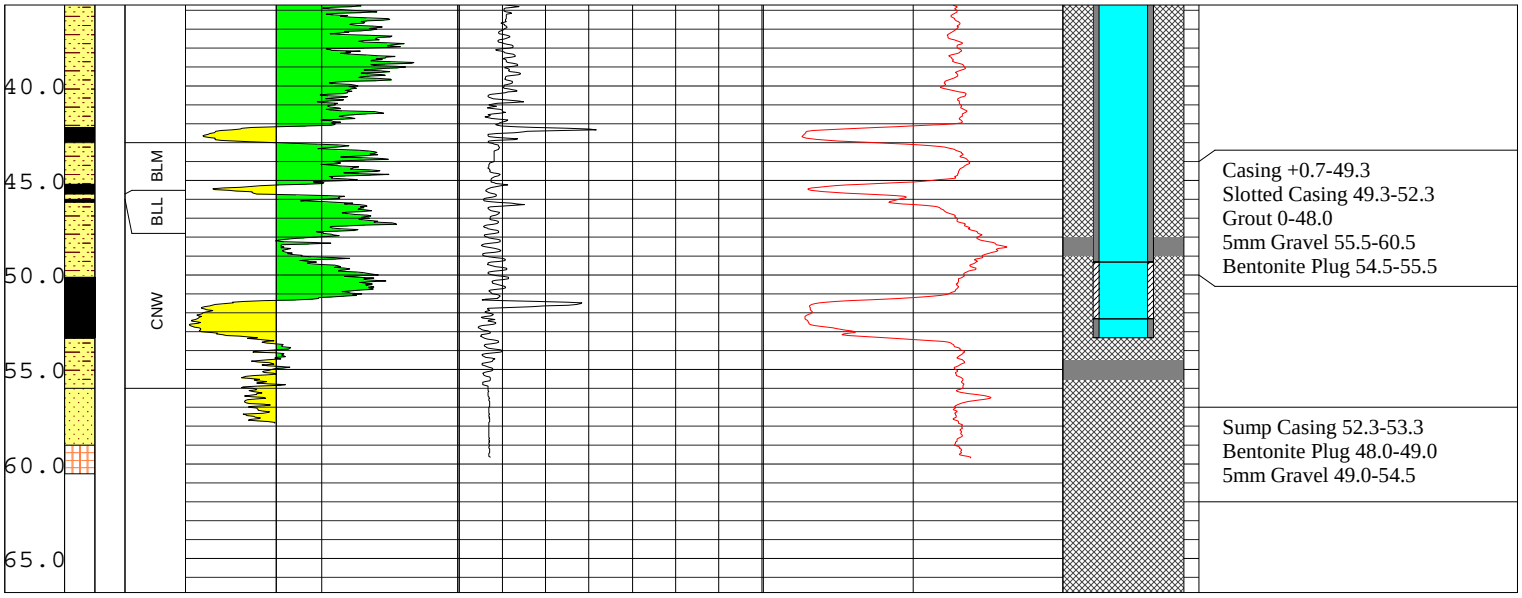

40.0
45.0
50.0
55.0
60.0
65.0
BLM
BLL
CNW
Casing +0.7-49.3
Slotted Casing 49.3-52.3
Grout 0-48.0
5mm Gravel 55.5-60.5
Bentonite Plug 54.5-55.5
Sump Casing 52.3-53.3
Bentonite Plug 48.0-49.0
5mm Gravel 49.0-54.5

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PLATE No: B

LITHOLOGY LEGEND

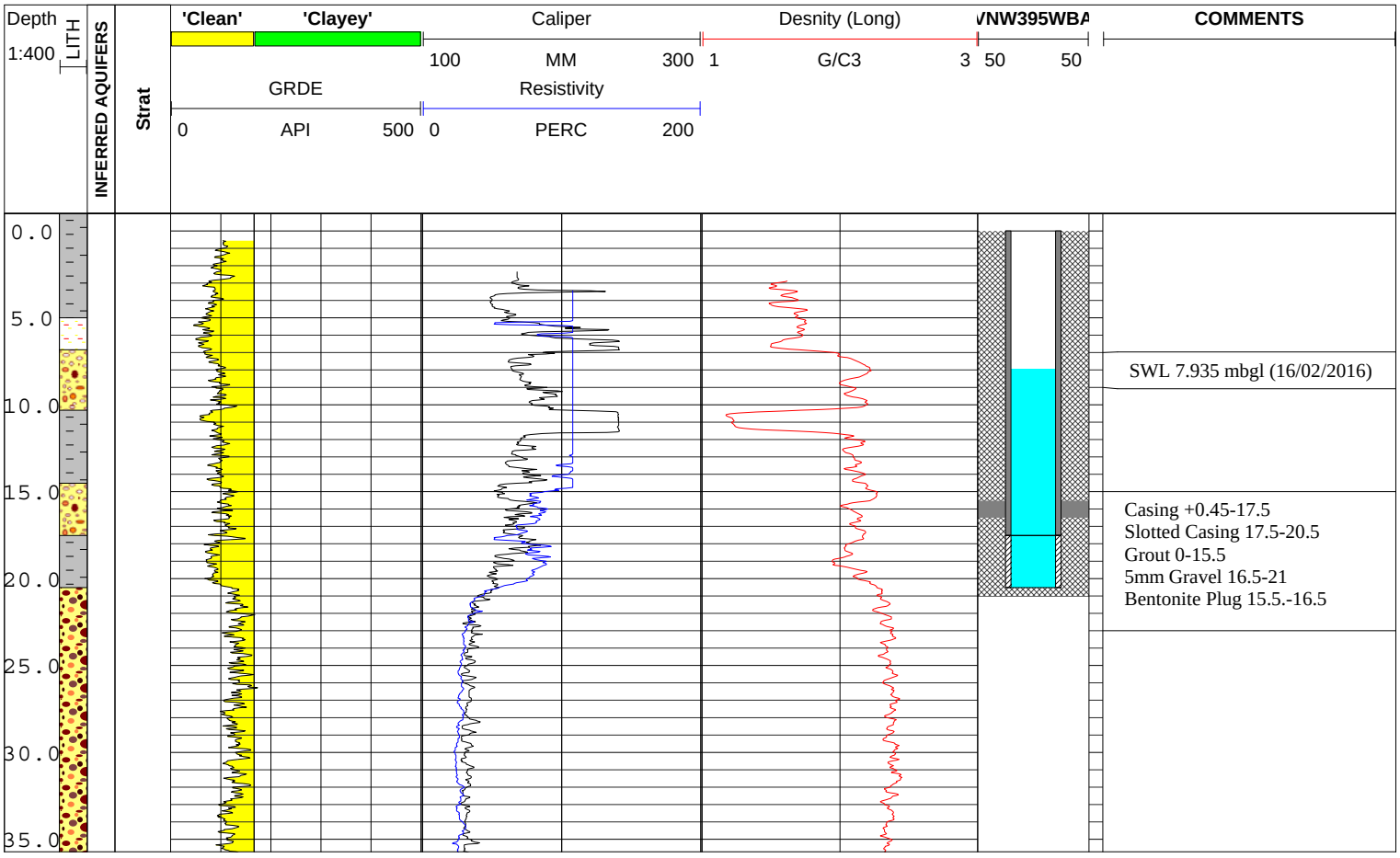
- Clay
- Silt
- Fine Sand
- Fine Gravel
- Claystone
- Conglomerate
- Coal

BORE NAME:

Site D
Bore VNW395WBA

SUMMARY COMPOSITE LOG

Author: Rohan Last	**Date:** 12/2/2016	**Location - MGA Zone:** 55 J	**Fluid Type:** Water
WellCAD File No:	**Project:** ENRS509 Vickery	**Easting:** 227103	**Fluid Salinity:** 2380 uS/cm
Drilled Depth: 63.5	**Client :** Whitehaven Coal Limited	**Northing:** 6592859	**Fluid Level:** 7.935 mbgl (16/12/16)
Logged Depth: 63.5	**Drilled:** -	**Logged:** 12/02/16	**Tool:** Mud Rotary
Hole Size: 127mm	**Casing:** 50mm Cl18 PVC	**Notes:** +0.45m Casing stick up	



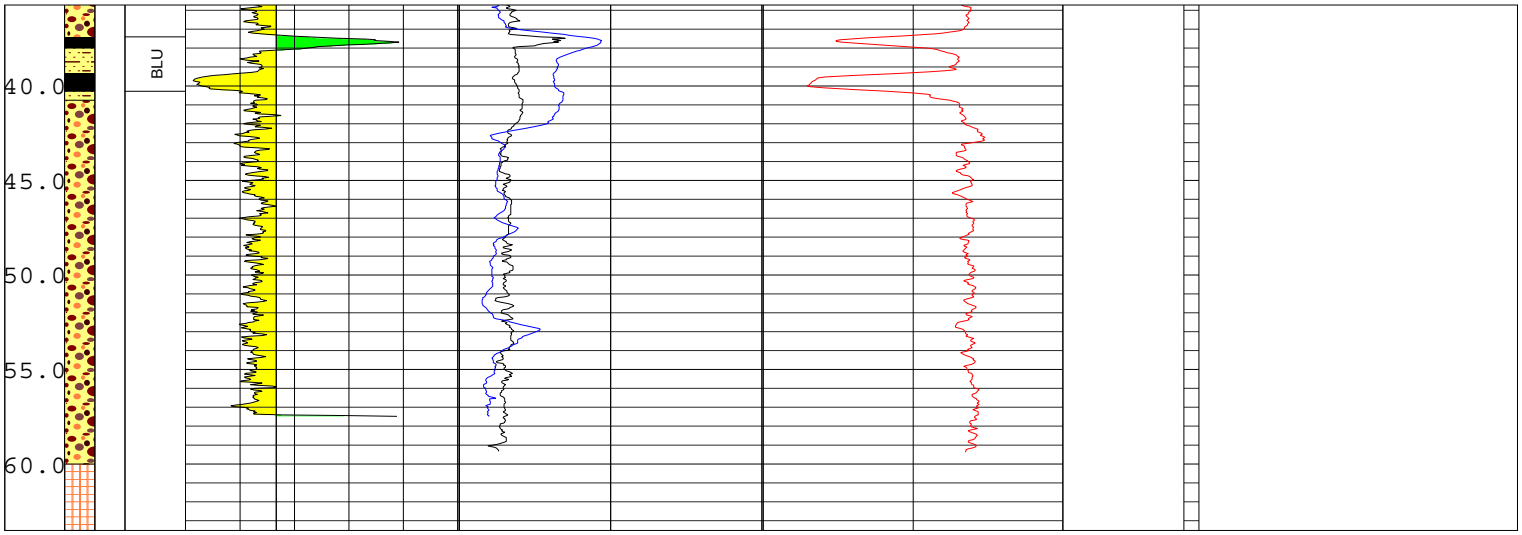

BLU
40.0
45.0
50.0
55.0
60.0

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PLATE No:C

LITHOLOGY LEGEND

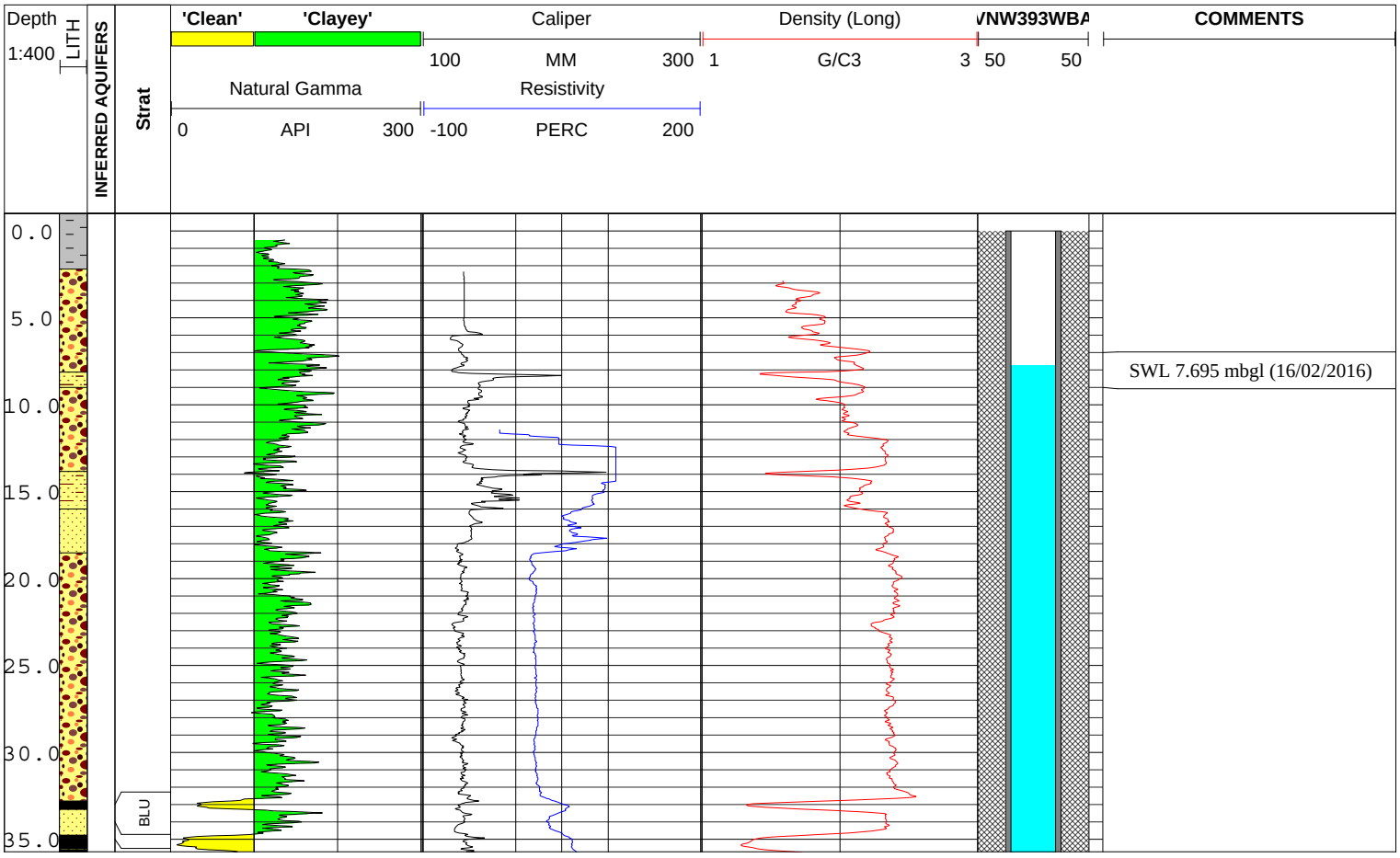
- Clay
- Silt
- Med Sand
- Conglomerate
- Basalt
- Coal

BORE NAME:

Site C
Bore VNW393WBA

SUMMARY COMPOSITE LOG

Author: Rohan Last	**Date:** 13/2/2016	**Location - MGA Zone:** 55 J	**Fluid Type:** Water
WellCAD File No:	**Project:** ENRS509 Vickery	**Easting:** 227103	**Fluid Salinity:** - uS/cm
Drilled Depth: 60.4	**Client :** Whitehaven Coal Limited	**Northing:** 6592859	**Fluid Level:** 7.695 mbgl (16/12/16)
Logged Depth:60.4	**Drilled:** -	**Logged:** 13/02/16	**Tool:** Air Rotary
Hole Size: 127mm	**Casing:** 50mm Cl18 PVC	**Notes:** +0.55m Casing stick up	



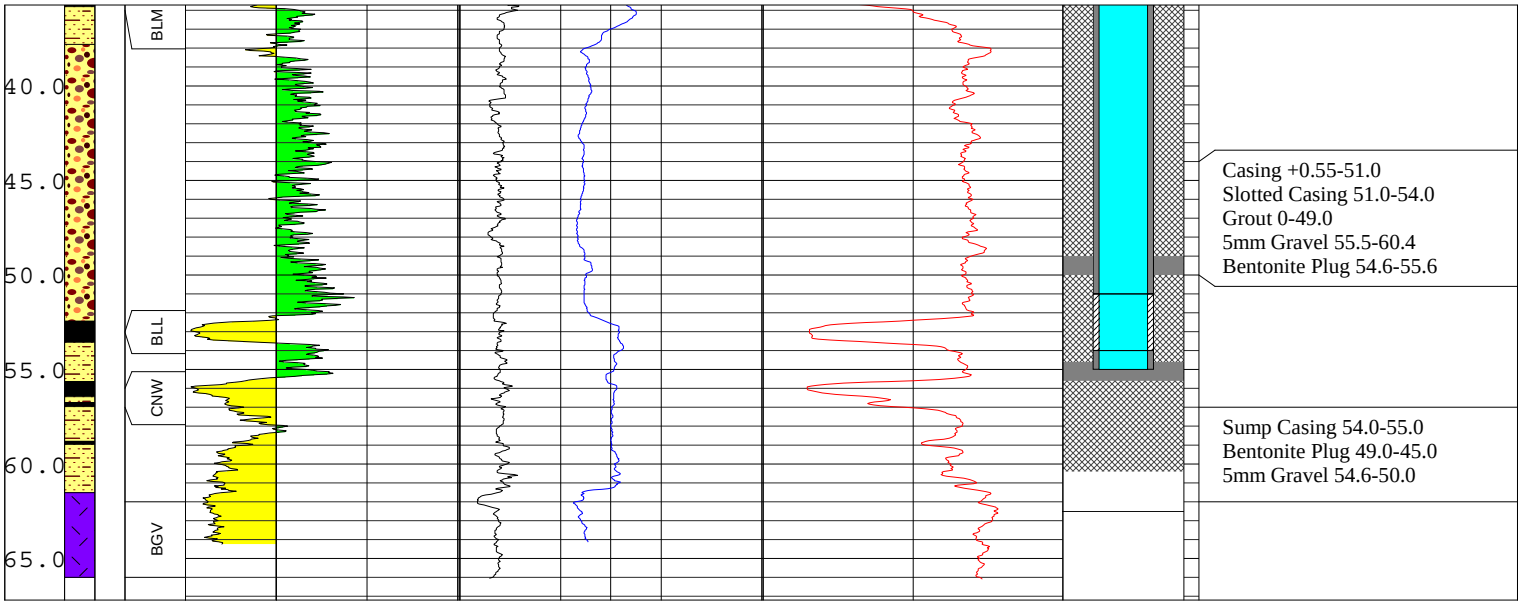

40.0
45.0
50.0
55.0
60.0
65.0
BLM
BLL
CNW
BGV
Casing +0.55-51.0
Slotted Casing 51.0-54.0
Grout 0-49.0
5mm Gravel 55.5-60.4
Bentonite Plug 54.6-55.6
Sump Casing 54.0-55.0
Bentonite Plug 49.0-45.0
5mm Gravel 54.6-50.0

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PLATE No:D

LITHOLOGY LEGEND

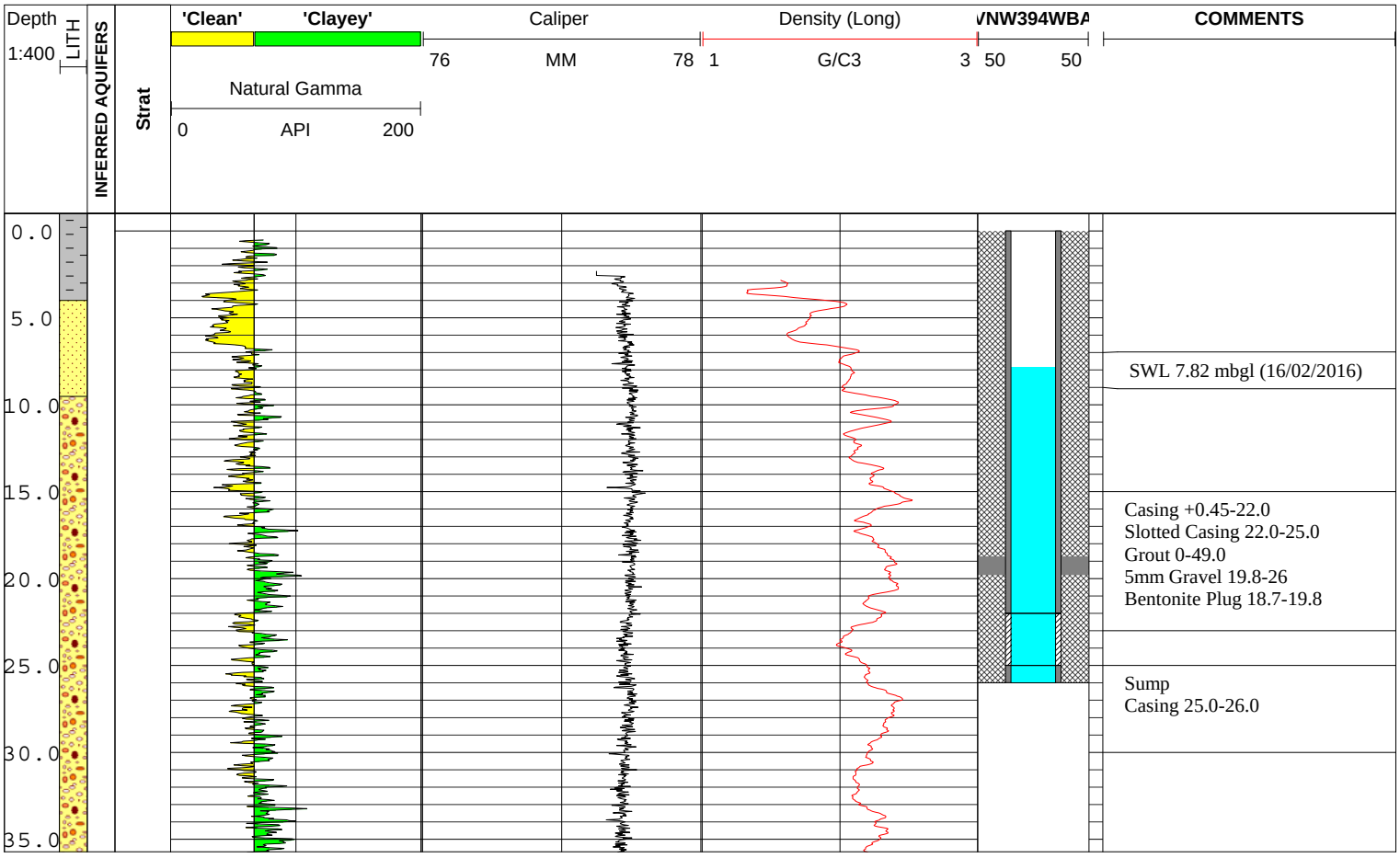
- Clay
- Silt
- Med Sand
- Fine Gravel
- Basalt

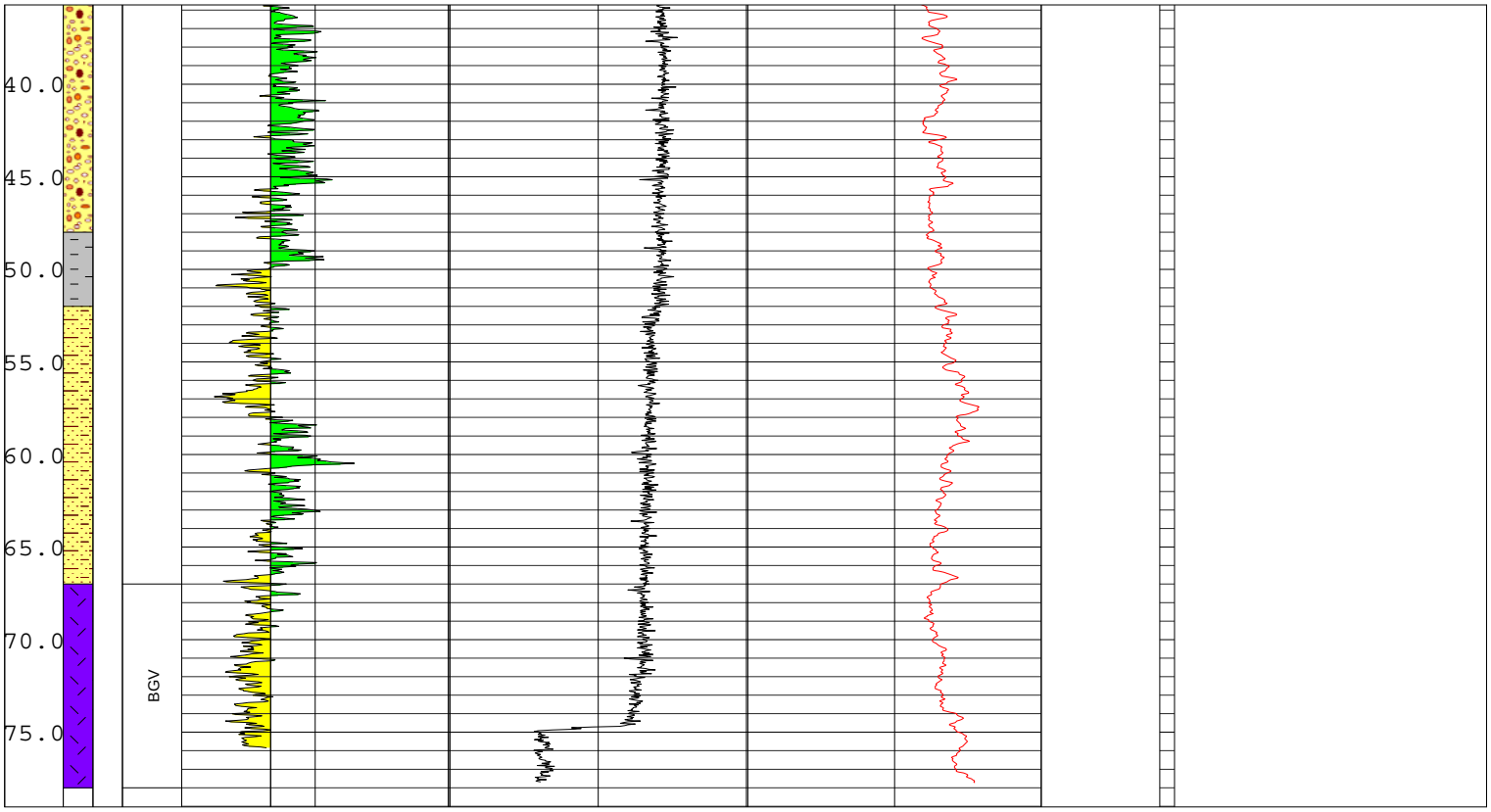
BORE NAME:

Site D
Bore VNW394WBA

SUMMARY COMPOSITE LOG

Author: Rohan Last	**Date:** 12/2/2016	**Location - MGA Zone:** 55 J	**Fluid Type:** Water
WellCAD File No:	**Project:** ENRS509 Vickery	**Easting:** 226098	**Fluid Salinity:** - uS/cm
Drilled Depth: 78	**Client :** Whitehaven Coal Limited	**Northing:** 6593882	**Fluid Level:** 7.82 mbgl (16/12/16)
Logged Depth:78	**Drilled:** -	**Logged:** 13/02/16	**Tool:** Mud Rotary
Hole Size: 127mm	**Casing:** 50mm Cl18 PVC	**Notes:** +0.45m Casing stick up	




40.0
45.0
50.0
55.0
60.0
65.0
70.0
75.0
BGV

Appendix B

English Field Logs

Depth	Thickness	Sample Number	Seam	Ply	Lithology
0.50	0.50				**SOIL**: dark brown, silty, clayey, residual soil.
1.00	0.50				**SILT**: dark brown, clayey pebbles in part, extremely weathered, loose.
2.00	1.00				**CONGLOMERATE, granular**: medium brown, clayey in part, highly weathered, low strength rock.
4.00	2.00				**CONGLOMERATE, pebbly**: medium greyish brown, highly weathered, medium strength rock.
8.50	4.50				**CONGLOMERATE, pebbly**: medium brown, highly weathered, medium strength rock.
9.50	1.00				**CONGLOMERATE, granular**: medium yellowish brown, moderately weathered, medium strength rock.
12.99	3.49				**CONGLOMERATE, pebbly**: medium brown, clayey near base of unit, moderately weathered, medium strength rock.
13.20	0.21				**CARBONACEOUS CLAYSTONE**: medium blackish brown, moderately weathered, low strength rock.
14.30	1.10				**CLAYSTONE**: medium greyish brown, moderately weathered, low strength rock, puggy.
14.60	0.30				**CARBONACEOUS CLAYSTONE**: dark brownish black, moderately weathered, low strength rock, puggy.
16.00	1.40				**CONGLOMERATE, granular**: medium greyish brown, moderately weathered, medium strength rock.
17.00	1.00				**CONGLOMERATE, granular**: dark orangey brown, ferruginous, moderately weathered, medium strength rock.
18.00	1.00				**CONGLOMERATE, granular**: medium greyish brown, moderately weathered, medium strength rock.
19.00	1.00				**SANDSTONE, fine to medium**: light yellowish brown, moderately weathered, low strength rock.
20.00	1.00				**CONGLOMERATE, pebbly**: medium greyish brown, moderately weathered, medium strength rock.

Depth	Thickness	Sample Number	Seam	Ply	Lithology
23.00	3.00				**CONGLOMERATE, pebbly**: dark greyish brown, moderately weathered, medium strength rock.
31.50	8.50				**CONGLOMERATE, pebbly**: light greyish brown, moderately weathered, medium strength rock.
34.00	2.50				**CONGLOMERATE, pebbly**: dark greyish brown, moderately weathered, medium strength rock.
34.25	0.25				**SILTSTONE**: dark brownish grey, slightly weathered, low strength rock.
					Base of Weathering
35.00	0.75				**SILTSTONE**: dark grey, fresh, low strength rock.
37.00	2.00				**SILTSTONE (80%)**: dark grey, fresh, medium strength rock **SANDSTONE, fine (20%)**: medium grey, fresh, medium strength rock.
45.61	8.61				**SILTSTONE**: dark grey, fresh, medium strength rock.
46.88	1.27		BLM		**COAL, undifferentiated**: black, fresh, very low strength rock.
47.81	0.93				**SILTSTONE (70%)**: medium grey, fresh, medium strength rock **CLAYSTONE (30%)**: medium brownish grey, fresh, low strength rock.
48.52	0.71		BLL		**COAL, undifferentiated**: black, fresh, very low strength rock.
48.83	0.31				**CARBONACEOUS SILTSTONE**: dark blackish grey, fresh, low strength rock.
49.05	0.22				**COAL, undifferentiated**: black, fresh, very low strength rock.
51.99	2.94				**SILTSTONE**: medium grey, fresh, medium strength rock.

Depth	Thickness	Sample Number	Seam	Ply	Lithology
54.29	2.30		CNW		**COAL, undifferentiated**: black, fresh, very low strength rock.
60.30	6.01				**SILTSTONE**: dark blackish grey, carbonaceous in part, fresh, medium strength rock.
62.50	2.20				**PELLET CLAYSTONE**: medium creamy grey, fresh, medium strength rock.
68.00	5.50				**PELLET CLAYSTONE**: dark reddish brown, fresh, medium strength rock.
					Top unit of Boggabri Volcanics
70.00	2.00				**BASIC VOLCANIC**: fresh, medium strength rock.
					Total Depth: 70.00

Depth	Thickness	Sample Number	Seam	Ply	Lithology
0.50	0.50				**SOIL**: dark brown, silty, clayey, residual soil.
2.00	1.50				**CLAY**: dark reddish brown, extremely weathered, firm.
3.50	1.50				**CLAY**: dark brown, highly weathered, firm, puggy.
4.00	0.50				**CONGLOMERATE, granular**: medium brown, clayey throughout, highly weathered, low strength rock.
6.20	2.20				**CONGLOMERATE, pebbly**: medium orangey brown, clayey near base of unit, highly weathered, low strength rock.
7.20	1.00				**CLAYSTONE**: medium greyish brown, rare (<1%) pebbles, highly weathered, very low strength rock, puggy.
9.25	2.05				**CONGLOMERATE, granular**: medium orangey brown, clayey in part, highly weathered, low strength rock.
12.00	2.75				**CONGLOMERATE, pebbly**: medium greyish brown, moderately weathered, low strength rock, slightly damp from 2m to 12m, wet at 13 metres depth.
15.25	3.25				**CONGLOMERATE, pebbly**: medium greyish brown, clayey in part, moderately weathered, low strength rock.
16.25	1.00				**CONGLOMERATE, granular**: medium greyish brown, moderately weathered, low strength rock, dry hole from 14 to 28m.
18.00	1.75				**CONGLOMERATE, pebbly**: medium greyish brown, moderately weathered, low strength rock.
22.00	4.00				**CONGLOMERATE, granular**: medium greyish brown, rare (<1%) pebbles, moderately weathered, low strength rock.
23.00	1.00				**CONGLOMERATE, pebbly**: medium greyish brown, moderately weathered, low strength rock.
24.00	1.00				**SANDSTONE, fine to medium**: medium yellowish brown, clayey in part, moderately weathered, low strength rock.

Depth	Thickness	Sample Number	Seam	Ply	Lithology
25.00	1.00				**CONGLOMERATE, granular**: medium greyish brown, moderately weathered, low strength rock.
28.00	3.00				**CONGLOMERATE, pebbly**: medium greyish brown, moderately weathered, medium strength rock, wet at 28m depth.
30.00	2.00				**CONGLOMERATE, pebbly**: medium greyish brown, moderately weathered, medium strength rock, V-notch water flow rate is 0.6L/sec.
31.00	1.00				**CONGLOMERATE, pebbly**: dark greyish brown, moderately weathered, medium strength rock.
					Base of Weathering
34.00	3.00				**SILTSTONE**: dark grey, fresh, medium strength rock.
35.00	1.00				**SILTSTONE**: dark grey, slightly sandstone laminae, fresh, medium strength rock.
41.00	6.00				**SILTSTONE**: dark grey, fresh, medium strength rock, minor (1-15%) calcite on fracture planes, V-notch water test flow rate is 3L/sec at 39.50m.
42.00	1.00				**SILTSTONE**: medium grey, slightly sandstone laminae, fresh, medium strength rock, minor (1-15%) calcite on fracture planes.
42.17	0.17				**SILTSTONE**: dark grey, fresh, medium strength rock.
42.99	0.82		BLM		**COAL, undifferentiated**: black, fresh, very low strength rock.
45.18	2.19				**SILTSTONE**: dark grey, fresh, medium strength rock.
45.71	0.53		BLL		**COAL, undifferentiated**: black, fresh, very low strength rock.
46.01	0.30				**CARBONACEOUS SILTSTONE**: dark blackish grey, fresh, low strength rock.

Depth	Thickness	Sample Number	Seam	Ply	Lithology
46.13	0.12				**COAL, undifferentiated**: black, fresh, very low strength rock.
48.00	1.87				**SILTSTONE**: dark grey, slightly coaly laminae, fresh, medium strength rock.
49.50	1.50				**SANDSTONE, fine**: medium grey, fresh, medium strength rock.
51.27	1.77				**SILTSTONE**: dark grey, fresh, medium strength rock.
53.36	2.09		CNW		**COAL, undifferentiated**: black, fresh, very low strength rock.
56.00	2.64				**SILTSTONE**: dark grey, fresh, medium strength rock.
59.00	3.00				**SILTSTONE (50%)**: dark grey, fresh, medium strength rock, intermixed with: **SANDSTONE, fine (50%)**: medium grey, fresh, medium strength rock.
60.50	1.50				**PELLET CLAYSTONE**: medium creamy brown, fresh, medium strength rock.

Total Depth: 60.50

Depth	Thickness	Sample Number	Seam	Ply	Lithology
0.50	0.50				**SOIL**: dark brown, residual soil.
3.00	2.50				**CLAY**: dark orangey brown, extremely weathered, firm.
4.00	1.00				**CLAY**: medium brown, highly weathered, firm.
6.00	2.00				**CLAY**: medium brown, sandy in part, highly weathered, soft.
8.00	2.00				**CONGLOMERATE, granular**: dark brown, highly weathered, low strength rock, damp from 6m to 23m.
10.00	2.00				**CONGLOMERATE, pebbly**: dark brown, highly weathered, low strength rock.
12.00	2.00				**CONGLOMERATE, pebbly**: medium brown, clayey in part, highly weathered, low strength rock.
13.00	1.00				**CONGLOMERATE, granular**: medium brown, highly weathered, low strength rock.
15.00	2.00				**CONGLOMERATE, pebbly**: medium brown, highly weathered, low strength rock.
16.00	1.00				**CONGLOMERATE, pebbly**: dark brown, clayey throughout, highly weathered, low strength rock.
23.00	7.00				**CONGLOMERATE, pebbly**: medium greyish brown, clayey in part, moderately weathered, low strength rock, could not drill further due to collapsing, start new hole approx., 2m SE of original location and drilled with mud from 6m depth.
29.50	6.50				**CONGLOMERATE, pebbly**: medium greyish brown, moderately weathered, low strength rock.
33.00	3.50				**CLAYSTONE**: medium orangey brown, moderately weathered, very low strength rock.
33.50	0.50				**CLAYSTONE**: dark brownish grey, slightly weathered, low strength rock, puggy.

Depth	Thickness	Sample Number	Seam	Ply	Lithology
					Base of Weathering
38.25	4.75				**SILTSTONE**: dark grey, clayey in part, fresh, low strength rock.
39.00	0.75				**SILTSTONE**: medium yellowish brown, moderately weathered, low strength rock.
41.50	2.50				**SANDSTONE**: medium yellowish brown, moderately weathered, low strength rock.
44.75	3.25				**CONGLOMERATE, pebbly**: medium greyish brown, moderately weathered, medium strength rock.
46.62	1.87				**CLAYSTONE**: medium yellowish brown, moderately weathered, low strength rock, puggy.
47.23	0.61		BLL		**COAL, undifferentiated**: black, fresh, very low strength rock.
47.51	0.28				**CARBONACEOUS CLAYSTONE**: dark blackish grey, coaly, fresh, low strength rock, puggy.
47.66	0.15				**COAL, undifferentiated**: fresh, very low strength rock.
51.25	3.59				**SILTSTONE**: dark grey, rare (<1%) coaly laminae, fresh, medium strength rock.
53.47	2.22		CNW		**COAL, undifferentiated**: black, fresh, very low strength rock.
55.50	2.03				**SILTSTONE**: dark blackish grey, carbonaceous in part, fresh, medium strength rock.
56.50	1.00				**CLAYSTONE**: medium greyish brown, fresh, medium strength rock.
58.00	1.50				**SILTSTONE**: dark grey, fresh, medium strength rock.
62.50	4.50				**PELLET CLAYSTONE**: medium greyish brown, fresh, medium strength rock.

Depth	Thickness	Sample Number	Seam	Ply	Lithology

Total Depth: 62.50

Depth	Thickness	Sample Number	Seam	Ply	Lithology
0.50	0.50				**SOIL**: dark brown, clayey, silty, residual soil.
1.00	0.50				**CLAY**: dark brown, extremely weathered, firm.
3.00	2.00				**CLAY**: medium brown, silty, highly weathered, soft.
6.00	3.00				**SILT**: medium brown, clayey, highly weathered, medium dense.
7.00	1.00				**CONGLOMERATE, pebbly**: medium brown, highly weathered, low strength rock.
14.80	7.80				**CONGLOMERATE, pebbly**: medium brown, highly weathered, medium strength rock.
16.50	1.70				**CONGLOMERATE, granular**: medium greyish brown, clayey throughout, moderately weathered, low strength rock.
31.00	14.50				**CONGLOMERATE, pebbly**: medium greyish brown, moderately weathered, medium strength rock.
31.50	0.50				**CONGLOMERATE, pebbly**: medium brownish grey, slightly weathered, medium strength rock.
					Base of Weathering
34.20	2.70				**CONGLOMERATE, pebbly**: light grey, fresh, high strength rock.
35.50	1.30				**SILTSTONE**: dark grey, fresh, medium strength rock.
35.75	0.25				**SANDSTONE, fine to medium**: light brownish grey, sideritic in part, fresh, high strength rock.
38.00	2.25				**SANDSTONE, fine**: light grey, slightly siltstone laminae, fresh, medium strength rock.

Depth	Thickness	Sample Number	Seam	Ply	Lithology
48.60	10.60				**CONGLOMERATE, pebbly**: light grey, fresh, high strength rock.
49.70	1.10		BLM		**COAL, undifferentiated**: black, fresh, very low strength rock.
51.03	1.33				**SILTSTONE**: dark grey, clayey, fresh, low strength rock.
51.60	0.57		BLL		**COAL, undifferentiated**: black, fresh, very low strength rock.
51.94	0.34				**CARBONACEOUS SILTSTONE**: dark grey, fresh, low strength rock.
52.08	0.14				**COAL, undifferentiated**: black, fresh, very low strength rock.
53.35	1.27				**SILTSTONE**: dark grey, fresh, low strength rock.
56.00	2.65				**SANDSTONE, fine**: medium grey, slightly siltstone laminae, fresh, medium strength rock.
57.00	1.00				**SILTSTONE**: dark grey, fresh, low strength rock.
57.59	0.59				**CARBONACEOUS SILTSTONE**: dark blackish grey, fresh, low strength rock.
59.75	2.16		CNW		**COAL, undifferentiated**: black, fresh, very low strength rock.
60.75	1.00				**CARBONACEOUS SILTSTONE**: dark blackish grey, fresh, low strength rock.
66.00	5.25				**PELLET CLAYSTONE**: medium greyish brown, fresh, medium strength rock, Wet at 10-12m depth, water at 28m depth.

Total Depth: 66.00

Depth	Thickness	Sample Number	Seam	Ply	Lithology
0.50	0.50				**SOIL**: dark brown, clayey, silty, residual soil.
2.20	1.70				**CLAY**: dark brown, extremely weathered, firm.
5.00	2.80				**CONGLOMERATE, pebbly**: dark brown, highly weathered, low strength rock.
6.20	1.20				**CONGLOMERATE, granular**: dark brown, highly weathered, medium strength rock.
8.10	1.90				**CONGLOMERATE, pebbly**: dark brown, highly weathered, medium strength rock.
8.35	0.25				**CARBONACEOUS CLAYSTONE**: dark blackish brown, highly weathered, low strength rock, puggy.
9.00	0.65				**CLAYSTONE**: dark brown, highly weathered, low strength rock, puggy.
13.83	4.83				**CONGLOMERATE, pebbly**: dark brown, highly weathered, medium strength rock.
14.06	0.23				**CARBONACEOUS CLAYSTONE**: dark blackish brown, moderately weathered, low strength rock, puggy.
16.00	1.94				**CLAYSTONE**: medium brown, moderately weathered, low strength rock, puggy.
18.50	2.50				**SANDSTONE, fine to medium**: medium brown, conglomeratic near base of unit, moderately weathered, medium strength rock.
19.00	0.50				**CONGLOMERATE, pebbly**: light brownish grey, slightly weathered, medium strength rock.
					Base of Weathering
32.79	13.79				**CONGLOMERATE, pebbly**: light grey, fresh, high strength rock.

Depth	Thickness	Sample Number	Seam	Ply	Lithology
33.26	0.47		BLU		**COAL, undifferentiated**: black, fresh, very low strength rock.
34.74	1.48				**SANDSTONE, fine to medium**: medium grey, fresh, medium strength rock, Water at 34m.
35.56	0.82		BLM		**COAL, undifferentiated**: black, fresh, very low strength rock.
35.64	0.08		BLM		**CARBONACEOUS SILTSTONE**: dark blackish grey, fresh, low strength rock.
35.78	0.14		BLM		**COAL, undifferentiated**: black, fresh, very low strength rock.
37.78	2.00				**SILTSTONE**: dark grey, clayey in part, fresh, low strength rock.
38.50	0.72				**CONGLOMERATE, granular**: light grey, fresh, high strength rock.
52.41	13.91				**CONGLOMERATE, pebbly**: light grey, fresh, high strength rock.
53.56	1.15		BLL		**COAL, undifferentiated**: black, fresh, very low strength rock.
55.62	2.06				**CLAYSTONE (60%)**: medium brownish grey, fresh, low strength rock, Increase in water flow at 55m, interbedded with: **SILTSTONE (40%)**: dark grey, fresh, medium strength rock.
56.43	0.81		CNW		**COAL, undifferentiated**: black, fresh, very low strength rock.
56.76	0.33				**CARBONACEOUS SILTSTONE**: dark blackish grey, fresh, low strength rock.
56.95	0.19				**COAL, undifferentiated**: black, fresh, very low strength rock.
57.25	0.30				**CARBONACEOUS SILTSTONE**: dark blackish grey, fresh, low strength rock.
58.80	1.55				**CLAYSTONE**: medium brownish grey, fresh, medium strength rock.
58.96	0.16				**COAL, undifferentiated**: black, fresh, very low strength rock.
60.21	1.25				**CLAYSTONE**: medium brownish grey, minor (1-15%) coaly laminae, fresh, low strength rock.

Depth	Thickness	Sample Number	Seam	Ply	Lithology
61.50	1.29				**PELLET CLAYSTONE** : medium greyish brown, fresh, medium strength rock.
					Top unit of Boggabri Volcanics
62.20	0.70		BGV		**BASIC VOLCANIC**: dark greyish green, fresh, high strength rock.
63.00	0.80		BGV		**BASIC VOLCANIC**: medium greyish green, fresh, high strength rock.
66.00	3.00		BGV		**BASIC VOLCANIC**: light greyish green, fresh, high strength rock, Bucket test of water flow is 1.5L/sec at 66m.
					Total Depth: 66.00

Depth	Thickness	Sample Number	Seam	Ply	Lithology
0.50	0.50				**SOIL**: dark brown, clayey, silty, residual soil.
1.00	0.50				**CLAY**: dark brown, silty, sandy, extremely weathered, soft.
4.00	3.00				**SAND, fine to medium**: dark brown, highly weathered, loose.
6.50	2.50				**SAND, fine to medium**: dark brown, rare (<1%) pebbles, highly weathered, loose.
9.50	3.00				**SAND, fine to medium**: dark brown, pebbles, clayey in part, highly weathered, medium dense, Damp at 9m depth.
20.00	10.50				**GRAVEL**: dark brown, pebbles in part, highly weathered, loose, Water at 17m depth.
24.00	4.00				**GRAVEL**: medium brown, pebbles, highly weathered, loose.
27.00	3.00				**GRAVEL**: dark brown, highly weathered, loose.
48.00	21.00				**GRAVEL (50%)**: dark brown, highly weathered, loose **CLAY (50%)**: dark brown, sandy, highly weathered, firm, puggy.
52.00	4.00				**CLAY (80%)**: medium yellowish brown, moderately weathered, firm, puggy **GRAVEL (20%)**: medium brown, moderately weathered, loose.
57.25	5.25				**CLAY, gravelly** : dark purplish brown, moderately weathered, firm, puggy.
67.00	9.75				**CLAYSTONE** : dark purplish brown, moderately weathered, low strength rock, puggy.
					Top unit of Boggabri Volcanics
69.00	2.00		BGV		**BASIC VOLCANIC**: dark yellowish brown, clayey, altered, moderately weathered, low strength rock.

Depth	Thickness	Sample Number	Seam	Ply	Lithology
73.00	4.00		BGV		**BASIC VOLCANIC**: medium greenish grey, clayey, altered, moderately weathered, low strength rock.
76.00	3.00		BGV		**BASIC VOLCANIC**: medium greenish grey, clayey, altered, slightly weathered, low strength rock.
					Base of Weathering
78.00	2.00		BGV		**BASIC VOLCANIC**: medium greenish grey, altered, clayey, fresh, medium strength rock, No coal intersected. Drilled with mud, no casing.
					Total Depth: 78.00

Depth	Thickness	Sample Number	Seam	Ply	Lithology
0.50	0.50				**SOIL**: dark brown, clayey, silty, residual soil.
1.00	0.50				**CLAY**: dark brown, extremely weathered, firm.
2.00	1.00				**CLAY**: medium brown, silty throughout, highly weathered, soft.
3.00	1.00				**SILT**: medium brown, clayey in part, highly weathered, loose.
4.38	1.38				**CLAY**: dark brown, silty throughout, highly weathered, soft.
5.00	0.62				**SILT**: medium brown, sandy, highly weathered, loose.
6.84	1.84				**SAND, fine to medium**: dark brown, highly weathered, loose.
10.32	3.48				**GRAVEL**: dark brown, sandy in part, highly weathered, loose.
11.50	1.18				**CLAY**: dark brown, highly weathered, firm, puggy.
13.00	1.50				**CLAY, gravelly** : dark brown, highly weathered, firm, puggy.
14.75	1.75				**CLAY**: medium brown, sandy throughout, highly weathered, soft.
17.75	3.00				**GRAVEL**: dark brown, sandy in part, highly weathered, loose.
20.50	2.75				**CLAY, gravelly** : medium brown, highly weathered, loose.
37.43	16.93				**CONGLOMERATE, pebbly**: medium brownish grey, moderately weathered, medium strength rock.
37.79	0.36		BLU		**COAL, weathered**: brownish black, moderately weathered, low strength rock, puggy.

Depth	Thickness	Sample Number	Seam	Ply	Lithology
39.35	1.56				**CLAYSTONE** : medium greyish brown, slightly weathered, low strength rock, puggy.
					Base of Weathering
40.25	0.90		BLL		**COAL, undifferentiated** : fresh, very low strength rock.
40.75	0.50				**CLAYSTONE** : medium brownish grey, fresh, low strength rock, puggy.
41.75	1.00				**CONGLOMERATE, pebbly** : light brownish grey, fresh, medium strength rock.
52.00	10.25				**CONGLOMERATE, pebbly** : light grey, fresh, high strength rock.
53.00	1.00				**CONGLOMERATE, pebbly** : light grey, minor (1-15%) coaly laminae, fresh, medium strength rock.
55.00	2.00				**CONGLOMERATE, pebbly** : light grey, clayey in part, fresh, medium strength rock.
60.00	5.00				**CONGLOMERATE, pebbly** : light grey, fresh, high strength rock.
63.00	3.00				**PELLET CLAYSTONE (70%)** : medium brownish grey, fresh, medium strength rock **CLAYSTONE (30%)** : dark grey, fresh, low strength rock, puggy.
63.50	0.50				**CLAYSTONE** : dark grey, fresh, low strength rock, puggy, Drilled with mud, no casing.
					Total Depth: 63.50

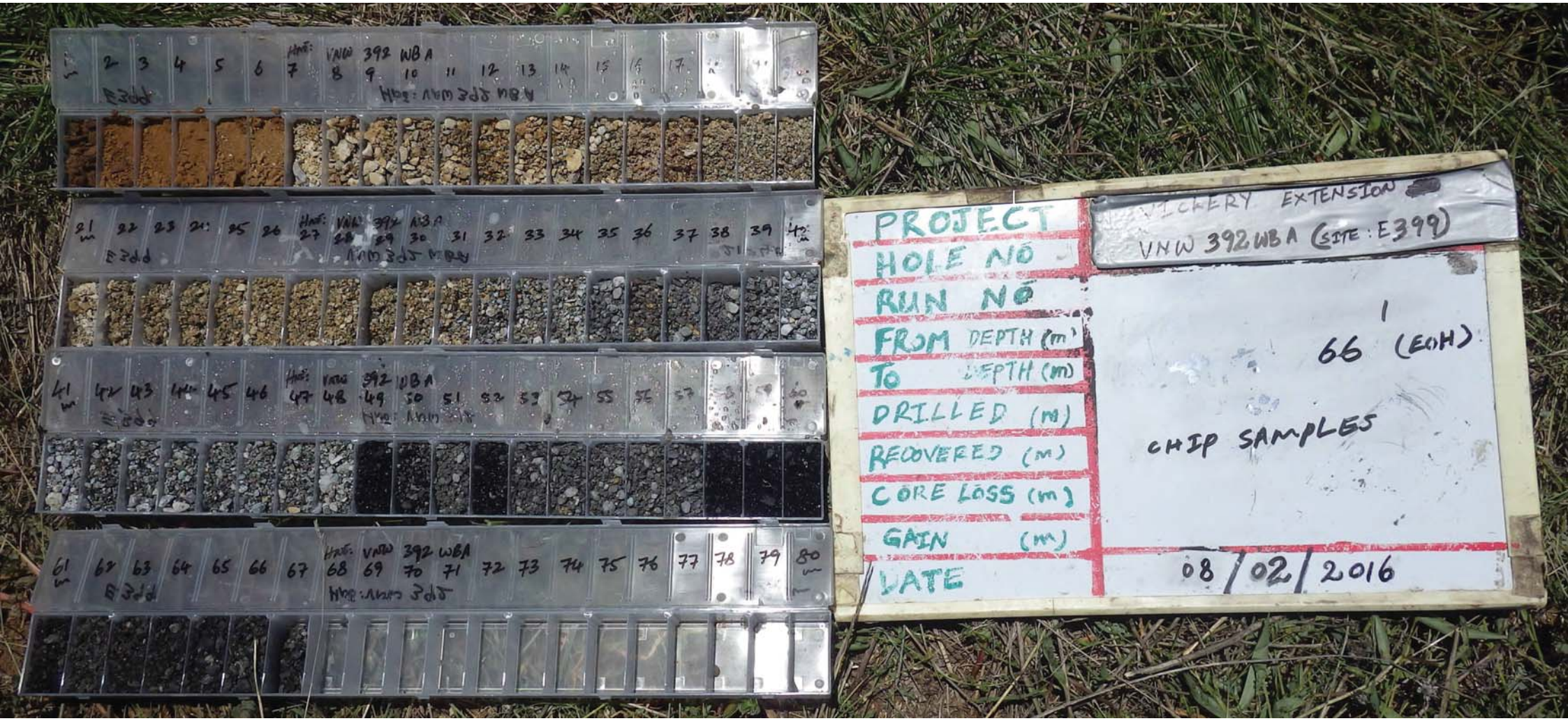
Appendix C

Photographic Record of Drill Cuttings


PROJECT
VICKERY EXTENSION
HOLE NO
VNW 389 (SITE: E405)
RUN NO
1
FROM DEPTH (m)
TO DEPTH (m)
70 (EOH)
DRILLED (m)
CHIP SAMPLES
RECOVERED (m)
CORE LOSS (m)
GAIN (m)
DATE
05/02/2016


PROJECT
VICKERY EXTENSION
HOLE NO
VNW 390WBA (SITE: E401)
RUN NO
1
FROM DEPTH (m)
TO DEPTH (m)
60.50(EOH)
DRILLED (m)
RECOVERED (m)
CHIP SAMPLES
CORE LOSS (m)
GAIN (m)
DATE
06/02/2016


PROJECT
VICKERY EXTENSION
HOLE NO
VNW 391 WBA (SITE: E400)
RUN NO
1
FROM DEPTH (m)
TO DEPTH (m)
62.50 (EOH)
DRILLED (m)
CHIP SAMPLES
RECOVERED (m)
CORE LOSS (m)
GAIN (m)
DATE
07/02/2016


PROJECT
HOLE NO
RUN NO
FROM DEPTH (m)
TO DEPTH (m)
DRILLED (m)
RECOVERED (m)
CORE LOSS (m)
GAIN (m)
DATE
VNW 392 WBA (SITE: E399)
1
66 (EOH)
CHIP SAMPLES
08/02/2016


PROJECT
VICKERY EXTENSION
HOLE NO
VNW 393 WB A (SITE: E403)
RUN NO
1
FROM DEPTH (m)
TO DEPTH (m)
66 (EOH)
DRILLED (m)
CHIP SAMPLES
RECOVERED (m)
CORE LOSS (m)
GAIN (m)
DATE
09/02/2016


PROJECT
HOLE NO
RUN NO
FROM DEPTH (m)
TO DEPTH (m)
DRILLED (m)
RECOVERED (m)
CORE LOSS (m)
GAIN (m)
DATE
VNW 394 WBA (SITE: E404)
78 (EOH)
CHIP SAMPLES
10/02/2016


PROJECT
VICKERY EXTENSION
HOLE NO
VNW 395 WB A (SITE: E402)
RUN NO
1
FROM DEPTH (m)
TO DEPTH (m)
63.50 (EOH)
DRILLED (m)
CHIP SAMPLES
RECOVERED (m)
CORE LOSS (m)
GAIN (m)
DATE
11/02/2016

Appendix D

Laboratory Certificates of Analysis

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

☐ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com
☐BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com
☐MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com
☐MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
☐MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com
☐NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304 Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com
☐NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com
☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com
☐WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: ENRS C/- WHC	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☑ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE:		☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact? Yes No N/A
PROJECT: VICKERY	ALS QUOTE NO.: WO-063-14	COC SEQUENCE NUMBER (Circle)	Freeze / frozen ice bricks present upon receipt: Yes No N/A
ORDER NUMBER: ENRS0509		COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: ROHAN CAST	CONTACT PH: 0401518443	OF: 1 2 3 4 5 6 7	Other comment: 9-7
SAMPLER: RC	SAMPLER MOBILE: "	RELINQUISHED BY:	RECEIVED BY:
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 16.2.2016	DATE/TIME: 16/2/16 1705
Email Reports to (will default to PM if no other addresses are listed): rohan@enrs.com.au			
Email Invoice to (will default to PM if no other addresses are listed):			

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).											Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	pH, EC, TDS	calcium, chloride	magnesium, potassium, sodium, sulphate	bicarbonate, carbonate, T. alk	boron, aluminium	arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, selenium, silver, mercury, zinc, boron,	nitrate, nitrite, TKN, total NOx					Comments on likely contaminant levels, dilutions, or samples requiring specific QC analyses etc.
1	VNW390WBA	16/2/16				✓	✓	✓	✓	✓	✓						
2	VNW391WBB	"				✓	✓	✓	✓	✓	✓						
3	VNW392WBA	"				✓	✓	✓	✓	✓	✓						
4	VNW393WBB	"				✓	✓	✓	✓	✓	✓						
5	VNW394WBB	"				✓	✓	✓	✓	✓	✓						
6	VNW395WBB	"				✓	✓	✓	✓	✓	✓						
				TOTAL													

Environmental Division
Sydney
Work Order Reference
ES1603464

Telephone : + 61-2-8784 8555

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

yde Preserved Glass;

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1603464**	Page	: 1 of 6
Client	: **ENVIRONMENT & NATURAL RESOURCE SOLUTIONS**	Laboratory	: Environmental Division Sydney
Contact	: Mr Rohan Last	Contact	:
Address	: 25 River Rd Shoalhaven Heads 2535	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: rohan@enrs.com.au	E-mail	:
Telephone	: ----	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: VICKERY	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ENRS0509	Date Samples Received	: 16-Feb-2016 17:05
C-O-C number	: ----	Date Analysis Commenced	: 16-Feb-2016
Sampler	: Rohan Last	Issue Date	: 23-Feb-2016 13:55
Site	: ----		
		No. of samples received	: 6
Quote number	: ----	No. of samples analysed	: 6

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- TDS by method EA-015 may bias high for sample 6 due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	VNW390WBA	VNW391WBB	VNW392WBA	VNW393WBB	VNW394WBB
				Client sampling date / time	[16-Feb-2016]	[16-Feb-2016]	[16-Feb-2016]	[16-Feb-2016]	[16-Feb-2016]
Compound	CAS Number	LOR	Unit		ES1603464-001	ES1603464-002	ES1603464-003	ES1603464-004	ES1603464-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.30	7.32	7.40	8.07	7.59
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		2330	2550	3490	2840	5720
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		1400	1440	2210	1660	3600
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		588	608	605	147	359
Total Alkalinity as CaCO3	----	1	mg/L		588	608	605	147	359
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		104	134	311	197	593
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		386	439	652	688	1190
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		178	189	269	75	216
Magnesium	7439-95-4	1	mg/L		43	63	98	29	82
Sodium	7440-23-5	1	mg/L		268	282	348	463	891
Potassium	7440-09-7	1	mg/L		14	14	20	12	14
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L		0.002	<0.001	<0.001	0.001	0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	0.018	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		0.003	0.001	<0.001	<0.001	0.007
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		0.014	0.009	0.009	<0.005	0.127
Manganese	7439-96-5	0.001	mg/L		0.054	0.179	0.078	0.001	1.24
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Boron	7440-42-8	0.05	mg/L		0.10	0.10	0.08	0.05	0.12
Iron	7439-89-6	0.05	mg/L		<0.05	0.05	<0.05	<0.05	<0.05
EG035F: Dissolved Mercury by FIMS									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	VNW390WBA	VNW391WBB	VNW392WBA	VNW393WBB	VNW394WBB
				Client sampling date / time	[16-Feb-2016]	[16-Feb-2016]	[16-Feb-2016]	[16-Feb-2016]	[16-Feb-2016]
Compound	CAS Number	LOR	Unit		ES1603464-001	ES1603464-002	ES1603464-003	ES1603464-004	ES1603464-005
					Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS - Continued									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**24.8**	**27.3**	**37.0**	**26.4**	**53.1**
Total Cations	----	0.01	meq/L		**24.4**	**27.2**	**37.1**	**26.6**	**56.6**
Ionic Balance	----	0.01	%		**0.74**	**0.15**	**0.25**	**0.23**	**3.23**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	VNW395WBB	----	----	----	----
			Client sampling date / time	[16-Feb-2016]	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1603464-006	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.30**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**2380**	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**2810**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**605**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**605**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**204**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**315**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**72**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**43**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**446**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**7**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.06**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.002**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.009**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.027**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**1.13**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L	**0.25**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	VNW395WBB	----	----	----	----
				Client sampling date / time	[16-Feb-2016]	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1603464-006	--------	--------	--------	--------
					Result	Result	Result	Result	Result
EG035F: Dissolved Mercury by FIMS - Continued									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.04**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	----	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**25.2**	----	----	----	----
Total Cations	----	0.01	meq/L		**26.7**	----	----	----	----
Ionic Balance	----	0.01	%		**2.84**	----	----	----	----

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1603464**	Page	: 1 of 8
Client	: **ENVIRONMENT & NATURAL RESOURCE SOLUTIONS**	Laboratory	: Environmental Division Sydney
Contact	: Mr Rohan Last	Telephone	: +61-2-8784 8555
Project	: VICKERY	Date Samples Received	: 16-Feb-2016
Site	: ----	Issue Date	: 23-Feb-2016
Sampler	: Rohan Last	No. of samples received	: 6
Order number	: ENRS0509	No. of samples analysed	: 6

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	ES1603464--003	VNW392WBA	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Control Samples (LCS)					
Dissolved Metals by ICP-MS - Suite B	0	6	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER** Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / ***Container*** / Client Sample ID(s)	***Sample Date***	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**16-Feb-2016**	16-Feb-2016	✓
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**16-Feb-2016**	15-Mar-2016	✓
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**19-Feb-2016**	23-Feb-2016	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**16-Feb-2016**	01-Mar-2016	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**16-Feb-2016**	15-Mar-2016	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**16-Feb-2016**	15-Mar-2016	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Natural (ED093F)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**18-Feb-2016**	23-Feb-2016	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Natural (EG020A-F)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**19-Feb-2016**	14-Aug-2016	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Natural (EG020B-F)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**19-Feb-2016**	14-Aug-2016	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Natural (EG035F)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**23-Feb-2016**	15-Mar-2016	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**16-Feb-2016**	18-Feb-2016	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
VNW390WBA, VNW391WBB, VNW392WBA, VNW393WBB, VNW394WBB, VNW395WBB	**16-Feb-2016**	**----**	----	----	**18-Feb-2016**	15-Mar-2016	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	6	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	2	6	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	6	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	0	6	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chloride by Discrete Analyser	ED045G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS) - Continued							
Chloride by Discrete Analyser	ED045G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

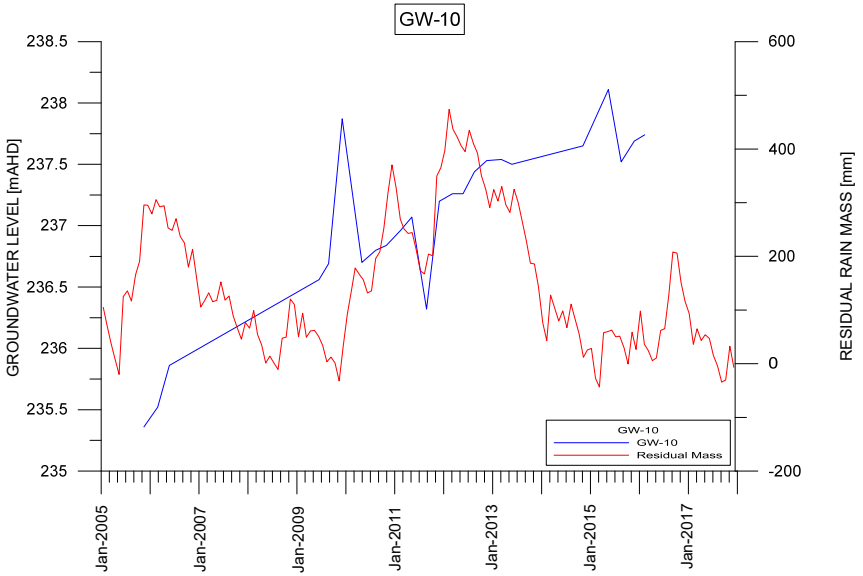
Brief Method Summaries

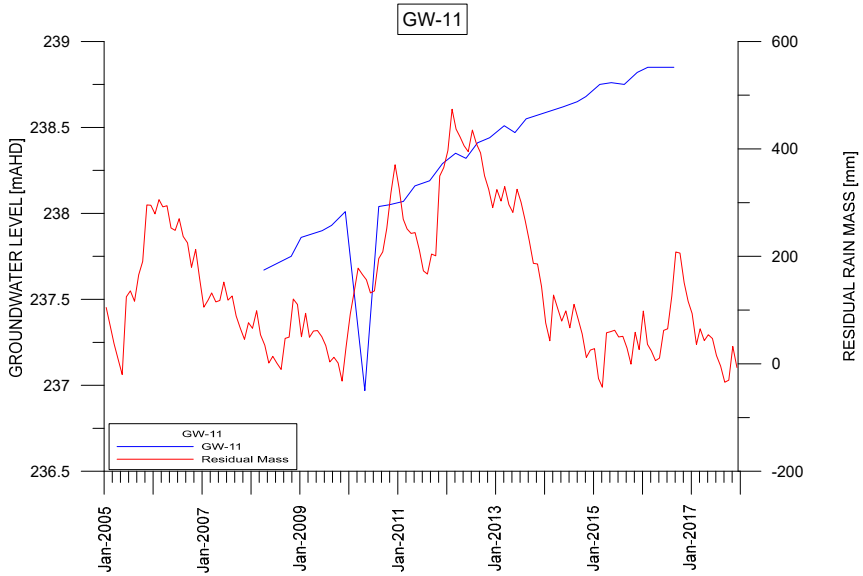
The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

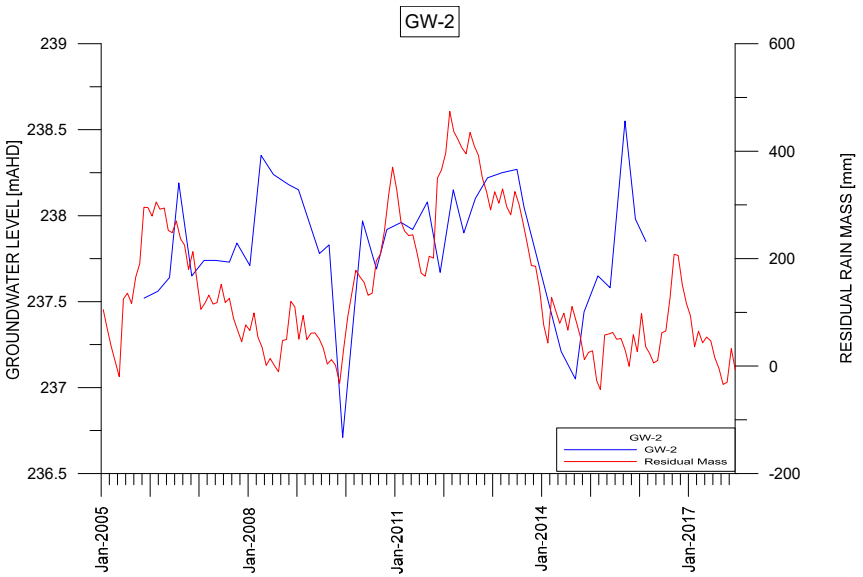
Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

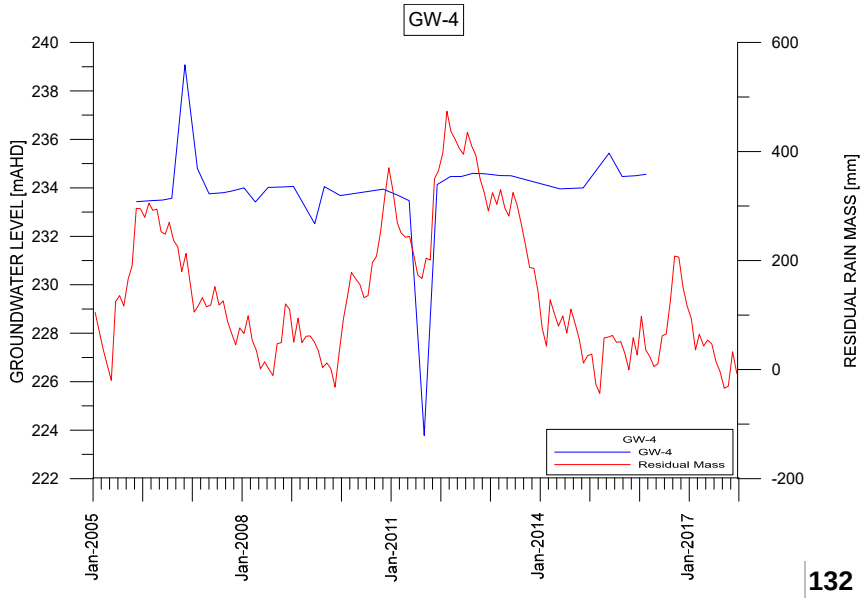
Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)

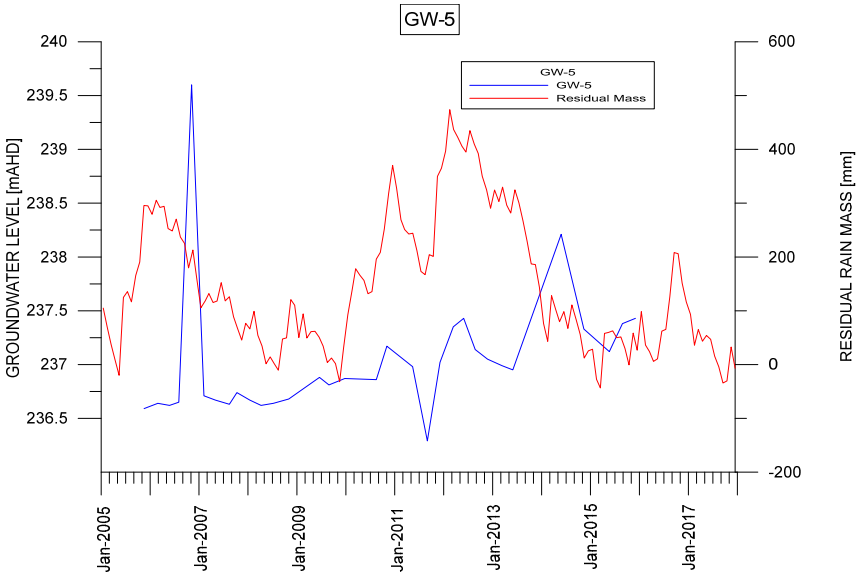
APPENDIX B – GROUNDWATER HYDROGRAPHS

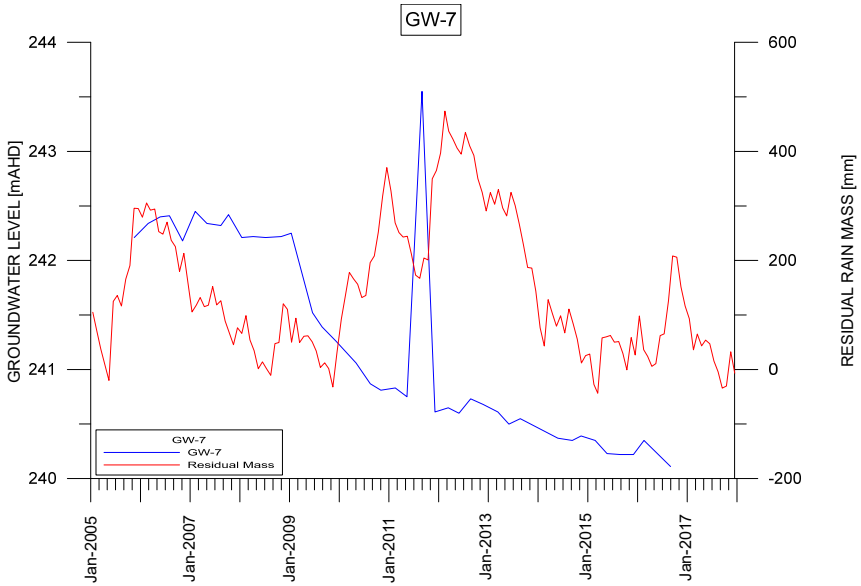


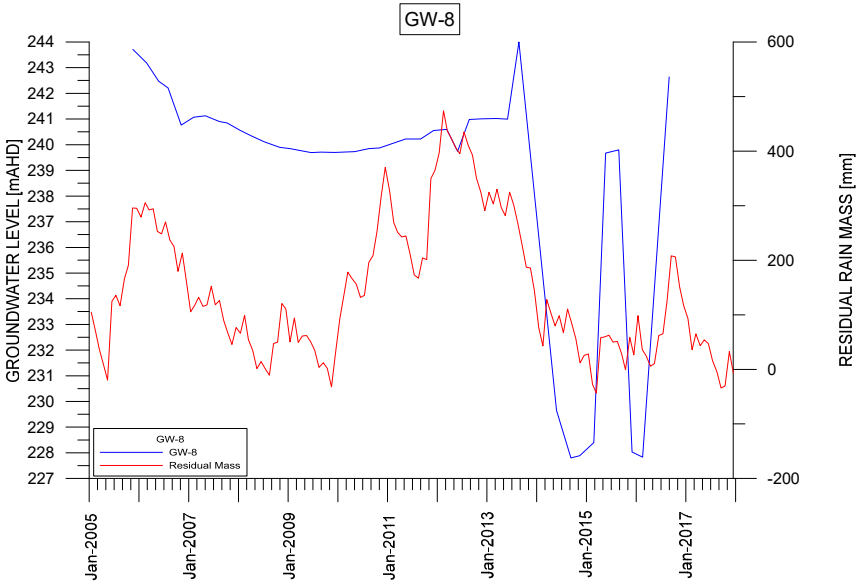


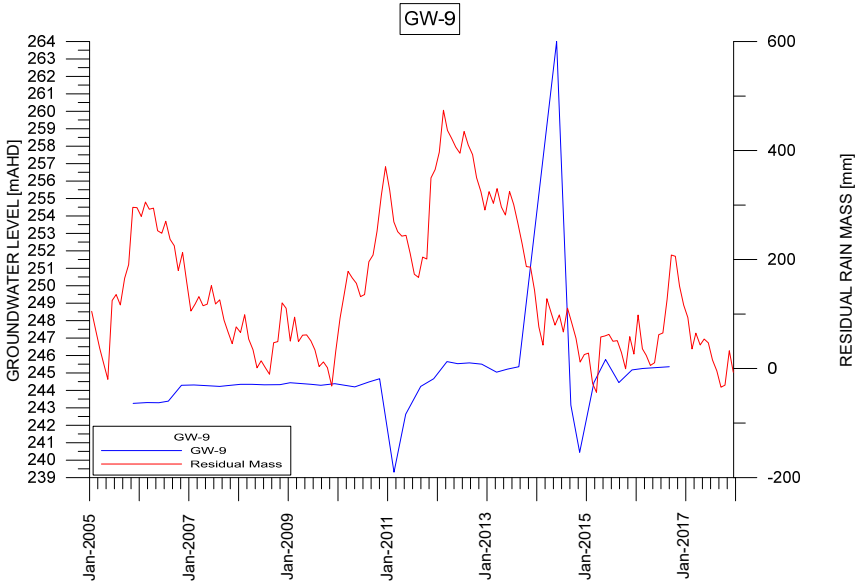


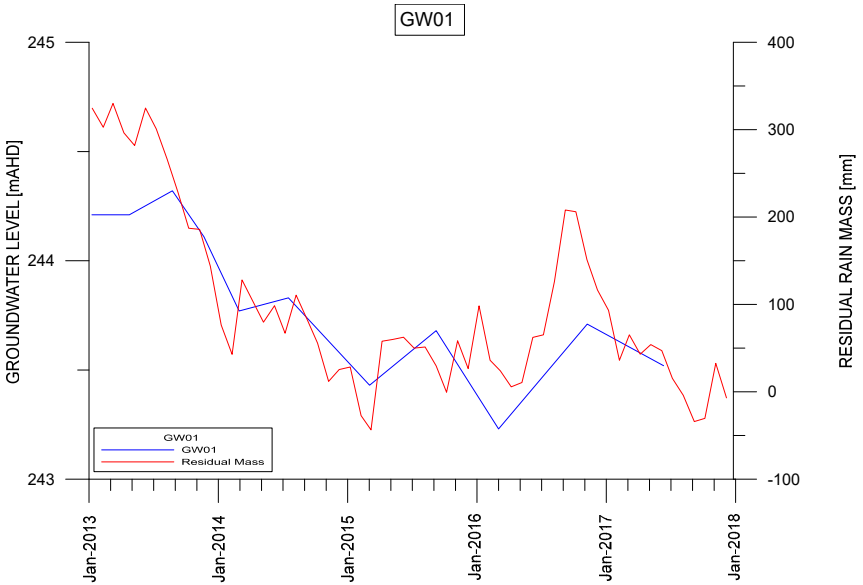


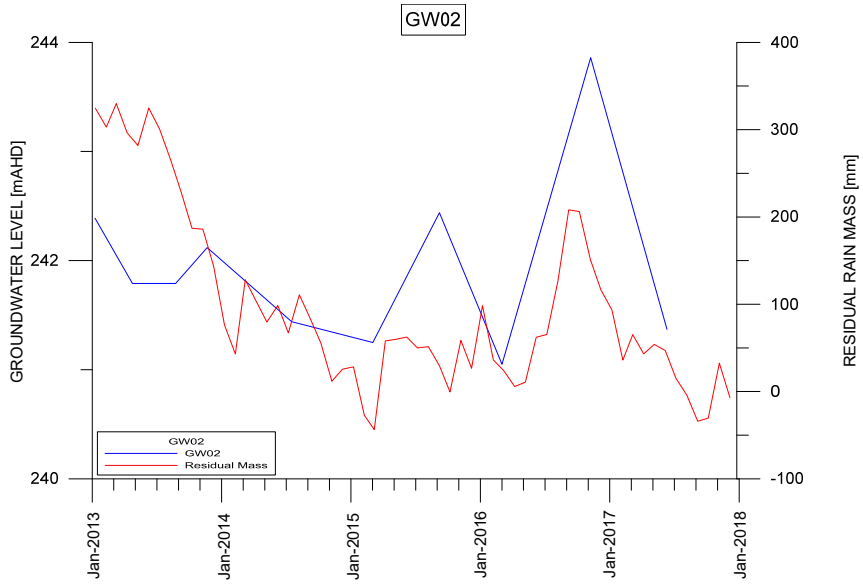

GW-5
GW-5
GW-5
Residual Mass
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
240
239.5
239
238.5
238
237.5
237
236.5
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017

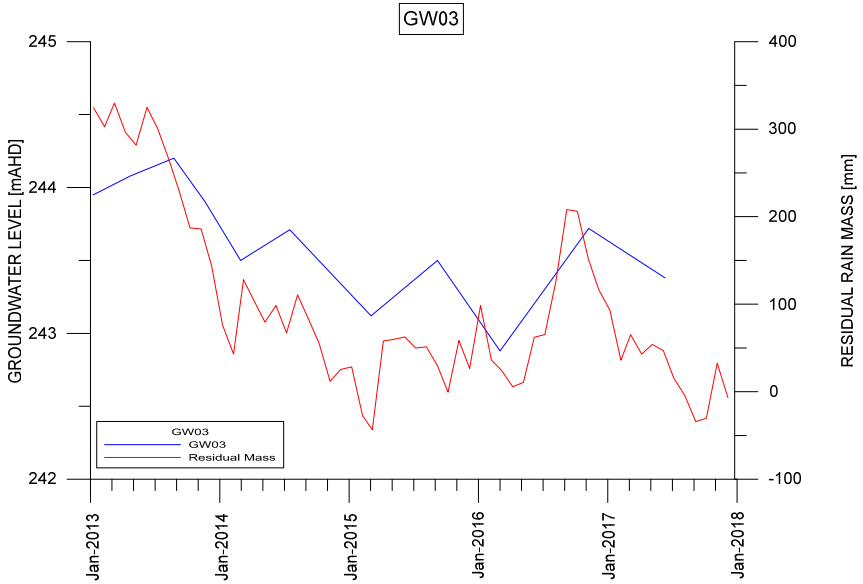

GW-7
GW-7
GW-7
Residual Mass
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
244
243
242
241
240
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017

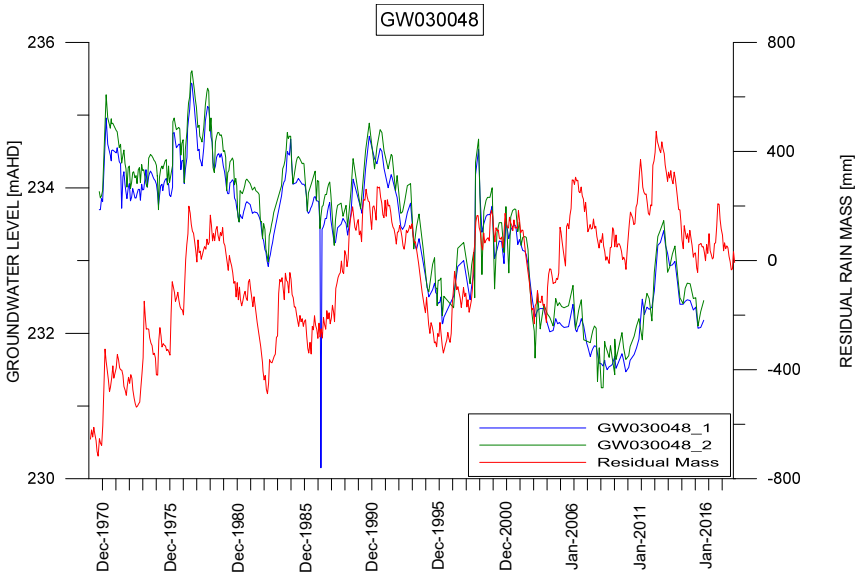

GW-8
GW-8
GW-8
Residual Mass
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
244
243
242
241
240
239
238
237
236
235
234
233
232
231
230
229
228
227
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017

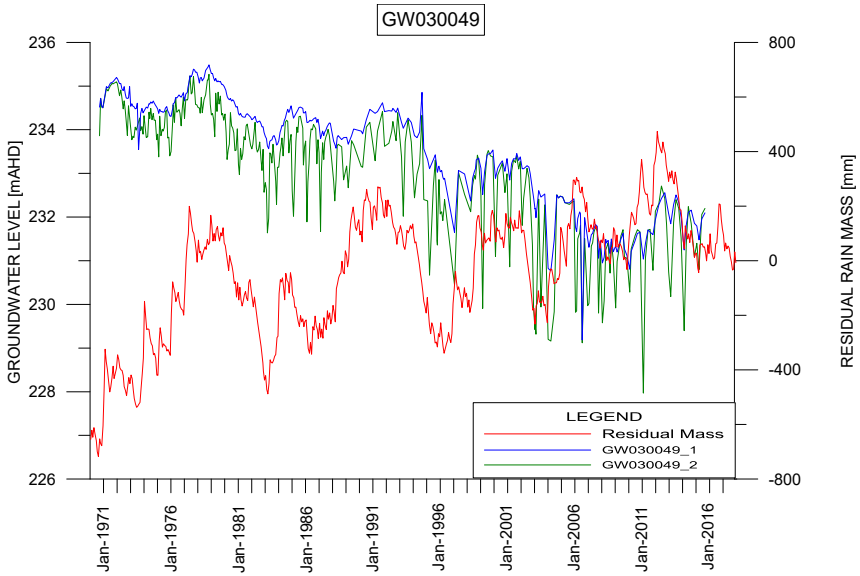

GW-9
GW-9
GW-9
Residual Mass
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
264
263
262
261
260
259
258
257
256
255
254
253
252
251
250
249
248
247
246
245
244
243
242
241
240
239
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017

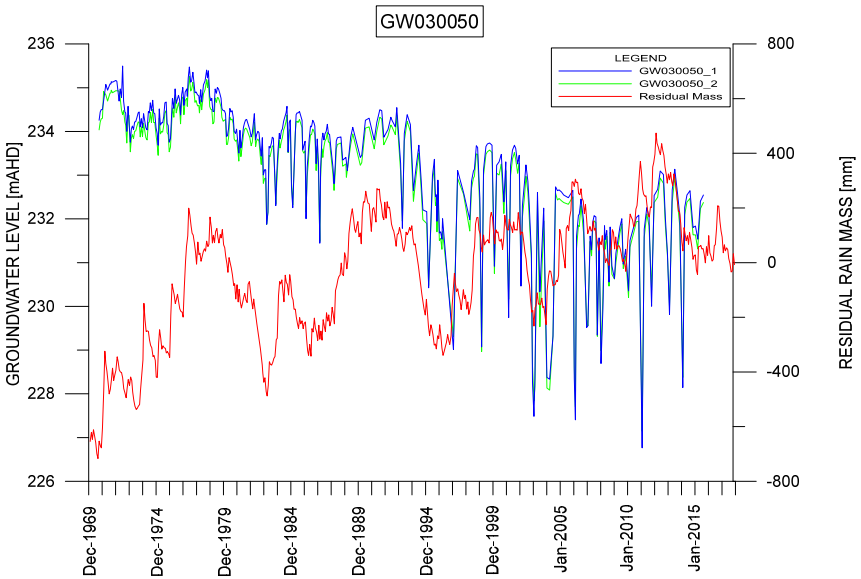

GW01
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
245
244
243
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
GW01
GW01
Residual Mass

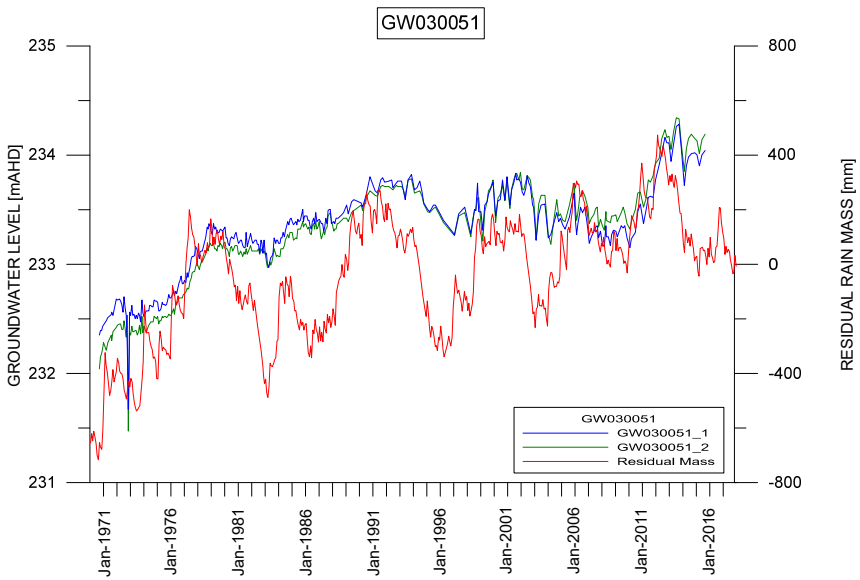

GW02
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
244
242
240
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
GW02
GW02
Residual Mass

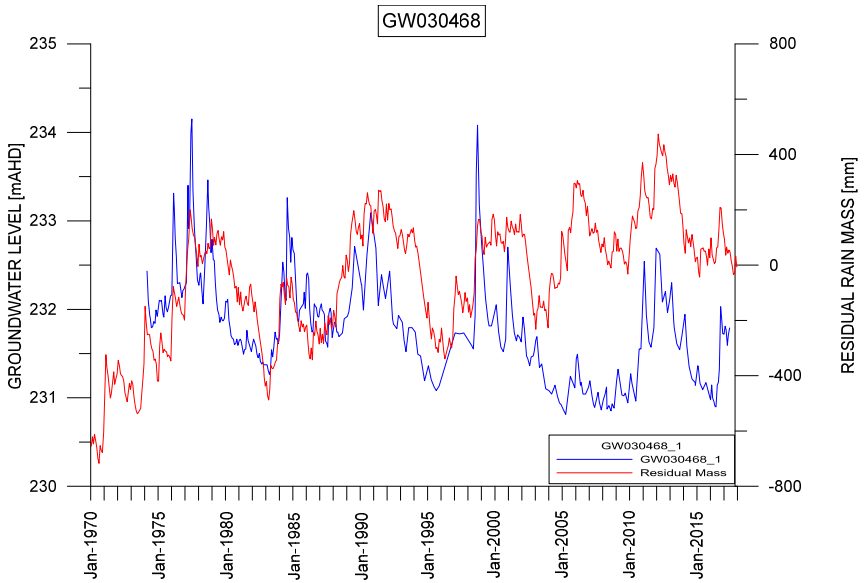

GW03
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
245
244
243
242
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
GW03
GW03
Residual Mass

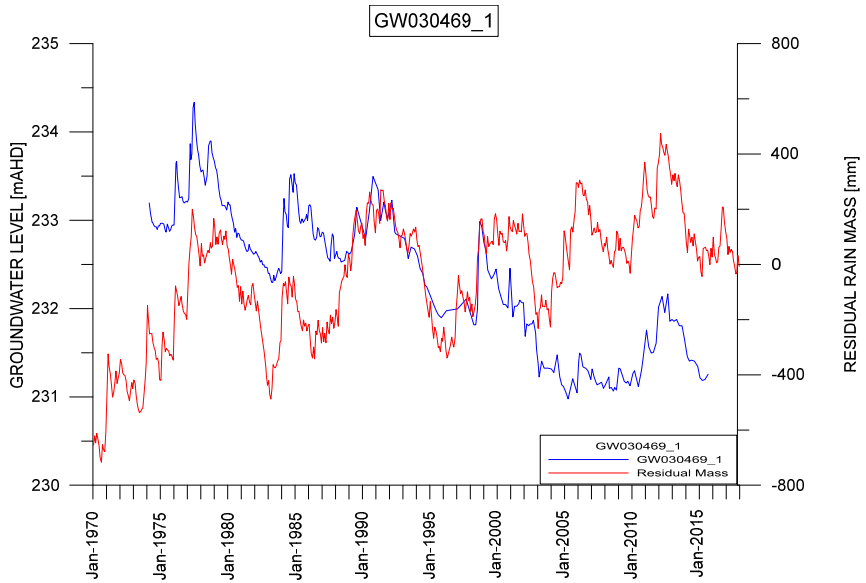

GW030048
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
236
234
232
230
800
400
0
-400
-800
Dec-1970
Dec-1975
Dec-1980
Dec-1985
Dec-1990
Dec-1995
Dec-2000
Jan-2006
Jan-2011
Jan-2016
GW030048_1
GW030048_2
Residual Mass


GW030049
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
236
234
232
230
228
226
800
400
0
-400
-800
Jan-1971
Jan-1976
Jan-1981
Jan-1986
Jan-1991
Jan-1996
Jan-2001
Jan-2006
Jan-2011
Jan-2016
LEGEND
Residual Mass
GW030049_1
GW030049_2


GW030050
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
236
234
232
230
228
226
800
400
0
-400
-800
Dec-1969
Dec-1974
Dec-1979
Dec-1984
Dec-1989
Dec-1994
Dec-1999
Jan-2005
Jan-2010
Jan-2015
LEGEND
GW030050_1
GW030050_2
Residual Mass


GW030051
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
235
234
233
232
231
800
400
0
-400
-800
Jan-1971
Jan-1976
Jan-1981
Jan-1986
Jan-1991
Jan-1996
Jan-2001
Jan-2006
Jan-2011
Jan-2016
GW030051
GW030051_1
GW030051_2
Residual Mass


GW030468
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
235
234
233
232
231
230
800
400
0
-400
-800
Jan-1970
Jan-1975
Jan-1980
Jan-1985
Jan-1990
Jan-1995
Jan-2000
Jan-2005
Jan-2010
Jan-2015
GW030468_1
GW030468_1
Residual Mass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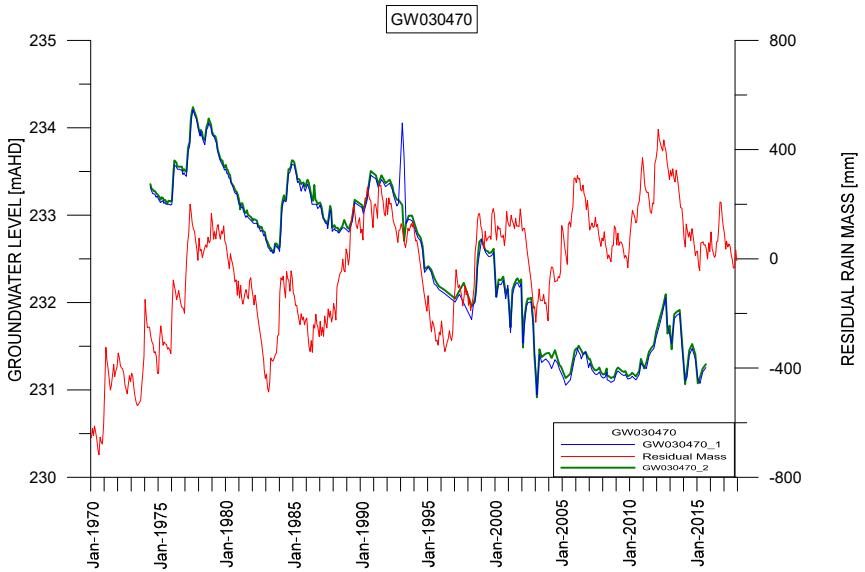
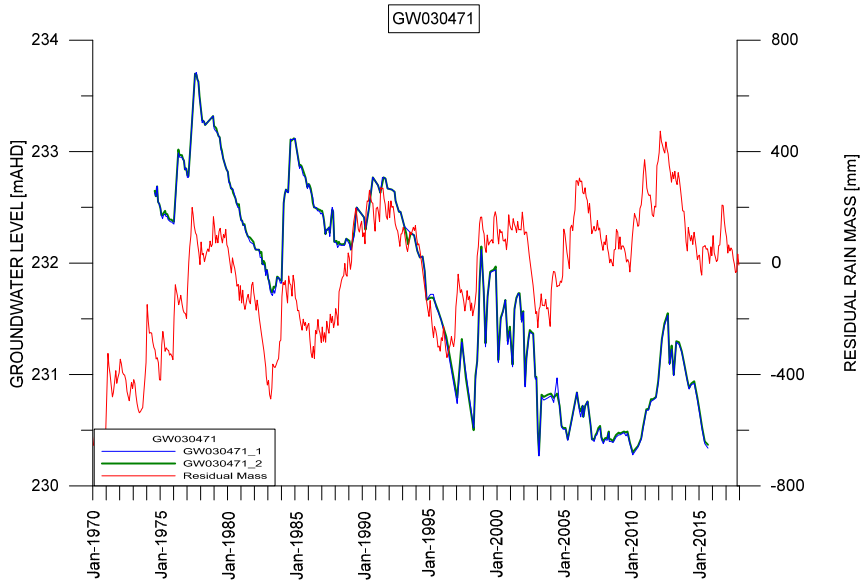
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
235
234
233
232
231
230
800
400
0
-400
-800
Jan-1970
Jan-1975
Jan-1980
Jan-1985
Jan-1990
Jan-1995
Jan-2000
Jan-2005
Jan-2010
Jan-2015
GW030469_1
GW030469_1
Residual Mass


GW030470
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
235
234
233
232
231
230
800
400
0
-400
-800
Jan-1970
Jan-1975
Jan-1980
Jan-1985
Jan-1990
Jan-1995
Jan-2000
Jan-2005
Jan-2010
Jan-2015
GW030470
GW030470_1
Residual Mass
GW030470_2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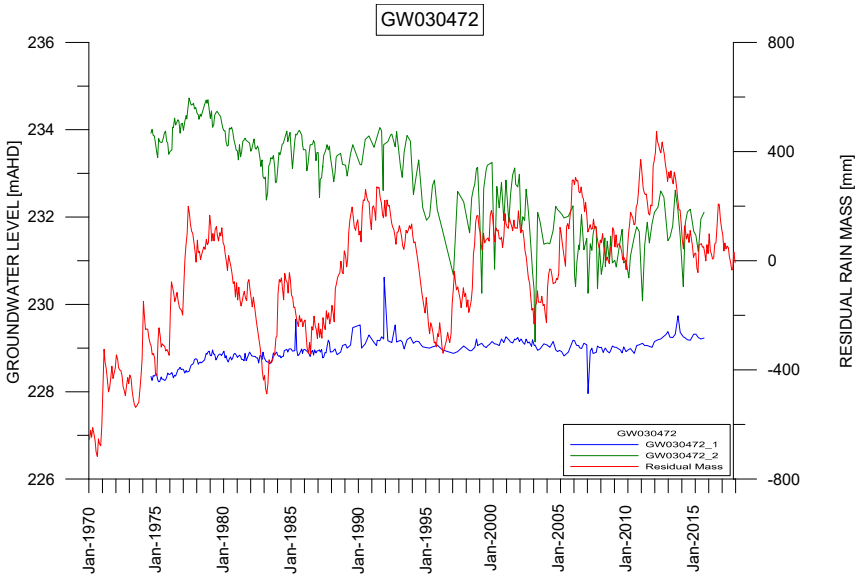
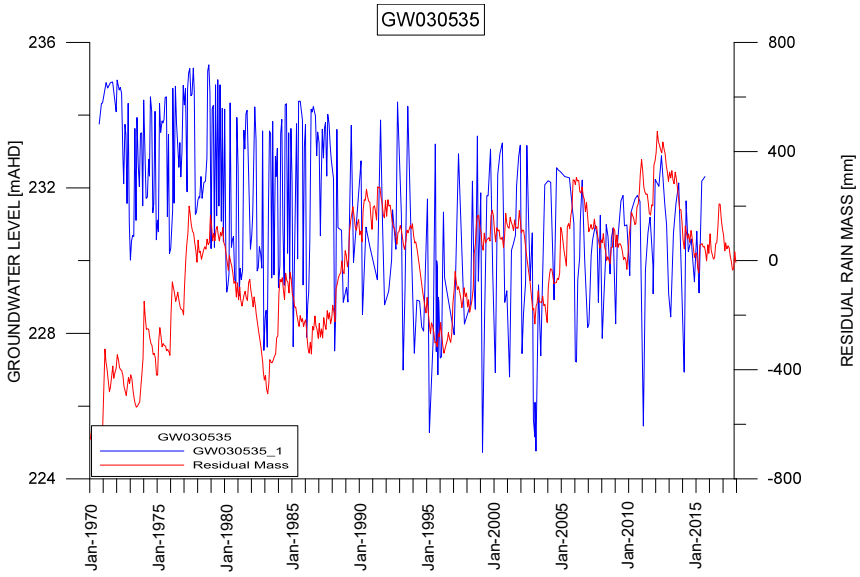
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
234
233
232
231
230
800
400
0
-400
-800
Jan-1970
Jan-1975
Jan-1980
Jan-1985
Jan-1990
Jan-1995
Jan-2000
Jan-2005
Jan-2010
Jan-2015
GW030471
GW030471_1
GW030471_2
Residual Mass


GW030472
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
236
234
232
230
228
226
800
400
0
-400
-800
Jan-1970
Jan-1975
Jan-1980
Jan-1985
Jan-1990
Jan-1995
Jan-2000
Jan-2005
Jan-2010
Jan-2015
GW030472
GW030472_1
GW030472_2
Residual Mass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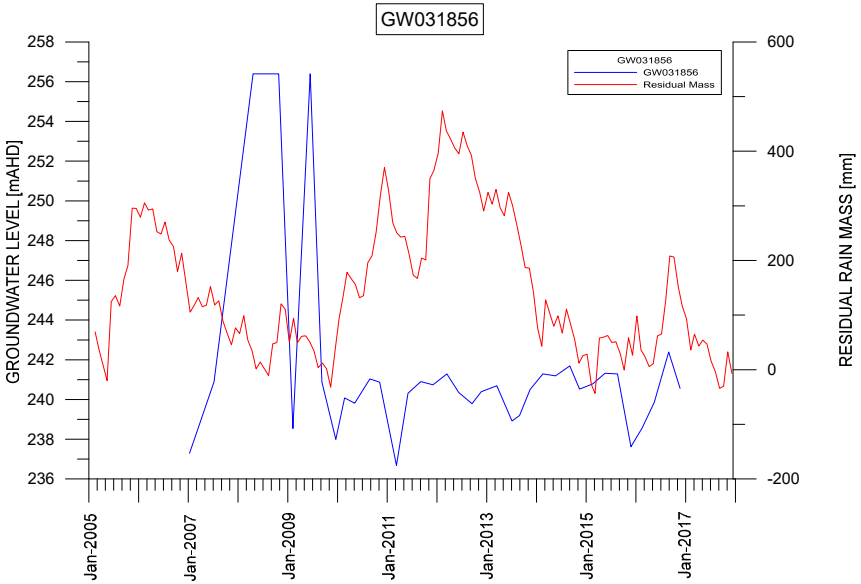
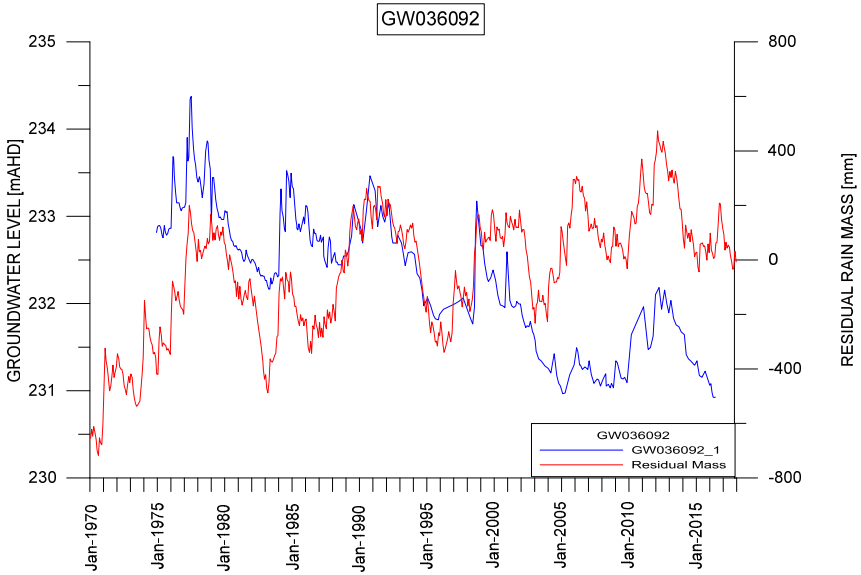
RESIDUAL RAIN MASS [mm]
236
232
228
224
800
400
0
-400
-800
Jan-1970
Jan-1975
Jan-1980
Jan-1985
Jan-1990
Jan-1995
Jan-2000
Jan-2005
Jan-2010
Jan-2015
GW030535
GW030535_1
Residual Mass


GW031856
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
258
256
254
252
250
248
246
244
242
240
238
236
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
GW031856
GW031856
Residual Mass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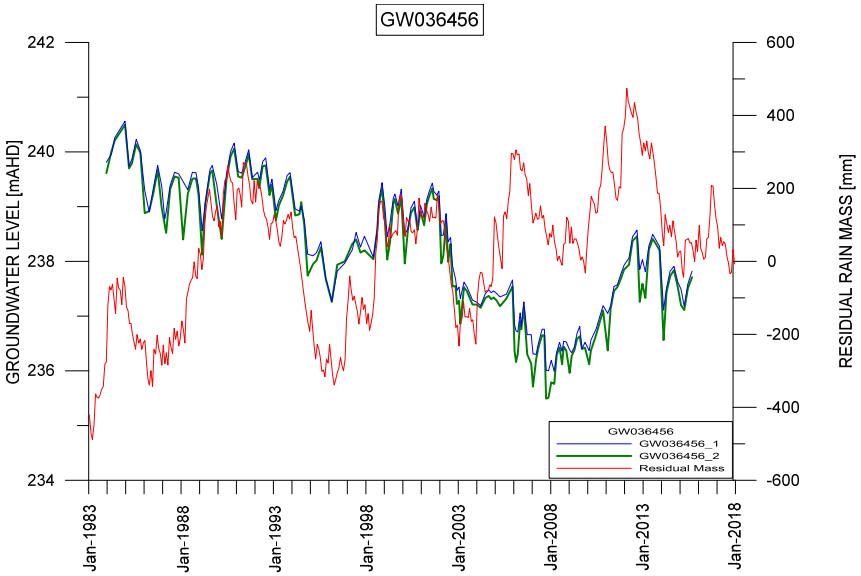
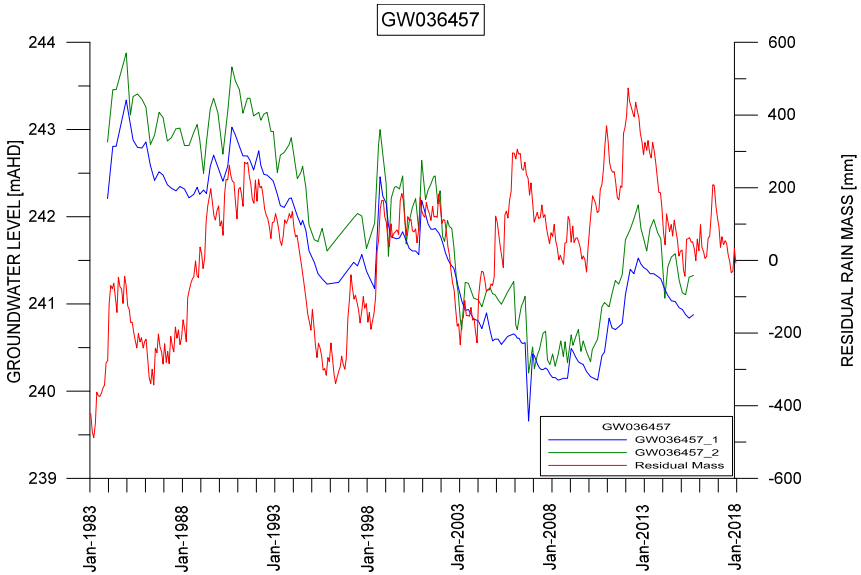
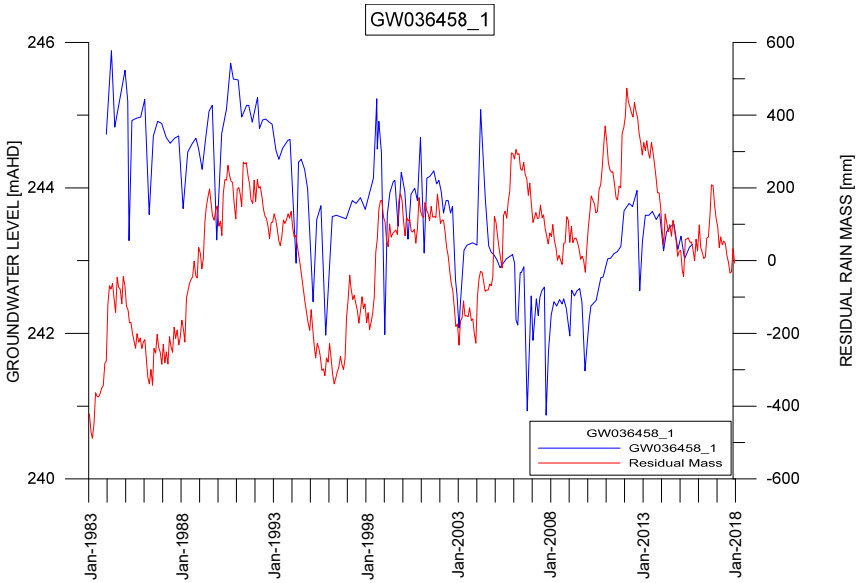
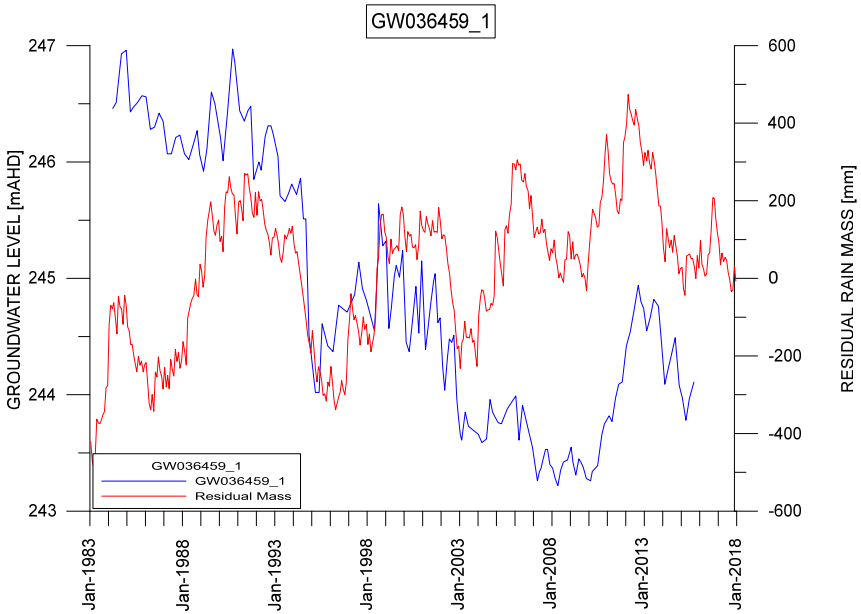
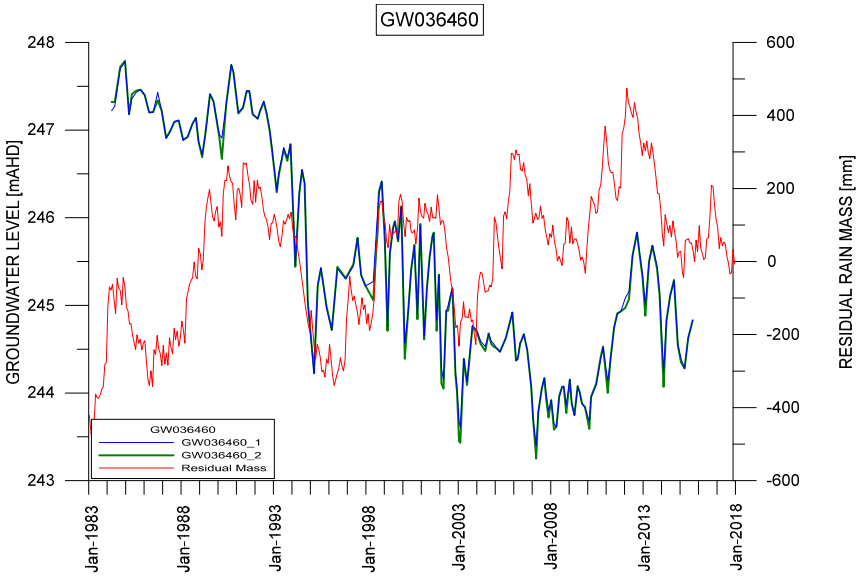
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
235
234
233
232
231
230
800
400
0
-400
-800
Jan-1970
Jan-1975
Jan-1980
Jan-1985
Jan-1990
Jan-1995
Jan-2000
Jan-2005
Jan-2010
Jan-2015
GW036092
GW036092_1
Residual Mass

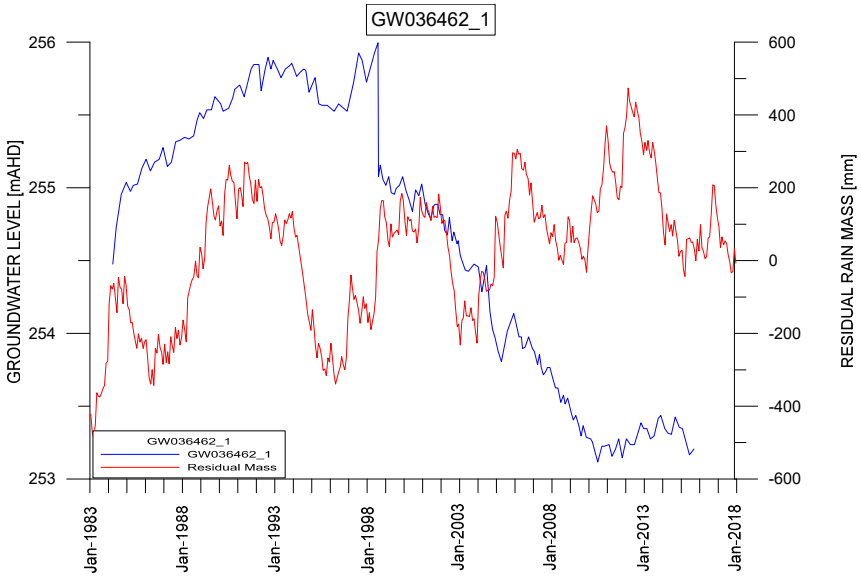

GW036456
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
242
240
238
236
234
600
400
200
0
-200
-400
-600
Jan-1983
Jan-1988
Jan-1993
Jan-1998
Jan-2003
Jan-2008
Jan-2013
Jan-2018
GW036456
GW036456_1
GW036456_2
Residual Mass

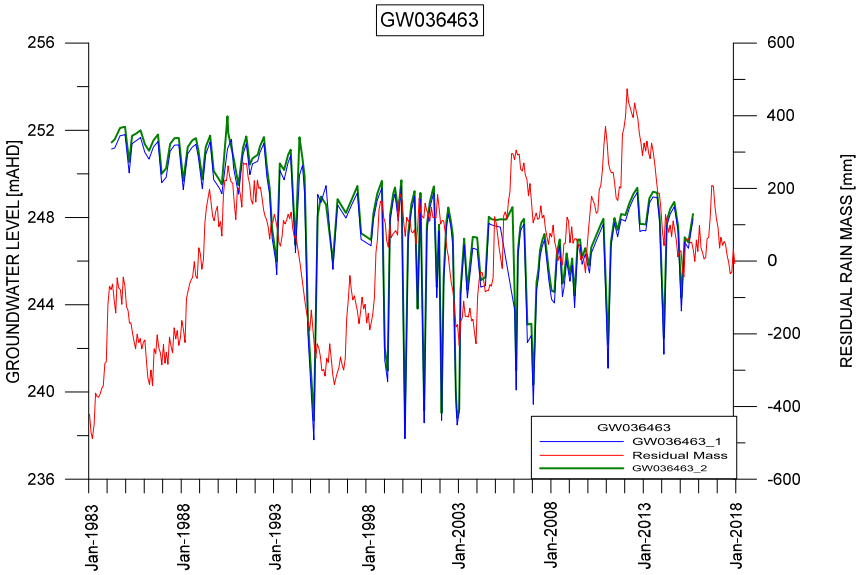

GW036457
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
244
243
242
241
240
239
600
400
200
0
-200
-400
-600
Jan-1983
Jan-1988
Jan-1993
Jan-1998
Jan-2003
Jan-2008
Jan-2013
Jan-2018
GW036457
GW036457_1
GW036457_2
Residual Mass

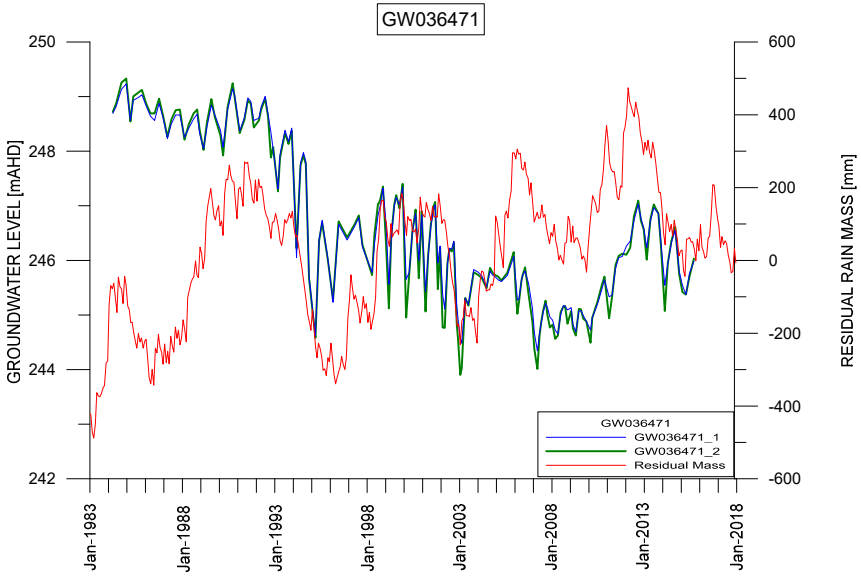

GW036458_1
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
246
244
242
240
600
400
200
0
-200
-400
-600
Jan-1983
Jan-1988
Jan-1993
Jan-1998
Jan-2003
Jan-2008
Jan-2013
Jan-2018
GW036458_1
GW036458_1
Residual Mass

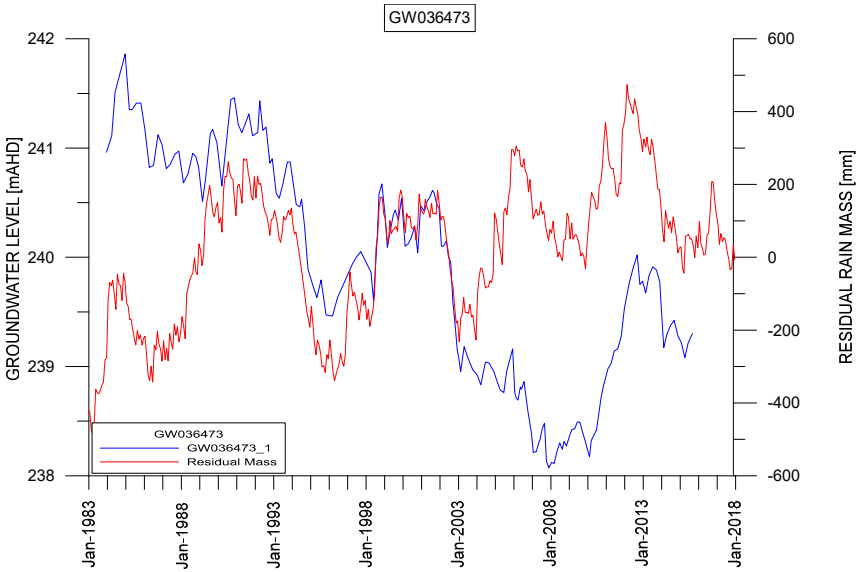

GW036459_1
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
247
246
245
244
243
600
400
200
0
-200
-400
-600
Jan-1983
Jan-1988
Jan-1993
Jan-1998
Jan-2003
Jan-2008
Jan-2013
Jan-2018
GW036459_1
GW036459_1
Residual Mass

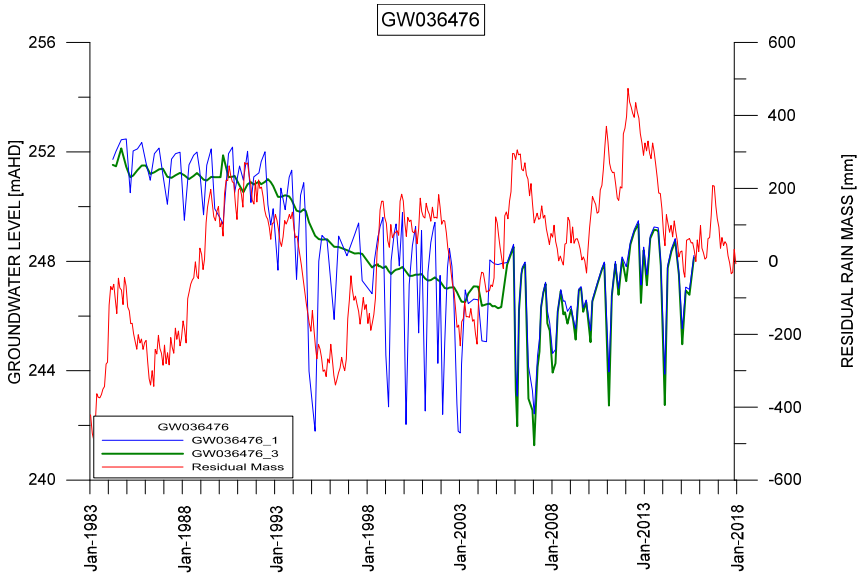

GW036460
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
248
247
246
245
244
243
600
400
200
0
-200
-400
-600
Jan-1983
Jan-1988
Jan-1993
Jan-1998
Jan-2003
Jan-2008
Jan-2013
Jan-2018
GW036460
GW036460_1
GW036460_2
Residual Mass

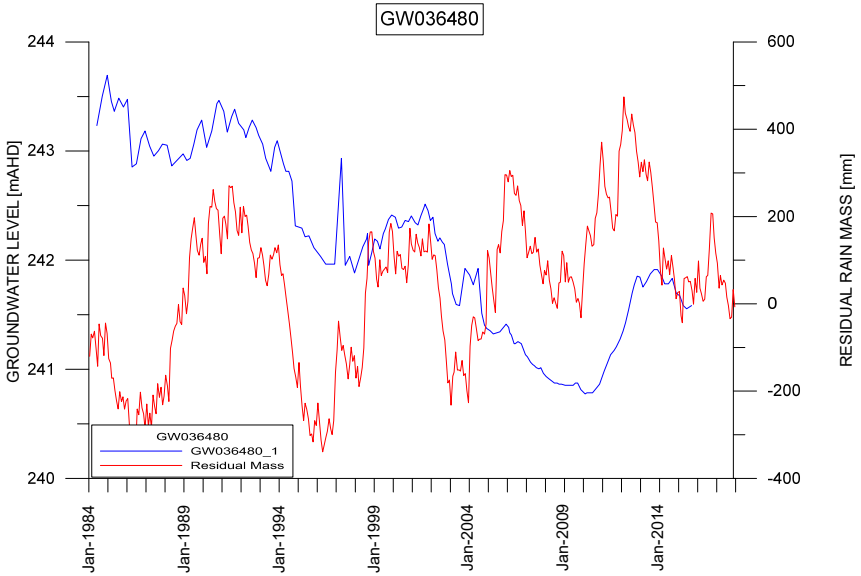

GW036462_1
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
256
255
254
253
600
400
200
0
-200
-400
-600
Jan-1983
Jan-1988
Jan-1993
Jan-1998
Jan-2003
Jan-2008
Jan-2013
Jan-2018
GW036462_1
GW036462_1
Residual Mass

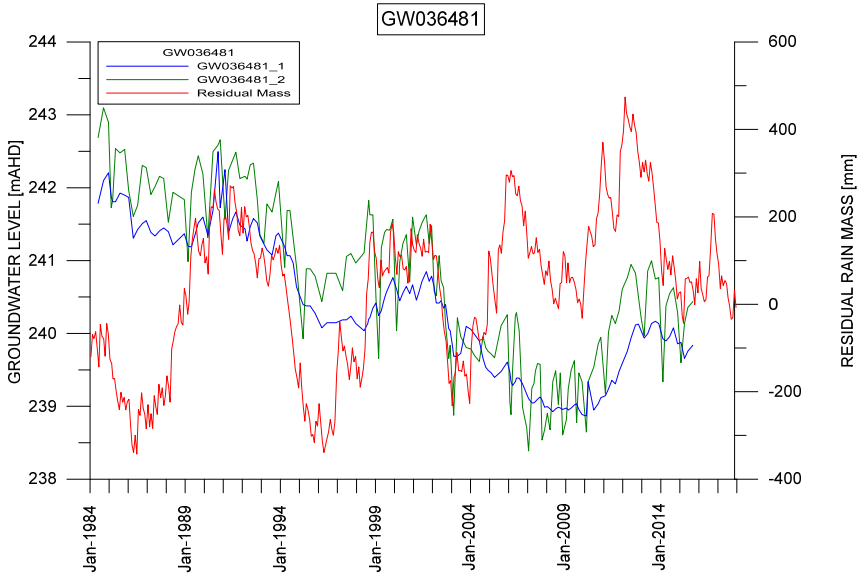

GW036463
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
256
252
248
244
240
236
600
400
200
0
-200
-400
-600
Jan-1983
Jan-1988
Jan-1993
Jan-1998
Jan-2003
Jan-2008
Jan-2013
Jan-2018
GW036463
GW036463_1
Residual Mass
GW036463_2

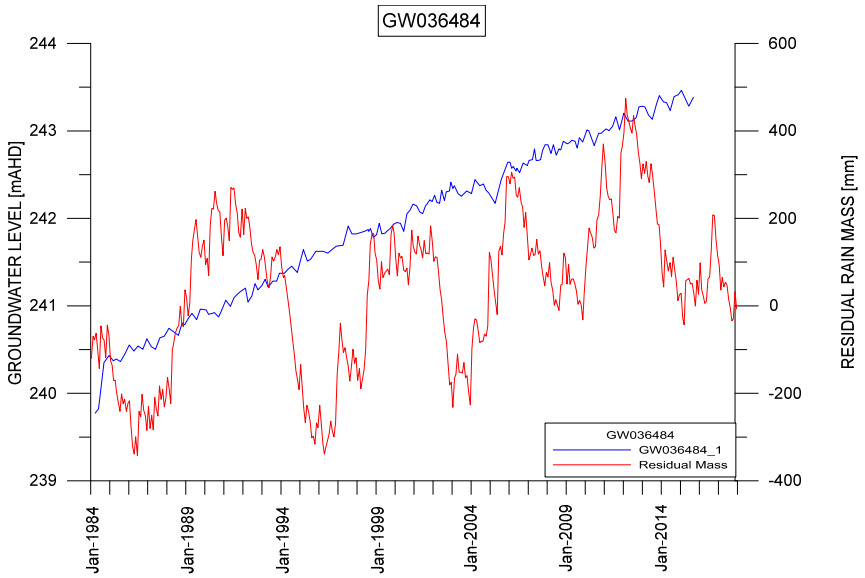

GW036471
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
250
248
246
244
242
600
400
200
0
-200
-400
-600
Jan-1983
Jan-1988
Jan-1993
Jan-1998
Jan-2003
Jan-2008
Jan-2013
Jan-2018
GW036471
GW036471_1
GW036471_2
Residual Mass

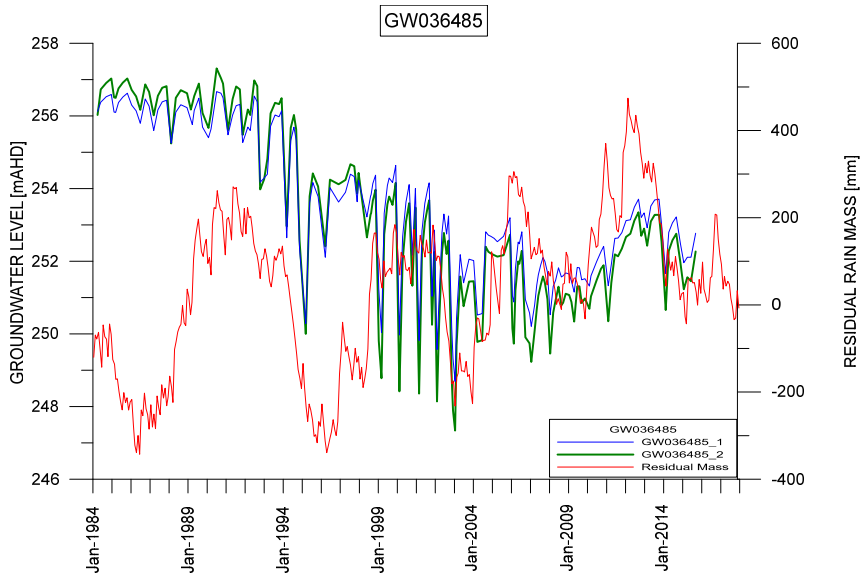

GW036473
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
242
241
240
239
238
600
400
200
0
-200
-400
-600
Jan-1983
Jan-1988
Jan-1993
Jan-1998
Jan-2003
Jan-2008
Jan-2013
Jan-2018
GW036473
GW036473_1
Residual Mass

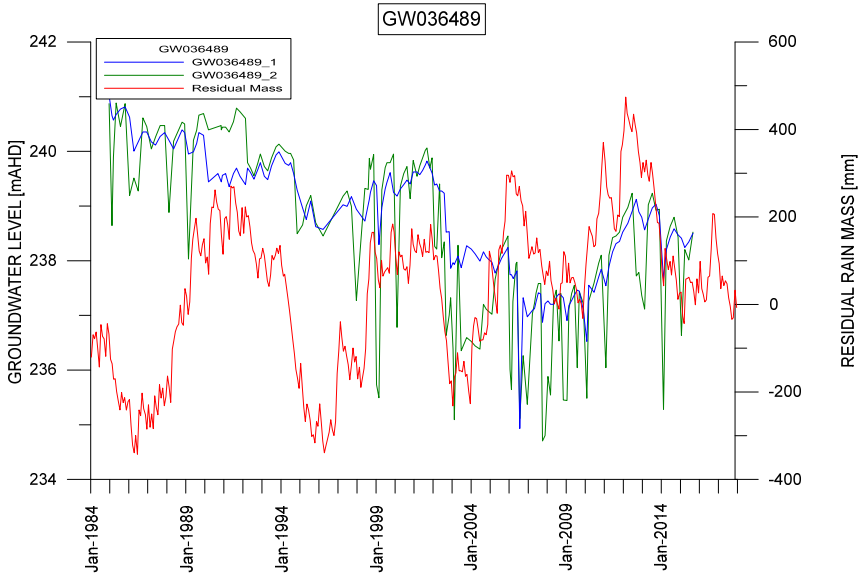

GW036476
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
256
252
248
244
240
600
400
200
0
-200
-400
-600
Jan-1983
Jan-1988
Jan-1993
Jan-1998
Jan-2003
Jan-2008
Jan-2013
Jan-2018
GW036476
GW036476_1
GW036476_3
Residual Mass

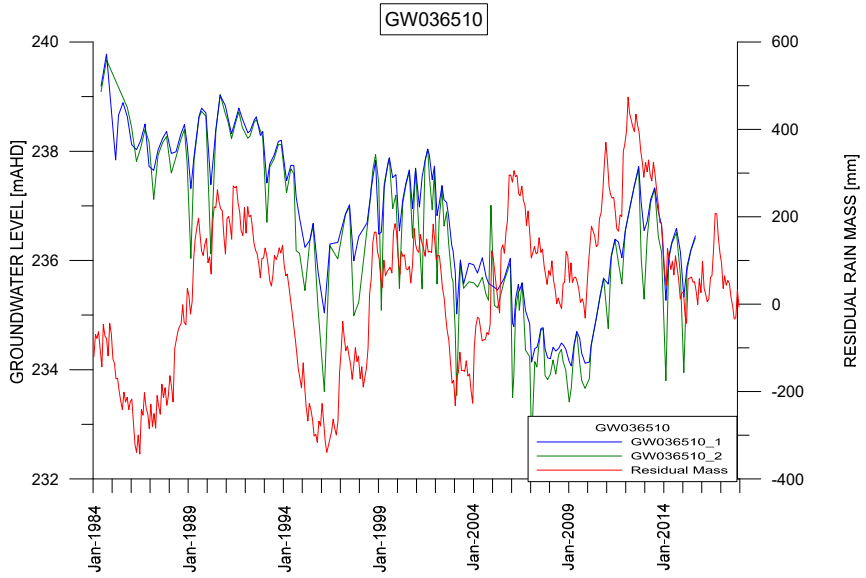

GW036480
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
244
243
242
241
240
600
400
200
0
-200
-400
Jan-1984
Jan-1989
Jan-1994
Jan-1999
Jan-2004
Jan-2009
Jan-2014
GW036480
GW036480_1
Residual Mass

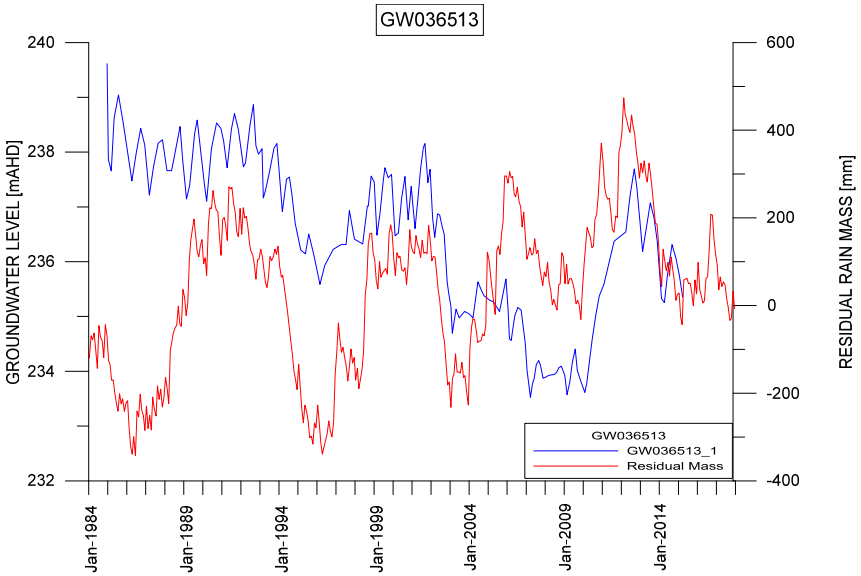

GW036481
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
244
243
242
241
240
239
238
600
400
200
0
-200
-400
Jan-1984
Jan-1989
Jan-1994
Jan-1999
Jan-2004
Jan-2009
Jan-2014
GW036481
GW036481_1
GW036481_2
Residual Mass

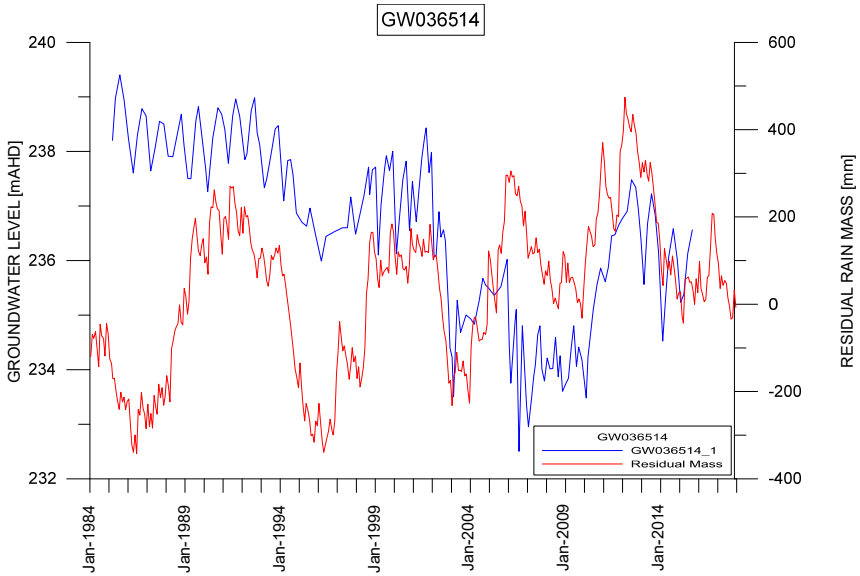

GW036484
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
244
243
242
241
240
239
600
400
200
0
-200
-400
Jan-1984
Jan-1989
Jan-1994
Jan-1999
Jan-2004
Jan-2009
Jan-2014
GW036484
GW036484_1
Residual Mass

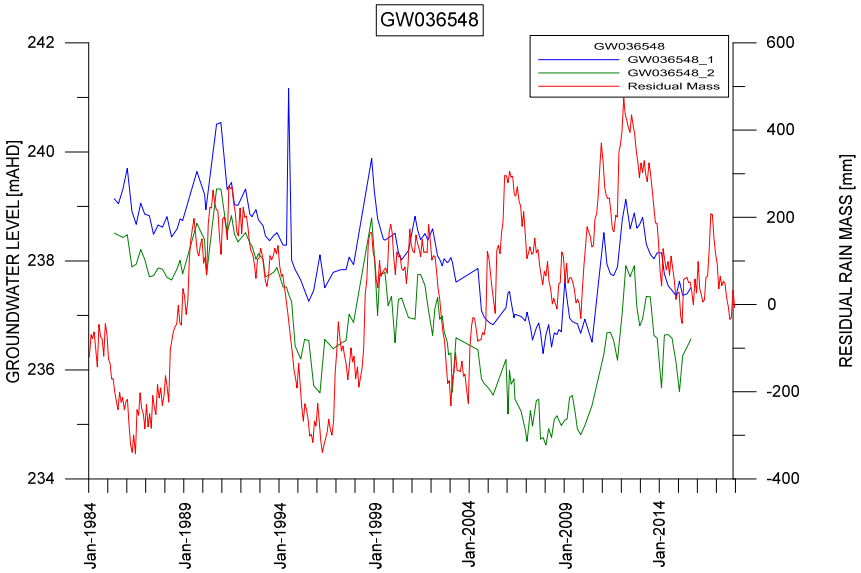

GW036485
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
258
256
254
252
250
248
246
600
400
200
0
-200
-400
Jan-1984
Jan-1989
Jan-1994
Jan-1999
Jan-2004
Jan-2009
Jan-2014
GW036485
GW036485_1
GW036485_2
Residual Mass

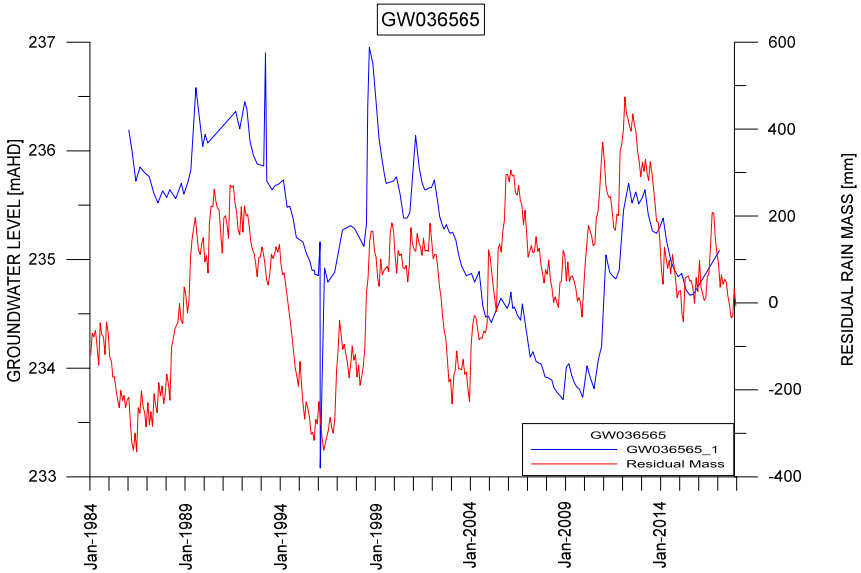

GW036489
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
242
240
238
236
234
600
400
200
0
-200
-400
Jan-1984
Jan-1989
Jan-1994
Jan-1999
Jan-2004
Jan-2009
Jan-2014
GW036489
GW036489_1
GW036489_2
Residual Mass

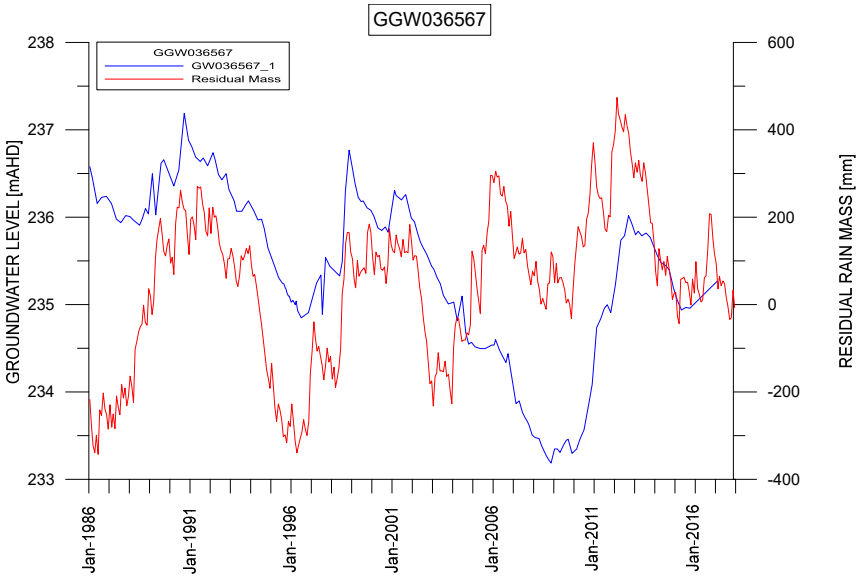

GW036510
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
240
238
236
234
232
600
400
200
0
-200
-400
Jan-1984
Jan-1989
Jan-1994
Jan-1999
Jan-2004
Jan-2009
Jan-2014
GW036510
GW036510_1
GW036510_2
Residual Mass

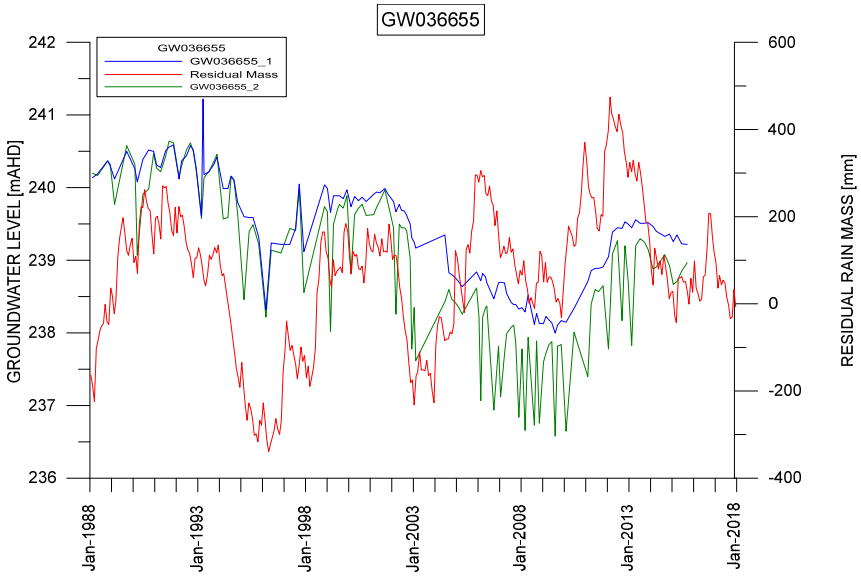

GW036513
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
240
238
236
234
232
600
400
200
0
-200
-400
Jan-1984
Jan-1989
Jan-1994
Jan-1999
Jan-2004
Jan-2009
Jan-2014
GW036513
GW036513_1
Residual Mass

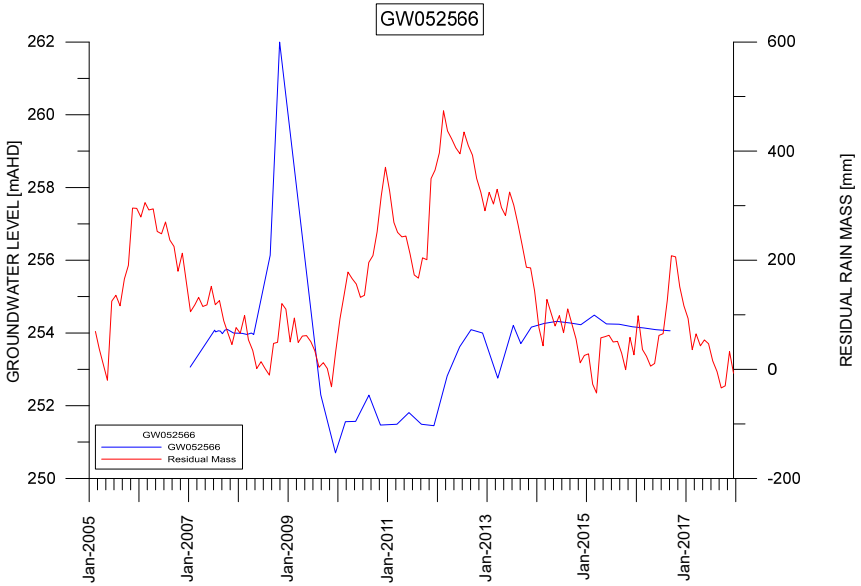

GW036514
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
240
238
236
234
232
600
400
200
0
-200
-400
Jan-1984
Jan-1989
Jan-1994
Jan-1999
Jan-2004
Jan-2009
Jan-2014
GW036514
GW036514_1
Residual Mass

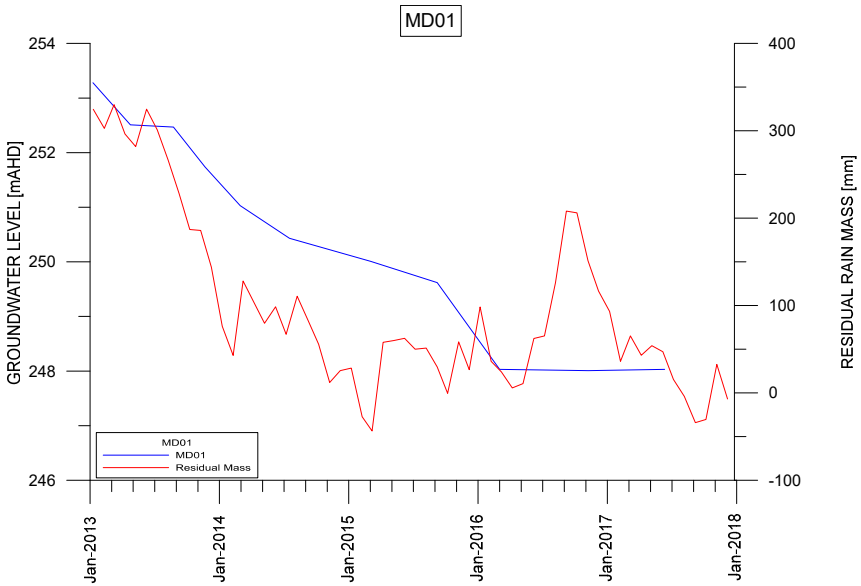

GW036548
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
242
240
238
236
234
600
400
200
0
-200
-400
Jan-1984
Jan-1989
Jan-1994
Jan-1999
Jan-2004
Jan-2009
Jan-2014
GW036548
GW036548_1
GW036548_2
Residual Mass

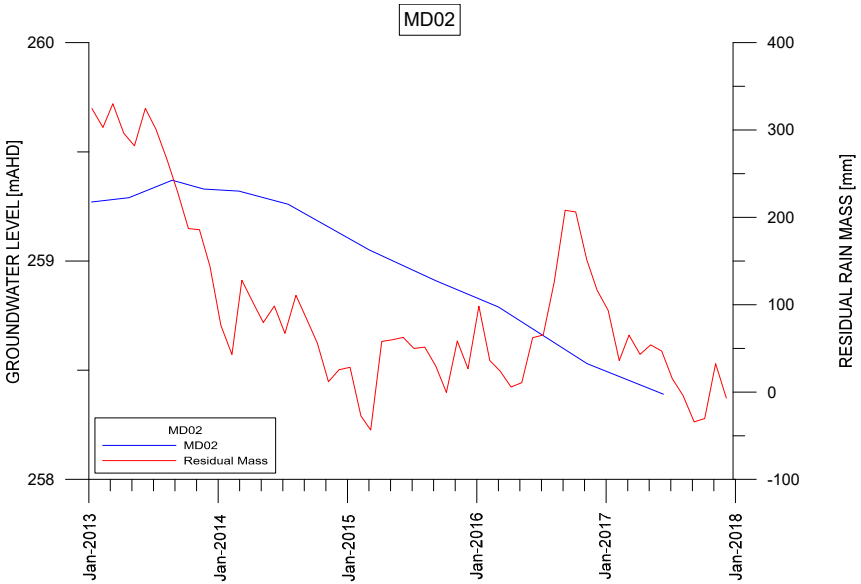

GW036565
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
237
236
235
234
233
600
400
200
0
-200
-400
Jan-1984
Jan-1989
Jan-1994
Jan-1999
Jan-2004
Jan-2009
Jan-2014
GW036565
GW036565_1
Residual Mass

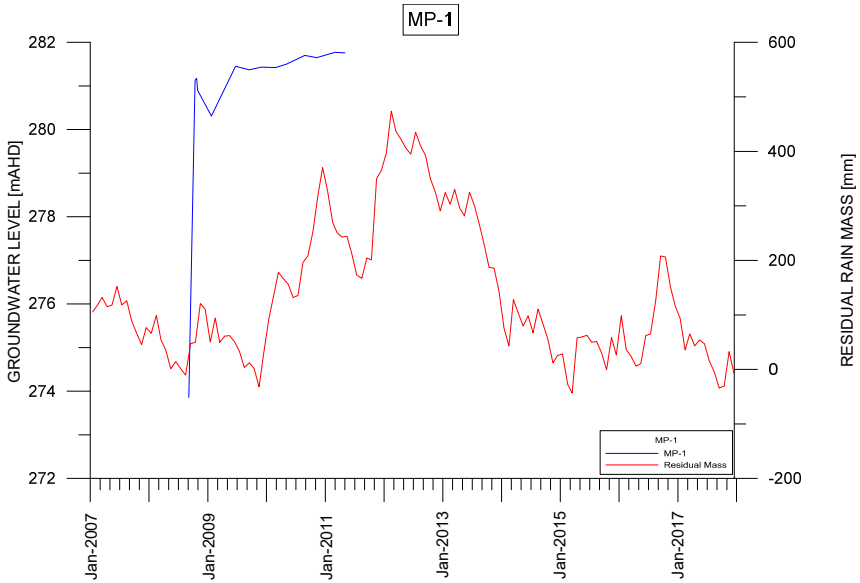

GGW036567
GGW036567
GW036567_1
Residual Mass
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
238
237
236
235
234
233
600
400
200
0
-200
-400
Jan-1986
Jan-1991
Jan-1996
Jan-2001
Jan-2006
Jan-2011
Jan-2016

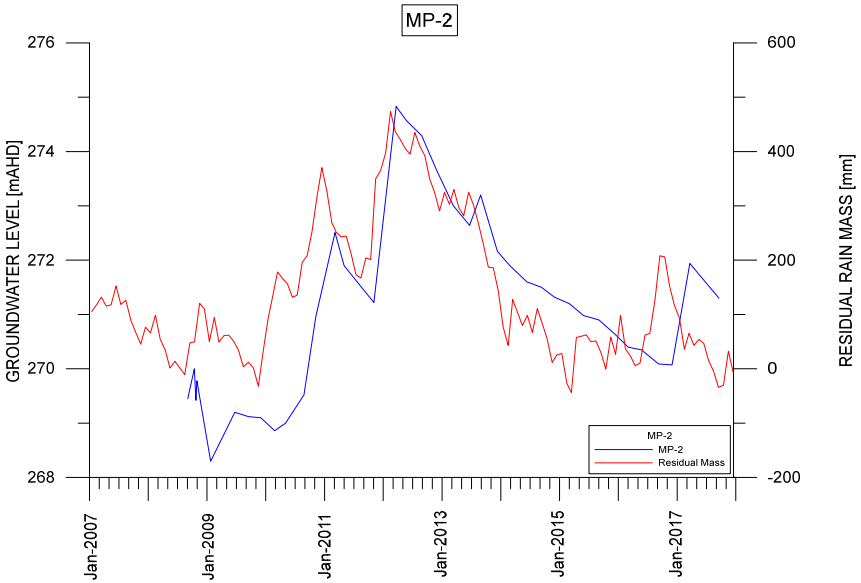

GW036655
GW036655
GW036655_1
Residual Mass
GW036655_2
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
242
241
240
239
238
237
236
600
400
200
0
-200
-400
Jan-1988
Jan-1993
Jan-1998
Jan-2003
Jan-2008
Jan-2013
Jan-2018

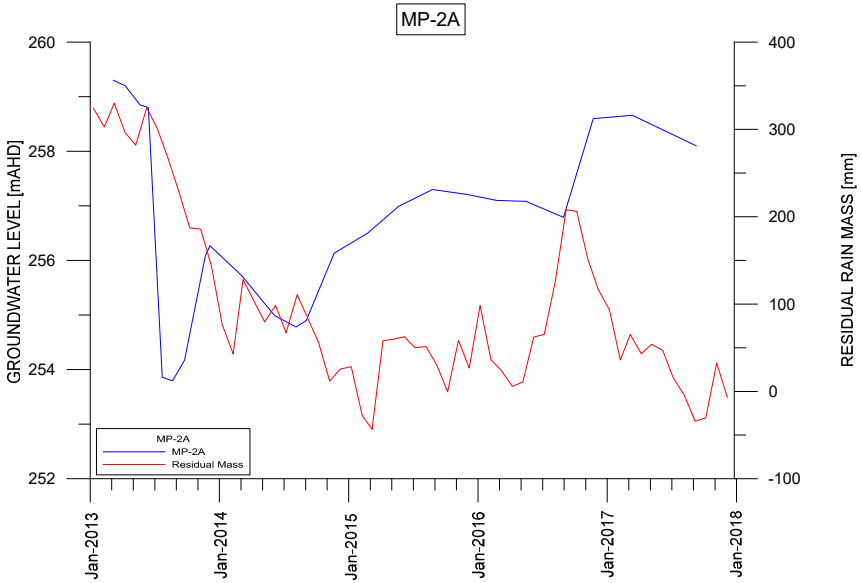

GW052566
GW052566
GW052566
Residual Mass
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
262
260
258
256
254
252
250
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017

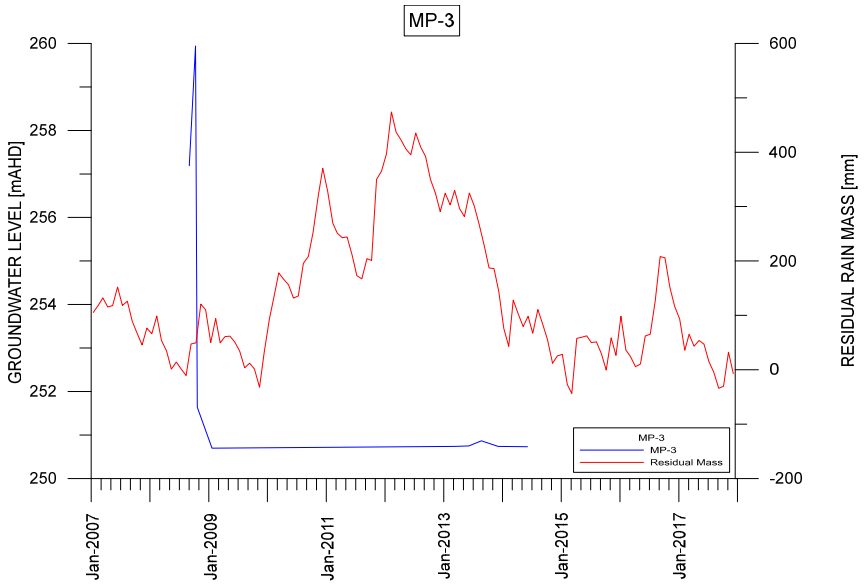

MD01
MD01
MD01
Residual Mass
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
254
252
250
248
246
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018

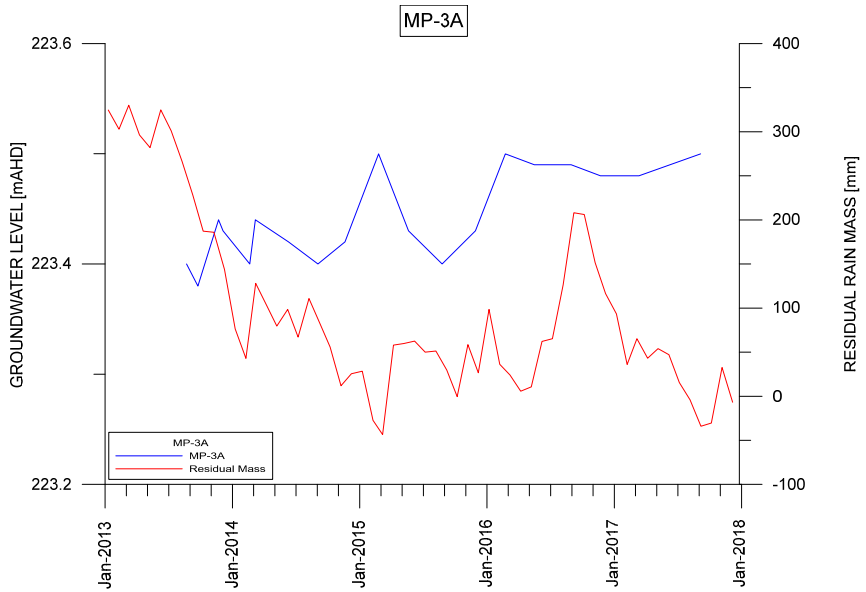

MD02
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
260
259
258
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MD02
MD02
Residual Mass

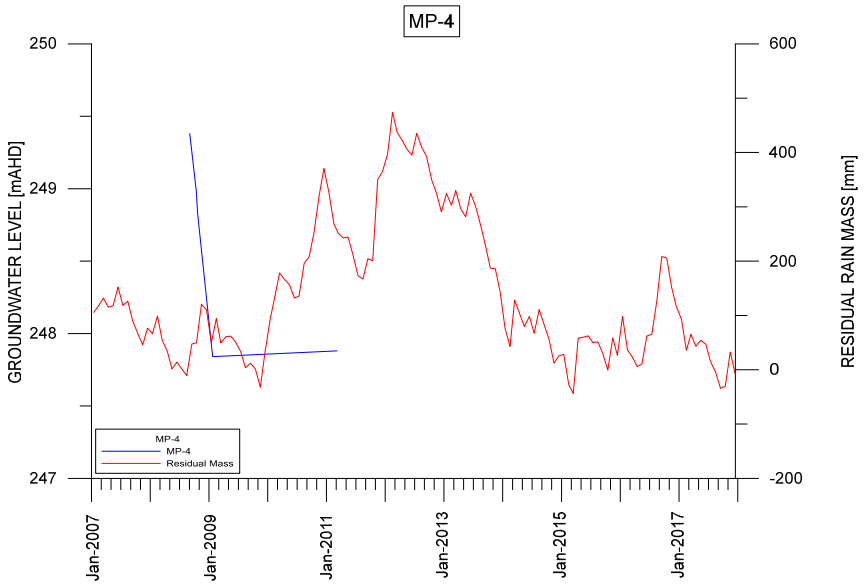

MP-1
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
282
280
278
276
274
272
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MP-1
MP-1
Residual Mass

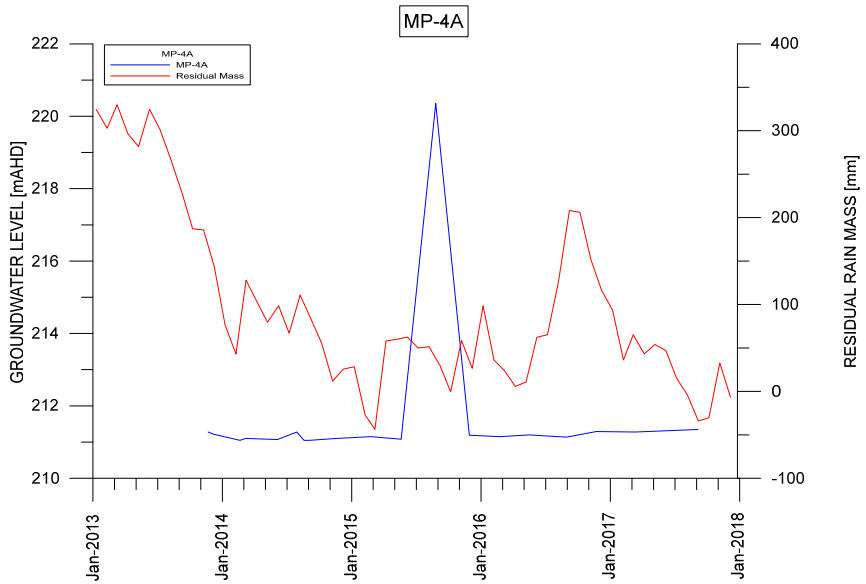

MP-2
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
276
274
272
270
268
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MP-2
MP-2
Residual Mass

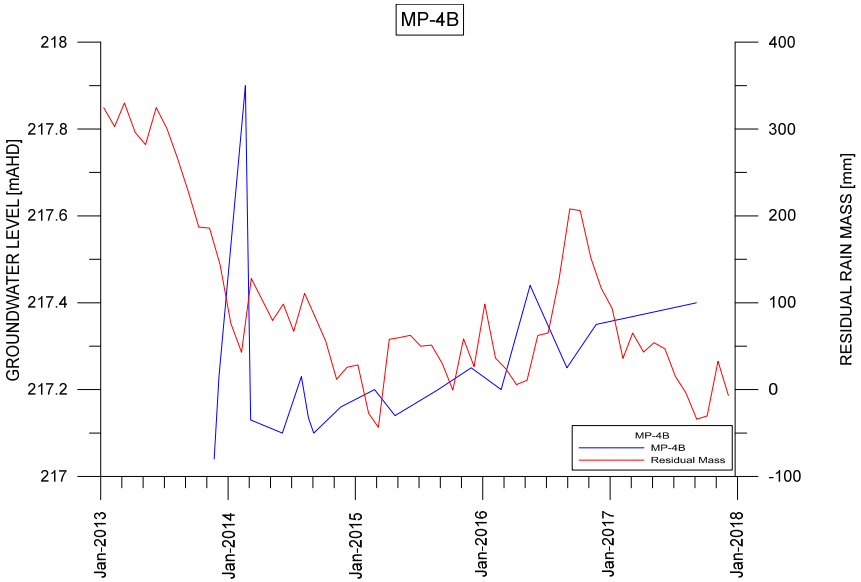

MP-2A
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
260
258
256
254
252
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MP-2A
MP-2A
Residual Mass

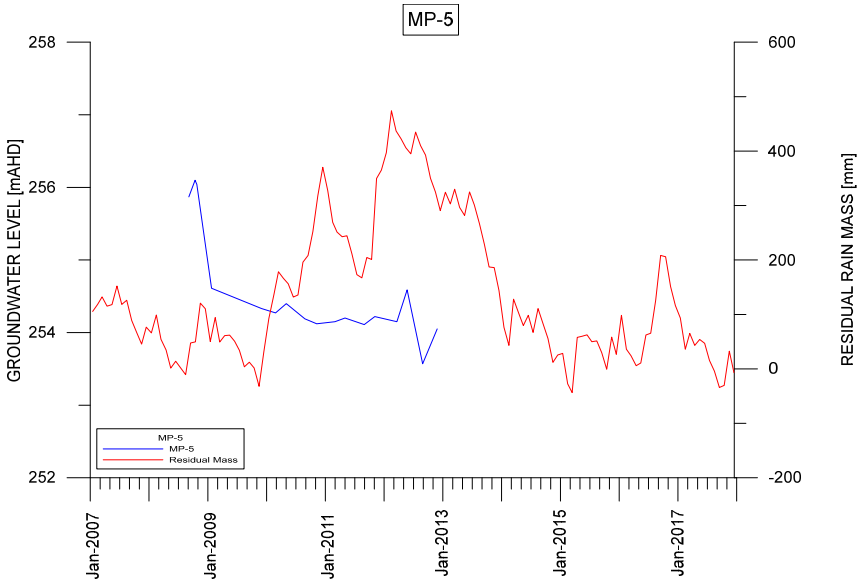

MP-3
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
260
258
256
254
252
250
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MP-3
MP-3
Residual Mass

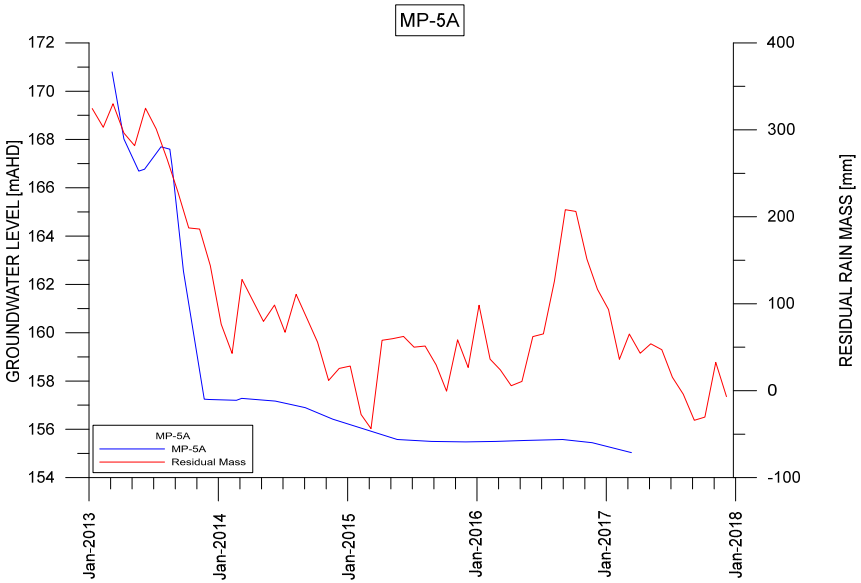

MP-3A
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
223.6
223.4
223.2
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MP-3A
MP-3A
Residual Mass

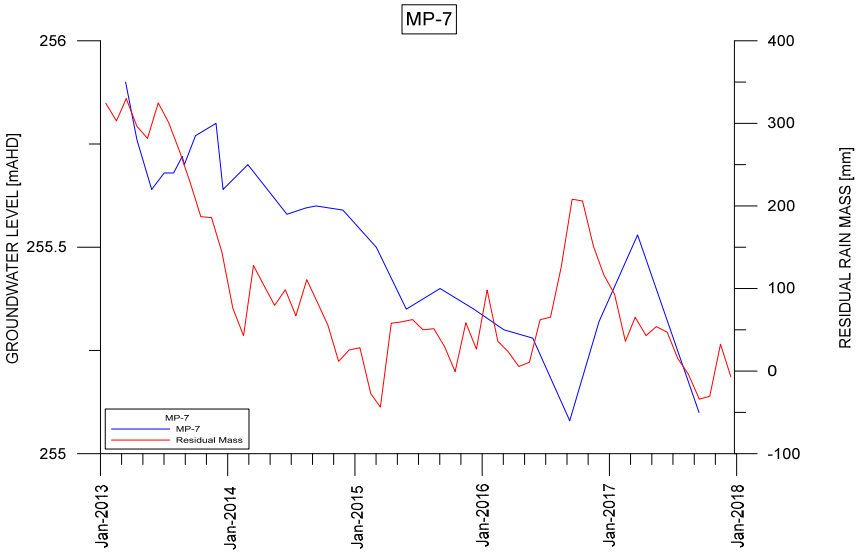

MP-4
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
250
249
248
247
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MP-4
MP-4
Residual Mass

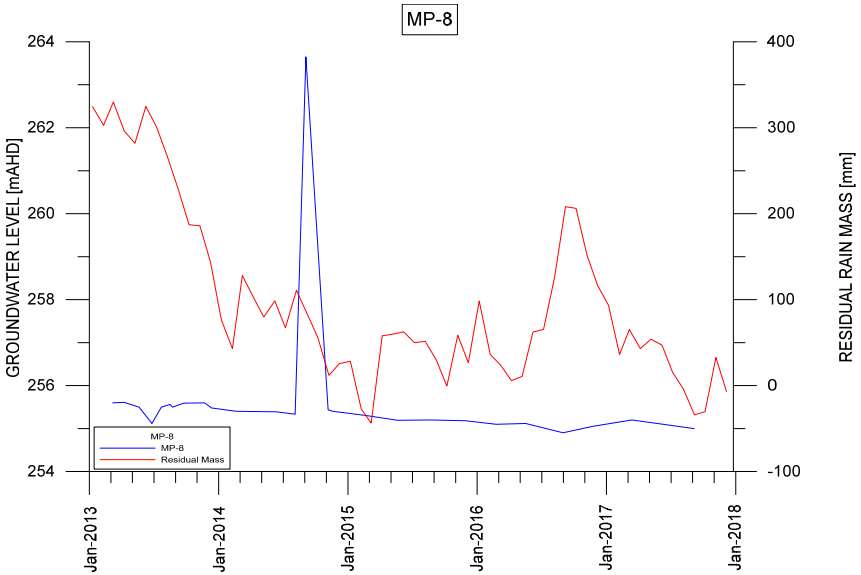

MP-4A
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
222
220
218
216
214
212
210
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MP-4A
MP-4A
Residual Mass

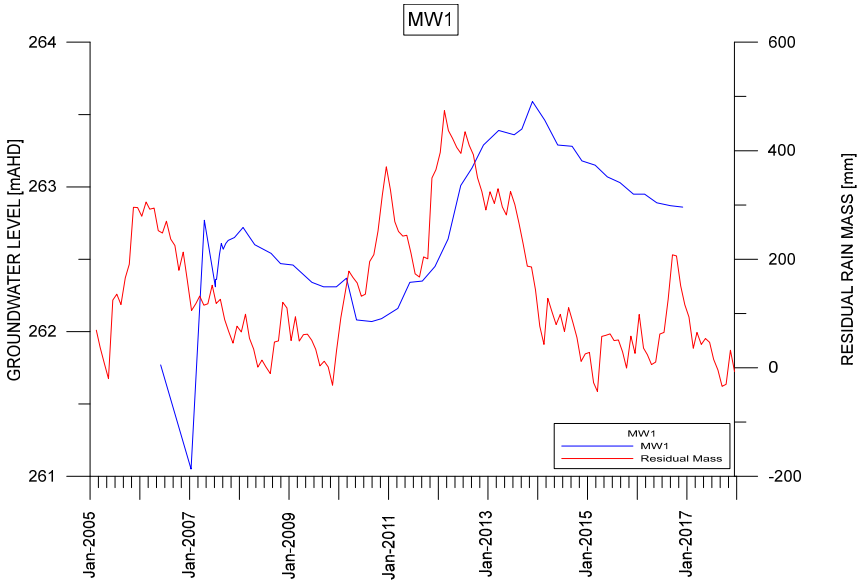

MP-4B
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
218
217.8
217.6
217.4
217.2
217
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MP-4B
MP-4B
Residual Mass

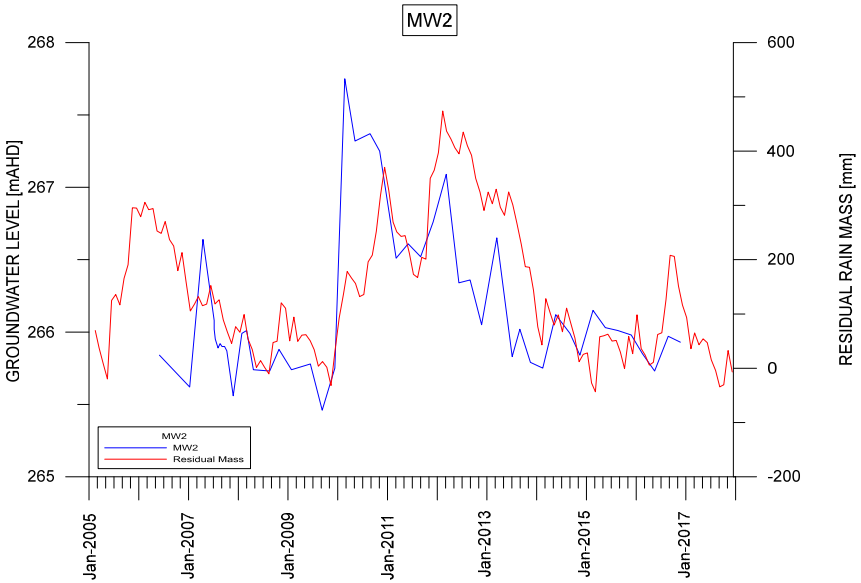

MP-5
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
258
256
254
252
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MP-5
MP-5
Residual Mass

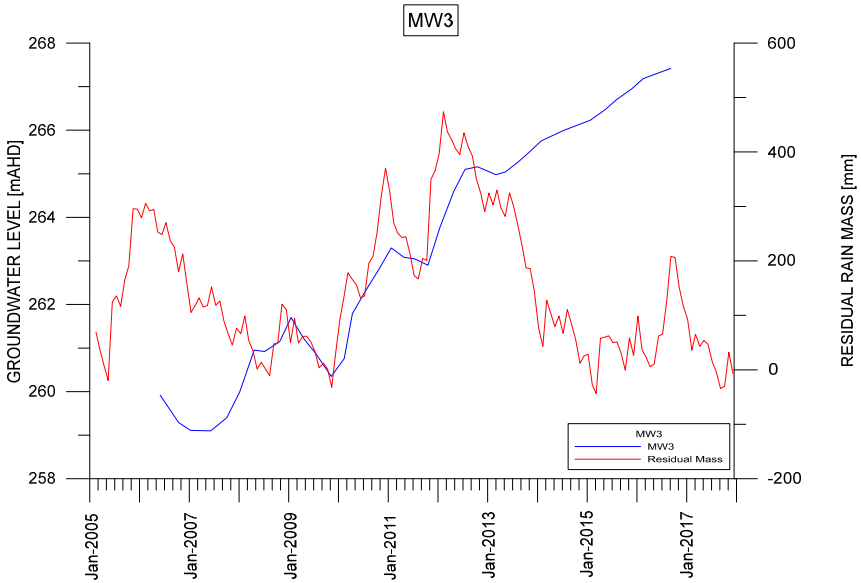

MP-5A
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
172
170
168
166
164
162
160
158
156
154
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MP-5A
MP-5A
Residual Mass

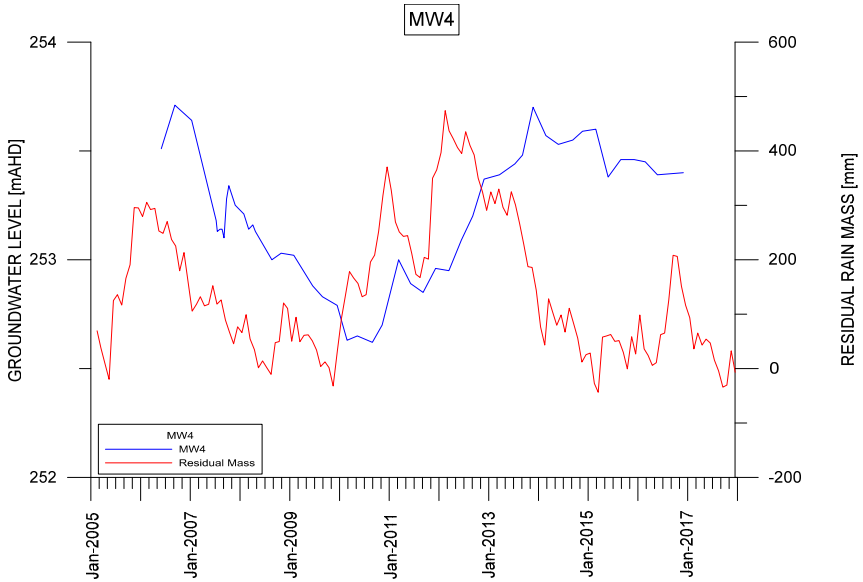

MP-7
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
256
255.5
255
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MP-7
MP-7
Residual Mass

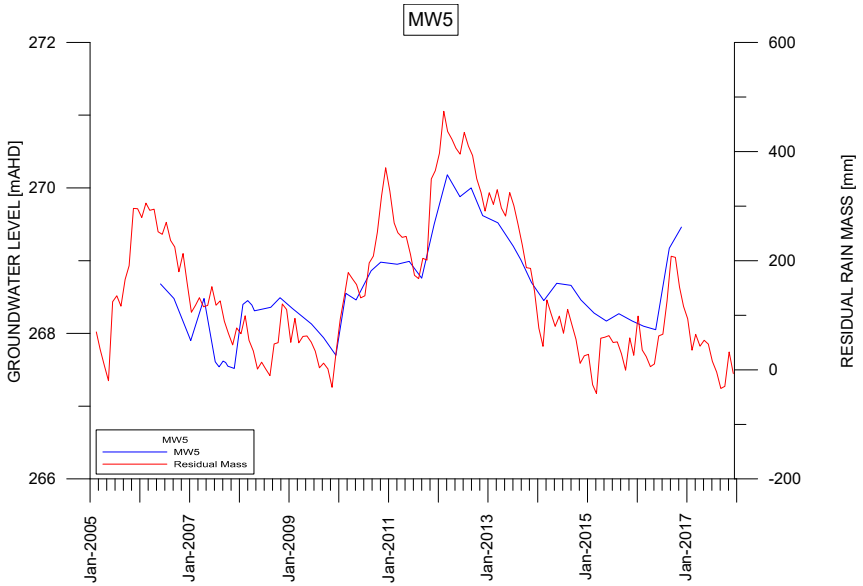

MP-8
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
264
262
260
258
256
254
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
MP-8
MP-8
Residual Mass

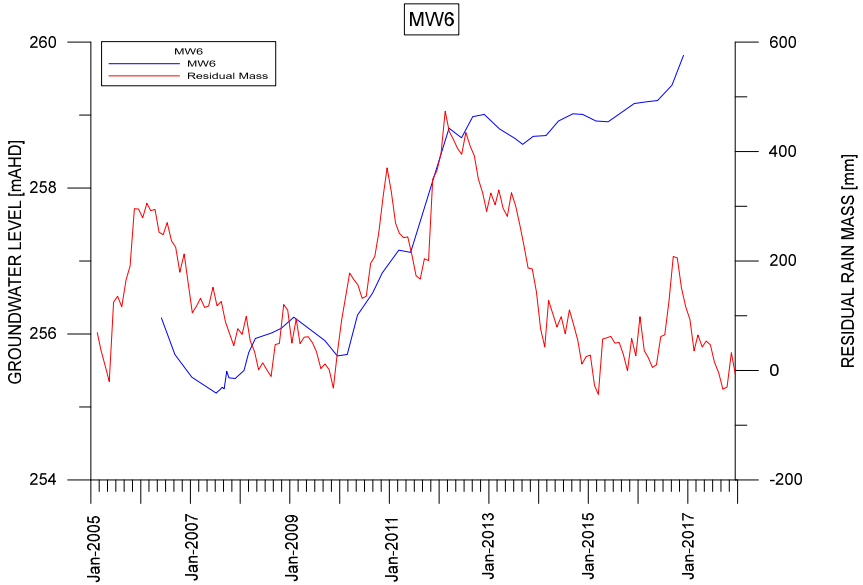

MW1
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
264
263
262
261
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MW1
MW1
Residual Mass

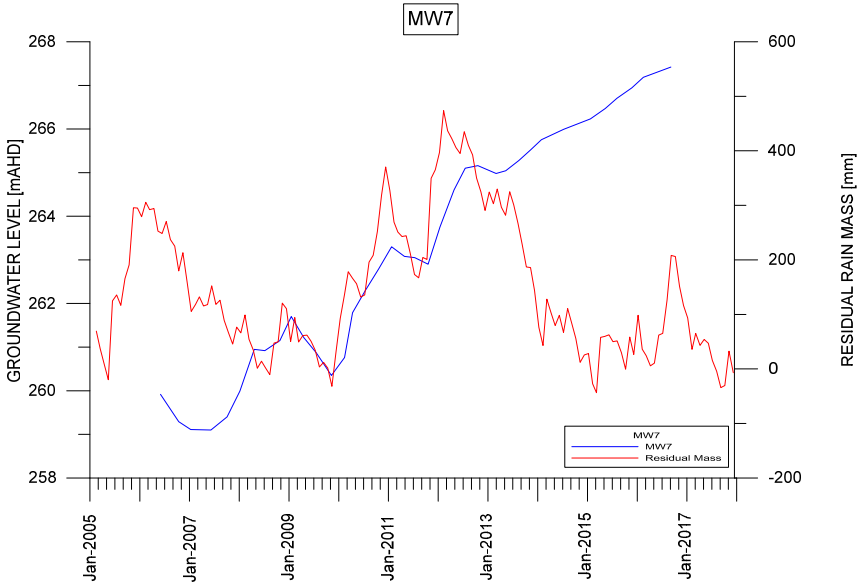

MW2
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
268
267
266
265
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MW2
MW2
Residual Mass

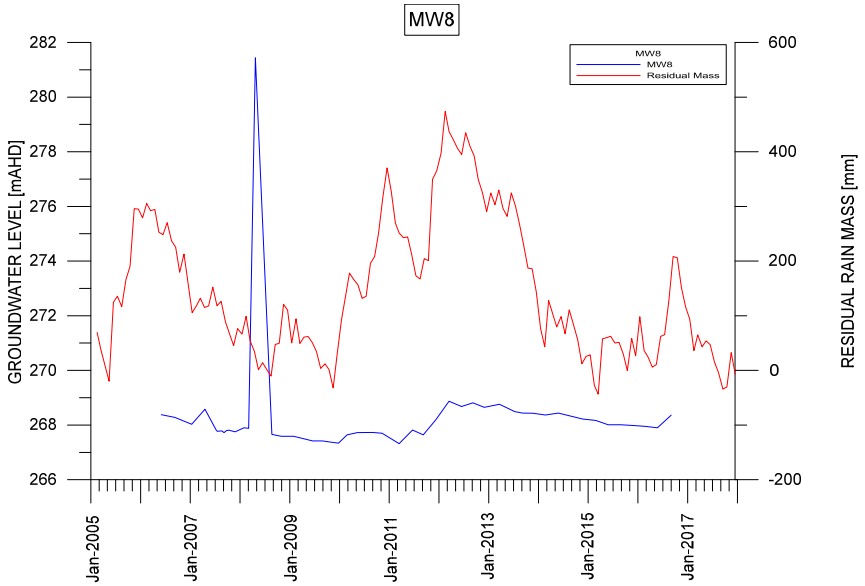

MW3
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
268
266
264
262
260
258
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MW3
MW3
Residual Mass

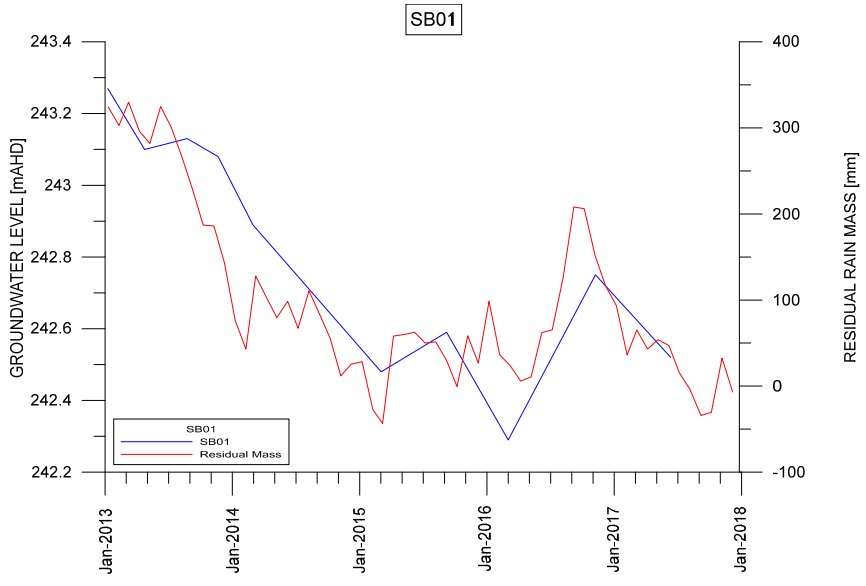

MW4
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
254
253
252
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MW4
MW4
Residual Mass

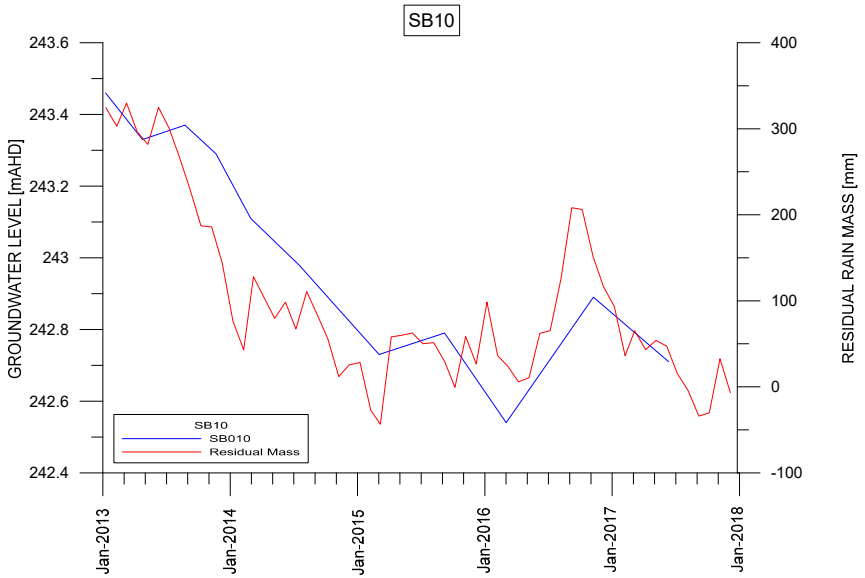

MW5
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
272
270
268
266
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MW5
MW5
Residual Mass

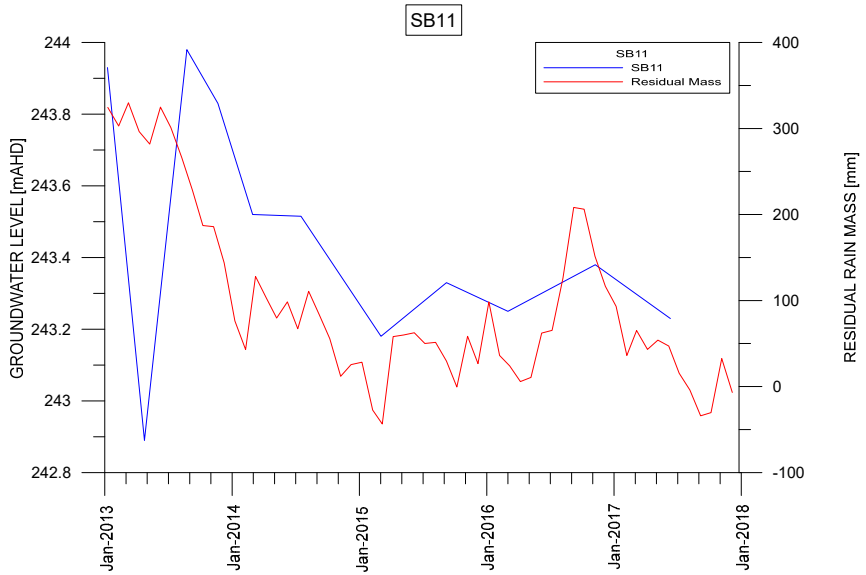

MW6
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
260
258
256
254
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MW6
MW6
Residual Mass

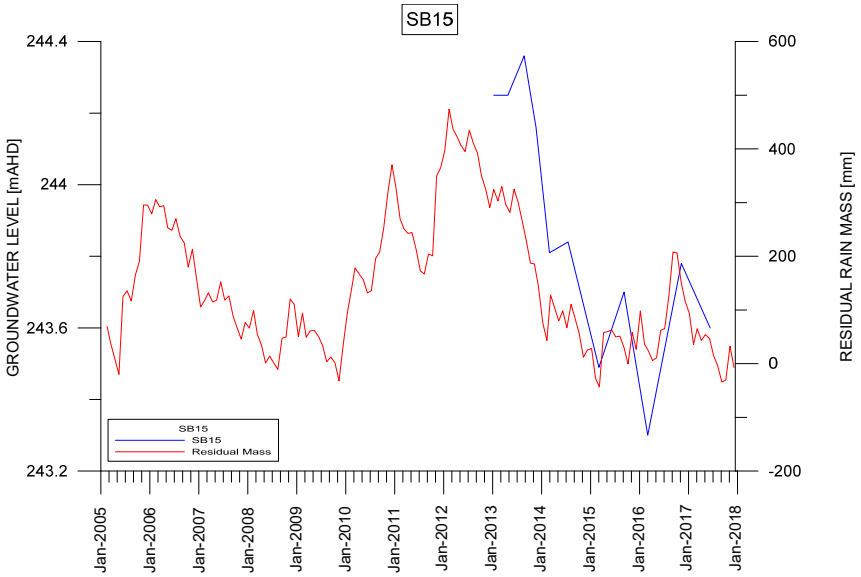

MW7
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
268
266
264
262
260
258
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
MW7
MW7
Residual Mass

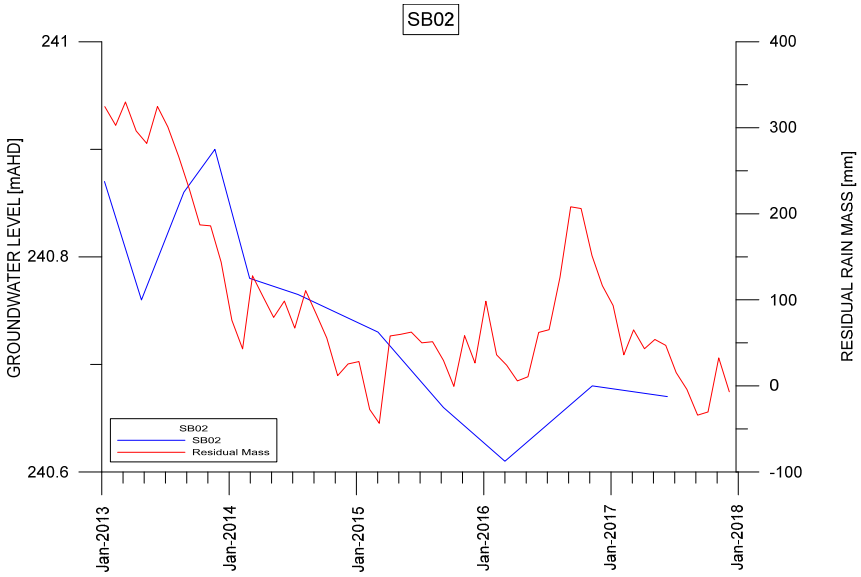

MW8
MW8
MW8
Residual Mass
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
282
280
278
276
274
272
270
268
266
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017

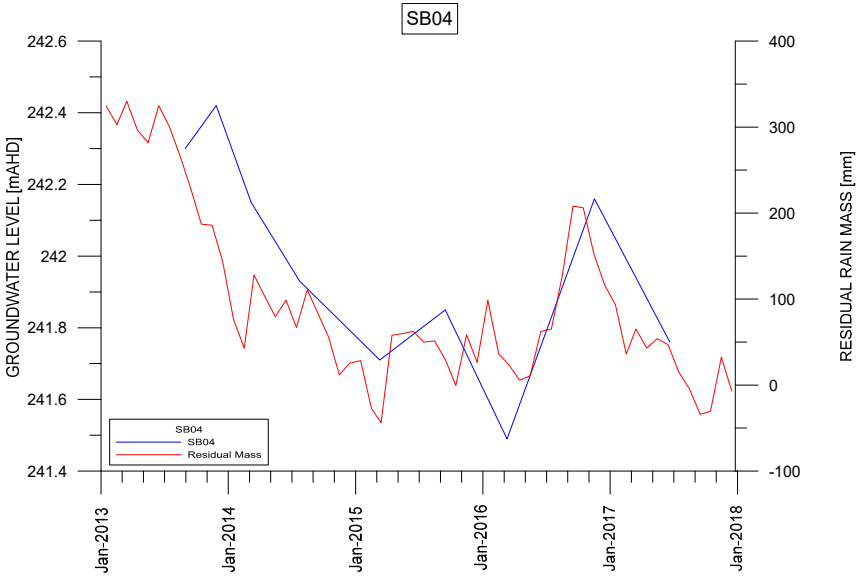

SB01
SB01
SB01
Residual Mass
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
243.4
243.2
243
242.8
242.6
242.4
242.2
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018

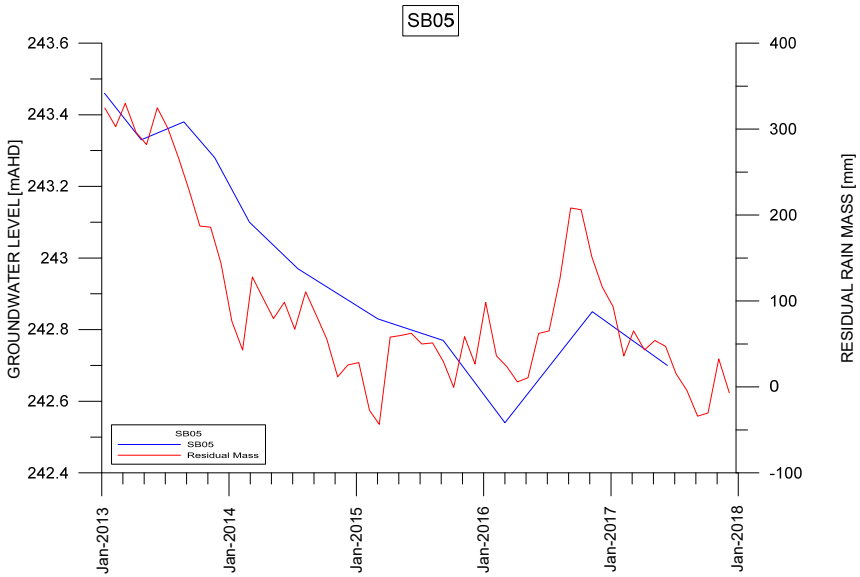

SB10
SB10
SB010
Residual Mass
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
243.6
243.4
243.2
243
242.8
242.6
242.4
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018

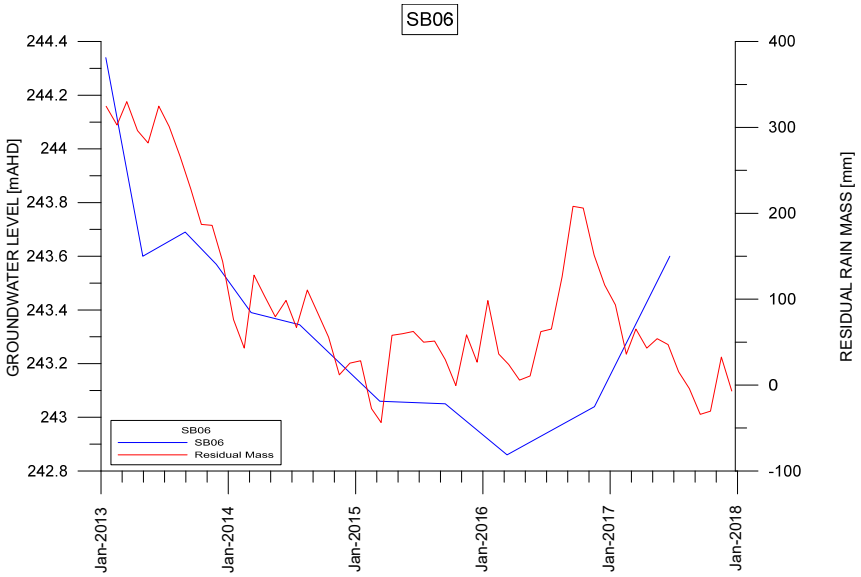

SB11
SB11
SB11
Residual Mass
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
244
243.8
243.6
243.4
243.2
243
242.8
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018

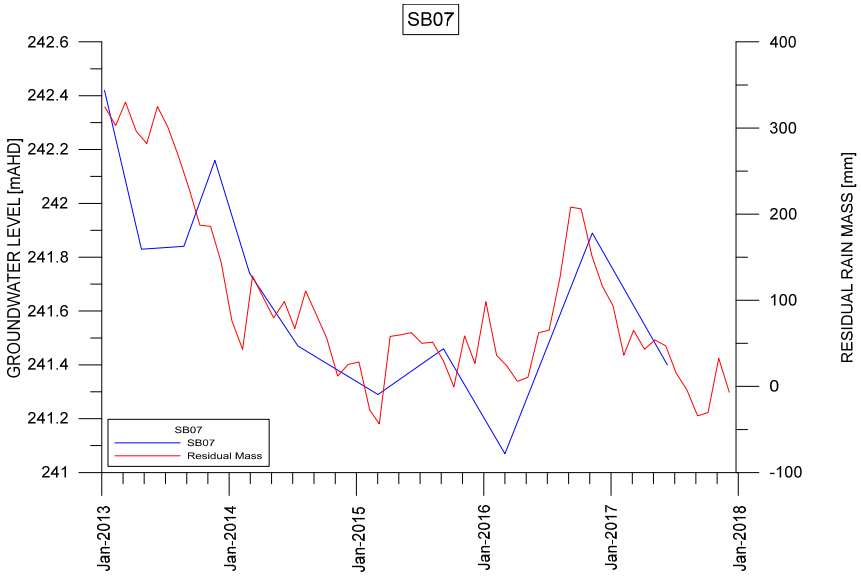

SB15
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
244.4
244
243.6
243.2
600
400
200
0
-200
SB15
SB15
Residual Mass
Jan-2005
Jan-2006
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018


SB02
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
241
240.8
240.6
400
300
200
100
0
-100
SB02
SB02
Residual Mass
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018

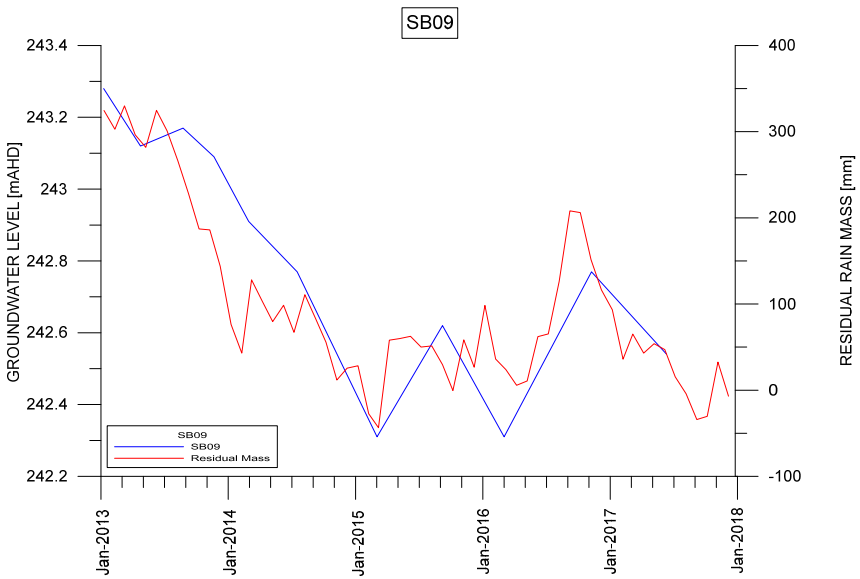

SB04
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
242.6
242.4
242.2
242
241.8
241.6
241.4
400
300
200
100
0
-100
SB04
SB04
Residual Mass
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018

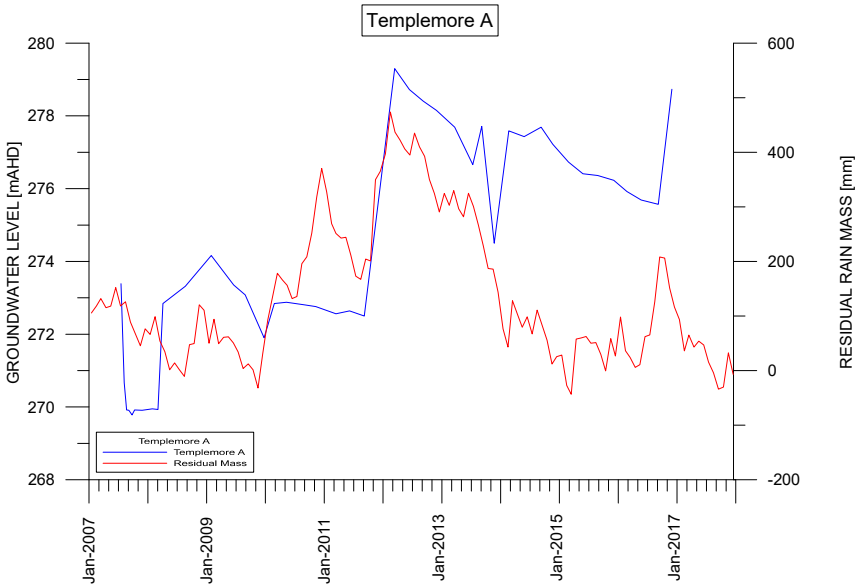

SB05
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
243.6
243.4
243.2
243
242.8
242.6
242.4
400
300
200
100
0
-100
SB05
SB05
Residual Mass
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018

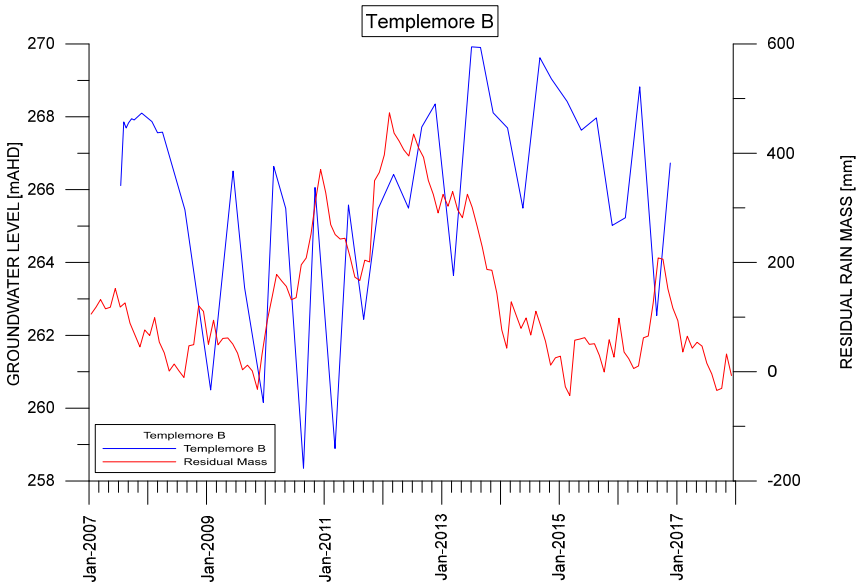

SB06
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
244.4
244.2
244
243.8
243.6
243.4
243.2
243
242.8
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
SB06
SB06
Residual Mass

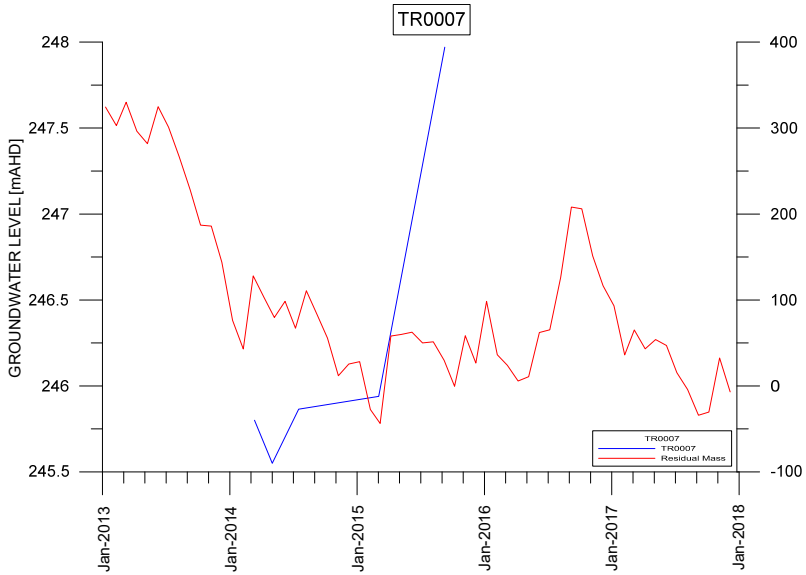

SB07
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
242.6
242.4
242.2
242
241.8
241.6
241.4
241.2
241
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
SB07
SB07
Residual Mass

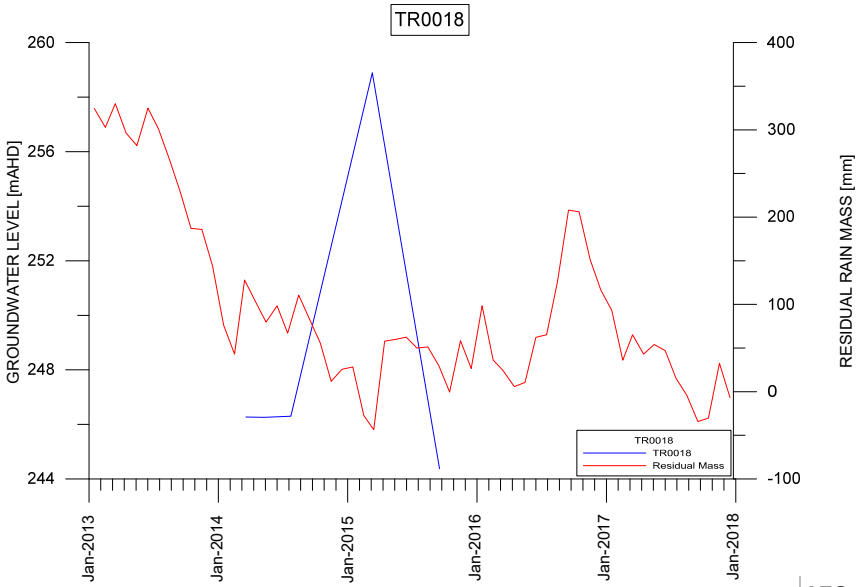

SB08
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
242.8
242.6
242.4
242.2
242
241.8
241.6
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
SB08
SB08
Residual Mass

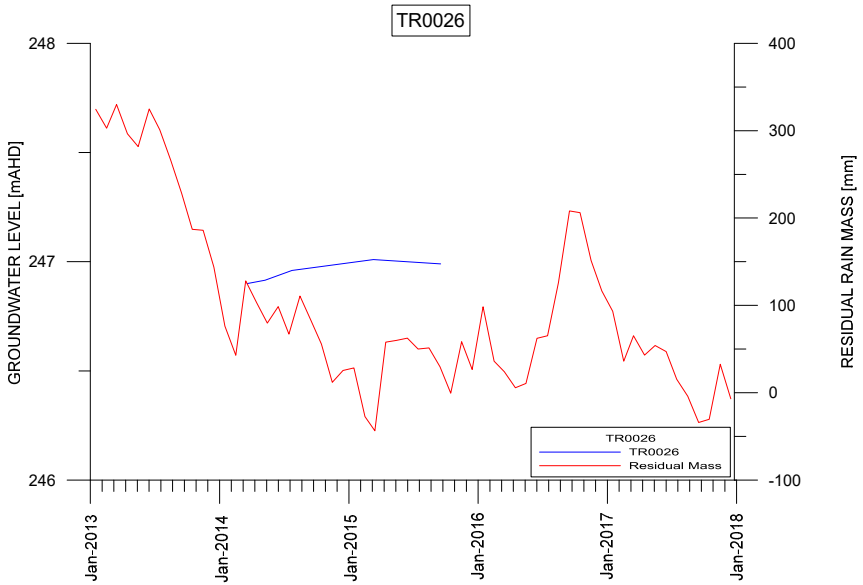

SB09
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
243.4
243.2
243
242.8
242.6
242.4
242.2
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
SB09
SB09
Residual Mass

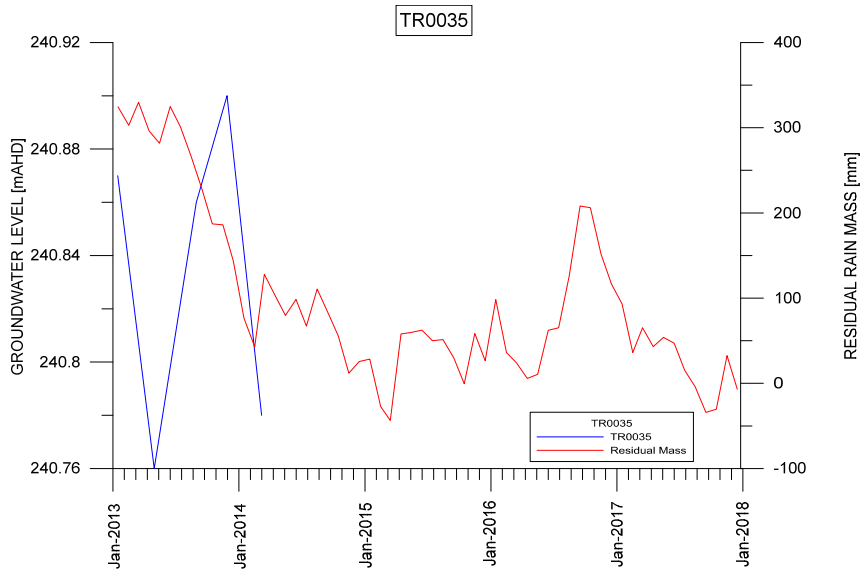

Templemore A
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
280
278
276
274
272
270
268
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
Templemore A
Templemore A
Residual Mass

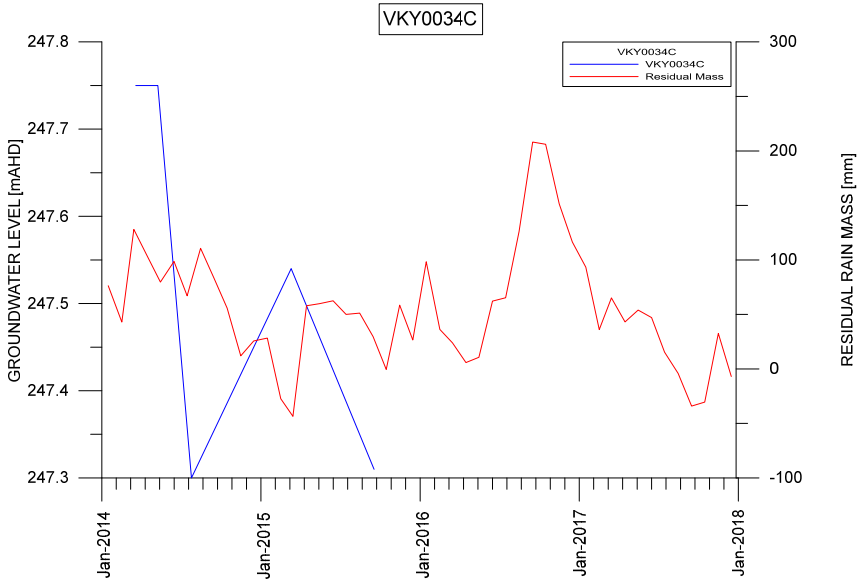

Templemore B
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
270
268
266
264
262
260
258
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
Templemore B
Templemore B
Residual Mass

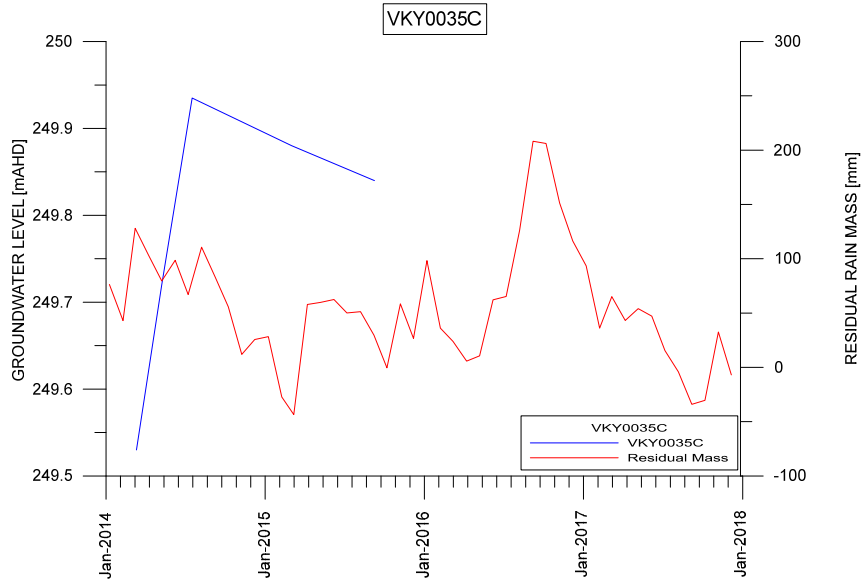

TR0007
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
248
247.5
247
246.5
246
245.5
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
TR0007
TR0007
Residual Mass

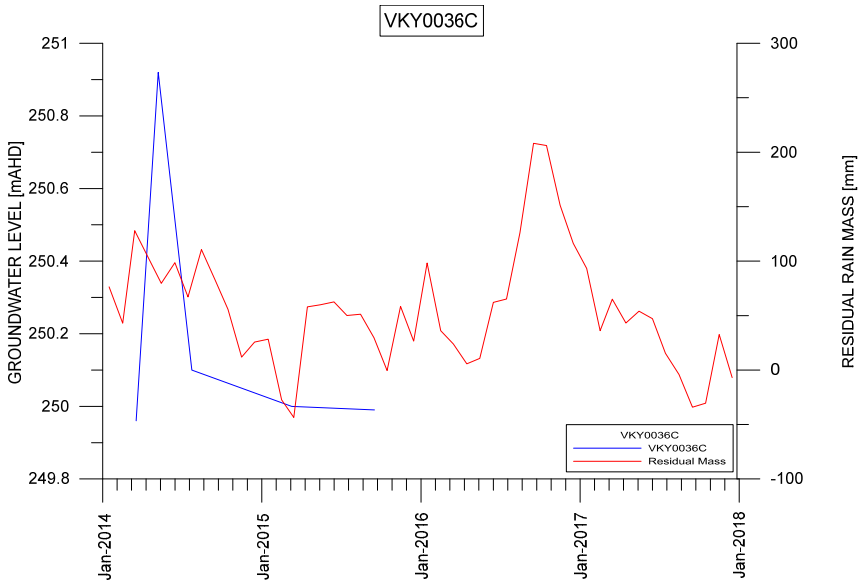

TR0018
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
260
256
252
248
244
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
TR0018
TR0018
Residual Mass

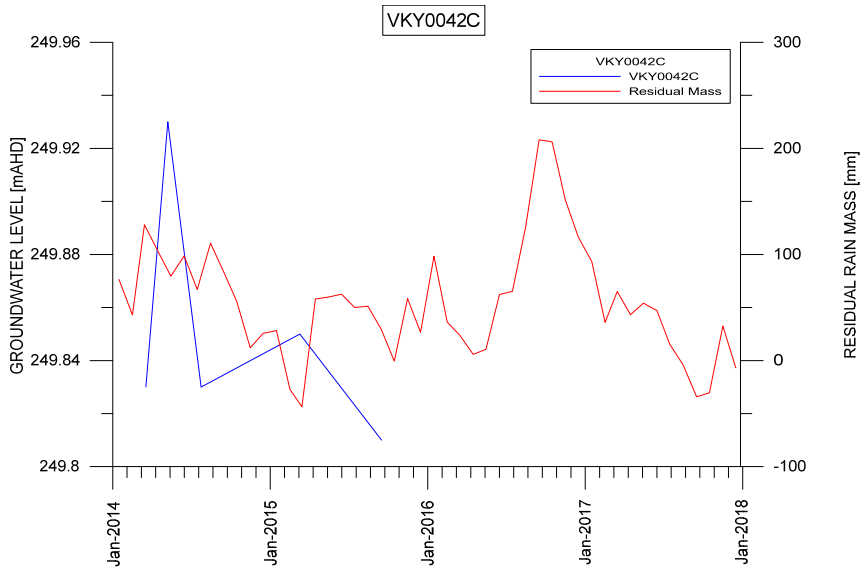

TR0026
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
248
247
246
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
TR0026
TR0026
Residual Mass

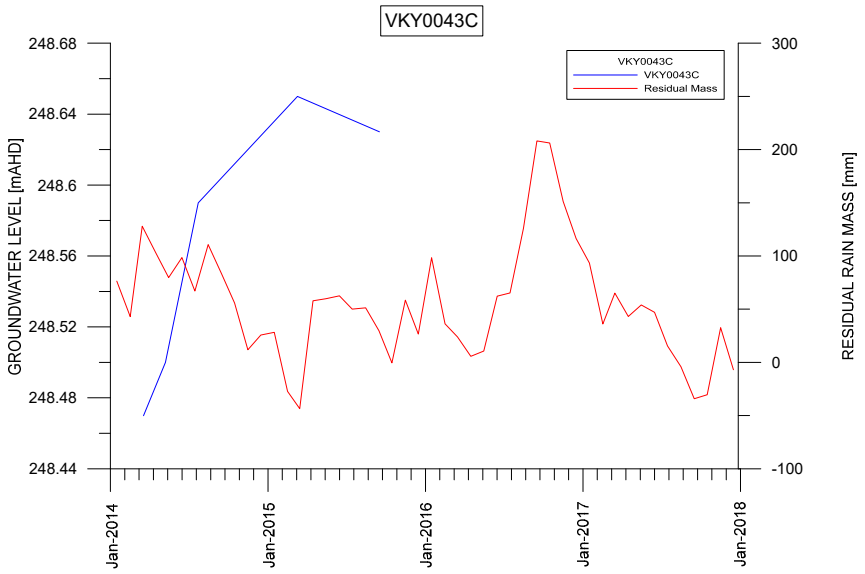

TR0035
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
240.92
240.88
240.84
240.8
240.76
400
300
200
100
0
-100
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
TR0035
TR0035
Residual Mass

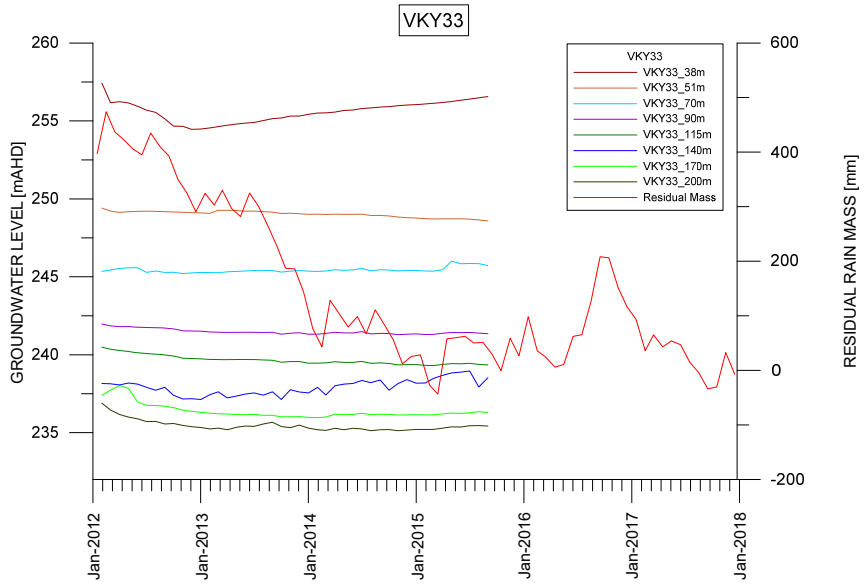

VKY0034C
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
247.8
247.7
247.6
247.5
247.4
247.3
300
200
100
0
-100
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
VKY0034C
VKY0034C
Residual Mass

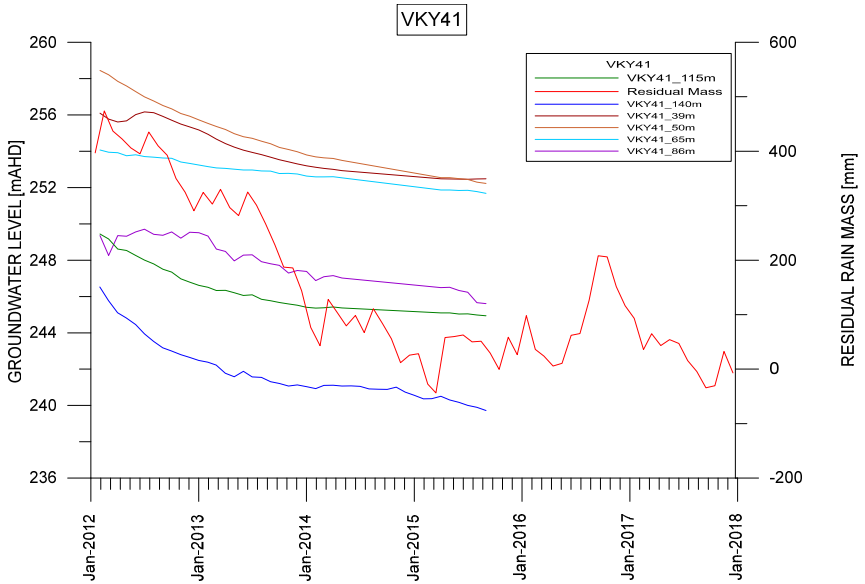

VKY0035C
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
250
249.9
249.8
249.7
249.6
249.5
300
200
100
0
-100
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
VKY0035C
VKY0035C
Residual Mass

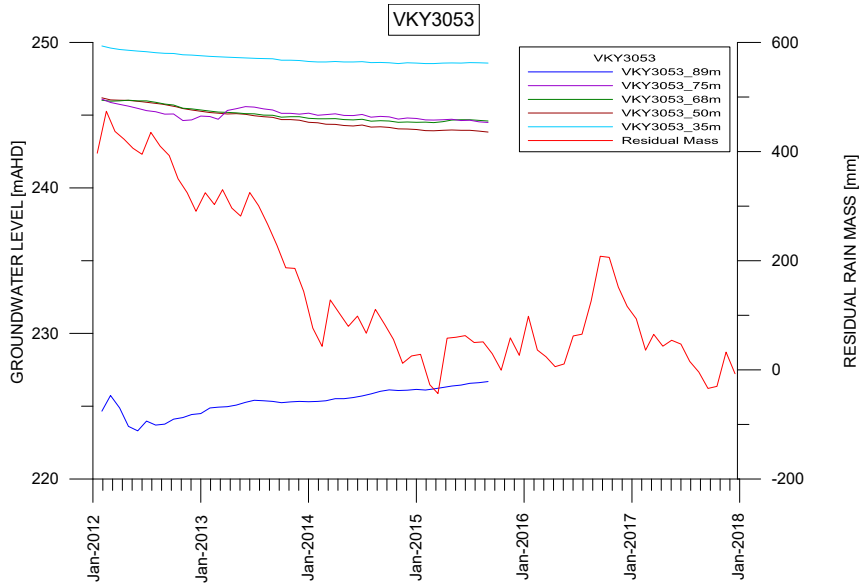

VKY0036C
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
251
250.8
250.6
250.4
250.2
250
249.8
300
200
100
0
-100
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
VKY0036C
VKY0036C
Residual Mass

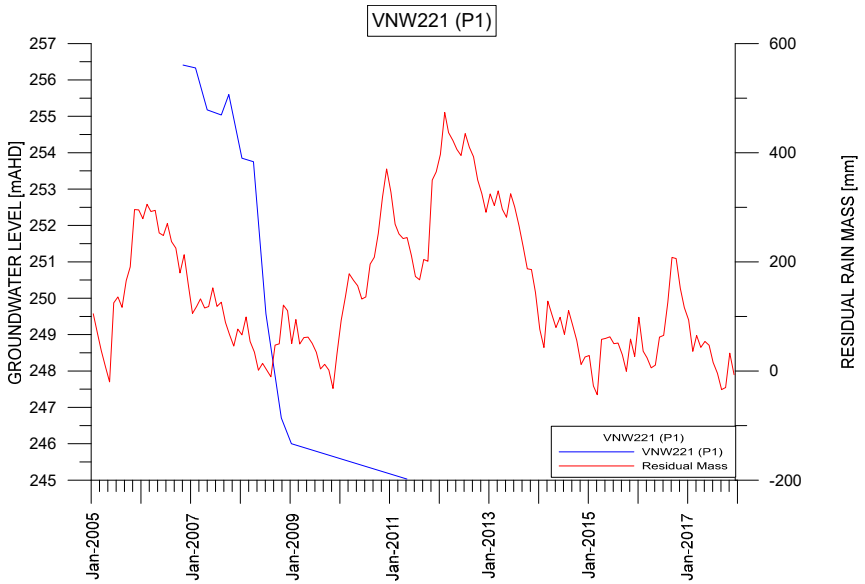

VKY0042C
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
249.96
249.92
249.88
249.84
249.8
300
200
100
0
-100
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
VKY0042C
VKY0042C
Residual Mass

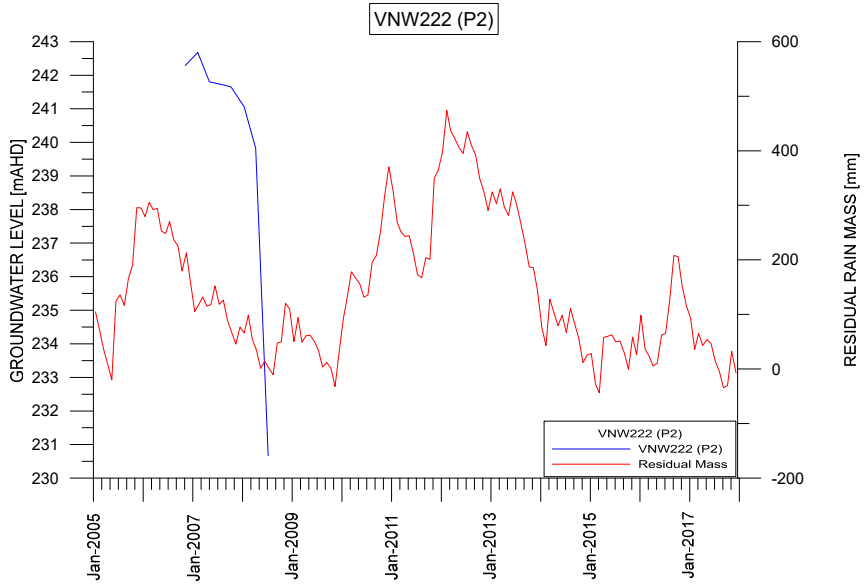

VKY0043C
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
248.68
248.64
248.6
248.56
248.52
248.48
248.44
300
200
100
0
-100
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
VKY0043C
VKY0043C
Residual Mass

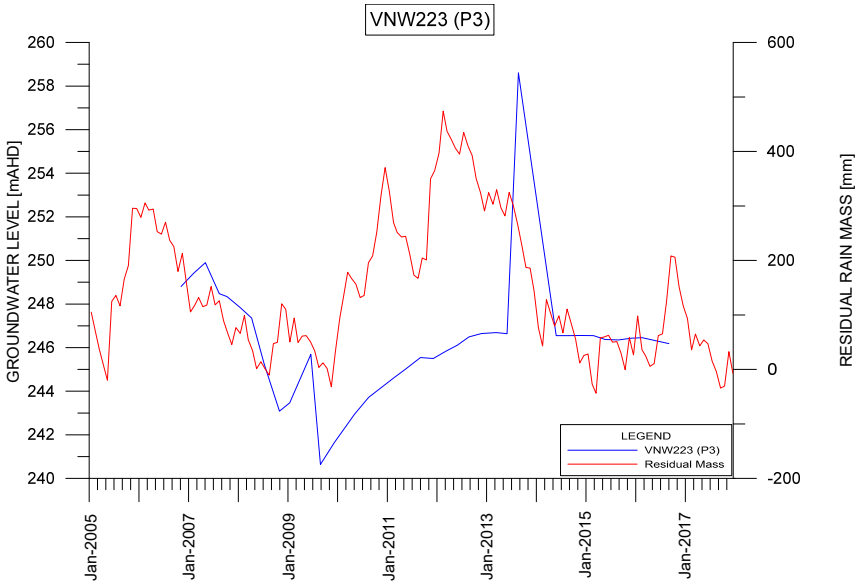

VKY33
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
260
255
250
245
240
235
600
400
200
0
-200
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
VKY33
VKY33_38m
VKY33_51m
VKY33_70m
VKY33_90m
VKY33_115m
VKY33_140m
VKY33_170m
VKY33_200m
Residual Mass

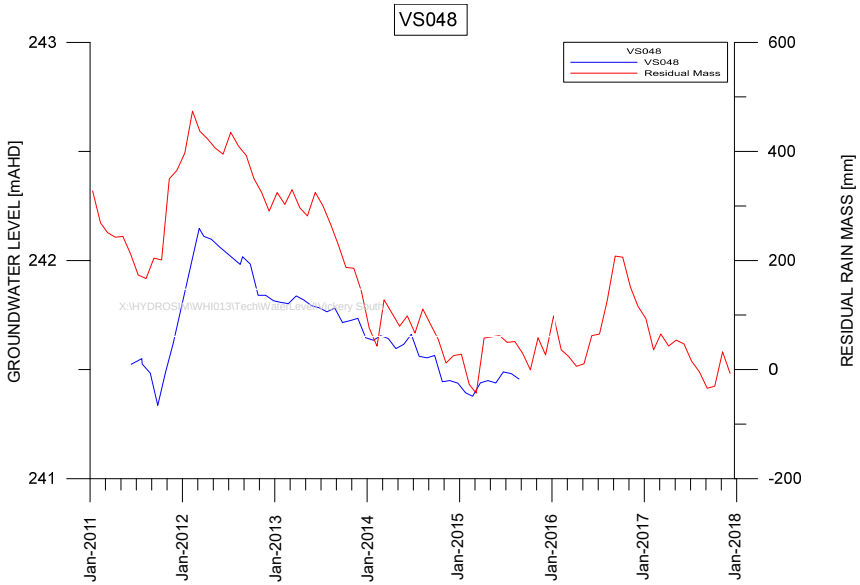

VKY41
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
260
256
252
248
244
240
236
600
400
200
0
-200
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
VKY41
VKY41_115m
Residual Mass
VKY41_140m
VKY41_39m
VKY41_50m
VKY41_65m
VKY41_86m

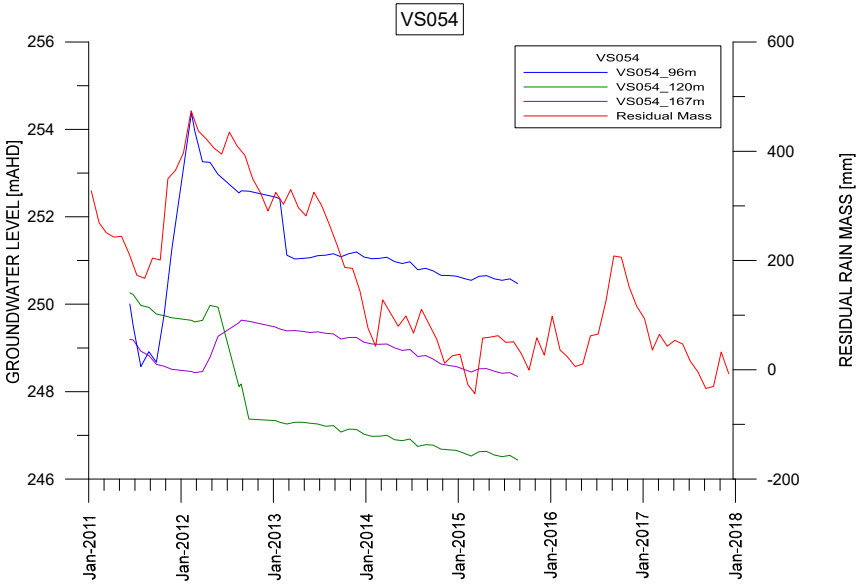

VKY3053
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
250
240
230
220
600
400
200
0
-200
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
VKY3053
VKY3053_89m
VKY3053_75m
VKY3053_68m
VKY3053_50m
VKY3053_35m
Residual Mass

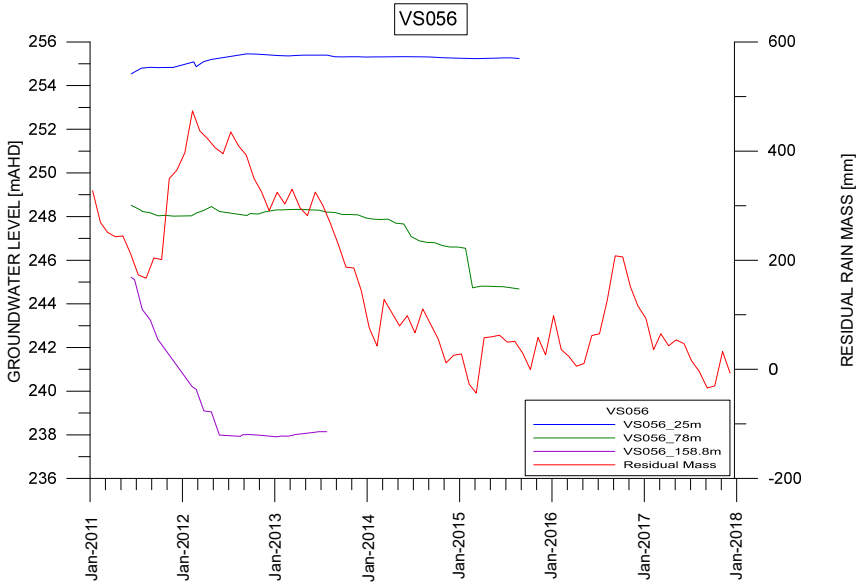

VNW221 (P1)
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
257
256
255
254
253
252
251
250
249
248
247
246
245
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
VNW221 (P1)
VNW221 (P1)
Residual Mass

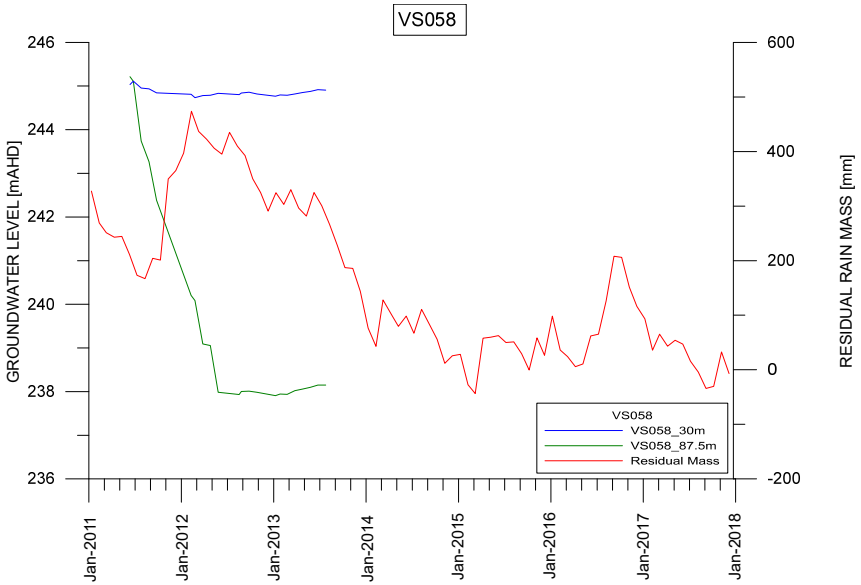

VNW222 (P2)
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
243
242
241
240
239
238
237
236
235
234
233
232
231
230
600
400
200
0
-200
Jan-2005
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
VNW222 (P2)
VNW222 (P2)
Residual Mass

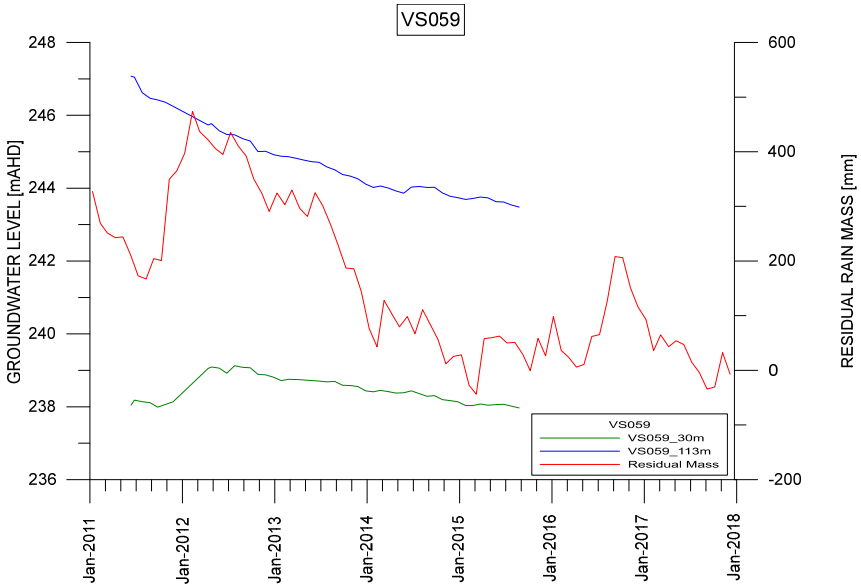

VNW223 (P3)
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
LEGEND
VNW223 (P3)
Residual Mass

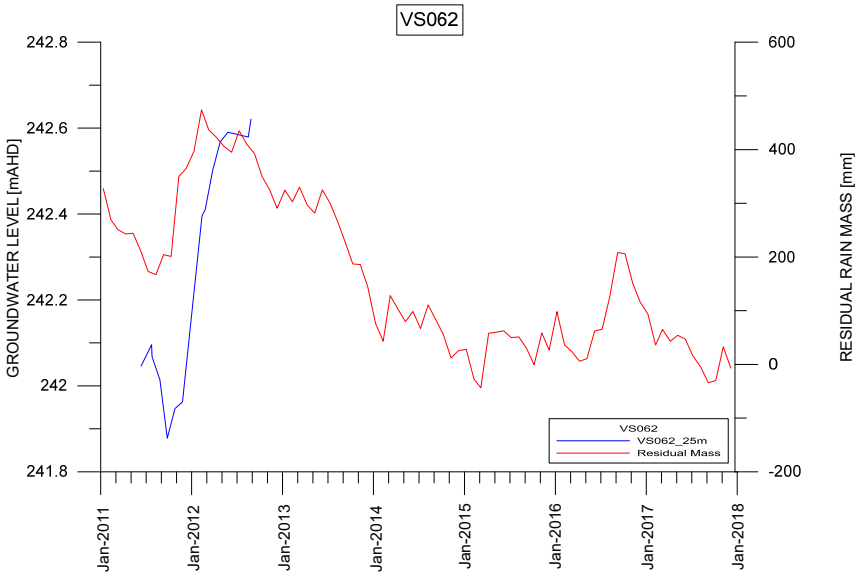

VS048
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
VS048
VS048
Residual Mass

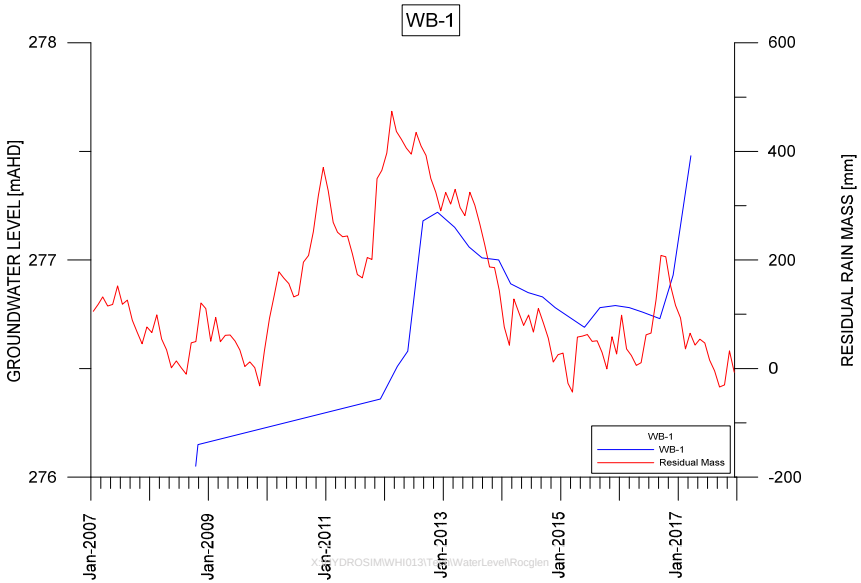

VS054
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
VS054
VS054_96m
VS054_120m
VS054_167m
Residual Mass

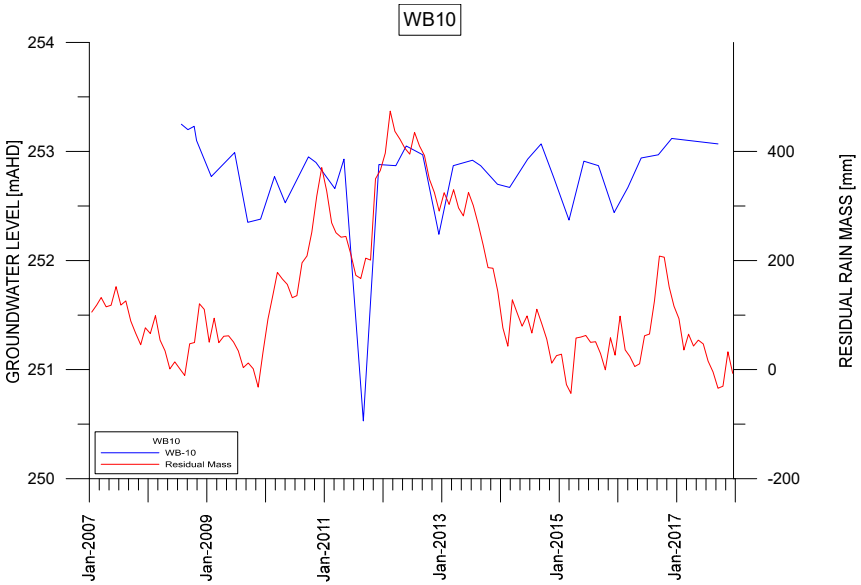

VS056
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
VS056
VS056_25m
VS056_78m
VS056_158.8m
Residual Mass

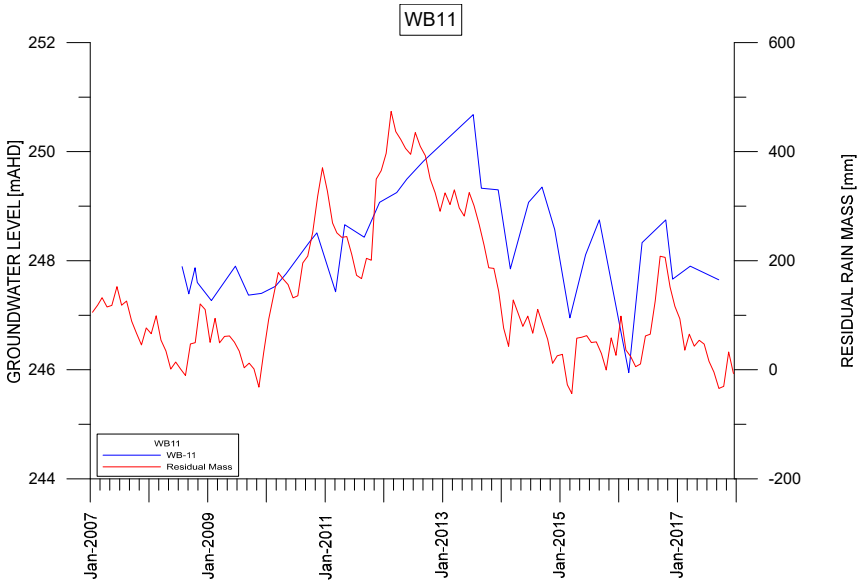

VS058
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
246
244
242
240
238
236
600
400
200
0
-200
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
VS058
VS058_30m
VS058_87.5m
Residual Mass

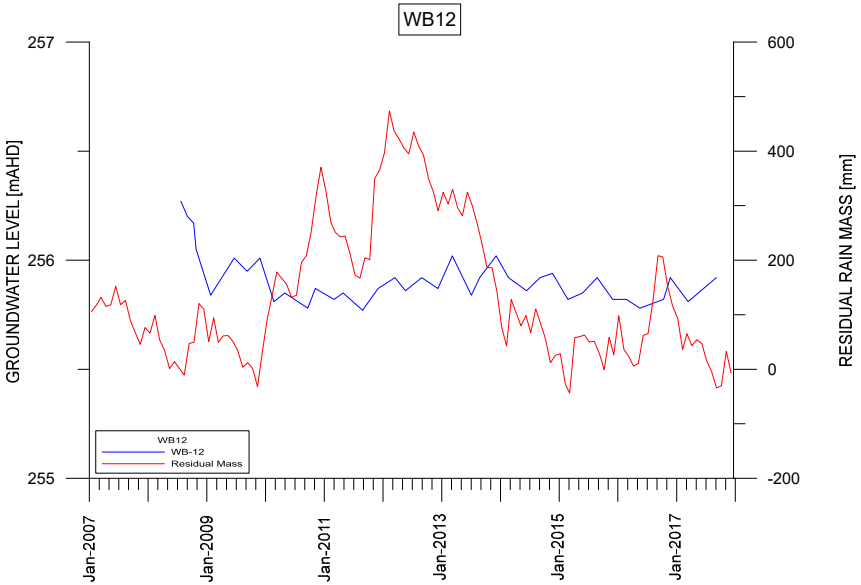

VS059
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
248
246
244
242
240
238
236
600
400
200
0
-200
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
VS059
VS059_30m
VS059_113m
Residual Mass

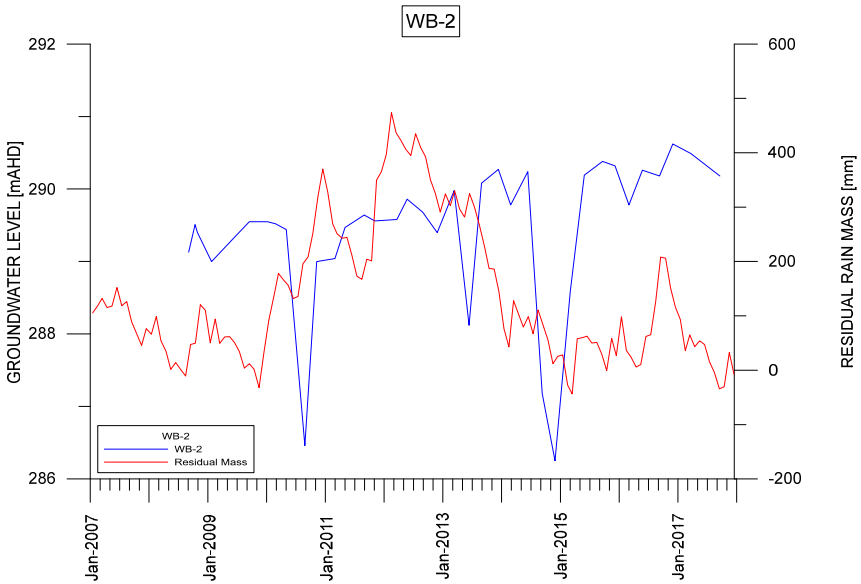

VS062
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
242.8
242.6
242.4
242.2
242
241.8
600
400
200
0
-200
Jan-2011
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
VS062
VS062_25m
Residual Mass

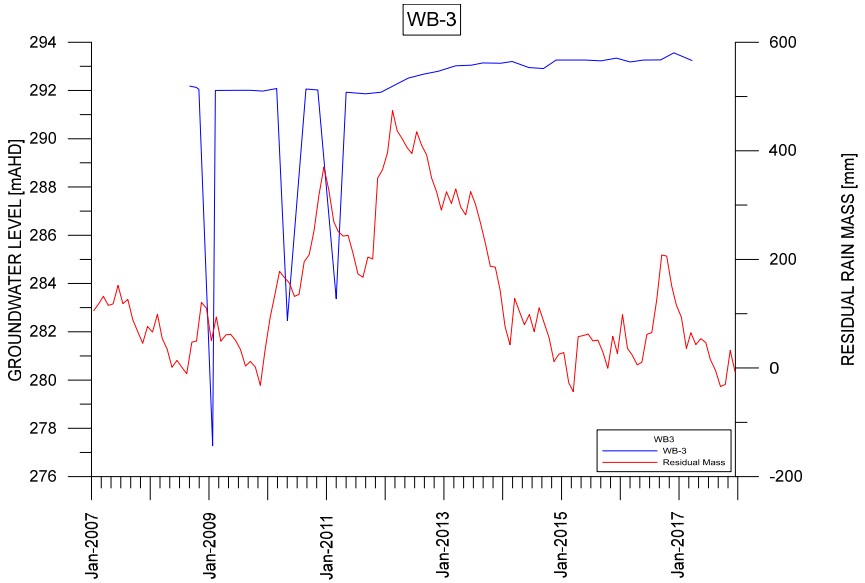

WB-1
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
278
277
276
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
WB-1
WB-1
Residual Mass

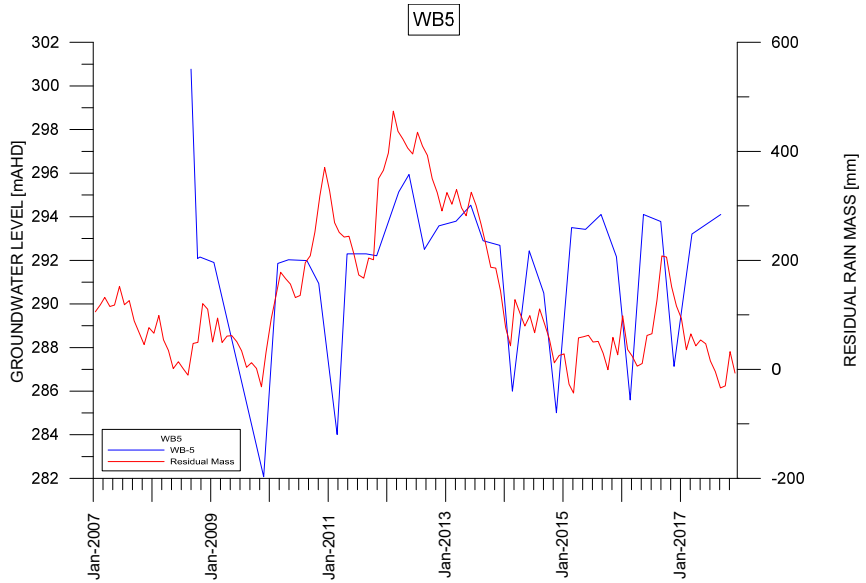

WB10
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
254
253
252
251
250
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
WB10
WB-10
Residual Mass

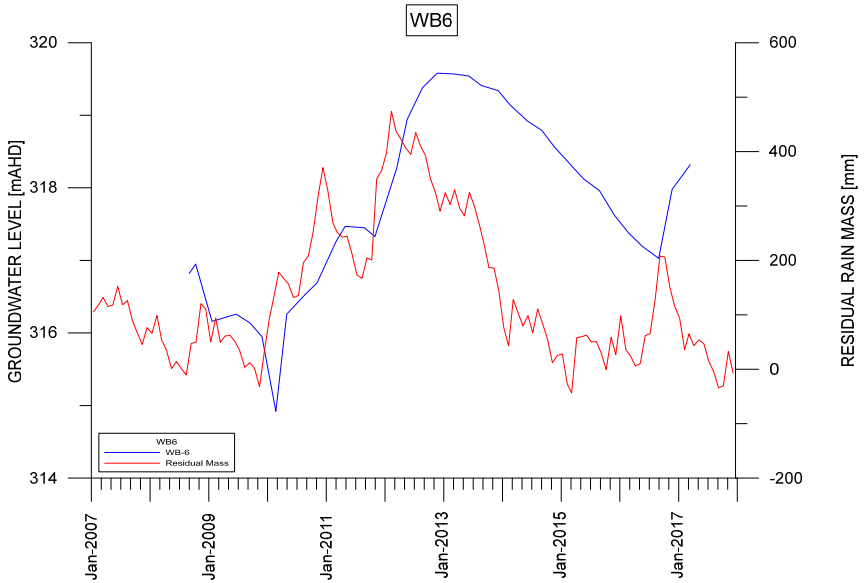

WB11
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
252
250
248
246
244
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
WB11
WB-11
Residual Mass

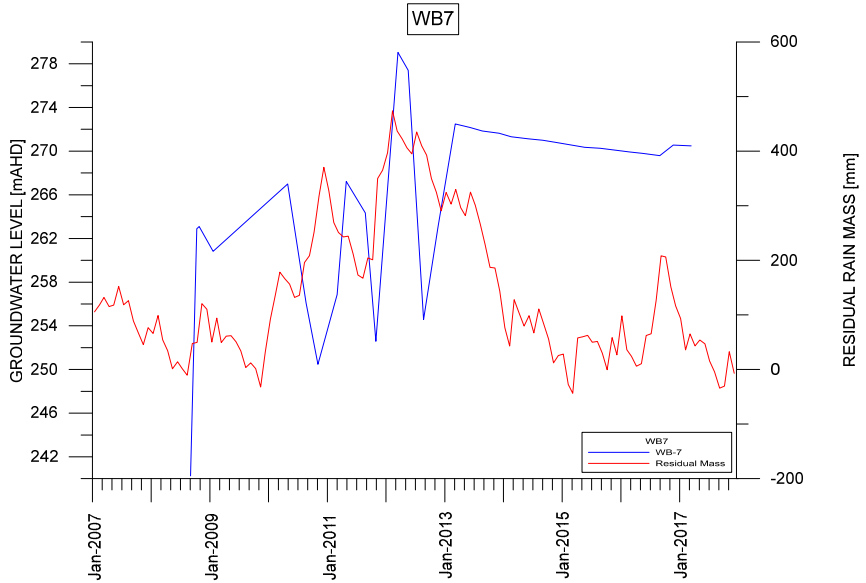

WB12
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
257
256
255
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
WB12
WB-12
Residual Mass

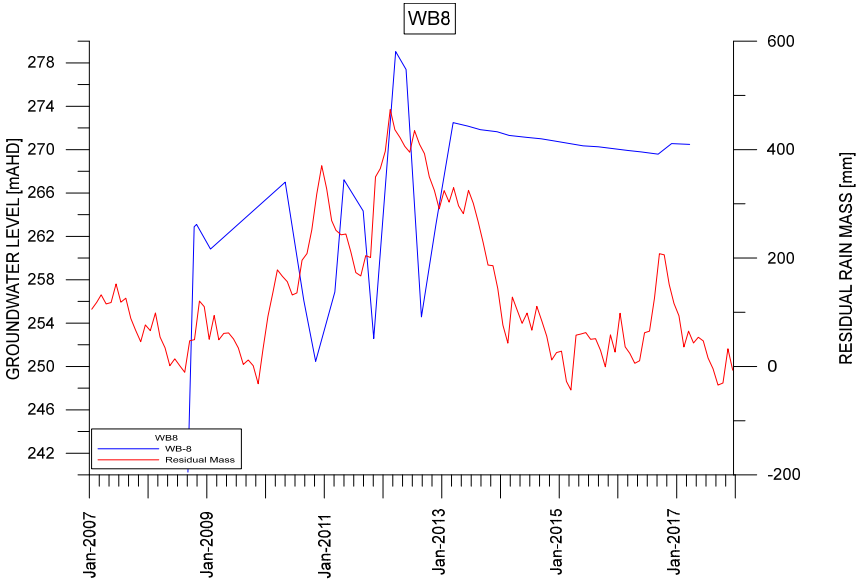

WB-2
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
292
290
288
286
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
WB-2
WB-2
Residual Mass

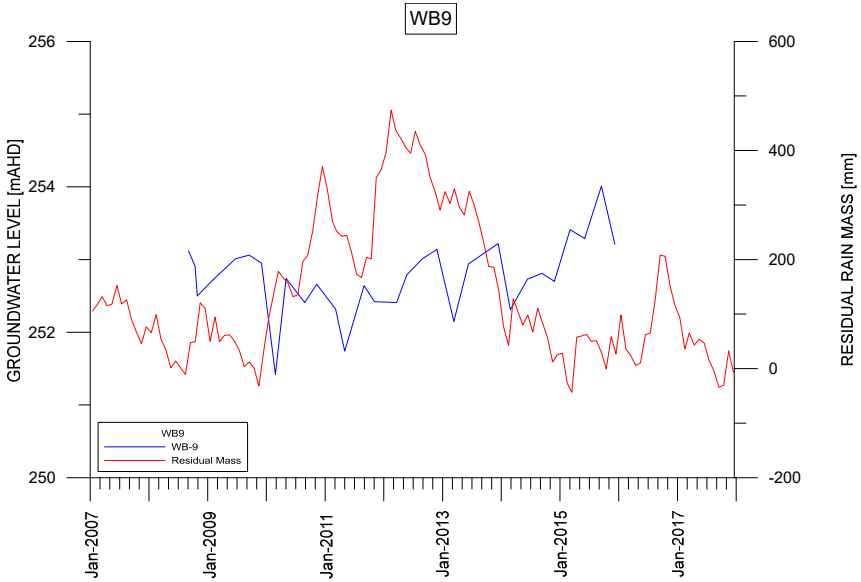

WB-3
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
294
292
290
288
286
284
282
280
278
276
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
WB3
WB-3
Residual Mass


WB5
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
302
300
298
296
294
292
290
288
286
284
282
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
WB5
WB-5
Residual Mass

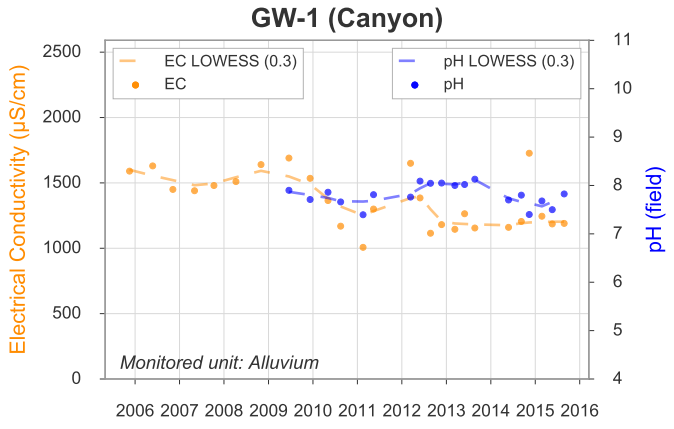

WB6
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
320
318
316
314
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
WB6
WB-6
Residual Mass

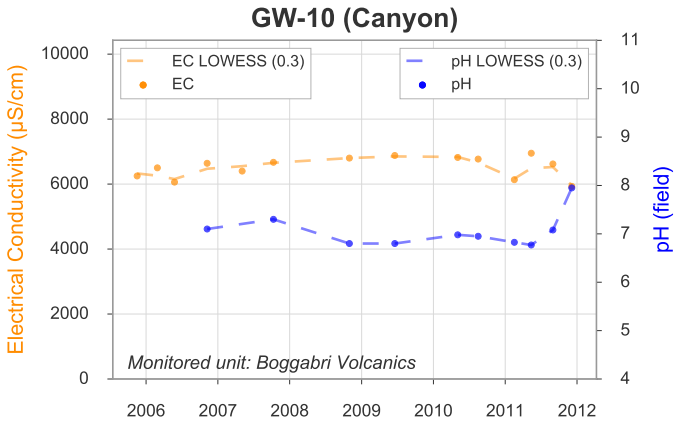

WB7
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
278
274
270
266
262
258
254
250
246
242
600
400
200
0
-200
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017
WB7
WB-7
Residual Mass

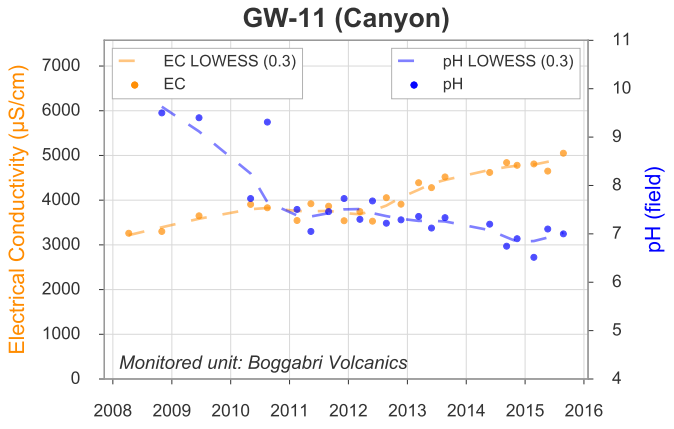

WB8
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
278
274
270
266
262
258
254
250
246
242
600
400
200
0
-200
WB8
WB-8
Residual Mass
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017

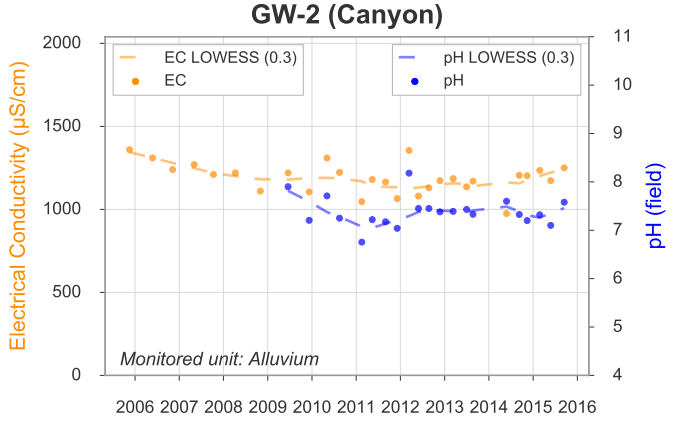

WB9
GROUNDWATER LEVEL [mAHD]
RESIDUAL RAIN MASS [mm]
256
254
252
250
600
400
200
0
-200
WB9
WB-9
Residual Mass
Jan-2007
Jan-2009
Jan-2011
Jan-2013
Jan-2015
Jan-2017

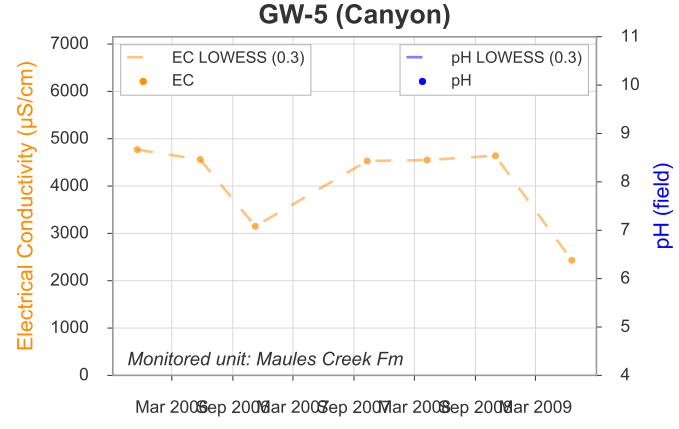
APPENDIX C – WATER QUALITY TIME SERIES

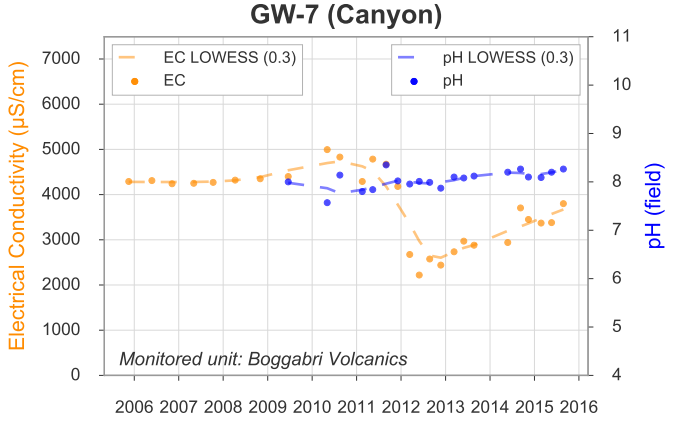

GW-1 (Canyon)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

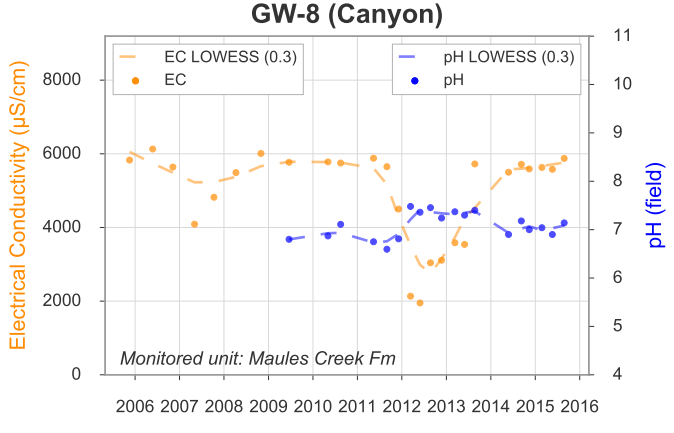

GW-10 (Canyon)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Boggabri Volcanics

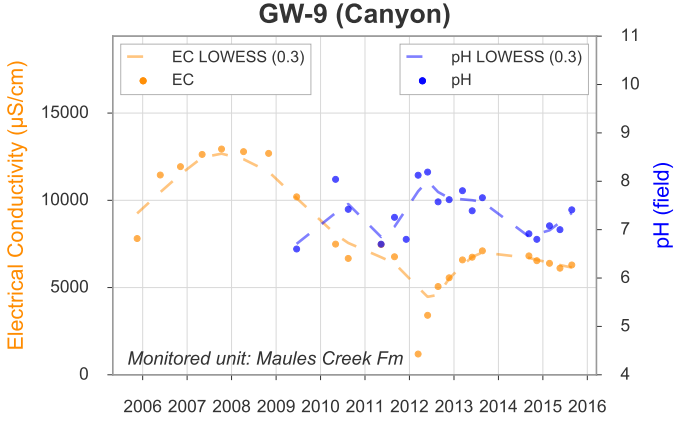

GW-11 (Canyon)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Boggabri Volcanics

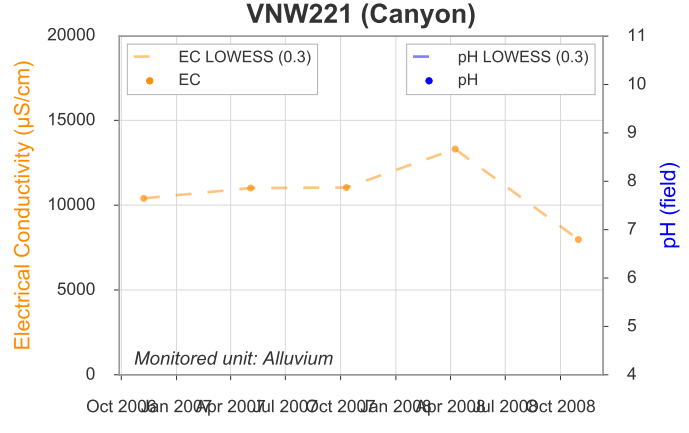

GW-2 (Canyon)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

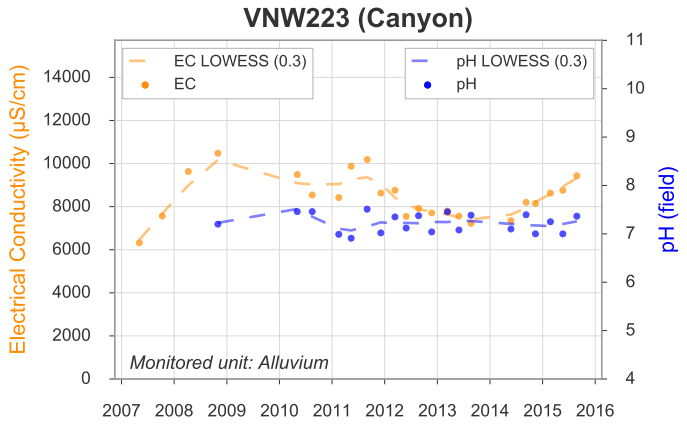

GW-5 (Canyon)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

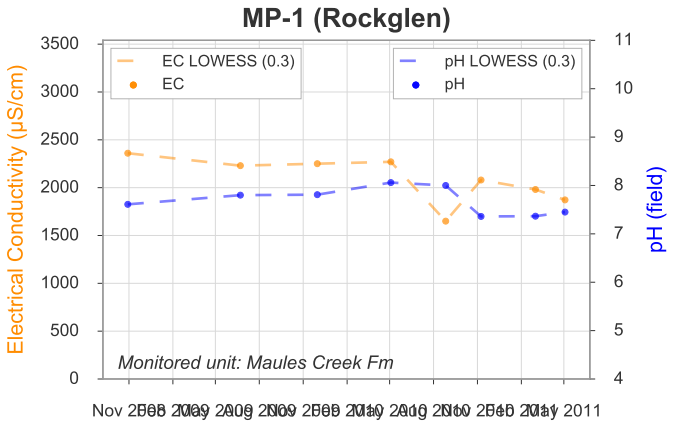

GW-7 (Canyon)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Boggabri Volcanics

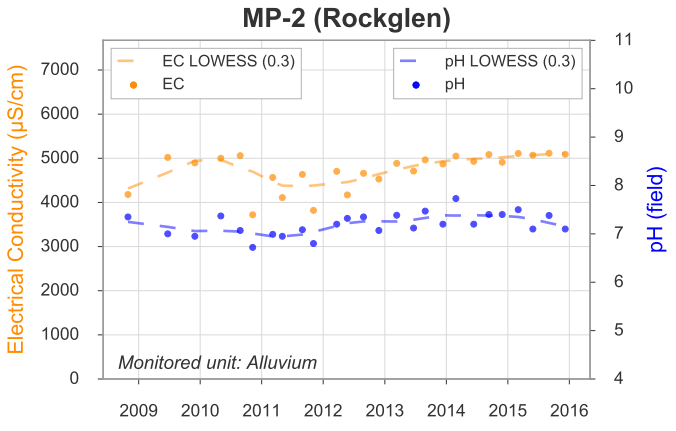

GW-8 (Canyon)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

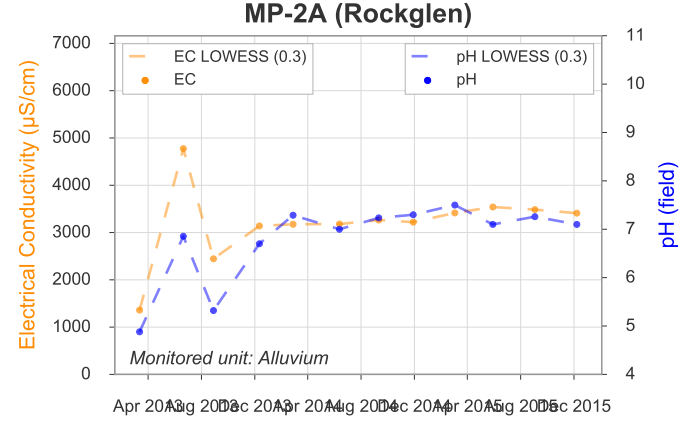

GW-9 (Canyon)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

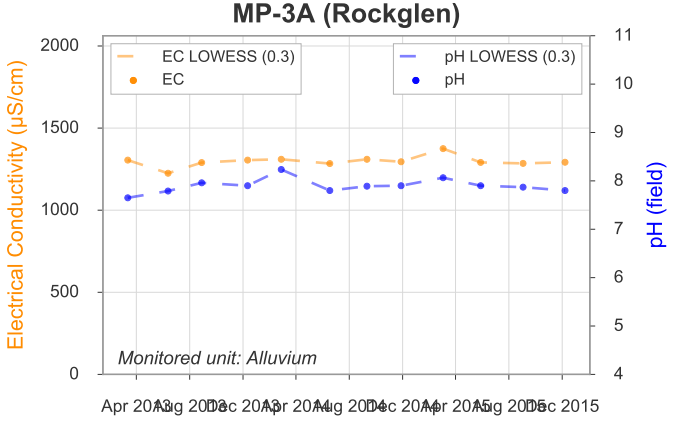

VNW221 (Canyon)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

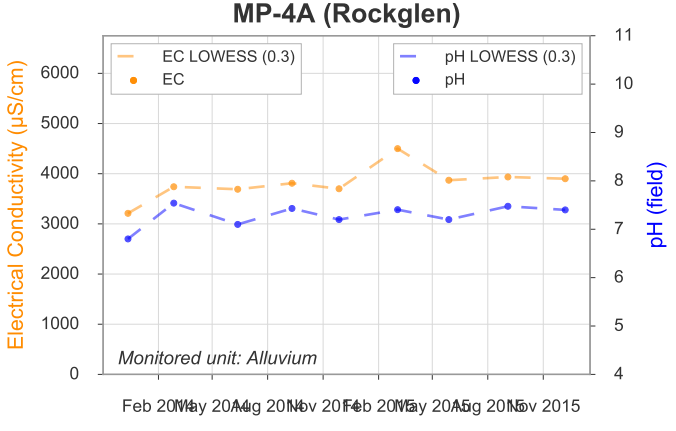

VNW223 (Canyon)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

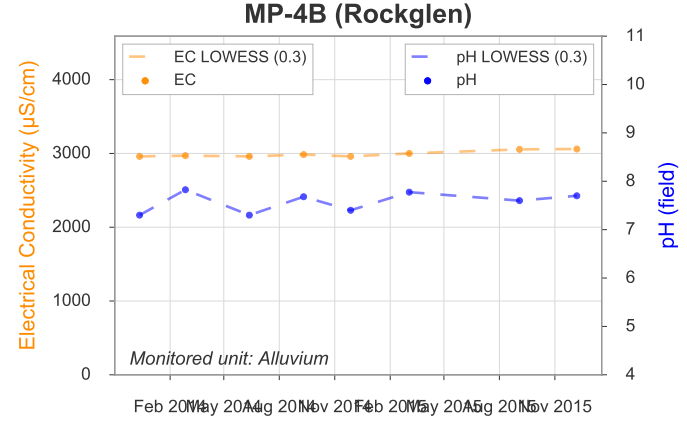

MP-1 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

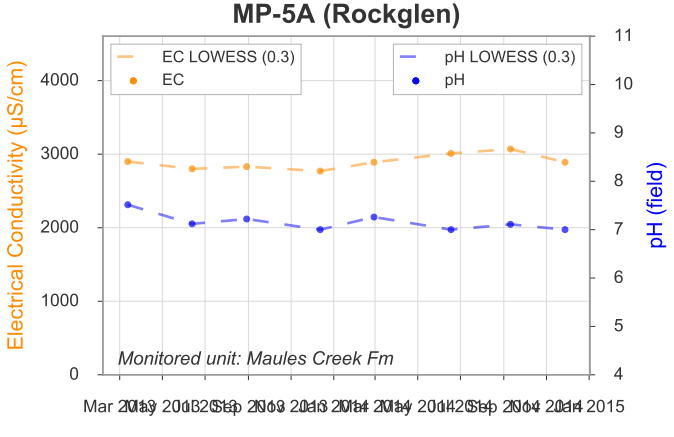

MP-2 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

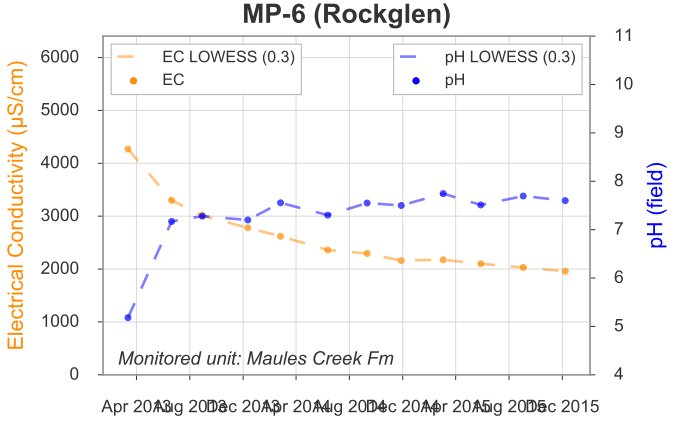

MP-2A (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

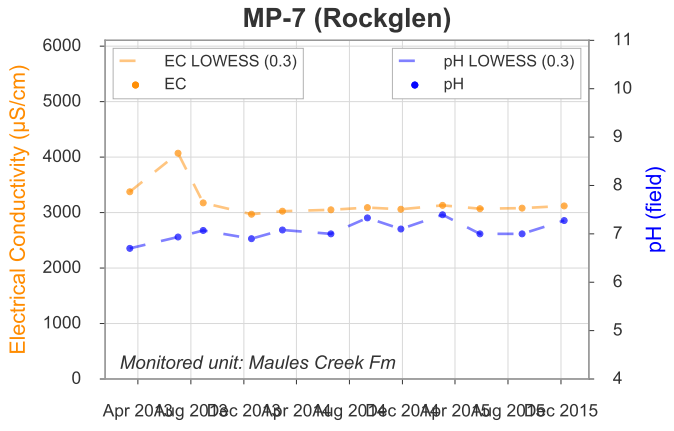

MP-3A (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

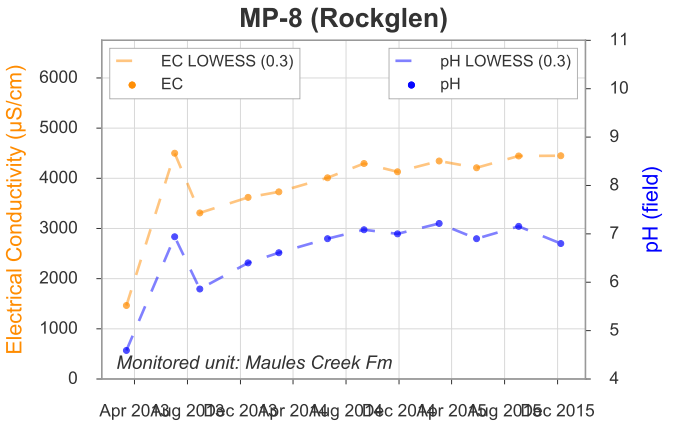

MP-4A (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

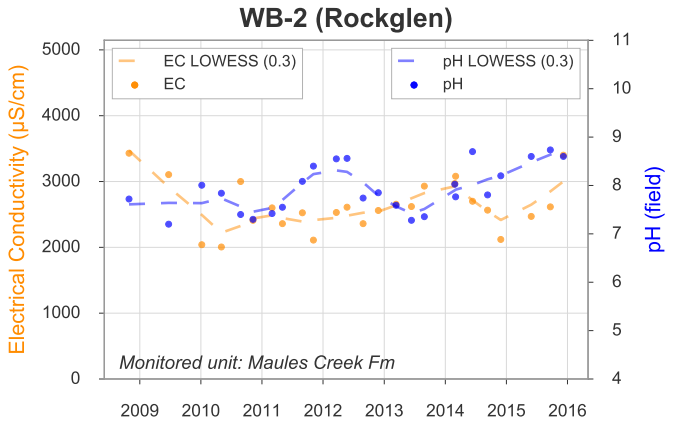

MP-4B (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

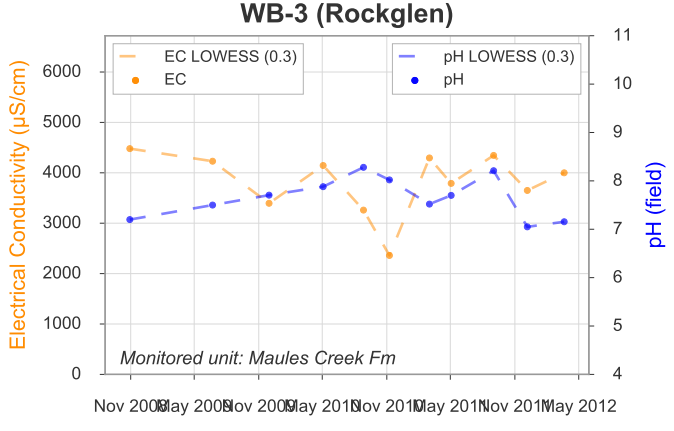

MP-5A (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

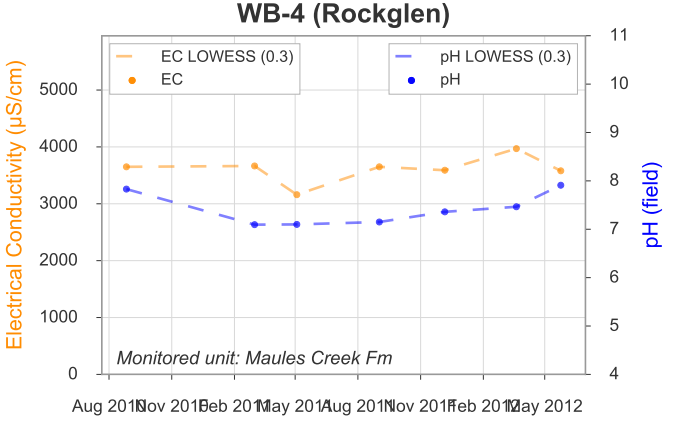

MP-6 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

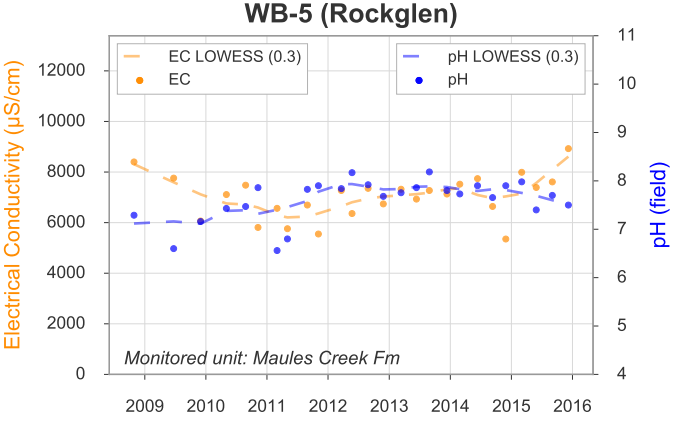

MP-7 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

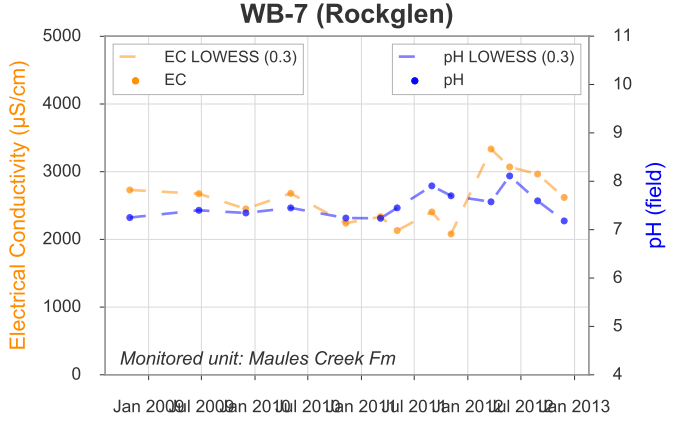

MP-8 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

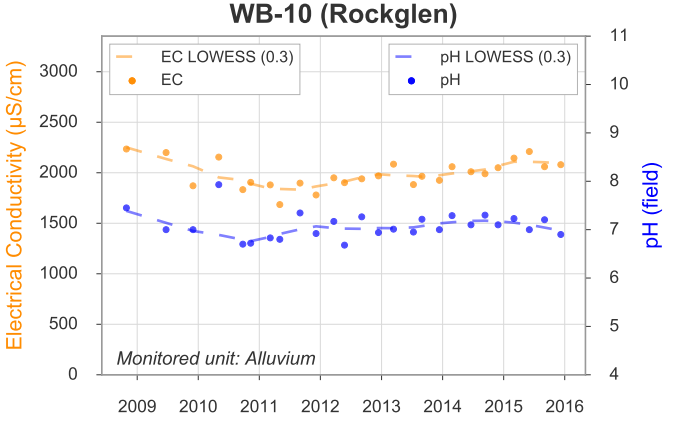

WB-2 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

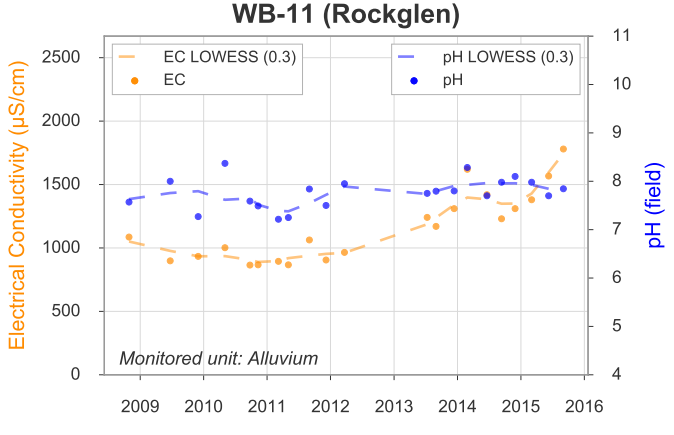

WB-3 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

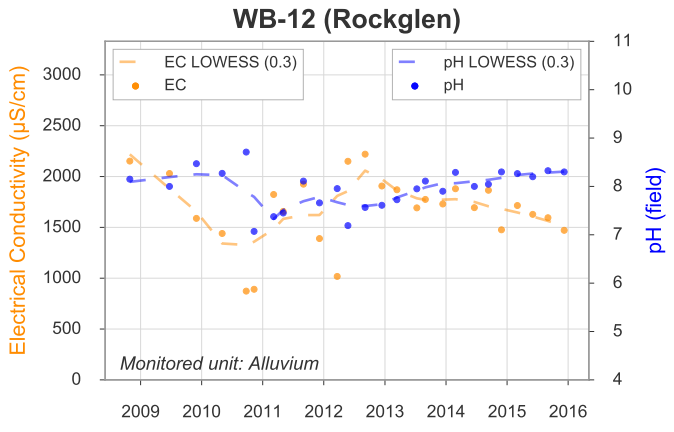

WB-4 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

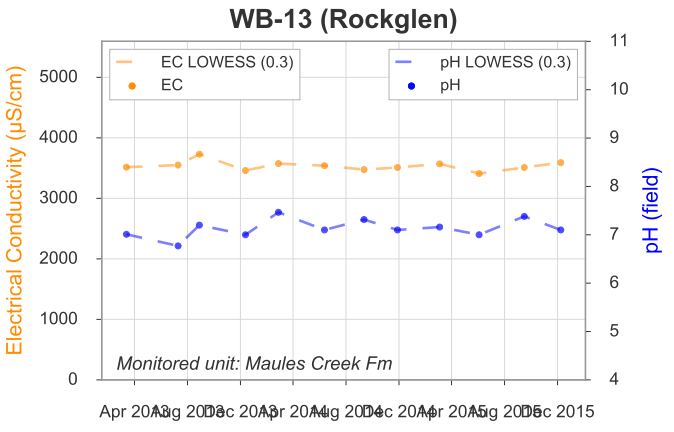

WB-5 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

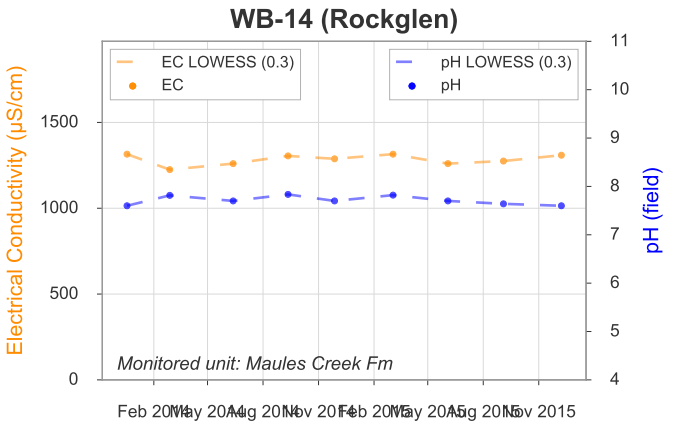

WB-7 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

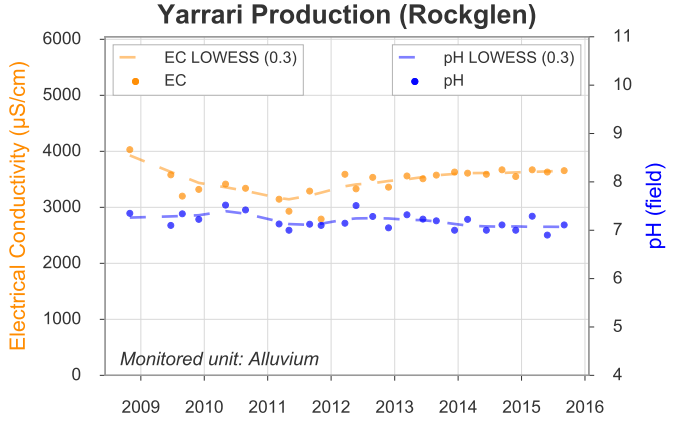

WB-10 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

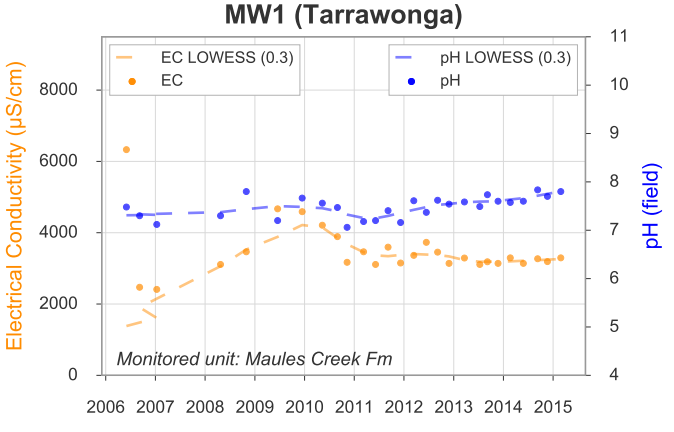

WB-11 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

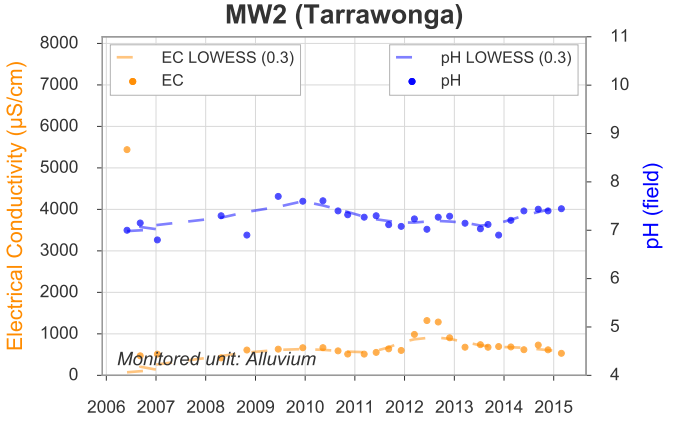

WB-12 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

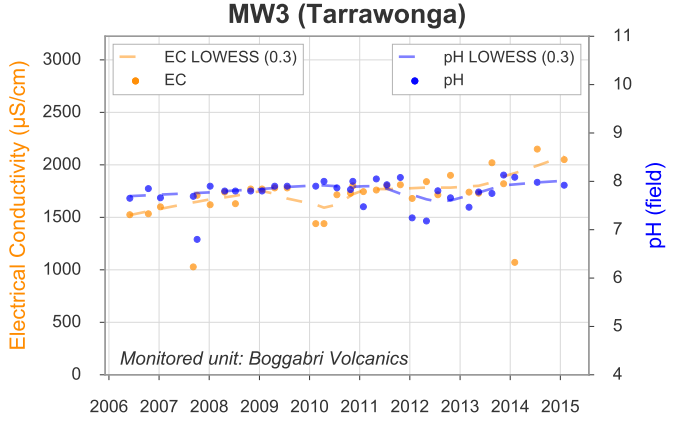

WB-13 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

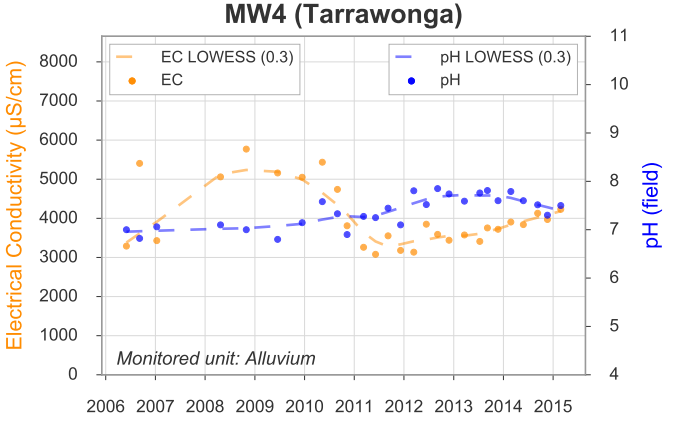

WB-14 (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

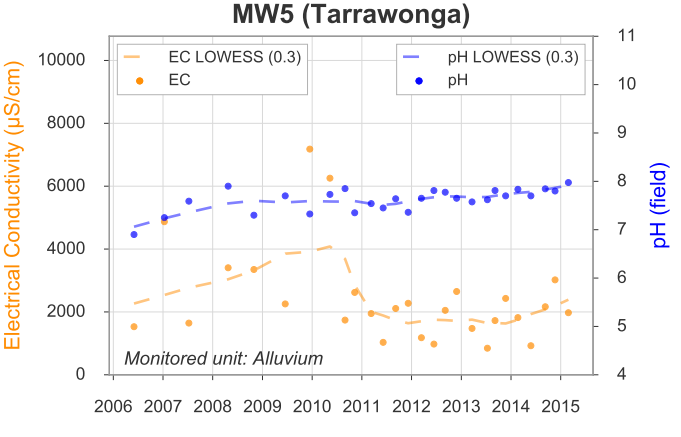

Yarrari Production (Rockglen)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

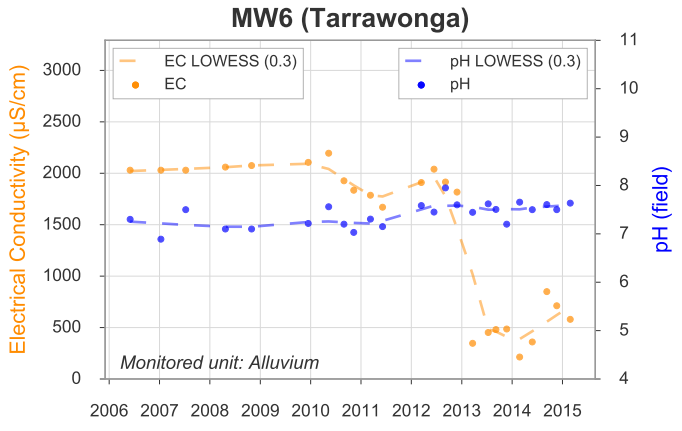

MW1 (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

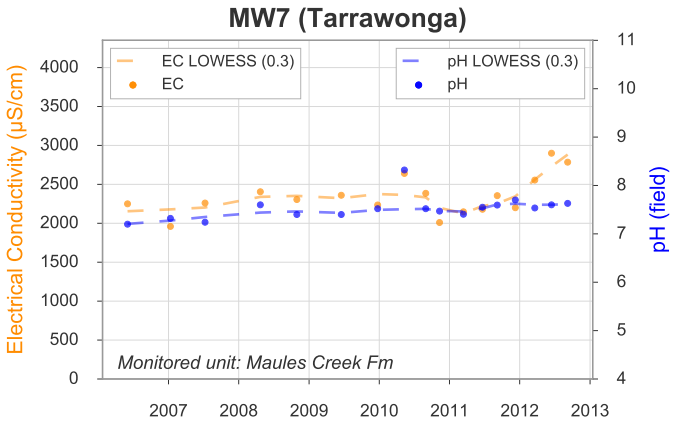

MW2 (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

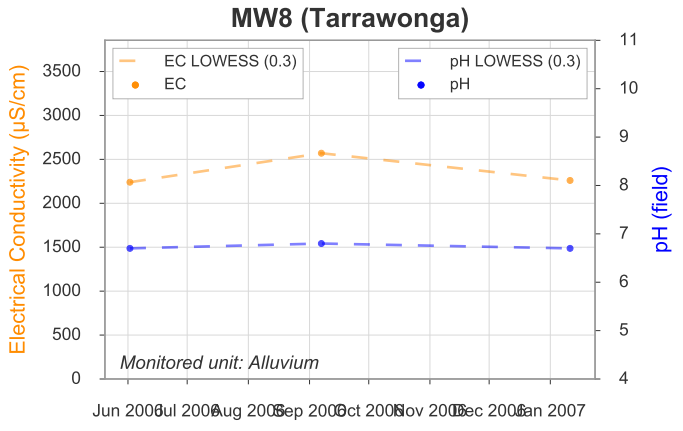

MW3 (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Boggabri Volcanics

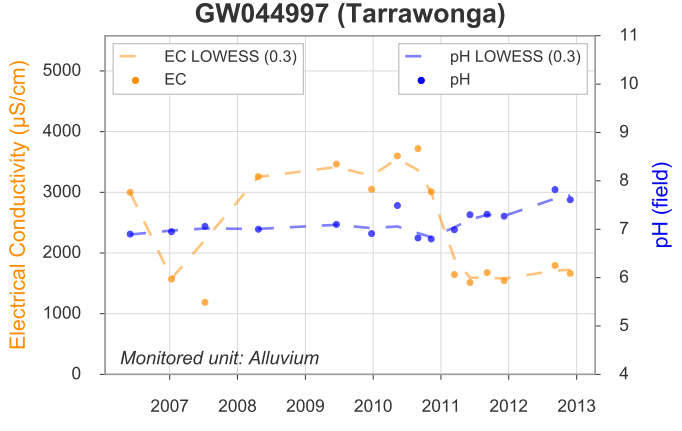

MW4 (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

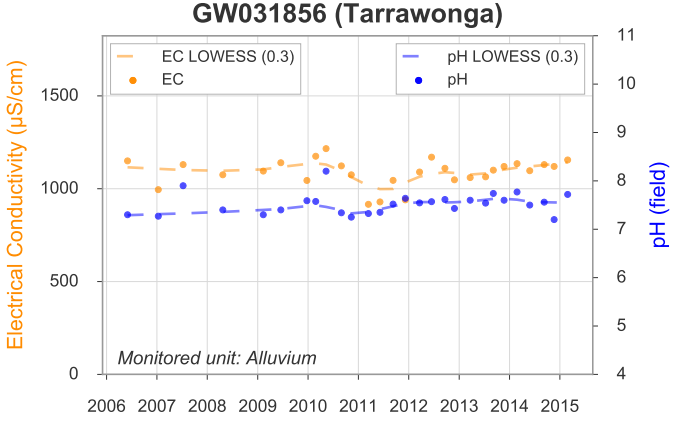

MW5 (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

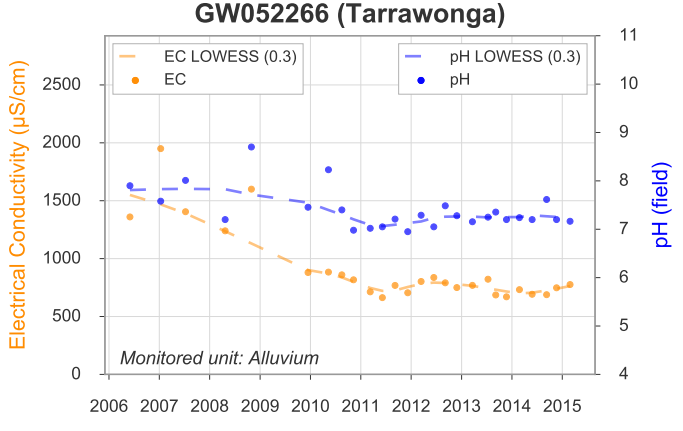

MW6 (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

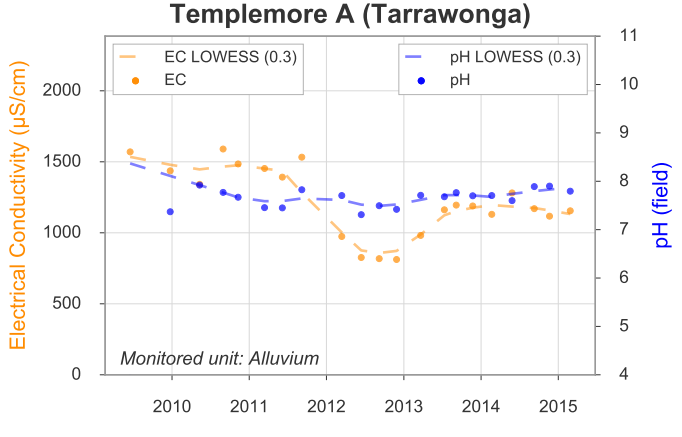

MW7 (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Maules Creek Fm

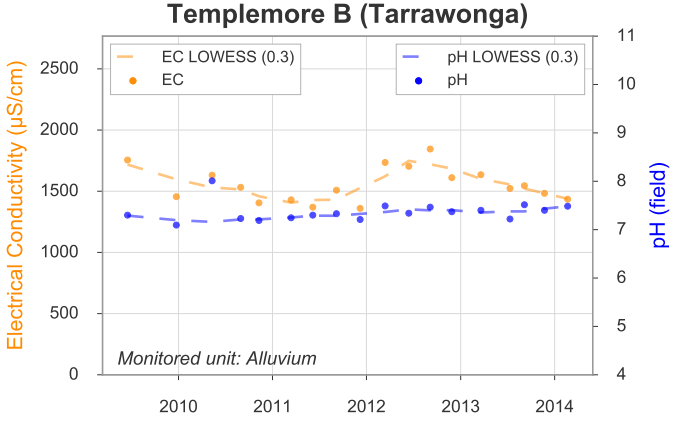

MW8 (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium


GW044997 (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

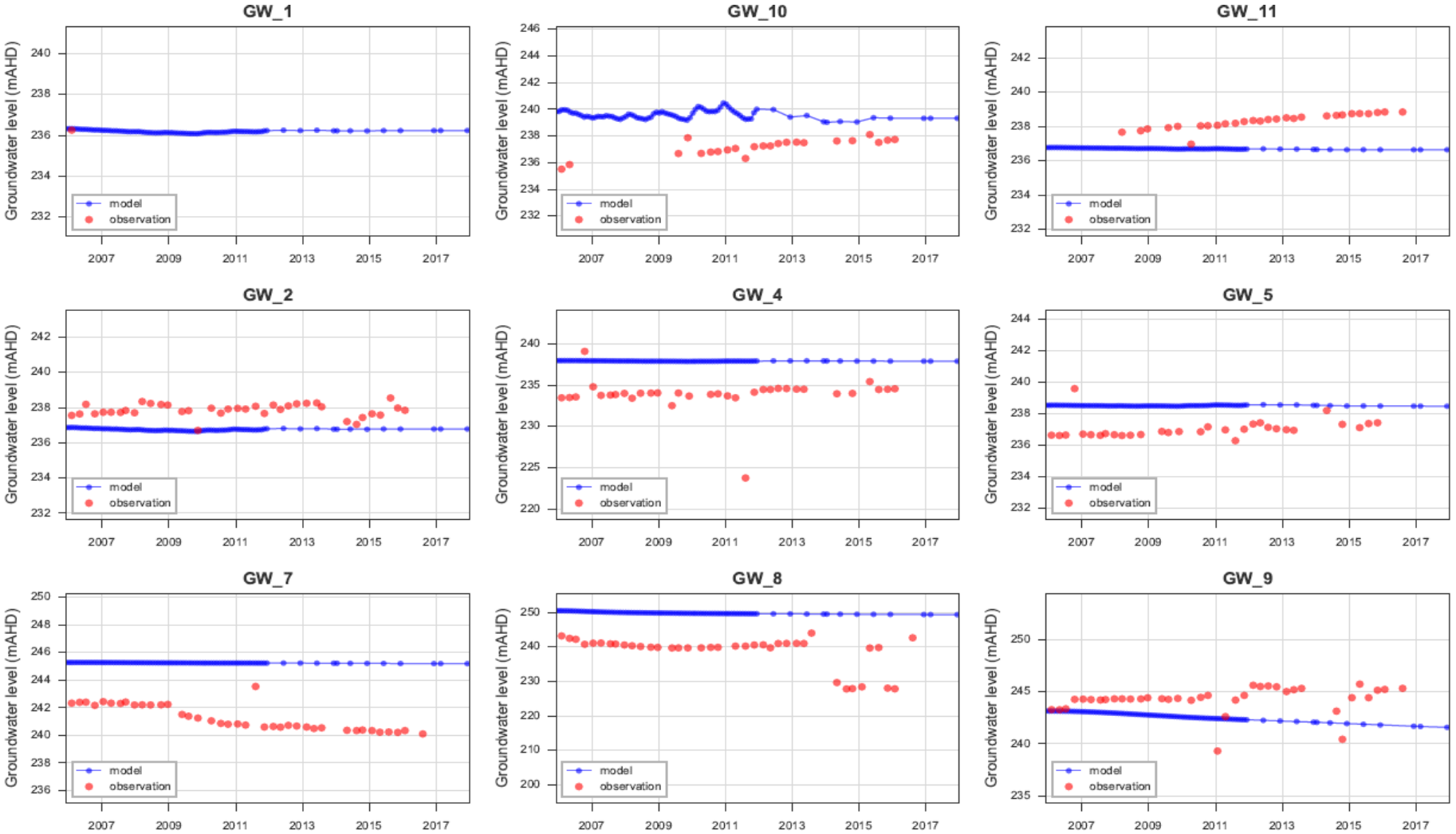

GW031856 (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

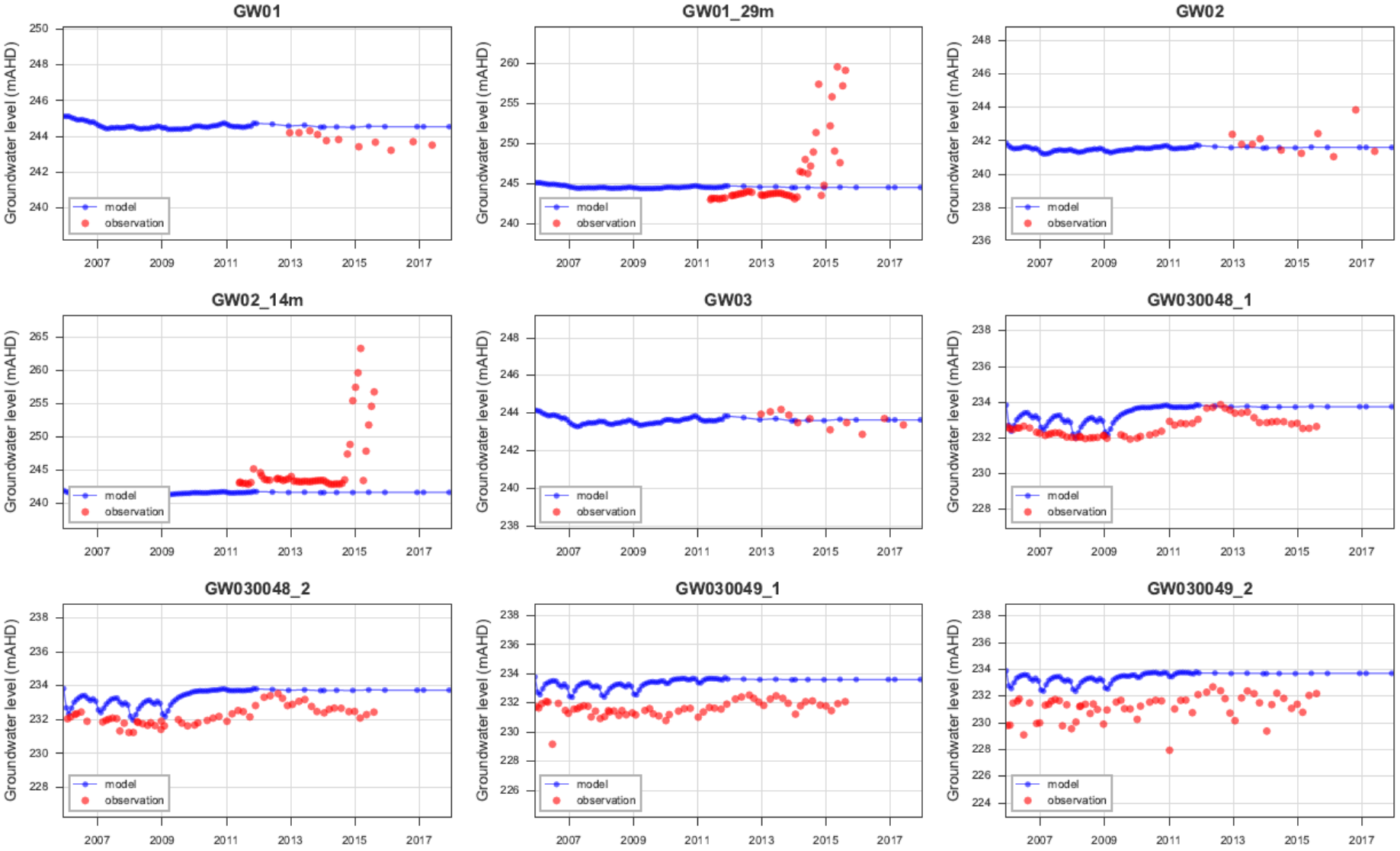

GW052266 (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

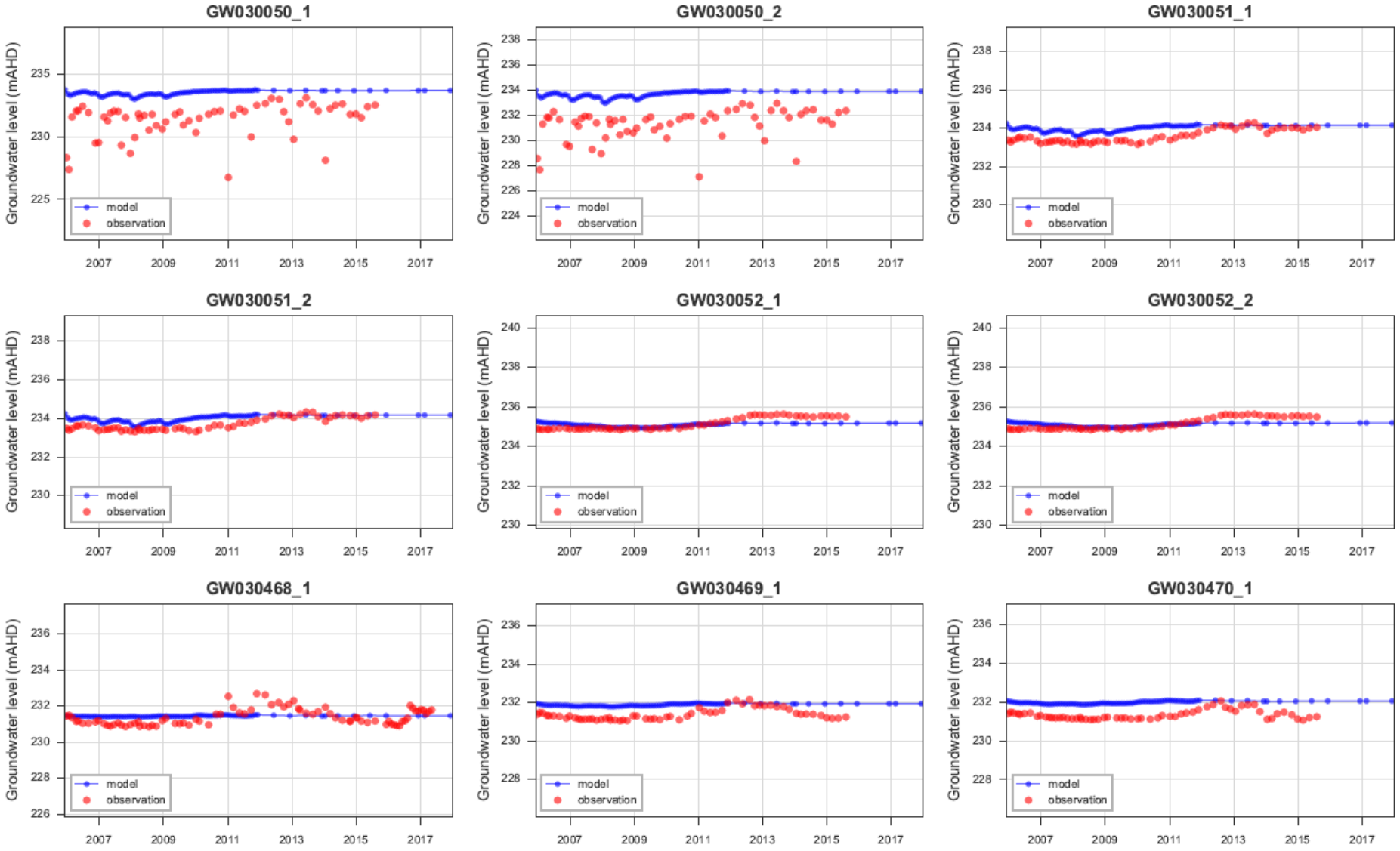

Templemore A (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

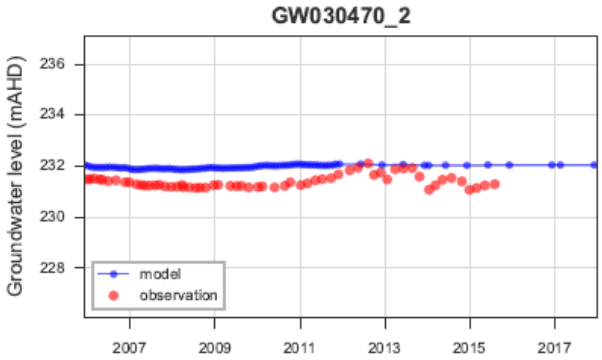

Templemore B (Tarrawonga)
EC LOWESS (0.3)
EC
pH LOWESS (0.3)
pH
Electrical Conductivity (µS/cm)
pH (field)
Monitored unit: Alluvium

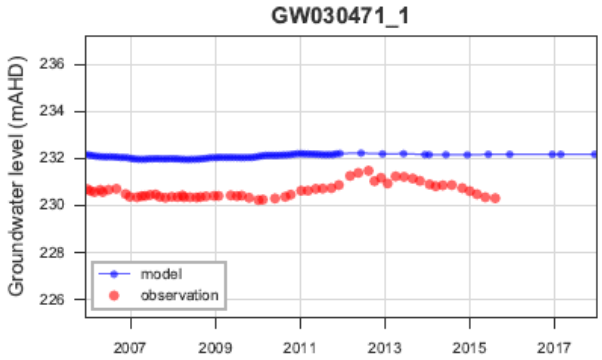
APPENDIX D – TRANSIENT CALIBRATION HYDROGRAPHS

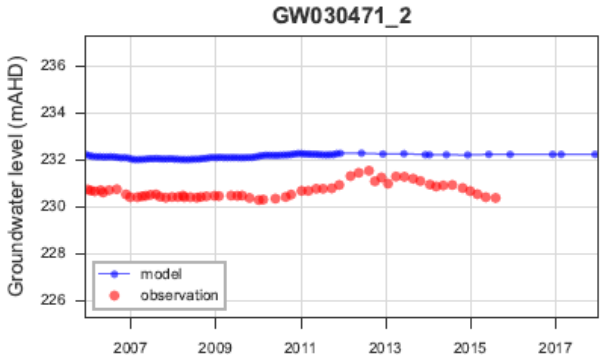


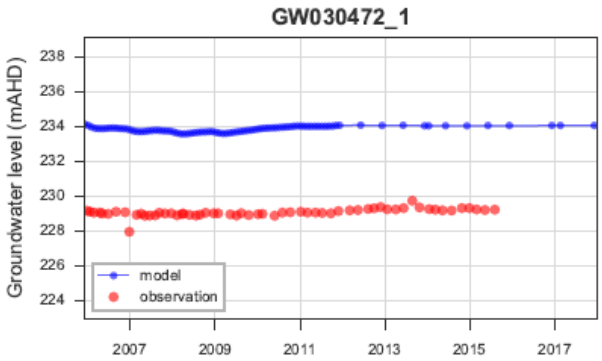

GW01
GW01_29m
GW02
GW02_14m
GW03
GW030048_1
GW030048_2
GW030049_1
GW030049_2
Groundwater level (mAHD)
model
observation
2007
2009
2011
2013
2015
2017

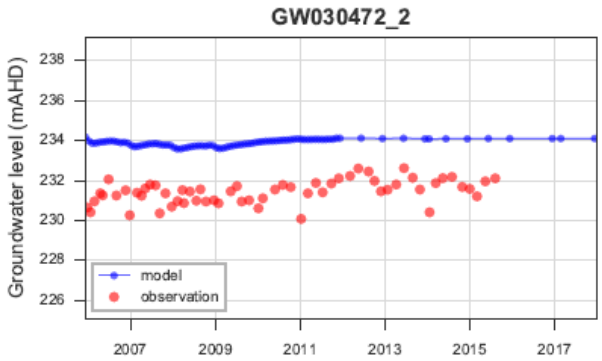

GW030050_1
GW030050_2
GW030051_1
GW030051_2
GW030052_1
GW030052_2
GW030468_1
GW030469_1
GW030470_1
Groundwater level (mAHD)
model
observation
2007
2009
2011
2013
2015
2017

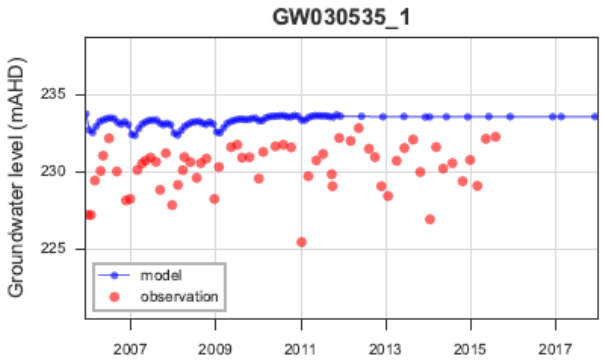

GW030470_2
Groundwater level (mAHD)
236
234
232
230
228
model
observation
2007
2009
2011
2013
2015
2017

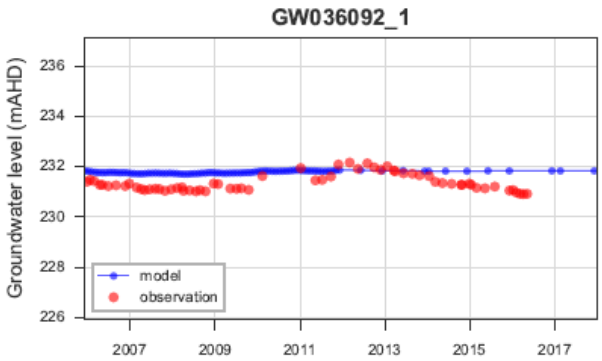

GW030471_1
Groundwater level (mAHD)
236
234
232
230
228
226
model
observation
2007
2009
2011
2013
2015
2017

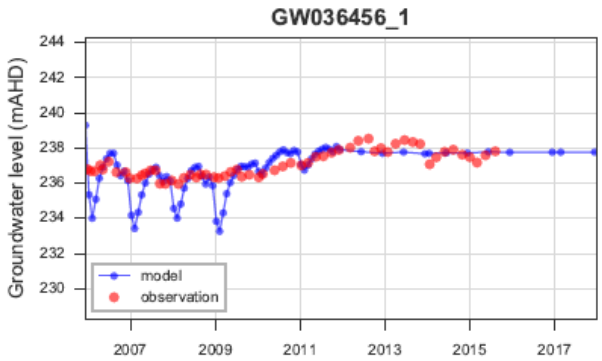

GW030471_2
Groundwater level (mAHD)
236
234
232
230
228
226
model
observation
2007
2009
2011
2013
2015
2017


GW030472_1
Groundwater level (mAHD)
238
236
234
232
230
228
226
224
model
observation
2007
2009
2011
2013
2015
2017


GW030472_2
Groundwater level (mAHD)
238
236
234
232
230
228
226
model
observation
2007
2009
2011
2013
2015
2017


GW030535_1
Groundwater level (mAHD)
235
230
225
model
observation
2007
2009
2011
2013
2015
2017


GW036092_1
Groundwater level (mAHD)
236
234
232
230
228
226
model
observation
2007
2009
2011
2013
2015
2017


GW036456_1
Groundwater level (mAHD)
244
242
240
238
236
234
232
230
model
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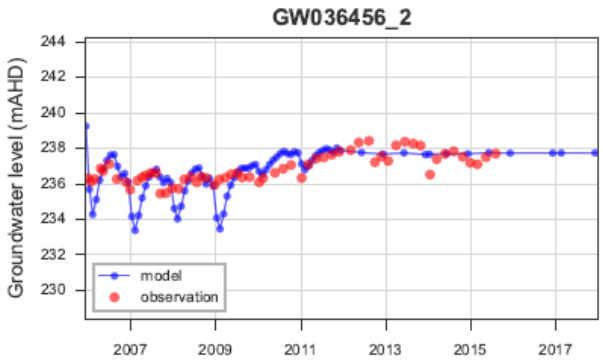
GW036456_2
Groundwater level (mAHD)
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model
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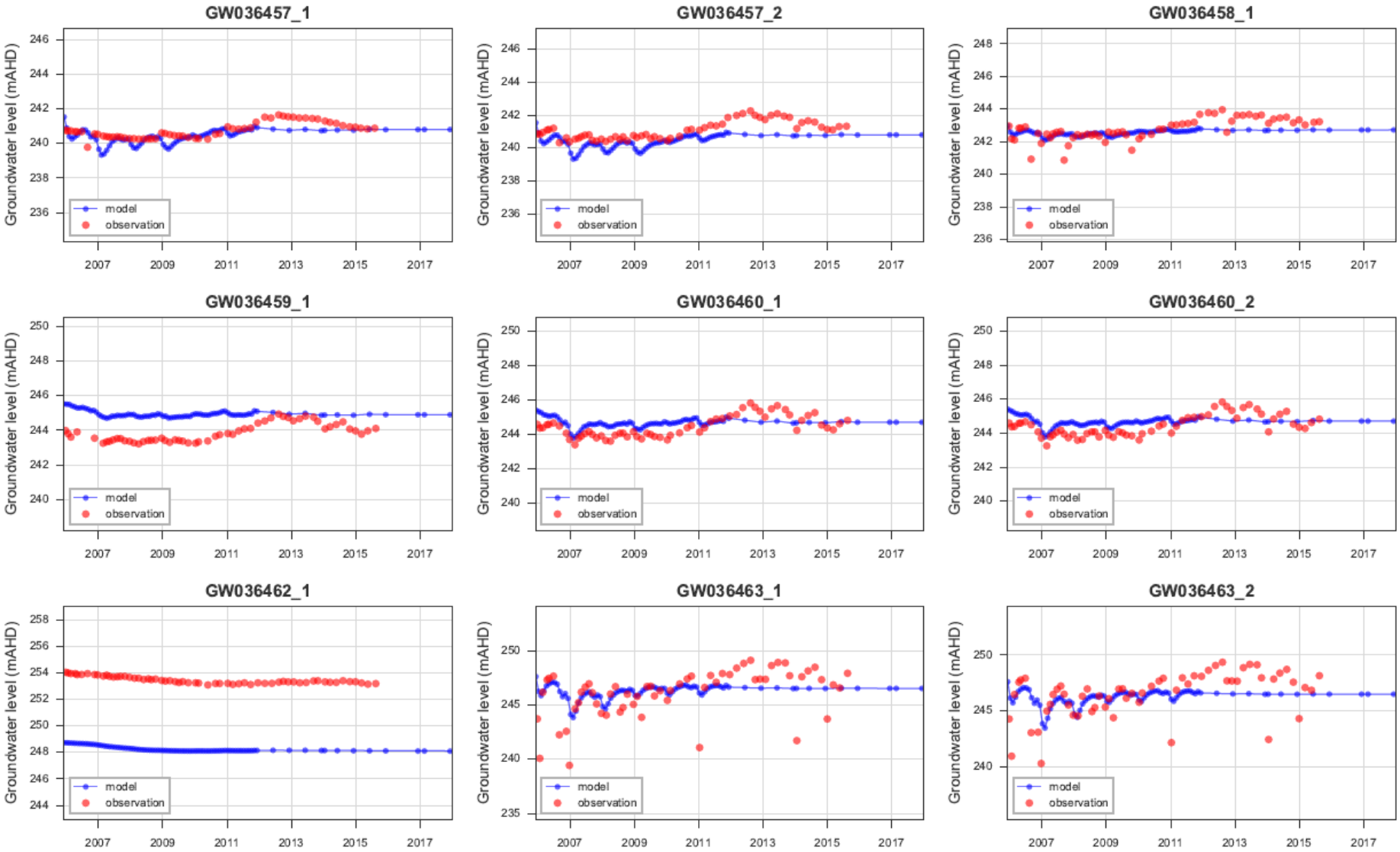
GW036457_1
GW036457_2
GW036458_1
GW036459_1
GW036460_1
GW036460_2
GW036462_1
GW036463_1
GW036463_2
Groundwater level (mAHD)
model
observation
2007
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2011
2013
2015
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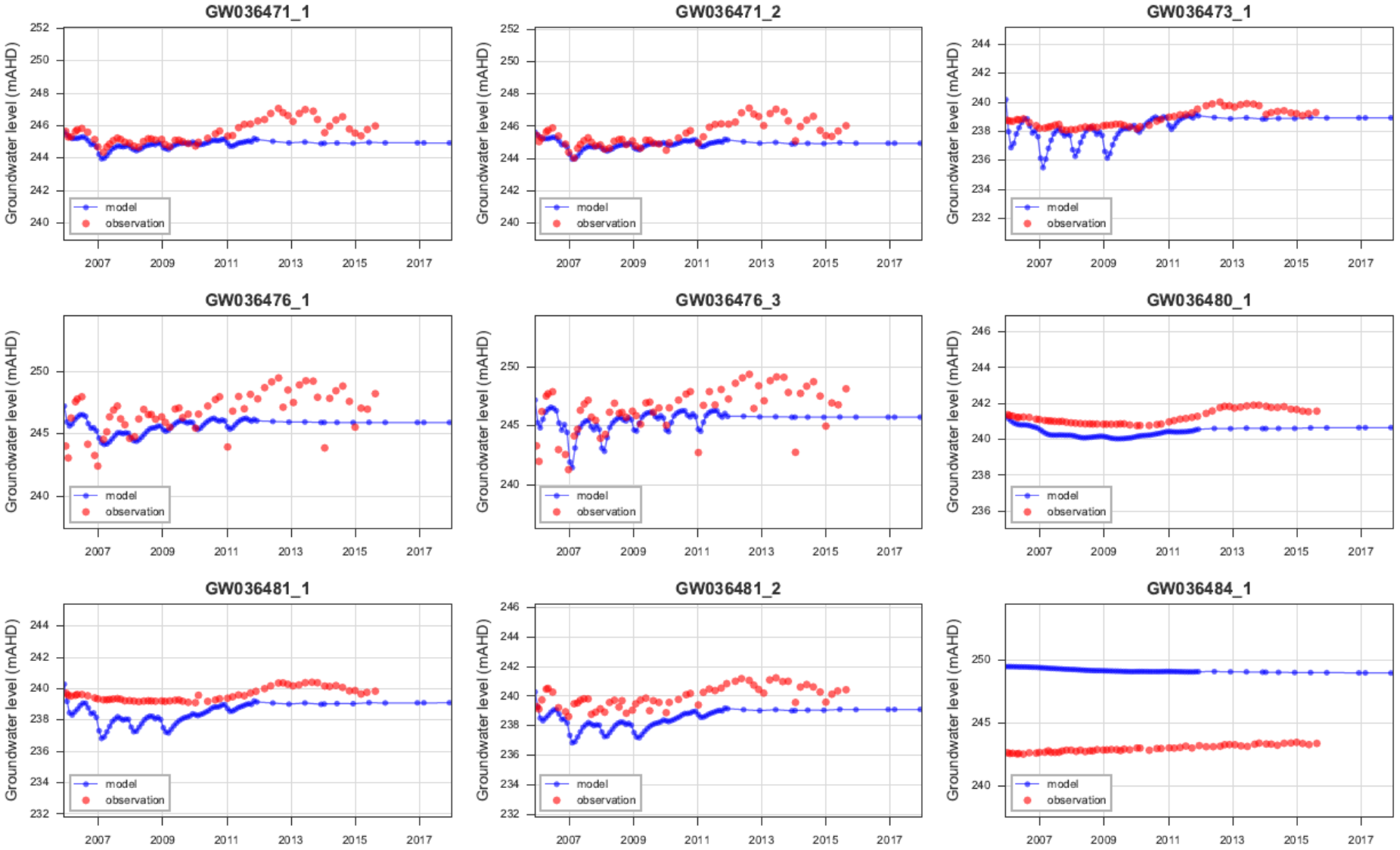
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GW036471_2
GW036473_1
GW036476_1
GW036476_3
GW036480_1
GW036481_1
GW036481_2
GW036484_1
Groundwater level (mAHD)
model
observation
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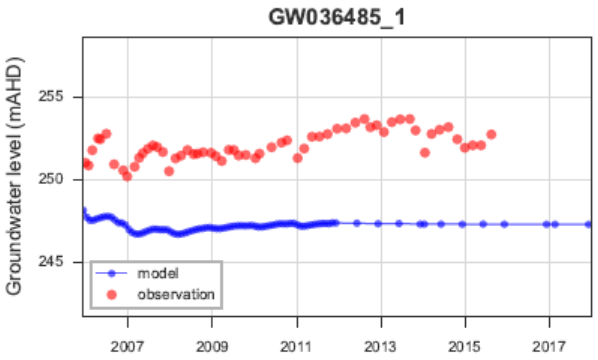
2013
2015
2017


GW036485_1
Groundwater level (mAHD)
model
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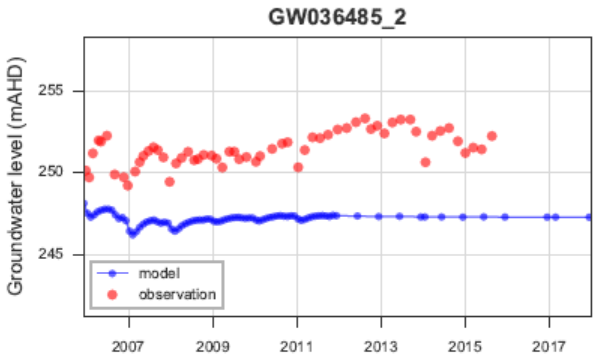
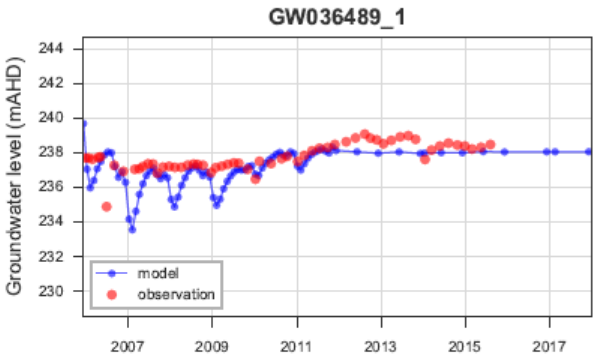
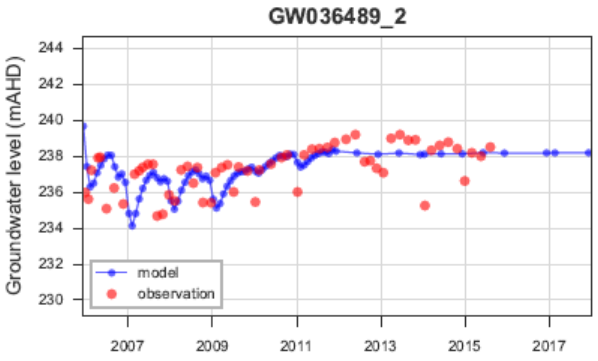
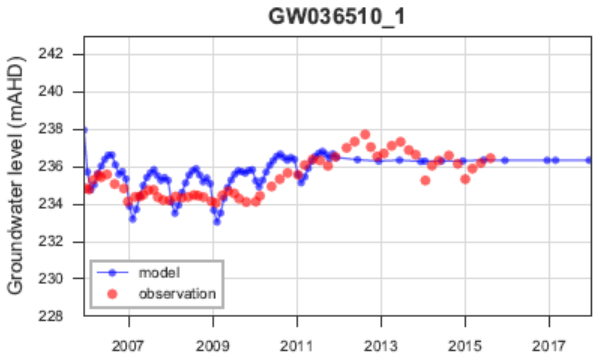
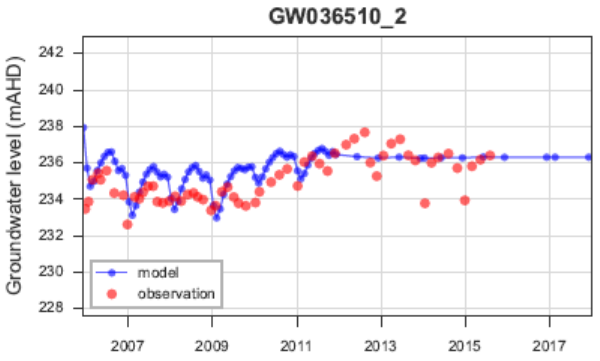
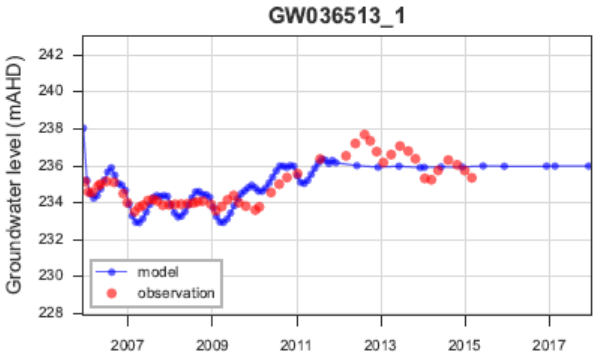

GW036485_2
Groundwater level (mAHD)
model
observation

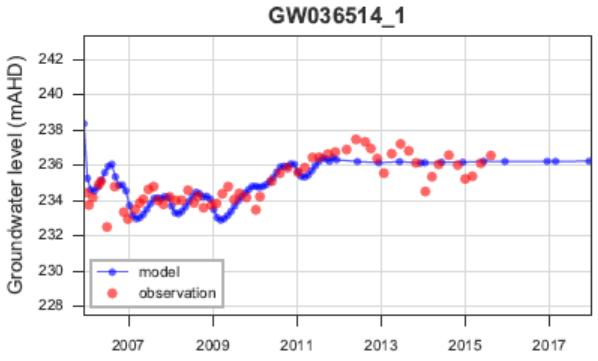

GW036489_1
Groundwater level (mAHD)
model
observation

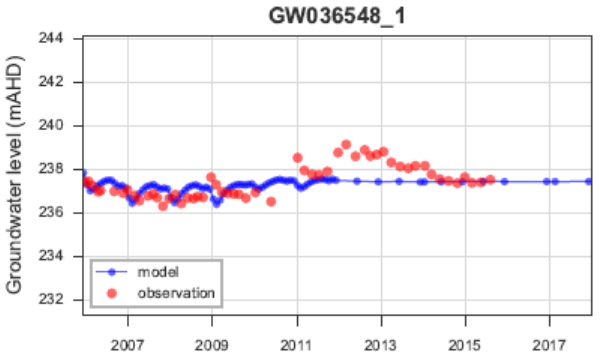

GW036489_2
Groundwater level (mAHD)
model
observation

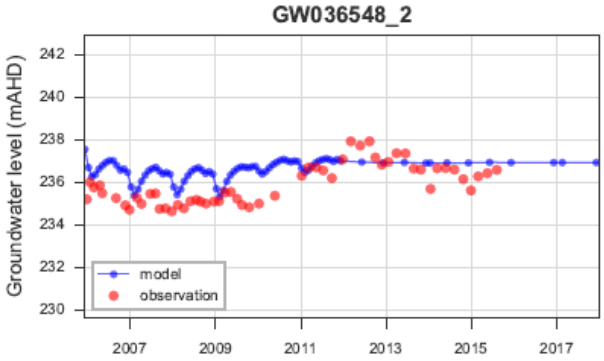

GW036510_1
Groundwater level (mAHD)
model
observation


GW036510_2
Groundwater level (mAHD)
model
observation


GW036513_1
Groundwater level (mAHD)
model
observation


GW036514_1
Groundwater level (mAHD)
model
observation


GW036548_1
Groundwater level (mAHD)
model
observation


GW036548_2
Groundwater level (mAHD)
model
observation
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2015
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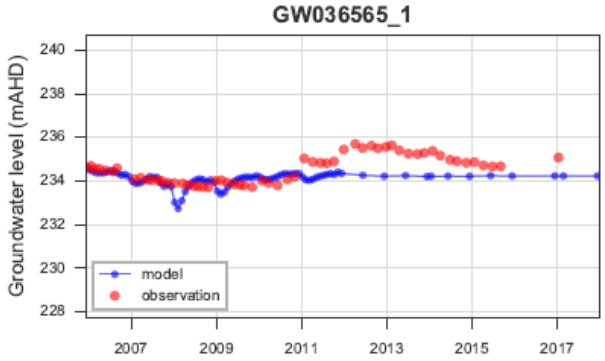
GW036565_1
Groundwater level (mAHD)
model
observation
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2015
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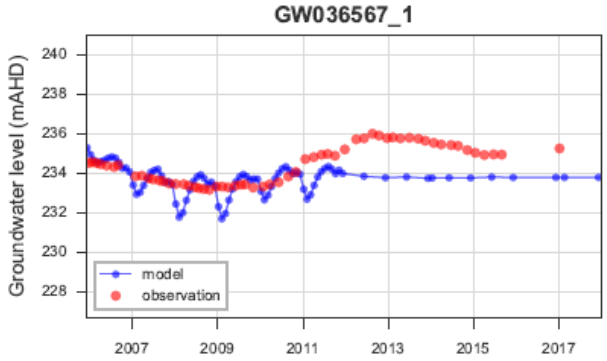
GW036567_1
Groundwater level (mAHD)
model
observation
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2015
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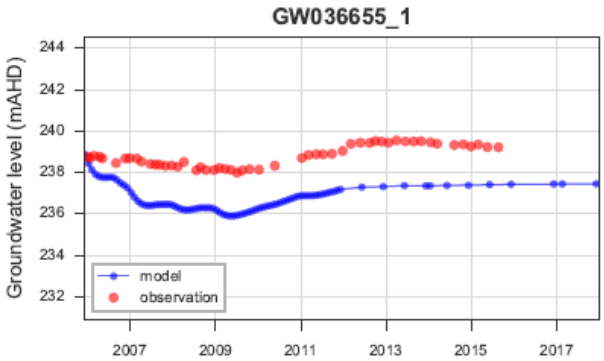
GW036655_1
Groundwater level (mAHD)
model
observation
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2015
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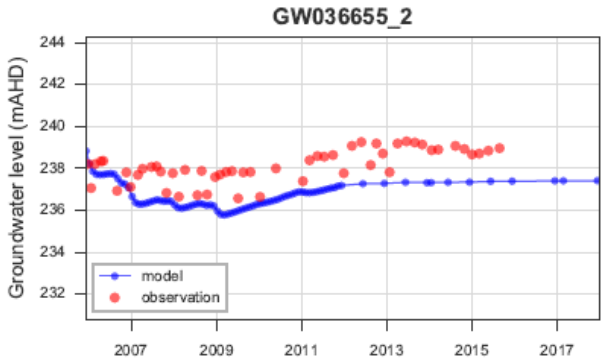
GW036655_2
Groundwater level (mAHD)
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2015
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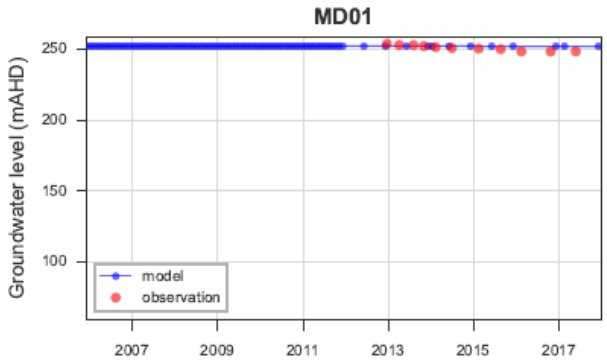
MD01
Groundwater level (mAHD)
model
observation
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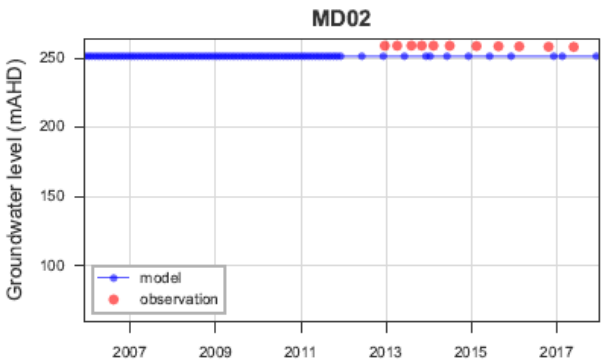
2013
2015
2017


MD02
Groundwater level (mAHD)
model
observation
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2015
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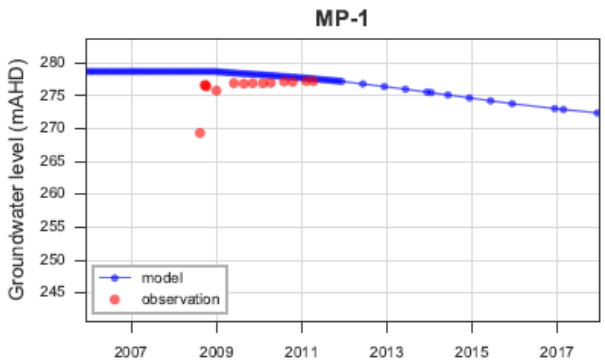
MP-1
Groundwater level (mAHD)
model
observation
2007
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2013
2015
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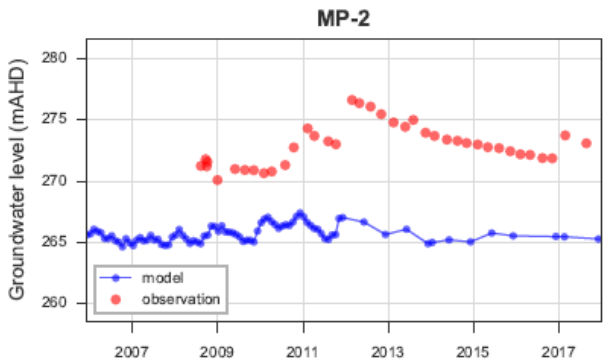
MP-2
Groundwater level (mAHD)
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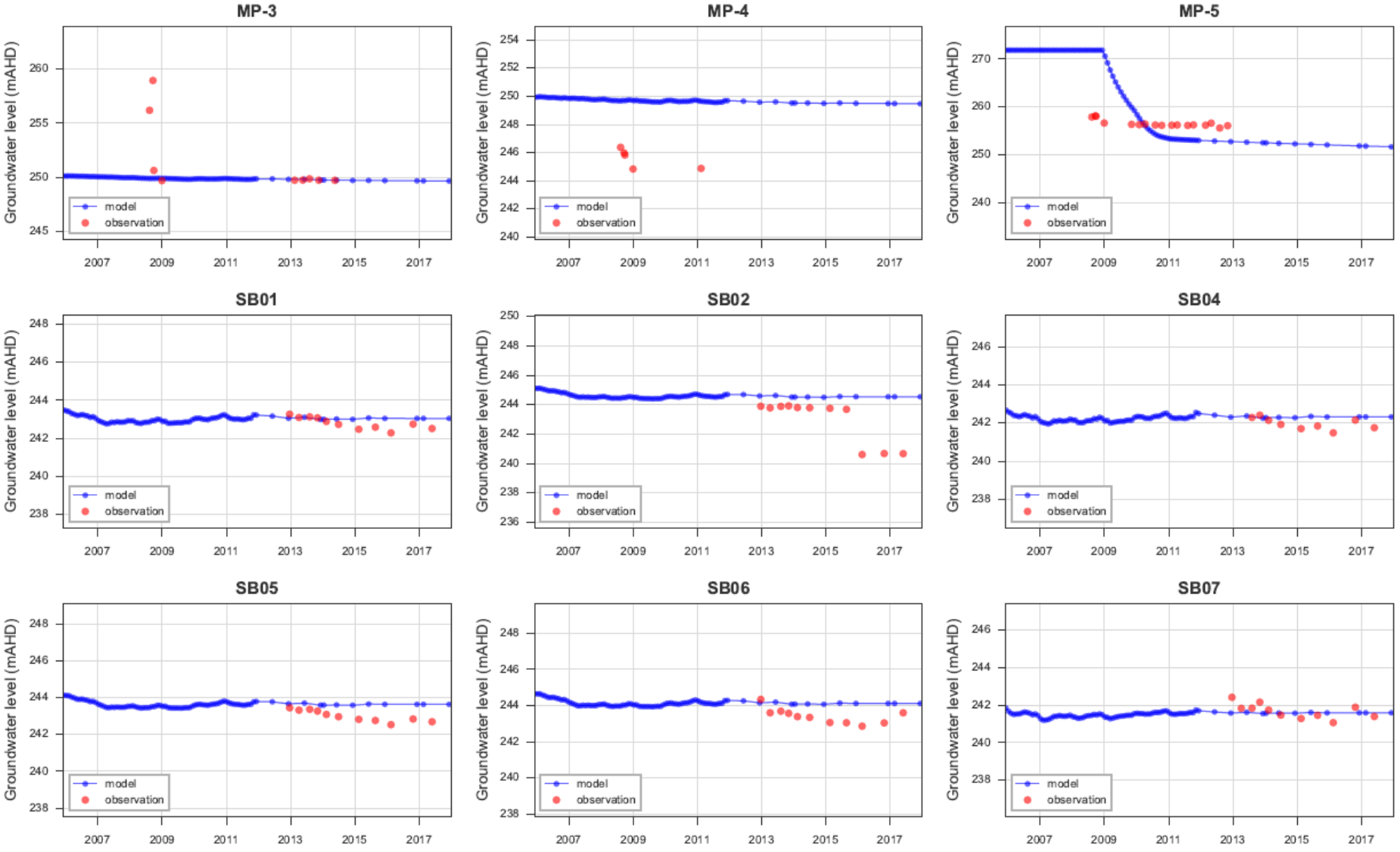
MP-3
MP-4
MP-5
SB01
SB02
SB04
SB05
SB06
SB07
Groundwater level (mAHD)
model
observation
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2011
2013
2015
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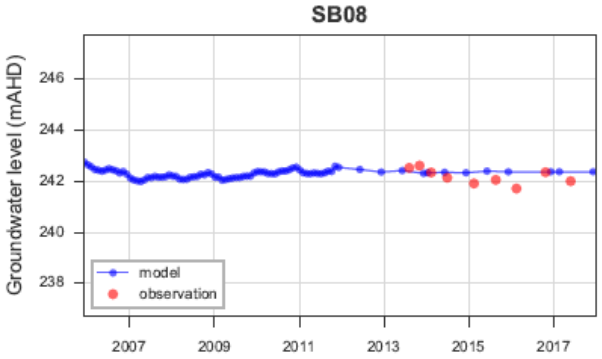
SB08
Groundwater level (mAHD)
246
244
242
240
238
model
observation
2007
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2011
2013
2015
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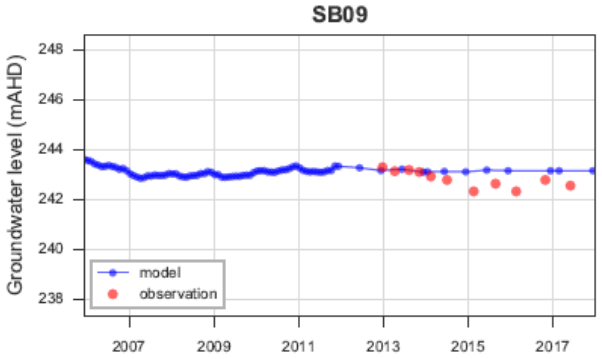
SB09
Groundwater level (mAHD)
248
246
244
242
240
238
model
observation
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2011
2013
2015
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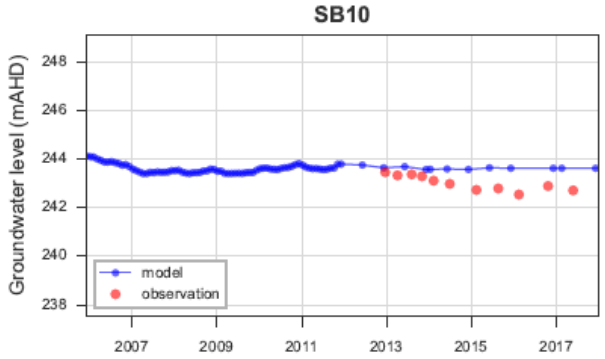
SB10
Groundwater level (mAHD)
248
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244
242
240
238
model
observation
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2011
2013
2015
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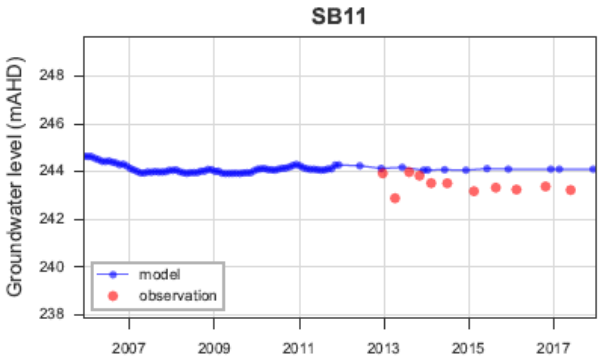
SB11
Groundwater level (mAHD)
248
246
244
242
240
238
model
observation
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2009
2011
2013
2015
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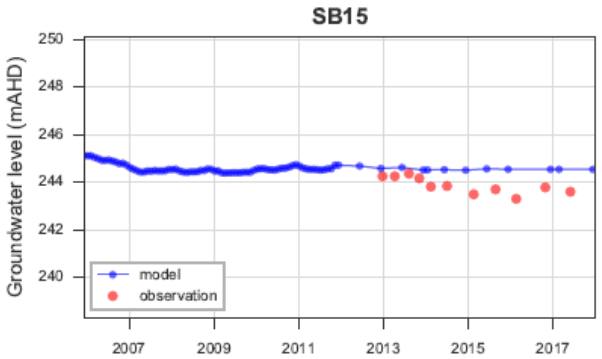
SB15
Groundwater level (mAHD)
250
248
246
244
242
240
model
observation
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2009
2011
2013
2015
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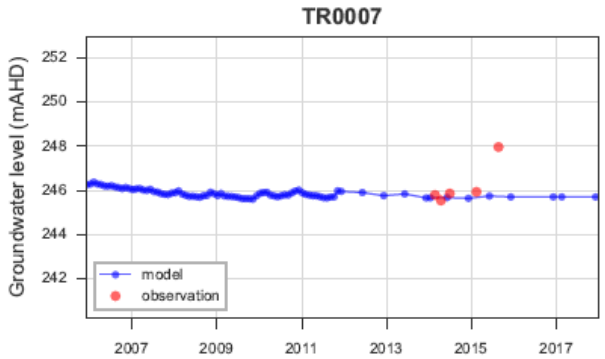
TR0007
Groundwater level (mAHD)
252
250
248
246
244
242
model
observation
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2013
2015
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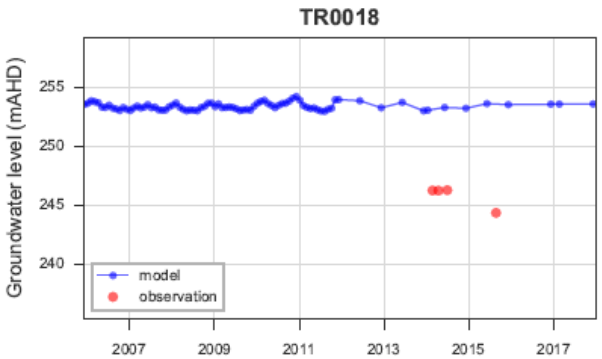
TR0018
Groundwater level (mAHD)
255
250
245
240
model
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2015
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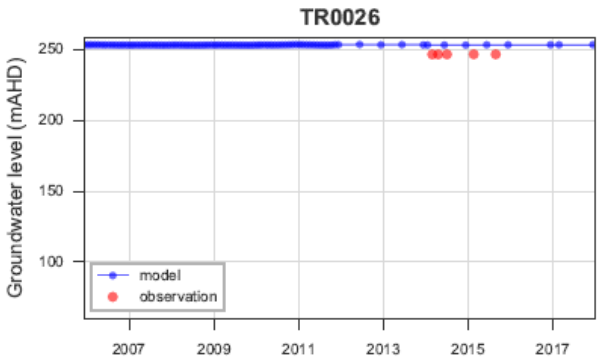
TR0026
Groundwater level (mAHD)
250
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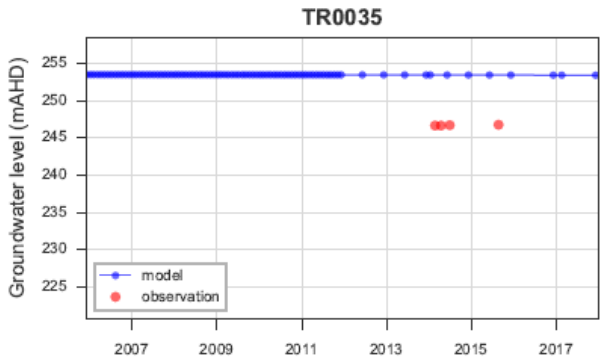
TR0035
Groundwater level (mAHD)
255
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230
225
model
observation
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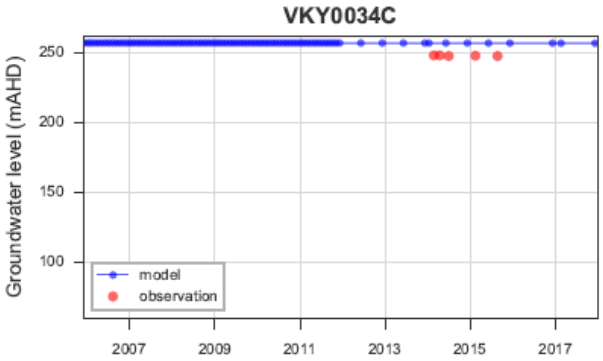
VKY0034C
Groundwater level (mAHD)
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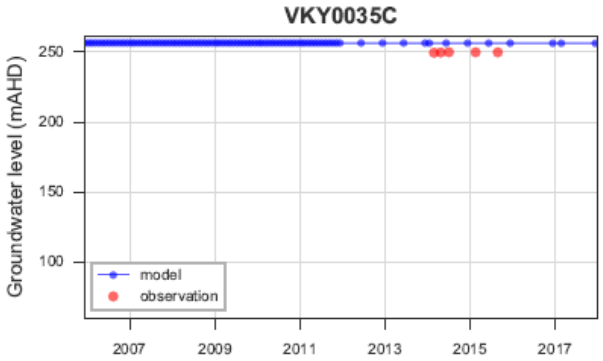
VKY0035C
Groundwater level (mAHD)
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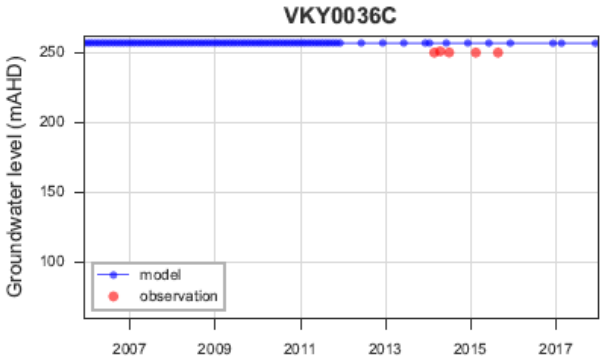
VKY0036C
Groundwater level (mAHD)
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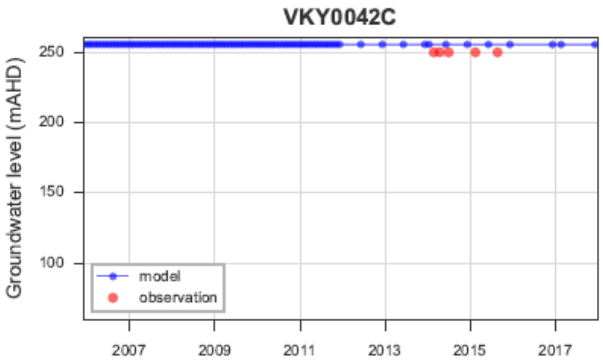
VKY0042C
Groundwater level (mAHD)
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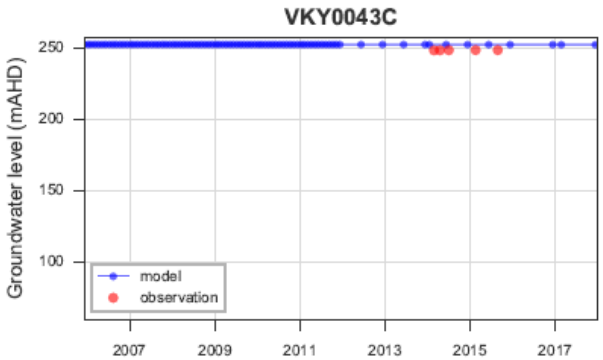
VKY0043C
Groundwater level (mAHD)
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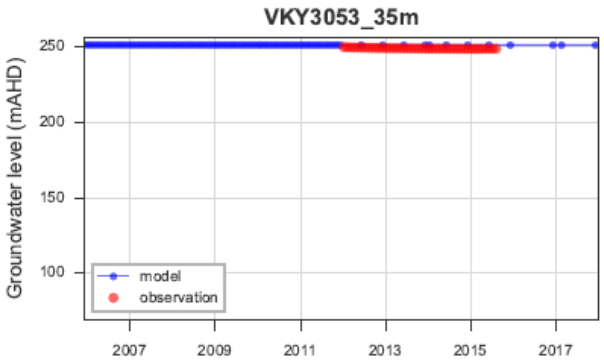
VKY3053_35m
Groundwater level (mAHD)
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model
observation
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2015
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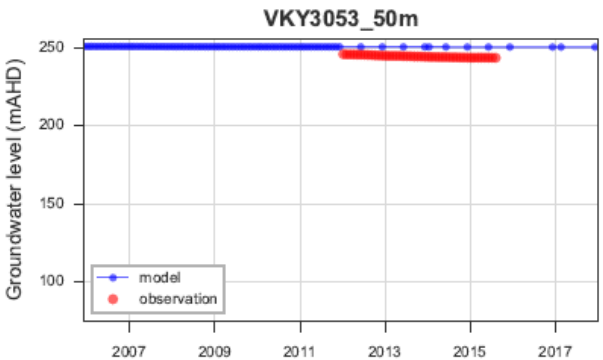
VKY3053_50m
Groundwater level (mAHD)
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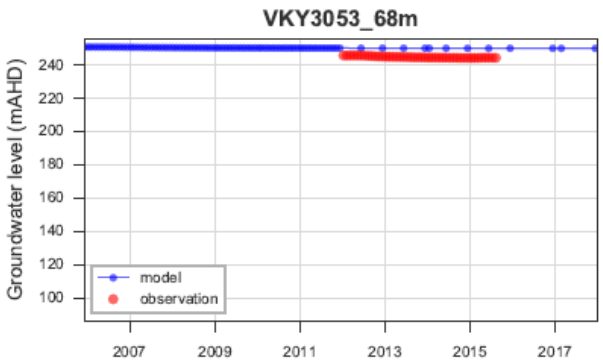
VKY3053_68m
Groundwater level (mAHD)
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model
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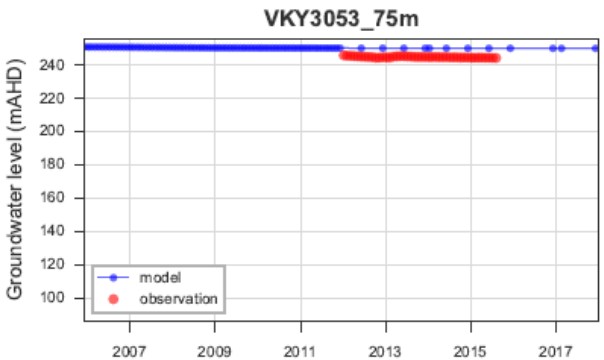
VKY3053_75m
Groundwater level (mAHD)
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2015
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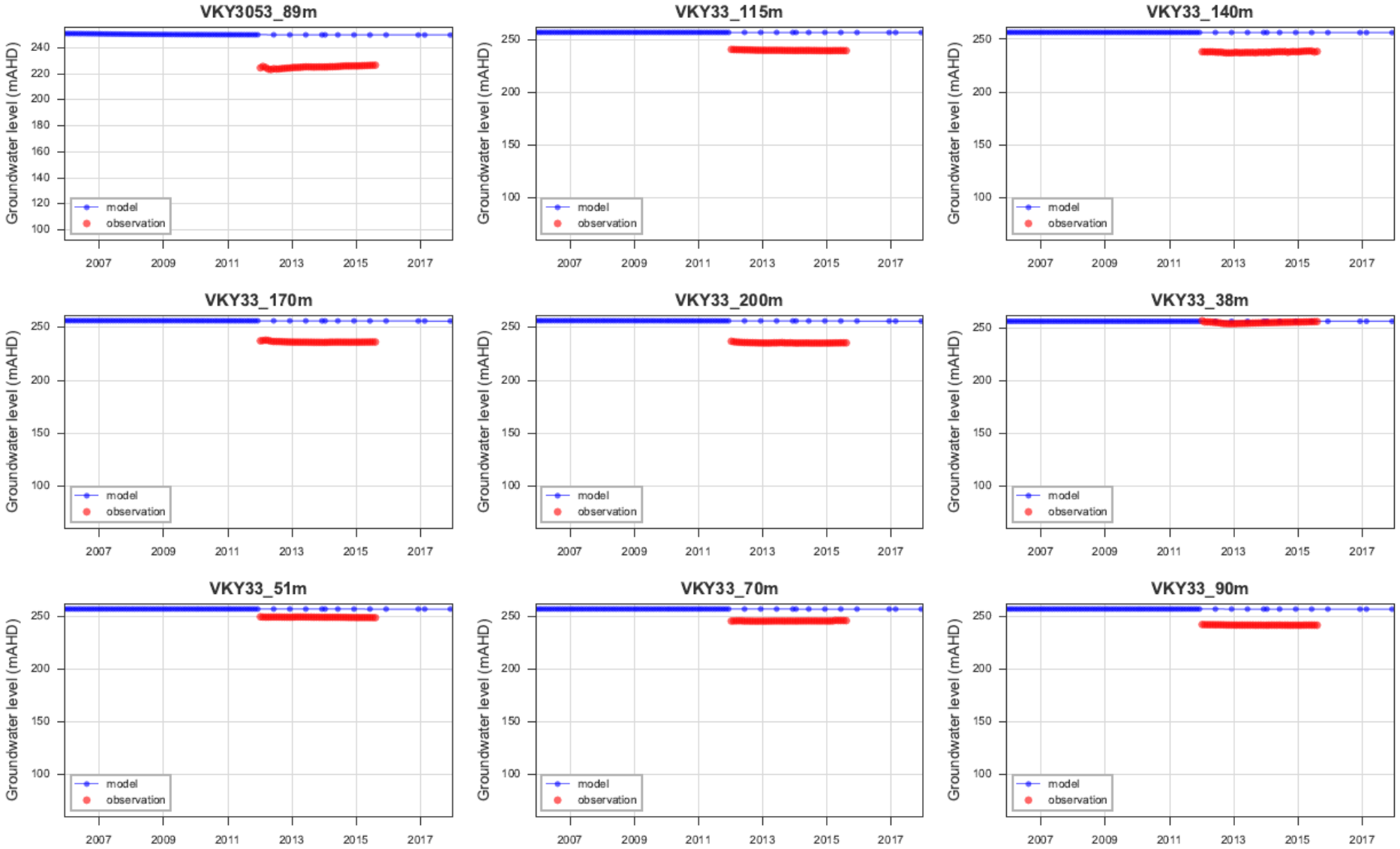
VKY3053_89m
VKY33_115m
VKY33_140m
VKY33_170m
VKY33_200m
VKY33_38m
VKY33_51m
VKY33_70m
VKY33_90m
Groundwater level (mAHD)
model
observation
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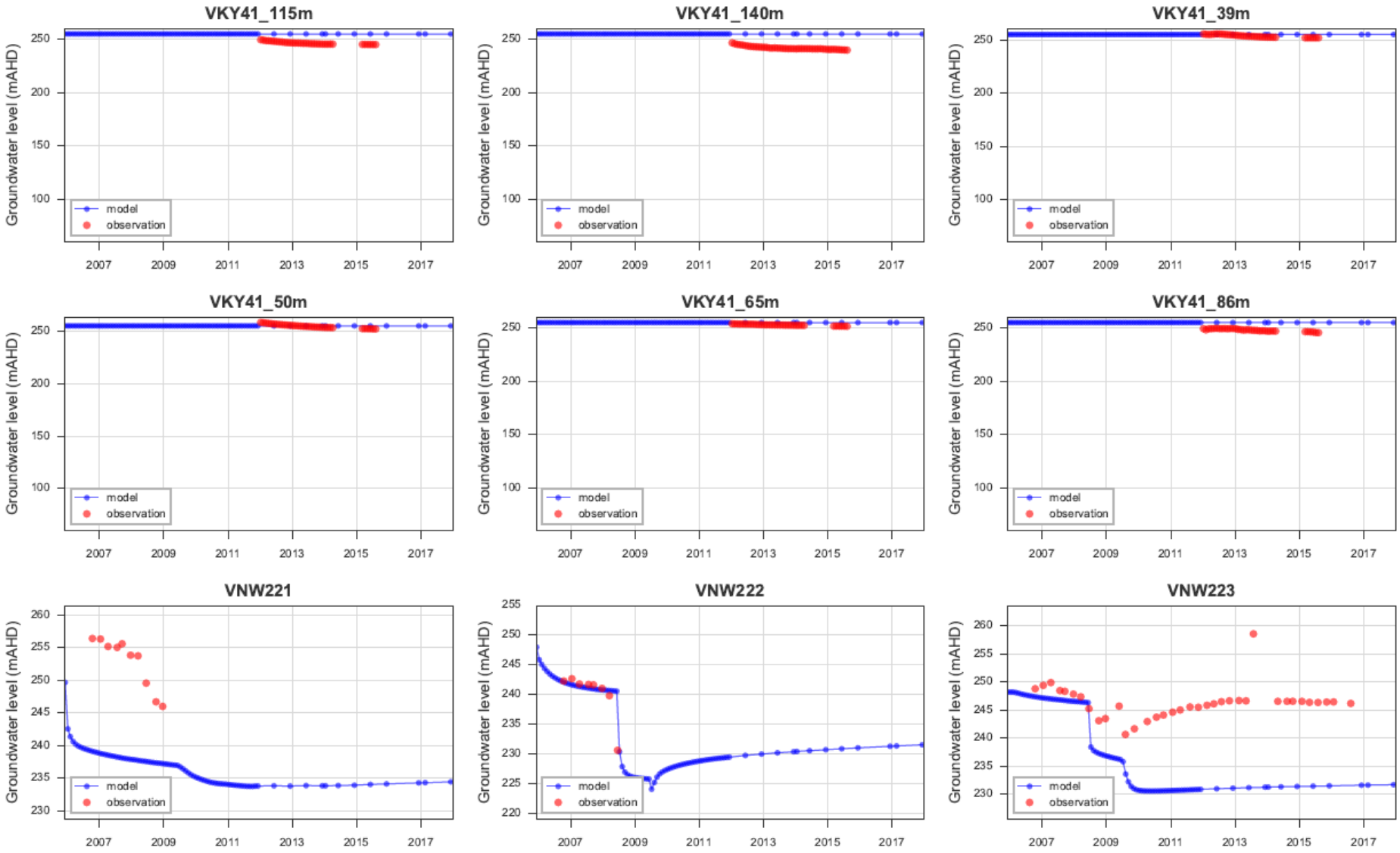
2013
2015
2017


VKY41_115m
VKY41_140m
VKY41_39m
VKY41_50m
VKY41_65m
VKY41_86m
VNW221
VNW222
VNW223
Groundwater level (mAHD)
model
observation
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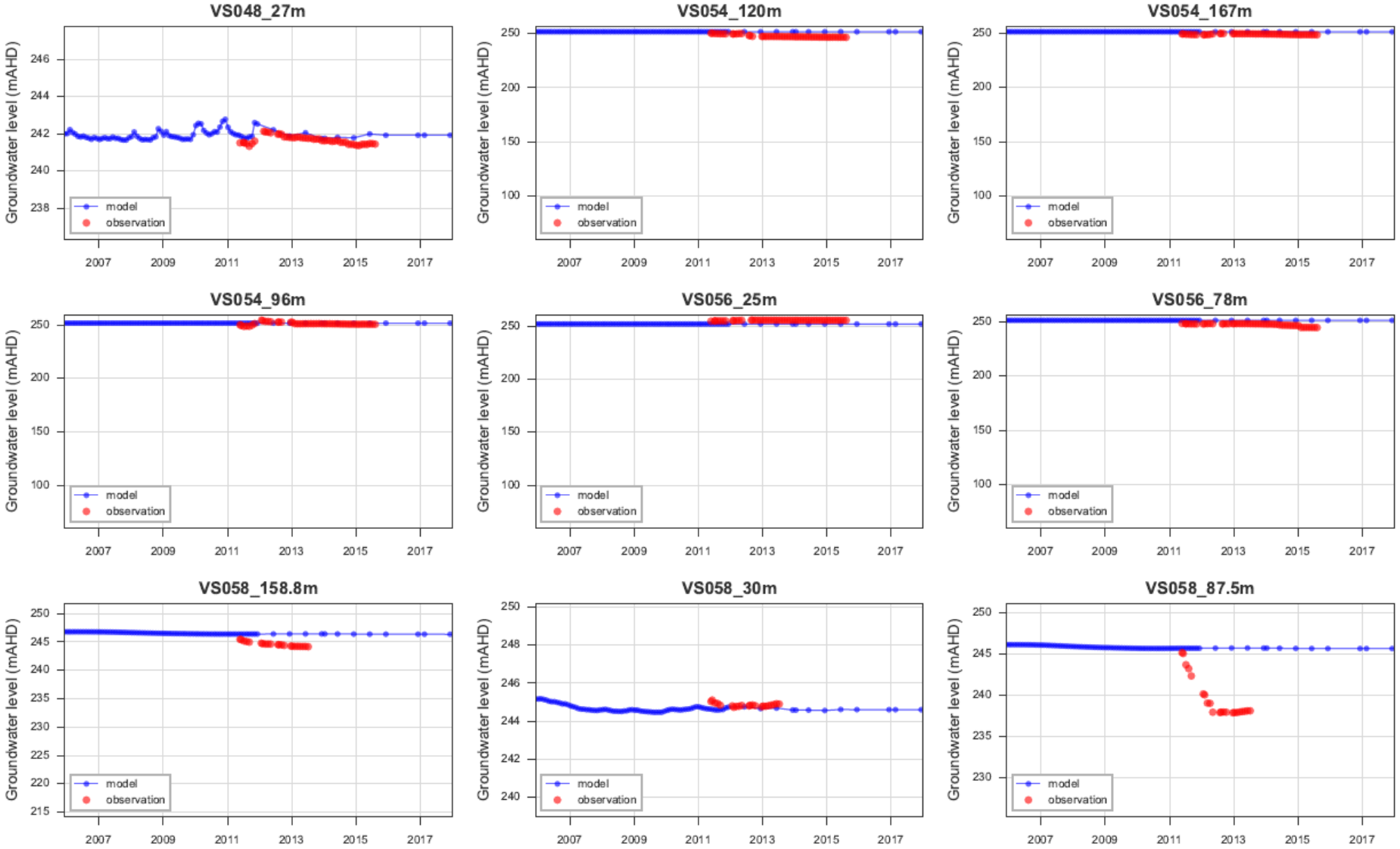
2013
2015
2017


VS048_27m
VS054_120m
VS054_167m
VS054_96m
VS056_25m
VS056_78m
VS058_158.8m
VS058_30m
VS058_87.5m
Groundwater level (mAHD)
model
observation
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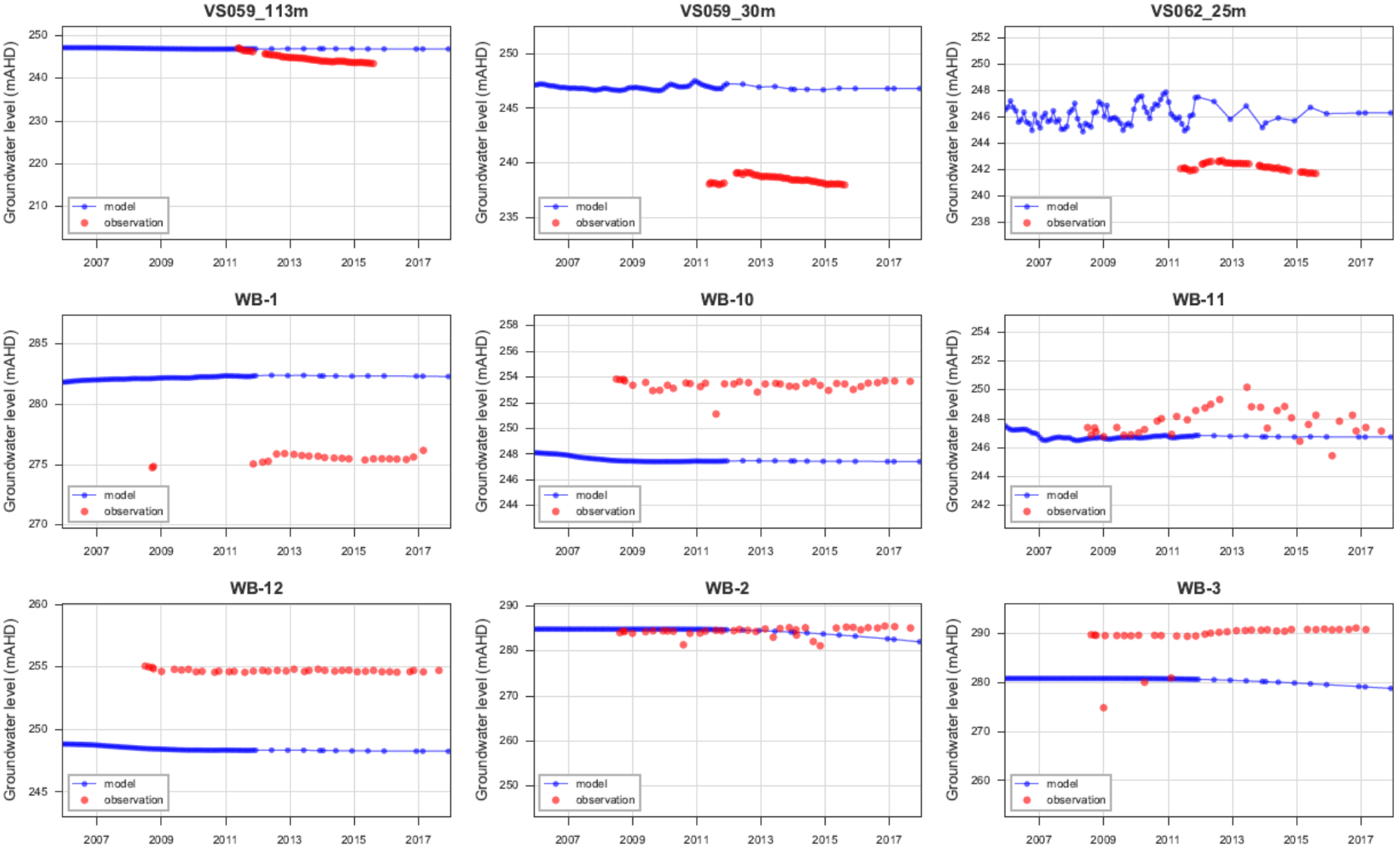
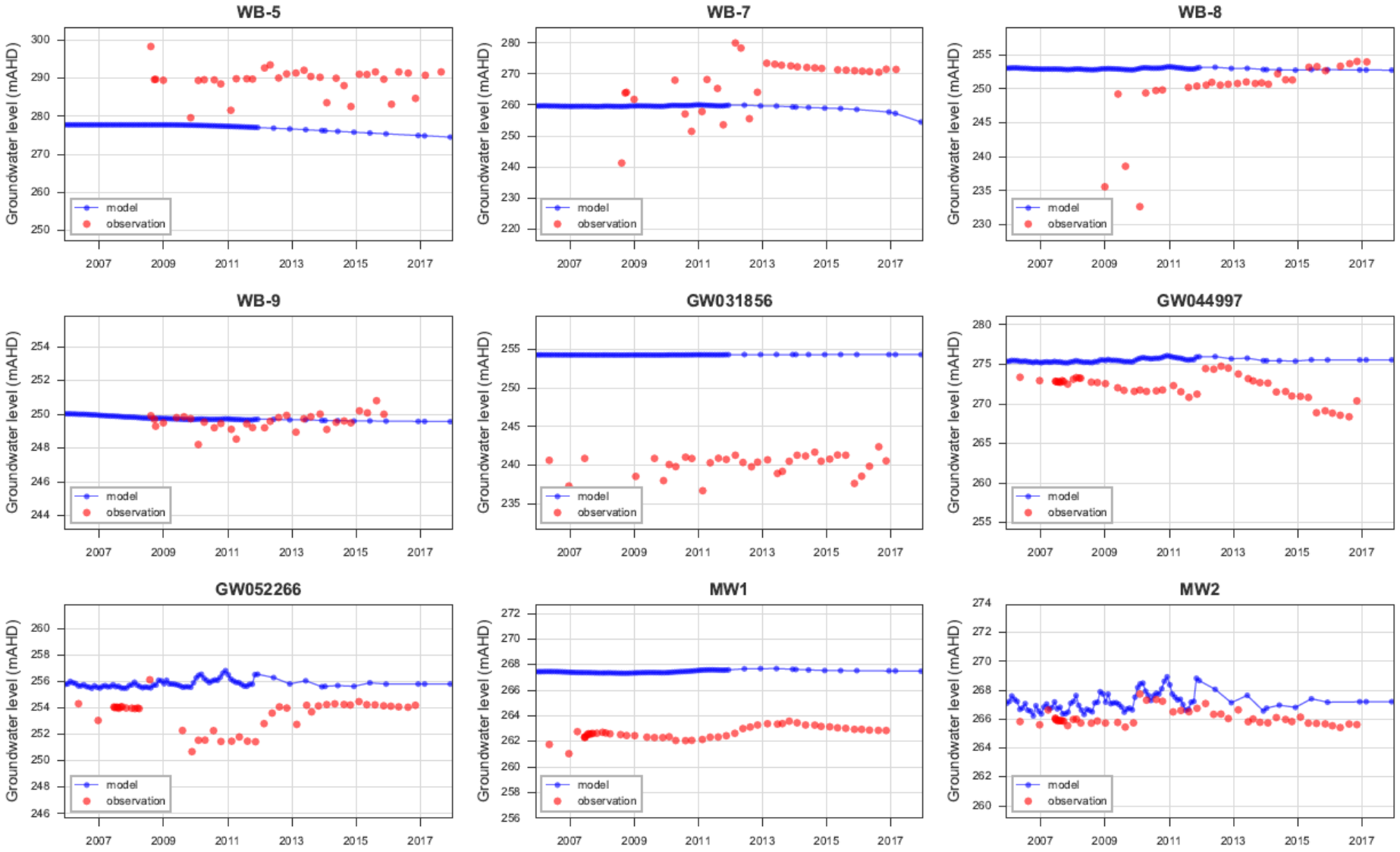
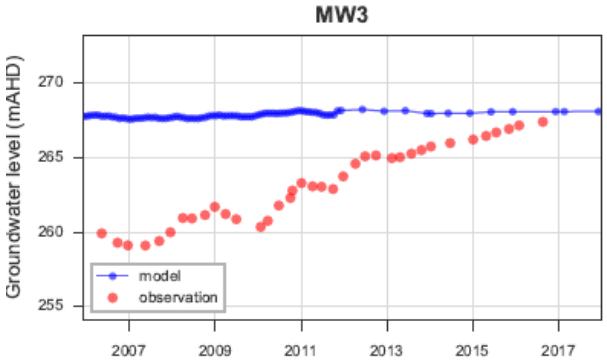
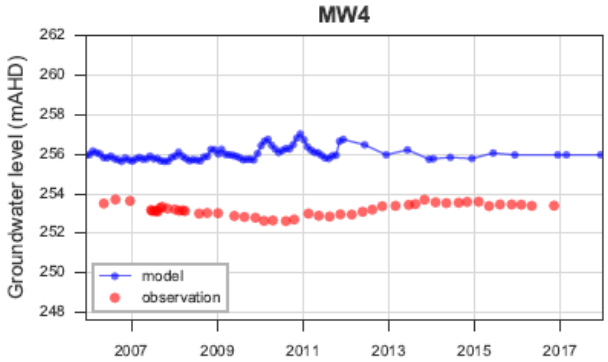
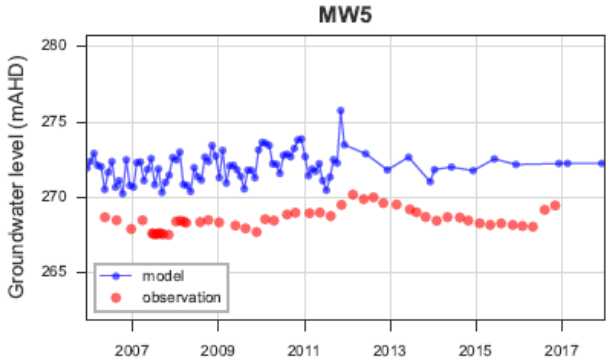
2013
2015
2017

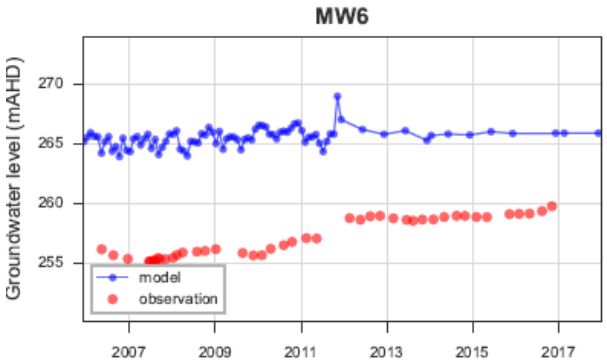

VS059_113m
VS059_30m
VS062_25m
WB-1
WB-10
WB-11
WB-12
WB-2
WB-3
Groundwater level (mAHD)
model
observation
2007
2009
2011
2013
2015
2017

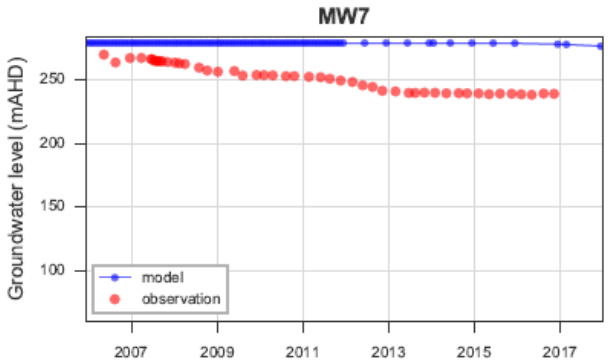

WB-5
WB-7
WB-8
WB-9
GW031856
GW044997
GW052266
MW1
MW2
Groundwater level (mAHD)
model
observation
2007
2009
2011
2013
2015
2017

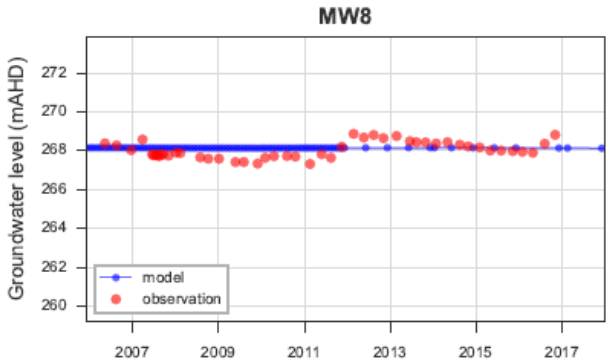

MW3
Groundwater level (mAHD)
270
265
260
255
2007
2009
2011
2013
2015
2017
model
observation

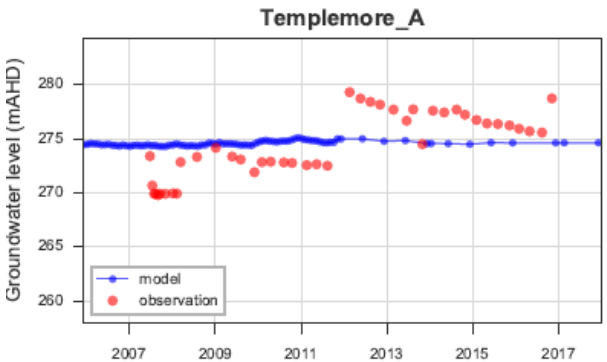

MW4
Groundwater level (mAHD)
262
260
258
256
254
252
250
248
2007
2009
2011
2013
2015
2017
model
observation

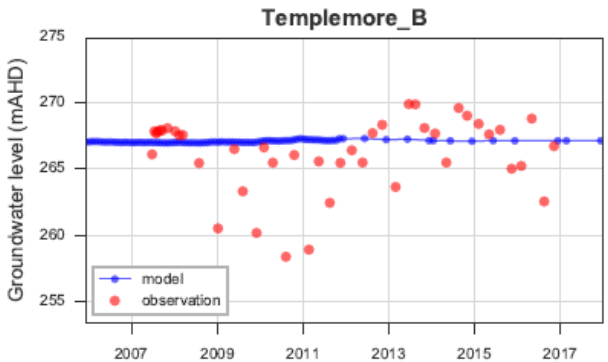

MW5
Groundwater level (mAHD)
280
275
270
265
2007
2009
2011
2013
2015
2017
model
observation


MW6
Groundwater level (mAHD)
270
265
260
255
2007
2009
2011
2013
2015
2017
model
observation


MW7
Groundwater level (mAHD)
250
200
150
100
2007
2009
2011
2013
2015
2017
model
observation


MW8
Groundwater level (mAHD)
272
270
268
266
264
262
260
2007
2009
2011
2013
2015
2017
model
observation


Templemore_A
Groundwater level (mAHD)
280
275
270
265
260
2007
2009
2011
2013
2015
2017
model
observation


Templemore_B
Groundwater level (mAHD)
275
270
265
260
255
2007
2009
2011
2013
2015
2017
model
observation

APPENDIX E – GROUNDWATER COUNTOUR PLOTS AT THE END OF PROJECT MINING AND RECOVERY

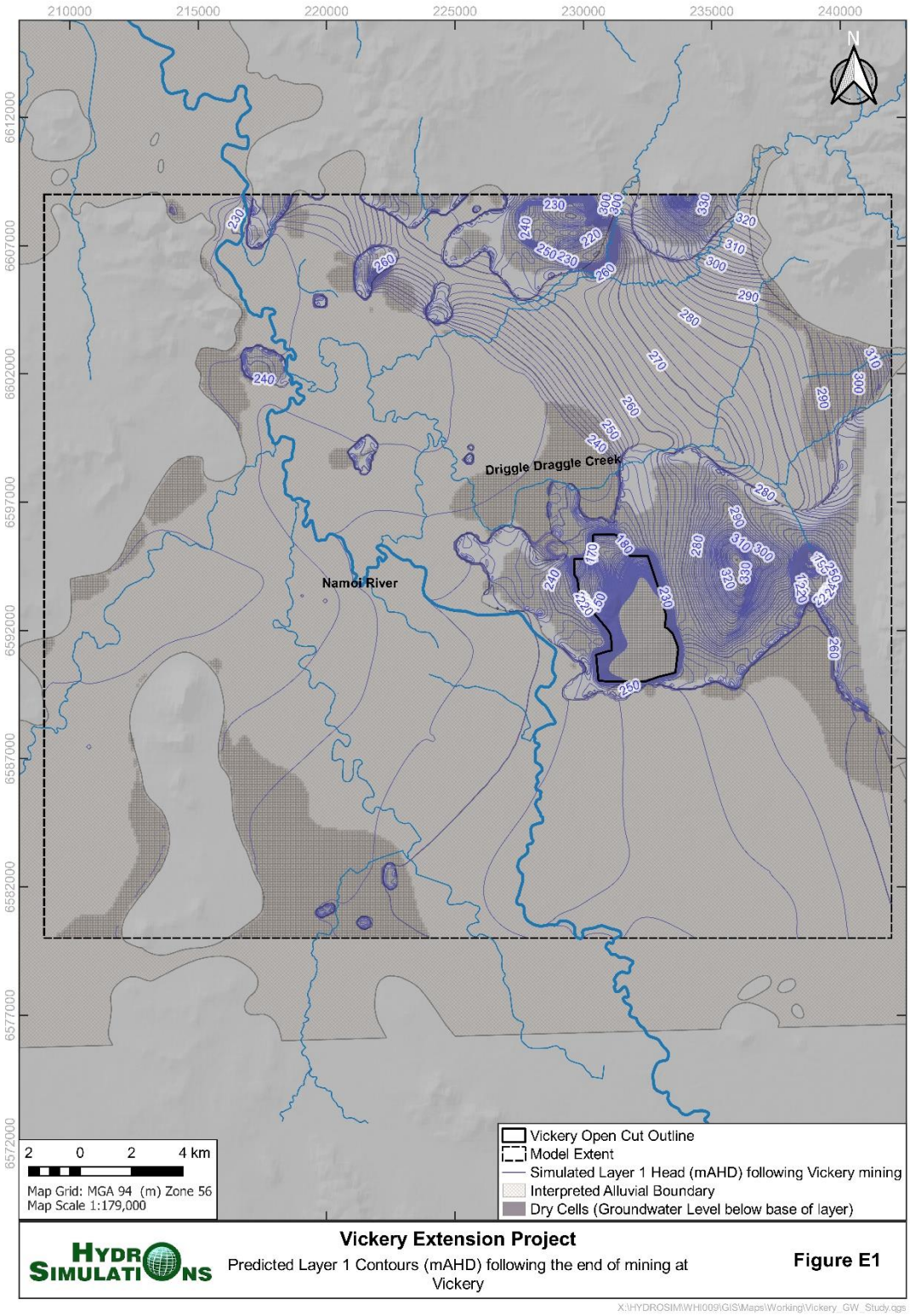


Figure E1 Predicted Layer 1 Contours (mAHD) following the end of mining at Vickery

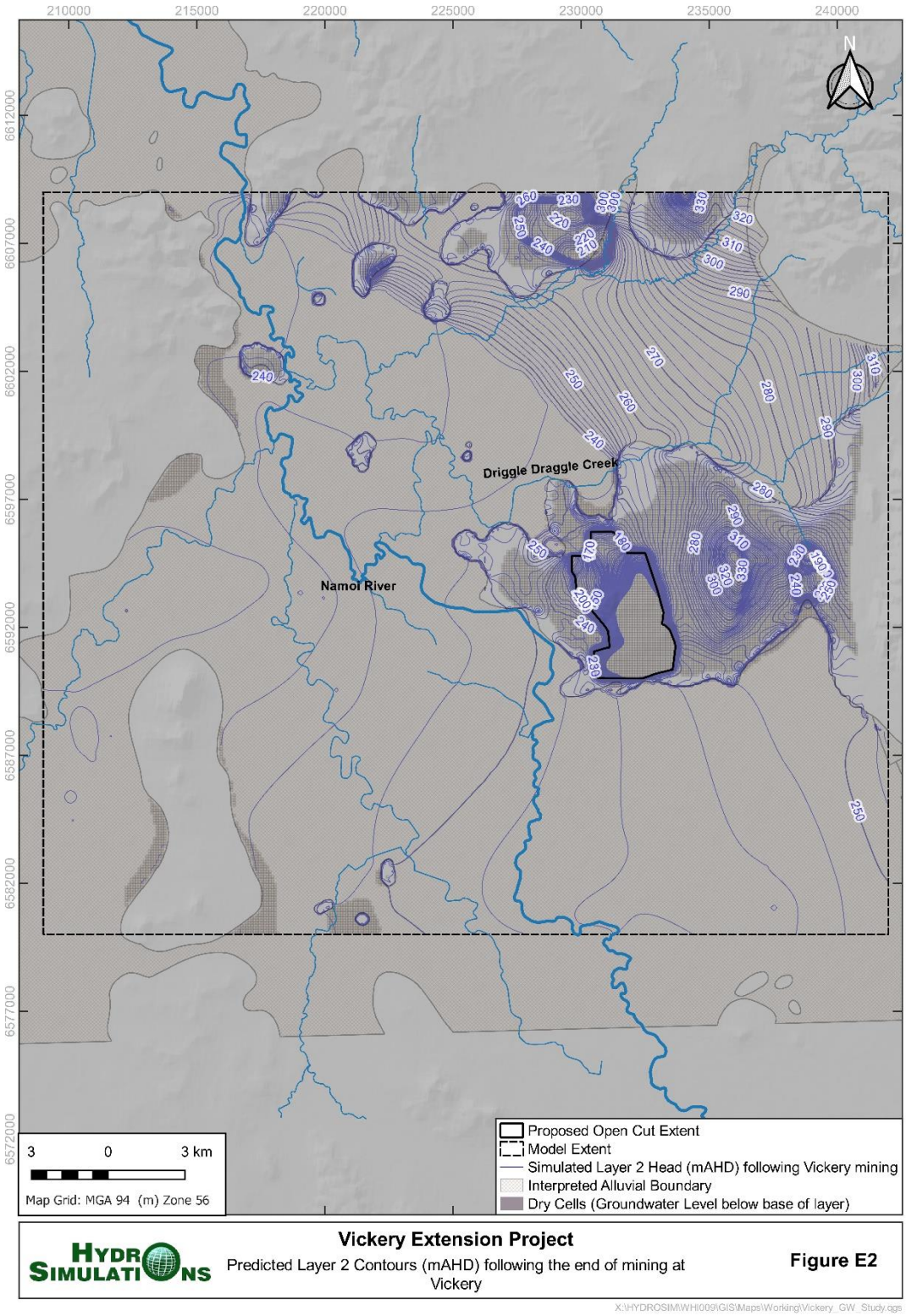


Figure E2 Predicted Layer 2 Contours (mAHD) following the end of mining at Vickery

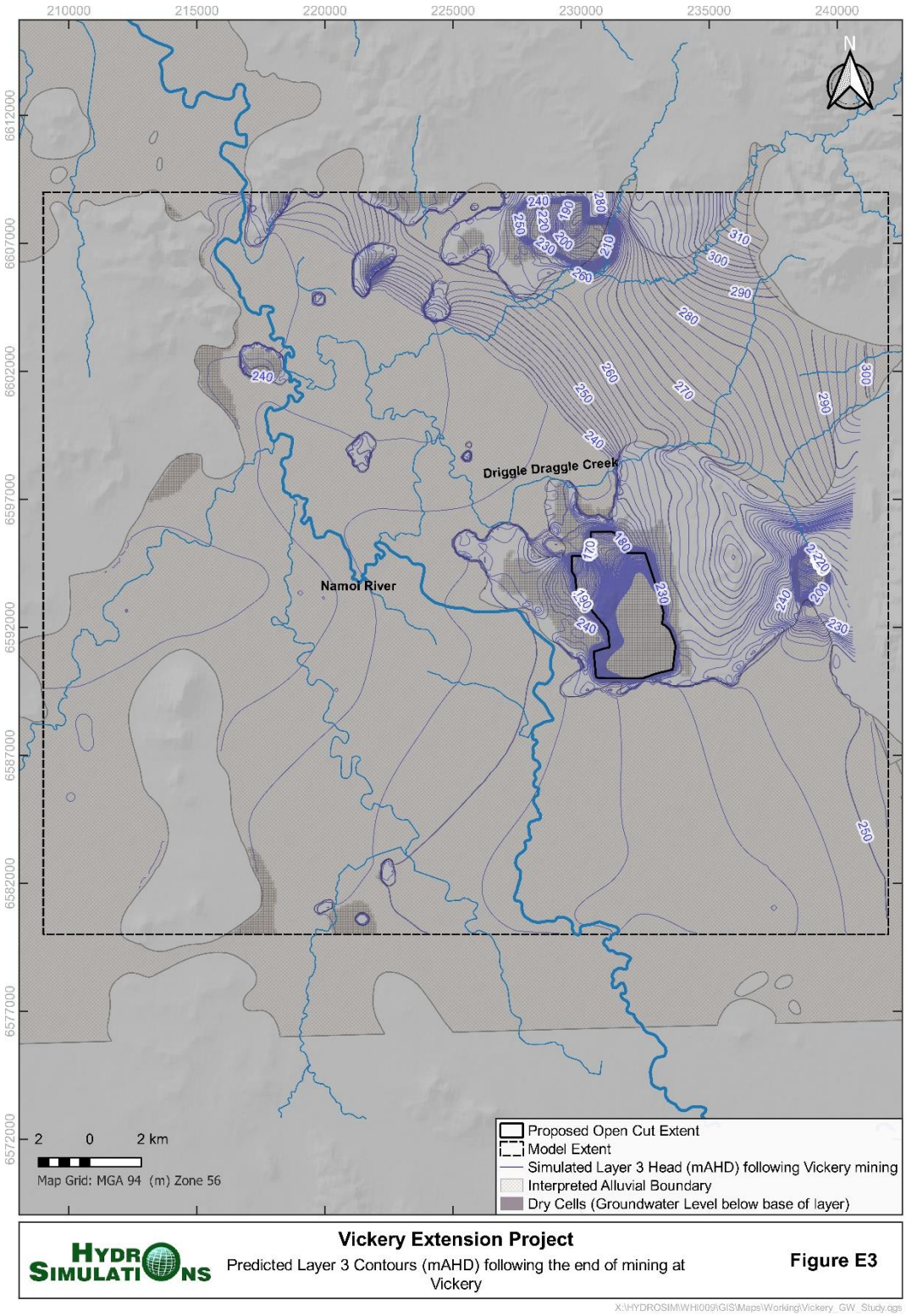


Figure E3 Predicted Layer 3 Contours (mAHD) following the end of mining at Vickery

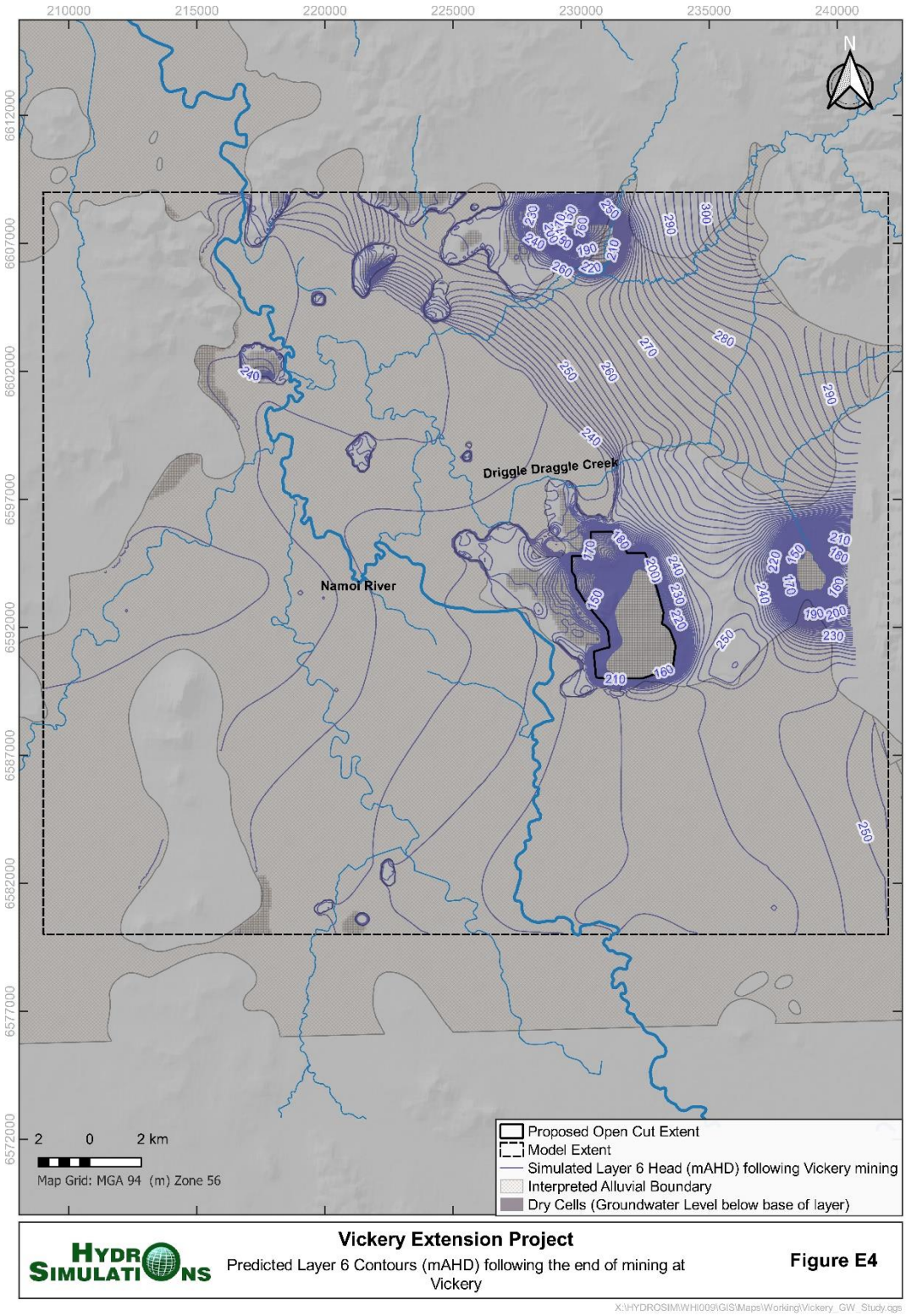


Figure E4 Predicted Layer 6 Contours (mAHD) following the end of mining at Vickery

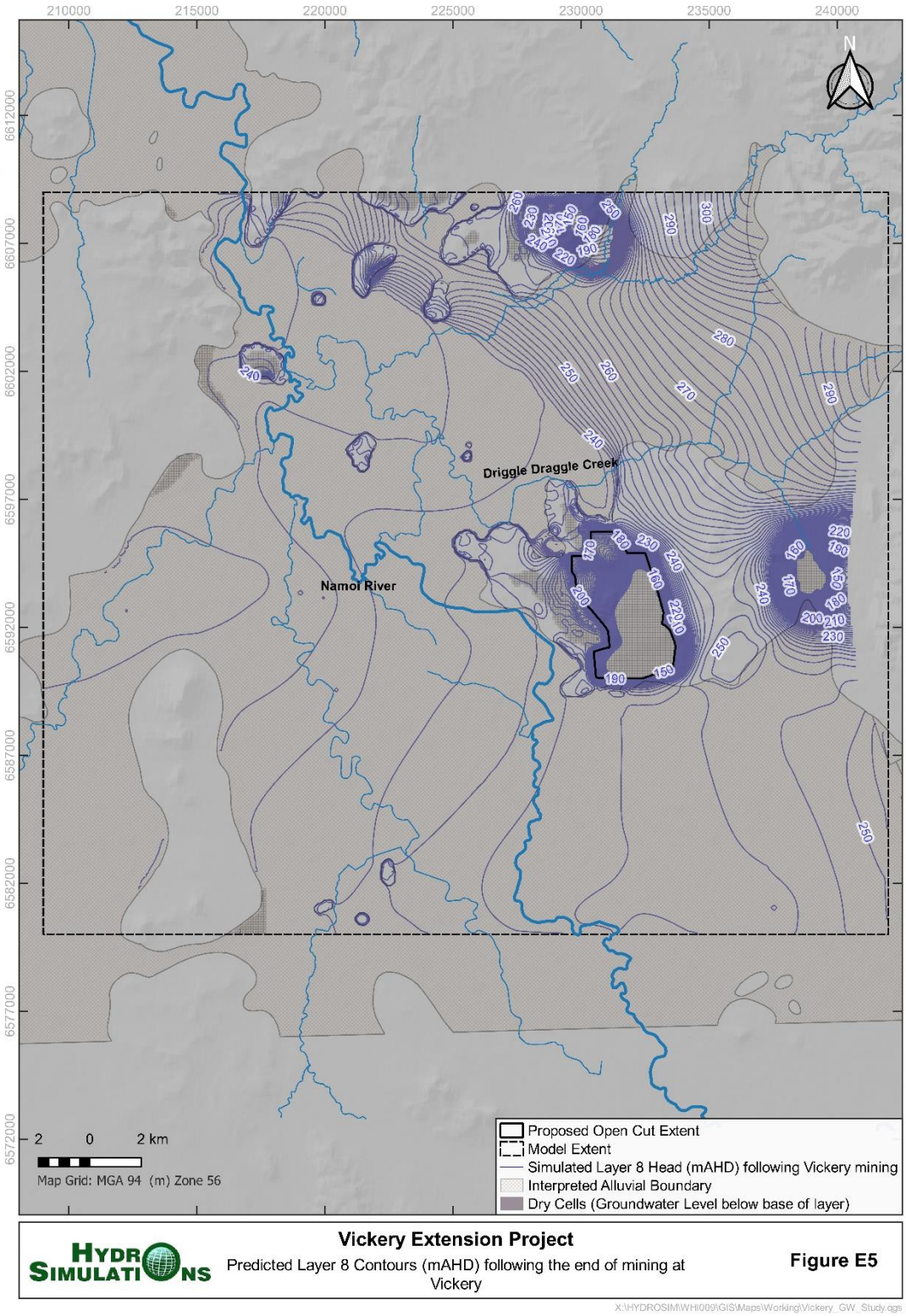


Figure E5 Predicted Layer 8 Contours (mAHD) following the end of mining at Vickery

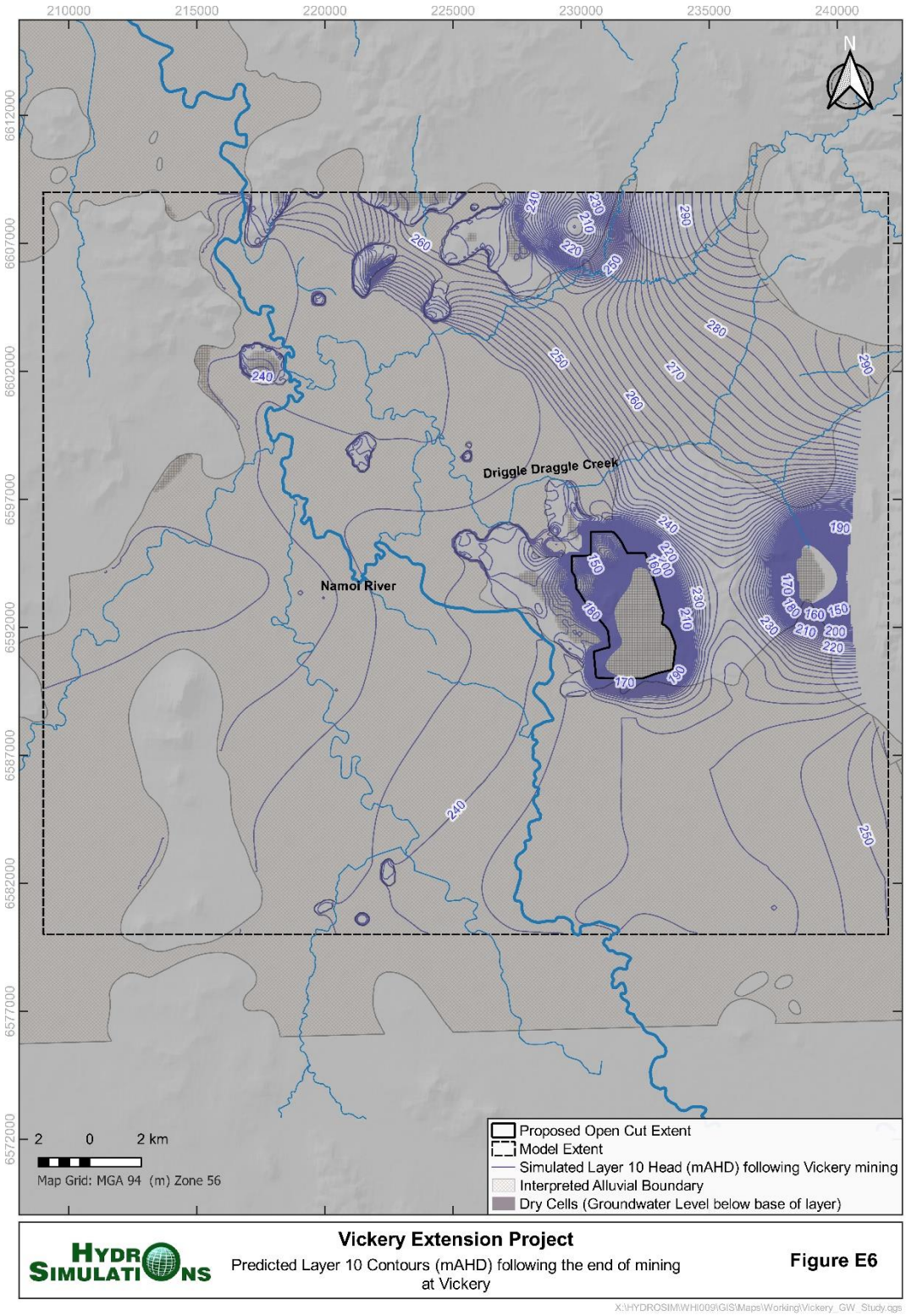
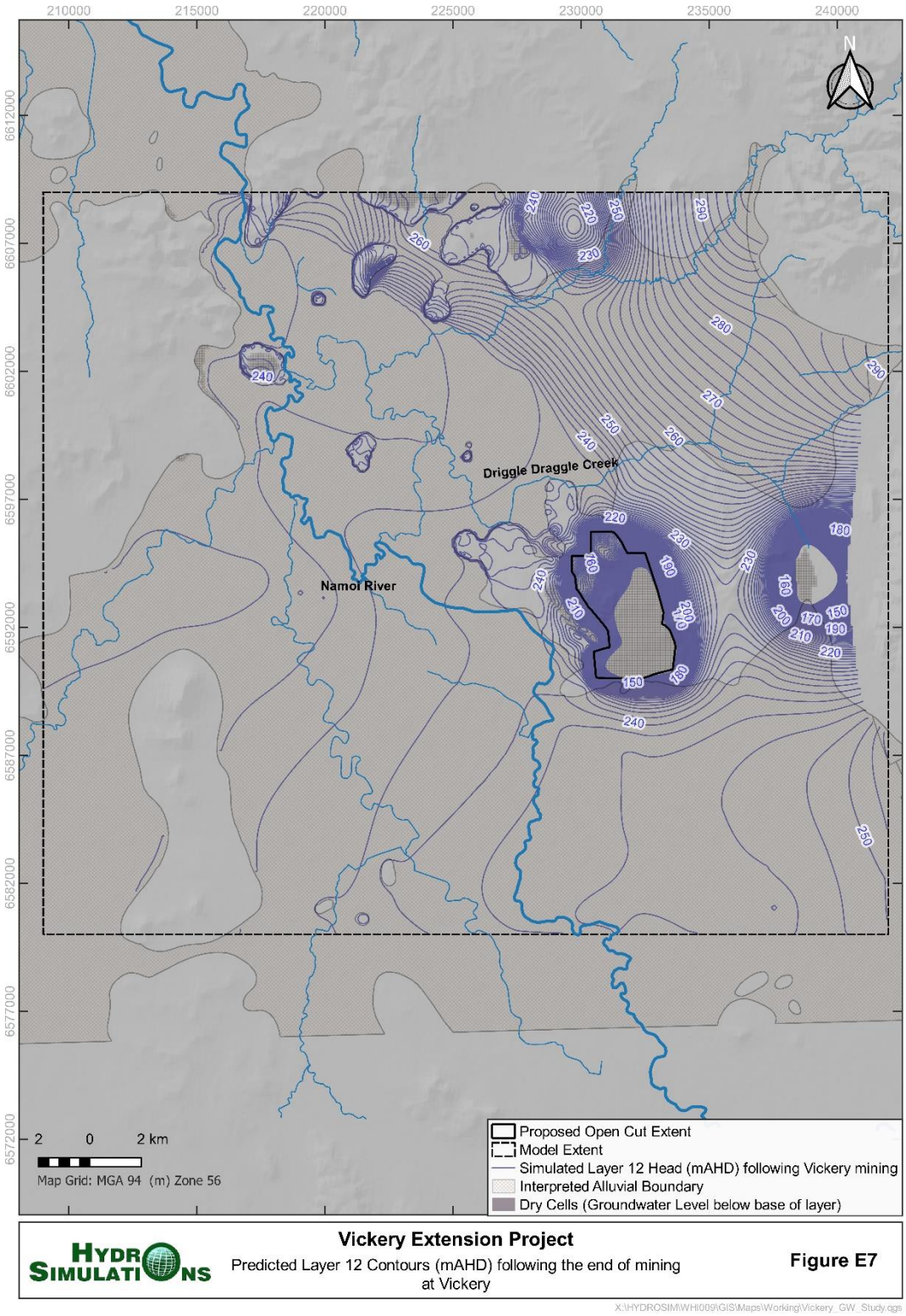


Figure E6 Predicted Layer 10 Contours (mAHD) following the end of mining at Vickery



Fgiure E7 Predicted Layer 12 Contours (mAHD) following the end of mining at Vickery

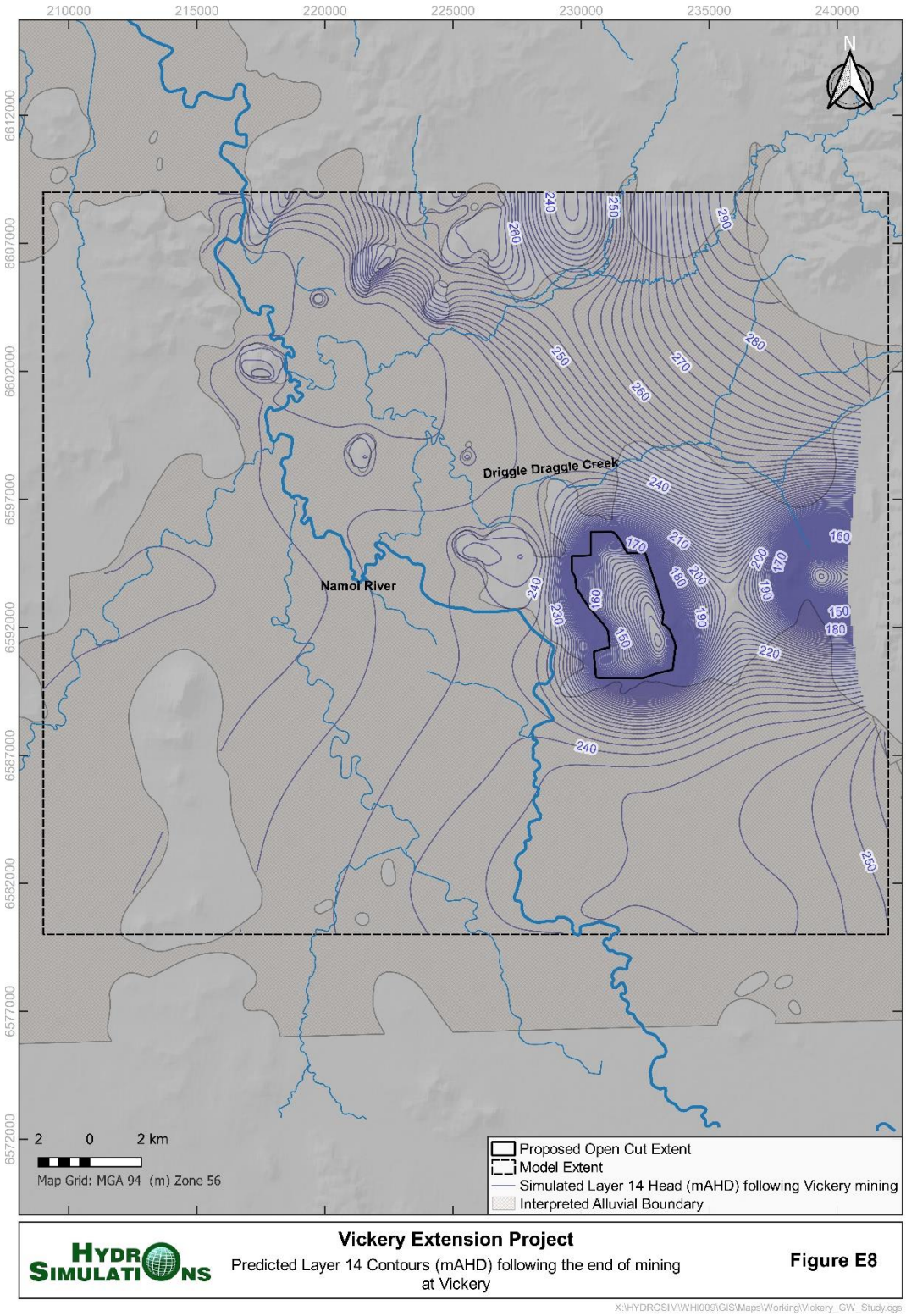


Figure E8 Predicted Layer 14 Contours (mAHD) following the end of mining at Vickery

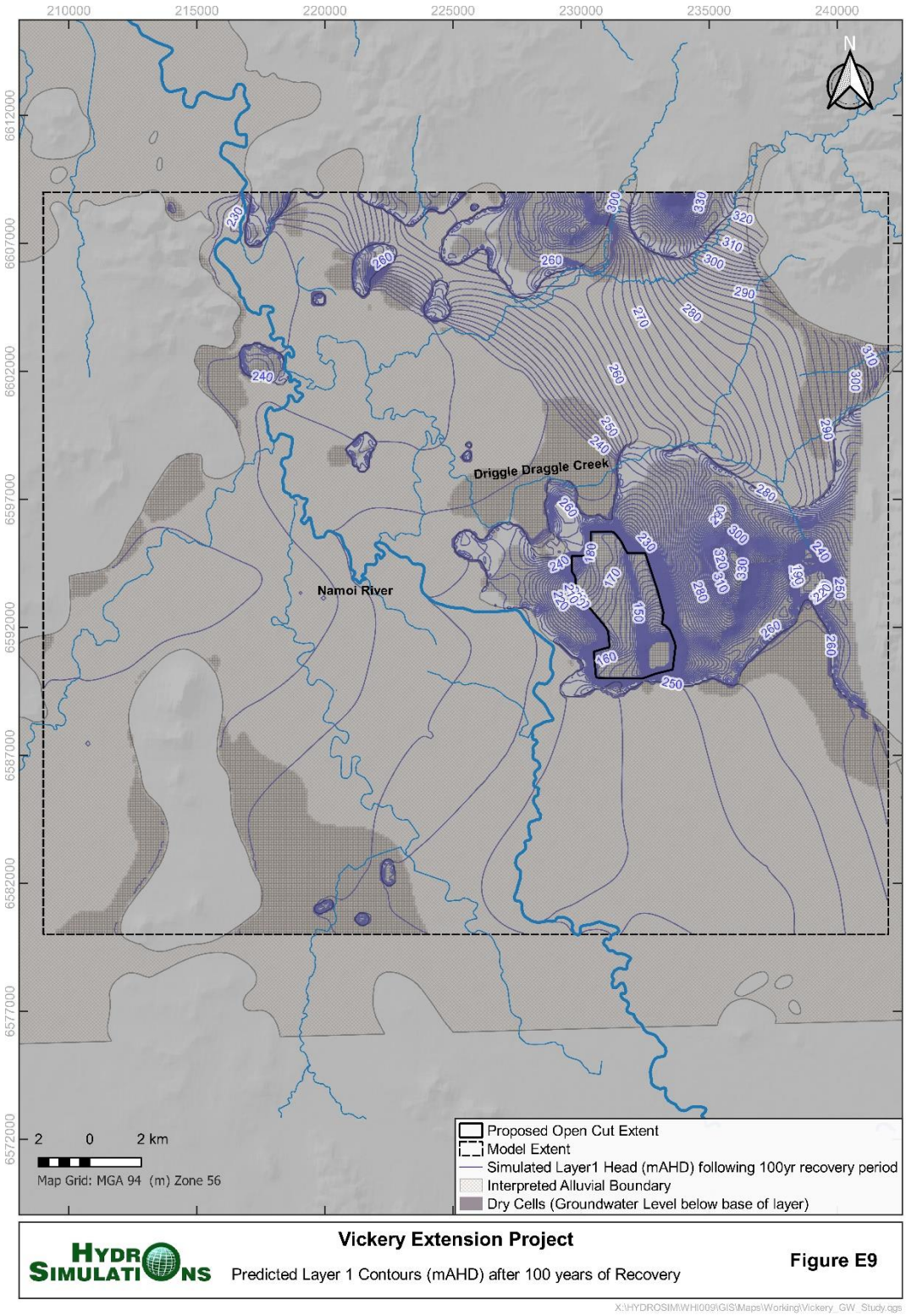


Figure E9 Predicted Layer 1 Contours (mAHD) after 100 years of Recovery at Vickery

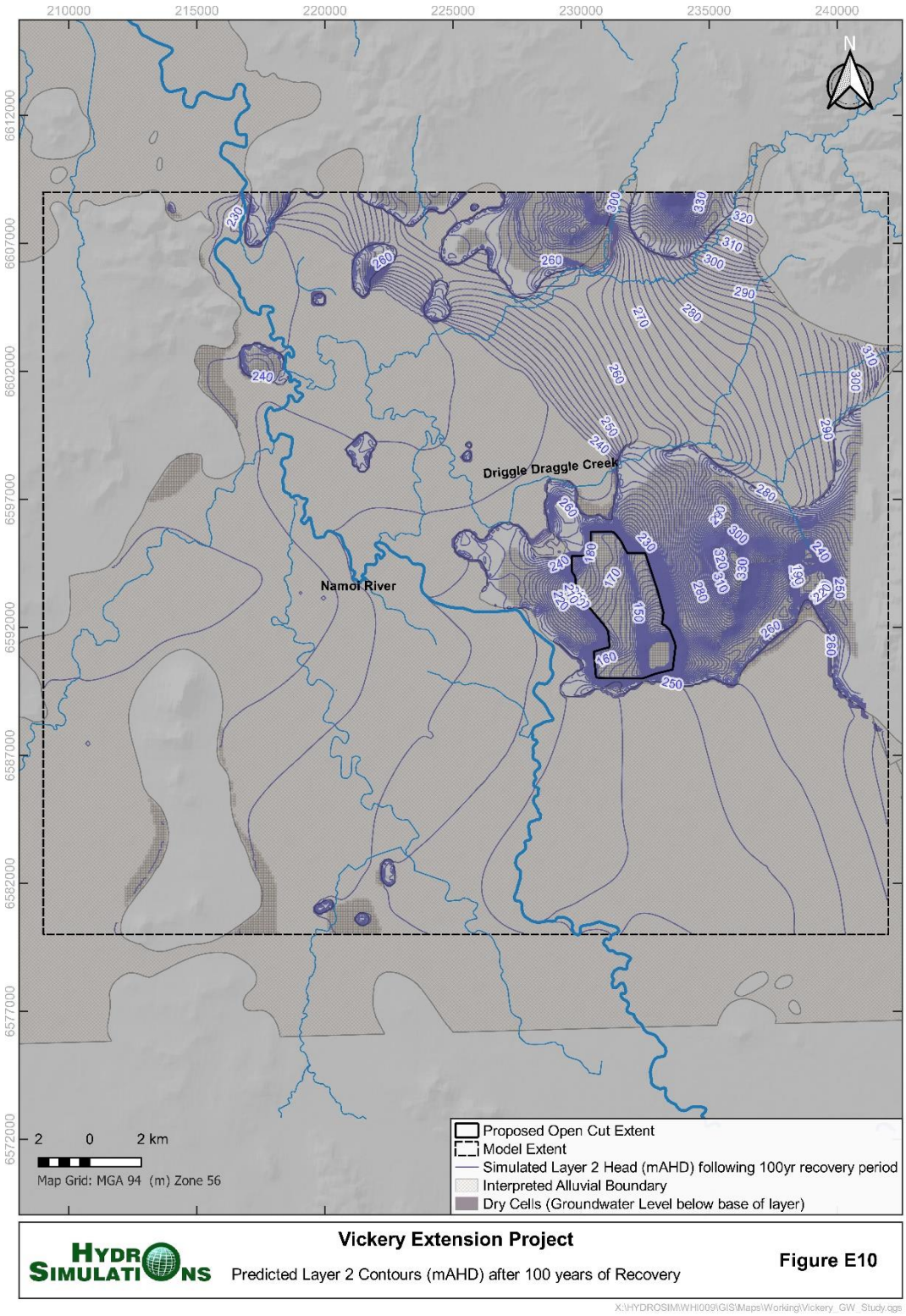


Figure E10 Predicted Layer 2 Contours (mAHD) after 100 years of Recovery at Vickery

APPENDIX F – PREDICTED GROUNDWATER DRAWDOWN AT BORES

Predicted Groundwater Drawdown at Whitehaven Owned Bores (or Bores on Properties Under Option Agreement with Whitehaven)

Bore Census ID	Predicted Maximum Ground-water Drawdown (m)	Year of Maximum Predicted Drawdown	Year of Predicted 0.2m Drawdown	Year of Predicted 2m Drawdown	Year of Predicted 5m Drawdown
BM1	<0.2	2115	n/a	n/a	n/a
BM2	<0.2	2145	n/a	n/a	n/a
BM3	<0.2	2119	n/a	n/a	n/a
BM4	<0.2	2081	n/a	n/a	n/a
BM5	<0.2	2084	n/a	n/a	n/a
BK1	<0.2	2145	n/a	n/a	n/a
BK2	0.98	2145	2031	n/a	n/a
BG1	<0.2	2119	n/a	n/a	n/a
BG2	<0.2	2119	n/a	n/a	n/a
BG3	2.88	2036	2023	2028	n/a
SK1	2.62	2145	2044	2100	n/a
WL1	15.62	2145	2028	2037	2051
CD1	<0.2	2123	n/a	n/a	n/a
CD2	<0.2	2119	n/a	n/a	n/a
CD3	<0.2	2119	n/a	n/a	n/a
CD4	<0.2	2119	n/a	n/a	n/a
WG1	4.06	2145	2031	2073	n/a
BW1	<0.2	2142	n/a	n/a	n/a
BW2	<0.2	2145	n/a	n/a	n/a

APPENDIX G – RECONCILIATION OF SEARS AND EPA, DOI WATER REQUIREMENTS

Relevant Requirement to Groundwater Assessment	Section in Report
SEARs	
an assessment of the likely impacts of the development on the quantity and quality of the region's surface and groundwater resources, having regard to the NSW Environment Protection Authority (EPA's) and the NSW Department of Primary Industries (DPI's) requirements and recommendations [see below]	• Sections 5 and 6 provide an assessment of potential impacts to groundwater resources (quantity and quality)
an assessment of the likely impacts of the development on aquifers, watercourses, riparian land, water related infrastructure, and other water users	• Drawdown predictions and groundwater inflows – Sections 5.4 and 5.5 • Predicted baseflow changes (water course) – Section 5.6 • Other users – Section 6.2 Potential impacts to riparian land and water related infrastructure are covered in other Appendices to the EIS.
EPA Requirement	
assess impacts on groundwater and groundwater dependent ecosystem	• Section 2.8 and Table 27
DoI Water Requirement	
Annual volumes of surface water and groundwater proposed to be taken by the activity (including through inflow and seepage) from each surface and groundwater source as defined by the relevant water sharing plan.	• Section 5.5.1 – Porous Rock • Section 5.5.2 – Upper Namoi Alluvium • Section 5.6 – Baseflow changes
Assessment of any volumetric water licensing requirements (including those for ongoing water take following completion of the project).	• Section 8.3
The identification of an adequate and secure water supply for the life of the project. Confirmation that water can be sourced from an appropriately authorised and reliable supply. This is to include an assessment of the current market depth where water entitlement is required to be purchased. The EIS should outline current licences obtained for the mine, including volumes of water and licences required for the expansion.	• Surface Water Assessment (Appendix B of the EIS)
An updated detailed and consolidated site water balance for the expansion.	• Surface Water Assessment (Appendix B of the EIS)
A detailed assessment against the NSW Aquifer Interference Policy (2012) using DoI Water's assessment framework.	• Section 9 (and Attachment 6 of the EIS)
Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, wetlands, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts.	• Section 6
Full technical details and data of all surface and groundwater modelling, and an independent peer review of the groundwater model.	• Section 4 (groundwater model details) • Peer review by Dr Frans Kalf (Attachment 4 to the EIS)

Relevant Requirement to Groundwater Assessment	Section in Report
Proposed surface and groundwater monitoring activities and methodologies. The EIS should include a spreadsheet outlining all monitoring bores currently monitored for the site.	• Section 8. • Monitoring bores shown on Figures 17 and 18 and listed in Table 2
Proposed management and disposal of produced or incidental water.	• Surface Water Assessment (Appendix B of the EIS)
Details of the final landform of the site, including final void management (where relevant) and rehabilitation measures.	• Section 5 of the EIS
Assessment of any potential cumulative impacts on water resources, and any proposed options to manage the cumulative impacts.	• Groundwater modelling results (Sections 5 and 6) include cumulative impacts from other mining operations. • Management measures – Section 8
Consideration of relevant policies and guidelines.	• Section 1.2.1
Assessment of whether the activity may have a significant impact on water resources, with reference to the Commonwealth Department of Environment Significant Impact Guidelines.	• Section 6.3
If the activity may have a significant impact on water resources, then provision of information in accordance with the Information Guidelines for Independent Expert Scientific Committee advice on coal seam gas and large coal mining development proposals, including completion of the information requirements checklist.	• Activity not predicted to have a significant impact on water resources. • Notwithstanding, reconciliation against IESC checklist provided in Attachment 2 of the EIS
A statement of where each element of the SEARs is addressed in the EIS (i.e. in the form of a table).	• This table.