Onshore natural gas water science studies

The Gippsland groundwater model

Technical report

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Executive summary

This report describes the conceptualisation, development, calibration and application of the Gippsland groundwater model. This model has been developed to investigate and understand the potential impacts of future onshore gas developments and to understand the possible impacts of a potential onshore natural gas industry on groundwater and surface waters within the Gippsland region.

The groundwater model was required to be conceptualised, constructed and calibrated within a six month period to provide information for a screening study. During this time data acquisition, quality control and data conversion tasks were undertaken. The model adopts a uniform spatial resolution of 400 m and includes representation of the dominant aquifers and aquitards. The model layer structure and attribution are based on a combination of (1) new stratigraphic mapping and interpretation developed by Geological Survey of Victoria, (2) the Victorian Aquifer Framework (VAF), (3) previous groundwater model data, and (4) existing maps and cross-sections. The model comprises 30 layers, coal seams specified as discrete layers and Cretaceous sediments of the Strzelecki formation in discrete sub-layers. Key improvements compared to previous Gippsland region groundwater models include (1) new interpreted data sets that extend to the catchment boundaries, (2) finer grid resolution, (3) the incorporation of offshore stratigraphic information as developed by CSIRO and Geological Survey of Victoria, and (4) incorporation of a basement layer representing the rocks underlying the sedimentary basin and extending to the upland regions of the Gippsland region where the basement outcrops.

The model has been used to quantify groundwater flow and groundwater head levels within specified aquifers under historical conditions. Analysis of simulated groundwater heads indicates that the calibrated model satisfies the designated model specifications. The groundwater model has the capacity to be used to assess the relative difference in predicted groundwater level changes between the proposed scenarios. It must be noted that it is not appropriate to use the model to assess the absolute water level or water balance under either calibration or scenario conditions.

Seven hypothetical tight and shale gas and coal seam gas (CSG) development scenarios were considered under a dry future climate. Each scenario was designed to estimate the likely water usage of onshore gas development under varying well field designs and configurations. Details of the scenarios are provided in Section 10.2 and Tables 20 and 21, and provide for a potential gas development area, target depth, well field design and other necessary modelling estimates. Additional scenarios with reduced scale of development (reduced volume of pumping for hypothetical gas development) were run to supplement understanding of model behaviour.

Simulation predictions were reported relative to a baseline state in which quarterly groundwater abstractions were fixed at averaged equivalent quarterly values for the period 2003 to 2012; all other conditions were as applied in the 2001–2012 model calibration/verification period.

Predictive scenario results suggest that the most substantial impacts on the shallow watertable are associated with coal seam gas development, whereas tight and shale gas developments have a negligible impact. Broadscale development of prospective coal seam gas areas is predicted to create an average drawdown in the shallow watertable of 10 m and impact 193 000 ha. The impacted area is predicted to reduce to 170 000 ha with an average drawdown of 8 m under a 50% volume coal seam gas development condition. Alternatively, under full entitlement pumping extraction and 50% volume coal seam gas development conditions the impacted area is 208 000 ha. In contrast, the maximum area affected under tight and shale gas extraction is estimated to be less than 1000 ha, and the effect on shallow watertable levels is very small.

Other key observations include:

- For each gas type, the relevant impacted area is increasing and has not reached an equilibrium condition by the end of the 30 year scenario period.
- For coal seam gas extractions, the impact on the shallow watertable occurs within 3 months following commencement of depressurisation.
- For tight and shale gas development, the impacts on the shallow watertable first begin 23 months following commencement of depressurisation.

All predictive scenario results are considered conservative and represent the likely maximum impacts of onshore gas development on the shallow watertable, aquifer potentiometric surfaces, aquifer heads and drawdowns. The conservative results are due to the following conditions:

- a prolonged dry future climate
- full development of the prospective gas field at commencement of gas extraction
- relatively high vertical hydraulic conductivities assigned to a some modelled layers when compared to other studies, though within reported limits.

In order to allow for recent history of water use in Gippsland groundwater use was averaged from the 2002–2012 extraction information, which is greater than the long-term average due to the drought conditions of the previous decade. No allowance for localised changes in aquifer hydraulic conductivity from gas and storage coefficients due to depressurisation processes.

Density head correction adjustments were also made to all groundwater observation bore data. Due to data limitations the model does not explicitly simulate non-isothermal processes, density-driven flows, contaminant flow or subsidence.

This groundwater model provides the capacity to evaluate and compare groundwater management scenarios and to assess the likely impacts of future climate and pumping regimes on groundwater resources within the Gippsland region. The model was conceptualised and calibrated at a design level that meets the requirements of a moderate complexity regional scale groundwater model as defined in the Murray-Darling Basin Commission Groundwater Flow Modelling Guidelines (Middlemis, 2000; Middlemis et al., 2000) and more recently meets the requirements of a Class 2 model confidence level classification as defined in the National Water Commission Australian Groundwater Modelling Guidelines (Barnett et al., 2012). Within the scope of the project this provided sufficient confidence for this model to be used in the Gippsland region onshore natural gas water science studies.

Importantly, it is considered that while the developed groundwater model cannot be used predictively to quantify the water balance or water levels at the regional scale under specific development scenarios, it is appropriate for comparison of different scenarios for volumetric changes to the water balance or water levels against a baseline condition.

1 Introduction

This report details the conceptualisation, development and calibration of a split steady-state transient groundwater model representing the Victorian Gippsland region located in Victoria's south-east as shown in Figure 1. The model incorporates both the highland areas north of the basin and extends offshore to beyond the current oil and gas extraction platforms. The report also details the design and evaluation of seven onshore hypothetical tight and shale gas and coal seam gas development scenarios.

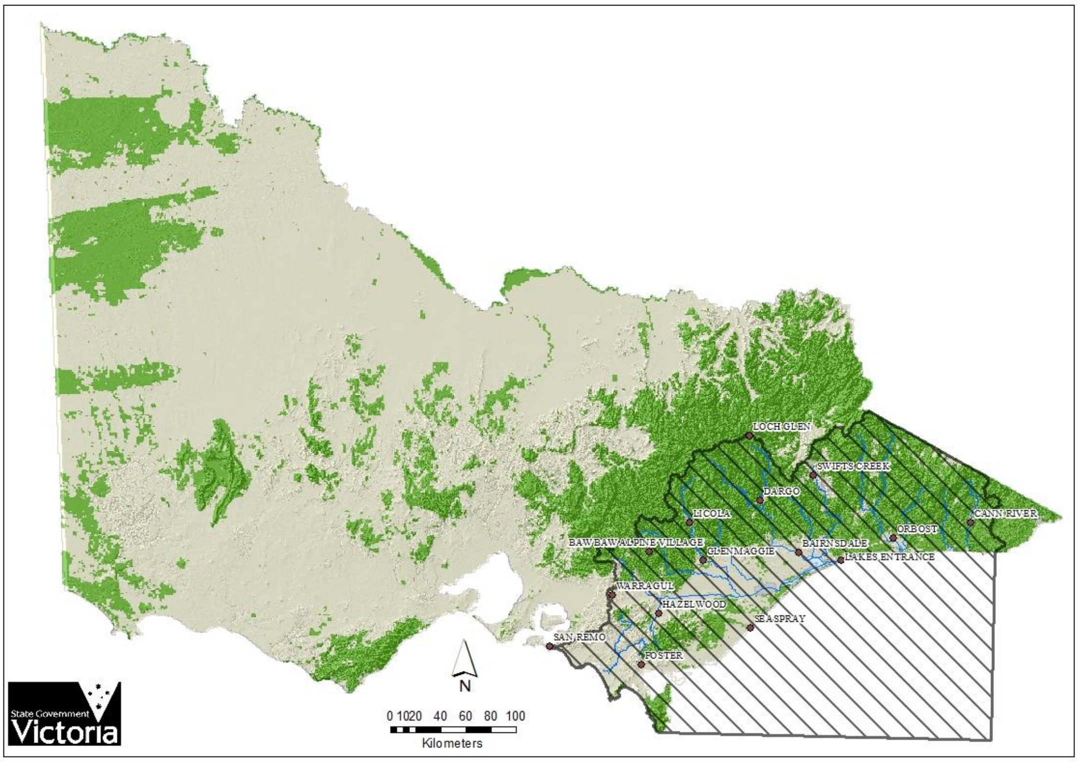

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Figure 1: Map of Victoria, with the hatched area the showing extent of the Gippsland region model described in this report

1.1 Project background

The Gippsland groundwater model was developed for the whole Gippsland region (incorporating onshore and offshore areas) and was developed using:

- available geological and groundwater data (including the Victorian Aquifer Framework mapping) and
- data obtained from universities, energy companies, water authorities and major licensed water users.

The calibrated groundwater model was designed to enable an assessment of the regional scale impacts on groundwater and surface water due to gas development. It can also assess the impacts of key water uses such as coal mine developments and offshore oil and natural gas extraction, although variations in these uses were not investigated. The modelling accounts for all existing groundwater usage (onshore and offshore) and integrated farming systems land use to best estimate the current water balance in the region. Mine pumping uses existing pumping wells, and pumping is set to achieve target pressures. Offshore extraction is explicitly modelled, using equivalent pumping volumes at the relevant offshore platforms.

Hypothetical coal seam gas, and tight and shale gas development scenarios have been used to determine the assess the potential impact a gas extraction industry may have on water resources. The model is intended to be used to compare different scenarios for changes to the water balance and water levels against a baseline condition. Absolute changes in the water balance, while informative, are difficult at this regional scale.

1.2 Project objectives

The Gippsland Groundwater Model was developed to help quantify the potential groundwater and surface water impacts of possible onshore gas developments in the Gippsland region. The model will be used to quantify impacts arising from potential developments (both individually and cumulatively) including:

- the drawdown in groundwater heads
- the reduction in baseflow to rivers that drain the basin
- the reduction in water availability to groundwater-dependent ecosystems.

1.3 Model specification

Minimum specifications for the groundwater model and associated outputs are:

- uniform finite difference grid of 400 metre cell size
- model domain represents the entire Victorian Gippsland region and extends offshore to adequately represent oil and gas extractions
- 30 modelled layers representing the major geological units and consistent with existing documented hydrostratigraphic units
- 822 groundwater monitoring observation bores used for calibration
- 8175 groundwater pumping bores representing licensed pumps, domestic and stock usage and offshore oil and gas platforms
- recharge estimates (steady-state and transient) generated using the Catchment Analysis Tool (CAT) farming system models and provided by DEDJTR
- allowance for episodic flood recharge events
- groundwater evaporation extinction depth to be based on land use
- groundwater evaporation rate to account for unsaturated vegetation evapotranspiration rates such that the summed saturated and unsaturated evaporation does not exceed potential evaporation as calculated from meteorological data
- a normalised (scaled) RMS of less than 5% for steady-state based on matching groundwater head observation data
- a normalised (scaled) RMS of less than 10% for the transient model based on matching groundwater head observation data at selected and agreed sites
- existing mapped depth to watertable and groundwater baseflow estimates to be considered
- a transient split calibration/validation period of 10 and 13 years respectively (1990–1999 and 2000–2012)
- a sensitivity analysis to assess the variability of modelled outputs to variations in key model input parameters
- catchment-scale model water balance error of less than 2%
- all significant catchment water balance features to be considered and reported
- the source and a statement of quality of all input data sets to be reported

- accuracy in drawdown outputs within 5 to 10 m
- an annual time step for the simulation period 1970–1989 and thereafter monthly time steps for the simulation period 1990–2012 and beyond, which was considered to be sufficiently small to determine adverse impacts during periods of low surface water flow but also mindful of the impact on model run time.

1.4 Project duration

The duration of the project to conceptualise, develop and calibrate the groundwater model of the Gippsland region as detailed in this report was from July 2014 to December 2014. Data acquisition, quality control, data conversion and review were undertaken within the same timeframe.

1.5 Existing models

A review of the existing groundwater management tools developed for the Gippsland Basin (SKM, 2011a) commissioned by the then Victorian Department of Sustainability and Environment (DSE) identified 19 models ranging in complexity from impact assessment frameworks to distributed physics-based numerical models. The models reviewed were:

- Stage 1 (Fraser 1980) and review of Stage 1 report (Golder Associates, 1990)
- Stage 2 (Evans, 1983)
- Stage 3 (Bolger, 1987)
- Reservoir simulation of the Gippsland Basin (Henzell et al., 1985)
- Loy Yang (Bolger 1990; Golder Associates, 1990)
- Latrobe Valley Resource Model — Update (Golder Associates, 1991)
- Latrobe Valley Resource Model — Update (Golder Associates, 1992a)
- Latrobe Valley Resource Model — Update (Golder Associates, 1992b)
- Latrobe Valley Resource Model — Update (Golder Associates, 1992c)
- Stage 4 (GeoEng, 1994)
- Stage 5 (GeoEng, 1996a)
- Gippsland Basin (SKM, 1995)
- Gippsland Basin (SKM, 1996)
- Yarram sub-regional model (SKM, 1999)
- Gippsland Basin (Nahm, 2002)
- Sale WSPA Groundwater Model (SKM, 2011a)
- Integrated Resource Model (IRM) of the Gippsland Basin (Schaeffer, 2008)
- ecoMarkets (GHD, 2008a; 2010a; 2010b; 2010c).

The review later included the DPI Gippsland Basin Model (Beverly et al., 2012) which was derived from the IRM Gippsland Basin model developed by Schaeffer (2008). Most recently CSIRO has developed a Latrobe Valley Coal Model (LVCM) to assess the likely water management issues associated with potential coal seam gas extractions in the Latrobe Valley (Freij-Ayoub et al., 2011a). Summarised below are the key features of those models considered to have sufficient extent, grid resolution, design focus and attribution relevant to this study.

1.5.1 IRM model

The Integrated Resource Model (IRM) was developed by Schaeffer (2008) to simulate the impacts of different groundwater abstractions and multiple pumping and artificial recharge scenarios on groundwater levels within the Gippsland Basin. The model represented eighteen layers comprising the unconfined surface layer, the basement layer, eight regional aquifers and eight regional aquitards (Figure 2). Time dependent general head boundaries were assigned to the eastern and southern regions of the model domain, with no flow boundaries assigned to the western and northern regions of the model (Figure 3 and Figure 4). Spatially variable conductivities were assigned based on lithological analysis and structural regions. Recharge was assigned to sub-cropping aquifers and incorporated groundwater extractions accounted for offshore pumping, coal mine dewatering and irrigation in the Yarram region.

Calibration of this model was based on matching simulated heads and groundwater trends with observation bore data for the period 1960–1999. The error criterion was 10 m with model validation based on the period 2000–2004.

The recommendations for future improvement of this model as reported by SKM (2011a) included improved calibration of the unconfined aquifer, refinement of the recharge input and extension of the eastern and southern boundaries to reduce boundary effects when assessing the impacts of artificial recharge and pumping adjacent to these boundaries.

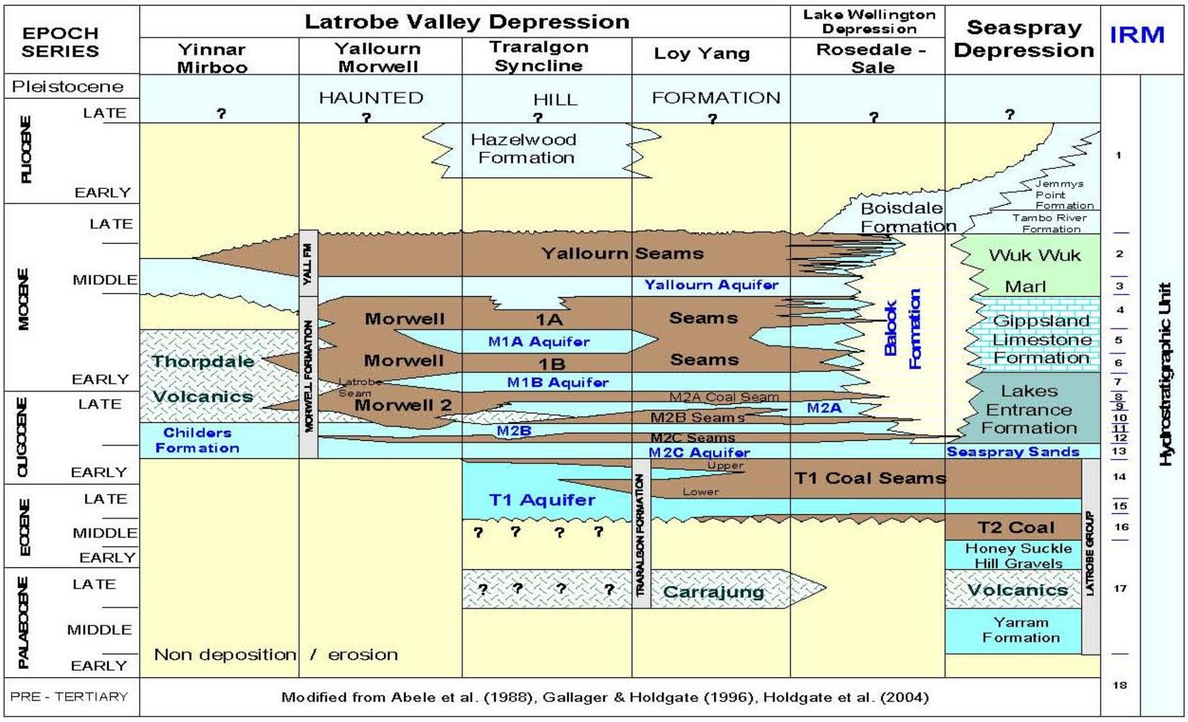

Figure 2: Grouping of hydrostratigraphic units incorporated into the IRM model layer structure (sourced from Schaeffer, 2008).

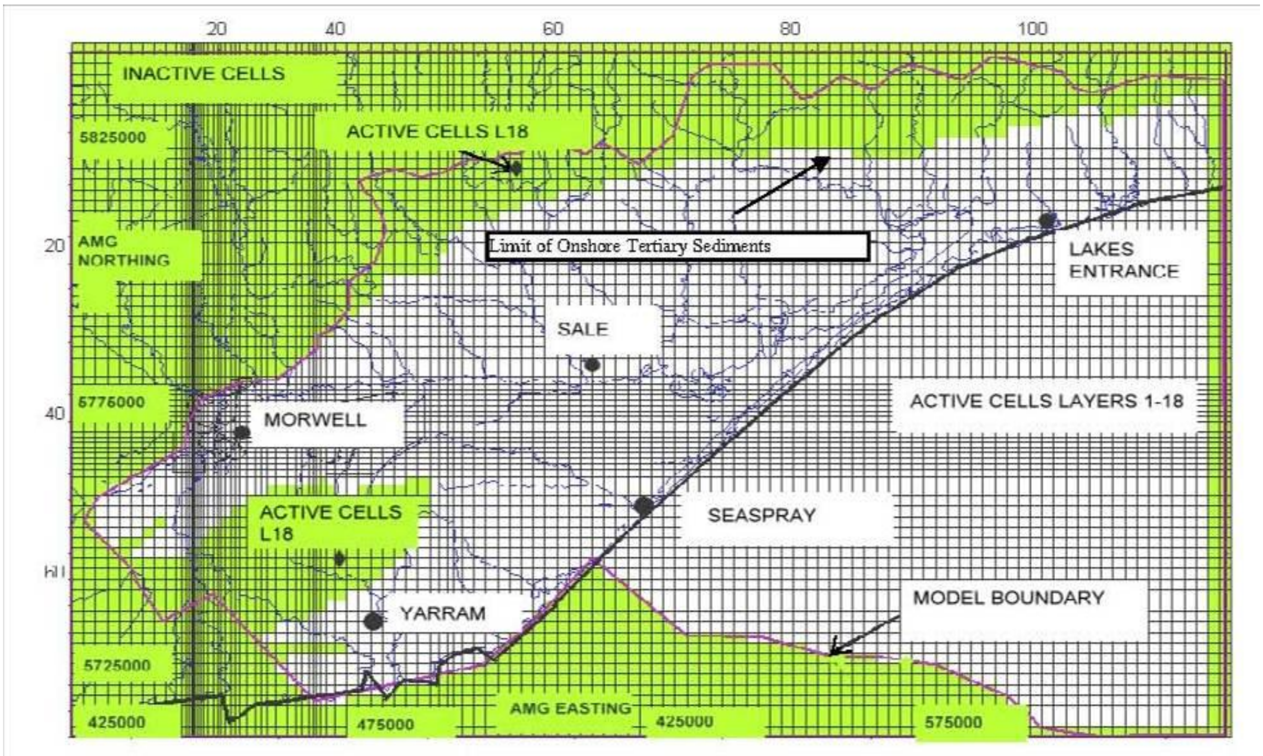

Figure 3: Location of active cells and IRM model domain (sourced from Schaeffer, 2008).

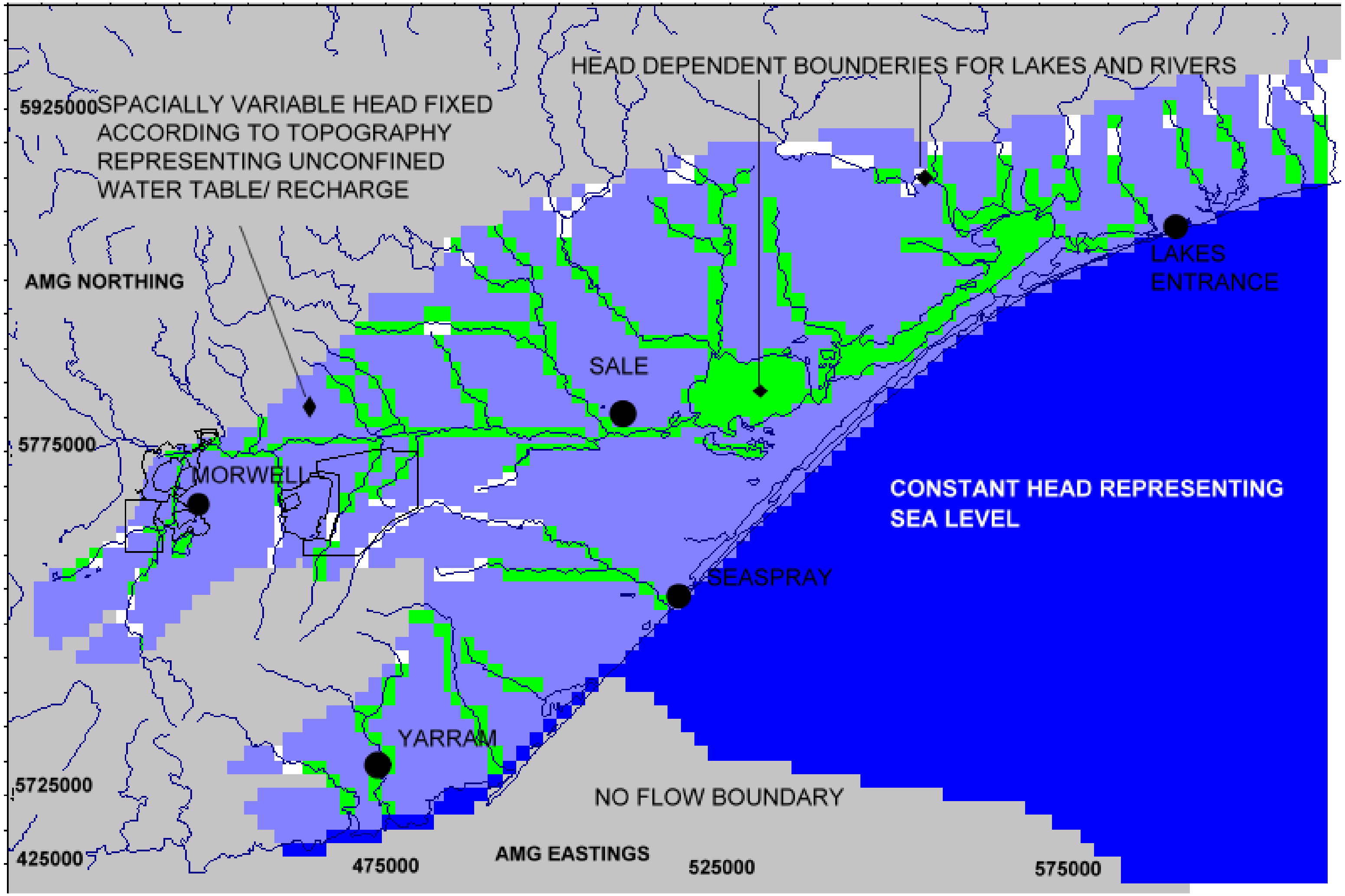

Figure 4: IRM boundary conditions for Layer 1 (source:Schaeffer, 2008).

1.5.2 ecoMarket models

The ecoMarket groundwater models (GHD, 2008a; 2010a) were developed to assess potential impacts on depth to the water table and baseflows for a range of land use change scenarios. Two models were developed with identical specifications: one for the West Gippsland Catchment Management Authority (CMA) region and one for the East Gippsland CMA region. Both models extend offshore to the freshwater–seawater interface. The offshore extent of the model is based on structural and stratigraphic mapping. Each model was constructed in MODFLOW (Harbaugh, A.W., 2005) using a 200 by 200 m grid and represented seven layers.

In the case of the East Gippsland model, transient head boundaries were used offshore so the effects of offshore oil and gas pumping could be simulated at the southern model boundary (Figure 5). Stream cells were used over a large proportion of the high ground area to simulate the streams and rivers, whereas river cells were used to simulate lakes. General head boundary cells were set at an average sea level (0.1 mAHD) across the upper most active layer in all offshore areas. The peer reviewer concluded these boundary conditions were appropriate (PB, 2010a). However, it is noteworthy that the steady-state model for this area did not converge and consequently had a large water balance error. That is, an adequate steady-state calibration was not achieved for the East Gippsland ecoMarkets groundwater model, which has implications for the robustness of the associated transient model.

A review of the East Gippsland model identified that the ability of the model to simulate the actual groundwater flow systems was constrained by a lack of data to define those flow systems over the majority of the modelled area (PB, 2010a). Consequently, the usefulness of this model is effectively limited to a proportion of the lowland areas. That part of the model covering the elevated areas representing the Mesozoic basement outcrop is not reliable and is considered to be of limited use. Even in the lowland areas, the model has significant limitations regarding its primary purpose. The limitations take into account regard the effects of land use changes, which are likely to be poorly predicted because in many areas the computed heads, gradients, trends in heads, and responses to stresses do not match the observed data. As reported by PB (2010a), more effort would be required in the calibration of localised areas for the East Gippsland ecoMarkets groundwater model to be fit for purpose in all areas for which groundwater level data are available.

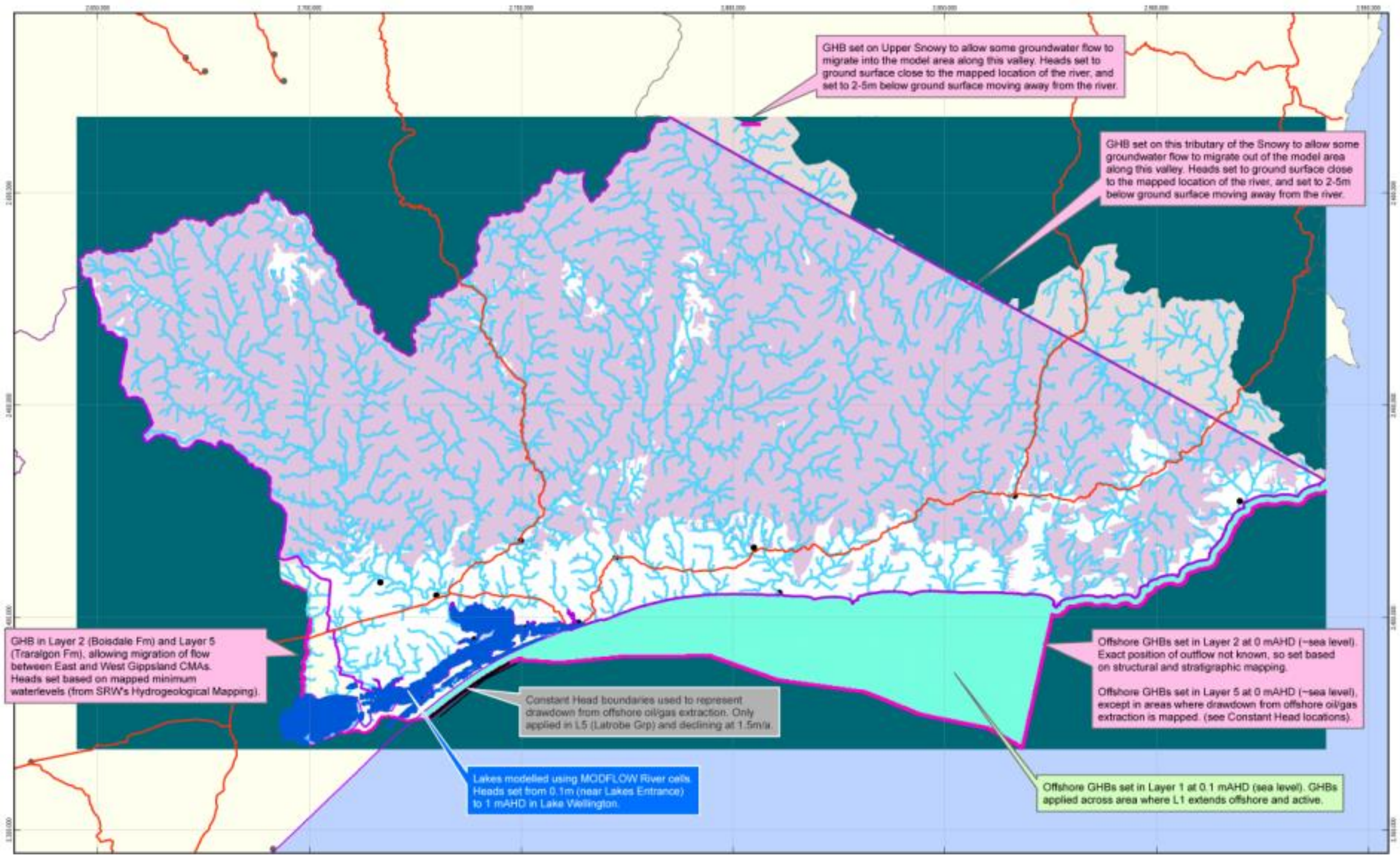

Figure 5: Domain and boundary conditions for the ecoMarkets East Gippsland groundwater model (source: GHD, 2010c).

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In the case of the ecoMarkets West Gippsland groundwater model, the model extends to the onshore topographic divides across which no-flow boundaries are assigned (Figure 6). The eastern boundary extends into East Gippsland along the Mitchell River, and the western boundary extends to the offshore saltwater interface, along which a no-flow boundary is assigned that forces groundwater outflow to climb along the interface and discharge far out to sea. The offshore extent of the model is based on structural and stratigraphic mapping.

The shoreline is simulated in Layer 1, only with a density corrected head of 0.1 mAHD. Stream cells representing third order and higher order streams are used over a large proportion of the high ground area, whereas first and second order streams are represented as drain cells. River boundaries are also used to represent surface water bodies on the lowlands. Time-varying drain cells with high conductance values (10 000 m^2/d) were used to represent the dewatering of coal mines. A reviewer (PB, 2010b) noted that, while this is normal practice, it was not clear why this approach was not successful in reducing adjacent heads to observed levels, given that some heads were identified as being 100 m too high.

Steady-state was based on 1970s pre-development water levels and 1957–2005 average recharge. While a steady-state solution was achieved, no comparative groundwater level contour maps were shown to demonstrate the degree of agreement with the observed groundwater level contour maps. The transient model calibration period was from 1970 to 1985, with monthly stress periods. A warm-up period was run from 1960 to 1969 to provide better initial conditions (than steady-state heads) in a system disturbed by mining and characterised by declining heads. Verification was undertaken for the period 1986 to 1990. From the statistics and other calibration evidence, PB (2010b) concluded that the model was fit for the purpose as specified for the ecoMarkets study, which focused on the watertable aquifer but could not be used reliably in deeper layers where coal-mining effects are evident in observed datasets.

The peer review of the West Gippsland model by PB (2010b) highlighted that the West Gippsland model was unique among the ecoMarkets models in having to simulate extensive dewatering associated with coal mining. The review identified that depressurisation caused by coal mining was poorly simulated and consequently the groundwater model could not be recommended for broader water resource management purposes. The review stated that the model might be suitable for this purpose in areas very distant from the mines. In conclusion, the review stated that there is uncertainty over the usefulness of the West Gippsland ecoMarkets groundwater model for the water resource management of deeper aquifers, given the poor simulation of mine depressurisation.

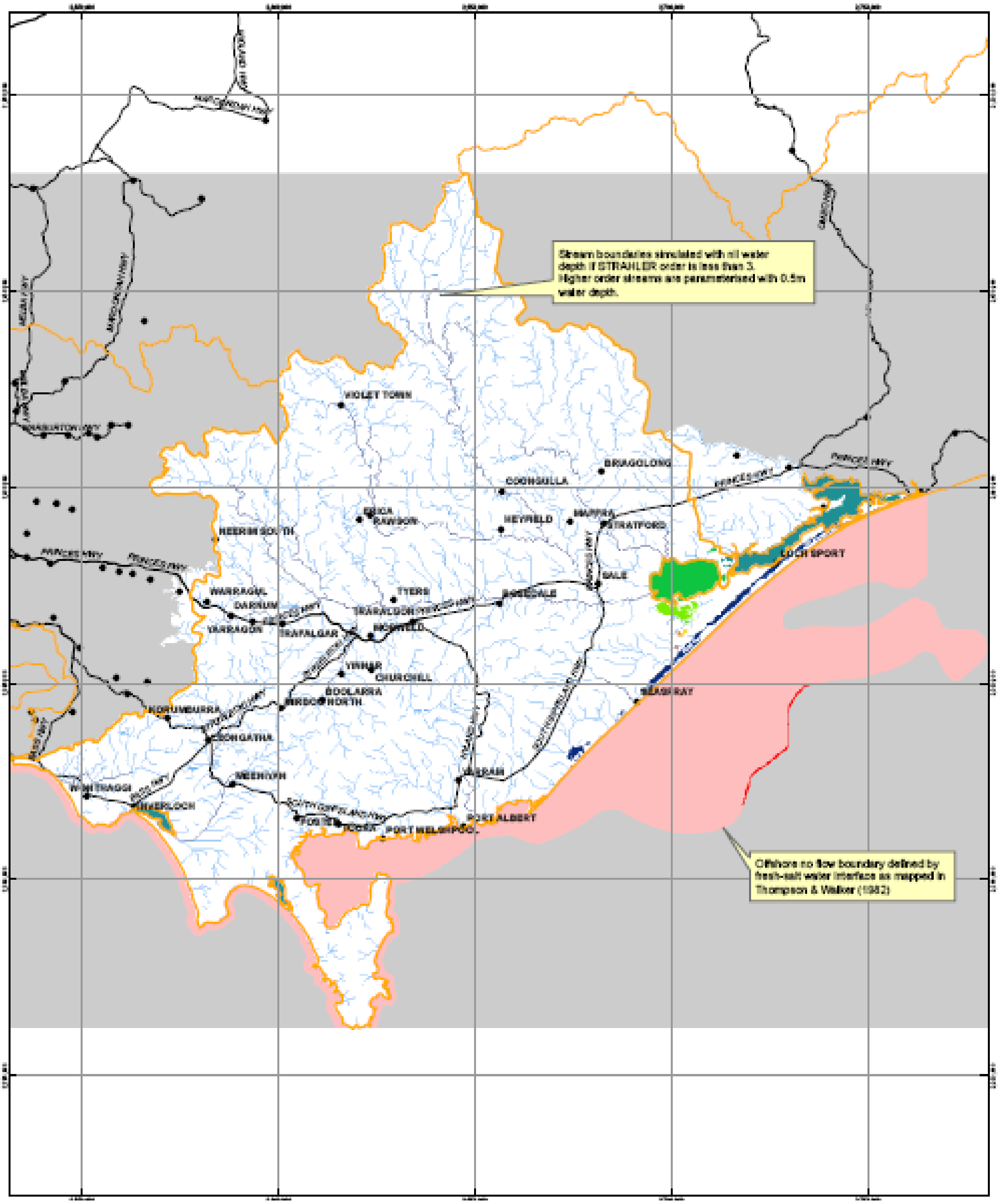

Figure 6: Domain and boundary conditions for the ecoMarkets East Gippsland groundwater models (source: GHD 2010b).

1.5.3 CSIRO model

The CSIRO Gippsland Basin model was developed in collaboration with DPI Victoria (Geological Survey of Victoria) to assess coal seam gas water management in the Gippsland Basin. The objective of the study was to build and show the capability CSIRO has in assessing the impact of producing coal seam gas on aquifer pressure heads. The study also provided information related to the risk of land subsidence adjacent to coal seam gas production wells. The area selected for the study was a region in the Gippsland Basin with abundant coal and mining activity.

The developed model qualitatively predicted the amount of recovered methane and water from single or multiple coal seams which could be separated by either an aquifer or a fine grained clayey-silty material typically considered to be an aquitard. The model coupled geomechanics and fluid flow and as such was capable of predicting possible land subsidence associated with reservoir depletion due to coal seam methane production. The modelling approach used the FLAC3D axisymmetric finite difference software, which assumes single-phase flow under which water and desorbed gas is modelled as one fluid. That is, the desorbed methane is treated as a chemical species carried with the fluid whereby methane transport is controlled by water advection and its diffusion in the water. This model simulates the simultaneous production of two coal seams 50 m and 44 m thick separated by 12 m of another layer of sediments (Freij-Ayoub et al., 2011b). The modelling explores the influence of coal permeability on the quantities of produced methane and water in a wellbore.

In addition to the bore modelling, the CSIRO study developed a numerical model based on Schaeffer (2008) to assess the impact of economically viable methane gas extractions on the hydraulic heads in aquifers underlying coal seams in the Latrobe Valley (Figure 7). This large-scale study used MODFLOW, which is limited to single phase water production. As such the predicted impact of extracted methane on the hydraulic head in the produced or adjacent layers was considered negligible at the modelled basin-wide scale (Freij-Ayoub et al., 2011b). The MODFLOW model considered a domain of 291 km by 186 km with a uniform grid resolution of 1 km, and adopted a 10-layered simplified stratigraphic representation of the Gippsland Basin as shown in Figure 8. Of note was that the model assumed that the head is hydrostatic. Constant head boundary conditions were assigned on the assumption that the edge-effect boundary impacts associated with the scenario modelling would be negligible. The domain and boundary conditions are shown in Figure 9. In addition to the large-scale basin-wide model, a smaller scale model was developed specifically for the Latrobe Valley with a domain of 40 km by 20 km with a uniform grid resolution of 100 m (Freij-Ayoub et al., 2011b). This model estimated the impact of coal seam gas extractions on aquifer heads in the Latrobe Valley. In this case, the extraction estimates were predicted using the COMET3 modelling package.

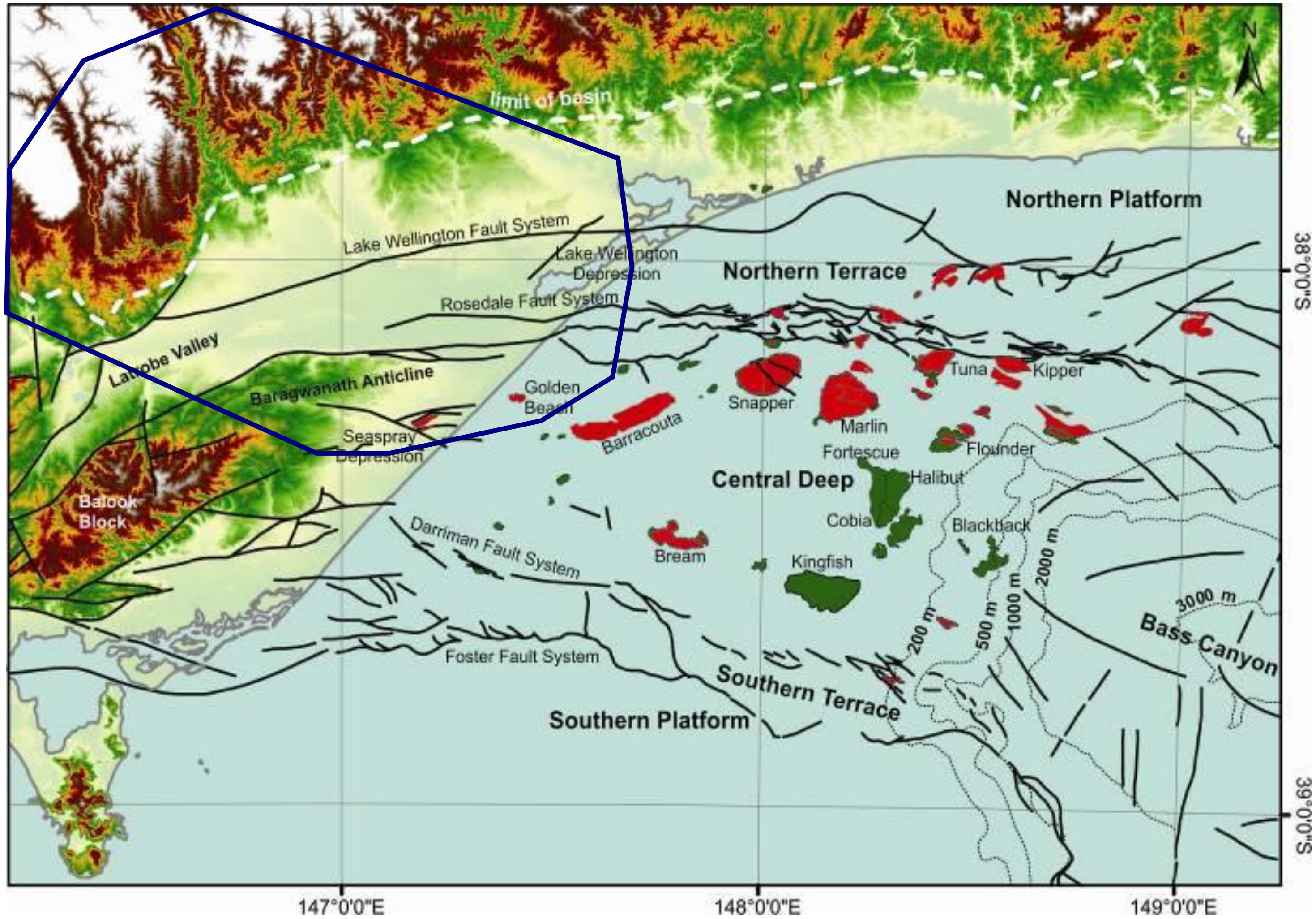

Figure 7: Locality map of the CSIRO large-scale model domain (source: CSIRO unpublished data).

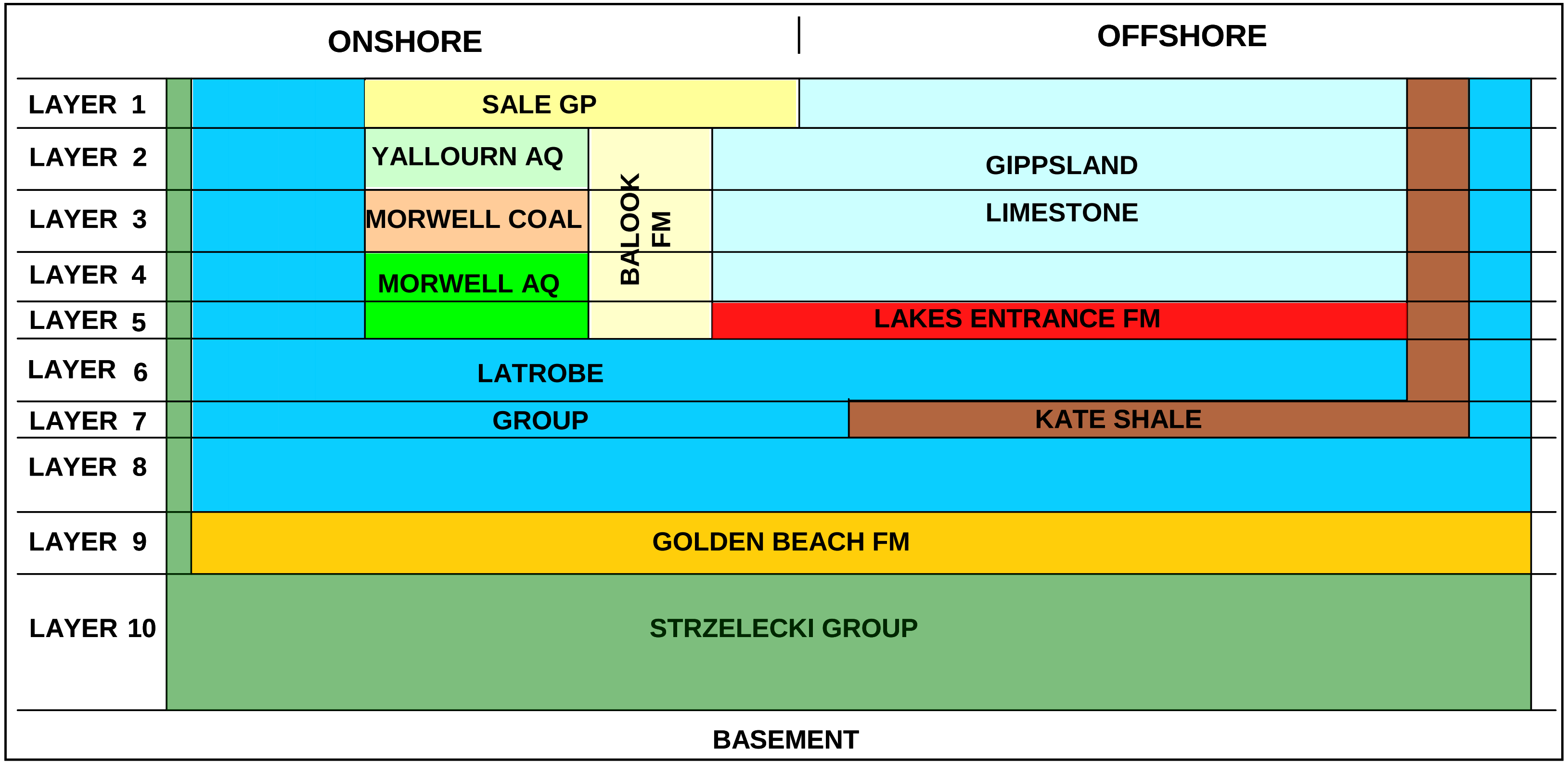

Figure 8: Conceptual model layers adopted in the CSIRO large-scale model (source: CSIRO, unpublished data.).

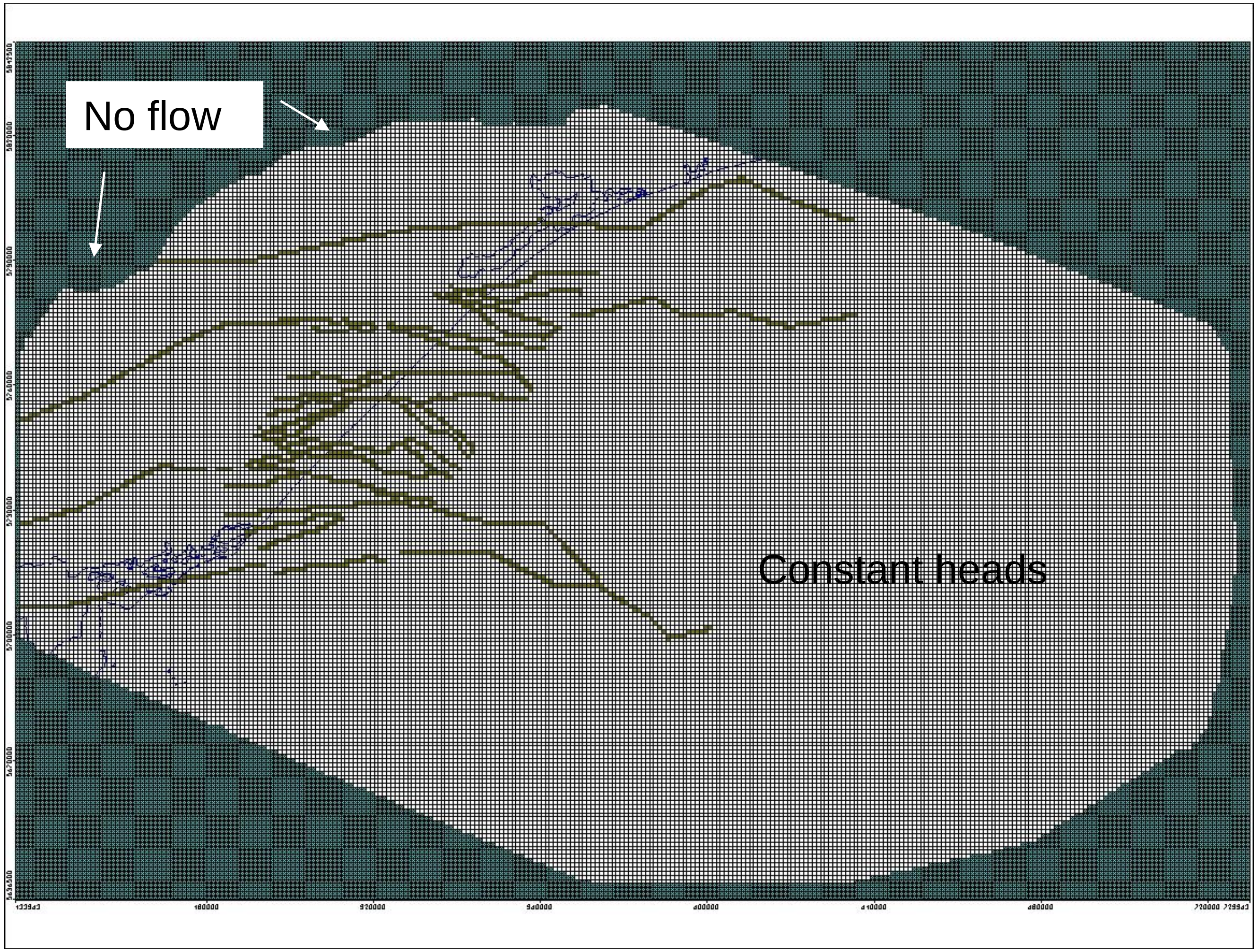

Figure 9: Latrobe Valley finite difference model domain and boundary conditions (source: CSIRO, unpublished data).

1.5.4 Summary of existing groundwater model attributes

A summary of the relevant model attributes and considerations required for this study is presented in Table 1. For each of the top five ranked models as reported by SKM (2011a) and including the CSIRO (Freij-Ayoub et al., 2011a) and DPI (Beverly et al., 2012) models developed in 2012, a score is assigned based on the original ranking procedure adopted in SKM (2011a) using a Multi Criteria Assessment (MCA) approach involving the following steps:

- definition of a set of criteria
- assignment of weightings to the various criteria
- identification of performance objectives for the agreed criteria
- scoring and ranking of the alternatives.

An aggregated performance rating of 1 to 3 was used in which 1 refers to does not meet the set of criteria, 2 satisfies more than 50% of the criteria and 3 satisfies all criteria It is noteworthy that the SKM (2011a) study compiled results from two independent reviewers.

In general, the MCA analysis has identified that no existing groundwater management tool meets all the model specifications required for this project. Specifically no existing model has sufficient spatial extent, vertical resolution or model grid as outlined in the project specification.

Table 1: Summary of key features of the top five ranked models by SKM (2011a) and the CSIRO model currently under development.

	Yarram sub-regional (SKM 1999)	Gippsland Basin (Nahm 2002)	Sale WSPA (SKM 2008)	Integrated Resource IRM (Schaeffer, 2008)	ecoMarkets (GHD, 2008a, 2010a)	CSIRO (Freij-Ayoub et al., 2011a)	DPI (Beverly et al., 2012)
Extent focus	onshore	offshore	onshore	onshore, offshore	onshore	offshore	onshore
Inclusion of offshore extractions	1	2	1	3	1	3	
Representation of within-Basin structural features	2	2	2	2	2	2	
Number of layers	4	7	4	18	7	10	18
Grid resolution	500–2000 m	?	1 km	1 km	200 m	1 km	200 m
Representation of major aquifers and aquitards	1	2	1	3	2	3	3
Representation of both onshore and offshore hydrogeology	2	2	0	3	2	3	3
Representation of appropriate boundary conditions	1	2	1	3	3	3	3
Accurate representation of groundwater/surface water interface	1	2	2	2	1	2	3
Ability to represent abstraction and injection wells	2	2	2	3	3	3	3
Ability to determine extraction impacts on environment/users	2	2	2	3	2	3	3
Ability to identify shallow water tables	2	2	2	3	2	3	3
Ability to simulate steady-state conditions	3	?	3	3	2	3	3

2 Hydrogeological setting

2.1 Study area

The proposed extent of the Gippsland Groundwater model is shown in Figure 10 and includes the East and West Gippsland CMA regions and significant offshore area. The model domain is defined to the north by the Great Dividing Range, to the west by the Latrobe and Tarwin river catchments, and to the east by the New South Wales – Victoria border and Thurra River catchment. The southern limit of Wilsons Promontory defines the boundary offshore. In total the model covers an area of 6,698,000 ha of which 3,629,000 ha exists onshore and 3,069,000 ha offshore.

The model domain was selected to provide regional scale assessment and cumulative impacts, as distinct from fine scale site specific local impact assessment. Importantly the domain extent ensures that boundary condition impacts on regions of interest associated with existing mine activity and likely areas of potential resource development are minimised. Key elements of the domain are as follows:

2.1.1 Spatial extent

The spatial extent of the model domain is shown in Figure 10. It illustrates the following:

- Offshore extents of the aquifers are extended to model offshore extraction and to avoid boundary condition influences.
- North-western and western boundaries are defined according to the full extents of the surface water catchments, thereby including all recharge zones to the pre-Tertiary. This enables consideration and evaluation of future of climate change scenarios.
- North-eastern boundary is defined based on the full extent of the surface water catchments, and bounded by the New South Wales – Victoria border. It was considered prudent to limit the model domain to the state border on the basis of data acquisition. In addition it was considered that the model domain terminating at the New South Wales – Victoria border was sufficiently large to capture the primary recharge extents that impact the study region.
- The south-western boundary follows the Victorian coastline along the Tarwin Groundwater Catchment outline.

The model domain covers key river basins, including the Latrobe, Thomson, Macalister, Avon, Mitchell, Tambo, Snowy, Tarwin, Agnes and Tarra Rivers. It includes four Water Supply Protection Areas (Denison, Sale, Wy Yung and Yarram) and eight Groundwater Management Areas (Giffard, Leongatha, Moe, Orbost, Rosedate, Stratford, Tarwin, Wa-De-Lock).

2.1.2 Vertical extent

The vertical scale of the model was designed to incorporate conventional, tight, shale and brown coal gas structures while enabling the calibration of pre-tertiary base flows. Key design features included the incorporation of:

- Mesozoic sediments (Strzelecki group) greater than 8km thick in the offshore basin (primarily incorporated for tight and shale gas scenarios)
- Tertiary layers based on Victorian Aquifer Framework (SKM 2011b; GHD 2012a), which groups hydrogeological units into major hydrostratigraphic units (all layers were explicitly modelled to allow for this.)
- coal seams based on stratigraphic information sourced from Jansen & Maher (2003).

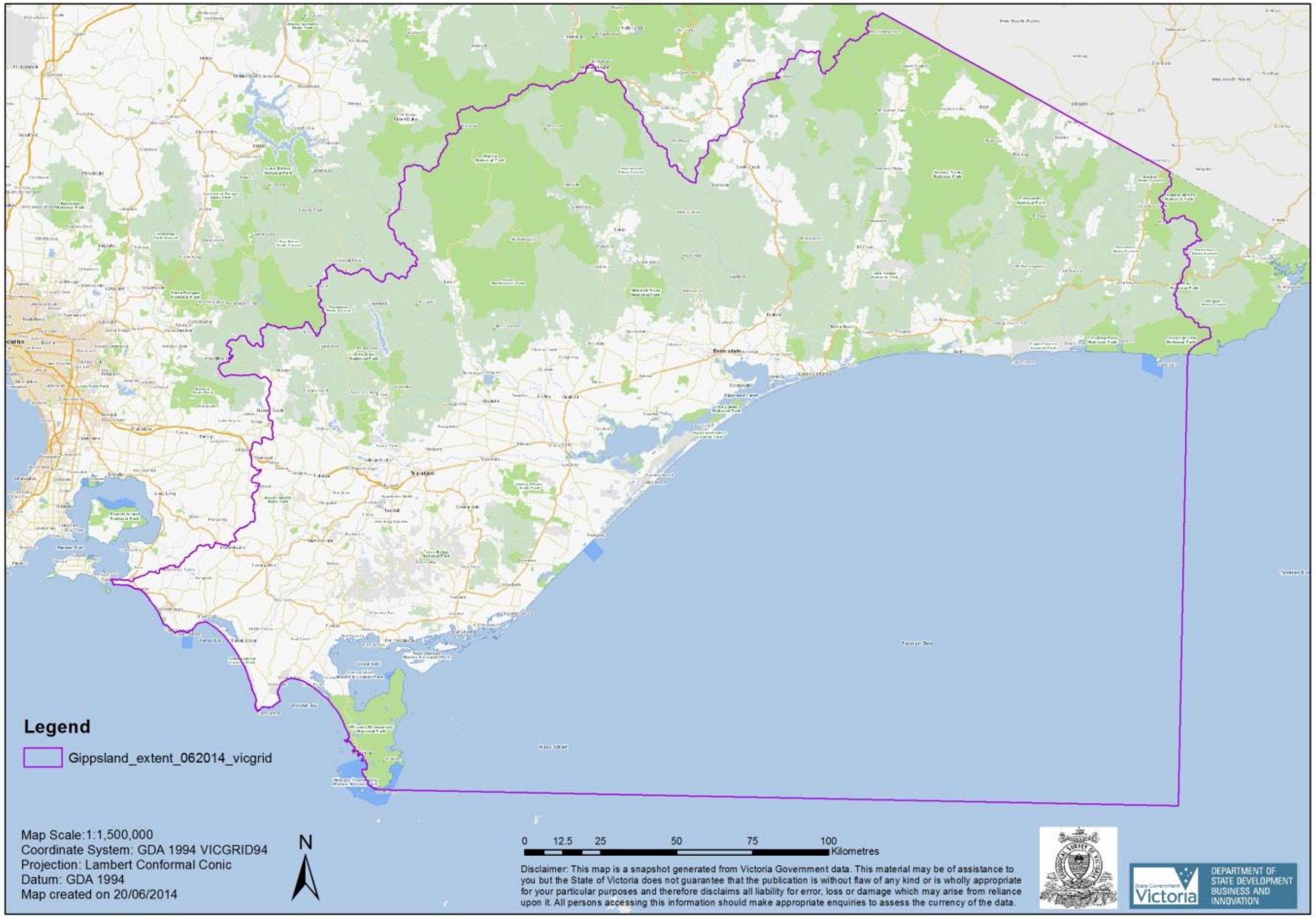

Figure 10: Extent of the 2014 Victorian Gippsland groundwater model.

2.2 Climate

The climate in the Gippsland region is temperate and generally humid. However, there is considerable variation across the region. In the Strzelecki Ranges and Great Dividing Range, annual rainfall can be as high as 1500 mm, averaging over 1000 mm, and includes snow falls on the higher peaks during winter. In lower levels east of the Snowy River, mean annual rainfall is typically about 900–950 mm. Rain shadows occur in the river valleys and on the plains in the central region. In the area around Sale, annual rainfall can be less than 600 mm. Mean maximum temperatures in lower areas range from 24 °C in January to 15 °C in July. In the highlands of the Baw Baw Plateau and the Errinundra Plateau, mean temperatures range from a maximum of 18 °C to a minimum of 8 °C, and in winter mean minima in these areas can be as low as –4 °C, leading to heavy snowfalls that often isolate the Errinundra Plateau between June and October.

For this study, daily climate information was obtained from data from the Queensland Department of Science, Information Technology, Innovation and the Arts SILO Climate data website (DSITI, 2015) for each of the 199 climate stations with meteorological data for the period 1957–2013 that are located within the study area (Figure 11). For a given climate station, daily climate data is a combination of original measurements and rectified data to remove any gaps in the record using interpolation methods discussed in Jeffrey et al. (2001). To account for sparsely located climate stations within the study area, daily rainfall, temperature, evaporation and solar radiation data were scaled to each solution point within the study area according to interpolated mean annual spatial layers created using the ANUClim software (Hutchinson 2001). This approach combines a DEM and temporal climatic data to generate a smoothed climate surface. Daily meteorological data assigned to each solution point within the study area was therefore a function of the data from the 199 climate stations, landscape position and topography. The patch point shape file identifying the extent of influence of each climate station is shown in Figure 11, whereas Figure 12, Figure 13, Figure 14 and Figure 15 show the mean annual rainfall, average daily temperature, average daily radiation and mean average potential evaporation for the period 1957–2012 across the study area, respectively.

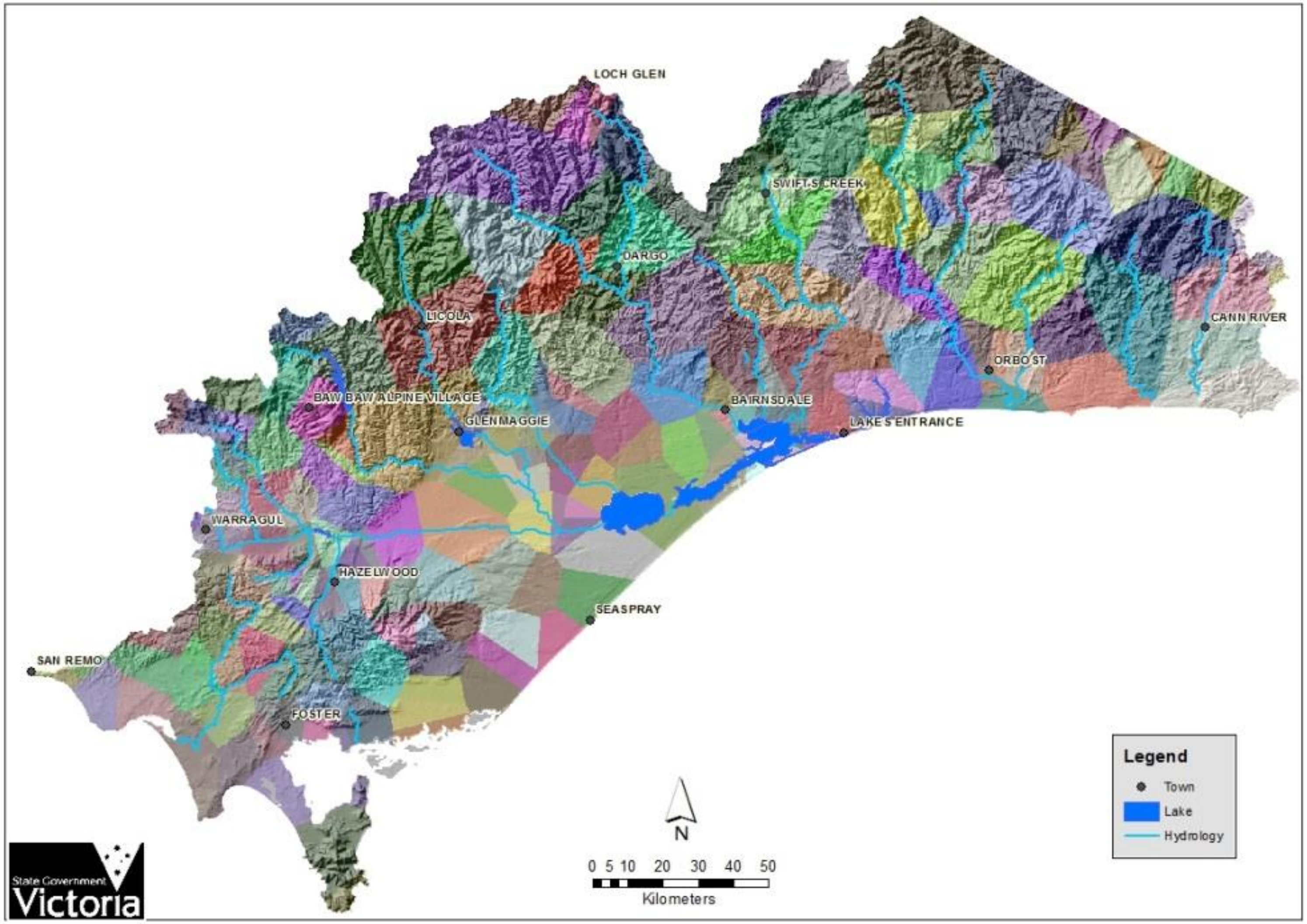

Figure 11: Zones of influence attributed to climate stations within the study area.

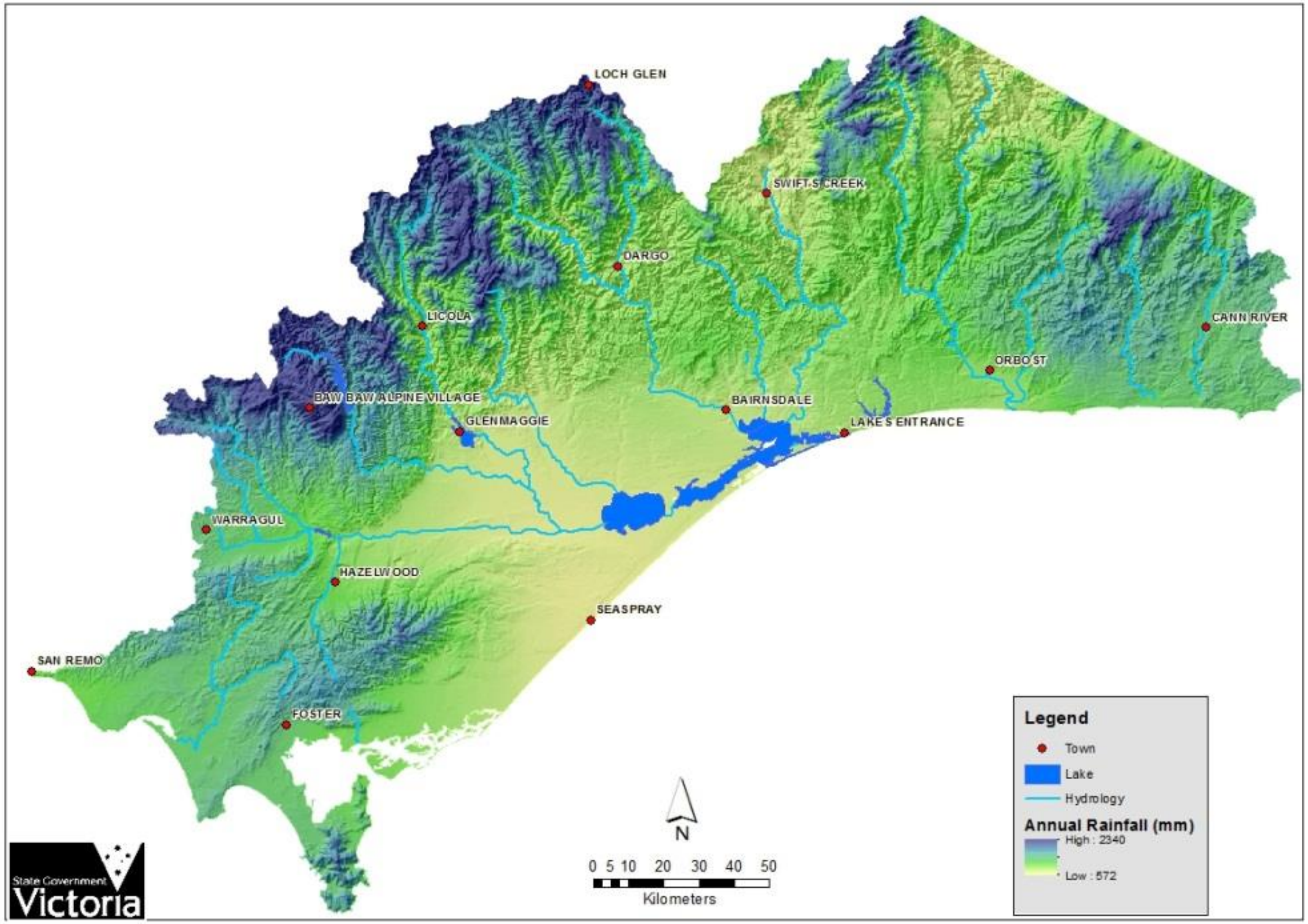

Figure 12: Interpolated mean annual rainfall (mm/yr) for the period 1957–2013.

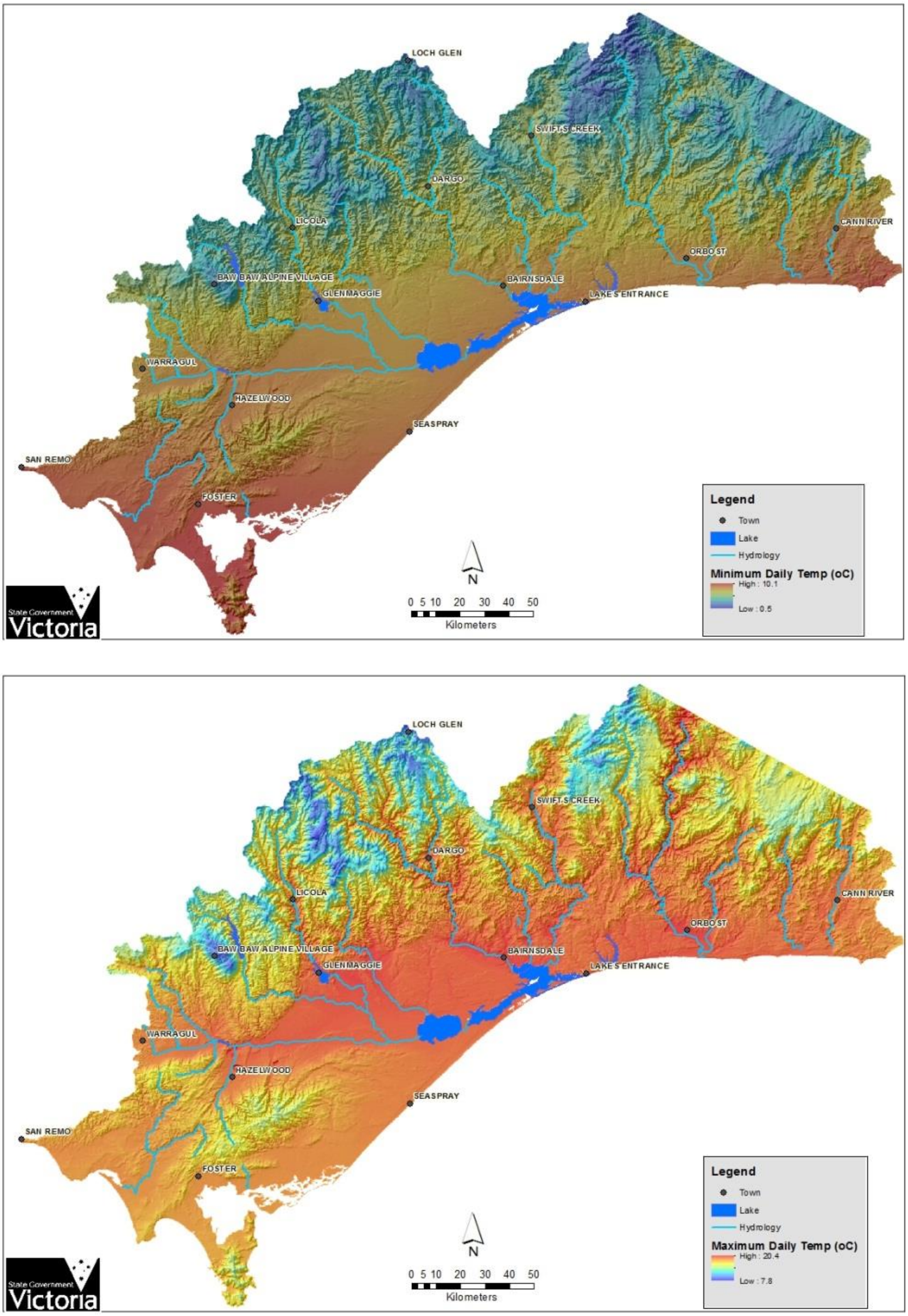

Figure 13: Interpolated average daily minimum (top) and maximum temperature (bottom) (ºC) for the period 1957–2013.

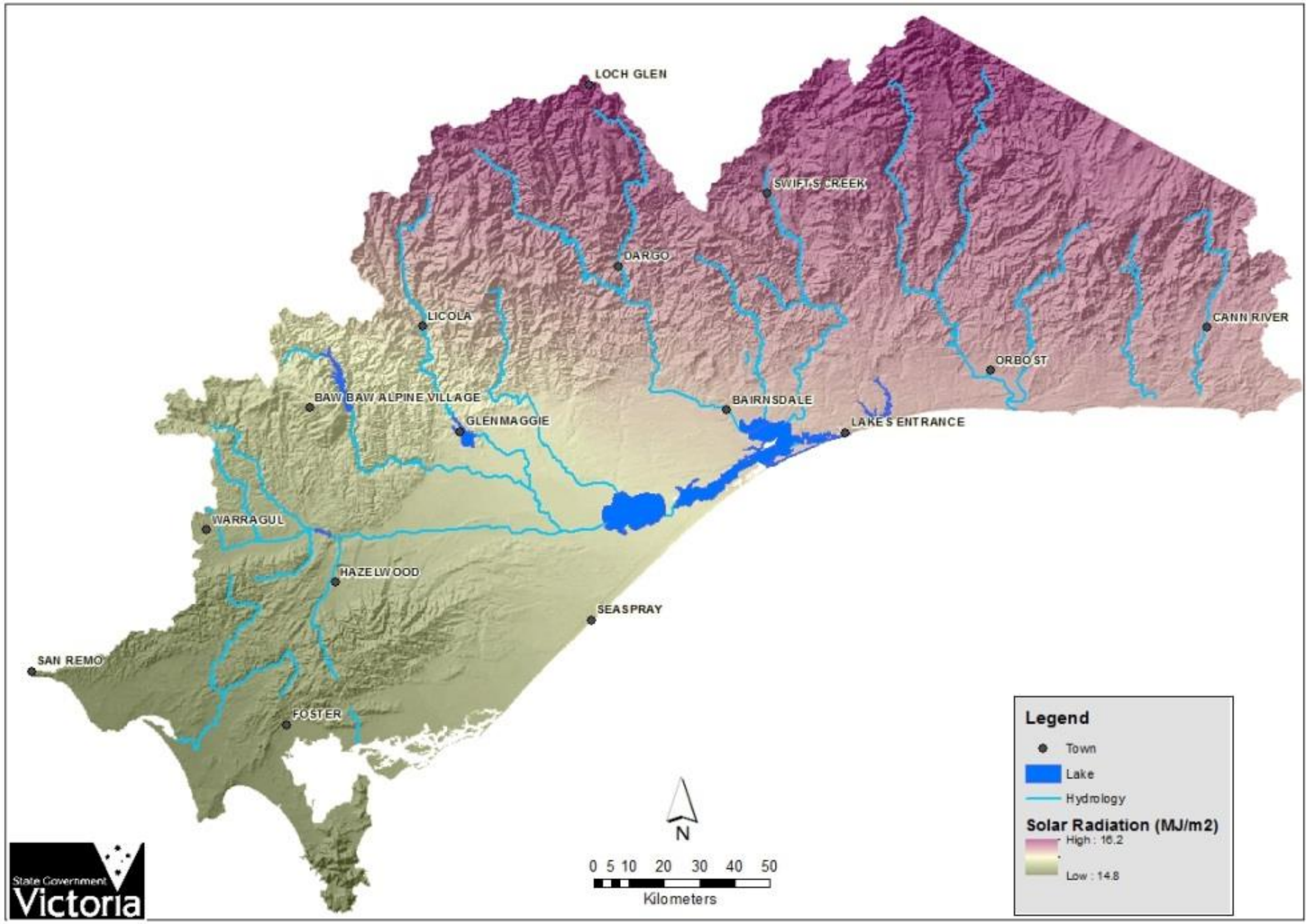

Figure 14: Interpolated average daily solar radiation (MJ/m^2) for the period 1957–2013.

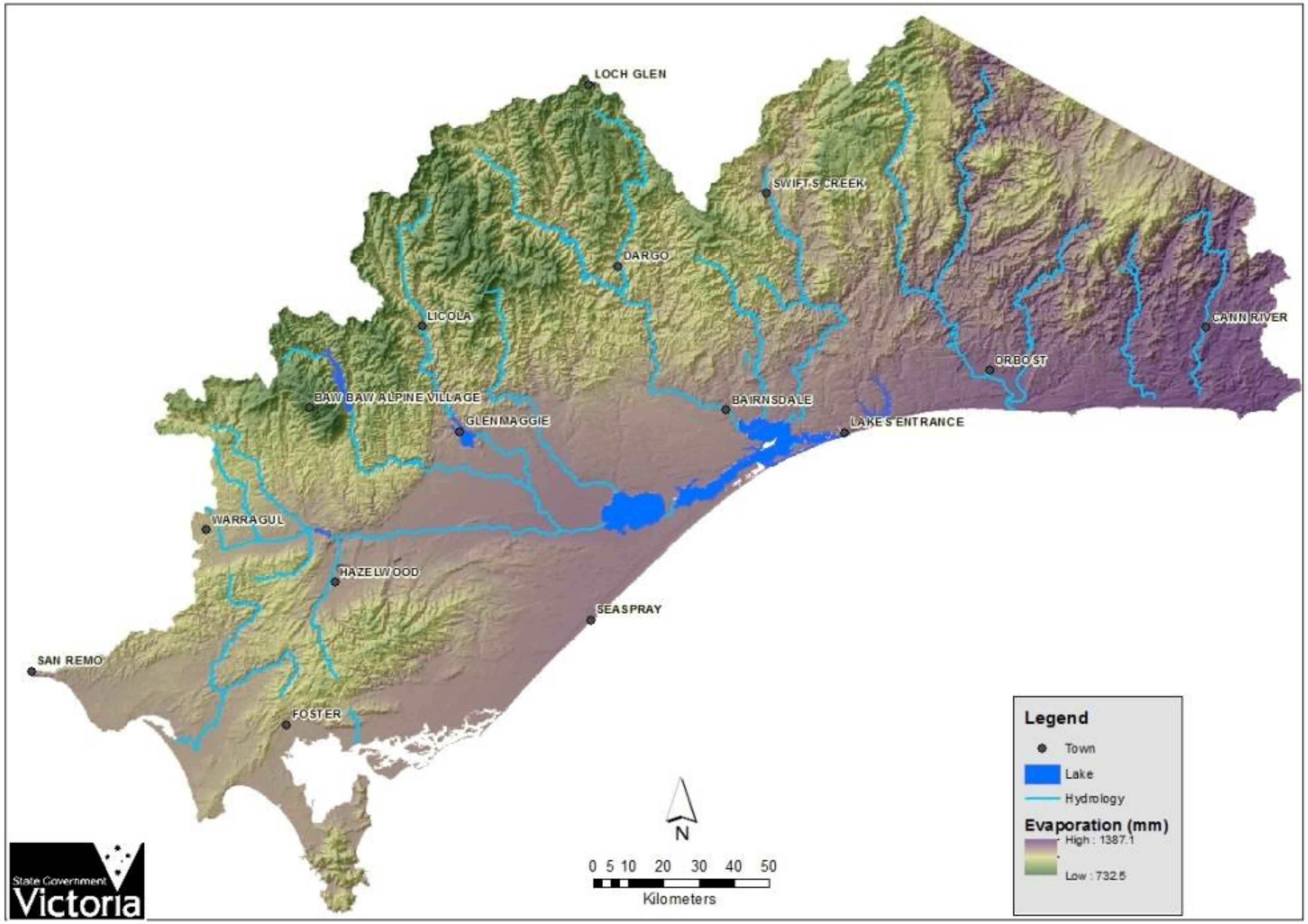

Figure 15: Potential mean annual evaporation (mm/yr).

2.3 Topography

The Gippsland region extends from the Great Dividing Range in the north to the Gippsland Lakes and Wilsons Promontory in the south and from the Latrobe River catchment and Strzelecki Ranges in the west to the New South Wales border in the east. The topography in the Gippsland region is highly varied (Figure 16, Figure 17 and Figure 18). The northern half is dominated by forested river valleys and mountains in the Great Dividing Range. Mt Wellington (1632 m) is a landmark at the southern end of the Snowy Range, a long ridge that extends south from Mt Howitt to form the divide between the Macalister and Wonnangatta Rivers, and on which Mt Reynard (1737 m) is the highest point south of the Great Divide. Most major rivers in the Gippsland region originate in the Great Dividing Range, including the Latrobe, Thomson, Macalister, Mitchell, Tambo, Nicholson and Snowy Rivers.

Much of the southern part of the Gippsland region is covered by the Eastern Plains, ranging from undulating rises to almost level plains. The surficial sediments are mostly alluvial and range in age from Quaternary to Recent. These mainly comprise sediments derived from the uplands to the north. The youngest sediments are the flood plains, swamps and morasses associated with the present rivers and streams. Between Traralgon and Bairnsdale, mostly north of the Latrobe River, are extensive Quaternary terraces associated with the earlier rivers and streams. A number of terraces have been identified; the earliest is suggested to be the result of the Kosciusko Uplift. Later terraces are attributed to sea level changes associated with glacial periods that occurred during the Quaternary. The most widespread terrace is believed to date from the Early Quaternary and is a high-level terrace extending from Stratford to Bairnsdale, in which some areas are mantled by sand dunes.

The Strzelecki Ranges is dominated by low volcanic hills stretching from Warragul to Thorpdale and Leongatha. The highest peak is Mount Tassie (approximately 740 m). The ranges were originally covered by a mosaic of wet forest and temperate rainforest. The native vegetation was extensively cleared for agriculture in the late 19th and early 20th centuries.

Most of East Gippsland is mountainous and wooded and is managed as a national park. The Buchan Caves near Orbost are one of the few examples of cavernous limestone in Gippsland.

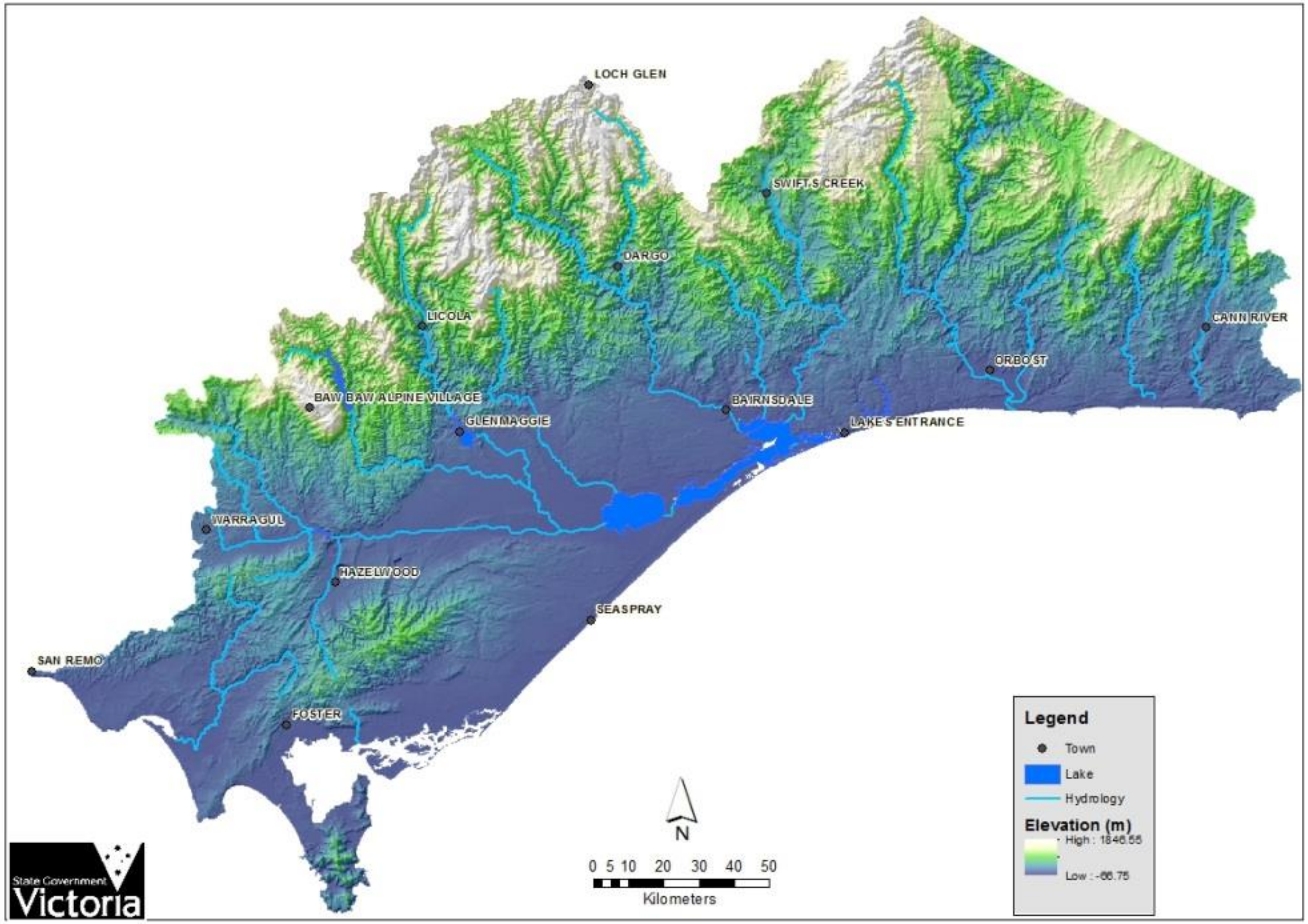

Figure 16: Elevation of ground surface (mAHD) based on a 20 m digital elevation model (source: Gallant et al., 2011).

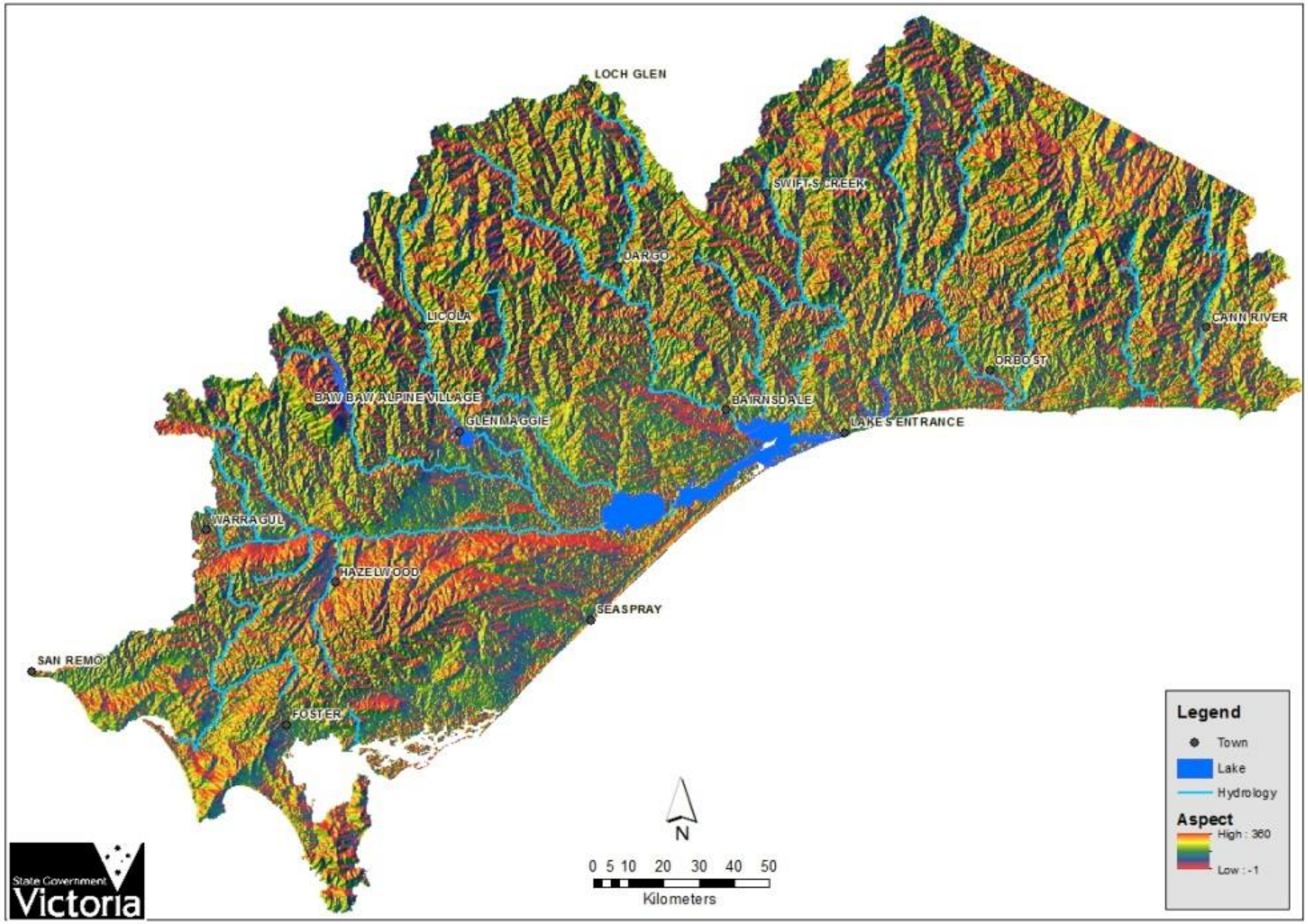

Figure 17: Aspect derived from the 20 m digital elevation model. Aspect is measured as the angle in degrees from north.

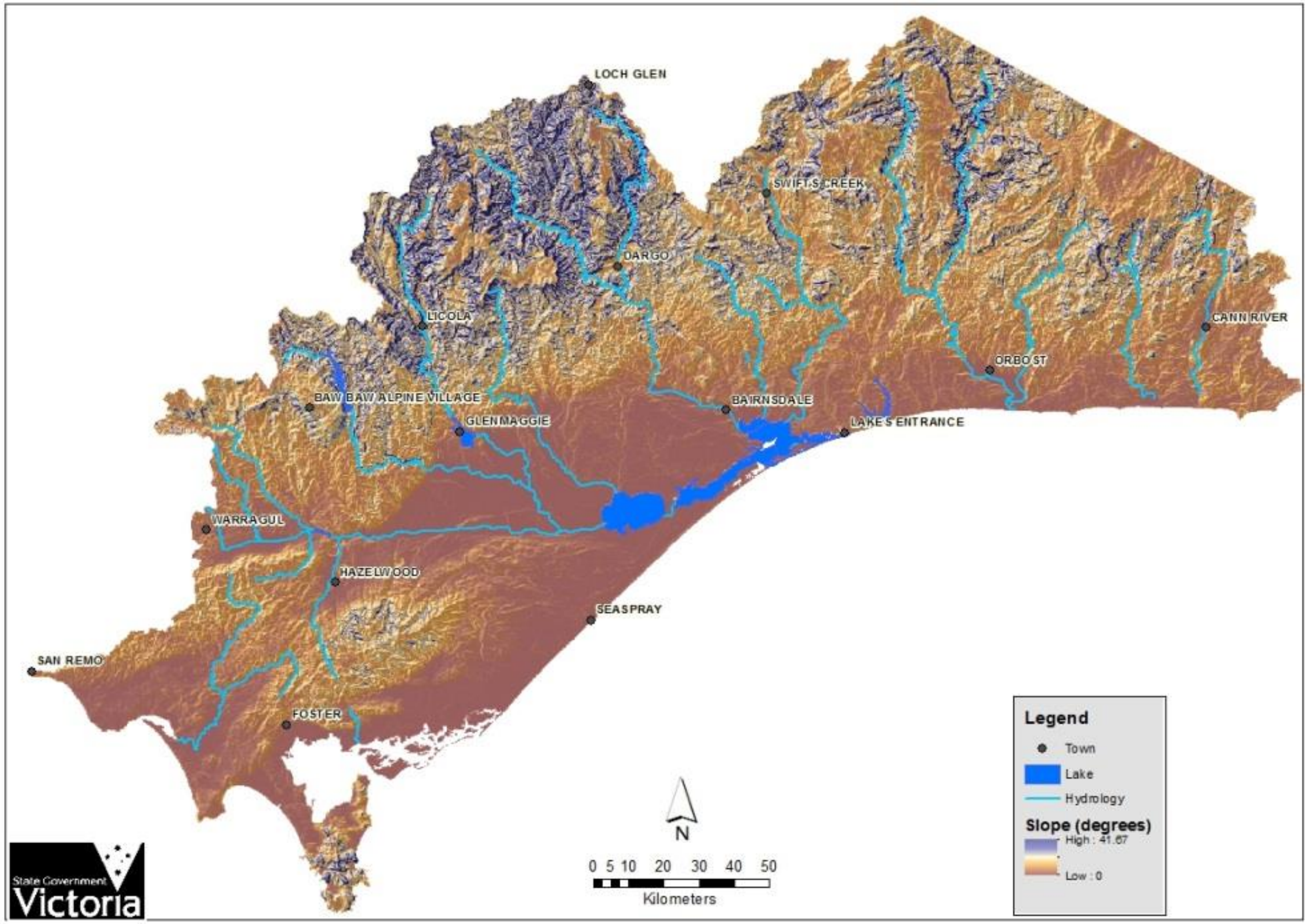

Figure 18: Slope derived from the 200 m DEM.

2.4 Land use

Land use varies greatly throughout the Gippsland region (Figure 19). The majority of arable land used for farming consists of dryland pasture and is used for grazing beef cattle and sheep as well as some dryland cropping. The high country is mostly used for beef and sheep production. Sheep production for both wool and prime lambs was historically a major enterprise within the hill areas. However, there has been a steep decline in sheep numbers due to the presence of wild dogs, drought, and labour shortages. The land use in the foothills and plains is predominantly sheep and beef, with some cropping enterprises.

The most significant irrigation area is the Macalister Irrigation District around Maffra, which is predominantly used for dairy production. Small pockets of irrigated agriculture (mainly horticulture and dairy) occur in the more fertile river flats around Orbost, Genoa, Cann River, Yarram and Bairnsdale. In these regions irrigated agriculture uses both surface water and groundwater.

Land use data for this study were classified using the Australia Land Use Mapping (ALUM) classification Version 6 (BRS 2006). The ALUM taxa describe land cover against which management strategies need to be specified. A total of 49 land use classifications were adopted in this study. In the case of cropping enterprises, crop rotations and cropping history were incorporated into the management scripts used in the catchment modelling. Based on the scale and resolution of the spatial land use mapping, more than 98% of land use in the study area is agricultural, with the remainder consisting of conservation areas, urban or built infrastructure and water bodies.

The following is a description of the land uses as they are defined for West Gippsland and East Gippsland Catchment Management Authority areas and as summarised in Table 2.

Tree cover accounts for 43% and 33% of the land use in the West Gippsland and East Gippsland regions respectively, including all natural conservation and reserve lands, managed natural resources and a range of production forestry uses. Most of this is concentrated in the northern and eastern highlands, Strzelecki Ranges and Wilsons Promontory. Smaller patches are scattered across the central and coastal areas. Softwood production areas are distinguished in the modelling, however they account for less than 7% and 17% of the total area in the West Gippsland and East Gippsland regions respectively, occurring in isolated patches. Forest nursery and some other woody plant land uses are also separated, and they comprise less than 0.1% of the area.

Grazing, dryland production systems, pasture mosaics and a range of other rural residential classes are grouped into a general “Annual Pasture” class which accounts for 49% and 64% of the area in the West Gippsland and East Gippsland regions respectively. A large proportion of this class occurs in the northwest and along the southern slopes of the study adjacent to the uplands forests.

Cropping includes cereals, legumes, shrub fruits and berries, seasonal and intensive horticulture, fruits and shade/glass houses. This broad group covers less than 1% of the study area and occurs most heavily in the west of the study area, although some is scattered across the central area. In contrast, irrigated crops (4% in West Gippsland and 2% in East Gippsland) occur only in the central region around Maffra and in the fertile river flats around Orbost, Genoa, Cann River, Yarram and Bairnsdale.

Degraded lands (<0.1%), urban development (1%) and water bodies (1.4%) make up the remaining land uses. By comparison they comprise small areas scattered across the study area.

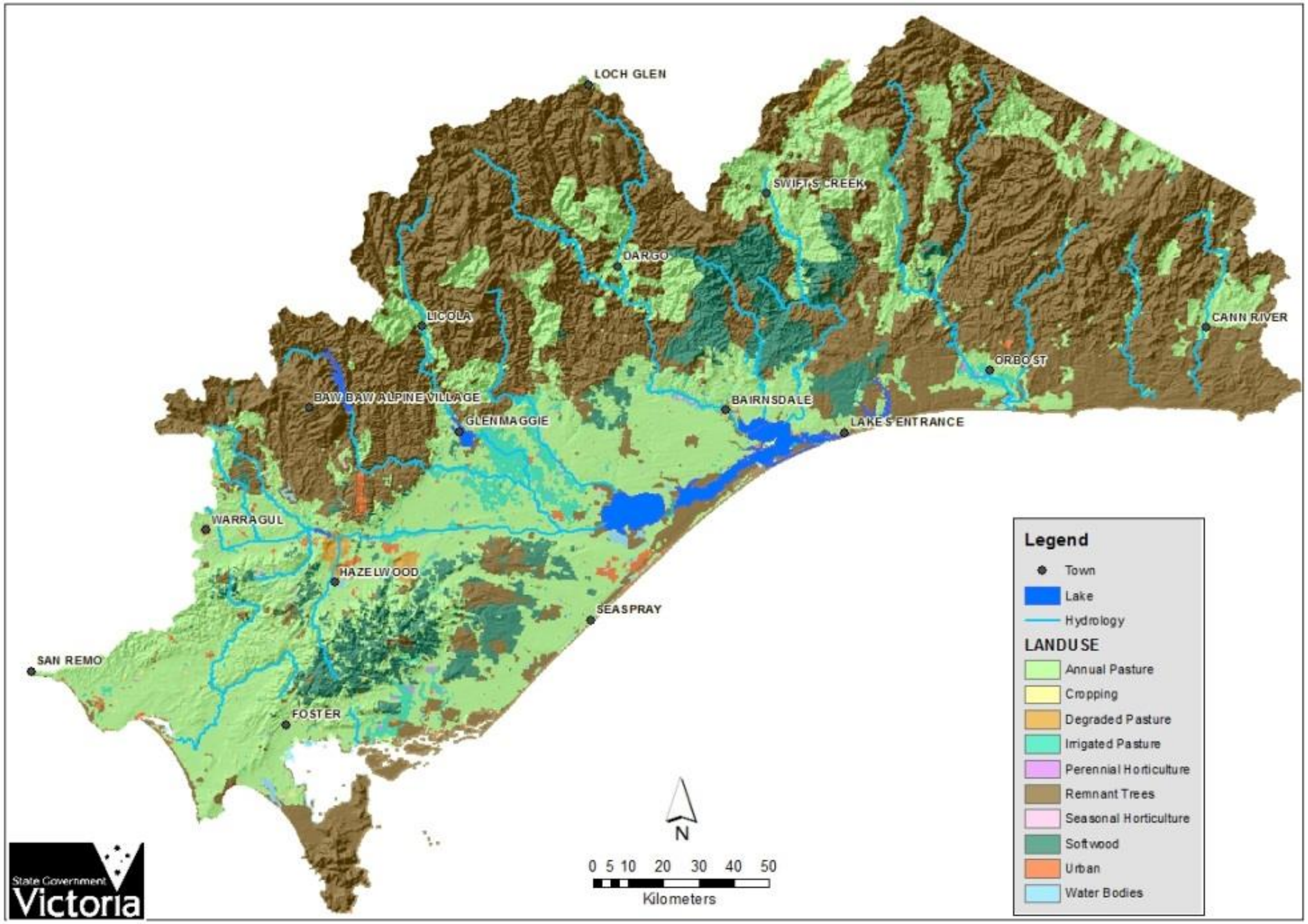

Figure 19: Land use classified into broad groupings.

Table 2: Land use per CMA, calculated as a percentage of the area of each CMA.

Description	West Gippsland	East Gippsland
Remnant trees	35.81	16.39
Softwood	7.46	16.66
Degraded pasture	0.78	0.33
Annual pasture	48.76	63.78
Irrigated pasture	3.82	1.72
Perennial horticulture	0.19	0.18
Seasonal horticulture	0.10	0.11
Cropping	0.24	0.00
Urban	1.13	0.42
Water	1.70	0.42

2.5 Soil

The Gippsland region has a great diversity of soil types that reflect differences in parent material, topography, climate, organic content and age (e.g. degree of weathering). Soils in the ranges are generally of granitic origin and have sandy loam to sandy clay loam textures. The foothills of the ranges include podosol type soils with a "coffee rock" layer at depth in the profile. Soils on the coastal plains around Bairnsdale largely originate from material deposited by streams and from dune forming processes. Most soils contain alluvial sediments and are texture contrast soils (soils with a loamy or sandy loam surface overlying a heavy clay subsoil). Textures vary from loamy sands to sandy loams and tend to be moderately to strongly acidic.

For this modelling study, soil data were derived by merging broadscale 1 : 250,000 land classification survey data and 1 : 25,000 soil attribute coverage (Smith 2002). The merged spatial soil layer was attributed using the Factual Key of Northcote (1979) at the Principal Profile Form (PPF) level to classify different soil types. Within the study area 169 different soil types were identified and spatially assigned. The spatially assigned key soil classifications are presented in Figure 20. The soil attribution through depth for each soil type was based on published data sources (McKenzie et al., 2000), field observations and pseudo-transfer functions (van Genuchten et al., 1991) and includes soil water characteristics, bulk densities, hydraulic properties and impedance properties specified for each soil layer modelled. Additionally each soil required specification of erodability, erosion and soil evaporation attributes.

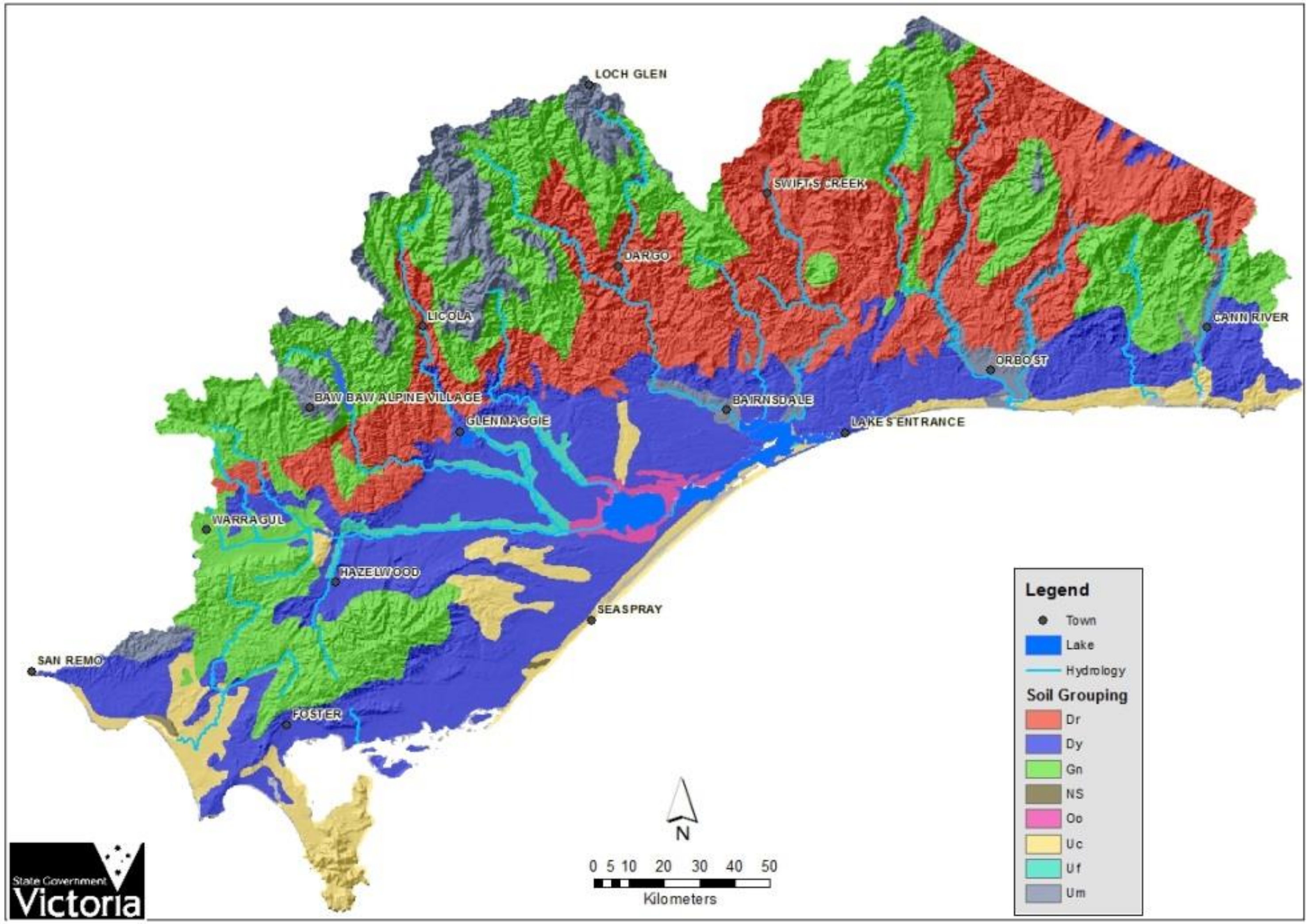

Figure 20: Spatial pattern of the key soil classifications in the Gippsland region.

2.6 Hydrology

The Gippsland region includes the South Gippsland, Latrobe, Thomson, Macalister, Avon, Mitchell, Tambo and Nicholson, Snowy and East Gippsland river basins (Figure 21). The Latrobe, Thomson-Macalister, Avon, Tambo, Nicholson and Mitchell rivers flow into the Gippsland Lakes, while the Tarwin, Snowy and Cann rivers flow into small estuaries or to the sea. The Tarwin, Agnes and Tarra Rivers flow steeply from the southern face of the Strzelecki Ranges to the coast. The Gippsland Lakes form the largest estuarine lake system in Australia. Along with Ninety Mile Beach they are major features of the region. Dunes and wetlands are common around the lakes and along the coast. There are also some large reservoirs such as Blue Rock, Thomson and Glenmaggie, and extensive channel and drain networks in the Macalister Irrigation District.

Latrobe River

The Latrobe Basin includes the Latrobe, Tanjil, Tyers, Moe, Morwell and Traralgon river systems. The Latrobe River rises at an elevation of approximately 750 m due west of Noojee. Its headwaters, together with the Ada, Loch and Toorongo rivers, drain the eastern and southern slopes of the Yarra Ranges, which form a southern extension of the Great Dividing Range. Approximately 70 km from its source, the Latrobe River emerges from the foothills onto its floodplain. The river flows through the Latrobe Valley and discharges into Lake Wellington, at the western end of the Gippsland Lakes. The Latrobe River is the highest contributor of freshwater inflows to the Gippsland Lakes contributing 44% of mean annual inflow. The Latrobe River system has been most affected by regulation and extraction, with a 33% reduction of inflows to Lake Wellington (Tilleard et al., 2009).

The Latrobe Valley houses two major water storages: Blue Rock Lake (capacity 208 GL) and Moondarra Reservoir (capacity 30 GL). Another much smaller storage, Lake Narracan, is situated on the main stem of the Latrobe River at Yallourn near Moe. Blue Rock and Lake Narracan are primarily used to supply Yallourn, Loy Yang A and Loy Yang B power stations.

The environmental condition of the Latrobe River varies from excellent in the headwaters to moderate and poor condition in the mid – lower reaches below the storages. Freshwater flows from the Latrobe Basin are critical for sustaining the health of the Ramsar-listed Gippsland Lakes, which underpin the region’s tourism industry.

Mitchell River

The Mitchell River has been identified as a heritage river and as one of two iconic rivers in Victoria. This is largely because of its size, being the largest unregulated river in Victoria, and because it supports a wide range of environmental and social values. Land use in the upper catchment includes sections of the Alpine National Park and the Mitchell River National Park.

The Mitchell River system originates on the southern slopes of the Great Dividing Range, with the Wonnangatta and Dargo Rivers being the two major rivers in this area, and forming the Mitchell River downstream at their confluence. The Mitchell River discharges to Lake King within the Gippsland Lakes. Other surface water systems include the Humfray, Dargo, Wongungarra and Wonnangatta rivers, Wentworth Creek and the Gippsland Lakes.

The river system is highly valued by the community for urban and rural water supply, recreation and its contribution to the Gippsland Lakes. The Mitchell River provides about one third of the total flow to the Lakes system on average.

Geologically 70% of the catchment consists of fractured rock systems in Palaeozoic-aged metasediments and intrusive rocks. Small areas of contained alluvial valley sequences occur in the highland valleys together with layered systems within Tertiary-aged volcanics. The southern third of the catchment contains the regional aquifer systems of the Gippsland Basin sequence (SKM, 2012a).

Thomson–Macalister system

The Thomson River flows from the Dividing Range and joins the Latrobe River south of Sale. The Macalister River flows from the Alpine National Park in the Snowy Ranges and joins the Thomson River between Maffra and Sale. The Thomson and Macalister rivers then continue towards and contribute flows to the Ramsar-listed Gippsland Lakes. The Thomson River above Cowwarr Weir is listed as a Heritage River.

There are two major storages within the Thomson–Macalister system, namely Lake Glenmaggie situated on the Macalister River and the Thomson Reservoir on the upper reaches of the Thomson River. Lake Glenmaggie is the main source of supply for the Macalister Irrigation District, the largest irrigation area south of the Great Dividing Range. The Thomson Dam provides water to Melbourne as well as the Macalister Irrigation District.

However, both the Thomson and Macalister Rivers are amongst the most stressed rivers in Victoria due to the altered flow regimes through regulation and over allocation of water for irrigation and consumptive use. As such river management is considered to have the greater impact on mitigating river stress than groundwater/baseflow management. The Thomson and Macalister Rivers directly below the Thomson Dam and Lake Glenmaggie respectively have reduced annual flows and reversed seasonality as a result of the reservoirs, with high flows in January and February and low flows during the winter months. This altered flow regime has significant impacts on the breeding and migration cues for fish. The dams and weirs are also a barrier to fish movement. Poor water quality in the rivers is affecting water supplies for consumptive use and recreation, as well as the Gippsland Lakes.

Avon River

The Avon River rises on the slopes of Mount Wellington in the eastern highlands and flows south to Lake Wellington. A significant portion of the upper catchment is protected in the Avon Wilderness Area (295 km^2). The upper catchment is steep, heavily forested and largely inaccessible. The channel is stable and confined by bedrock. The upper reaches of the Avon River including Turton and Dolodrook Rivers and Ben Cruachan Creek have been listed as Natural Catchment Areas.

The Lower Avon catchment below the Valencia Creek confluence flows through a topographically flat area which has been predominantly cleared for agriculture. The Avon River above Stratford and Freestone Creek has experienced dramatic widening since European settlement and now flow through wide mobile gravel beds. The Perry River joins the Avon approximately 1 km upstream from where the Avon discharges into Lake Wellington.

In the lower part of the Avon catchment, both surface water and groundwater are utilised for irrigation. The river has experienced low flows over the past decade and as a consequence, frequent irrigation restrictions have been imposed (Jones et al., 2009).

Snowy River

The Snowy River originates on the slopes of Mount Kosciuszko, draining the eastern slopes of the Snowy Mountains in New South Wales, before flowing through the Alpine National Park and the Snowy River National Park in Victoria and emptying into Bass Strait. The river flow was drastically reduced in the mid 20th century after the construction of four large dams (Guthega, Island Bend, Eucumbene and Jindabyne) and many smaller diversion structures in its headwaters in New South Wales, as part of the Snowy Mountains Scheme.

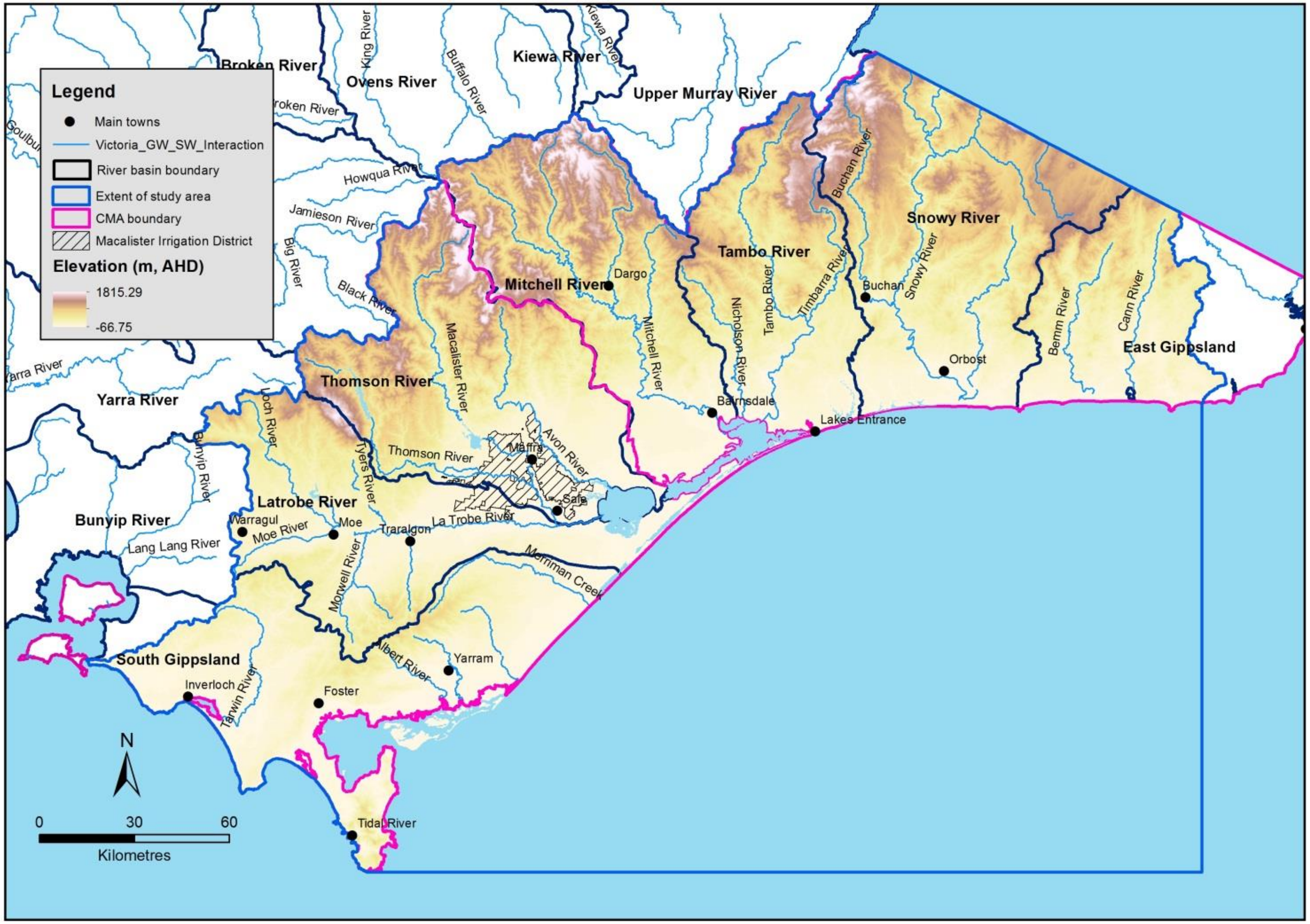

Figure 21: Major rivers of the Gippsland region.

2.7 Flooding

Flooding contributes to episodic recharge and was considered in the Gippsland groundwater modelling study. For example, in early June 2012 much of Gippsland experienced heavy rainfall, causing flooding across a number of municipalities, including Latrobe, Wellington and East Gippsland. Hydrograph analysis revealed that groundwater levels responded to this event.

For this study flood data was sourced from the Victorian Flood Database and included information regarding location and extent of a 1-in-100 year event (Figure 22) and historical flood events. Figure 23 shows the location and extent of recent major floods and Table 3 presents the magnitude of each flooding event in the past 100 years (including area directly affected and duration).

Although damage caused by some recent flooding events (e.g. June 2012) to towns and communities was widespread in the Gippsland region, the areas directly affected by flooding were relatively small compared to total area of the region. The extent of the 1-in-100 year flooding event only covers 4.8% of the total area of the Gippsland region. In the last 100 years, flooding events mainly occurred in small areas around the lower reaches of the Mitchell, Thomson, Latrobe and Snowy Rivers. The area directly affected by flooding was generally less than 1% of the Gippsland region. The largest flood event occurred in June 2012 and covered 1.4% of the Gippsland region. Given the areas affected by historic flooding events were relatively small, it is believed that the impact of flooding on groundwater recharge is insignificant at the regional scale, but likely to be significant at the local scale.

By examining groundwater hydrographs across the Gippsland region, a noticeable impact of flooding on groundwater recharge is only evidenced in the shallow aquifer systems well connected to the lower reaches of the Thomson, Mitchell and Latrobe rivers. It was found that recharge spikes in groundwater hydrographs of some shallow bores near the rivers are aligned to high river flow events.

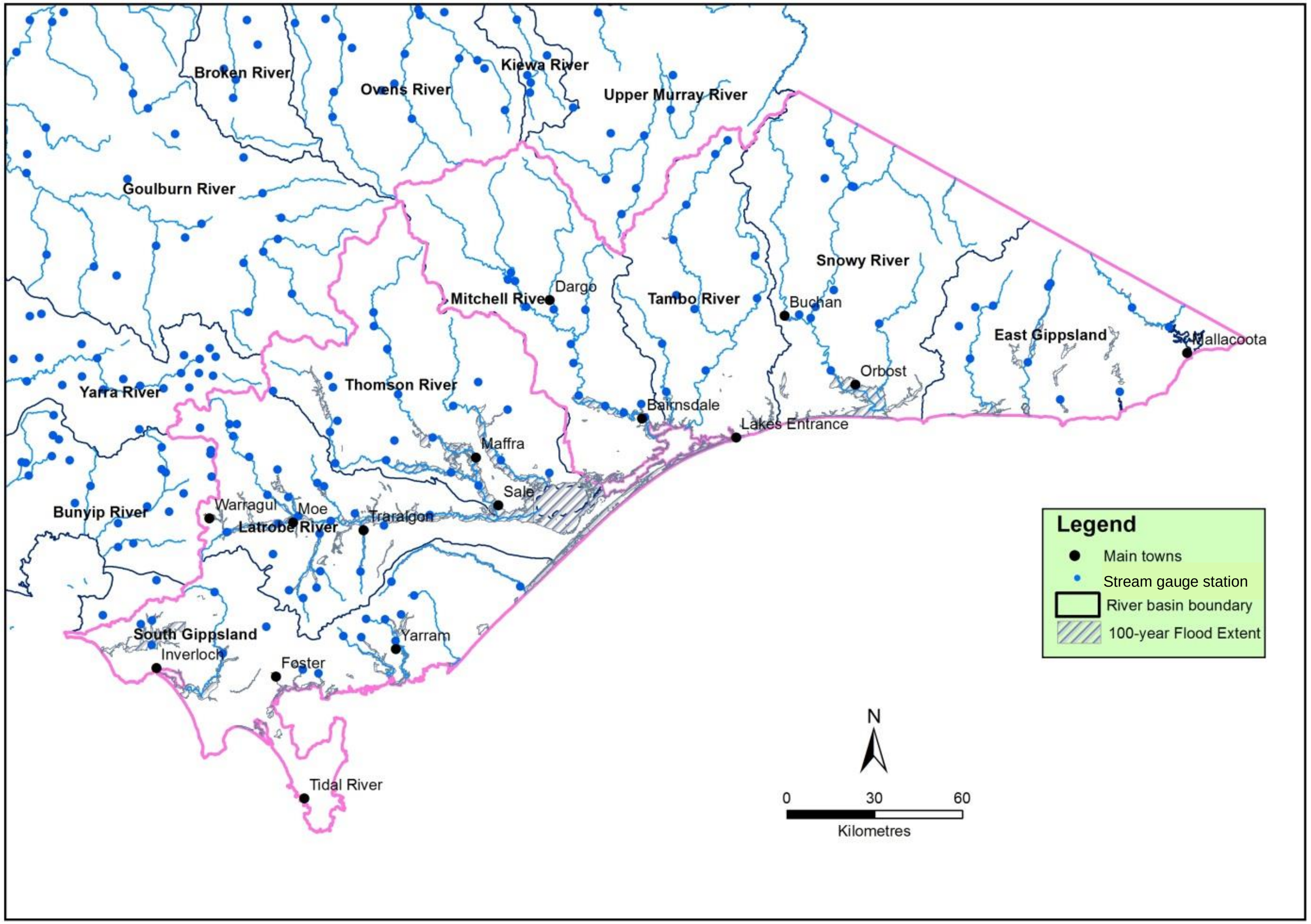

Figure 22: Location and extent of 1-in-100 year flooding events in the Gippsland region (source: Victorian Flood Database).

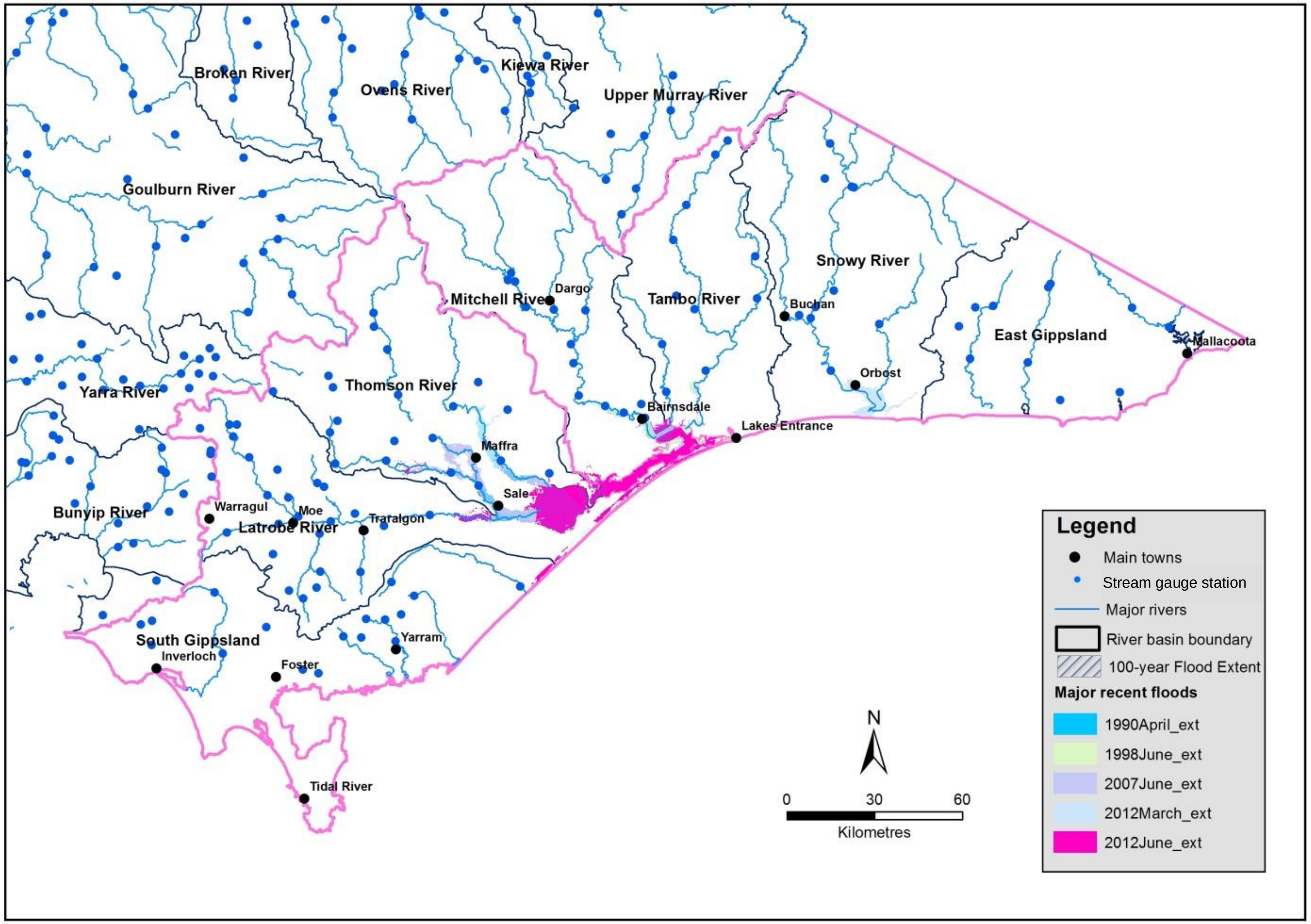

Figure 23: Location and extent of major recent flooding events (source: the Victorian Flood Database).

Table 3: Extents of historical flood events (sourced from the Victorian Flood Database).

Date	Duration (days)	Area affected (ha)	% of total catchment area
Jan-1919	Not known	2717	0.1
Jan-1920	Not known	1129	0.0
Oct-1923	Not known	208	0.0
Jan-1934	Not known	7527	0.2
Dec-1934	Not known	13361	0.4
May-1968	1	544	0.0
Jun-1969	1	644	0.0
Feb-1971	Not known	1666	0.0
Sep-1974	Not known	42	0.0
Jan-1977	Not known	11323	0.3
Jul-1977	3	20248	0.5
Jan-1978	Not known	2884	0.1
May-1978	5	14947	0.4
Jun-1978	5	12086	0.3
Jul-1978	1	3709	0.1
Jan-1985	Not known	740	0.0
Dec-1985	1	6427	0.2
Nov-1988	1	7061	0.2
Apr-1990	27	32563	0.9
Oct-1990	1	3278	0.1
Oct-1991	1	169	0.0
Sep-1993	16	2155	0.1
Jun-1998	3	6364	0.2
Nov-1998	1	949	0.0
Jun-2007	4	23308	0.6
Jul-2011	Not known	36	0.0
Mar-2012	8	9023	0.2
Jun-2012	3	54912	1.4
1-in-100 year extent	N/A	181490	4.8

Table 4: Modelled flood extents and dates.

Flood event date	Recorded dates
2012June_ext	6/6, 7/6
2012March_ext	3/3, 9/3,10/3
2011July_ext	1/7
2007June	26/6, 29/9
1998Nov_ext	14/11
1998June_ext	23/6, 24/6, 25/6
1993Sep_ext	1/9, 14/9, 15/9, 16/9
1991Oct_ext	3/10
1990Oct_ext	11/10
1990April_ext	1/4, 22/4, 23/4, 25/4, 27/4
1988Nov_ext	18/11
1985Dec_ext	12/12
1985Jan_ext	1/1
1978July_ext	9/7
1978June_ext	1/6, 4/6, 5/6
1978May_ext	21/5, 22/5, 25/5
1978Jan_ext	1/1
1977July_ext	1/7, 27/7
1977Jan_ext	1/1
1974Sep_ext	1/9
1971Feb_ext	1/2
1969June_ext	4/6

2.8 Surface water and groundwater interactions

Groundwater generally interacts with surface water through various processes and pathways. The development of groundwater often has impacts on major streams (and vice versa). As such it is necessary to manage groundwater and surface water resources in combination. This requires an understanding of the interconnectivity and processes underpinning surface water and groundwater interactions. In the context of water resource management it is important to understand and account for surface-groundwater water interaction when considering issues, including:

- double accounting of water resources
- impacts of groundwater pumping on stream flow, particularly flow depletion
- surface water requirements for downstream users
- water requirements for environmental purposes (e.g. floodplain, stream, wetland ecosystems)
- health of groundwater dependent ecosystems (GDEs)
- conjunctive resource management strategy development and water allocation regime
- salinity impacts on water quality, salt loads, and ecosystem health
- management for climate variation/change and its impacts on groundwater–surface water systems.

To better inform the numerical groundwater model developed for the Gippsland region, a brief assessment of surface-groundwater water interaction across the study area was undertaken, based on available literature (e.g. DSE 2012, SKM 2012a, 2012b; Hofmann, 2011) and analysis of groundwater and surface water information. DSE (2012) collated a state wide dataset of groundwater and surface water interaction from numerous investigations across Victoria. The dataset described groundwater and surface water interaction in four broad classes: neutral/losing, gaining, variable and unclassified (Figure 24). SKM (2012a) undertook baseflow separation analysis for 180 stream gauges on unregulated rivers in Victoria. This included 51 gauges in the Gippsland region. The baseflow separation analysis was undertaken on historical river flow records up to 2012 and utilised a filter parameter of 0.98. The results of the analysis for the 51 stream gauges in the Gippsland region is summarised in Table 5.

The groundwater and surface water interaction in the main rivers in the Gippsland regions is summarised below.

In the **East Gippsland catchment** it is believed that the shallow aquifers are well connected to the rivers and all river reaches are generally gaining. The annual average base flow indices (BFI) are high, ranging from 0.72 to 0.79 (DSE, 2012; SKM, 2012b). As there are few groundwater monitoring bores in the catchment, these gaining conditions are not evidenced by a groundwater hydrograph.

In the **Latrobe catchment**, the river reaches in the upper part of the catchment (upstream of Traralgon) are generally gaining with high annual average BFI ranging from 0.71 to 0.79 (DSE, 2012; SKM, 2012b). The surface water – groundwater interaction in the lower part of the catchment is not well understood. Analysis of groundwater and stream flow data indicated that the flux exchange between the river and shallow aquifers is temporally and spatially variable. The river reaches near the Macalister Irrigation District (MID) might be dominated by gaining condition due to elevated watertable in the MID (Figure 25). Deep aquifers (e.g. Latrobe Group) are generally artesian and poorly connected to the river. Total licensed groundwater use in the catchment is estimated to be 14.4 GL/yr and extractions for mine dewatering are approximately twice this volume (SKM, 2012a). SKM (2012a) conclude that the impacts of current rates of groundwater extraction on the streamflow in the Latrobe River are low.

In the **Mitchell catchment** the river reaches in the upper part of the catchment are generally gaining with annual average BFI ranging from 0.66 to 0.76 (DSE, 2012; SKM, 2012b). The surface-groundwater interaction in the lower part of the catchment was investigated by Monash University and SKM (2012a) using hydrogeochemistry and radon as a tracer (Hofmann 2011) and using an analytical modelling approach respectively. There is a significant interaction between groundwater and surface water in the Mitchell River floodplain area. Hofmann (2011) found that these river reaches have gaining and losing sections and these invert depending on the flow conditions of the river. This is supported by groundwater hydrographs of the bores near the river (Figure 26). SKM (2012a) found that a high proportion of the Mitchell River catchment water yield is derived from the higher altitude areas in the upper catchment. Flows at Bairnsdale are much lower than those upstream and the Mitchell River becomes a losing stream as it emerges from the ranges (SKM, 2012a). SKM (2012a) estimated that the volume of discharge lost from the Mitchell River due to groundwater extraction is negligible when compared to the cumulative yearly discharge, but considerable during periods of low flow. During low flows periods, it is estimated that groundwater extraction can lead to a 13% reduction in streamflow. Groundwater levels are therefore considered to have a significant influence on the flow and aquatic habitat condition of the Mitchell River during low flow periods.

In the **Snowy catchment** most river reaches are gaining with annual average BFI ranging from 0.69 to 0.79 (DSE, 2012; SKM, 2012a). The surface water – groundwater interaction in the lower part of the catchment is not well understood. Analysis of limited groundwater and stream flow data indicated that the flux exchange between the river and aquifers is variable (Figure 27).

In the **South Gippsland catchment**, based on stream flow analysis, most river reaches are gaining, with annual average BFI ranging from 0.64 to 0.78 (DSE, 2012; SKM, 2012a).

In the **Tambo catchment** the river reaches in the upper part of the catchment are generally gaining, with annual average BFI ranging from 0.69 to 0.77 (DSE, 2012; SKM, 2012a). The surface water-groundwater interaction in the lower part of the catchment was investigated by Unland (2013) using hydrogeochemistry tracer techniques. Unland (2013) found that these river reaches have gaining and losing sections and these invert depending on the flow conditions of the river.

In the **Thomson catchment** (including the Avon catchment) the river reaches in the upper part of the catchment are generally gaining, with annual average BFI ranging from 0.64 to 0.73 (DSE, 2012; SKM, 2012a). The river reaches in the MID are also dominated by gaining condition due to elevated watertable (Figure 28). The surface water-groundwater interaction in the lower part of the catchment was investigated by Monash University using hydrogeochemistry and radon as a tracer (Hofmann 2011). Hofmann (2011) found that these river reaches have gaining and losing sections and these invert depending on the flow conditions of the river. There is significant groundwater/surface water interaction along the Avon River. SKM (2008b) reported that the Avon River is strongly gaining along its main stem and along most tributaries. During periods of average rainfall, the groundwater baseflow component of stream flow is approximately 24–36% of average annual flow in the Avon River and 17–25% of average annual flow in Freestone Creek. Groundwater entitlement in the catchment is 13.8 GL/yr and current use is approximately 3.6 GL/yr. SKM (2008b) suggests that current groundwater use reduces streamflow by approximately 3.4 GL/yr. Based on these estimates it is suggested that if groundwater usage increases to full entitlement (assuming pumping infrastructure can support such usage) then groundwater extractions may have a significant impact on streamflow.

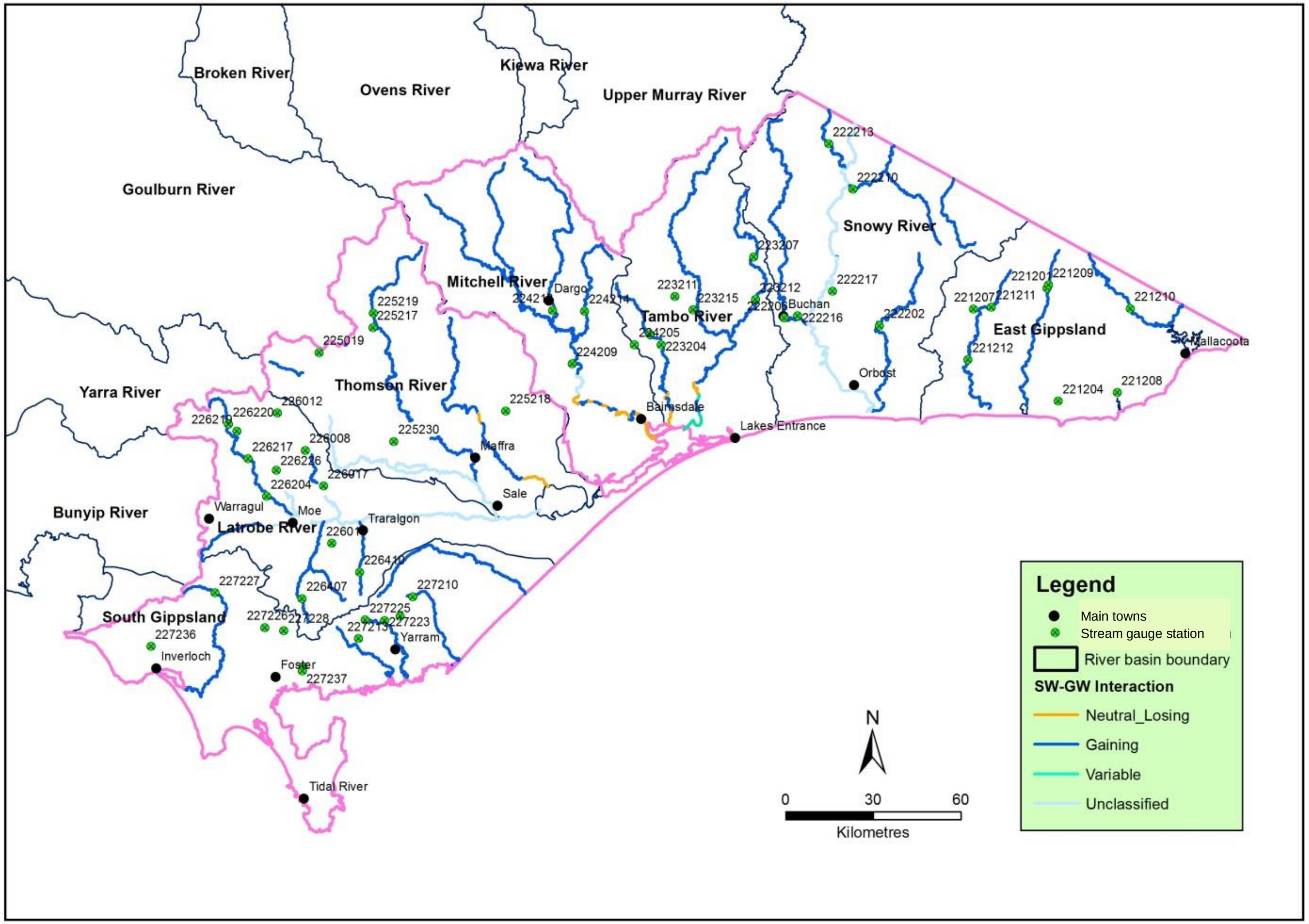

Figure 24: Surface-groundwater connectivity in the Gippsland region (source: data compiled by DSE in 2012).

Table 5: Estimated average baseflow index (BFI) (by season and annual) in 51 unregulated catchments in the Gippsland region (sourced from SKM 2012b).

Gauge ID	Gauge name	River basin	BFI Summer	BFI Autumn	BFI Winter	BFI Spring	BFI Annual
221201	Cann River (West Branch) @ Weeragua	East Gippsland	0.81	0.83	0.71	0.74	0.77
221204	Thurra River @ Point Hicks	East Gippsland	0.79	0.78	0.61	0.7	0.72
221207	Errinundra River @ Errinundra	East Gippsland	0.83	0.86	0.72	0.75	0.79
221208	Wingan River @ Wingan Inlet National Park	East Gippsland	0.82	0.79	0.6	0.71	0.73
221209	Cann River (East Branch) @ Weeragua	East Gippsland	0.81	0.8	0.67	0.72	0.75
221210	Genoa River @ The Gorge	East Gippsland	0.8	0.78	0.67	0.72	0.74
221211	Combienbar River @ Combienbar	East Gippsland	0.82	0.84	0.72	0.74	0.78
221212	Bemm River @ Princes Highway	East Gippsland	0.83	0.86	0.71	0.75	0.79
226008	Tyers River West Branch @ Morgans Mill	Latrobe River	0.83	0.83	0.7	0.71	0.77
226012	Tanjil River East Branch @ Tanjil Bren	Latrobe River	0.79	0.77	0.69	0.61	0.72
226016	Waterhole Creek @ Morwell	Latrobe River	0.9	0.82	0.68	0.73	0.78
226017	Jacobs Creek @ Otooles	Latrobe River	0.79	0.81	0.61	0.64	0.71
226204	Latrobe River @ Willow Grove	Latrobe River	0.86	0.87	0.72	0.73	0.8
226217	Latrobe River @ Hawthorn Bridge	Latrobe River	0.85	0.87	0.69	0.72	0.78
226219	Tooronga River @ Noojee	Latrobe River	0.85	0.88	0.7	0.72	0.79
226220	Loch River @ Noojee	Latrobe River	0.87	0.89	0.68	0.73	0.79
226226	Tanjil River @ Tanjil Junction	Latrobe River	0.83	0.87	0.67	0.65	0.75
226407	Morwell River @ Boolarra	Latrobe River	0.85	0.82	0.58	0.66	0.72
226410	Traralgon Creek @ Koornalla	Latrobe River	0.84	0.81	0.55	0.64	0.71
224205	Dargo River @ Dargo (Upper Site)	Mitchell River	0.79	0.8	0.57	0.53	0.67
224209	Cobbannah Creek @ Near Bairnsdale	Mitchell River	0.67	0.69	0.66	0.68	0.67
224213	Dargo River @ Lower Dargo Road	Mitchell River	0.79	0.83	0.48	0.56	0.66

Gauge ID	Gauge name	River basin	BFI Summer	BFI Autumn	BFI Winter	BFI Spring	BFI Annual
224214	Wentworth River @ Tabberabbera	Mitchell River	0.78	0.86	0.7	0.7	0.76
222202	Brodribb River @ Sardine Creek	Snowy River	0.83	0.86	0.71	0.75	0.79
222206	Buchan River @ Buchan	Snowy River	0.77	0.83	0.6	0.61	0.7
222210	Deddick River @ Deddick (Caseys)	Snowy River	0.79	0.83	0.76	0.77	0.74
222213	Suggan Buggan River @ Suggan Buggan	Snowy River	0.77	0.84	0.57	0.58	0.69
222216	Murrindal River @ Basin Road (Buchan)	Snowy River	0.76	0.75	0.62	0.65	0.7
222217	Rodger River @ Jacksons Crossing	Snowy River	0.79	0.85	0.67	0.71	0.75
227203	Franklin River @ Henwoods Bridge	South Gippsland	0.84	0.79	0.61	0.67	0.73
227210	Bruthen Creek @ Carrajung Lower	South Gippsland	0.82	0.83	0.63	0.68	0.74
227213	Jack River @ Jack River	South Gippsland	0.83	0.84	0.61	0.68	0.74
227220	Greig Creek @ Mumfords	South Gippsland	0.84	0.85	0.67	0.68	0.76
227223	Macks Creek @ Richards	South Gippsland	0.84	0.81	0.68	0.7	0.76
227225	Tarra River @ Fischers	South Gippsland	0.84	0.86	0.68	0.73	0.78
227226	Tarwin River East Branch @ Dumbalk North	South Gippsland	0.85	0.79	0.52	0.62	0.69
227227	Wilkur Creek @ Leongatha	South Gippsland	0.84	0.74	0.45	0.6	0.64
227228	Tarwin River East Branch @ Mirboo	South Gippsland	0.85	0.76	0.54	0.62	0.69
227236	Powlett River @ D/S Foster Creek Junction	South Gippsland	0.9	0.8	0.42	0.6	0.67
227237	Franklin River @ Toora	South Gippsland	0.85	0.8	0.55	0.65	0.71
223204	Nicholson River @ Deptford	Tambo River	0.78	0.8	0.71	0.73	0.75
223206	Tambo River @ Bindi	Tambo River	0.78	0.84	0.57	0.58	0.69
223207	Timbarra River @ Timbarra	Tambo River	0.81	0.85	0.71	0.69	0.76
223211	Haunted Stream @ Stirling	Tambo River	0.78	0.83	0.72	0.67	0.75
223212	Timbarra River @ D/S Of Wilkinson Creek	Tambo River	0.79	0.86	0.69	0.69	0.76

Gauge ID	Gauge name	River basin	BFI Summer	BFI Autumn	BFI Winter	BFI Spring	BFI Annual
223215	Haunted Stream @ Hells Gate	Tambo River	0.77	0.86	0.71	0.73	0.77
225019	North Cascade Creek @ Thomson Valley Road	Thomson River	0.8	0.77	0.7	0.62	0.64
225217	Barkly River @ Glencairn	Thomson River	0.81	0.83	0.45	0.57	0.66
225218	Freestone Creek @ Briagalong	Thomson River	0.73	0.78	0.64	0.68	0.71
225219	Macalister River @ Glencairn	Thomson River	0.8	0.81	0.42	0.53	0.64
225230	Glenmaggie Creek @ The Gorge	Thomson River	0.75	0.8	0.67	0.71	0.73

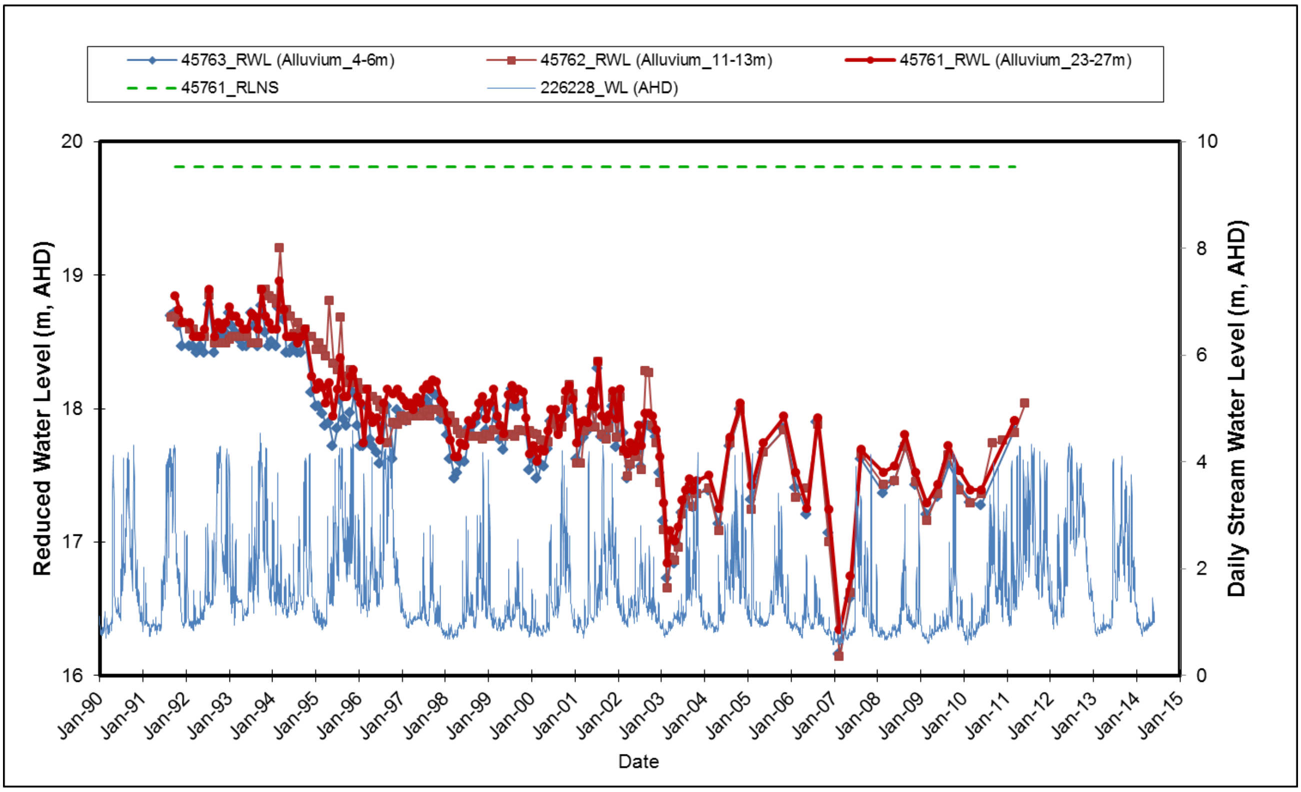

Figure 25: Groundwater hydrographs of three nested bores located in MID west of Sale plotted against daily stream water level of Latrobe River at Rosedale (gauge station no. 226228).

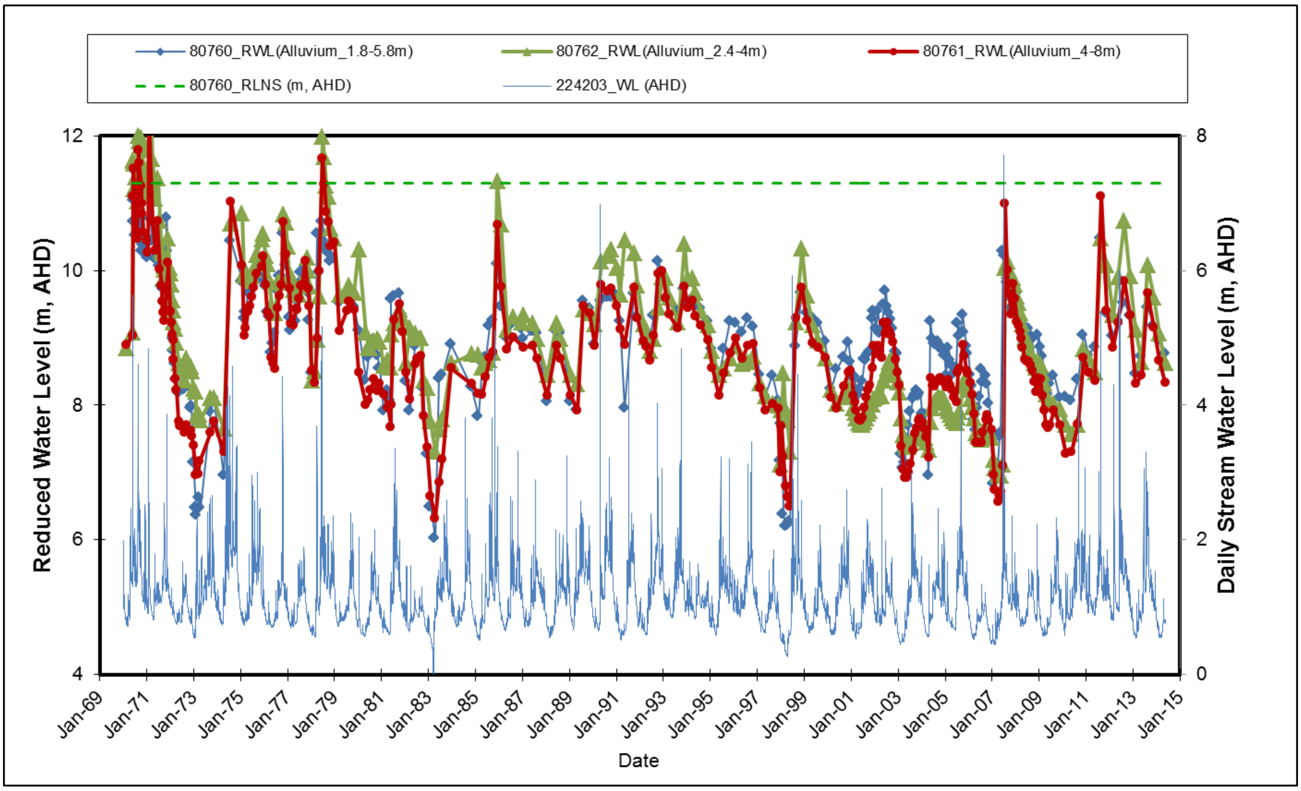

Figure 26: Groundwater hydrographs of a transect of bores located near Mitchell River west of Bairnsdale plotted against daily stream water level of Mitchell River at Rose (gauge station no. 224203).

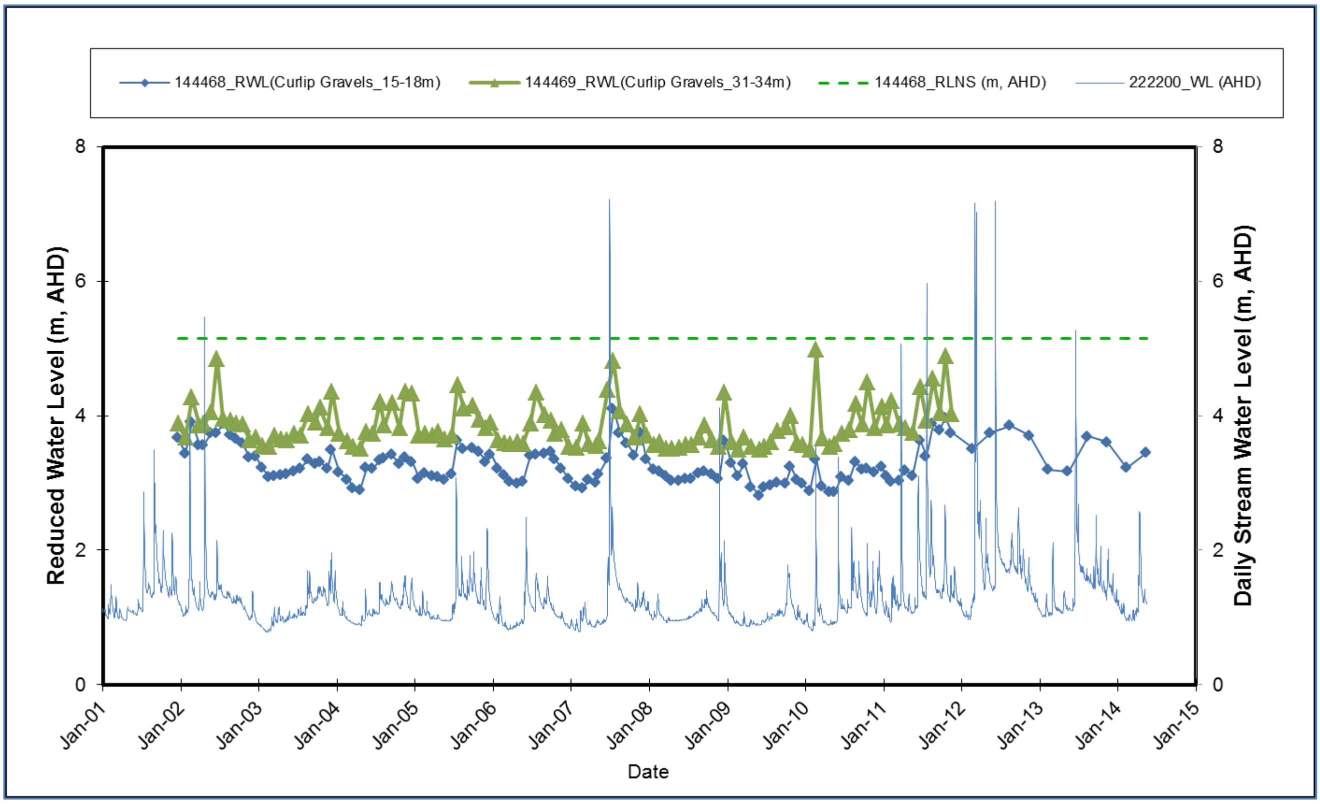

Figure 27: Groundwater hydrographs of two nested bores located near Snowy River west of Orbost plotted against daily stream water level of Snowy River at Jarrahmond (gauge station no. 222200).

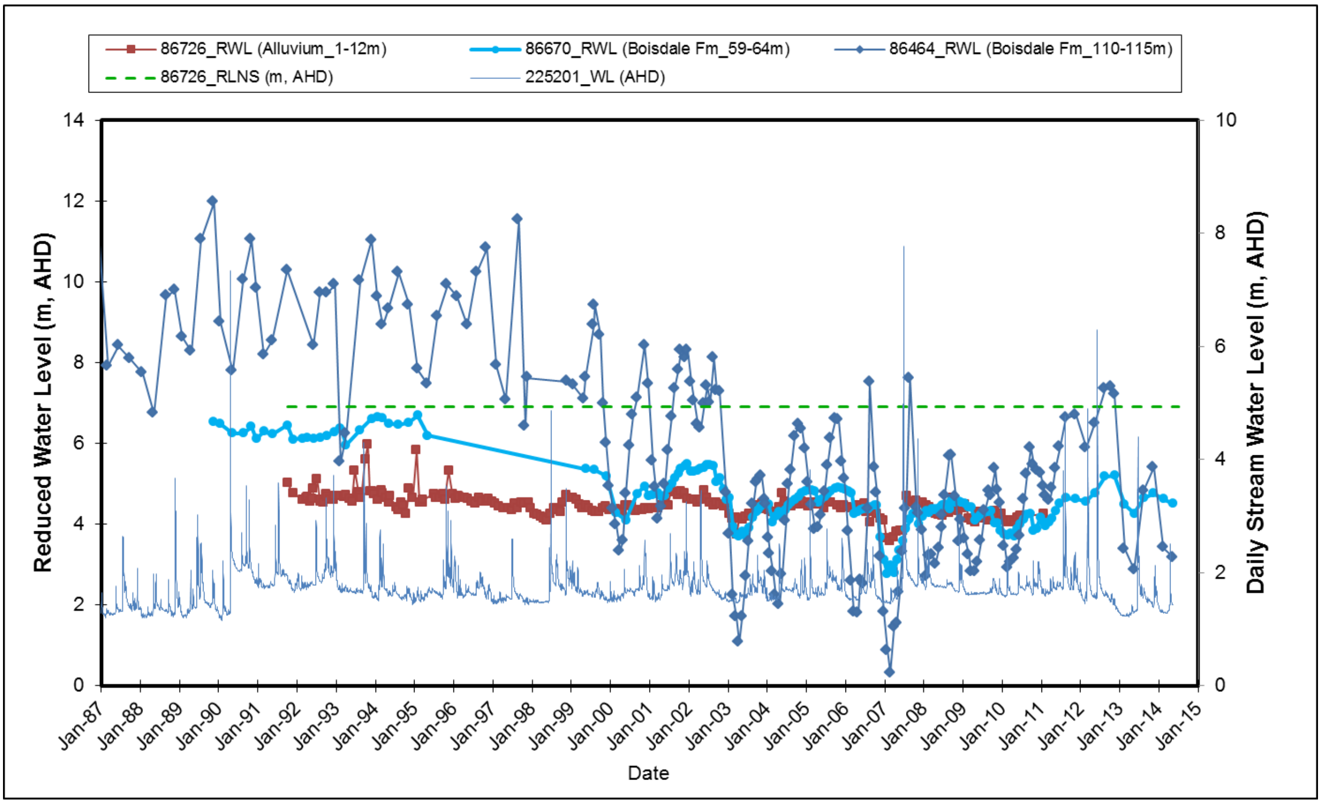

Figure 28: Groundwater hydrographs of three nested bores located in the Macalister Irrigation District north of Sale plotted against daily stream water level of Avon River at Stratford (gauge station no. 225201).

2.9 Hydrogeology

The surface and sub-surface geology is diverse and complex in the region. Outcropping Cretaceous sedimentary bedrocks (Strzelecki Group and Strzelecki Ranges) occur in the uplands in the southwest, while Silurian to Devonian sedimentary, metamorphic and igneous bedrock outcrops in the uplands in the west and north. The bedrocks underlie a sequence of up to 900 m of Upper Cretaceous to Quaternary marine and terrestrial siliclastic sediments, volcanics, coal measures and carbonate sediments in the Gippsland Basin which extends more than 80 km offshore. Structurally, the Gippsland Basin consists of fault-bounded uplifted and down-thrown blocks, and monoclines and anticlines which produced a series of depressions separated by bedrock “highs”. These diverse geological units and complex structures result in a large number of aquifer systems across the model domain. Hydrogeology in the model domain was investigated and described in detail in several previous studies (Schaeffer 2008; GHD, 2008a, 2010b, 2012a, 2012b). Table 7 summaries the hydrostratigraphic units defined across the modelling area. The main aquifer systems in the modelling area are summarised below.

2.9.1 Quaternary alluvium and Haunted Hill Gravel

The Quaternary alluvial units are relatively thin but extensive across the plains of the Gippsland Basin. Sand and gravel beds form largely unconfined aquifers, usually from 5 to 15 m thick. Hydraulic conductivity ranges from 0.1 to more than 50 m/day (Schaeffer, 2008; GHD, 2008a, 2010a). Specific yield ranges from 0.04 to 0.25 in the unconfined aquifers while specific storage ranges from 1×10^{-5} to 1×10^{-4} m^{-1} in the semi-confined or confined condition (Walker & Mollica, 1990; Schaeffer, 2008; GHD, 2008a, 2010a). The Haunted Hill Gravel is composed of sands, gravels and clays and conformably overlies the older Tertiary units across most of the Gippsland Basin and the East Gippsland coastal plain. Records from the Haunted Hill Formation in the Bairnsdale area show hydraulic conductivity of up to 100 m/day and a specific yield of 0.1 (Schaeffer, 2008). The limited lateral extent of many of these units and usually thin vertical extent means that transmissivity and aquifer yields are variable but generally low (i.e. less than 5 L/s). These upper units are not as heavily utilised as the deeper aquifers due to their lower yield potential.

2.9.2 Boisdale Formation Aquifer

The Boisdale Formation extends across much of the Gippsland Basin, except between Stratford and Bairnsdale north of the Princes Highway. The formation is an Upper Tertiary terrestrial sequence that primarily consists of sands, silts and clays. It can be subdivided into an upper clay unit (the Nuntin Clay Member), and a lower sand unit (the Wurruk Sand Member), the latter forming the Boisdale Formation aquifer. SKM (2006) mapped (and subsequently modelled) the aquifer as extending and narrowing to as far west as Traralgon. The lithological interpretations of Schaeffer (2008) indicate only minor, patchy Boisdale Formation Aquifer towards Traralgon. The aquifer thins to absence in the Lakes Entrance area. The Boisdale Formation also occurs in the onshore part of the Seaspray Depression, extending from the Lake Wellington area in the northeast to near Yarram in the southwest.

The Boisdale Formation Aquifer is confined to semiconfined by either the Nuntin Clay Member (i.e. upper clay), or by clays within the overlying Haunted Hill Formation (Leonard, 2003). The aquifer is highly permeable, particularly around Sale, where it is used as a source for urban water supply. To the south and east of Sale, the Boisdale Formation merges laterally into calcareous sands of the Jemmys Point Formation. This transition is thought to occur close to the existing shoreline in the Seaspray Depression, but in this area the Boisdale Formation is known to interfinger with the upper parts of the Jemmys Point Formation (SKM, 2001). The Boisdale Formation Aquifer is considered to be in direct hydraulic connection with the Morwell Formation Aquifer System (MFAS) (described in Section 2.9.6) further west in the Latrobe Valley via the Balook Formation.

Walker and Mollica (1990) reported a hydraulic conductivity for the Boisdale Formation Aquifer (at Sale, just inside the eastern boundary of West Gippsland CMA region) of 24 m/day (Schaeffer (2008) suggested up to 30 m/d), and a storage coefficient of 1×10^{-4} (Schaeffer also suggested S_s up to 1×10^{-2} m^{-1} depending on the degree of confinement). SKM (2006) report transmissivities ranging from 470 to 1300 m^2/day, and storage coefficients ranging from 1×10^{-4} to 5×10^{-4}. Yields of 5–20 L/s are reported for the Boisdale Formation.

SKM (2006) reported that the majority of recharge occurs along the northern extent of the aquifer, beneath the floodplains of the Thomson and Macalister Rivers west of Maffra, and south of Sale, along the northern flank of the Baragwanath Anticline. Walker and Mollica (1990) suggested that a significant proportion of recharge to the Boisdale Formation Aquifer may be derived from rainfall and stream infiltration via the Haunted Hill and Quaternary Formations where the aquifer subcrops at shallow depths, near its margins. Groundwater flow is from the west towards offshore areas in the southeast. Groundwater quality is less than 500 mg/L total dissolved solids (TDS) around Sale and in the north and west, increasing to 500–1500 mg/L TDS in the south and southeast. Around Lakes Entrance it increases to 1500–3000 mg/L TDS.

2.9.3 Jemmys Point Formation Aquifer

The Jemmys Point Formation is an Upper Tertiary aged marine sequence primarily overlain by, and distal to, the Boisdale Formation (Walker and Mollica, 1990). It is thought to have coarse-grained facies in its upper horizon, and a marlier lower horizon with properties similar to those underlying marine carbonates of the Tambo River Formation, Bairnsdale Limestone Member, Wuk Wuk Marl and Gippsland Limestone. Lithology between the Boisdale sand aquifer (LSU), sandy facies of Jemmys Point Formation and the Lake Welling Formation is very similar and good hydraulic connection between them is highly likely. GHD (2010b) considers the Boisdale sand aquifer (LSU), sandy facies of Jemmys Point Formation and the Lake Welling Formation as a single continuous aquifer unit.

The sandier facies of the Jemmy's Point Formation are believed to have similar hydraulic properties to its lateral equivalent Boisdale Formation (Walker and Mollica, 1990) while the clay-rich horizons are a much poorer aquifer, with properties similar to those of the Gippsland Limestone and other marine carbonates in this area. Hydraulic conductivity in these marls and limestones is thought to be about an order of magnitude lower (2–10 m/d) with storage coefficients ranging from 10^{-5} to 10^{-6} (Schaeffer, 2008; GHD, 2008a, 2010a).

2.9.4 Balook Formation Aquifer

The Balook Formation is a Mid-Cenozoic aged unit and represents a transition zone in depositional environment, from a largely terrestrial sequence in the west and north, to a marine sequence in the south and east. Brumley et al. (1981) and later publications discuss the importance of the Balook Formation barrier sand sequence to regional groundwater flow. This is due to the formation being a largely sandy deposit that crosses much of the vertical sedimentary pile, and therefore provides hydraulic connection between deep aquifers (Traralgon Formation Aquifer System (TFAS) and MFAS) and shallow unconfined to semiconfined aquifers (Haunted Hill Formation, Boisdale) over a large section of the Gippsland Basin. The Balook Formation also provides hydraulic connection between the MFAS and its marine equivalents of the Seaspray Group (Gippsland Limestone and Lakes Entrance Formations), although the average hydraulic conductivity of these lateral equivalents is thought to be relatively low (Schaeffer, 2008), and therefore groundwater could be expected to preferentially migrate upwards via the Balook Formation.

Brumley et al. (1981) reported an estimated transmissivity for the Balook Formation of 1000 m^2/day based upon (unreferenced) relatively low hydraulic conductivities of 2 to 7 m/day, and a 500 m average formation thickness. Higher hydraulic conductivities (up to 57 m/day) were reported by Schaeffer (2008) and Walker and Mollica (1990). Specific yield ranges from 0.04 to 0.1 in the aquifers under unconfined condition while specific storage ranges from 1×10^{-6} to 1×10^{-3} m^{-1} in the aquifers under semi-confined or confined condition (Walker and Mollica, 1990; Schaeffer, 2008; GHD, 2010b).

Groundwater quality mapping (DCNR, 1995) indicates groundwater within the Balook Formation (and associated formations) is typically 500–1000 mg/L TDS.

2.9.5 Childers Formation / Thorpdale Volcanics / Yarragon Formation Aquifers

These units are Early Cenozoic in age. The, Lower Morwell Formation (M2) and Childers Formation Aquifer lateral equivalent (see Section 2.9.6 below) is found in the Moe Basin and the Tarwin Basin respectively. In the Tarwin Basin, it is considered an insignificant aquifer, having relatively low hydraulic conductivity, and limited thickness (Pratt, 1985). Pratt (1985) also reported that it is essentially in direct hydraulic connection with the Thorpdale Volcanics, with minor locally confined conditions. For this reason the Childers Formation is lumped together with the Thorpdale Volcanics in GHD's Gippsland ecoMarket models (GHD, 2010a, 2010b).

The Thorpdale Volcanics form the primary aquifer in the Tarwin Basin, and are considered to be in direct hydraulic connection with the overlying Haunted Hill Formation (Pratt, 1985). A hydraulic conductivity for the Thorpdale Volcanics of 0.03 to 1 m/day and a specific storage of 1×10^{-6} to 1×10^{-4} m^{-1} were reported (Schaeffer, 2008; GHD, 2010b); these two units form a largely unconfined aquifer. Based on limited data, Pratt (1985) reported that most groundwater flow in the Tarwin Basin is from the west and northwest to the southeast, where the Koorooman Fault largely forces groundwater to discharge upward into the Tarwin River as baseflow. Pratt (1985) also reported that recharge largely occurs via rainfall infiltration to outcropping Haunted Hills Formation, Thorpdale Volcanics, and Quaternary units. Pratt (1985) estimated around 10,000ML/year total annual recharge (6% of mean annual rainfall), using the throughflow method, and suggested that much of this discharges to the Tarwin River. An urban water supply has recently been developed in the Volcanics for Leongatha.

In the Tarwin Basin, groundwater quality in the Childers Formation / Thorpdale Volcanics Aquifer ranges from 200 mg/L TDS to 2,000 mg/L TDS, and tends to decrease at greater aquifer depths (Pratt, 1985).

In the Moe Basin, the Yarragon Formation, a lateral equivalent of the Latrobe Valley's Yallourn Formation overlies the Thorpdale Volcanics. The Yarragon Formation forms an aquifer towards its base, although the waterbearing sands and gravels are intermittent in extent, primarily found in the south of the basin (GHD, 2010a; Brumley and Holdgate, 1983). A lateral facies change from sandy to clayey sediments occurs around the Moe monocline, approximately 5 km west of Moe (Brumley and Holdgate, 1983). Brumley and Holdgate (1983) state that discharge occurs from the highly confined Yarragon Formation by upwards leakage through the confining beds in the east of the basin, up into the watertable aquifer, and presumably the Latrobe River. Groundwater flows from the north-western and southern basin margins towards the east, where basement topography rises and narrows (around Moe, on the Haunted Hills Block). This, in combination with the lateral facies change, restricts groundwater flow eastwards out of the basin and into the Latrobe Valley (Brumley and Holdgate, 1983).

The Thorpdale Volcanics also forms a significant confined to semiconfined aquifer, with greater reported transmissivity than the Yarragon and Childers Formations (GHD, 2010a). The volcanics form a major aquifer in the west of the basin, where it is at lesser depths, and outcropping over large areas (Brumley and Holdgate, 1983).

The Childers Formation forms a minor confined aquifer in the Moe Basin, primarily due to its limited extent, thickness, and depth of burial (Brumley and Holdgate, 1983).

Walker and Mollica (1990) considered that recharge occurs primarily via direct rainfall and stream infiltration into outcropping units along the southern basin margin, and in the northwest. They also suggested that the majority of discharge is to streams and rivers via upward vertical leakage, with none into the Latrobe Valley via subsurface flow. Recharge was estimated to be around 10,000 ML/year in the Moe Basin. In the Moe Basin, groundwater quality varies from less than 500 mg/L TDS to 1,000 mg/L TDS (DCNR, 1995).

2.9.6 Morwell Formation Aquifer System (MFAS)

Within the MFAS, there are two regionally extensive aquifers, the M1B Aquifer, and the M2 (or M2C) Aquifer. Corresponding coal units (the M1B Coal and M2 Coals) confine both aquifers. The M2 Aquifer (and its lateral equivalents) extends from the Moe Basin in the west (where it is termed the Childers Formation), to around Rosedale, where the Morwell Formation (including the M1B) merges into the Balook Formation barrier sand sequence. However, the M2 Aquifer equivalent effectively passes beneath, but is in direct connection with, the Balook Formation, extending further east to the Bairnsdale – Lakes Entrance area, where it is named the Seaspray Sands (Schaeffer, 2008). The M2 Aquifer equivalents also extend offshore. The Childers Formation (M2 equivalent) occurs in the Tarwin Basin (in the southwest). The portions of the MFAS overlying the M2 Aquifer laterally transition into relatively poor aquifers on the east side of the Balook Formation, namely into the Lakes Entrance Limestone, Gippsland Limestone and Wuk Wuk Marl.

Schaeffer (2008) reported a hydraulic conductivity of 22 m/day and a storage coefficient of 1×10^{-3} for the M1B Aquifer, and 57 m/day and 3×10^{-4} for the M2 Aquifer (although these are based upon pumping tests at the Hazelwood Mine, outside the East Gippsland CMA region). Tests conducted at Loy Yang Mine, also in the West Gippsland CMA region, indicate an M2 Aquifer hydraulic conductivity of 2 to 7 m/day, and storage coefficient of 10^{-6} to 10^{-4} (Thatcher, 1976), but Schaeffer (2008) notes that the M2 is less sandy at Loy Yang compared to Hazelwood, and grades back into sands and gravels to the east of Loy Yang.

Groundwater salinity within the MFAS varies from less than 500 mg/L TDS to 1,000 mg/L TDS in the north and west, becoming increasingly saline (up to 3500 mg/L TDS) towards coastal areas in the south and east (DCNR, 1995). The presence of fresher groundwater in the north and west indicates that these are the primary areas of recharge, probably via rainfall infiltration into subcropping MFAS along the northern margins of the basin, and surrounding the Strzelecki Ranges in the west. Some of this recharge is also likely to be derived from infiltration of stream leakage and overland flow from the surrounding hills. There appears to be more recharge along the northern margins of the basin into the MFAS compared to the TFAS, based upon groundwater salinity mapping (DCNR, 1995).

Groundwater flow within the MFAS is in an easterly and south-easterly direction, from the recharge areas of the west and north, towards offshore areas. As for the TFAS, discharge is thought to ultimately occur in offshore areas via the oil and gas production wells, and/or via vertical seepage over large areas, or directly into Bass Canyon, where the Latrobe Group are thought to outcrop (Holdgate and Gallagher, 2003; Nahm, 2002). The MFAS is dewatered in the Latrobe Valley coalmines, and used as a source for cooling water for the power stations, which locally influence flow directions.

2.9.7 Traralgon Formation Aquifer System (TFAS)

Within the Latrobe Valley, the TFAS has been subdivided into two confining beds and two aquifers: the T1 Coal, overlying and confining the T1 Aquifer, and the T2 Coal, which overlies and confines the T2 Aquifer. Equivalents of these units are regionally extensive in the Gippsland Basin, however the T2 Coal is limited in thickness and extent, and the T1 Coal therefore forms the primary confining unit for the TFAS. The TFAS is up to 100 m thick in the Latrobe Valley, and thickens in an offshore direction to more than 2000 m.

Aquifer tests throughout the onshore Gippsland Basin indicate hydraulic conductivity for the TFAS of 7.5 to 88 m/day, and storage coefficients of 2.5×10^{-5} to 4×10^{-4} (Brumley et al, 1981; SKM 1999).

Groundwater salinity within the TFAS varies from less than 500 mg/L TDS to 1000 mg/L TDS, becoming increasingly saline towards the east (DCNR, 1995). The comparatively fresh groundwater quality in the west indicates that recharge to the TFAS primarily occurs in this area, around the base of the Strzelecki Ranges, and along the Baragwanath Anticline, the subsurface continuation of the Strzelecki Range, which extends towards Sale. Evidence for this inference also includes mapped TFAS outcrop (including the Carrajung Volcanics) around the flanks of the Strzelecki Range (Douglas et al., 1971). It is thought that recharge is derived directly from infiltrating rainfall and from leakage from streams crossing the TFAS where it outcrops or subcrops (Brumley et al., 1981; Walker and Mollica, 1990). Greater recharge is made possible to the TFAS over the Baragwanath Anticline compared to areas where the TFAS is more deeply buried within the sedimentary pile because it is brought closer to the land surface by basement topography and subcrops at shallow depth.

Groundwater flow is generally from the recharge areas in the west, offshore to the east and southeast. CSIRO report that while the original offshore discharge was predominantly through vertical leakage and from the continental shelf, since 1995 discharge is predominantly through extraction (Hatton et al, 2004) or directly into Bass Canyon, where the Latrobe Group are thought to outcrop (Holdgate and Gallagher, 2003; Nahm, 2002). Localised flow directions vary, particularly around the Latrobe Valley coalmines where the TFAS is dewatered at Loy Yang. Flow directions are also complicated by features such as the Baragwanath Anticline and Rosedale Monocline/Fault, which direct flow from the west in an easterly direction until the anticline plunges to sufficient depth to allow flow towards offshore areas in the southeast (Schaeffer, 2008). Schaeffer (2008) and Underschultz et al. (2006) state that faults in the Gippsland Basin primarily act as flow barriers rather than conduits.

2.9.8 Bedrock Aquifers

While not transmitting great quantities of water in Gippsland, the Palaeozoic and Strzelecki bedrock geology is known to maintain baseflows in the many rivers and streams in the upland parts of the region. Most of the outcropping bedrock comprises Siluro-Devonian metasediments, Cretaceous sediments, and Devonian granites. Groundwater flow through the bedrock aquifers is typically via fractures rather than pore space, although the distinction between flow media becomes blurred in highly weathered bedrock. Hydraulic conductivities for the bedrock aquifers are typically low ranging from less than 0.0001 to 1 m/day and storage coefficients range from less than 3×10^{-6} to 5×10^{-4} (Batu, 1998; Shugg & Harris, 1975; Szabo, 1979; Leonard, 2006). Bore yields are typically less than 1 L/s but are highly variable over short distances, and there is similarly wide variation in groundwater salinity (Heislers, 1993). Yields are typically lower in granitic bedrock (less than 0.5 L/s) and as such these aquifers are typically only used for stock and domestic supply.

2.10 Current groundwater development

Groundwater resources in the tertiary formations of the Gippsland Basin have been developed since 1970, firstly in the offshore basin with the exploitation of oil and gas resources, and in the Latrobe Valley to allow the extensive coal mining associated with power station operations. This has resulted in extensive regional depressurisation of the MFAS and the TFAS, and the local dewatering of these aquifer systems around the mines.

The system is consequently far from equilibrated and unlikely to establish equilibrium in the foreseeable future. In the shallow system, water levels are relatively stable in the areas east of Sale and the Gippsland Lakes.

2.11 Dominant aquifers

The dominant aquifers in the Gippsland region are summarised below.

Quaternary deposits. The quaternary aquifers primarily consist of coarse sand and gravel along the river valleys and floodplains of the major rivers and dune deposits in coastal areas. They are generally unconfined. Permeability ranges from low to high.

Upper Cenozoic aquifer. This aquifer is primarily comprised of various fluvial deposits (Wurruk Sand) in the Boisdale Formation and some unnamed Tertiary sands. It occurs in many parts of the floodplain in West Gippsland. It is generally greater than 50 m thick with highly variable permeability. It is generally semiconfined or unconfined depending on the permeability of overlying materials.

Upper Mid-Cenozoic aquifer. This aquifer primarily consists of sands and gravel in the Balook Formation, Morwell Formation and Alberton Formation. Relatively permeable members of Hazelwood Formation, Gippsland Limestone and Lakes Entrance Formation also form parts of this aquifer. The aquifer is buried up to 1000 m and is dominantly semiconfined to confined.

Lower Mid-Cenozoic aquifer. Seaspray Sand forms the main part of this aquifer. It mainly occurs around the Morwell area in West Gippsland and is generally confined with moderate permeability.

Lower Cenozoic aquifer. This aquifer primarily consists of the Childers Formation, M2, Traralgon Formation and Burong formations. These formations mainly occur around the Latrobe Valley. The aquifer is mainly semiconfined to confined with moderate permeability.

Tertiary Basalts. They include Thorpdale Volcanics, Carrajung Volcanics and Older Volcanics. They occur around the Warragul, Thorpdale and Leongatha areas. Their permeability ranges from low to moderate depending on the density of fracturing. This aquifer is generally confined with little outcrop.

Palaeozoic metasediments and Strzelecki Group. Fractured rock aquifers in fresh rock with variable permeability depending on the density of fracturing.

Additionally, there are a number of well-defined aquitards in the region, specifically:

Nuntin Clay in the Boisdale Formation. This occurs beneath the Quaternary deposits and covers the majority of the floodplains.

Clay/coal seams. These aquitards occur in various formations (e.g. Yallourn, Yarragon, Morwell, Traralgon and Burong formations) in the northwest of the Gippsland Basin.

Upper Gippsland Limestone. This occurs in the east and centre of the Gippsland Basin.

2.12 Schematic conceptualisation

A schematic conceptual understanding of the water balance and hydrogeology within the Gippsland region is presented in Figure 29. The important water balance features considered within the model include:

- groundwater recharge
- groundwater inflow and outflow
- groundwater abstraction
- groundwater evaporation
- groundwater – surface water interaction.

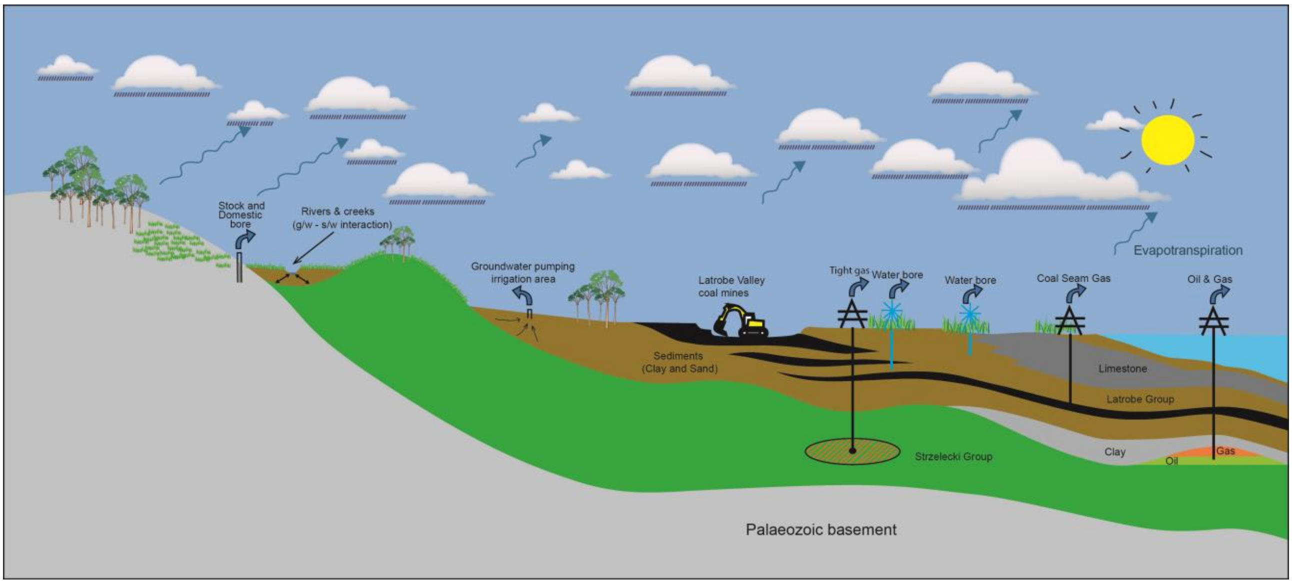

Figure 29: Stylised conceptualisation of the dominant water balance components within the Gippsland region.

The regional groundwater flow conceptualisation considers the Tertiary aquifers in the Gippsland region as behaving as three distinct flow systems underlain by the regional basement aquifer of the Strzelecki Group. The most significant of the Tertiary aquifers are the Moe sub-basin, Latrobe Valley, Seaspray depression (in which the catchments of the Thomson, Latrobe and Mitchell rivers occur) and Southern Terrace (which includes the catchment of the Tarra River).

Flow in the northern terrace and Seaspray depression aquifers is dominantly west to east, with limited lateral interconnectivity due to both faulting and the Baragwanath Anticline (see Figure 30). Flow in the southern terrace is topographically driven off the southern slopes of the Strzelecki ranges.

Hatton et al (2004) noted the widespread declines in aquifer pressures in the Seaspray depression 'are clearly associated to some large but geographically variable degree with offshore oil and gas production'. These declines and the cone of depression associated with the Loy Yang and Hazelwood mine dewatering are distinctly disconnected responses. The other basins are the Tarwin Basin (included in the model domain) which is effectively a disconnected basin flowing south, and the Westernport Basin flowing westerly towards Westernport Bay (and is not included in the model domain).

The conceptual model considers flows in the exposed meta-sediments in the high-relief areas of the Strzelecki and Eastern Highlands are primarily local flow systems discharging to nearby streams with some recharge to the basement rocks. Regional scale flows occur in deeper tertiary units where recharge primarily occurs on the margins of basins where units sub-crop or outcrop, dominated by rainfall (GHD, 2010d).

Coal, silt and clay layers are effective aquitards over the region. However, the complex depositional history results in regional scale connections between aquifers within coal seams. The Balook Formation in particular provides a significant connection between the Morwell and Traralgon formation aquifers and the Boisdale Aquifer.

The aquifers of the Latrobe Formation contain good quality water for many kilometres offshore indicating this groundwater is formation water associated with deposition and a result of long term flow from onshore. However near the seaward margin much higher salinities are encountered which are considered to pre-date the onset of oil and gas production and represent formation water.

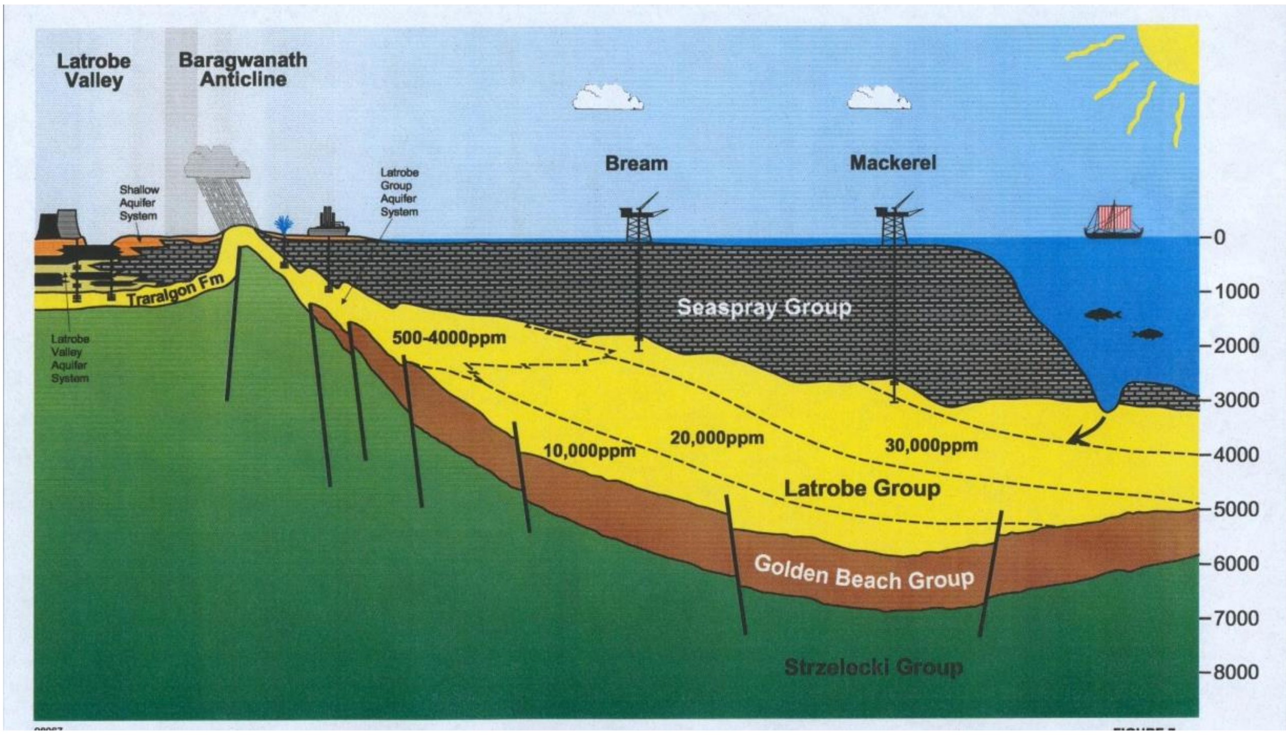

Figure 30: Schematic flow conceptualisation of the Seaspray depression showing the Baragwanath anticline and typical water quality variation offshore (source: DNRE unpublished data).

3 Numerical model design

3.1 Modelling approach

The modelling tasks involved using an unsaturated biophysical catchment model to generate daily evapotranspiration demands and recharge estimates. This data was then used as input into a distributed groundwater model. As such the simulation procedure was uncoupled. This approach was considered to better represent farming systems and farm practices due to the construct of the unsaturated biophysical catchment model, functions of which are not commonly available in commercial groundwater models. Importantly this approach enables (1) finer resolution representation of farm management units to be captured and integrated into coarser resolution groundwater models, and (2) a holistic water balance that describes both soil-water-plant interactions and groundwater dynamics. In addition to the unsaturated and groundwater modelling frameworks, customised software was also developed to assist in the pre- and post-processing of input data and simulation outputs. Each modelling approach is described below.

3.1.1 Unsaturated modelling software

Modelling of the unsaturated zone was undertaken using the Catchment Analysis Tool (CAT) (Beverly et al., 2005, Beverley, 2009). The CAT model utilises a suite of farming system models linked within a catchment framework with allowance for landscape connectivity and connection to a distributed, multi-layered groundwater model. The farm-scale models account for position in the landscape (topography, soil type, aspect and slope), climate, land use and land management and simulates water balance, nutrient transport and production on a daily time step.

3.1.2 Groundwater modelling software

Two groundwater modelling frameworks have been deployed, namely:

- Modflow-2005: A uniform rectilinear grid of the model domain was constructed and incorporated into the Modflow-2005 finite difference modelling software. This model has provided predictions at a scale consistent with previous regional scale assessments.
- Groundwater Vistas: The commercial software version of Modflow-2005 embedded in Groundwater Vistas was used to independently check results derived using the source code version of the Modflow-2005 finite difference modelling software. This was deemed necessary as Groundwater Vistas has implemented modifications to the solver algorithms enabling convergence to be met based on outer iterations only.

Both models were developed using the same spatial and temporal data inputs.

3.1.3 Customised software

Numerous software programs were developed to automate data manipulation, undertake quality assurance, interrogate model input data sets and process simulation outputs.

3.2 Data sources

The model layer structure that define the surfaces that separate overlying hydrogeological units, and the initial attribution of these layers, were based on a combination of (1) stratigraphic mapping and interpretation (see Appendix G), (2) the Victorian Aquifer Framework (VAF) (SKM, 2011b; GHD, 2012a), (3) the DPI Gippsland Basin groundwater model (Beverly et al., 2012), (4) work of Schaeffer (2008), and (5) published maps and cross-sections as reported in previous studies including the ecoMarket model reports and reviews.

Time series calibration information was sourced from on-line databases as summarised in Table 6. An assessment of the confidence of each key data set is also included based on criteria that considered:

- expertise of those groups responsible for data collection and collation
- processes for consistency of field measurement
- processes used to quality assure data
- data management and custodianship
- degree of acceptance of data robustness by other groups and end-users.

Table 6: Sources of calibration data used.

Time-series data	Source	Confidence in data
Groundwater level	Victorian Water Measurement Information System (http://data.water.vic.gov.au/monitoring.htm)	High
Surface water level	Victorian Water Measurement Information System (http://data.water.vic.gov.au/monitoring.htm)	High
Baseflow	SKM reports and derived estimates from Victorian Water Measurement Information System (http://data.water.vic.gov.au/monitoring.htm)	Moderate
Flood mapping	Department of Environmental and Primary Industries	
Groundwater extraction (onshore)	Southern-Rural Water, Water, Department of Environmental and Primary Industries	Moderate to High; some data has been inferred and some actual
Groundwater extraction (offshore)	Volume equivalent groundwater extractions associated with offshore oil and gas operations were sourced from Hatton, et al (2004) and Varma, et al (2012)	Moderate
Mine floor elevations	Department of Environmental and Primary Industries	Moderate
Climatic data	Bureau of Meteorology (http://www.bom.gov.au/climate/)	High

3.3 Groundwater model layer extents

The model consists of 30 layers and includes coal seams similar to those represented in the IRM model in addition to a basement layer that extends to the upland regions of the Gippsland region. Key refinements to the previous DEPI Gippsland Basin groundwater model include (1) new interpreted data layers that extend to the catchment boundaries, (2) finer grid resolution, (3) the incorporation of offshore aquifer stratigraphic information as developed by CSIRO and Geological Survey of Victoria and (4) incorporation of a basement layer representing the upland outcropped regions of the Gippsland region.

All dominant coal seams were specified as individual layers.

Table 7 summarises the grouping of coal and interseams into modelled layers. Model layers 23 to 29 represent the Strzelecki Group. Rather than allocating this as one layer, it was necessary to split this geological unit into six model layers to accommodate the likely scenarios which require depressurisation within parts of the formation.

Table 7: Groundwater model layers.

Model layer	VAF name	Coal name	Comment
1			Marine water thickness
2	101		Quaternary
3	102		Haunted Hill Formation
4	103		Nuntin clay
5	105		Boisdale Formation
6	106		Jemmy's Point Formation and upper Hazelwood Formation
7	106	Yallourn Coal Seam	Y, Y1a, Y1b, Y2, Y1; y_all
8	106	Yallourn Aquifer & interseam	Hazelwood Formation; y_all floor & M1a_all top
9	107	Lower M2 interseam,	Balook Formation Tambo River, Wuk Wuk Marl, Gippsland Limestone
10		M1A coal	Yarragon Formation, M10, M1a, M1b2, ML, M12; M1a_all
11		Morwell 1A interseam/aquifer	M1a_all_floor and M1b_top
12		Morwell 1B coal	M1b, M1b1, M1b2, ML, M12
13		Morwell 1B interseam	Floor M1b_all & M2_all top
14		Morwell 2	M2, M2A, M2B coal; M2_all
15	108		Lakes Entrance Formation
16	109		M2c aquifer/Seaspray Sands
17	112		Thorpdale volcanics
18	111		Upper Latrobe Group
19	111	T1 coal	TP, T1, TRU, TRM, TRL
20	111	T1 interseam	Floor T1_all & Top T2_all
21	111	T2 coal	
22	111	T2 interseam	Lower Latrobe Group; T2_all floor
23			Strzelecki top 500 m
24			Strzelecki 500–1000 m
25			Strzelecki 1–2 km
26			Strzelecki 2–3 km
27			Strzelecki 3–4 km
28			Strzelecki 4–6 km
29			Strzelecki >6 km
30	114		Palaeozoic basement

3.4 Groundwater model layer boundary conditions

Groundwater boundary conditions are features which influence groundwater flow. In a groundwater model context, boundary conditions are constraints imposed onto the model to reflect an area which is influenced by external features (such as wells, rivers, no-flow barriers, etc.). Groundwater flow boundary conditions considered in this study are listed below.

- No flow boundary – represents locations where groundwater does not flow and/or the aquifer is absent; such features include groundwater divides (specified flow boundary type).
- Well boundary – represents locations where fluxes are applied to the model (on a layer-by-layer basis). They are used to represent groundwater extraction from stock, domestic, industrial bores and from groundwater pumping in offshore oil and gas fields.
- River boundary – represents a head dependent boundary condition where groundwater can either recharge or discharge into/from the model based upon a specified head elevation, the model-predicted head in neighbouring cells and a specified boundary conductance term. Rivers in this model have been grouped as either major or minor rivers. Major rivers represent primary tributaries and were assigned a width and depth of 20 metres with a stage of 4 metres from the base. Minor rivers were considered as significant tributaries and assigned a width and depth of 10 metres and a stage of 2 metres from the base. In the absence of river bed elevation data, the base elevation was assumed to be surface elevation less 5 metres for major rivers and surface elevation less 2 metres for minor rivers.
- Drain boundary – represents a head dependent boundary condition where water is removed from the model depending on the specified head elevation, the predicted head in neighbouring cells and the specified boundary conductance term.
- Constant head boundary (time constant specified head) – represents flows into or out of the model domain where groundwater connects or interacts with features (and the ocean) outside the model domain.

Appendix F illustrates the locations of nominated boundary conditions for each modelled layer.

3.5 Groundwater model layer parameter attribution

Parameter ranges presented in Table 8 are sourced from literature and previous numerical modelling and show that there is considerable variability in both the hydraulic conductivity and storage estimates. Initial model parameter attribution is also summarised in Table 8, this attribution is based upon the perceived likely value of the aquifer based upon the pre-existing studies cited. Initial model parameters are based on the average aquifer values, and by definition within the range cited, for the particular hydrogeological unit that the layer represents.

The depositional history of the basin is dominated by fluvial, deltaic, marginal marine and open marine environments (Schaeffer, 2008, after others). Typically vertical hydraulic conductivity is approximated as an order of magnitude less than lateral conductivity, and as an initial calibration value, Kz values were set to 0.1 of the Kxy value, and the final, calibrated, value of this ratio is provided in Table 17.

Table 8: Values of specific yield (Sy), specific storage (Ss) and lateral hydraulic conductivity (Kxy) assigned to each modelled layer in the Gippsland model.

Model layer	VAF no.	Coal name	Comment	VAF HGU	Layers (Schaeffer 2008)	Aquifer type[1]	Ss (m^{-1}) [2,3]	Sy[2,3]	Kxy (m/d) [2,3]	Reference
1			Marine water thickness	N/A	N/A	N/A	(1.0×10^{-5})	(1.0)	(100)	Initial values in this study
2	101		Quaternary	Various Aeolian deposits, various fluvial, lacustrine, alluvial and colluvial sediments	1	UC	2.5×10^{-5}	0.15	0.01 to 10.26	Schaeffer (2008)
							0.02 to 0.05	0.04 to 0.08	0.1 to 1	GHD (2008a, 2008b)
							1.0×10^{-5} to 1.0×10^{-4}	0.04 to 0.25	2 to 50	GHD (2010a, 2010b)
							N/A	0.001 to 0.05	1.0×10^{-6} to 100	Dahlhaus et al. (2004)
							2.4×10^{-6}	N/A	59	Mollica (1991)
							(1.0×10^{-5})	(0.07)	(2.0)	Initial values in this study
3	102		Haunted Hill Formation	Haunted Hill Formation, Eagle Point Sand	1	UC	1.0×10^{-5}	0.1 to 0.15	0.01 to 10.26	Schaeffer (2008)
							0.02 to 0.05	0.04 to 0.08	1 to 10	GHD (2008a, 2008b)
							0.01	0.1	2 to2.01	GHD (2010a; 2010b)
							N/A	0.001 to 0.05	1.0×10^{-6} to 100	Dahlhaus et al. (2004)
							(1.0×10^{-5})	(0.1)	(2.01)	Initial values in this study
4	103		Nuntin clay	Boisdale Fm (Nuntin Clay), Jemmys Point Fm Sale Grp	1	C/UC	1.0×10^{-6} to 1.0×10^{-5}	0.005 to 0.1	0 to 0.5	Schaeffer (2008)
							0.001	0.02	0.2 to 0.5	GHD (2008a, 2008b)
							0.01	0.1	0.1 to 0.23	GHD (2010a, 2010b)
							(1.0×10^{-6})	(0.04)	(0.23)	Initial values in this study

5	105		Boisdale Formation	Boisdale Fm (Wurruk Sand), Jemmys Point Fm, Unnamed Tertiary Sands, Gravels and Clays	1	C/UC	1.0×10^{-5} to 1.0×10^{-3}	0.1 to 0.2	1 to 30	Schaeffer (2008)
							N/A	N/A	5.31	Nahm (1977)
							N/A	N/A	6.5	Nahm & Reid (1979a)
							N/A	0.1	0.1 to 1	SKM (1999)
							1.0×10^{-4}	N/A	5 to 24	Walker and Mollica (1990)
							0.001	0.02	15 to 25	GHD (2008a, 2008b)
							0.01	0.1	2 to 12.38	GHD (2010a, 2010b)
							1.0×10^{-4} to 5.0×10^{-4}	N/A	4.7 to 13	SKM (2006)
							(1.0×10^{-4})	(0.1)	(12.38)	Initial values in this study
6	106		Jemmy's Point Formation and upper Hazelwood Formation	Jemmy's Point Formation and upper Hazelwood Formation	1	C/UC	1.0×10^{-5} to 5.0×10^{-4}	0.1 to 0.2	0.2 to 13	Schaeffer (2008)
							0.001	0.02	0.2 to 0.5	GHD (2008a, 2008b)
							1.0×10^{-6} to 1.0×10^{-5}	0.1	2 to 10	GHD (2010a; 2010b)
							(2.0×10^{-5})	(0.1)	(0.23)	Initial values in this study
7	106	Yallourn Coal Seam	Y, Y1a, Y1b, Y2, Y1; y_all	Yallourn Formation	2	C/UC (Aquitard)	2.5×10^{-5} to 2.1×10^{-4}	0.001 to 0.05	2.0×10^{-6} to 0.1	Schaeffer (2008)
							N/A	N/A	0.005	Brumley et al. (1981)
							0.0001	0.005	0.04	Aquaterra (2008)
							N/A	N/A	0.015 to 0.1	PDA (2006)
							N/A	N/A	6×10^{-5} to 1.8×10^{-1}	Harlow & LeCain (1993)
							3.0×10^{-6} to 5.0×10^{-4}	N/A	0.0005 to 1.36	USQ (2011)

							(2.0×10^{-5})	(0.02)	(0.0002)	Initial values in this study
8	106	Yallourn Aquifer & interseam	Hazelwood Formation; all floor & M1a_all top	Hazelwood Formation, Yallourn Formation	3	C/UC	1.0×10^{-6} to 2.5×10^{-5}	0.05 to 0.1	0.2 to 8	Schaeffer (2008)
							0.001	0.02	0.2 to 0.5	GHD (2008a, 2008b)
							0.01	0.1	2 to 2.44	GHD (2010a, 2010b)
							1.0×10^{-4}	0.1	0.2 to 0.5	SKM (1999)
							6.8×10^{-5}	N/A	8	Blake (1972)
							(1.0×10^{-5})	(0.1)	(2.44)	Initial values in this study
9	107, 108	Lower M2 interseam	Balook Formation Tambo River, Wuk Wuk Marl, Gippsland Limestone,	Balook Fm, LVG: Yarragon Fm, Alberton Fm, Tambo River Fm, Gippsland Limestone, Middle Lakes Entrance Fm	5, 9	C/UC	1.0×10^{-6} to 1.0×10^{-4}	0.04-0.06	2 to 57	Schaeffer (2008)
							0.0008	0.05	1.5 to 2	GHD (2008a, 2008b)
							0.01	0.1	1 to 7.5	GHD (2010a, 2010b)
							N/A	N/A	10 to 58	Reid (1985)
							1.0×10^{-5}	0.06	1	Golder Associates (1990)
							1.0×10^{-4}	0.1	0.5 to 8	SKM (1999)
							N/A	N/A	2 to 7	Brumley et al. (1981)
							1×10^{-5} to 09.0×10^{-4}	N/A	2 to 30	Walker & Mollica (1990)
							(5.0 X 10-6)	(0.05)	(3.53)	Initial values in this study
10		M1A coal	Yarragon Formation, M10, M1a, M1b2, ML, M12;	Yarragon Formation, Upper Gippsland Limestone	4	C/UC (Aquitard)	1.0×10^{-5} to 1.0 X 10-4	0.001 to 0.05	2.0×10^{-6} to 0.1	Schaeffer (2008)
							N/A	N/A	0.015 to 0.1	PDA (2006)
							0.0001	0.005	0.04	Aquaterra (2008)

			M1a_all				N/A	N/A	6 X 10^{-5} to 1.8 X 10^{-1}	Harlow & LeCain (1993)
							3.0 X 10^{-6} to 5.0 X 10^{-4}	N/A	0.0005 to 1.36	USQ (2011)
							(1.0 X 10^{-5})	(0.02)	(0.0005)	Initial values in this study
11		Morwell 1A interseam/aquifer	M1a_all_floor & M1b_top	Morwell Formation, Middle Gippsland Limestone	5	C/UC	1.0 X 10^{-6} to 1.0 X 10^{-4}	0.05 to 0.1	7.7 X 10^{-5} to 8	Schaeffer (2008)
							0.0002	0.02	0.04 to 0.05	GHD (2008a, 2008b)
							0.01	0.1	2 to 2.44	GHD (2010a; 2010b)
							1.0 X 10^{-4}	0.1	0.28 to 0.5	SKM (1999)
							1.2 X 10^{-5}	N/A	0.27	Nahm (1972)
							(5.0 X 10^{-6})	(0.1)	(2.44)	Initial values in this study
12		Morwell 1B coal	M1b, M1b1, M1b2, ML, M12	Morwell Formation / Morwell seams, Lower Gippsland Limestone	6	C/UC (Aquitard)	1.0 X 10^{-6} to 5.0 X 10^{-4}	0.001-0.05	2.0 X 10^{-6} to 0.1	Schaeffer (2008)
							0.0002	0.02	0.04-0.05	GHD (2008a, 2008b)
							N/A	N/A	0.0001	Brumley et al. (1981)
							N/A	N/A	0.015 to 0.1	PDA (2006)
							0.0001	0.005	0.04	Aquaterra (2008)
							N/A	N/A	6 X 10^{-5} to 1.8 X 10^{-1}	Harlow & LeCain (1993)
							3.0 X 10^{-6} to 5.0 X 10^{-4}	N/A	0.0005 to 1.36	USQ (2011)
							(5.0 X 10-6)	(0.05)	(0.0015)	Initial values in this study
13		Morwell 1B interseam	Floor M1b_all & M2_all top	Morwell Formation / Morwell seams, Upper	7	C/UC	9.35 X 10^{-9} to 1 X 10^{-4}	0.06-0.1	2.3 X 10^{-4} to 40.39	Schaeffer (2008)
							0.0002	0.02	0.04-0.05	GHD (2008a, 2008b)

				Lakes Entrance Formation			0.01	0.1	0.97-1	GHD (2010a, 2010b)
							1.0 X 10^{-6} to 9.4 X 10^{-9}	N/A	0.08 to 4.07	Nahm (1977)
							0.003	N/A	2.5	Brumley et al. (1981)
							0.001	N/A	10.83	Fraser (1980)
							N/A	N/A	4.48 to 47.68	Barton (1971)
							1.0 X 10^{-6} to 1.0 X 10^{-4}	N/A	2 to 7	Thatcher (1976)
							2.5 X 10^{-5}	0.06	0.2 to 5	Golder Associates (1990)
							1.0 X 10^{-4}	0.1	0.5 to 8	SKM (1999)
							N/A	N/A	6.91	Golder Brawner (unpubl. data)
							(4.0 X 10^{-6})	(0.1)	(0.97)	Initial values in this study
14		Morwell 2	M2, M2A, M2B coal; M2_all	Morwell Formation / Morwell seams / Middle Lakes Entrance Formation	8, 10	C/UC (Aquitard)	8.8 X 10^{-7} to 9.2 X 10^{-4}	0.001 to 0.05	1.0 X 10^{-5} to 0.1	Schaeffer (2008)
							0.0002	0.02	0.04 to 0.05	GHD (2008a, 2008b)
							0.01	0.1	0.1 to 0.42	GHD (2010a, 2010b)
							N/A	N/A	0.015 to 0.1	PDA (2006)
							0.0001	0.005	0.04	Aquaterra (2008)
							N/A	N/A	6 X 10^{-5} to 1.8 X 10^{-1}	Harlow and LeCain (1993)
							3.0 X 10^{-6} to 5.0 X 10^{-4}	N/A	0.0005 to 1.36	USQ (2011)
							(1.0 X 10^{-5})	(0.02)	(0.42)	Initial values in this study

15	108		Lakes Entrance Formation	Lakes Entrance Fm /Morwell Formation	8, 10, 12	C/UC (Aquitard)	3.4×10^{-7} to 1.0×10^{-4}	0.001 to 0.05	1.0×10^{-5} to 0.1	Schaeffer (2008)
							0.0002	0.02	0.04 to 0.05	GHD (2008a, 2008b)
							0.01	0.1	0.1 to 0.42	GHD (2010a; 2010b)
							N/A	N/A	0.03	Thatcher (1976)
							(1.0×10^{-5})	(0.02)	(0.05)	Initial values in this study
16	109		M2c aquifer/ Seaspray Sands	LVG: M2C aquifer, Seaspray Sand, Lower Lakes Entrance Fm, Seaspray Sands	11, 13	C/UC	1×10^{-6} to 4.7×10^{-4}	0.03 to 0.1	6.4×10^{-4} to 76.06	Schaeffer (2008);
							0.0008	0.05	1.5 to 2	GHD (2008a, 2008b)
							0.01	0.1	0.1 to 1.91	GHD (2010a, 2010b)
							6.3×10^{-6} to 2.2×10^{-5}	N/A	2 to 48	Nahm (1973a, 1973b, 1977)
							4.0×10^{-4}	N/A	5.7 to 32.35	Brumley et al. (1981)
							5.0×10^{-5} to 2.5×10^{-4}	N/A	0.1 to 1.11	Thatcher (1976)
							N/A	N/A	0.22 to 19.38	Geo-Eng (1993, 1996a, 2001)
							N/A	N/A	7.49	Reid (1985)
							N/A	N/A	23.23	Barton (1971)
							1.0×10^{-5} to 1.0×10^{-3}	0.015 to 0.06	0.2 to 8	Golder Associates (1990)
							1.0×10^{-4}	0.1	0.5 to 8	SKM (1999)
							3.0×10^{-4}	N/A	13.6	Fraser (1980)
							(3.0×10^{-5})	(0.1)	(1.63)	Initial values in this study

17	112		Thorpdale volcanics	Thorpdale Volcanics	7, 9, 11	C/UC	$1.0 X 10^{-6}$ to $4.7 X 10^{-4}$	0.015 to 0.1	0.03 to 6.4	Schaeffer (2008)
							0.04	0.05	0.2 to 1	GHD (2008a, 2008b)
							0.01	0.1	0.51 to 2	GHD (2010a, 2010b)
							$5.0 X 10^{-5}$ to $2.5 X 10^{-4}$	N/A	0.1 to 1.11	Thatcher (1976)
							$1.7 X 10^{-7}$ to $3.5 X 10^{-5}$	N/A	7.49 to 23.6	Reid (1985a; 1985b)
							$1.0 X 10^{-5}$ to $1.0 X 10^{-3}$	0.015 to 0.06	0.2 to 8	Golder Associates (1990)
							$1.0 X 10^{-4}$	0.1	8	SKM (1999)
							$6.3 X 10^{-6}$ to $2.2 X 10^{-5}$	N/A	2 to 48	Nahm & Reid (1979a, 1979b)
							N/A	<0.05	0.001 to 100	Dahlhaus et al. (2004)
							$5.0 X 10^{-5}$	N/A	6 to 35.6	Pratt (1985)
							($1.0 X 10^{-5}$)	(0.1)	(0.51)	Initial values in this study
18	111		Upper Latrobe Group	Childers Fm, M2 / M2C aquifer (when basal aquifer)	13	C/UC	$1.0 X 10^{-5}$ to $5.6 X 10^{-2}$	0.03 to 0.1	$1.6 X 10^{-3}$ to 32.35	Schaeffer (2008)
							0.04	0.05	0.2 to 1	GHD (2008a, 2008b)
							0.01	0.1	0.76	GHD (2010a, 2010b)
							$1.5 X 10^{-6}$ to $4.0 X 10^{-5}$	N/A	1 to 13.84	Brumley et al. (1981)
							$1.0 X 10^{-5}$ to $1.1 X 10^{-4}$	N/A	0.25 to 7.3	Thatcher (1976)
							N/A	N/A	2.34 to 76.06	Geo-Eng (1993, 1996b, 2001)
							$1.7 X 10^{-7}$ to $3.5 X 10^{-5}$	N/A	7.49 to 23.6	Reid (1985a, 1985b)

							1.0×10^{-4} to 1.0×10^{-3}	0.015 to 0.06	0.8 to 8	Golder Associates (1990)
							1.0×10^{-4}	0.1	8	SKM (1999)
							3.0×10^{-4}	N/A	13.6	Fraser (1980)
							N/A	N/A	2.0	Nahm (1974)
							6.3×10^{-6} to 2.2×10^{-5}	N/A	2 to 48	Nahm & Reid (1979a, 1979b)
							5.0×10^{-5}	N/A	6 to 35.6	Pratt (1985)
							(1.0 X 10-4)	(0.1)	(1.63)	Initial values in this study
19	111	T1 coal	TP, T1, TRU, TRM, TRL	Traralgon Fm/ Burong Fm, Carrajung Volcanics	14	C/UC (Aquitard)	2.9×10^{-7} to 6.9×10^{-5}	0.001 to 0.05	1×10^{-6} to 5.0×10^{-3}	Schaeffer (2008)
							N/A	N/A	0.015 to 0.1	PDA (2006)
							3.0×10^{-6} to 5.0×10^{-4}	N/A	0.0005 to 1.36	USQ (2011)
							0.0001	0.005	0.04	Aquaterra (2008)
							N/A	N/A	6×10^{-5} to 1.8×10^{-1}	Harlow & LeCain (1993)
							(1.0×10^{-5})	(0.02)	(0.0025)	Initial values in this study
20	111	T1 interseam	Floor T1_all & Top T2_all	Traralgon Fm/ Burong Fm	15	C/UC	2.5×10^{-6} to 9.8×10^{-4}	0.015 to 0.1	1.6×10^{-3} to 48.26	Schaeffer (2008)
							0.04	0.05	1.1 to 2	GHD (2008a, 2008b)
							0.01	0.1	1 to 2.02	GHD (2010a, 2010b)
							1.0×10^{-6}	N/A	4.07	Nahm (1977)
							1.0×10^{-6} to 7.5×10^{-6}	N/A	1.1 to 6.83	Nahm & Reid (1979b, 1979c, 1979d, 1979e)
							2.5×10^{-5} to 4.0×10^{-4}	N/A	2 to 88	Brumley et al. (1981)

							N/A	N/A	6.33 to 48.26	Geo-Eng (1993, 2001)
							1.0×10^{-4} to 5.0×10^{-4}	0.015 to 0.06	3 to 10	Golder Associates (1990)
							1.0×10^{-4}	0.1	8	SKM (1999)
							(1.0×10^{-4})	(0.1)	(2.02)	Initial values in this study
21	111	T2 coal		Traralgon Fm/ Burong Fm	16	C/UC (Aquitard)	1.7×10^{-7} to 2.4×10^{-5}	0.001 to 0.05	1×10^{-6} to 5×10^{-3}	Schaeffer (2008)
							8.30×10^{-7} to 5×10^{-6}	N/A	1.1×10^{-6} to 3.56×10^{-6}	SKM (2001)
							N/A	N/A	0.015 to 0.1	PDA (2006)
							3.0×10^{-6} to 5.0×10^{-4}	N/A	0.0005 to 1.36	USQ (2011)
							0.0001	0.005	0.04	Aquaterra (2008)
							N/A	N/A	6×10^{-5} to 1.8×10^{-1}	Harlow & LeCain (1993)
							(1.0 X 10-5)	(0.02)	(0.0025)	Initial values in this study
22	111	T2 interseam	Lower Latrobe Group; T2_all floor	Lower Latrobe Group; T2_all floor & Traralgon Fm/Burong Fm, Honeysuckle Gravels, Yarram Fm	17	C/UC	1.1×10^{-7} to 4.9×10^{-5}	0.015 to 0.1	1.6×10^{-7} to 24.65	Schaeffer (2008)
							0.04	0.05	1.1 to 2	GHD (2008a, 2008b)
							0.01	0.1	1 to 2.02	GHD (2010a, 2010b)
							1.0×10^{-5} to 4.0×10^{-4}	N/A	4.27 to 88	Brumley et al. (1981)
							1.0×10^{-6}	N/A	4.02	Thompson (1968)
							1.0×10^{-4}	0.1	8	SKM (1999)
							(7.0×10^{-6})	(0.1)	(2.02)	Initial values in this study

23	114		Strzelecki 500 m; >0–500 m		18	C/UC	4.5×10^{-6} to 1.0×10^{-5}	N/A	1×10^{-10} to 1.0×10^{-5}	Schaeffer (2008)
							<3 $\times 10^{-6}$ to 5×10^{-3}	0.03 to 0.1	2.6×10^{-9} to 2.6	Domenico & Schwartz (1990); Batu (1998); Todd (1980)
							N/A	N/A	0.001 to 0.3	Leonard (2006)
							0.00004-0.005	0.005-0.02	0.001 to 0.008	GHD (2008a, 2008b)
							0.01	0.02	0.0001 to 0.008	GHD (2010a; 2010b)
							N/A	0.02 to 0.1	1.0×10^{-4} to 1	Dahlhaus et al. (2004)
							2.2×10^{-5}	N/A	0.02 to 1	Shugg & Harris (1975)
							3.6×10^{-5}	N/A	0.3	Szabo (1979)
							(1.0×10^{-6})	(0.02)	(0.002)	Initial values in this study
24	114		Strzelecki 500 m; 500–1000 m		18	C/UC	4.5×10^{-6} to 1×10^{-5}	N/A	1×10^{-10} to 1×10^{-5}	Schaeffer (2008)
							<3 $\times 10^{-6}$ to 5×10^{-3}	0.03 to 0.1	2.6×10^{-9} to 2.6	Domenico & Schwartz (1990); Batu (1998); Todd (1980)
							N/A	N/A	0.001 to 0.3	Leonard (2006)
							0.00004-0.005	0.005 to 0.02	0.001 to 0.008	GHD (2008a, 2008b)
							0.01	0.02	0.0001 to 0.008	GHD (2010a; 2010b)
							(1.0×10^{-6})	(0.02)	(0.002)	Initial values in this study
25	114		Strzelecki 1 km; 1000–2000 m		18	C/UC	4.5×10^{-6} to 1×10^{-5}	N/A	1×10^{-10} to 1×10^{-5}	Schaeffer (2008)
							<3 $\times 10^{-6}$ to 5×10^{-3}	0.03 to 0.1	2.6×10^{-9} to 2.6	Domenico & Schwartz (1990); Batu (1998); Todd (1980)
							N/A	N/A	0.001 to 0.3	Leonard (2006)

							0.00004 to 0.005	0.005 to 0.02	0.001 to 0.008	GHD (2008a, 2008b)
							0.01	0.02	0.0001 to 0.008	GHD (2010a, 2010b)
							(1 X 10^{-6})	(0.02)	(0.0004)	Initial values in this study
26	114		Strzelecki 1 km; 2000–3000 m		18	C/UC	4.5 X 10^{-6} to 1.0 X 10^{-5}	N/A	1 X 10^{-10} to 1 X 10^{-5}	Schaeffer (2008)
							<3 X 10^{-6} to 5 X 10^{-3}	0.03 to 0.1	2.6 X 10^{-9} to 2.6	Domenico & Schwartz (1990); Batu (1998); Todd (1980)
							N/A	N/A	0.001 to 0.3	Leonard (2006)
							0.00004 to 0.005	0.005 to 0.02	0.001 to 0.008	GHD (2008a, 2008b)
							0.01	0.02	0.0001 to 0.008	GHD (2010a, 2010b)
							(1.0 X 10^{-6})	(0.02)	(0.0004)	Initial values in this study
27	114		Strzelecki 1km; 3000-4000m		18	C/UC	4.5 X 10^{-6} to 1 X 10^{-5}	N/A	1 X 10^{-10} to 1 X 10^{-5}	Schaeffer (2008)
							<3.0 X 10^{-6} to 5.0 X 10^{-3}	0.03 to 0.1	2.6 X 10^{-9} to 2.6	Domenico & Schwartz (1990); Batu (1998); Todd (1980)
							N/A	N/A	0.001 to 0.3	Leonard (2006)
							0.00004 to 0.005	0.005 to 0.02	0.001 to 0.008	GHD (2008a, 2008b)
							0.01	0.02	0.0001 to 0.008	GHD (2010a, 2010b)
							(1.0 X 10^{-6})	(0.02)	(0.0004)	Initial values in this study
28	114		Strzelecki 1km; 4000-6000m		18	C/UC	4.5 X 10^{-6} to 1.0 X 10^{-5}	N/A	1 X 10^{-10} to 1 X 10^{-5}	Schaeffer (2008)
							<3 X 10^{-6} to 5 X 10^{-3}	0.03 to 0.1	2.6 X 10^{-9} to 2.6	Domenico & Schwartz (1990); Batu (1998); Todd (1980)
							N/A	N/A	0.001 to 0.3	Leonard (2006)

							0.00004 to 0.005	0.005 to 0.02	0.001 to 0.008	GHD (2008a, 2008b)
							0.01	0.02	0.0001 to 0.008	GHD (2010a, 2010b)
							(1.0×10^{-6})	(0.01)	(0.0004)	Initial values in this study
29			Strzelecki 4km; >6000m		18	C/UC	4.5×10^{-6} to 1.0×10^{-5}	N/A	1×10^{-10} to 1×10^{-5}	Schaeffer (2008)
							<3×10^{-6} to 5×10^{-3}	0.03 to 0.1	2.6×10^{-9} to 2.6	Domenico & Schwartz (1990); Batu (1998); Todd (1980)
							N/A	N/A	0.001 to 0.3	Leonard (2006)
							0.00004 to 0.005	0.005 to 0.02	0.001 to 0.008	GHD (2008a, 2008b)
							0.01	0.02	0.0001 to 0.008	GHD (2010a, 2010b)
							(1×10^{-6})	(0.01)	(0.0004)	Initial values in this study
30			Palaeozoic basement 200m thick		18		4.5×10^{-6} to 1×10^{-5}	N/A	1×10^{-10} to 1×10^{-5}	Schaeffer (2008)
							<3×10^{-6} to 5×10^{-3}	0.03 to 0.1	2.6×10^{-9} to 2.6	Domenico & Schwartz (1990); Batu (1998); Todd (1980)
							N/A	N/A	0.001 to 0.3	Leonard (2006)
							0.00004 to 0.005	0.005 to 0.02	0.001 to 0.008	GHD (2008a, 2008b)
							0.01	0.02	0.0001 to 0.008	GHD (2010a; 2010b)
							(1×10^{-6})	(0.02)	(0.0004)	Initial values in this study

1. UC = unconfined, C/UC = confined/unconfined.
2. The ranges of aquifer parameter values were obtained from the publications listed in the table.
3. The aquifer parameter values in bracket are the initial values for the groundwater model in the study. They are primarily sourced from the previously calibrated groundwater models.
4. A Kx to Kz ratio of 10:1 was assumed prior to calibration.

The model has been developed by adopting a regular gridding of 400 metres, totalling 740,768 solution points comprised of 633 rows and 905 columns in 30 layers. In total the model contains 8,290,157 active cells.

In recognition that most pseudo-three dimensional groundwater models assume connection between adjacent modelled aquifers, a layered approach was applied for the assignment and attribution where the model layers, which must extend over the full model area, are assigned to an aquifer that may be absent in some areas.

The approach sets a minimum thickness of 2 metres for all layers. In locations where a cell is assigned to a model layer for an aquifer which is not present, the model cell is set to a minimum thickness of 2 metres and the aquifer attributes are the same as the next underlying active layer. The underlying aquifer thickness is reduced by the 2m thickness. If several sequential layers are absent, this process is applied to all “missing” aquifers. The application of this approach results in the artificially infilled spatial data sets presented in *Figure 31* to 59 inclusive; the resultant thickness of each modelled layer is presented in Appendix D.

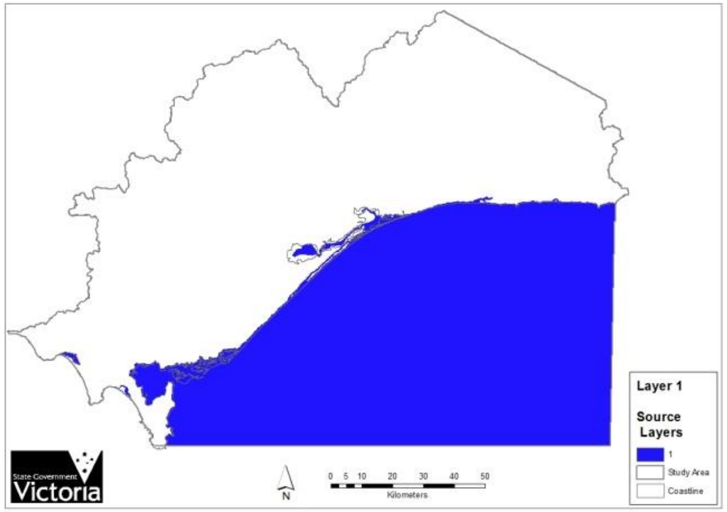

Figure 31: Modelled layer 1 attribution source layer.

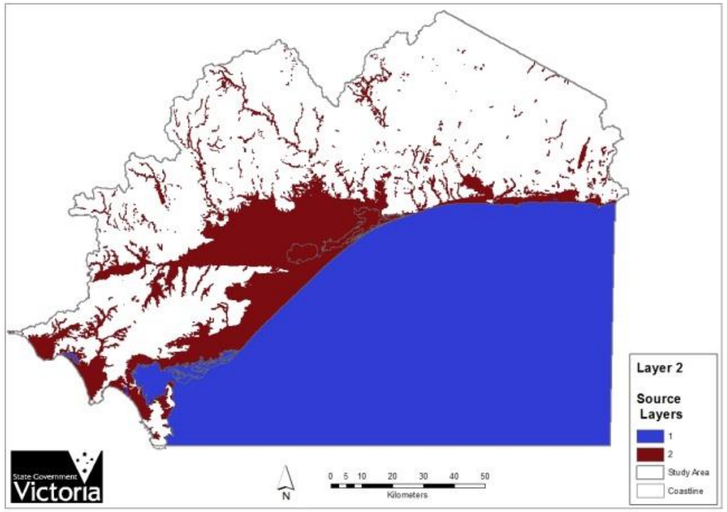

Figure 32: Modelled layer 2 attribution source layer.

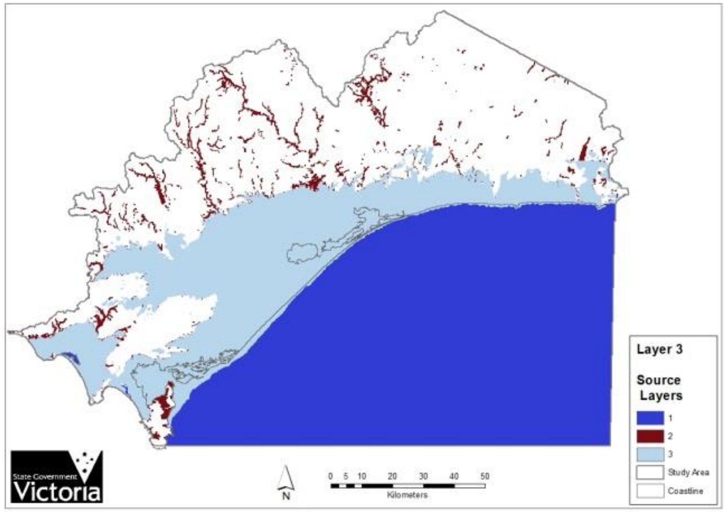

Figure 33: Modelled layer 3 attribution source layer.

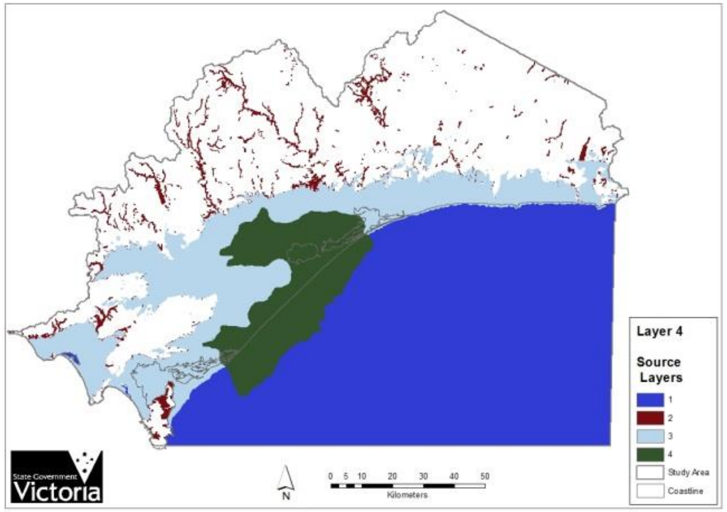

Figure 34: Modelled layer 4 attribution source layer.

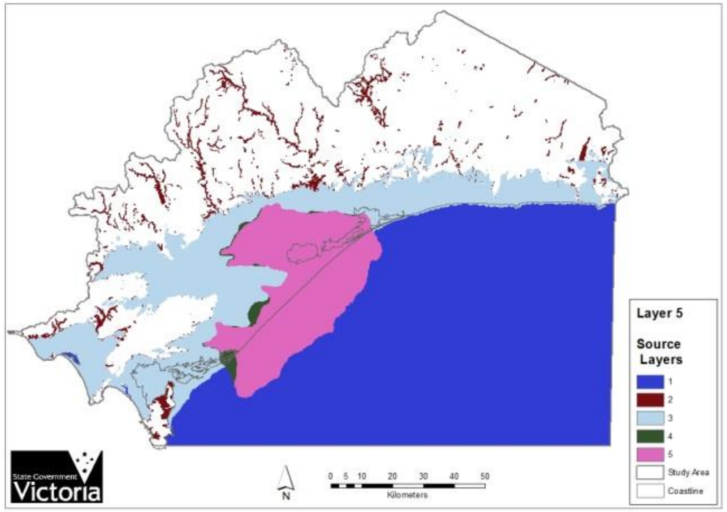

Figure 35: Modelled layer 5 attribution source layer.

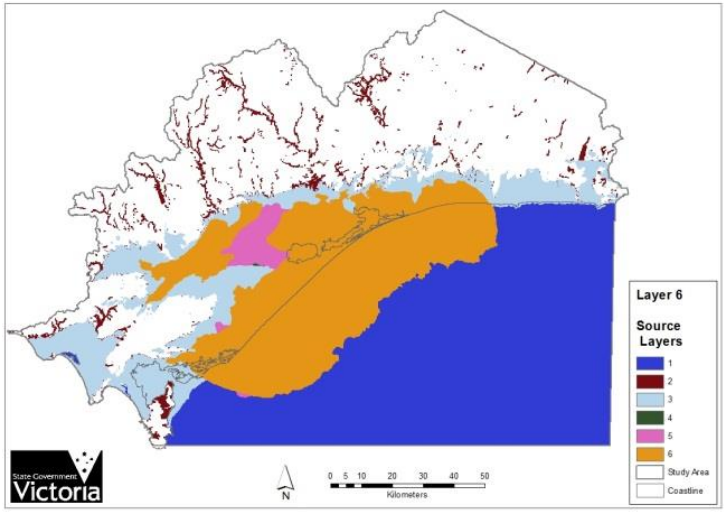

Figure 36: Modelled layer 6 attribution source layer.

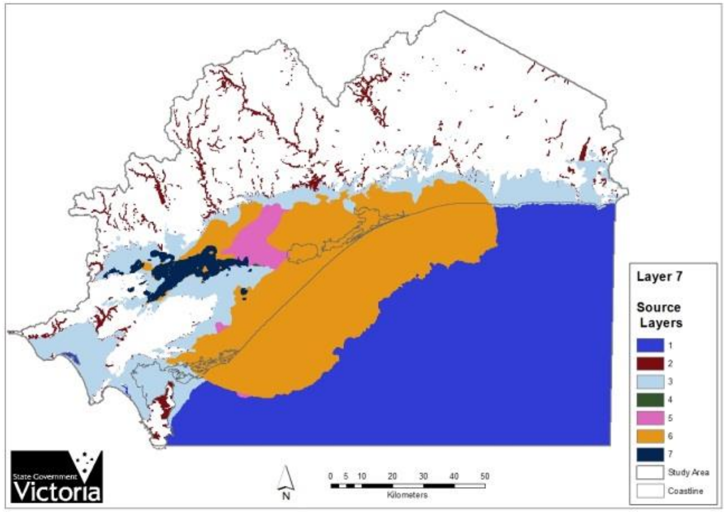

Figure 37: Modelled layer 7 attribution source layer.

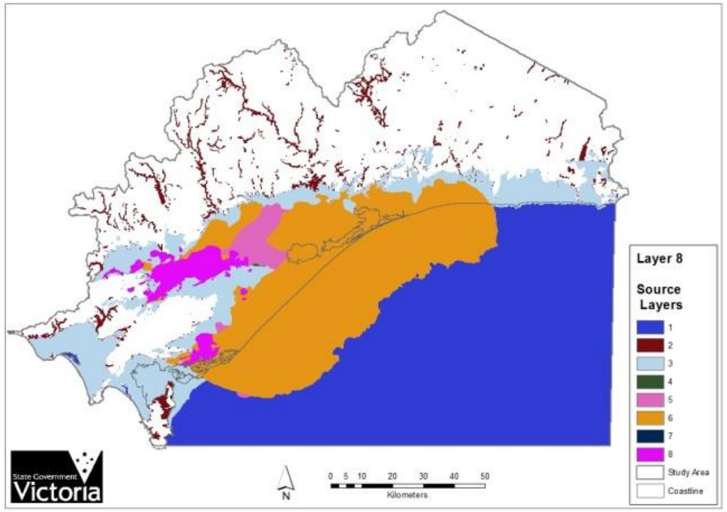

Figure 38: Modelled layer 8 attribution source layer.

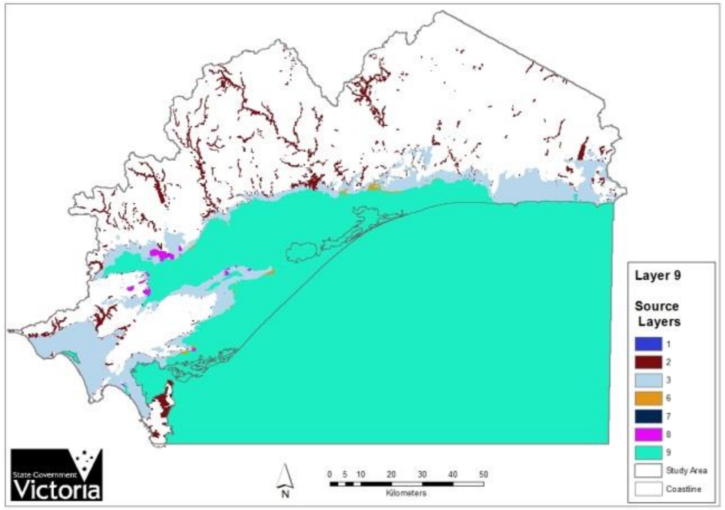

Figure 39: Modelled layer 9 attribution source layer.

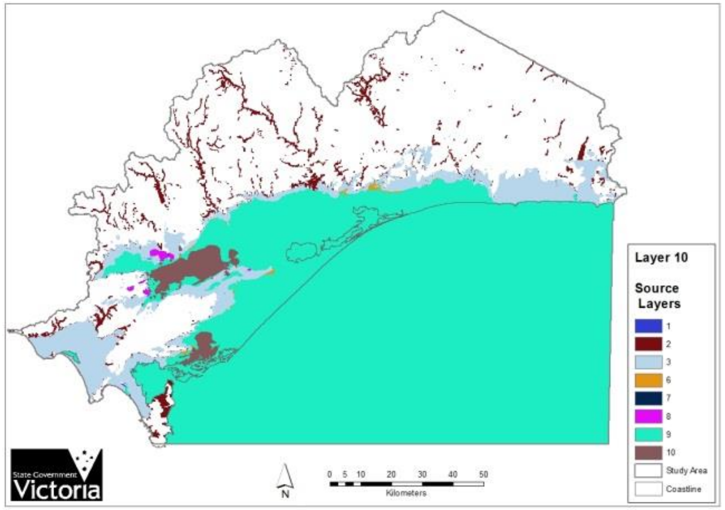

Figure 40: Modelled layer 10 attribution source layer.

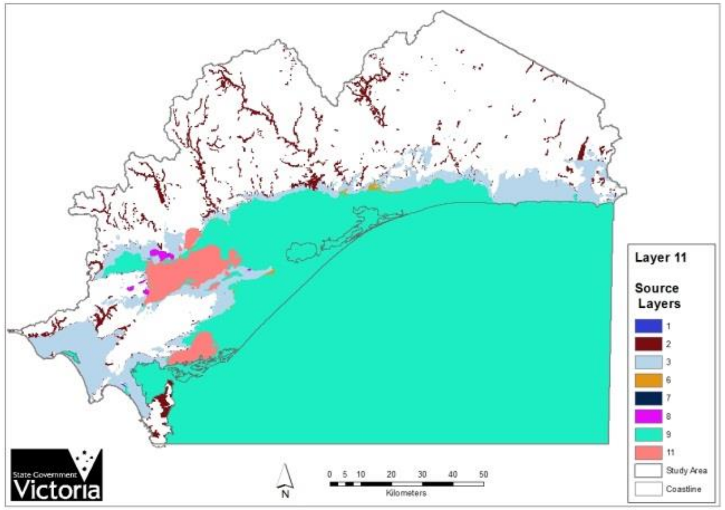

Figure 41: Modelled layer 11 attribution source layer.

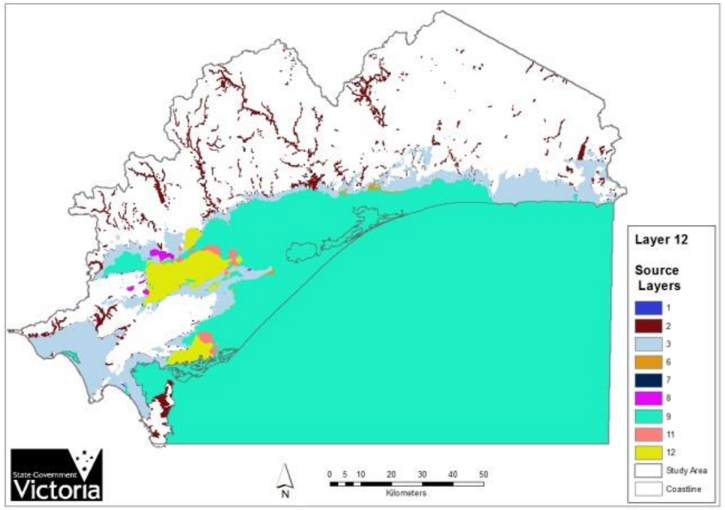

Figure 42: Modelled layer 12 attribution source layer.

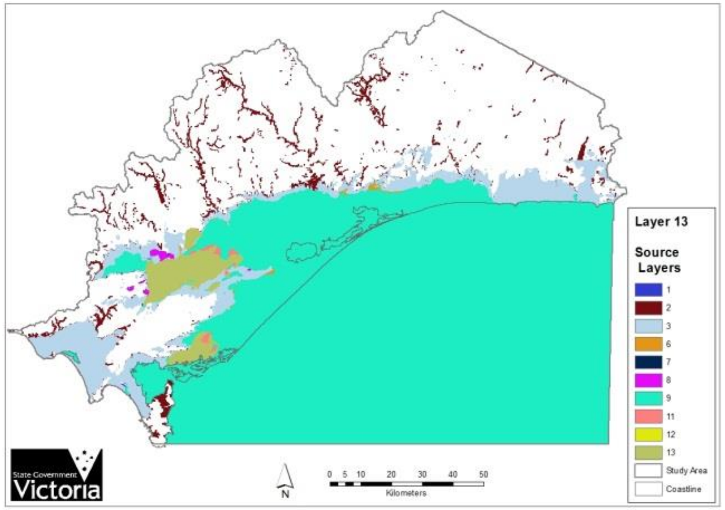

Figure 43: Modelled layer 13 attribution source layer.

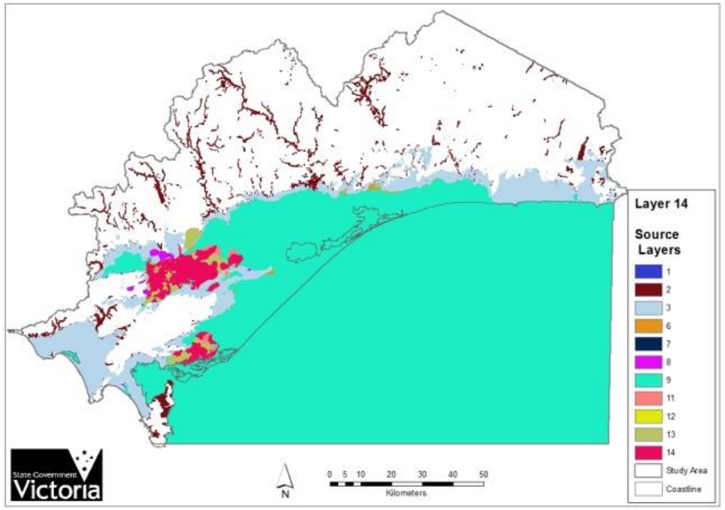

Figure 44: Modelled layer 14 attribution source layer.

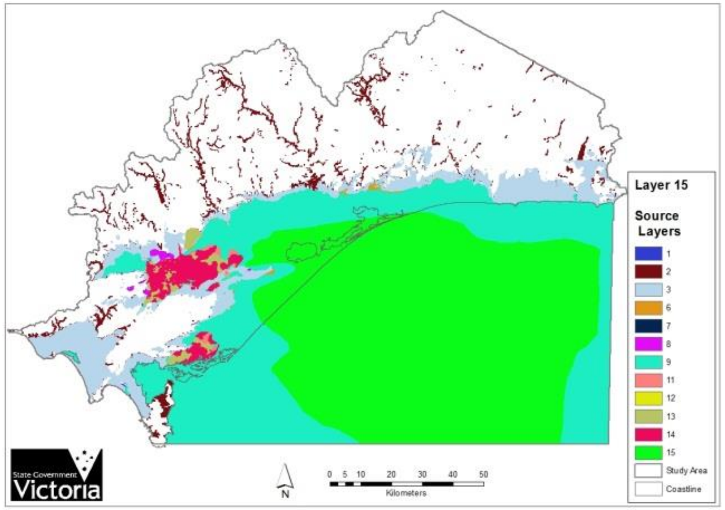

Figure 45: Modelled layer 15 attribution source layer.

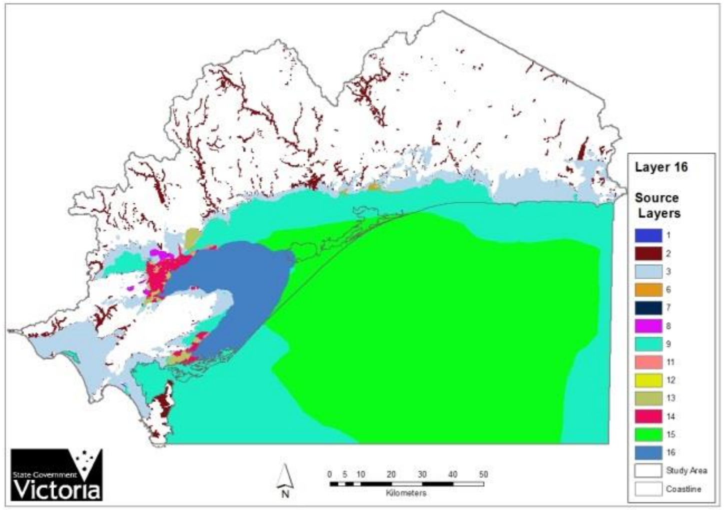

Figure 46: Modelled layer 16 attribution source layer.

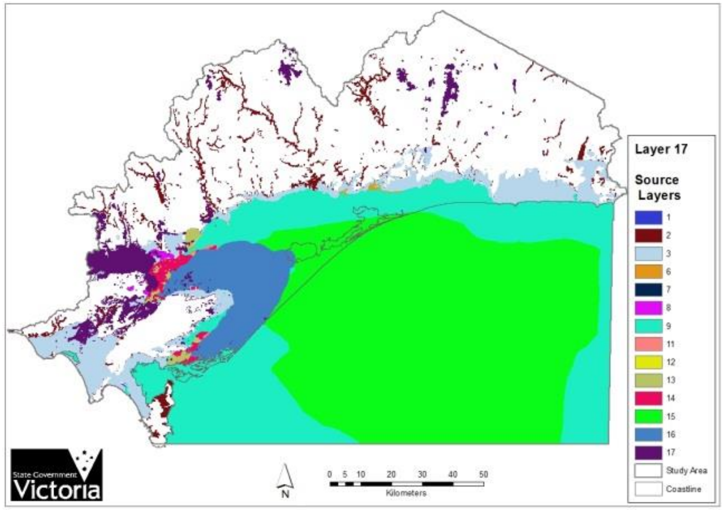

Figure 47: Modelled layer 17 attribution source layer.

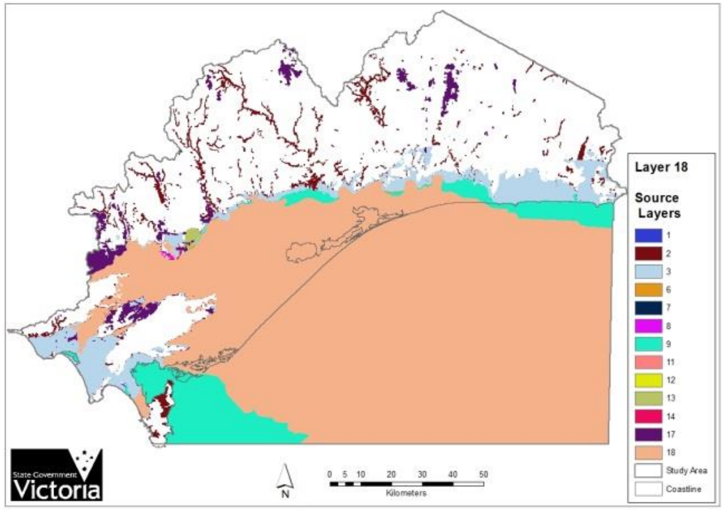

Figure 48: Modelled layer 18 attribution source layer.

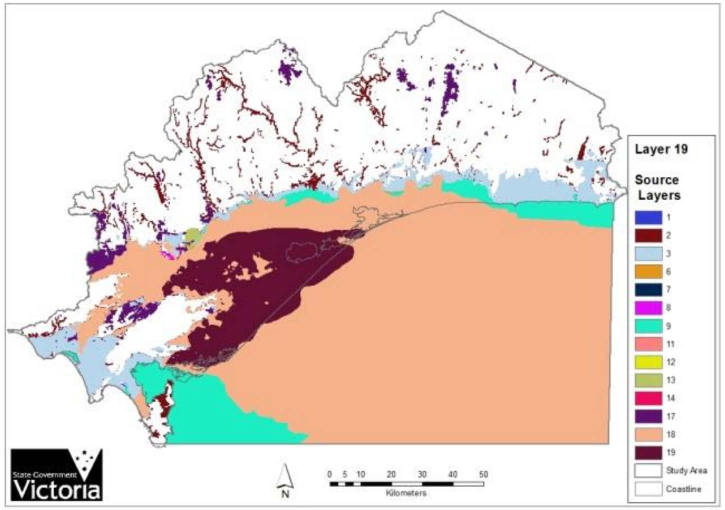

Figure 49: Modelled layer 19 attribution source layer.

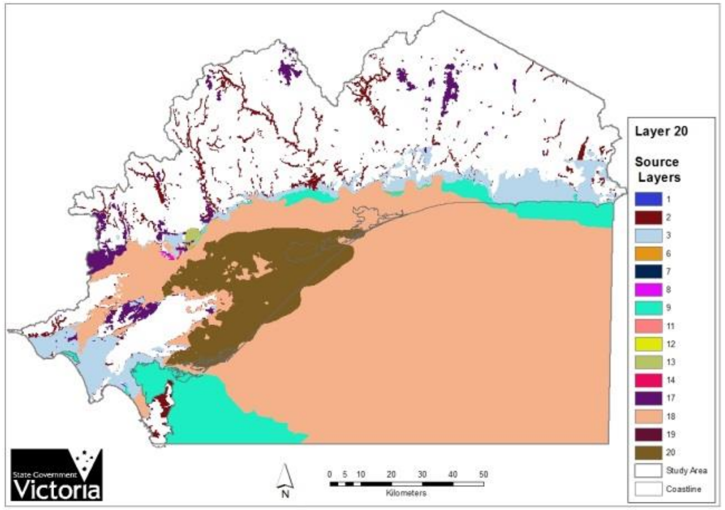

Figure 50: Modelled layer 20 attribution source layer.

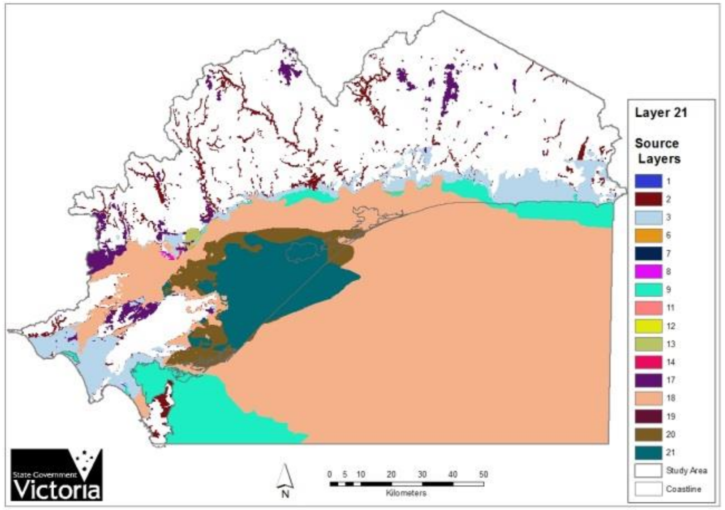

Figure 51: Modelled layer 21 attribution source layer.

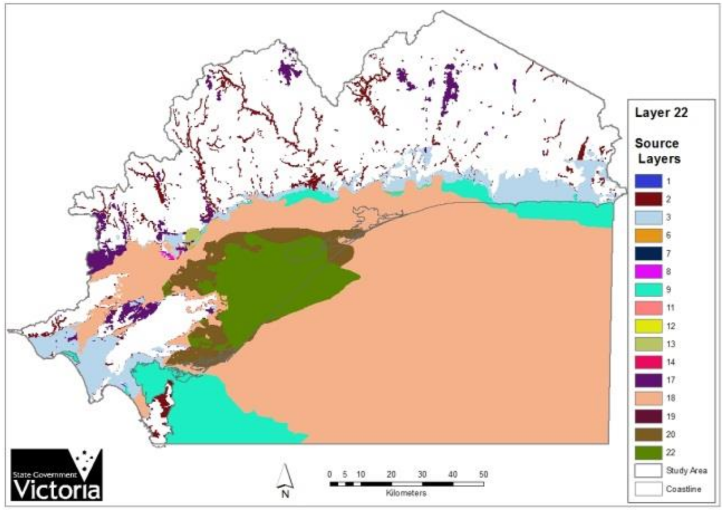

Figure 52: Modelled layer22 attribution source layer.

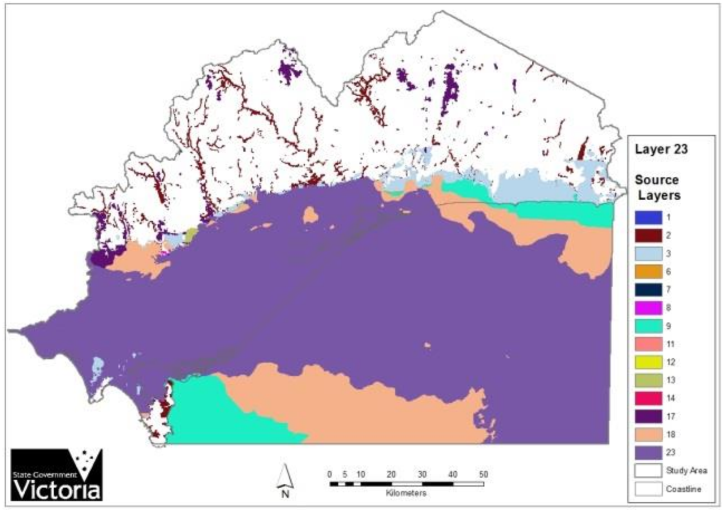

Figure 53: Modelled layer 23 attribution source layer.

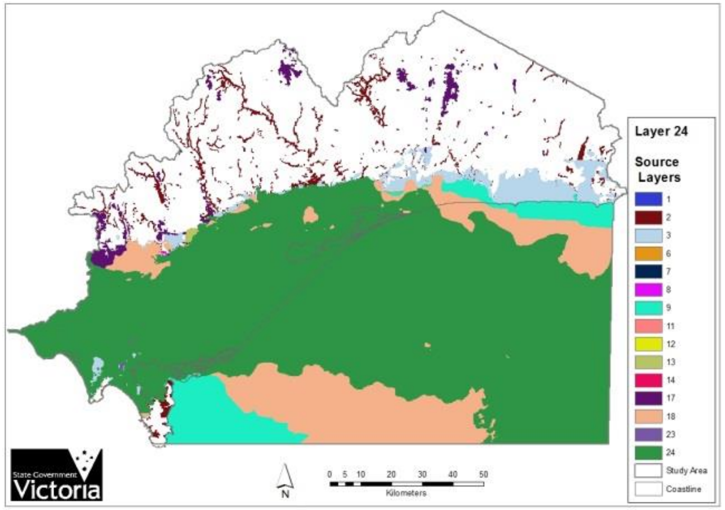

Figure 54: Modelled layer 24 attribution source layer.

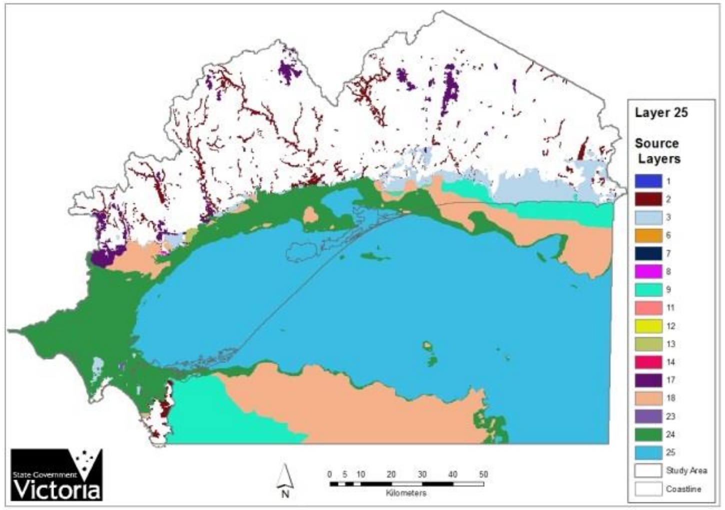

Figure 55: Modelled layer 25 attribution source layer.

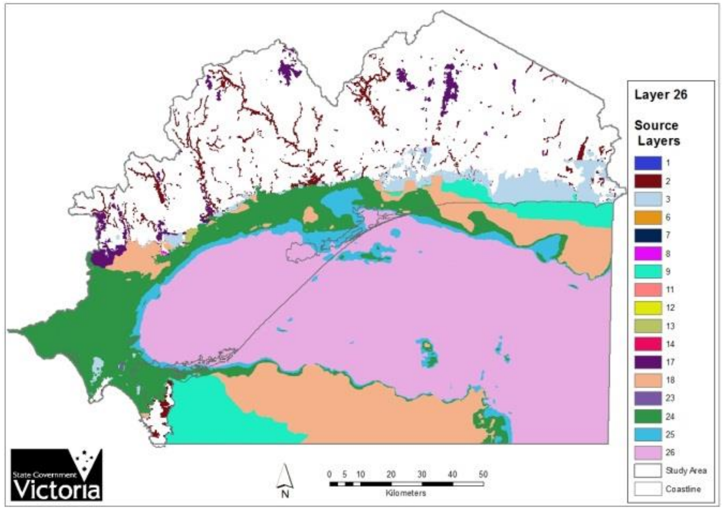

Figure 56: Modelled layer26 attribution source layer.

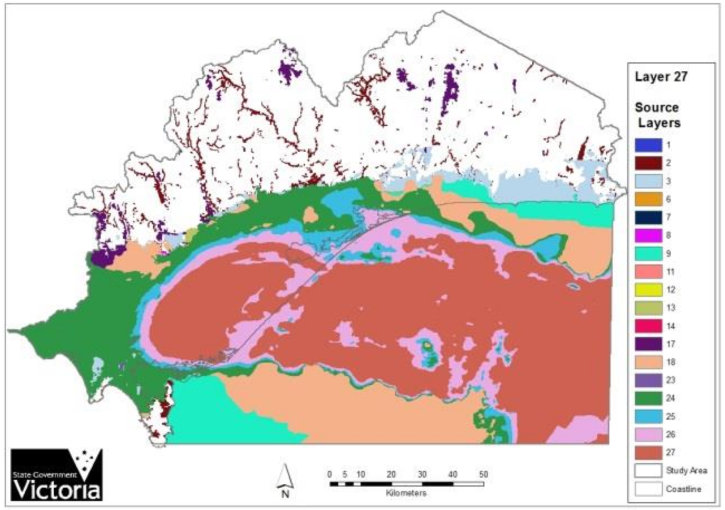

Figure 57: Modelled layer 27 attribution source layer.

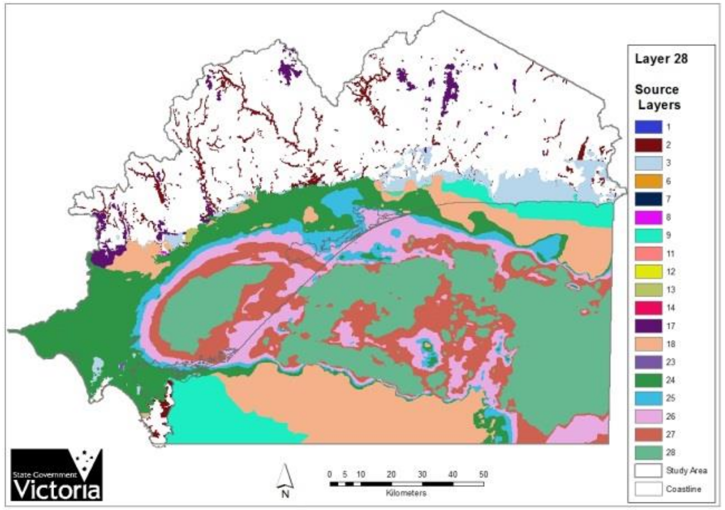

Figure 58: Modelled layer 28 attribution source layer.

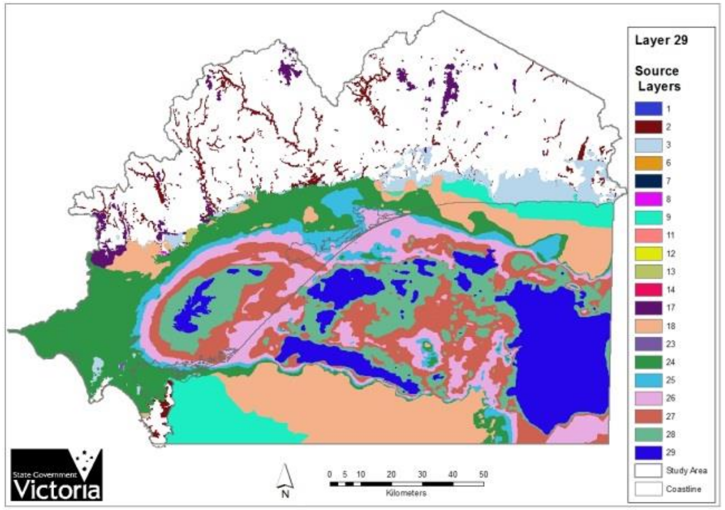

Figure 59: Modelled layer 29 attribution source layer.

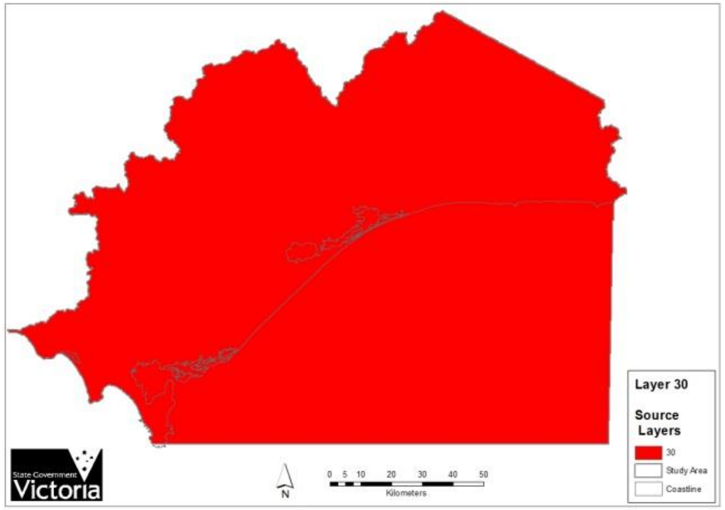

Figure 60: Modelled layer 30 attribution source layer.

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3.6 Model complexity

The complexity of the Gippsland region groundwater model is consistent with the “Impact Assessment” class described by Middlemis et al. (2000). Based on a model appraisal the developed model conceptualisation is on average assumed to have moderate complexity and is suitable for predicting the impacts of proposed developments or management policies. This is further supported using the more recent Australian Groundwater Modelling Guidelines (Barnett et al., 2012) which adopts a Confidence Level Classification. The Confidence Level Classification is a cornerstone of the national guidelines and is used to indicate the reliability of model predictions based on a number of criteria related to the available data with which the model is conceptualised and calibrated, the manner and accuracy of calibration and the manner in which the predictions are formulated. The assessment criteria are summarised in Table 9. Three confidence level classes are defined with Class 1 being the lowest confidence and Class 3 the highest. On assessing the various relevant criteria as reported in Table 10, it is considered that the model should be targeted as Class 2 which is appropriate for assessing regional groundwater impacts. Factors limiting higher confidence include the limited availability of data in the offshore parts of the model domain and the absence of any historic coal seam gas or tight and shale gas developments and hence predictive scenarios include stresses and associated impacts that have yet to be demonstrated.

Table 9: Summary of Confidence Level Classification criteria adopted in the Australian Groundwater Modelling Guidelines (Barnett et al., 2012).

CLASS	DATA	CALIBRATION	PREDICTION	INDICATORS
1	Not much. Sparse. No metered usage. Remote climate data.	Not possible. Large error statistic. Inadequate data spread. Targets incompatible with model purpose.	Timeframe >> calibration Long stress periods. Transient prediction but steady-state calibration. Bad verification.	Timeframe > 10x Stresses > 5x Mass balance > 1% (or single 5%) Properties <> field. Bad discretisation. No review.
2	Some. Poor coverage. Some usage info. Baseflow estimates.	Partial performance. Long-term trends wrong. Short time record. Weak seasonal replication. No use of targets compatible with model purpose.	Timeframe > calibration. Long stress periods. New stresses not in calibration. Poor verification.	Timeframe = 3-10x Stresses = 2-5x Mass balance < 1% Some properties <> field measurements. Some key coarse discretisation. Review by hydrogeo.
3	Lots. Good aquifer geometry. Good usage info. Local climate info. K measurements. Hi-res DEM.	Good performance stats. Long-term trends replicated. Seasonal fluctuations OK. Present day data targets. Head and flux targets.	Timeframe ~ calibration. Similar stress periods. Similar stresses to those in calibration. Steady-state prediction consistent with steady-state calibration. Good verification.	Timeframe < 3x Stresses < 2x Mass balance < 0.5% Properties ~ field measurements. Some key coarse discretisation. Review by modeller.

Table 10: Gippsland Model appraisal based on the abbreviated guideline (Table 9).

Class	Data	Calibration	Prediction	Indicators
1				X Timeframes > 10 × stresses
2	X Some	X Partial performance	X Timeframe > calibration	
3				

3.7 Allowance for temperature and density

The model does not explicitly simulate non-isothermal processes, density driven flows, contaminant flow or subsidence. As such solute transport and water quality has not been explicitly modelled. It is acknowledged that temperature variation over the depth range considered, both onshore and offshore, is large as are the off-shore salinity variations. Density gradients offshore are known to significantly influence pressure distributions resulting in flows towards the shoreline that are difficult to approximate using a constant density model. There are limitations to this approach to ignoring density variations at the coast and off-shore but there was insufficient time to address the significance of these. However, the assumption of constant density is not considered to significantly compromise the onshore predictions of the shallow system response for the purpose of this study.

It is noteworthy that data used in CSIRO modelling that accounted for density (to assess potential for seawater intrusion) and temperature (due to geothermal resources in the basin) has been used in the calibration process. Specifically the predevelopment and 2005 simulated potentiometric surfaces derived by CSIRO modelling for the Latrobe Group have been adjusted to remove the density and temperature impacts. These adjusted surfaces were then used in the calibration procedures. Given the limited available data this approach was deemed appropriate and pragmatic. Density head correction adjustments were also made to all groundwater observation bore data.

3.8 Allowance for faults

Geological faults and other geological discontinuities have not been explicitly modelled. Analysis of the stratigraphic data identified connection between the offshore and onshore units. Additionally, the properties were estimated to be continuous and not truncated. Faults were therefore considered to the extent that they were incorporated in the model geometry.

3.9 Model recharge

Dryland rainfall recharge, irrigation recharge and flood induced episodic recharge have been incorporated into the groundwater model from predictions derived using the CAT unsaturated catchment model (Beverly et al., 2005; Beverley, 2009a). Recharge derived from irrigation has been estimated based on management scripts representing irrigation practices adopted by each irrigated agricultural industry. These management scripts are assigned to irrigated land units within the land use layer and describe irrigation triggers, application volumes and frequency of irrigation events. Flood induced episodic recharge has been simulated by maintaining saturation in the surface soil layer in all regions within mapped flood extents. The duration of inundation was arbitrarily set as 5 days, unless specific information to the contrary was available. The spatially averaged annual recharge is summarised in Appendix C.

3.10 Model evapotranspiration

In Modflow the evapotranspiration (ET) module simulates ET from shallow watertables based on a root extinction depth (m) and a maximum groundwater extraction rate (mm/yr). The extinction depth identifies the watertable depth below natural surface below which no ET will occur; see for example Shah et al. (2007). In the current application, the extinction depth was based on the vegetation root depth assigned in the various farming system models used to estimate recharge within the CAT modelling framework as reported in Beverly et al. (2011). The extinction depths vary from 800 mm for annual pasture to 7 m for forests. The maximum evapotranspiration rate was calculated as the difference between potential daily ET and estimated daily vegetative ET as predicted using the CAT modelling framework. This approach ensures that the sum of estimated daily vegetative ET from the unsaturated zone and the assigned maximum groundwater ET from the saturated zone cannot exceed daily potential ET calculated from meteorological data.

3.11 Model rivers and drains

A total of 197 river gauges were identified within the model area representing all of the major rivers. Daily gauge level data was sourced from the Victorian Department of Environment, Land, Water and Planning Water Measurement Information System (WMIS, 2015). A list of the river gauges is provided in Appendix A.

Only main stems of the major rivers were included in the model. These river reaches were identified using the DEPI hydro25 spatial data set (DEPI, 2014). The river classification was used to vary river incision depth (depth below the ground surface as defined by the digital elevation model) and width attributes. In the absence of recorded stage height information, river classification was used to estimate river stage heights. A total of 22,573 river cells are included in the model. Fifty-one gauges were selected to calibrate the catchment modelling framework in unregulated catchments based on Base Flow Indexes and observed stream flows.

Drainage channels and man-made drainage features in the Macalister Irrigation District (MID) were included in the model based on available drainage network mapping (Figure 61). This information was sourced from Southern Rural Water (SRW) and the DEPI Corporate Spatial Data library. Drainage cells are assigned to the uppermost cells within the model to capture groundwater discharge processes. Drain cells in Modflow can only act as groundwater discharge points and as such those cells outside drainage channels will be characterised as having a bed elevation equivalent to ground surface elevation. A total of 410,504 drainage cells are incorporated in the model. Apart from 3 river gauges sourced from the WMIS, SRW also has 15 gauges (Figure 61 and Table 11) monitored drainage from the MID. The measurements commenced between 1997 and 2005. Of the 15 gauges, six were selected to calibrate the catchment modelling framework based on observed discharge. The mean monthly discharge and annual discharge at these six gauges are presented in Figure 62 and Figure 63, respectively.

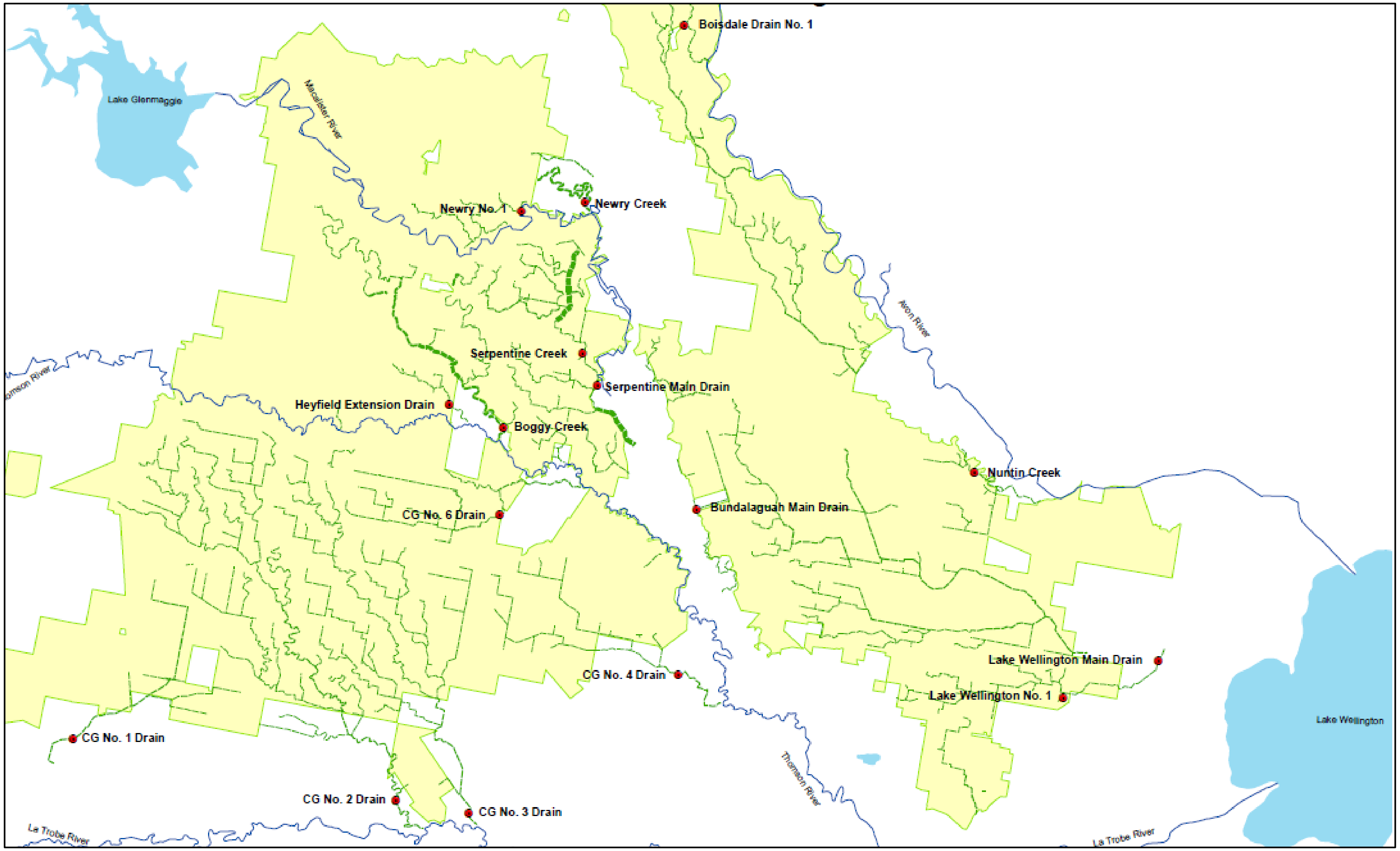


Figure 61: Drainage channels and monitoring sites in the Macalister Irrigation District.

Table 11: Gauges monitoring drain from the Macalister Irrigation District (sourced from SWR).

Site code	Site name	Eastings_z55	Northings_z55	Data Record		Mean Annual Discharge (ML/yr)
				From	to	
225248A	Boggy Creek	5793110	493086	2001	2013	3710
225731A	Boisdale No 1 Drain	5807657	499378	2001	2013	623
225732A	Bundalaguah	5790315	500025	2001	2013	1696
225735A	CG1	5781567	478177	2001	2013	2106
225729A	CG2	5779780	489665	1999	2013	4960
225709A	CG3	5779400	492200	1997	2013	5431
225728A	CG4	5784308	499554	2000	2013	4161
225734A	CG6	5790162	493141	2001	2013	1955
225733A	Heyfield Ext	5793889	491102	2001	2013	2685
225730A	Lake Wellington Main Drain	5785744	515613	1997	2013	6133
225745A	Lake Wellington No 1 Drain	5783956	513485	2004	2013	1366
225245A	Newry Creek	5801277	495980	2000	2013	4251
225746A	Newry No 1	5800909	493696	2004	2013	388
225251A	Nuntin Creek	5791751	509946	2001	2013	1799
225250A	Serpentine Main Drain	5794788	496506	2000	2013	3203

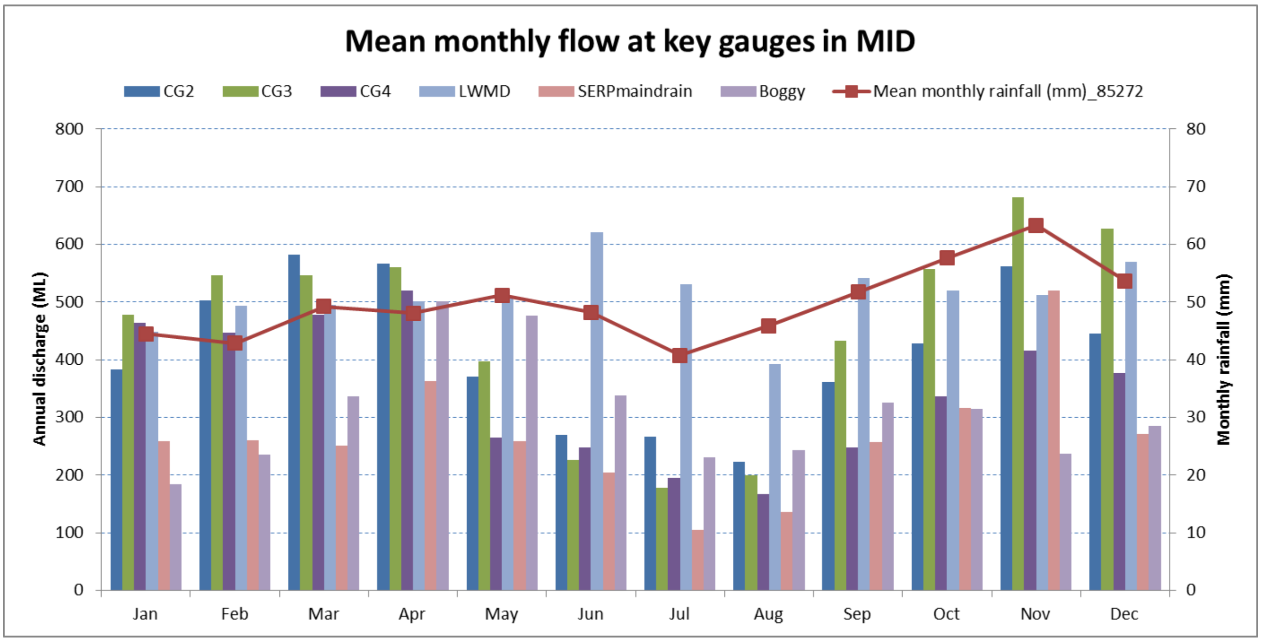


Figure 62: Mean monthly flow (ML/month) at key gauges monitored by SRW in the Macalister Irrigation District.

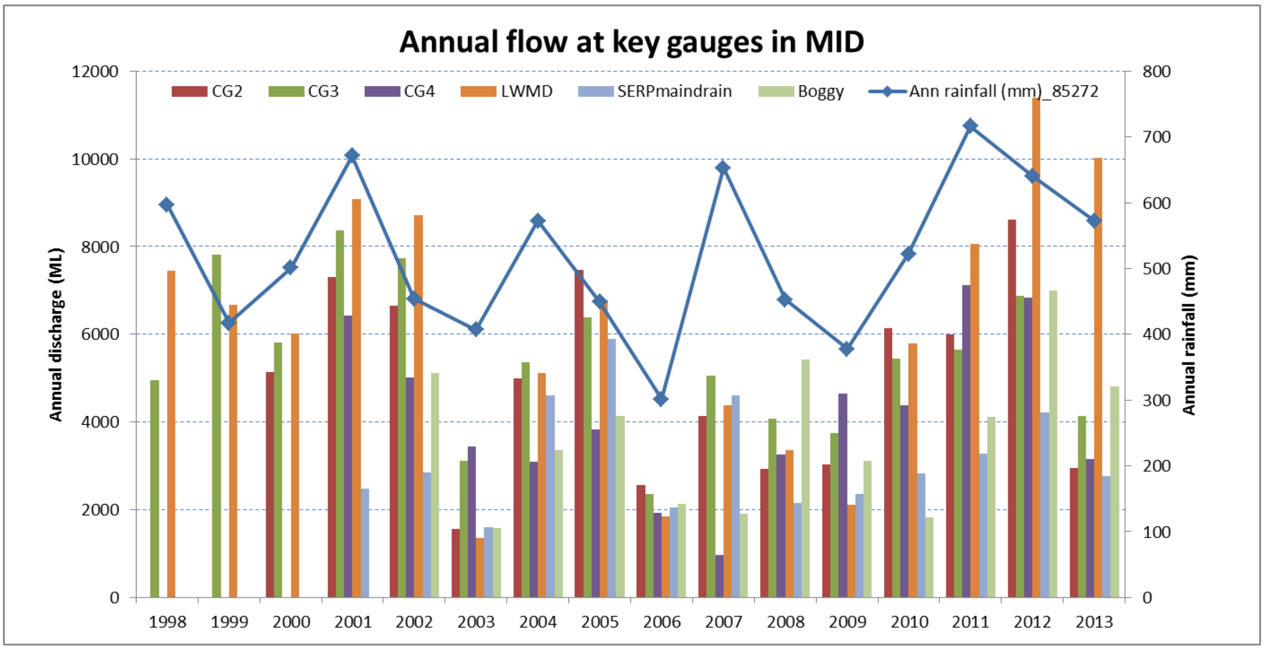


Figure 63: Annual flow (ML/yr) at key gauges monitored by SRW in the Macalister Irrigation District.

3.12 Model groundwater extractions

Time series groundwater extraction data was sourced from various independent data sets, namely:

Southern Rural Water – This data includes groundwater bore locations, bore construction date, entitlement and metered usage.

GHD mine models – Pre-existing simulation model well files sourced to provide site specific groundwater extractions associated with Latrobe Valley coal mines (GHD 2011a, GHD 2011b).

EcoMarkets data – This data set captured the groundwater usage information incorporated in the East Gippsland and West Gippsland groundwater models developed by GHD Pty Ltd (GHD 2010a, 2010b) as part of the ecoMarkets project commissioned by DSE in 2008.

Stock and domestic – Victorian state-wide stock and domestic data was provided by DSE and included location, completion date, top of screen and annual extraction volume.

Offshore extractions – Volume equivalent groundwater extractions associated with offshore oil and gas operations were sourced from Hatton, et al. (2004) and Varma, et al (2012).

All bores were assigned to aquifers according to the following criteria (in order of preference):

- as defined by the source of any historical abstraction data
- based upon bore construction (screen depth) information in conjunction with assigned GMU
- based upon bore construction (screen or bore depth) information
- bores without any GMU or construction data were assigned to the upper most (watertable) aquifer.

East Gippsland groundwater extraction estimates for the period 1970 to 1990 were derived based on the relative change as observed in the West Gippsland extraction for the same period with allowance for bore construction dates and entitlement volumes. This was required as limited monitored groundwater usage data was available for East Gippsland bores for the period 1970 to 1990. The process assigned the West Gippsland annualised usage trend derived for the period 1970 to 1990 to those East Gippsland bores with missing data. Bore construction dates were used to ensure extraction were only assigned post construction. Importantly all abstractions within the model domain were forced to exactly match the Water Account usage volumes for the 2003-2012 reporting periods as summarised in Table 12.

The final allocation and composition of groundwater extraction bores incorporated in the model and as associated to various Groundwater Management Areas (GMA) and Water Supply Protection Areas (WSPA) is summarised Table 13. Figure 64 shows the specified annual extraction volumes and source that were compiled into the model groundwater extraction input file.

Table 12: State Water Accounts (usage ML).

GMA/WSPA	2003–04	2004–05	2005–06	2006–07	2007–08	2008-09	2009–10	2010–11	2011–12
Denison	15,224	6,500	6,680	10,152	6,147	8,385	7,987	3,695	2,992
Giffard	2,719	2,520	3,260	3,719	3,205	3,662	1,717	865	845
Leongatha	648	515	441	625	600	344	158	31	72
Moe	1,098	1,084	990	1,447	1,414	1,081	1,095	191	330
Orbost	464	270	350	540	490	578	333	95	0
Rosedale	15,457	9,920	10,860	7,539	10,678	11,540	11,009	7,543	7,739
Sale	14,680	7,680	10,450	13,358	9,504	11,185	11,094	7,164	6,324
Stratford	27,355	17,230	17,690	19,182	24,099	26,897	27,896	24,904	26,042
Tarwin	18	14	12	12	2	6	6	9	15
Wa De Lock	12,095	9,403	8,059	10,509	7,194	9,517	10,386	4,832	3,767
Wy Yung	2,438	790	1,110	1,895	631	1,024	798	309	347
Yarram	12,205	8,100	11,070	16,009	12,048	13,911	11,778	6,882	6,740

Table 13: Modelled extractions within each GMA and WSPA reporting region.

	Depth upper (m)	Depth lower (m)	Licensed pumps	Mine pumps	S&D	Total pumps
Denison WSPA	0	25	183	0	118	301
Giffard GMA	500	200	16	0	152	168
Leongatha GMA	0	basement	27	0	130	157
Moe GMA	25	basement	67	0	249	316
Orbost GMA	20	45	11	0	13	24
Rosedale GMA Zone 1	50	150	20	48	19	87
Rosedale GMA Zone 2	25	350	229	0	506	735
Rosedale GMA Zone 3	200	350	15	0	11	26
Sale WSPA	25	200	413	0	1011	1424
Stratford GMA Zone 1	150	Basement	1	8	7	16
Stratford GMA Zone 2	350	Basement	5	0	15	24
Tarwin GMA	0	25	1	0	23	24
WaDeLock GMA	0	25	301	0	323	627
Wy Yung WSPA	0	25	110	0	71	181
Yarram WSPA Zone 1	0	basement	102	0	510	612
Yarram WSPA Zone 2	200	basement	6	0	17	23

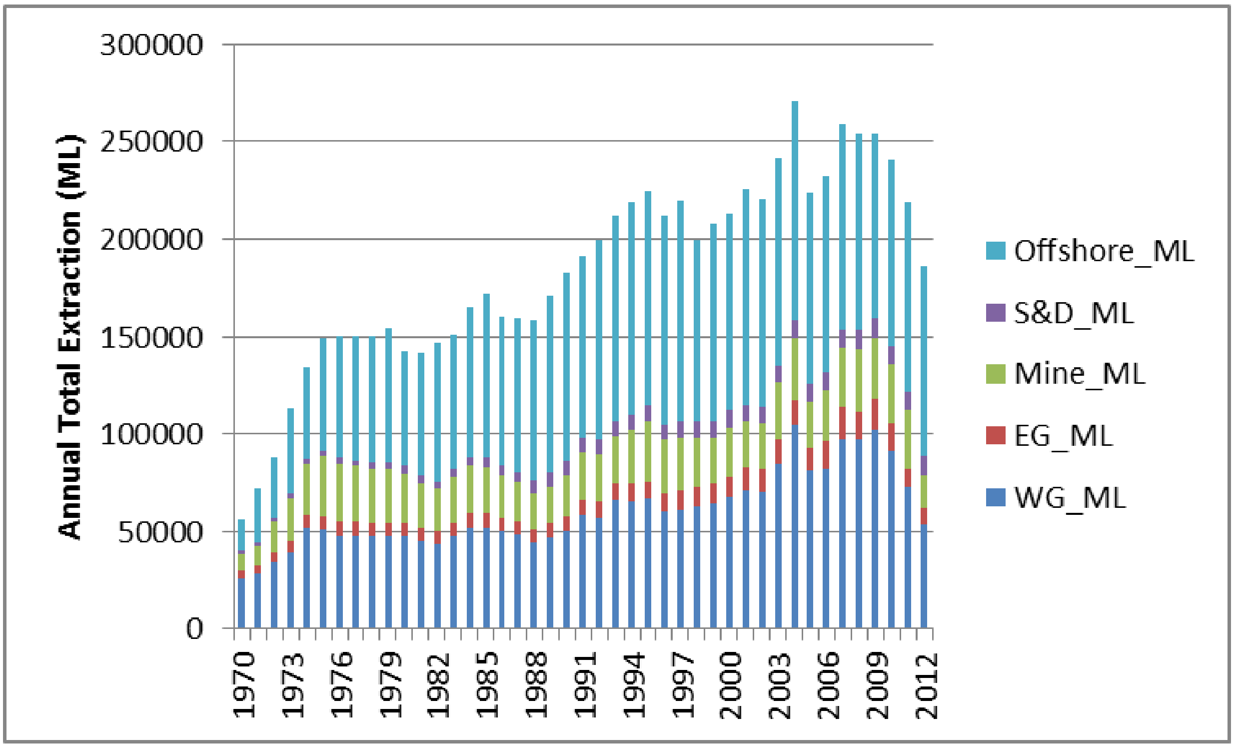


Figure 64: Annual total extraction (ML/yr) by contribution incorporated into the model.

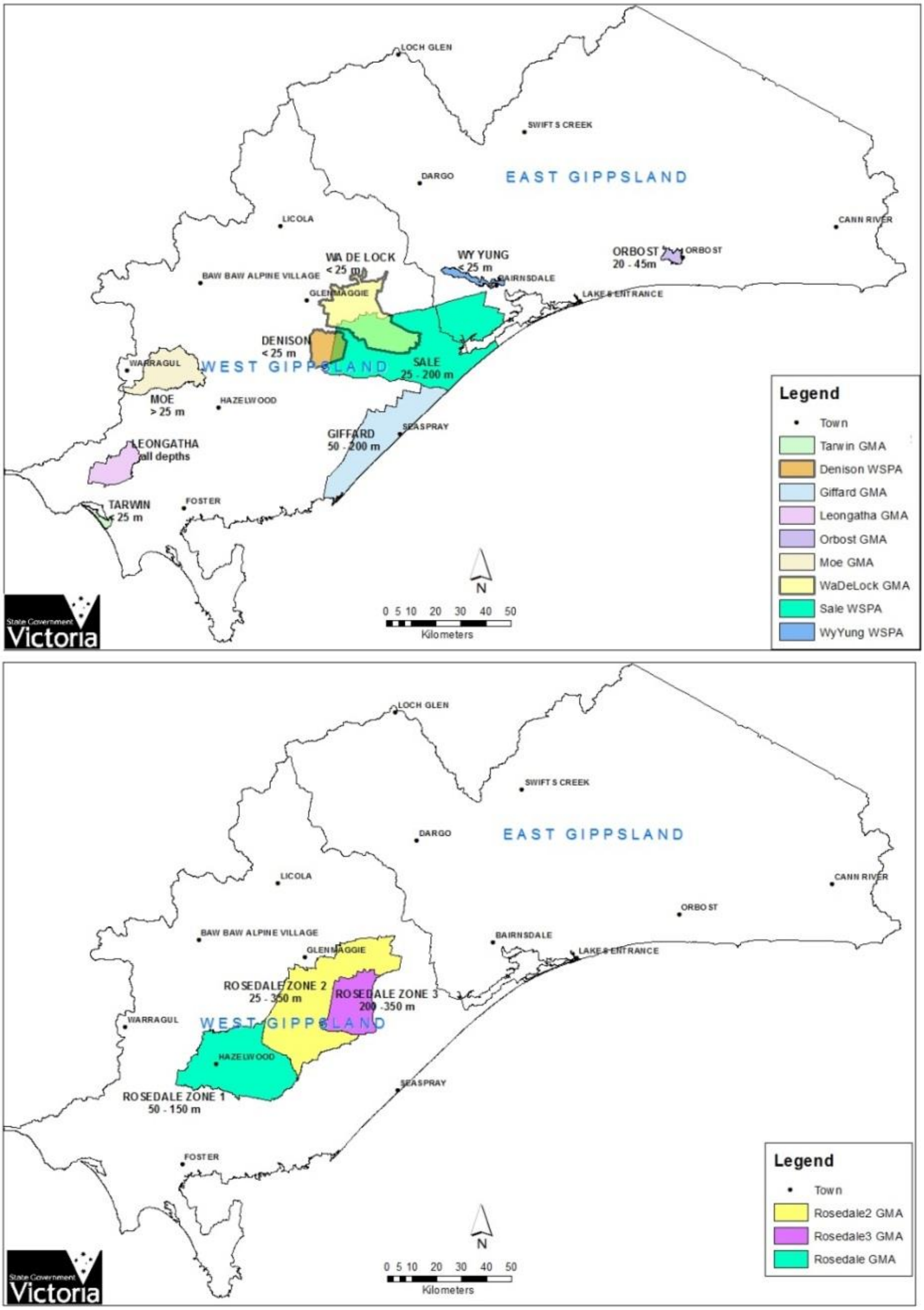


Figure 65: State water account reporting regions (separate figures to avoid overlapping)

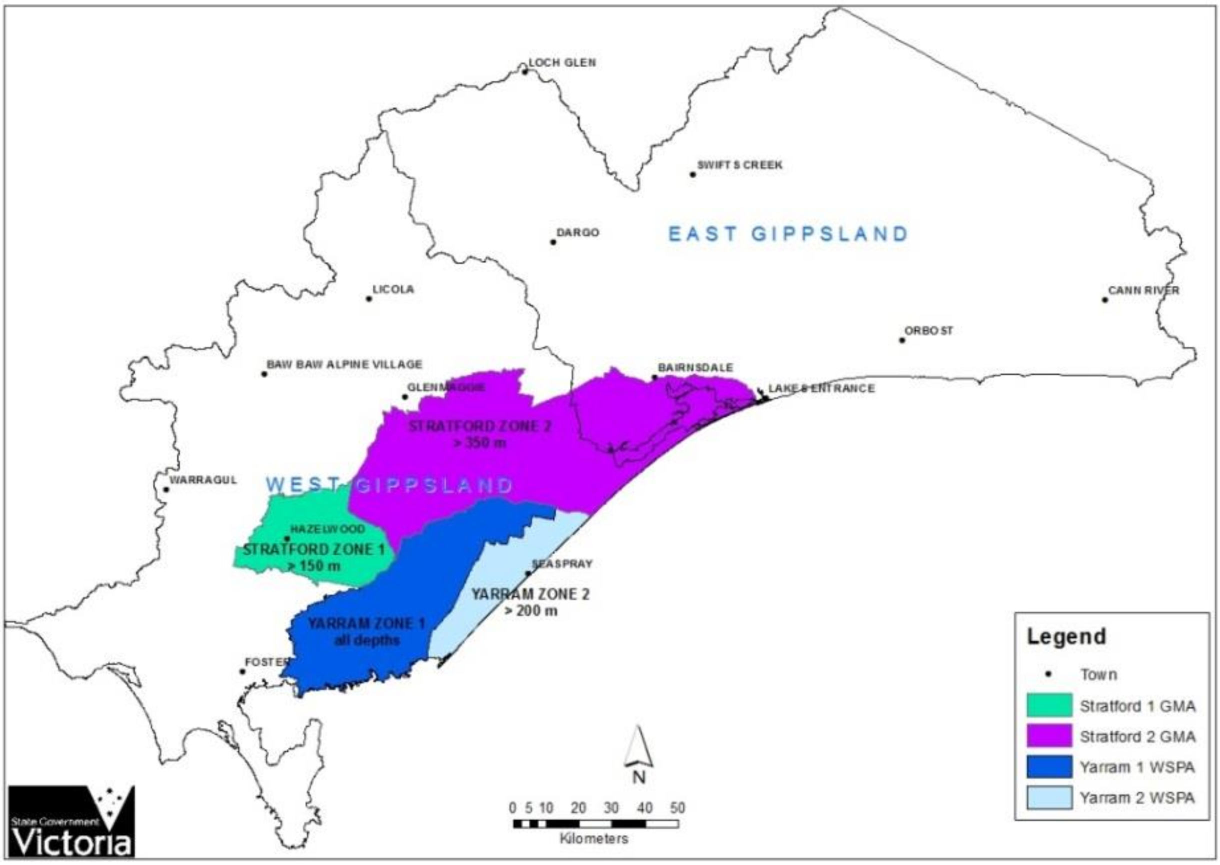


Figure 65 (cont'd): State water account reporting regions (separate figures to avoid overlapping)

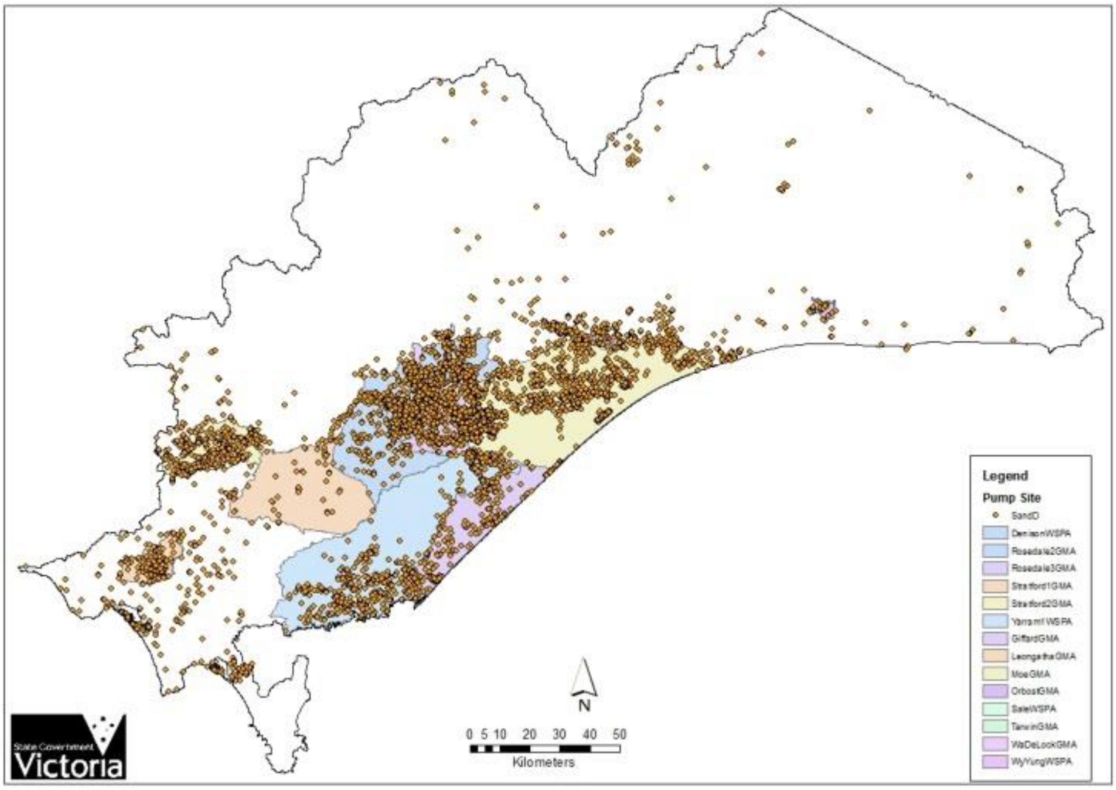


Figure 66: Location of all extractions including S&D bores.

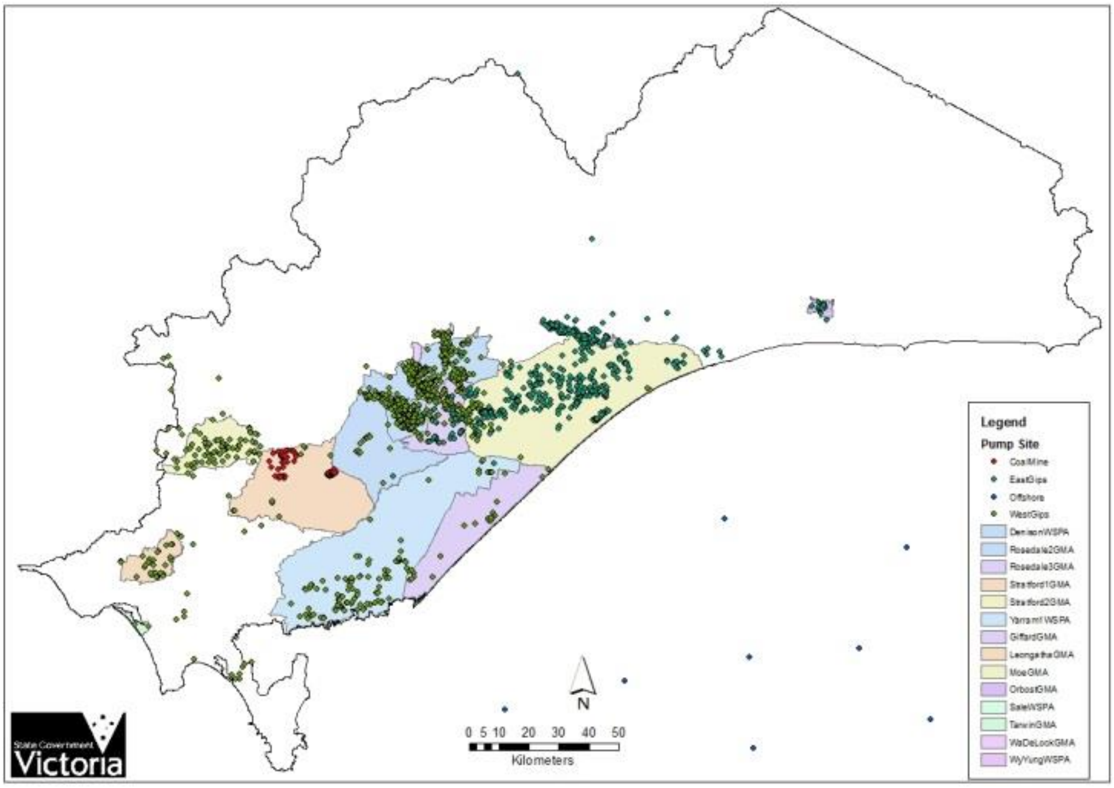


Figure 67: Location of all extraction bores excluding S&D bores.

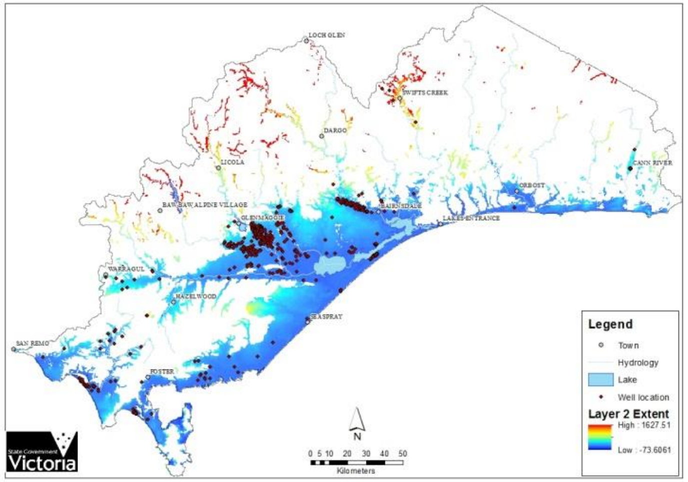


Figure 68: Location of extraction bores in modelled layer 2.

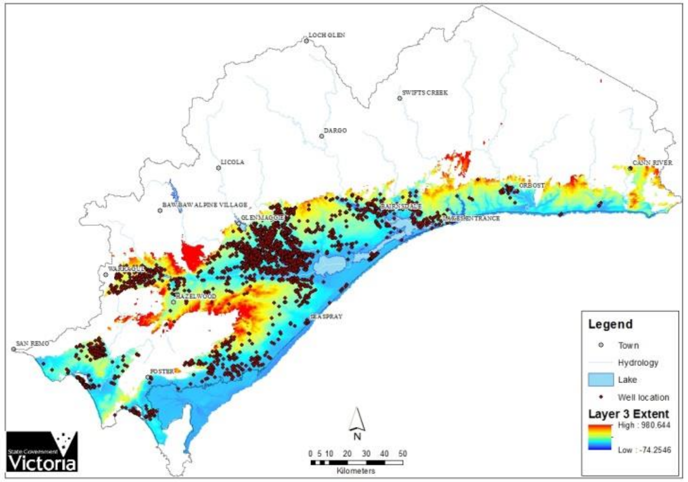


Figure 69: Location of extraction bores in modelled layer 3.

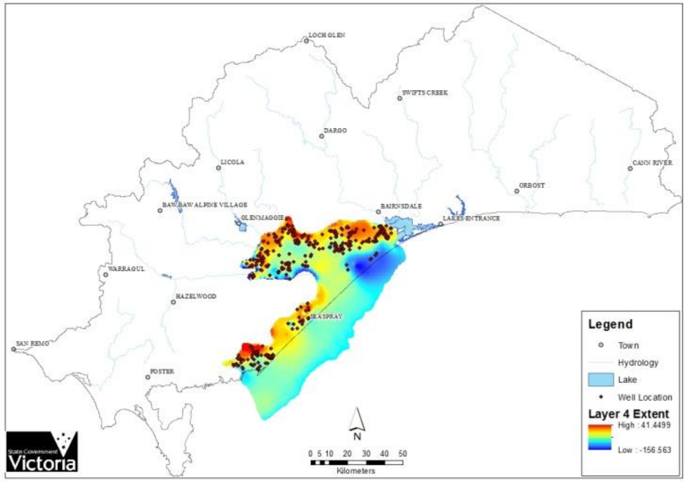


Figure 70: Location of extraction bores in modelled layer 4.

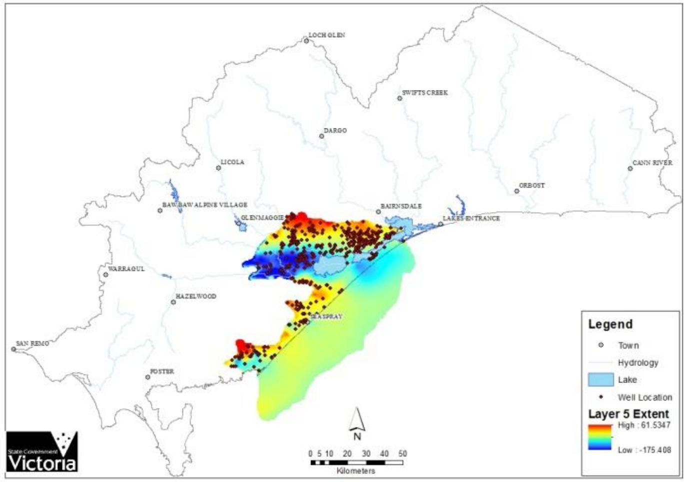


Figure 71: Location of extraction bores in modelled layer 5.

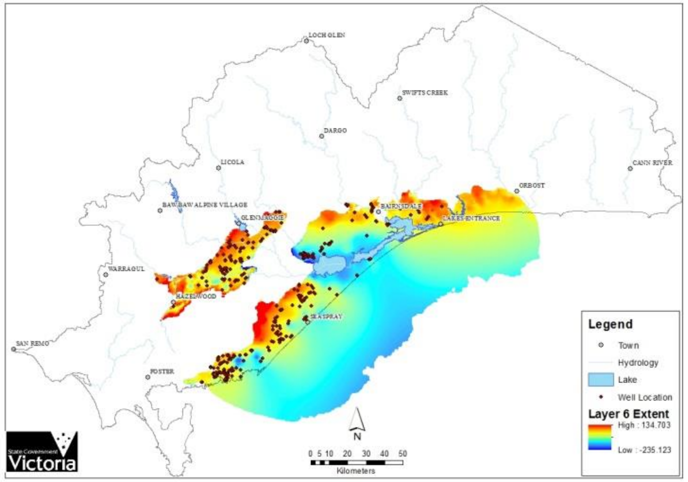


Figure 72: Location of extraction bores in modelled layer 6.

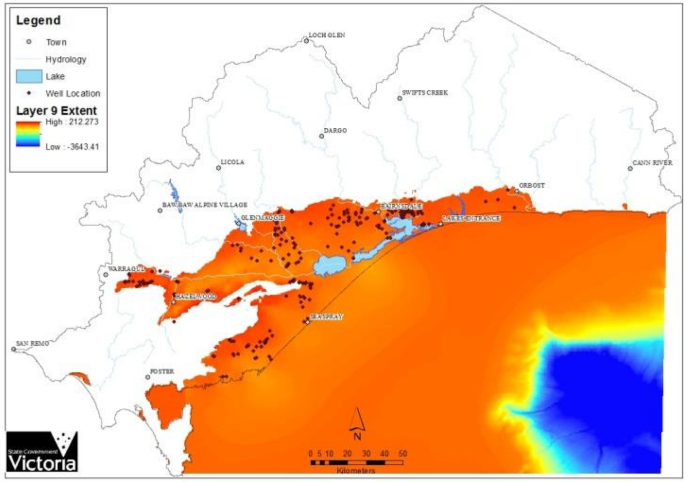


Figure 73: Location of extraction bores in modelled layer 9.

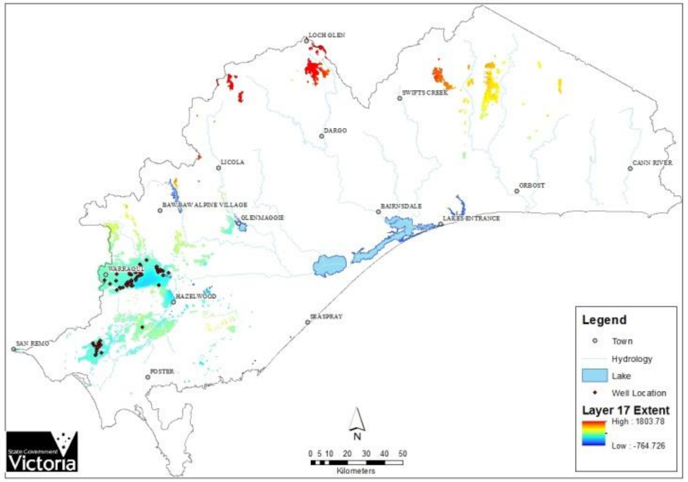


Figure 74: Location of extraction bores in modelled layer 17.

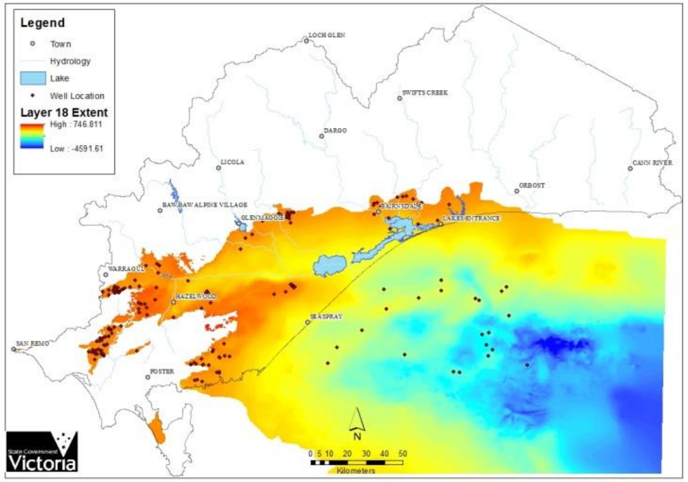


Figure 75: Location of extraction bores in modelled layer 18.

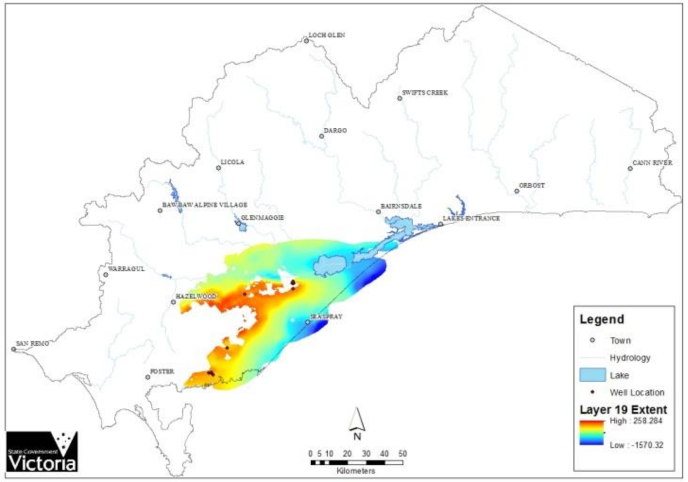


Figure 76: Location of extraction bores in modelled layer 19.

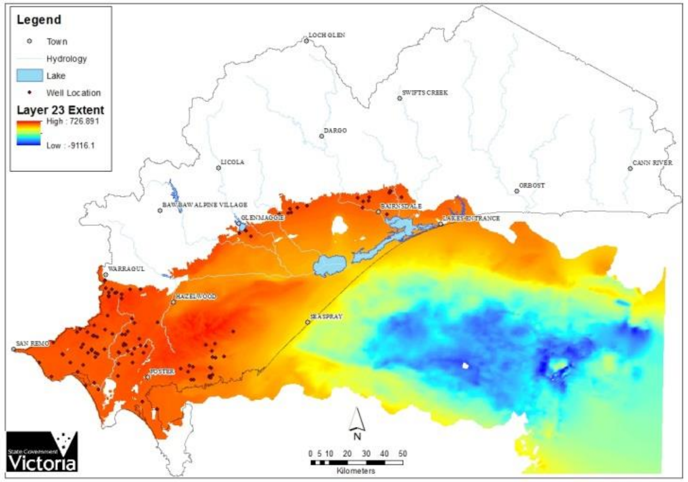


Figure 77: Location of extraction bores in modelled layer 23.

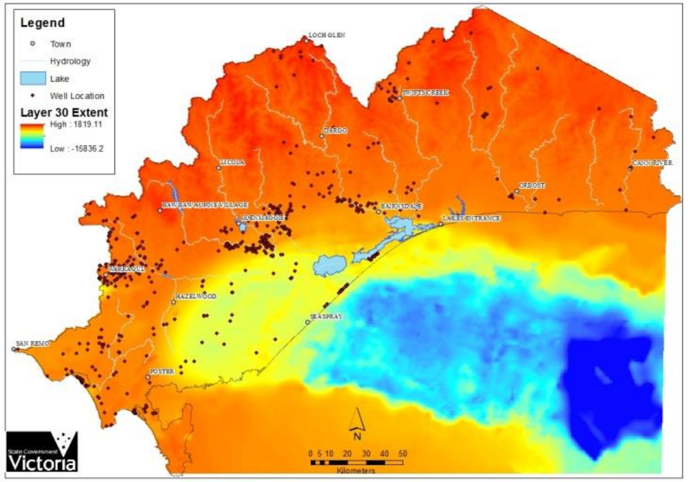


Figure 78: Location of extraction bores in modelled layer 30.

3.13 Model simulation period

Groundwater recharge in southern Australia is strongly correlated with annual rainfall. This is particularly true when the seasonal rainfall pattern follows that established by the long-term trend. In this condition most rainfall occurs during cold wet winters and to a lesser extent in hot dry summers.

When considering the steady-state condition it is useful to consider the hypothetical condition that has stable climate and land use over time. This allows for an appreciation of a quasi-equilibrium condition that is ultimately realised between surface water and groundwater. This approach was adopted as the basis of a steady-state groundwater model.

Choosing a year that best represents the climatic circumstances for the simulation objectives is an essential part of the steady-state assessment. This decision was influenced by the availability of appropriate calibration data. This approach generally allows for the selection of a year that was outside the bounds of a longer term shift in annual rainfall distribution. The selected steady-state condition was based on 1970 rainfall and assumed no groundwater extractions. This initial state was selected to represent predevelopment conditions as post-1970 historic groundwater pumping in the region (on and offshore) have not achieved a quasi-equilibrium response as based on available groundwater hydrograph trends.

The transient simulation period was 1970 to 2012. This period captures both pre-mine development and a range of varying climatic conditions, including above average wet and dry sequences. The 1970 starting date enables the incorporation of historic groundwater extraction data into the model and provides sufficient lead time for the groundwater model to minimise the impact of initial conditions on model predictions associated with the period of interest, namely the calibration/validation period of 2000 to 2012.

3.14 Model stress periods

The transient calibration period has been formulated with annual stress periods for the period 1970–1990, and monthly stress periods throughout the 1991–2012 calibration/verification periods. The model stress periods were based on adequately capturing historical offshore and offshore extractions, specifically Latrobe Valley coal mine and offshore oil and gas production wells. To this end, pre-1990 stress periods were assigned as annual within which twelve time-steps were adopted. For the more recent post-1990 calibration/verification period the stress period was based on representing seasonal water level oscillation and extractions data. Following consultation with ecologists it was subsequently agreed that post-1990 monthly time-steps were required to determine the potential impacts of water changes on water dependent ecosystems. It is also noted that daily data was used in the generation of stress period recharge and potential groundwater evapotranspiration rates.

3.15 Steady-state model conditions

The steady-state calibration model represents the 1970 Latrobe Valley pre-development conditions. On the basis that steady-state predictions reflect long-term equilibrium conditions assuming constant groundwater inputs and stresses throughout time, no groundwater extractions were assigned during the steady-state simulation.

3.16 Transient model initial conditions

The initial conditions for the transient model were based on a steady-state solution representing the 1970 pre-development condition which assumed no groundwater pumping.

4 Model calibration criteria

The calibration procedure adopted a split calibration/verification approach in which the calibration period was 1990 to 1999 and the verification period was 2000 to 2012. Model calibration was based on matching groundwater hydrograph response and groundwater discharge to streams. In addition to these data sets, model predictions were also compared to mapped discharge extents in regions where this information was available.

Numerous statistical performance measures were applied to assess the goodness of fit model predicted and observed groundwater heads as summarised in Table 14. Analysis includes the coefficient of determination (CD) and the Nash–Sutcliffe index (NSI) (Nash and Sutcliffe, 1970). Each coefficient is defined by the number of observations n, measured data at time i, (Y_i), and the corresponding modelled prediction at time i (X_i). The CD value is a measure of the relationship between observed and simulated values whereas the NSI value indicates how well the plot of the observed versus simulated values fit the 1:1 line. If the CD and NSI values approach zero (or are negative), the model performance is considered to be unacceptable or poor. If the values are equal to one, the model prediction is considered perfect (Middlemis et al., 2000). An NSI value of 0.6 is viewed as “satisfactory” whereas an NSI of 0.8 or higher is considered “good” (Chiew et al*.,* 1993).

Both manual and automated calibration procedures were adopted in this study. In the case of automated calibration three independent software packages were utilised, namely:

1. Groundwater Vistas
2. DOS version of PEST
3. A simplex optimisation approach.

A common underpinning data set was used by each package to enable a comparison of results. A zonal parameter distribution approach was employed.

Table 14: Statistical measure of model performance.

Statistical Measure	Definition	Units	Description
Mean sum of squares	$MSSQ = \left(\frac{1}{N}\right)\sum_{i=1}^{N}(X_i - Y_i)^2$	m	MSSQ is the average of the square of the differences between predicted values and observed values.
Root mean square (RMS) error	$RMS = \sqrt{\left(\frac{1}{N}\right)\sum_{i=1}^{N}(X_i - Y_i)^2}$	m	Root Mean Square (RMS) error is the sample standard deviation of the differences between predicted values and observed values.
Scaled root mean square error	$SRMS = \frac{100\sqrt{\left(\frac{1}{N}\right)\sum_{i=1}^{N}(X_i - Y_i)^2}}{(Y_{\max} - Y_{\min})}$	%	Scales the RMS error to the range of the observed values and is expressed as a percentage. The SRMS is more meaningful than root mean square error as it is independent of scale.
Root mean fraction square error	$RMFS = 100\sqrt{\left(\frac{1}{N}\right)\sum_{i=1}^{N}\left(\frac{(X_i - Y_i)}{Y_i}\right)^2}$	%	RMFS represents the sample standard deviation of the differences between predicted values and observed values as a fraction of the observed value expressed as a percentage.
Scaled root mean fraction square error	$SRMFS = \frac{100\ \bar{Y}}{(Y_{\max} - Y_{\min})}\sqrt{\left(\frac{1}{N}\right)\sum_{i=1}^{N}\left(\frac{(X_i - Y_i)}{Y_i}\right)^2}$	%	Scales the RMFS error by the ratio of the mean observed value to the range of the observed values expressed as a percentage.
Mean sum of residual	$MSR = \left(\frac{1}{N}\right)\sum_{i=1}^{N}(X_i - Y_i)$	m	MSR or residual mean is not an unbiased estimator of the error variance.
Scaled mean sum of residuals	$SMSR = \frac{\left(\frac{1}{n}\right)\sum_{i=1}^{n}(X_i - Y_i)^2}{(Y_{\max} - Y_{\min})}$	%	As per Root Mean Square error but further scaled by the range of observation data and expressed as a percentage.
Coefficient of determination	$CD = \frac{\sum_{i=1}^{N}(Y_i - \bar{Y})^2}{\sum_{i=1}^{N}(X_i - \bar{Y})^2}$		Describes the causation of change in *Y* by changes in *X*.
Nash–Sutcliffe index	$NSI = 1 - \frac{\sum_{i=1}^{n}(X_i - Y_i)^2}{\sum_{i=1}^{n}(Y_i - \bar{Y})^2}$		The NSI value is a measure of the relationship between observed and simulated values.

4.1 Key groundwater observation bores

All available groundwater observation bores data was compiled and included in the model as calibration targets. A total of 822 target bores are utilised for the transient calibration model whereas only 71 bores have data available to calibrate the predevelopment steady-state condition. Figure 79 shows the location of the observation bores used for model calibration. Bore hydrographs identified in SKM (2014) and GHD (2014b) are considered “high reliability” and were assigned a calibration weight of 5; all other observation bore data were assigned a calibration weight of 1.

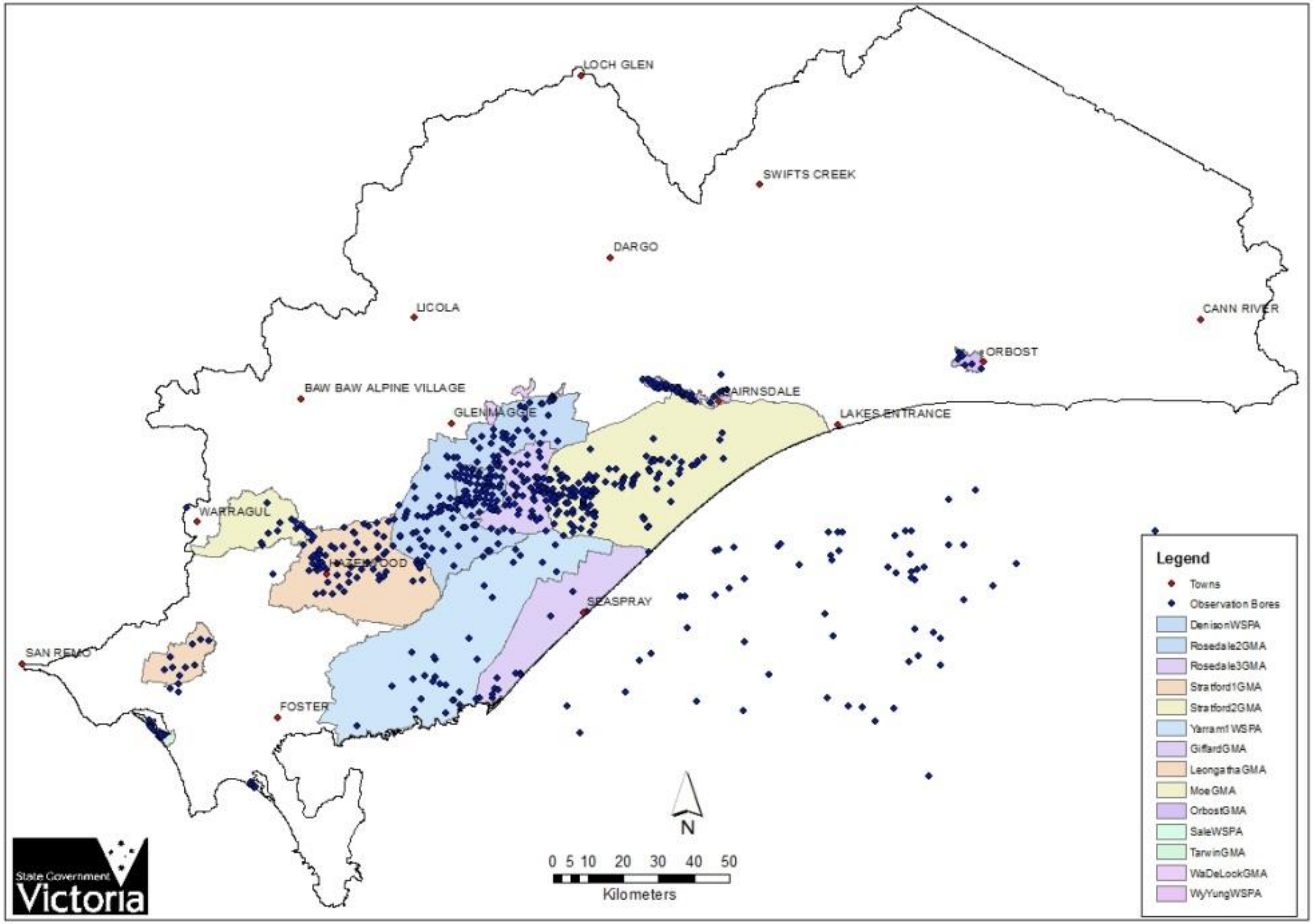


Figure 79: Location of observation bores used for model calibration.

4.2 Baseflow estimates

Baseflow separation and analysis were conducted on all stream flow data within the study area to estimate the contribution of groundwater to streamflow. The estimated groundwater discharge volumes to streams were then used as a calibration flux target within ungauged catchments.

Baseflow separation was estimated using the approach developed by the USGS and subsequently implemented in the BFI software. Daily streamflow input data was sourced from the Victorian Water resources data Warehouse (http://www.vicwaterdata.net/vicwaterdata/home) and extracted as computed daily flows. Periods with poor quality data and/or missing records were infilled to ensure a complete data record at each location. The program implements a digital filter procedure and combines a local minimums approach with a recession slope test. The program estimates the annual base-flow volume of unregulated rivers and streams and computes an annual base-flow index (BFI, the ratio of base flow to total flow volume for a given year) for multiple years of data at one or more gage sites. Although the method may not yield the true base flow as might be determined by a more sophisticated analysis, the index has been found to be consistent and indicative of base flow, and thus may be useful for analysis of long term base-flow trends (Arnold et al., 2010).

As a comparison, the derived BFI estimates were compared to independent values based on the Lyne and Hollick digital filter method (SKM, 2012b) and recent GHD's study (GHD, 2013). The comparative values adopted a single consistent baseflow filter parameter of 0.98 applied to all sites thereby allowing a comparison from site to site on an equivalent basis. Appendix A tabulates the BFI estimates derived in this project and those reported in the SKM study for all stream gauges within the study region.

4.3 Manual calibration

Initial model calibration was made by using a manual trial-and-error approach. Due to the large number of solution points and the large number of model layers, it was found to be inefficient and difficult to make notable enhancements in the calibration process. As a result automated calibration methods were adopted.

4.4 Automated calibration

The automated calibration approach utilised three independent software packages, namely:

1. BeoPest implemented in Groundwater Vistas
2. DOS version of PEST (Doherty, 2010)
3. A simplex optimisation approach.

The same calibration targets were used by each package to enable a comparison of results.

The automated calibration procedure adopted a zonal approach. The zone calibration approach was based on a series of parameter zones in which the horizontal and vertical hydraulic conductivities were modified in order to minimise the variation between observed data and modelled prediction. A total of 36 zones based on geological extents and attributes were mapped as shown in Figures 80 to 109.

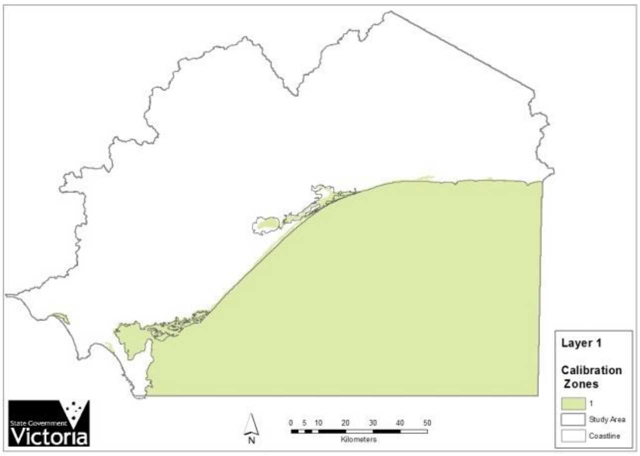


Figure 80: Calibration zones for model layer 1.

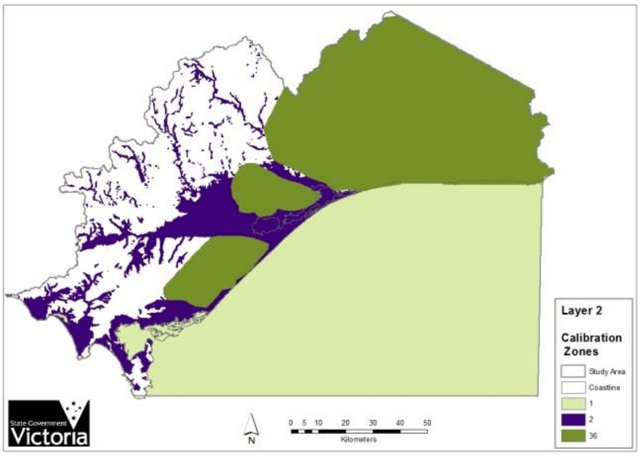


Figure 81: Calibration zones for model layer 2.

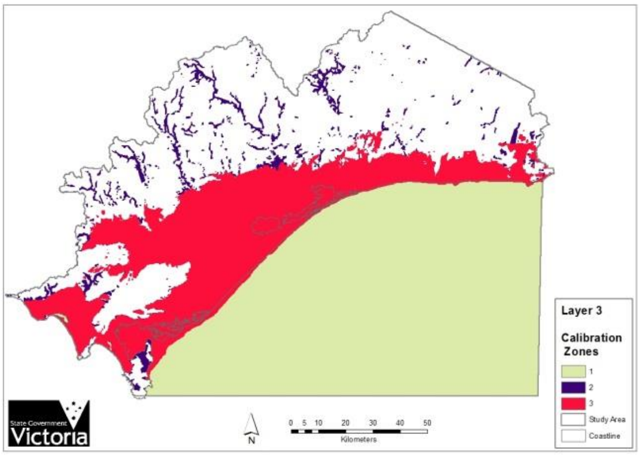


Figure 82: Calibration zones for model layer 3.

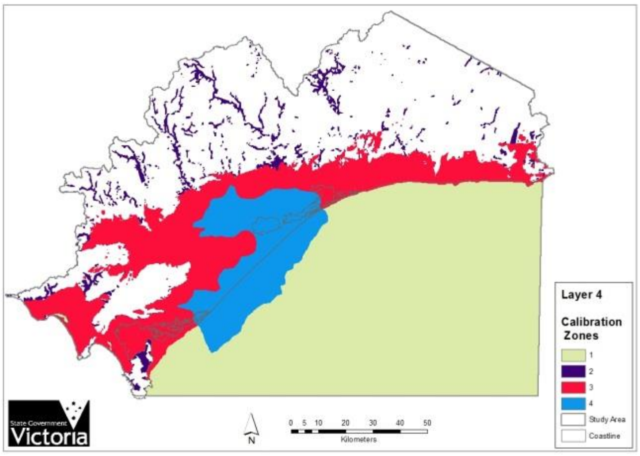


Figure 83: Calibration zones for model layer 4.

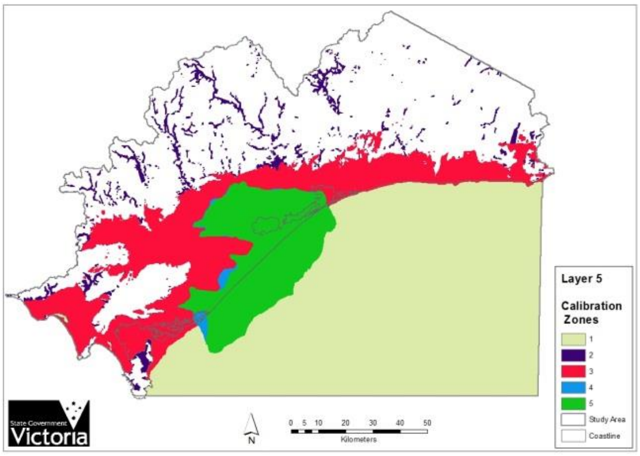


Figure 84: Calibration zones for model layer 5.

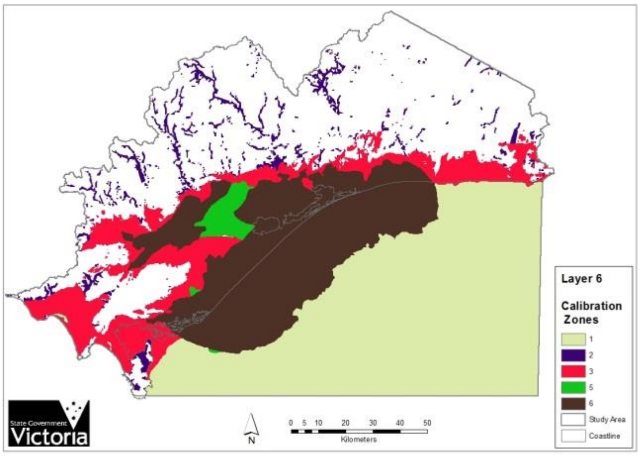


Figure 85: Calibration zones for model layer 6.

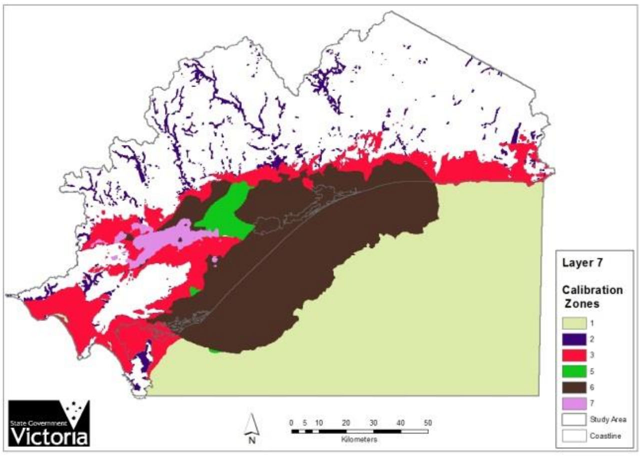


Figure 86: Calibration zones for model layer 7.

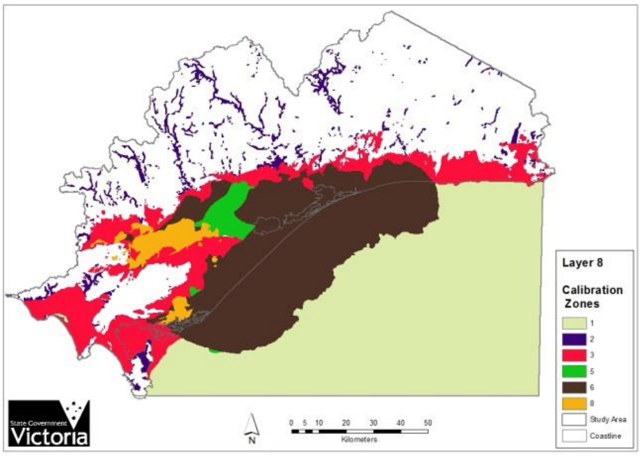


Figure 87: Calibration zones for model layer 8.

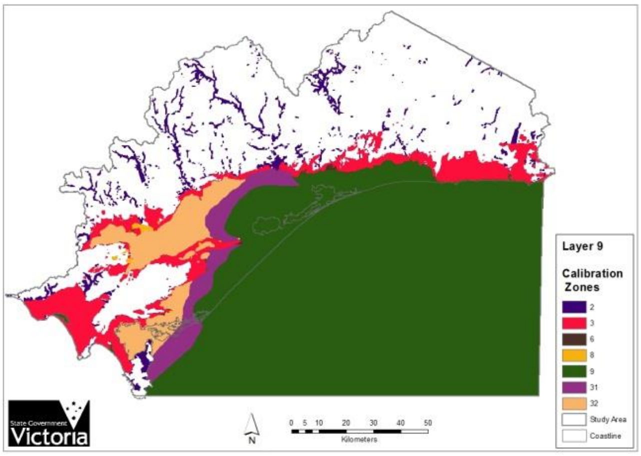


Figure 88: Calibration zones for model layer 9.

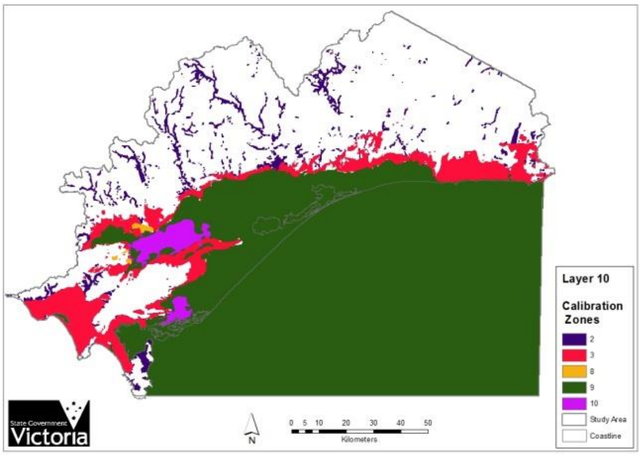


Figure 89: Calibration zones for model layer 10.

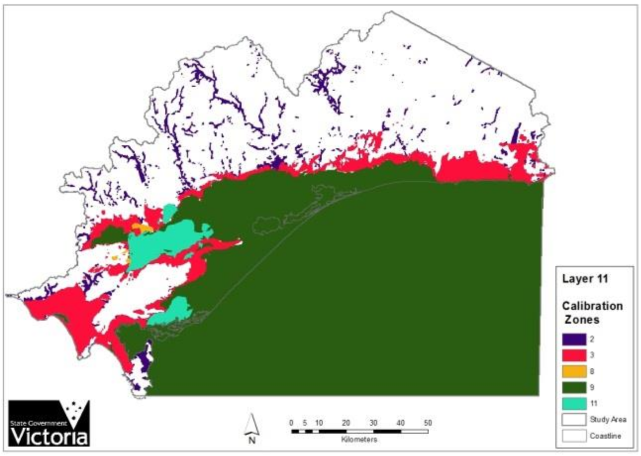


Figure 90: Calibration zones for model layer 11.

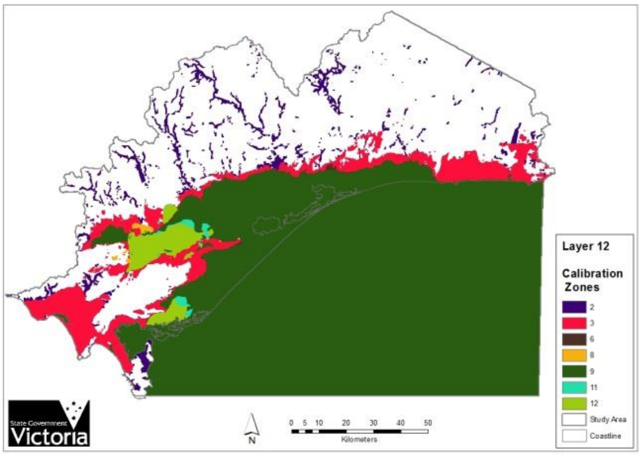


Figure 91: Calibration zones for model layer 12.

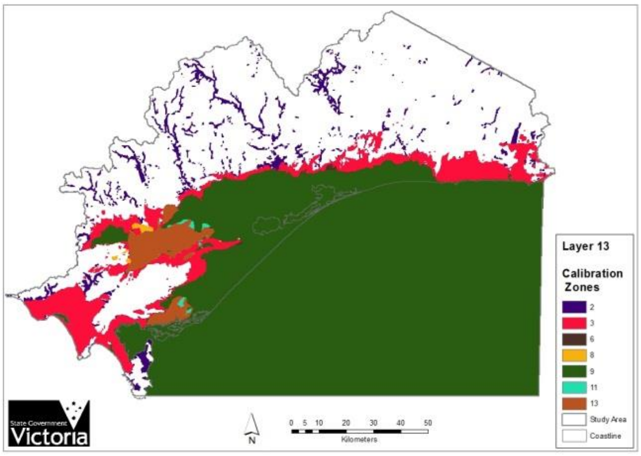


Figure 92: Calibration zones for model layer 13.

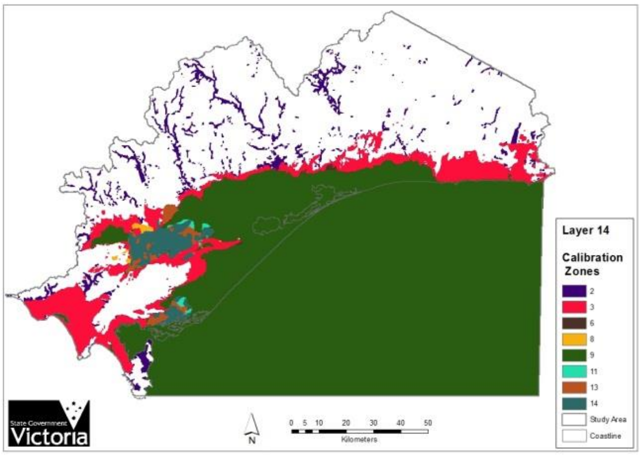


Figure 93: Calibration zones for model layer 14.

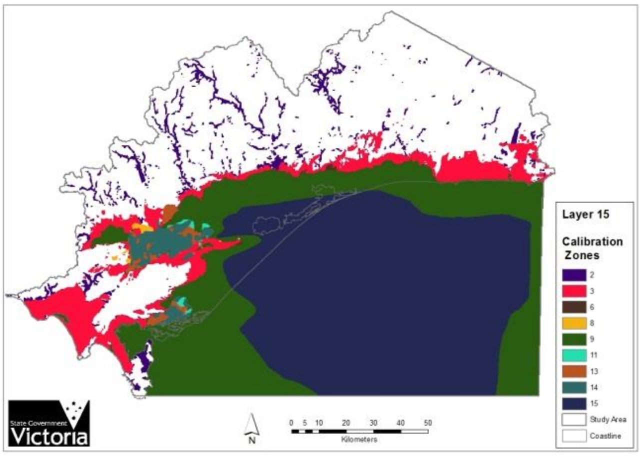


Figure 94: Calibration zones for model layer 15.

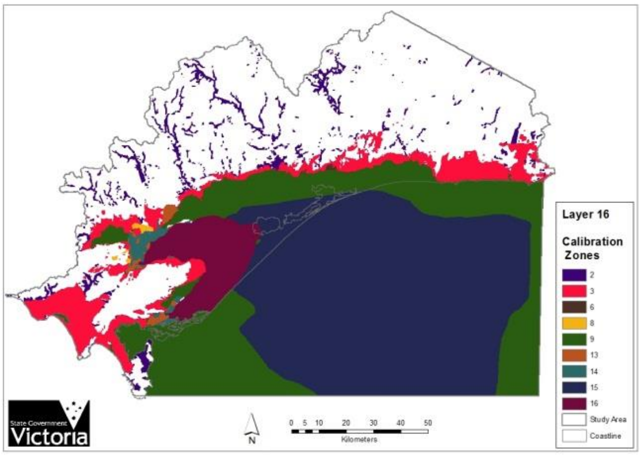


Figure 95: Calibration zones for model layer 16.

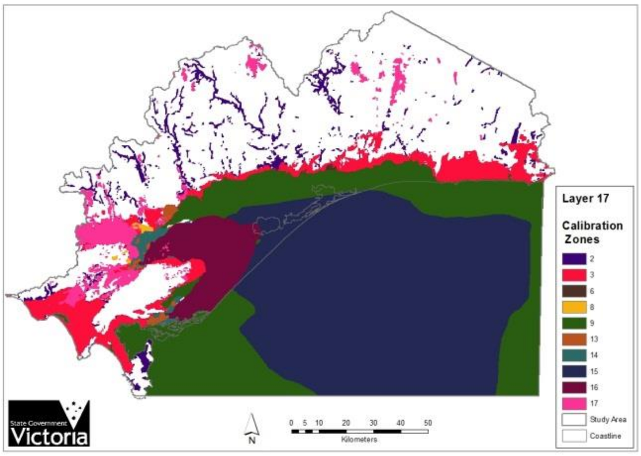


Figure 96: Calibration zones for model layer 17.

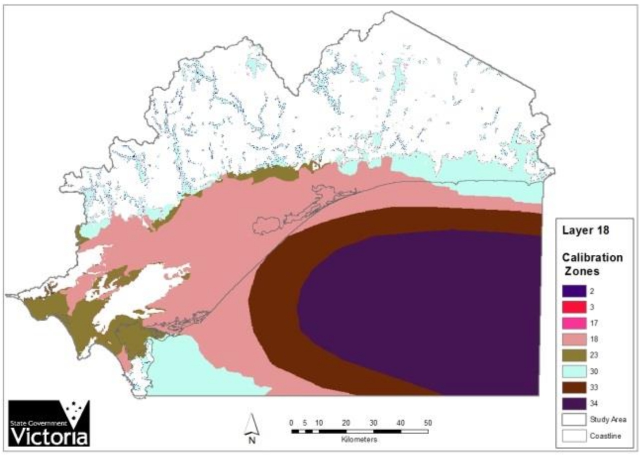


Figure 97: Calibration zones for model layer 18.

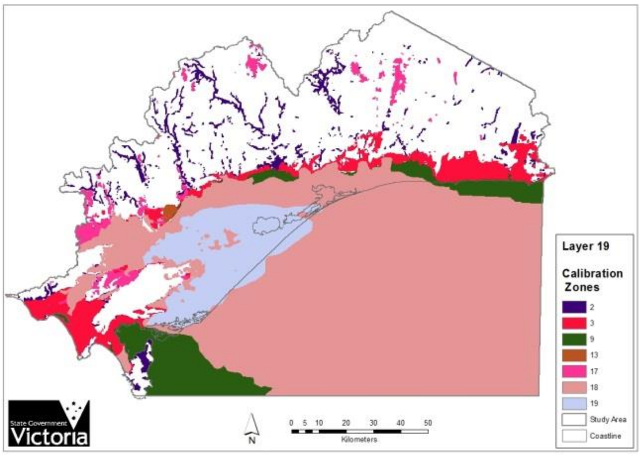


Figure 98: Calibration zones for model layer 19.

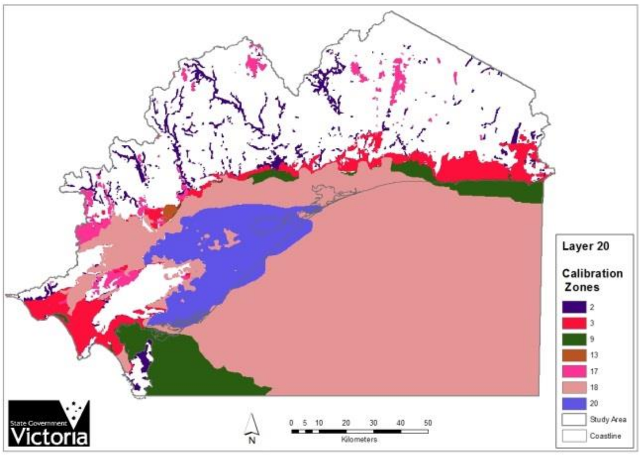


Figure 99: Calibration zones for model layer 20.

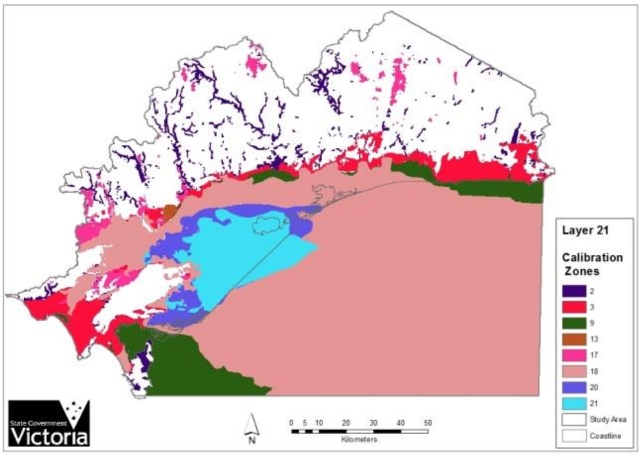


Figure 100: Calibration zones for model layer 21.

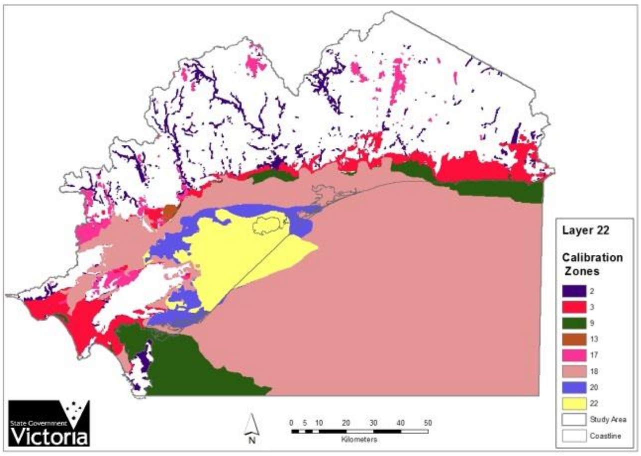


Figure 101: Calibration zones for model layer 22.

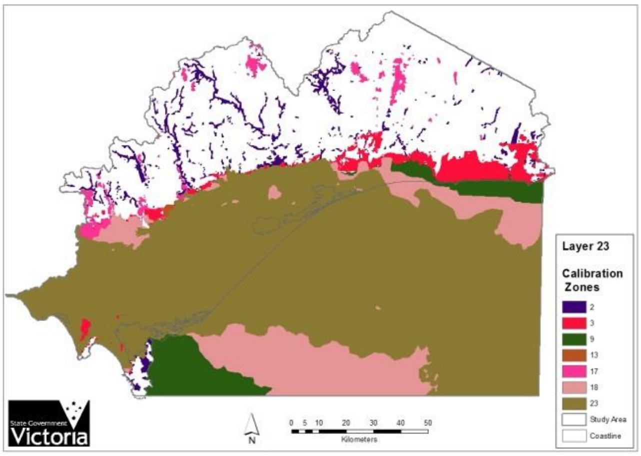


Figure 102: Calibration zones for model layer 23.

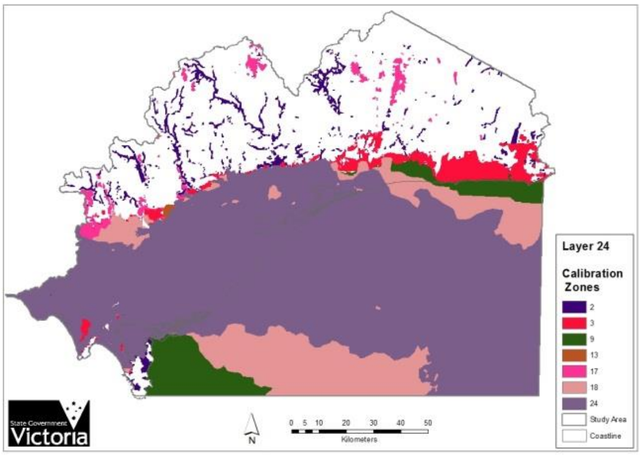


Figure 103: Calibration zones for model layer 24.

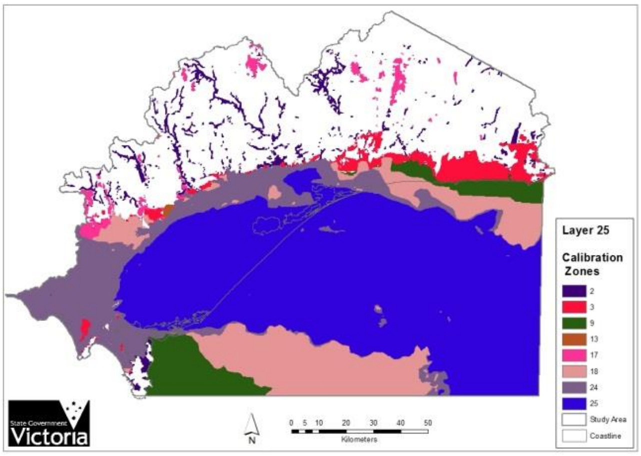


Figure 104: Calibration zones for model layer 25.

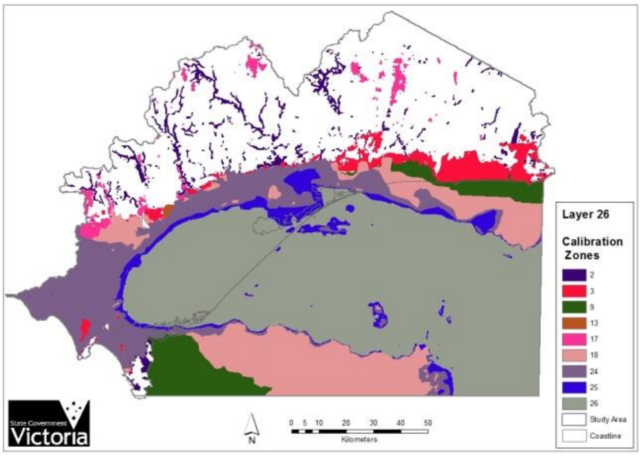


Figure 105: Calibration zones for model layer 26.

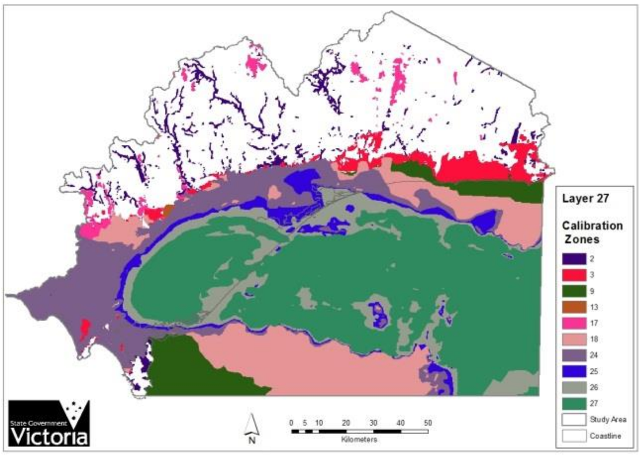


Figure 106: Calibration zones for model layer 27.

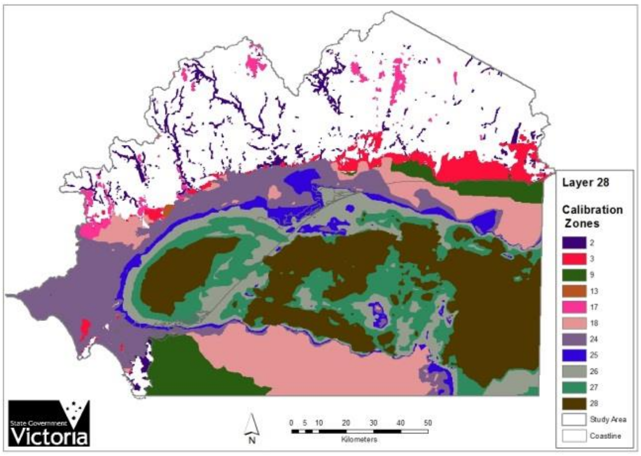


Figure 107: Calibration zones for model layer 28.

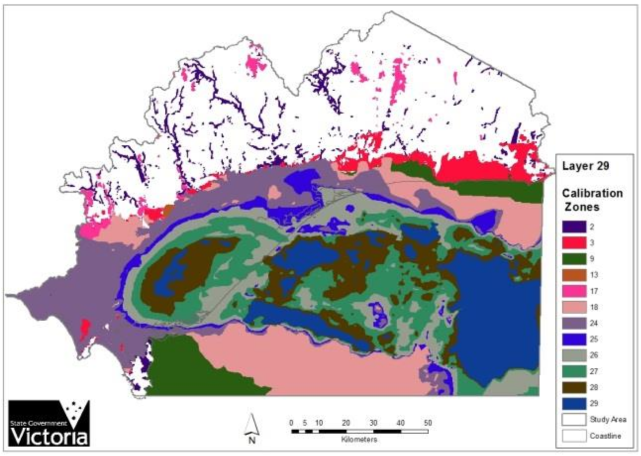


Figure 108: Calibration zones for model layer 29.

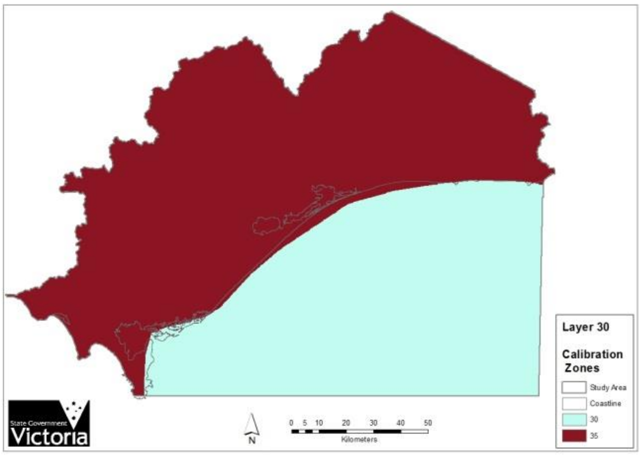


Figure 109: Calibration zones for model layer 30.

4.5 Sensitivity analysis

A comprehensive analysis was undertaken to assess the sensitivity of key modelled outputs to variations in input data. Modelled outputs considered included baseflow rates, saturated area and groundwater discharges (evapotranspiration, boundary fluxes and aquifer interflows). The sensitivity analysis procedure involved altering by up to three orders of magnitude the calibrated input data sets (including horizontal hydraulic conductivities, specific storage, specific yield, vertical hydraulic conductivities, recharge, maximum evapotranspiration rates, river and boundary conductance terms) and recording the groundwater response relative to the calibrated condition. Each input data set was systematically modified while maintaining all other input data. In total, approximately 4200 simulations were undertaken to test the robustness of the groundwater model and the uniqueness of the combination of input data required to meet the calibration criteria.

5 Steady-state model calibration

The steady-state model assumed 1970 pre-development conditions in which there was no groundwater extractions and annual recharge and potential evapotranspiration rates are shown in Figure 110 and Figure 111 respectively.

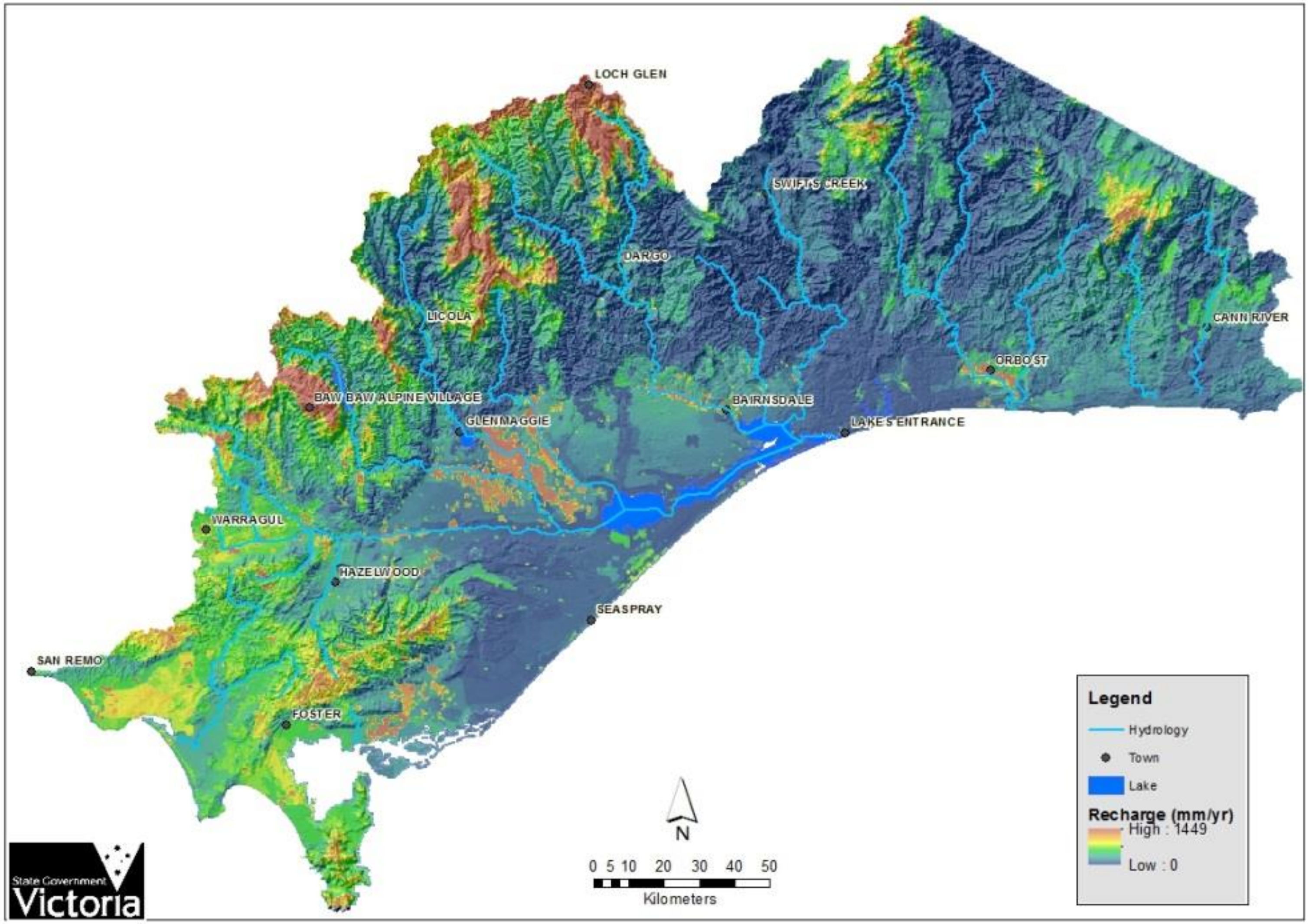


Figure 110: Steady-state equivalent annual recharge (mm/yr).

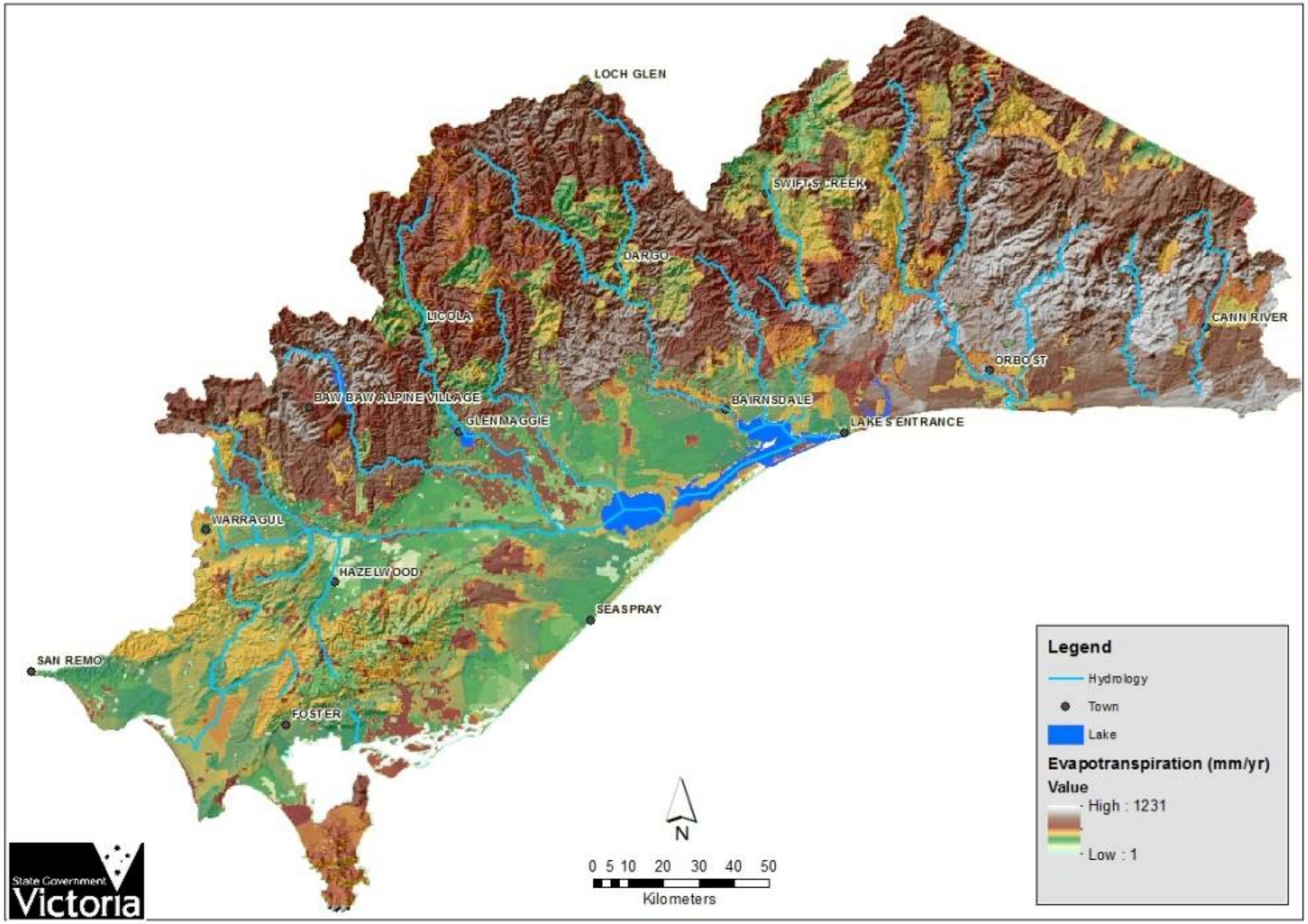


Figure 111: Steady-state equivalent annual potential groundwater evapotranspiration (mm/yr).

5.1 Mass balance

Simulated steady-state water balance results for the active model domain are summarised in Table 15. It is noteworthy that all domain cells remained saturated. The percentage mass balance closure error reported by Modflow-2005 was 0.7%, which satisfies the prescribed target.

Table 15: Steady-state mass balance.

	Flow in ML/day	Flow out ML/day	Net flow ML/day	% Recharge
Recharge	9737.7		9737.7	
Evapotranspiration		4002	–4002	41
Major rivers	15	353	–338	4
Drains/streams		3468	–3468	36
Constant head	777	2632	–1855	19

Results suggest that:

- **40% of groundwater recharge** discharges to river and drains
- **41% of groundwater recharge** is “lost” through evapotranspiration
- **19% of groundwater recharge** is discharged as a net outflow across the model boundaries predominantly through flux offshore.

5.2 Calibration statistics

The calibration statistics for the steady-state groundwater model based on 71 observation points are summarised in Table 16. These target statistics meet the calibration criteria as specified by the project. The observed versus computed target values are shown in Figure 112 whereas the observed versus residual error is shown in Figure 113.

Table 16: Steady-state model calibration statistics.

Statistic	Code	Unit	Steady-state
Mean sum of squares	MSSQ	m	3.50
Root mean square	RMS	m	1.87
Scale root mean square	SRMS	%	5.34
Root mean fraction square	RMFS	%	10.24
Scaled root mean fraction square	SRMFS	%	0.60
Sum of residuals	SR	m	398.07
Mean sum of residuals	MSR	m	0.52
Scaled mean sum of residuals	SMSR	%	1.49
Coefficient of determination	CD		0.66
Nash–Sutcliffe index	NSI		0.69

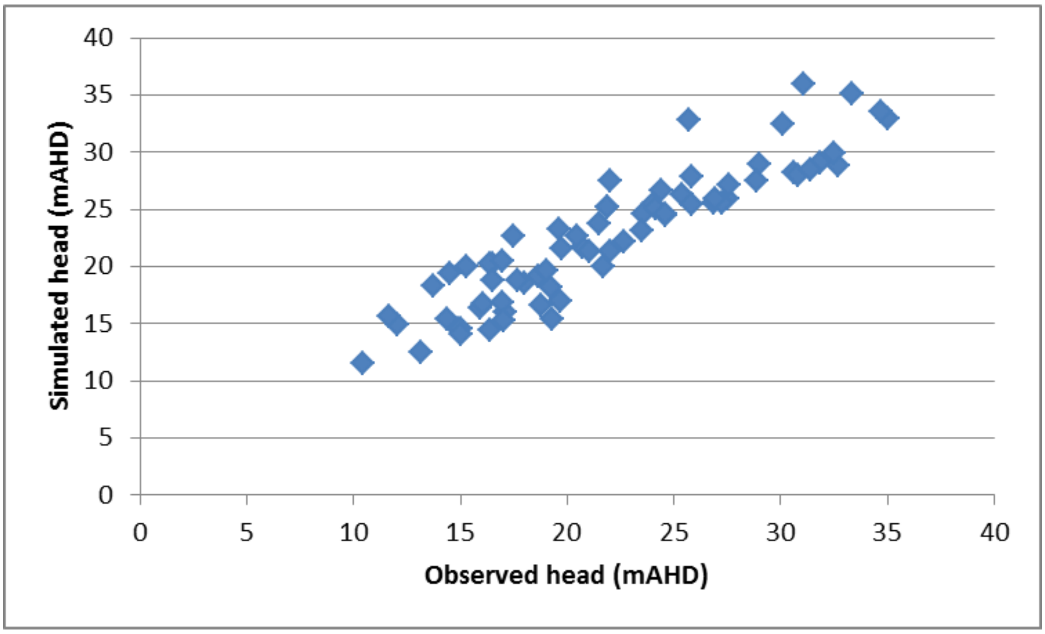


Figure 112: Observed versus computed steady-state heads (mAHD).

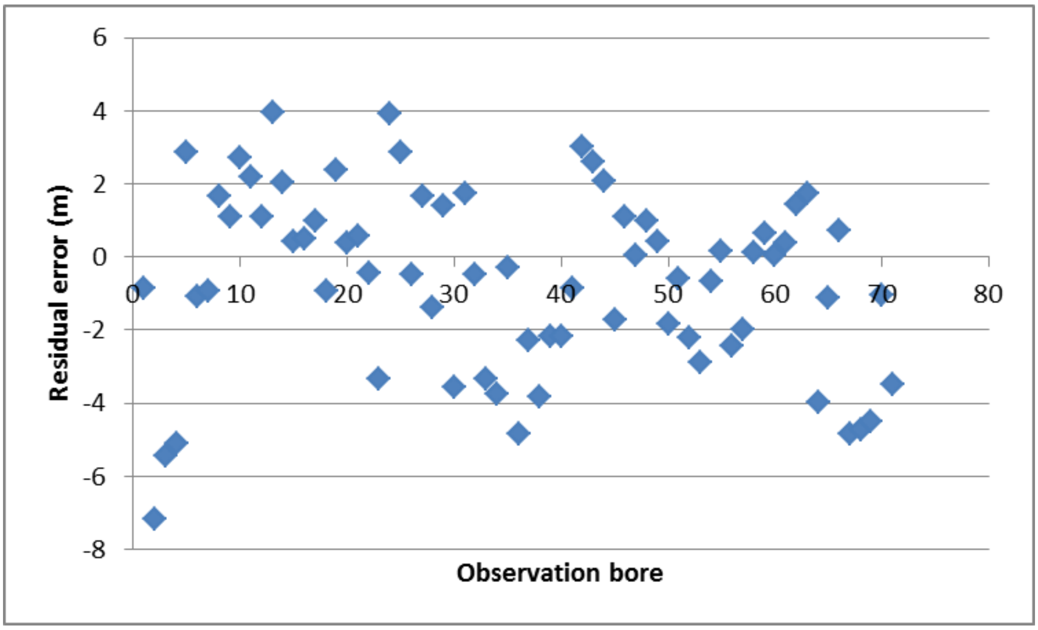


Figure 113: Residual error (observed head – modelled head) (m) for each steady-state calibration bore.

5.3 Depth to watertable and potentiometric surfaces

The simulated 1970 unconfined potentiometric surface (watertable) and depth-to-watertable across the entire model domain is shown in Figure 114 and Figure 115 respectively.

Visual comparison of the Victorian SAFE depth to watertable map (Figure 116) with the steady-state simulated depth to watertable shows the watertable surface is reasonable within the alluvial systems, however in some upland locations the watertable appears in greater connection with surface features than presented in the Victorian Aquifer Framework (VAF) data. This is not considered a significant issue as these areas are well beyond the zone of interest.

It must be noted that the VAF depth to watertable map was derived using a combination of terrain analysis and interpolated bore data, and in part on proximity to streams within the exposed basement areas. Additionally, the VAF reflects the 1990 conditions whereas the simulated steady-state depth to watertable represents pre-development conditions. As such, it is expected that that the simulated steady-state depth to watertable map would have a greater area of shallow watertable than reported in the VAF spatial layer.

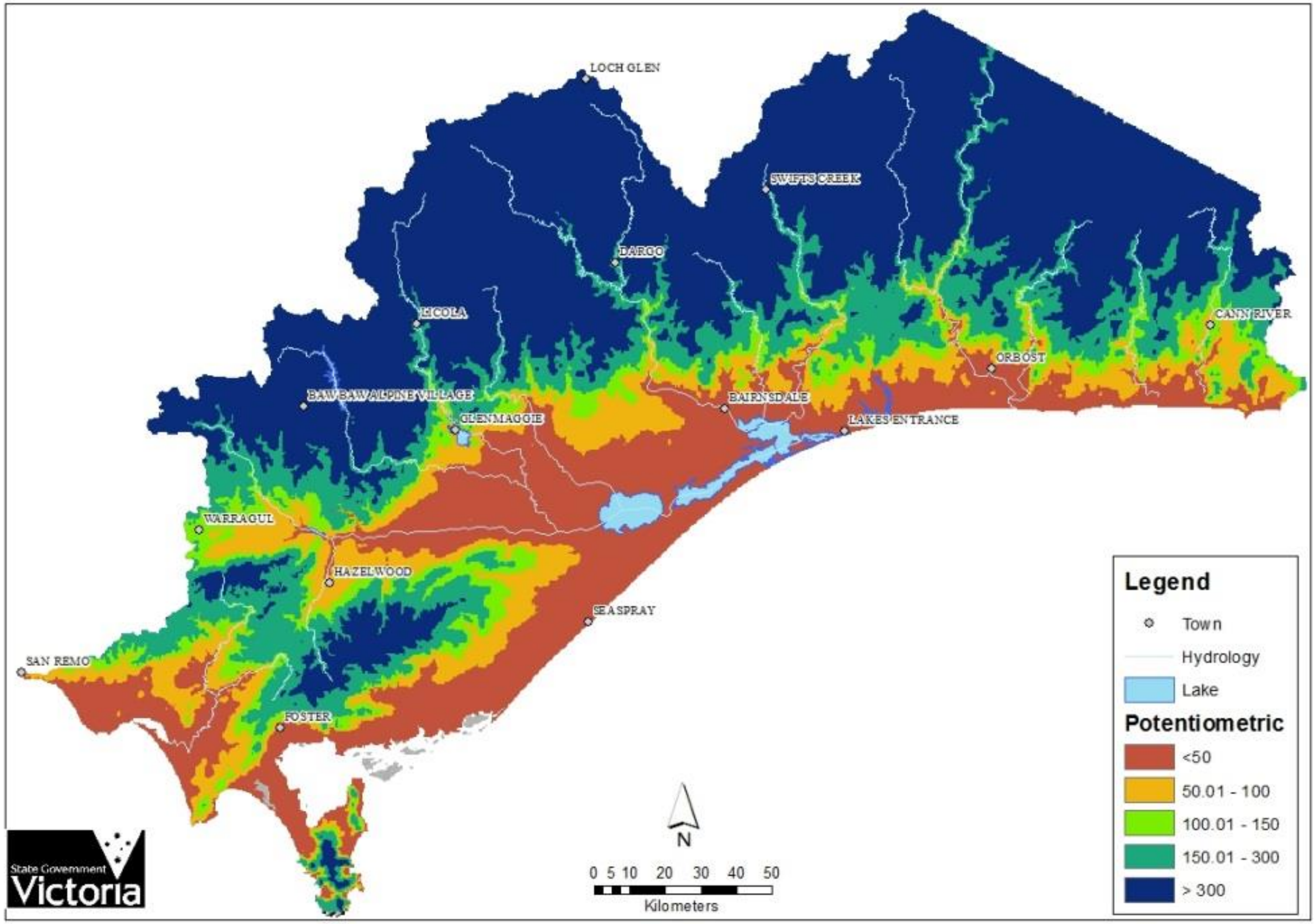


Figure 114: Simulated 1970 unconfined aquifer potentiometric surface (mAHD).

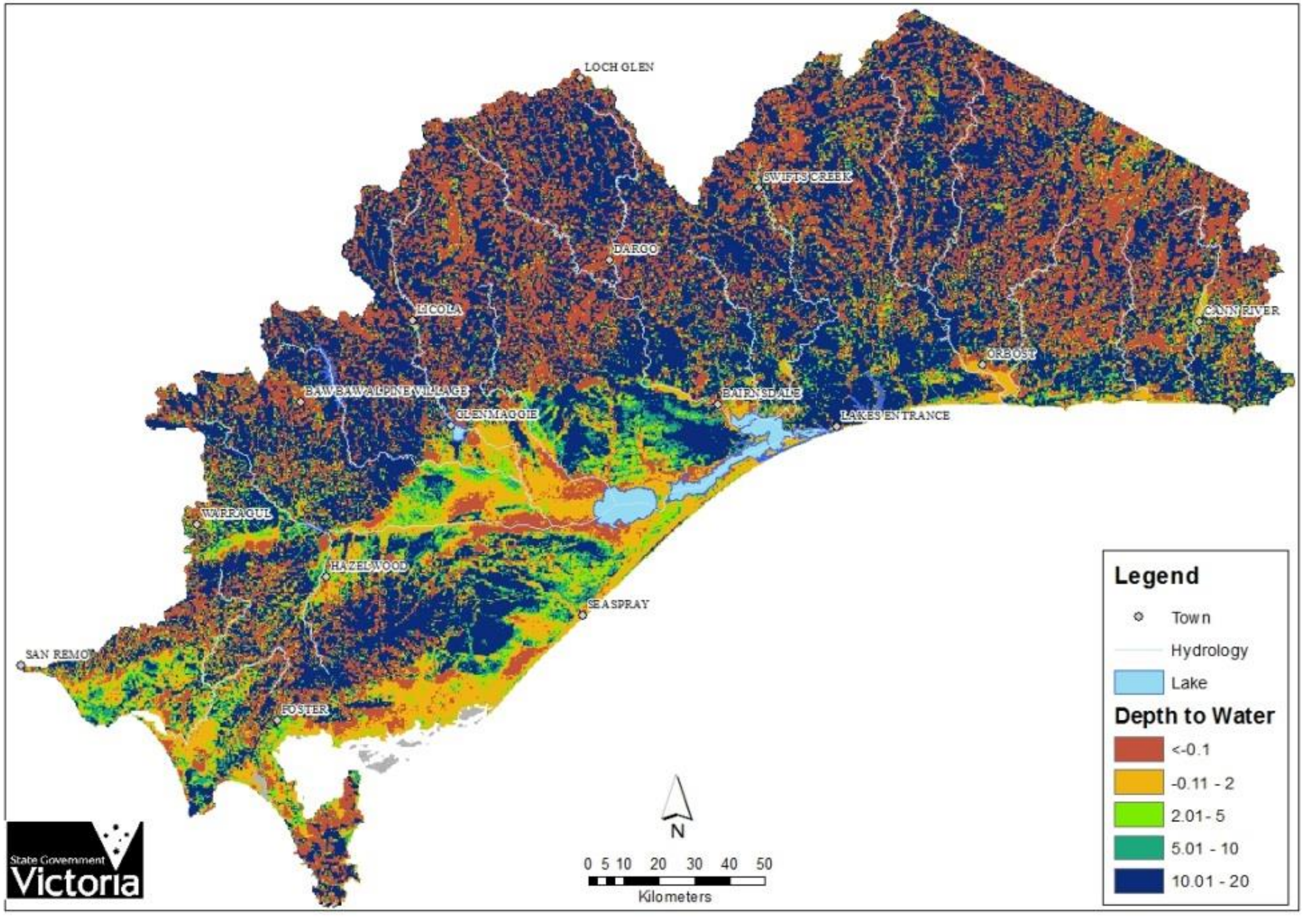


Figure 115: Simulated 1970 steady-state depth to watertable (m).

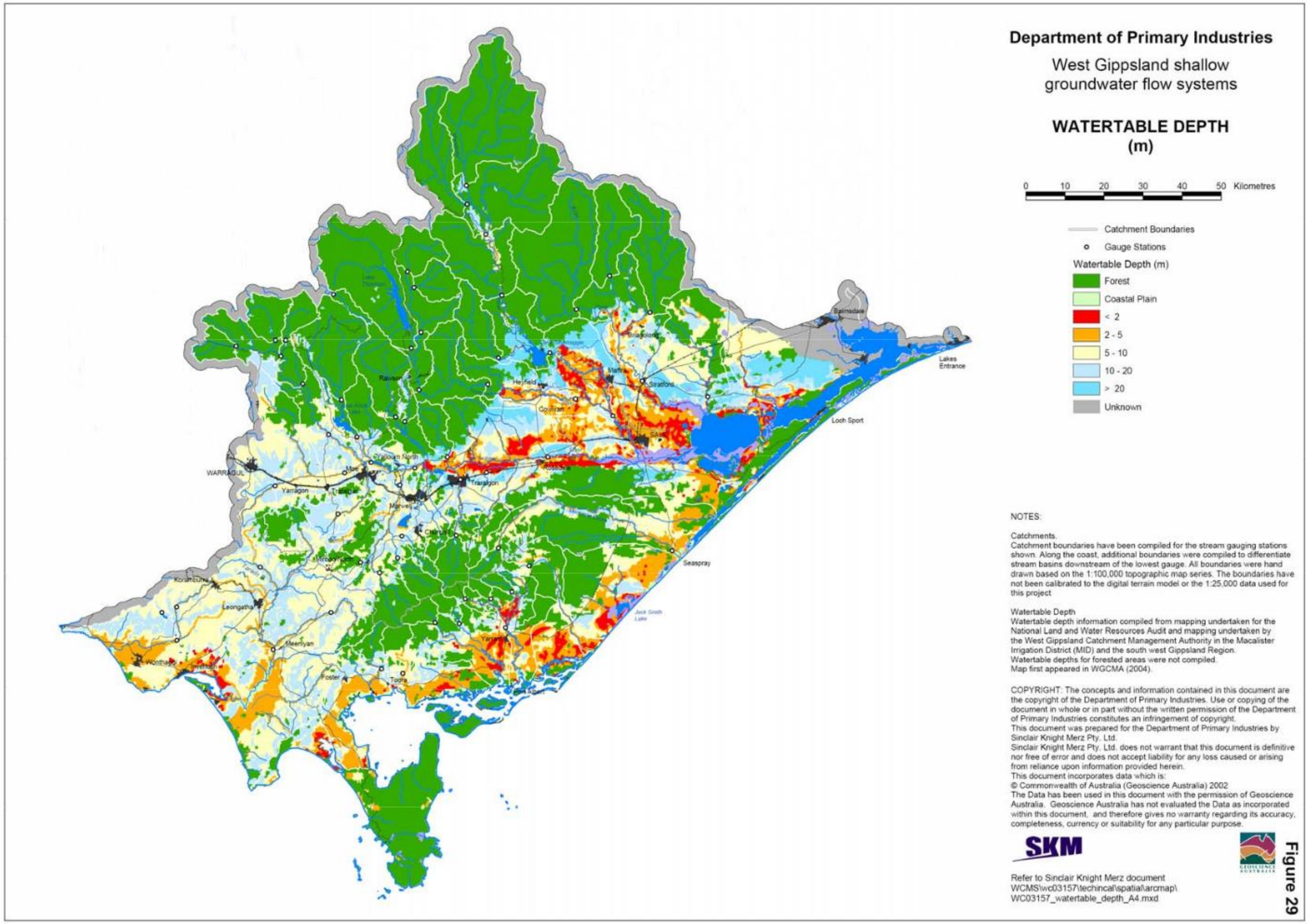


Figure 116: 1990 watertable depth (m) within the West Gippsland CMA region.

6 Transient model calibration

6.1 Calibrated model aquifer parameterisation

The transient model calibration was based on a spilt calibration/verification approach in which parameter optimisation was applied for the period 1990-2000 following which verification was assessed over the subsequent last eleven years from 2001 to 2012. Time constraints impacted on the progress of the transient calibration. The calibration strategy was to produce modelled hydrographs that match the trends of the observation bores. It was acknowledged that any elevation offsets between observed and predicted heads would be addressed as part of any future model refinement phase.

With the exception of zones 23-29 representing the Strzelecki Formation parameterisation, the post-calibration modelled aquifer parameterisation is summarised in Table 17. The aquifer parameterisation attributed to zones 23-29 were revised following a review of the Strzelecki Formation parameterisation. The model calibration results in the horizontal hydraulic conductivity for the uppermost Strzelecki units of the order 0.195 m/day and the vertical hydraulic conductivity be 0.0295 m/day which are inconsistent with the potential for this layer to act as a tight or shale gas reservoir. In order to better represent this potential a lower value was used for scenario purposes.

Table 17: Calibrated model aquifer parameterisation

Zone	Aquifer	Kxy (m/d)	Kzz (m/d)	Specific Yield	Specific storage (m^{-1})	Kzz/Kxy
1	Marine water thickness	1.063×10^{2}	1.594×10^{1}	0.1	1×10^{-5}	0.150
2	Quaternary	6.507	9.761×10^{-1}	0.1	1×10^{-5}	0.150
3	Haunted Hill Formation	3.203	4.804×10^{-1}	0.1	1×10^{-5}	0.150
4	Nuntin clay	3.333	5×10^{-1}	0.04	1×10^{-5}	0.150
5	Boisdale Formation	2.986×10^{1}	4.479	0.1	1×10^{-5}	0.150
6	Jemmys Point & Upper Hazelwood Formation	8.890×10^{-2}	1.334×10^{-2}	0.1	1×10^{-5}	0.150
7	Yallourn Coal Seam	2×10^{-3}	3×10^{-4}	0.1	1×10^{-5}	0.150
8	Yallourn Aquifer and interseam	7.667×10^{-1}	1.15×10^{-1}	0.1	1×10^{-5}	0.150
9	Lower M2 interseam	1.605×10^{1}	1.202	0.1	1×10^{-5}	0.075
10	M1A coal	2.230×10^{-1}	3.345×10^{-2}	0.02	1×10^{-5}	0.150
11	Morwell 1A interseam/aquifer	7.450	7.45×10^{-1}	0.1	1×10^{-5}	0.100
12	Morwell 1B coal	4.525×10^{-2}	6.79×10^{-3}	0.1	1×10^{-5}	0.150
13	Morwell 1B interseam	9.691	1.602×10^{-1}	0.1	1×10^{-5}	0.017
14	Morwell 2	4.108 X 10-1	6.162×10^{-2}	0.1	1×10^{-5}	0.150
15	Lakes Entrance Formation	9.572×10^{-2}	8.860×10^{-3}	0.05	1×10^{-5}	0.093
16	M2c aquifer/Seaspray sands	6.119	3.902×10^{-1}	0.1	1×10^{-5}	0.064
17	Thorpdale volcanics	6.522×10^{-1}	1.820×10^{-2}	0.1	1×10^{-5}	0.028
18	Upper Latrobe Group	2.350	3.524 X 10-1	0.1	1×10^{-5}	0.150

19	T1 coal	1.92×10^{-3}	2.9×10^{-4}	0.02	1×10^{-5}	0.151
20	T1 interseam	1.262	1.894×10^{-1}	0.1	1×10^{-5}	0.150
21	T2 coal	1.420×10^{-3}	8×10^{-5}	0.02	1×10^{-5}	0.056
22	T2 interseam	8.862×10^{-1}	9.566×10^{-2}	0.1	1×10^{-5}	0.108
23	Strzelecki top 500m	1×10^{-2}	1×10^{-3}	0.02	1×10^{-5}	0.100
24	Strzelecki 500-1000m	2×10^{-4}	1×10^{-5}	0.02	1×10^{-5}	0.050
25	Strzelecki 1km-2km	2×10^{-4}	1×10^{-5}	0.02	1×10^{-5}	0.050
26	Strzelecki 2km-3km	2 X 10-4	1×10^{-5}	0.02	1×10^{-5}	0.050
27	Strzelecki 3km-4km	2×10^{-4}	1×10^{-5}	0.02	1×10^{-5}	0.050
28	Strzelecki 4km-6km	2×10^{-4}	1×10^{-5}	0.02	1×10^{-5}	0.050
29	Strzelecki >6km	2×10^{-4}	1×10^{-5}	0.02	1×10^{-5}	0.050
30	Palaeozoic basement 200m thick	1.012×10^{-1}	1.518×10^{-2}	0.02	1×10^{-5}	0.150
31	Lower M2 interseam	8.747	1.312	0.1	1×10^{-5}	0.150
32	Lower M2 interseam	6.077	6.273×10^{-1}	0.1	1×10^{-5}	0.103
33	Upper Latrobe Group	2.665	3.997×10^{-1}	0.1	1×10^{-5}	0.150
34	Upper Latrobe Group	2.930	3.163×10^{-1}	0.12	1×10^{-5}	0.108
35	Palaeozoic basement 200m thick	1.950	2.337×10^{-2}	0.04	1×10^{-5}	0.012
36	Quaternary	1.501×10^{-1}	2.009×10^{-2}	0.07	1×10^{-5}	0.134

6.2 Mass balance

Simulated transient volumetric water balance components for the active model domain are shown in Figure 117. Presented results clearly show the transition phase from the initial steady-state conditions to the calibration period commencing 1990. Also of note is the lack of seasonal responses during the 1970 to 1990 simulation period during which annual stress periods have been assigned.

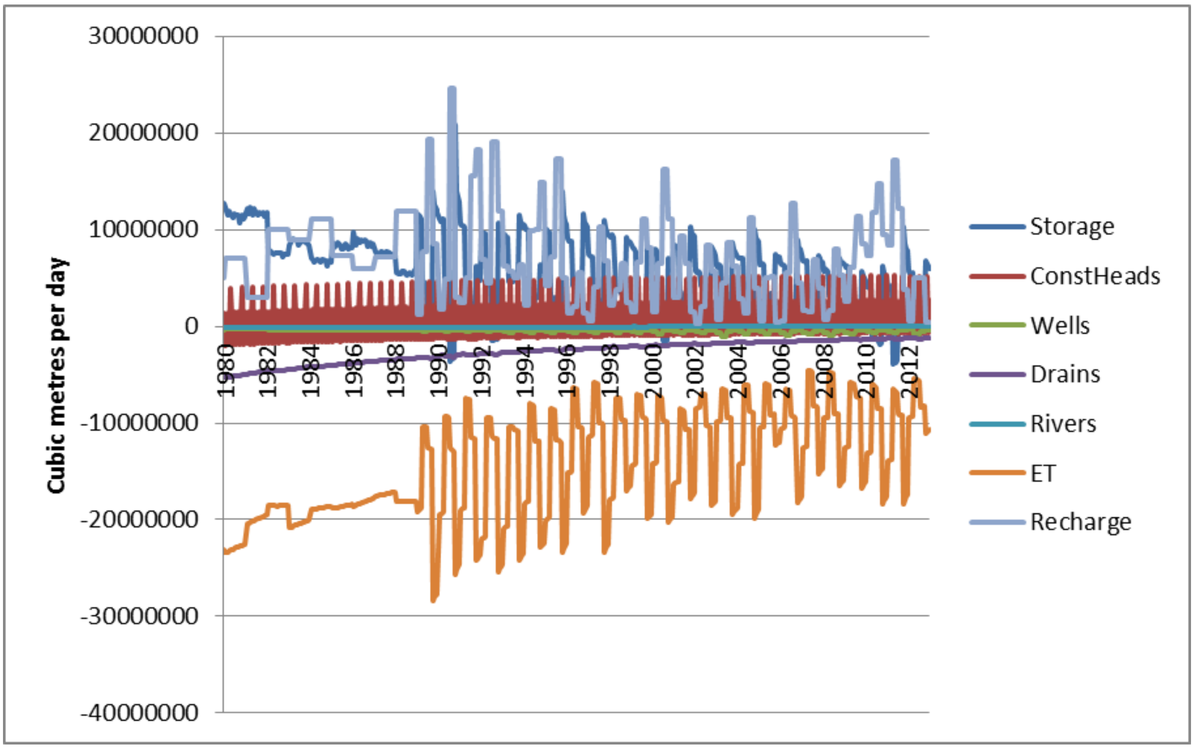


Figure 117: Transient model mass balance components (m^3/day per timestep).

6.3 Calibration statistics

The calibration statistics for the transient groundwater model based on 88, 799 observation points are summarised in Table 18 for the transition, calibration and verification periods. The transient calibration statistics suggest that there is a poor match between the modelled and observed data during the initial twenty years of simulation, which is also when the stress periods are large and the transition from the pseudo steady-state conditions would have the greatest impact on model predictions. This suggests that the simulated pseudo steady-state solution describes the 1970 groundwater condition poorly. Importantly the calibration statistics improve during the 1990-1999 calibration period as evidenced with an improved scaled RMS of 5.62% relative to the pre-calibration period scaled RMS of 8.82%. The 2000–2010 verification period has improved calibration statistics with a scaled RMS of 1.42%, a mean sum of residuals of 5 m and a coefficient of determination of 0.9. Key calibration criteria traces are presented in Figure 118 to Figure 121.

Simulated versus observed time-series traces are presented in Appendix H.

Table 18: Transient model calibration statistics.

Name of statistics	Code	Unit	1970–1989	1990–1999	2000–2010
Number of observations			16050	30158	42591
Mean Sum of Squares	MSSQ	m	876.30	354.53	231.78
Root Mean Square	RMS	m	29.60	18.83	15.22
Scale Root Mean Square	SRMS	%	8.82	5.62	1.42
Root Mean Fraction Square	RMFS	%	42186.37	5403.267	10633.07
Scaled Root Mean Fraction Square	SRMFS	%	3318.30	271.58	139.77

Name of statistics	Code	Unit	1970–1989	1990–1999	2000–2010
Sum of Residuals	SR	m	59826.58	221472.12	223509.96
Mean Sum of Residuals	MSR	m	3.73	7.34	5.25
Scaled Mean Sum of Residuals	SMSR	%	1.11	2.19	0.49
Coefficient of Determination	CD		0.45	0.68	0.90

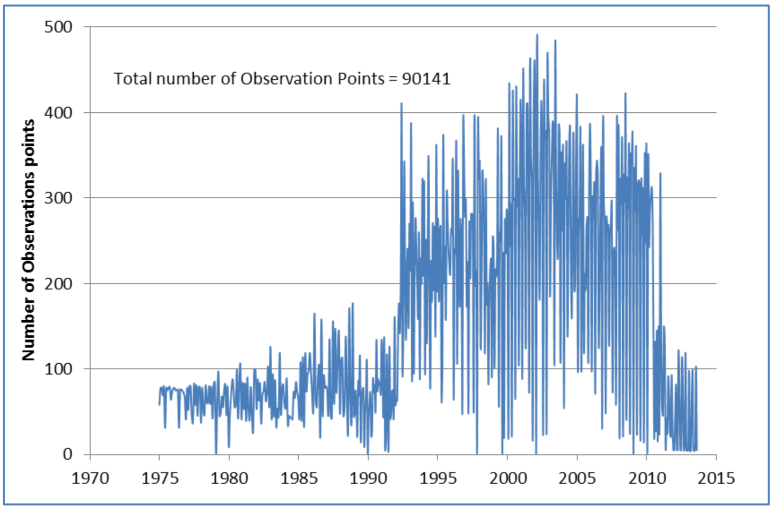


Figure 118: Number of observation points throughout the simulation period.

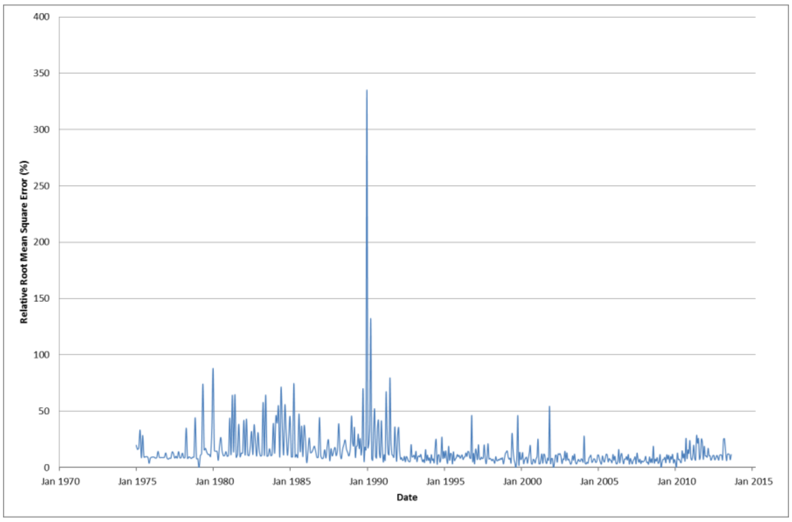


Figure 119: Temporal trace of RMS error (%) throughout simulation period.

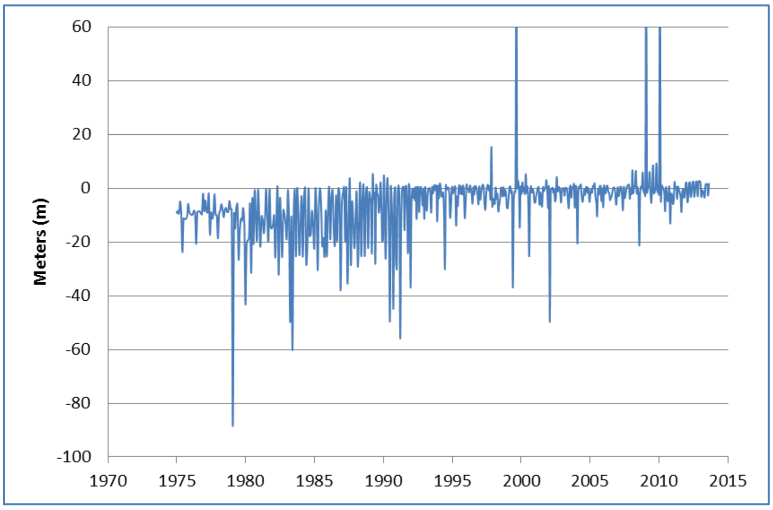


Figure 120: Temporal trace of mean residual error (m) throughout simulation period.

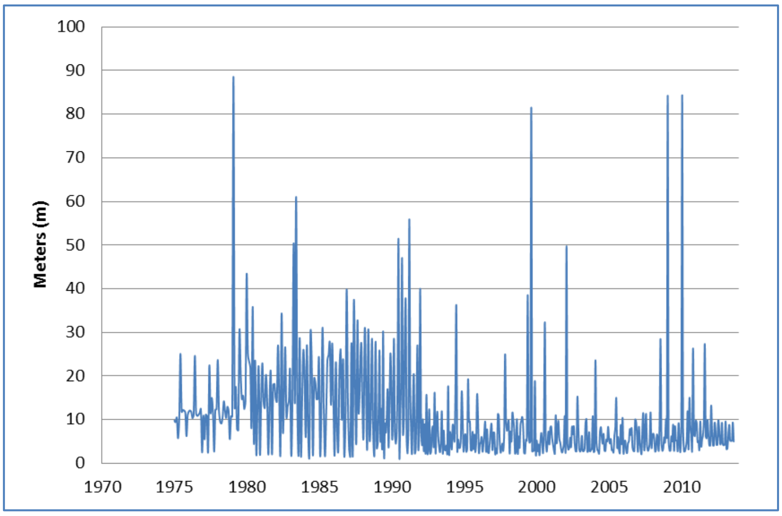


Figure 121: Temporal trace of mean absolute error (m) throughout the simulation period.

6.4 Spatial residual error

The spatial distributions of residual errors are presented in Figure 122, Figure 123, Figure 124 and Figure 125 for 1980, 1990, 2000 and 2010 respectively. The mean residual water level is defined such that negative numbers refer to points where predicted groundwater head values are higher than observed and positive values indicate that predicted groundwater head values are lower than observed.

Results shown in Figures 121 to 124 suggest that the model over predicts the heads in the outcropped regions and under predicts the heads in the lower parts of the landscape. The greatest errors are shown to be in the outcropping regions of the Strzelecki Formation suggesting that the model attribution associated with model layer 23 requires further analysis. This is consistent with observations reported in Section 6.1 that considered the hydraulic conductivities attributed to zones 23–29 were on the lower bounds of previously reported values.

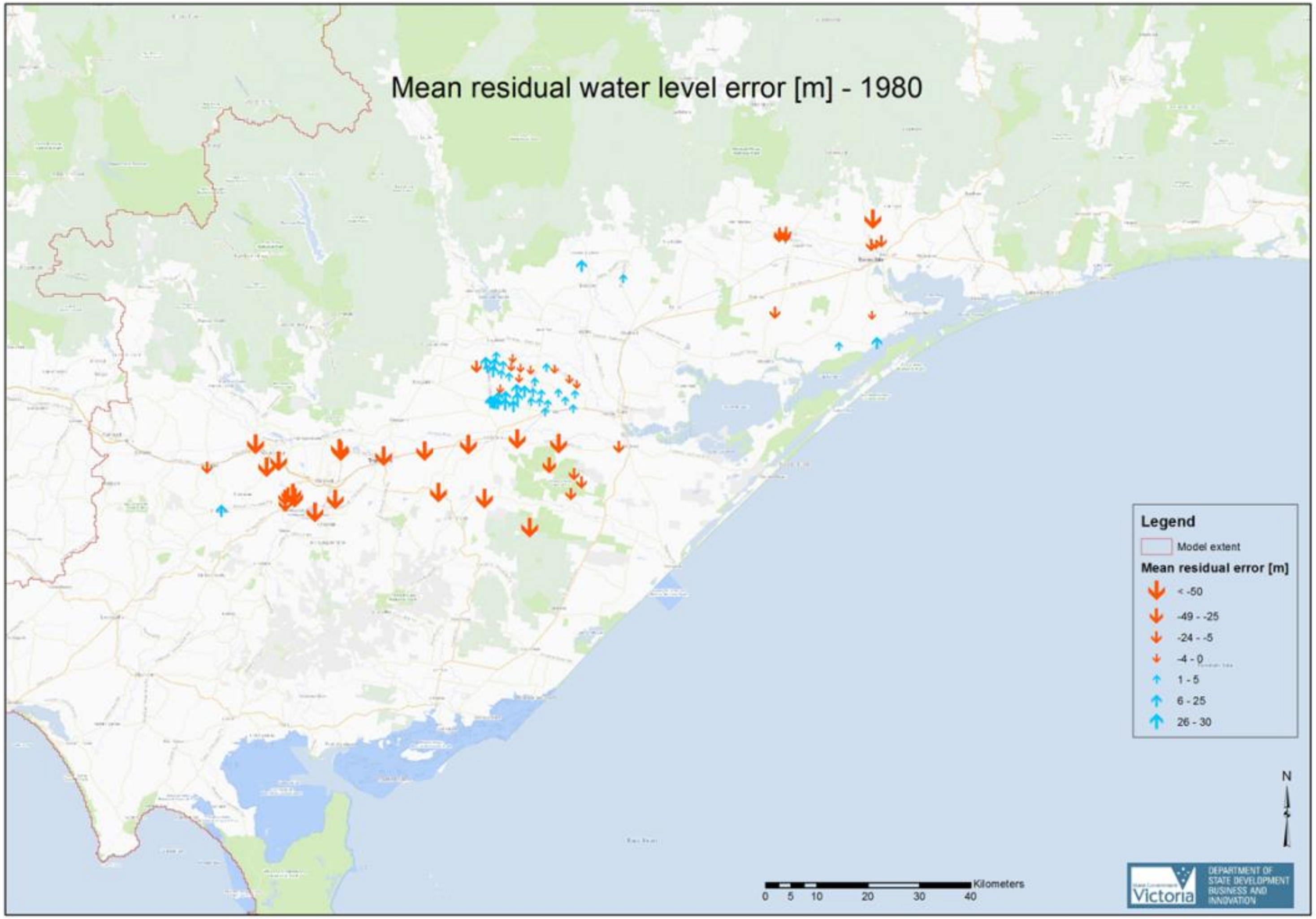


Figure 122: Spatial mean residual water level error (m) for 1980 based on observed and predicted heads.

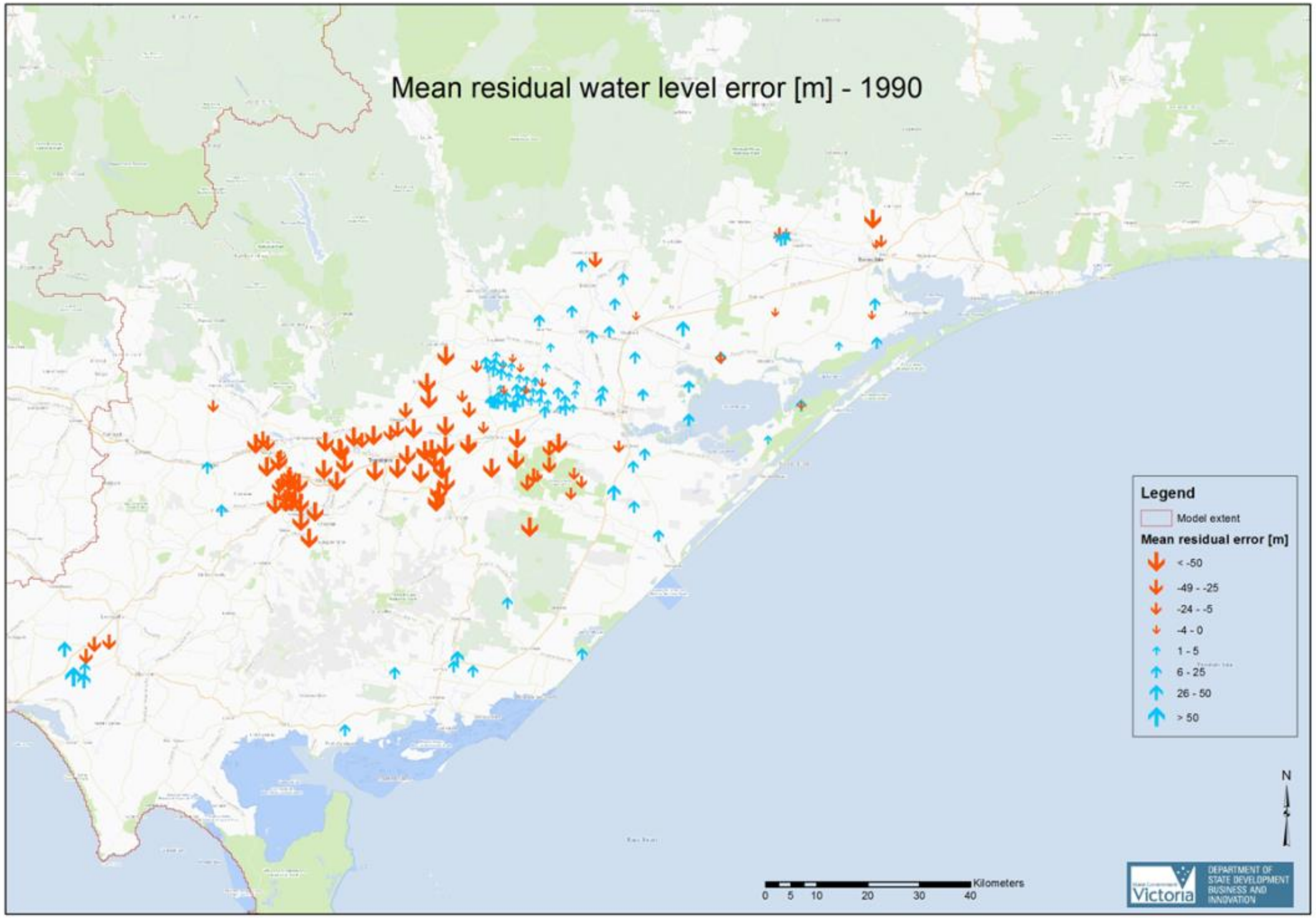


Figure 123: Spatial mean residual water level error (m) for 1990 based on observed and predicted heads.

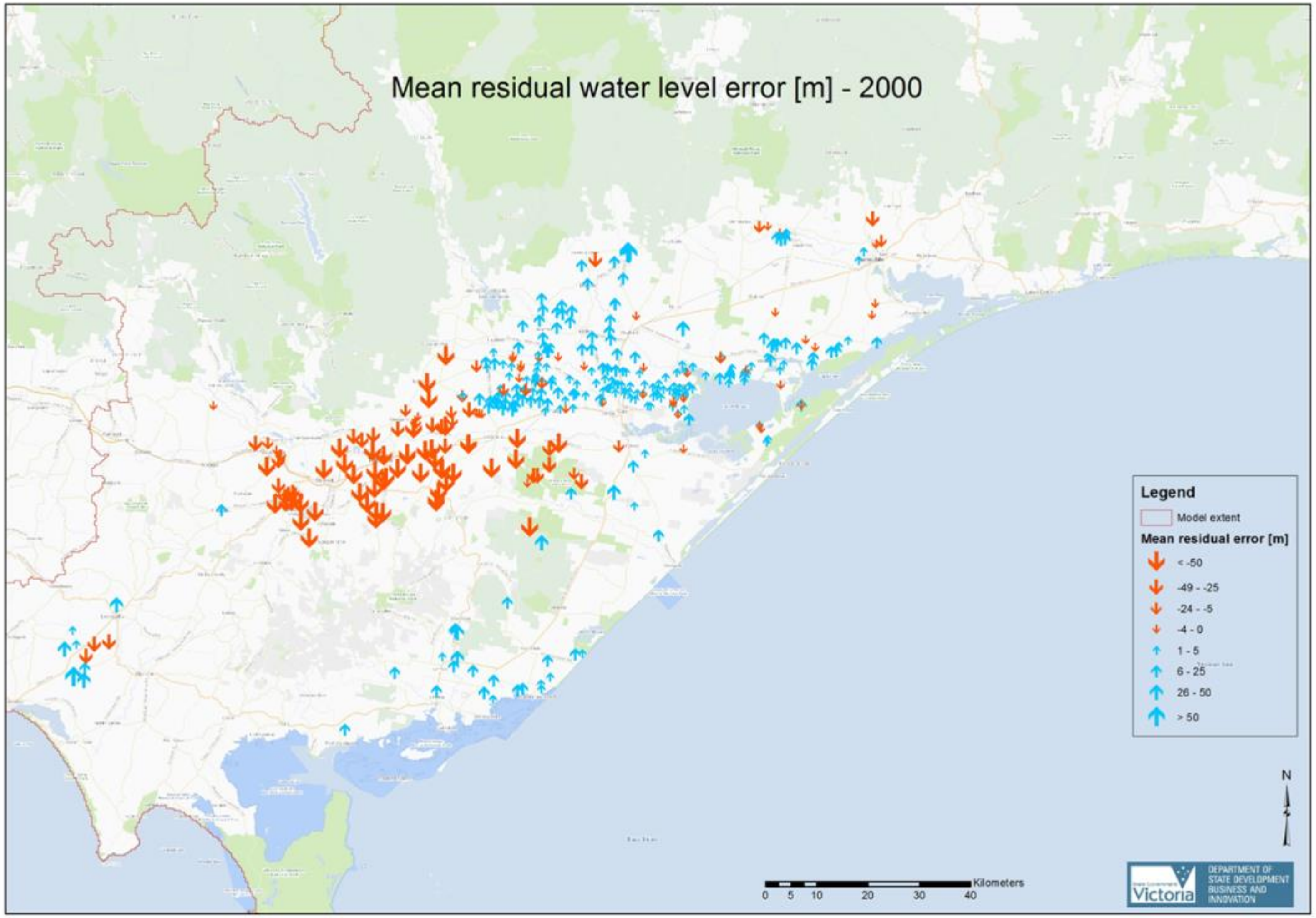


Figure 124: Spatial mean residual water level error (m) for 2000 based on observed and predicted heads.

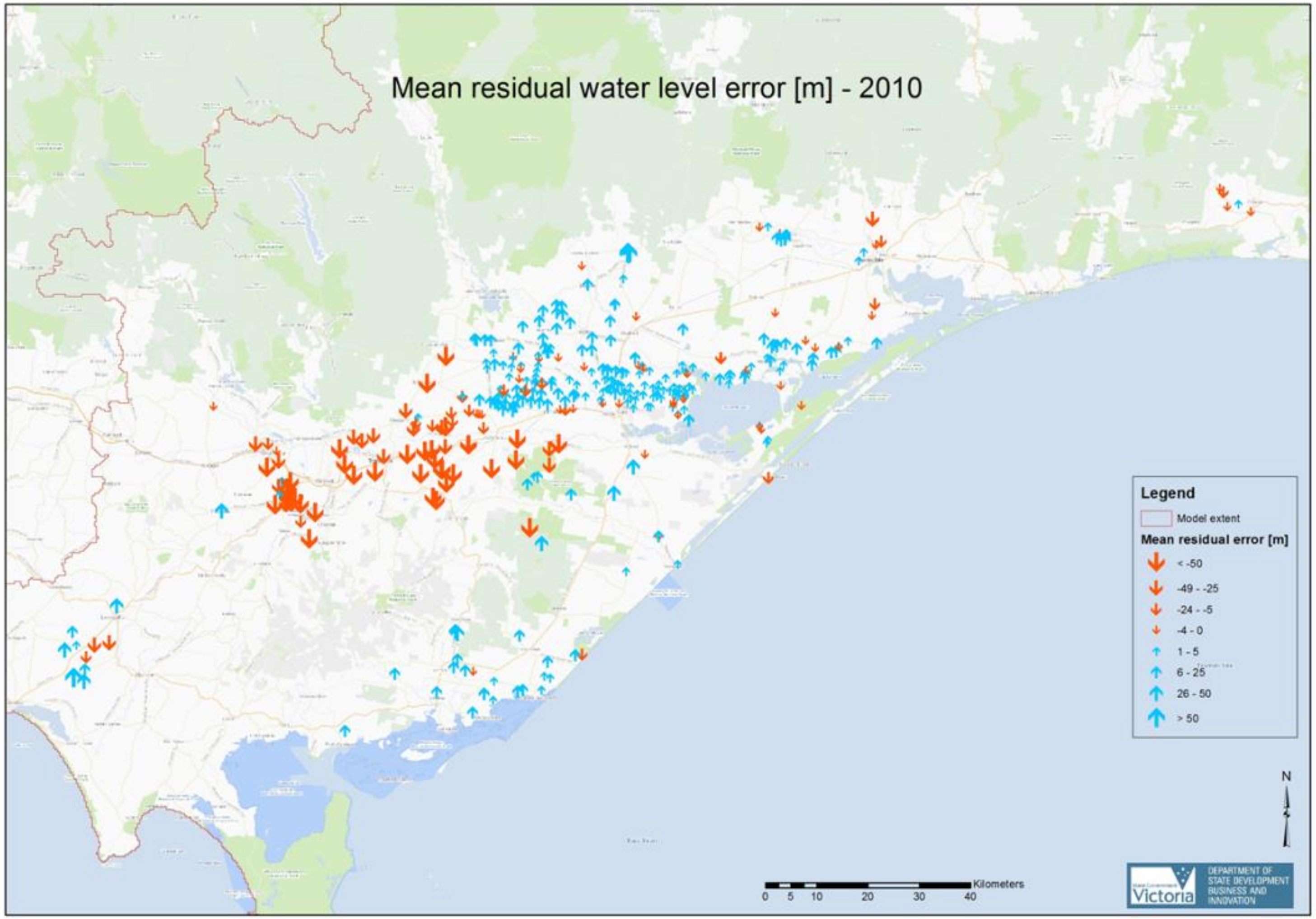


Figure 125: Spatial mean residual water level error (m) for 2010 based on observed and predicted heads.

7 Model sensitivity

A sensitivity analysis was undertaken to assess the performance of the groundwater model simulation to changes in various input parameter values. The model performance was assessed based on scaled RMS, coefficient of determination and NSI criteria (see Section 4) using observed and predicated calibration bore hydrograph responses. A total of 4200 simulations were examined in detail, in which changes in recharge, groundwater evapotranspiration rates, river conductance, horizontal and vertical hydraulic conductivities, specific storage and specific yields were modified by three orders of magnitude from the calibrated values. Although 4200 simulations were examined in detail, model performance results based on variations in recharge, groundwater evapotranspiration rates, river conductance, drain conductance and lateral hydraulic conductivities are presented for the steady-state in Figure 126 to Figure 129 respectively.

The sensitivity of the model to recharge estimates is shown in Figure 126. This figure shows the variation in MAE, coefficient of determination and NSI criteria due to altered recharge. The trajectory of each response curve reflects the solution uniqueness and stability of the model. The flatter the curve, the less sensitive the output to the associated model attribute.

Results from the sensitivity analysis show the comparatively high sensitivity of simulated shallow watertable extent to variations in recharge and maximum groundwater evapotranspiration. This is to be expected as these parameter changes are applied across large extents of the model, whereas hydraulic conductivity changes are applied on a zone by zone basis which may be of minor/limited areal extents. A similar outcome applies to river conductance changes which impact localised processes and is limited by the density of the river network incorporated in the model.

The sensitivity of predicted baseflow to parameter change, the most significant parameters are (in order of significance) recharge, potential groundwater evapotranspiration rates and river conductance. The least significant parameters are those associated with the deeper aquifers.

With respect to the modelled area of shallow watertable, the most significant parameters are (in order of significance) recharge, potential groundwater evapotranspiration rates and conductivities of the unconfined aquifers.

Based on this analysis, model uncertainty is most impacted by estimates of recharge and potential groundwater evapotranspiration rates. The hydraulic conductivities of the unconfined and outcropping aquifers also have significant influence on predicted baseflow and watertable extent.

In general the sensitivity analysis show model parameters generally fit within type I or II classification as described by Middlemis et al. (2000).

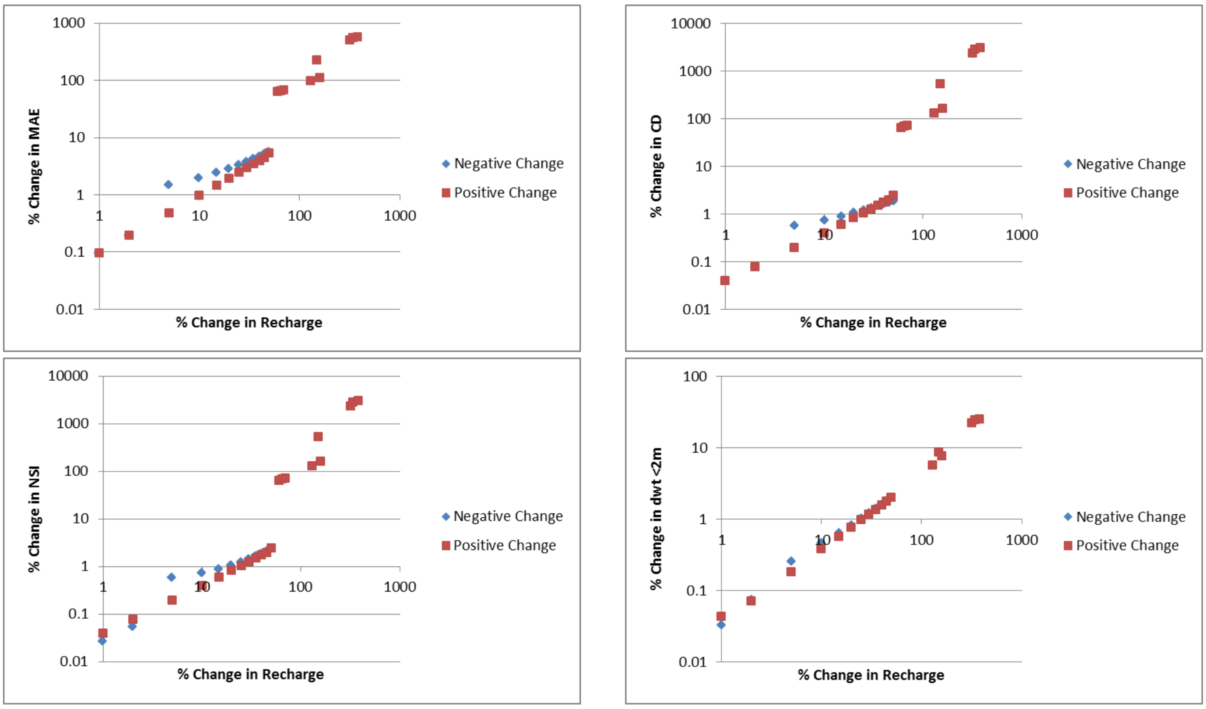


Figure 126: Sensitivity of the steady-state model to variations in recharge.

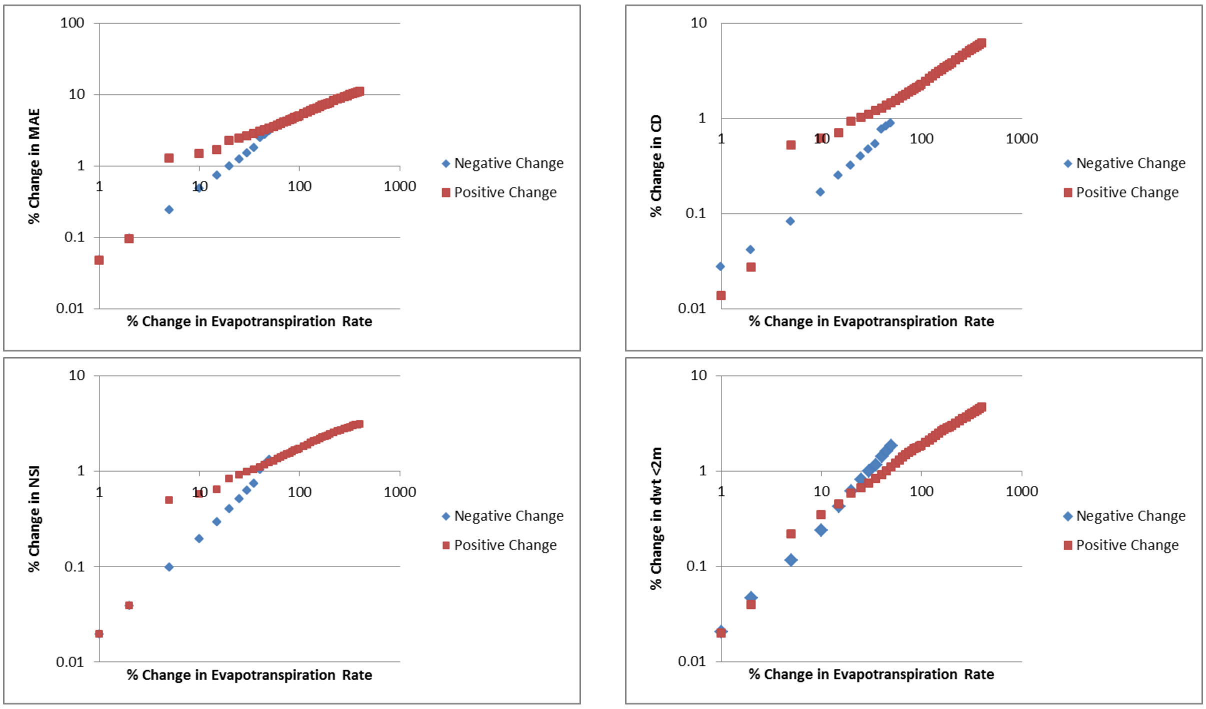


Figure 127: Sensitivity of the steady-state model to variations in potential groundwater evapotranspiration rate.

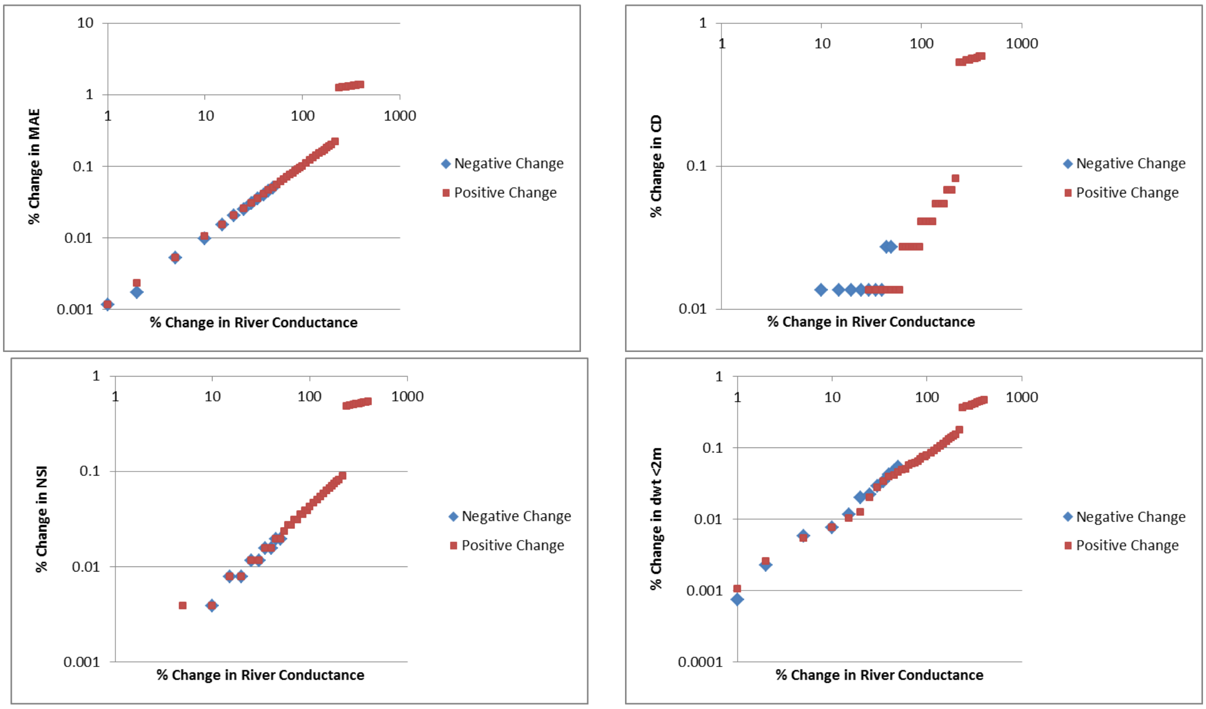


Figure 128: Sensitivity of the steady-state model to variations in river conductance.

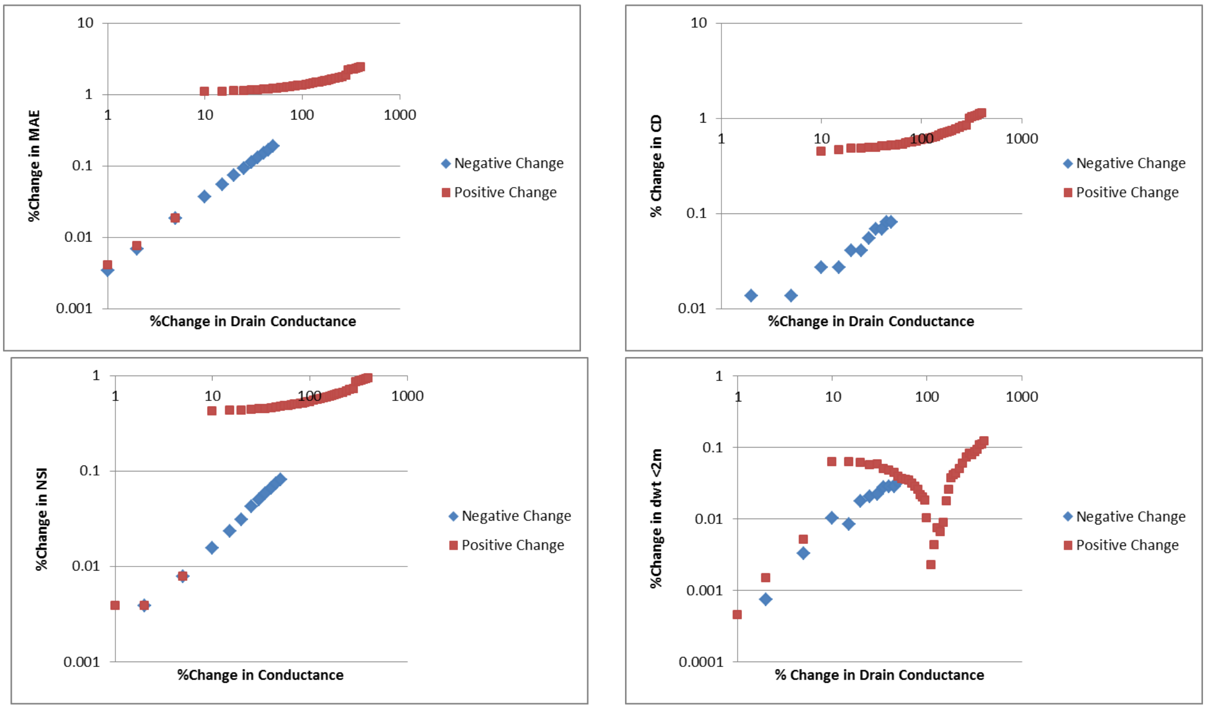


Figure 129: Sensitivity of the steady-state model to variations in drain conductance.

8 Model assumptions

The key assumptions underpinning the development of the Gippsland region groundwater model are summarised in Table 19. These assumptions provide a foundation for the development of the model; while there is always some level of uncertainty the best available data has been used to limit predictive errors. It is likely that in some areas detailed hydrogeological processes have not been fully captured in the conceptualisation. Sub-catchment or site-specific investigations would be required to better define local variations and responses.

Table 19: Key model assumptions.

Assumption	Basis
There is no dual porosity.	Dual porosity models are only applicable to solute transport models and are not meaningful for flow models.
Groundwater concentration gradients are acknowledged to have some impact on groundwater heads but have not been explicitly included in the simulation.	Data limitations make inclusion into a dispersion-convective transient model problematic and would require significant additional computational resources and time.
Groundwater temperature gradients are acknowledged to have some impact on groundwater heads but have not been explicitly included in the simulation.	As for density driven.
Bores used in the model have been correctly assigned to aquifers.	Significant data cleansing work used to preparing data sets, however minor inaccuracies may exist.
The digital elevation model (DEM) has adequate vertical resolution to allow reasonable calibration of the model and represents the land surface topology over the entire domain.	Self-evident.
Land use change data is limited in availability and extent and has not been incorporated in this study.	Development scenarios based on existing land use.
The model cell size is adequate to meet project objectives.	Self-evident.

9 Model fit for purpose

Review of model calibration (spatial and temporal) data in combination with the sensitivity analysis results suggests the groundwater model has the capacity to be used to assess the relative difference in predicted groundwater level changes between the proposed scenarios. It must be noted that it is not appropriate to use the model to assess the absolute water level or water balance under either calibration or scenario conditions. If additional scenarios (e.g. any not presented within this report) were to be applied to this calibrated groundwater model, the suitability (e.g. the fit for purpose for each) would need to be assessed on an individual basis.

10 Scenario modelling

Scenario modelling considers combinations of the following conditions:

- various climate scenarios, although not the same scenarios as modelled under the CSIRO Sustainable Yields Project
- development phases: the model has the capacity to simulate tight and shale and coal seam gas developments continuing for up to 30 years into the future with and without offshore development.

The purpose of the modelling was to quantify the impacts of potential onshore gas projects. The design of the scenarios was to consider combinations of tight and shale gas and coal seam gas extractions within defined prospective development regions. Note there is negligible/limited conventional gas. The impacts of each predictive scenario were estimated based on a comparison with a defined baseline condition.

10.1 Scenario future climate projects

Future climate regimes commence at the end of the calibration/validation period and extend from 1 January 2013 to December 2042. Prior to 1 January 2013 recorded daily meteorological data were used to derive recharge and groundwater evapotranspiration rate estimates as assigned during the model calibration/validation process. The future climate scenarios were based on a “dry” climate period selected to be 2006. Rainfall in 2006 was consistently close to the average for the 2003–2010 period concurrent with the drought, as shown in Figure 130.

All measured 2006 daily climate conditions were concatenated throughout the scenario period. It is noteworthy that the interannual distributions were unaltered, including potential evapotranspiration and solar radiation. Additionally it is important to note that no time varying climate change projections were applied, nor were the impacts of elevated carbon dioxide on plant performance considered. The climate change scenario directly influences future recharge and potential groundwater evapotranspiration rate estimates only.

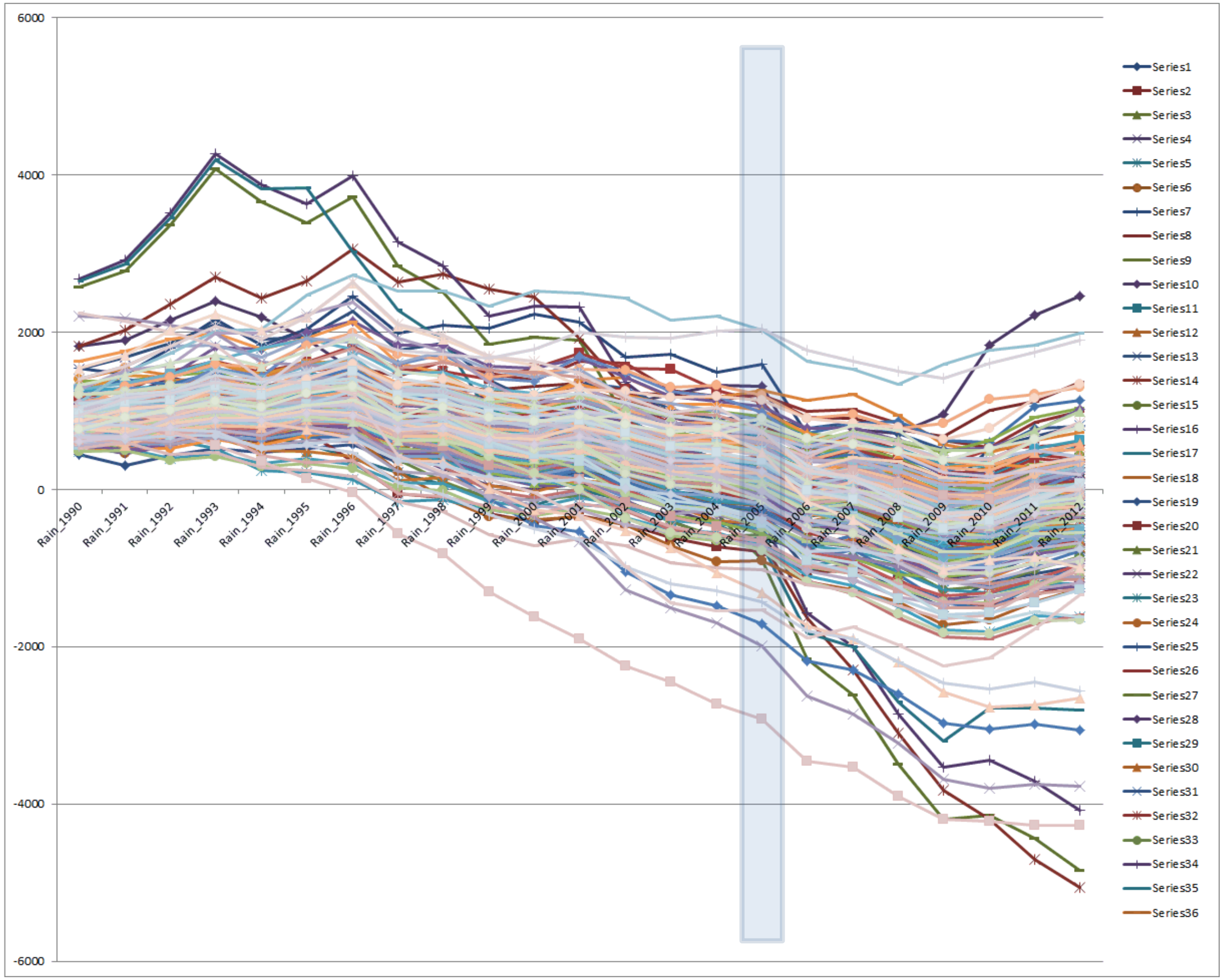


Figure 130: Cumulative residual rainfall traces for each climate station within the study domain and showing 2006, selected as the future climate scenario.

10.2 Scenario development conditions

The scenarios regarding potential onshore natural gas development focuses on onshore depressurisation due to potential future tight and shale gas and coal seam gas extractions. Table 20 summarises the basic attributes of the primary development scenarios.

The areas for potential onshore natural gas projects are reported in Goldie Divko (2014) and shown in Figure 131. The extent indicated by the “regional scale” boundary (Figure 131) is not representative of the likely development field; only the extent of the sub-cropping rock formation that has the potential to contain gas. For potential impact assessment purposes, the “sub-regional” extent represents the maximum limit to the area in which large scale resource development may occur and is applied in the model as the development scenario.

Gas extraction (both coal seam and tight and shale) was modelled using the Modflow drain function which removes water from the aquifer at a rate proportional to the difference between the head in the aquifer and some fixed head or elevation (called the drain elevation) so long as the head in the aquifer is above that elevation. If, however, the aquifer head falls below the drain elevation, then the drain has no effect on the aquifer. This approach does not enforce a pressure head elevation (which is unknown in this study) rather it assigns a potential head elevation and volumetric flux conductance based on aquifer properties. . In this case the drain elevation is set to the potential head elevation. In this way the time-varying pressure head elevation is not fixed but rather fluctuates based on the extracted volumetric flux defined as a function of drain conductance and difference in pressure head elevation to drain elevation. It was considered that this approach was appropriate in preference to assigning the following alternative options:

1. A well function which relies on an a-priori user defined extraction volume (m^3/day). A suitable time-varying extraction volume was unknown.
2. A fixed head condition. This assumes that the assigned head elevation is known. Additionally the flux across this fixed head boundary could not be bounded by known extraction volume limits and therefore could result in unrealistic extracted volumes of water.
3. An evaporation function. The evaporation function is similar to a drain function except that the rate of extraction varies linearly from an uppermost elevation or “ET surface” and an “extinction depth” or cutoff depth below the “Et surface” elevation below which no extractions occur.

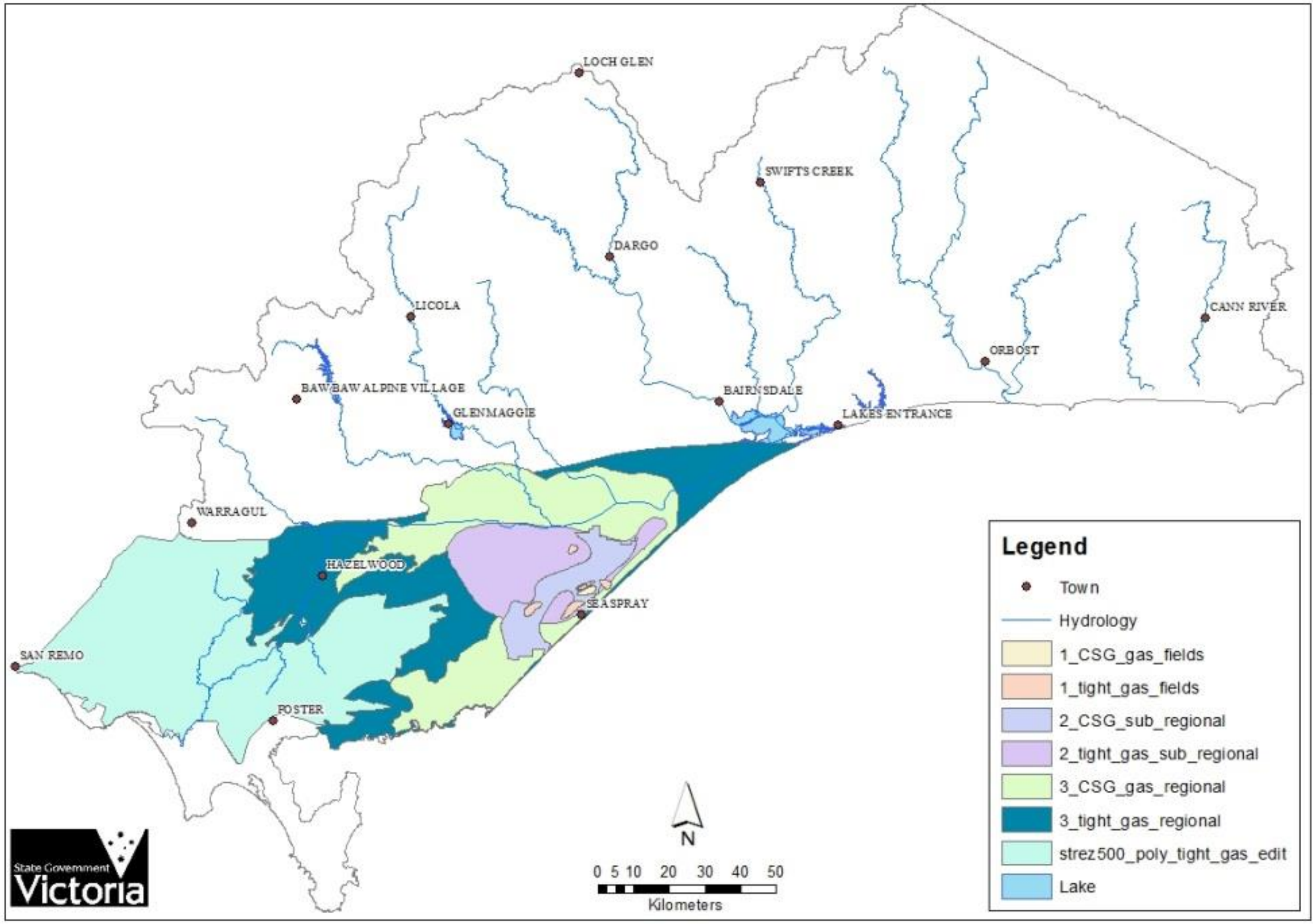


Figure 131: Spatial extents of the prospect fields (1), sub-regional (2) and regional (3) boundaries. Refer to Table 20 for data type attributes.

Table 20: Onshore natural gas development data (Goldie Divko, 2015).

	Development Type	Target formation / Depth (m below NS)	Total gas field area (km2) a Note (a)	GIIP (Tcf)	Target formation water pressure during gas extraction	Well pad/ well spacing	Flow rate (gas) mmcfpd	Flow rate (gas) cubic m/d	Porosity (%) Note (b)	Permeability (milli Darcy)	Water extraction (L/s)
Tight and shale	(1) Prospect/ field scale	1400	8.6	0.89	dry	1 km			<10	1.7-5.7	<0.5
		1400–1800	18.1	0.78	dry	1 km	0.6-1.2	16992–33984	<10	0.2	<0.5
		1000–1500	10.8	?	dry	1 km			<10		<0.5
		750–950	4.8	?	dry	1 km			<10	0.35	<0.5
		1600	5.7	?	dry	1 km			<10		<0.5
	(2) Sub-regional	1000–1800	1132	?	dry	1 km			2		<0.5
	(3) Regional	1000–2700	5374	?	dry	1 km					<0.5
Coal Seam Gas (brown coal)	(1) Prospect/ field scale	692	8.4	?	30 m above top of coal	354 m					
	(2) Sub-regional	400–800	438	3.7	30 m above top of coal	354 m					
	(3) Regional	200–1200	2793	?	30 m above top of coal	354 m					

Note (a): Area as per Figure 131

Note (b): Not specific yield

The development scenarios (Table 20) considered in this study focused on the sub-regional extents as shown in Figure 132 and adopted various configurations as summarised in Table 21. Scenario 1 and 2 were modelled by assigning drain cells to either layer 23 (Scenario 1) or layer 19 (Scenario 2) respectively. Drain bed hydraulic conductivities were initially assumed to be 50% of the horizontal hydraulic conductivity in which the drain cells are located and calibrated thereafter to match extraction volumes estimated by the New York State Department of Environmental Conservation (2009) for tight and shale gas and Sander and Connell (2014) for coal seam gas. Accordingly for coal seam gas developments the extraction volume was assumed to be 146 ML/yr/bore at 400 m spacing at start-up and for tight and shale gas the extraction volume was assumed to range between 2 and 5 ML/yr/km^2. These estimates were further tested through a model sensitivity procedure. The drain elevations for Scenario 1 were set to the top of the uppermost modelled layer representing the assigned formation whereas for Scenario 2 the drain elevation was set at 20 metres above the top of the uppermost modelled layer representing the assigned formation.

Table 21: Basic description of the primary development scenarios.

Scenario	Latrobe Valley coal mines	Groundwater licence entitlement	Offshore oil and gas	Onshore natural gas project
Scenario 0 (average) (baseline)	70% of the mine licence groundwater entitlement	Average usage over 10 years	Last 10 years	None
Scenario 0 (maximum) (sensitivity)	100% of the mine licence groundwater entitlement	As above	As above	As above
Scenario 1 (tight and shale)	As above	As above	As above	See Table 20 – “Tight and shale, sub-regional”
Scenario 2 (coal seam gas)	As above	As above	As above	See Table 20 – “CSG, sub-regional”

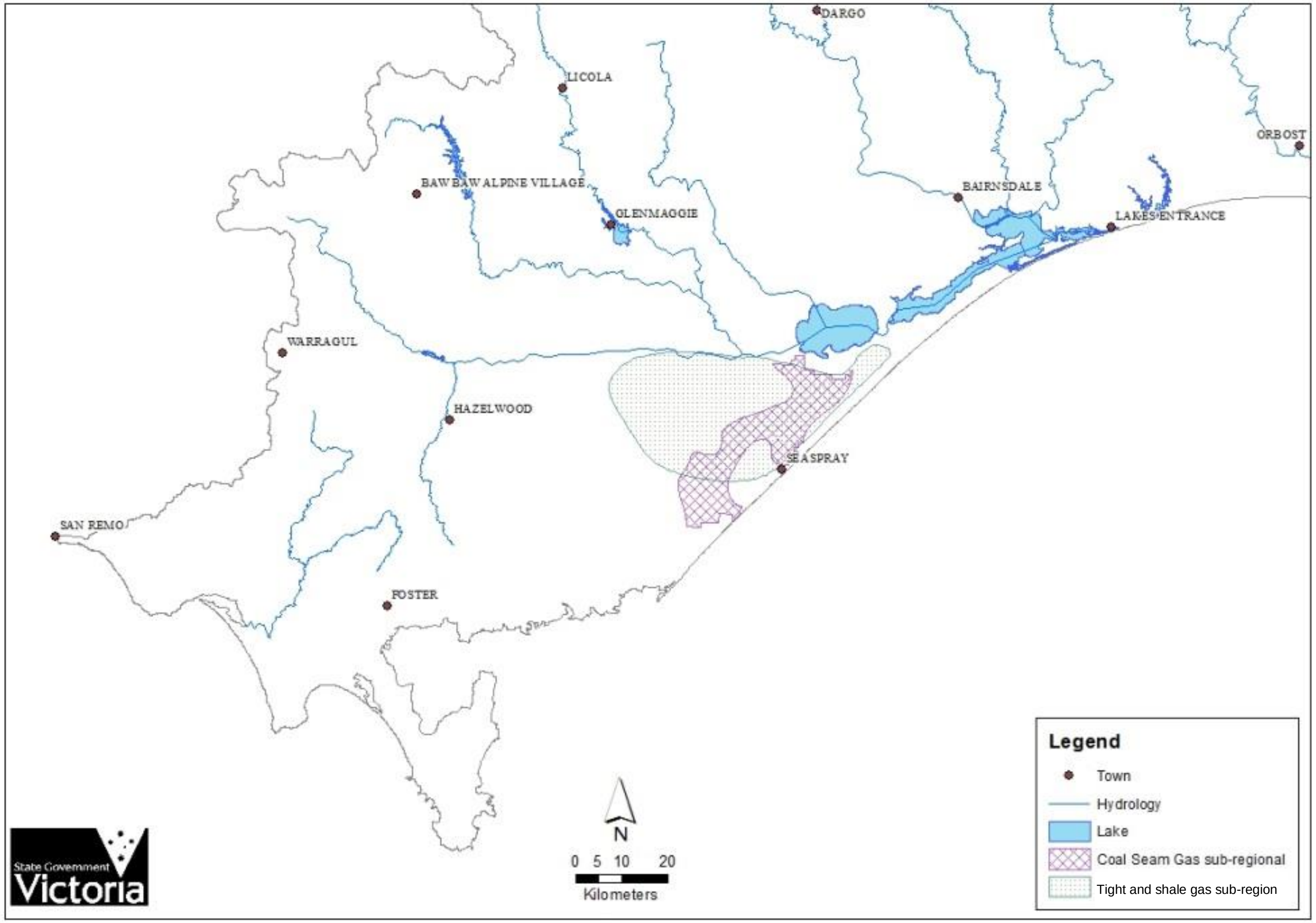


Figure 132: Sub-regional tight and shale and coal seam gas extents.

10.3 Scenario model recharge and evapotranspiration rates

For each scenario considered, a synthetic annualised recharge and potential groundwater evapotranspiration rate was applied to all modelled years post 2012; the recharge and potential groundwater evapotranspiration rate for the period 1970-2012 was assumed to be as applied during the model initialisation and calibration/validation phases. The synthetic annual sequences were based on simulated daily recharge and evapotranspiration derived using the CAT model for 2006.

10.4 Scenario modelling stress periods

Projected development time extended from 1 January 2013 to 31 December 2042 throughout which a three monthly stress period was adopted for all scenario modelling. A recovery scenario, in which all abstractions were set to zero, extends from 2042 to 2125 and similarly adopted a three-monthly stress period.

10.5 Scenario model boundary conditions

All boundary conditions assigned for the simulation period 1970-2012 remain unchanged. Post 2012 all boundary conditions as assigned to the last stress period of the verification period were applied throughout the projected potential onshore natural gas scenario simulation.

10.6 Scenario model rewetting setting

Modflow does not allow a cell that goes “dry” to return to “wet” (i.e. return to a value with a head of pressure or water level). In order overcome the possibility of solution cells going dry in a particular layer, Modflow-2005 has several options to enable cells to rewet. Two options are available to convert dry cells to partially saturated cells. Option 1 enforces rewetting based only on the head in the cell below whereas option 2 nominates that wetting is based on the heads from the four surrounding horizontal cells and the cell below. In this study all simulations adopt rewetting option 2.

10.7 Scenario reporting bores

The changes in groundwater trends for all observation bores were considered and reported separately for each scenario. Simulated groundwater hydrographs for all observation bores have been compiled into a database for review and analysis.

10.8 Scenario reporting regions

The scenarios are reported for the entire region, specifically the change in depth-to-watertable and groundwater heads in specified aquifers relative to baseline conditions.

10.9 Scenario reporting attributes

The key scenario assessments were based on groundwater levels in the Tertiary aquifers and maintenance of productive base. The criteria considered the following attributes:

- stabilisation of groundwater levels (key environmental function)
- stabilisation of extraction (productive base)
- prevention of dewatering confined aquifers (productive base)
- maintenance of environmental river flows (key environmental outcome).

10.10 Scenario results

The scenario results are presented as impacts relative to a baseline condition in which monthly groundwater abstractions were fixed at averaged equivalent monthly values for the period 2003 to 2012; all other conditions were as applied in the 2001-2012 verification period. In all cases recharge and groundwater potential evapotranspiration rates were based on 2006 daily climate as reported in Section 11.1. Scenarios 1 and 2 adopted the upper limit of abstractions as referenced in Section 11.2 (5 ML/yr/km^2 for tight and shale gas and 146 ML/yr/bore at 400 m^2 spacing for coal seam gas), whereas all other scenarios adopt 50% abstractions of either scenario 1 or scenario 2 as applicable with the exception of scenario 7. Scenario 7 applied the upper limit of coal seam gas abstractions to only half the area identified for potential onshore natural gas projects. The area from which abstractions were applied was defined based on a region centred on the shallowest cell within the potential onshore coal seam gas zone. Table 22 summarises the start-up abstraction volumes and area over which the abstractions are applied for each scenario.

The shallow watertable impacts in metres relative to the baseline estimates at 2042 are summarised in Table 23 for each of the seven scenarios considered. Also tabled are the maximum drawdown (m) and mean drawdown (m) within an impacted area. The impacted area is defined based on a drawdown threshold of 0.2 m below which no impact is assumed. The drawdown threshold reflects the groundwater model solver tolerance with a fourfold confidence factor assigned. The corresponding coal seam gas and tight and shale gas impacts are summarised in Table 24 and
Table 25 respectively. Results suggest that the greatest impacts on the shallow watertable are associated with coal seam gas development.

Table 22: Scenario configurations.

Scenario	Description	Abstraction	Applied area (ha)
1	CSG only	146 ML/yr/400 m^2	Entire potential area
2	Tight and shale only	5 ML/yr/km^2	Entire potential area
3	CSG only at 50%	73 ML/yr/400 m^2	Entire potential area
4	Tight and shale only at 50%	2.5 ML/yr/km^2	Entire potential area
5	CSG and Tight and shale at 50%	As per scenarios 3 & 4	Entire potential area
6	CSG only at 50% plus licence entitlement	As per scenario 3 + LE	Entire potential area
7	CSG only over half potential area	146 ML/yr/400 m^2	Half potential area

Table 23: Scenario shallow watertable impacts (m) relative to baseline at 2042.

Scenario	Description	Max drawdown (m)	Mean drawdown (m)	Impacted area (ha)
1	CSG only	47.8	10.4	193,120
2	Tight and shale only	1.9	1.4	736
3	CSG only at 50%	34.2	6.7	170,384
4	Tight and shale only at 50%	1.4	1.2	64
5	CSG and Tight and shale at 50%	34.3	6.4	180,080
6	CSG only at 50% plus licence entitlement	34.3	5.8	208,256
7	CSG only over half potential area	47.8	5.6	127,952

Table 24: Scenario coal seam gas impacts (m) relative to baseline at 2042.

Scenario	Description	Max drawdown (m)	Mean drawdown (m)	Impacted area (ha)
1	CSG only	220.9	25.2	424,192
3	CSG only at 50%	149.3	6.2	303,408
5	CSG and Tight and shale at 50%	130.9	17.9	344,816
6	CSG only at 50% plus licence entitlement	130.8	17.2	362,640
7	CSG only over half potential area	175.5	18.5	270,320

Table 25: Scenario tight and shale gas impacts (m) relative to baseline at 2042.

Scenario	Scenario	Max drawdown (m)	Mean drawdown (m)	Impacted area (ha)
2	Tight and shale only	30.8	4.1	147,904
4	Tight and shale only at 50%	30.6	2.4	116,528
5	CSG and Tight and shale at 50%	30.5	7.3	384,032

The response of the water table in the affected area, and the gas resource layer following initiation of coal seam gas extractions (Scenario 1) on the impacted area (ha) and the average drawdown (m) within the impacted area are shown in Figure 133 and Figure 134 respectively. Each figure shows two traces, one representing the shallow watertable impacts, the other showing the impact within the coal seam gas extraction layer.

Similar response trajectories arising from the initiation of tight and shale gas extractions (Scenario 2) are shown in Figure 135 and Figure 136. The simulated extraction volumes under nominated maximum and 50% coal seam gas and tight and shale gas conditions are shown in Figure 137 and Figure 138 respectively.

Key observations are:

- The trajectories of impacted area are increasing and have not reached an equilibrium condition by 2042.
- Coal seam gas extractions impact on the shallow watertable within 3 months following commencement of extractions.
- Tight and shale gas extractions impact on the shallow watertable after 23 months following commencement of extractions. This lag is not observed under the coal seam gas scenarios.

It is acknowledged that time lags predicted for water table response are likely to be under-estimated (i.e. the model responds more rapidly than would be the case in reality) because aquitards are generally represented as single layers which are unable to simulate the gradual vertical migration of pressure responses within these units.

The difference in the spatial impacts on shallow watertable and the assumed gas extraction layer for each of the seven scenarios compared to the baseline scenario (no gas development) are shown in Figure 139 to Figure 145. Also shown are the outlines of either the coal seam gas or tight and shale development zones as appropriate.

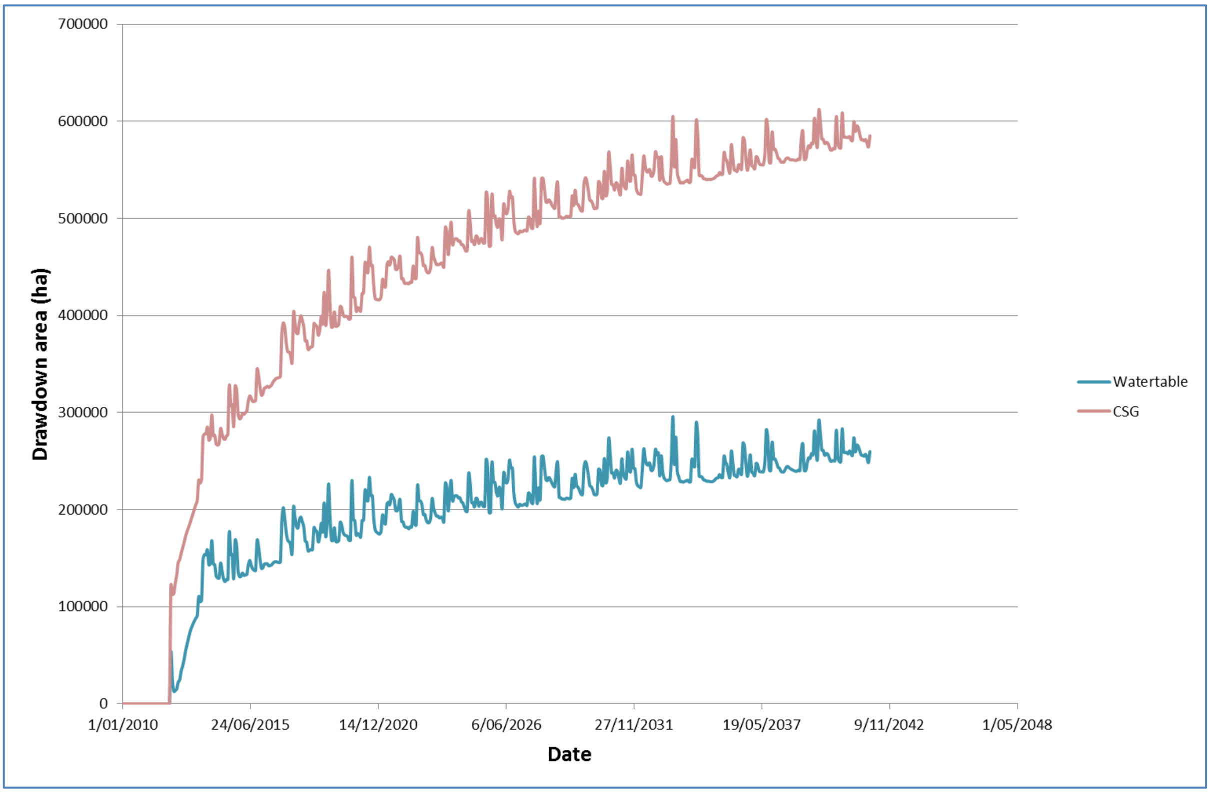


Figure 133: "Coal seam gas affected area": Scenario 1 total drawdown area (ha) on shallow watertable and T1 coal due to coal seam gas development.

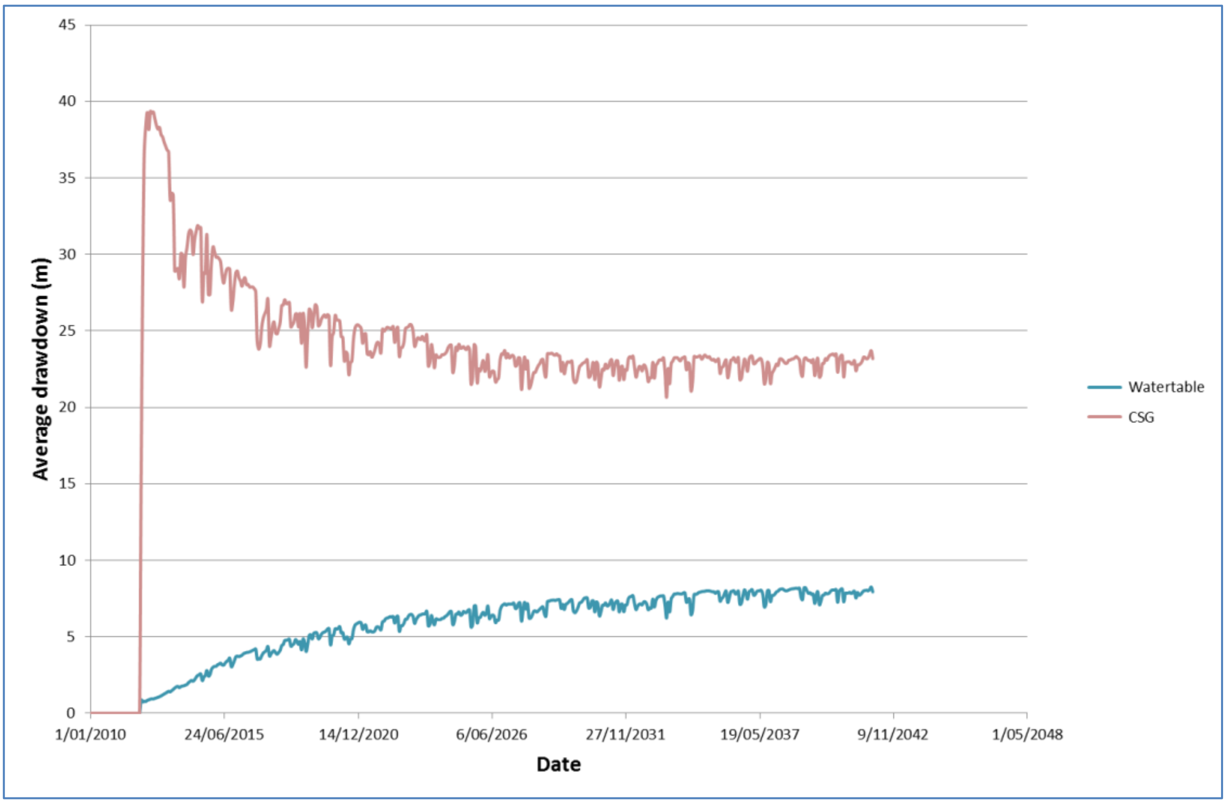


Figure 134: "Coal seam gas drawdown": Scenario 1 average drawdown (m) in the impacted shallow watertable and T1 coal due to coal seam gas development.

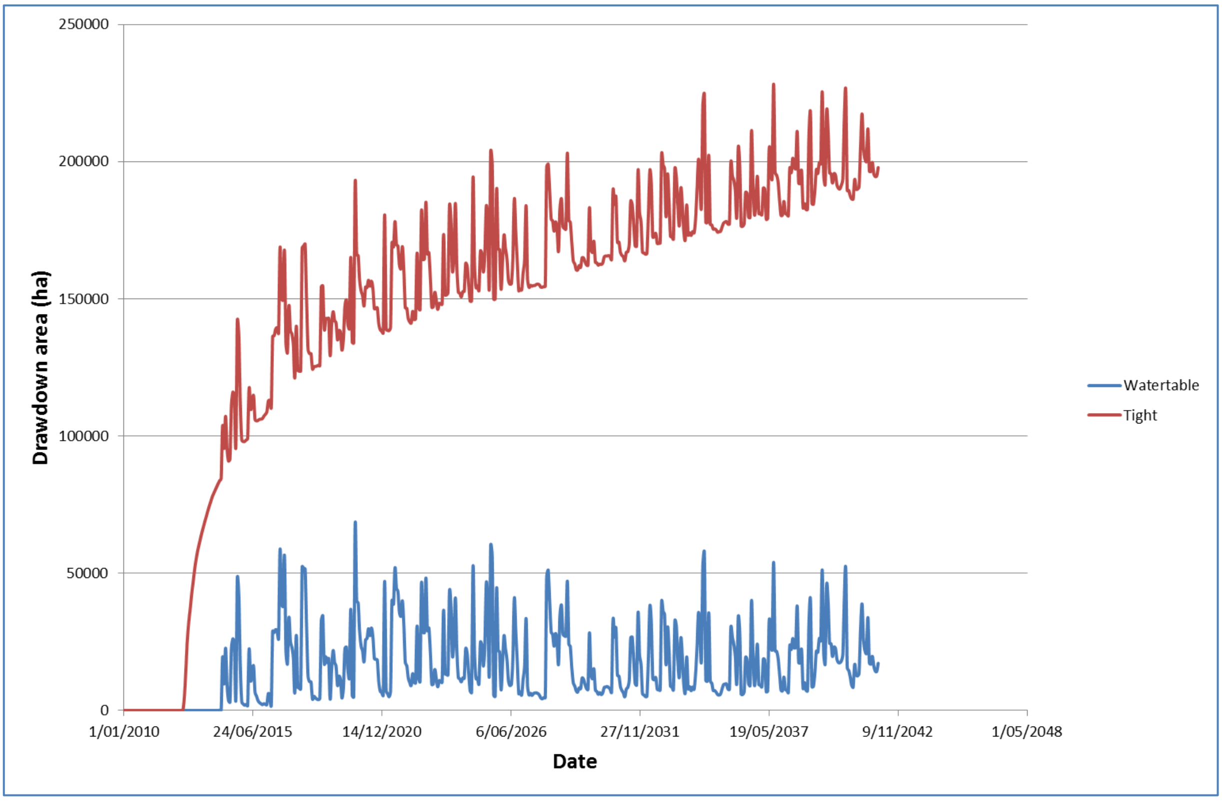


Figure 135: "Tight and shale gas affected area": Scenario 2 total drawdown area (ha) on shallow watertable and Strzelecki Group due to tight and shale gas development.

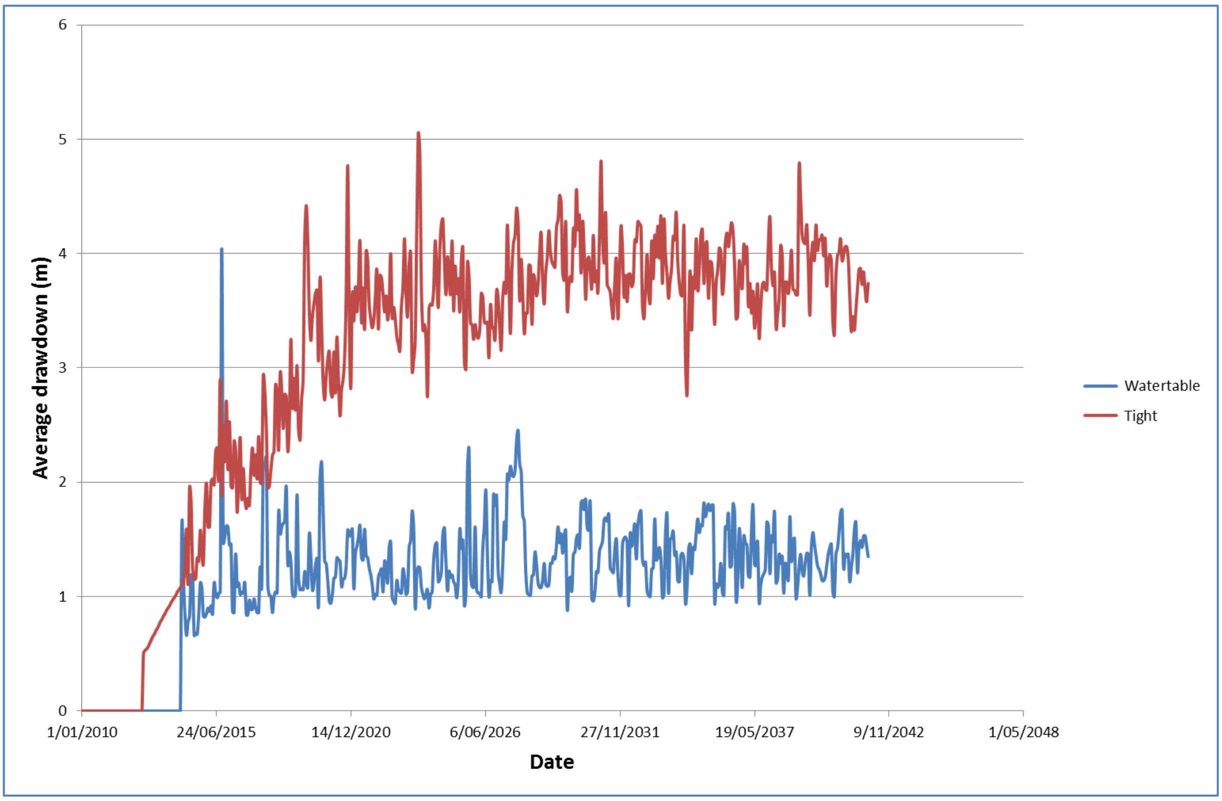


Figure 136: "Tight and shale gas drawdown" Scenario 2 average drawdown (m) in the impacted shallow watertable and Strzelecki Group due to tight and shale gas development

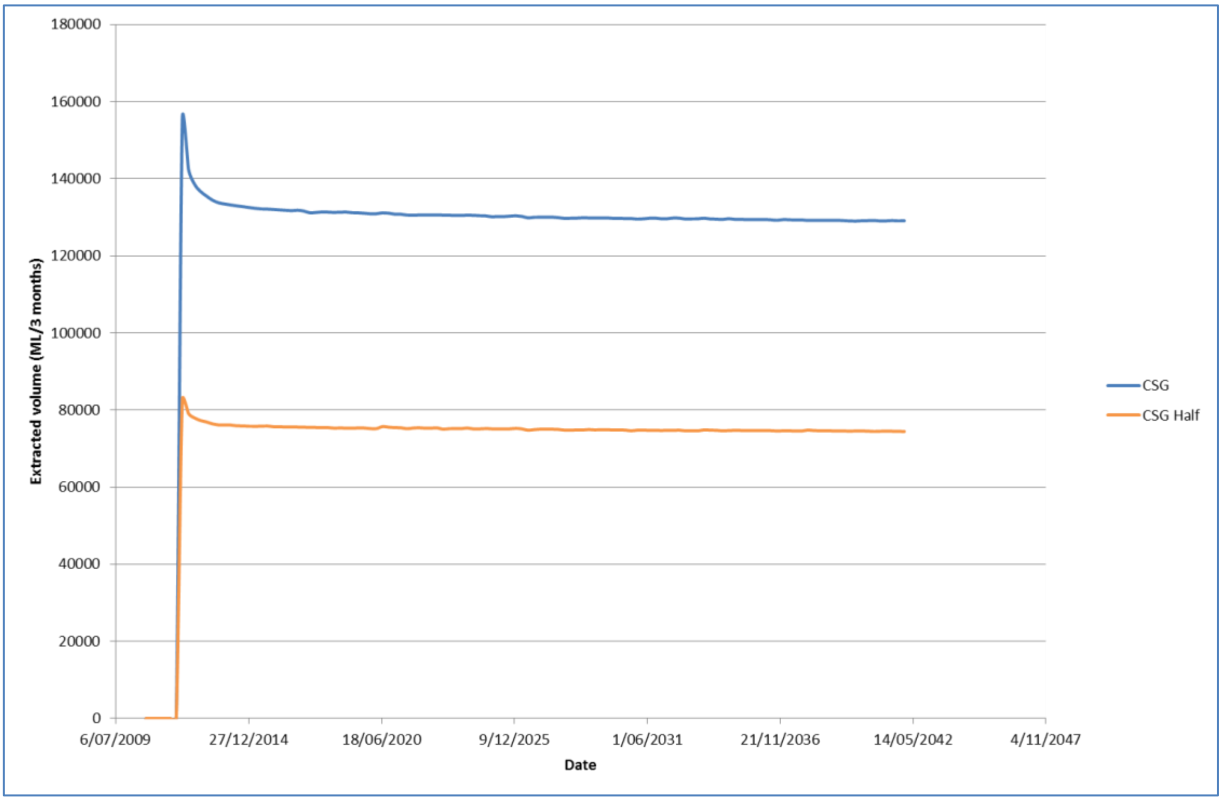


Figure 137: Simulated coal seam gas extraction volume (ML/3 months) under maximum (Scenario 1) and 50% (Scenario 6) conditions.

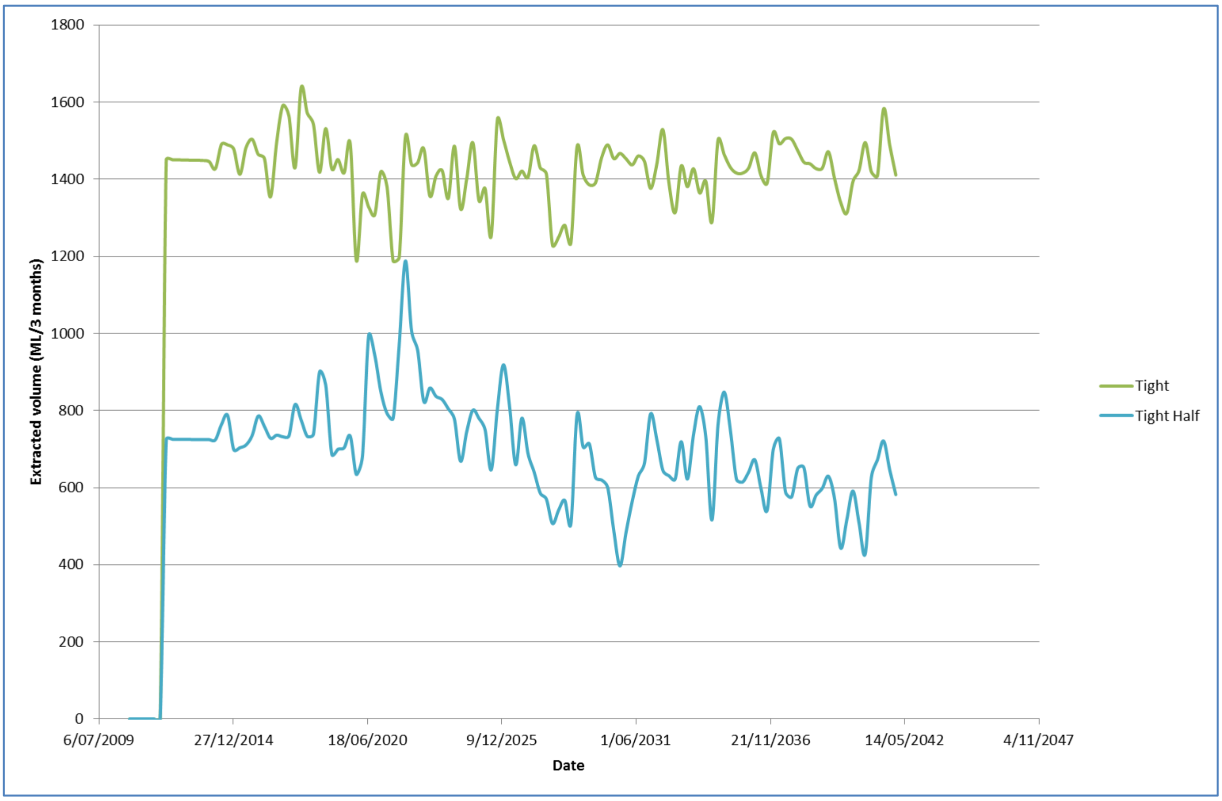


Figure 138: Simulated tight and shale gas extraction volume (ML/3 months) under maximum (Scenario 2) and 50% (Scenario 4) conditions.

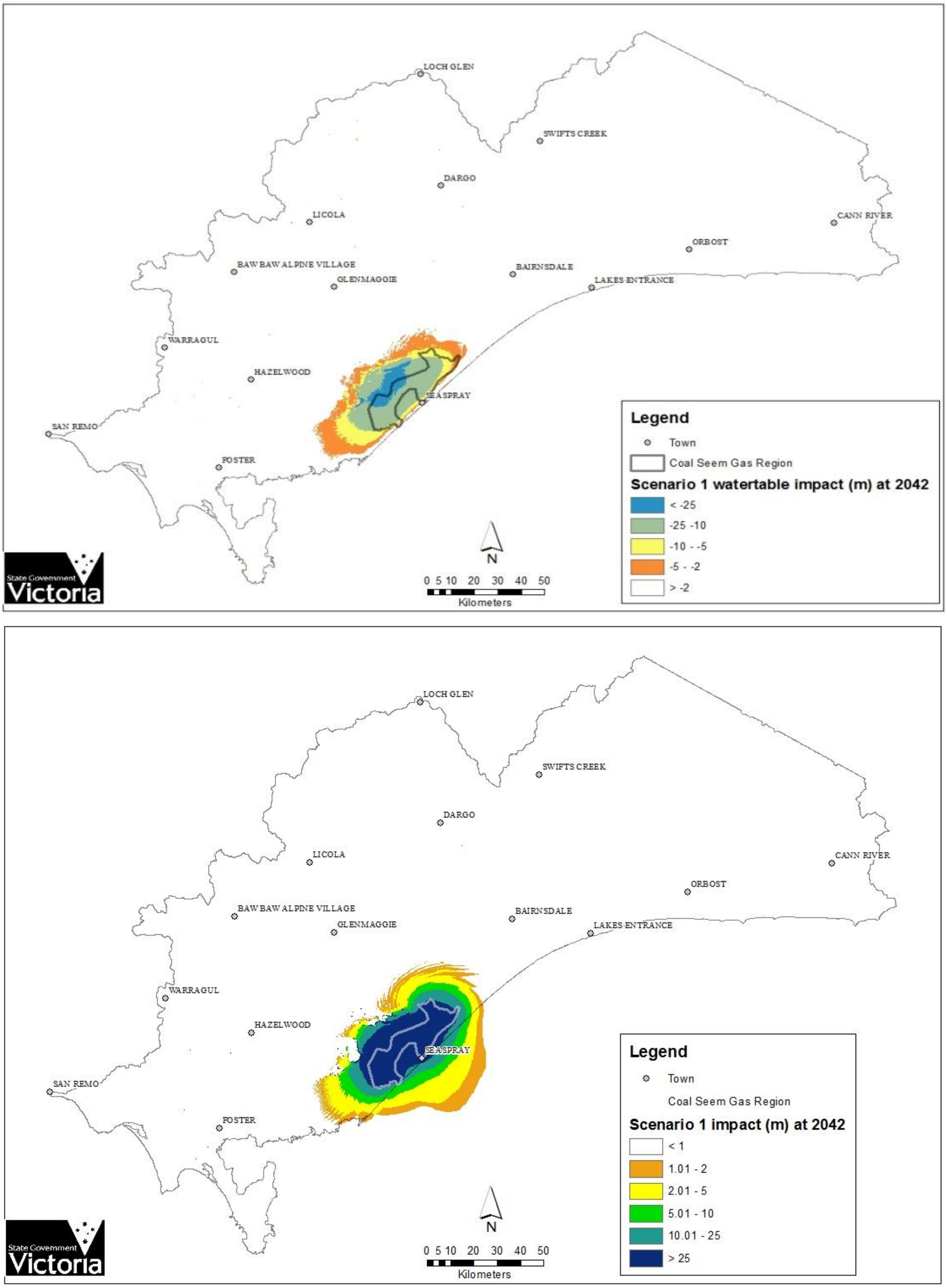


Figure 139: Scenario 1 shallow watertable (top) and coal seam gas aquifer (bottom) drawdown (m) compared to baseline at 2042.

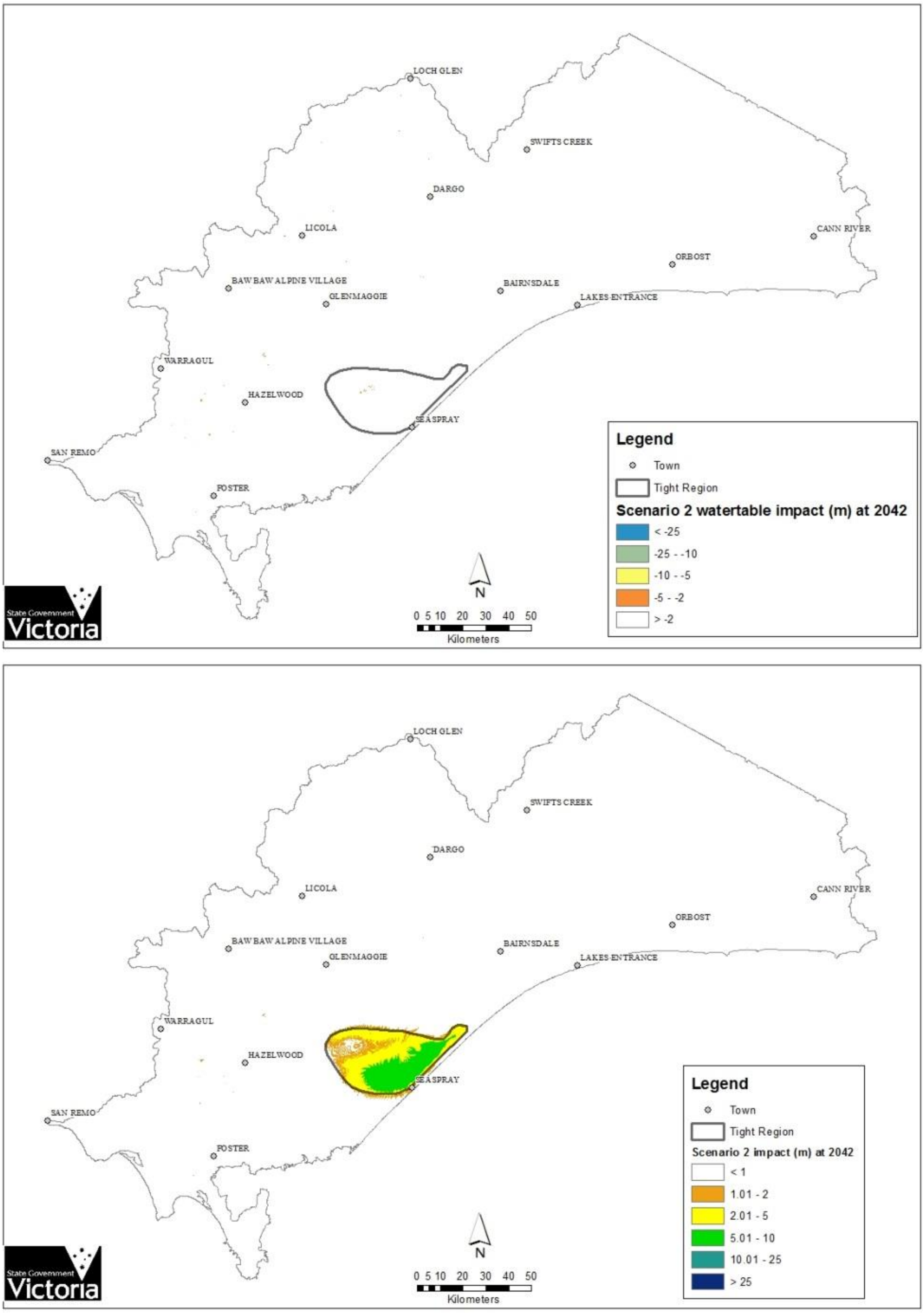
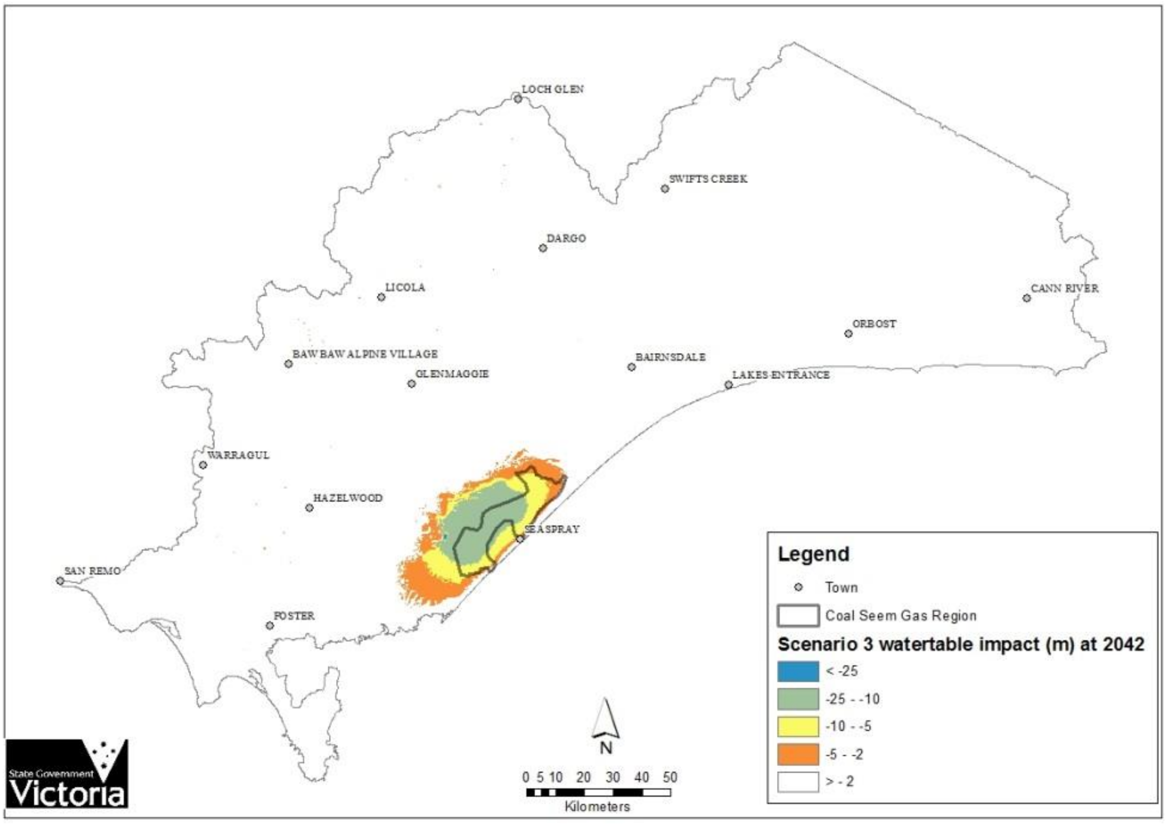


Figure 140: Scenario 2 shallow watertable (top) and tight and shale gas aquifer (bottom) drawdown (m) compared to baseline at 2042.



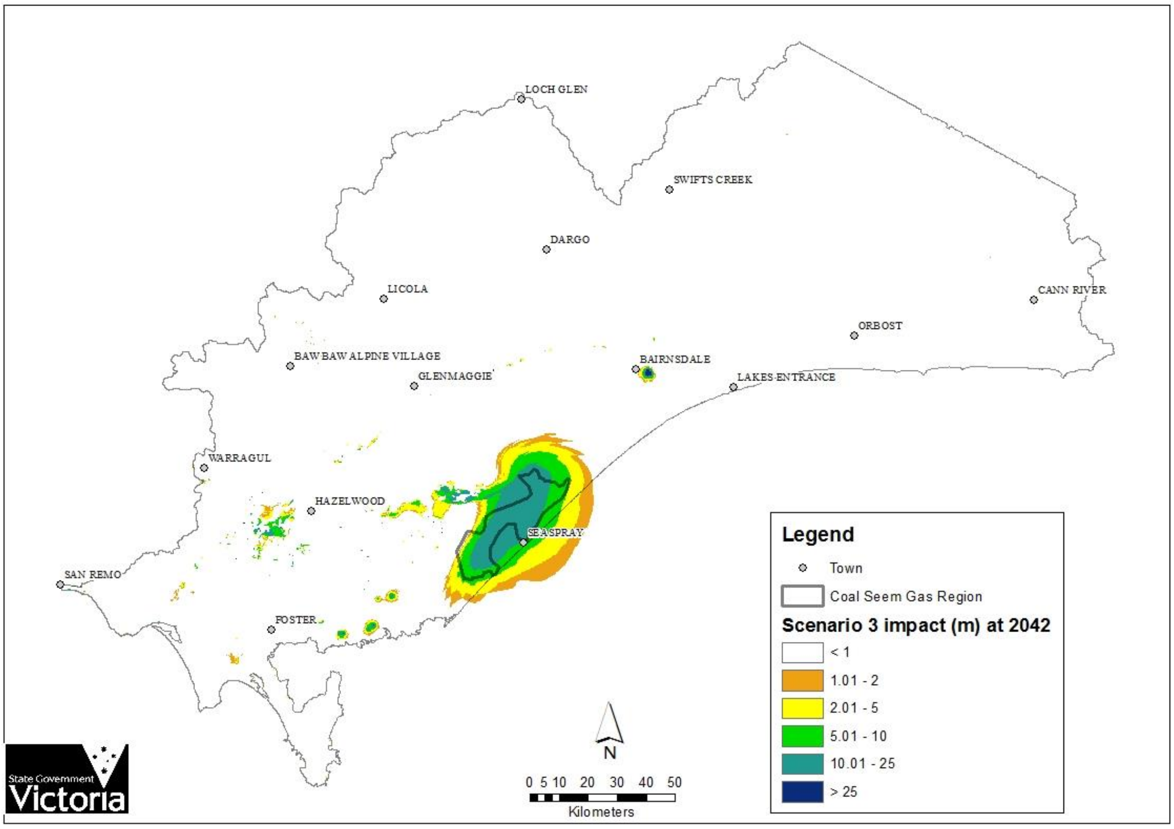
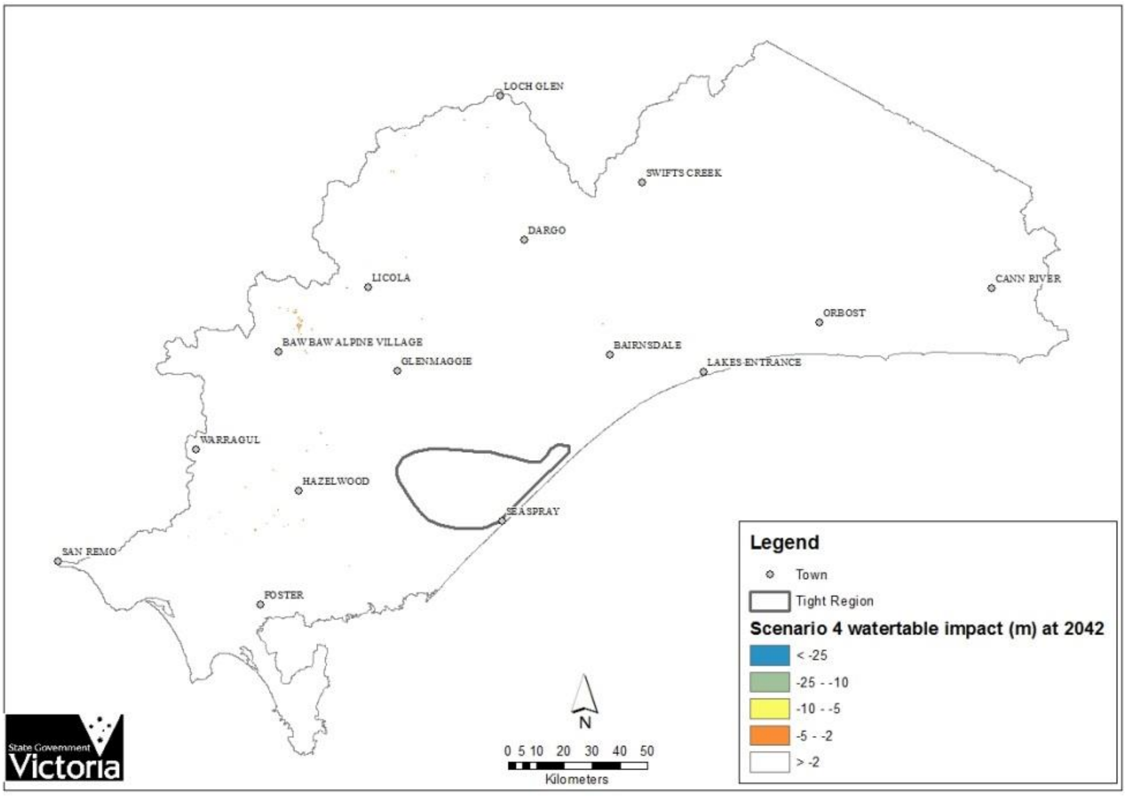


Figure 141: Scenario 3 shallow watertable (top) and coal seam gas aquifer (bottom) drawdown (m) compared to baseline at 2042.



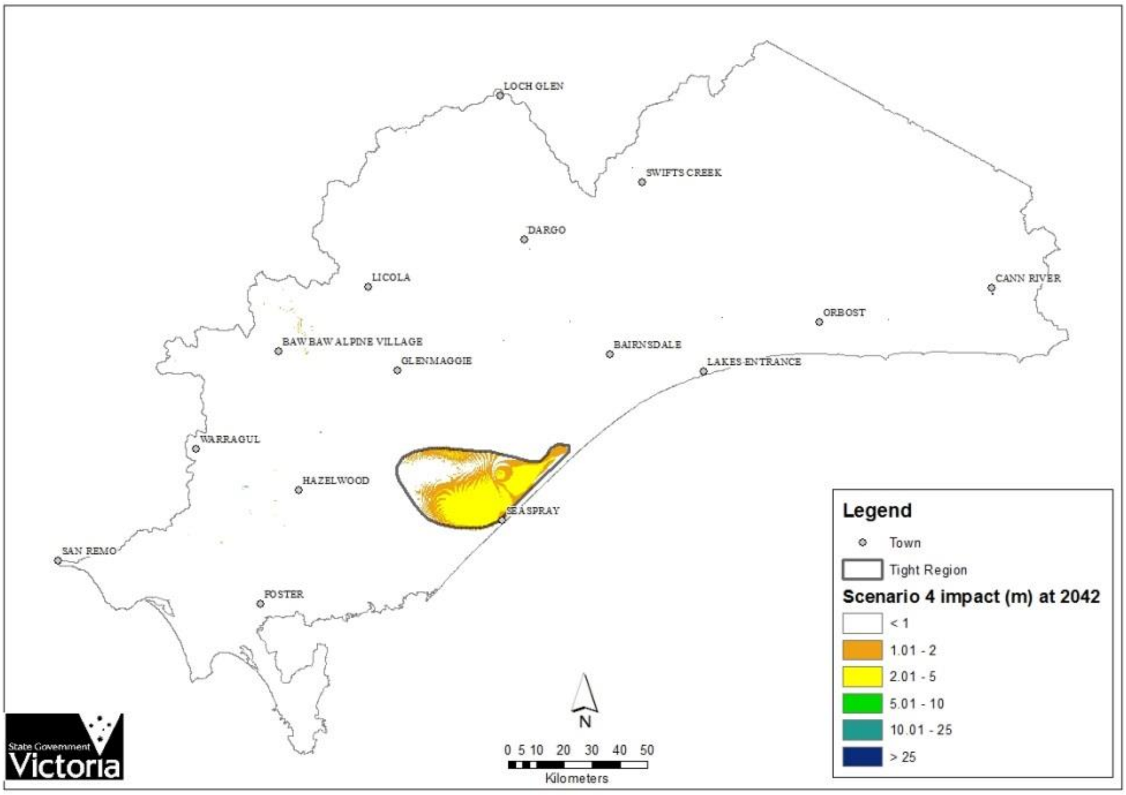


Figure 142: Scenario 4 shallow watertable (top) and tight and shale gas aquifer (bottom) drawdown (m) compared to baseline at 2042.

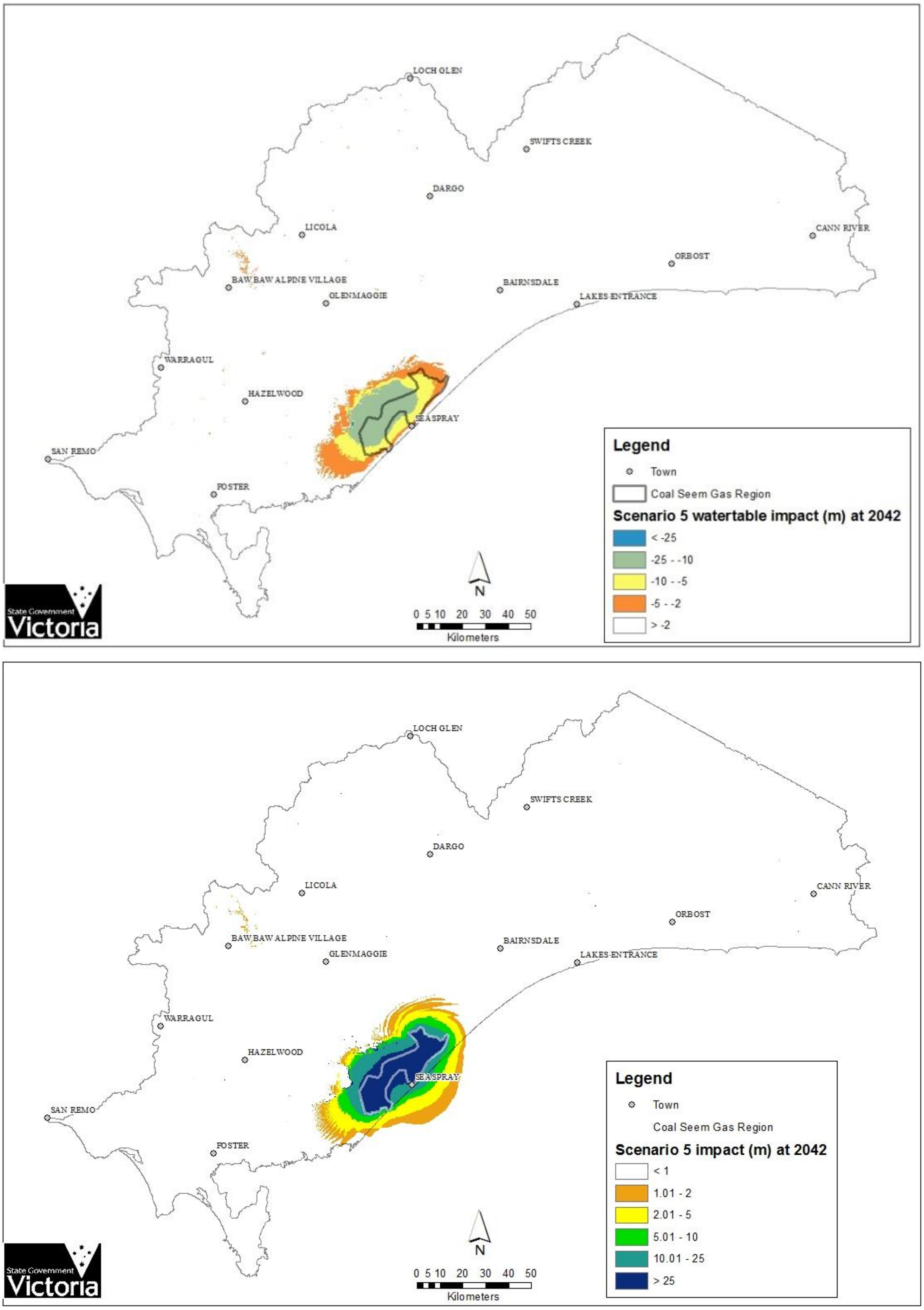
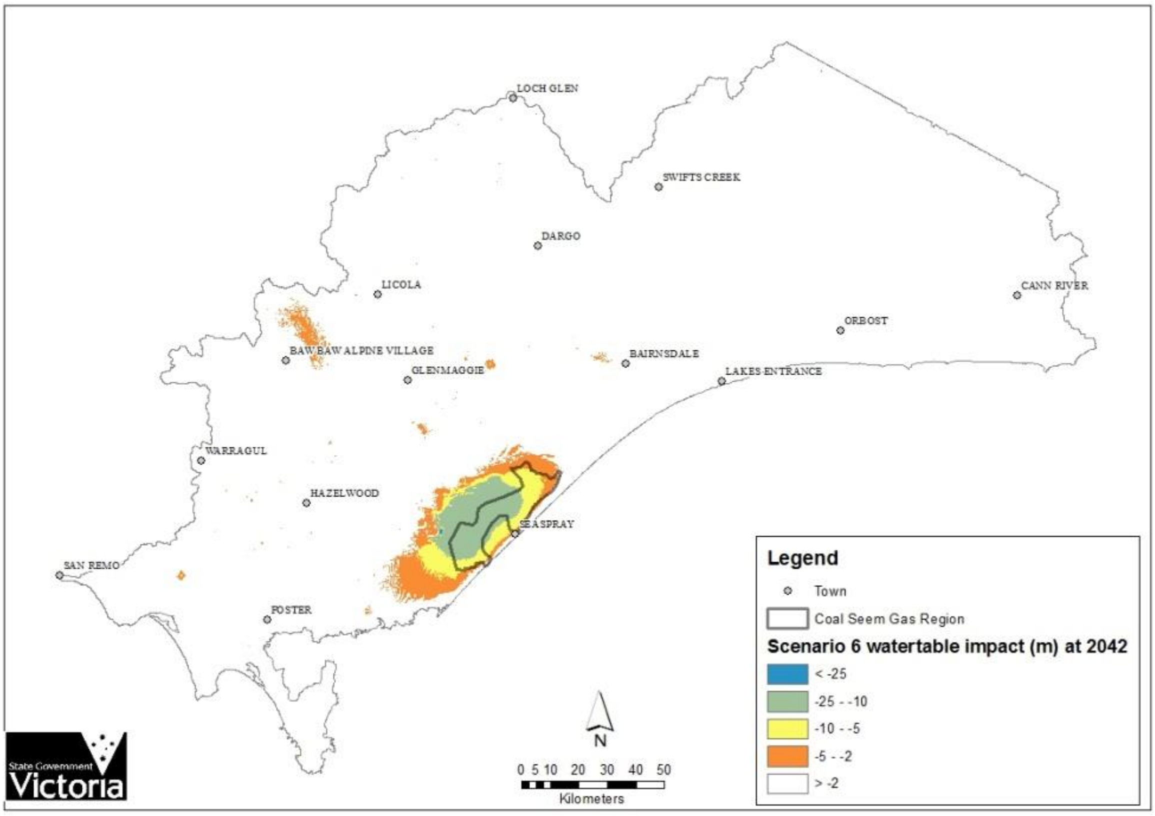


Figure 143: Scenario 5 shallow watertable (top) and coal seam gas aquifer (bottom) drawdown (m) compared to baseline at 2042.



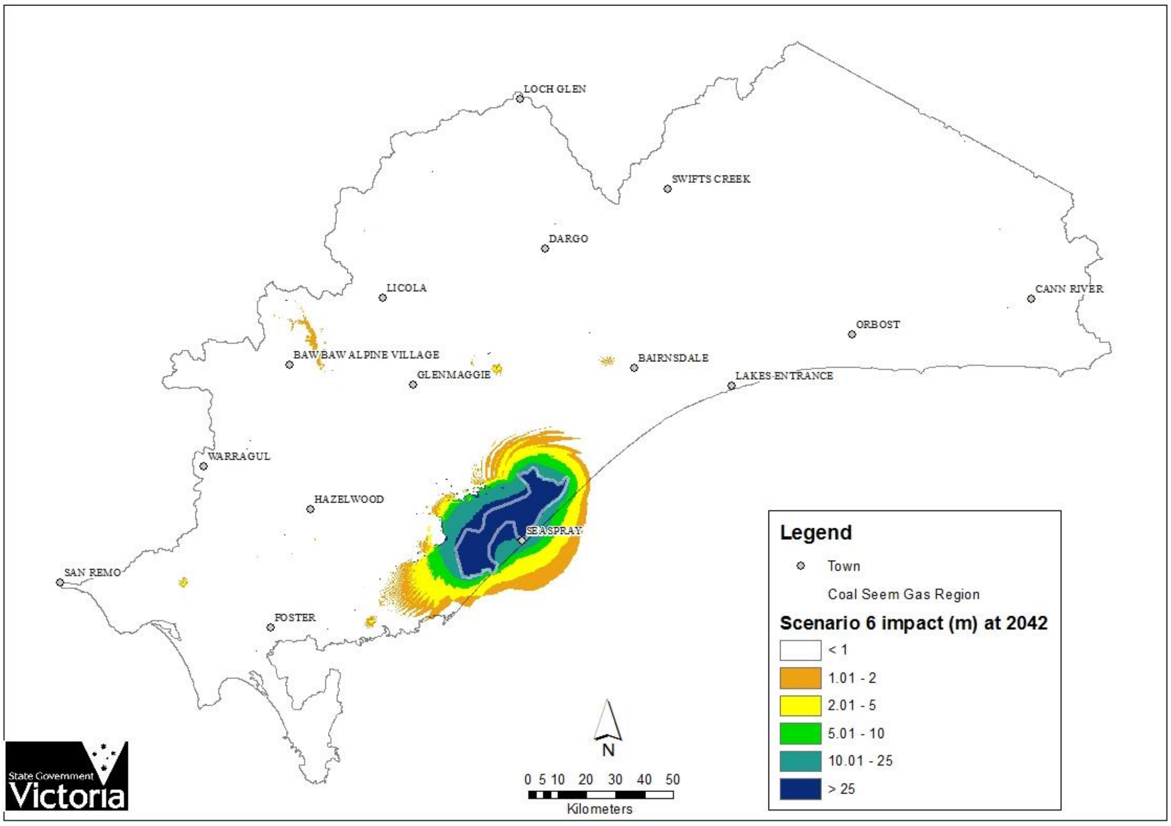


Figure 144: Scenario 6 shallow watertable (top) and coal seam gas aquifer (bottom) drawdown (m) compared to baseline at 2042.

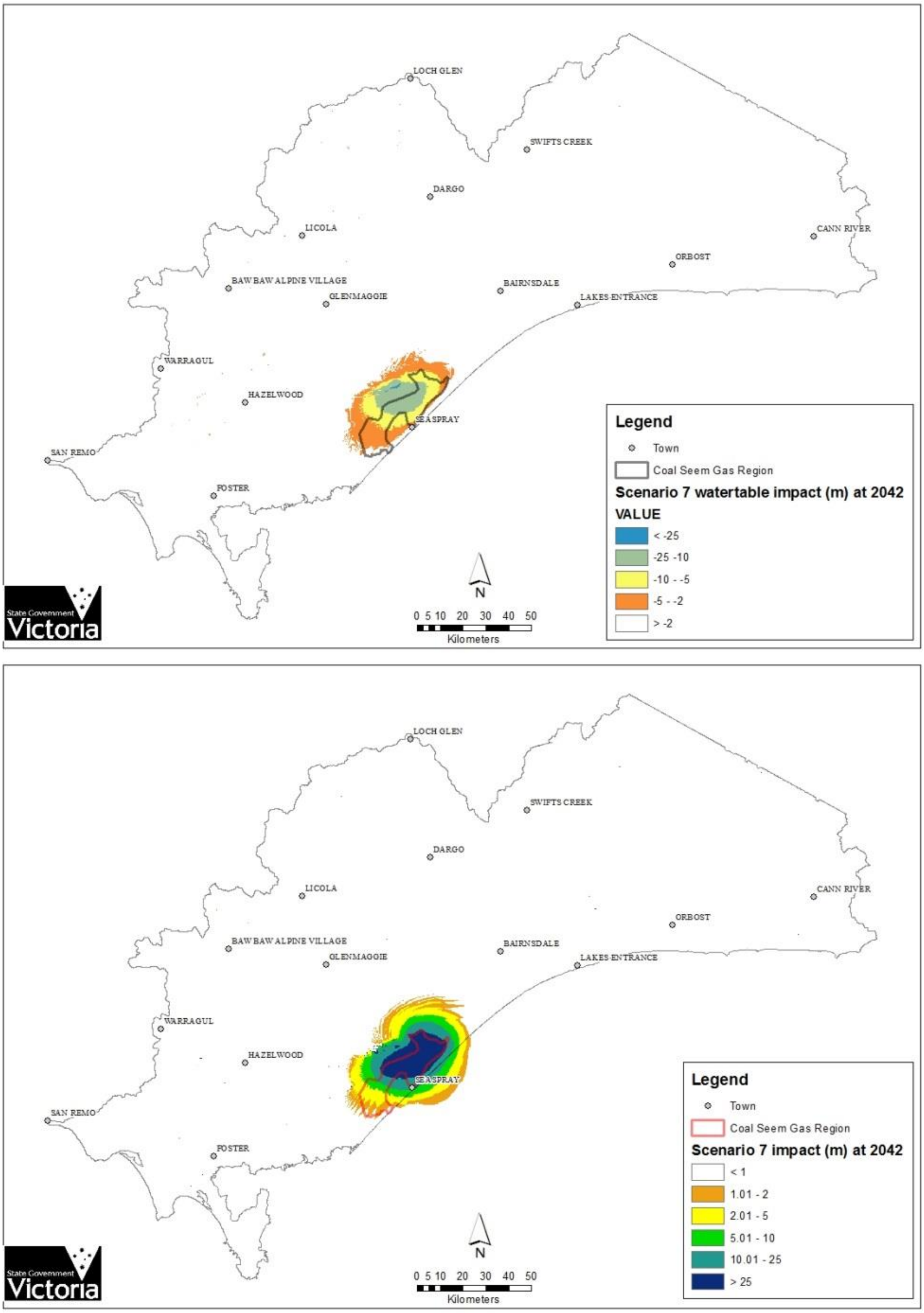


Figure 145: Scenario 7 shallow watertable (top) and coal seam gas aquifer (bottom) drawdown (m) compared to baseline at 2042.

10.11 Recovery scenario and results

The possible long term implications of a gas resource development on the water resources needs to consider the effects of time lag for overlying aquifers. For the coal seam gas development, Figures 132 and 133 show both the area impacted and the drawdown in the area continue to increase however the trend to an asymptote or stable trend appears to be established. For the tight and shale gas developments, Figures 134 and 135 indicate the shallow water table drawdown and area of impact have already reached near stable values, indicating further impacts after development are unlikely to show an increase. These figures also show the time lag for the system is relatively short, as the onset of drawdown for the water table begins within 3 months after coal seam gas extraction begins, and less than 2 years after the beginning of tight and shale gas extraction.

A recovery scenario was applied to the model to evaluate the impact of cessation of coal seam gas abstractions on groundwater observation bores. The application extended Scenario 1 above for a further 100 years during which coal seam gas abstractions were set to zero, all other conditions remaining unaltered. This scenario considered the time required for the model to reach equilibrium and the recovery of the system, assuming the same “baseline condition” (off-shore, mine and licensed extraction) continued throughout the 100 years after the end of coal seam gas development and using the 2006 climate series.

Equilibrium was tested by considering the trend in calibration bore levels. The hydrograph gradient of “typical” bores over 5 time steps at (a) the end of the transient model period (2012 or if not available then the last 5 recorded observation points), (b) the end of the development scenario (2042) and (c) the end of the extended period (2142) was assessed for return to historical trend; recovery was defined as a more positive trend relative to the baseline trend. Results based on 766 groundwater calibration bore hydrograph trends estimate that 74% of calibration bores return to baseline or improved trends following cessation of coal seam gas abstractions after 100 years. A summary of the results for each modelled layer in which calibration groundwater observation bores are assigned is tabulated in Table 26

Table 26: Summary of recovery results by modelled layer.

Layer	Total number of bores	%Recover	%Not Recovered
2	198	64	36
3	288	66	34
4	8	88	13
5	27	70	30
6	4	100	0
7	1	100	0
8	1	100	0
9	50	98	2
10	4	75	25
11	14	86	14
12	8	100	0
13	4	75	25
14	5	80	20
15	1	100	0
16	10	90	10
17	13	77	23
18	69	84	16
19	6	83	17
20	10	100	0
21	7	100	0
22	8	100	0
23	15	100	0
30	15	93	7

Conclusions and recommendations

The developed groundwater model has been shown to broadly quantify groundwater flow and match historical hydrograph trends. The groundwater model is capable of predicting relative changes in water level heads and baseflow estimates. The model is deemed appropriate to assess the potential regional cumulative impacts of gas developments and other groundwater users (including coal mines and offshore oil and gas extraction) on existing groundwater users and the environment against a baseline condition of current development.

Key observations arising from this study are as follows:

- The need to recognise the assumptions and limitations associated with the model so as to ensure the appropriate use of the model and interpretation of model predictions. This groundwater model may be used to consider relative changes in the catchment water balance. However, the spatial accuracy of simulation results may not correlate well with gauged data due to the model construct and spatial resolution and therefore should be used with regards to these considerations.
- Caution should be exercised when using the solver option available in Groundwater Vistas by enabling the solution to continue if the convergence criteria are met for only the outer iterations without satisfying all convergence tolerances.

The following recommendations could improve the robustness and confidence of the groundwater model predictions as follows:

- Improve knowledge of groundwater abstraction across the region. This should extend to the compilation of basic information including the (1) location of pumping wells, (2) the groundwater volumes abstracted and (3) the nature of the aquifers from which abstractions are sourced.
- Translate the groundwater model into the recently developed USGS UnStructured Grid (USG) MODFLOW application would likely increase accuracy in the representation of processes in those regions of steep hydraulic gradients (such as near mines, near connected surface features, adjacent to groundwater extraction points and in regions of stream/aquifer interaction) thereby improving groundwater predictions and water budget estimates. A preliminary unstructured grid has been developed for the study region as shown in Figure 146 and Figure 147.
- Further assess groundwater recharge estimates and associated hydrograph response would likely increase mass balance prediction accuracy.
- Incorporate temperature and density correction functions.
- Review model layers assigned to groundwater extraction bores.
- Review the attribution of the model layer representing the uppermost Strzelecki Formation. This recommendation is based on analysis of the spatial residual error presented in this report.

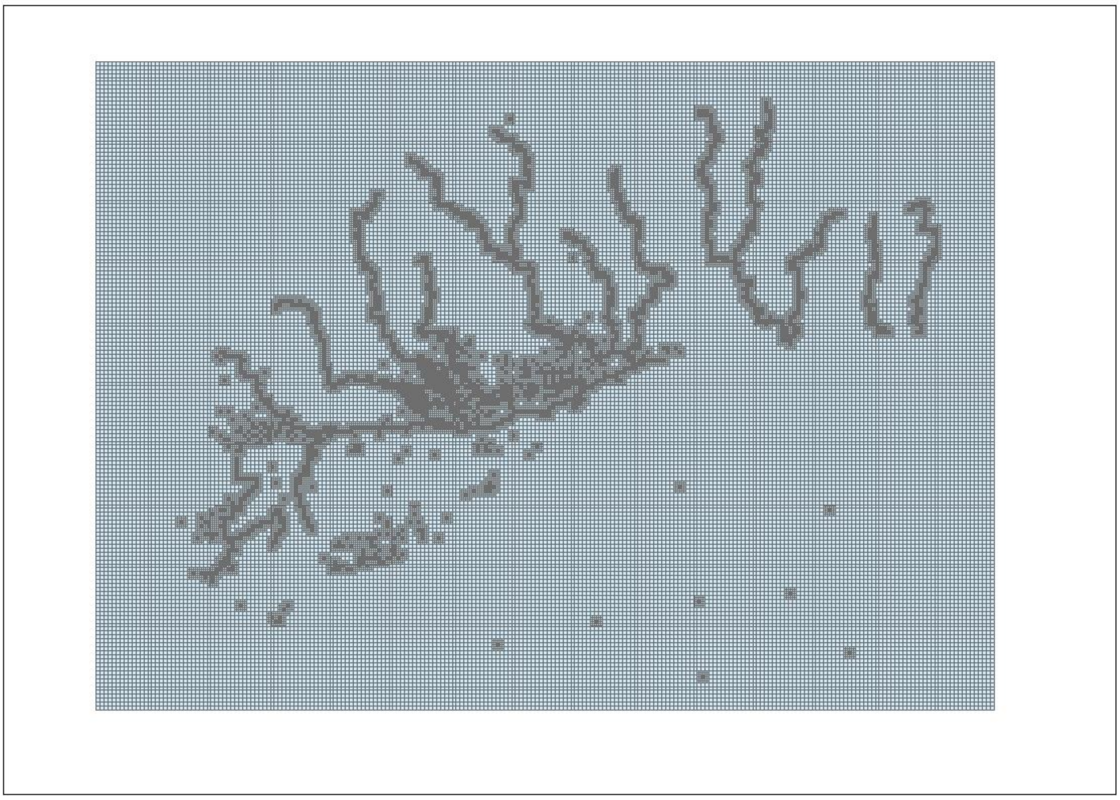


Figure 146: Preliminary unstructured grid developed for the study area.

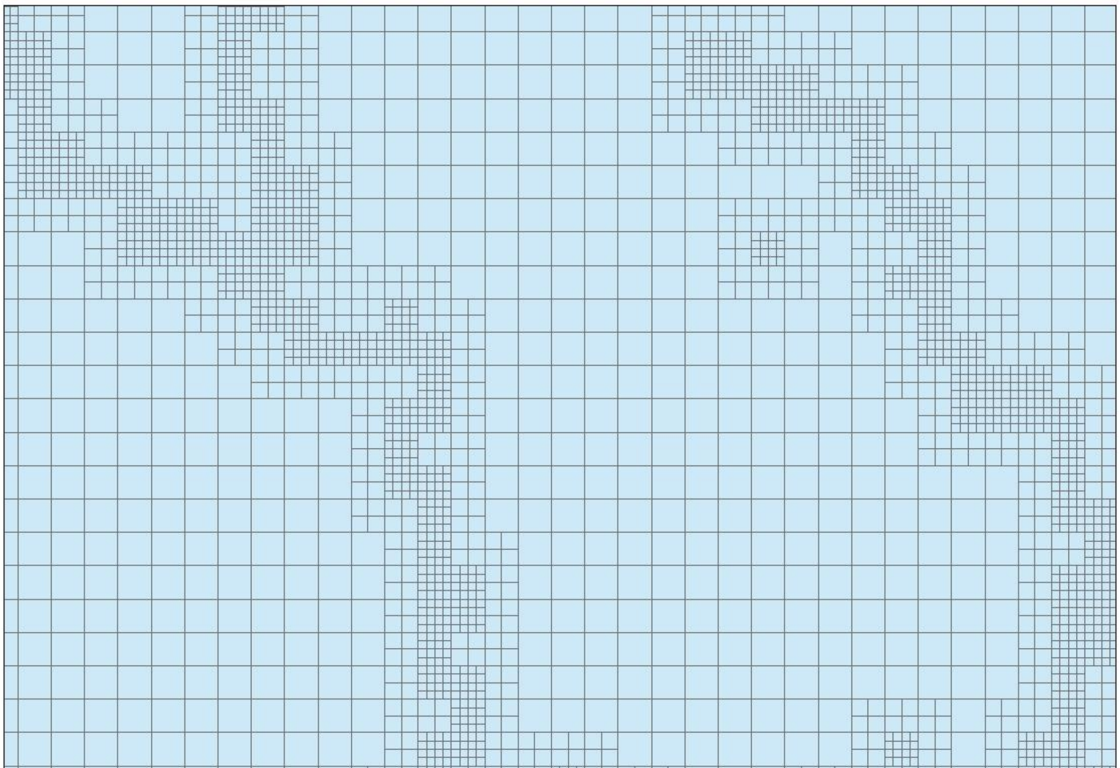


Figure 147: Zoomed in area within the preliminary unstructured grid highlighting the construct of the model and localised grid refinement adjacent to surface features.

Glossary

Term	Meaning	Units (if applicable)
ALUM	Australia Land Use Mapping	
aquifer	rock or soil that readily transmits water	
aquitard	rock or soil that transmits water very slowly	
baseflow	contribution of surface water flow due attributed to groundwater	ML
BFI	Base flow index [0–1] representing the percentage of streamflow due to groundwater inflows	
BoM	Bureau of Meteorology	
CAT	Catchment Analysis Tool biophysical catchment model	
CD	coefficient of determination	
CMA	Catchment Management Authority	
confined aquifer	an aquifer in which an impermeable rock or soil layer or layers prevents water from seeping into the aquifer vertically	
COMET3	A reservoir simulator for gas shale, shale oil, and coalbed methane (CBM) reservoirs provided by Advanced Resources International Inc.	
constant head boundary	time constant specified head which represents flows into or out of the model domain where groundwater connects or interacts with features (and the ocean) outside the model domain	mAHD
CSG	coal seam gas	
CSIRO	Commonwealth Scientific and Industrial Research Organisation	
DEDJTR	Department of Economic Development, Jobs, Transport and Resources	
DELWP	Department of Environment, Land, Water and Planning	
DEM	digital elevation model defining surface elevations in mAHD	
DEPI	Department of Environment and Primary Industries	
drain boundary	Represents a head dependent boundary condition where water is removed from the model depending on the specified head elevation, the predicted head in neighbouring cells and the specified boundary conductance term.	
drawdown	Reduction in groundwater head elevation relative to a nominated baseline condition.	m
DSE	former Department of Sustainability and Environment	

Term	Meaning	Units (if applicable)
ET	water lost due to a combination of soil evaporation and vegetation transpiration	m
GA	Geoscience Australia	
GDE	groundwater-dependent ecosystem	
GMA	Groundwater Management Area	
hydraulic head		m
hydraulic conductivity (Kxy)		m/day
IRM	Integrated Resource (groundwater) Model	
LVCM	Latrobe Valley Coal Model	
LVRM	Latrobe Valley Resource Model	
mAHD	Metres Australian Height Datum	m
MDBA	Murray-Darling Basin Authority	
MDBC	Murray-Darling Basin Commission	
MID	Macalister Irrigation District	
no flow boundary	Represents locations where groundwater does not flow and/or the aquifer is absent; such features include groundwater divides (specified flow boundary type).	
NPA	National Partnership Agreement	
NSI	Nash-Sutcliffe index [0-1]	
permeability		
PPF	Principal Profile Form used to describe soil classifications	
porosity		
potentiometric surface		
quickflow	stream flow component attributed to surface runoff and sub-surface flow	ML
river boundary	Represents a head dependent boundary condition where groundwater can either recharge or discharge into/from the model based upon a specified head elevation, the model-predicted head in neighbouring cells and a specified boundary conductance term.	
recharge rate	water that flows below the root zone and enters the groundwater	m/day
residual error		
root mean fraction square (RMFS)		%
SAFE	Victorian Secure Allocation Future Entitlement	
scaled mean sum of residuals (SMSR)		%
scale root mean square (SRMS)		%
scaled root mean fraction square (SRMFS)		%

Term	Meaning	Units (if applicable)
SKM	Sinclair Knight Merz Pty Ltd	
specific yield (Sy)		
specific storage (Ss)		m^{-1}
steady-state condition	Represents an equilibrium condition based on constant inputs in which time is indeterminate.	
sum of residuals (Sr)		m
sum of squares (SSQ)		m^2
SVERS	Strengthening Victoria's Earth Resources Sector Initiative	
TDS	total dissolved solids	mg/L
transient	time-varying	
transmissivity		m^2/day
unconfined aquifer		
VAF	Victorian Aquifer Framework	
vertical hydraulic conductivity (Kz)		
watertable	the "surface" where the groundwater level is balanced against atmospheric pressure	mAHD
WSPA	Water Supply Protection Area	
well boundary	represents locations where fluxes are applied to the model (on a layer-by-layer basis); they are used to represent groundwater extraction from stock, domestic, industrial bores and from groundwater pumping in offshore oil and gas fields	
yield		L/s

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Appendix A: Baseflow estimates

East Gippsland

Site ID	Site name	Easting	Northing	Gauge zero (Ahd)	Site start date	Site cease date	Drainage area (km^2)	BFI GHD	BFI
221001	GENOA RIVER @ ROCKTON	705825	5887218	414.72	26/05/1993		125.6		0.28
221201	CANN RIVER (WEST BRANCH) @ WEERAGUA	694682	5861473	153.96	21/02/1957		311		0.51
221202	GENOA RIVER @ WANGARABELL	721597.1	5858290.5	0	13/10/1927	30/06/1929	780		0.42
221203	BETKA RIVER @ MALLACOOTA	737895.1	5836091.4	0	26/01/1966	24/07/1972	117		0.37
221204	THURRA RIVER @ POINT HICKS	699200	5822200	0	17/05/1966	28/07/1978	345		0.43
221205	BEMM RIVER @ BEMM RIVER	671893.8	5821410.8	0	28/06/1966	5/06/1975	935		0.55
221206	CANN RIVER @ NOORINBEE	694397	5854712.4	0	31/05/1967	3/02/1971	541		0.43
221207	ERRINUNDRA RIVER @ ERRINUNDRA	669418	5853798	0	28/07/1971		162		0.65
221208	WINGAN RIVER @ WINGAN INLET NATIONAL PARK	719710.3	5825779.5	0	14/12/1982		420		0.39
221209	CANN RIVER (EAST BRANCH) @ WEERAGUA	695470	5863398	0	23/10/1972		154		0.36
221210	GENOA RIVER @ THE GORGE	723046	5856007	0	22/08/1972		837		0.34
221211	COMBIENBAR RIVER @ COMBIENBAR	675439	5854433	0	12/08/1974		179		0.48
221212	BEMM RIVER @ PRINCES HIGHWAY	667855	5836059	0	30/04/1975		725		0.59
221213	GOOLENGOOK RIVER @ D/S OF ARTE RIVER JUNCTION	663700	5846900	0	1/05/1978	18/12/1986	171		0.69
221214	CANN RIVER @ D/S OF CANN RIVER	688655	5836283	0	26/07/1979		675		0.44
221216	GENOA RIVER @ D/S OF BIG FLAT CREEK JUNCTION	722308.7	5858209.9	0	23/05/1967	10/12/1970	829		0.43
221217	GENOA RIVER @ GIPSY POINT (WOOD'S JETTY)	736900	5848600	-1.3	8/07/1992	3/11/1998	0		
221218	BETKA RIVER @ MINERS TRACK	732688	5835801	0	16/01/1996		0		0.29
221222	HENSLEIGH CREEK U/S COMBIENBAR	679158	5863650	0	18/05/2006	17/11/2010	0		
221223	COMBIENBAR RIVER @ TIGER SNAKE CK	680158	5864336	0	18/05/2006	17/11/2010	0		
221224	CANN RIVER U/S CANN RIVER OFFTAKE	690544	5843171	0	11/03/2009		0		0.52
221225	BEMM RIVER U/S OF PUMPHOUSE	671929	5822377	0			0		0.44
221800	RAINGAUGE (GENOA RIVER) @ THE GORGE	722715	5855916.4	0	22/08/1972		0		

Latrobe Basin

Site ID	Site name	Easting	Northing	Gauge zero (mAHD)	Site start date	Site cease date	Drainage area (km^2)	BFI GHD	BFI
226005	LATROBE RIVER @ THOMS BRIDGE	448418	5775480	0	24/05/1960		2657		0.57
226006	TYERS RIVER @ BOOLA	448568.9	5781803	112.027	16/04/1958		293		0.44
226007	TYERS RIVER @ BROWNS	443476	5788600	169.359	17/08/1961		207		0.60
226008	TYERS RIVER WEST BRANCH @ MORGANS MILL	439256	5800120	0	27/04/1960		80		0.64
226012	TANJIL RIVER EAST BRANCH @ TANJIL BREN	429307.7	5812543.1	0	18/01/1961	11/08/1971	12		0.65
226016	WATERHOLE CREEK @ MORWELL	449045.2	5767997.4	60.56	22/08/1961	15/02/1982	41		0.42
226017	JACOBS CREEK @ O'TOOLES	446350	5788246	0	16/04/1962		36		0.43
226021	NARRACAN CREEK @ MOE	435969	5775832	0	26/06/1996		0		0.69
226023	TRARALGON CREEK @ TRARALGON	460064	5772541	32.673	18/09/1998		189		0.48
226027	LATROBE RIVER AT SWING BRIDGE	511200	5778084	0	7/05/2010		0		0.41
226028	TYERS R @ PUMP HOUSE	451503	5778560	0	5/04/2007		0		0.63
226033	LATROBE RIVER @ SCARNES BRIDGE	460763	5777041	21.185	20/12/1996		0		0.44
226039	BILLY CREEK @ U/S OF OFFTAKE WEIR	446116.2	5755155.9	0	2/03/1967	8/05/1968	22		0.57
226041	LAKE WELLINGTON @ BULL BAY	532876	5780415	0	25/02/1991		0		
226202	TYERS RIVER @ GOULD	444451.2	5785659.5	0	19/05/1926	28/02/1941	220		0.59
226204	LATROBE RIVER @ WILLOW GROVE	426308	5784017	0	17/10/1966		580		0.74
226205	LATROBE RIVER @ NOOJEE	414035	5804037	0	1/05/1996		290		0.79
226206	LATROBE RIVER @ APM MARYVALE	452119.2	5774427.3	27.546	2/01/1946	3/05/1977	3002		0.62
226209	MOE RIVER @ DARNUM	412633	5770880	79.598	19/10/1960		214		0.48
226216	TANJIL RIVER @ TANJIL SOUTH	433560	5783395	69.245	5/04/1955		358		0.70
226217	LATROBE RIVER @ HAWTHORN BRIDGE	419490.7	5796547.9	0	2/06/1955	9/01/1989	440		0.73
226218	NARRACAN CREEK @ THORPDALE	428843	5763687	0	22/06/1955		66		0.75
226219	TOORONGA RIVER @ NOOJEE	415838.9	5810012	0	1/10/1924	1/07/1933	65		0.78
226220	LOCH RIVER @ NOOJEE	412644	5808497	0	25/04/1978		106		0.74

Site ID	Site name	Easting	Northing	Gauge zero (mAHD)	Site start date	Site cease date	Drainage area (km^2)	BFI GHD	BFI
226222	LATROBE RIVER @ NEAR NOOJEE (US ADA R JUNCT.)	402650	5806658	272.304	10/05/1971		62		0.80
226223	LATROBE RIVER @ NEERIM EAST	414328.5	5800194.3	0	16/03/1972	8/01/1979	378		0.77
226224	LATROBE RIVER @ ROSEDALE (ANABRANCH)	481555	5777709	9.7	1/12/1936		4144		0.12
226226	TANJIL RIVER @ TANJIL JUNCTION	429155	5796100	0	25/05/1960		289		0.69
226227	LATROBE RIVER @ KILMANY SOUTH	492900	5778721	2.571	16/12/1976		4464		0.62
226228	LATROBE RIVER @ ROSEDALE (MAIN STREAM)	481748	5778351	9.7	1/12/1936		4144		0.62
226229	TANJIL RIVER @ D/S OF BLUE ROCK DAM	432764.2	5784646.8	75.315	11/05/1979	28/02/1982	352		0.71
226232	TANJIL RIVER @ MOE-WALHALLA ROAD BRIDGE	0	0	0	17/05/1990	5/06/1990	514		
226233	TANJIL RIVER @ U/S OF SERPENTINE CREEK	435276.4	5783132.8	0	16/07/1992	12/12/2006	0		0.74
226235	TYERS RIVER @ TYERS JUNCTION	441506	5798197	0	20/08/2003		132.2		0.61
226244	TYERS R EAST BRANCH @ CORRINGAL SCOUT CAMP	441496	5798505	0	27/10/2004	18/09/2008	0		
226245	TYERS R WEST BRANCH U/S SOUTH FACE RD	436327	5807354	0	1/11/2004	24/02/2009	0		
226246	TYERS R WEST BRANCH D/S SOUTH FACE RD	436123	5807237	0	28/10/2004	24/02/2009	0		
226247	HOPE CK U/S SOUTHFACE ROAD BRIDGE	434283	5810028	0	26/03/2007	24/02/2009	0		
226248	HOPE CK D/S SOUTHFACE ROAD BRIDGE	434267	5809990	0	26/03/2007	24/02/2009	0		
226400	LATROBE RIVER @ YALLOURN	437171.9	5776866.3	0	1/11/1923		1940		
226402	MOE DRAIN @ TRAFALGAR EAST	431070	5774351	0	7/06/1957		622		
226407	MORWELL RIVER @ BOOLARRA	439351	5748787	98.302	9/05/1972		114		
226408	MORWELL R @ YALLOURN	444702	5770110.4	0	21/04/2004		622		
226410	TRARALGON CREEK @ KOORNALLA	459050	5758231	0	9/07/1953		89		
226415	TRARALGON CREEK @ TRARALGON SOUTH (JONES RD)	459805	5764127	60	27/05/1976		128		
226602	AREA 2 SITE1 @ DOWDS MORASS NTH	515887	5777885	-0.016	17/06/2003	24/09/2009	0		
226603	AREA 4 SITE 2 @ DOWDS MORASS STH	516572	5776987	-0.016	17/06/2003		0		
226605	LAKE VICTORIA AT MCLENNAN'S STRAIT	539492.4	5787708	0	17/11/2010		0		
226606	LAKE VICTORIA AT LOCH SPORT	551177	5789006		26/11/2010				

Site ID	Site name	Easting	Northing	Gauge zero (mAHD)	Site start date	Site cease date	Drainage area (km^2)	BFI GHD	BFI
226607	MCMILLAN STRAIT AT PAYNESVILLE	564019	5803744.2		21/10/2010				
226608	LAKE KING AT METUNG	576509	5807127.8		17/11/2010				
226609	CUNNINGHAM ARM AT BULLOCK ISLAND	585591	5806582.2		19/10/2010				
226700	LOY YANG OUTFALL TO TRARALGON CREEK	0	0	0	17/12/1997	7/02/2000	0		
226702	MORWELL GROSS POLLUTION TRAP D/S CIRCULAR PIPE	447900	5766700	0	1/06/1998	7/10/1998	0		
226801	RAINGAUGE (REPRESENTATIVE BASIN) @ LATROBE NO. 2	399410	5810382.1	0	19/01/1982	17/08/1988	0		
226802	RAINGAUGE (REPRESENTATIVE BASIN) @ LATROBE NO. 3	398477.4	5802787.5	0	19/01/1982	6/03/1986	0		
226804	RAINGAUGE (SITE 3) @ WALHALLA ST - NEWBOROUGH	438000	5772500	0	6/12/1994	16/10/1995	0		
226805	RAINGAUGE (SITE 4) @ MOE INDOOR RECREATION CENTRE	437018.3	5772948.1	0	7/12/1994	16/10/1995	0		
226814	RAIN GAUGE @ MT TASSIE	461784	5750077	0	3/12/1998		0		
226815	RAIN GAUGE (TRARALGON CK) @ TRARALGON - EPA YARD	458982	5772514	0	25/05/1999		0		
226816	RAIN GAUGE @ MT HOOGHLY	453401	5750509	0	29/09/1999	15/05/2008	0		
226817	RAIN GAUGE @ LE ROY QUARRY	457656	5750650	0	30/09/1999	31/10/2009	0		
226818	RAIN GAUGE @ BALOOK	459952	5746341	0	10/06/1999		0		
226819	RAIN GAUGE @ CALIGNEE NORTH	462063	5758780	0	25/05/1999		0		
226825	RAINGAUGE @ MOE SOUTH	434231.7	5769648.9		6/10/2009				
226826	RAINGAUGE AT YARRAGON SOUTH	420511	5763367.1		21/10/2009				
226827	RAINGAUGE @ THORPDALE PEAK	431275	5760002.4		17/09/2009				
226828	RAINGAUGE @ JEERALANG SOUTH HALLAMS RD	451008.4	5752916		6/10/2009	16/11/2011			
226829	RAINGAUGE AT JERRALANG, DOBBINS ROAD	450883.6	5754699.5		29/01/2013				

Mitchell Basin

Site ID	Site name	Easting	Northing	Gauge zero (Ahd)	Site start date	Site cease date	Drainage area (km^2)	BFI GHD	BFI
224200	MITCHELL RIVER @ BAIRNSDALE	552241	5813267	0			4425		
224201	WONNANGATTA RIVER @ WATERFORD	514714	5850745	175.337	15/07/1976		1979		
224203	MITCHELL RIVER @ GLENALADALE	533010	5820334	28.951	22/02/1991		3903		
224205	DARGO RIVER @ DARGO (UPPER SITE)	524129.9	5861627.7	0	1/06/1953	26/06/1974	539		
224206	WONNANGATTA RIVER @ CROOKED RIVER	507891	5859903	240.829	13/04/1977		1096		
224207	WONGUNGARRA RIVER @ GUYS	508800	5862200	247.234	7/05/1953	10/01/1989	736		
224208	MITCHELL RIVER @ HOWITT DAM SITE	532433.8	5827894.3	51.586	14/02/1969	22/12/1975	3761		
224209	COBBANNAH CREEK @ NEAR BAIRNSDALE	530900	5831600	0	15/05/1970	1/07/1987	106		
224210	WONNANGATTA RIVER @ KINGSWELL BRIDGE (HAWKHURST)	510185.8	5859581.7	224.768	12/02/1970	25/03/1981	1883		
224213	DARGO RIVER @ LOWER DARGO ROAD	523752	5850152	172.824	24/05/1973		676		
224214	WENTWORTH RIVER @ TABBERABBERA	534808	5850099	0	4/07/1974		443		
224215	MITCHELL RIVER @ ANGUSVALE (TABBERABBERA)	529928	5838289	92.644	28/05/1975	30/09/2008	3430		
224216	CLIFTON CREEK @ WY YUNG	554294.5	5816639.7	0	28/01/1977	4/01/1979	129		
224217	MITCHELL RIVER @ ROSEHILL	550366	5814542	0	2/04/2003		4413		
224220	RAIN GAUGE (BOGGY CREEK) @ BULLUMWAAL	548565.5	5830013.3	178.885	26/02/1991		83		
224222	MITCHELL RIVER U/S GLENALADALE PUMPHOUSE	532443	5823351	0	18/12/2009		0		

Snowy Basin

Site Id	Site Name	Easting	Northing	Gauge Zero (Ahd)	Site Start Date	Site Cease Date	Drainage Area (Sq.km)	BFI GHD	BFI
222200	SNOWY RIVER @ JARRAHMOND	620071	5830901	0	30/06/1971		13421		
222201	SNOWY RIVER @ ORBOST	627898	5825644.4	-0.141	27/03/1997		13572		
222202	BRODRIBB RIVER @ SARDINE CREEK	636752	5847240	78.591	16/06/1998		658		
222203	SNOWY RIVER @ MARLO JETTY	634504.8	5815384.5	-0.745	25/06/1934	18/01/1998	0		
222204	SNOWY RIVER @ BETE BELONG	623487.8	5824589.9	0	21/10/1938	26/07/1949	13540		
222205	SNOWY RIVER @ NEWMERELLA-LOCHEND ROAD	632611.9	5821910.2	-0.479	1/03/1960	27/01/1983	13600		
222206	BUCHAN RIVER @ BUCHAN	603711	5849459	74.85	27/03/1926		822		
222207	BUCHAN RIVER @ MURRINDAL	609403	5848400.8	0	15/02/1951	21/11/1972	1204		
222209	SNOWY RIVER @ MCKILLOP BRIDGE	625612	5894902	0	5/04/1967		10619		
222210	DEDDICK RIVER @ DEDDICK (CASEYS)	626577.7	5894693.7	0	5/04/1973		857		
222212	SNOWY RIVER @ BASIN CREEK NEAR BUCHAN	613458.7	5850738.1	0	4/05/1932	10/01/1934	11836		
222213	SUGGAN BUGGAN RIVER @ SUGGAN BUGGAN	618048	5909278	0	25/06/1974		361		
222214	ROCKY RIVER @ NEAR ORBOST	645109.5	5833372.7	0	8/12/1969	17/03/1978	20		
222216	MURRINDAL RIVER @ BASIN ROAD (BUCHAN)	608500	5849900	0	4/02/1976	30/06/1987	302		
222217	RODGER RIVER @ JACKSONS CROSSING	620346	5858744	0	3/06/1976		447		
222218	LITTLE RIVER @ WULGULMERANG	616400	5897200	0	21/04/1977	18/07/1984	88		
222219	SNOWY RIVER @ D/S OF BASIN CREEK	612580	5848984	0	12/12/1978		11964		
222221	BUCHAN RIVER @ EGW OFFTAKE	603874	5852271	0	14/05/2009		0		
222222	ROCKY RIVER U/S OT THE WEIR	645938	5834053	0	11/03/2009		0		
222400	MOYANGUL RIVER @ LOOKOUT NEAR TIN MINE	613203.5	5941897.7	0	14/03/1955	14/11/1963	29		
222401	INGEEGOODBEE RIVER @ D/S OF TIN MINE HUTS	613098.4	5933947.3	0	19/05/1955	14/11/1963	21		
222403	BUCHAN RIVER @ GLENMORE	600499.4	5879843.5	0	27/01/1955	22/07/1969	513		
222404	MELLICK MUNJIE CREEK @ GILLINGALL	598595.5	5877355.2	0	5/07/1955	22/07/1969	70		

South Gippsland region

Site ID	Site name	Easting	Northing	Gauge zero (Ahd)	Site start date	Site cease date	Drainage area (km^2)	BFI GHD	BFI
227001	MERRIMAN CREEK @ SEASPRAY	514294.7	5754491	0	29/09/1966	17/06/1971	525		
227200	TARRA RIVER @ YARRAM	471649	5734286	0	18/02/1976		215		
227201	BRUTHEN CREEK @ WOODSIDE	488800	5735750	0	1/03/1946	30/09/1960	174		
227202	TARWIN RIVER @ MEENIYAN	412165	5729150	0	22/06/1955		1067		
227203	FRANKLIN RIVER @ HENWOODS BRIDGE	436475.8	5725293.9	0	3/12/1946	8/01/1985	12		
227205	MERRIMAN CREEK @ CALIGNEE SOUTH	469833	5755048	172.448	13/12/1965		36		
227210	BRUTHEN CREEK @ CARRAJUNG LOWER	477651	5750309	0	7/08/1952		18		
227211	AGNES RIVER @ TOORA	445387	5722973	0	10/01/1957		67		
227213	JACK RIVER @ JACK RIVER	459739	5735728	0	1/12/1962		34		
227216	ALBERT RIVER @ HIAWATHA (BELOW FALLS)	453863.5	5735533.5	0	25/06/1964	23/02/1989	41		
227217	LILLYPILLY CREEK @ STAIRCASE	442292	5680222.7	0	2/09/1965	15/01/1974	5		
227219	BASS RIVER @ LOCH	388609	5753722	0	1/04/1966		52		
227220	GREIG CREEK @ MUMFORDS	473100	5743600	0	6/05/1968	2/12/1998	25		
227221	BODMAN CREEK @ BRIDGES	476725.7	5746055.5	0	7/05/1968	20/10/1978	15		
227222	SPRING CREEK @ BOWDENS	475282.4	5742352.5	65.909	20/05/1968	13/06/1975	10		
227223	MACKS CREEK @ RICHARDS	467870.1	5741586.5	0	24/04/1968	15/06/1987	19		
227224	WOMERAH CREEK @ TARR VALLEY ROAD	462201	5741376.9	0	29/04/1968	20/12/1982	1		
227225	TARRA RIVER @ FISCHERS	461190	5741983	0	24/04/1968		16		
227226	TARWIN RIVER EAST BRANCH @ DUMBALK NORTH	426838	5738399	0	8/01/1969		127		
227227	WILKUR CREEK @ LEONGATHA	408948	5750056	0	31/07/1970		106		
227228	TARWIN RIVER EAST BRANCH @ MIRBOO	433155.3	5737488.6	0	30/04/1971	18/06/1987	43		
227231	BASS RIVER @ GLEN FORBES SOUTH	370463	5741320	0	30/03/1973		233		

Site ID	Site name	Easting	Northing	Gauge zero (Ahd)	Site start date	Site cease date	Drainage area (km^2)	BFI GHD	BFI
227232	LANCE CREEK U/S LANCE CREEK RESERVOIR	383783	5738738	0	31/03/2008		14		
227234	SPRING CREEK @ BEAUMONT	475276.8	5744201.8	0	3/04/1975	15/12/1982	7		
227235	MIDDLE CREEK @ TALL TIMBERS	460742.6	5742294.6	0	27/04/1978	18/01/1989	9		
227236	POWLETT RIVER @ D/S FOSTER CREEK JUNCTION	387508	5731353	0	18/05/1979		228		
227237	FRANKLIN RIVER @ TOORA	439771	5724088	0	7/04/1983		75		
227238	FOSTER CREEK @ DAM SITE	387050.1	5739746.7	0	8/06/1979	17/01/1989	55		
227239	MERRIMAN CREEK @ STRADBROKE WEST	492658	5764652	71.868	18/11/1983		256		
227240	MERRIMAN CREEK @ PROSPECT ROAD SEASPRAY	514320	5754179	2.544	26/08/1983		529		
227242	MERRIMAN CREEK @ SEASPRAY TOWNSHIP	516203	5752529	0	6/03/1990		8		
227243	BRUTHEN CREEK @ D/S REEDY CREEK	484778	5747810	79.91	13/05/1992		124		
227244	DEEP CREEK @ FOSTER	432312	5725707	0	29/04/1993		0		
227245	LITTLE BASS RIVER @ POOWONG U/S LITTLE BASS RES.	39050	5753576	0	18/05/1999		0		
227246	COALITION CREEK	396827	5748087.4	0	8/06/2004		0		
227248	BELLVIEW CREEK U/S BELLVIEW RESERVOIR	396367	5749105	0	18/05/1999		0		
227249	RUBY CREEK @ ARAWATA	402379	5748848	0	23/07/2008		0		
227251	TARRA RIVER @ TARRA WEIR OFFTAKE	463301	5741305	0	27/10/2004		0		
227264	COALITION CREEK @ LEONGATHA (SPENCERS ROAD BRIDGE)	409001	5743754	0	21/10/2008		0		
227265	GOLDEN CREEK @ BLACK SWAMP ROAD	428266	5711026	0	15/02/2008	18/11/2008	0		
227266	TARWIN RIVER @ KOONWARRA	408996	5735402	0	22/09/2008		0		
227270	FOSTER CREEK AT KORUMBURRA	394617.6	5745540		13/10/2011				

Tambo Basin

Site Id	Site Name	Easting	Northing	Gauge Zero (Ahd)	Site Start Date	Site Cease Date	Drainage Area (Sq.km)	BFI GHD	BFI
223202	TAMBO RIVER @ SWIFTS CREEK	564619	5875047	280.863	8/03/1977		943		
223204	NICHOLSON RIVER @ DEPTFORD	561543	5839104	0	12/05/1961		287		
223205	TAMBO RIVER @ D/S OF RAMROD CREEK	576710	5830147	15.452	9/06/1965		2681		
223206	TAMBO RIVER @ BINDI	571424.2	5896694.3	0	8/08/1957	19/12/1974	401		
223207	TIMBARRA RIVER @ TIMBARRA	592900	5869900	0	9/09/1957	4/06/1973	205		
223208	TAMBO RIVER @ BINDI (NEAR JUNCTION CREEK)	568710	5887104	0	21/03/1974	14/07/2003	523		
223209	TAMBO RIVER @ BATTENS LANDING	574796.1	5820757.9	0	26/01/1977		2781		
223210	NICHOLSON RIVER @ SARSFIELD	562646	5823050	0	21/09/1977		471		
223212	TIMBARRA RIVER @ D/S OF WILKINSON CREEK	594066	5855069	0	6/05/1982		438		
223213	TAMBO RIVER @ D/S OF DUGGAN CREEK	578509	5904321	746.726	16/09/1987		96		
223214	TAMBO RIVER @ U/S OF SMITH CREEK	582588	5909736	0	2/03/1989		32		
223215	HAUNTED STREAM @ HELLS GATE	573015	5851389	153.892	8/02/1990		180		
223216	TAMBO RIVER U/S SWIFTS CK OFFTAKE	563729	5877748	0	20/05/2009		0		
223217	NICHOLSON RIVER AT PUMP HOUSE	564088	5821594	0	20/01/2011		0		
223402	TIMBARRA RIVER @ NUNNIONG PLAINS	587028.3	5888208.6	0	22/06/1955	16/02/1960	16		
223403	TAMBO RIVER @ NUNNIONG PLAINS	583943.9	5892462.9	0	21/06/1955	16/02/1960	39		
223800	RAINGAUGE (TAMBO RIVER) @ MOUNT ELIZABETH	582300	5850700	0	15/01/1985	20/10/2004	0		
223801	RAIN GAUGE (TAMBO RIVER) @ MT ELIZABETH HELIPAD	581909	5850809	0	20/10/2004	19/01/2011	0		
223802	RAINGAUGE AT MOUNT ELIZABETH SOMMERVILLE TRACK	580733	5851999		19/01/2011				

Thomson Basin

Site Id	Site Name	Easting	Northing	Gauge Zero (Ahd)	Site Start Date	Site Cease Date	Drainage Area (Sq.km)	BFI GHD	BFI
225019	NORTH CASCADE CREEK @ THOMSON VALLEY ROAD	441836.2	5815577.5	0	11/01/1962	6/06/1974	11		
225105	THOMSON RIVER @ NEWLAND ROAD	427654.1	5819829.7	0	30/03/1954	1/05/1984	16		
225114	THOMSON RIVER @ D/S WHITELAWS CREEK	436711	5825795	0	27/03/1987		155.3		
225200	THOMSON RIVER @ HEYFIELD	480693	5795763	35.846	17/01/1991		1238		
225201	AVON RIVER @ STRATFORD	506676	5797653	0	1/11/1976		1485		
225204	MACALISTER RIVER @ LAKE GLENMAGGIE (TAIL GAUGE)	482885	5805021	47.015	28/09/1966		1891		
225207	THOMSON RIVER @ WALHALLA	449064.3	5798590.9	0	9/03/1950	22/05/1952	875		
225209	MACALISTER RIVER @ LICOLA	466762	5835198	2	1/08/1952		1233		
225210	THOMSON RIVER @ THE NARROWS	447551	5805990	247.08	9/04/1957		518		
225212	THOMSON RIVER @ WANDOCKA	489554	5792978	19.423	1/03/1977		1417		
225213	ABERFELDY RIVER @ BEARDMORE	450135	5810238	305.552	27/06/1963		311		
225216	JORDAN RIVER @ ABERFELDY	439747.8	5829099.3	0	4/10/1971	18/07/1972	124		
225217	BARKLY RIVER @ GLENCAIRN	461700	5842800	263.1	12/05/1966	4/01/1989	248		
225218	FREESTONE CREEK @ BRIAGALONG	508366.4	5815232.8	63.238	14/07/1975		309		
225219	MACALISTER RIVER @ GLENCAIRN	461689	5847757	293.54	7/04/1967		570		
225221	MACALISTER RIVER @ STRINGYBARK CREEK	470738	5819709	105.249	18/03/1968		1542		
225222	GLENMAGGIE CREEK @ SEATON (AUBREYS)	471117.4	5803309.8	111.285	10/03/1970	18/12/1975	141		
225223	VALENCIA CREEK @ GILLIO ROAD	499321	5822633	85.481	26/03/1991		195		
225224	AVON RIVER @ THE CHANNEL	489868	5816150	72	12/07/1972		554		
225225	MACALISTER RIVER @ LAKE GLENMAGGIE (HEAD GAUGE)	482418.6	5804322.1		26/01/1925				
225228	THOMSON RIVER @ COWWARR TIMBER WEIR H.G.	469855.4	5794299.7	-0.96	1/01/1958		1093		
225230	GLENMAGGIE CREEK @ THE GORGE	469772	5803687	120.847	2/05/1975		139		

Site Id	Site Name	Easting	Northing	Gauge Zero (Ahd)	Site Start Date	Site Cease Date	Drainage Area (Sq.km)	BFI GHD	BFI
225231	THOMSON RIVER @ U/S OF COWWARR WEIR	467065	5796878	69.4	1/04/1976		1080		
225232	THOMSON RIVER @ BUNDALAGUAH	499308	5789148	5.094	3/11/1976		3538		
225233	PERRY RIVER @ PERRY BRIDGE	523288.7	5793397.5	-0.938	24/12/1976	19/11/1982	357		
225234	AVON RIVER @ CLYDEBANK (CHINN'S BRIDGE)	515238	5791515	0	29/06/2004		1584		
225236	RAINBOW CREEK @ HEYFIELD	480686	5793911	33.837	30/04/1992		0		
225247	MACALISTER RIVER @ RIVERSLEA	498044.5	5791335.7	0	11/01/2001		0		
225248	BOGGY CREEK @ CORNWALLS ROAD	492831	5793649.7	0	29/08/2008		0		
225255	AVON RIVER U/S VALENCIA CK JUNCTION	498324	5813965	0	30/06/2004		0		
225256	MACALISTER R D/S MAFFRA (SMITHS BR.)	498377	5793730	0	26/10/2005		0		
225600	LAKE WELLINGTON @ SALE	519212	5781295.6	0	1/12/1973	1/07/1977	0		
225703	THOMSON RIVER DIVERSION CHANNEL @ COWWARR WEIR	470010	5794250	0	5/02/2001	19/07/2007	0		
225711	LAKE WELLINGTON DRAIN @ 5 MILES 32 CHAIN MEASURING WEIR	512208.2	5787288.3	0	12/11/1976	3/05/2001	0		
225715	CENTRAL GIPPSLAND DRAIN 3 @ NAMBROK (RD 1066M)	488590	5786295	0	24/02/1980	15/04/2005	0		
225716	CENTRAL GIPPSLAND 1/2 DRAIN 3 @ DROP STRUCTURE (RD500)	491500	5784700	0	24/02/1980	4/02/2004	0		
225717	CENTRAL GIPPSLAND 2/3 DRAIN @ US OF DRAIN 3 (RD 500M)	491102	5783737	0	24/02/1980	15/04/2005	0		
225721	CENTRAL GIPPSLAND DRAIN NO 3/3 U/S OUTFALL	487050	5788350	0	29/05/2000	13/02/2004	0		
225722	CENTRAL GIPPSLAND DRAIN NO 3 D/S NO3 O/FALL	487100	5788300	0	29/05/2000	13/02/2004	0		
225723	CENTRAL GIPPSLAND DRAIN NO 1/3 @ D/S 11/4/1 JUNCTION	488200	5784600	0	29/05/2000	13/02/2004	0		
225724	CHANNEL O/FALL 11/4/1 U/S JUNCTION CG DR 1/3	488150	5784500	0	29/05/2000	15/04/2005	0		
225725	CENTRAL GIPPSLAND DRAIN NO 3 D/S O/FALL 11/1	490400	5783500	0	26/05/2000	15/04/2005	0		
225726	CENTRAL GIPPSLAND DRAIN NO 3 D/S RAILWAY LINE	491000	5781800	0	29/05/2000	15/04/2005	0		
225727	CENTRAL GIPPSLAND DRAIN NO 2/3 @ SOLDIERS RD	490100	5785600	0	26/05/2000	13/02/2004	0		
225737	CENTRAL GIPPSLAND DRAIN NO 8/2 @ DENISON ROAD	483978	5789779	0	28/05/2002	15/04/2005	0		
225738	CENTRAL GIPPSLAND DRAIN NO 2 @ SALE-TOONGABBIE ROAD	487500	5782800	0	28/05/2002	15/04/2005	0		

Site Id	Site Name	Easting	Northing	Gauge Zero (Ahd)	Site Start Date	Site Cease Date	Drainage Area (Sq.km)	BFI GHD	BFI
225739	CENTRAL GIPPSLAND DRAIN NO 2/2 @ DESSENTS	487311	5782836	0	28/05/2002	15/04/2005	0		
225740	CENTRAL GIPPSLAND DRAIN NO 2 U/S TINAMBA-ROSEDALE ROAD	487800	5781900	0	16/05/2002	15/04/2005	0		
225741	CENTRAL GIPPSLAND DRAIN NO 2 U/S NAMBROK ROAD	485335	5786592	0	16/05/2002	15/04/2005	0		
225742	CENTRAL GIPPSLAND DRAIN NO 2 U/S SALE-COWWARR ROAD	484488	5788744	0	28/05/2002	15/04/2005	0		
225743	CENTRAL GIPPSLAND DRAIN NO 6/2 U/S DENISON ROAD	483670	5788400	0	28/05/2002	15/04/2005	0		
225747	NOBLES O/FALL @ VALENCIA CK	498563	5813297	0	24/02/2004	1/07/2005	0		
225748	TINAMBA MAIN O/FALL @ MENBURN PARK	498214	5813767	0	25/02/2004	27/06/2005	0		
225801	RAIN GAUGE (MACALISTER RIVER) @ MURDERERS HILL	460964	5810725	0	8/06/1970		0		
225802	RAIN GAUGE (MACALISTER RIVER) @ MOUNT TAMBORITHA	472550	5853466	0	1/04/1986		0		
225809	RAIN GAUGE (AVON RIVER) @ MOUNT WELLINGTON	487412	5850069	0	21/05/1997		0		
225810	RAIN GAUGE (AVON RIVER) @ REEVE KNOB	500533.2	5846182	0	21/05/1997		0		
225819	RAINGAUGE @ MT USEFUL	456353	5827872	0	27/05/2002		0		
225823	RAINGAUGE AT BLANKET HILL	472533.6	5811892.1		26/07/2010				
225824	RAINGAUGE (MACALISTER RV) AT SNOWY RANGE	0	0		22/02/2011				
225825	RAINGAUGE (MACALISTER RV) AT HIGH RIDGE	0	0						
225826	RAINGAUGE (MACALISTER RV) AT MOUNT SUNDAY	448995	5867264		6/04/2011				

Appendix B: Gippsland region recharge

Spatially averaged groundwater potential evapotranspiration and recharge for each modelled time period.

Stress period	Period	Time step (ts)	Days per timestep	Rain (mm/ts)	G'water Evap'n (mm/ts)	Recharge (mm/ts)	Rech/Rain (%)
1	01/01/1971 – 31/12/1971	365	365	1022	783	65	6.31
2	01/01/1972 – 31/12/1972	366	731	626	619	20	3.14
3	01/01/1973 – 31/12/1973	365	1096	1035	644	76	7.37
4	01/01/1974 – 31/12/1974	365	1461	1353	678	173	12.78
5	01/01/1975 – 31/12/1975	365	1826	1064	682	108	10.18
6	01/01/1976 – 31/12/1976	366	2192	914	641	78	8.49
7	01/01/1977 – 31/12/1977	365	2557	840	639	78	9.28
8	01/01/1978 – 31/12/1978	365	2922	1378	639	166	12.02
9	01/01/1979 – 31/12/1979	365	3287	677	615	49	7.29
10	01/01/1980 – 31/12/1980	366	3653	879	662	50	5.72
11	01/01/1981 – 31/12/1981	365	4018	945	671	71	7.51
12	01/01/1982 – 31/12/1982	365	4383	671	616	29	4.38
13	01/01/1983 – 31/12/1983	365	4748	1021	569	102	10.04
14	01/01/1984 – 31/12/1984	366	5114	965	649	91	9.39
15	01/01/1985 – 31/12/1985	365	5479	1143	613	113	9.85
16	01/01/1986 – 31/12/1986	365	5844	782	626	75	9.55
17	01/01/1987 – 31/12/1987	365	6209	828	631	59	7.13
18	01/01/1988 – 31/12/1988	366	6575	995	626	72	7.25
19	01/01/1989 – 31/12/1989	365	6940	1031	655	122	11.81
20	01/01/1990 – 31/03/1990	90	7030	145	179	3	1.77
21	01/04/1990 – 30/06/1990	91	7121	283	96	19	6.86
22	01/07/1990 – 30/09/1990	92	7213	308	114	50	16.25
23	01/10/1990 – 31/12/1990	92	7305	238	262	22	9.15
24	01/01/1991 – 31/03/1991	90	7395	199	194	4	1.90
25	01/04/1991 – 30/06/1991	91	7486	243	92	12	4.92
26	01/07/1991 – 30/09/1991	92	7578	359	118	64	17.82
27	01/10/1991 – 31/12/1991	92	7670	165	241	7	4.53
28	01/01/1992 – 31/03/1992	91	7761	193	191	6	3.01
29	01/04/1992 – 30/06/1992	91	7852	216	76	12	5.77

Stress period	Period	Time step (ts)	Days per timestep	Rain (mm/ts)	G'water Evap'n (mm/ts)	Recharge (mm/ts)	Rech/Rain (%)
30	01/07/1992 – 30/09/1992	92	7944	303	111	40	13.34
31	01/10/1992 – 31/12/1992	92	8036	377	231	47	12.50
32	01/01/1993 – 31/03/1993	90	8126	248	217	17	6.89
33	01/04/1993 – 30/06/1993	91	8217	125	94	11	9.11
34	01/07/1993 – 30/09/1993	92	8309	339	112	49	14.55
35	0110/1993 – 31/12/1993	92	8401	304	247	31	10.14
36	01/01/1994 – 31/03/1994	90	8491	266	213	15	5.77
37	01/04/1994 – 30/06/1994	91	8582	192	107	14	7.45
38	01/07/1994 – 30/09/1994	92	8674	143	111	13	9.14
39	01/10/1994 – 31/12/1994	92	8766	243	249	16	6.59
40	01/01/1995 – 31/03/1995	90	8856	207	202	5	2.32
41	01/04/1995 – 30/06/1995	91	8947	252	87	25	9.94
42	01/07/1995 – 30/09/1995	92	9039	203	121	26	12.65
43	0110/1995 – 31/12/1995	92	9131	378	234	38	10.11
44	01/01/1996 – 31/03/1996	91	9222	230	220	10	4.50
45	01/04/1996 – 30/06/1996	91	9313	191	92	18	9.45
46	01/07/1996 – 30/09/1996	92	9405	304	122	45	14.71
47	01/10/1996 – 31/12/1996	92	9497	211	246	13	6.08
48	01/01/1997 – 31/03/1997	90	9587	141	178	3	1.97
49	01/04/1997 – 30/06/1997	91	9678	174	73	5	2.75
50	01/07/1997 – 30/09/1997	92	9770	148	113	14	9.68
51	01/10/1997 – 31/12/1997	92	9862	158	223	3	1.96
52	01/01/1998 – 31/03/1998	90	9952	131	143	1	0.73
53	01/04/1998 – 30/06/1998	91	10043	295	69	10	3.32
54	01/07/1998 – 30/09/1998	92	10135	196	111	26	13.50
55	01/10/1998 – 31/12/1998	92	10227	317	264	17	5.44
56	01/01/1999 – 31/03/1999	90	10317	210	219	5	2.36
57	01/04/1999 – 30/06/1999	91	10408	156	91	9	5.99
58	01/07/1999 – 30/09/1999	92	10500	164	113	17	10.26
59	0110/1999 – 31/12/1999	92	10592	203	207	6	2.78
60	01/01/2000 – 31/03/2000	91	10683	168	188	3	1.84
61	01/04/2000 – 30/06/2000	91	10774	248	89	17	6.67
62	01/07/2000 – 30/09/2000	92	10866	235	112	29	12.26
63	01/10/2000 – 31/12/2000	92	10958	211	237	21	9.83

Stress period	Period	Time step (ts)	Days per timestep	Rain (mm/ts)	G'water Evap'n (mm/ts)	Recharge (mm/ts)	Rech/Rain (%)
64	01/01/2001 – 31/03/2001	90	11048	199	179	3	1.58
65	01/04/2001 – 30/06/2001	91	11139	217	90	16	7.53
66	01/07/2001 – 30/09/2001	92	11231	285	113	42	14.73
67	01/10/2001 – 31/12/2001	92	11323	309	237	29	9.26
68	01/01/2002 – 31/03/2002	90	11413	216	205	7	3.17
69	01/04/2002 – 30/06/2002	91	11504	267	105	24	8.81
70	01/07/2002 – 30/09/2002	92	11596	145	128	17	11.73
71	01/10/2002 – 31/12/2002	92	11688	156	231	3	2.14
72	01/01/2003 – 31/03/2003	90	11778	104	121	0	0.45
73	01/04/2003 – 30/06/2003	91	11869	169	93	5	2.68
74	01/07/2003 – 30/09/2003	92	11961	228	130	22	9.45
75	01/10/2003 – 31/12/2003	92	12053	244	236	14	5.78
76	01/01/2004 – 31/03/2004	91	12144	111	143	2	1.40
77	01/04/2004 – 30/06/2004	91	12235	229	86	11	4.69
78	01/07/2004 – 30/09/2004	92	12327	220	119	22	10.13
79	01/10/2004 – 31/12/2004	92	12419	262	252	16	6.05
80	01/01/2005 – 3103/2005	90	12509	223	203	7	2.98
81	01/04/2005 – 30/06/2005	91	12600	116	86	3	2.74
82	01/07/2005 – 30/09/2005	92	12692	298	115	29	9.63
83	01/10/2005 – 31/12/2005	92	12784	223	266	10	4.48
84	01/01/2006 – 31/03/2006	90	12874	114	161	1	0.98
85	01/04/2006 – 30/06/2006	91	12965	239	86	12	5.08
86	01/07/2006 – 30/09/2006	92	13057	174	123	13	7.38
87	01/10/2006 – 31/12/2006	92	13149	86	186	1	1.23
88	01/01/2007 – 31/03/2007	90	13239	190	157	1	0.37
89	01/04/2007 – 30/06/2007	91	13330	326	99	14	4.18
90	01/07/2007 – 30/09/2007	92	13422	188	126	33	17.44
91	01/10/2007 – 31/12/2007	92	13514	251	254	11	4.56
92	01/01/2008 – 31/03/2008	91	13605	172	193	4	2.11
93	01/04/2008 – 30/06/2008	91	13696	106	70	4	3.32
94	01/07/2008 – 30/09/2008	92	13788	199	117	18	8.82
95	01/10/2008 – 31/12/2008	92	13880	280	223	9	3.38
96	01/01/2009 – 31/03/2009	90	13970	81	154	2	2.10
97	01/04/2009 – 30/06/2009	91	14061	132	73	4	2.82

Stress period	Period	Time step (ts)	Days per timestep	Rain (mm/ts)	G'water Evap'n (mm/ts)	Recharge (mm/ts)	Rech/Rain (%)
98	01/07/2009 – 30/09/2009	92	14153	252	133	21	8.18
99	01/10/2009 – 31/12/2009	92	14245	225	244	13	5.85
100	01/01/2010 – 31/03/2010	90	14335	251	195	6	2.35
101	01/04/2010 – 30/06/2010	91	14426	197	90	15	7.76
102	01/07/2010 – 30/09/2010	92	14518	205	106	30	14.53
103	01/10/2010 – 31/12/2010	92	14610	314	240	22	6.93
104	01/01/2011 – 31/03/2011	90	14700	293	198	18	6.18
105	01/04/2011 – 30/06/2011	91	14791	232	88	30	12.87
106	01/07/2011 – 30/09/2011	92	14883	278	117	38	13.71
107	01/10/2011 – 31/12/2011	92	14975	315	259	25	7.80
108	01/01/2012 – 31/03/2012	91	15066	335	216	22	6.41
109	01/04/2012 – 30/06/2012	91	15157	322	95	44	13.63
110	01/07/2012 – 30/09/2012	92	15249	202	125	32	15.76
111	01/10/2012 – 31/12/2012	92	15341	191	266	9	4.96

Appendix C: Calibration bores

Summarised in Table F.1 are all the bores used to calibrate the groundwater model. Included in the table are the layer allocations based on the VAF data (VAF Lay) and the corresponding layer allocation based on bore depth and surface elevation data (New Lay). The top and bottom elevations of the VAF assigned layer (columns TopLay and BotLay respectively) are included for comparison with the associated bore depth. The tabled information suggests that in most cases the VAF assigned bore layer varies from the depth based layer as reported by the last column of Table F.1.

Table C.1: Calibration bore attribution.

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
114161	3	2568202	2315100	6	9.56	3.56	1.66	-0.34	2	yes
114156	3	2568974	2314144	38	0	-38	-5.73	-7.73	19	yes
114157	3	2568974	2314142	17	0	-17	-5.73	-7.73	8	yes
114158	3	2568974	2314141	11	0	-11	-5.73	-7.73	5	yes
94807	2	2568974	2314146	4	0	-4	-3.73	-5.73	2	no
94814	3	2569007	2313783	9	12	3	3.16	1.01	3	no
94813	3	2570892	2310487	21	12.15	-8.85	9.7	6.99	9	yes
94804	2	2571195	2311454	4	7.48	3.48	7.11	3.41	2	no
94816	3	2571454	2310076	12	5.97	-6.03	8.43	6.27	9	yes
94815	2	2571634	2310081	1	5.97	4.97	16.82	8.43	4	yes
94803	3	2572449	2311040	6	3	-3	-0.63	-2.63	4	yes
94802	2	2572605	2310763	4	6.99	2.99	4.9	0.85	2	no
113124	3	2572605	2310763	22	6.99	-15.01	0.85	-1.15	10	yes
113125	3	2572606	2310763	12	6.99	-5.01	0.85	-1.15	5	yes
75405	17	2572685	2329154	16	74.84	58.84	48	40.09	11	yes
75404	18	2574268	2332762	70	68.94	-1.06	29.8	20.57	21	yes
61429	18	2574390	2323889	28	66	38	40.62	33.35	18	no
75566	18	2574974	2330073	29	59	30	23.75	20.93	14	yes
61430	18	2576510	2323093	25	86	61	41.25	38.08	8	yes
75399	17	2576679	2325405	16	55	39	30.79	12.22	12	yes
75400	17	2576892	2327769	20	38	18	5.79	-5.95	10	yes
75401	18	2578498	2330054	26	32.87	6.87	-0.9	-4.75	14	yes
61184	30	2578770	2375435	38	174	136	58.57	-141.43	23	yes
75565	18	2580601	2336533	68	94	26	94.26	78.82	22	yes
75403	18	2581386	2330524	84	38	-46	-6.19	-14.54	22	yes

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
75563	18	2582856	2337821	29	73	44	59.78	48.99	19	yes
71148	18	2585325	2337641	79	46	-33	-14.24	-19.08	21	yes
71149	18	2585360	2337644	65	46	-19	-14.24	-19.08	18	no
100979	2	2596905	2296875	3	8.17	5.17	3.95	-0.02	0	yes
100978	2	2597197	2297400	1	4.94	3.94	-2.9	-4.9	0	yes
100980	2	2597499	2296386	4	11.24	7.24	2.14	-0.03	0	yes
100977	2	2598224	2296343	3	8.67	5.67	16.94	-0.06	2	no
100975	2	2598284	2295929	3	11.09	8.09	12.05	-0.04	2	no
100976	2	2598608	2296044	3	6.31	3.31	9.39	-0.09	2	no
79775	18	2600542	2364722	141	75	-66	-32.4	-45.44	20	yes
79774	30	2600569	2364712	0	75	n/a	-189.08	-389.08	30	no
110729	30	2601696	2376617	68	105	37	29.05	-170.95	26	yes
YG55	17	2602034	2367878	187	59.99	-127.01	-110.96	-156.59	17	no
79784	18	2603345	2356315	21	252.83	231.83	249.6	229.92	18	no
YG49	17	2604822	2368537	221	56	-165	-148.32	-164.89	18	yes
YG43	17	2605523	2370851	168	63	-105	-90.02	-131.46	17	no
YG34	10	2608727	2371814	58	68.1	10.1	32.18	27.29	14	yes
107971	17	2609634	2371458	111	78.97	-32.03	20.67	-58.85	17	no
107970	17	2609634	2371458	66	78.97	12.97	20.67	-58.85	17	no
107972	18	2609981	2369233	226	65	-161	-139.37	-141.37	28	yes
107973	17	2609981	2369233	136	65	-71	-52.9	-139.37	17	no
N3788	17	2611466	2370191	98	58	-40	-10.2	-59.61	17	no
84155	18	2612123	2364811	156	133.83	-22.17	-5.59	-7.59	26	yes
N3789	23	2612432	2369327	216	75.39	-140.61	-73.07	-75.07	30	yes
N3787	12	2613479	2368347	222	86	-136	-40.22	-54.95	30	yes
110731	18	2613789	2357471	69	90.11	21.11	39.36	10.53	18	no
N3726	23	2614021	2367934	197	103.98	-93.02	-52.08	-54.08	30	yes
84156	18	2614468	2365921	209	163.05	-45.95	-50.33	-52.33	17	yes
N3607	17	2614508	2361004	97	131.69	34.69	56.98	54.98	19	yes
N3615	14	2614602	2359409	69	89.21	20.21	57.85	55.85	18	yes
N3799	23	2614973	2366950	236	140.35	-95.65	-39.56	-41.56	30	yes
N3567	17	2615132	2361777	135	139.88	4.88	40.84	38.84	21	yes
Y135	10	2615627	2350900	330	79.89	-250.11	-106.88	-108.88	19	yes
N3270	13	2615782	2358819	49	66	17	39.35	25.36	17	yes
N3288	10	2615836	2357563	49	75	26	48.16	46.16	14	yes

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
N3694	14	2615904	2357479	75	75	0	32.37	24.17	18	yes
N5952	14	2616110	2360737	144	87	-57	-14.87	-19.87	18	yes
N4558	14	2616386	2362578	178	88.73	-89.27	-64.61	-81.05	15	yes
N3263	14	2616411	2359248	102	67.94	-34.06	11.07	4.84	18	yes
N4651	9	2616643	2362376	194	79	-115	30.23	28.23	15	yes
N3780	17	2616695	2361984	200	81	-119	-114.94	-130.54	17	no
N3369	10	2616696	2361995	145	81	-64	33.37	28.84	14	yes
N4652	9	2616749	2363272	219	80.36	-138.64	31.76	29.76	16	yes
N3570	23	2616929	2358071	283	62	-221	-211.1	-482.18	23	no
N3271	14	2617255	2359681	120	59	-61	-45.73	-65.57	14	no
N2491	14	2617641	2358877	117	52	-65	-22.33	-41.69	16	yes
Y122	17	2617726	2351085	410	74	-336	-278.86	-283.34	20	yes
N4541	9	2618455	2361561	228	49	-179	-11.47	-13.47	16	yes
H1095	14	2618694	2357662	106	72	-34	21.44	12.17	17	yes
H1502	10	2618826	2354188	347	73	-274	-102.74	-148.07	18	yes
M3787	3	2619925	2364195	10	44.93	34.93	35.04	31.35	3	no
Y152	23	2620417	2350817	645	96.97	-548.03	-533.59	-705.45	23	no
M2758	14	2620950	2363802	276	69	-207	-184.49	-211.95	14	no
H1320	23	2621603	2355955	571	82	-489	-474.01	-974.01	23	no
H1691	18	2622148	2352910	429	105	-324	-202.01	-259.54	20	yes
M3282	9	2623325	2364252	250	72	-178	-30.31	-32.31	14	yes
TE1694	17	2623554	2369626	355	33.99	-321.01	-249.75	-259.32	30	yes
H1726	22	2623761	2351447	365	154.81	-210.19	-181.26	-219.72	22	no
H1719	20	2624946	2354097	352	112	-240	-183.63	-239.99	21	yes
H1348	12	2625037	2356496	643	109	-534	-130.55	-216.32	23	yes
H1632	17	2625505	2358509	703	88.1	-614.9	-519.68	-521.68	22	yes
H1631	12	2625507	2358524	298	88.1	-209.9	-197.54	-269.22	12	no
H1333	16	2625515	2358500	600	88.1	-511.9	-509.26	-519.68	16	no
M3101	17	2625832	2362004	694	62	-632	-489.94	-496.25	23	yes
M3054	14	2626343	2368322	357	57.25	-299.75	-266.75	-307.76	14	no
M942	7	2626659	2367886	529	43	-486	-27.79	-124.35	20	yes
T487	9	2627182	2355413	303	116.99	-186.01	1.97	-1.73	15	yes
M3190	14	2627377	2365373	463	47.41	-415.59	-341.02	-456.66	14	no
110724	9	2627413	2313451	119	9	-110	-43.98	-55.23	14	yes
T426	12	2628599	2357891	202	106.98	-95.02	-85.74	-126.72	12	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
BB195	23	2629104	2370602	480	43	-437	-359.07	-460.48	23	no
T493	10	2629164	2363251	267	60.3	-206.7	-210.32	-246.92	8	yes
T494	23	2629164	2363251	712	60.3	-651.7	-618.72	-1118.7	23	no
T454	23	2630325	2359681	644	100.97	-543.03	-544.64	-1044.6	22	yes
T440	14	2630346	2359679	294	100.97	-193.03	-174.39	-293.37	14	no
BB196	9	2630715	2369875	360	35.98	-324.02	-71.88	-90.01	15	yes
T256	23	2631780	2357668	536	159.39	-376.61	-358.35	-858.35	23	no
T485	23	2632831	2367857	704	44	-660	-598.85	-1098.8	23	no
TS37	23	2632959	2370884	607	34	-573	-557.39	-856.45	23	no
T489	23	2633154	2360587	627	120.34	-506.66	-439.08	-939.08	23	no
T445	18	2633252	2363852	632	87	-545	-451.29	-473.66	22	yes
T466	23	2633307	2364240	722	77.06	-644.94	-574.96	-1075	23	no
T442	23	2633472	2354615	149	143.63	-5.37	-32.83	-532.83	21	yes
T495	23	2633534	2355971	242	122.24	-119.76	-146.93	-646.93	22	yes
T496	19	2633534	2355973	182	122.24	-59.76	47.83	25.14	21	yes
LY3298	23	2634759	2355782	243	84	-159	-108.99	-608.99	23	no
LY3299	20	2634760	2355786	115	84	-31	34.89	-13.07	21	yes
LY3055	20	2634887	2362019	420	55	-365	-323.31	-366.79	20	no
T433	12	2634984	2366881	353	39.76	-313.24	-287.33	-308.72	13	yes
T491	20	2635423	2362597	529	62.98	-466.02	-385.32	-419.78	22	yes
LY2477	23	2635544	2357010	226	82.31	-143.69	-150.18	-650.18	22	yes
TS40	11	2636291	2371312	330	31.6	-298.39	-168.16	-305.8	11	no
110721	9	2637094	2324642	25	26	1	11.19	-13.5	9	no
LY3118	23	2637659	2364370	607	90	-517	-510.39	-1010.4	23	no
LY3119	10	2637670	2364367	150	90	-60	-79.2	-129.89	8	yes
TS38	20	2637732	2372083	575	30	-545	-507.3	-527.89	21	yes
TS32	17	2639294	2375777	430	54	-376	-302.87	-338.98	23	yes
LY2268	14	2639531	2367013	451	51	-400	-352.69	-442.46	14	no
LY2676	20	2639563	2367251	705	51	-654	-571.26	-606.51	22	yes
TS42	23	2640827	2372258	621	31	-590	-578.57	-1078.6	23	no
LY2472	23	2642202	2363504	570	60	-510	-500.11	-1000.1	23	no
76074	30	2643006	2367953	0	31	n/a	-2530.2	-2730.2	30	no
110722	9	2643027	2367954	0	31	n/a	-177.81	-185.53	9	no
TB212	23	2643128	2354433	193	186.11	-6.89	35.64	-464.36	23	no
TN25	30	2643402	2381160	433	70.83	-362.17	-477.9	-677.9	23	yes

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
TS34	30	2643796	2378073	514	52	-462	-1051.7	-1251.7	23	yes
TB214	12	2644238	2359737	117	91.87	-25.13	63.6	-22.36	13	yes
76079	18	2644285	2368211	703	33.71	-669.29	-569.95	-571.95	21	yes
TB213	12	2644367	2360412	147	88	-59	56.17	-38.24	14	yes
TB220	12	2644636	2358912	256	110.4	-145.6	7.73	-89.14	19	yes
LY2678	23	2644987	2366319	691	63	-628	-639.33	-1139.3	22	yes
LY2310	14	2644989	2366328	347	63	-284	-264.49	-339.06	14	no
TB205	19	2645186	2357946	189	153.35	-35.65	56.21	-37.66	19	no
TB198	20	2645269	2358285	199	167.84	-31.16	-22.09	-76.9	20	no
TB176	20	2645685	2359864	528	119.92	-408.08	-308.82	-348.52	22	yes
TB165	9	2645751	2359904	271	119.92	-151.08	78.42	76.42	15	yes
TB167	22	2645828	2354613	196	217.38	21.38	55.43	-88.28	22	no
LY1967	23	2646204	2364366	656	77	-579	-619.58	-1119.6	22	yes
LY1979	14	2646328	2364358	400	77	-323	-310.14	-373.82	14	no
LY2883	3	2646335	2364355	71	77	6	50.74	31.28	5	yes
LY2809	9	2646402	2364342	456	77	-379	-122.91	-124.91	15	yes
LY2810	20	2646418	2364339	658	77	-581	-472.35	-521.43	22	yes
105220	18	2646432	2327644	329	27.7	-301.3	-223.96	-225.96	21	yes
TS36	23	2647000	2372700	743	29	-714	-717.22	-1217.2	22	yes
LY2269	14	2647013	2368728	403	44.36	-358.64	-331.64	-408.88	14	no
TN24	30	2647139	2386406	358	62	-296	-214.75	-414.75	30	no
R330	23	2647174	2361701	665	85.25	-579.75	-563.82	-1063.8	23	no
TS43	20	2648186	2375355	644	27.98	-616.02	-550.06	-570.42	23	yes
105222	18	2648660	2325903	318	24	-294	-173.26	-230.01	20	yes
105221	18	2649379	2327361	185	40.77	-144.23	-43.06	-45.06	21	yes
45759	3	2650353	2378495	20	41	21	29.06	21.69	4	yes
45760	3	2650353	2378495	12	41	29	29.06	21.69	3	no
103811	8	2650359	2378494	78	41	-37	-103.25	-134.25	6	yes
147173	18	2650869	2325257	238	16	-222	-217.72	-219.72	19	yes
R324	9	2651453	2369213	400	35	-365	-119.14	-139.12	14	yes
R340	9	2651482	2369201	558	35	-523	-119.14	-139.12	15	yes
R344	3	2651644	2362903	451	71.78	-379.22	84.51	69.33	23	yes
147174	9	2652295	2317015	156	4.72	-151.28	-216.4	-218.4	7	yes
110726	18	2652400	2324979	520	19	-501	-259.87	-261.87	21	yes
45757	3	2653706	2377948	13	29	16	21.81	13.81	3	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
45756	3	2653706	2377948	28	29	1	21.81	13.81	5	yes
WN47	9	2654438	2372380	452	60	-392	-174.54	-196.14	13	yes
WL196	23	2654621	2358697	402	135.54	-266.46	-216.36	-716.36	23	no
WL197	21	2654640	2358703	358	135.54	-222.46	-133.56	-147.24	23	yes
45758	2	2655668	2374732	6	23	17	34.07	11.35	2	no
R343	22	2656046	2364512	358	87.86	-270.14	-200.25	-305.38	22	no
103822	4	2657145	2377374	91	23	-68	-9.06	-129.65	4	no
103820	8	2658261	2384698	64	37	-27	-27.73	-43.22	7	yes
45764	3	2658276	2375990	20	21	1	12.46	-45.73	3	no
45765	3	2658276	2375990	12	21	9	12.46	-45.73	3	no
WN52	20	2658441	2379797	703	28	-675	-577.22	-608.74	23	yes
DN58	9	2659538	2372849	572	31	-541	-158.8	-219.8	15	yes
45761	3	2660163	2375868	24	23	-1	11.04	-15.53	3	no
45762	3	2660163	2375868	11	23	12	11.04	-15.53	2	yes
45763	2	2660163	2375868	4	23	19	34.82	11.04	2	no
R323	11	2660757	2366250	219	109.16	-109.84	54.83	4.51	14	yes
89809	18	2661060	2370220	804	15	-789	-708.65	-710.65	22	yes
R325	12	2661080	2370219	373	15	-358	-324.71	-357.05	13	yes
145094	5	2661499	2332102	0	57.12	n/a	6.56	-17.14	5	no
DN56	9	2662121	2373826	434	42	-392	-133.49	-135.49	14	yes
58937	18	2662747	2379792	710	23.89	-686.11	-674.39	-676.39	19	yes
HP207	21	2663024	2361507	359	165.04	-193.96	-107.14	-121.52	23	yes
S51	23	2663451	2353016	362	196.51	-165.49	-165.84	-665.84	22	yes
HP221	19	2664291	2362982	327	161.24	-165.76	17.32	-7.26	23	yes
59308	4	2664623	2381390	65	23	-42	2.46	-89.14	4	no
HP196	23	2665014	2362962	339	154.74	-184.26	-143.19	-643.19	23	no
HP204	10	2665364	2369310	313	17.16	-295.84	-157.11	-167.82	14	yes
92118	18	2665789	2349930	214	154.47	-59.53	-28.7	-30.7	19	yes
DN341	22	2665917	2381168	692	25.5	-666.5	-675.35	-697.84	21	yes
58934	5	2666053	2374972	122	17	-105	-82.96	-109.81	5	no
145090	5	2666243	2324016	0	12	n/a	-52.3	-79.06	5	no
HP220	19	2667289	2368318	302	41.45	-260.55	-219.6	-245.22	20	yes
HP177	21	2667300	2365125	183	130.59	-52.41	-24.93	-47.56	22	yes
HP188	21	2667311	2365094	229	130.59	-98.41	-24.93	-47.56	23	yes
HP189	21	2667314	2365075	216	130.59	-85.41	-24.93	-47.56	23	yes

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
95482	5	2667529	2388040	67	26	-41	-30.89	-42.92	5	no
67442	30	2669134	2369326	120	19.06	-100.94	-3067.4	-3267.4	8	yes
105134	9	2669366	2376001	0	31.72	n/a	-143.23	-206.54	9	no
110725	18	2670480	2376025	668	32	-636	-556.96	-558.96	22	yes
67441	18	2671405	2368736	889	39.1	-849.9	-628.01	-639.27	22	yes
C97	21	2671536	2359557	254	118.72	-135.28	2.25	-41.48	22	yes
105132	3	2671954	2376198	28	31	3	21.05	-24.92	3	no
105196	5	2672137	2378998	123	18	-105	-91.06	-103.21	6	yes
C93	21	2672162	2363449	126	142.33	16.33	29.92	-4.53	21	no
105547	5	2673156	2374585	154	13	-141	-112.64	-128.83	6	yes
C96	21	2673608	2361845	222	152.61	-69.39	17.12	-17.52	22	yes
98028	9	2673618	2404058	55	52	-3	33.72	27.5	14	yes
C94	23	2673622	2361830	233	152.61	-80.39	-76.9	-576.9	23	no
104536	18	2673691	2328292	993	2	-991	-834.63	-836.63	21	yes
BDL11	2	2674741	2382600	0	12	n/a	9.97	7.97	2	no
52752	9	2675691	2390117	115	32	-83	-47.92	-102.93	9	no
51532	30	2676358	2405156	0	49	n/a	-39.38	-239.38	30	no
105548	5	2677006	2374317	145	24	-121	-104.08	-126.04	5	no
52754	18	2677284	2377910	879	8	-871	-760.31	-762.31	21	yes
52753	5	2677730	2379523	169	17	-152	-104.62	-115.14	9	yes
110172	2	2679710	2404836	3	53	50	39.31	37.31	0	yes
64835	18	2679945	2359719	233	78.46	-154.54	-66.05	-68.05	20	yes
110171	3	2679975	2404783	6	53	47	37.31	33.59	0	yes
92176	9	2680120	2396546	73	35.43	-37.57	-31.77	-57.61	9	no
92175	18	2681697	2401558	87	67.8	-19.2	-12.4	-35.13	18	no
145092	5	2682235	2344458	0	27	n/a	-56.05	-73.52	5	no
110166	3	2682626	2406700	6	65	59	60.56	58.56	3	no
110167	3	2682829	2406593	5	65	60	60.56	58.56	3	no
110168	3	2683040	2406454	6	64	58	54.51	52.51	0	yes
90149	5	2683141	2370724	143	3.88	-139.12	-108.83	-122.79	7	yes
G46	19	2683676	2364817	200	59.58	-140.42	-13.29	-56.53	22	yes
WWK7	23	2683864	2357055	799	51.5	-747.5	-721.54	-1221.5	23	no
86669	5	2684013	2386136	85	9	-76	-73.44	-81.29	5	no
92177	5	2684210	2394150	38	49	11	11.1	-3.26	5	no
86464	5	2685541	2378892	105	8	-97	-99.36	-111.68	4	yes

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
86670	4	2685542	2378884	59	8	-51	-19.53	-99.36	4	no
86726	3	2685548	2378915	12	8	-4	0.57	-19.53	3	no
G54	19	2685958	2367270	234	54	-180	-113.42	-162.36	20	yes
90148	5	2688532	2374035	106	3	-103	-81.79	-92.85	6	yes
105483	18	2688625	2351378	1029	28	-1001	-736.02	-738.02	21	yes
105484	5	2688656	2351346	52	28	-24	-20.12	-47	5	no
145091	5	2692353	2345871	0	1.99	n/a	-47.37	-63.28	5	no
109044	5	2693425	2391702	0	44.84	n/a	-11.44	-40.29	5	no
G66	22	2693472	2368179	801	6	-795	-688.26	-895.73	22	no
90400	15	2694503	2373976	787	0.73	-786.27	-682.64	-840.38	15	no
90366	16	2694529	2374029	830	0.73	-829.27	-840.38	-842.87	15	yes
86465	5	2694549	2380502	112	4.99	-107.01	-91.65	-114.1	5	no
86466	5	2694551	2380500	112	4.99	-107.01	-91.65	-114.1	5	no
77947	8	2700775	2386061	107	30.17	-76.83	-91.3	-100.86	6	yes
77945	18	2700814	2386079	775	30.17	-744.83	-721.9	-723.9	19	yes
105478	9	2708356	2411556	48	39	-9	-15.12	-17.12	5	yes
105479	2	2708360	2411571	13	39	26	29	-3.12	2	no
105392	2	2709725	2411335	22	37	15	30.5	-16.12	2	no
50876	5	2709899	2370039	57	5	-52	-50.62	-110.61	5	no
110177	9	2709953	2411714	39	37	-2	-28.12	-30.12	2	yes
145093	5	2710101	2362746	0	10	n/a	-34.85	-74.67	5	no
105477	2	2710822	2410369	3	28.23	25.23	23.91	-10.07	0	yes
56545	15	2711368	2394903	43	46.67	3.67	-371.08	-424.47	4	yes
105476	2	2711423	2411015	6	32	26	30.24	-1.97	2	no
56541	2	2711424	2409624	0	32	n/a	37.01	27.78	2	no
56546	2	2711451	2409610	5	32	27	37.01	27.78	3	yes
56548	9	2712147	2409756	6	30	24	0.79	-4.03	2	yes
56540	9	2712152	2409786	3	30	27	0.79	-4.03	2	yes
111800	9	2712155	2409797	58	30	-28	0.79	-4.03	14	yes
56539	9	2712249	2410310	5	31	26	-3.78	-7.43	0	yes
56536	9	2713306	2409284	4	26	22	9.28	2.13	2	yes
56537	9	2713402	2409814	5	26	21	0.4	-4.14	2	yes
56550	9	2713411	2409842	6	26	20	0.4	-4.14	2	yes
56538	9	2713520	2410442	5	27	22	-2.57	-6.09	2	yes
56533	2	2714924	2409073	3	23	20	22.69	-5.37	2	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
56534	2	2715048	2409763	5	24	19	22.14	-17.1	2	no
56535	2	2715143	2410293	3	23	20	20.95	-7.22	2	no
90615	5	2716462	2376783	65	8	-57	-60.44	-89.95	4	yes
56531	2	2716561	2408898	3	21	18	20.33	-27.94	2	no
56532	2	2716677	2409530	4	23	19	19.94	-33.21	2	no
140692	5	2717298	2389460	69	26	-43	-20.03	-90.37	5	no
56744	2	2718291	2409242	4	19.95	15.95	19.03	-3.13	2	no
110165	2	2718609	2408008	4	18	14	19.2	-7.09	2	no
56530	2	2719538	2406888	4	17	13	19.89	3.52	2	no
56528	2	2719629	2407381	2	18	16	19	-4.99	2	no
56529	2	2719718	2407957	7	18	11	18.9	-7.89	2	no
105480	2	2720462	2407322	3	17	14	18	-3.82	2	no
80760	2	2721827	2406046	2	12	10	17	0.79	2	no
80761	2	2722005	2406657	4	15	11	17.96	-19.54	2	no
80762	2	2722108	2407287	2	15	13	17.84	-5.37	2	no
140279	2	2723314	2405478	6	11	5	18.25	-4.03	2	no
65762	5	2723813	2388361	71	25	-46	-23.71	-92.66	5	no
140281	15	2727673	2405062	0	8	n/a	-110.67	-127.08	15	no
140280	3	2728606	2406724	11	4.22	-6.78	-1.79	-22	3	no
105733	18	2730124	2408060	149	53	-96	-97.33	-117.05	17	yes
46968	5	2730196	2394362	36	37	1	-7.97	-50.85	4	yes
105725	30	2730404	2413138	0	28	n/a	-532.58	-732.58	30	no
47063	18	2730849	2396570	553	36	-517	-502.22	-507.36	20	yes
105728	18	2731009	2408220	132	30	-102	-69.75	-81.19	20	yes
65764	5	2731255	2389067	45	0	-45	-41.48	-80.4	5	no
105730	18	2732144	2408798	83	36	-47	-19.54	-30.56	20	yes
144468	3	2797767	2417344	15	6	-9	9.69	4.37	7	yes
144469	30	2798169	2419147	31	3.14	-27.86	-47.19	-247.19	20	yes
115733	30	2798901	2418392	29	12	-17	-46.03	-246.03	15	yes
144467	15	2799610	2415561	32	14	-18	-20.92	-22.92	13	yes
115734	15	2801774	2416059	27	9	-18	-18.89	-20.89	14	yes
115732	15	2804218	2414545	29	7	-22	-24.46	-26.46	13	yes
41973	3	2660288	2376718	13.71	22	8.29	12.93	2.45	3	no
42001	2	2656732	2377395	10.05	23	12.95	27.18	16.01	3	yes
42002	3	2663477	2376112	14.32	19	4.68	11.7	-23.04	3	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
42003	3	2666460	2375529	10.66	23.95	13.29	15.47	-0.6	3	no
42004	3	2655966	2377510	14.63	26	11.37	17.64	-22.75	3	no
42005	2	2659365	2376894	12.49	23	10.51	34.08	13.2	3	yes
42006	3	2658709	2377052	16.15	25	8.85	14.34	2.49	3	no
42007	3	2665085	2375827	17.37	21	3.63	12.13	-22.33	3	no
42020	3	2660710	2376652	18.59	22	3.41	12.81	1.35	3	no
42026	3	2657303	2377286	19.2	24	4.8	14.15	-3.73	3	no
42027	3	2656397	2377442	18.89	22	3.11	16.75	-33.32	3	no
42028	3	2657317	2378300	18.89	21	2.11	18.33	-2.54	3	no
42038	3	2665681	2379023	13.71	21	7.29	18.75	6.25	3	no
42039	3	2658760	2378541	18.28	23	4.72	19.12	-15.77	3	no
42041	3	2665377	2377422	15.84	21	5.16	17	1.51	3	no
42045	2	2655864	2377547	10.97	26	15.03	27.12	17.64	3	yes
42051	4	2664100	2379330	44	22	-22	-1.06	-102.19	4	no
42058	3	2663738	2377525	20.42	20	-0.42	17.25	-0.61	3	no
42059	3	2654903	2385150	25.9	44.6	18.7	35.33	25.33	4	yes
42063	3	2657676	2379947	17.37	28	10.63	21.78	13.42	4	yes
42066	3	2667692	2380777	23.16	20.9	-2.26	18.3	2.21	4	yes
42067	3	2664453	2381417	32.61	23	-9.61	19.2	2.46	4	yes
42068	3	2662883	2381711	20.42	26	5.58	20.04	-29.95	3	no
42069	3	2661361	2381995	19.2	31.1	11.9	20.08	1.41	3	no
42070	3	2659404	2382358	14.93	30	15.07	22.79	10.44	3	no
42071	3	2657925	2382929	12.19	36	23.81	27.12	17.42	3	no
42072	3	2656373	2383538	15.24	37	21.76	29.85	20.25	3	no
42073	9	2655126	2384033	85	40	-45	-43.81	-74.33	9	no
42074	3	2656599	2384879	14.02	39	24.98	30.11	21.66	3	no
42075	3	2658253	2384589	17.67	37	19.33	28.51	20.1	4	yes
42076	3	2659861	2384312	13.1	32	18.9	25.19	15.77	3	no
42077	3	2661654	2383970	19.2	35	15.8	21.73	12.47	3	no
42078	3	2663670	2383687	18.89	28.99	10.1	19	-9.47	3	no
42079	3	2665061	2384478	18.59	28	9.41	18	-0.62	3	no
42080	2	2666693	2384226	10.05	28	17.95	19.95	17.95	3	yes
42081	3	2668281	2383852	14.93	26.24	11.31	12.78	0.14	3	no
42083	3	2669022	2379228	15.24	20	4.76	17	0.55	3	no
42084	3	2667005	2377117	15.24	21	5.76	16.53	5.54	3	no

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42085	2	2656914	2386440	10.66	42	31.34	34.9	30.43	2	no
42086	3	2658488	2386159	18.89	37.7	18.81	26.62	21.66	4	yes
42087	3	2660108	2385873	18.89	37	18.11	23.27	18.41	4	yes
42088	3	2661859	2385103	18.89	34	15.11	20.95	16.13	4	yes
42095	3	2662487	2379615	22.25	26	3.75	22.95	-63.88	3	no
42108	2	2660954	2379913	10.97	27	16.03	30.01	20.39	3	yes
42117	3	2661090	2378288	18.89	22.22	3.33	19.61	-11.72	3	no
42118	3	2662146	2377826	14.1	20	5.9	19.19	-3.53	3	no
42121	3	2670362	2377738	11.27	20.98	9.71	16.48	-7.34	3	no
42122	3	2671190	2381876	14.32	23	8.68	14.8	-7.23	3	no
42123	2	2672604	2380876	9.14	18	8.86	12.99	10.99	3	yes
42128	3	2672289	2378975	13.41	18	4.59	13.11	-21.44	3	no
42134	2	2665666	2374594	11.35	18	6.65	16.79	11.33	3	yes
42135	2	2665652	2374445	6.75	18	11.25	16.51	10.74	2	no
42136	2	2666359	2374612	9.8	17	7.2	16.03	11.14	3	yes
42137	2	2667385	2374192	9.8	18	8.2	18.82	12.87	3	yes
42181	5	2664919	2374924	110	17	-93	-65.8	-89.72	6	yes
45962	18	2643354	2317957	229.3	2	-227.3	-178.77	-180.77	21	yes
50867	3	2708672	2372152	6.55	5	-1.55	-2.05	-21.08	2	yes
50868	2	2708672	2372152	2.8	5	2.2	2.19	-2.05	0	yes
50870	3	2709643	2369543	23	10	-13	1.25	-13.49	3	no
50871	3	2708309	2372760	21.3	0.1	-21.2	-2.69	-20.93	4	yes
50872	3	2709643	2369543	23	10	-13	1.25	-13.49	3	no
50877	2	2708309	2372760	4.75	0.1	-4.65	1.05	-2.69	3	yes
50878	2	2708309	2372760	1.9	0.1	-1.8	1.05	-2.69	2	no
50891	2	2708794	2371999	3	3	0	2.83	-2.06	2	no
51535	3	2683008	2406070	20	69	49	53.86	51.03	4	yes
51539	2	2682716	2405765	10.4	63	52.6	53.76	51.76	2	no
51575	2	2682229	2405778	10.66	61	50.34	51.09	49.09	2	no
51590	3	2682263	2405901	13.41	61	47.59	49.09	47.09	3	no
51592	2	2682001	2405356	28	60	32	48.89	46.89	10	yes
52872	3	2680268	2383579	25	15	-10	9.99	-26.28	3	no
52873	3	2677763	2383982	20	20	0	9.91	-23.45	3	no
52874	3	2679068	2380040	20	16	-4	9.24	-22.87	3	no
52875	3	2679451	2381595	17.5	15	-2.5	9.77	-24.31	3	no

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52877	3	2675601	2387655	14.87	15.71	0.84	15.61	-0.36	3	no
52878	2	2675601	2387655	5.95	15.71	9.76	18.15	15.61	3	yes
52879	3	2680560	2386750	13.97	21	7.03	12.84	-29.28	3	no
52880	2	2680560	2386750	10.02	21	10.98	18.59	12.84	3	yes
52882	3	2677763	2383982	12.69	20	7.31	9.91	-23.45	3	no
52883	2	2677763	2383982	5.42	20	14.58	15.01	9.91	2	no
52885	2	2680268	2383579	7.08	15	7.92	14.8	9.99	3	yes
52886	2	2680268	2383579	4.99	15	10.01	14.8	9.99	2	no
52888	3	2679068	2380040	13.34	16	2.66	9.24	-22.87	3	no
52889	3	2679068	2380040	10.78	16	5.22	9.24	-22.87	3	no
52890	2	2679068	2380040	5.09	16	10.91	11.24	9.24	2	no
52891	3	2676431	2380996	13.86	11	-2.86	6.98	-23.61	3	no
52892	2	2676431	2380996	4.89	11	6.11	9.06	6.98	3	yes
52893	2	2679451	2381595	10.18	15	4.82	11.77	9.77	3	yes
52894	2	2679451	2381595	5.42	15	9.58	11.77	9.77	3	yes
56497	18	2680887	2368715	774.14	27	-747.14	-501.13	-554.29	23	yes
56547	9	2711758	2409462	13	30	17	8.55	2.22	4	yes
56549	9	2712564	2409113	12	31	19	3.72	-3.28	2	yes
56551	9	2713298	2409256	14	26	12	9.28	2.13	7	yes
56552	2	2718110	2408193	10	19	9	19.27	-11.97	2	no
56553	2	2718243	2408935	11	19.95	8.95	19.03	-3.13	2	no
58935	9	2666399	2375524	862	17	-845	-183.86	-185.86	23	yes
59328	2	2664419	2381449	5.36	22.82	17.46	21.32	19.32	3	yes
59329	3	2664567	2382021	10.05	24	13.95	19.05	0.32	3	no
59330	2	2664567	2382021	5.41	24	18.59	21.05	19.05	3	yes
59331	2	2665106	2384501	4.99	28	23.01	20	18	0	yes
59336	2	2657303	2377286	6.17	24	17.83	28.98	14.15	2	no
59337	2	2657339	2377269	3.02	24	20.98	28.98	14.15	2	no
60082	9	2643050	2326627	30.5	21	-9.5	-37.39	-39.39	6	yes
66881	9	2621756	2359451	100	14	-86	-1.56	-3.56	15	yes
76860	3	2669776	2396182	20.13	33	12.87	29.16	26.24	7	yes
76888	3	2666044	2395310	25	38	13	33.58	27.9	7	yes
76891	3	2669776	2396182	10.08	33	22.92	29.16	26.24	5	yes
76892	2	2669776	2396182	5.75	33	27.25	33.08	29.16	3	yes
76894	2	2665829	2397604	5	40	35	39.87	31.37	2	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
76895	2	2666044	2395310	10.3	38	27.7	35.58	33.58	4	yes
76896	2	2666044	2395310	5.45	38	32.55	35.58	33.58	3	yes
77914	2	2700547	2381991	10.7	1.1	-9.6	4.4	-2.21	3	yes
77915	3	2705710	2383644	21	10.81	-10.19	4.71	-24.78	3	no
77918	3	2705591	2382981	19	10	-9	1.12	-23.36	3	no
77919	3	2705591	2382981	10.01	10	-0.01	1.12	-23.36	3	no
77920	2	2705591	2382981	6.65	10	3.35	7.69	1.12	2	no
77921	3	2705632	2383248	18.75	10	-8.75	1.12	-23.36	3	no
77922	2	2705632	2383248	12.02	10	-2.02	7.69	1.12	3	yes
77924	3	2705470	2382325	19	3.58	-15.42	-6.09	-20.77	3	no
77925	2	2705470	2382325	10.31	3.58	-6.73	4.74	-6.09	3	yes
77926	2	2705470	2382325	5.63	3.58	-2.05	4.74	-6.09	2	no
77927	3	2705284	2381449	20.97	1.6	-19.37	-8.65	-19.72	3	no
77928	2	2705284	2381449	10.23	1.6	-8.63	1.8	-8.65	2	no
77929	2	2705284	2381449	5.49	1.6	-3.89	1.8	-8.65	2	no
77930	3	2702941	2383982	21.28	22.68	1.4	13.11	-23.18	3	no
77933	3	2702676	2383292	21.28	17.66	-3.62	3.09	-19.4	3	no
77936	3	2702580	2382756	21.7	4	-17.7	-1.02	-18.41	3	no
77937	3	2702580	2382756	9.7	4	-5.7	-1.02	-18.41	3	no
77938	2	2702580	2382756	4.91	4	-0.91	9.6	-1.02	2	no
77939	3	2702476	2382096	21.14	1	-20.14	-6.67	-16.77	4	yes
77940	2	2702476	2382096	10.27	1	-9.27	5.59	-6.67	3	yes
77941	2	2702476	2382096	4.92	1	-3.92	5.59	-6.67	2	no
77942	3	2702281	2381024	21.35	1	-20.35	-7.94	-14.64	4	yes
77943	2	2702281	2381024	10.27	1	-9.27	2.14	-7.94	3	yes
77944	2	2702281	2381024	4.92	1	-3.92	2.14	-7.94	2	no
80866	2	2721083	2407535	10	18	8	18	-7.35	2	no
86653	3	2697822	2382551	19.37	1.69	-17.68	-2.8	-15.49	4	yes
86654	3	2695174	2379864	20	2.42	-17.58	-2.05	-19.29	3	no
86655	3	2695174	2379864	9.23	2.42	-6.81	-2.05	-19.29	3	no
86656	3	2691898	2378707	21	4	-17	-1.17	-20.33	3	no
86657	2	2691898	2378707	4.77	4	-0.77	2.68	-1.17	2	no
86658	3	2690815	2379555	20	3	-17	-0.17	-21.44	3	no
86659	2	2690815	2379555	5.4	3	-2.4	5.31	-0.17	3	yes
86660	3	2688409	2379916	17.26	5	-12.26	0.01	-21.91	3	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
86661	2	2688409	2379916	4.77	5	0.23	6.8	0.01	2	no
86662	3	2687427	2380215	20.5	8	-12.5	-0.05	-22.74	3	no
86663	2	2687427	2380215	5.26	8	2.74	7.75	-0.05	2	no
86664	3	2692667	2380142	10.25	6	-4.25	-1.91	-21.28	3	no
86665	2	2692667	2380142	5.6	6	0.4	5.13	-1.91	2	no
86666	3	2695267	2384265	19.74	1.33	-18.41	-3.31	-18.98	3	no
86667	2	2695267	2384265	5.65	1.33	-4.32	3.5	-3.31	3	yes
86725	4	2685548	2378915	50	8	-42	-19.53	-99.36	4	no
86727	2	2685548	2378915	8	8	0	5	0.57	3	yes
86736	3	2697822	2382551	13.45	1.69	-11.76	-2.8	-15.49	3	no
86737	2	2697822	2382551	4.53	1.69	-2.84	2.6	-2.8	3	yes
86739	3	2682856	2379347	12.45	10	-2.45	5.99	-20.27	3	no
86740	2	2682856	2379347	5.66	10	4.34	7.99	5.99	3	yes
86741	3	2694215	2383036	16.49	1.65	-14.84	-7.77	-21.12	3	no
86742	2	2694215	2383036	9.33	1.65	-7.68	3.86	-7.77	2	no
86743	2	2694215	2383036	5.5	1.65	-3.85	3.86	-7.77	2	no
86744	3	2689996	2382237	25.25	7	-18.25	-3.17	-26.23	3	no
86745	2	2689996	2382237	9.73	7	-2.73	6.73	-3.17	2	no
86746	2	2689996	2382237	5.23	7	1.77	6.73	-3.17	2	no
86747	3	2685658	2384116	17.4	11	-6.4	0.01	-31.08	3	no
86748	2	2685658	2384116	6.51	11	4.49	9	0.01	2	no
86749	2	2685658	2384116	6.45	11	4.55	9	0.01	2	no
89810	30	2651492	2369190	702.02	35	-667.02	-3440.4	-3640.4	23	yes
89818	3	2658117	2369716	22.55	18	-4.55	10.15	6.4	6	yes
89841	2	2657221	2369554	9.3	17	7.7	17.45	11.15	4	yes
89842	2	2657221	2369554	5.32	17	11.68	17.45	11.15	2	no
89845	3	2658117	2369716	30	18	-12	10.15	6.4	6	yes
89850	2	2660328	2370169	4.75	13.94	9.19	18.32	9.69	3	yes
90138	18	2694513	2374002	1049.8	0.73	-1049.03	-845.36	-847.36	22	yes
90357	3	2691134	2372094	21.6	0.02	-21.58	-4.62	-28.95	3	no
90358	2	2691134	2372094	10.34	0.02	-10.32	2	-4.62	3	yes
90359	2	2691134	2372094	6.57	0.02	-6.55	2	-4.62	3	yes
90360	3	2691200	2375245	20	3	-17	-1.18	-44.15	3	no
90361	2	2691200	2375245	5.84	3	-2.84	2.24	-1.18	3	yes
90423	3	2683852	2373197	21.17	13	-8.17	0.11	-39.77	3	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
90424	3	2684537	2374124	21.5	11	-10.5	0.55	-42.78	3	no
90428	3	2686816	2373735	14.07	7	-7.07	-0.03	-55.51	3	no
90429	2	2686816	2373735	10.34	7	-3.34	5	-0.03	3	yes
90430	2	2686816	2373735	5.12	7	1.88	5	-0.03	2	no
90431	3	2688593	2373773	21.55	3	-18.55	-2.66	-63.71	3	no
90432	2	2688493	2373775	10.71	3	-7.71	3.89	-2.66	3	yes
90433	2	2688493	2373775	5.3	3	-2.3	3.89	-2.66	2	no
90434	3	2688607	2374448	22.04	4	-18.04	-2.02	-59.4	3	no
90435	2	2688607	2374448	8.15	4	-4.15	3.98	-2.02	3	yes
90436	2	2688607	2374448	4.44	4	-0.44	3.98	-2.02	2	no
90437	3	2694679	2374109	15.7	0.73	-14.97	-2.32	-29.1	3	no
90438	3	2694679	2374109	11.05	0.73	-10.32	-2.32	-29.1	3	no
90439	3	2694679	2374109	6.32	0.73	-5.59	-2.32	-29.1	3	no
90614	18	2716462	2376783	1246.4	8	-1238.39	-1014.5	-1016.5	22	yes
92296	4	2680164	2396489	33	38	5	10.63	-21.78	4	no
92297	3	2680164	2396489	15	38	23	25.57	10.63	3	no
94805	3	2569818	2312072	11.5	6.9	-4.6	7.44	4.91	7	yes
94806	3	2569395	2313647	10	5	-5	-5.49	-7.5	2	yes
94808	3	2568601	2314320	10	8.95	-1.05	4.41	2.18	5	yes
94809	3	2568284	2313546	11.5	13.08	1.58	7.71	5.37	5	yes
94810	3	2568745	2313304	22	18.73	-3.27	1.9	-0.2	5	yes
94811	3	2568572	2313057	26.5	18.73	-7.77	1.9	-0.2	7	yes
95196	18	2660434	2394286	96	75.09	-20.91	34.87	32.87	23	yes
95401	2	2672432	2385695	5.22	23	17.78	13.05	11.05	0	yes
95485	4	2667519	2388050	34	26	-8	11.47	-30.89	4	no
95486	3	2667529	2388049	15	26	11	15.43	11.47	4	yes
95487	3	2661349	2388017	41	42	1	30.82	27.22	7	yes
95488	9	2662140	2392315	28	36.74	8.74	17.58	11.8	10	yes
95489	8	2665364	2393361	33	38.06	5.06	10.66	5.47	9	yes
95491	2	2665364	2393361	8.81	38.06	29.25	34.96	29.64	3	yes
95492	2	2665364	2393361	6.51	38.06	31.55	34.96	29.64	2	no
95493	2	2669865	2390902	8.39	29	20.61	23.25	20.52	2	no
95494	2	2669865	2390902	5.49	29	23.51	23.25	20.52	0	yes
95495	2	2671771	2395185	8.35	27	18.65	27.4	23.75	5	yes
95496	2	2671771	2395185	5.48	27	21.52	27.4	23.75	4	yes

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
95497	3	2669041	2386192	17.4	26	8.6	13.78	4.02	3	no
95498	2	2669041	2386192	8.35	26	17.65	15.78	13.78	0	yes
95499	2	2669041	2386192	5.48	26	20.52	15.78	13.78	0	yes
95500	3	2665108	2386529	19.53	27.45	7.92	16.89	-27.41	3	no
95501	2	2665108	2386529	7.69	27.45	19.76	18.89	16.89	0	yes
95502	2	2665108	2386529	4.89	27.45	22.56	18.89	16.89	0	yes
95503	3	2661349	2388017	18.69	42	23.31	30.82	27.22	5	yes
95504	2	2662140	2392315	8.87	36.74	27.87	40.74	29.58	3	yes
95505	2	2662140	2392315	5.45	36.74	31.29	40.74	29.58	2	no
96560	18	2635010	2366948	583	34.78	-548.22	-518.07	-546.7	19	yes
98114	8	2674804	2400464	26	35	9	12.82	6.85	8	no
98115	3	2672955	2397251	42	73	31	50.49	40.73	4	yes
98119	3	2679319	2389598	19.2	21	1.8	11.61	-19.48	3	no
98120	2	2679319	2389598	10.8	21	10.2	18.99	11.61	3	yes
98121	2	2679319	2389598	4.68	21	16.32	18.99	11.61	2	no
98122	2	2679053	2391234	9.63	19	9.37	18.17	13.35	3	yes
98123	2	2679053	2391234	4.24	19	14.76	18.17	13.35	2	no
98124	2	2675572	2397024	5.31	30	24.69	31.02	27.85	4	yes
98125	3	2674794	2400454	14.01	35	20.99	30.77	28.77	6	yes
98126	3	2674794	2400454	10.88	35	24.12	30.77	28.77	6	yes
98127	2	2674794	2400454	3.81	35	31.19	38.88	30.77	2	no
103582	9	2653126	2384365	460.33	61	-399.33	-47.98	-77.14	20	yes
103583	18	2651685	2375860	727.67	21	-706.67	-617.23	-619.23	23	yes
103734	3	2653116	2375225	20	18	-2	8.08	-1.97	4	yes
103825	2	2653051	2375271	10.44	18	7.56	18.1	8.08	3	yes
103826	2	2653116	2375225	4.86	18	13.14	18.1	8.08	2	no
103828	2	2655864	2377547	7.47	26	18.53	27.12	17.64	2	no
104537	4	2673518	2327830	39	4	-35	-14.28	-31.29	5	yes
105199	3	2674346	2378582	20.46	14	-6.46	9.44	-25.41	3	no
105200	2	2674334	2378590	9.4	14	4.6	11.91	9.44	3	yes
105201	2	2674346	2378582	5.43	14	8.57	11.91	9.44	3	yes
109039	9	2698908	2386140	121.92	4	-117.92	-98.96	-168.22	9	no
110199	2	2689066	2378191	9	2	-7	3.81	0.04	3	yes
110201	2	2688604	2380983	8.3	7	-1.3	8.53	-0.04	3	yes
110206	3	2688274	2379098	13.4	4	-9.4	-0.02	-20.8	3	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
110208	3	2688163	2378590	10.95	4	-6.95	-0.04	-20.53	3	no
110720	18	2659138	2338232	333	92.79	-240.21	-116.22	-118.22	21	yes
110727	9	2600232	2365476	193.3	69.46	-123.84	-19.58	-32.9	16	yes
110728	3	2600200	2365480	80	69.46	-10.54	60.55	47.19	8	yes
110732	9	2651454	2369213	400.2	35	-365.2	-119.14	-139.12	14	yes
110733	9	2661081	2370219	373.2	15	-358.2	-189.05	-272.22	13	yes
110749	3	2695267	2384265	10.47	1.33	-9.14	-3.31	-18.98	3	no
110976	9	2710822	2410345	116	28.23	-87.77	-22.07	-24.29	23	yes
110978	9	2708309	2411580	74.5	39	-35.5	-15.12	-17.12	19	yes
112982	2	2688703	2369493	9	11	2	6.75	-2.19	2	no
112983	2	2688703	2369493	5.1	11	5.9	6.75	-2.19	2	no
112984	3	2688480	2368397	12.95	19	6.05	12.04	1.79	3	no
112987	3	2694523	2370272	13.3	1	-12.3	-2.2	-34.72	3	no
112988	3	2694523	2370272	10.25	1	-9.25	-2.2	-34.72	3	no
112989	2	2694523	2370272	5.05	1	-4.05	1.24	-2.2	3	yes
112991	2	2677658	2377230	11.17	5	-6.17	7.59	-0.93	3	yes
112992	2	2677658	2377230	4.78	5	0.22	7.59	-0.93	2	no
112993	3	2679253	2372193	13.46	5	-8.46	-1.29	-30.79	3	no
112994	2	2679253	2372193	4.77	5	0.23	8.09	-1.29	2	no
112995	3	2672975	2373426	20.45	9	-11.45	6	-48.26	3	no
112996	3	2650006	2374078	19.32	25	5.68	9.94	0.82	3	no
112997	3	2652942	2367743	9.37	37	27.63	21.54	17.7	0	yes
112998	3	2648550	2363533	22.05	61	38.95	40.67	26.92	3	no
113000	3	2665385	2369383	21.69	11.98	-9.71	9.78	-37.35	3	no
113668	30	2571699	2310853	50	11.32	-38.68	-742.42	-942.42	23	yes
113669	3	2571699	2310854	19	11.32	-7.68	7.61	5.61	10	yes
114155	30	2571699	2310855	32	11.32	-20.68	-742.42	-942.42	17	yes
114159	3	2568204	2315100	50	9.56	-40.44	1.66	-0.34	23	yes
114160	3	2568203	2315099	23	9.56	-13.44	1.66	-0.34	10	yes
115218	2	2684708	2384637	14.3	16	1.7	10.49	2.74	3	yes
115220	3	2687560	2378473	15.7	7	-8.7	-0.07	-19.73	3	no
115221	3	2684421	2379069	14.1	9	-5.1	3.3	-20.31	3	no
115223	3	2686471	2376614	14.6	8	-6.6	0.16	-22.78	3	no
115225	3	2686471	2376614	20.6	8	-12.6	0.16	-22.78	3	no
115226	3	2687049	2376502	16.7	7	-9.7	0.12	-27.43	3	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
115245	2	2687049	2376502	8.9	7	-1.9	5.01	0.12	3	yes
115630	3	2681968	2379501	13.33	11	-2.33	7.31	-21.2	3	no
115631	3	2681856	2378923	12.91	12.98	0.07	7.95	-20.58	3	no
115937	3	2664427	2381049	20.5	26	5.5	19.64	-6.78	3	no
115939	3	2661734	2384545	20.5	33	12.5	21.05	14.9	4	yes
115940	3	2667702	2380907	20.5	20.9	0.4	18.3	2.21	4	yes
115941	3	2667877	2381778	20.5	23	2.5	18.78	1.67	3	no
119103	3	2654568	2320729	0	3	n/a	-0.1	-29.35	3	no
119104	2	2654573	2320724	0	3	n/a	7.18	-0.1	2	no
119105	2	2654573	2320719	0	3	n/a	7.18	-0.1	2	no
119106	2	2654559	2320689	0	3	n/a	7.18	-0.1	2	no
119107	2	2654568	2320675	0	3	n/a	7.18	-0.1	2	no
119108	2	2656313	2319385	0	5	n/a	2.75	-2.45	2	no
119109	3	2656307	2319382	0	5	n/a	-2.45	-47.77	3	no
119110	3	2656423	2323075	0	12.13	n/a	6.2	-18.69	3	no
119113	3	2665743	2321355	0	8	n/a	0.03	-30.19	3	no
119114	2	2665745	2321356	0	8	n/a	3.76	0.03	2	no
119115	3	2667011	2326948	0	16	n/a	9.09	-13.19	3	no
119116	2	2667424	2323704	0	8	n/a	5.58	-0.24	2	no
119117	3	2667422	2323704	0	8	n/a	-0.24	-27.87	3	no
119118	2	2662140	2321449	0	7	n/a	8.56	0.01	2	no
119119	2	2662139	2321453	0	7	n/a	8.56	0.01	2	no
119120	2	2661150	2321142	0	5	n/a	6.64	0.01	2	no
119121	2	2661149	2321138	0	5	n/a	6.64	0.01	2	no
119122	2	2672405	2328230	0	2	n/a	5.68	-0.19	2	no
119123	3	2672405	2328228	0	2	n/a	-0.19	-11.56	3	no
119132	2	2665655	2322353	0	7	n/a	4.76	0.02	2	no
119136	3	2645306	2320962	0	13	n/a	9.5	1.25	3	no
119137	3	2649317	2332391	0	58.81	n/a	46.22	44.22	3	no
119138	3	2649029	2332819	0	50	n/a	47.1	45.1	3	no
119892	3	2689529	2379798	12.2	7.3	-4.9	0.02	-21.79	3	no
120793	3	2692906	2373778	25	4	-21	-1.5	-48.88	3	no
120794	3	2694222	2373580	20.5	3.99	-16.51	-1.57	-42.03	3	no
120795	3	2694065	2373223	20.5	2.53	-17.97	-2.02	-48.77	3	no
120796	3	2693678	2379595	14.5	2.45	-12.05	-1.69	-19.13	3	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
120799	3	2693873	2378891	20.5	0.98	-19.52	-0.49	-16.9	4	yes
120800	3	2693714	2378464	20.5	3	-17.5	-1.57	-15.9	4	yes
120801	3	2692396	2378572	13	3.99	-9.01	-1.83	-19.97	3	no
120802	3	2692561	2379289	12	0	-12	-1.02	-19.91	3	no
120997	3	2693233	2384648	18.1	2.23	-15.87	-3.95	-22.48	3	no
121802	3	2709866	2386171	23.5	20.96	-2.54	11.46	-21.26	3	no
121803	3	2712227	2383520	25	3	-22	-5.46	-23.46	3	no
121804	3	2706711	2384376	20.5	18	-2.5	9.37	-26.33	3	no
121805	3	2713407	2388988	25	14	-11	14.52	-9.51	4	yes
121806	3	2718562	2384778	16	10	-6	-7.28	-24.99	2	yes
121807	3	2715586	2387942	19.5	15	-4.5	8.06	-14.61	3	no
121808	3	2725593	2389414	23.5	14	-9.5	9.83	-4.8	4	yes
121809	3	2719211	2388067	20.5	29	8.5	13.79	-9.24	3	no
121810	3	2723768	2388272	20.5	25	4.5	17.31	-8.01	3	no
122449	2	2710505	2385647	3	5	2	6.66	-0.69	2	no
122450	3	2710505	2385647	14.5	5	-9.5	-0.69	-20.3	3	no
122451	2	2713007	2384714	6.1	3	-3.1	3.99	-4.77	2	no
122452	2	2712403	2380704	7	4	-3	1.02	-1.9	3	yes
122453	2	2716187	2382226	2	4	2	1	-2.86	0	yes
122454	2	2722295	2387202	5	5	0	16.81	-3.02	2	no
122455	2	2722295	2387202	9	5	-4	16.81	-3.02	3	yes
122456	3	2722295	2387202	20	5	-15	-3.02	-10.5	4	yes
122457	2	2718869	2386073	5	6	1	10.82	-7.6	2	no
122458	2	2718869	2386073	10	6	-4	10.82	-7.6	2	no
122459	3	2718869	2386073	16	6	-10	-7.6	-18.77	3	no
122461	3	2711719	2388674	16.79	6	-10.79	9.87	-13.53	3	no
122462	3	2711719	2388674	9.74	6	-3.74	9.87	-13.53	3	no
122463	3	2711719	2388674	20.99	6	-14.99	9.87	-13.53	4	yes
122464	3	2711724	2388924	20	6	-14	9.87	-13.53	4	yes
122465	3	2711070	2388737	20	5.49	-14.51	6.86	-16.4	3	no
122466	3	2710709	2388244	20.43	10	-10.43	2.69	-18.51	3	no
122467	3	2713574	2388885	10.8	6	-4.8	1.59	-10.61	3	no
122468	2	2713572	2388785	5.48	6	0.52	15.89	1.59	3	yes
122469	2	2713570	2388685	5.13	6	0.87	15.89	1.59	3	yes
122470	3	2723300	2387431	16.03	5	-11.03	-1.9	-11.58	3	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
122471	2	2723300	2387431	9.49	5	-4.49	17.05	-1.9	3	yes
122472	2	2723300	2387431	5.51	5	-0.51	17.05	-1.9	2	no
122473	3	2723820	2388371	20.83	25	4.17	17.31	-8.01	3	no
123721	3	2666401	2388173	13	28	15	20	5.89	3	no
126436	3	2680435	2380824	35	14	-21	9	-23.44	3	no
126437	3	2683019	2380474	16.5	11	-5.5	6.57	-21.25	3	no
127134	3	2691340	2376422	18.6	3	-15.6	-0.98	-26.57	3	no
127135	3	2691388	2376792	17.4	5	-12.4	-1	-23.31	3	no
127137	3	2691496	2377180	17	3	-14	-0.99	-21.34	3	no
127144	3	2691546	2377639	14	3	-11	-0.92	-20.57	3	no
127302	3	2672127	2378746	14.5	16	1.5	13.25	-22.33	3	no
127303	3	2672568	2378922	11	16	5	12.42	-23.8	3	no
127611	3	2711712	2388364	15	6.49	-8.51	-1.48	-14.91	3	no
127612	2	2711712	2388364	5	6.49	1.49	9.79	-1.48	2	no
127613	2	2692110	2383070	5	1	-4	4.99	-6.32	2	no
127614	2	2693807	2383355	5	0	-5	3.86	-7.5	2	no
127615	3	2693807	2383355	15	0	-15	-7.5	-21.61	3	no
127616	3	2693467	2378149	15	1.99	-13.01	-0.26	-16.74	3	no
127617	3	2693467	2378149	5	1.99	-3.01	-0.26	-16.74	3	no
127618	3	2692431	2375009	15	3	-12	-1.43	-35.6	3	no
127619	3	2692431	2375009	5	3	-2	-1.43	-35.6	3	no
127620	3	2692110	2383070	14	1	-13	-6.32	-24.35	3	no
127621	3	2694724	2372669	15	1.65	-13.35	-2.67	-49.33	3	no
127622	3	2694724	2372669	5	1.65	-3.35	-2.67	-49.33	3	no
127623	3	2687929	2370740	15	0	-15	-4.04	-25.34	3	no
127624	2	2687929	2370740	5	0	-5	2.35	-4.04	3	yes
127625	3	2690899	2369227	15	6.94	-8.06	-1.46	-11.45	3	no
127626	2	2690899	2369227	5	6.94	1.94	1.22	-1.46	0	yes
127896	3	2681312	2380655	16	14	-2	8	-23.1	3	no
127897	3	2680684	2380769	16	13	-3	8.85	-23.38	3	no
127898	3	2679957	2380904	17.5	15	-2.5	9	-23.5	3	no
127899	3	2680219	2379107	19	14	-5	8.9	-21.64	3	no
127996	3	2691992	2379361	13	3	-10	-1.19	-20.96	3	no
127997	3	2691564	2380430	11.5	4	-7.5	-1.5	-21.97	3	no
128028	3	2648483	2373659	13	25	12	11.38	2.9	2	yes

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
128029	3	2646285	2372498	20.5	27	6.5	19.16	8.09	4	yes
128030	3	2644525	2372823	15	29	14	20.08	12.95	3	no
128031	3	2641280	2373330	19	34	15	28.93	19.56	4	yes
128033	3	2641613	2374433	14.5	38	23.5	30.94	23.18	3	no
129031	3	2664660	2382406	12.5	25	12.5	19	-1.58	3	no
129032	3	2664851	2383490	12	28	16	18	-1.21	3	no
130367	3	2673705	2387669	11	20	9	14.93	5.93	3	no
130368	3	2674095	2384349	10	16	6	9.97	-9.13	3	no
130369	2	2668751	2391936	11.6	31	19.4	27.74	22.9	3	yes
130370	2	2671345	2393012	10	26	16	25.2	19.94	3	yes
130371	2	2669928	2394623	10	31	21	29.66	23	3	yes
130372	2	2671415	2388238	11.75	26	14.25	19.04	17.04	3	yes
130373	2	2662613	2395537	7	45	38	44.15	31.61	2	no
130374	2	2667404	2389723	11	29.99	18.99	20.92	18.92	2	no
131246	3	2675496	2383379	10.5	13	2.5	9.88	-18.28	3	no
131249	3	2679167	2393348	13	23	10	18.95	-4.87	3	no
131250	2	2676821	2395499	10	28	18	26.36	21.36	4	yes
131253	3	2666038	2389942	10	28	18	22.73	20.73	5	yes
131255	2	2674784	2403816	6.5	44	37.5	37.83	35.83	2	no
131257	2	2668746	2395008	11	32	21	30.7	26.82	4	yes
131259	3	2684843	2382953	14	13	-1	2.08	-29.14	3	no
135289	2	2682217	2383238	10	15	5	12.15	9.04	3	yes
135416	3	2684086	2377895	17.5	11	-6.5	2.5	-20.9	3	no
136519	3	2678617	2383364	18	18	0	9.9	-25.01	3	no
136529	3	2678970	2380154	20.5	16	-4.5	9	-23.29	3	no
136531	3	2678981	2380174	21	16	-5	9	-23.29	3	no
136533	3	2678125	2381843	19	17	-2	9.1	-24.3	3	no
136537	3	2683171	2378175	10.97	13	2.03	5.01	-19.93	3	no
136539	3	2681699	2383359	24	13	-11	9.66	-26.34	3	no
136540	3	2685888	2380789	14.5	8	-6.5	0.52	-23.4	3	no
136718	3	2693543	2376046	20.5	2.93	-17.57	-1.88	-17.49	4	yes
136719	2	2693553	2376046	5.9	2.93	-2.97	1	-1.88	3	yes
136999	3	2665923	2381163	20	25.5	5.5	20.09	7.94	4	yes
137476	2	2678696	2383792	7.5	18	10.5	15.19	10.02	2	no
137478	3	2681548	2383312	14	15	1	9.79	-26.04	3	no

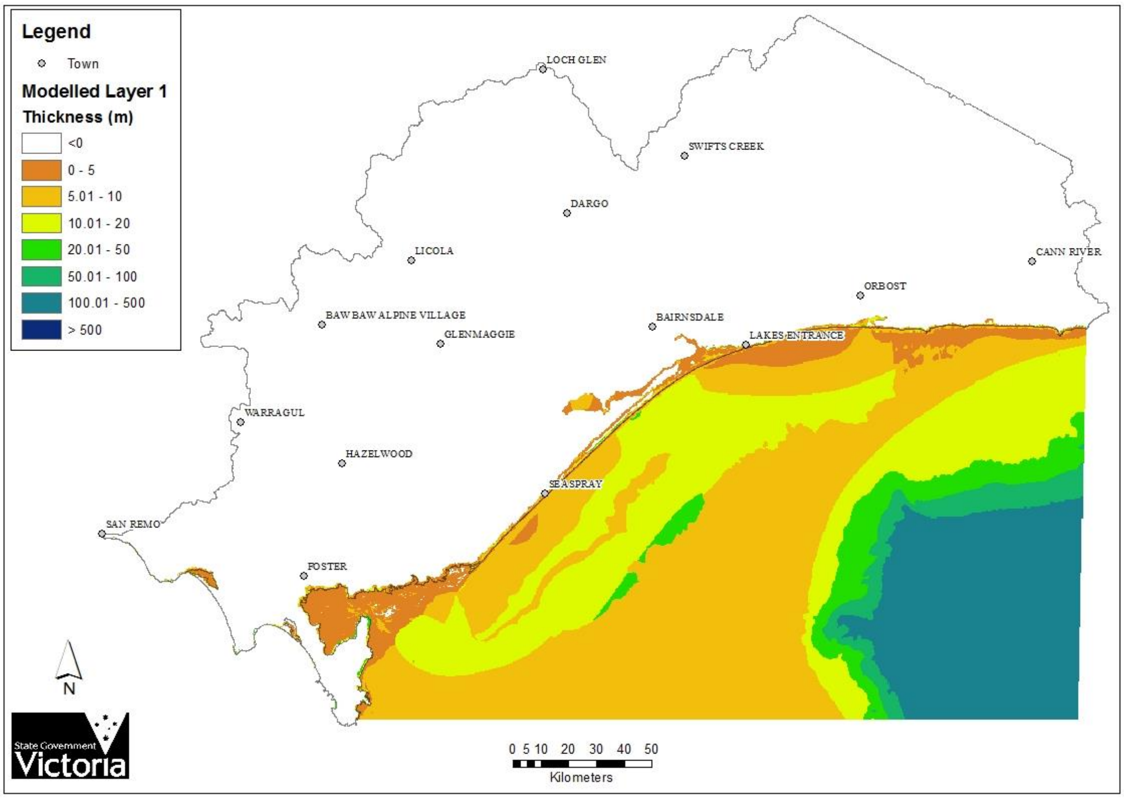
Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
137479	2	2681553	2383312	7	15	8	12.99	9.79	3	yes
137481	3	2678679	2380090	20	15	-5	8.67	-22.95	3	no
137539	3	2678696	2383782	18	18	0	10.02	-25.05	3	no
139365	2	2654096	2374994	18	19	1	22.15	9.95	3	yes
139366	3	2651180	2374394	20	18	-2	9.62	0.81	4	yes
139367	3	2653588	2375115	14	17	3	8.9	-2.59	3	no
139370	3	2650900	2375697	20	25	5	15.63	8.15	4	yes
139374	3	2655426	2376387	30	22	-8	11.35	-31.02	3	no
139379	3	2665260	2386009	19	27	8	16.63	-12.6	3	no
139380	3	2660191	2386345	17	35	18	23.3	19.29	4	yes
139381	3	2656390	2387026	15	39	24	30.19	25.47	4	yes
140201	3	2667171	2387227	13.7	24	10.3	19.78	0.75	3	no
140202	3	2677244	2373096	15	4	-11	-3.91	-22.9	3	no
140204	3	2676701	2372493	13	3	-10	-4.19	-31.01	3	no
140213	3	2666872	2387253	16	24	8	19.78	0.75	3	no
140277	3	2678206	2371734	17	8	-9	-5.65	-32.03	3	no
140691	5	2709255	2389826	80	17	-63	-30.43	-56.65	7	yes
143099	3	2654794	2389638	22	46	24	42.25	36.28	6	yes
143100	2	2654794	2389638	6	46	40	46	42.25	3	yes
143101	2	2655890	2389618	8.3	42	33.7	47.21	35.72	3	yes
143102	3	2655895	2389615	21	42	21	35.72	31.18	6	yes
143103	3	2653131	2389533	8	56	48	45.68	41.51	0	yes
143104	3	2652817	2389800	8.3	54	45.7	48.77	44.86	3	no
143747	3	2686847	2383581	15	3.49	-11.51	-0.57	-30.24	3	no
143748	2	2685426	2384541	10	5	-5	9.01	0.11	3	yes
143749	3	2684009	2386122	9	7.69	-1.31	5.56	-31.49	3	no
144943	3	2668684	2396519	11	33	22	28.47	25.37	5	yes
145207	3	2681633	2375102	27	14	-13	0.64	-22.26	3	no
145214	2	2681633	2375102	27	14	-13	6.98	0.64	3	yes
145215	3	2680897	2377188	19.5	13.93	-5.57	1.8	-20.49	3	no
145216	2	2680897	2377188	19.5	13.93	-5.57	9.3	1.8	3	yes
145217	3	2683658	2376258	20	13	-7	1.71	-24.76	3	no
145218	2	2683658	2376258	20	13	-7	8.13	1.71	3	yes
145219	3	2682544	2377315	22	11	-11	3.11	-21.03	3	no
145220	2	2682544	2377315	22	11	-11	9	3.11	3	yes

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
WRK059 121	18	2642696	2334157	23	71.73	48.73	19.65	12.54	3	yes
Sole1	18	2853712	2368609	n/a	0	n/a	-795.3	-1376.6	18	no
Scallop1	18	2814360	2359237	n/a	0	n/a	-1697.4	-2131.5	18	no
Grunter1	18	2807716	2353253	n/a	0	n/a	-1987.6	-2463.6	18	no
Patricia1	18	2802636	2380240	n/a	0	n/a	-701.47	-727.65	18	no
Flounder 1	18	2799462	2348982	n/a	0	n/a	-2000.3	-2640.5	18	no
Tuna1	18	2799392	2364629	n/a	0	n/a	-1324.7	-1662.4	18	no
SpermW hale1	18	2795214	2377488	n/a	0	n/a	-822.87	-847	18	no
Kahawai 1	18	2795163	2364658	n/a	0	n/a	-1403.5	-1766.4	18	no
Mackerel 1	18	2792860	2330670	n/a	0	n/a	-2551	-3272	18	no
Halibut2	18	2790885	2339980	n/a	0	n/a	-2342	-3122.3	18	no
Anemone 1A	18	2789397	2299109	n/a	0	n/a	-2597.8	-2933.1	18	no
Marlin2	18	2788238	2358496	n/a	0	n/a	-2070.2	-2589.1	18	no
Cobia1	18	2786606	2333302	n/a	0	n/a	-2443.4	-3141.7	18	no
Turrum7	18	2785594	2354766	n/a	0	n/a	-1676.6	-2286.1	18	no
Sunfish2	18	2784391	2368653	n/a	0	n/a	-1683.8	-1944.4	18	no
Turrum5	18	2780180	2356691	n/a	0	n/a	-1411.7	-1846.7	18	no
Kingfish9	18	2774207	2314644	n/a	0	n/a	-2314	-2987.9	18	no
Kingfish8	18	2766768	2319041	n/a	0	n/a	-2289.3	-3010.8	18	no
Snapper 1	18	2763929	2362938	n/a	0	n/a	-1172.8	-1709	18	no
Snapper	18	2763929	2362938	n/a	0	n/a	-1172.8	-1709	18	no
WestMoo nfish1	18	2760997	2368277	n/a	0	n/a	-1523.4	-1946.5	18	no
ZaneGre y1	18	2760502	2321223	n/a	0	n/a	-2297.7	-2989.3	18	no
Bream1	18	2743954	2327976	n/a	0	n/a	-1878.8	-2595.4	18	no
Omeo	18	2736696	2317734	n/a	0	n/a	-2280.9	-2512.5	18	no
Seahorse 1	18	2734125	2364019	n/a	0	n/a	-1406	-1453.3	18	no
Barracou ta3	18	2728797	2350406	n/a	0	n/a	-1001.5	-1463.7	18	no
Bullseye	18	2723620	2320362	n/a	0	n/a	-2100.8	-2267	18	no
WestWhi	18	2719026	2350092	n/a	0	n/a	-1172.4	-1229.2	18	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
ptail1										
Blenny1	18	2710713	2333805	n/a	0	n/a	-1243.7	-1592.6	18	no
Dolphin1	18	2707487	2332052	n/a	0	n/a	-1242.1	-1650.7	18	no
Pearch2	18	2703421	2323090	n/a	0	n/a	-1161.1	-1273.7	18	no
Kyarra1A	18	2690428	2311385	n/a	0	n/a	-964.2	-1010.9	18	no
TommyRuff1	18	2686766	2319025	n/a	0	n/a	-952.69	-1114.6	18	no
Drummer 1	18	2783672	2331495	n/a	0	n/a	-2460.2	-3137.7	18	no
Fortescue3	18	2785434	2340855	n/a	0	n/a	-2407.3	-3210	18	no
Barracouta5	18	2732789	2352535	n/a	0	n/a	-1052.7	-1485.1	18	no
Barracouta4	18	2737315	2355029	n/a	0	n/a	-1097.6	-1508.5	18	no
Whiptail1A	18	2720415	2350188	n/a	0	n/a	-1149.7	-1206.1	18	no
Tarwhine 1	18	2720950	2341321	n/a	0	n/a	-1418.5	-1826.4	18	no
Seahorse 2	18	2728764	2363182	n/a	0	n/a	-1409.6	-1450.5	18	no
West Seahorse	18	2729819	2363297	n/a	0	n/a	-1414.9	-1457.3	18	no
Luderick 1	18	2737252	2337069	n/a	0	n/a	-1826.8	-2499.2	18	no
Wirrah1	18	2746783	2364504	n/a	0	n/a	-1505.6	-2058.9	18	no
Wirrah2	18	2747519	2365142	n/a	0	n/a	-1491.9	-2021.7	18	no
Whiting1	18	2752555	2359104	n/a	0	n/a	-1265.5	-1880.2	18	no
Cod1	18	2760055	2345032	n/a	0	n/a	-2096.8	-2698.3	18	no
Snapper 3	18	2761498	2361584	n/a	0	n/a	-1281.6	-1813.1	18	no
Snapper 5	18	2761883	2360486	n/a	0	n/a	-1279.3	-1830.8	18	no
Veilfin1	18	2762314	2338728	n/a	0	n/a	-1939.3	-2519.7	18	no
Moonfish 1	18	2763787	2368350	n/a	0	n/a	-1379.7	-1722.7	18	no
Moonfish 2	18	2764969	2368408	n/a	0	n/a	-1332.3	-1683.9	18	no
West Kingfish	18	2770563	2318779	n/a	0	n/a	-2247.7	-2999.5	18	no
Turrum6	18	2777935	2358316	n/a	0	n/a	-1492.2	-1967.5	18	no

Bore_ID	VAF Lay	Bore_x	Bore_y	Depth (m)	Surface (mAHD)	Depth (mAHD)	TopLay (mAHD)	BotLay (mAHD)	New Lay	Diff
Remora1	18	2779805	2367419	n/a	0	n/a	-2187.9	-2447.5	18	no
Kingfish1	18	2779609	2318261	n/a	0	n/a	-2297.3	-3094.4	18	no
Sunfish1	18	2782979	2368800	n/a	0	n/a	-1752.3	-1997.1	18	no
Turrum1	18	2784149	2361923	n/a	0	n/a	-2069.4	-2462	18	no
Turrum2	18	2784501	2357221	n/a	0	n/a	-1538	-2039.1	18	no
Turrum3	18	2784501	2355320	n/a	0	n/a	-1579.7	-2174	18	no
Marlin4	18	2786130	2357629	n/a	0	n/a	-1838.3	-2359.6	18	no
Trumpeter1	18	2792616	2338145	n/a	0	n/a	-2477.7	-3188.3	18	no

Appendix D: Modelled layer thicknesses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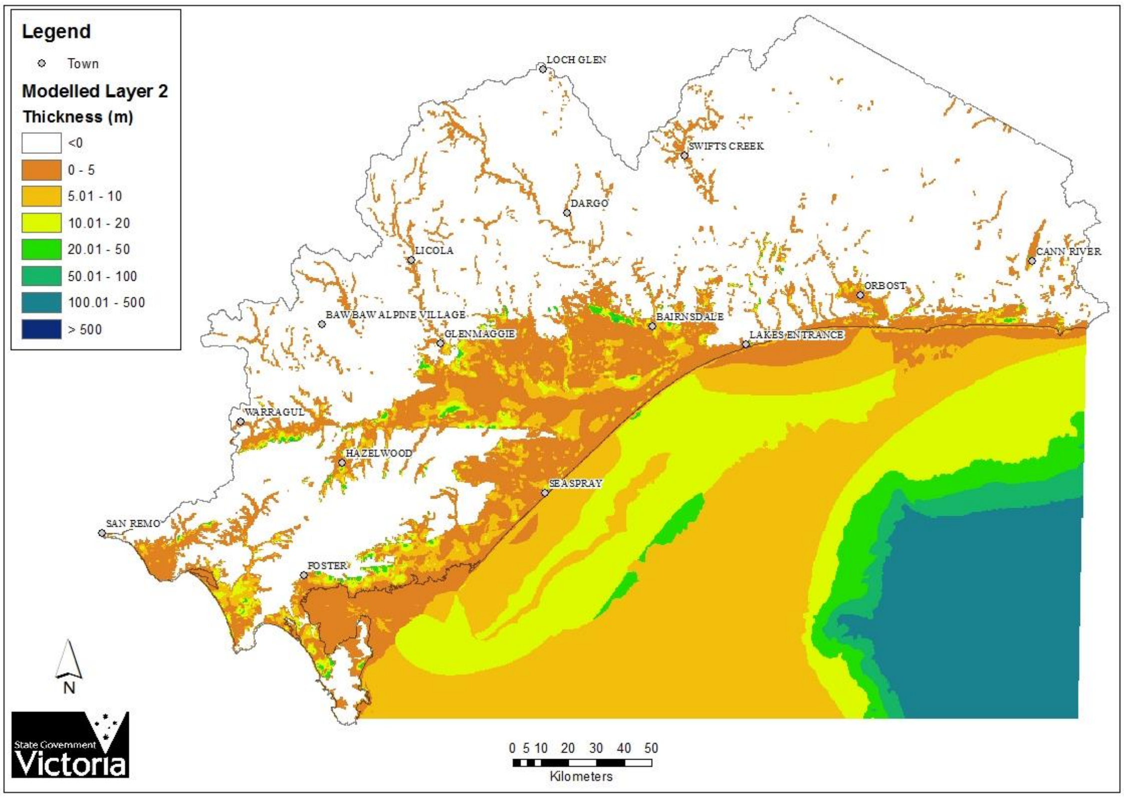
SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
LAKES ENTRANCE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
N
State Government Victoria
0 5 10 20 30 40 50
Kilometers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DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
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HAZELWOOD
SEASPRAY
SAN REMO
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State Government Victoria
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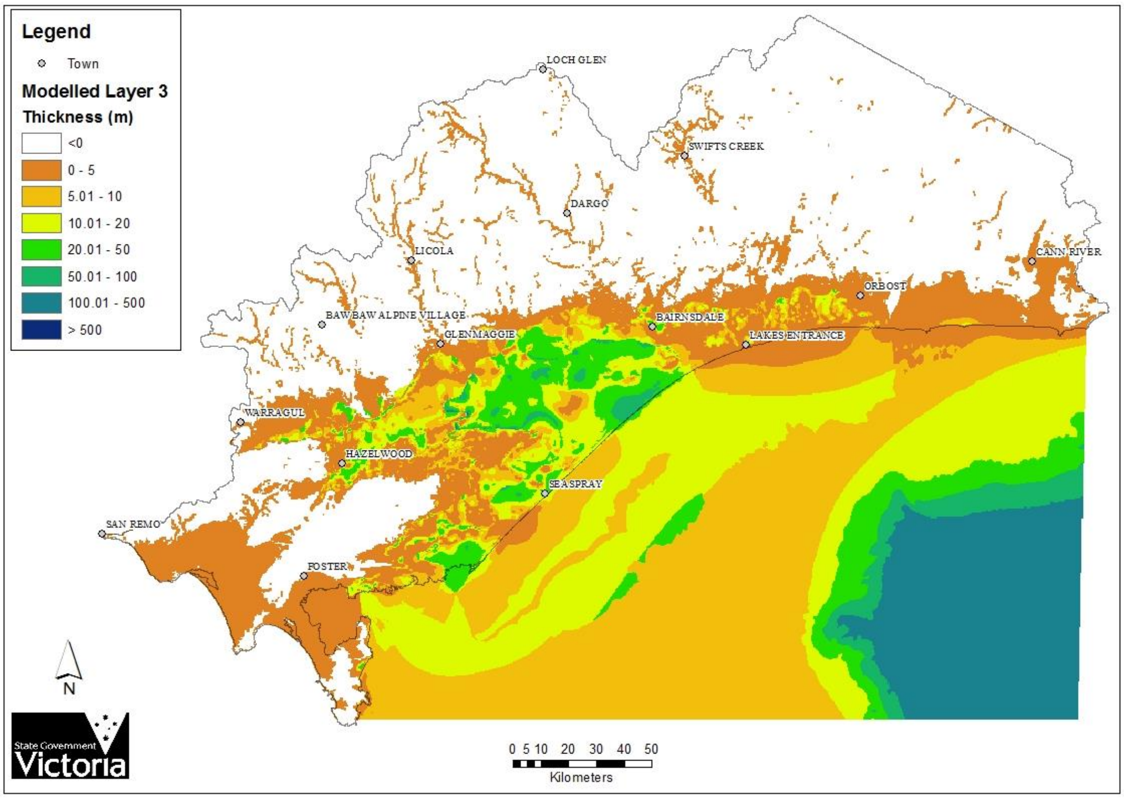
Kilometers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DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
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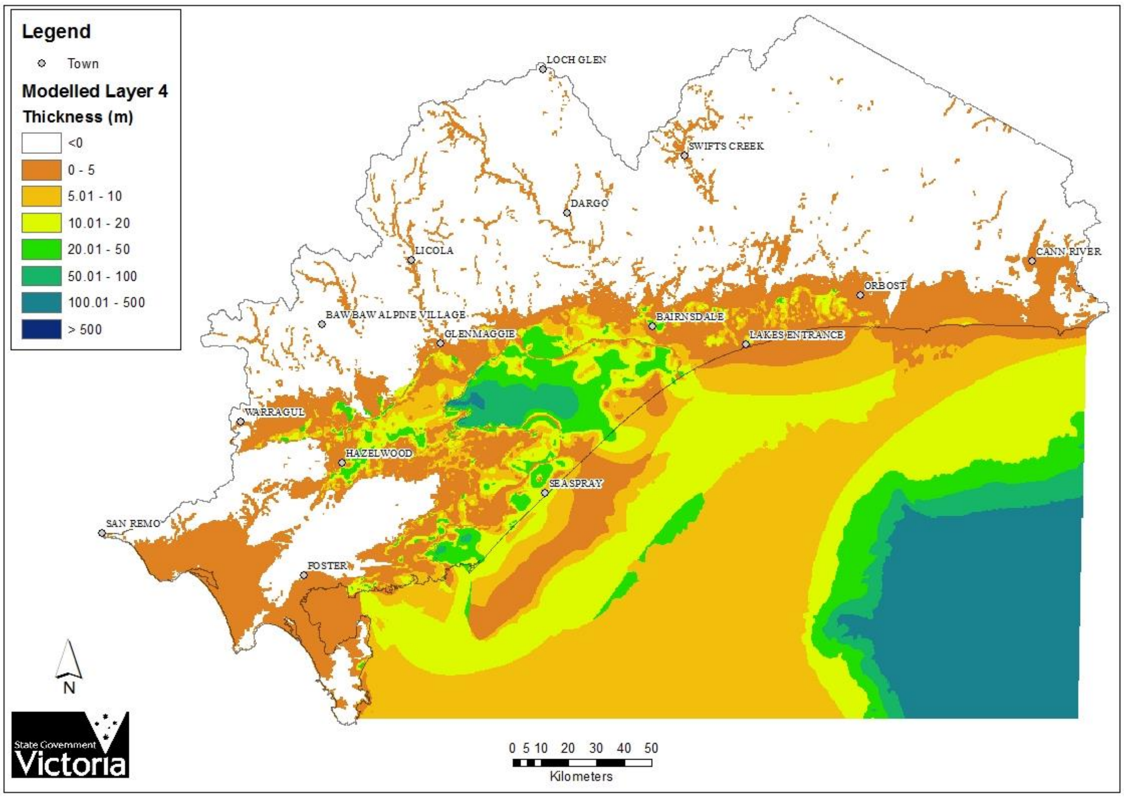
Kilometers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DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
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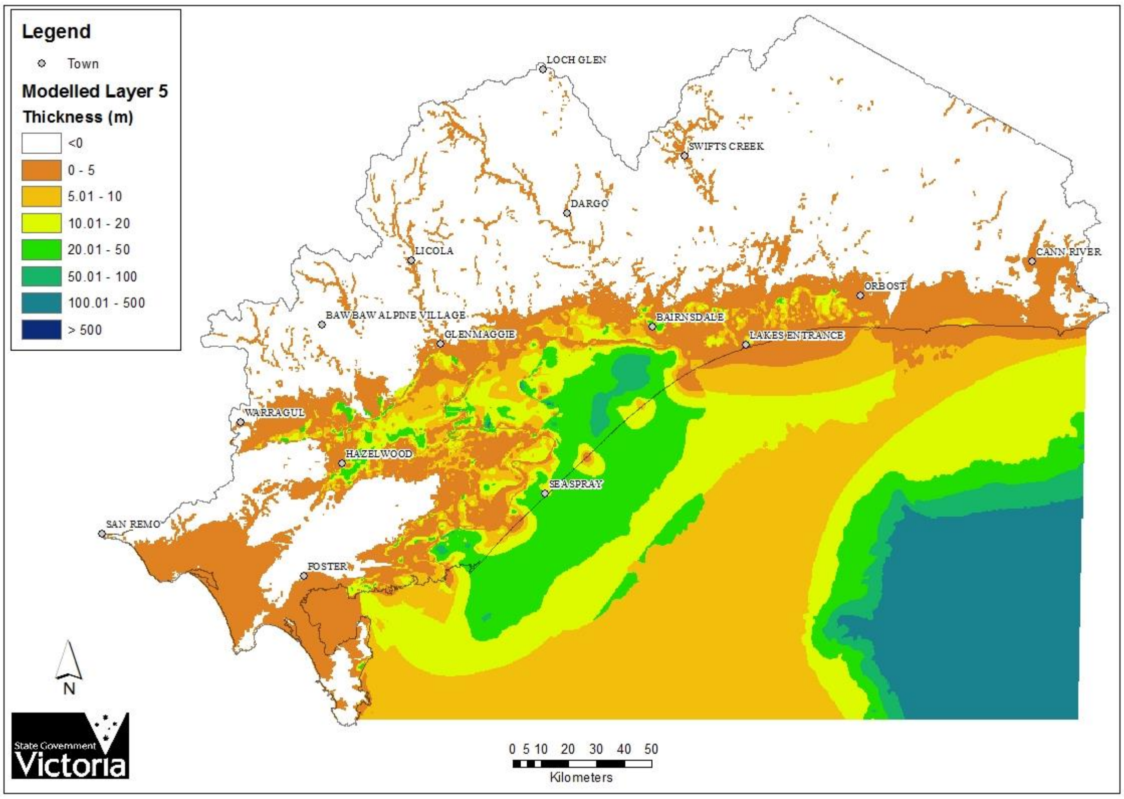
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DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
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N
State Government
Victoria
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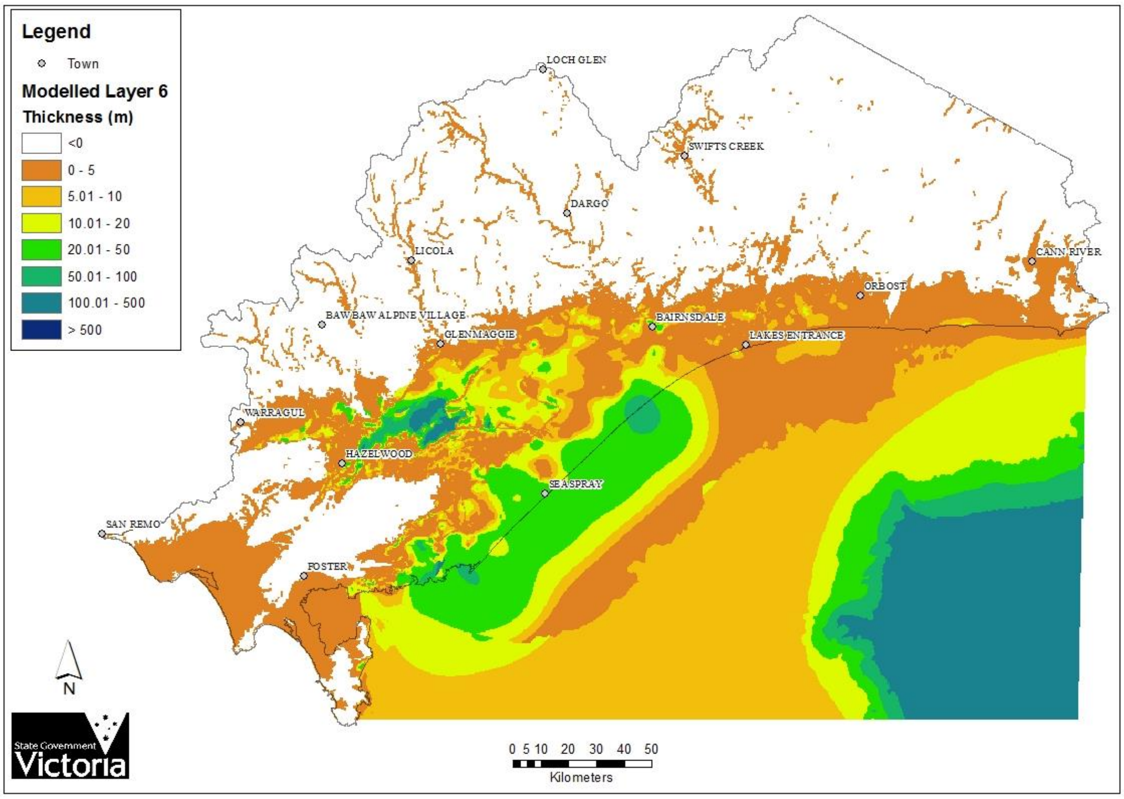
Kilometers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SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
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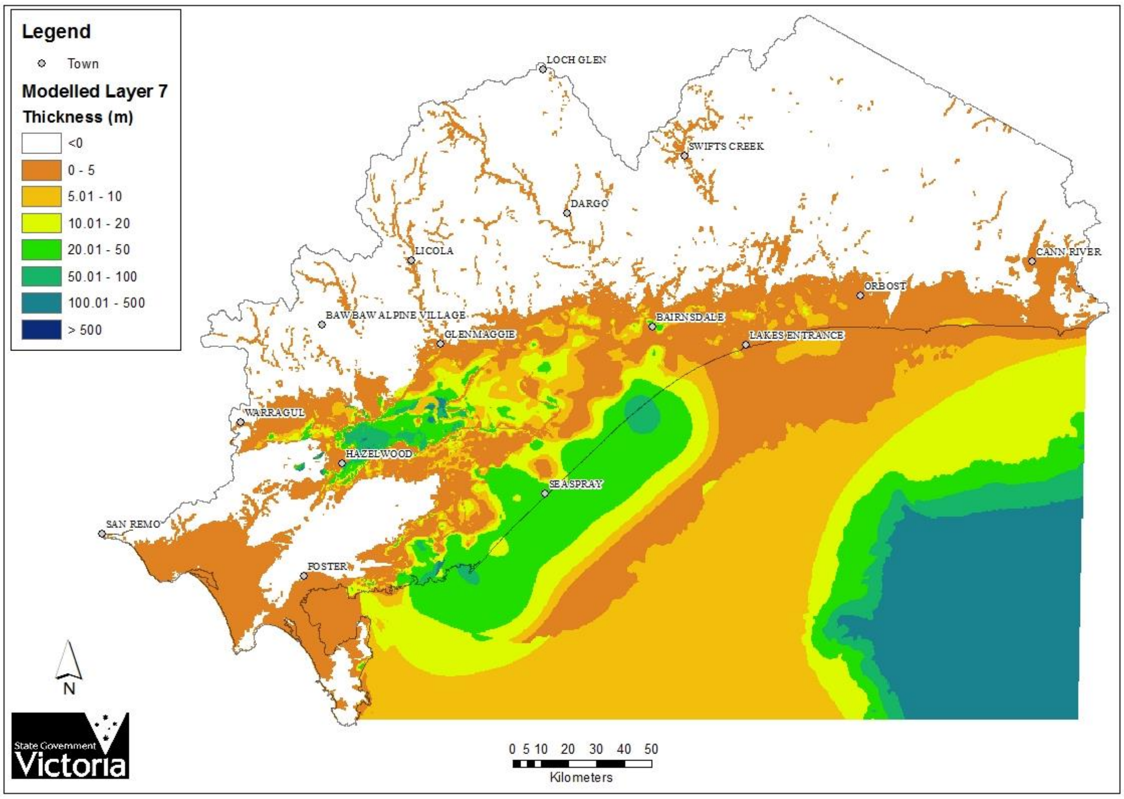
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SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
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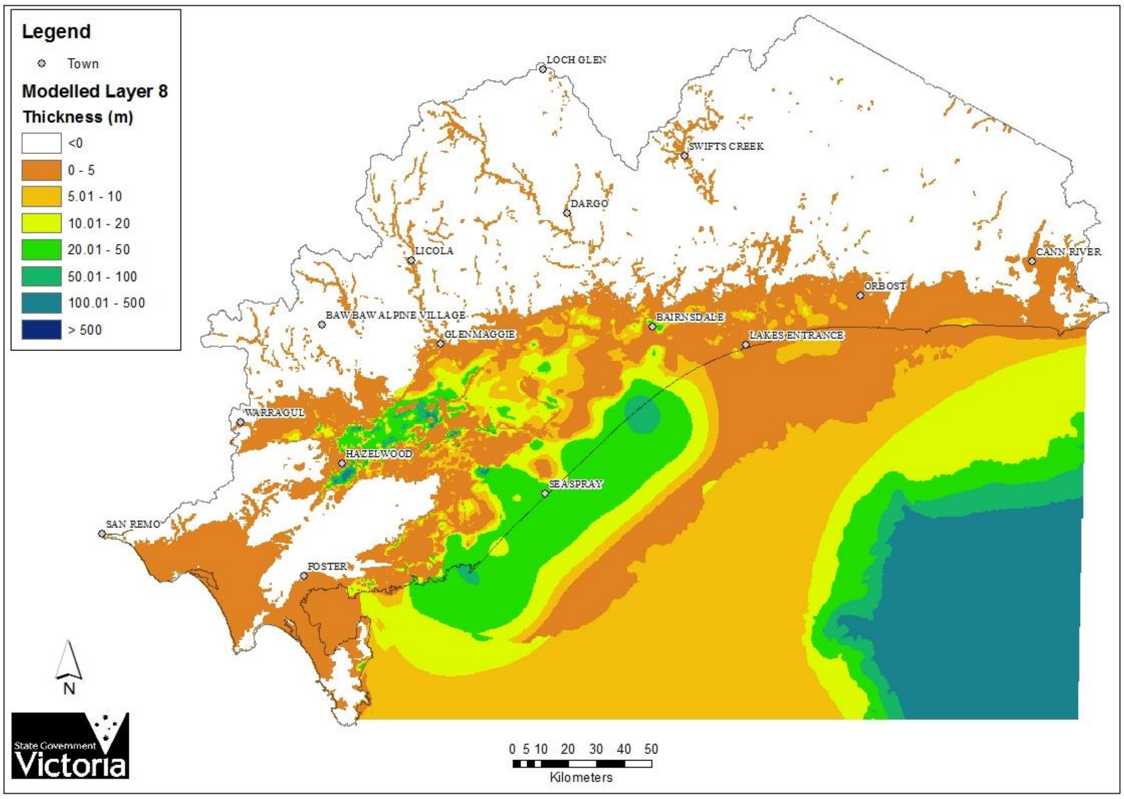
Kilometers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SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
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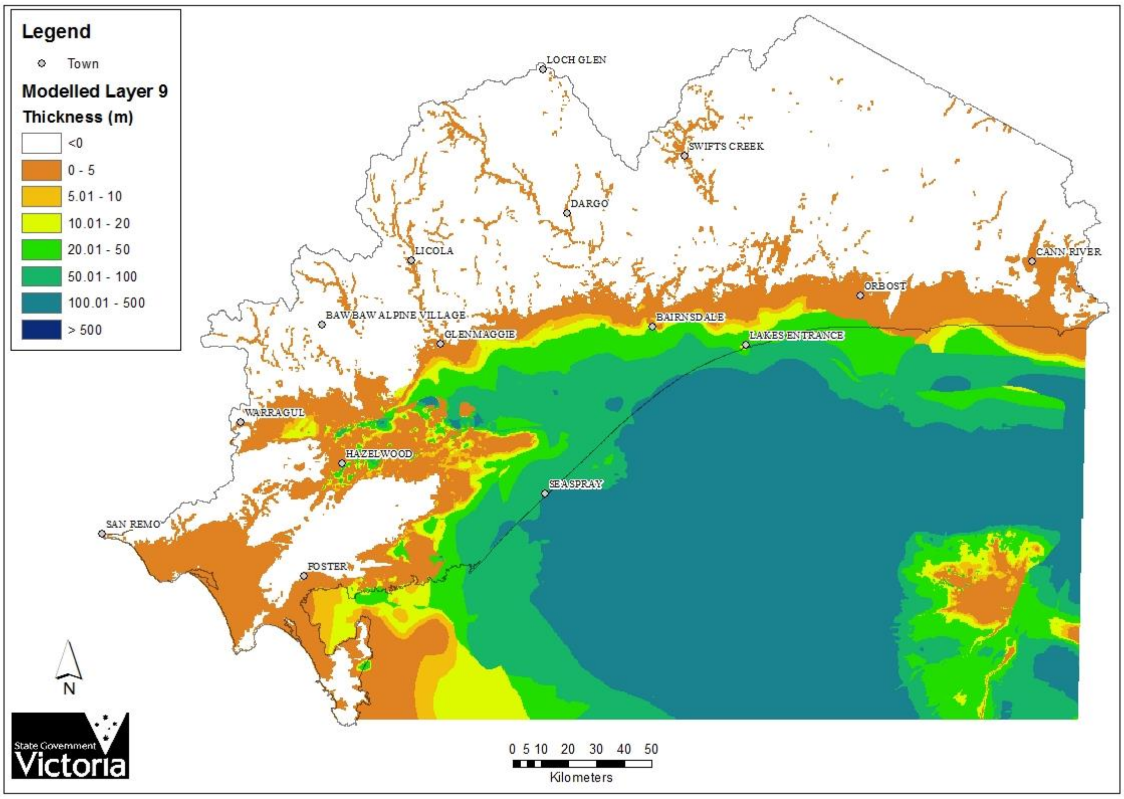
Kilometers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DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
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N
State Government Victoria
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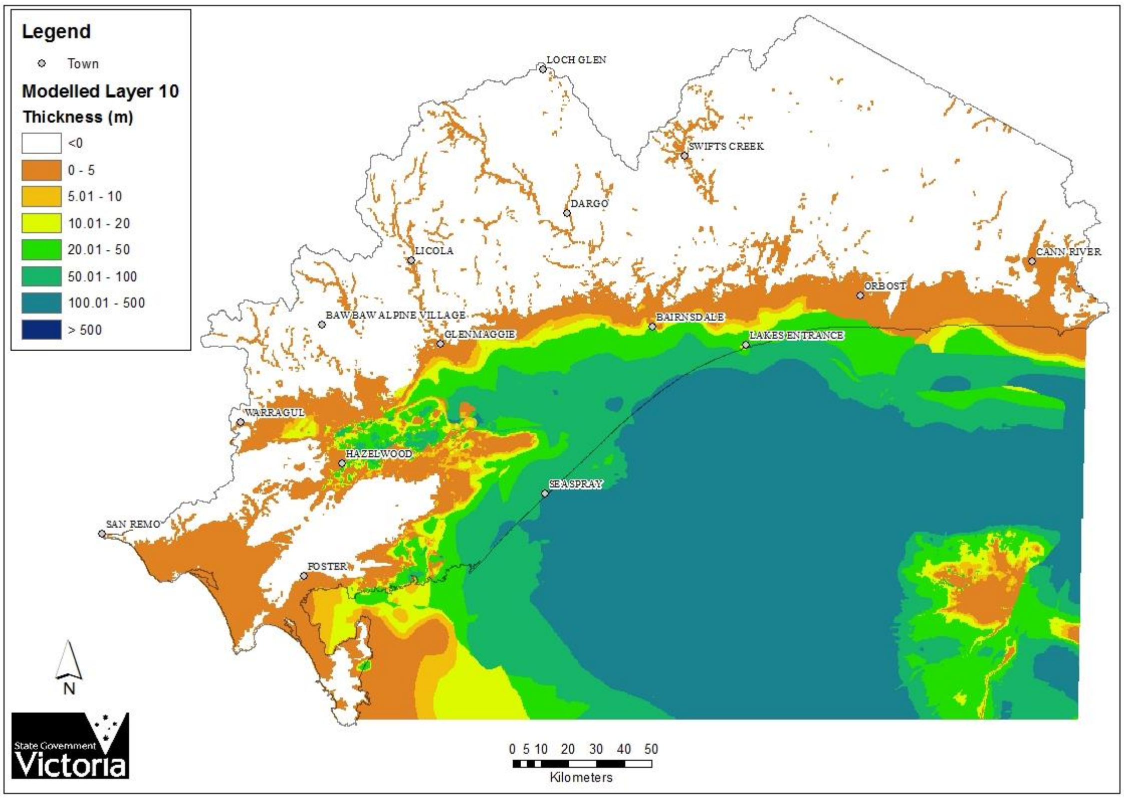
Kilometers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DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
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GLENMAGGIE
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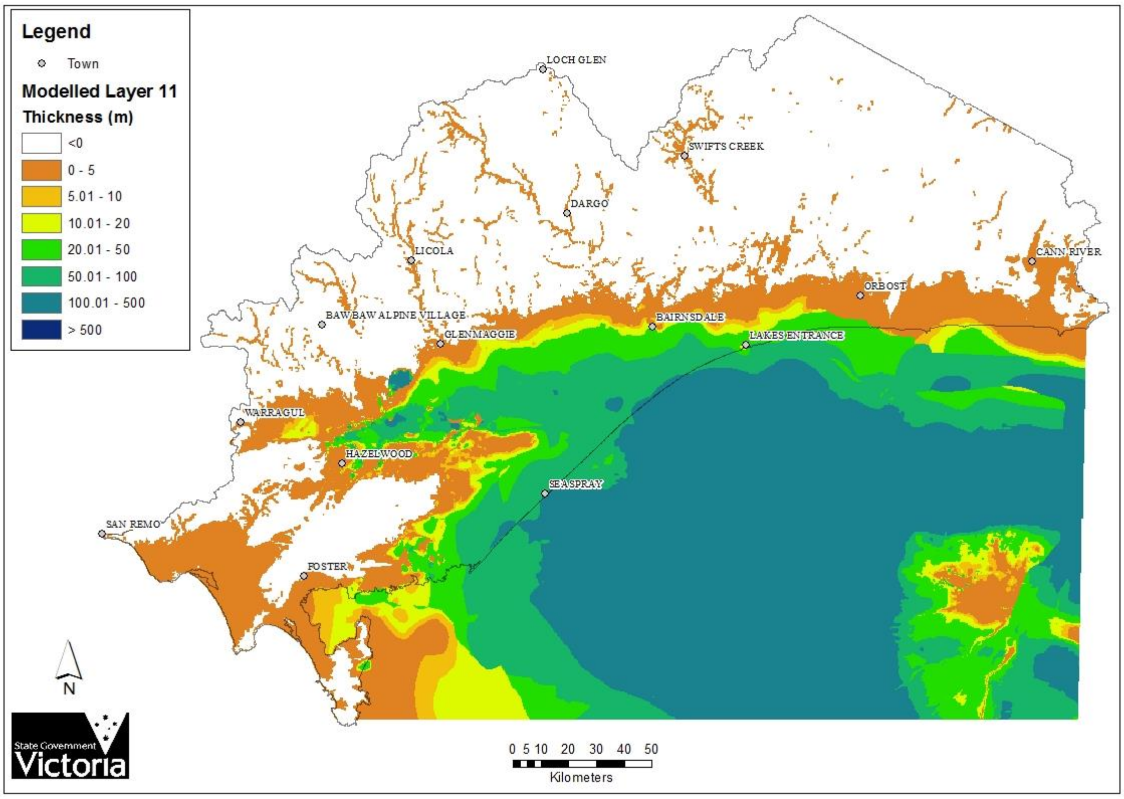
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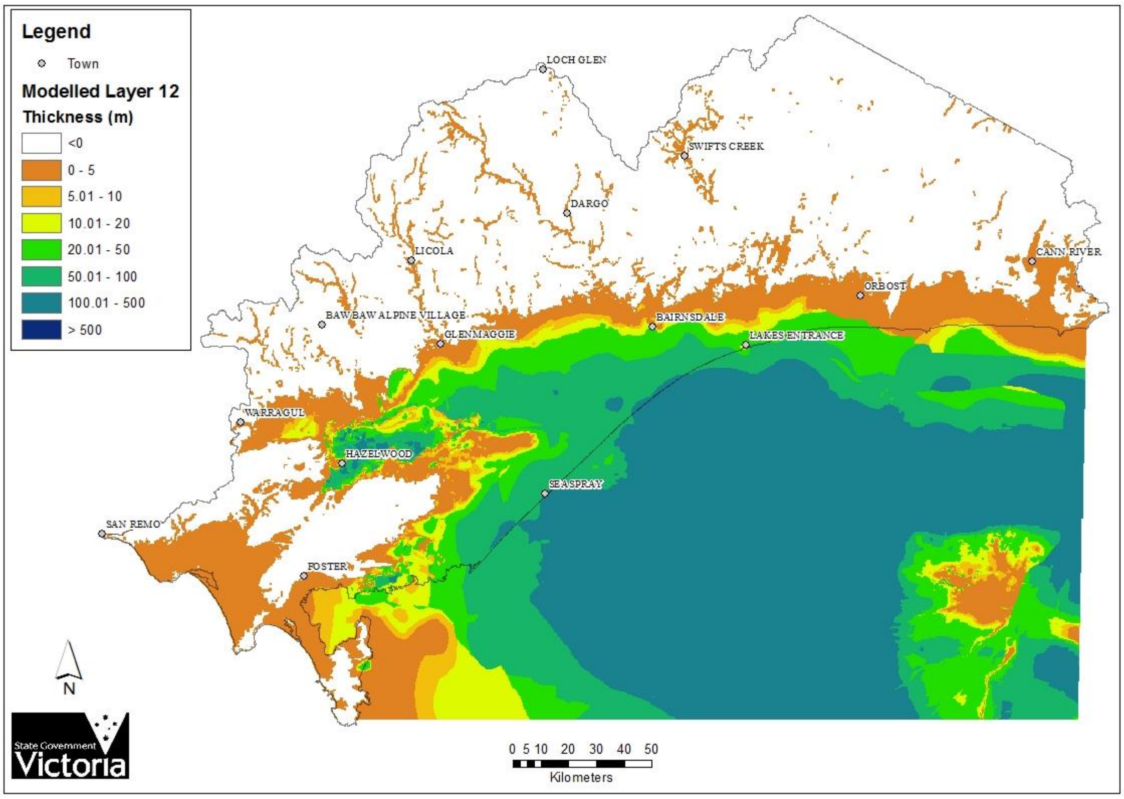
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DARGO
LICOLA
CANN RIVER
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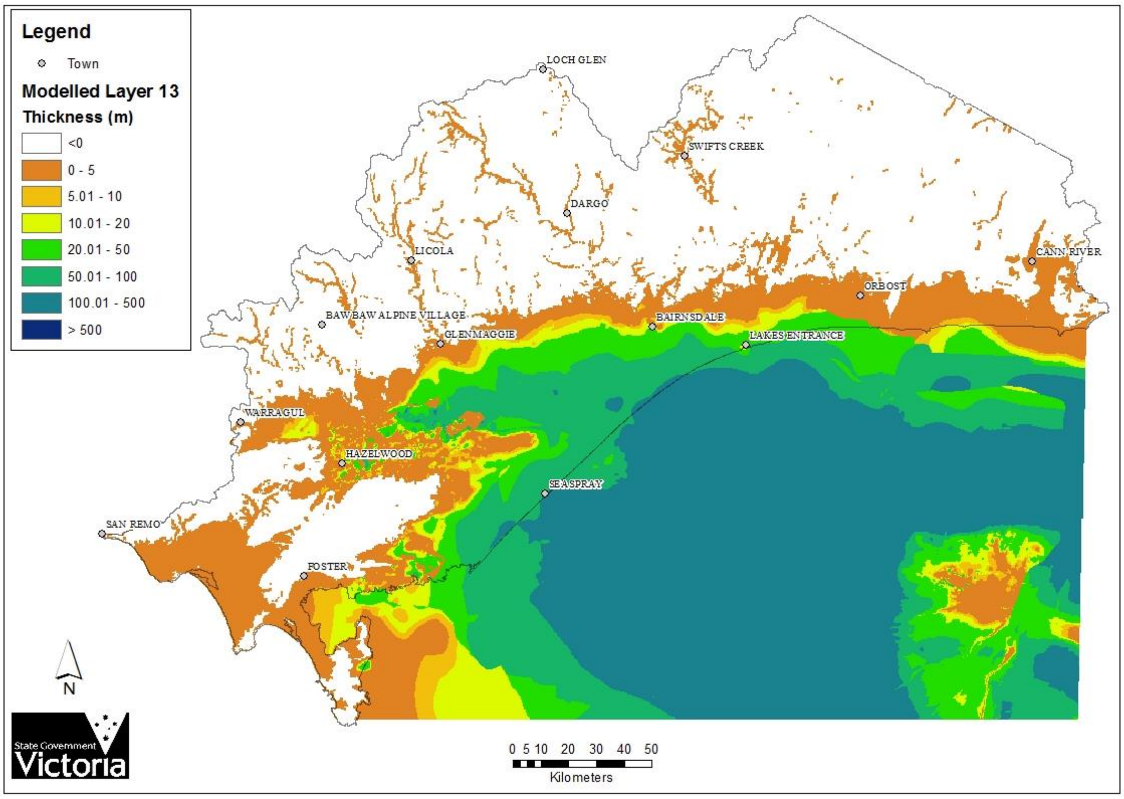
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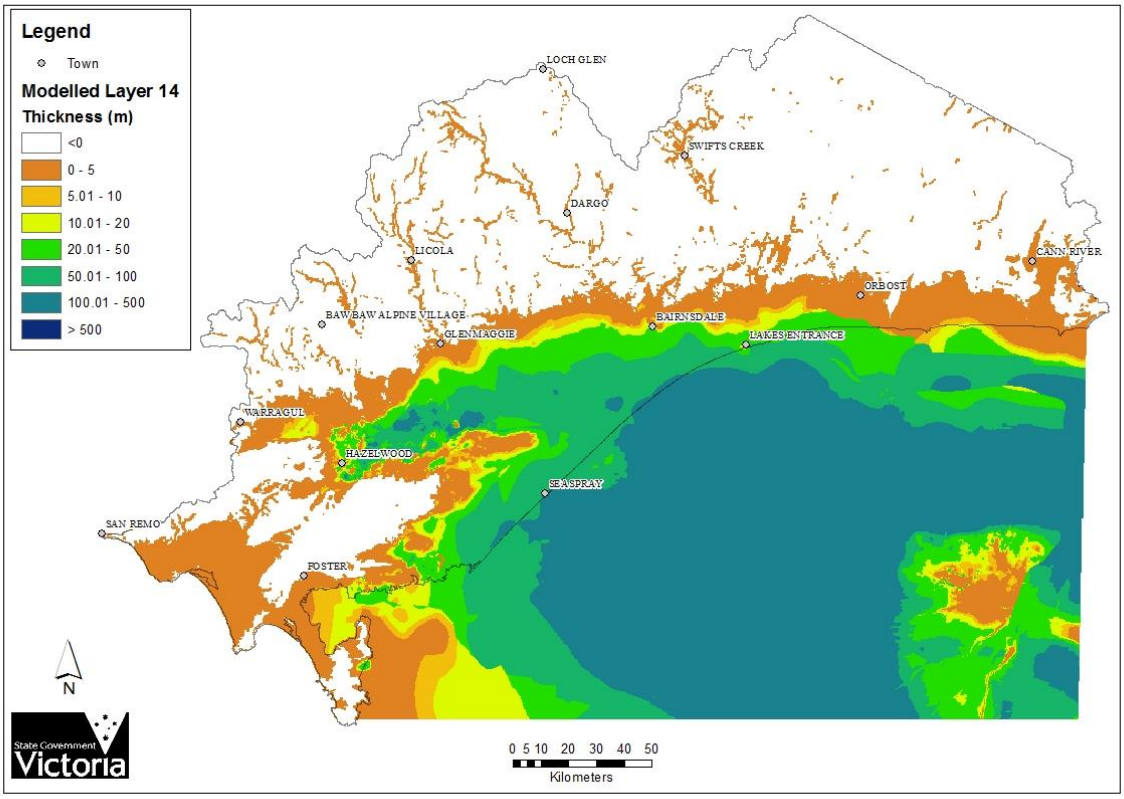
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DARGO
LICOLA
CANN RIVER
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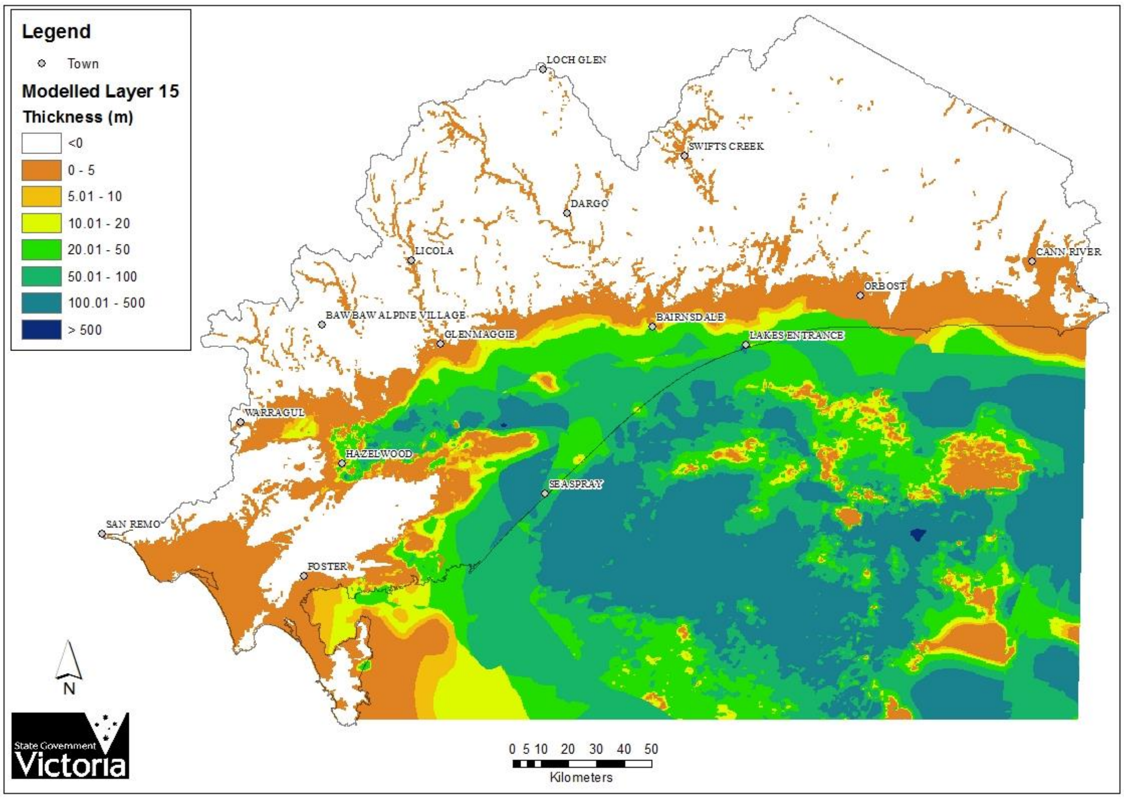
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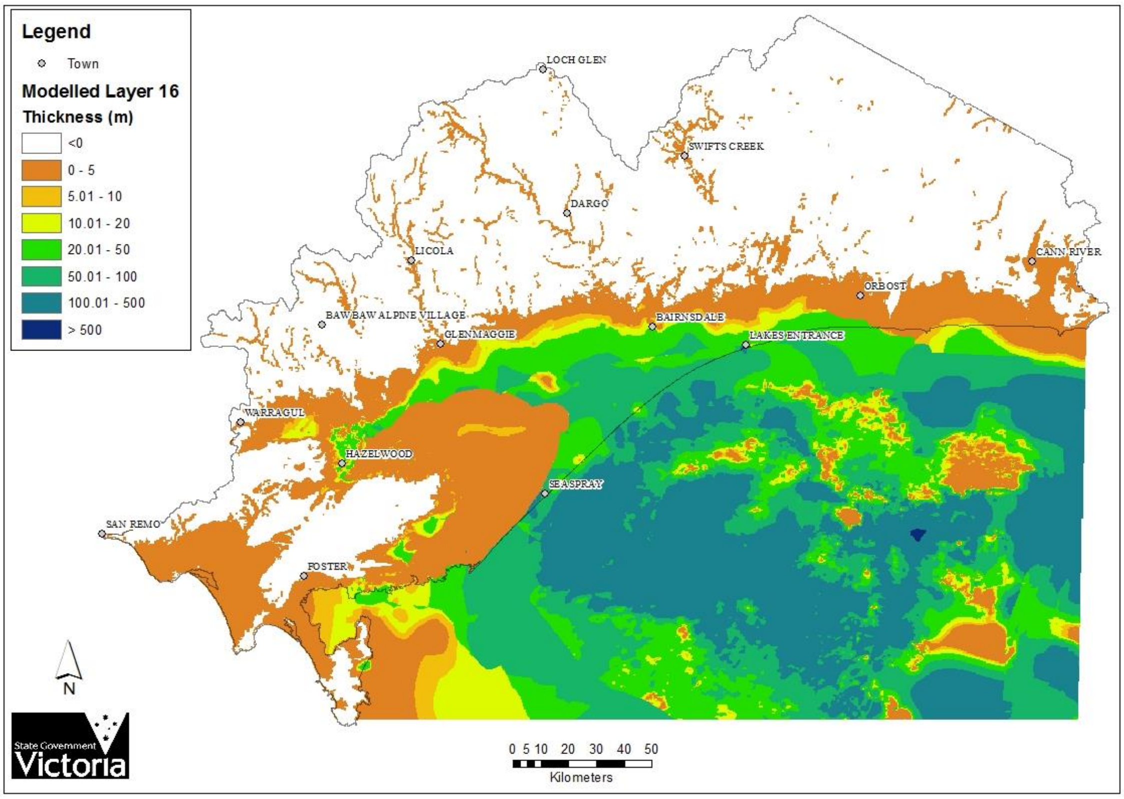
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DARGO
LICOLA
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ORBOST
BAW BAW ALPINE VILLAGE
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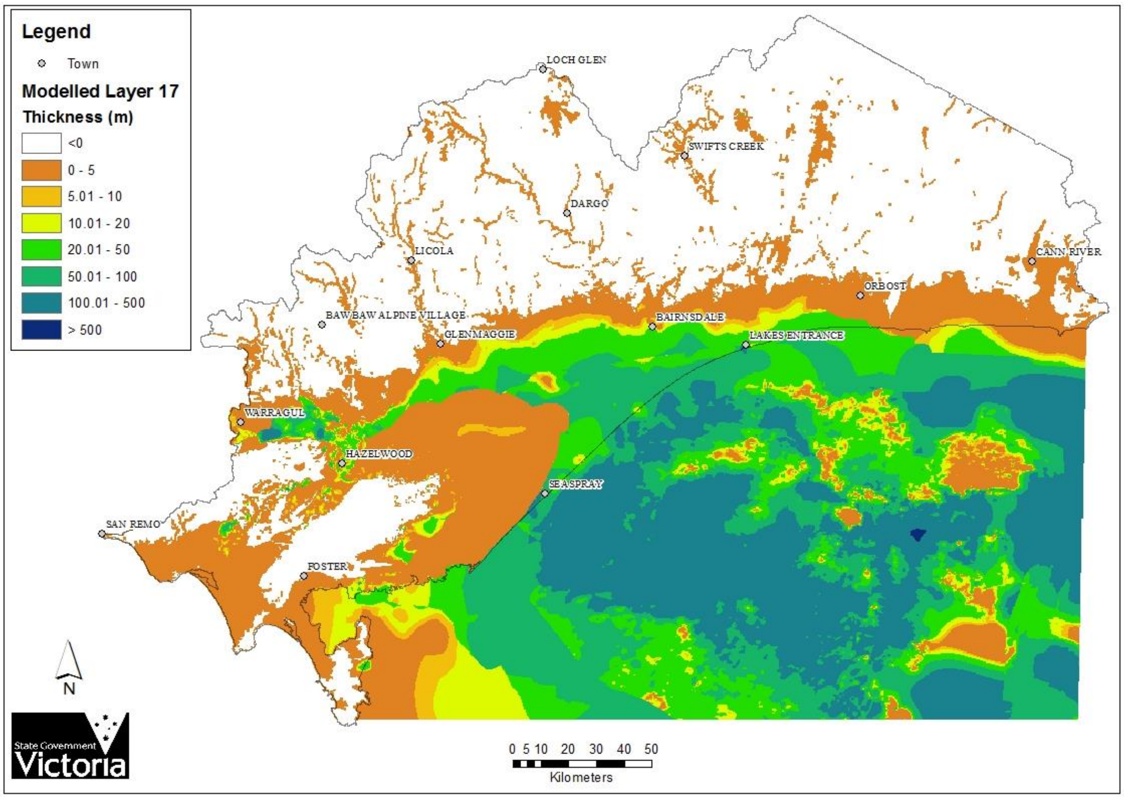
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DARGO
LICOLA
CANN RIVER
ORBOST
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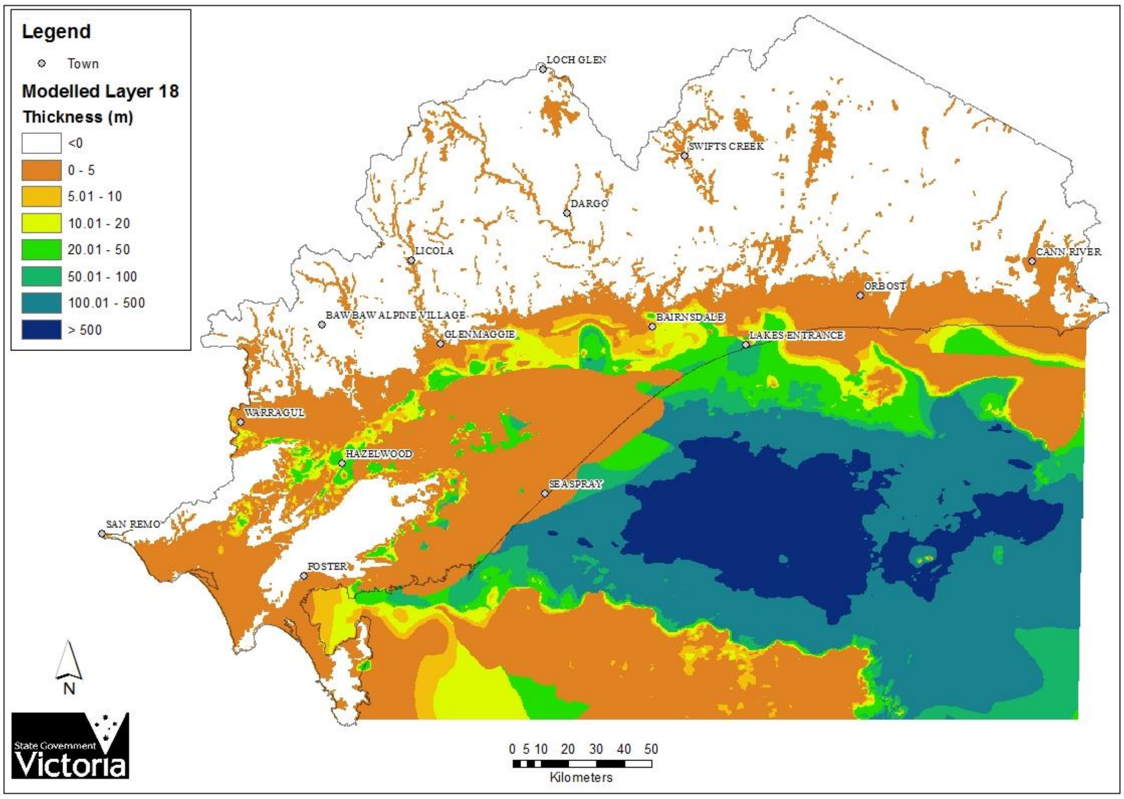
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DARGO
LICOLA
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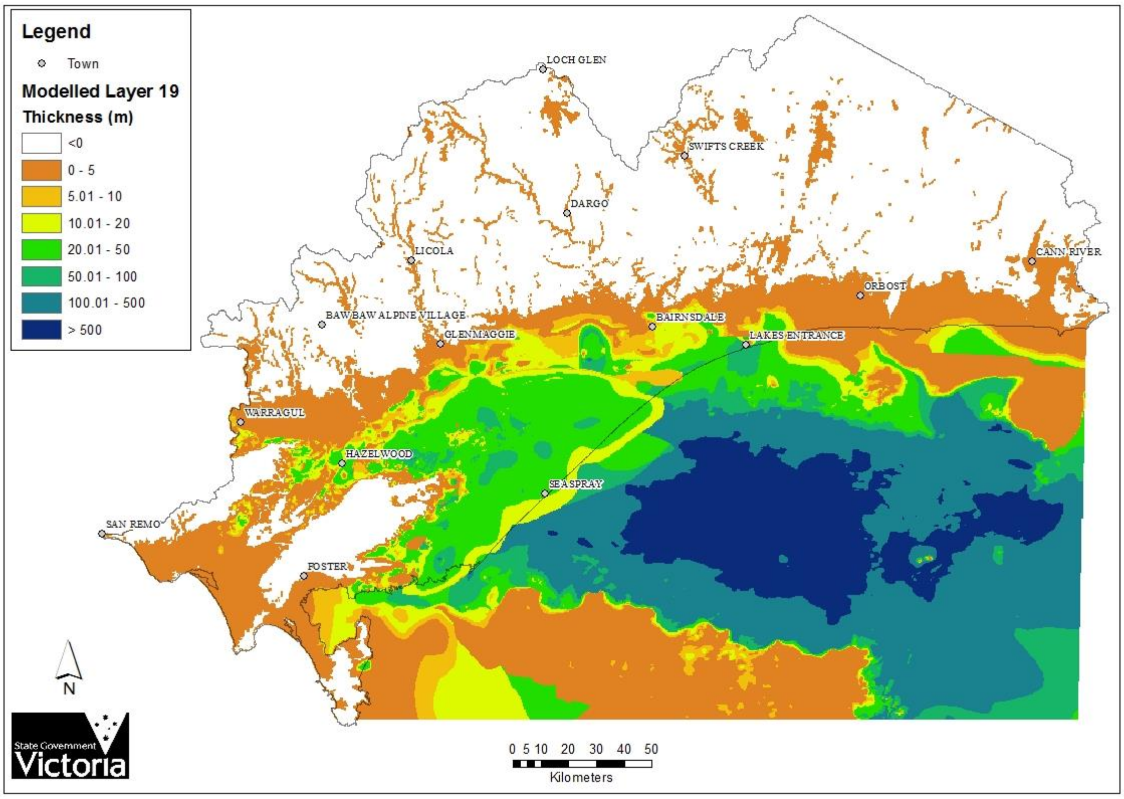
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DARGO
LICOLA
CANN RIVER
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BAW BAW ALPINE VILLAGE
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GLENMAGGIE
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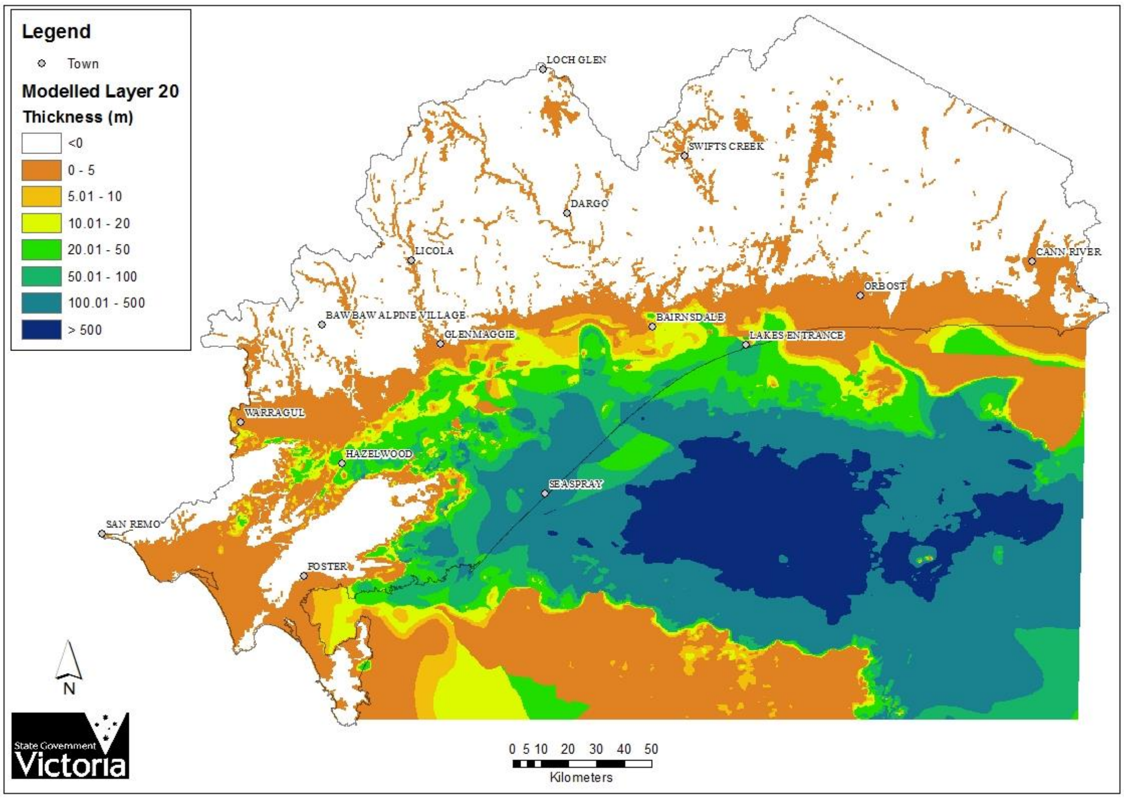
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DARGO
LICOLA
CANN RIVER
ORBOST
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GLENMAGGIE
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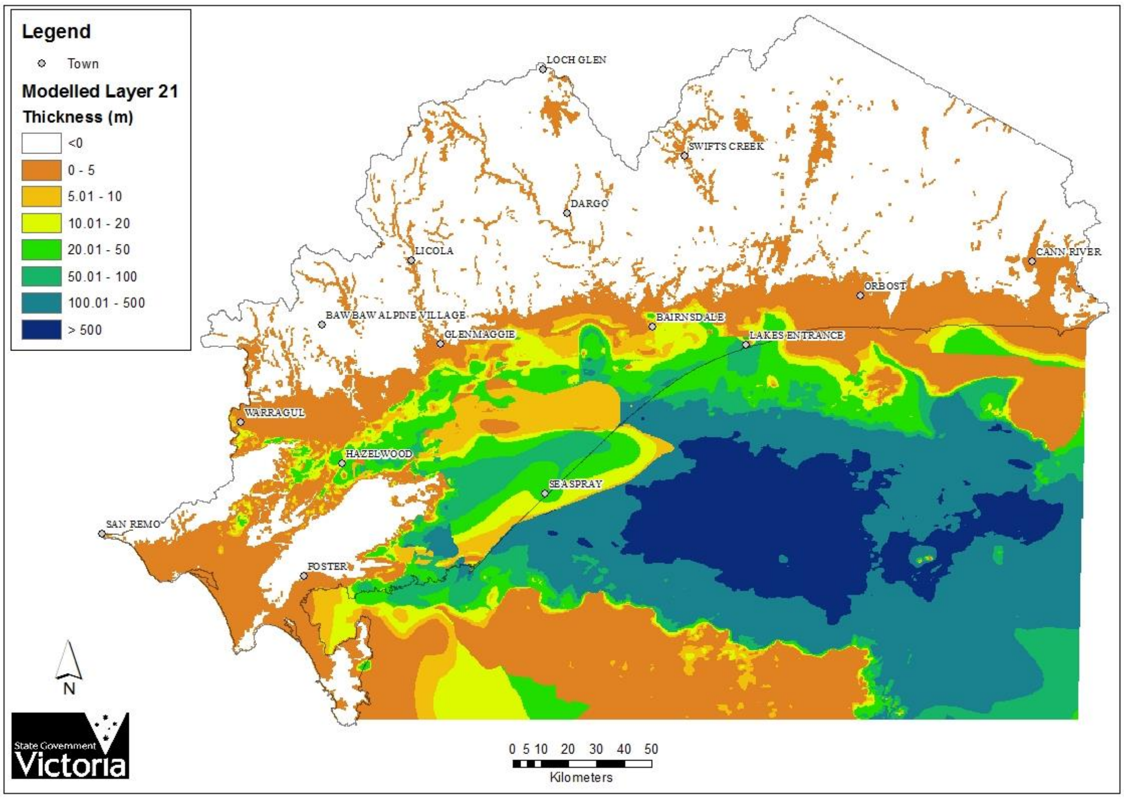
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SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
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FOSTER
N
State Government Victoria
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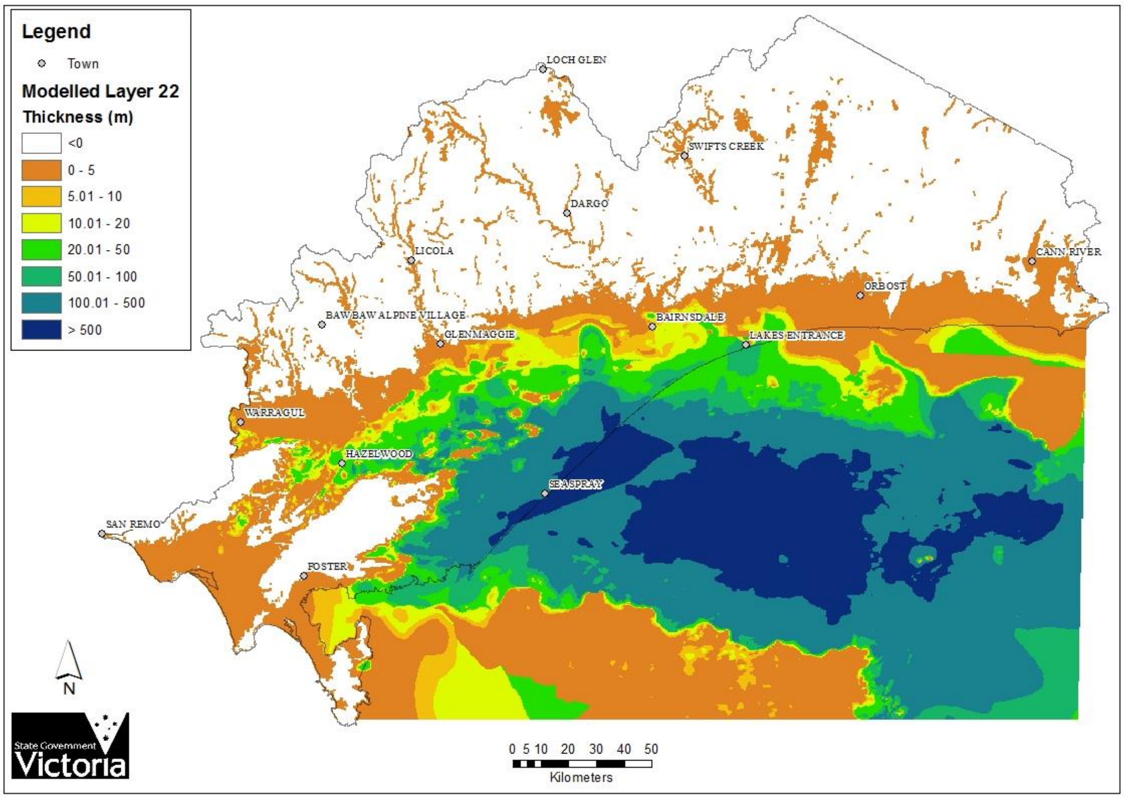
Kilometers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SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
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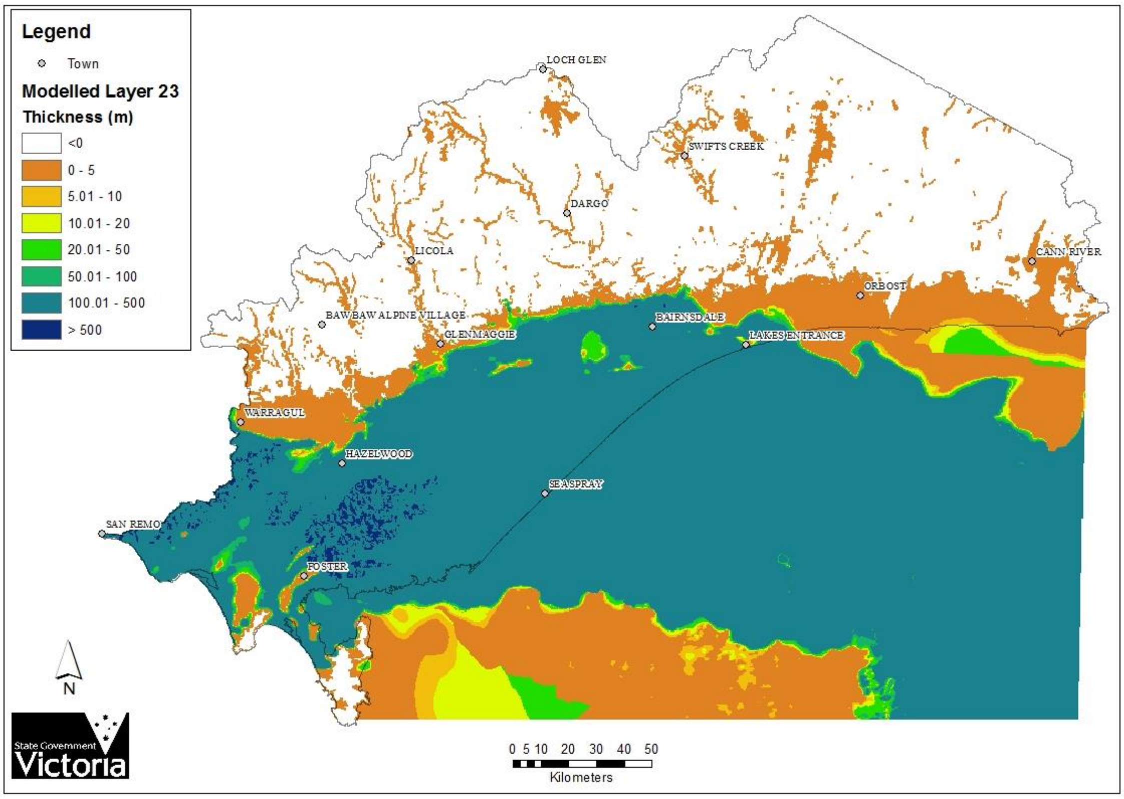
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DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
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SAN REMO
FOSTER
N
State Government Victoria
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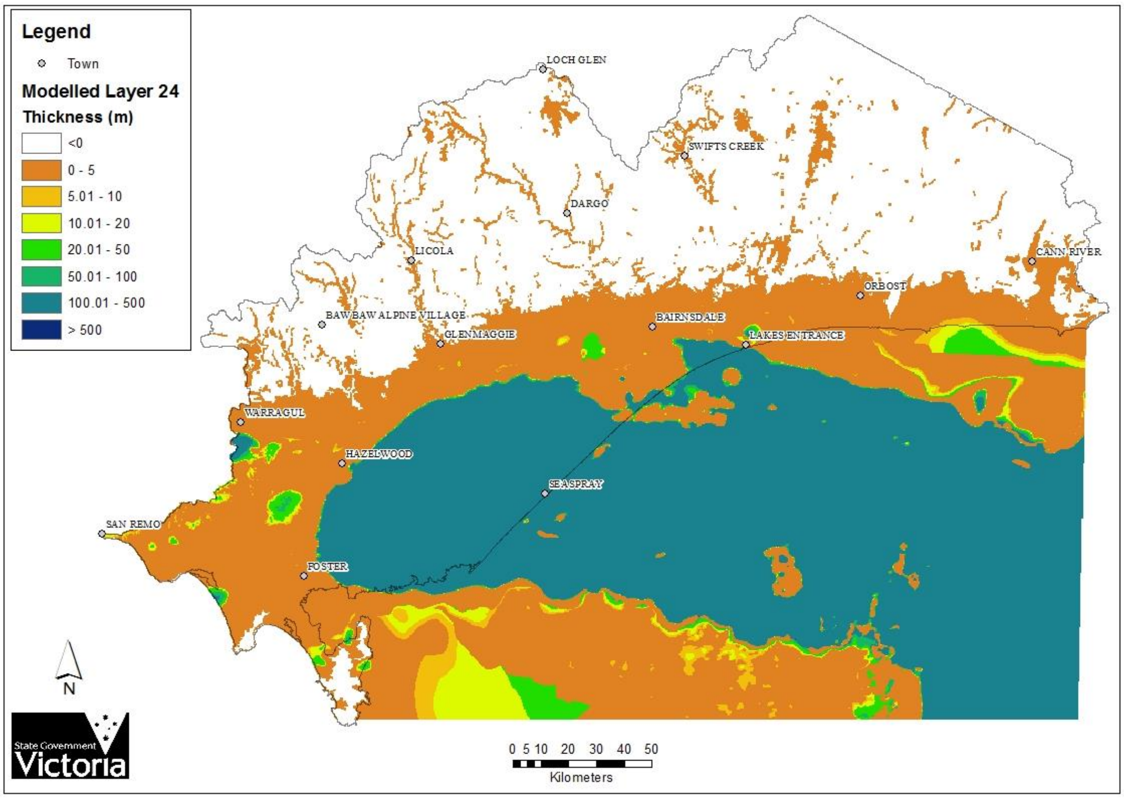
Kilometers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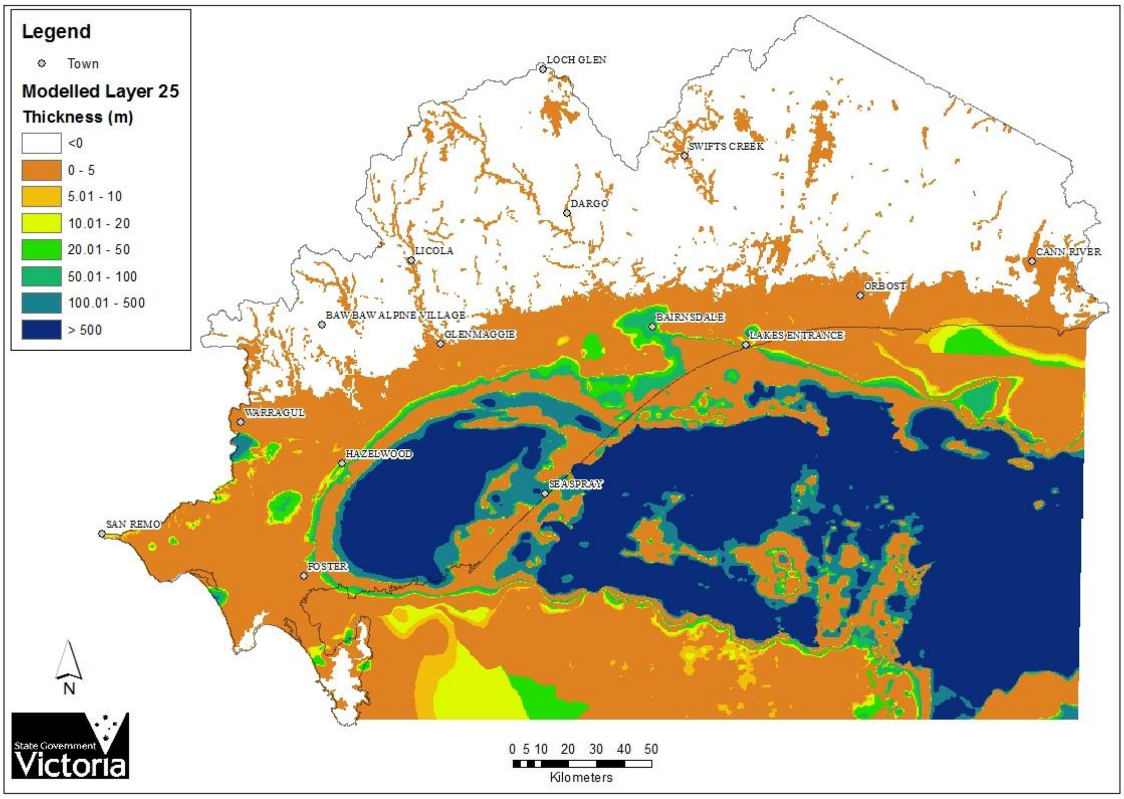
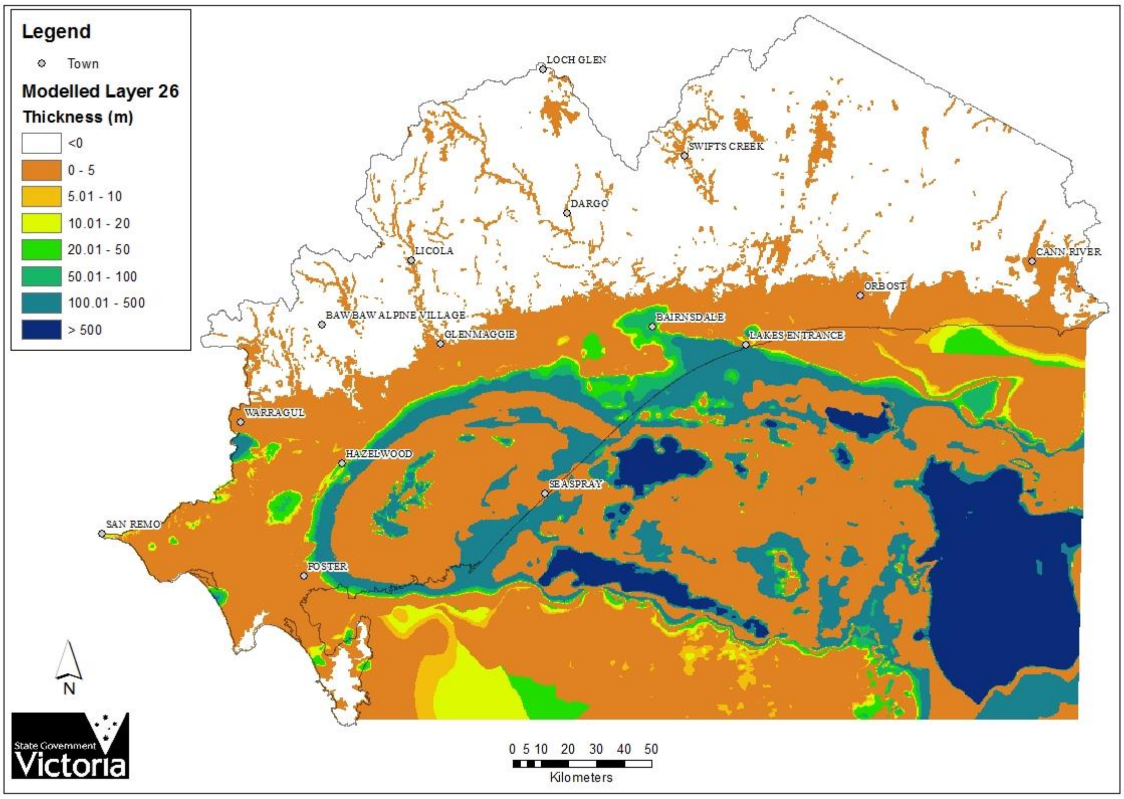
LOCH GLEN
SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
LAKES ENTRANCE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
N
State Government Victoria
0 5 10 20 30 40 50
Kilometers


Legend
Town
Modelled Layer 25
Thickness (m)
<0
0 - 5
5.01 - 10
10.01 - 20
20.01 - 50
50.01 - 100
100.01 - 500
> 500
LOCH GLEN
SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
LAKES ENTRANCE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
N
State Government Victoria
0 5 10 20 30 40 50
Kilometers


Legend
Town
Modelled Layer 26
Thickness (m)
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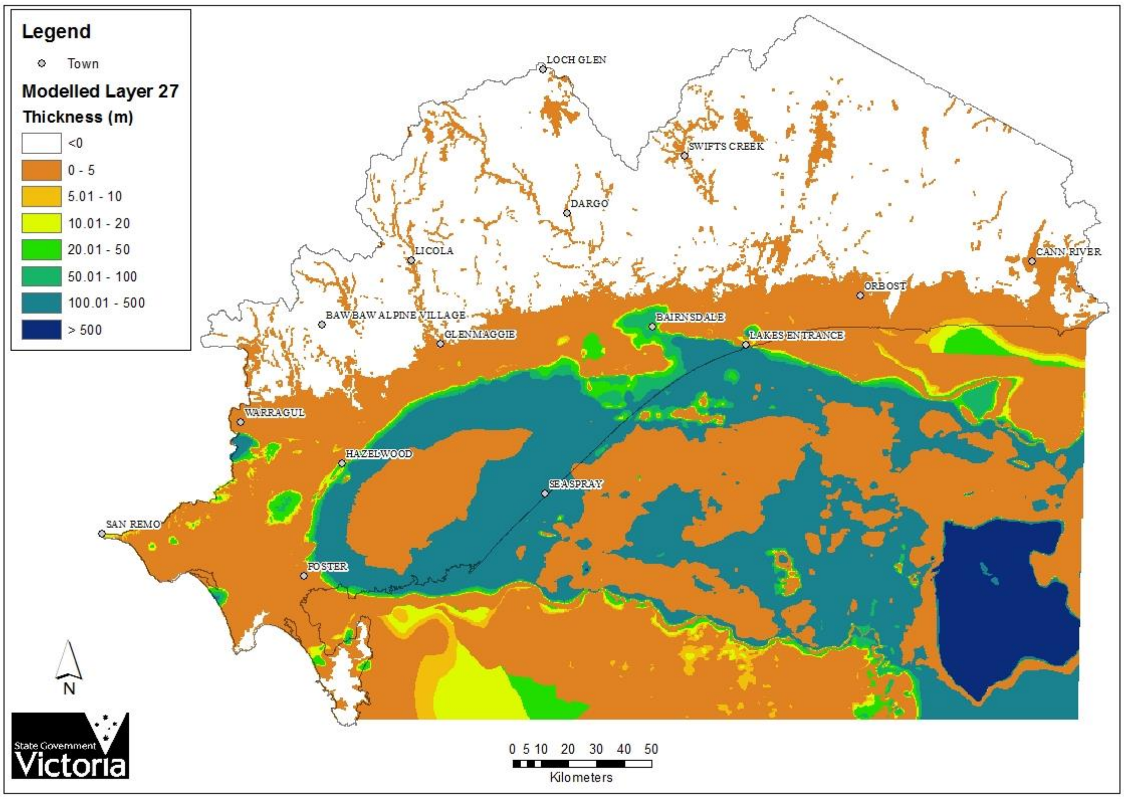
10.01 - 20
20.01 - 50
50.01 - 100
100.01 - 500
> 500
LOCH GLEN
SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
LAKES ENTRANCE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
N
State Government Victoria
0 5 10 20 30 40 50
Kilometers


Legend
Town
Modelled Layer 27
Thickness (m)
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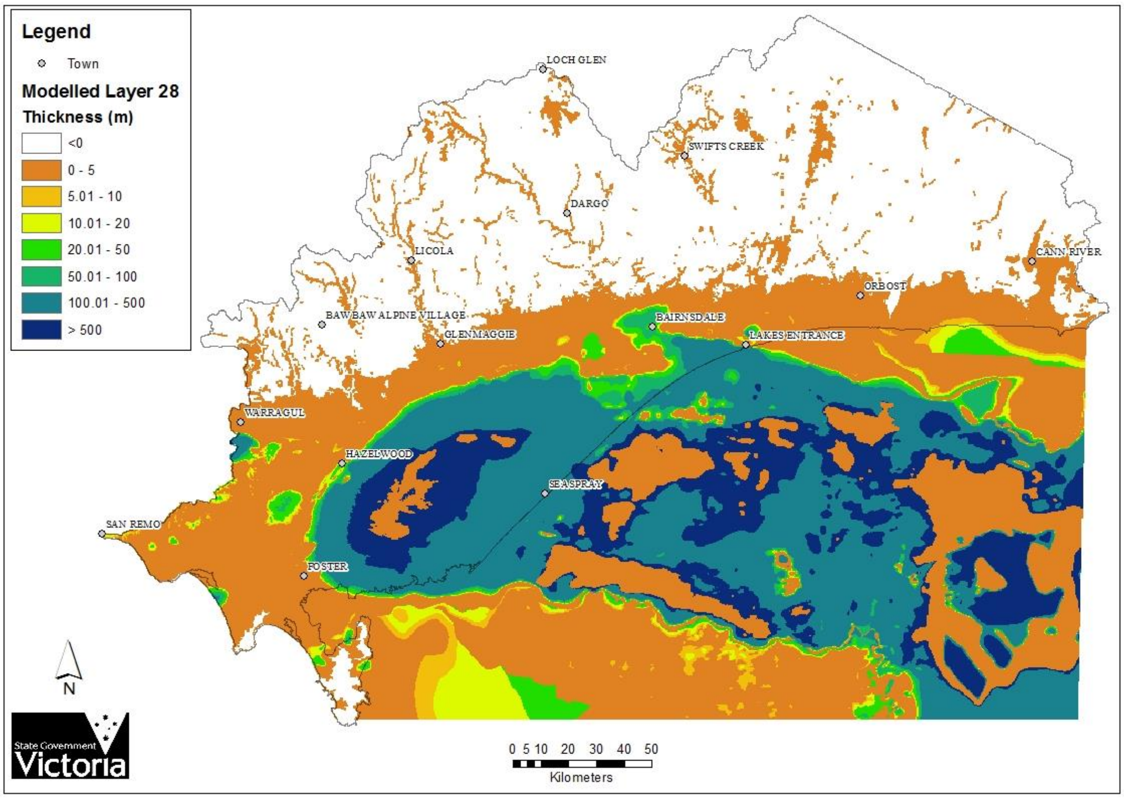
0 - 5
5.01 - 10
10.01 - 20
20.01 - 50
50.01 - 100
100.01 - 500
> 500
LOCH GLEN
SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
LAKES ENTRANCE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
N
State Government Victoria
0 5 10 20 30 40 50
Kilometers


Legend
Town
Modelled Layer 28
Thickness (m)
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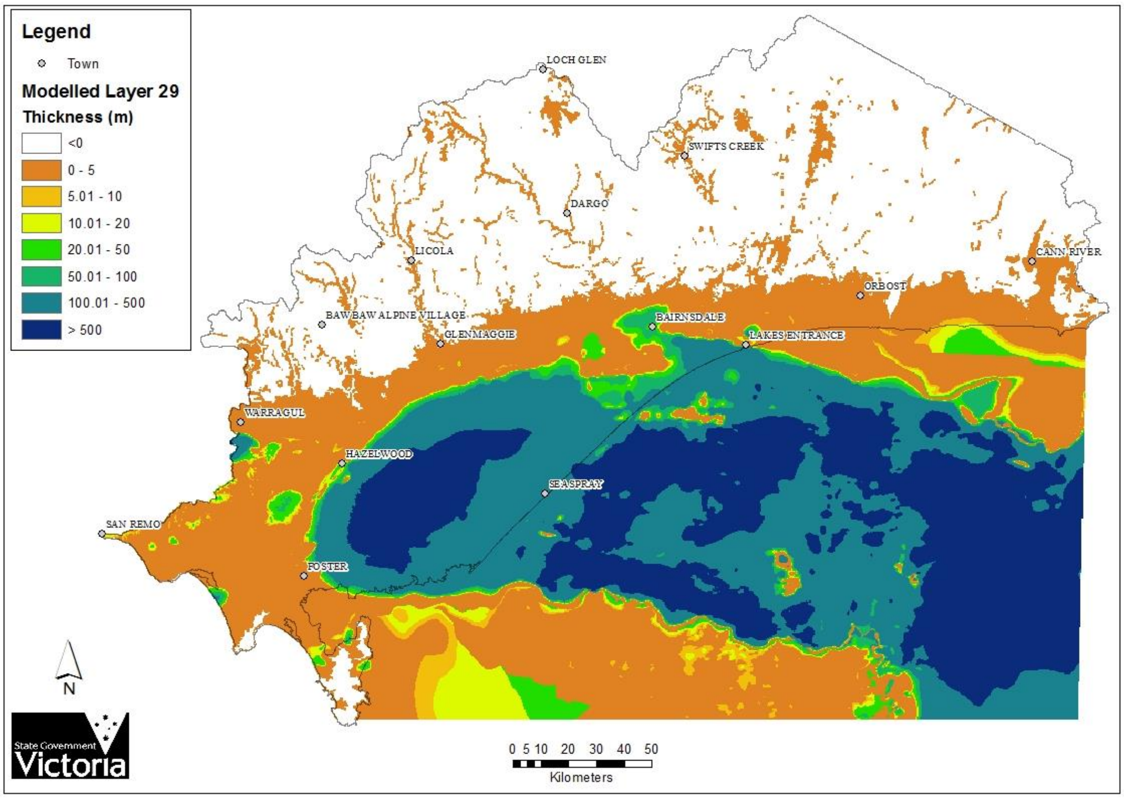
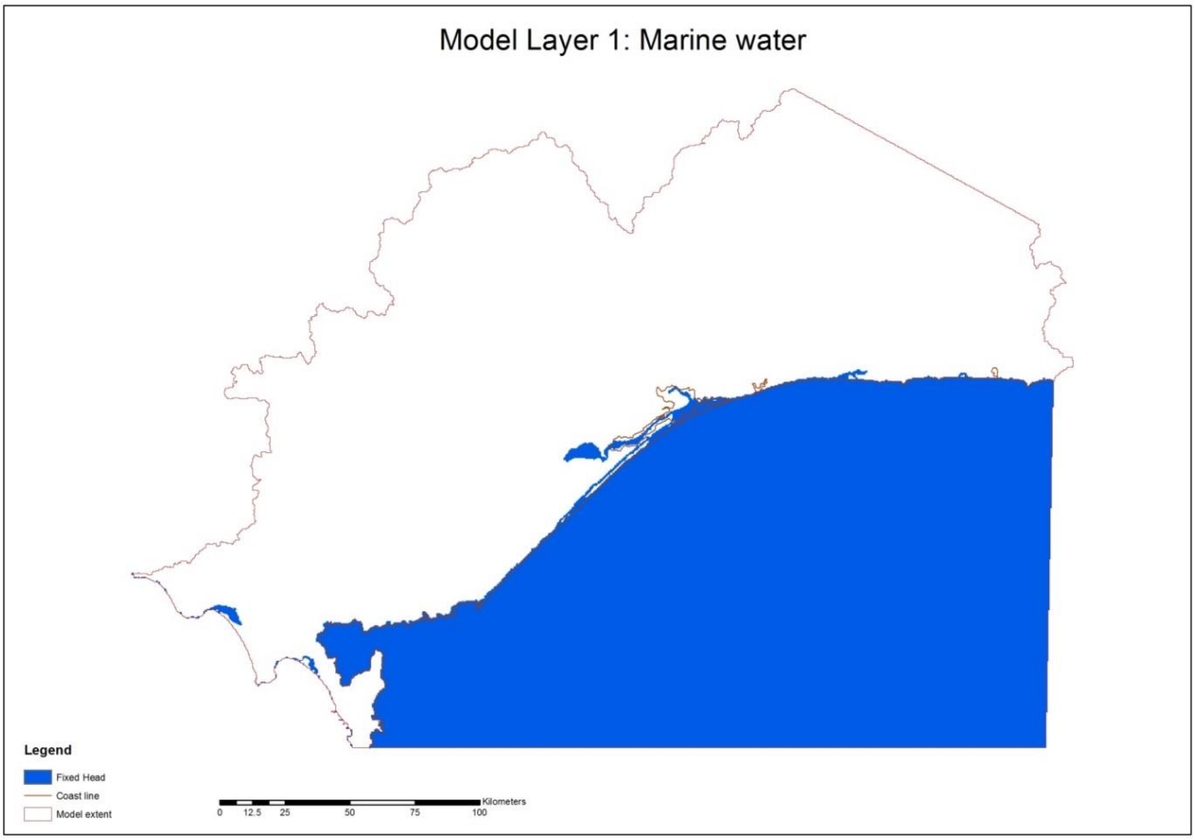
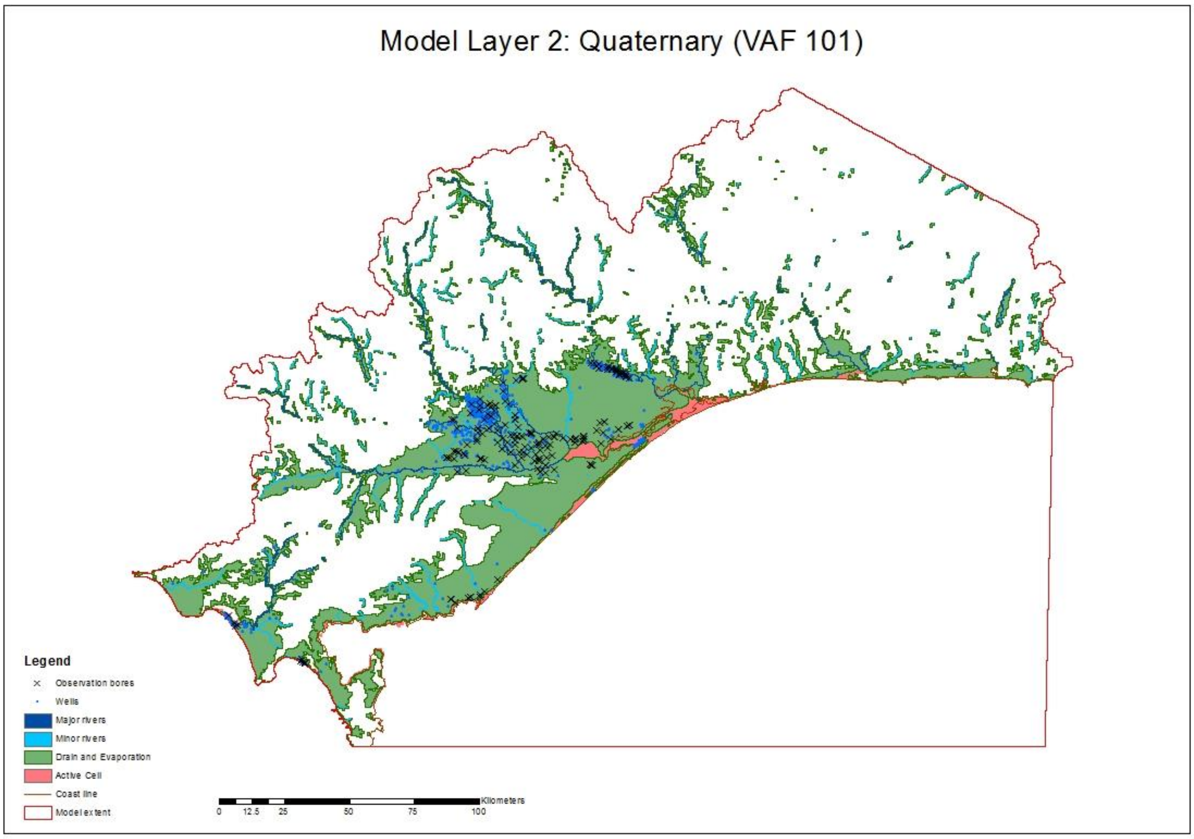
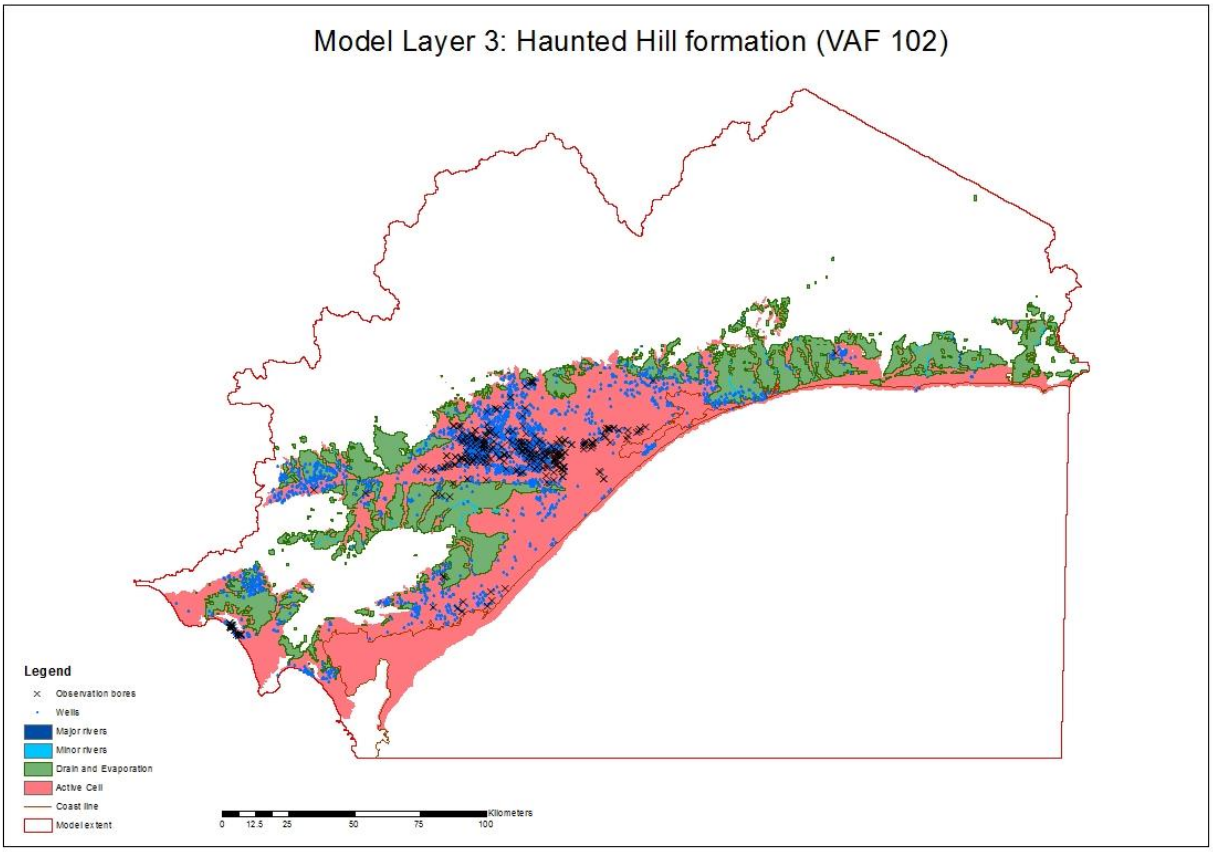
5.01 - 10
10.01 - 20
20.01 - 50
50.01 - 100
100.01 - 500
> 500
LOCH GLEN
SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
LAKES ENTRANCE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
N
State Government Victoria
0 5 10 20 30 40 50
Kilometers

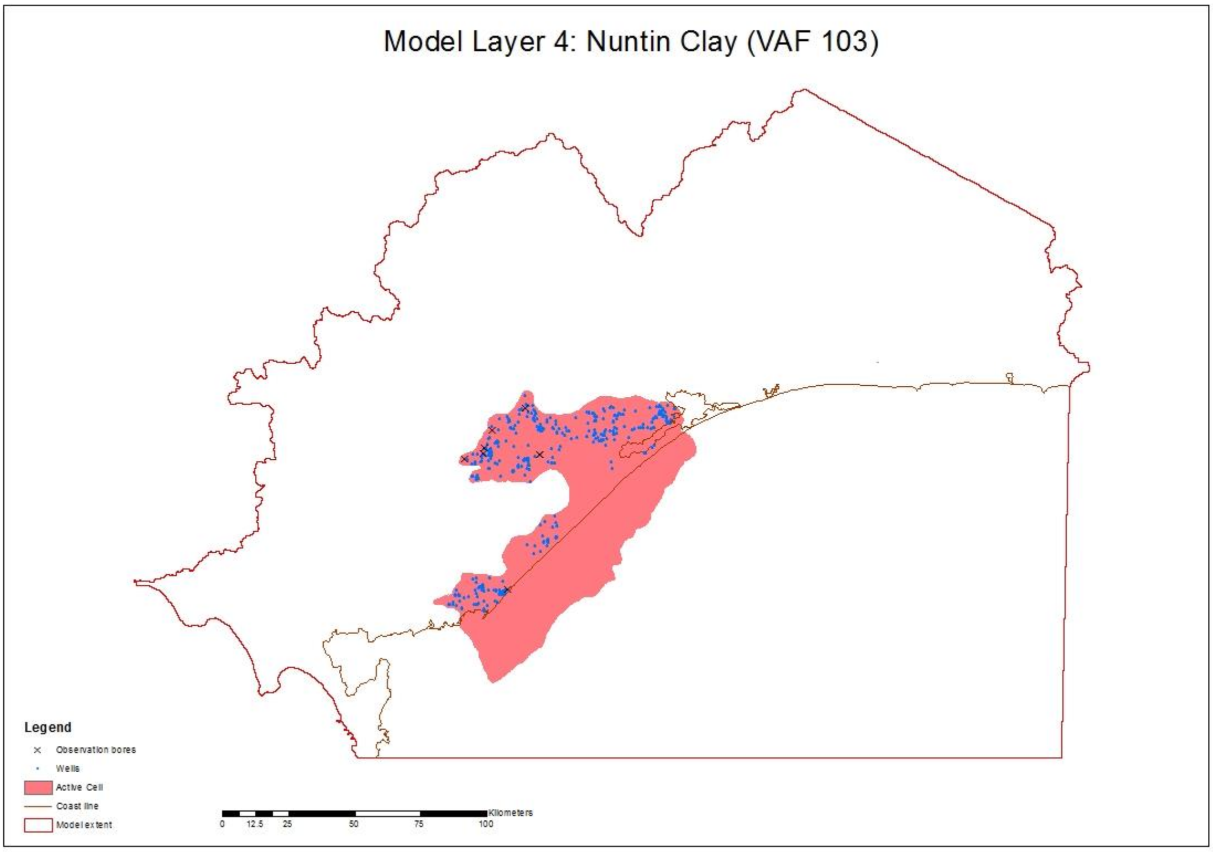

Legend
Town
Modelled Layer 29
Thickness (m)
<0
0 - 5
5.01 - 10
10.01 - 20
20.01 - 50
50.01 - 100
100.01 - 500
> 500
LOCH GLEN
SWIFTS CREEK
DARGO
LICOLA
CANN RIVER
ORBOST
BAW BAW ALPINE VILLAGE
BAIRNSDALE
GLENMAGGIE
LAKES ENTRANCE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
N
State Government Victoria
0 5 10 20 30 40 50
Kilometers

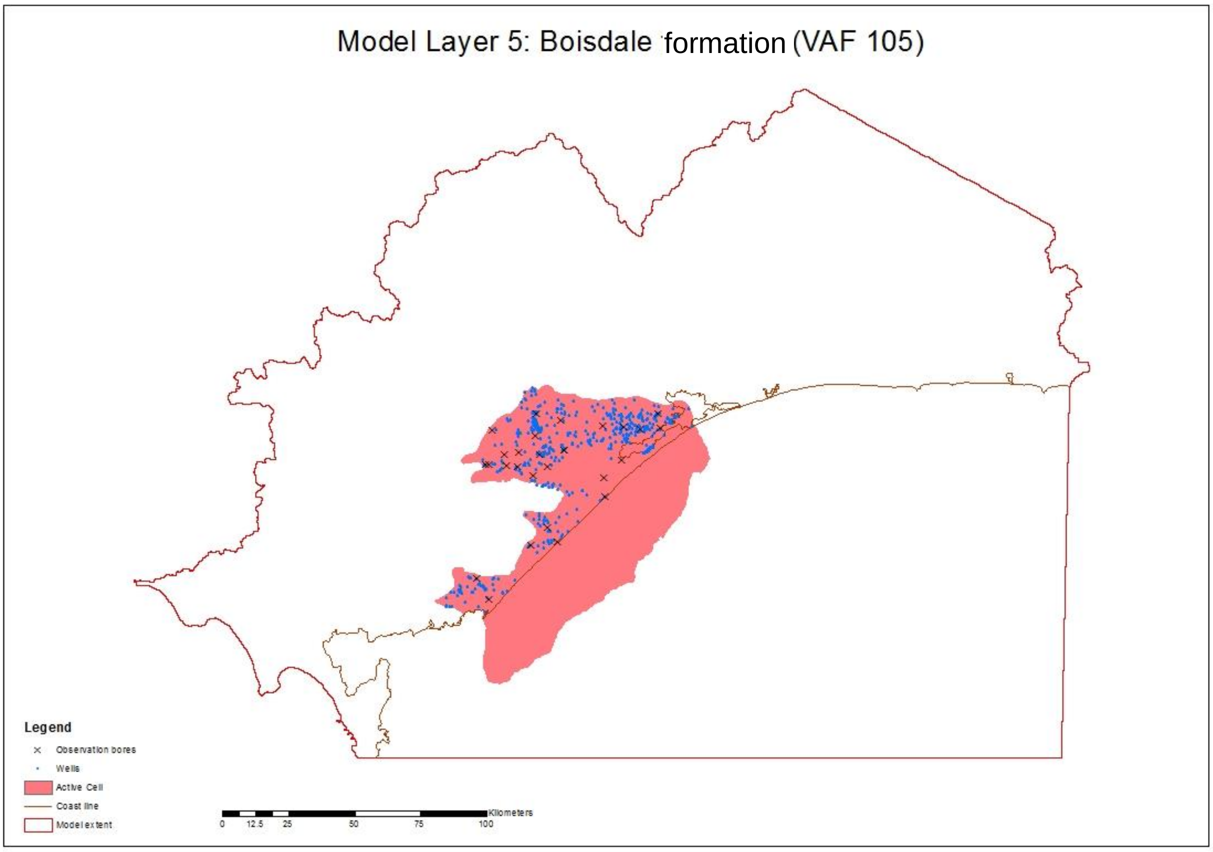
Appendix E: Model boundary conditions

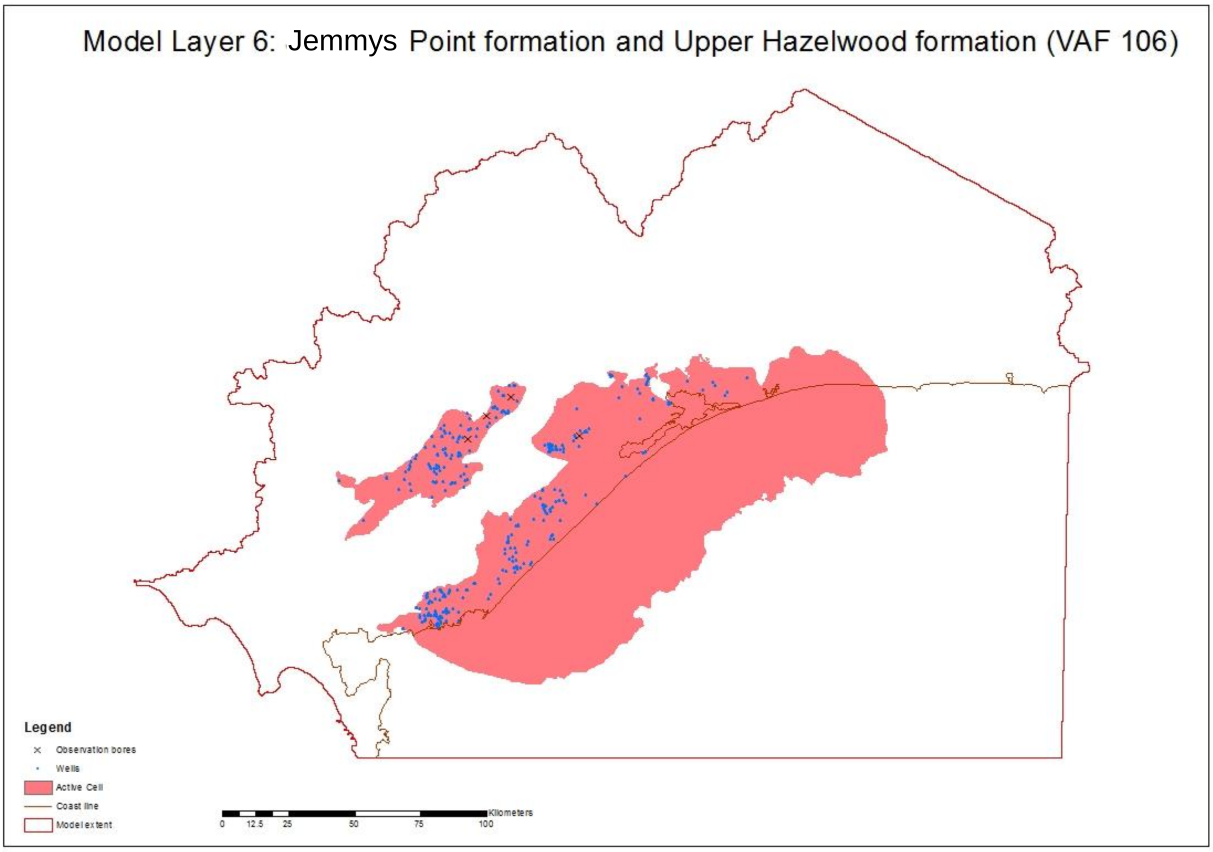

Model Layer 1: Marine water
Legend
Fixed Head
Coast line
Model extent
Kilometers
0
12.5
25
50
75
100

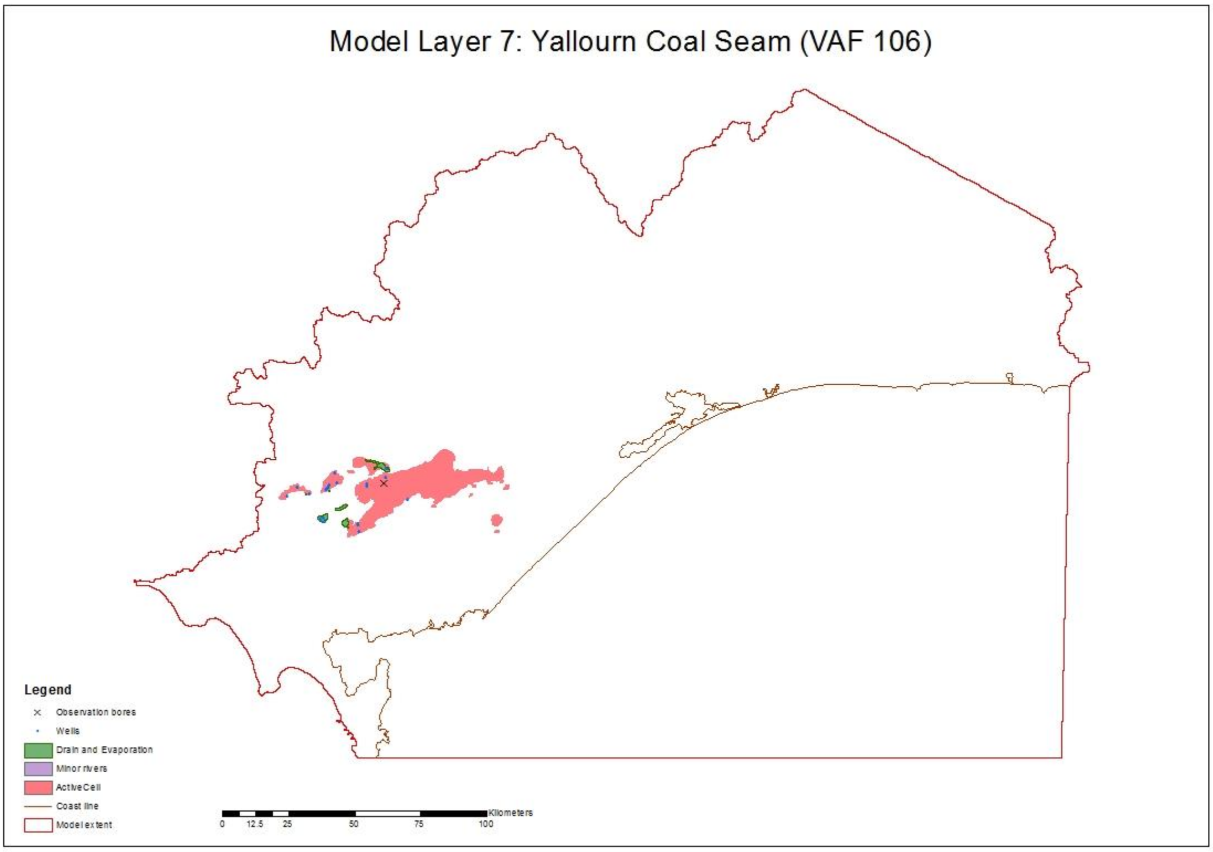

Model Layer 2: Quaternary (VAF 101)
Legend
Observation bores
Wells
Major rivers
Minor rivers
Drain and Evaporation
Active Cell
Coast line
Model extent
Kilometers
0
12.5
25
50
75
100

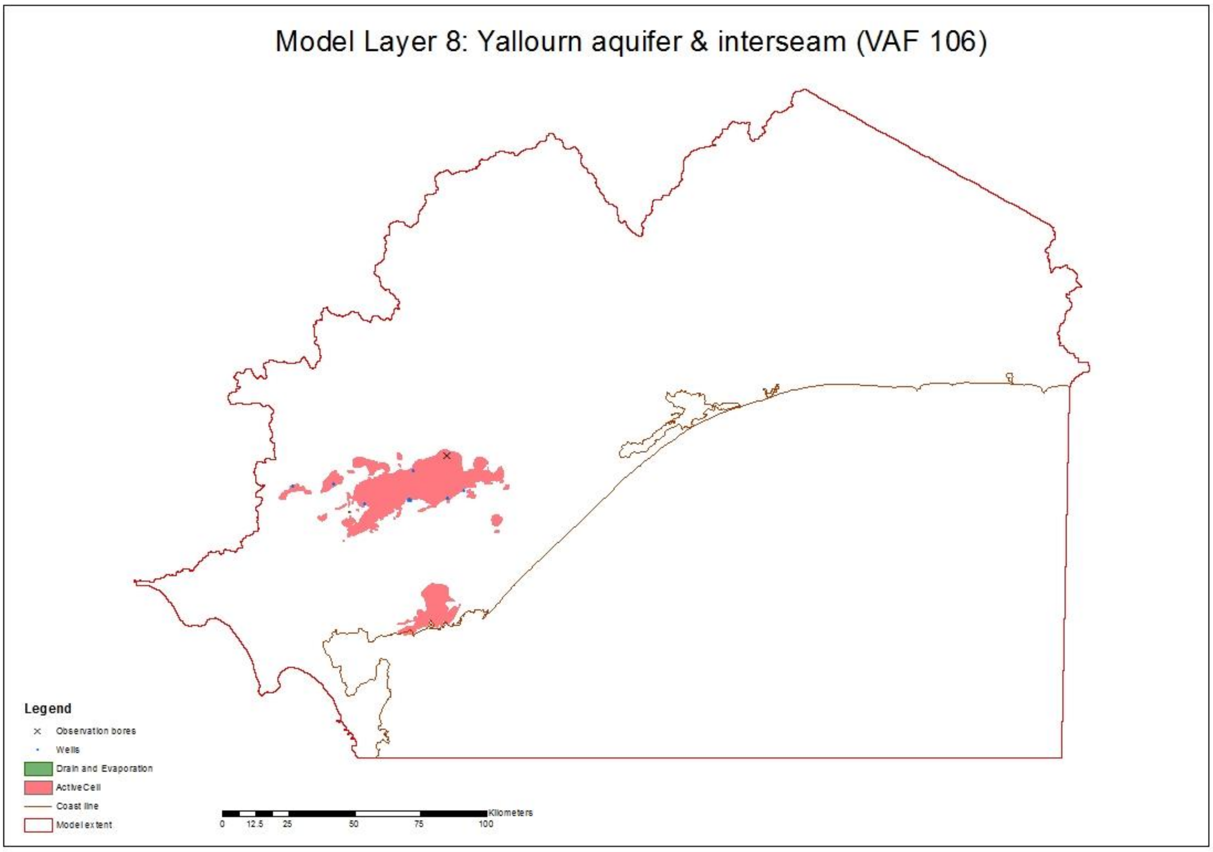

Model Layer 3: Haunted Hill formation (VAF 102)
Legend
Observation bores
Wells
Major rivers
Minor rivers
Drain and Evaporation
Active Cell
Coast line
Model extent
Kilometers
0 12.5 25 50 75 100

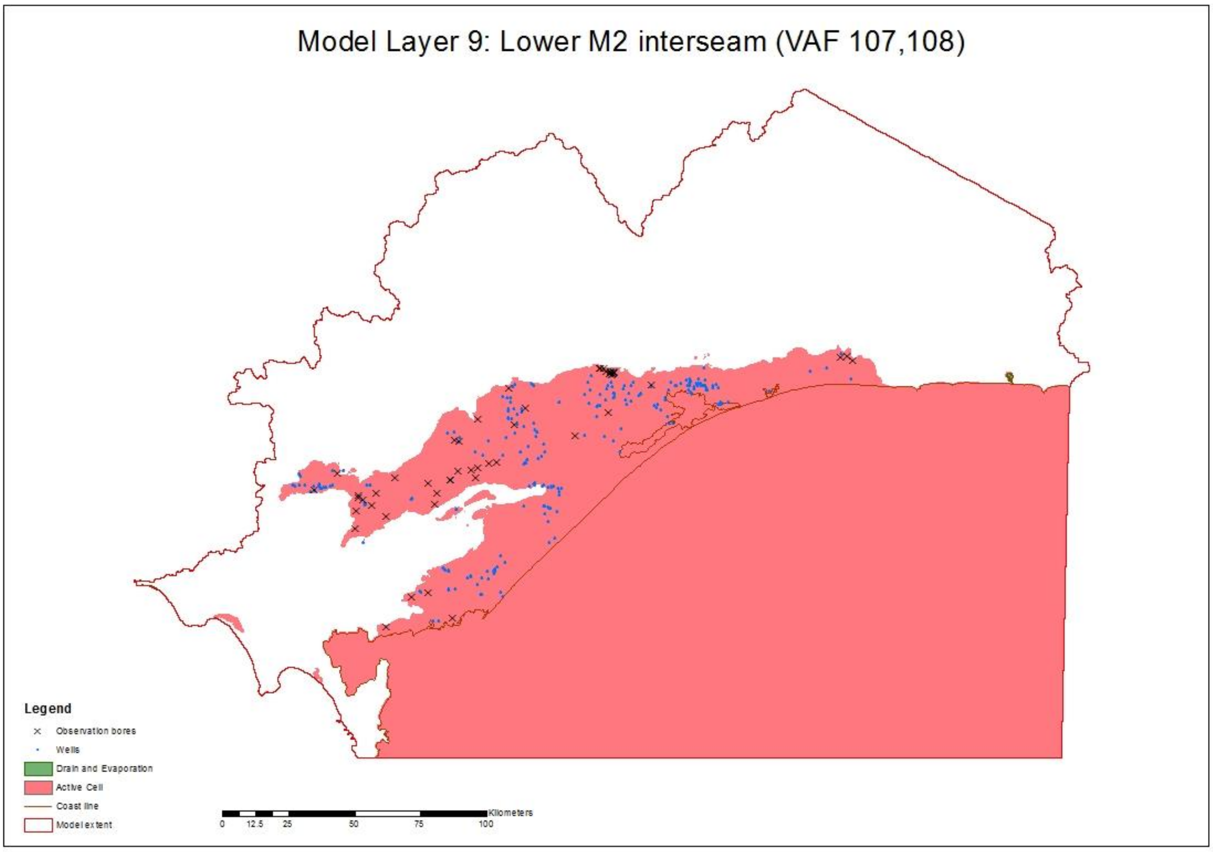

Model Layer 4: Nuntin Clay (VAF 103)
Legend
Observation bores
Wells
Active Cell
Coast line
Model extent
Kilometers
0 12.5 25 50 75 100

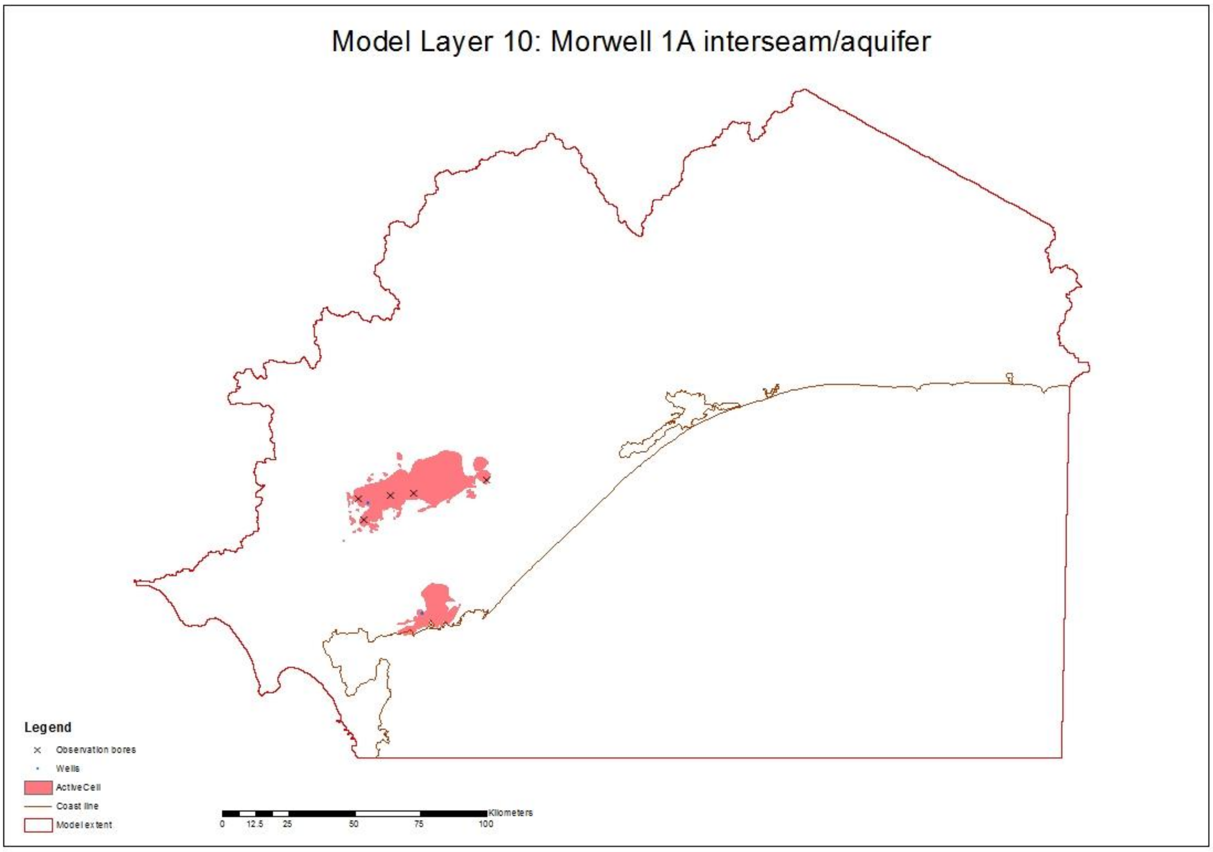

Model Layer 5: Boisdale formation (VAF 105)
Legend
Observation bores
Wells
Active Cell
Coast line
Model extent
Kilometers
0
12.5
25
50
75
100

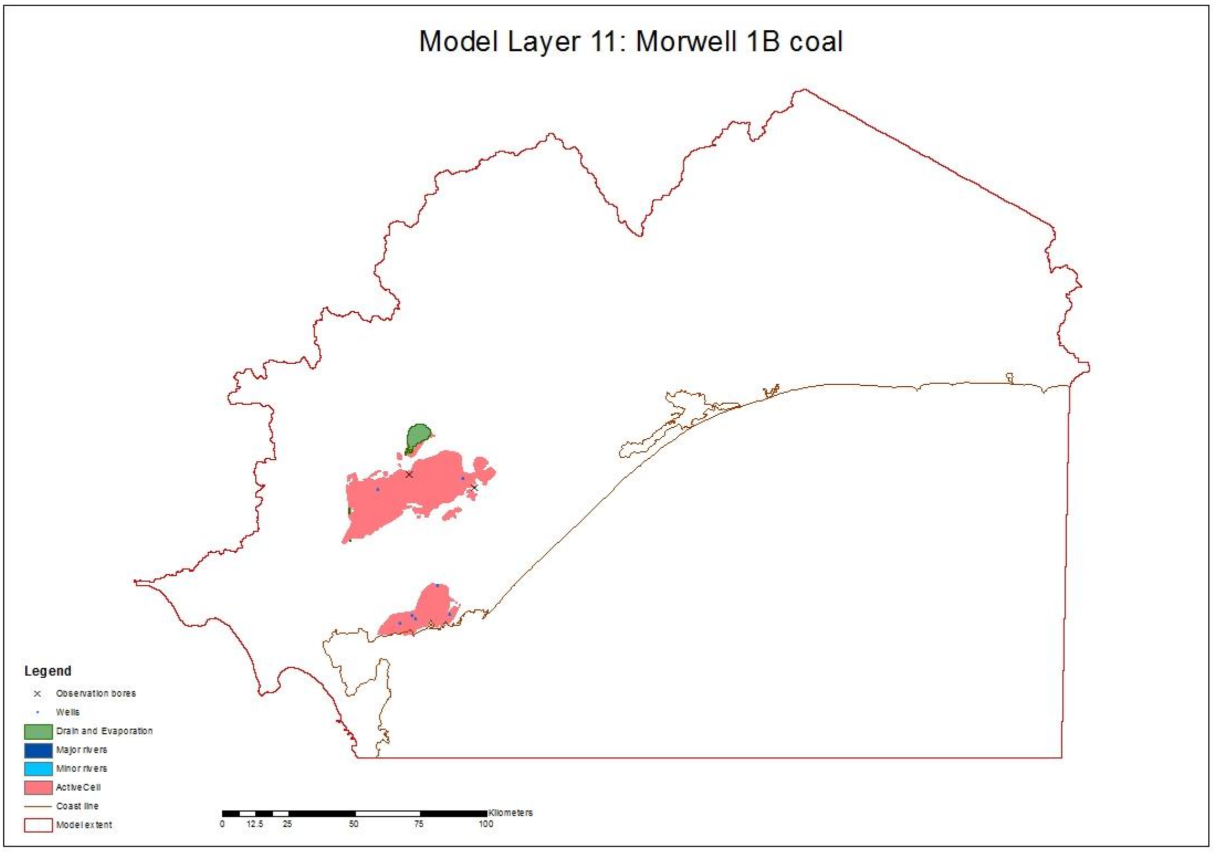

Model Layer 6: Jemmys Point formation and Upper Hazelwood formation (VAF 106)
Legend
Observation bores
Wells
Active Cell
Coast line
Model extent
Kilometers
0
12.5
25
50
75
100

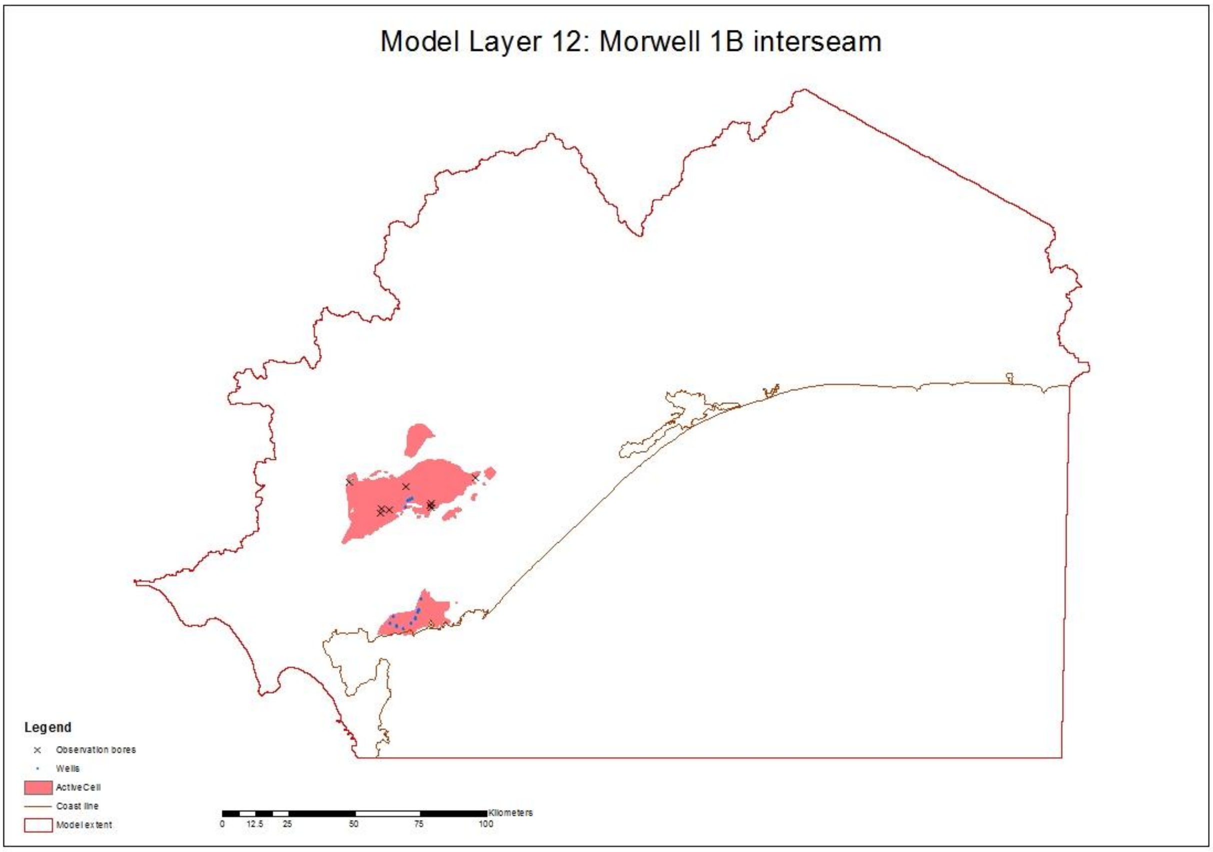

Model Layer 7: Yallourn Coal Seam (VAF 106)
Legend
Observation bores
Wells
Drain and Evaporation
Minor rivers
ActiveCell
Coast line
Model extent
0
12.5
25
50
75
100
Kilometers

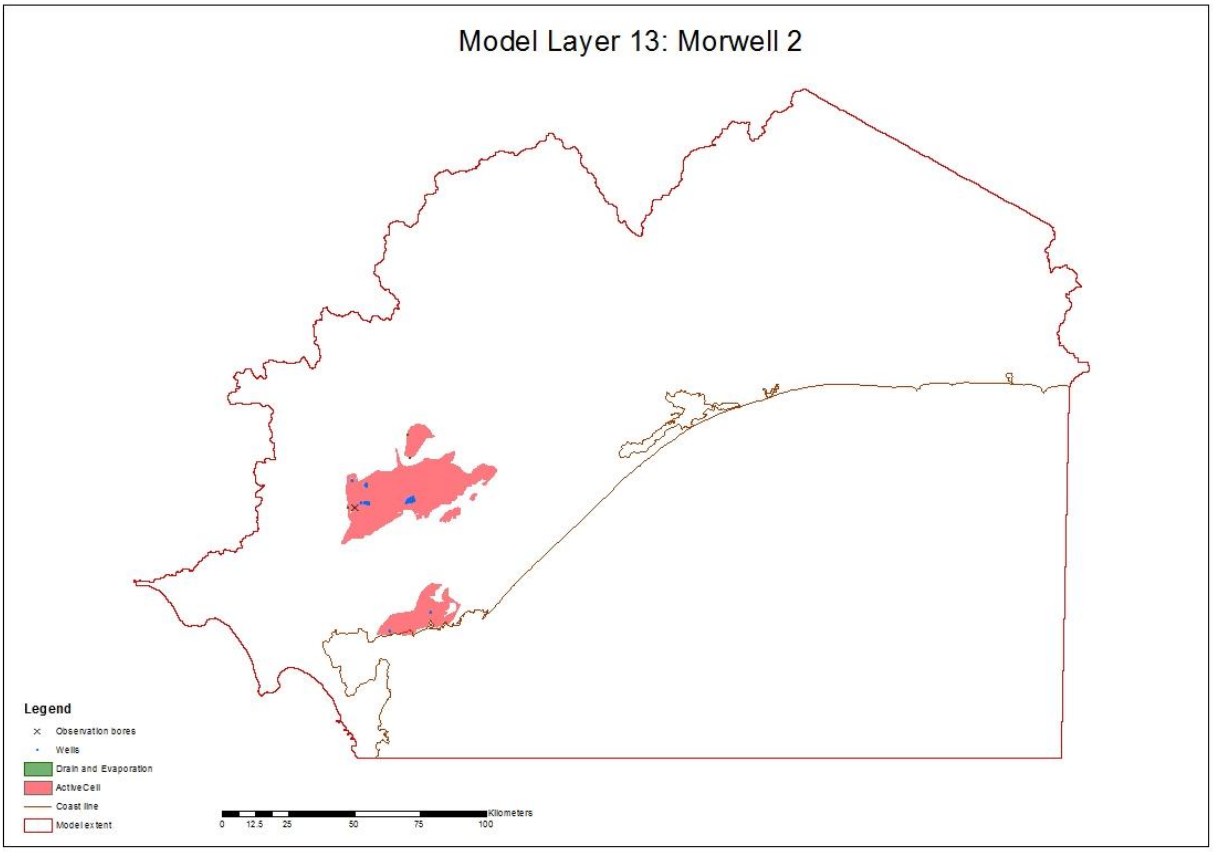

Model Layer 8: Yallourn aquifer & interseam (VAF 106)
Legend
Observation bores
Wells
Drain and Evaporation
ActiveCell
Coast line
Model extent
0
12.5
25
50
75
100
Kilometers

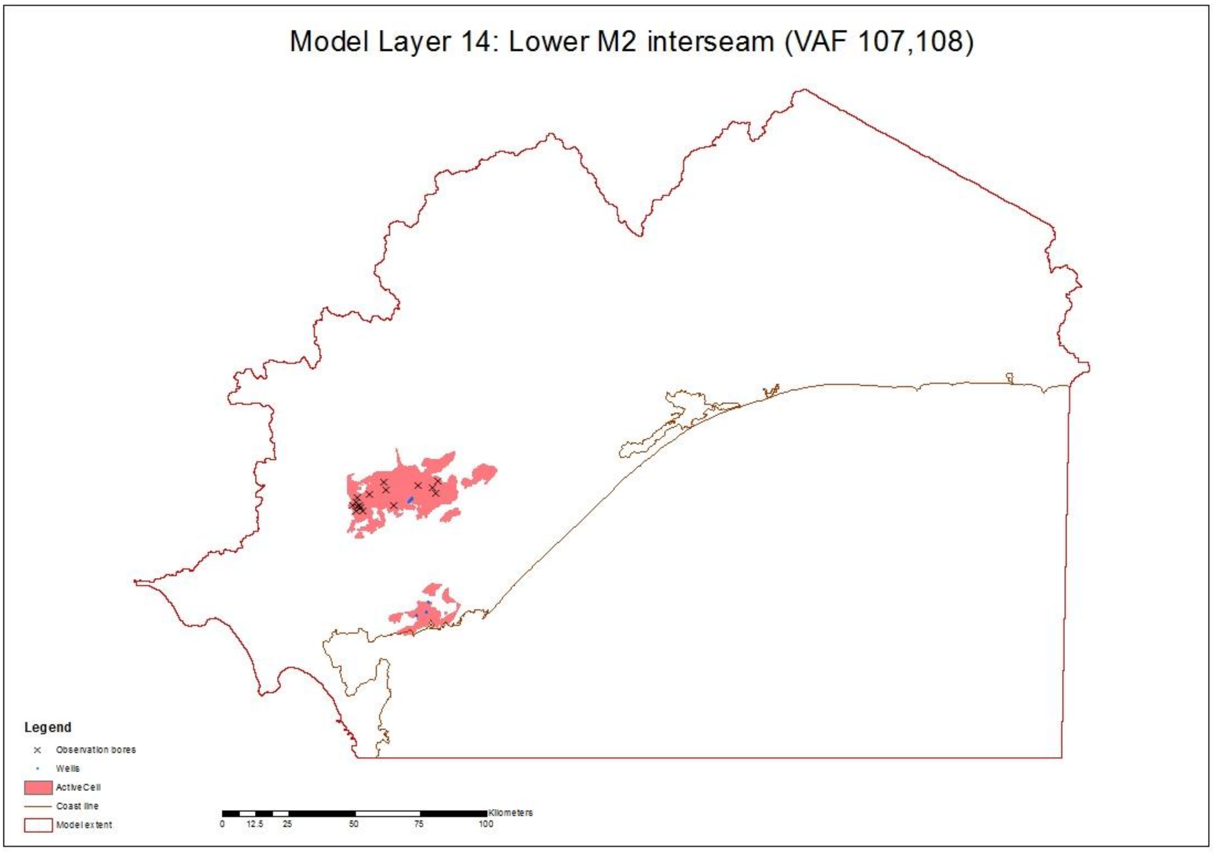

Model Layer 9: Lower M2 interseam (VAF 107,108)
Legend
Observation bores
Wells
Drain and Evaporation
Active Cell
Coast line
Model extent
Kilometers
0 12.5 25 50 75 100

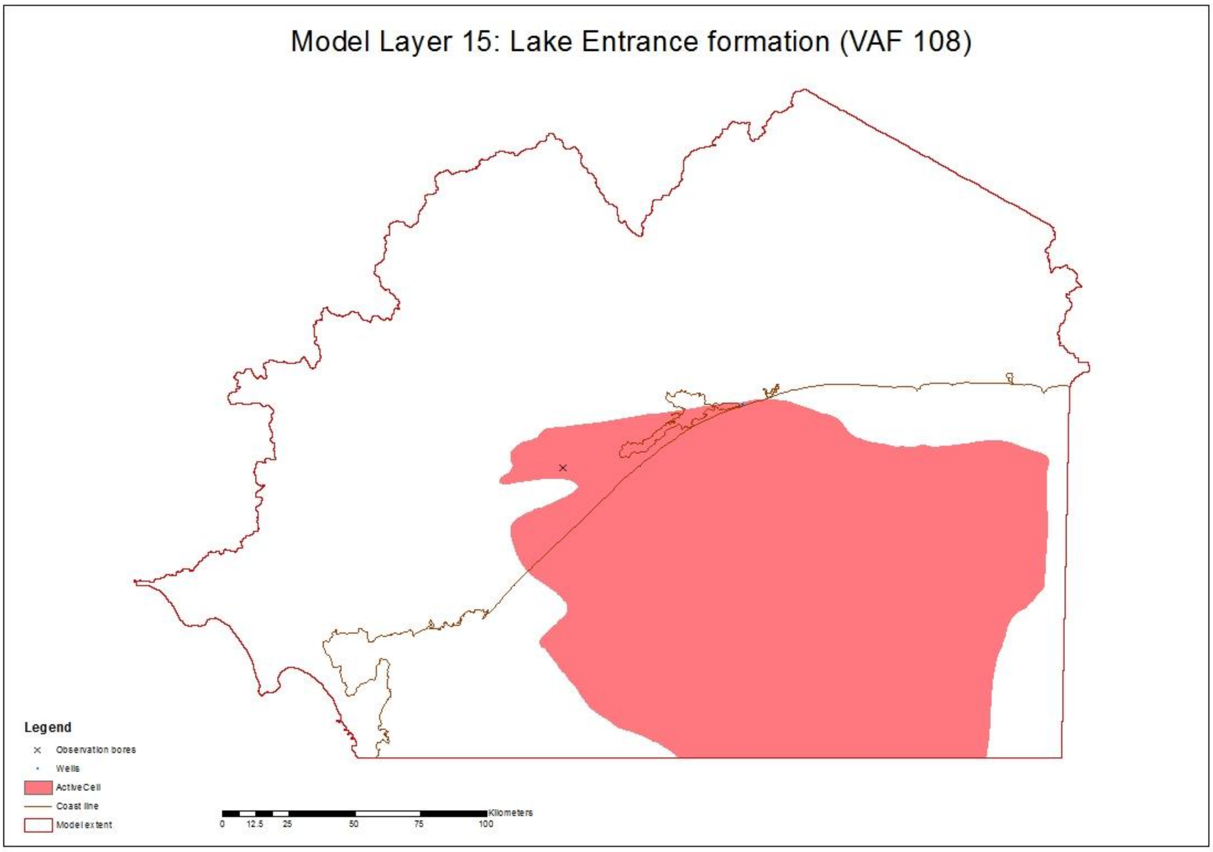

Model Layer 10: Morwell 1A interseam/aquifer
Legend
Observation bores
Wells
Active Cell
Coast line
Model extent
Kilometers
0 12.5 25 50 75 100

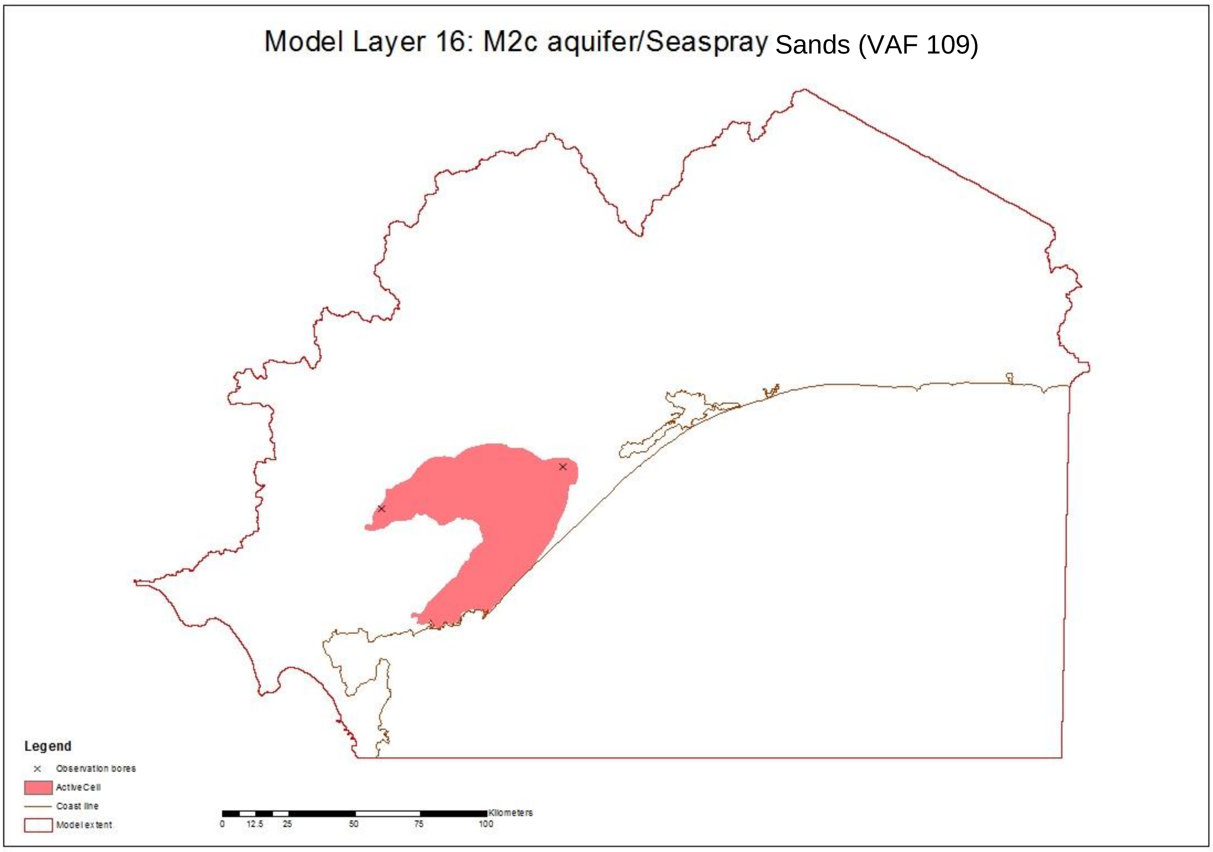

Model Layer 11: Morwell 1B coal
Legend
Observation bores
Wells
Drain and Evaporation
Major rivers
Minor rivers
ActiveCell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers

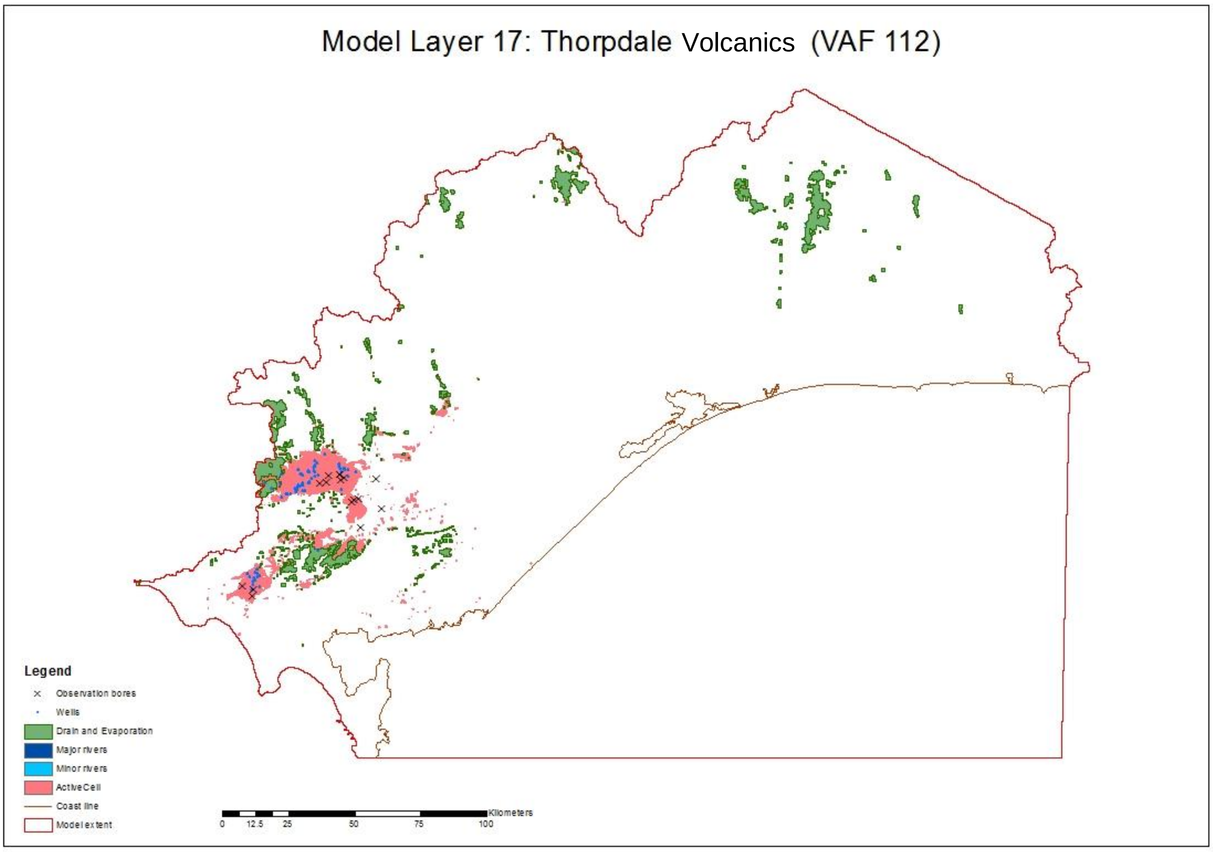

Model Layer 12: Morwell 1B interseam
Legend
Observation bores
Wells
ActiveCell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers

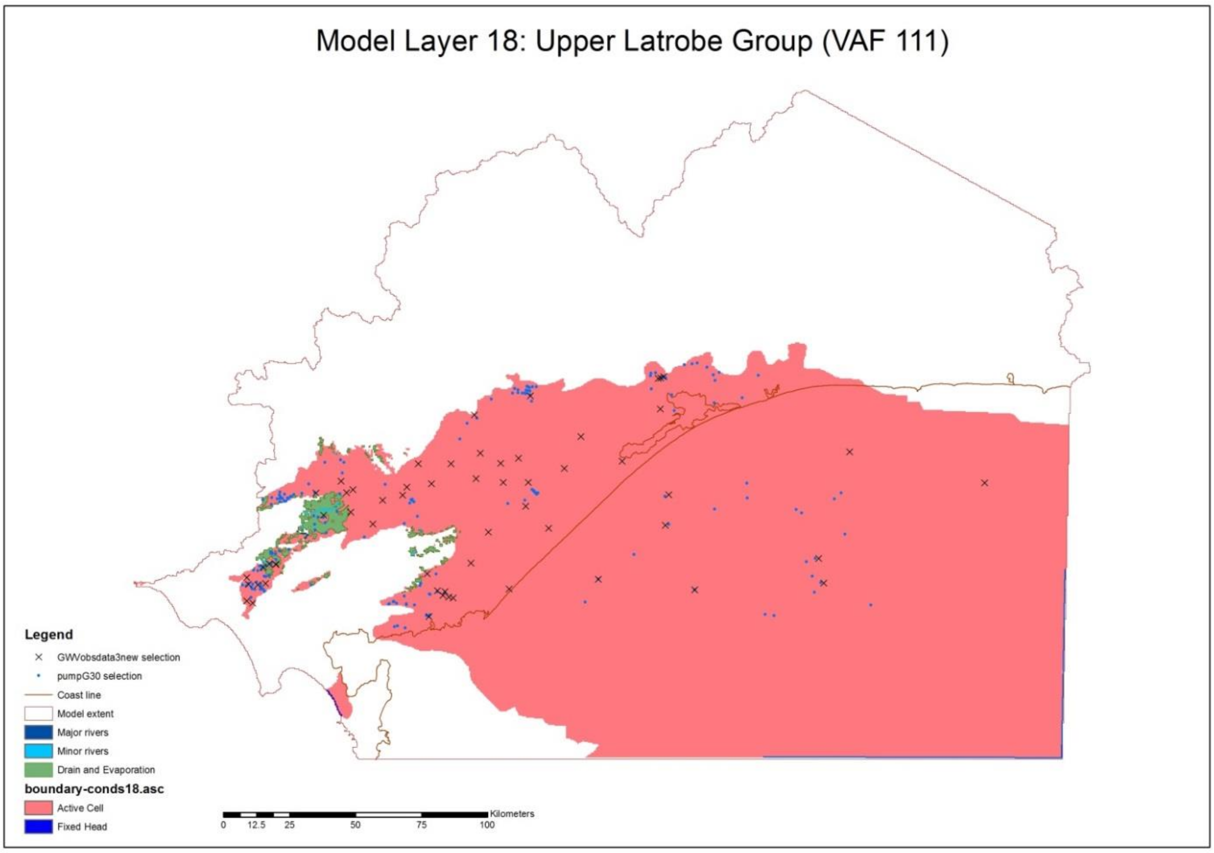

Model Layer 13: Morwell 2
Legend
Observation bores
Wells
Drain and Evaporation
Active Cell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers

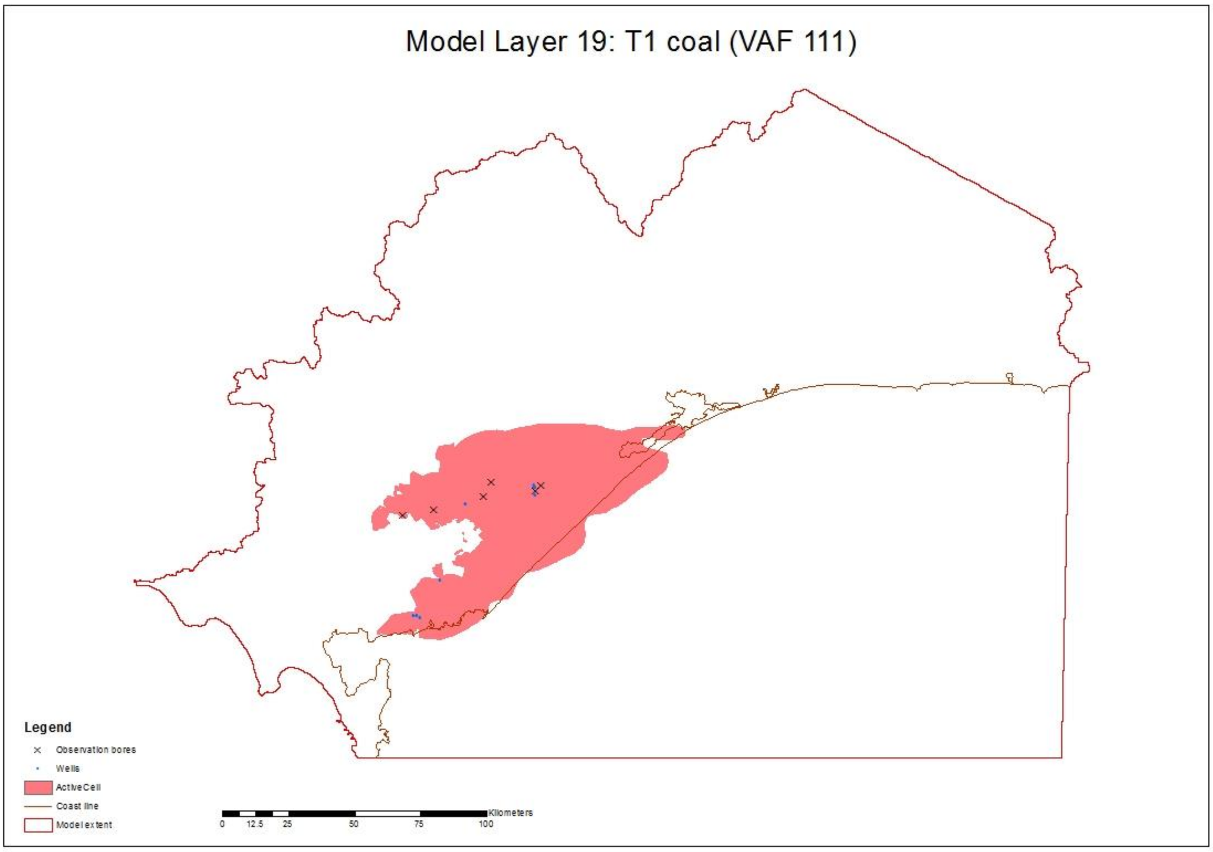

Model Layer 14: Lower M2 interseam (VAF 107,108)
Legend
Observation bores
Wells
Active Cell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers

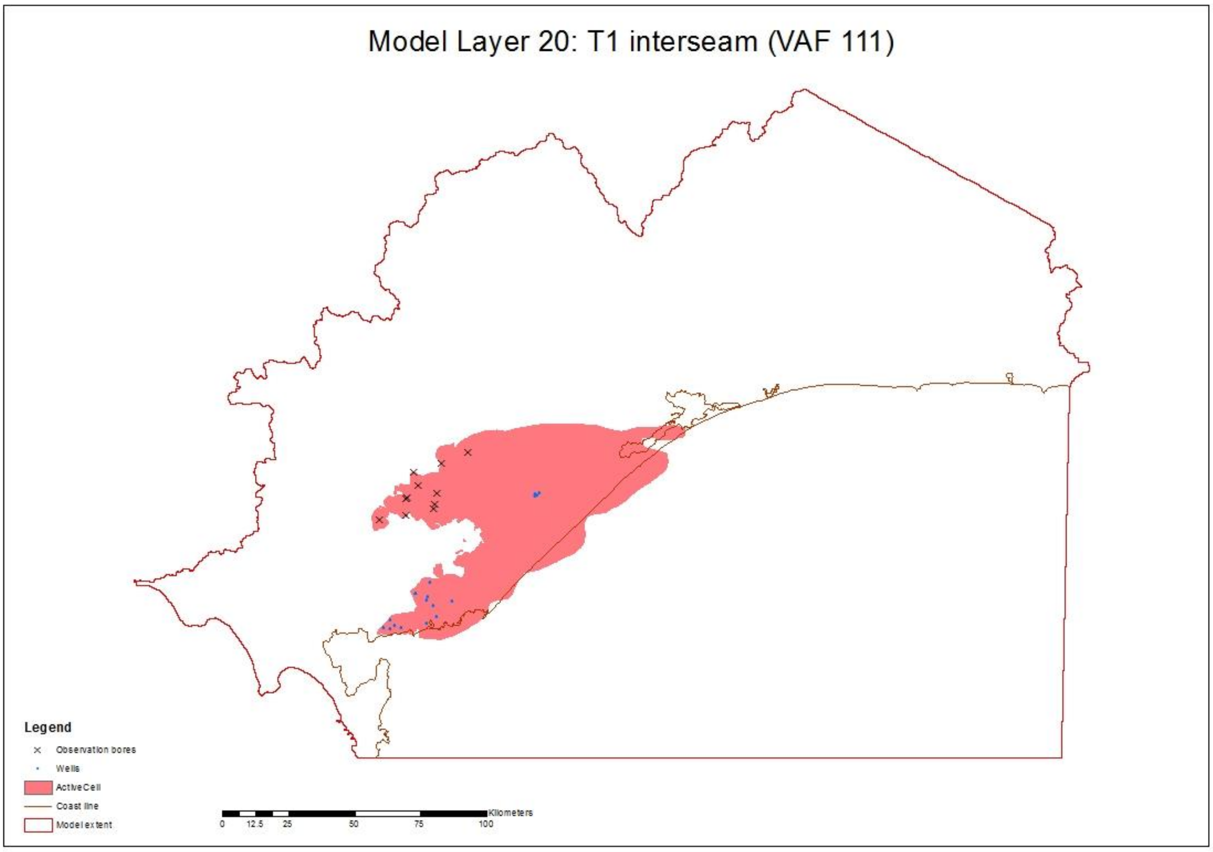

Model Layer 15: Lake Entrance formation (VAF 108)
Legend
Observation bores
Wells
Active Cell
Coast line
Model extent
Kilometers
0
12.5
25
50
75
100

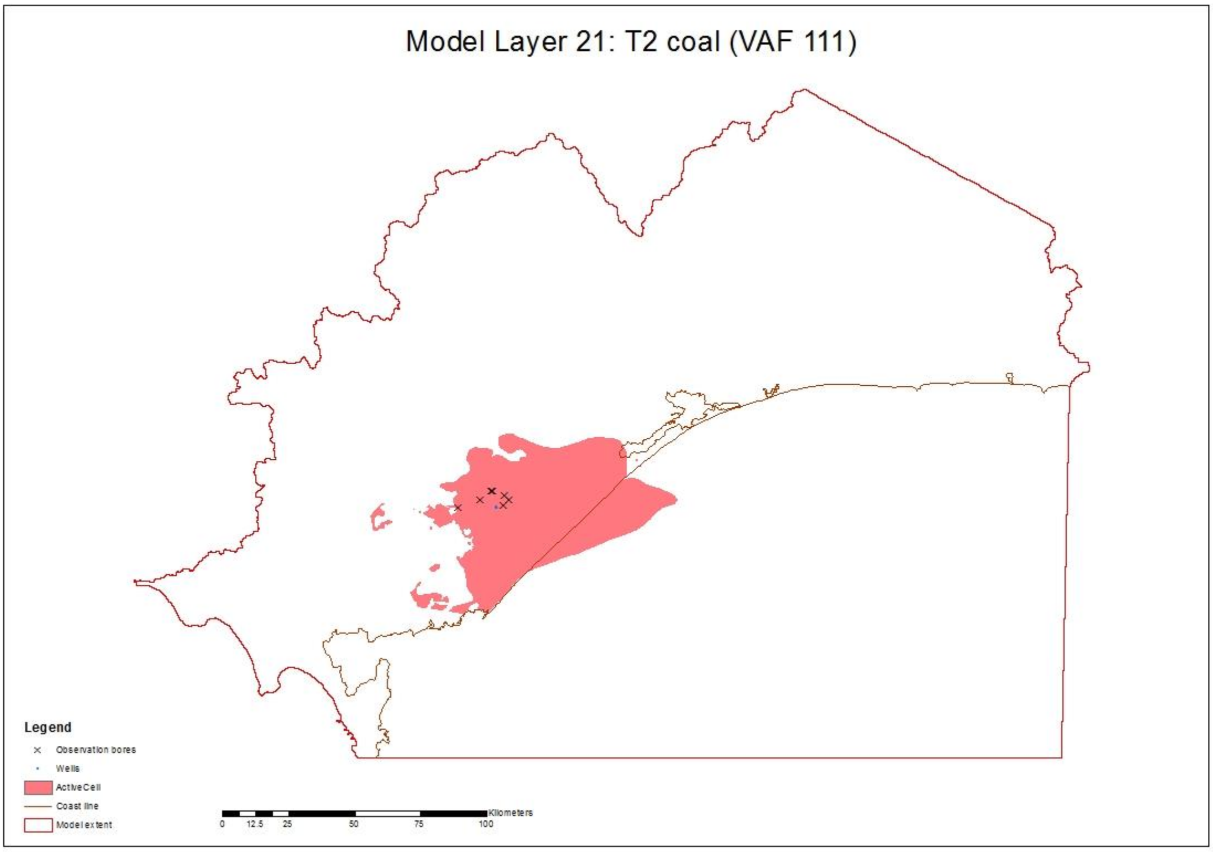

Model Layer 16: M2c aquifer/Seaspray Sands (VAF 109)
Legend
Observation bores
Active Cell
Coast line
Model extent
Kilometers
0
12.5
25
50
75
100

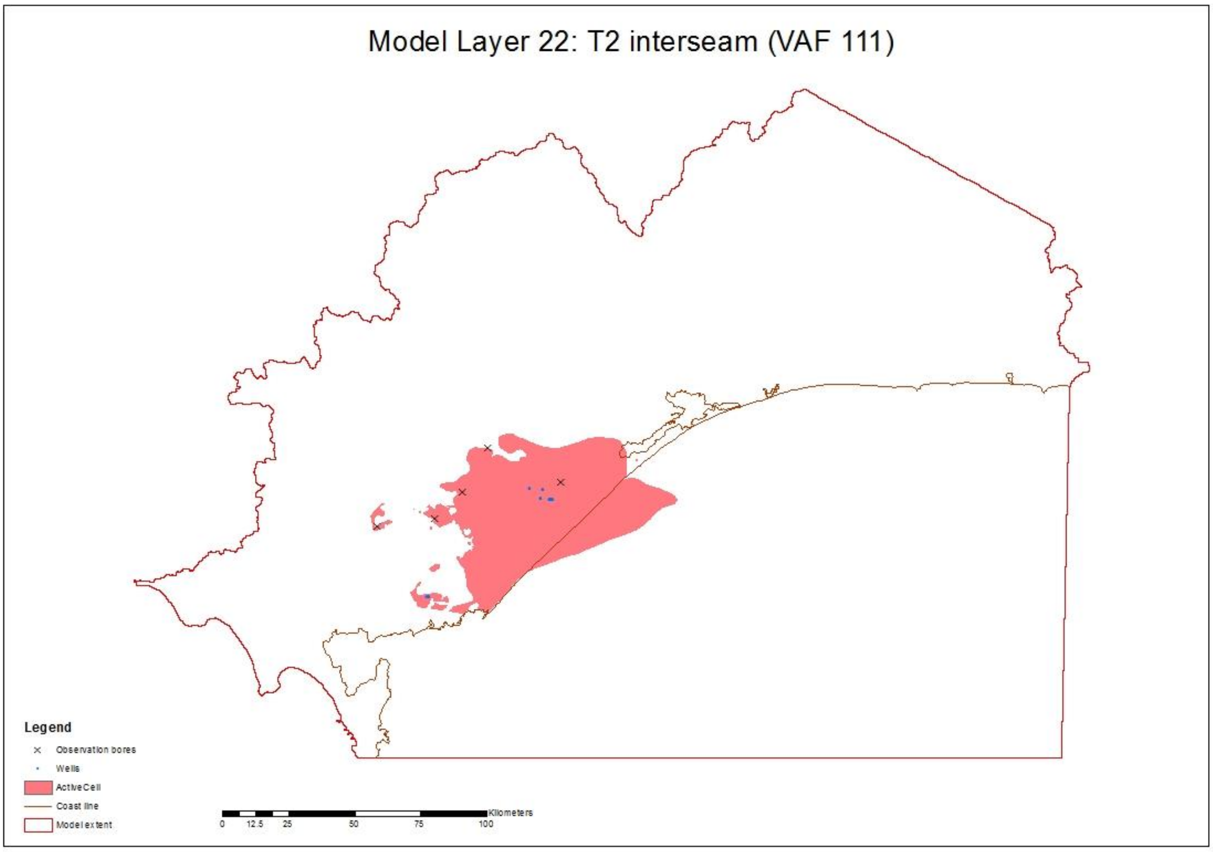

Model Layer 17: Thorpdale Volcanics (VAF 112)
Legend
Observation bores
Wells
Drain and Evaporation
Major rivers
Minor rivers
ActiveCell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers

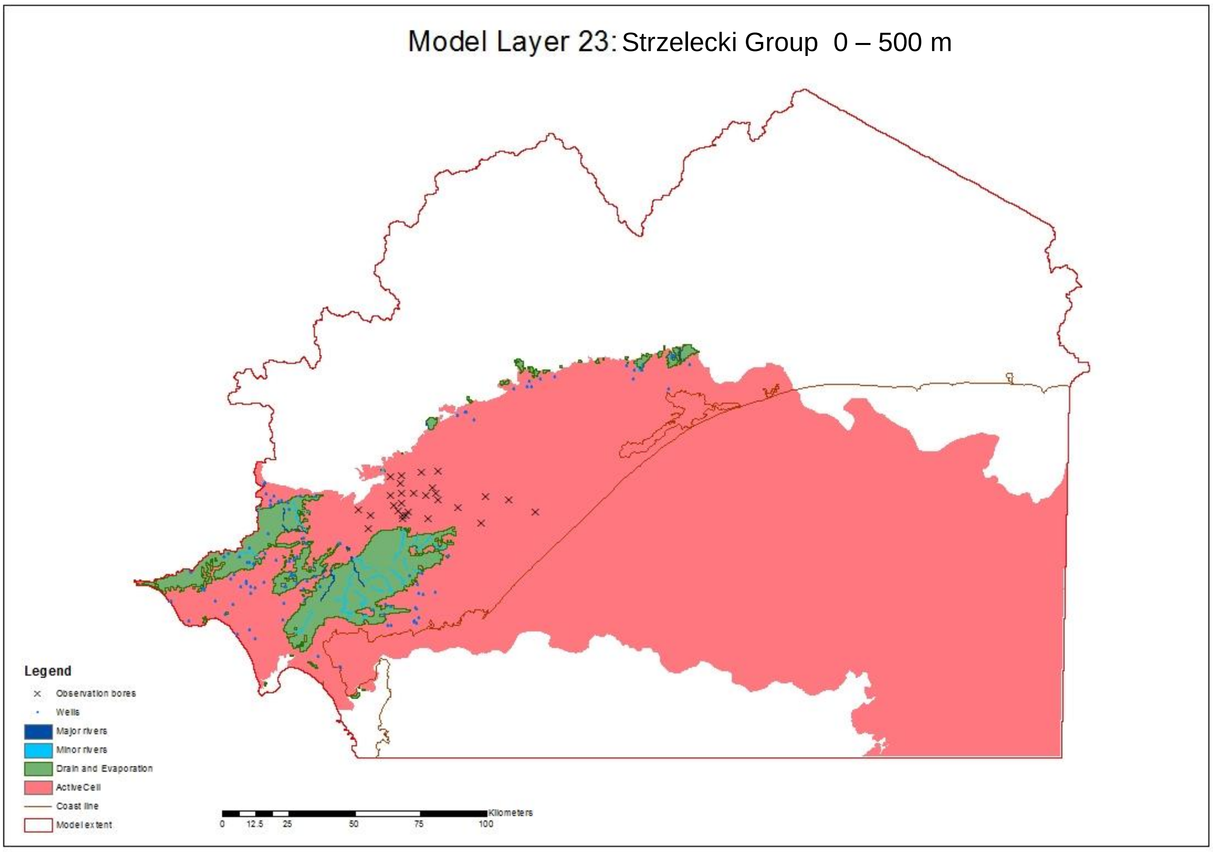

Model Layer 18: Upper Latrobe Group (VAF 111)
Legend
GWobsdata3new selection
pumpG30 selection
Coast line
Model extent
Major rivers
Minor rivers
Drain and Evaporation
boundary-conds18.asc
Active Cell
Fixed Head
0 12.5 25 50 75 100
Kilometers

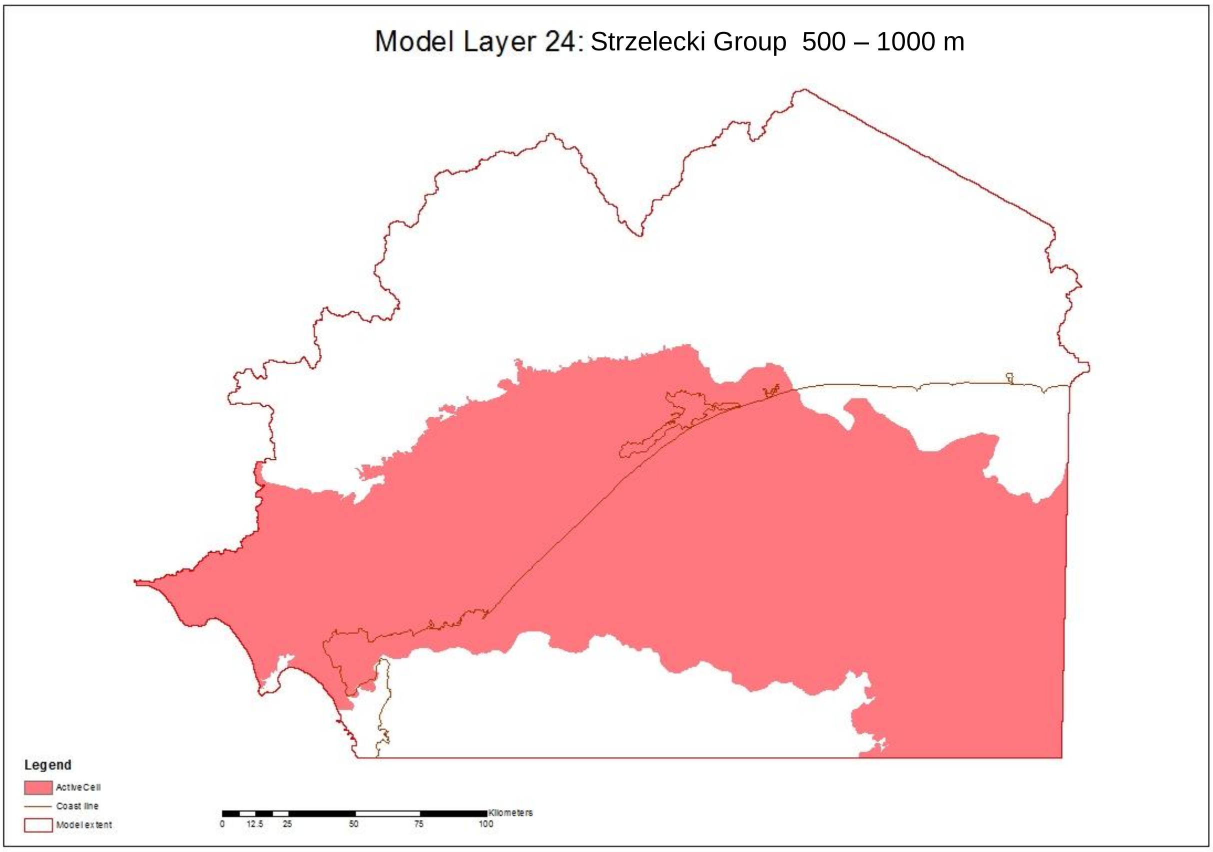

Model Layer 19: T1 coal (VAF 111)
Legend
Observation bores
Wells
ActiveCell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers


Model Layer 20: T1 interseam (VAF 111)
Legend
Observation bores
Wells
ActiveCell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers

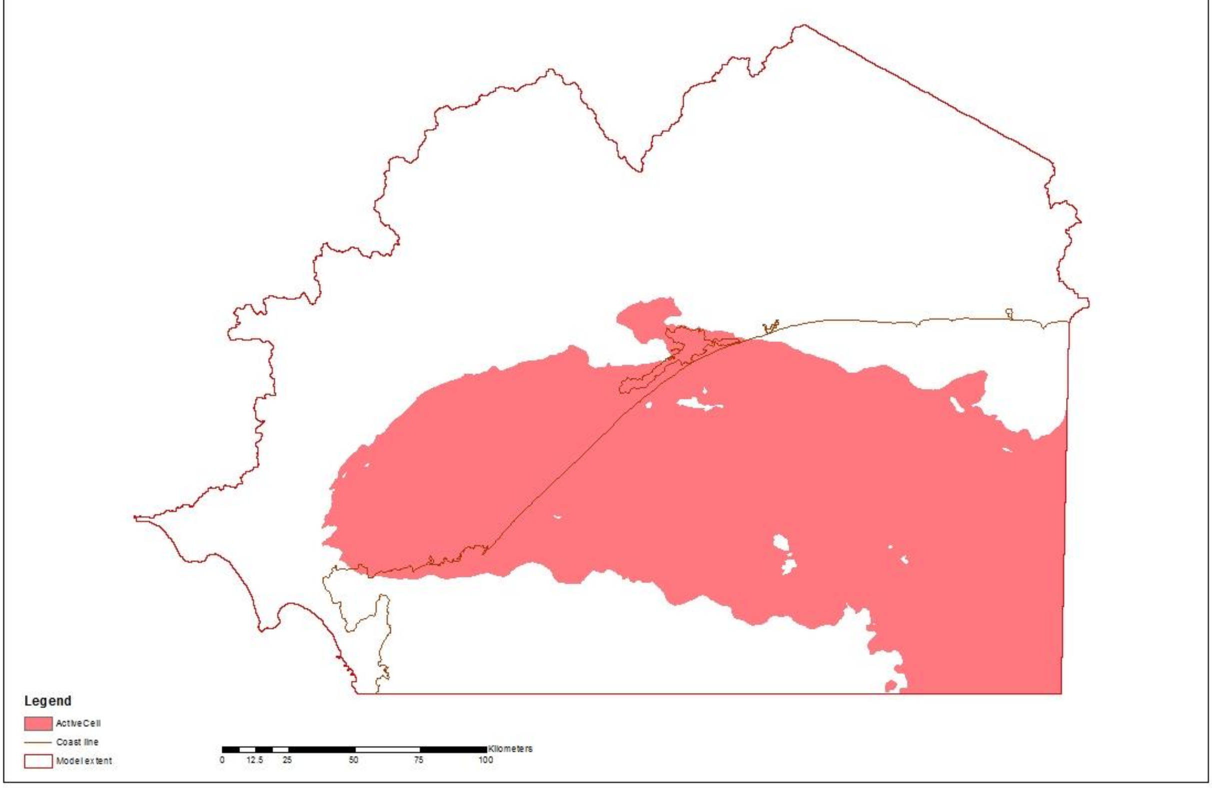

Model Layer 21: T2 coal (VAF 111)
Legend
Observation bores
Wells
Active Cell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers


Model Layer 22: T2 interseam (VAF 111)
Legend
Observation bores
Wells
Active Cell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers

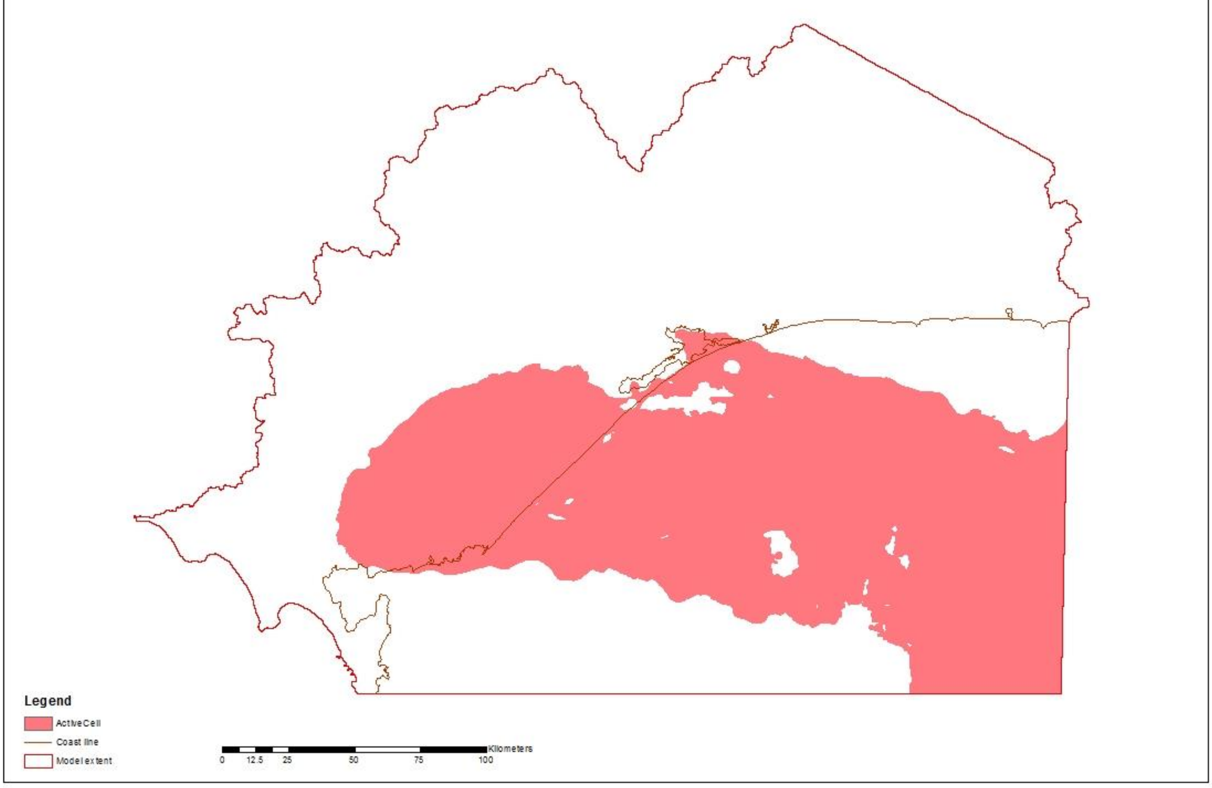

Model Layer 23: Strzelecki Group 0 – 500 m
Legend
Observation bores
Wells
Major rivers
Minor rivers
Drain and Evaporation
ActiveCell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers

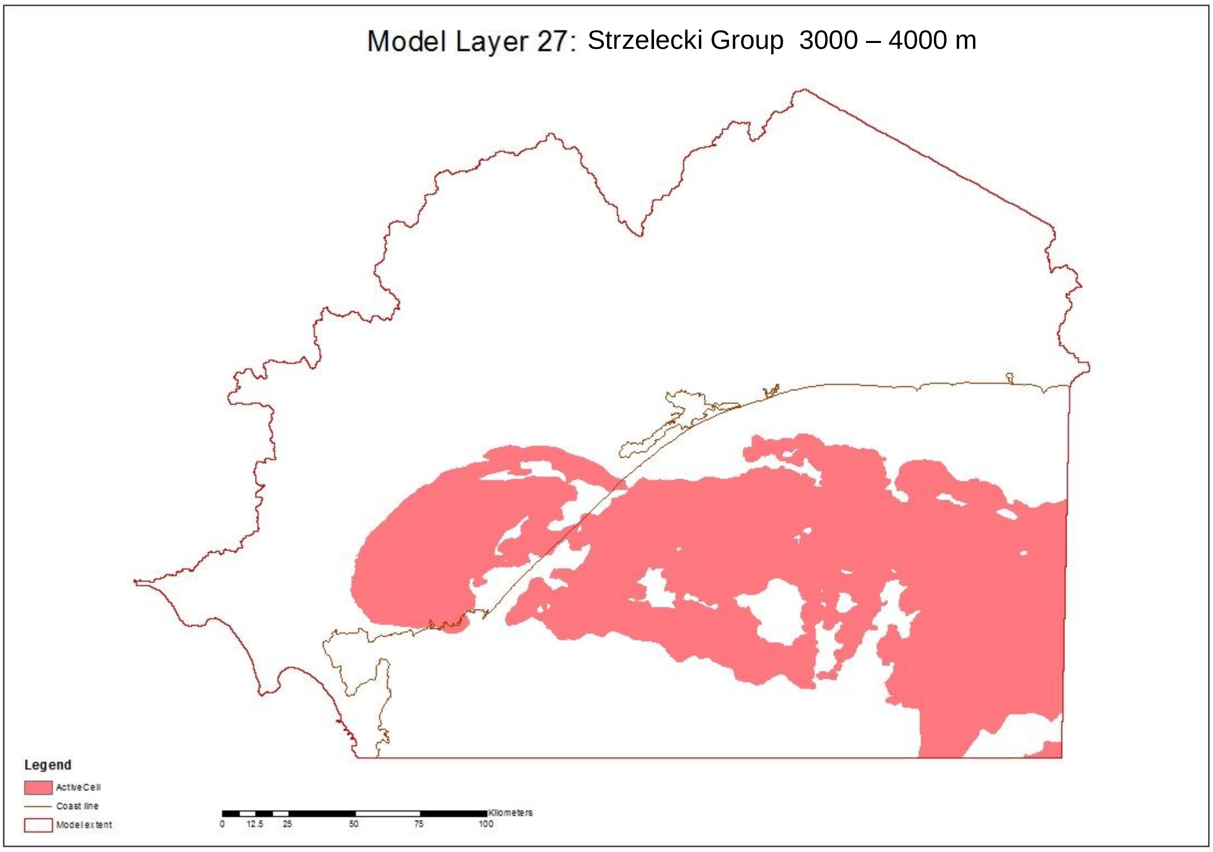

Model Layer 24: Strzelecki Group 500 – 1000 m
Legend
ActiveCell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers

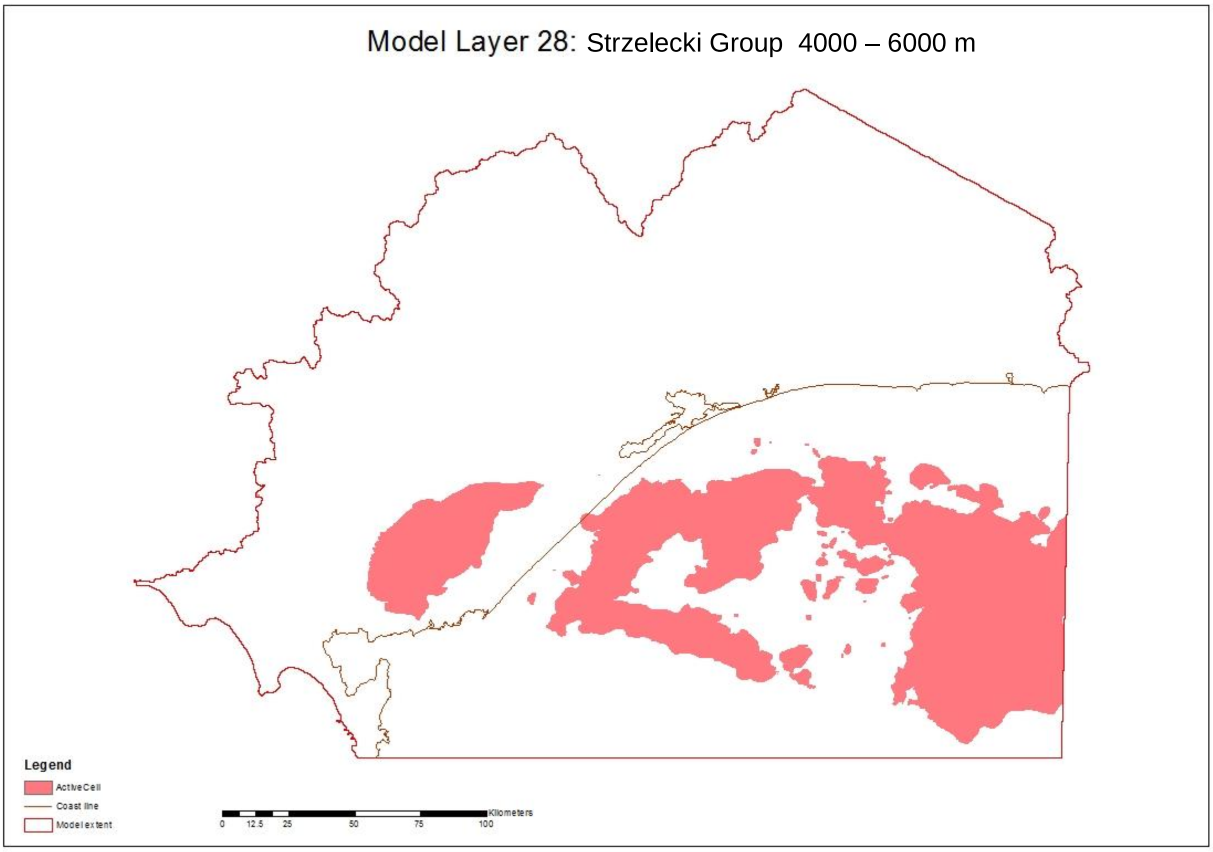
Model Layer 25: Strzelecki Group 1000 – 2000 m

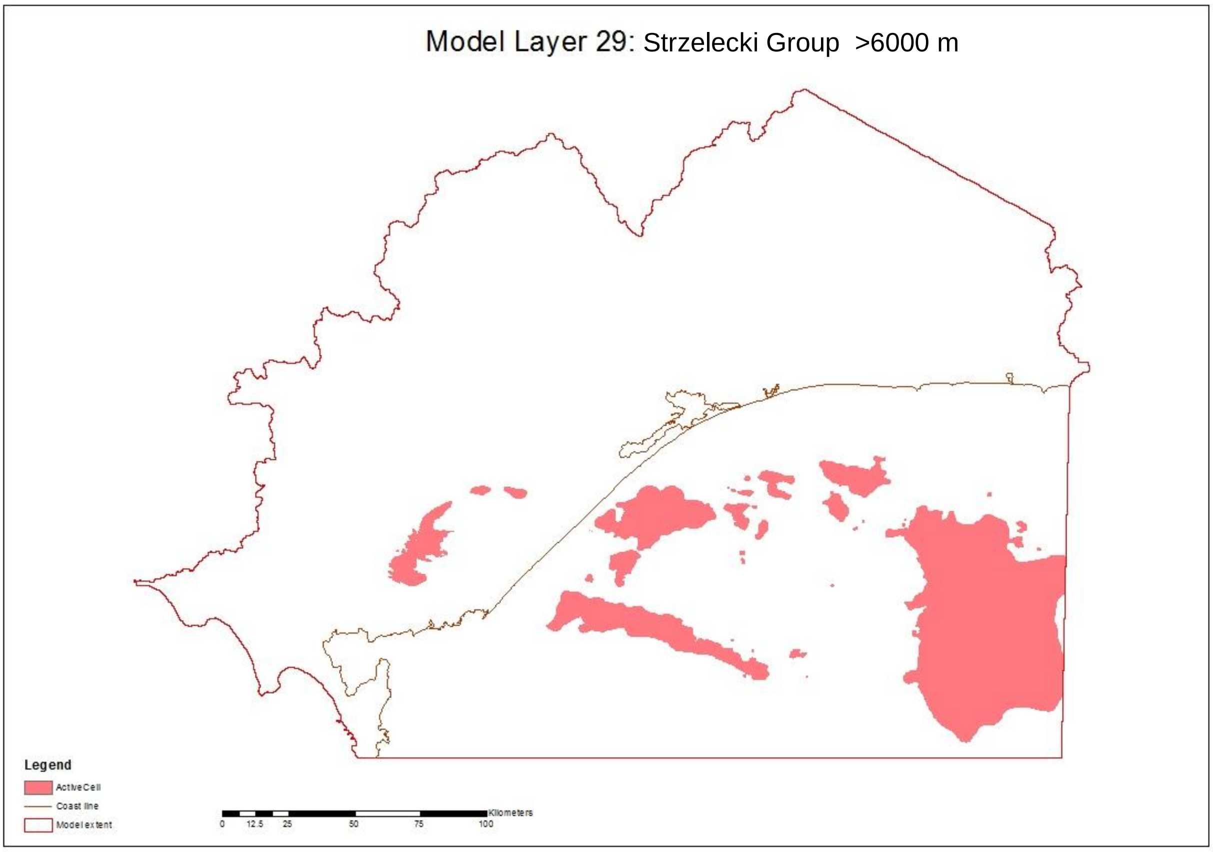


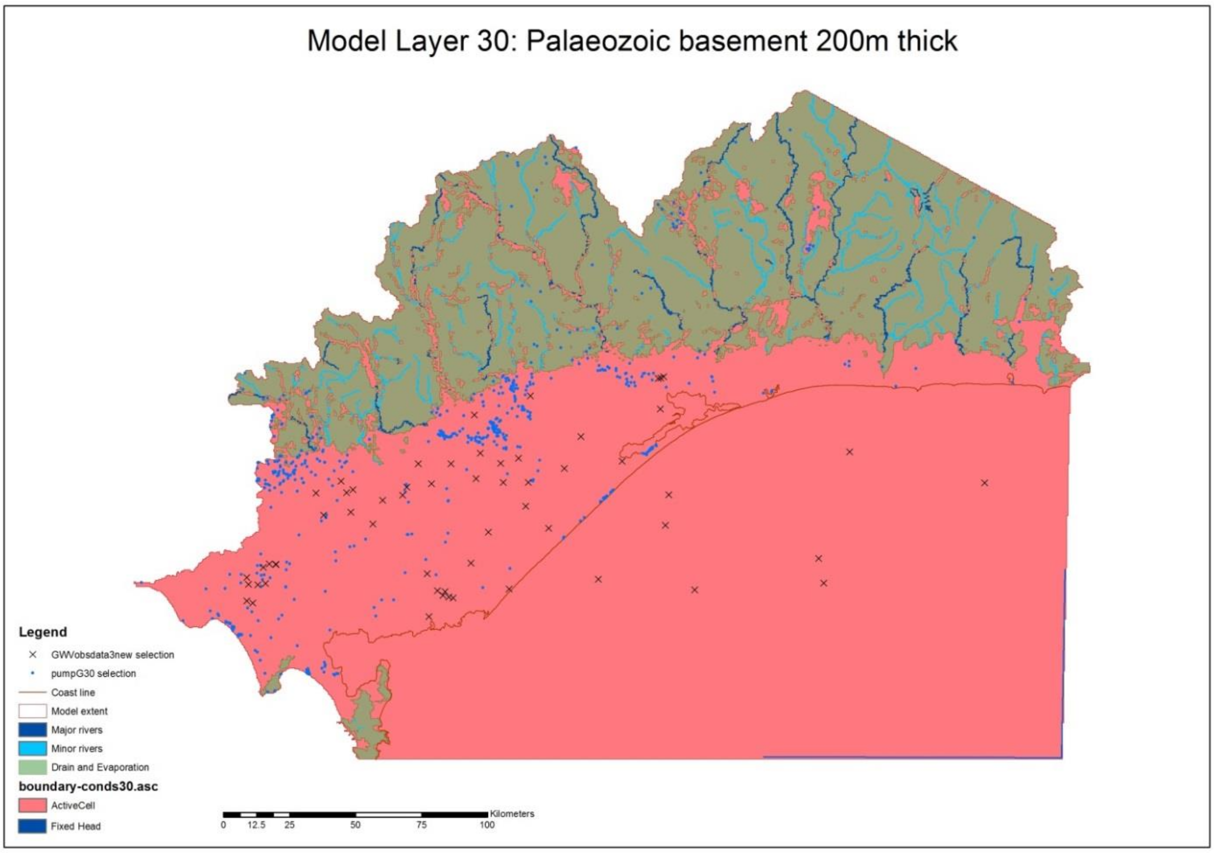
Model Layer 26: Strzelecki Group 2000 – 3000 m



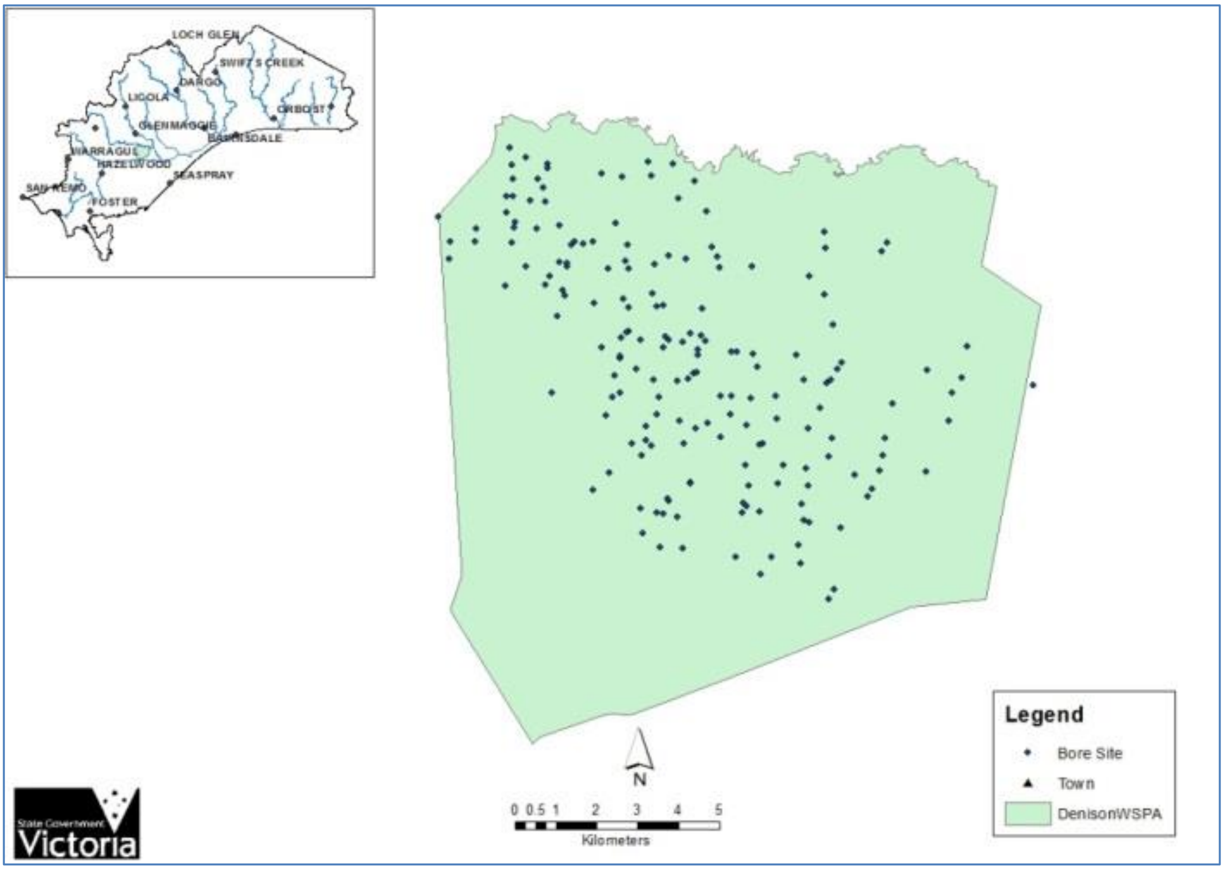

Model Layer 27: Strzelecki Group 3000 – 4000 m
Legend
Active Cell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers

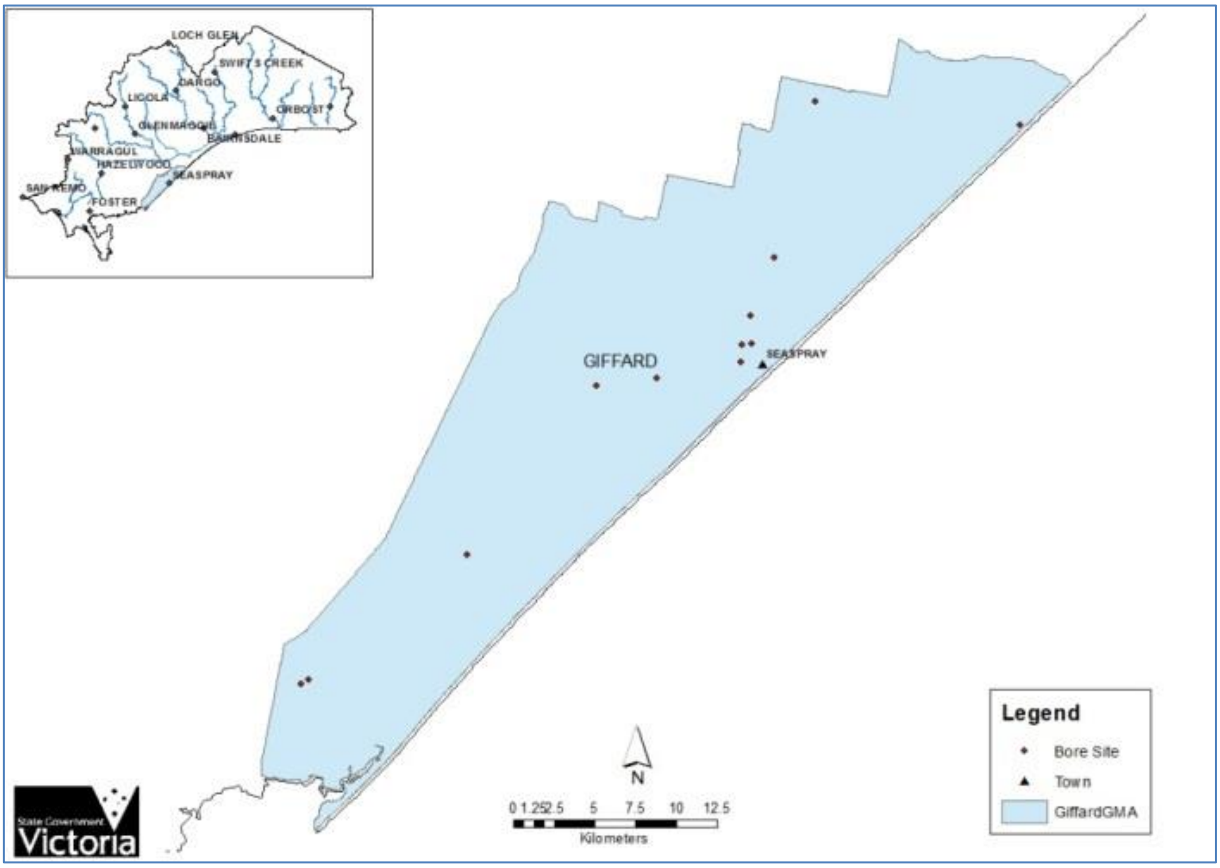

Model Layer 28: Strzelecki Group 4000 – 6000 m
Legend
Active Cell
Coast line
Model extent
0 12.5 25 50 75 100
Kilometers

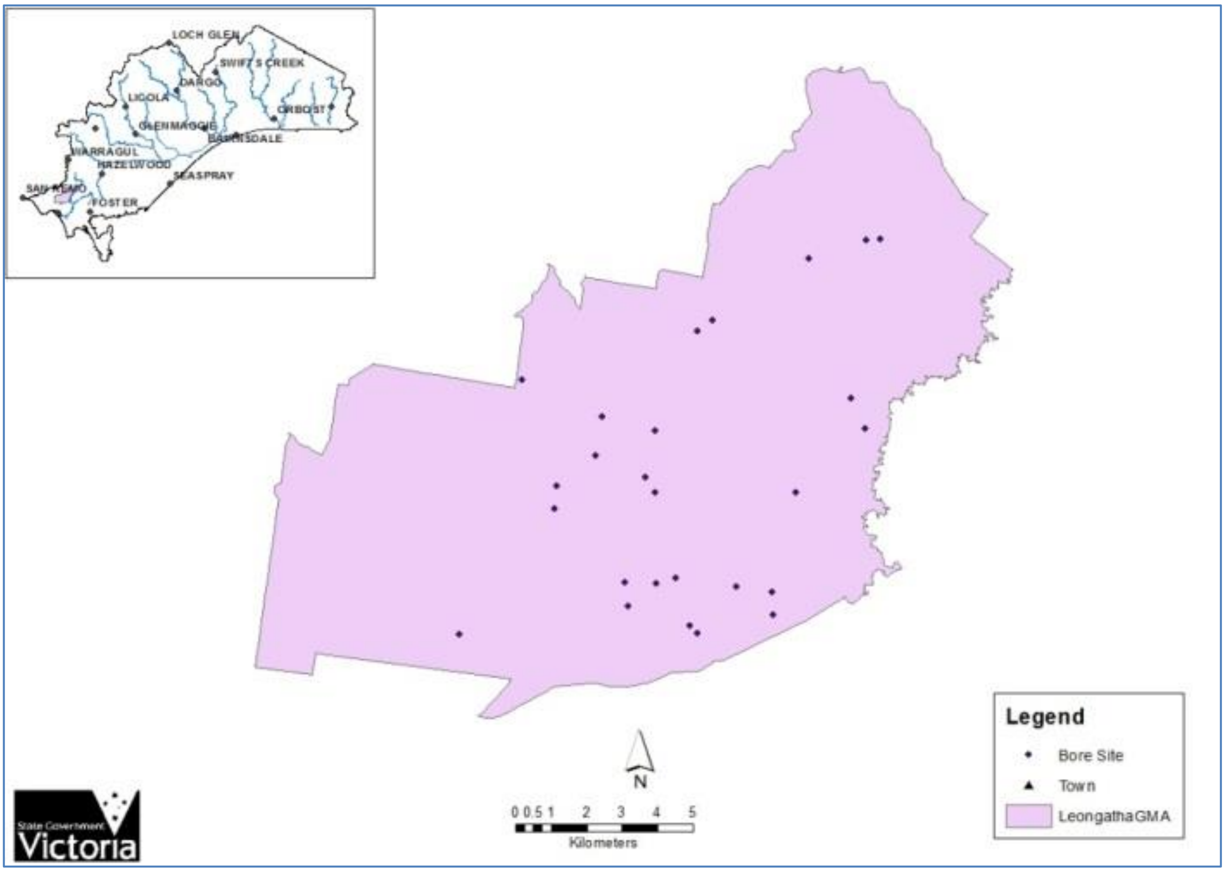

Model Layer 29: Strzelecki Group >6000 m
Legend
ActiveCell
Coast line
Model extent
0
12.5
25
50
75
100
Kilometers

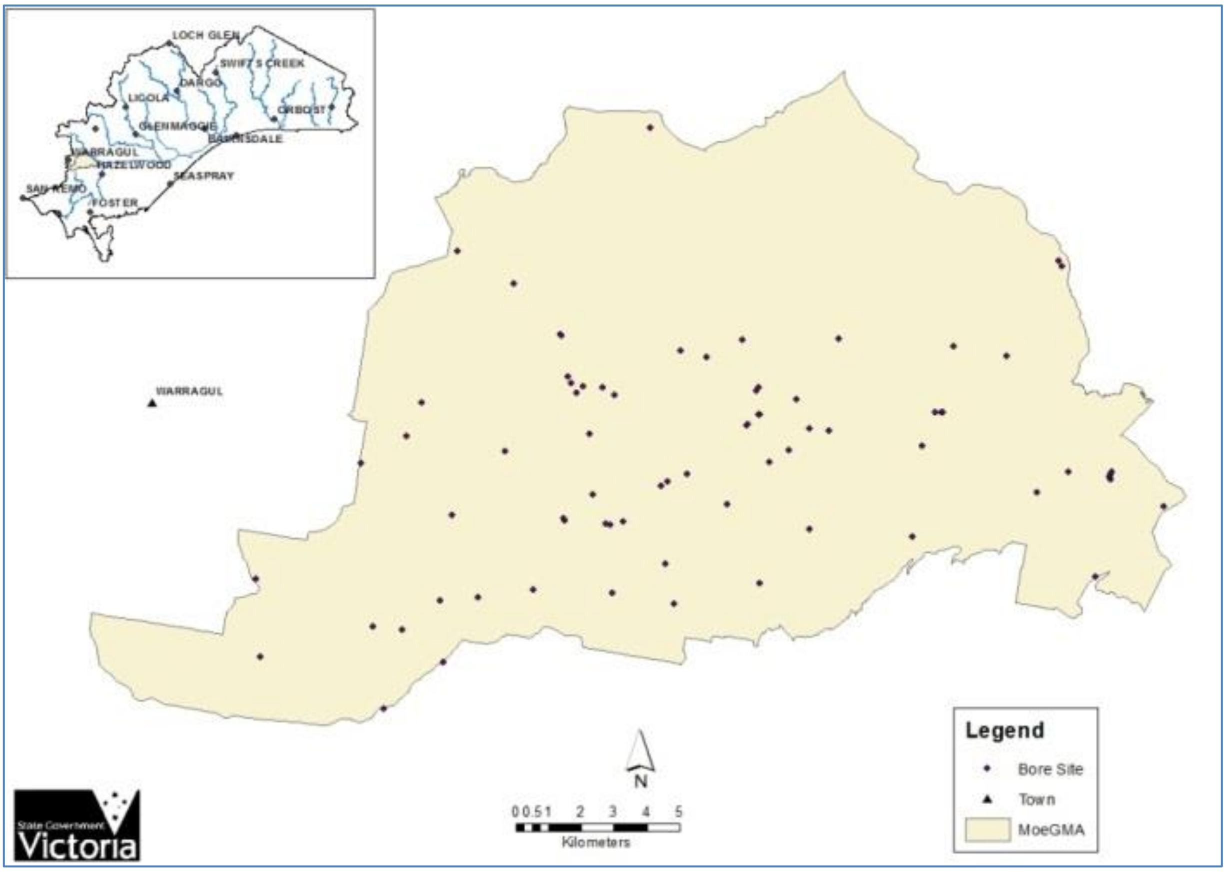

Model Layer 30: Palaeozoic basement 200m thick
Legend
GWobsdata3new selection
pumpG30 selection
Coast line
Model extent
Major rivers
Minor rivers
Drain and Evaporation
boundary-conds30.asc
ActiveCell
Fixed Head
0
12.5
25
50
75
100
Kilometers

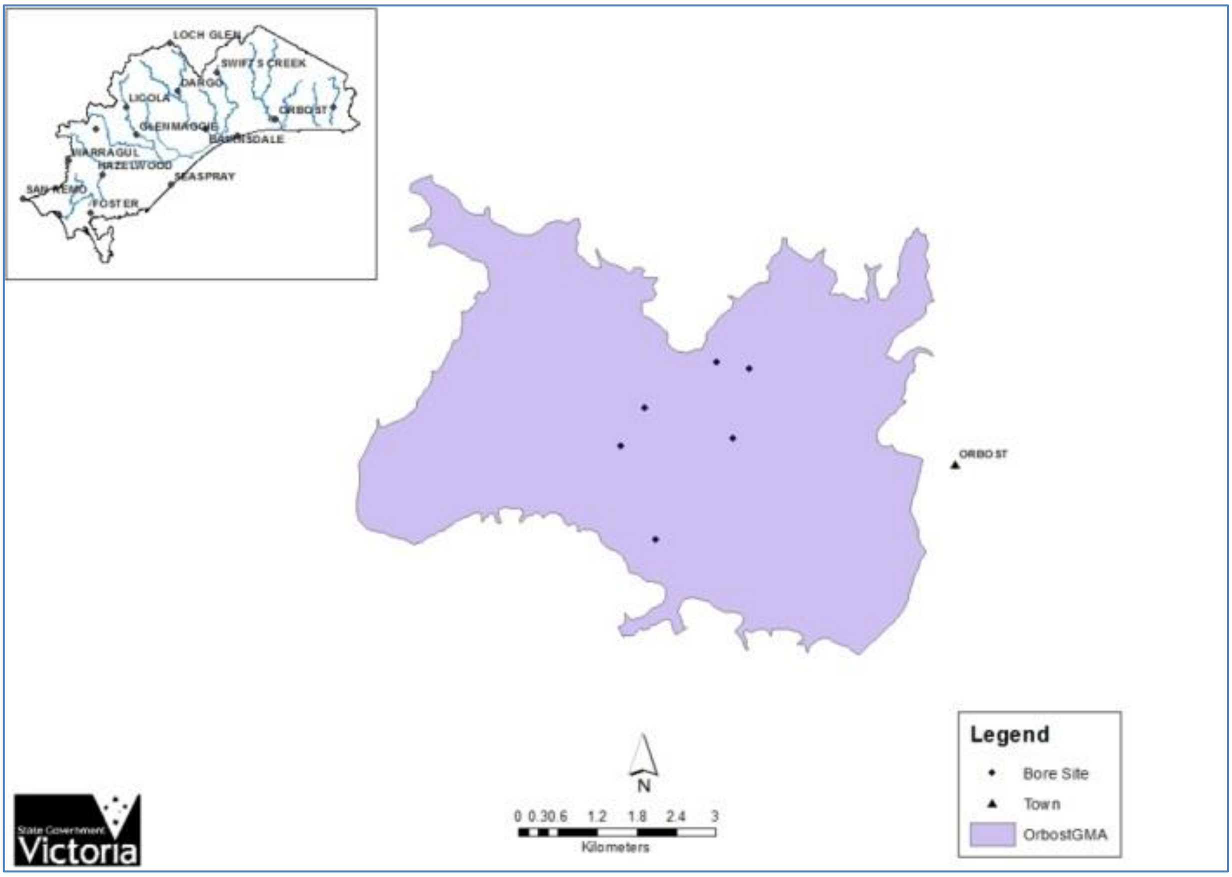
Appendix F: Groundwater extraction reporting regions

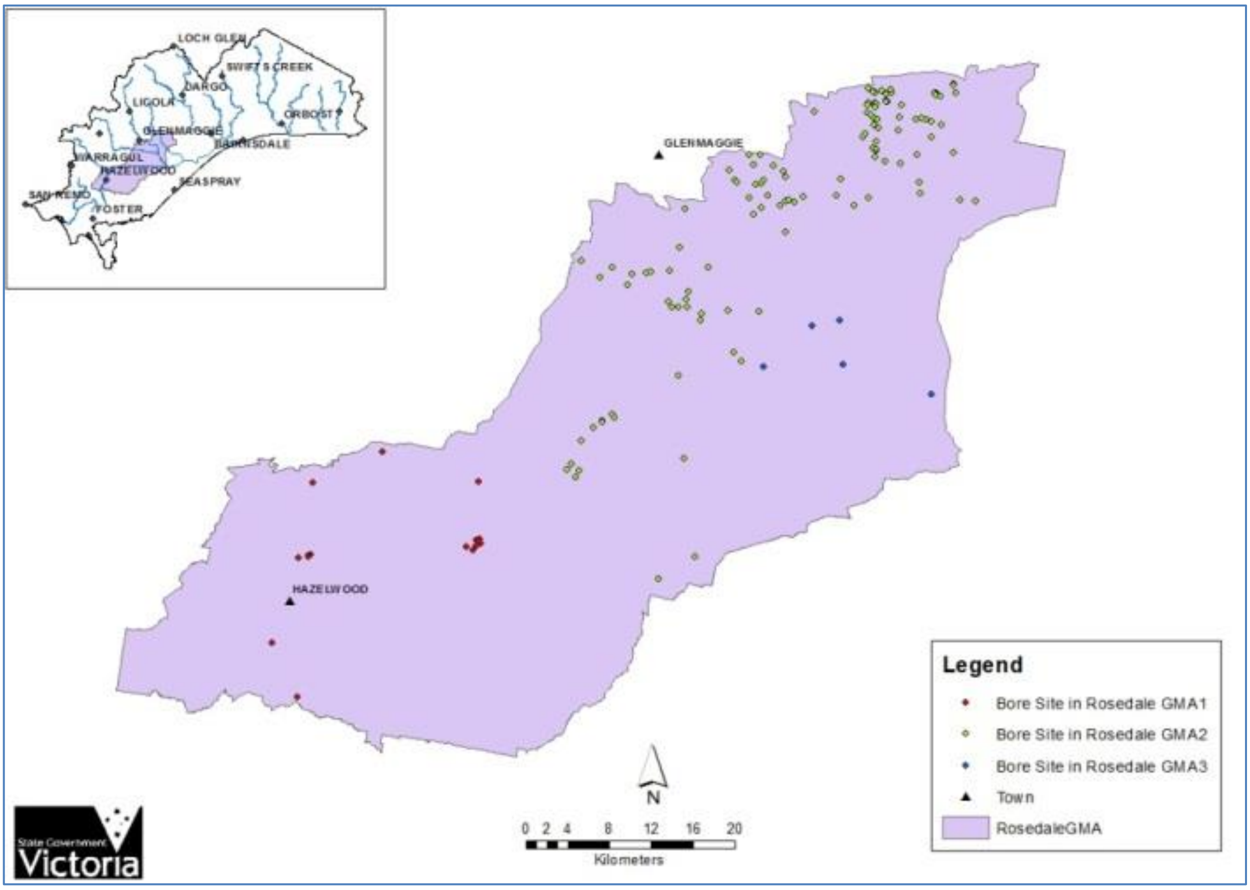

LOCH GLEN
SWIFT'S CREEK
DARGO
LICOLA
ORBOST
GLENMAGGIE
BAIRNSDALE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
N
0 0.5 1 2 3 4 5
Kilometers
Legend
Bore Site
Town
DenisonWSPA
State Government
Victoria

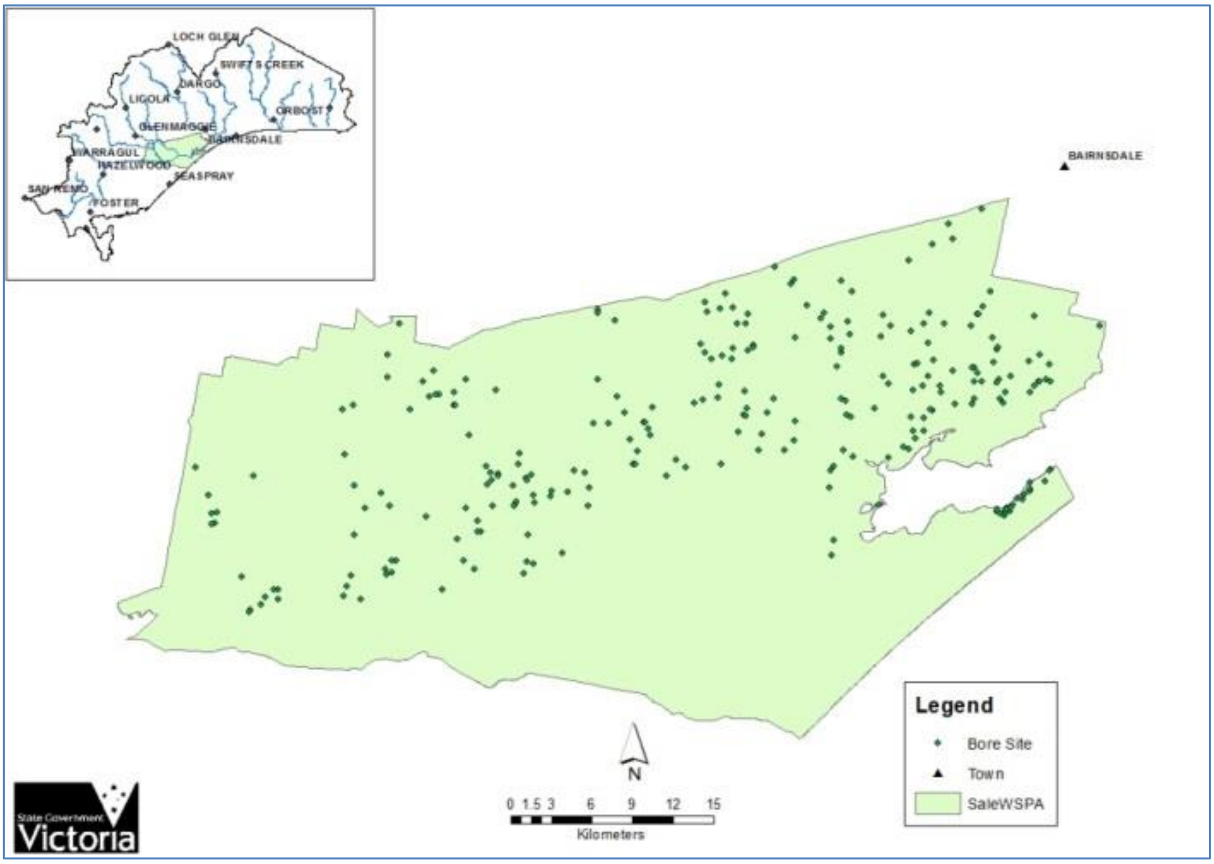

LOCH GLEN
SWIFT'S CREEK
DARGO
LICOLA
ORBOST
GLENMAGGIE
BAIRNSDALE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
GIFFARD
SEASPRAY
N
0 1.25 2.5 5 7.5 10 12.5
Kilometers
Legend
Bore Site
Town
GiffardGMA
State Government
Victoria


LOCH GLEN
SWIFTS CREEK
DARGO
LICOLA
ORBOST
GLENMAGGIE
BAIRNSDALE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
N
0 0.5 1 2 3 4 5
Kilometers
Legend
Bore Site
Town
LeongathaGMA
State Government Victoria


LOCH GLEN
SWIFTS CREEK
DARGO
LICOLA
ORBOST
GLENMAGGIE
BAIRNSDALE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
WARRAGUL
N
0 0.5 1 2 3 4 5
Kilometers
Legend
Bore Site
Town
MoeGMA
State Government Victoria


LOCH GLEN
SWIFTS CREEK
DARGO
LIGOLA
ORBOST
GLENMAGGIE
BAIRNSDALE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
ORBOST
N
0 0.3 0.6 1.2 1.8 2.4 3
Kilometers
Legend
Bore Site
Town
OrbostGMA
State Government
Victoria


LOCH GLEN
SWIFTS CREEK
DARGO
LIGOLA
ORBOST
GLENMAGGIE
BAIRNSDALE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
GLENMAGGIE
HAZELWOOD
N
0 2 4 8 12 16 20
Kilometers
Legend
Bore Site in Rosedale GMA1
Bore Site in Rosedale GMA2
Bore Site in Rosedale GMA3
Town
RosedaleGMA
State Government
Victoria


LOCH GLEN
SWIFT'S CREEK
DARGO
LIGOLA
ORBOST
GLENMAGGIE
BAIRNSDALE
WARRAGUL
HAZELWOOD
SEASPRAY
SAN REMO
FOSTER
BAIRNSDALE
Legend
Bore Site
Town
SaleWSPA
N
0 1.5 3 6 9 12 15
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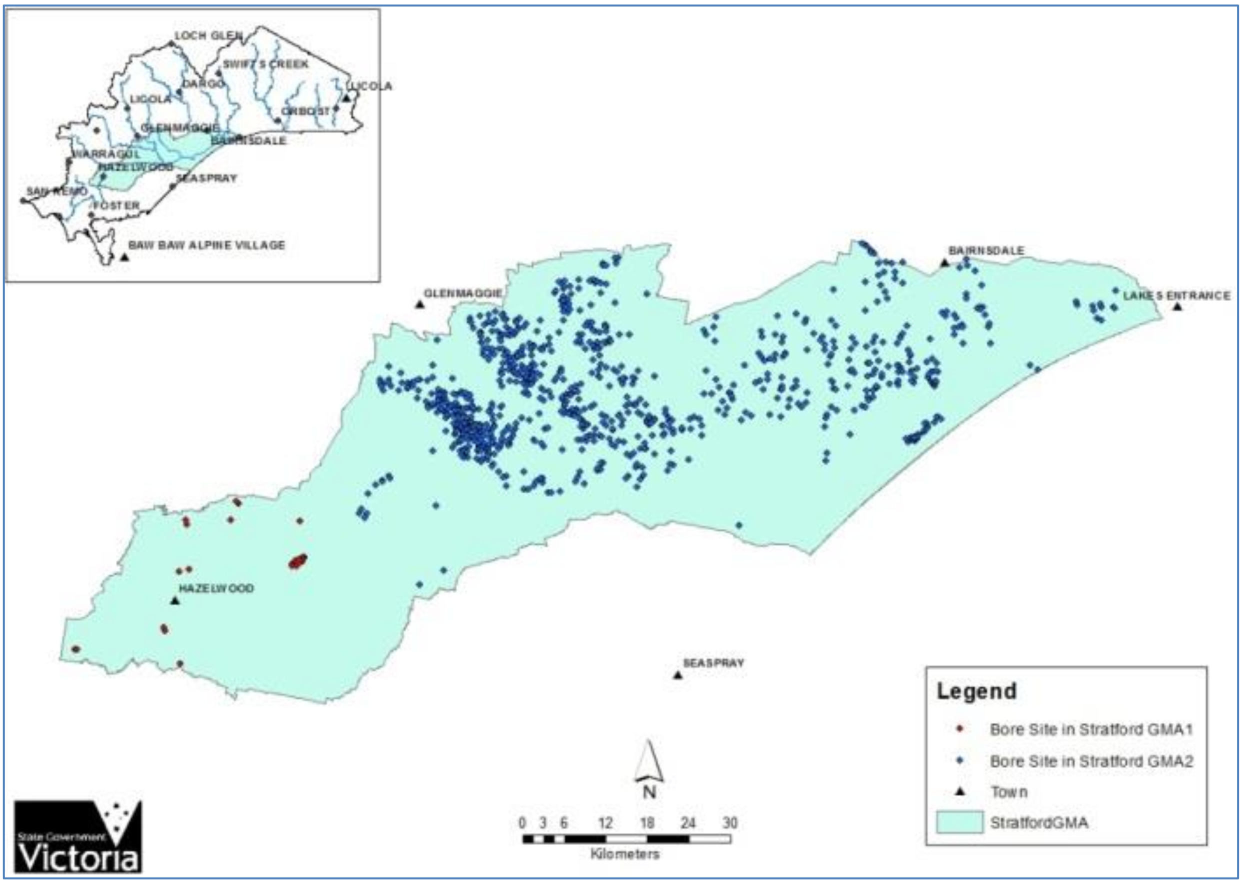
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SEASPRAY
SAN REMO
FOSTER
BAW BAW ALPINE VILLAGE
GLENMAGGIE
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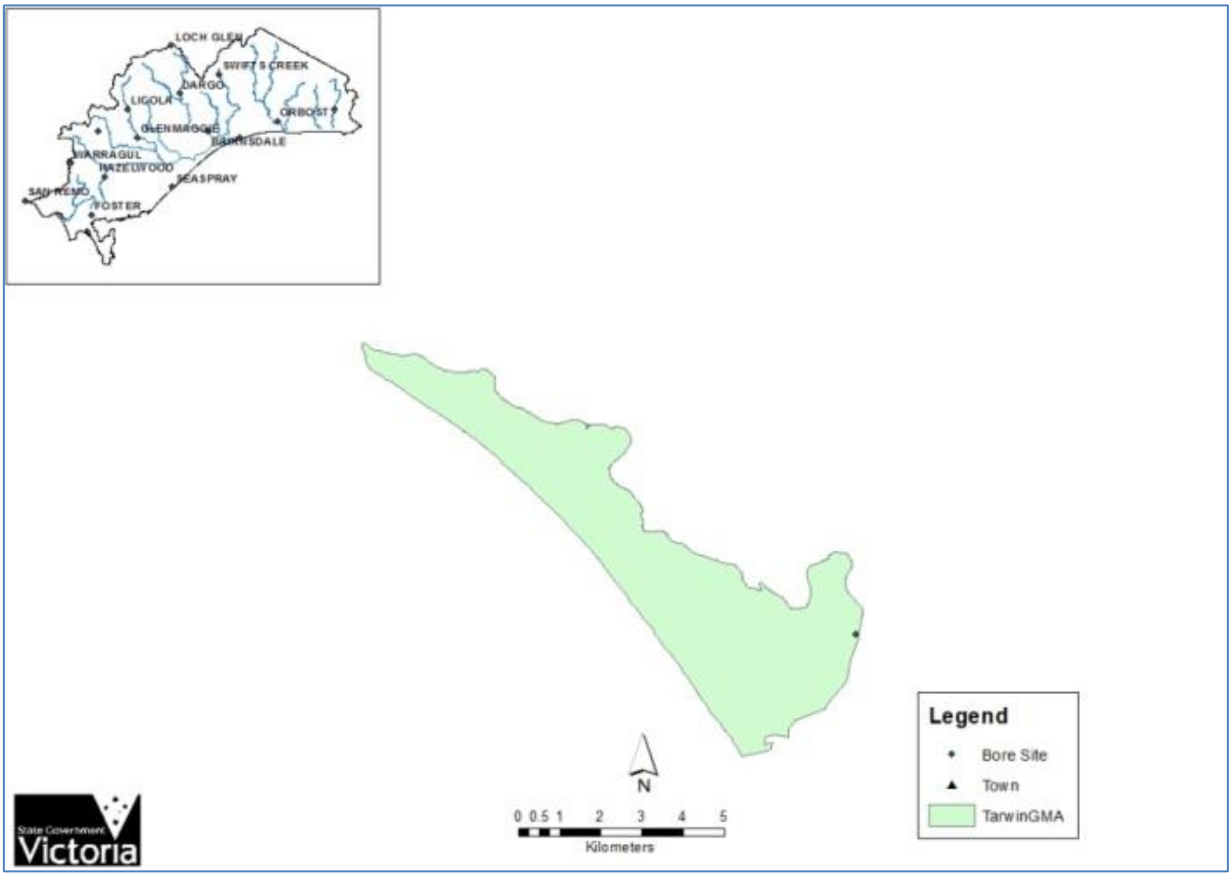
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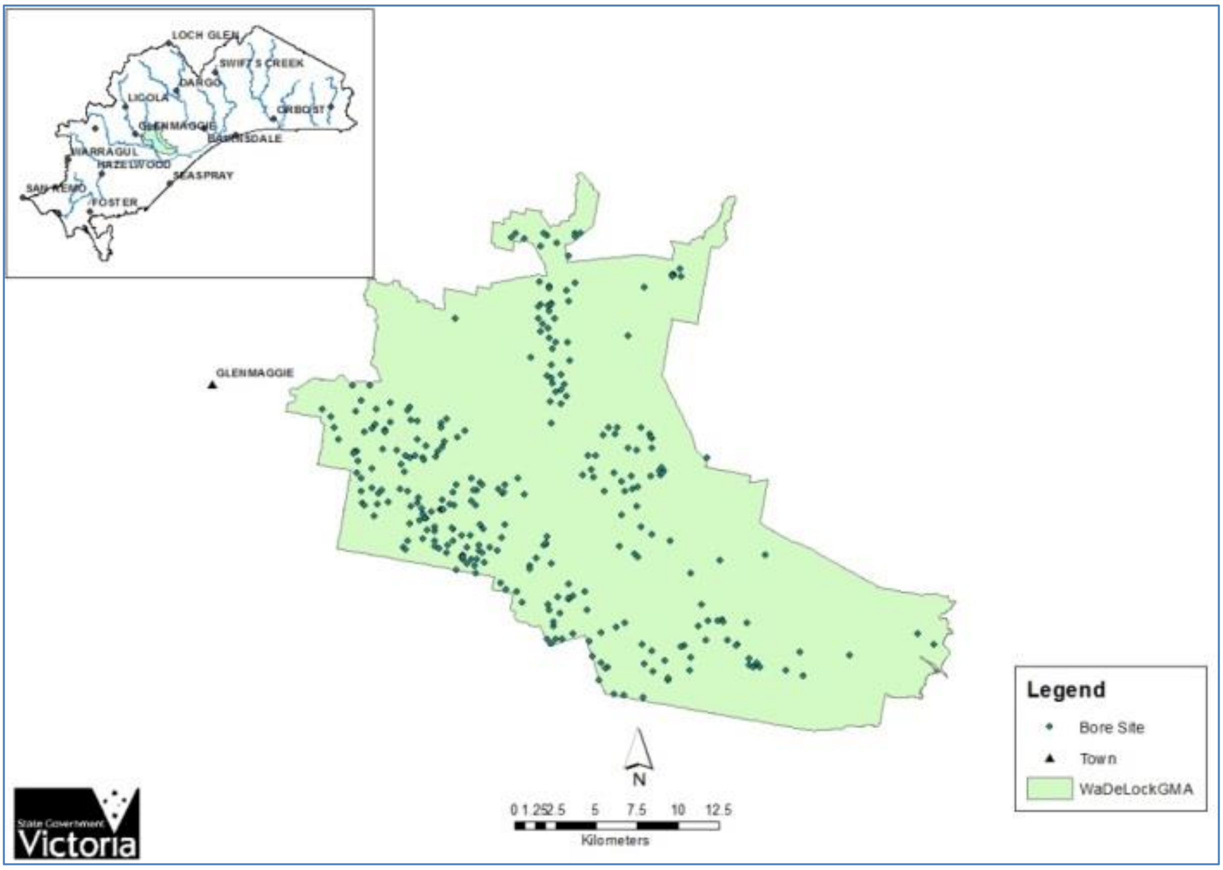
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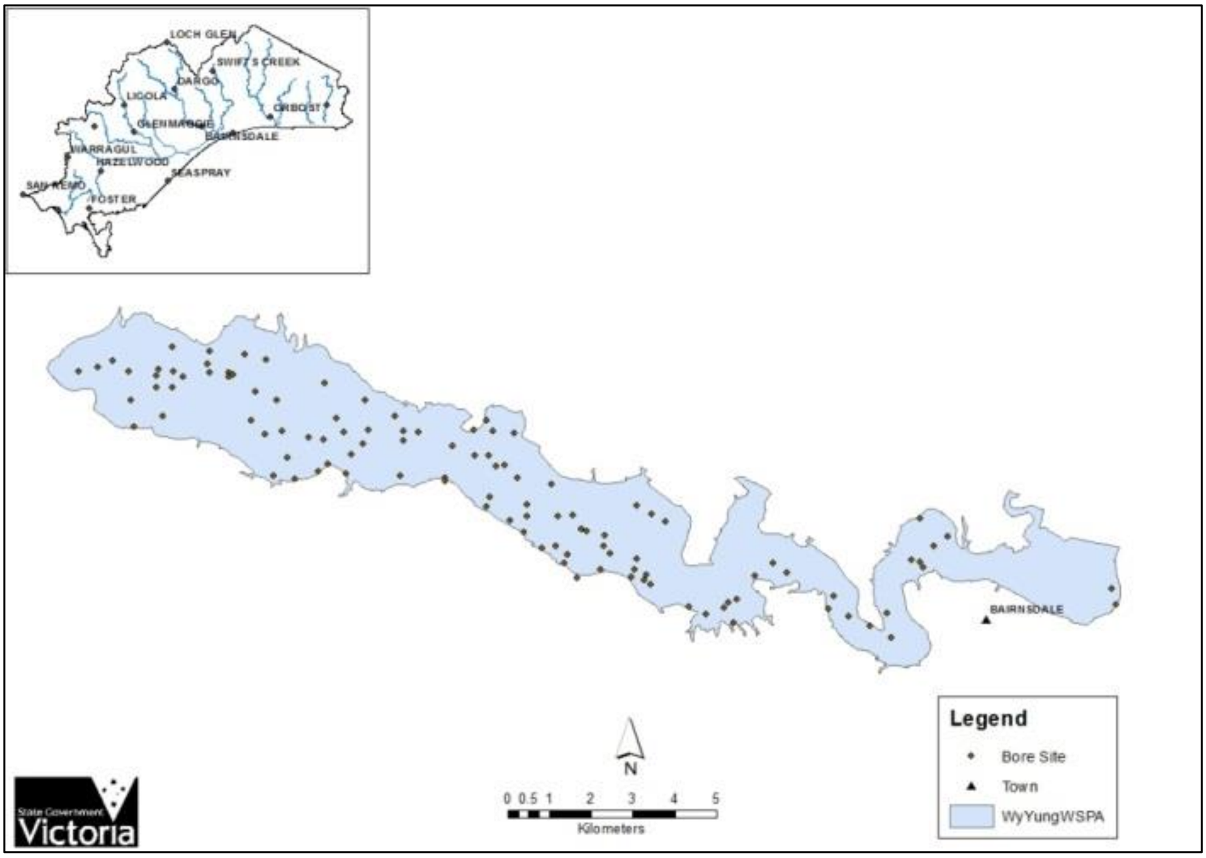
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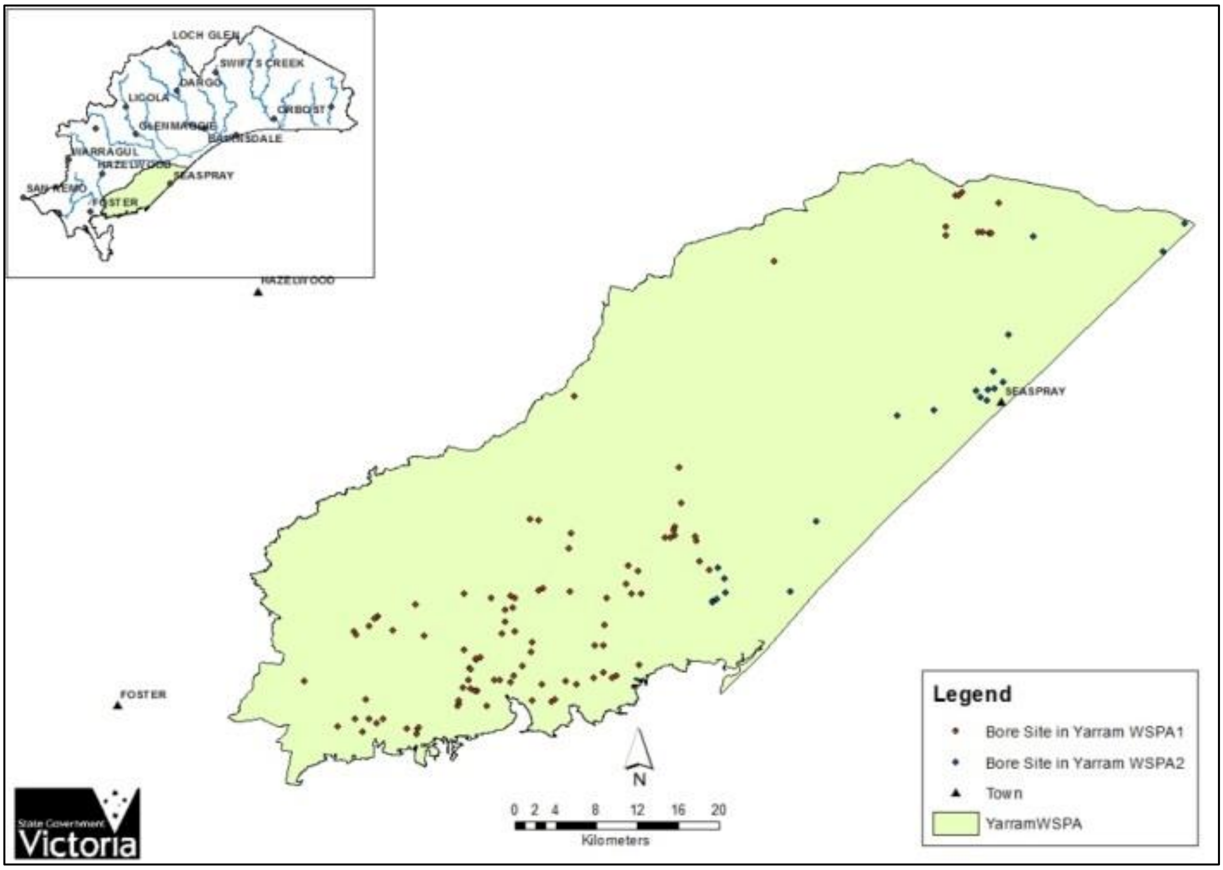
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Bore Site in Yarram WSPA2
Town
YarramWSPA
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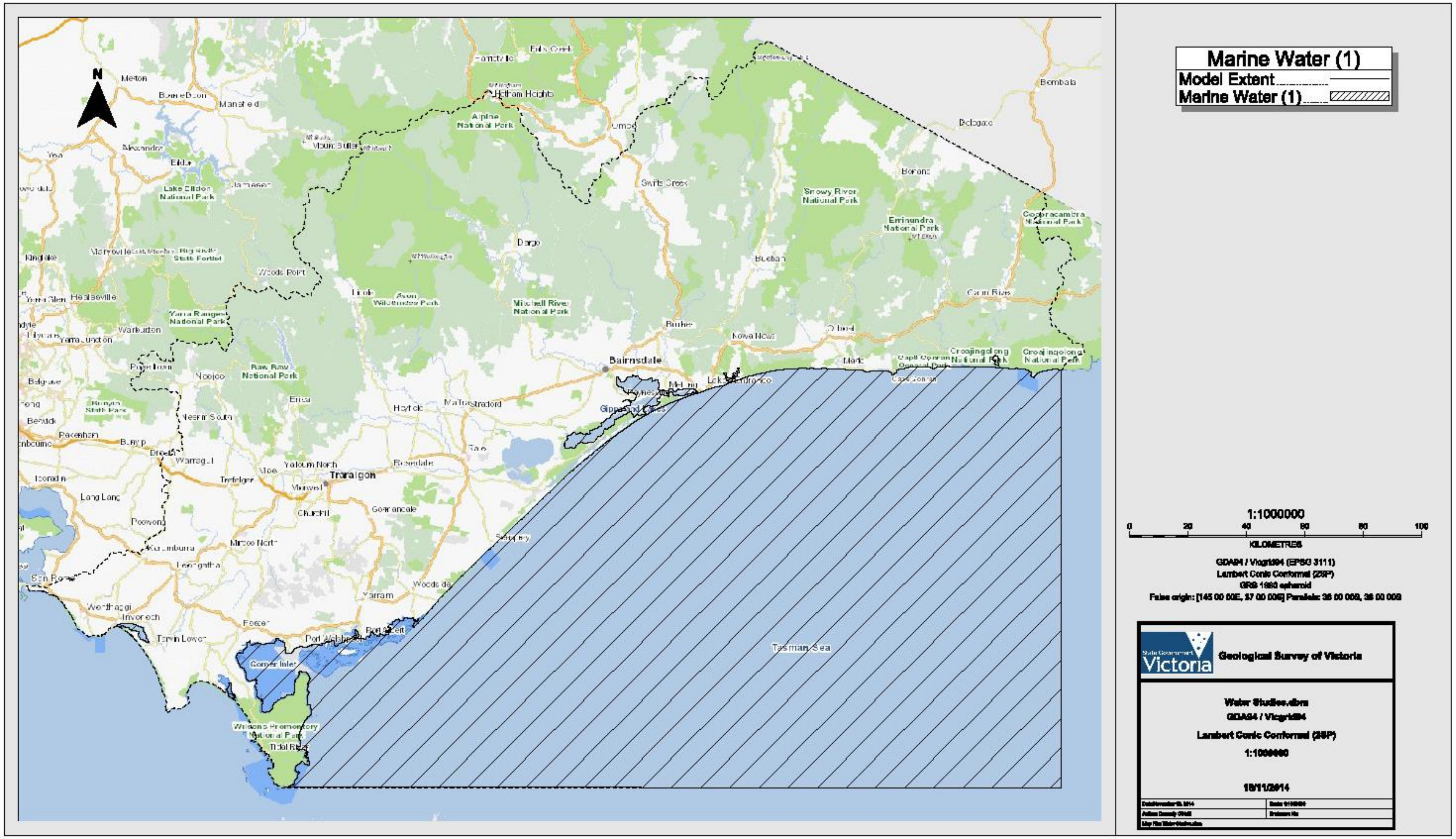
Victoria

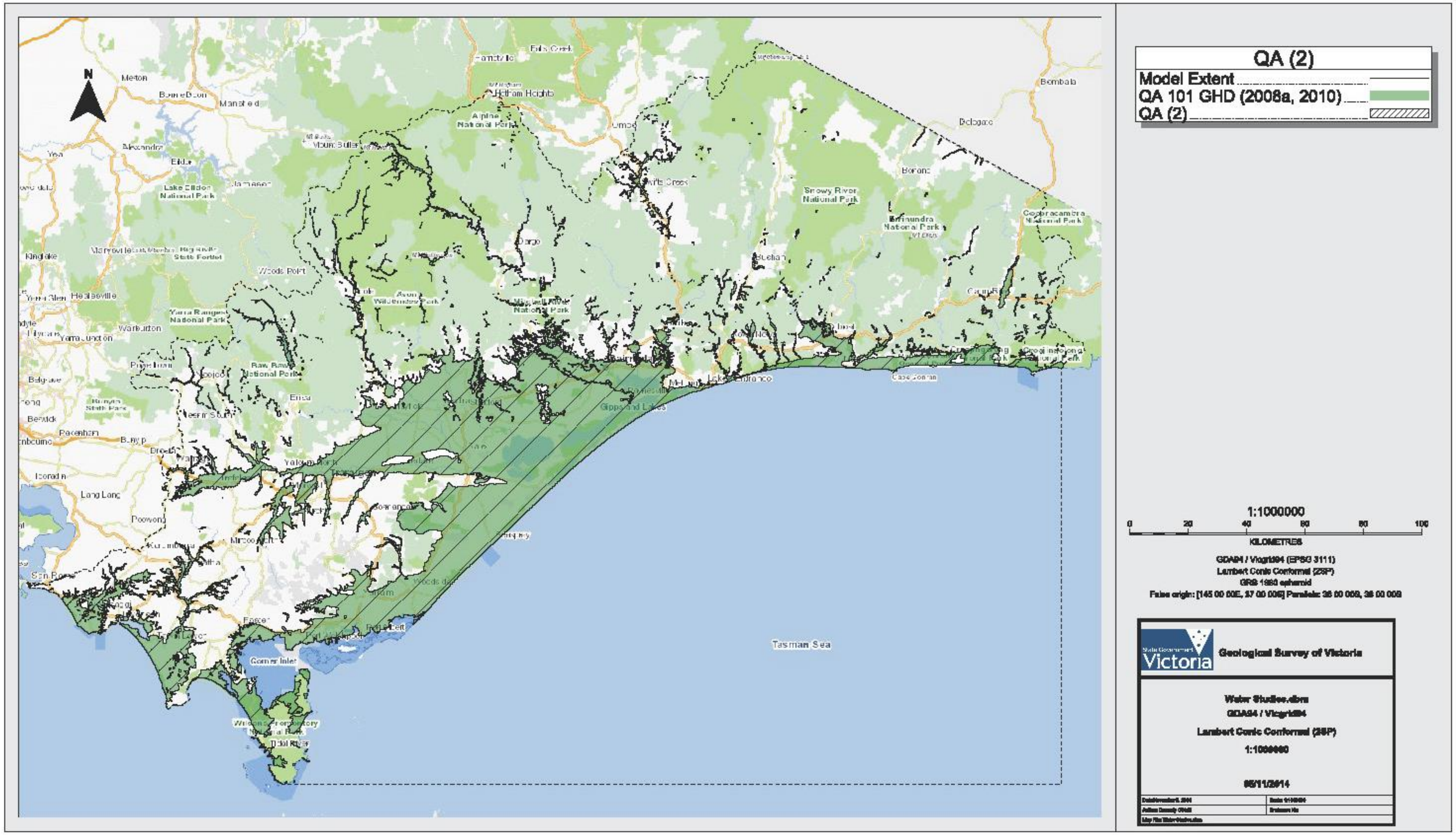
Appendix G: Hydrogeological units



HGU 1 – Represents marine waters throughout the offshore portion of the modelled area.

The unit top is mean sea level and the unit bottom is the sea floor. Marine waters extend beyond the modelled area. Marine Water is clipped to the model extent in the south and east and the coastline in the northwest. Bathymetry is from Whiteway (2009).

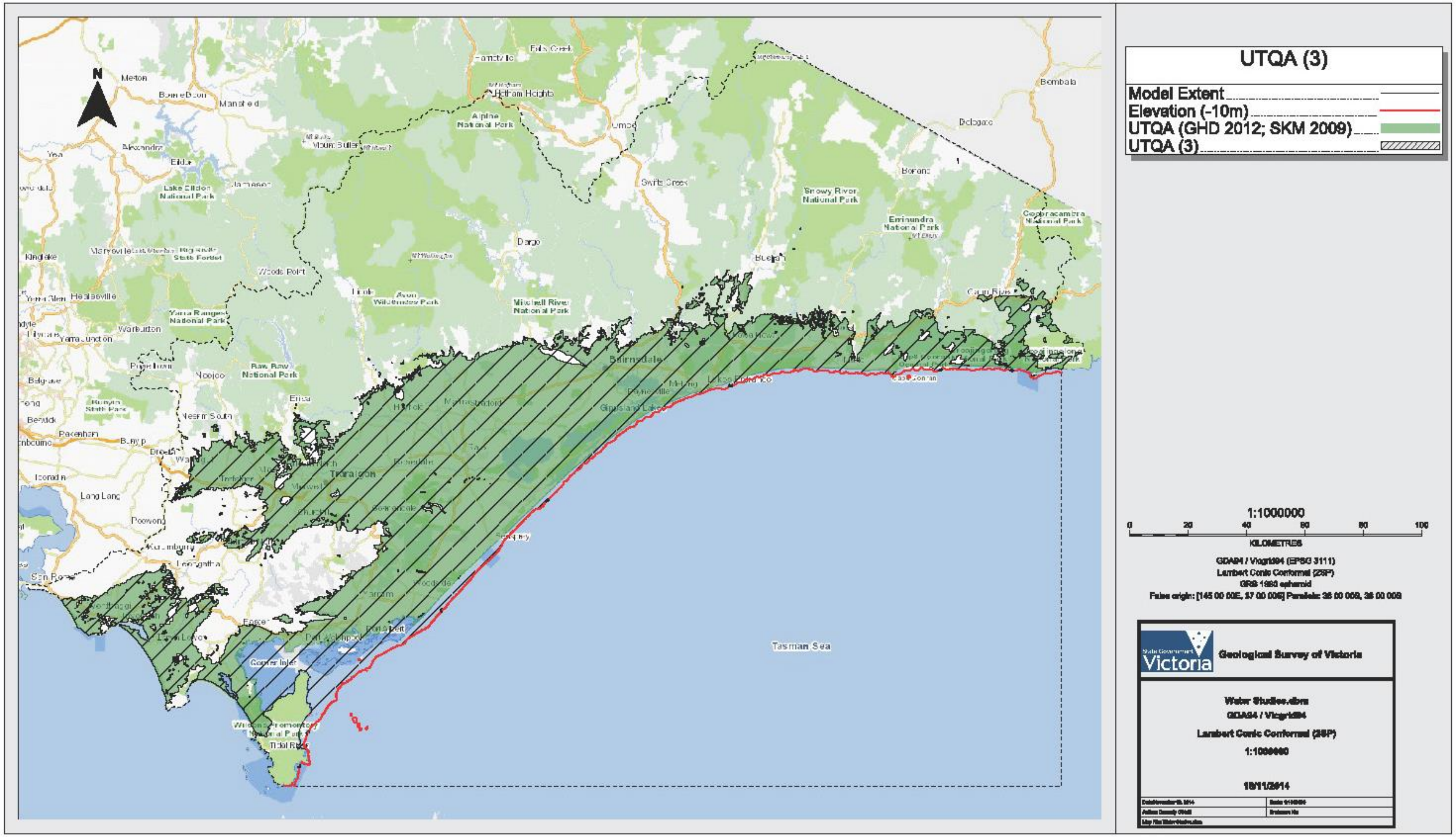
The thickness of Marine Water ranges from 2 m at the coastline to 455 m in the southeast corner.



HGU 2 – Represents the Quaternary Alluvium and includes Fluvial, lacustrine, alluvial and colluvial sediments. Quaternary Alluvium overlies the Haunted Hill Formation in the valleys and the Strzelecki Group and Palaeozoic Basement in the highlands.

The QA HGU is based on the aquifer QA from (GHD 2012; SKM 2009). QA extends to the Gippsland coast.

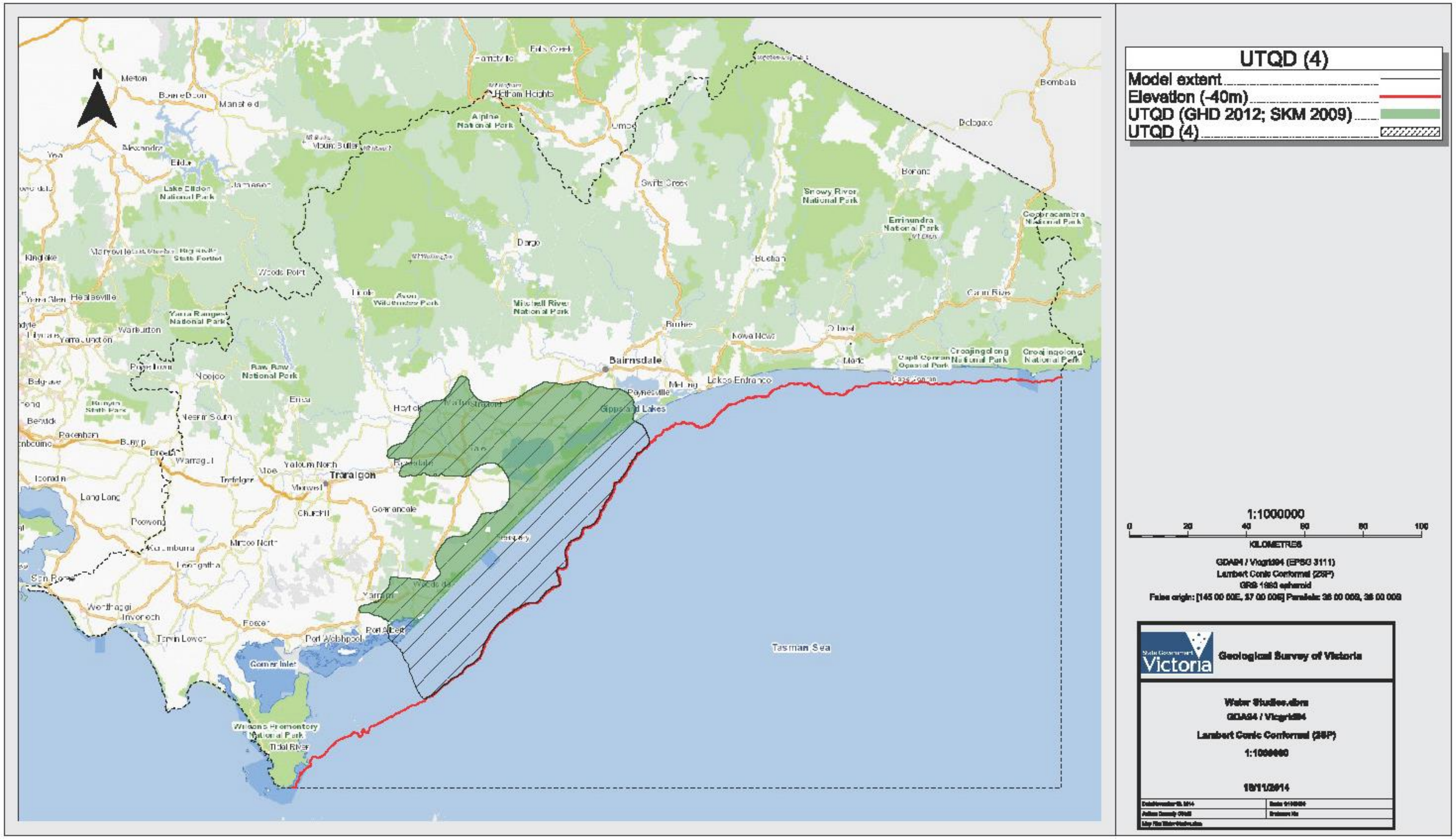
The thickness of Quaternary Alluvium ranges from 2 m to 105 m in small isolated pockets.



HGU 3 – Represents the Upper Tertiary Quaternary Alluvium and includes the Haunted Hill Formation.

The UTQA HGU is based on the aquifer UTQA from (GHD 2012; SKM 2009). UTQA was extended offshore by re-gridding using bathymetry and a 1 km buffer zone. UTQA was modified to account for the offshore pinching out of the unit Haunted Hill Formation. The unit extends to the 10m bathymetric contour.

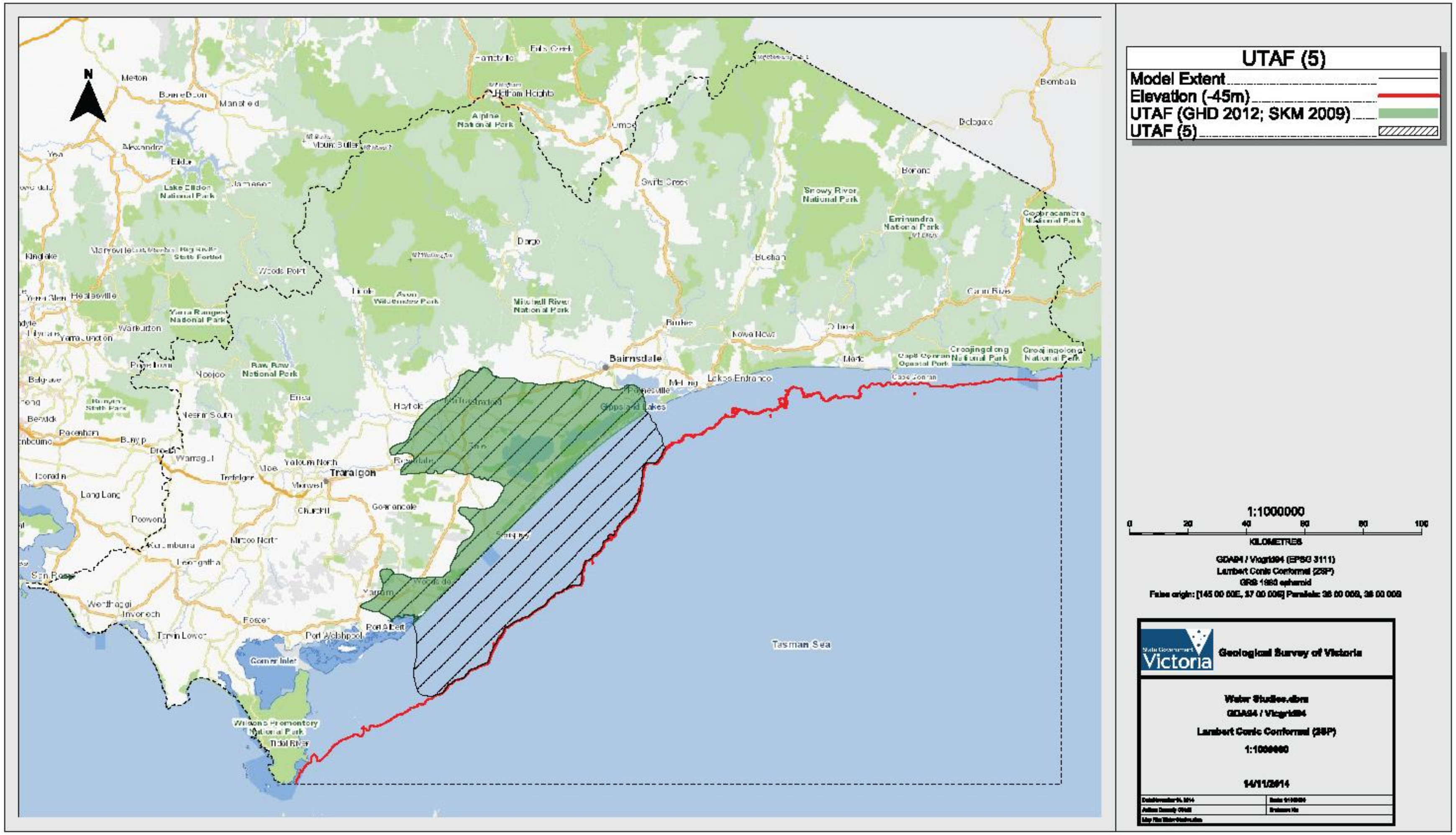
The thickness of UTQA ranges from 2 m to 175 m near Lake Wellington.



HGU 4 - Represents the Upper Tertiary Quaternary Aquitard which includes the Haunted Hills Gravel, Eagle Point Sand and Boisdale Formation (Nuntin Clay Member).

The UTQD HGU is based on the aquitard UTQD from (GHD 2012; SKM 2009). UTQD was extended offshore by re-gridding with bathymetry and using a 15 km buffer zone. UTQD was modified to account for the offshore pinching out of the unit. The surface extends to the 40m bathymetric contour.

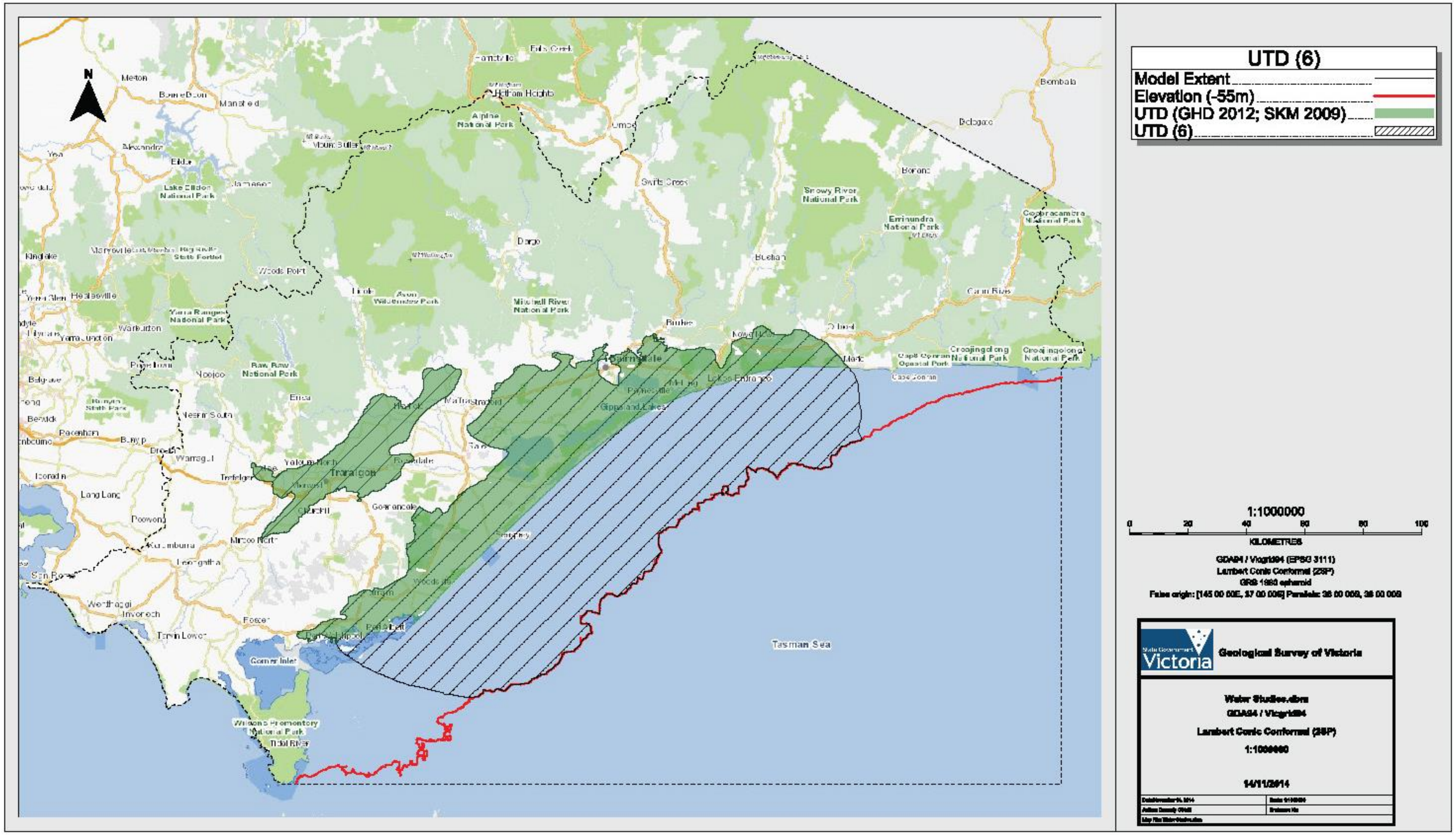
The thickness of UTQD ranges from 2 m to 157 m west of Sale.



HGU 5 - Represents the Upper Tertiary Aquifer which includes the Boisdale (Wurruk Sand Member).

The UTAF HGU is based on the aquifer UTAF from (GHD 2012; SKM 2009). UTAF was extended offshore by re-gridding with Bathymetry and using a 20 km buffer zone. UTAF was modified to account for the offshore pinching out of the Wurruk Sand Member. The surface extends to the 45m bathymetric contour.

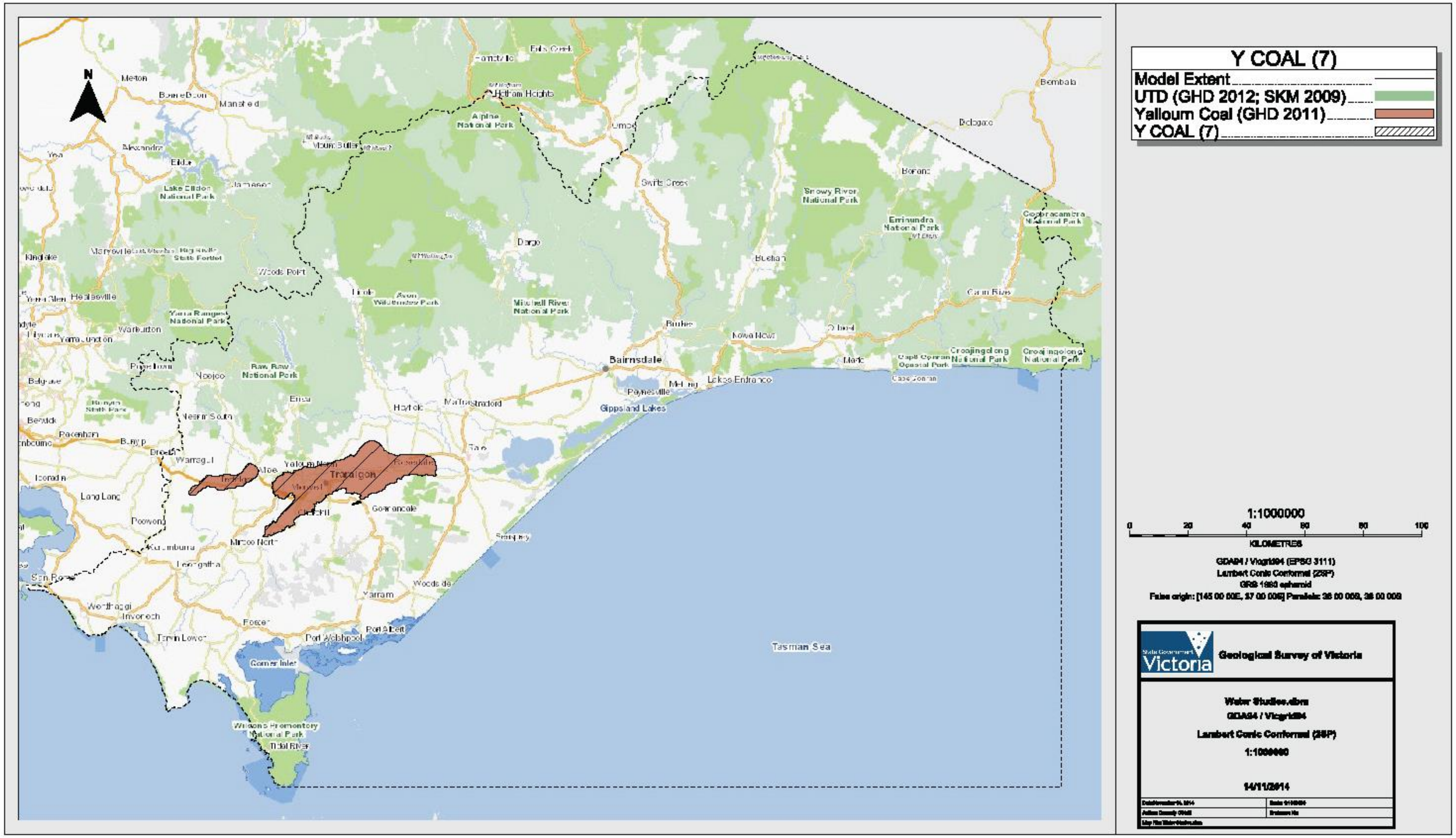
The thickness of UTAF ranges from 2 m to 141 m beneath Lake Victoria.



HGU 6 - Represents the Upper Tertiary Aquitard and includes the Hazelwood Formation, Yallourn Formation and Jemmys Point Formation.

The UTD HGU is based on the aquitard UTD from (GHD 2012; SKM 2009). UTD was extended offshore by re-gridding with Bathymetry and using a 40 km buffer zone. UTD was modified to account for the offshore pinching out of the Jemmys Point Formation. The surface extends to the 55 m bathymetric contour.

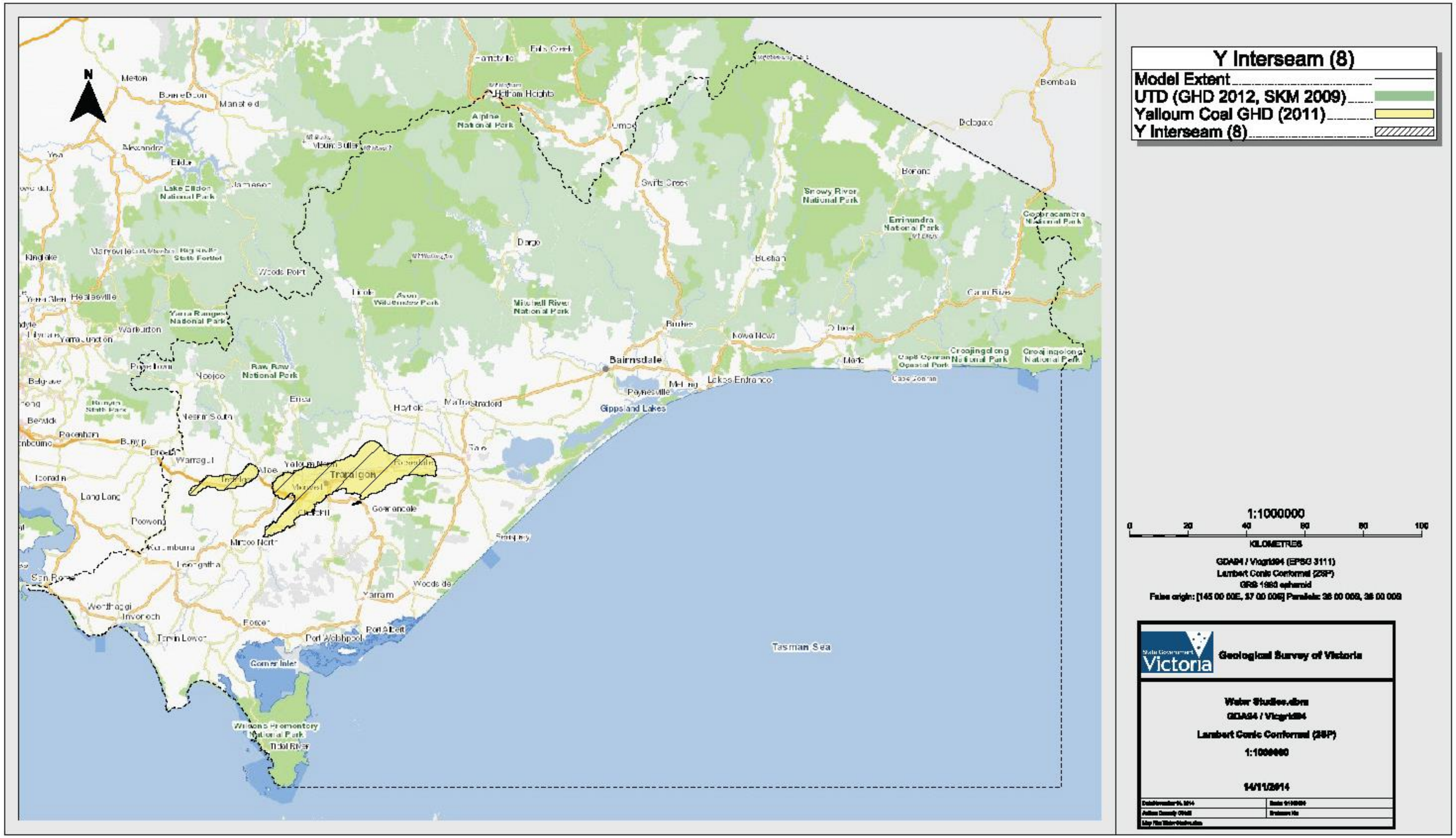
The thickness of UTD ranges from 2 m to 200 m southwest of Rosedale.



HGU 7 – Represents the Yallourn Coal seams (Y Coal) and includes the Yallourn Y1A, Y1B and Y2 coal seams.

Coal seam isopachs and extents were determined from the Latrobe Valley coal model Yallourn Coal seams (Jansen & Maher 2003; GHD 2011b; Osbourne et al., 2014). These isopachs have been incorporated into UTD (6).

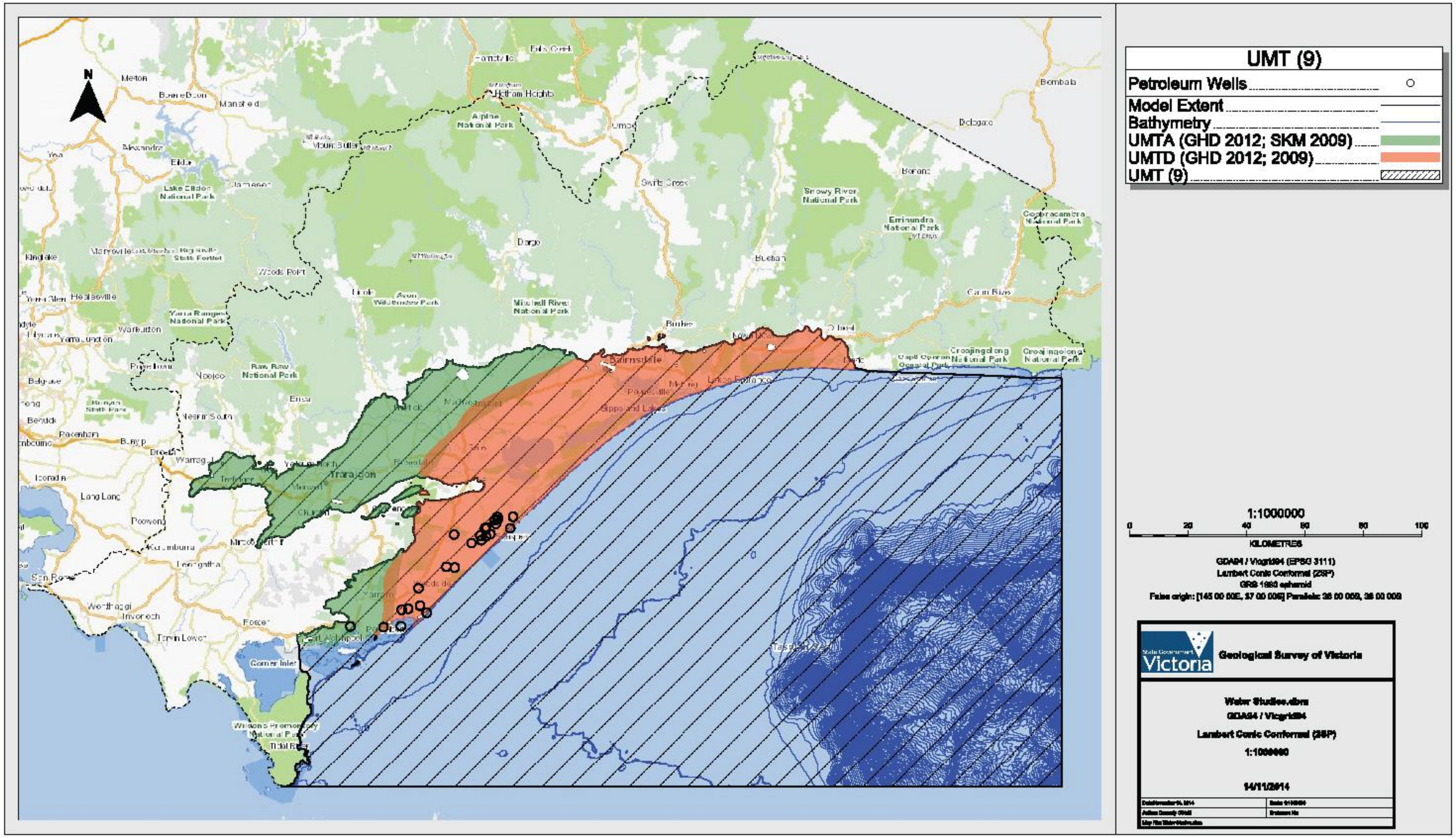
The thickness of Y Coal ranges from 2m to 228m north of Rosedale.



HGU 8 – Represents the Yallourn interseam. Y Interseam represents the sediments below the Yallourn Coal floor and above the Morwell Coal roof.

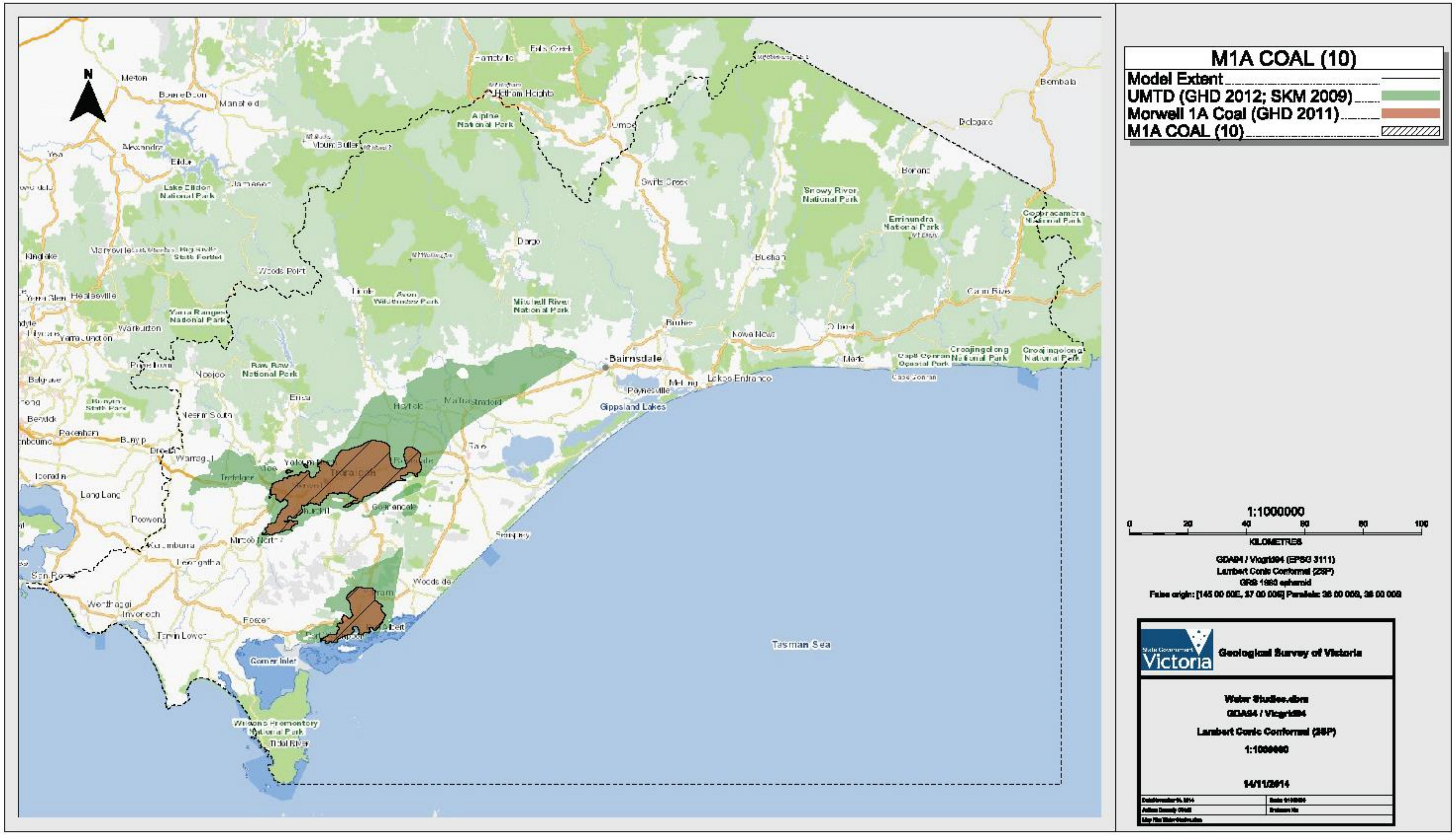
This interseam was incorporated into UTD (6).

The thickness of Y Interseam ranges from 2m to 160m beneath Hazelwood.



HGU 9 – Represents the Upper Mid-Tertiary Aquifer and Aquitard. This includes the Morwell, Balook and Tambo River Formations and the Gippsland Limestone.

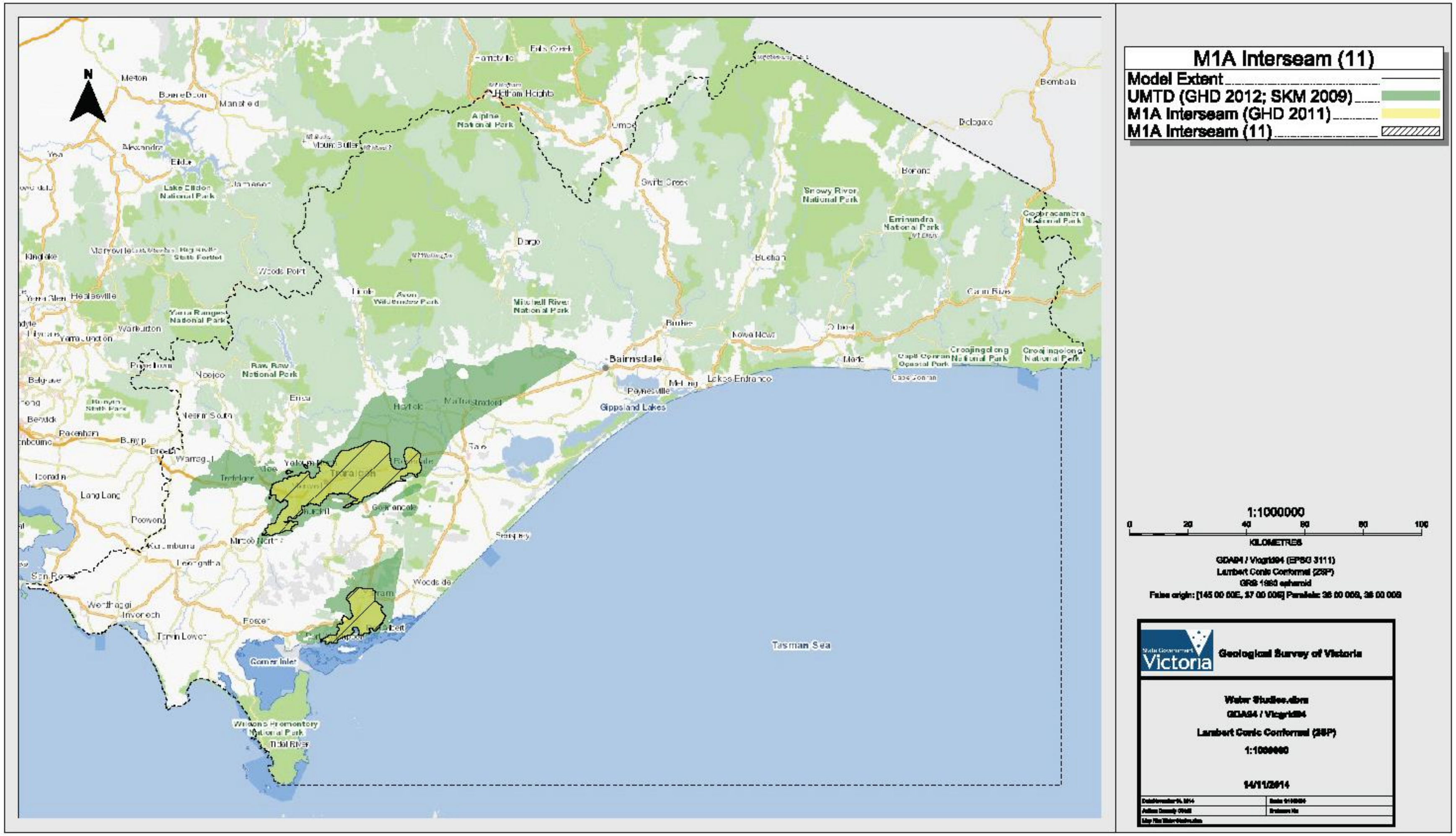
The UMT HGU is based on the aquifer UMTA and aquitard UMTD from (GHD 2012; SKM 2009). To merge UMTA and UMTD the boundary was re-gridded to smooth conflicts. This occurred through the area of overlap between UMTA and UMTD. UMT was extended offshore by re-gridding with bathymetry and using a 40km buffer zone. The buffer was designed to account for the offshore pinching out of the Jemmys Point Formation. UMT was modified to account for the significant volume of the Gippsland Limestone. Proximal to corner inlet onshore, the UMT was re-gridded to align with petroleum wells and remove conflicts with Strzelecki. The re-gridding occurred over an area approximately 20kmx20km. The UMT extends beyond the study area where it has been clipped. The thickness of UMT ranges from 2m to 428m offshore central deep.



HGU 10 - Represents the Morwell 1A Coal Seam (M1A).

Coal seam isopachs and extents were determined from the Latrobe Valley coal model M1A seams (Jansen & Maher 2003; GHD 2011b; Osbourne et al., 2014). M1A was incorporated into UMT (9).

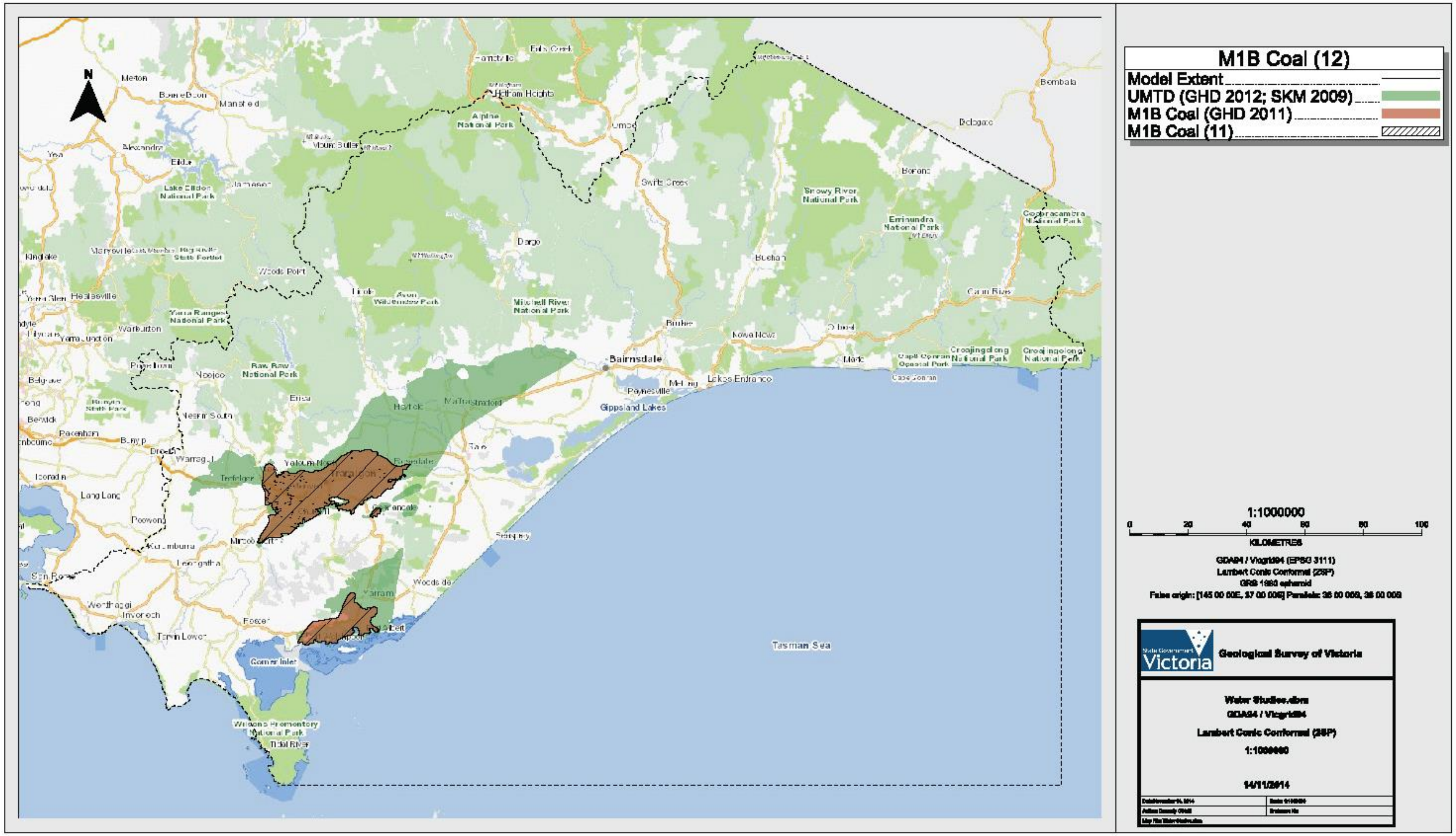
The M1A Coal thickness ranges from 2m to 228m east of Traralgon.



HGU 11 - Represents the interseam between the Morwell 1A Coal floor and the Morwell 1B Coal roof.

The M1A interseam was incorporated into UMT (9).

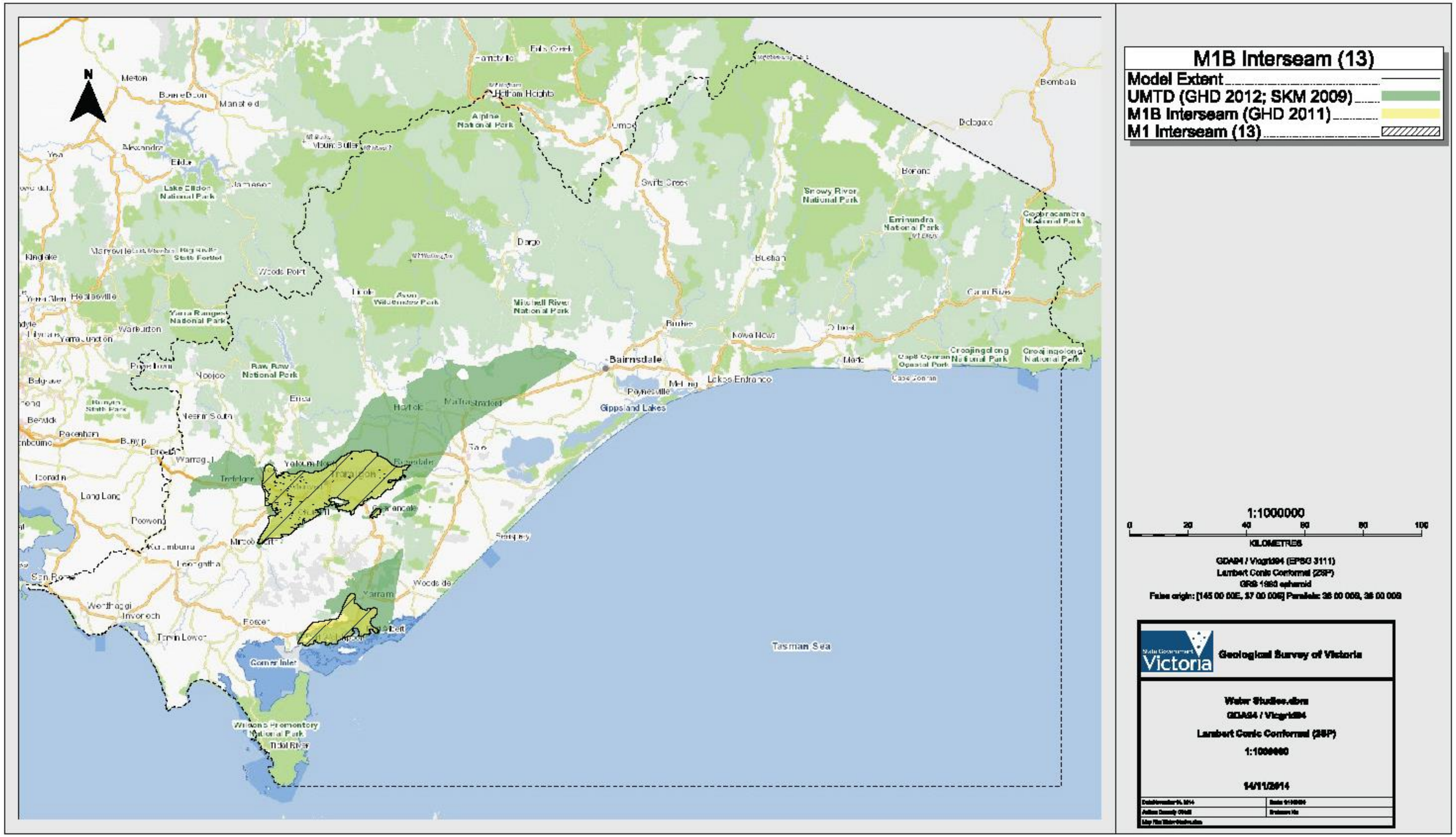
The thickness of the M1A Interseam ranges from 2m to 252m south of Rosedale.



HGU 12 - Represents the Morwell 1B (M1B) coal seams.

Coal seam isopachs and extents were determined from the Latrobe Valley coal model M1B seams (Jansen & Maher 2003; GHD 2011b; Osbourne et al., 2014). M1B was incorporated into UMT 9.

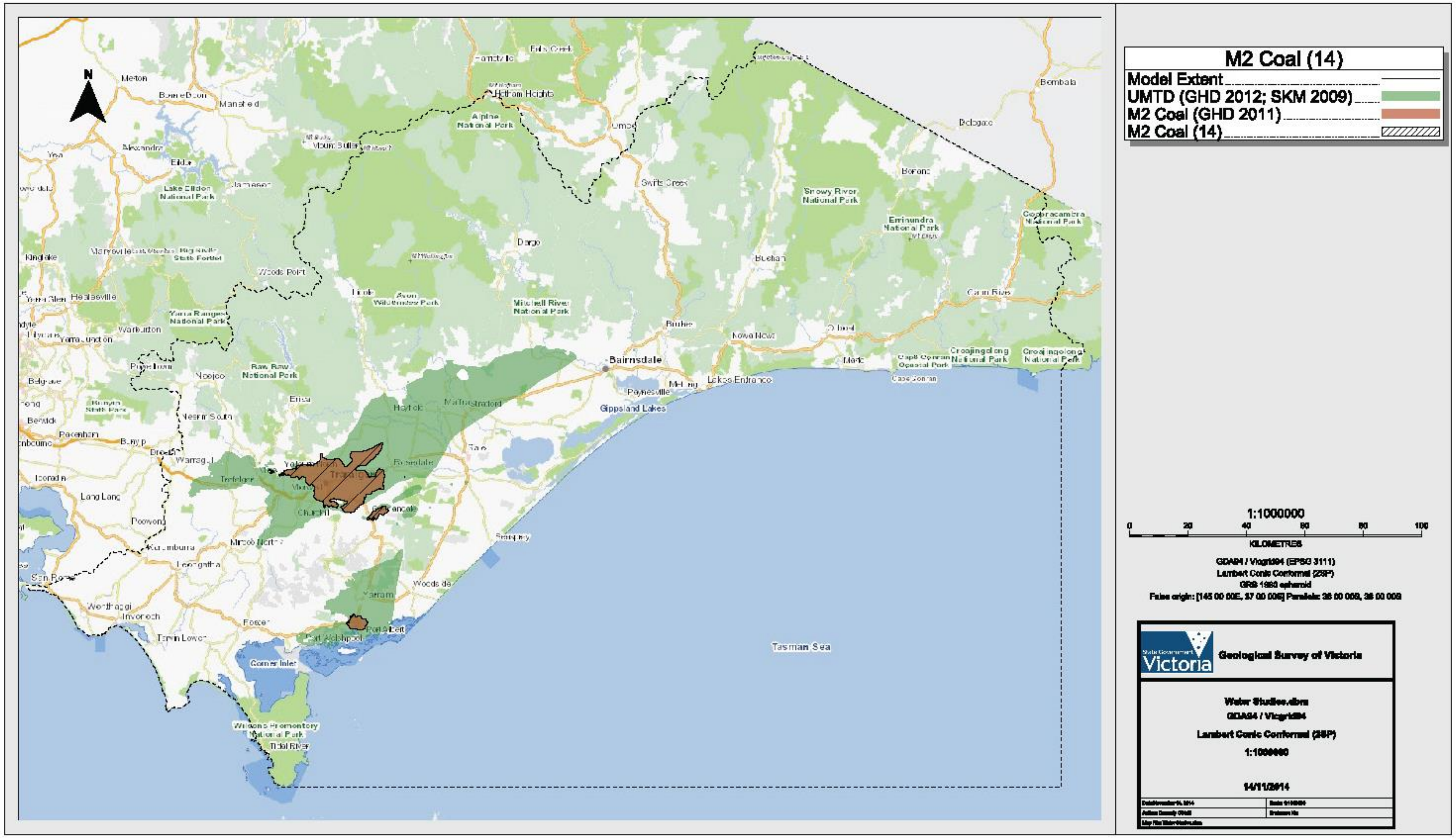
The M1B Coal thickness ranges from 2 m to 252 m proximal to Morwell.



HGU 13 - Represents the Morwell 1B interseam between the Morwell 1B coal floor and Morwell 2 coal roof.

M1a Interseam was incorporated within UMT 9.

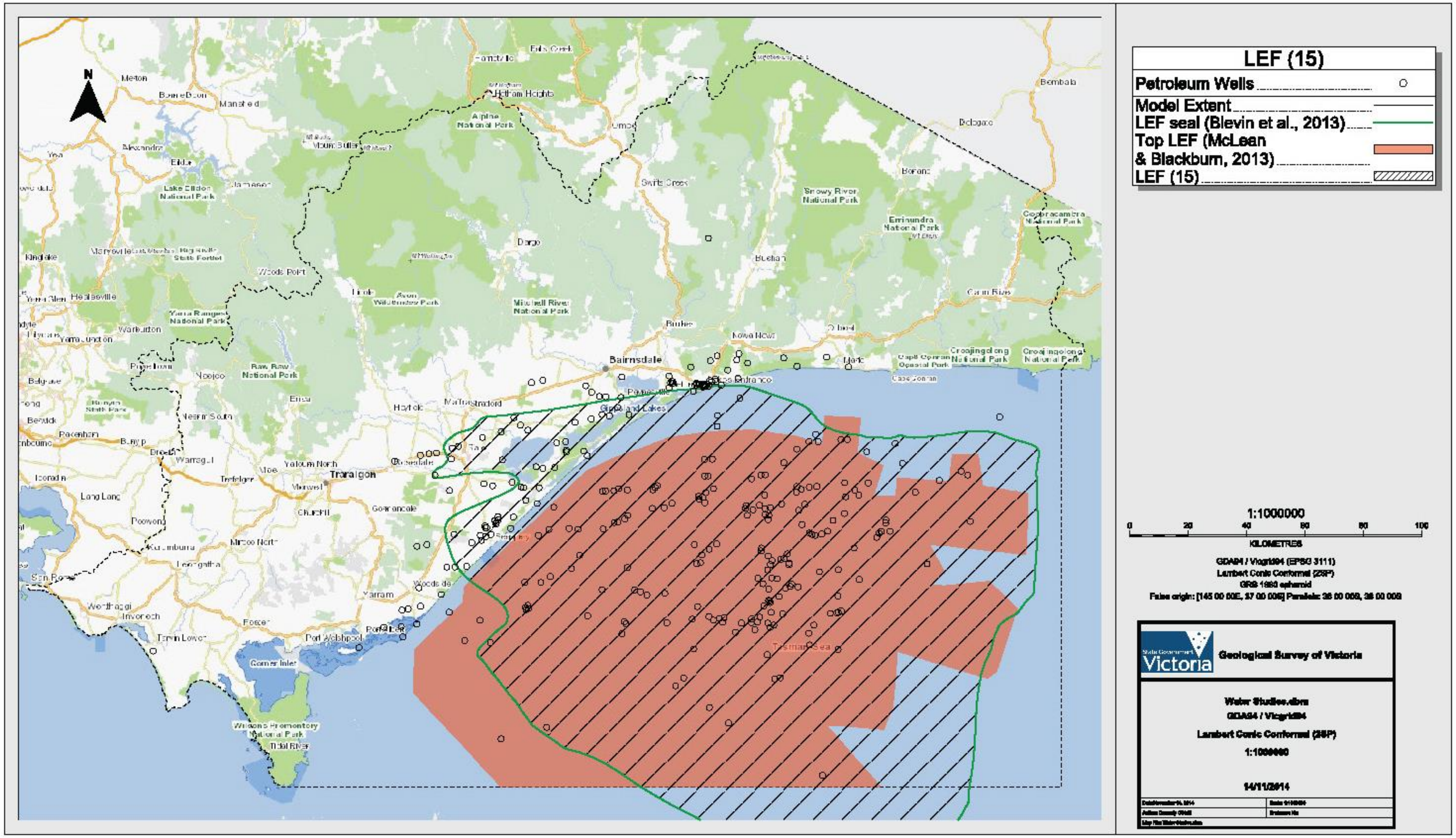
The thickness of the M1B Interseam ranges from 2m to 252m proximal to Rosedale.



HGU 14 - Represents the Morwell 2 Coal Seam (M2).

Coal seam isopachs and extents were determined from M2 coals, (Jansen & Maher 2003; GHD 2011b; Osbourne et al., 2014). M2 was incorporated into UMT (9).

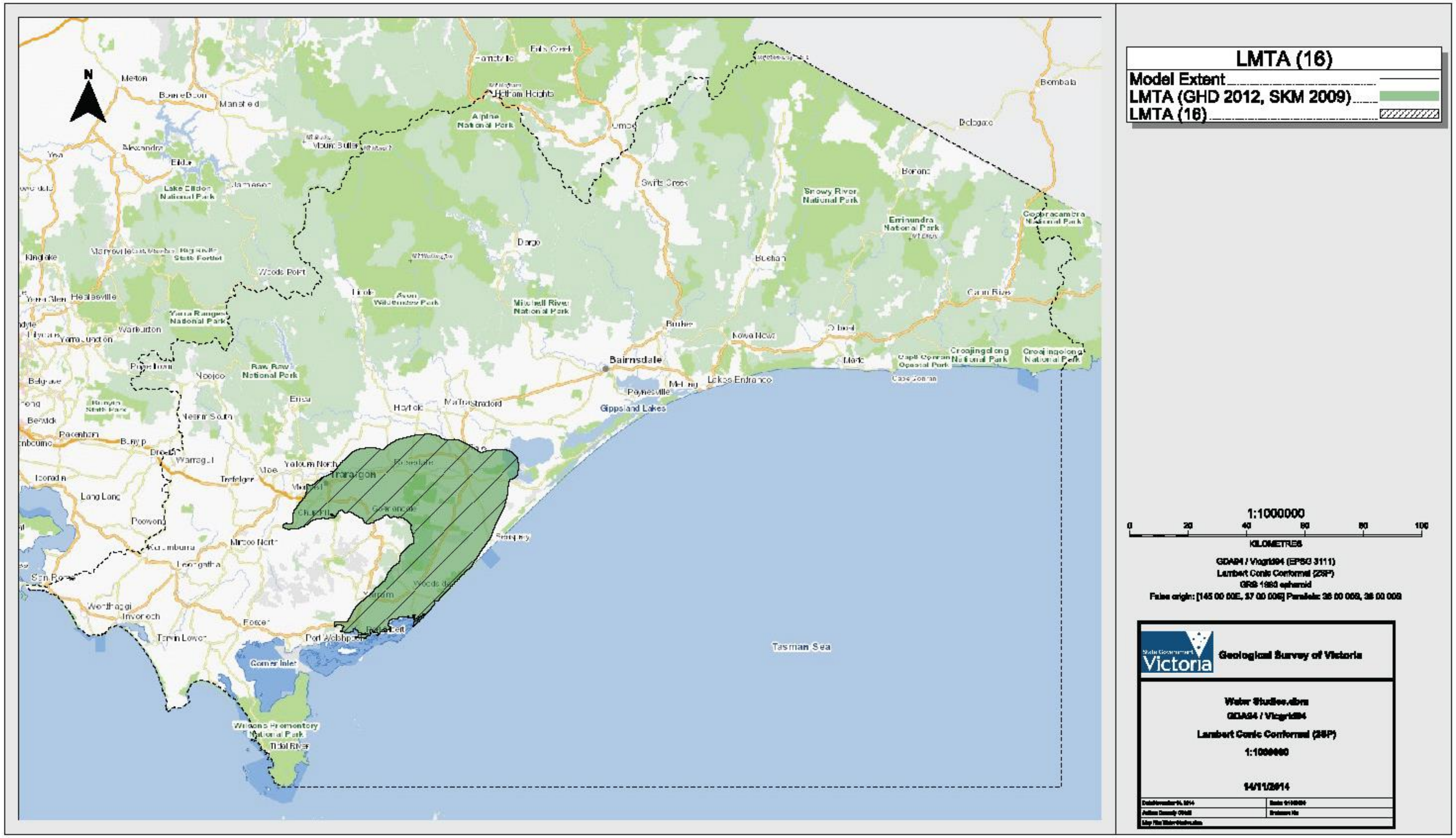
The M2 Coal thickness ranges from 2m to 239m east of Rosedale.



HGU 15 - Represents the Lakes Entrance Formation. The Lakes Entrance Formation thickness ranges from 2m to 605m offshore in the central deep.

The LEF HGU is based on the top Lakes Entrance Formation from McLean & Blackburn (2013). LEF was extended onshore by re-gridding with petroleum well control. The surface extends to the terminal effective seal proposed by Blevin et al. (2013) although it is acknowledged that sealing characteristics will extend onshore beyond this line.

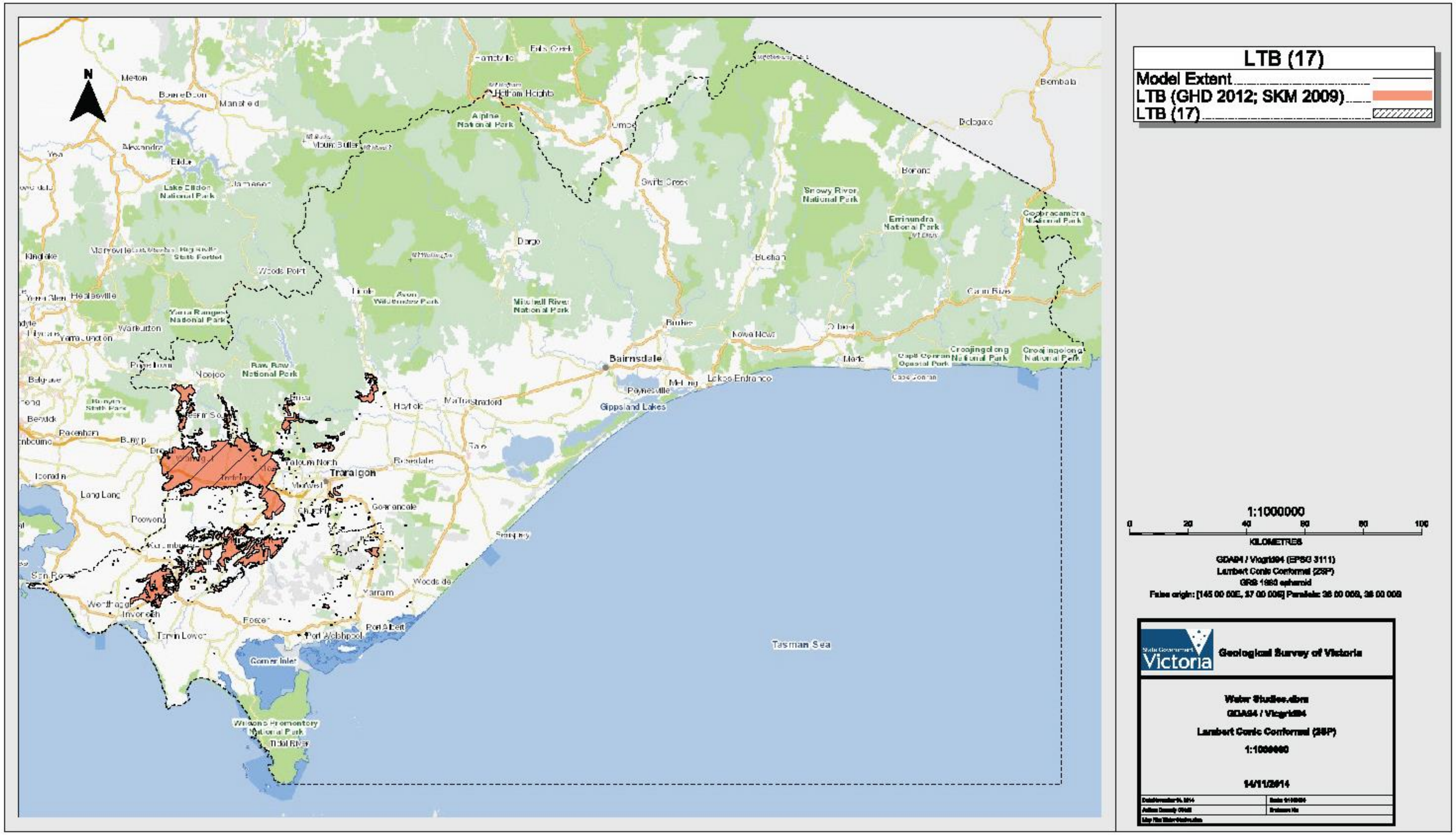
The Lakes Entrance Formation thickness ranges from 2m to 605m offshore in the central deep.



HGU 16 - Represents the Lower Mid Tertiary Aquifer and contains the Morwell 2C aquifer and Seaspray Sands.

The LMTA HGU is based on the aquifer LMTA from (GHD 2012; SKM 2009). LMTA isopachs and extent were determined and were then incorporated above HGU 18. No offshore extension was modelled for this aquifer.

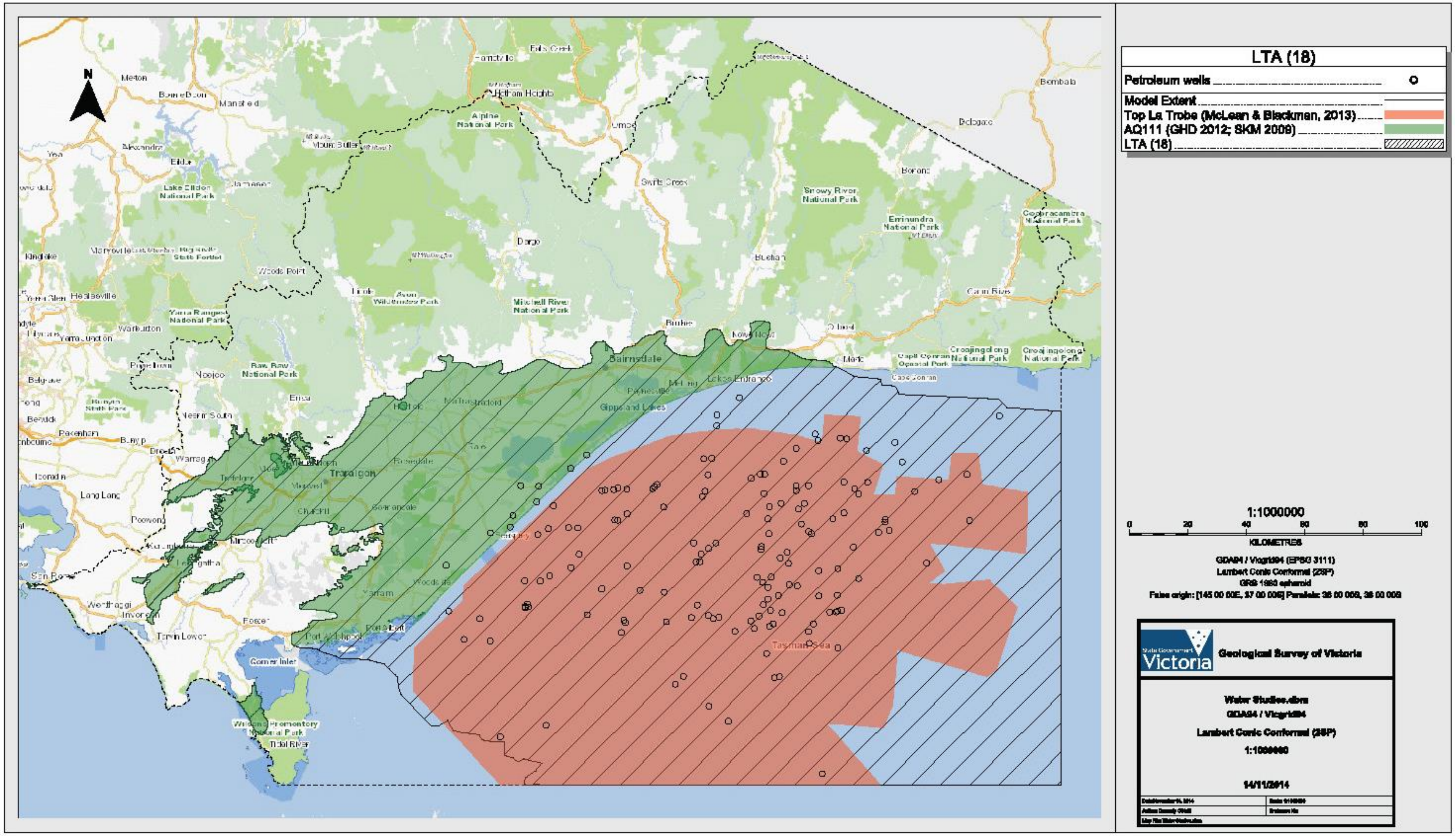
The LMTA thickness ranges from 2m to 123m proximal to Longford.



HGU 17 – Represents the Lower Tertiary Basalts.

The LTB HGU is based on the aquifer LTB from (GHD 2012; SKM 2009). LTB was not extended offshore.

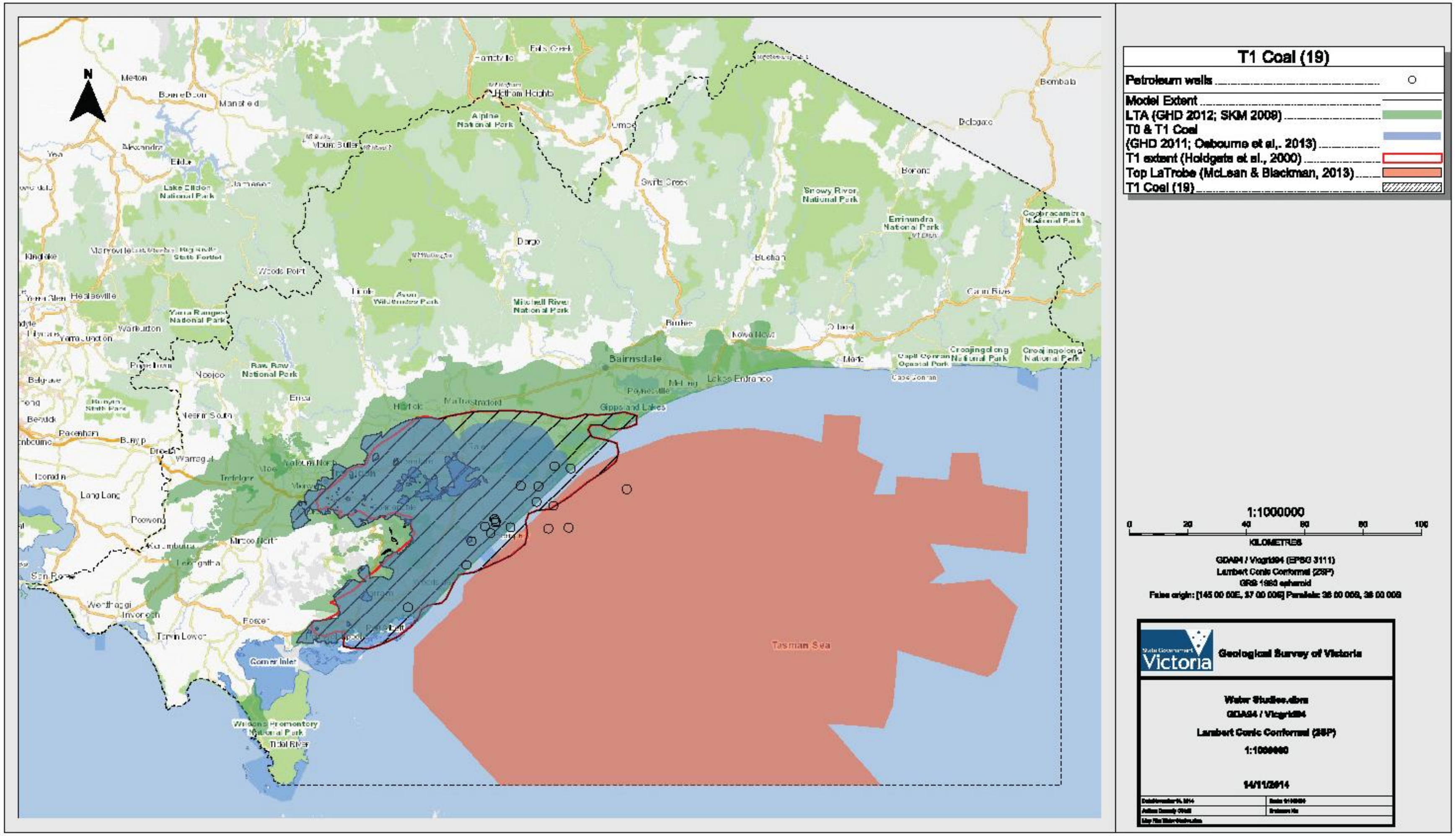
The Lower Tertiary Basalts range in thickness ranges from 2m to 163m proximal to Yarragon.



HGU 18 - Represents the Lower Tertiary Aquifer and contains the Traralgon coals, Cobia Subgroup, Halibut Subgroup, Golden Beach Subgroup, and Emperor Subgroup.

The LTA HGU is based on the aquifer LTA from (GHD 2012; SKM 2009). LTA was extended offshore by re-gridding with top La Trobe (McLean & Blackman 2013). Well intersections used to better constrain top LTA were applicable. This has particularly the case onshore proximal to 90 mile beach. The unit extends to the model extent in the east. In the southeast the LTA extent is based upon the interpretations from Blevin et al. (2013).

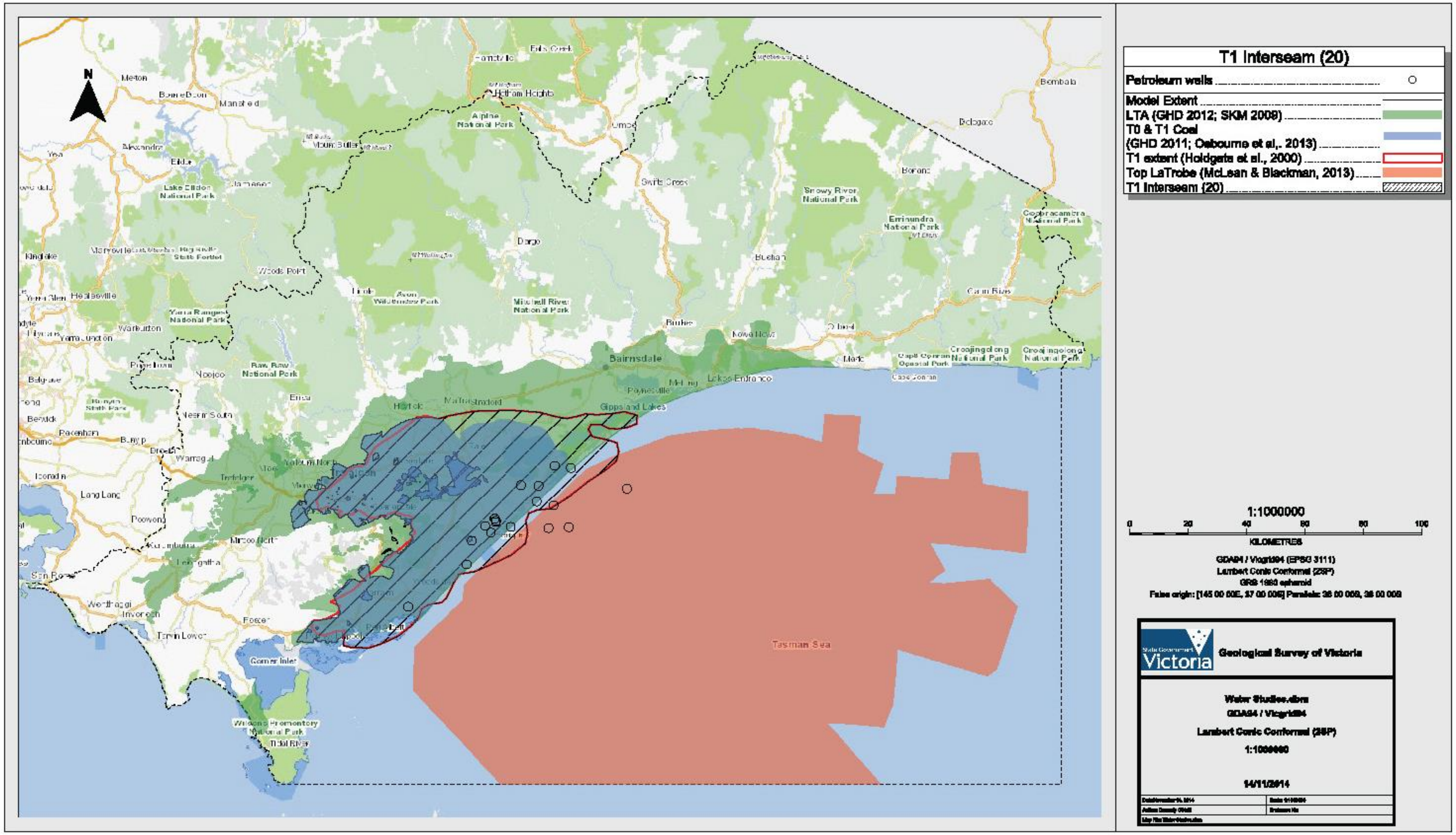
The Latrobe Aquifer ranges in thickness from 2m to 1192m offshore in the central deep.



HGU 19 - Represents the Traralgon T0 and T1 coal seams and T0 inter-burden (T1 Coal).

Coal isopachs and extents were determined for TP, TRU, TRM and TRL from the Latrobe Valley Coal Model (Jansen & Maher 2003; GHD 2011b; Osbourne et al., 2014). Additional Coal isopachs were determined for T0 and T1 from Holdgate et al. (2000). Coal model isopachs were aggregated and extended offshore by merging with T0/T1 isopachs. Depth control was derived the coal model and petroleum wells where available. T1 Coal was incorporated into LTA 18.

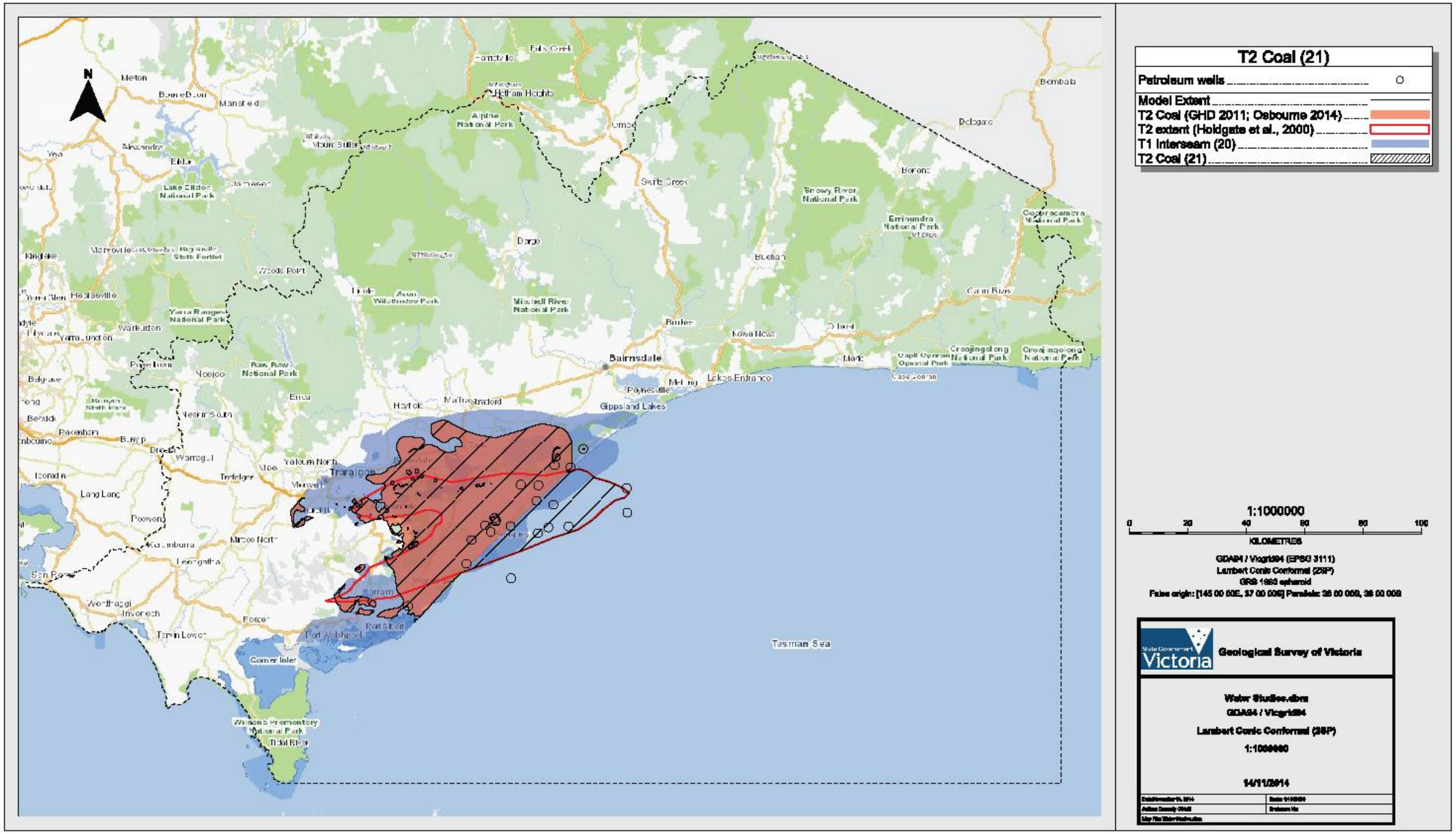
The T1 Coal ranges in thickness from 2 m to 133 m near Yarram and Longford.



HGU 20 - Represents the Traralgon T1 aquifer and includes the T1 interseam.

T1 Interseam isopachs and extents were determined by subtracting T2 Coal roof from T1 Coal floor. Petroleum wells were used for depth control where available. T1 Interseam was incorporated into LTA 18.

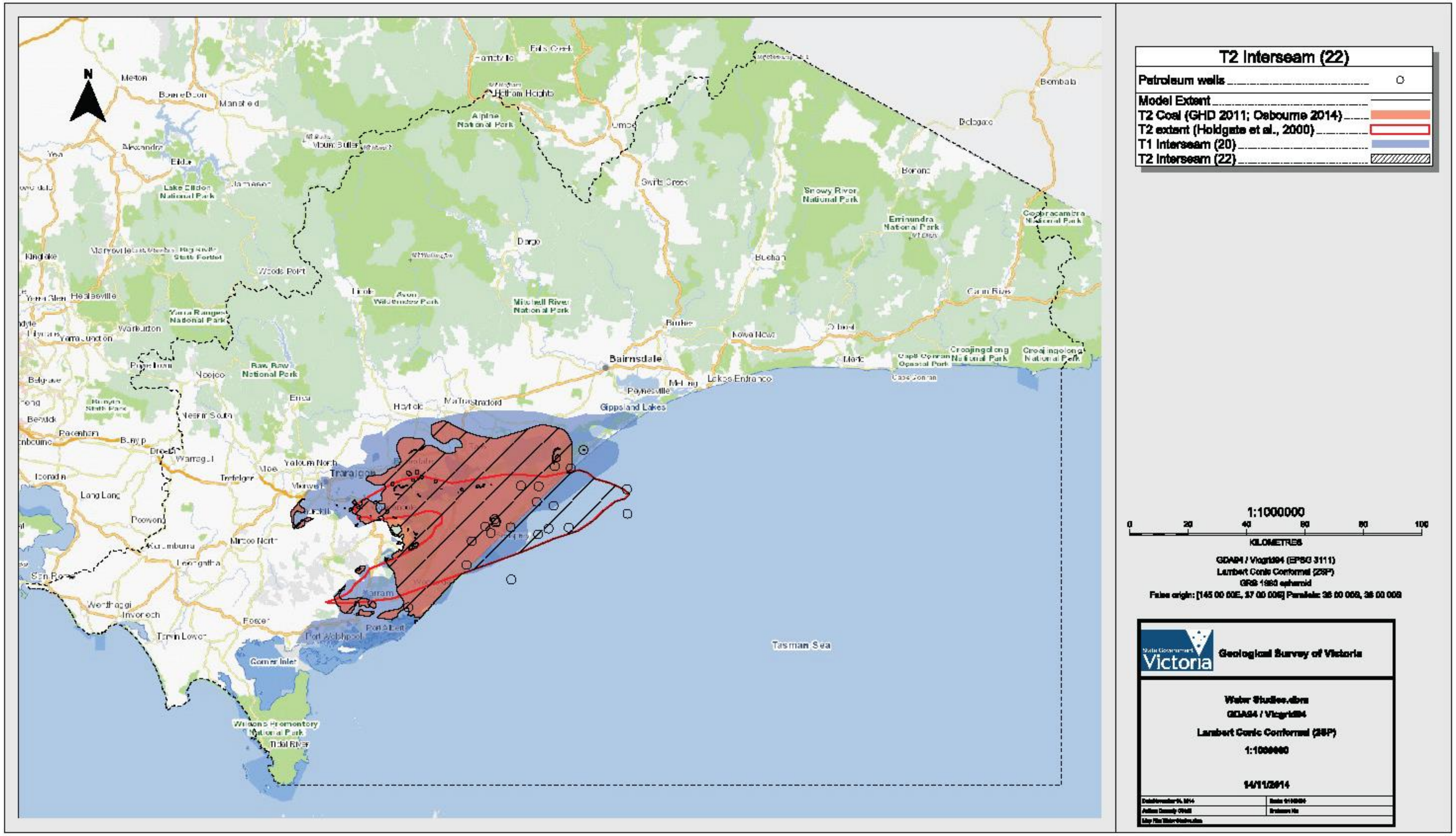
The T1 Interseam ranges in thickness from 2 m to 562 m offshore from Lake Wellington.



HGU 21 – Represents the Traralgon T2 coal seams and minor interseams (T2 Coal).

Coal isopachs and extents were determined for T2A, T2B from the Latrobe Valley Coal Model (Jansen & Maher 2003; GHD 2011b; Osbourne et al., 2014). Additional Coal isopachs for the T2 coals were taken from Holdgate et al, (2000). Coal model isopachs were aggregated and extended offshore by merging with T2 isopachs. Depth control was derived from the coal model and petroleum wells where available. T2 Coal was incorporated into LTA 18.

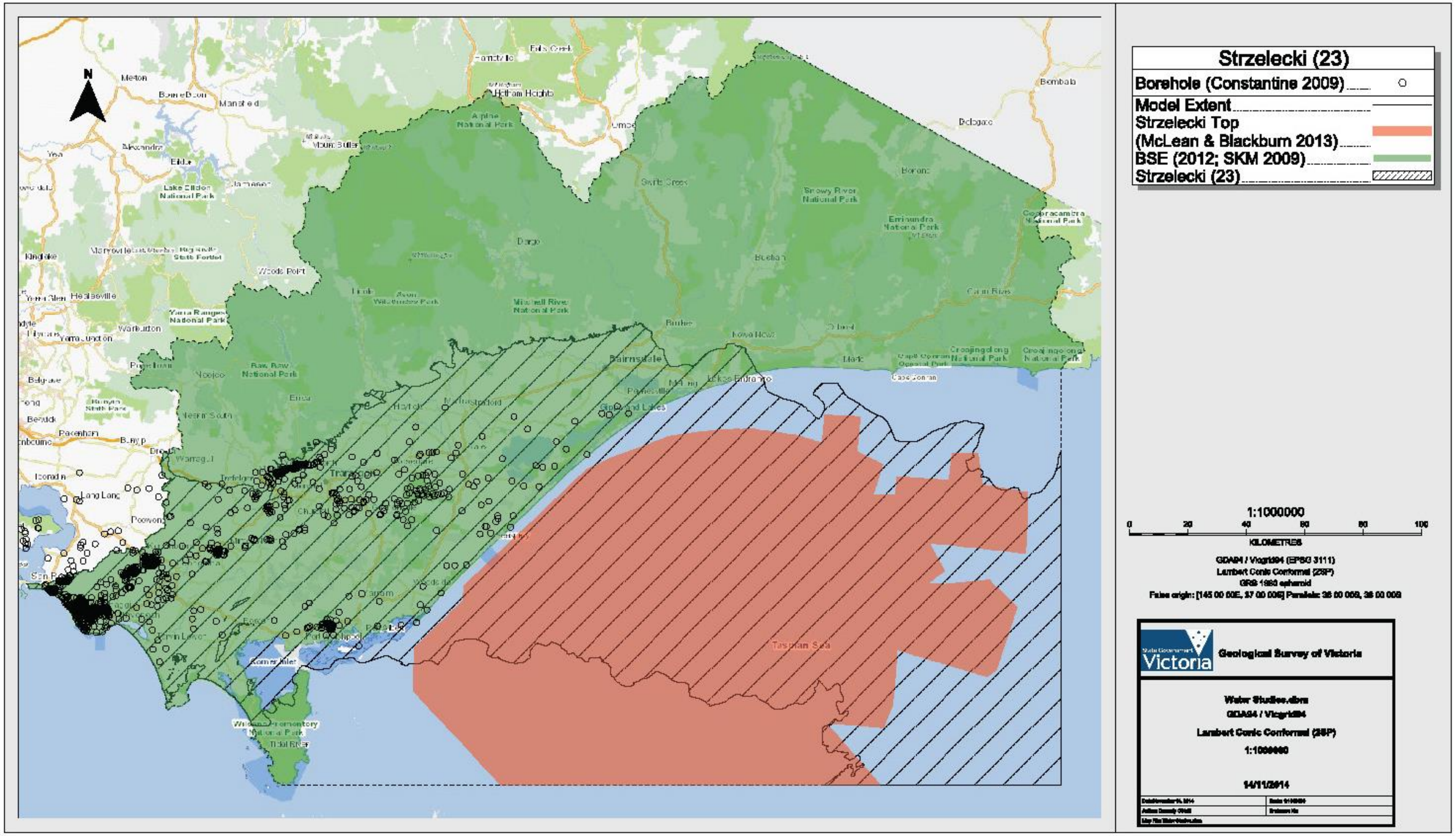
The T2 coals range in thickness from 2 m to 448 m with the thicker coals tracing the Baragwaneth Anticline and thinner coals north of the Rosedale Fault.



HGU 22 - Represents the Traralgon T2 inter-burden (aquifer) below the T2 coal seams.

T2 Interseam isopachs and extents were determined by subtracting LTA top from T2 Coal floor. Petroleum wells were used for depth control where available. T2 Interseam was incorporated into LTA 18.

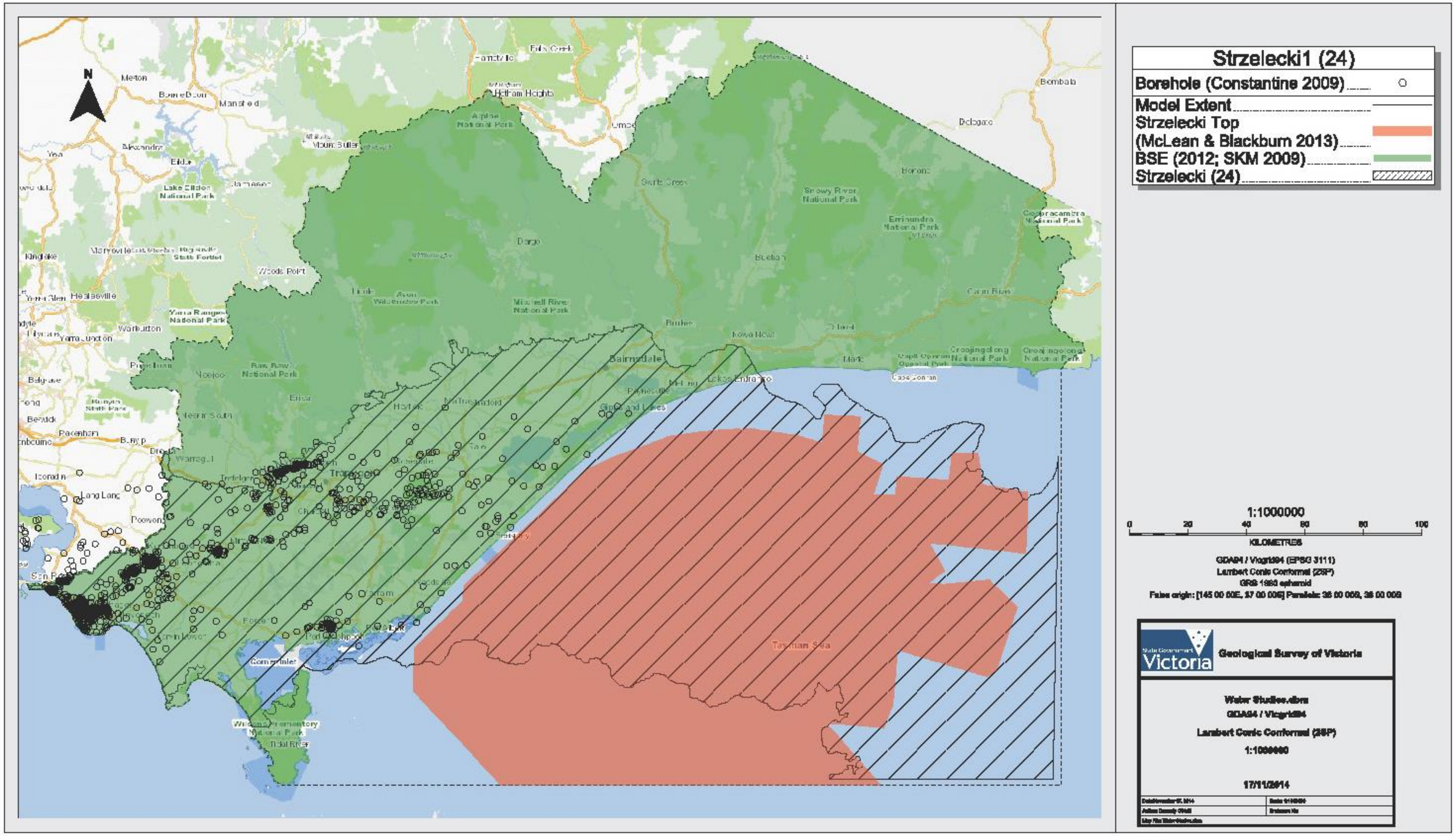
The T2 Interseam ranges in thickness from 2 m to 2645 m offshore where top Strzelecki Group is deeper.



HGU 23 – Represents the upper 500 m of the Strzelecki Group and includes the Wombat gas fields near Seaspray and the historical Black Coal mines at Wonthaggi.

Areas where the Palaeozoic Basement outcrops were clipped from BSE, GHD (2012), to produce the Strzelecki HGU onshore. This surface was then blended with the offshore top Strzelecki (McLean and Blackburn, 2013) using a 10km feathering distance. The unit extends to the intersection with Palaeozoic Basement (30) at which point it has been clipped.

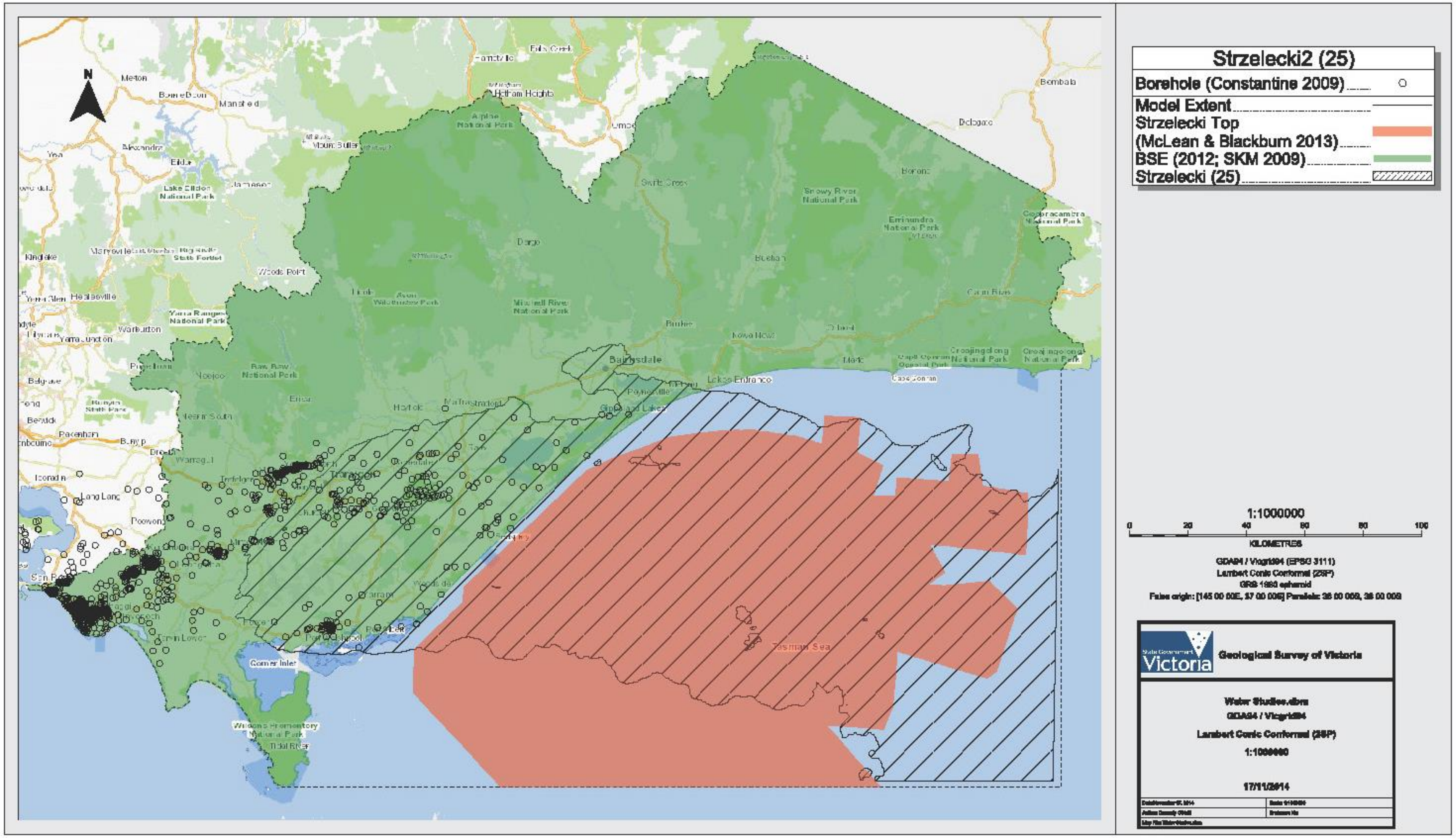
Strzelecki ranges in thickness from 2 m to 624 m.



HGU 24 – Represents from 500 m to 1000 m depth within the Strzelecki Group.

The Strzelecki Group was arbitrarily subdivided by subtracting a 500 m thick slab from Strzelecki (23). The unit extends to the intersection with Palaeozoic Basement (30) at which point it has been clipped.

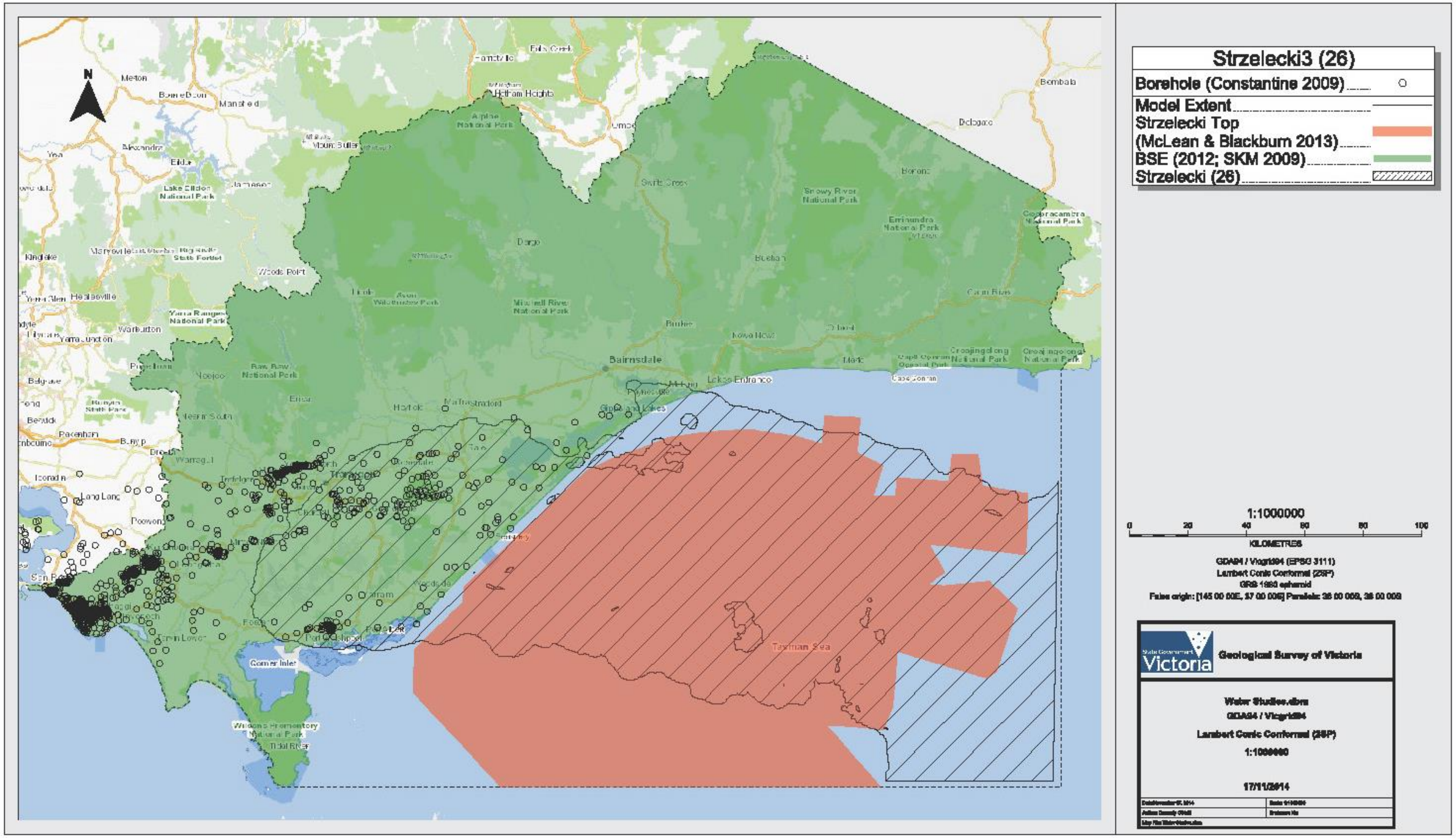
Strzelecki1 ranges in thickness from 2 m to 545 m.



HGU 25 – Represents from 1000 m to 2000 m depth within the Strzelecki Group.

The Strzelecki Group was arbitrarily subdivided by subtracting a 1000m thick slab from Strzelecki1 (23). The unit extends to the intersection with Palaeozoic Basement (30) at which point it has been clipped.

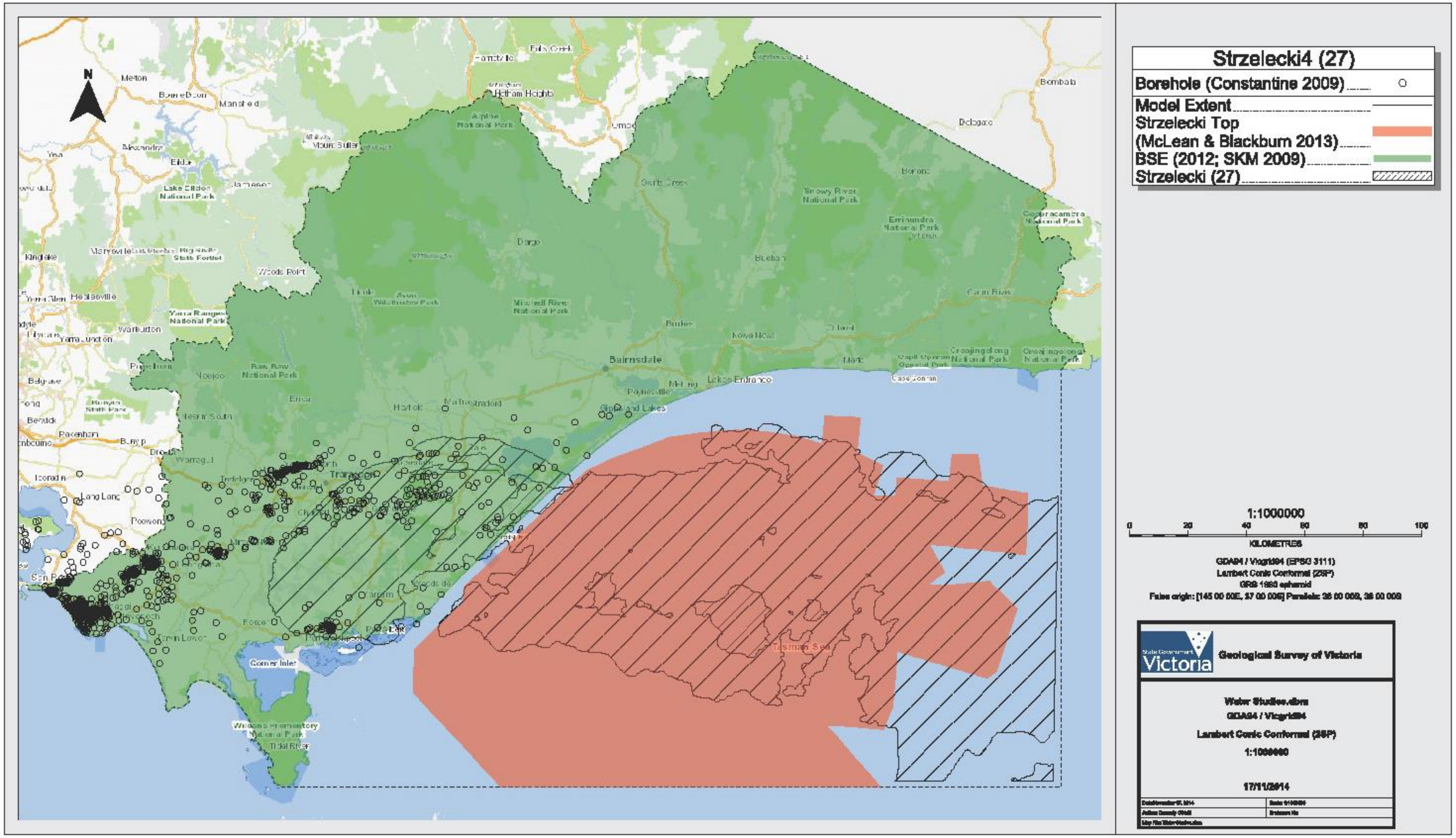
Strzelecki2 ranges in thickness from 2 m to 1000 m.



HGU 26 – Represents from 2000 m to 3000 m depth within the Strzelecki Group.

The Strzelecki Group was arbitrarily subdivided by subtracting a 1000m thick slab from Strzelecki2 (25). The unit extends to the intersection with Palaeozoic Basement (30) at which point it has been clipped.

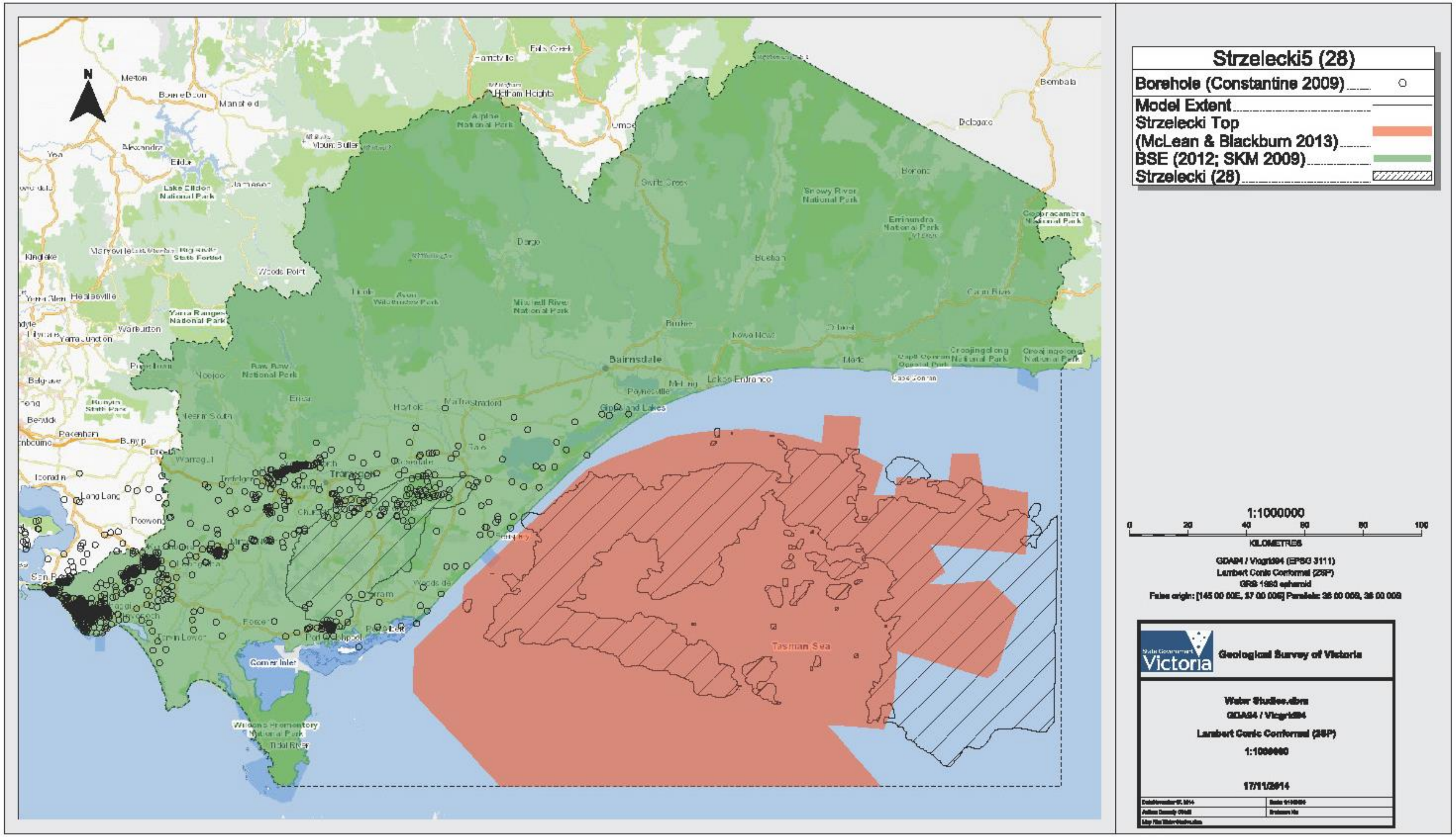
Strzelecki3 ranges in thickness from 2 m to 1000 m.



HGU 27 – Represents from 3000 m to 400 m depth within the Strzelecki Group.

The Strzelecki Group was arbitrarily subdivided by subtracting a 500m thick slab from Strzelecki3 (26). The unit extends to the intersection with Palaeozoic Basement (30) at which point it has been clipped.

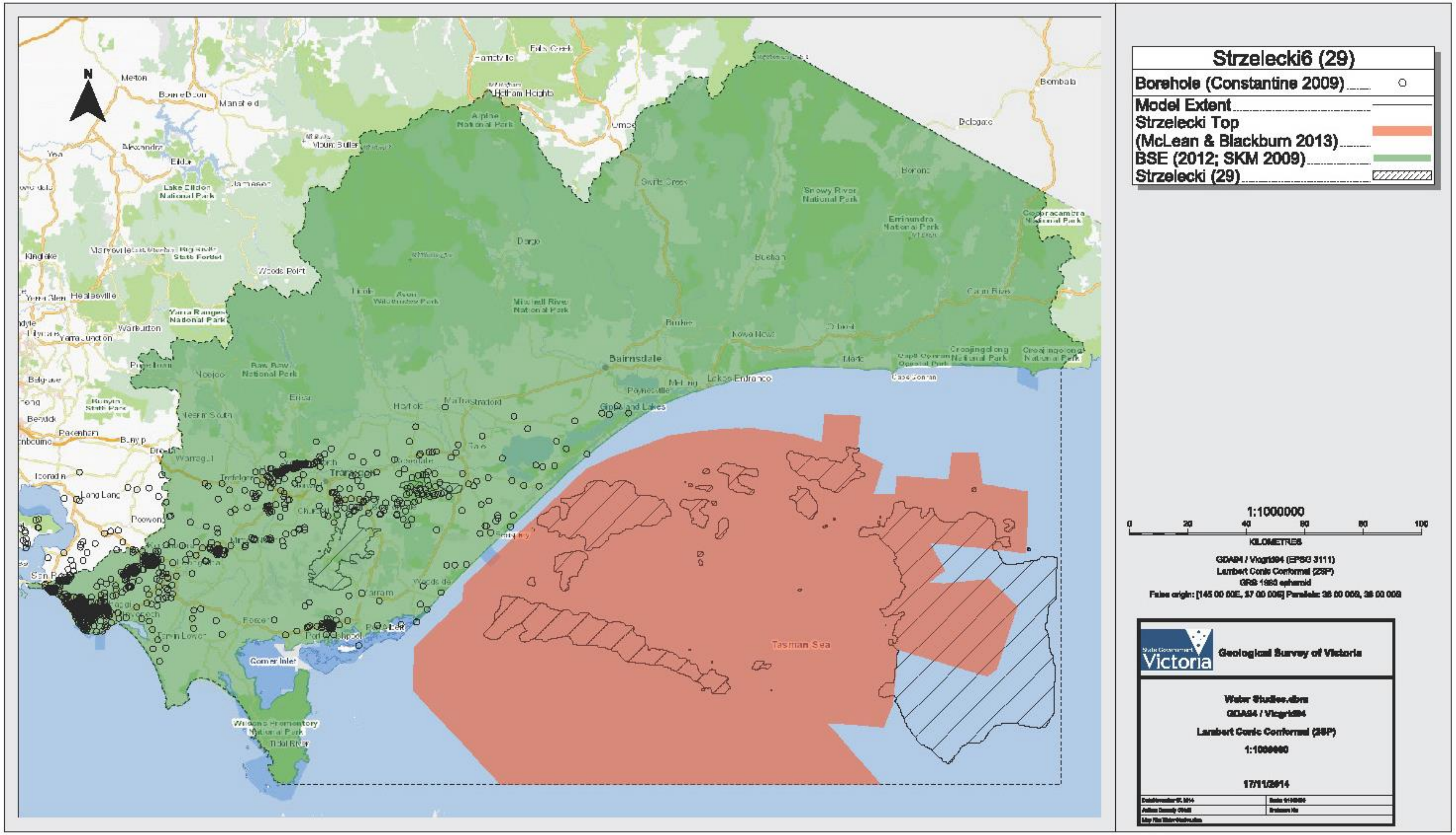
Strez4 ranges in thickness from 2 m to 1000 m.



HGU 28 – Represents from 4000 m to 7000 m depth within the Strzelecki Group.

The Strzelecki Group was arbitrarily subdivided by subtracting a 3000 m thick slab from Strzelecki4 (27). The unit extends to the intersection with Palaeozoic Basement (30) at which point it has been clipped.

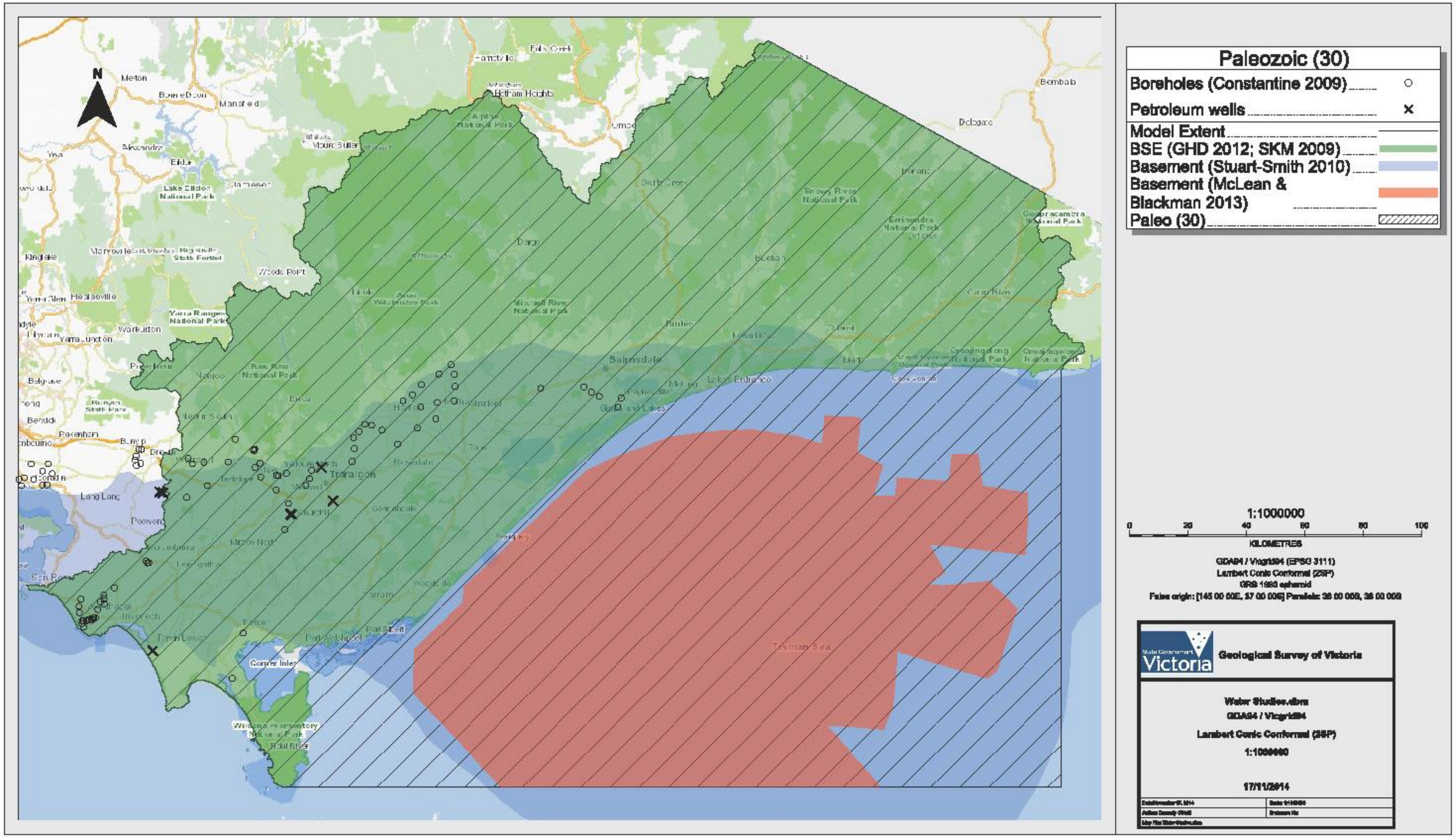
Strzelecki5 ranges in thickness from 2 m to 3134 m.



HGU 29 – Represents from 7000 m to Palaeozoic Basement depth within the Strzelecki Group.

The Strzelecki Group was arbitrarily subdivided and Strzelecki6 represents the remaining Strzelecki Group not already incorporated into overlying layers. The unit extends to the intersection with Palaeozoic Basement (30) at which point it has been clipped.

Strzelecki6 ranges in thickness from 266 m to 4000 m.



HGU 30 – Represents the Palaeozoic Basement.

Internal GSV grids were used as the foundation for the Palaeozoic (30) HGU. The Palaeozoic surface was then modified in the following ways: BSE (GHD 2012; SKM 2009) was clipped to the extent of Palaeozoic outcrop and merged with Palaeozoic basement; Basement intersections from Constantine (2009) were used to constrain Palaeozoic basement depth; Strzelecki intersections from (Constantine 2009) were used to limit the upward extent; Interpretations based on isostatic gravity anomalies were used to mould the geometry of troughs; offshore basement surfaces from McLean & Blackman (2013) and Stuart-Smith et al. (2010) were merged together.

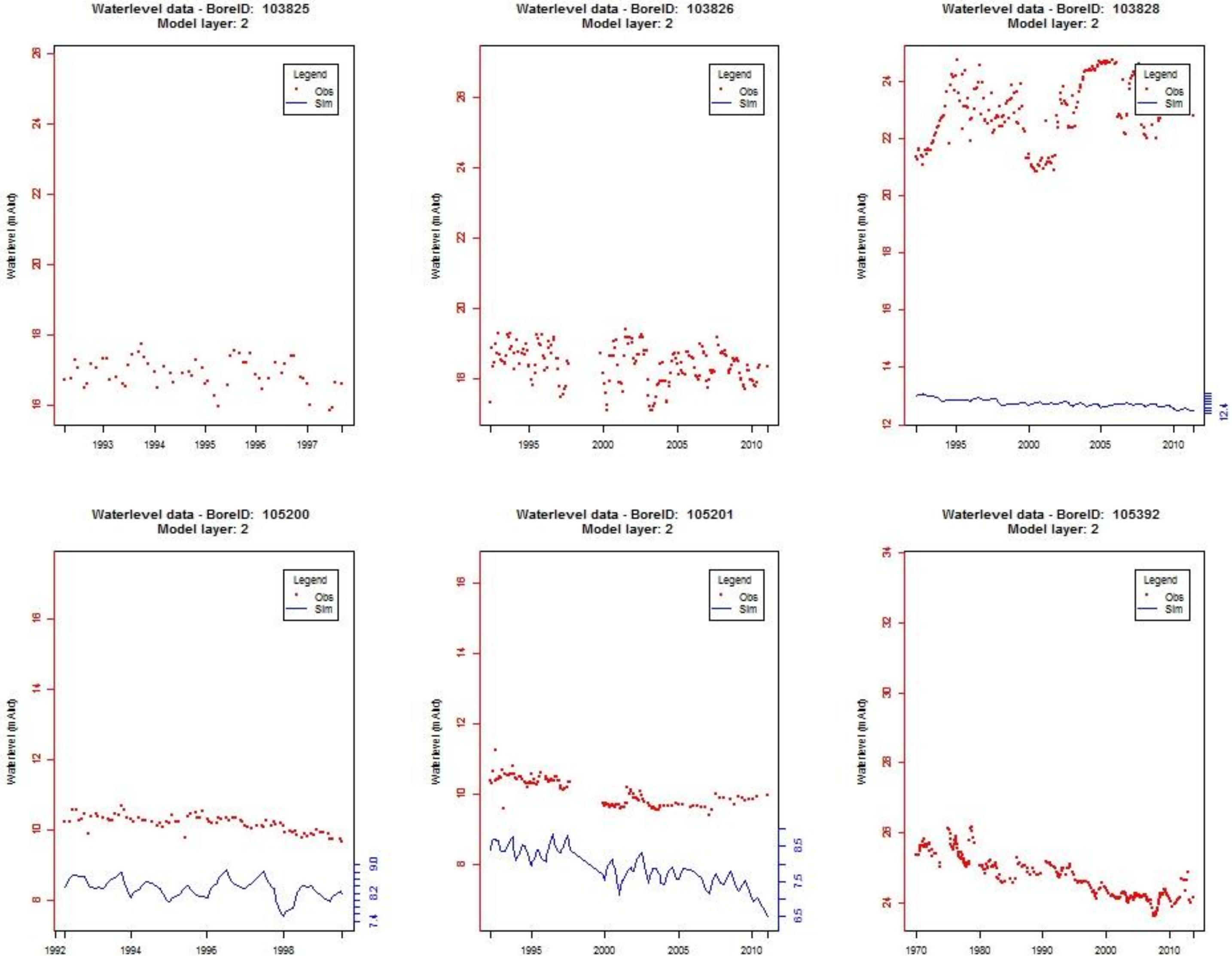
The Palaeozoic HGU ranges in thickness from 2 m to 262 m.

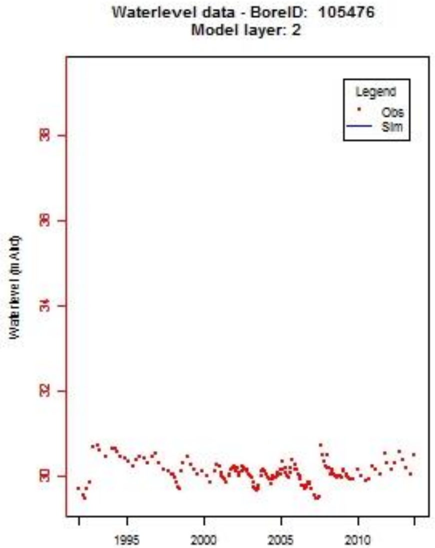
Model layer	Name	Inputs	Geology - Comment	References
1	Marine Water	Bathymetry	Marine water thickness	Whiteway (2009)
2	QA	VAF 101	Quaternary	GHD (2012) SKM (2009)
3	UTQA	VAF 102; -10m elevation contour	Haunted Hill Formation	GHD (2012) SKM (2009)
4	UTQD	VAF 103	Nuntin clay	GHD (2012) SKM (2009)
5	UTAF	VAF 105	Boisdale Formation	GHD (2012) SKM (2009)
6	UTD	VAF 106	Jemmys Point Formation and upper Hazelwood Formation	GHD (2012) SKM (2009)
7	Y COAL	VAF 106 Yallourn Coal (isopach)	Yallourn coal seams; 1,1a, 1b and 2	GHD (2012) SKM (2009) GHD (2011)
8	Y Interseam	VAF 106 Yallourn Coal Interseam	y_all floor & M1a_all top	GHD (2012) SKM (2009) GHD (2011)
9	UMT A&D	UMTA 107 UMTD 108	Balook Formation Tambo River, Wuk Wuk Marl, Gippsland Limestone, Morwell Coals	GHD (2012) SKM (2009)
10	M1A COAL	UMTA 107 Morwell 1A coal (isopach)	Yarragon Formation, M10, M1a, M1b2, ML, M12; M1a_all	GHD (2012) SKM (2009) GHD (2011)
11	M1A Interseam	UMTA 107 Morwell 1A Interseam	M1a_all_floor & M1b_top	GHD (2012) SKM (2009) GHD (2011)
12	M1B COAL	UMTA 107 Morwell 1B coal (isopach)	M1b, M1b1, M1b2, ML, M12	GHD (2012) SKM (2009)

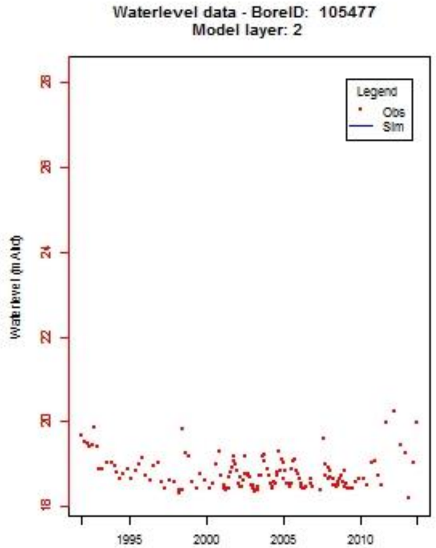
Model layer	Name	Inputs	Geology - Comment	References
				GHD (2011)
13	M1B Interseam	UMTA 107 Morwell 1B Interseam	Floor M1b_all & M2_all top	GHD (2012) SKM (2009) GHD (2011)
14	M2 COAL	UMTA 107 Morwell 2 coal (isopach)	M2, M2A, M2B coal; M2_all	GHD (2012) SKM (2009) GHD (2011)
15	LEF	LEF Top; LEF Terminal Seal; LEF well picks	Lake Entrance Formation	McLean & Blackburn. (2013); (Blevin et al, 2013); Goldie Divko pers. comm. (2014)
16	LMTA	LMTA 109 Morwell 2 interseam,	M2c aquifer/Seaspray sands	GHD (2012) SKM (2009)
17	LTB	LTB 112	Thorpdale Volcanics	GHD (2012) SKM (2009)
18	LTA	LTA 111 Top La Trobe Petroleum wells	Upper Latrobe Group	GHD (2012) SKM (2009) McLean & Blackburn (2013)
19	T1 COAL	LTA 111 T0 & T1 Coal Petroleum wells	TP, T1, TRU, TRM, TRL	GHD (2012) SKM (2009) GHD (2011)
20	T1 Interseam	LTA 111 T1-T2 interseam Petroleum wells	Floor T1_all & Top T2_all	GHD (2012) SKM (2009) GHD (2011)
21	T2 COAL	LTA 111 T2 coal Petroleum wells	T2 coal seams	GHD (2012) SKM (2009) GHD (2011) Osbourne et al. (2014)
22	T2 Interseam	LTA 111 T2 interseam	Lower Latrobe Group; T2_all floor &	GHD (2012) SKM (2009)

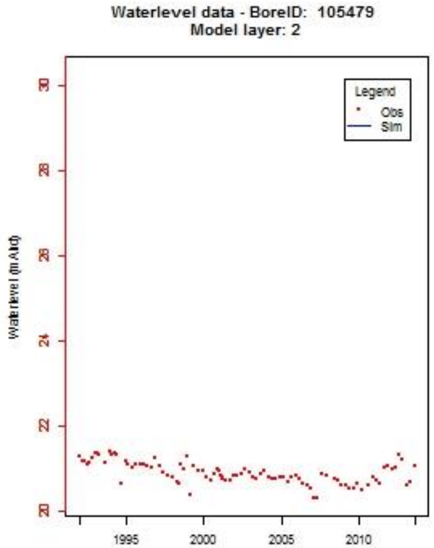
Model layer	Name	Inputs	Geology - Comment	References
		Petroleum wells		GHD (2011) Osbourne et al. (2014)
23	STRZ	BSE 114	Strzelecki 500 m; >0–500 m	GHD (2012) SKM (2009) McLean & Blackburn (2013)
24	STRZ1	BSE 114	Strzelecki 500 m; >500–1000 m	GHD (2012) SKM (2009) McLean & Blackburn (2013)
25	STRZ2	BSE 114	Strzelecki 1 km; >1000–2000 m	GHD (2012) SKM (2009) McLean & Blackburn (2013)
26	STRZ3	BSE 114	Strzelecki 2 km; >2000–3000 m	GHD (2012) SKM (2009) McLean & Blackburn (2013)
27	STRZ4	BSE 114	Strzelecki 2 km; >3000–4000 m	GHD (2012) SKM (2009) McLean & Blackburn (2013)
28	STRZ5	BSE 114	Strzelecki 3 km; >3000–7000 m	GHD (2012) SKM (2009) McLean & Blackburn (2013)
29	STRZ6	BSE 114	Strzelecki; >7000 m	GHD (2012) SKM (2009) McLean & Blackburn (2013)
30	PALEO	BSE 114	Palaeozoic basement 200 m thick	GHD (2012) SKM (2009) McLean & Blackburn (2013) Stuart-Smith et al. (2010) Constantine (2009)

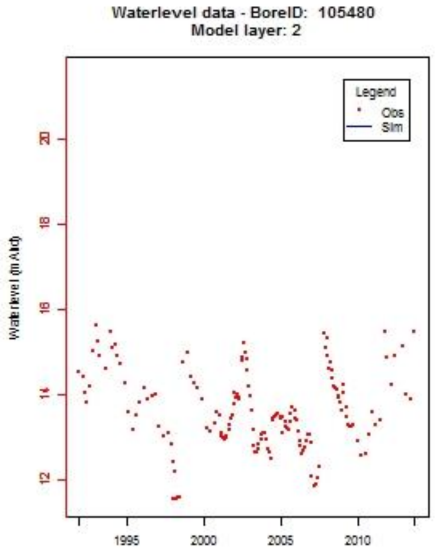
Appendix H: Time-series simulated versus observed water level data

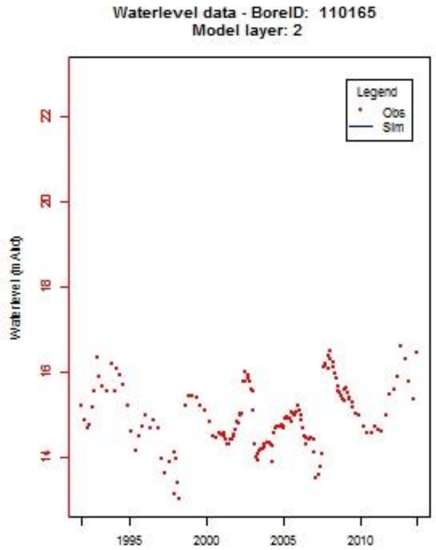

Waterlevel data - BoreID: 103825
Model layer: 2
Waterlevel data - BoreID: 103826
Model layer: 2
Waterlevel data - BoreID: 103828
Model layer: 2
Waterlevel data - BoreID: 105200
Model layer: 2
Waterlevel data - BoreID: 105201
Model layer: 2
Waterlevel data - BoreID: 105392
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

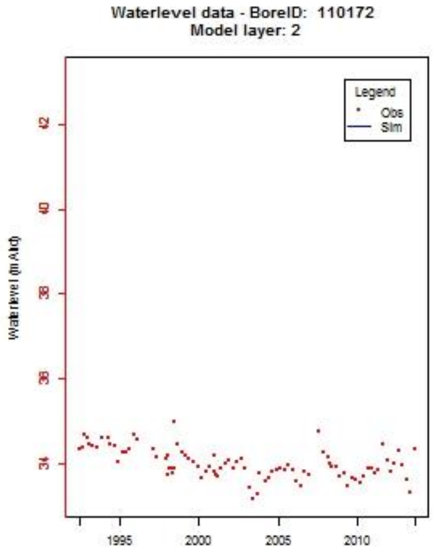

Waterlevel data - BoreID: 105476
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim
1995
2000
2005
2010

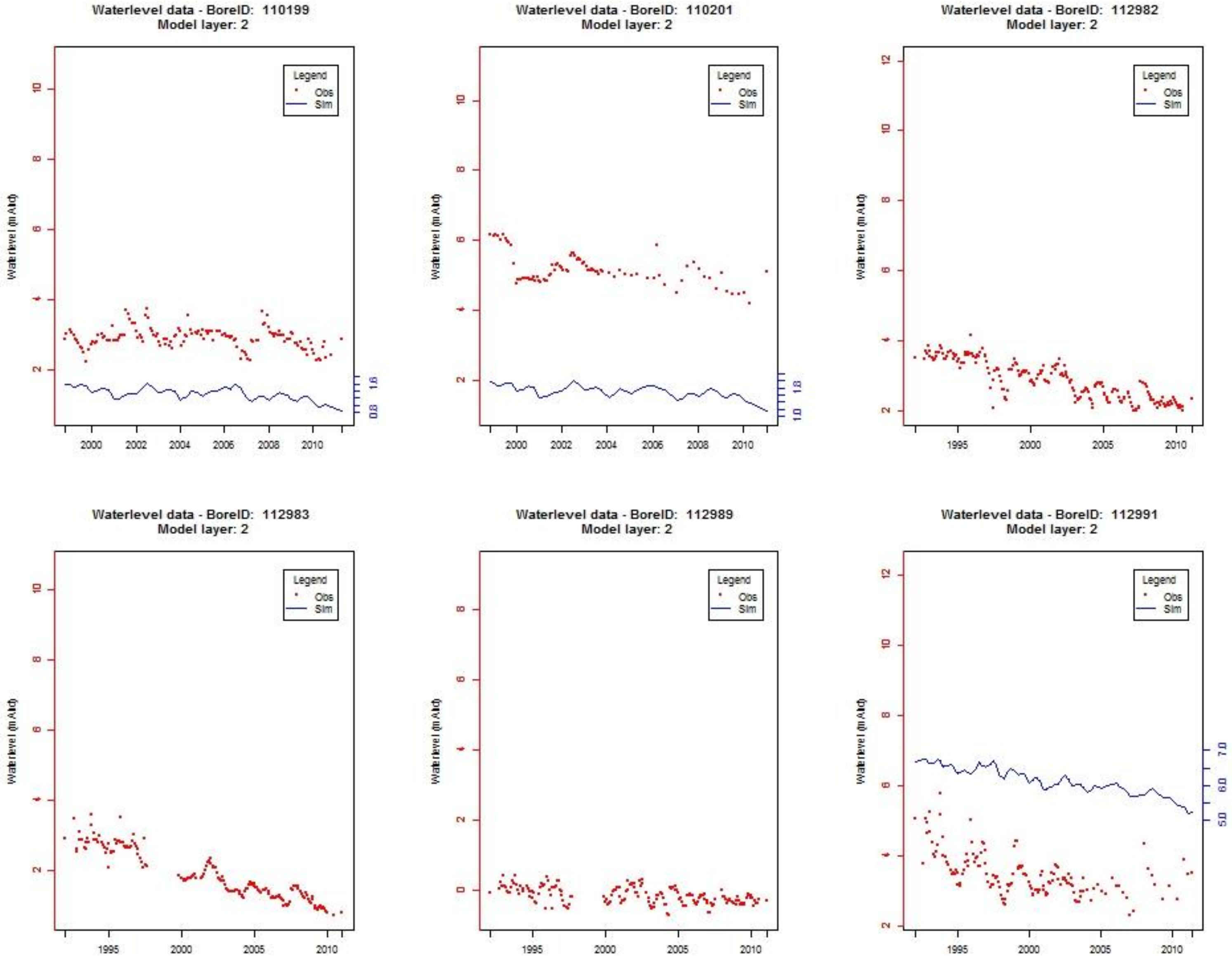

Waterlevel data - BoreID: 105477
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim
1995
2000
2005
2010

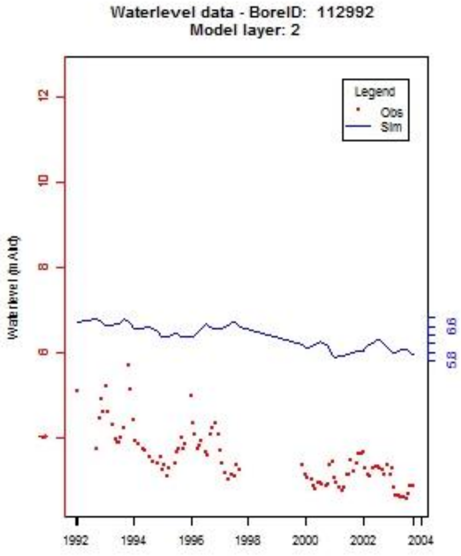

Waterlevel data - BoreID: 105479
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim
1995
2000
2005
2010

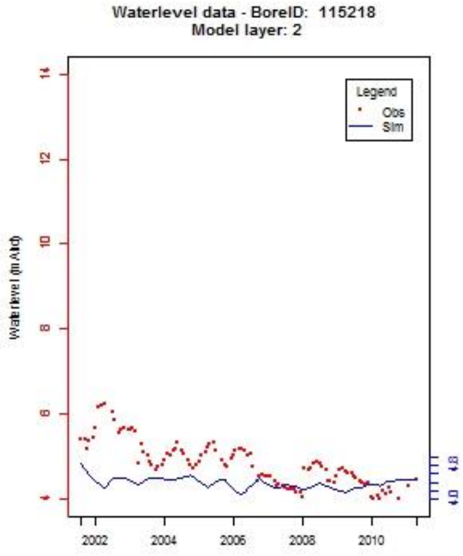

Waterlevel data - BoreID: 105480
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim
1995
2000
2005
2010

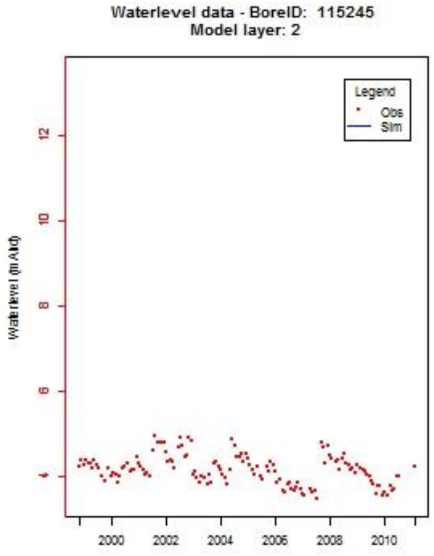

Waterlevel data - BoreID: 110165
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim
1995
2000
2005
2010

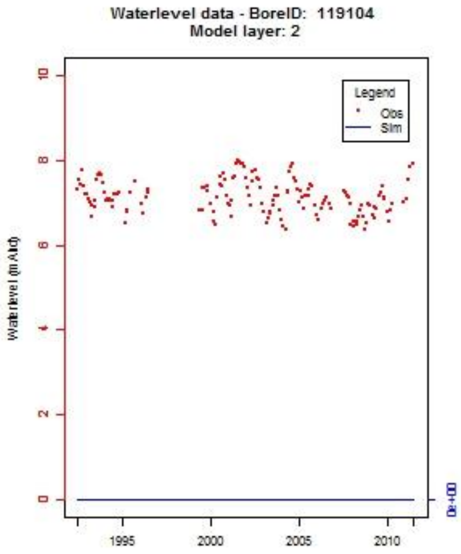

Waterlevel data - BoreID: 110172
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim
1995
2000
2005
2010

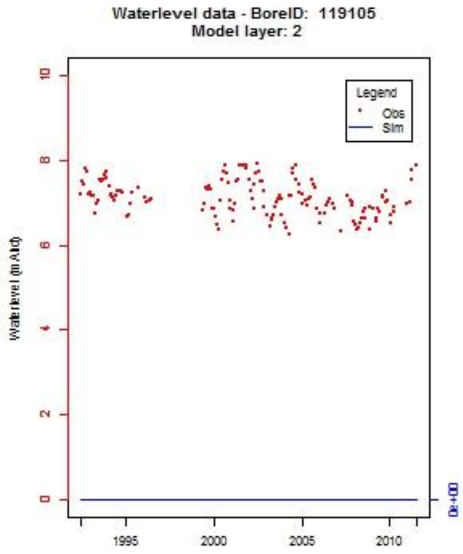

Waterlevel data - BoreID: 110199
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 110201
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 112982
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 112983
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 112989
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 112991
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

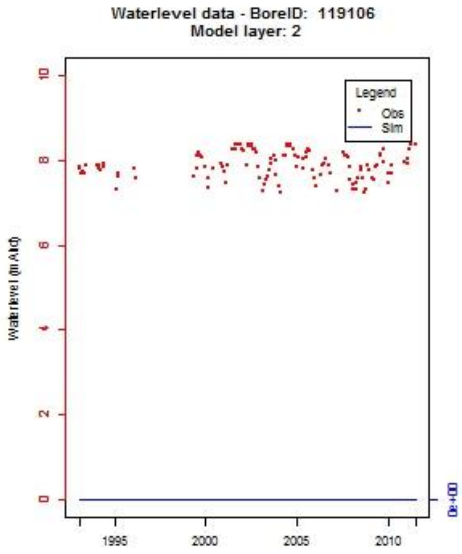

Waterlevel data - BoreID: 112992
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

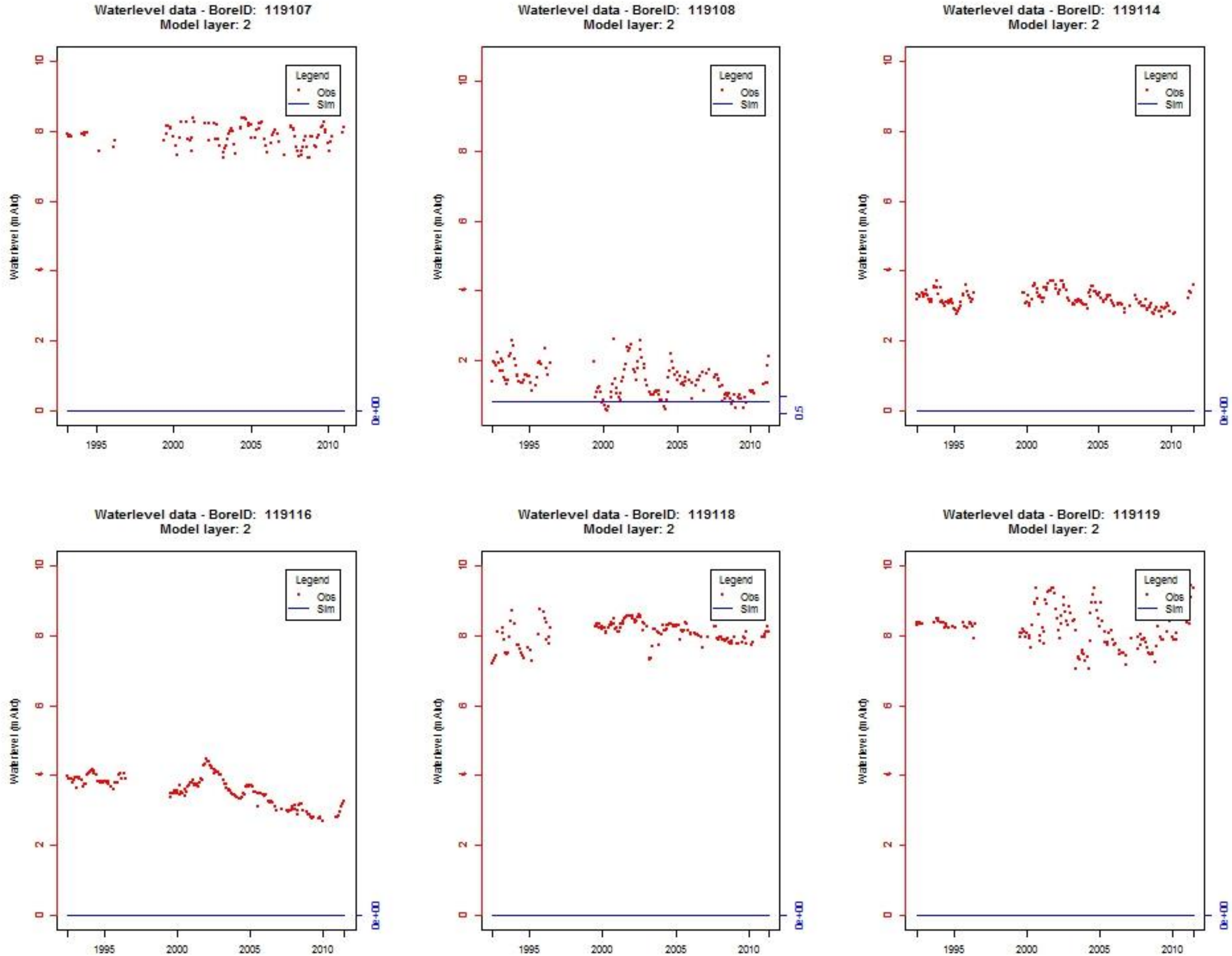

Waterlevel data - BoreID: 115218
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

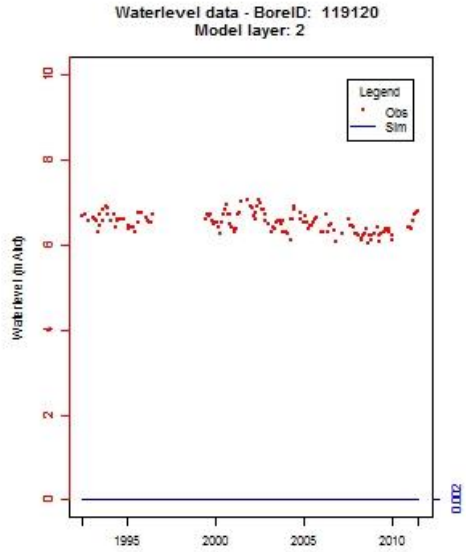

Waterlevel data - BoreID: 115245
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

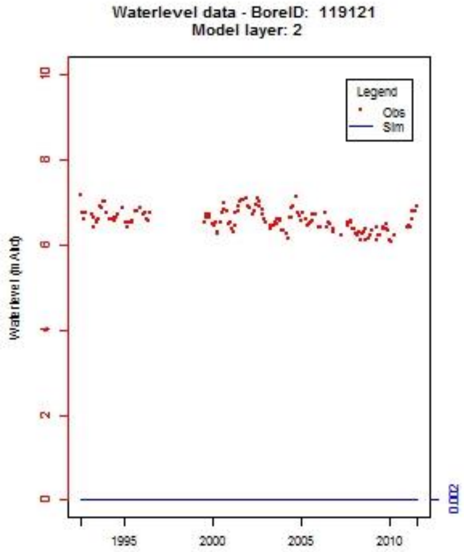

Waterlevel data - BoreID: 119104
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

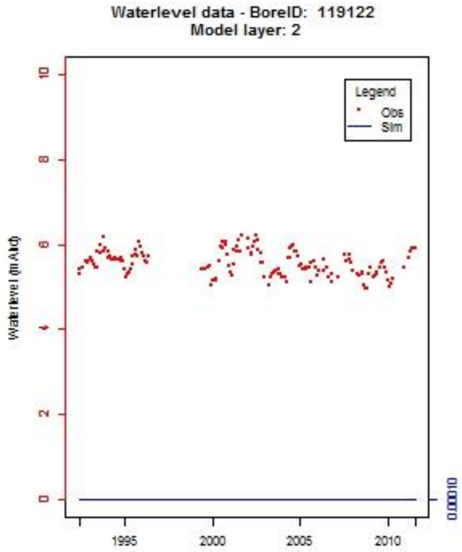

Waterlevel data - BoreID: 119105
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

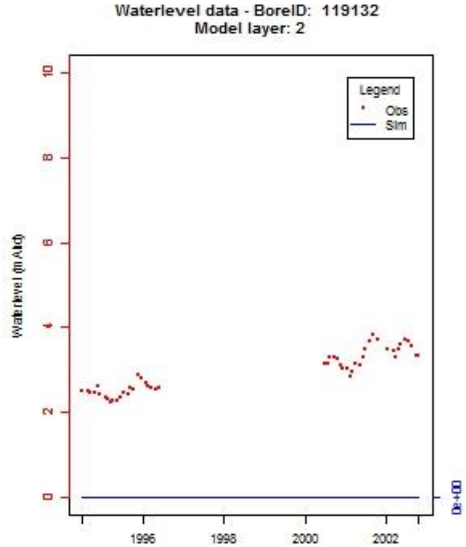

Waterlevel data - BoreID: 119106
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

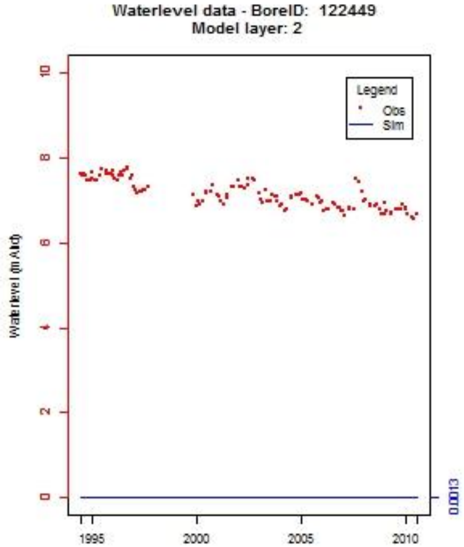

Waterlevel data - BoreID: 119107
Model layer: 2
Waterlevel data - BoreID: 119108
Model layer: 2
Waterlevel data - BoreID: 119114
Model layer: 2
Waterlevel data - BoreID: 119116
Model layer: 2
Waterlevel data - BoreID: 119118
Model layer: 2
Waterlevel data - BoreID: 119119
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010
0e+00
0.5

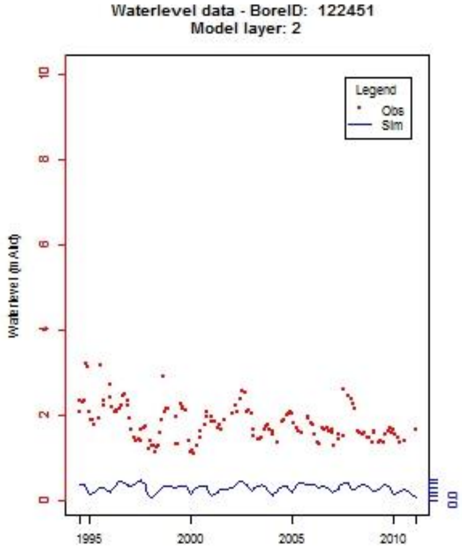

Waterlevel data - BoreID: 119120
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

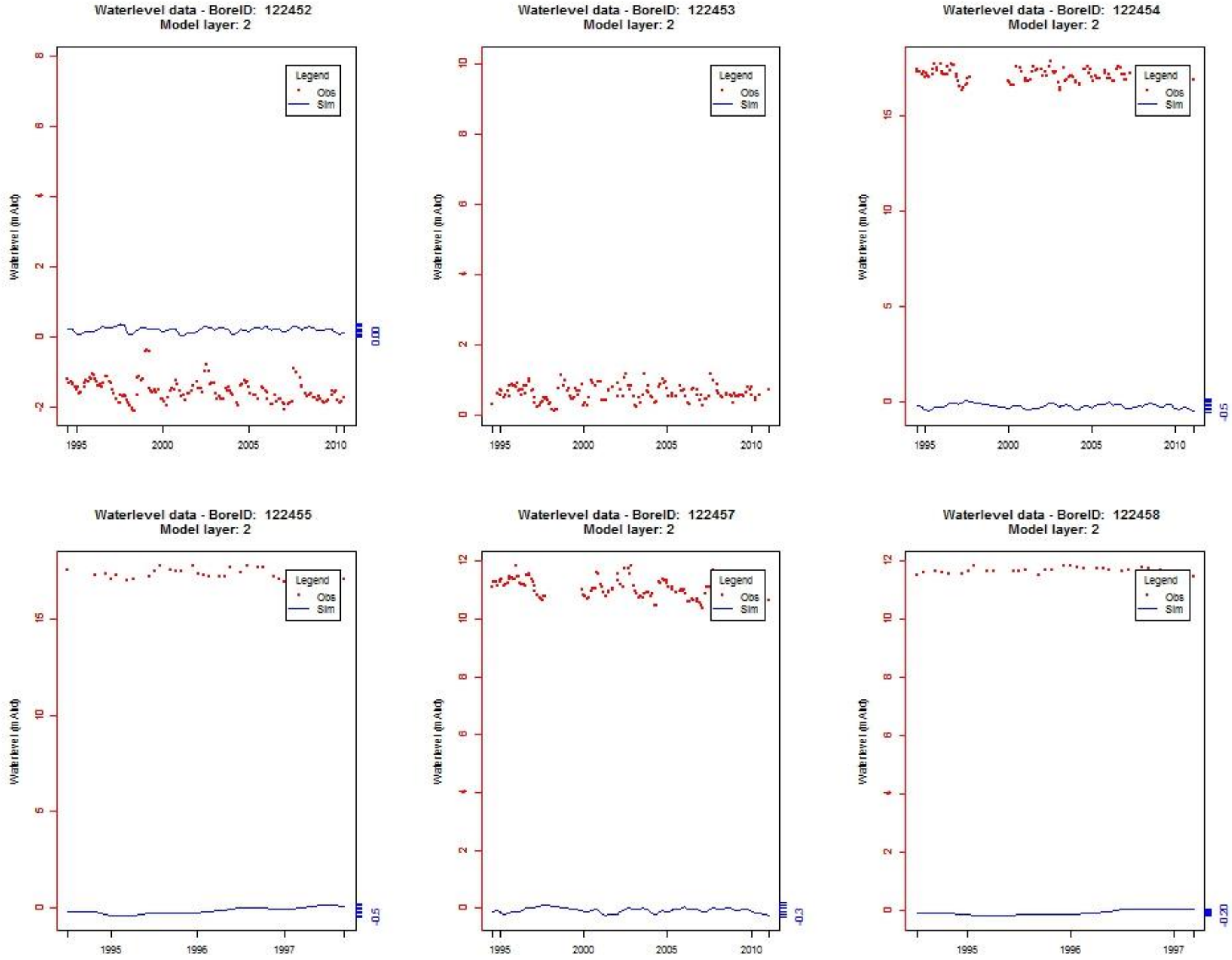

Waterlevel data - BoreID: 119121
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

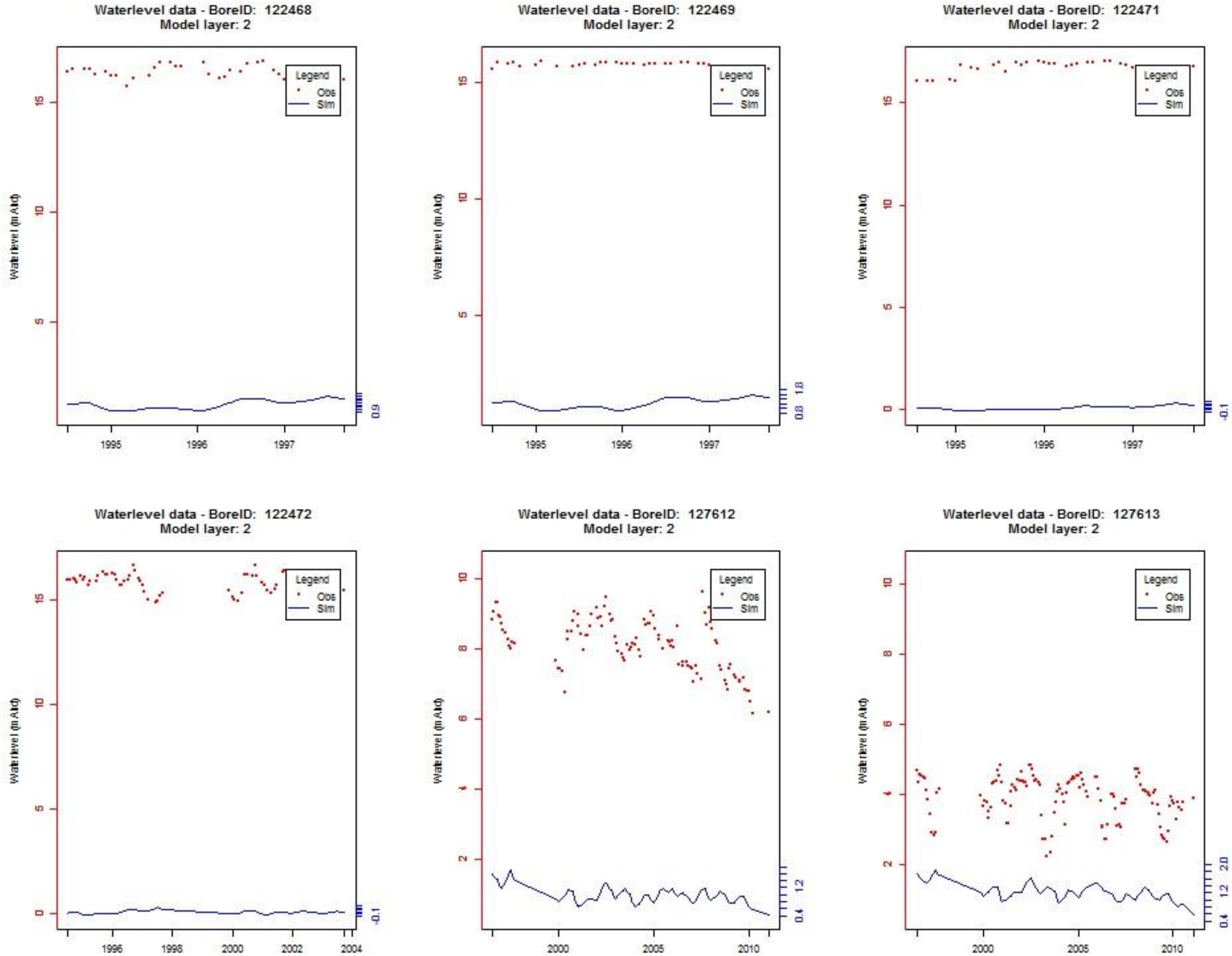

Waterlevel data - BoreID: 119122
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

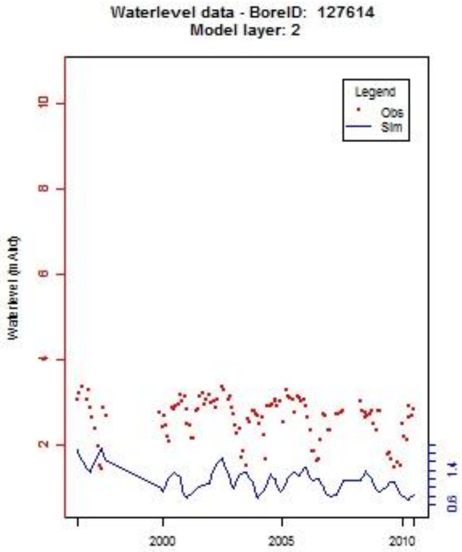

Waterlevel data - BoreID: 119132
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1996
1998
2000
2002

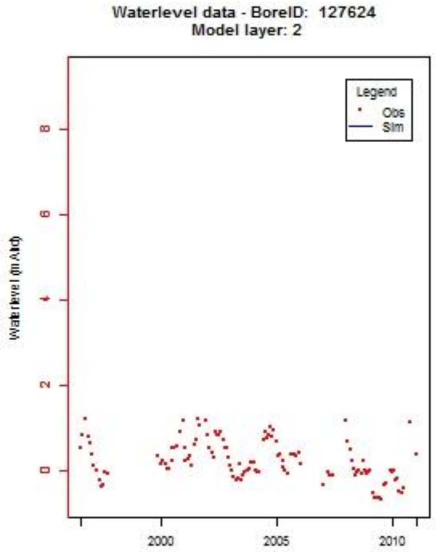

Waterlevel data - BoreID: 122449
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

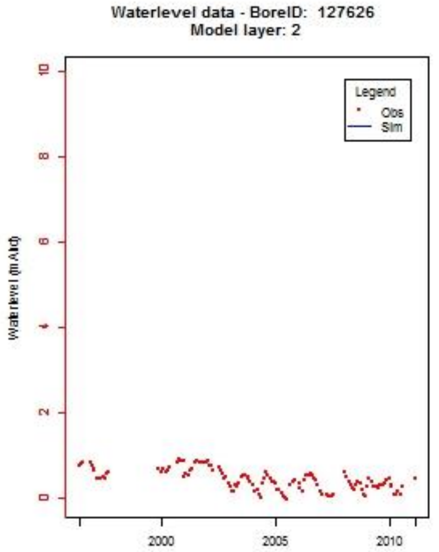

Waterlevel data - BoreID: 122451
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

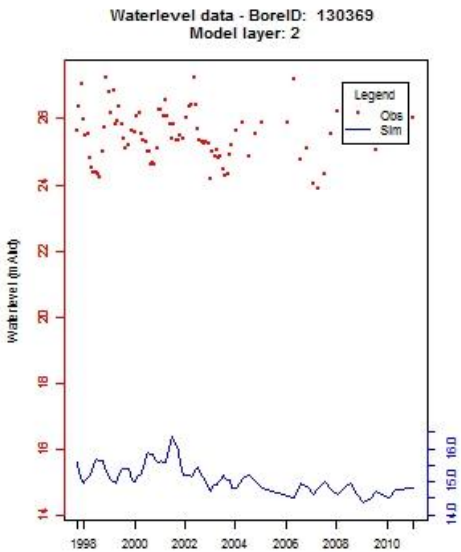

Waterlevel data - BoreID: 122452
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 122453
Model layer: 2
Waterlevel data - BoreID: 122454
Model layer: 2
Waterlevel data - BoreID: 122455
Model layer: 2
Waterlevel data - BoreID: 122457
Model layer: 2
Waterlevel data - BoreID: 122458
Model layer: 2

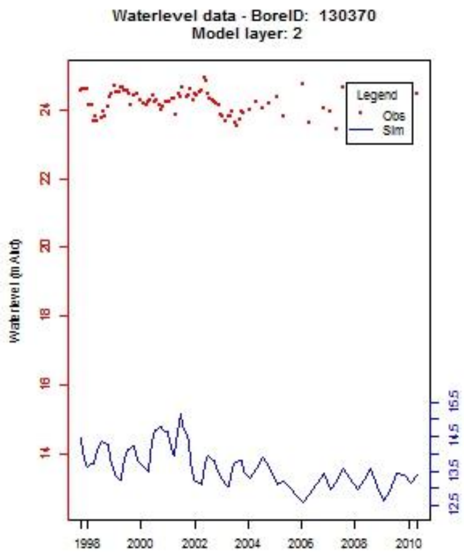

Waterlevel data - BoreID: 122468
Model layer: 2
Waterlevel data - BoreID: 122469
Model layer: 2
Waterlevel data - BoreID: 122471
Model layer: 2
Waterlevel data - BoreID: 122472
Model layer: 2
Waterlevel data - BoreID: 127612
Model layer: 2
Waterlevel data - BoreID: 127613
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

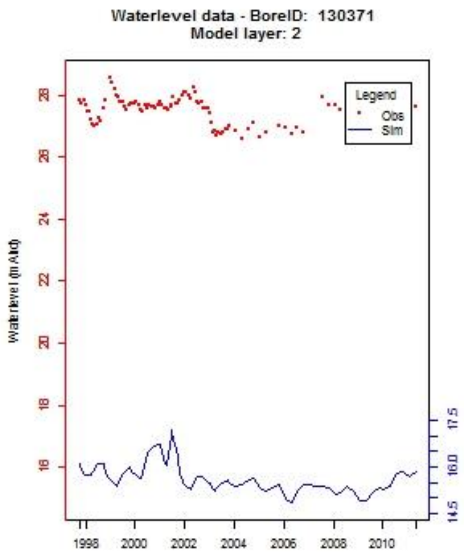

Waterlevel data - BoreID: 127614
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

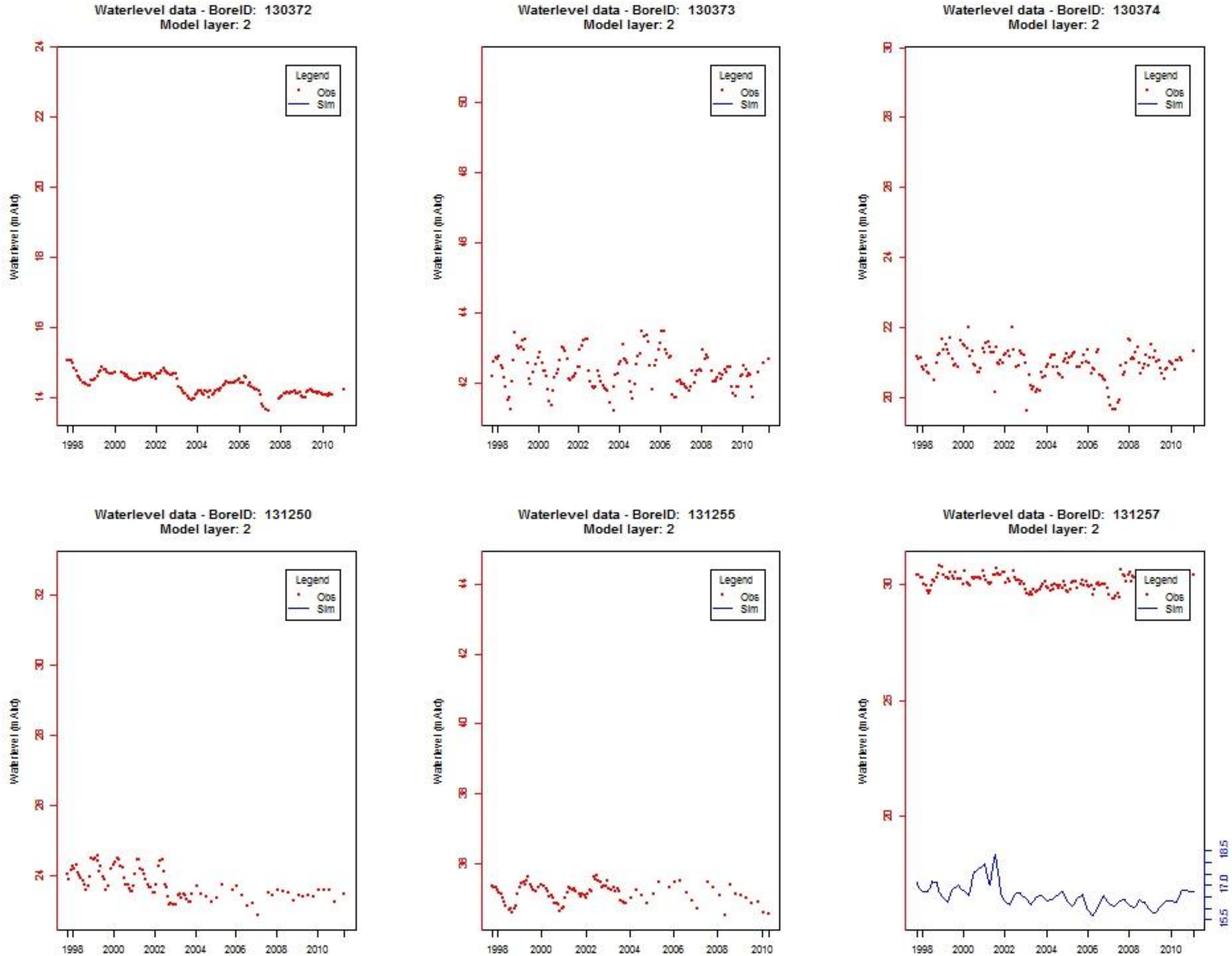

Waterlevel data - BoreID: 127624
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

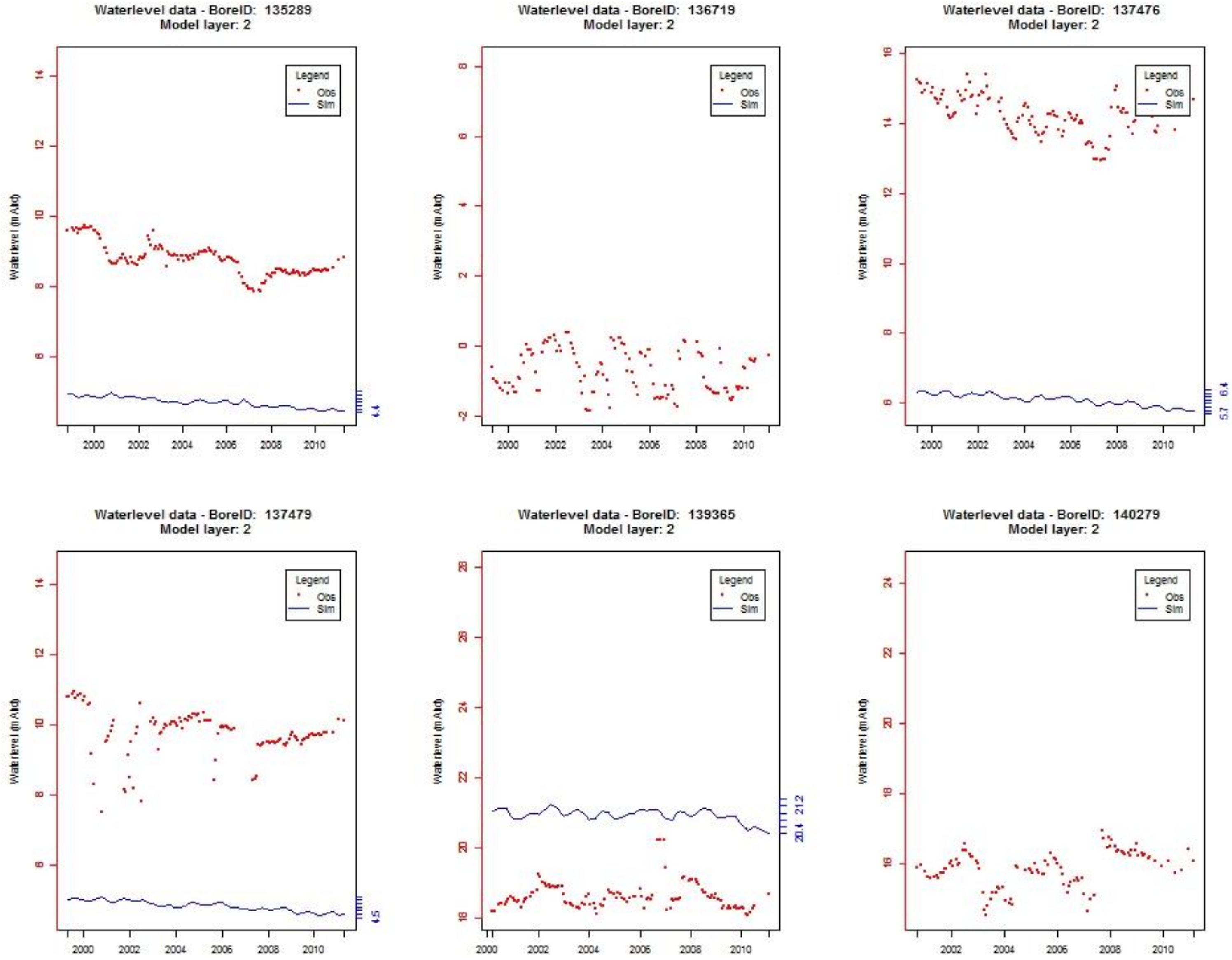

Waterlevel data - BoreID: 127626
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

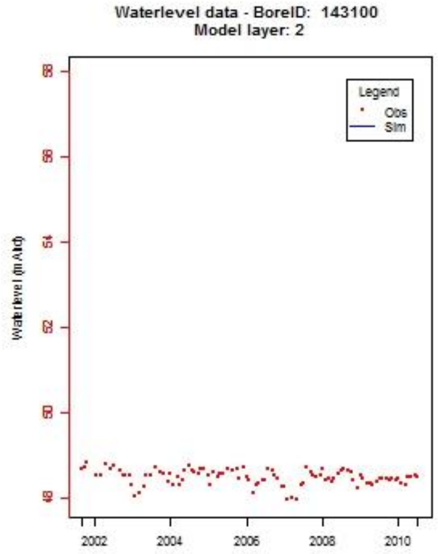

Waterlevel data - BoreID: 130369
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

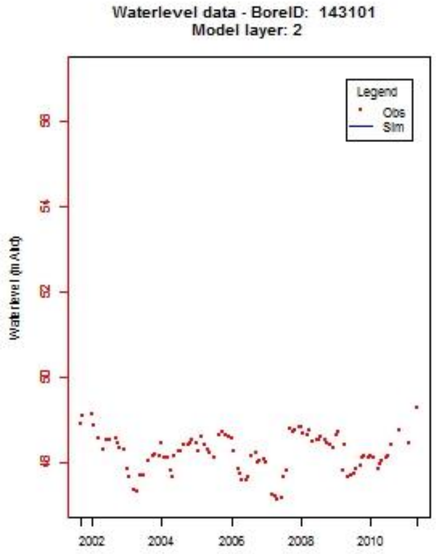

Waterlevel data - BoreID: 130370
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

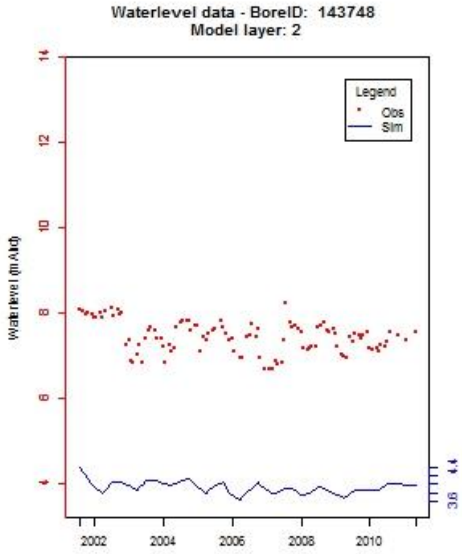

Waterlevel data - BoreID: 130371
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

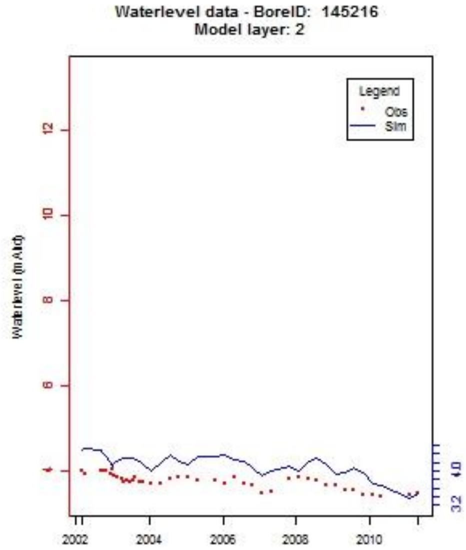

Waterlevel data - BoreID: 130372
Model layer: 2
Waterlevel data - BoreID: 130373
Model layer: 2
Waterlevel data - BoreID: 130374
Model layer: 2
Waterlevel data - BoreID: 131250
Model layer: 2
Waterlevel data - BoreID: 131255
Model layer: 2
Waterlevel data - BoreID: 131257
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1998
2000
2002
2004
2006
2008
2010

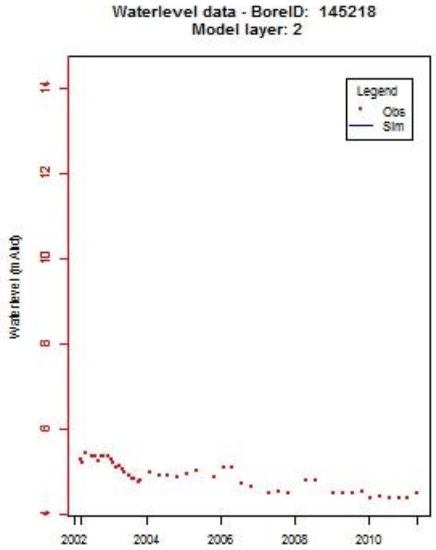

Waterlevel data - BoreID: 135289
Model layer: 2
Waterlevel data - BoreID: 136719
Model layer: 2
Waterlevel data - BoreID: 137476
Model layer: 2
Waterlevel data - BoreID: 137479
Model layer: 2
Waterlevel data - BoreID: 139365
Model layer: 2
Waterlevel data - BoreID: 140279
Model layer: 2
Legend
Obs
Sim

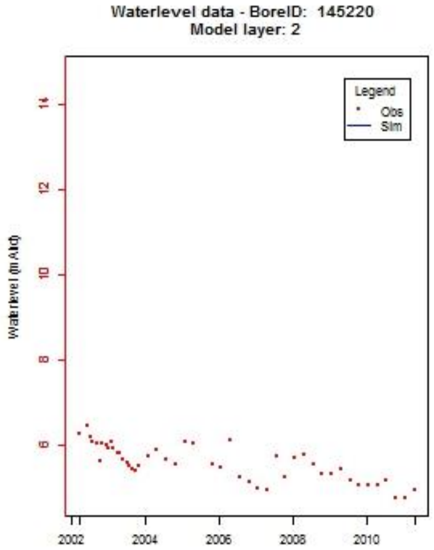

Waterlevel data - BoreID: 143100
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

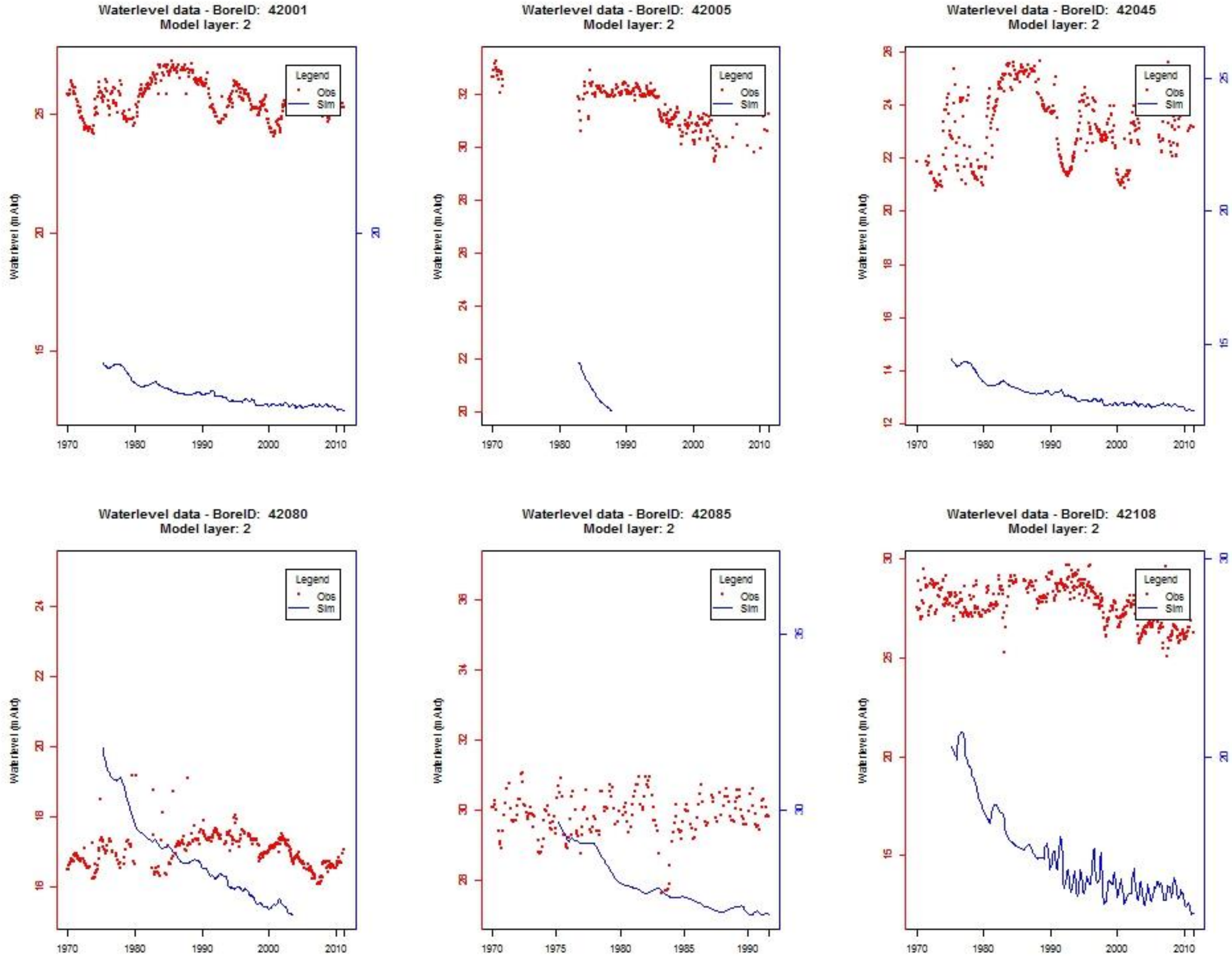

Waterlevel data - BoreID: 143101
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

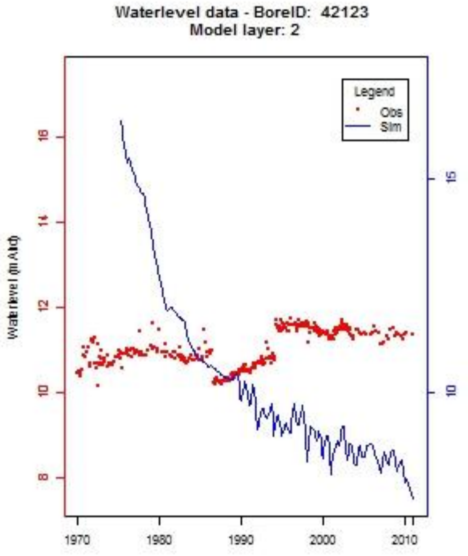

Waterlevel data - BoreID: 143748
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

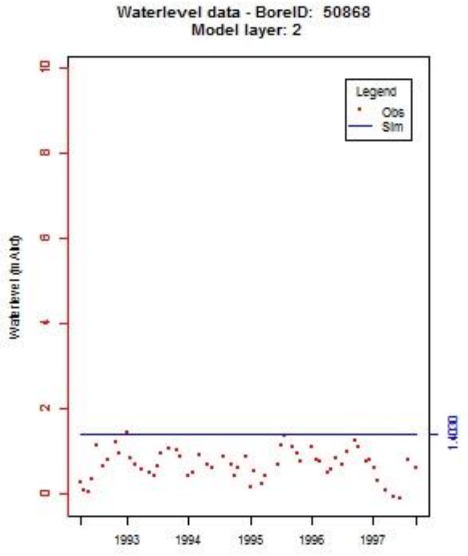

Waterlevel data - BoreID: 145216
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

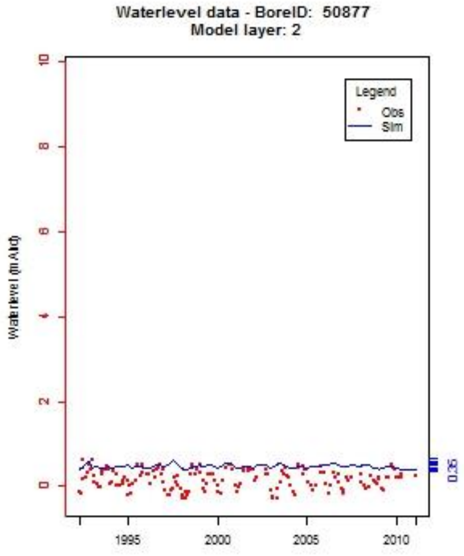

Waterlevel data - BoreID: 145218
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

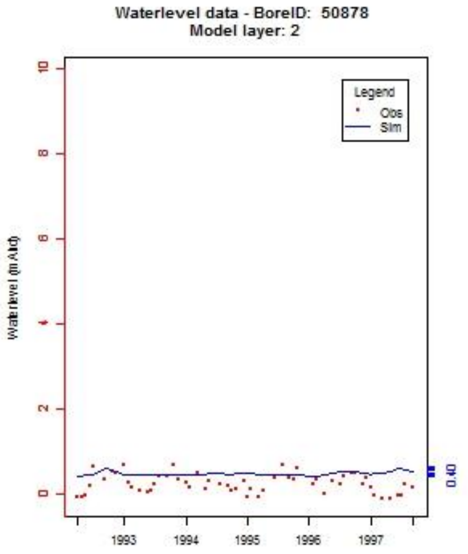

Waterlevel data - BoreID: 145220
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

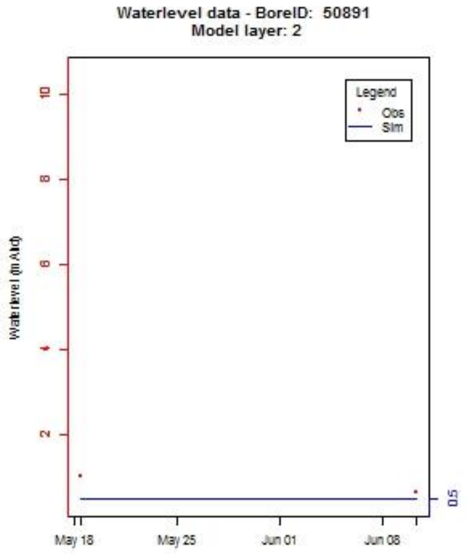

Waterlevel data - BoreID: 42001
Model layer: 2
Waterlevel data - BoreID: 42005
Model layer: 2
Waterlevel data - BoreID: 42045
Model layer: 2
Waterlevel data - BoreID: 42080
Model layer: 2
Waterlevel data - BoreID: 42085
Model layer: 2
Waterlevel data - BoreID: 42108
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010
1975
1985

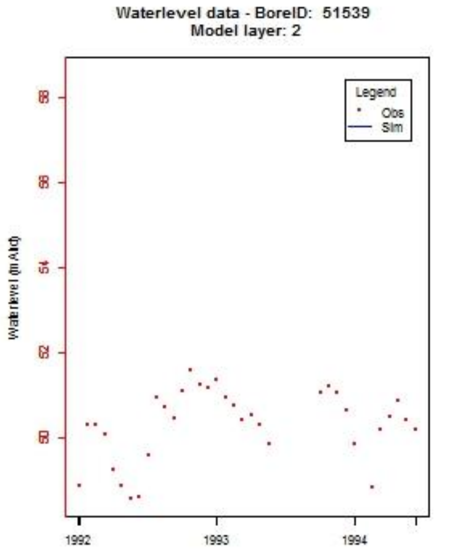

Waterlevel data - BoreID: 42123
Model layer: 2
Legend
Obs
Sim

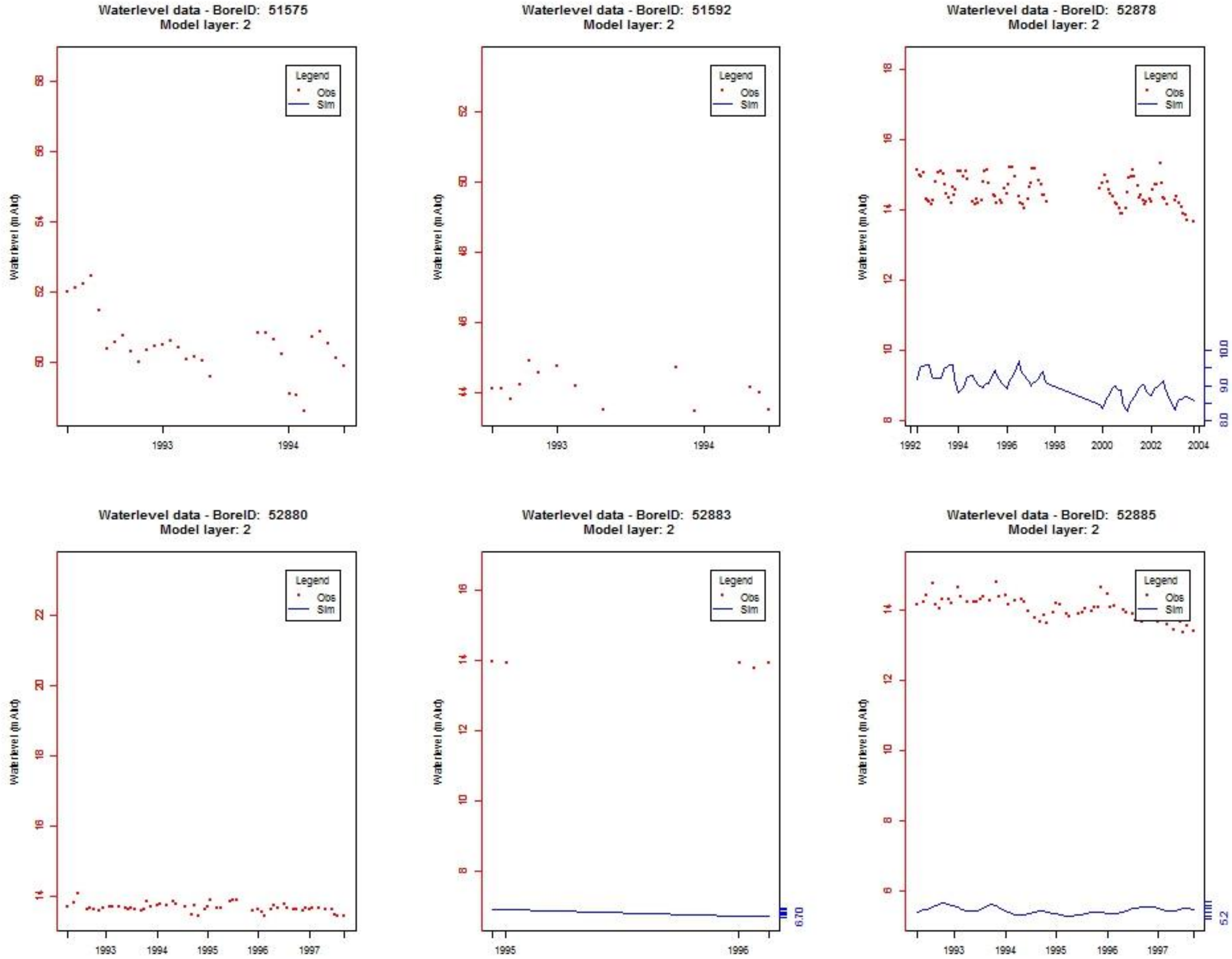

Waterlevel data - BoreID: 50868
Model layer: 2
Legend
Obs
Sim

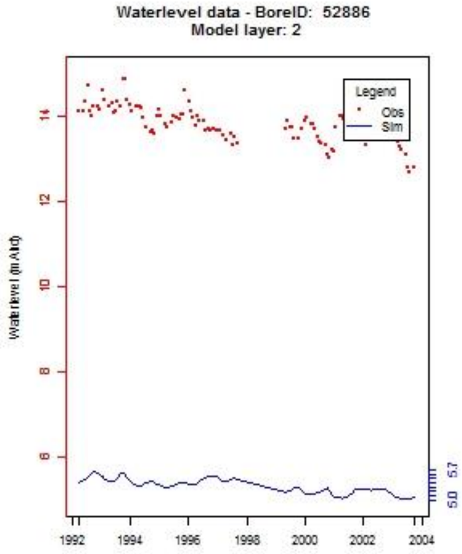

Waterlevel data - BoreID: 50877
Model layer: 2
Legend
Obs
Sim

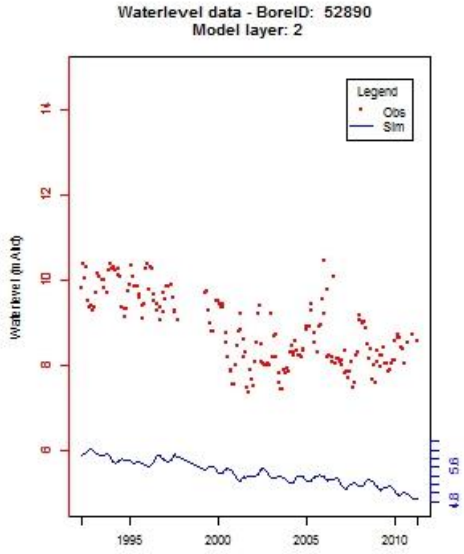

Waterlevel data - BoreID: 50878
Model layer: 2
Legend
Obs
Sim

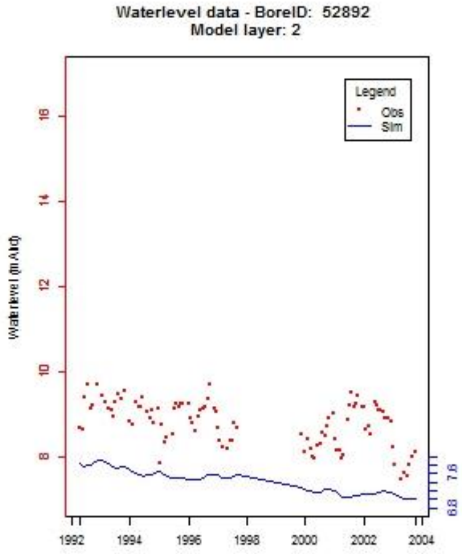

Waterlevel data - BoreID: 50891
Model layer: 2
Legend
Obs
Sim

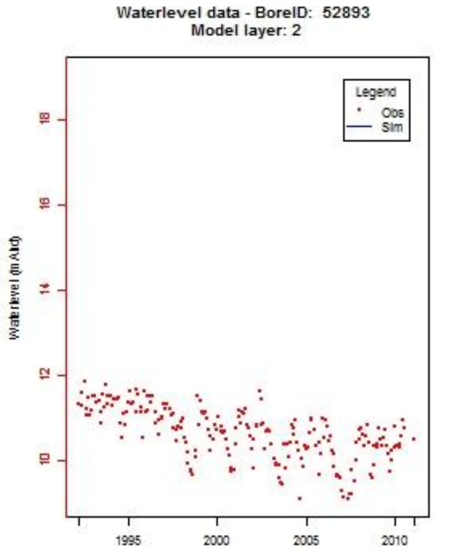

Waterlevel data - BoreID: 51539
Model layer: 2
Legend
Obs
Sim

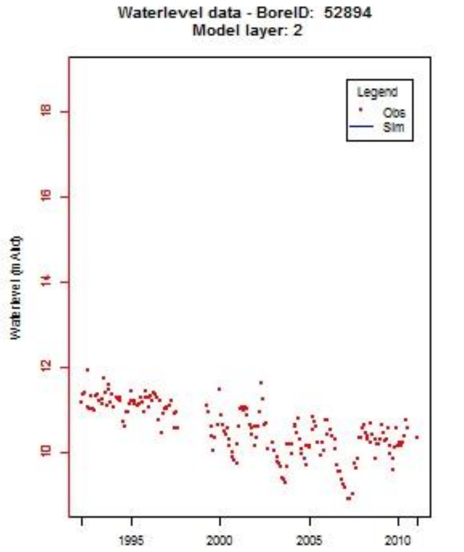

Waterlevel data - BoreID: 51575
Model layer: 2
Waterlevel data - BoreID: 51592
Model layer: 2
Waterlevel data - BoreID: 52878
Model layer: 2
Waterlevel data - BoreID: 52880
Model layer: 2
Waterlevel data - BoreID: 52883
Model layer: 2
Waterlevel data - BoreID: 52885
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

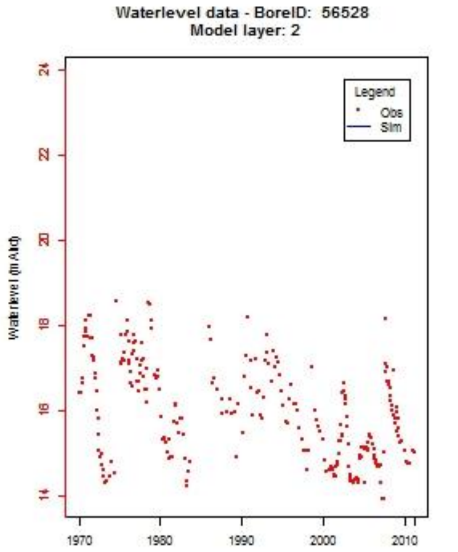

Waterlevel data - BoreID: 52886
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

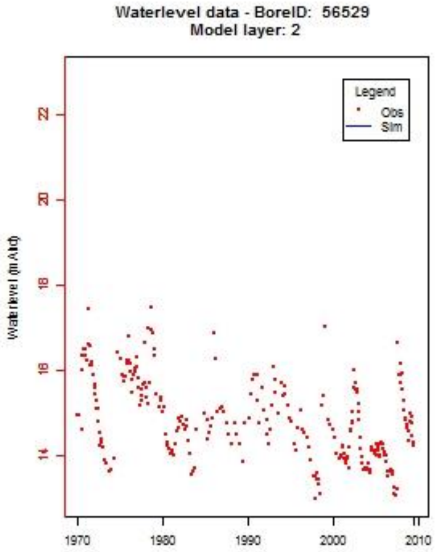

Waterlevel data - BoreID: 52890
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

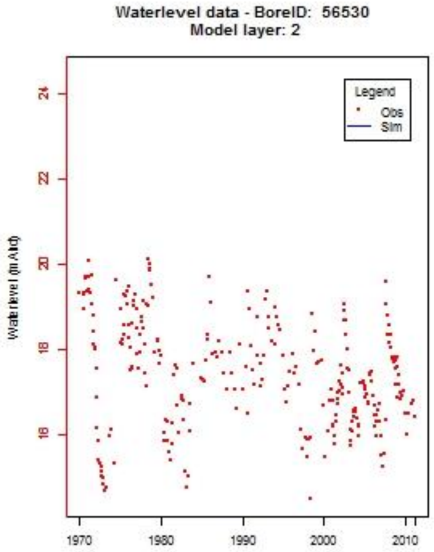

Waterlevel data - BoreID: 52892
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

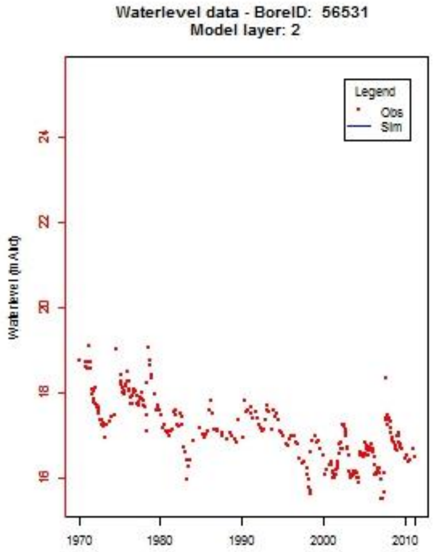

Waterlevel data - BoreID: 52893
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

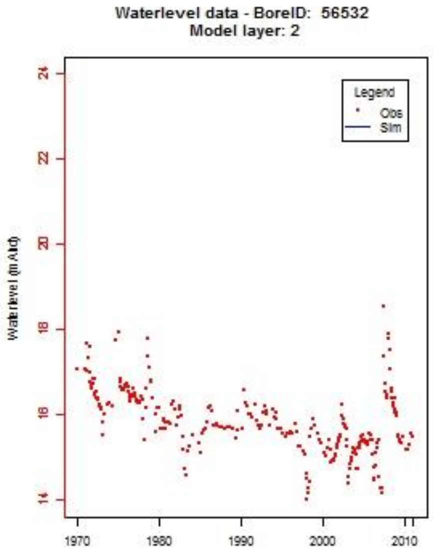

Waterlevel data - BoreID: 52894
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

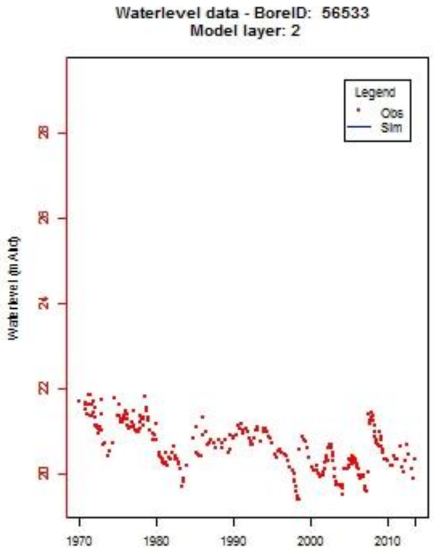

Waterlevel data - BoreID: 56528
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

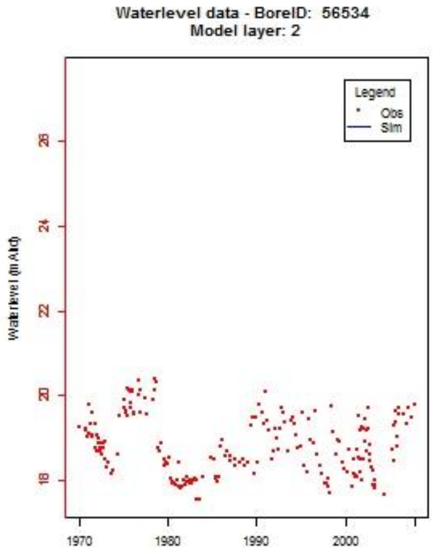

Waterlevel data - BoreID: 56529
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
14
16
18
20
22
1970
1980
1990
2000
2010

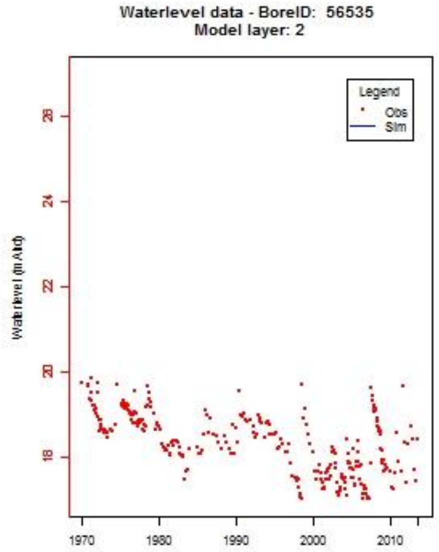

Waterlevel data - BoreID: 56530
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
16
18
20
22
24
1970
1980
1990
2000
2010

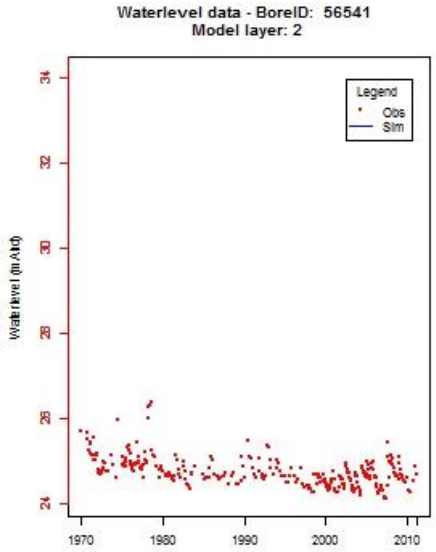

Waterlevel data - BoreID: 56531
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
16
18
20
22
24
1970
1980
1990
2000
2010

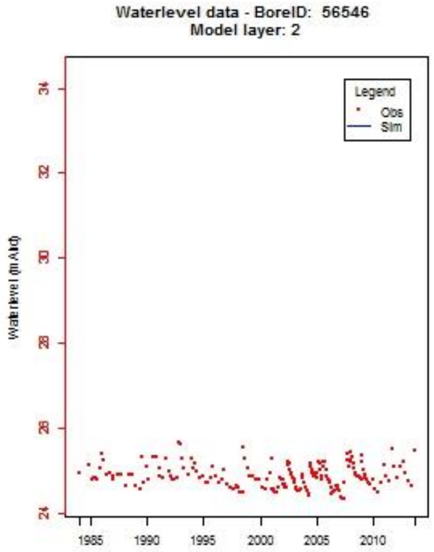

Waterlevel data - BoreID: 56532
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
14
16
18
20
22
24
1970
1980
1990
2000
2010

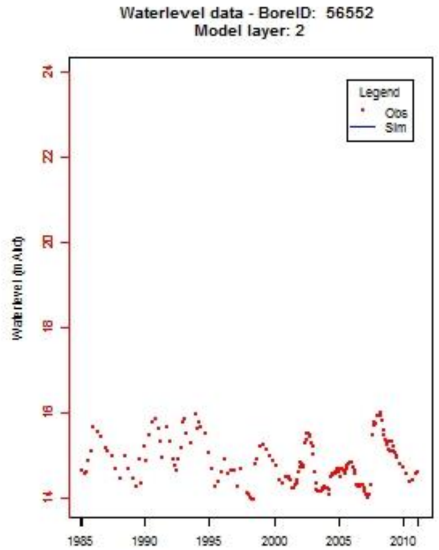

Waterlevel data - BoreID: 56533
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
20
22
24
26
28
1970
1980
1990
2000
2010

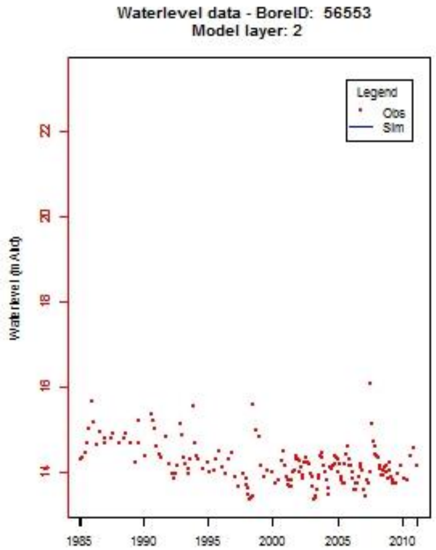

Waterlevel data - BoreID: 56534
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
18
20
22
24
26
1970
1980
1990
2000

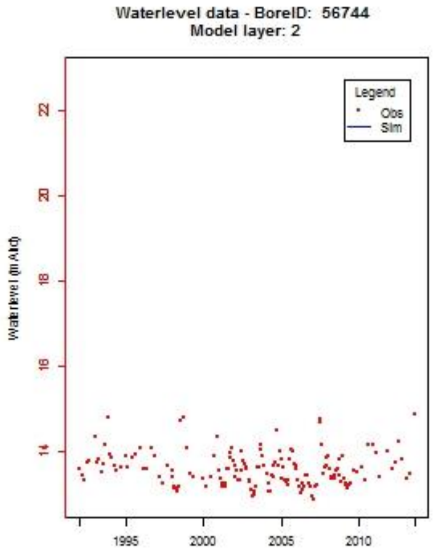

Waterlevel data - BoreID: 56535
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

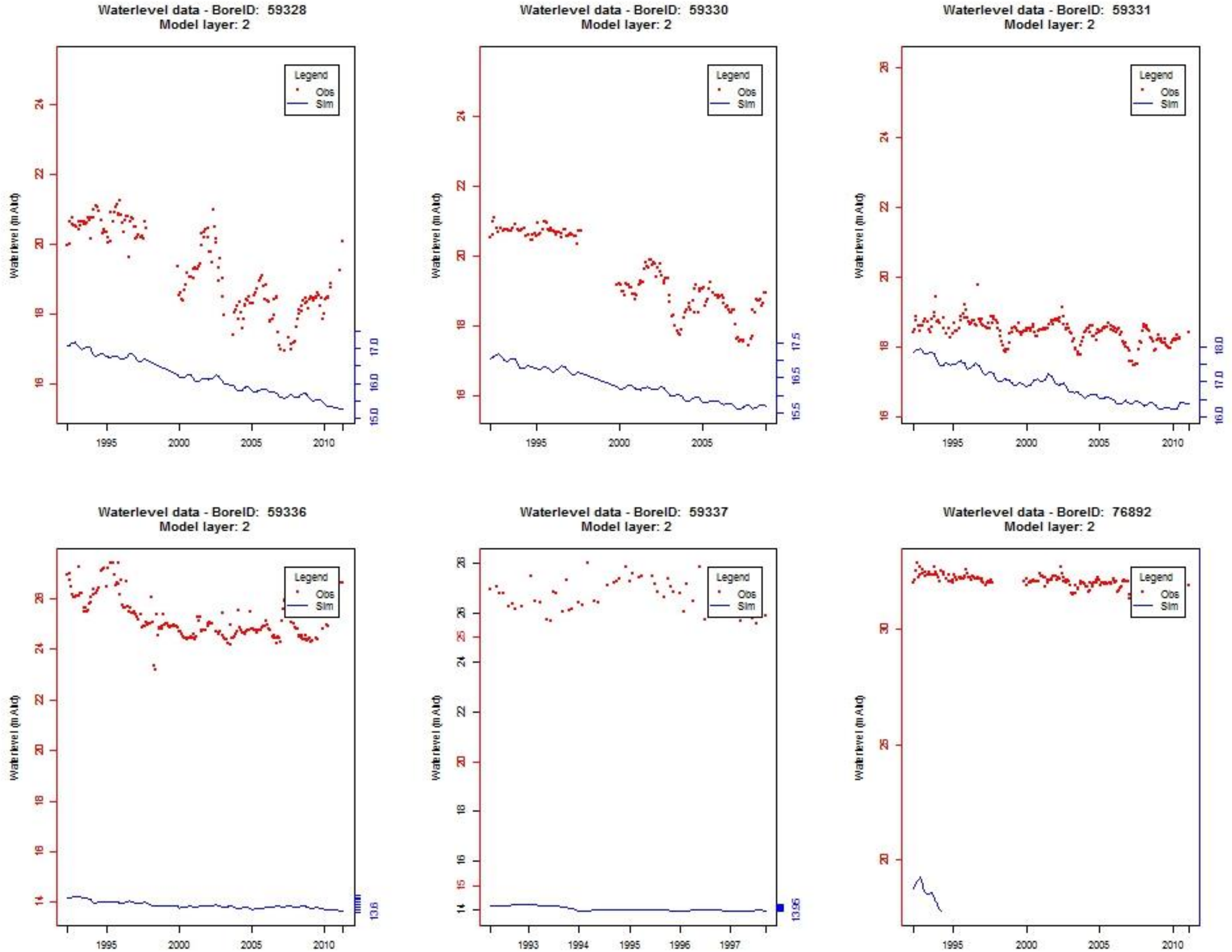

Waterlevel data - BoreID: 56541
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

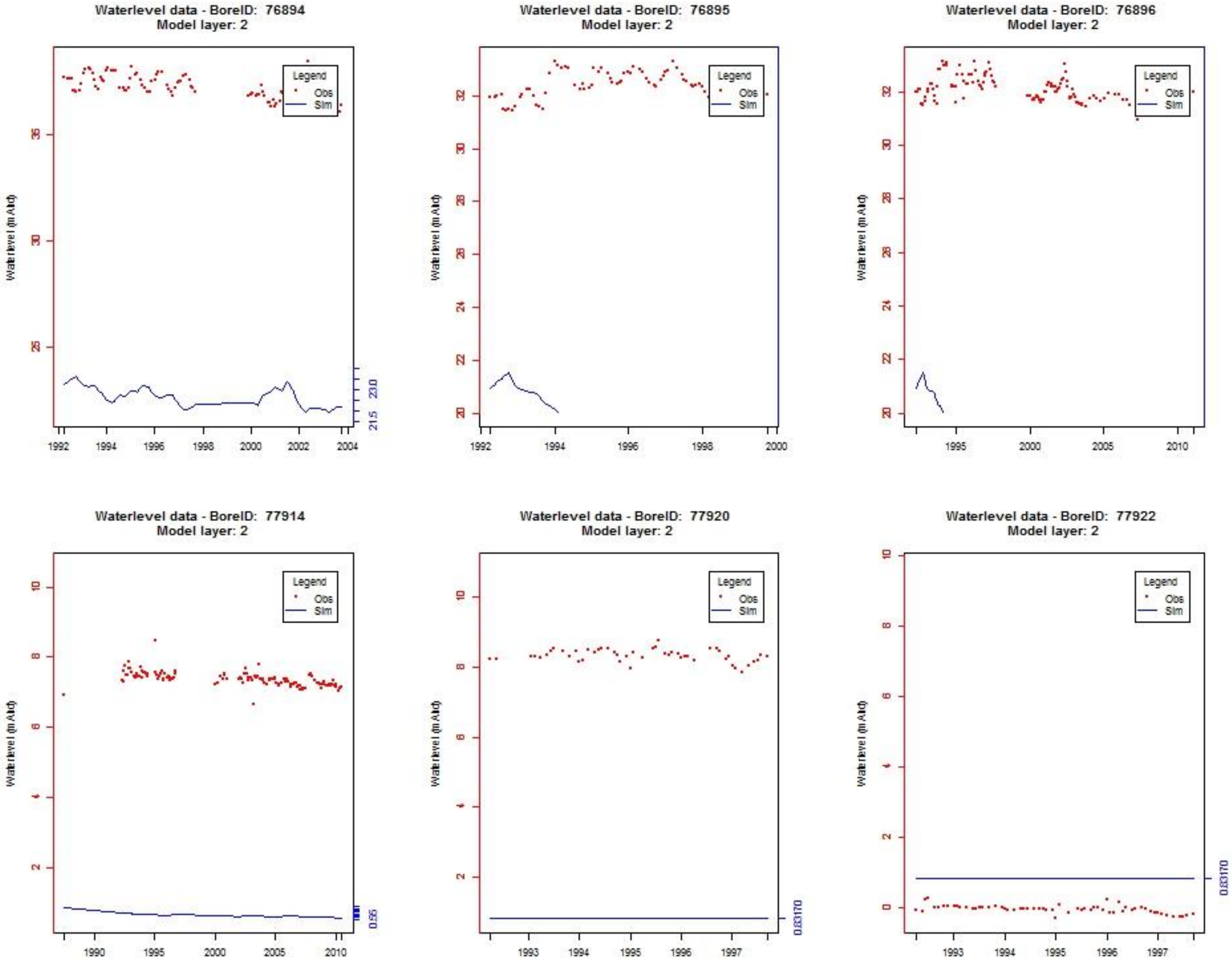

Waterlevel data - BoreID: 56546
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1985
1990
1995
2000
2005
2010

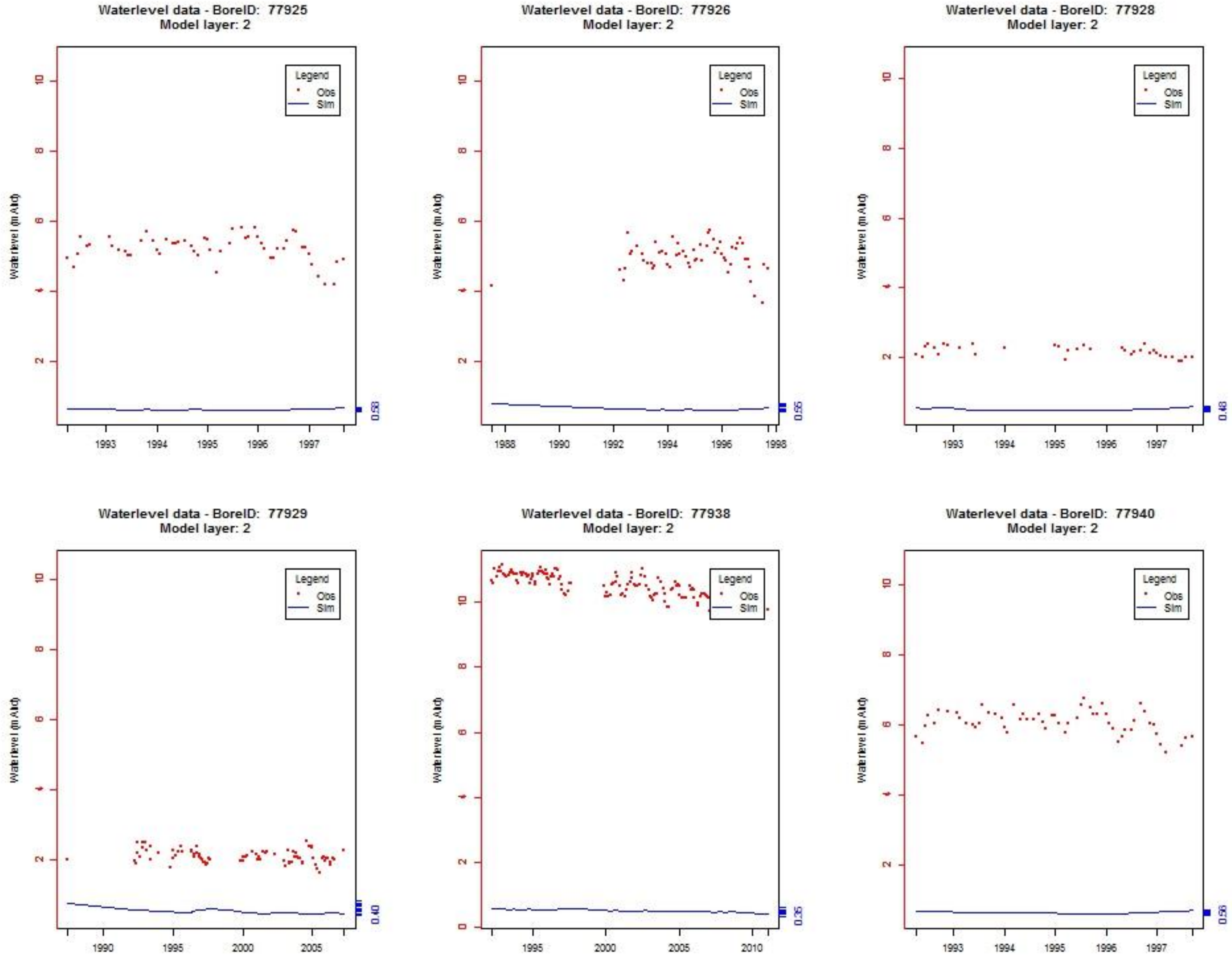

Waterlevel data - BoreID: 56552
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1985
1990
1995
2000
2005
2010

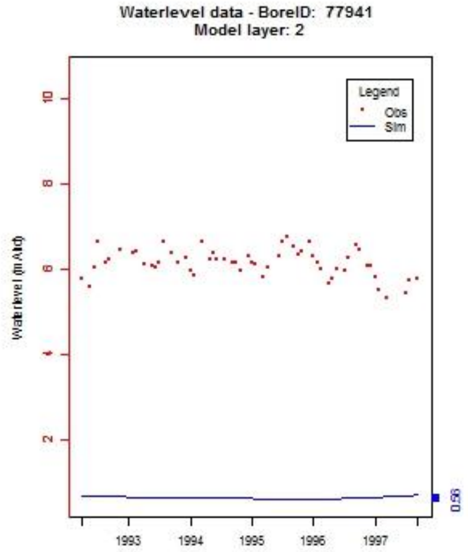

Waterlevel data - BoreID: 56553
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1985
1990
1995
2000
2005
2010

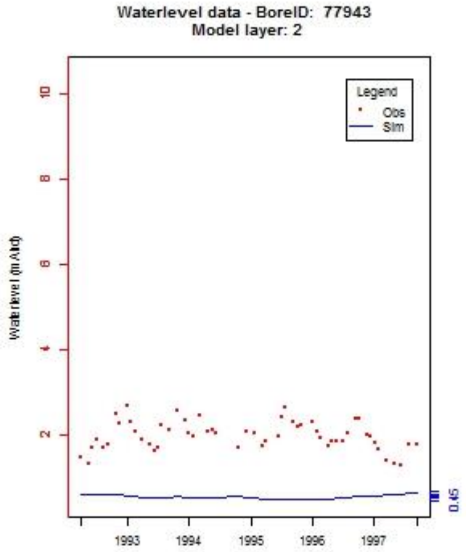

Waterlevel data - BoreID: 56744
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

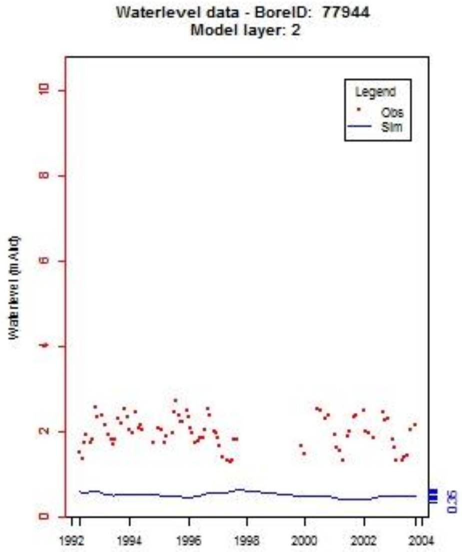

Waterlevel data - BoreID: 59328
Model layer: 2
Waterlevel data - BoreID: 59330
Model layer: 2
Waterlevel data - BoreID: 59331
Model layer: 2
Waterlevel data - BoreID: 59336
Model layer: 2
Waterlevel data - BoreID: 59337
Model layer: 2
Waterlevel data - BoreID: 76892
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

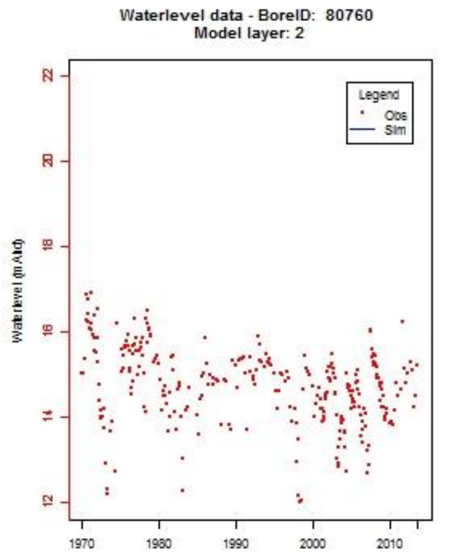

Waterlevel data - BoreID: 76894
Model layer: 2
Waterlevel data - BoreID: 76895
Model layer: 2
Waterlevel data - BoreID: 76896
Model layer: 2
Waterlevel data - BoreID: 77914
Model layer: 2
Waterlevel data - BoreID: 77920
Model layer: 2
Waterlevel data - BoreID: 77922
Model layer: 2
Legend
Obs
Sim

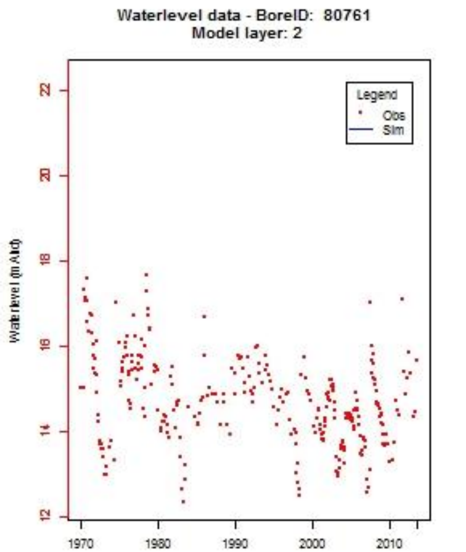

Waterlevel data - BoreID: 77925
Model layer: 2
Waterlevel data - BoreID: 77926
Model layer: 2
Waterlevel data - BoreID: 77928
Model layer: 2
Waterlevel data - BoreID: 77929
Model layer: 2
Waterlevel data - BoreID: 77938
Model layer: 2
Waterlevel data - BoreID: 77940
Model layer: 2
Legend
Obs
Sim

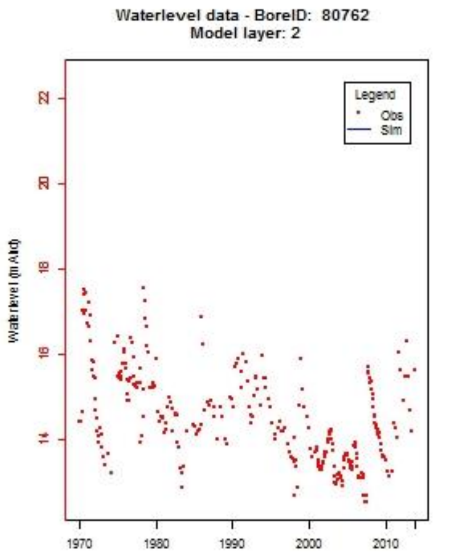

Waterlevel data - BoreID: 77941
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
0.56

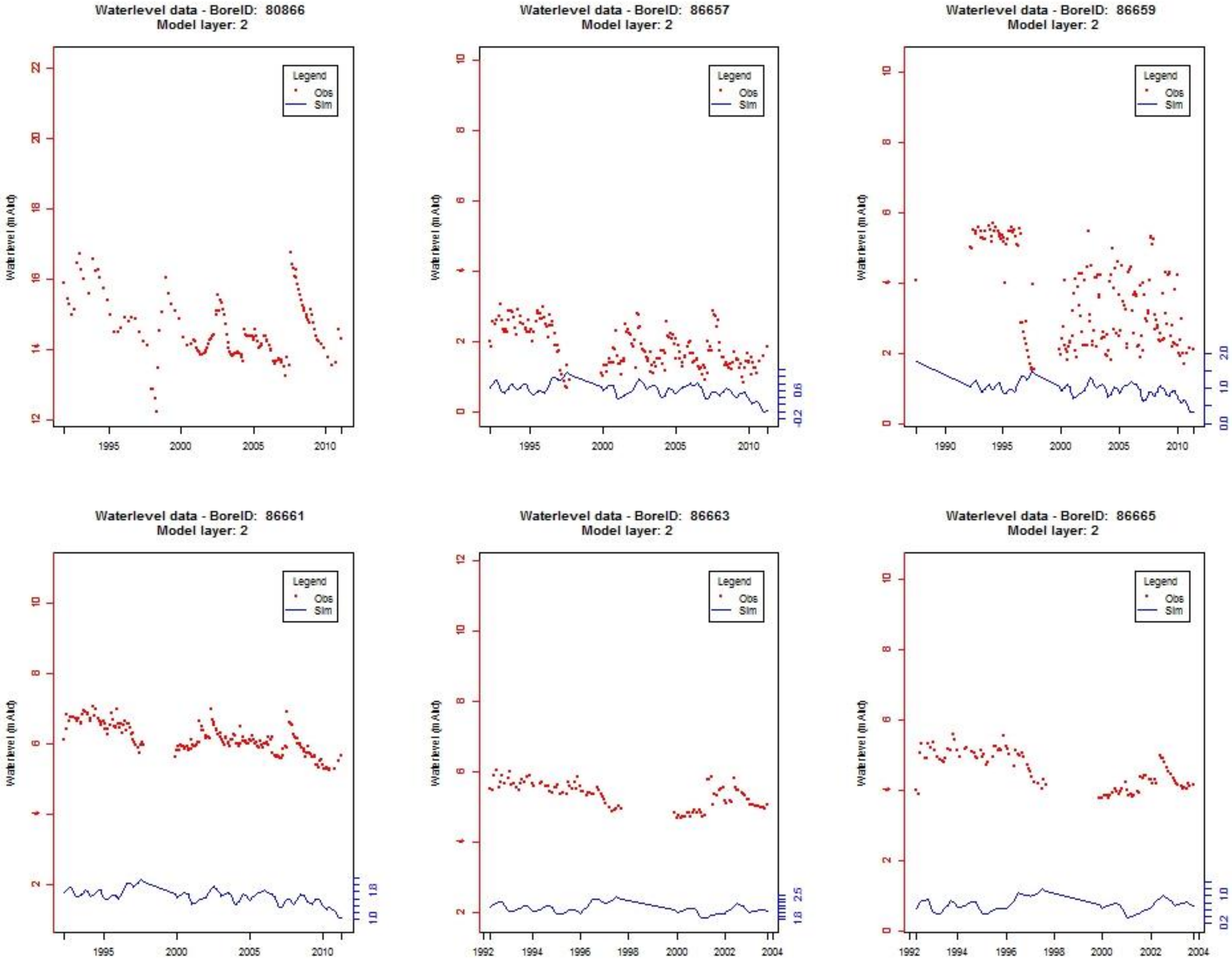

Waterlevel data - BoreID: 77943
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
0.45

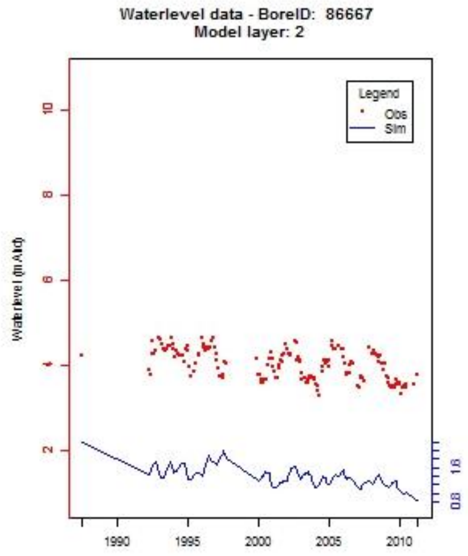

Waterlevel data - BoreID: 77944
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
0.36

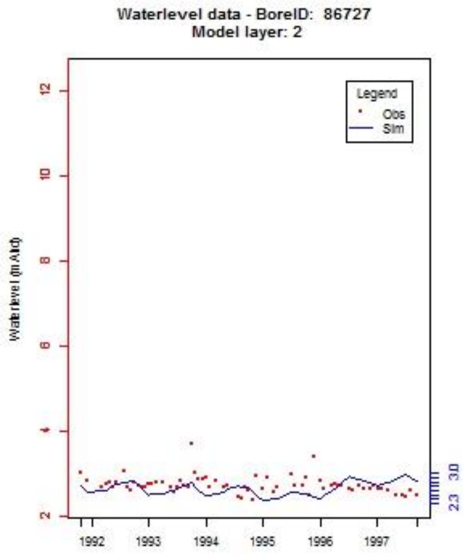

Waterlevel data - BoreID: 80760
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

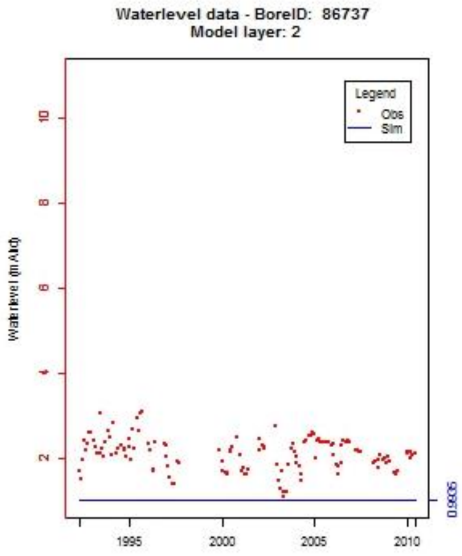

Waterlevel data - BoreID: 80761
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

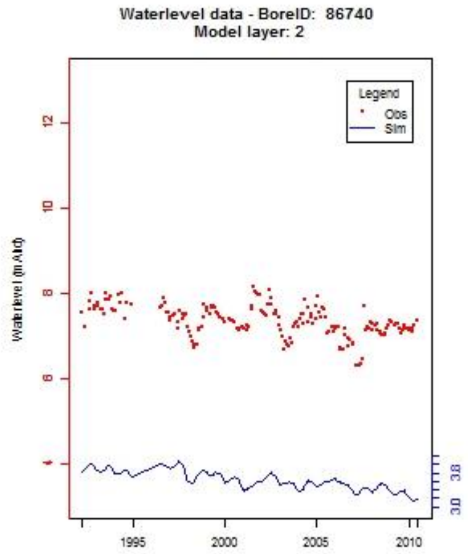

Waterlevel data - BoreID: 80762
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

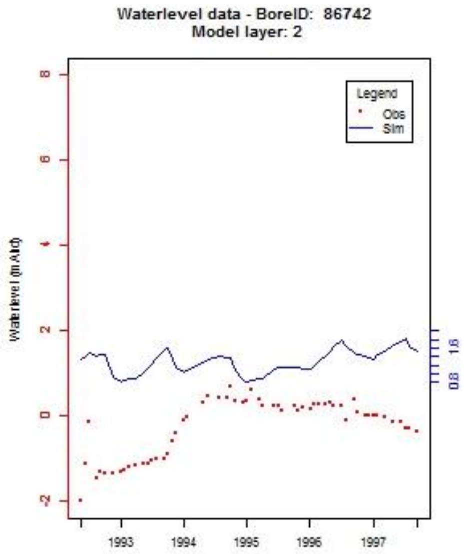

Waterlevel data - BoreID: 80866
Model layer: 2
Legend
Obs
Sim
Waterlevel data - BoreID: 86657
Model layer: 2
Legend
Obs
Sim
Waterlevel data - BoreID: 86659
Model layer: 2
Legend
Obs
Sim
Waterlevel data - BoreID: 86661
Model layer: 2
Legend
Obs
Sim
Waterlevel data - BoreID: 86663
Model layer: 2
Legend
Obs
Sim
Waterlevel data - BoreID: 86665
Model layer: 2
Legend
Obs
Sim

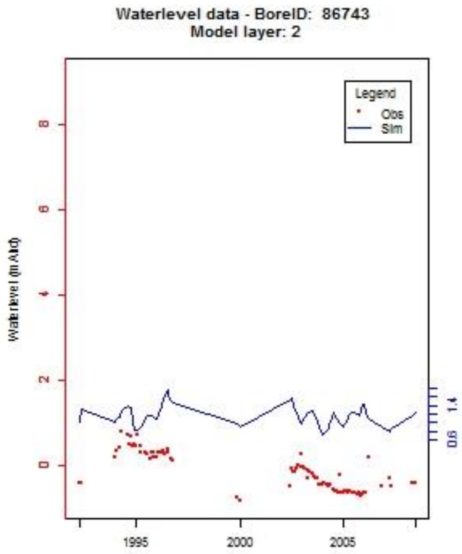

Waterlevel data - BoreID: 86667
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1990
1995
2000
2005
2010

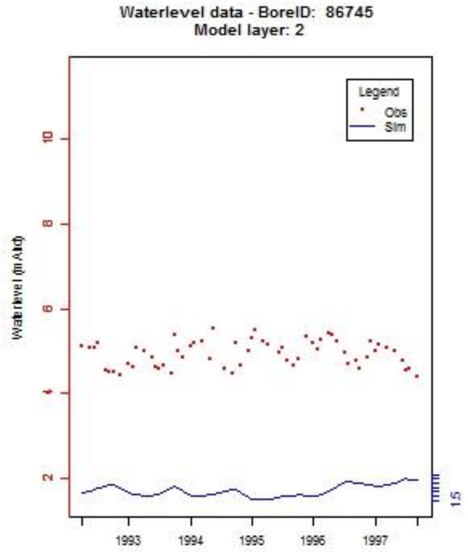

Waterlevel data - BoreID: 86727
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1992
1993
1994
1995
1996
1997

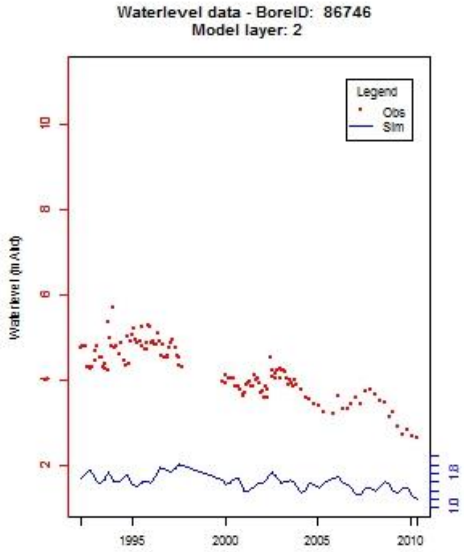

Waterlevel data - BoreID: 86737
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

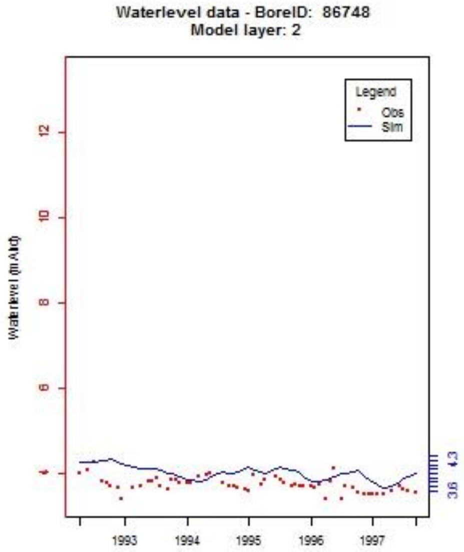

Waterlevel data - BoreID: 86740
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

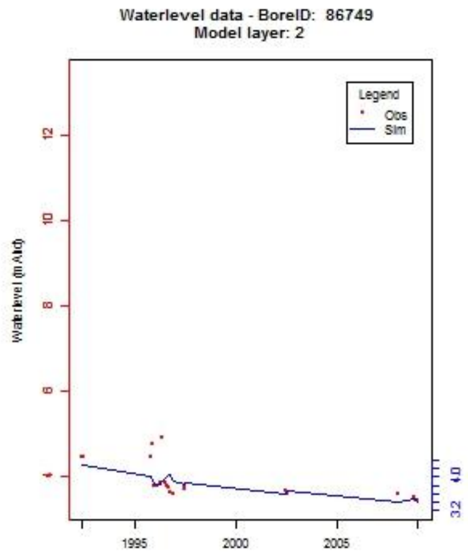

Waterlevel data - BoreID: 86742
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1993
1994
1995
1996
1997

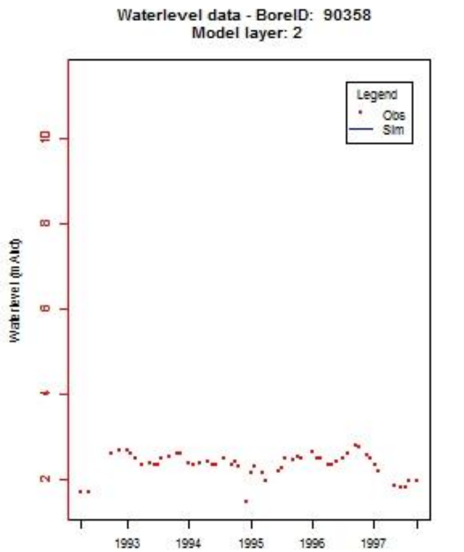

Waterlevel data - BoreID: 86743
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005

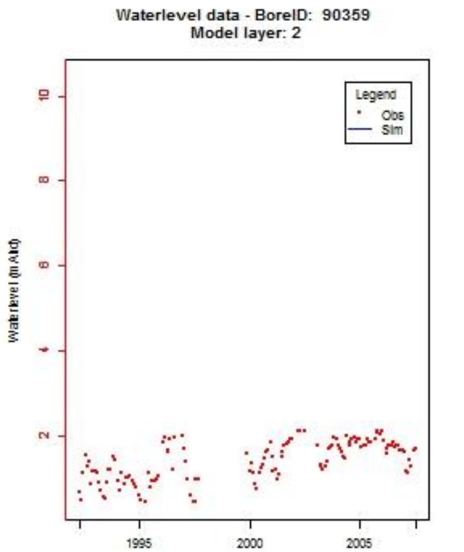

Waterlevel data - BoreID: 86745
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

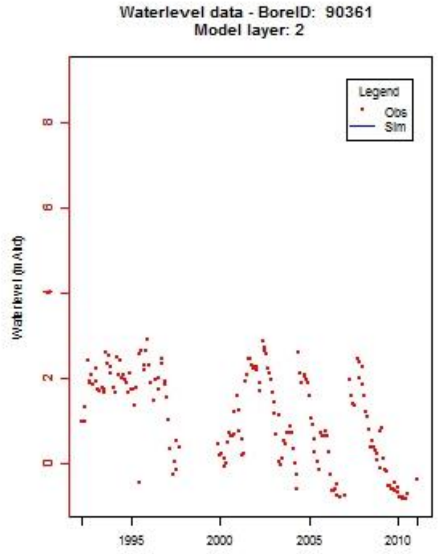

Waterlevel data - BoreID: 86746
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

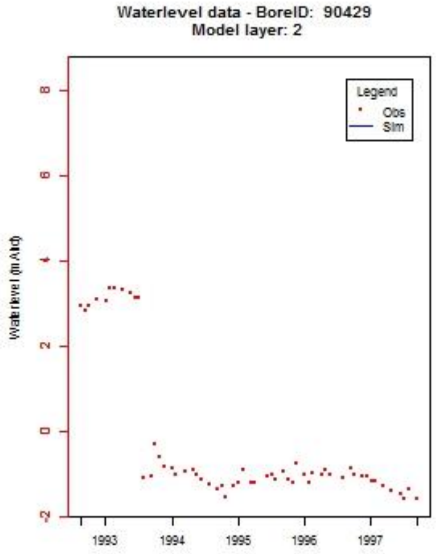

Waterlevel data - BoreID: 86748
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

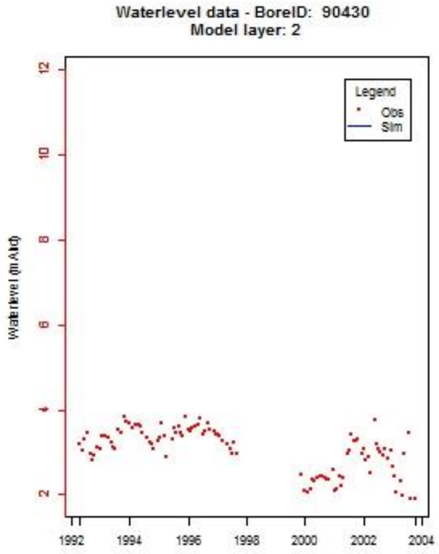

Waterlevel data - BoreID: 86749
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

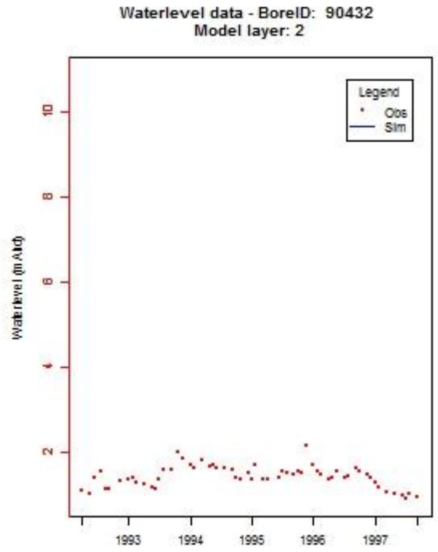

Waterlevel data - BoreID: 90358
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

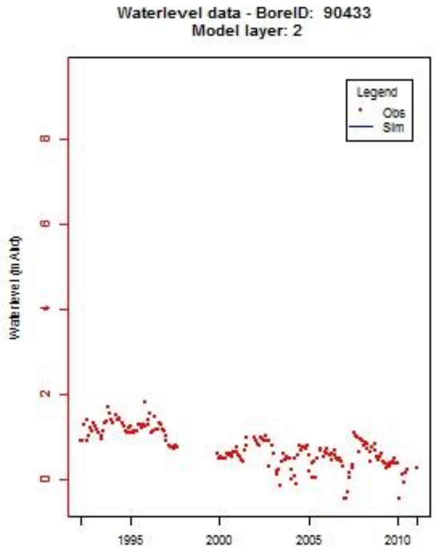

Waterlevel data - BoreID: 90359
Model layer: 2
Waterlevel (m Ahd)
Legend
Obs
Sim

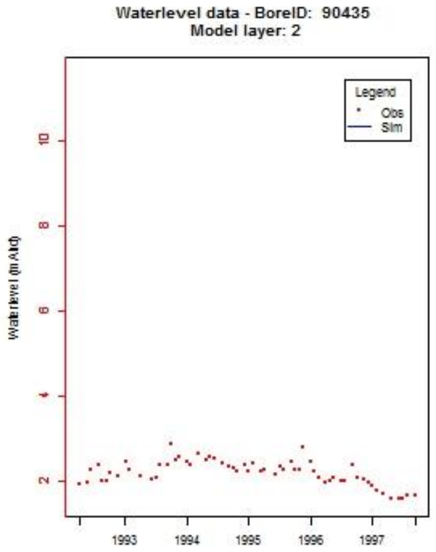

Waterlevel data - BoreID: 90361
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

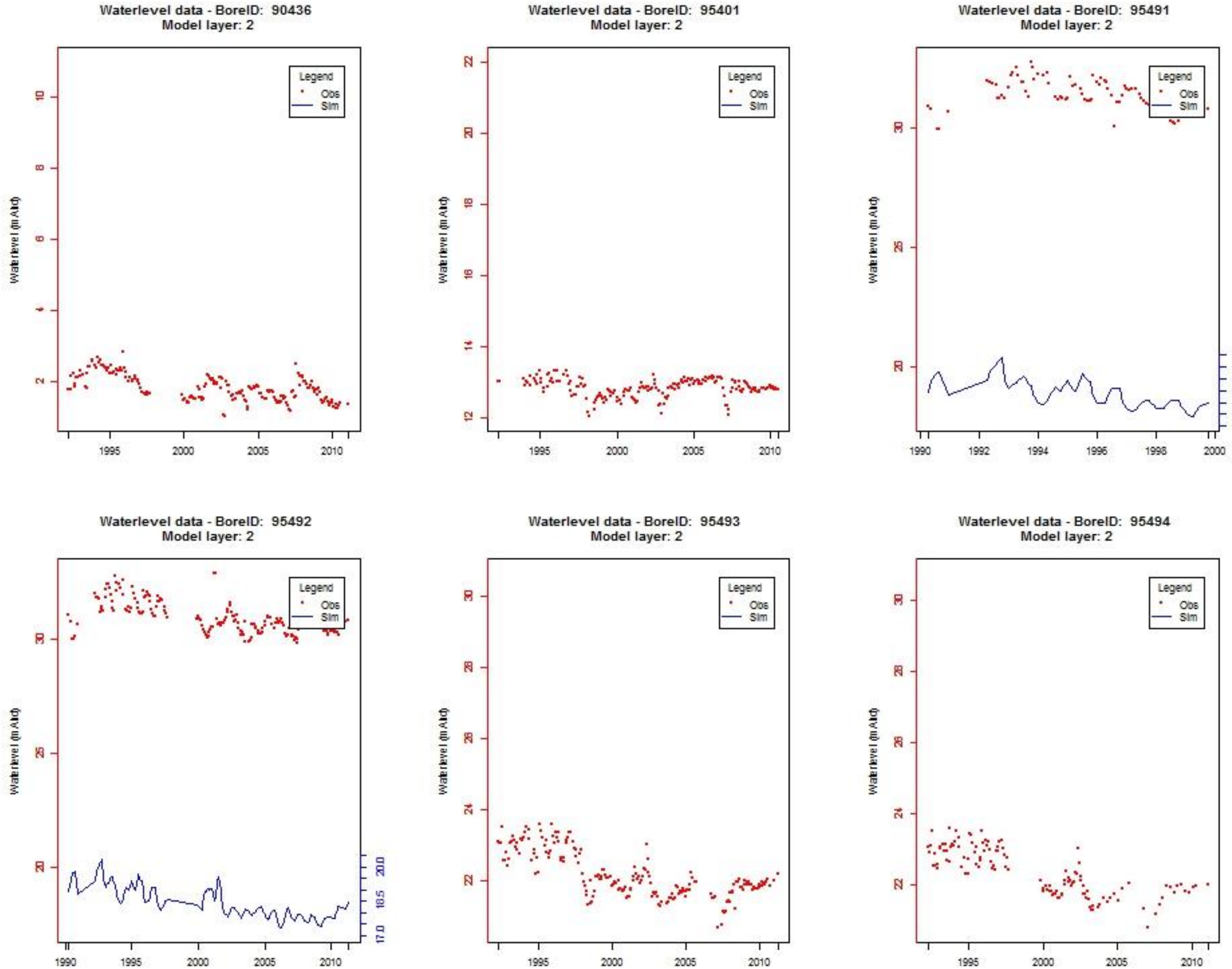

Waterlevel data - BoreID: 90429
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

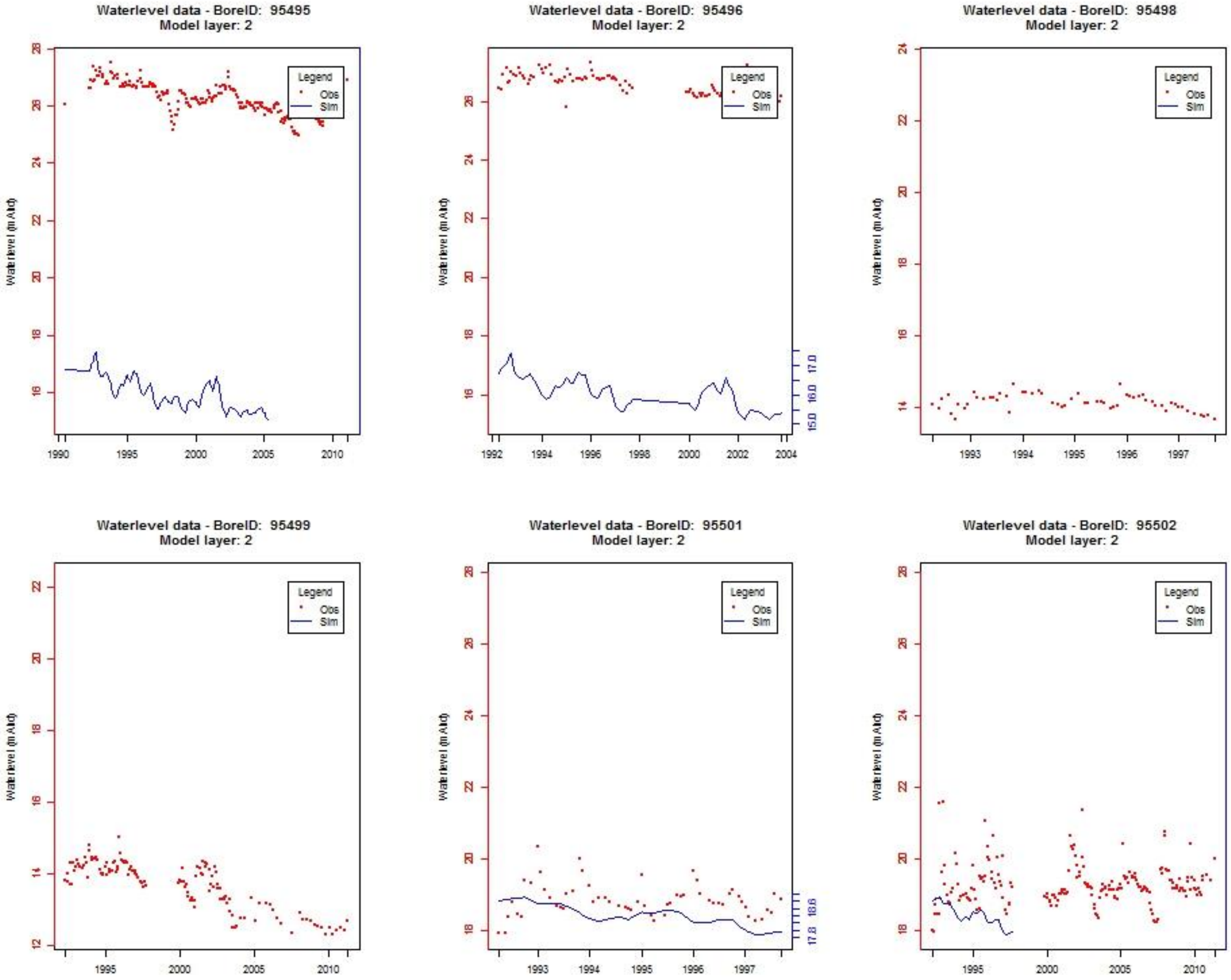

Waterlevel data - BoreID: 90430
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

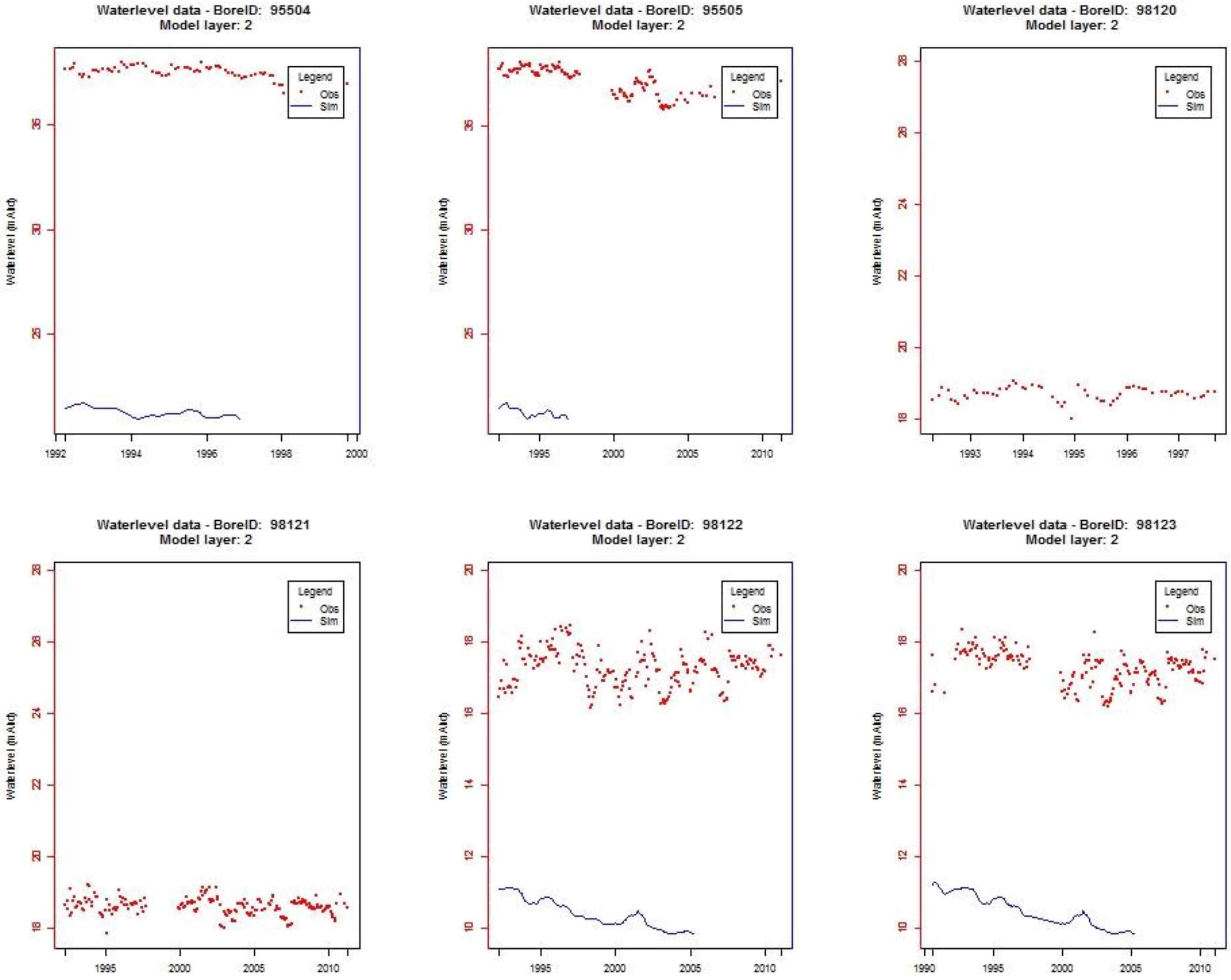

Waterlevel data - BoreID: 90432
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

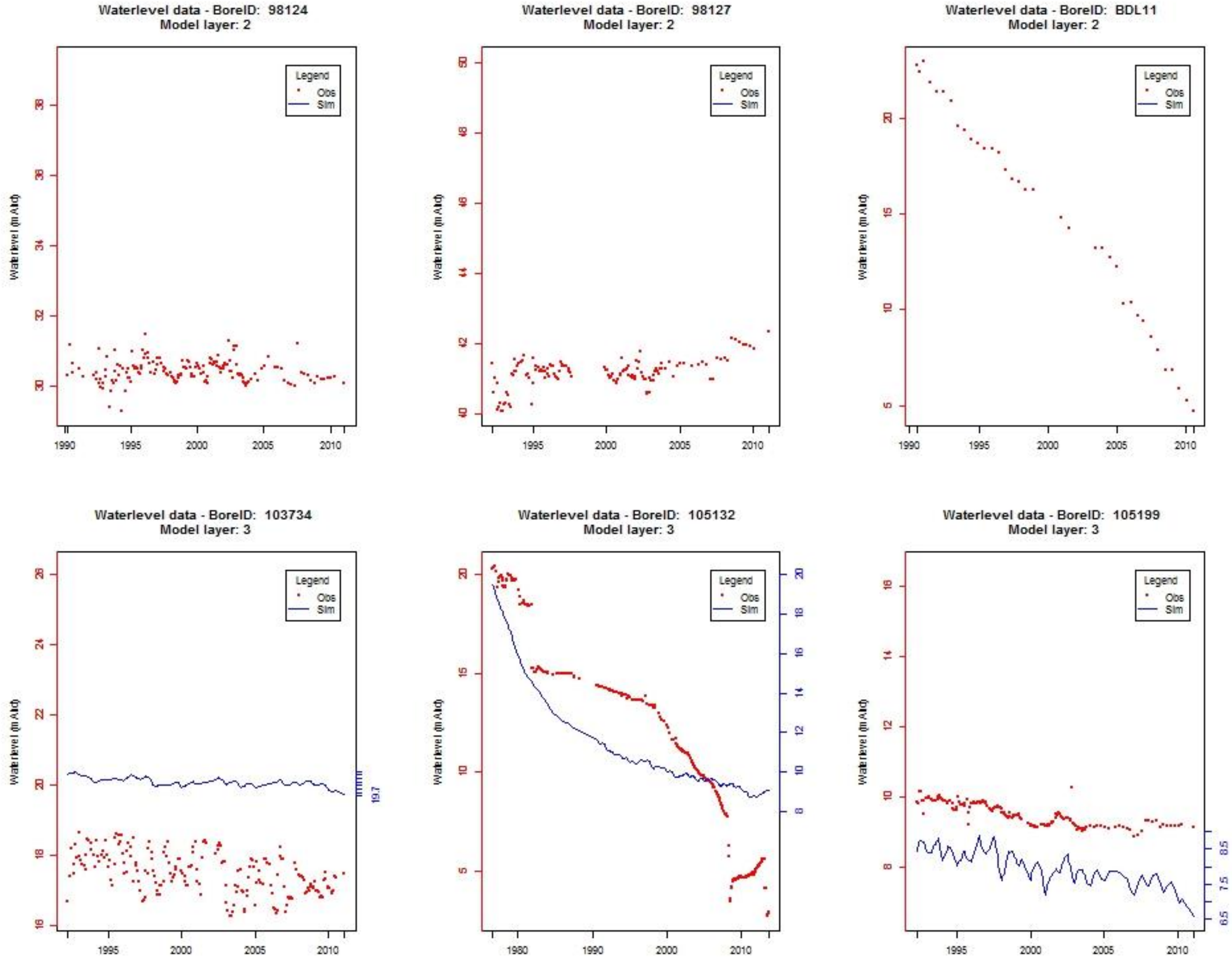

Waterlevel data - BoreID: 90433
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

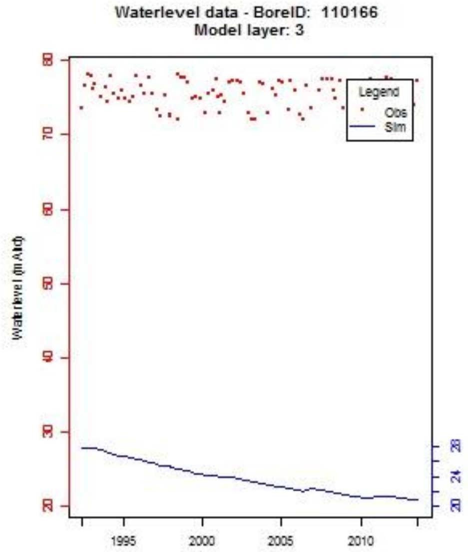

Waterlevel data - BoreID: 90435
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

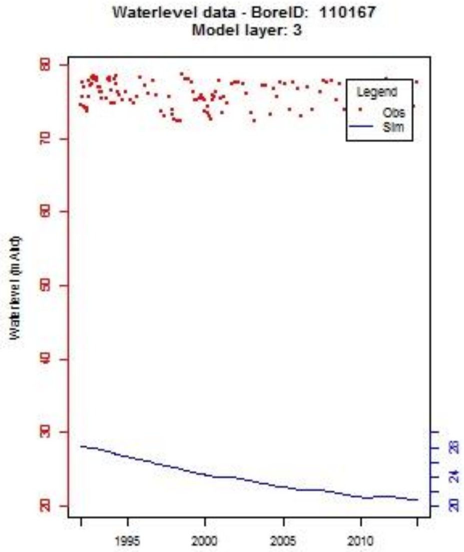

Waterlevel data - BoreID: 90436
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 95401
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 95491
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 95492
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 95493
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 95494
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

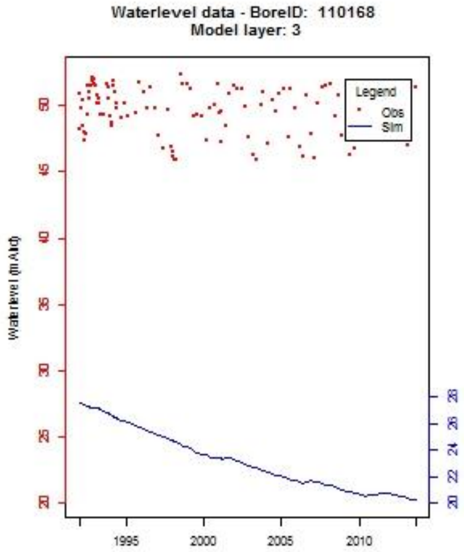

Waterlevel data - BoreID: 95495
Model layer: 2
Waterlevel data - BoreID: 95496
Model layer: 2
Waterlevel data - BoreID: 95498
Model layer: 2
Waterlevel data - BoreID: 95499
Model layer: 2
Waterlevel data - BoreID: 95501
Model layer: 2
Waterlevel data - BoreID: 95502
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

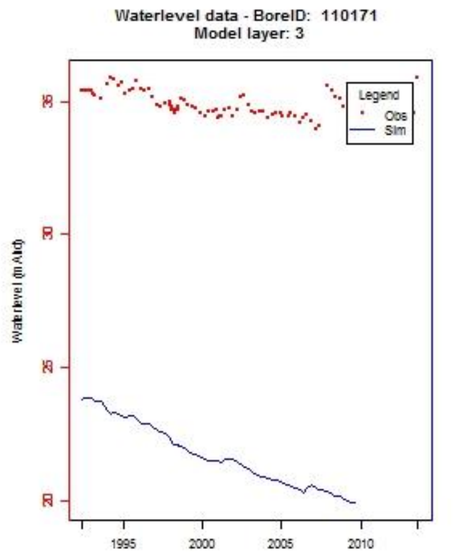

Waterlevel data - BoreID: 95504
Model layer: 2
Waterlevel data - BoreID: 95505
Model layer: 2
Waterlevel data - BoreID: 98120
Model layer: 2
Waterlevel data - BoreID: 98121
Model layer: 2
Waterlevel data - BoreID: 98122
Model layer: 2
Waterlevel data - BoreID: 98123
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)

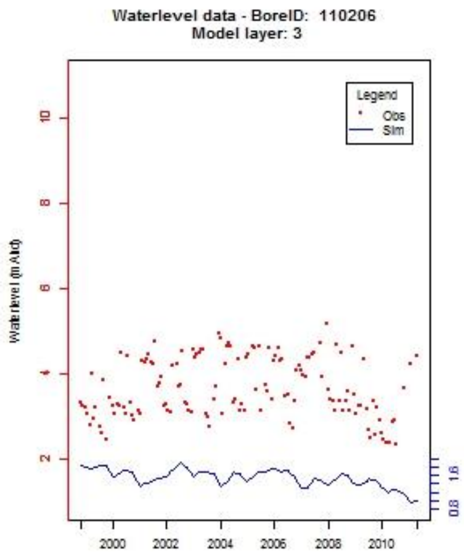

Waterlevel data - BoreID: 98124
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 98127
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: BDL11
Model layer: 2
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 103734
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 105132
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 105199
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

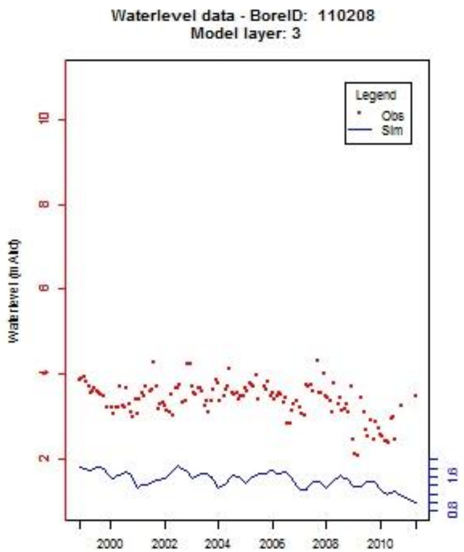

Waterlevel data - BoreID: 110166
Model layer: 3
Waterlevel (m Ahd)
Legend
Obs
Sim
20
30
40
50
60
70
80
20
24
28
1995
2000
2005
2010

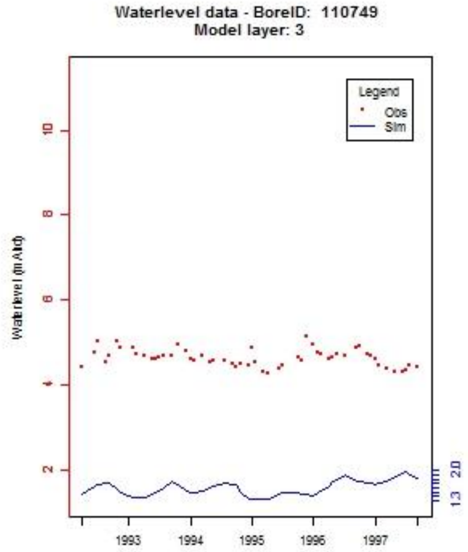

Waterlevel data - BoreID: 110167
Model layer: 3
Waterlevel (m Ahd)
Legend
Obs
Sim
20
30
40
50
60
70
80
20
24
28
1995
2000
2005
2010

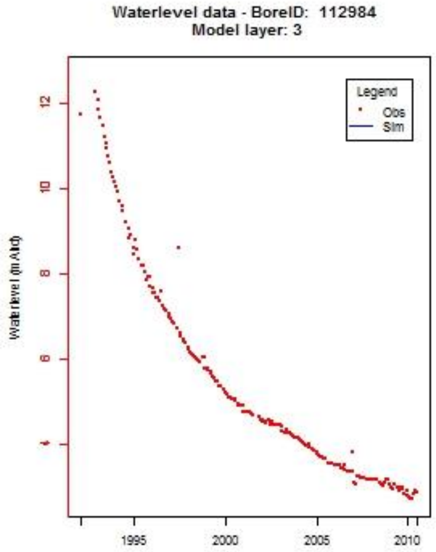

Waterlevel data - BoreID: 110168
Model layer: 3
Waterlevel (m Ahd)
Legend
Obs
Sim
20
25
30
35
40
45
50
20
22
24
26
28
1995
2000
2005
2010

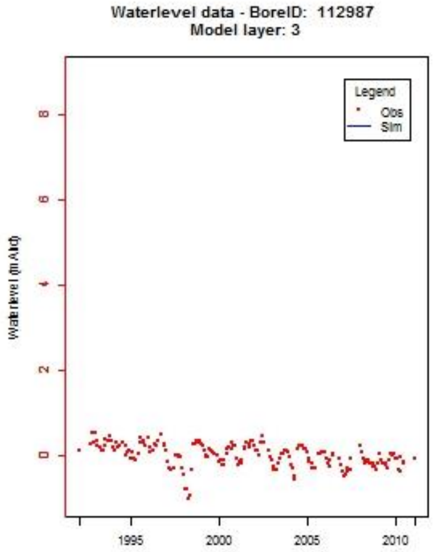

Waterlevel data - BoreID: 110171
Model layer: 3
Waterlevel (m Ahd)
Legend
Obs
Sim
20
25
30
35
1995
2000
2005
2010

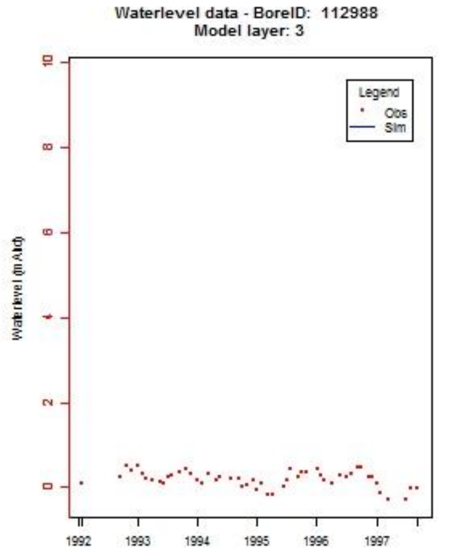

Waterlevel data - BoreID: 110206
Model layer: 3
Waterlevel (m Ahd)
Legend
Obs
Sim
2
4
6
8
10
0.8
1.6
2000
2002
2004
2006
2008
2010

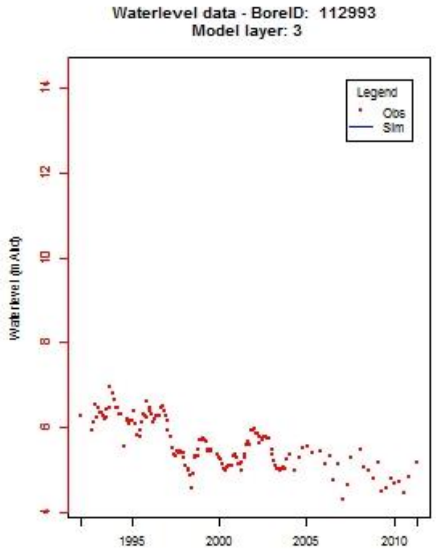

Waterlevel data - BoreID: 110208
Model layer: 3
Waterlevel (m Ahd)
Legend
Obs
Sim
2
4
6
8
10
0.8
1.6
2000
2002
2004
2006
2008
2010

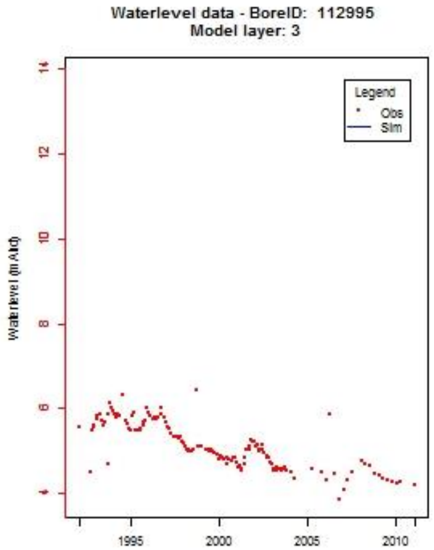

Waterlevel data - BoreID: 110749
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1993
1994
1995
1996
1997

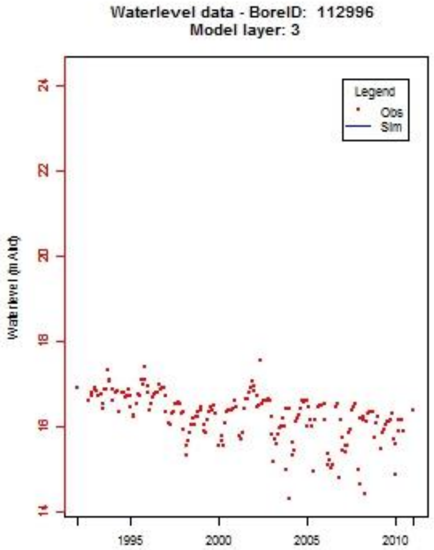

Waterlevel data - BoreID: 112984
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

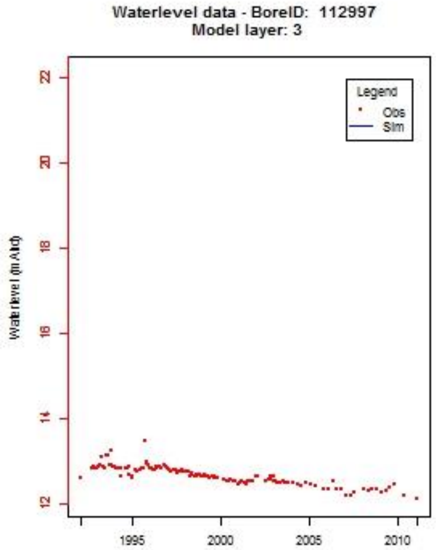

Waterlevel data - BoreID: 112987
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

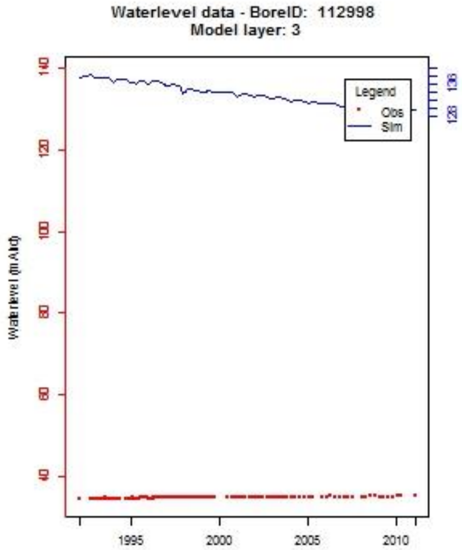

Waterlevel data - BoreID: 112988
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1992
1993
1994
1995
1996
1997

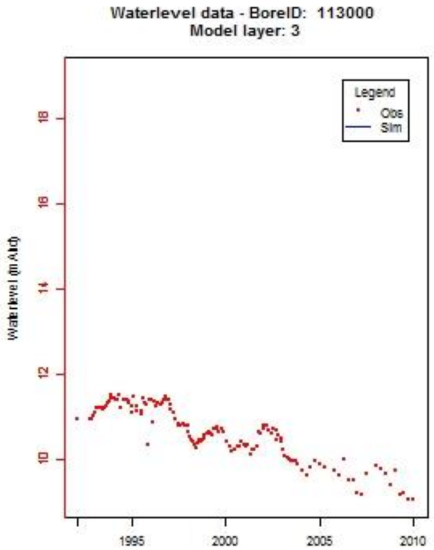

Waterlevel data - BoreID: 112993
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

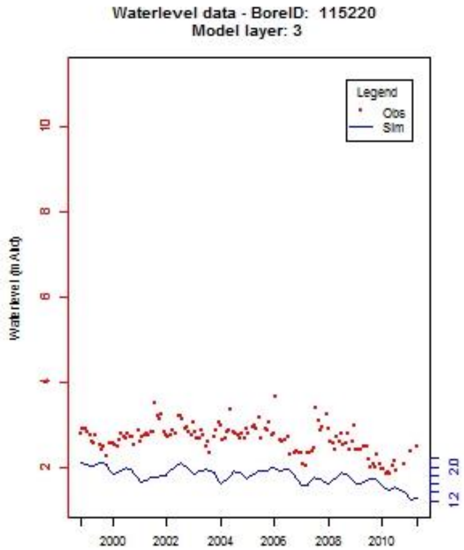

Waterlevel data - BoreID: 112995
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

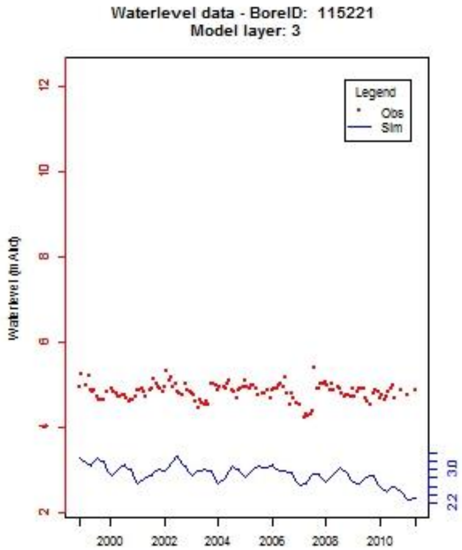

Waterlevel data - BoreID: 112996
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
14
16
18
20
22
24
1995
2000
2005
2010

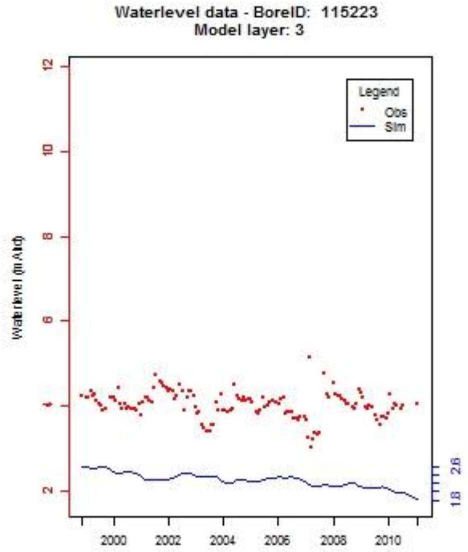

Waterlevel data - BoreID: 112997
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
12
14
16
18
20
22
1995
2000
2005
2010

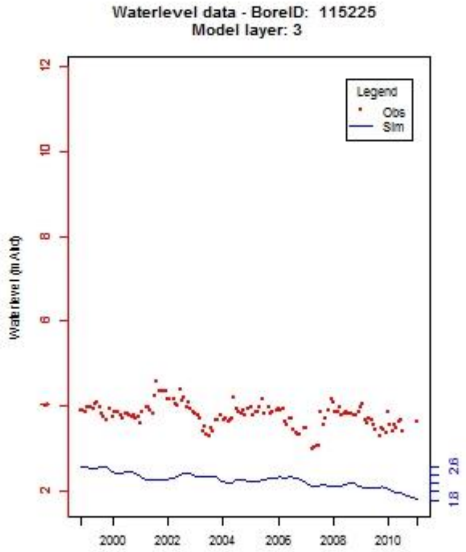

Waterlevel data - BoreID: 112998
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
40
60
80
100
120
140
128
136
1995
2000
2005
2010

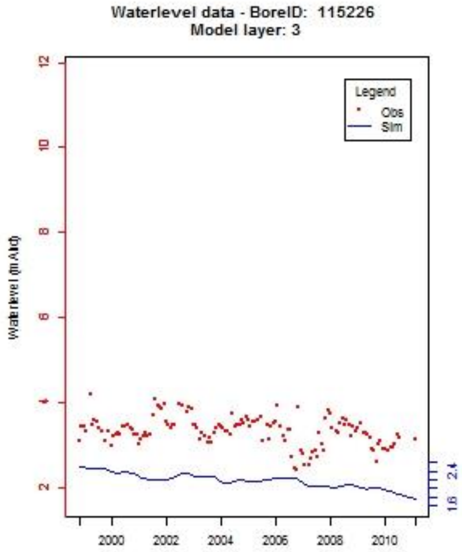

Waterlevel data - BoreID: 113000
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
10
12
14
16
18
1995
2000
2005
2010

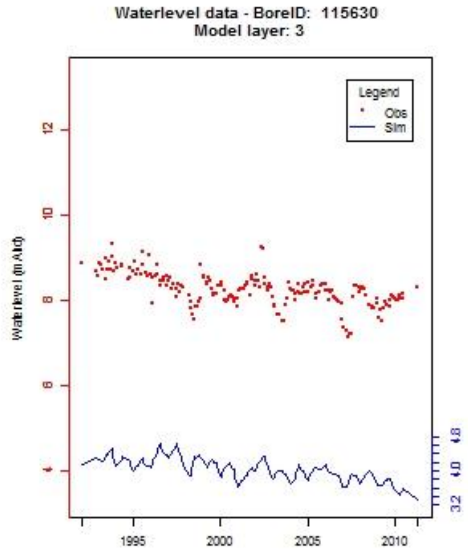

Waterlevel data - BoreID: 115220
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2
4
6
8
10
1.2
2.0
2000
2002
2004
2006
2008
2010

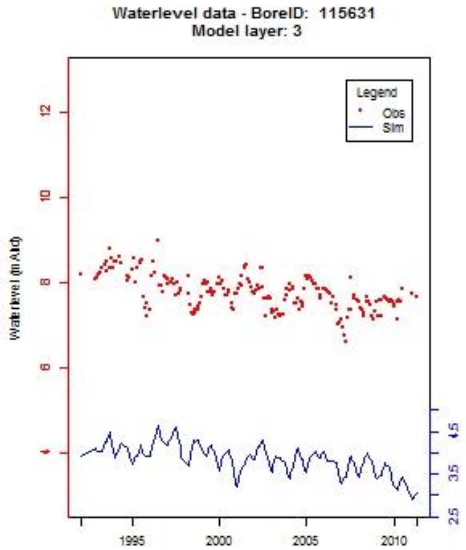

Waterlevel data - BoreID: 115221
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2
4
6
8
10
12
2.2
3.0
2000
2002
2004
2006
2008
2010

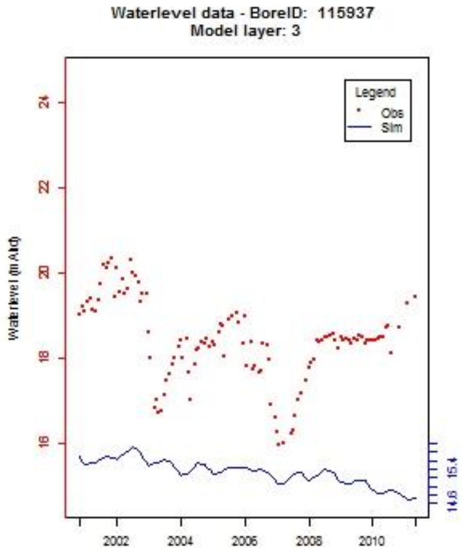

Waterlevel data - BoreID: 115223
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

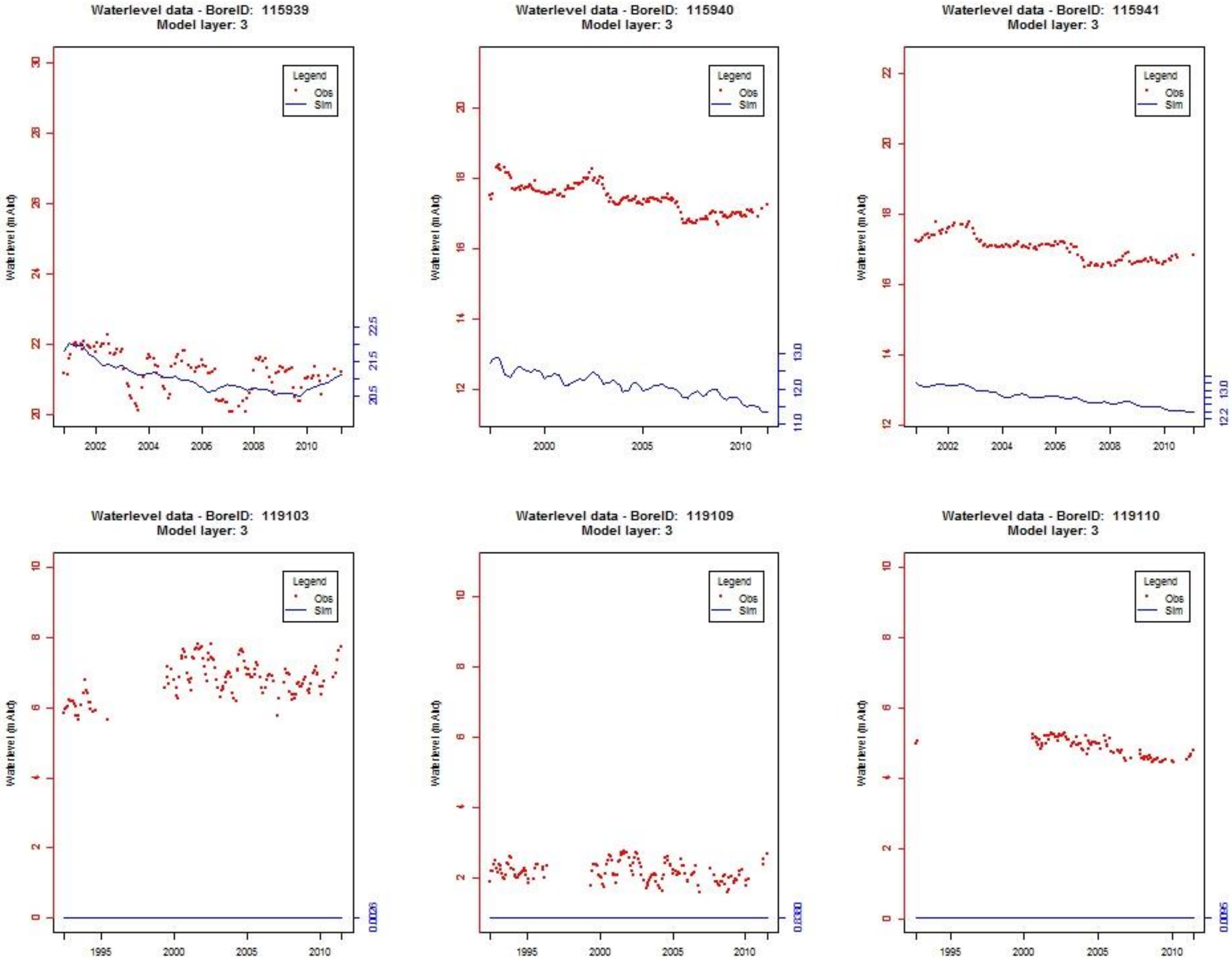

Waterlevel data - BoreID: 115225
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

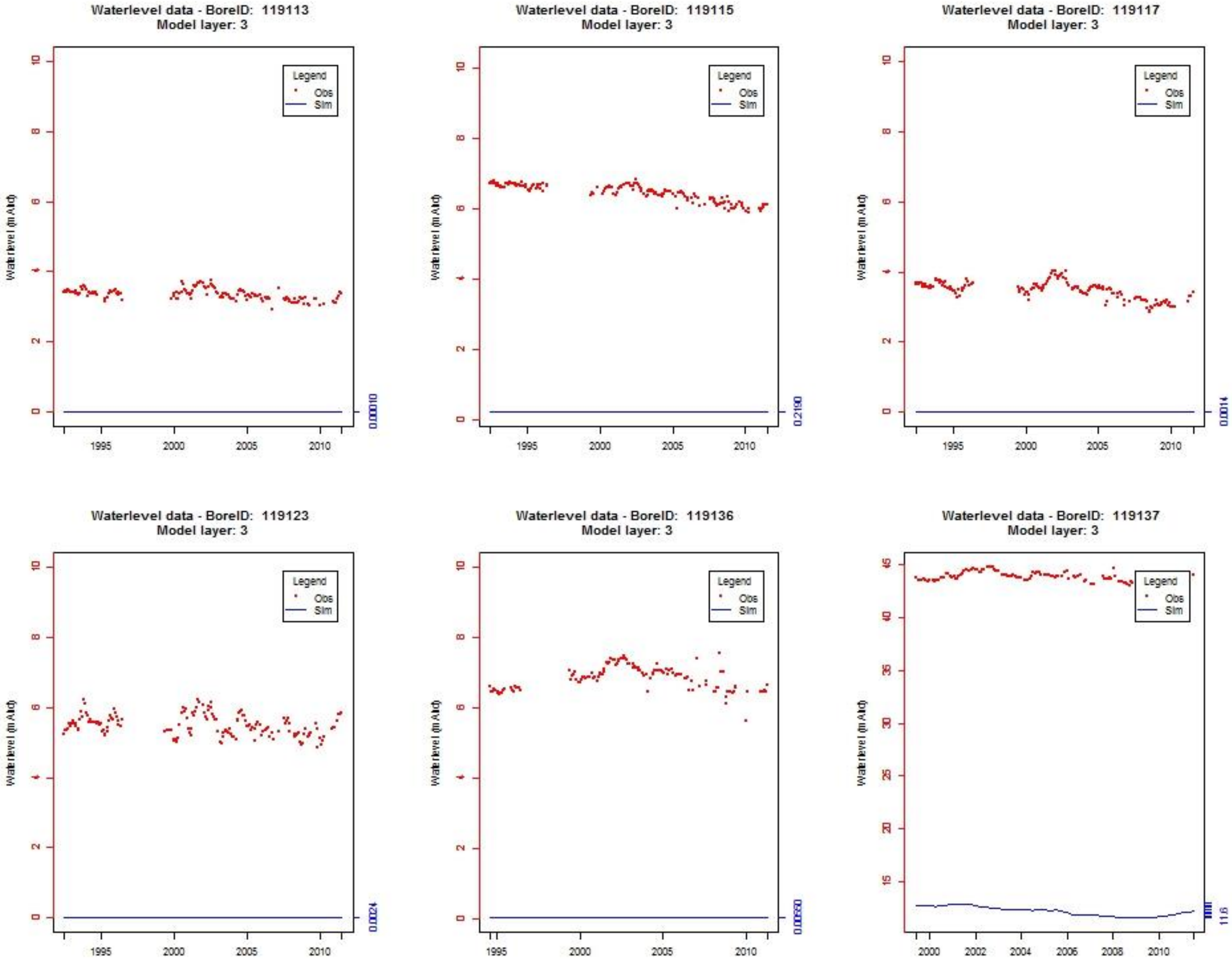

Waterlevel data - BoreID: 115226
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

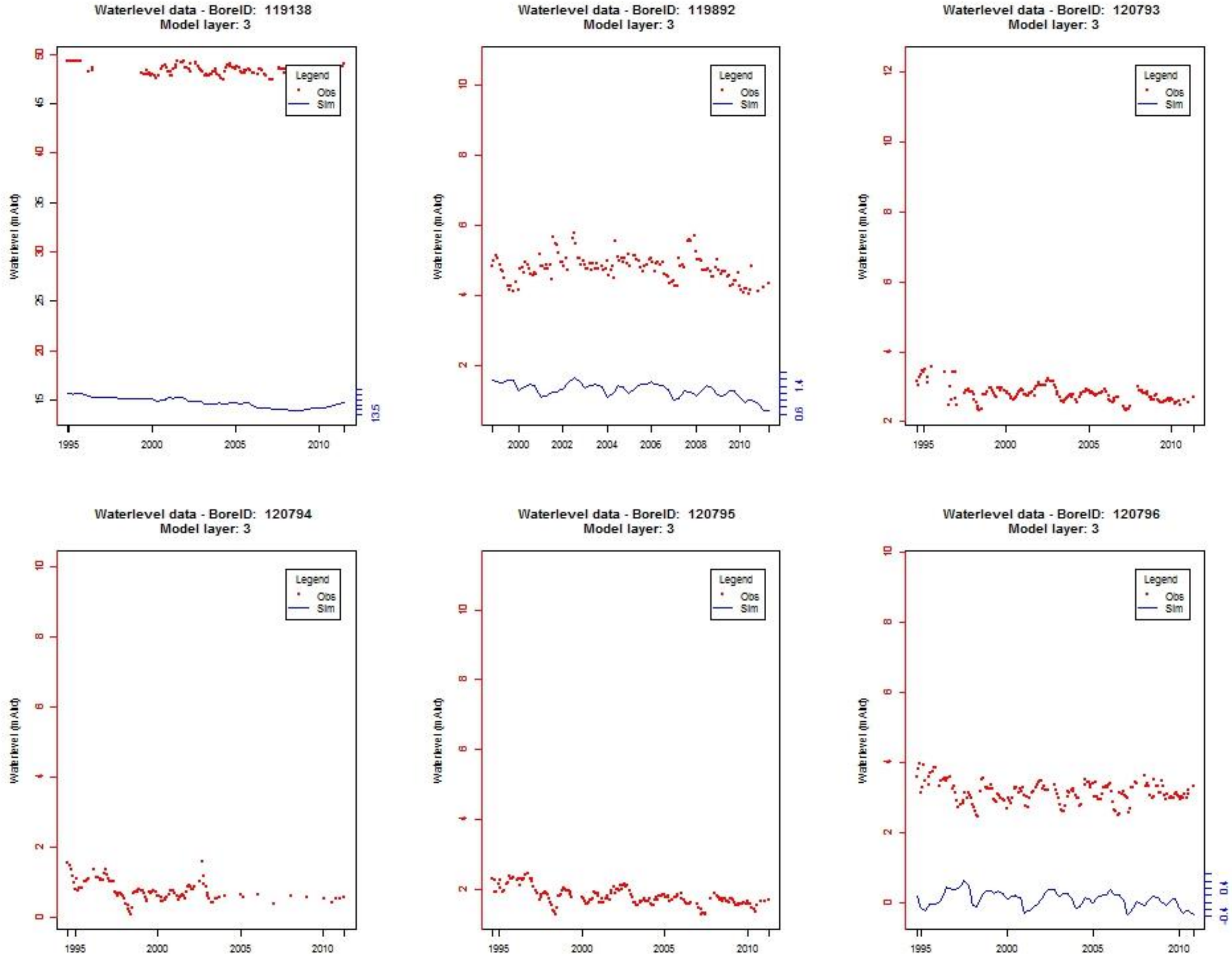

Waterlevel data - BoreID: 115630
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

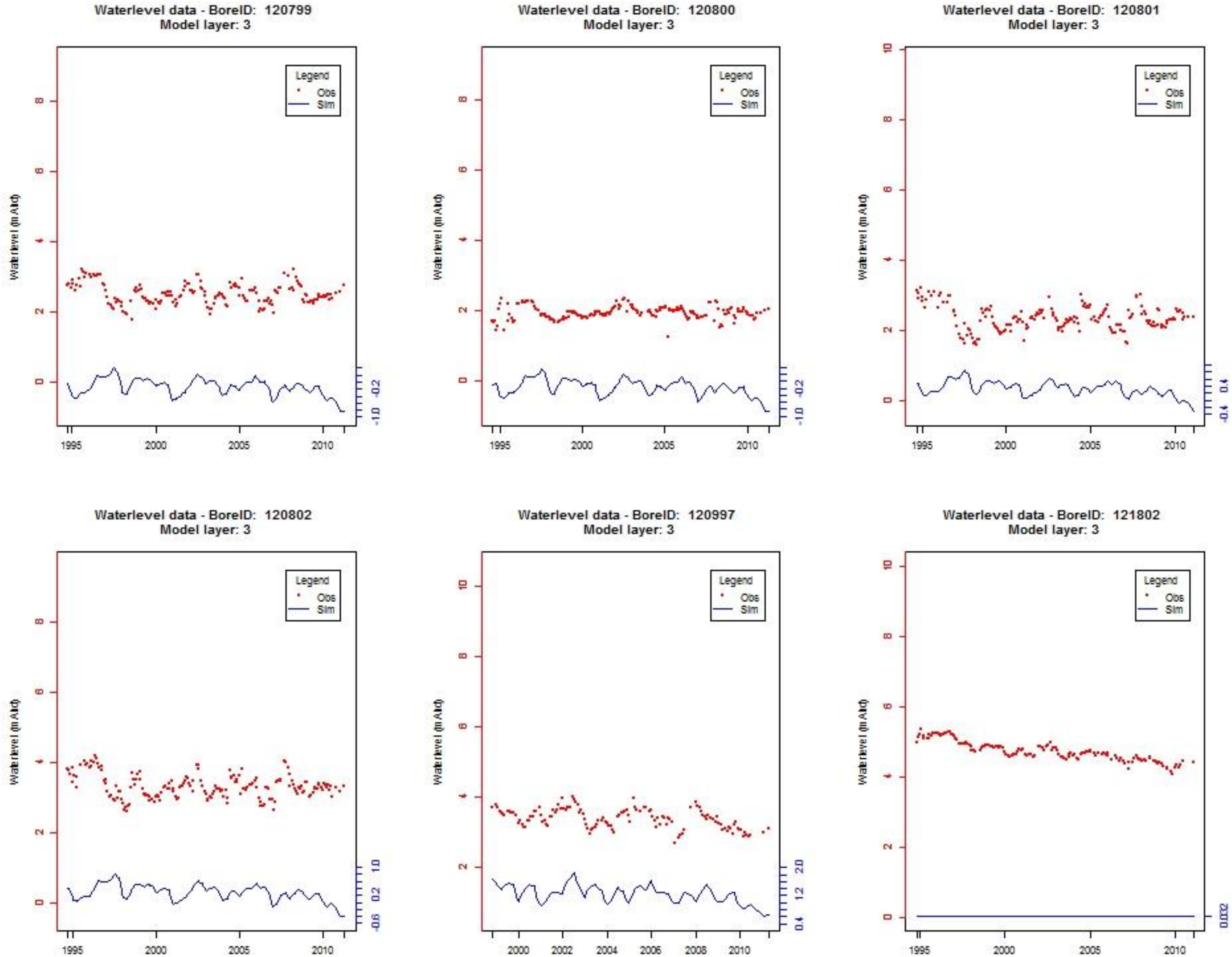

Waterlevel data - BoreID: 115631
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

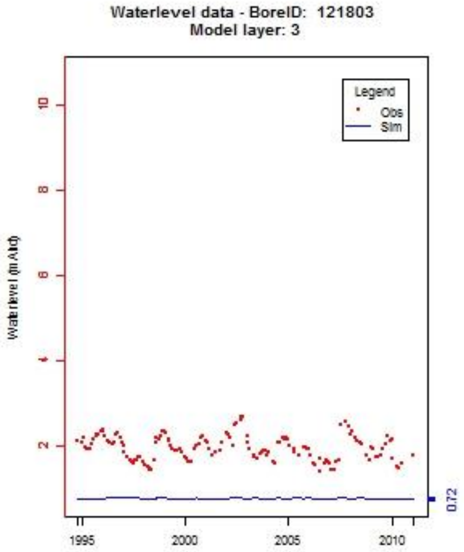

Waterlevel data - BoreID: 115937
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

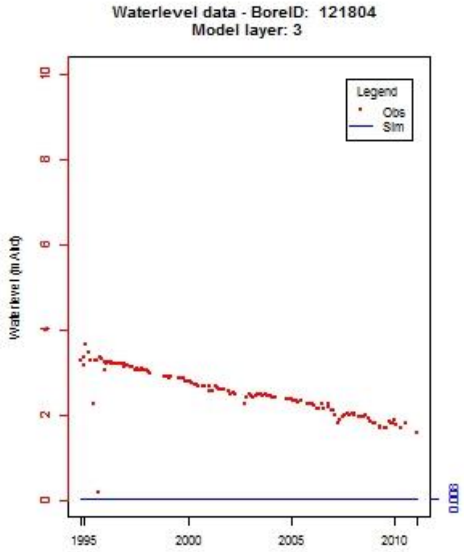

Waterlevel data - BoreID: 115939
Model layer: 3
Waterlevel data - BoreID: 115940
Model layer: 3
Waterlevel data - BoreID: 115941
Model layer: 3
Waterlevel data - BoreID: 119103
Model layer: 3
Waterlevel data - BoreID: 119109
Model layer: 3
Waterlevel data - BoreID: 119110
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

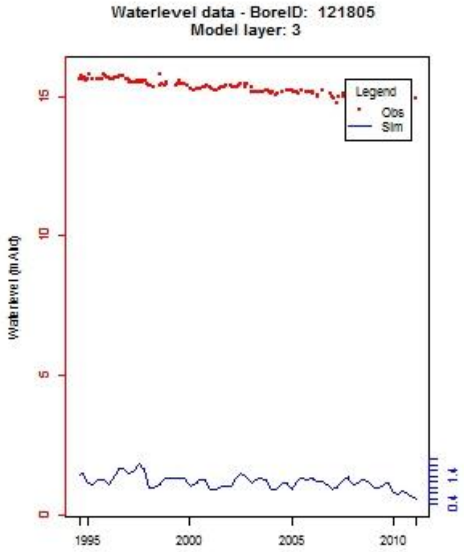

Waterlevel data - BoreID: 119113
Model layer: 3
Waterlevel data - BoreID: 119115
Model layer: 3
Waterlevel data - BoreID: 119117
Model layer: 3
Waterlevel data - BoreID: 119123
Model layer: 3
Waterlevel data - BoreID: 119136
Model layer: 3
Waterlevel data - BoreID: 119137
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

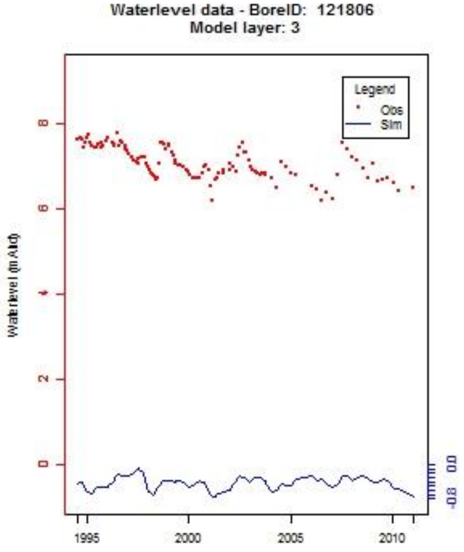

Waterlevel data - BoreID: 119138
Model layer: 3
Waterlevel data - BoreID: 119892
Model layer: 3
Waterlevel data - BoreID: 120793
Model layer: 3
Waterlevel data - BoreID: 120794
Model layer: 3
Waterlevel data - BoreID: 120795
Model layer: 3
Waterlevel data - BoreID: 120796
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

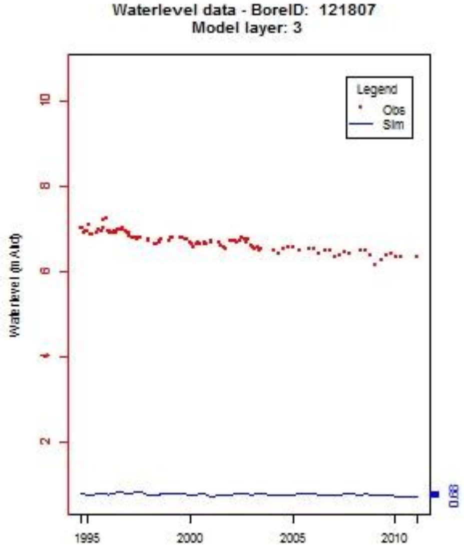

Waterlevel data - BoreID: 120799
Model layer: 3
Waterlevel data - BoreID: 120800
Model layer: 3
Waterlevel data - BoreID: 120801
Model layer: 3
Waterlevel data - BoreID: 120802
Model layer: 3
Waterlevel data - BoreID: 120997
Model layer: 3
Waterlevel data - BoreID: 121802
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

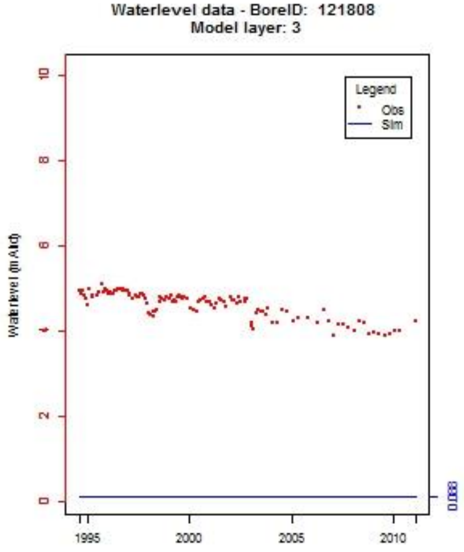

Waterlevel data - BoreID: 121803
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

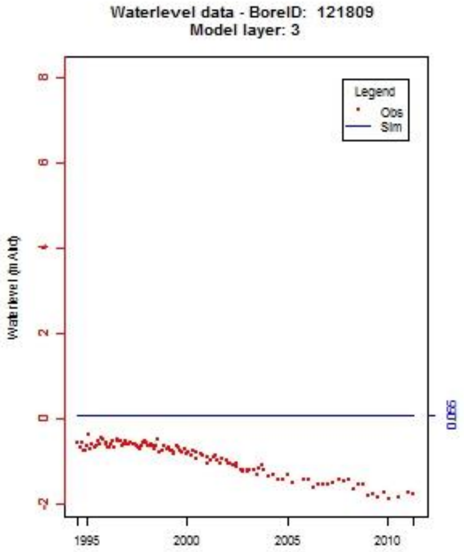

Waterlevel data - BoreID: 121804
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

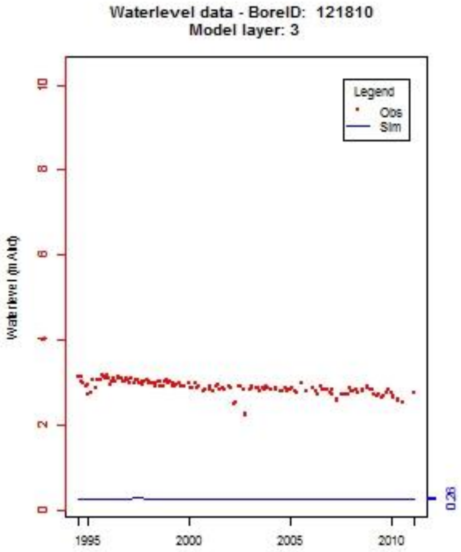

Waterlevel data - BoreID: 121805
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

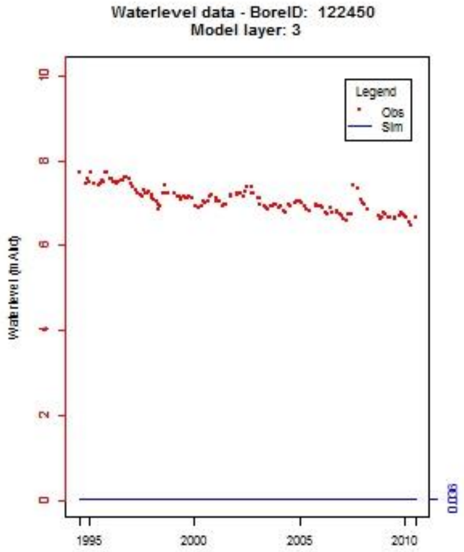

Waterlevel data - BoreID: 121806
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

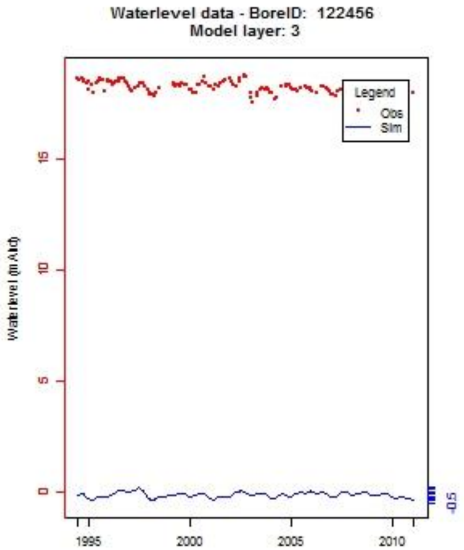

Waterlevel data - BoreID: 121807
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

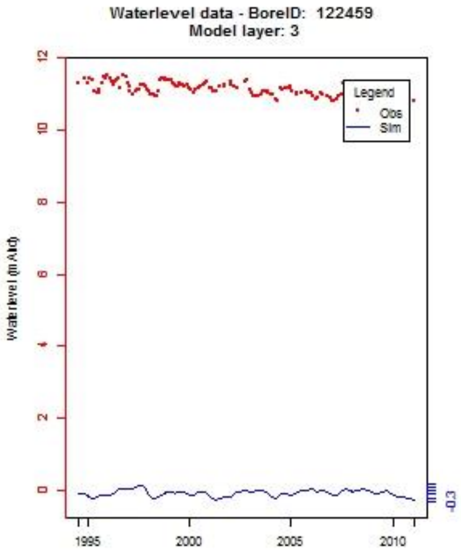

Waterlevel data - BoreID: 121808
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

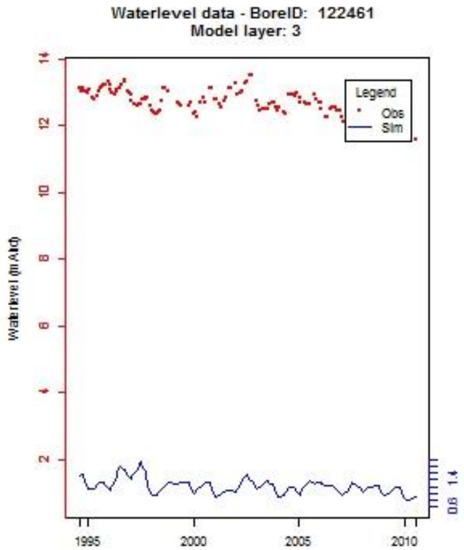

Waterlevel data - BoreID: 121809
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010
0.066

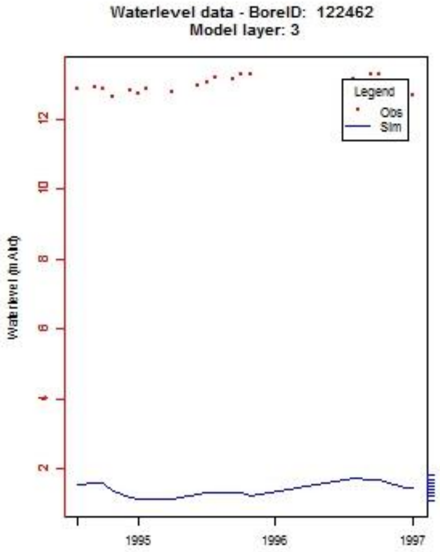

Waterlevel data - BoreID: 121810
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010
0.26

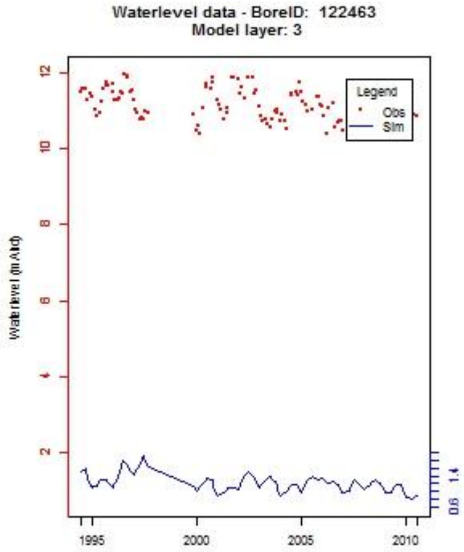

Waterlevel data - BoreID: 122450
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010
0.036

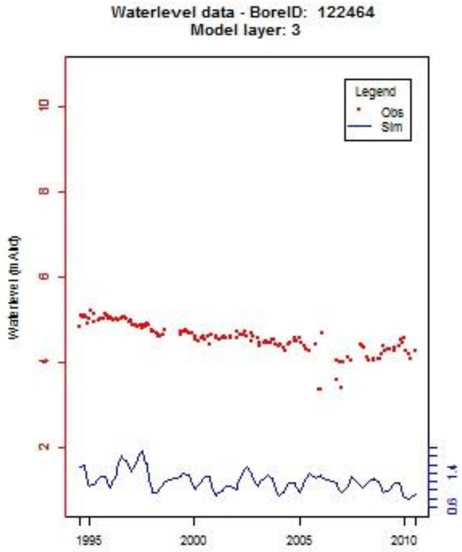

Waterlevel data - BoreID: 122456
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010
-0.5

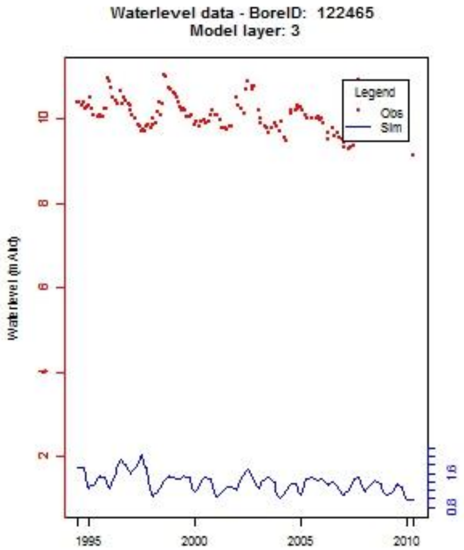

Waterlevel data - BoreID: 122459
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010
-0.3

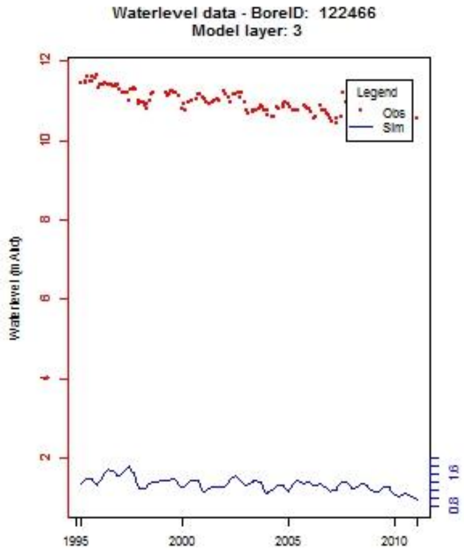

Waterlevel data - BoreID: 122461
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010
0.6
1.4

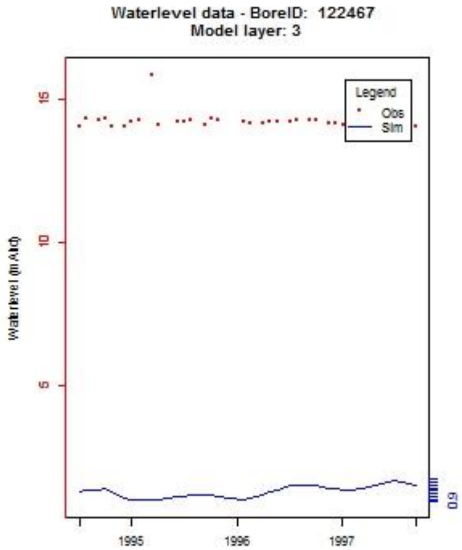

Waterlevel data - BoreID: 122462
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

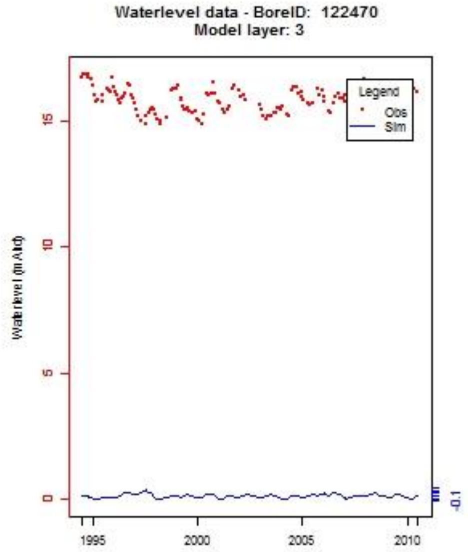

Waterlevel data - BoreID: 122463
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

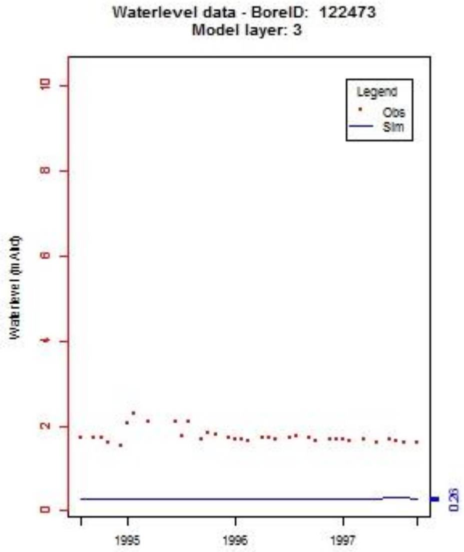

Waterlevel data - BoreID: 122464
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

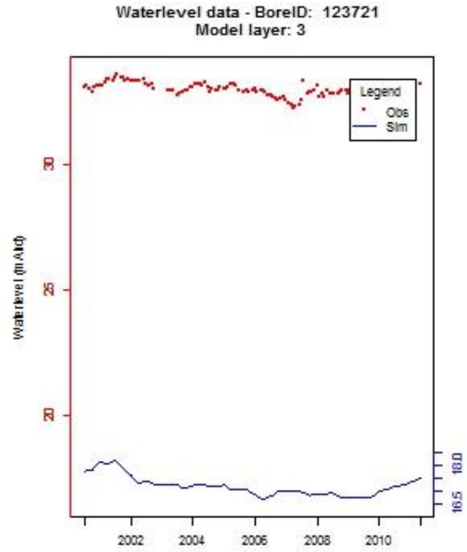

Waterlevel data - BoreID: 122465
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

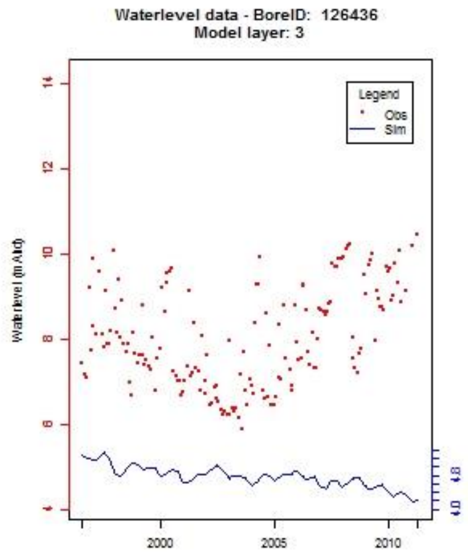

Waterlevel data - BoreID: 122466
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

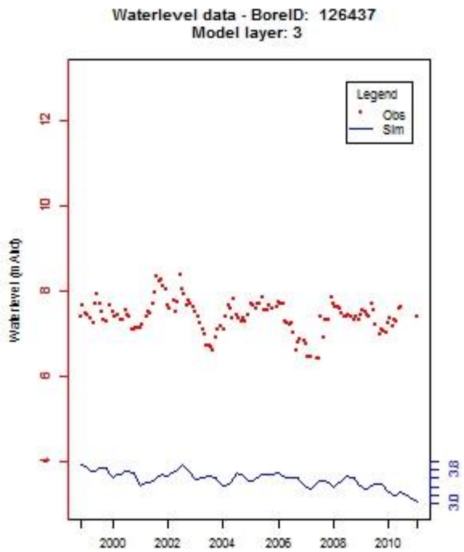

Waterlevel data - BoreID: 122467
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

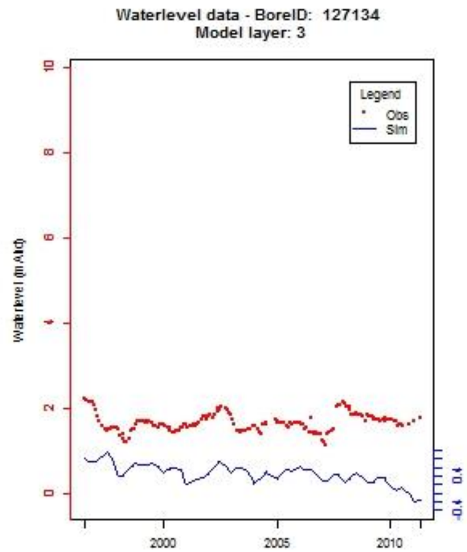

Waterlevel data - BoreID: 122470
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

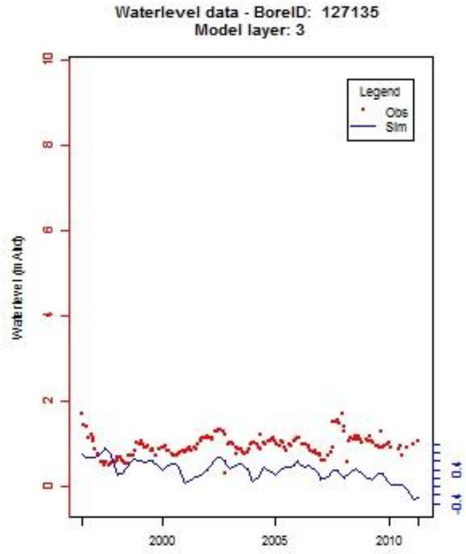

Waterlevel data - BoreID: 122473
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

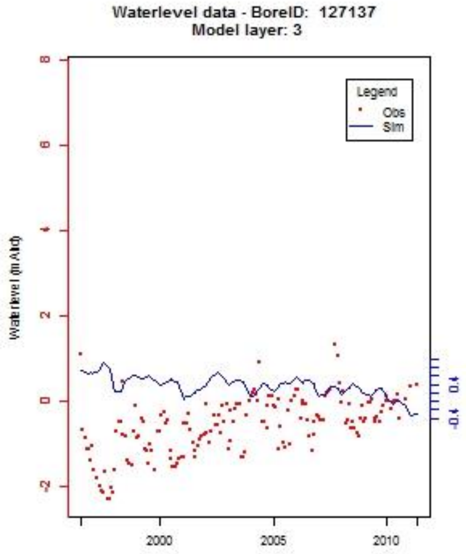

Waterlevel data - BoreID: 123721
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

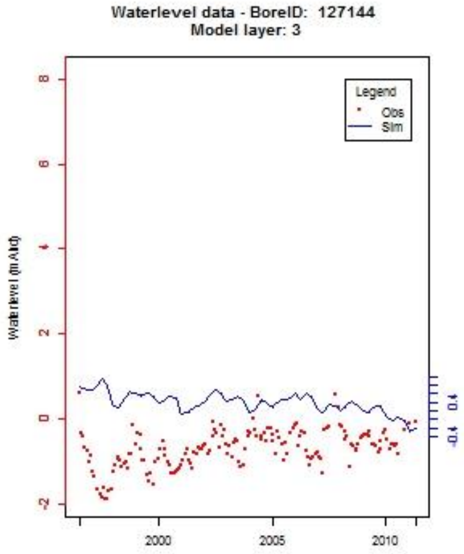

Waterlevel data - BoreID: 126436
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

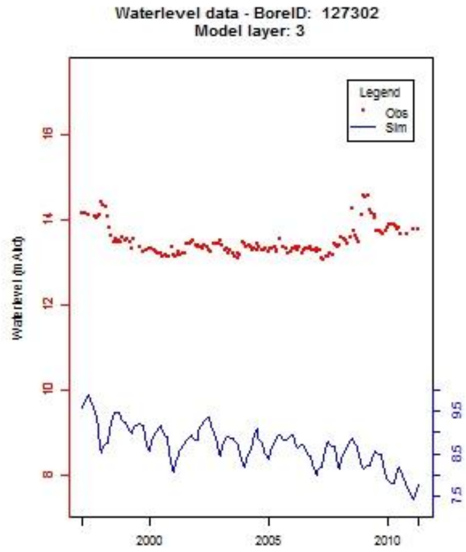

Waterlevel data - BoreID: 126437
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

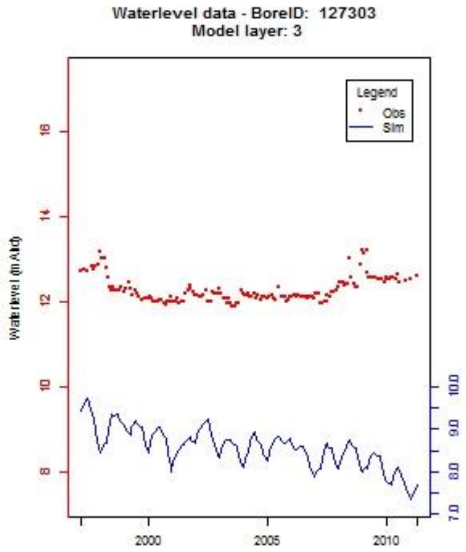

Waterlevel data - BoreID: 127134
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

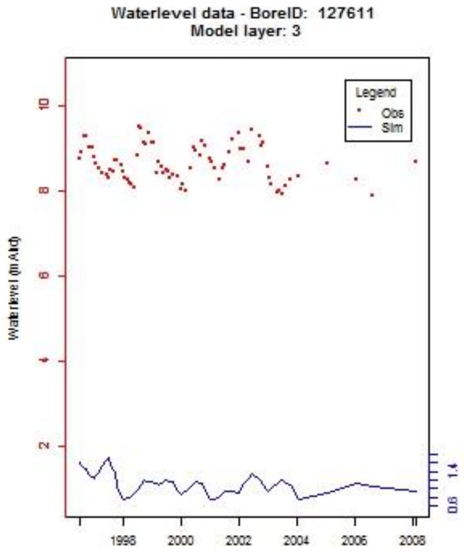

Waterlevel data - BoreID: 127135
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

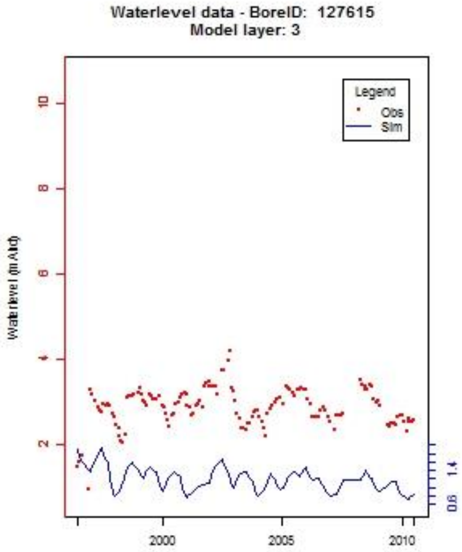

Waterlevel data - BoreID: 127137
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

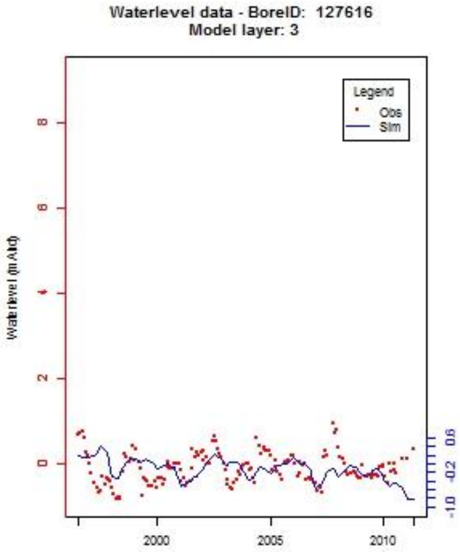

Waterlevel data - BoreID: 127144
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

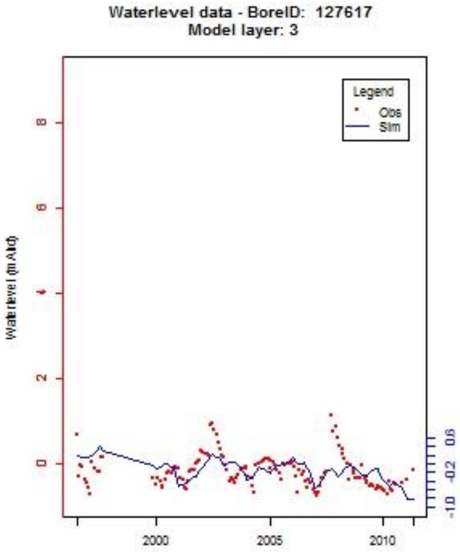

Waterlevel data - BoreID: 127302
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

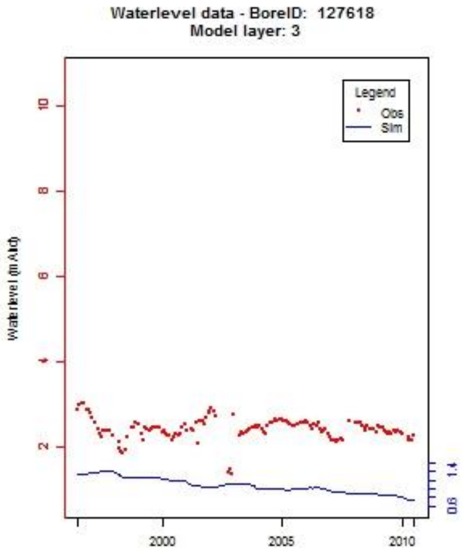

Waterlevel data - BoreID: 127303
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

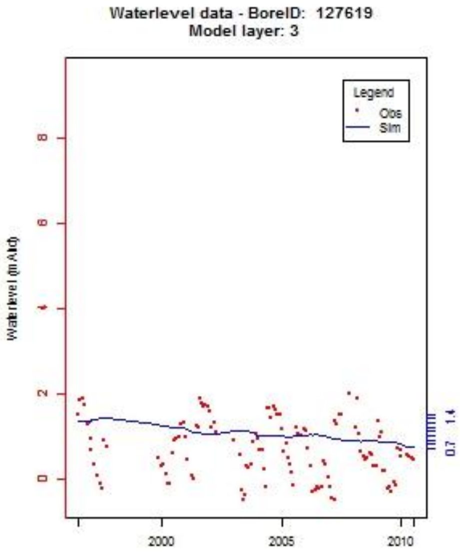

Waterlevel data - BoreID: 127611
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1998
2000
2002
2004
2006
2008

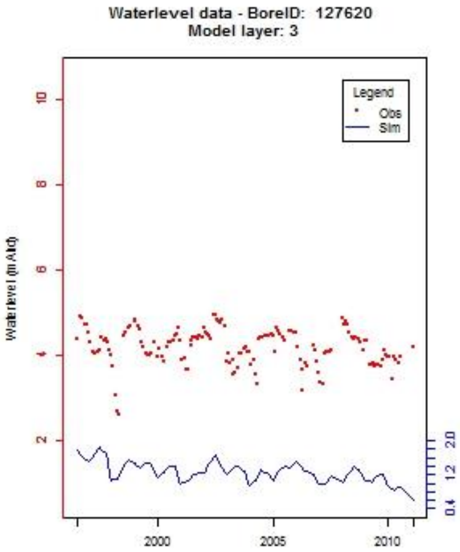

Waterlevel data - BoreID: 127615
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

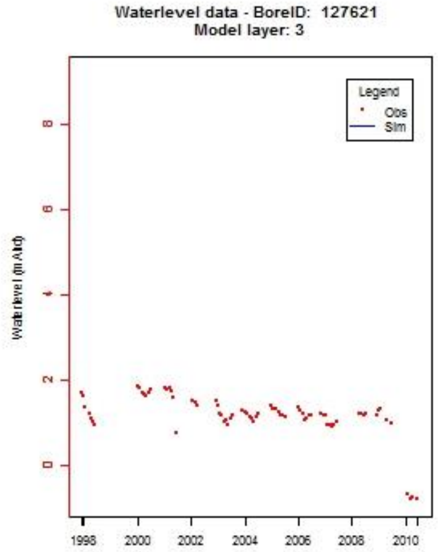

Waterlevel data - BoreID: 127616
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

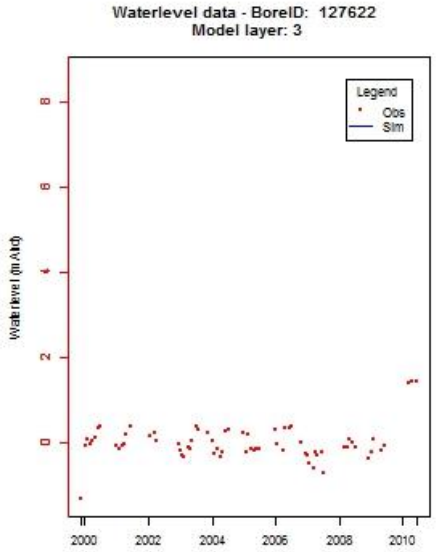

Waterlevel data - BoreID: 127617
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

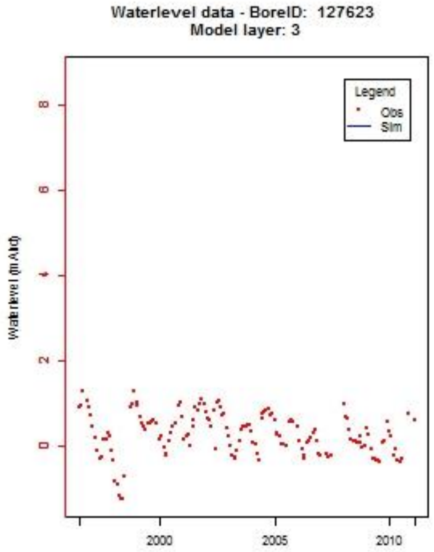

Waterlevel data - BoreID: 127618
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

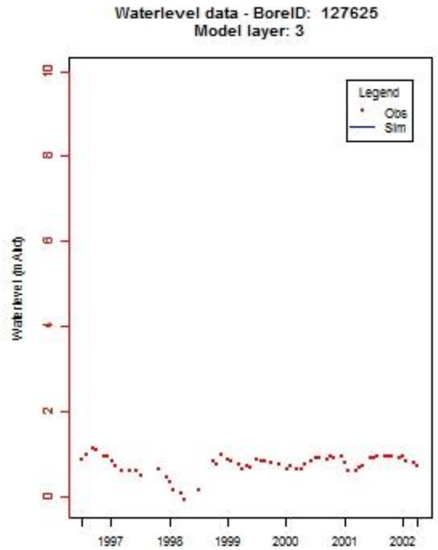

Waterlevel data - BoreID: 127619
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

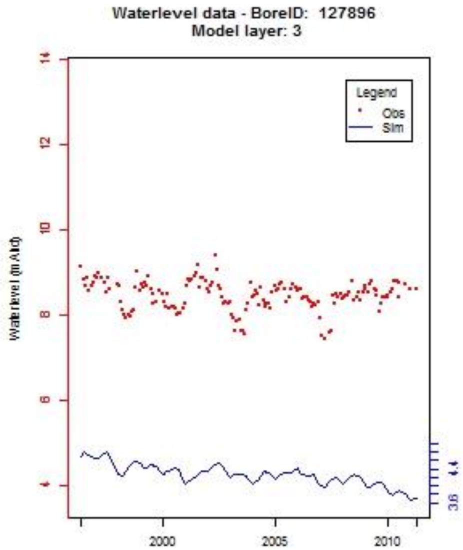

Waterlevel data - BoreID: 127620
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

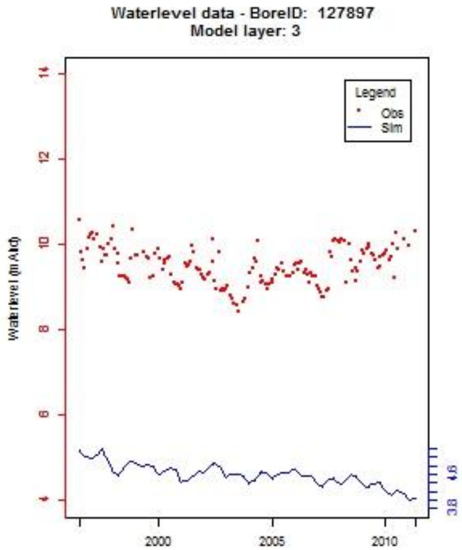

Waterlevel data - BoreID: 127621
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

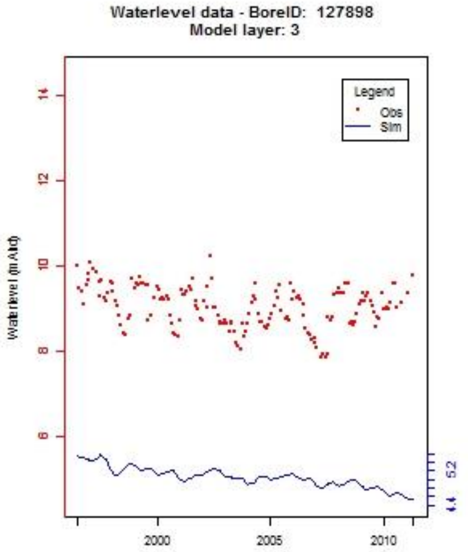

Waterlevel data - BoreID: 127622
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

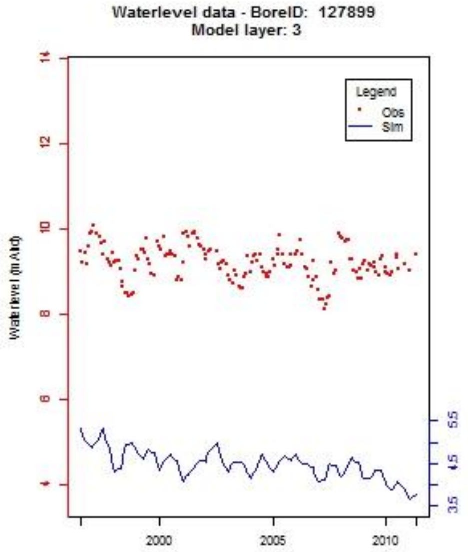

Waterlevel data - BoreID: 127623
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

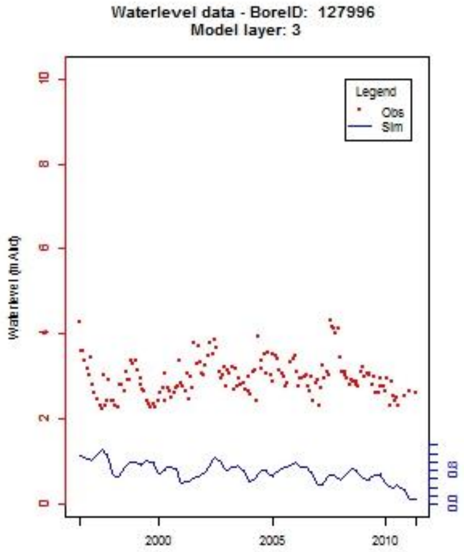

Waterlevel data - BoreID: 127625
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

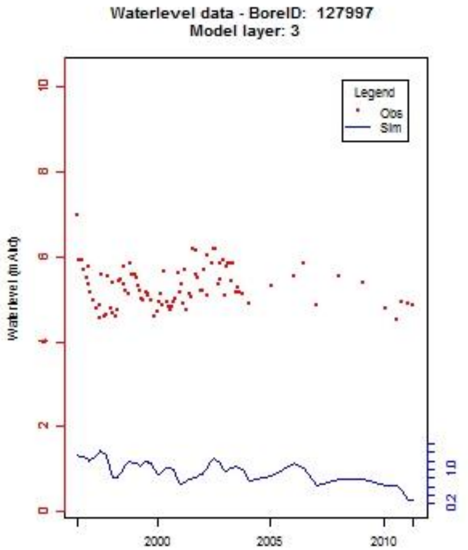

Waterlevel data - BoreID: 127896
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

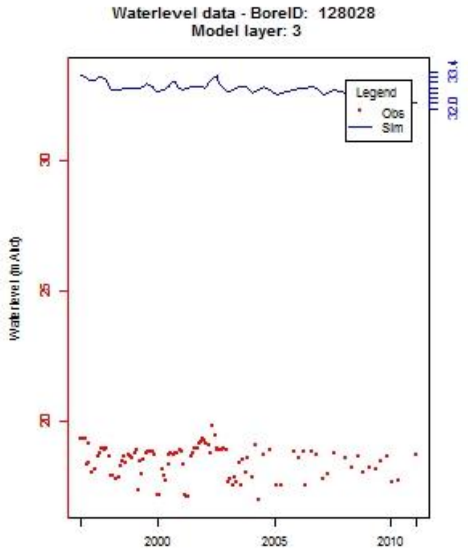

Waterlevel data - BoreID: 127897
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

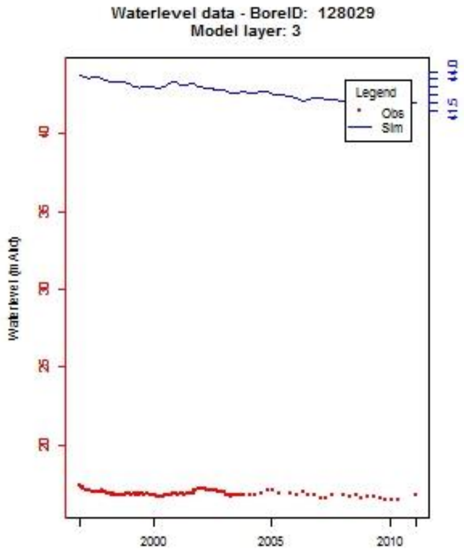

Waterlevel data - BoreID: 127898
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

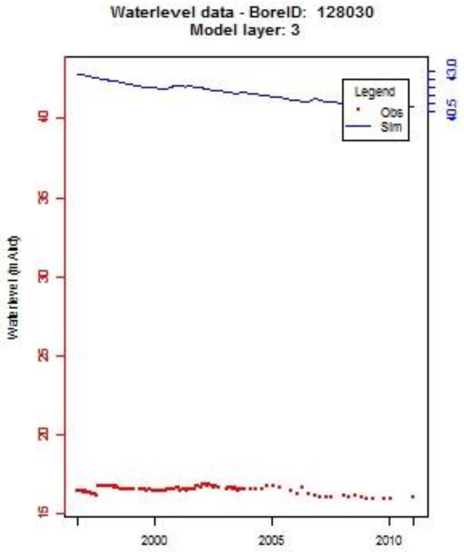

Waterlevel data - BoreID: 127899
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

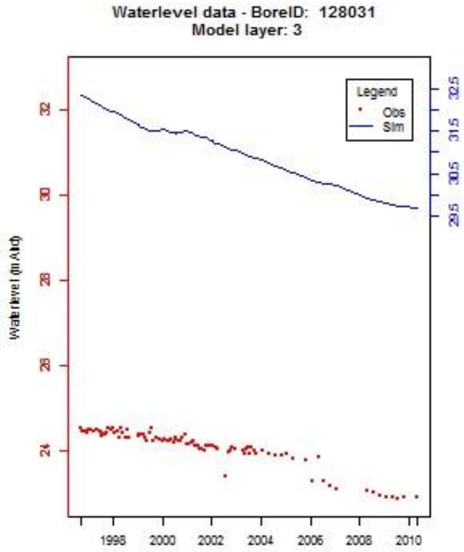

Waterlevel data - BoreID: 127996
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

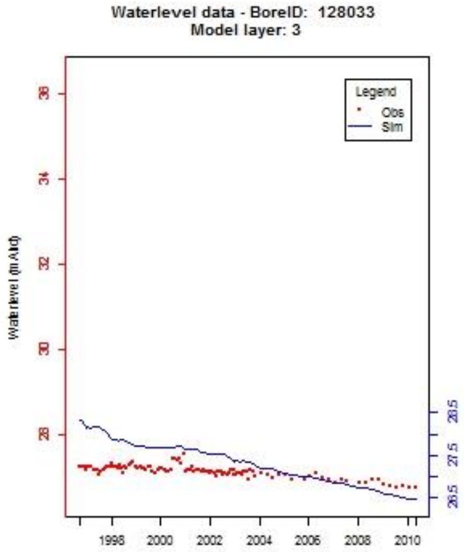

Waterlevel data - BoreID: 127997
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

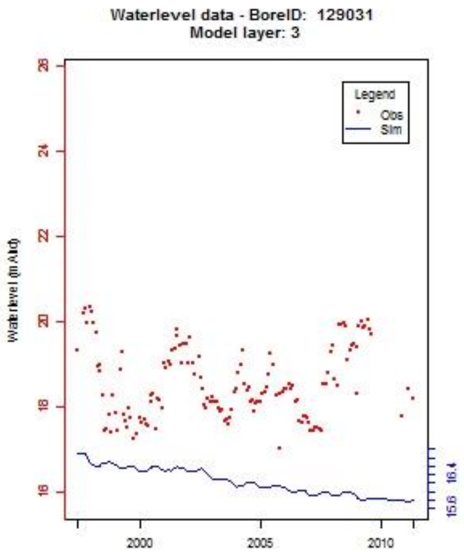

Waterlevel data - BoreID: 128028
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

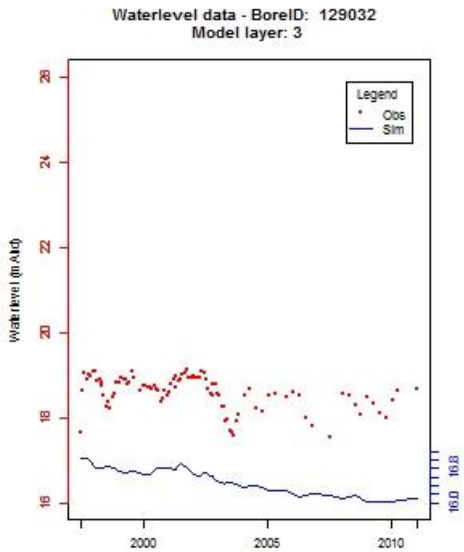

Waterlevel data - BoreID: 128029
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2005
2010

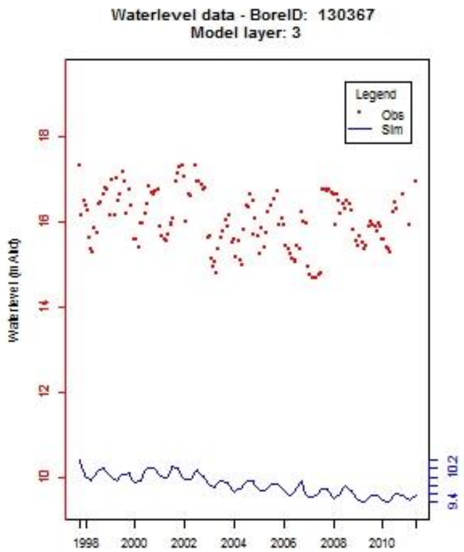

Waterlevel data - BoreID: 128030
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

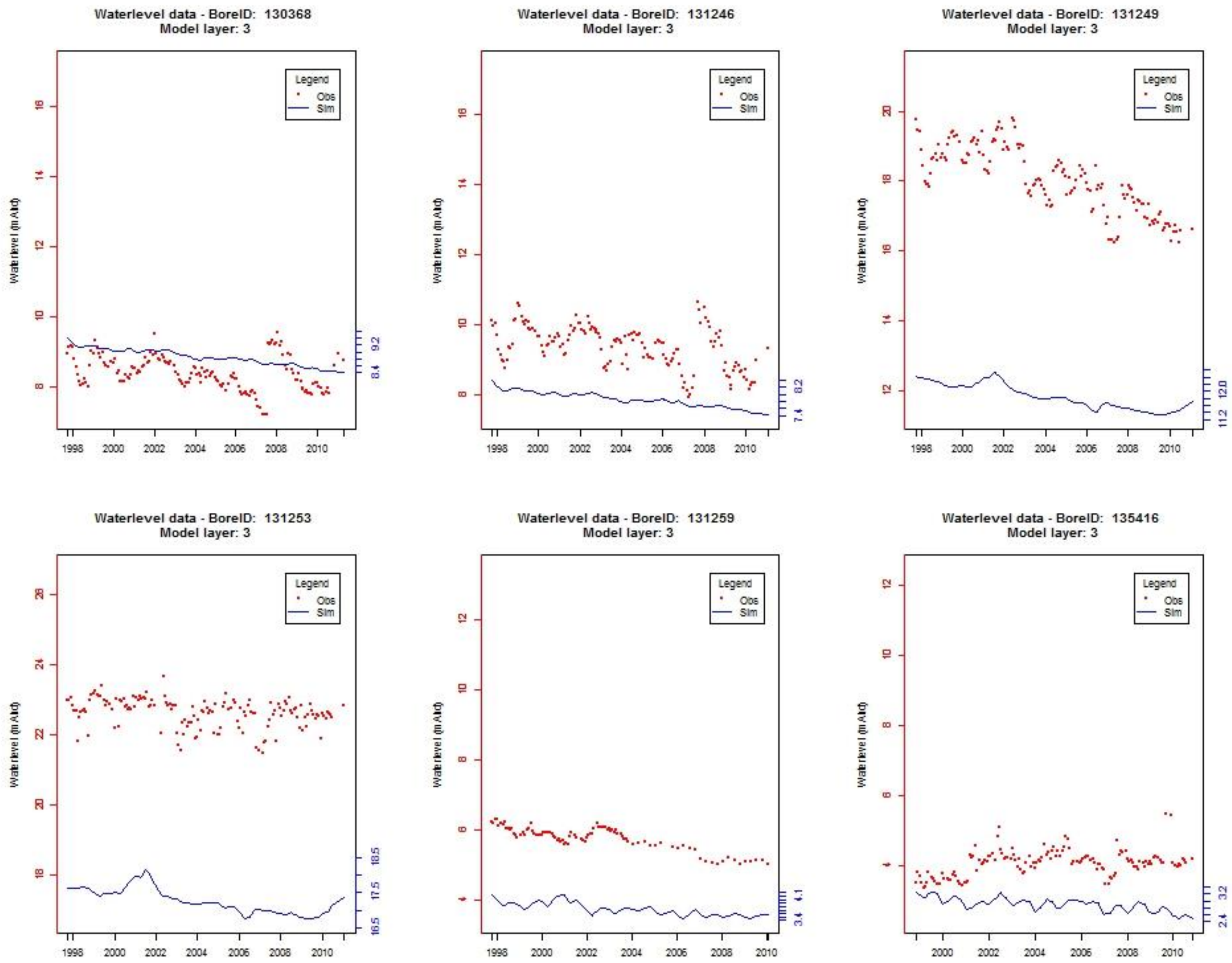

Waterlevel data - BoreID: 128031
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

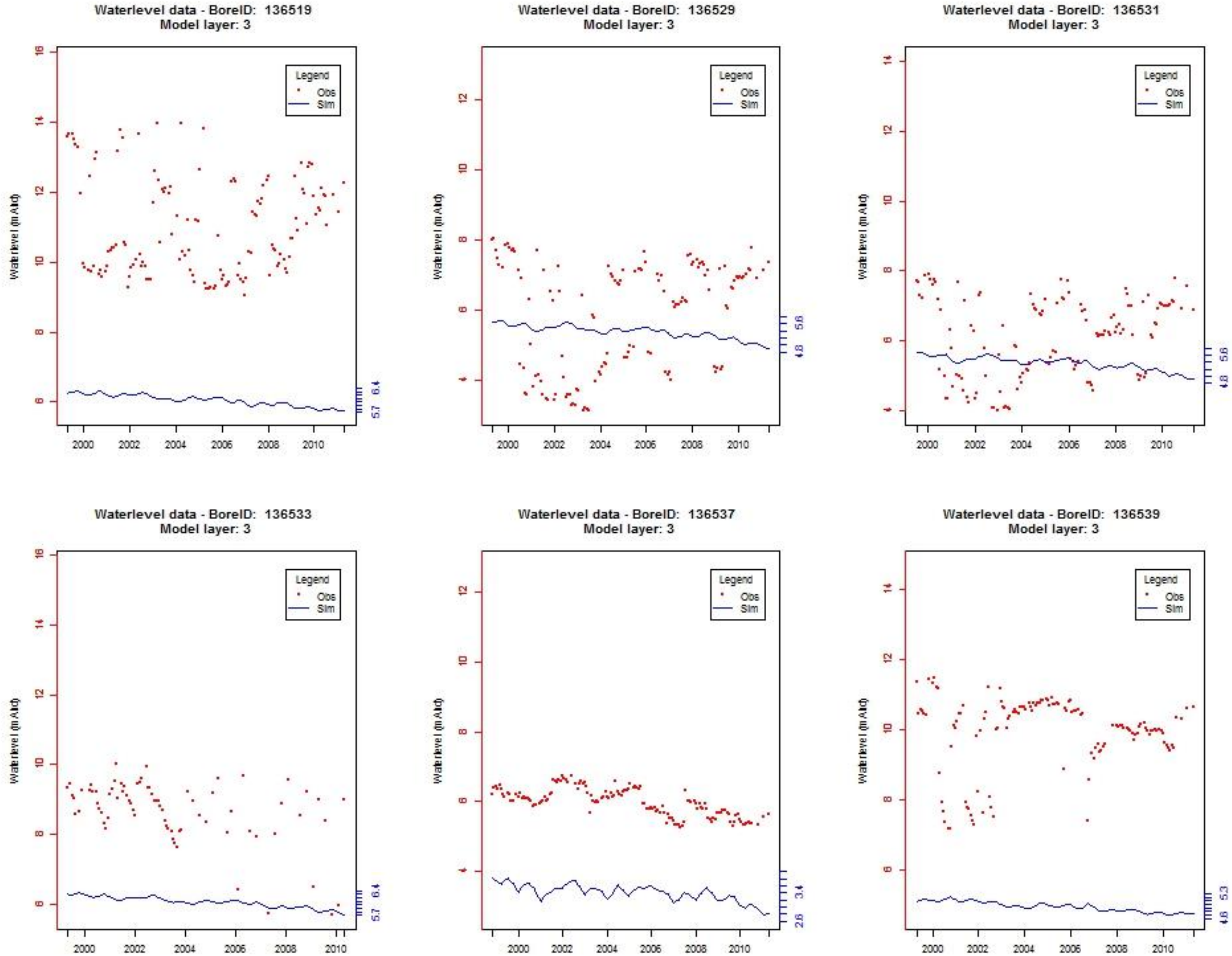

Waterlevel data - BoreID: 128033
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

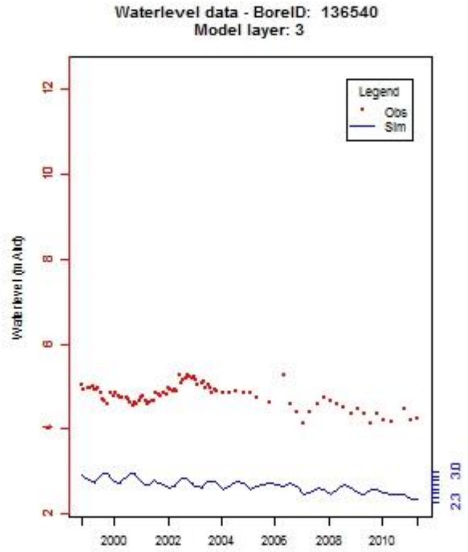

Waterlevel data - BoreID: 129031
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

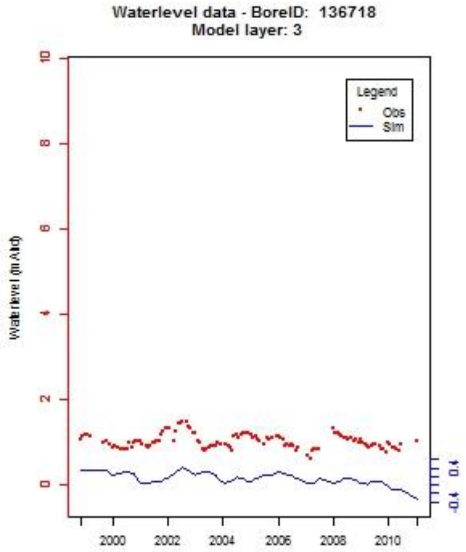

Waterlevel data - BoreID: 129032
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

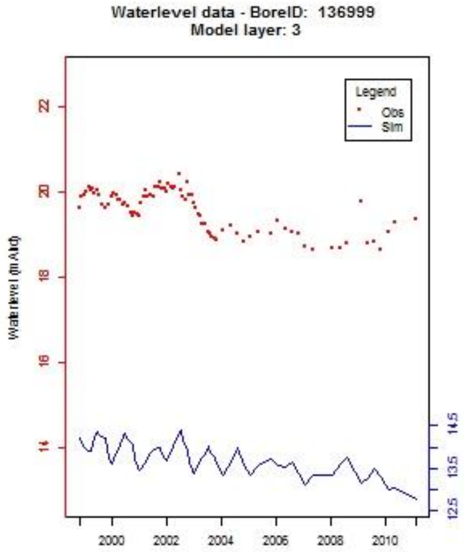

Waterlevel data - BoreID: 130367
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

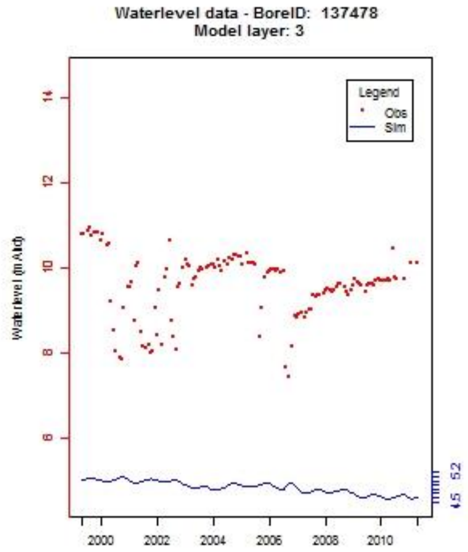

Waterlevel data - BoreID: 130368
Model layer: 3
Waterlevel data - BoreID: 131246
Model layer: 3
Waterlevel data - BoreID: 131249
Model layer: 3
Waterlevel data - BoreID: 131253
Model layer: 3
Waterlevel data - BoreID: 131259
Model layer: 3
Waterlevel data - BoreID: 135416
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

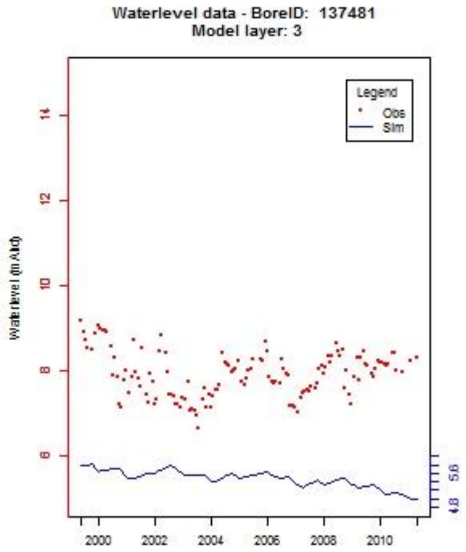

Waterlevel data - BoreID: 136519
Model layer: 3
Waterlevel data - BoreID: 136529
Model layer: 3
Waterlevel data - BoreID: 136531
Model layer: 3
Waterlevel data - BoreID: 136533
Model layer: 3
Waterlevel data - BoreID: 136537
Model layer: 3
Waterlevel data - BoreID: 136539
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2000
2002
2004
2006
2008
2010

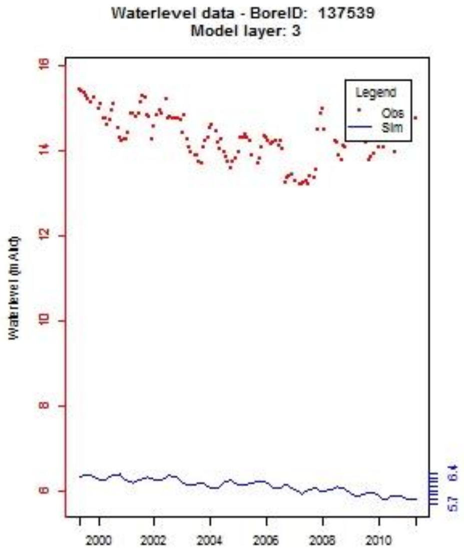

Waterlevel data - BoreID: 136540
Model layer: 3
Legend
Obs
Sim

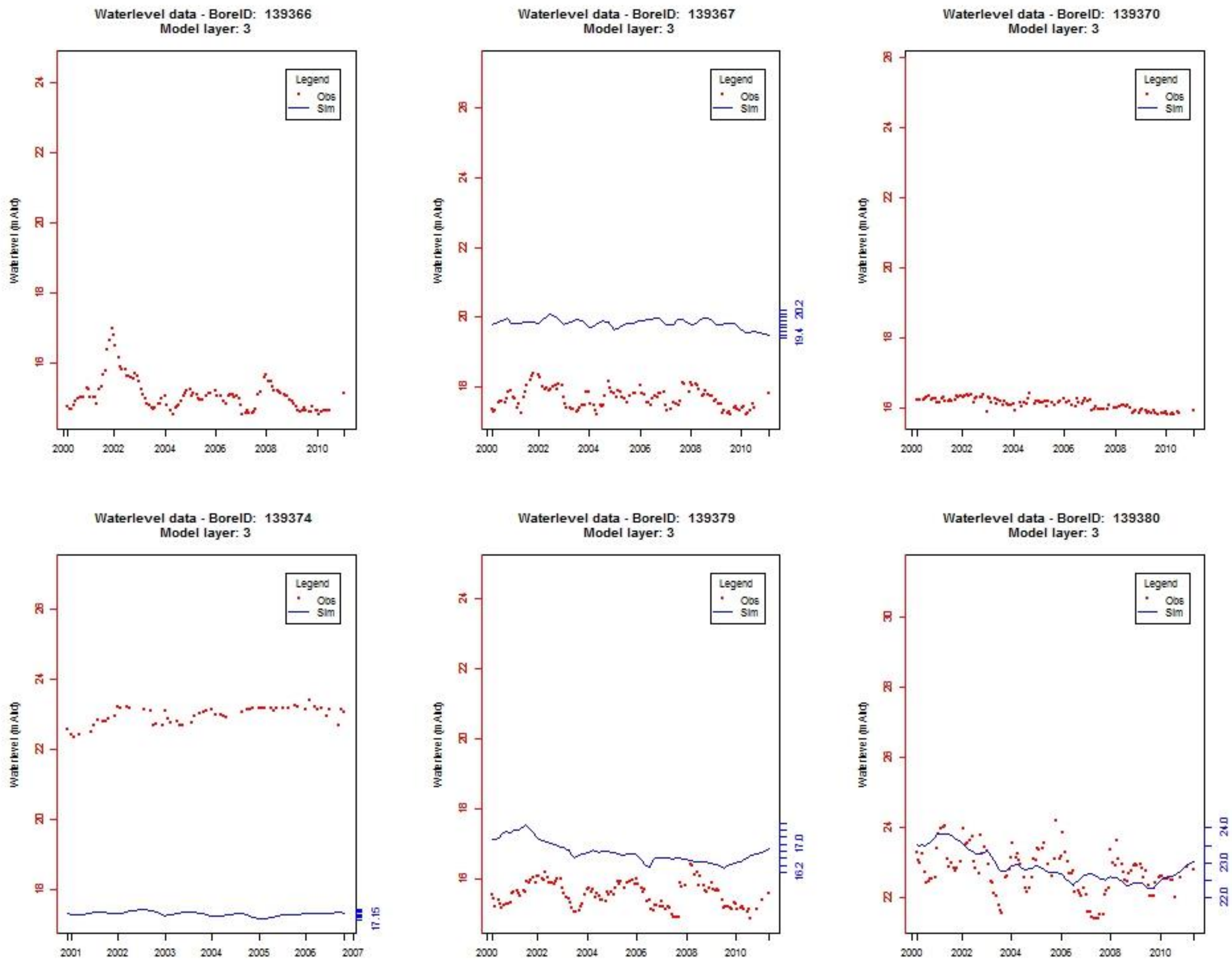

Waterlevel data - BoreID: 136718
Model layer: 3
Legend
Obs
Sim

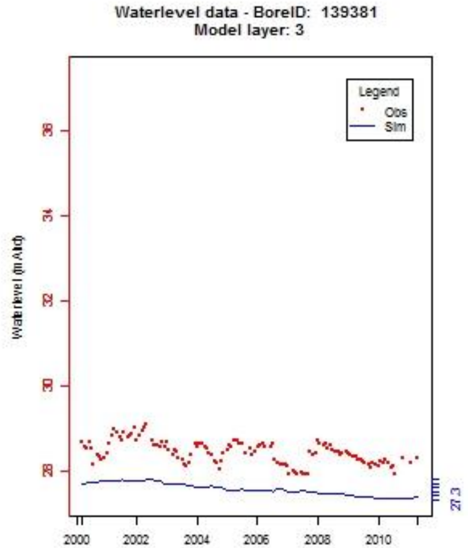

Waterlevel data - BoreID: 136999
Model layer: 3
Legend
Obs
Sim

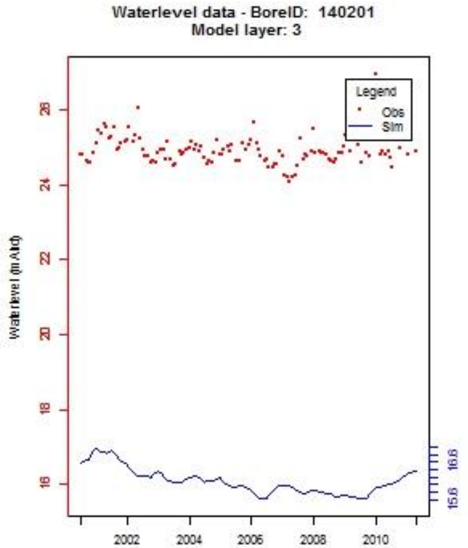

Waterlevel data - BoreID: 137478
Model layer: 3
Legend
Obs
Sim

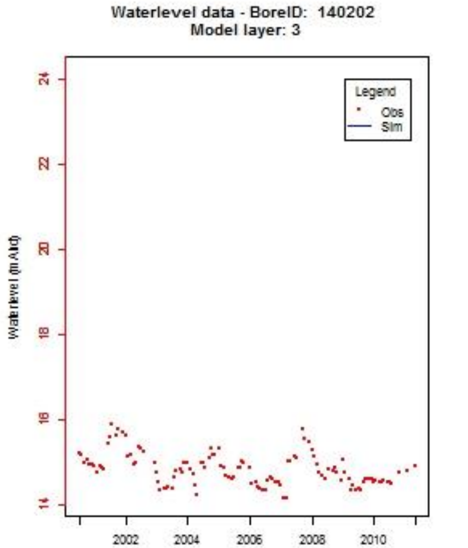

Waterlevel data - BoreID: 137481
Model layer: 3
Legend
Obs
Sim

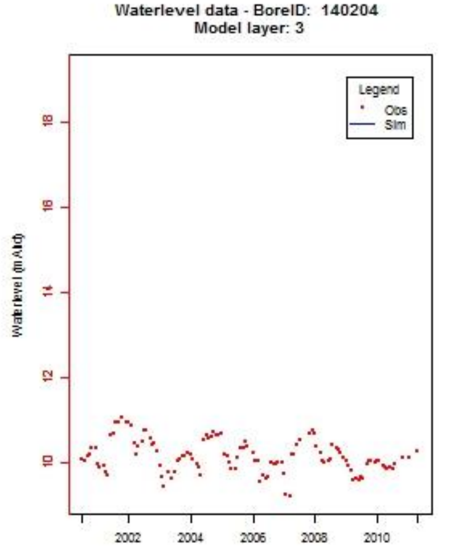

Waterlevel data - BoreID: 137539
Model layer: 3
Legend
Obs
Sim

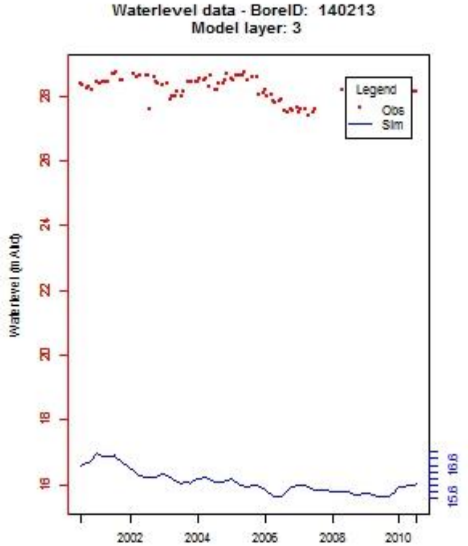

Waterlevel data - BoreID: 139366
Model layer: 3
Waterlevel data - BoreID: 139367
Model layer: 3
Waterlevel data - BoreID: 139370
Model layer: 3
Waterlevel data - BoreID: 139374
Model layer: 3
Waterlevel data - BoreID: 139379
Model layer: 3
Waterlevel data - BoreID: 139380
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

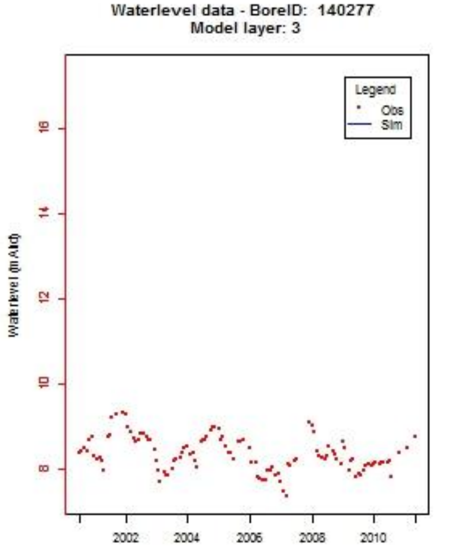

Waterlevel data - BoreID: 139381
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
28
30
32
34
36
27.3
2000
2002
2004
2006
2008
2010

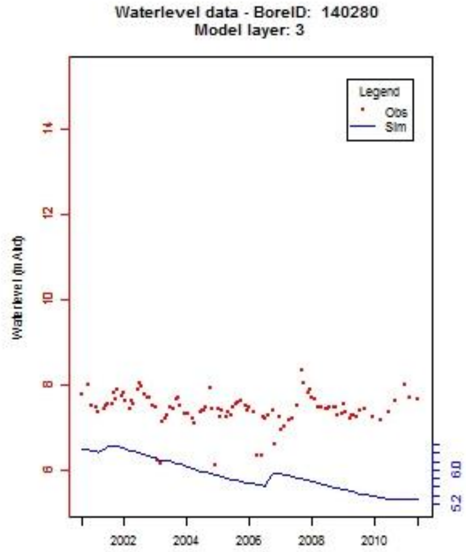

Waterlevel data - BoreID: 140201
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
16
18
20
22
24
26
16.6
15.6
2002
2004
2006
2008
2010

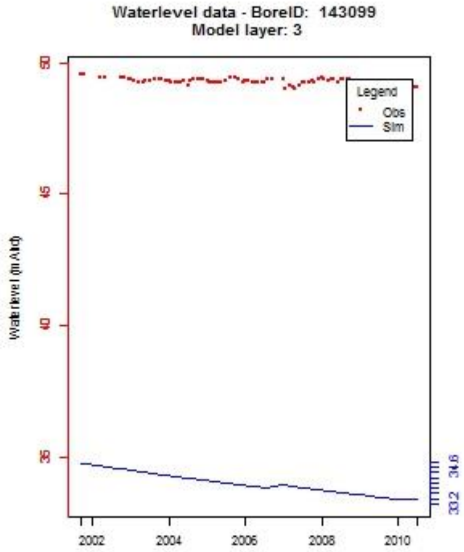

Waterlevel data - BoreID: 140202
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
14
16
18
20
22
24
2002
2004
2006
2008
2010

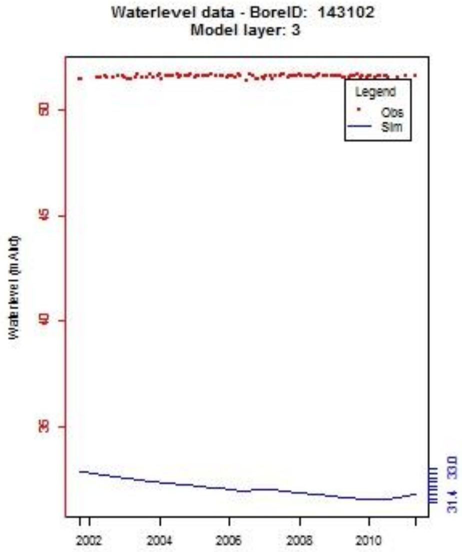

Waterlevel data - BoreID: 140204
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
10
12
14
16
18
2002
2004
2006
2008
2010

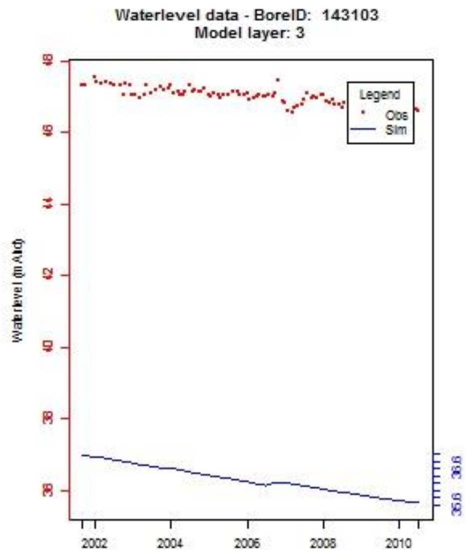

Waterlevel data - BoreID: 140213
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
16
18
20
22
24
26
28
16.6
15.6
2002
2004
2006
2008
2010

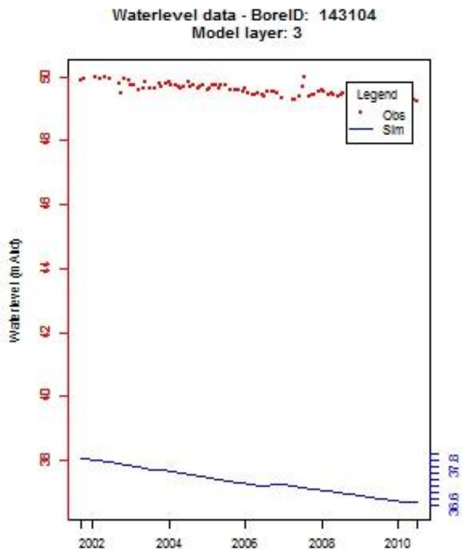

Waterlevel data - BoreID: 140277
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
8
10
12
14
16
2002
2004
2006
2008
2010

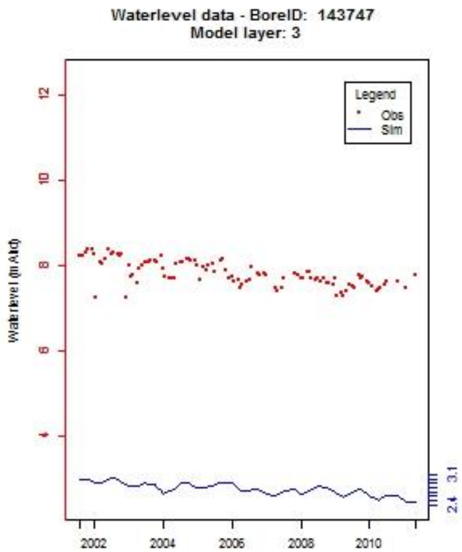

Waterlevel data - BoreID: 140280
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

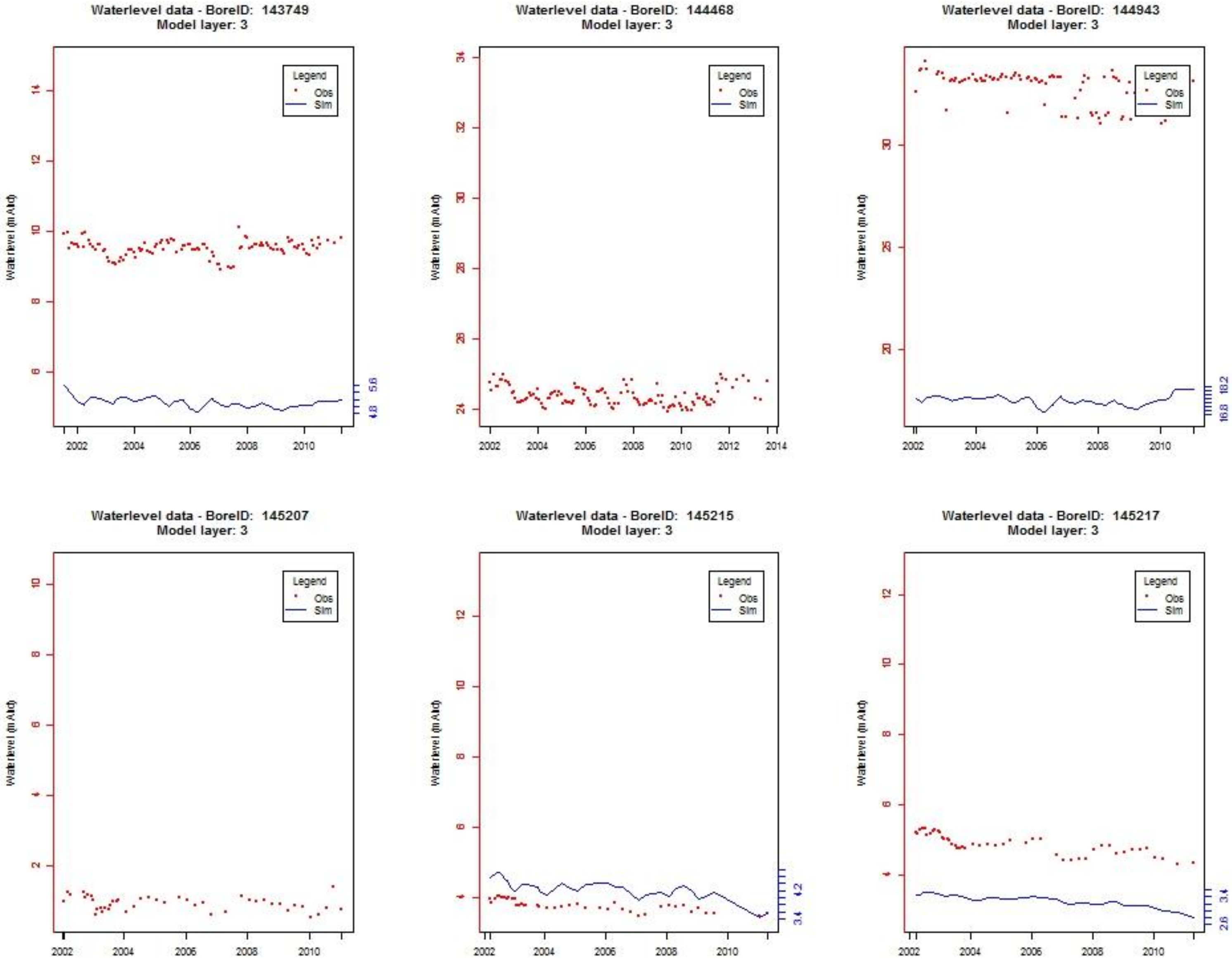

Waterlevel data - BoreID: 143099
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

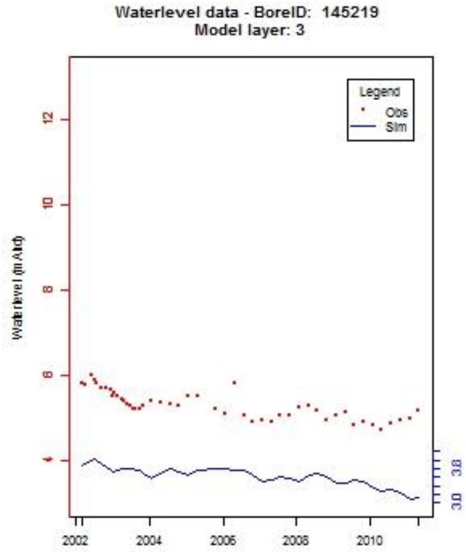

Waterlevel data - BoreID: 143102
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

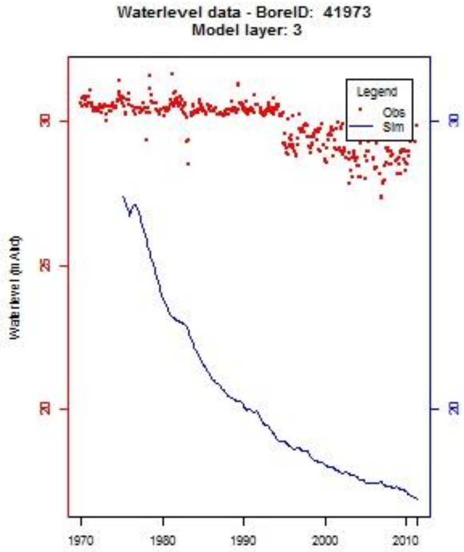

Waterlevel data - BoreID: 143103
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

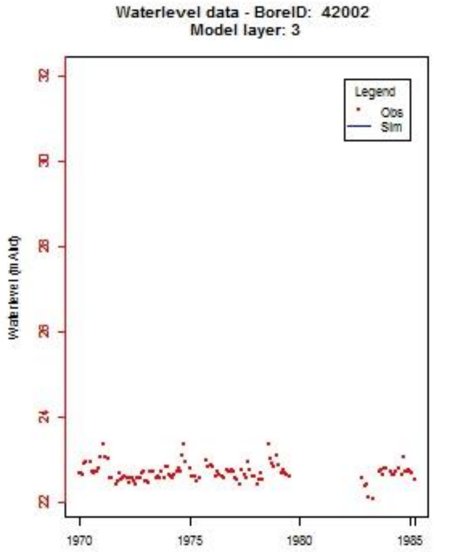

Waterlevel data - BoreID: 143104
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

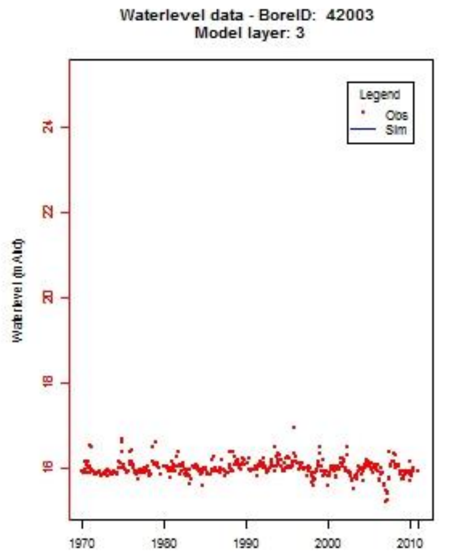

Waterlevel data - BoreID: 143747
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

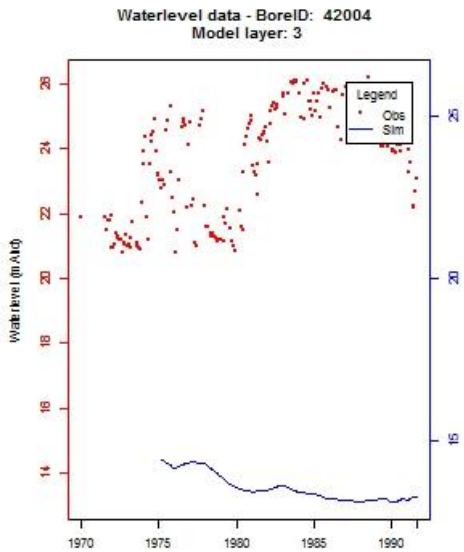

Waterlevel data - BoreID: 143749
Model layer: 3
Waterlevel data - BoreID: 144468
Model layer: 3
Waterlevel data - BoreID: 144943
Model layer: 3
Waterlevel data - BoreID: 145207
Model layer: 3
Waterlevel data - BoreID: 145215
Model layer: 3
Waterlevel data - BoreID: 145217
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

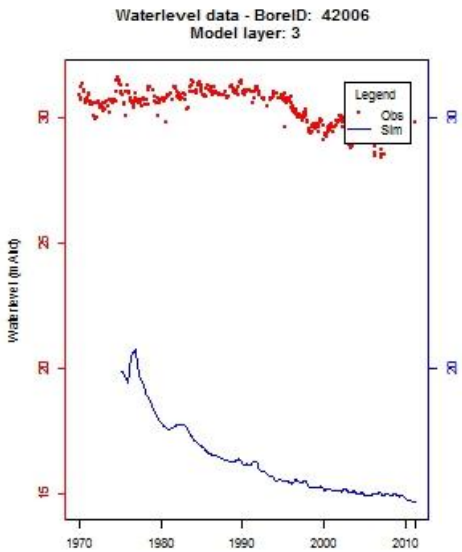

Waterlevel data - BoreID: 145219
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

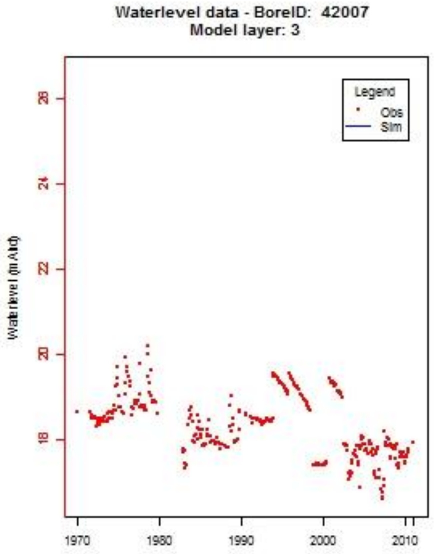

Waterlevel data - BoreID: 41973
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

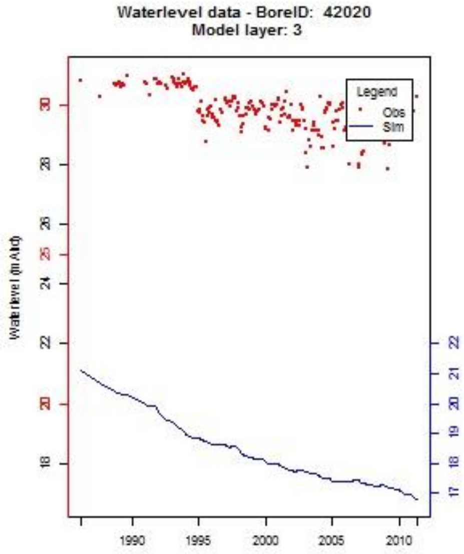

Waterlevel data - BoreID: 42002
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

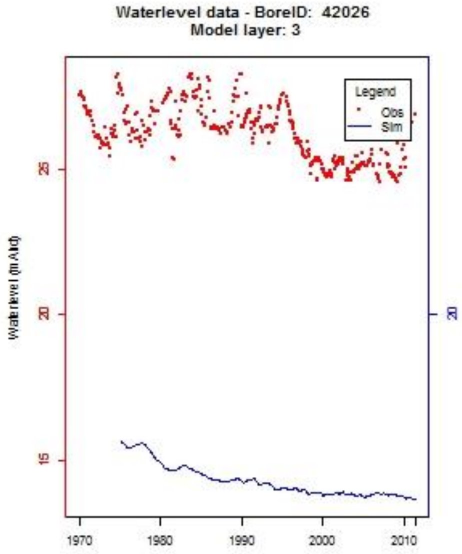

Waterlevel data - BoreID: 42003
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

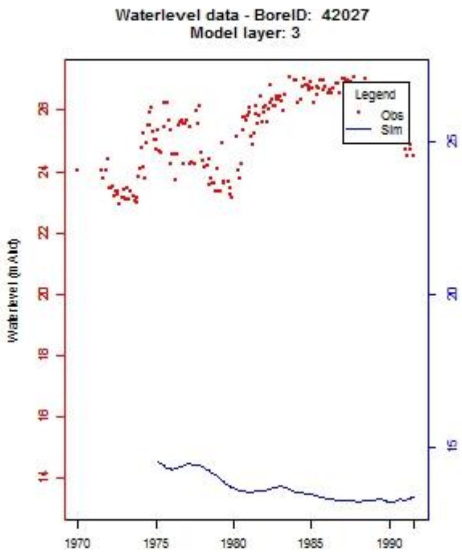

Waterlevel data - BoreID: 42004
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

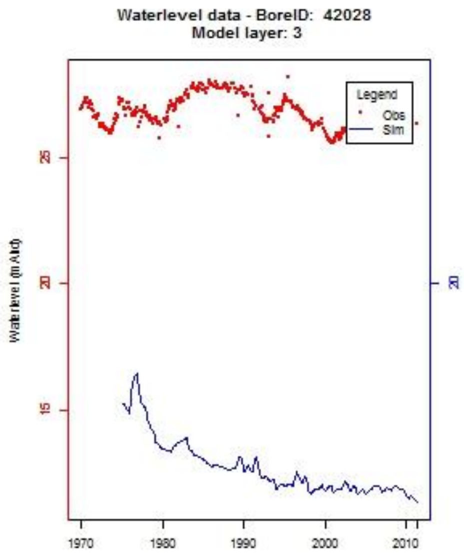

Waterlevel data - BoreID: 42006
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

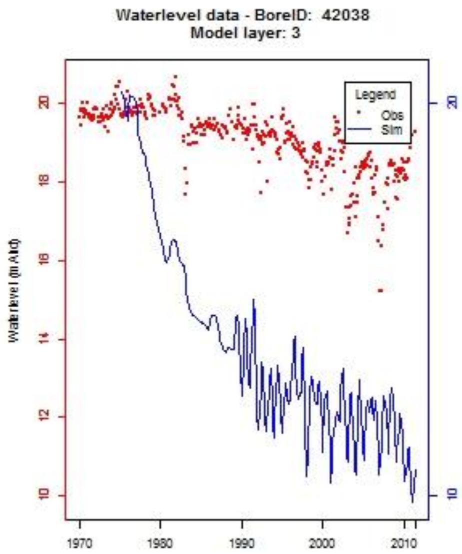

Waterlevel data - BoreID: 42007
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

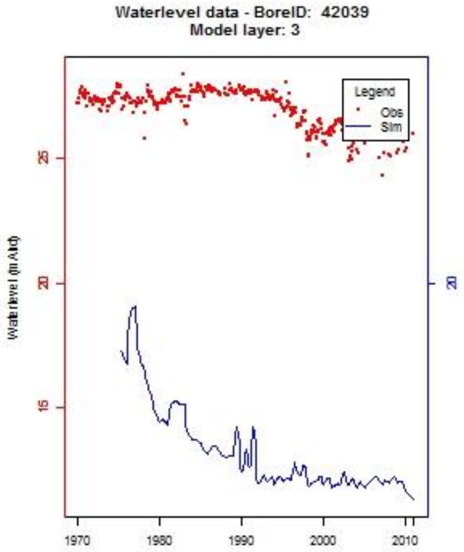

Waterlevel data - BoreID: 42020
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

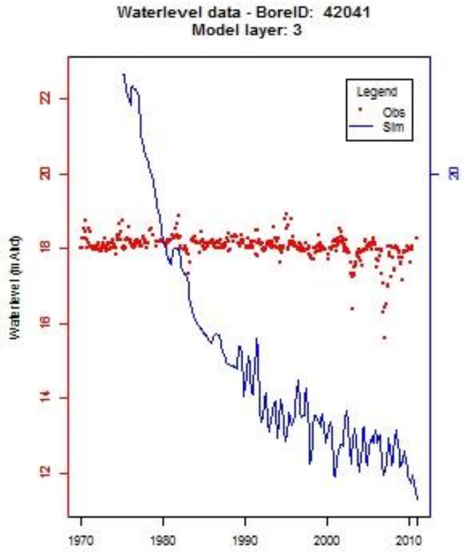

Waterlevel data - BoreID: 42026
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

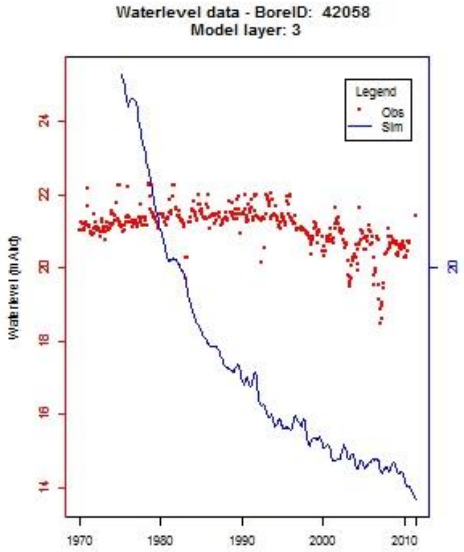

Waterlevel data - BoreID: 42027
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

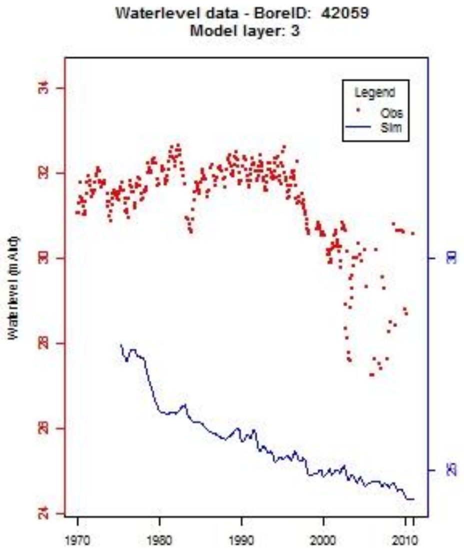

Waterlevel data - BoreID: 42028
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

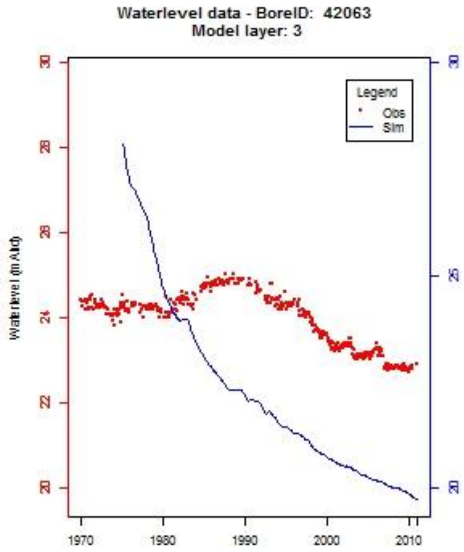

Waterlevel data - BoreID: 42038
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

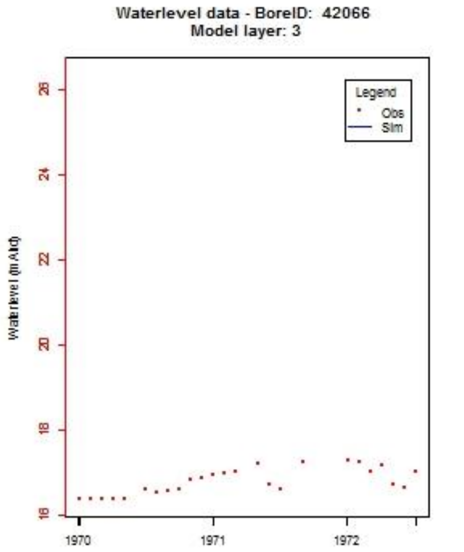

Waterlevel data - BoreID: 42039
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

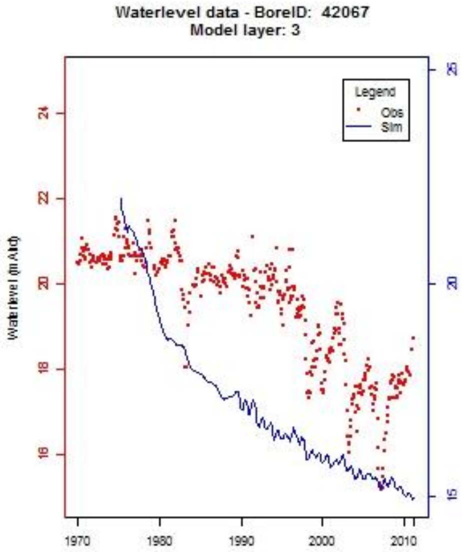

Waterlevel data - BoreID: 42041
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

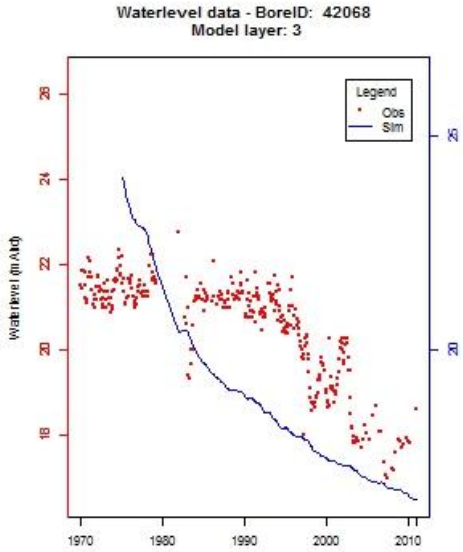

Waterlevel data - BoreID: 42058
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

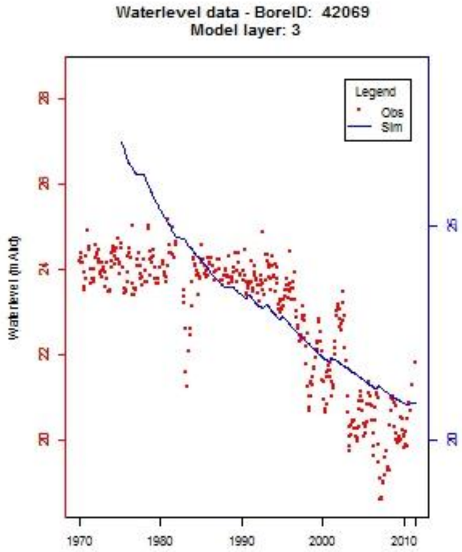

Waterlevel data - BoreID: 42059
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

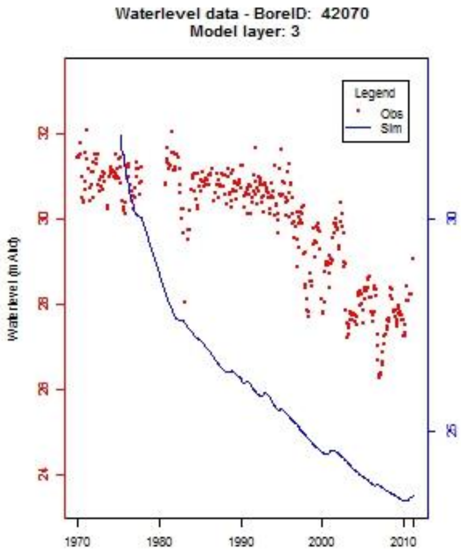

Waterlevel data - BoreID: 42063
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

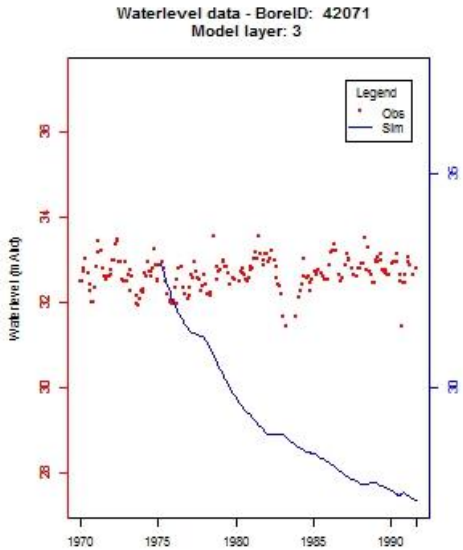

Waterlevel data - BoreID: 42066
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1971
1972

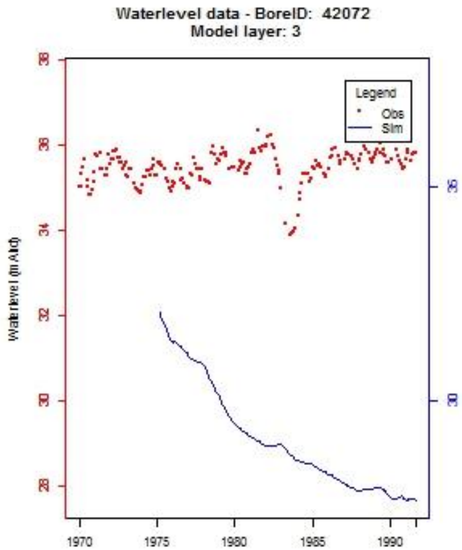

Waterlevel data - BoreID: 42067
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

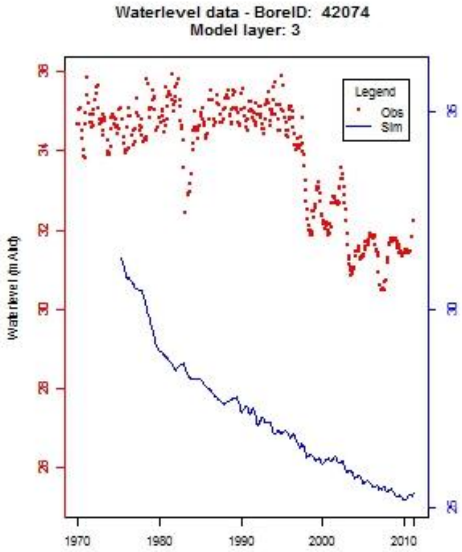

Waterlevel data - BoreID: 42068
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

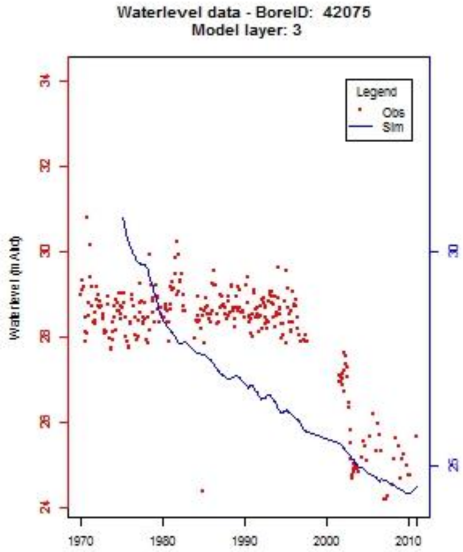

Waterlevel data - BoreID: 42069
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

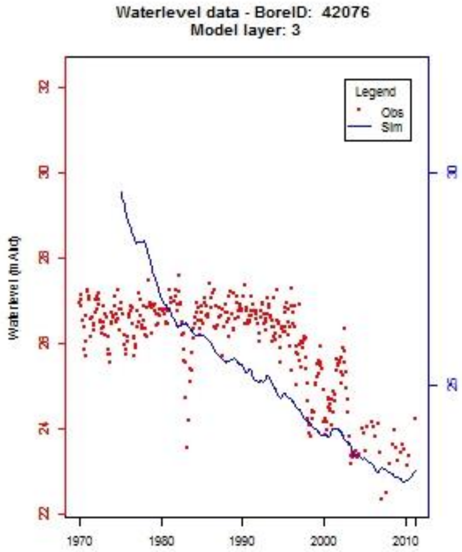

Waterlevel data - BoreID: 42070
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

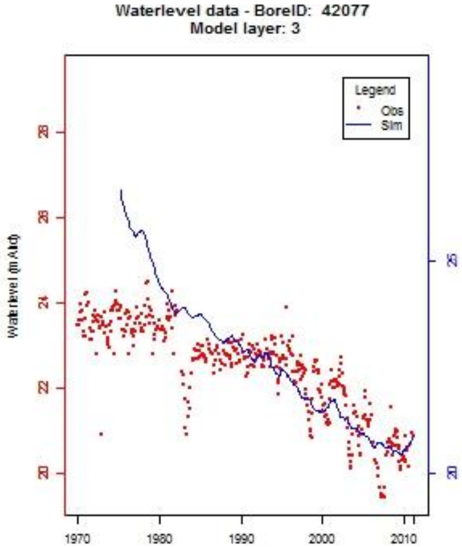

Waterlevel data - BoreID: 42071
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1975
1980
1985
1990

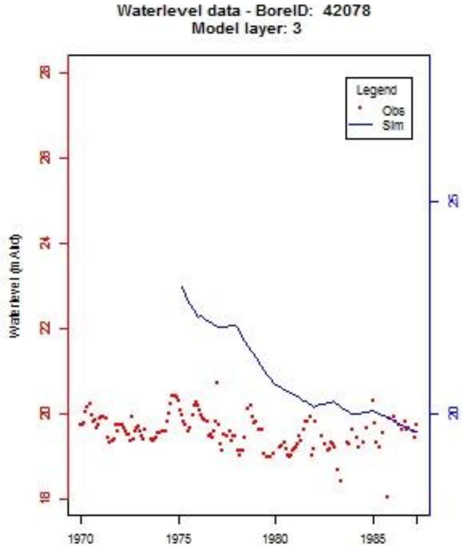

Waterlevel data - BoreID: 42072
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1975
1980
1985
1990

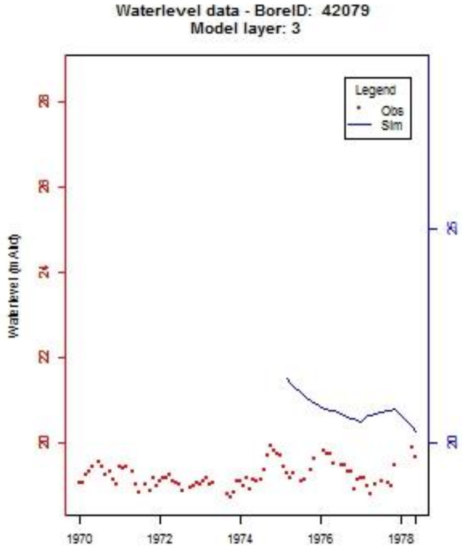

Waterlevel data - BoreID: 42074
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

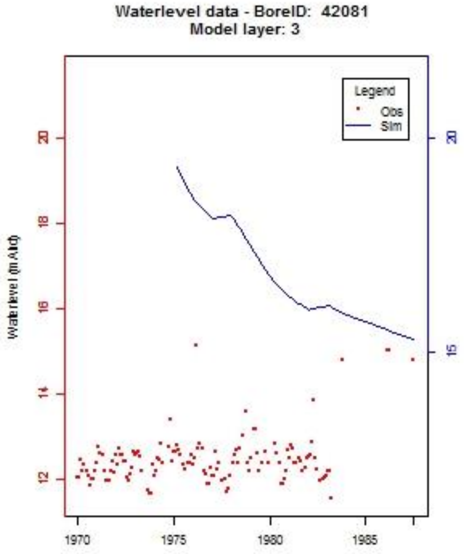

Waterlevel data - BoreID: 42075
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

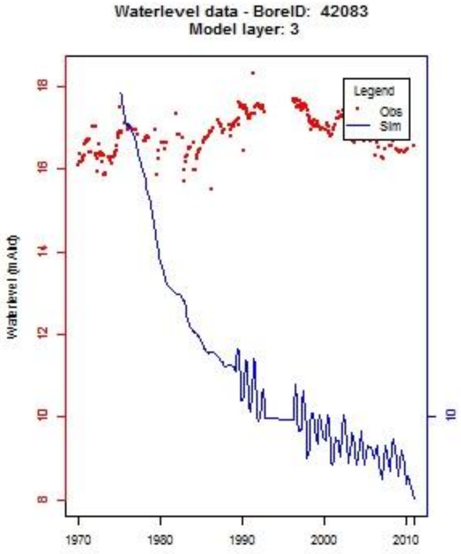

Waterlevel data - BoreID: 42076
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

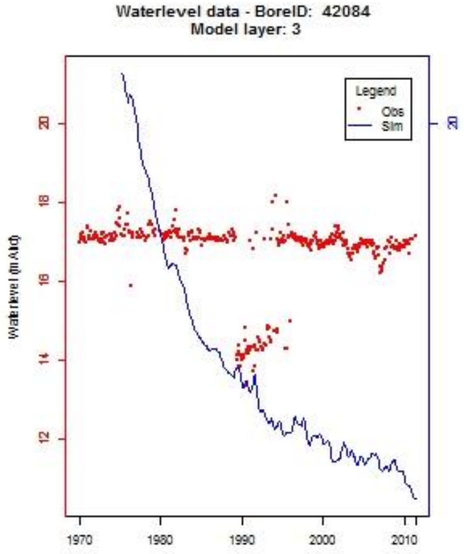

Waterlevel data - BoreID: 42077
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

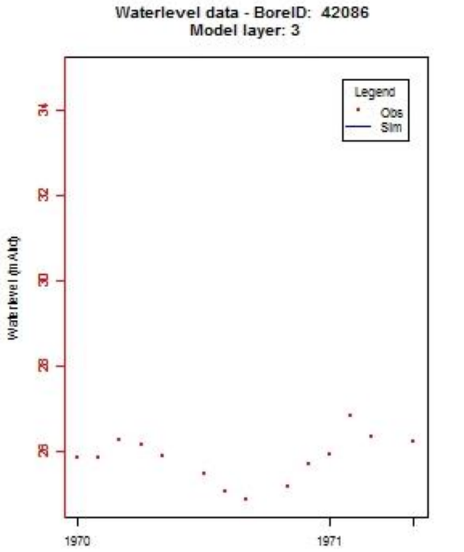

Waterlevel data - BoreID: 42078
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1975
1980
1985

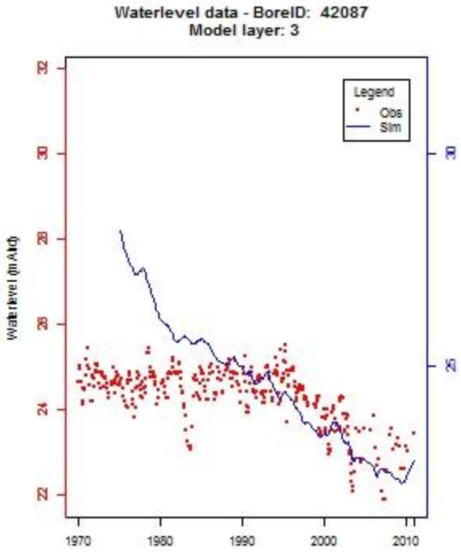

Waterlevel data - BoreID: 42079
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1972
1974
1976
1978

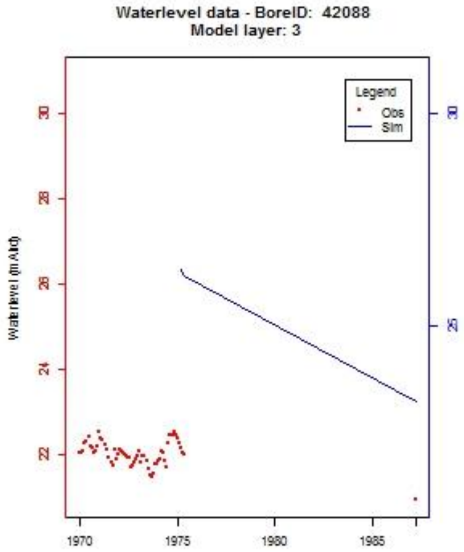

Waterlevel data - BoreID: 42081
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1975
1980
1985

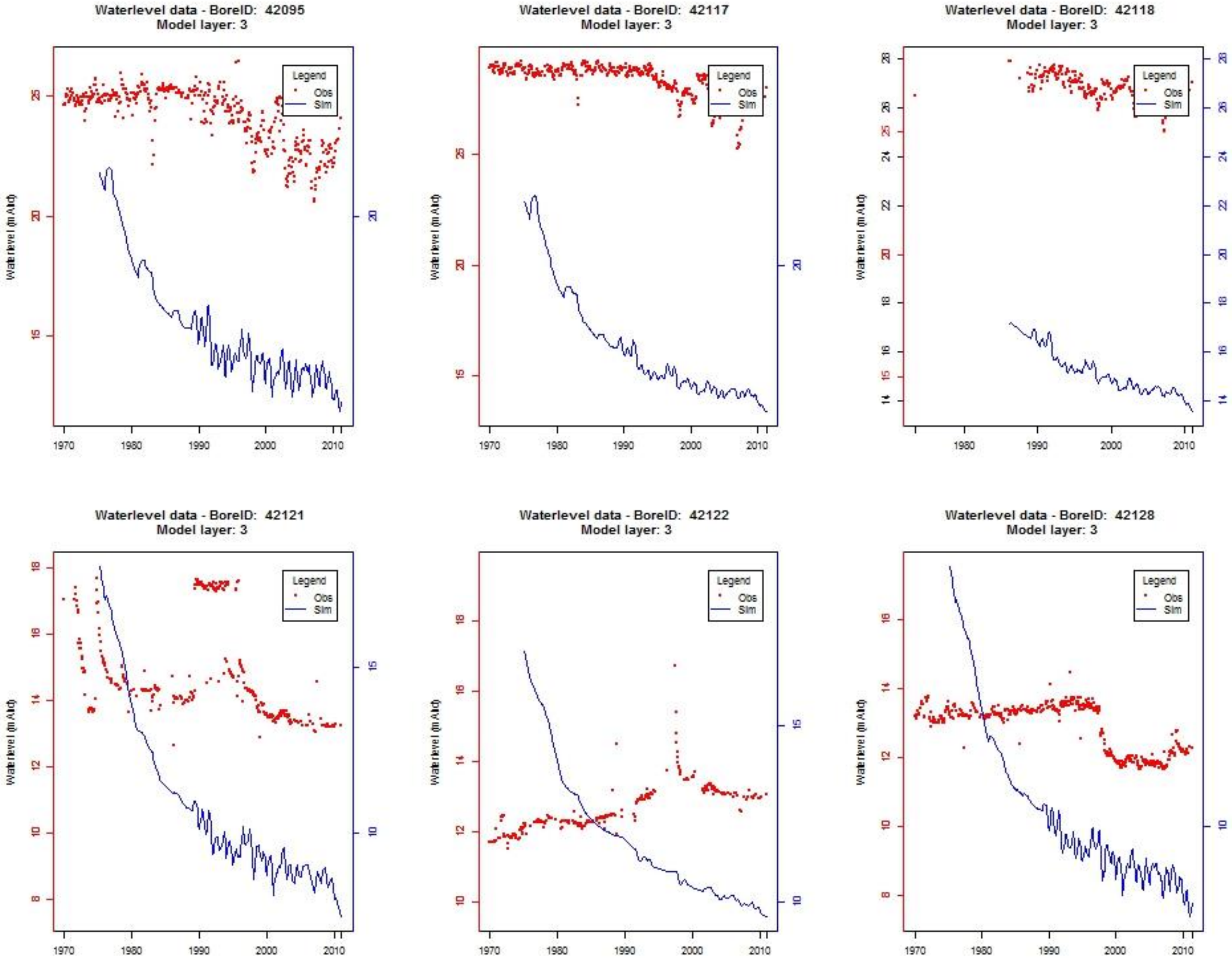

Waterlevel data - BoreID: 42083
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

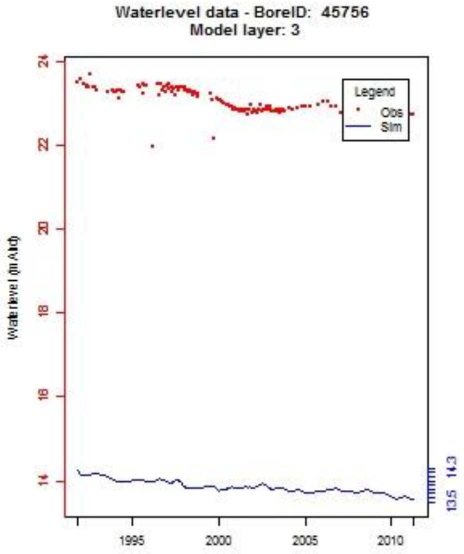

Waterlevel data - BoreID: 42084
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

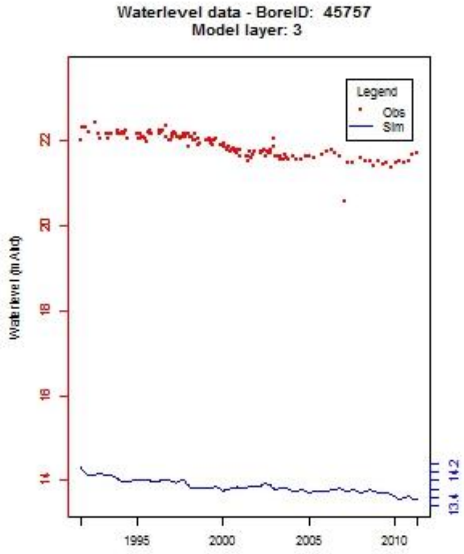

Waterlevel data - BoreID: 42086
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1971

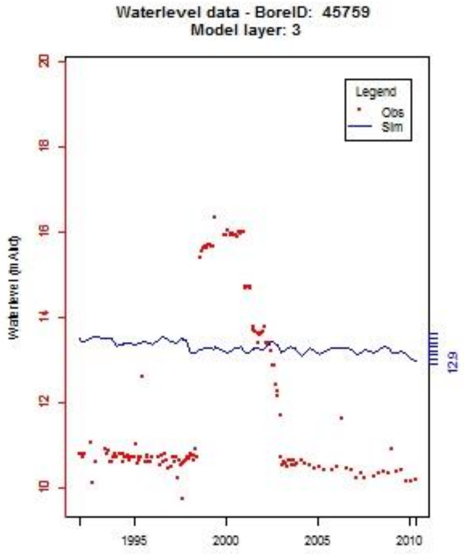

Waterlevel data - BoreID: 42087
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010

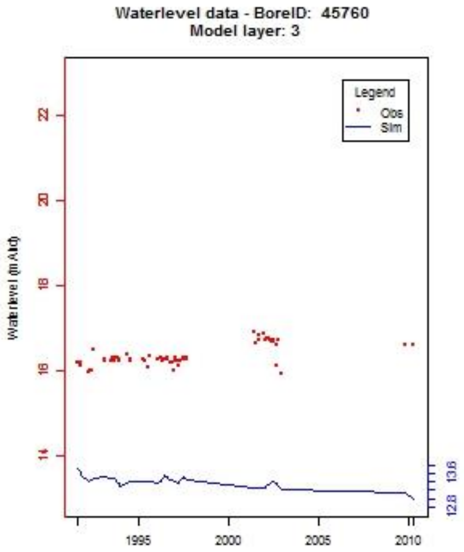

Waterlevel data - BoreID: 42088
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1975
1980
1985

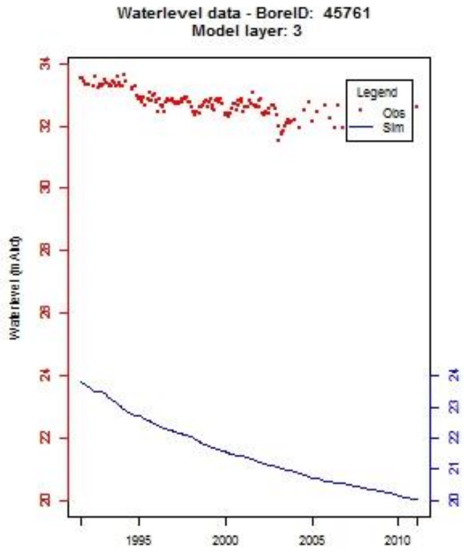

Waterlevel data - BoreID: 42095
Model layer: 3
Waterlevel data - BoreID: 42117
Model layer: 3
Waterlevel data - BoreID: 42118
Model layer: 3
Waterlevel data - BoreID: 42121
Model layer: 3
Waterlevel data - BoreID: 42122
Model layer: 3
Waterlevel data - BoreID: 42128
Model layer: 3
Legend
Obs
Sim
1970
1980
1990
2000
2010

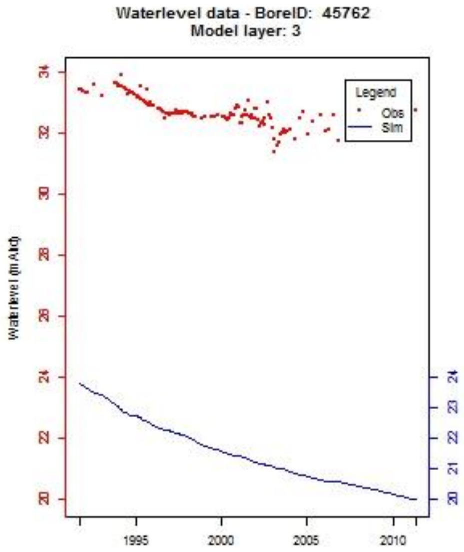

Waterlevel data - BoreID: 45756
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
24
22
20
18
16
14
14.3
13.5
1995
2000
2005
2010

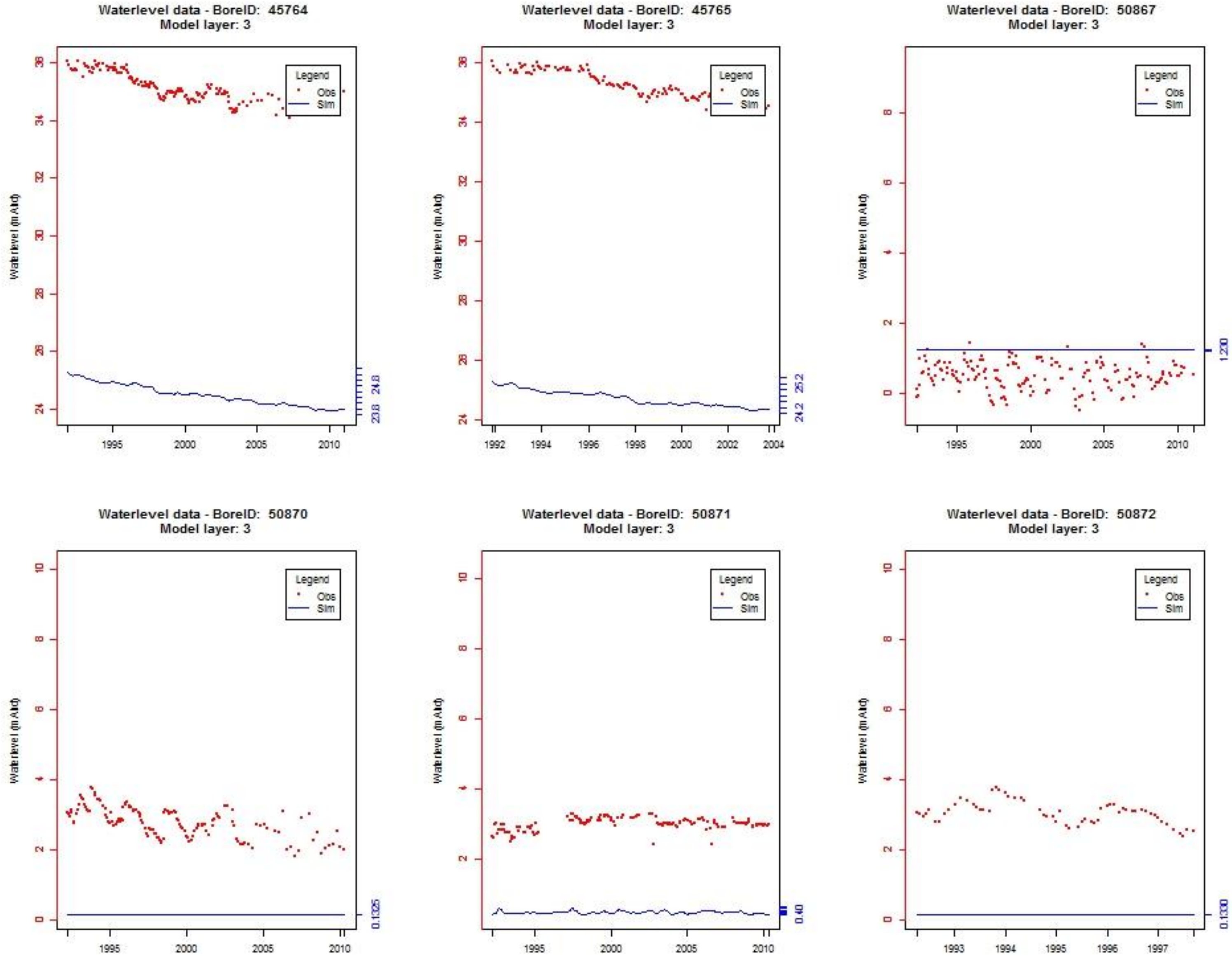

Waterlevel data - BoreID: 45757
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
22
20
18
16
14
14.2
13.4
1995
2000
2005
2010

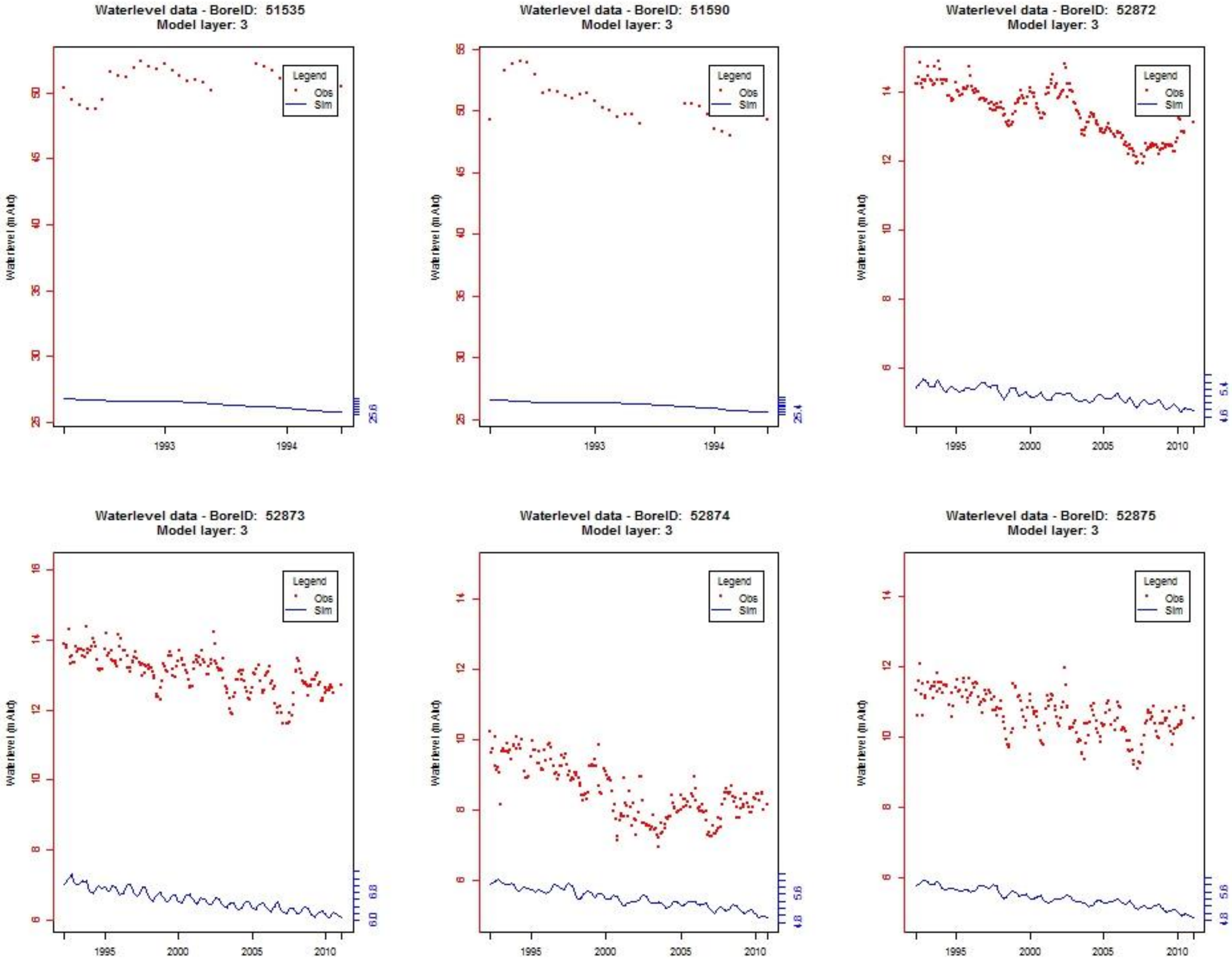

Waterlevel data - BoreID: 45759
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
20
18
16
14
12
10
12.9
1995
2000
2005
2010

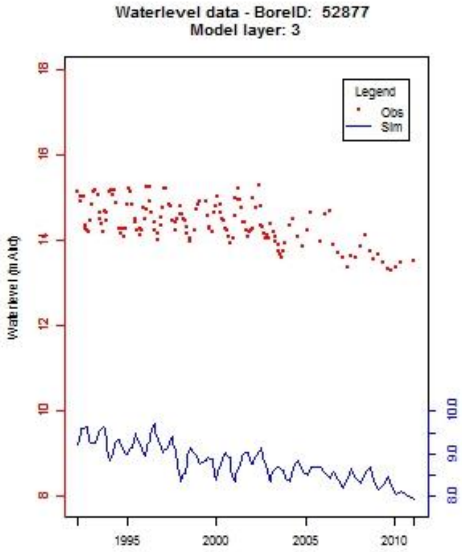

Waterlevel data - BoreID: 45760
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
22
20
18
16
14
13.6
12.8
1995
2000
2005
2010

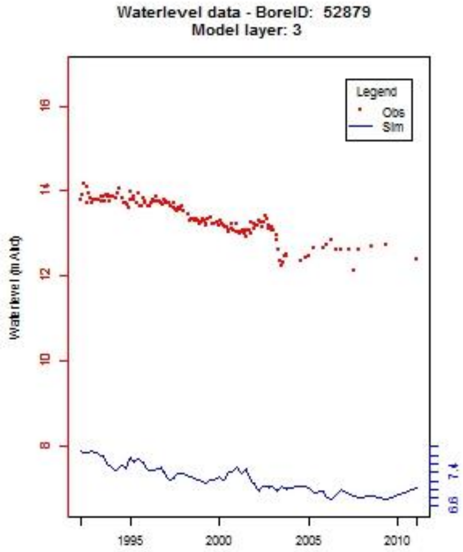

Waterlevel data - BoreID: 45761
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
34
32
30
28
26
24
22
20
24
23
22
21
20
1995
2000
2005
2010

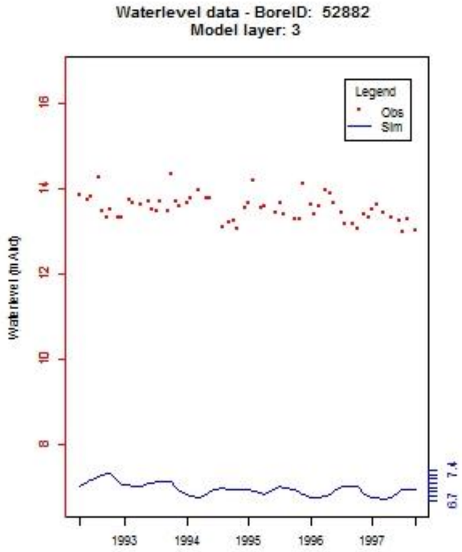

Waterlevel data - BoreID: 45762
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
34
32
30
28
26
24
22
20
24
23
22
21
20
1995
2000
2005
2010

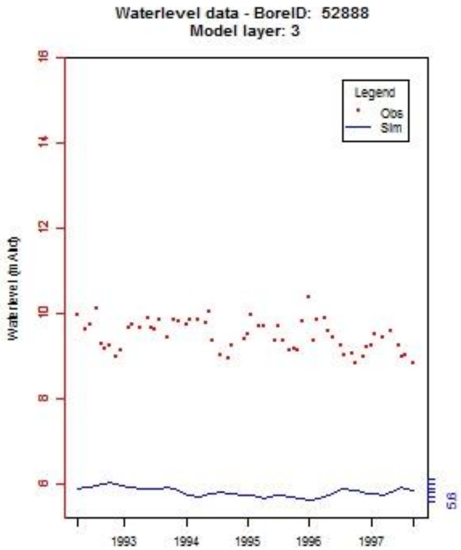

Waterlevel data - BoreID: 45764
Model layer: 3
Waterlevel data - BoreID: 45765
Model layer: 3
Waterlevel data - BoreID: 50867
Model layer: 3
Waterlevel data - BoreID: 50870
Model layer: 3
Waterlevel data - BoreID: 50871
Model layer: 3
Waterlevel data - BoreID: 50872
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

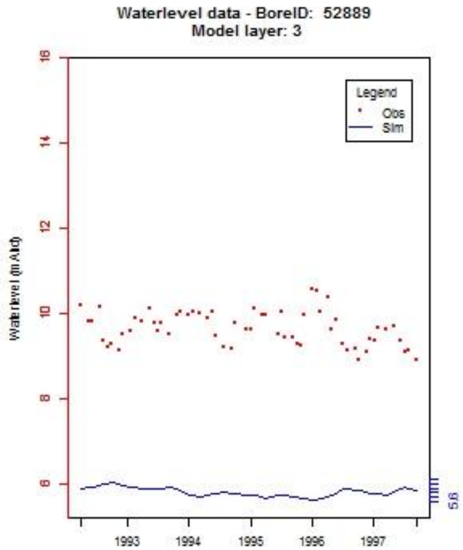

Waterlevel data - BoreID: 51535
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 51590
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 52872
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 52873
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 52874
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 52875
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

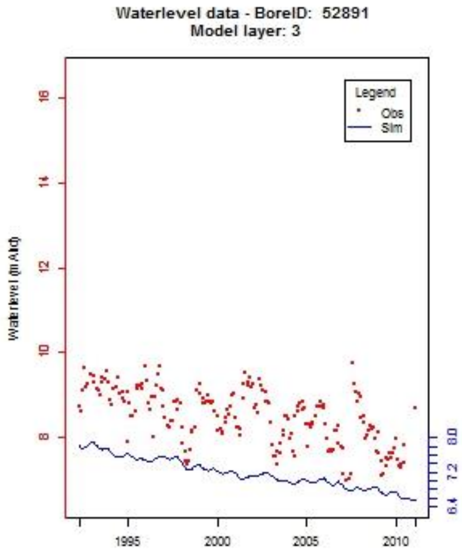

Waterlevel data - BoreID: 52877
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
8
10
12
14
16
18
8.0
9.0
10.0
1995
2000
2005
2010

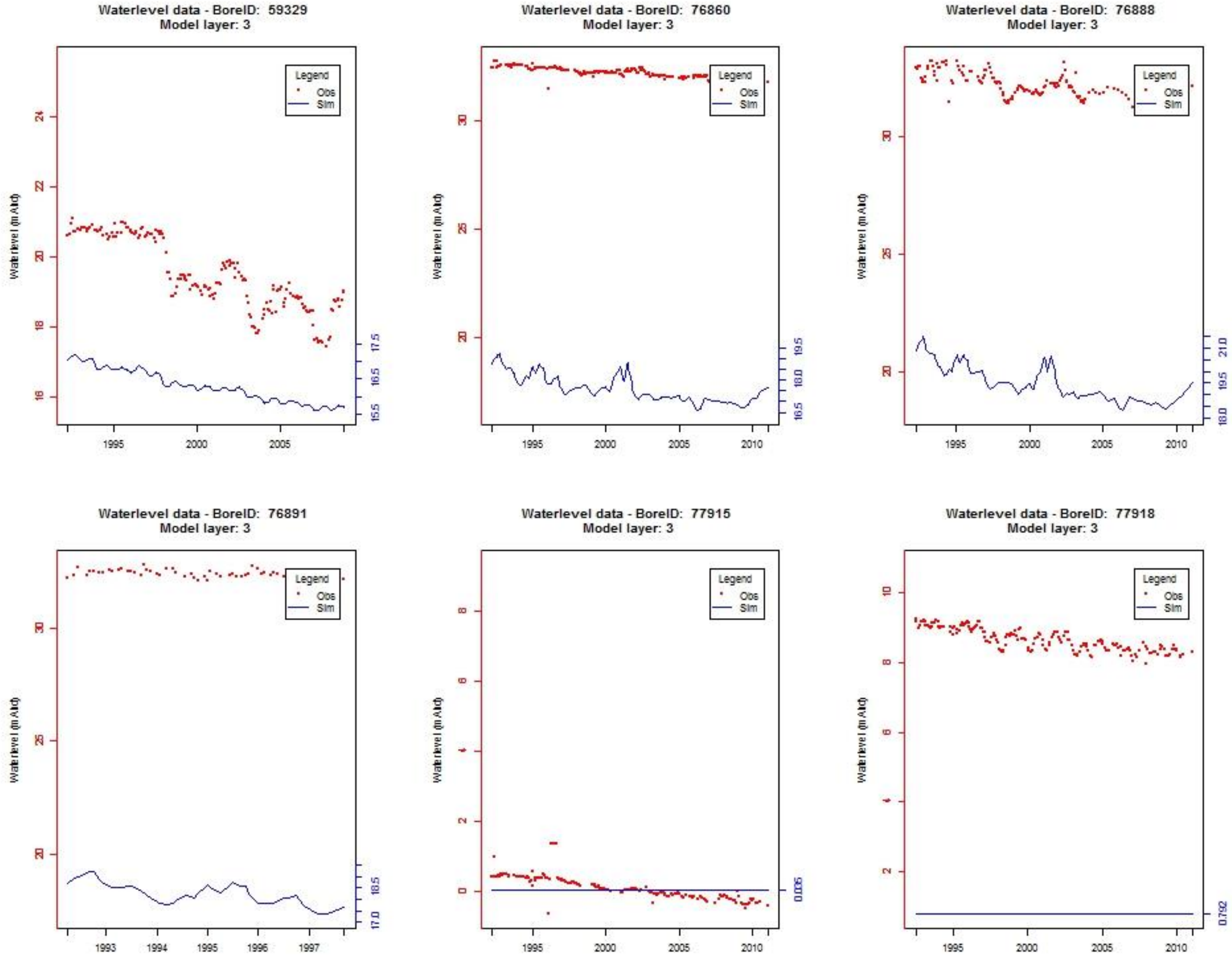

Waterlevel data - BoreID: 52879
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
8
10
12
14
16
6.6
7.4
1995
2000
2005
2010

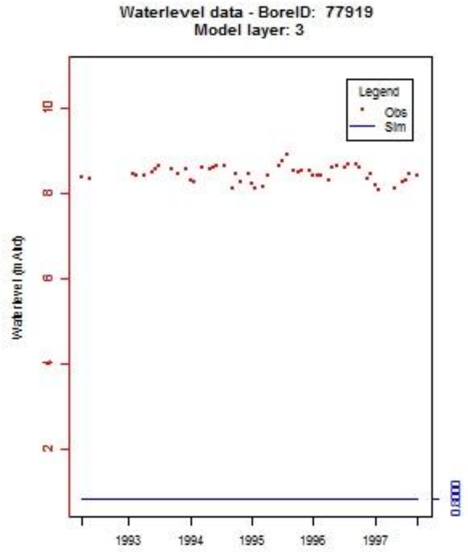

Waterlevel data - BoreID: 52882
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
8
10
12
14
16
6.7
7.4
1993
1994
1995
1996
1997

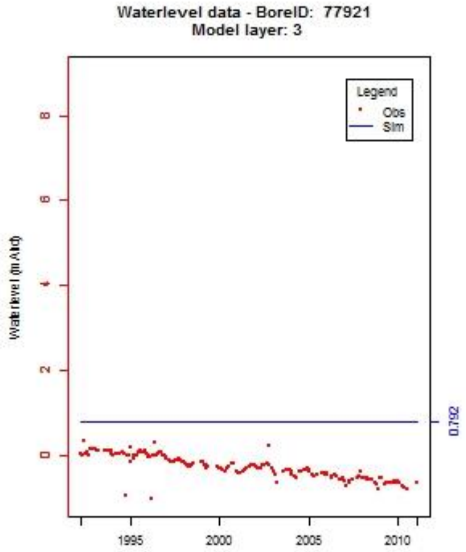

Waterlevel data - BoreID: 52888
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
6
8
10
12
14
16
5.6
1993
1994
1995
1996
1997

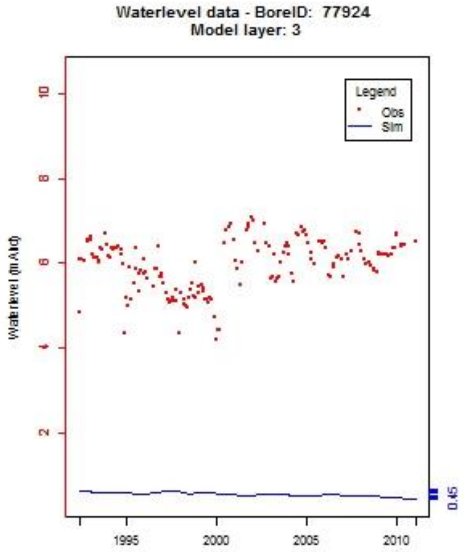

Waterlevel data - BoreID: 52889
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
6
8
10
12
14
16
5.6
1993
1994
1995
1996
1997

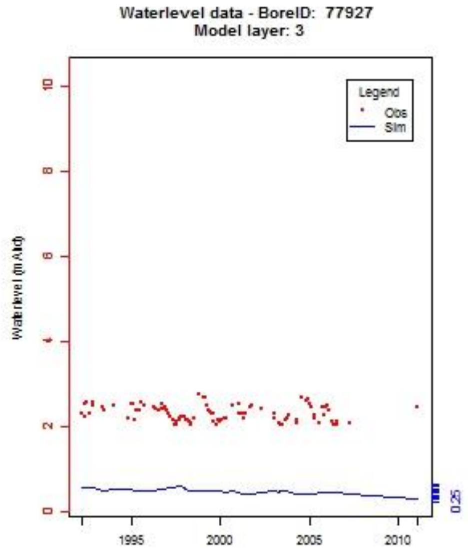

Waterlevel data - BoreID: 52891
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
8
10
12
14
16
6.4
7.2
8.0
1995
2000
2005
2010

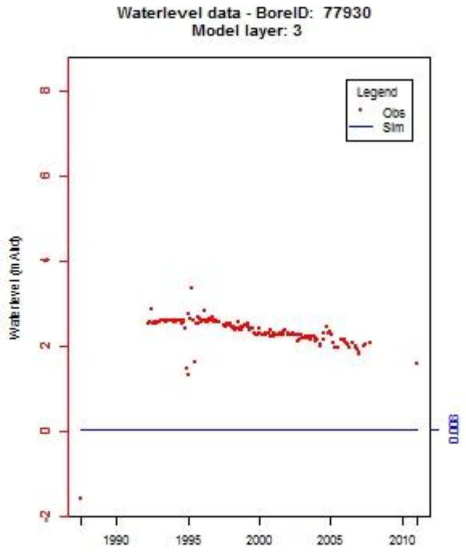

Waterlevel data - BoreID: 59329
Model layer: 3
Waterlevel data - BoreID: 76860
Model layer: 3
Waterlevel data - BoreID: 76888
Model layer: 3
Waterlevel data - BoreID: 76891
Model layer: 3
Waterlevel data - BoreID: 77915
Model layer: 3
Waterlevel data - BoreID: 77918
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

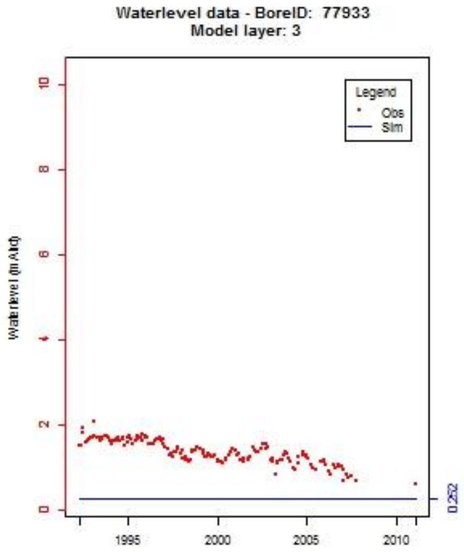

Waterlevel data - BoreID: 77919
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
0.8000

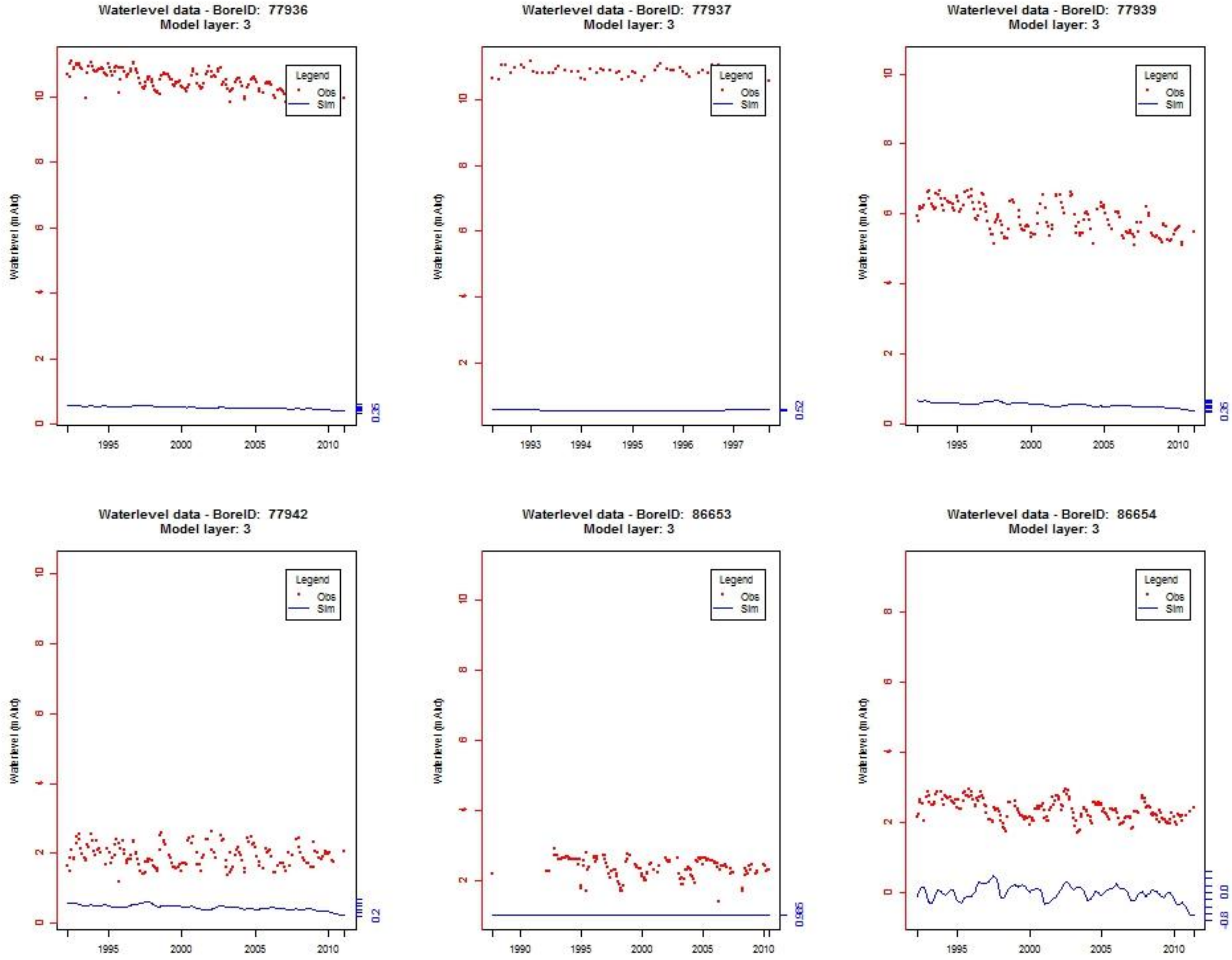

Waterlevel data - BoreID: 77921
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
0.792

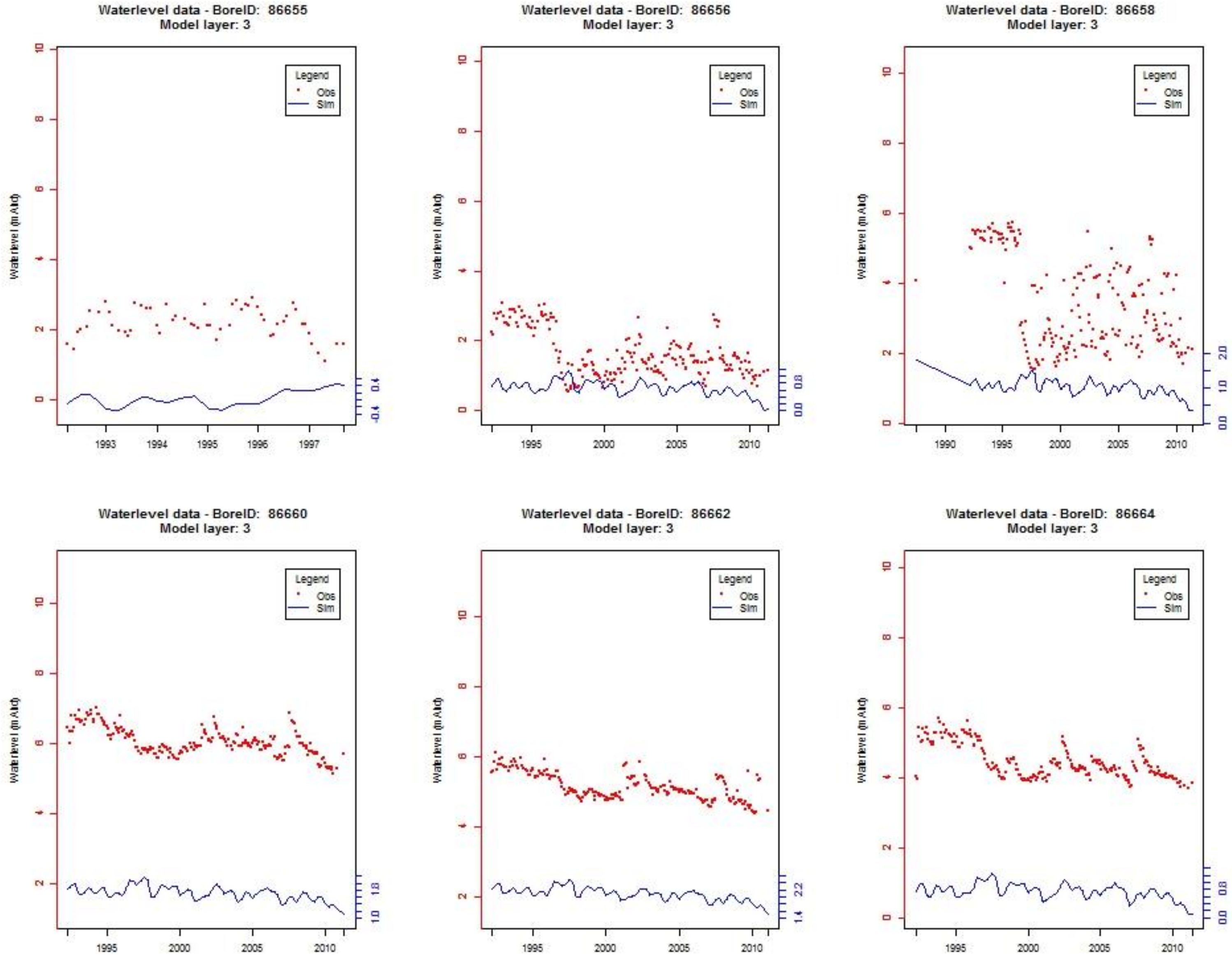

Waterlevel data - BoreID: 77924
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
0.45


Waterlevel data - BoreID: 77927
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
0.25

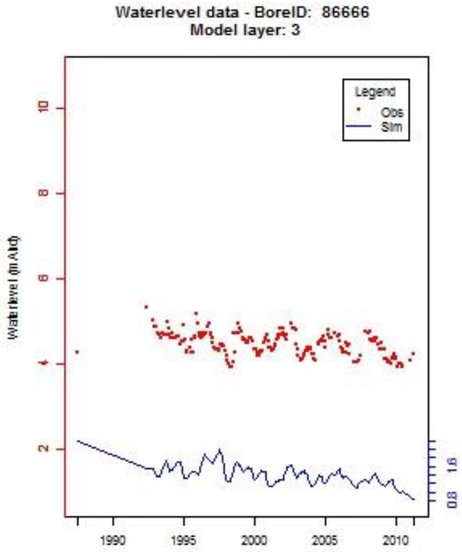

Waterlevel data - BoreID: 77930
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
0.008

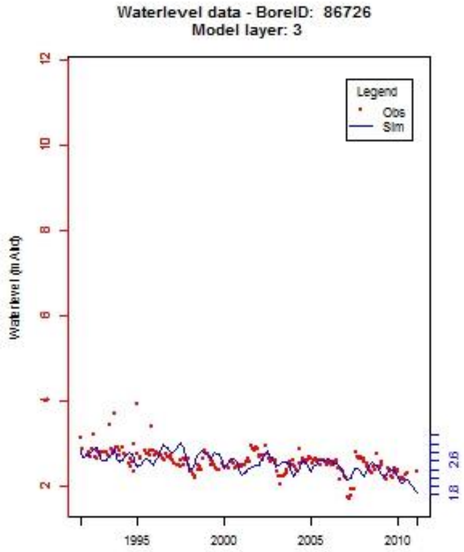

Waterlevel data - BoreID: 77933
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
0.252

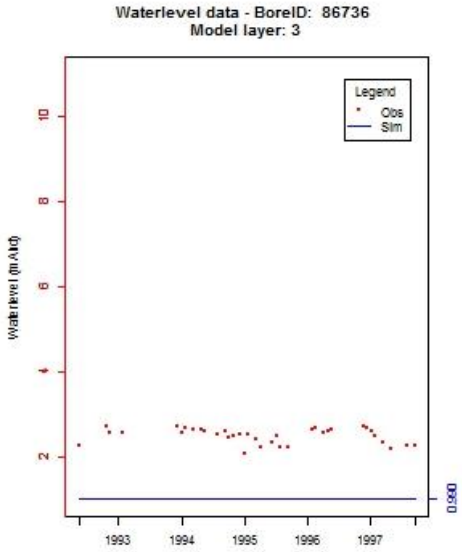

Waterlevel data - BoreID: 77936
Model layer: 3
Waterlevel data - BoreID: 77937
Model layer: 3
Waterlevel data - BoreID: 77939
Model layer: 3
Waterlevel data - BoreID: 77942
Model layer: 3
Waterlevel data - BoreID: 86653
Model layer: 3
Waterlevel data - BoreID: 86654
Model layer: 3
Legend
Obs
Sim

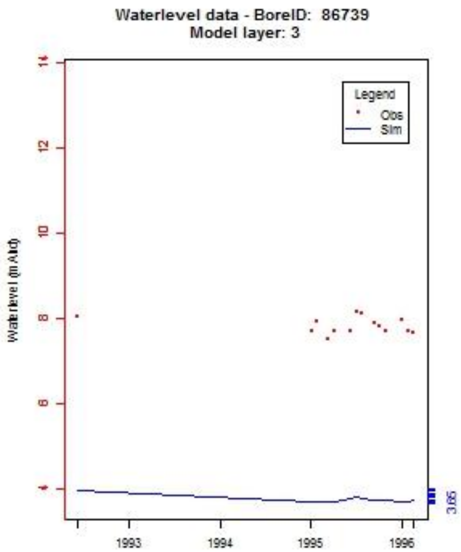


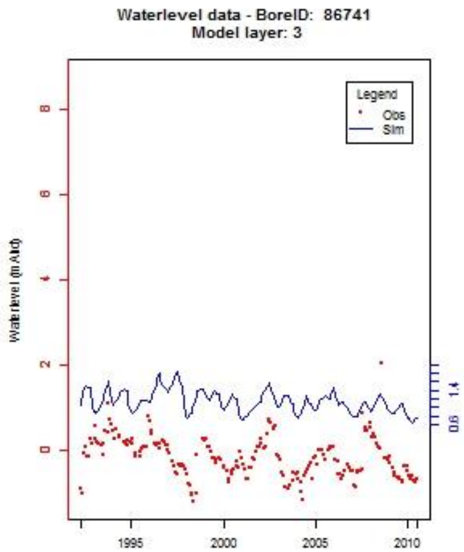
Waterlevel data - BoreID: 86655
Model layer: 3
Waterlevel data - BoreID: 86656
Model layer: 3
Waterlevel data - BoreID: 86658
Model layer: 3
Waterlevel data - BoreID: 86660
Model layer: 3
Waterlevel data - BoreID: 86662
Model layer: 3
Waterlevel data - BoreID: 86664
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

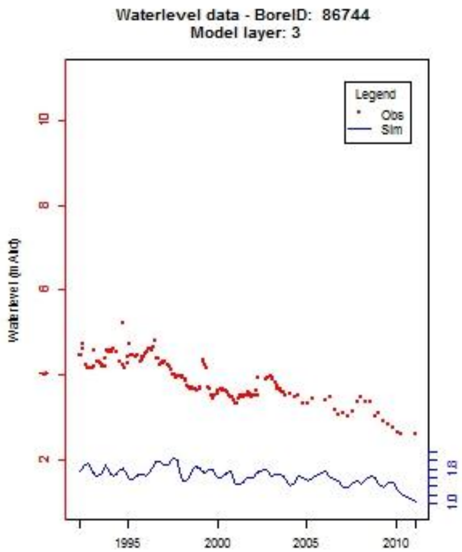

Waterlevel data - BoreID: 86666
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1990
1995
2000
2005
2010

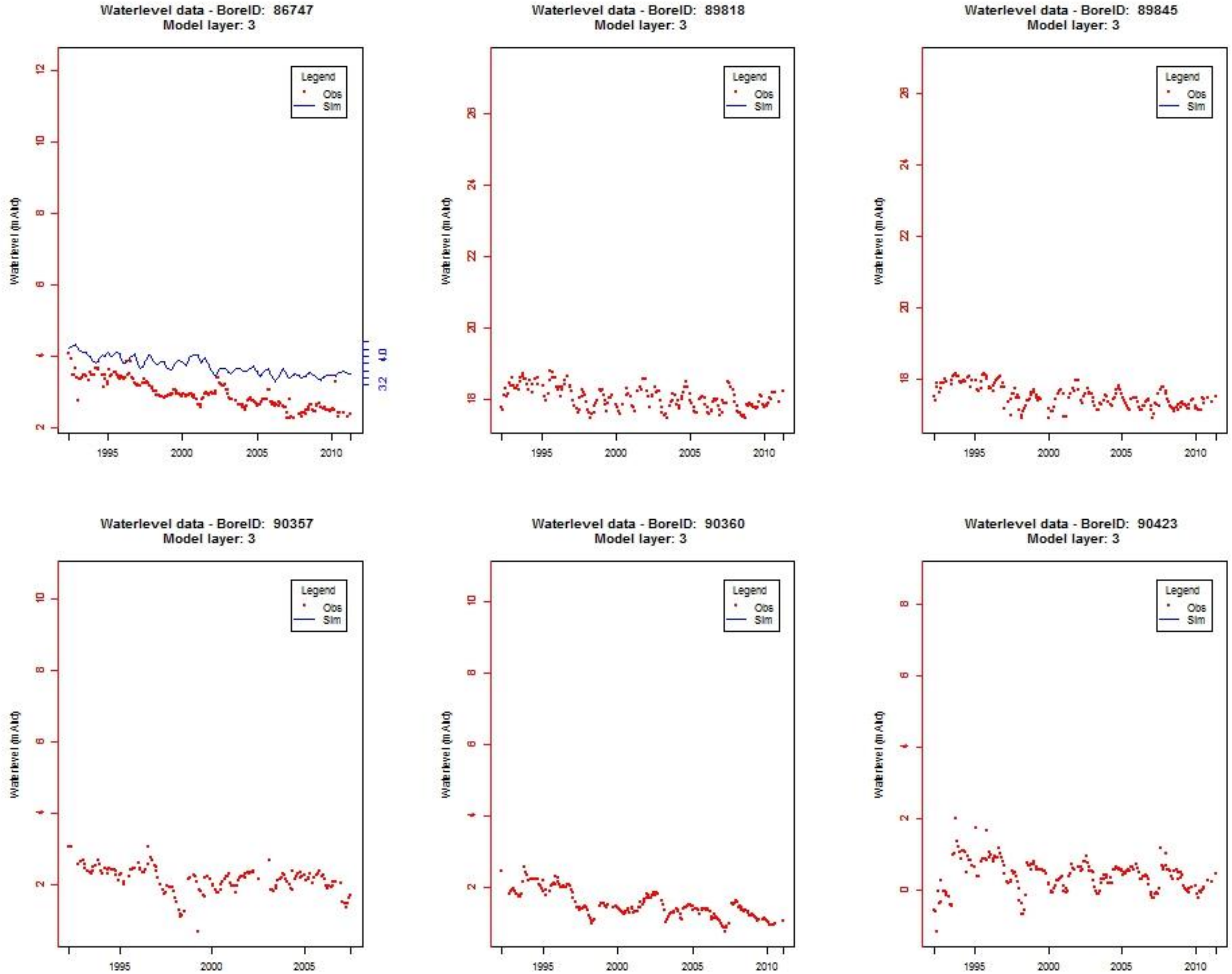

Waterlevel data - BoreID: 86726
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

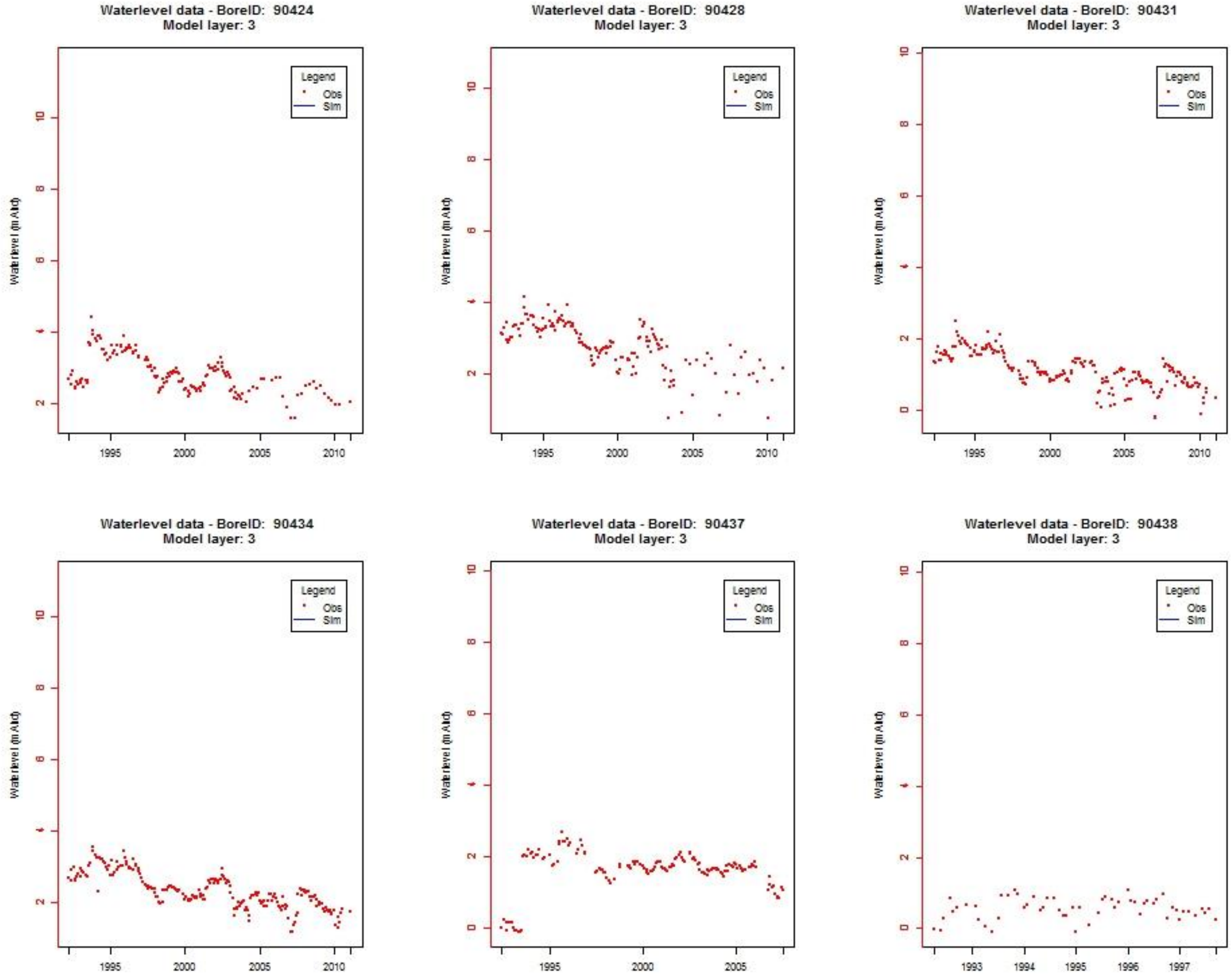

Waterlevel data - BoreID: 86736
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1993
1994
1995
1996
1997

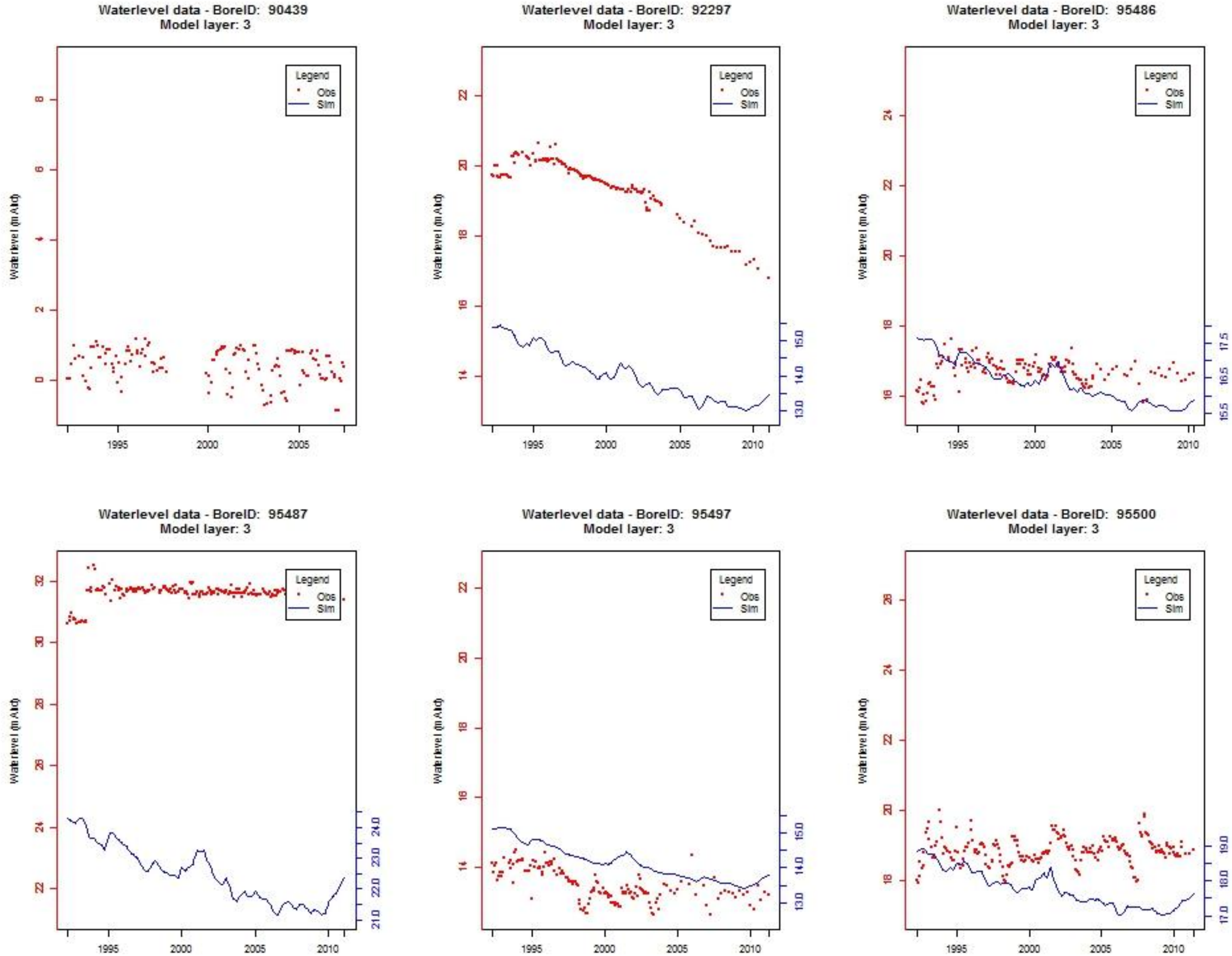

Waterlevel data - BoreID: 86739
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1993
1994
1995
1996

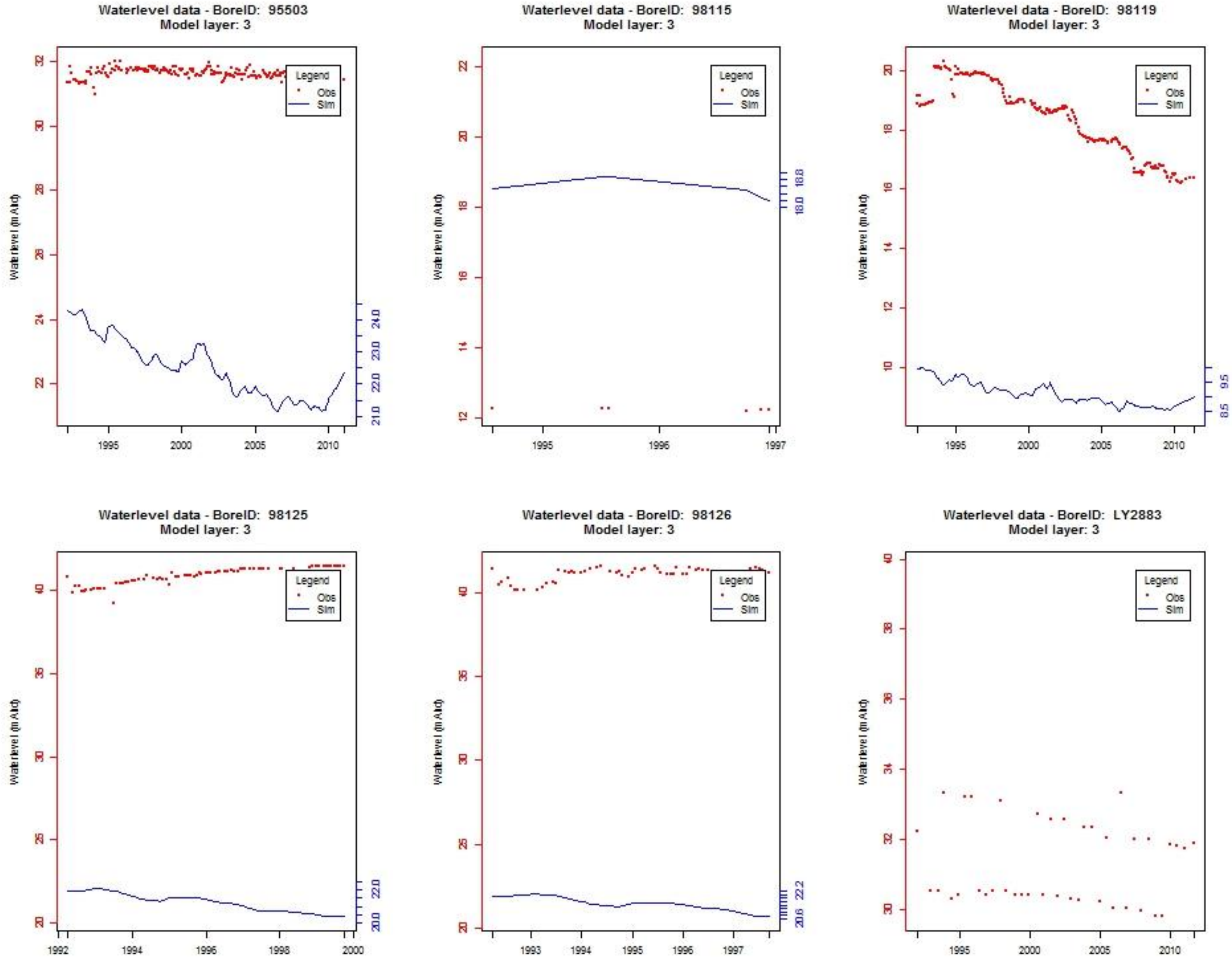

Waterlevel data - BoreID: 86741
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

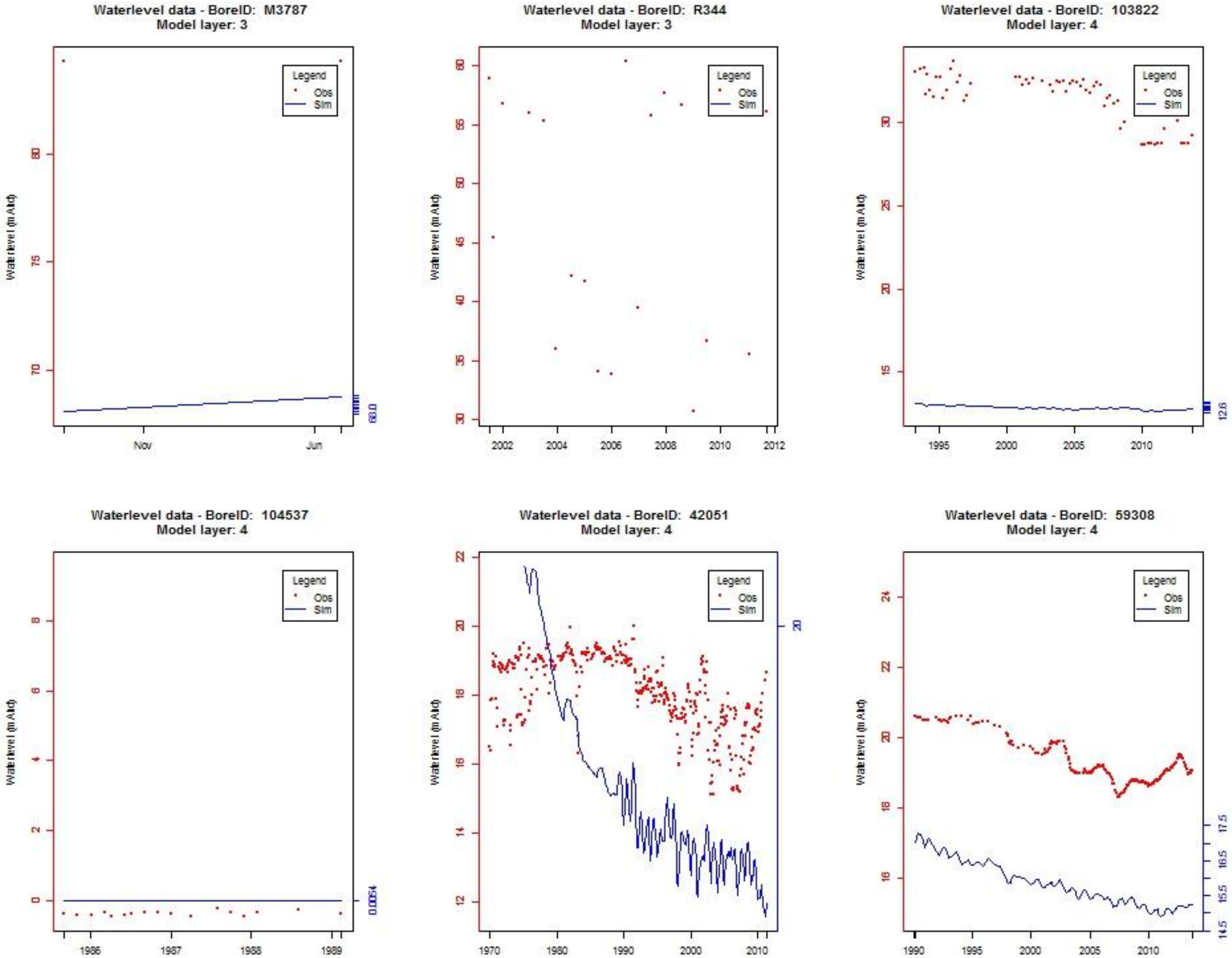

Waterlevel data - BoreID: 86744
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

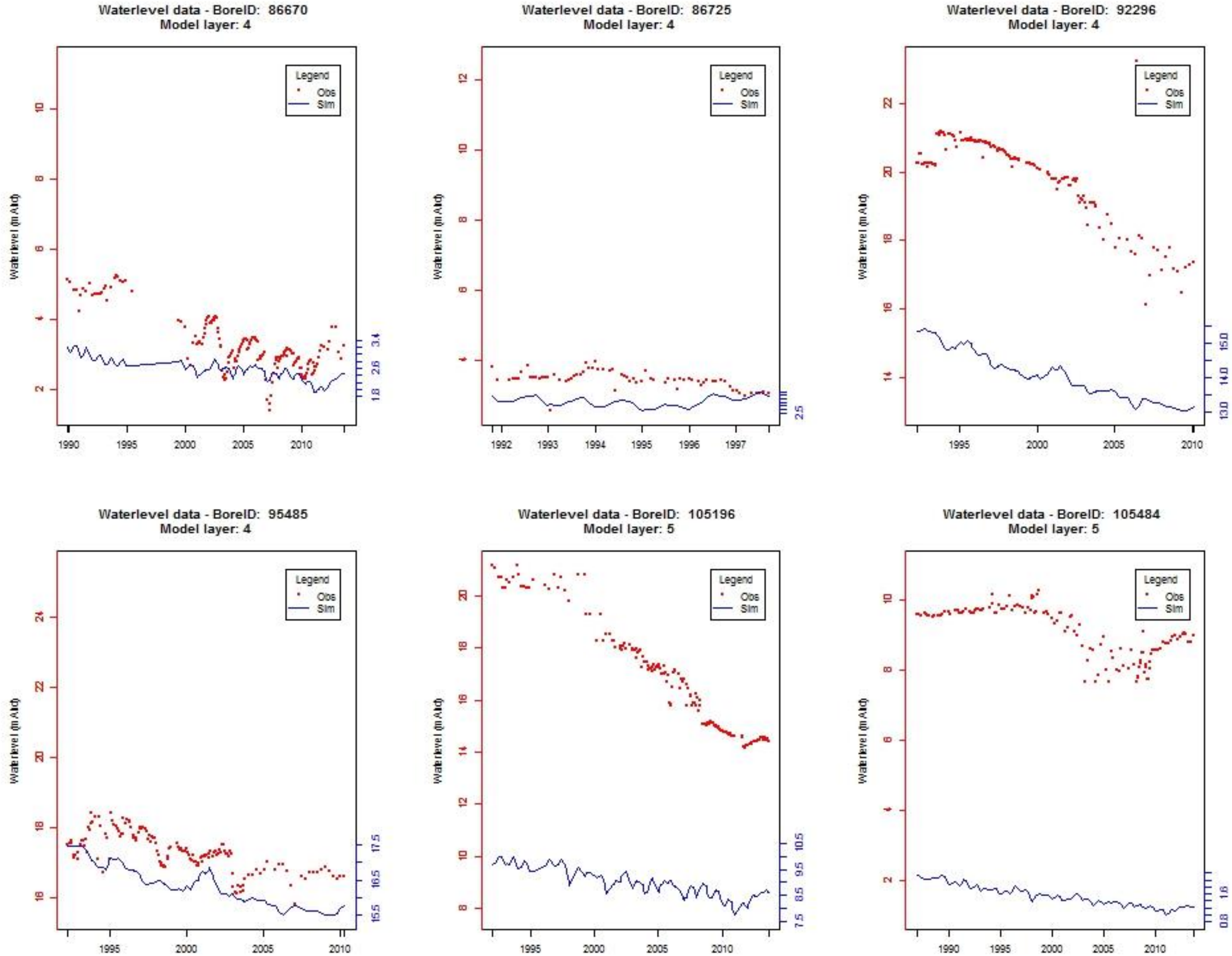

Waterlevel data - BoreID: 86747
Model layer: 3
Waterlevel data - BoreID: 89818
Model layer: 3
Waterlevel data - BoreID: 89845
Model layer: 3
Waterlevel data - BoreID: 90357
Model layer: 3
Waterlevel data - BoreID: 90360
Model layer: 3
Waterlevel data - BoreID: 90423
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

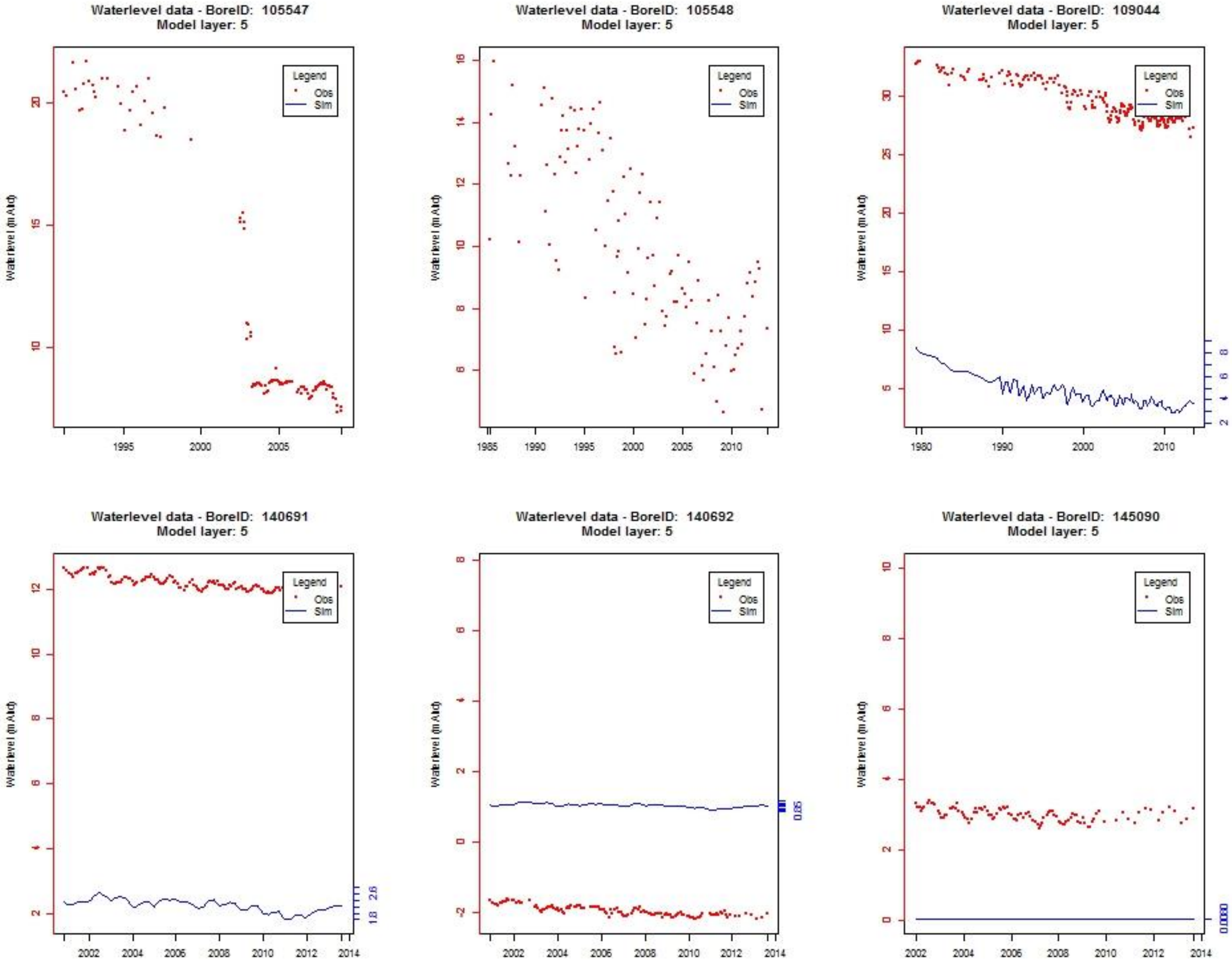

Waterlevel data - BoreID: 90424
Model layer: 3
Waterlevel data - BoreID: 90428
Model layer: 3
Waterlevel data - BoreID: 90431
Model layer: 3
Waterlevel data - BoreID: 90434
Model layer: 3
Waterlevel data - BoreID: 90437
Model layer: 3
Waterlevel data - BoreID: 90438
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010
1993
1994
1996
1997

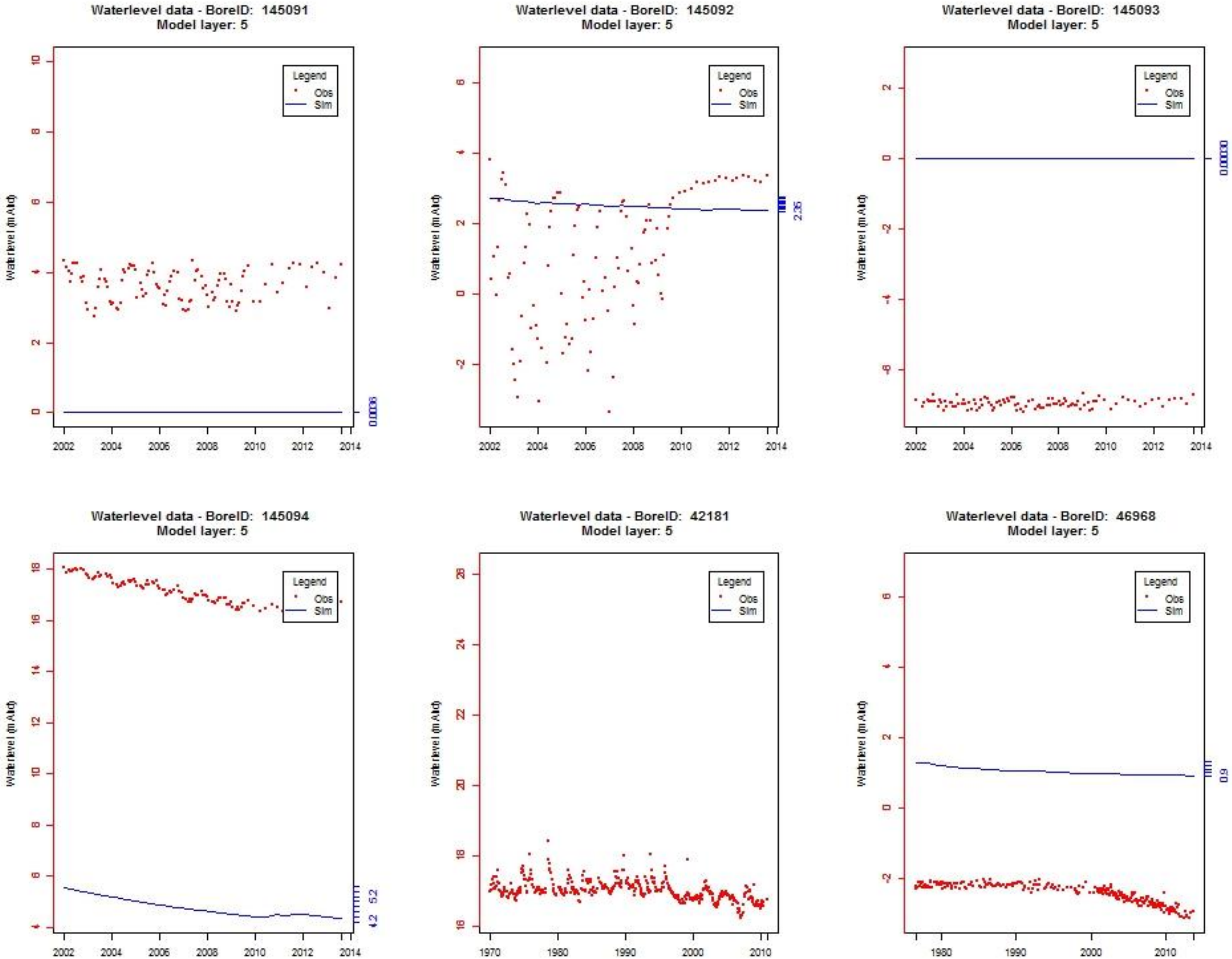

Waterlevel data - BoreID: 90439
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 92297
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 95486
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 95487
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 95497
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 95500
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

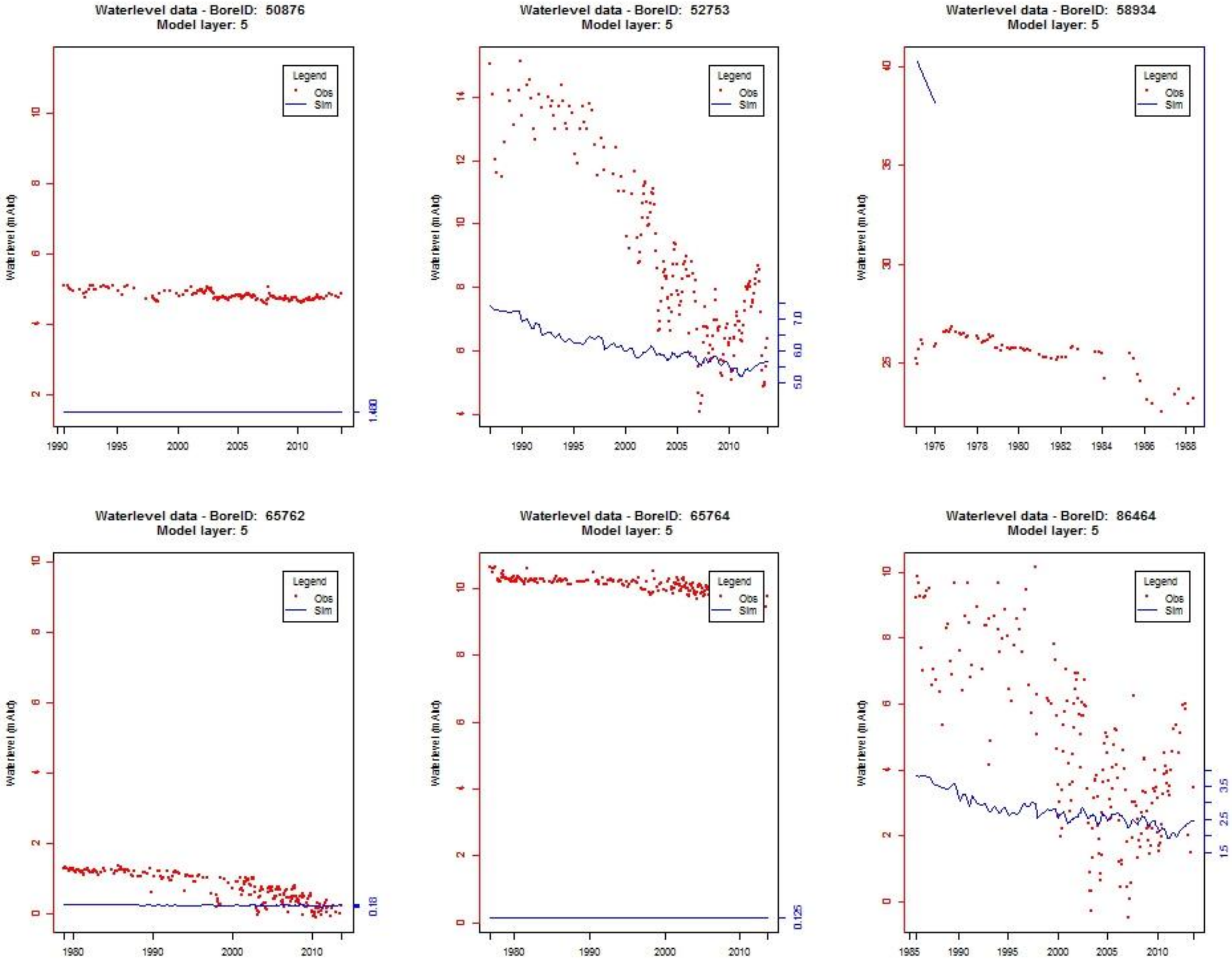

Waterlevel data - BoreID: 95503
Model layer: 3
Waterlevel data - BoreID: 98115
Model layer: 3
Waterlevel data - BoreID: 98119
Model layer: 3
Waterlevel data - BoreID: 98125
Model layer: 3
Waterlevel data - BoreID: 98126
Model layer: 3
Waterlevel data - BoreID: LY2883
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)

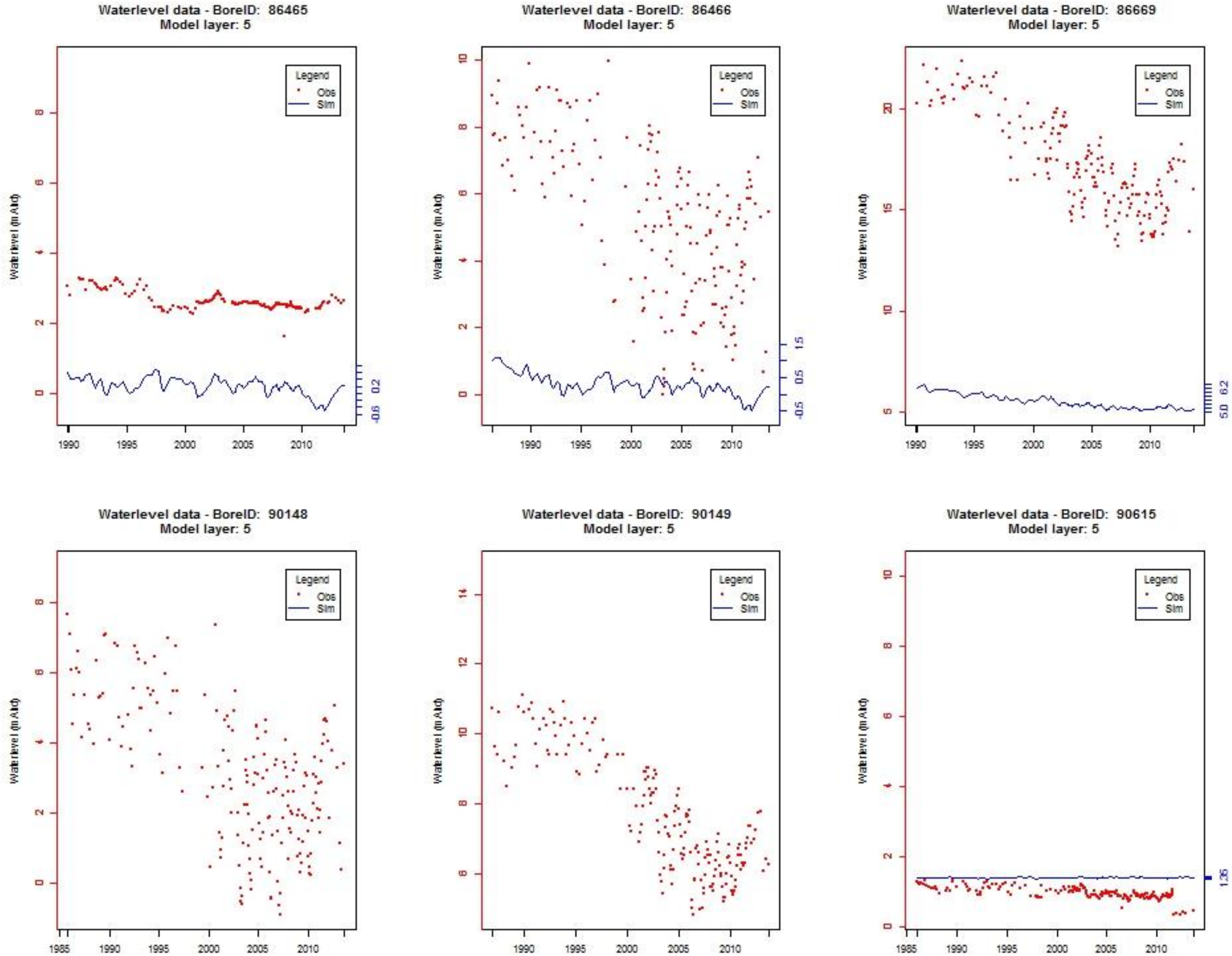

Waterlevel data - BoreID: M3787
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
Nov
Jun
Waterlevel data - BoreID: R344
Model layer: 3
Legend
Obs
Sim
Waterlevel (m Ahd)
2002
2004
2006
2008
2010
2012
Waterlevel data - BoreID: 103822
Model layer: 4
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010
Waterlevel data - BoreID: 104537
Model layer: 4
Legend
Obs
Sim
Waterlevel (m Ahd)
1986
1987
1988
1989
Waterlevel data - BoreID: 42051
Model layer: 4
Legend
Obs
Sim
Waterlevel (m Ahd)
1970
1980
1990
2000
2010
Waterlevel data - BoreID: 59308
Model layer: 4
Legend
Obs
Sim
Waterlevel (m Ahd)
1990
1995
2000
2005
2010

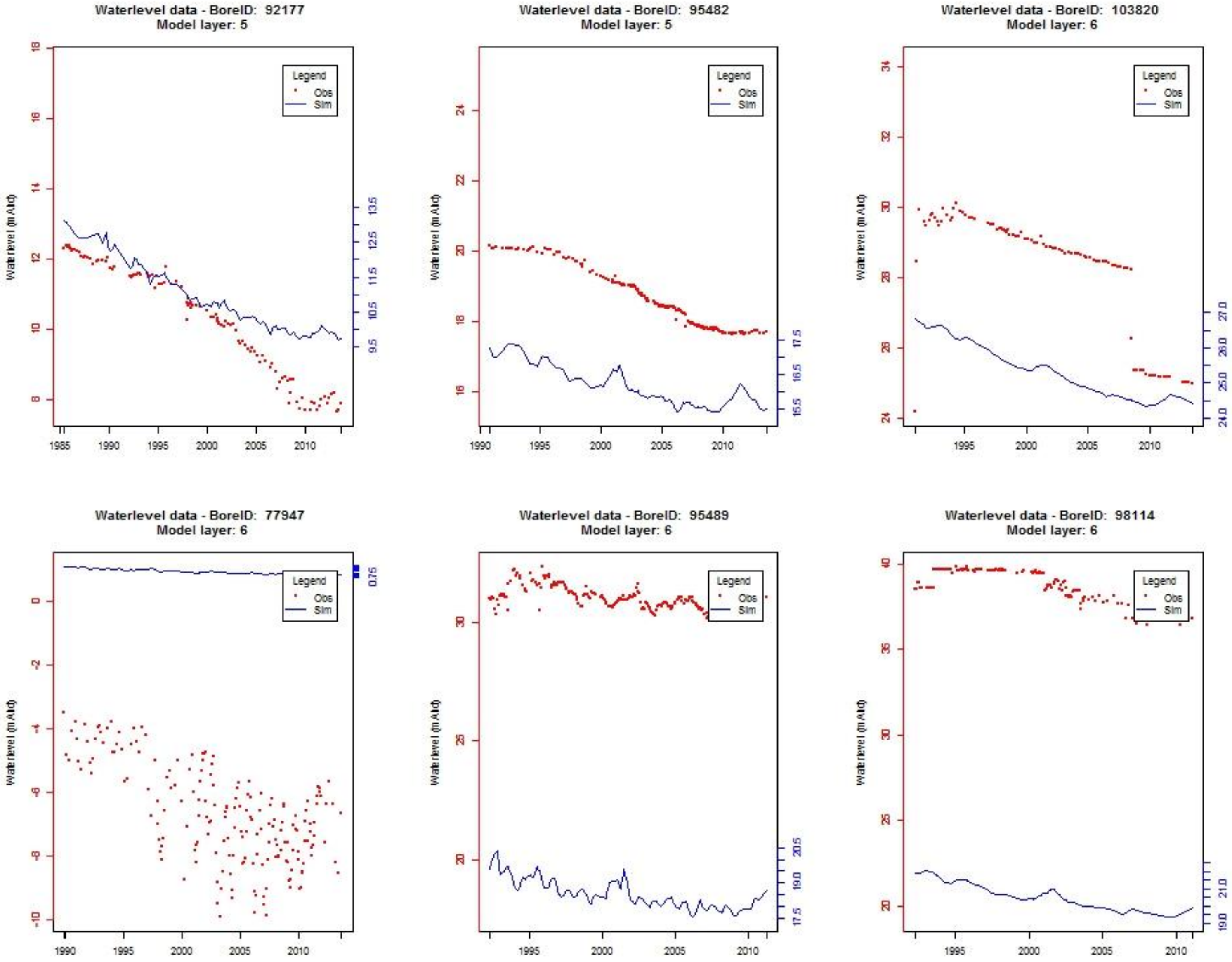

Waterlevel data - BoreID: 86670
Model layer: 4
Waterlevel data - BoreID: 86725
Model layer: 4
Waterlevel data - BoreID: 92296
Model layer: 4
Waterlevel data - BoreID: 95485
Model layer: 4
Waterlevel data - BoreID: 105196
Model layer: 5
Waterlevel data - BoreID: 105484
Model layer: 5
Legend
Obs
Sim

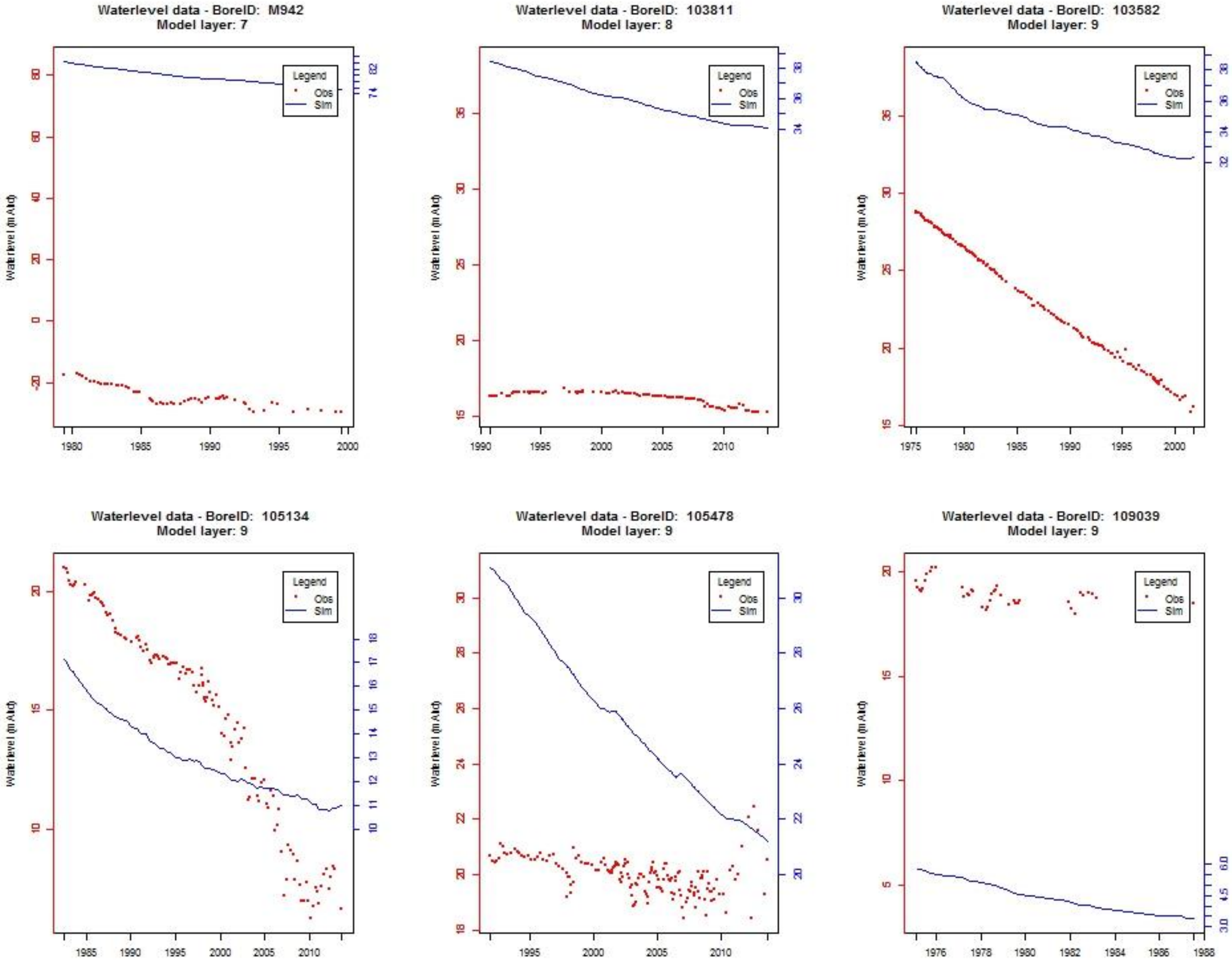

Waterlevel data - BoreID: 105547
Model layer: 5
Waterlevel data - BoreID: 105548
Model layer: 5
Waterlevel data - BoreID: 109044
Model layer: 5
Waterlevel data - BoreID: 140691
Model layer: 5
Waterlevel data - BoreID: 140692
Model layer: 5
Waterlevel data - BoreID: 145090
Model layer: 5
Legend
Obs
Sim
Waterlevel (m Ahd)

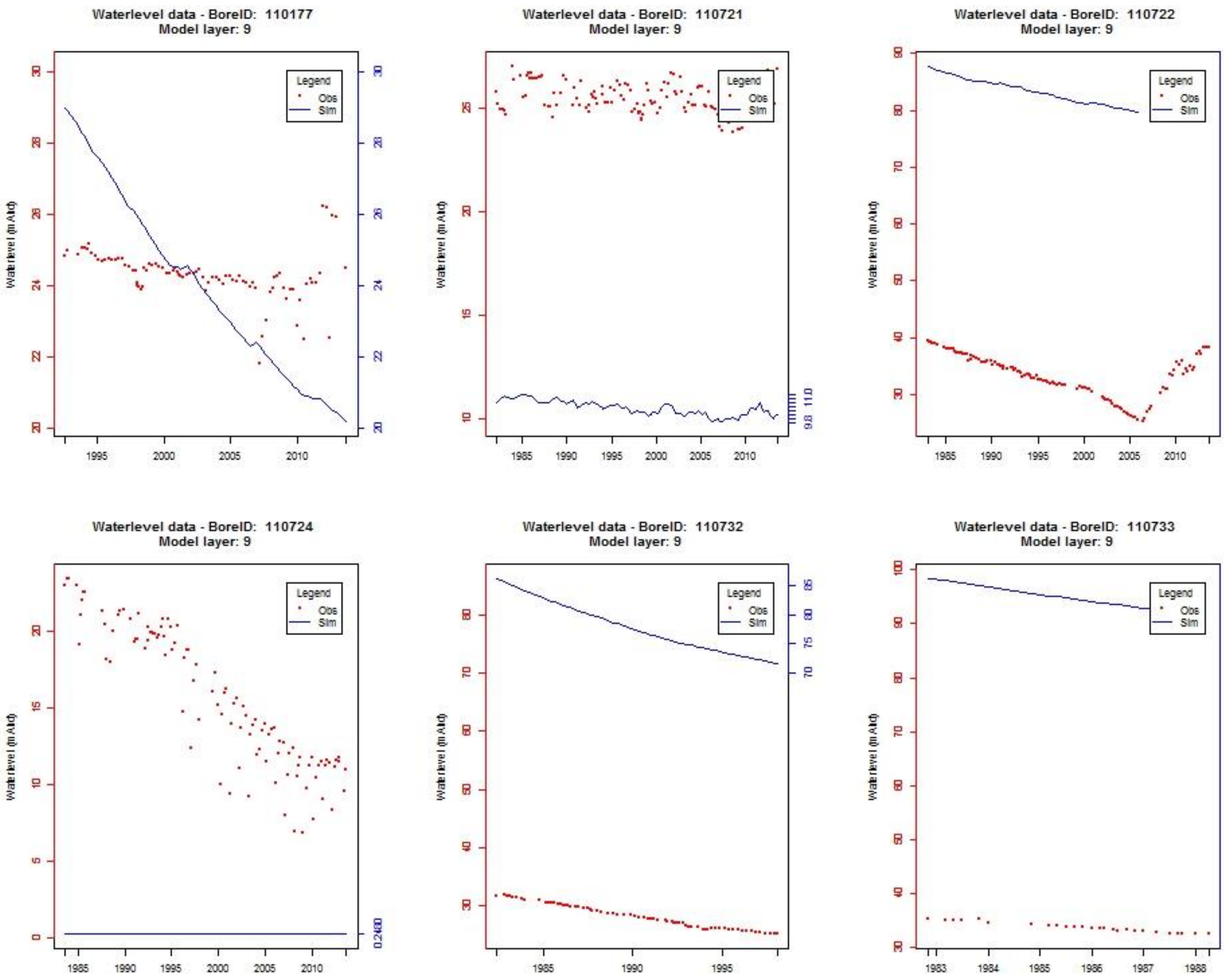

Waterlevel data - BoreID: 145091
Model layer: 5
Waterlevel data - BoreID: 145092
Model layer: 5
Waterlevel data - BoreID: 145093
Model layer: 5
Waterlevel data - BoreID: 145094
Model layer: 5
Waterlevel data - BoreID: 42181
Model layer: 5
Waterlevel data - BoreID: 46968
Model layer: 5
Legend
Obs
Sim
Waterlevel (m Ahd)

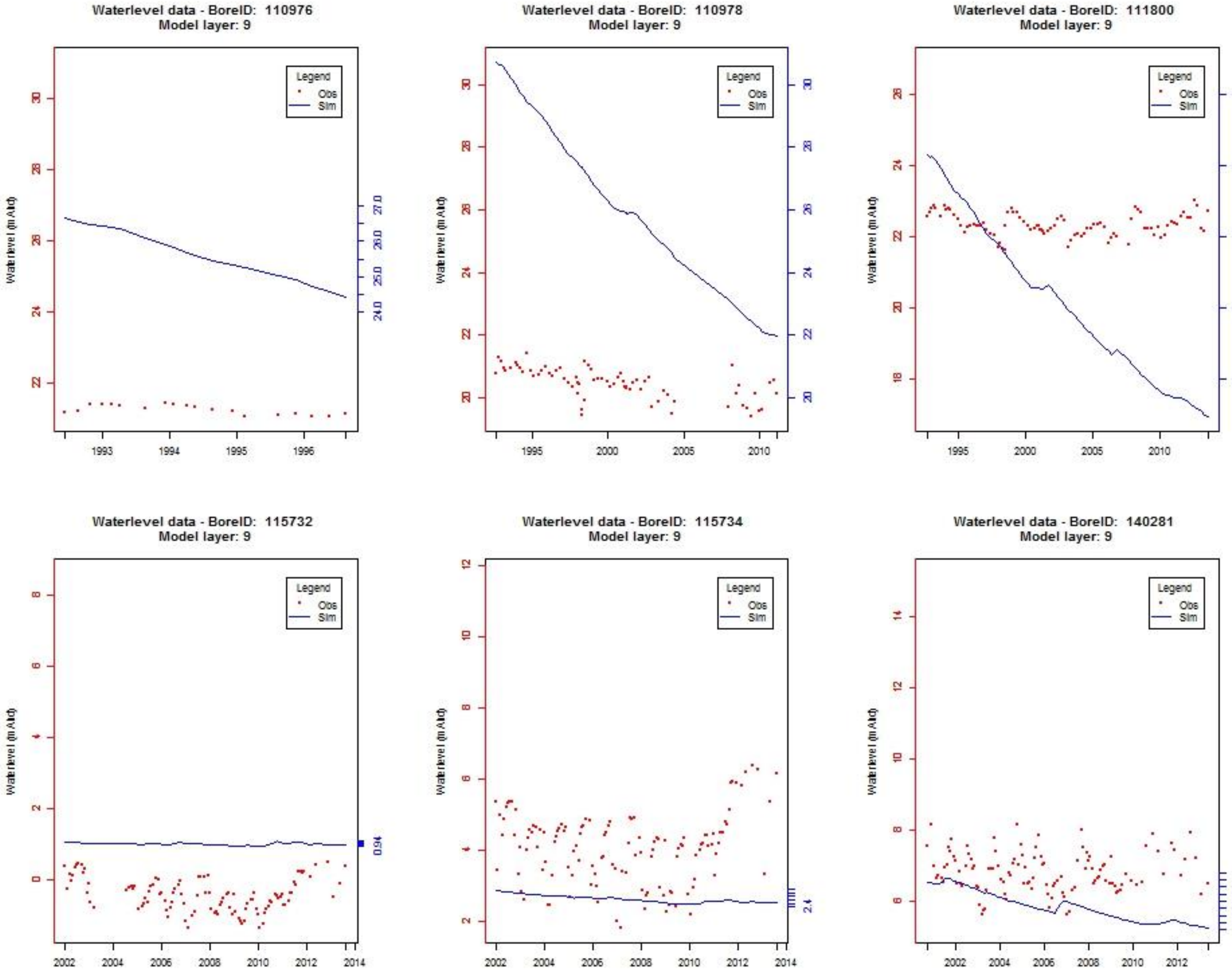

Waterlevel data - BoreID: 50876
Model layer: 5
Waterlevel data - BoreID: 52753
Model layer: 5
Waterlevel data - BoreID: 58934
Model layer: 5
Waterlevel data - BoreID: 65762
Model layer: 5
Waterlevel data - BoreID: 65764
Model layer: 5
Waterlevel data - BoreID: 86464
Model layer: 5
Legend
Obs
Sim
Waterlevel (m Ahd)

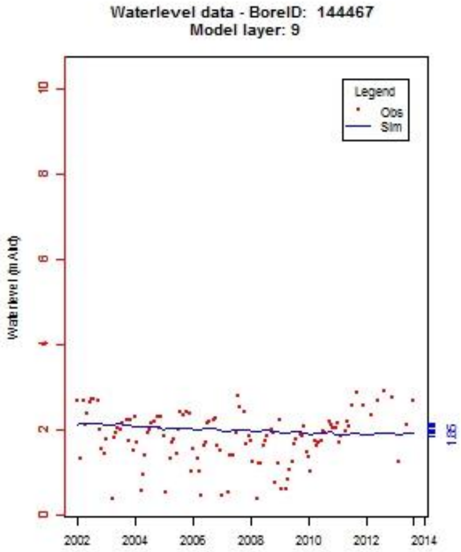

Waterlevel data - BoreID: 86465
Model layer: 5
Waterlevel data - BoreID: 86466
Model layer: 5
Waterlevel data - BoreID: 86669
Model layer: 5
Waterlevel data - BoreID: 90148
Model layer: 5
Waterlevel data - BoreID: 90149
Model layer: 5
Waterlevel data - BoreID: 90615
Model layer: 5
Legend
Obs
Sim
Waterlevel (m Ahd)

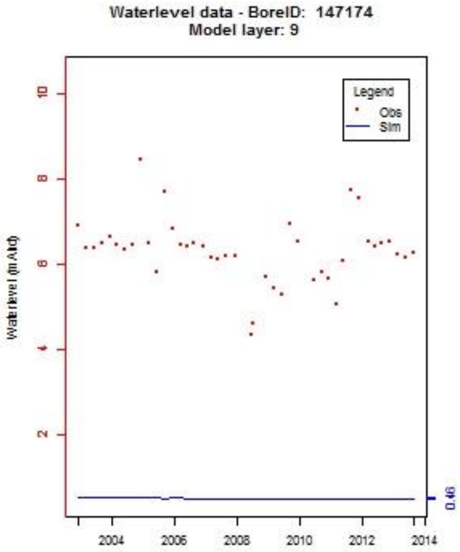

Waterlevel data - BoreID: 92177
Model layer: 5
Waterlevel data - BoreID: 95482
Model layer: 5
Waterlevel data - BoreID: 103820
Model layer: 6
Waterlevel data - BoreID: 77947
Model layer: 6
Waterlevel data - BoreID: 95489
Model layer: 6
Waterlevel data - BoreID: 98114
Model layer: 6
Legend
Obs
Sim
Waterlevel (m Ahd)

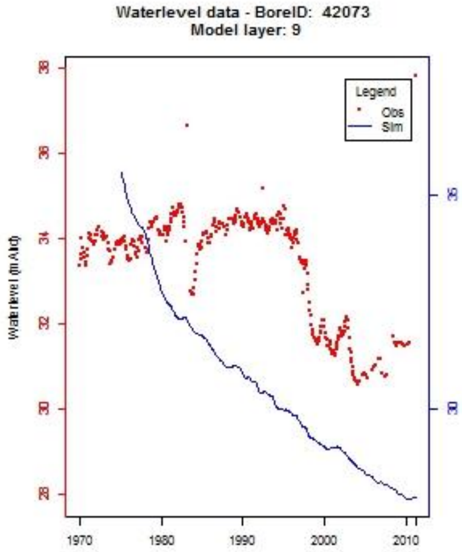

Waterlevel data - BoreID: M942
Model layer: 7
Waterlevel data - BoreID: 103811
Model layer: 8
Waterlevel data - BoreID: 103582
Model layer: 9
Waterlevel data - BoreID: 105134
Model layer: 9
Waterlevel data - BoreID: 105478
Model layer: 9
Waterlevel data - BoreID: 109039
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

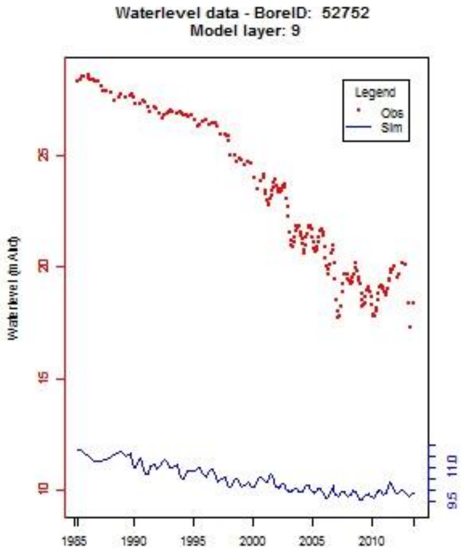

Waterlevel data - BoreID: 110177
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 110721
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 110722
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 110724
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 110732
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 110733
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

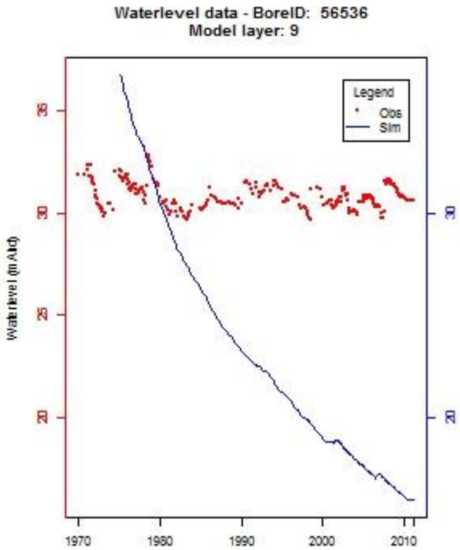

Waterlevel data - BoreID: 110976
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 110978
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 111800
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 115732
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 115734
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: 140281
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

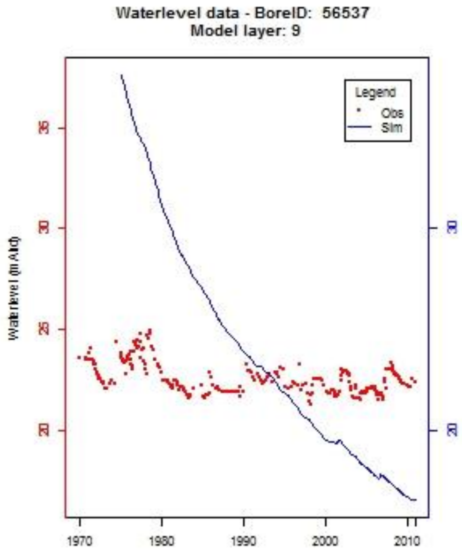

Waterlevel data - BoreID: 144467
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)


Waterlevel data - BoreID: 147174
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

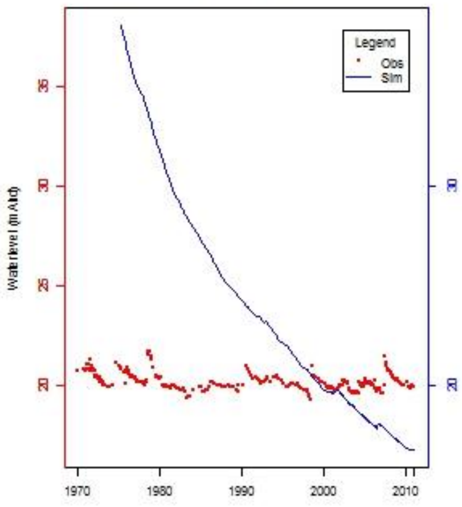

Waterlevel data - BoreID: 42073
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)


Waterlevel data - BoreID: 52752
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

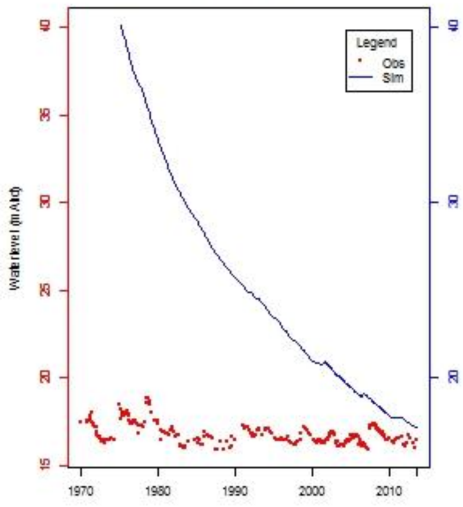

Waterlevel data - BoreID: 56536
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)


Waterlevel data - BoreID: 56537
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

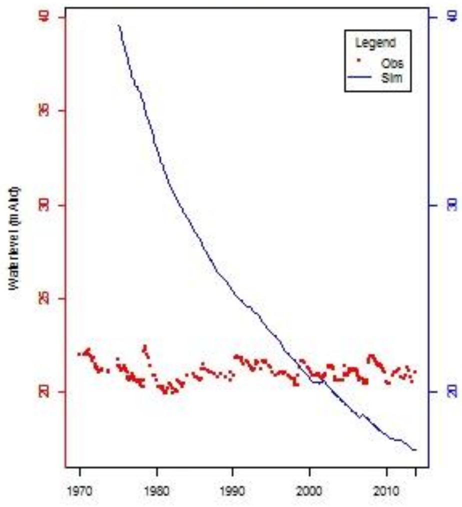
Waterlevel data - BoreID: 56538
Model layer: 9



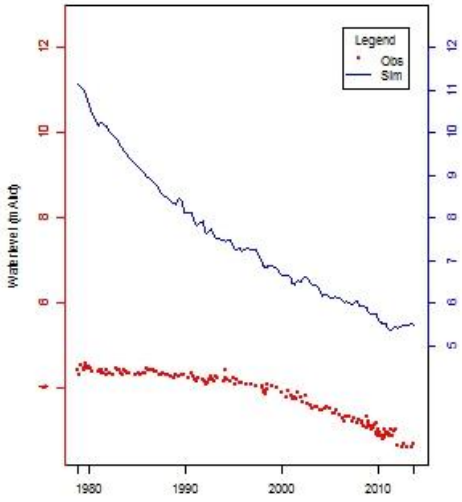
Waterlevel data - BoreID: 56539
Model layer: 9



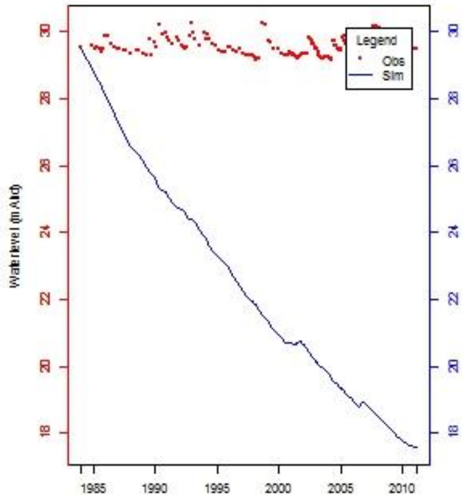
Waterlevel data - BoreID: 56540
Model layer: 9



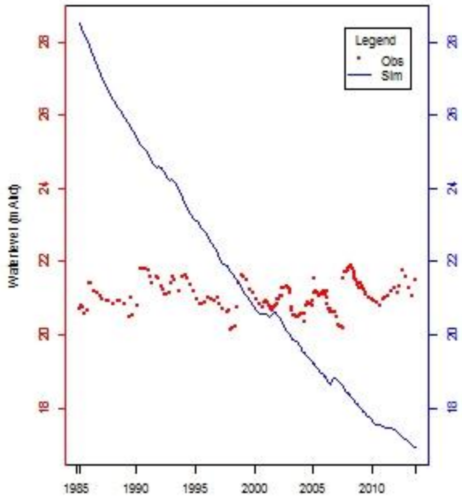
Waterlevel data - BoreID: 56545
Model layer: 9

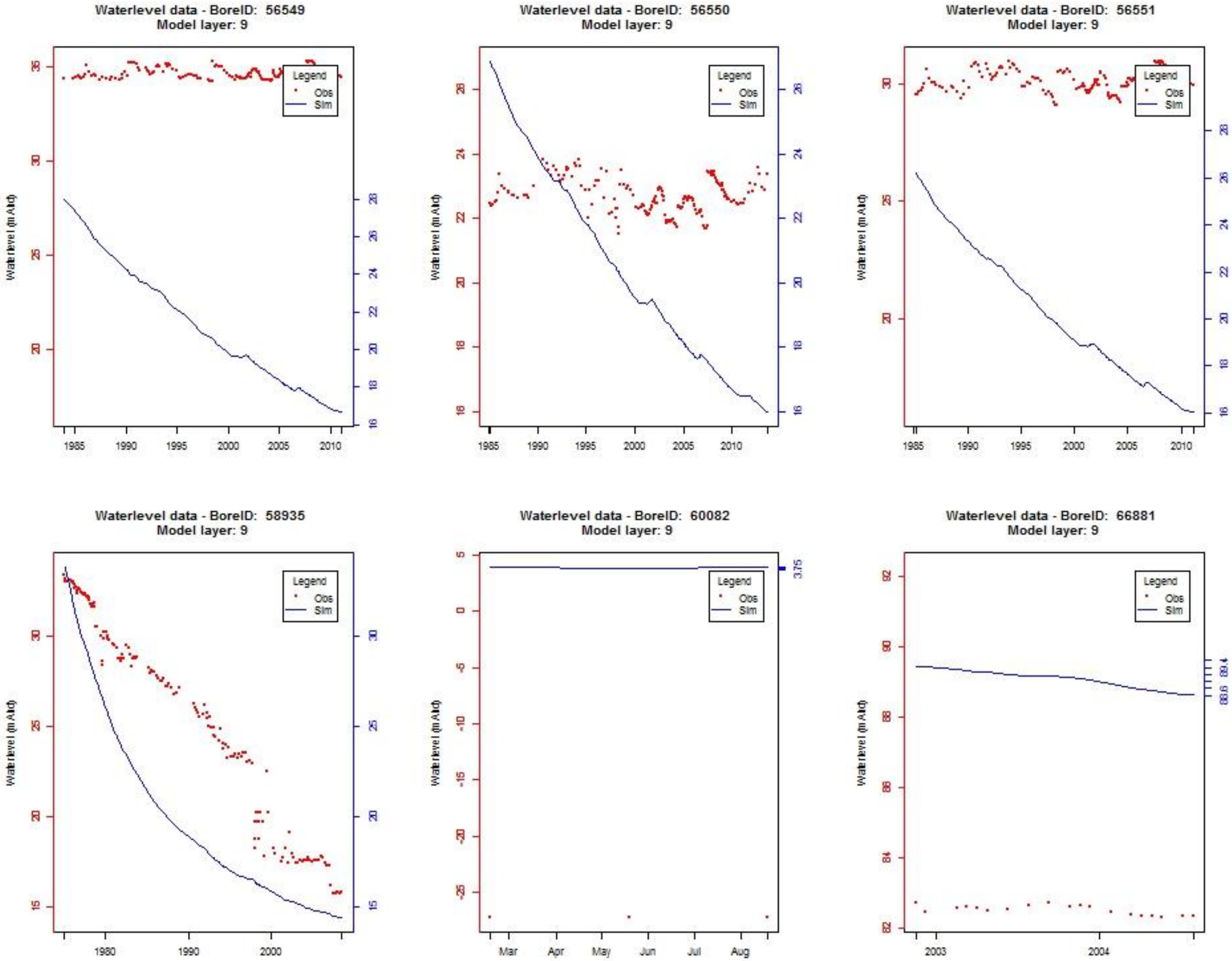


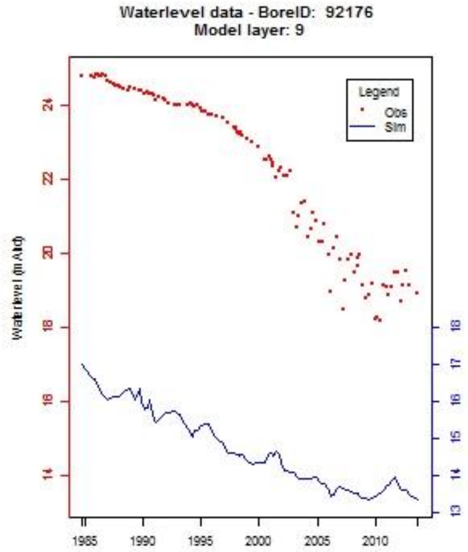
Waterlevel data - BoreID: 56547
Model layer: 9

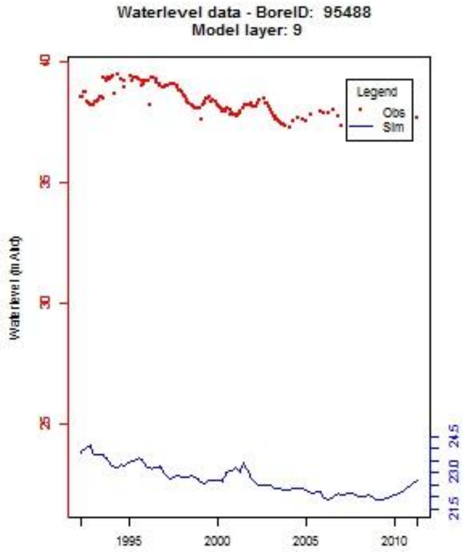


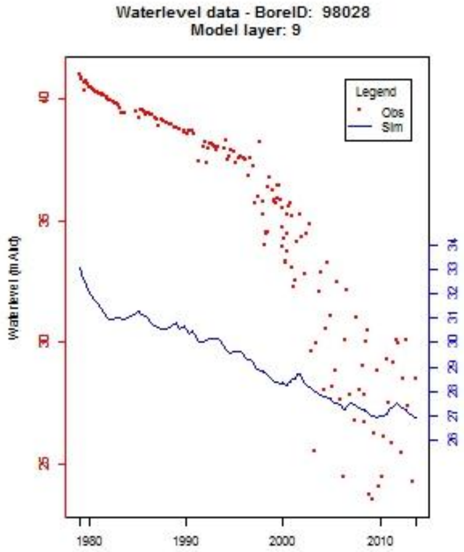
Waterlevel data - BoreID: 56548
Model layer: 9

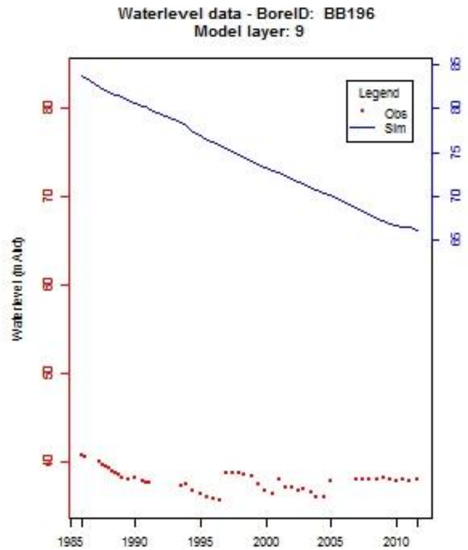


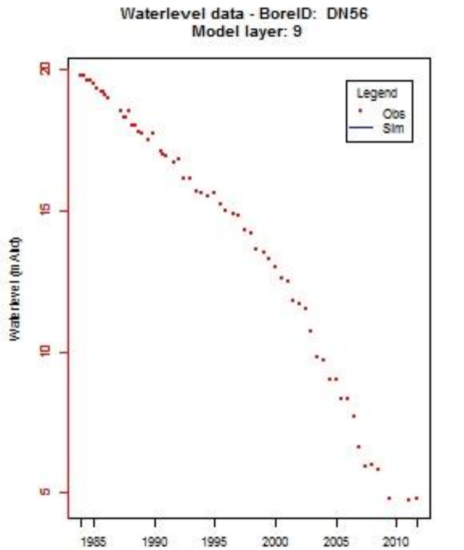

Waterlevel data - BoreID: 56549
Model layer: 9
Waterlevel data - BoreID: 56550
Model layer: 9
Waterlevel data - BoreID: 56551
Model layer: 9
Waterlevel data - BoreID: 58935
Model layer: 9
Waterlevel data - BoreID: 60082
Model layer: 9
Waterlevel data - BoreID: 66881
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

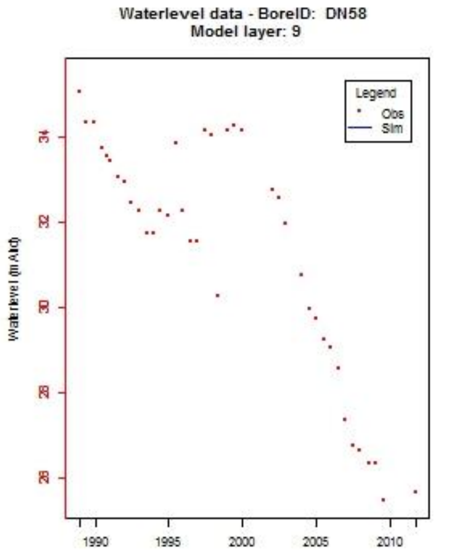

Waterlevel data - BoreID: 92176
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

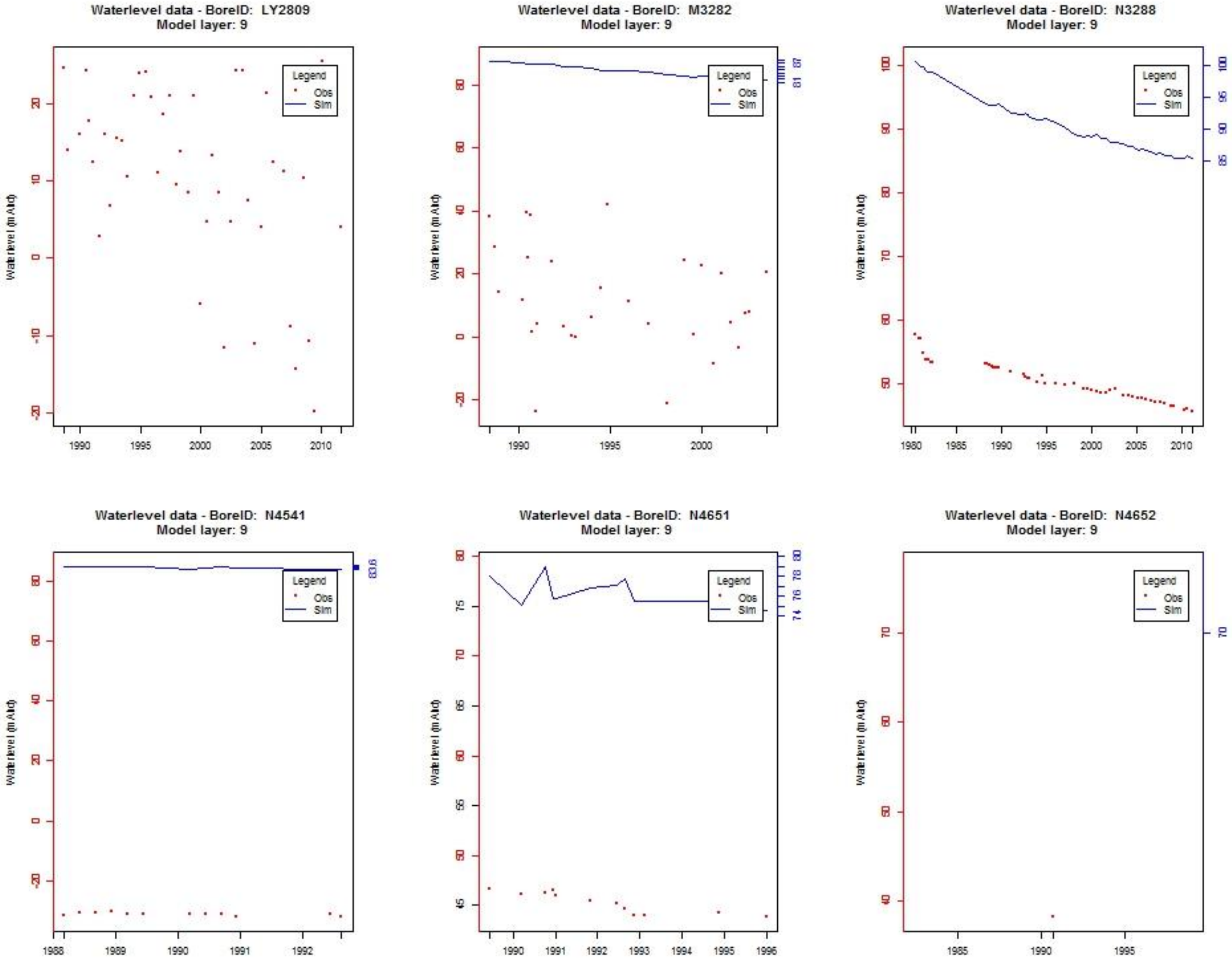

Waterlevel data - BoreID: 95488
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

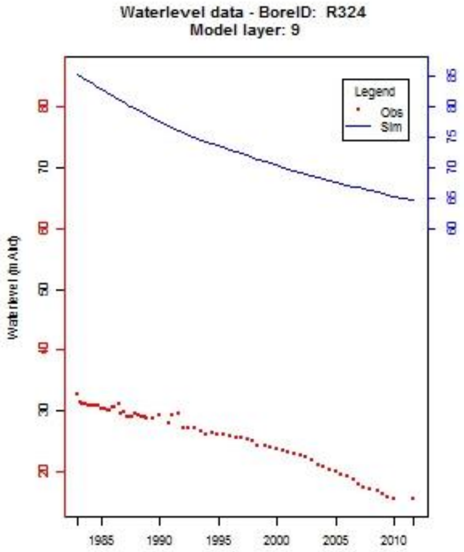

Waterlevel data - BoreID: 98028
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)


Waterlevel data - BoreID: BB196
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

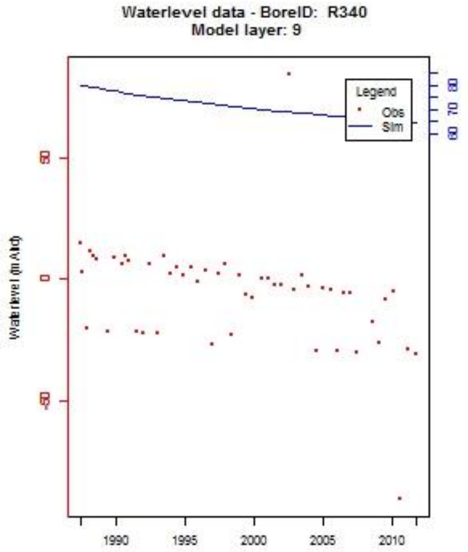

Waterlevel data - BoreID: DN56
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)


Waterlevel data - BoreID: DN58
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

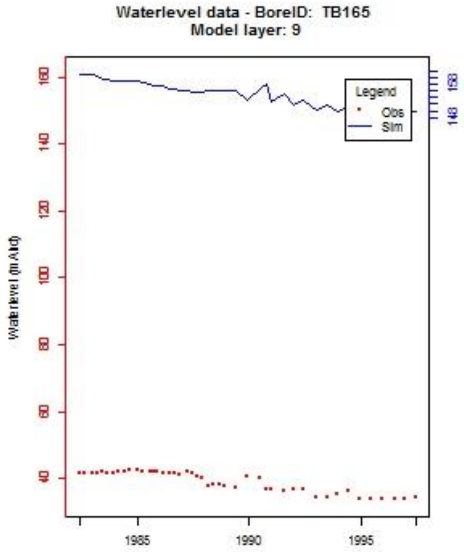

Waterlevel data - BoreID: LY2809
Model layer: 9
Waterlevel data - BoreID: M3282
Model layer: 9
Waterlevel data - BoreID: N3288
Model layer: 9
Waterlevel data - BoreID: N4541
Model layer: 9
Waterlevel data - BoreID: N4651
Model layer: 9
Waterlevel data - BoreID: N4652
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)



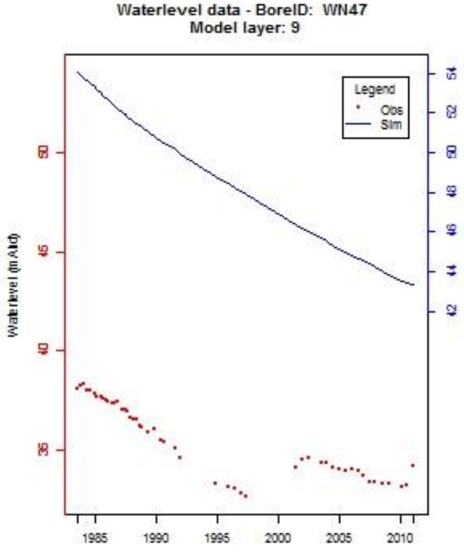
Waterlevel data - BoreID: R324
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)



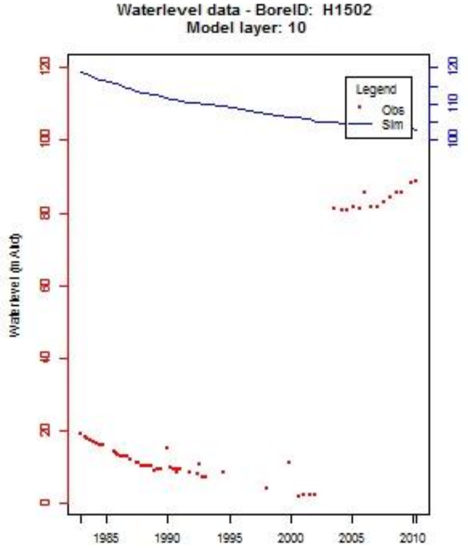
Waterlevel data - BoreID: R340
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)



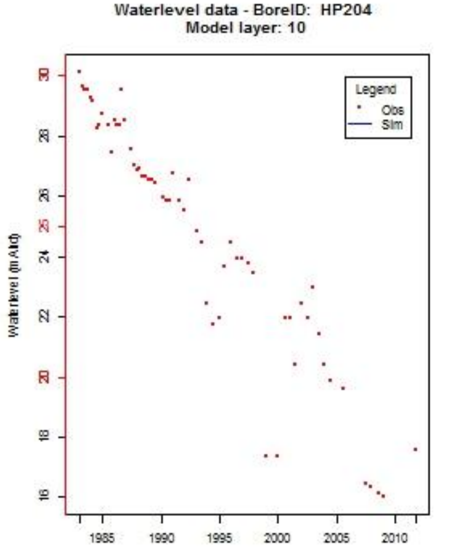
Waterlevel data - BoreID: TB165
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)



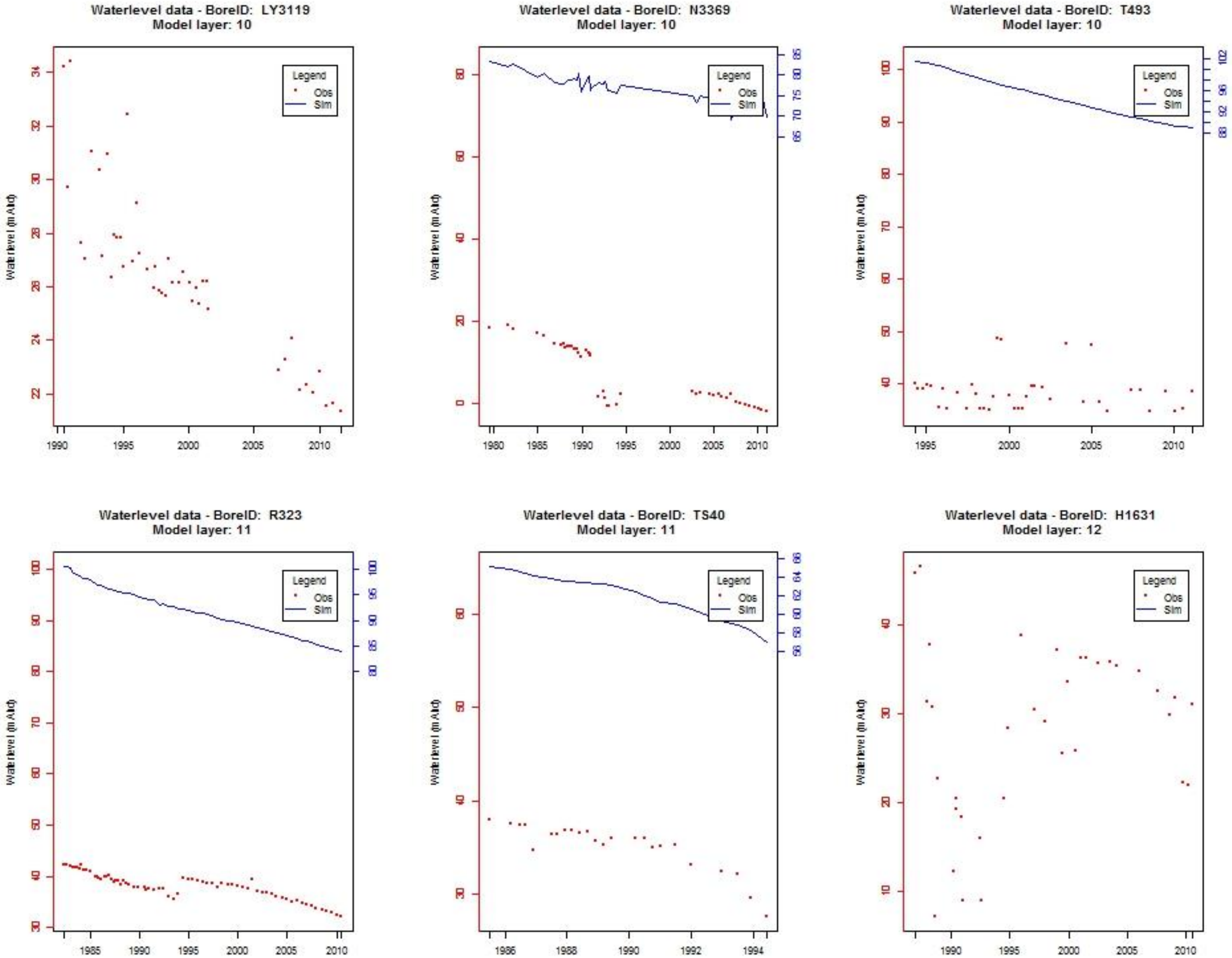
Waterlevel data - BoreID: WN47
Model layer: 9
Legend
Obs
Sim
Waterlevel (m Ahd)

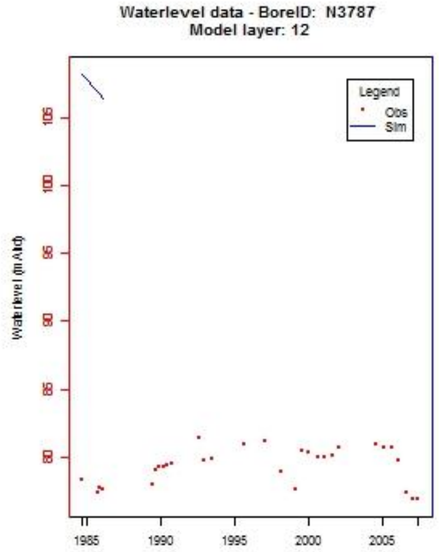


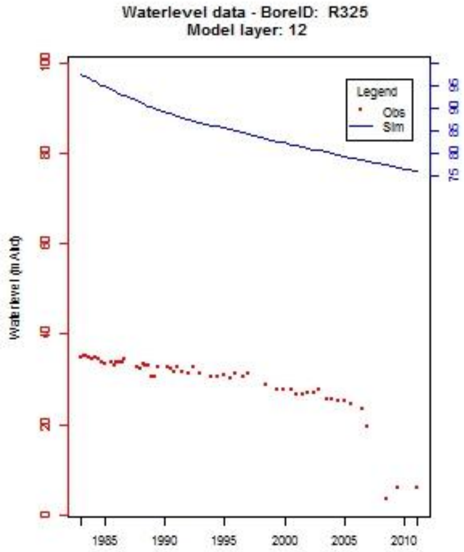
Waterlevel data - BoreID: H1502
Model layer: 10
Legend
Obs
Sim
Waterlevel (m Ahd)

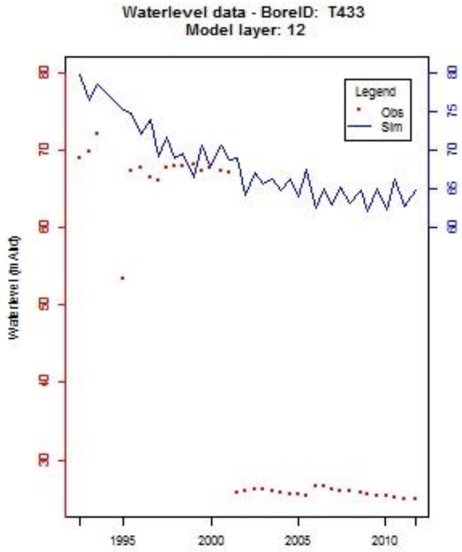


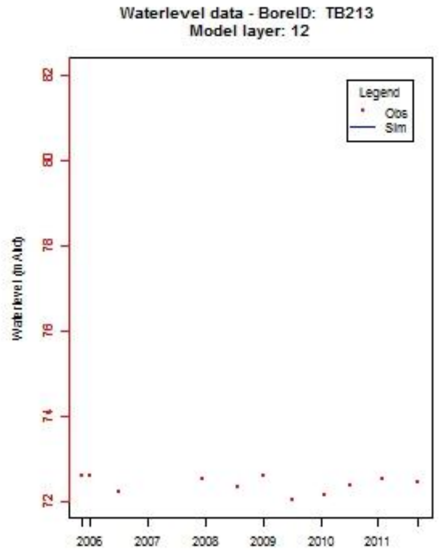
Waterlevel data - BoreID: HP204
Model layer: 10
Legend
Obs
Sim
Waterlevel (m Ahd)

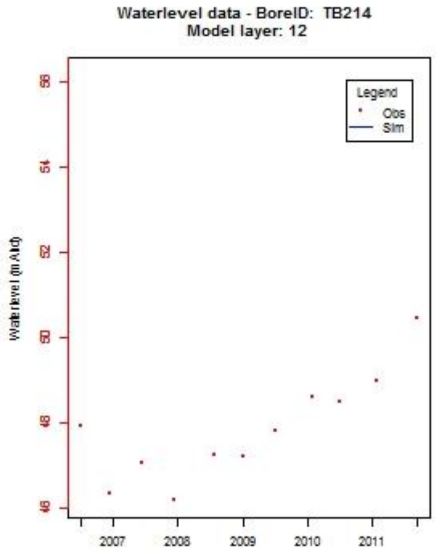

Waterlevel data - BoreID: LY3119
Model layer: 10
Waterlevel data - BoreID: N3369
Model layer: 10
Waterlevel data - BoreID: T493
Model layer: 10
Waterlevel data - BoreID: R323
Model layer: 11
Waterlevel data - BoreID: TS40
Model layer: 11
Waterlevel data - BoreID: H1631
Model layer: 12
Legend
Obs
Sim
Waterlevel (m Ahd)

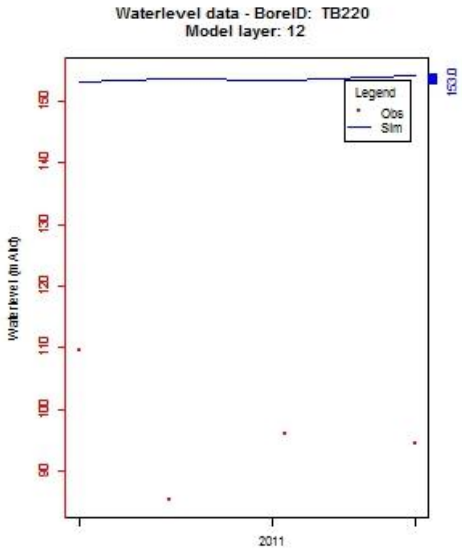

Waterlevel data - BoreID: N3787
Model layer: 12
Legend
Obs
Sim
Waterlevel (m Ahd)
1985
1990
1995
2000
2005

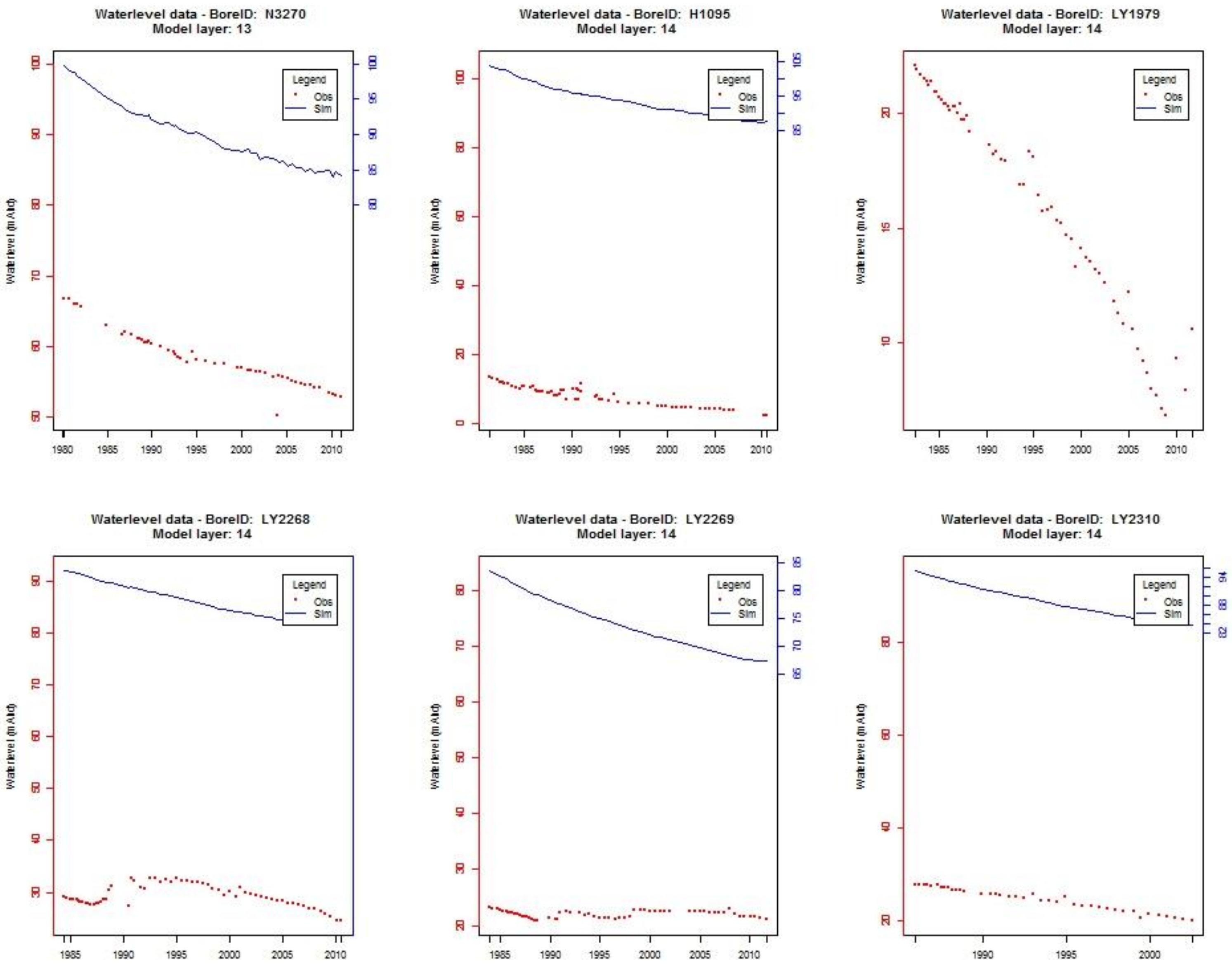

Waterlevel data - BoreID: R325
Model layer: 12
Legend
Obs
Sim
Waterlevel (m Ahd)
1985
1990
1995
2000
2005
2010

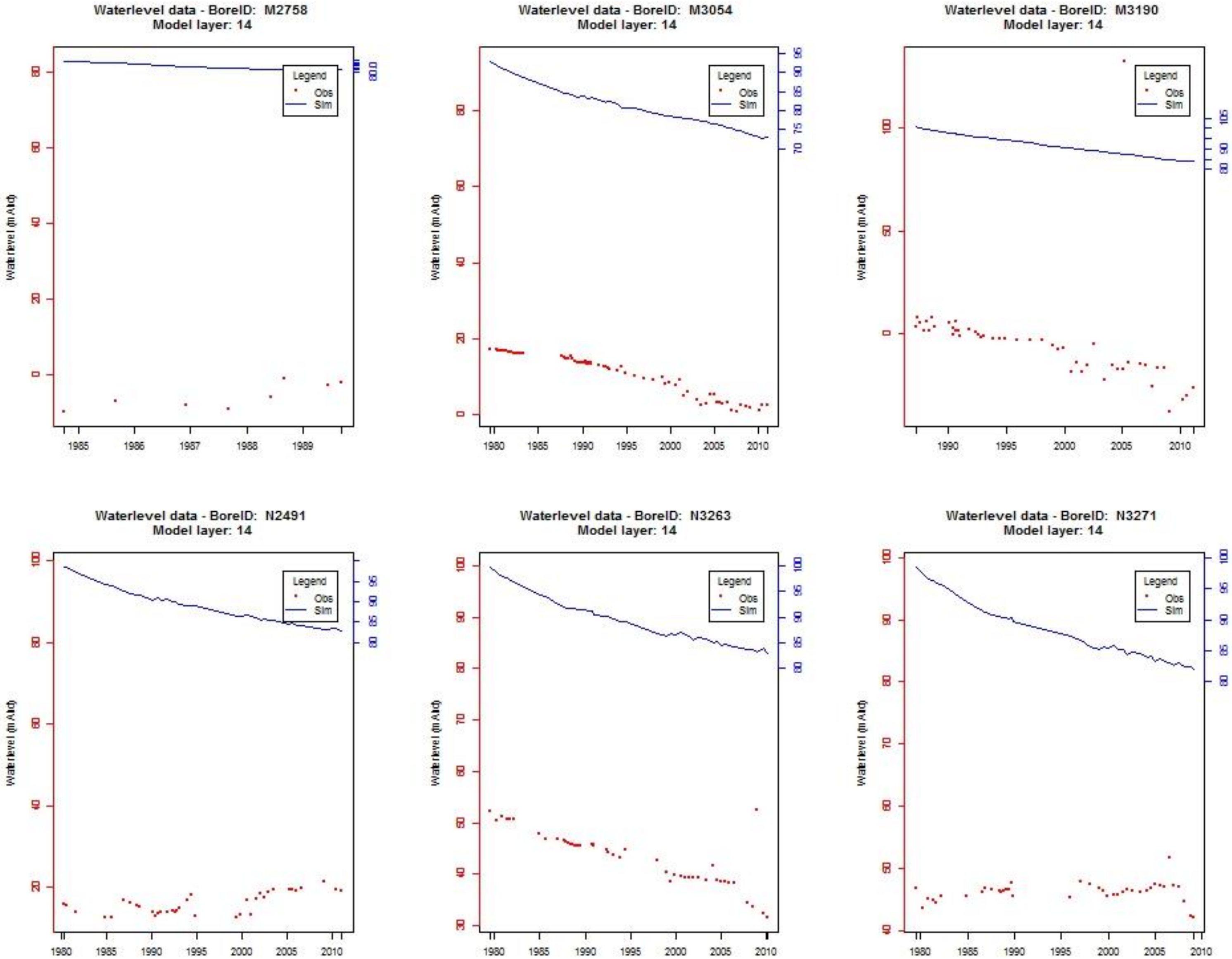

Waterlevel data - BoreID: T433
Model layer: 12
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

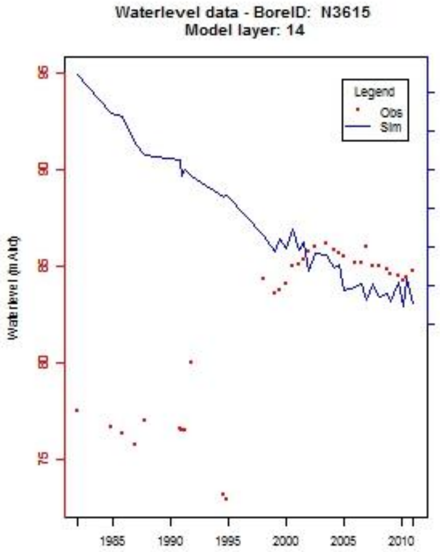

Waterlevel data - BoreID: TB213
Model layer: 12
Legend
Obs
Sim
Waterlevel (m Ahd)
2006
2007
2008
2009
2010
2011

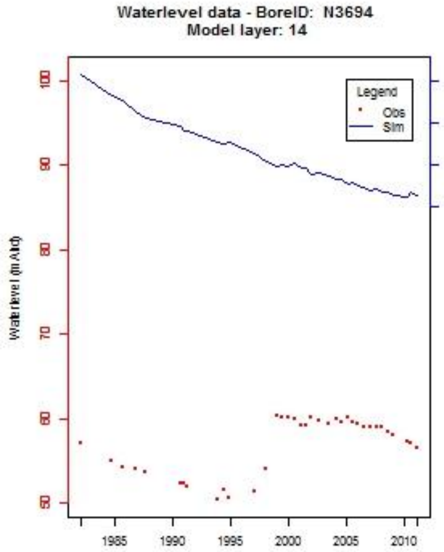

Waterlevel data - BoreID: TB214
Model layer: 12
Legend
Obs
Sim
Waterlevel (m Ahd)
2007
2008
2009
2010
2011

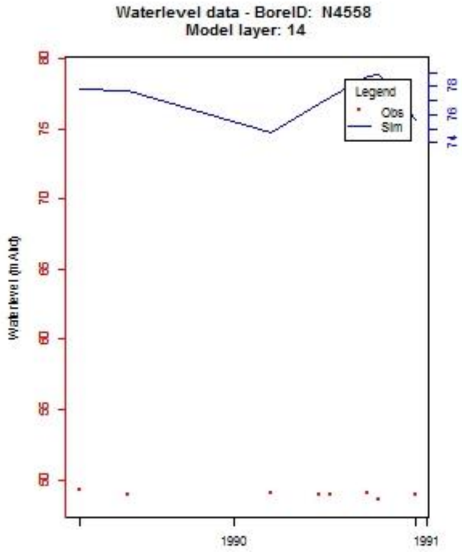

Waterlevel data - BoreID: TB220
Model layer: 12
Legend
Obs
Sim
Waterlevel (m Ahd)
2011

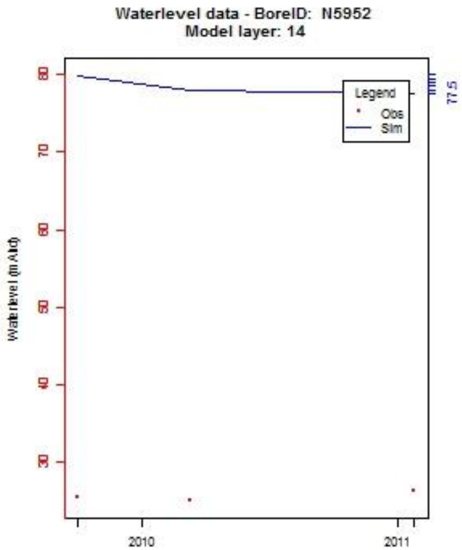

Waterlevel data - BoreID: N3270
Model layer: 13
Waterlevel data - BoreID: H1095
Model layer: 14
Waterlevel data - BoreID: LY1979
Model layer: 14
Waterlevel data - BoreID: LY2268
Model layer: 14
Waterlevel data - BoreID: LY2269
Model layer: 14
Waterlevel data - BoreID: LY2310
Model layer: 14
Legend
Obs
Sim
Waterlevel (m Ahd)

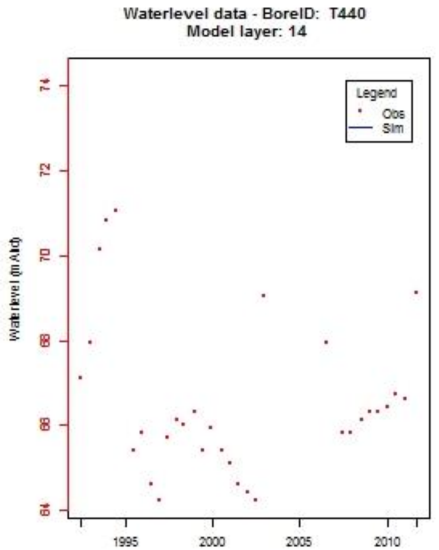

Waterlevel data - BoreID: M2758
Model layer: 14
Waterlevel data - BoreID: M3054
Model layer: 14
Waterlevel data - BoreID: M3190
Model layer: 14
Waterlevel data - BoreID: N2491
Model layer: 14
Waterlevel data - BoreID: N3263
Model layer: 14
Waterlevel data - BoreID: N3271
Model layer: 14
Legend
Obs
Sim
Waterlevel (m Ahd)

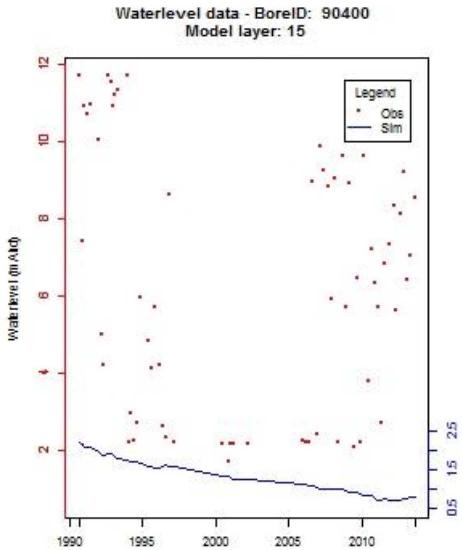

Waterlevel data - BoreID: N3615
Model layer: 14
Legend
Obs
Sim
Waterlevel (m Ahd)

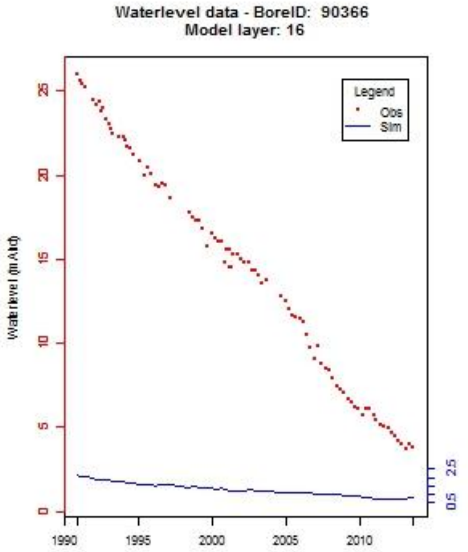

Waterlevel data - BoreID: N3694
Model layer: 14
Legend
Obs
Sim
Waterlevel (m Ahd)

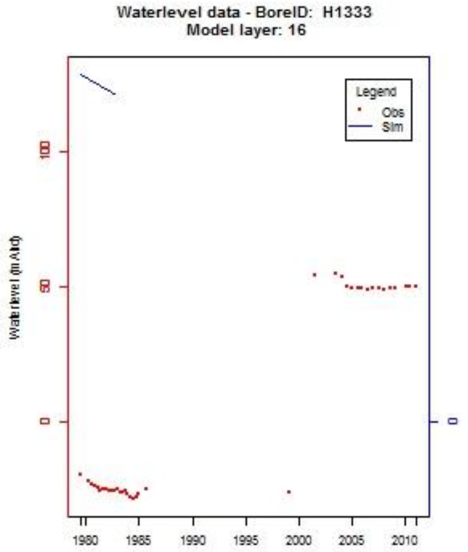

Waterlevel data - BoreID: N4558
Model layer: 14
Legend
Obs
Sim
Waterlevel (m Ahd)

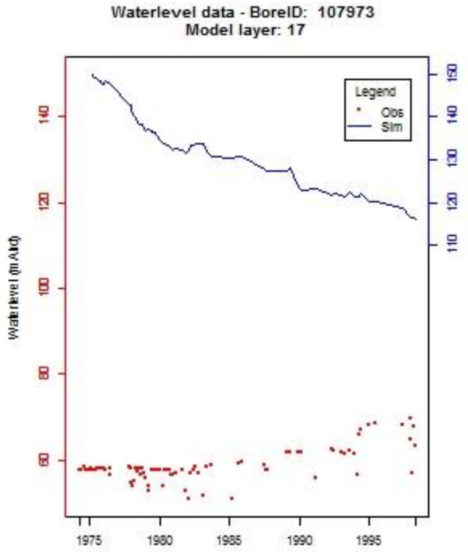

Waterlevel data - BoreID: N5952
Model layer: 14
Legend
Obs
Sim
Waterlevel (m Ahd)

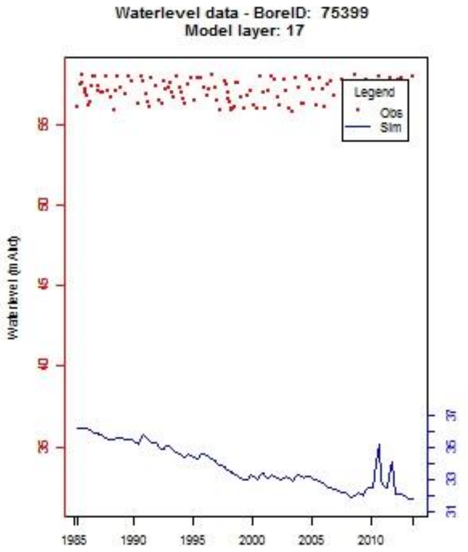

Waterlevel data - BoreID: T440
Model layer: 14
Legend
Obs
Sim
Waterlevel (m Ahd)

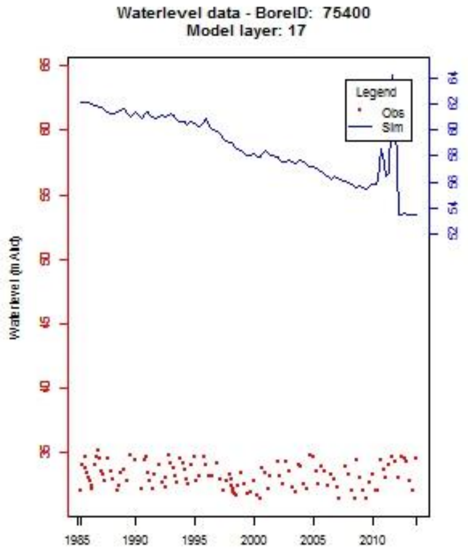

Waterlevel data - BoreID: 90400
Model layer: 15
Legend
Obs
Sim
Waterlevel (m Ahd)

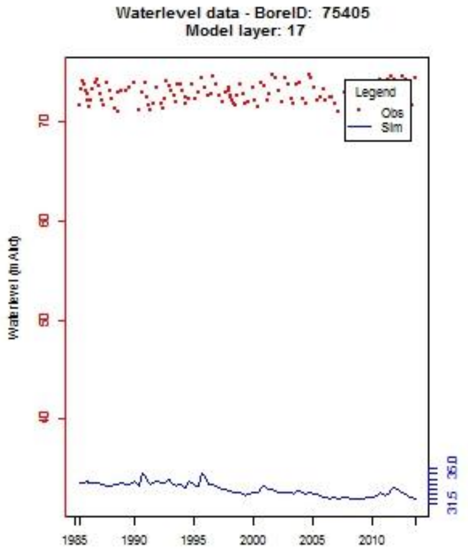

Waterlevel data - BoreID: 90366
Model layer: 16
Legend
Obs
Sim
Waterlevel (m Ahd)

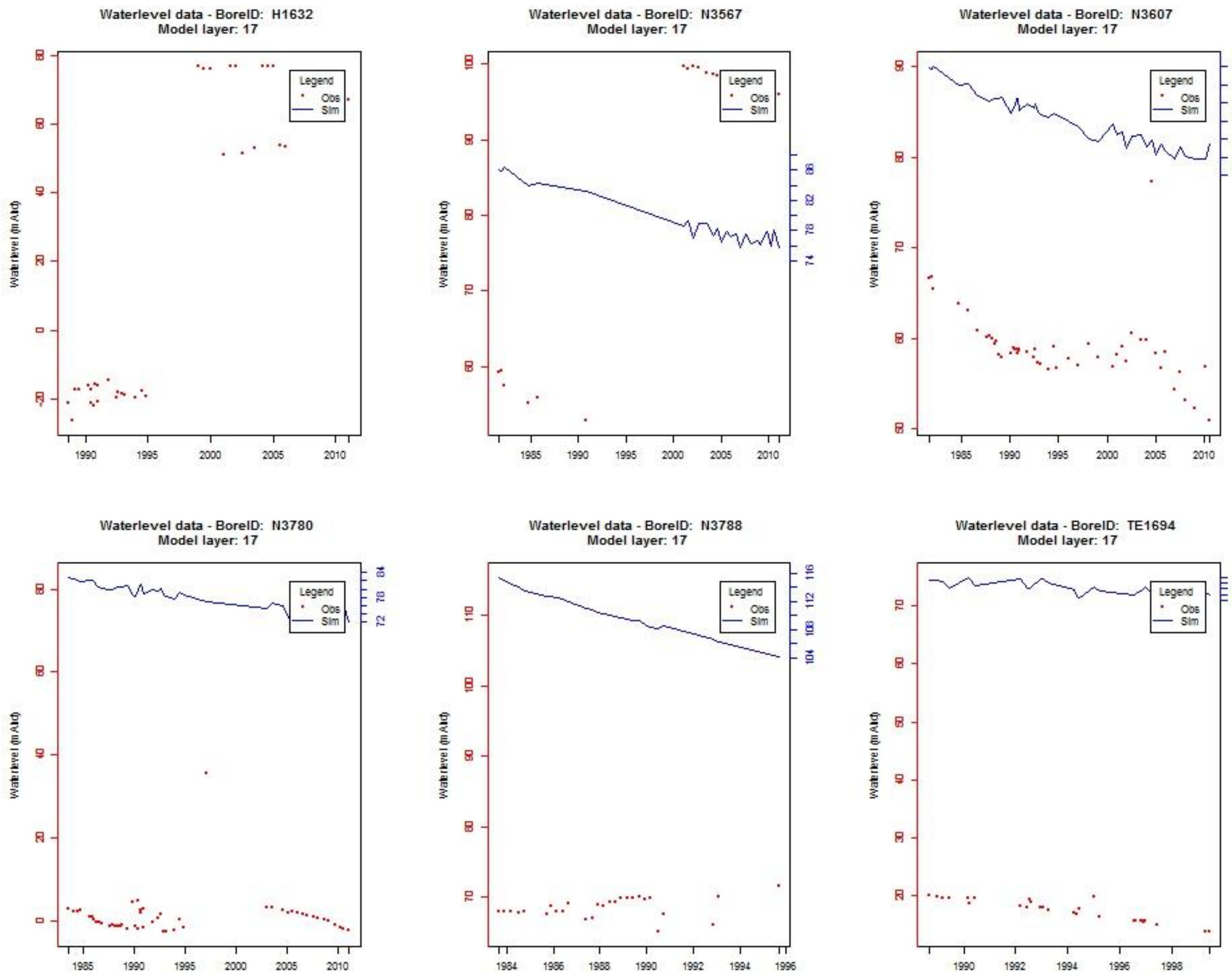

Waterlevel data - BoreID: H1333
Model layer: 16
Legend
Obs
Sim
Waterlevel (m Ahd)

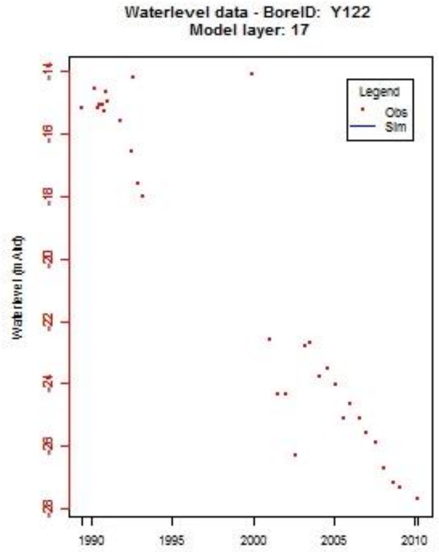

Waterlevel data - BoreID: 107973
Model layer: 17
Legend
Obs
Sim
Waterlevel (m Ahd)

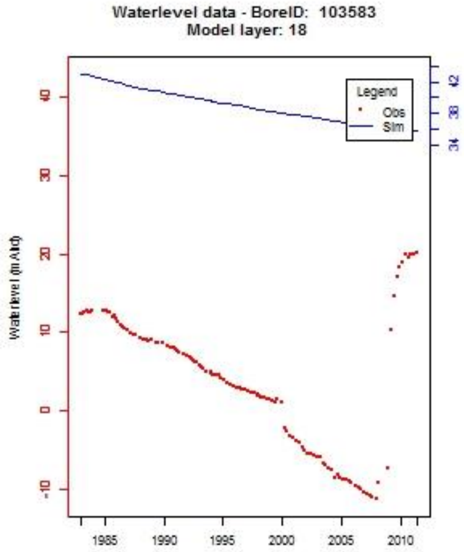

Waterlevel data - BoreID: 75399
Model layer: 17
Legend
Obs
Sim
Waterlevel (m Ahd)

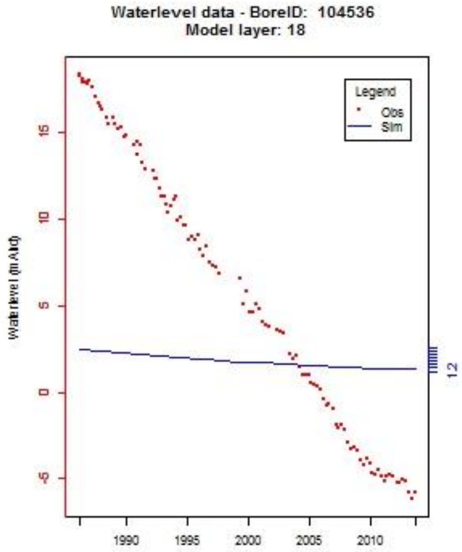

Waterlevel data - BoreID: 75400
Model layer: 17
Legend
Obs
Sim
Waterlevel (m Ahd)

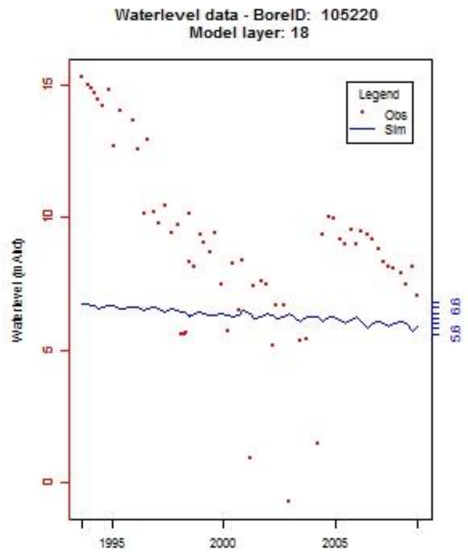

Waterlevel data - BoreID: 75405
Model layer: 17
Legend
Obs
Sim
Waterlevel (m Ahd)

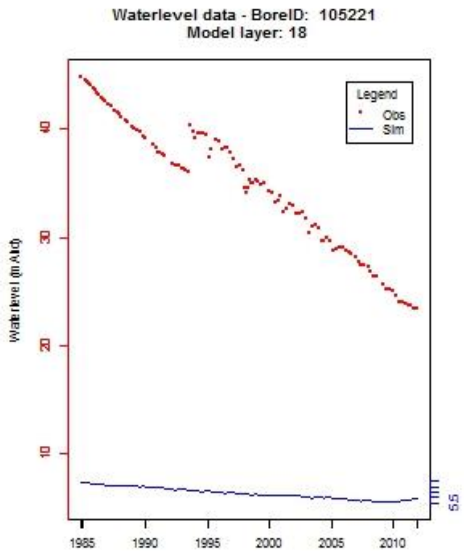

Waterlevel data - BoreID: H1632
Model layer: 17
Waterlevel data - BoreID: N3567
Model layer: 17
Waterlevel data - BoreID: N3607
Model layer: 17
Waterlevel data - BoreID: N3780
Model layer: 17
Waterlevel data - BoreID: N3788
Model layer: 17
Waterlevel data - BoreID: TE1694
Model layer: 17
Legend
Obs
Sim
Waterlevel (m Ahd)

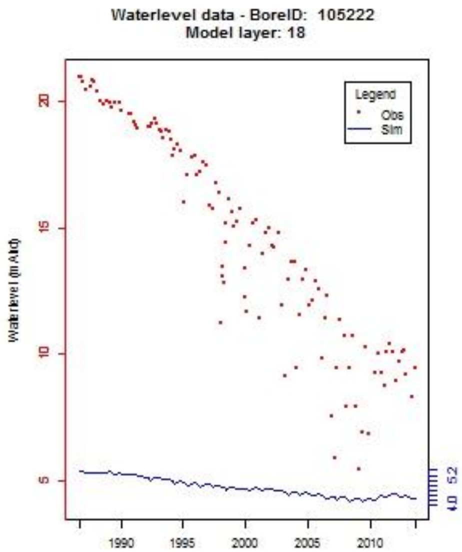

Waterlevel data - BoreID: Y122
Model layer: 17
Legend
Obs
Sim

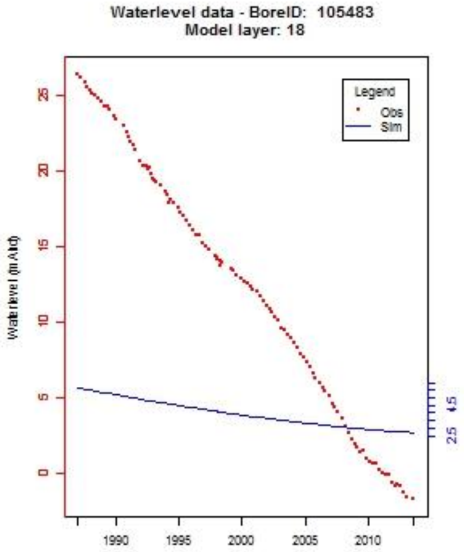

Waterlevel data - BoreID: 103583
Model layer: 18
Legend
Obs
Sim

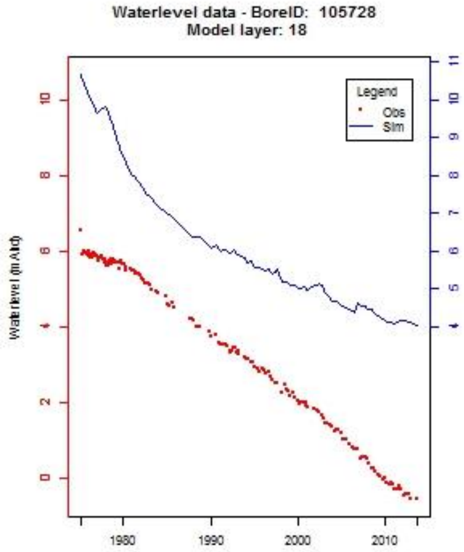

Waterlevel data - BoreID: 104536
Model layer: 18
Legend
Obs
Sim

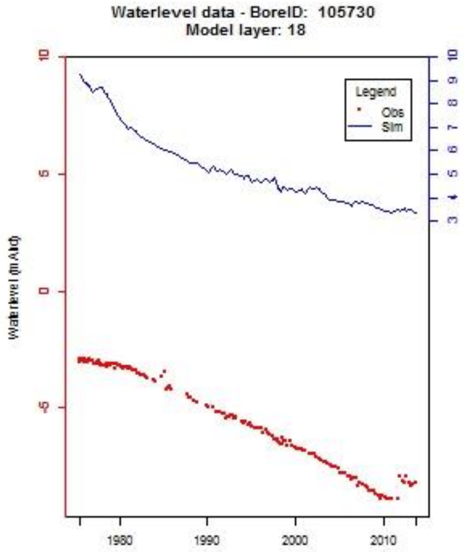

Waterlevel data - BoreID: 105220
Model layer: 18
Legend
Obs
Sim

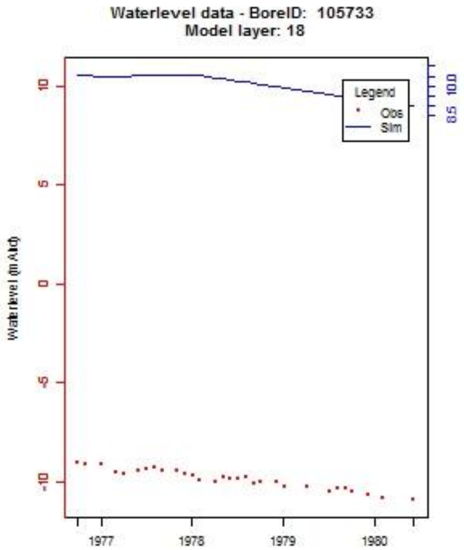

Waterlevel data - BoreID: 105221
Model layer: 18
Legend
Obs
Sim

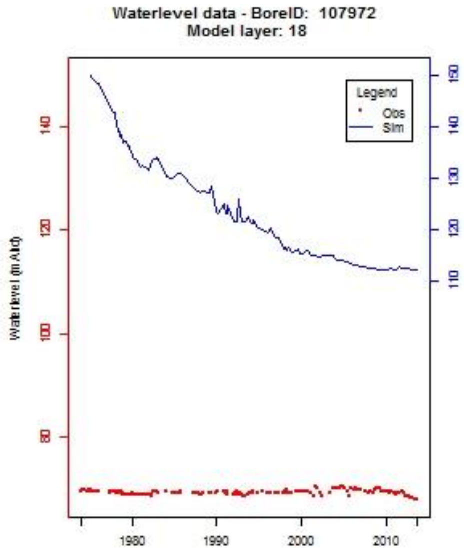

Waterlevel data - BoreID: 105222
Model layer: 18
Legend
Obs
Sim

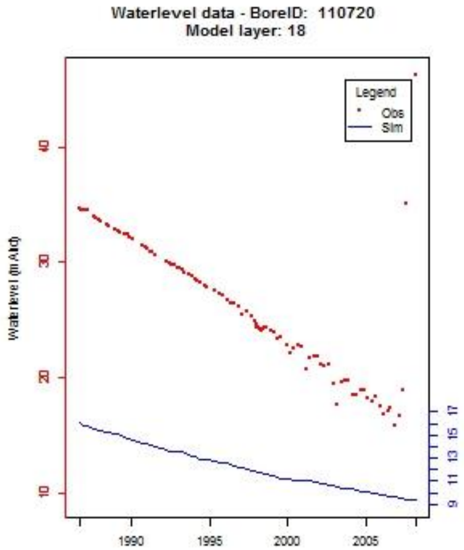

Waterlevel data - BoreID: 105483
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

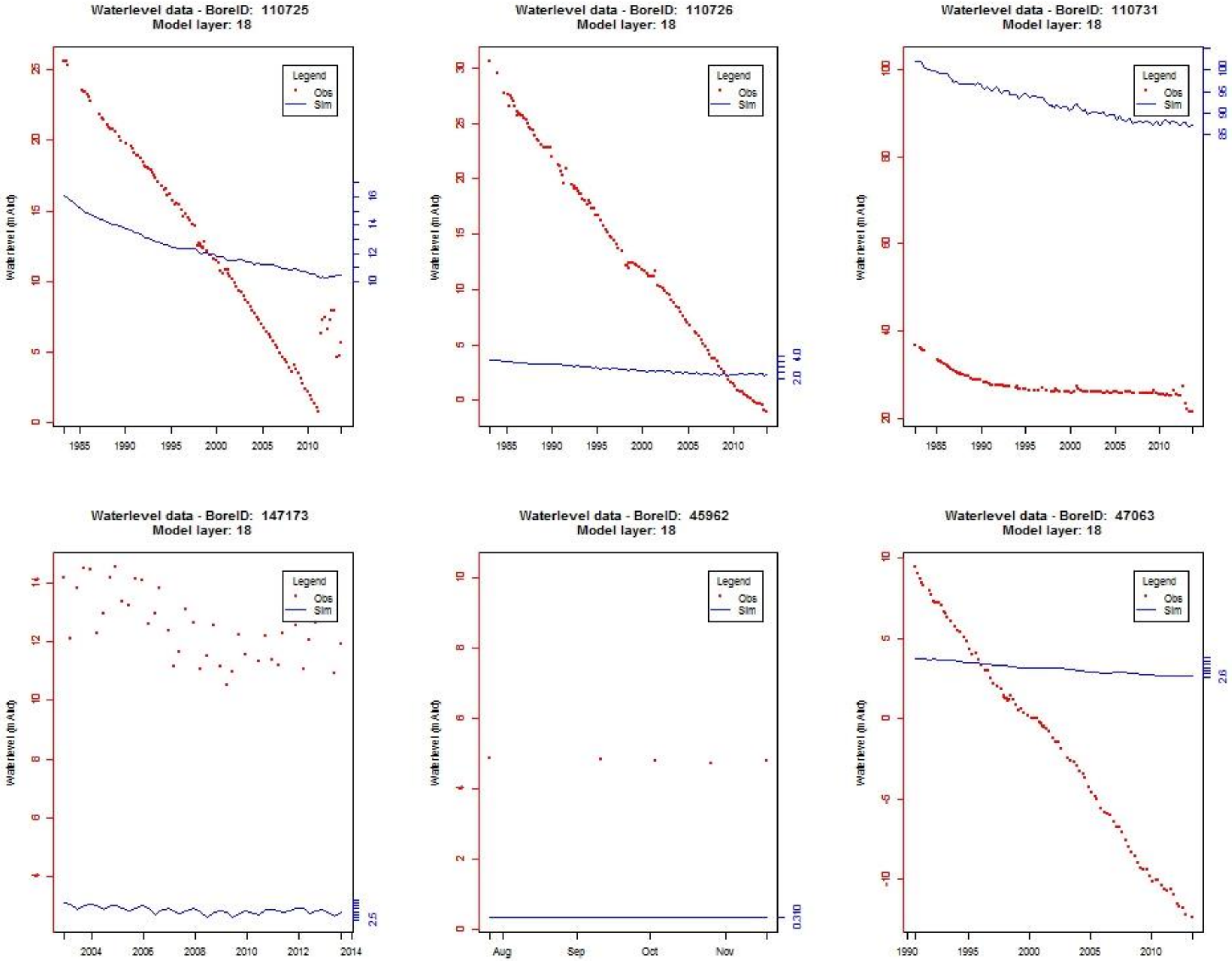

Waterlevel data - BoreID: 105728
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

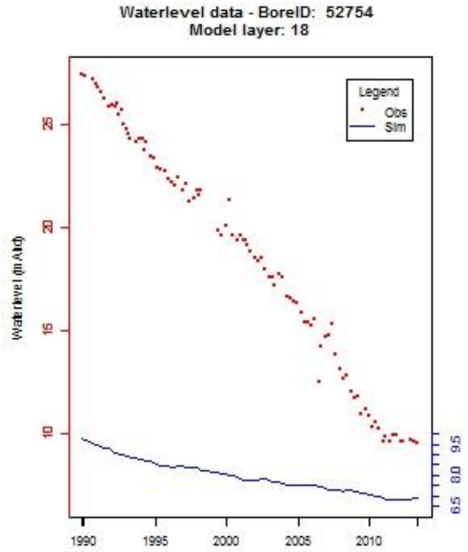

Waterlevel data - BoreID: 105730
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

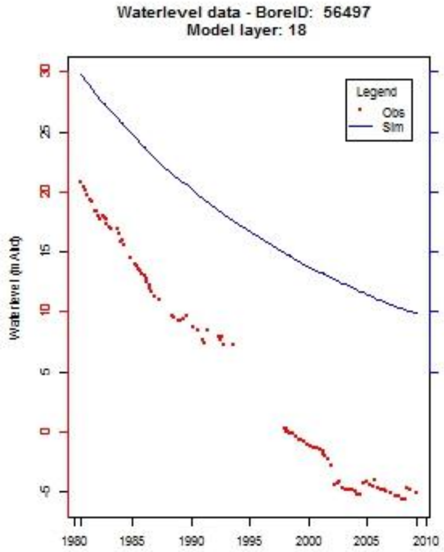

Waterlevel data - BoreID: 105733
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

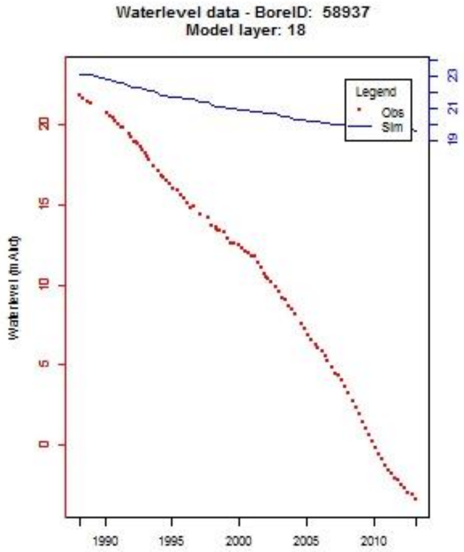

Waterlevel data - BoreID: 107972
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

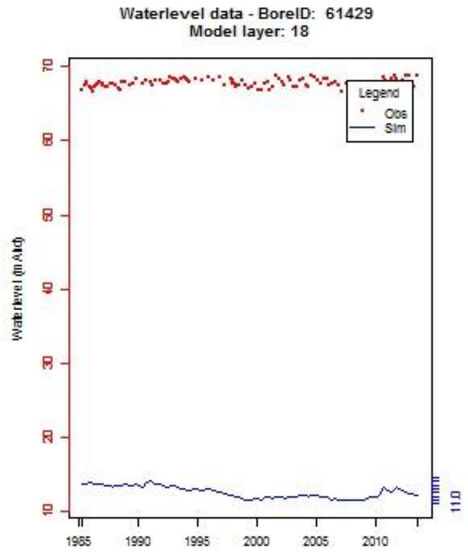

Waterlevel data - BoreID: 110720
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

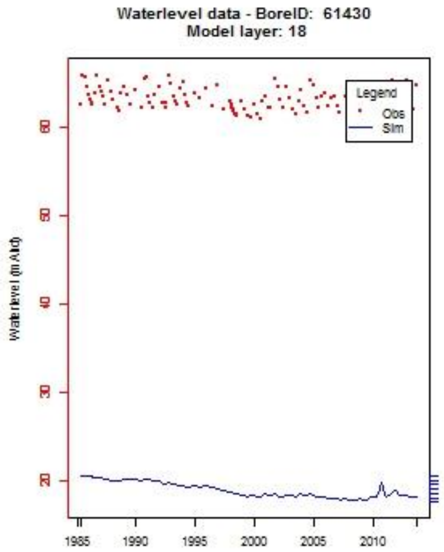

Waterlevel data - BoreID: 110725
Model layer: 18
Waterlevel data - BoreID: 110726
Model layer: 18
Waterlevel data - BoreID: 110731
Model layer: 18
Waterlevel data - BoreID: 147173
Model layer: 18
Waterlevel data - BoreID: 45962
Model layer: 18
Waterlevel data - BoreID: 47063
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

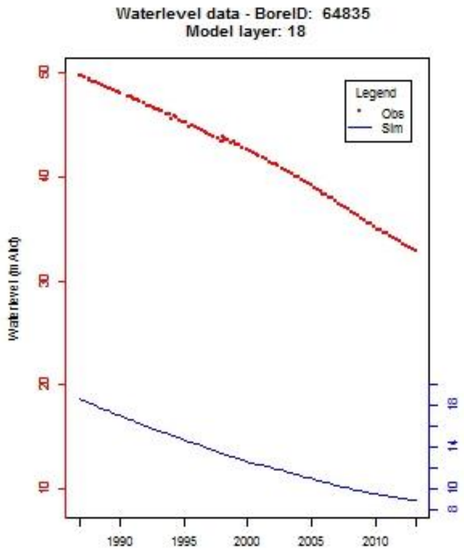

Waterlevel data - BoreID: 52754
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

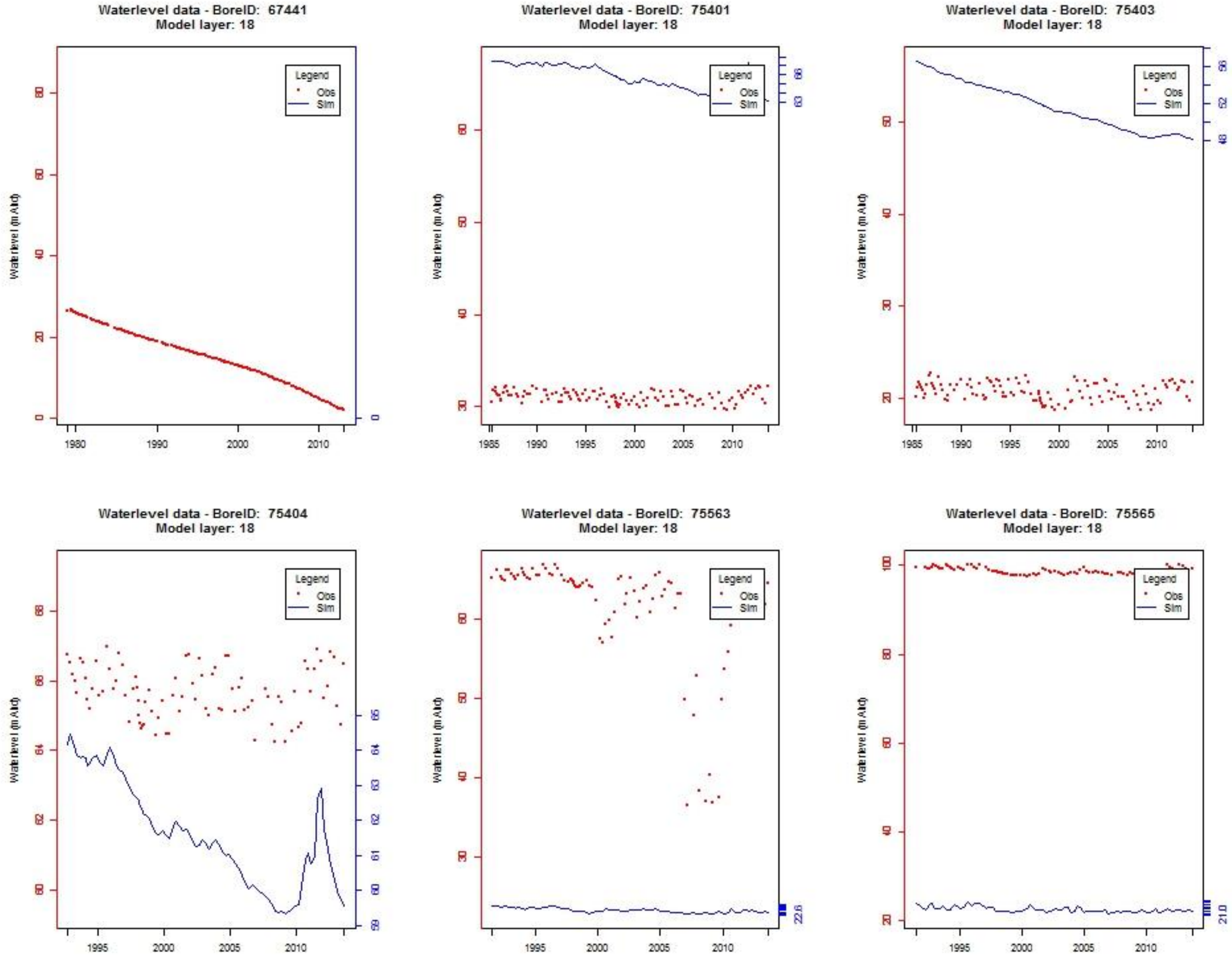

Waterlevel data - BoreID: 56497
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

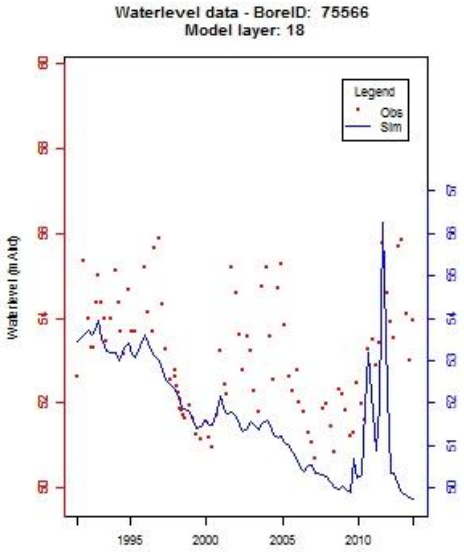

Waterlevel data - BoreID: 58937
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

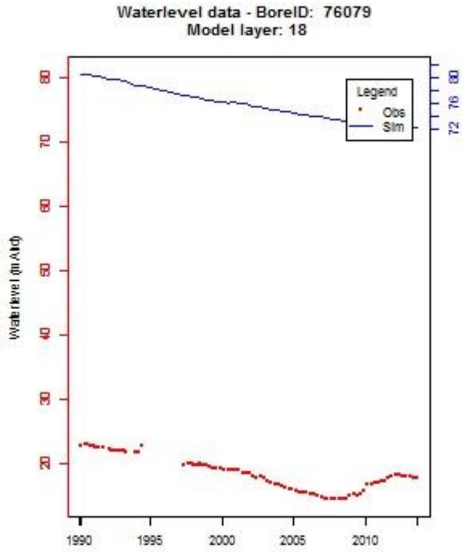

Waterlevel data - BoreID: 61429
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

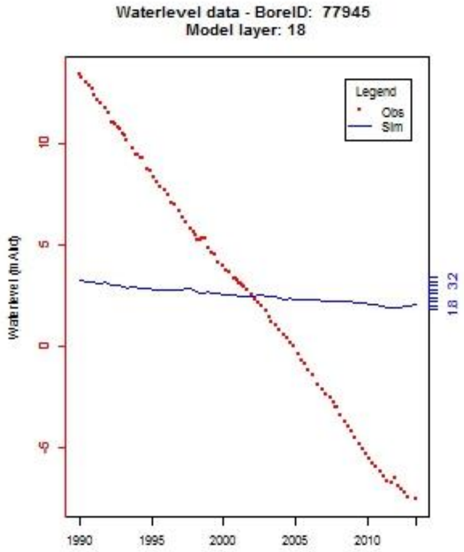

Waterlevel data - BoreID: 61430
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

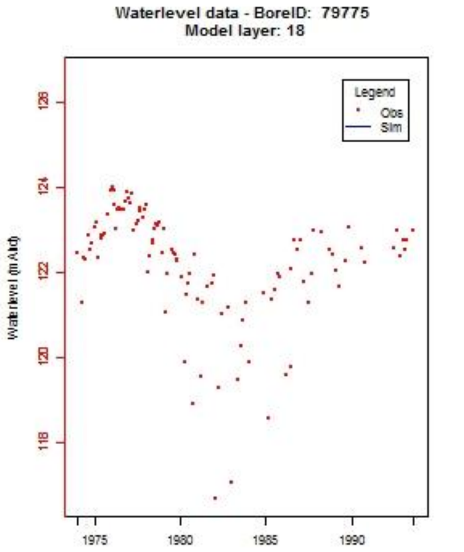

Waterlevel data - BoreID: 64835
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

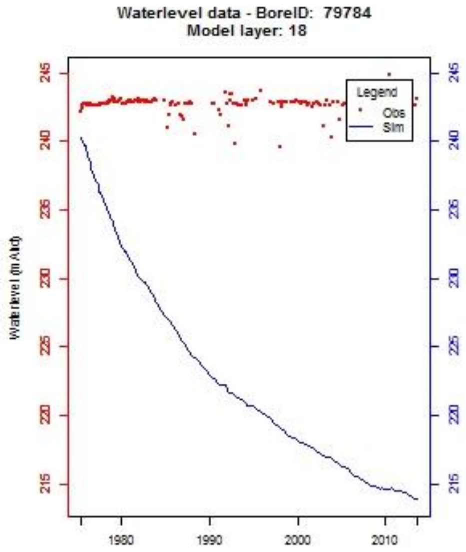

Waterlevel data - BoreID: 67441
Model layer: 18
Waterlevel data - BoreID: 75401
Model layer: 18
Waterlevel data - BoreID: 75403
Model layer: 18
Waterlevel data - BoreID: 75404
Model layer: 18
Waterlevel data - BoreID: 75563
Model layer: 18
Waterlevel data - BoreID: 75565
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

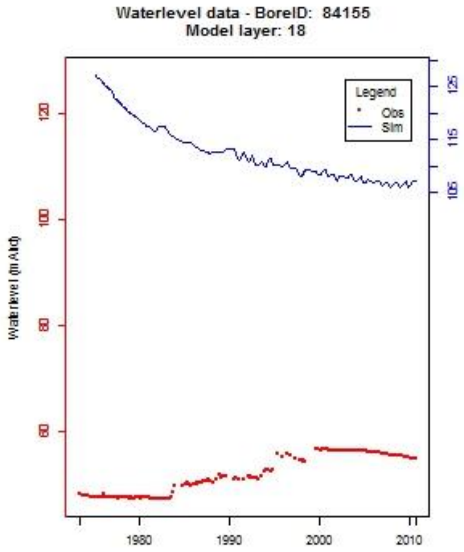

Waterlevel data - BoreID: 75566
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

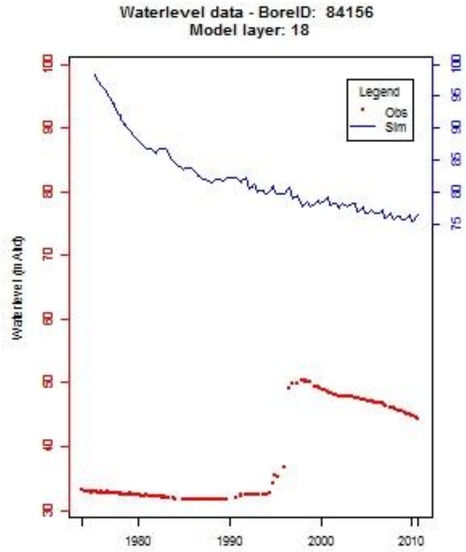

Waterlevel data - BoreID: 76079
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

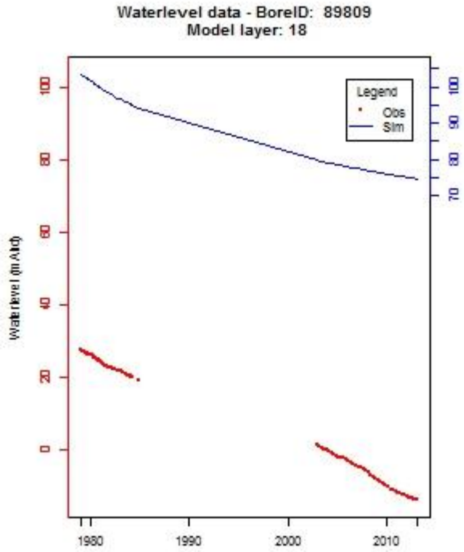

Waterlevel data - BoreID: 77945
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

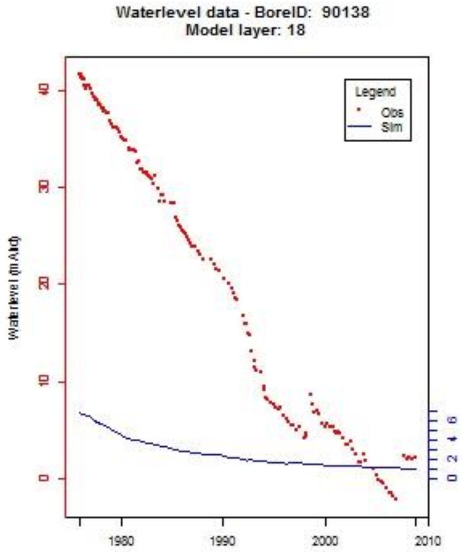

Waterlevel data - BoreID: 79775
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

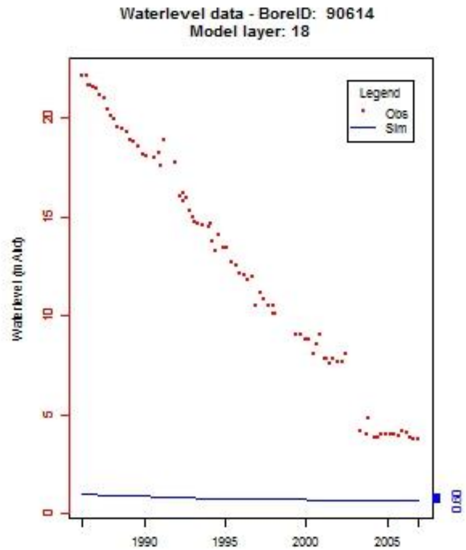

Waterlevel data - BoreID: 79784
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

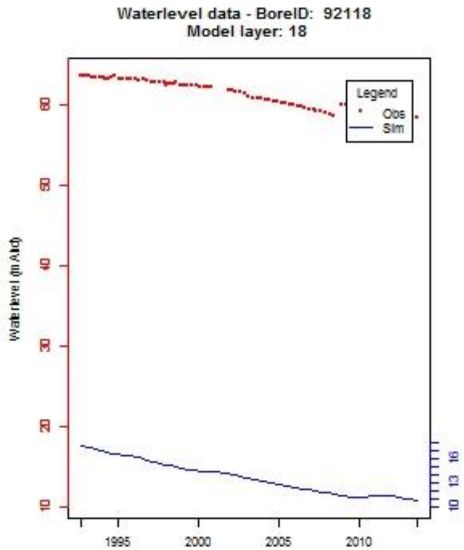

Waterlevel data - BoreID: 84155
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

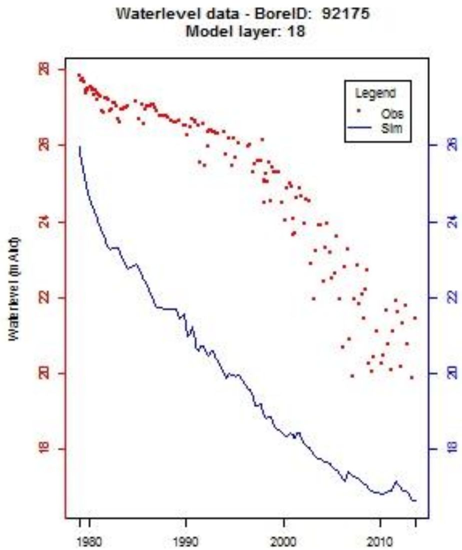

Waterlevel data - BoreID: 84156
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

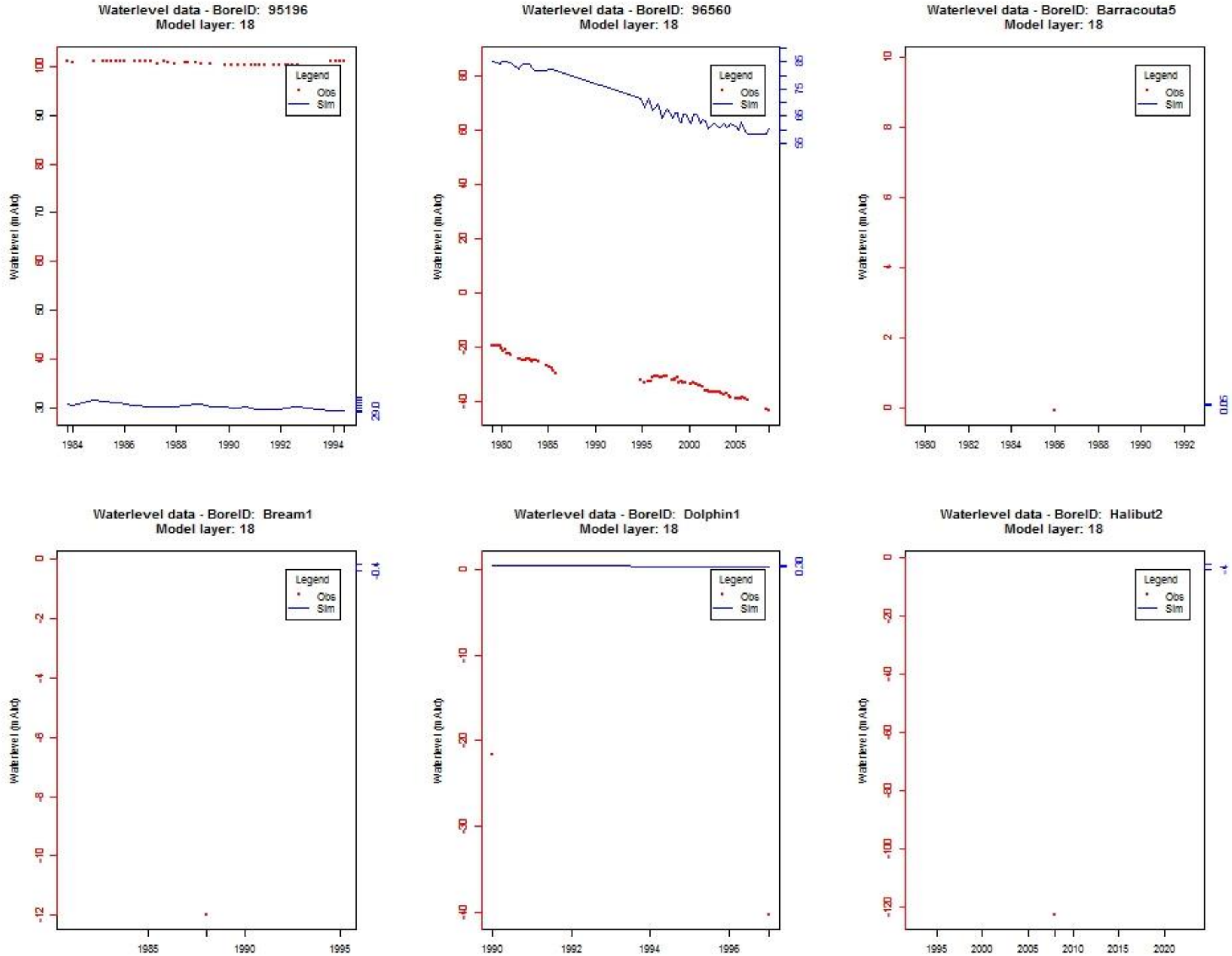

Waterlevel data - BoreID: 89809
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

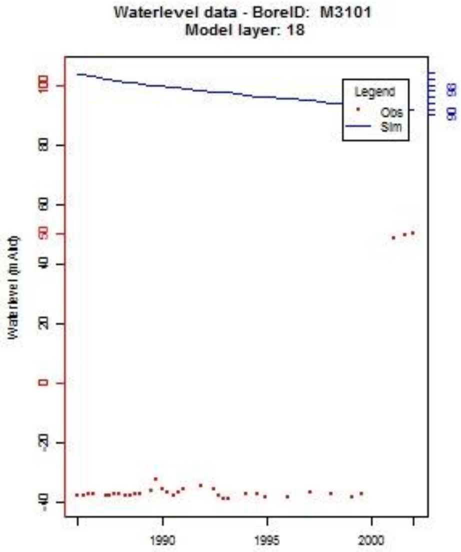

Waterlevel data - BoreID: 90138
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

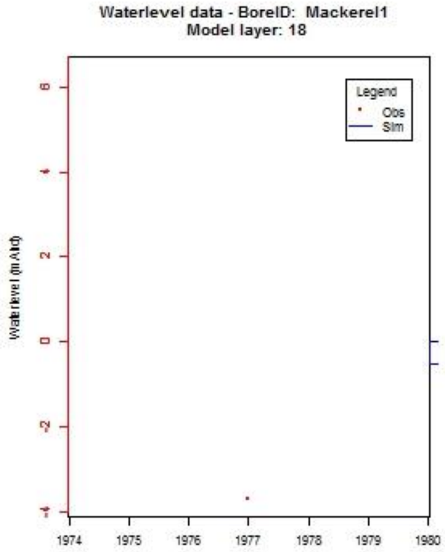

Waterlevel data - BoreID: 90614
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

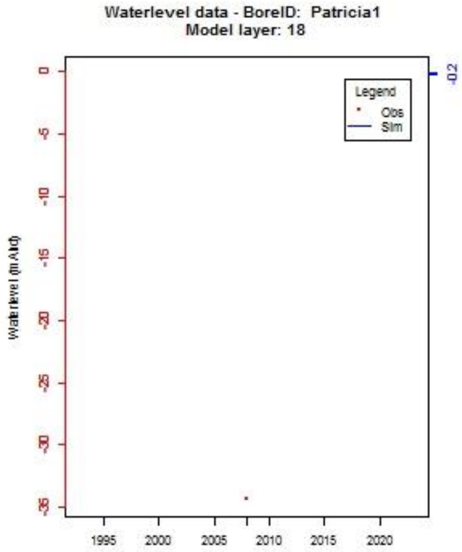

Waterlevel data - BoreID: 92118
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

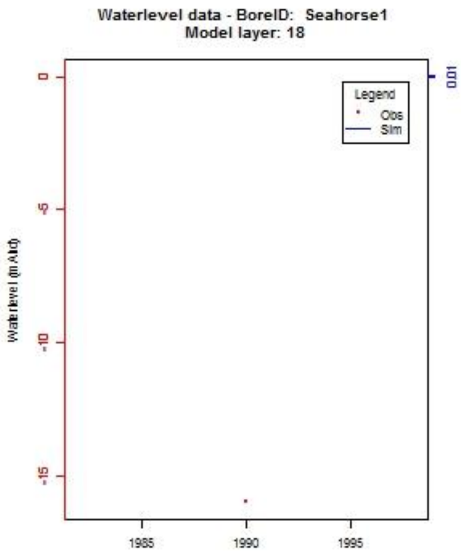

Waterlevel data - BoreID: 92175
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

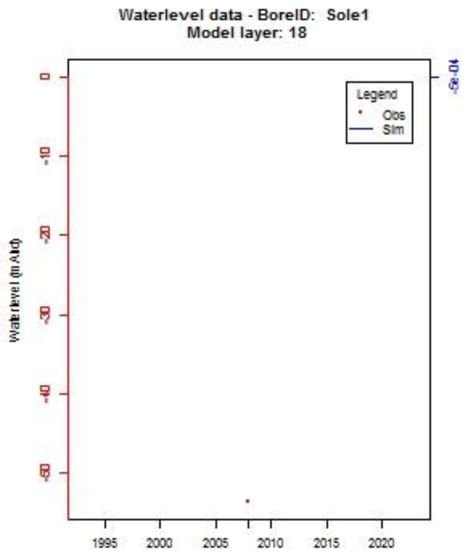

Waterlevel data - BoreID: 95196
Model layer: 18
Waterlevel data - BoreID: 96560
Model layer: 18
Waterlevel data - BoreID: Barracouta5
Model layer: 18
Waterlevel data - BoreID: Bream1
Model layer: 18
Waterlevel data - BoreID: Dolphin1
Model layer: 18
Waterlevel data - BoreID: Halibut2
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

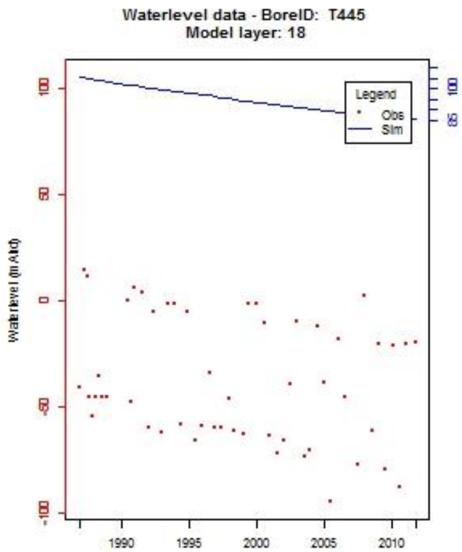

Waterlevel data - BoreID: M3101
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

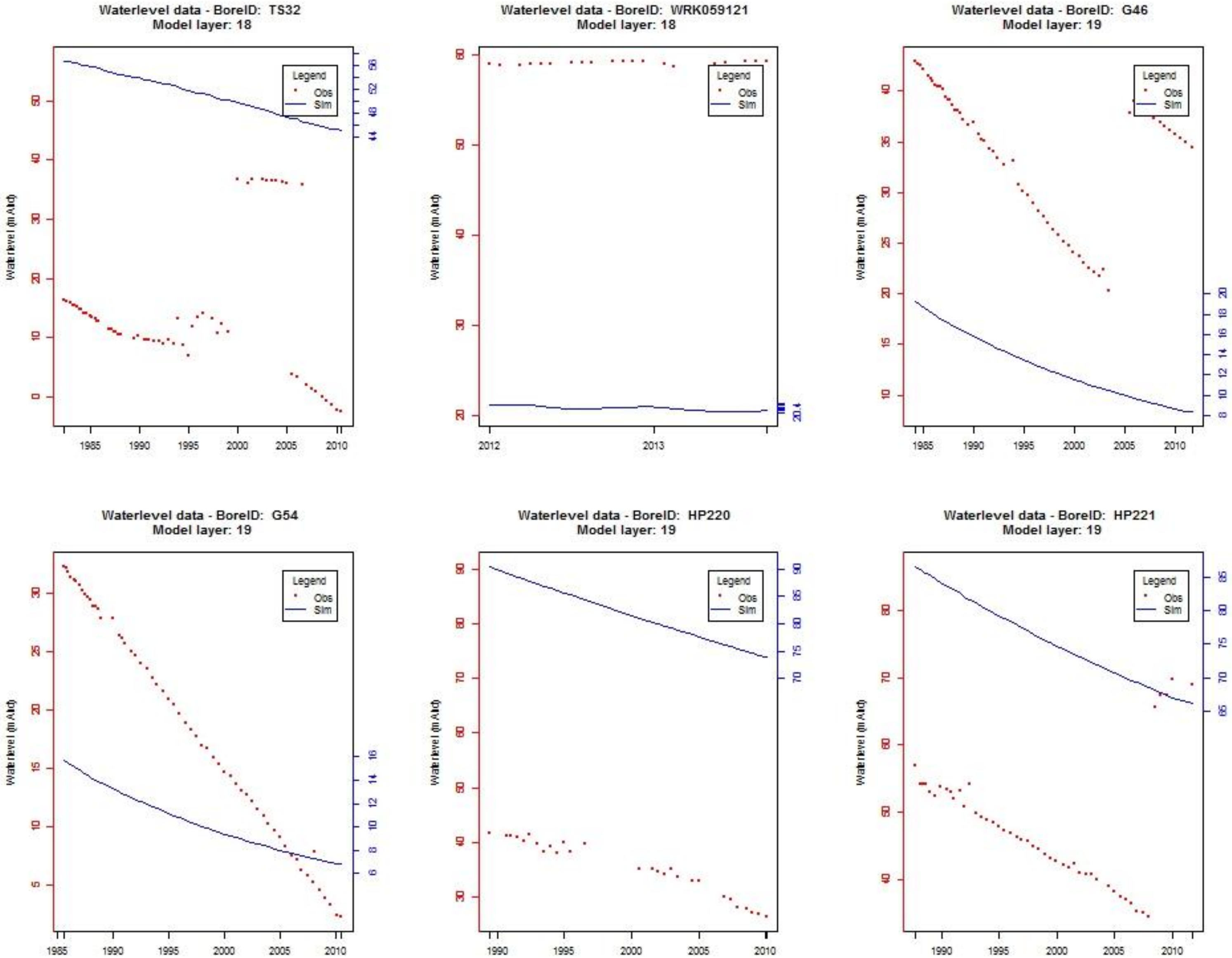

Waterlevel data - BoreID: Mackerel1
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

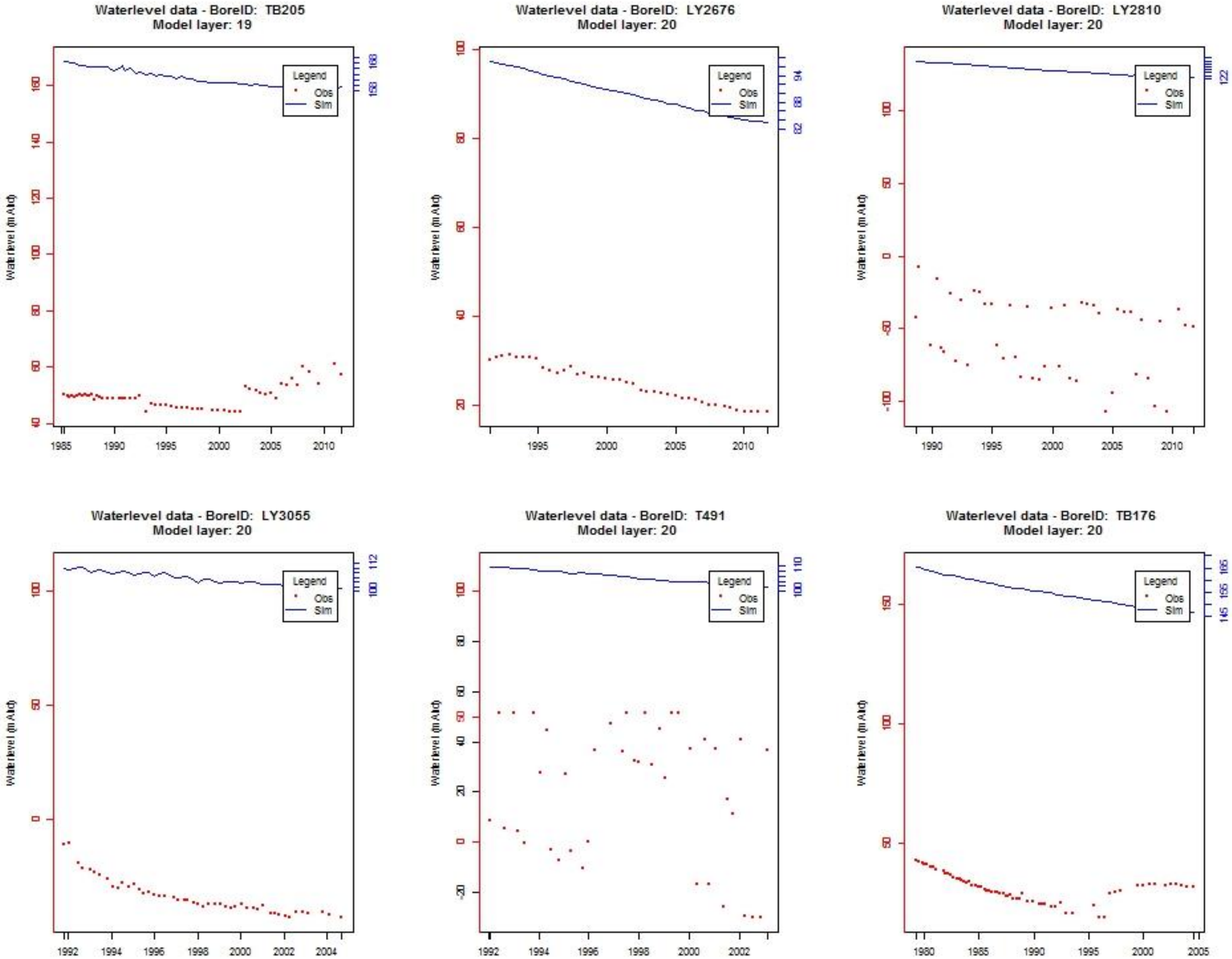

Waterlevel data - BoreID: Patricia1
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

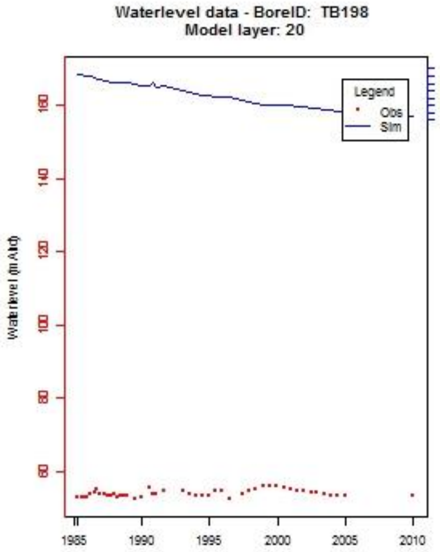

Waterlevel data - BoreID: Seahorse1
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

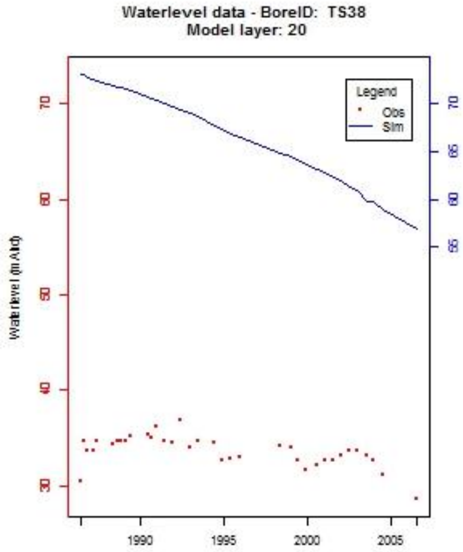

Waterlevel data - BoreID: Sole1
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

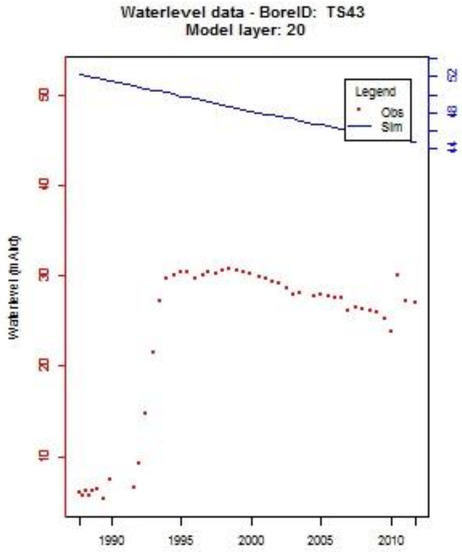

Waterlevel data - BoreID: T445
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)

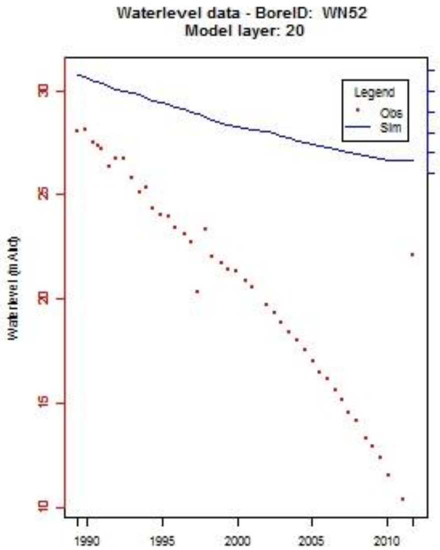

Waterlevel data - BoreID: TS32
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: WRK059121
Model layer: 18
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: G46
Model layer: 19
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: G54
Model layer: 19
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: HP220
Model layer: 19
Legend
Obs
Sim
Waterlevel (m Ahd)
Waterlevel data - BoreID: HP221
Model layer: 19
Legend
Obs
Sim
Waterlevel (m Ahd)

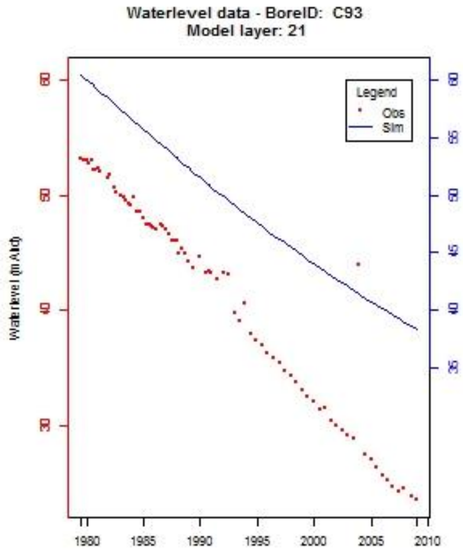

Waterlevel data - BoreID: TB205
Model layer: 19
Waterlevel data - BoreID: LY2676
Model layer: 20
Waterlevel data - BoreID: LY2810
Model layer: 20
Waterlevel data - BoreID: LY3055
Model layer: 20
Waterlevel data - BoreID: T491
Model layer: 20
Waterlevel data - BoreID: TB176
Model layer: 20
Legend
Obs
Sim

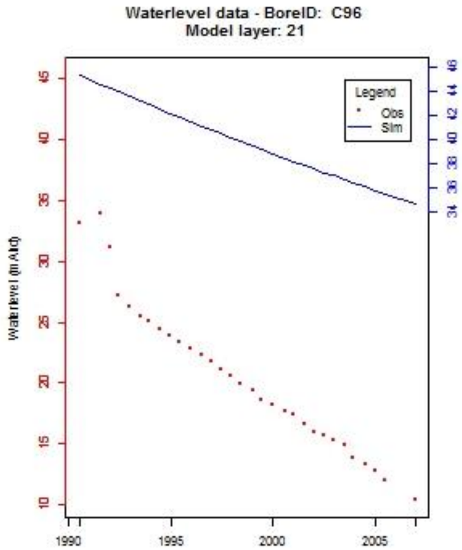

Waterlevel data - BoreID: TB198
Model layer: 20
Legend
Obs
Sim
Waterlevel (m Ahd)

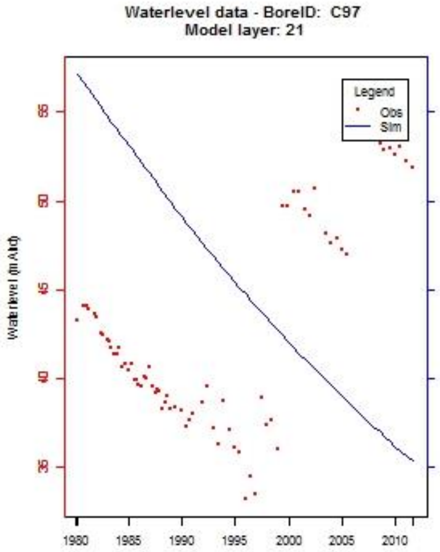

Waterlevel data - BoreID: TS38
Model layer: 20
Legend
Obs
Sim
Waterlevel (m Ahd)

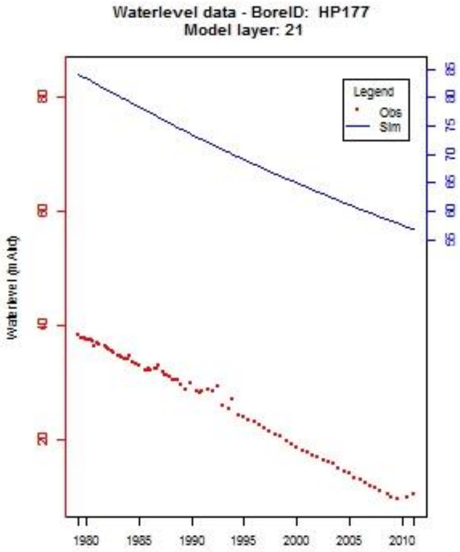

Waterlevel data - BoreID: TS43
Model layer: 20
Legend
Obs
Sim
Waterlevel (m Ahd)

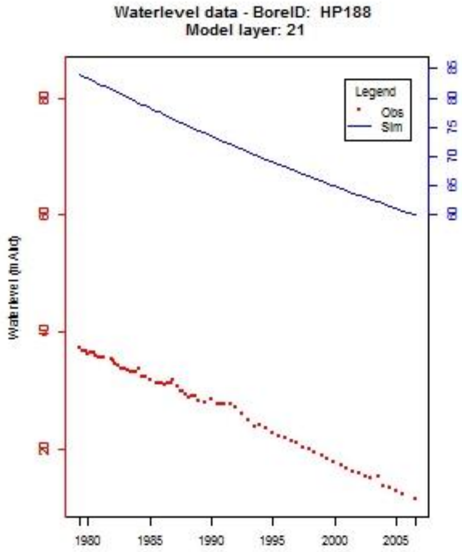

Waterlevel data - BoreID: WN52
Model layer: 20
Legend
Obs
Sim
Waterlevel (m Ahd)

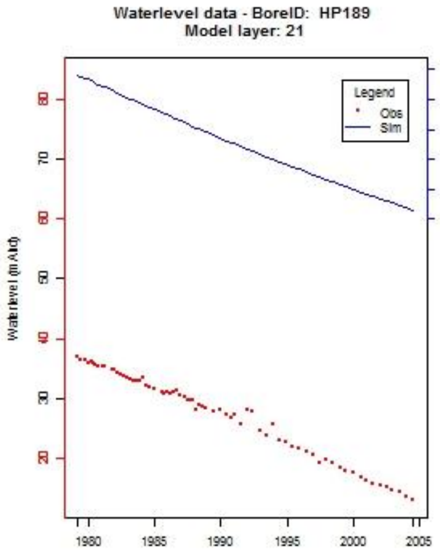

Waterlevel data - BoreID: C93
Model layer: 21
Legend
Obs
Sim
Waterlevel (m Ahd)

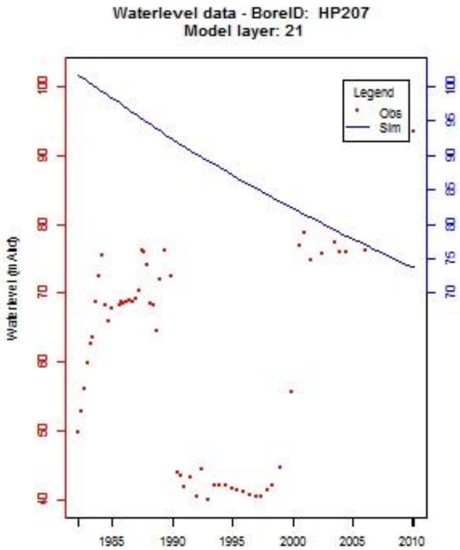

Waterlevel data - BoreID: C96
Model layer: 21
Legend
Obs
Sim
Waterlevel (m Ahd)

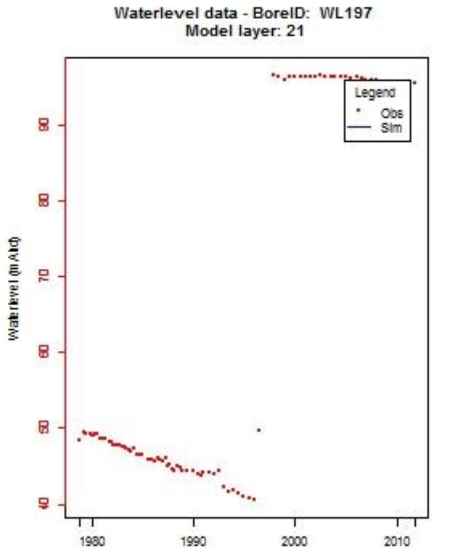

Waterlevel data - BoreID: C97
Model layer: 21
Legend
Obs
Sim
Waterlevel (m Ahd)

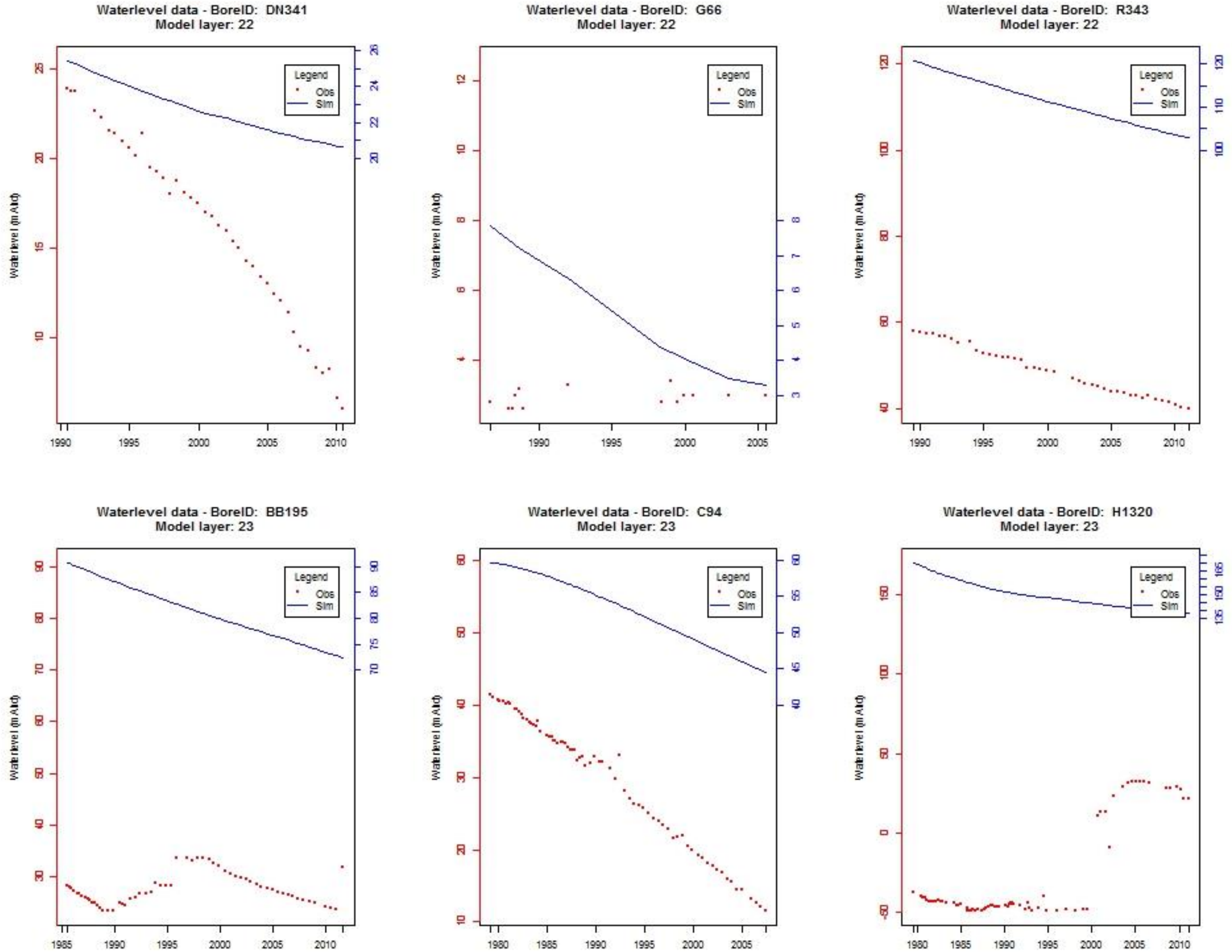

Waterlevel data - BoreID: HP177
Model layer: 21
Legend
Obs
Sim
Waterlevel (m Ahd)

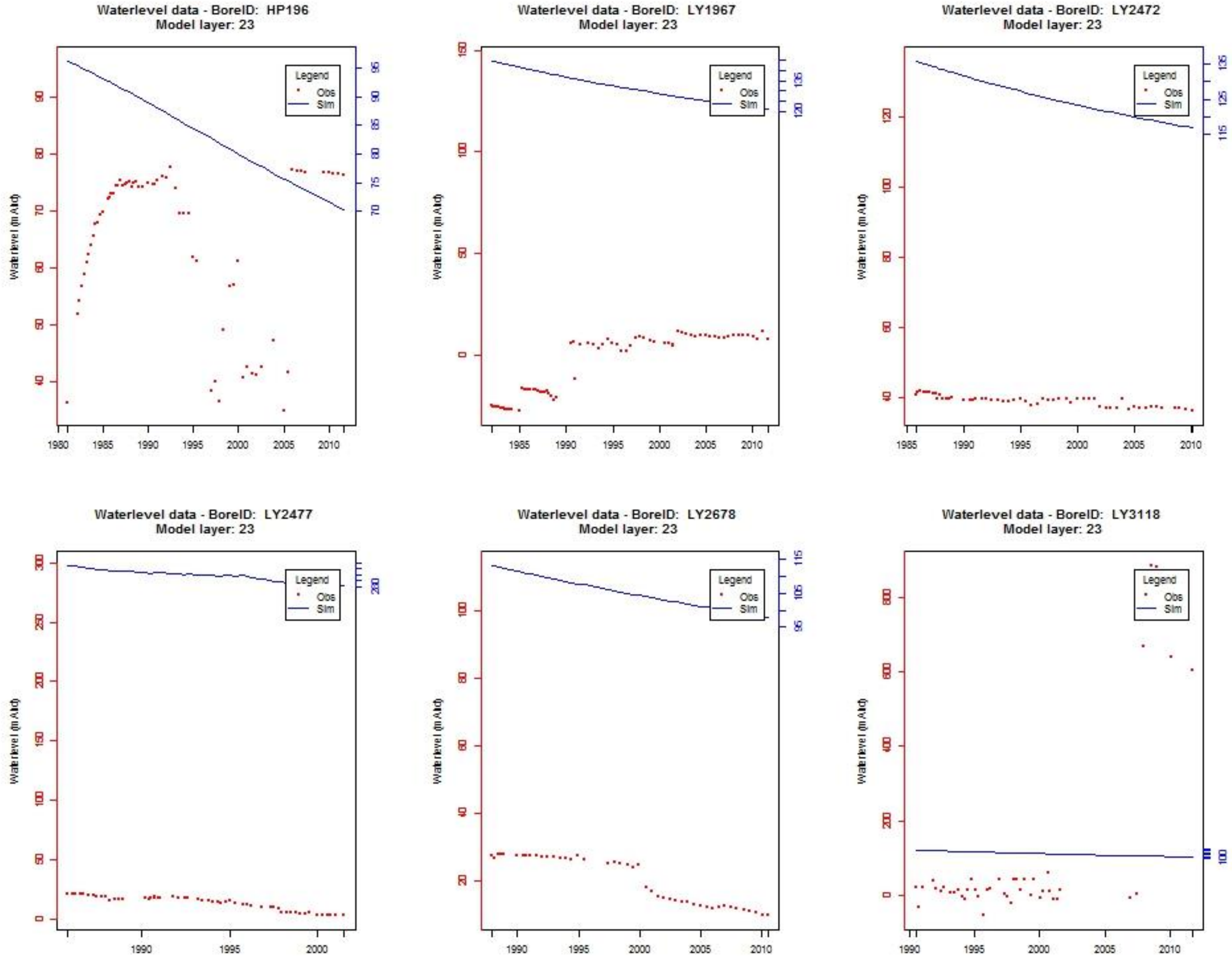

Waterlevel data - BoreID: HP188
Model layer: 21
Legend
Obs
Sim
Waterlevel (m Ahd)

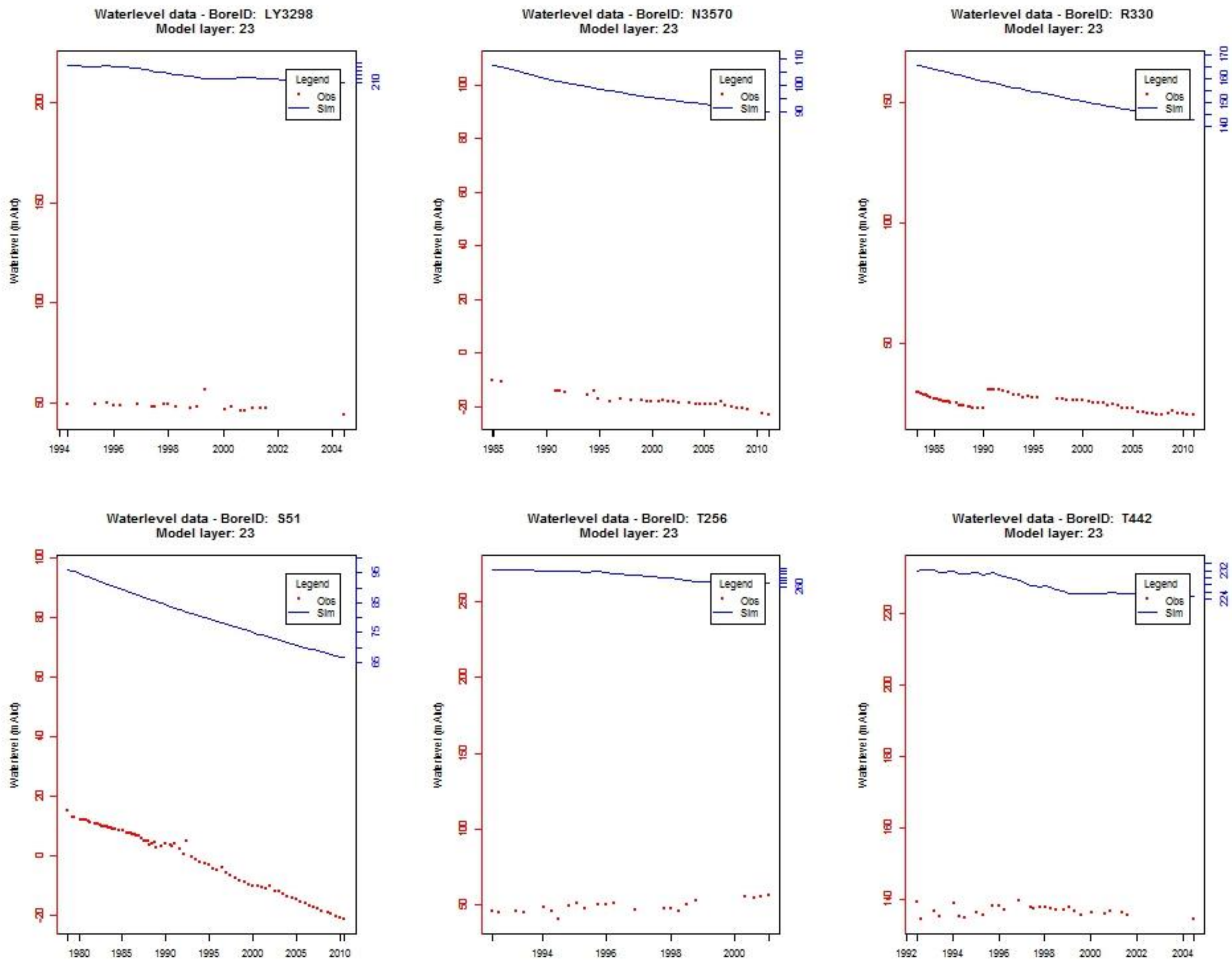

Waterlevel data - BoreID: HP189
Model layer: 21
Legend
Obs
Sim
Waterlevel (m Ahd)

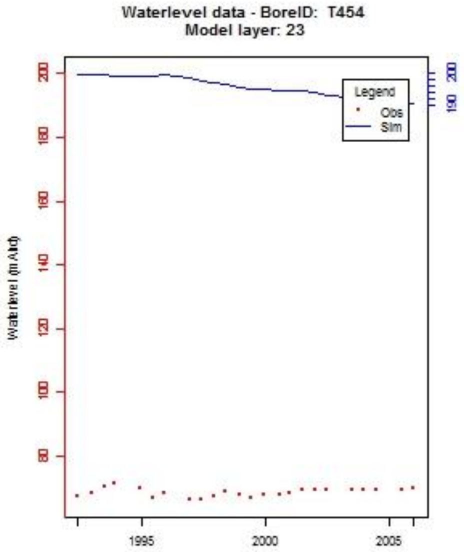

Waterlevel data - BoreID: HP207
Model layer: 21
Legend
Obs
Sim
Waterlevel (m Ahd)

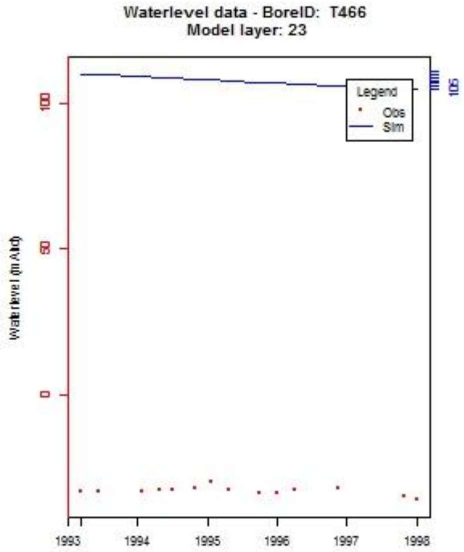

Waterlevel data - BoreID: WL197
Model layer: 21
Legend
Obs
Sim
Waterlevel (m Ahd)

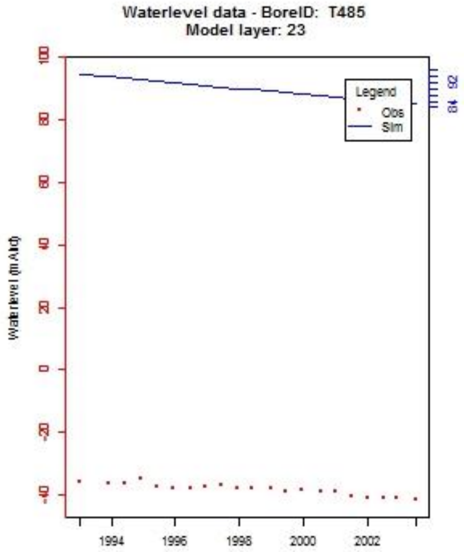

Waterlevel data - BoreID: DN341
Model layer: 22
Waterlevel data - BoreID: G66
Model layer: 22
Waterlevel data - BoreID: R343
Model layer: 22
Waterlevel data - BoreID: BB195
Model layer: 23
Waterlevel data - BoreID: C94
Model layer: 23
Waterlevel data - BoreID: H1320
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)

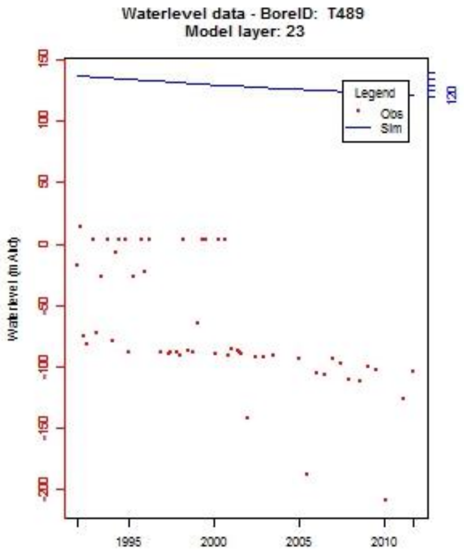

Waterlevel data - BoreID: HP196
Model layer: 23
Waterlevel data - BoreID: LY1967
Model layer: 23
Waterlevel data - BoreID: LY2472
Model layer: 23
Waterlevel data - BoreID: LY2477
Model layer: 23
Waterlevel data - BoreID: LY2678
Model layer: 23
Waterlevel data - BoreID: LY3118
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)

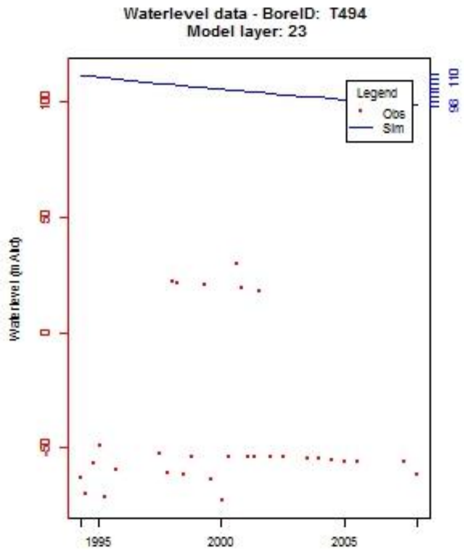

Waterlevel data - BoreID: LY3298
Model layer: 23
Waterlevel data - BoreID: N3570
Model layer: 23
Waterlevel data - BoreID: R330
Model layer: 23
Waterlevel data - BoreID: S51
Model layer: 23
Waterlevel data - BoreID: T256
Model layer: 23
Waterlevel data - BoreID: T442
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)

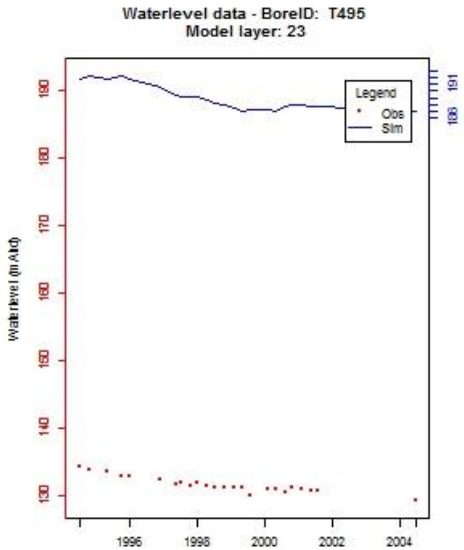

Waterlevel data - BoreID: T454
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005

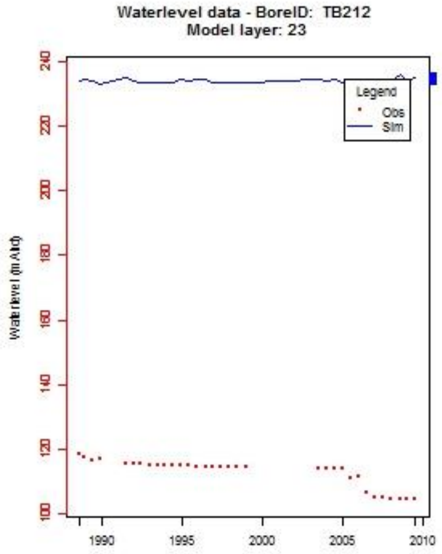

Waterlevel data - BoreID: T466
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)
1993
1994
1995
1996
1997
1998

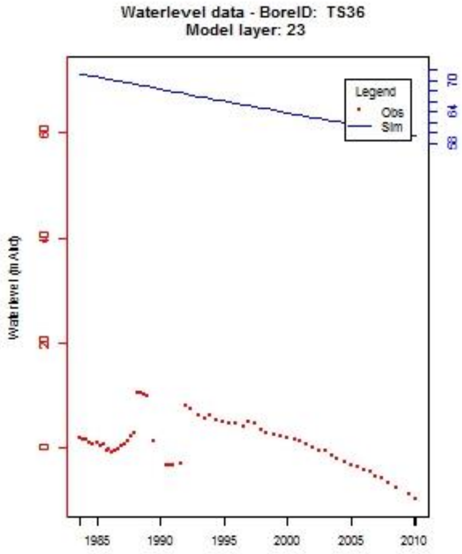

Waterlevel data - BoreID: T485
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)
1994
1996
1998
2000
2002

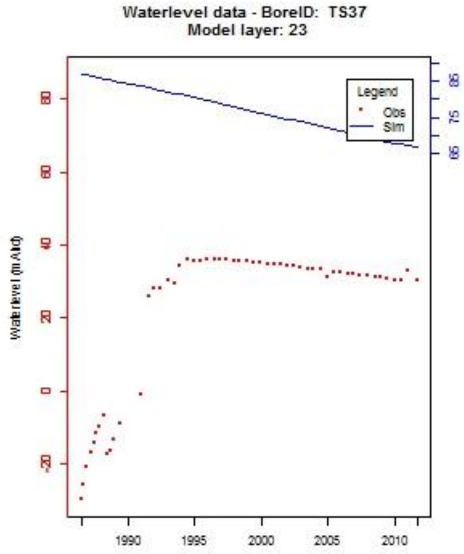

Waterlevel data - BoreID: T489
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005
2010

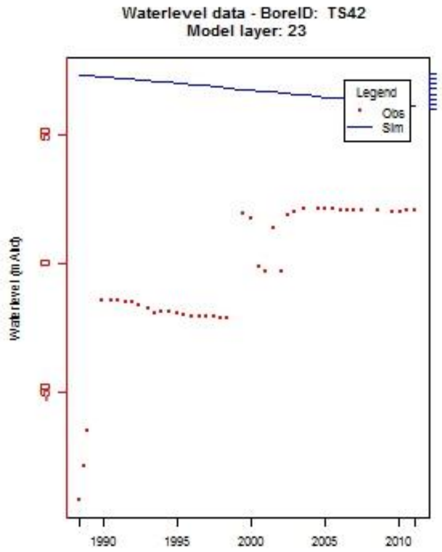

Waterlevel data - BoreID: T494
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)
1995
2000
2005

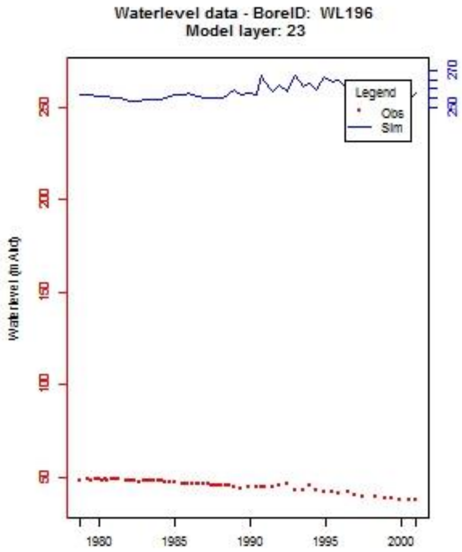

Waterlevel data - BoreID: T495
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)
1996
1998
2000
2002
2004

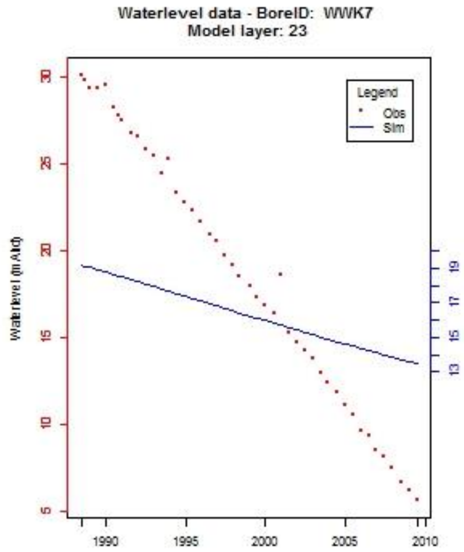

Waterlevel data - BoreID: TB212
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)

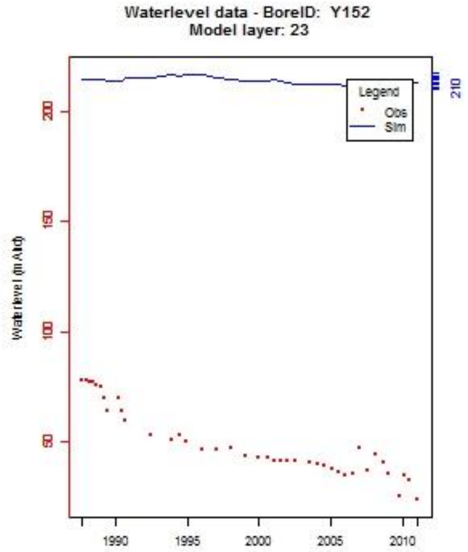

Waterlevel data - BoreID: TS36
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)

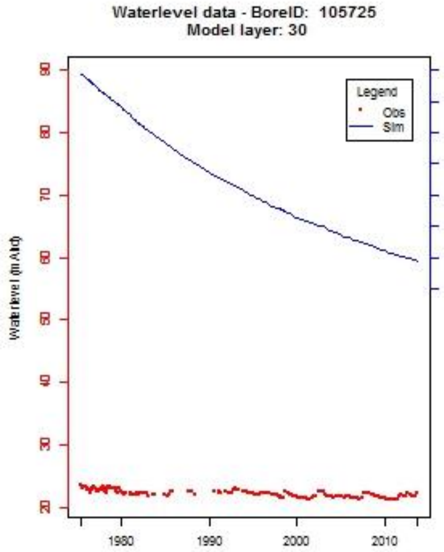

Waterlevel data - BoreID: TS37
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)

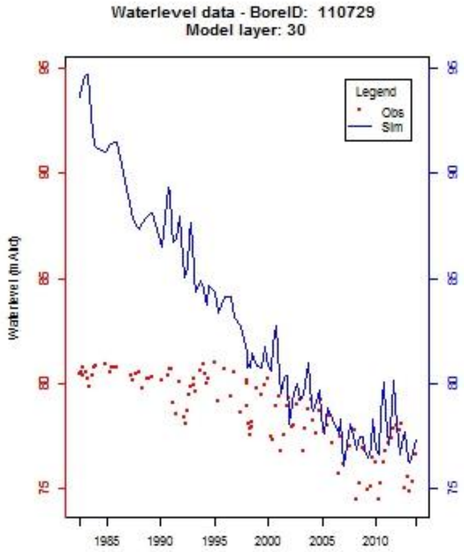

Waterlevel data - BoreID: TS42
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)

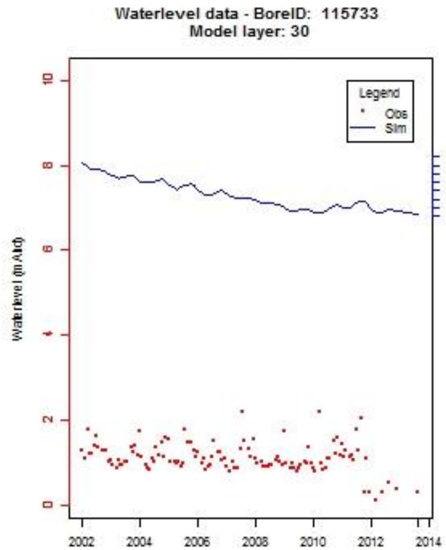

Waterlevel data - BoreID: WL196
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)

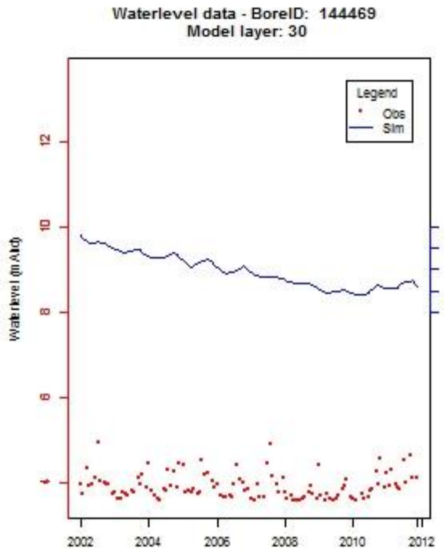

Waterlevel data - BoreID: WWK7
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)

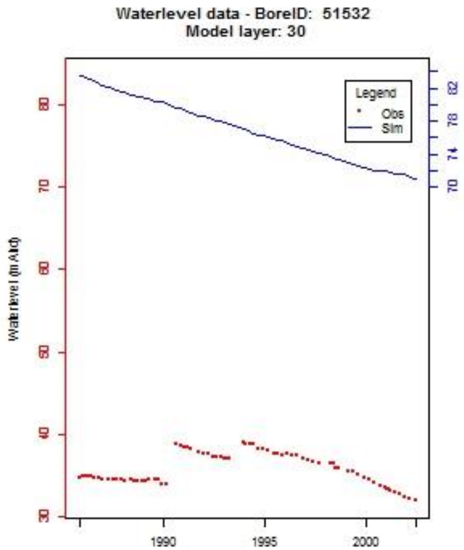

Waterlevel data - BoreID: Y152
Model layer: 23
Legend
Obs
Sim
Waterlevel (m Ahd)
1990
1995
2000
2005
2010

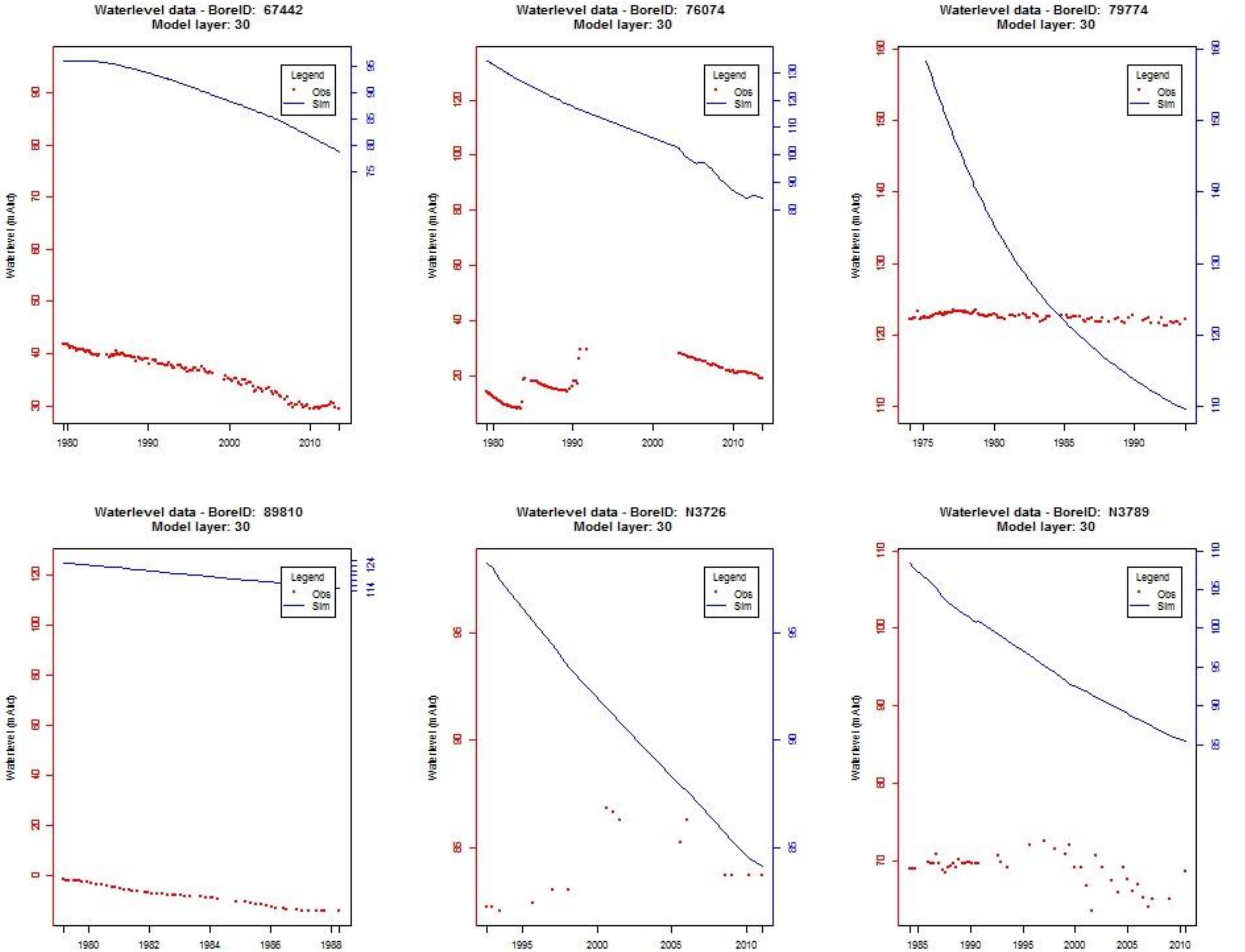

Waterlevel data - BoreID: 105725
Model layer: 30
Legend
Obs
Sim
Waterlevel (m Ahd)
1980
1990
2000
2010

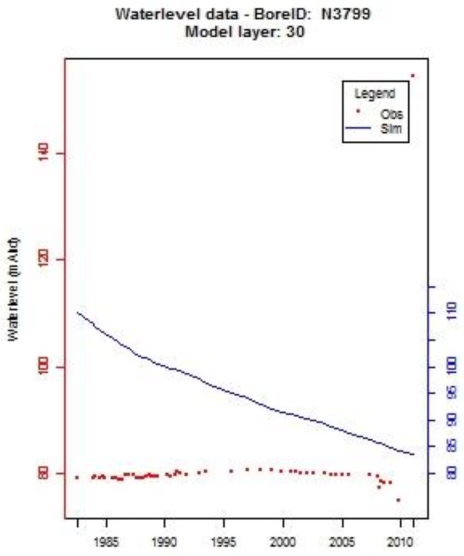

Waterlevel data - BoreID: 110729
Model layer: 30
Legend
Obs
Sim
Waterlevel (m Ahd)
1985
1990
1995
2000
2005
2010

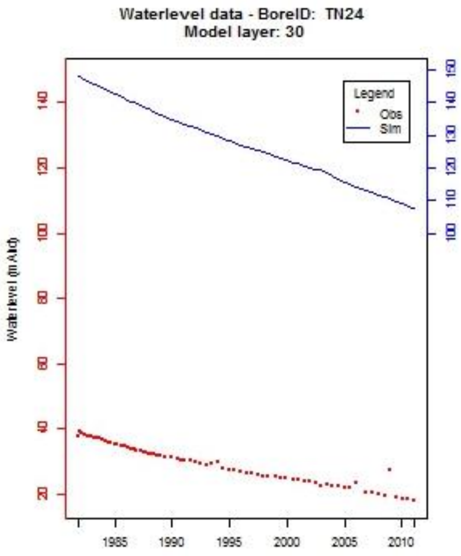

Waterlevel data - BoreID: 115733
Model layer: 30
Legend
Obs
Sim
Waterlevel (m Ahd)
2002
2004
2006
2008
2010
2012
2014

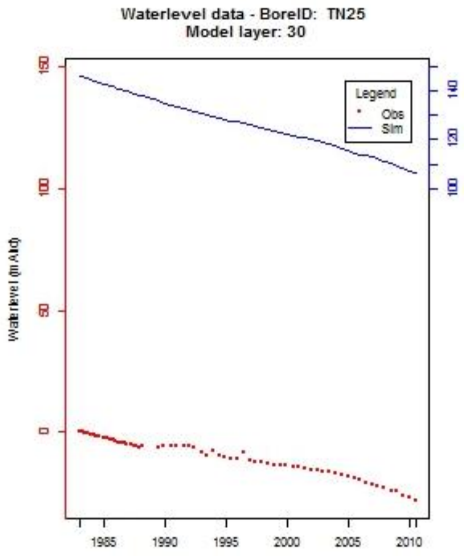

Waterlevel data - BoreID: 144469
Model layer: 30
Legend
Obs
Sim
Waterlevel (m Ahd)
2002
2004
2006
2008
2010
2012

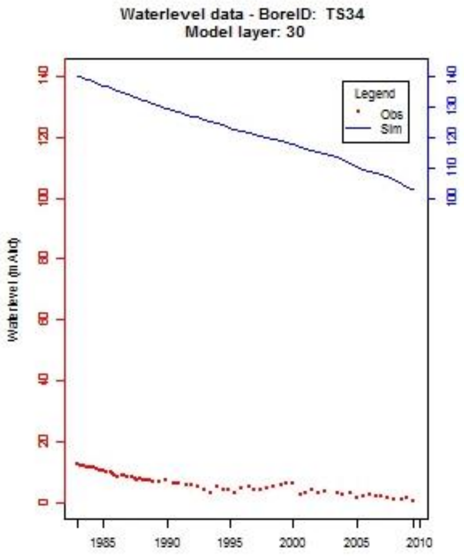

Waterlevel data - BoreID: 51532
Model layer: 30
Legend
Obs
Sim
Waterlevel (m Ahd)
1990
1995
2000


Waterlevel data - BoreID: 67442
Model layer: 30
Waterlevel data - BoreID: 76074
Model layer: 30
Waterlevel data - BoreID: 79774
Model layer: 30
Waterlevel data - BoreID: 89810
Model layer: 30
Waterlevel data - BoreID: N3726
Model layer: 30
Waterlevel data - BoreID: N3789
Model layer: 30
Legend
Obs
Sim
Waterlevel (m Ahd)


Waterlevel data - BoreID: N3799
Model layer: 30
Legend
Obs
Sim
Waterlevel (m Ahd)


Waterlevel data - BoreID: TN24
Model layer: 30
Legend
Obs
Sim
Waterlevel (m Ahd)


Waterlevel data - BoreID: TN25
Model layer: 30
Legend
Obs
Sim
Waterlevel (m Ahd)


Waterlevel data - BoreID: TS34
Model layer: 30
Legend
Obs
Sim
Waterlevel (m Ahd)

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Accessibility

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