Department of Sustainability and Environment

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Port Phillip CMA Groundwater Model

Transient model development report

A Victorian Government initiative

Victoria The Place To Be

Produced by GHD on behalf of the Victorian Government Department of Sustainability and Environment Melbourne May, 2010.

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Department of Sustainability and Environment

Report for Port Phillip CMA

Groundwater Flow Modelling Report

May 2010

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1. Introduction

This report has been prepared by GHD Pty Ltd (GHD) on the behalf of the Department of Sustainability and Environment Victoria (DSE) and describes conceptualisation, attribution and calibration of a three dimensional groundwater flow model of the entire Port Phillip Catchment Management Area (CMA) (see Figure 1).

1.1 ecoMarkets Project Background

The Port Phillip study represents part of a state-wide 18 month program aimed at producing groundwater models for each CMA in Victoria and follows completion of a pilot groundwater modelling study of the Corangamite CMA. The resulting models will predominantly be used, in conjunction with a recharge model of each CMA developed separately by the DSE, to assess the impacts of land use change on depth to water table. This information will be used as part of the DSE 'ecoMarkets' initiative, a new system of market based approaches designed to reward landholders for environmental improvements on their properties. One of the approaches under the 'ecoMarkets' umbrella is known as 'ecoTender'. This scheme is currently being demonstrated in the Corangamite CMA where the groundwater model developed by Hocking et al Pty Ltd and the DSE will be one of the tools used to compare the relative merits of different bids aimed at improving native vegetation management and revegetation in selected parts of the CMA.

1.1.1 EnSym

EnSym (Environmental Systems Modelling Platform) is a computer program designed by the Victorian Government to provide:

- simple and intuitive access to complex science that helps prioritise natural resource investment
- an understanding of the environmental benefits delivered by actions undertaken in the landscape; and
- a framework for scientists and researchers to test and apply empirical and process based scientific models.

Ensym employs scientific models to improve understanding about the impacts that actions such as revegetation, weed control and riparian management, have on the landscape. Users can visualise, test and interpret results of changes in climate, land use and land management practices through a single interface. Models are grouped into 5 toolboxes that relate to different sections of the landscape and analytical capabilities. The toolbox that simulates surface water dynamics and thus provides the recharge values is known as Biosym.

1.1.2 Biosym

Biosym (biophysical systems toolbox) is the name given the biophysical modelling toolbox within the Ensym model. BioSym originated from the Catchment Analysis Tool, also known as CAT1D (Beverley, 2007) which was jointly developed by DSE and DPI. From December 2008 onward, DSE and DPI

followed different paths in further developments and modifications of the CAT1D module, thus to distinguish and to reflect the divergence of the simulation codes, BioSym was the name adopted as the computer program for biophysical modelling within the Ensym model.

BioSym solves for physical processes conceptually by using simplied analytical solutions and empirical equations. The code for BioSym was written with the objective of simulating all major hydrologic components as simply and realistically as possible, and to use inputs readily available over large spatial scales to enhance the likelihood that the model would become routinely used in planning and water resource decision making.

The model components of BioSym can be placed into eight major categories - hydrology, weather, sedimentation, soil temperature, crop growth, nutrients, agricultural management, and pesticides.

Water entering the soil profile is initially determined by subtracting the calculated surface runoff from the total daily precipitation and irrigation. Once in the soil profile, water can be removed by evapotranspiration, lateral flow, downward movement if soil capacity is exceeded. Water fills up lower soil layers until it exits the soil profile and becomes drainage. Drainage is then partioned into sub surface lateral flow and recharge.

The Biosym modelling approach, results in several limitations in regards to recharge calculations, the most major of which are:

- no recharge time lags are taken account of, thus it is assumed that water partitioned for recharge instantly hits the water table. This limitation is of most concern in areas of deeper water tables and of little concern in shallow water table areas.
- surface runoff does not cascade from upstream modelling cells to downstream modelling cells, thus no pooling can be modelled or accumulation of water in low lying areas. This may result in the underestimation of recharge is low lying areas.
- similarly floods are not modelled thus recharge events caused by flood waters will be missed. Obviously recharge still tends to peak during flood events as a result of high rainfall however recharge will be underestimated in areas where flood waters contribute to recharge.
- all biophysical processes are simulated on a daily timestep thus processes that occur on a smaller timestep may be poorly accounted for, such as short high intensity storm events.
- any influence that underlying geology has on impeding or aiding recharge is not taken into account, for example in some areas of upland Victoria the deeper regolith is suspected to throttle recharge depending on it’s water content.
- the soil mapping used is the best currently available across the state however it is primarily a landsystem map thus large variations in soil types can exist within each of the Biosym soil units.
- Biosym assumes no temporal changes in landuse, thus for example, recharge changes from afforestation are not modelled during the groundwater model time period.
- Biosym doesn’t take into account areas where the soil profile is saturated due to groundwater discharge.

It is important that these recharge modelling limitations are taken into account when assessing the overall limitations of a groundwater model using Biosym recharge values.

For further detail on the Biosym toolbox please refer to the CAT1D technical manual (Beverley, 2007) and to the Programmer's Guide for BioSym (Ha, in preparation)

1.2 Model Objectives and Context

It should be stressed that the groundwater model described in this report has been developed with the overall aim of the project in mind i.e. to provide a tool for assessing the impacts of land use change on depth to water table. Whilst it is intended that the groundwater models produced could also be used in the future by other stakeholders such as Southern Rural Water for water resource assessment it is recognised that the complexity of the model may not be sufficient to provide accurate predictions for all possible uses. The suitability of the model for any particular use will therefore need to be assessed on a case by case basis as potential future uses and projects are identified.

A staged approach was adopted for the modelling work. The first phase involved conceptualisation of the multi-layered aquifer system present within the Port Phillip CMA followed by development and calibration of a steady state multi-layered groundwater model based on the conceptualisation. At completion of Phase 1, the multi-layered conceptualisation and associated steady-state groundwater model was independently reviewed and approved for further development during Phase 2 of the project. The second phase of the work involved the refinement and expansion of Phase 1 outputs. Specifically, this phase built upon the conceptualisation and data sets developed/collated in Phase 1 and lead to the construction and calibration of a multi-layer transient groundwater model of the Port Phillip CMA. Minimum specifications for the modelling work are summarised below in Section 1.3.

1.3 Model Specifications

Specifications for this modelling exercise as stipulated in the contract for the work are;

- Finite difference gridding at a maximum 200 metre cell size,
- Multi-layer groundwater model (representing major geological units) consistent with existing models;
- Common boundary conditions and consistent aquifer parameters with adjacent models (as arising from the state-side groundwater modelling workshop outlined below in Section 1.4)
- A normalised (scaled) RMS of less than 5 per cent for the Phase 1 steady state model based on matching mapped depth to water table;
- A normalised (scaled) RMS of less than 10 per cent for the transient model based on matching mapped depth to water table, sub-catchment baseflow and groundwater hydrograph responses for selected and agreed groundwater monitoring bores;
- A calibration period of no less than 10 years
- A sensitivity analysis to assess the variability of modelled outputs to variations in key model input parameters;

- Catchment groundwater balance errors of less than 2 per cent;
- All catchment water balance features to be considered and reported;
- The source and statement of quality of all input data sets to be reported;
- At least 500 groundwater monitoring observation bores used for calibration (if > 500 present);
- Model domain represents the entire extent of the catchment management area; and
- The steady-state and transient groundwater recharge layers developed and provided by the DSE are to be incorporated unaltered into each model unless demonstrated to be erroneous.

In order to be relevant to state-wide aspirations for the project and ensure that the resulting groundwater model is consistent with models of the other CMAs as a minimum the following geological units must be represented in the Port Phillip CMA:

- Quaternary and Volcanics (i.e. Post Tertiary age strata);
- Pliocene (i.e. Upper Tertiary age strata);
- Early Tertiary age strata
- Pre-Cainozoic (i.e. Pre-Tertiary age basement strata)

All modelling work is to be carried out and reported in accordance with the Murray Darling Basin groundwater modelling guidelines described by Middlemis, Merrick and Ross (2000), which has become a surrogate Australian standard for groundwater flow modelling including review and appraisal.

1.4 External Reviews and Workshops

Independent external review of the key project outputs forms an integral part of the project. External review is to be achieved via a series of 5 workshops, held at key stages during the project, combined with regular informal communication and review by the appointed reviewers. The following review and workshops were carried out:

- Informal review workshop. To be carried out following collation of all relevant data sets and development of preliminary aquifer conceptualisation;
- State-wide groundwater modelling workshop. To be carried out following preliminary conceptualisation of each model area to ensure consistency between model areas;
- Formal Phase 1 model review workshop. Formal presentation of final aquifer conceptualisation and a calibrated multi-layer, steady state groundwater model for review;
- Final model workshop. Formal presentation of a calibrated multi-layer transient groundwater model and report for review; and
- Final audit workshop. Formal audit of the final groundwater model including handover and review of the model input and output data files.

Hugh Middlemis and John Leonard were appointed as the external reviewers for the Port Phillip CMA.

2. Conceptualisation

2.1 Study Area

The Port Phillip Catchment Management Area (PP CMA) covers an area of around 12,800 km^2, and is bordered to the west by the Corangamite CMA, to the north-west by the North Central CMA, to the north-east by the Goulburn CMA and to the east by the West Gippsland CMA. The CMA comprises the surface water catchments of all water courses which drain into Port Phillip and Westernport Bay and hence includes the Nepean Peninsula (but not the Bellarine Peninsula which is part of the Corangamite CMA). All islands within both the Port Phillip and Westernport Bay are also considered to fall within the CMA (see Figure 1).

The CMA extends from Ballan in the west to Droiun in the east and from Lancefield in the north to Flinders in the south.

2.2 Climate

Long-term average annual rainfall varies from less than 600 mm/yr in the area to the west of Melbourne to over 1600 mm/yr towards the north-eastern corner of the CMA (north-east of Warburton) in the headwaters of the Yarra River (see Figure 2).

Long term average rainfall data for Melbourne suggests only limited seasonal fluctuations with average monthly totals varying from 48 mm in February to 67 mm in October. Data for Warburton however show rainfall varying from 69 mm in February to 158 mm in August. This suggests that seasonal rainfall variations are more significant in the wetter upland areas around the margins of the CMA than in the drier low lying coastal areas.

Average annual potential evaporation (PE) is presented in Figure 3. PE varies from 800-1100mm/year in the topographically elevated areas in the northwest and east of the CMA, and from 1100-1300mm/year in the low-lying relatively flat central and south western areas.

2.3 Topography

Topographically the area is characterised by high upland areas which form the northern boundary of the CMA falling gradually towards the Port Phillip and Westernport Bay areas. Maximum elevations of around 1500 mAHD occur towards the north-eastern corner of the CMA (north-east of Warburton) in the headwaters of the Yarra River (see Figure 4). Extensive areas of low lying land are present around Port Phillip and Westernport Bay and in the area north east of Koo-Wee-Rup.

Bathymetric data for Port Phillip Bay suggests sea bed elevations of as low as -78 mAHD in the Bass Strait south of the Bellarine and Nepean Peninsulas.

2.4 Landuse

Current land use within Port Phillip CMA is presented in Figure 5. It primarily comprises grazing modfied pastures, which extends across the entire CMA area. Other significant land uses are:

- Urban residential, largely in the Melbourne area and fringing Port Phillip Bay, and rural residential in surrounding areas; and
- Production forestry and National Park, largely confined to the north east and north west of the CMA.

Less significant land uses comprise roads, cropping, remnant native cover, and conserved and minimal use areas.

The land use mapping indicates that the landscape is highly modified across most of the CMA.

2.5 Hydrology

The Port Phillip CMA is drained by a series of generally north-south trending water courses which carry water from wetter upland areas which form the northern boundary of the area into either the Port Phillip of Westernport Bay. Exceptions to this general north-south trending rule include the Yarra River, the largest river in the catchment which drains an area of around 4,100 km^2 (or around one third of the total area of the CMA). The Yarra flows in a predominantly east to west direction from its source in the Yarra Ranges in the north east of the CMA eventually discharging into the Port Phillip Bay south of Melbourne, a total length of around 242 km.

For water resource assessment purposes the Port Phillip CMA has been spilt into four separate drainage basins as summarised in Table 1 below. Only part of the Moorabool River and South Gippsland basins are within the CMA.

Table 1 Port Phillip CMA Water Resource Basins [1]

Basin	Catchment Area (km^2)	Natural Flow Yield (mm/yr)	Natural Flow Yield Range (mm/yr)
Moorabool River (Part – Little River[2])	555	12	12
Werribee River	1991	74	48-96
Maribynong River	1434	87	96-144
Yarra River	4142	290	360-492
Bunyip River	3813	93	132-228
South Gippsland (Part – Bass River[3])	236	252	252

Observed flows in each of the water resources basins are in many cases significantly affected by reservoir impoundments and other flow diversions. Major reservoirs in each basin are as follows:

[1] Data extracted from Australian Natural Resource Atlas Website

[2] Data for gauge 232200, Little River at Little River

[3] Data for gauge 227206, Bass River at Glen Forbes

- Little River (part of the Moorabool River Basin) – None;
- Werribee River Basin - Colbrook, Pykes Creek, Merrimu, Melton and Djerriwarrh Reservoirs;
- Maribynong River Basin - Rosslynne, McDonalds and Lancefield Reservoirs;
- Yarra River Basin - Yan Yean, Sugarloaf, Maroondah, Upper Yarra, Oshannassy, Notting Hill, Mitcham, Greenvale and Toorourrong Reservoirs;
- Bunyip River Basin - Tarago, Cardinia, Silvan, Beaconsfield, Devilbend/Bittern and Frankston Reservoirs; and
- Bass River (part of the South Gippsland Basin) - Bellview Creek, Little Bass and Candowie Reservoirs.

A list of the main rivers in the Port Phillip CMA is provided in Table 2 along with information on the approximate catchment area, long term average rainfall and streamflow predominantly calculated from data included in Leonard (1992).

Table 2 Main River Catchment Areas and Flow Yields[4]

River/Area Name	Basin	Catchment Area (km^2)	Streamflow (mm/yr)	Rainfall (mm/yr)
Little River[5]	Moorabool River	555	15	580
Werribee River	Werribee River	1557	96	636
Skeleton Creek	Werribee River	147	82	510
Kororoit Creek	Werribee River	323	111	526
Maribyrnong River	Maribyrnong River	1471	120	693
Moonee Ponds Creek	Yarra River	127	165	630
Merri Creek	Yarra River	392	143	638
Darebin Crek	Yarra River	160	138	688
Plenty River	Yarra River	375	117	720
Diamond Creek	Yarra River	323	127	839
Gardiners Creek	Yarra River	135	252	815
Yarra R Remainder	Yarra River	2474	202	1200
NE Coast	Bunyip River	228	224	746
Patterson River/Dandenong	Bunyip River	496	149	847

[4] Port Phillip River data from Leonard (1992)

[5] Stream flow and rainfall data for gauge 232200, Little River at Little River

River/Area Name	Basin	Catchment Area (km^2)	Streamflow (mm/yr)	Rainfall (mm/yr)
Creek				
Kananook Creek	Bunyip River	185	141	784
Mount Martha	Bunyip River	143	154	839
Nepean Peninsula	Bunyip River	106	113	755

Summary statistics and flow hydrographs for selected flow gauges in the CMA are included as Appendix A.

Figure 7 shows observed long term average flow yields at each of the flow gauging locations for which data have been collated for the current project. As mentioned above the spatial distribution of observed flow yields is considered to have been significantly affected by the impact of reservoirs. Of the main rivers in the CMA only the Little River does not have a reservoir in the catchment.

Data for the only flow gauge on the Little River at Little River (Gauge Ref 232200) suggests a surprisingly low flow yield of around 15 mm/yr for the upstream catchment which only represents around 3% of long term average rainfall to the catchment. This is significantly less than the yield observed in any of the other main river catchments which suggests that this gauge may be unreliable and/or that significant bypass flows are occurring.

Naturalised long term average flow yields as extracted from the Australian Natural Resources Website are shown in Figure 8 and are also summarised in Table 1. These data have been naturalised to remove the effect of reservoirs and other anthropogenic impacts and suggest a spatial distribution that is broadly consistent with the rainfall data, as would be expected. Hence a naturalised yield of 290 mm/yr has been calculated for the Yarra Basin, whilst values for the remaining basins are typically less than 100 mm (see Table 1).

2.6 Geology

Outcrop geology with the Port Phillip CMA is shown in Figure 9. A simplified version of the same information which has been created by grouping the outcropping units together based on their ages (see Table 3) is shown in Figure 10. Faults and other mapped structural features present within the area are also shown in Figure 10.

The Port Phillip CMA can be divided into two geologically distinct regions by a north west to south east trending line, which separates a basin and trough dominated southern area from the predominantly basin free northern area. The southern part of the CMA contains two major basins, the Port Phillip Basin in the west and the Western Port Basin in the east. The northern margins of both of these basins are marked by outcropping pre-Tertiary basement bedrock which form the Southern Uplands (Holdgate & Gallagher, 2003). The Selwyn and Rowsley Faults define the eastern and western margins of the Port Phillip Basin whilst the Mornington Peninsula (west) and the Heath Hill Fault (east) delineate the extent of the Western Port Basin (see Figure 10).

Pre-Tertiary age basement bedrock underlie the entire Port Phillip CMA and comprise sedimentary, metamorphic and volcanic rocks of Ordovician, Devonian, Silurian and Cretaceous ages. These bedrock strata are overlain by a sequence of non-marine sandstone, claystone and coals of the Werribee and Yaloak Formations (Port Phillip Basin) and the sand and gravel dominated Childers Formation (Western Port Basin). The Werribee, Yaloak and Childers Formations are typically intercalated with basalts of the Older Volcanics, which can be highly weathered in places.

In the Port Phillip Basin the Fyansford Formation (predominantly marine silt, clay and some limestone) overlies the Werribee and Yaloak Formations, and is interbedded with the Batesford Limestone in the south west corner of Port Phillip CMA. Except in the Sorrento Graben where the Demons Bluff is also present the Fyansford Formation is overlain by the Brighton Group (marine sandstone and terrestrial sand). In the area to the east of Melbourne the Brighton Group and Fyansford Formation are typically lithologically very similar and hence difficult to differentiate (Leonard 1979).

North and west of Melbourne the Brighton Group is typically overlain by the Newer Volcanics whilst to the south and west the Wannaeue and Bridgewater Formations predominate. Various other Quaternary age aeolian, fluvial, swamp and deltaic sediments dominate the outcrop geology along the coastline of Port Phillip Bay west of Melbourne and are particularly significant in the Yarra and Werribee Deltas and the Carrum Swamp.

In the Western Port Basin the Yallock Formation (sand and gravel), Sherwood Marl and Baxter Sandstone of the Western Port Group overlie the Older Volcanics. The Sherwood Marl and Yallock Formations are considered to be lateral equivalents of the Fyansford Formation whilst the Baxter Formation is contemporary with the Brighton Group (Holdgate & Gallagher, 2003). In the Koo-Wee-Rup area the Baxter Formation is overlain by the Heath Hill Silt and other various Quaternary age aeolian, fluvial and lacustrine sediments.

Table 3 Generalised Stratigraphy of Port Phillip CMA[6]

Period	Epoch/ Series	Formation/ Group		
		Port Phillip Basin	Werribee Delta	Western Port Basin
Quaternary	Holocene/ Pleistocene	Alluvial clays, silts, sands & gravels/ dune deposits/ swamp deposits. Includes Port Melbourne Sand, Coode Island Silt (Yarra Delta)	Alluvial gravel, sand and silt.	Alluvial clays, silts, sands & gravels/ dune deposits/ swamp deposits (peat, clay & channel deposits). Includes Cranbourne Sands (aeolian dune deposits)
Quaternary	Pleistocene/ Pliocene	Bridgewater Formation/ aeolian dune deposits. Fishermens Bend Silt & Moray Street Gravels (Yarra Delta) Newer Volcanics Wannaeue Formation	Aeolian dune deposits Newer Volcanics	Heath Hill Silt
Tertiary (Upper)	Pliocene/ Miocene	Brighton Group / Moorabool Viaduct Sand / Baxter Formation	Brighton Group	Baxter Formation (part of Western Port Group)
Tertiary (Middle)	Miocene/ Oligocene	Fyansford Formation & Batesford Limestone (Torquay Group) Demons Bluff Group[7]	Fyansford Formation	Sherwood and Yallock Formations (both part of Western Port Group)

[6] Table compiled from Holdgate & Gallagher (2003), Cupper, White & Neilson (2003), Holdgate (2003), Leonard (1992) and Thompson (1974)

Period	Epoch/ Series	Formation/ Group		
		Port Phillip Basin	Werribee Delta	Western Port Basin
Tertiary (Lower)	Miocene/ Oligocene/ Palaeocene	Werribee & Yaloak Formations with intercalated Older Volcanics	Werribee Formation	Older Volcanics/ Thorpdale Volcanics & Flinders Formation Childers Formation
Pre-Tertiary		Lower Cretaceous, Devonian, Silurian and Ordovician basement bedrock (including Otway Group, Lysterfield Granodiorite & Mount Danenong Volcanics)	Ordovician basement bedrock	Lower Cretaceous, and Devonian basement bedrock (including the Strzelecki Group and the Lysterfield Granodiorite)

[7] Described as a transitional facies into Fyansford Formation, Sorento Graben Nepean Peninsula (Holdgate & Gallagher, 2003)

2.7 Hydrogeology

2.7.1 Approach

A three dimensional understanding of the hydrogeology of the area is a pre-requisite of any groundwater modelling study. As discussed in Section 2.6 the Port Phillip CMA comprises two major geological basins the Port Phillip Basin towards the west of the area and the Western Port Basin to the east. The geology and hydrogeology of both of these basins is dominated by Quaternary and Tertiary age sedimentary and volcanic rocks which wedge out northward onto the pre-Tertiary basement bedrock which dominates the geology of the remainder of the Port Phillip CMA.

Both the Port Phillip and Western Port basins have been the subject of a number of key ongoing and previous hydrogeological investigations and reports including:

- Ongoing work by Sinclair Knight Merz funded by the Victorian Smart Water Fund aimed at producing updated hydrogeoloical mapping of the Port Phillip CMA. Aspects of this work relating to mapping of aquifer storage and recovery (ASR) potential have already been published (SKM, 2006);
- Comprehensive studies of groundwater resources in the Port Phillip region undertaken by John Leonard in 1979 and updated in 1992 (Leonard, 1979 and 1992);
- Geology of Victoria (Birch(Ed), 2003);
- A study of groundwater flow systems in the Port Phillip CMA (Dalhaus et al, 2004);
- The geology and hydrogeology of the Western Port Sunklands (Thompson, 1974); and
- 1:100,000 scale hydrogeological mapping and explanatory notes of the Western Port Basin (Lakey & Tickell, 1981).

The adopted approach to developing a hyrodgeological model of the area predominantly involved collation and review of these key documents in addition to input from a number of GHD staff including David Stanley and Paul Bolger both of whom have extensive experience of geological and hydrogeological conditions in the Port Phillip region.

2.7.2 Hydrogeological Structure

Initial work concentrated on developing a three dimensional understanding of the hydrogeology of the Port Phillip CMA. This involved the collation and review of data from the following sources:

- Published maps, cross sections and text descriptions from previous studies of the area;
- 1:250,000 scale digital geological mapping of the area; and
- Interpreted borehole log data provided by SKM which is currently being used as an input data set for the ongoing Smart Water funded Port Phillip Hydrogeological Mapping project.

Key cross sections identified are included as Appendix B.

A key requirement of the current study is that the groundwater model produced should be consistent with the hydrogeological mapping of the Port Phillip area currently being undertaken by SKM. The

interpreted borehole log data provided by SKM and the associated 5 layer system which has been developed to simplify the hydrogeology of the area therefore formed a starting point for the current study. This 5 layer framework is described in the ASR potential report (SKM, 2006) and groups the various hydrogeological units together based on their geological age as follows:

- Layer 1 - Quaternary and Recent deposits including the Newer Volcanics, Bridgewater and Wannaeue Formations;
- Layer 2 – Upper Tertiary Age deposits including the Brighton Group and the Moorabool Viaduct Formation;
- Layer 3 – Middle Tertiary Age deposits including the Fyansford and Batesford Limestone Formations;
- Layer 4 – Lower Tertiary Age deposits including the Older Volcanics and the Werribee Formation;
- Layer 5 – Pre-Tertiary Age basement bedrock deposits;

Whist this framework is considered adequate to represent the hydrogeology of the pre-Tertiary and Tertiary age units reference to cross sections through the Werribee and Yarra Deltas (see Appendix B Sections 4 and 5) suggests that further differentiation of the Quaternary and Recent age deposits would be useful in these (and potentially other) areas. In particular separation of the Newer Volcanics and the other younger Quaternary age deposits is recommended. Whilst there is limited information on the Newer Volcanics it is likely that the aquifer properties of this basalt unit will be significantly different from the overlying unconsolidated predominantly sedimentary units such as the Werribee Delta deposits. A 6 layer framework was therefore adopted as outlined in Table 4 including differentiation of the Newer Volcanic Group and the overlying Quaternary Age sedimentary deposits. A 7 layer framework was initially suggested with three layers for the various Quaternary age units. This would have allowed better representation of the hydrogeological setting in the Werribee and Yarra Deltas and other areas such as the Nepean Peninsula and the Port Phillip Bay East where multiple Quaternary strata are present (see Appendix B, Sections 1 and 2). However a review of the available geological data (borehole logs and mapping data) confirmed that there is insufficient information in most areas to separate different units within the Quaternary sediments.

Application of the adopted 6 layer system can be seen illustrated on each of the cross sections included in Appendix B. This system is used throughout subsequent sections of the report although where authors refer to individual formations then this information is retained.

Table 4 Summary of Proposed Hydrogeological Layers

Layer	Age(Epoch)	Hydrogeological Units Present
1	Quaternary 1	Quaternary Sediments and Dunes
2	Quaternary 2	Newer Volcanics
3	Upper Tertiary (Pleistocene to Pliocene/Miocene)	Brighton Group Moorabool Viaduct Sand[8] Baxter Formation [9]

[8] Lateral equivalent of the Brighton Group (Holdgate & Gallagher, 2003)

Layer	Age(Epoch)	Hydrogeological Units Present
4	Middle Tertiary (Miocene to Oligocene)	Fyansford Formation Maddingley Coal Seam[10] Batesford Limestone[11] Yallock Formation[12] Sherwood Formation[13]
5	Lower Tertiary (Oligocene/Pliocene to Palaeocene)	Werribee Formation Older Volcanics Demons Bluff Formation[14] Childers Formation[15]
6	Pre-Tertiary	Pre-Tertiary age basement bedrock

It should be stressed that since the proposed hydrogeological structure is based on age then different formations will be represented using the same layer in different areas. For instance under the adopted system the Brighton Group and its lateral equivalents (the Baxter Formation and the Moorabool Viaduct sands) are all simulated within the same model layer. Unfortunately information of the lateral extents and hence the boundaries between these different formations is limited.

2.7.3 General Hydrogeological Description

The main hydrogeological units present within of the Port Phillip Basin can be described as follows:

- In the Werribee Delta the sands and gravels of elongated river channel deposits form important local aquifers, with the surrounding clay and silt rich deposits functioning as aquitards (Leonard, 2003);
- Four sedimentary units have been recognised in the deltaic sequence which forms the Yarra Delta. The upper and lowermost strata in the sequence (the Port Melbourne Sands and Moray Street Gravels) are aquifers which are separated by up to two separate aquitard units (the Coode Island and/or Fishermans Bend Silts), (Leonard, 2003);

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[9] Lateral equivalent of the Brighton Group (Holdgate & Gallagher, 2003)

[10] Lower Tertiary age unit at top of Werribee Formation but is lumped in with the overlying Fyansford Formation since the coals are also understood to be relatively low permeability deposits

[11] Thought to be present in and around the Corio Bay area only (Leonard, 1992) and hence largely absent from the Port Phillip CMA

[12] Lateral equivalent of the Fyansford Formation (Holdgate & Gallagher, 2003)

[13] Lateral equivalent of the Fyansford Formation (Birch, 2003)

[14] Only present at depth in the Nepean Peninsula area

[15] Lateral equivalent of the Werribee Formation (Holdgate & Gallagher, 2003)

- Newer Volcanics Group. The basalts of the Newer Volcanics Group, which are only present in the area to the west of Melbourne, typically comprise a multi-layered leaky system of aquifers and aquitards associated with groups of basalt flows;
- The calcareous and quartzose sands of the Bridgewater Formation directly overlie the calcarenites, shelly sands and clays of the Wannaeue Formations. Combined with the underlying Brighton Group these Quaternary age formations form an important unconfined aquifer system on the Nepean Peninsula (Mallet & Holdgate, 1985; and Leonard, 1992);
- The sands of the Brighton Group and its lateral equivalents (i.e. the Moorabool Viaduct Sand and Baxter Formation) are characterised by relatively low permeability to the north and west of Melbourne due to increased clay content, (Leonard, 1979). To the east however permeability tends to increase and together with the underlying Fyansford Formation (which is also typically more permeable in this area) the Brighton Group forms an important aquifer system (Leonard 1979). The similar nature of these two aquifers in this area means they are typically difficult to differentiate and considered to be hydraulically connected;
- The marl, clay, limestone and sands of the Fyansford Formation and its lateral equivalents typically either overlie the Werribee Formation or sit directly on the basement bedrock. West of Melbourne the formation is typically characterised by relatively low permeability, whilst to the east it contains more significant sand horizons which form the lower part of the Fyansford Formation – Brighton Group aquifer system (Leonard, 1992);
- The sand, gravel clay and coal of the Werribee Formation and its lateral equivalents plus the intercalated Older Volcanics form one of the more important aquifers in the area, particularly where the volcanics comprise relatively fresh rock. Permeability tends to decrease in areas where the volcanic rock is highly weathered to clay. Where the basalts have been weathered to a clay material then this can form a low permeability layer confining groundwater levels in the Werribee Formation; and
- The pre-Tertiary basement bedrock, both sedimentary and igneous, are typically massive and hence are characterised by relatively low primary porosity and permeability. However where jointing, fracturing and weathering of the bedrock provides sufficient secondary porosity and permeability then the strata can provide useful quantities of water. Weathering profiles can exceed 50m (Leonard 1992);

The main hydrogeological units present within the Western Port Basin can be summarised as follows:

- Over much of the Westernport Basin the Tertiary sediments are overlain and confined by significant thicknesses of Quaternary clay. However to the north east of Koo Wee Rup the Quaternary alluvial deposits are sufficiently permeable to support stock and domestic abstraction.
- The Westernport Group comprises the Baxter, Sherwood and Yallock formations which together comprise the most important aquifer in the Westernport Basin. Both the Baxter and Yallock Formations typically comprise coarse sand and gravel whilst the Sherwood Formation is characterised by fine sand (Leonard, 2003). These units form an important leaky aquifer system and are considered to be the lateral equivalents of the Fyansford Formation and Brighton Group in the Port Phillip Basin;

- Older Volcanics. As in the Port Phillip Basin the development of secondary porosity in the Older Volcanics in the Westernport basin is variable. However test bores in the central part of the basin have produced relatively high yields (25L/s) for only around 2 m drawdown (Leonard 2003); and
- The Childers Formation aquifer typically comprises sand and gravel with interspersed lignite and clay beds and is considered to be the lateral equivalent of the Werribee Formation. Combined with the overlying units the Childers Formation forms a leaky confined horizontally stratified aquifer system (Leonard 2003); and
- Pre-Tertiary basement bedrock (as for the Port Phillip Basin, see text above)

2.7.4 Aquifer Properties and Yields

Information on aquifer properties and yields derived from aquifer pumping tests is unfortunately not currently collated into a single publicly accessible location and hence the current study is limited to information that can be obtained from published material and data sets and from information and knowledge already held by GHD.

Some potentially useful information on yields and drawdowns from short yield tests completed in water bores is however held within the GMS database. These data are typically limited to single values summarising the lithology tested, test depth, pumping rate (Q) and drawdown (Sw) and hence there is insufficient information to obtain an accurate estimate of aquifer properties (i.e. transmissivity/hydraulic conductivity and storage) or in most cases confirm the aquifer formation tested. However it is possible to obtain crude estimates of transmissivity (T) from specific capacity (i.e. pumping rate (Q, m3/d) / drawdown (Sw, m)) and assuming typical values for aquifer storage and the well radius using the following equation:

$$T\ (m^2/d) = 1.042\ (Q/Sw)$$ (Batu, 1999)

Unfortunately information on the formation tested is also lacking from the GMS data set and hence it was necessary to infill this information through comparison of the test depth to the hydrogeological surfaces developed for the current study. Hence where there are in-accuracies in these surfaces then yields and calculated transmissivities may have been assigned to the wrong formation.

Whilst the absolute values calculated using this approach are clearly crude the application of the same equation and assumptions to the entire data set means the calculated transmissivity values can assist with identifying spatial variations (both lateral and vertical) and likely ranges of values within the different hydrogeological layers.

Estimated transmissivity values, calculated as described above from data included within the GMS database, are shown in Figure 11 to Figure 16.

Collated information on aquifer properties and yields is also available from previous work by Leonard (1979, 1992 and 2003). Available data for each hydrogeological unit and formation are described below and summarised in Appendix E.

Quaternary Age Sediments

Yields from wells completed into Quaternary age sediments are reported by Leonard (2003) to be:

- Up to 25 l/s from the Bridgewater Formation on the Nepean Peninusla although the average yield is reported to be 1.2 l/s;
- Between 5 and 15 l/s from the Quaternary alluvial deposits within the Werribee Delta; and
- Around 0.2 l/s from dune deposits around Port Phillip bay; and
- Minor yields sufficient for stock and domestic use from Quaternary age alluvial deposits in the area to the north east of Koo Wee Rup.

These estimates are broadly consistent with the GMS yield data which suggest the following average yields and ranges for Quaternary age sediments:

- Nepean Peninsula, 1112 test results indicating an average yield of 1.9 l/s with individual borehole yields ranging from 0.1 to 53 l/s;
- Werribee Delta, 61 tests giving an average yield of 7 l/s with individual yields ranging from 0.1 to 57 l/s; and
- Koo Wee Rup, 335 tests giving an average yield of 1.1 l/s with individual yields from 0.1 to 28 l/s.

Leonard (1992) reports typical hydraulic conductivities for the Bridgwater Formation on the Nepean Peninsula of 5 to 30 m/d but considers a value of 20 m/d to be representative of the regional aquifer mass. For the Werribee Delta Leonard suggests hydraulic conductivities of 10-15 m/d for coarser deposits but with suggests a value of around 5 m/d for the aquifer as a whole. For the Yarra Delta Cooney (1984) quotes tested values of between 0.86 and 43 m/d. No data have been identified for the Quaternary sediments in the Koo Wee Rup area.

Hydraulic conductivity values as estimated from yield test results included with the GMS database and assuming full saturated thickness suggest median hydraulic conductivities of around 0.4 m/d in the Nepean Peninsula, 7 m/d in the Werribee Delta, 1 m/d in the Yarra Delta and around 0.4 m/d in the Koo Wee Rup area. For the most part these values are comparable to the estimates in the literature. The relatively low value estimated from the GMS data for the Nepean Peninsula may be related to assuming that the full thickness of the sediments is saturated. Where the full thickness of the strata is not saturated then the GMS calculation will tend to under-estimate the hydraulic conductivity.

Leonard (1992) reports specific yield values of 0.2-0.35 for the Bridgewater Formation on the Nepean Peninsula, 0.15-0.2 for the coarser deposits on the Werribee Delta (0.1 for the aquifer mass) and 0.1-0.25 for the Port Melbourne Sands in the Yarra Delta.

Newer Volcanic Group

Yields from wells completed into the Newer Volcanic Group are reported to range from 0.4 to 40 l/s but are typically less than 1.2 l/s (Leonard, 2003). This range is broadly consistent with the GMS data which suggest wide ranging yields (from 0.1 to 303 l/s) but return an average yield of 2.6 l/s, around 67% of the tests returned yields of less than 1.2 l/s.

Riha and Kenley (1978) report transmissivity values for the Newer Volcanic Group of between less than 50 m^2/d and over 300 m^2/d depending on the thickness and degree of jointing. Calculated transmissivity from the GMS data are broadly consistent with these values returning a median transmissivity of around 10 m^2/d from values ranging from 0.2 to 756 m^2/d. The majority (78%) of the

calculated transmissivity test results fall in the range 1-50 m^2/d although around 8% of tests return values of over 100 m^2/d. GMS data suggest relatively high calculated transmissivities within the Newer Volcanic Group within the Deutgam WSPA which forms part of the Werribee Delta (Figure 12), 21 out of the 50 tests carried out in this area returned values of over 50 m^2/d. The relatively high values returned in this area may be related to vertical leakage from the overlying Quaternary Sediments. The majority of tests from areas where the Newer Volcanic Group occur at outcrop return values of less than 50 m^2/d.

Leonard (1992) suggests typical hydraulic conductivity values for the Newer Volcanic Group of 1 to 6 m/d. Assuming full saturation and based on modelled thicknesses of the Newer Volcanic Group hydraulic conductivity can also be calculated from the GMS data. The majority of values fall in the range 0.01-5 m/d returning a median hydraulic conductivity of around 0.4 m/d, a value which is slightly below than the range reported by Leonard. Around 44% of the hydraulic conductivity values calculated from the GMS data exceed 1 m/d and hence 5 m/d may well be realistic in some areas.

Leonard (1992) reports that the specific yield of the Newer Volcanics could vary from 0.01 to 0.3 depending on the degree of fracturing but suggests a value of 0.02 as being representative of the aquifer mass.

Upper Tertiary Age Units

Yields from wells completed into upper Tertiary age strata are reported to range from <0.6 – 15 l/s for the Brighton Group west of Melbourne and <0.6 to 4 l/s for the same strata east of Melbourne. Leonard (2003) reports yields of up to over 25 l/s from the Baxter Formation in the Westernport Basin. These values are broadly consistent with data from GMS which suggest yields ranging from 0.1 to 150 l/s with an average yield of around 4.5 l/s, although around 61% of the tests thought to have been carried out in the upper Tertiary returned yields of less than 1 l/s.

Leonard (1992) reports typical transmissivity ranges for the Brighton Group to the west of Melbourne of 5 to 10 m^2/d in areas with high silt/ clay content and up to around 75 m^2/d in sandier areas. Values of less than 5 m^2/d are quoted for the Brighton Group sediments east of Melbourne. Thompson (1974) reports transmissivity values of between 50 and 300 m^2/d for the Baxter Formation. Calculated transmissivity from the GMS data suggest slightly higher values for the Brighton Group although the majority of the data apply to the area to the east of Melbourne (Figure 13) and hence may be representative of the combined Fyansford Formation – Brighton Group or the Baxter Formation aquifers. Analysis of the GMS data suggests a median transmissivity of 18 m^2/d. 75% of the calculated transmissivity test results fall in the range 1-50 m^2/d although around 11% of tests return values of over 100 m^2/d.

Leonard (1992) suggests a representative hydraulic conductivity of less than 0.5 m/d for the Brighton Group west of Melbourne and around 0.4 m/d for the combined Fyansford Formation / Brighton Group aquifer to the east of Melbourne. Assuming full saturation and based on modelled thicknesses of the upper Tertiary age strata hydraulic conductivity can also be calculated from the GMS data. The majority of values for the upper Tertiary strata fall in the range 0.01-5 m/d returning a median hydraulic conductivity of around 0.5 m/d, a value which is consistent with Leonard’s estimate.

Leonard (1992) reports specific yield values of between 0.05 and 0.15 for the Brighton Group and a typical confined storage coefficient of 0.0004.

Middle Tertiary Age Units

Based on reported transmissivity ranges for the Fyansford Formation (20 to 30 m^2/d, (Leonard, 1992) and for the Sherwood Formation (30 to 75 m^2/d, (Thompson, 1974)) middle Tertiary age deposits to the east of Melbourne are likely to lie in the range of 20 to 75 m^2/d. Aquifer yields are reported to range from <2.6 up to around 40 L/s, with the higher yields typically attributed to the Sherwood and Yalloak Formations in the Western Port Basin.

To the west of Melbourne the Fyansford Formation pre-dominantly comprises clay and marl and has been described as an aquitard with limited yield (Leonard 1992). This is reflected in the distribution of the GMS data which shows that calculated transmissivity results are largely confined to the Moorabbin and Koo Wee Rup areas east of Melbourne (Figure 14).

Yield data for tests included in the GMS database and thought to have been completed in middle Tertiary age strata are broadly consistent with the literature values and range from <1 to 46 l/s with an average yield of around 2 l/s. Calculated transmissivities range from 0.5 to over 5000 m^2/d although the median value is only around 10 m^2/d, which is below the range of values previously quoted in the literature. 80% of calculated transmissivity values fall in the range 1-50 m^2/d although around 6% of tests return values of over 100 m^2/d.

Assuming full saturation and based on modelled thicknesses of the middle Tertiary age strata hydraulic conductivity can also be calculated. The majority of values for the middle Tertiary strata fall in the range 0.01-5 m/d returning a median hydraulic conductivity of around 0.5 m/d.

Leonard (1992) reports specific yield values of up to 0.1 for the Fyansford Formation.

Lower Tertiary Age Units

Yields from wells completed into lower Tertiary age strata are reported to range from 0.6 to > 50 l/s for the Werribee Formation and <5 L/s to >15 L/s for the Older Volcanics (Leonard, 1992). The GMS data suggest yields ranging from 0.1 to 253 l/s with an average yield of around 3 l/s, around 66% of the tests thought to have been carried out in the lower Tertiary returned yields of less than 1 l/s.

Leonard (1992) reports typical transmissivity ranges of 75 to 300 m^2/d for the Werribee Formation and 1 to 155 m^2/d for the Older Volcanics. Similar estimates have been reported more recently by SKM who suggest a typical value of 155 m^2/d for the Werribee Formation in the Nepean Peninsula (SKM 2002). Leonard (1992) suggests a representative hydraulic conductivity value of 5 m/d for the Werribee Formation.

Calculated transmissivity values from the GMS data however suggest lower typical values. Results from tests thought to have been carried out in lower Tertiary age strata range from between <1 to over 3000 m^2/d but return a median value of only 11 m^2/d, indicating that relatively low values predominate. 83% of calculated transmissivity values fall in the range 1-50 m^2/d although around 7% of tests return values of over 100 m^2/d. The eastern part of the Koo Wee Rup area appears to be characterised by relatively high transmissivity values (Figure 15).

Assuming full saturation and based on modelled thicknesses of the lower Tertiary age strata hydraulic conductivity can also be estimated. The majority (79%) of the calculated values range between 0.1 and 5 m/d and give a median hydraulic conductivity for the lower Tertiary age strata of around 0.5 m/d.

Leonard (1992) reports specific yield values of up to 0.3 for the Werribee Formation and a typical confined storage coefficient of 0.0002. For the Older Volcanics Leonard suggests a specific yield of up to 0.1 in highly fractured areas falling to as little as 0.005 in areas of relatively fresh basalt. Confined storage coefficients are reported to vary between around 0.00004 and 0.0002.

Pre-Tertiary Age Units

Yields from wells completed into pre-Tertiary age deposits are reported by Leonard (1992) to range from <0.6 L/s up to around 32 L/s. This is broadly consistent with data held within the GMS which as would be expected for a fractured rock aquifer show a wide range of observed yields from 0.1 up to as high 379 L/s. The GMS data however suggest relatively low yields are typical, over half the tests returned yields of less than 1 l/s with an average yield of around 2.6 l/s.

Leonard (1992) references data from a single pumping test in the Pre-Tertiary age strata and quotes a transmissivity values of around 50 m^2/d which given that fracturing in the basement bedrocks is likely to be highly variable is unlikely to be regionally representative. Based on data for strata north of the Port Phillip CMA Leonard (1992) suggests that the hydraulic conductivity of the basement bedrock could range between 0.01 and 10 m/d.

This estimate is broadly consistent with the GMS data which suggest calculated transmissivity values ranging between <1 to over 2000 m^2/d but with a median value of only 8 m^2/d, indicating that relatively low values predominate. . 79% of calculated transmissivity values fall in the range 1-50 m^2/d. There are no obvious spatial patterns to the calculated GMS values (Figure 16) although the many of the higher transmissivity values are in areas where the basement bedrock is overlain by Quaternary sediments which suggests the estimated transmissivity is being enhance by leakage from the overlying deposits.

Transmissivity in the pre-Tertiary bedrock is likely to be dominated by relatively high values in weathered strata close to the surface (say 50m) which suggests a typical hydraulic conductivity value of between say 0.02 to 1 m/d assuming a saturated thickness of 50m. However around 4% of test results suggest transmissivity values of between 100 and 500 m^2/d which suggests a realistic upper bound hydraulic conductivity value of 10 m/d.

Leonard (1992) suggests typical specific yield (effective porosity) values for the basement bedrock of less than 0.05 ranging between 0.01 and 0.1 depending on the degree of fracturing.

Transmissivity Variations with Depth

The estimated transmissivity values calculated from the GMS data can also be used to investigate potential variability in aquifer properties with depth in the different hydrogeological strata. Scatter plots showing transmissivity plotted against test depth in metres below ground level are shown in Figure 17 to Figure 22.

Data for the Quaternary sediments (Figure 17) and the middle and lower Tertiary age units (Figure 20 and Figure 21) suggests no significant variation with depth. Data for the upper Tertiary age units (i.e.

the Brighton Group and its lateral equivalents, Figure 19) however suggest increasing transmissivity with depth. This is consistent with the idea that coarser sand and gravel units typically occur towards the base of the Brighton Group (Leonard, 2003). Plots of estimated transmissivity vs depth for the Newer Volcanic Group (Figure 18) and the pre-Tertiary basement bedrock (Figure 22) suggest a tendency for transmissivity to decrease with test depth. This is consistent with decreasing fracturing and weathering with depth in these hardrock deposits.

2.7.5 Groundwater Levels

Groundwater level data have been collated from four different classes of boreholes as follows:

- State Observation Network (SON) boreholes. Both the formation monitored and the borehole datum and/or ground level are typically known for these boreholes and they are generally dipped on a monthly basis producing a reliable time series record of groundwater level elevations in mAHD;
- Primary Industries Research, Victoria (PIRVIC) monitoring network boreholes. These are typically shallow monitoring boreholes installed for salinity monitoring purposes. Borehole datum and/or ground level is typically known although no information is available on the strata monitored. However given the shallow depth of the boreholes it is reasonable to assume that they are monitoring the uppermost hydrogeological unit present;
- GMS boreholes with time series groundwater level elevation data. Whilst the borehole datum is known for these boreholes, allowing groundwater level elevations in mAHD to be calculated, information on the formation monitored is not available;
- Other GMS boreholes with spot groundwater level readings recording during or soon after drilling and installation. No information is provided within the GMS database on either the borehole datum and/or the formation monitored.

Borehole locations are shown in Figure 23. Total numbers of SON and other boreholes in each hydrogeological strata monitored within the Port Phillip CMA are shown in Table 5. Reference to this information confirms that the SON boreholes are predominantly concentrated within areas designated as either Groundwater Management or Water Supply Protection Areas (GMAs or WSPAs). Coverage outside of these areas is poor. Given the large amount of additional groundwater level information potentially provided by non SON boreholes these additional data have been used to produce the 'observed' groundwater level contours as described below.

Table 5 Groundwater Monitoring Boreholes by Hydrogeological Strata

Hydrogeological Strata Monitored[16]	SON BHs	Other GMS BHs with time series data	PIRVIC BHs	Other GMS BHs with spot groundwater level data
Quaternary Sediments	46	19	53	1754

[16] Strata monitored by non SON GMS boreholes estimated through comparison of information on screen depths and hydrogeological layer elevations developed for the current study. Shallow PIRVIC boreholes assumed to monitor outcropping unit.

Hydrogeological Strata Monitored[16]	SON BHs	Other GMS BHs with time series data	PIRVIC BHs	Other GMS BHs with spot groundwater level data
Newer Volcanic Group	99	10	11	825
Upper Tertiary Age Units	68	26	7	983
Middle Tertiary Age Units	42	16	0	271
Lower Tertiary Age Units	58	10	30	461
Pre-Tertiary Age Units	14	16	25	3094
Unknown	36	0	0	0
Total	363	97	126	7388

Groundwater Level Hydrographs

Grouped groundwater level hydrographs for all GMS and PIRVIC boreholes with time series groundwater level data, one graph per GMA, WSPA, parish or map name, are included as Appendix C. For the most part these data show relatively minor seasonal groundwater level fluctuations and a general lack of long term trends. Exceptions to this general rule include boreholes in the Koo Wee Rup and Deutgam WSPA areas which seem to be being affected by groundwater abstraction and/or recent drought conditions.

Data for the Deutgam WSPA suggest declining groundwater levels from around 1997 onwards. Groundwater level data for the Koo Wee Rup WSPA show significant seasonal fluctuations of up to 5 m and groundwater levels which are well below sea level in places, suggesting significant seasonal groundwater abstraction. Data for south east Koo Wee Rup also show declining water levels from around 1997 onwards.

Groundwater Level Contours

In order to maximise the volume of available data all groundwater level contours have been produced using long term averages of all available data. As a result the contours produced represent a composite picture of groundwater levels collected on a variety of different dates. Whilst this is not considered ideal the majority of the time series data available (see Appendix C) suggests relatively minor seasonal and long term trends and hence the errors introduced into the resulting contours should be relatively minor, particularly on a regional scale.

It should be noted that definitive groundwater level contours for the Port Phillip CMA are currently under preparation as part of the Smart Water Funded Hydrogeological Mapping work currently being undertaken by SKM. Only a limited amount of time has therefore been devoted to developing groundwater level contours for the current project. Calibration of the groundwater flow model will be carried out through comparison of modelled and observed groundwater levels at the State Observation Borehole and PIRVIC monitoring locations, rather than through comparison with ‘observed’ contours.

Water table elevation contours are shown in Figure 24. Water table in this case is defined as the observed groundwater level in the uppermost hydrogeological unit present. Depth to water table contours are shown in Figure 25. Groundwater level contours for each of the individual hydrogeological units considered are shown in Figure 26 to Figure 31.

All contours were produced from average groundwater level data using the default 'Natural Neigbour' (also known as Voronoi Interpolation) algorithm in SURFER. The resulting contours were then checked visually to identify anomalies or 'bulls-eyes' which were not supported by surrounding data. Data from 43 boreholes within the Port Phillip CMA were deleted from the dataset as part of this process. Reference to the observed water table elevation and depth to water table contours (Figure 24 and Figure 25) indicate several areas where the calculated contours are at ground surface. Comparison of these areas with known wetland and artificially drained areas suggests a generally good level of agreement with extensive high water table areas modelled in the Werribee, Yarra and Dadenong Creek Deltas, and Koo Wee Rup. However the calculated contours also suggest high water table conditions in several inland areas where there are no known wetlands. These are predominantly areas where groundwater level elevation data have been extrapolated across river valleys.

Unfortunately the borehole density in the majority of layers and areas is typically insufficient to provide much insight into hydrogeological processes and properties.

Relatively dense monitoring networks are in place in the Deutgam, Koo Wee Rup and Nepean Peninsula areas although groundwater levels in these low lying areas are typically close to sea level and hence don't tend to show up well in regional scale contouring. Groundwater level contours for the middle Tertiary age units (Figure 29) suggest flow towards the Bunyip River despite the fact that the river is underlain by thick (over 40 m in places) Quaternary deposits in this area.

Vertical Gradients

Useful information on interaction between different hydrogeological units can be provided through reference to groundwater level data for locations with monitoring in more than one hydrogeological unit. Data are available for 64 such locations in the Port Phillip CMA (Figure 32). Time series graphs for each location are included as Appendix C.

Only 3 sites in the Koo Wee Rup area (Sites 13,16 and 48, see Appendix D) provide information on vertical gradients between the Quaternary sediments and the underlying units. Data for these two of these sites (Sites 13 and 16) suggest downward gradients within the Quaternary sediments and between the underlying layers. Groundwater levels in the underlying Sherwood Formation appear to be being drawn down to well below sea level in parts of the Koo Wee Rup area presumably as a result of groundwater abstraction. Groundwater levels in Quaternary at Sites 13 and 16 however remain above sea level suggesting a low degree of hydraulic connectivity with the underlying deposits. However, data for Site 48 show little or no head difference between the Quaternary sediments and the Sherwood Formation suggesting a high degree of hydraulic connectivity at this location.

Information on vertical gradients within the New Volcanic Group are available for around 20 sites (see Appendix D). These data suggest vertical gradients of up to 8 m within the basalts themselves which tends to confirm the stratified nature of these deposits (see Section 2.7.3).

Vertical gradients within the upper Tertiary age units and the underlying units are recorded at 13 different locations predominantly in the Koo Wee Rup WSPA and Moorabbin GMA. The majority of these data show downward gradients of up to 3 m between the Brighton Group or Baxter Formation and the underlying Older Volcanics. As for the Sherwood Formation (see above) groundwater levels in both the Baxter Formation and the Older Volcanics in the Koo Wee Rup area typically below sea level and subject to significant seasonal fluctuations.

Five sites (12, 15, 19, 54 and 60, see Appendix D) provide information on vertical gradients within the middle Tertiary age strata and the underlying deposits. As for the other units the majority of these sites are in the Koo Wee Rup WSPA. The majority of the sites suggest relatively minor downward gradients between the Yallock or Sherwood Formation and the underlying Older Volcanics. Vertical gradients between the Yallock Formation and the Older Volcanics at Site 60 switch seasonally from downward during the winter to upward during the summer. This is thought to be related to seasonal abstraction from the uppermost layer. A subdued response to abstraction can also be seen in the Older Volcanics.

This same pattern is seen in the majority of the other data for the Koo Wee Rup area and is consistent with the concept that the Westernport Group (i.e. the Baxter, Sherwood and Yallock Formations) act as a series of leaky aquifers.

No reliable information is available on vertical gradients between the lower and pre Tertiary age units.

2.8 Surface Water and Groundwater Interactions

2.8.1 Recharge

Actual evapotranspiration and recharge for the use in the current study have been calculated by the DSE using the ENSYM model (formerly known as CAT1D). ENSYM represents an enhancement of the one-dimensional crop PERFECT (Productivity, Erosion and Runoff Functions to Evaluate Conservation Techniques) model (Littleboy et al. 1989) and uses daily weather input data (rainfall and pan evaporation) and a series of plant growth models to produce a near surface water balance for a number of different land use types. Further information can be found in the CAT1D Technical Manual (DSE, 2007).

Long term average recharge (January 1957 to December 2005) for the Port Phillip CMA as calculated using the ENSYM model is shown in Figure 33. Results suggest an average recharge rate of 143 mm/yr. The calculated recharge data show a similar pattern of variation to the input rainfall data and hence the highest rates of recharge (up to 1025 mm/yr) typically occur towards the east of the CMA in the headwaters of the Yarra River.

No information is available on how ENSYM calculates recharge in urban areas or in areas such as the Werribee Delta where natural recharge is being enhanced by discharges from the Werribee Treatment Complex. It is interesting to note however that the influence of neither Melbourne nor the Werribee complex is obvious in the supplied recharge data (Figure 33).

Recharge to all of the aquifer units present in the area is likely to be dominated by rainfall infiltration in outcrop areas. As a result the total outcrop area (Table 10) will have a significant influence on total recharge to each hydrogeological unit.

Outcrop geology in the Port Phillip CMA is dominated by pre-Tertiary basement bedrock in upland areas which account for around 44% of the area. In lower lying areas the basement has been overlain by significant thicknesses of Tertiary age units. However the tertiary pile has in turn been overlain by Quaternary age deposits including the Newer Volcanic Group and Quaternary sediments which tend to dominate the outcrop in lower lying areas and account for around 43% of the area. The Tertiary age strata are therefore present at outcrop over a relatively small proportion (around 13%) of the area. Outside of these outcrop areas recharge to the Tertiary aquifers will be limited to vertical leakage from under and /or overlying units.

Table 6 Total Outcrop Area, Port Phillip CMA

Strata	Approximate Outcrop Area (km^2)	Approximate Cover (%)
Quaternary	2908	22.7%
Newer Volcanic Group	2645	20.7%
Upper Tertiary Age Units	958	7.5%
Middle Tertiary Age Units	1	0%
Lower Tertiary Age Units	608	4.8%
Pre-Tertiary Age Units	5680	44.4%
Total	12800	100%

2.8.2 Actual Evapotranspiration

Long term average actual evapotranspiration (January 1957 to December 2005) for the Port Phillip CMA as calculated by the DSE using the ENSYM model is shown in Figure 34. Results suggest an actual evapotranspiration rate of 242 mm/yr although it should be noted that the calculated values shown do not include any allowance for upwards seepage of groundwater and hence are likely to represent an under-estimate in some areas. This issue has been addressed through simulation of actual evapotranspiration losses from wetland and other high water table areas using the groundwater flow model (see Section 3.2.6).

2.8.3 River Interaction

Useful information on the magnitude and location of groundwater discharge to surface water courses is provided through carrying out a baseflow separation using the USGS HYSEP methodology and a 7 day turning point (Sloto & Cruse, 1996). Baseflow indices for selected gauges are summarised in Table 7 and shown in Figure 35.

Calculated baseflow indices range from 0.69 for the Yarra at Millgrove to 0.2 for the Little River at Little River. It should be noted, however, that only two of the gauges (Lang Lang River at Hamiltons Bridge and Little River at Little River) for which baseflow separations have been carried out do not have major reservoirs in the upstream catchment. Three gauges Jackson Creek at Gisborne, Pykes Creek at Pykes

Creek Reservoir and Werribbee River at Melton Reservoir are thought to be directly downstream of reservoirs. Flow hydrographs for these gauges (see Appendix A) confirm the significant impact that reservoir releases can have on the flow regime downstream. Depending on the discharge regime (which will vary from reservoir to reservoir) such releases are likely to have a significant impact on calculated baseflow indices for any downstream gauges. As noted previously by Leonard (1992) the number of water storage schemes, diversions and regulated flow in major watercourses in the area makes it difficult to assess the contribution of groundwater discharge to surface water flow. However, perennial flow limits are thought to extend well up into highland areas in many cases suggesting that the main watercourses in the area gain flow from groundwater discharge along the majority of their length. The significant depth to water table observed in many upland areas away from the main river valleys (Figure 25) however suggests that many tributary watercourses in pre-Tertiary outcrop areas are likely to be ephemeral features.

Table 7 Calculated Baseflow Indices, Port Phillip CMA

Gauge Name / Ref No	Baseflow Index (BFI)	Notes
Bass River @ Glen Forbes South (227231)	0.31	Downstream Candowie, Little Bass and Bellview Creek Reservoirs
Lang Lang River @ Hamiltons Bridge (228209)	0.35	No upstream reservoirs
Bunyip River @ Iona (228213)	0.57	Downstream Tarago Reservoir
Cardinia Creek @ Cardinia (228228)	0.42	Downstream Cardinia Reservoir
Yarra River @ Warrandyte (229200)	0.65	Downstream Upper Yarra, Oshannassy, Maroondah and Sugarloaf Reservoirs
Yarra River @ Millgrove (229212)	0.69	Downstream Upper Yarra and O'Shannassy Reservoirs
Maribyrnong River @ Keilor (230200)	0.36	Downstream Rosslynne Reservoir
Jackson Creek @ Sunbury (230202)	0.31	Downstream Rosslynne Reservoir
Deep Creek @ Bulla (230205)	0.35	Downstream Rosslynne Reservoir
Jackson Creek @ Gisborne (230206)	0.36	Immediately downstream of Rosslynne Reservoir, highly influenced by anthropogenic discharge
Pykes Creek @ Pykes Creek Reservior (231203)	0.32	Immediately downstream of Pikes Creek Reservoir, highly influenced by anthropogenic discharge
Werribee River @ Werribee (Diversion Weir) (231204)	0.22	Downstream of Pykes Creek, Merrimu and Melton Reservoir, highly influenced by anthropogenic discharge
Werribee River @ Melton Reservoir (231205)	0.26	Immediately downstream of Melton Reservoir, highly influenced by anthropogenic discharge
Pyrites Creek @ Bacchus Marsh (231214)	0.20	Downstream of Merrimu Reservoir
Little River @ Little River (232200)	0.20	No upstream reservoirs

2.8.4 Irrigation and Wetland Areas

Reference to mapping data for the area (Figure 35) suggests the presence of a large number of swamp and wetland and other surface water features throughout the area. The relative importance of groundwater and surface water inputs is poorly understood for the majority of these sites, however it is considered likely that groundwater discharge represents a significant component of the water balance at many locations. Significant groundwater discharge is also likely to be occurring to a number low lying coastal areas including:

- The Werribee and Yarra Deltas;
- The original Carrum swamp area which underlies the south eastern suburbs of Melbourne; and
- The Koo Wee Rup area including the extensive inter-tidal flats mapped within Westerport Bay; and
- The lower reaches of the Bass River.

Indirect evidence of significant groundwater discharge in the majority of these lowland areas is provided by the presence of dense artificial drainage networks.

2.8.5 Other Surface Water Bodies

As discussed previously the Port Phillip CMA includes some 33 reservoirs which are predominantly used for water supply purposes. Given that these reservoirs have typically formed behind man made dam structures they are likely to represent a source of groundwater recharge rather than discharge although this may very seasonally in response to changes in reservoir water levels.

2.8.6 Ocean

Significant groundwater discharge is also likely to occur direct to the Port Phillip and Western Port Bay. Unfortunately relatively little is known about the geology and hence the hydrogeology of the areas offshore. The margins of the Port Phillip Bay however are dominated by Quaternary & Recent sediments which are thought to increase in thickness out into the bay. The upper horizons of these deposits are likely to consist of relatively low permeability marine deposits and hence oceanic groundwater discharge is likely to decrease gradually with distance into the bay.

2.9 Stresses

2.9.1 Groundwater Abstractions

Total licensed groundwater abstractions within each GMA and WSPA area and in the remainder of the CMA are summarised in

Table 8. These values have been estimated from parish data provided by Southern Rural Water (SRW). Unfortunately information is not available on the location of all the licensed abstractions.

Table 8 therefore includes a second column summarising total abstractions from licenses where the grid reference of the abstraction is available from SRW. These abstractions are also shown in Figure 36. In most areas the location of the majority of abstractions are known and hence the two totals shown in

Table 8 are similar. However location information appears to be lacking from a significant number of licences in the Koo Wee Rup area since the total licensed quantity for the area provided by SRW (i.e. 13,440 ML/yr) is almost three times the total licensed quantity for licenses shown in Figure 36 (i.e. 4,851 ML/yr).

Estimated actual abstraction data for 2007 are shown in Table 9. Actual abstractions appear to vary widely between around 1% of the total licensed quantity in the Deutgam WSPA to around 55% in the Corinella GMA.

A large number of unlicensed stock and domestic bores are also thought to be present within the Port Phillip CMA. Based on data provided by SRW there are around 5371 such boreholes within the various GMA and WSPA areas. Assuming an estimated abstraction rate of 2 ML/yr from each borehole then this suggests an additional abstraction of 10,742 ML/d for stock and domestic use from within the GMA and WSPA areas over and above the licensed abstractions (see

Table 9). No information is currently available on the location of these stock and domestic wells.

Only very limited information is available from SRW from which time series of historic groundwater abstractions could be produced. The licence data includes a start date but information on the end date is almost entirely lacking which either suggests that licences are never revoked or that information on revoked licences are removed from the SRW database. It is therefore very difficult to build up a time series of licensed groundwater abstractions.

Information on estimated actual groundwater abstraction is currently limited to annual totals by parish from 2004/05 onwards. These data could be used to calculate an annual uptake coefficient (i.e. estimated actual abstraction / total licensed abstraction) for each parish which could then be extrapolated backwards through time to calculate an actual abstraction time series. However this approach will require a reliable time series of licensed abstraction plus since it is based on a parish based uptake coefficient is unlikely to give a reliable estimate of actual abstraction for individual abstractions.

Table 8 Total Licensed Groundwater Abstractions by GMA and WSPA Area

GMA / WSPA Area	Total Licensed GW Abstraction (ML/yr)	Licences with location information (ML/yr)
Corinella GMA	128	139
Cut Paw Paw GMA	511	451
Deutgam WSPA	5,050	4,819
Frankston GMA	988	1,018
Koo Wee Rup WSPA	13,440	4,851
Lancefield GMA	1,300	1,260
Merrimu GMA	402	238
Moorabbin GMA	2,388	2,198

GMA / WSPA Area	Total Licensed GW Abstraction (ML/yr)	Licences with location information (ML/yr)
Nepean GMA	6,880	5,554
Wandin Yallock WSPA	3,086	2,911
Other areas	20,048	10,823
Total	54,220	34,262

Table 9 Total Estimated Actual Groundwater Abstraction, 2007 by GMA and WSPA Area

GMA / WSPA Area	Licensed Abstractions (ML/yr)	Stock and Domestic Bores (ML/yr)	Total (ML/yr)
Corinella GMA	70	314	384
Cut Paw Paw GMA	242	4	246
Deutgam WSPA	51	514	565
Frankston GMA	239	398	637
Koo Wee Rup WSPA	4194	5000	9194
Lancefield GMA	360	152	512
Merrimu GMA	12	26	38
Moorabbin GMA	1169	476	1645
Nepean GMA	3285	3532	6817
Wandin Yallock WSPA	563	326	889
Other areas	?	?	?
Total	10185+	10742+	20927+

Reference to Figure 36 indicates a concentration of groundwater abstraction in the Kinglake area close to the northern boundary of the CMA. Given the proximity of these abstractions to the boundary of the Port Phillip CMA it is likely that a proportion of the abstraction drawn from the boreholes in the Kinglake GMA is derived from within the Port Phillip CMA boundary.

2.10 Conceptual Model

Conceptual sketch sections for the western half of the Port Phillip Basin and the Koo Wee Rup area in Westernport are shown in Figure 37 and Figure 38. These sections have been developed from the hydrogeological and other information discussed above in Sections 2.1 through to 2.9. The major features of each sketch are described briefly below.

Port Phillip Basin

The upland areas in the Port Phillip Basin are dominated by pre-Tertiary age basement bedrock at outcrop. Whilst rainfall in these areas is also typically high the relatively steep topography, low permeability of the basement bedrock and the dense vegetation cover results in relatively low recharge. This is reflected in the groundwater level data which suggest significant depths to water table and relatively steep hydraulic gradients. Away from the main river valley areas surface water courses in the upland areas are likely to be ephemeral.

Moving further east the geological boundary between the pre-Teriary basement bedrock and the overlying Tertiary deposits is also marked by a topographic break in slope. Groundwater level gradients also reduce and the surface water courses are underlain by significant thicknesses of Quaternary & Recent deposits. The thickness and permeability of the deposits underlying the Werribee River is sufficient to support groundwater abstractions within the Merrimu GMA. Groundwater abstraction in this area is likely to be supported at least in part by groundwater discharge from the pre-Tertiary strata up gradient.

Further east from Merrimu the Tertiary strata increase in thickness and are overlain by the Quaternary age Newer Volcanic Group and the alluvial deposits of the Werribee Delta. The Newer Volcanic Group comprises a number of separate basalt flows and hence is thought to be stratified, this is supported by information on vertical hydraulic gradients which suggest head differentials of up to 8 m. In the Werribee Delta erosion has entirely removed the Newer Volcanics in places and the Quaternary alluvium sits directly on the underyling upper Tertiary age Brighton Group. The relatively high storage and hydraulic conductivity provided by shoe string gravel deposits within the Delta is sufficient to support shallow groundwater abstraction from the Duetgam WSPA. As in the Merrimu GMA these abstractions are likely to be supported at least in part by groundwater discharge to the delta from the underlying Tertiary strata. Groundwater discharge is also likely to be occurring direct to the Port Phillip Bay in this area. Only limited eastward flow is expected in the various strata underlying the bay since the permeability of these deposits (particularly the pre-Tertiary basement) is likely to be limited by the weight of the overlying deposits. Groundwater levels in the Werribee Formation and the pre-Tertiary basement are likely to be confined beneath the overlying Fyansford Formation which is typically relatively low permeability.

Drainage of the low lying delta deposits is achieved via a dense network of drains some of which are associated with the Werribee Treatment Complex which extends south from the Werribee River as far as the Little River.

Westernport Basin

The Westernport Basin is characterised by a number of isolated Older Volcanic outcrop areas where the basalts form a high level plateau underlain by pre-Tertiary basement bedrock. In the Wandin Yallock

WSPA the Older Volcanics are sufficiently permeable to support significant groundwater abstraction. Groundwater level data for this area confirms relatively high groundwater levels in the Older Volcanics which suggests a possible perched water table in this area and groundwater discharge via springs and seepages to the various minor water courses which drain the plateau.

Moving further south the outcrop geology is dominated by pre-Tertiary basement bedrock as far as the Koo Wee Rup. As in the Port Phillip Basin the geological boundary between the basement bedrock and the younger Tertiary and Quaternary strata coincides with a marked break in topographic slope. The thickness of the overlying deposits also increases rapidly towards the Westernport Bay and hence it is likely that the majority of groundwater flow within the pre-Tertiary basement discharges into the adjacent younger deposits rather than continuing to flow southward within the basement bedrock. Groundwater abstraction from within the Koo Wee Rup area is typically from the coarse sands of the Baxter, Sherwood and Yallock Formations (known collectively as the Westernport Group). These strata form an important leaky aquifer system which is typically confined beneath the low permeability Quaternary & Recent strata which are present at the surface. Any flow within the Tertiary aquifer which is not intercepted by groundwater abstraction from the area will most likely discharge to the extensive intertidal flats system which dominates this part of the Westernport Bay.

Comparison to the Corangamite CMA

The proposed 6 layer hydrogeological structure is predominantly consistent with that already developed for the adjacent Corangamite CMA. The conceptual model for this area also comprised a 6 layer system as outlined below in Table 10.

Table 10 Summary of Hydrogeological Layers – Corangamite CMA

Layer	Age(System)	Hydrogeological Units Present
1	Quaternary 1	Quaternary sediments and dunes
2	Quaternary 2	Newer Volcanics
3	Upper Tertiary (Pleistocene to Pliocene/Miocene?)	Pliocene Sands Moorabool Viaduct Sand
4	Middle Tertiary (Miocene to Oligocene?)	Port Campbell Limestone Gellibrand Marl
5	Lower Tertiary (Oligocene/Pliocene to Palaeocene?)	Demons Bluff Formation Eastern View Formation Timboon Sand Pebble Point Formation Clifton Formation Wiridjil Gravel

Layer	Age(System)	Hydrogeological Units Present
6	Pre-Tertiary	Pre-Tertiary age basement bedrock

2.11 Assumptions and Limitations

2.11.1 Topography

Topographic information collated for the project is limited to a statewide DTM at 20m resolution. Whilst this data set should relatively accurately define the average ground level in most areas it is unlikely to provide accurate information on the elevation of surface water features particularly in low lying areas. Comparison of DTM and river survey data for other areas suggests typical errors of + or – 5m.

2.11.2 Hydrological Data

The highly variable nature of the observed flow yields in the project area suggests that reservoir releases and other surface water abstractions and discharges are significantly biasing the observed flow data set. Simulation of these surface water stresses is beyond the scope of the current groundwater modelling project and hence it may be difficult in many cases to achieve good agreement between modelled and observed baseflows in all cases.

2.11.3 Hydrogeological Structure

Key assumptions and limitations inherent in the proposed 6 layer hydrogeological framework include:

- Insufficient project resources to collate and re-interpret lithological information on borehole logs included within the GEDIS and GMS;
- Insufficient detail in the published outcrop information and borehole log information in GEDIS and GMS to identify distinct layers in the Quaternary sediments;
- Based on Holdgate & Gallagher (2003) it has been assumed that the Moorabool Viaduct Sand and the Baxter Formation are lateral equivalents of the Brighton Group and hence can be represented by the same hydrogeological layer;
- Only a single layer is proposed to represent the middle Tertiary strata which include the Fyansford Formation (and its lateral equivalents the Yallock/Sherwood Formation) plus the Batesford Limestone. Reference to Appendix B, Section 2 suggests that up to 3 middle Tertiary layers would be required to represent the low permeability Fyansford Formation and the Batesford Limestone aquifer in the Corio region. However reference to mapping of the extent of the Batesford Limestone included in Leonard (1992) confirms that the limestone is only present in the Corio Bay area immediately north of Geelong and hence is almost entirely absent from the Port Phillip CMA;
- Reference to Appendix B, Sections 3 and 5 suggests that the Lower Tertiary age Werribee Formation and the Older Volcanics are typically interbedded in a hydrogeologically complex sequence. Hence whilst it would be preferable to represent these units as separate layers at least 3 additional layers would be required and only limited information is likely to be available to carry out and/or justify

such a separation. A single composite layer is therefore proposed to represent all the Lower Tertiary deposits; and

- A single layer is proposed to represent the pre-tertiary basement bedrock. Hence no interaction with underlying fresh bedrock strata is assumed.

2.11.4 Aquifer Properties and Yields

Key limitations related to the aquifer property and yield information collated for the project include:

- Insufficient project resources to collate information on aquifer properties and yields from pumping test results included within consultants and other unpublished reports;
- Transmissivity and hydraulic conductivity have been estimated from yield test information included within the GMS database. However these values are inevitably relatively crude and have been assigned to individual strata based on the test depth, rather than definitive information on the formation tested;

2.11.5 Groundwater Levels

Key limitations related to the groundwater information collated for the project include:

- Information on the hydrgeological formation monitored are available for 327 of the 363 state observation network monitoring boreholes located within the Port Phillip CMA. The density of coverage provided by these boreholes is insufficient to produce reliable regional groundwater level contours for each formation; and
- Other groundwater level data are available via the PIRVIC and GMS databases although no information is available on the hydrogeological formation monitored. Information on the depth of these boreholes has therefore been used to assign the observed groundwater levels to individual strata;

2.11.6 Surface Water & Groundwater Interactions

As discussed above the widespread development of water storage schemes, diversions and other flow regulations is likely to significantly bias observed total flows and hence calculated baseflows in many cases. The size of the total groundwater and surface water resources is therefore poorly constrained.

2.11.7 Groundwater Abstractions

Little or no information is available from which reliable time series of licensed and/or actual abstraction can be derived.

3. Numerical Model Design

3.1 Groundwater Modelling Software

As stipulated by the DSE model development has been carried out using the MODFLOW suite of modelling code and modules. MODFLOW is a finite difference saturated groundwater flow model that has been comprehensively tested, is widely utilised and accepted, is freely available and well documented. All model runs have currently been carried out using MODFLOW 96 although the use of MODFLOW SURFACT (Hydrogeologic, 1996) was also considered since this code allows simulation of unsaturated flow using pseudo soil parameters. One advantage of this capability is that model layers remain active throughout the simulation regardless of whether a layer is saturated or not. This is particularly useful in steeply dipping formations such as the pre-Tertiary basement bedrock strata which dominate much of the outcrop area. Unfortunately initial attempts to execute the steady state model using MODFLOW-SURFACT were unsuccessful due to memory limitations. However based on feedback from the modeller reviewer Hugh Middlemiss it is possible that the Port Phillip model would execute using MODFLOW-SURFACT using starting heads from a previous steady state MODFLOW 96 simulation. Unfortunately given the compressed timeframe allowed for transient model development there has been insufficient time to test this hypothesis. Hence at this stage transferring the current model to the MODFLOW-SURFACT platform remains an option for future development.

3.2 Model Extent, Gridding and Boundary Conditions

3.2.1 Model Complexity, Extent and Gridding

Based on the aims of the project, the ultimate end use and the resources available for completion of the project the groundwater model produced is considered to be a moderately complex model according to the definitions included in the Murray Darling Basin guidelines (Middlemis, Merrick & Ross, 2000). This guidance suggests that moderately complex models should be suitable for predicting the impacts of proposed developments or management policies. This level of detail is considered to be consistent with the primary end use of the model which is to assess the impacts of proposed land use changes on the depth to water table.

The Port Phillip modelling area forms a 183 km by 148 km square covering the entire CMA (Figure 39). This area has been sub-divided into 200 m by 200 m north-south aligned model cells as stipulated by the DSE, producing a 740 row by 915 column model or up to 677,100 model cells in each layer. Given that the conceptual model developed shows a minimum 6 layer system this gives up to 4,062,600 active cells which is well in excess of the 1 million cells rule of thumb commonly used by experienced modellers to define the maximum dimensions of a viable groundwater model. Practical issues which were encountered relating to the size of the model included:

- The size of the model output files, c50GB per 15 year transient simulation;
- Long run times, c2-3 hours per 15 year transient simulation;
- Inability to use MODFLOW-SURFACT due to memory demands (see Section 3.1 above);

- Inability to use MODFLOW executables from within pre and post-processing software such as Groundwater Vistas. All model runs were therefore carried out using DOS based MODFLOW executables formatted from the original source code which was modified and re-compiled as necessary to allow for the large array sizes generated for the Port Phillip model.

3.2.2 No Flow Boundary Cells

Outcrop geology along the landward boundary of the Port Phillip CMA is dominated by pre-Tertiary age basement bedrock (Figure 10). Groundwater flow in these strata is thought likely to be limited to fracture zones and flow directions are likely to be consistent with the topography hence minimal flow across the landward Port Phillip CMA boundary is anticipated. No flow cells have therefore currently been adopted for all model layers outside of the landward boundary of the CMA. Some cross boundary flow is however likely in the Kinglake area due to the concentration of abstractions from the Kinglake GMA immediately to the north of the Port Phillip CMA boundary.

A slightly different approach has been adopted for the south western part of the groundwater model grid which includes the Port Phillip Bay, the Bellarine and Nepean Peninsulas and the offshore parts of the Ottway Basin. Whilst the Bellarine Peninsula lies outside the Port Phillip CMA, recharge to this area is likely to discharge into the Port Phillip Bay and significant cross CMA boundary flows may therefore be occurring. Similarly recharge to areas which are inside the Port Phillip CMA may well discharge to the Ottway Basin and/or the Bellarine Peninsula. The active model area therefore includes Port Phillip Bay, the Bellarine Peninsula and parts of the Ottway Basin i.e. areas which are within the Corangamite CMA area.

No-flow boundary cells are shown in grey in Figure 39.

3.2.3 General Head Boundary Cells

MODFLOW general head boundary cells set at average sea level (i.e. 0.1 mAHD) have been adopted in the upper most active layer in all offshore areas (Figure 39). A relatively high conductance value of 1000 m^2/d has been assumed for general head boundary cells such that flows into the offshore area will tend to be limited by the permeabiltity of the modelled hydrogeological units rather than the boundary conductance.

Time constant sea elevations have been assumed for the transient simulation and hence a modelled sea level of 0.1 mAHD has been assumed throughout. Minor seasonal fluctuations in average sea level are therefore not represented within the model.

3.2.4 Stream Boundary Cells

The various water courses present within the area have been represented using an extensive network of MODFLOW stream cells (Figure 39). Whilst the MODFLOW stream (STR) package is more difficult to parameterise than the alternative river (RIV) package it has a number advantages. In particular modelled baseflows are routed through the defined network and hence losses from any model stream cell are limited to the total volume of flow gained upstream, hence ensuring that modelled stream-aquifer interactions remain within realistic bounds. As a result stream boundary cells do not need to be

limited to areas where stream-aquifer interactions are thought to be occurring. An extensive stream network extending into interfluvial areas can instead be defined and MODFLOW then effectively defines the limit of perennial flow by de-activating stream cells where the modelled groundwater levels are beneath the stream bed and there is no baseflow from upstream cells.

Water levels in each stream cell have been defined using a filled version of the project DTM to resolve any issues with sinks and hence ensure that all defined stream cells flow downhill. Modelled stream stages are therefore typically set at the same elevation as the modelled ground surface which is based on DTM data. The only exceptions to this general rule is in low lying coastal areas where the DTM suggests ground elevations below sea level in some cases. For water courses which drain into the sea then a minimum stage of 0.1 mAHD has been assumed to ensure modelled stream stages are at or above modelled sea level.

The stream bed top and stream bed bottom parameters required by MODFLOW have also been derived direct from filled DTM data assuming that stream bed top = DTM - 0.5 and stream bed bottom = DTM – 0.6. This results in nominal water depth and stream bed thicknesses of 0.5 m and 0.1 m respectively, except in low lying coastal areas where modelled water depths can exceed 0.5 due to the use of a minimum stream stage of 0.1 mAHD, as described above.

Time series information on actual surface water levels is limited to the relatively small number of locations where permanent gauging stations are maintained, see Figure 6. However, surface water levels and depths can vary significantly over short distances due to site specific factors such as channel shape, slope and roughness etc and hence the limited gauging station level data set is not considered to provide reliable data on actual surface water levels for modelling purposes. In the absence of this data stream water levels have been assumed to be constant for transient modelling purposes.

MODFLOW also requires definition of a stream bed conductance for each stream boundary cell. The conductance of each stream model cell is given by the following equation:

Stream Conductance = K x L x W / M

Where:

K = stream bed hydraulic conductivity

L = stream length

W = stream width

M = stream bed thickness

In the absence of detailed survey of the stream channel and un-disturbed sampling of the stream bed materials none of these parameters is known with any degree of accuracy and hence most models use assumed stream conductivity values and assess the sensitivity of model results to this assumption. A stream conductivity value of 100 m^2/d has currently been assumed for all stream boundary cells.). This represents an effective vertical hydraulic conductivity of 0.05 m/d assuming a 200m long (i.e. the full length of a model cell) 5m wide stream with a 0.1 m thick stream bed and is considered to be towards the upper end of a realistic range of values for a silty alluvial material. The sensitivity of model results to this parameter is assessed as part of the model sensitivity analysis (Section 5).

Problems were also encountered during the steady state calibration with groundwater levels rising above the modelled ground surface in areas such as Wandin Yallock where isolated pockets of Older Volcanics (Layer 5) are present at outcrop overlying the pre-Tertiary basement bedrock (Layer 6). This problem is related to the low hydraulic conductivity values currently assigned to Layer 6 (see Sections 3.3.1 and 6.2 for further discussion of this problem). Additional stream cells were therefore added in areas where Layer 5 is present at outcrop to ensure modelled groundwater levels remain below ground surface (Figure 39). These additional cells have been parameterised to act like drain cells to prevent leakage back into the groundwater model.

3.2.5 Drain Cells

Drain cells have also been included within the model to represent the dense man-made drainage networks present in the low lying area south of the Werribee River and in the Koo Wee Rup area (Figure 39). The location of these drains has been defined using VICMAPS 'blue line' mapping information which includes information on the watercourse type. Drain elevations have been set using the project DTM. A relatively high conductance of 1000 m^2/d has been assumed for this boundary condition to ensure that flow into these boundary cells is governed predominantly by the hydraulic properties of the underlying layer rather than the drain conductance.

3.2.6 Recharge and Evaporation

Recharge as calculated by ENSYM (see Figure 33 and Section 1.1) has been applied unlagged to the uppermost active layer in each model cell. The applied recharge is therefore based on soil moisture balance and actual evapotranspiration calculations carried out in ENSYM. However, in areas where groundwater levels are present close to the surface then actual evapotranspiration is likely to exceed the rates estimated by ENSYM since this model assumes that rainfall provides the only input to the soil moisture balance. Hence the MODFLOW evaporation (EVT) package has also been used to estimate additional evapotranspiration losses from any areas where modelled groundwater levels approach the surface. In order to ensure consistency with the recharge model and prevent double counting of evaporative losses the maximum evaporation rate (EVTR) for use in MODFLOW has been taken as:

- 0.45 (PE – AE)

Where:

- PE = Potential Evapotranspiration, extracted from ENSYM
- AE = Actual Evapotranspiration, extracted from ENSYM; and
- 0.45 is a correction factor applied to the ENSYM evaporation data to ensure consistency between the total volume of evaporation calculated by the two models. MODFLOW reduces evaporation linearly from the potential rate at the evaporative surface (ground level in this case) to zero at the extinction depth. Whilst ENSYM uses a non-linear Ritchie root distribution function (pers comm. Craig Beverly, DPI).

This approach effectively ensures that the sum of actual evapotranspiration (as calculated by ENSYM) and groundwater evaporation (as calculated by MODFLOW) in each cell cannot exceed the potential evapotranspiration rate (see Figure 3).

Other input parameters required by the MODFLOW evaporation package include definition of an upper evaporation surface (SURF) and evaporation extinction depth (EXDP). For the Port Phillip model these parameters have been defined as follows:

- Upper evapotranspiration surface (SURF) = modelled ground surface
- Extinction depth = ENSYM rooting depth

Average rooting depths from ENSYM data vary between 0.01 and 5480 mm.

Like recharge evaporation has been assumed to occur from the highest active layer in each model cell.

In order to prevent numerical stability issues related to conflicts between critical elevations, as defined in the MODFLOW evaporation and stream packages, evaporation rates for the steady state simulation were set to zero in stream cells. An alternative approach to this problem is to reduce the modelled stream stage elevations to below the evaporation extinction depth which effectively switches off evaporation in stream cells anyway. In this case this latter option was not considered optimal since it would result in stream stages at below the modelled sea level in coastal areas which is not considered realistic.

For the transient model evaporation has been allowed from every cell including stream cells and this has been achieved without significantly affecting the model stability. However some additional stability issues were encountered during the transient modelling in cells where the modelled extinction depth exceeded the thickness of the uppermost active layer. This reflects an inconsistency between the maximum ENSYM extinction depths, which are up to 5.48m, and the minimum layer thickness of 1m adopted for the groundwater model. To overcome this issue it was necessary to cross check and reduce the modelled extinction depth in any cells where it exceeded the thickness of the uppermost active layer.

3.2.7 Lakes and Reservoirs

Lakes and reservoirs within the Port Phillip CMA have currently not been included within the groundwater flow model.

3.3 Model Layers – Spatial Extent and Initial Parameterisation

The numerical model includes a six layer representation of the three dimensional regional geology as described in Section 2.7.2 and summarised in Table 4. Isopachs of each model layer are shown in Figure 41 to Figure 46.

The elevation of the top of each layer has been defined using the following data:

- 1:250,000 scale geological mapping data which effectively defines the upper surface of each layer where it occurs at outcrop;
- Interpreted borehole log data provided by SKM which is currently being used as an input data set for the ongoing Smart Water funded Port Phillip Hydrogeological Mapping project; and

- Information on the elevation of the top of the Newer Volcanic Group and the thickness of the Maddingley Coal Seam and Quaternary & Recent sediments from lithological log data stored within the GMS and GEDIS databases.

The borehole data used to create each layer are shown in Figure 41 to Figure 46. Model layers were initially created in isolation and then overlain and cross referenced to ensure that the modelled outcrop is as similar as possible to the geological mapping information, and that the final layers are suitable for use in MODFLOW. In particular MODFLOW does not allow subcropping model layers to pinch out and hence although the Newer Volcanic Group (Layer 2) is only present in the west of the area it is active everywhere where the Quaternary & Recent deposits are present. In areas where it is not actually present a minimum thickness of 1 m and the hydraulic properties of the underlying layer (i.e. the underlying Upper Tertiary Unit, Layer 3) have been assumed.

Hydraulic parameter ranges considered acceptable for model calibration purposes are outlined in Appendix E. Given that individual model layers represent in some cases a number of different units which are present in different areas a small number of parameter areas or zones have been identified for each layer. For example the Fyansford Formation is thought to relatively sandy and hence more permeable to the east of Melbourne than to the west. In addition the Fyansford Formation is not thought to present within the Koo Wee Rup area where the middle Tertiary age strata comprise the Sherwood and Yallock Formations.

The delineation and definition of parameter zones in each model layer is described in Section 4.1.2.

3.3.1 Pre-Tertiary Basement Bedrock Parameterisation

Initial steady state model runs were carried out assuming a thickness of 200 m for the pre-Tertiary basement bedrock strata and assuming a single hydraulic conductivity value of 0.5 m/d. However given the steep topography in the majority of pre-Tertiary outcrop areas significant problems were encountered with this layer drying out over large parts of the model. Given the thickness of the basement bedrock and the likely very low permeability at depth it is not considered realistic for this layer to dry out. As an initial effort to resolve this problem the hydraulic conductivity of the pre-tertiary basement was decreased with depth of burial based on the relationship shown in Figure 22. This is broadly consistent with the conceptual model presented in Figure 37 and Figure 38, although since only one layer has been used it is not possible to represent the effect of weathering in outcrop areas. This only presented a partial solution and hence the model was migrated across to MODFLOW SURFACT, as discussed previously in Section 3.1, since this version of MODFLOW also simulates un-saturated flow which effectively prevents any layers drying out. Unfortunately it was not possible to run the Port Phillip model using the available hardware and hence as an alternative the pre-Tertiary basement (Layer 6) was simulated using a flat bottom at -1420 mAHD (i.e. 50m below the top of the pre-Tertiary strata in the Otway Basin). Hydraulic conductivity for this layer, which is up to around 3000 m thick in places, was then calculated by dividing the depth dependent transmissivity values defined by the relationship shown in Figure 22 by the layer thickness. This ensures a realistic total transmissivity of around 10 m^2/d in outcrop areas falling to around 1 m^2/d where the pre-Tertiary strata are buried to 200 m. The low calculated hydraulic conductivity values are therefore equivalent to an average for the modelled pre-Tertiary bedrock mass i.e. a thin relatively high permeability weathered horizon close to

the surface underlain by a thick relatively low permeability fresh rock mass. A conceptually more representative alternative would be to use MODFLOW 96 VKD (Environment Agency, 2003) a publicly available MODFLOW variant developed for the UK Environment Agency which allows hydraulic conductivity to be varied within a single layer. The use of MODFLOW 96 VKD was considered during transient model development, since it would allow a high permeability weathered horizon and low permeability bedrock to be represented more correctly within a single layer. However this option was not pursued based on guidance from the model reviewer Hugh Middlemiss who mentioned stability issues associated with this version of the MODFLOW code.

3.4 Steady State and Transient Simulation Periods

3.4.1 Steady State Time Selection

As discussed during the state-wide modelling workshop on the 4th August 2008, the primary purpose of the steady state modelling was to set initial conditions for subsequent transient simulations as well as provide preliminary estimates of hydraulic conductivity for further calibration using the transient model.

Steady state modelling was therefore carried out using long term average recharge and evapotranspiration data sets extracted from the full ENSYM simulation period i.e. 1957 to 2005.

3.4.2 Steady State Abstractions

The simulation of groundwater abstractions is typically problematic in steady state models. If say current groundwater abstractions are included then the impacts of these abstractions tend to be over-estimated (and hence groundwater levels under-estimated) since the steady state nature of the model means that the simulated abstractions are effectively assumed to have been taking place continuously. Conversely where groundwater abstractions are not included then abstraction impacts will obviously be under-estimated and hence groundwater levels will tend to be over-estimated. Either option is therefore a potential source of significant error in the steady state calibration. However reference to the available groundwater level data for Port Phillip (see Appendix C) suggests a general lack of significant abstraction impacts, apart from in the Koo Wee Rup area, and hence the zero abstraction option was considered most appropriate in the Port Phillip CMA.

3.4.3 Steady State Calibration Data Sets

Given that abstractions have not been included in the steady state model and that long term average recharge has been assumed (see Sections 3.4.2 and 3.4.2 above) it would have been preferable to calibrate against pre-abstraction groundwater level data. However, other than spot groundwater level readings during drilling of the boreholes included within the GMS database, groundwater level and surface water flows data are typically not available until the late 1960s. Hence there are little or no reliable data for from which to calculate long term average pre-abstraction groundwater levels and baseflow for calibration purposes. Steady state groundwater levels have therefore been calibrated against long term average groundwater levels for all boreholes with time series data. Whilst this is not ideal, as discussed in Section 3.4.2 above, the available groundwater level data shows a general absence of long term trends and hence pre and post abstractions groundwater levels should be

comparable in many areas. Exceptions to this general rule include the Koo Wee Rup area where current groundwater levels are below sea level in many boreholes suggesting significant groundwater abstraction impacts. Given that zero abstraction has been assumed it should be expected that modelled steady state groundwater levels will exceed observed level in Koo Wee Rup and other areas where abstraction impacts have occurred.

Modelled baseflows have also been compared to long term average naturalised flow yields where available since actual total flow and baseflow yields are known to have been biased by reservoir discharges.

3.4.4 Transient Time Selection

Given that the ENSYM runoff-recharge model of the area has been run for the period from January 1957 to December 2005 it would be possible to run the transient model for this full 48 year period. However given that:

- The recharge model is based on a static picture of current land use;
- The majority of the other project data sets are relatively recent; and
- Transient runs will take some time to complete given the size of the model.

Based on feedback from the model reviewers all transient simulations have been run over the 15 year period from January 1991 to December 2005 inclusive. However, for calibration purposes more emphasis was placed on the last 10 years of this period i.e. 1996 to 2005 inclusive since the long term average (1957 to 2005) data set used for the steady state simulation may not be representative of climatic conditions in the years immediately prior to the intended transient start date (i.e. January 1990).

Monthly stress periods have been adopted for the transient simulation giving a total of 180 model stress periods over the 15 year simulation period. Initially a single model time step was applied in each stress period although this was increased in selected stress periods during model calibration in order to ensure that modelled water balance errors remained within acceptable limits (see Section 4.1.2).

3.4.5 Transient Groundwater Abstractions

As previously discussed in Section 2.9.1 information on licensed and actual abstraction quantities is limited in a number of key areas including:

- No information is available on the location of unlicensed abstractions;
- Location information for some licensed abstractions is missing particularly in the Koo Wee Rup area;
- No reliable data on actual abstraction is available for the calibration period, although estimated total abstraction data by WSPA / GMA area are available for 2007;
- Whilst information is typically available indicating the start date of each licence no data are available on end dates; and
- No information is available on the abstraction formation although data on screened intervals and/or maximum borehole depths are typically available via the GMS database.

Bearing in mind these limitations monthly abstraction time series for use in the transient groundwater model have been derived as described below.

Initially a time series of annual licensed quantities was developed for each abstraction, where information on both the location and quantity of the licence was available. Time series of estimated actual abstractions were then derived by multiplying the annual quantities by:

- The abstraction uptake coefficients shown in Table 11, hence generating time series of estimated actual annual quantities; and
- The use specific monthly abstraction profiles shown in Table 12, hence generating monthly time series.

Uptake factors were tweaked as necessary on an area by area basis to ensure that the total abstraction modelled for 2007 for each GMA/WSPA was equal to the estimate actual quantities shown in Table 9. This approach also indirectly accounts for any missing abstractions in the licence location data by distributing the estimated total abstraction between the licences with location information. In areas such as Koo Wee Rup where there are significant numbers of licences with no location information it was expected that this might result in actual abstractions from licences with location information being over-estimated. However, transient modelling results (see Section 4.3.2) suggest that if anything abstractions from the Koo Wee Rup area are still being under-estimated.

The adopted monthly abstraction profiles were taken from other modelling work undertaken for the DSE in the Lower Ovens catchment. These profiles suggest marked increases in irrigation abstraction during the summer months (as would be expected), slightly increased stock and domestic abstractions over the same period but little or no variation in abstractions for industrial or dairy use.

Table 11 Modelled Abstraction Uptake Coefficients

GMA/WSPA Area	Uptake Coefficient
Corinella	0.55
Cut Paw Paw	0.53
Deutgam	0.20
Frankston	0.23
Heywood	0.3
Kinglake	0.6
Koo Wee Rup-Dalmore	0.48
Lancefield	0.28
Lang Lang (now part of Koo Wee Rup)	0.85

GMA/WSPA Area	Uptake Coefficient
Merrimu	0.2
Moorabbin	0.54
Nepean	0.76
Wandin Yallock	0.19
Others	0.3

Table 12 Monthly Abstraction Profiles

Monthly	Irrigation	Stock & Domestic	Industry	Dairy	Other
January	0.25	0.1	0.084	0.084	0.1
February	0.2	0.1	0.084	0.084	0.1
March	0.203	0.1	0.083	0.083	0.1
April	0.08	0.09	0.083	0.083	0.09
May	0	0.08	0.083	0.083	0.08
June	0	0.07	0.083	0.083	0.07
July	0	0.06	0.083	0.083	0.06
August	0	0.06	0.083	0.083	0.06
September	0.006	0.07	0.083	0.083	0.07
October	0.011	0.08	0.083	0.083	0.08
November	0.05	0.09	0.084	0.084	0.09
December	0.2	0.1	0.084	0.084	0.1

Given the lack of any actual data on the aquifer each abstraction draws its water from it was also necessary to ‘guesstimate’ which model layer to assign each abstraction to. This was done initially through comparison of the screened interval, or maximum borehole depth, to the model geometry at

each location to identify the lowest layer screened or penetrated by the abstraction borehole. The results of this analysis were then quality checked through comparison with general information on which formations are typically targeted in different areas (see Table 13) and manual adjustments to the abstraction layer made as necessary.

Table 13 Modelled Abstraction Layers

GMA/WSPA Area	Dominant Abstraction Formation	Model Layer
Corinella	Childers Formation	5
Cut Paw Paw	Werribee Formation	5
Deutgam	<30m	1-2
Frankston	Brighton Group	3
Kinglake	Humevale Siltstone	6
Koo Wee Rup/Lang Lang	All Tertiary units i.e. Layers 3-5	3-5
Lancefield	Ordovician Sandstone and Mudstone	6
Merrimu	Quaternary sediments	1
Moorabbin	Brighton Group	3
Nepean	Quaternary sediments	1
Wandin Yallock	Older Volcanics	5

Using the approach outlined above time series of estimated actual abstractions from some 1207 licensed abstractions were developed and imported into the model. Average abstraction over the entire model area and modelling period (i.e. January 1991 to December 2005) is only around 34 ML/d and hence groundwater abstraction is likely to represent a relatively minor, although potentially locally important, component of the overall water balance for the CMA.

It should be noted that whilst the approach outlined above is considered to be a rigorous attempt at generating time series of actual abstraction for modelling purposes reliable data on actual quantities can only be provided by metering of all major abstractions. It is unlikely that any of the modelled time series represent an accurate simulation of actual abstraction at any individual location and this represents a significant barrier to accurate simulation of groundwater levels in boreholes that are affected by nearby abstractions. This limitation is discussed further in Sections 4.1.2 and 6.6.

3.4.6 Transient Calibration Data Sets

Transient calibration was achieved through comparison of observed and simulated groundwater levels at all available observation boreholes with time series data over the selected calibration period (January 1991 to December 2005). Boreholes with time series data over this period include:

- 336 State Observation Network (SON) Boreholes;
- 86 GMS boreholes with time series data; and
- 126 PIRVIC monitoring boreholes.

As discussed previously in Section 2.7.5 whilst the borehole datum is typically known for the majority of these boreholes confirmation of the formation monitored is only available for the SON boreholes. For the PIRVIC and GMS boreholes it was therefore necessary to 'guesstimate' which formation or model layer each borehole is likely to be monitoring. Given the shallow depth of the PIRVIC boreholes it has been assumed that these bores are monitoring the uppermost hydrogeological unit or model layer. Model layers were assigned to the GMS boreholes through comparison of screen or maximum borehole depths and modelled layer thicknesses.

Model calibration was also tested against estimated baseflows for selected permanent flow gauging locations which are not thought to be significantly biased by releases from upstream reservoirs. In total 18 gauges were identified which are not thought to be downstream of any major reservoirs. Baseflow separations were carried on total flow data for each of these gauges using the same USGS HYSEP methodology (Sloto & Cruse, 1996) used to assess baseflows at the gauges listed in Table 7. Calculated baseflow indices for the 18 gauges considered during transient model calibration are shown in Table 14, along with data on baseflow and total flow yields and catchment area. Comparison of the total flow yields shown in Table 14 with more general information on flow yields in the project area (see Table 2) indicates very low flow yields at the Goodman Creek Junction, Melton South, Parwan and Little River gauges which suggests flows may be being under-recorded at these locations.

Table 14 Calculated Baseflow Indices, Transient Calibration Gauges

Gauge Name / Ref No	Catchment Area (km^2)	Baseflow Index (BFI)	Total Flow Yield (mm/yr)	Baseflow Yield (mm/yr)
Eumerring Creek @ Lyndhurst (228203)	149	0.23	154	36
Dandenong Creek @ Dandenong (228204)	-	0.23	-	-
Tarago River @ Neerim (228206)	80	0.67	235	157
Bunyip River @ Headworks (228207)	-	0.68	-	-
Lang Lang River @ Hamiltons Bridge (228209)	288	0.35	210	74
Bunyip River @ Tonimbuk (228212)	174	0.69	184	127
Toomuc Creek @ Pakenham (228217)	58	0.35	120	42

Gauge Name / Ref No	Catchment Area (km^2)	Baseflow Index (BFI)	Total Flow Yield (mm/yr)	Baseflow Yield (mm/yr)
Little Yarra River @ Yarra Junction (229214)	140	0.77	345	267
Woori Yallock Creek @ Woori Yallock (229215)	312	0.64	286	181
Saltwater Creek @ Bullengarook (230210)	-	0.23	-	-
Emu Creek @ Clarkefield (230211)	79	0.34	96	33
Turritable Creek @ Mount Macedon (230213)	-	0.67	-	-
Lerderberg Creek @ Goodman Creek Junction (231211)	1046	0.39	20	8
Lerderberb Creek @ Sardine Creek Crossing (231213)	66	0.44	411	181
Werribee River @ Ballan (231225)	-	0.40	-	-
Toolern Creek @ Melton South (231231)	67	0.12	39	5
Parwan Creek @ Parwan (231234)	154	0.12	9	1
Little River @ Little River (232200)	400	0.20	17	3

Whilst these gauges have been used as an indicator of modelled fit there are a number of limitations associated with using a comparison of calculated and modelled baseflows to assess model reliability. There limitations include:

- Baseflow separation accuracy. Given that actual baseflow cannot be measured directly then the accuracy of the baseflow estimate cannot be confirmed. However, given that total flow records from reliable gauging stations are likely to be characterised by errors of plus or minus 10% then any estimate of baseflow derived from these total flow is likely to be characterised by errors of at least plus or minus 20-25%; and
- Surface water abstractions are not included in the groundwater flow model;
- Modelled baseflows are typically relatively insensitive to changes in the modelled hydraulic conductivity and/or storage instead being largely dependent on total modelled recharge to the upstream catchment;

Accurate model calibration to flow therefore only represents an achievable goal in integrated groundwater and surface water resource models which include simulation of surface water abstractions, runoff, interflow and baseflow thereby producing estimates of modelled total flow for comparison with observed total flow data. For a groundwater model such as this where recharge is provided by an external recharge model and runoff and interflow are not routed through either model then comparison of modelled and estimated baseflows only provides a guide to the reliability of model calibration.

4. Model Calibration

4.1 Major Parameter Changes

4.1.1 Phase 1 Steady State Model

An acceptable steady state calibration was achieved during Phase 1 of the project with a relatively simple parameter zonation system and minor adjustments to the initial parameter set. Two zones were used to simulate parameter variations in model layers 1, 3 and 4 with relatively high permeabilities west of Melbourne and relatively low permeabilities east of Melbourne. This zonation is consistent with data presented in Leonard's paper (Leonard, 1992) which suggested changes in the hydraulic properties of units such as the Brighton Group and Fyansford Formation around the Melbourne area. Two zones were also used to represent the Werribee Formation and Older Volcanics (Layer 5), model results suggesting that the fractured Older Volcanics in the Wandin Yallock area were likely to be more permeable than the interbedded Werribee Formation and Older Volcanics found elsewhere. A single value of hydraulic conductivity was assigned to the Newer Volcanics (Layer 2). As described previously a continuous distribution of values based on the depth of burial (see Figure 22) was used to represent the hydraulic conductivity of the pre-Tertiary bedrock (Model Layer 6). Hydraulic conductivity values for Layer 6 were initially derived using the best fit line shown in Figure 22 which gives a transmissivity value of 10 m^2/d in outcrop areas. Hydraulic conductivity and hence transmissivity were, however, gradually increased during the steady state calibration process by multiplication of the initial grid of values. A final calibrated equivalent transmissivity of around 40 m^2/d in outcrop areas, reducing gradually with depth of burial, was adopted for Layer 6. Whilst this is considered to be relatively high for the bedrock it is within the realistic range of values shown in Appendix E and does result in significantly better fit to the observed data.

At the end of Phase 1 an overall scaled RMS error of 2.0% was reported which was well within the 5% target specified for Phase 1 of the project (see Section 1.3).

4.1.2 Phase 2 Transient Model

Initial runs of the transient model also suggested a low scaled RMS error of 2.2% i.e. already well within the 10% target specified for the transient Phase 2 model. However, further examination of the detail of the model output and feedback from the external reviewers revealed that some further work was required to improve the model performance in the following areas:

- Elevated (>2%) water balance errors were initially modelled in around 10% of stress periods;
- A tendency for model cells to dry out in some areas including Bacchus Marsh, Corinella, Frankston, Koo Wee Rup WSPA North West and the Yarra River Catchment;
- Marked downward trends in modelled groundwater levels in some of the Koo Wee Rup, Moorabbin, Nepean and Wandin Yallock boreholes not seen in the observed data;

- Consistent over or under-estimation of observed groundwater levels in several discrete areas including Wandin Yallock, Koo Wee Rup, Woodend, Woolamai, Werribee, Nepean Peninsula, Merrimu, French Island and Bacchus Marsh; and
- A need to revise the initial storage parameters to reduce groundwater level fluctuations in some areas particularly Bacchus Marsh, Woolamai, Wandin Yallock and the Yarra River Catchment;

These issues were resolved as far as possible using a combination of parameter adjustments and other model adjustments as described below.

Evaporation Package

The elevated water balance errors and to a lesser extent the tendency for selected model cells to dry out were traced to cells where the modelled extinction depth exceeded the thickness of the uppermost active layer. As discussed previously in Section 3.2.6 this reflects an inconsistency between the maximum ENSYM extinction depths, which are up to 5.48m, and the minimum layer thickness of 1m adopted for the groundwater model. To overcome this issue it was necessary to cross check and reduce the modelled extinction depth in any cells where it exceeded the thickness of the uppermost active layer.

Downward Trending Boreholes

Results from initial transient model runs showed marked downward trends in modelled groundwater levels in some Koo Wee Rup, Moorabbin, Nepean and Wandin Yallock boreholes not seen in the observed data. Based on discussions during the Phase 2 review meeting it was suggested that this feature might be a result of:

- Incorrect initial heads related to the use of a long term average 1957 to 2005 data set for the steady state simulation which may not be representative of climatic conditions in the years immediately prior to the intended transient start date (i.e. January 1990); and/or
- Over-estimated abstraction rates or under-estimated hydraulic conducitivity/storage values leading to over-estimation of abstraction impacts.

In order to isolate which of these explanations was most likely further sensitivity runs of the transient model were undertaken as follows:

1. Switching off abstraction (to assess sensitivity to abstraction rates);
2. Using a different (lower) set of initial groundwater levels based on a re-run of the steady state model but using average recharge for the January 1991 to December 2005 period (to assess sensitivity to starting conditions); and
3. Increasing hydraulic conductivity of Layer 1 in the Nepean Peninsula area.

Analysis of modelled output from these runs indicated that the modelled trends were relatively insensitive to the abstraction rate or starting heads but that the modelled fit could be improved by increasing the hydraulic conductivity. This suggests that the modelled downward trends are a reflection of a general downward trend in modelled recharge over the relatively dry calibration period.

Based on the results of these sensitivity runs the modelled fit in the Nepean Peninsula was significantly improved by adding a new parameter zone and gradually increasing the hydraulic conductivity of the Quaternary deposits in this area (predominantly Aeolian dunes) from 3 to 20 m/d.

Similar changes were considered in the other areas including Moorabbin, Koo Wee Rup and Wandin Yallock where marked trends can be seen in the modelled data. However unlike the Nepean Peninsula area the other bores showing marked trends were relatively isolated examples in areas where there is no consistent pattern of over-estimated groundwater levels during the early part of the calibration period. Increasing hydraulic conductivity in these areas would not therefore have improved the overall calibration.

Parameter Zonation

Additional zones were added to the Quaternary sediments (Layer 1) based on lithological information including in published geological mapping for the area which suggests the presence of five different dominant lithologies comprising: Aeolian Dunes (Zone 103); weathered Newer Volcanics (Zone 104); Alluvium (Zone 105); Colluvium (Zone 107); and Palustrine (i.e. lake bed) deposits (Zone 106). As described above an additional elevated hydraulic conductivity zone (Zone 123) was also added to improve the model calibration in the Nepean Peninsula. The final parameter zones adopted for Layer 1 are shown in Figure 47.

Layer 2 represents the Newer Volcanics and as such is only actually present in the west of the area. However, limitations inherent within MODFLOW mean that Layer 2 must be present in any areas where Layer 1 is present at outcrop i.e. subcropping layers cannot pinch out. A single parameter zone (Zone 58) has therefore been used to represent the Newer Volcanics where this unit is present. In areas where the Newer Volcanics are not present but where Layer 1 is present at outcrop (e.g. in the Koo Wee Rup area) a minimum 1m thickness of Layer 2 is assumed and hydraulic properties are copied from the underlying upper Tertiary units (Layer 3). Comparison of Figure 48 and Figure 49 therefore shows an identical parameter zonation system for Layers 2 and 3 outside of the area the Newer Volcanics are though to be present.

Three zones were initially adopted for hydraulic conductivity and storage values in Layer 3 representing the approximate boundaries of the Brighton Group (Zone 101), Baxter (Zone 100) and Haunted Hills (Zone 102) formations (as estimated from SON borehole data and maps included in Leonard, 1992). Following initial model runs a fourth zone was added separating the Brighton Group into two distinct zones east and west of Melbourne (Zones 117 and 100 respectively). This same conceptual idea was included in the Phase 1 steady state model (see Section 4.1.1) and is consistent with data presented in Leonard's paper (Leonard, 1992) which suggests typically higher yields and hydraulic conductivity values to the east of the city. Further zones were also added in the upper reaches of the Yarra valley. This is an area where outcrop mapping suggests the presence of relatively thin Quaternary sediments at outcrop (i.e model layer 1) along the river valley overlying pre-Tertiary bedrock units (i.e. model Layer 6). The intervening upper, middle and lower Tertiary units (model layer 3, 4 and 5) are therefore not thought to be present and this situation has been represented in the model by copying values from Layer 1 to all of underlying layers above the bedrock (i.e. Layers 2,3,4 and 5). The final parameter zones adopted for Layer 3 are shown in Figure 49.

As for Layer 3 three zones were initially adopted for hydraulic conductivity and storage values in Layer 4 representing the approximate boundaries of the Fyansford Formation (Zone 110), Sherwood / Yallock Formation (Zone 112) and mapped deep marine sediments (Zone 109). A fourth zone was added after initial model runs to separate the Fyansford Formation into to zones east (Zone 118) and west (Zone 110) of Melbourne. Layer 4 zonation in the upper Yarra valley is the same as for Layer 3 (see above). A further high permeability zone (Zone 122) was also added in Layer 4, in Koo Wee Rup in an area bounded by the Heath Hill, Koo Wee Rup and Lang Lang faults (see Figure 10), in order to improve the model calibration in this area. The final parameter zones adopted for Layer 4 are shown in Figure 50.

Four zones were initially adopted for hydraulic conductivity and storage values in Layer 5 representing the approximate boundaries of the Childers and Werribee Formation (Zones 114 and 116 respectively) and also areas where these units are thought to be interbedded with the Older Volcanics (Zones 113 and 115). Two further zones were added during model calibration to improve the fit to observed groundwater level data in the Wandin Yallock (Zone 120) and in an area north and west of Melbourne known as the Yarra River Catchment (Zone 124). Somewhat surprisingly given the steady state results (see Section 4.1.1) a more accurate transient calibration was achieved in the Wandin Yallock area by using a relatively low hydraulic conductivity value. The final parameter zones adopted for Layer 5 are shown in Figure 51.

As described previously a continuous distribution of values based on the depth of burial (see Figure 22) was used to represent the hydraulic conductivity of the pre-Tertiary bedrock (Model Layer 6) in the steady state model. This approach was retained during transient model calibration although the modelled values were 'tweaked' slightly, using a multiplier grid approach, in order to reduce modelled residuals as far as possible whilst maintaining the transmissivity of Layer 6 within acceptable limits. In practice this process was only moderately successful at reducing modelled residuals particularly in areas where the model tends to over-estimate groundwater levels in bedrock strata. This is discussed further in Section 4.2, below. The final conductivity values adopted for Layer 6 are shown in Figure 52.

A simpler approach to parameterisation of storage in Layer 6 was adopted whereby twenty four zones were identified initially, based on GIS data downloaded from the Geology Victoria website which includes lithological data for bedrock units at both outcrop and subcrop. Reference to the lithological data, however, suggested the presence of only three broad lithological types within these 24 zones i.e. intrusive and extrusive metamorphics and mixed sequences of fluvial or marine derived sandstones, siltstones, shales etc. Only three different parameter sets were therefore used in the modelling and these values remained unchanged during calibration (see Table 16).

Parameter Adjustment

Having defined zones in each layer as described above modelled hydraulic conductivity and storage values were then adjusted as necessary, within the acceptable parameter ranges outlined in Appendix E, in order to improve the model fit in selected areas. The following 'major' parameter changes were undertaken:

- Bedrock Layer 6 hydraulic conductivity 'tweaked' slightly using a multiplier grid approach in order to reduce modelled residuals as far as possible whilst maintaining the transmissivity of Layer 6 within acceptable limits;

- Reduced hydraulic conductivity and storage values for the Older Volcanics (Layer 5) in the Wandin Yallock area (Zone 120);
- Reduced storage and increased hydraulic conductivity values for the Newer Volcanics (Layer 2, Zone 58);
- Increased hydraulic conductivity for the Aeolian Dune deposits (Layer 1) in the Nepean Peninsula (Zone 123);
- Increasing storage values in the Werribee and Childers/Older Volcanics (i.e. Model Layer 5, Zones 113 and 116) to improve the modelled fit in the Western Port and Woolamai areas;
- Increased hydraulic conductivity values in the Koo Wee Rup area in Layers 1-5 (i.e. Zones 100, 102, 112, 121 and 122) to reduce modelled groundwater levels; and
- Adjusting modelled storage values in outcropping layers such that storativity is equal to specific yield hence preventing MODFLOW from using the confined storage when modelled heads exceed the ground surface, thereby improving modelled fit in the Bacchus March area.

4.2 Calibrated Parameters

Calibrated hydraulic conductivity values for each model layer and parameter are shown in Table 15 and also in Figure 47 to Figure 52. Vertical conductivity was typically assumed to be one tenth of the horizontal value in most cases apart from in the various Quaternary units modelled in Layer 1 where a ratio of 1:100 has been assumed to reflect the stratified nature of these deposits, and the presence of low permeability silts in areas such as the Werribee and Yarra Deltas.

Calibrated storage values are summarised in Table 16.

Table 15 Calibrated Hydraulic Conductivity Values

Dominant Unit	Model Layer	Model Zone	Kh (m/d)	Kv (m/d)
Quaternary Sediments - Aeolian Dunes	1	103	3	0.03
Quaternary Sediments - Aeolian Dunes, Nepean Peninsula	1	123	20	0.2
Quaternary Sediments - Colluvium	1	107	1	0.01
Quaternary Sediments – Weathered Newer Volcanics	1	104	5	0.5
Quaternary Sediments – Alluvium	1	105	1	0.01
Quaternary Sediments – Palustrine	1	106	0.5	0.05
Newer Volcanic Group	2	58	2.5	0.25
Brighton Group West	3	101	1	0.1
Brighton Group East	3	117	10	1
Baxter Formation	3	100	10	1.0
Haunted Hills Formation	3	102	10	1.0

Dominant Unit	Model Layer	Model Zone	Kh (m/d)	Kv (m/d)
Fyansford Formation West	4	110	0.1	0.01
Fyansford Formation East	4	118	10	1
Sherwood/ Yallock Formation	4	112	10	1.0
Sherwood/ Yallock Formation Koo Wee Rup Fault Zone	4	122	30	3.0
Deep Marine Sediments	4	109	0.01	0.001
Werribee Formation	5	116	5	0.5
Werribee Formation / Older Volcanics	5	115	1	0.1
Childers Formation	5	114	10	0.1
Childers Formation / Older Volcanics	5	113	1	0.1
Werribee Formation / Older Volcanics – Wandin Yallock Area	5	120	0.35	0.035
Werribee Formation / Older Volcanics – Yarra River Catchment	5	124	3.0	0.03
Basement Bedrock[17]	6	Entire CMA	$8x10^{-7}$ to 0.03	$8x10^{-8}$ to 0.003

Table 16 Calibrated Storage Values

Dominant Unit	Model Layer	Model Zone	Specific Yield, Sy	Storativity, S
Quaternary Sediments - Aeolian Dunes	1	103	0.1	NA
Quaternary Sediments - Aeolian Dunes, Nepean Peninsula	1	123	0.1	NA
Quaternary Sediments - Colluvium	1	107	0.05	NA
Quaternary Sediments – Weathered Newer Volcanics	1	104	0.04	NA
Quaternary Sediments - Alluvium	1	105	0.075	NA
Quaternary Sediments – Palustrine	1	106	0.04	NA
Newer Volcanic Group	2	58	0.04	0.0004
Brighton Group West	3	101	0.05	0.0005
Brighton Group East	3	117	0.05	0.0005
Baxter Formation	3	100	0.075	0.0075
Haunted Hills Formation	3	102	0.1	0.001

[17] See Figure 47

Dominant Unit	Model Layer	Model Zone	Specific Yield, Sy	Storativity, S
Fyansford Formation West	4	110	0.04	0.0004
Fyansford Formation East	4	118	0.04	0.0004
Sherwood/ Yallock Formation	4	112	0.075	0.00075
Sherwood/ Yallock Formation Koo Wee Rup Fault Zone	4	122	0.075	0.00075
Deep Marine Sediments	4	109	0.04	0.0004
Werribee Formation	5	116	0.1	0.001
Werribee Formation / Older Volcanics	5	115	0.01	0.0001
Childers Formation	5	114	0.1	0.001
Childers Formation / Older Volcanics	5	113	0.01	0.0001
Werribee Formation / Older Volcanics – Wandin Yallock Area	5	120	0.01	0.0001
Werribee Formation / Older Volcanics – Yarra River Catchment	5	124	0.01	0.0001
Intrusive/Extrusive Metamorphics	6	70-82, 93 and 94	0.0001	0.01
Fluvial Sandstone, Siltstones, Shales etc	6	83-87	0.00075	0.075
Marine Sandstone, Siltstones, Shales etc	6	88-92	0.0004	0.04

Comparison of the calibrated values shown above in Table 15 and Table 16 and the values shown in Appendix E. indicates that the modelled hydraulic conductivity and storage values are typically towards the upper end of the ranges considered to be realistic for each hydrogeological unit. This suggests that the current recharge estimate provided by the ENSYM model may represent an over-estimate of actual recharge or in some cases that groundwater abstractions may have been under-estimated.

4.3 Comparison of Observed and Modelled Groundwater Levels

4.3.1 Steady State

Scatter plots of modelled steady state against observed long term average groundwater levels for state observation network and other boreholes are shown in Figure 53 and Figure 54 respectively. Calibration statistics are summarised in Table 17 and Table 18.

Steady state calibration results indicate a scaled RMS error of 1.7% overall (Table 17) which is within the 5% target specified for the project (Section 1.3). Modelled groundwater levels are within 5 m of observed at around 68% of the locations for which time series groundwater level data are available (Table 18). Given that the average error in the modelled ground surface (which defines the elevation of all of the modelled discharge boundaries and is based on statewide DEM data) is likely to be at least

plus or minus 5 m then a residual error of 5m is considered to be the most appropriate measure of model performance.

Table 17 Steady State Model RMS Errors

Borehole Group	Scaled RMS Error	Number of Boreholes
State Observation Network Boreholes	2.3%	321
Other GMS and PIRVIC Boreholes with time series data	2.3%	190
All Boreholes	1.7%	511

Table 18 Steady State Model Error Classes

Borehole Group	Absolute 'Error' <3m	Absolute 'Error' <5m	Absolute 'Error' <10m	Absolute 'Error' >10m
State Observation Network Boreholes	168 (52%)	222 (69%)	296 (92%)	25 (8%)
Other GMS and PIRVIC Boreholes with time series data	87 (46%)	124 (65%)	167 (88%)	23 (12%)
All Boreholes	255 (50%)	346 (68%)	463 (91%)	48 (9%)

4.3.2 Transient

Summary Statistics

A scatter plot of modelled against observed groundwater levels for all bore data used for transient calibration are shown in Figure 55. Transient calibration statistics are summarised in Table 19 and Table 20.

Calibration results indicate a scaled RMS error of 1.7% overall (Table 19) which is well within the 10% target specified for the transient Phase 2 model (Section 1.3). Modelled groundwater levels are within 5 m of observed at around 73% of the locations for which time series groundwater level data are available (Table 20). It should be noted that these statistics and the plot shown in Figure 55 exclude model cells where the relevant layer has dried out and hence direct comparison of modelled and observed heads is not possible.

Table 19 Transient Model Scaled RMS Errors (excluding dry cells)

Model Layer	Scaled RMS Error	Number of Data Points
Layer 1	4.7%	3634
Layer 2	2.1%	5199
Layer 3	8.4%	1681
Layer 4	7.6%	5223
Layer 5	3.4%	8743
Layer 6	3.2%	3849
Overall Transient Model	1.7%	28328

Table 20 Transient Model Error Classes (excluding dry cells)

Model Layer	Absolute 'Error' < 3m	Absolute 'Error' < 5m	Absolute 'Error' < 10m	Absolute 'Error' > 10m
Layer 1	3027 (83%)	3363 (93%)	3558 (98%)	76 (2%)
Layer 2	3738 (72%)	4709 (91%)	5184 (100%)	15 (0%)
Layer 3	716 (43%)	1302 (77%)	1577 (94%)	104 (6%)
Layer 4	3844 (74%)	4383 (84%)	5005 (96%)	218 (4%)
Layer 5	4242 (49%)	5671 (65%)	7418 (85%)	1324 (15%)
Layer 6	859 (22%)	1391 (36%)	2262 (59%)	1587 (41%)
Overall	16426 (58%)	20819 (73%)	25004 (88%)	3324 (12%)

Reference to the scatterplot and summary statistics shown in Figure 55 and Table 20 suggests a relatively large number of residuals over 5m for boreholes that monitor groundwater levels in Layer 5 and 6 (i.e. the Childers/Werribee/Older Volcanics and the pre-Tertiary bedrock) particularly in upland areas. This is not surprising given that the permeability of these deposits will be largely governed by the degree of fracturing and hence is likely to be highly spatially variable. This variability is typically difficult to capture in a regional groundwater flow model such as the Port Phillip model and hence accurate simulation of groundwater levels in all fractured hard rock areas is unlikely to be achievable. Reference to model results for both the steady state and transient models plotted in Figure 53, Figure 54 and Figure 55, however, suggests that the average hydraulic conductivity in Layers 5 and 6 is reasonably well represented in the model since observed groundwater levels in these layers are both under and over-estimated.

Spatial Error Distribution

Maps showing the spatial distribution of residual errors (i.e. long term average observed groundwater level minus modelled groundwater level) for each layer are shown in Figure 56 to Figure 61.

Long term average residual errors for Layer 1 are shown in Figure 56. Of the 71 boreholes thought to be monitoring groundwater levels in the Quaternary and Recent Sediments, 9 are situated in areas where the groundwater model suggests this layer is actually dry. It is therefore not possible to directly compare observed and modelled groundwater levels at these locations, although it is indicative of modelled heads being too low. It should be noted however that 5 of the 9 'dry' bores are PIRVIC monitoring bores where there is no definitive information on the formation monitored. These 5 bores have been assigned to model layer 1 since this is the uppermost active model layer. However, it may well be that these bores are actually monitoring deeper units which are more likely to be saturated in the model. The four remaining SON boreholes which are modelled as dry are located towards the eastern limit of the Quaternary deposits on the Nepean Peninsula and in an isolated area of Quaternary strata close to the boundary between the Koo Wee Rup WSPA and Frankston GMA. These areas are most likely to have been erroneously modelled as dry due to:

- Potentially relatively minor structural differences between modelled and actual conditions (e.g. underestimating the thickness of the Quaternary deposits);
- The presence of perched water table units not represented within the regional groundwater model; and/or
- Local scale parameter variations not represented in the numerical model

Of the 62 remaining bores in Layer 1 which are not simulated as dry, residual errors are within + or - 5m at 54 (or 85%) of locations. Residual errors of greater than 5m can be seen in:

- Two of the areas where dry bores were modelled (i.e. towards the eastern limit of the Quaternary deposits on the Nepean Peninsula and in an isolated area of Quaternary strata close to the boundary between the Koo Wee Rup WSPA and Frankston GMA); and
- In an isolated borehole towards the north of the Koo Wee Rup WSPA.

Long term average residual errors for Layer 2 are shown in Figure 57. Of the 64 boreholes thought to be monitoring groundwater levels in the Newer Volcanics, 4 are situated in areas towards the center of the Deutgam WSPA and Cut Paw Paw GMA where the groundwater model suggests this layer is actually dry. Potential causes of these areas being erroneously modelled as dry are outlined above in the discussion on Layer 1.

Of the 60 remaining bores in Layer 2 which are not simulated as dry in the model, residual errors are within + or - 5m at 46 (or 77%) of locations. Residual errors of greater than 5m can be seen in a number of boreholes scattered relatively evenly throughout the Newer Volcanics outcrop area which suggests a general lack of systematic errors in the model.

Long term average residual errors for Layer 3 are shown in Figure 58. Of the 42 boreholes thought to be monitoring groundwater levels in the Upper Tertiary aged units, 7 are situated in areas where the groundwater model suggests this layer is actually dry. These dry bores are situated close to areas

where Layer 3 thins out and hence becomes inactive in the Moorabbin GMA, on French Island and close to the boundary of the Frankston GMA and Koo Wee Rup WSPA.

Of the 60 remaining bores in Layer 3 which are not simulated as dry in the model, residual errors are within + or - 5m at 46 (or 77%) of locations. Residual errors of greater than 5m can be seen in a number of boreholes scattered relatively evenly across the upper Tertiary units which suggests a general lack of systematic errors in the model.

Long term average residual errors for Layer 4 are shown in Figure 59. Of the 69 boreholes thought to be monitoring groundwater levels in the Middle Tertiary aged units, 1 borehole, situated on French Island close to an area where Layer 4 is thought to thin out has been modelled as dry.

Of the 68 remaining bores in Layer 4 which are not simulated as dry, residual errors are within + or - 5m at 55 (or 81%) of locations. Residual errors of greater than 5m can be seen in a number of boreholes towards the north east of the Koo Wee Rup WSPA, on French Island and close to the edge of the Moorabbin and Cut Paw Paw GMA areas.

Attempts were made during model calibration to reduce modelled heads and hence residual errors in the Koo Wee Rup area. This included adding an extra high hydraulic conductivity zone in an area bounded by the Heath Hill, Koo Wee Rup and Lang Lang faults (see Figure 10 and Figure 50). However, modelled heads in Layer 4 in this area proved relatively insensitive to hydraulic conductivity, probably since this layer is largely only present at subcrop and hence is not directly connected to any modelled discharge boundaries. An alternative solution to the higher than observed modelled heads at depth in the Koo Wee Rup would be to increase the modelled abstraction rates. Given the general lack of licence returns from which to estimate actual abstractions it is entirely possible that abstractions are being under-estimated in this area. The elevated residual errors in other parts of Layer 4 are not considered to be significant.

Long term average residual errors for Layer 5 are shown in Figure 60. Of the 119 boreholes thought to be monitoring groundwater levels in the lower Tertiary aged units, 11 boreholes are situated in areas which are modelled as dry. These dry bores are situated close to areas where Layer 5 thins out and hence even relatively minor errors in layer thicknesses can cause these cells to dry out in the model. Other potential causes of these areas being erroneously modelled as dry are outlined above in the discussion on Layer 1.

Of the 108 remaining bores in Layer 5 which are not simulated as dry in the model, residual errors are within + or - 5m at 66 (or 61%) of locations. Residual errors of greater than 5m can be seen in a number of areas including Koo Wee Rup GMA, Wandin Yallock WSPA, Bacchus Marsh (close to the south western boundary of the CMA) and the Yarra Catchment (north west of Melbourne). However, closer inspection of the majority of these areas indicates a 'mixed bag' of locations where the observed groundwater levels are both over and under-estimated in the groundwater model and hence a single parameter change would have been unlikely to improve the overall model fit. As for model layer 4 systematic over-estimation of groundwater levels does appear to be occurring in layer 5 in the Koo Wee Rup area. However, groundwater levels in subcropping units in this area are not sensitive to modelled hydraulic conductivity and it is possible that the over-estimated heads in this area are related to under-estimated groundwater abstractions.

Long term average residual errors for Layer 6 are shown in Figure 61. Of the 56 bores which are thought to be monitoring groundwater levels in the pre-Tertiary bedrock residual errors are within + or - 5m at only 19 (or 37%) of locations. It should be noted that a significant amount of time was invested during the calibration process attempting to improve the calibration of Layer 6, with only a limited amount of success. Areas where modelled heads were too high, including the Merrimu GMA and Koo Wee Rup WSPA, were particularly insensitive to changes in modelled hydraulic conductivity. Heads in these areas could only be reduced significantly by adopting permeability and hence transmissivity values which were well above the range of values considered to be realistic for the pre-Tertiary bedrock. In the cases of Merrimu GMA and Koo Wee Rup it is possible that the over-estimated heads in Layer 6 is related to underestimate abstractions. Other possible explanations for the relatively poor fit achieved elsewhere in model Layer 6 include:

- The simplicity of the single layer, flat bottomed approach used to simulate the pre-Tertiary deposits. A two layer approach would have been conceptually more realistic but could not be implemented due to the steeply dipping nature of the bedrock at outcrop;
- General difficulties associated with simulating low primary porosity bedrock units using Darcy's Law implemented in a regional groundwater flow model;
- Over-estimation of recharge in upland pre-Tertiary bedrock outcrop areas

It is also worthwhile noting that only 14 of the 56 boreholes which are thought to be completed in the pre-Tertiary bedrock are State Observation Network boreholes. The remainder are either PIRVIC or other GMS bores for which there is no definitive information on the formation monitored. It is possible therefore that a significant number of the boreholes thought to be monitoring Layer 6 are actually monitoring other units, including perched water table strata in overlying Quaternary deposits.

Hydrograph Comparison

Transient calibration has been carried out through consideration of all available boreholes with time series data. However, in order to reduce the reporting effort discussion is limited to a sub-set of 'key' observation boreholes. The location of these boreholes is shown in Figure 62. Hydrographs of observed and modelled groundwater levels at each key location are included as Appendix F. Hydrographs of all boreholes considered for the transient simulation are included as Appendix H.

Key boreholes were selected initially to give a good geographic spread across the project area but also to give an honest picture of the model degree of fit. To this end two boreholes were selected in each area: one demonstrating a relatively good match between observed and modelled data and one representing a relatively poor match. It is worthwhile bearing in mind that around 73% of the calibration data set falls into the less than 5m error category (see Table 20). Hence reference to the full set of hydrographs in Appendix G confirms that the majority of data probably falls into the 'good' category. The 'poor' hydrographs are therefore relatively few in number and this is reflected in the low overall scaled RMS value for the model.

As would be expected at least half of the plots included in Appendix F show a relatively good match between observed and modelled groundwater levels. Modelled groundwater level hydrographs which demonstrate a relatively poor match generally fit into the following types:

- Boreholes which are modelled as dry (e.g. boreholes 12022, 59539, 76206 and 63291). Possible causes of this type of error were discussed in the section on the long term average errors. Most importantly the majority of the bores which are modelled as 'dry' are situated close to the edge of active layers i.e. in areas where the units modelled are relatively thin. As a result even minor discrepancies in model geometry or simulated heads can cause modelled layers to dry out;
- Boreholes in Bacchus Marsh (e.g. the PIRVIC borehole 7055) which show sharp increases in modelled groundwater level during October 1993 and June 2001 which are not replicated in the observed data. This is likely to be related to either inadequate level control in the model (e.g. a need for more stream and/or drain cells in the model in this area) or over-estimated net recharge (i.e. modelled recharge – evapotranspiration) during these relatively wet periods;
- Modelled hydrographs where seasonal abstraction impacts are relatively poorly simulated (e.g. boreholes 71845 and 127480). These boreholes are situated in relatively heavily abstracted areas (Koo Wee Rup WSPA and Moorabbin GMA) and the observed data shows large seasonal fluctuations, which are thought to be related to abstraction impacts, and are not well simulated by the groundwater model. This is not considered a surprise and reflects the lack of any data on actual abstraction quantities for the modelled period;
- Modelled hydrographs which demonstrate gradual downward trends in groundwater levels not seen in the observed data (e.g. boreholes 91080 in Koo Wee Rup and 98409 in Wandin Yallock). This issue was previously discussed in Section 4.1.2 and was largely resolved in the Nepean Peninsula by increasing the modelled hydraulic conductivity in this area. Similar changes were considered in other areas including Koo Wee Rup and Wandin Yallock but rejected since only a relatively small number of modelled hydrographs show this trend and hence changes in these areas would have reduced the accuracy of the overall model fit.

4.4 Baseflow Calibration

4.4.1 Comparison of 'Observed' and Modelled Long Term Average Baseflow

Further useful information on the quality of the model calibration can also be provided through comparison of 'observed' and modelled baseflows. As discussed previously in Sections 2.8.3 and 3.4.6 this comparison is made difficult in the Port Phillip CMA by the impact of reservoirs on the observed total flow time series. Only two of the main gauges within the project area do not have significant upstream reservoirs. However, data are available for 18 other gauges which are not thought to be downstream of any significant water storages. Reference to Figure 62 indicates that these 18 gauges are for the most part situated on towards the headwaters of tributary water courses rather than main rivers. Baseflow time series have been estimated from the observed total flow time series for each of these gauges as described in Section 3.4.6 and are compared to modelled baseflow time series in Appendix G.

As discussed in Section 3.4.6 accurate simulation of baseflow hydrographs is not considered to be a realistic goal for this model, in part since the 'observed' baseflow data is an estimate of unknown accuracy. Nevertheless comparison of the 'observed' and modelled data at each location does provide some qualitative information on the likely reliability of the model in different areas. Given the potential

inaccuracy in the 'observed' baseflow time series baseflow calibration has been assessed by considering the degree of fit between modelled and 'observed' baseflows during low flow periods. It is likely that a high percentage of flow during these periods is derived from baseflow and hence errors in the 'observed' data are likely to be minimised.

Reference to the time series included in Appendix G indicates a relatively good match between 'observed' and modelled baseflows during low flow periods at the following four gauges:

- Eumerring Creek at Lyndhurst (Gauge Ref 228203);
- Dandenong Creek at Dandenong (Gauge Ref. 228204);
- Little Yarra River at Yarra Junction (Gauge Ref 229214); and
- Woori Yallock Creek at Woori Yallock (Gauge Ref 229215).

Reference to Figure 62 indicates that these gauges are located towards the north east of the project area and the relatively good match between 'observed' and modelled baseflows suggests that groundwater levels and recharge are relatively accurately modelled within the upper Yarra and Dandenong Creek catchments.

Baseflows appear to be over-estimated at 10 of the remaining 14 locations. These gauges can be grouped into 2 separate groups as follows:

- Gauges on water courses which drain into the Koo Wee Rup area i.e. the Lang Lang River at Hamiltons Bridge (Gauge Ref. 228209), the Toomuc Creek at Pakenham (Gauge Ref 228217) and the Bunyip River at Tonimbuk (Gauge Ref 228212); and
- Gauges on various water courses which drain the western portion of the project area and which are dominated by pre-Tertiary bedrock at outcrop, including the Saltwater Creek at Bullengarook (Gauge Ref. 230210), Emu Creek at Clarkefield (Gauge ref. 230211), Turritable Creek at Mount Macedon (Gauge Ref. 230213), Lerderberg Creek at Goodman Creek Junction (Gauge Ref. 231211), Lerderberg Creek at Sardine Creek Crossing (Gauge Ref 231213), Werribee River at Ballan (Gauge Ref 231225), Parwan Creek at Parwan (Gauge Ref 231234).

Over-estimation of flows in these areas is consistent with the groundwater level data which also indicates a tendency for the model to over-estimate heads in both of these areas (see Section 4.3.2). In the Koo Wee Rup area this was attributed to a possible under-estimate of groundwater abstraction. Whilst in the pre-Tertiary outcrop areas toward the west of the CMA modelled groundwater levels remain to high despite the relatively high modelled transmissivity (c40 m^2/d) adopted. The tendency for both heads and flows to be over-estimated in this area suggests that groundwater recharge may be being over-estimated in upland pre-Tertiary outcrop areas.

Baseflows appear to be under-estimated at the four remaining locations. Two of these gauges, the Tarago River at Neerim (Gauge Ref. 228206) and the Bunyip River at Headworks (Gauge Ref. 228207) are located on watercourses upstream of the Koo Wee Rup area. Reference to 'observed' baseflow and total flow time series for these gauges (see Appendix G) suggests surprisingly high baseflows were maintained throughout a 3 year period from January 1995 to January 1998 period. These high baseflows are particularly poorly represented in the model. However, it should be noted that the minimum baseflows over this period are around 3 times higher than during other years and this pattern

is not repeated in the other gauges in the project area which suggests that the high observed flows might be the result of gauge error and/or artifical influences. Alternatively it may be that a relatively high storage aquifer system, which is poorly represented in the model, became saturated over this relatively wet period leading to the elevated 'observed' baseflows.

Baseflows also appear to be under-estimated on the Little River at Little River (Gauge Ref. 232200) towards the south western boundary of the CMA (see Figure 62). The catchment area to this gauge is dominated by Quaternary alluvium and Newer Volcanics at outcrop with some pre-Tertiary bedrock. Groundwater levels in this catchment are monitored at a number of locations in and around the Bacchus Marsh area. However, comparison of observed and modelled groundwater levels at these boreholes (see Appendix H) suggests a tendency for the model to over-estimate groundwater levels which is therefore not consistent with the tendency for modelled baseflow to be too low. The cause of the low modelled baseflows in this part of the model is therefore not known, although it is worthwhile noting that observed total flows at Little River commonly fall to less than 1 ML/d (or around 10 L/s) during the summer and hence gauge error or relatively minor errors in say modelled evaporation rates in the relatively large 400 km^2 upstream catchment could easily cause the observed discrepancies. Similarly the model also appears to be under-estimating baseflow upstream of the Melton South gauge on the Toolern Creek (Gauge Ref. 231231). Total flows at this location fall to as low as 0.1 ML/d (or around 1 L/s), flows which are probably difficult to gauge accurately let alone model.

4.4.2 Modelled Surface Water – Groundwater Interaction

Further information on the reliability of the model calibration can be obtained through reference to the spatial distribution of modelled baseflows and surface water – groundwater interactions. Figure 63 therefore shows long term average modelled baseflows for the full transient calibration run and Figure 64 and Figure 65 show modelled surface water – groundwater interactions for selected wet and dry periods.

As would be expected modelled baseflows typically increase with the catchment area drained and hence maximum baseflows are modelled in the Yarra River. Model results suggest net baseflow baseflow gains in the majority of the main river catchments under long term average conditions (Figure 63). However many of the tributary streams particularly in pre-Tertiary basement outcrop areas are characterised by little or no baseflow input, which is consistent with the conceptual model for the CMA which suggests that water courses in these areas are typically ephemeral.

Reference to the wet and dry period interaction plots (Figure 64 and Figure 65) as would be expected show substantially more active stream cells in October 1992 (wet) than in March 2004 (dry). This tends to confirm that modelled groundwater baseflows are sensitive to recharge which is considered to be an important result given the final intended use of the model i.e. to assess the impact of landuse changes on recharge, depth to water table and stream baseflows. One interesting feature of both of the interaction plots is that the majority of the modelled baseflow appears to occur in the upper and middle sections of each of the main rivers with little or no baseflow gain as the rivers cross the low lying sedimentary basins such as the Koo Wee Rup area.

4.5 Groundwater Balance

4.5.1 Long Term Average

Long term average water balance results for the entire active transient model area are summarised in Table 21. The cumulative water balance error, for the 180 modelled stress periods, is 0.04%, which is well within the acceptable level of error of 2% specified for the project (see Section 1.3). Errors within individual stress periods are also within 2% for all but one of the modelled stress periods (stress period 120, December 2000) although errors of between 1 and 2% occur relatively often during the summer months. This is discussed further in Section 4.5.2 below.

Table 21 Transient Modelled Groundwater Balance (Jan 1991 – Dec 2005)

Component	Flow IN (ML/d)	Flow OUT (ML/d)	IN-OUT (ML/d)
Recharge	2941.4	0.0	2941.4
Evaporation Boundary Cells	0.0	1035.5	-1035.5
Wells	0.0	37.7	-37.7
Stream Boundary Cells	173.6	2362.2	-2188.6
Drain Boundary Cells	0.0	51.1	-51.1
Sea Boundary Cells	1.3	328.7	-327.4
Storage	2256.9	1555.8	701.1
Total	5373.2	5370.9	2.4 (0.04%)

4.5.2 Water Balance Time Series

Detailed output including time series plots of all water balance components and errors in individual stress periods are included as Appendix I.

Full convergence of the model is not achieved in all stress periods and water balance errors of over 1% occur relatively frequently during the summer months i.e. during periods when recharge inputs are exceeded by evaporation outputs. Hence it would appear that the water balance errors are predominantly attributable to the evaporation package. This was confirmed in an early sensitivity run of the model run, which was carried out with and without evaporation, resulting in increased water balance errors in 116 out of 180 stress periods. Experience with other similar models suggests that this is a common problem which often relates to the use of more than boundary condition in a single cell. In this case evaporation and stream boundaries occur in a large number of model cells. Both of these boundary types include setting a number of critical elevations e.g. stream stage in the stream package and extinction depth in the evaporation package. Non convergence issues arise when say MODFLOW calculates a groundwater head which is above the evaporation extinction elevation but below the

stream stage. MODFLOW therefore calculates a loss from the stream which tends to increase groundwater levels in the underlying cell thereby increasing evaporation losses and lowering groundwater levels hence causing a feedback loop of oscillating groundwater levels. This problem can be reduced (although typically not entirely eliminated) by switching off evaporation in stream cells or by reducing the stream stage to below the evaporation extinction depth. However, given that this solution is considered to be conceptually un-realistic and that the water balance errors are currently relatively minor, evaporation has been allowed from each model cell.

Water balance errors could also be reduced further by increasing the number of time steps in each stress period. Three time steps are currently used in selected stress periods where errors of over 2% were encountered and this approach could be extended to the use of 3 time steps in any stress periods where errors exceed 1%. This would however tend to increase model run times. Water balance errors in stress period 120 were unfortunately insensitive to the number of time steps used.

4.6 Depth to Watertable

Modelled depth to water table i.e. modelled ground surface minus modelled groundwater level in the uppermost active layer is shown in Figure 66. As would be expected given the relatively close agreement between observed and modelled groundwater levels modelled depths to water table are for the most part consistent with the observed data (see Figure 25).

High water table conditions are therefore predicted in low lying areas around the margins of Port Phillip and Westernport Bay. Modelled output also suggests groundwater levels above ground surface along the majority of the main rivers which explains the gaining surface water reaches seen in Figure 64. This is consistent with actual flow data for the CMA which suggests baseflow to the majority of the main rivers but is not typically picked up by the observed water table contours since there are typically insufficient boreholes to pick up the full detail of the actual water table.

Large areas of elevated depths (>100m) to water table are simulated in interfluvial areas towards the east of the project area in the Upper Yarra catchment. This is not inconsistent with the observed data although it should be noted that there is a general lack of borehole data in this area (see Figure 25) and hence the ‘observed’ groundwater level contours are unlikely to be reliable. It is worthwhile noting that whilst model results show substantial unsaturated thicknesses in the interfluvial areas, modelled water tables along the majority of the main river valleys in the area are at or close to ground surface and hence baseflow gains are simulated even during relatively dry periods (see Figure 65 and Figure 66).

5. Model Sensitivity

5.1 Introduction

The sensitivity of the Port Phillip groundwater model to variations in selected parameters has been assessed through repeated runs of the steady state model. After completion of each run water balance data and modelled heads were extracted and processed as necessary to assess the effect of each parameter change on:

- The percentage of the active model area where the modelled water table is within 2m of the modelled ground surface; and
- Net modelled baseflow i.e. total modelled baseflow gains minus baseflow losses

Parameters included within the sensitivity analysis are shown in Table 22 along with the range of values considered. Detailed results in the form of a series of XY plots 1 for each parameter set are included as Appendix J, and are discussed briefly below.

Table 22 Sensitivity Analysis Parameters

Parameter	Multipliers	Notes
Horizontal Hydraulic Conductivity (Kx, m/d) – Layers 1 - 6	0.1 to 10 (i.e. -1000% to +1000%)	Applied to all parameter zones
Vertical Hydraulic Conductivity (VCONT, m/d) – Layers 1 – 5	0.1 to 10 (i.e. -1000% to +1000%)	Assessed via multiplication of MODFLOW VCONT arrays
Recharge Rate (m/d)	0.5 to 2 (i.e. -100% to +100%)	
Evaporation Rate (m/d)	0.5 to 2 (i.e. -100% to +100%)	
Stream Conductance (m^2/d)	0.1 to 10 (i.e. -1000% to +1000%)	Starting value = 100 m^2/d.

5.2 Horizontal Hydraulic Conductivity

As would be expected increasing the modelled horizontal hydraulic conductivity (Kx) generally decreases shallow water table areas by reducing hydraulic gradients towards modelled discharge boundaries (see Appendix J). Similarly decreasing Kx results tends to result in an increase in shallow water table areas. It should be noted that significant water balance errors were encountered for model runs where factors of 0.1, 0.2 and 0.25 were applied to the Kx Layer 6 and hence these results are not considered to be reliable.

Results suggest that modelled heads are most sensitive to changes in Kx in Layer 6 and least sensitive to changes in Layer 1.

5.3 Vertical Hydraulic Conductivity

Modelled sensitivity to vertical conductivity was assessed through multiplication of the MODFLOW VCONT or Vertical Conductance arrays. These arrays govern vertical leakage between pairs of layers and effectively represent a weighted average of the modelled vertical hydraulic conductivity of the underlying and overlying layers. Hence for the 6 layer Port Phillip model 5 VCONT arrays are defined. The first for governs vertical leakage between Layer 1 and Layer 2, the second between Layer 2 and 3, etc.

Reference to sensitivity analysis results for vertical hydraulic conductivity or VCONT (see Appendix J) indicates an increase in shallow water table with increasing vertical leakage. This is somewhat counter intuitive and suggests that modelled vertical head gradients are typically upward in and around shallow water table areas. Hence increasing the vertical leakage between say layer 1 and layer 2 tends to reduce the modelled head gradient reducing heads in layer 2 whilst at the same time increasing heads in layer 1 i.e tending to increase the shallow water table area.

Results suggest that modelled groundwater levels are most sensitive to vertical leakage between layers 5 and 6 and least sensitive to vertical leakage between layers 3 and 4.

5.4 Recharge and Evaporation

Sensitivity analysis results (see Appendix J) suggest relatively simple linear relationships between recharge and evaporation rates and the shallow water table area. Somewhat surprisingly the shallow water table area is only slightly more sensitive to recharge or evaporation than the other parameters considered. Hence increasing recharge by a factor of 2 increases the shallow water table area by around 0.5% and decreasing the recharge by the same factor decreases the shallow water table area by around -0.5%. Doubling evaporation rates only decreases the shallow water table area by around -0.1% whist the same increase in rate only increases the water table area by around 0.03%.

5.5 Stream Conductance

The sensitivity of modelled outputs to stream conductance has been assessed through consideration of the shallow water table area and also net modelled baseflows (see Appendix J). Whilst results tend to confirm (as would be expected) that modelled baseflows are sensitive to changes in stream conductance, as discussed in Section 3.4.6, they are significantly more sensitive to modelled recharge. Hence decreasing stream conductance by a factor of two reduces net baseflows by around 6% whilst reducing recharge by the same factor reduces baseflows by around 50%. Similarly doubling recharge increases net baseflow by 100% (indicating a one to one relationship between increasing recharge and net baseflow) whilst a similar increase in stream conductance results in only a 5% increase in modelled net baseflow.

In terms of the shallow water table area model results appear to be almost insensitive to increases in the modelled stream conductance, whilst reducing the conductance by a factor of 10 results in a small 0.4% increase in the shallow water table area.

6. Model Assumptions and Limitations

It should be noted that the assumptions and limitations of the numerical model as developed outlined below are made within the context of the project and considering the overall aim which is to provide a tool for assessing the impacts on land use change on depth to water table and stream baseflows. Where the model is used for other (as yet undefined) purposes (e.g. water resource assessments) then a different array of limitations are likely to apply.

Like any numerical model the Port Phillip CMA groundwater model represents a simplification of a vastly more complex reality. In particular given the size of the area modelled six layers is considered to be close to the maximum practicable. Hence whilst additional layers would have improved the model conceptualisation in a number of areas this would have significantly increased the time required to construct, calibrate and use the resulting model.

The main limitations resulting from this process of simplification are outlined in below in Sections 6.1 to 6.4.

6.1 Model Geometry

Key assumptions and limitations inherent in the 6 layer hydrogeological framework used in the numerical model include:

- A general lack of information on the outcrop geology and interpreted borehole logs from which to assess the thickness and composition of the Quaternary and Recent sediments. Hence, it has not been possible within the timeframe and resources of the current project, to separate the Port Melbourne Sands and the underlying silts in the Yarra Delta or the shoe string sands and the underlying alluivial material in the Werribee Delta. A single layer has therefore been used to represent these strata although a reduced vertical hydraulic conductivity value has been adopted in an attempt to simulate the stratified nature of these deposits in a single layer;
- Groundwater level data for nested boreholes installed into the Newer Volcanics indicate vertical head gradients of up to 8m. This is consistent with observations made by John Leonard which suggest that the Newer Volcanics west of Melbourne are composed of two or more superposed basalt flows that are often separated by clay and silt aquitards. Whilst it is recognised that these different units may be mappable the significant effort which would be required in field mapping and borehole log interpretation is considered to be outside of the scope of the current project. A single layer has therefore been used to represent this strata;
- Only a single layer has also been used to represent the middle Tertiary strata which include the Fyansford Formation (and its lateral equivalents the Yallock/Sherwood Formation) plus the Batesford Limestone. Reference to Appendix B Section 2 suggests that up to 3 middle Tertiary layers would be required to represent the low permeability Fyansford Formation and the Batesford Limestone aquifer in the Corio region. However reference to mapping of the extent of the Batesford Limestone included in Leonard (1992) confirms that the limestone is only present in the Corio Bay area immediately north of Geelong and hence is almost entirely absent from the Port Phillip CMA; and

- Reference to Appendix B Sections 3 and 5 suggests that the Lower Tertiary age Werribee Formation and the Older Volcanics are typically interbedded in a hydrogeologically complex sequence. Hence whilst it would be preferable to represent these units as separate layers at least 4 additional layers would be required in some areas and only limited information is likely to be available to carry out and/or justify such a separation. A single composite layer has therefore been used to represent all the lower Tertiary deposits.

6.2 Model Boundaries

Cross boundary flow is anticipated in the Kinglake area due to the presence of a large number of abstractions within the Kinglake GMA immediately to the north of the Port Phillip CMA boundary. Given that the majority of the Kinglake GMA is located outside of the Port Phillip CMA then the majority of any induced cross boundary flow is likely to be from Port Phillip into the Goulburn CMA to the north. Unfortunately no groundwater level data are available for boreholes in this area which may help to assess the significance of cross boundary flow in this area. If this is considered to be a significant issue then the active modelled area of either the Port Phillip or the Goulburn model could be extended to include the entire Kinglake area.

6.3 Parameterisation of the pre-Tertiary Bedrock (Layer 6)

A flat bottomed approach has currently been used to simulate groundwater levels in the pre-Tertiary basement bedrock. Hydraulic conductivity for this layer, which is up to around 3000 m thick in places, was initially calculated by dividing the depth dependent transmissivity values, defined by the relationship shown in Figure 22, by the layer thickness. These values were then increased by a factor of 4 during the steady state calibration such that transmissivity modelled bedrock outcrop areas is currently around 40 m^2/d. Whilst this gives a relatively high transmissivity it is within realistic ranges for the total transmissivity of the entire unit. Whilst this approach results in realistic modelled groundwater levels within Layer 6 and prevents this layer drying out, since only one layer has been used it is not possible to represent the effect of weathering in outcrop areas.

A conceptually more representative alternative would be to use MODFLOW 96 VKD (Environment Agency, 2003) a publicly available MODFLOW variant developed for the UK Environment Agency which allows hydraulic conductivity to be varied within a single layer. The use of MODFLOW 96 VKD was considered during transient model development, since it would allow a high permeability weathered horizon and low permeability bedrock to be represented more correctly within a single layer. However this option was not pursued based on guidance from the model reviewer Hugh Middlemiss who mentioned stability issues associated with MODFLOW VKD. However, this version of MODFLOW has been widely applied in the UK with no apparent issues and hence may be worth further investigation.

Where MODFLOW VKD is not used then a two layer modelling approach implemented in MODFLOW SURFACT might be the most appropriate way forward, assuming that the current memory limitations inherent in this commercial code can be overcome.

6.4 Simulation of Evaporation and Recharge

Recharge has been applied unlagged to the uppermost active layer in the groundwater model and hence no time lag has been assumed between the generation of recharge at the soil zone and its arrival at the water table. In areas characterised by elevated depths to water table then this zero lag assumption may represent a significant model limitation. There is, however, little evidence in the available groundwater level data set of significant recharge lags although it should be noted that there is a general lack of groundwater level data in areas such as the upper Yarra where model results suggest significant depths to water table may be present. Some hydrographs in the Deutgam area (see Appendix H) also show discrepancies between modelled and observed groundwater level peaks which may be associated with unsaturated zone recharge lags or (more likely in this case) stratification of the Newer Volcanics in this area.

Groundwater evaporation has currently been allowed in any cell where the modelled groundwater level rises above the ENSYM rooting depth. It is considered likely that this approach will tend to over-estimate the area within which groundwater supported evaporation is occurring.

6.5 Modelled Stream Boundary Elevations

Modelled stream elevations for the project have been derived from regional scale DTM data. The accuracy of this data for defining the elevation of stream bed and water levels is unlikely to be better than plus or minus 5m in relatively flat areas and errors well in excess of 5m are possible in steeply incised river valleys. Stream boundary cells represent the main point of discharge from the model in terrestrial areas and hence the relatively large errors likely in this data set represents a significant limitation on model accuracy.

6.6 Groundwater Abstraction Time Series

As previously discussed in Section 2.9.1 information on licensed and actual abstraction quantities is limited in a number of key areas including:

- No information is available on the location of unlicensed abstractions;
- Location information for some licensed abstractions is missing particularly in the Koo Wee Rup area;
- No reliable data on actual abstraction is available for the calibration period, although estimated total abstraction data by WSPA / GMA area are available for 2007;
- Whilst information is typically available indicating the start date of each licence no data are available on end dates; and
- No information is available on the abstraction formation although data on screened intervals and/or maximum borehole depths are typically available via the GMS database.

Hence whilst a rigorous method for generating time series of actual abstraction has been developed and applied, reliable data on actual quantities can only be provided by metering of all major abstraction quantities. It is therefore unlikely that any of the modelled time series represent an accurate simulation of actual abstraction at any individual location and this represents a significant barrier to accurate simulation of groundwater levels in boreholes that are affected by nearby abstractions.

6.7 Calibration Data Sets

The depth of the Werribee Formation beneath the Nepean Peninsula means that groundwater within these strata typically demonstrate elevated temperatures. The observed groundwater level data set has currently not been corrected for the effects of temperature on measured groundwater levels. However, data have currently only been used for a single deep state observation borehole in the Werribee Formation (Borehole ID 84887) and hence no significant impact on the current steady or transient calibration is anticipated.

The State Observation Network (SON) observation boreholes are largely concentrated within the WSPA and GMA areas and hence outside of the areas groundwater level data is limited to scattered PIRVIC boreholes and other GMS borehole. These secondary bore data sets are typically lacking key information on the formation monitored and/or screened intervals and hence represent a less reliable data set than that provided by the SON bores. Outside of the WSPA and GMA areas the reliability of the model calibration is therefore largely unknown.

As discussed in Section 4.4 surface water flows to all but two of the main flow gauges within the CMA are thought to have been significantly affected by upstream reservoirs. There is therefore a general lack of reliable observed flow data for calibration of modelled baseflows in the main rivers. 18 gauges on tributaries which are not thought to be affected by upstream reservoirs have however been identified and have been used as a further qualitative check on the transient calibration.

6.8 Model Calibration

A relatively good match to observed groundwater levels has been achieved in model layers 1, 2, 3 and 4 using a relatively small number of parameter zones. To a large extent this is considered to be a result of the fact that the units modelled in these layers are appropriate for modelled using a regional flow developed in MODFLOW i.e. the are relatively homogenous aquifer units which behave like porous media. Considerably less success was achieved in calibrating model layers 5 and 6 which represent the interbedded Werribee / Childers Formation and Older Volcanics and the pre-Tertiary bedrock strata. These are units which are characterised by relatively low primary porosity and permeability and hence by significant spatial variation in properties, depending on the degree of fracturing and/or weathering. Hence reference to data for observation boreholes in Wandin Yallock indicates a wide variety of groundwater level hydrographs (see Appendix H) some of which of suggest a relatively high storage, high permeability aquifer system and others which are more typical of a low storage, low permeability fractured rock system. In the absence of relatively detailed information on weathering and fracture frequencies and depths etc it is not likely to be feasible to be able to model all observed hydrographs in areas like Wandin Yallock particularly not in a large regional scale model with limited layers and cell sizes.

Comparison of modelled and observed groundwater water levels and baseflow data suggests that flows groundwater levels continue to be over-estimated in the Koo Wee Rup area and in pre-Tertiary outcrop areas to the west of the modelled area. In the Koo Wee Rup area it is considered most likely that this is due to actual abstractions being under-estimated. In the pre-Tertiary outcrop area to the west over-estimation of heads and flows is considered most likely to be related to the simplicity of the modelled representation of the bedrock strata and/or over-estimation of recharge.

In addition given that most of the reliable groundwater level calibration data set (i.e. the SON observation bores) are located almost exclusively in WSPA and GMA areas then the calibration quality is largely unknown outside of these areas.

7. Conclusions

Steady state and transient six layer models of the entire Port Phillip CMA has been developed and successfully calibrated to observed groundwater level data as described above in Sections 2 to 5. Both of these models meet the agreed specifications and end use requirements of the ecoMarkets projects.

Transient calibration results indicate a scaled RMS error of 1.77% overall which is well within the 10% target specified for the Phase 2 model. Modelled groundwater levels are within 5 m of observed at around 73% of the locations for which time series groundwater level data are available. This was achieved using a relatively small number of parameter zones based largely on estimated formation boundaries and using parameter values which remained within previously identified realistic ranges. However, calibrated parameter values are for the most part towards the upper end of the realistic ranges identified which suggests that recharge may be being over-estimated.

Although scaled RMS values for layers 5 and 6, which represent the interbedded Werribee / Childers Formation and Older Volcanics and the pre-Tertiary bedrock strata, are also within the specified limits the quality of the calibration is not considered to be as high as the other layers. This is considered largely to be a result of inherent difficulties in modelling low primary porosity and permeability fractured rock aquifers within a regional scale groundwater flow model.

Comparison of modelled and observed groundwater water levels and baseflow data suggests that flows groundwater levels continue to be over-estimated in the Koo Wee Rup area and in pre-Tertiary outcrop areas to the west of the modelled area. In the Koo Wee Rup area it is considered most likely that this is due to actual abstractions being under-estimated. In the pre-Tertiary outcrop area to the west over-estimation of heads and flows is considered most likely to be related to the simplicity of the modelled representation of the bedrock strata and/or over-estimation of recharge.

Cumulative water balance error, for the 15 year (January 1991 to December 2005) transient simulation calibration period, is 0.04%, which is also well within the acceptable level of error of 2% specified for the project. Errors within individual stress periods are also within 2% for all but one of the 180 modelled stress periods (stress period 120, December 2000).

Sensitivity analysis results suggest that the shallow water table area is relatively insensitive to modelled hydraulic conductivity, recharge, evaporation or modelled stream conductance which suggests a strongly level controlled system characterised by relatively static shallow water table areas. As would be expected modelled baseflows are extremely sensitive to modelled recharge and to a lesser extent stream bed conductance.

8. Recommendations

- Incorporation of total surface water flow (i.e. runoff and interflow from ENSYM) into the MODFLOW Stream Boundary package of at least one, if not all, of the ecoMarkets groundwater models. This would provide for complete simulation of the total water budget for all catchments across the State and allow the groundwater models and ENSYM to be calibrated to gauged total surface water flows. It is likely that this would significantly improve the simulation of recharge and runoff/interflow processes, particularly on bedrock areas. The East and West Gippsland ecoMarkets models are also currently built to easily accommodate this extremely valuable feature;
- Consideration of using the alternative MODFLOW VKD or MODFLOW-SURFACT modelling platforms such that simulation of the pre-Tertiary bedrock strata can be improved;
- Incorporation of historical actual abstraction data for the Koo Wee Rup WSPA and any other areas where returns data are available. This existence of returns data for the Koo Wee Rup area was only identified during the later stages of the project and hence there was insufficient time to incorporate this information;
- Revision of the modelled ground and boundary elevations in low lying coastal areas based on available LIDAR data. This existence of LIDAR data for coastal areas was only identified part way through the project and hence considerable re-work would have been required to incorporate this information. Given the relatively good model fit achieved in coastal areas without reference to the LIDAR data this re-work was not considered necessary in order to deliver the current project to specification. However, tt is likely that incorporation of this data would improve the overall model fit in low lying coastal areas;
- Validation of the model by carrying out a 1981 to 1991 run and comparing modelled and observed heads and flows.

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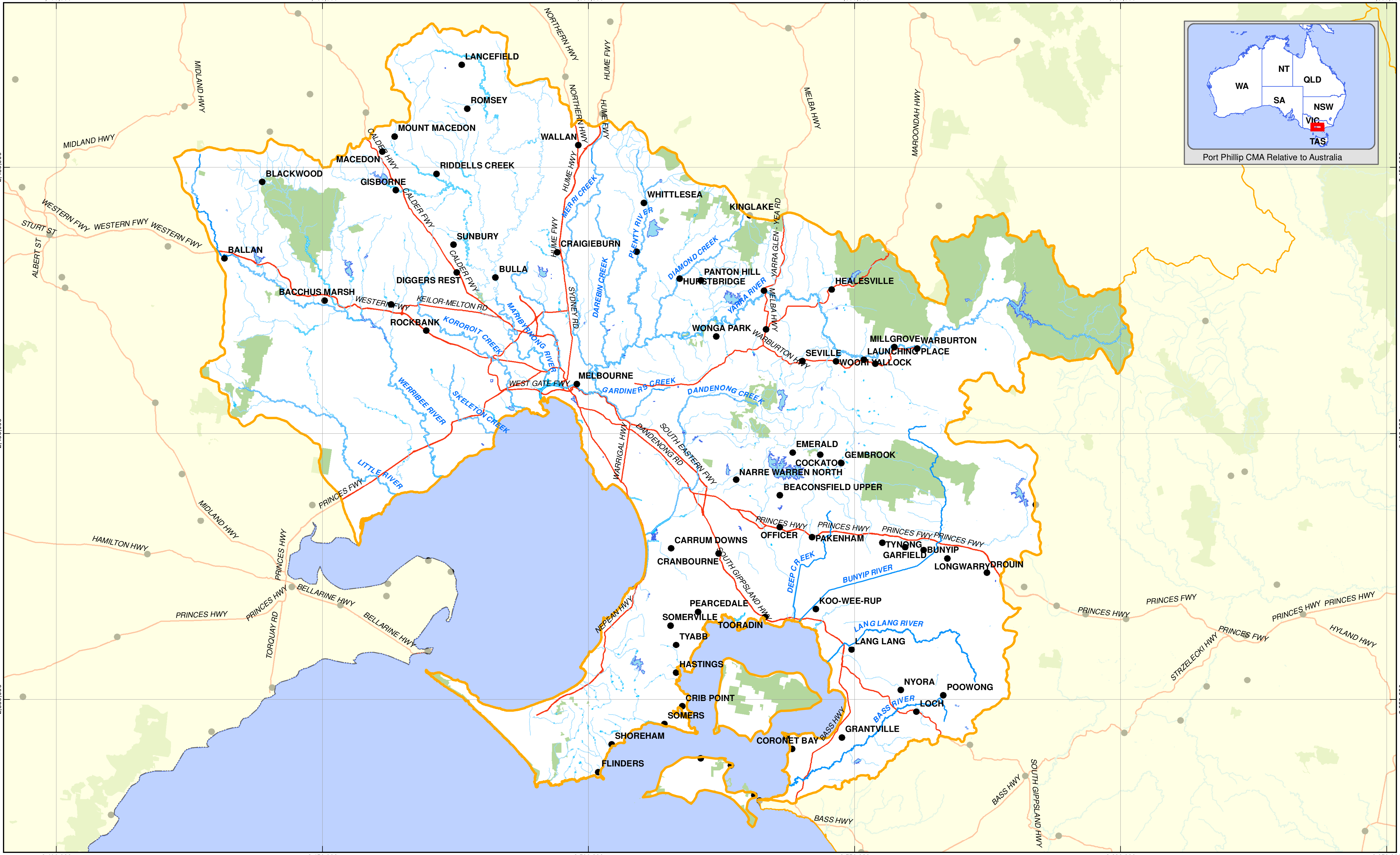

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

LEGEND

- Towns
- Main River
- River
- Highway
- State Boundary
- Other CMA
- PORT PHILLIP

Surface Water

- Lake
- Salt Lake
- Watercourse Area
- Wetland / Swamp
- Flat
- Pondage
- National Parks and Reserves

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Port Phillip - Data Collation and Conceptualisation

Project Area Location

Job Number	31-22410
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Figure 1

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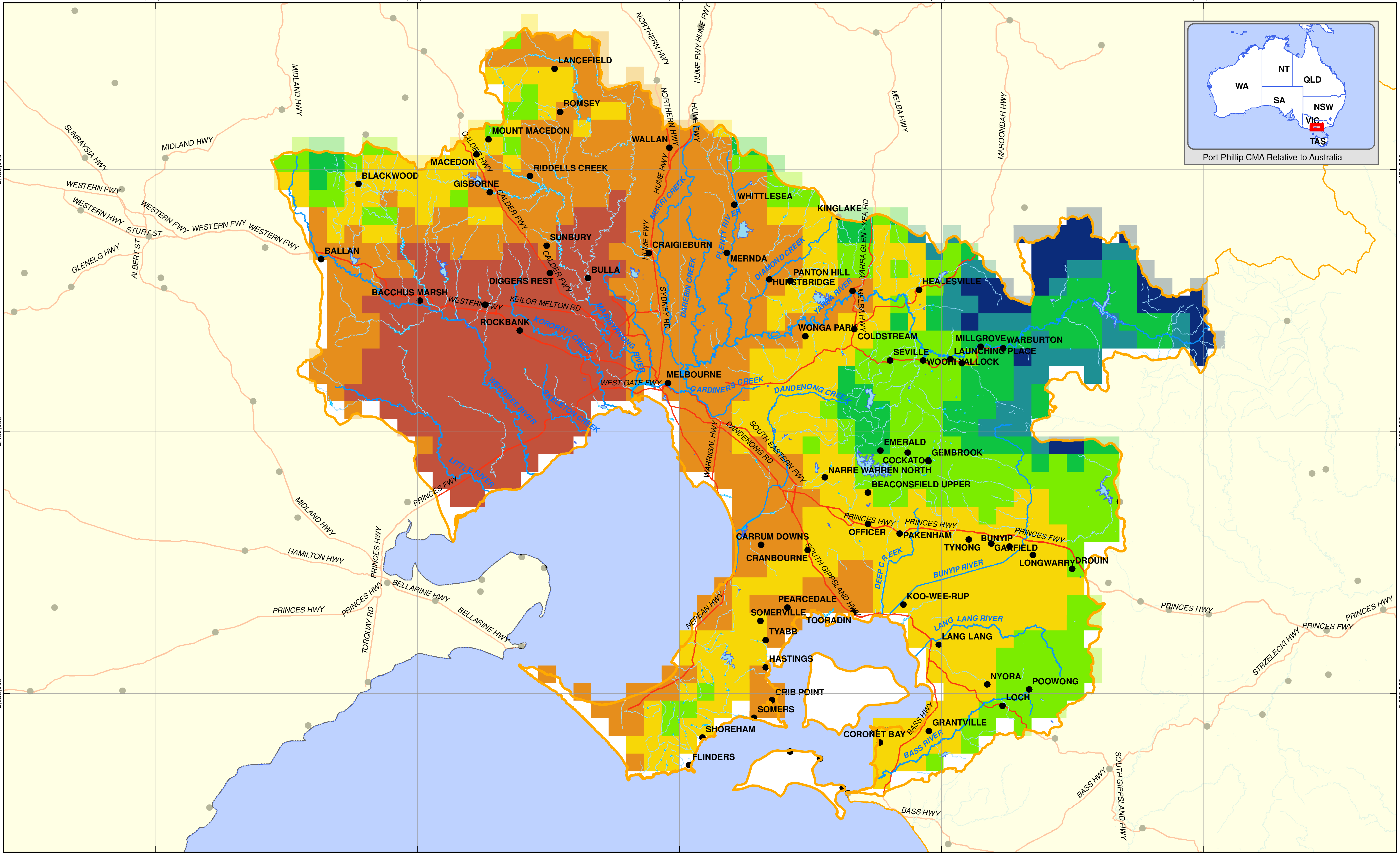
Data source: DSE and VicMAP. Khan Kamruzzaman



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0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Highway
- Main River
- River
- Other CMA
- PORT PHILLIP
- State Boundary
- Water Area
  - Lake
- Salt Lake
- Watercourse Area
- Wetland / Swamp
- Flat
- Pondage

Annual Rainfall (mm)

- < 600
- 600 - 800
- 800 - 1,000
- 1,000 - 1,200
- 1,200 - 1,400
- 1,400 - 1,600
- 1,600 - 2,000

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Long Term Average Annual Rainfall (1961-1990)

Figure 2

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Data source: DSE, Bureau of Meteorology, VicMAP. Khan Kamruzzaman

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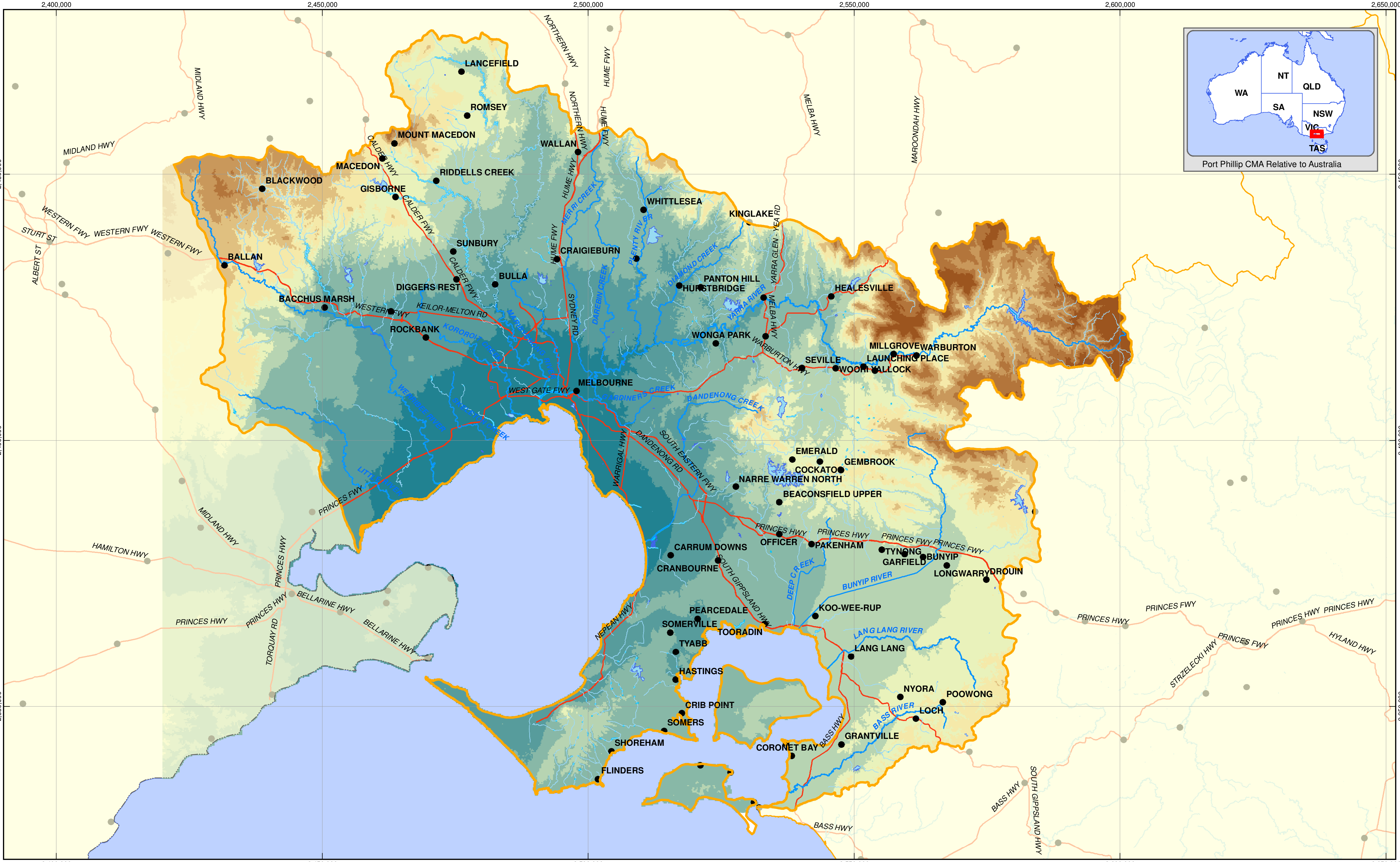

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0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Main River
- River
- Highway
- State Boundary
- Other CMA
- PORT PHILLIP

Surface Water

- Lake
- Salt Lake
- Watercourse Area
- Wetland / Swamp
- Flat
- Pondage

Evaporation

- < 900
- 900.01 - 950
- 950.01 - 1,000
- 1,000.01 - 1,050
- 1,050.01 - 1,100
- 1,100.01 - 1,150
- 1,150.01 - 1,200
- 1,200.01 - 1,250
- 1,250.01 - 1,300
- 1,300+

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Long Term Average Potential Evaporation

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Figure 3

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Data source: DSE and VicMAP. Khan Kamruzzaman

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1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94, Australia

N

LEGEND

Towns	State Boundary	Watercourse Area	**DTM (mAHD)**	400.1 - 600
Main River	Highway	Wetland / Swamp	0 - 50	600.1 - 800
River	**Water Area**	Flat	50.1 - 100	800.1 - 1,000
Other CMA	Lake	Pondage	100.1 - 200	1,000.1 - 1,200
PORT PHILLIP	Salt Lake		200.1 - 400	1,200.1 - 2,113

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Digital Terrain Model

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Figure 4

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Data source: DSE and VicMAP. Khan Kamruzzaman

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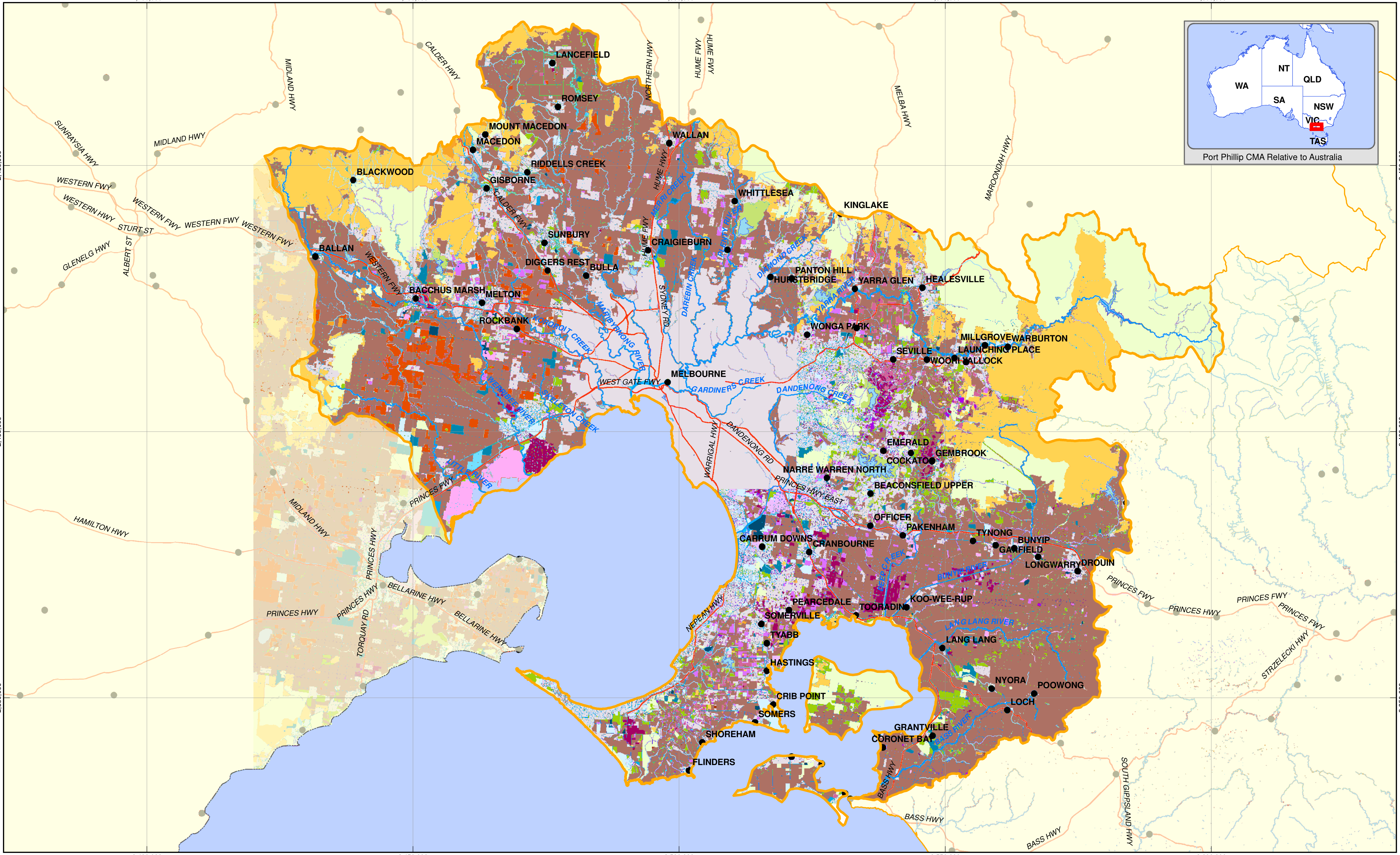

LEGEND

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94, Australia

N

- Towns
- River
- Main River
- Highway
- Other CMA
- PORT PHILLIP
- State Boundary

Water Area

- Lake
- Salt Lake
- Watercourse Area
- Wetland / Swamp
- Flat
- Pondage

Landuse

- Nature conservation
- Managed resource protection
- Other minimal use
- Production forestry
- Plantation forestry
- Grazing modified pastures
- Cropping
- Perennial horticulture
- Seasonal horticulture
- Irrigated plantation forestry
- Irrigated modified pastures
- Irrigated cropping
- Irrigated perennial horticultu
- Irrigated seasonal horticultur
- Intensive horticulture
- Intensive animal production
- Manufacturing and industrial
- Residential
- Services
- Utilities
- Transport and communication
- Mining
- Waste treatment and disposal
- Lake,wetland, channel, river

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Landuse

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Figure 5

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Data source: DSE, National Land and Water Resources Audit, VicMAP. Khan Kamruzzaman

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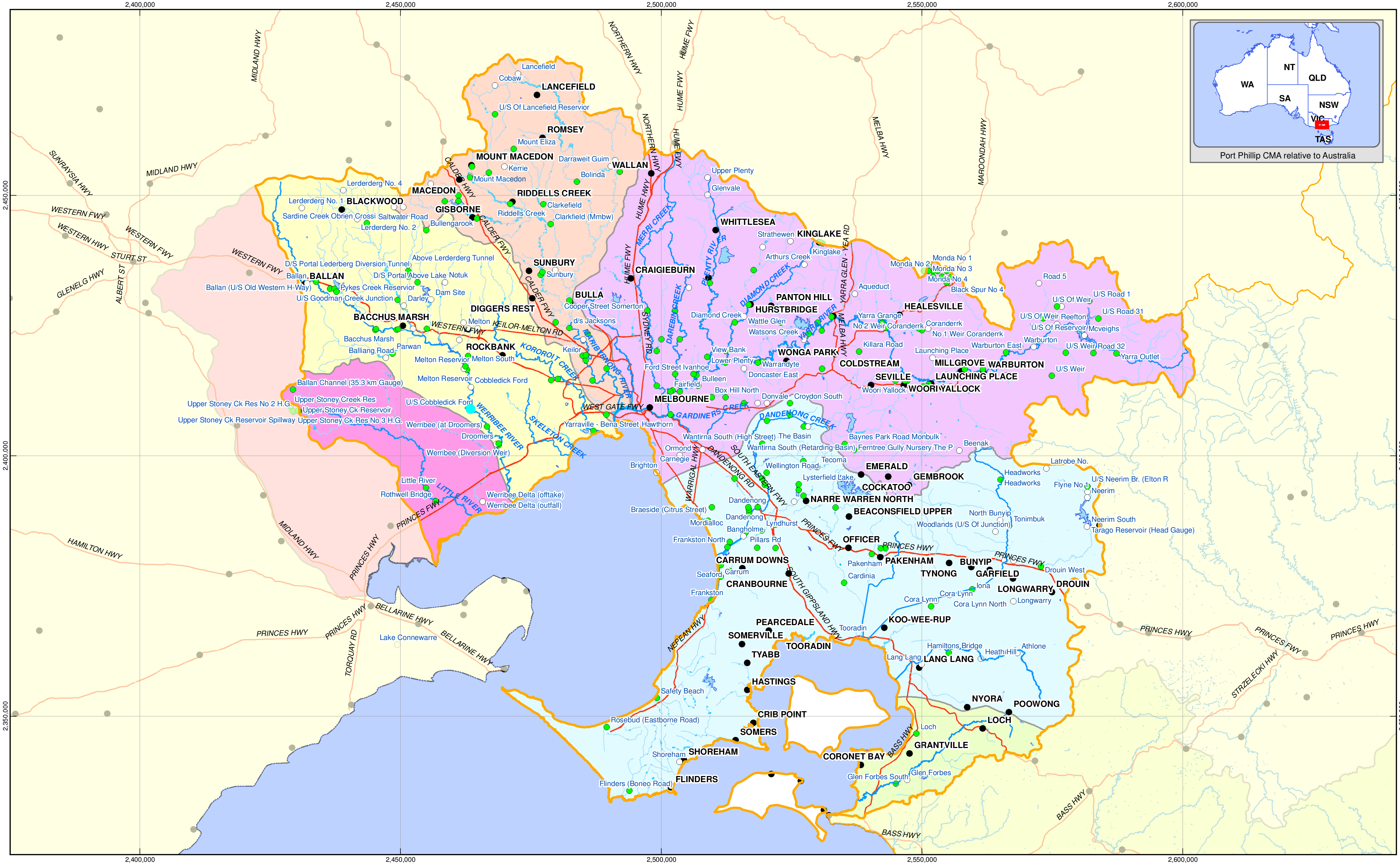

Scale	Legend		
1:660,013	Towns	River gauging station (old)	Salt lake
0 5 10 20 30 Kilometres (at A3)	Main River	Active	Watercourse
Map Projection: Lambert Conformal Conic	River	Inactive	Wetland / swamp
Horizontal Datum: Geocentric Datum of Australia 1994	Highway	Water Area	Flat
Grid: VICGRID94	State boundary	Lake	Pondage

N

Bunyip River Basin
Maribynong River Basin
Moorabool River Basin
South Gippsland Basin
Werribee River Basin
Yarra River Basin

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West Gippsland - Data Collation and Conceptualisation

Flow Gauging Locations and Hydrological Features

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Figure 6

G:\31\22410\CADD\GIS\Projects\3003_Port_Phillip_Suface_Water_Gauging.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

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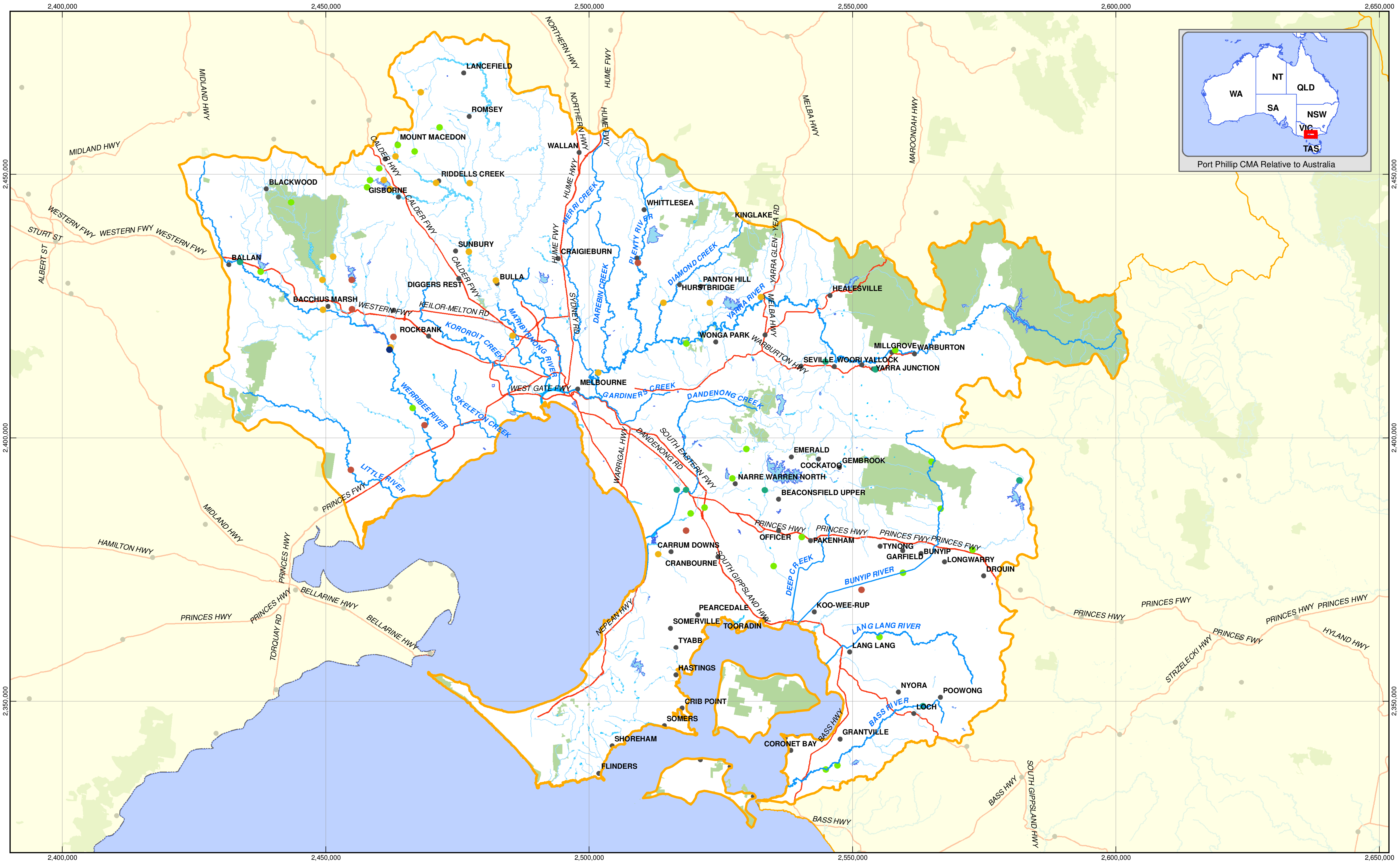

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0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Flow Yield (mm/yr)
  - 1 - 50
  - 51 - 100
  - 101 - 250
  - 251 - 500
  - 500+
- Other CMA
- PORT PHILLIP
- State Boundary
- River
- Main River
- Highway
- National Parks and Reserves

Surface Water

- Lake
- Salt Lake
- Watercourse Area
- Wetland / Swamp
- Flat
- Pondage

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Observed Long Term Average Flow Yields

Figure 7

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Data source: DSE and VicMAP. Khan Kamruzzaman

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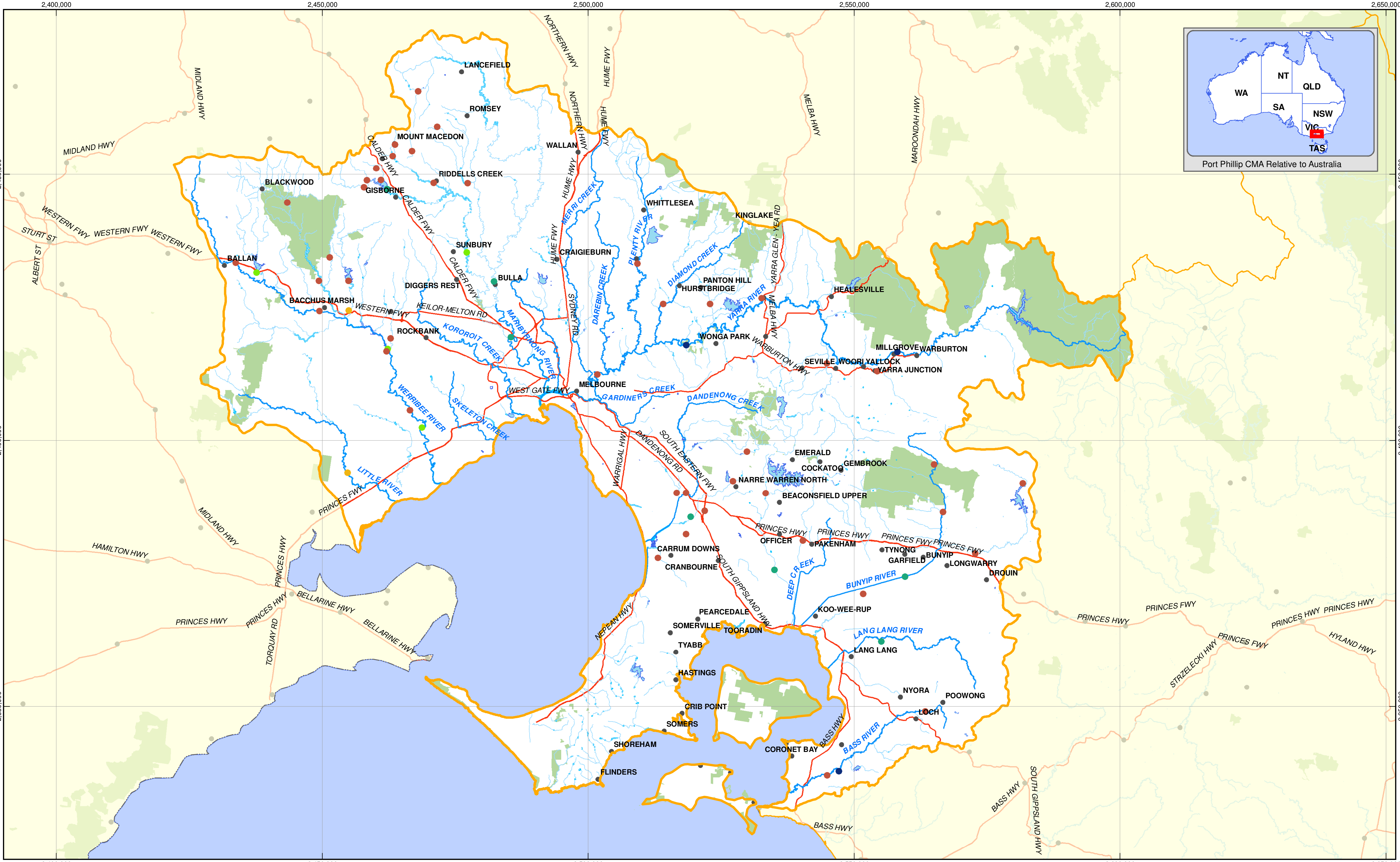


1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Flow Yield (mm/yr)
  - 0 - Nodata
  - 1 - 50
  - 51 - 100
  - 101 - 250
  - 251 - 500
- Other CMA
- PORT PHILLIP
- State Boundary
- River
- Main River
- Highway
- National Parks and Reserves
- Surface Water
  - Lake
  - Salt Lake
  - Watercourse Area
  - Wetland / Swamp
  - Flat
  - Pondage

GHD

Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Estimated Natural Long Term Average Flow Yields

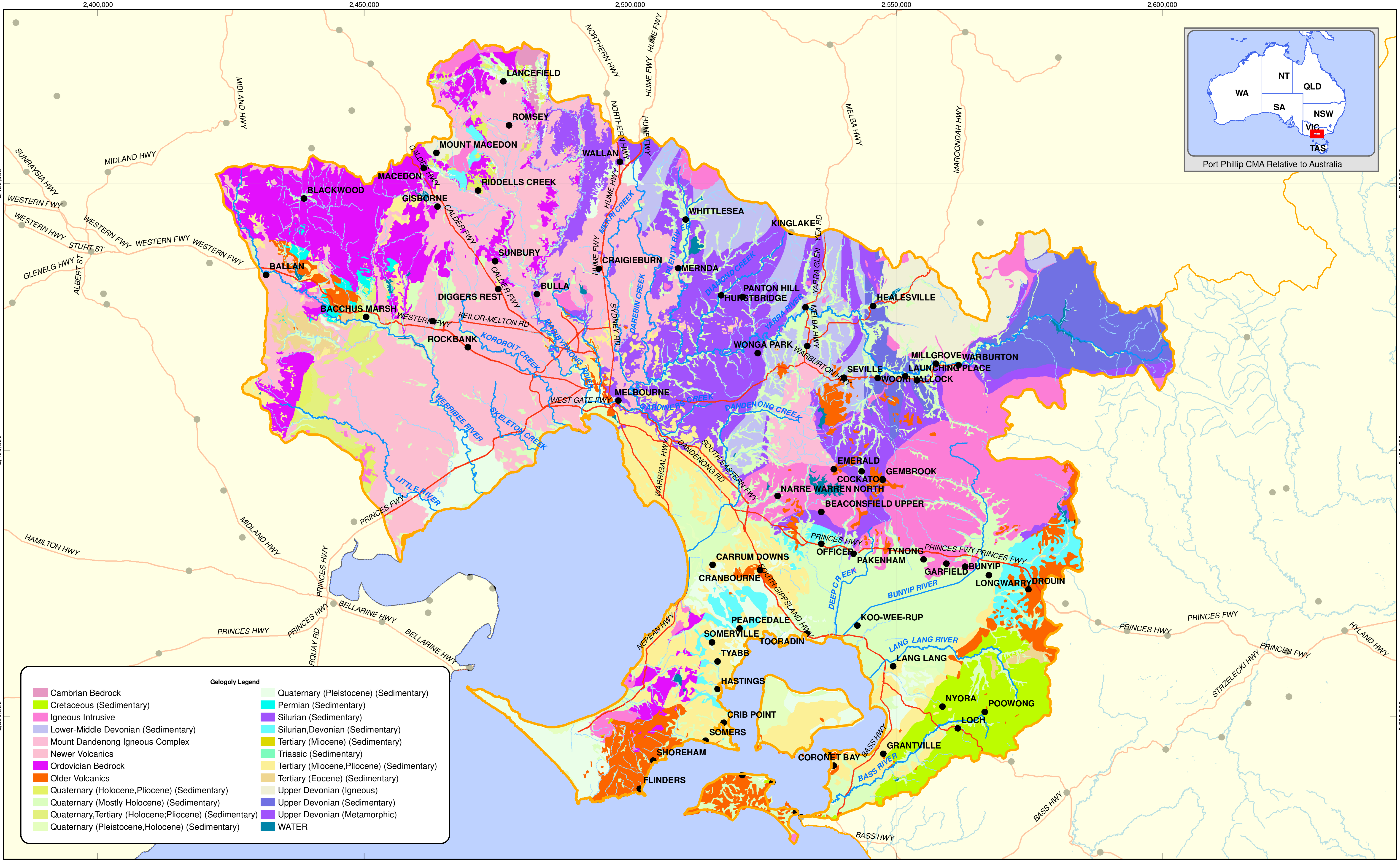
Job Number	31-22410
Revision	A
Date	October 2008

Figure 8

G:\31\22410\CADD\GIS\Projects\3015_Port_Phillip_Estimated_Natural_Long_Term_Average_Yields

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- River
- Main River
- Highway
- Other CMA
- PORT PHILLIP
- State Boundary
- Water Area

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West Gippsland - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

Outcrop Geology

Figure 9

G:\31\22410\CADD\GIS\Projects\3005_Port_Phillip_Geology.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

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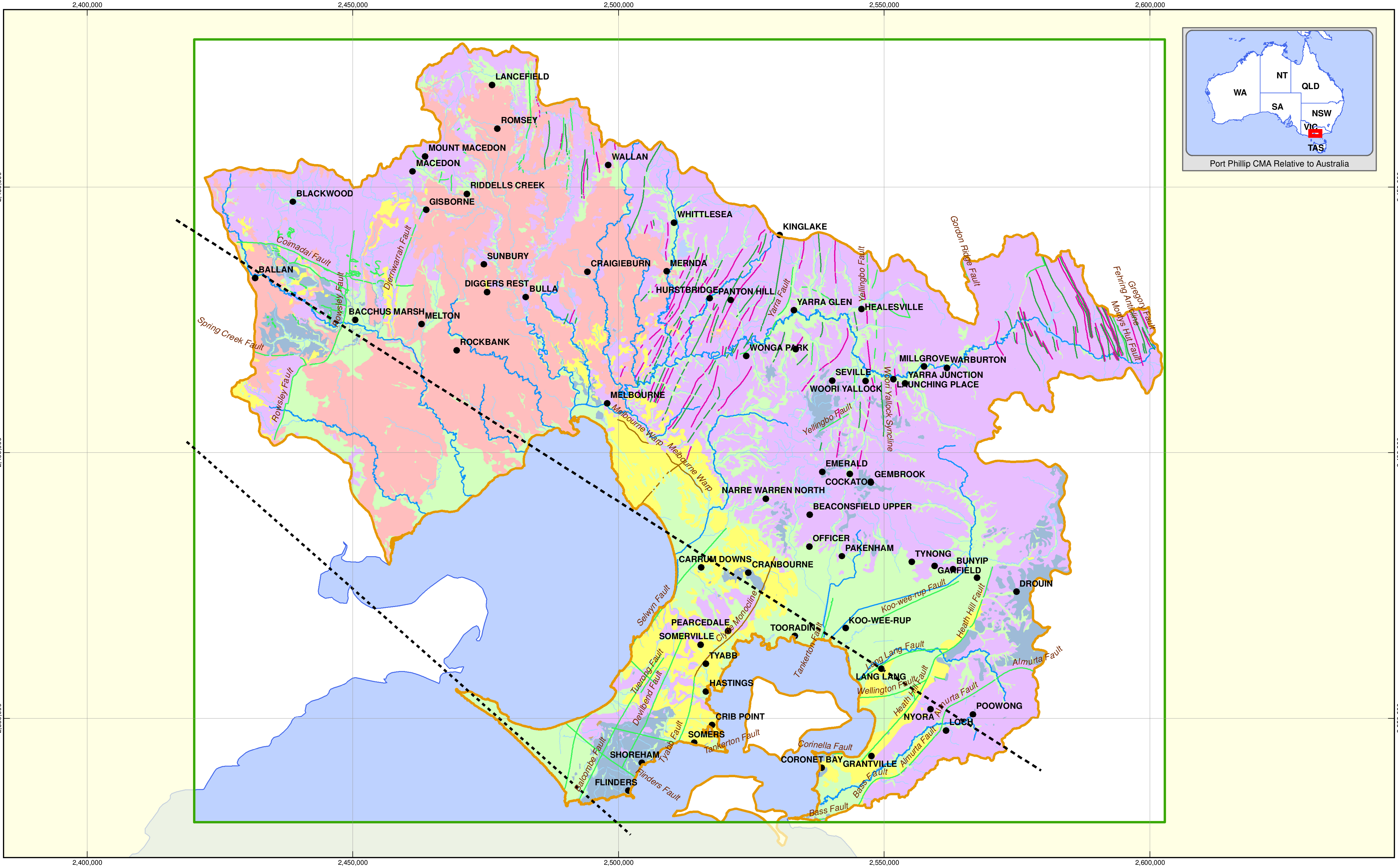

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID, Australia

N

LEGEND

- Towns
- Regional Cross Section SKM (2006, See Appendix B)
- Model Grid Extent
- CMA Boundary

Geological Faults
- Fault
- Syncline
- Anticline
- Monocline

- Main River
- River
- Quaternary Mapped Outcrop
- Newer Volcanic Mapped Outcrop
- UpperTertiary Mapped Outcrop
- MiddleTertiary Mapped Outcrop
- LowerTertiary Mapped Outcrop
- PreTertiary Mapped Outcrop

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Department of Sustainability
Port Phillip CMA Groundwater Model

Job Number 31-22410
Revision A
Date October 2008

Simplified Outcrop Geology and Structure

Figure 10

G:\31\22410\CADD\GIS\Projects\3012_Port_Phillip_Mapped_Outcrop_and_Structure.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns

Transmissivity m²/d
- 0 - 10
- 10 - 50
- 50 - 100
- 100 - 500
- 500+

- Other CMA
- PORT PHILLIP
- River
- Main River
- Highway
- State Boundary
- National Parks and Reserves

Surface Water
- Lake
- Salt Lake
- Watercourse Area
- Wetland / Swamp
- Flat
- Pondage

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Port Phillip - Data Collation and Conceptualisation

Estimated Transmissivity - Quaternary Sediments

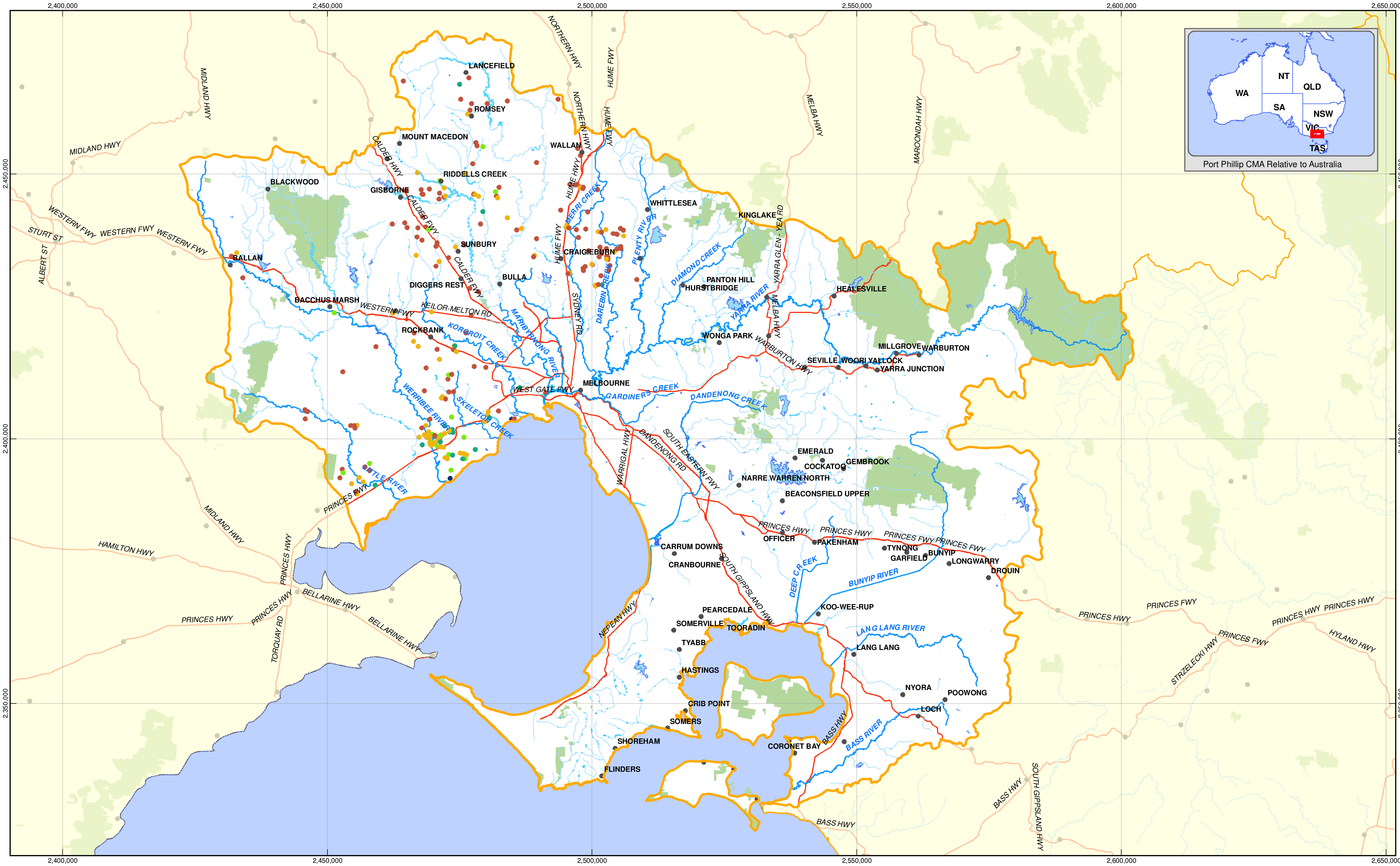
Job Number	31-22410
Revision	A
Date	October 2008

Figure 11

G:\31\22410\CADD\GIS\Projects\3016_Port_Phillip_Estimated_Transmissivity_Quaternary_Sediments.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Transmissivity m²/d
  - 0 - 10
  - 10 - 50
  - 50 - 100
  - 100 - 500
  - 500+
- Other CMA
- PORT PHILLIP
- River
- Main River
- Highway
- State Boundary
- National Parks and Reserves

Surface Water

- Lake
- Salt Lake
- Watercourse Area
- Wetland / Swamp
- Flat
- Pondage

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Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
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Date	October 2008

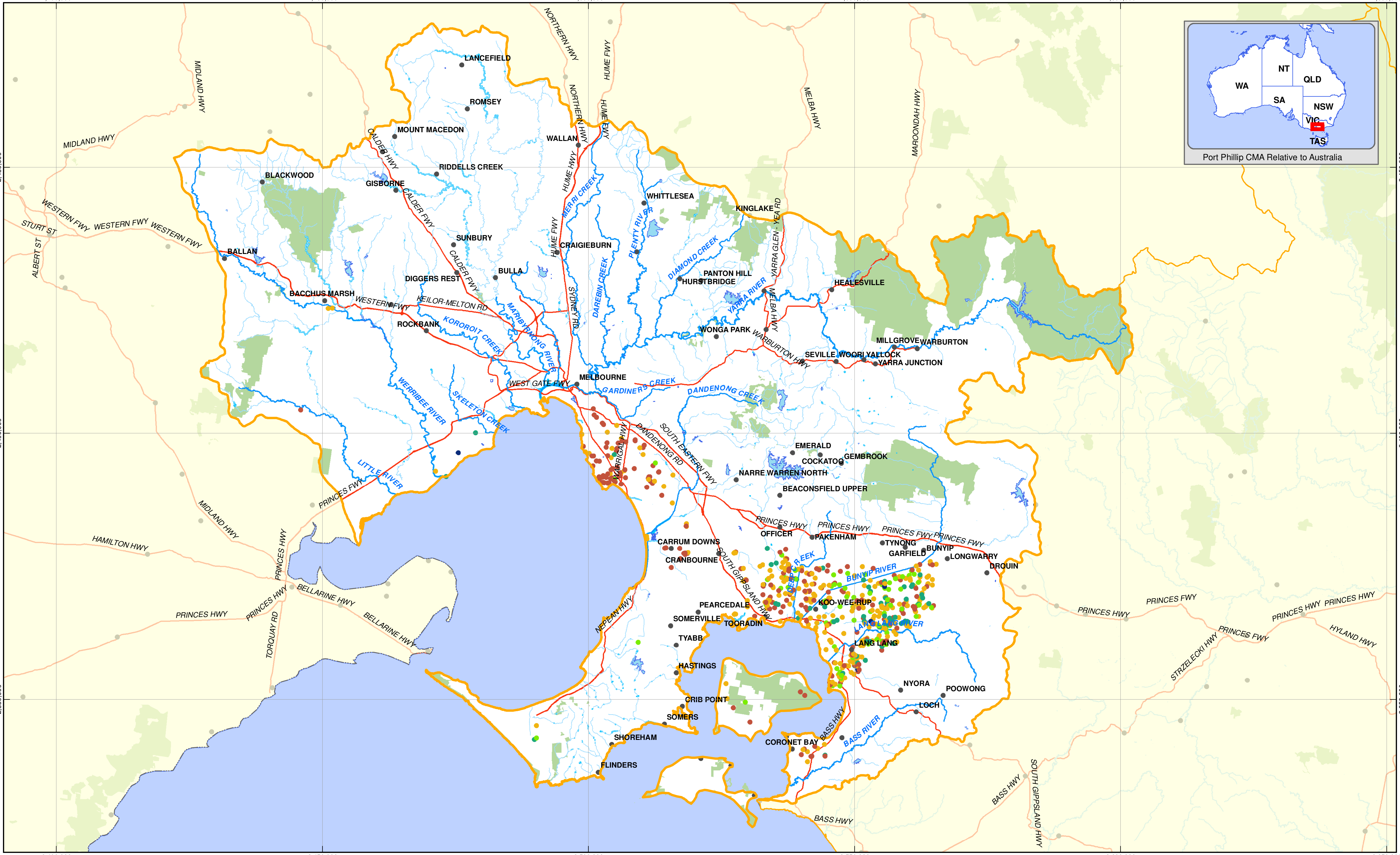
Estimated Transmissivity - Newer Volcanic Group

Figure 12

G:\31\22410\CADD\GIS\Projects\3017_Port_Phillip_Estimated_Transmissivity_Newer_Volcanic_Group.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000
0 5 10 20 30
Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- **Transmissivity m²/d**
  - 0 - 10
  - 10 - 50
  - 50 - 100
  - 100 - 500
  - 500+
- Other CMA
- PORT PHILLIP
- River
- Main River
- Highway
- State Boundary
- National Parks and Reserves
- **Surface Water**
  - Lake
  - Salt Lake
  - Watercourse Area
  - Wetland / Swamp
  - Flat
  - Pondage

Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

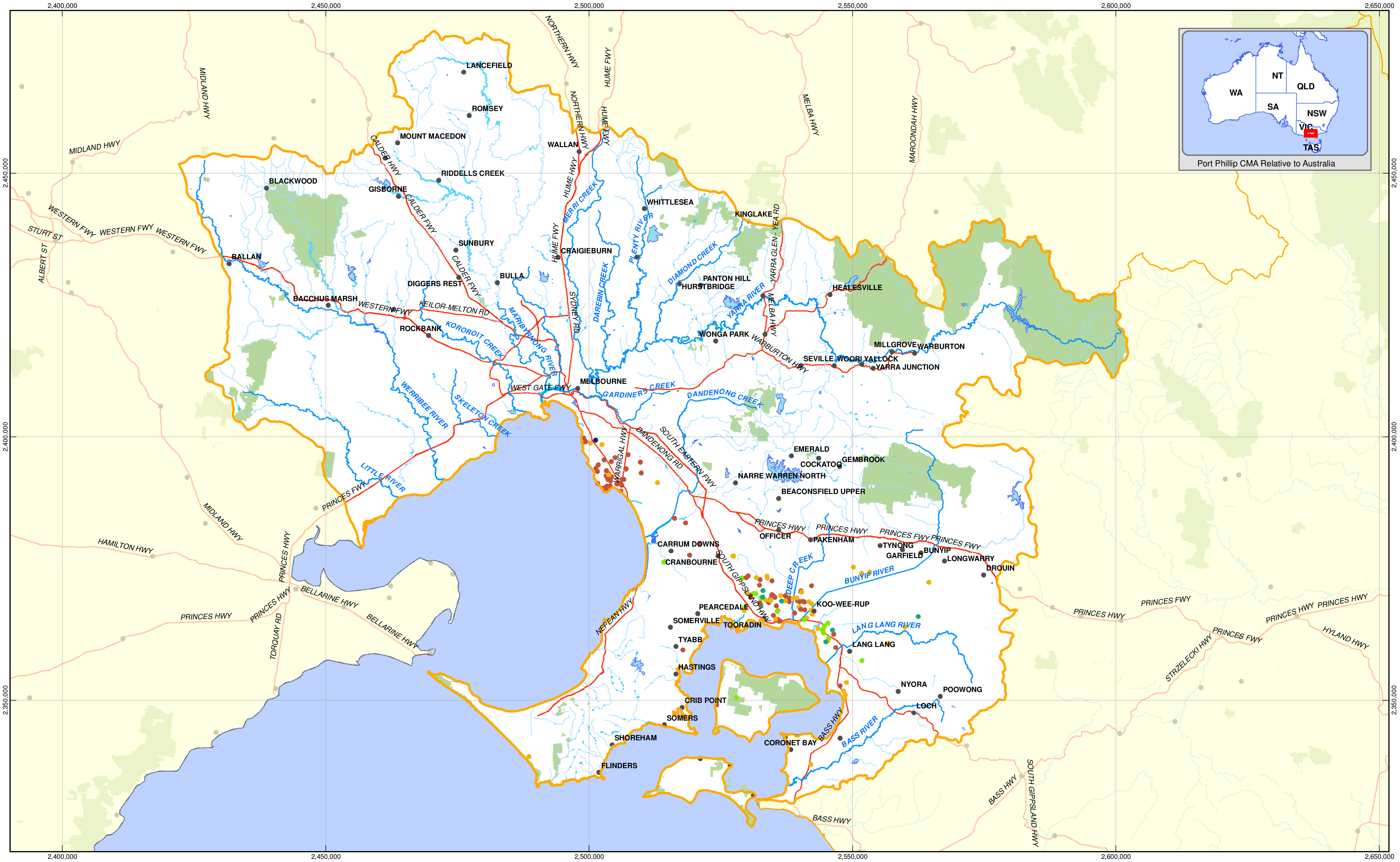
Estimated Transmissivity - Upper Tertiary Age Units

Figure 13

G:\31\22410\CADD\GIS\Projects\3018_Port_Phillip_Estimated_Transmissivity_Upper_Tertiary_Age_Units.mxd

Data source: DSE and VicMAP. Prepared by: Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- **Transmissivity m²/d**
  - 0 - 10
  - 10 - 50
  - 50 - 100
  - 100 - 500
  - 500+
- Other CMA
- PORT PHILLIP
- Main River
- River
- Highway
- State Boundary
- National Parks and Reserves
- **Surface Water**
  - Lake
  - Salt Lake
  - Watercourse Area
  - Wetland / Swamp
  - Flat
  - Pondage

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Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

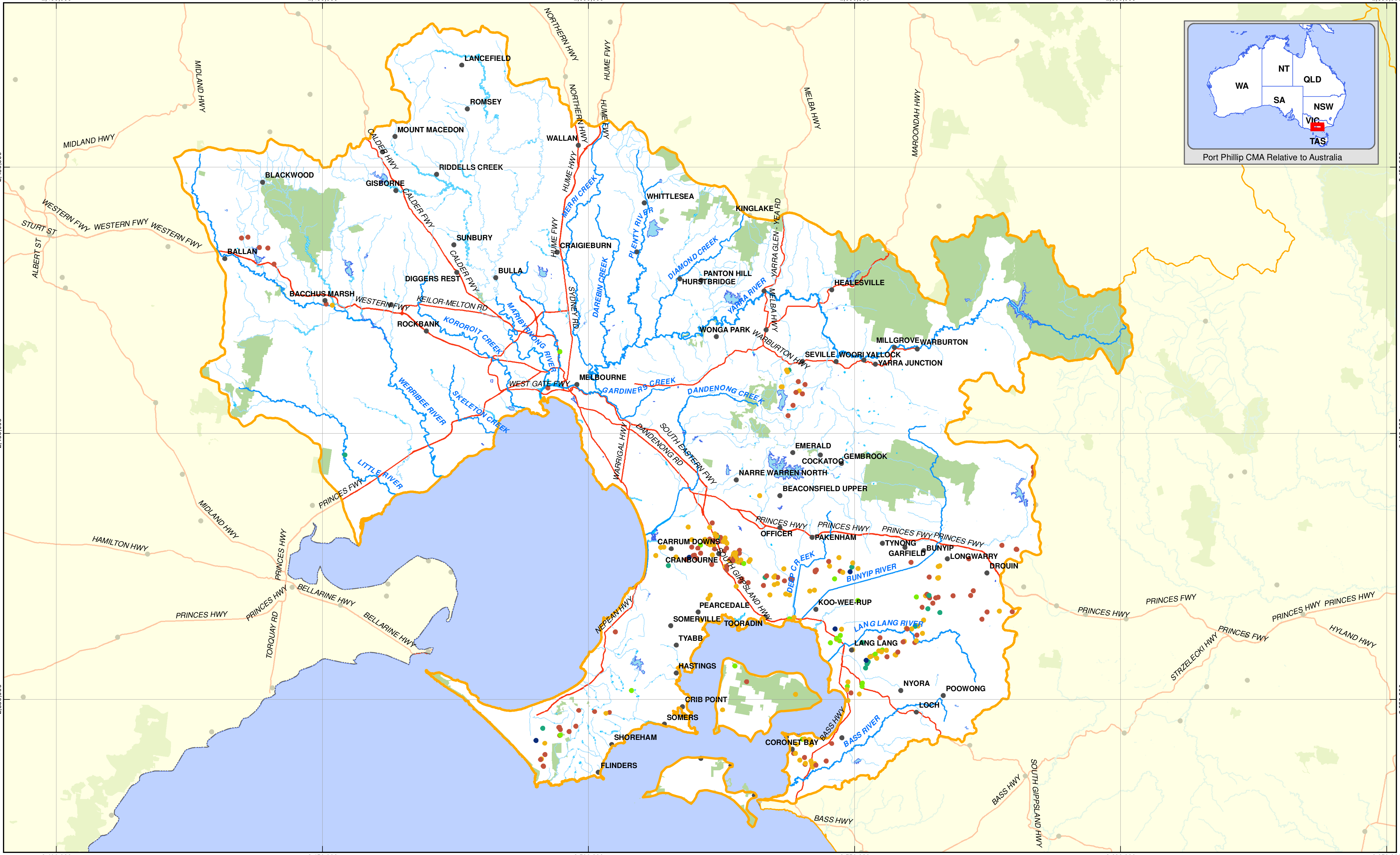
Estimated Transmissivity - Middle Tertiary Age Units

Figure 14

G:\31\22410\CADD\GIS\Projects\3019_Port_Phillip_Estimated_Transmissivity_Middle_Tertiary_Age_Units.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- **Transmissivity m²/d**
  - 0 - 10
  - 10 - 50
  - 50 - 100
  - 100 - 500
  - 500+
- Other CMA
- PORT PHILLIP
- Main River
- River
- Highway
- State Boundary
- National Parks and Reserves
- **Surface Water**
  - Lake
  - Salt Lake
  - Watercourse Area
  - Wetland / Swamp
  - Flat
  - Pondage

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Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

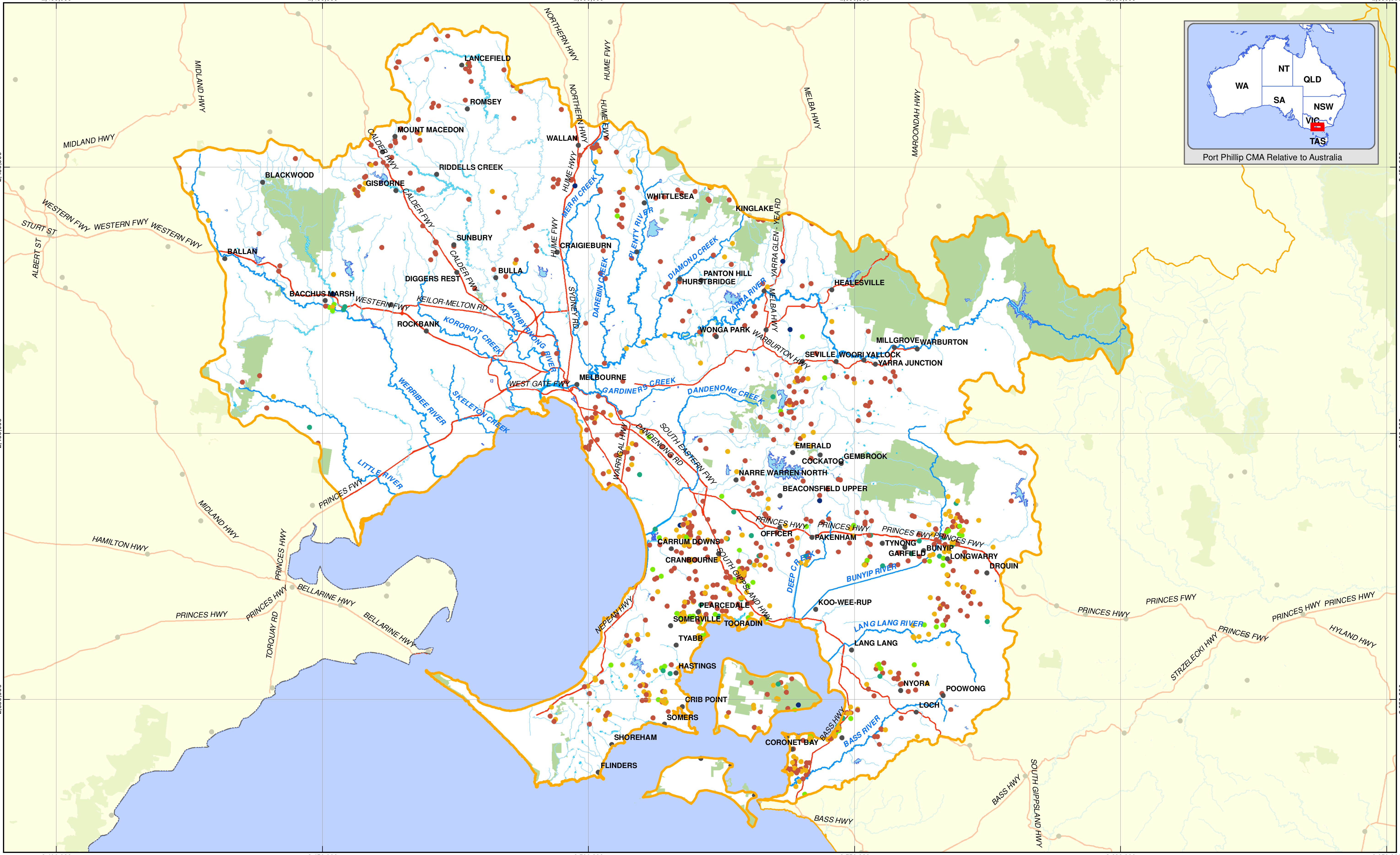
Estimated Transmissivity - Lower Tertiary Age Units

Figure 15

G:\31\22410\CADD\GIS\Projects\3020_Port_Phillip_Estimated_Transmissivity_Lower_Tertiary_Age_Units.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Transmissivity m²/d
  - 0 - 10
  - 10 - 50
  - 50 - 100
  - 100 - 500
  - 500+
- Other CMA
- PORT PHILLIP
- River
- Main River
- Highway
- State Boundary
- National Parks and Reserves
- Surface Water
  - Lake
  - Salt Lake
  - Watercourse Area
- Wetland / Swamp
- Flat
- Pondage

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Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

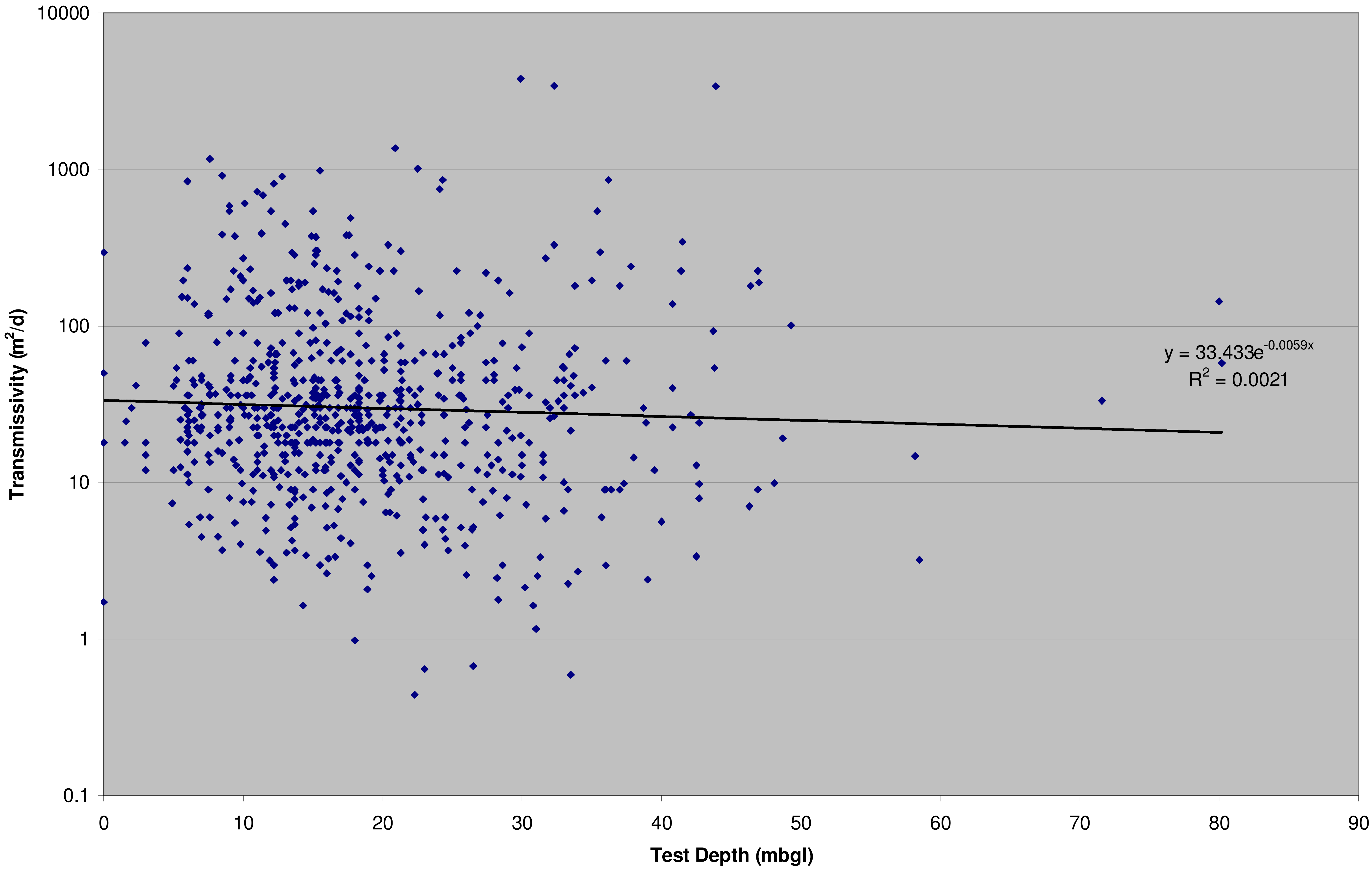
Estimated Transmissivity - Pre-Tertiary Age Units

Figure 16

G:\31\22410\CADD\GIS\Projects\3021_Port_Phillip_Estimated_Transmissivity_Pre_Tertiary_Age_Units.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



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Port Phillip - Data Collation and Conceptualisation

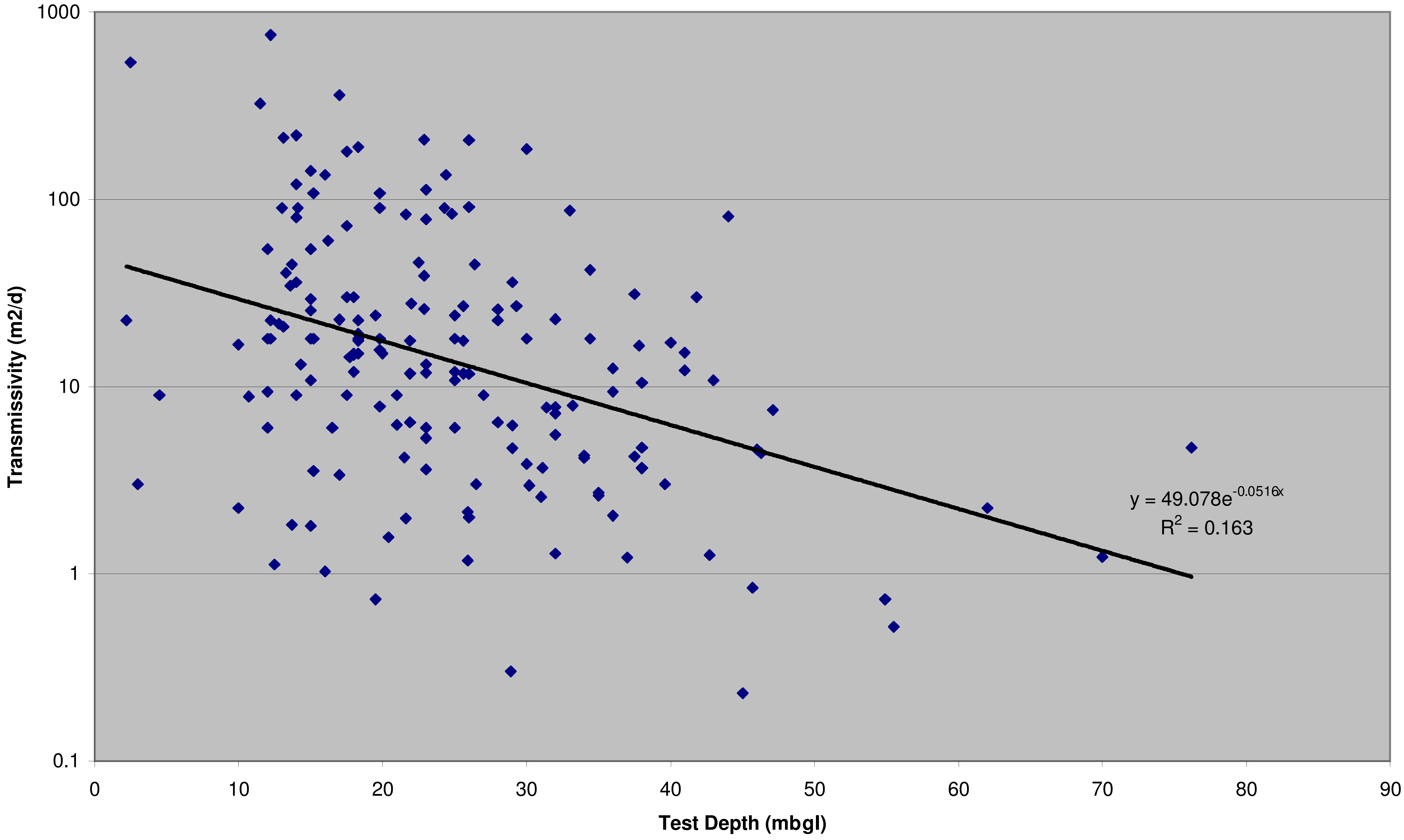
Job Number	31-22410
Revision	A
Date	October 2008

Estimated Transmissivity vs Test Depth – Quaternary Sediments

Figure 17

Data source: DSE and GHD. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



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Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

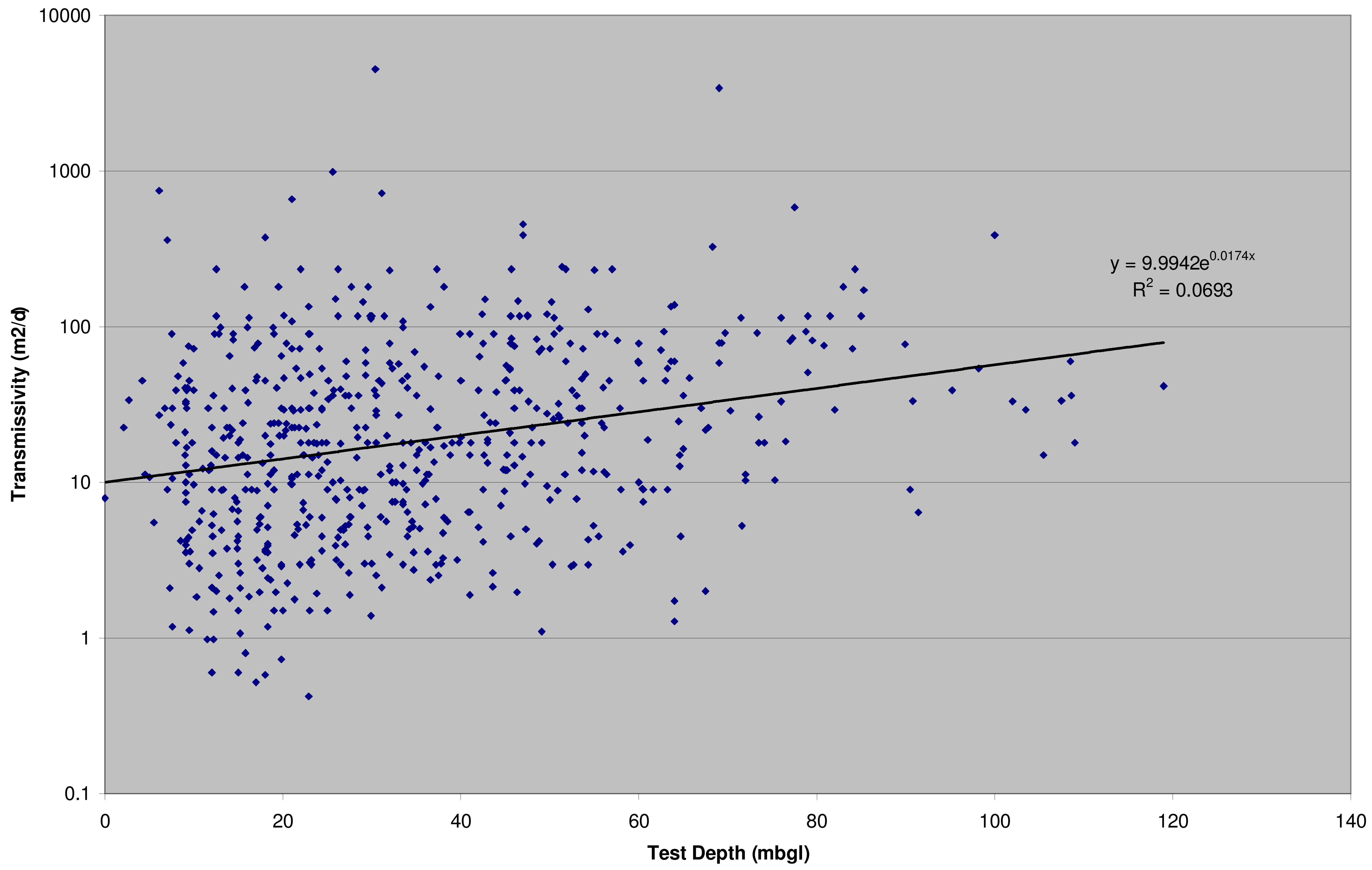
Estimated Transmissivity vs Test Depth – Newer Volcalic Group

Figure 18

8/180 Lonsdale St Melb VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com.au **W** www.ghd.com.au

Poject File: G:\31\22410\CADD\GIS\Projects\3024_Port_Phillip_Estimated_Transmissvity_Vs_Test_Depth_NewVolcs.mxd; Spreadsheet: G:\31\22410\CADD\GIS\D_Create\Conceptualisation\Yield_PP\TransvDepth_NewVolcs.xls

Data source: DSE and GHD. Khan Kamruzzaman



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Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

Estimated Transmissivity vs Test Depth – Upper Tertiary

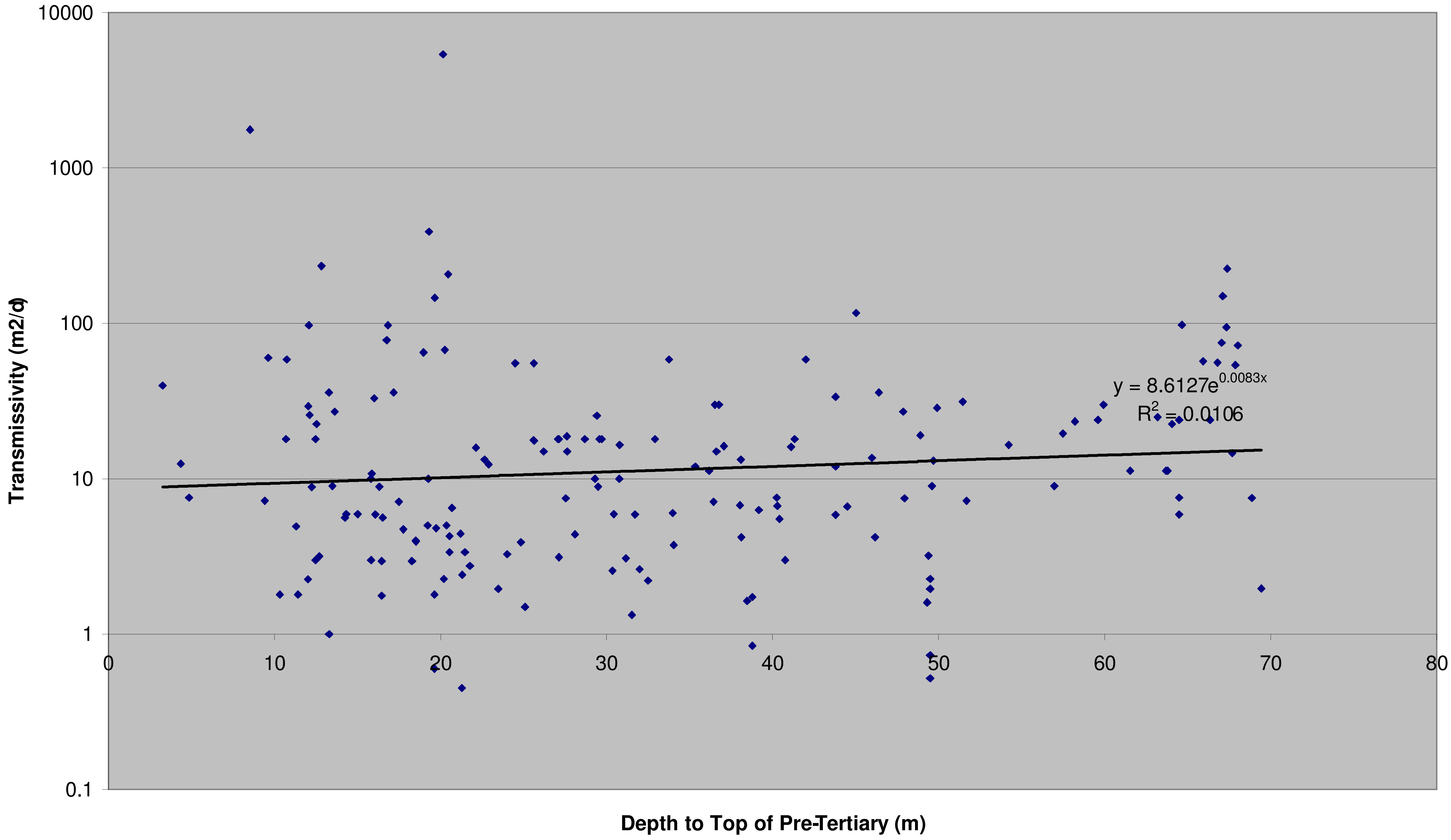
Figure 19

Poject File: G:\31\22410\CADD\GIS\Projects\3025_Port_Phillip_Estimated_Transmissivity_Vs_Test_Depth_UpperTertiary.mxd Spreadsheet: G:\31\22410\CADD\GIS\D_Create\Conceptualisation\Yield_PP\TransvDepth_UpperTertiary.xls

Data source: DSE and GHD. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com.au **W** www.ghd.com.au

T vs Depth to Top of Middle Tertiary



Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

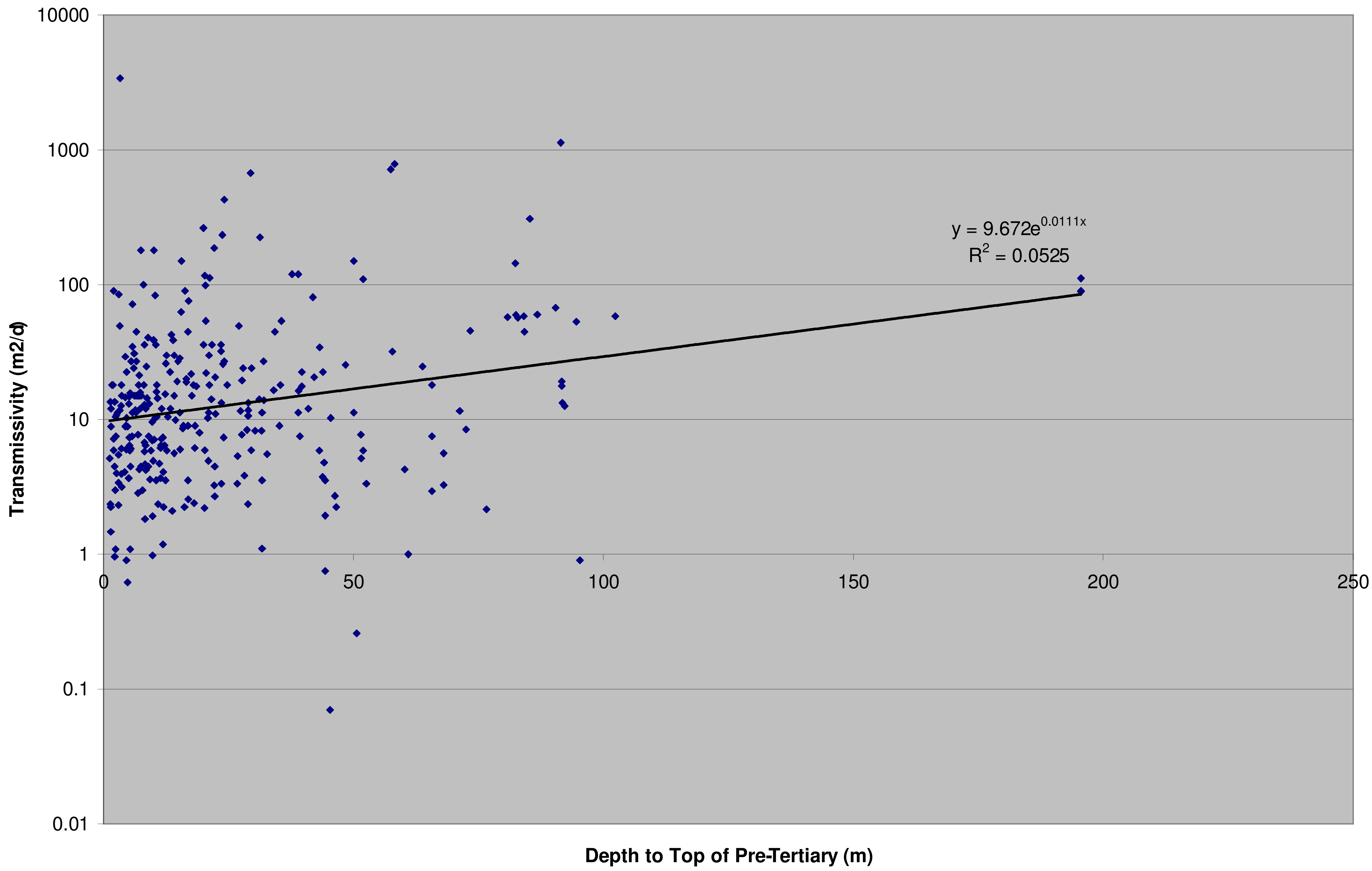
Estimated Transmissivity vs Test Depth – Middle Tertiary Age Units

Figure 20

Poject File: G:\31\22410\CADD\GIS\Projects\3026_Port_Phillip_Estimated_Transmissivity_Vs_Test_Depth_MiddleTertiary.mxd Spreadsheet: G:\31\22410\CADD\GIS\D_Create\Conceptualisation\Yield_PP\TransvDepth_MiddleTertiary.xls

Data source: DSE and GHD. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



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Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

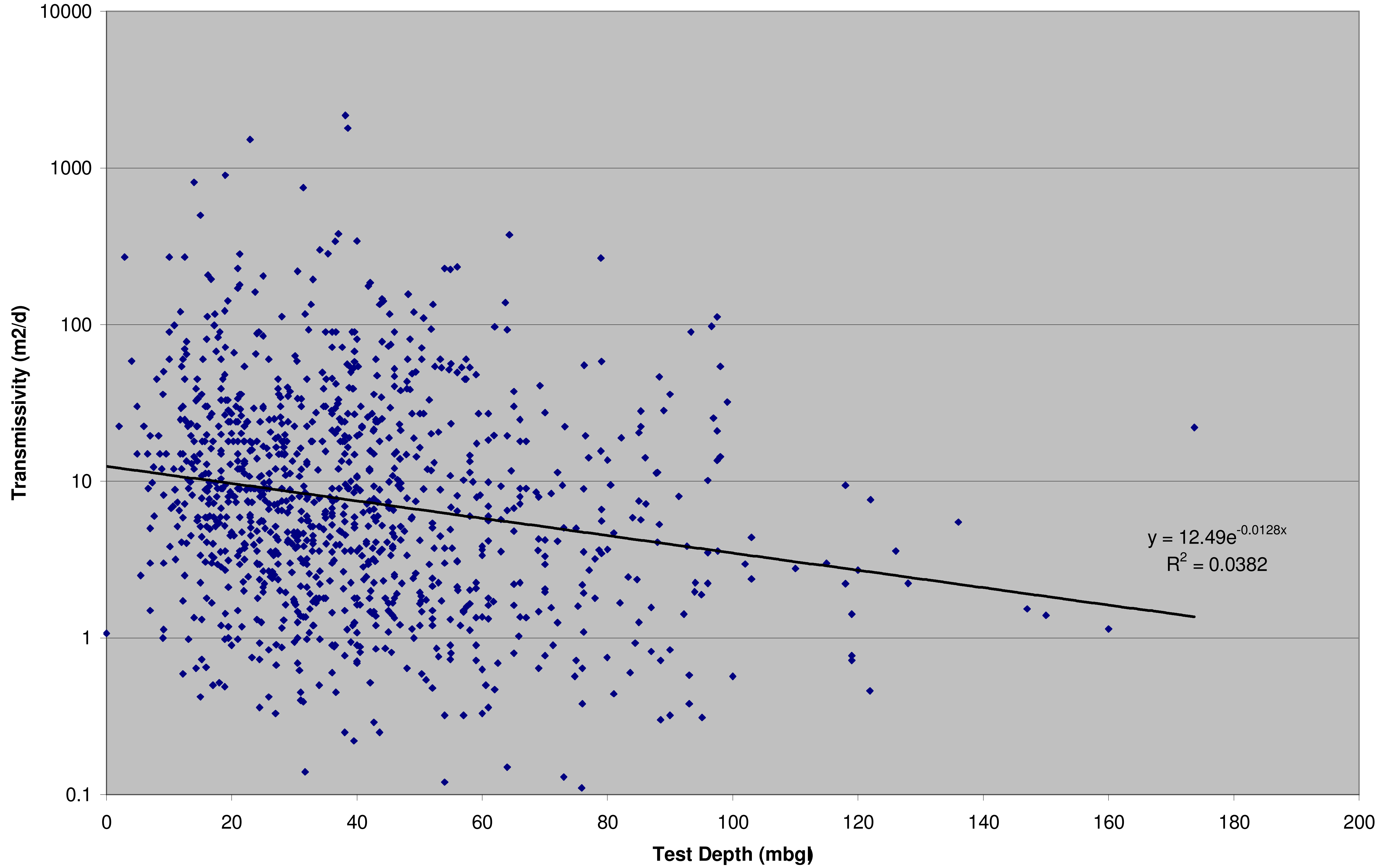
Estimated Transmissivity vs Test Depth – Lower Tertiary

Figure 21

Poject File: G:\31\22410\CADD\GIS\Projects\3022_Port_Phillip_Estimated_Transmissvity_Vs_Test_Depth_Lower_Tertiary.mxd; Spreadsheet: G:\31\22410\CADD\GIS\D_Create\Conceptualisation\Yield_PP\TransvDepth_LowerTertiary.xls

Data source: DSE and GHD. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

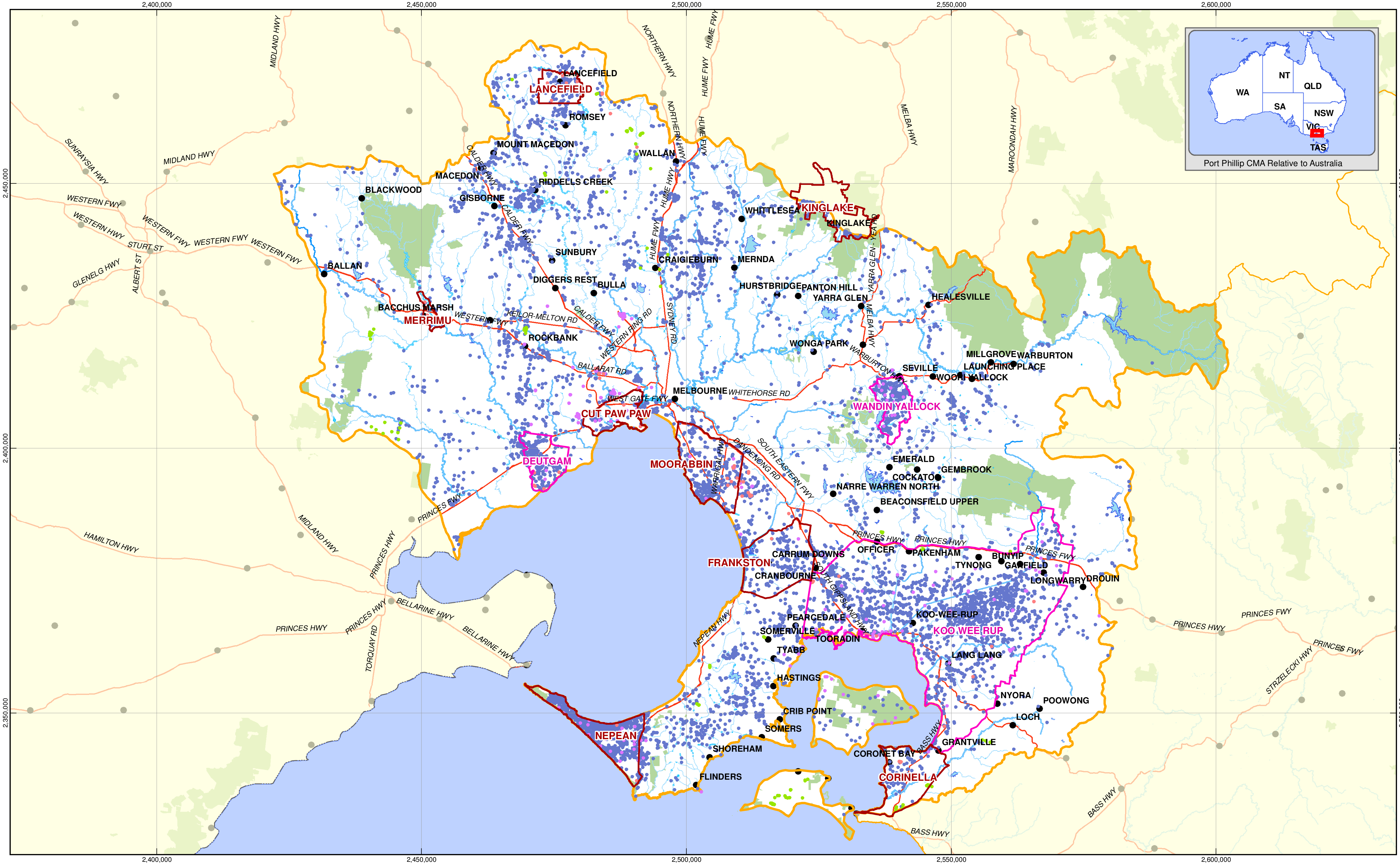
Estimated Transmissivity vs Test Depth – Pre-Tertiary Age Units

Figure 22

Poject File: G:\31\22410\CADD\GIS\Projects\3027_Port_Phillip_Estimated_Transmissivity_Vs_Test_Depth_Pre-Tertiary.mxd Spreadsheet: G:\31\22410\CADD\GIS\D_Create\Conceptualisation\Yield_PP\TransvDepth_PreTertiary.xls

Data source: DSE and GHD. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

- Towns
- Main River
- River
- Highway
- Other CMA
- PORT PHILLIP
- GMAs Boundary
- WSPAs Boundary
- National Parks and Reserves

Surface Water
- Lake
- Salt Lake
- Watercourse Area
- Wetland / Swamp
- Flat
- Pondage
- GMS Bore with SWL Data
- PIRVIC Bores
- SOB Network Bores
- GMS Bores with RWL Data

Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

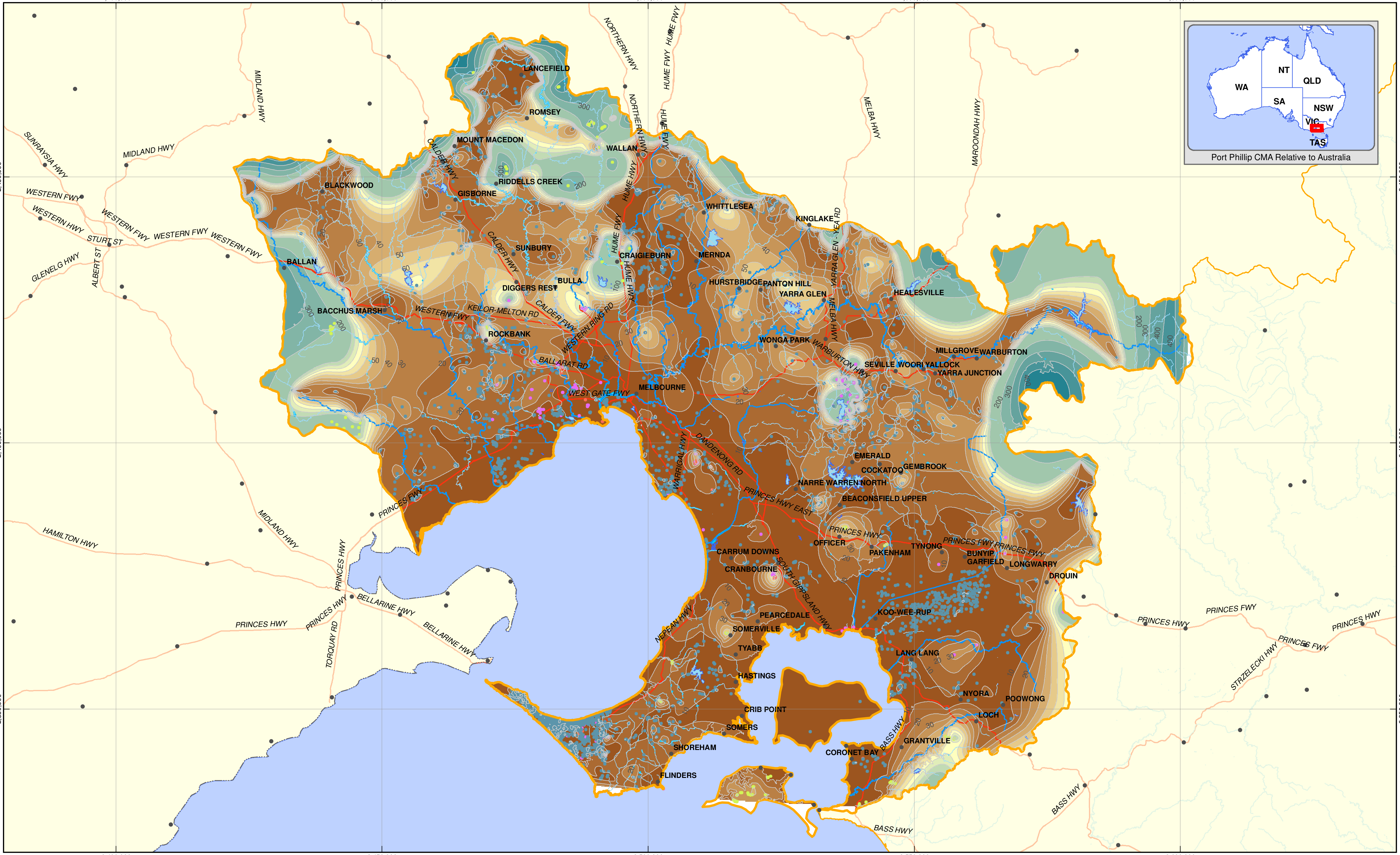
Groundwater Level Monitoring Boreholes

Figure 23

G:\31\22410\CADD\GIS\Projects\3052_Port_Phillip_Groundwater_Level_Monitoring_Boreholes.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

- Towns
- Main River
- Highway
- River
- Other CMA
- PORT PHILLIP
- Contour

Bore

- SOB Network Bores
- Other GMS Bores
- PIRVIC Bores
- Spot Groundwater Level

Water Table Elevation (mAHD)

10 20 30 40 50 60 70 80 90 100 200 300 400 500 500+

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Port Phillip - Data Collation and Conceptualisation

Observed Water Table Elevation Contours

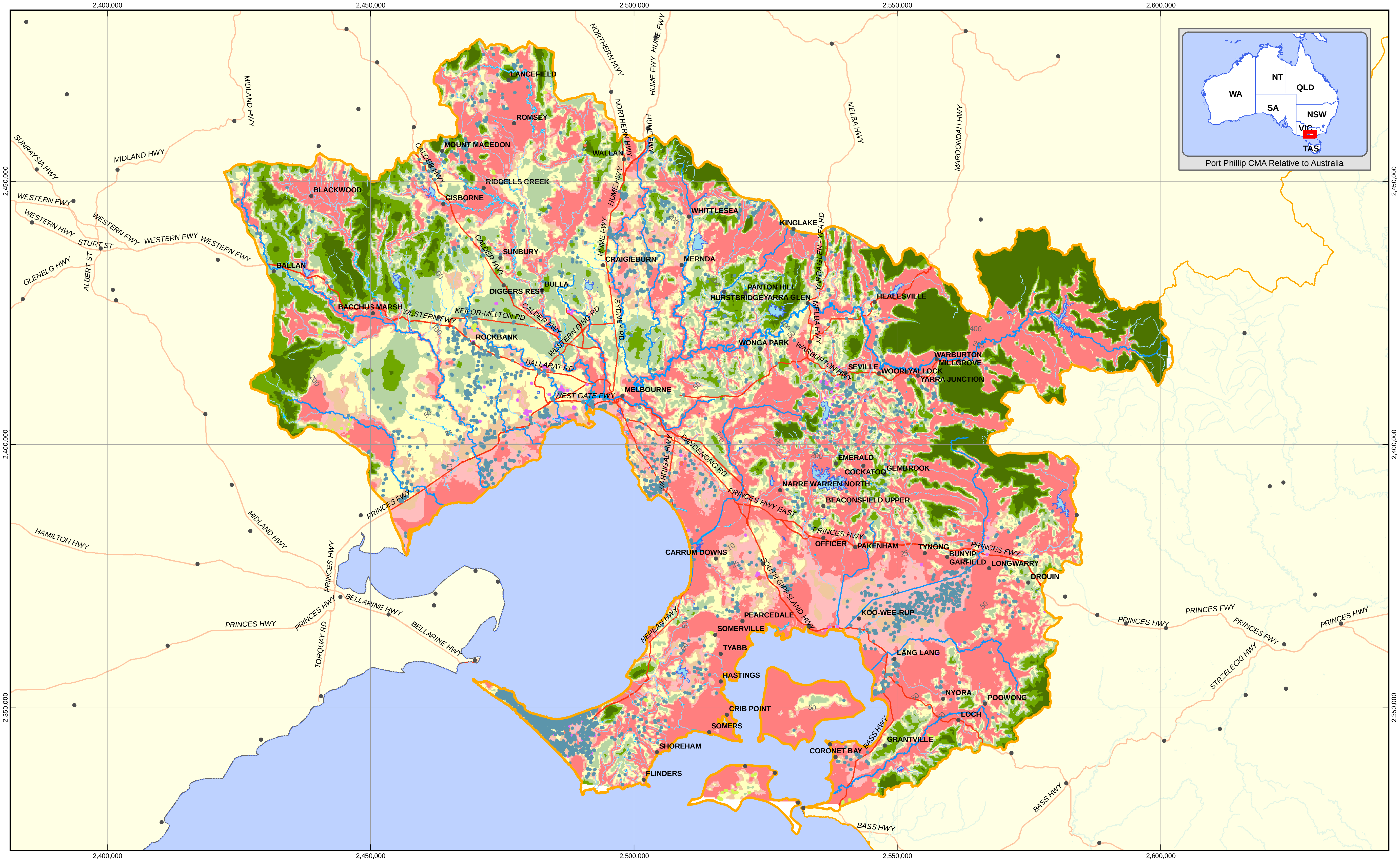
Job Number	31-22410
Revision	A
Date	October 2008

Figure 24

G:\31\22410\CADD\GIS\Projects\3029_Port_Phillip_Observed_Water_Table_Elevation_Contours.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

- Towns
- Main River
- Highway
- River
- Other CMA
- PORT PHILLIP

Bore

- SOB Network Bores
- Other GMS Bores
- PIRVIC Bores
- Spot Groundwater Level

Depth to Water Table m

- <=1
- 1.01 - 5
- 5.01 - 10
- 10.01 - 25
- 25.01 - 50
- 50.01 - 100
- 100+

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Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Observed Depth To Water Table Contours

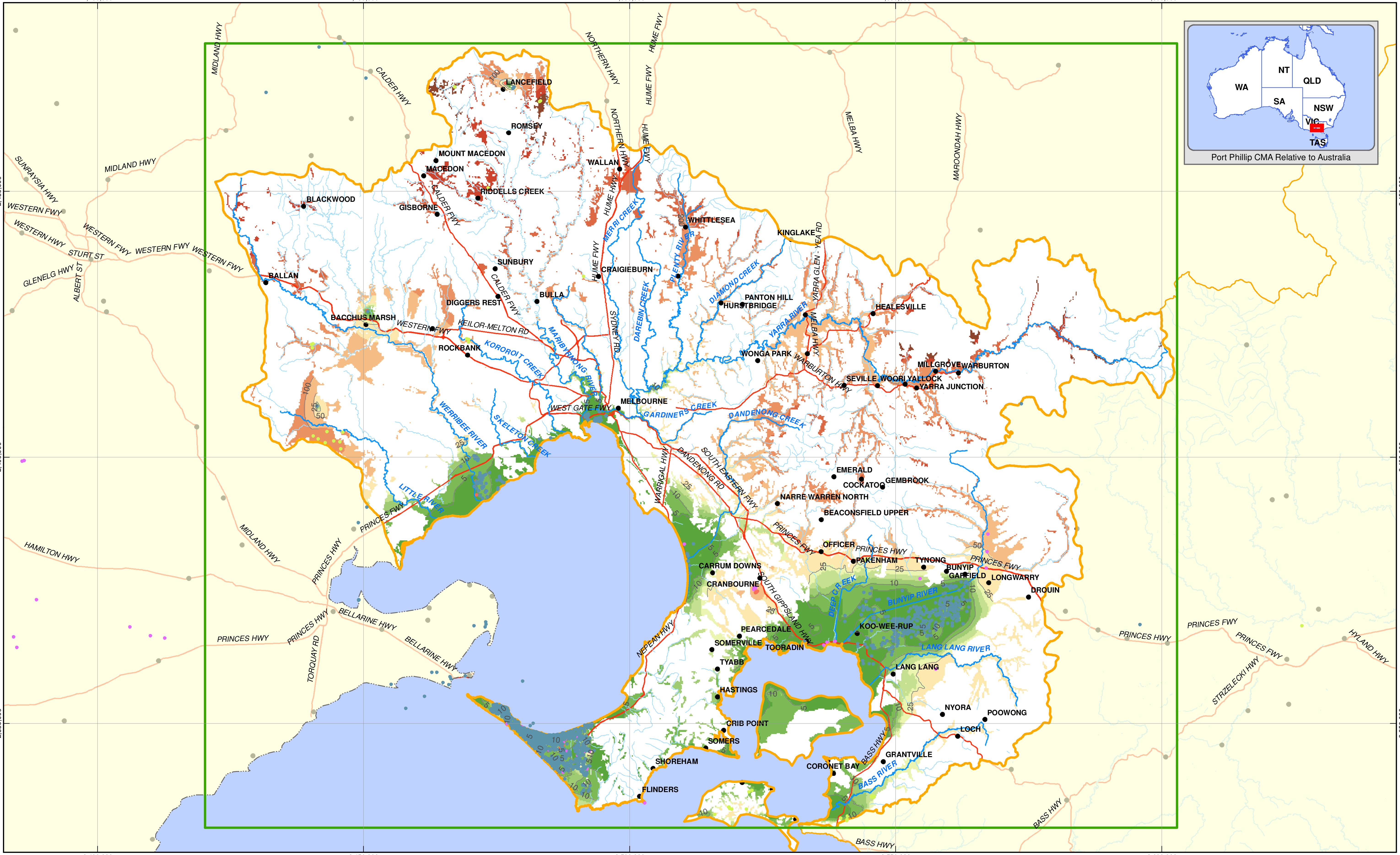
Job Number	31-22410
Revision	A
Date	May 2010

Figure 25

G:\31\22410\CADD\GIS\Projects\3030_Port_Phillip_Observed_Depth_To_Water_Table_Contours.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

- Towns
- Main River
- River
- Highway
- Contour
- State Boundary

Bore
- SOB Network Bores
- Other GMS Bores
- PIRVIC Bores
- Spot Groundwater Level
- Model Grid Extent

- Other CMA
- PORT PHILLIP

Groundwater Level mAHD
- No Data
- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25-50
- 50-100
- 100-200
- 200-300
- 300-400
- >400

Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Observed Groundwater Level Quaternary Sediments

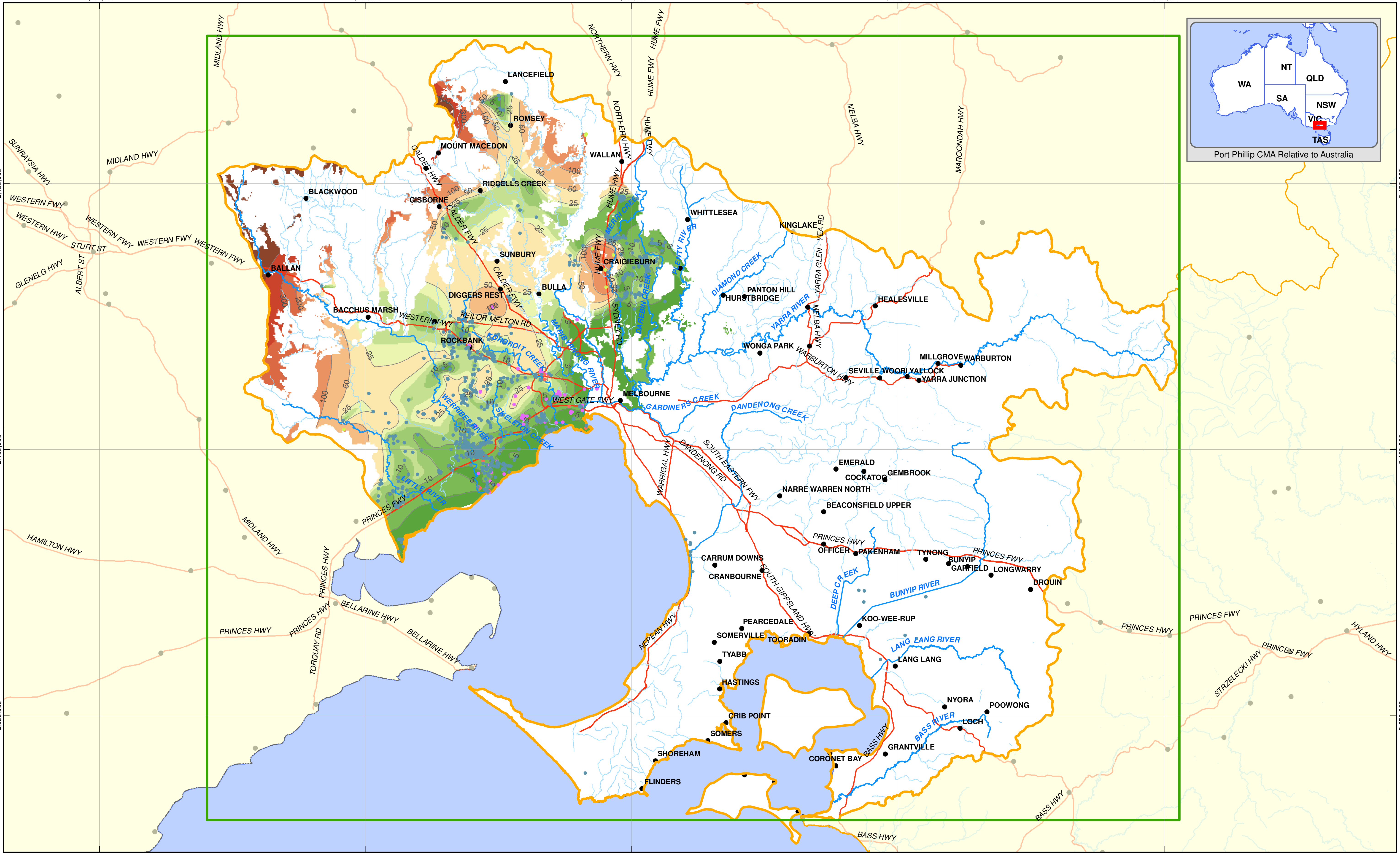
Job Number	31-22410
Revision	A
Date	October 2008

Figure 26

G:\31\22410\CADD\GIS\Projects\3031_Port_Phillip_Observed_Groundwater_Level_Contours_Quaternary_Sediments.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

- Towns
- Highway
- Contour
- Main River
- River
- State Boundary

Bore
- SOB Network Bores
- Other GMS Bores
- PIRVIC Bores
- Spot Groundwater Level
- Model Grid Extent

- Other CMA
- PORT PHILLIP

Groundwater (Level mAHD)
- No Data
- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25-50
- 50-100
- 100-200
- 200-300
- 300-400
- >400

Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Observed Groundwater Level - Newer Volcanic Group

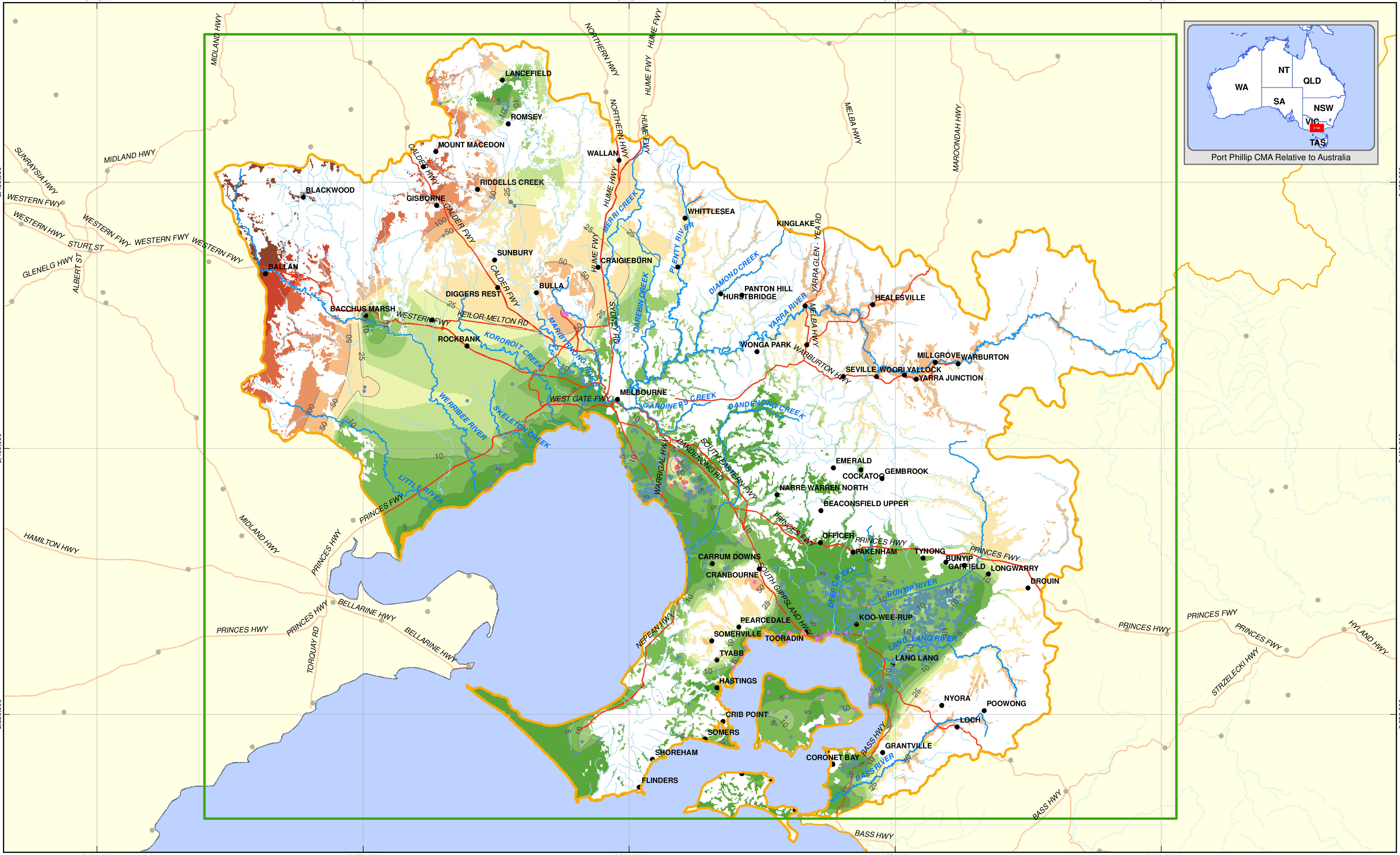
Job Number	31-22410
Revision	A
Date	October 2008

Figure 27

G:\31\22410\CADD\GIS\Projects\3032_Port_Phillip_Observed_Groundwater_Level_Contour_Newer_Volcanic_Group.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

- Towns
- Highway
- Main River
- River
- Contour
- State Boundary

Bore

- SOB Network Bores
- Other GMS Bores
- PIRVIC Bores
- Spot Groundwater Level
- Model Grid Extent

- Other CMA
- PORT PHILLIP

Groundwater Level (mAHD)

- No Data
- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25-50
- 50-100
- 100-200
- 200-300
- 300-400
- >400

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Port Phillip - Data Collation and Conceptualisation

Observed Groundwater Level Upper Tertiary Age Units

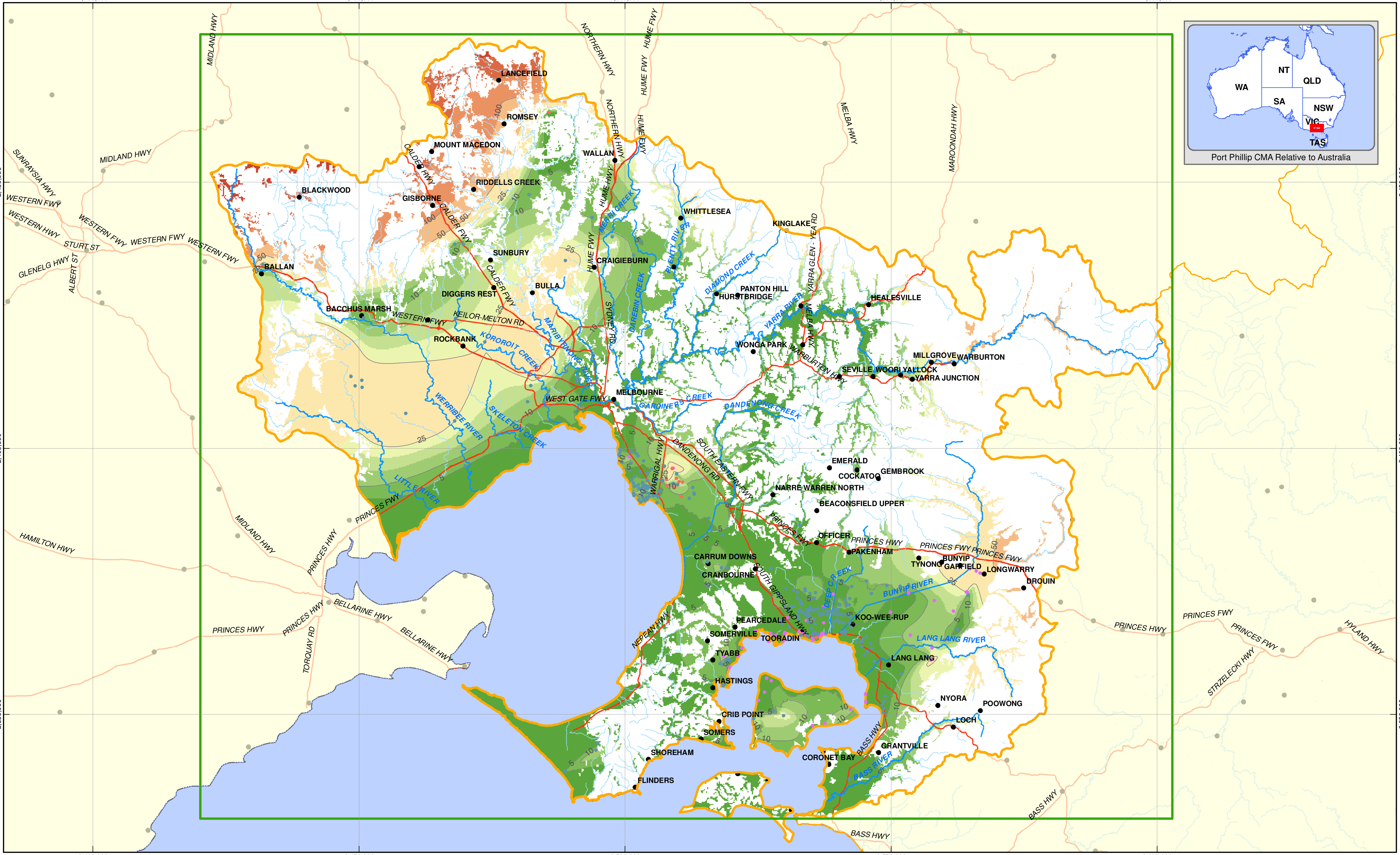
Job Number	31-22410
Revision	A
Date	October 2008

Figure 28

G:\31\22410\CADD\GIS\Projects\3033_Port_Phillip_Observed_Groundwater_Level_Contours_Upper_Tertiary_Age_Units.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

- Towns
- Highway
- Main River
- River
- Contour
- State Boundary

Bore

- SOB Network Bores
- Other GMS Bores
- PIRVIC Bores
- Spot Groundwater Level
- Model Grid Extent

- Other CMA
- PORT PHILLIP

Groundwater Level (mAHD)

- No Data
- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25-50
- 50-100
- 100-200
- 200-300
- 300-400
- >400

GHD

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Port Phillip - Data Collation and Conceptualisation

Observed Groundwater Level
Middle Tertiary Age Units

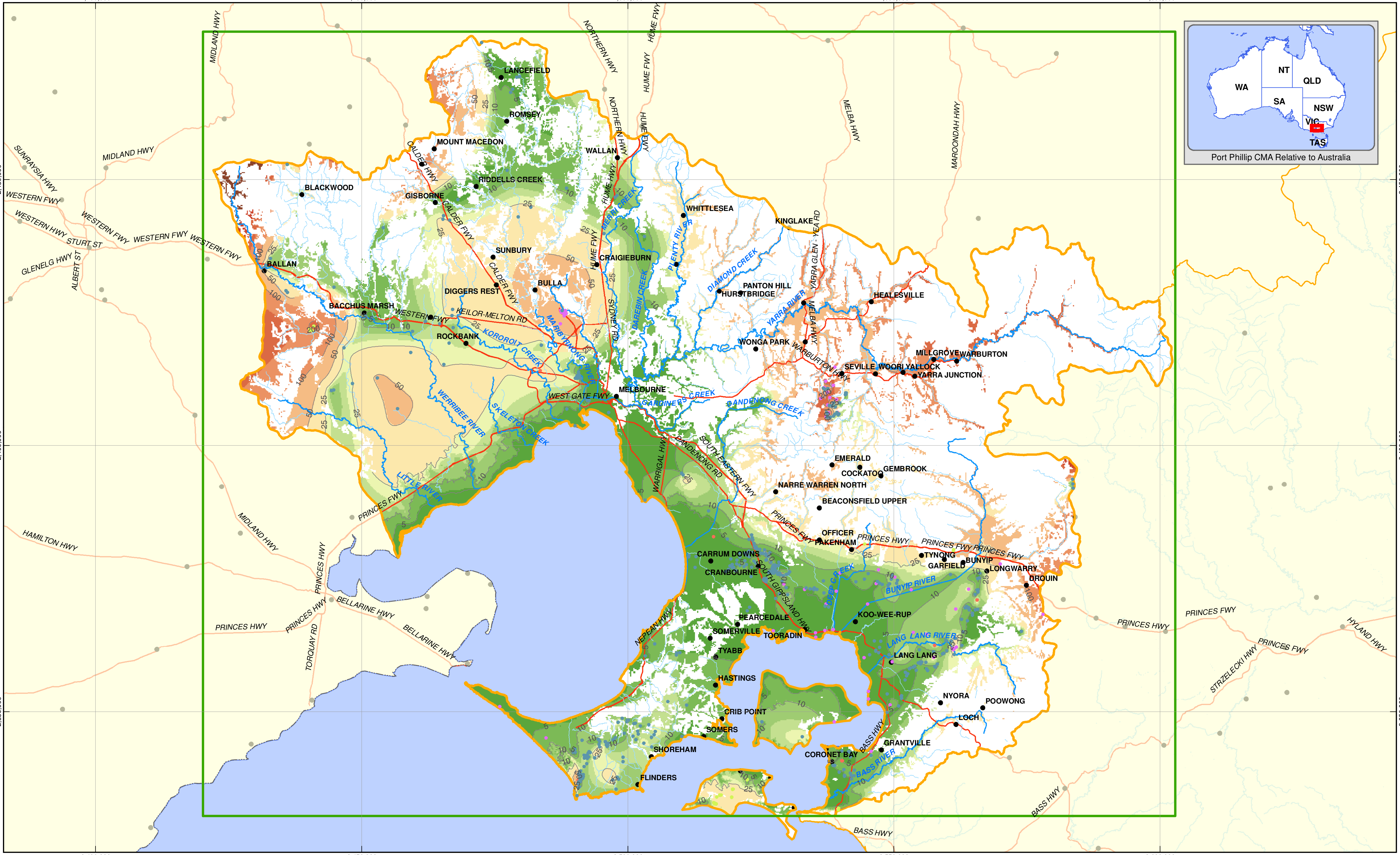
Job Number	31-22410
Revision	A
Date	October 2008

Figure 29

G:\31\22410\CADD\GIS\Projects\3034_Port_Phillip_Observed_Groundwater_Level_Contours_Middle_Tertiary_Age_Units.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

- Towns
- Highway
- Main River
- River
- Contour
- State Boundary

Bore
- SOB Network Bores
- Other GMS Bores
- PIRVIC Bores
- Spot Groundwater Level
- Model Grid Extent

- Other CMA
- PORT PHILLIP

Groundwater Level (mAHD)
- No Data
- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25-50
- 50-100
- 100-200
- 200-300
- 300-400
- >400

GHD

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Port Phillip - Data Collation and Conceptualisation

Observed Groundwater Level LowerTertiary Age Units

Job Number	31-22410
Revision	A
Date	October 2008

Figure 30

G:\31\22410\CADD\GIS\Projects\3035_Port_Phillip_Observed_Groundwater_Level_Contours_Lower_Tertiary_Age_Units.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

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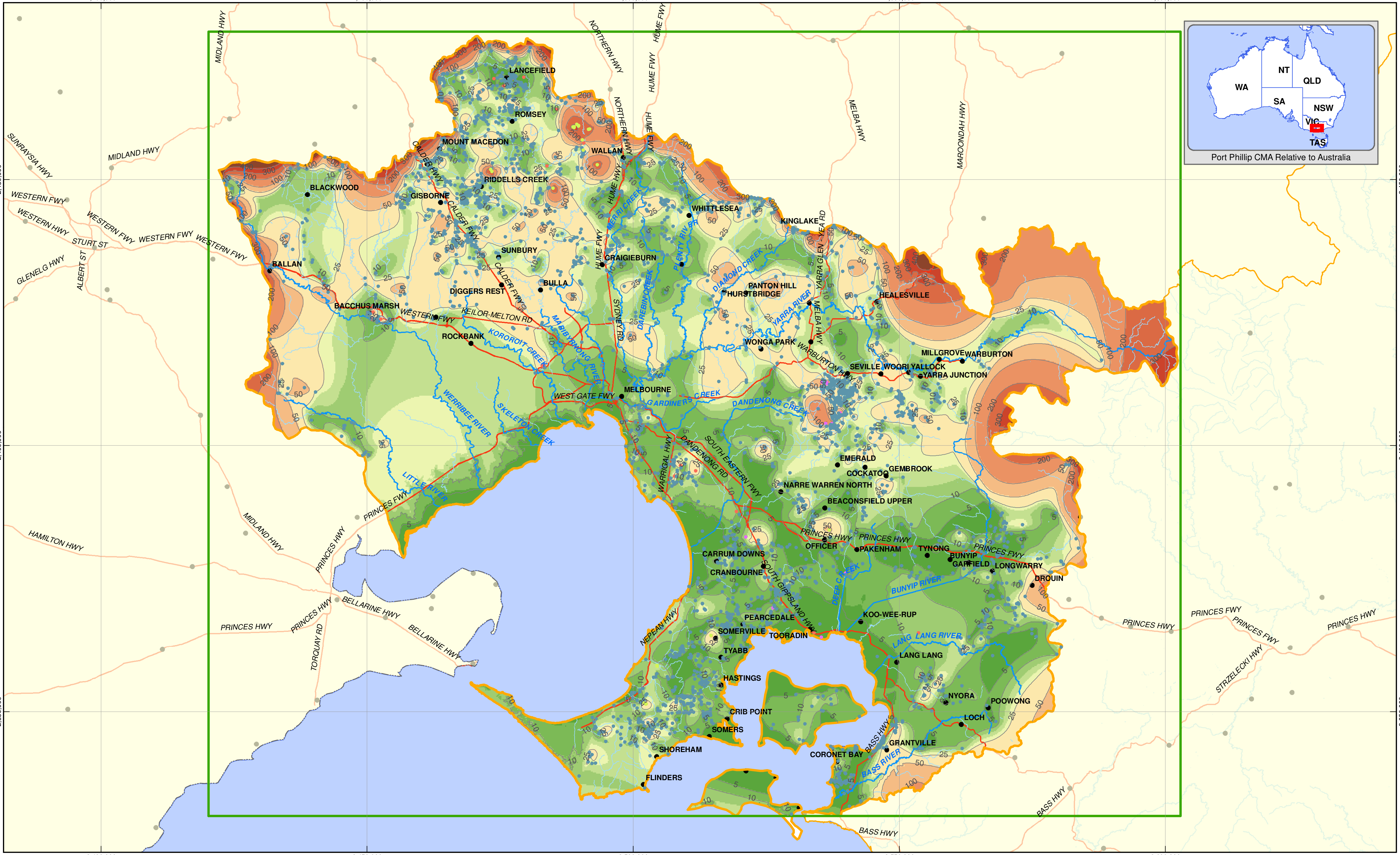

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

- Towns
- Highway
- Main River
- River
- Contour
- State Boundary

Bore

- SOB Network Bores
- Other GMS Bores
- PIRVIC Bores
- Spot Groundwater Level
- Model Grid Extent

- Other CMA
- PORT PHILLIP

Groundwater Level (mAHD)

- No Data
- 0-5
- 5-10
- 10-15
- 15-20
- 20-25
- 25-50
- 50-100
- 100-200
- 200-300
- 300-400
- >400

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Port Phillip - Data Collation and Conceptualisation

Observed Groundwater Level PreTertiary Age Units

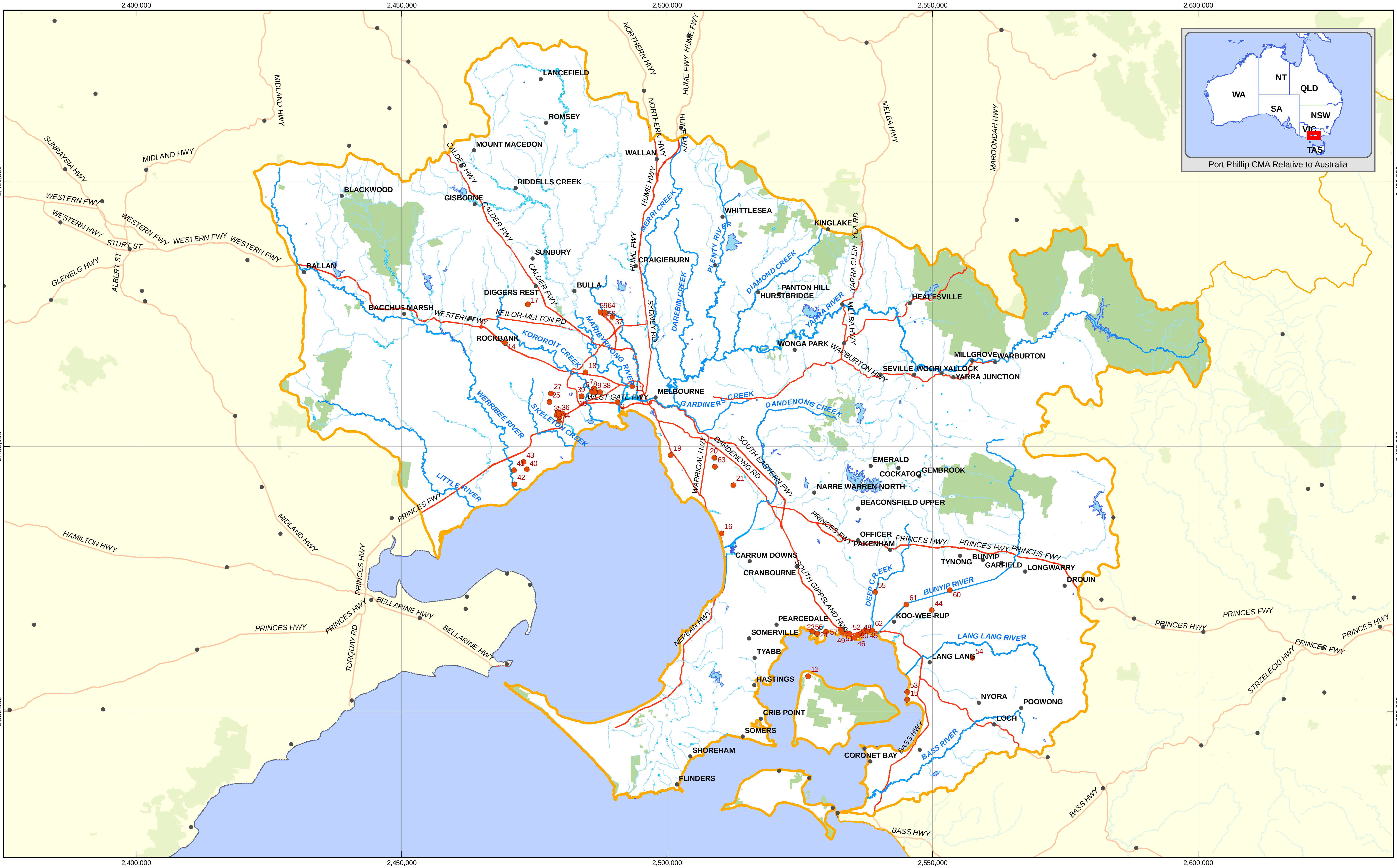
Job Number	31-22410
Revision	A
Date	October 2008

Figure 31

G:\31\22410\CADD\GIS\Projects\3036_Port_Phillip_Observed_Groundwater_Level_Contours_PreTertiary_Age_Units.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

LEGEND

- Vertical Gradient Sites
- Towns
- Main River
- River
- Highway
- Other CMA
- PORT PHILLIP
- State Boundary

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Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

Multi-Level Groundwater Level Monitoring Locations

Figure 32

G:\31\22410\CADD\GIS\Projects\3037_Port_Phillip_Multi-Level_Groundwater_Level_Monitoring_Locations

Data source: DSE and VicMAP. Khan Kamruzzaman

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1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Main River
- River
- Highway
- State Boundary
- Other CMA
- PORT PHILLIP

Surface Water

- Lake
- Salt Lake
- Watercourse Area
- Wetland / Swamp
- Flat
- Pondage

Average Recharge

- 0 - 50
- 50- 100
- 100 - 150
- 150 - 200
- 200 - 300
- 300 - 400
- >400

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Long Term Average Recharge

Job Number	31-22410
Revision	A
Date	October 2008

Figure 33

G:\31\22410\CADD\GIS\Projects\3051_Port_Phillip_Long_Term_Average_Potential_Evaporation.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

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1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Main River
- River
- Highway
- Other CMA
- PORT PHILLIP
- DSE Wetlnad
- State Boundary

Water Area

- Lake
- Salt Lake
- Watercourse Area
- Wetland / Swamp
- Flat
- Pondage

Baseflow Yield (mm/yr)

- 1 - 50
- 50.01 - 100
- 100.01 - 250
- 250.01 - 500
- 500+

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Job Number	31-22410
Revision	A
Date	October 2008

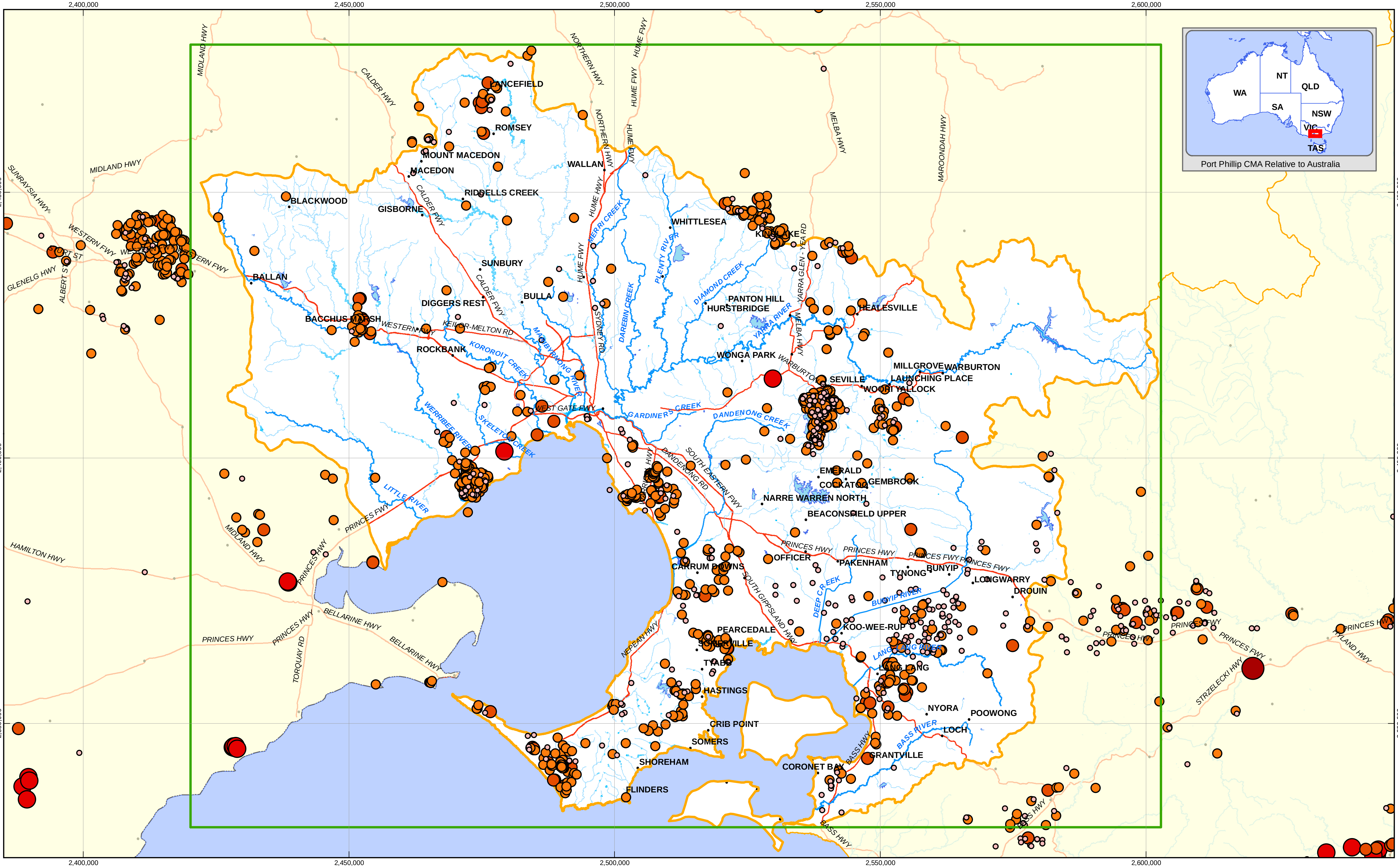
Groundwater - Surfacewater Interaction

Figure 35

G:\31\22410\CADD\GIS\Projects\3056_Port_Phillip_Groundwater-Surface Water Interaction.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



LEGEND

- Towns
- Main River
- River
- Highway
- State Boundary
- Other CMA
- PORT PHILLIP

Surface Water

- Lake
- Salt Lake
- Watercourse Area
- Wetland / Swamp
- Flat
- Pondage

Licensed Volume (Ml/a)

- 0 - 10
- 11 - 100
- 101 - 365
- 366 - 3650
- 3651 - 23000

1:650,000

0 5 10 20 30

Kilometres (at A3)

N

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

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Port Phillip - Data Collation and Conceptualisation

Groundwater Abstractions

Job Number	31-22410
Revision	A
Date	October 2008

Figure 36

G:\31\22410\CADD\GIS\Projects\3053_Port_Phillip_Groundwater_Abstractions.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

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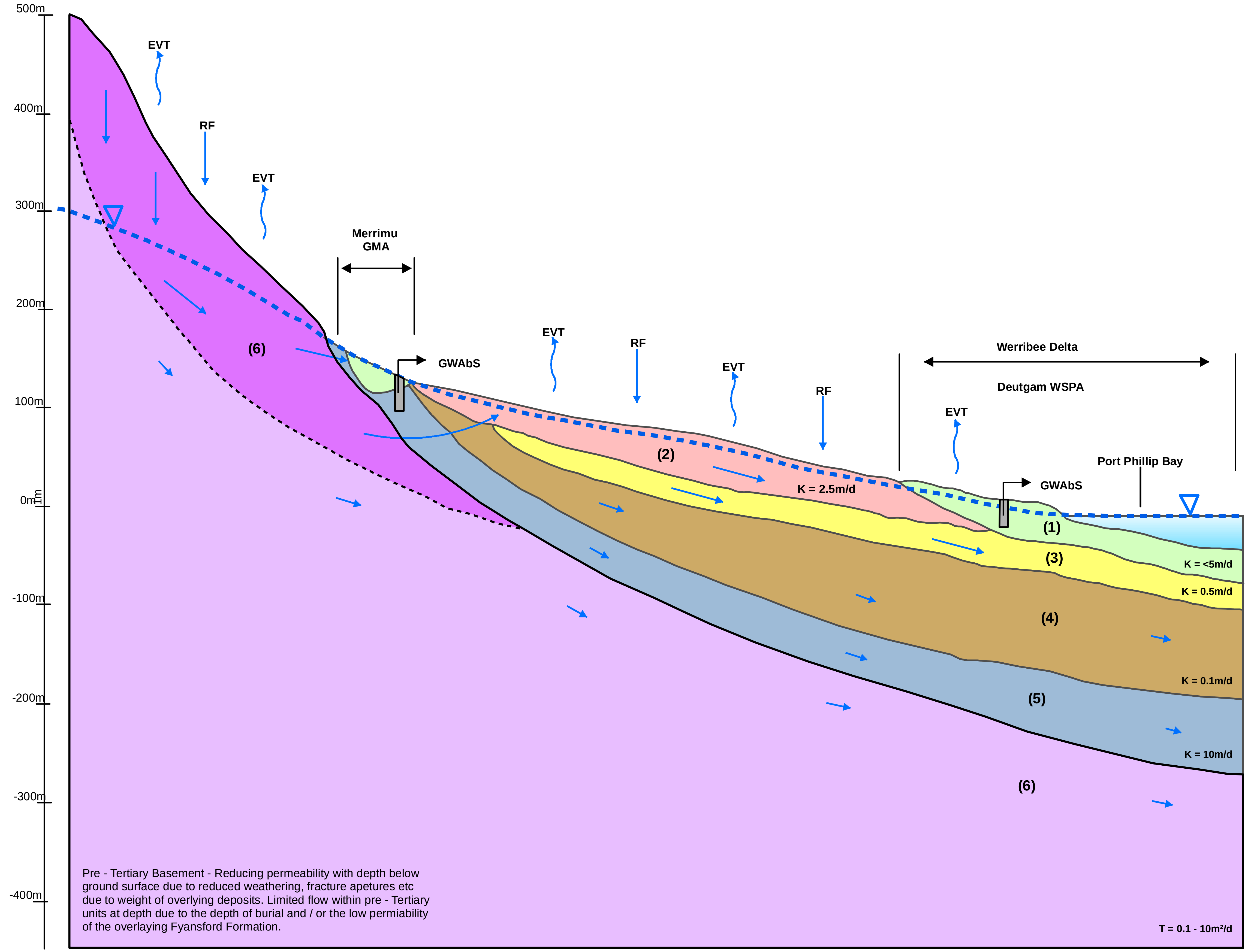

NOT TO SCALE

Legend

- WaterTable
- Groundwater Flow
- Quaternary Sediments (Model Layer 1)
- Newer Volcanic Group (Model Layer 2)
- Brighton Group (Upper Tertiary Model Layer 3)
- Fyansford Formation (Middle Tertiary Model Layer 4)
- Werribee Formation/Older Volcanics (Lower Tertiary Model Layer 5)
- Fresh Basement Bedrock (pre-Tertiary Model Layer 6)
- Weathered Bedrock (pre-Tertiary Model Layer 6)
- Sea

RF - Rainfall
EVT - Evaporation
RO - Runoff
(1)-(6) Numerical Model Layer Number

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Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	May 2010

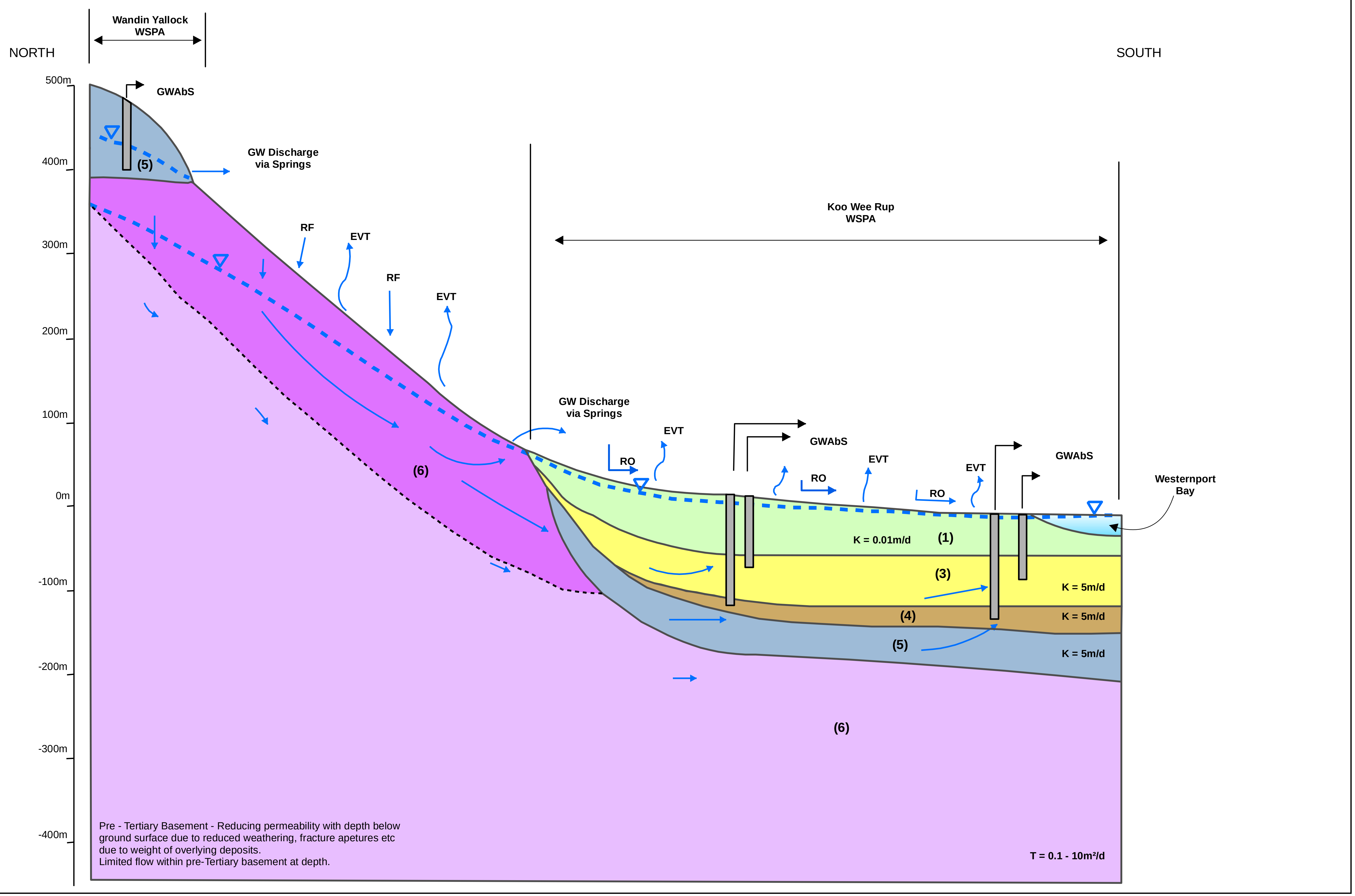
Conceptual Model Port Phillip Basin

Figure 37

G:\31\22410\CADD\GIS\Projects\3048_Port_Phillip_Conceptual_Model.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



NOT TO SCALE

Legend

- Groundwater Flow
- Water Table
- Quaternary Sediments (Model Layer 1)
- Baxter Formation (Upper Tertiary Model Layer 3)
- Sherwood/Yallock Formation (Middle Tertiary Model Layer 4)
- Childers Formation (Lower Tertiary Model Layer 5)
- Fresh Basement Bedrock (pre-Tertiary Model Layer 6)
- Weathered Bedrock (pre-Tertiary Model Layer 6)
- Westernport Bay
- (1)-(6) Numerical Model Layer Number
- EVT - Evaporation
- RF - Rainfall
- RO - Runoff

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Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	May 2008

Conceptual Model Westernport Basin

Figure 38

G:\31\22410\CADD\GIS\Projects\3049_Westernport_Conceptual_Model.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com.au **W** www.ghd.com.au

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Highway
- State Boundary
- Other CMA
- PORT PHILLIP
- Model Grid Extent
- Stream cells
- Additional stream cells (drains)
- Evaporation cells
- GHB cells
- No Flow Cells

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Port Phillip - Data Collation and Conceptualisation

Job Number 31-22410
Revision A
Date October 2008

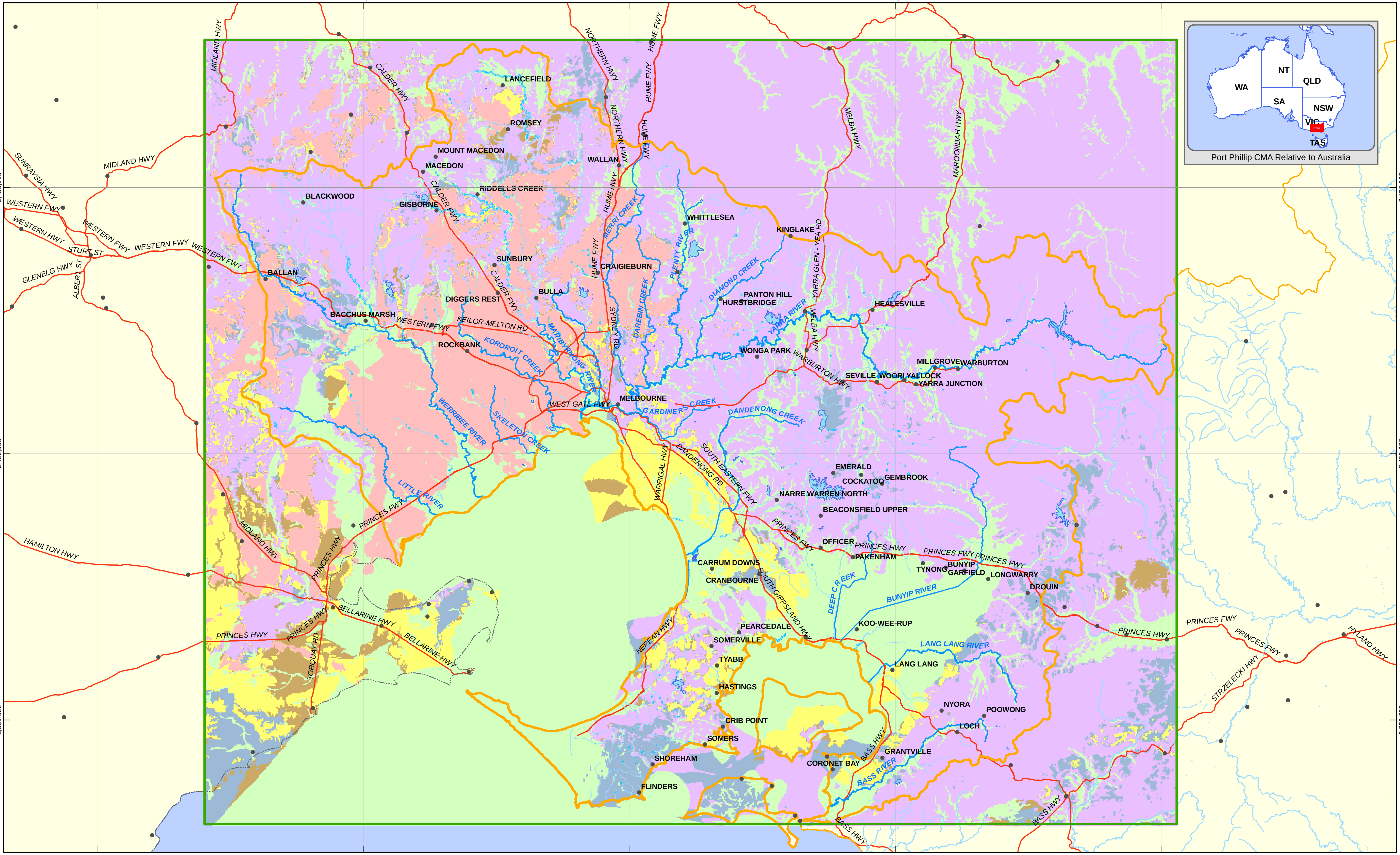
Model Grid and Boundary Conditions

Figure 39

G:\31\22410\CADD\GIS\Projects\3054_Port_Phillip_Model_Grid_and_Boundary_Conditions.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



LEGEND

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

- Towns
- Main River
- River
- Model Grid Extent
- Highway
- Other CMA
- PORT PHILLIP
- State Boundary

Outcrop

- Quarternary Sediments (Layer 1)
- Newer Volcanic Group (Layer 2)
- Upper Tertiary Age Units (Layer 3)
- Middle Tertiary Age Units (Layer 4)
- Lower Tertiary Age Units (Layer 5)
- Pre-Tertiary Age Units (Layer 6)

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Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

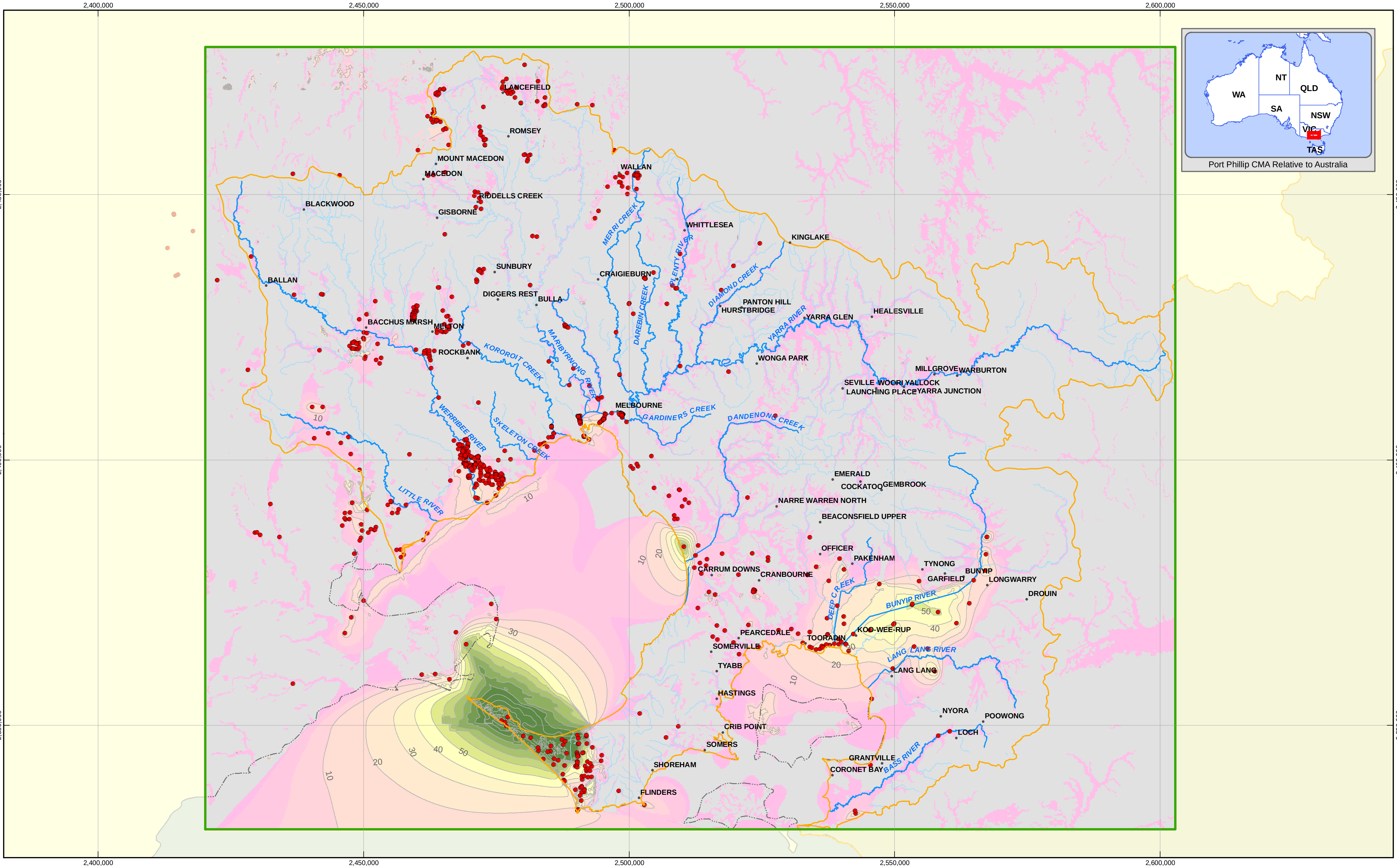
Modelled Outcrop

Figure 40

G:\31\22410\CADD\GIS\Projects\3068_Port_Phillip_Meodelled_Outcrop.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



LEGEND

Towns	Other CMA
Borehole Location	East Gippsland CMA
Thickness Contour	Model Grid Extent
Main River	Layer Inactive
River	

Thickness (m): 1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 100+

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

GHD

Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Model Layer 1 - Quaternary Sediment Thickness

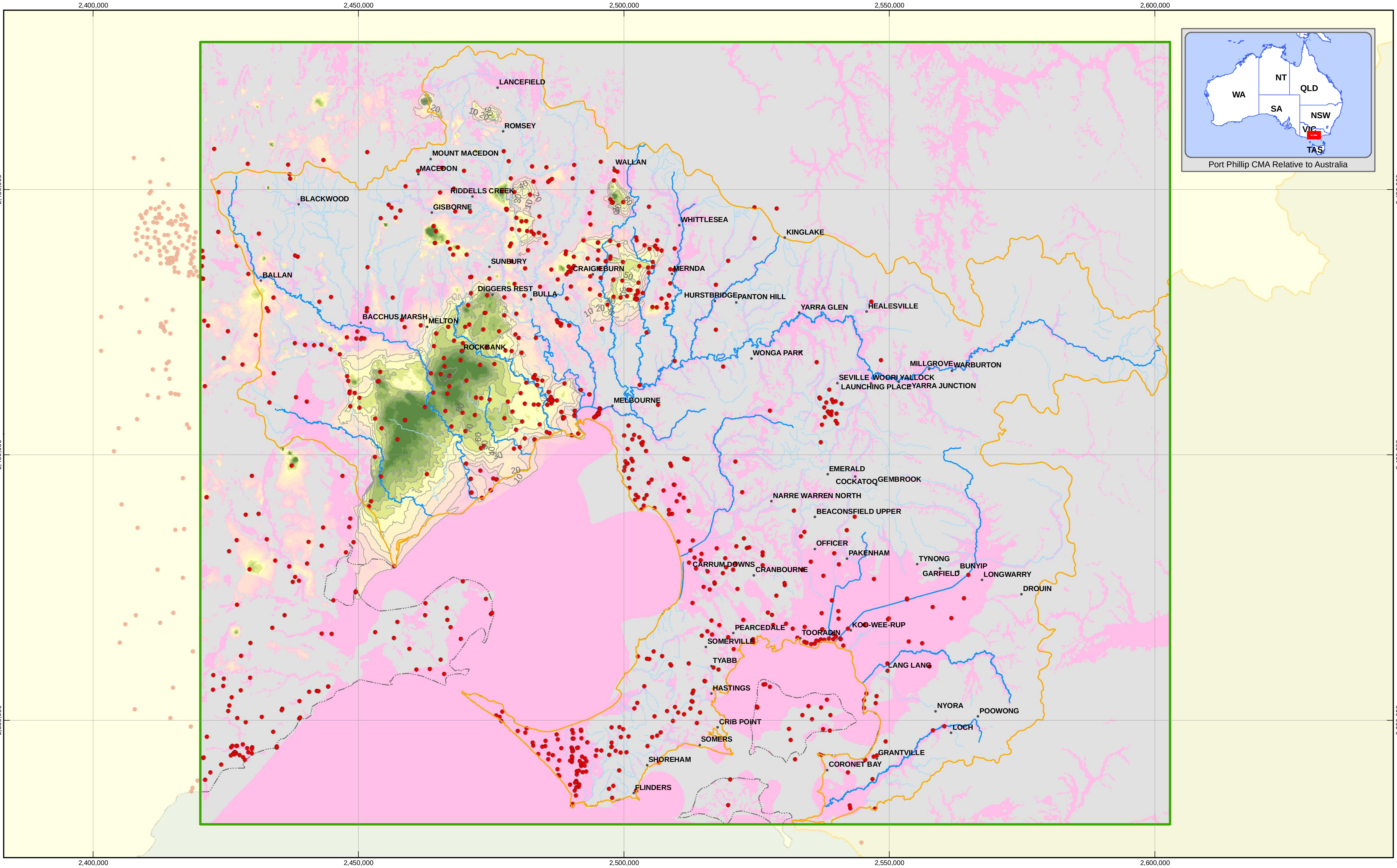
Job Number	31-22410
Revision	A
Date	October 2008

Figure 41

G:\31\22410\CADD\GIS\Projects\33042_Port_Phillip_Model_Layer1_Quaternary_Sediment_Thickness.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Borehole Location
- Thickness Contour
- Main River
- River
- Other CMA
- East Gippsland CMA
- Model Grid Extent
- Layer Inactive

Thickness (m)

1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 100+

Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

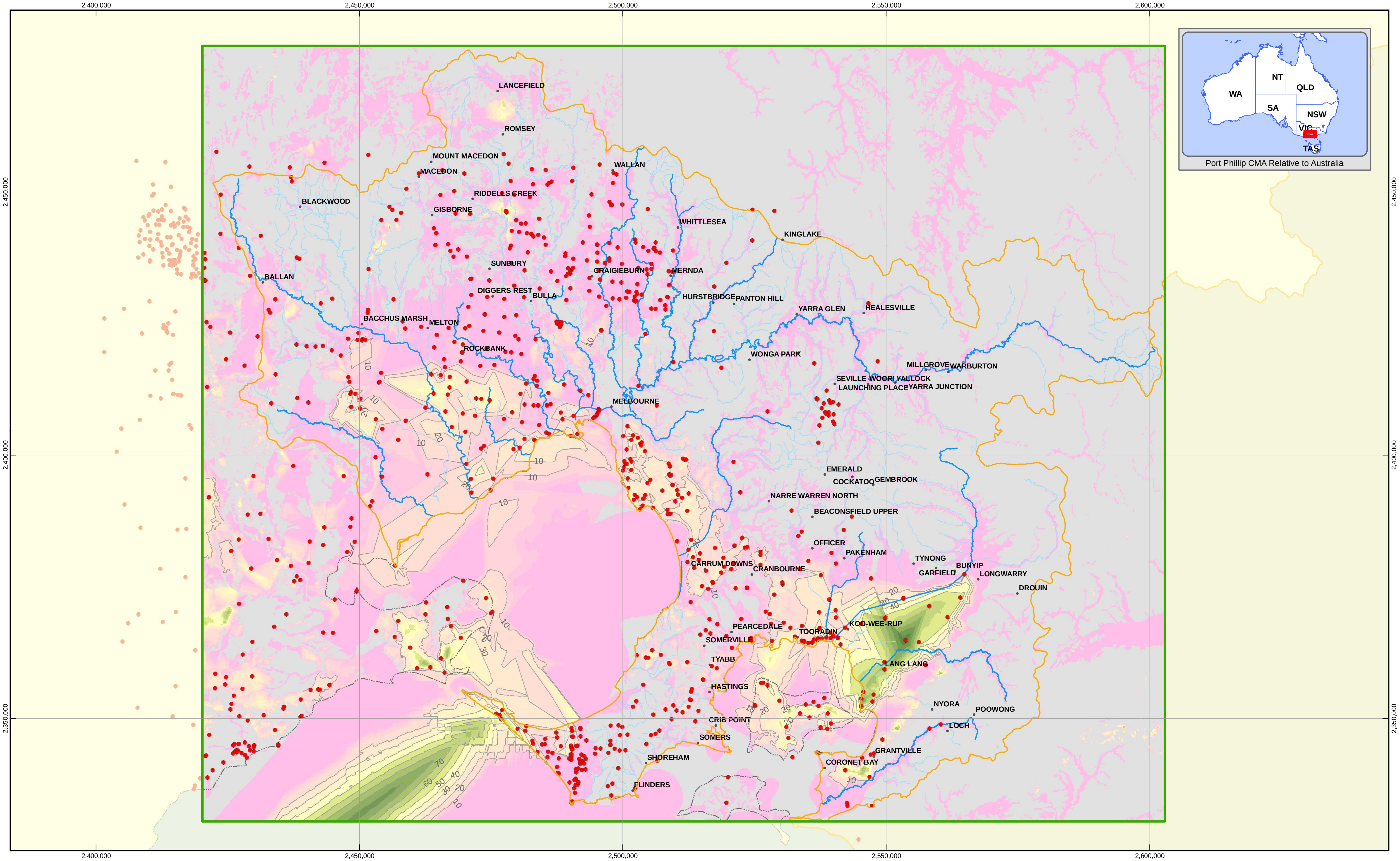
Model Layer 2 - Newer Volcanic Group Thickness

Figure 42

G:\31\22410\CADD\GIS\Projects\3043_Port_Phillip_Model_Layer2_Newer_Volcanic_Group_Thickness.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Borehole Location
- Thickness Contour
- Main River
- River
- Other CMA
- East Gippsland CMA
- Model Grid Extent
- Layer Inactive

Thickness (m)

1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 100+

Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

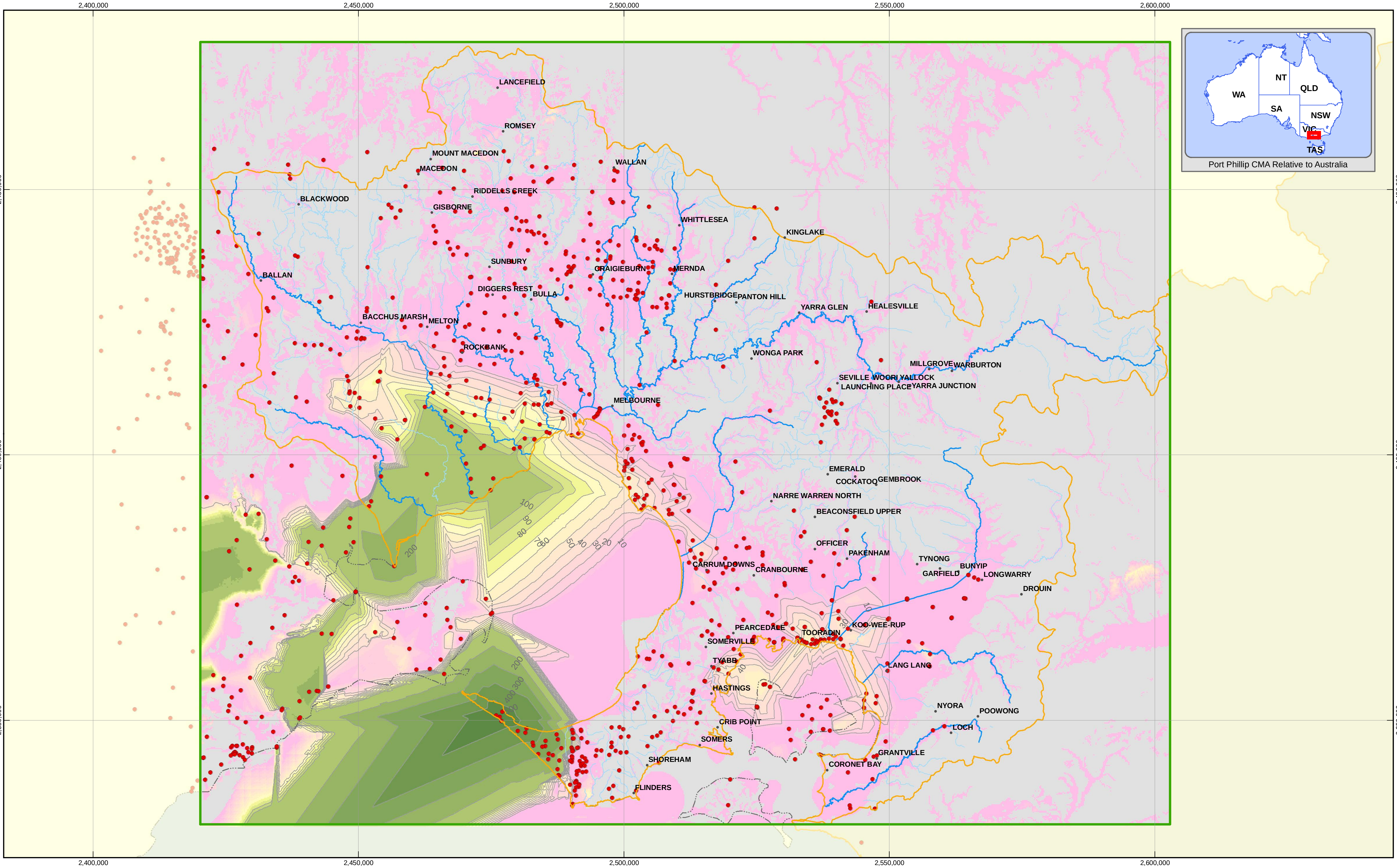
Model Layer 3 - Upper Tertiary Age Units Thickness

Figure 43

G:\31\22410\CADD\GIS\Projects\3044_Port_Phillip_Model_Layer3_Upper_Tertiary_Age_Units_Thickness.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com.au **W** www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Borehole Location
- Main River
- River
- Thickness Contour
- Other CMA
- East Gippsland CMA
- Model Grid Extent
- Layer Inactive

Thickness (m)

5 10 20 30 40 50 60 70 80 90 100 200 300 400 500 500+

GHD

Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Model Layer 4 - Middle Tertiary Age Units Thickness

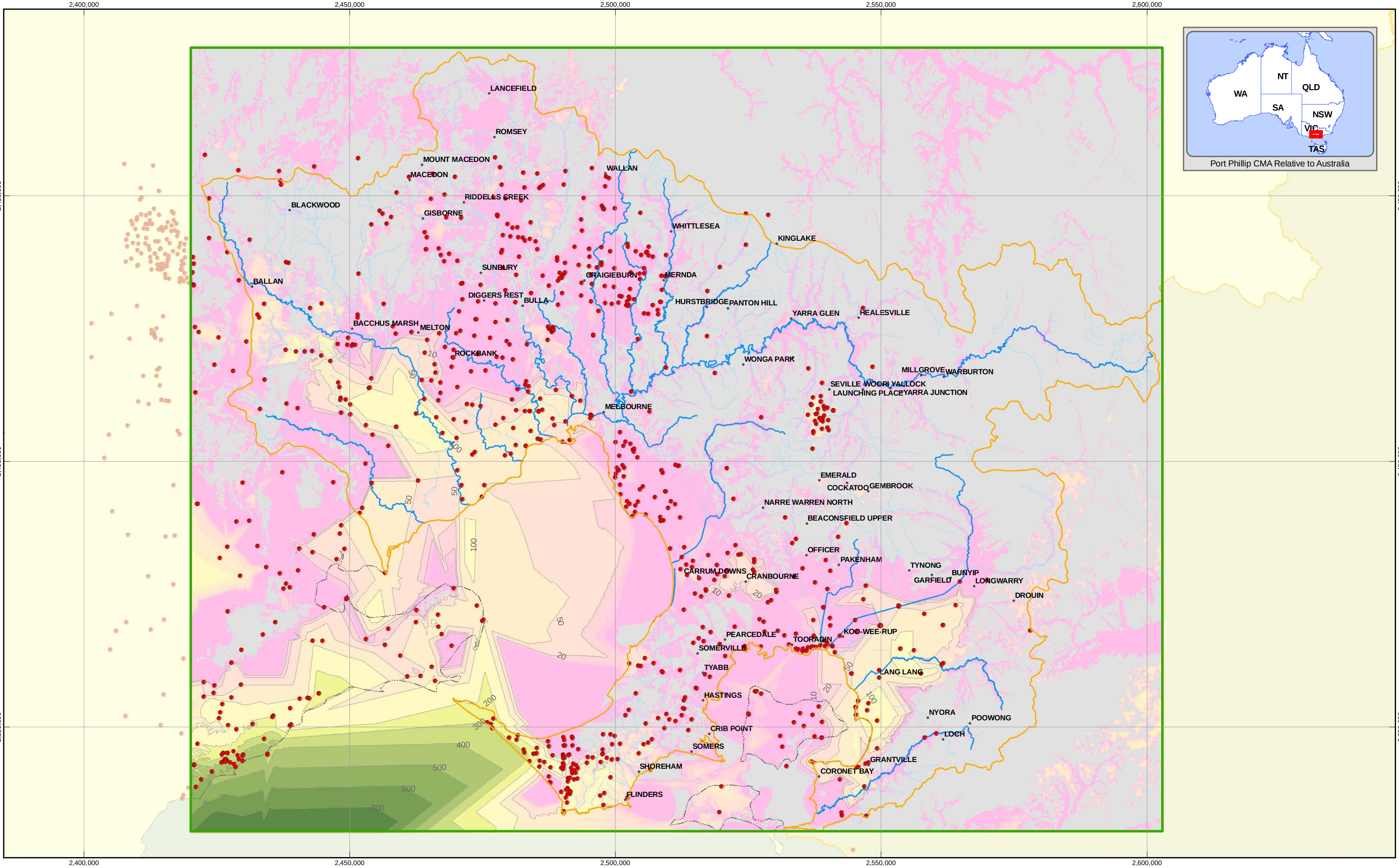
Job Number	31-22410
Revision	A
Date	October 2008

Figure 44

G:\31\22410\CADD\GIS\Projects\3045_Port_Phillip_Model_Layer4_Middle_Tertiary_Age_Units_Thickness.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Borehole Location
- Thickness Contour
- Main River
- River
- Other CMA
- East Gippsland CMA
- Model Grid Extent
- Layer Inactive

Thickness (m)

5, 10, 20, 50, 100, 200, 300, 400, 500, 600, 700, 700+

Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

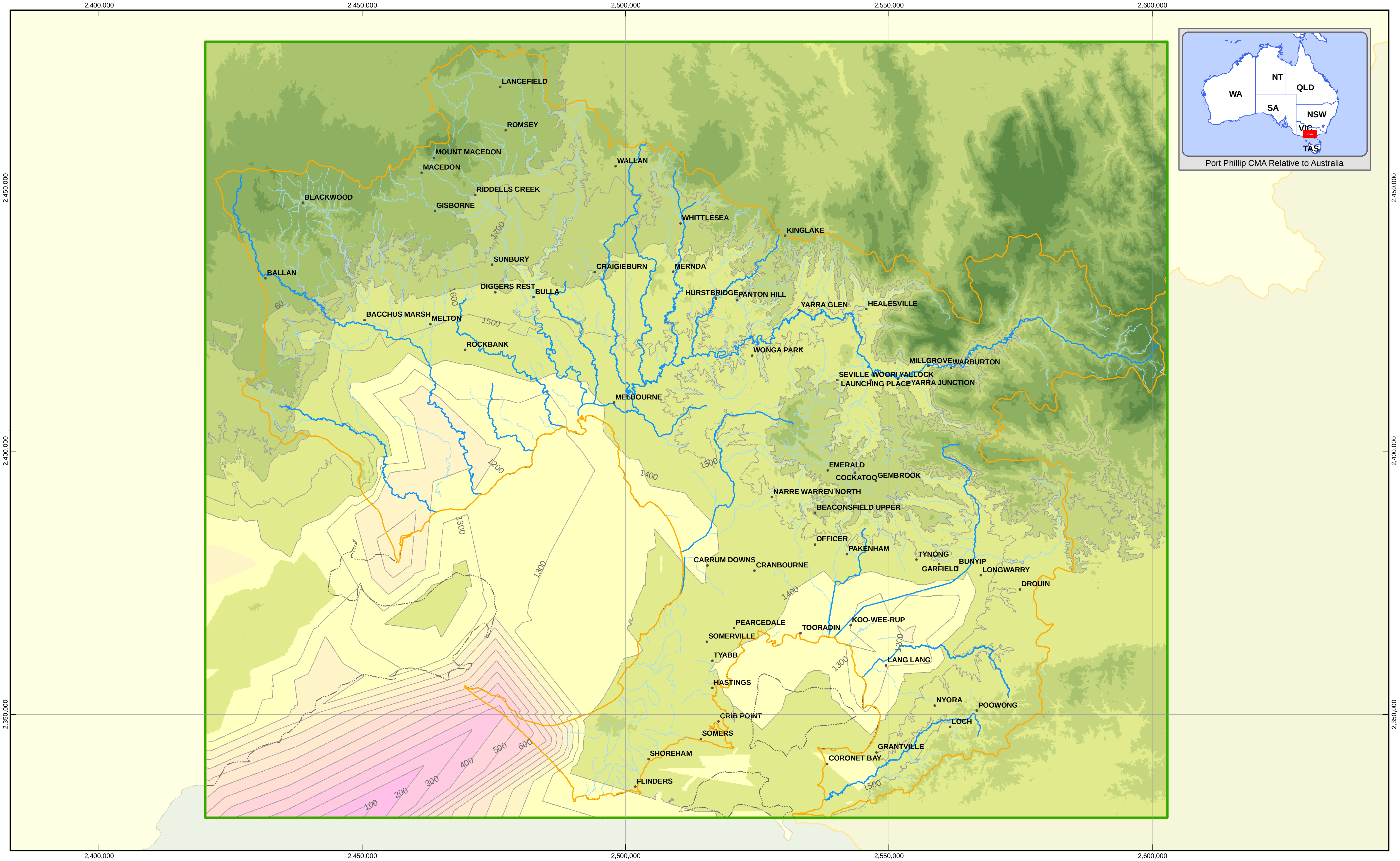
Model Layer 5 - Lower Tertiary Age Units Thickness

Figure 45

G:\31\22410\CADD\GIS\Projects\3046_Port_Phillip_Model_Layer5_Lower_Tertiary_Age_Units_Thickness.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- • Towns
- Thickness Contour
- River
- Main River
- Other CMA
- East Gippsland CMA
- Model Grid Extent
- Layer Inactive

Thickness (m)

200, 400, 600, 800, 1,000, 1,200, 1,400, 1,600, 1,800, 2,000, 2,200, 2,400, 2,400+

Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Model Layer 6 - PreTertiary Age Units Thickness

Job Number	31-22410
Revision	A
Date	October 2008

Figure 46

G:\31\22410\CADD\GIS\Projects\3047_Port_Phillip_Model_Layer6_PreTertiary_Age_Units_Thickness.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au

Zone	Kx (m/d)	Ky (m/d)	Kz (m/d)
102	10.00	10.00	1.00
103	3.00	3.00	0.03
104	5.00	5.00	0.50
105	10.00	10.00	0.10
106	0.50	0.50	0.05
123	20.00	20.00	0.20
125	0.01	0.01	0.001

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Main River
- River
- Other CMA
- East Gippsland CMA
- Model Grid Extent
- Layer inactive
- GHB cells

Conductivity Zone: 102, 103, 104, 105, 106, 123, 125

Department of Sustainability and Environment
Port Phillip - Phase 2 Model Construction and Calibration

Modelled Hydraulic Conductivity and Storage Zonation Layer 1

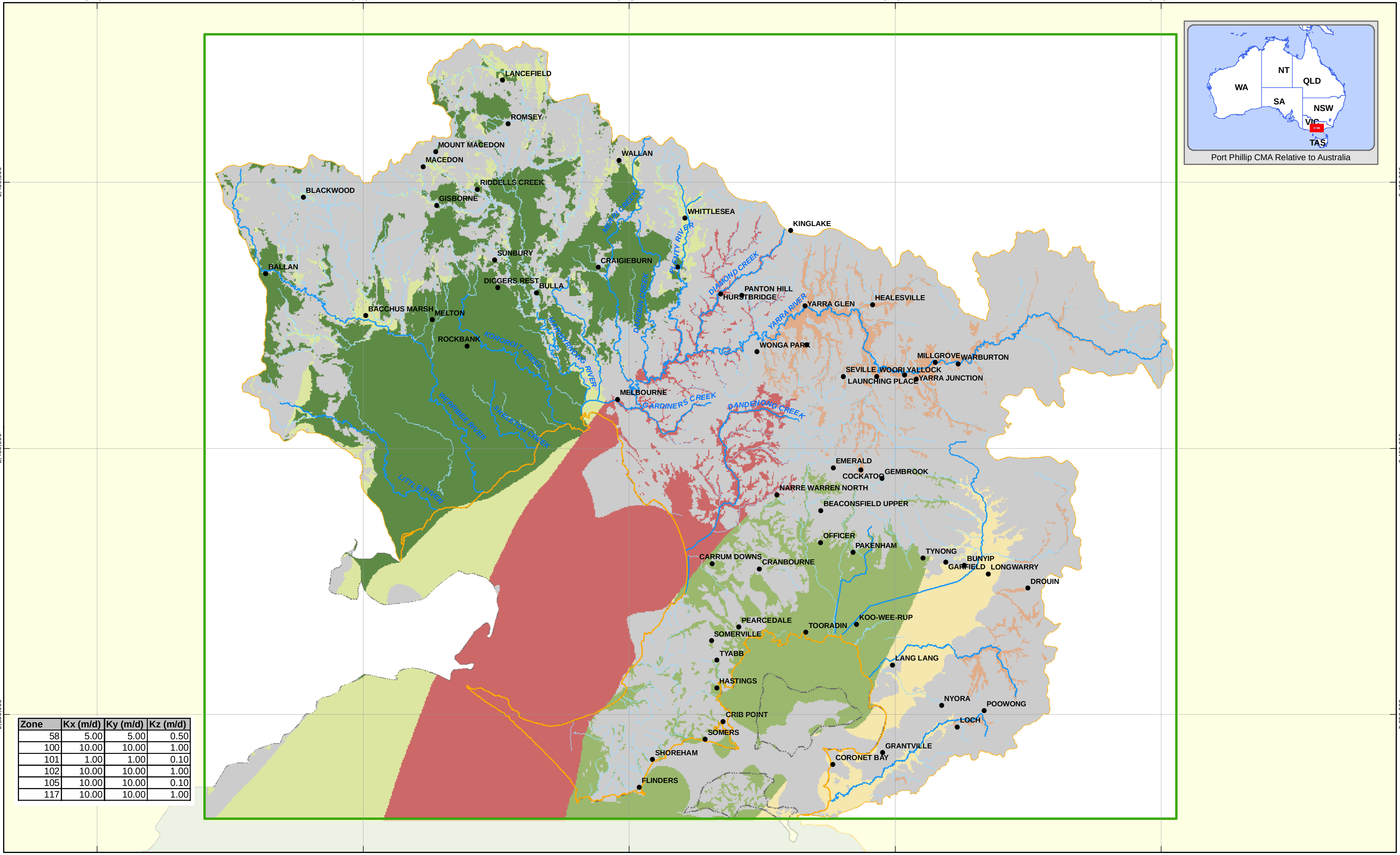
Job Number	31-22410
Revision	A
Date	May 2010

Figure 47

G:\31\22410\CADD\GIS\Projects\3082_Port_Phillip_Modelled Hydraulic Conductivity and Storage Zonation Layer 1.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



Zone	Kx (m/d)	Ky (m/d)	Kz (m/d)
58	5.00	5.00	0.50
100	10.00	10.00	1.00
101	1.00	1.00	0.10
102	10.00	10.00	1.00
105	10.00	10.00	0.10
117	10.00	10.00	1.00

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

LEGEND

- Towns
- Main River
- River
- Other CMA
- East Gippsland CMA
- Layer inactive
- Model Grid Extent

Conductivity Zone: 58, 100, 101, 102, 105, 117

Department of Sustainability and Environment
Port Phillip - Phase 2 Model Construction and Calibration

Modelled Hydraulic Conductivity and Storage Zonation Layer 2

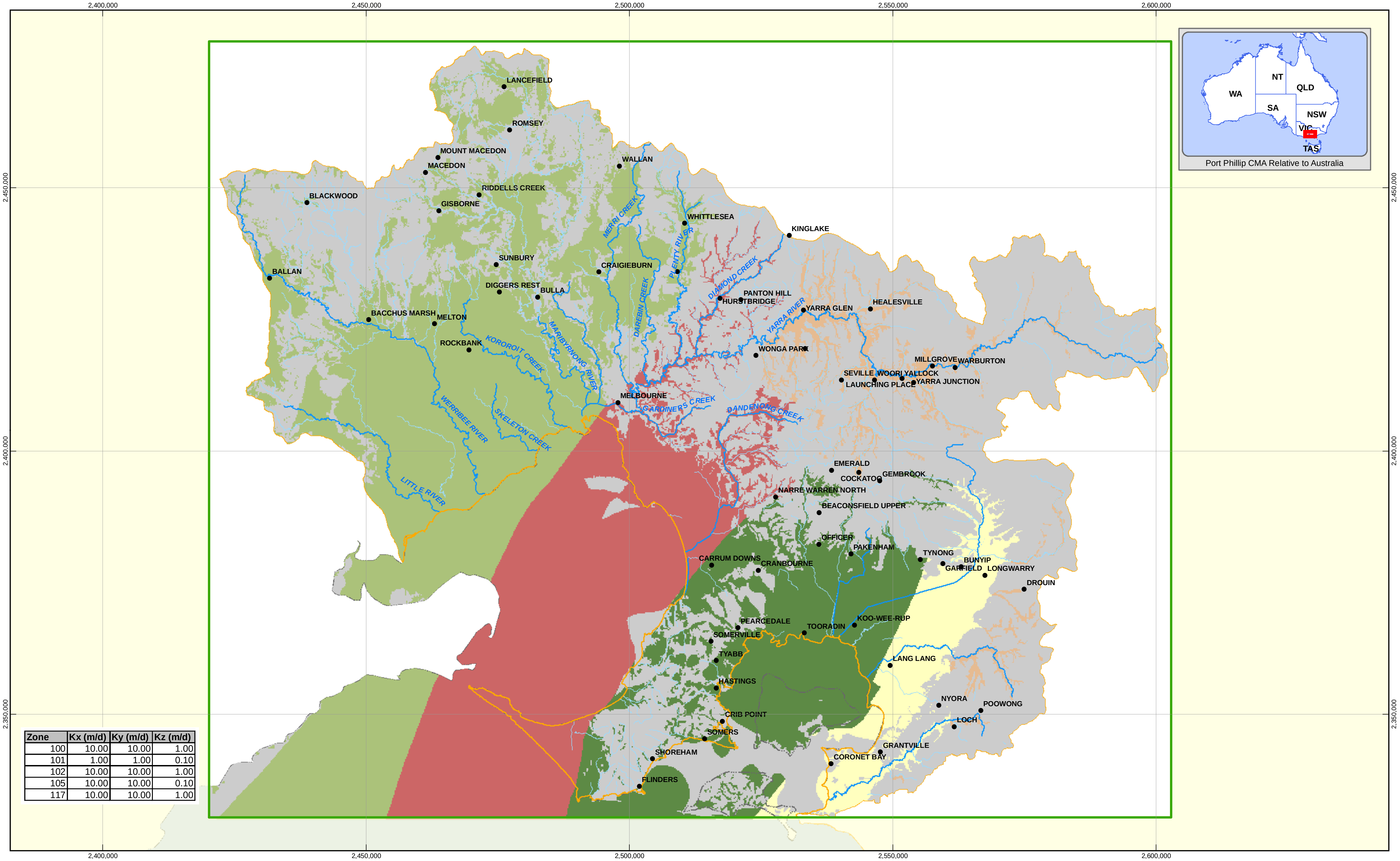
Job Number	31-22410
Revision	A
Date	May 2010

Figure 48

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au

G:\31\22410\CADD\GIS\Projects\3083_Port_Phillip_Modelled Hydraulic Conductivity and Storage Zonation Layer 2.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman



Zone	Kx (m/d)	Ky (m/d)	Kz (m/d)
100	10.00	10.00	1.00
101	1.00	1.00	0.10
102	10.00	10.00	1.00
105	10.00	10.00	0.10
117	10.00	10.00	1.00

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Main River
- River
- Other CMA
- East Gippsland CMA
- Model Grid Extent
- Layer inactive

Conductivity Zone: 100, 101, 102, 105, 117

GHD

Department of Sustainability and Environment
Port Phillip - Phase 2 Model Construction and Calibration

Job Number	31-22410
Revision	A
Date	May 2010

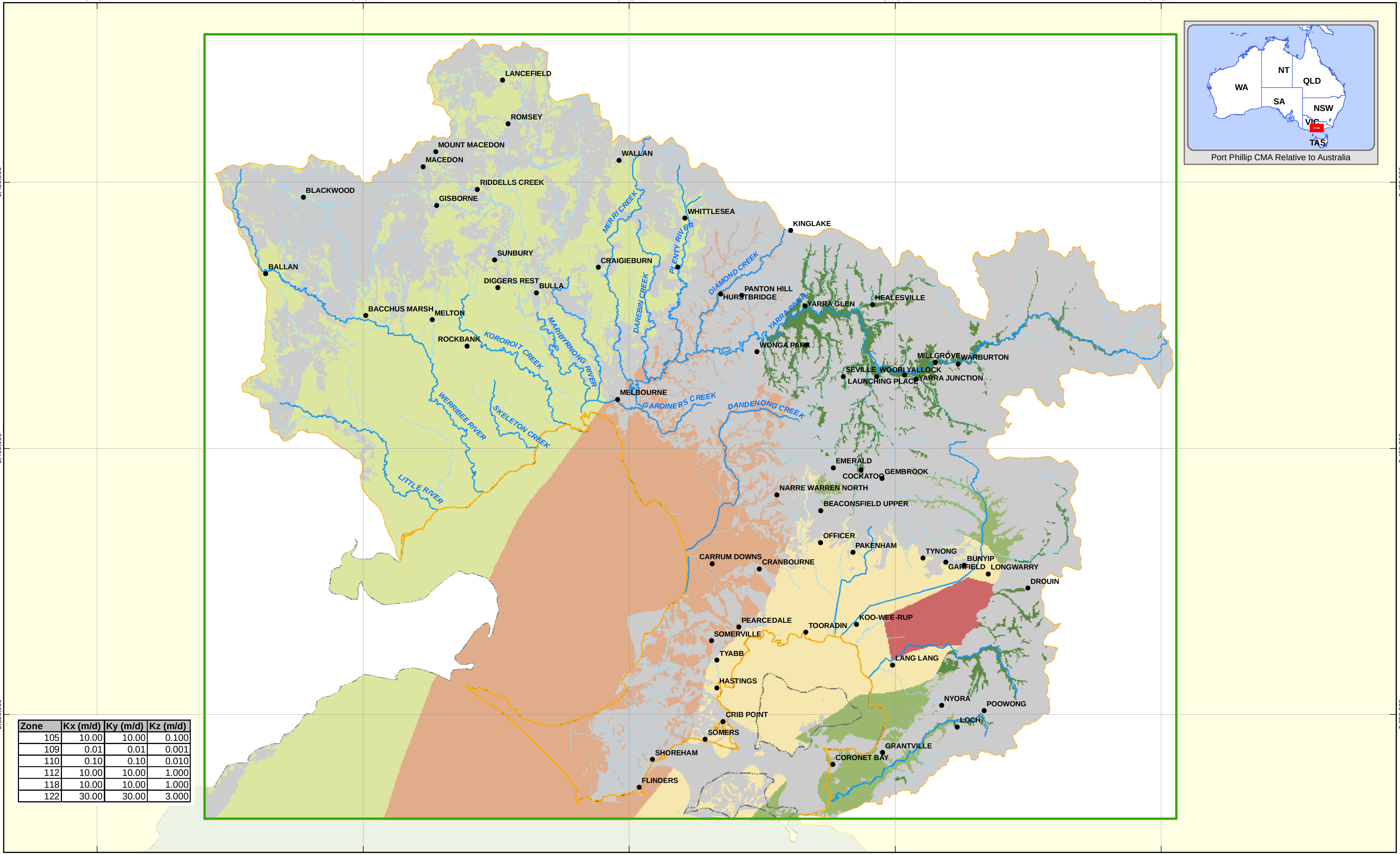
Modelled Hydraulic Conductivity and Storage Zonation Layer 3

Figure 49

G:\31\22410\CADD\GIS\Projects\3084_Port_Phillip_Modelled Hydraulic Conductivity and Storage Zonation Layer 3.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



Zone	Kx (m/d)	Ky (m/d)	Kz (m/d)
105	10.00	10.00	0.100
109	0.01	0.01	0.001
110	0.10	0.10	0.010
112	10.00	10.00	1.000
118	10.00	10.00	1.000
122	30.00	30.00	3.000

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Main River
- River
- Other CMA
- East Gippsland CMA
- Model Grid Extent
- Layer inactive

Conductivity Zone: 105, 109, 110, 112, 118, 122

GHD

Department of Sustainability and Environment
Port Phillip - Phase 2 Model Construction and Calibration

Modelled Hydraulic Conductivity and Storage Zonation Layer 4

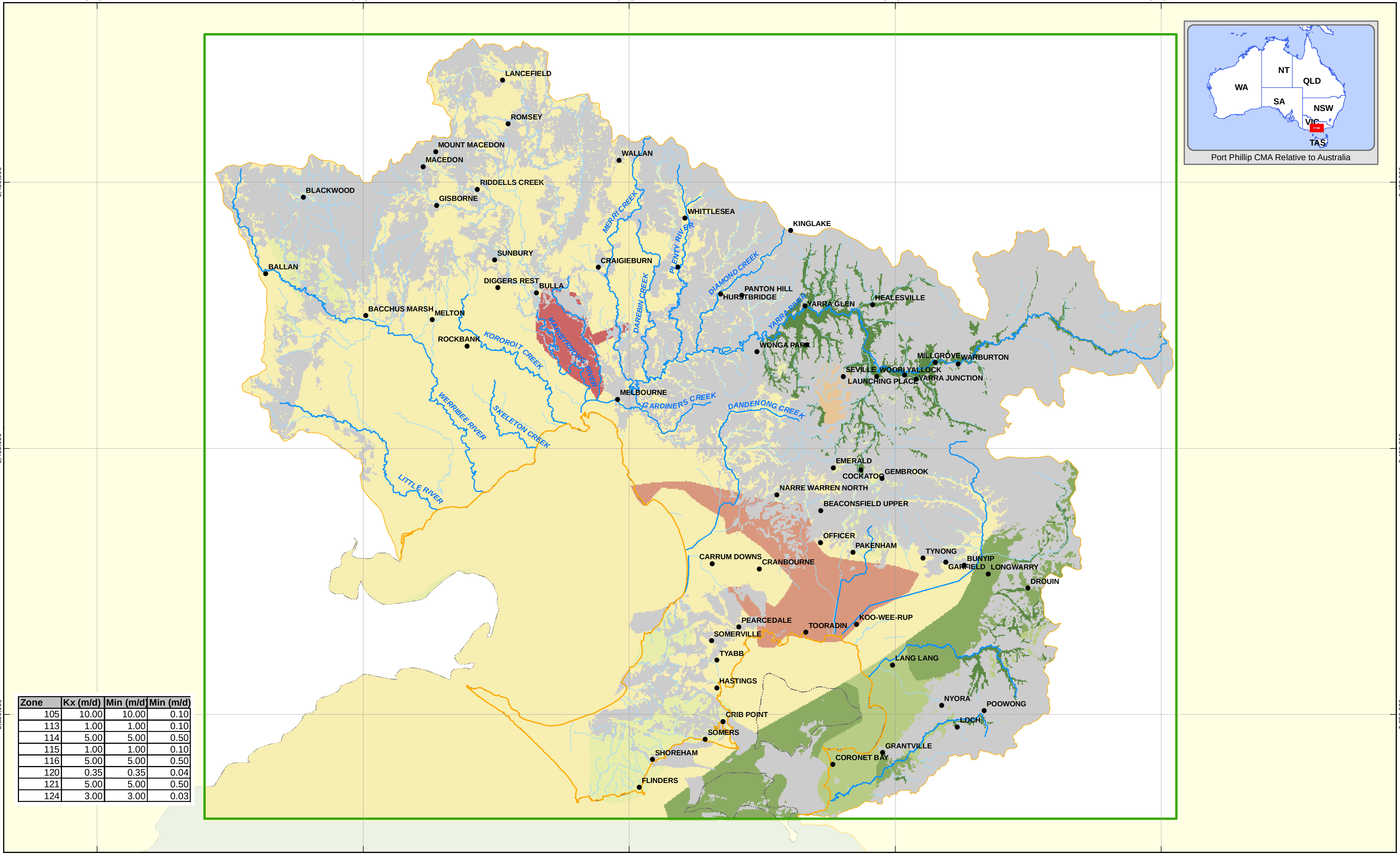
Job Number	31-22410
Revision	A
Date	May 2010

Figure 50

G:\31\22410\CADD\GIS\Projects\3085_Port_Phillip_Modelled Hydraulic Conductivity and Storage Zonation Layer 4.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



Zone	Kx (m/d)	Min (m/d)	Min (m/d)
105	10.00	10.00	0.10
113	1.00	1.00	0.10
114	5.00	5.00	0.50
115	1.00	1.00	0.10
116	5.00	5.00	0.50
120	0.35	0.35	0.04
121	5.00	5.00	0.50
124	3.00	3.00	0.03

1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Main River
- River
- Other CMA
- East Gippsland CMA
- Model Grid Extent
- Layer inactive

Conductivity Zone: 105, 113, 114, 115, 116, 120, 121, 124

GHD

Department of Sustainability and Environment
Port Phillip - Phase 2 Model Construction and Calibration

Modelled Hydraulic Conductivity and Storage Zonation Layer 5

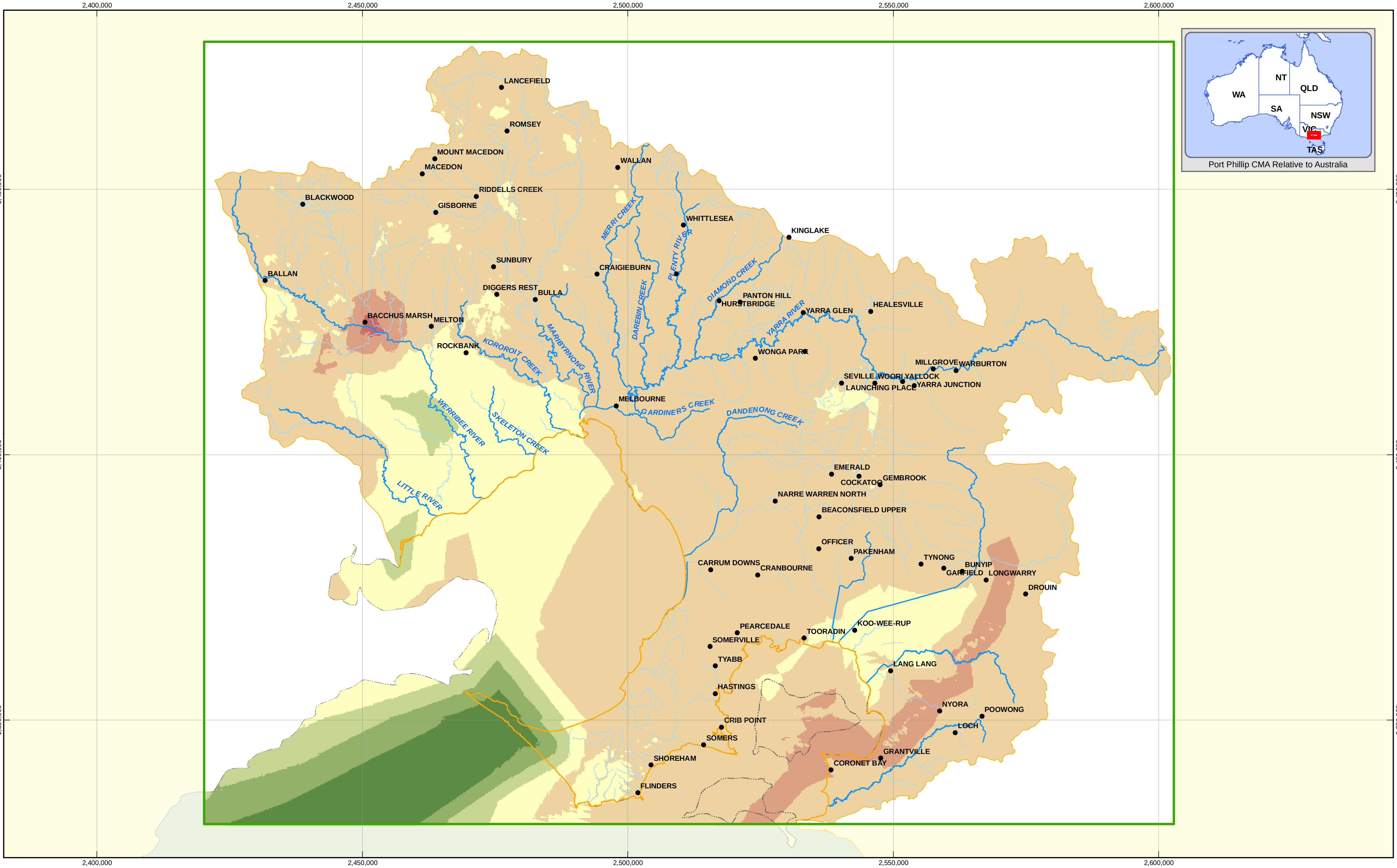
Job Number	31-22410
Revision	A
Date	May 2010

Figure 51

G:\31\22410\CADD\GIS\Projects\3086_Port_Phillip_Modelled Hydraulic Conductivity and Storage Zonation Layer 5.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

LEGEND

- Towns
- Main River
- River
- Other CMA
- East Gippsland CMA
- Model Grid Extent

Hydraulic Conductivity (m/d)

- < 0.00001
- 0.00001- 0.0001
- 0.0001 - 0.001
- 0.001 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2

Department of Sustainability and Environment
Port Phillip - Phase 2 Model Construction and Calibration

Job Number	31-22410
Revision	A
Date	May 2010

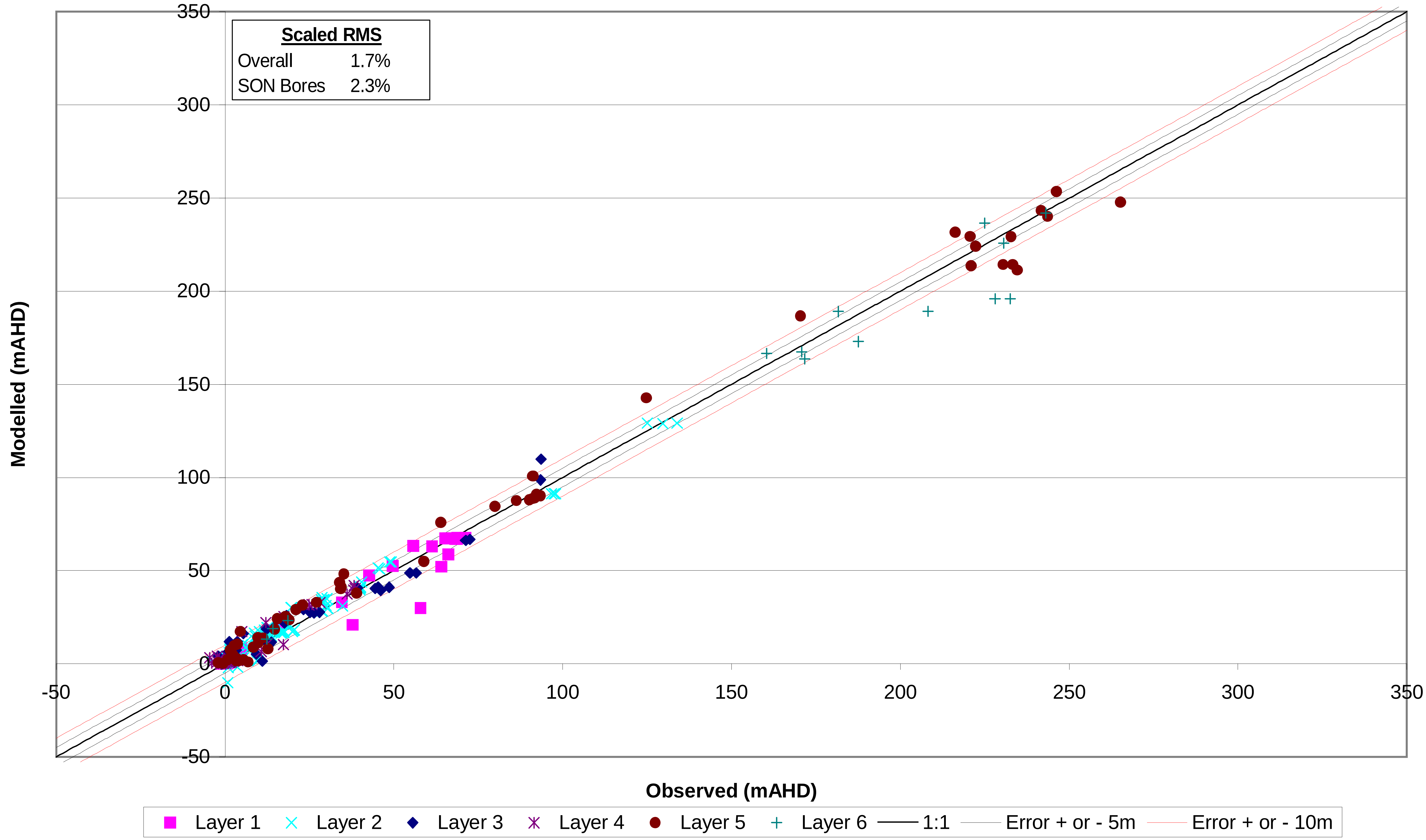
Modelled Hydraulic Conductivity Layer 6

Figure 52

G:\31\22410\CADD\GIS\Projects\3087_Port_Phillip_Modelled Hydraulic Conductivity and Storage Zonation Layer 6.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	May 2010

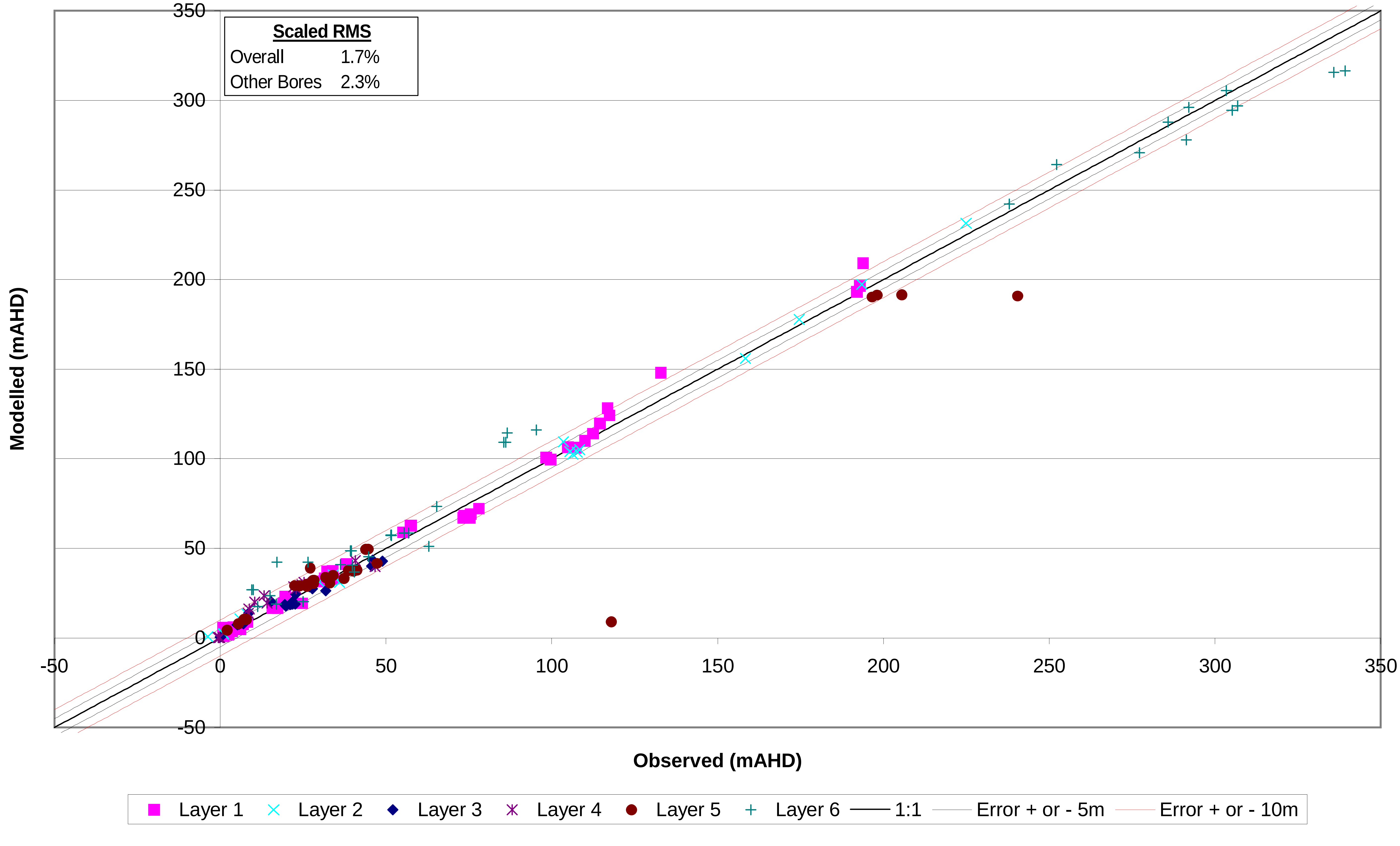
Simulated v Observed Groundwater Levels State Observation Network Boreholes – Steady State Model

Figure 53

G:\31\22410\CADD\GIS\Projects\3078_Port_Phillip_Simulated v Observed Groundwater Levels State Observation Network Boreholes – Steady State Model.mxd

Data source: DSE and GHD. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia **T** 61 3 8687 8000 **F** 61 3 8687 8111 **E** melmail@ghd.com.au **W** www.ghd.com.au



Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	May 2010

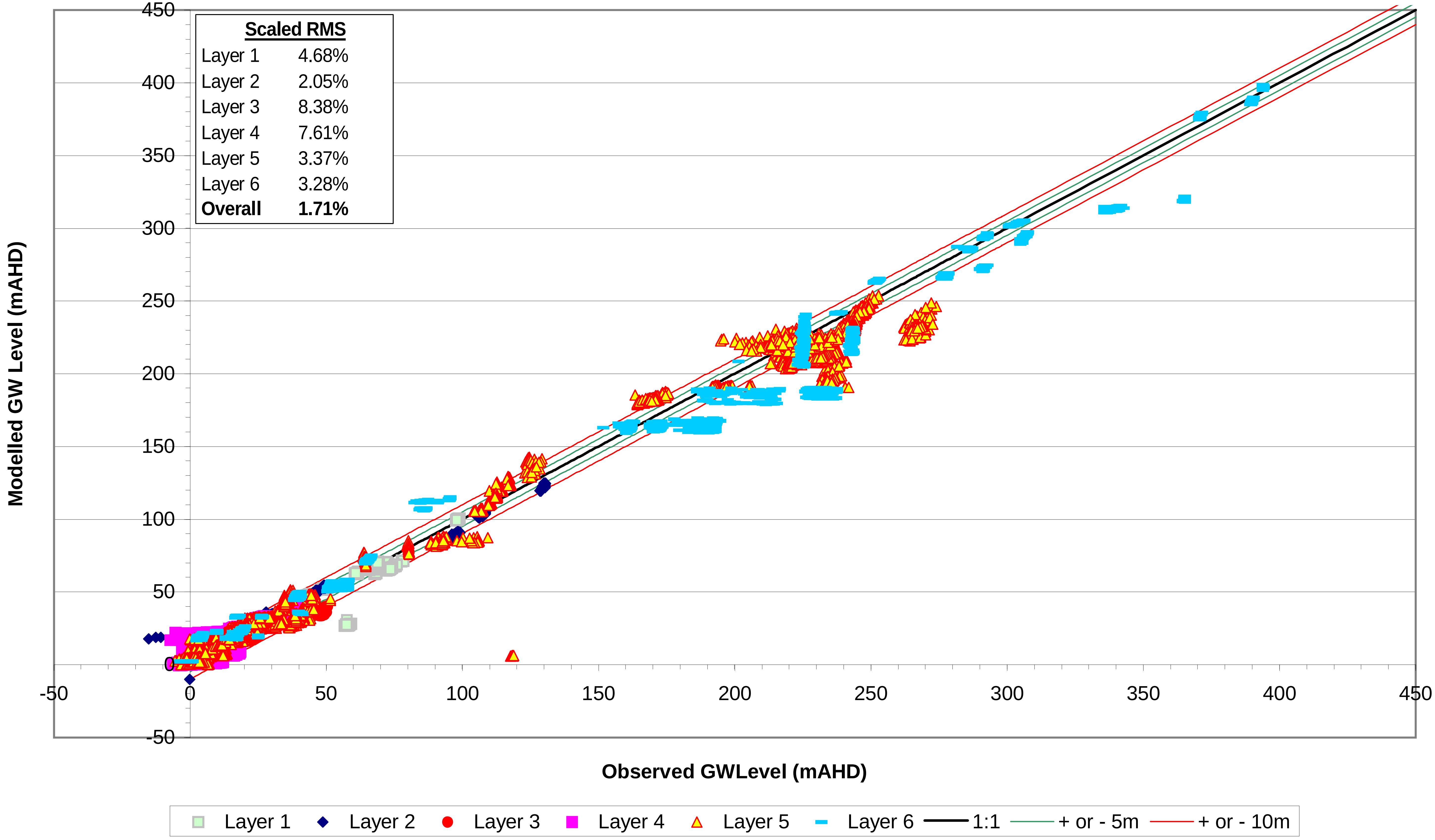
Simulated v Observed Groundwater Levels Other Boreholes – Steady State Model

Figure 54

G:\31\22410\CADD\GIS\Projects\3079_Port_Phillip_Simulated v Observed Groundwater Levels Other Boreholes – Steady State Model.mxd

Data source: DSE and GHD. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	May 2010

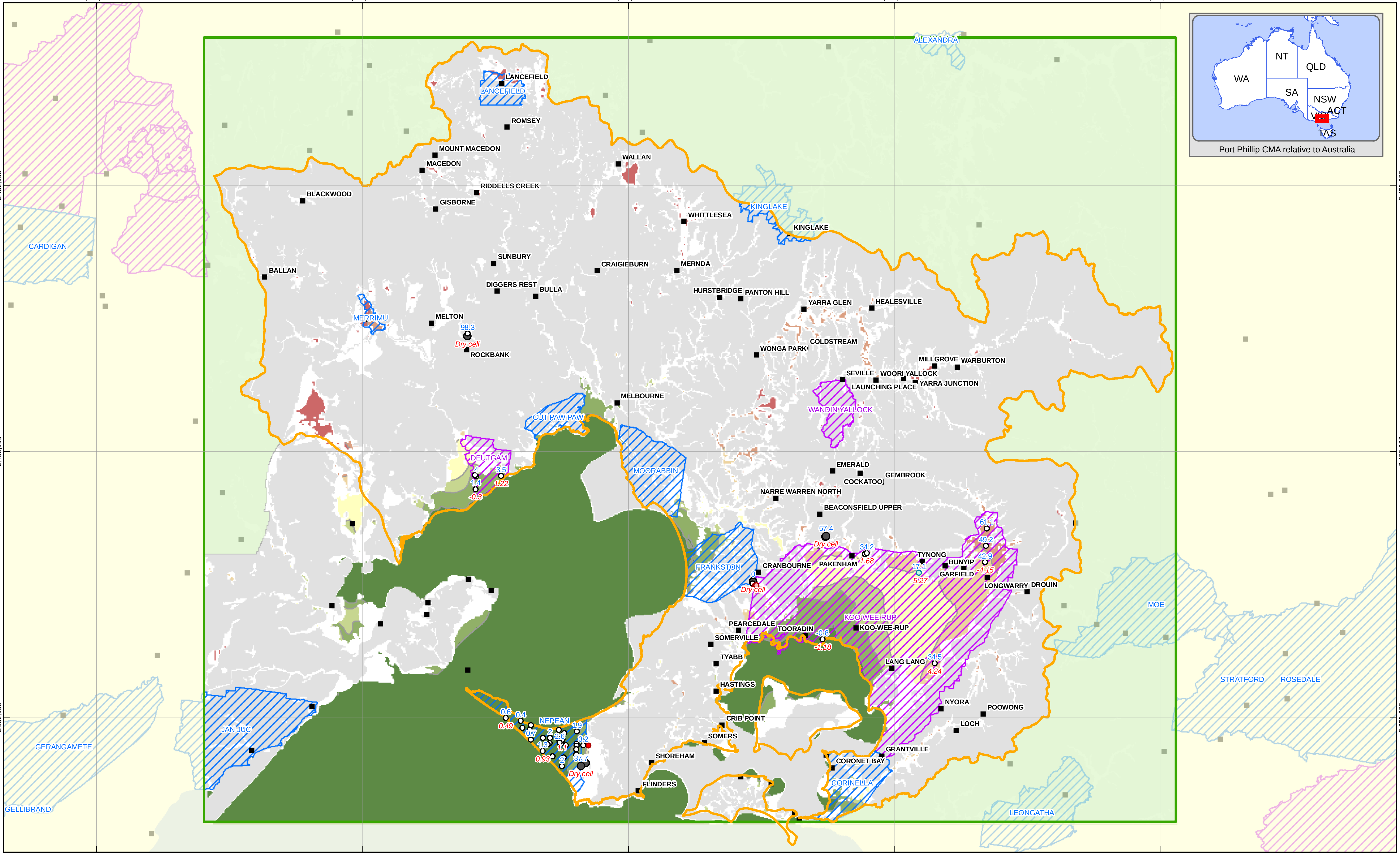
Simulated v Observed Groundwater Levels All Boreholes – Transient Model

Figure 55

G:\31\22410\CADD\GIS\Projects\3080_Port_Phillip_Simulated v Observed Groundwater Levels All Boreholes – Transient Model.mxd

Data source: DSE and GHD. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

Towns
Model No Flow Cells
Layer Inactive
Port Phillip CMA Boundary
Model Grid Extent
Modelled Head Contour

Residual Error (m)
Dry Cell
< -10
-10 to -5
-5 to 5
5 to 10
> 10

Water Supply Protection Areas
Groundwater Management Areas

Modelled Head Contour Dec 2005
<=1
1 - 5
5 - 10
10 - 25
25 - 50
50 - 100
100 +

Blue labels - Observed water level (mAHD)
Red labels - Residual error (m)

Department of Sustainability and Environment
Port Phillip - Phase 1 Model Construction and Calibration

Job Number	31-22410
Revision	A
Date	May 2010

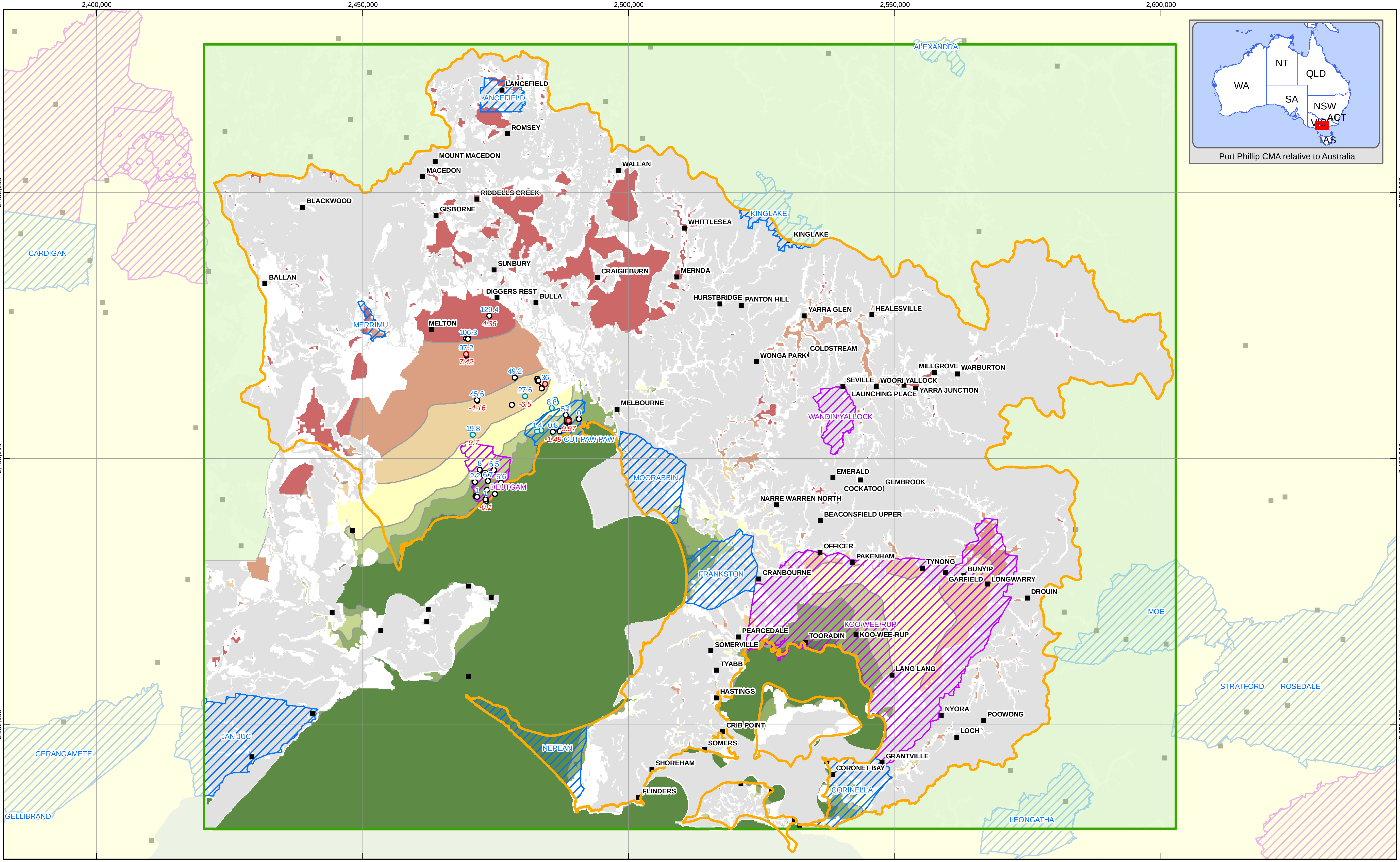
Model Layer 1 – Quaternary Sediments Simulated v Observed Long Term Average Groundwater Levels

Figure 56

G:\31\22410\CADD\GIS\Projects\3067_Port_Phillip_ModelledSteadyState_GWLevels_L1.mxd

Data source: DSE and VicMAP. Chris Nicol

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

- Towns
- Model No Flow Cells
- Layer Inactive
- Port Phillip CMA Boundary
- Model Grid Extent
- Modelled Head Contour

Residual Error (m)
- Dry Cell
- < -10
- -10 to -5
- -5 to 5
- 5 to 10
- > 10

- Water Supply Protection Areas
- Groundwater Management Areas

Modelled Head Contour Dec 2005
- <=1
- 1 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 +

Blue labels - Observed water level (mAHD)
Red labels - Residual error (m)

GHD

Department of Sustainability and Environment
Port Phillip - Phase 1 Model Construction and Calibration

Job Number	31-22410
Revision	A
Date	May 2010

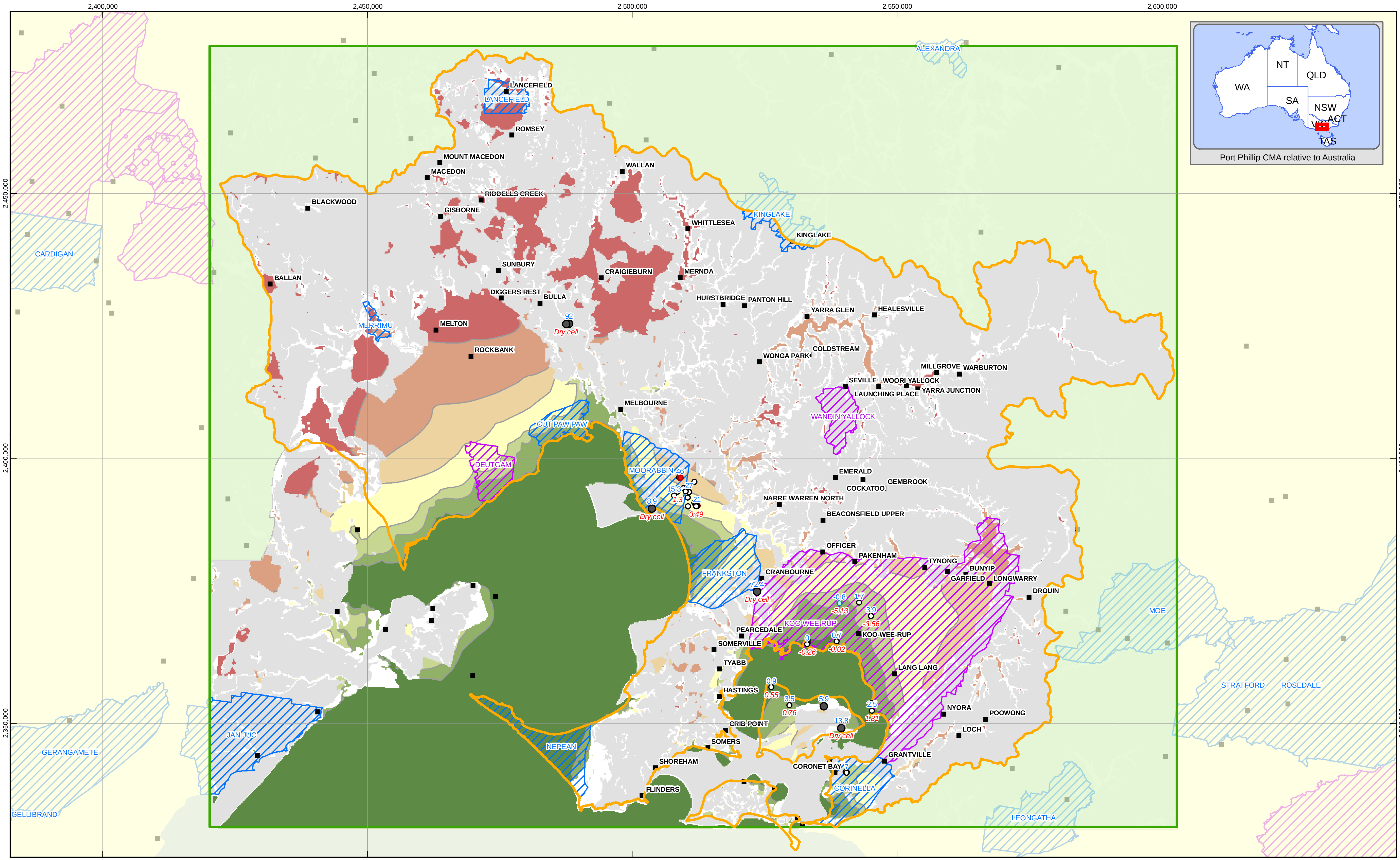
Model Layer 2 – Newer Volcanics Group Simulated v Observed Long Term Average Groundwater Levels

Figure 57

G:\31\22410\CADD\GIS\Projects\3069_Port_Phillip_ModelledSteadyState_GWLevels_L2.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

- Towns
- Model No Flow Cells
- Layer Inactive
- Port Phillip CMA Boundary
- Model Grid Extent
- Modelled Head Contour
- Dry Cell
- < -10
- -10 to -5
- -5 to 5
- 5 to 10
- > 10
- Water Supply Protection Areas
- Groundwater Management Areas

Modelled Head Contour Dec 2005
- <=1
- 1 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 +

Blue labels - Observed water level (mAHD)
Red labels - Residual error (m)

Department of Sustainability and Environment
Port Phillip - Phase 1 Model Construction and Calibration

Job Number	31-22410
Revision	A
Date	May 2010

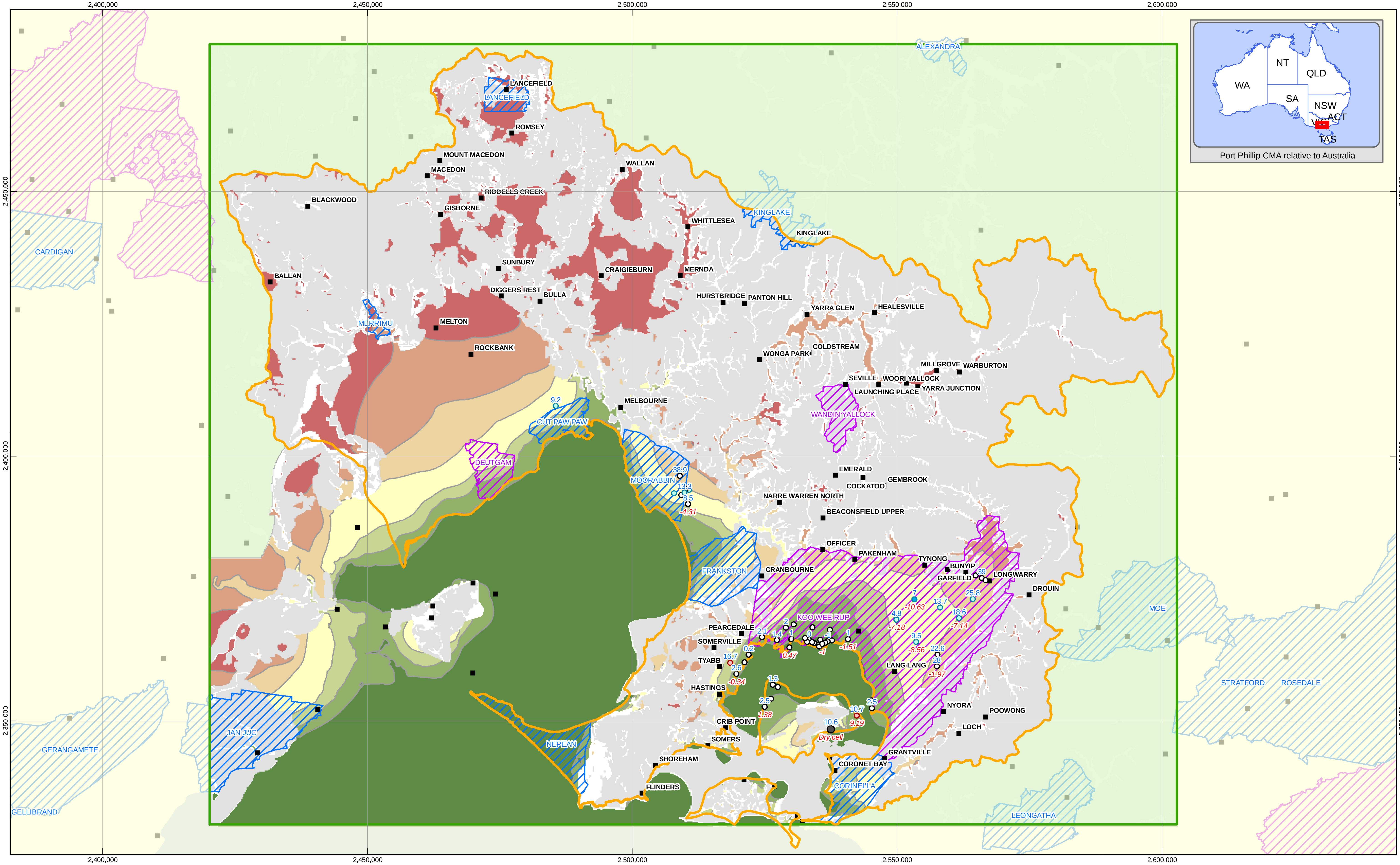
Model Layer 3 – Upper Tertiary Age Units Simulated v Observed Long Term Average Groundwater Levels

Figure 58

G:\31\22410\CADD\GIS\Projects\3070_Port_Phillip_ModelledSteadyState_GWLevels_L3.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

- Towns
- Model No Flow Cells
- Layer Inactive
- Port Phillip CMA Boundary
- Model Grid Extent
- Modelled Head Contour

- Dry Cell
- < -10
- -10 to -5
- -5 to 5
- 5 to 10
- > 10

- Water Supply Protection Areas
- Groundwater Management Areas

Modelled Head Contour Dec 2005
- <=1
- 1 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 +

Blue labels - Observed water level (mAHD)
Red labels - Residual error (m)

Department of Sustainability and Environment
Port Phillip - Phase 1 Model Construction and Calibration

Job Number	31-22410
Revision	A
Date	May 2010

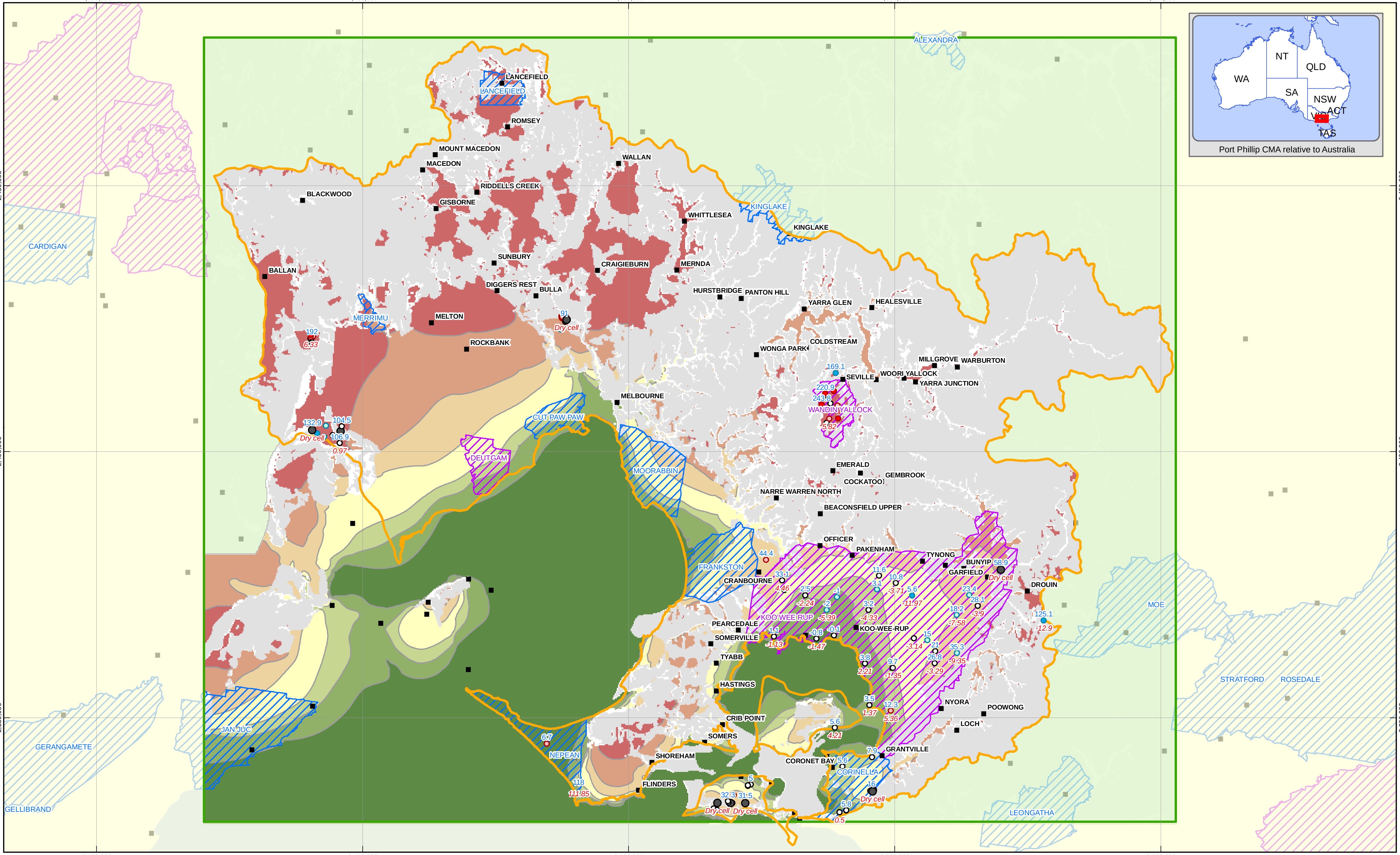
Model Layer 4 – Middle Tertiary Age Units Simulated v Observed Long Term Average Groundwater Levels

Figure 59

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au

G:\31\22410\CADD\GIS\Projects\3071_Port_Phillip_ModelledSteadyState_GWLevels_L4.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

Towns
Model No Flow Cells
Layer Inactive
Port Phillip CMA Boundary
Model Grid Extent
Modelled Head Contour

Dry Cell
< -10
-10 to -5
-5 to 5
5 to 10
> 10

Water Supply Protection Areas
Groundwater Management Areas
Modelled Head Contour Dec 2005
<=1
1 - 5
5 - 10
10 - 25
25 - 50
50 - 100
100 +

Blue labels - Observed water level (mAHD)
Red labels - Residual error (m)

GHD

Department of Sustainability and Environment
Port Phillip - Phase 1 Model Construction and Calibration

Job Number	31-22410
Revision	A
Date	May 2010

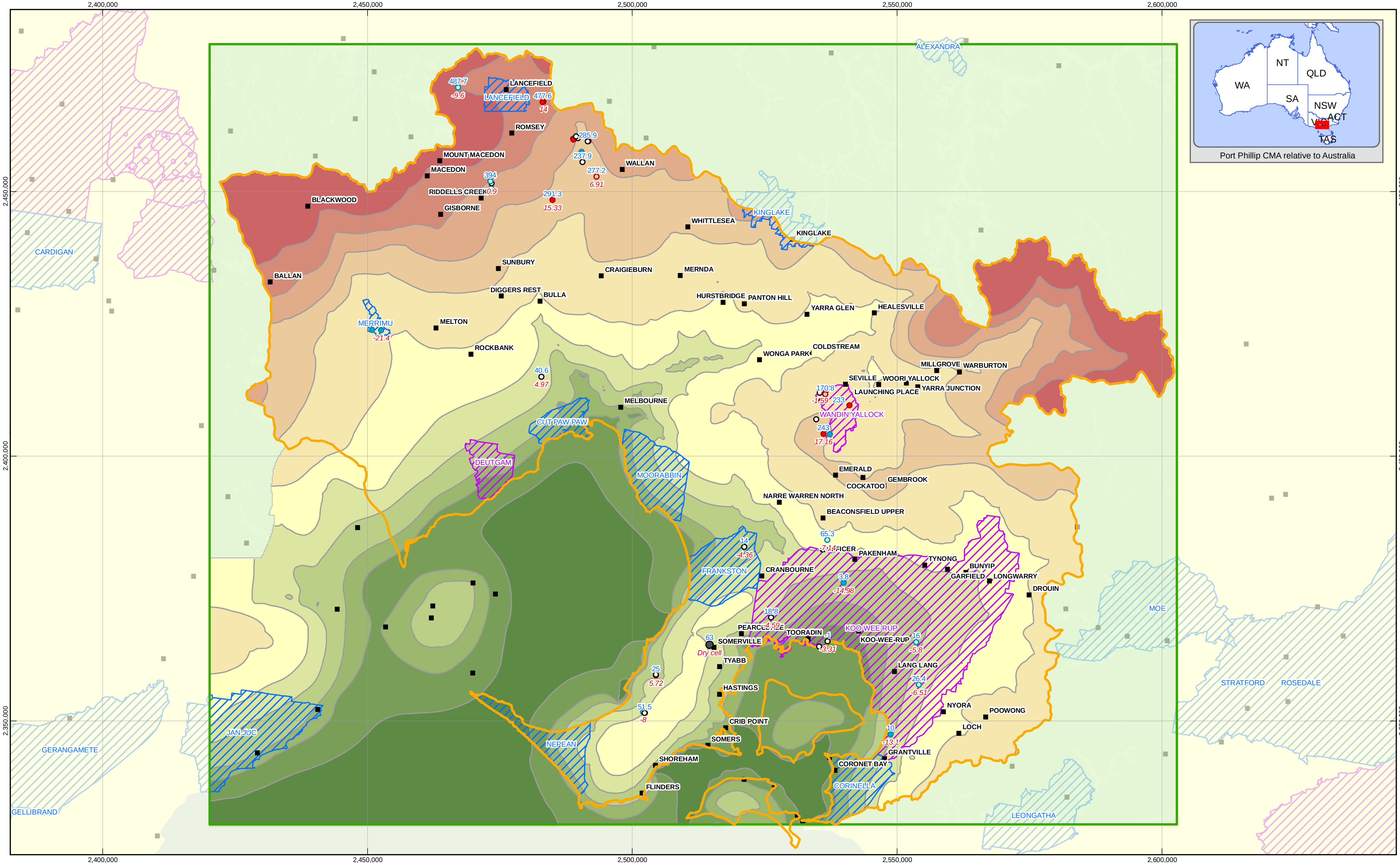
Model Layer 5 – Lower Tertiary Age Units Simulated v
Observed Long Term Average Groundwater Levels

Figure 60

G:\31\22410\CADD\GIS\Projects\3072_Port_Phillip_ModelledSteadyState_GWLevels_L5.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

Towns
Model No Flow Cells
Layer Inactive
Port Phillip CMA Boundary
Model Grid Extent
Modelled Head Contour

Residual Error (m)
Dry Cell
< -10
-10 to -5
-5 to 5
5 to 10
> 10

Water Supply Protection Areas
Groundwater Management Areas

Modelled Head Contour Dec 2005
<=1
1 - 5
5 - 10
10 - 25
25 - 50
50 - 100
100 - 200
200 - 300
300 - 400
400 - 500
>500

Blue labels - Observed water level (mAHD)
Red labels - Residual error (m)

GHD

Department of Sustainability and Environment
Port Phillip - Phase 1 Model Construction and Calibration

Job Number 31-22410
Revision A
Date May 2010

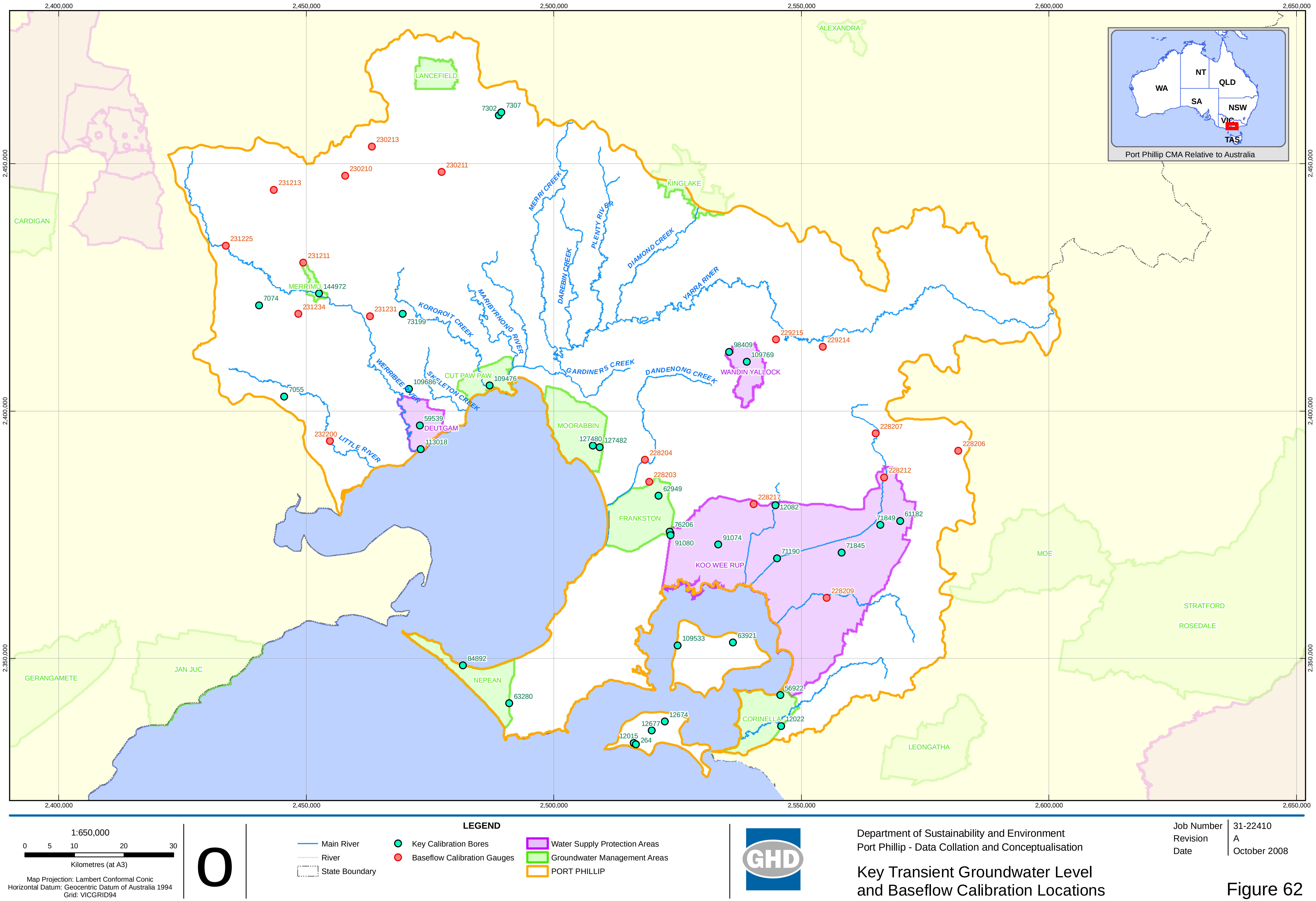
Model Layer 6 – PreTertiary Age Units Simulated v Observed Long Term Average Groundwater Levels

Figure 61

G:\31\22410\CADD\GIS\Projects\3073_Port_Phillip_ModelledSteadyState_GWLevels_L6.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



Department of Sustainability and Environment
Port Phillip - Data Collation and Conceptualisation

Job Number	31-22410
Revision	A
Date	October 2008

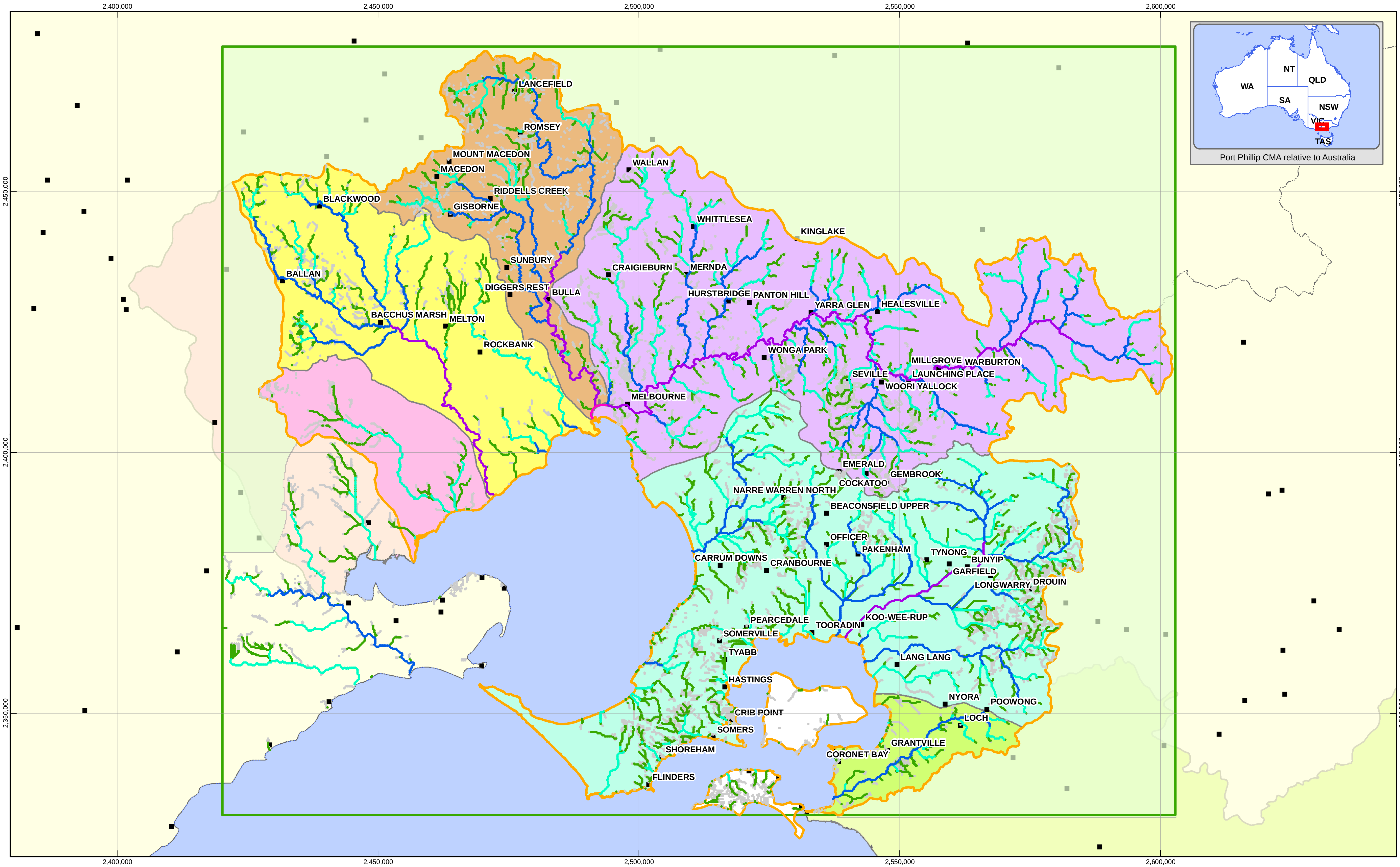
Key Transient Groundwater Level and Baseflow Calibration Locations

Figure 62

G:\31\22410\CADD\GIS\Projects\3077_Port_Phillip_Key_Transient_GW_Level_And_Baseflow_Calibration_Locations.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:660,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

Legend

- Towns
- State boundary
- Model Grid Extent
- Port Phillip
- Model No Flow Cells
- Bunyip River Basin
- Maribynong River Basin
- Moorabool River Basin
- South Gippsland Basin
- Werribee River Basin
- Yarra River Basin

Modelled Total Baseflow (ML/d)

- < 0.1
- 0.1 - 1
- 1 - 10
- 10 - 100
- 100 - 1000
- >1000

Department of Sustainability and Environment
Port Phillip - Phase 1 Model Construction and Calibration

Job Number	31-22410
Revision	A
Date	May 2010

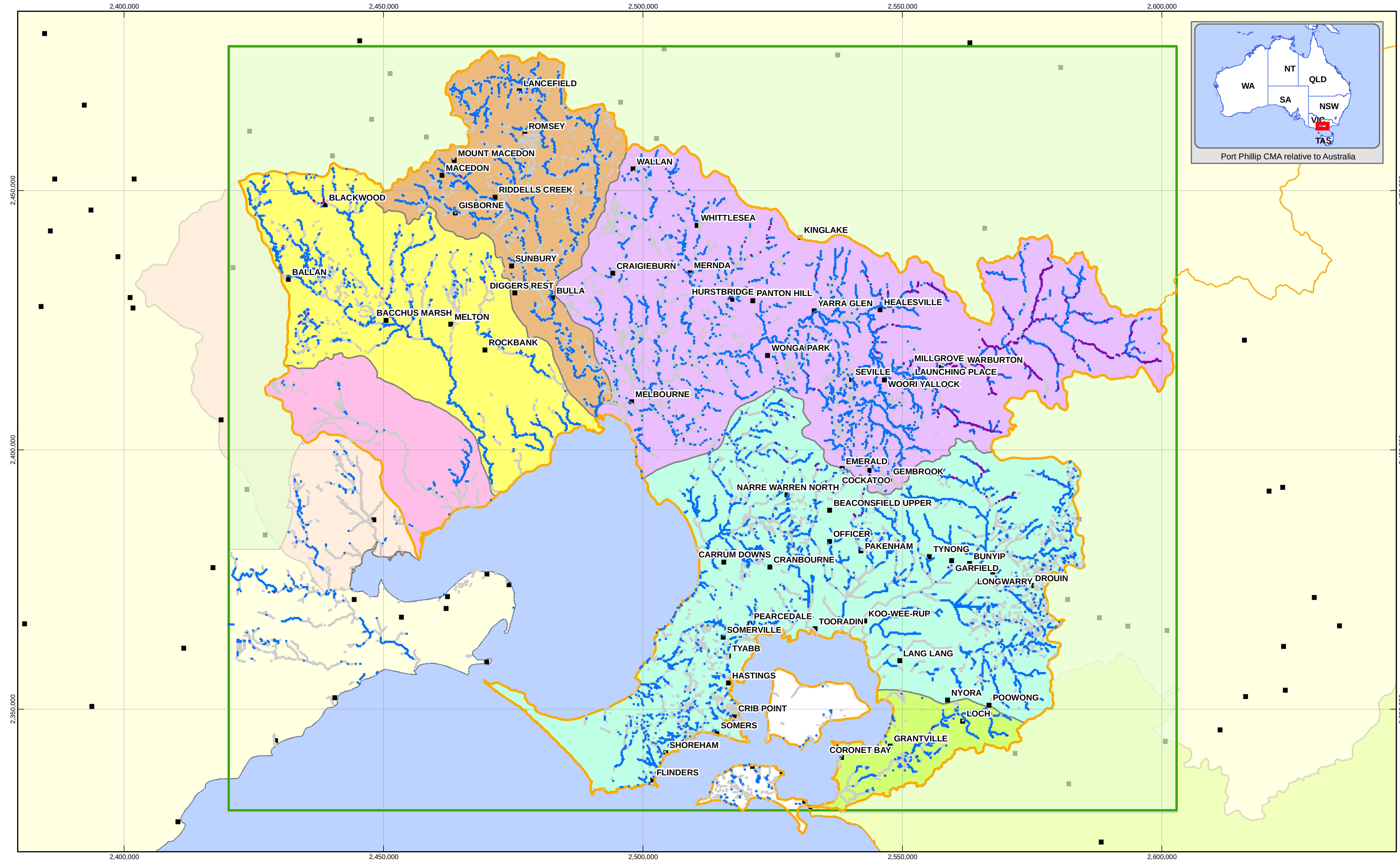
Modelled Long Term Average Total Baseflow (January 1991 to December 2005)

Figure 63

G:\31\22410\CADD\GIS\Projects\3066_Port_Phillip_ModelledSteadyState_NetSWFlows.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:660,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

Legend

- Towns
- State boundary
- Model Grid Extent
- Other CMA
- Port Phillip
- Model No Flow Cells
- Bunyip River Basin
- Maribyrnong River Basin
- Moorabool River Basin
- South Gippsland Basin
- Werribee River Basin
- Yarra River Basin

Modelled Flow Grain/Losses (ML/d)

- 5 ML/d (Baseflow Gain)
- 1 to 5 ML/d (Baseflow Gain)
- 0.1 to 1 ML/d (Baseflow Gain)
- Little/No baseflow Gain/Loss

GHD

Department of Sustainability and Environment
Port Phillip - Phase 1 Model Construction and Calibration

Job Number	31-22410
Revision	A
Date	May 2010

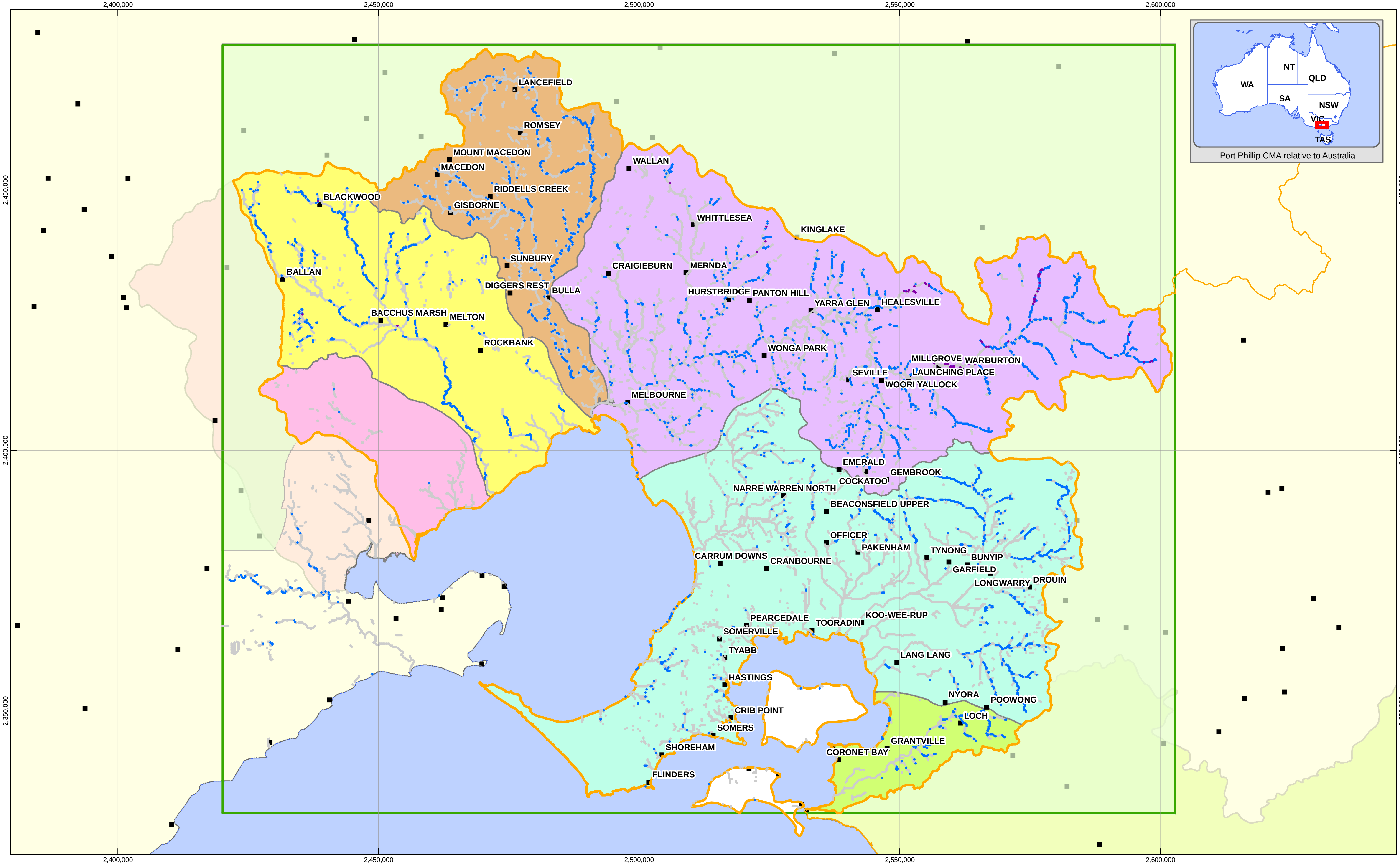
Modelled Surface Water – Groundwater Interaction, Wet Period October 1992

Figure 64

G:\31\22410\CADD\GIS\Projects\3055_Port_Phillip_ModelledSteadyState_SWGWInteraction.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:660,372

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

Legend

- Towns
- State boundary
- Model Grid Extent
- Other CMA
- Port Phillip
- Model No Flow Cells
- Bunyip River Basin
- Maribynong River Basin
- Moorabool River Basin
- South Gippsland Basin
- Werribee River Basin
- Yarra River Basin

Modelled Flow Grain/Losses (ML/d)

- 5 ML/d (Baseflow Gain)
- 1 to 5 ML/d (Baseflow Gain)
- 0.1 to 1 ML/d (Baseflow Gain)
- Little/No baseflow Gain/Loss

Department of Sustainability and Environment
Port Phillip - Phase 1 Model Construction and Calibration

Job Number	31-22410
Revision	A
Date	May 2010

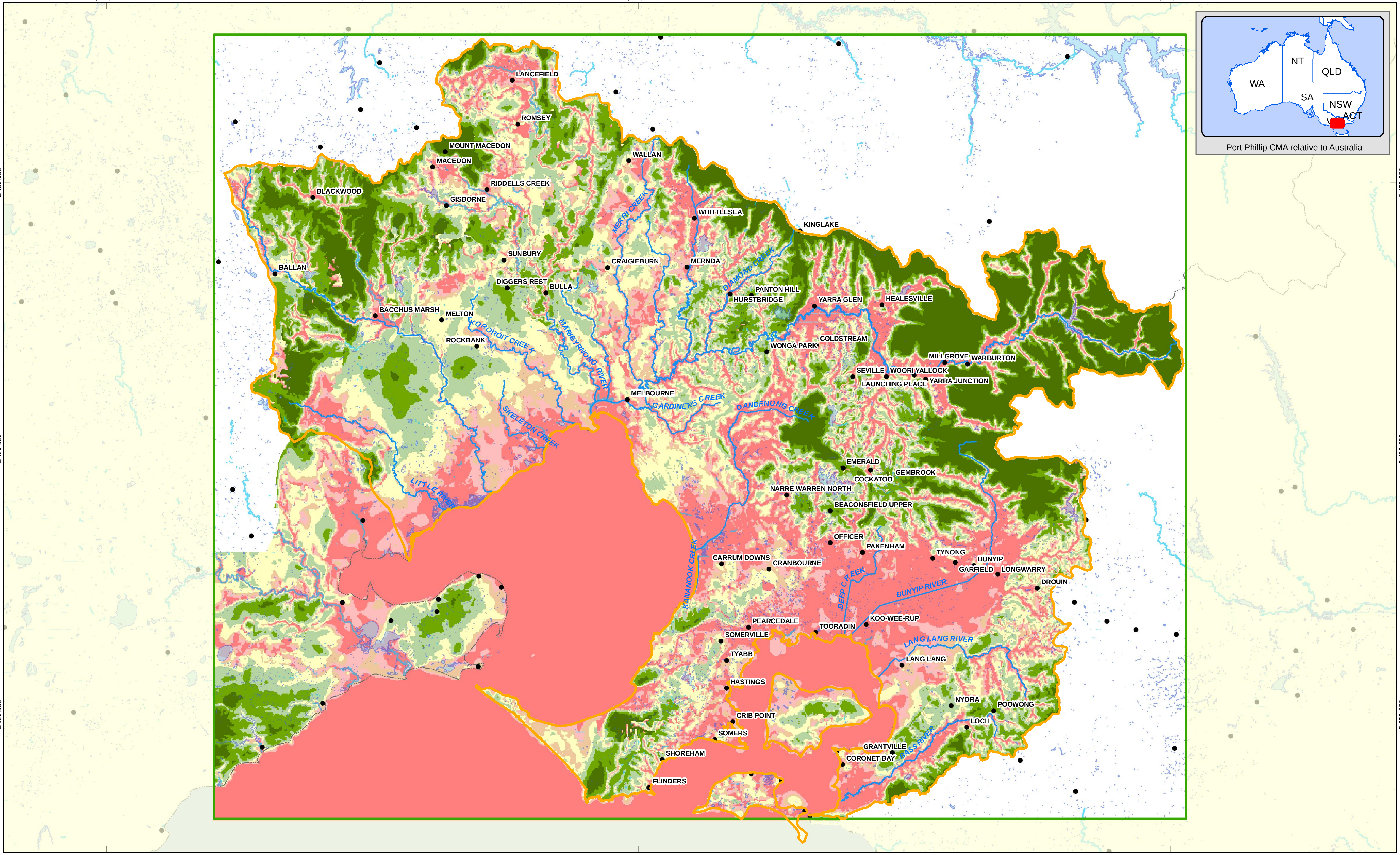
Modelled Surface Water – Groundwater Interaction, Dry Period March 2004

Figure 65

G:\31\22410\CADD\GIS\Projects\3080_Port_Phillip_Modelled Surface Water – Groundwater Interaction, Dry Period March 2004.mxd

Data source: DSE and VicMAP. Khan Kamruzzaman

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au



1:650,000

0 5 10 20 30

Kilometres (at A3)

Map Projection: Lambert Conformal Conic
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: VICGRID94

N

Legend

- Towns
- Port Philliip CMA Boundary
- Model Grid Extent
- Main River

Water Table Depth (m)

- <=1
- 1.01 - 5
- 5.01 - 10
- 10.01 - 25
- 25.01 - 50
- 50.01 - 100
- 100+

GHD

Department of Sustainability and Environment
Port Phillip - Phase 1 Model Construction and Calibration

Modelled Depth to Water Table

Job Number	31-22410
Revision	A
Date	May 2010

Figure 66

G:\31\22410\CADD\GIS\Projects\3074_Port_Phillip_ModelledDepth_To_WaterTable.mxd

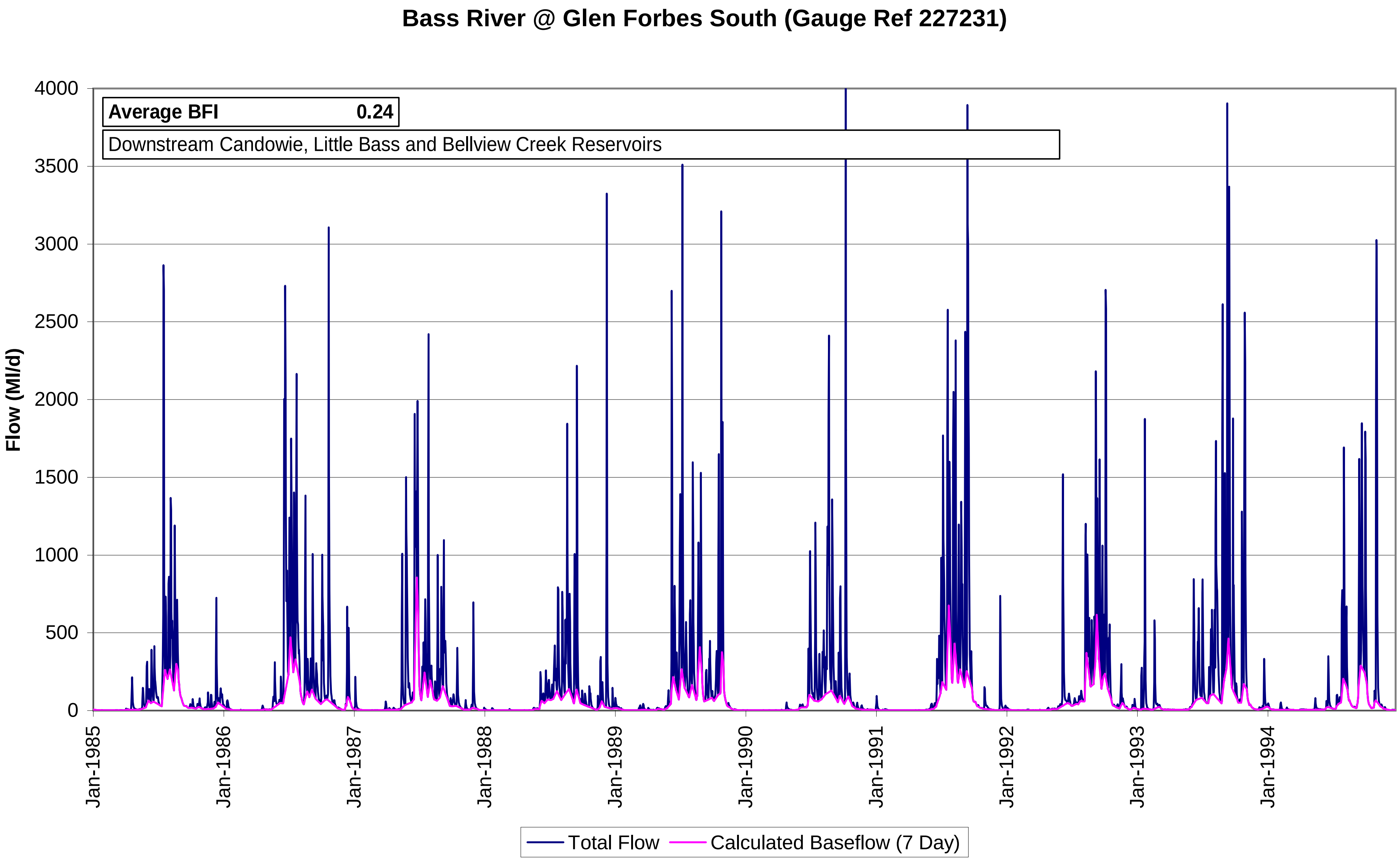
Data source: DSE and VicMAP. Chris Nicol

8/180 Lonsdale St Melb VIC 3000 Australia T 61 3 8687 8000 F 61 3 8687 8111 E melmail@ghd.com.au W www.ghd.com.au

Appendix A

Flow Gauge Summary Statistics

Basin	Gauge No	Sitename	Status	Data Start Date	Data End Date	Carea (Km^2)	Rainfall (mm/yr)	Runoff (mm/yr)	Natural Runoff (mm/yr)	Runoff Coeff	Model Row	Model Col	Baseflow Index (7 day)	Baseflow Yield (mm/yr)
Bunyip River	228234	Boggy Creek @ Seaford	Active	Mar-1979	Mar-1987	32	-	90	-	-				
Bunyip River	228207	Bunyip River @ Headworks	Active	Feb-1980	Jun-2001	41	-	224	-	-				
Bunyip River	228212	Bunyip River @ Tonimbuk	Active	Nov-1975	Aug-2001	174	1319	180	-	0.14	458	735		
Bunyip River	228213	Bunyip River @ Iona	Active	Nov-1971	Aug-2001	719	1160	211	132	0.18	515	712	0.5	105.5
Bunyip River	228230	Cardinia Creek @ D/S Muddy Creek Junction	Active	May-1975	Mar-2000	22	-	294	-	-				
Bunyip River	228228	Cardinia Creek @ Cardinia	Active	Apr-1974	Aug-2001	132	1050	133	132	0.13	513	576	0.37	49.21
Bunyip River	228204	Dandenong Creek @ Dandenong	Active	Jun-1972	Sep-2001	269	-	279	-	-				
Bunyip River	228233	East Contour Drain @ Dandenong (Glasscocks Road	Active	Mar-1978	Mar-2000	42	-	22	-	-				
Bunyip River	228235	Eumemmering Creek @ Narre Warren North	Active	Feb-1980	Mar-2000	21	-	110	-	-				
Bunyip River	228203	Eumemmering Creek @ Lyndhurst	Active	Nov-1969	Sep-2001	164	910	185	180	0.20	463	498		
Bunyip River	228231	Hallam Contour Drain @ Hampton Park	Active	Jun-1977	Jun-1987	86	-	109	-	-				
Bunyip River	228209	Lang Lang River @ Hamiltons Bridge	Active	Feb-1980	Aug-2001	288	1150	227	228	0.20	577	676	0.29	65.83
Bunyip River	228210	Mile Creek @ Dandenong	Active	May-1969	Nov-1982	48	-	268	-	-				
Bunyip River	228229	Monbulk Creek @ Tecoma	Active	Mar-1975	Aug-1988	19	-	196	-	-				
Bunyip River	228206	Tarago River @ Neerim	Inactive	Sep-1980	Aug-2001	80	1403	281	-	0.20	433	809		
Bunyip River	228201	Tarago River @ Drouin West	Active	Dec-1974	Jul-2001	218	-	140	-	-				
Bunyip River	228217	Toomuc Creek @ Pakenham	Active	Aug-1974	Sep-2001	41	-	170	-	-				
Bunyip River	228225	Yallock Outfall @ Cora Lynn	Active	Sep-1981	Sep-2001	736	-	14	-	-				
Maribyrnong River	230209	Barringo Creek @ Barringo (U/S Of Diversion)	Active	Aug-1983	Jun-2008	6	-	124	-	-				
Maribyrnong River	230218	Bolinda Creek @ Mount Eliza	Active	Oct-1977	May-2001	12	-	124	-	-				
Maribyrnong River	230205	Deep Creek @ Bulla (D/S Of Emu Creek Junct.)	Active	Jun-1955	Jun-2008	866	800	87	132	0.11	241	313	0.26	22.62
Maribyrnong River	230211	Emu Creek @ Clarkefield	Active	Jun-1975	Aug-2004	93	-	82	-	-				
Maribyrnong River	230217	Garden Hut Creek @ U/S Of Lancefield Reservior	Active	Feb-1996	Jul-2001	16	-	96	-	-				
Maribyrnong River	230222	Gisborne Creek @ U/S Of Rosslynne Reservoir	Active	Aug-1983	Sep-2001	16	-	101	-	-				
Maribyrnong River	230206	Jackson Creek @ Gisborne	Active	Jun-1971	Jun-2008	93	970	85	144	0.09	155	212	0.27	22.95
Maribyrnong River	230202	Jackson Creek @ Sunbury	Active	Dec-1974	Jun-2008	345	870	88	96	0.10	214	287	0.24	21.12
Maribyrnong River	230200	Maribyrnong River @ Keilor	Active	Dec-1974	Jun-2008	1308	810	73	120	0.09	294	328	0.28	20.44
Maribyrnong River	230204	Riddells Creek @ Riddells Creek	Active	Nov-1974	Jun-2008	79	-	90	-	-				
Maribyrnong River	230210	Saltwater Creek @ Bullengarook	Active	Nov-1973	Jun-2008	39	-	109	-	-				
Maribyrnong River	230226	Slaty Creek @ Blackwood Road	Active	Aug-1983	Jul-2001	9	-	152	-	-				
Maribyrnong River	230223	Slaty Creek At Rosslynne Reservior	Active	Aug-1983	Sep-2001	17	-	80	-	-				
Maribyrnong River	230213	Turritable Creek @ Mount Macedon	Active	Mar-1975	Jun-2008	15	-	79	-	-				
Maribyrnong River	230231	Willimigongon Ck @ Mt Macedon-Anzac Rd	Active	Mar-1992	Jul-2001	4	-	179	-	-				
Moorabool River	232200	Little River @ Little River	Active	Dec-1974	May-2008	400	580	15	12	0.03	421	175	0.26	3.9
South Gippsland	227219	Bass River @ Loch	Active	Dec-1973	May-2008	52	1140	347	-	0.30	645	717		
South Gippsland	227231	Bass River @ Glen Forbes South	Active	Dec-1974	May-2008	233	-	213	-	-			0.24	
South Gippsland	227206	Bass River @ Glen Forbes	Inactiv	Jan-1900	Jan-1900	236	1140	245	252	0.21	699	636	0.24	58.8
Werribbee River	231218	Goodman Creek @ Goodman Creek Diversion Weir	Active	Nov-1983	Sep-2001	39	-	62	-	-				
Werribbee River	231213	Lerderderg River @ Sardine Creek Obrien Crossi	Active	Apr-1959	Jun-2008	153	1083	207	-	0.19	167	118		
Werribbee River	231211	Lerderderg River @ U/S Goodman Creek Junction	Active	Aug-1978	Jun-2008	234	-	87	-	-				
Werribbee River	231203	Pykes Creek @ Pykes Creek Reservior	Active	Sep-1960	Jun-2008	126	920	138	96	0.15	233	91	0.24	33.12
Werribbee River	231223	Pyrites Creek @ Merrimu Reservoir (Head Gauge)	Active	Jan-1973	Sep-2001	74	-	36	-	-				
Werribbee River	231214	Pyrites Creek @ Bacchus Marsh	Active	May-1974	Sep-2001	97	730	1	48	0.00	269	179	0.23	0.23
Werribbee River	231231	Toolern Creek @ Melton South	Active	May-1979	Feb-2008	95	-	27	-	-				
Werribbee River	231225	Werribee River @ Ballan (U/S Old Western H-Way)	Active	May-1973	Sep-2001	71	-	298	-	-				
Werribbee River	231200	Werribee River @ Bacchus Marsh	Active	Jun-1978	Jun-2008	363	-	59	-	-				
Werribbee River	231205	Werribee River @ Melton Reservior	Active	Oct-1978	Jun-2008	1141	770	60	84	0.08	305	212	0.19	11.4
Werribbee River	231221	Werribee River @ Melton Reservoir (Head Gauge)	Active	Oct-1978	Sep-2001	1155	-	1113	-	-				
Werribbee River	231232	Werribee River @ Droomers	Active	May-1979	Jul-2001	1397	-	135	-	-				
Werribbee River	231204	Werribee River @ Werribee (Diversion Weir)	Active	Apr-1982	Aug-2007	1404	740	37	72	0.05	379	244	0.17	6.29
Yarra River	229223	Diamond Creek @ Diamond Creek	Active	May-1975	Sep-1993	271	-	54	-	-				
Yarra River	229214	Little Yarra River @ Yarra Junction	Active	Mar-1970	Sep-2001	140	-	345	-	-				
Yarra River	229216	Plenty River @ Mernda	Active	Jul-1975	Aug-2004	298	-	45	-	-				
Yarra River	229218	Watsons Creek @ Watsons Creek	Active	Nov-1974	Mar-1999	36	-	60	-	-				
Yarra River	229215	Woori Yallock Creek @ Woori Yallock	Active	Dec-1974	Sep-2001	311	1169	313	-	0.27	318	626		
Yarra River	229212	Yarra River @ Millgrove	Active	Mar-1970	Sep-2001	853	1670	197	492	0.12	309	691	0.57	112.29
Yarra River	229206	Yarra River @ Yarra Glen	Active	Sep-1997	Mar-1998	1927	-	64	-	-				
Yarra River	229200	Yarra River @ Warrandyte	Active	Dec-1974	Aug-2001	2366	1450	223	360	0.15	301	495	0.58	129.34
Yarra River	229143	Yarra River @ Kew Chandler Highway	Active	May-1998	Sep-1999	3290	-	98	-	-				



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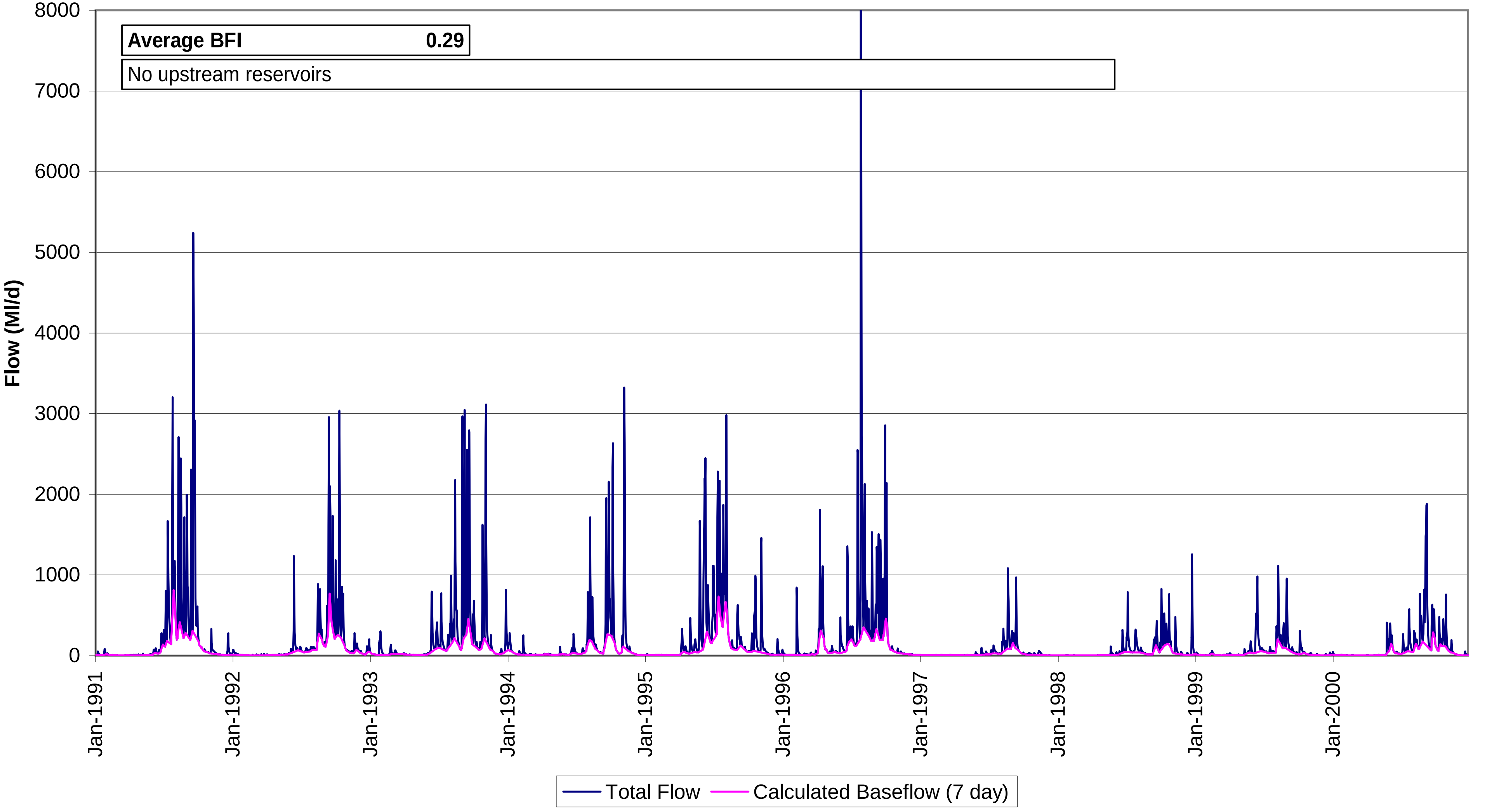
Lang Lang River @ Hamiltons Bridge (Gauge Ref 228209)



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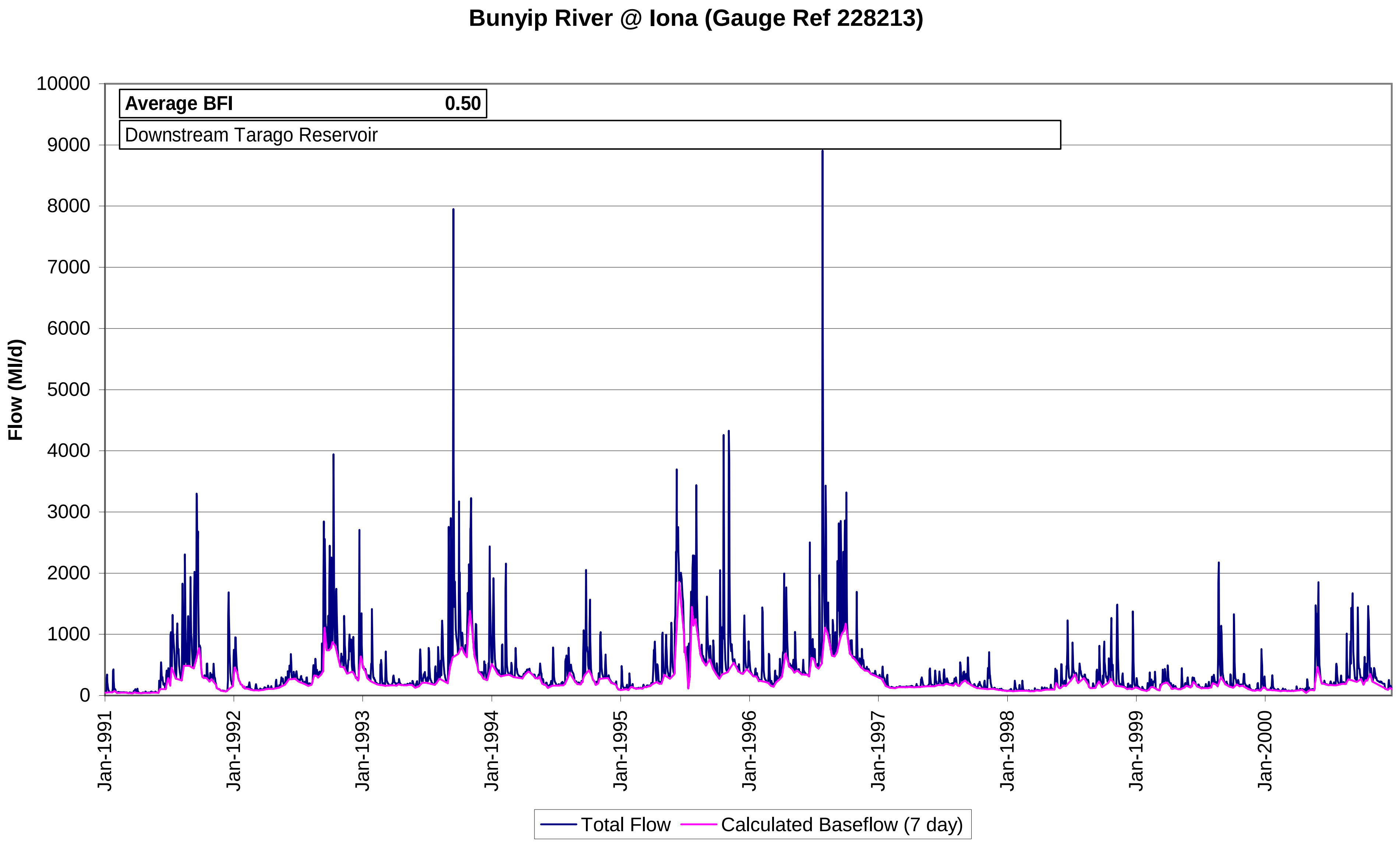

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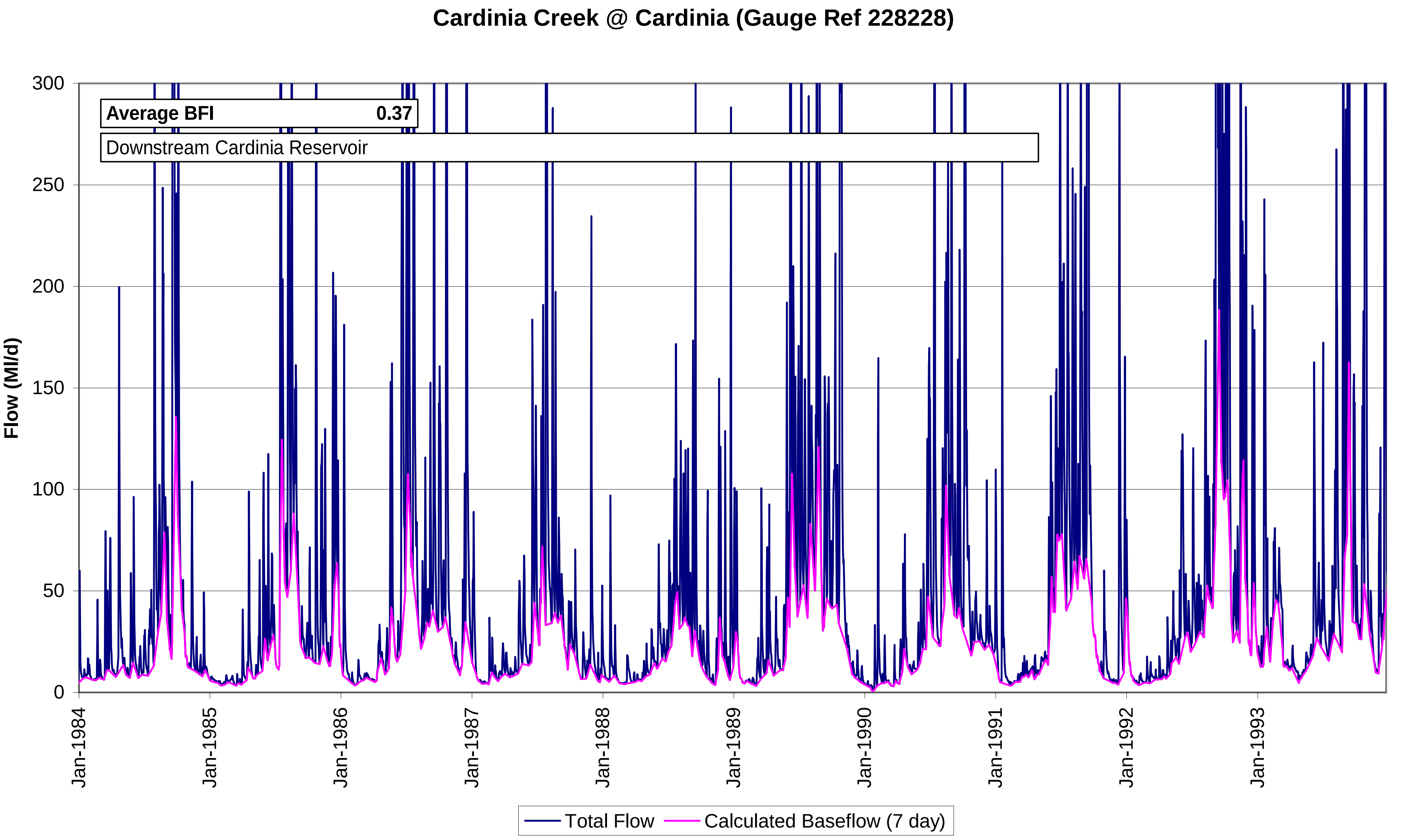

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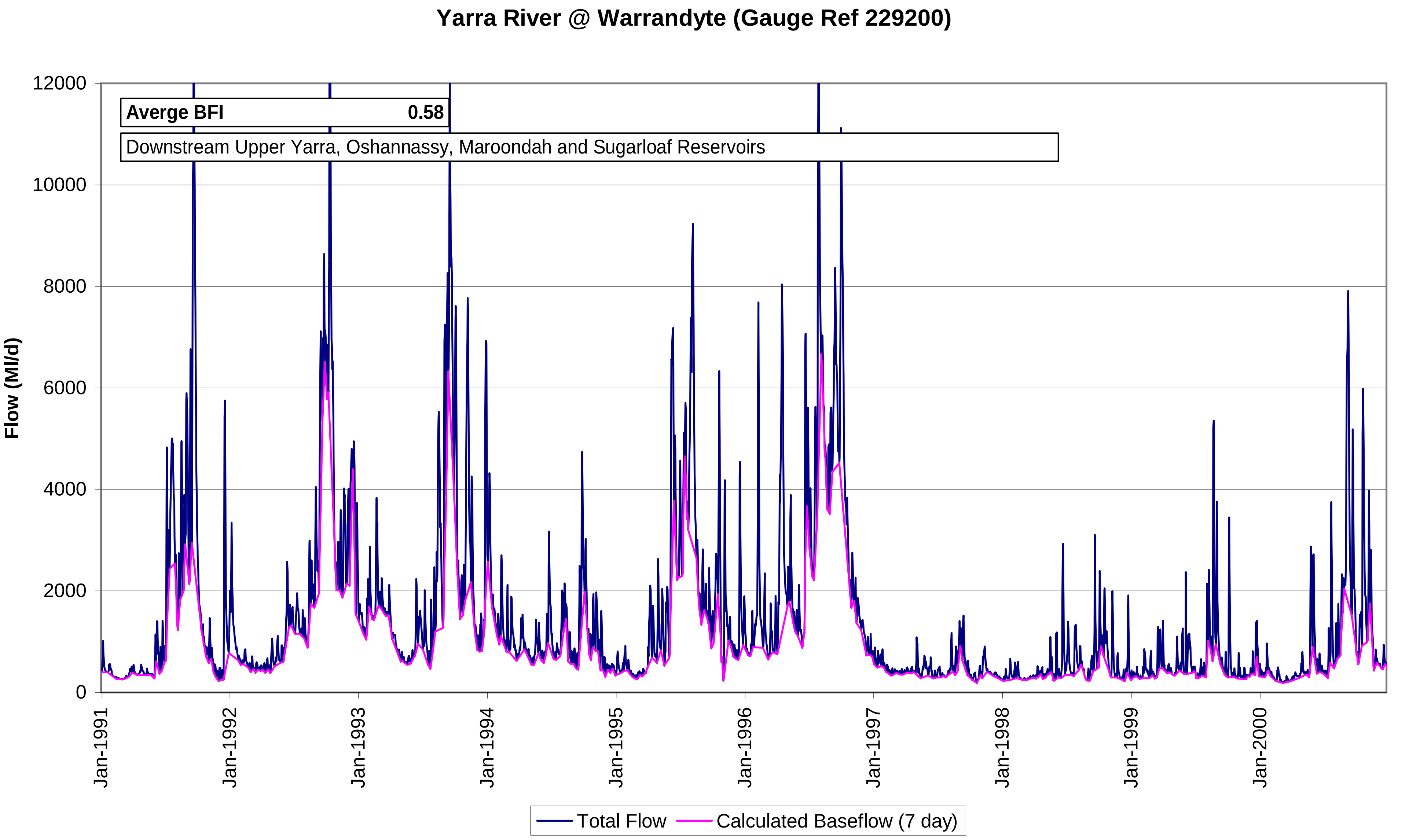

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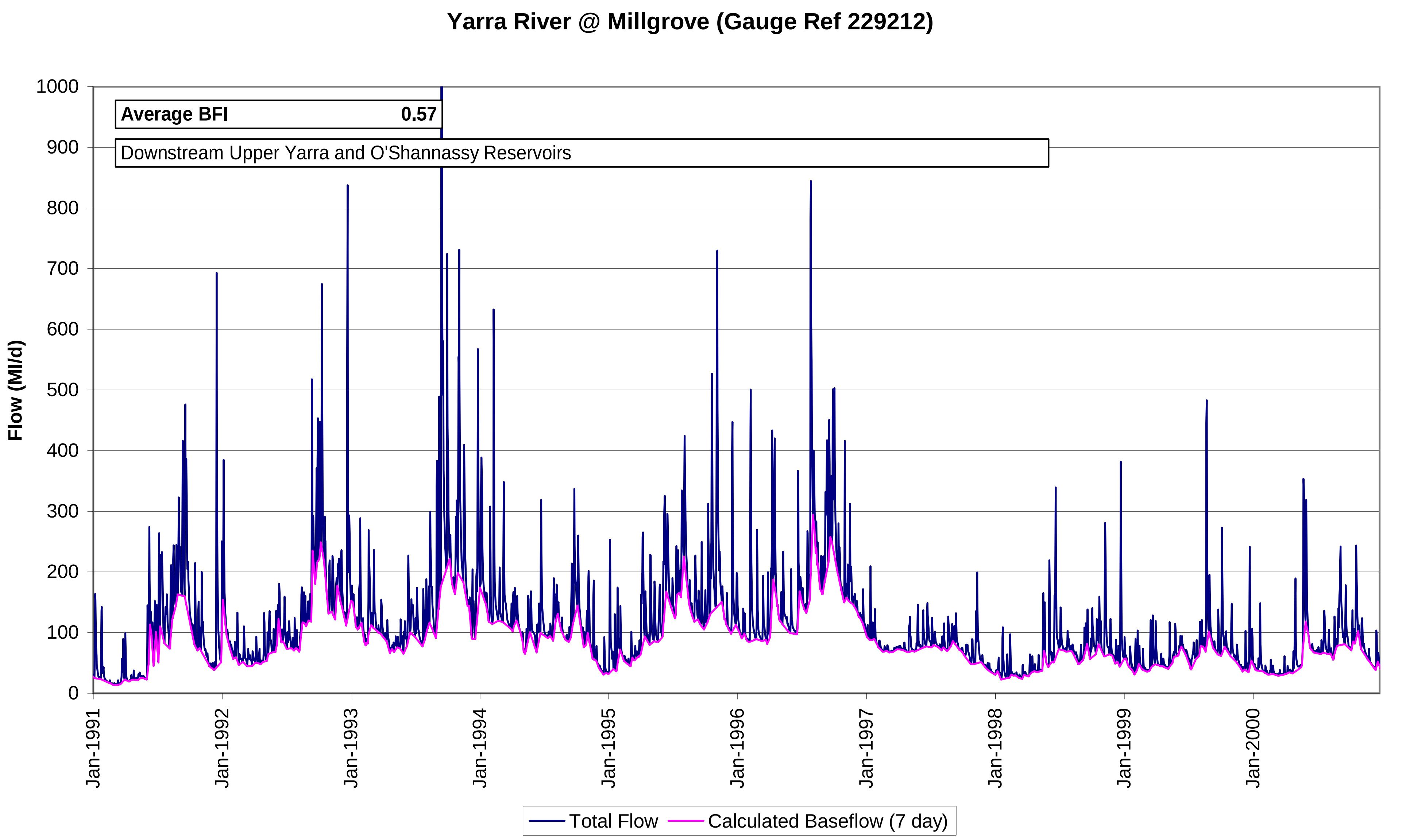

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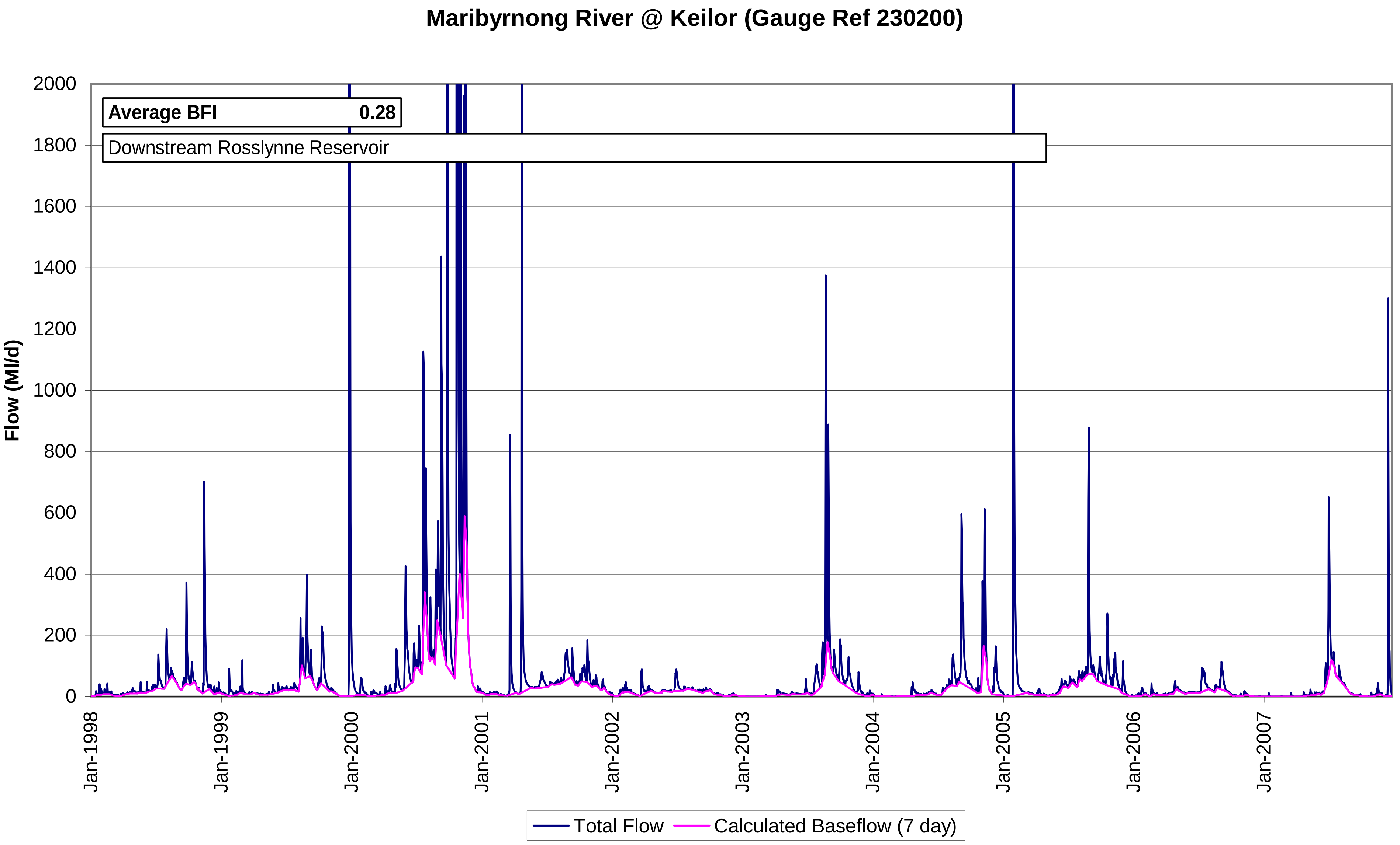

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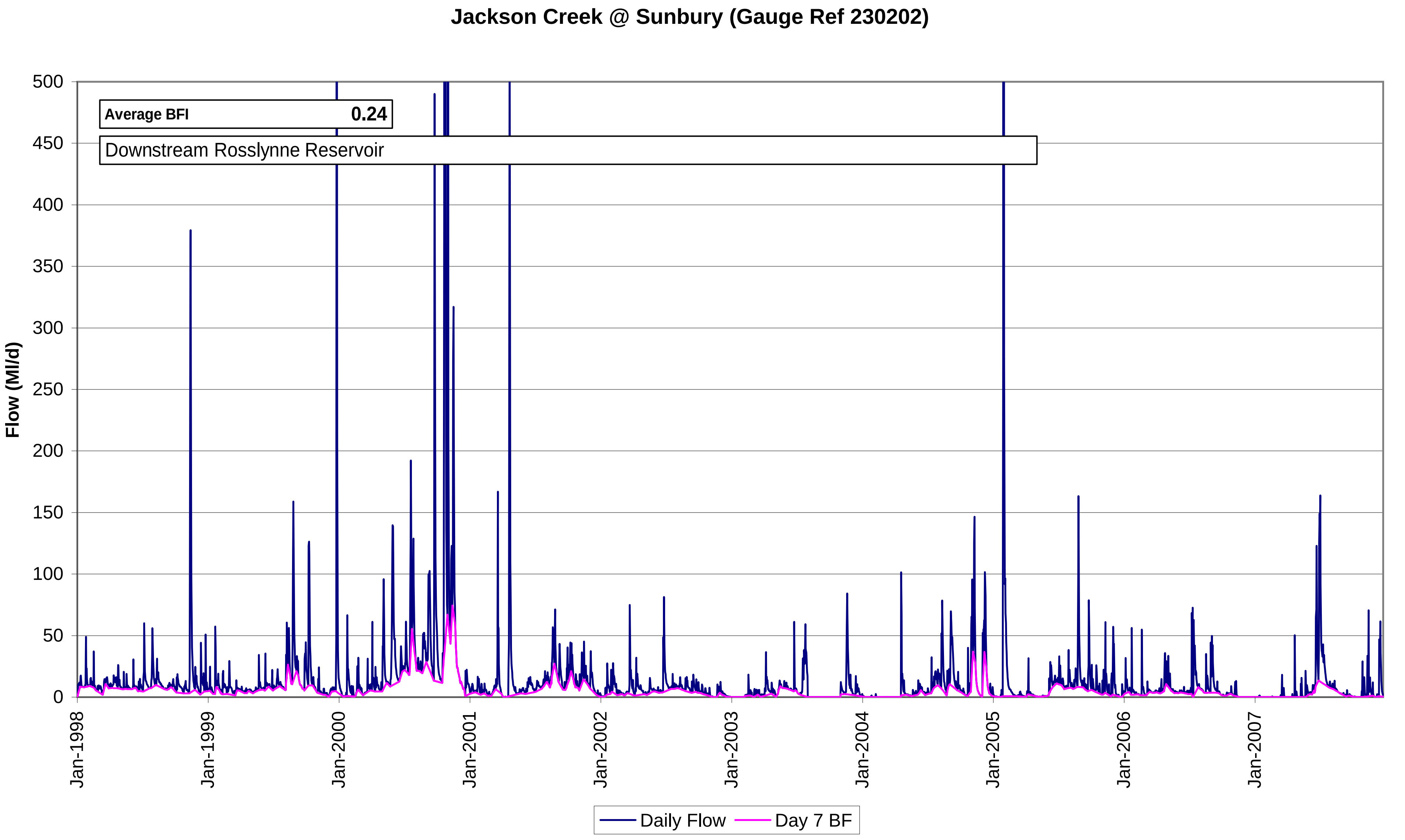

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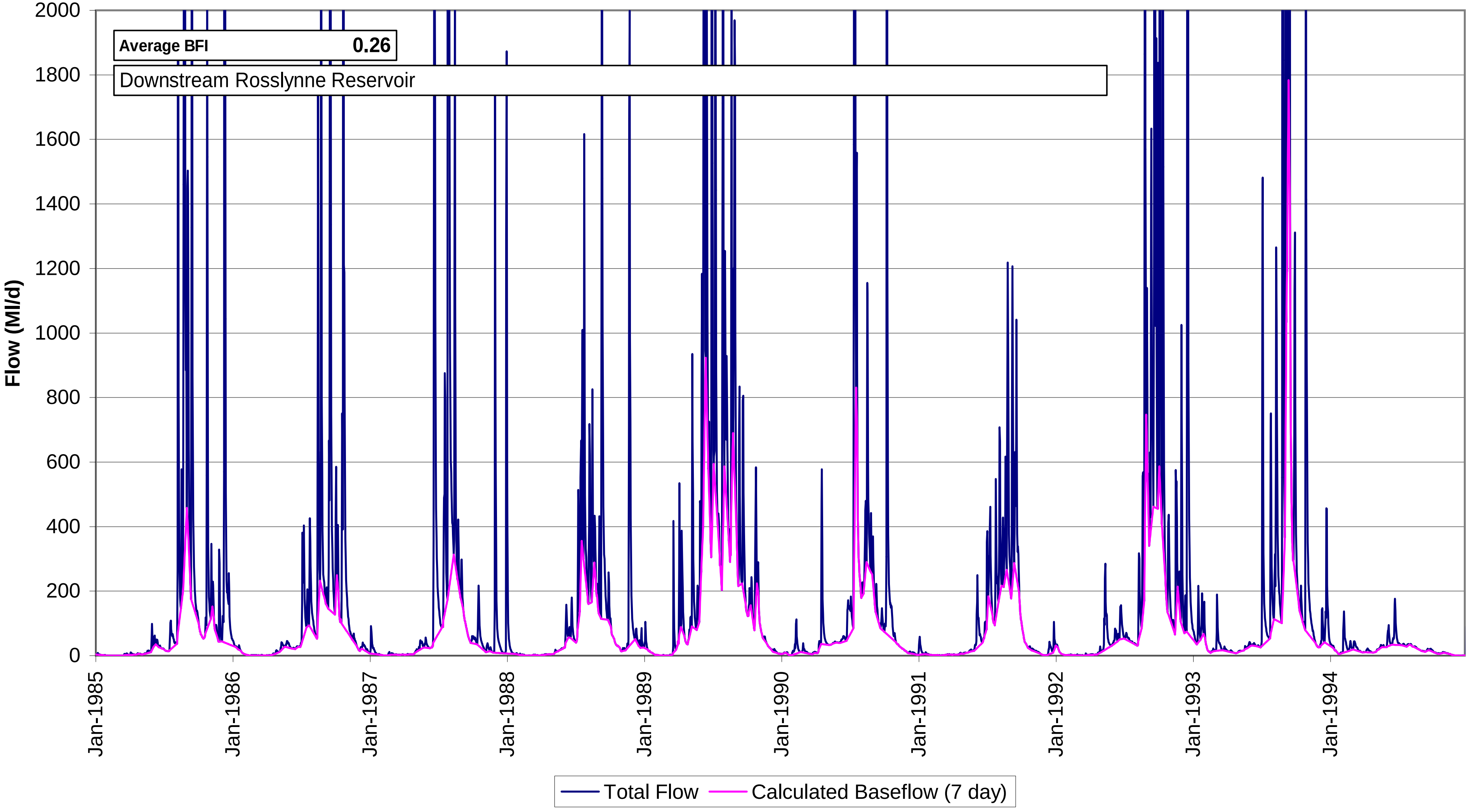
Deep Creek @ Bulla (Gauge Ref 230205)



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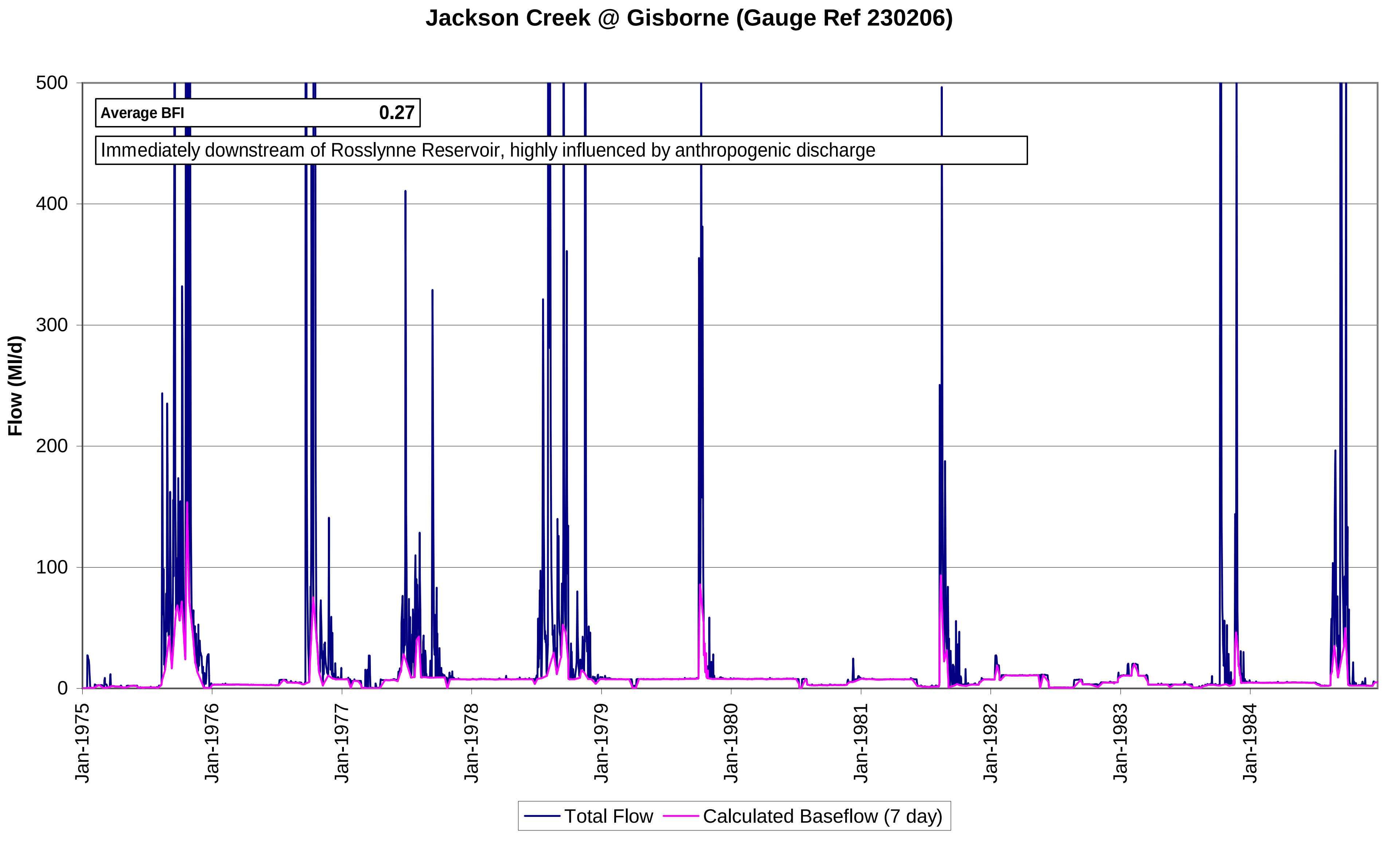

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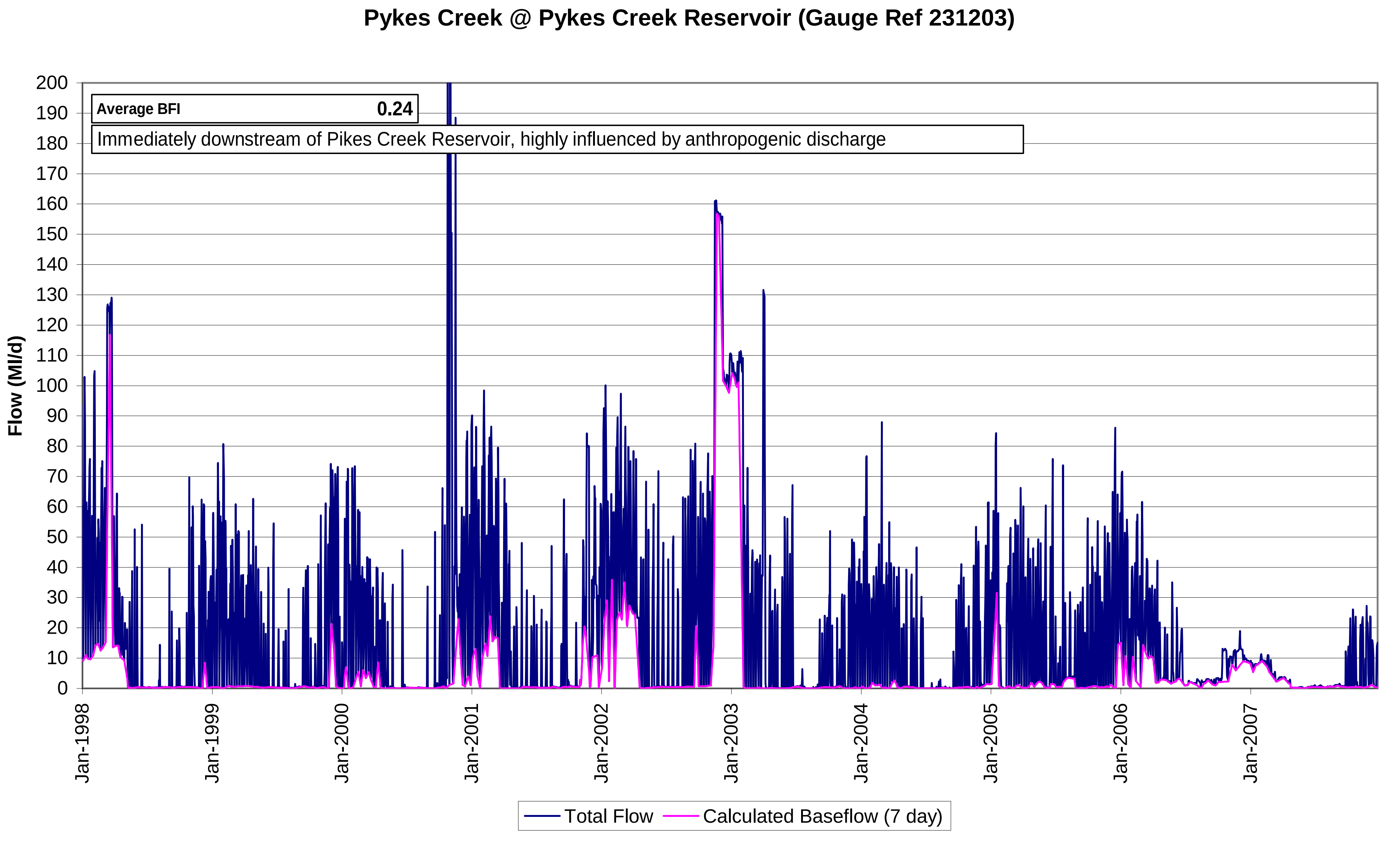

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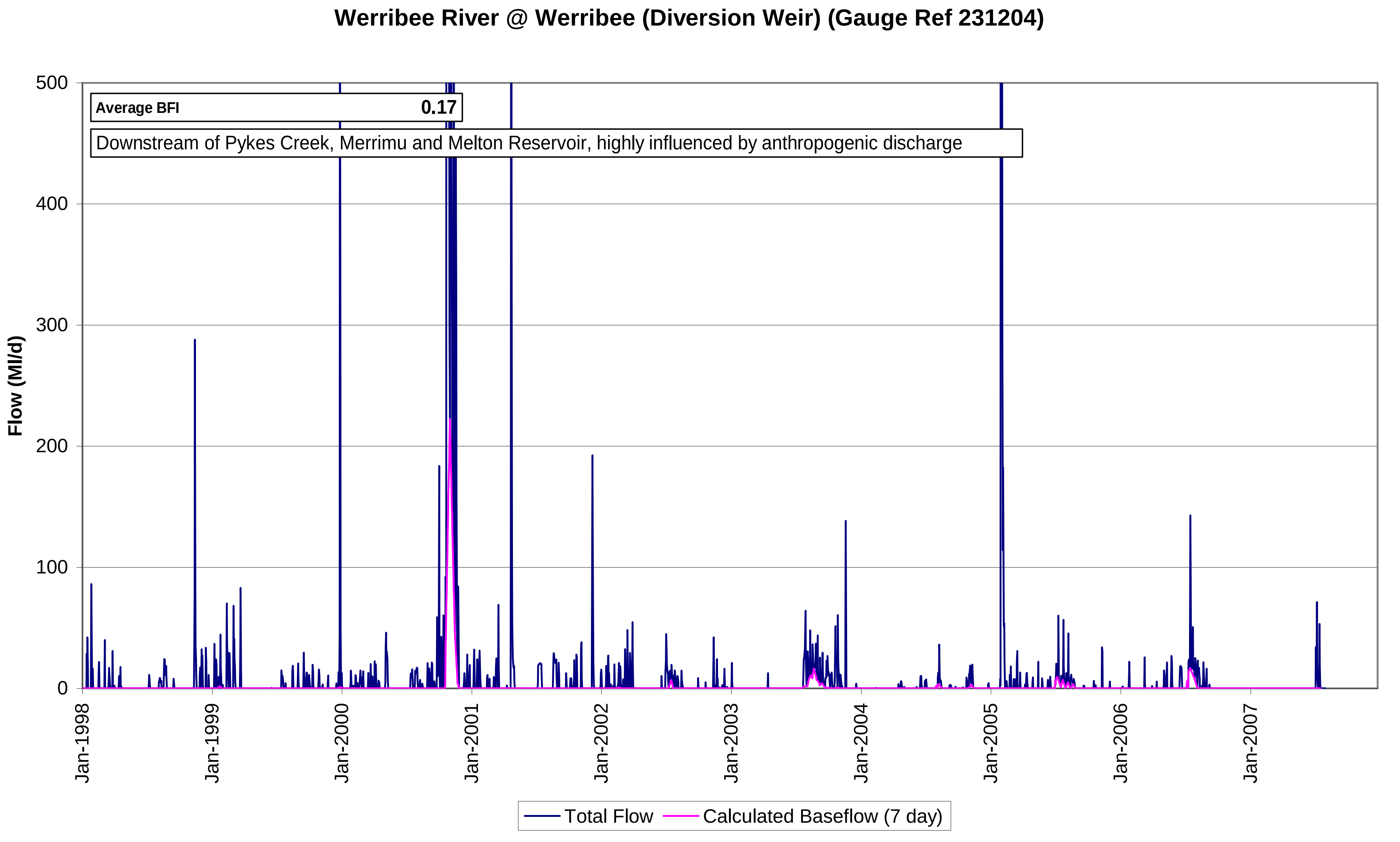

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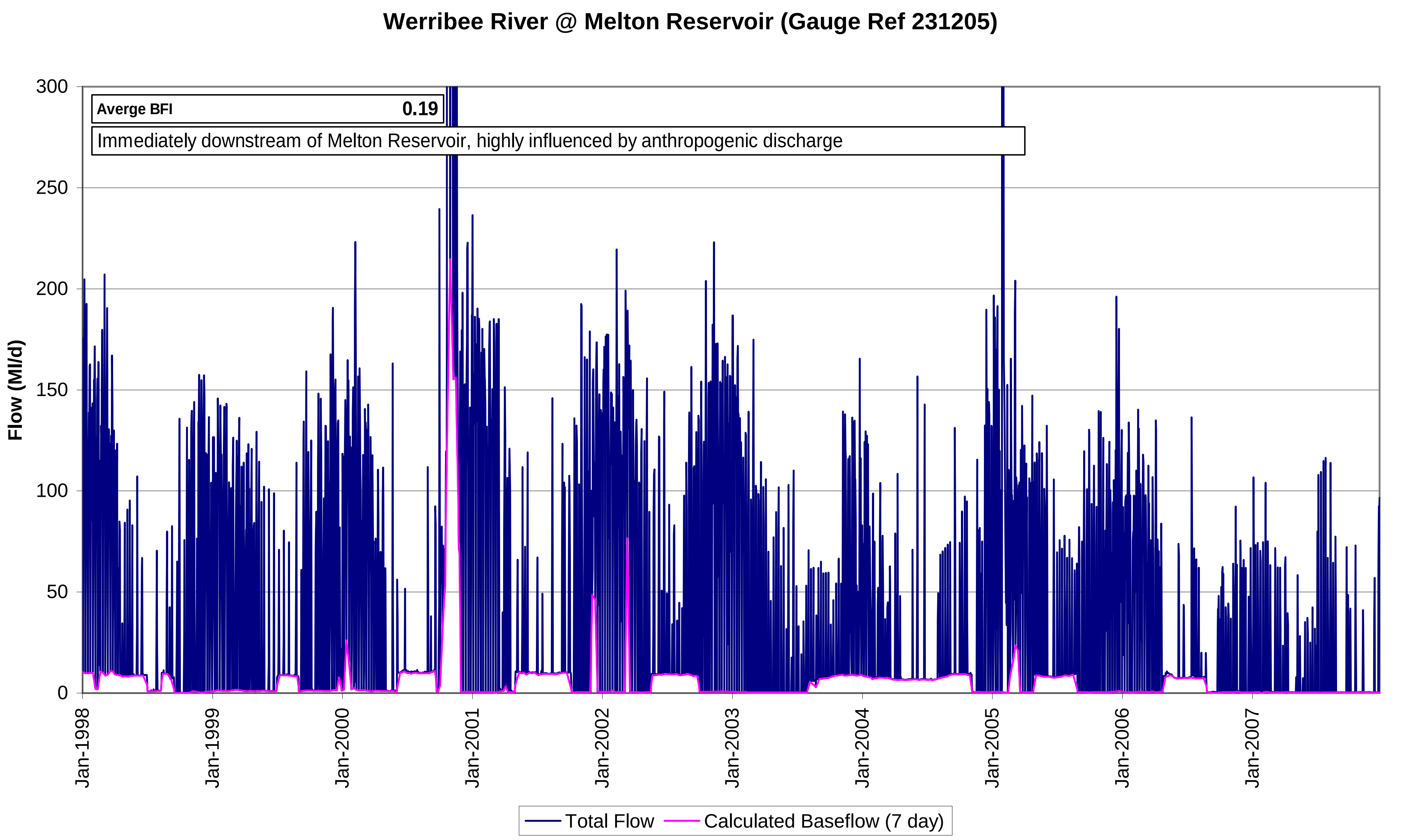

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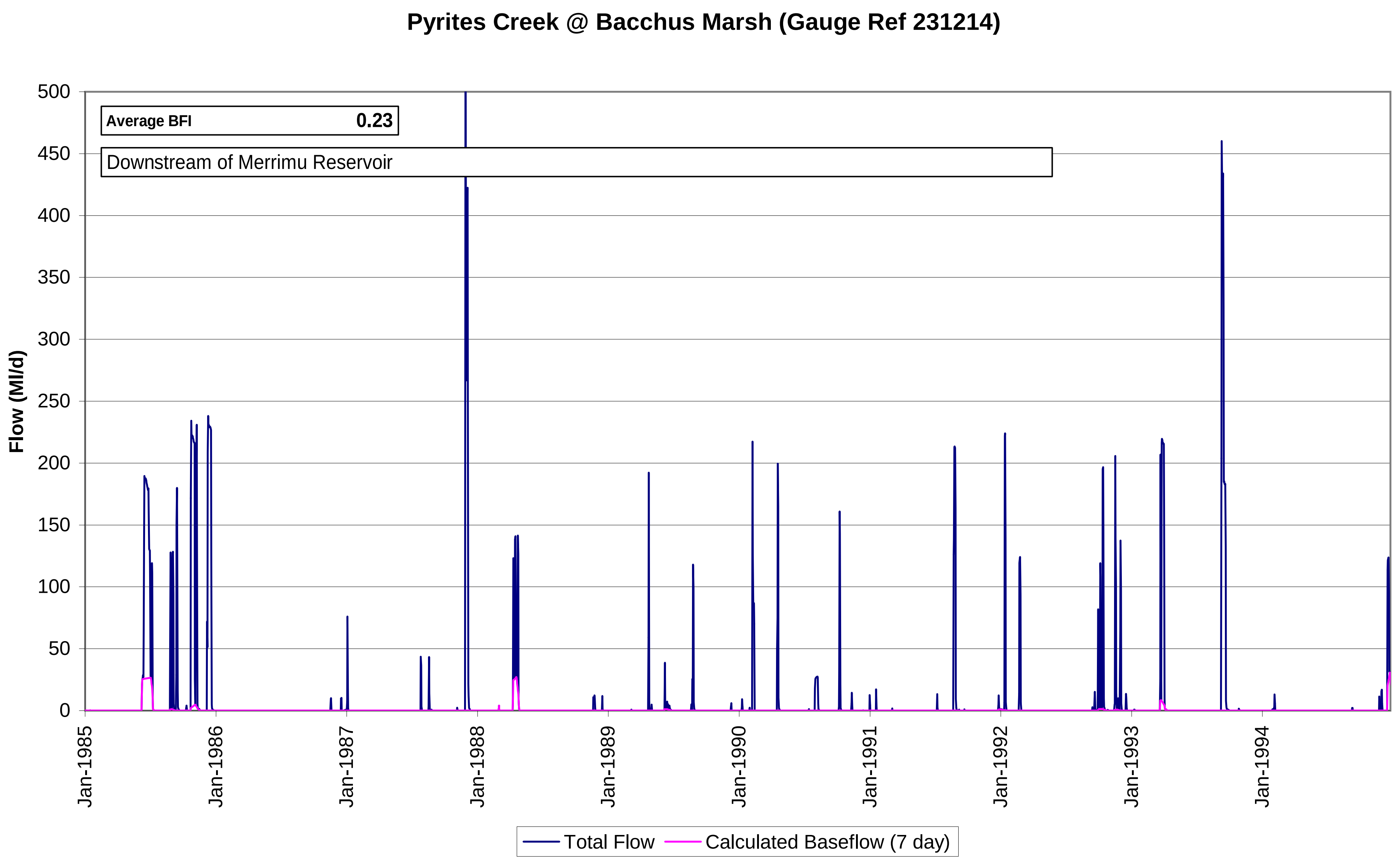

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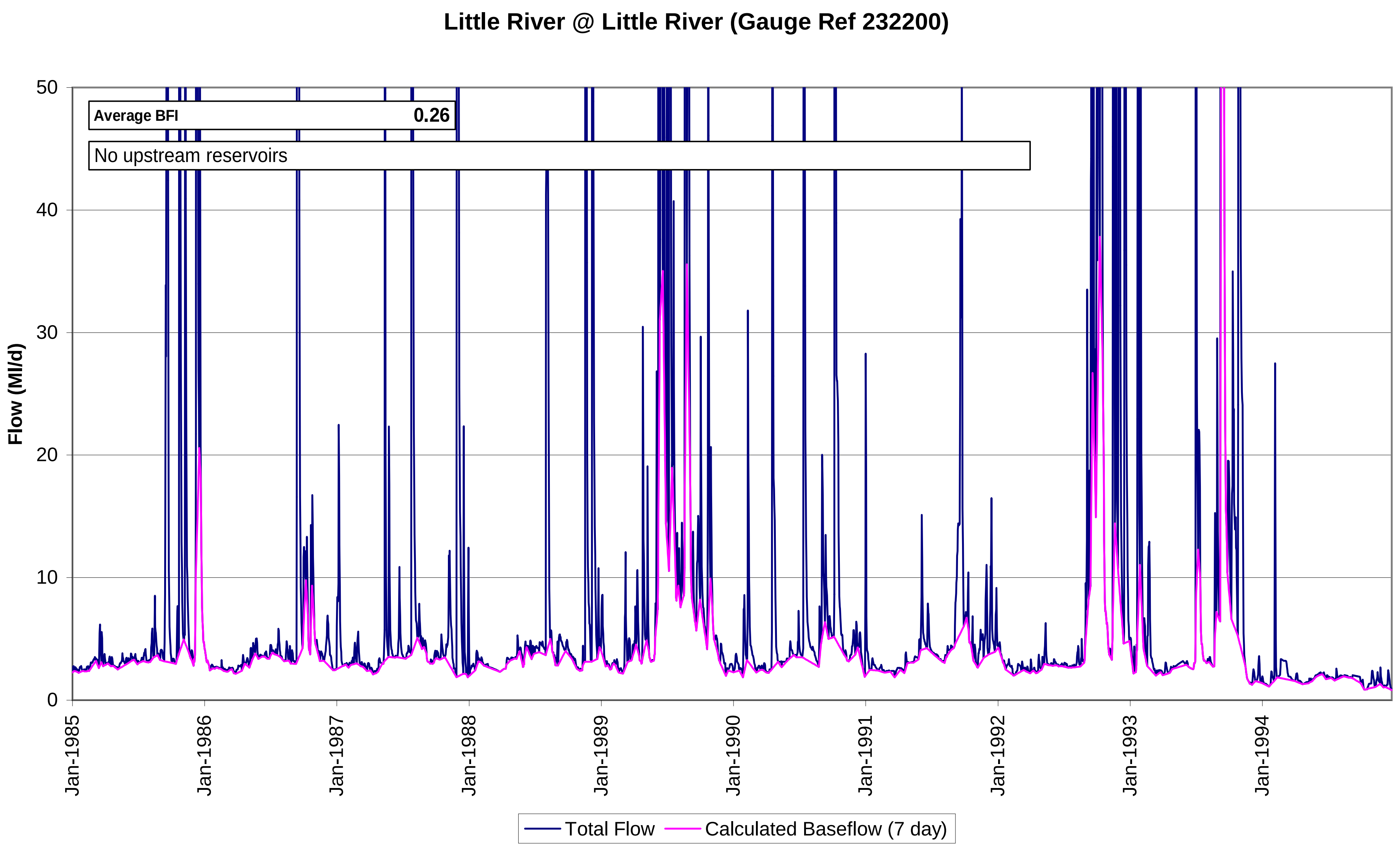

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Appendix B

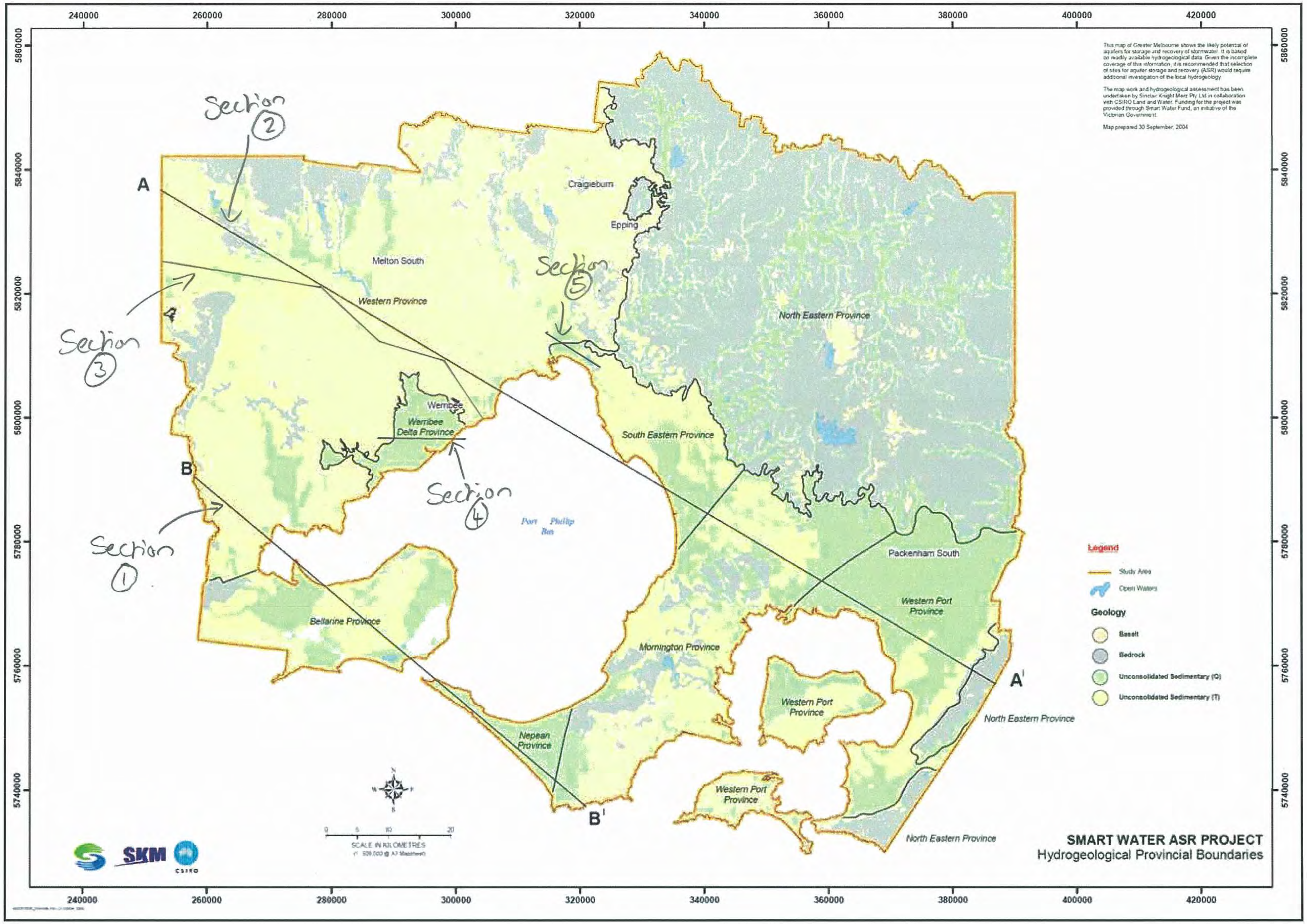
Hydrogeological Cross Sections

Location Map (SKM, 2006)

Section 1	Corio, Bellarine, Nepean and Mornington Peninsulas (SKM, 2006) and Modelled
Section 2	Western Province, Port Phillip Bay West and East, Mornington Peninsula and Koo Wee Rup (SKM, 2006) and Modelled
Section 3	Ballan Graben and Parwan Trough (Holdgate et al, 2002)
Section 4	Port Phillip CMA North
Section 5	Werribee Delta (after Leonard, 1992)
Section 6	Yarra Delta (Leonard, 2003)

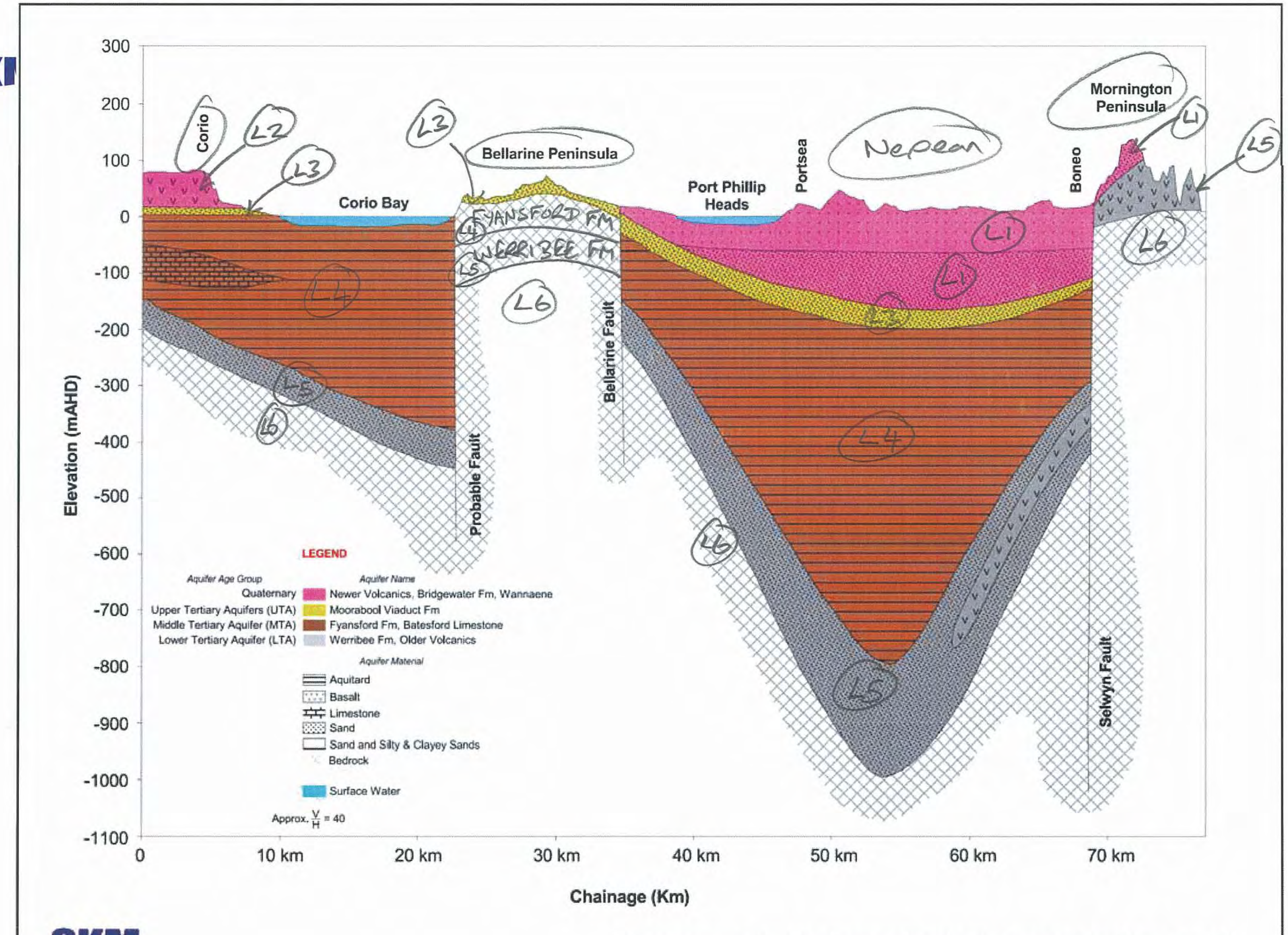
Appendix A Surficial Geology, Provinces, and Geological Sections

- **Figure 1 Geological Provinces**



Section (1)

- **Figure 3 Geological Section B-B'**



Diagrammatic Hydrogeological Cross Section B - B`

(L1) – Recent Alluvium (Bellarine)
– Bridgewater Fm (Nepean + Mornington)
– Wanneaue (Nepean)

(L2) – Newer Volcanic Gp.

(L3) – Brighton Group

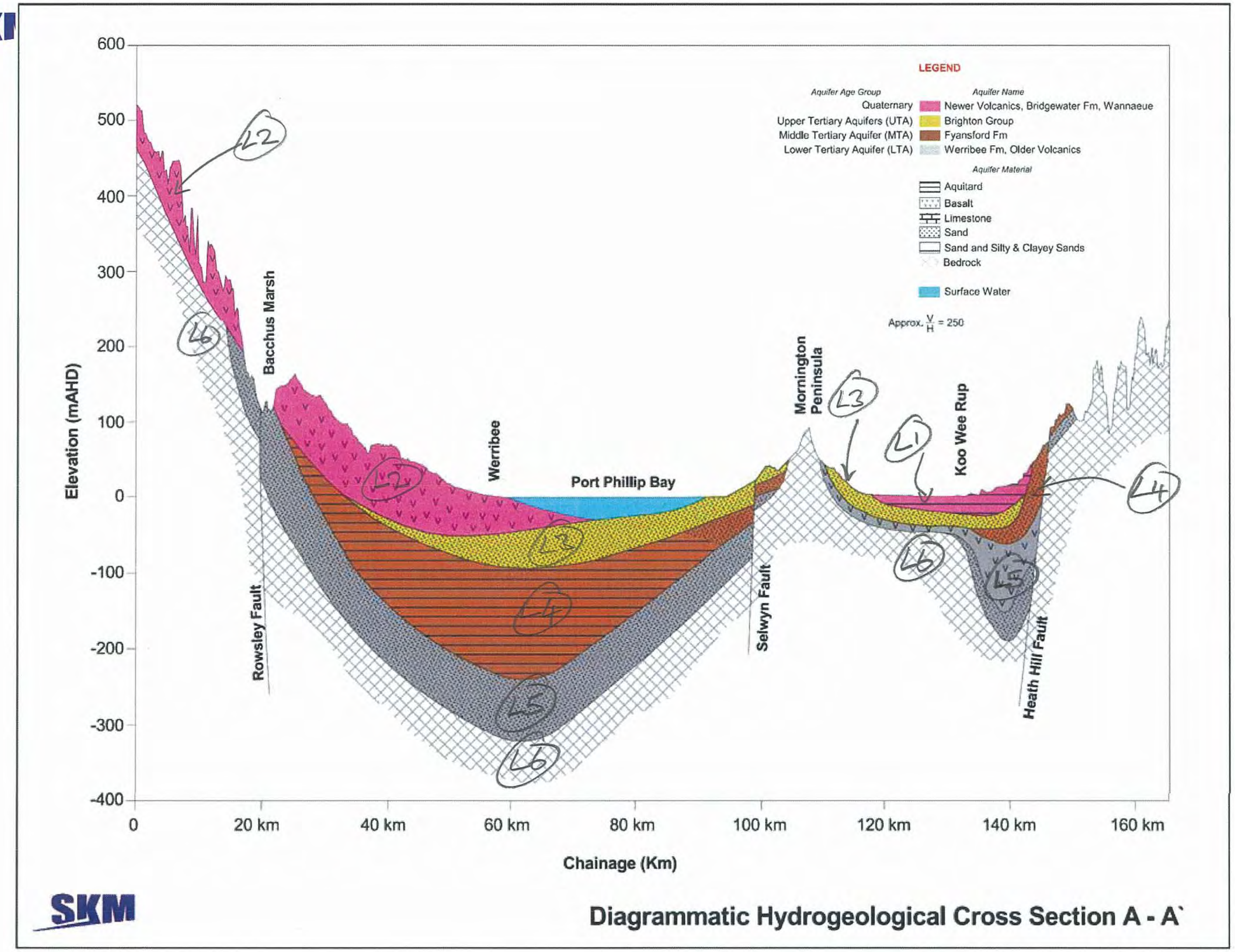
(L4) – Fyansford Fm
Batesford LST (Corio only)

(L5) – Werribee Fm
Older Volcanics

(L6) – Mesozoic Basement.

SECTION (2)

- **Figure 2 Geological Section A-A'**



(L1) – DUNE SAND (Port Phillip + Koo Wee Rup)

Recent Alluvium (Port Phillip)

Heath Hill Silt (Koo Wee Rup)

(L2) – Newer Volcanic Group

(L3) – Brighton Group (Port Phillip)

Baxter Fm (Koo Wee Rup)

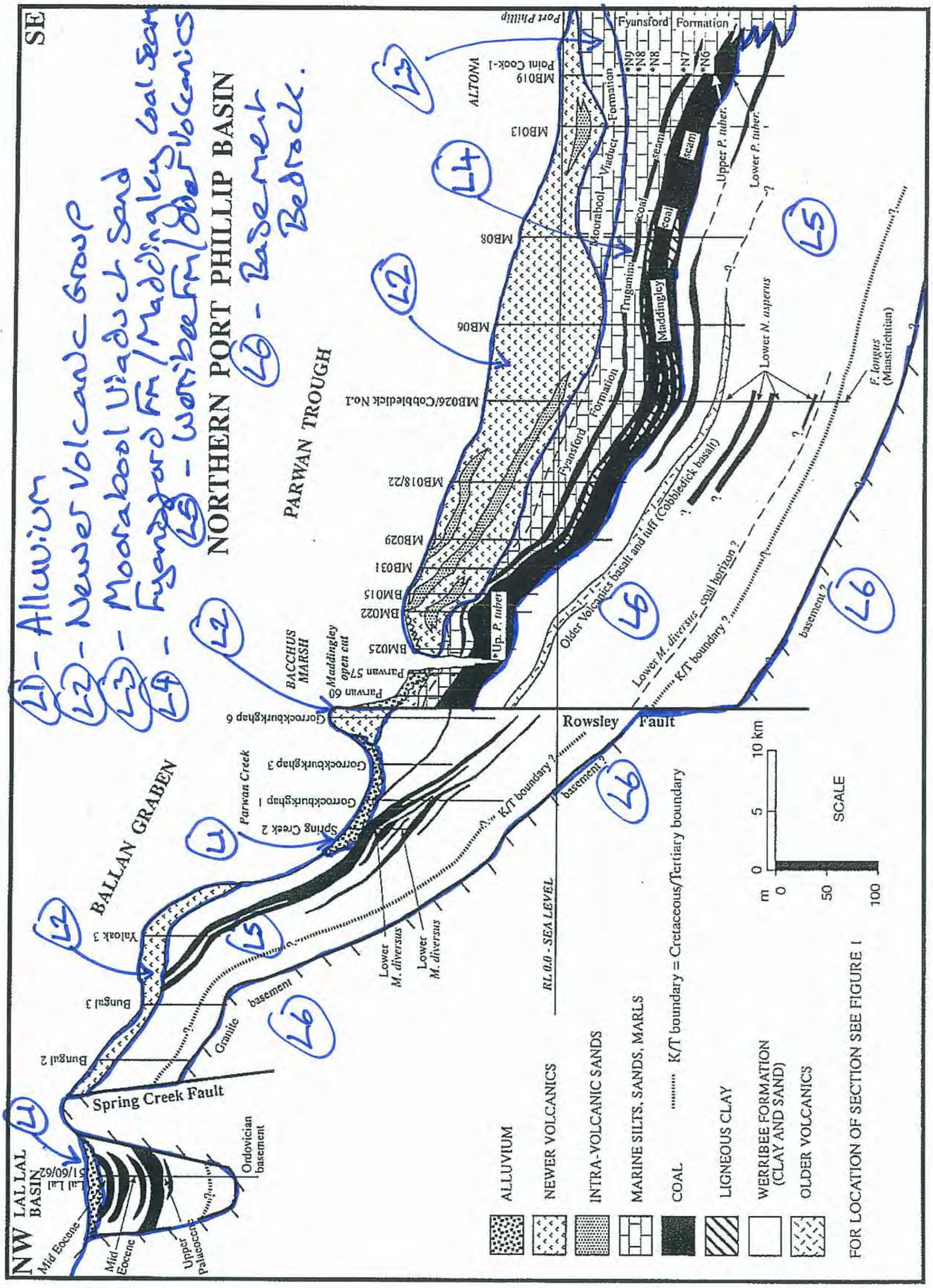
(L4) – Fyansford Fm (Port Phillip)

Yallock/Sherwood Fm (Koo Wee Rup)

(L5) Werribee Fm / Older Volcanics (Port Phillip)

Childers Fm / Older Volcanics (Koo Wee Rup)

(L6) Basement Bedrock.


NW
SE
LAL LAL BASIN
Lal Lal 60/61/62
Mid Eocene
Mid Eocene
Upper Palaeocene
Ordovician basement
Spring Creek Fault
Bungal 2
Bungal 3
Yaloak 3
BALLAN GRABEN
Granite
basement
Lower M. diversus
Lower M. diversus
Spring Creek 2
Parwan Creek
Gorrockburkghap 1
Gorrockburkghap 3
Gorrockburkghap 6
K/T boundary ?
basement ?
RL 0.0 - SEA LEVEL
Rowsley Fault
BACCHUS MARSH
Maddingley open cut
Parwan 60
Parwan 57
BM025
BM022
BM015
MB031
MB029
MB018/22
MB026/Cobbledick No.1
MB06
MB08
MB013
MB019
Point Cook-1
Port Phillip
ALTONA
NORTHERN PORT PHILLIP BASIN
PARWAN TROUGH
Up. P. tuber.
Fyansford Formation
Maddingley
Trugamina
Moorabool Viaduct Formation
coal seam
Upper P. tuber.
Lower P. tuber.
Lower N. asperus
F. longus (Maastrichtian)
Older Volcanics basalt and tuff (Cobbledick basalt)
Lower M. diversus coal horizon ?
K/T boundary ?
basement ?
N9 N8 N8 N7 N6
ALLUVIUM
NEWER VOLCANICS
INTRA-VOLCANIC SANDS
MARINE SILTS, SANDS, MARLS
COAL
K/T boundary = Cretaceous/Tertiary boundary
LIGNEOUS CLAY
WERRIBEE FORMATION (CLAY AND SAND)
OLDER VOLCANICS
FOR LOCATION OF SECTION SEE FIGURE 1
m 0 50 100
0 5 10 km
SCALE

SECTION 3

SECTION (4)

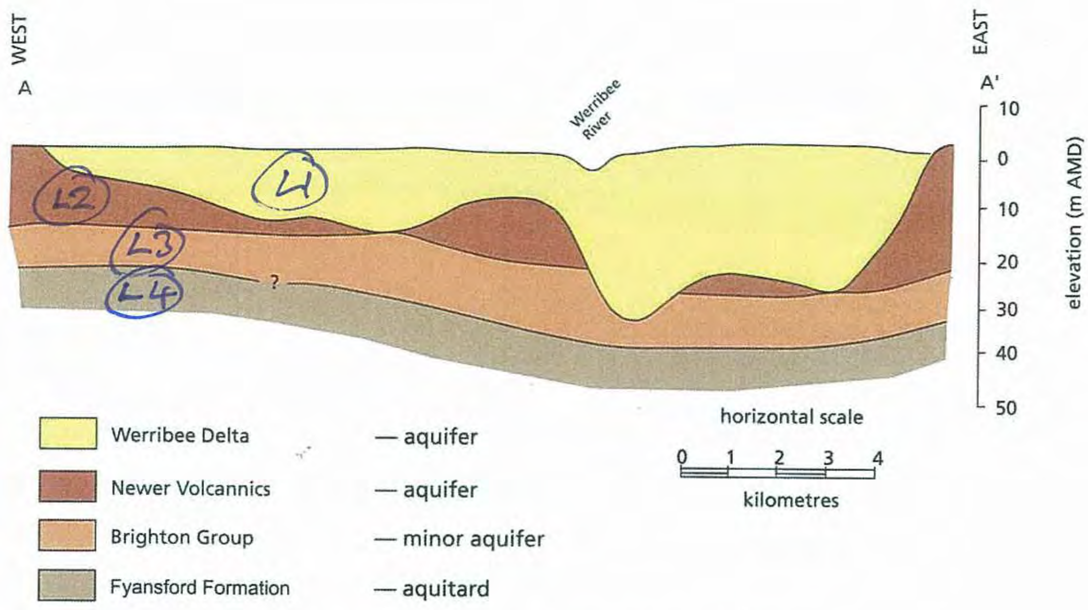


Fig. 17.10: Generalised hydrogeological coastal cross-section of the Werribee Delta, Port Phillip Basin. (after Leornard, 1992b).

SECTION (5)

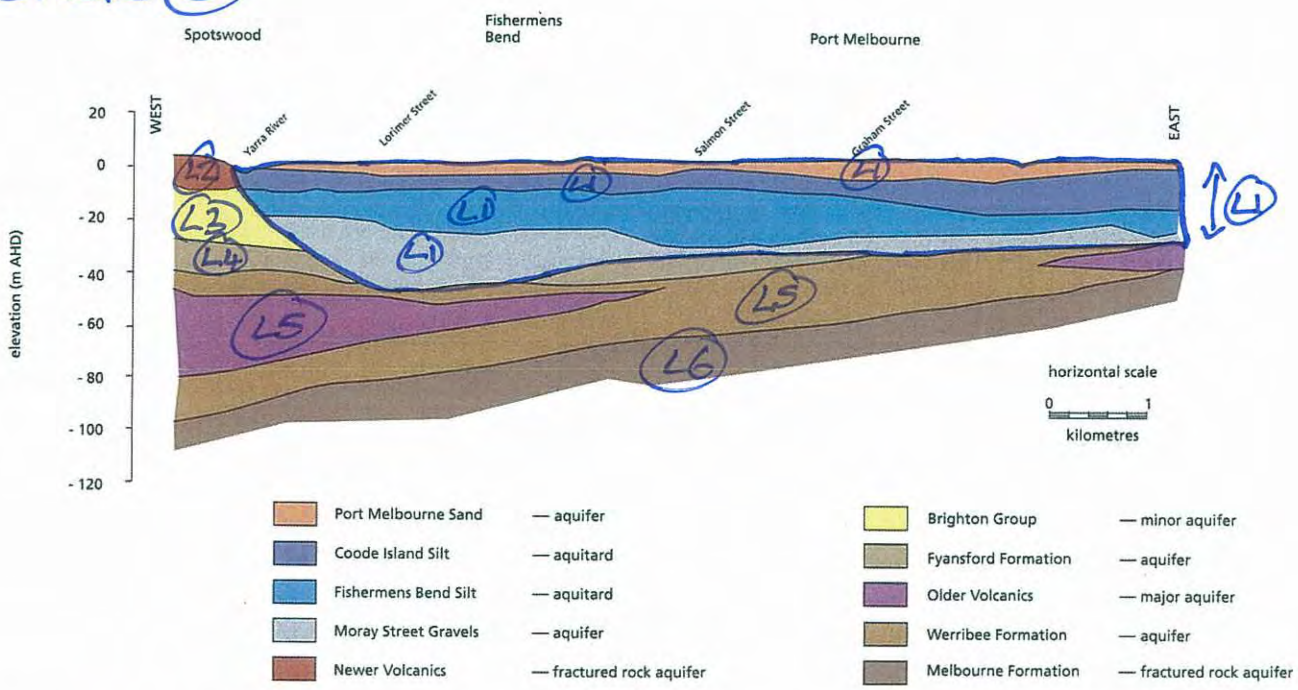
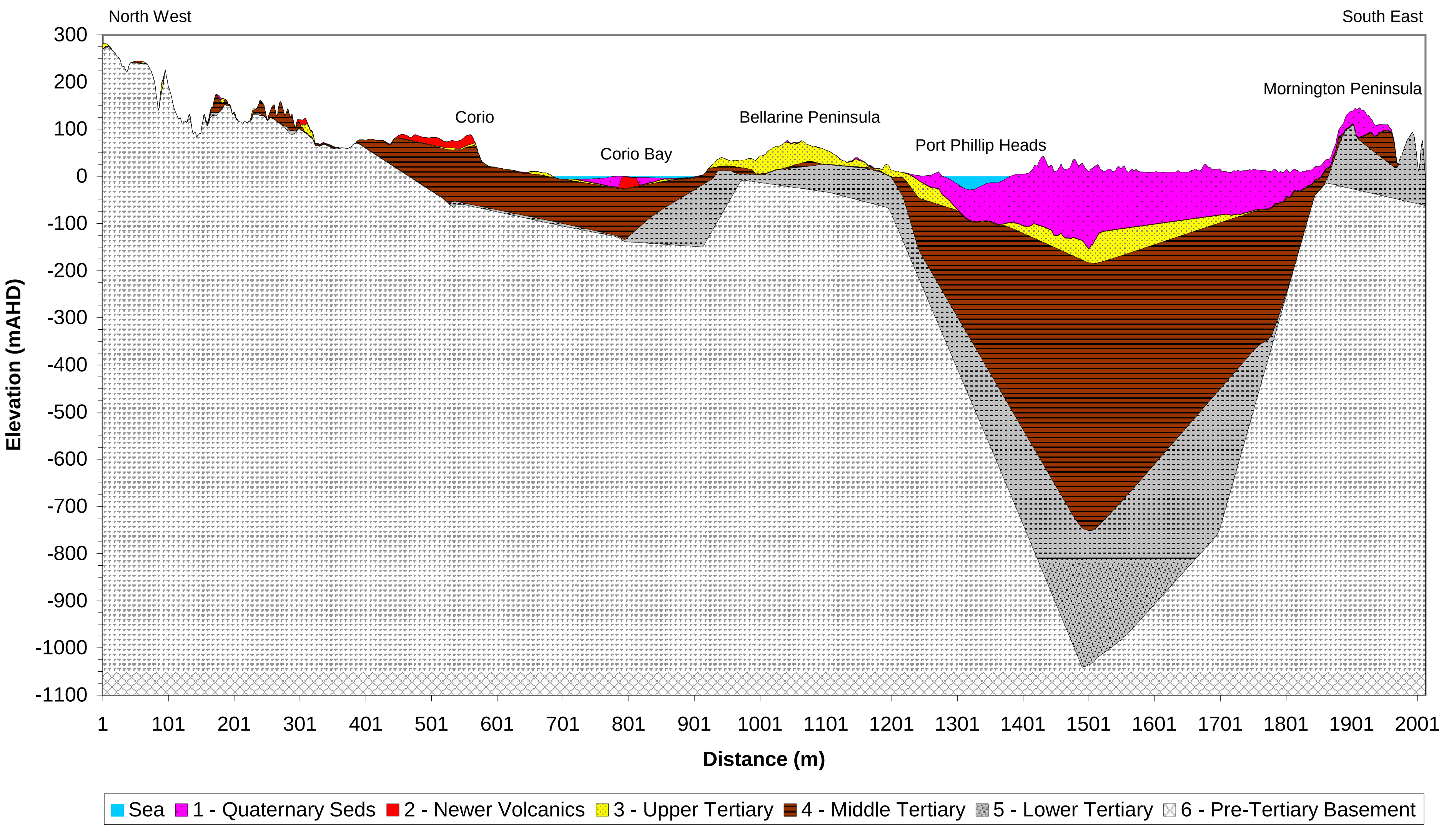


Fig. 17.11: Generalised hydrogeological cross-section of the Yarra Delta, Port Phillip Basin.

Port Phillip Modelled Cross Section, Port Phillip Bay South



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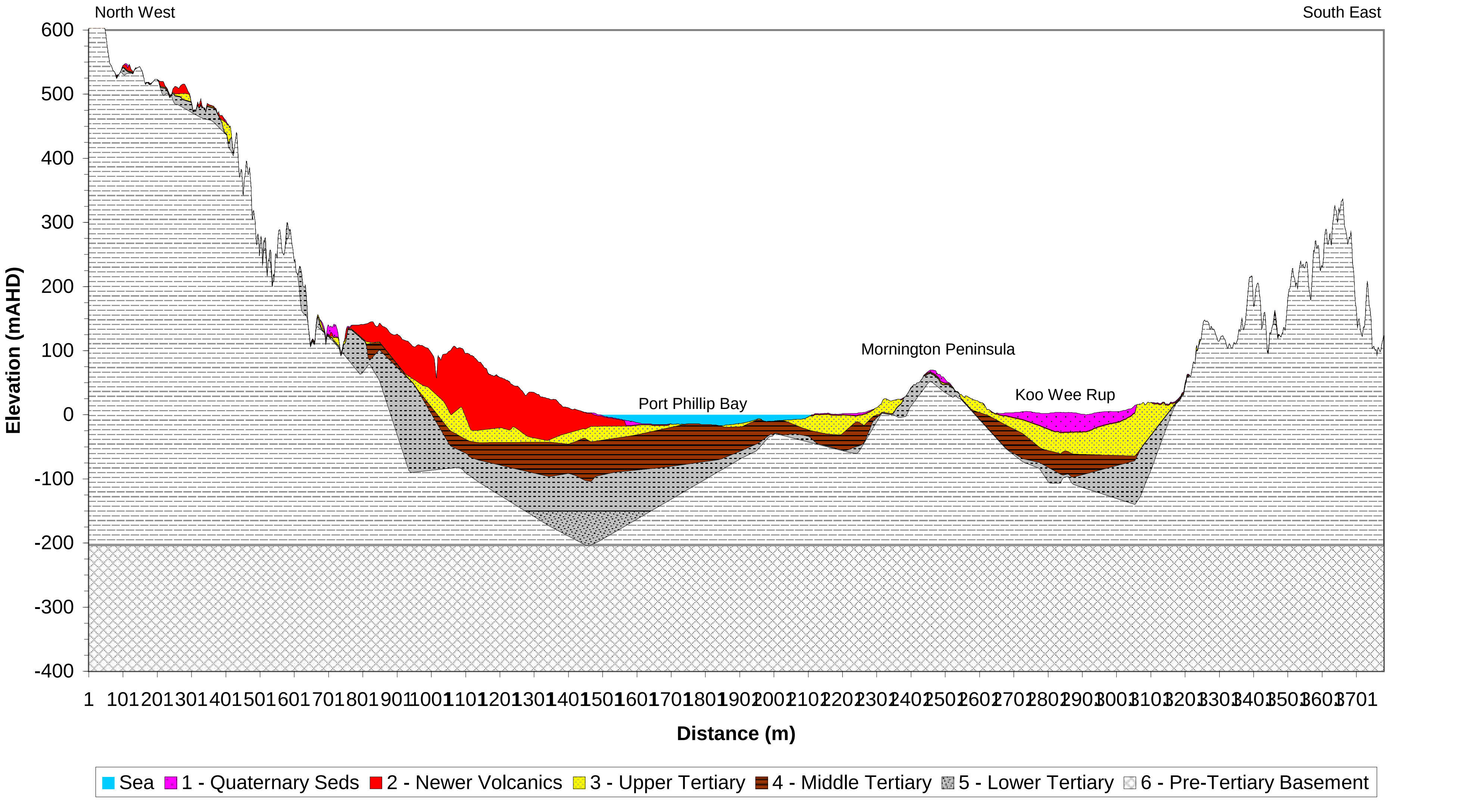
Port Phillip Modelled Cross Section, Port Phillip Bay North



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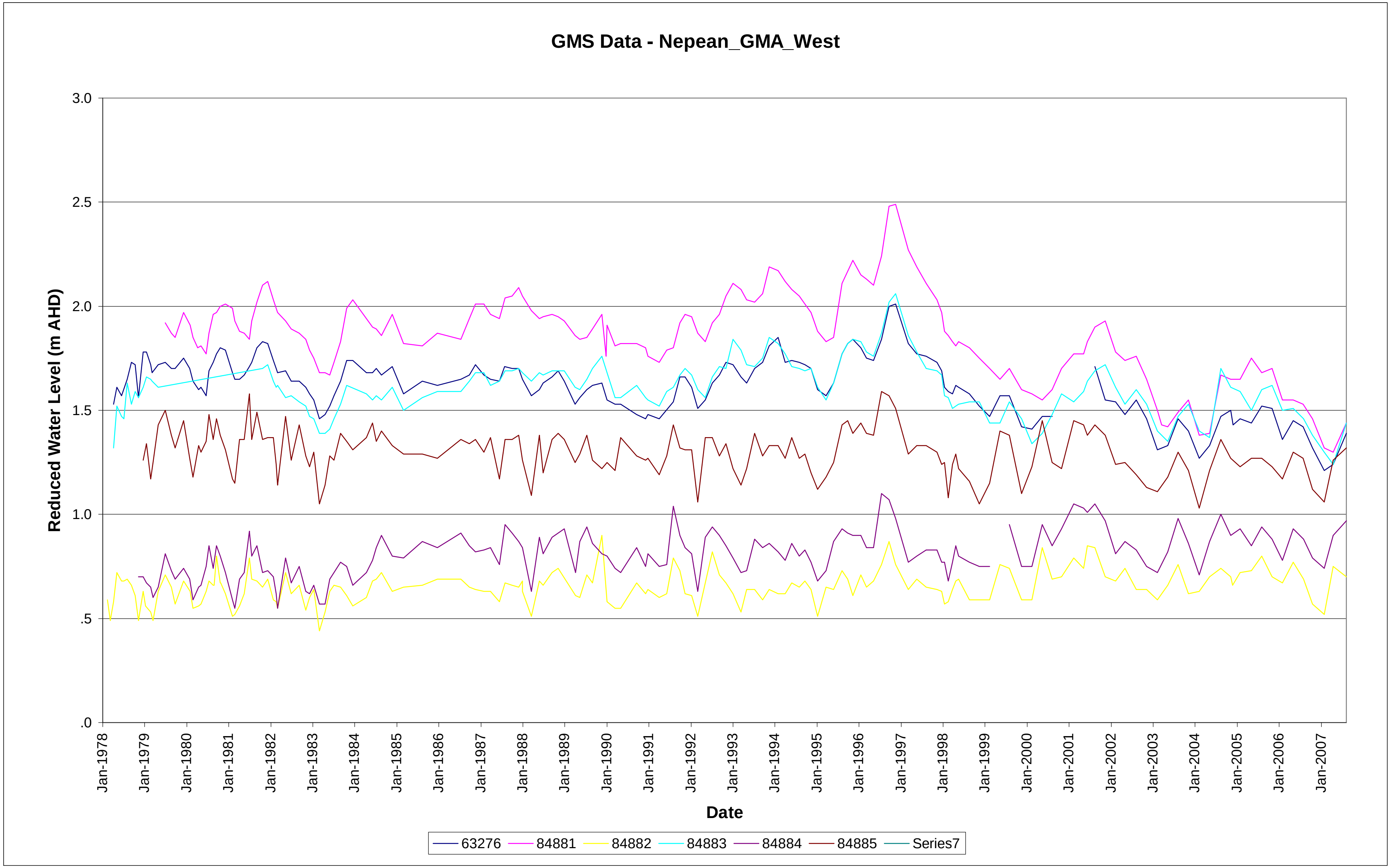
Appendix C

Grouped Groundwater Level Hydrographs



GMS Data - Nepean_GMA_West
Reduced Water Level (m AHD)
3.0
2.5
2.0
1.5
1.0
.5
.0
Jan-1978
Jan-1979
Jan-1980
Jan-1981
Jan-1982
Jan-1983
Jan-1984
Jan-1985
Jan-1986
Jan-1987
Jan-1988
Jan-1989
Jan-1990
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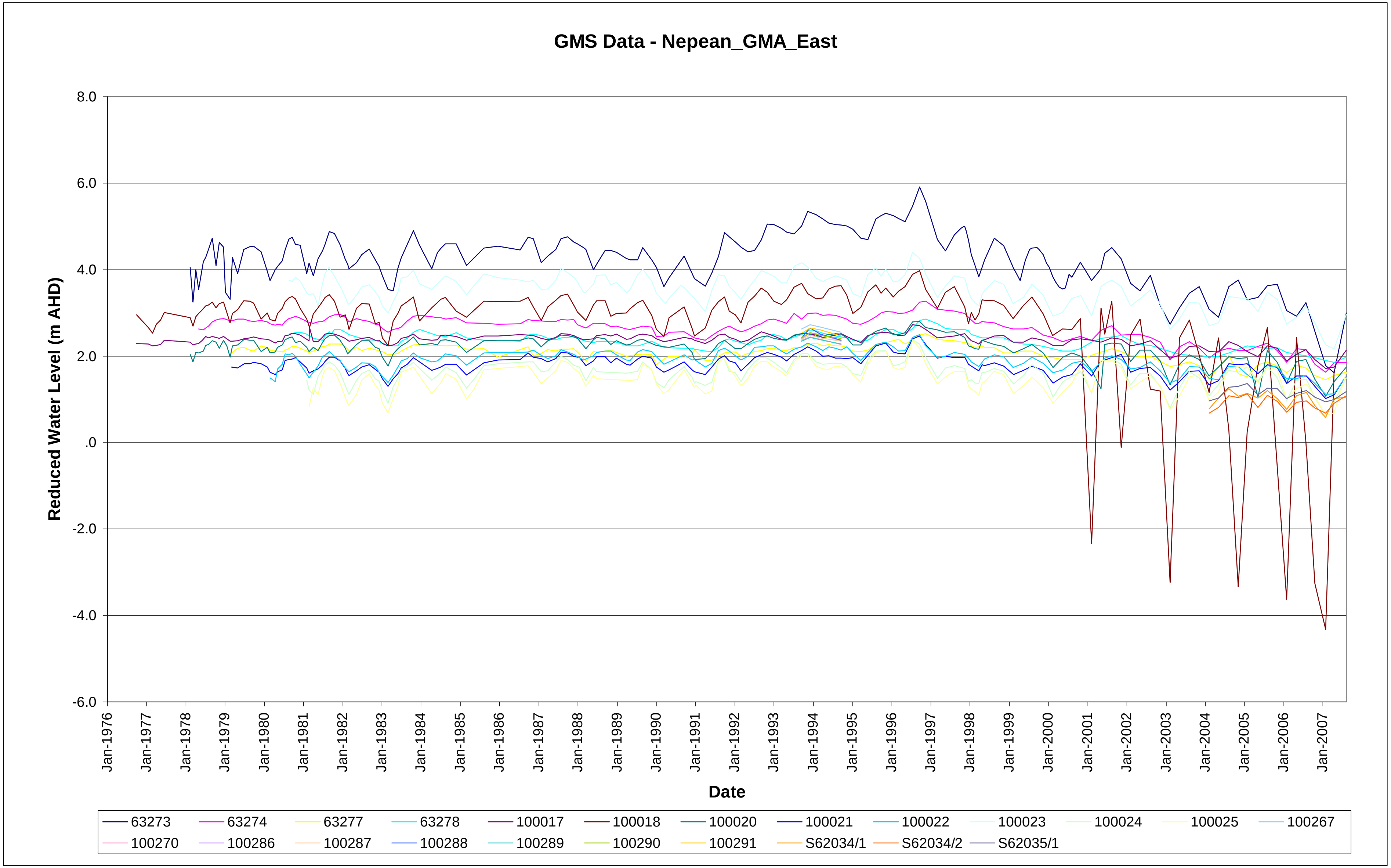
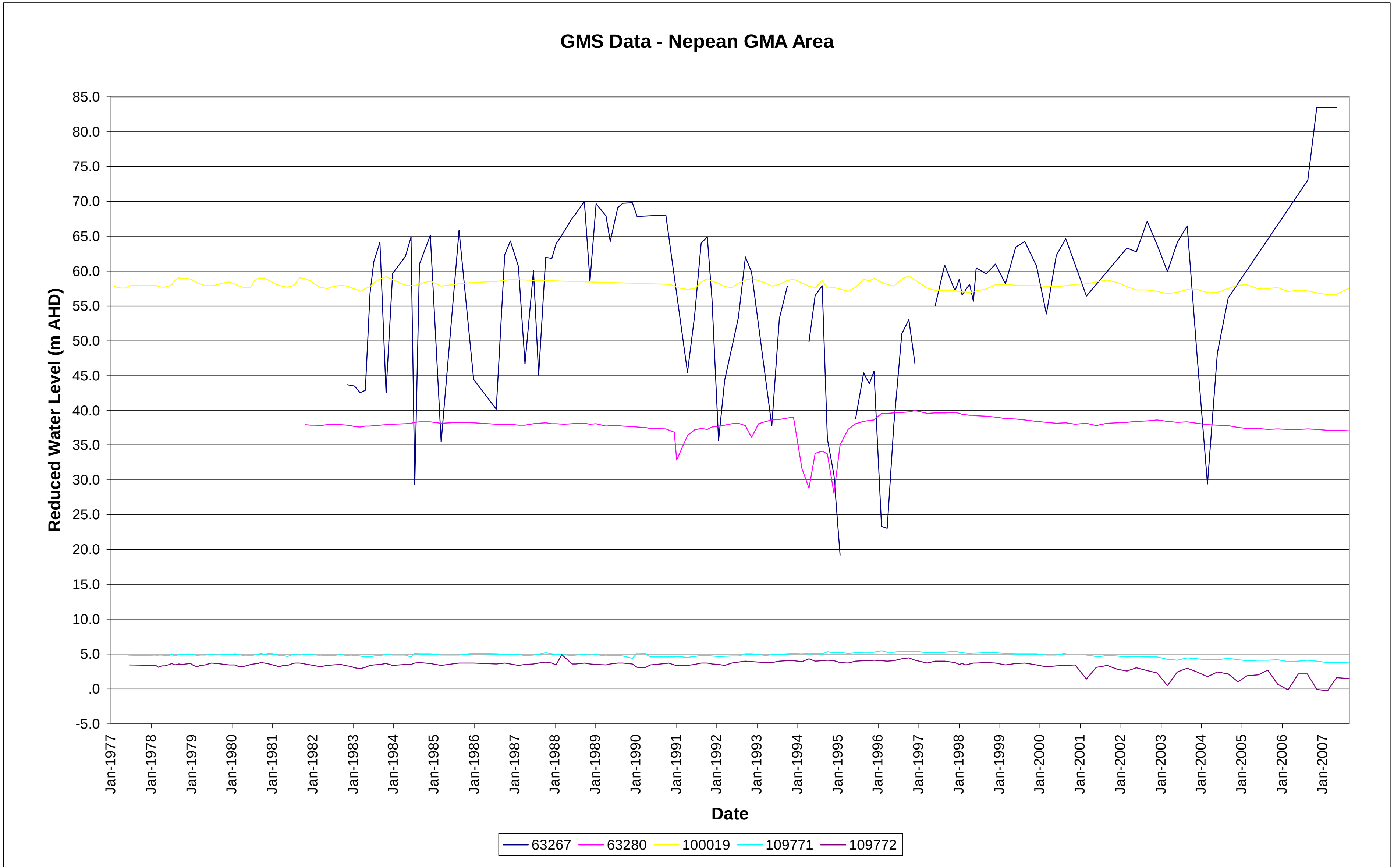
Jan-2002
Jan-2003
Jan-2004
Jan-2005
Jan-2006
Jan-2007
Date
63276
84881
84882
84883
84884
84885
Series7



GMS Data - Nepean_GMA_East
Reduced Water Level (m AHD)
8.0
6.0
4.0
2.0
.0
-2.0
-4.0
-6.0
Jan-1976
Jan-1977
Jan-1978
Jan-1979
Jan-1980
Jan-1981
Jan-1982
Jan-1983
Jan-1984
Jan-1985
Jan-1986
Jan-1987
Jan-1988
Jan-1989
Jan-1990
Jan-1991
Jan-1992
Jan-1993
Jan-1994
Jan-1995
Jan-1996
Jan-1997
Jan-1998
Jan-1999
Jan-2000
Jan-2001
Jan-2002
Jan-2003
Jan-2004
Jan-2005
Jan-2006
Jan-2007
Date
63273
63274
63277
63278
100017
100018
100020
100021
100022
100023
100024
100025
100267
100270
100286
100287
100288
100289
100290
100291
S62034/1
S62034/2
S62035/1



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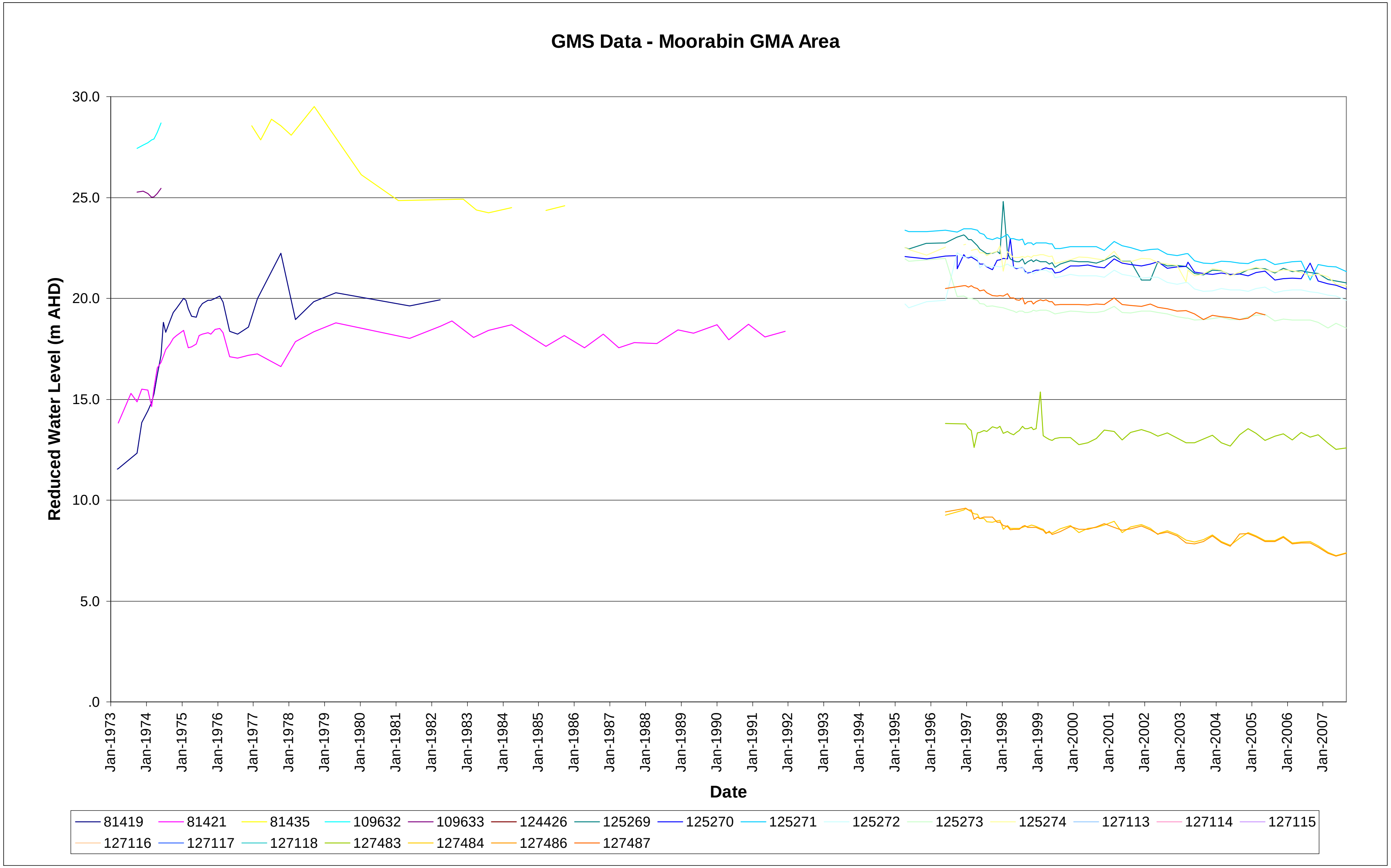
GMS Data - Moorabin GMA Area
30.0
25.0
20.0
15.0
10.0
5.0
.0
Reduced Water Level (m AHD)
Jan-1973
Jan-1974
Jan-1975
Jan-1976
Jan-1977
Jan-1978
Jan-1979
Jan-1980
Jan-1981
Jan-1982
Jan-1983
Jan-1984
Jan-1985
Jan-1986
Jan-1987
Jan-1988
Jan-1989
Jan-1990
Jan-1991
Jan-1992
Jan-1993
Jan-1994
Jan-1995
Jan-1996
Jan-1997
Jan-1998
Jan-1999
Jan-2000
Jan-2001
Jan-2002
Jan-2003
Jan-2004
Jan-2005
Jan-2006
Jan-2007
Date
81419
81421
81435
109632
109633
124426
125269
125270
125271
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125273
125274
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127115
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127117
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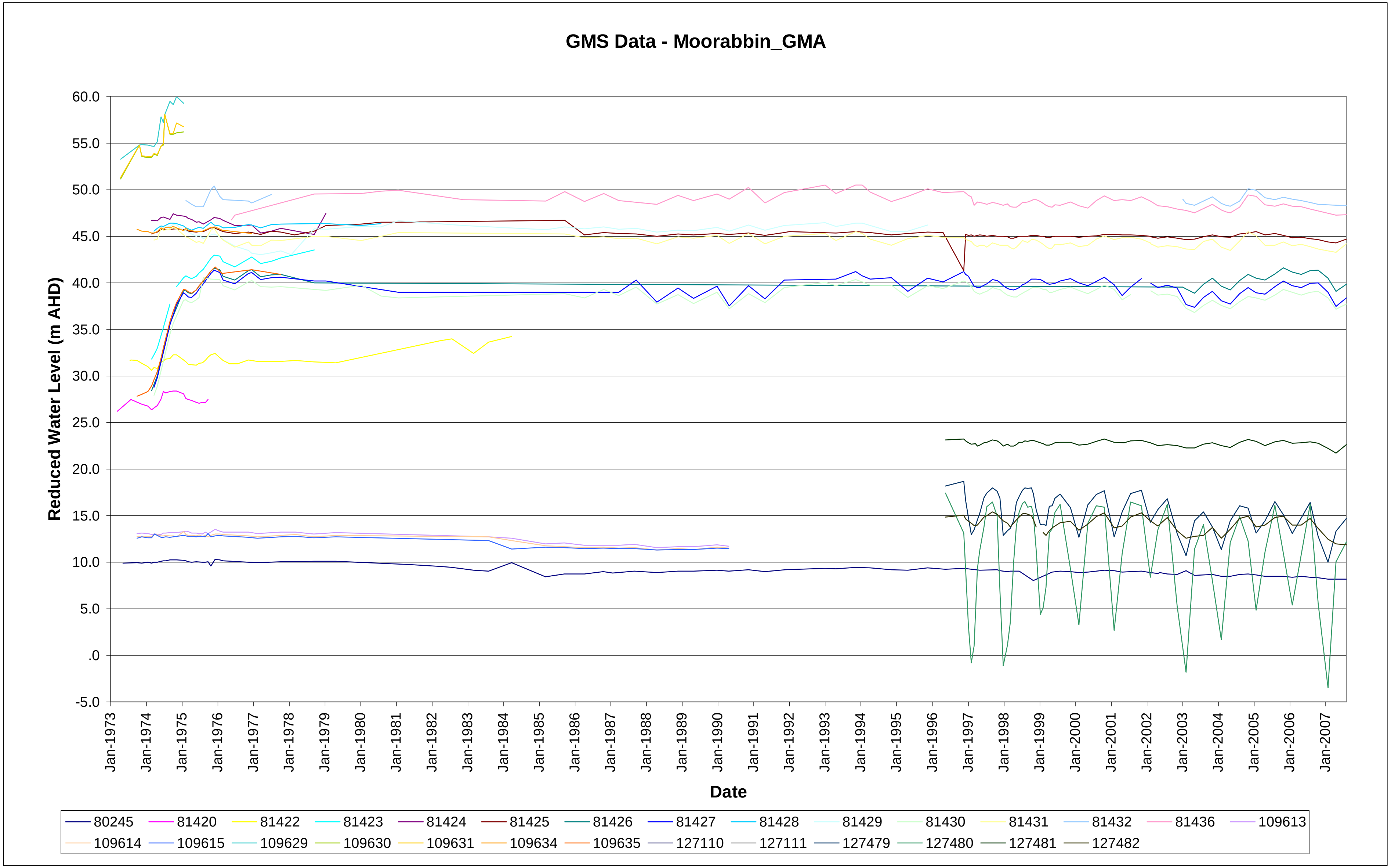
127484
127486
127487



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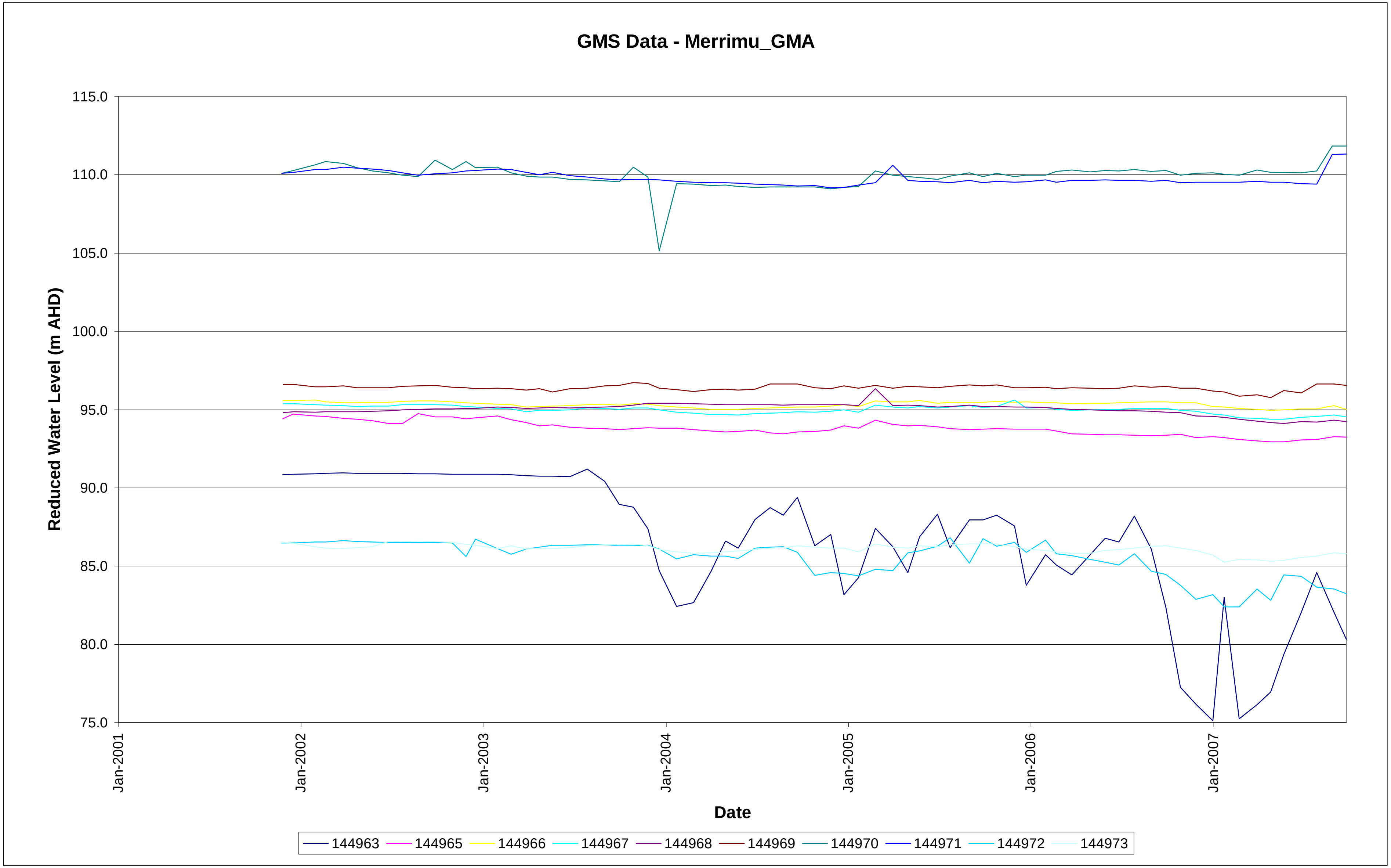

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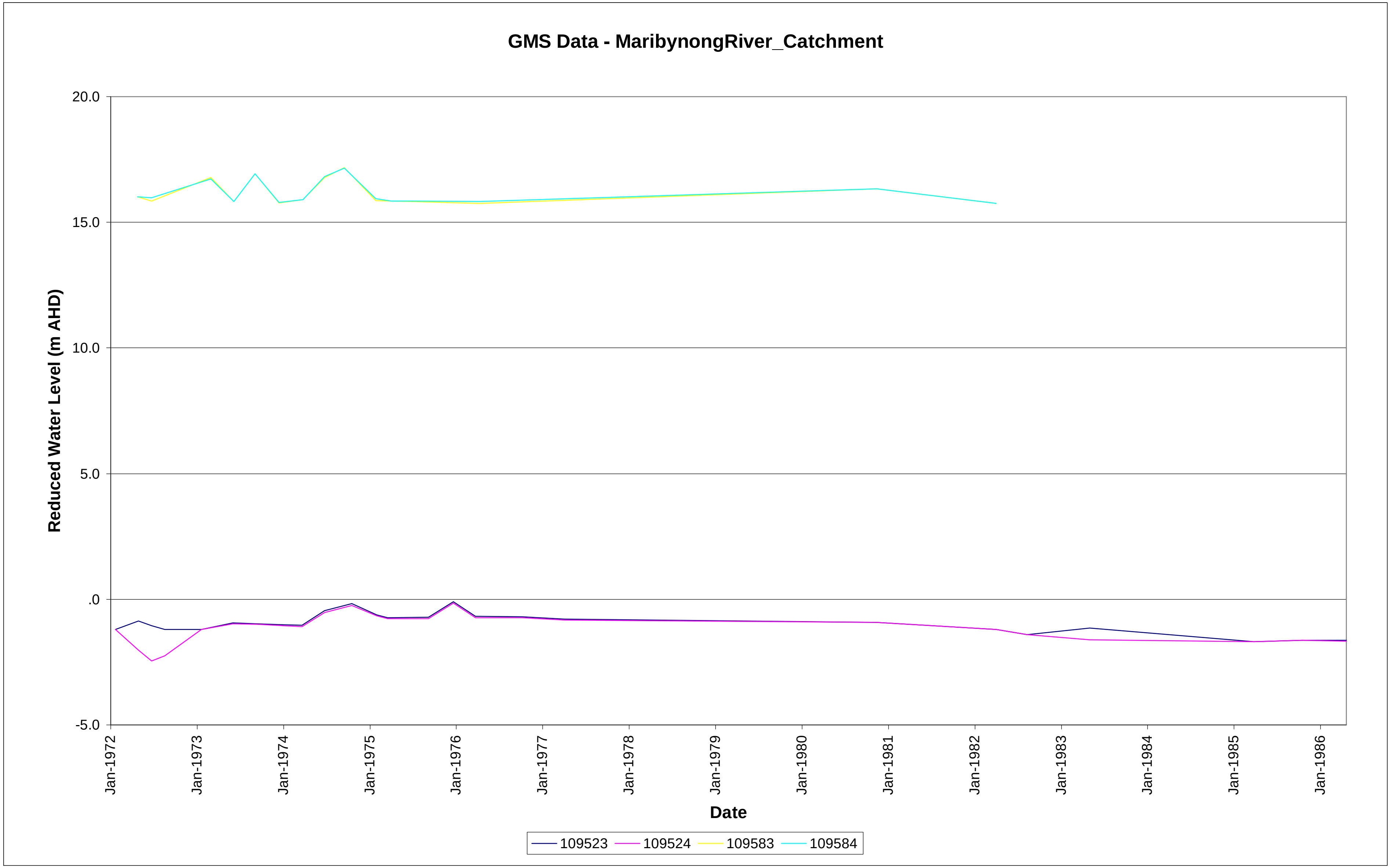

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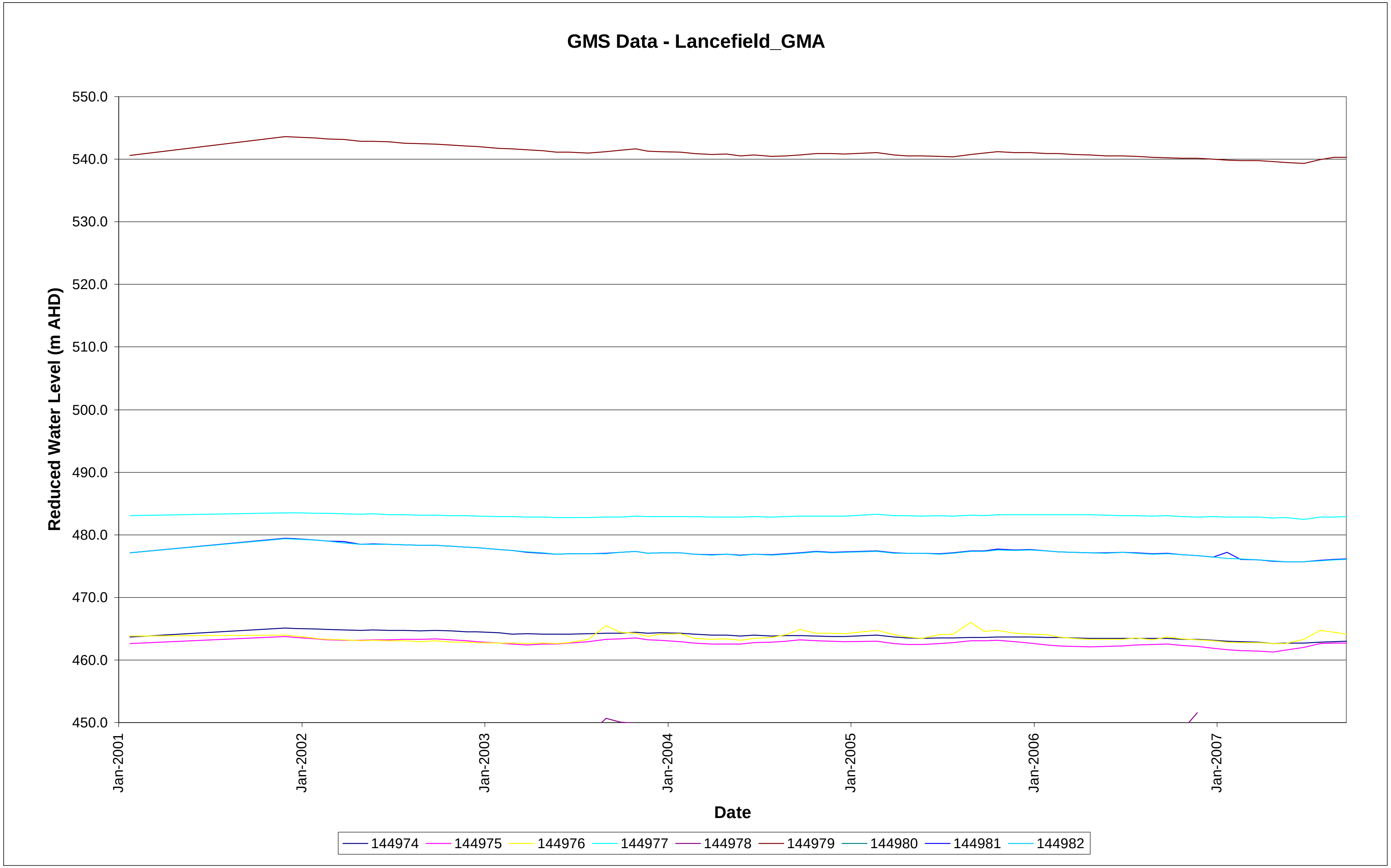

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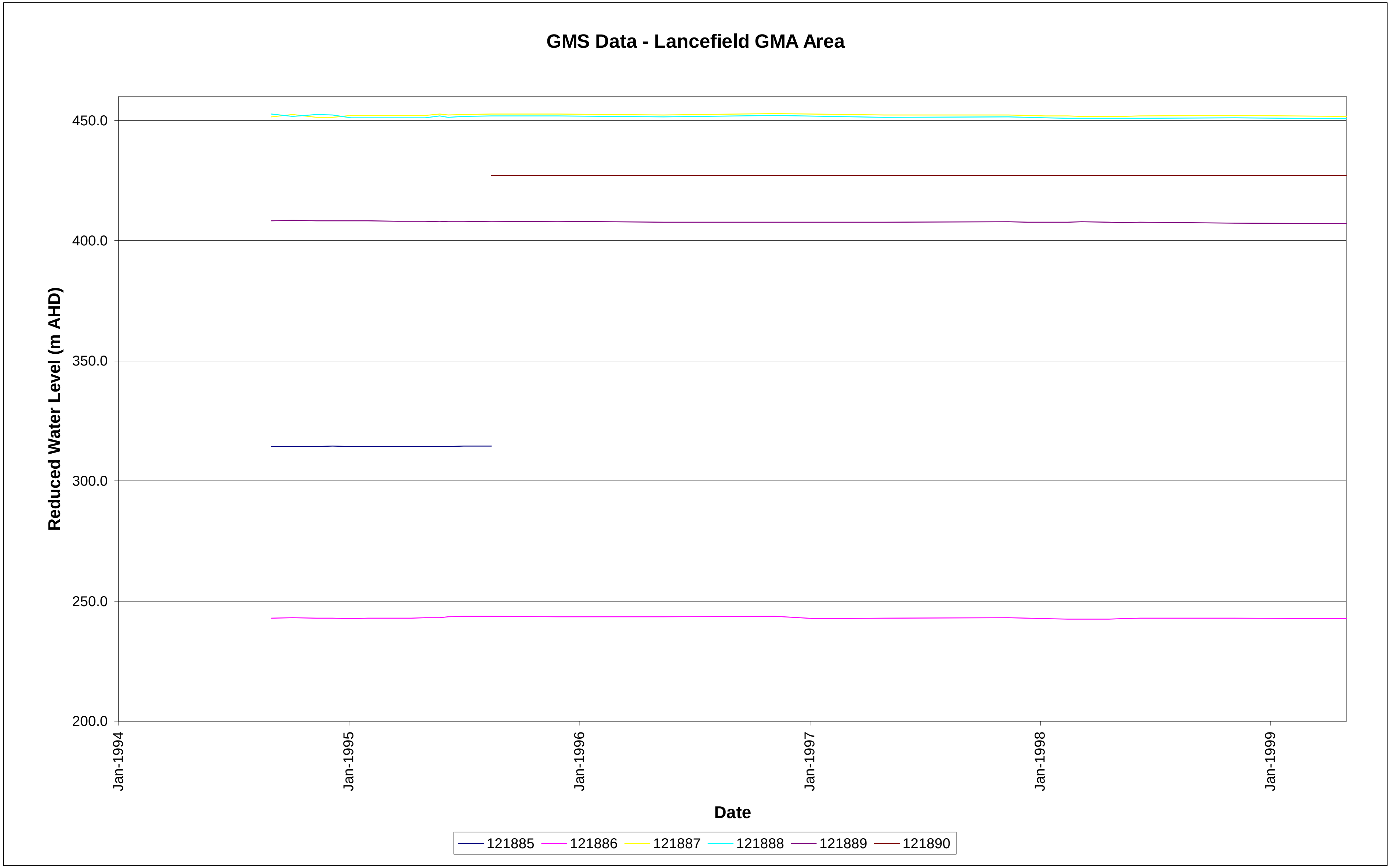

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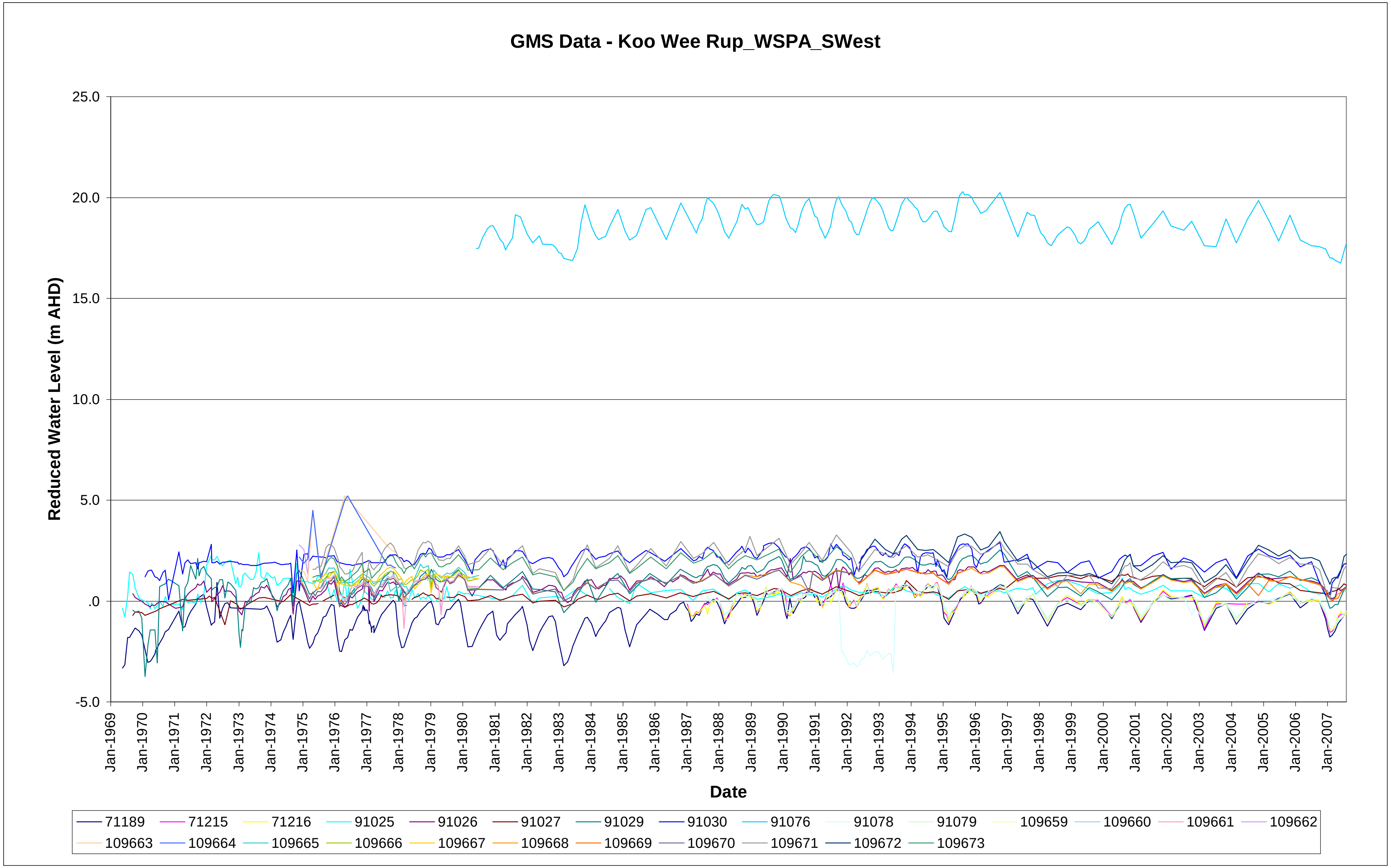

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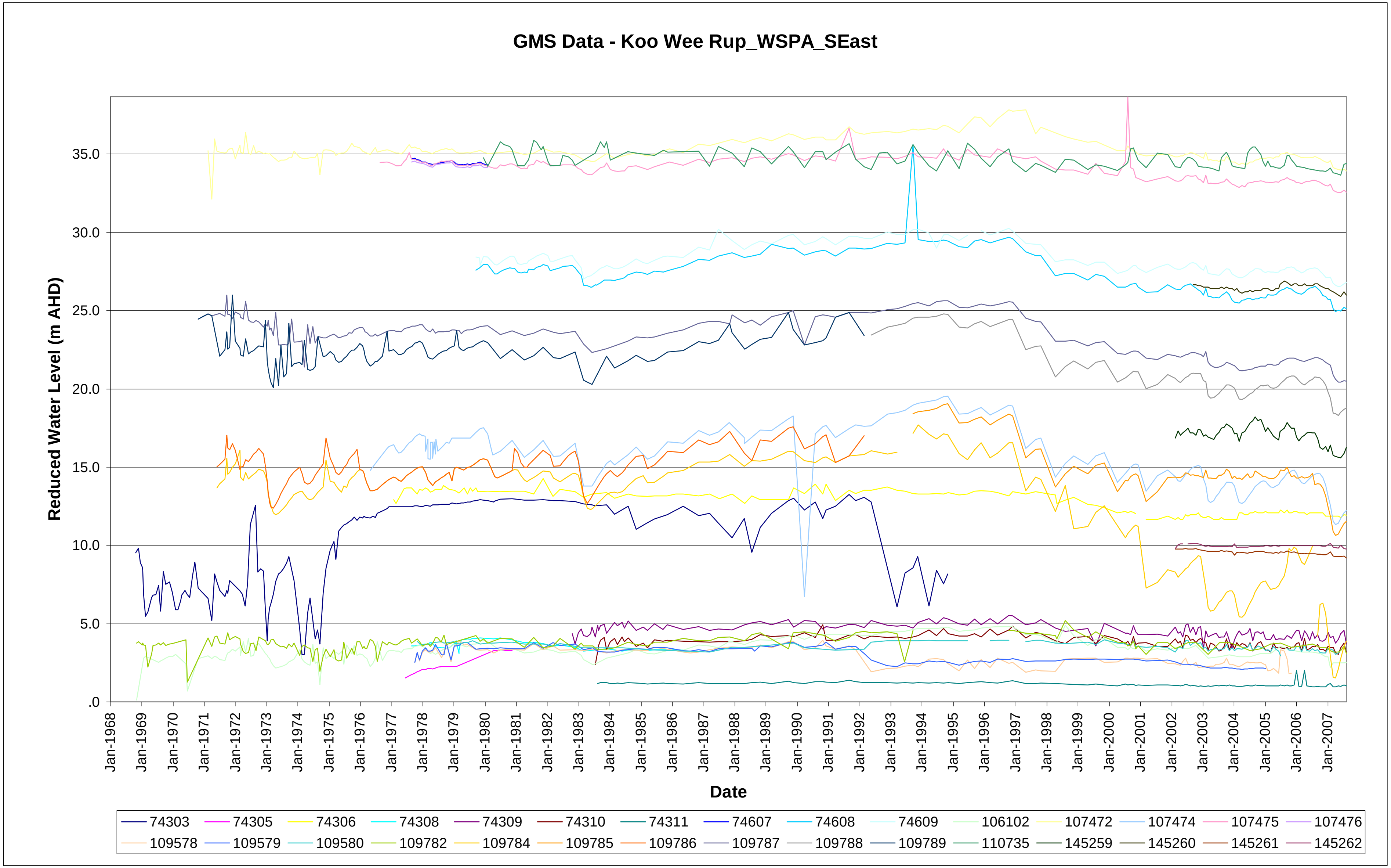

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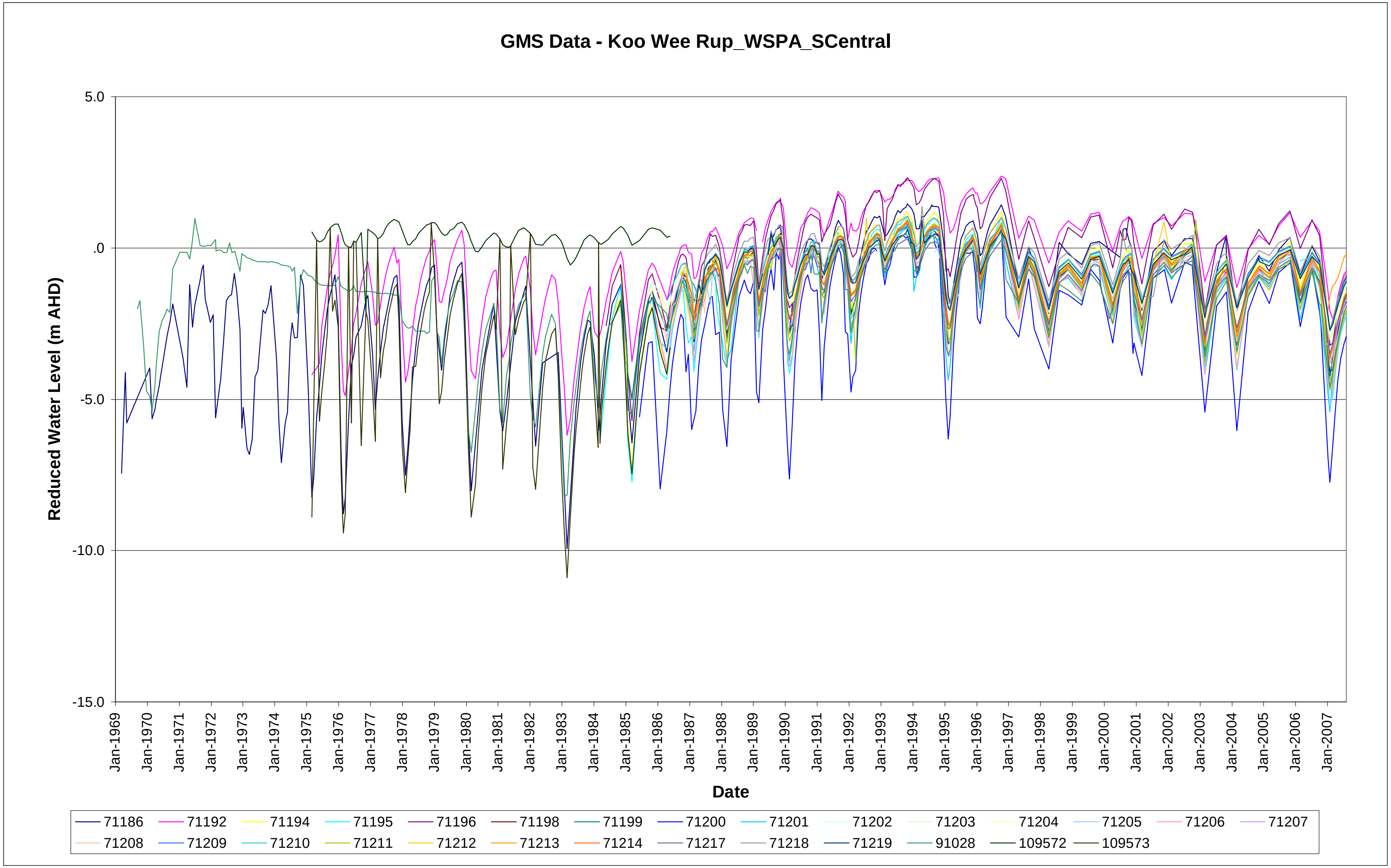

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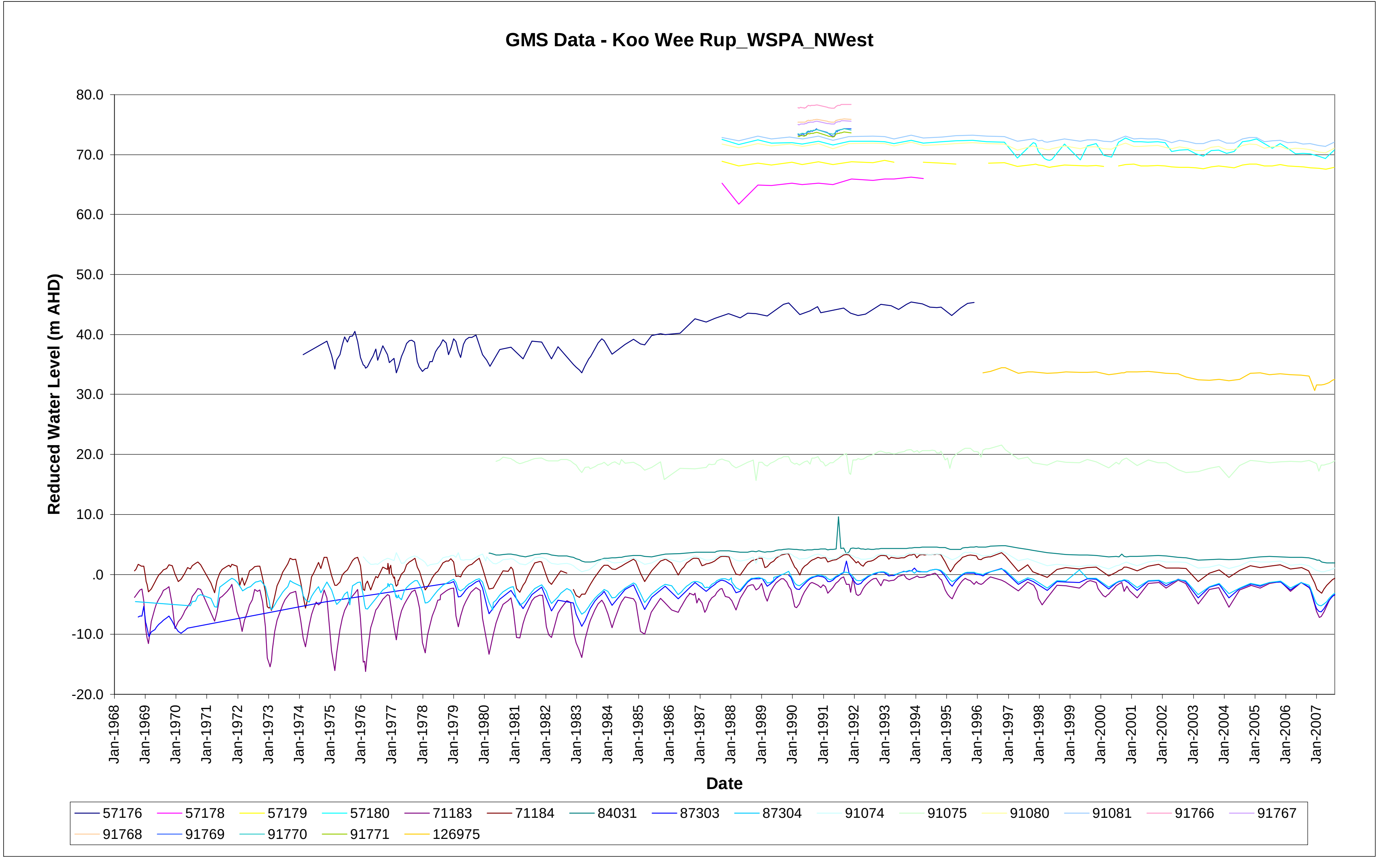

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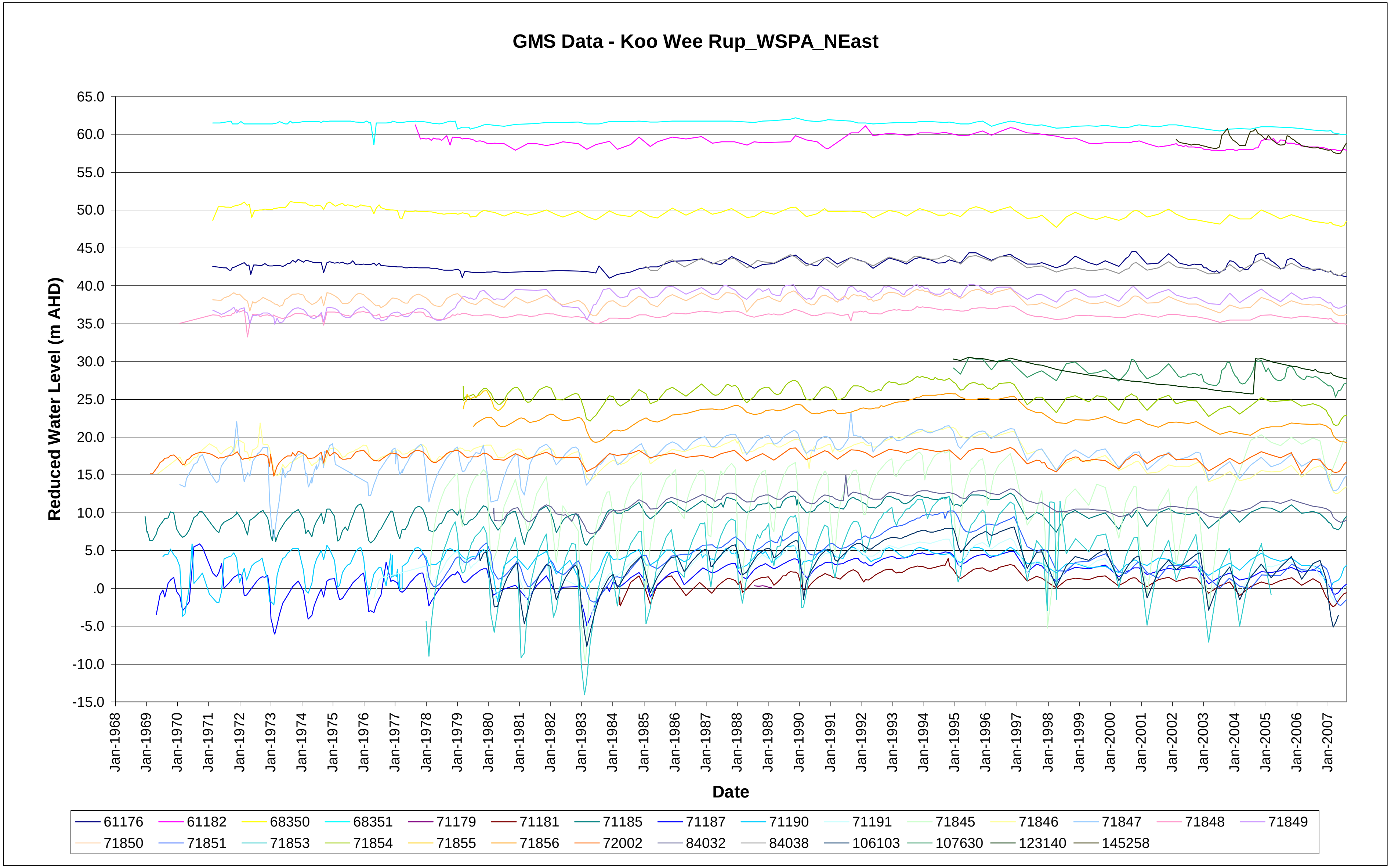

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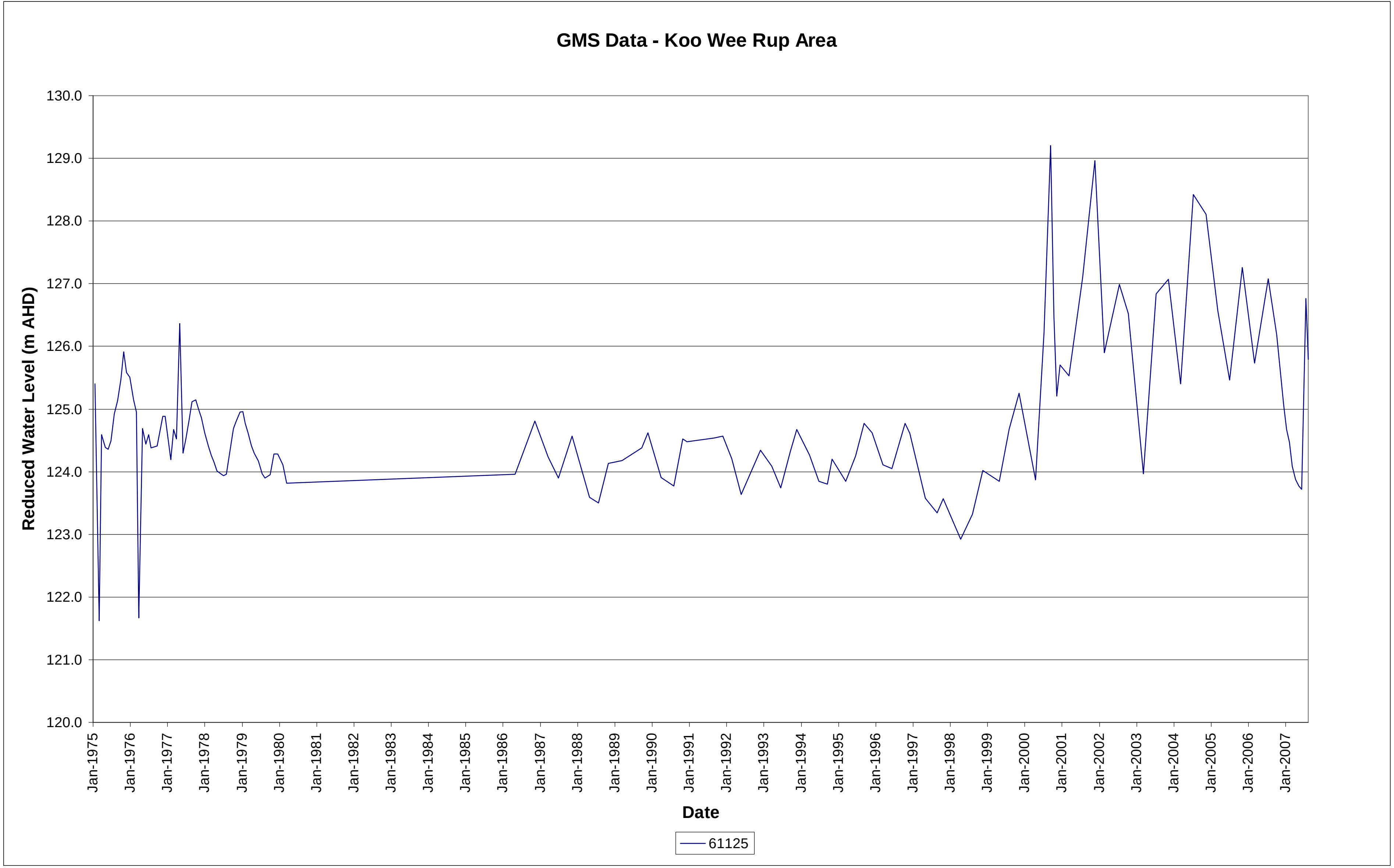

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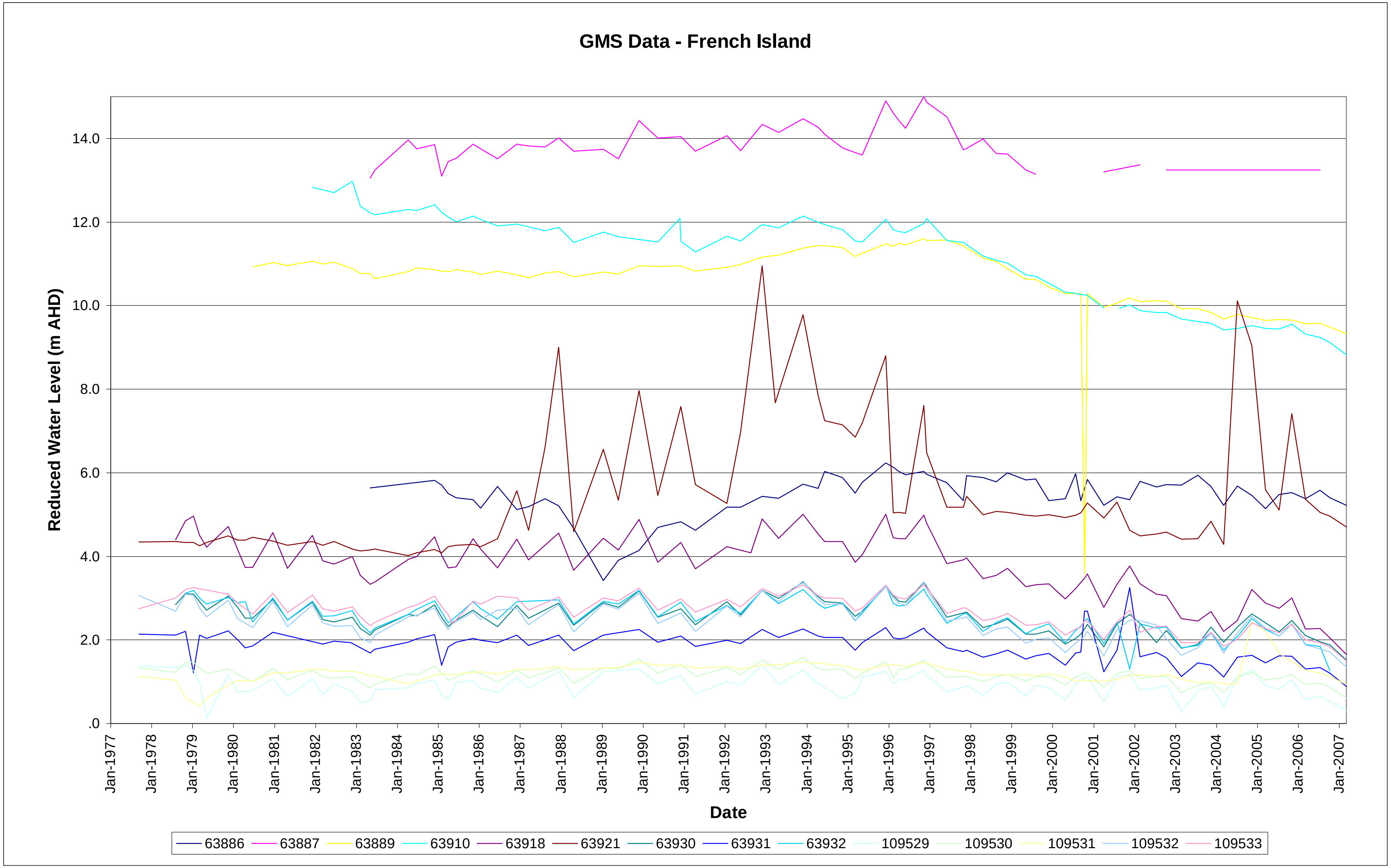

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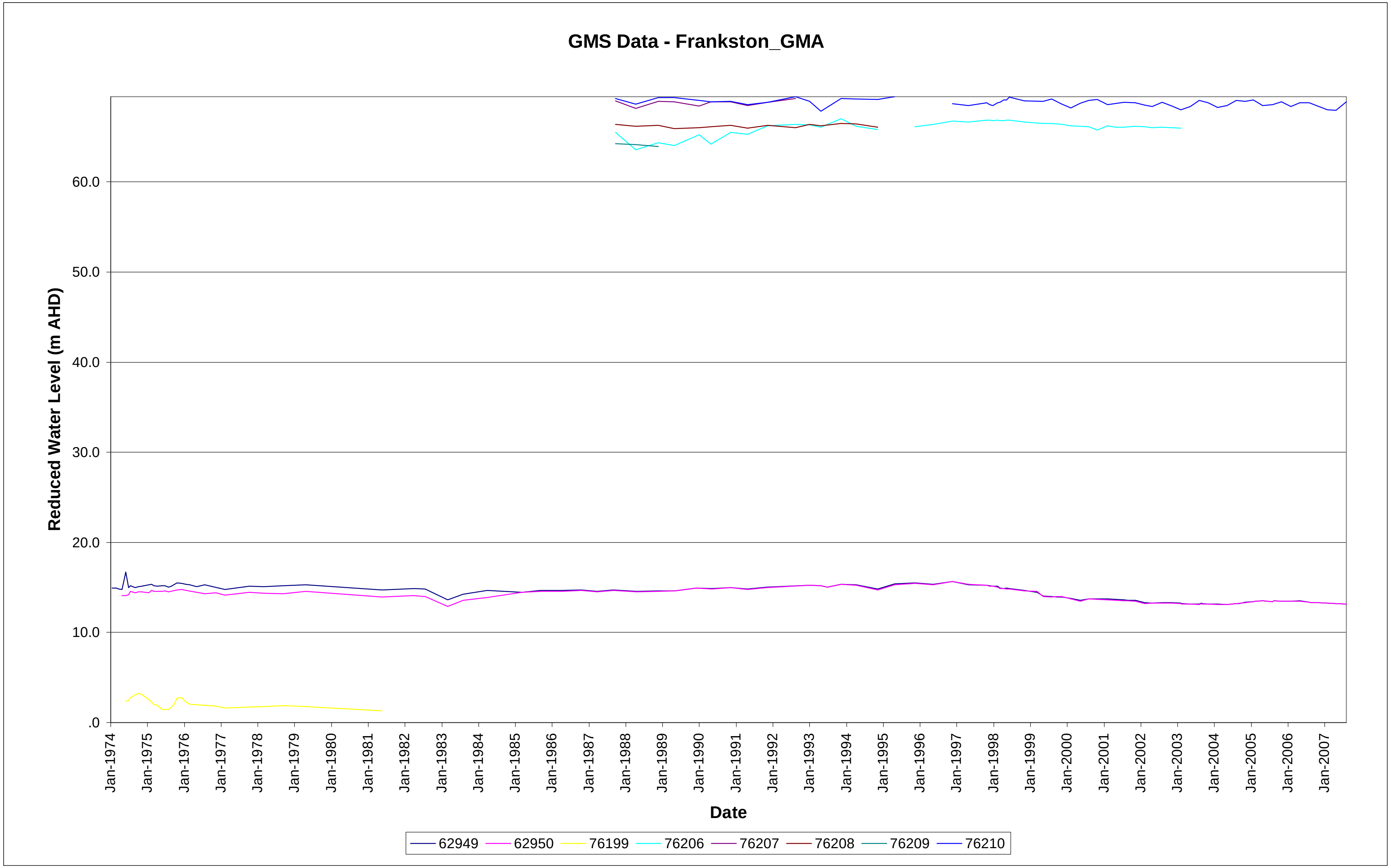

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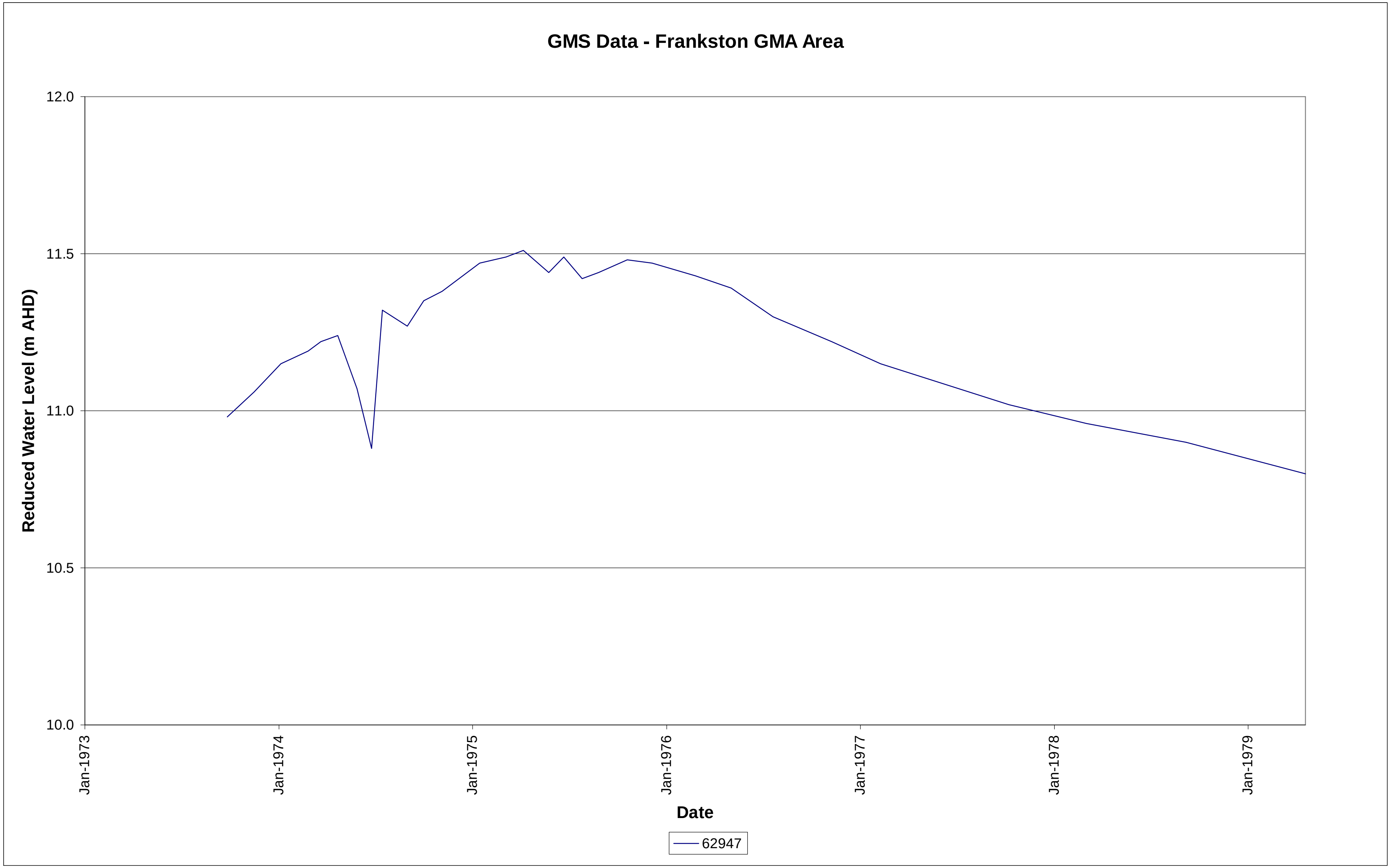

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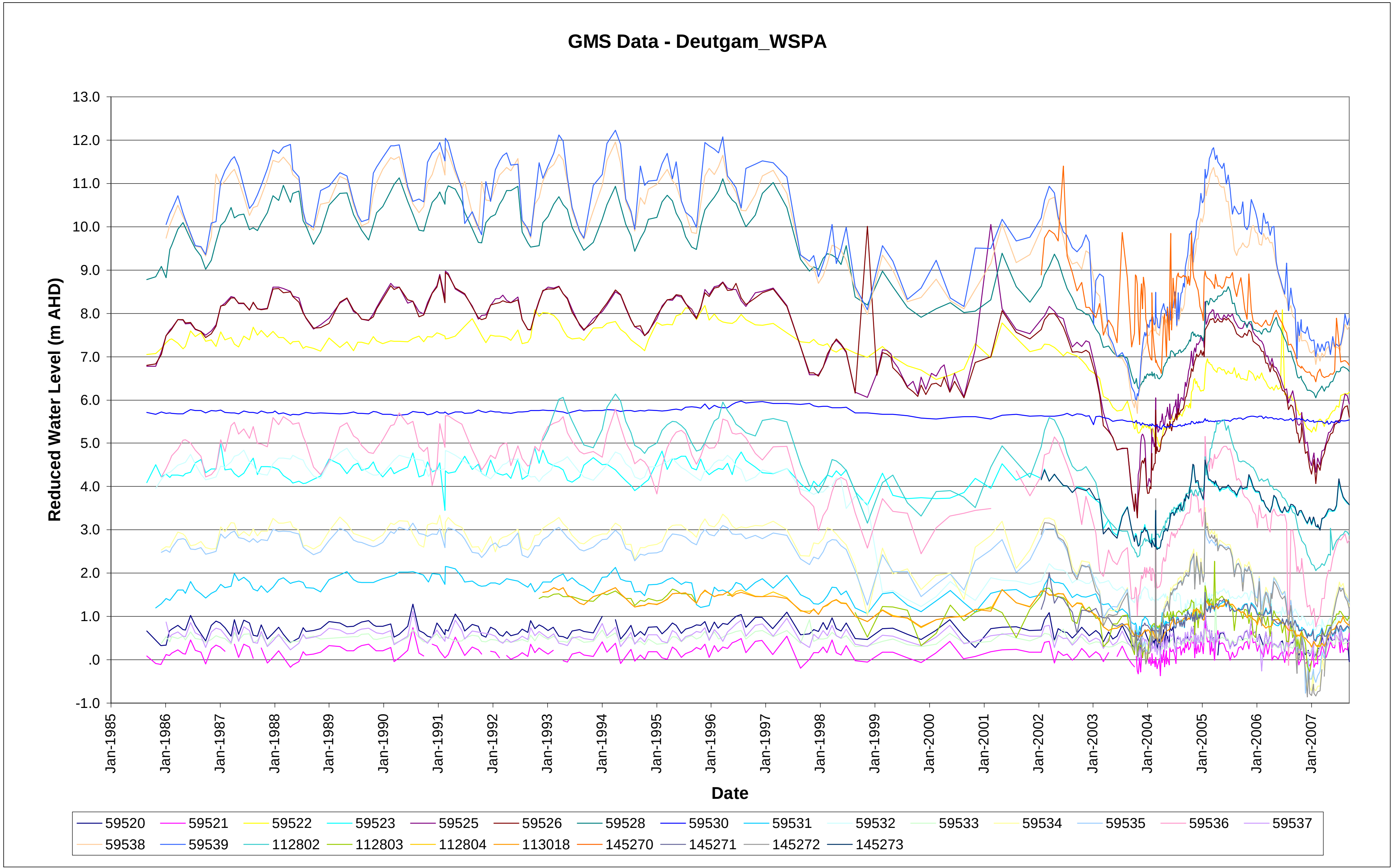

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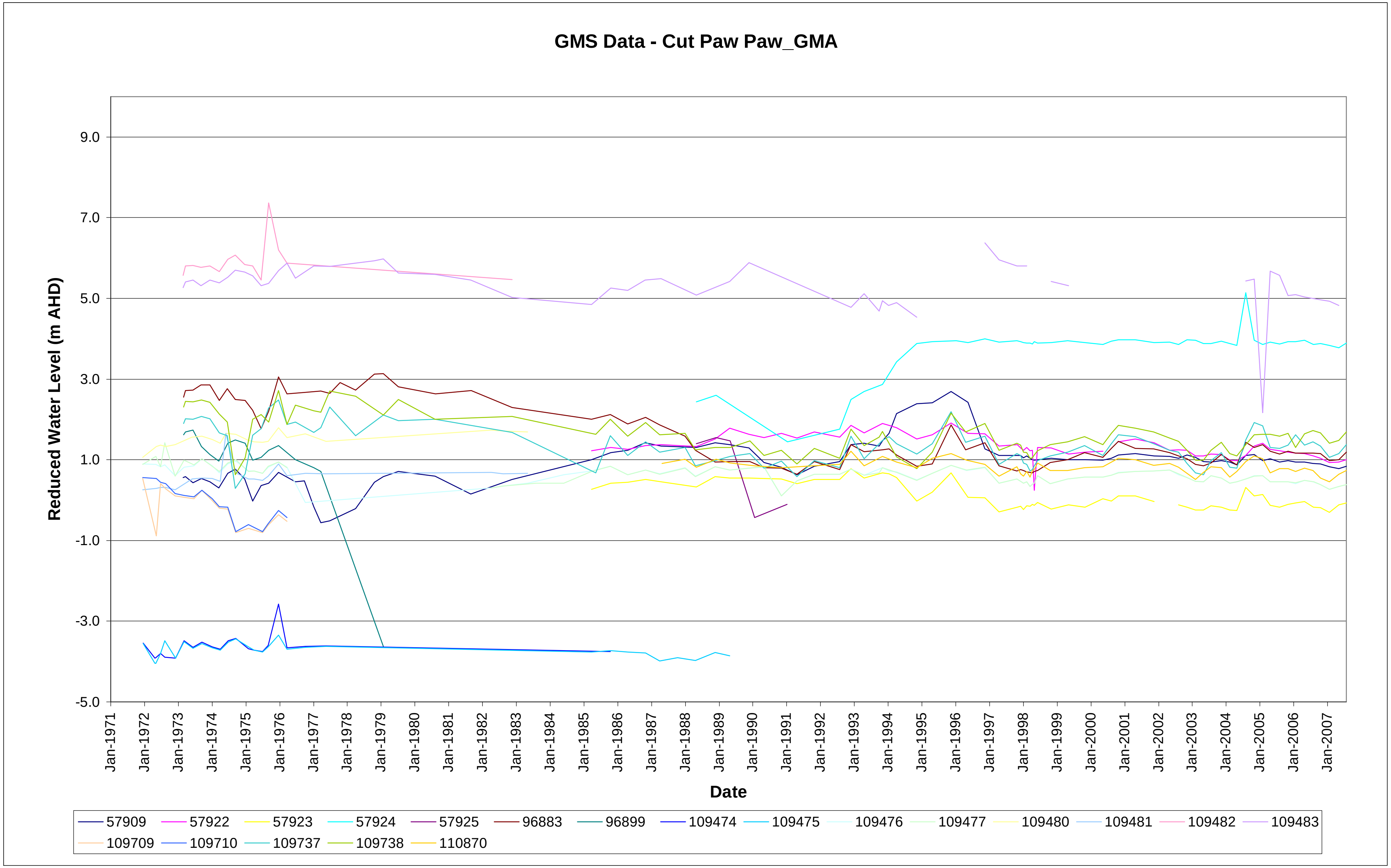

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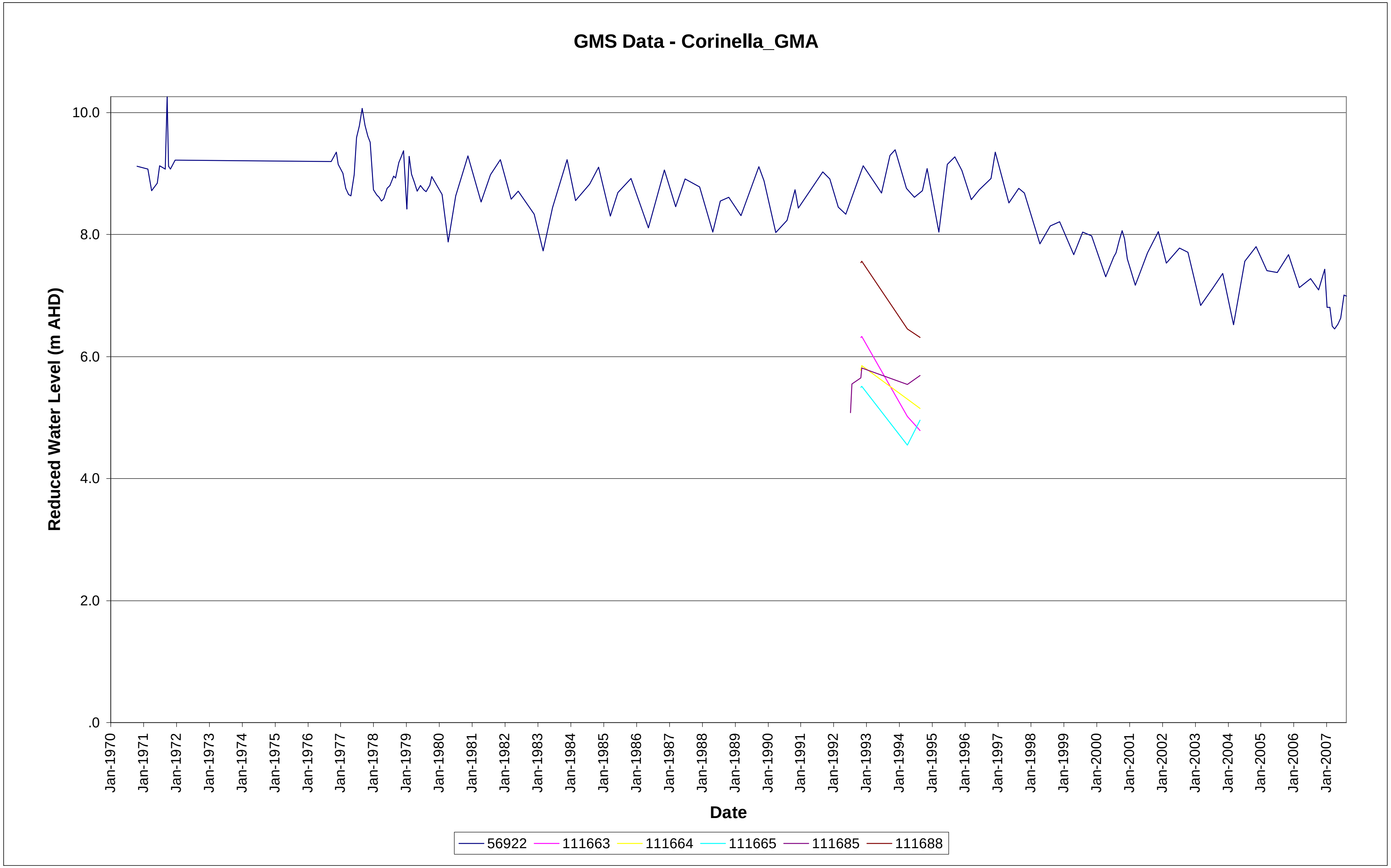

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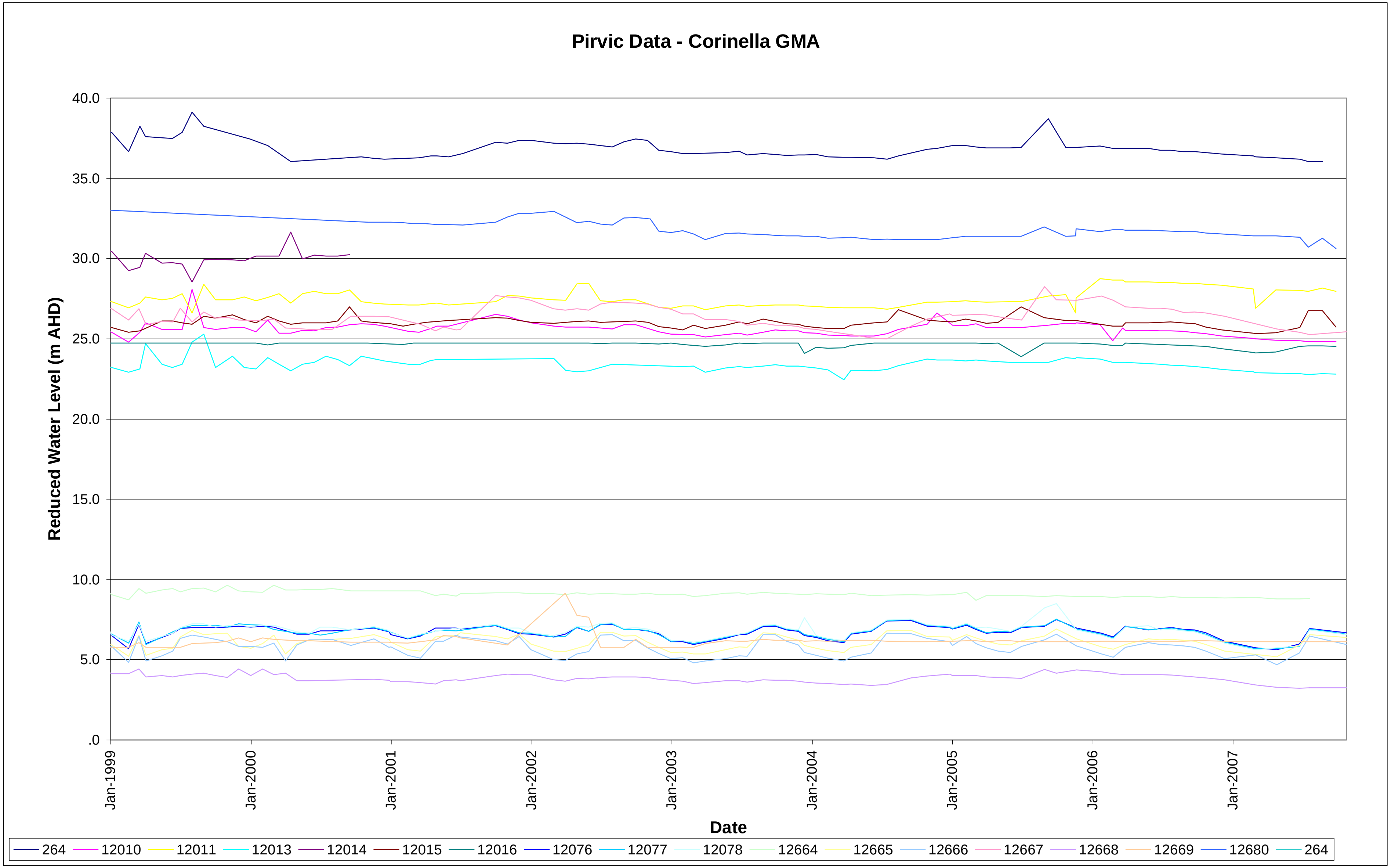

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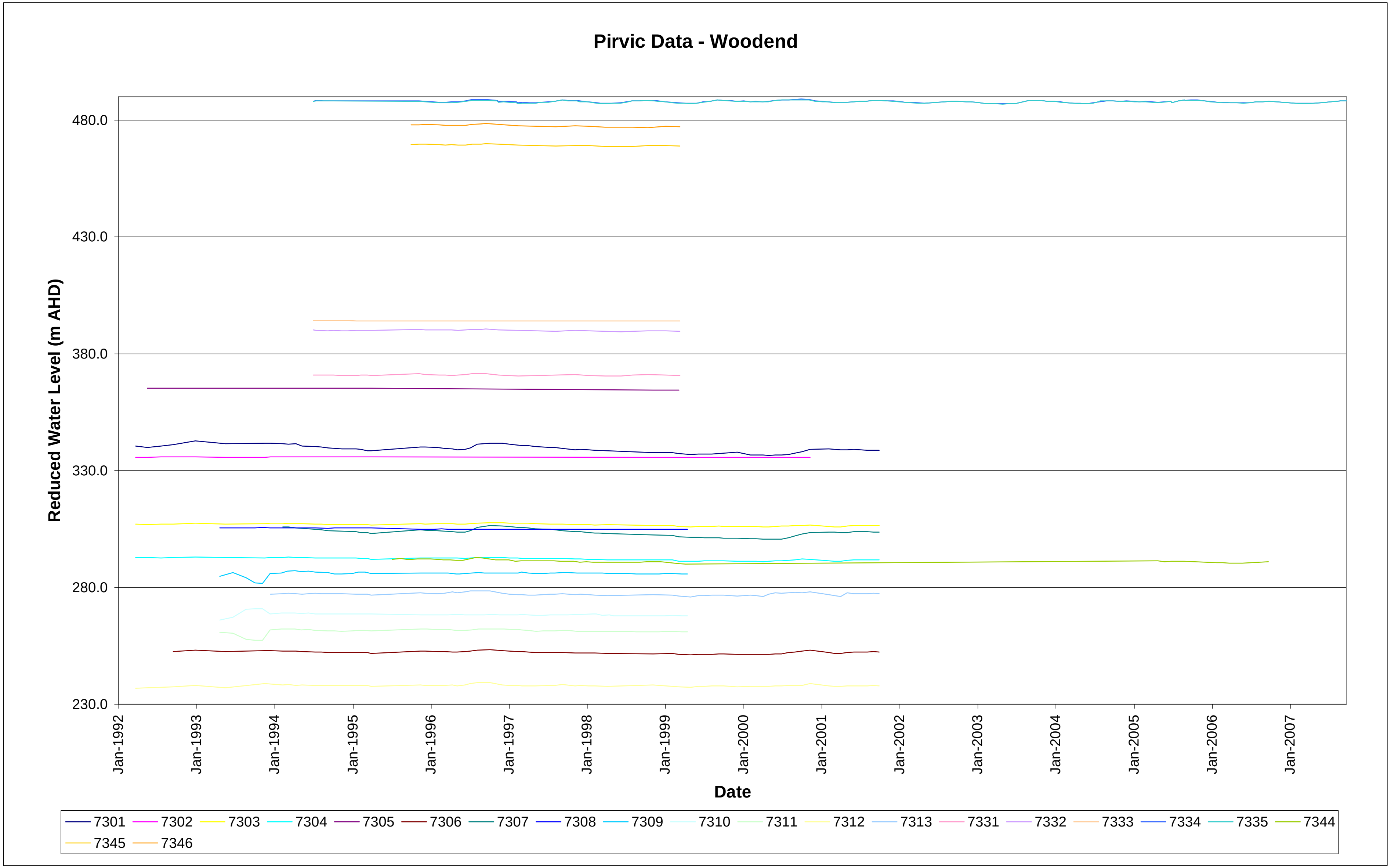

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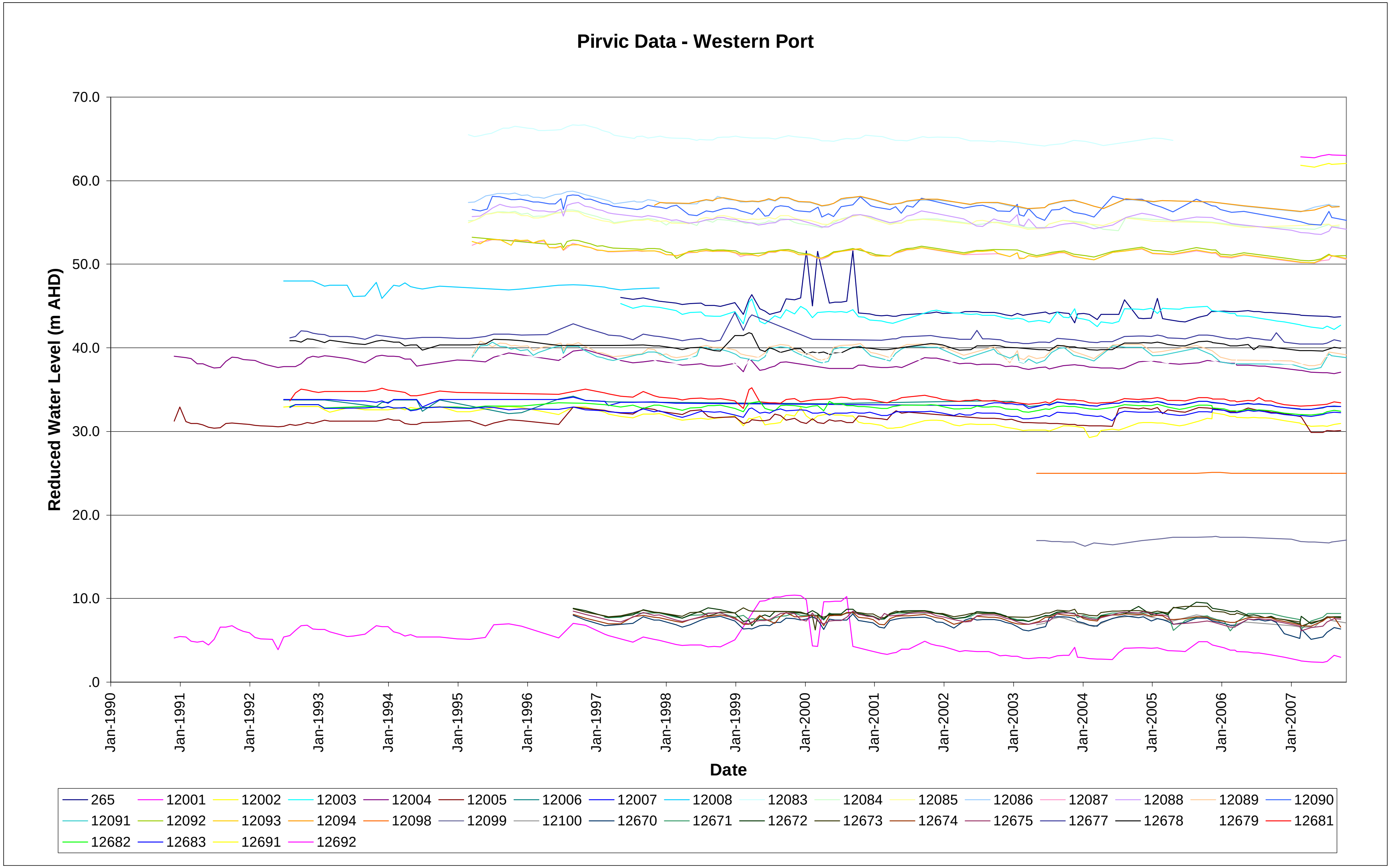

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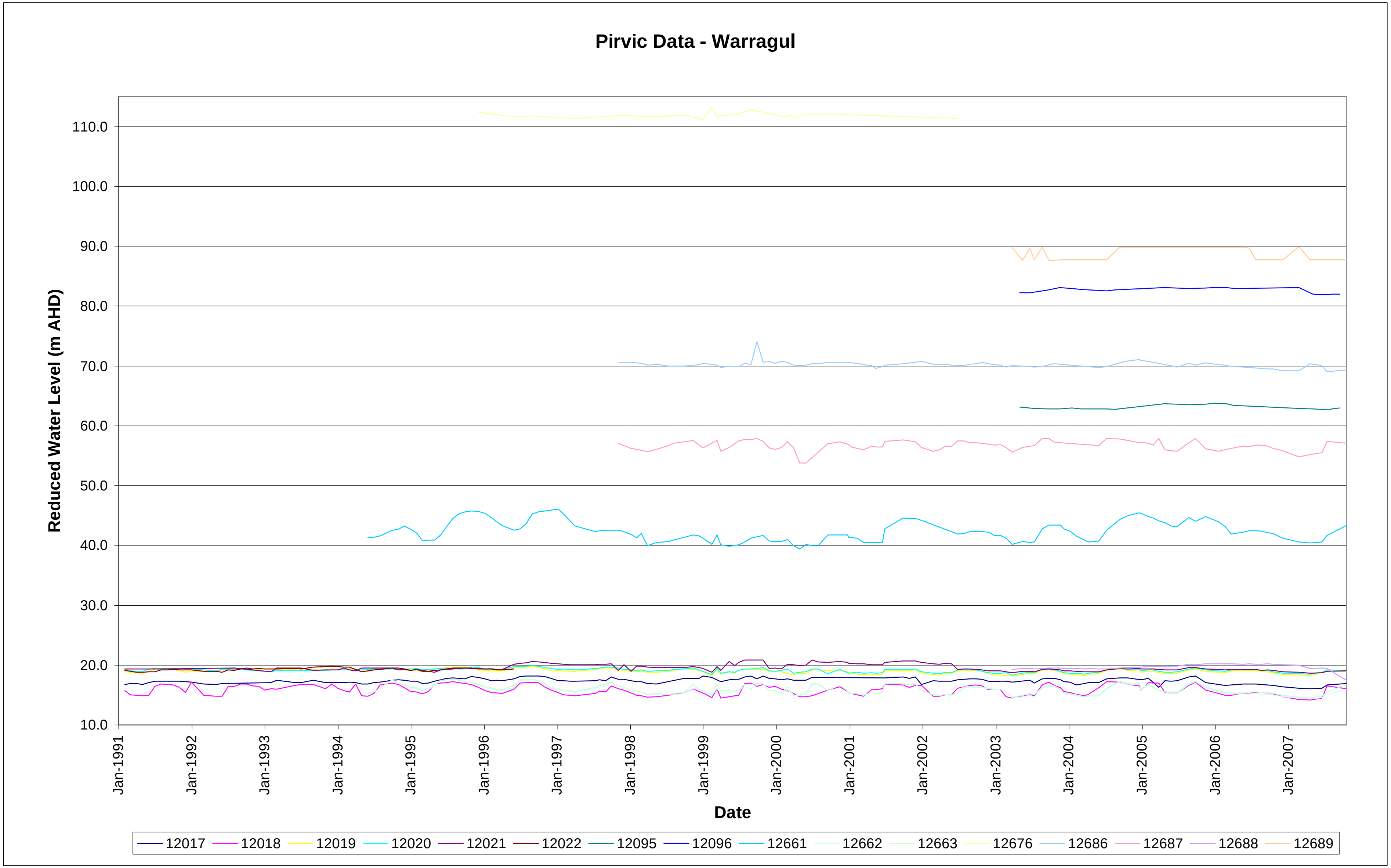

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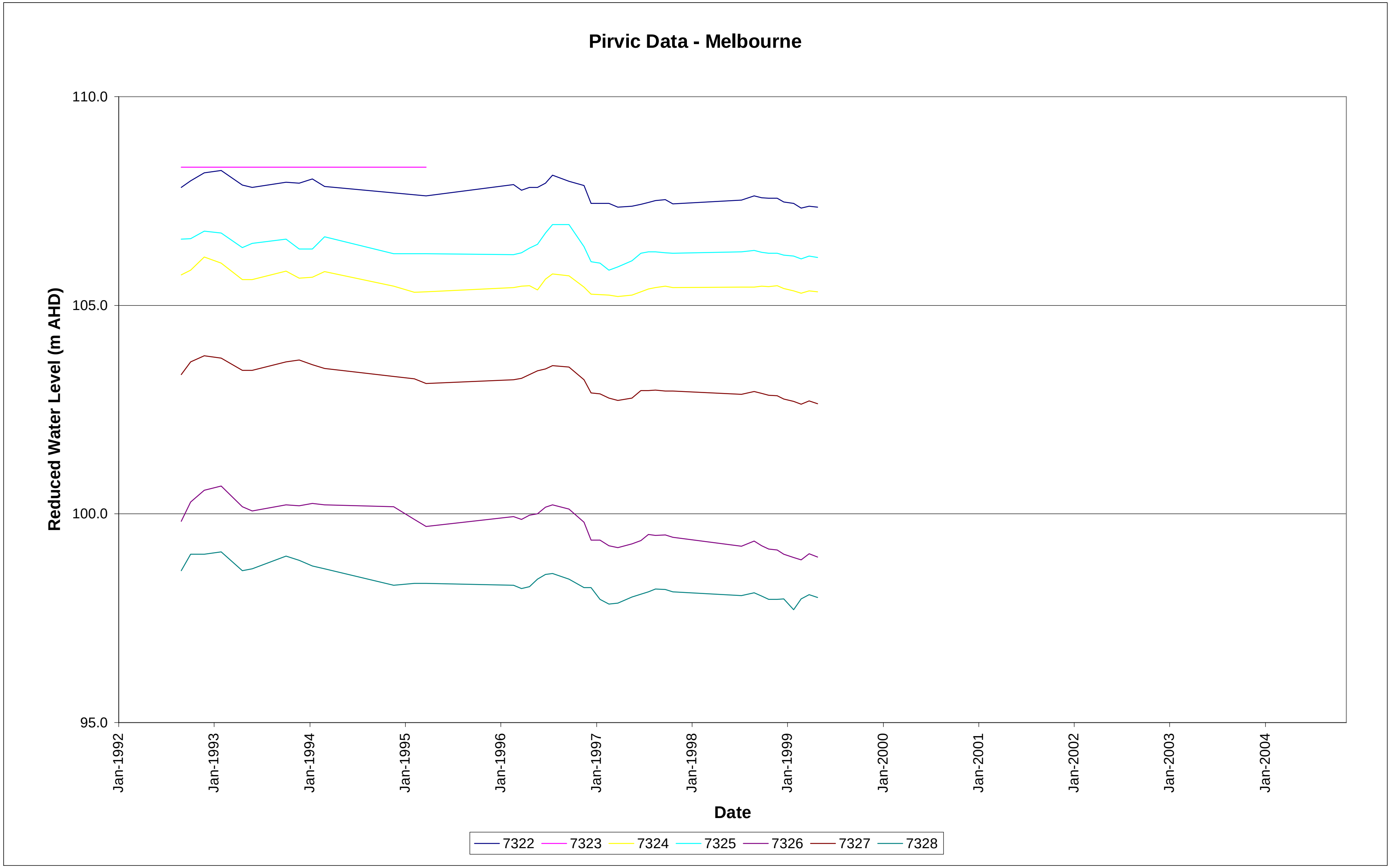

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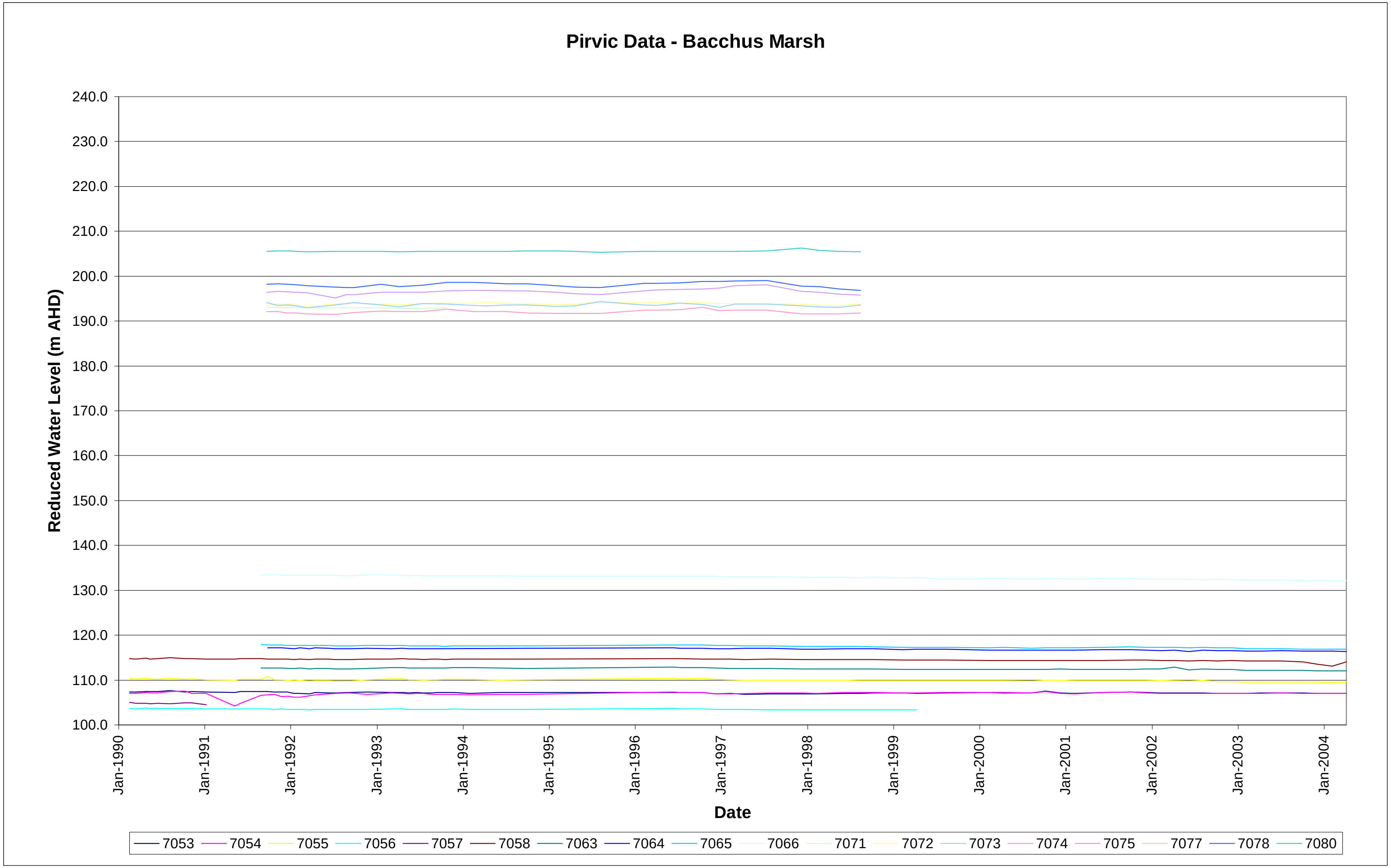

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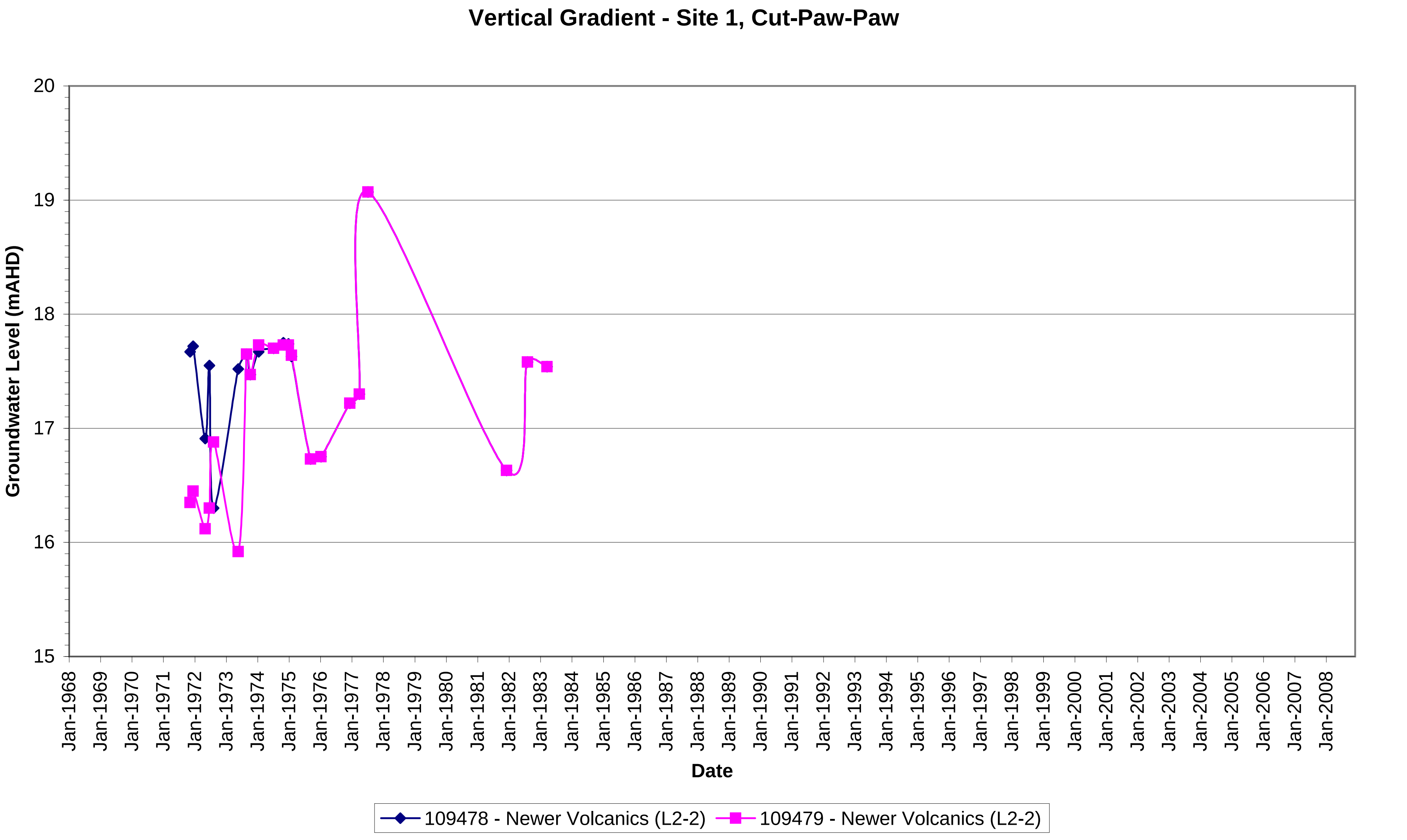
Appendix D

Groundwater Level Hydrographs – Multi-Level Monitoring Locations



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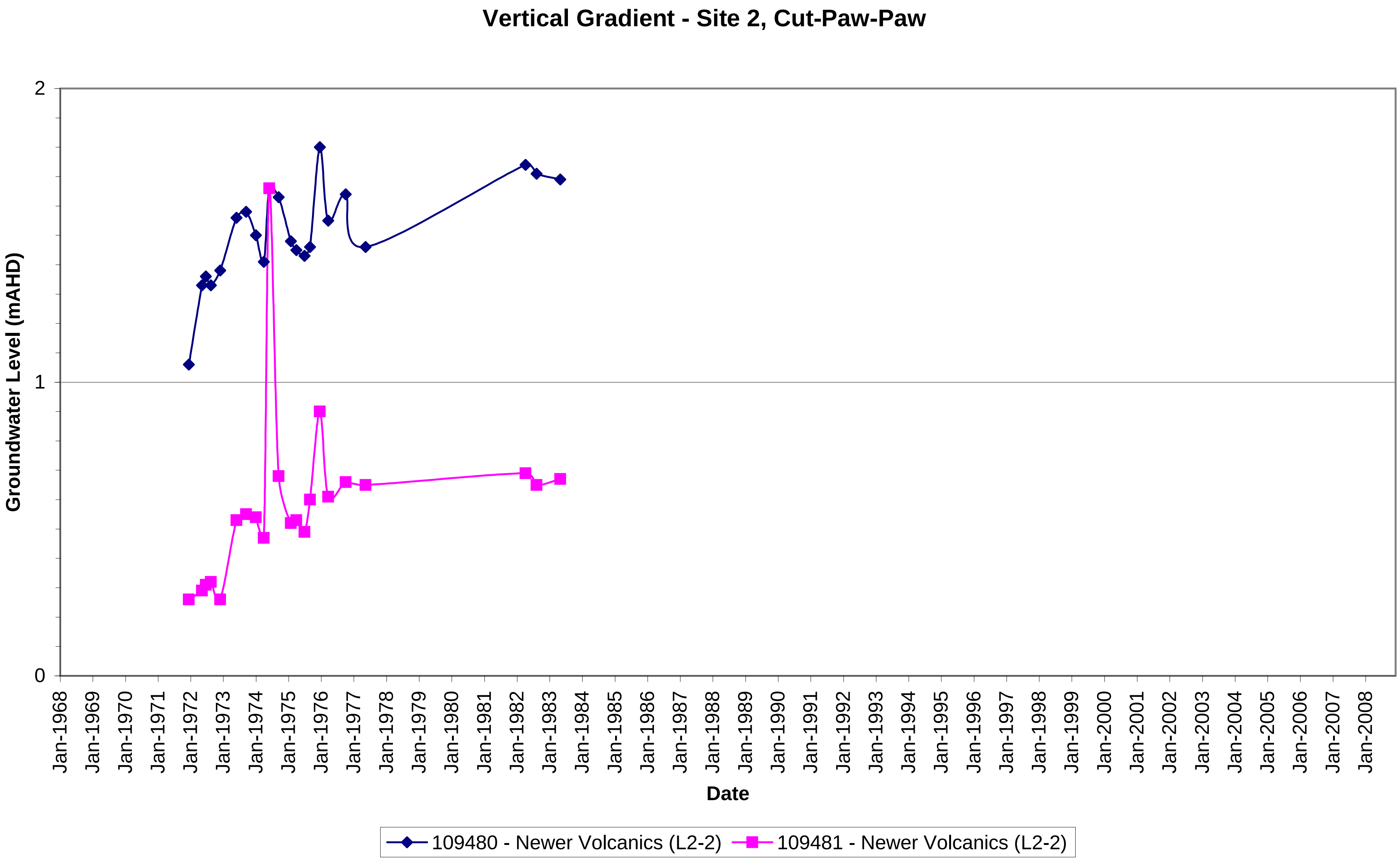

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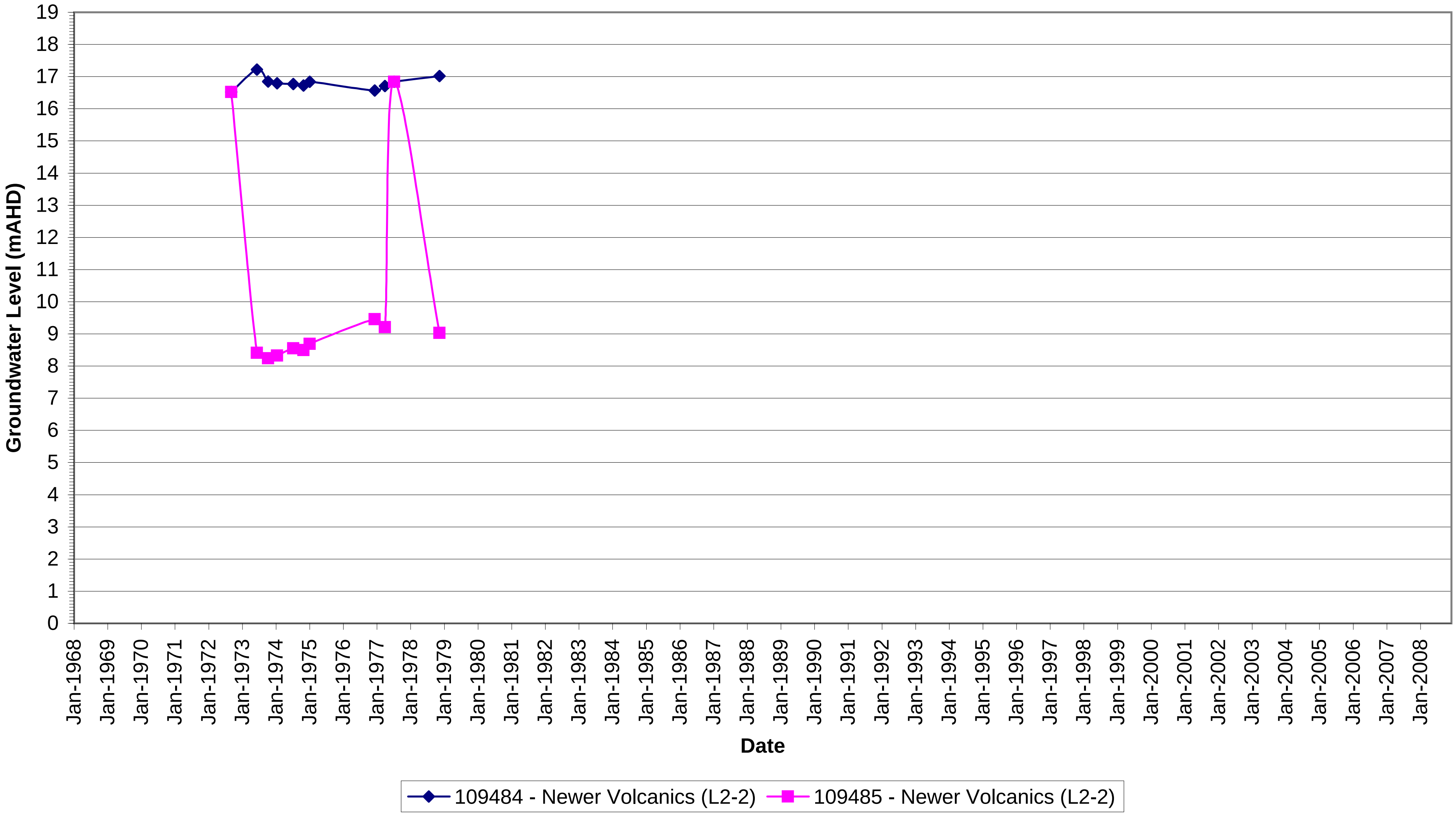
Vertical Gradient - Site 3, Cut-Paw-Paw



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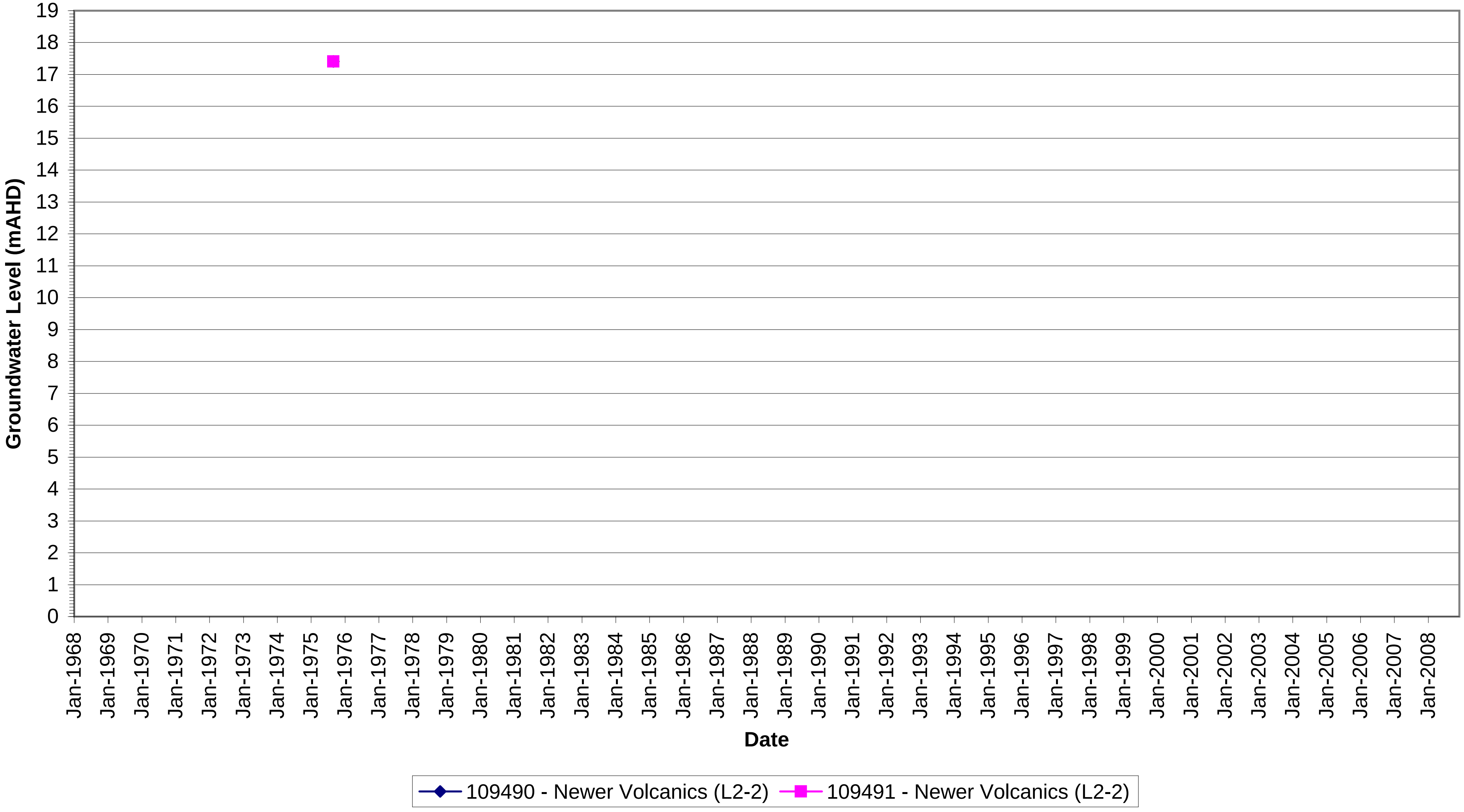

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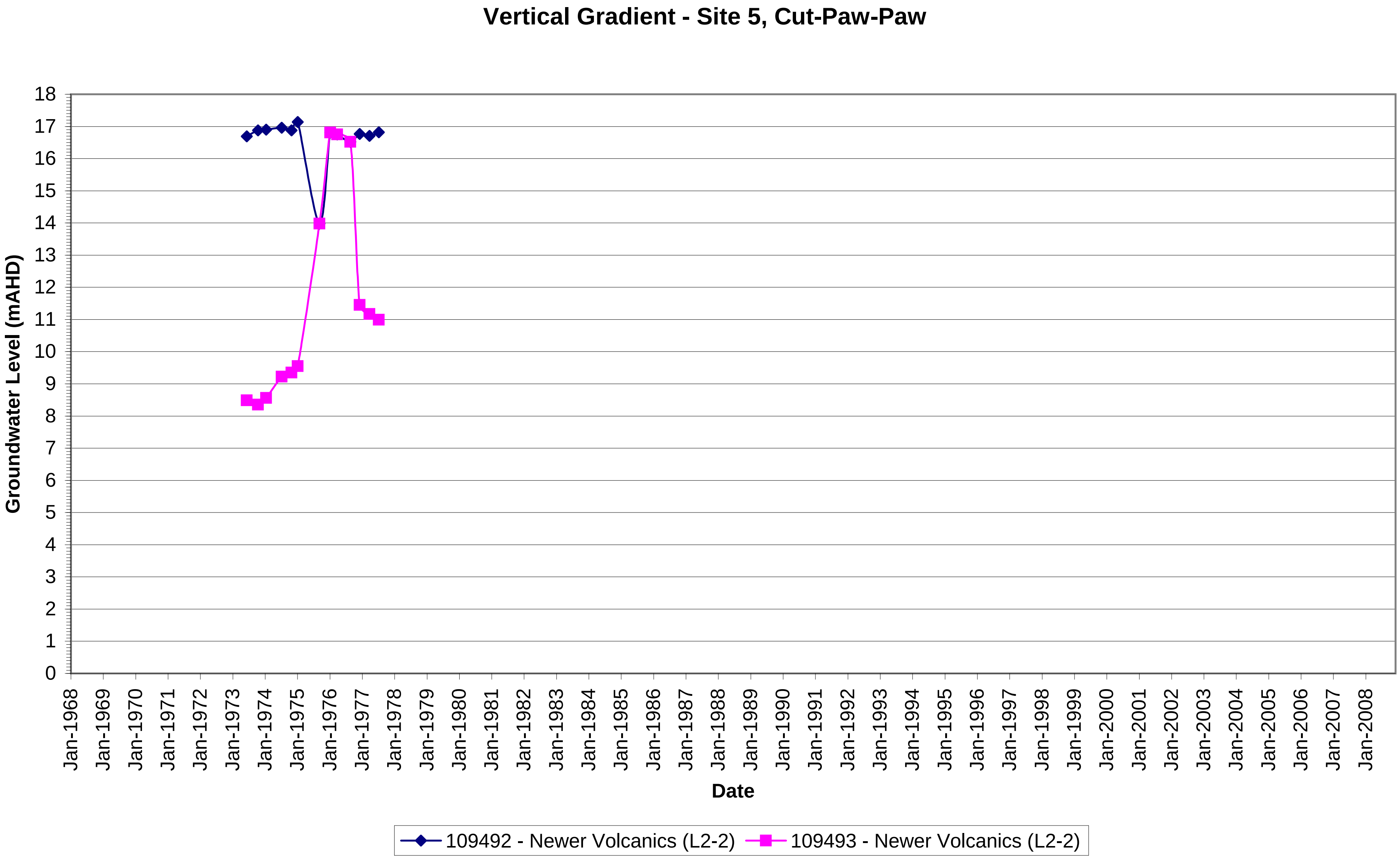

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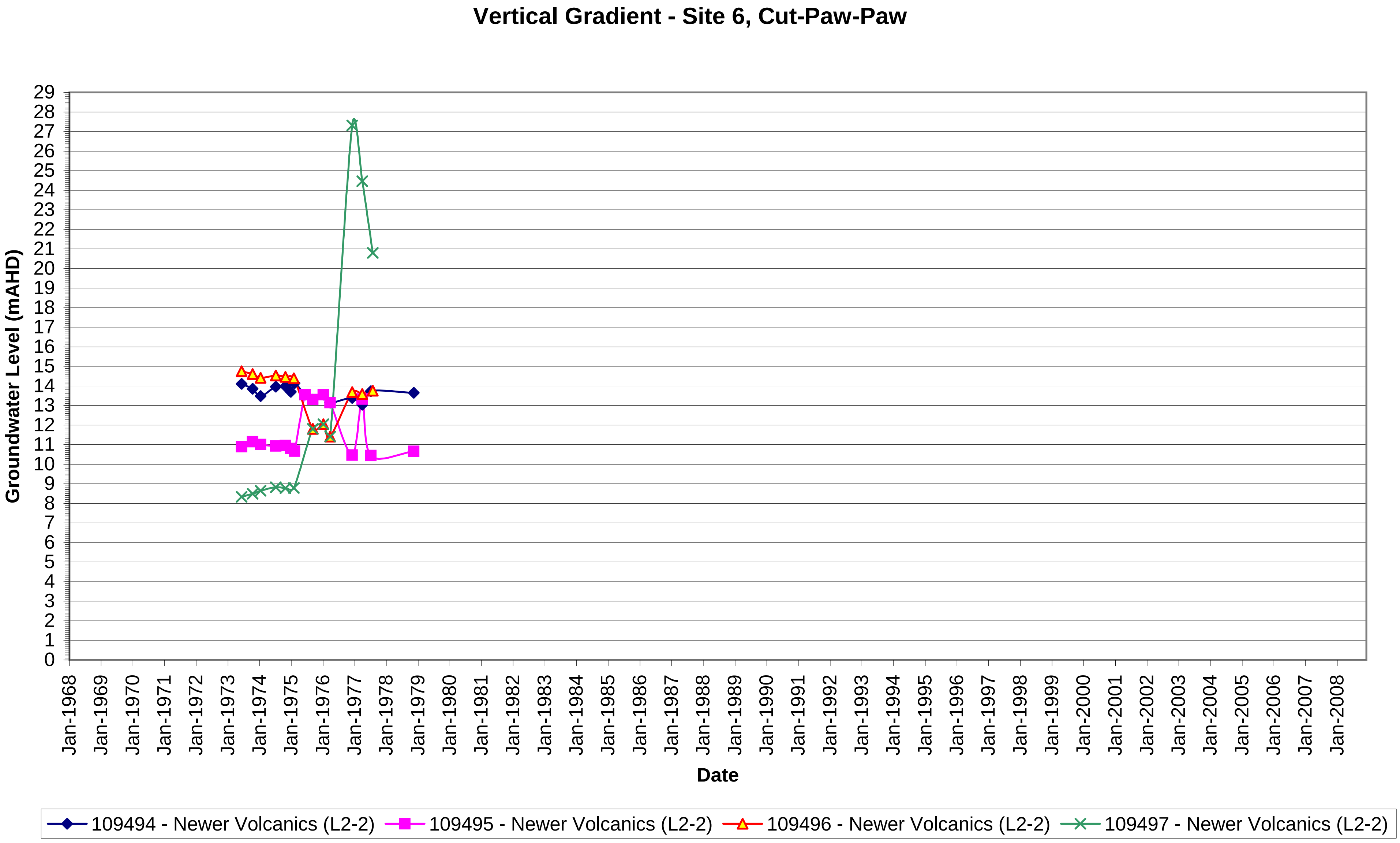

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Vertical Gradient - Site 7, Cut-Paw-Paw

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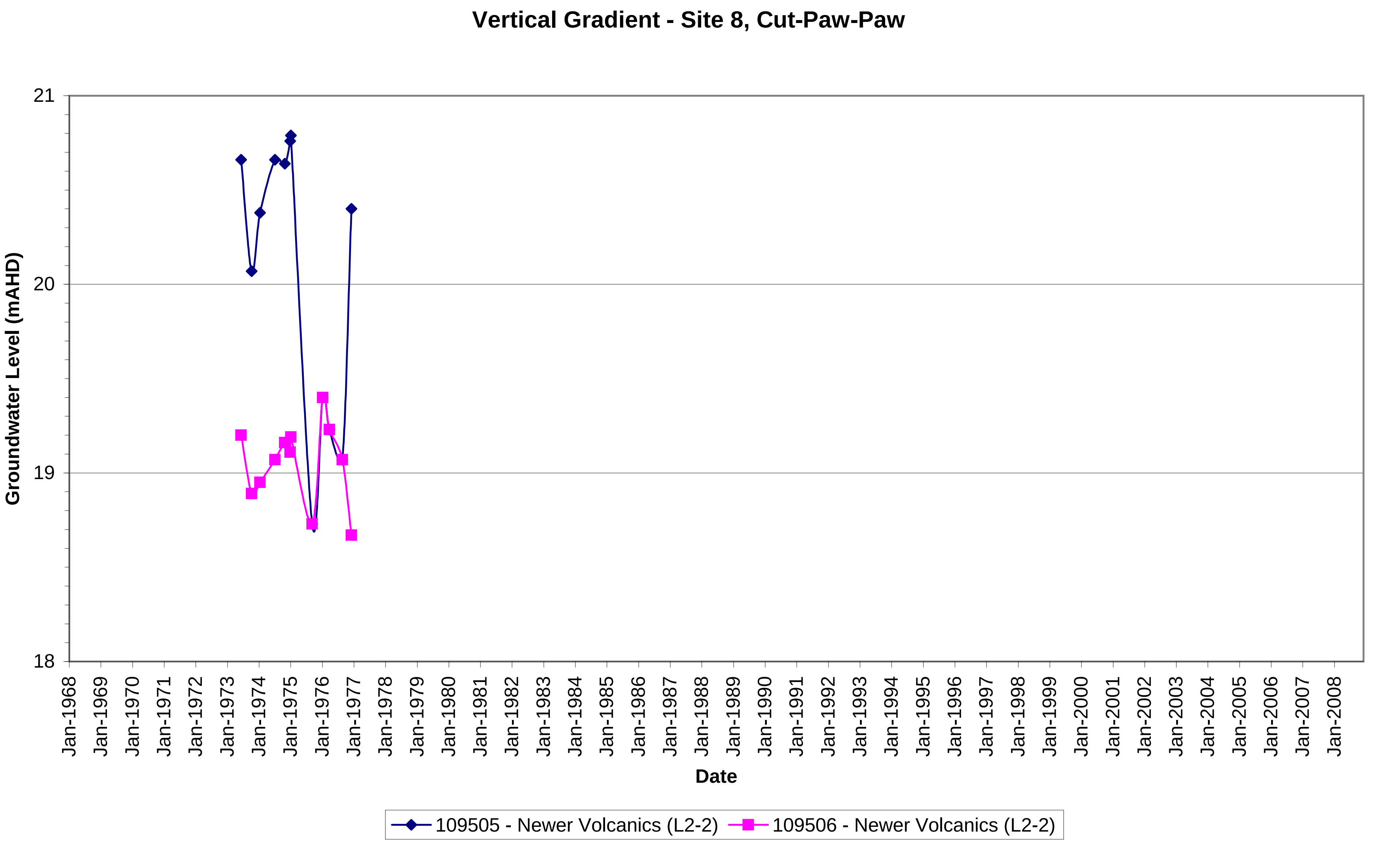

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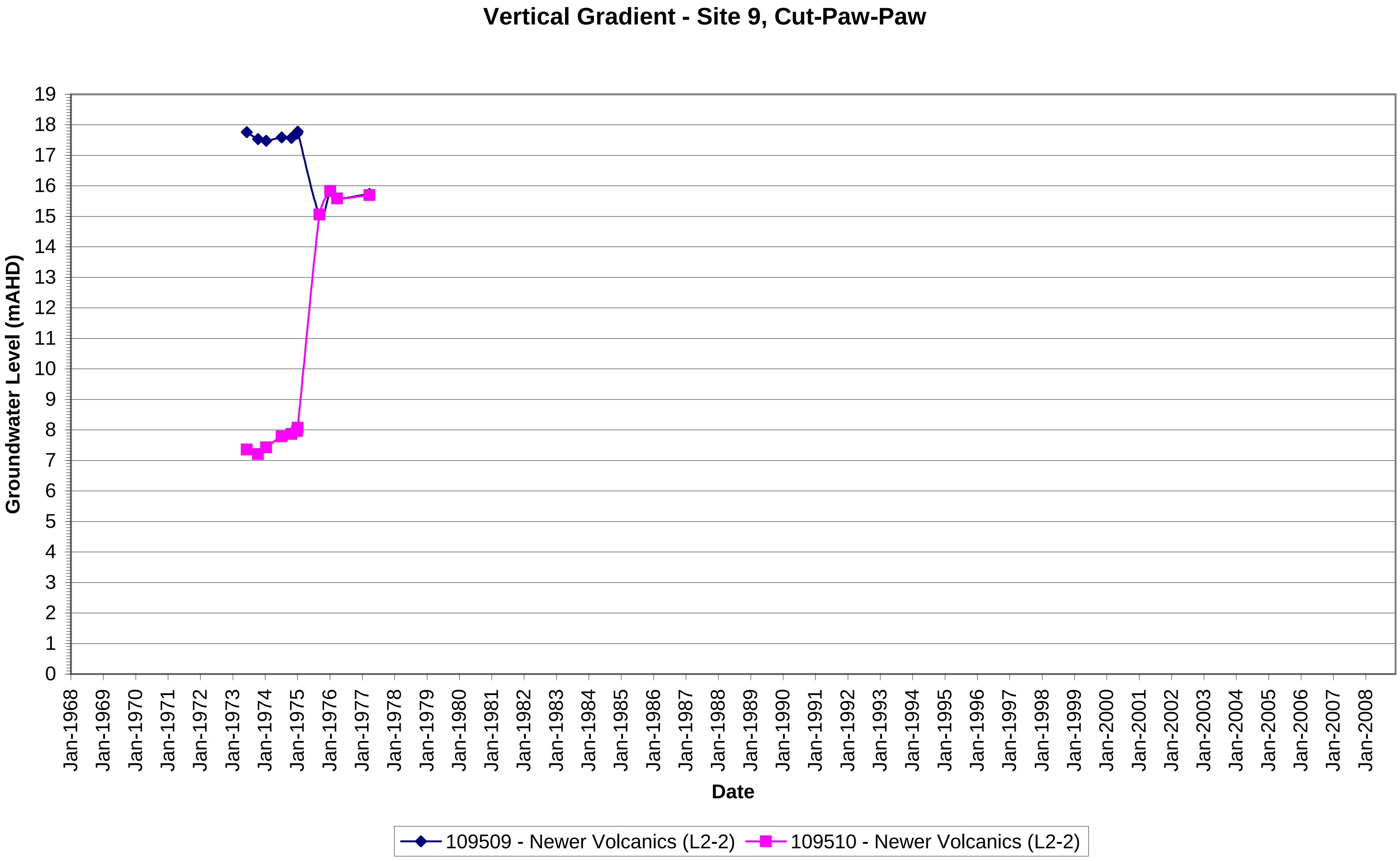

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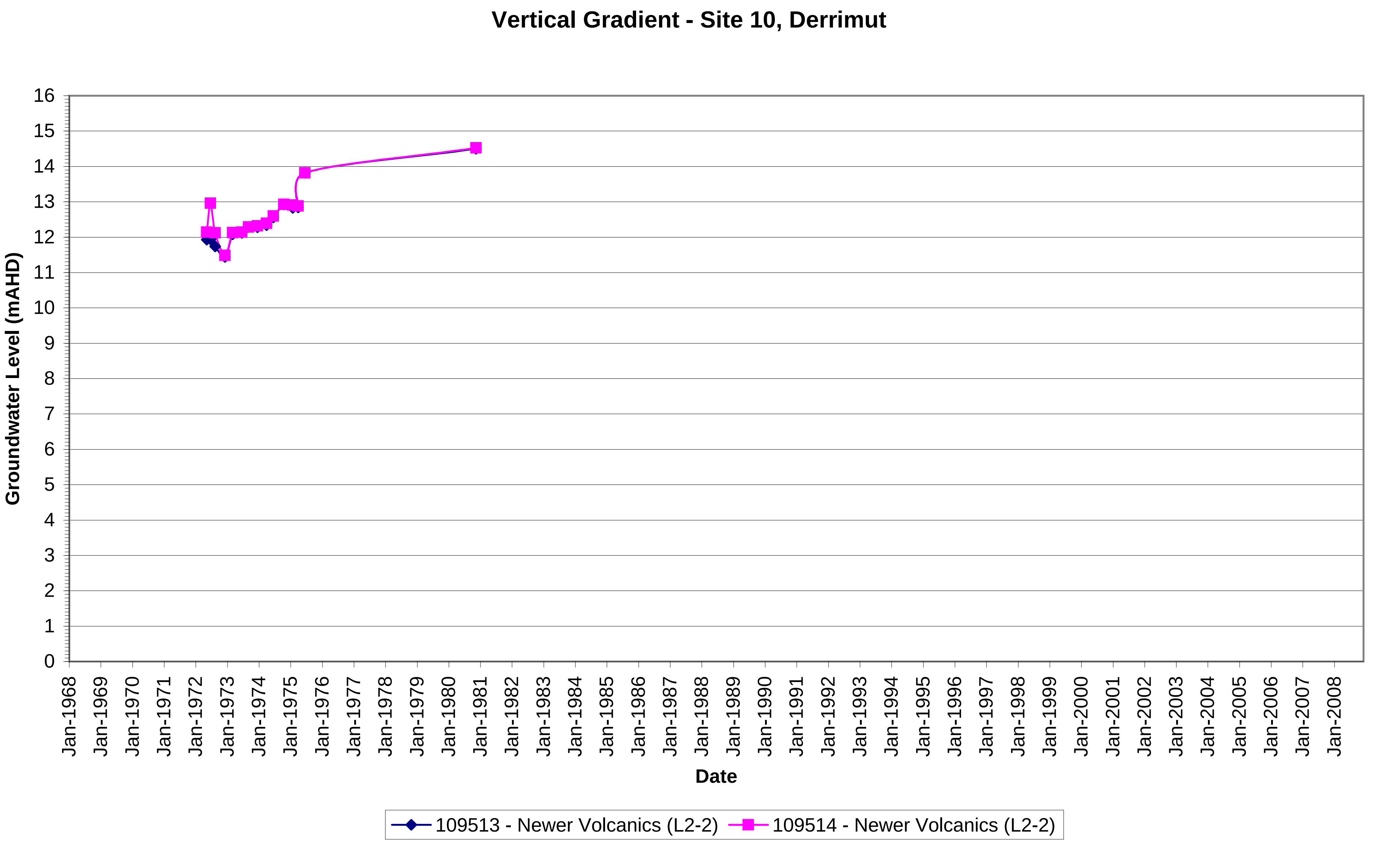

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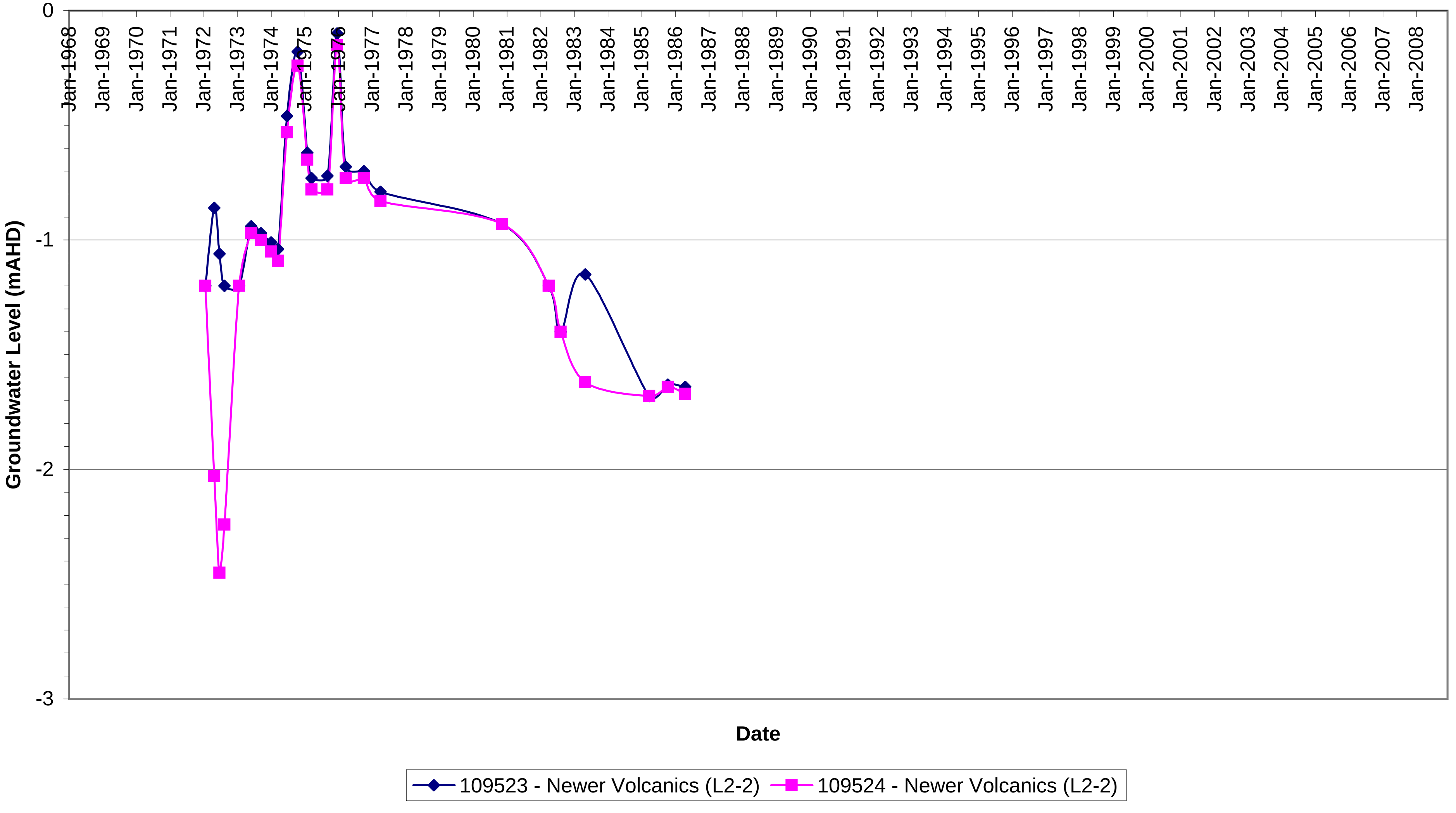
Vertical Gradient - Site 11



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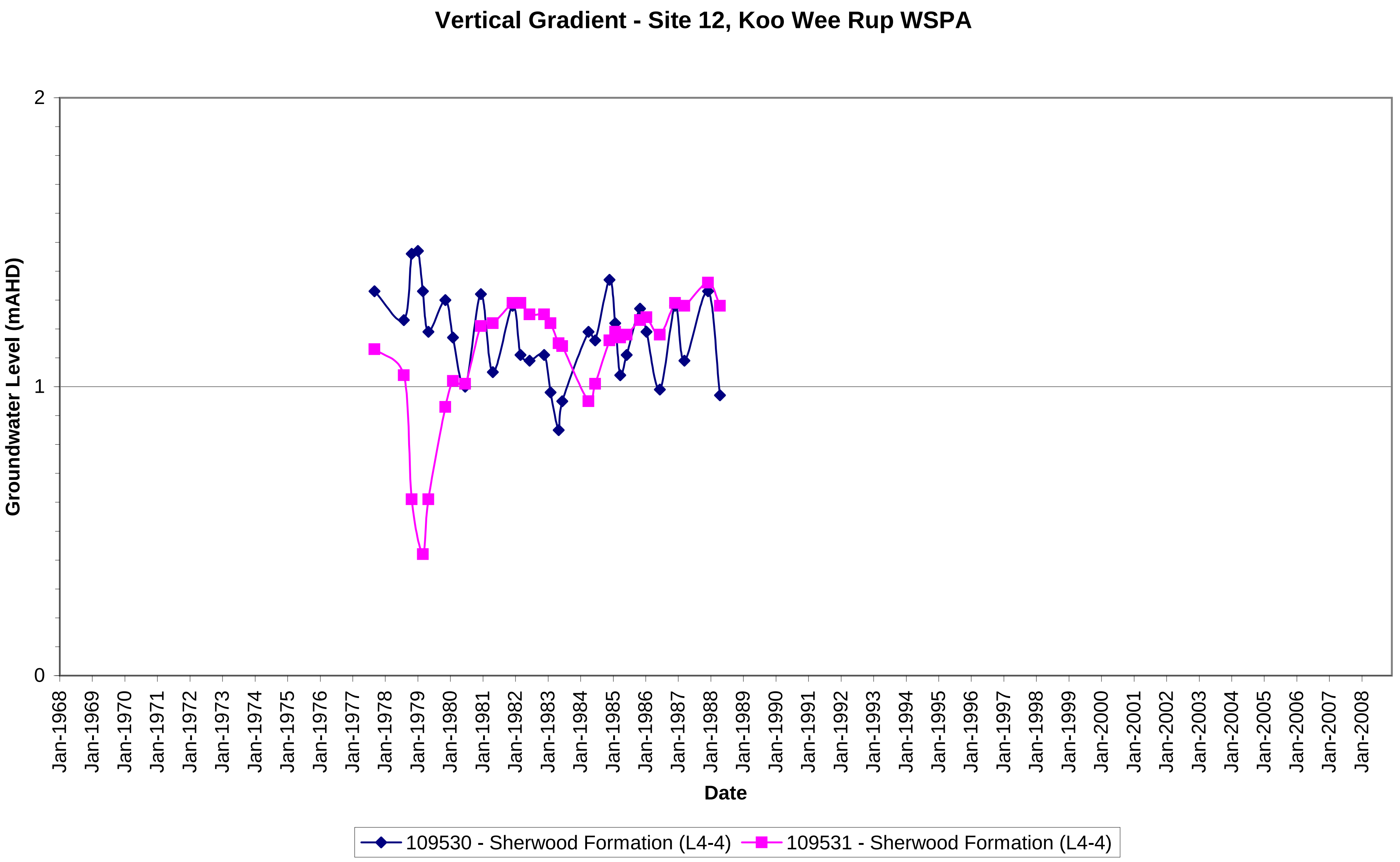

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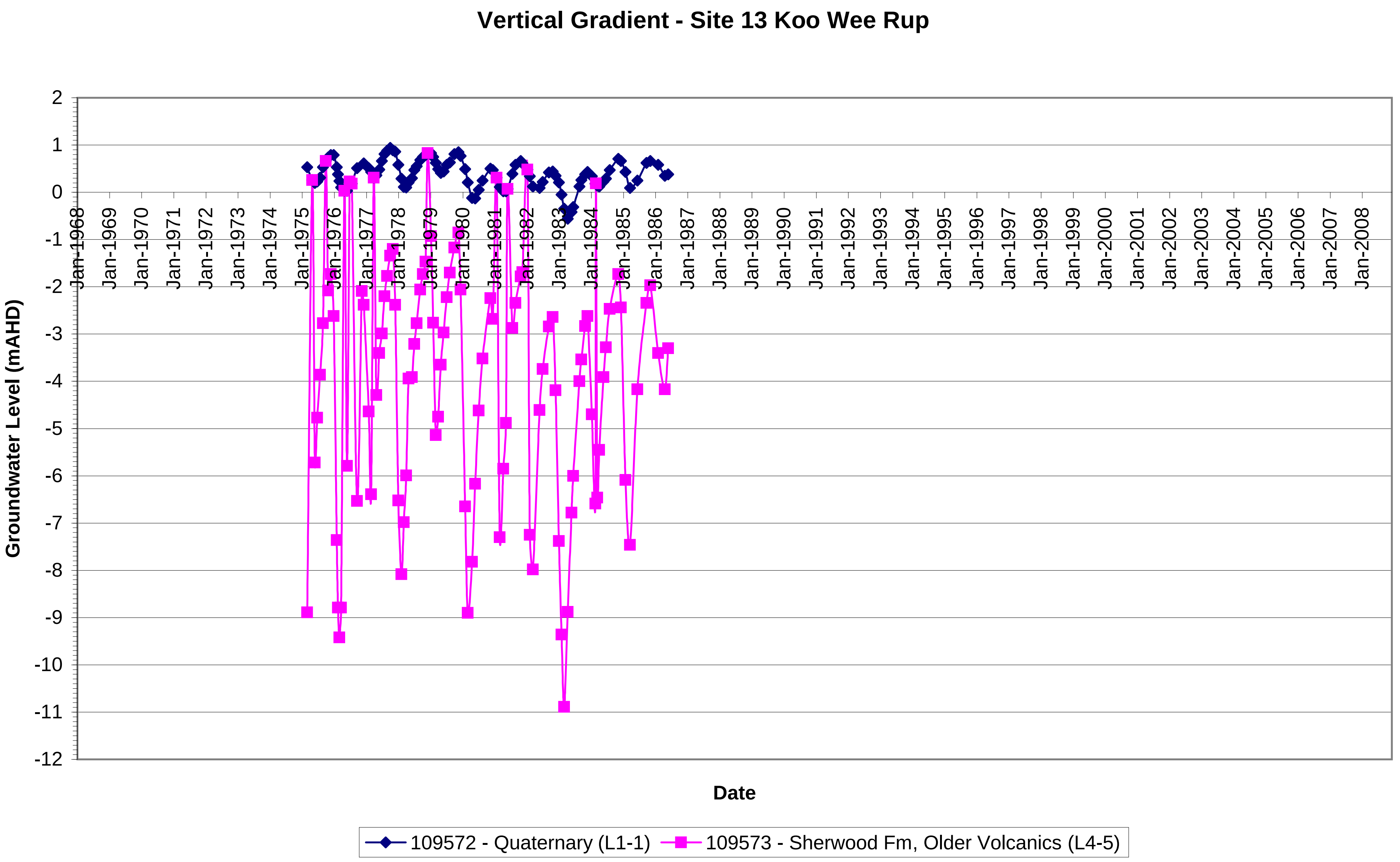

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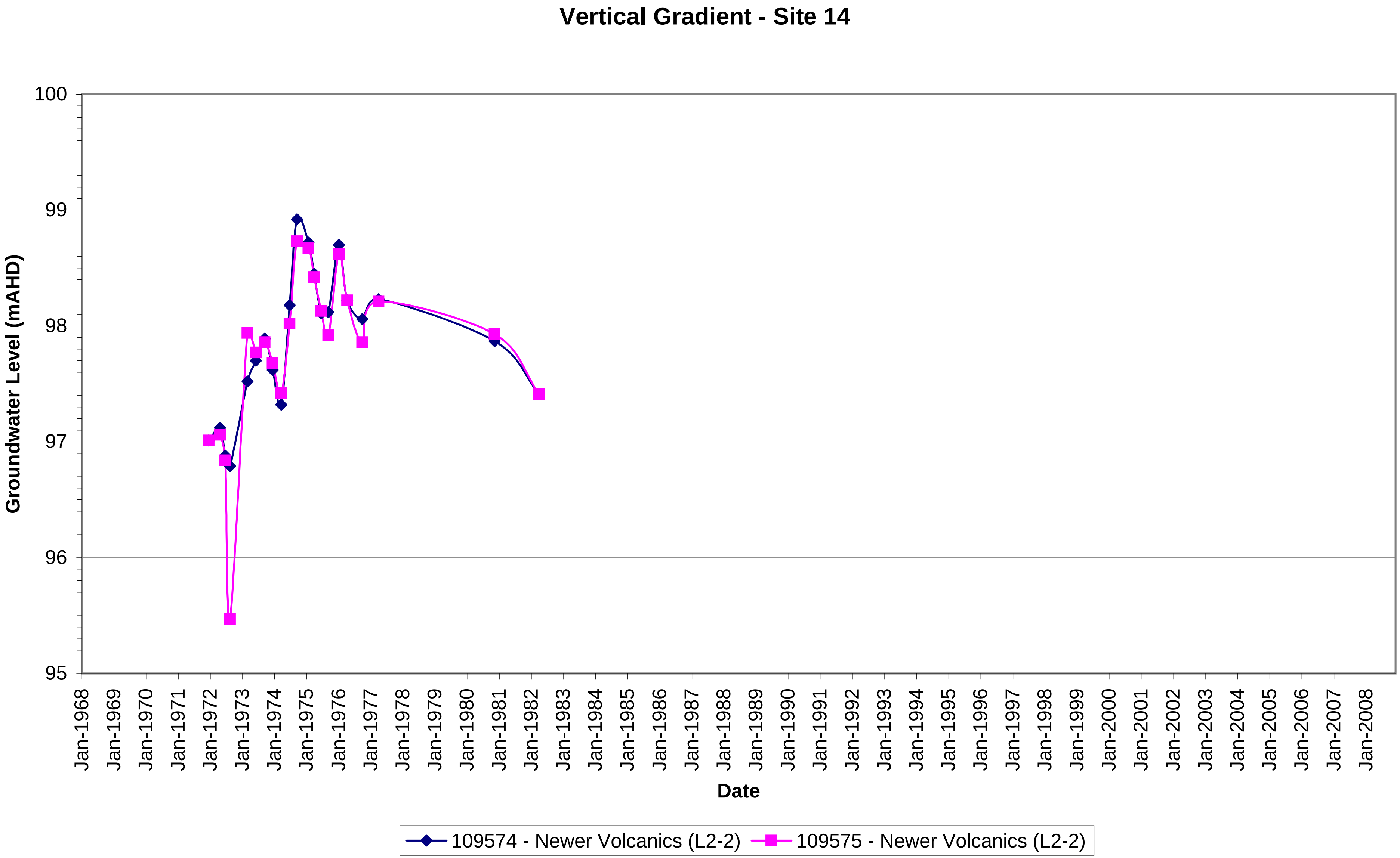

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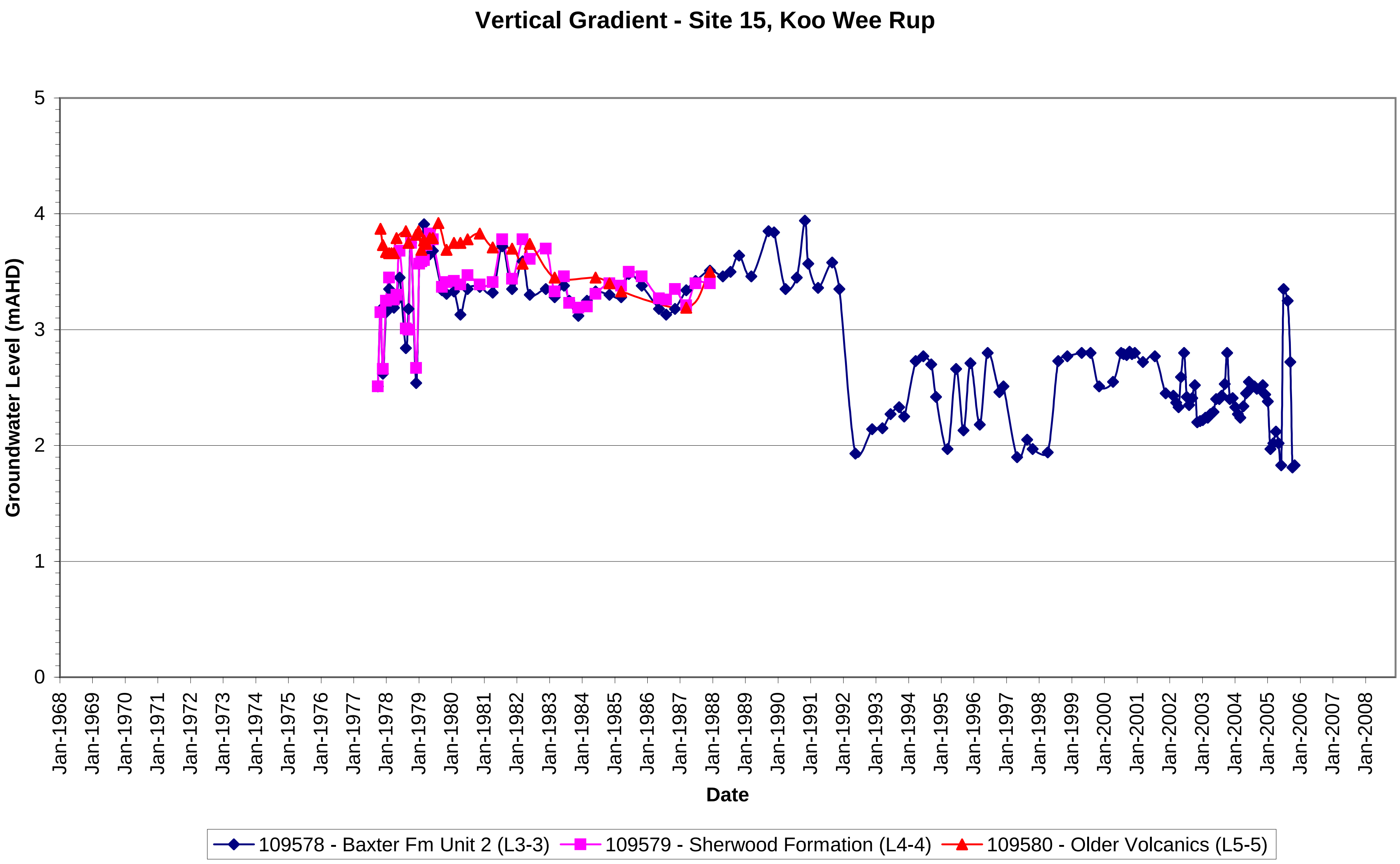

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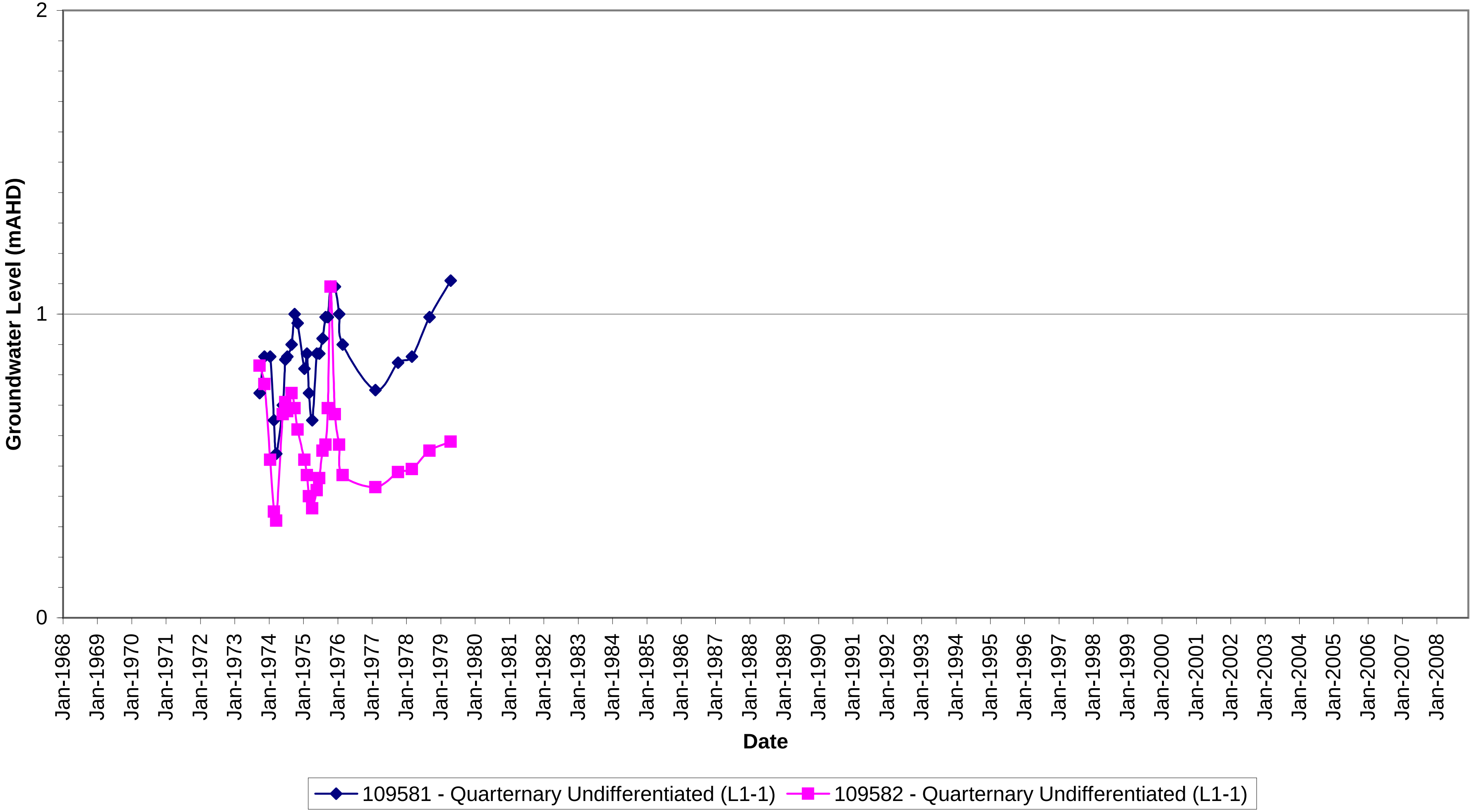
Vertical Gradient - Site 16 Koo Wee Rup



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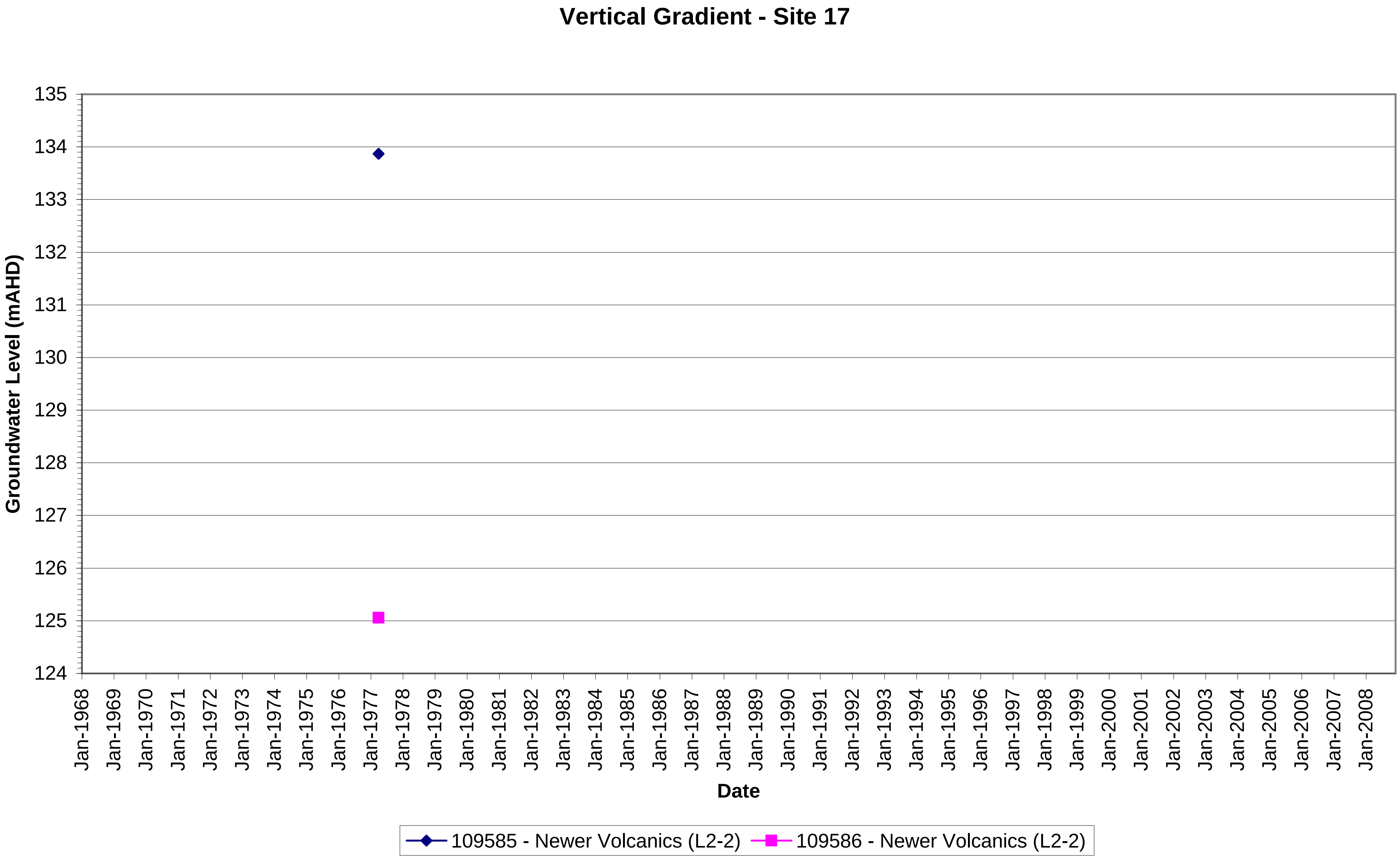

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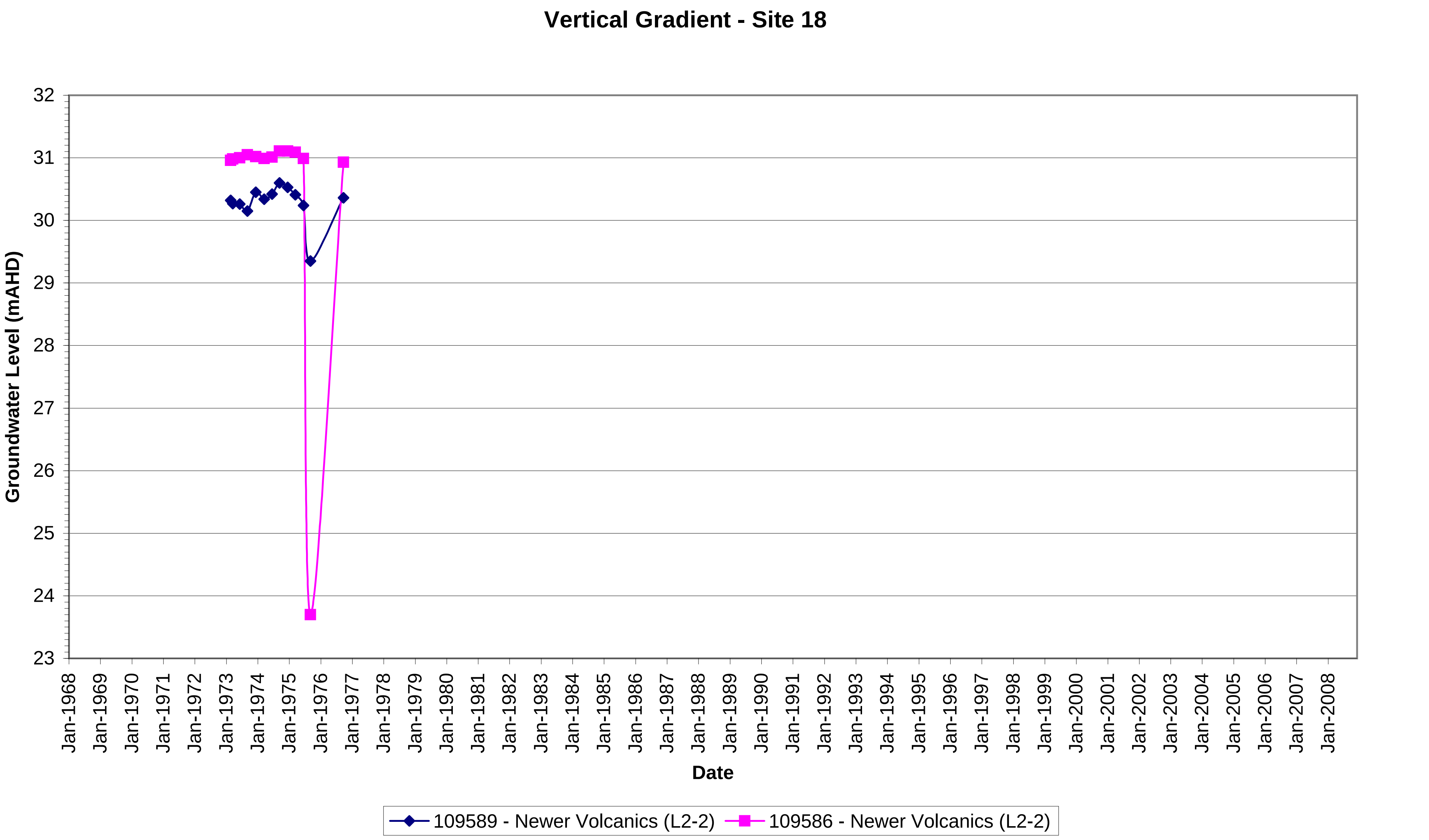

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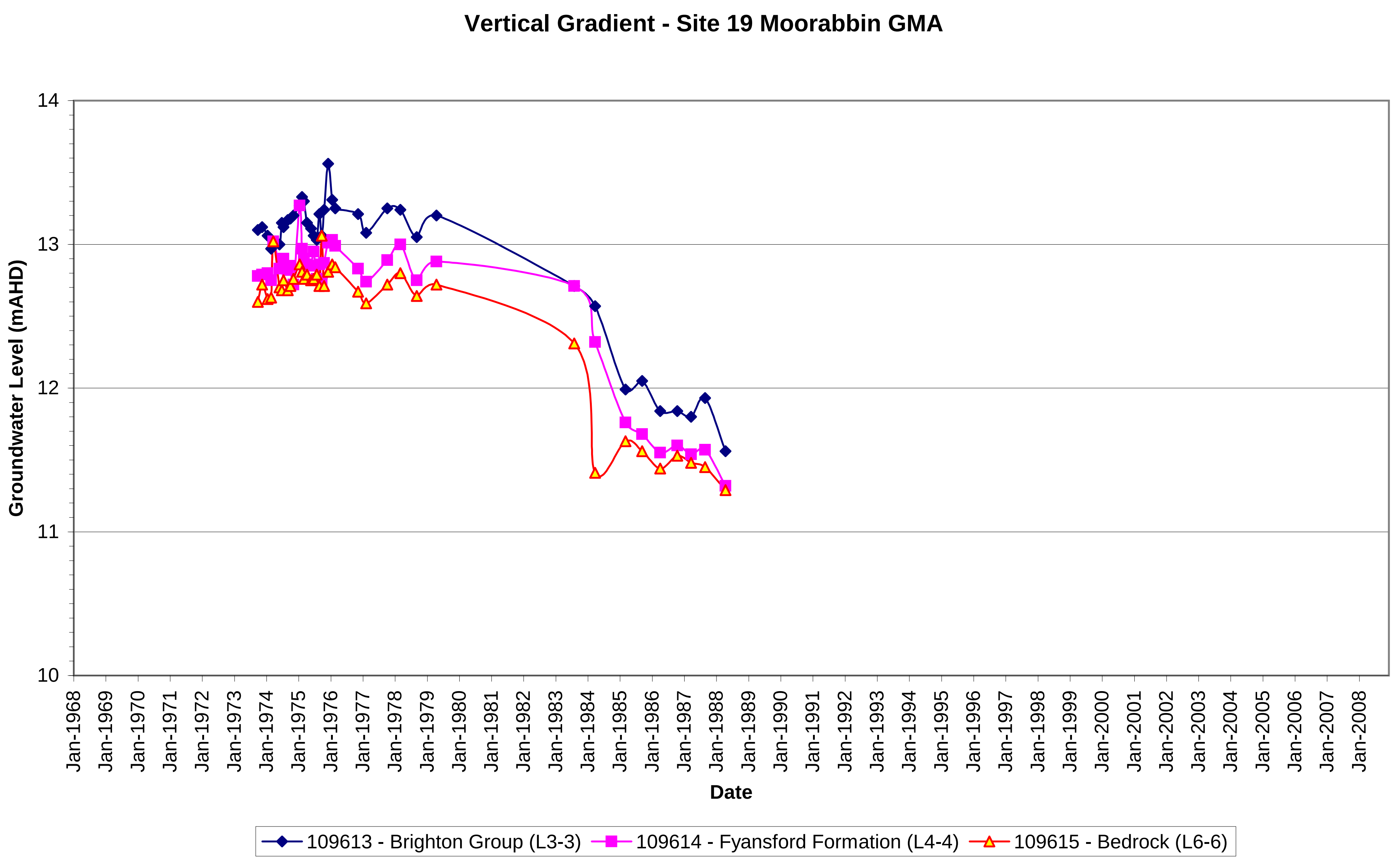
Vertical Gradient - Site 19 Moorabbin GMA



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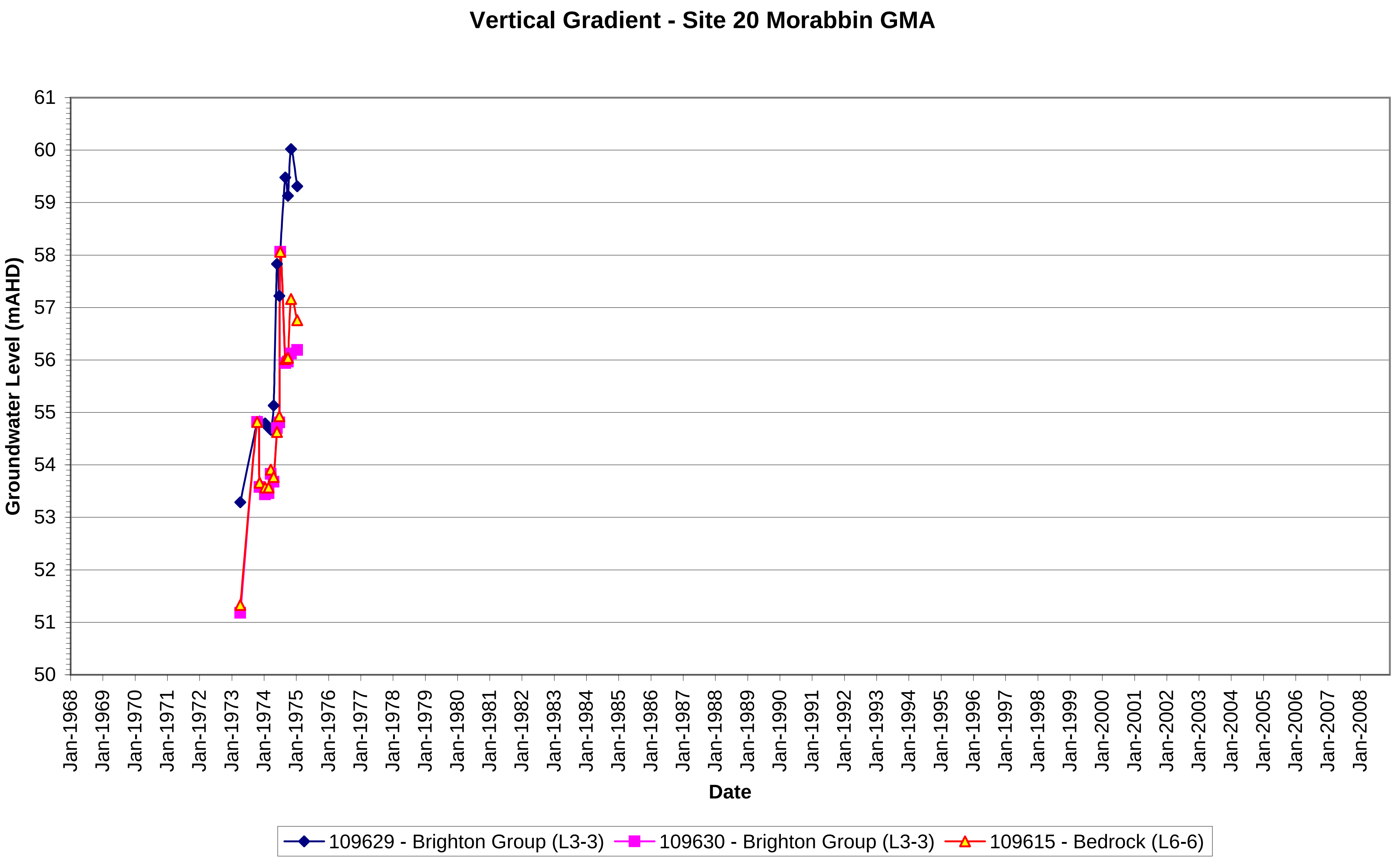

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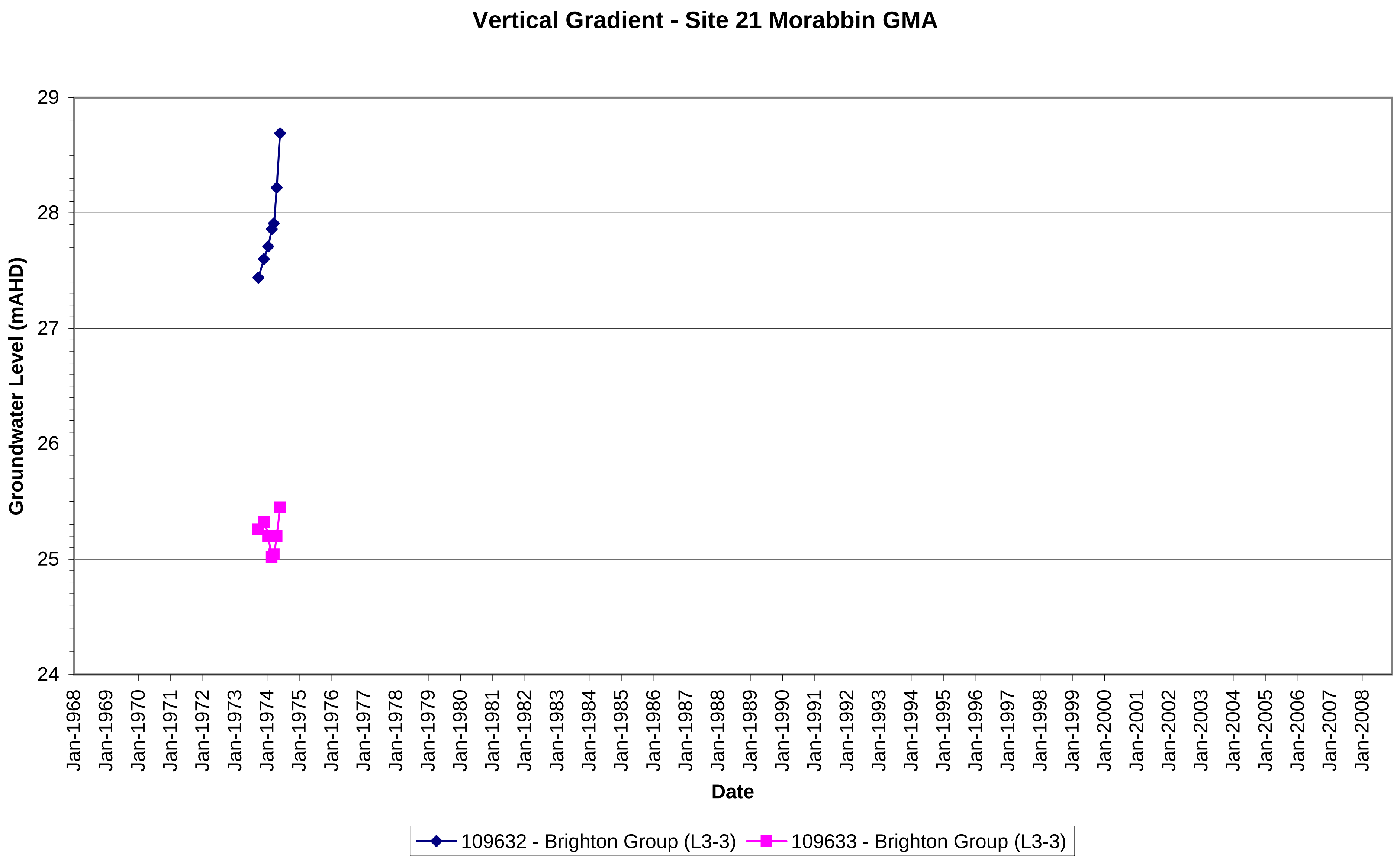

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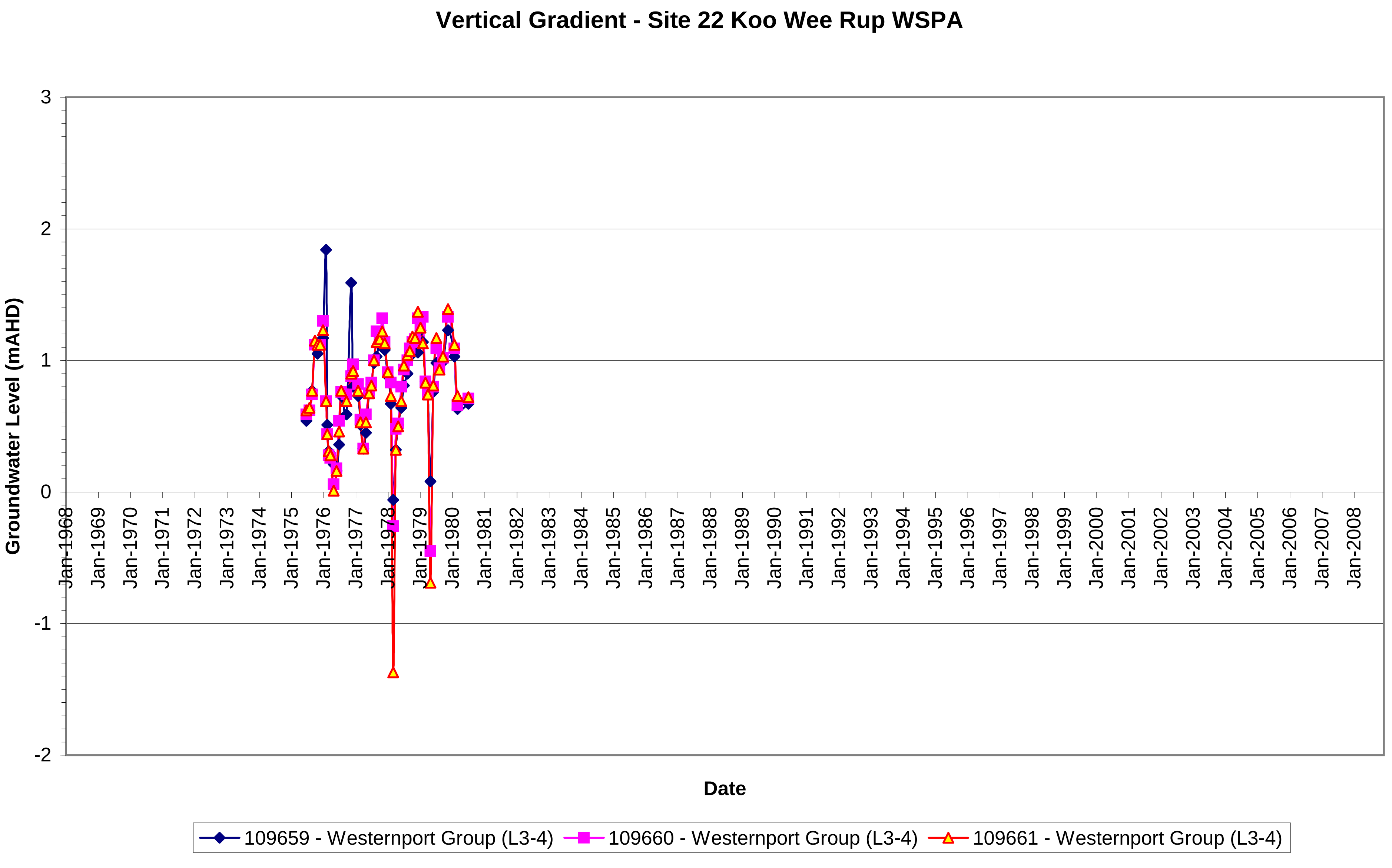

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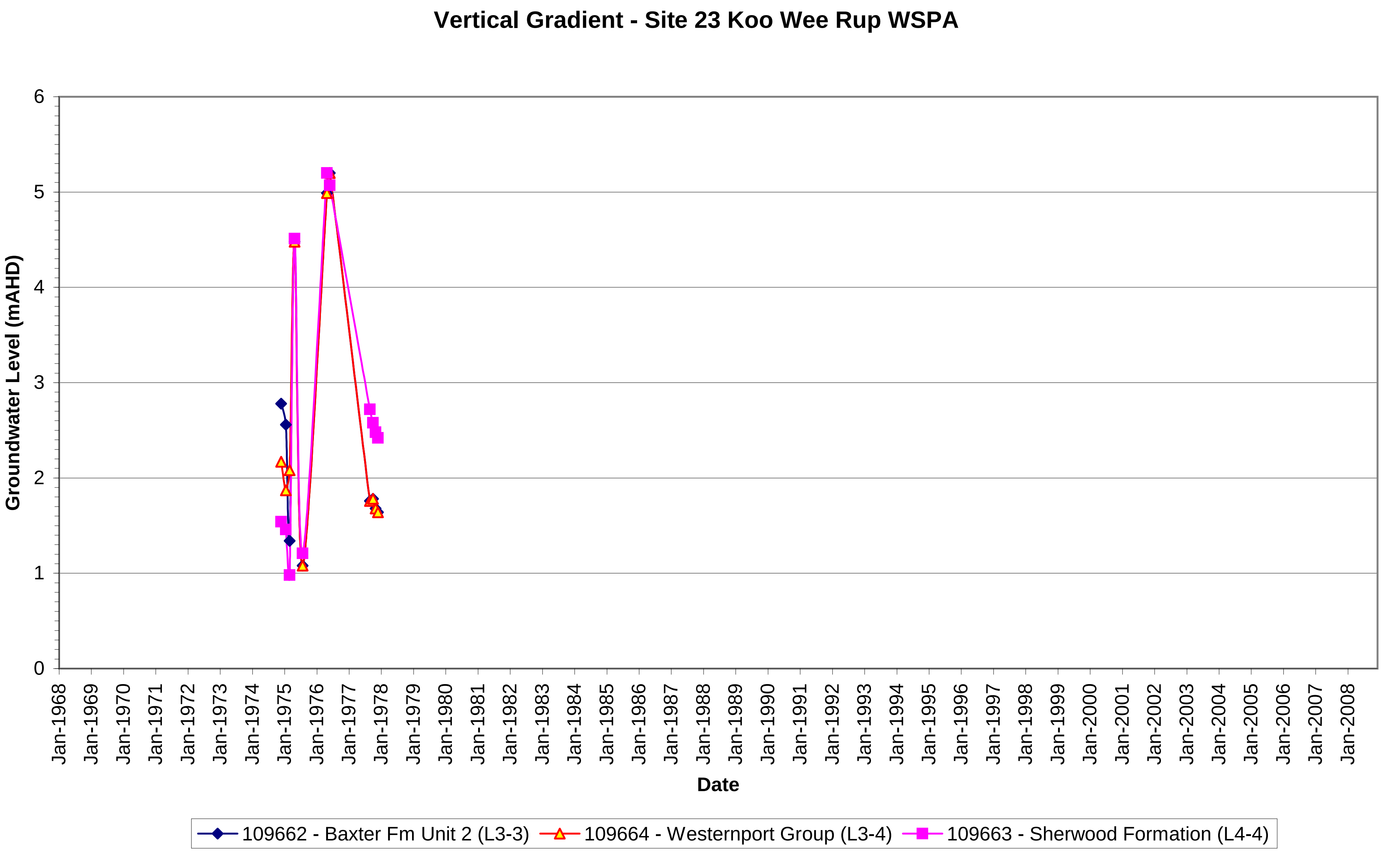

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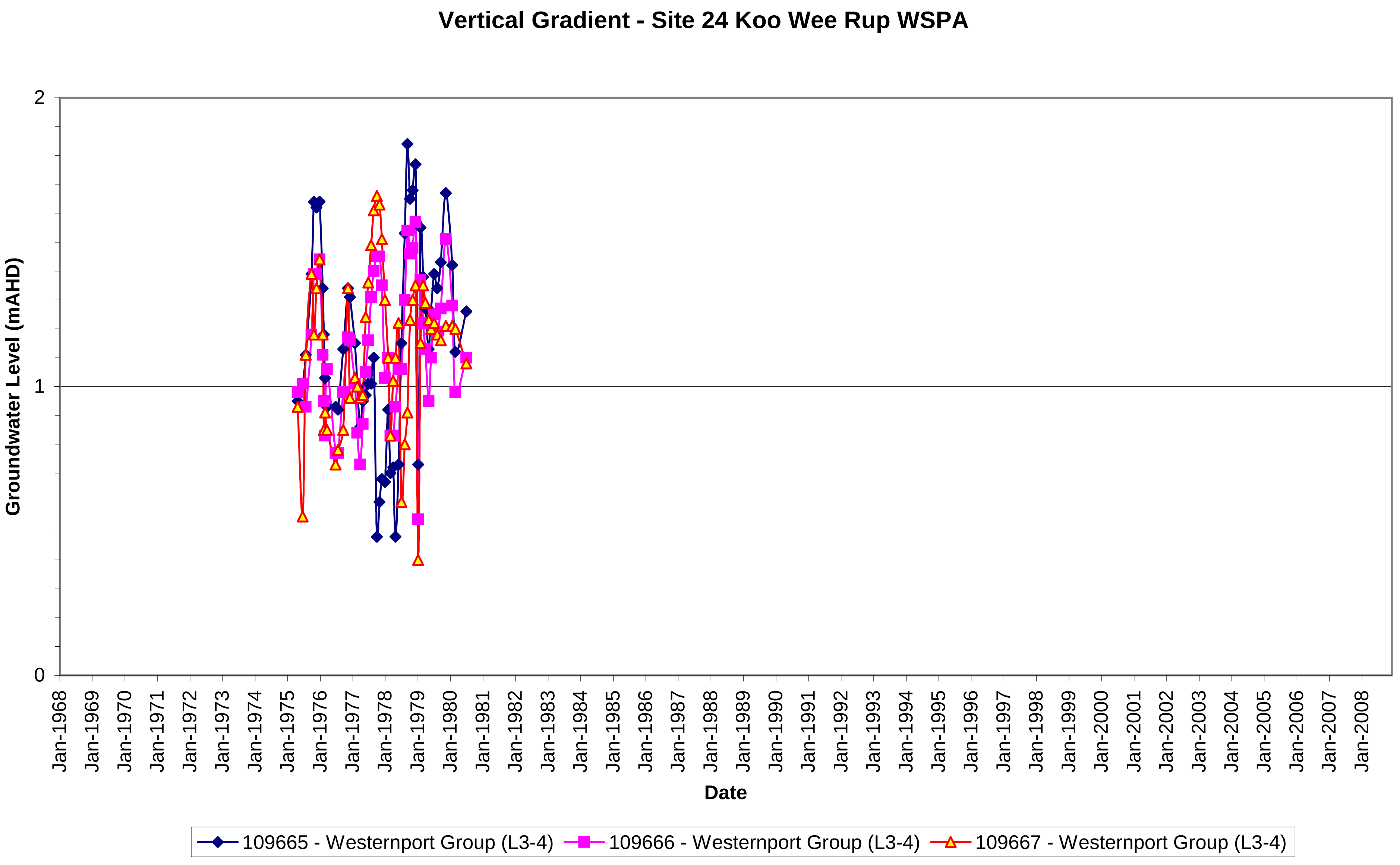

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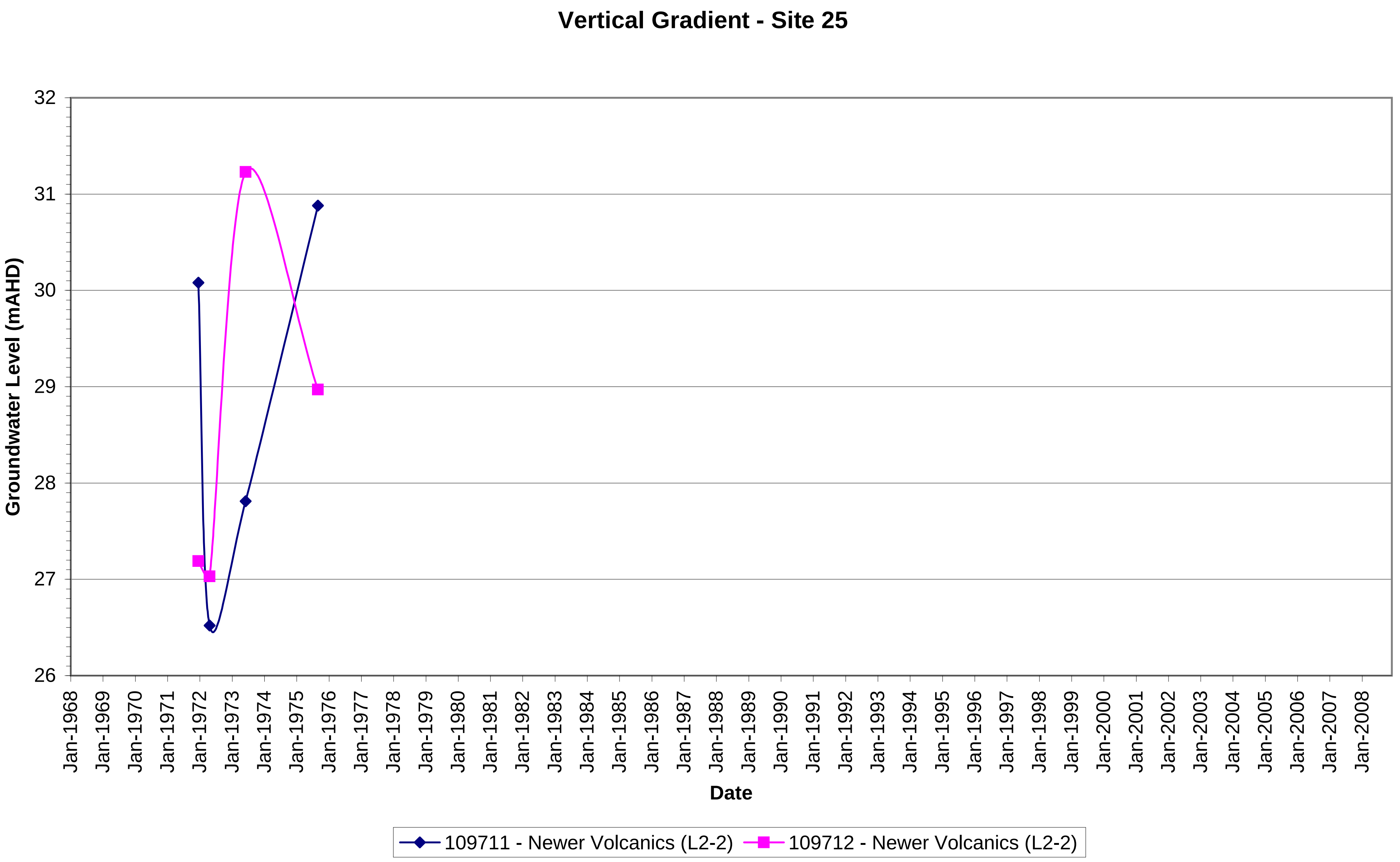

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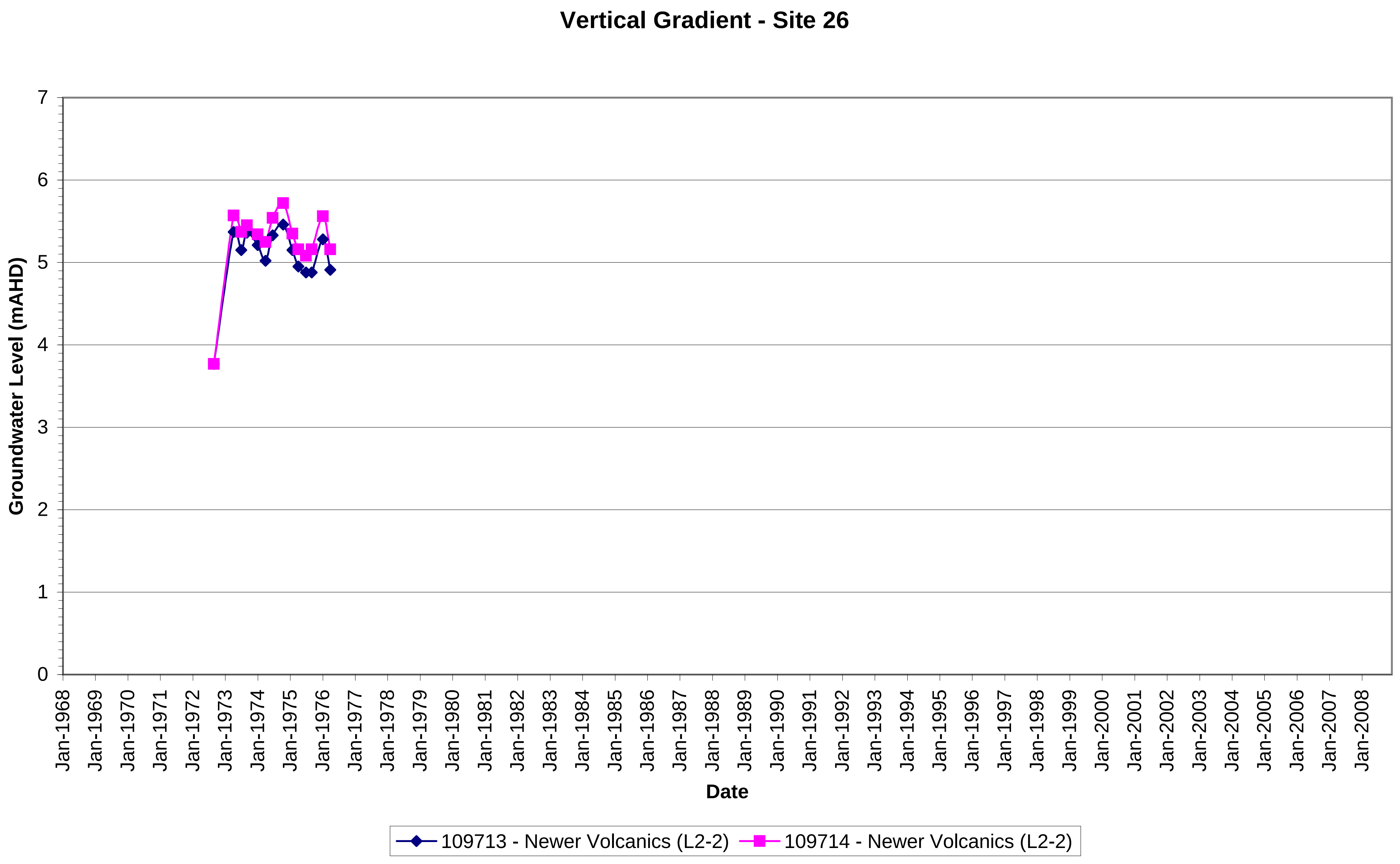

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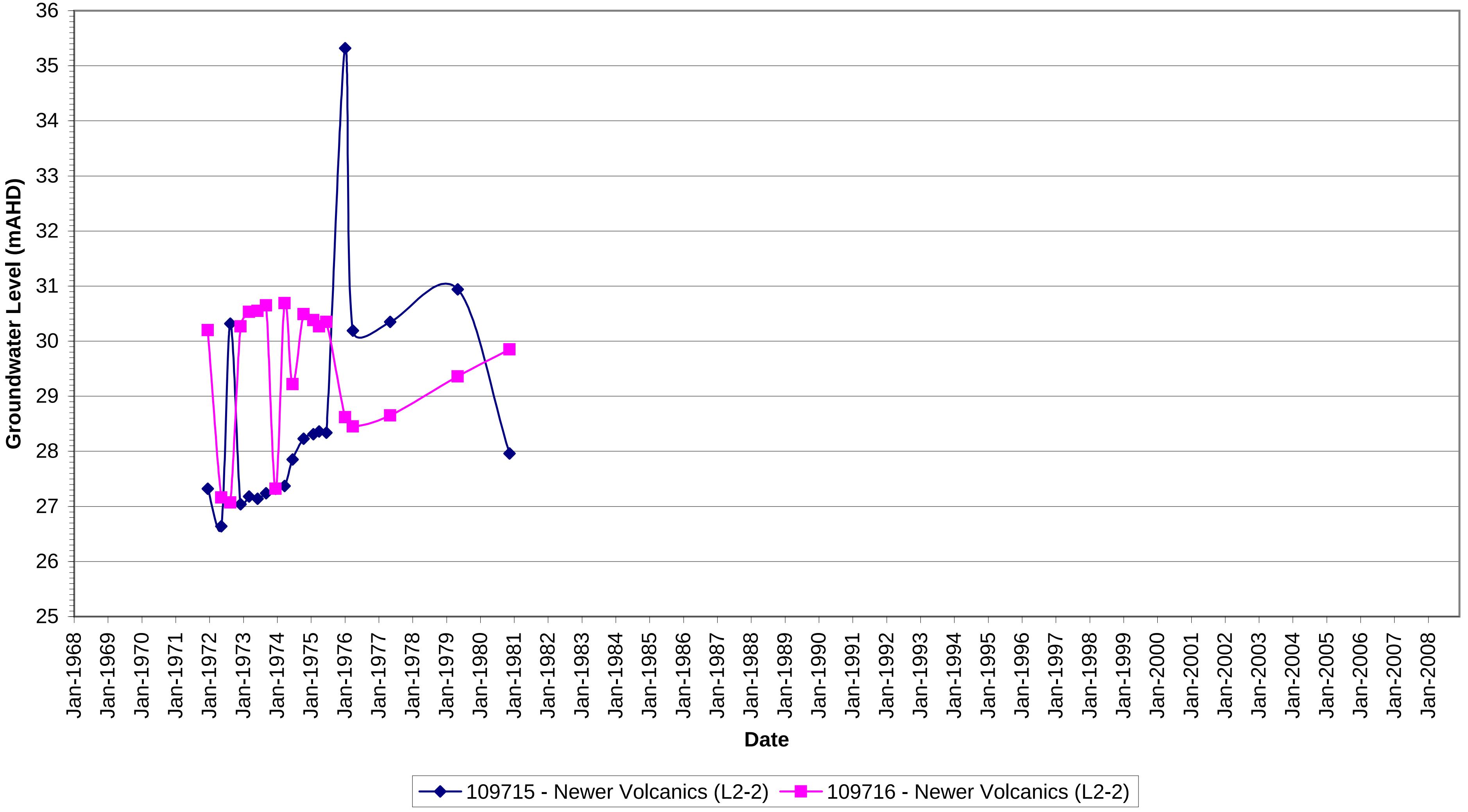
Vertical Gradient - Site 27



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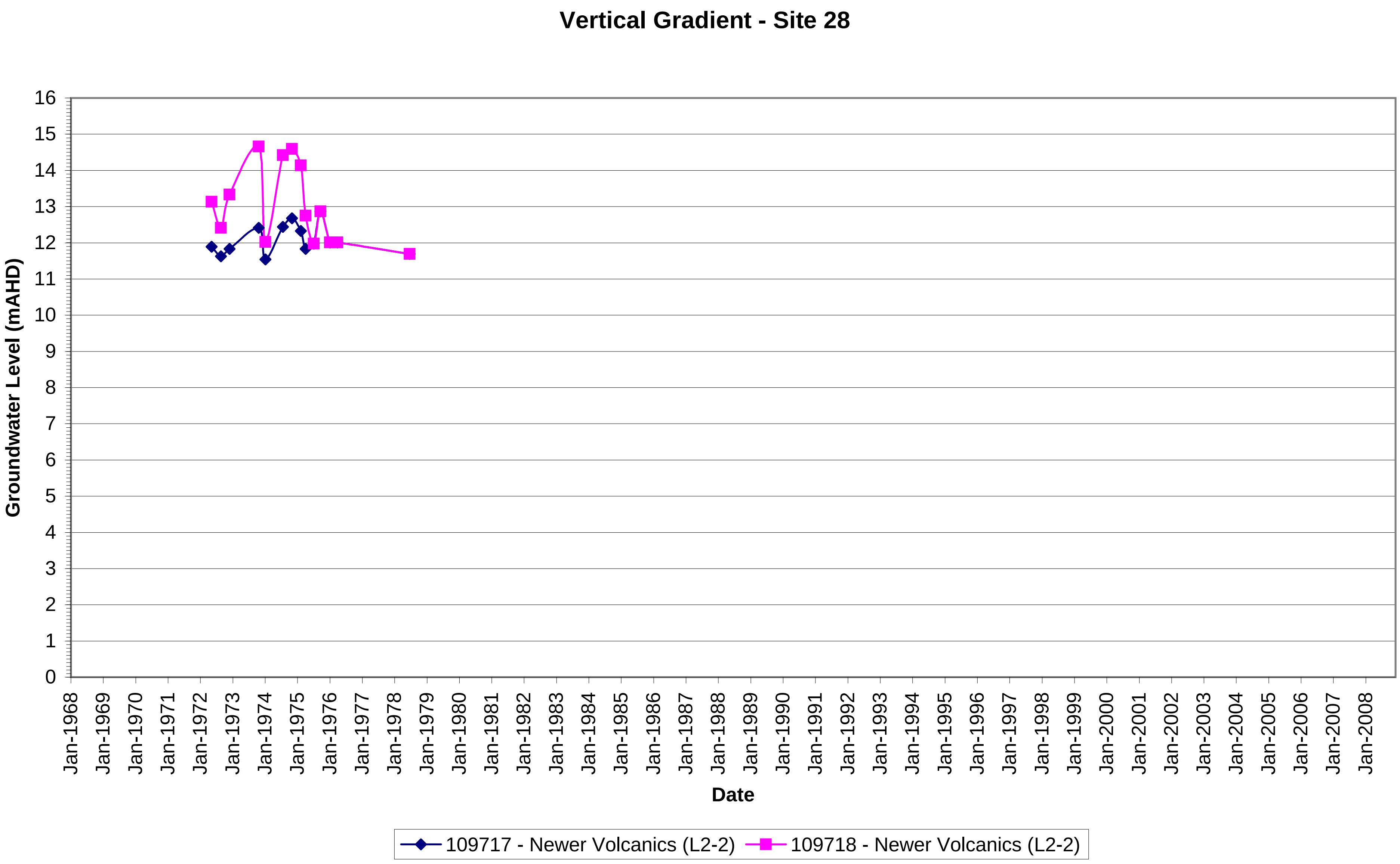

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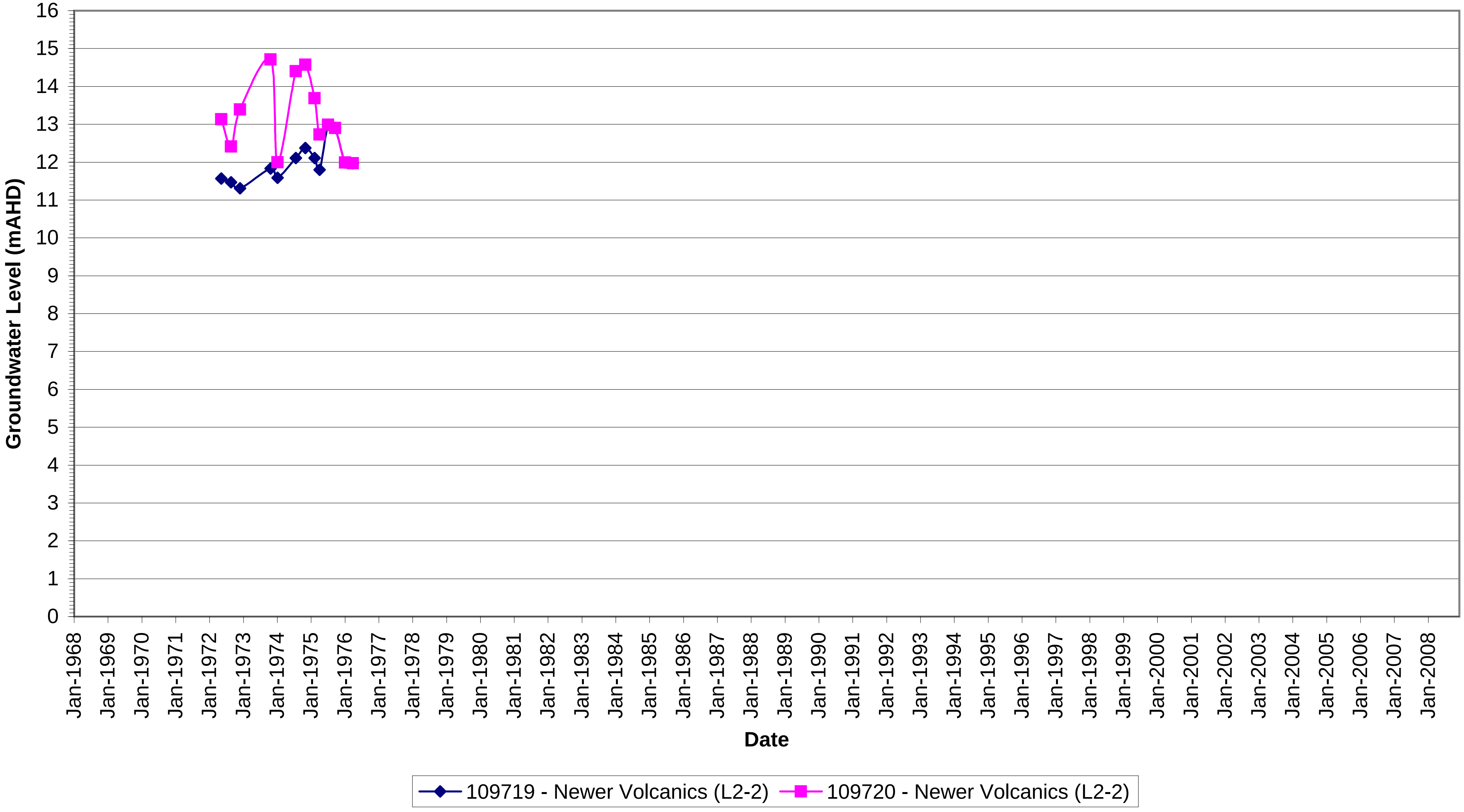

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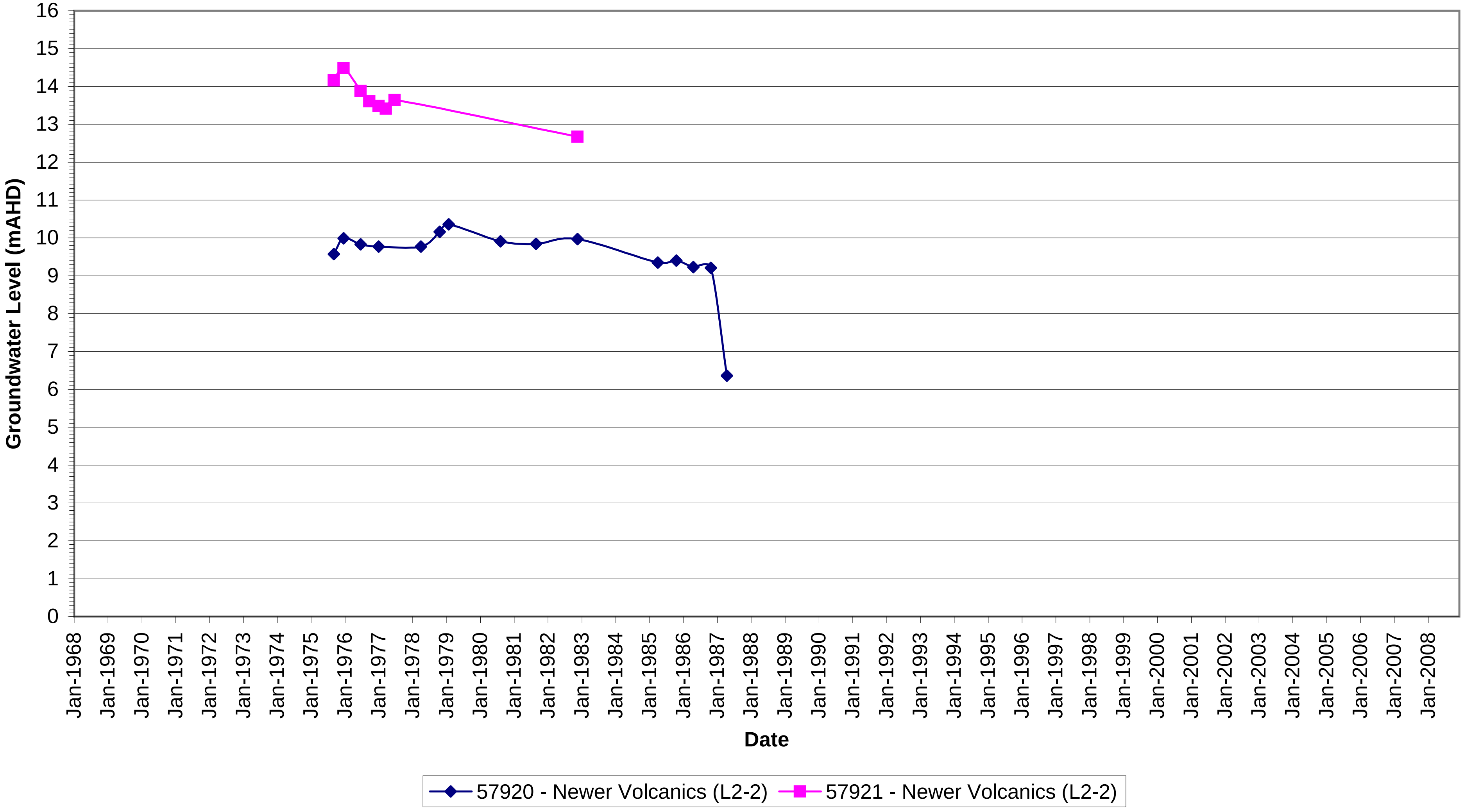
Vertical Gradient - Site 38



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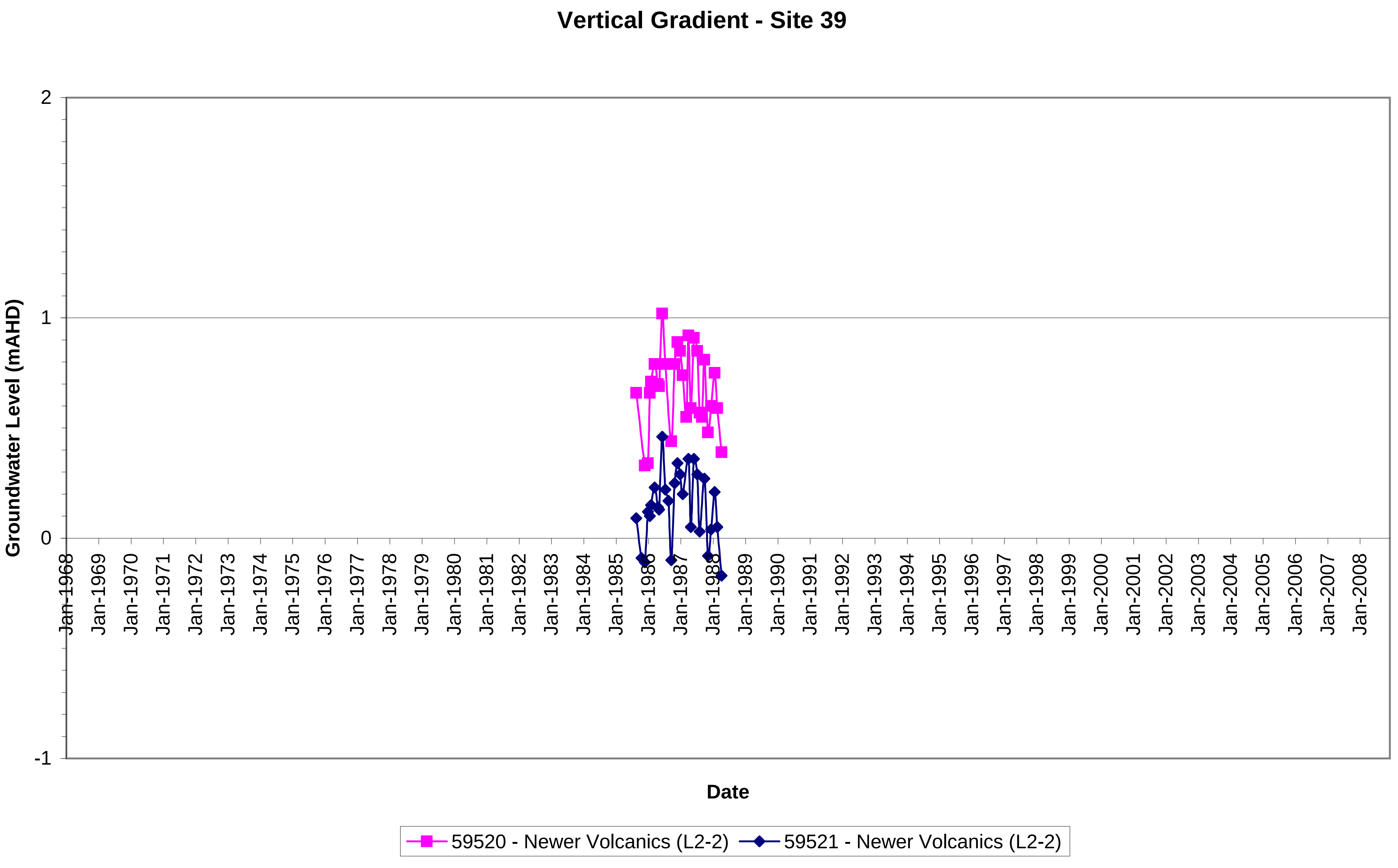

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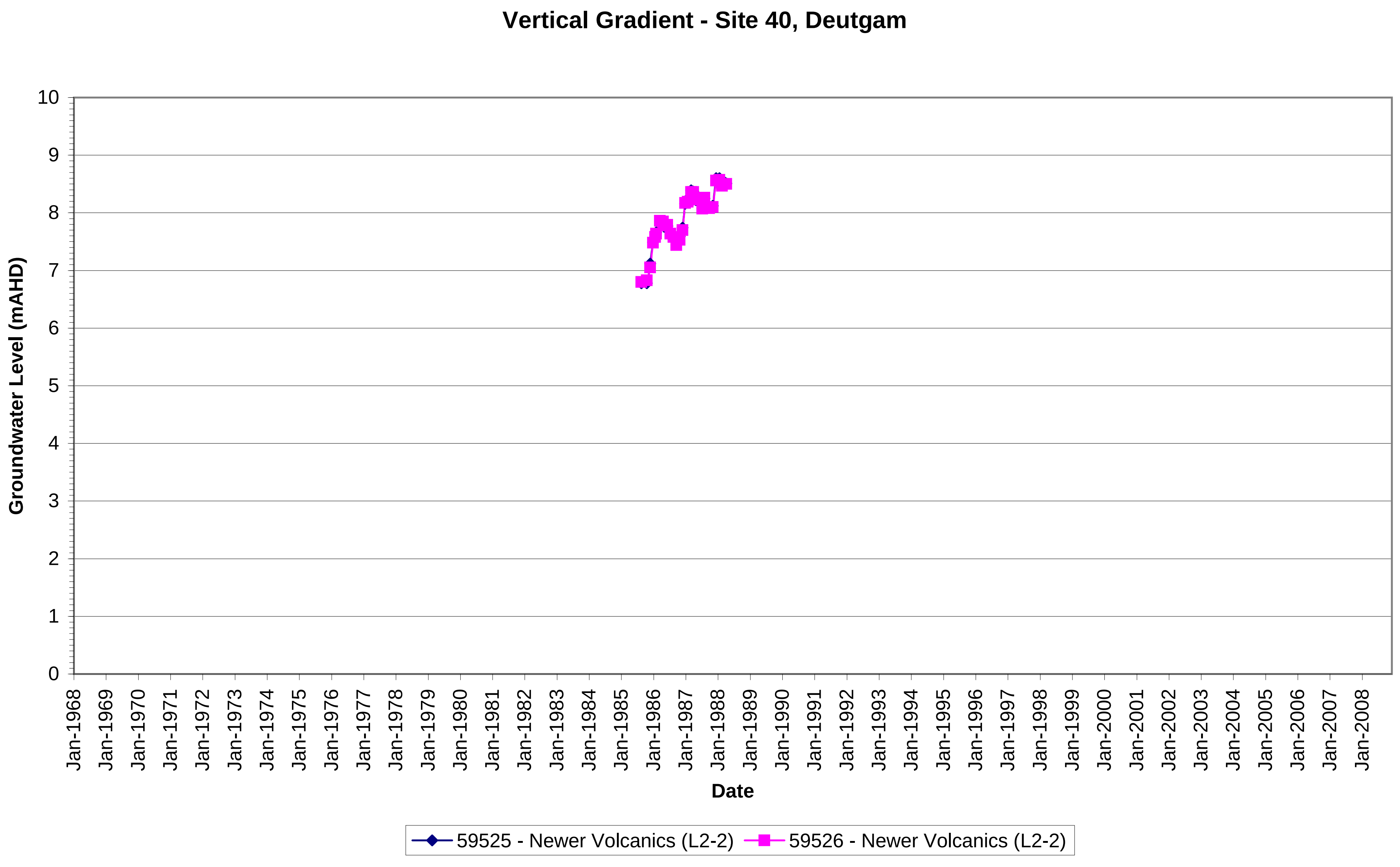

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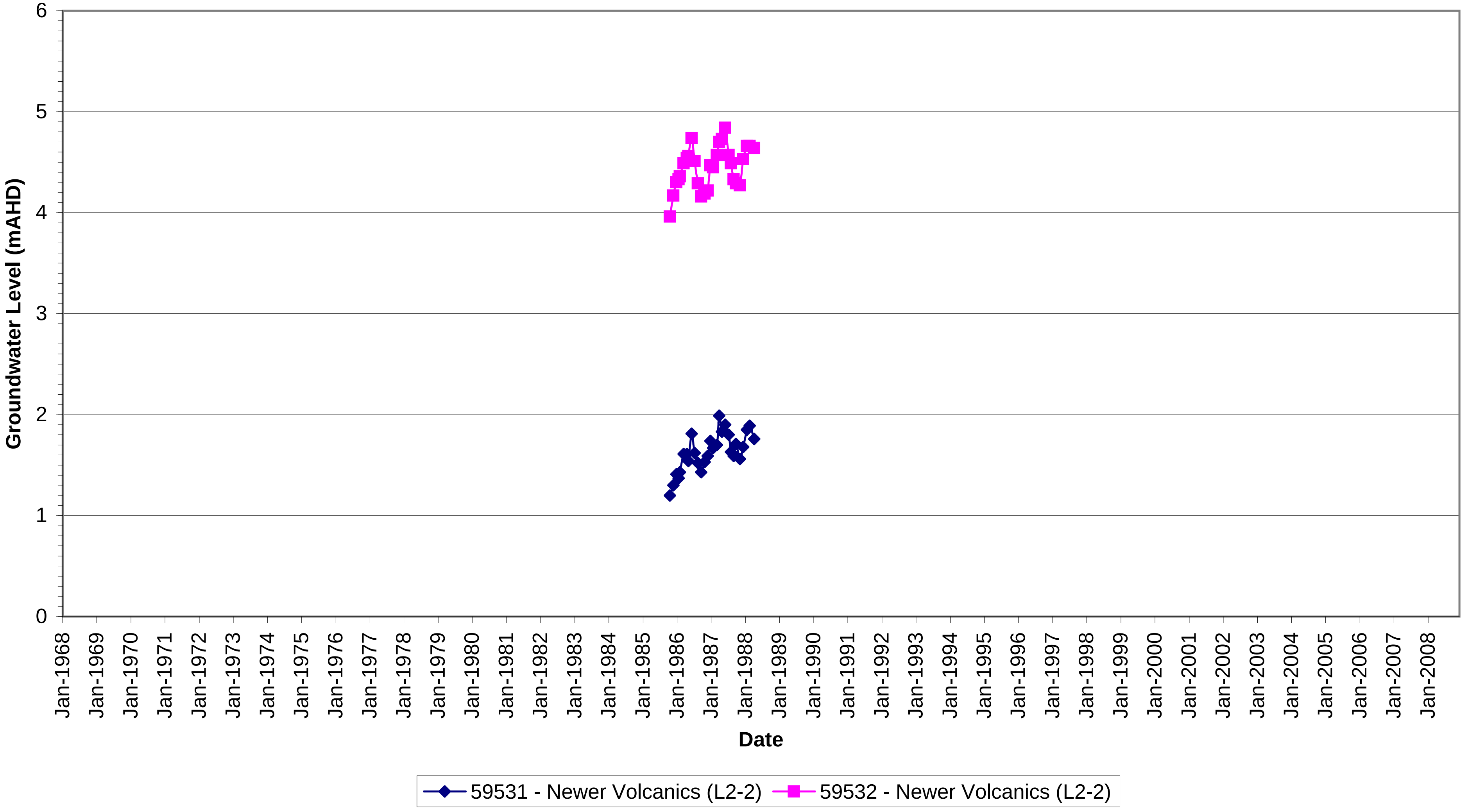
Vertical Gradient - Site 41, Deutgam



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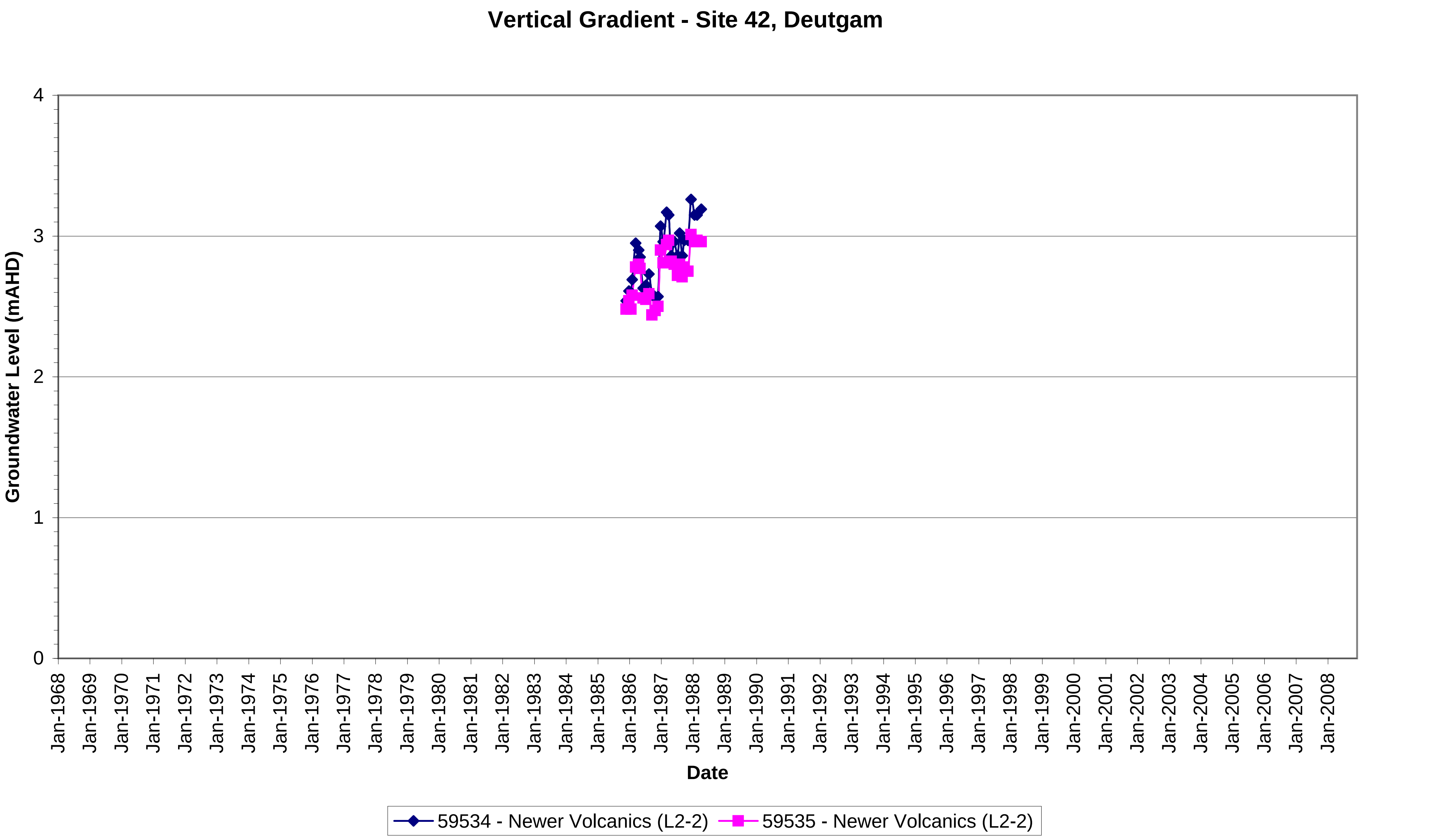

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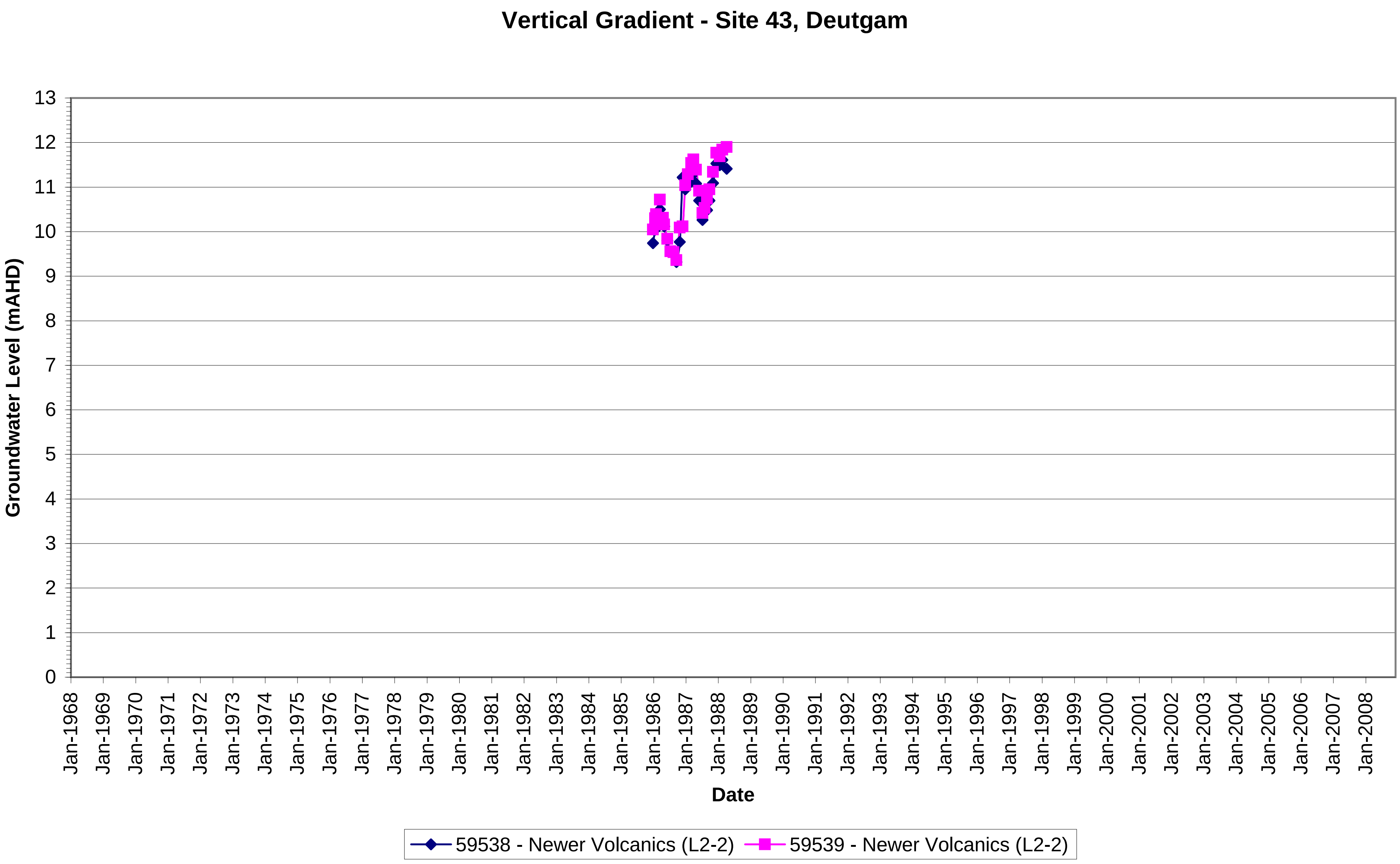

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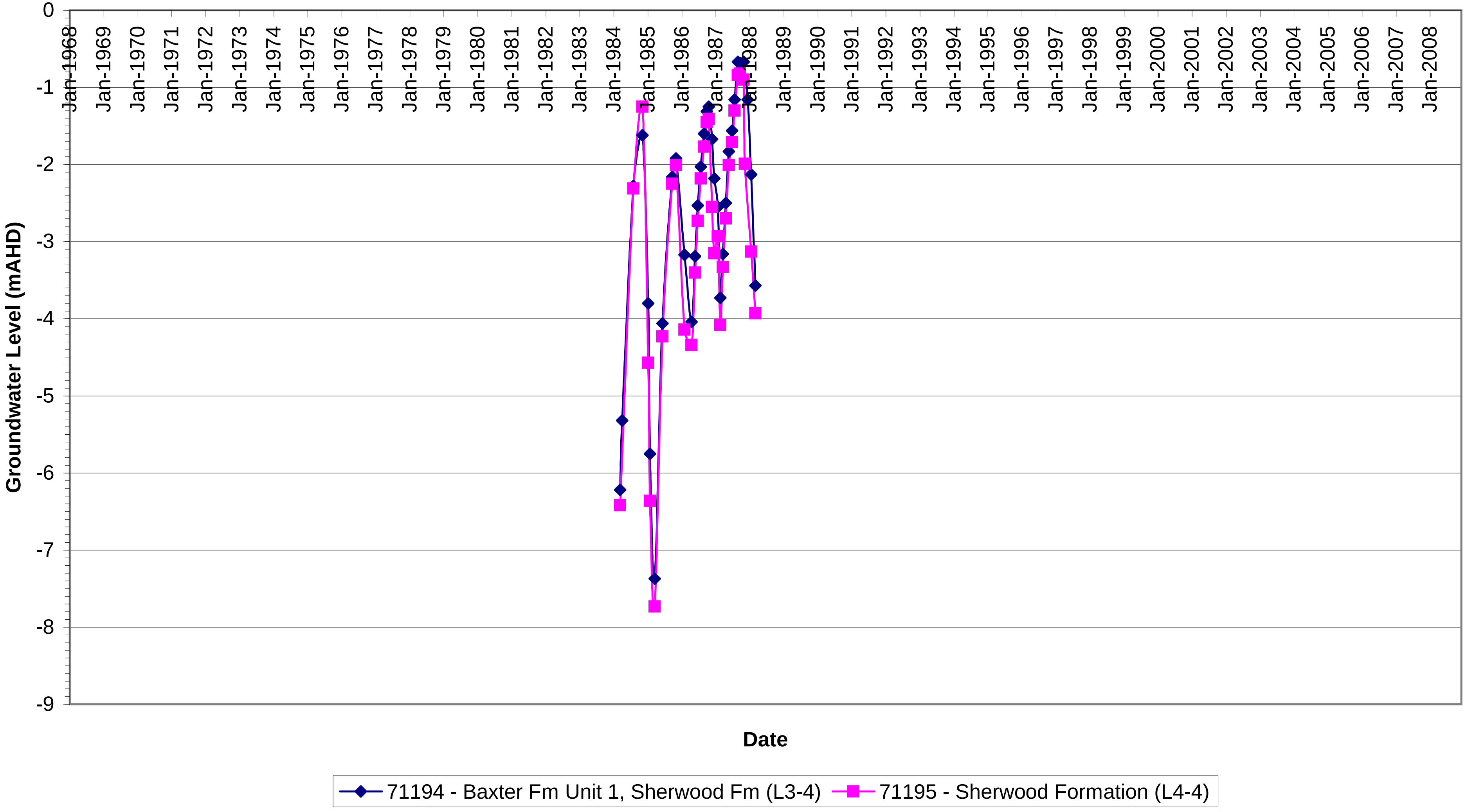

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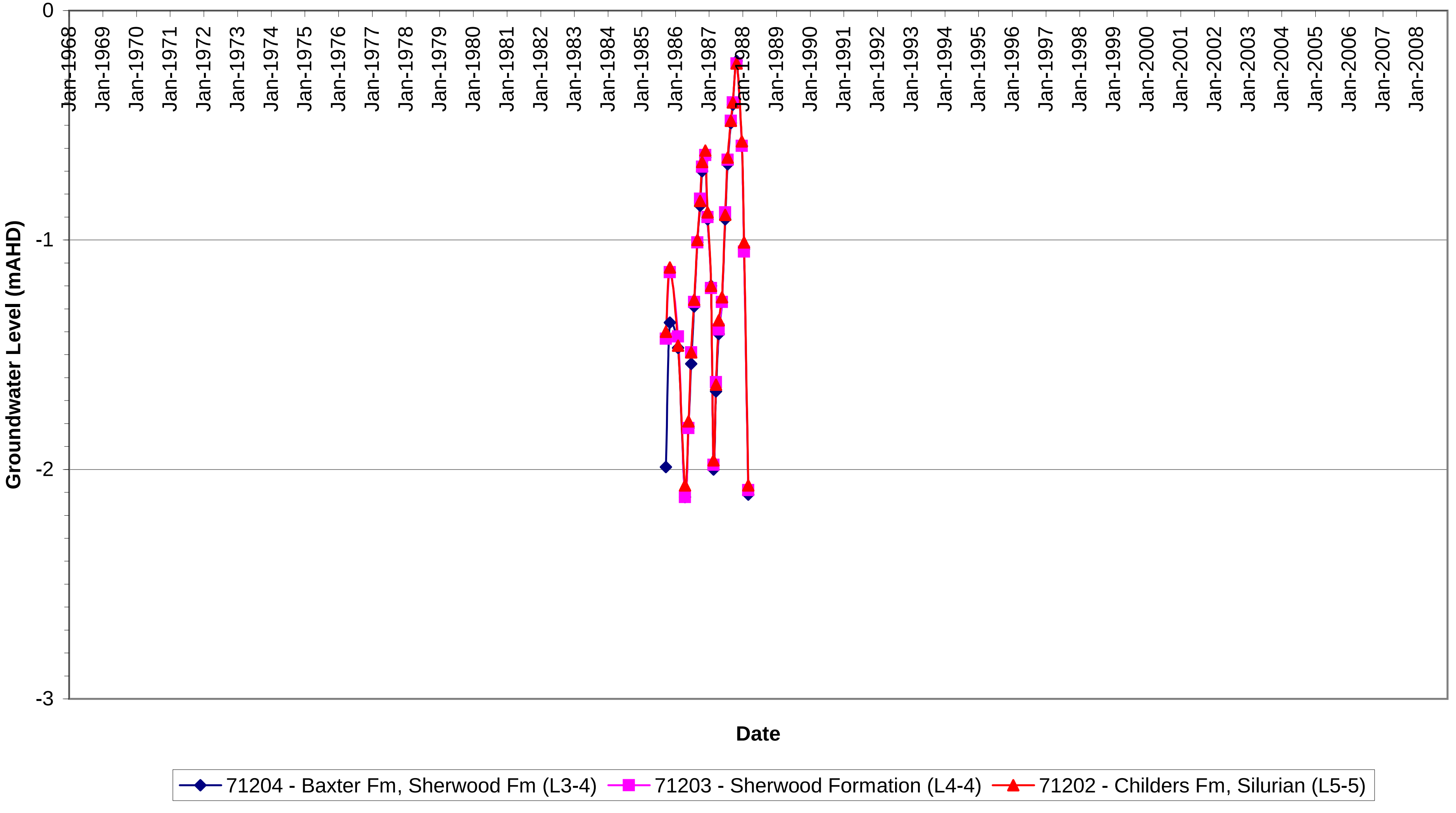

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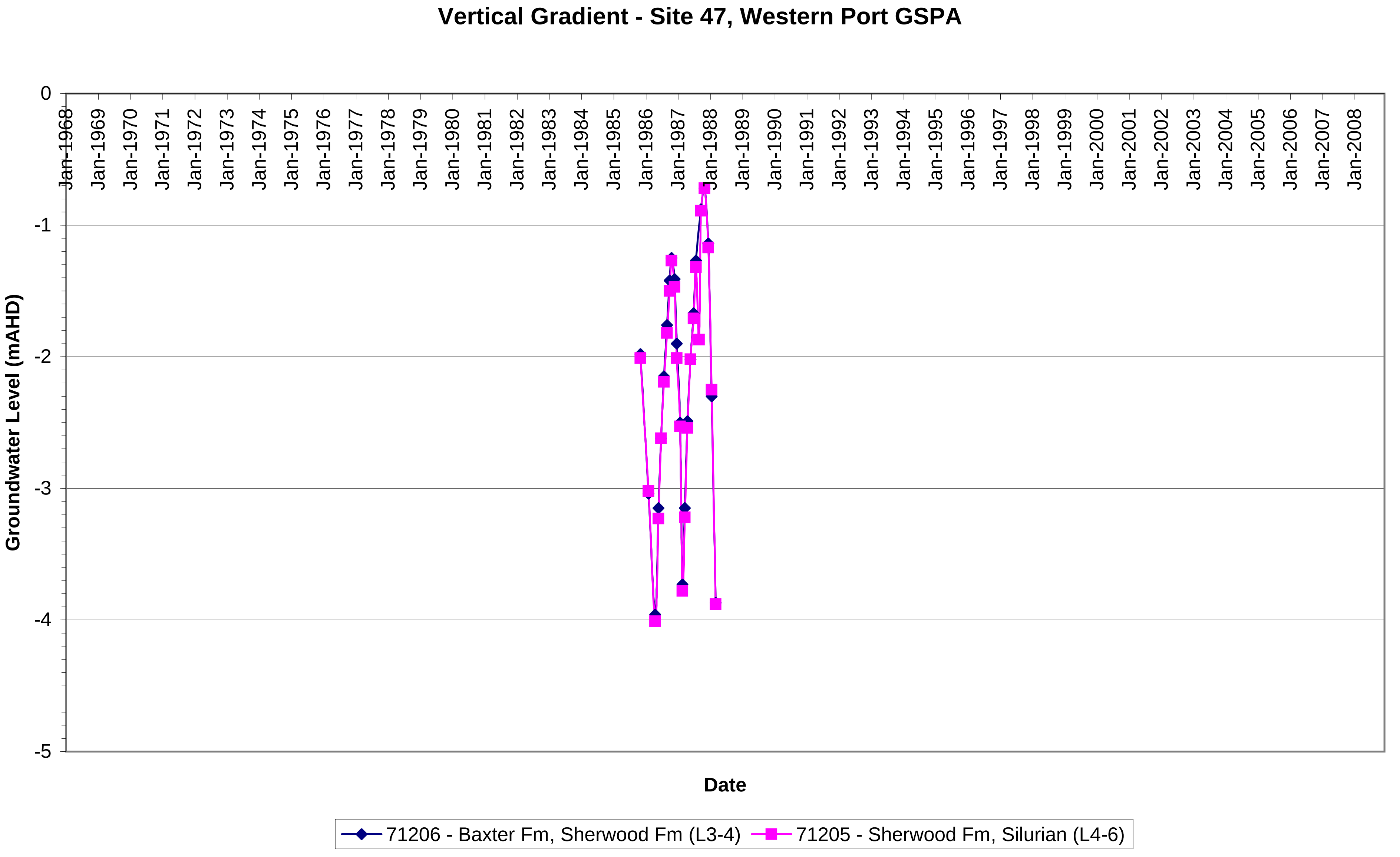

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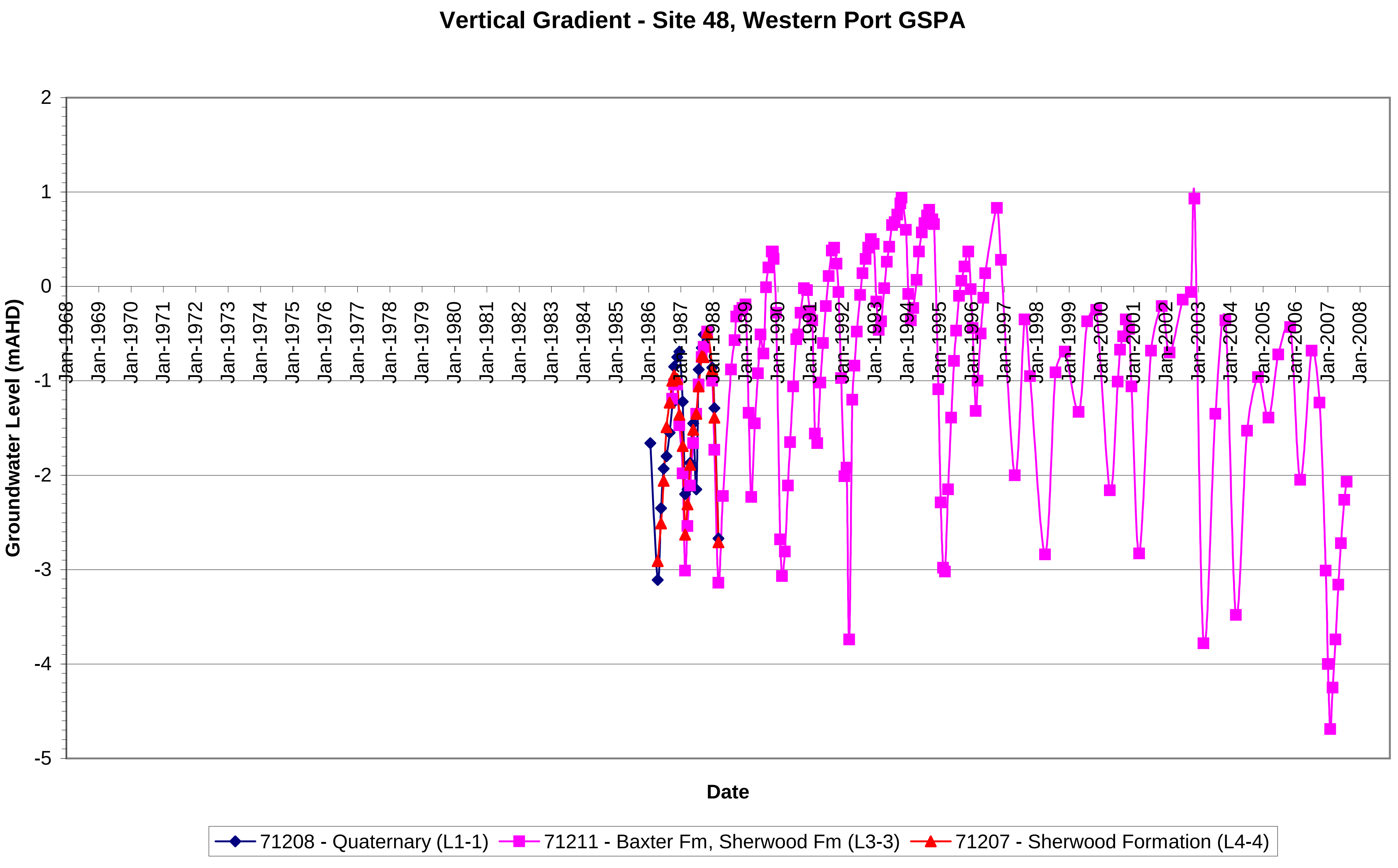

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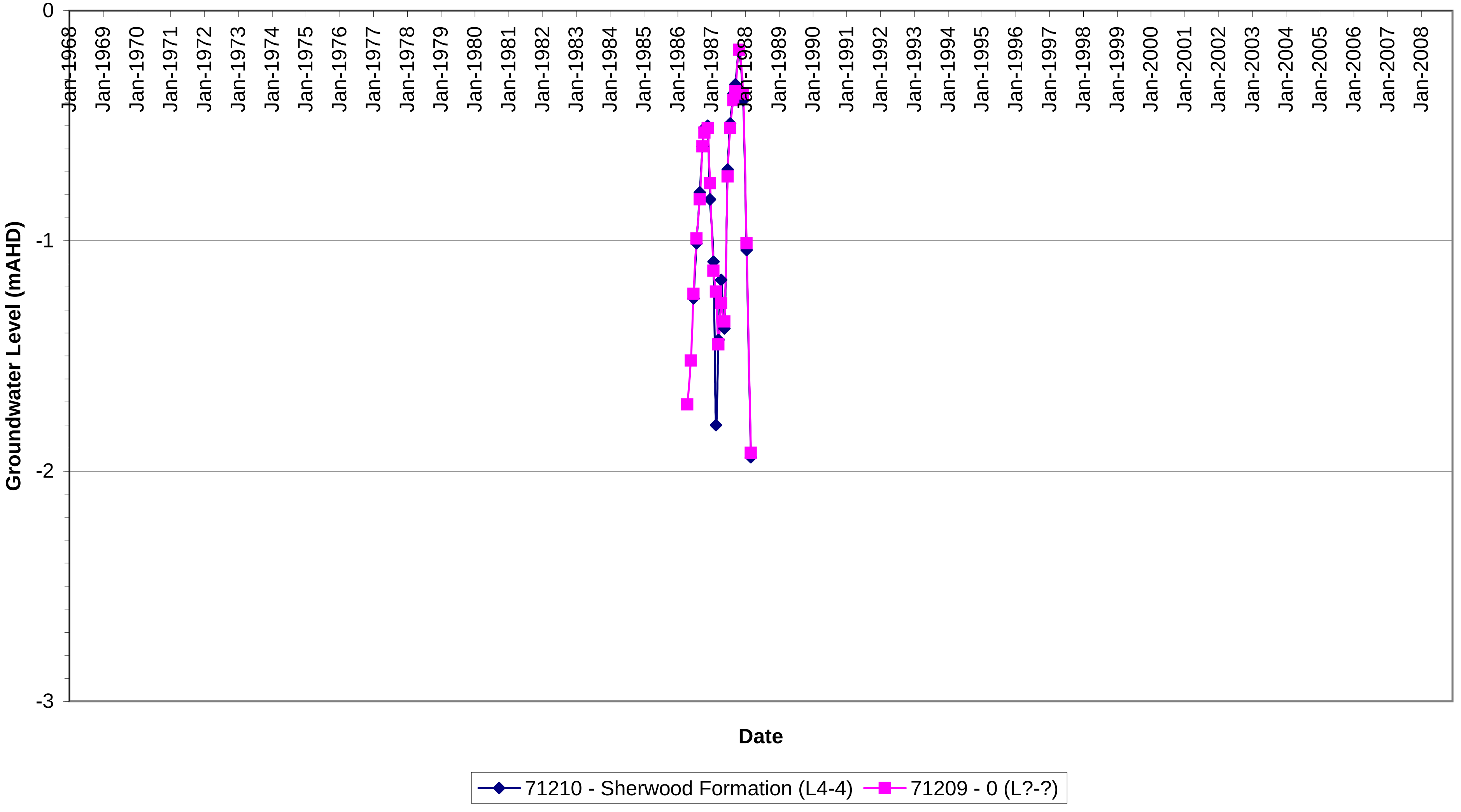

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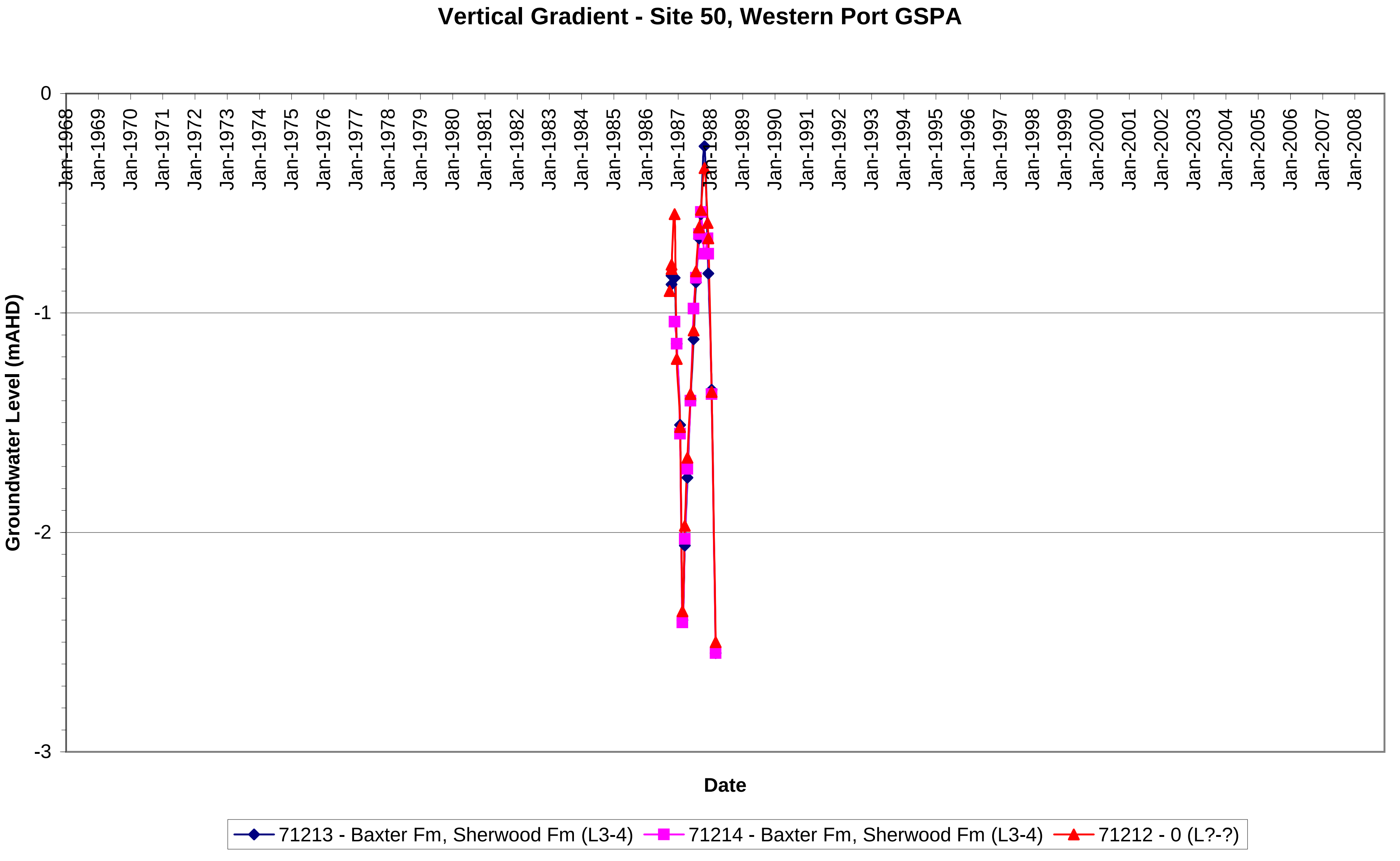

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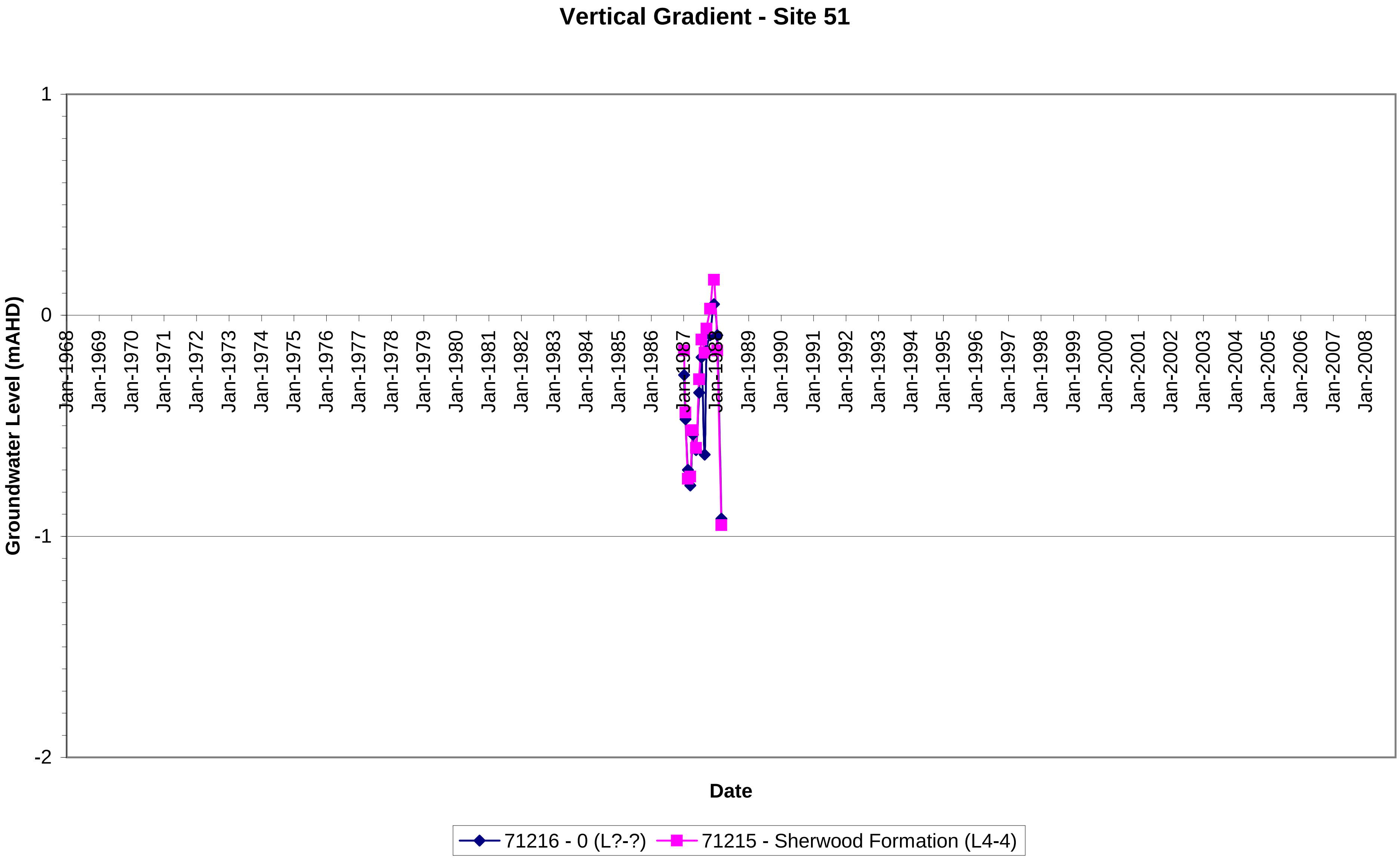

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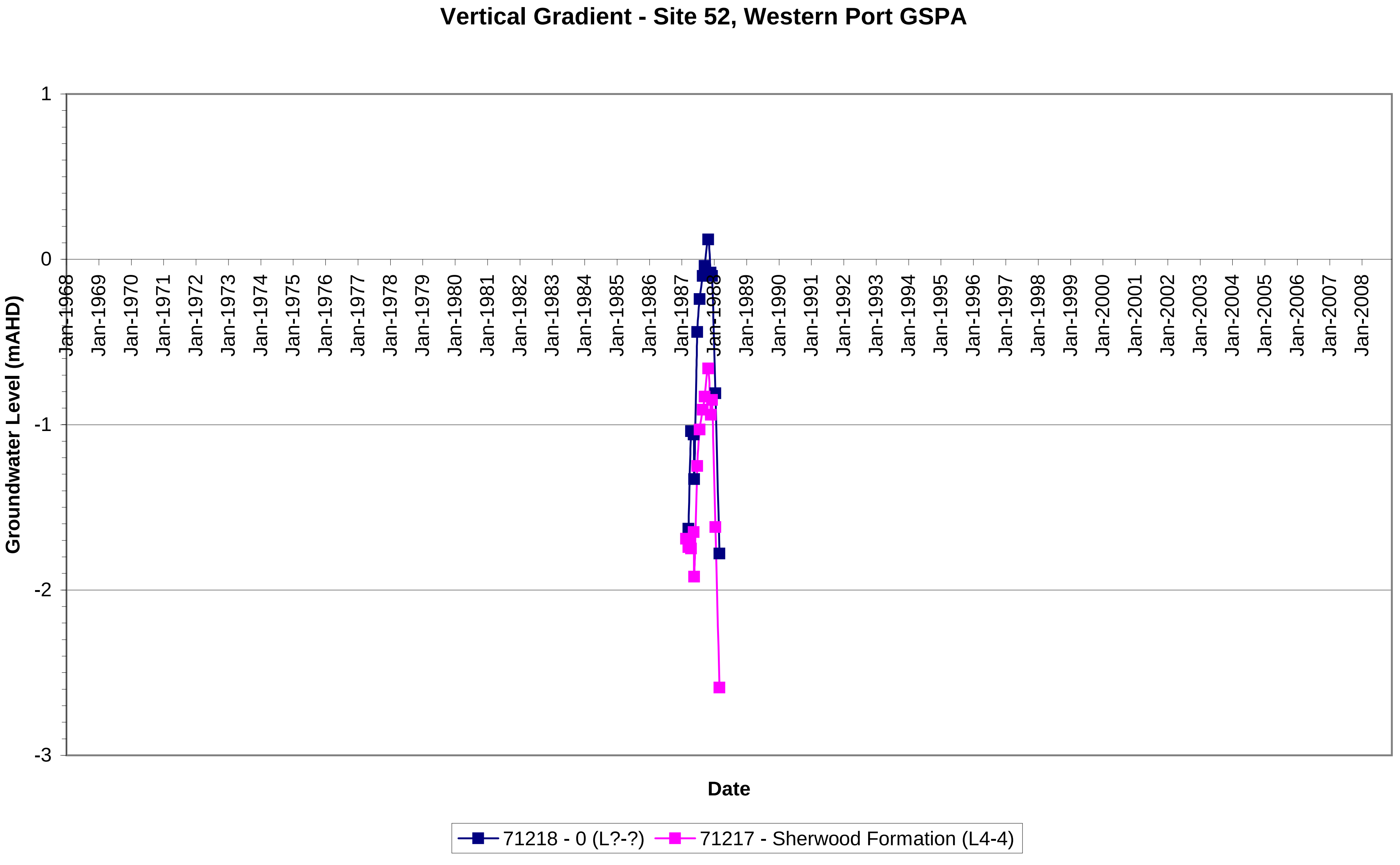

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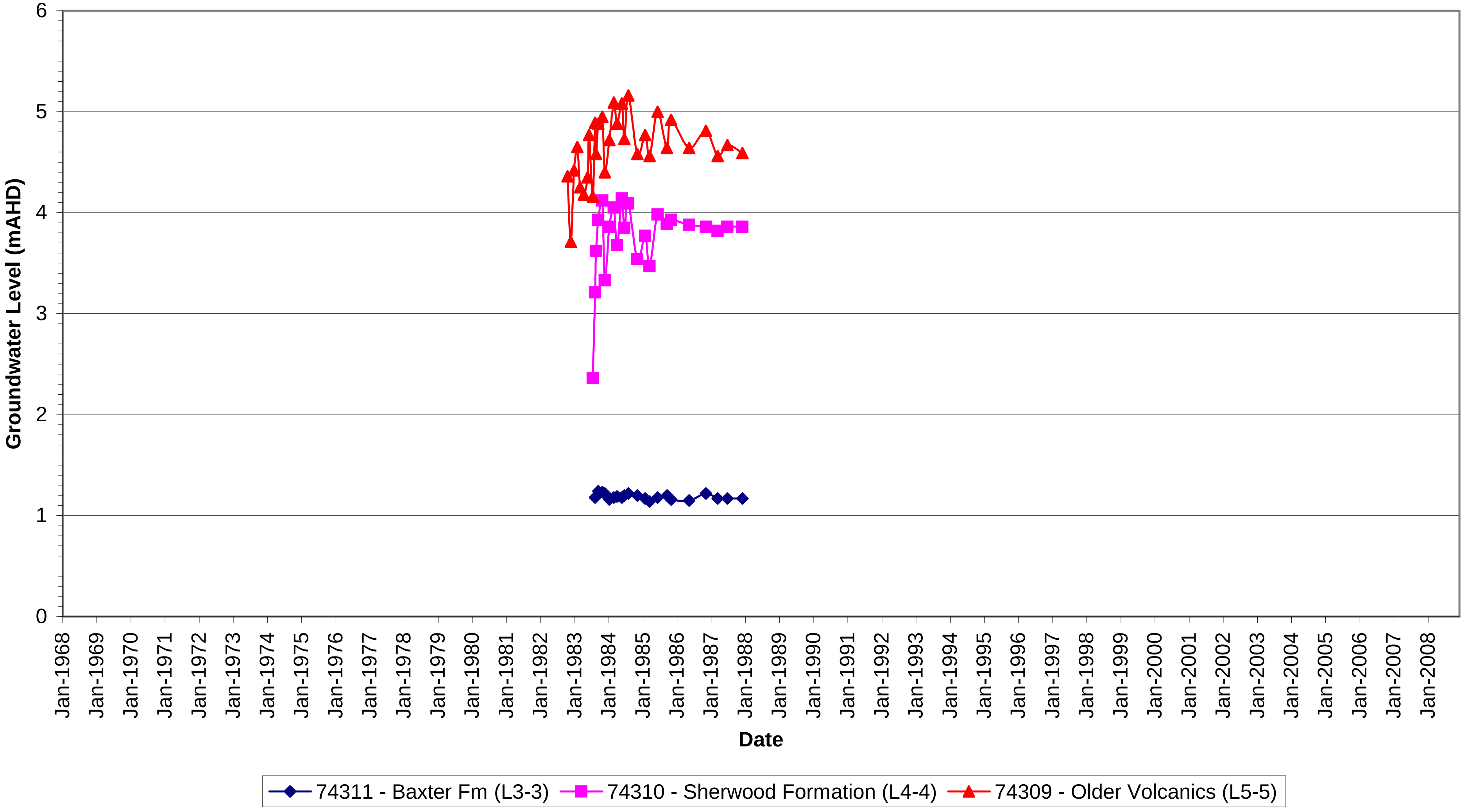
Vertical Gradient - Site 53, Koo Wee Rup



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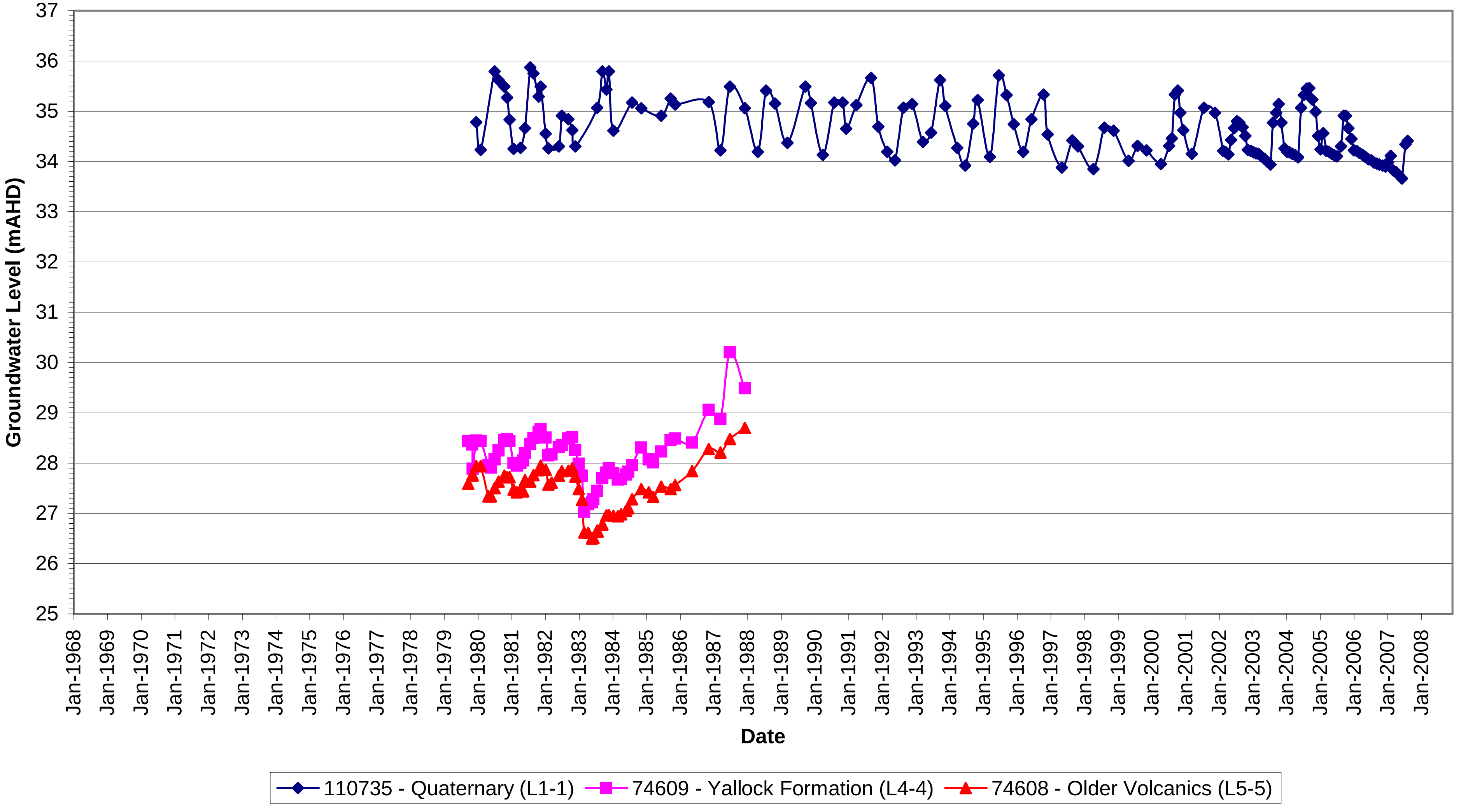

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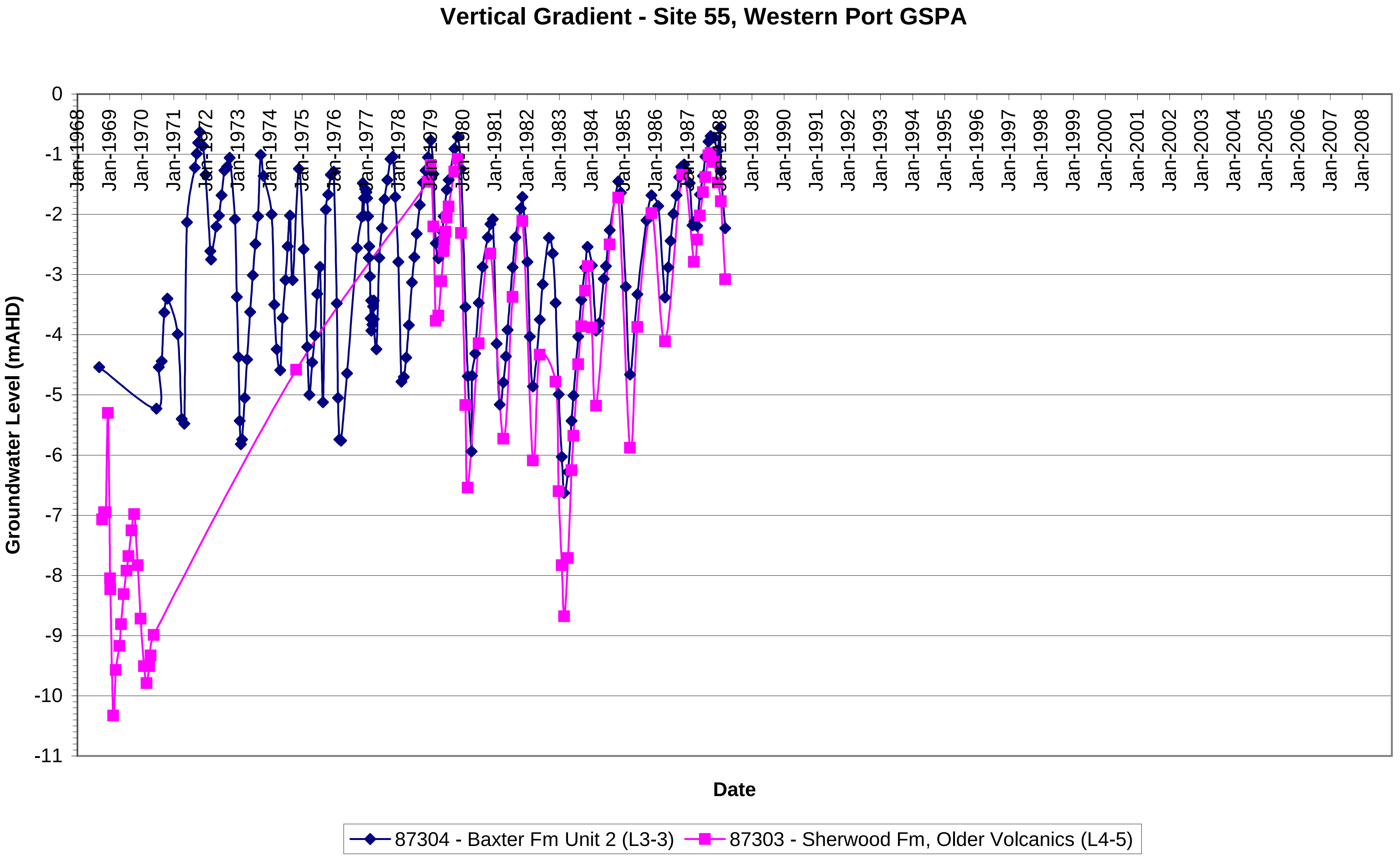

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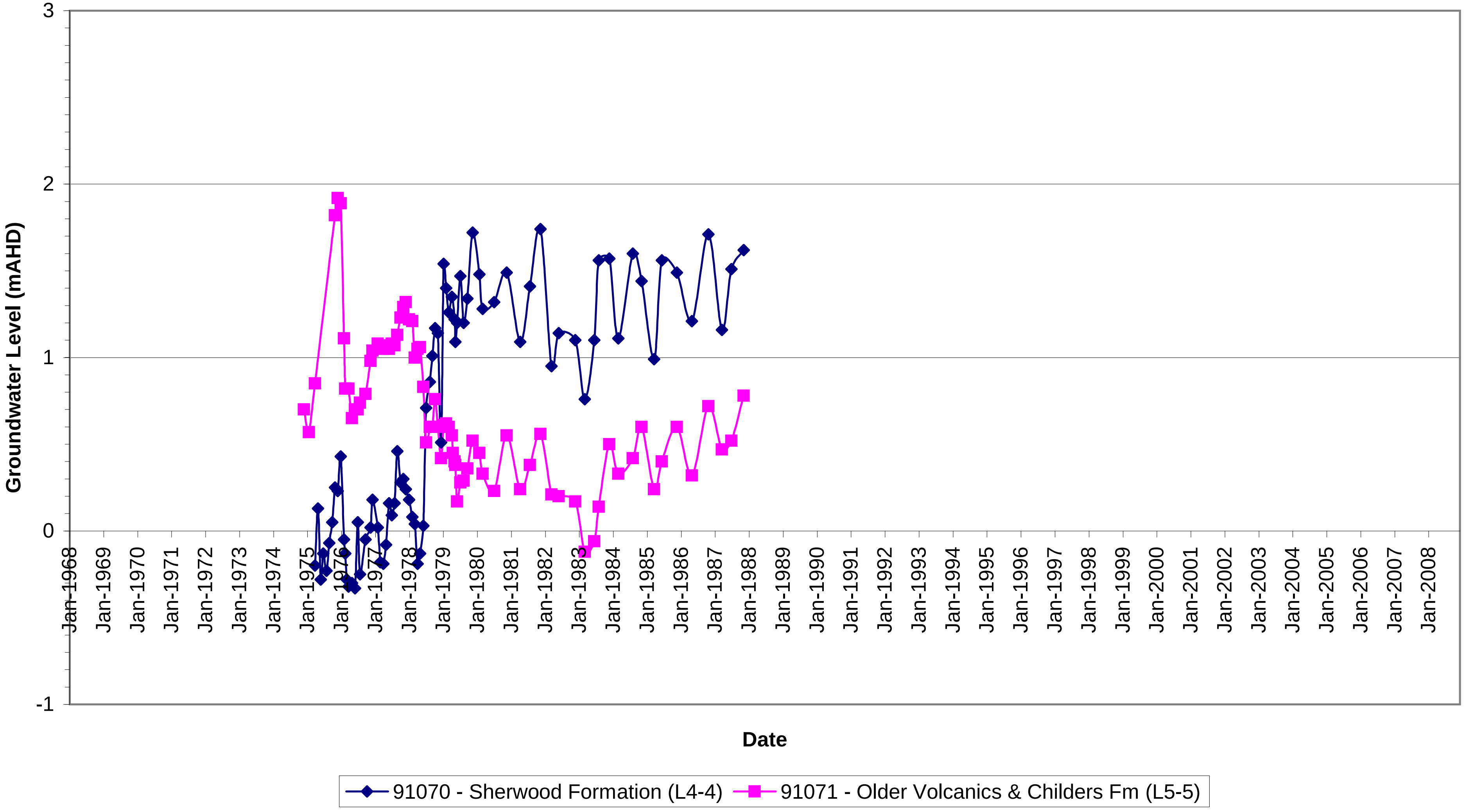
Vertical Gradient - Site 56, Koo Wee Rup WSPA



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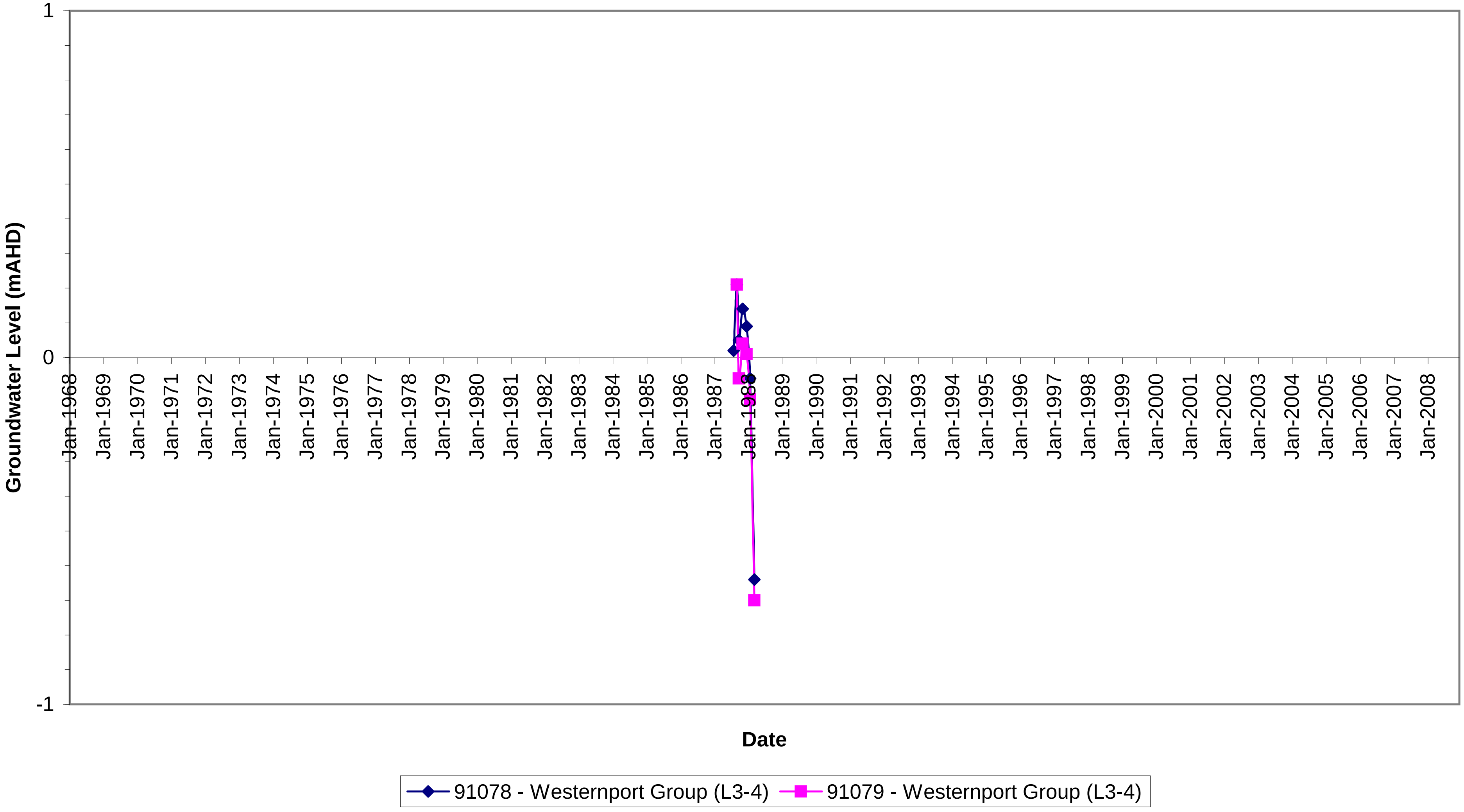

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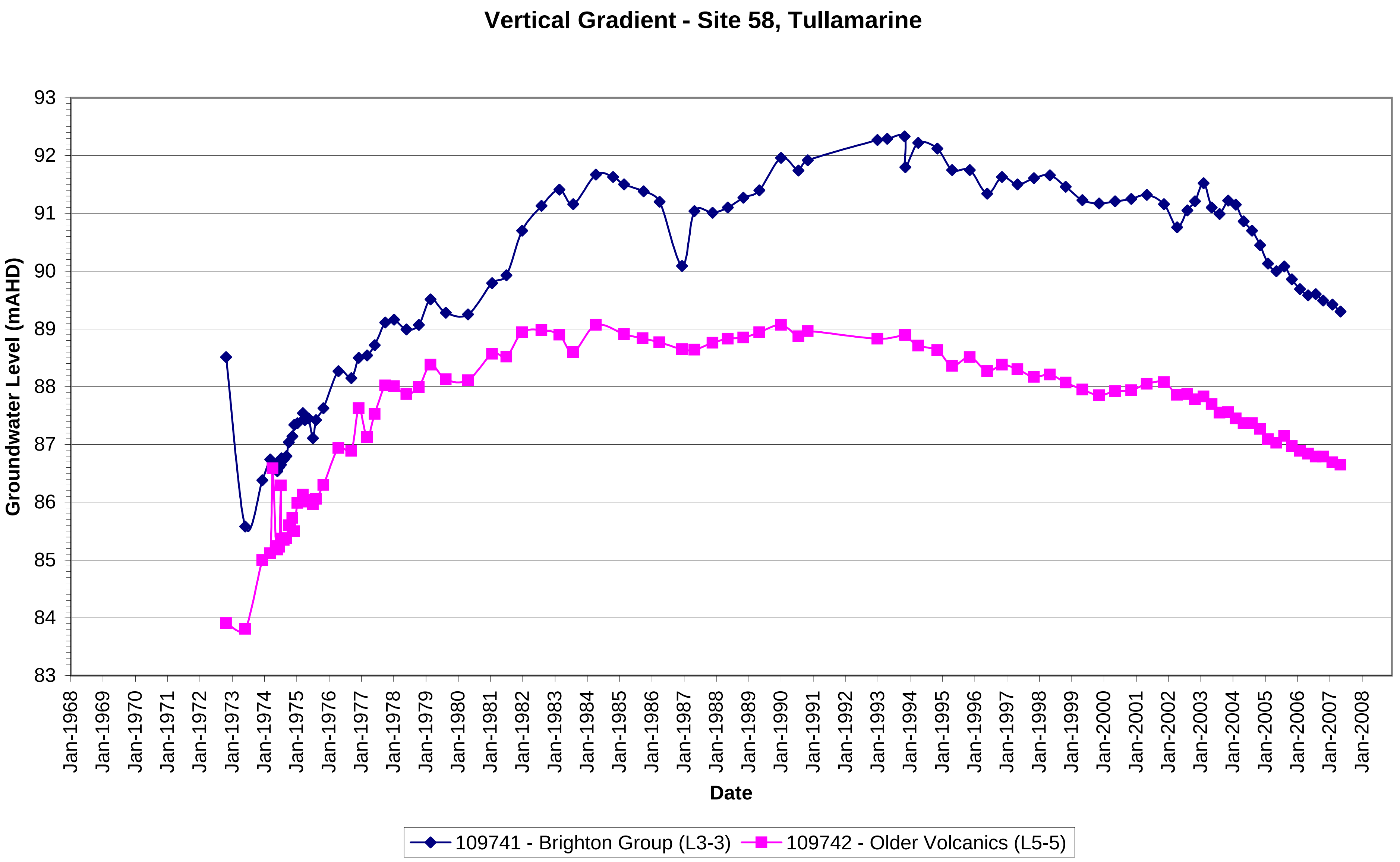

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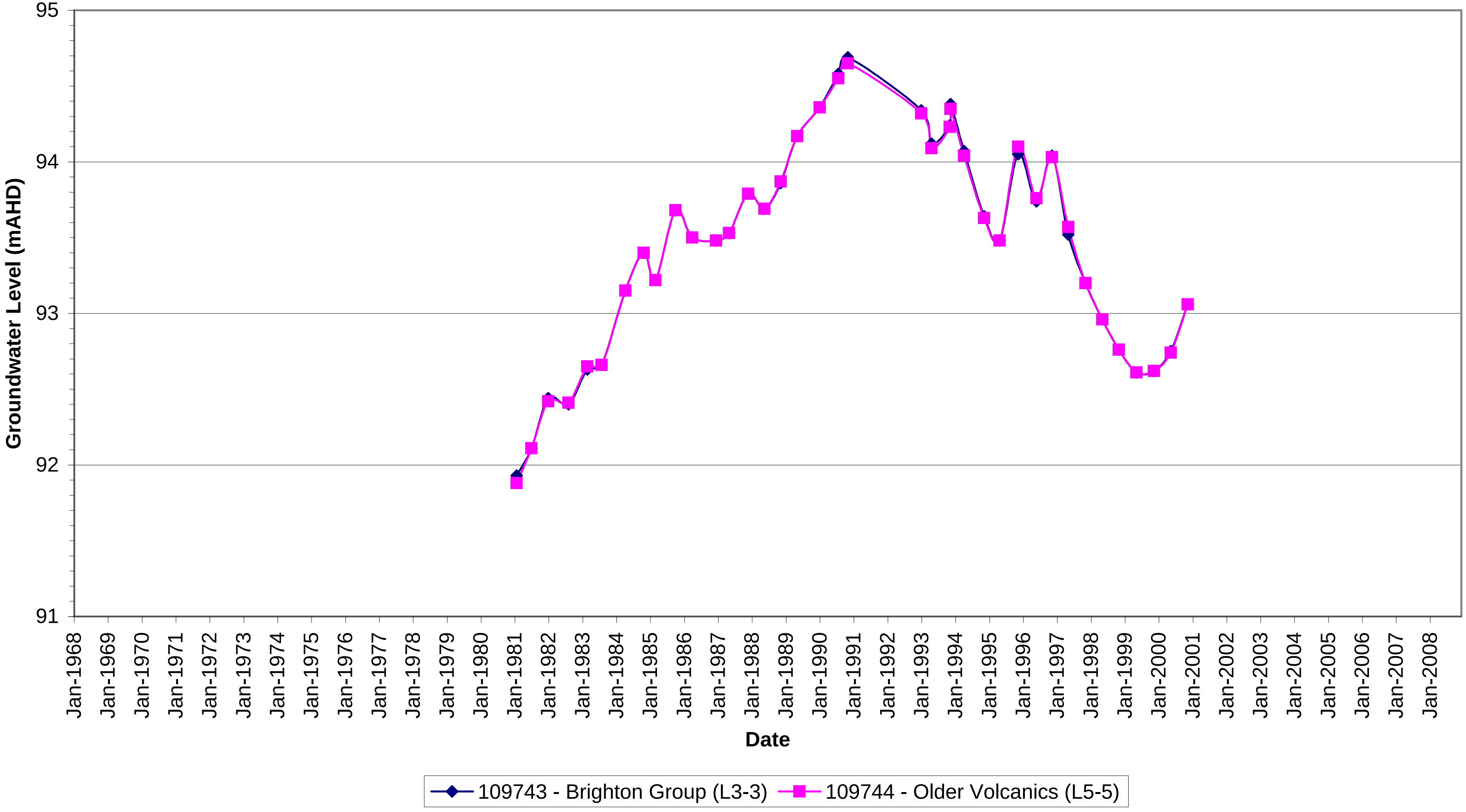

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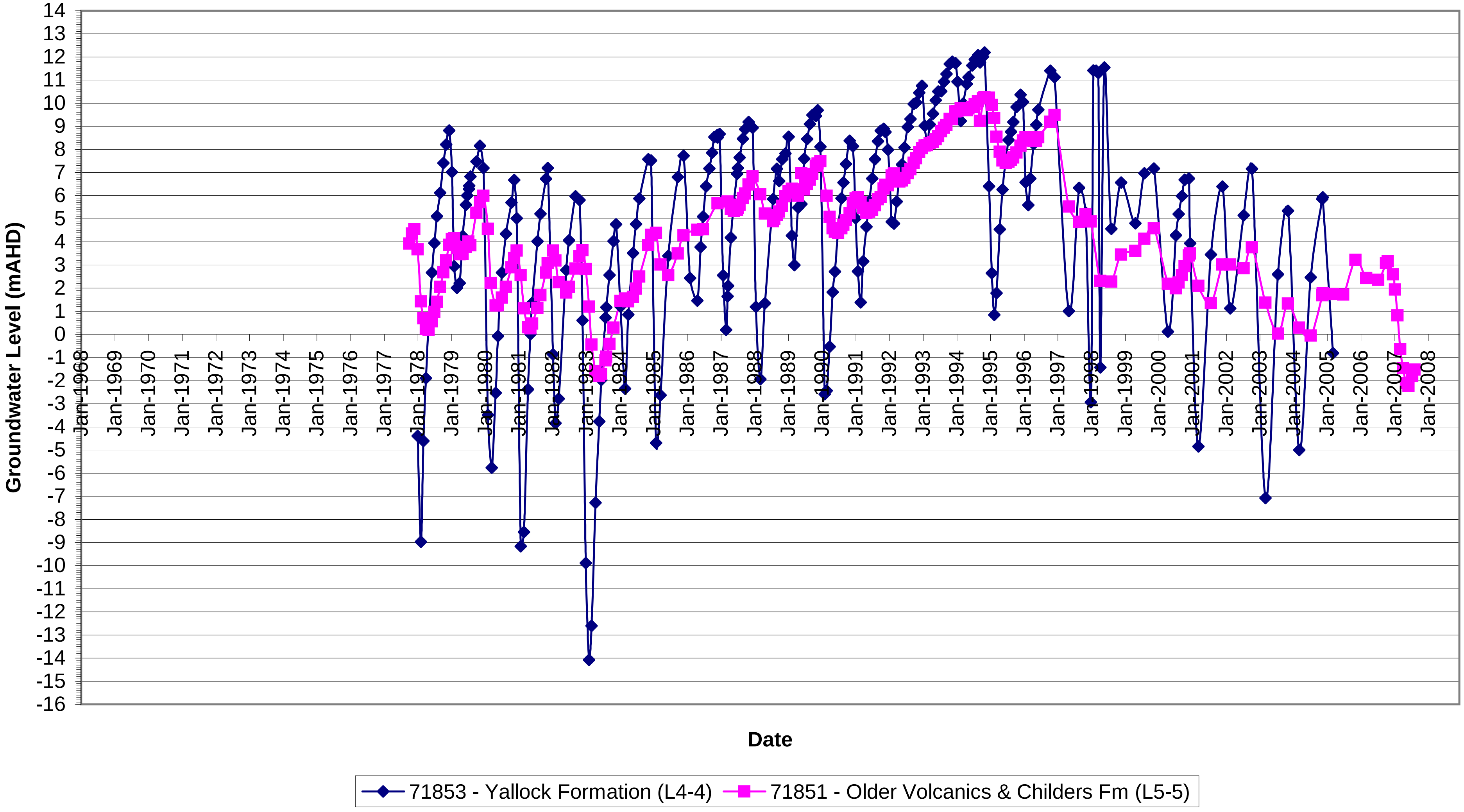

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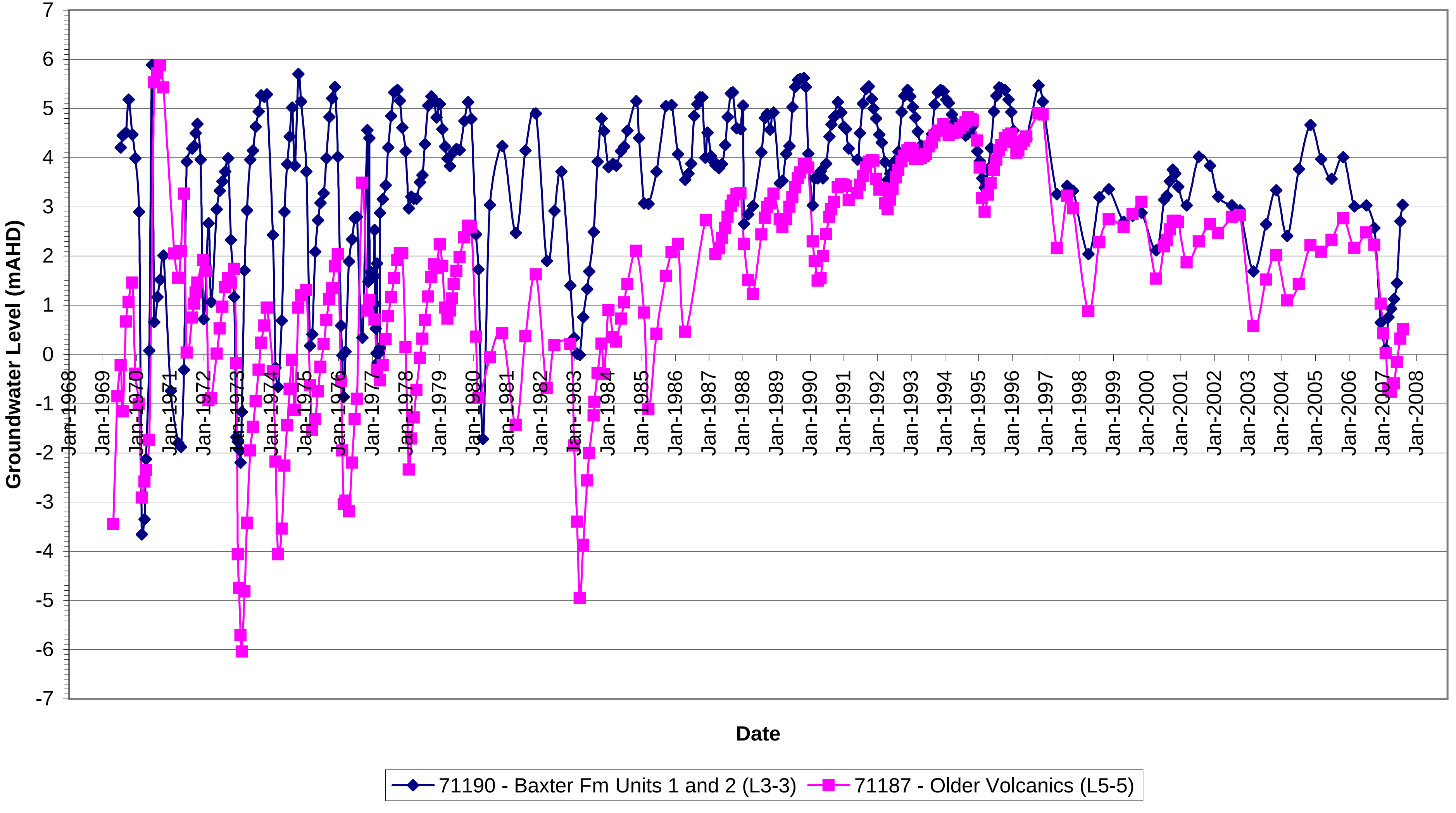

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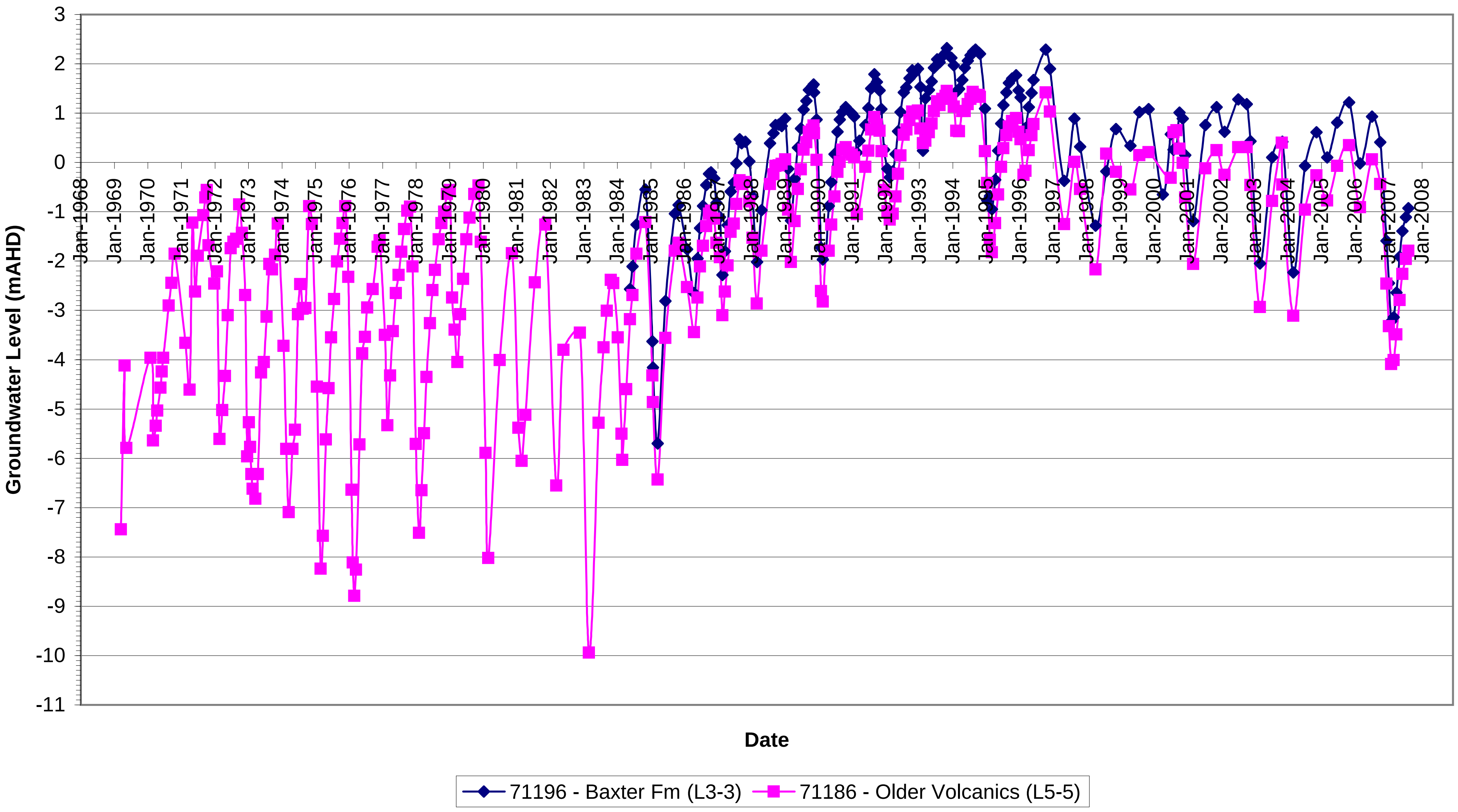

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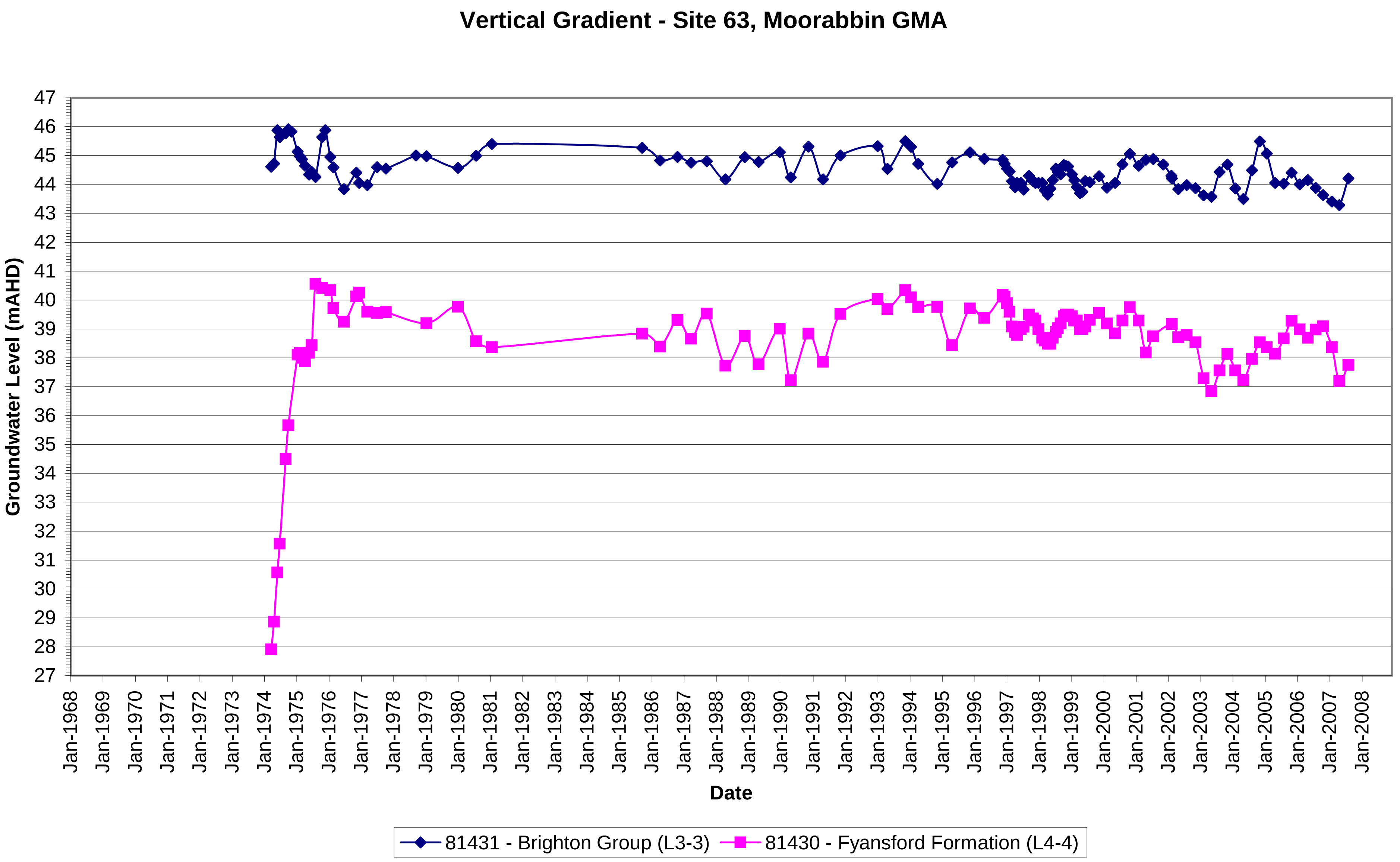

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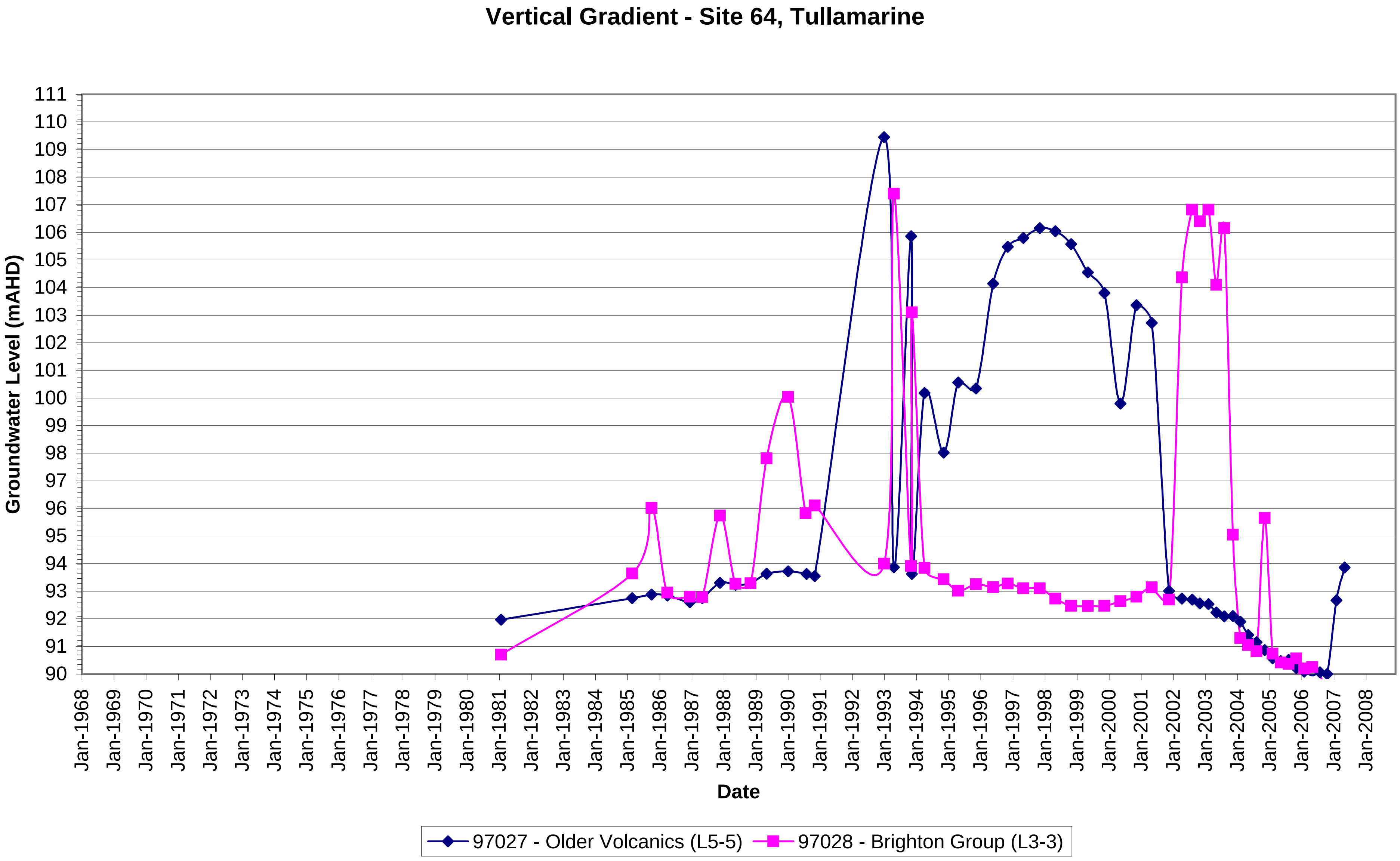

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Appendix E

Typical Hydraulic Parameters

Model Layer	Formation	Confined/Unconfined	Lithological Description	Basin	Area/Zone	T (m^2/d) Best Estimate	T Range	K (m/d) Best Estimate	K Range	Specific Yield, Sy Best Estimate	Sy Range	Storativity, S Best Estimate	S Range
Quaternary Sediments - L1	Bridgewater Formation	Unconfined	Calcereous sand and limestone	Port Phillip	Nepean Peninsula	NA	NA	10	1-30	0.2	0.15-0.35	NA	NA
Quaternary Sediments - L1	Alluvial deposits	Unconfined	Shoe string sands	Port Phillip	Werribee Delta	NA	NA	5	1-15	0.1	0.01-0.25	NA	NA
Quaternary Sediments - L1	Port Melbourne Sand	Unconfined	Fine to medium sand	Port Phillip	Yarra Delta	NA	NA	5	0.5-10	0.1	0.01-0.2	NA	NA
Quaternary Sediments - L1	Fishermans Bend and Coode Island Silts	Aquitard	Sandy silts and clays	Port Phillip	Yarra Delta	NA	NA	0.001	0.0001-0.01	0.05	0.01-0.1	NA	NA
Quaternary Sediments - L1	Moray Street Gravels	Confined / semi-confined	Fine to medium grained sand and gravel	Port Phillip	Yarra Delta	NA	NA	5	1-50	0.15	0.1-0.3	NA	NA
Quaternary Sediments - L1	Alluvial deposits	Aquitard	Heath Hill Silt	Westernport	Koo Wee Rup	NA	NA	0.01	0.001-0.1	0.05	0.01-0.1	NA	NA
Newer Volcanic Group - L2	Newer Volcanic Group	Predominantly unconfined	Basalt	Port Phillip	West	50	1-100	2.5	0.1-35	0.02	0.01-0.3	0.0001	0.00001-0.0005
Upper Tertiary Age Units - L3	Brighton Group	Confined / semi-confined	Clay, sand and fine silt	Port Phillip	West	10	1-100	0.5	0.1-5	0.1	0.03-0.15	0.0002	0.00002-0.0008
Upper Tertiary Age Units - L3	Brighton Group	Confined / semi-confined	Clay, sand and fine silt	Port Phillip	East	5	1-100	0.5	0.1-5	0.1	0.03-0.15	0.0002	0.00002-0.0008
Upper Tertiary Age Units - L3	Baxter Formation	Confined / semi-confined	Coarse sand and gravel with clay lenses	Westernport	Koo Wee Rup	100	50-300	5	1-10	0.2	0.1-0.3	0.0002	0.00002-0.0008
Middle Tertiary Age Units - L4	Fyansford Formation	Confined / semi-confined	Clay, silt and marl	Port Phillip	West	1	0.1-10	0.1	0.01-1	0.05	0.03-0.15	0.0002	0.00002-0.0008
Middle Tertiary Age Units - L4	Fyansford Formation	Confined / semi-confined	Clay, silt and marl with sand, sandy limestone and gravel	Port Phillip	East	1	0.1-50	0.1	0.01-1	0.05	0.03-0.15	0.0002	0.00002-0.0008
Middle Tertiary Age Units - L4	Sherwood Formation	Confined / semi-confined	Fine calcareous sand	Westernport	Koo Wee Rup	50	1-100	2.5	1-10	0.1	0.05-0.15	0.0002	0.00002-0.0008
Middle Tertiary Age Units - L4	Yallock Formation	Confined / semi-confined	Coarse sand and gravel	Westernport	Koo Wee Rup	100	10-300	10	1-30	0.2	0.1-0.3	0.0002	0.00002-0.0008
Lower Tertiary Age Units - L5	Werribee Formation	Confined / semi-confined	Sand, gravel clay and coal	Port Phillip	Entire CMA	50	10-300	10	1-20	0.2	0.1-0.3	0.0002	0.00002-0.0008
Lower Tertiary Age Units - L5	Childers Formation	Confined / semi-confined	Sand and gravel with lignite and clay horizons	Westernport	Koo Wee Rup	25	10-300	5	1-10	0.15	0.1-0.3	0.0002	0.00002-0.0008
Lower Tertiary Age Units - L5	Older Volcanics	Confined / semi-confined	Basalt	Port Phillip and Westernport	Entire CMA	10	1-200	5	0.01-10	0.02	0.005-0.1	0.0001	0.00004-0.0002
Pre-Tertiary Age Units - L6	Basement Bedrock	Unconfined/Confined	Sandstone, siltstone, mudstone, shale and granites	Port Phillip and Westernport	Entire CMA	10	1-100	0.5	0.01-10	0.02	0.01-0.1	0.0001	0.00004-0.0002

Appendix F

Modelled v Observed Key Borehole Hydrographs

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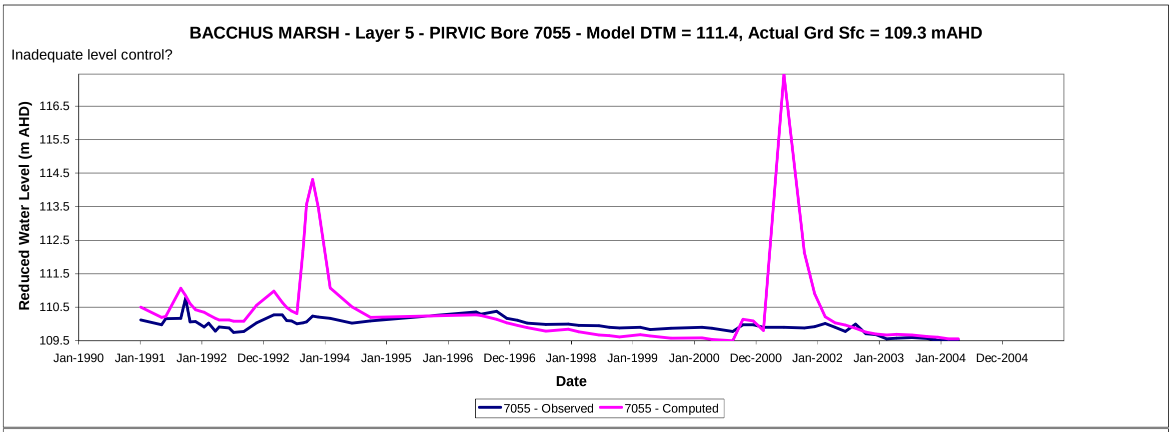
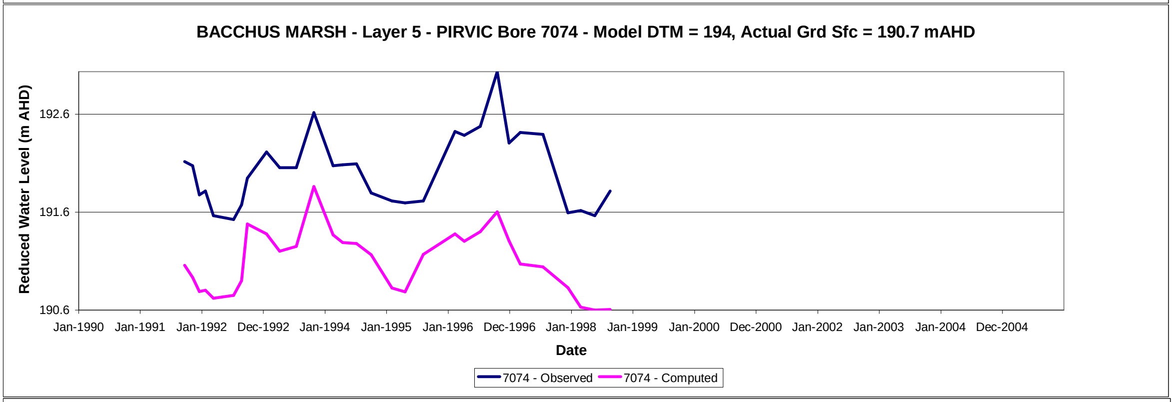
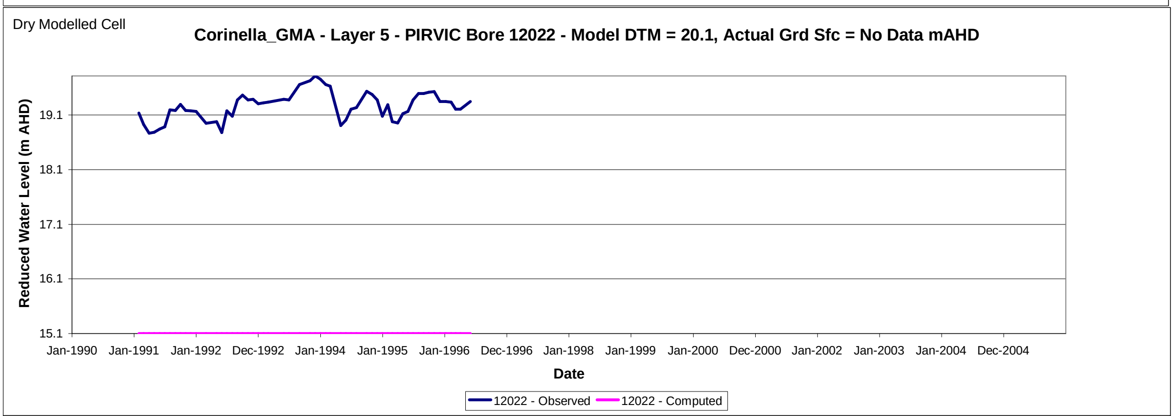
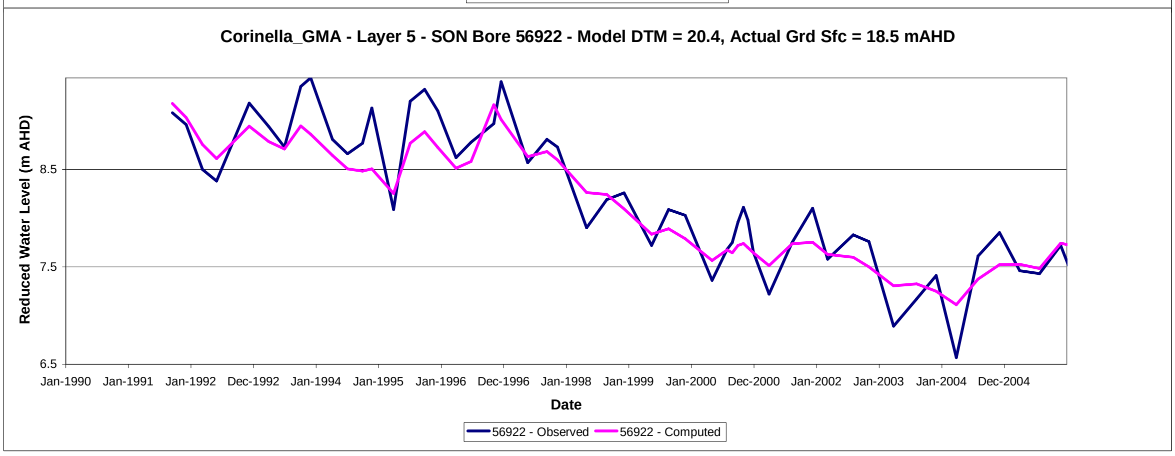
Modelled vs Observed Groundwater Levels

Showing Good and Poor Fit For All Areas









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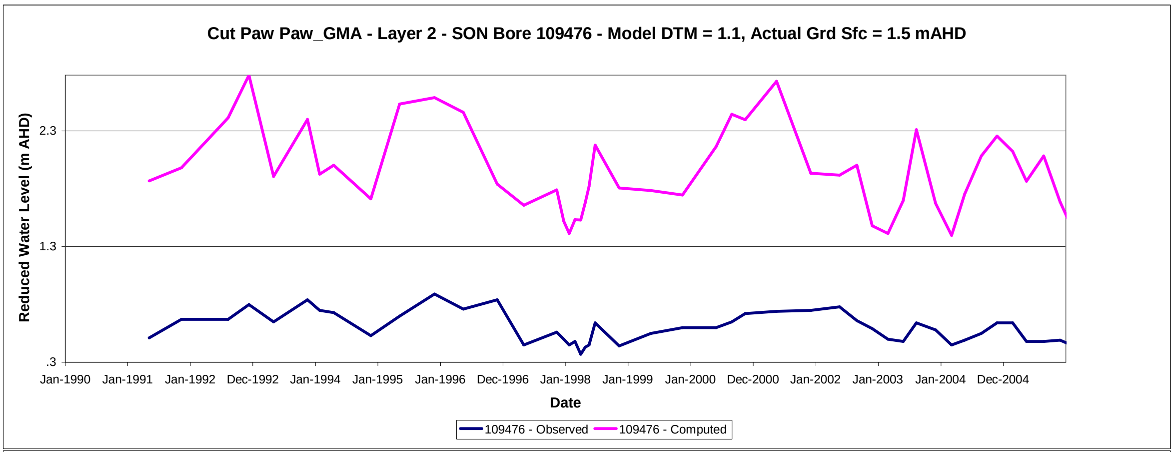

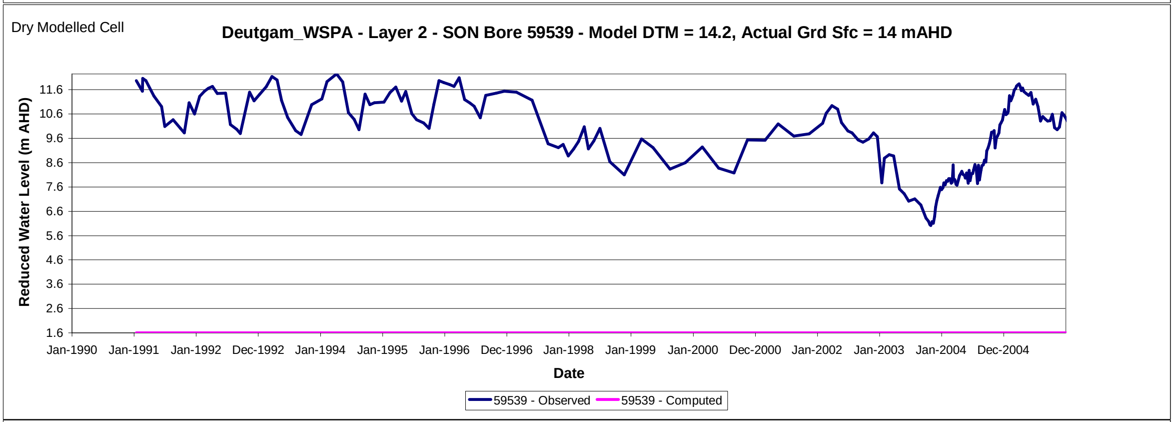

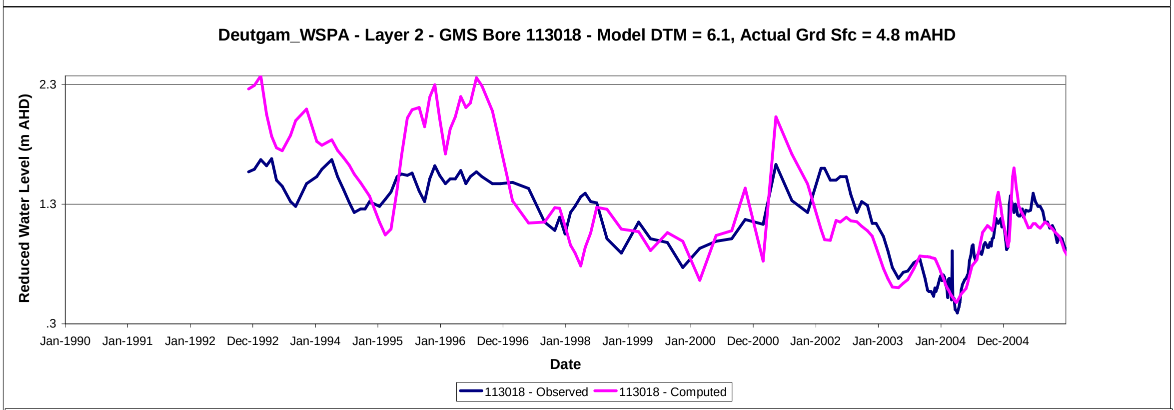

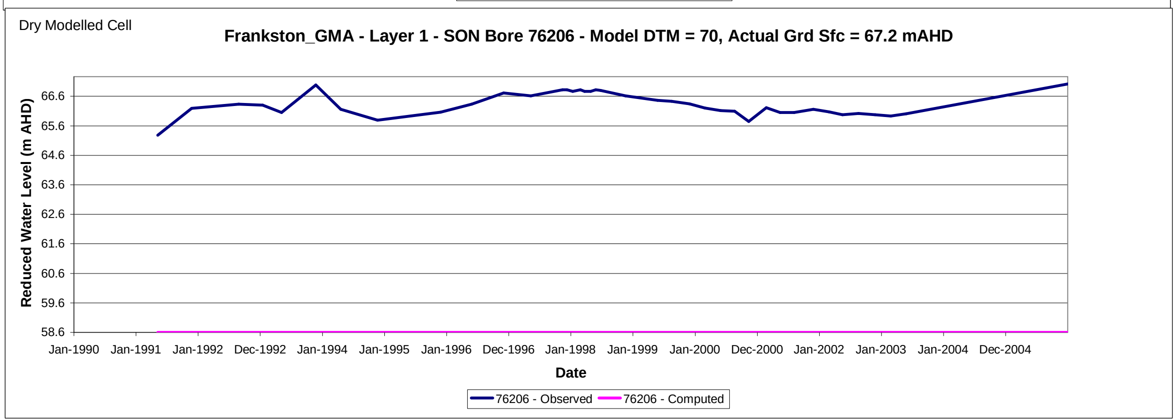

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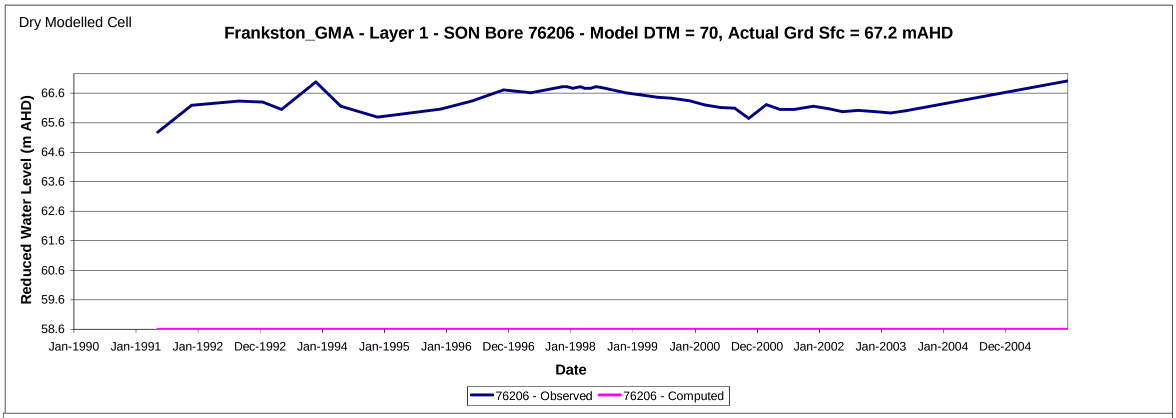
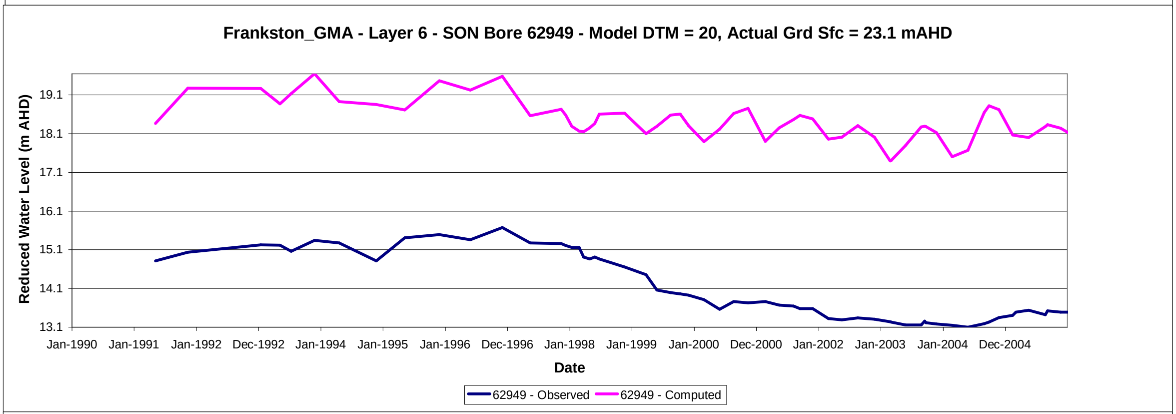
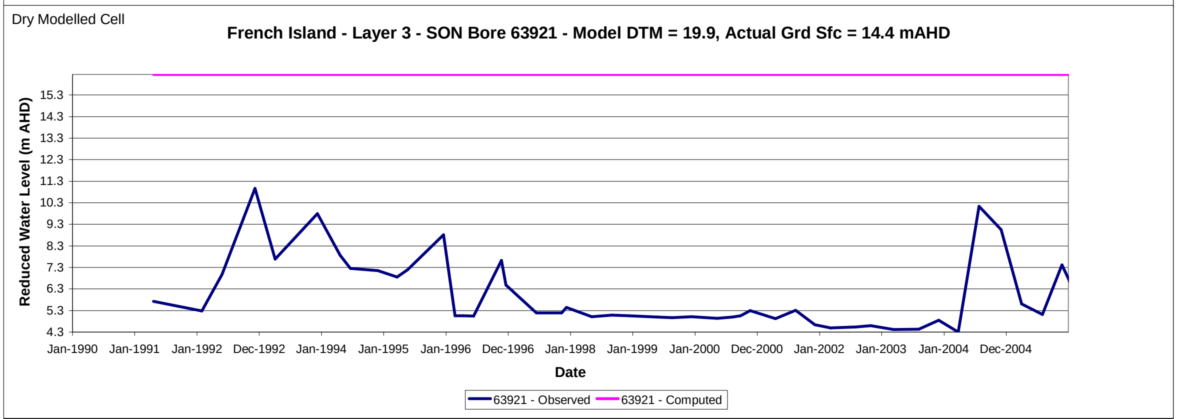
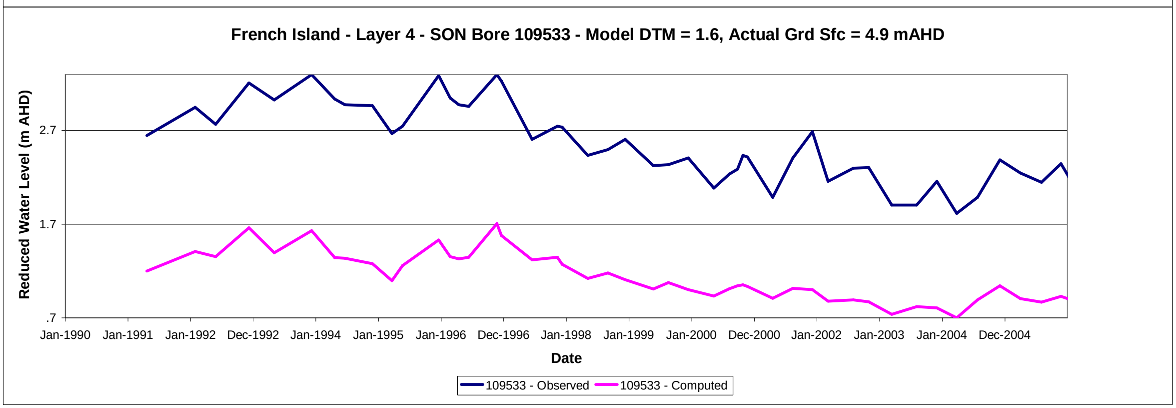


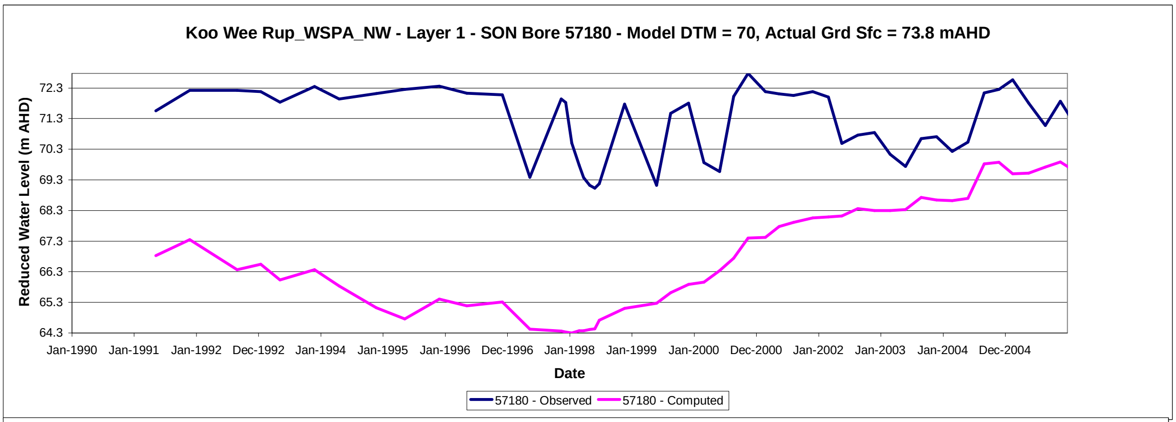


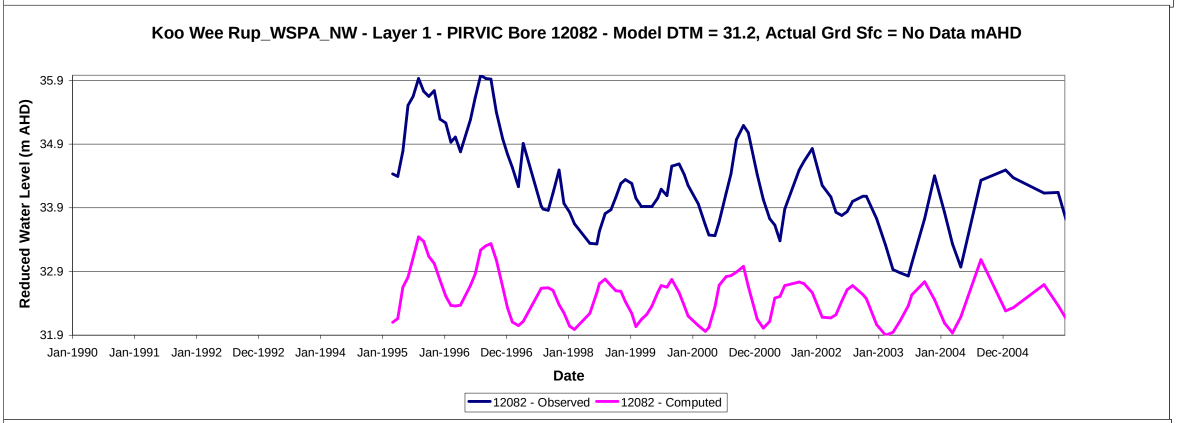


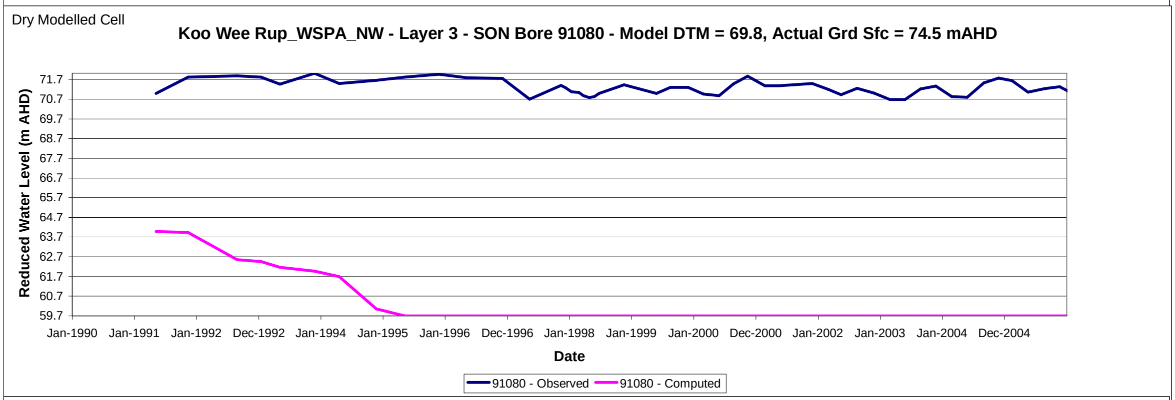


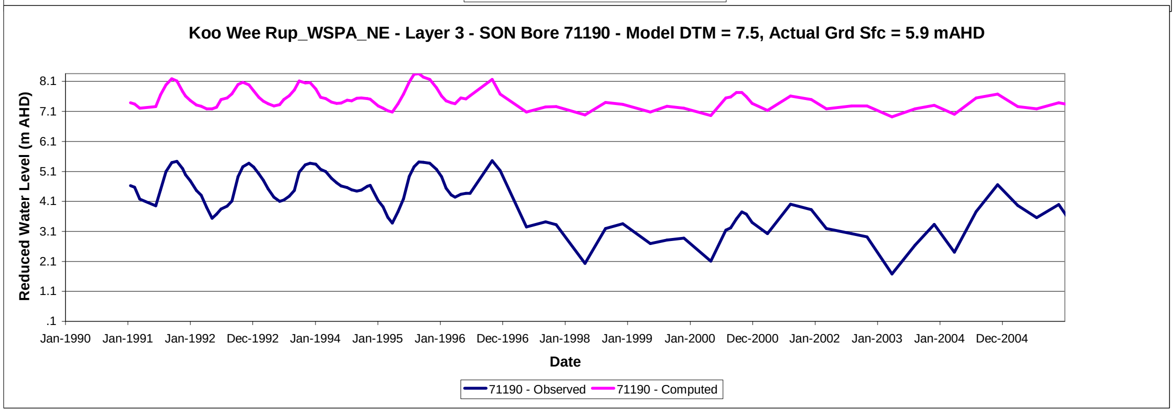
Modelled vs Observed Groundwater Levels

Showing Good and Poor Fit For All Areas



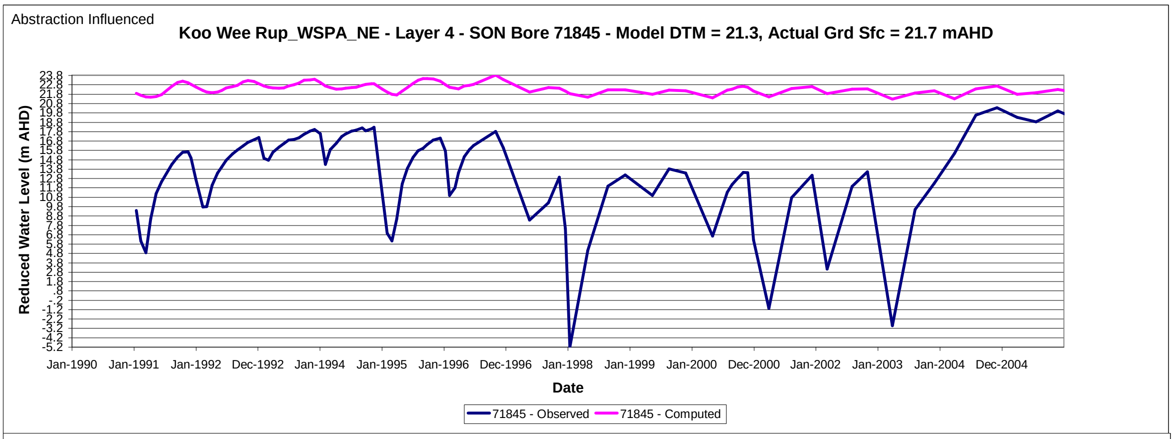


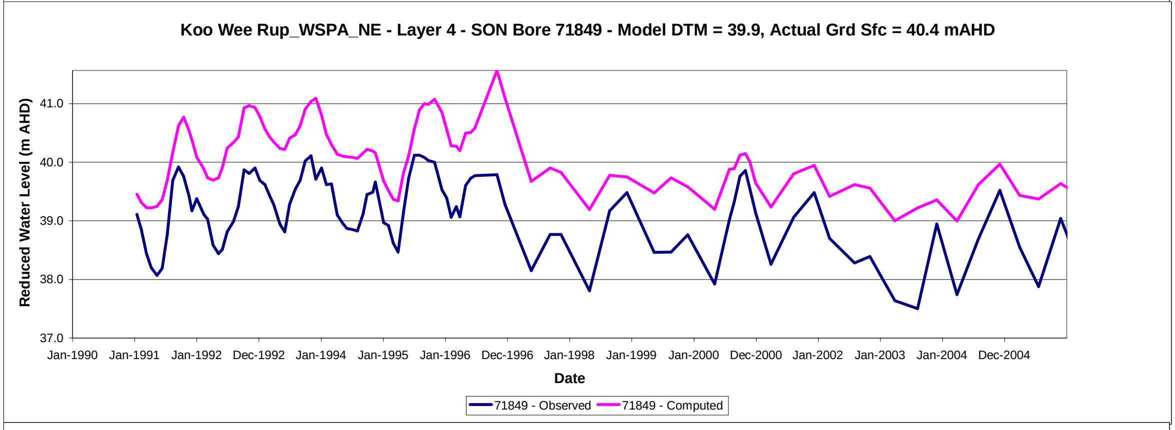


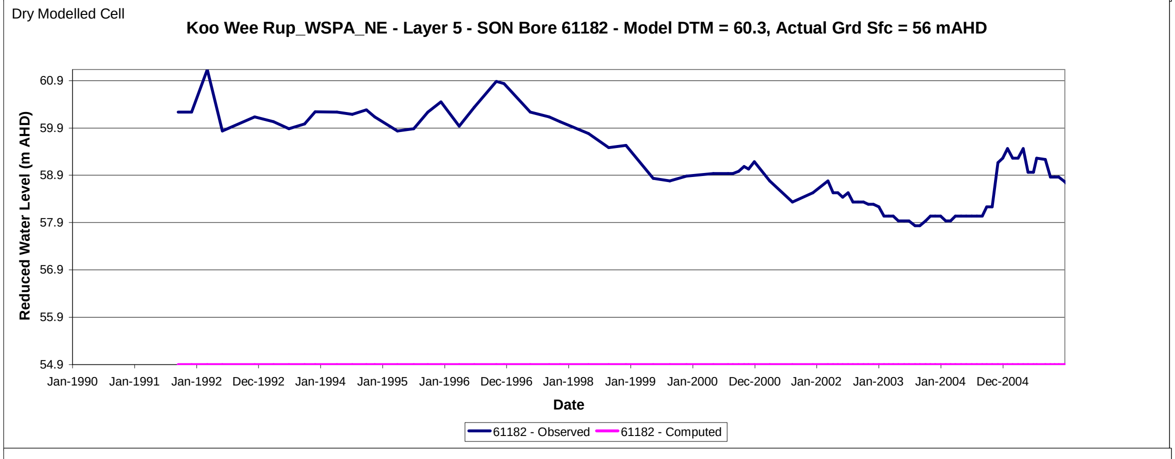


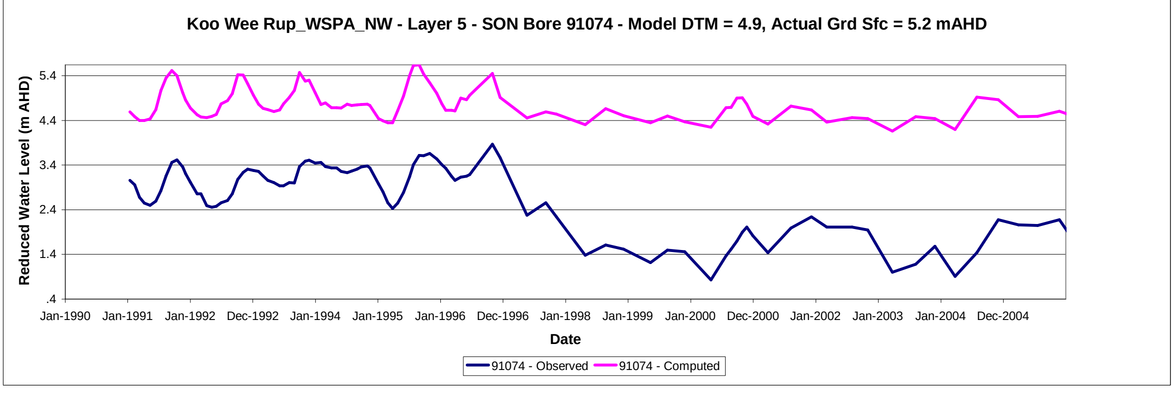
Modelled vs Observed Groundwater Levels

Showing Good and Poor Fit For All Areas



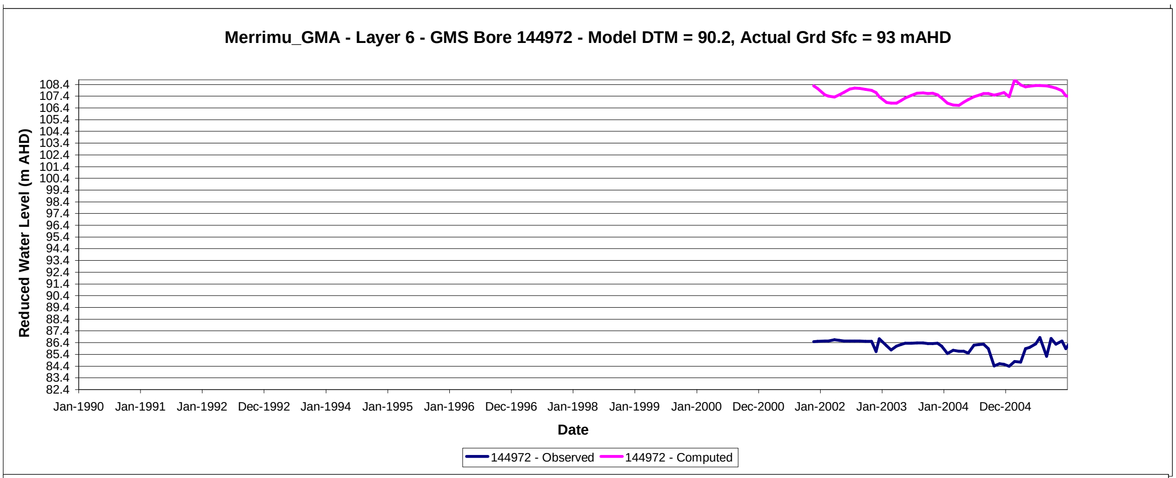


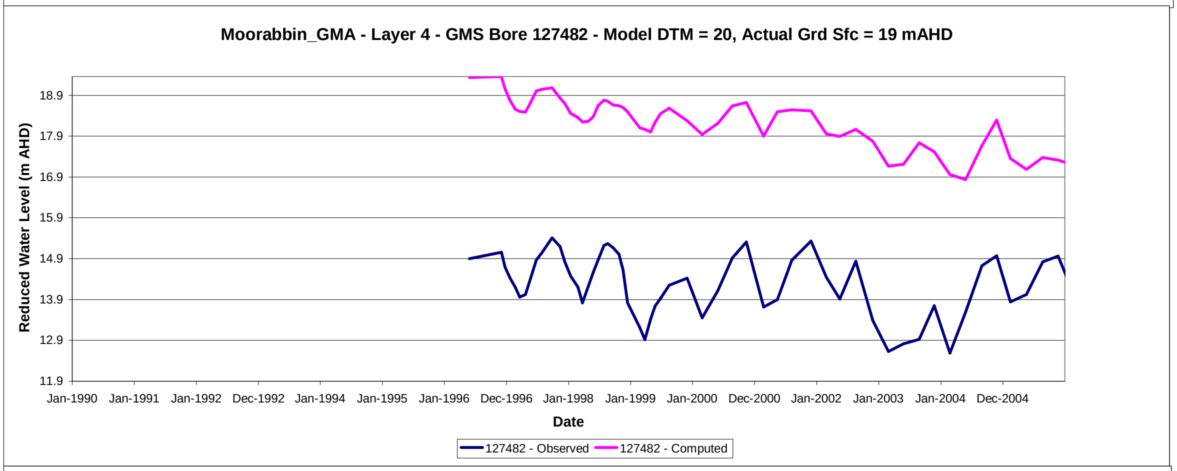


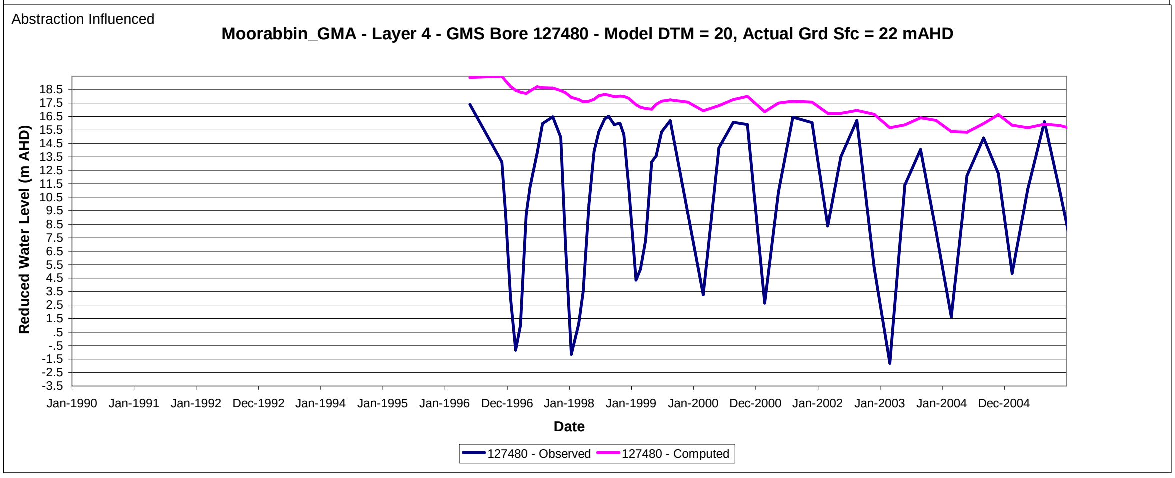


Modelled vs Observed Groundwater Levels

Showing Good and Poor Fit For All Areas







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Modelled vs Observed Groundwater Levels

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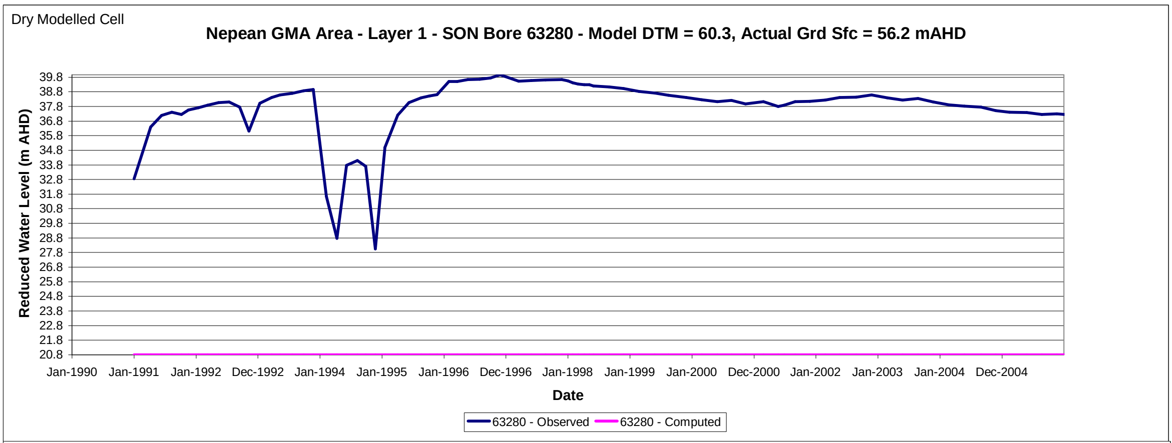

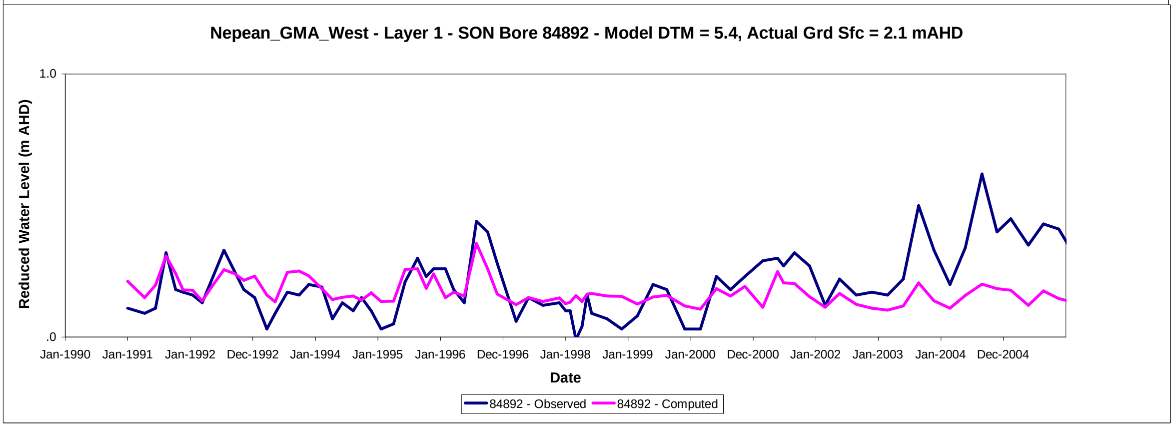

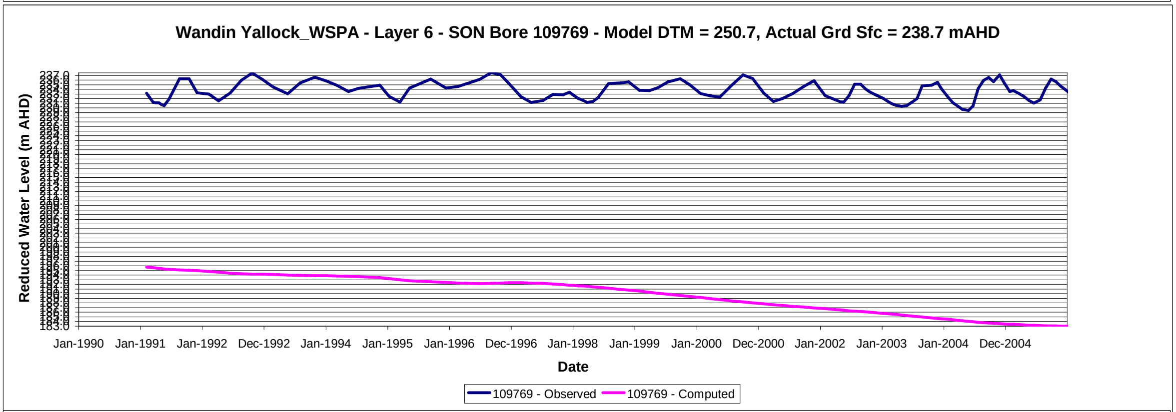

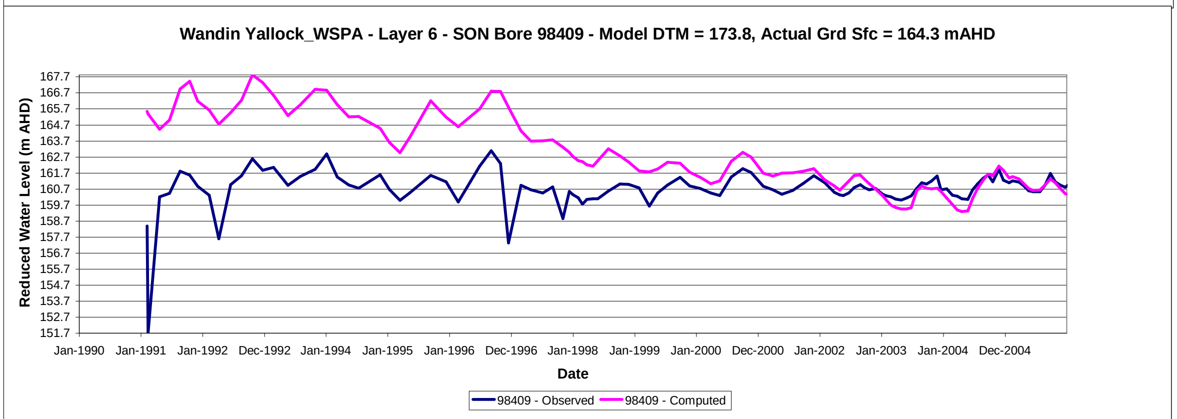

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Modelled vs Observed Groundwater Levels

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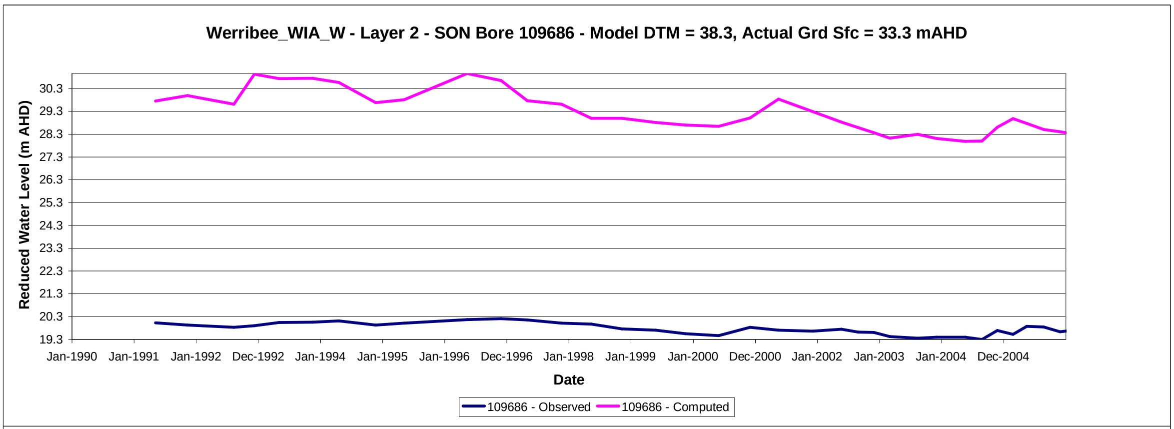
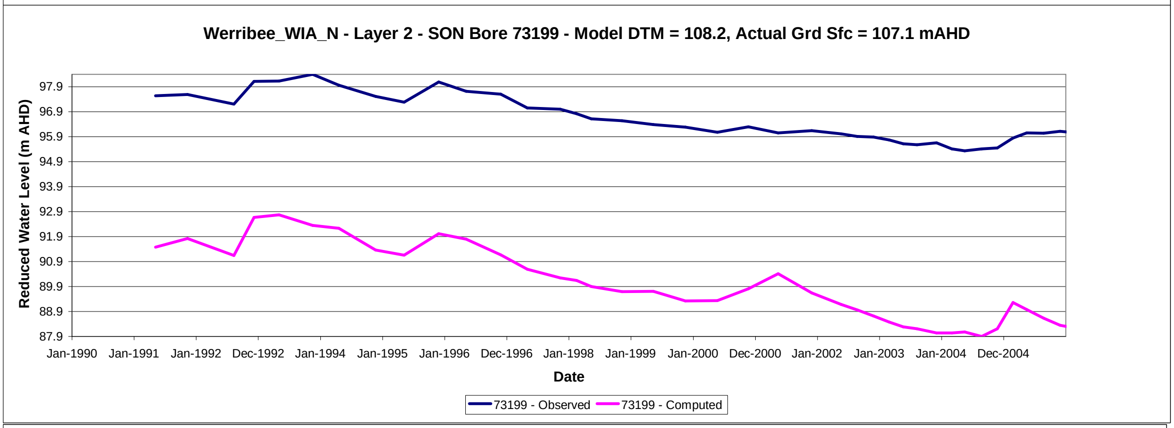
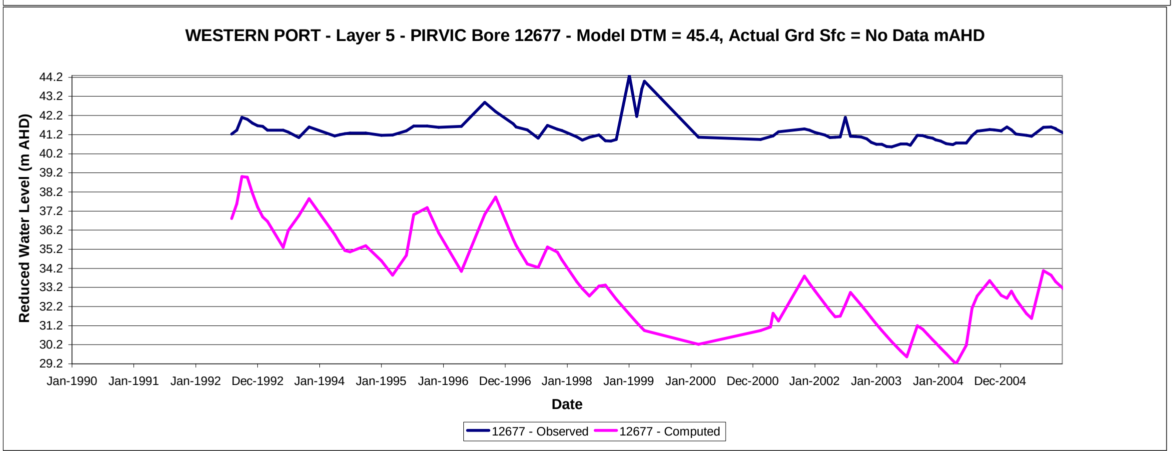
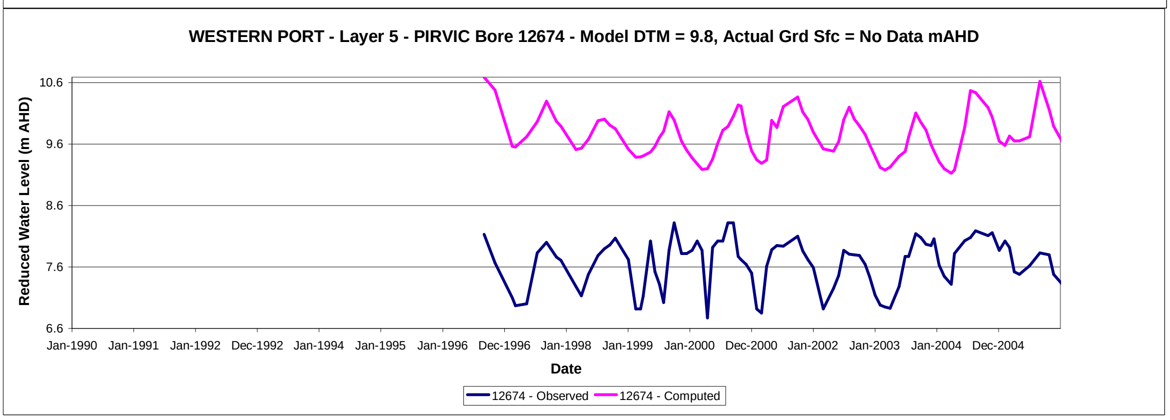


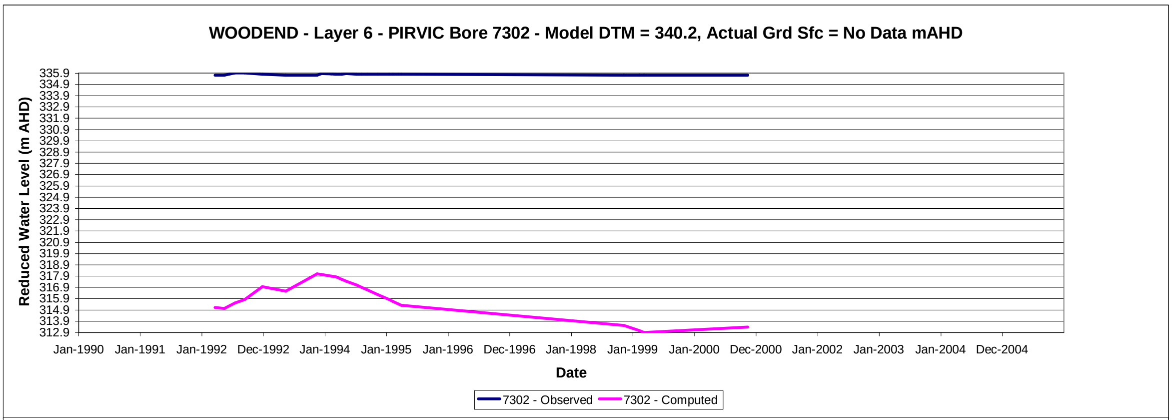


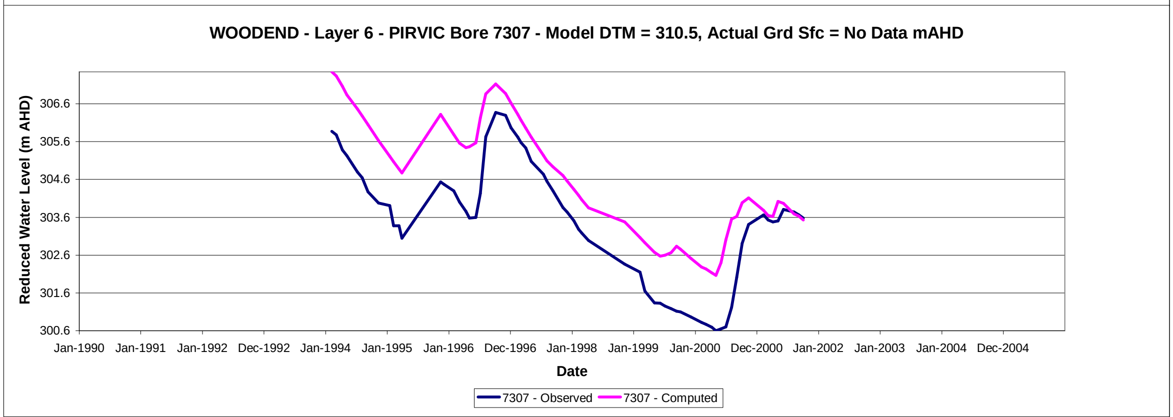


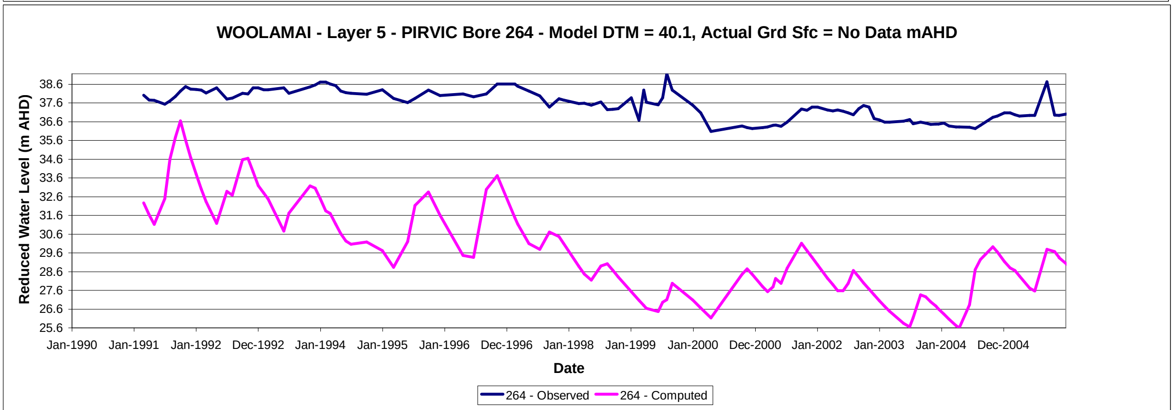


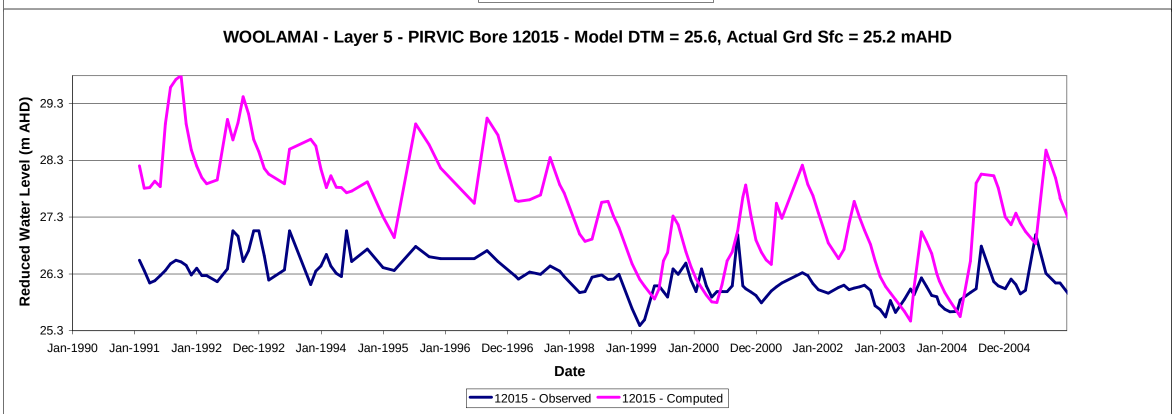
Modelled vs Observed Groundwater Levels

Showing Good and Poor Fit For All Areas









Appendix G

Modelled v Observed Baseflow Hydrographs

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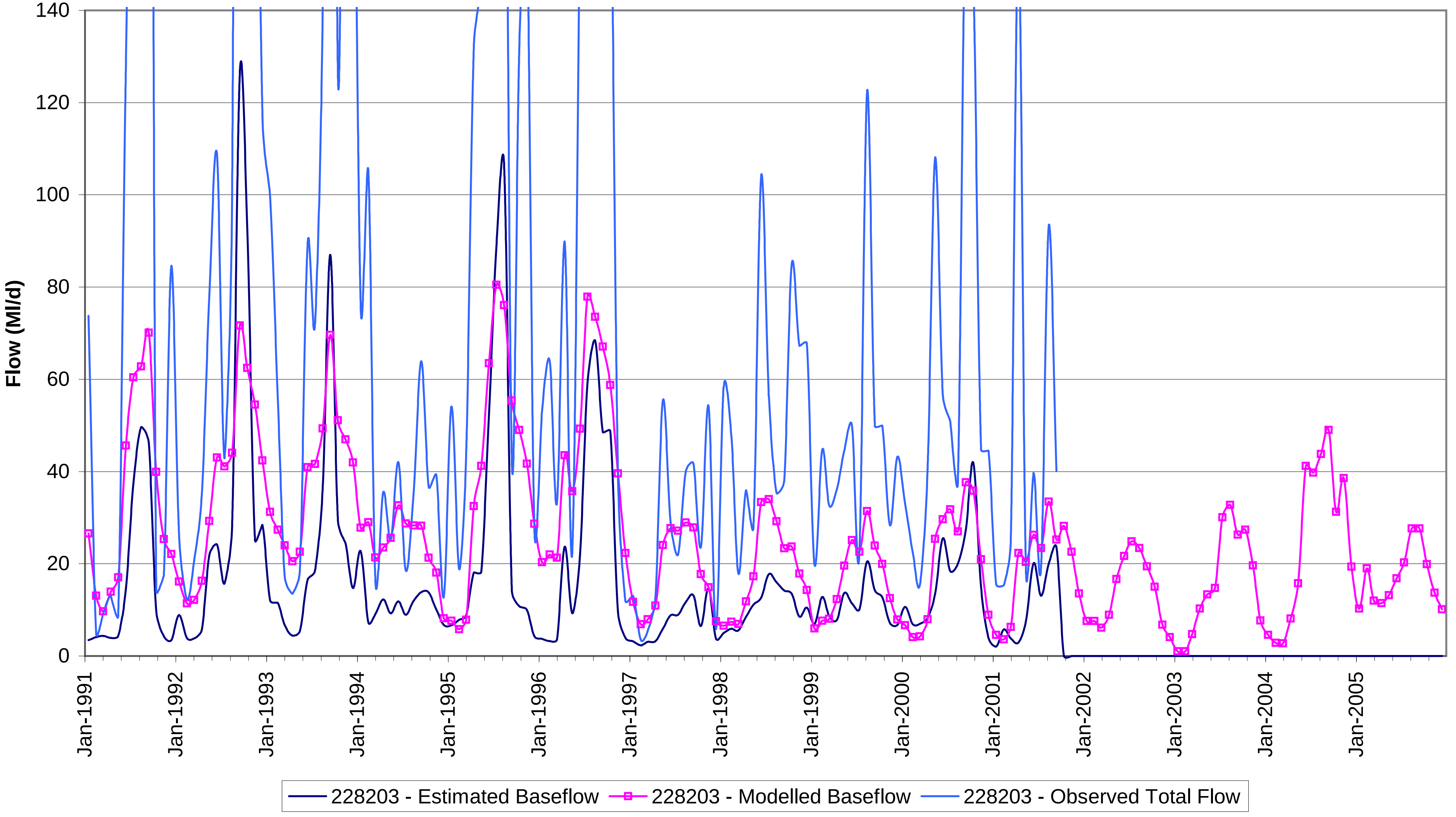
Eumerring Creek @ Lyndhurst



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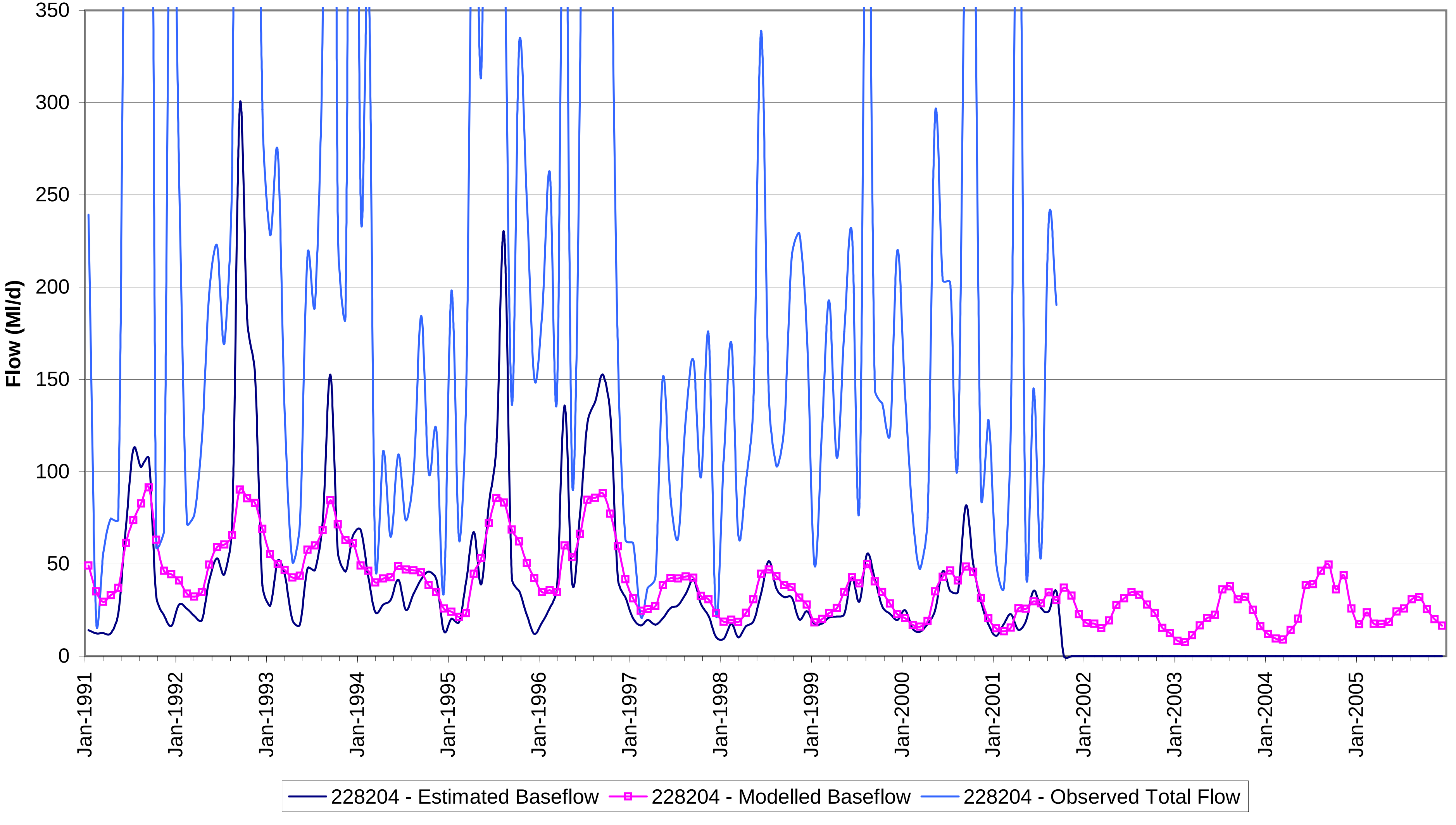
Dandenong Creek @ Dandenong



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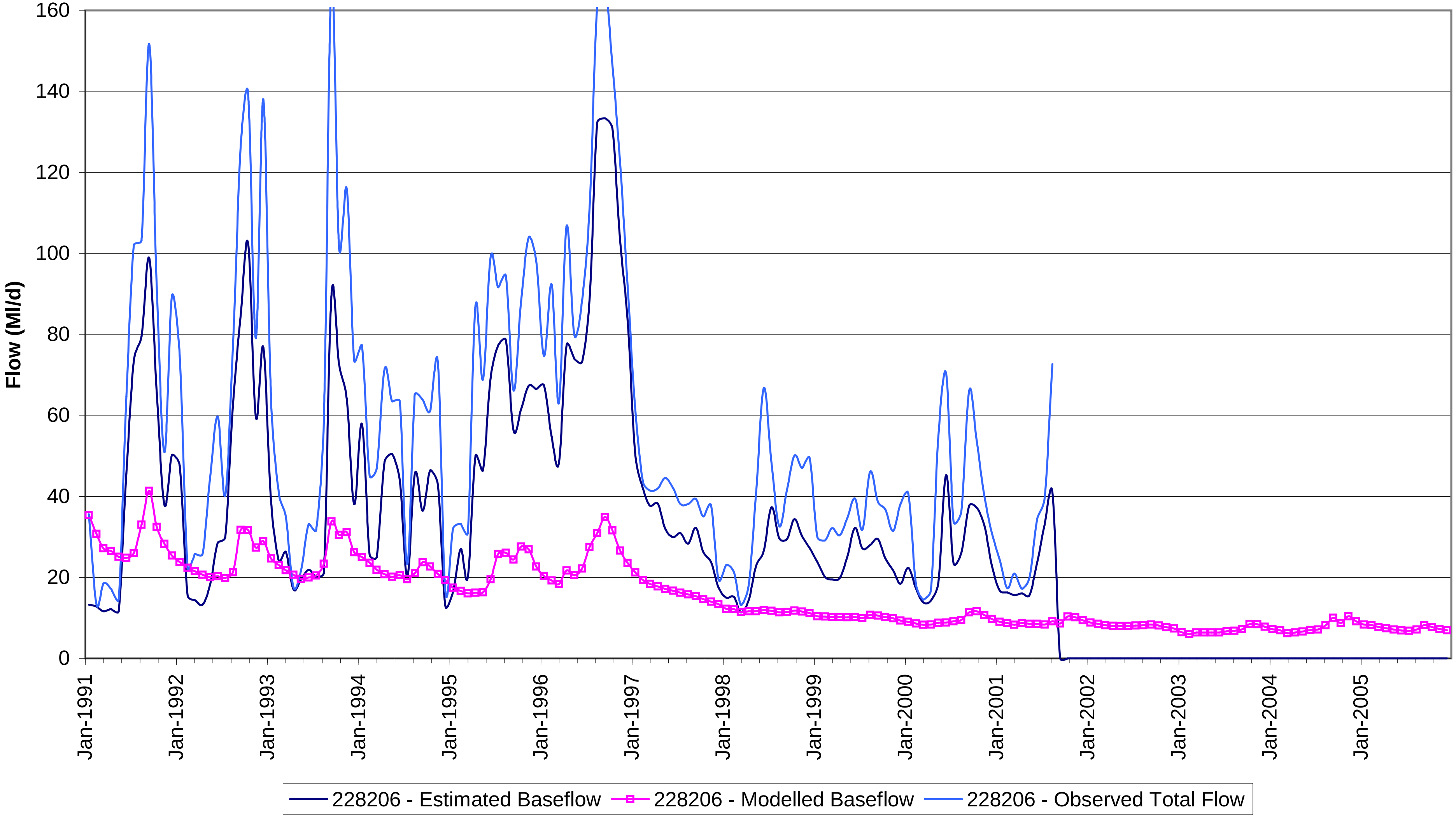
Tarago River @ Neerim



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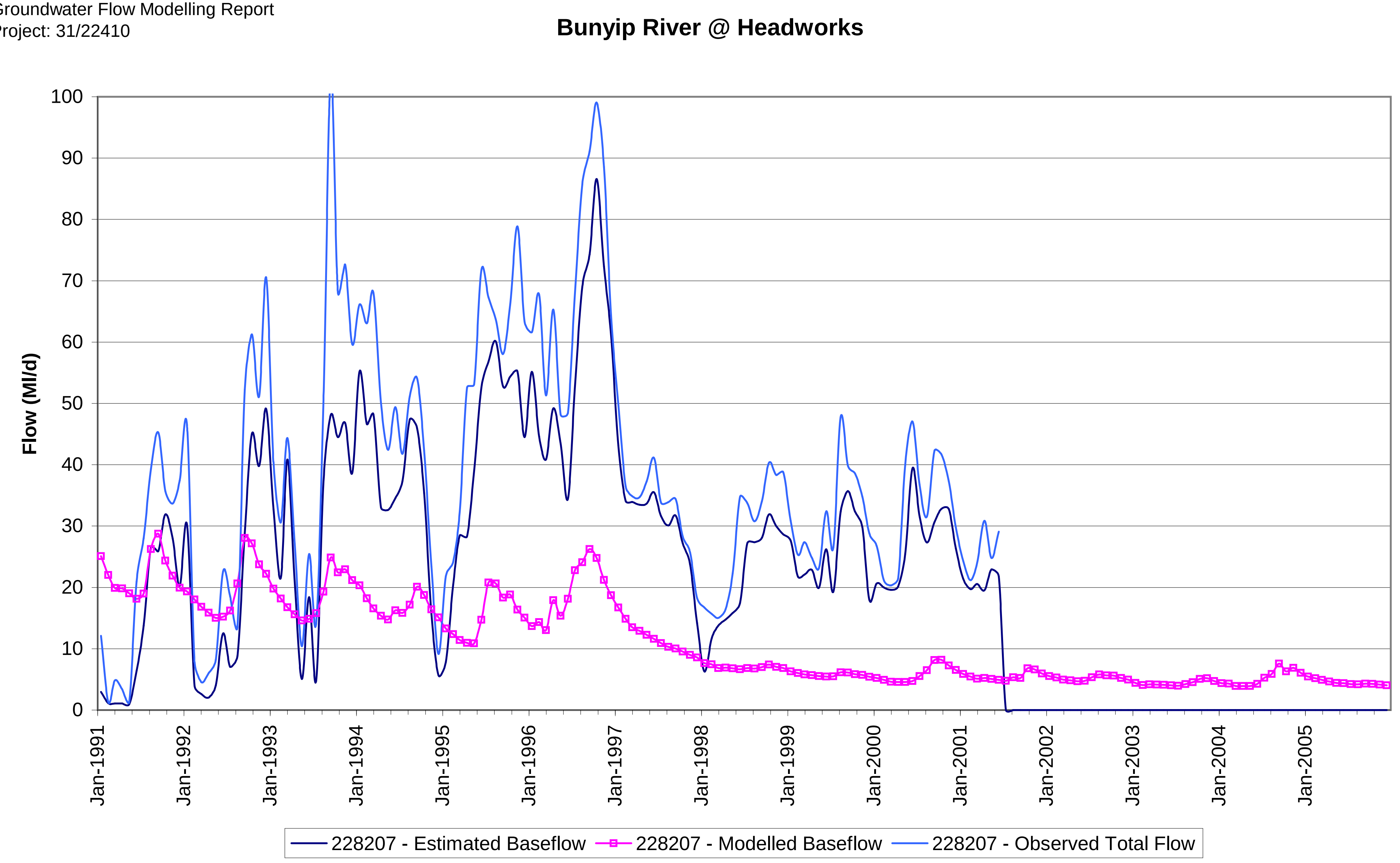

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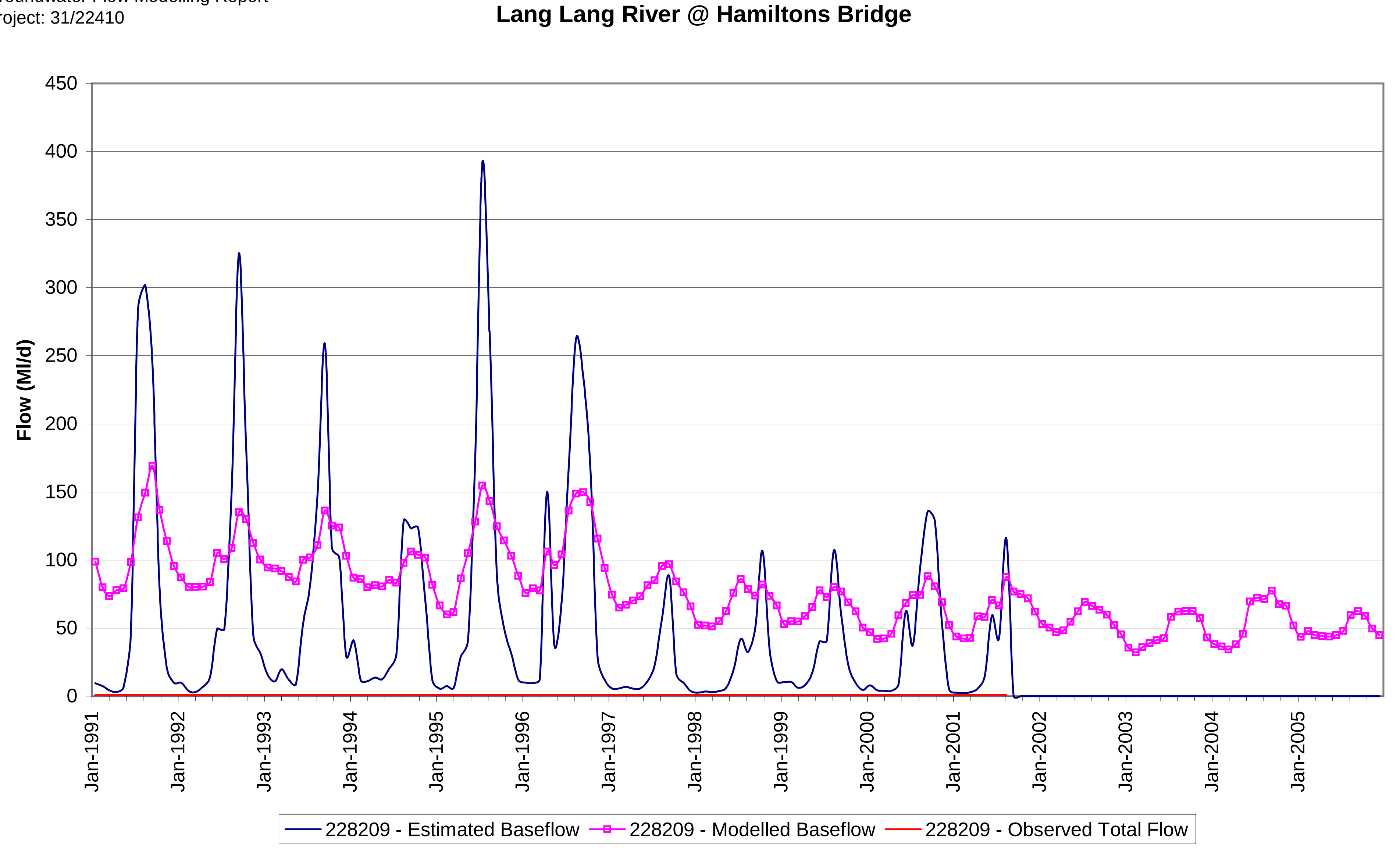

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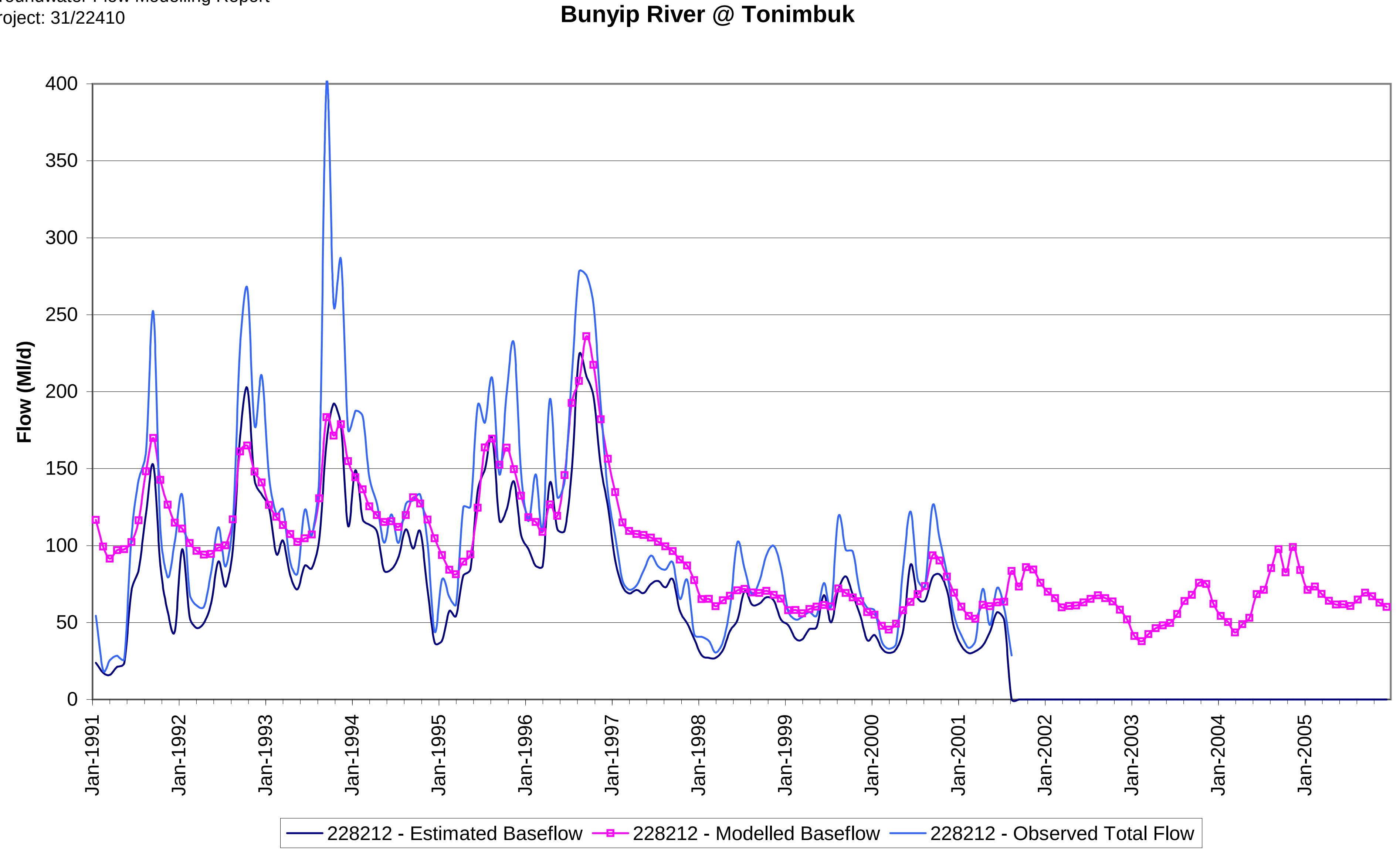

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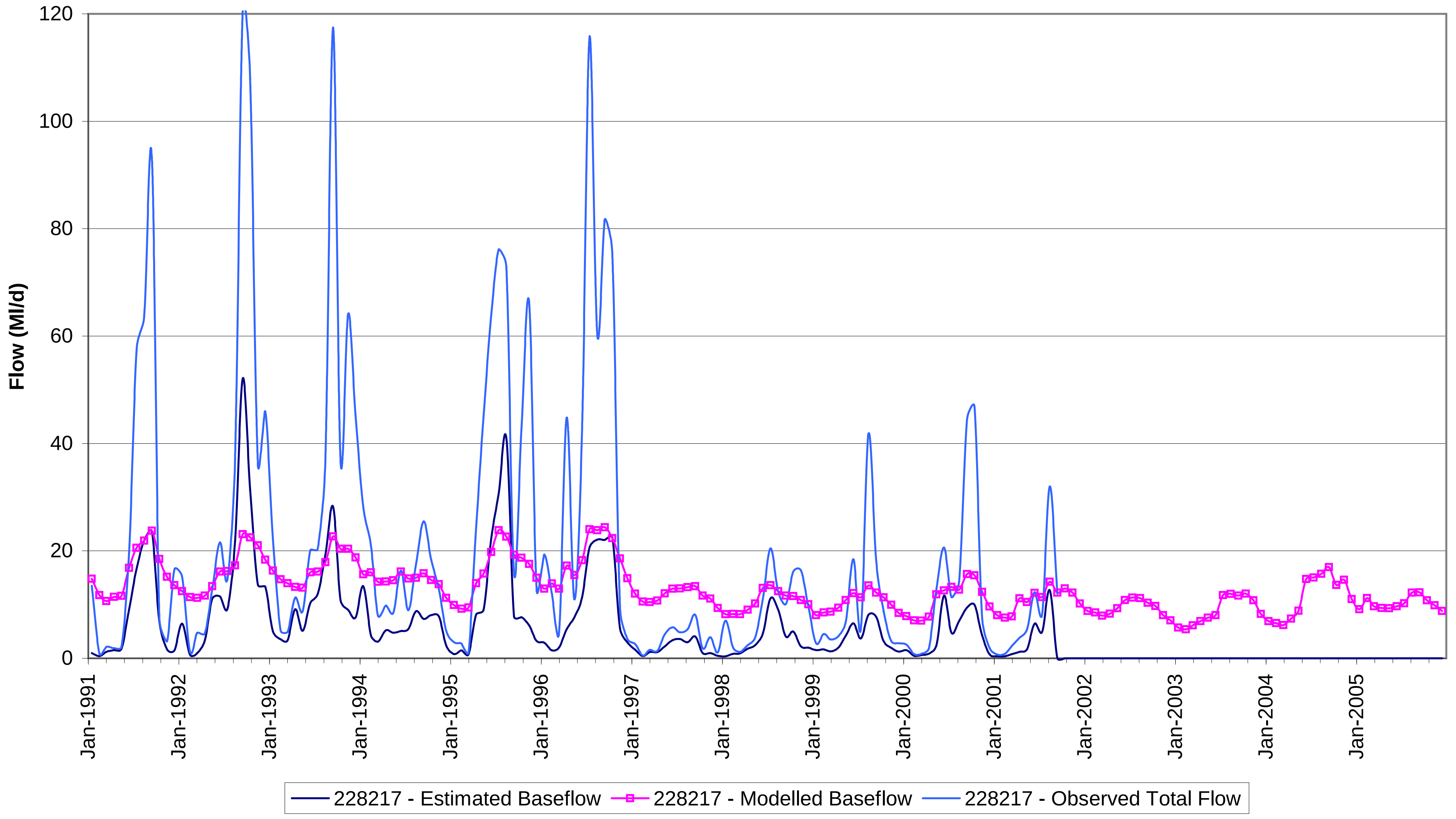
Toomuc Creek @ Pakenham



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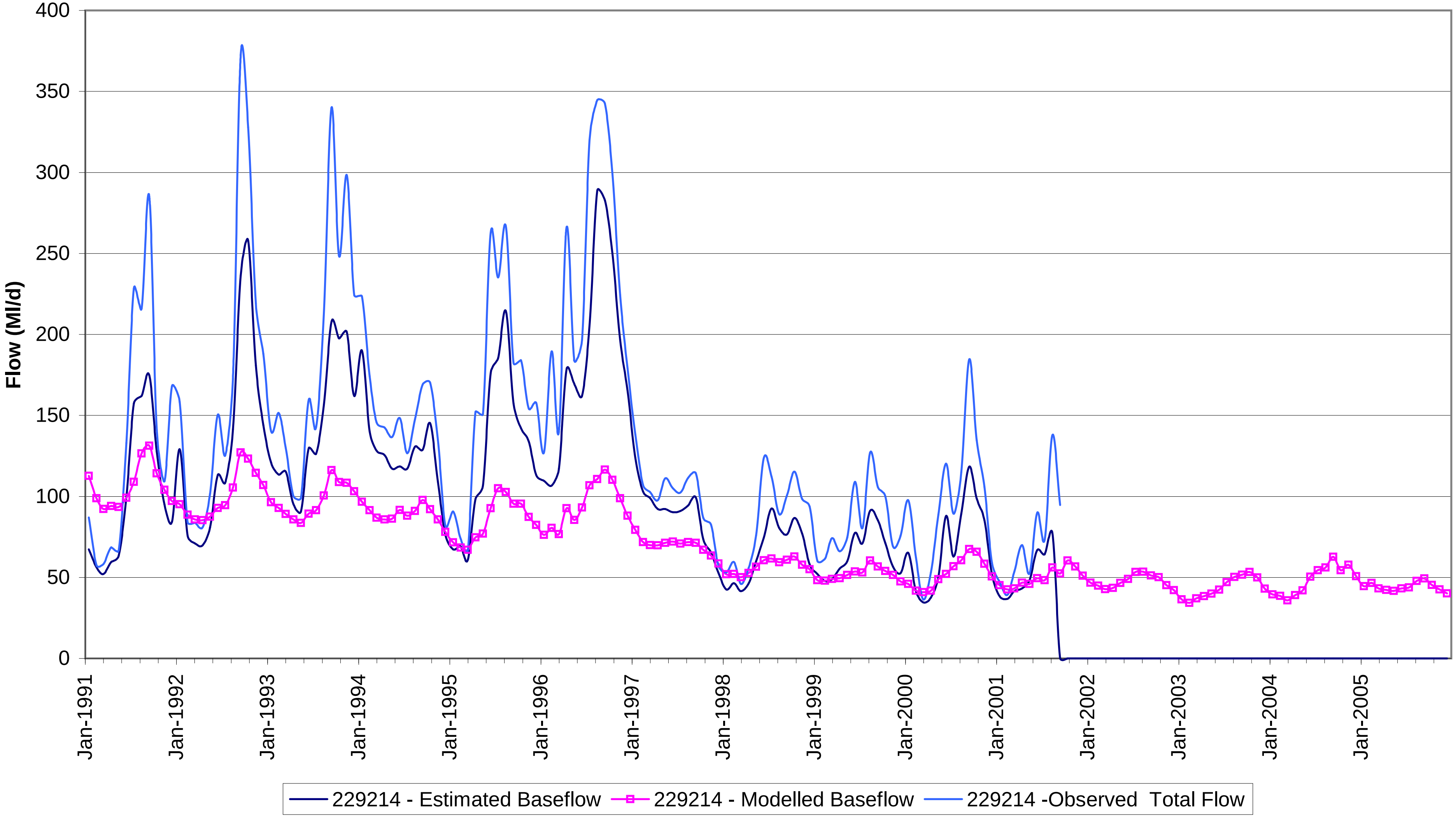
Little Yarra River @ Yarra Junction



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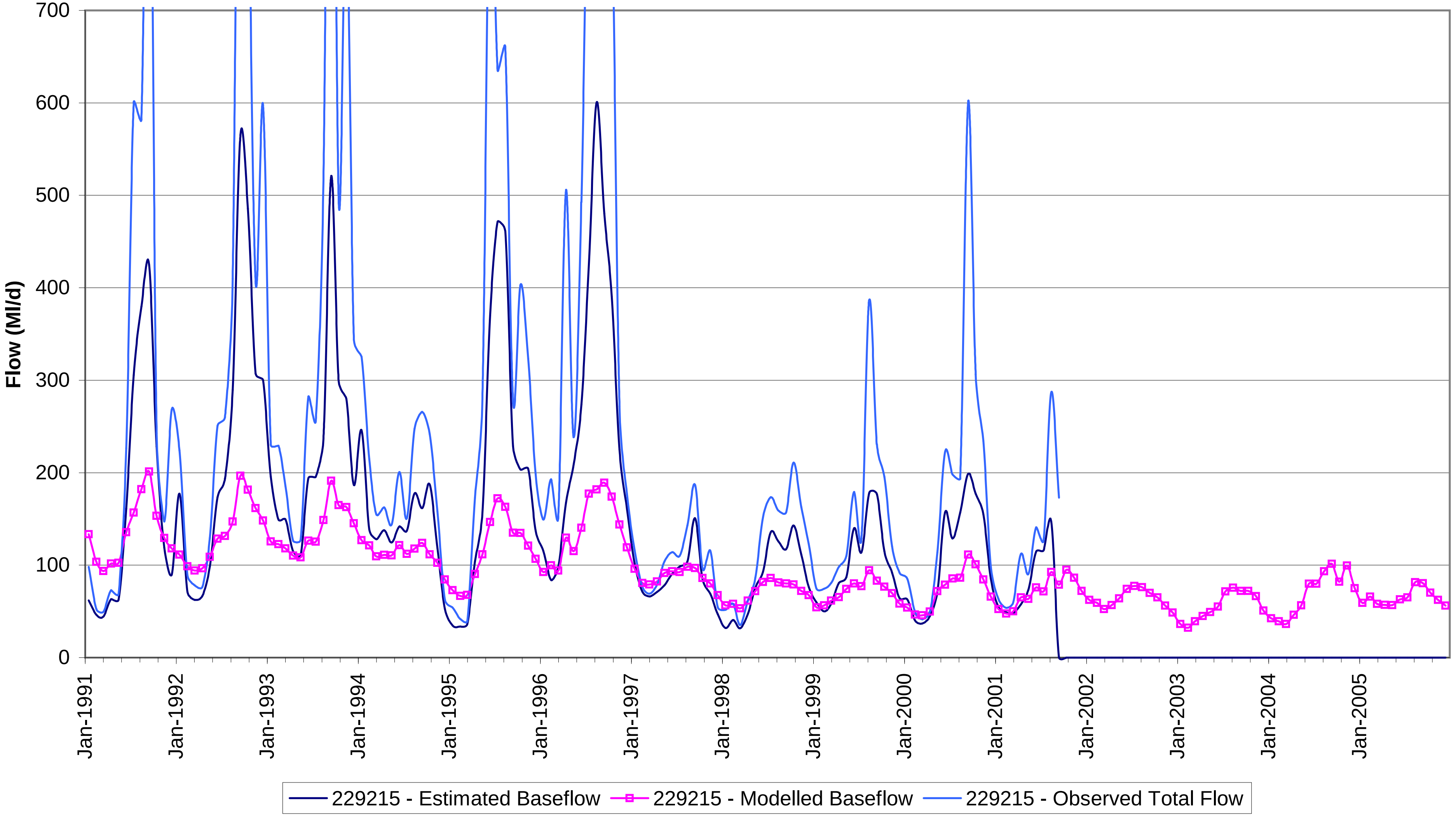
Woori Yallock Creek @ Woori Yallock



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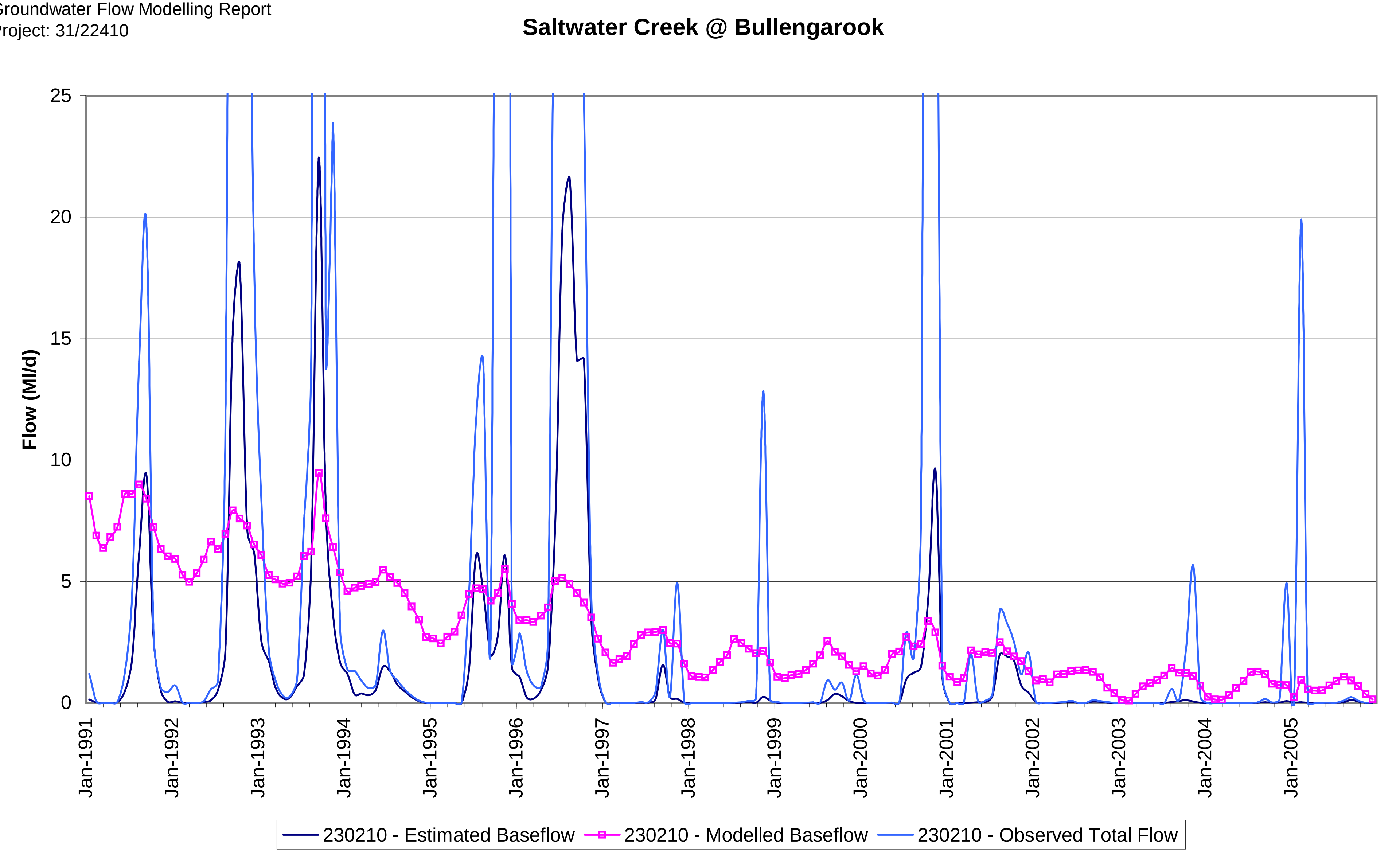

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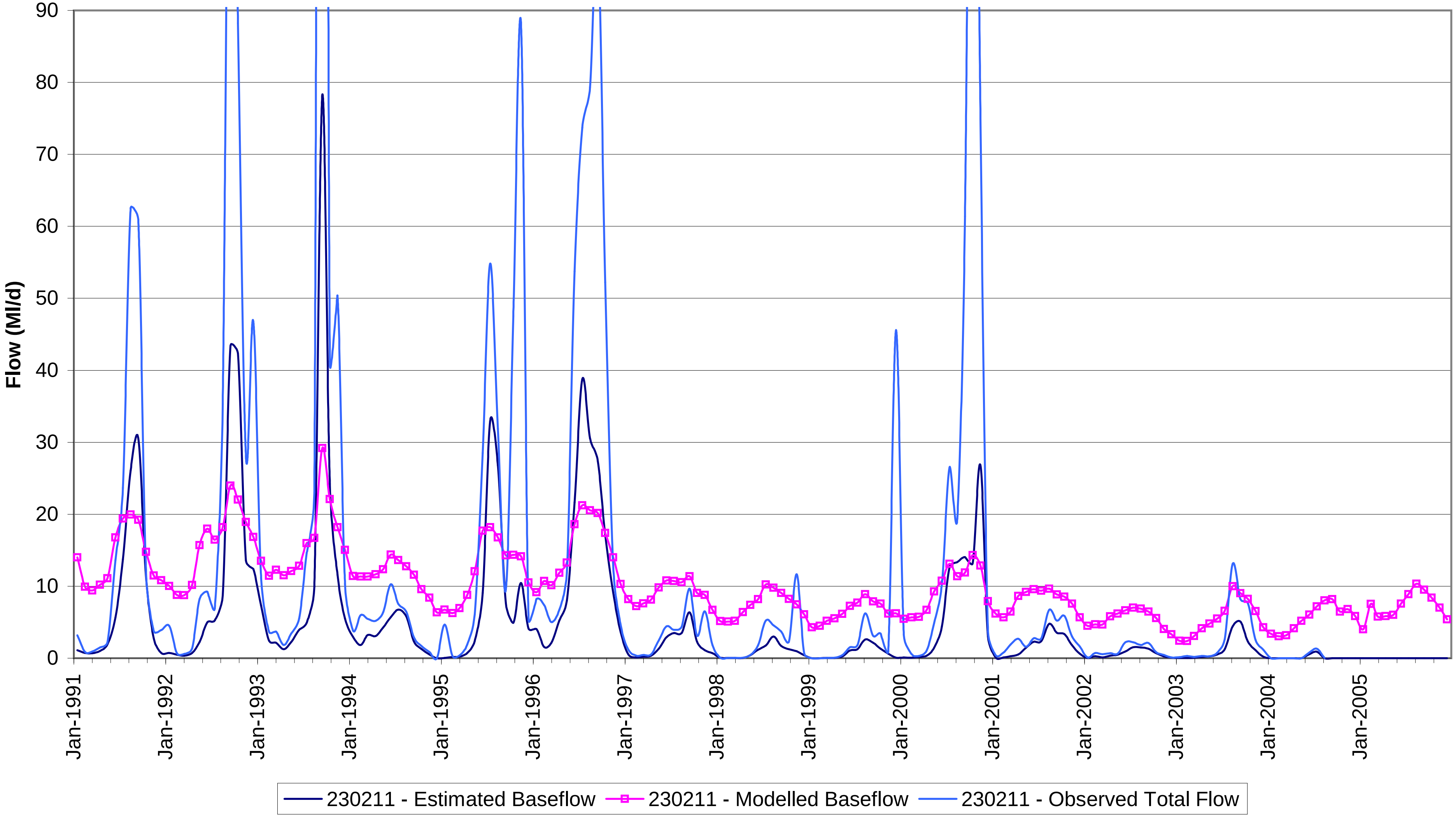
Emu Creek @ Clarkefield



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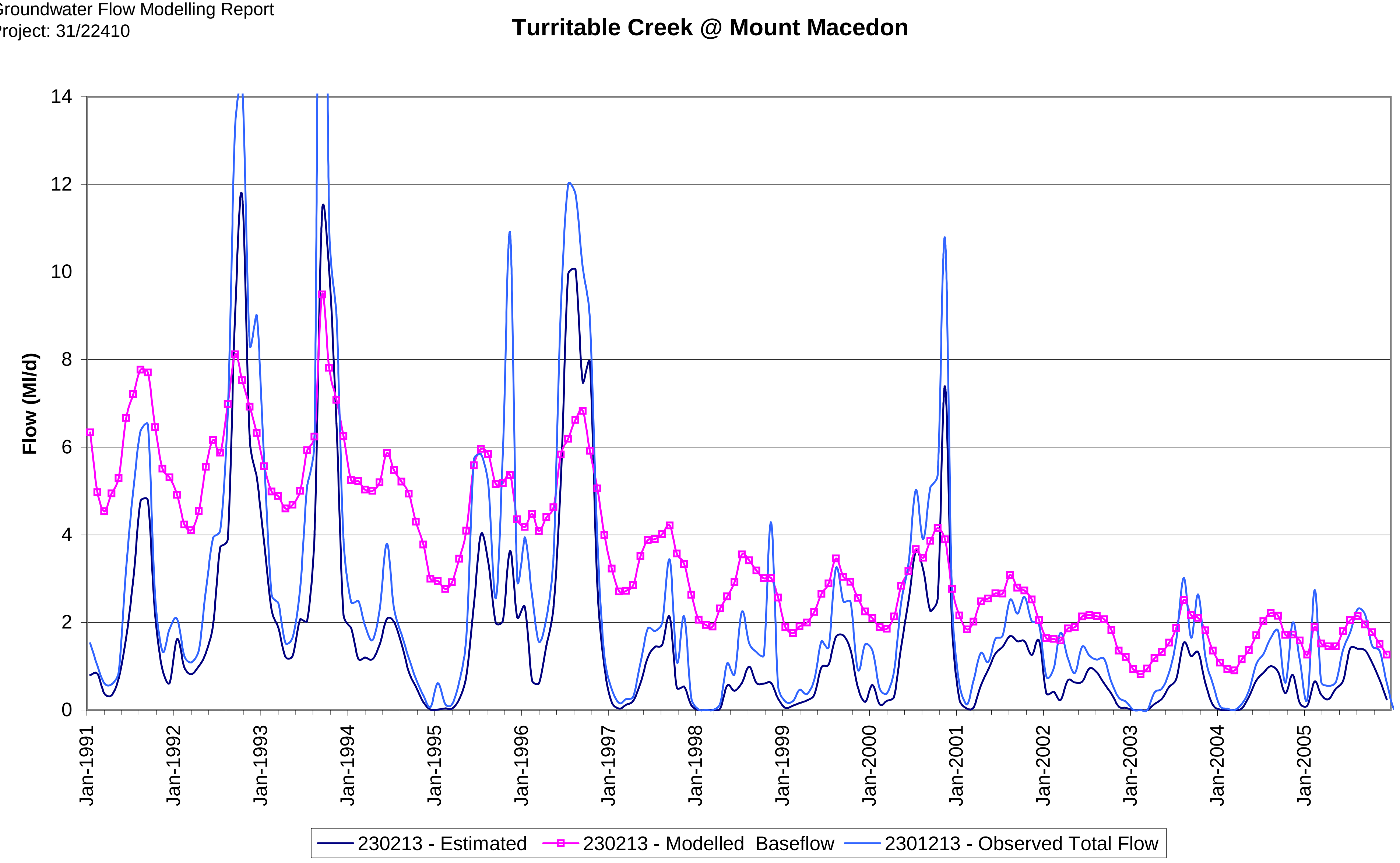

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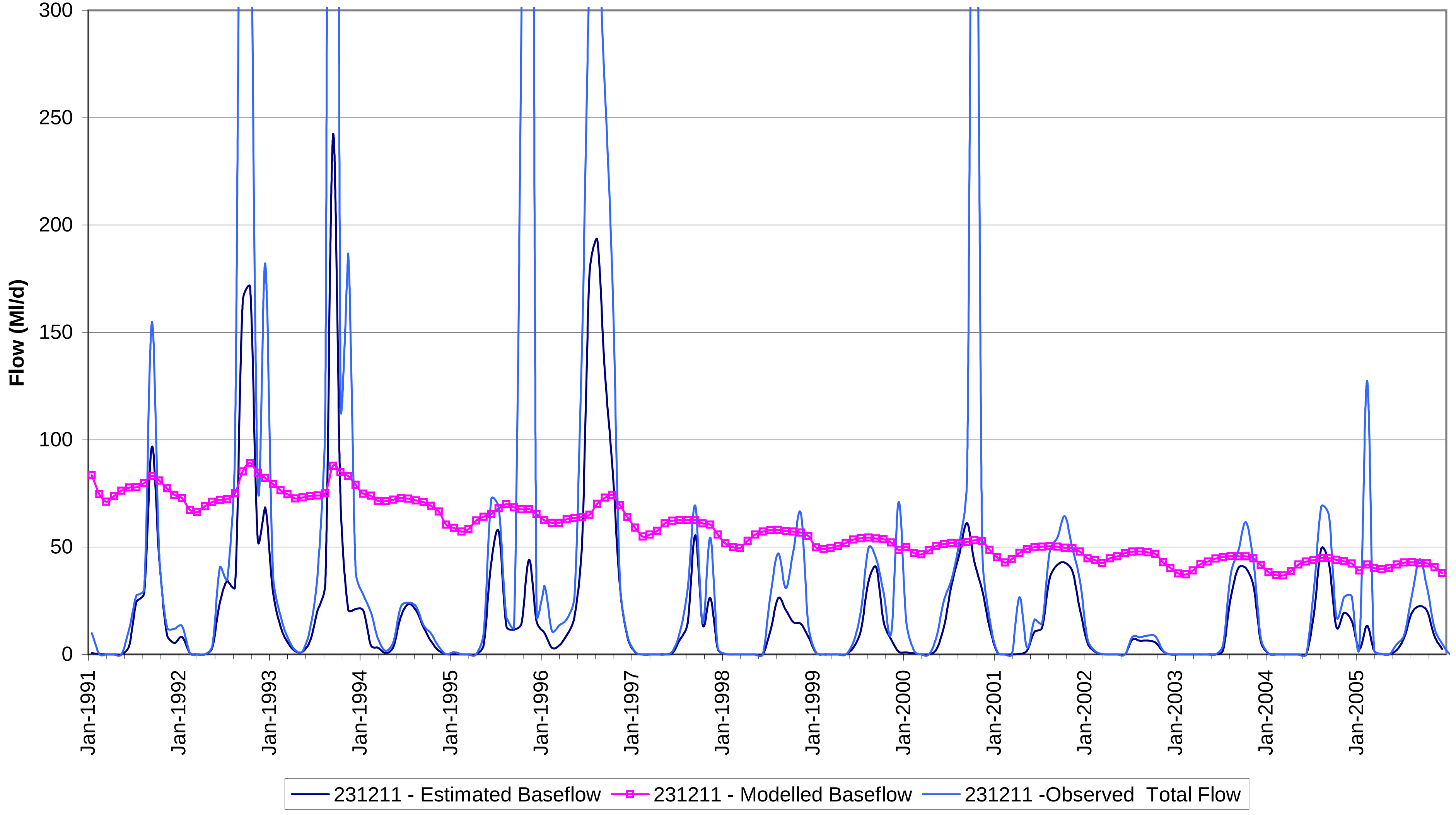
Lerderberg Creek @ Goodman Creek Junction



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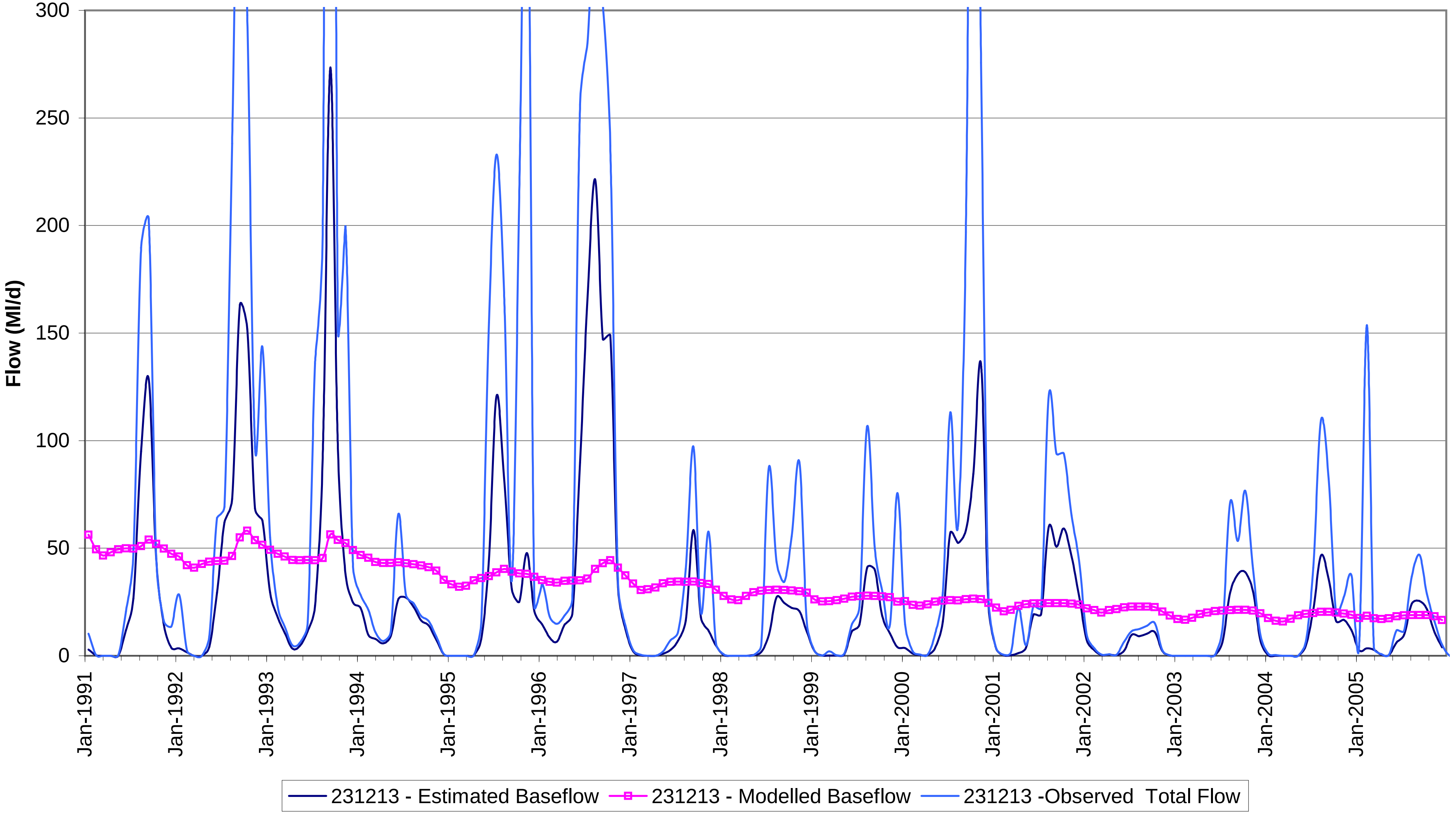
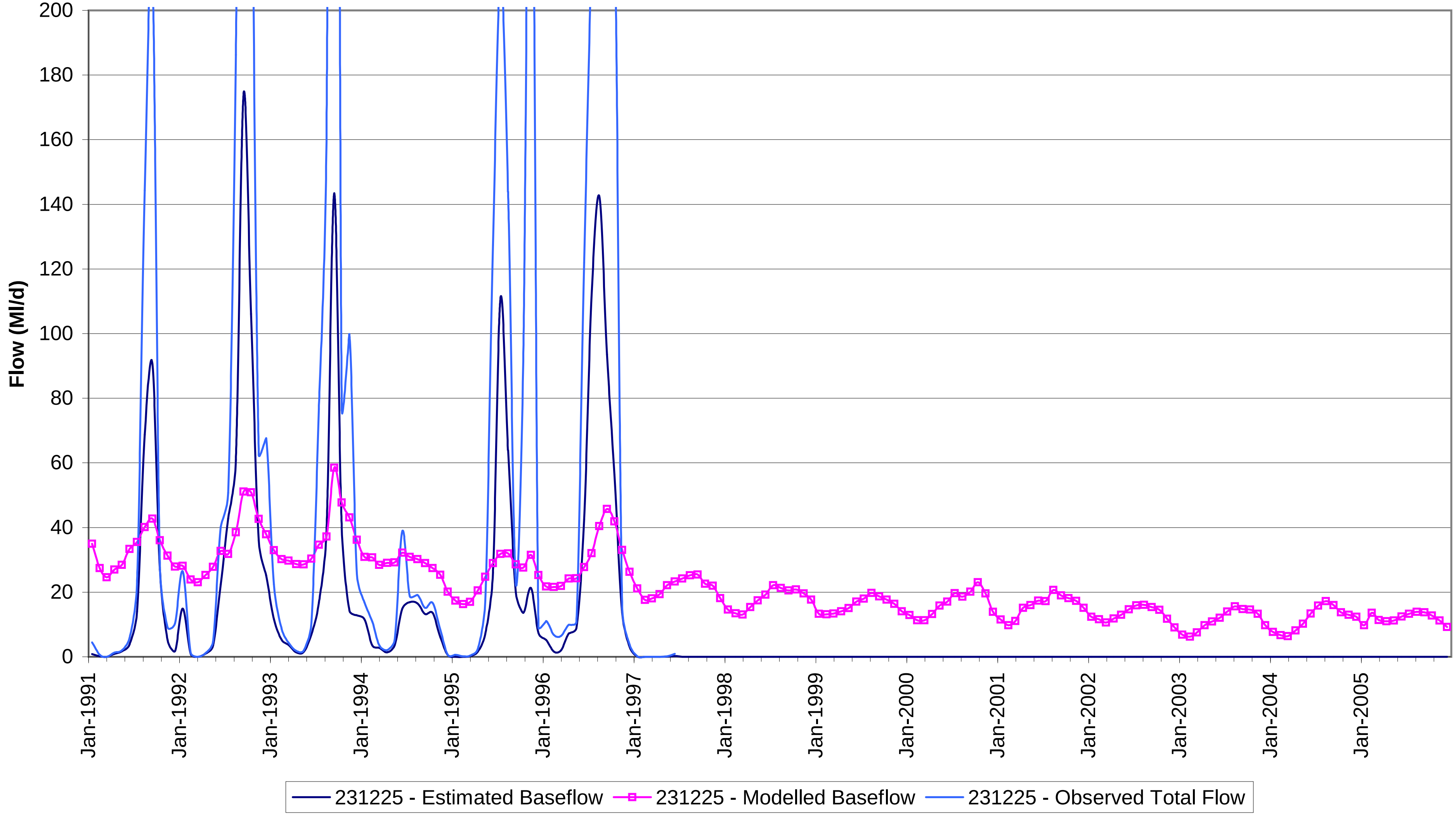
Lerderberg Creek @ Sardine Creek Crossing



Werribee River @ Ballan



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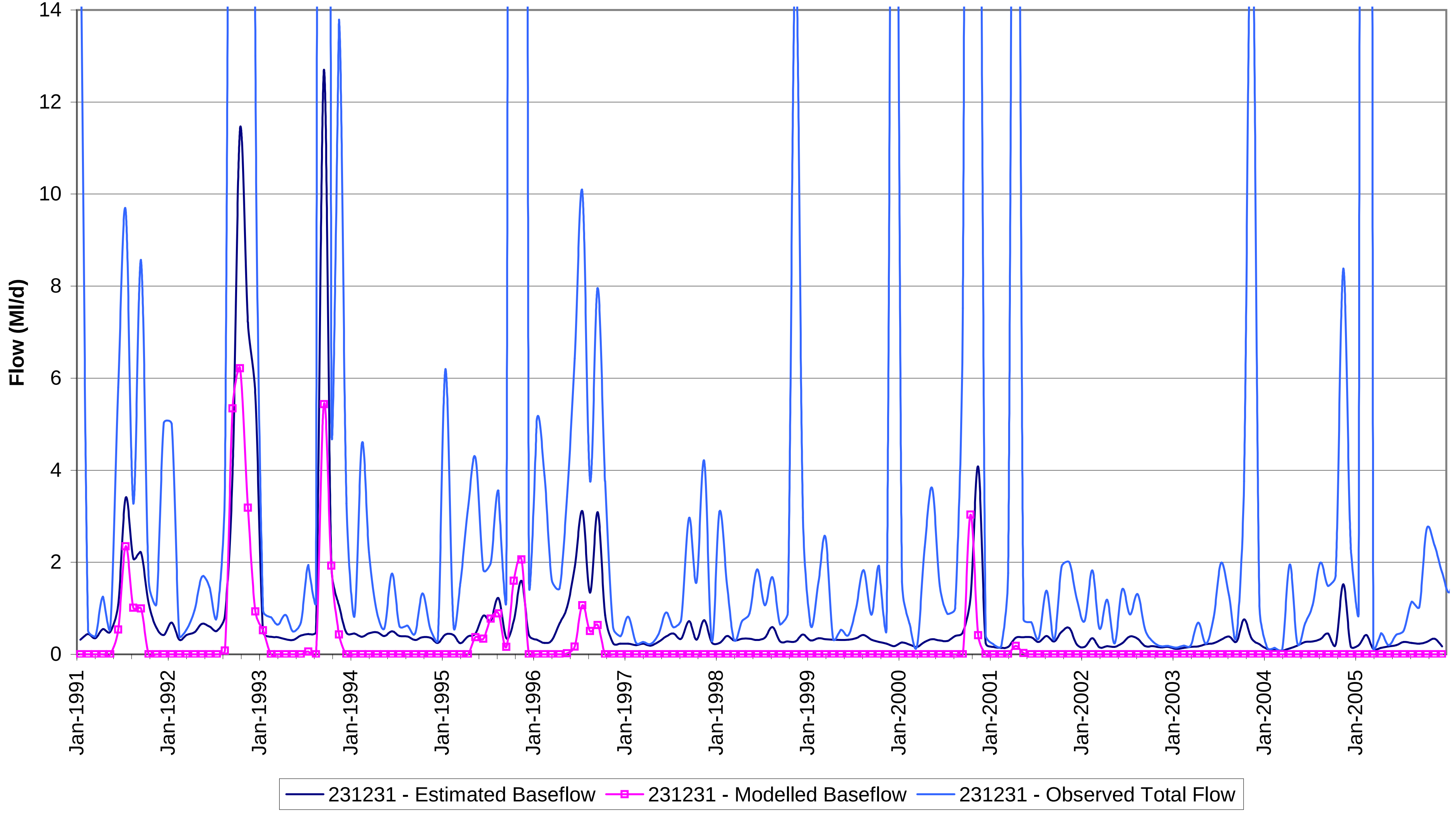
Toolern Creek @ Melton South



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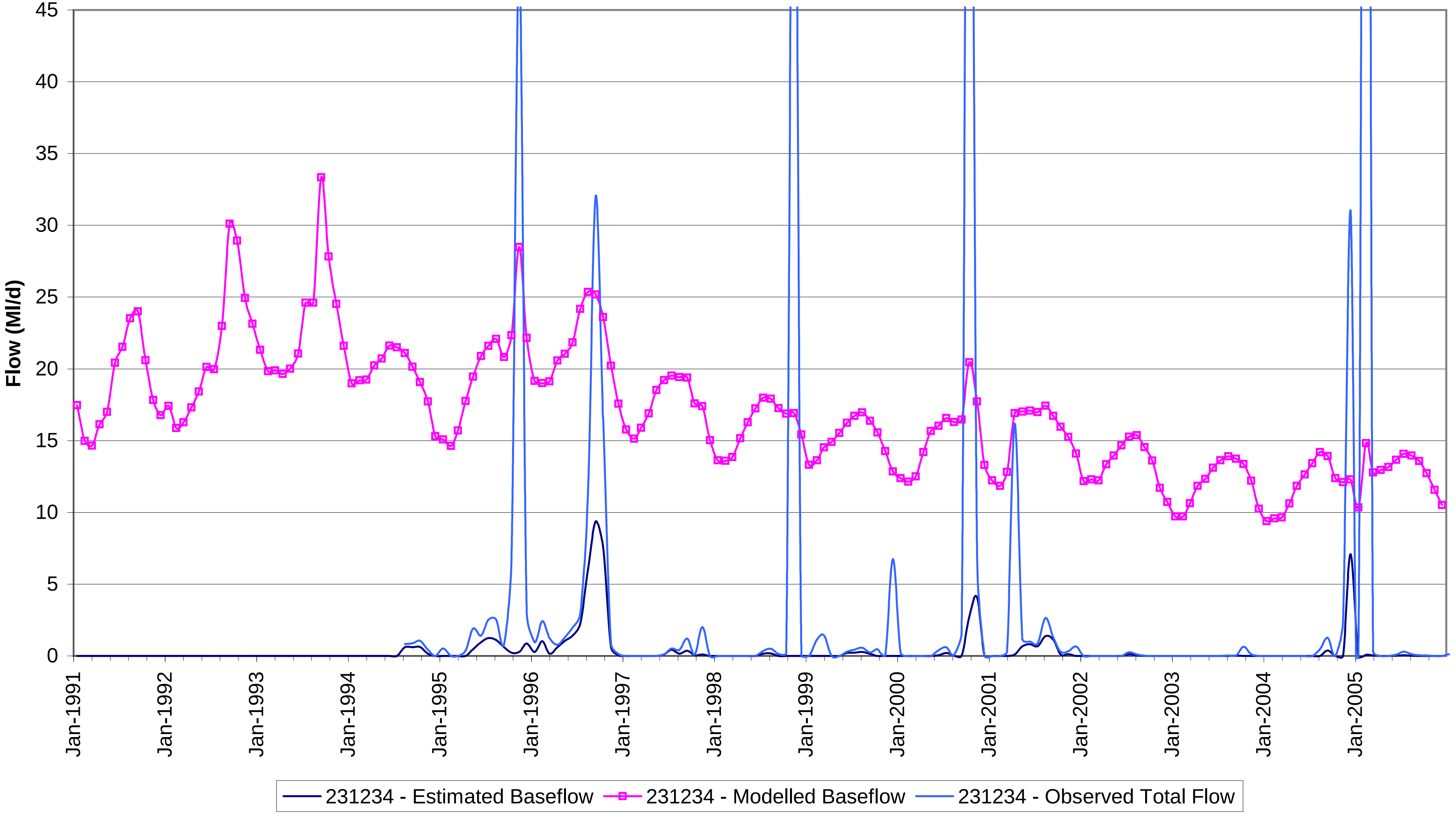
Parwan Creek @ Parwan



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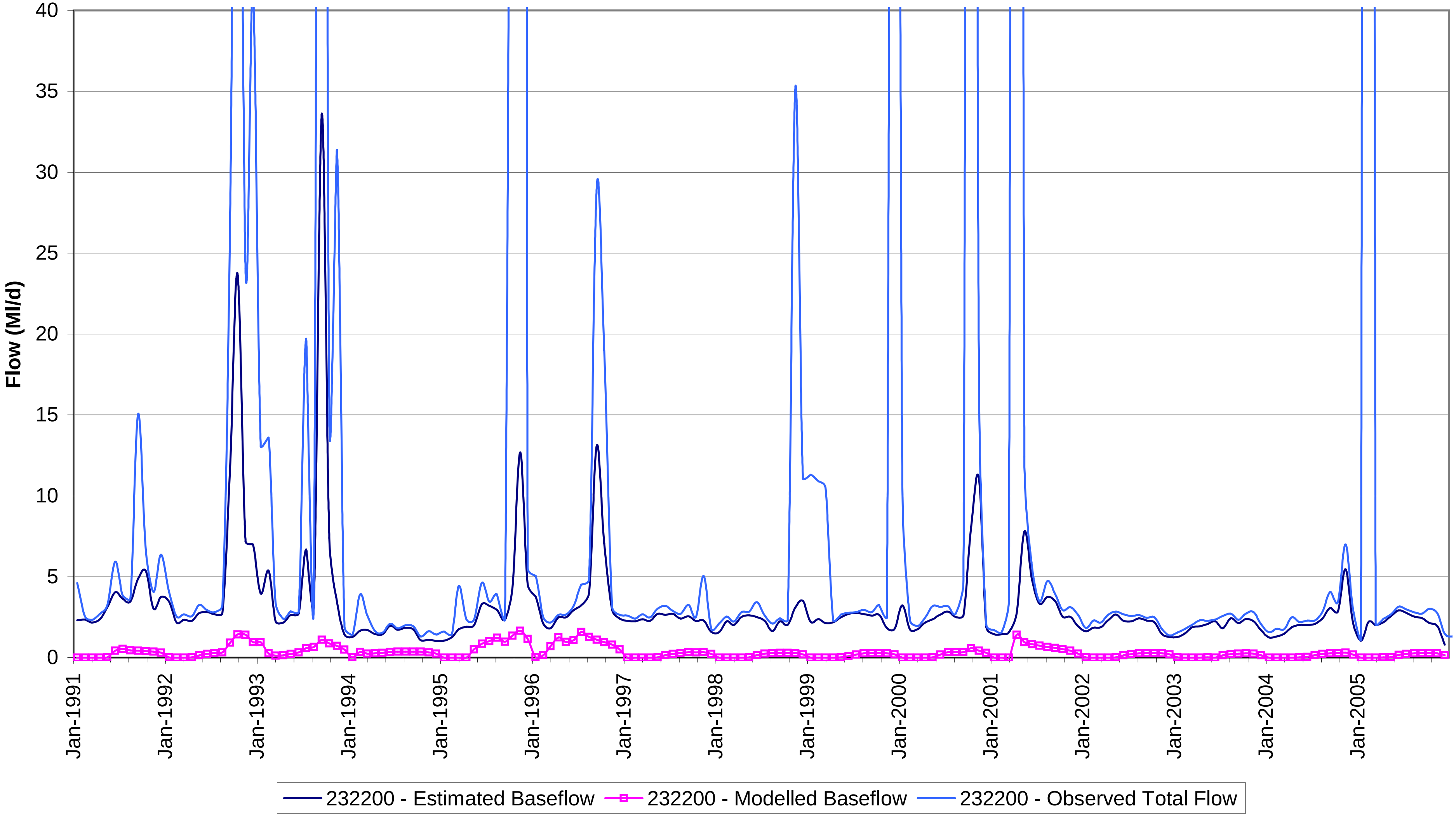
Little River @ Little River



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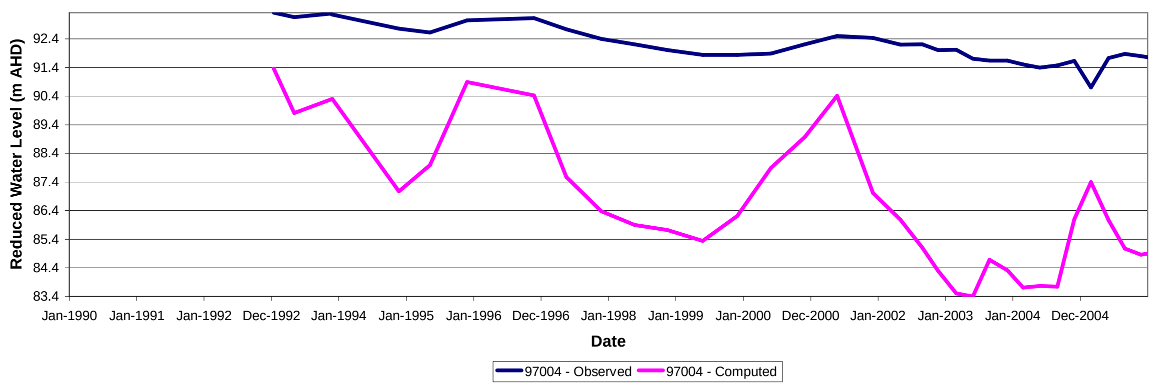
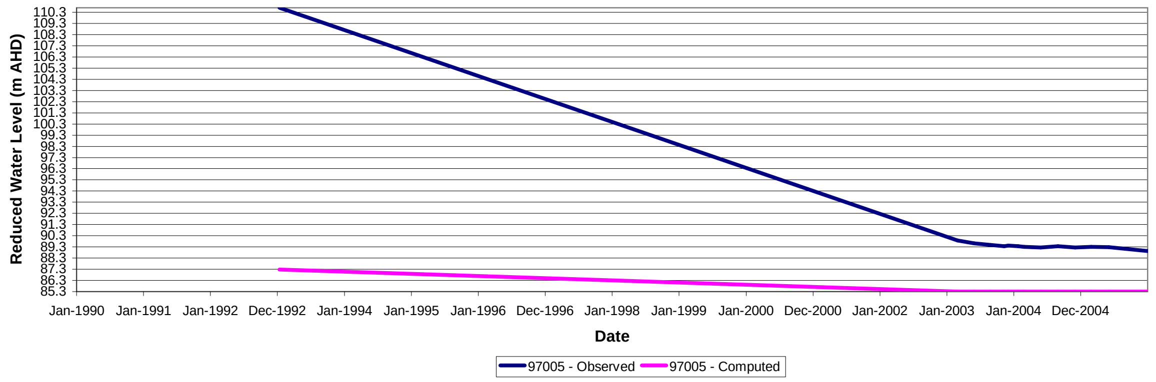
Appendix H

Modelled v Observed All Borehole Hydrographs

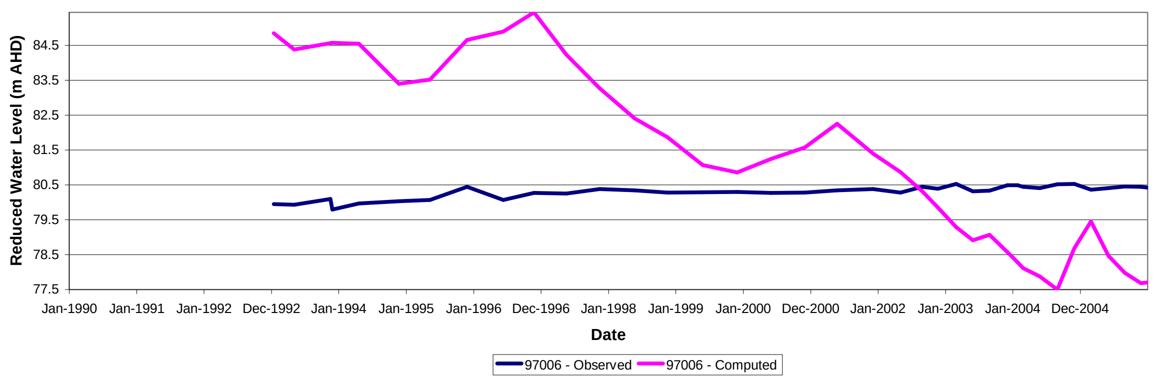
YarraRiver_Catchment - Layer 5 - SON Bore 97004 - Model DTM = 105, Actual Grd Sfc = 112.8 mAHD



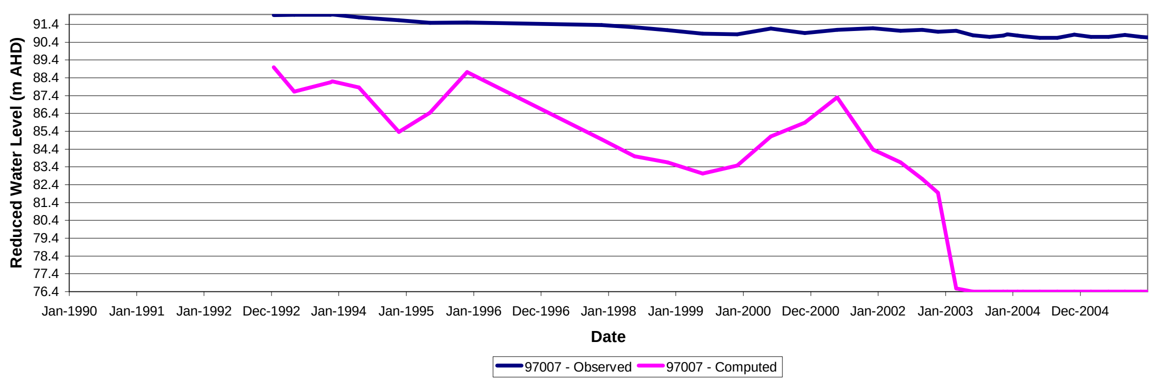
YarraRiver_Catchment - Layer 5 - SON Bore 97005 - Model DTM = 114.4, Actual Grd Sfc = 113 mAHD

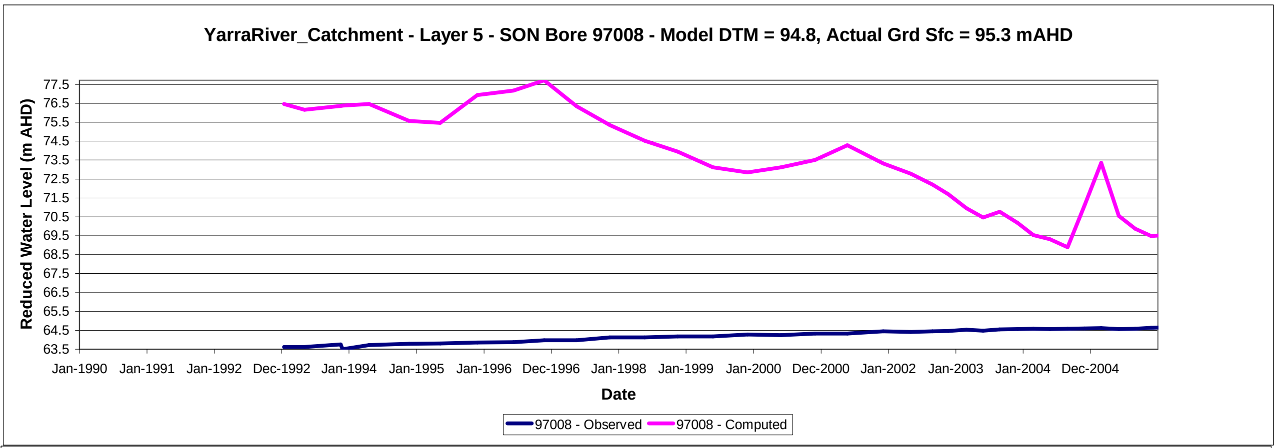


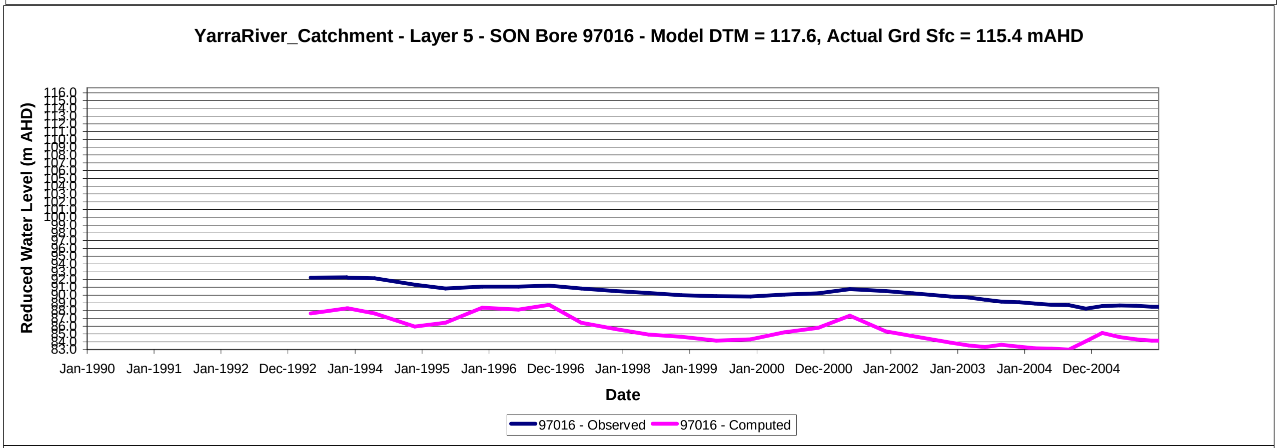
YarraRiver_Catchment - Layer 5 - SON Bore 97006 - Model DTM = 108.5, Actual Grd Sfc = 108.5 mAHD

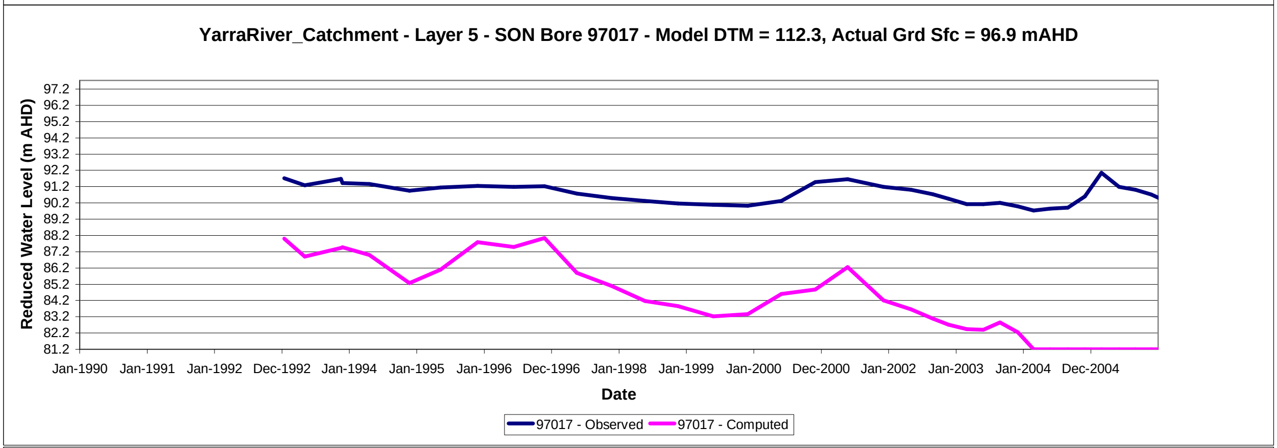


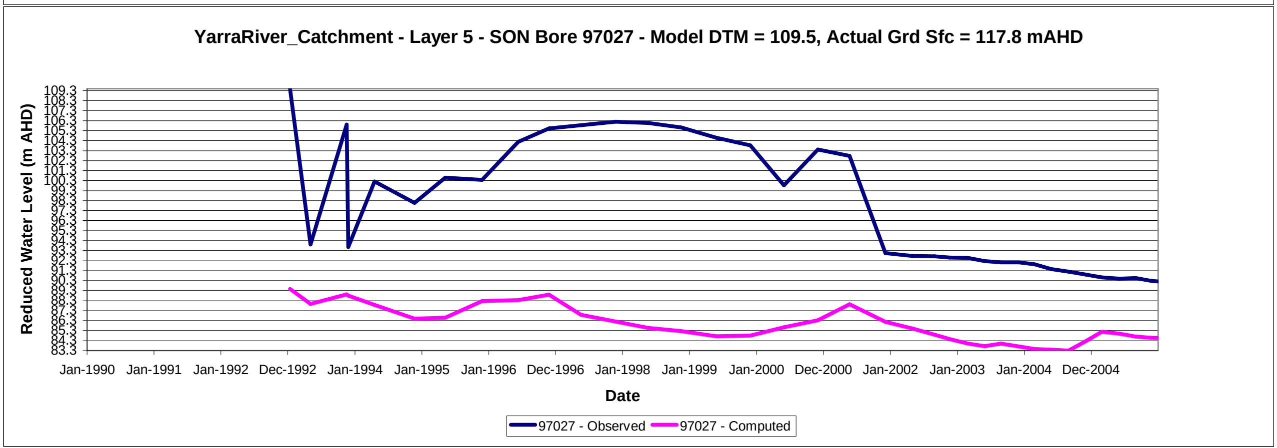
YarraRiver_Catchment - Layer 5 - SON Bore 97007 - Model DTM = 109.4, Actual Grd Sfc = 112.9 mAHD

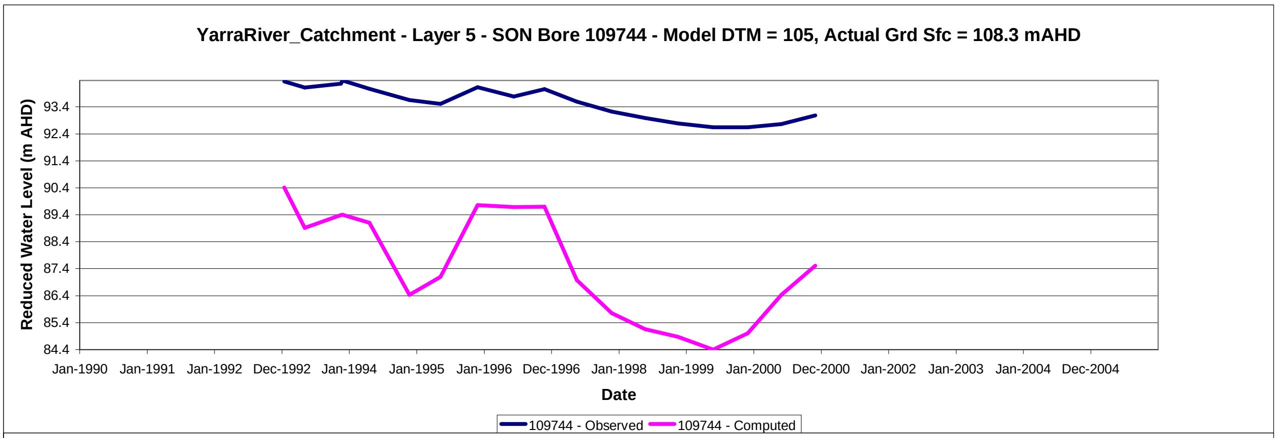


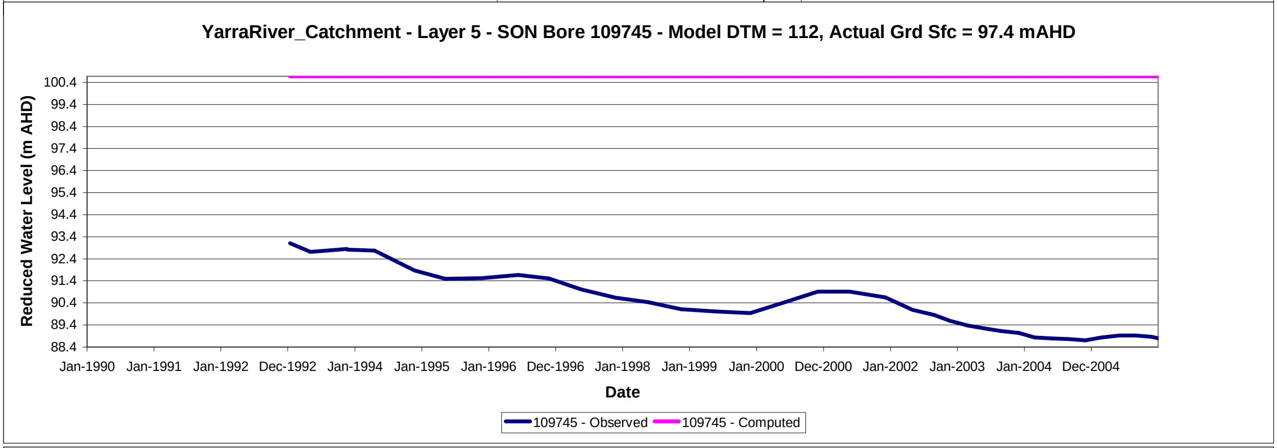

YarraRiver_Catchment - Layer 5 - SON Bore 97008 - Model DTM = 94.8, Actual Grd Sfc = 95.3 mAHD
Reduced Water Level (m AHD)
Date
97008 - Observed
97008 - Computed

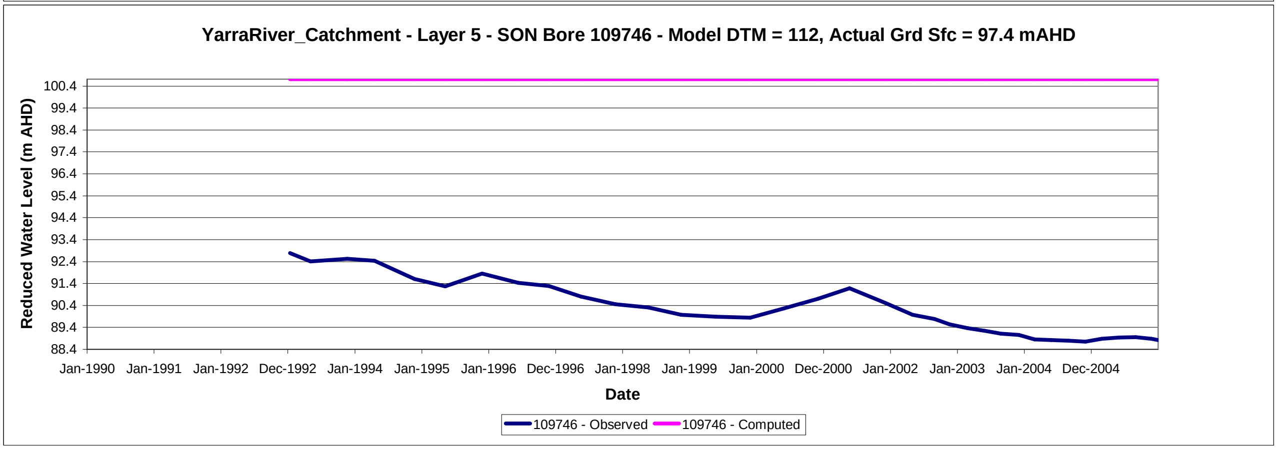

YarraRiver_Catchment - Layer 5 - SON Bore 97016 - Model DTM = 117.6, Actual Grd Sfc = 115.4 mAHD
Reduced Water Level (m AHD)
Date
97016 - Observed
97016 - Computed

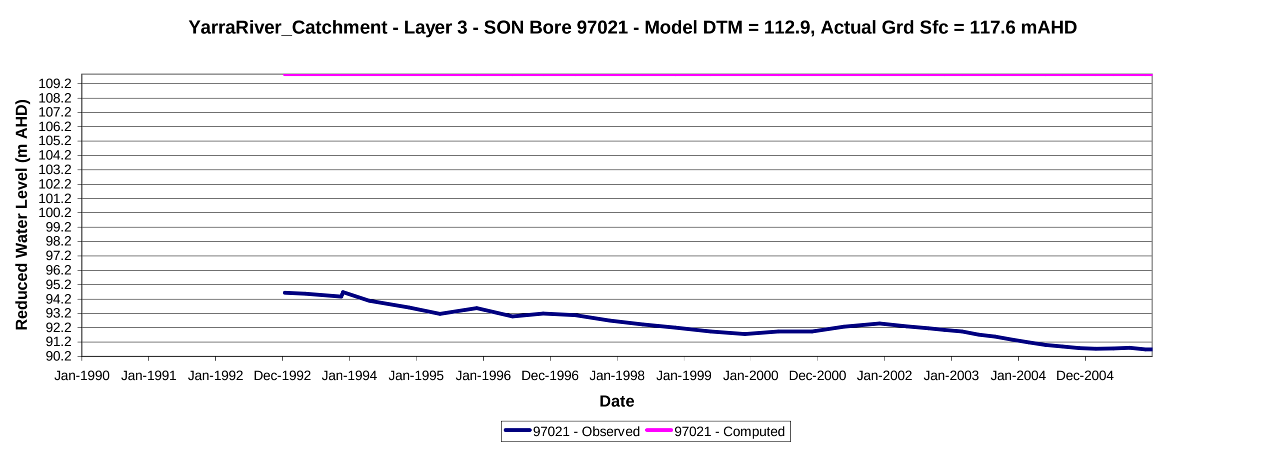

YarraRiver_Catchment - Layer 5 - SON Bore 97017 - Model DTM = 112.3, Actual Grd Sfc = 96.9 mAHD
Reduced Water Level (m AHD)
Date
97017 - Observed
97017 - Computed

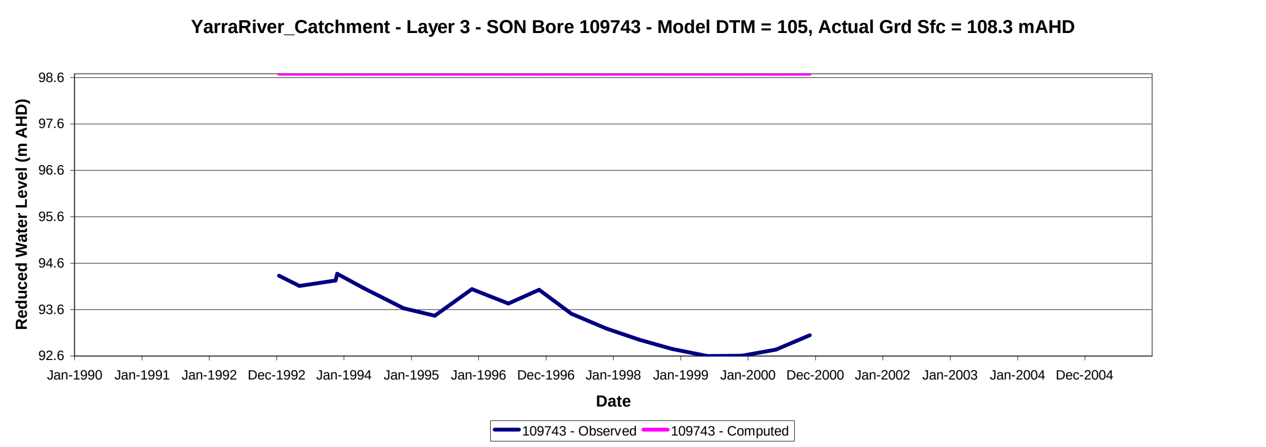

YarraRiver_Catchment - Layer 5 - SON Bore 97027 - Model DTM = 109.5, Actual Grd Sfc = 117.8 mAHD
Reduced Water Level (m AHD)
Date
97027 - Observed
97027 - Computed

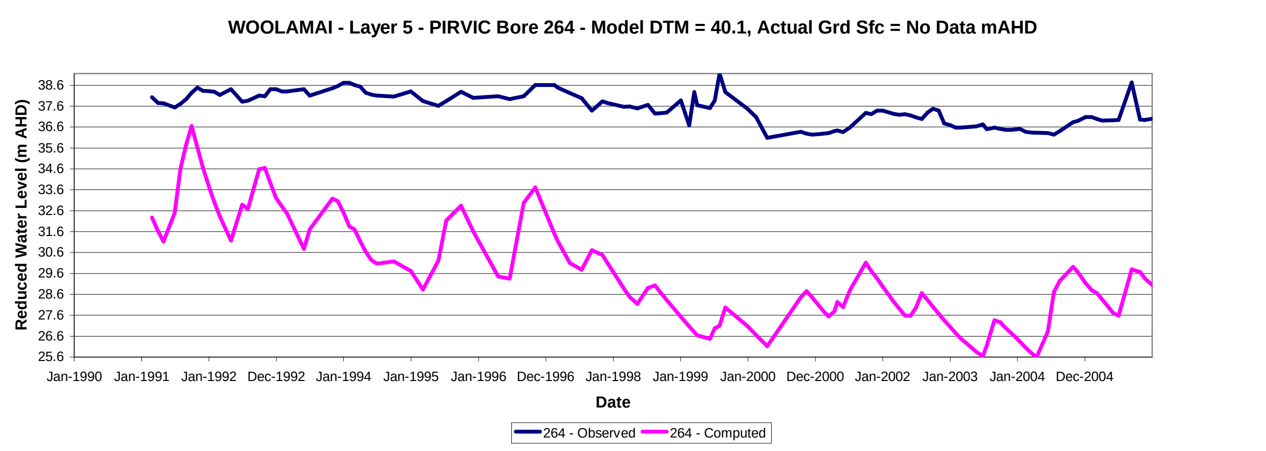

YarraRiver_Catchment - Layer 5 - SON Bore 109744 - Model DTM = 105, Actual Grd Sfc = 108.3 mAHD
Reduced Water Level (m AHD)
93.4
92.4
91.4
90.4
89.4
88.4
87.4
86.4
85.4
84.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109744 - Observed
109744 - Computed

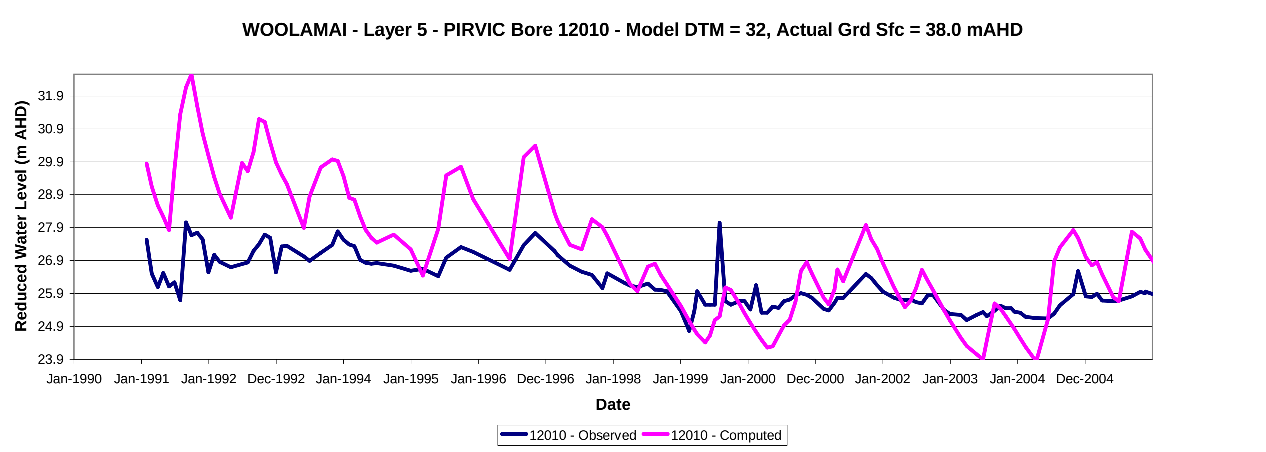

YarraRiver_Catchment - Layer 5 - SON Bore 109745 - Model DTM = 112, Actual Grd Sfc = 97.4 mAHD
Reduced Water Level (m AHD)
100.4
99.4
98.4
97.4
96.4
95.4
94.4
93.4
92.4
91.4
90.4
89.4
88.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109745 - Observed
109745 - Computed

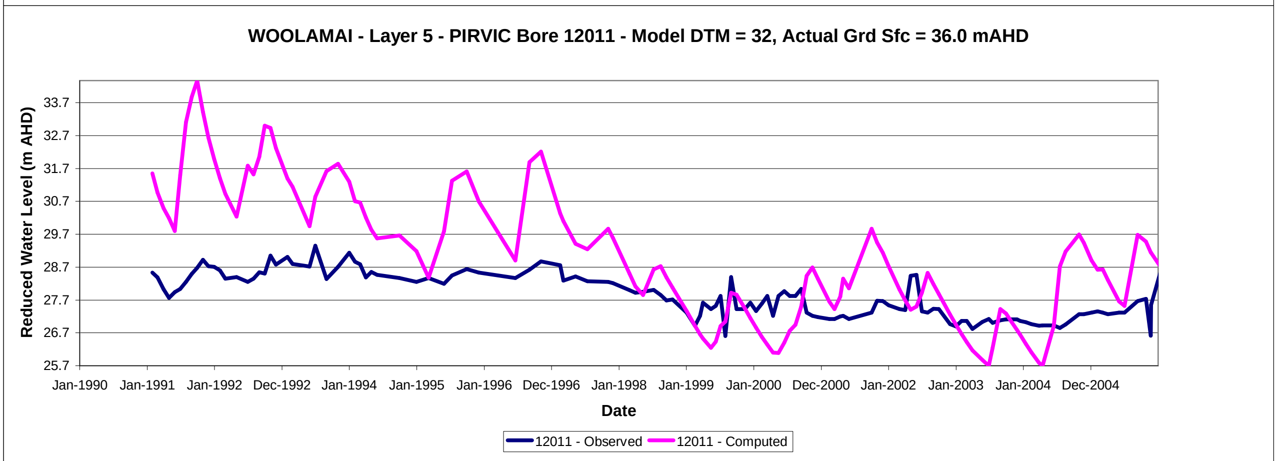

YarraRiver_Catchment - Layer 5 - SON Bore 109746 - Model DTM = 112, Actual Grd Sfc = 97.4 mAHD
Reduced Water Level (m AHD)
100.4
99.4
98.4
97.4
96.4
95.4
94.4
93.4
92.4
91.4
90.4
89.4
88.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109746 - Observed
109746 - Computed

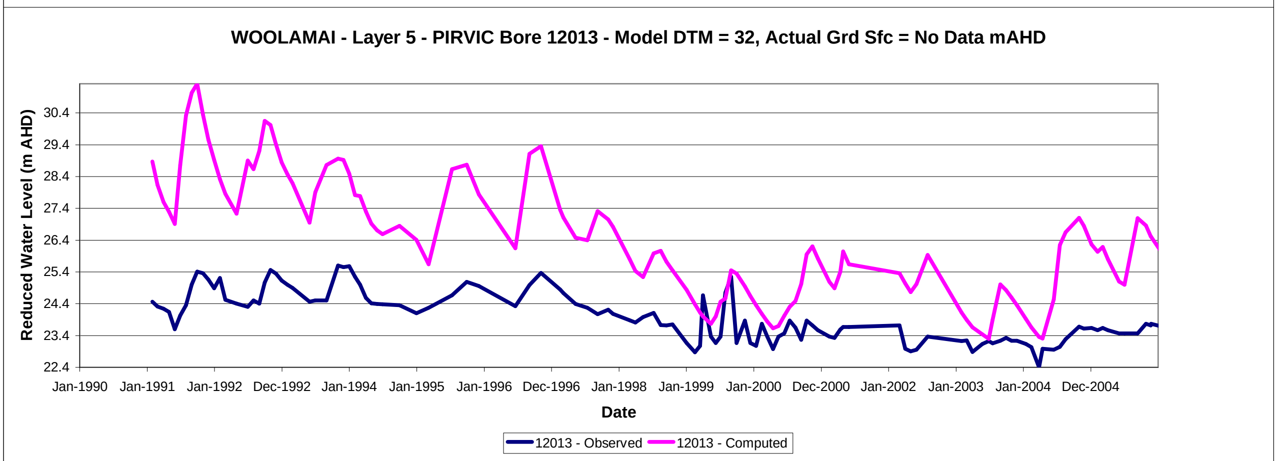

YarraRiver_Catchment - Layer 3 - SON Bore 97021 - Model DTM = 112.9, Actual Grd Sfc = 117.6 mAHD
Reduced Water Level (m AHD)
109.2
108.2
107.2
106.2
105.2
104.2
103.2
102.2
101.2
100.2
99.2
98.2
97.2
96.2
95.2
94.2
93.2
92.2
91.2
90.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
97021 - Observed
97021 - Computed

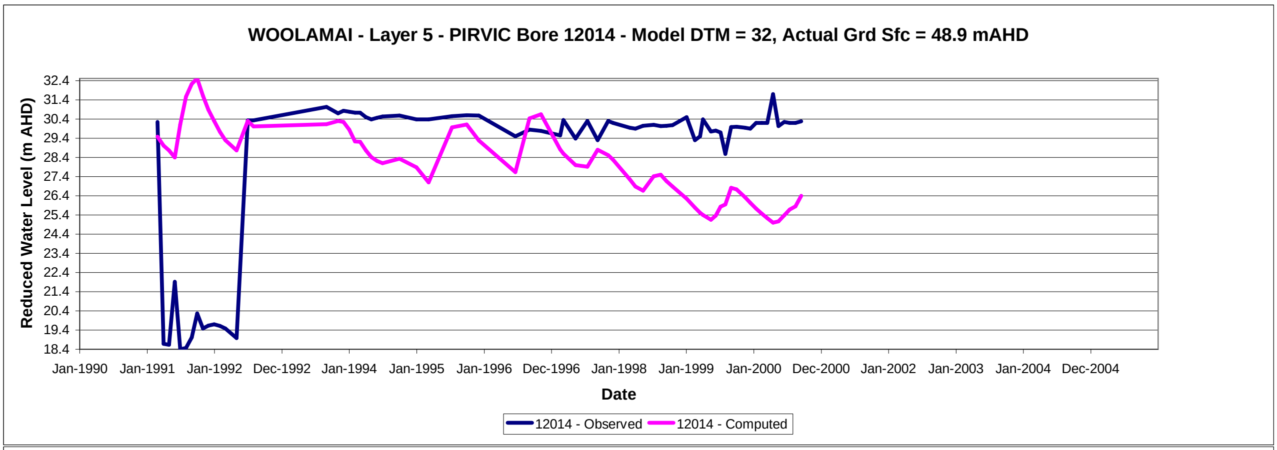

YarraRiver_Catchment - Layer 3 - SON Bore 109743 - Model DTM = 105, Actual Grd Sfc = 108.3 mAHD
Reduced Water Level (m AHD)
98.6
97.6
96.6
95.6
94.6
93.6
92.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109743 - Observed
109743 - Computed

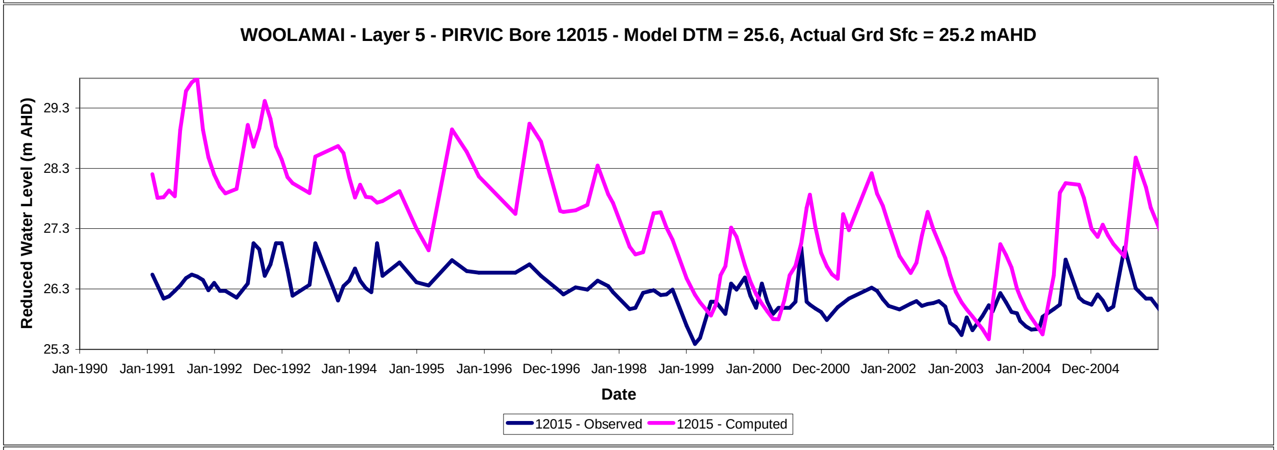

WOOLAMAI - Layer 5 - PIRVIC Bore 264 - Model DTM = 40.1, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
38.6
37.6
36.6
35.6
34.6
33.6
32.6
31.6
30.6
29.6
28.6
27.6
26.6
25.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
264 - Observed
264 - Computed

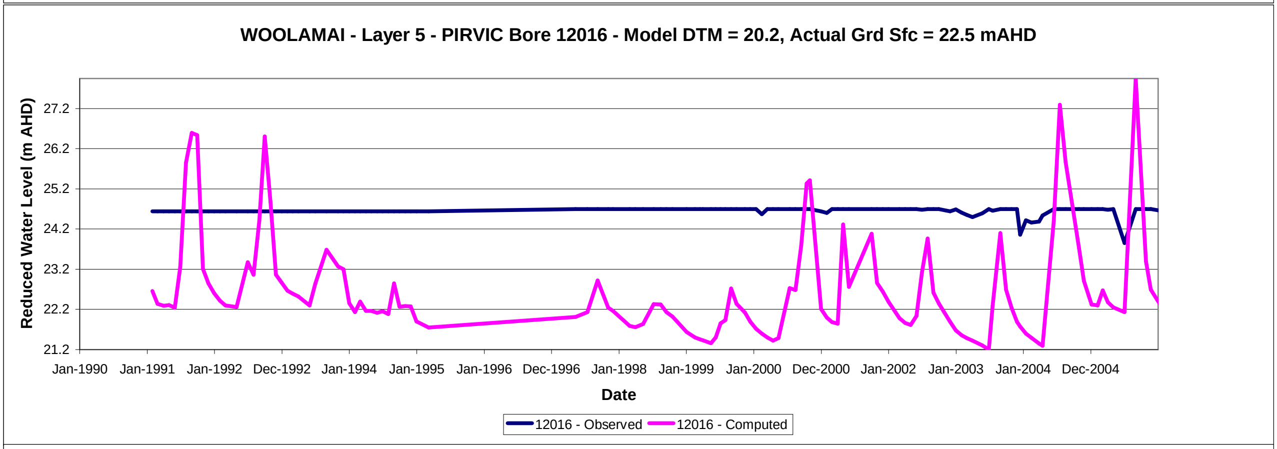

WOOLAMAI - Layer 5 - PIRVIC Bore 12010 - Model DTM = 32, Actual Grd Sfc = 38.0 mAHD
Reduced Water Level (m AHD)
31.9
30.9
29.9
28.9
27.9
26.9
25.9
24.9
23.9
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12010 - Observed
12010 - Computed

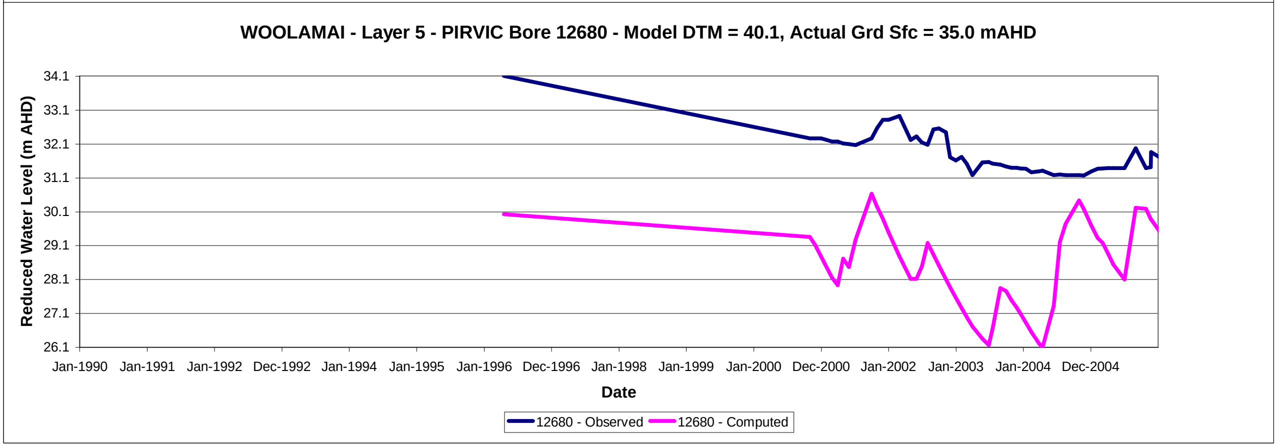

WOOLAMAI - Layer 5 - PIRVIC Bore 12011 - Model DTM = 32, Actual Grd Sfc = 36.0 mAHD
Reduced Water Level (m AHD)
33.7
32.7
31.7
30.7
29.7
28.7
27.7
26.7
25.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12011 - Observed
12011 - Computed


WOOLAMAI - Layer 5 - PIRVIC Bore 12013 - Model DTM = 32, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
30.4
29.4
28.4
27.4
26.4
25.4
24.4
23.4
22.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12013 - Observed
12013 - Computed

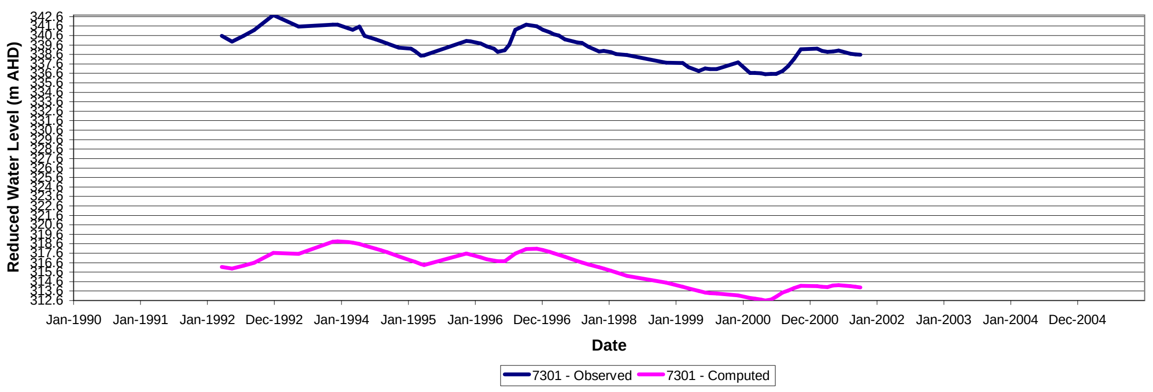

WOOLAMAI - Layer 5 - PIRVIC Bore 12014 - Model DTM = 32, Actual Grd Sfc = 48.9 mAHD
Reduced Water Level (m AHD)
32.4
31.4
30.4
29.4
28.4
27.4
26.4
25.4
24.4
23.4
22.4
21.4
20.4
19.4
18.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12014 - Observed
12014 - Computed


WOOLAMAI - Layer 5 - PIRVIC Bore 12015 - Model DTM = 25.6, Actual Grd Sfc = 25.2 mAHD
Reduced Water Level (m AHD)
29.3
28.3
27.3
26.3
25.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12015 - Observed
12015 - Computed

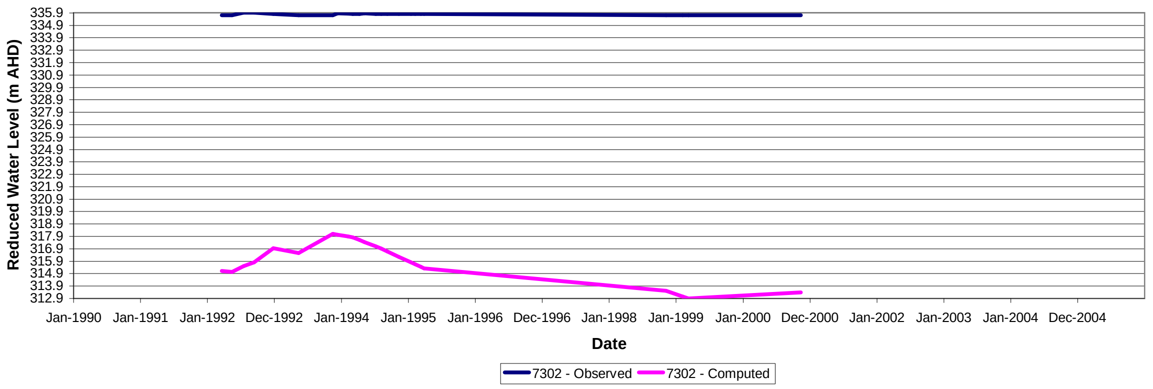

WOOLAMAI - Layer 5 - PIRVIC Bore 12016 - Model DTM = 20.2, Actual Grd Sfc = 22.5 mAHD
Reduced Water Level (m AHD)
27.2
26.2
25.2
24.2
23.2
22.2
21.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12016 - Observed
12016 - Computed


WOOLAMAI - Layer 5 - PIRVIC Bore 12680 - Model DTM = 40.1, Actual Grd Sfc = 35.0 mAHD
Reduced Water Level (m AHD)
34.1
33.1
32.1
31.1
30.1
29.1
28.1
27.1
26.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12680 - Observed
12680 - Computed

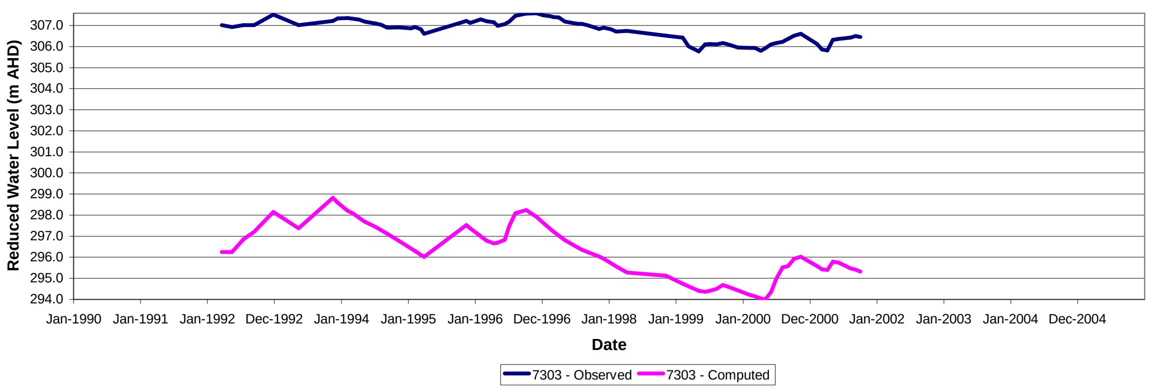
WOODEND - Layer 6 - PIRVIC Bore 7301 - Model DTM = 343, Actual Grd Sfc = No Data mAHD



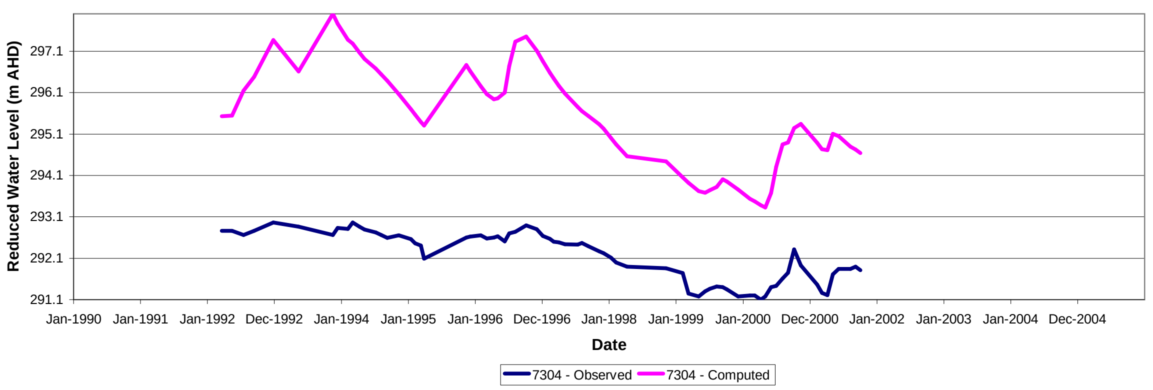
WOODEND - Layer 6 - PIRVIC Bore 7302 - Model DTM = 340.2, Actual Grd Sfc = No Data mAHD



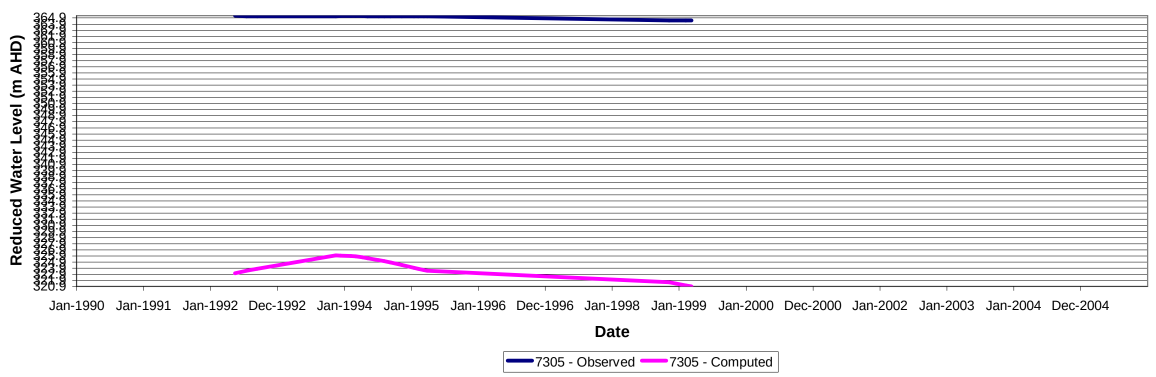
WOODEND - Layer 6 - PIRVIC Bore 7303 - Model DTM = 300.2, Actual Grd Sfc = No Data mAHD



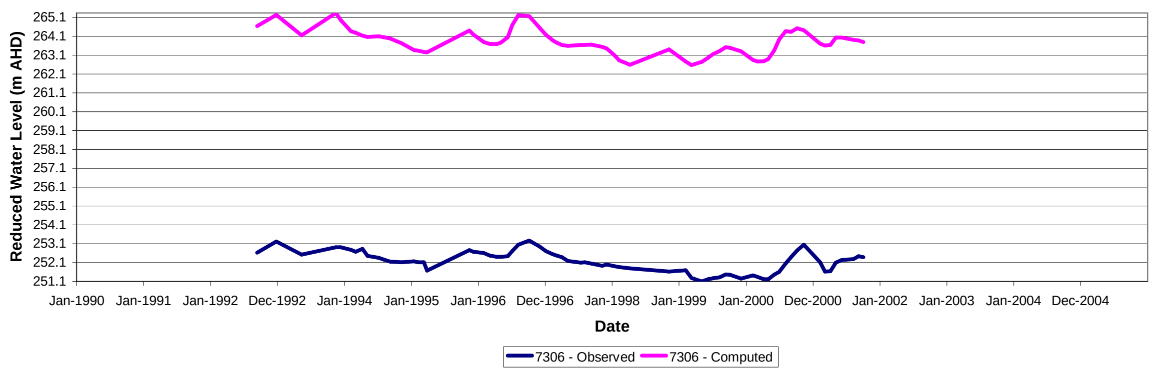
WOODEND - Layer 6 - PIRVIC Bore 7304 - Model DTM = 300.2, Actual Grd Sfc = No Data mAHD



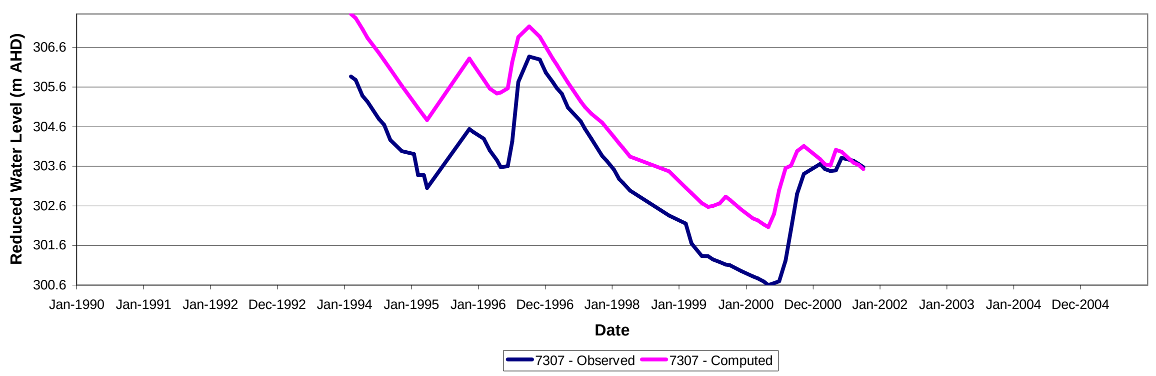
WOODEND - Layer 6 - PIRVIC Bore 7305 - Model DTM = 364.1, Actual Grd Sfc = No Data mAHD



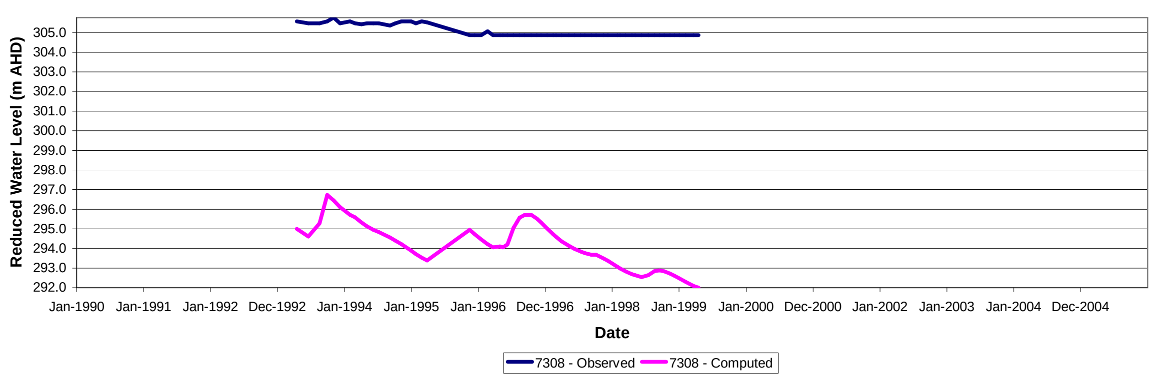
WOODEND - Layer 6 - PIRVIC Bore 7306 - Model DTM = 269.4, Actual Grd Sfc = No Data mAHD

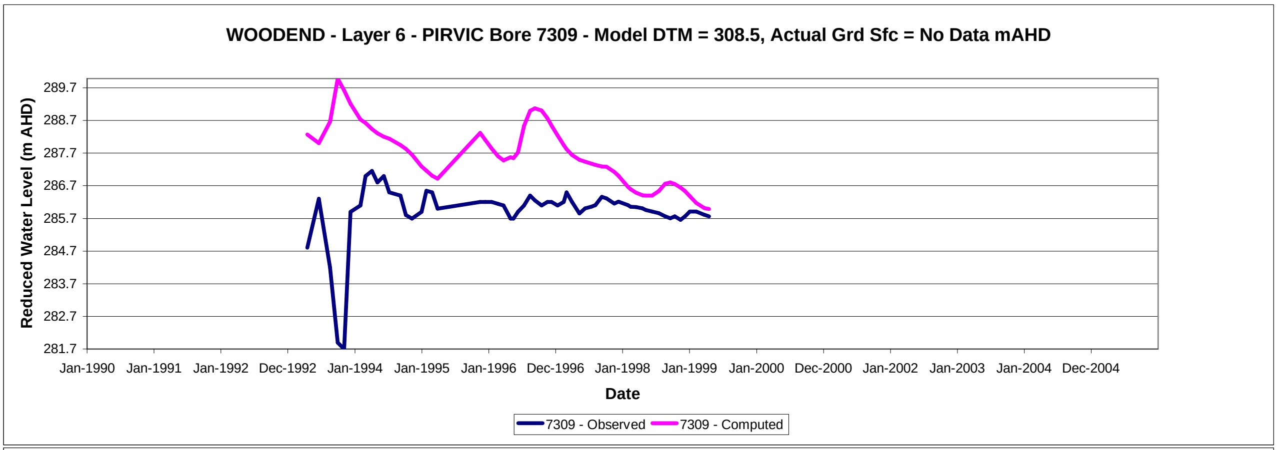


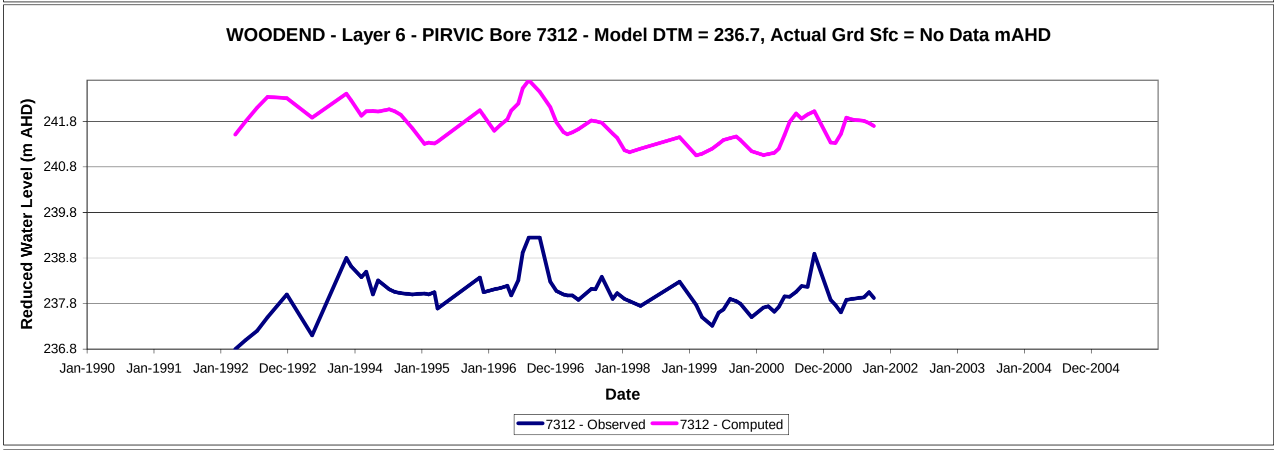
WOODEND - Layer 6 - PIRVIC Bore 7307 - Model DTM = 310.5, Actual Grd Sfc = No Data mAHD

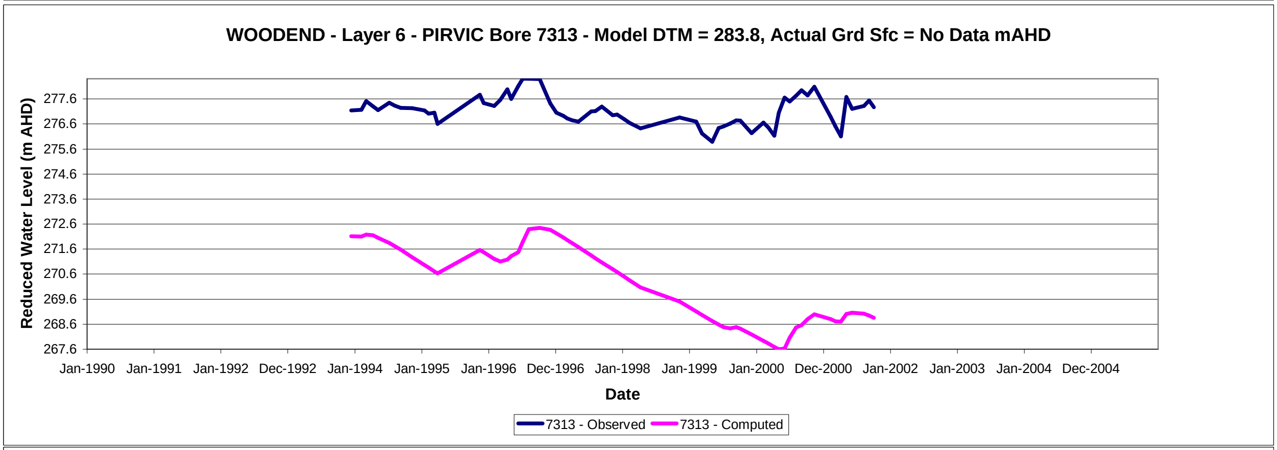


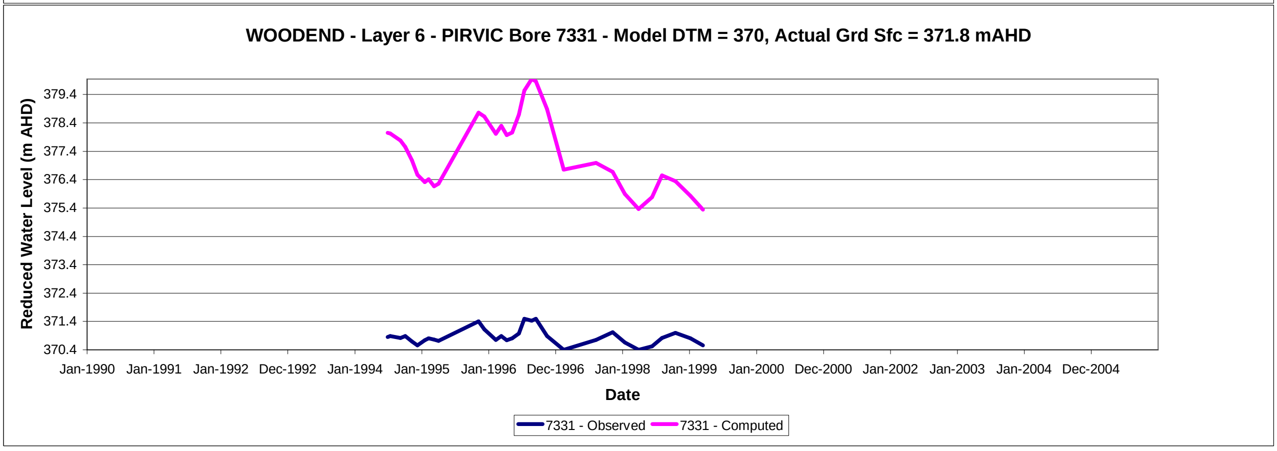
WOODEND - Layer 6 - PIRVIC Bore 7308 - Model DTM = 319.4, Actual Grd Sfc = No Data mAHD

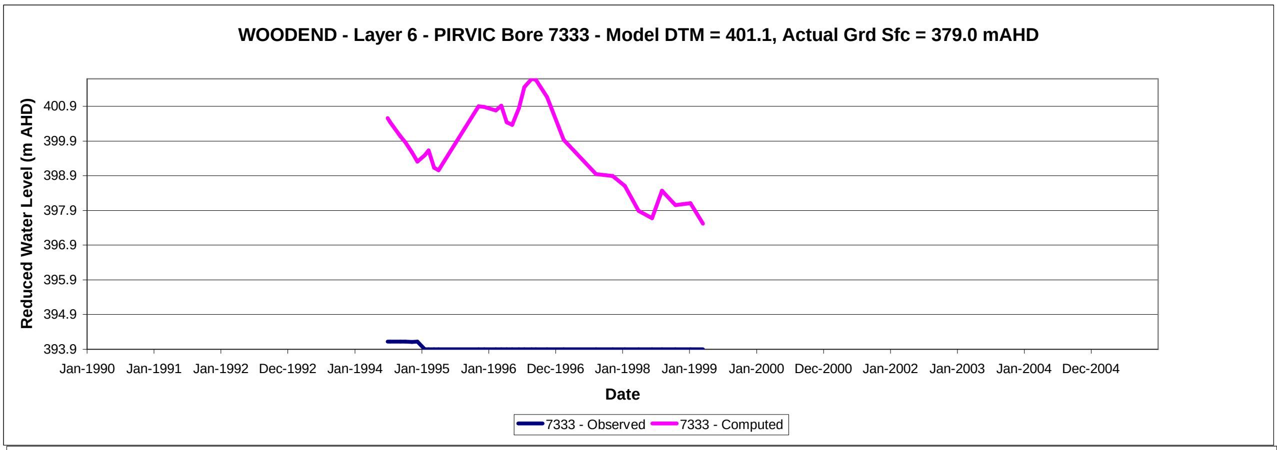


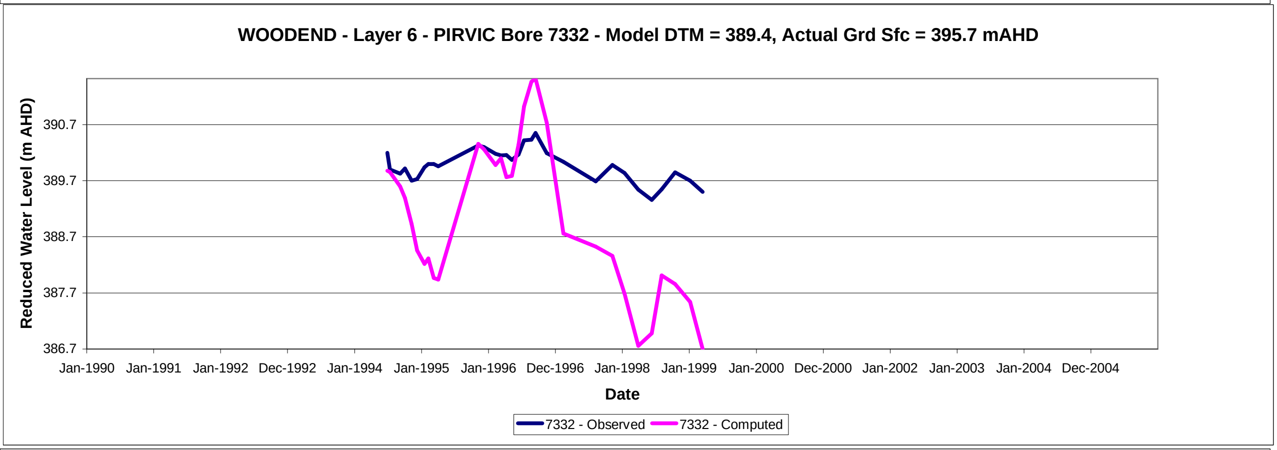

WOODEND - Layer 6 - PIRVIC Bore 7309 - Model DTM = 308.5, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
289.7
288.7
287.7
286.7
285.7
284.7
283.7
282.7
281.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7309 - Observed
7309 - Computed

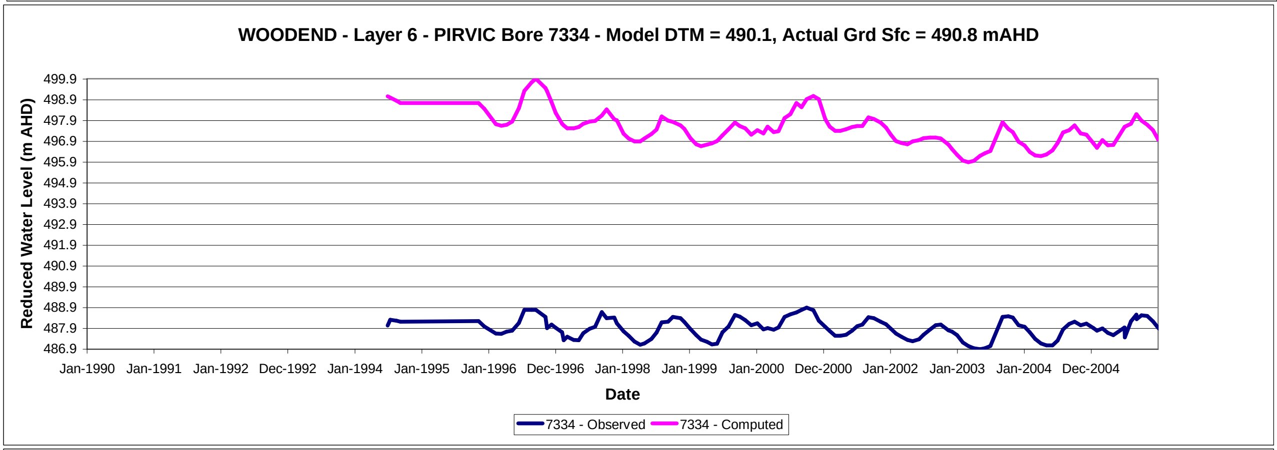

WOODEND - Layer 6 - PIRVIC Bore 7312 - Model DTM = 236.7, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
241.8
240.8
239.8
238.8
237.8
236.8
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7312 - Observed
7312 - Computed

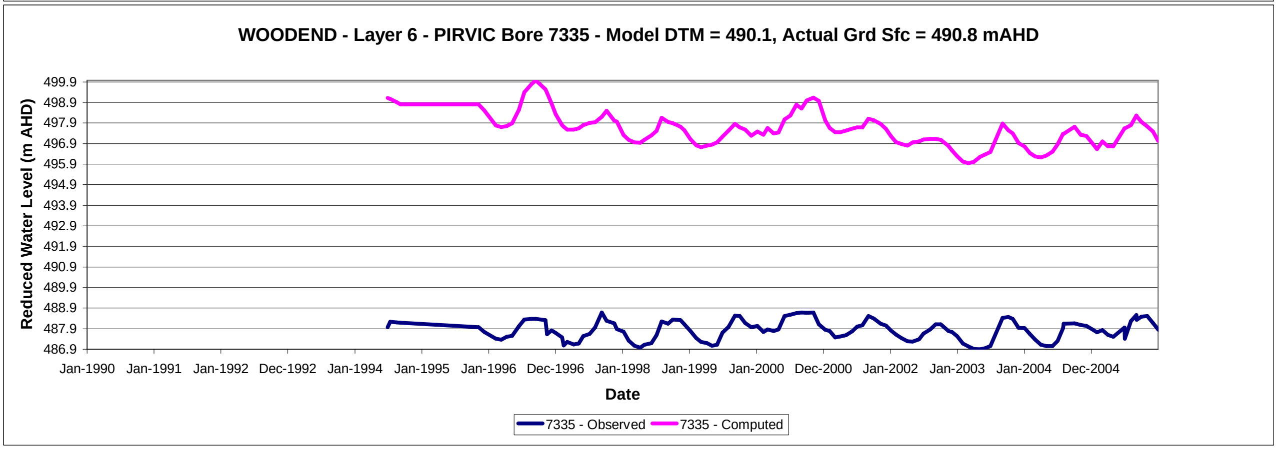

WOODEND - Layer 6 - PIRVIC Bore 7313 - Model DTM = 283.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
277.6
276.6
275.6
274.6
273.6
272.6
271.6
270.6
269.6
268.6
267.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7313 - Observed
7313 - Computed

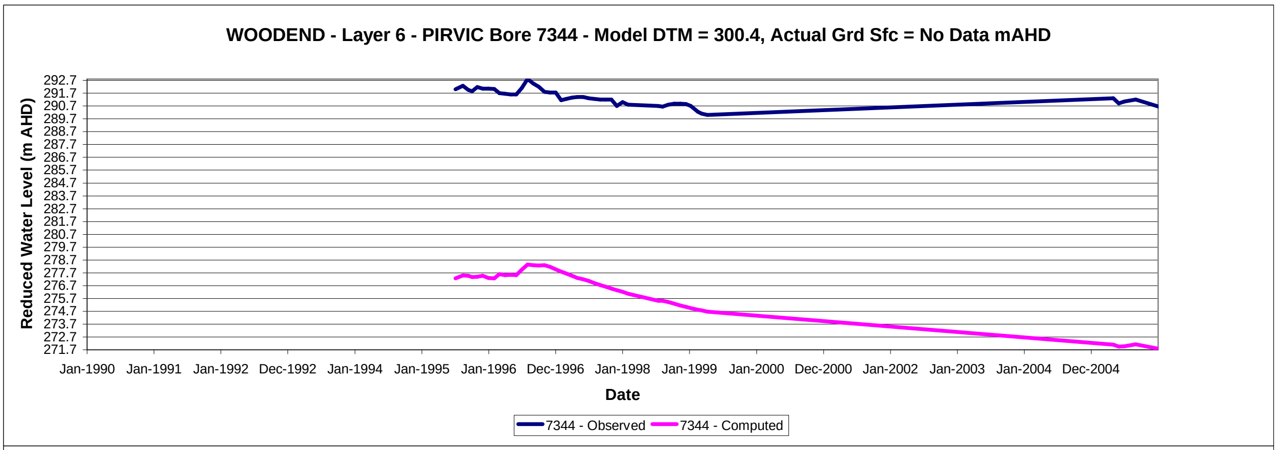

WOODEND - Layer 6 - PIRVIC Bore 7331 - Model DTM = 370, Actual Grd Sfc = 371.8 mAHD
Reduced Water Level (m AHD)
379.4
378.4
377.4
376.4
375.4
374.4
373.4
372.4
371.4
370.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7331 - Observed
7331 - Computed

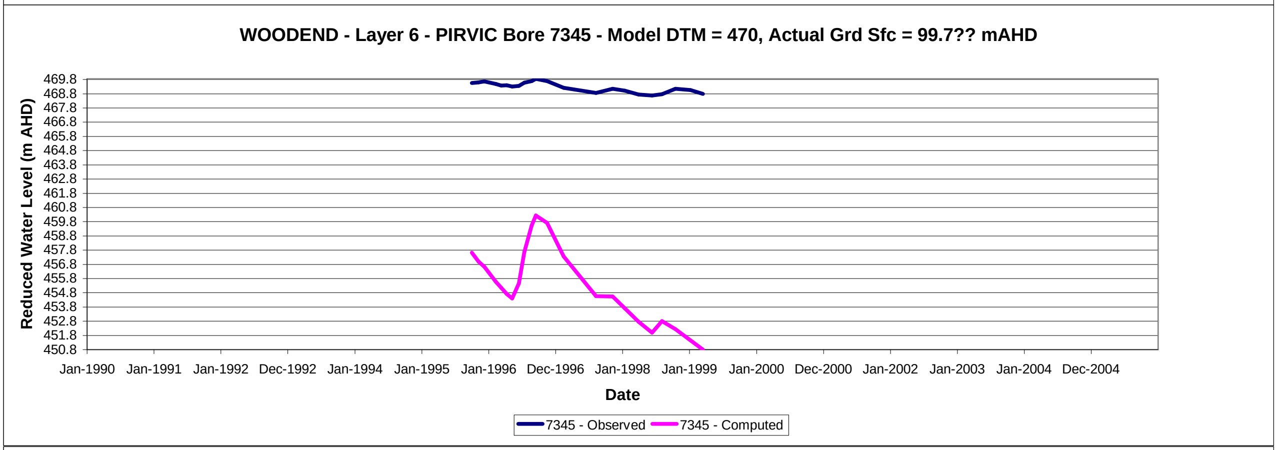

WOODEND - Layer 6 - PIRVIC Bore 7333 - Model DTM = 401.1, Actual Grd Sfc = 379.0 mAHD
Reduced Water Level (m AHD)
Date
7333 - Observed
7333 - Computed

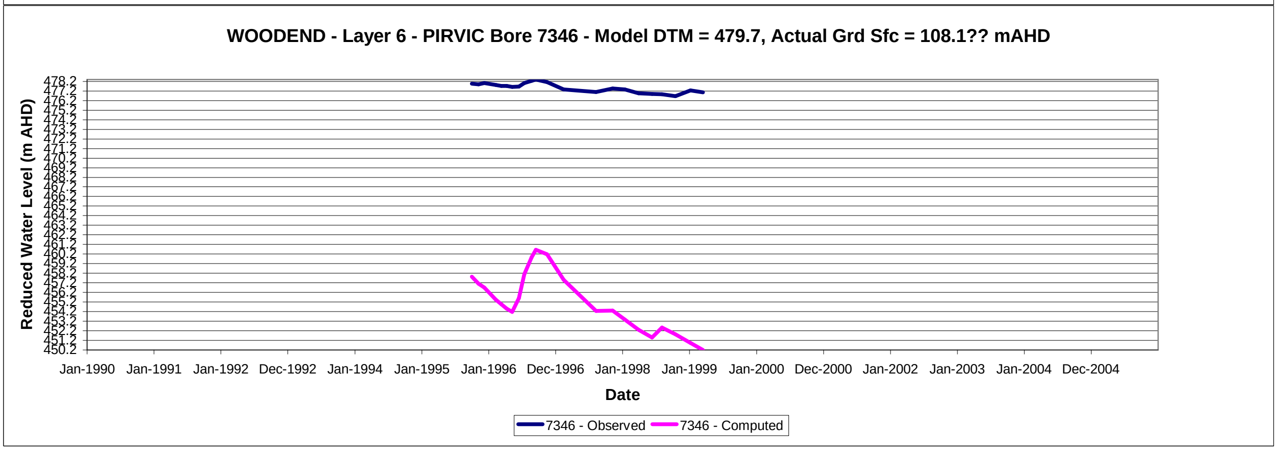

WOODEND - Layer 6 - PIRVIC Bore 7332 - Model DTM = 389.4, Actual Grd Sfc = 395.7 mAHD
Reduced Water Level (m AHD)
Date
7332 - Observed
7332 - Computed

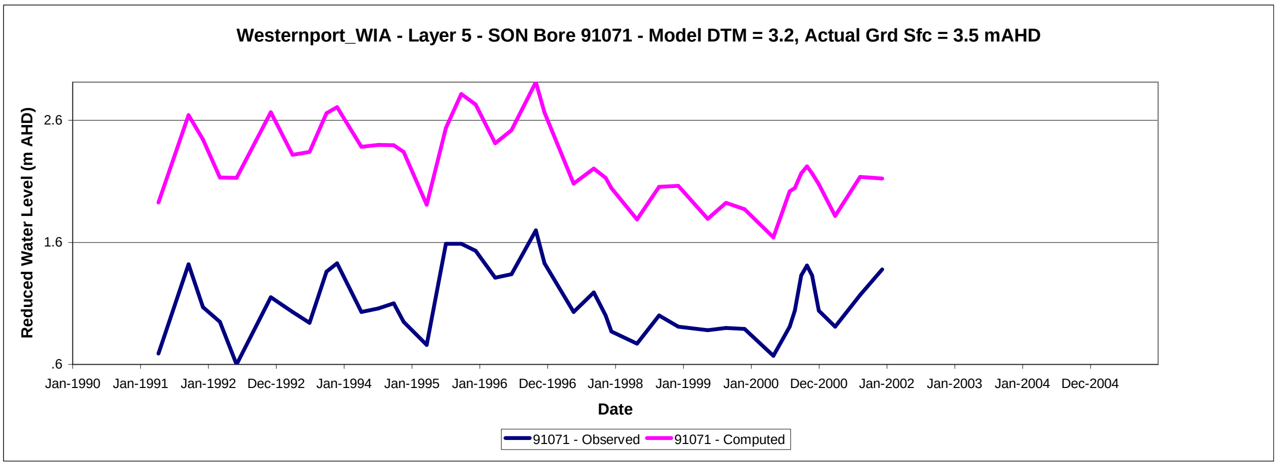

WOODEND - Layer 6 - PIRVIC Bore 7334 - Model DTM = 490.1, Actual Grd Sfc = 490.8 mAHD
Reduced Water Level (m AHD)
Date
7334 - Observed
7334 - Computed

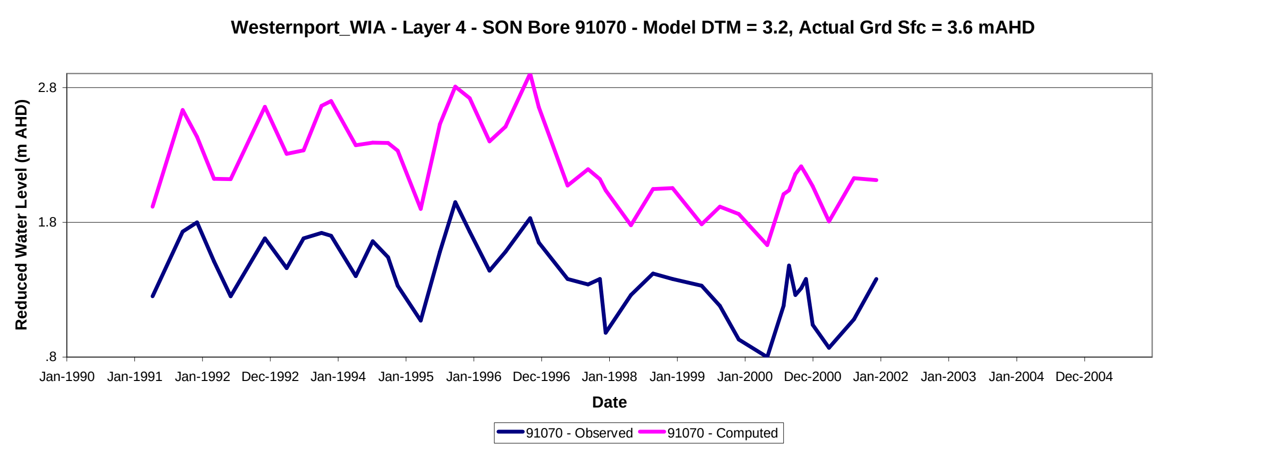

WOODEND - Layer 6 - PIRVIC Bore 7335 - Model DTM = 490.1, Actual Grd Sfc = 490.8 mAHD
Reduced Water Level (m AHD)
Date
7335 - Observed
7335 - Computed

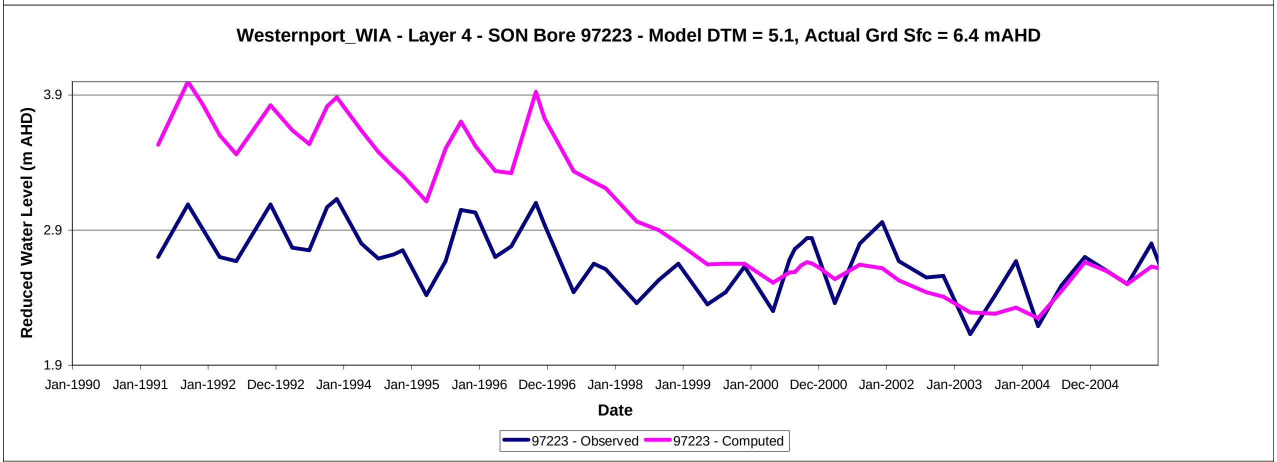

WOODEND - Layer 6 - PIRVIC Bore 7344 - Model DTM = 300.4, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
Date
7344 - Observed
7344 - Computed

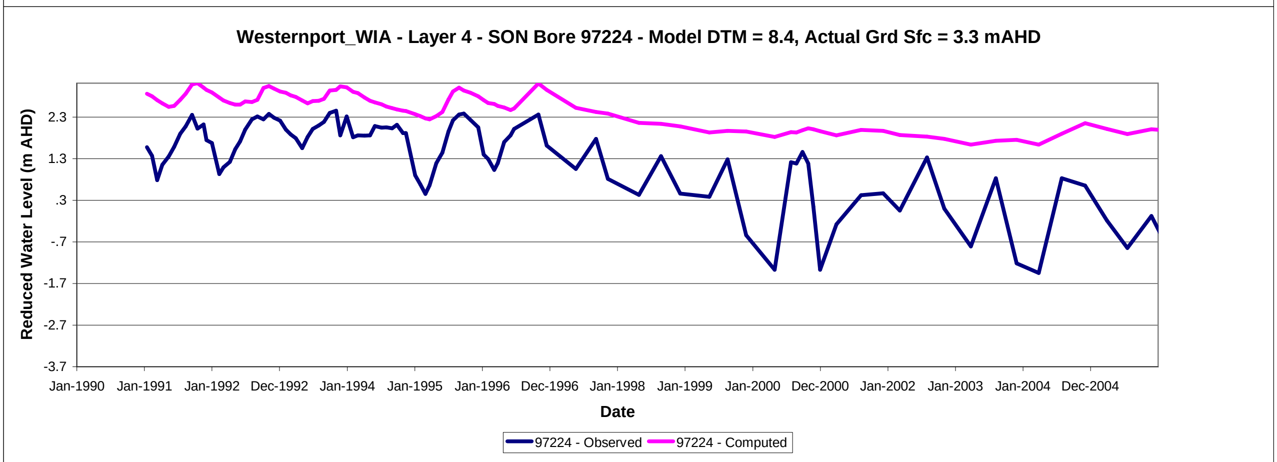

WOODEND - Layer 6 - PIRVIC Bore 7345 - Model DTM = 470, Actual Grd Sfc = 99.7?? mAHD
Reduced Water Level (m AHD)
Date
7345 - Observed
7345 - Computed

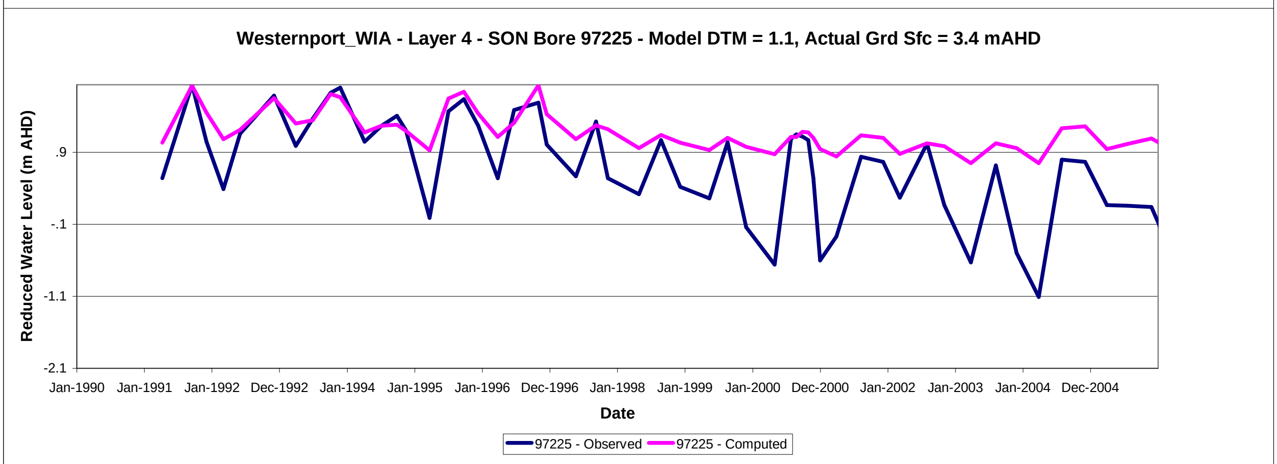

WOODEND - Layer 6 - PIRVIC Bore 7346 - Model DTM = 479.7, Actual Grd Sfc = 108.1?? mAHD
Reduced Water Level (m AHD)
Date
7346 - Observed
7346 - Computed


Westernport_WIA - Layer 5 - SON Bore 91071 - Model DTM = 3.2, Actual Grd Sfc = 3.5 mAHD
Reduced Water Level (m AHD)
2.6
1.6
.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
91071 - Observed
91071 - Computed


Westernport_WIA - Layer 4 - SON Bore 91070 - Model DTM = 3.2, Actual Grd Sfc = 3.6 mAHD
Reduced Water Level (m AHD)
2.8
1.8
.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
91070 - Observed
91070 - Computed


Westernport_WIA - Layer 4 - SON Bore 97223 - Model DTM = 5.1, Actual Grd Sfc = 6.4 mAHD
Reduced Water Level (m AHD)
3.9
2.9
1.9
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
97223 - Observed
97223 - Computed


Westernport_WIA - Layer 4 - SON Bore 97224 - Model DTM = 8.4, Actual Grd Sfc = 3.3 mAHD
Reduced Water Level (m AHD)
2.3
1.3
.3
-.7
-1.7
-2.7
-3.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
97224 - Observed
97224 - Computed


Westernport_WIA - Layer 4 - SON Bore 97225 - Model DTM = 1.1, Actual Grd Sfc = 3.4 mAHD
Reduced Water Level (m AHD)
.9
-.1
-1.1
-2.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
97225 - Observed
97225 - Computed

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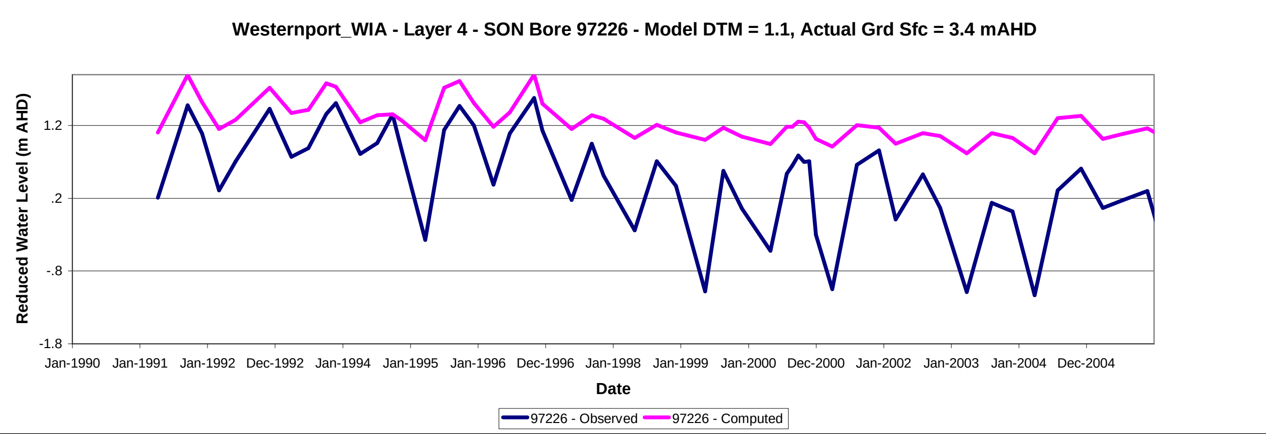
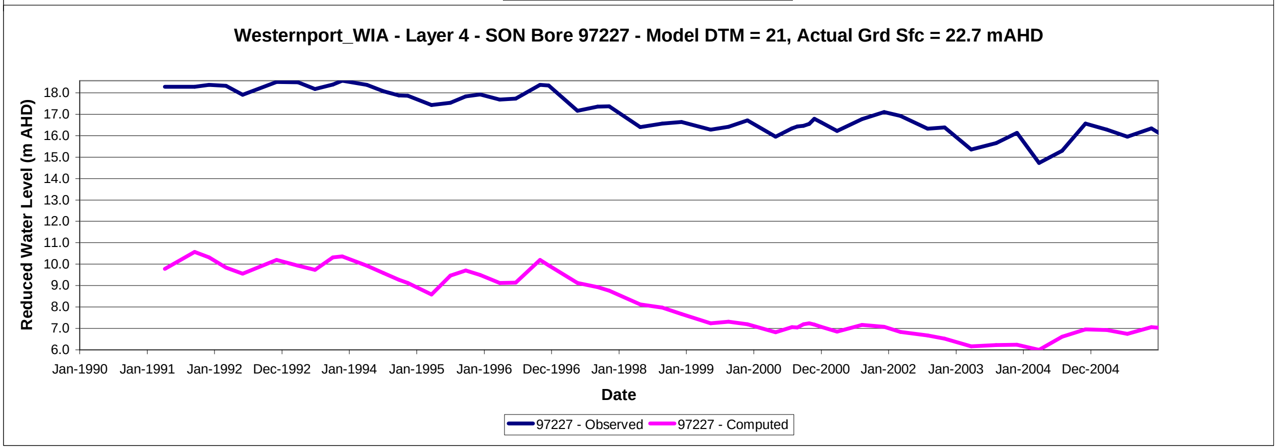
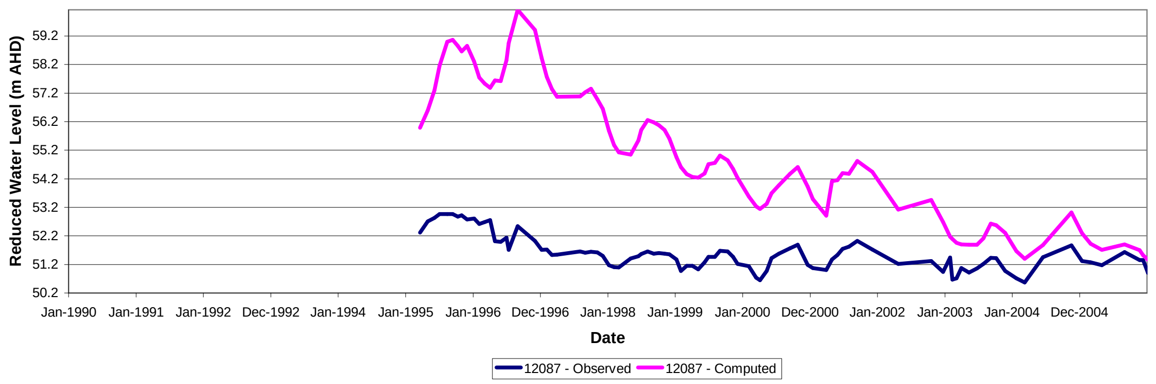
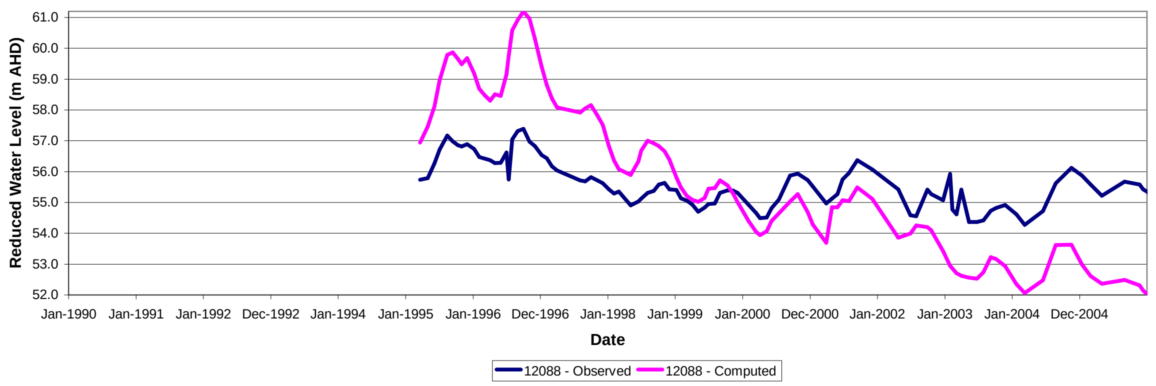




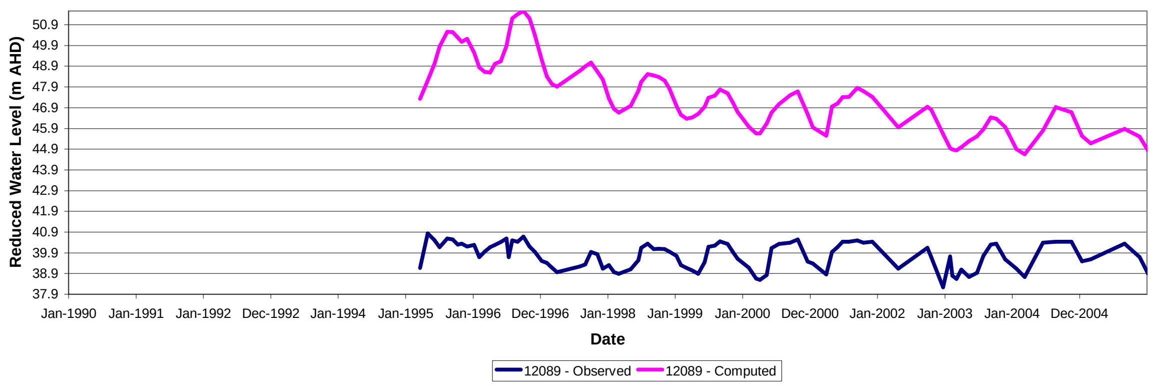
WESTERN PORT - Layer 6 - PIRVIC Bore 12087 - Model DTM = 50.3, Actual Grd Sfc = No Data mAHD



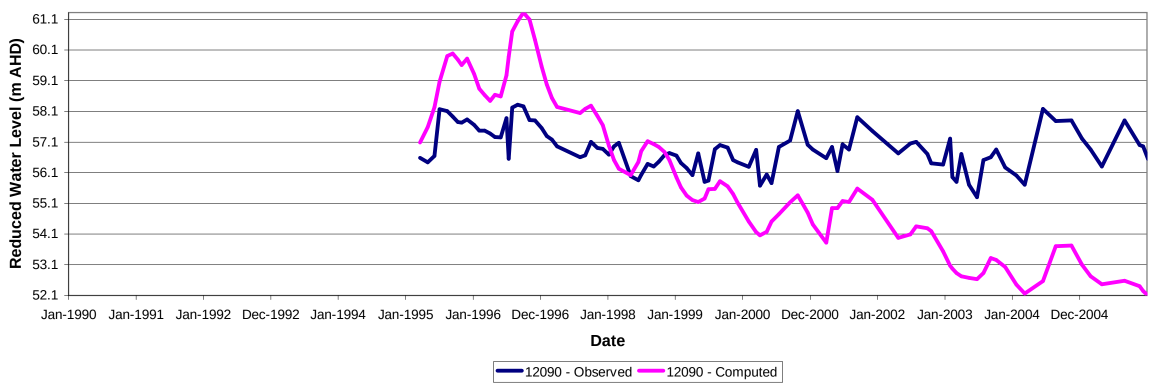
WESTERN PORT - Layer 6 - PIRVIC Bore 12088 - Model DTM = 60.2, Actual Grd Sfc = No Data mAHD

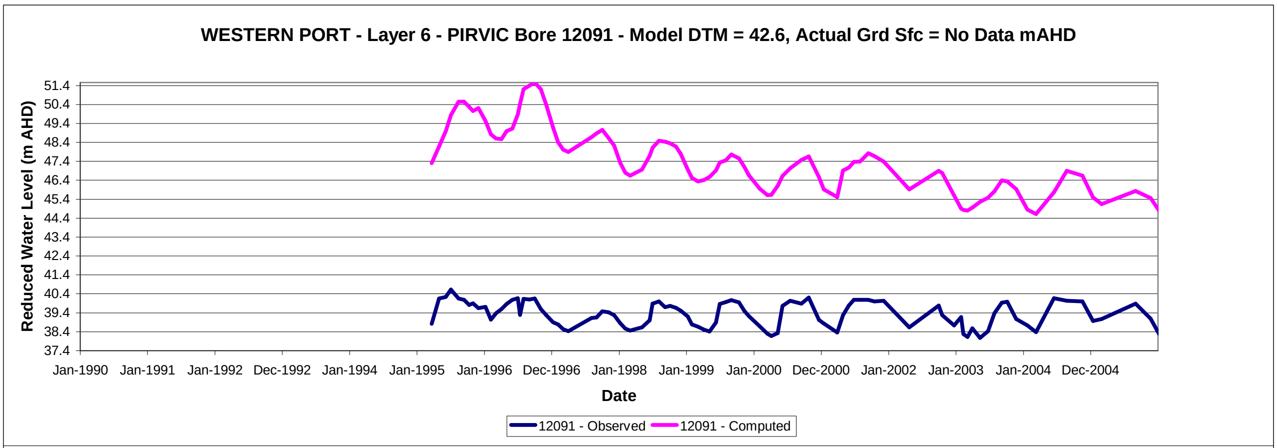


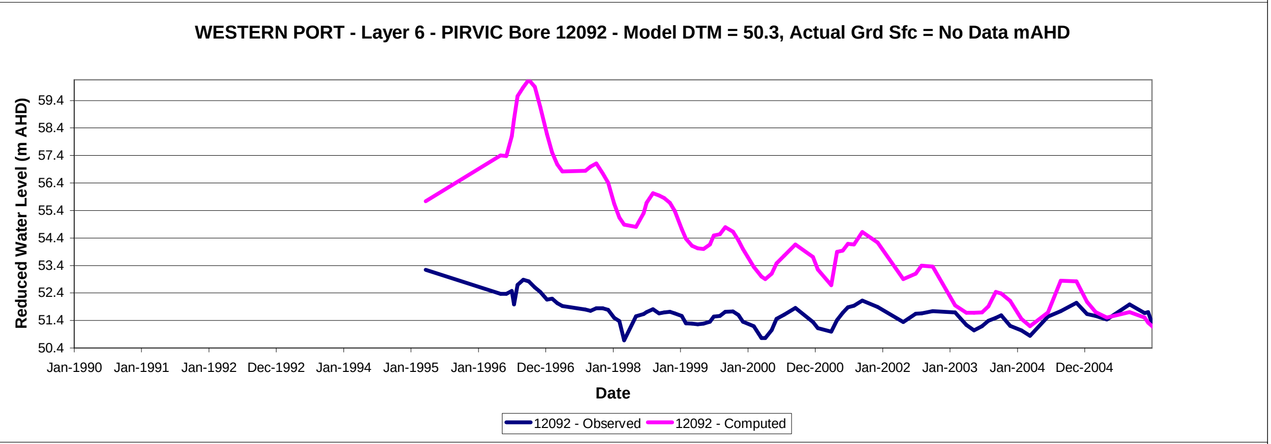
WESTERN PORT - Layer 6 - PIRVIC Bore 12089 - Model DTM = 42.6, Actual Grd Sfc = No Data mAHD

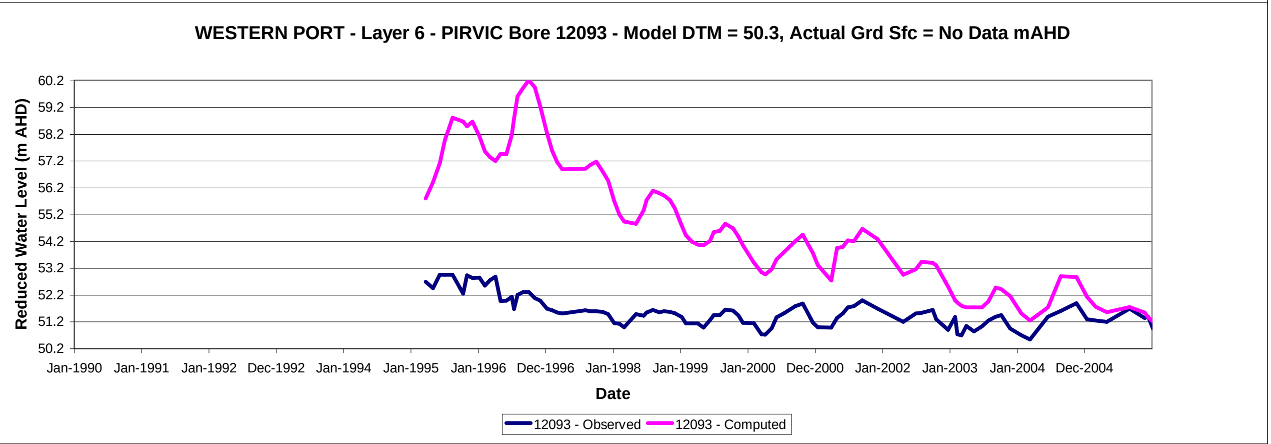


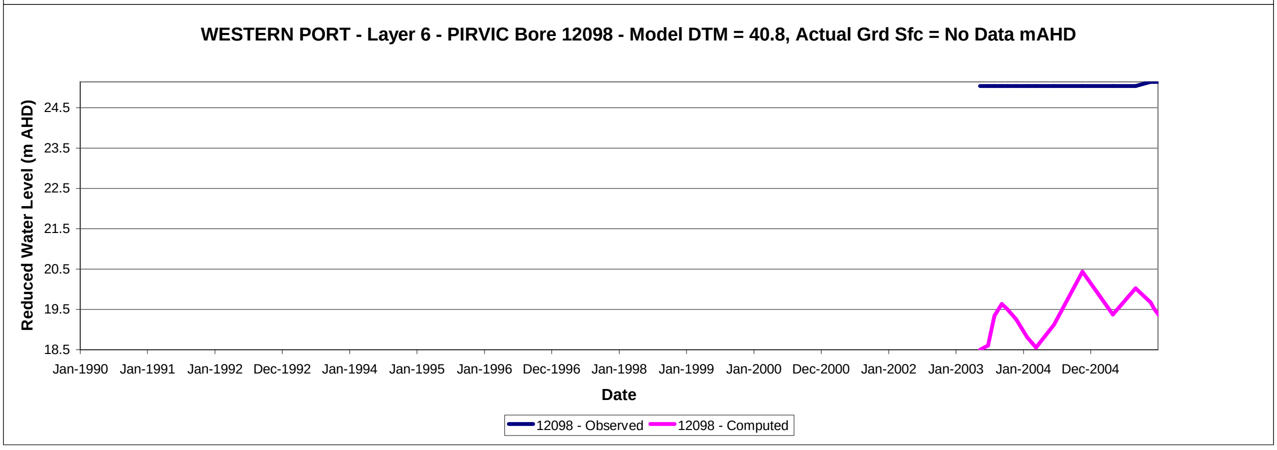
WESTERN PORT - Layer 6 - PIRVIC Bore 12090 - Model DTM = 60.2, Actual Grd Sfc = No Data mAHD

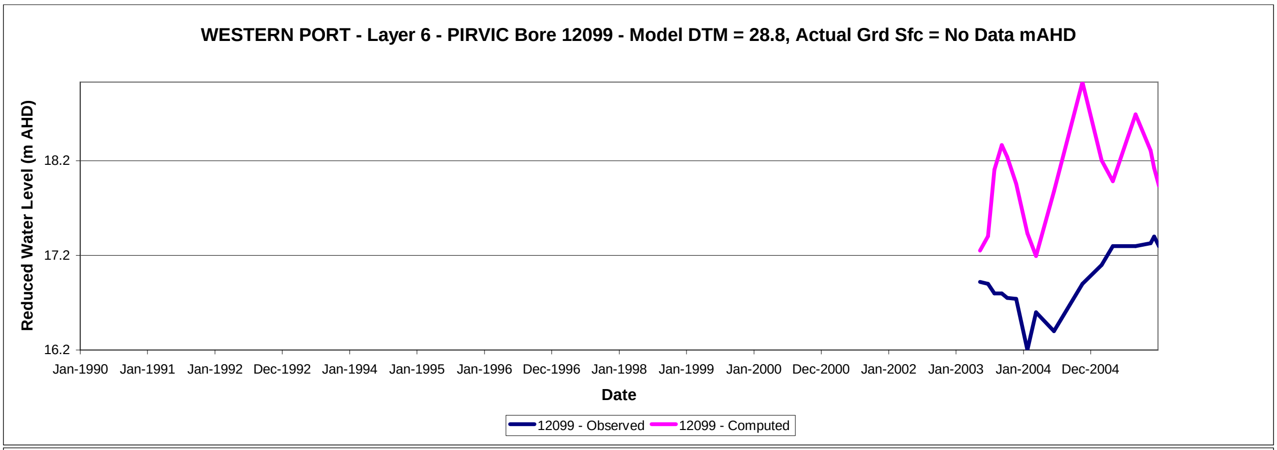


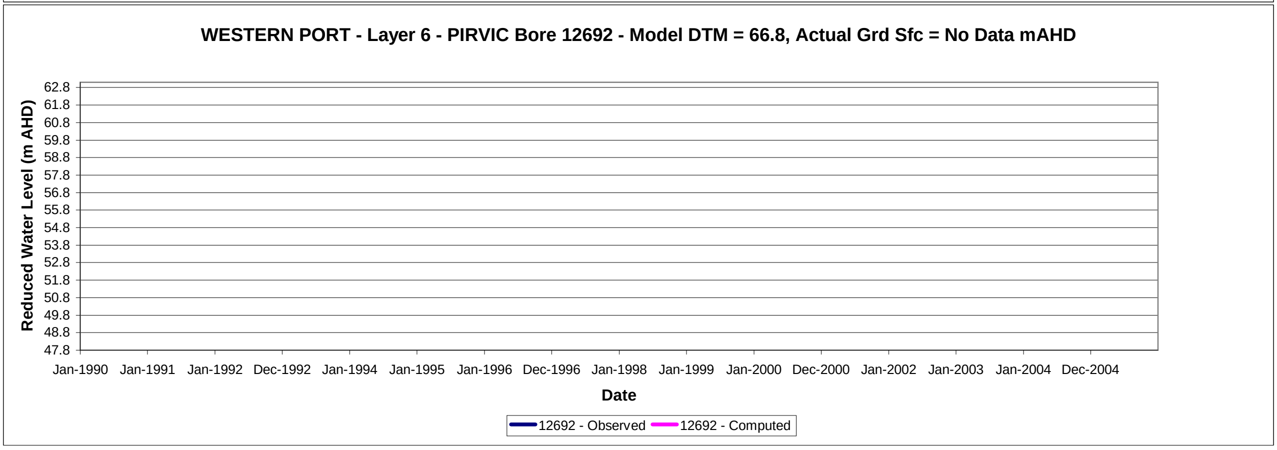

WESTERN PORT - Layer 6 - PIRVIC Bore 12091 - Model DTM = 42.6, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
51.4
50.4
49.4
48.4
47.4
46.4
45.4
44.4
43.4
42.4
41.4
40.4
39.4
38.4
37.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12091 - Observed
12091 - Computed


WESTERN PORT - Layer 6 - PIRVIC Bore 12092 - Model DTM = 50.3, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
59.4
58.4
57.4
56.4
55.4
54.4
53.4
52.4
51.4
50.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12092 - Observed
12092 - Computed

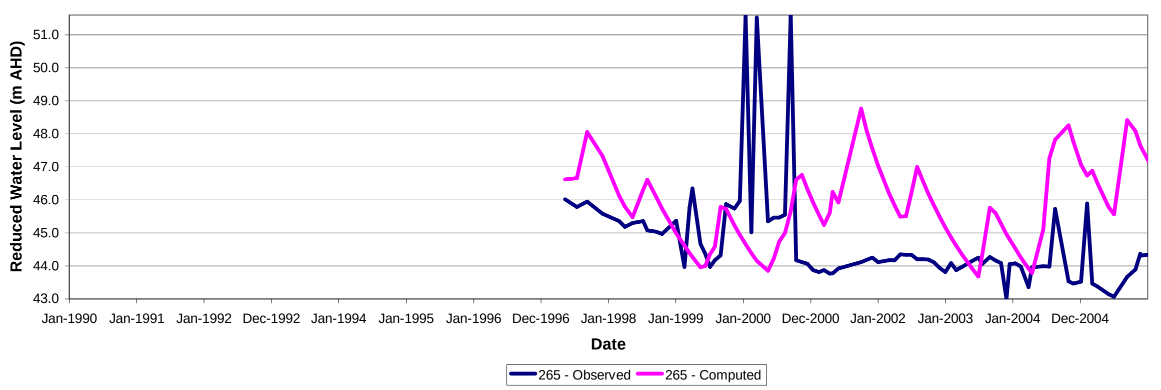

WESTERN PORT - Layer 6 - PIRVIC Bore 12093 - Model DTM = 50.3, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
60.2
59.2
58.2
57.2
56.2
55.2
54.2
53.2
52.2
51.2
50.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12093 - Observed
12093 - Computed


WESTERN PORT - Layer 6 - PIRVIC Bore 12098 - Model DTM = 40.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
24.5
23.5
22.5
21.5
20.5
19.5
18.5
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12098 - Observed
12098 - Computed

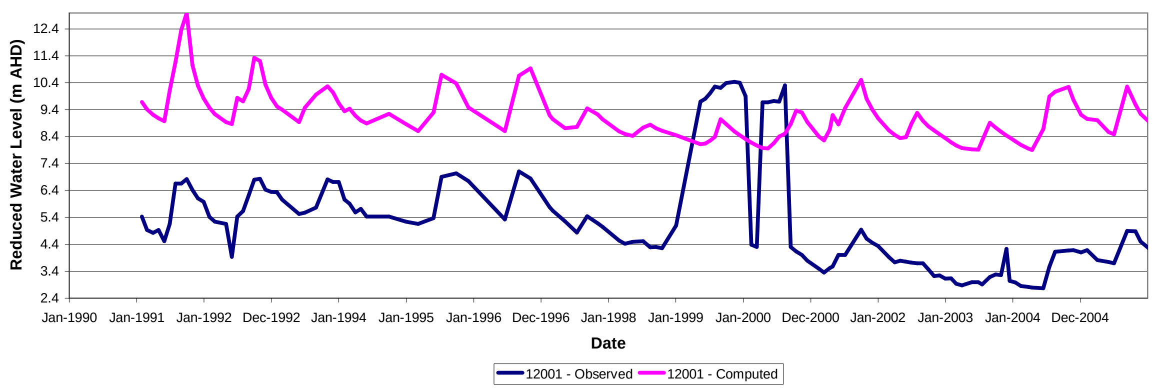

WESTERN PORT - Layer 6 - PIRVIC Bore 12099 - Model DTM = 28.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
18.2
17.2
16.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12099 - Observed
12099 - Computed


WESTERN PORT - Layer 6 - PIRVIC Bore 12692 - Model DTM = 66.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
62.8
61.8
60.8
59.8
58.8
57.8
56.8
55.8
54.8
53.8
52.8
51.8
50.8
49.8
48.8
47.8
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12692 - Observed
12692 - Computed

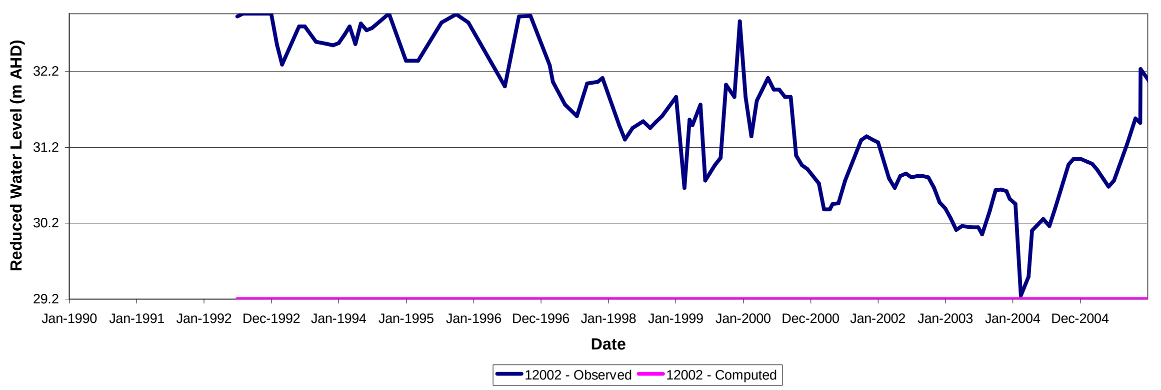
WESTERN PORT - Layer 5 - PIRVIC Bore 265 - Model DTM = 50, Actual Grd Sfc = No Data mAHD



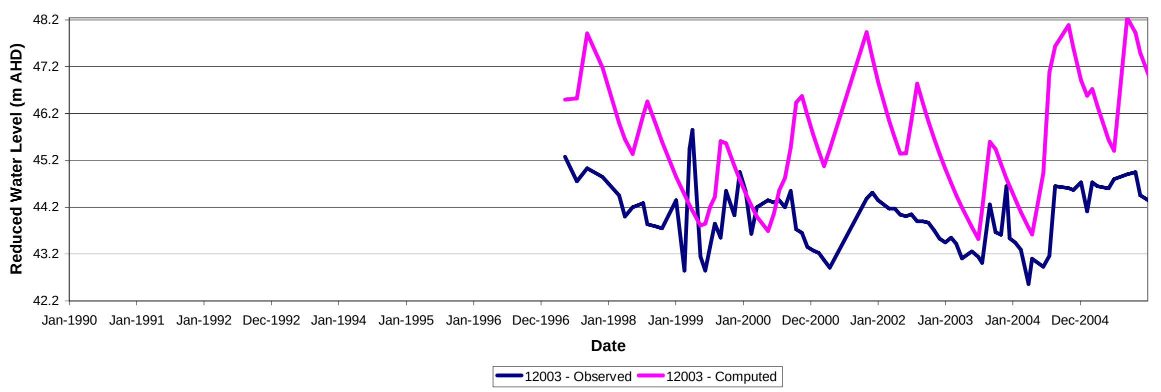
WESTERN PORT - Layer 5 - PIRVIC Bore 12001 - Model DTM = 14.3, Actual Grd Sfc = 14.0 mAHD

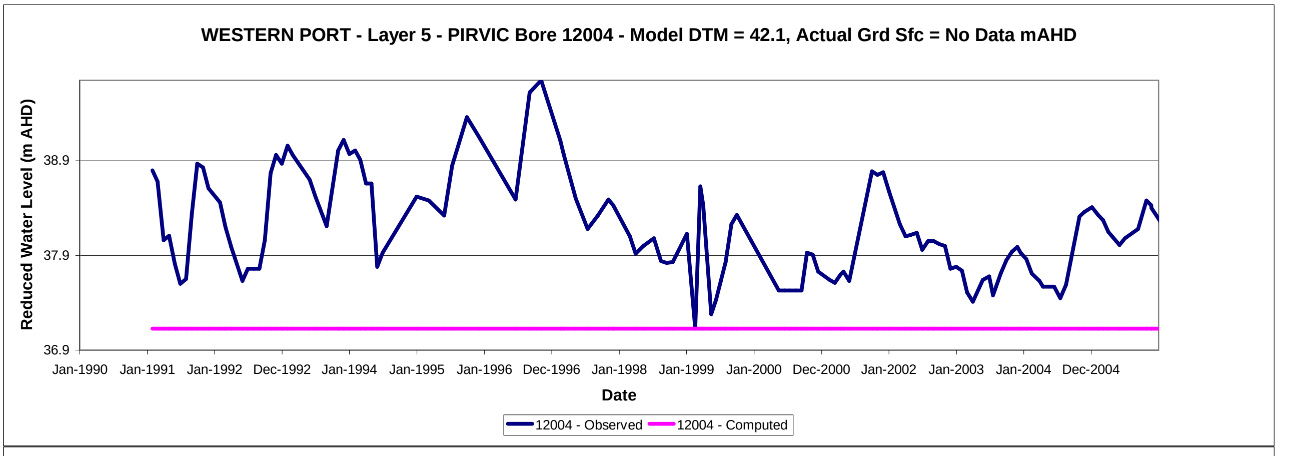


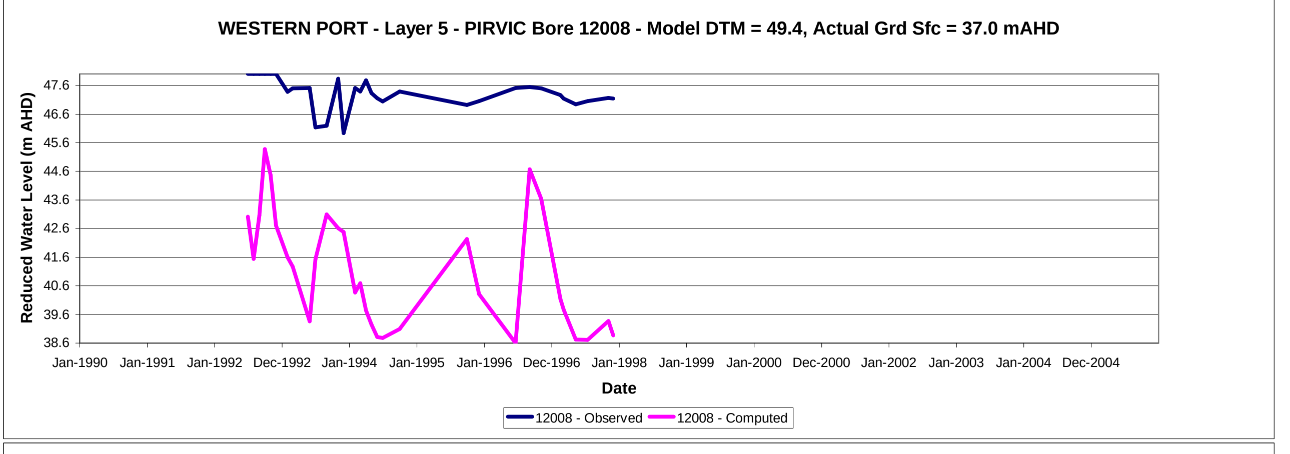
WESTERN PORT - Layer 5 - PIRVIC Bore 12002 - Model DTM = 34.2, Actual Grd Sfc = 36.0 mAHD

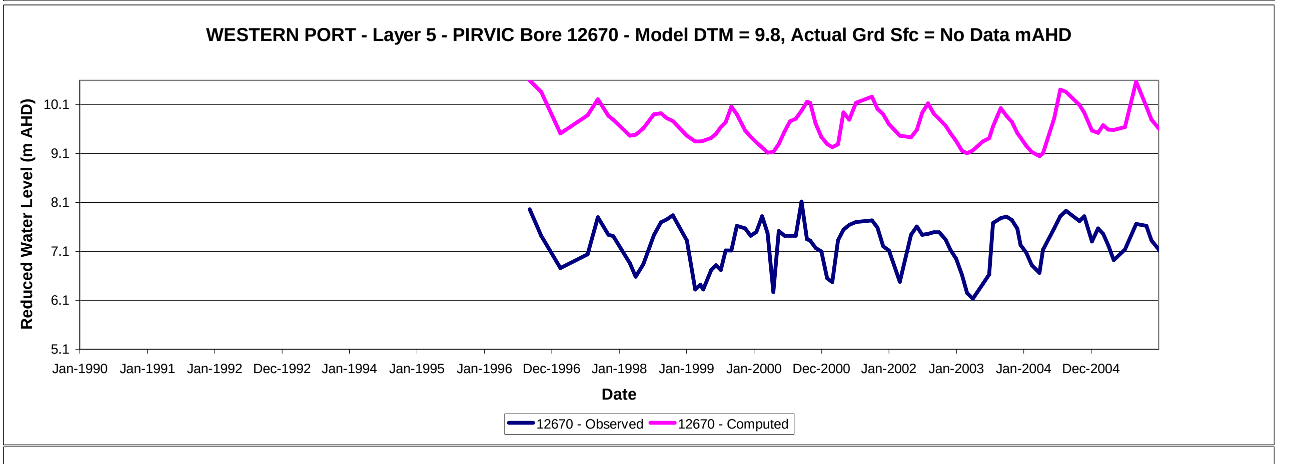


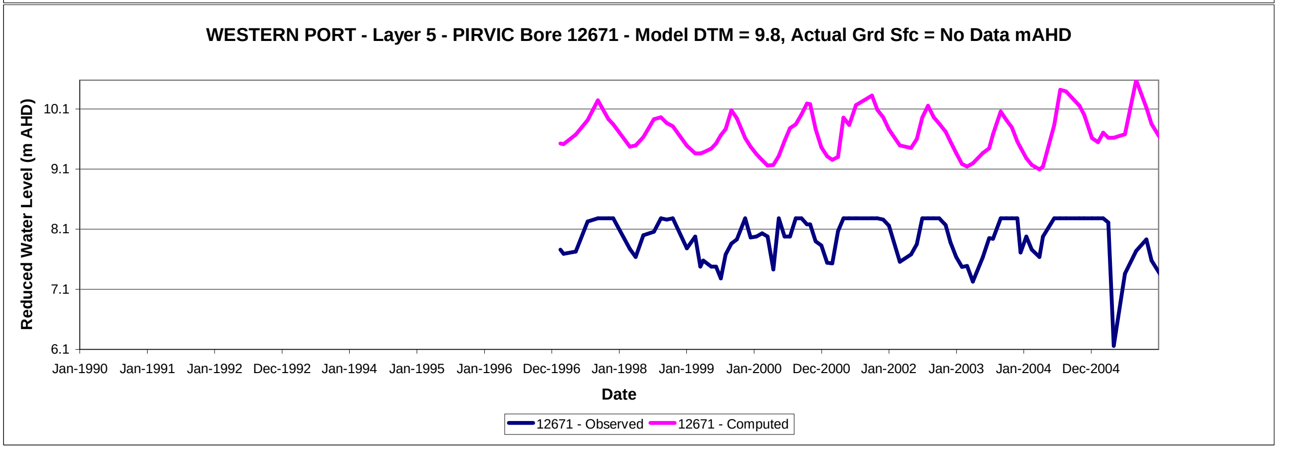
WESTERN PORT - Layer 5 - PIRVIC Bore 12003 - Model DTM = 50, Actual Grd Sfc = No Data mAHD

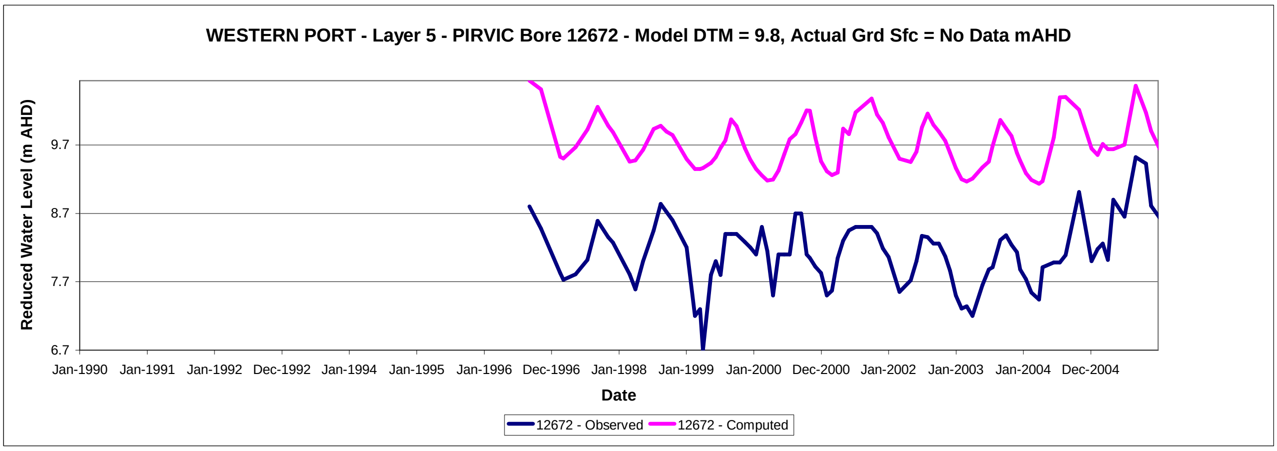


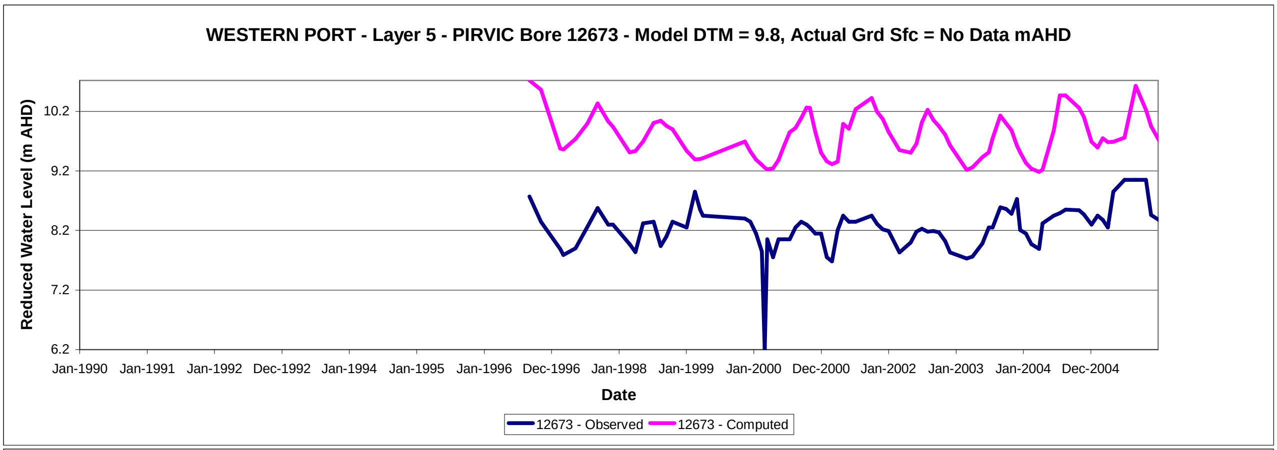

WESTERN PORT - Layer 5 - PIRVIC Bore 12004 - Model DTM = 42.1, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
38.9
37.9
36.9
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12004 - Observed
12004 - Computed

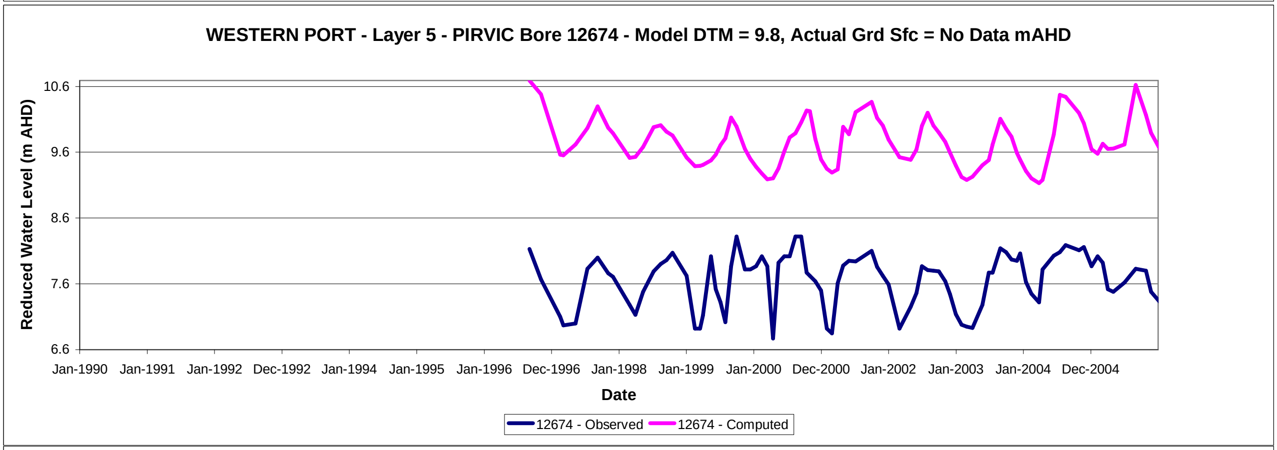

WESTERN PORT - Layer 5 - PIRVIC Bore 12008 - Model DTM = 49.4, Actual Grd Sfc = 37.0 mAHD
Reduced Water Level (m AHD)
47.6
46.6
45.6
44.6
43.6
42.6
41.6
40.6
39.6
38.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12008 - Observed
12008 - Computed

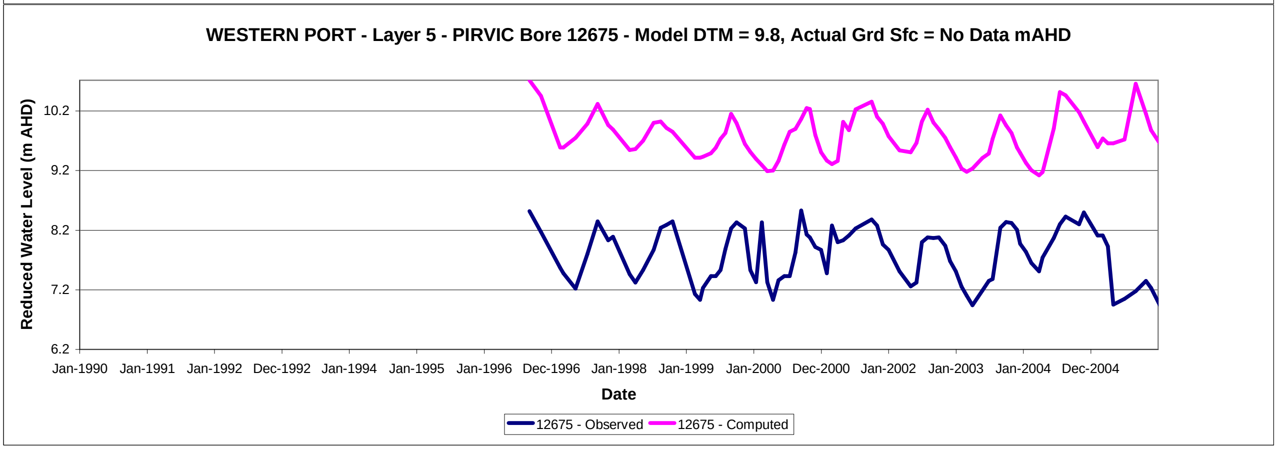

WESTERN PORT - Layer 5 - PIRVIC Bore 12670 - Model DTM = 9.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
10.1
9.1
8.1
7.1
6.1
5.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12670 - Observed
12670 - Computed


WESTERN PORT - Layer 5 - PIRVIC Bore 12671 - Model DTM = 9.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
10.1
9.1
8.1
7.1
6.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12671 - Observed
12671 - Computed


WESTERN PORT - Layer 5 - PIRVIC Bore 12672 - Model DTM = 9.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
9.7
8.7
7.7
6.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12672 - Observed
12672 - Computed


WESTERN PORT - Layer 5 - PIRVIC Bore 12673 - Model DTM = 9.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
10.2
9.2
8.2
7.2
6.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12673 - Observed
12673 - Computed


WESTERN PORT - Layer 5 - PIRVIC Bore 12674 - Model DTM = 9.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
10.6
9.6
8.6
7.6
6.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12674 - Observed
12674 - Computed


WESTERN PORT - Layer 5 - PIRVIC Bore 12675 - Model DTM = 9.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
10.2
9.2
8.2
7.2
6.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12675 - Observed
12675 - Computed

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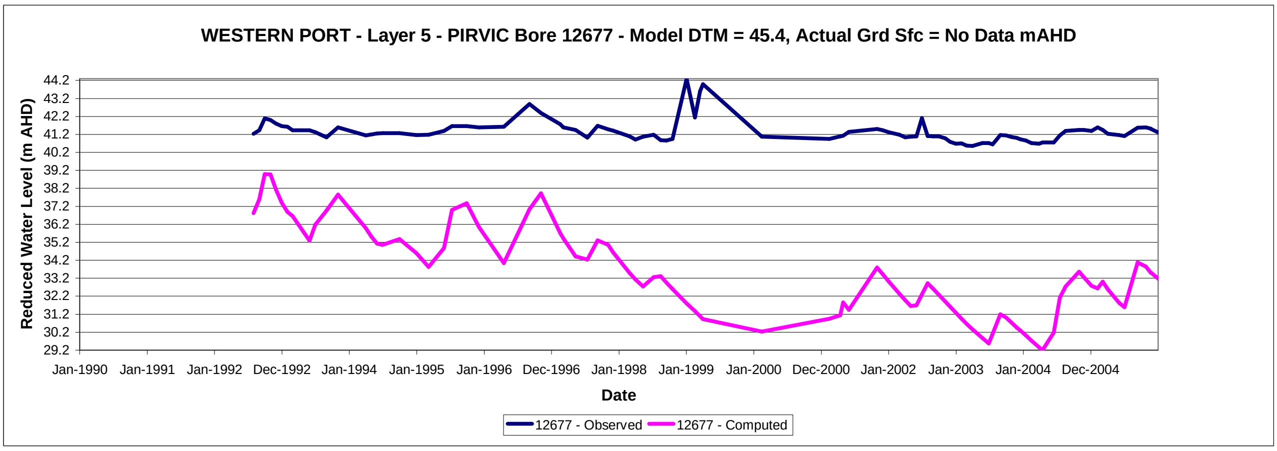
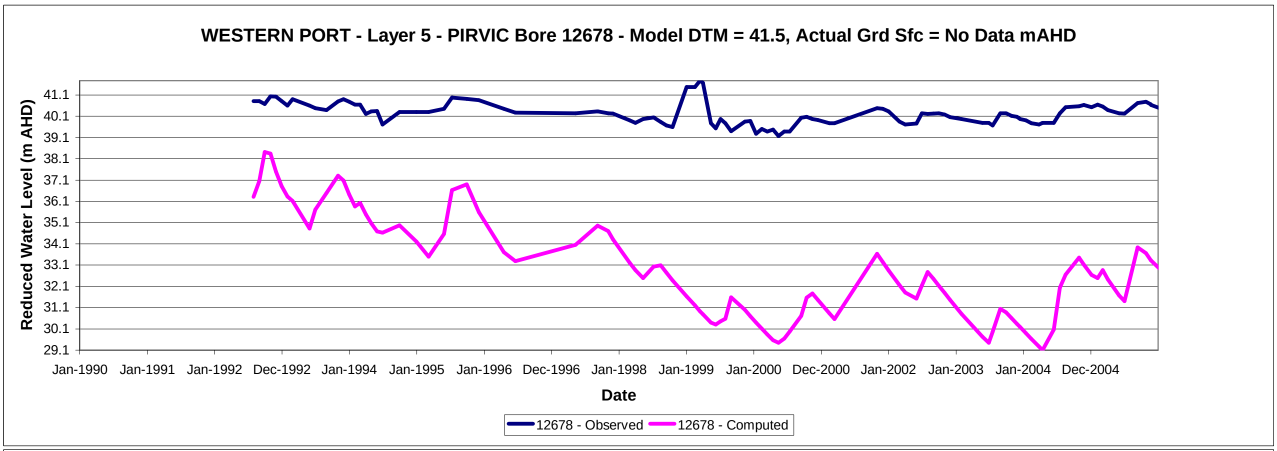
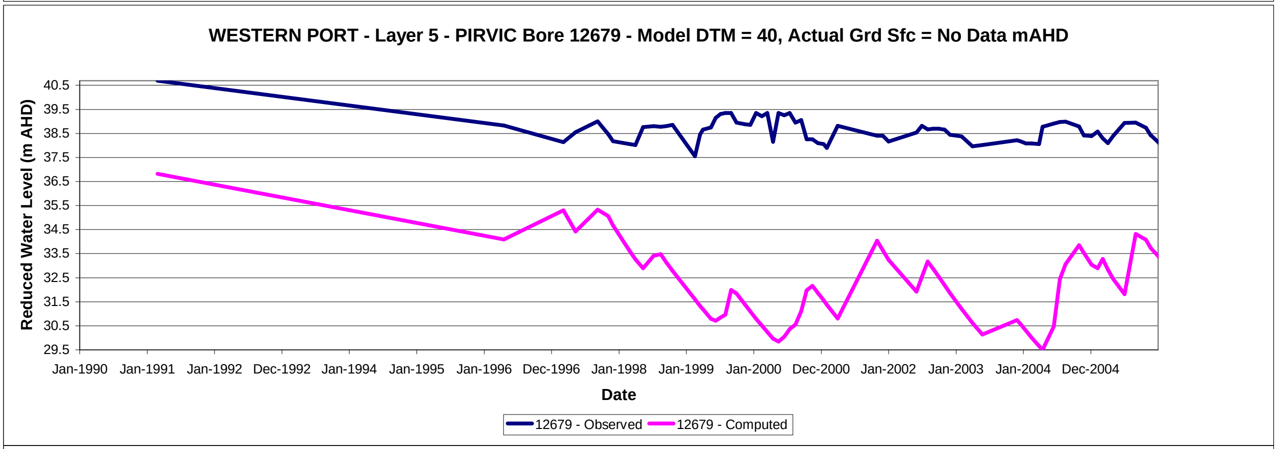
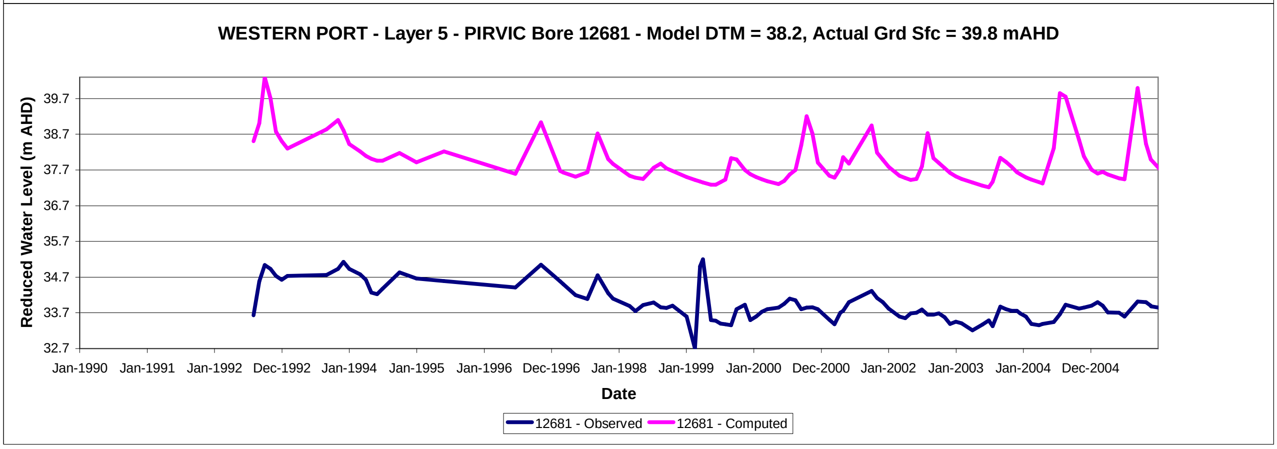
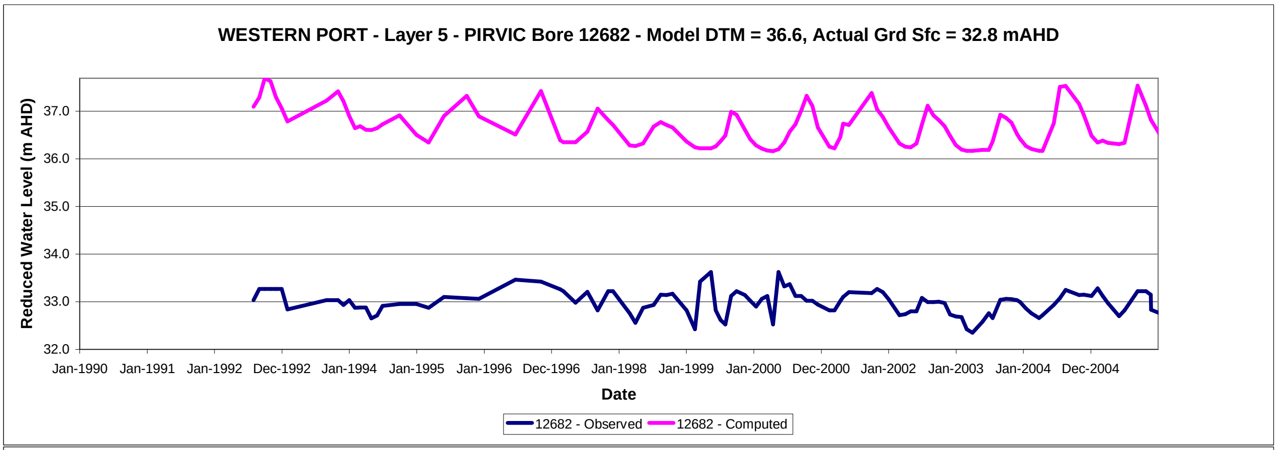
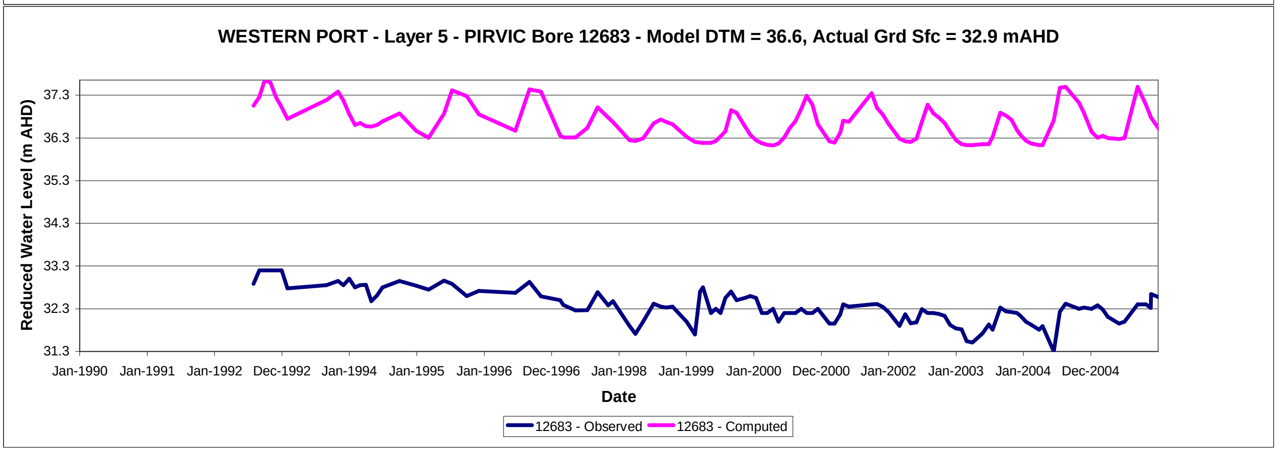


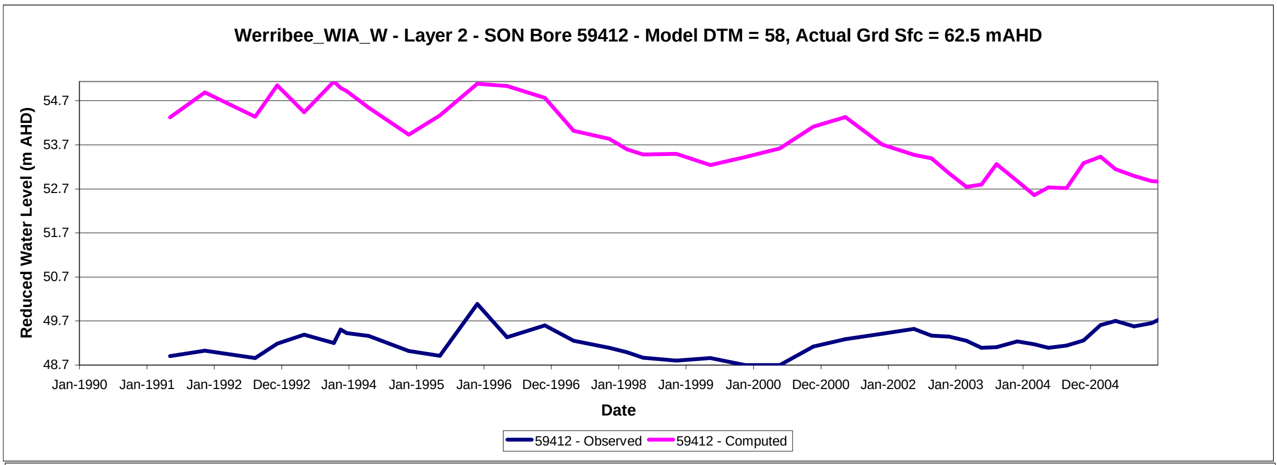


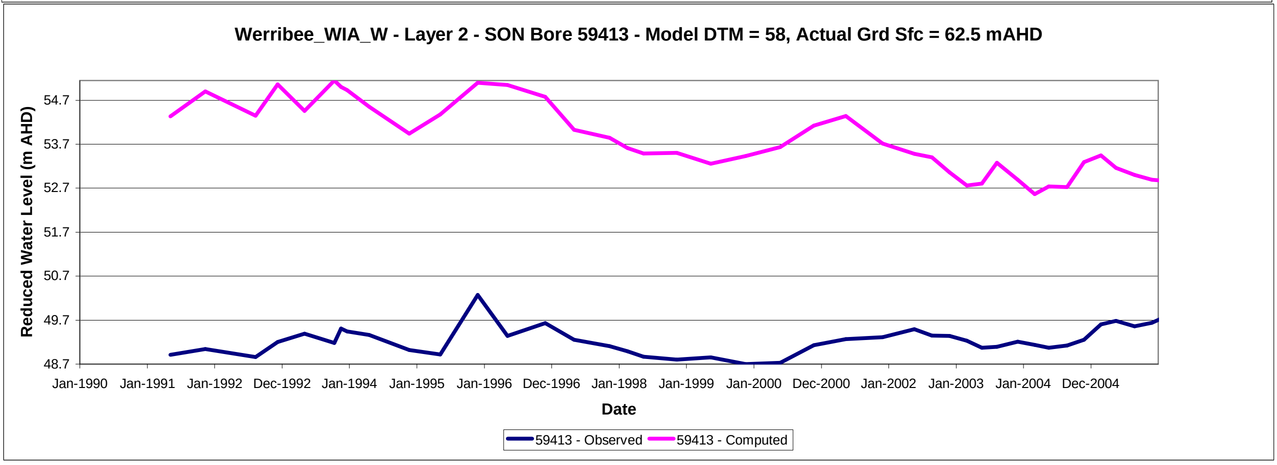


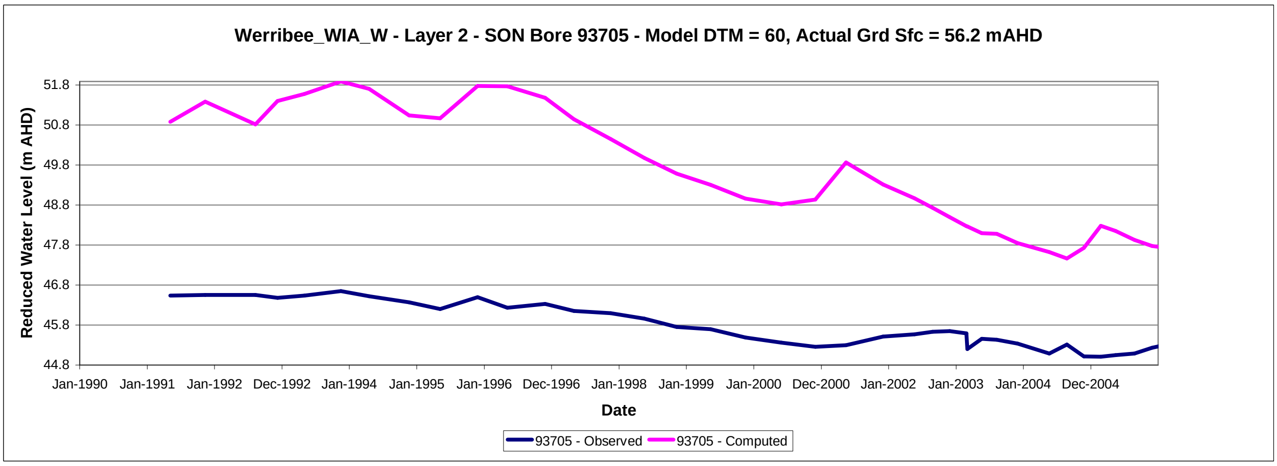


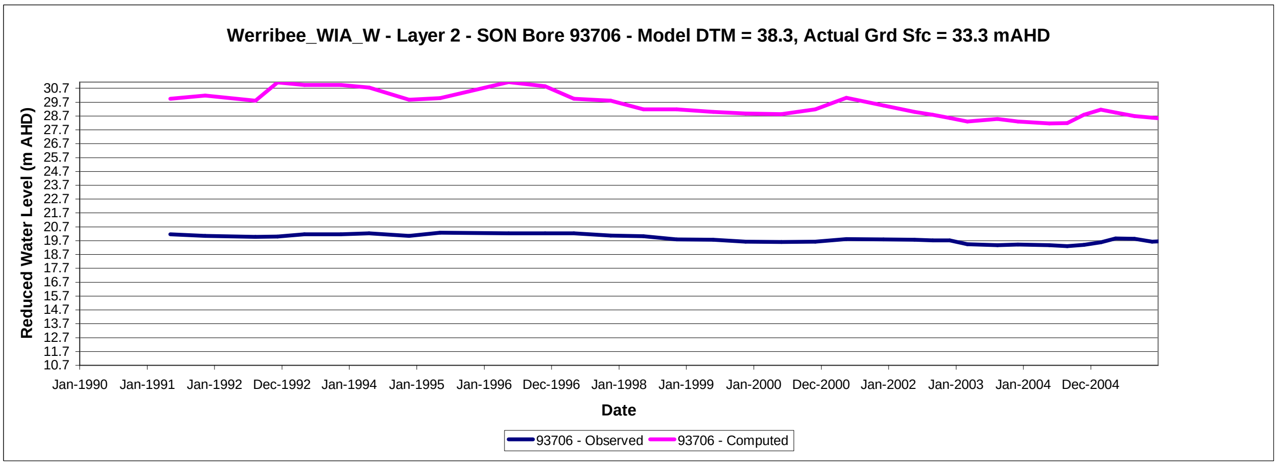

WESTERN PORT - Layer 5 - PIRVIC Bore 12682 - Model DTM = 36.6, Actual Grd Sfc = 32.8 mAHD
Reduced Water Level (m AHD)
37.0
36.0
35.0
34.0
33.0
32.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12682 - Observed
12682 - Computed

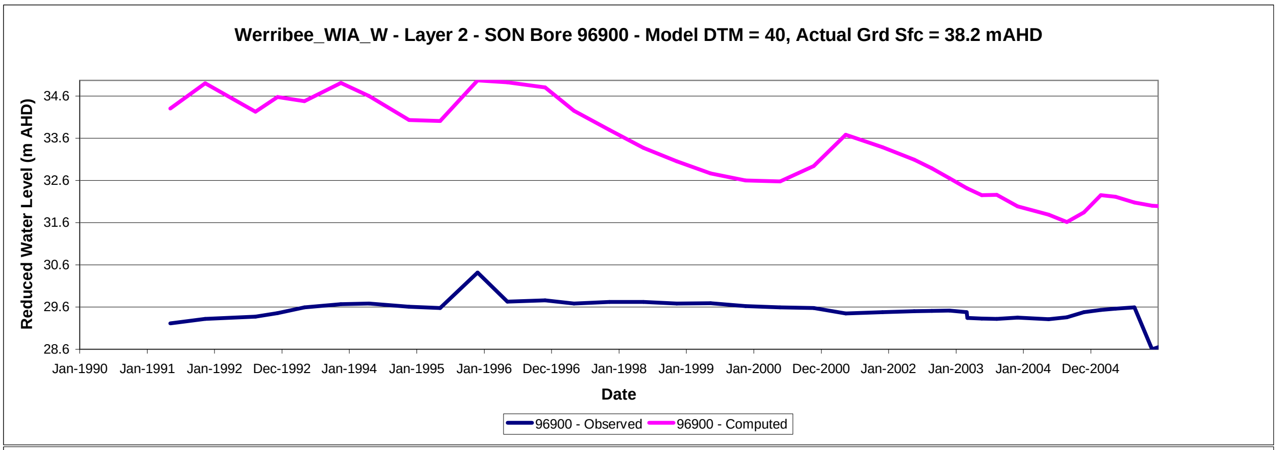

WESTERN PORT - Layer 5 - PIRVIC Bore 12683 - Model DTM = 36.6, Actual Grd Sfc = 32.9 mAHD
Reduced Water Level (m AHD)
37.3
36.3
35.3
34.3
33.3
32.3
31.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12683 - Observed
12683 - Computed

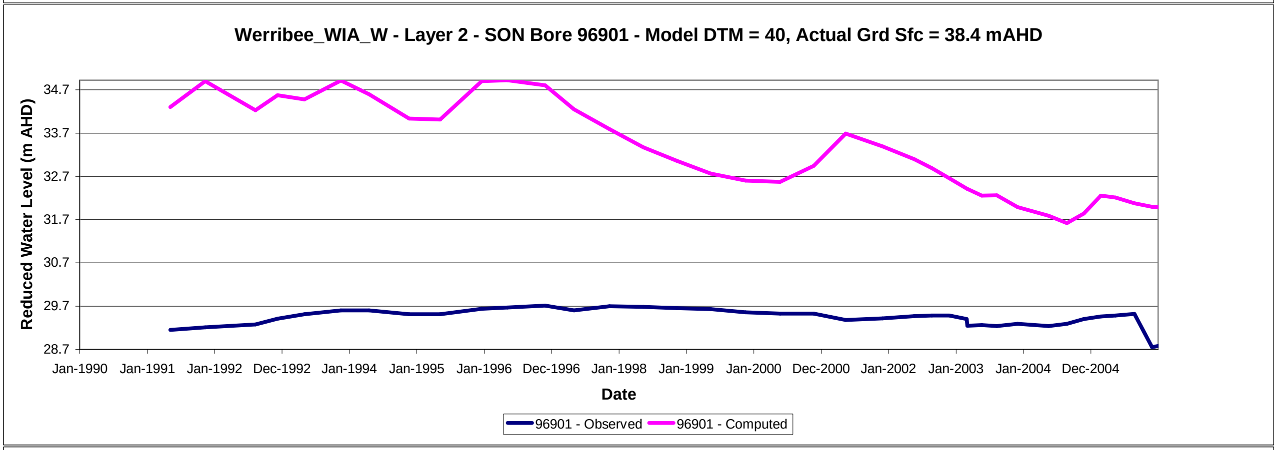

Werribee_WIA_W - Layer 2 - SON Bore 59412 - Model DTM = 58, Actual Grd Sfc = 62.5 mAHD
Reduced Water Level (m AHD)
54.7
53.7
52.7
51.7
50.7
49.7
48.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
59412 - Observed
59412 - Computed

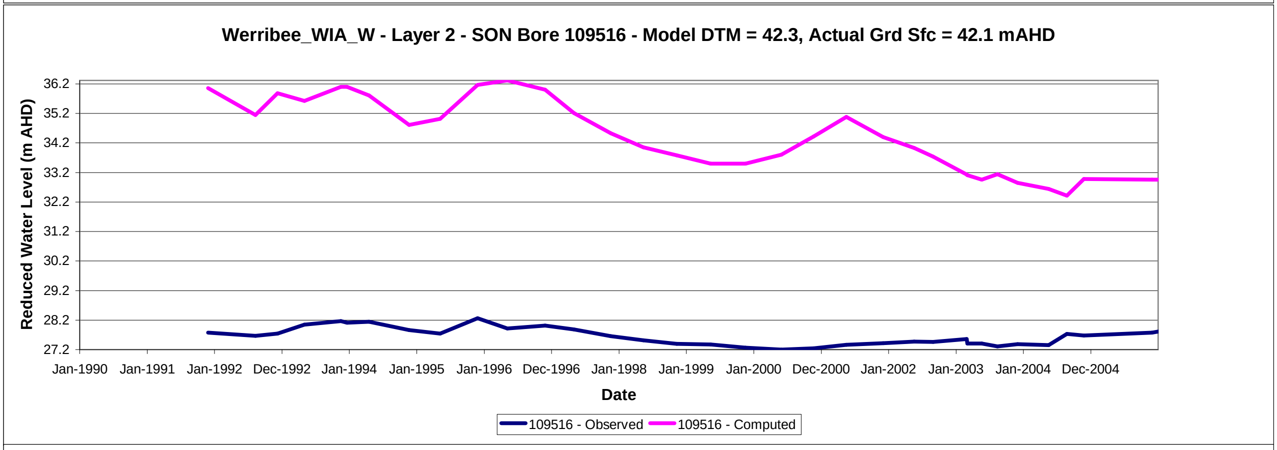

Werribee_WIA_W - Layer 2 - SON Bore 59413 - Model DTM = 58, Actual Grd Sfc = 62.5 mAHD
Reduced Water Level (m AHD)
54.7
53.7
52.7
51.7
50.7
49.7
48.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
59413 - Observed
59413 - Computed

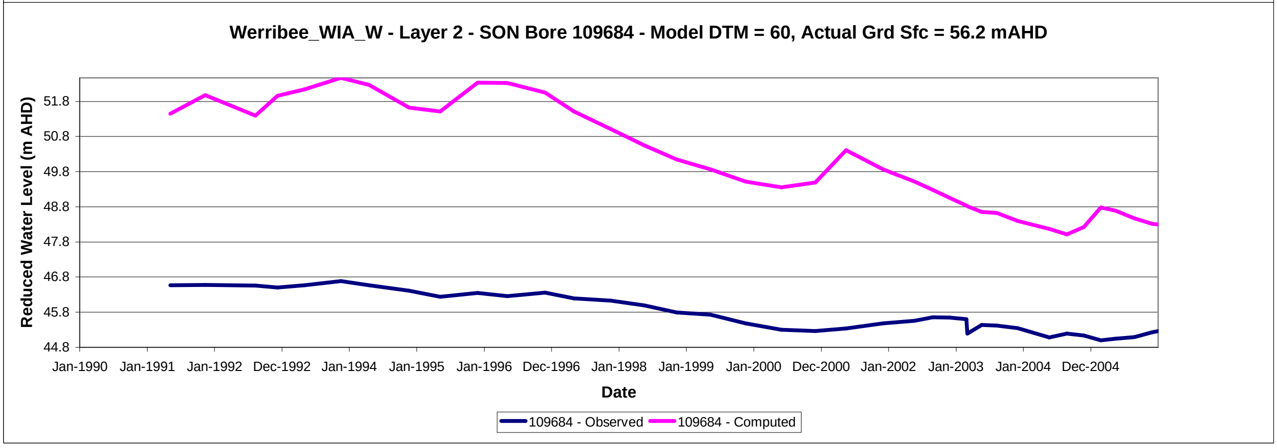

Werribee_WIA_W - Layer 2 - SON Bore 93705 - Model DTM = 60, Actual Grd Sfc = 56.2 mAHD
Reduced Water Level (m AHD)
51.8
50.8
49.8
48.8
47.8
46.8
45.8
44.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
93705 - Observed
93705 - Computed

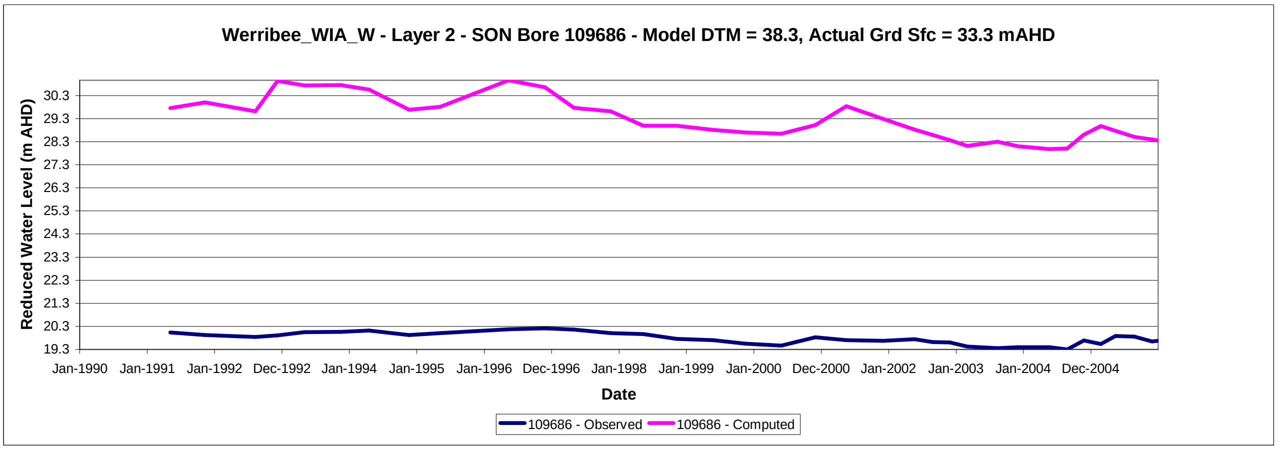

Werribee_WIA_W - Layer 2 - SON Bore 93706 - Model DTM = 38.3, Actual Grd Sfc = 33.3 mAHD
Reduced Water Level (m AHD)
30.7
29.7
28.7
27.7
26.7
25.7
24.7
23.7
22.7
21.7
20.7
19.7
18.7
17.7
16.7
15.7
14.7
13.7
12.7
11.7
10.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
93706 - Observed
93706 - Computed

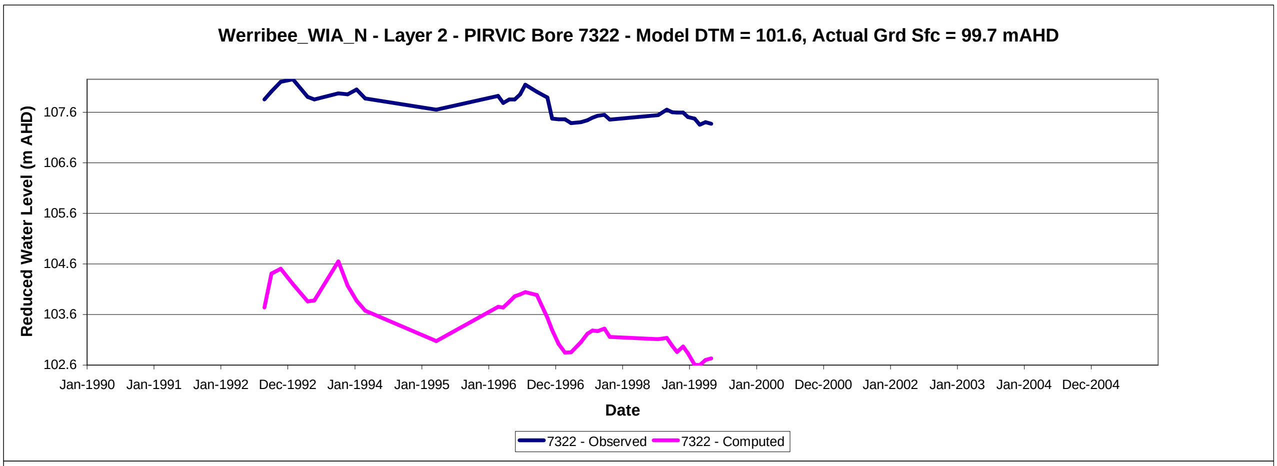

Werribee_WIA_W - Layer 2 - SON Bore 96900 - Model DTM = 40, Actual Grd Sfc = 38.2 mAHD
Reduced Water Level (m AHD)
34.6
33.6
32.6
31.6
30.6
29.6
28.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
96900 - Observed
96900 - Computed

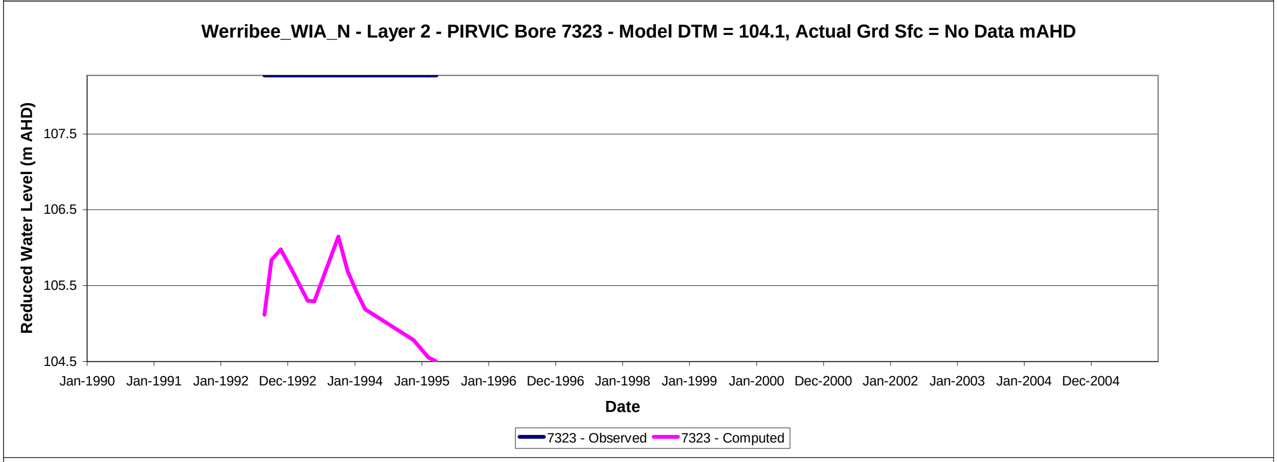

Werribee_WIA_W - Layer 2 - SON Bore 96901 - Model DTM = 40, Actual Grd Sfc = 38.4 mAHD
Reduced Water Level (m AHD)
34.7
33.7
32.7
31.7
30.7
29.7
28.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
96901 - Observed
96901 - Computed

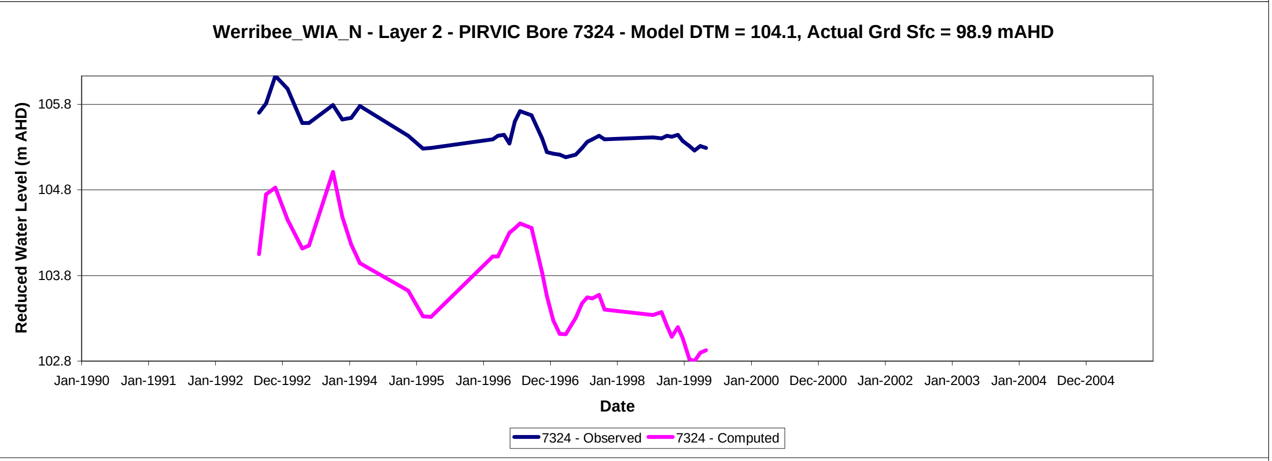

Werribee_WIA_W - Layer 2 - SON Bore 109516 - Model DTM = 42.3, Actual Grd Sfc = 42.1 mAHD
Reduced Water Level (m AHD)
36.2
35.2
34.2
33.2
32.2
31.2
30.2
29.2
28.2
27.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109516 - Observed
109516 - Computed

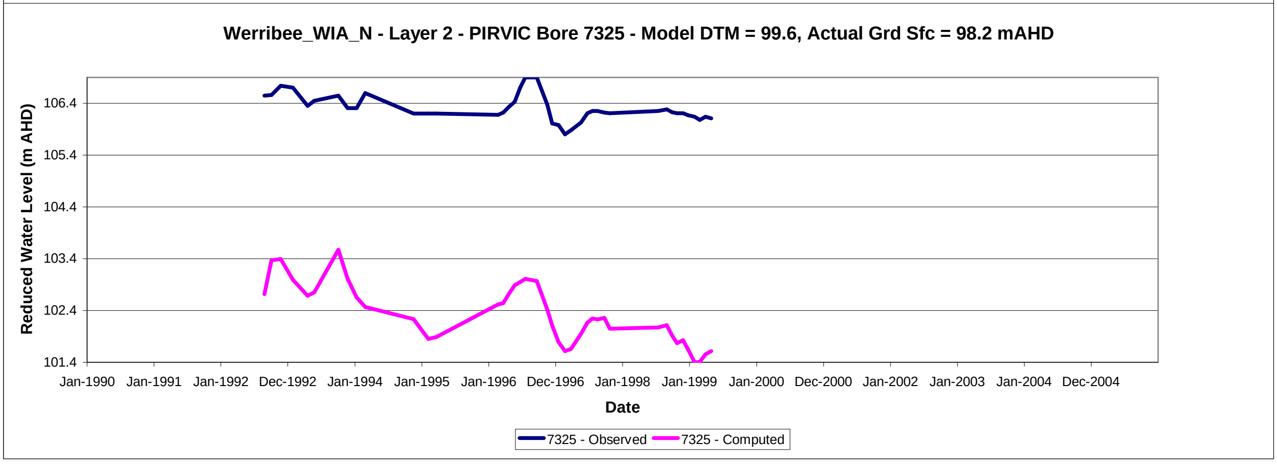

Werribee_WIA_W - Layer 2 - SON Bore 109684 - Model DTM = 60, Actual Grd Sfc = 56.2 mAHD
Reduced Water Level (m AHD)
51.8
50.8
49.8
48.8
47.8
46.8
45.8
44.8
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109684 - Observed
109684 - Computed

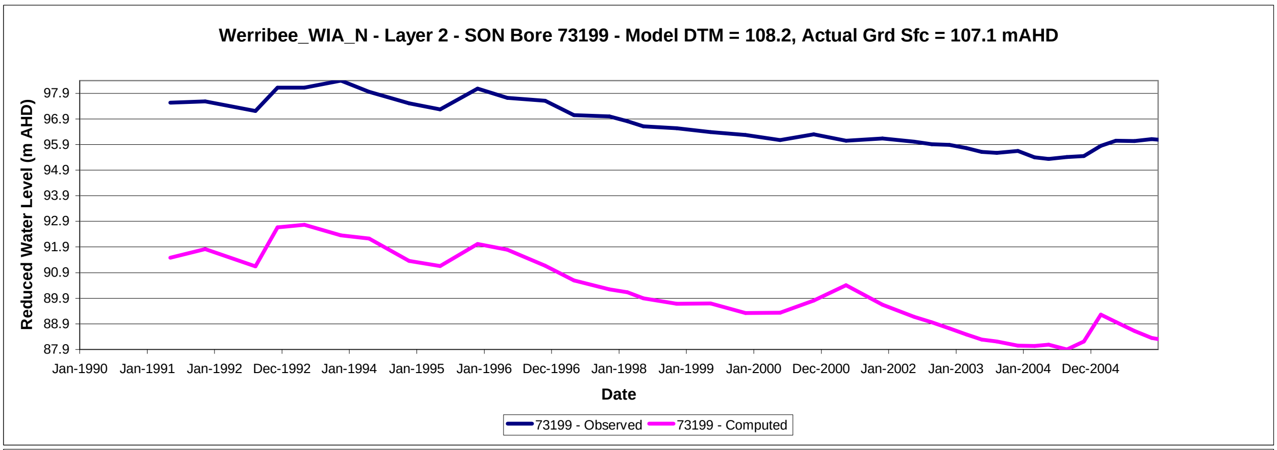

Werribee_WIA_W - Layer 2 - SON Bore 109686 - Model DTM = 38.3, Actual Grd Sfc = 33.3 mAHD
Reduced Water Level (m AHD)
30.3
29.3
28.3
27.3
26.3
25.3
24.3
23.3
22.3
21.3
20.3
19.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109686 - Observed
109686 - Computed

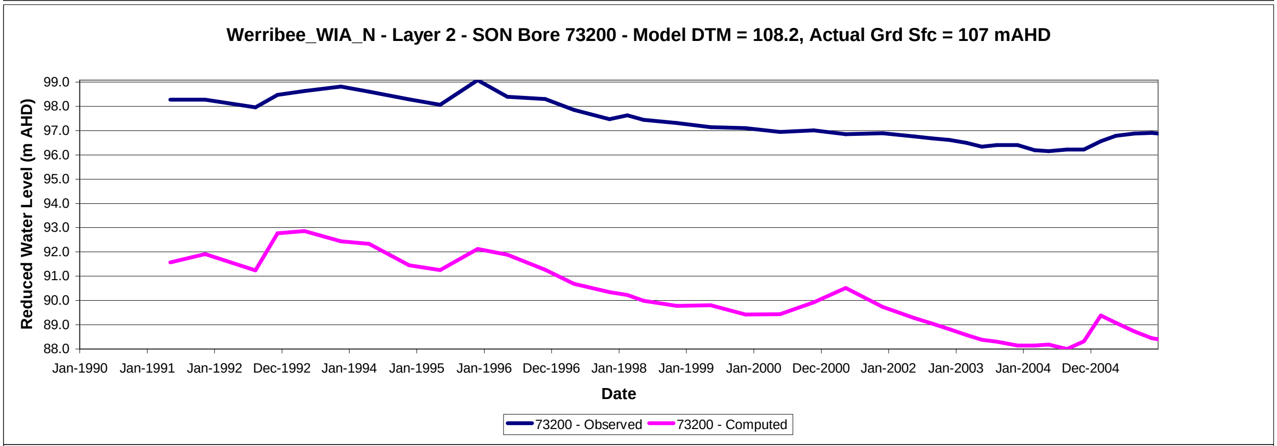

Werribee_WIA_N - Layer 2 - PIRVIC Bore 7322 - Model DTM = 101.6, Actual Grd Sfc = 99.7 mAHD
Reduced Water Level (m AHD)
107.6
106.6
105.6
104.6
103.6
102.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7322 - Observed
7322 - Computed

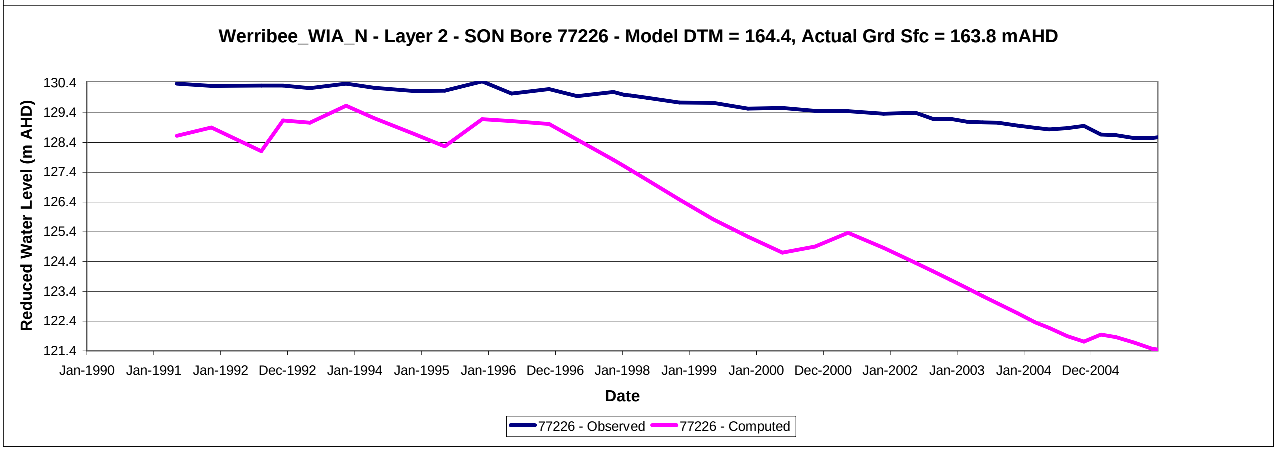

Werribee_WIA_N - Layer 2 - PIRVIC Bore 7323 - Model DTM = 104.1, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
107.5
106.5
105.5
104.5
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7323 - Observed
7323 - Computed

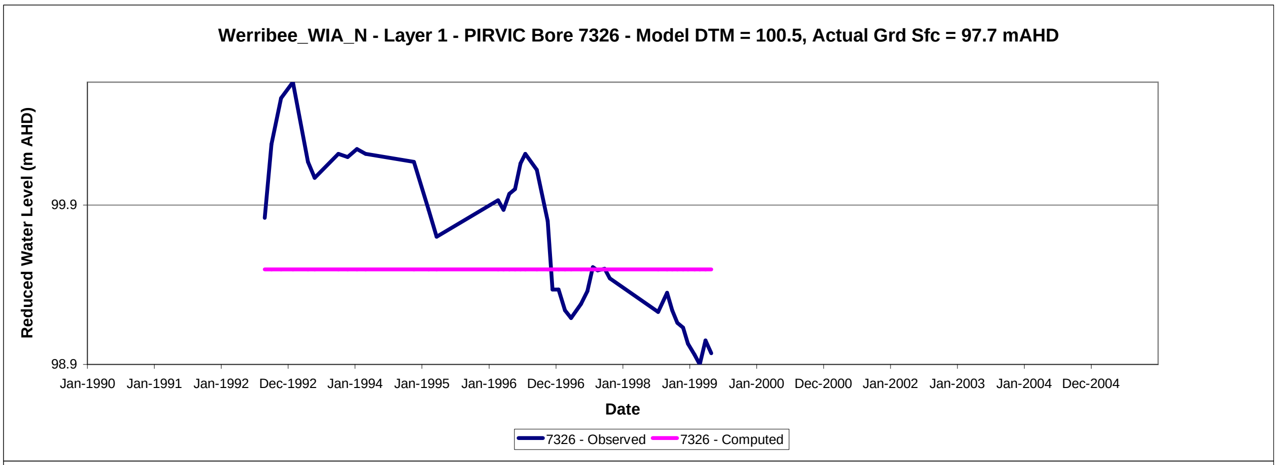

Werribee_WIA_N - Layer 2 - PIRVIC Bore 7324 - Model DTM = 104.1, Actual Grd Sfc = 98.9 mAHD
Reduced Water Level (m AHD)
105.8
104.8
103.8
102.8
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7324 - Observed
7324 - Computed

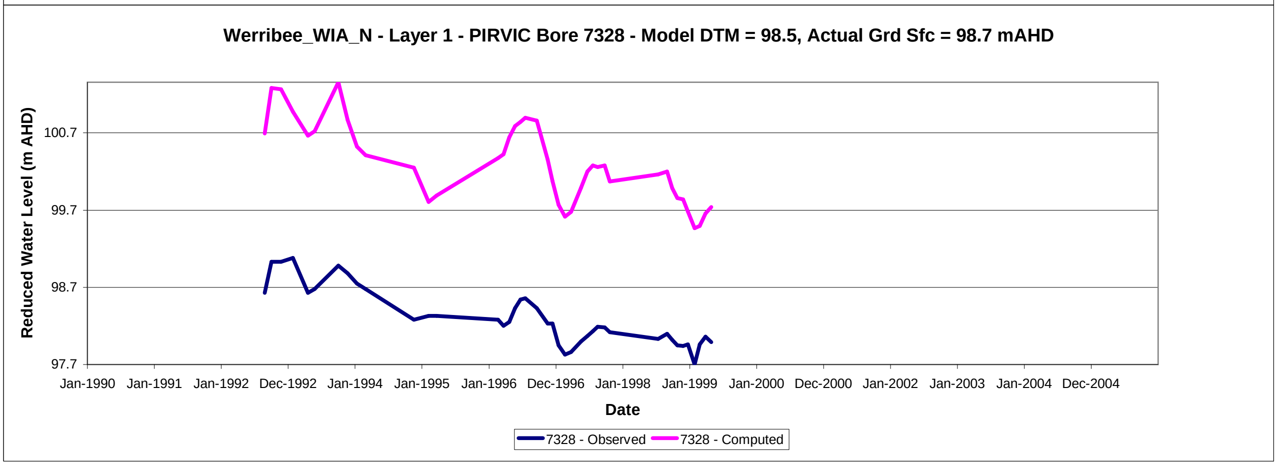

Werribee_WIA_N - Layer 2 - PIRVIC Bore 7325 - Model DTM = 99.6, Actual Grd Sfc = 98.2 mAHD
Reduced Water Level (m AHD)
106.4
105.4
104.4
103.4
102.4
101.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7325 - Observed
7325 - Computed

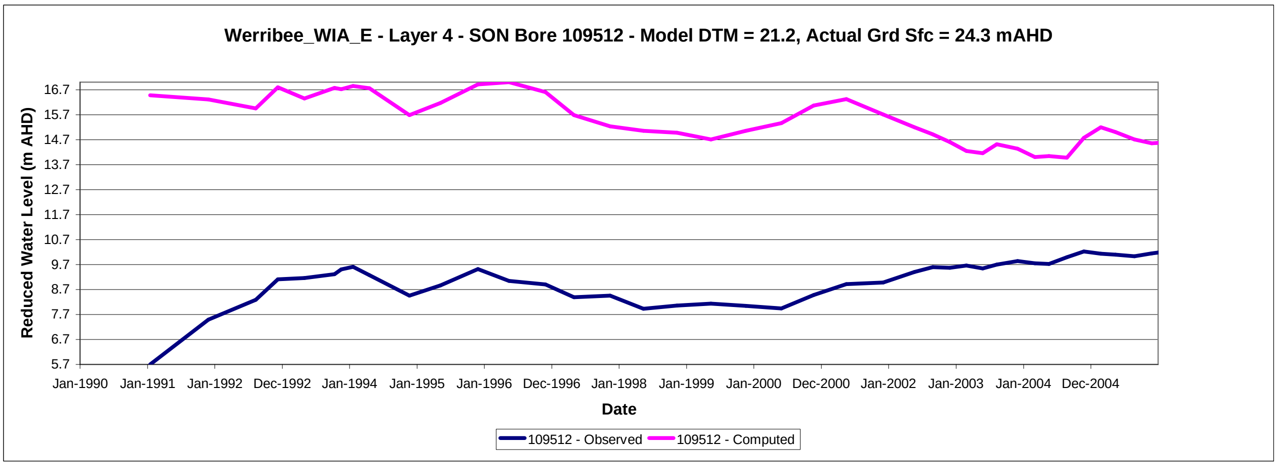

Werribee_WIA_N - Layer 2 - SON Bore 73199 - Model DTM = 108.2, Actual Grd Sfc = 107.1 mAHD
Reduced Water Level (m AHD)
97.9
96.9
95.9
94.9
93.9
92.9
91.9
90.9
89.9
88.9
87.9
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
73199 - Observed
73199 - Computed

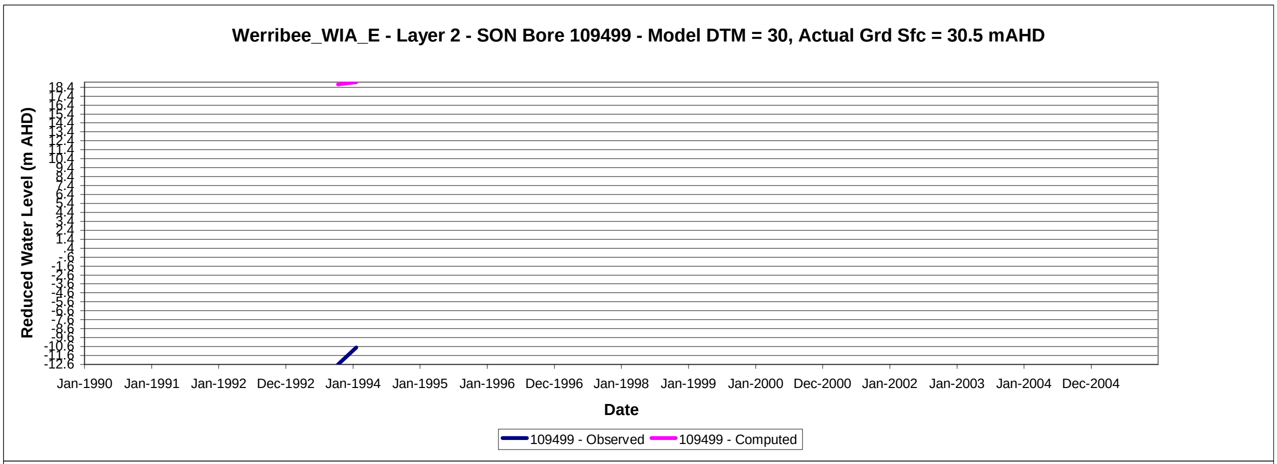

Werribee_WIA_N - Layer 2 - SON Bore 73200 - Model DTM = 108.2, Actual Grd Sfc = 107 mAHD
Reduced Water Level (m AHD)
99.0
98.0
97.0
96.0
95.0
94.0
93.0
92.0
91.0
90.0
89.0
88.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
73200 - Observed
73200 - Computed

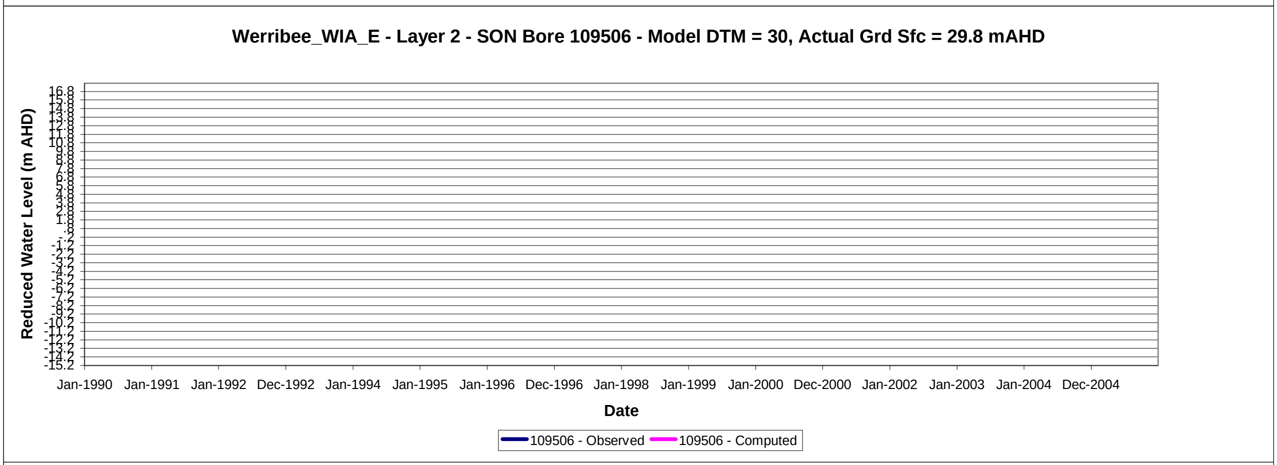

Werribee_WIA_N - Layer 2 - SON Bore 77226 - Model DTM = 164.4, Actual Grd Sfc = 163.8 mAHD
Reduced Water Level (m AHD)
130.4
129.4
128.4
127.4
126.4
125.4
124.4
123.4
122.4
121.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
77226 - Observed
77226 - Computed

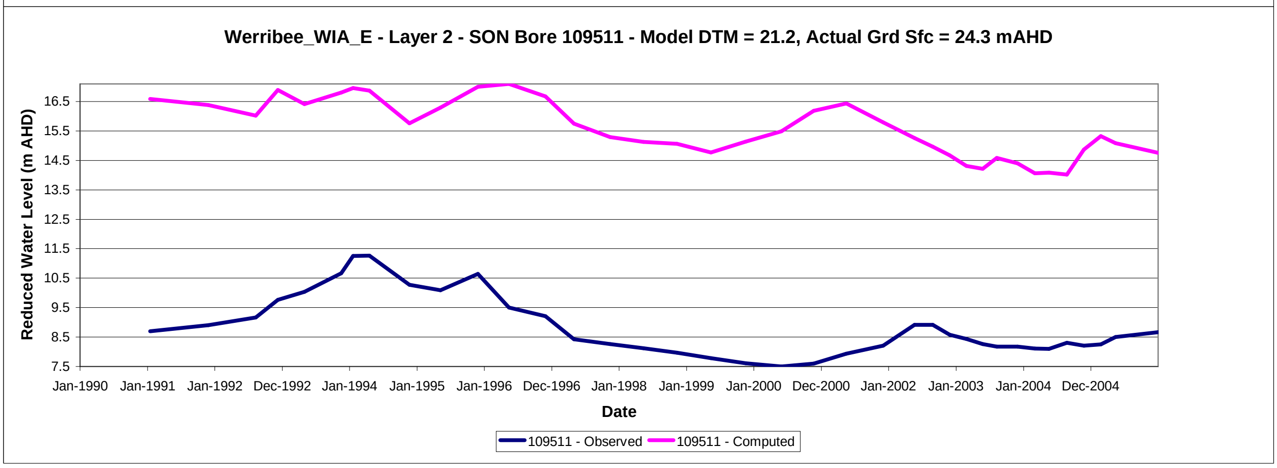

Werribee_WIA_N - Layer 1 - PIRVIC Bore 7326 - Model DTM = 100.5, Actual Grd Sfc = 97.7 mAHD
Reduced Water Level (m AHD)
99.9
98.9
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7326 - Observed
7326 - Computed

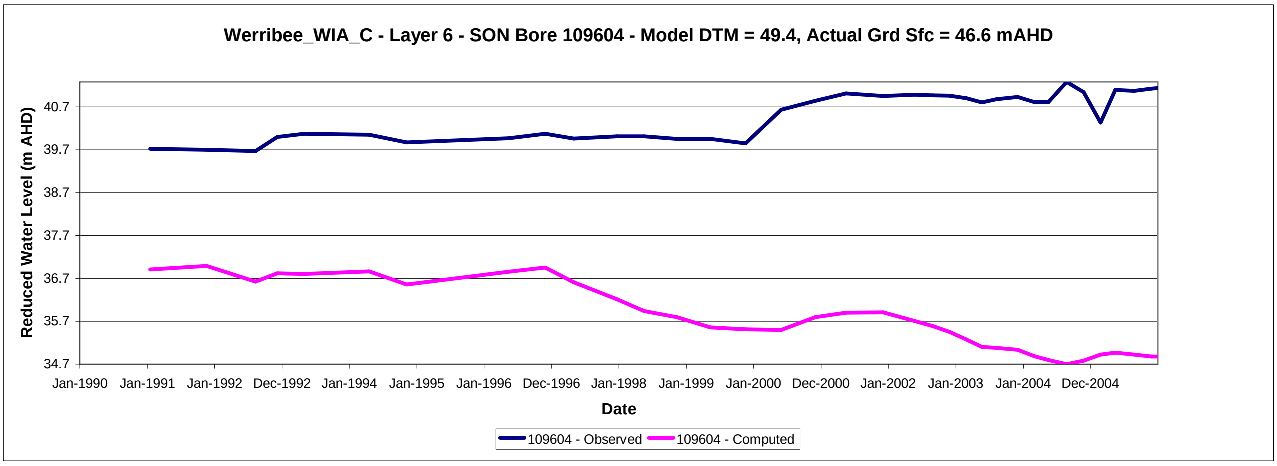

Werribee_WIA_N - Layer 1 - PIRVIC Bore 7328 - Model DTM = 98.5, Actual Grd Sfc = 98.7 mAHD
Reduced Water Level (m AHD)
100.7
99.7
98.7
97.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7328 - Observed
7328 - Computed

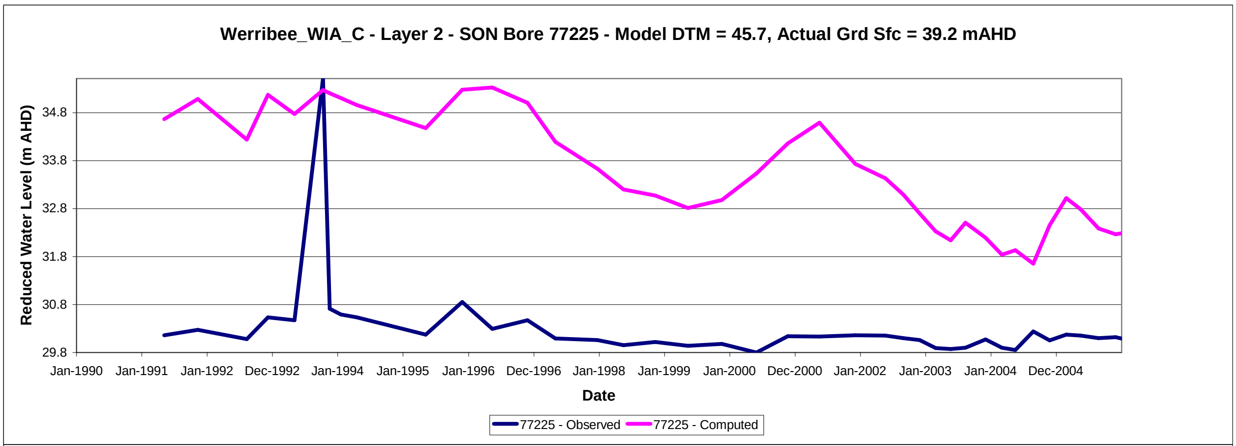

Werribee_WIA_E - Layer 4 - SON Bore 109512 - Model DTM = 21.2, Actual Grd Sfc = 24.3 mAHD
Reduced Water Level (m AHD)
16.7
15.7
14.7
13.7
12.7
11.7
10.7
9.7
8.7
7.7
6.7
5.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109512 - Observed
109512 - Computed

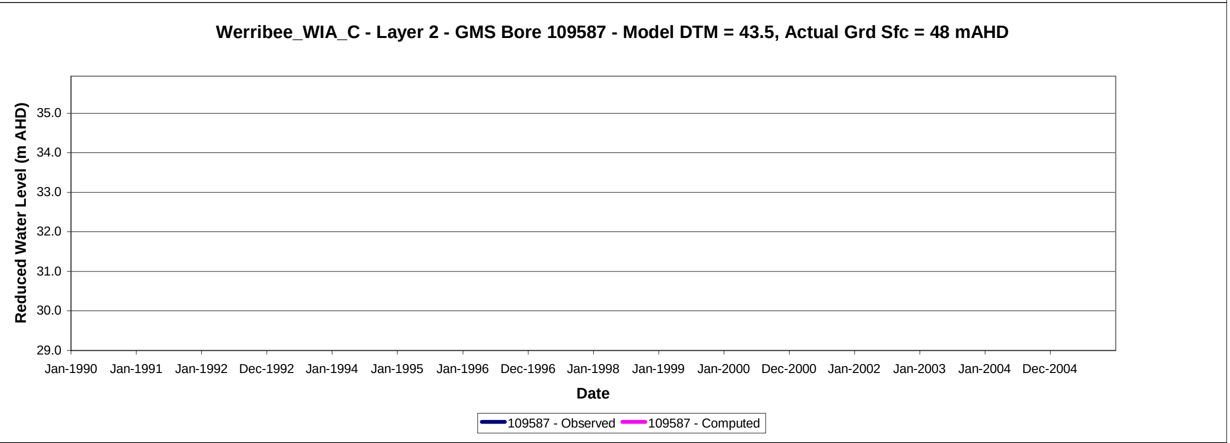

Werribee_WIA_E - Layer 2 - SON Bore 109499 - Model DTM = 30, Actual Grd Sfc = 30.5 mAHD
Reduced Water Level (m AHD)
Date
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
109499 - Observed
109499 - Computed

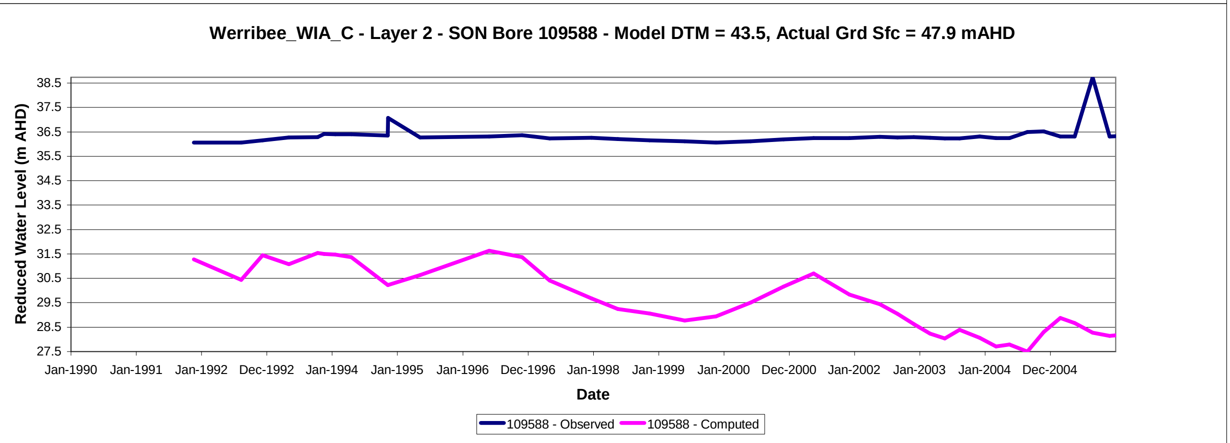

Werribee_WIA_E - Layer 2 - SON Bore 109506 - Model DTM = 30, Actual Grd Sfc = 29.8 mAHD
Reduced Water Level (m AHD)
Date
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
109506 - Observed
109506 - Computed

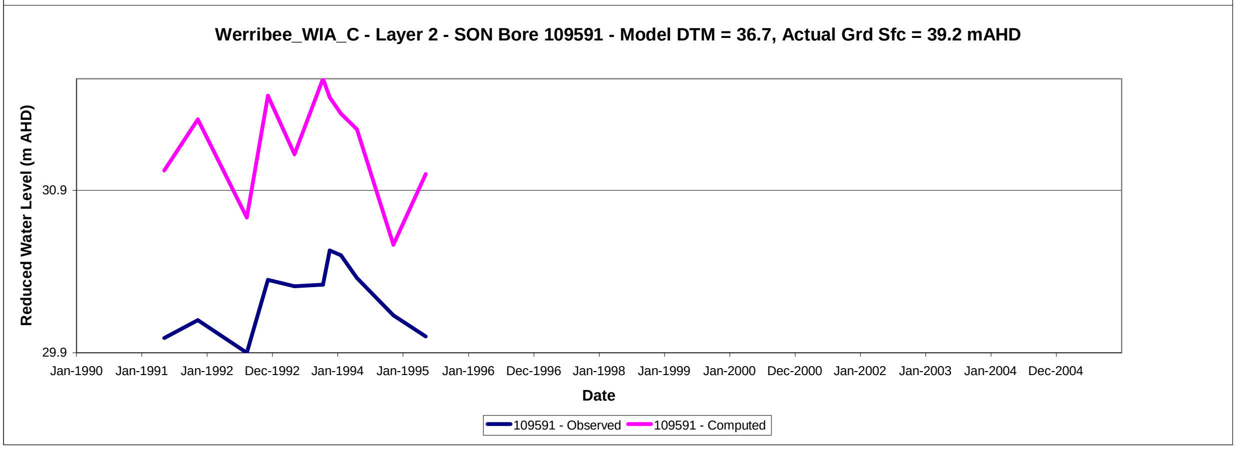

Werribee_WIA_E - Layer 2 - SON Bore 109511 - Model DTM = 21.2, Actual Grd Sfc = 24.3 mAHD
Reduced Water Level (m AHD)
16.5
15.5
14.5
13.5
12.5
11.5
10.5
9.5
8.5
7.5
Date
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
109511 - Observed
109511 - Computed

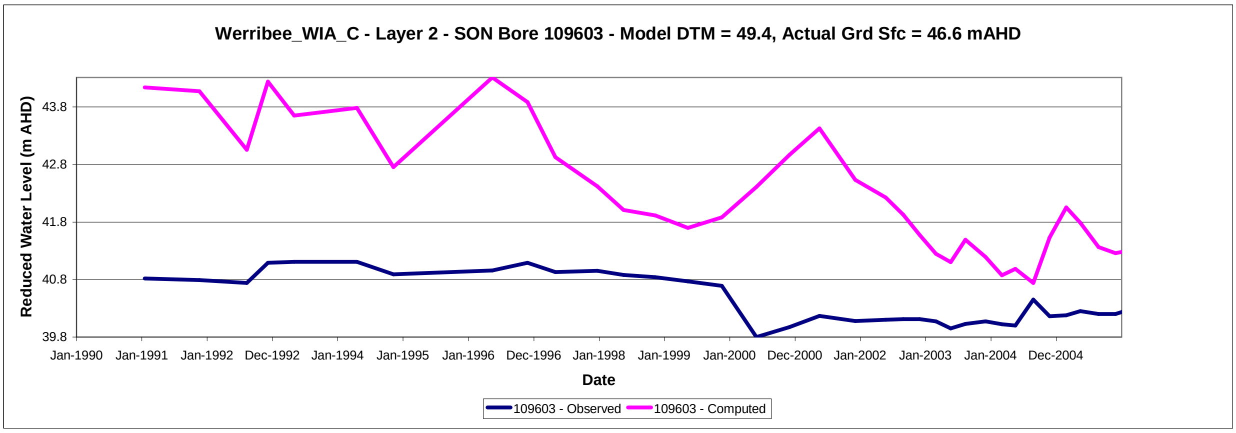

Werribee_WIA_C - Layer 6 - SON Bore 109604 - Model DTM = 49.4, Actual Grd Sfc = 46.6 mAHD
Reduced Water Level (m AHD)
40.7
39.7
38.7
37.7
36.7
35.7
34.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109604 - Observed
109604 - Computed

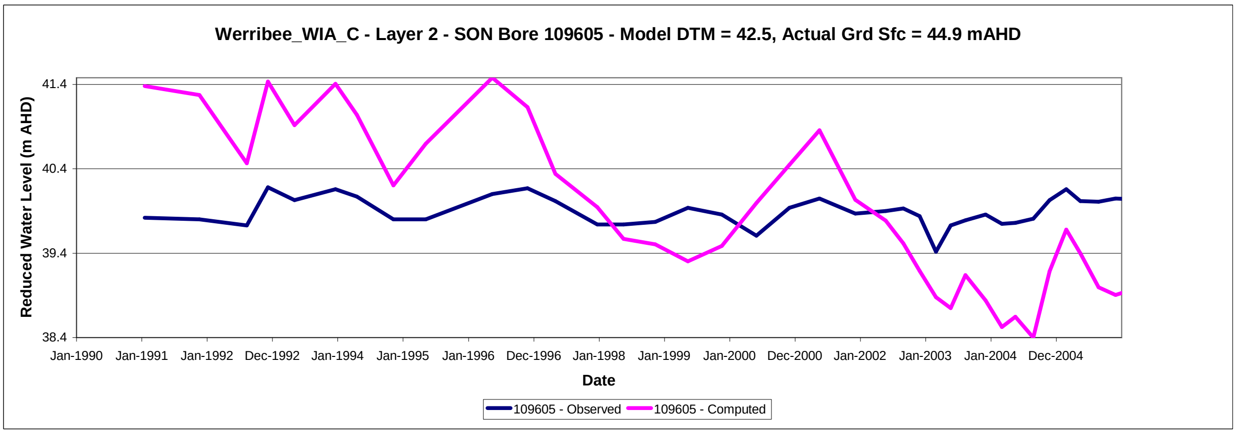

Werribee_WIA_C - Layer 2 - SON Bore 77225 - Model DTM = 45.7, Actual Grd Sfc = 39.2 mAHD
Reduced Water Level (m AHD)
34.8
33.8
32.8
31.8
30.8
29.8
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
77225 - Observed
77225 - Computed

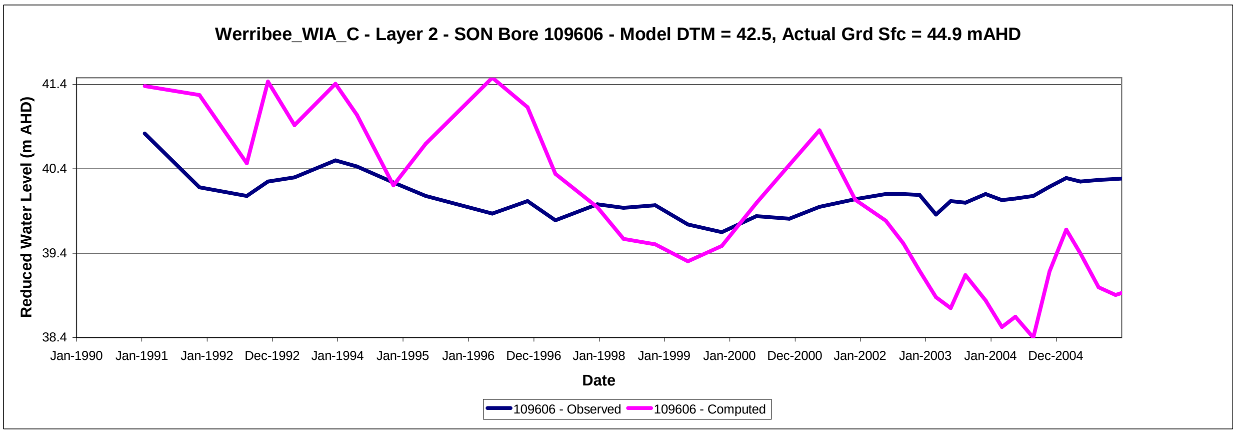

Werribee_WIA_C - Layer 2 - GMS Bore 109587 - Model DTM = 43.5, Actual Grd Sfc = 48 mAHD
Reduced Water Level (m AHD)
35.0
34.0
33.0
32.0
31.0
30.0
29.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109587 - Observed
109587 - Computed

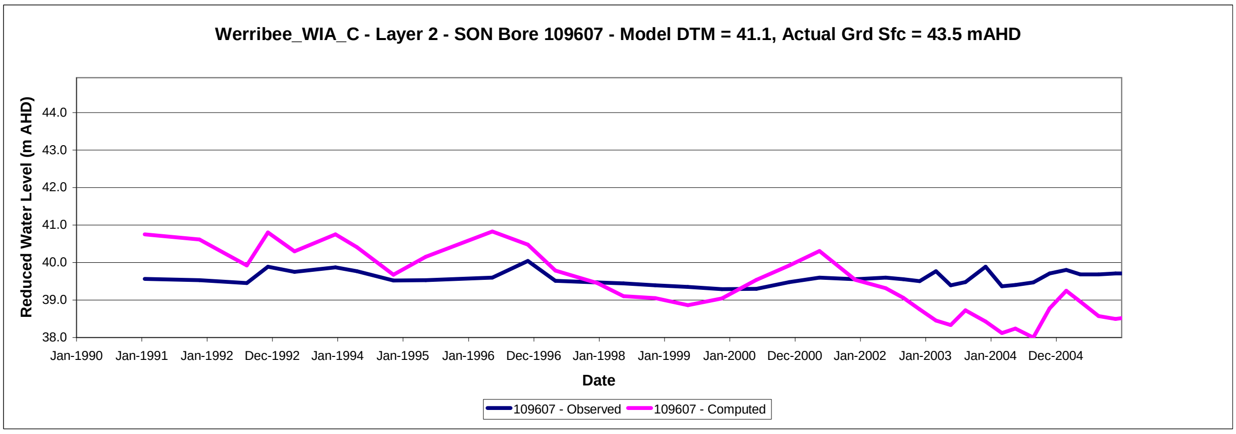

Werribee_WIA_C - Layer 2 - SON Bore 109588 - Model DTM = 43.5, Actual Grd Sfc = 47.9 mAHD
Reduced Water Level (m AHD)
38.5
37.5
36.5
35.5
34.5
33.5
32.5
31.5
30.5
29.5
28.5
27.5
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109588 - Observed
109588 - Computed

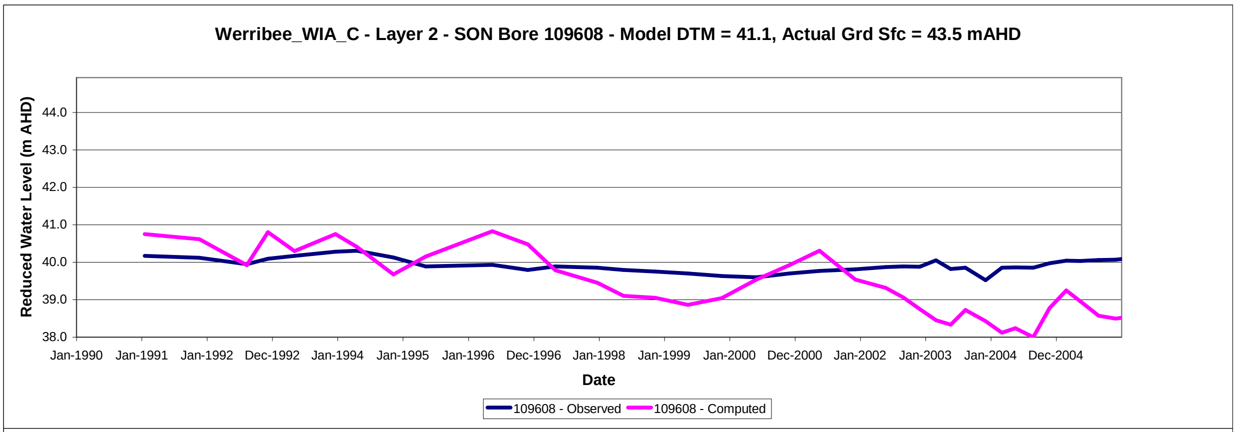

Werribee_WIA_C - Layer 2 - SON Bore 109591 - Model DTM = 36.7, Actual Grd Sfc = 39.2 mAHD
Reduced Water Level (m AHD)
30.9
29.9
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109591 - Observed
109591 - Computed

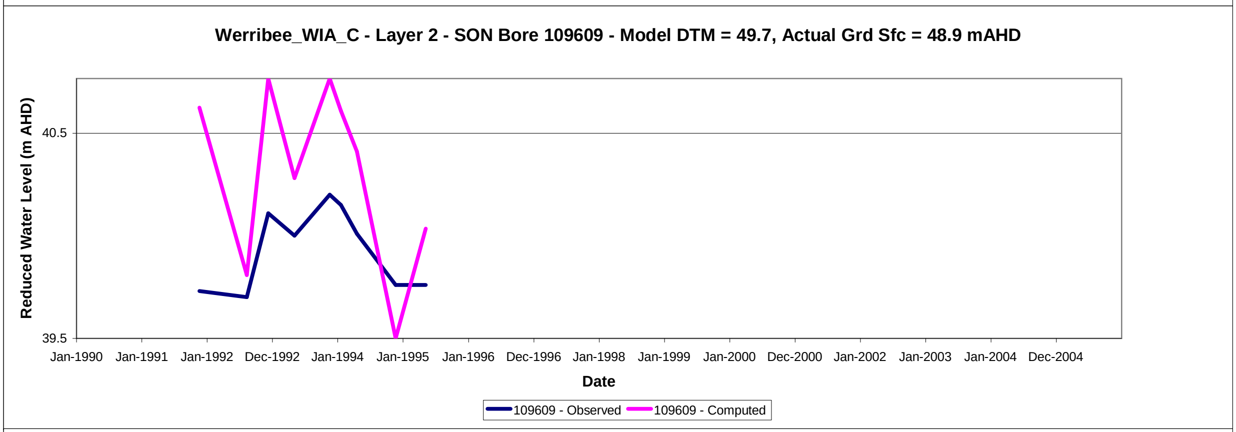

Werribee_WIA_C - Layer 2 - SON Bore 109603 - Model DTM = 49.4, Actual Grd Sfc = 46.6 mAHD
Reduced Water Level (m AHD)
43.8
42.8
41.8
40.8
39.8
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109603 - Observed
109603 - Computed

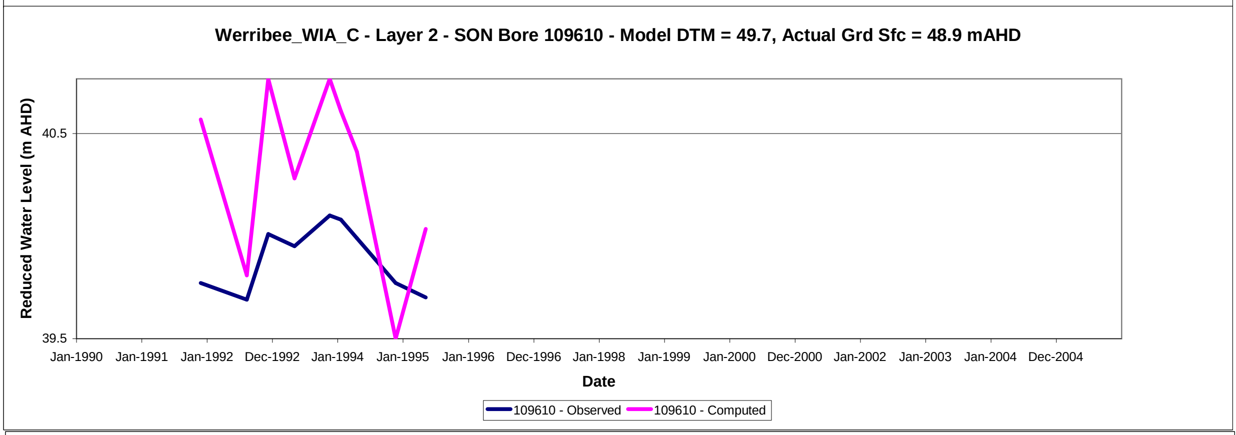

Werribee_WIA_C - Layer 2 - SON Bore 109605 - Model DTM = 42.5, Actual Grd Sfc = 44.9 mAHD
Reduced Water Level (m AHD)
41.4
40.4
39.4
38.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109605 - Observed
109605 - Computed

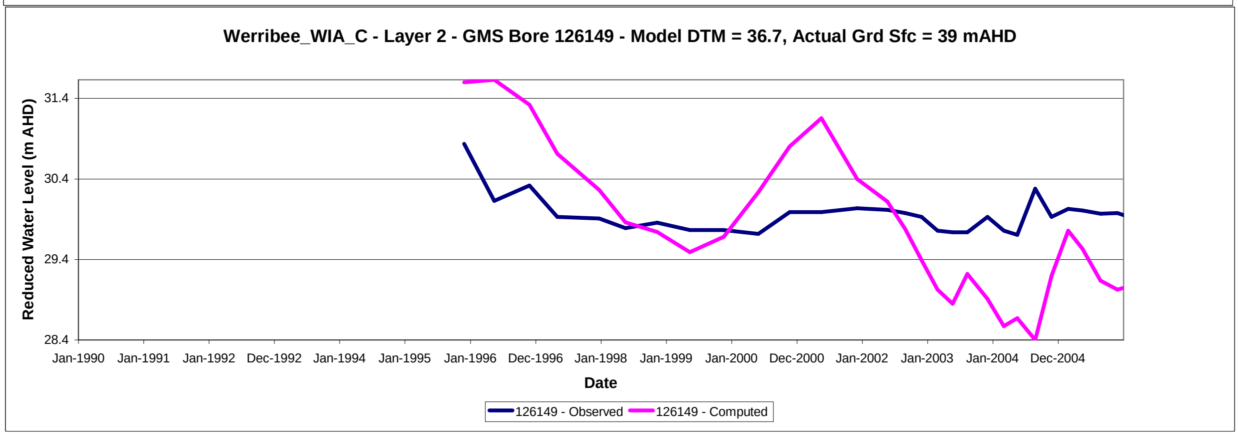

Werribee_WIA_C - Layer 2 - SON Bore 109606 - Model DTM = 42.5, Actual Grd Sfc = 44.9 mAHD
Reduced Water Level (m AHD)
41.4
40.4
39.4
38.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109606 - Observed
109606 - Computed


Werribee_WIA_C - Layer 2 - SON Bore 109607 - Model DTM = 41.1, Actual Grd Sfc = 43.5 mAHD
Reduced Water Level (m AHD)
44.0
43.0
42.0
41.0
40.0
39.0
38.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109607 - Observed
109607 - Computed

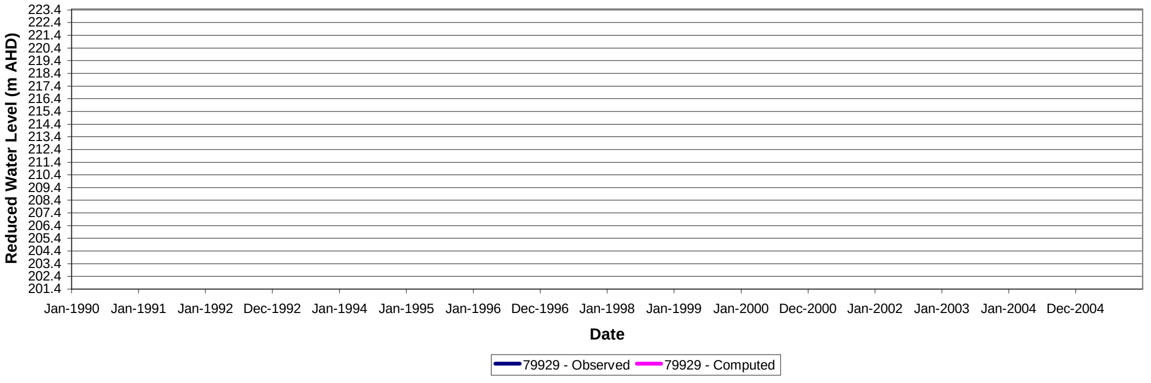

Werribee_WIA_C - Layer 2 - SON Bore 109608 - Model DTM = 41.1, Actual Grd Sfc = 43.5 mAHD
Reduced Water Level (m AHD)
44.0
43.0
42.0
41.0
40.0
39.0
38.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109608 - Observed
109608 - Computed


Werribee_WIA_C - Layer 2 - SON Bore 109609 - Model DTM = 49.7, Actual Grd Sfc = 48.9 mAHD
Reduced Water Level (m AHD)
40.5
39.5
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109609 - Observed
109609 - Computed

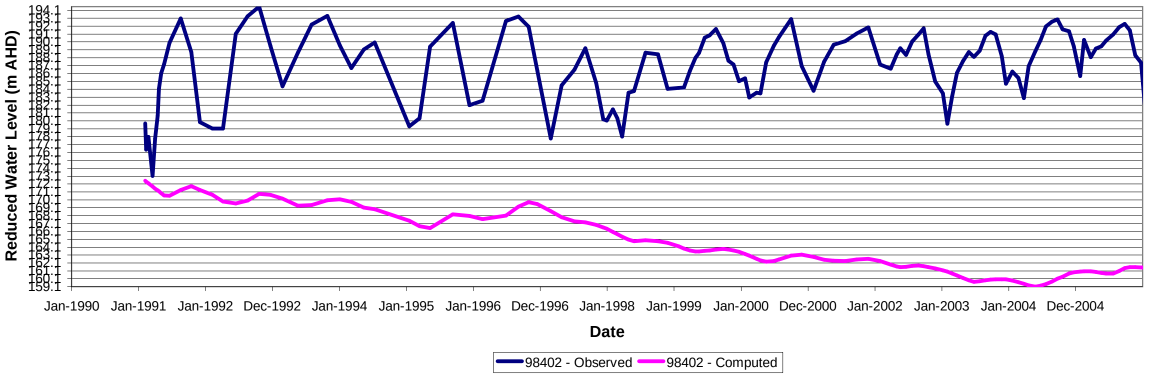

Werribee_WIA_C - Layer 2 - SON Bore 109610 - Model DTM = 49.7, Actual Grd Sfc = 48.9 mAHD
Reduced Water Level (m AHD)
40.5
39.5
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109610 - Observed
109610 - Computed


Werribee_WIA_C - Layer 2 - GMS Bore 126149 - Model DTM = 36.7, Actual Grd Sfc = 39 mAHD
Reduced Water Level (m AHD)
31.4
30.4
29.4
28.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
126149 - Observed
126149 - Computed

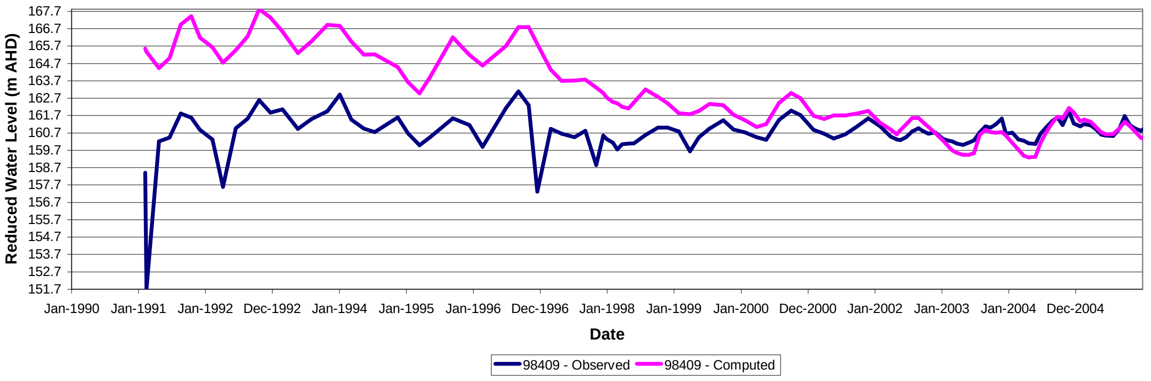
Wandin Yallock_WSPA - Layer 6 - SON Bore 79929 - Model DTM = 248.4, Actual Grd Sfc = 244.9 mAHD



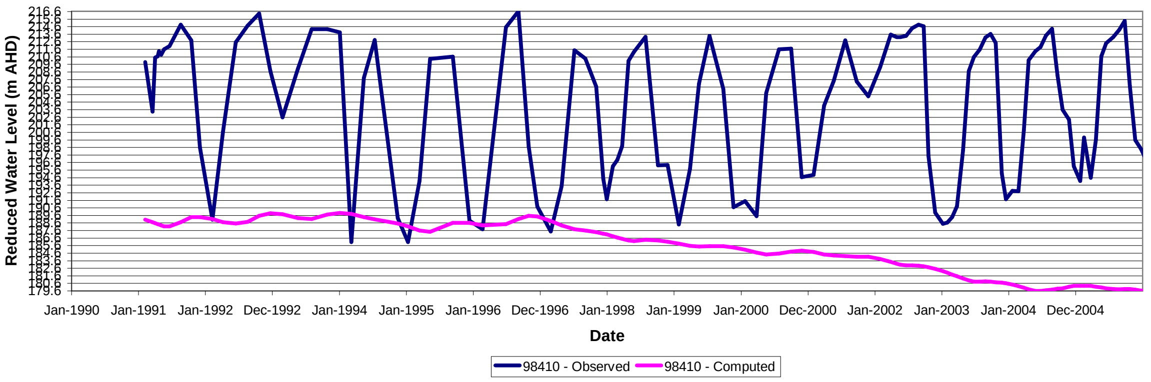
Wandin Yallock_WSPA - Layer 6 - SON Bore 98402 - Model DTM = 209.9, Actual Grd Sfc = 195.3 mAHD

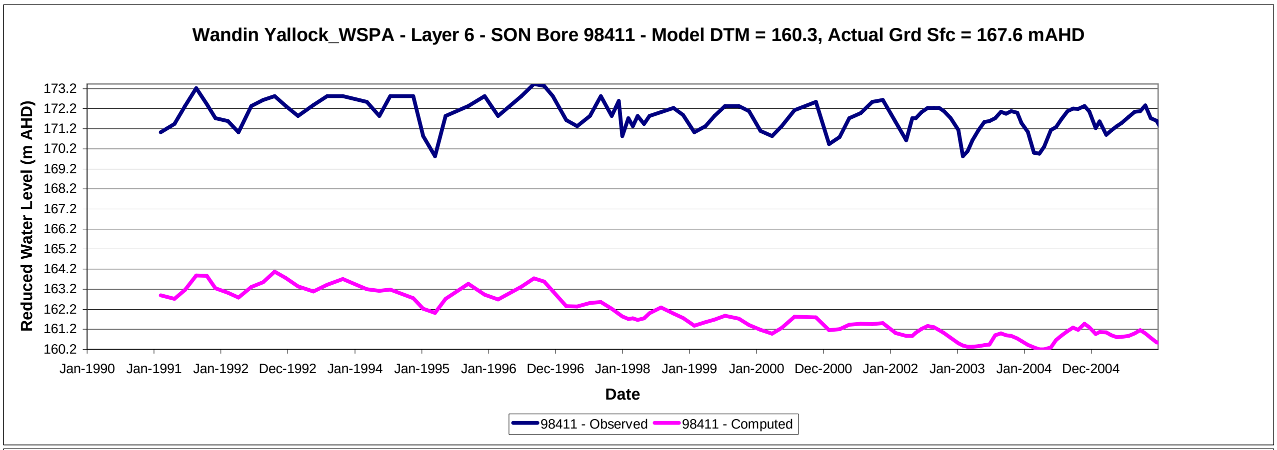


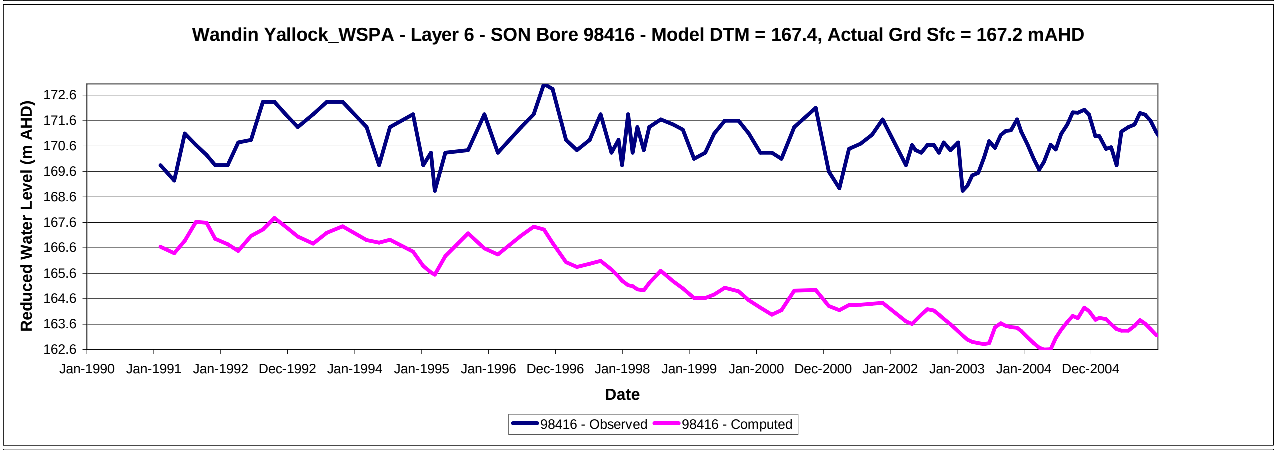
Wandin Yallock_WSPA - Layer 6 - SON Bore 98409 - Model DTM = 173.8, Actual Grd Sfc = 164.3 mAHD

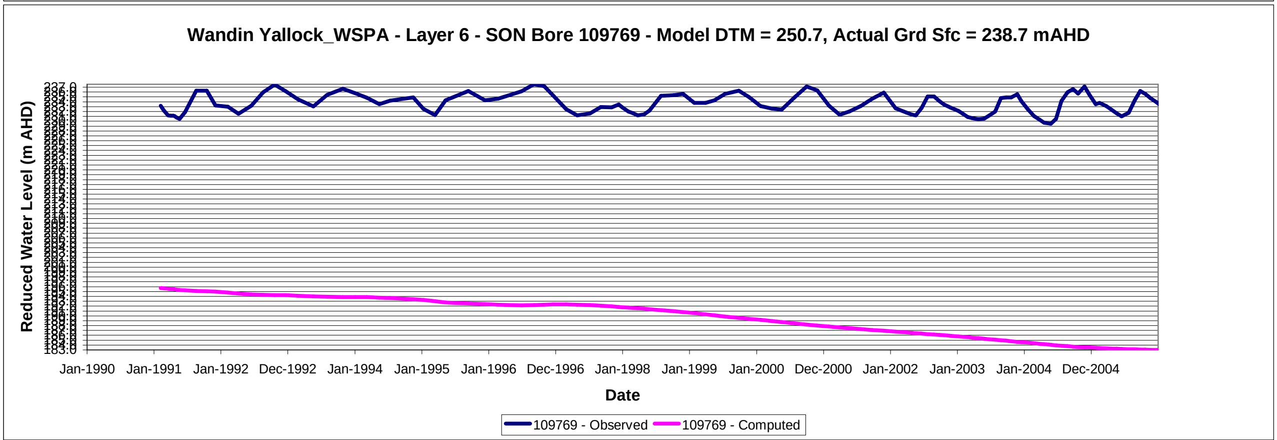


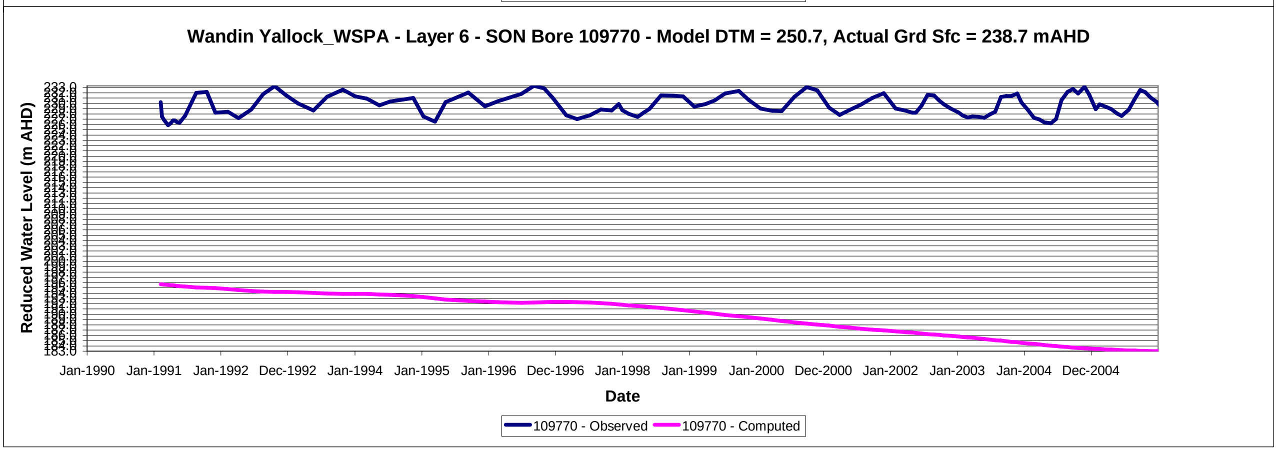
Wandin Yallock_WSPA - Layer 6 - SON Bore 98410 - Model DTM = 217.3, Actual Grd Sfc = 229.7 mAHD

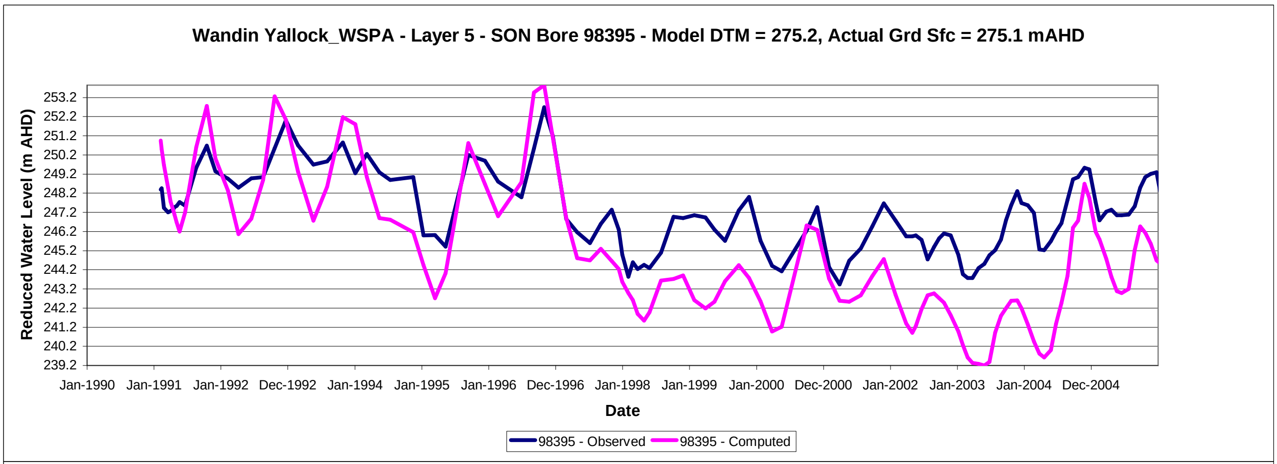


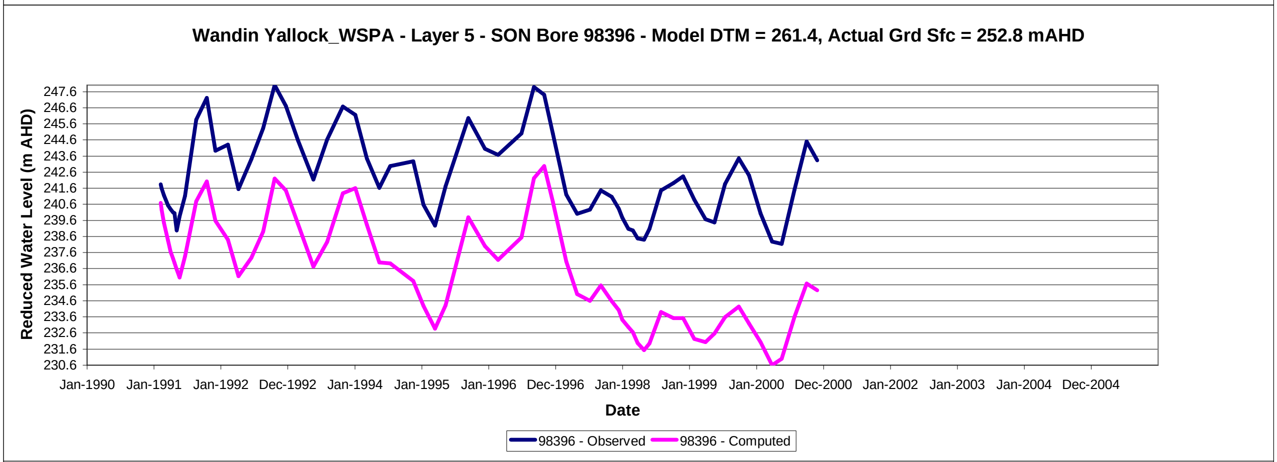

Wandin Yallock_WSPA - Layer 6 - SON Bore 98411 - Model DTM = 160.3, Actual Grd Sfc = 167.6 mAHD
Reduced Water Level (m AHD)
173.2
172.2
171.2
170.2
169.2
168.2
167.2
166.2
165.2
164.2
163.2
162.2
161.2
160.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
98411 - Observed
98411 - Computed

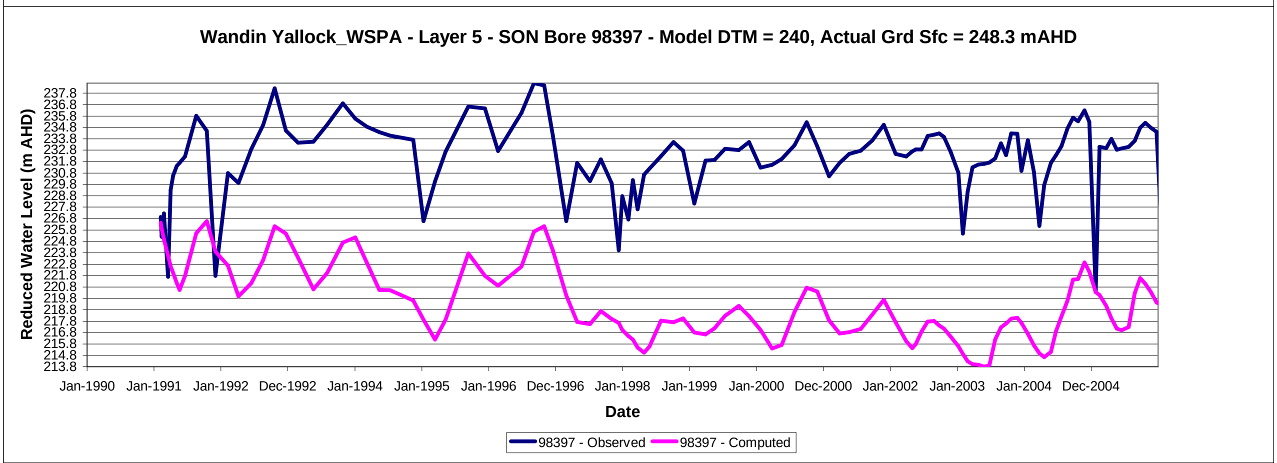

Wandin Yallock_WSPA - Layer 6 - SON Bore 98416 - Model DTM = 167.4, Actual Grd Sfc = 167.2 mAHD
Reduced Water Level (m AHD)
172.6
171.6
170.6
169.6
168.6
167.6
166.6
165.6
164.6
163.6
162.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
98416 - Observed
98416 - Computed

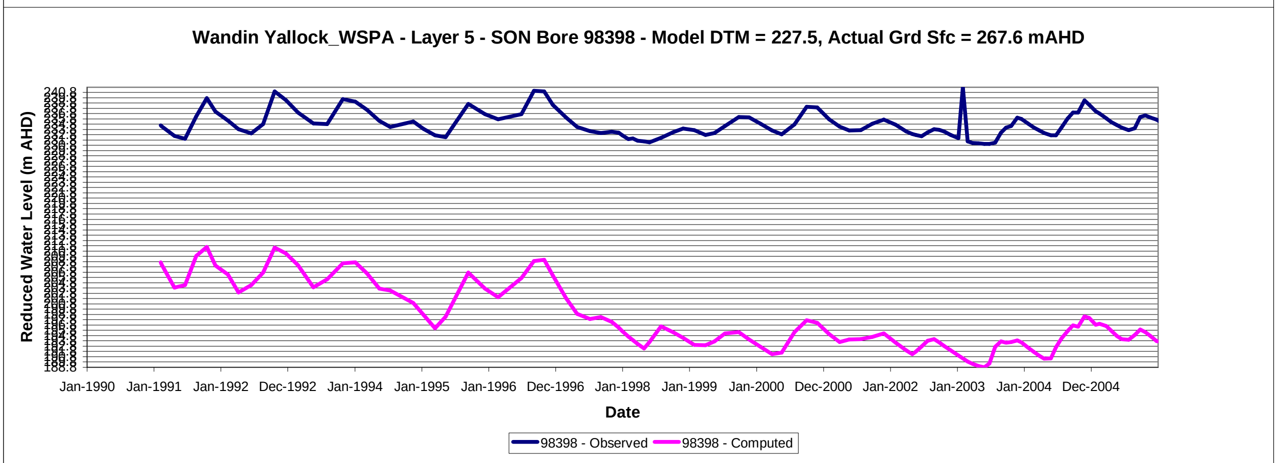

Wandin Yallock_WSPA - Layer 6 - SON Bore 109769 - Model DTM = 250.7, Actual Grd Sfc = 238.7 mAHD
Reduced Water Level (m AHD)
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109769 - Observed
109769 - Computed

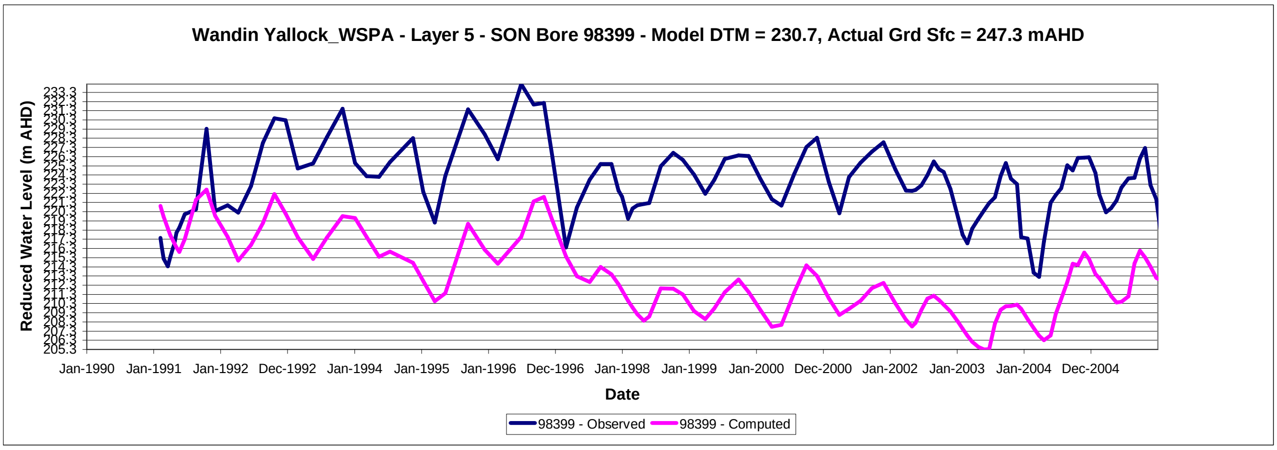

Wandin Yallock_WSPA - Layer 6 - SON Bore 109770 - Model DTM = 250.7, Actual Grd Sfc = 238.7 mAHD
Reduced Water Level (m AHD)
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109770 - Observed
109770 - Computed

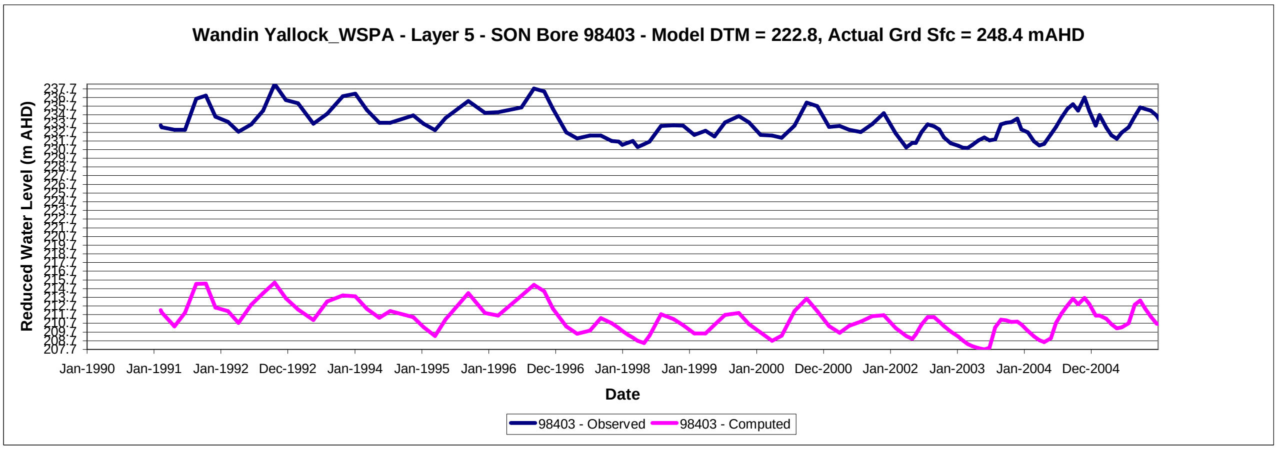

Wandin Yallock_WSPA - Layer 5 - SON Bore 98395 - Model DTM = 275.2, Actual Grd Sfc = 275.1 mAHD
Reduced Water Level (m AHD)
253.2
252.2
251.2
250.2
249.2
248.2
247.2
246.2
245.2
244.2
243.2
242.2
241.2
240.2
239.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
98395 - Observed
98395 - Computed

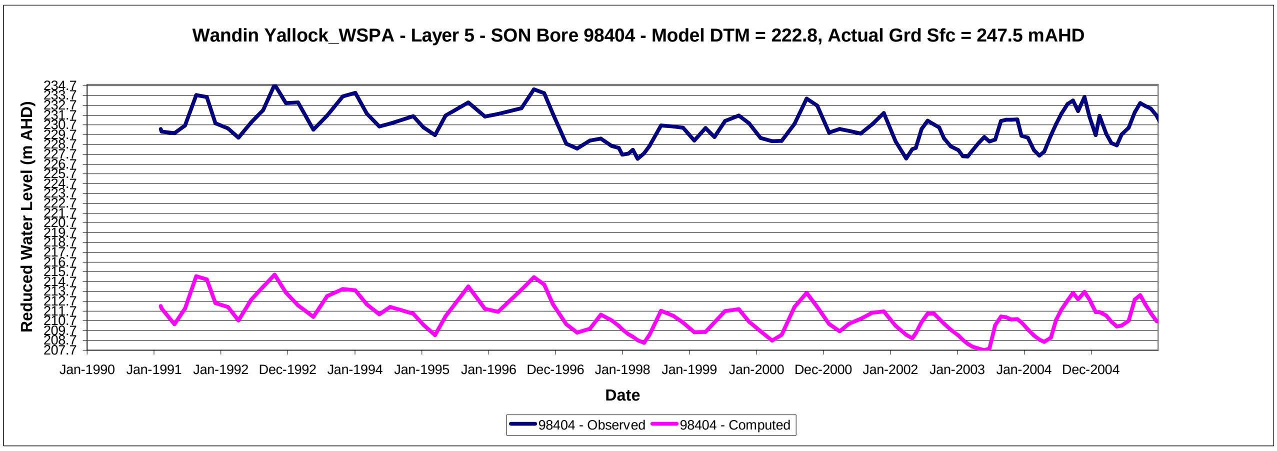

Wandin Yallock_WSPA - Layer 5 - SON Bore 98396 - Model DTM = 261.4, Actual Grd Sfc = 252.8 mAHD
Reduced Water Level (m AHD)
247.6
246.6
245.6
244.6
243.6
242.6
241.6
240.6
239.6
238.6
237.6
236.6
235.6
234.6
233.6
232.6
231.6
230.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
98396 - Observed
98396 - Computed

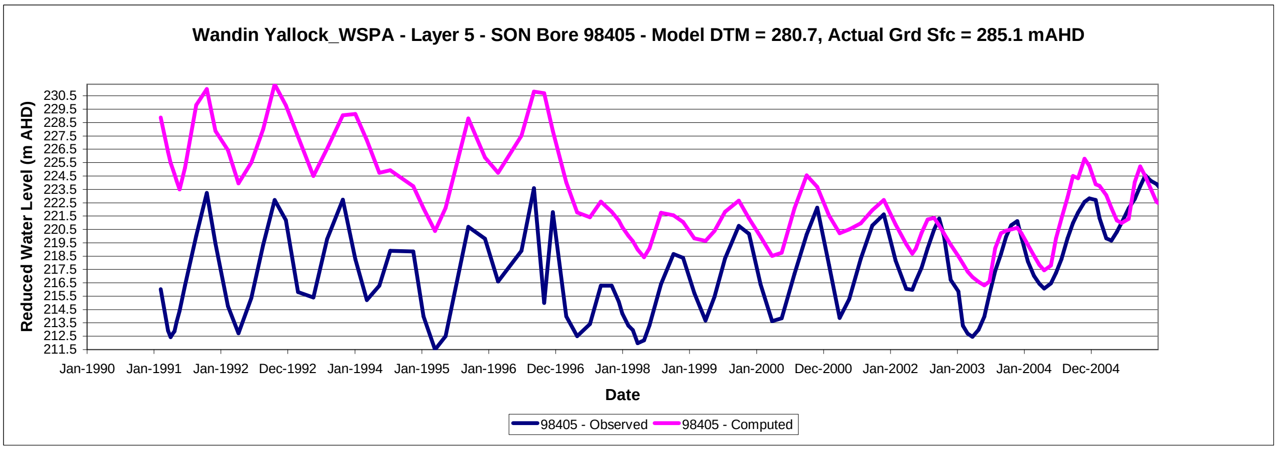

Wandin Yallock_WSPA - Layer 5 - SON Bore 98397 - Model DTM = 240, Actual Grd Sfc = 248.3 mAHD
Reduced Water Level (m AHD)
237.8
236.8
235.8
234.8
233.8
232.8
231.8
230.8
229.8
228.8
227.8
226.8
225.8
224.8
223.8
222.8
221.8
220.8
219.8
218.8
217.8
216.8
215.8
214.8
213.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
98397 - Observed
98397 - Computed

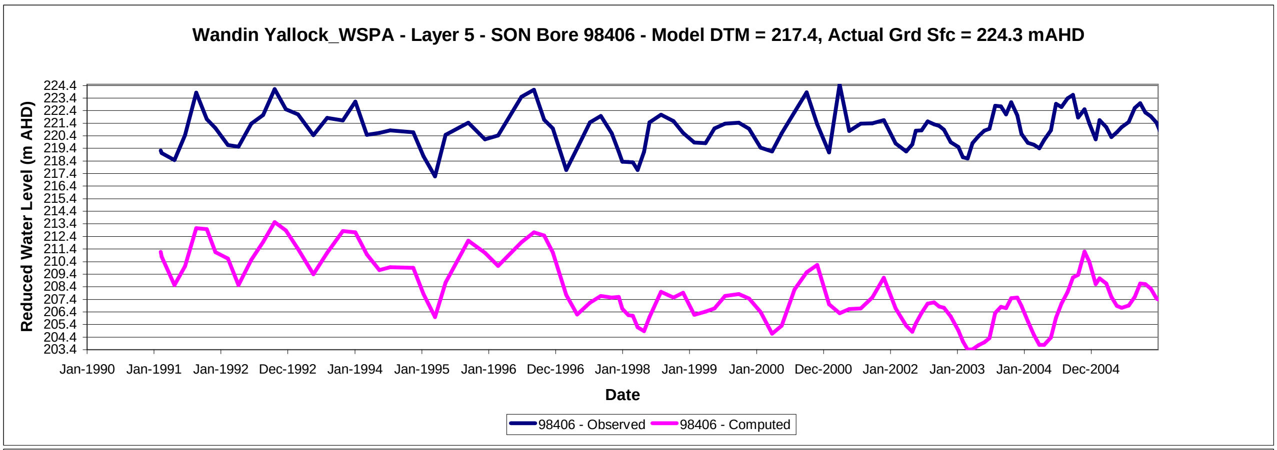

Wandin Yallock_WSPA - Layer 5 - SON Bore 98398 - Model DTM = 227.5, Actual Grd Sfc = 267.6 mAHD
Reduced Water Level (m AHD)
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
98398 - Observed
98398 - Computed

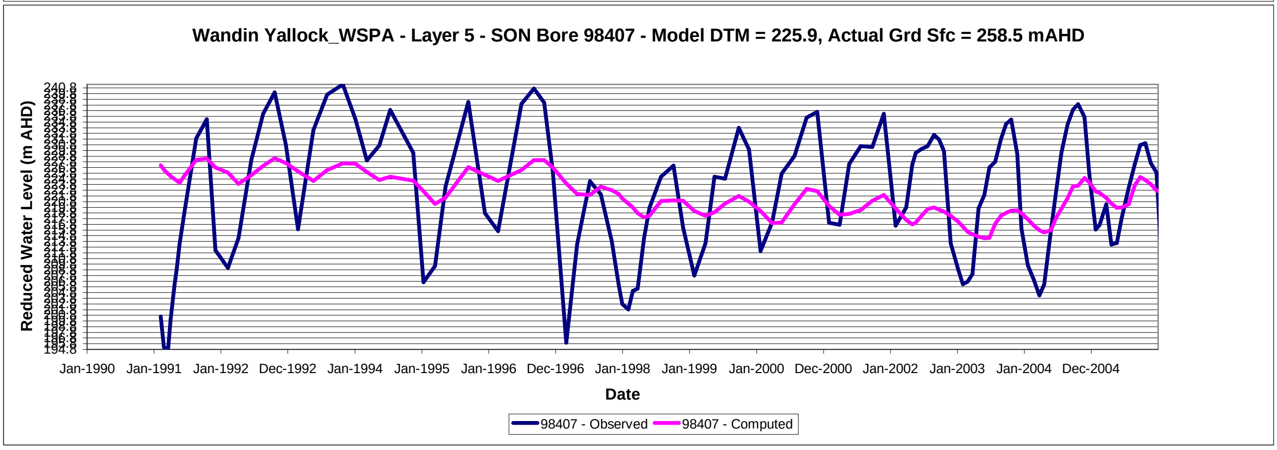

Wandin Yallock_WSPA - Layer 5 - SON Bore 98399 - Model DTM = 230.7, Actual Grd Sfc = 247.3 mAHD
Reduced Water Level (m AHD)
Date
98399 - Observed
98399 - Computed

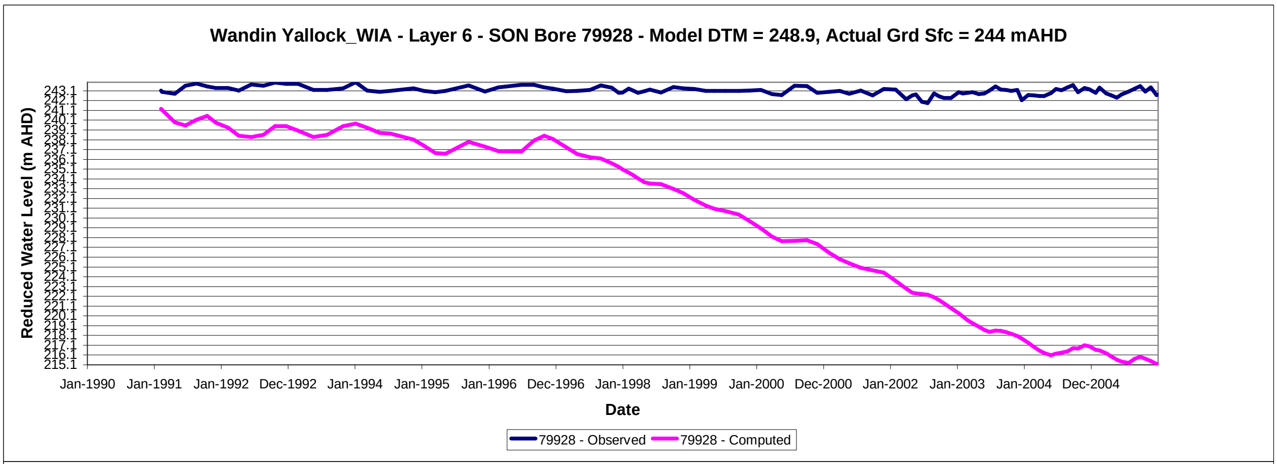

Wandin Yallock_WSPA - Layer 5 - SON Bore 98403 - Model DTM = 222.8, Actual Grd Sfc = 248.4 mAHD
Reduced Water Level (m AHD)
Date
98403 - Observed
98403 - Computed

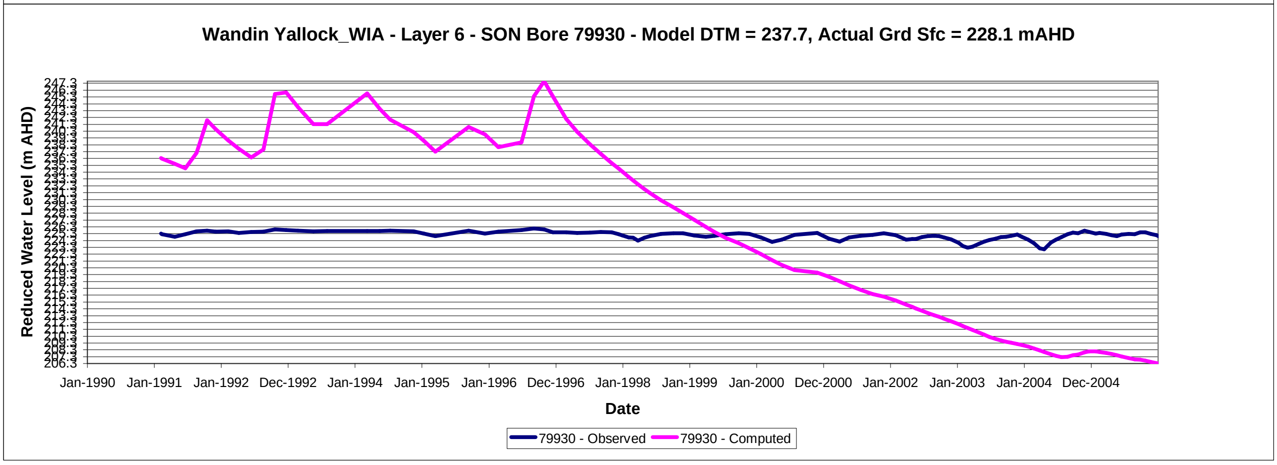

Wandin Yallock_WSPA - Layer 5 - SON Bore 98404 - Model DTM = 222.8, Actual Grd Sfc = 247.5 mAHD
Reduced Water Level (m AHD)
Date
98404 - Observed
98404 - Computed

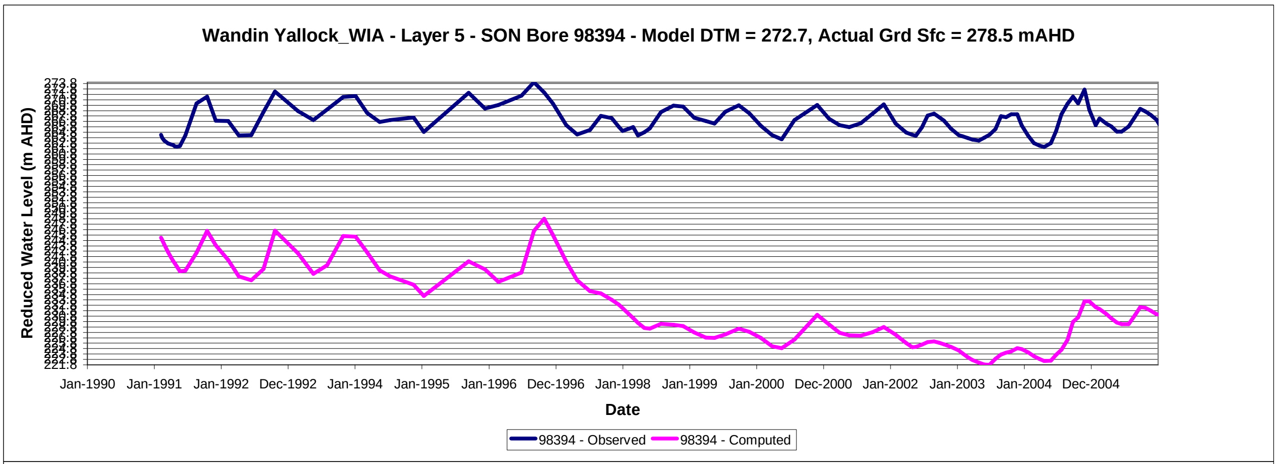

Wandin Yallock_WSPA - Layer 5 - SON Bore 98405 - Model DTM = 280.7, Actual Grd Sfc = 285.1 mAHD
Reduced Water Level (m AHD)
Date
98405 - Observed
98405 - Computed

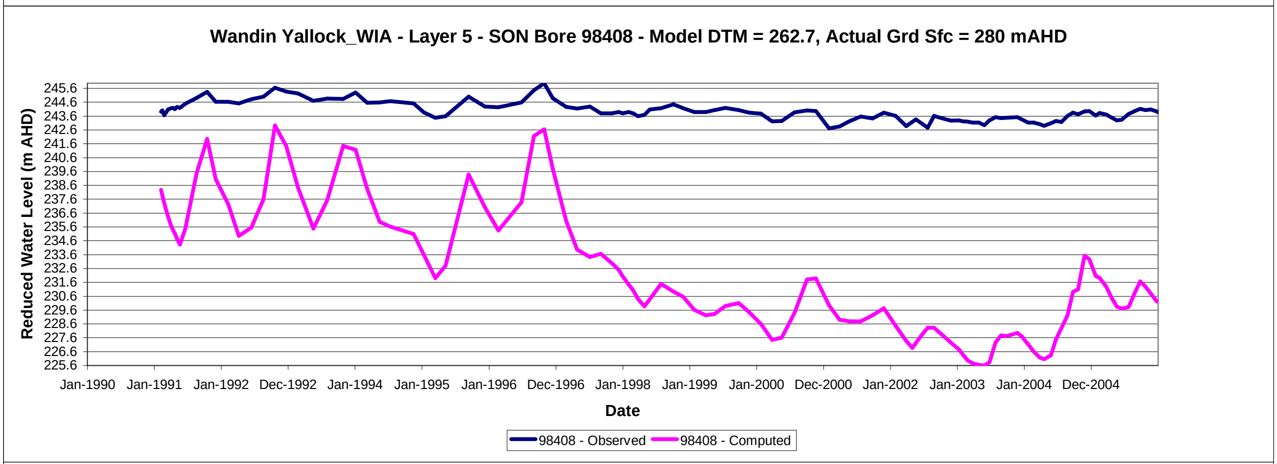

Wandin Yallock_WSPA - Layer 5 - SON Bore 98406 - Model DTM = 217.4, Actual Grd Sfc = 224.3 mAHD
Reduced Water Level (m AHD)
Date
98406 - Observed
98406 - Computed

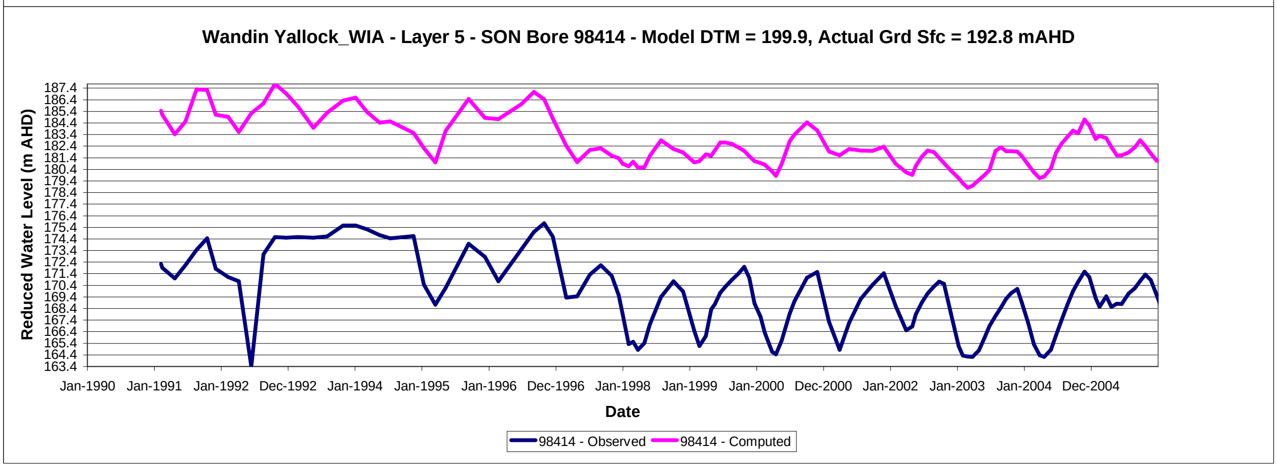

Wandin Yallock_WSPA - Layer 5 - SON Bore 98407 - Model DTM = 225.9, Actual Grd Sfc = 258.5 mAHD
Reduced Water Level (m AHD)
Date
98407 - Observed
98407 - Computed

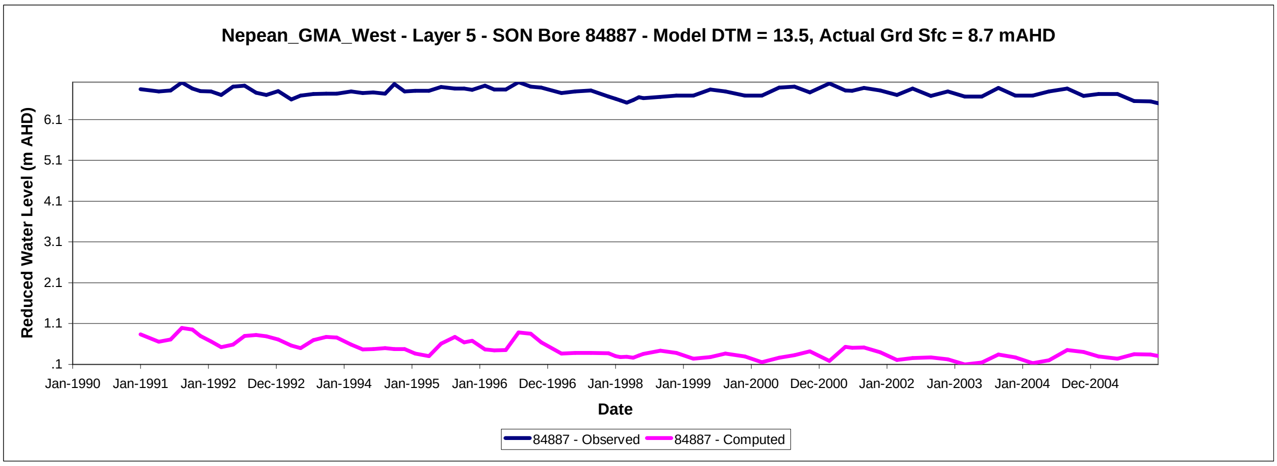

Wandin Yallock_WIA - Layer 6 - SON Bore 79928 - Model DTM = 248.9, Actual Grd Sfc = 244 mAHD
Reduced Water Level (m AHD)
Date
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
79928 - Observed
79928 - Computed

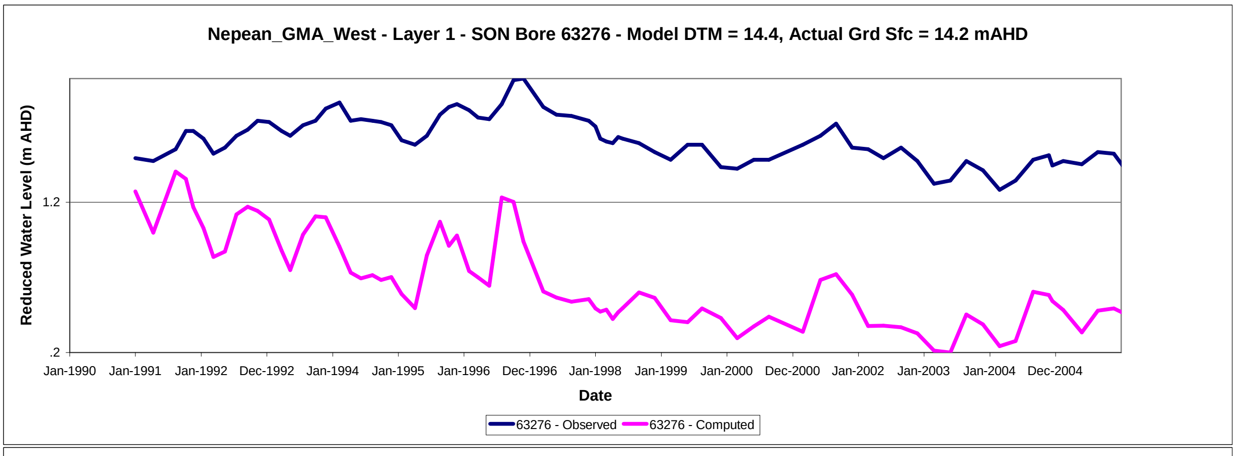

Wandin Yallock_WIA - Layer 6 - SON Bore 79930 - Model DTM = 237.7, Actual Grd Sfc = 228.1 mAHD
Reduced Water Level (m AHD)
Date
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
79930 - Observed
79930 - Computed

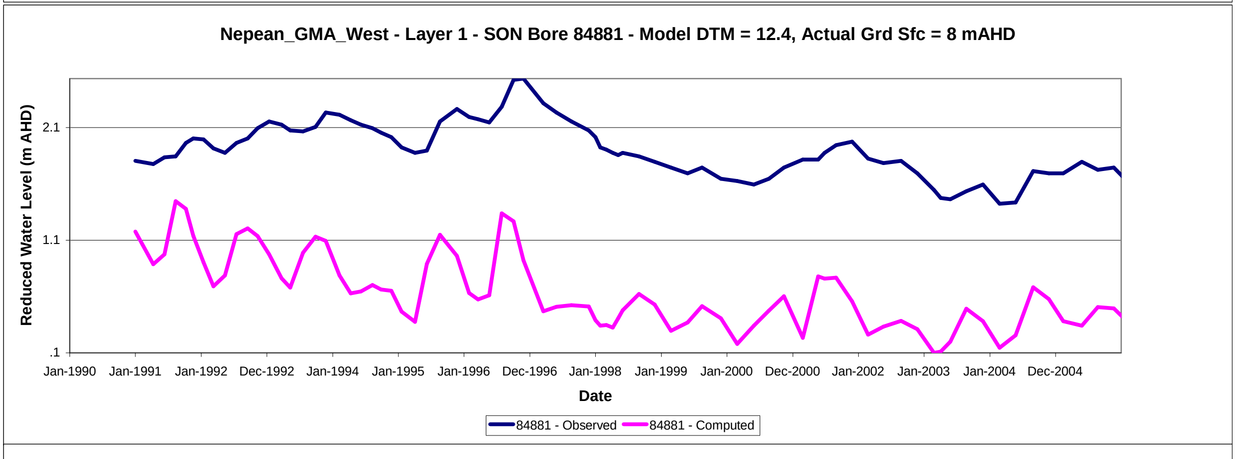

Wandin Yallock_WIA - Layer 5 - SON Bore 98394 - Model DTM = 272.7, Actual Grd Sfc = 278.5 mAHD
Reduced Water Level (m AHD)
273.8
221.8
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
98394 - Observed
98394 - Computed

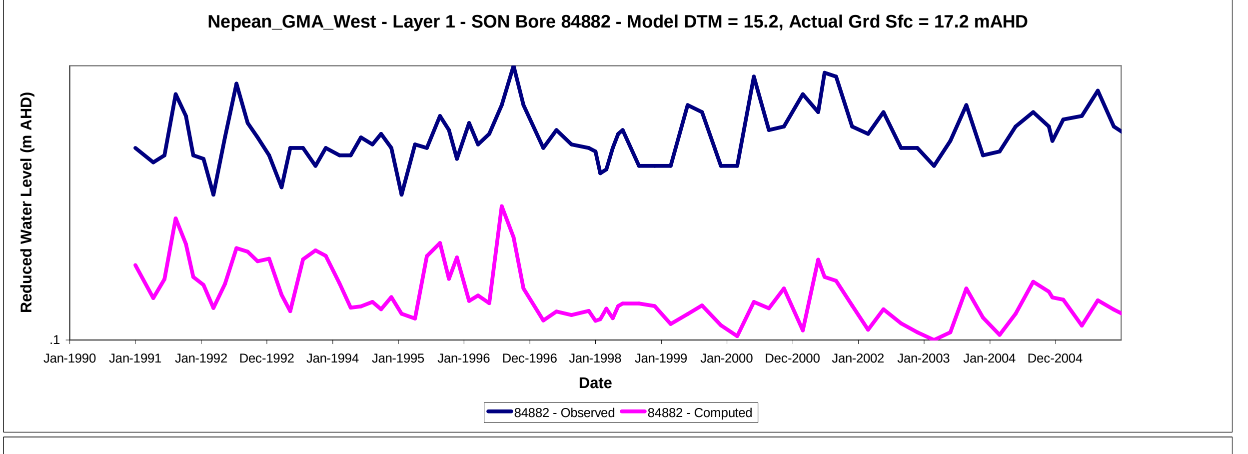

Wandin Yallock_WIA - Layer 5 - SON Bore 98408 - Model DTM = 262.7, Actual Grd Sfc = 280 mAHD
Reduced Water Level (m AHD)
245.6
244.6
243.6
242.6
241.6
240.6
239.6
238.6
237.6
236.6
235.6
234.6
233.6
232.6
231.6
230.6
229.6
228.6
227.6
226.6
225.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
98408 - Observed
98408 - Computed

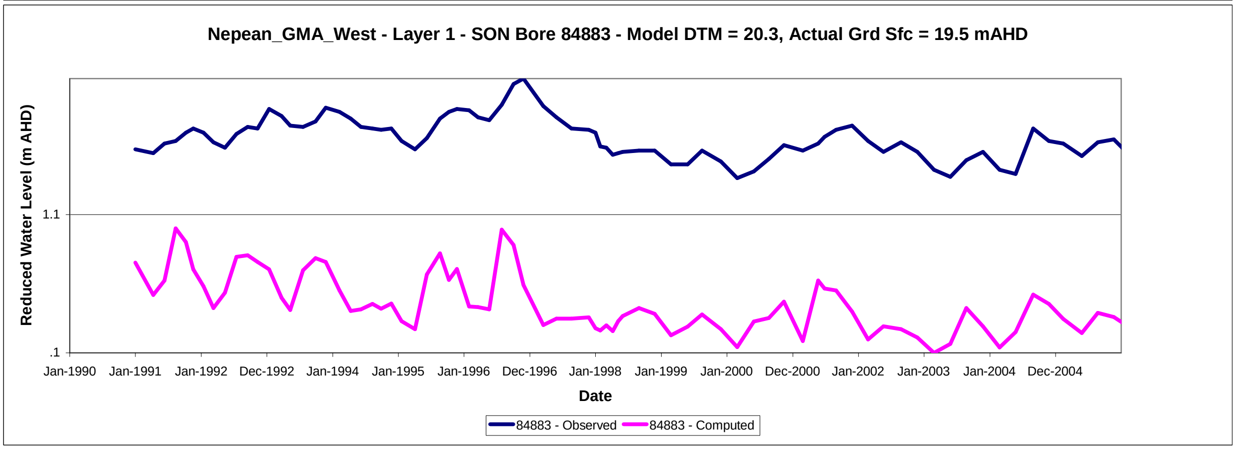

Wandin Yallock_WIA - Layer 5 - SON Bore 98414 - Model DTM = 199.9, Actual Grd Sfc = 192.8 mAHD
Reduced Water Level (m AHD)
187.4
186.4
185.4
184.4
183.4
182.4
181.4
180.4
179.4
178.4
177.4
176.4
175.4
174.4
173.4
172.4
171.4
170.4
169.4
168.4
167.4
166.4
165.4
164.4
163.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
98414 - Observed
98414 - Computed

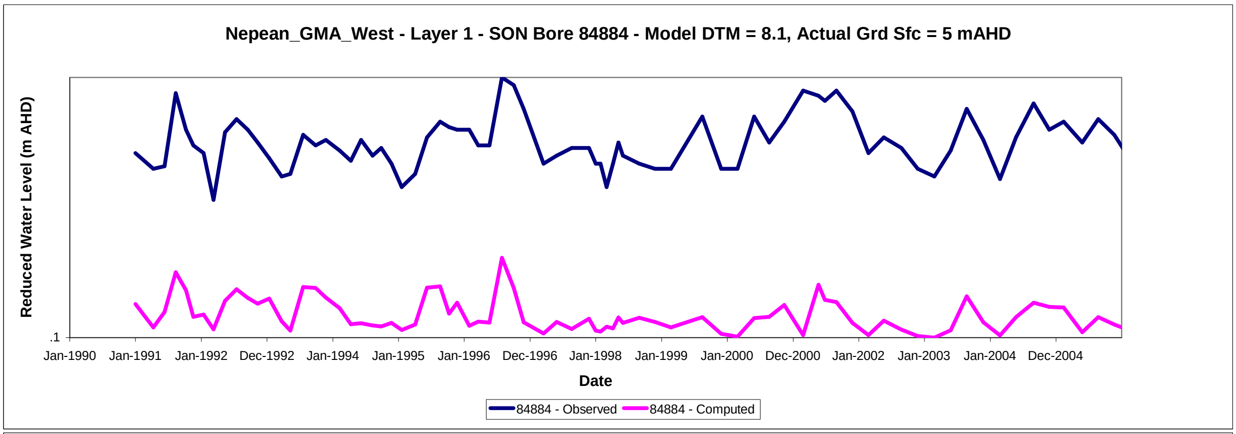

Nepean_GMA_West - Layer 5 - SON Bore 84887 - Model DTM = 13.5, Actual Grd Sfc = 8.7 mAHD
Reduced Water Level (m AHD)
6.1
5.1
4.1
3.1
2.1
1.1
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84887 - Observed
84887 - Computed

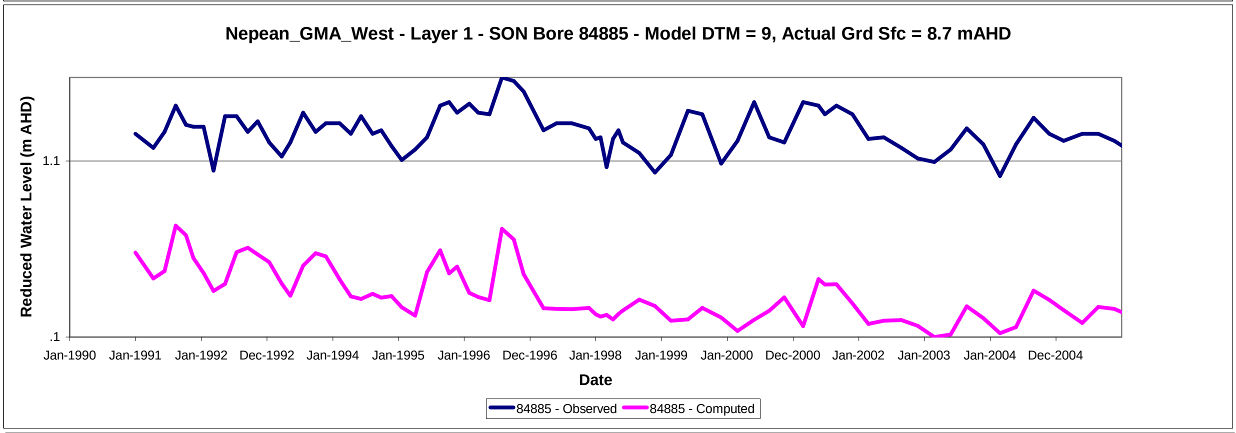

Nepean_GMA_West - Layer 1 - SON Bore 63276 - Model DTM = 14.4, Actual Grd Sfc = 14.2 mAHD
Reduced Water Level (m AHD)
1.2
.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
63276 - Observed
63276 - Computed

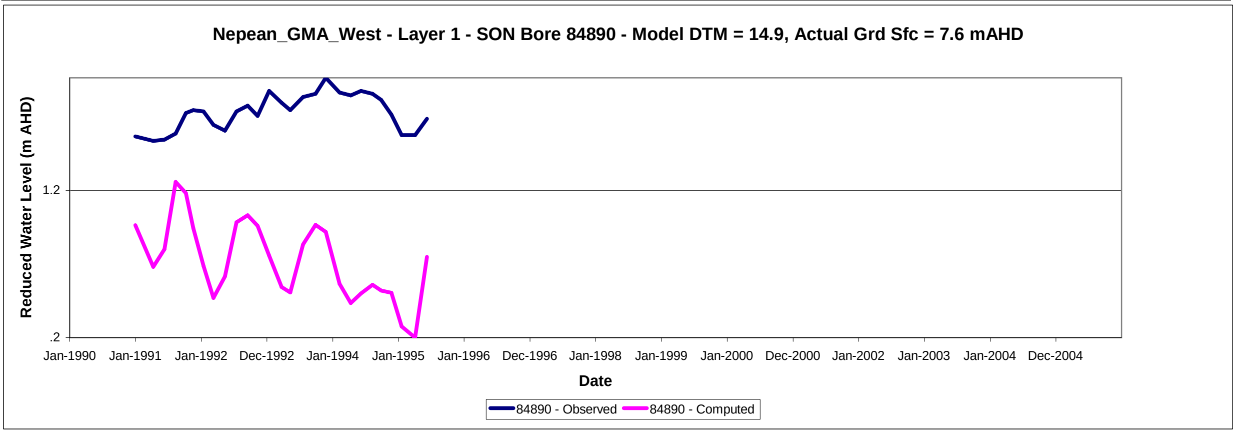

Nepean_GMA_West - Layer 1 - SON Bore 84881 - Model DTM = 12.4, Actual Grd Sfc = 8 mAHD
Reduced Water Level (m AHD)
2.1
1.1
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84881 - Observed
84881 - Computed

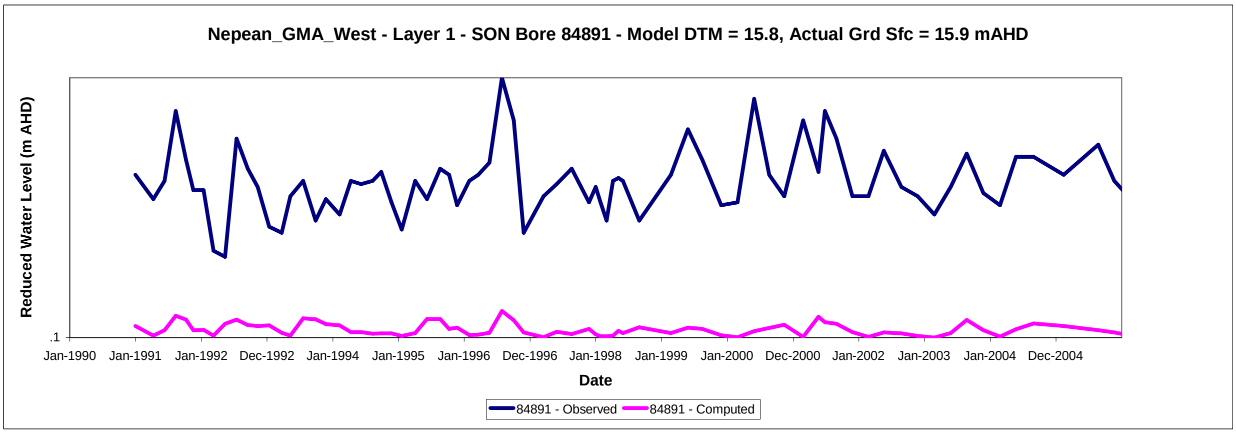

Nepean_GMA_West - Layer 1 - SON Bore 84882 - Model DTM = 15.2, Actual Grd Sfc = 17.2 mAHD
Reduced Water Level (m AHD)
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84882 - Observed
84882 - Computed

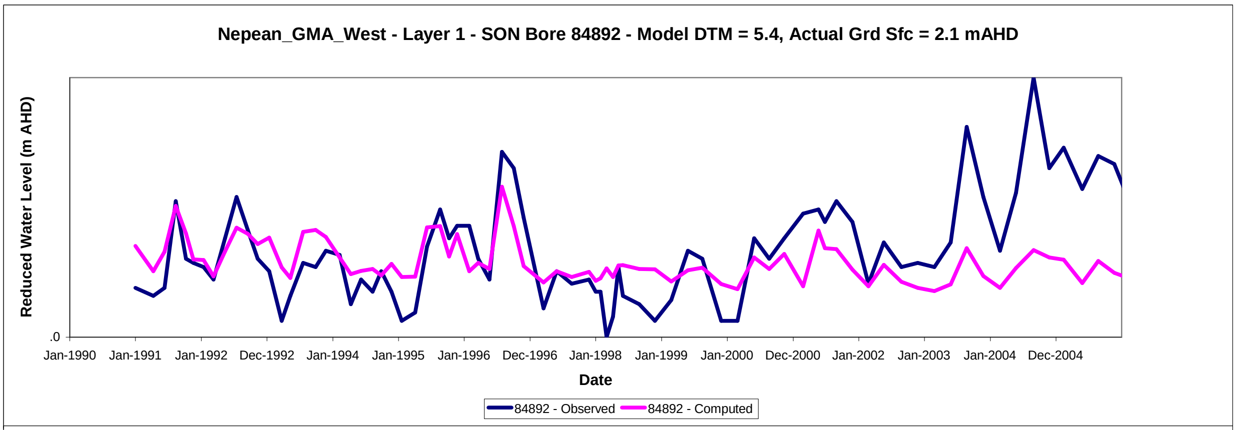

Nepean_GMA_West - Layer 1 - SON Bore 84883 - Model DTM = 20.3, Actual Grd Sfc = 19.5 mAHD
Reduced Water Level (m AHD)
1.1
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84883 - Observed
84883 - Computed

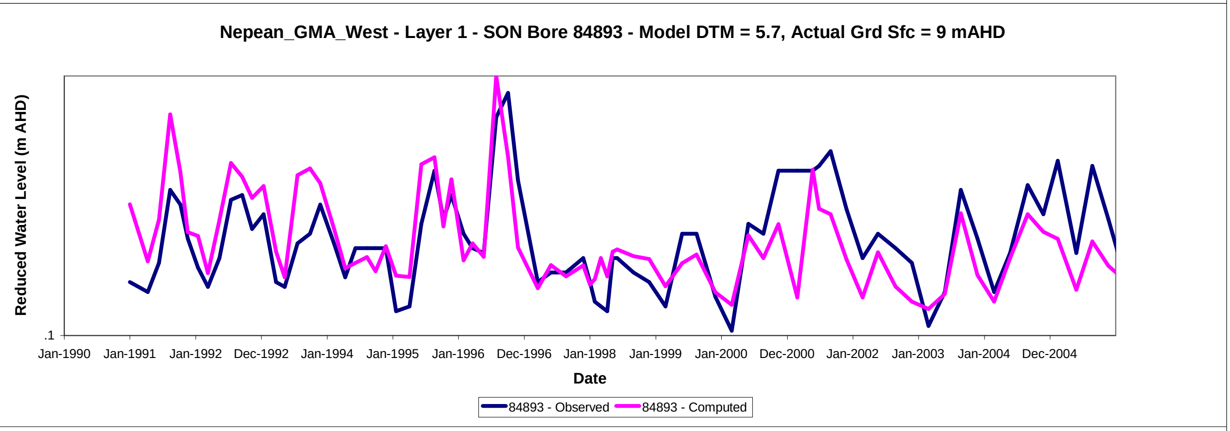

Nepean_GMA_West - Layer 1 - SON Bore 84884 - Model DTM = 8.1, Actual Grd Sfc = 5 mAHD
Reduced Water Level (m AHD)
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84884 - Observed
84884 - Computed

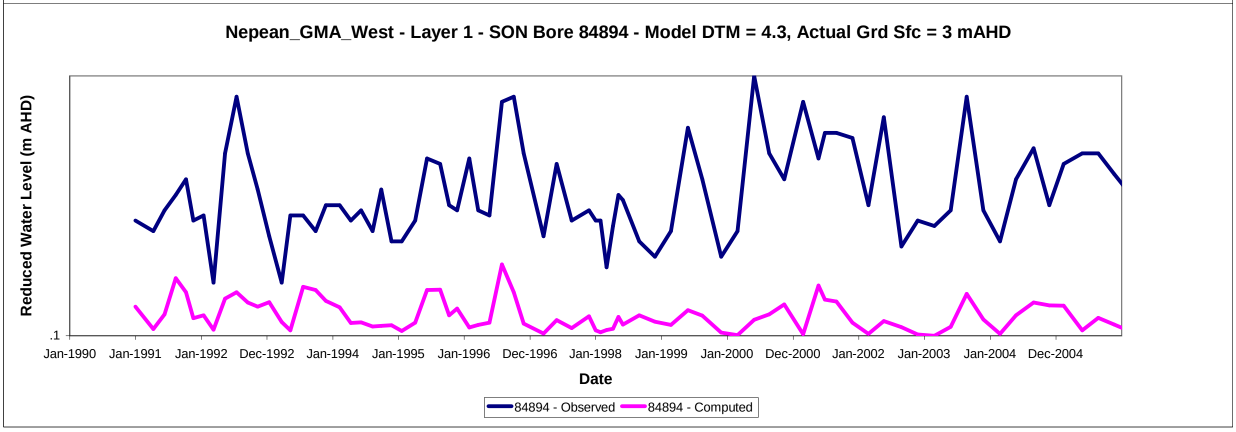

Nepean_GMA_West - Layer 1 - SON Bore 84885 - Model DTM = 9, Actual Grd Sfc = 8.7 mAHD
Reduced Water Level (m AHD)
1.1
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84885 - Observed
84885 - Computed

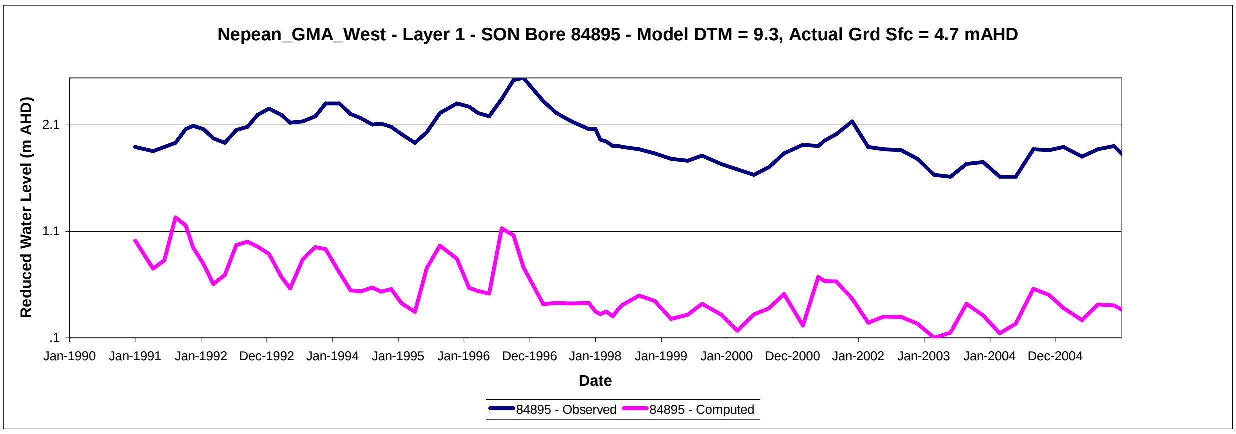

Nepean_GMA_West - Layer 1 - SON Bore 84890 - Model DTM = 14.9, Actual Grd Sfc = 7.6 mAHD
Reduced Water Level (m AHD)
1.2
.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84890 - Observed
84890 - Computed

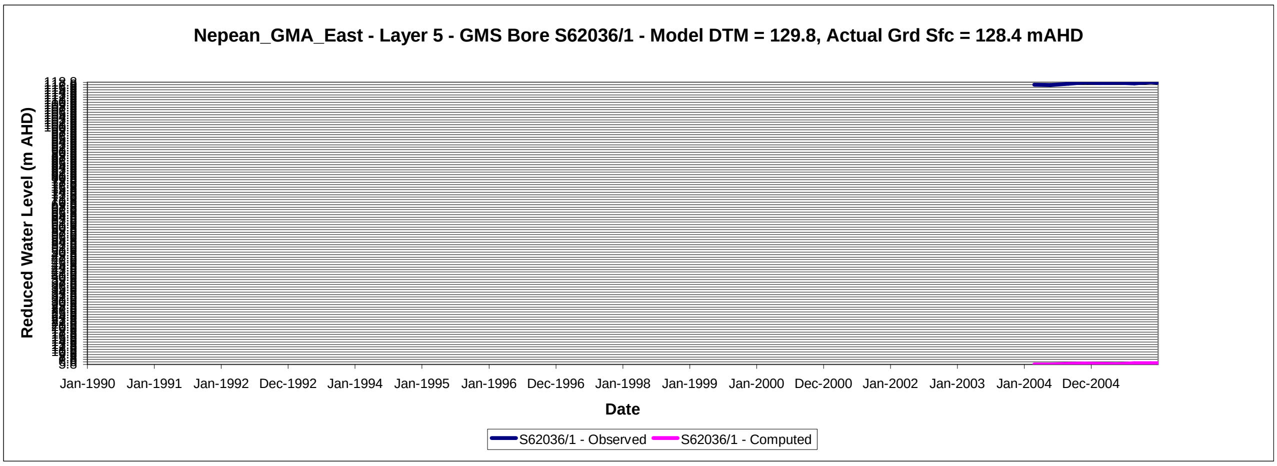

Nepean_GMA_West - Layer 1 - SON Bore 84891 - Model DTM = 15.8, Actual Grd Sfc = 15.9 mAHD
Reduced Water Level (m AHD)
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84891 - Observed
84891 - Computed


Nepean_GMA_West - Layer 1 - SON Bore 84892 - Model DTM = 5.4, Actual Grd Sfc = 2.1 mAHD
Reduced Water Level (m AHD)
.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84892 - Observed
84892 - Computed

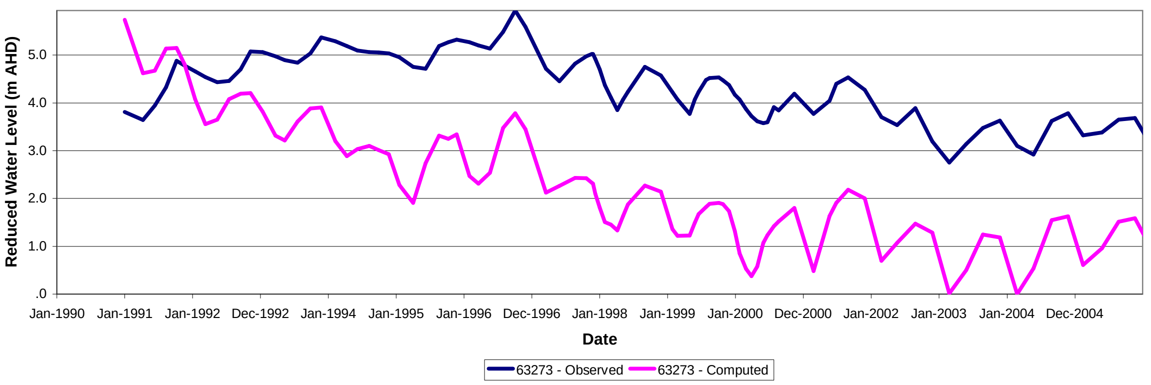

Nepean_GMA_West - Layer 1 - SON Bore 84893 - Model DTM = 5.7, Actual Grd Sfc = 9 mAHD
Reduced Water Level (m AHD)
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84893 - Observed
84893 - Computed


Nepean_GMA_West - Layer 1 - SON Bore 84894 - Model DTM = 4.3, Actual Grd Sfc = 3 mAHD
Reduced Water Level (m AHD)
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84894 - Observed
84894 - Computed

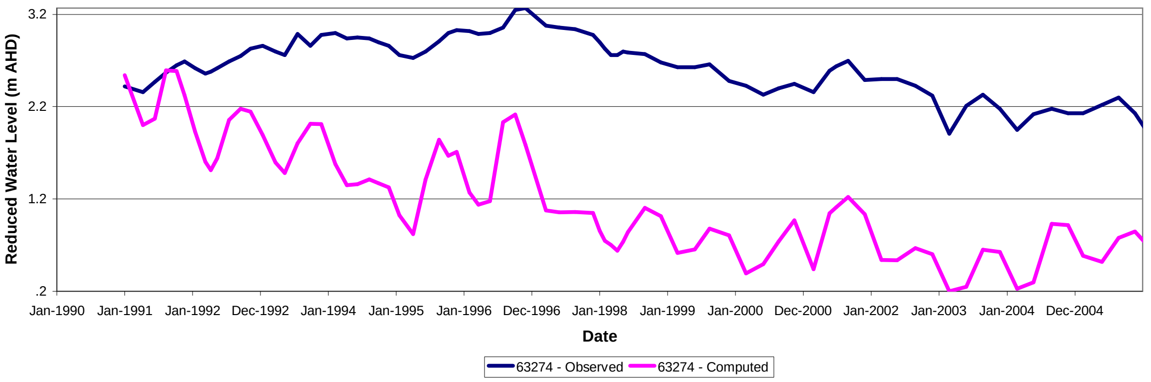

Nepean_GMA_West - Layer 1 - SON Bore 84895 - Model DTM = 9.3, Actual Grd Sfc = 4.7 mAHD
Reduced Water Level (m AHD)
2.1
1.1
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
84895 - Observed
84895 - Computed


Nepean_GMA_East - Layer 5 - GMS Bore S62036/1 - Model DTM = 129.8, Actual Grd Sfc = 128.4 mAHD
Reduced Water Level (m AHD)
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
S62036/1 - Observed
S62036/1 - Computed

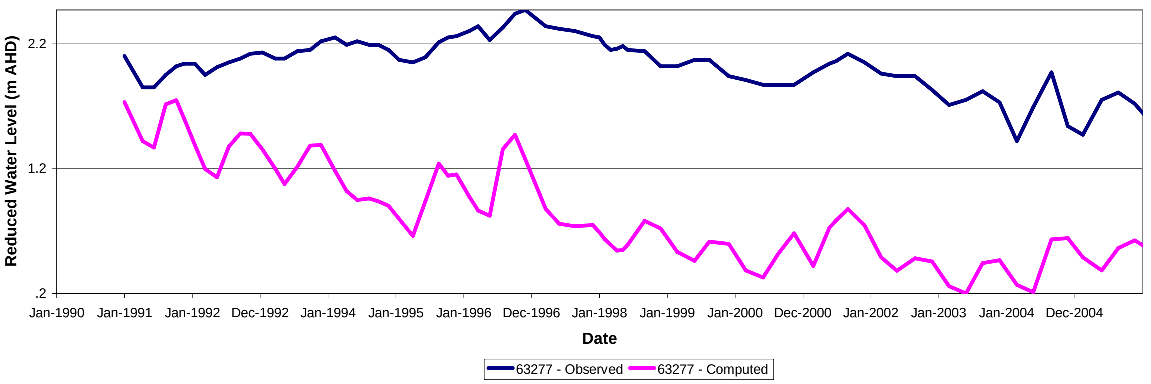
Nepean_GMA_East - Layer 1 - SON Bore 63273 - Model DTM = 9.4, Actual Grd Sfc = 9.9 mAHD



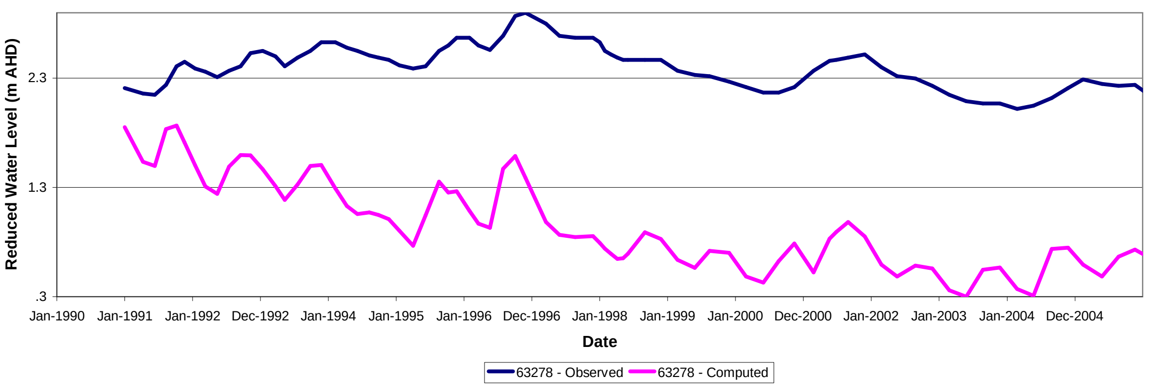
Nepean_GMA_East - Layer 1 - SON Bore 63274 - Model DTM = 10, Actual Grd Sfc = 9.4 mAHD

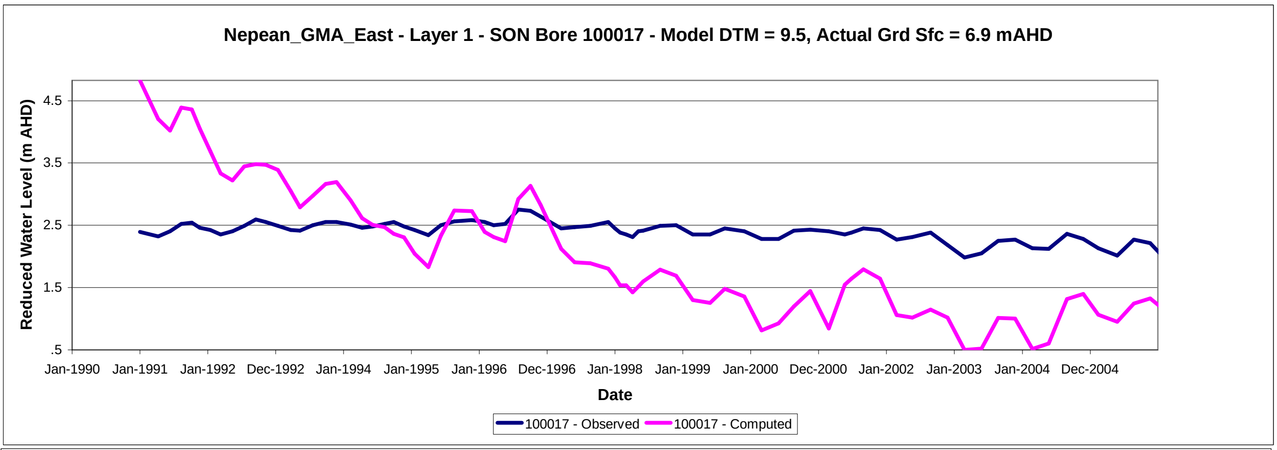


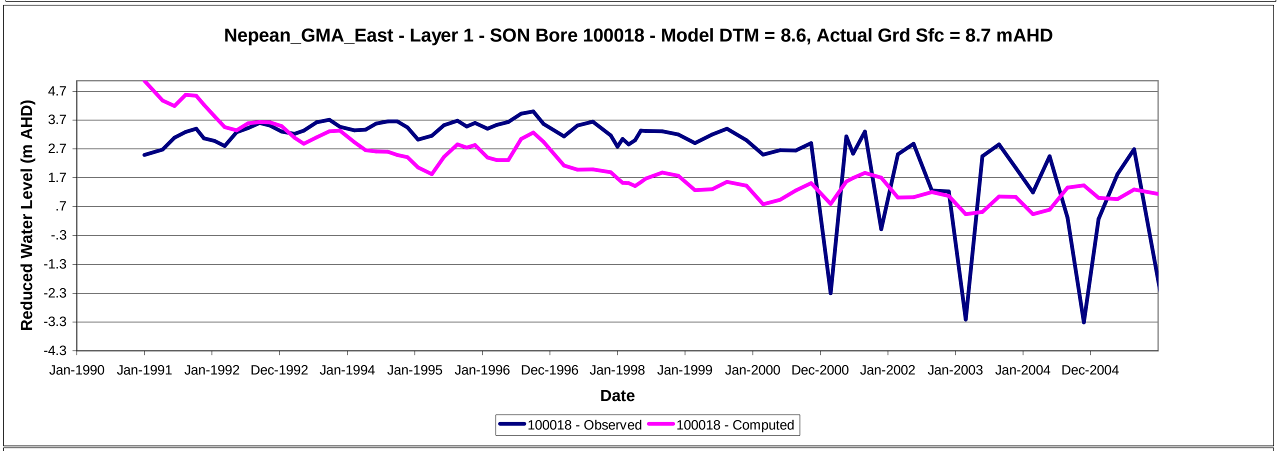
Nepean_GMA_East - Layer 1 - SON Bore 63277 - Model DTM = 10, Actual Grd Sfc = 6.7 mAHD

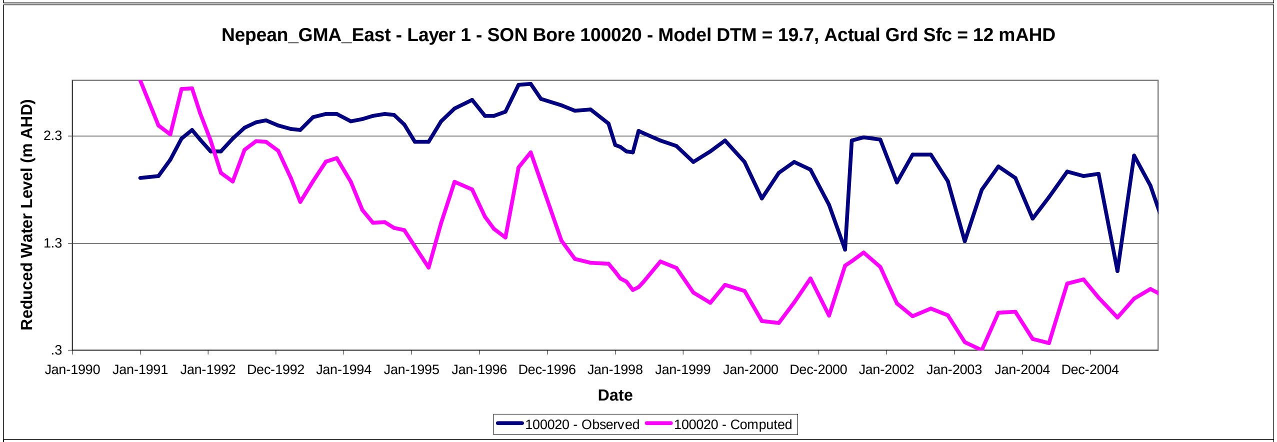


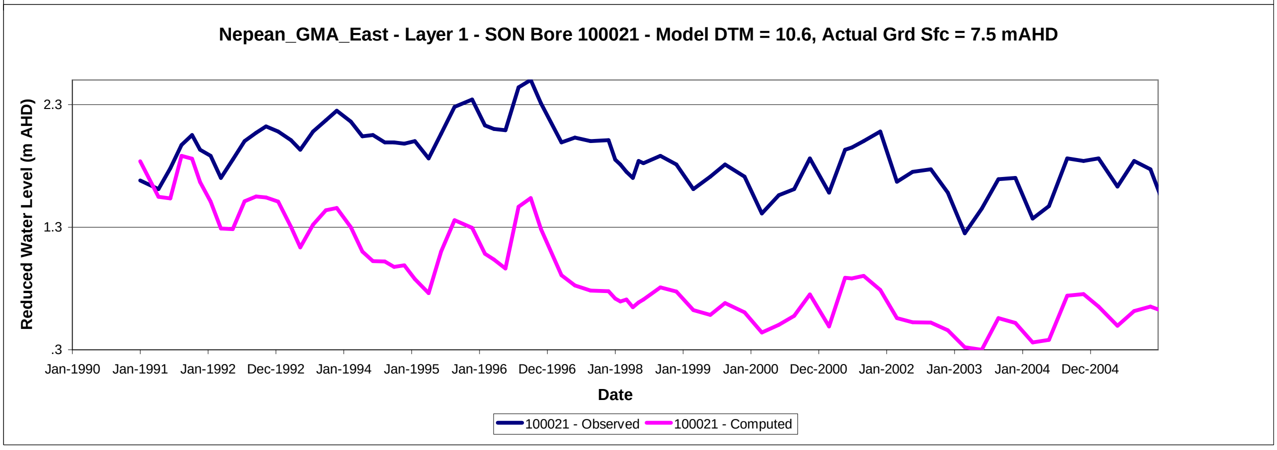
Nepean_GMA_East - Layer 1 - SON Bore 63278 - Model DTM = 10, Actual Grd Sfc = 6.9 mAHD

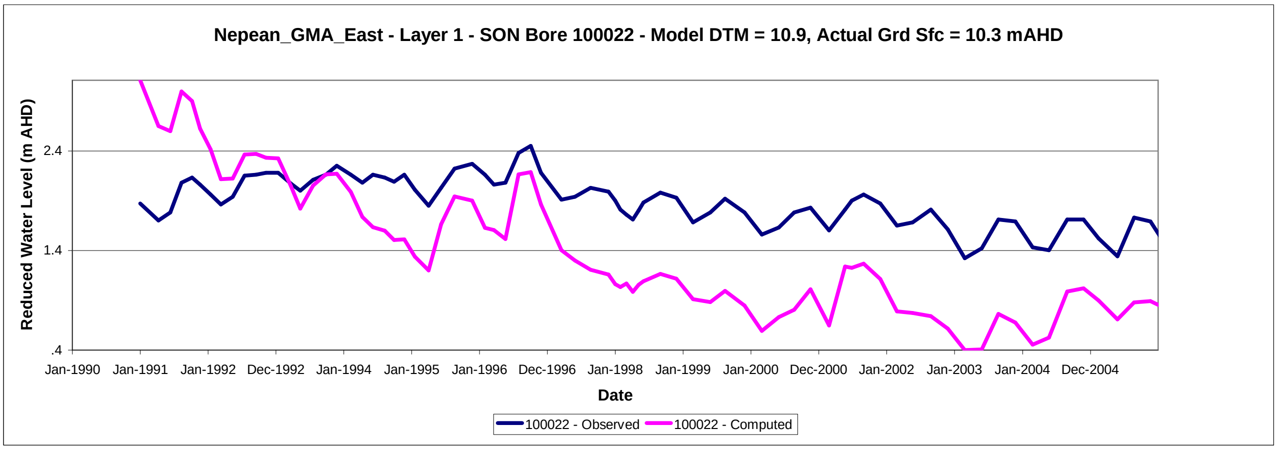


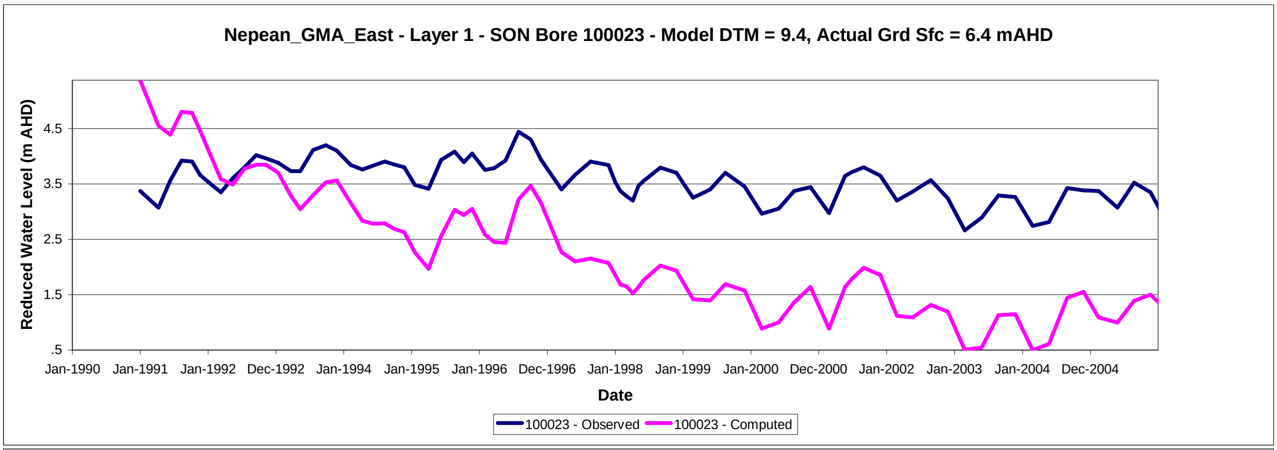

Nepean_GMA_East - Layer 1 - SON Bore 100017 - Model DTM = 9.5, Actual Grd Sfc = 6.9 mAHD
Reduced Water Level (m AHD)
4.5
3.5
2.5
1.5
.5
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
100017 - Observed
100017 - Computed

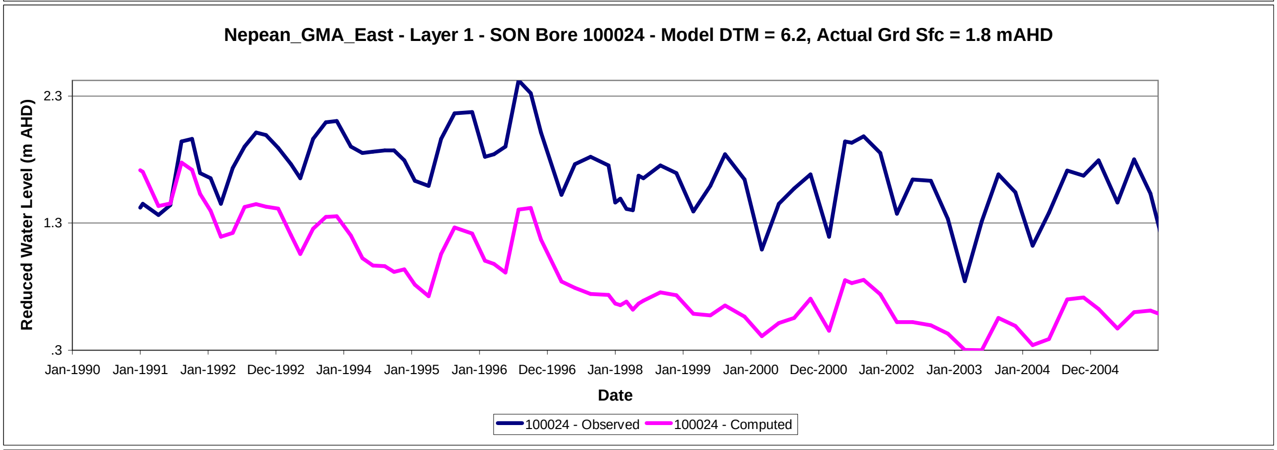

Nepean_GMA_East - Layer 1 - SON Bore 100018 - Model DTM = 8.6, Actual Grd Sfc = 8.7 mAHD
Reduced Water Level (m AHD)
4.7
3.7
2.7
1.7
.7
-.3
-1.3
-2.3
-3.3
-4.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
100018 - Observed
100018 - Computed

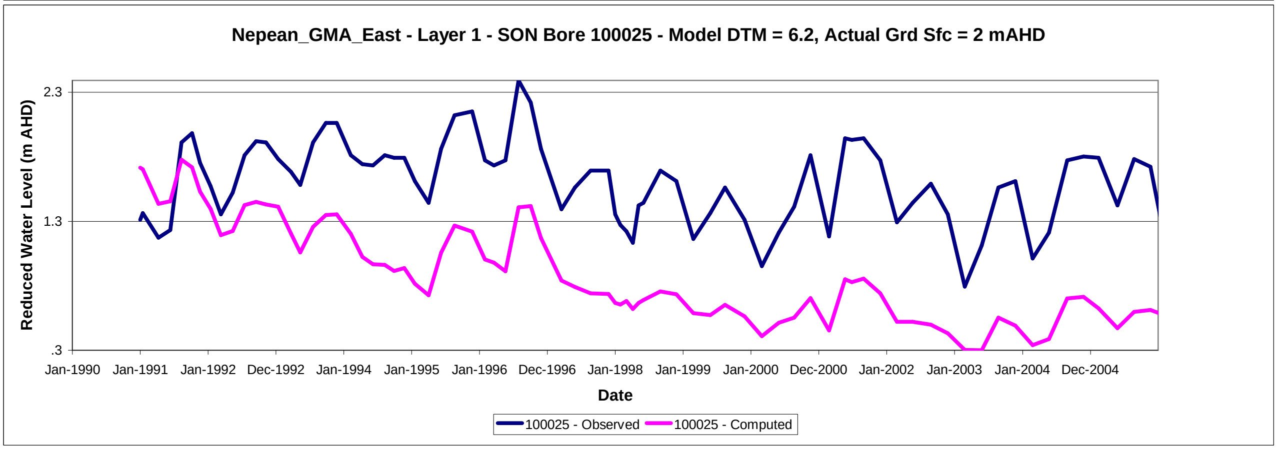

Nepean_GMA_East - Layer 1 - SON Bore 100020 - Model DTM = 19.7, Actual Grd Sfc = 12 mAHD
Reduced Water Level (m AHD)
2.3
1.3
.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
100020 - Observed
100020 - Computed

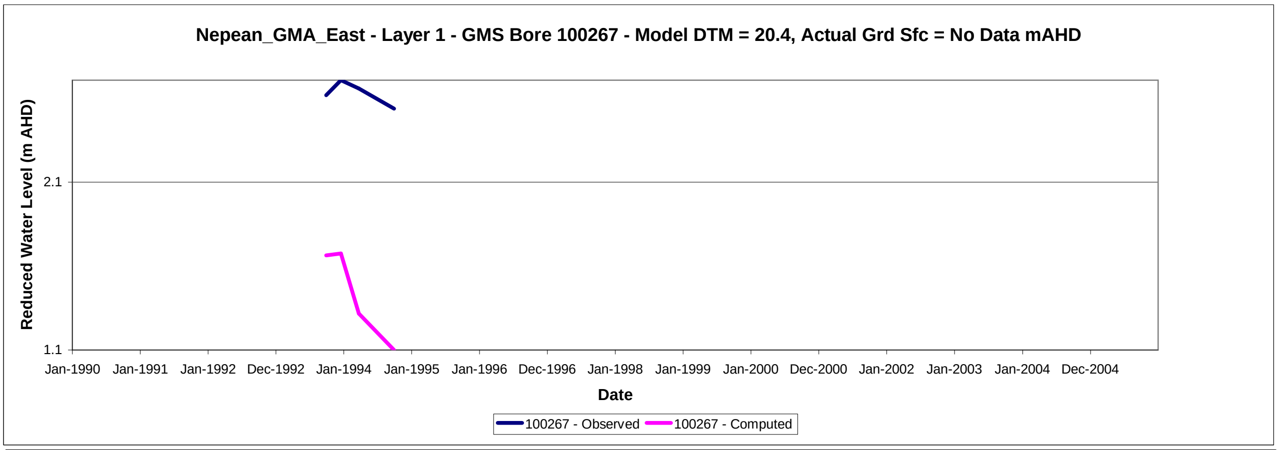

Nepean_GMA_East - Layer 1 - SON Bore 100021 - Model DTM = 10.6, Actual Grd Sfc = 7.5 mAHD
Reduced Water Level (m AHD)
2.3
1.3
.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
100021 - Observed
100021 - Computed

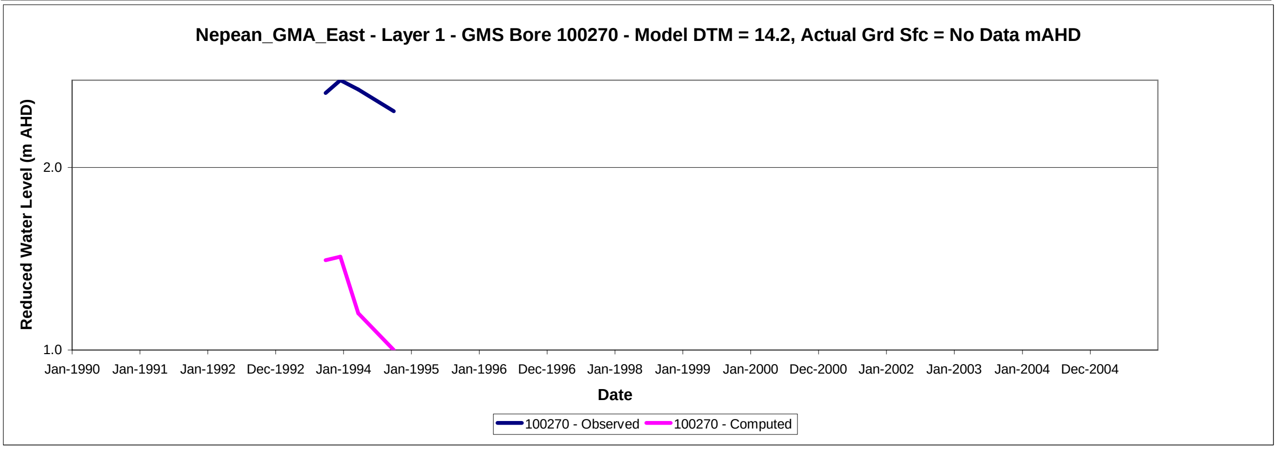

Nepean_GMA_East - Layer 1 - SON Bore 100022 - Model DTM = 10.9, Actual Grd Sfc = 10.3 mAHD
Reduced Water Level (m AHD)
2.4
1.4
.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
100022 - Observed
100022 - Computed

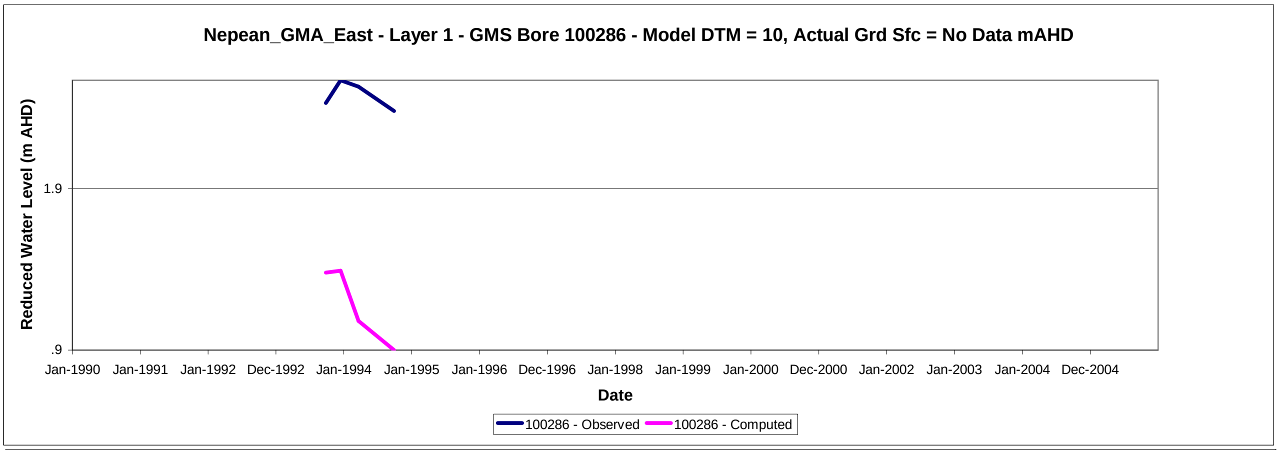

Nepean_GMA_East - Layer 1 - SON Bore 100023 - Model DTM = 9.4, Actual Grd Sfc = 6.4 mAHD
Reduced Water Level (m AHD)
4.5
3.5
2.5
1.5
.5
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
100023 - Observed
100023 - Computed

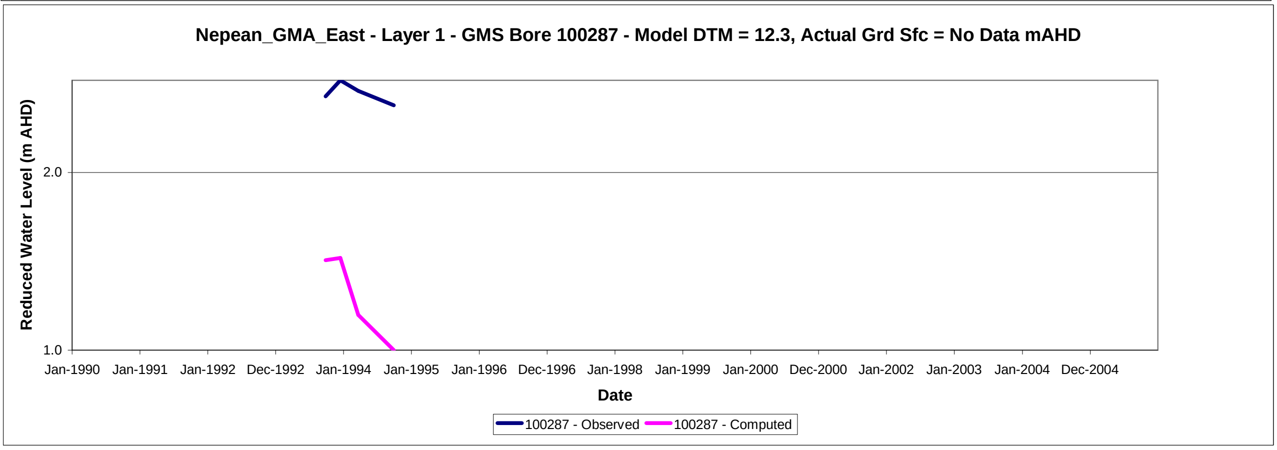

Nepean_GMA_East - Layer 1 - SON Bore 100024 - Model DTM = 6.2, Actual Grd Sfc = 1.8 mAHD
Reduced Water Level (m AHD)
2.3
1.3
.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
100024 - Observed
100024 - Computed

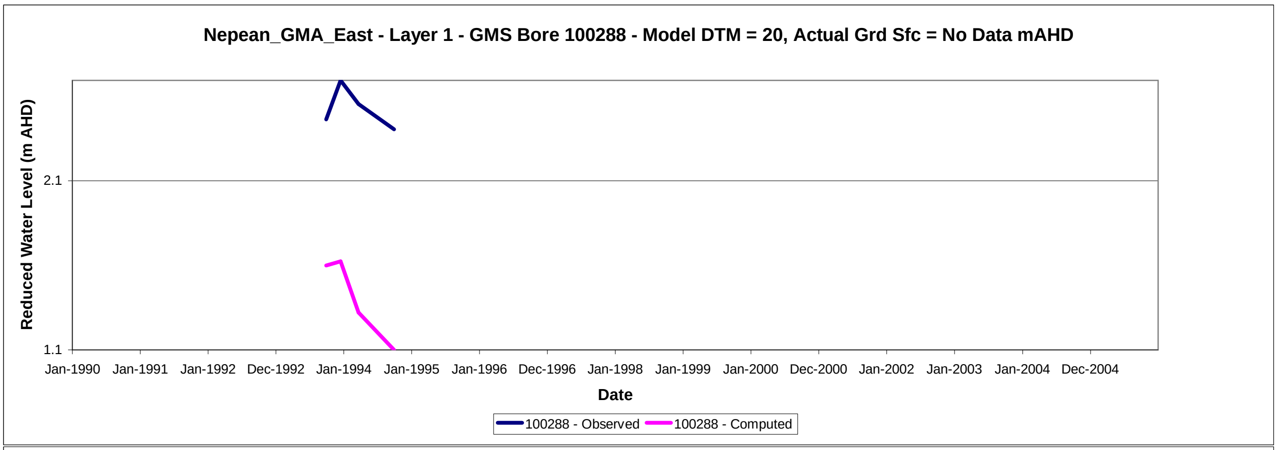

Nepean_GMA_East - Layer 1 - SON Bore 100025 - Model DTM = 6.2, Actual Grd Sfc = 2 mAHD
Reduced Water Level (m AHD)
2.3
1.3
.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
100025 - Observed
100025 - Computed

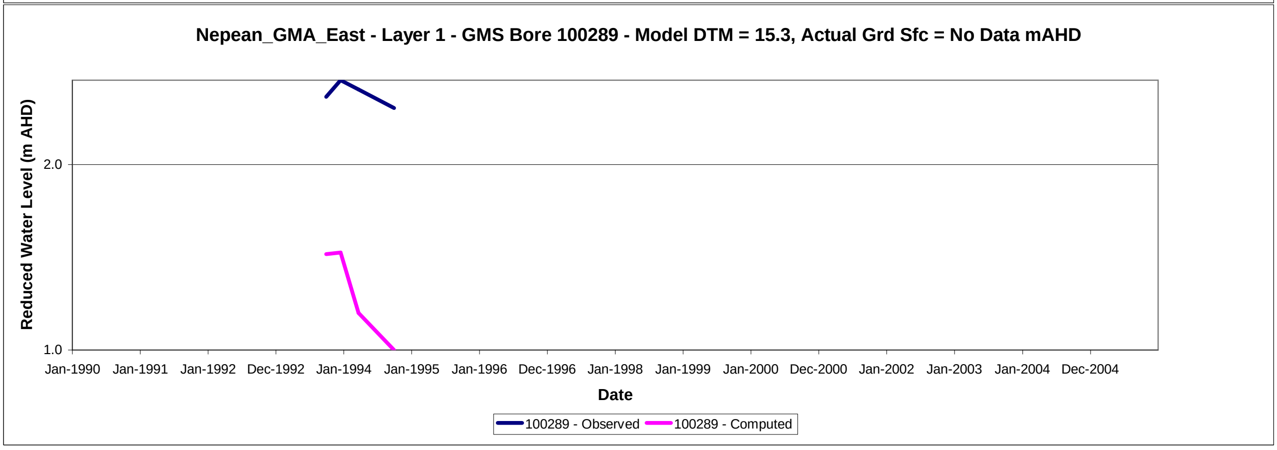

Nepean_GMA_East - Layer 1 - GMS Bore 100267 - Model DTM = 20.4, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
2.1
1.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
100267 - Observed
100267 - Computed

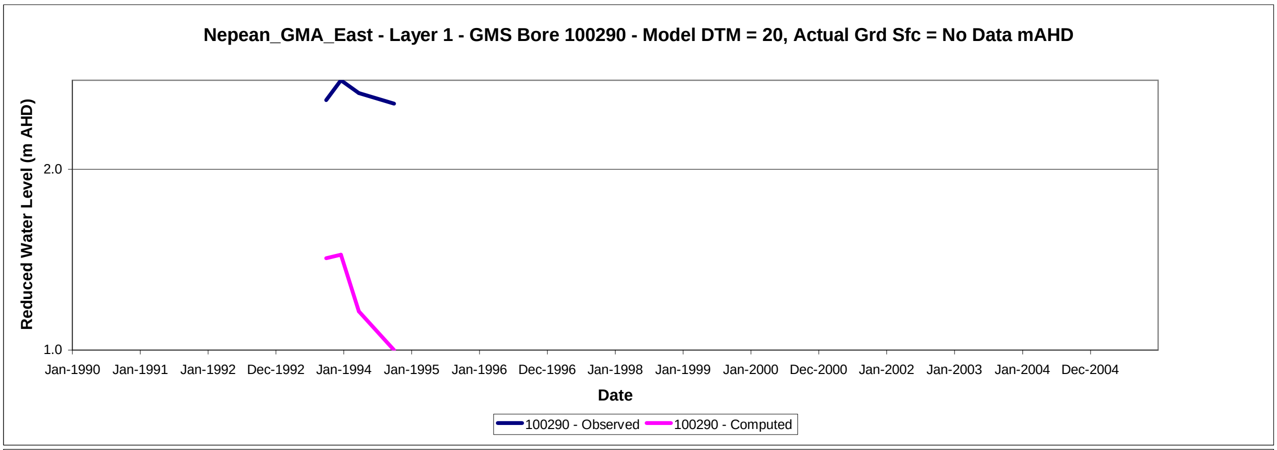

Nepean_GMA_East - Layer 1 - GMS Bore 100270 - Model DTM = 14.2, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
2.0
1.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
100270 - Observed
100270 - Computed

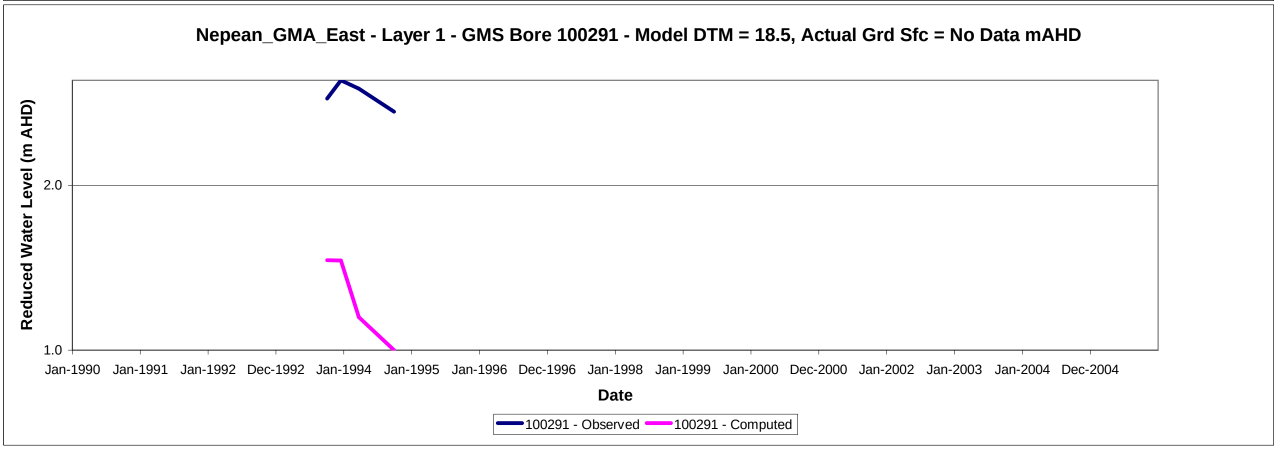

Nepean_GMA_East - Layer 1 - GMS Bore 100286 - Model DTM = 10, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
1.9
.9
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
100286 - Observed
100286 - Computed

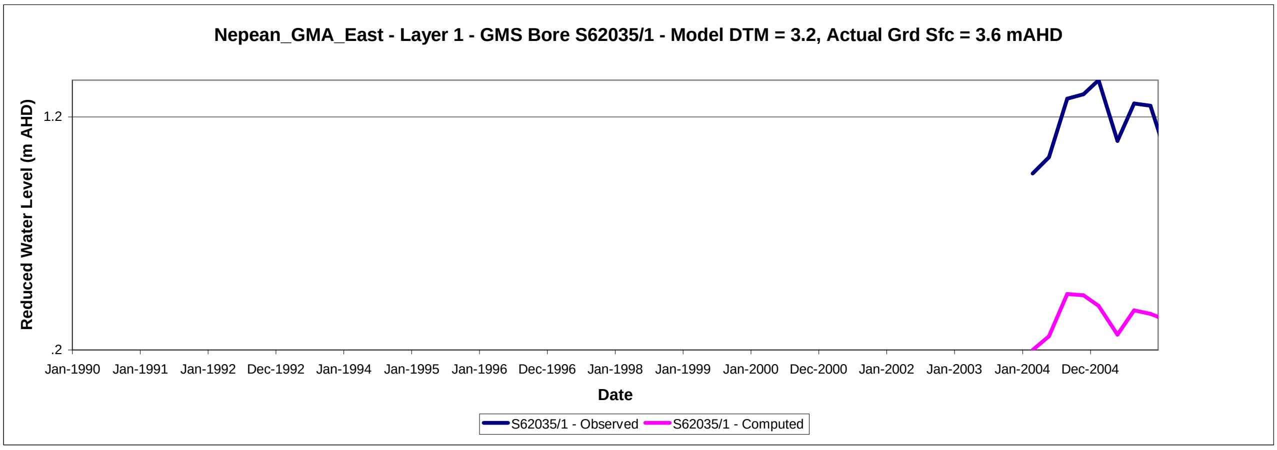

Nepean_GMA_East - Layer 1 - GMS Bore 100287 - Model DTM = 12.3, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
2.0
1.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
100287 - Observed
100287 - Computed


Nepean_GMA_East - Layer 1 - GMS Bore 100288 - Model DTM = 20, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
2.1
1.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
100288 - Observed
100288 - Computed

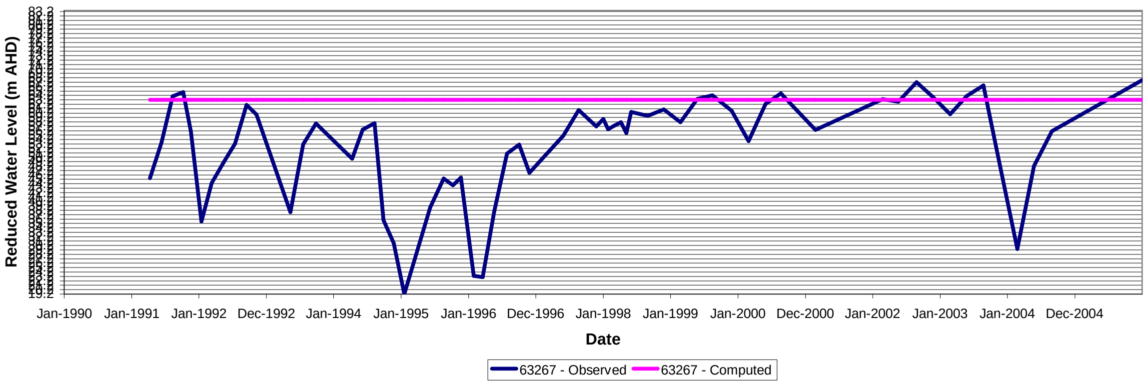

Nepean_GMA_East - Layer 1 - GMS Bore 100289 - Model DTM = 15.3, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
2.0
1.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
100289 - Observed
100289 - Computed


Nepean_GMA_East - Layer 1 - GMS Bore 100290 - Model DTM = 20, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
2.0
1.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
100290 - Observed
100290 - Computed

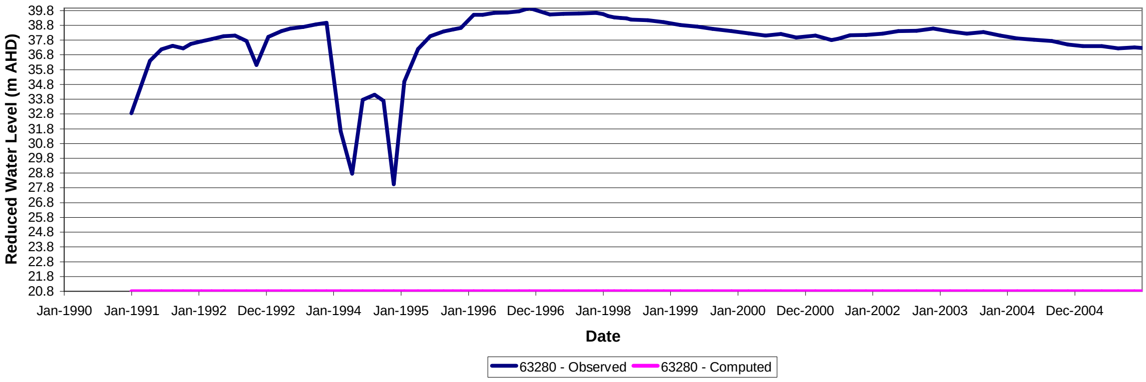

Nepean_GMA_East - Layer 1 - GMS Bore 100291 - Model DTM = 18.5, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
2.0
1.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
100291 - Observed
100291 - Computed


Nepean_GMA_East - Layer 1 - GMS Bore S62035/1 - Model DTM = 3.2, Actual Grd Sfc = 3.6 mAHD
Reduced Water Level (m AHD)
1.2
.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
S62035/1 - Observed
S62035/1 - Computed

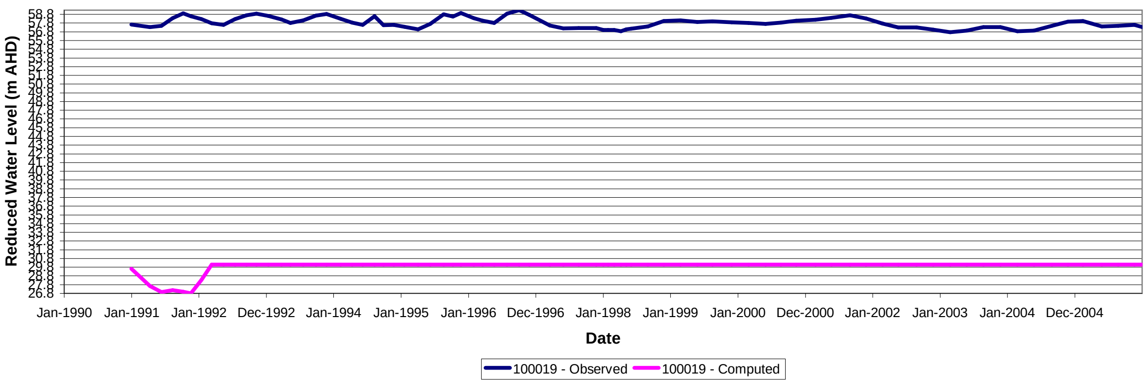
Nepean GMA Area - Layer 1 - SON Bore 63267 - Model DTM = 86.5, Actual Grd Sfc = 83.4 mAHD



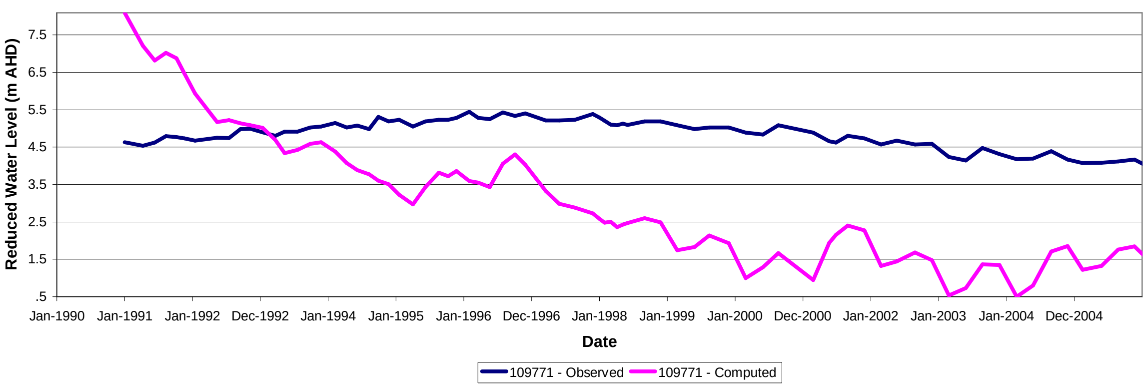
Nepean GMA Area - Layer 1 - SON Bore 63280 - Model DTM = 60.3, Actual Grd Sfc = 56.2 mAHD

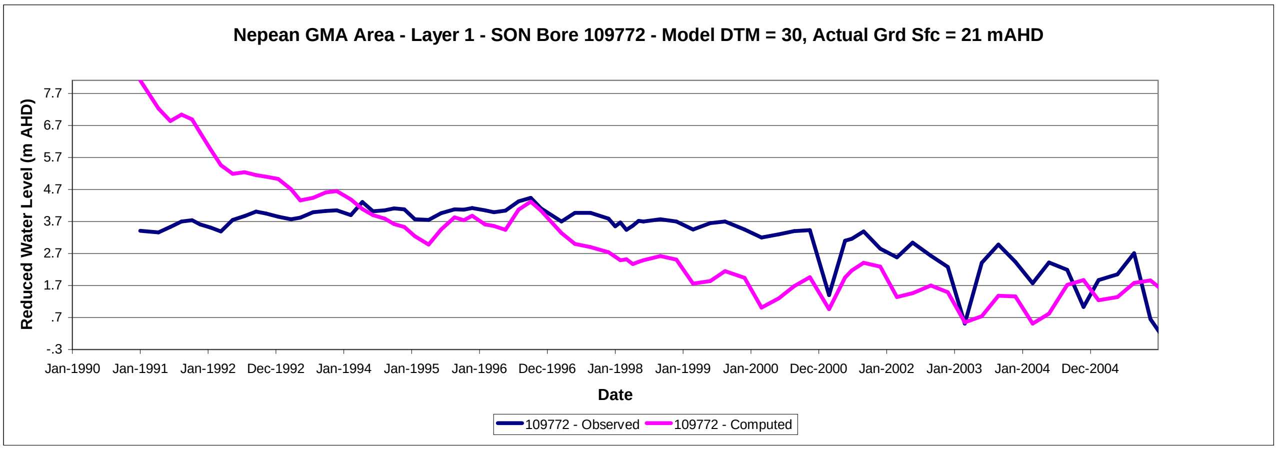


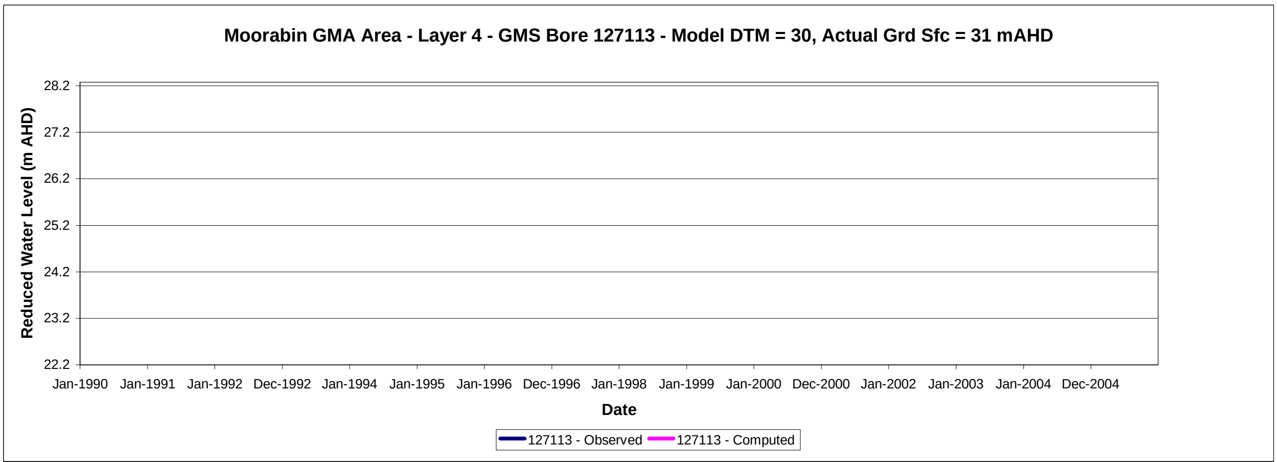
Nepean GMA Area - Layer 1 - SON Bore 100019 - Model DTM = 70, Actual Grd Sfc = 60.5 mAHD

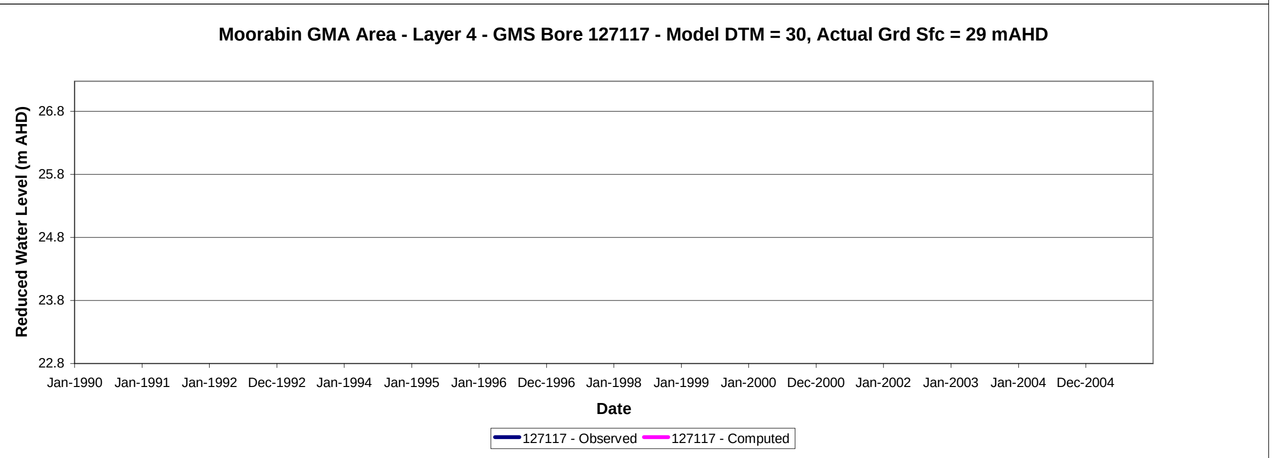


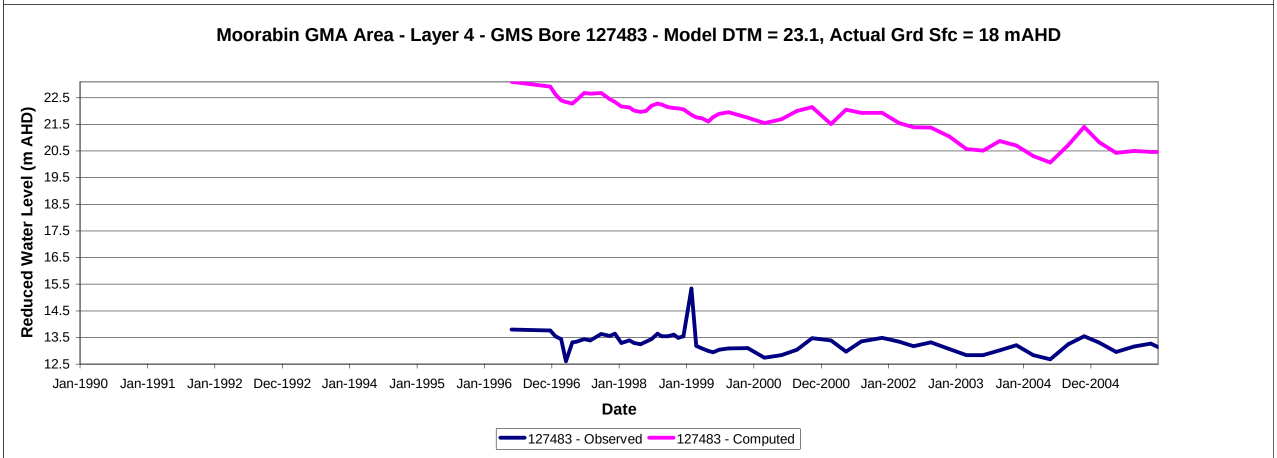
Nepean GMA Area - Layer 1 - SON Bore 109771 - Model DTM = 30, Actual Grd Sfc = 21 mAHD

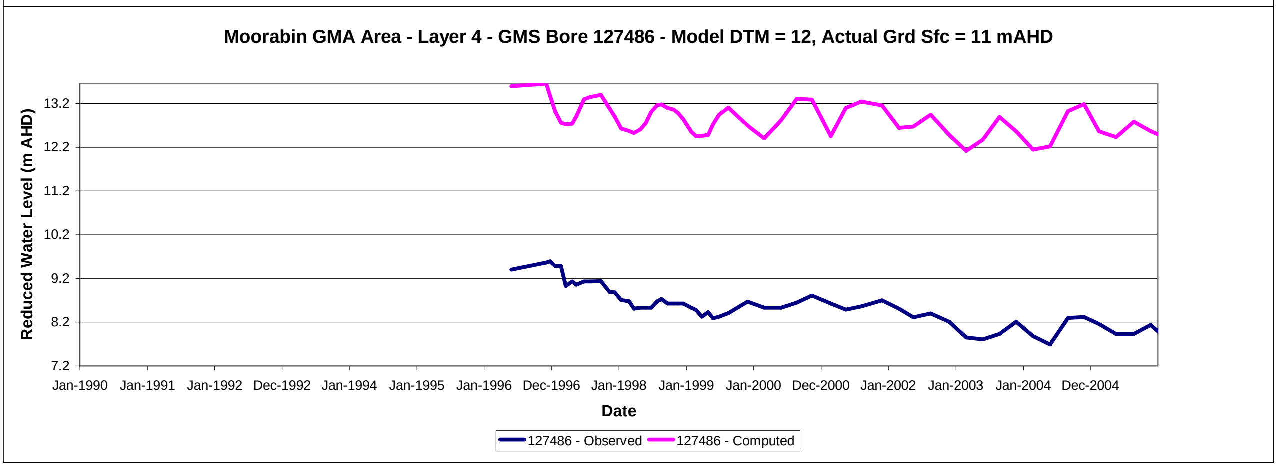


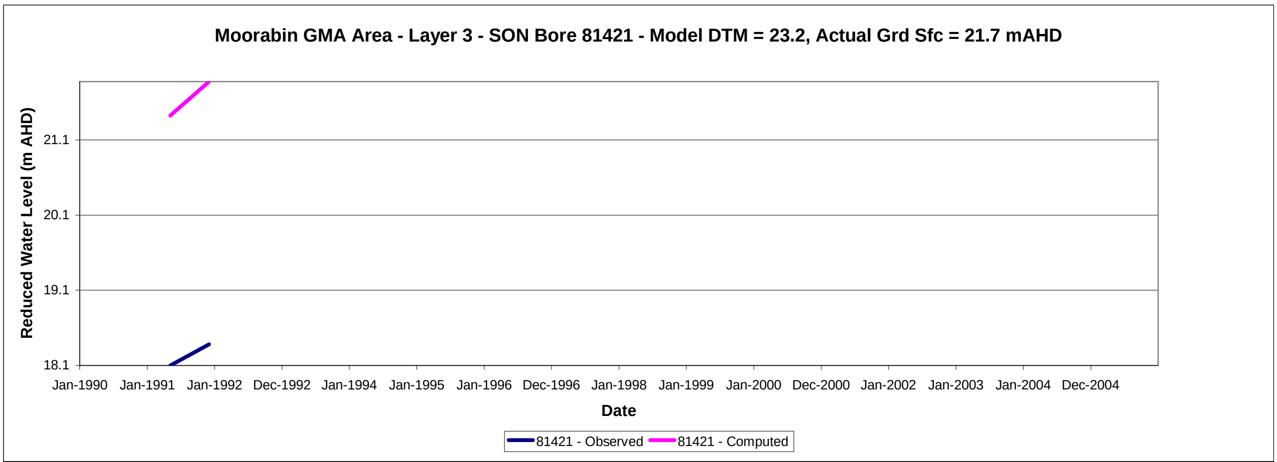

Nepean GMA Area - Layer 1 - SON Bore 109772 - Model DTM = 30, Actual Grd Sfc = 21 mAHD
Reduced Water Level (m AHD)
7.7
6.7
5.7
4.7
3.7
2.7
1.7
.7
-.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109772 - Observed
109772 - Computed

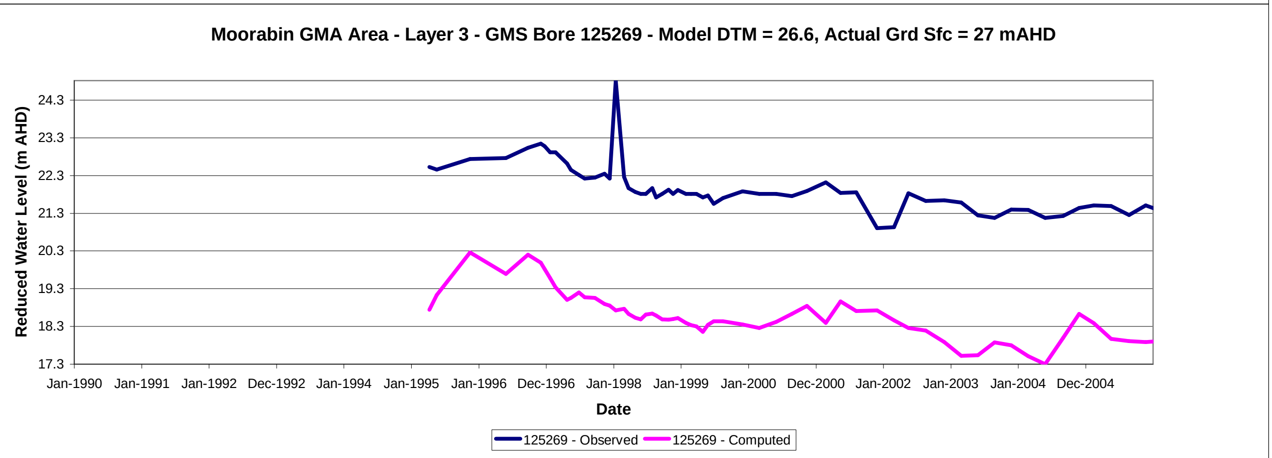

Moorabin GMA Area - Layer 4 - GMS Bore 127113 - Model DTM = 30, Actual Grd Sfc = 31 mAHD
Reduced Water Level (m AHD)
28.2
27.2
26.2
25.2
24.2
23.2
22.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
127113 - Observed
127113 - Computed

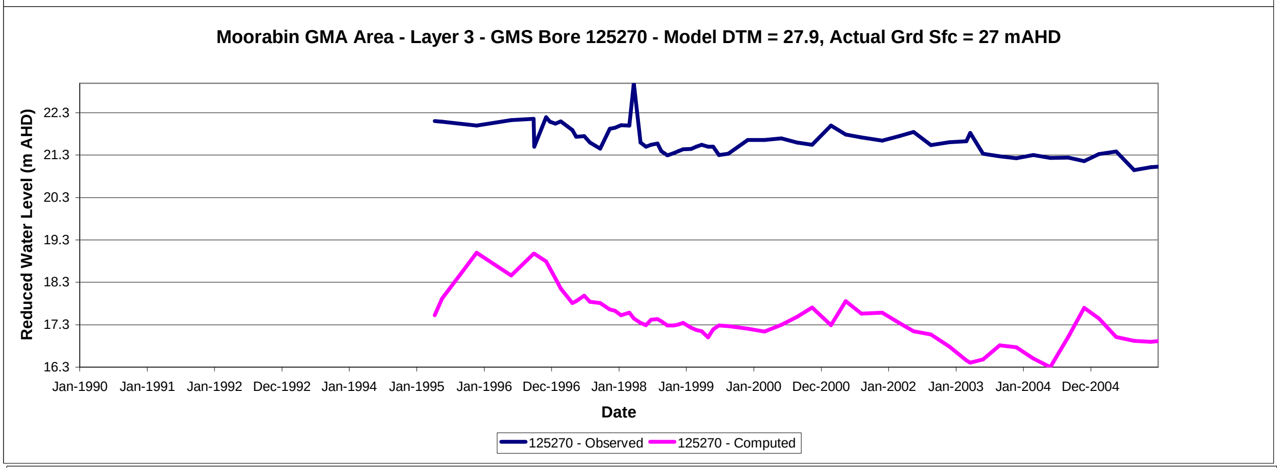

Moorabin GMA Area - Layer 4 - GMS Bore 127117 - Model DTM = 30, Actual Grd Sfc = 29 mAHD
Reduced Water Level (m AHD)
26.8
25.8
24.8
23.8
22.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
127117 - Observed
127117 - Computed

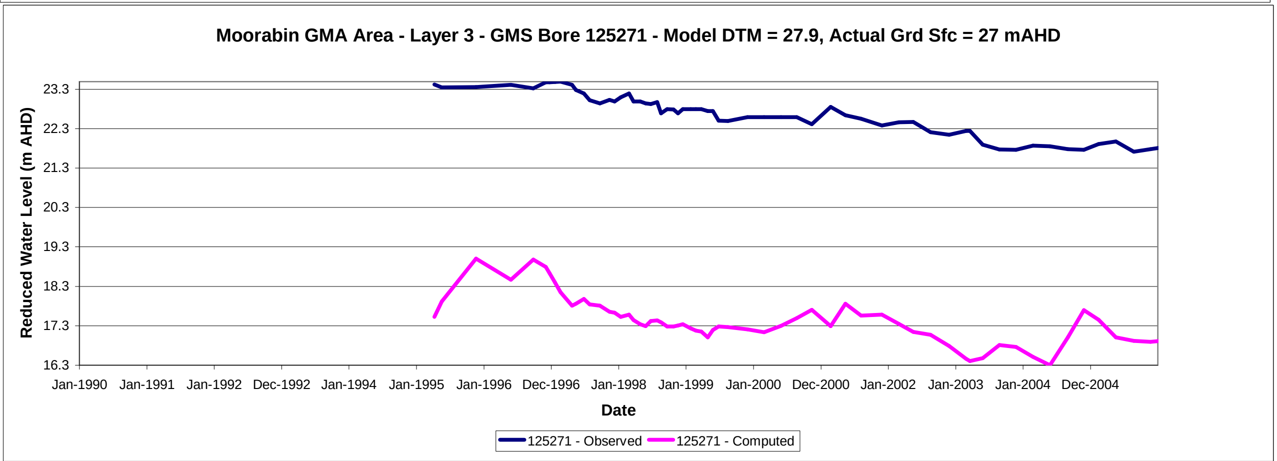

Moorabin GMA Area - Layer 4 - GMS Bore 127483 - Model DTM = 23.1, Actual Grd Sfc = 18 mAHD
Reduced Water Level (m AHD)
22.5
21.5
20.5
19.5
18.5
17.5
16.5
15.5
14.5
13.5
12.5
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
127483 - Observed
127483 - Computed

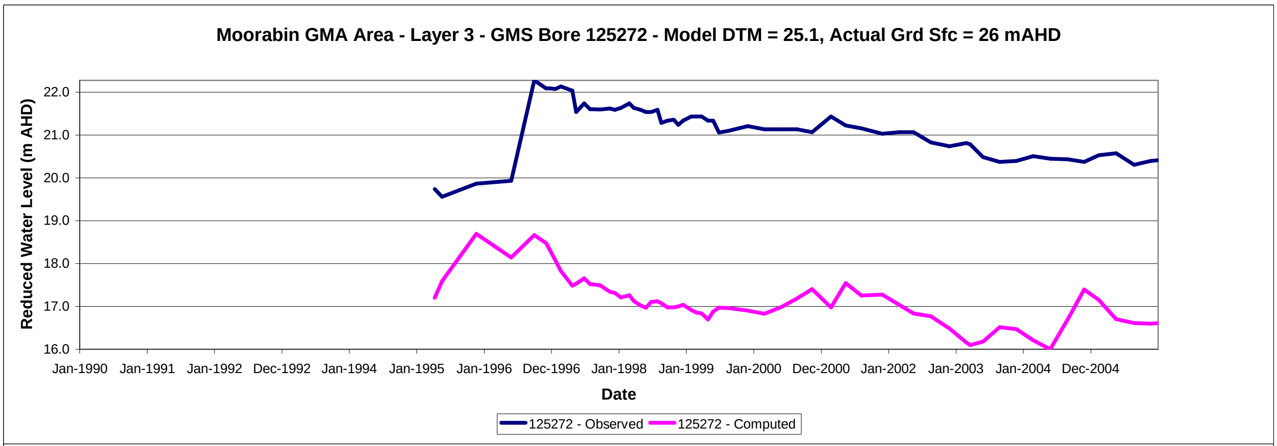

Moorabin GMA Area - Layer 4 - GMS Bore 127486 - Model DTM = 12, Actual Grd Sfc = 11 mAHD
Reduced Water Level (m AHD)
13.2
12.2
11.2
10.2
9.2
8.2
7.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
127486 - Observed
127486 - Computed

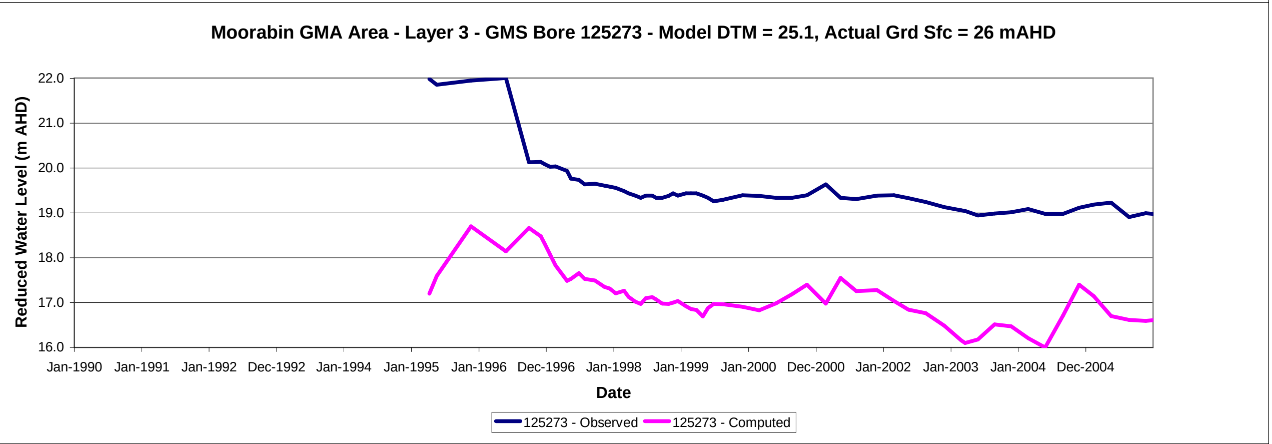

Moorabin GMA Area - Layer 3 - SON Bore 81421 - Model DTM = 23.2, Actual Grd Sfc = 21.7 mAHD
Reduced Water Level (m AHD)
21.1
20.1
19.1
18.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
81421 - Observed
81421 - Computed

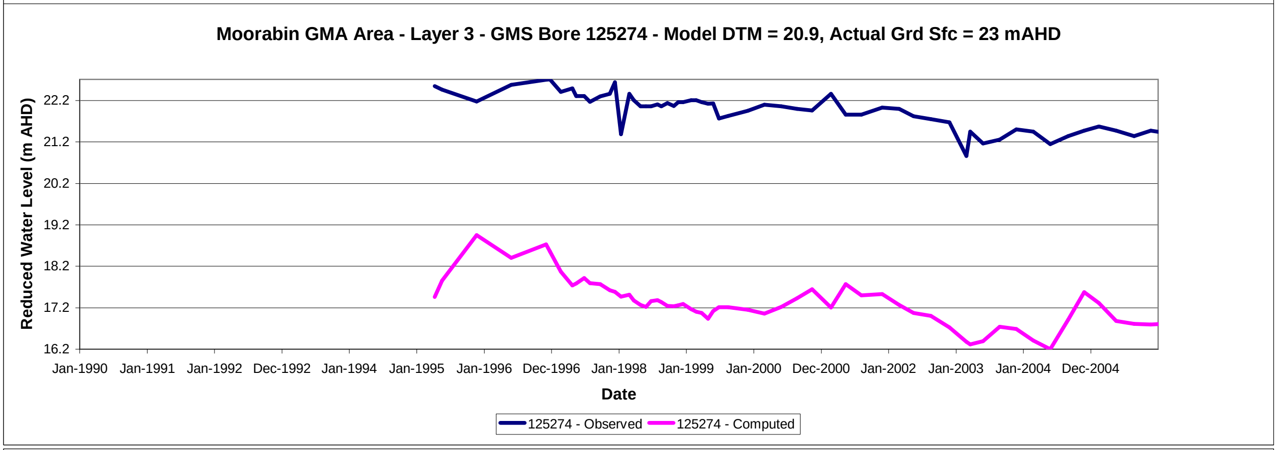

Moorabin GMA Area - Layer 3 - GMS Bore 125269 - Model DTM = 26.6, Actual Grd Sfc = 27 mAHD
Reduced Water Level (m AHD)
24.3
23.3
22.3
21.3
20.3
19.3
18.3
17.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
125269 - Observed
125269 - Computed

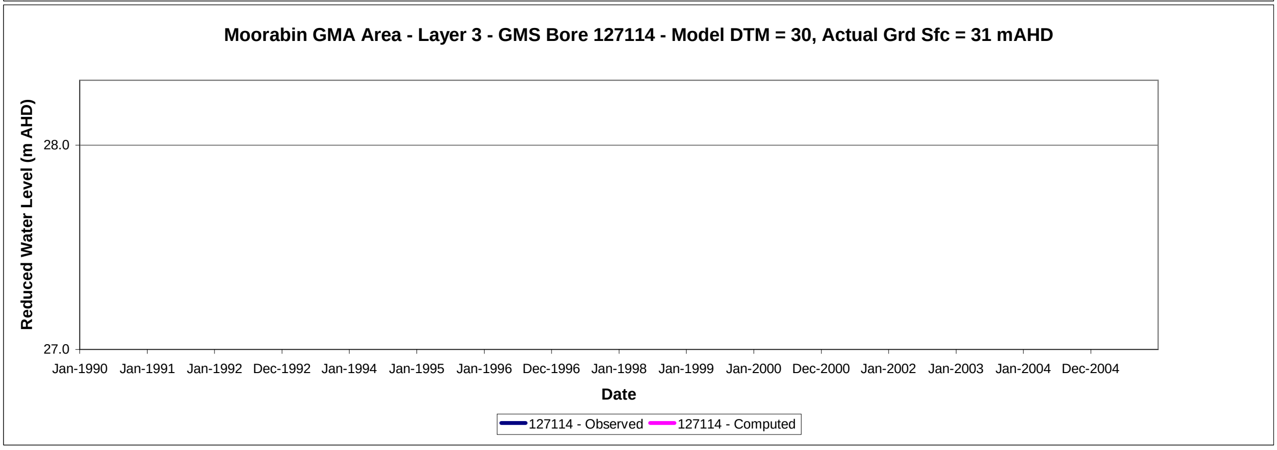

Moorabin GMA Area - Layer 3 - GMS Bore 125270 - Model DTM = 27.9, Actual Grd Sfc = 27 mAHD
Reduced Water Level (m AHD)
22.3
21.3
20.3
19.3
18.3
17.3
16.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
125270 - Observed
125270 - Computed


Moorabin GMA Area - Layer 3 - GMS Bore 125271 - Model DTM = 27.9, Actual Grd Sfc = 27 mAHD
Reduced Water Level (m AHD)
23.3
22.3
21.3
20.3
19.3
18.3
17.3
16.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
125271 - Observed
125271 - Computed


Moorabin GMA Area - Layer 3 - GMS Bore 125272 - Model DTM = 25.1, Actual Grd Sfc = 26 mAHD
Reduced Water Level (m AHD)
22.0
21.0
20.0
19.0
18.0
17.0
16.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
125272 - Observed
125272 - Computed


Moorabin GMA Area - Layer 3 - GMS Bore 125273 - Model DTM = 25.1, Actual Grd Sfc = 26 mAHD
Reduced Water Level (m AHD)
22.0
21.0
20.0
19.0
18.0
17.0
16.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
125273 - Observed
125273 - Computed


Moorabin GMA Area - Layer 3 - GMS Bore 125274 - Model DTM = 20.9, Actual Grd Sfc = 23 mAHD
Reduced Water Level (m AHD)
22.2
21.2
20.2
19.2
18.2
17.2
16.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
125274 - Observed
125274 - Computed


Moorabin GMA Area - Layer 3 - GMS Bore 127114 - Model DTM = 30, Actual Grd Sfc = 31 mAHD
Reduced Water Level (m AHD)
28.0
27.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
127114 - Observed
127114 - Computed

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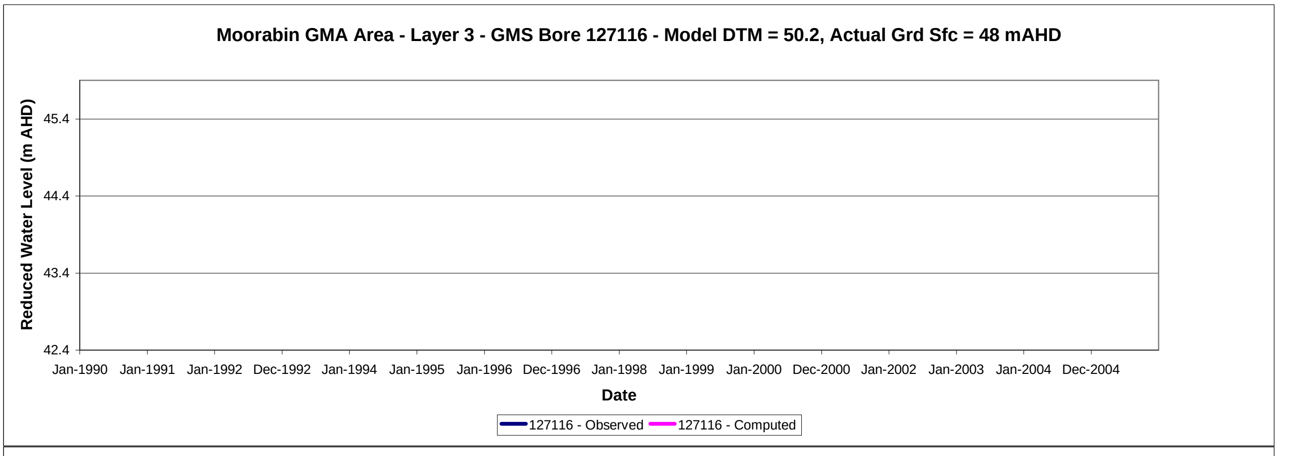
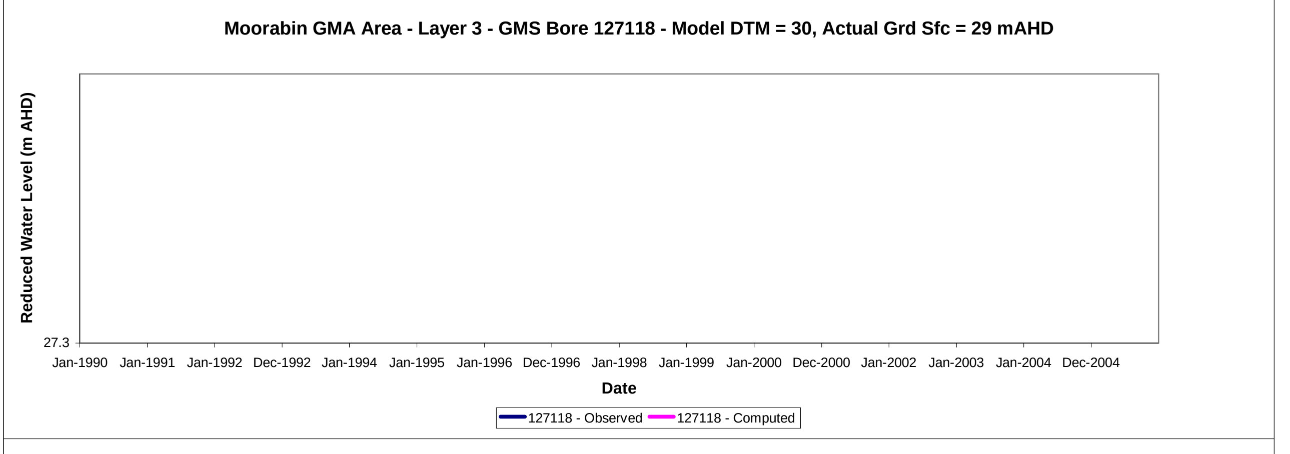
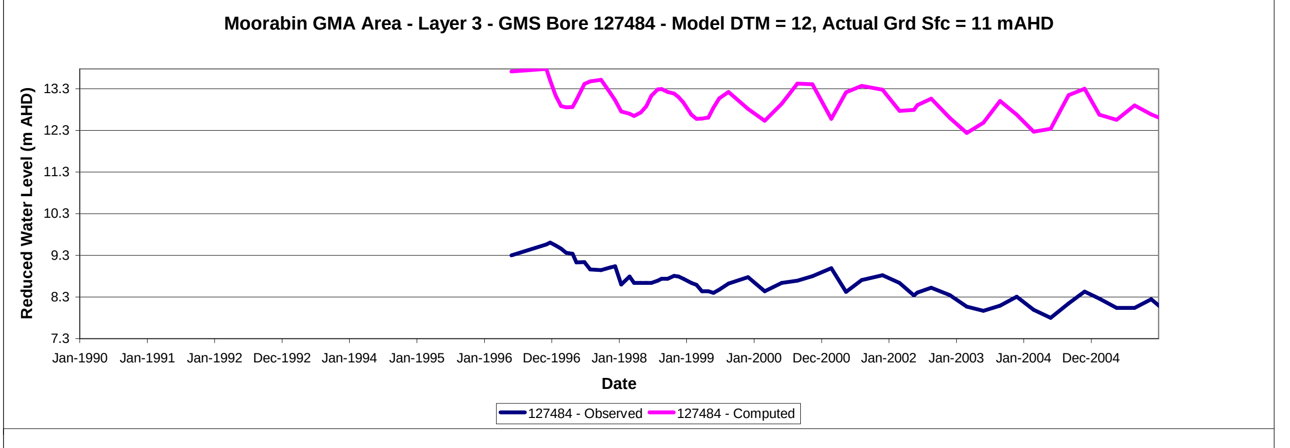
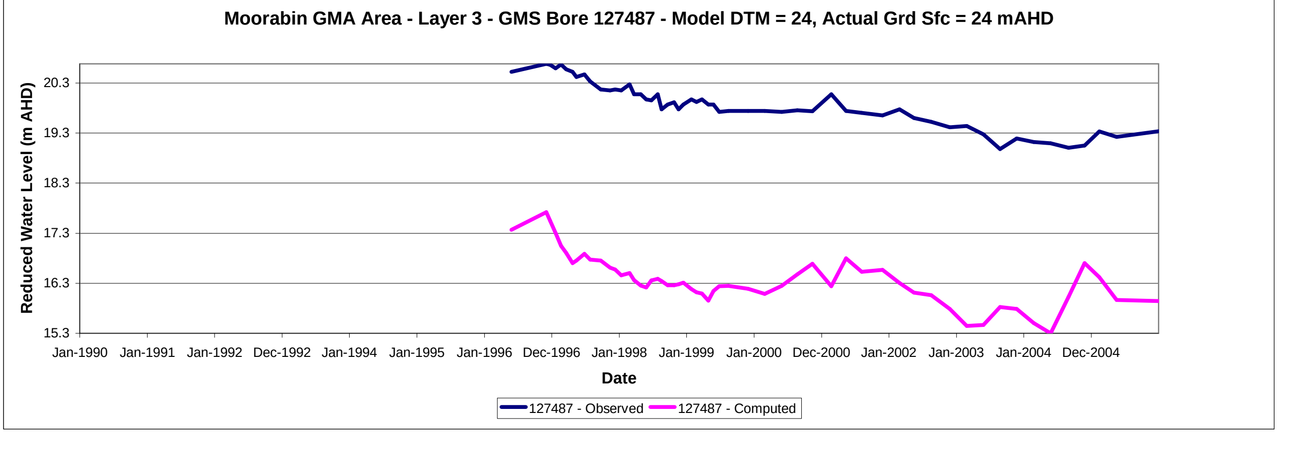
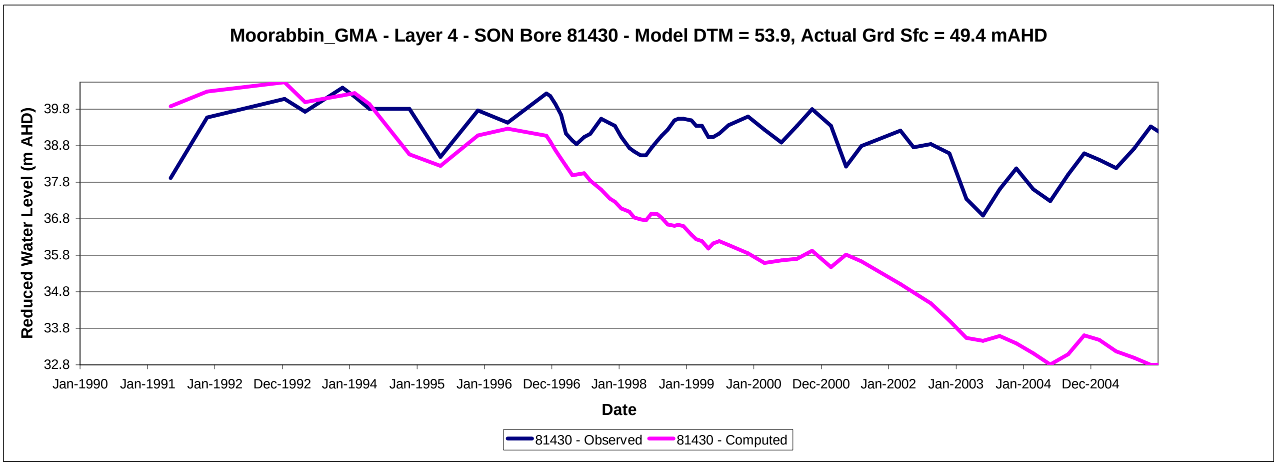
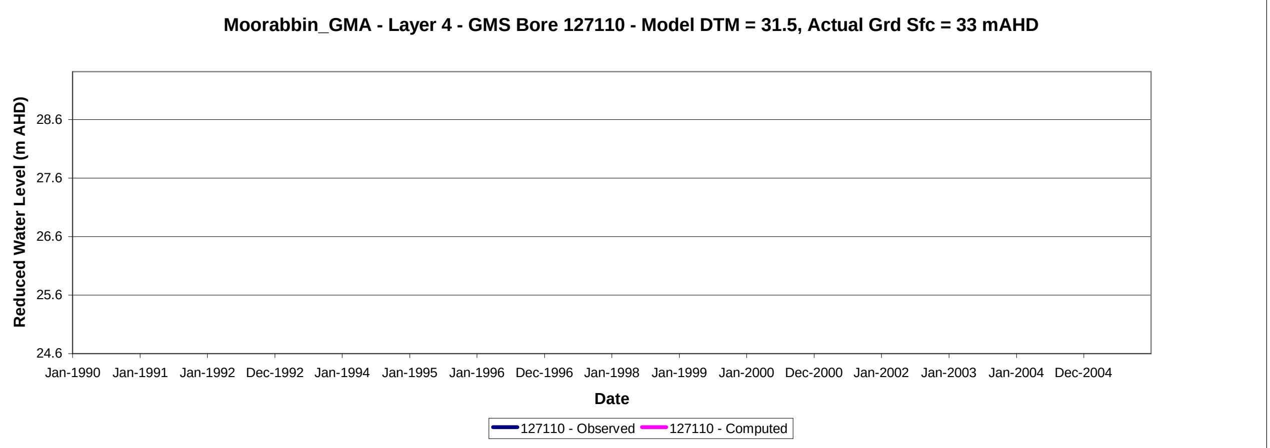


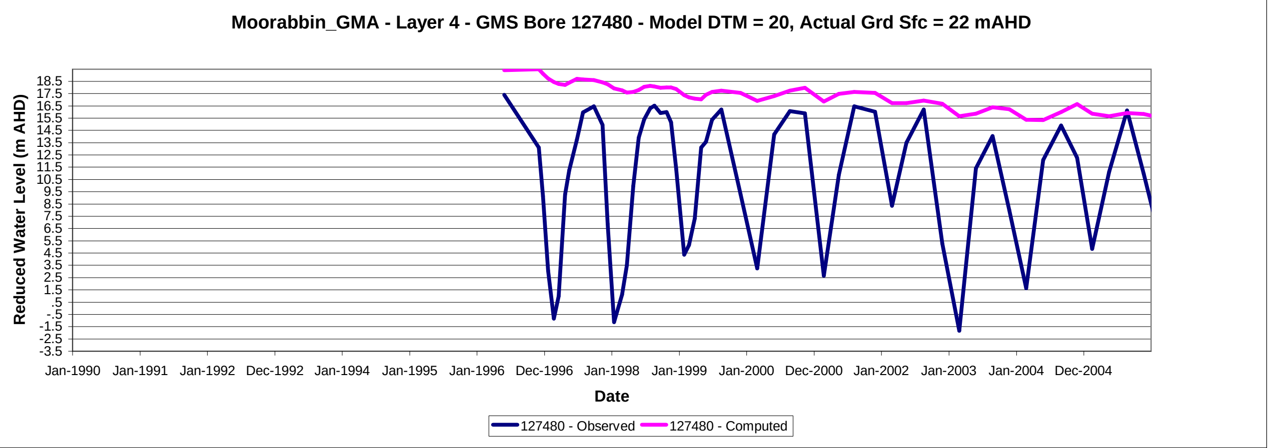


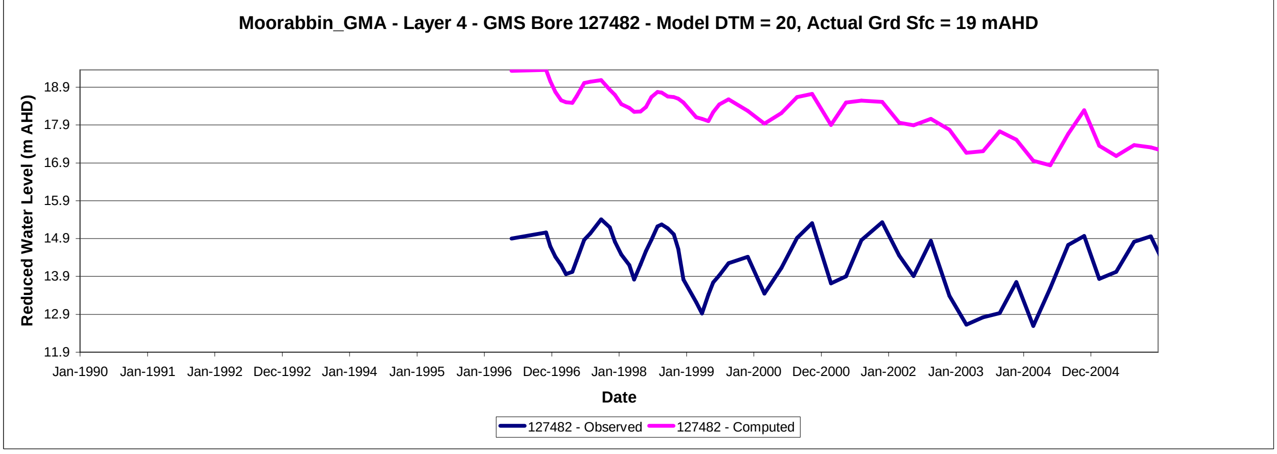


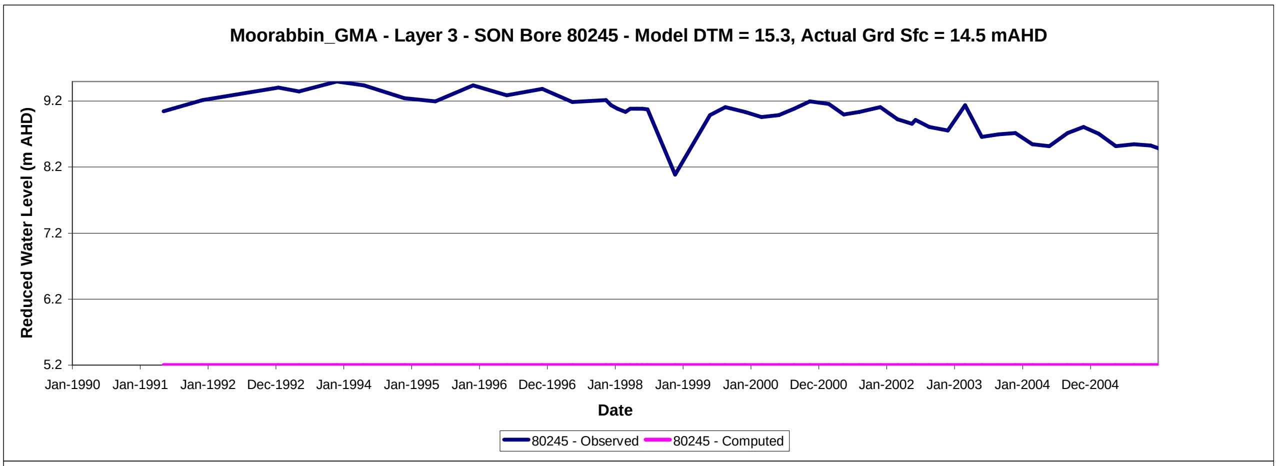


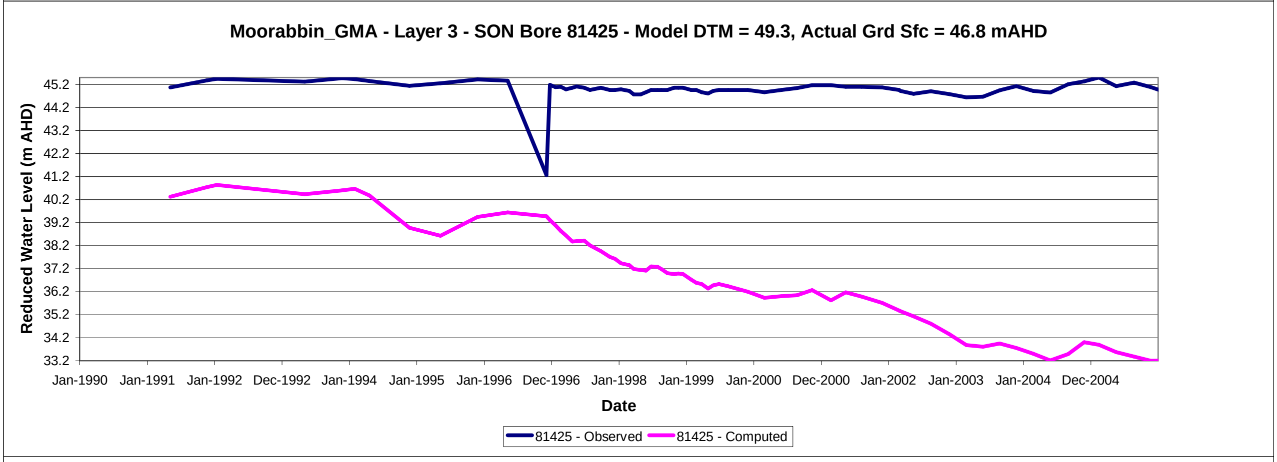

Moorabbin_GMA - Layer 4 - SON Bore 81430 - Model DTM = 53.9, Actual Grd Sfc = 49.4 mAHD
Reduced Water Level (m AHD)
39.8
38.8
37.8
36.8
35.8
34.8
33.8
32.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
81430 - Observed
81430 - Computed

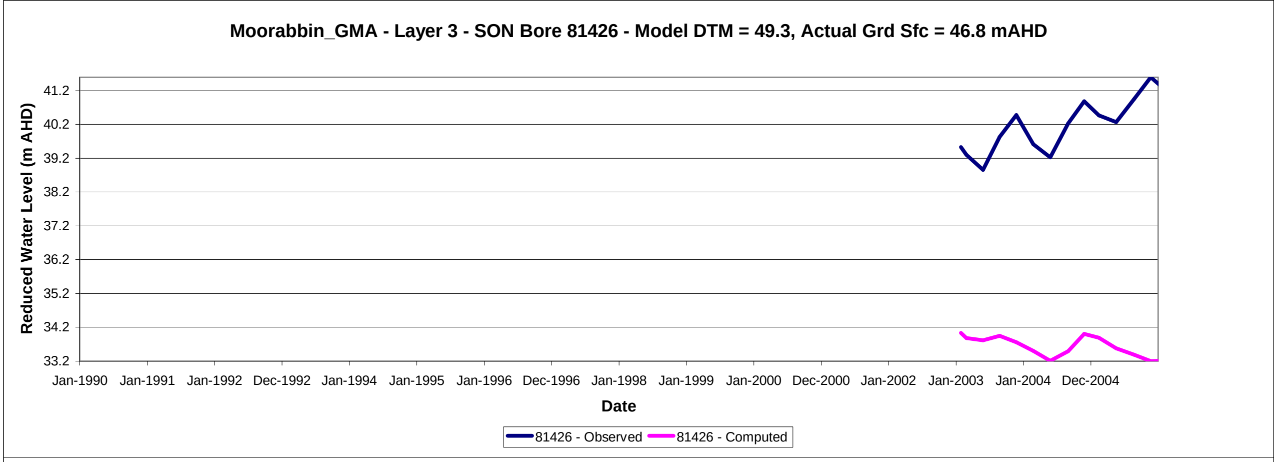

Moorabbin_GMA - Layer 4 - GMS Bore 127110 - Model DTM = 31.5, Actual Grd Sfc = 33 mAHD
Reduced Water Level (m AHD)
28.6
27.6
26.6
25.6
24.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
127110 - Observed
127110 - Computed

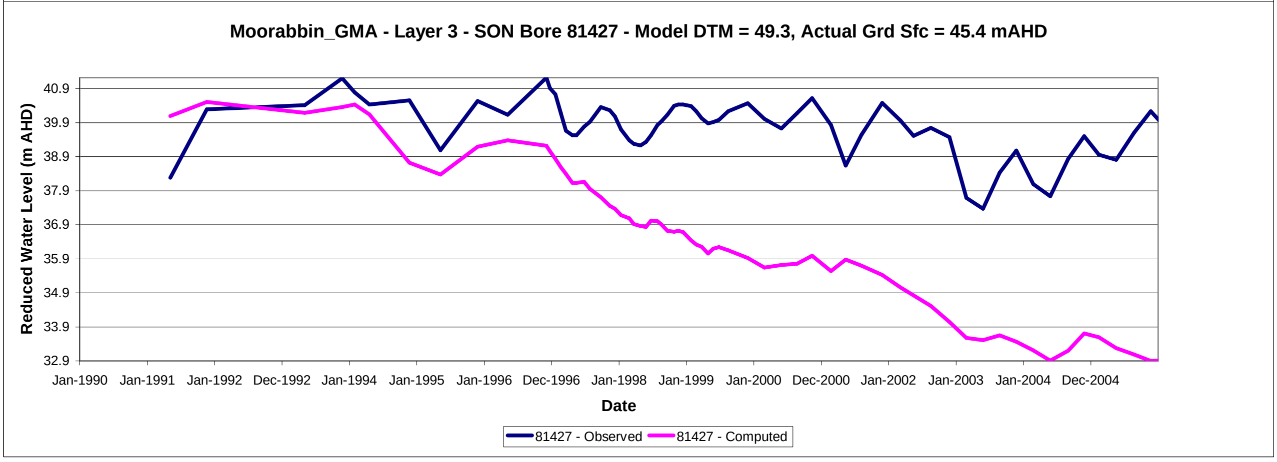

Moorabbin_GMA - Layer 4 - GMS Bore 127480 - Model DTM = 20, Actual Grd Sfc = 22 mAHD
Reduced Water Level (m AHD)
18.5
17.5
16.5
15.5
14.5
13.5
12.5
11.5
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
.5
-.5
-1.5
-2.5
-3.5
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
127480 - Observed
127480 - Computed

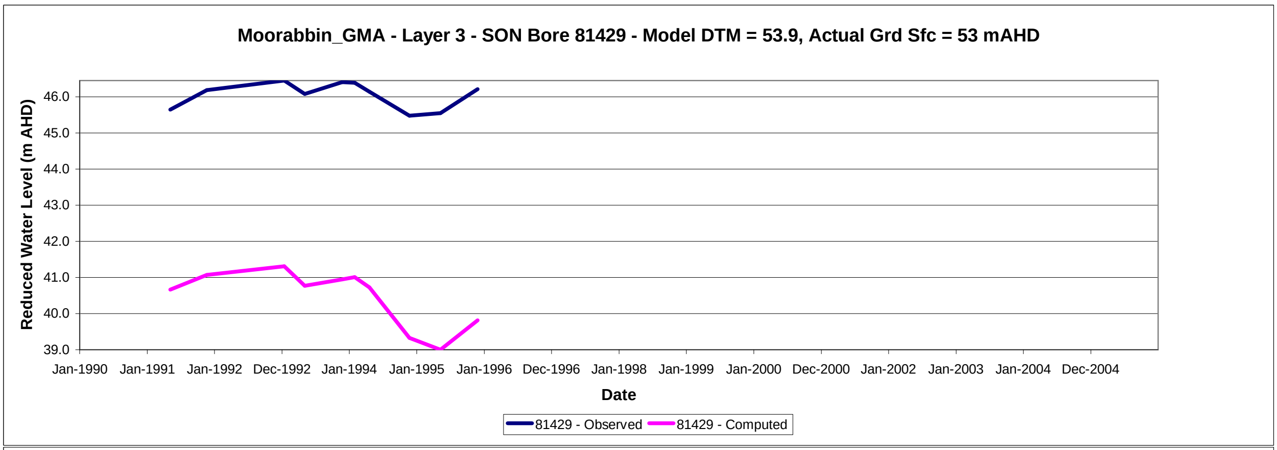

Moorabbin_GMA - Layer 4 - GMS Bore 127482 - Model DTM = 20, Actual Grd Sfc = 19 mAHD
Reduced Water Level (m AHD)
18.9
17.9
16.9
15.9
14.9
13.9
12.9
11.9
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
127482 - Observed
127482 - Computed

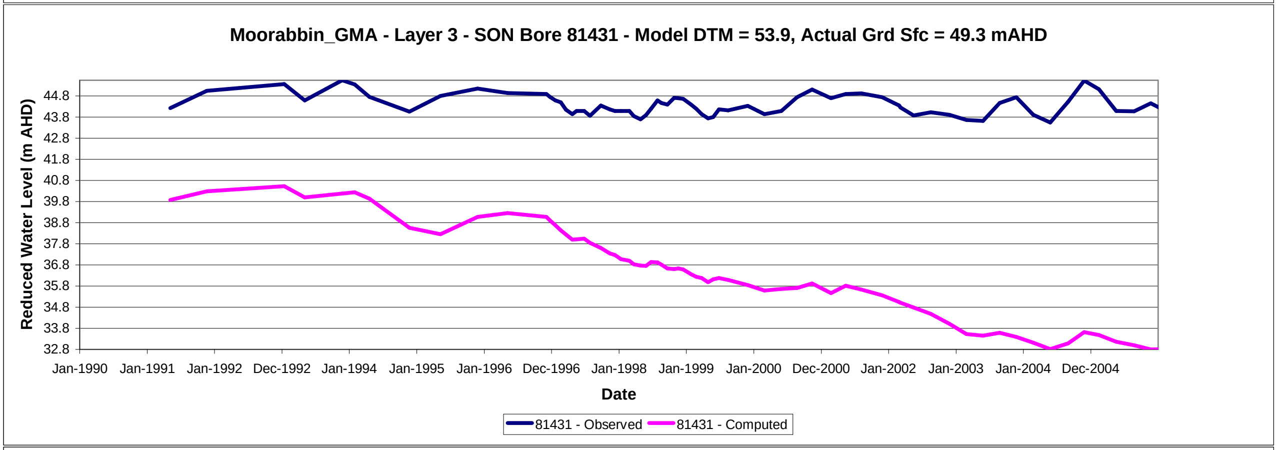

Moorabbin_GMA - Layer 3 - SON Bore 80245 - Model DTM = 15.3, Actual Grd Sfc = 14.5 mAHD
Reduced Water Level (m AHD)
Date
80245 - Observed
80245 - Computed

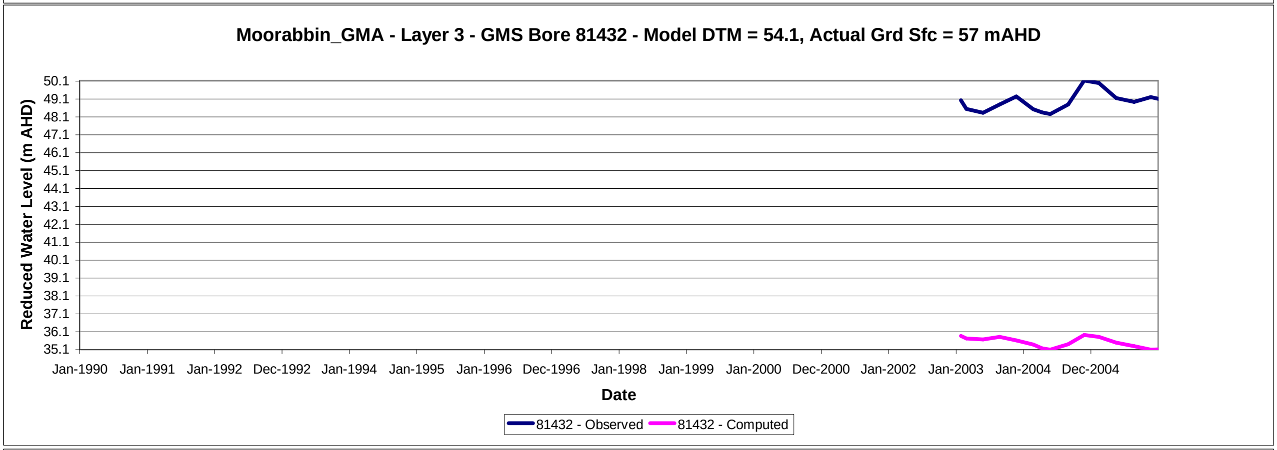

Moorabbin_GMA - Layer 3 - SON Bore 81425 - Model DTM = 49.3, Actual Grd Sfc = 46.8 mAHD
Reduced Water Level (m AHD)
Date
81425 - Observed
81425 - Computed

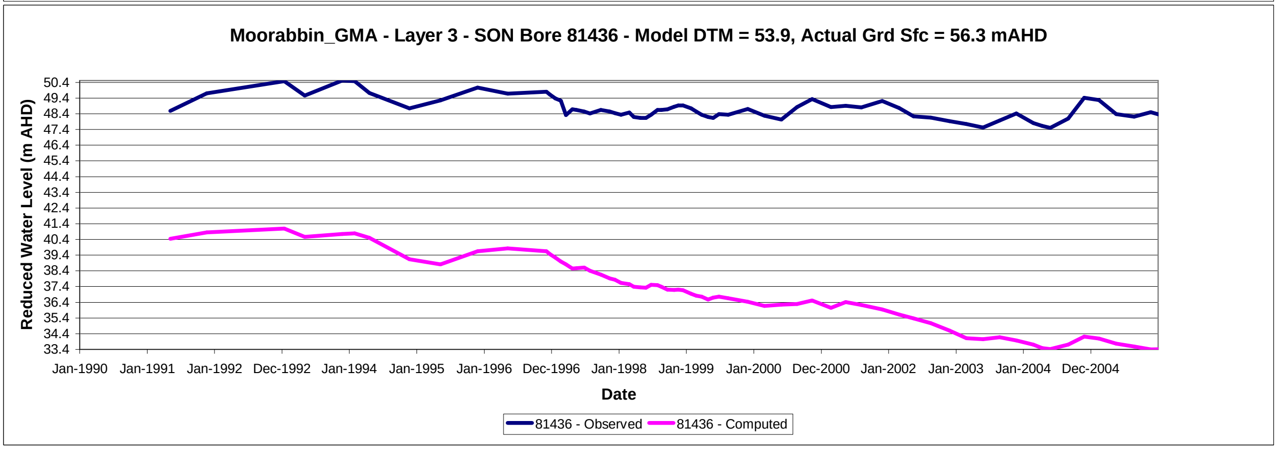

Moorabbin_GMA - Layer 3 - SON Bore 81426 - Model DTM = 49.3, Actual Grd Sfc = 46.8 mAHD
Reduced Water Level (m AHD)
Date
81426 - Observed
81426 - Computed

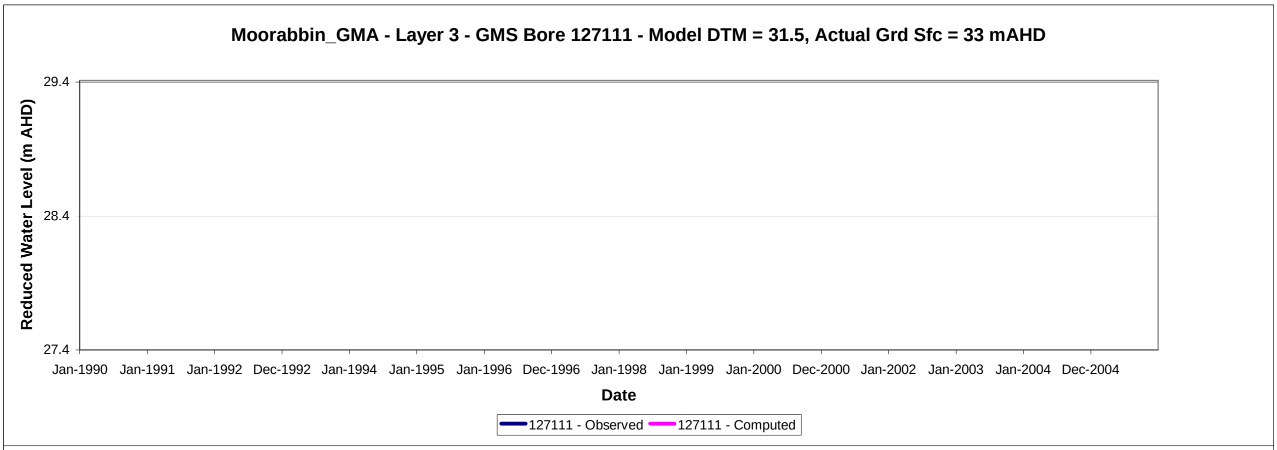

Moorabbin_GMA - Layer 3 - SON Bore 81427 - Model DTM = 49.3, Actual Grd Sfc = 45.4 mAHD
Reduced Water Level (m AHD)
Date
81427 - Observed
81427 - Computed

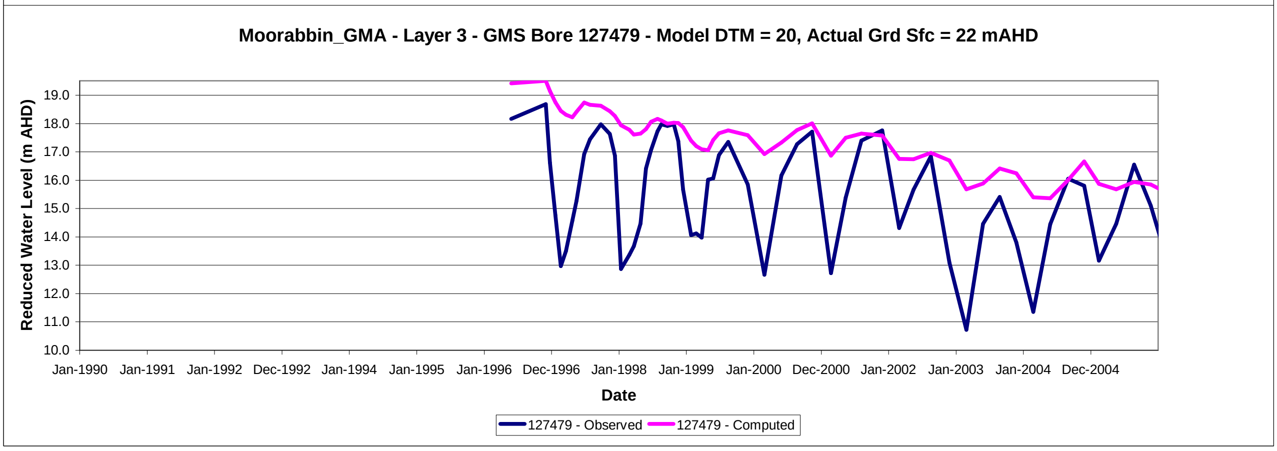

Moorabbin_GMA - Layer 3 - SON Bore 81429 - Model DTM = 53.9, Actual Grd Sfc = 53 mAHD
Reduced Water Level (m AHD)
Date
81429 - Observed
81429 - Computed

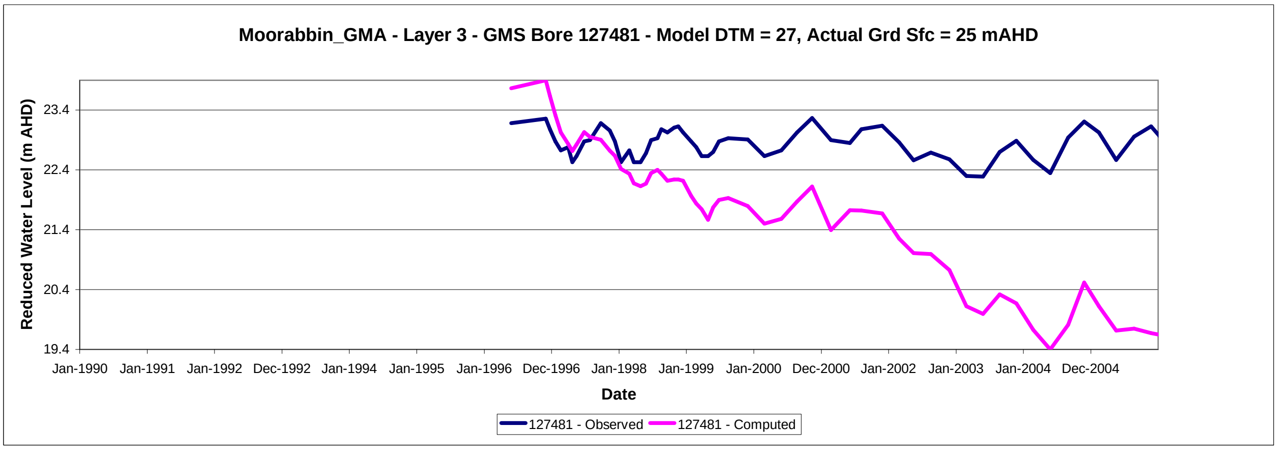

Moorabbin_GMA - Layer 3 - SON Bore 81431 - Model DTM = 53.9, Actual Grd Sfc = 49.3 mAHD
Reduced Water Level (m AHD)
Date
81431 - Observed
81431 - Computed

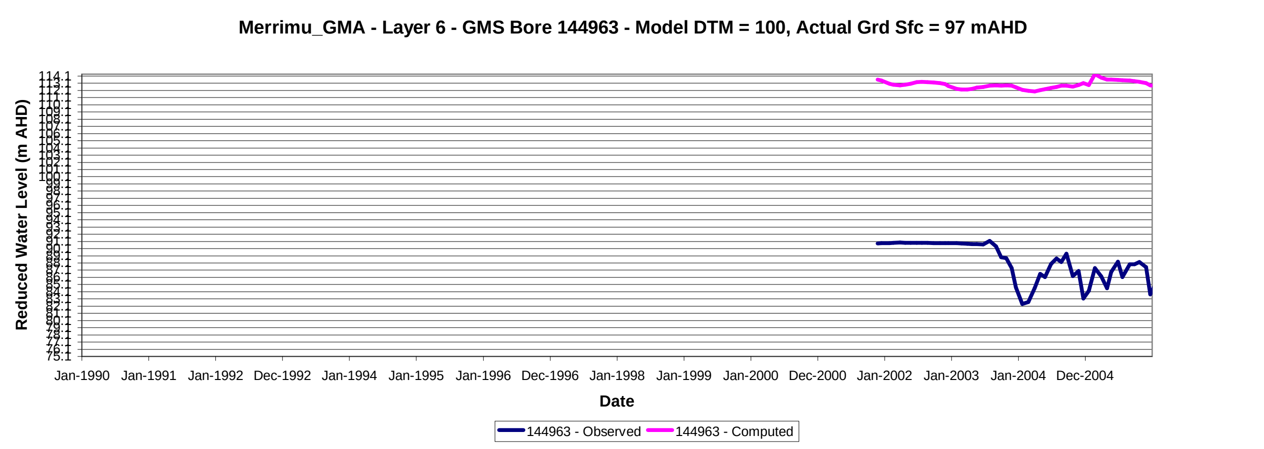

Moorabbin_GMA - Layer 3 - GMS Bore 81432 - Model DTM = 54.1, Actual Grd Sfc = 57 mAHD
Reduced Water Level (m AHD)
Date
81432 - Observed
81432 - Computed

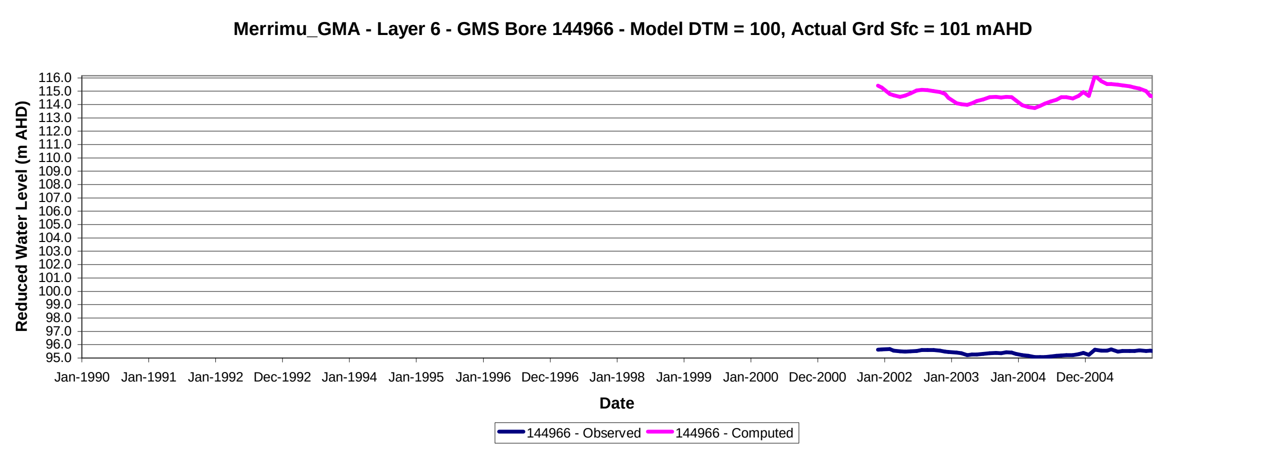

Moorabbin_GMA - Layer 3 - SON Bore 81436 - Model DTM = 53.9, Actual Grd Sfc = 56.3 mAHD
Reduced Water Level (m AHD)
Date
81436 - Observed
81436 - Computed

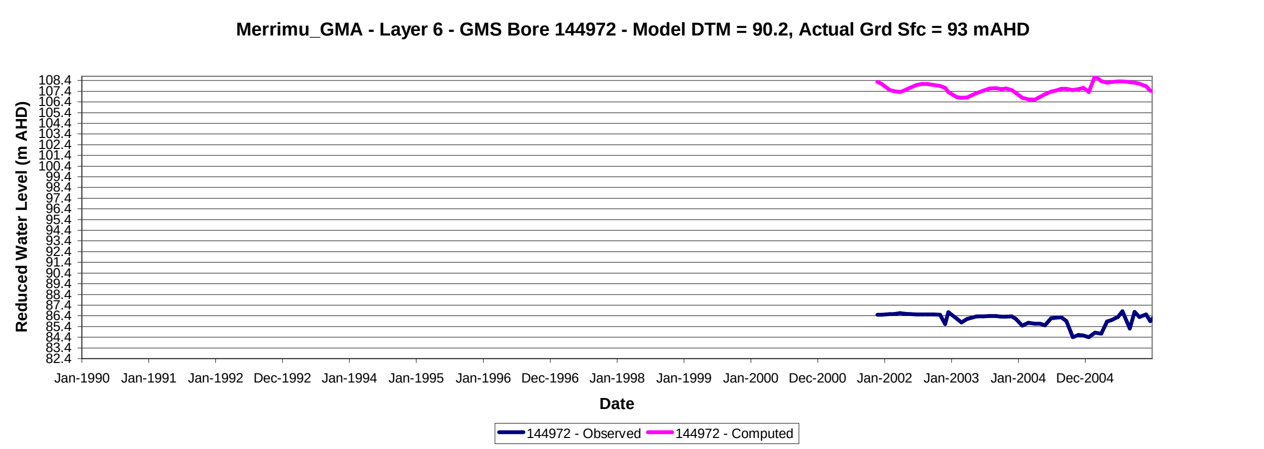

Moorabbin_GMA - Layer 3 - GMS Bore 127111 - Model DTM = 31.5, Actual Grd Sfc = 33 mAHD
Reduced Water Level (m AHD)
29.4
28.4
27.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
127111 - Observed
127111 - Computed

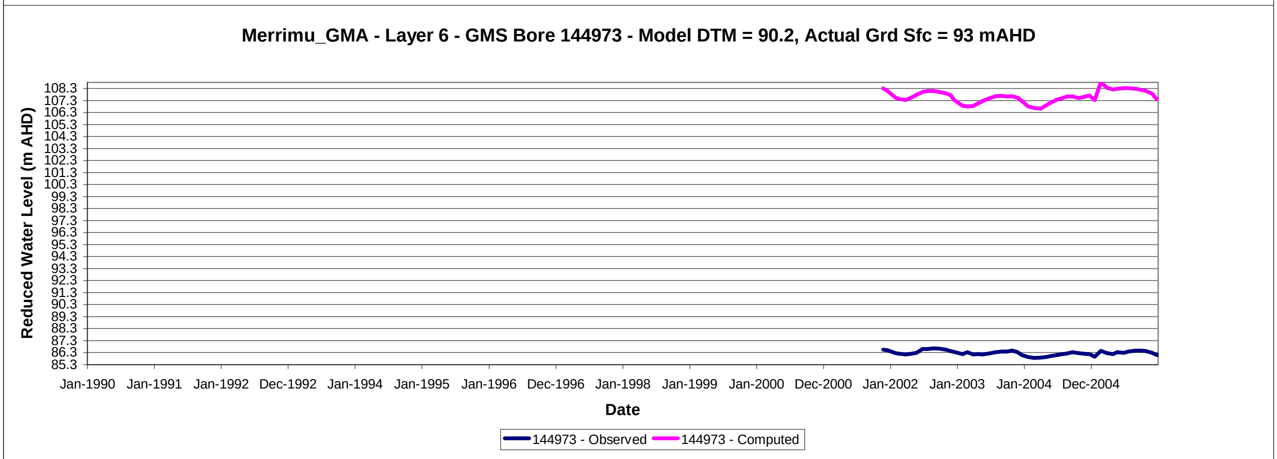

Moorabbin_GMA - Layer 3 - GMS Bore 127479 - Model DTM = 20, Actual Grd Sfc = 22 mAHD
Reduced Water Level (m AHD)
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
127479 - Observed
127479 - Computed

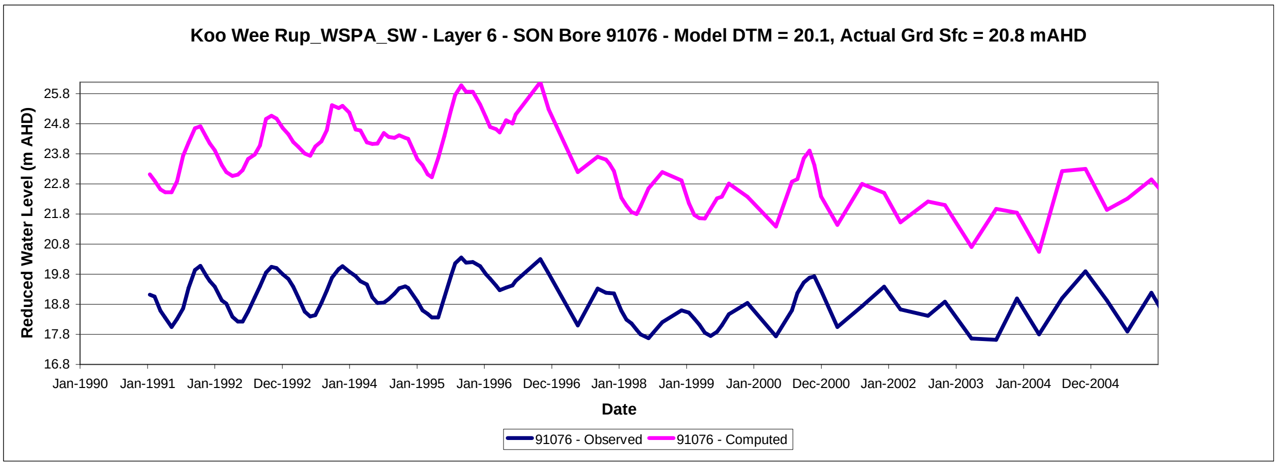

Moorabbin_GMA - Layer 3 - GMS Bore 127481 - Model DTM = 27, Actual Grd Sfc = 25 mAHD
Reduced Water Level (m AHD)
23.4
22.4
21.4
20.4
19.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
127481 - Observed
127481 - Computed

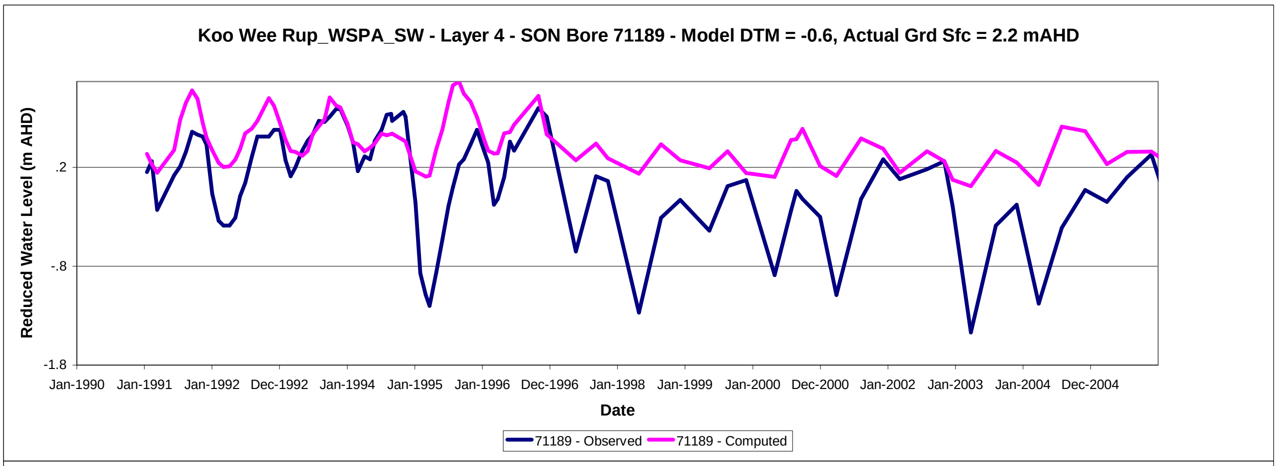

Merrimu_GMA - Layer 6 - GMS Bore 144963 - Model DTM = 100, Actual Grd Sfc = 97 mAHD
Reduced Water Level (m AHD)
Date
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
144963 - Observed
144963 - Computed

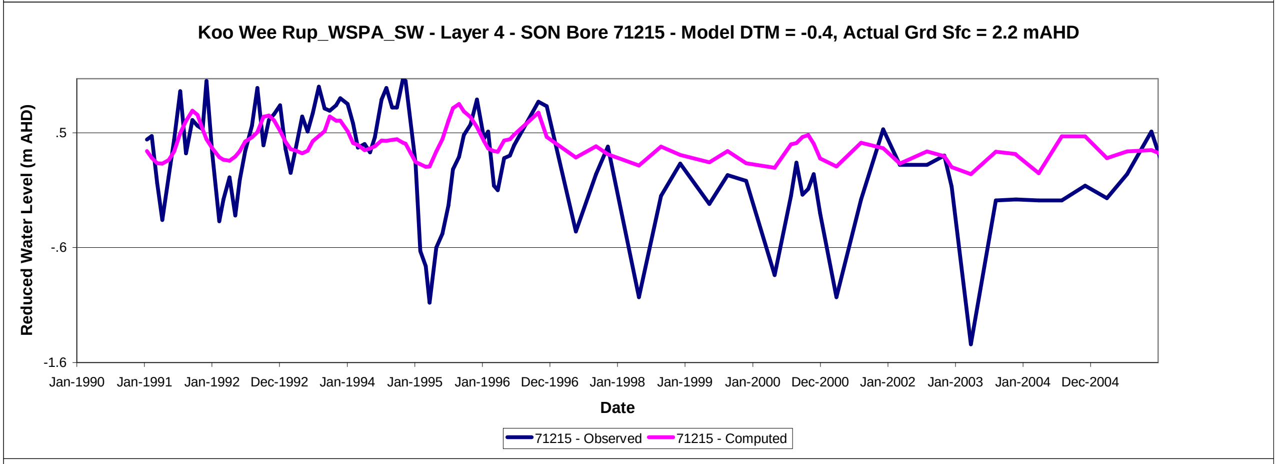

Merrimu_GMA - Layer 6 - GMS Bore 144966 - Model DTM = 100, Actual Grd Sfc = 101 mAHD
Reduced Water Level (m AHD)
Date
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
144966 - Observed
144966 - Computed

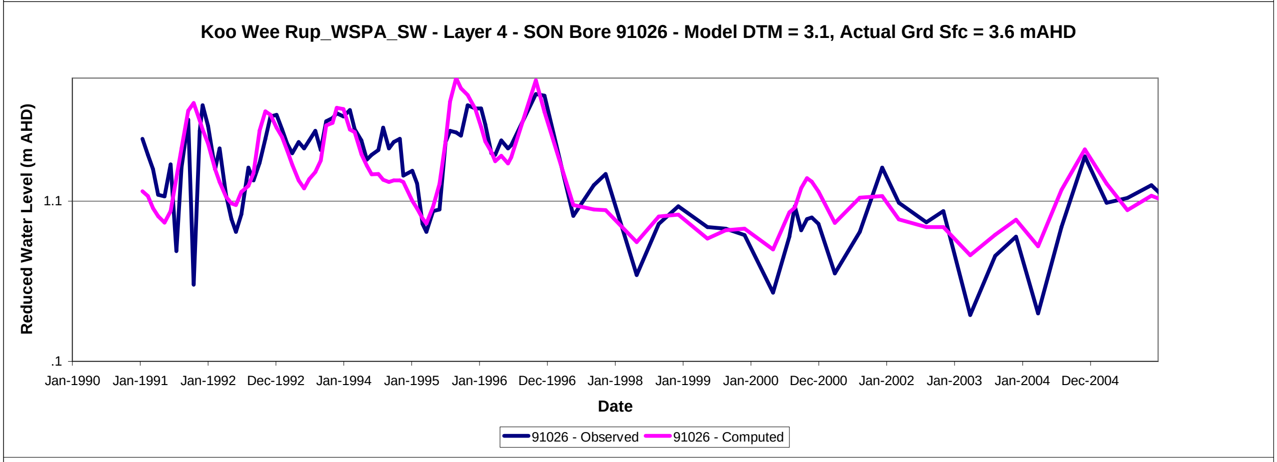

Merrimu_GMA - Layer 6 - GMS Bore 144972 - Model DTM = 90.2, Actual Grd Sfc = 93 mAHD
Reduced Water Level (m AHD)
Date
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
144972 - Observed
144972 - Computed

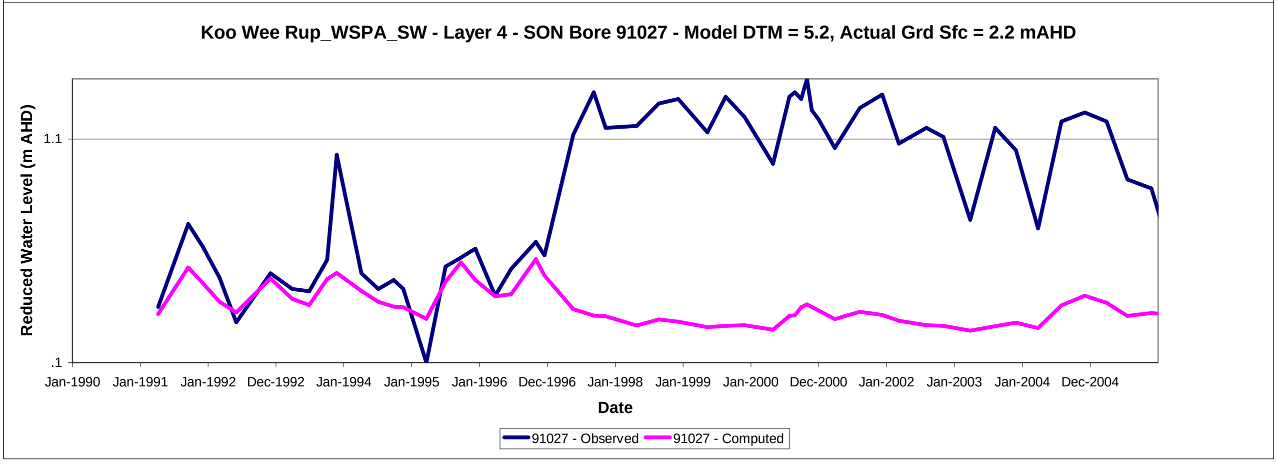

Merrimu_GMA - Layer 6 - GMS Bore 144973 - Model DTM = 90.2, Actual Grd Sfc = 93 mAHD
Reduced Water Level (m AHD)
Date
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
144973 - Observed
144973 - Computed

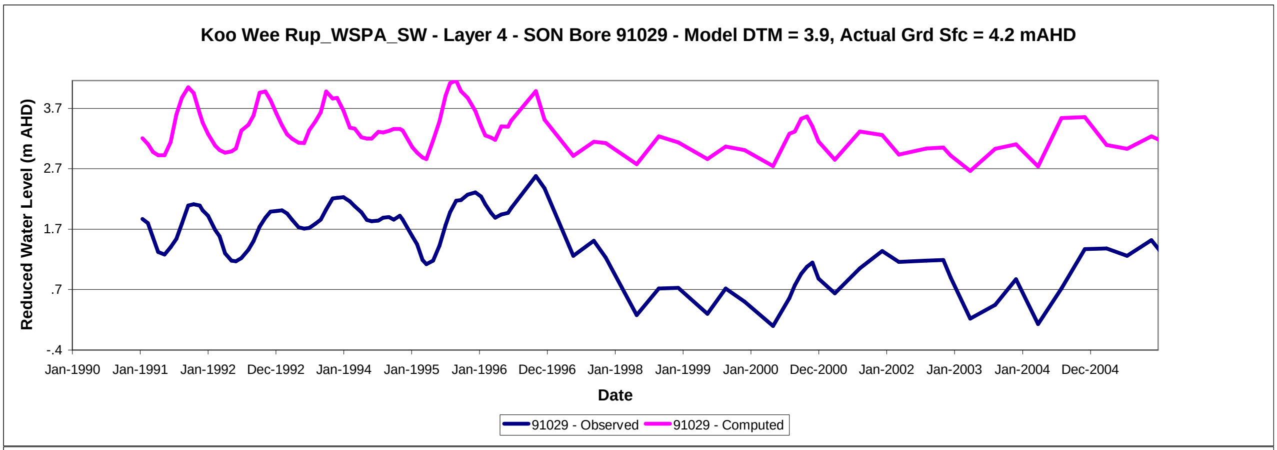

Koo Wee Rup_WSPA_SW - Layer 6 - SON Bore 91076 - Model DTM = 20.1, Actual Grd Sfc = 20.8 mAHD
Reduced Water Level (m AHD)
25.8
24.8
23.8
22.8
21.8
20.8
19.8
18.8
17.8
16.8
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
91076 - Observed
91076 - Computed

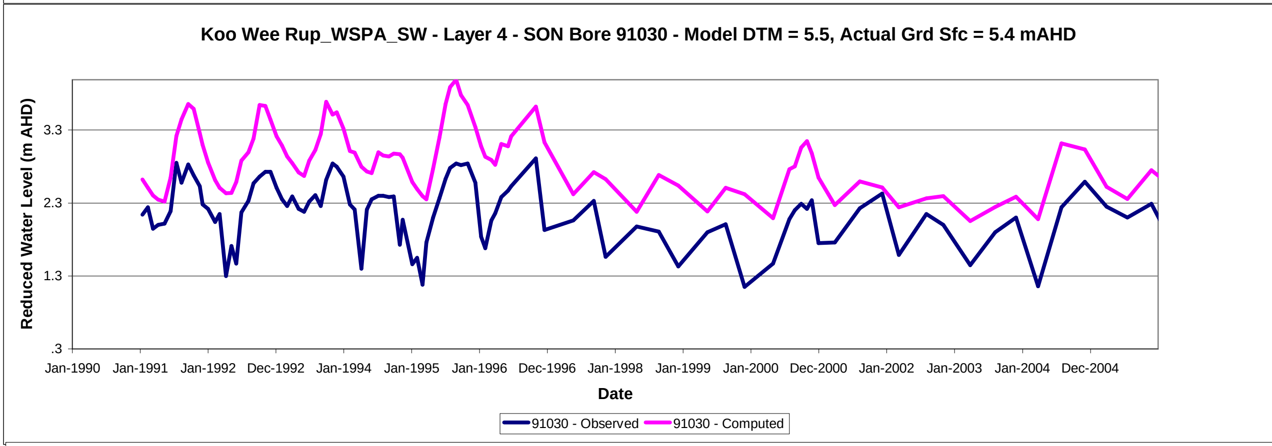

Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 71189 - Model DTM = -0.6, Actual Grd Sfc = 2.2 mAHD
Reduced Water Level (m AHD)
.2
-.8
-1.8
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71189 - Observed
71189 - Computed

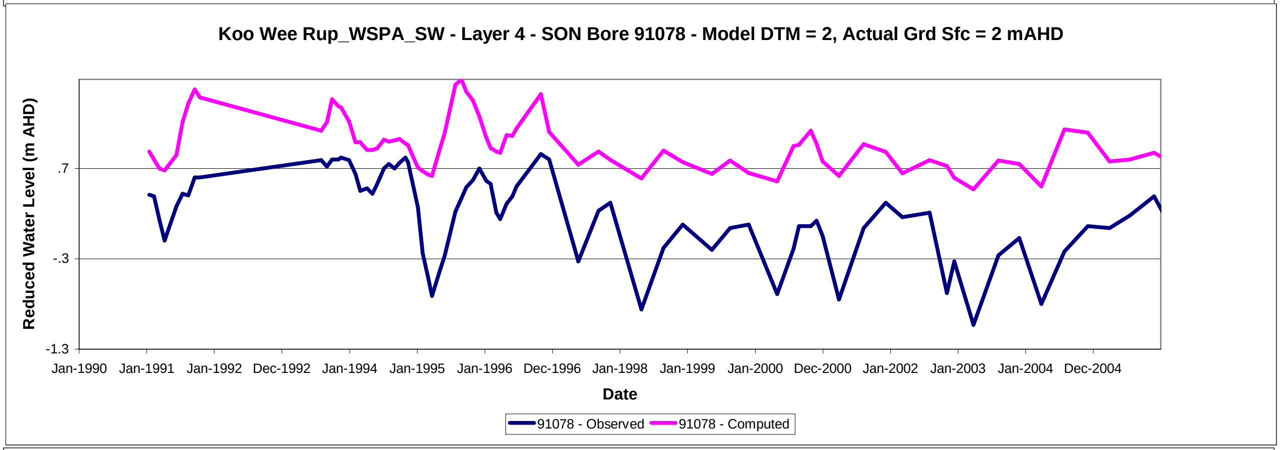

Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 71215 - Model DTM = -0.4, Actual Grd Sfc = 2.2 mAHD
Reduced Water Level (m AHD)
.5
-.6
-1.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71215 - Observed
71215 - Computed

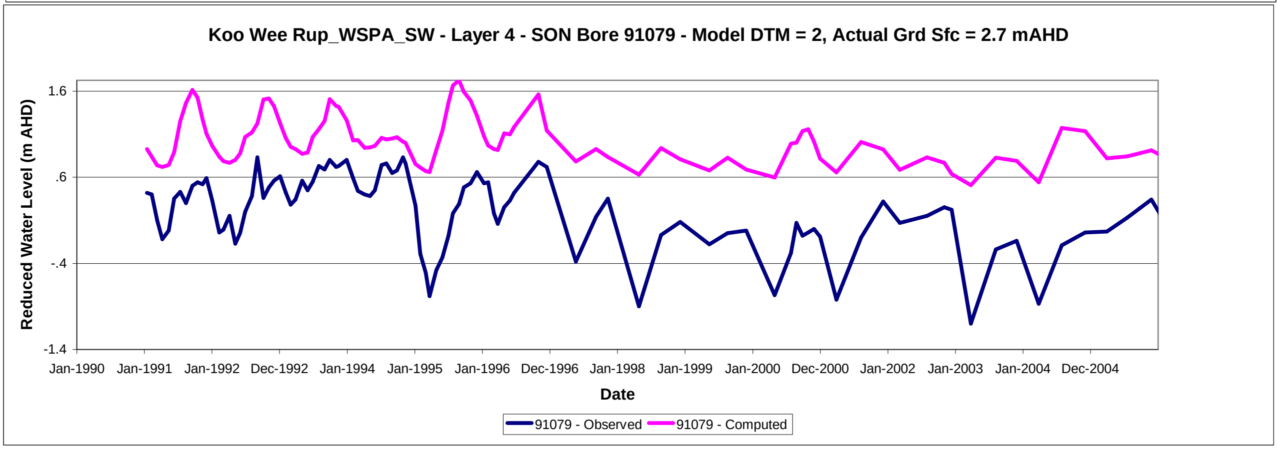

Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 91026 - Model DTM = 3.1, Actual Grd Sfc = 3.6 mAHD
Reduced Water Level (m AHD)
1.1
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
91026 - Observed
91026 - Computed

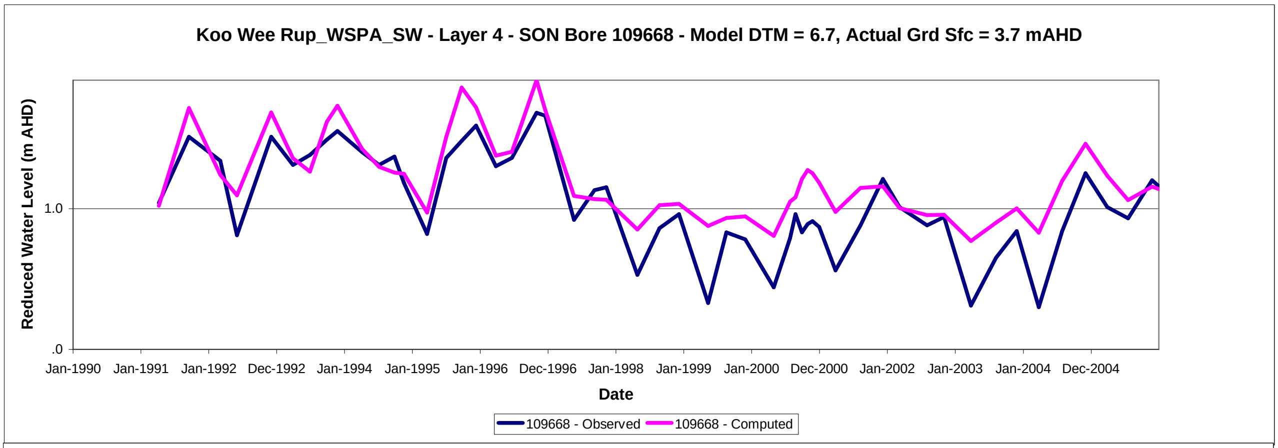

Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 91027 - Model DTM = 5.2, Actual Grd Sfc = 2.2 mAHD
Reduced Water Level (m AHD)
1.1
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
91027 - Observed
91027 - Computed

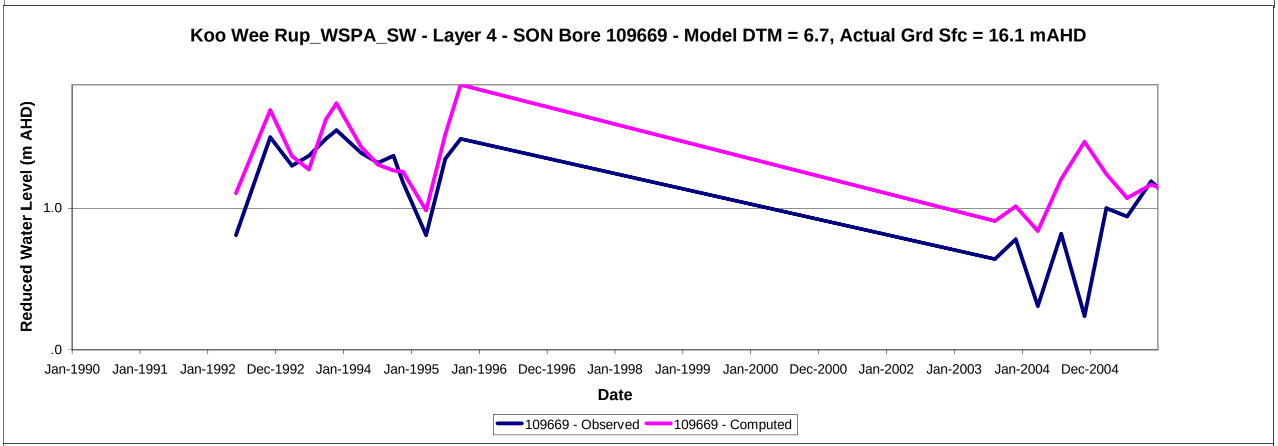

Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 91029 - Model DTM = 3.9, Actual Grd Sfc = 4.2 mAHD
Reduced Water Level (m AHD)
3.7
2.7
1.7
.7
-.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
91029 - Observed
91029 - Computed

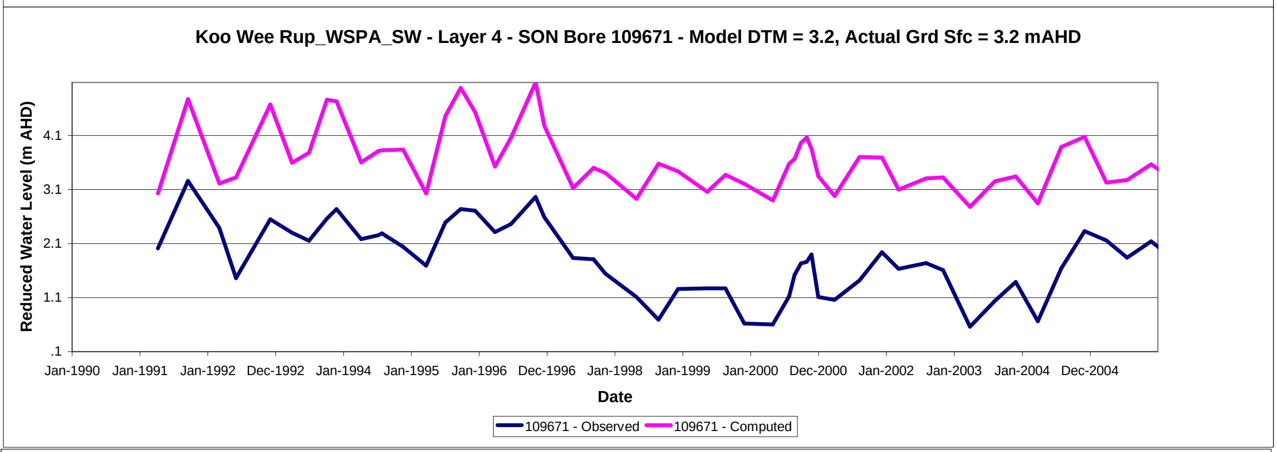

Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 91030 - Model DTM = 5.5, Actual Grd Sfc = 5.4 mAHD
Reduced Water Level (m AHD)
3.3
2.3
1.3
.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
91030 - Observed
91030 - Computed

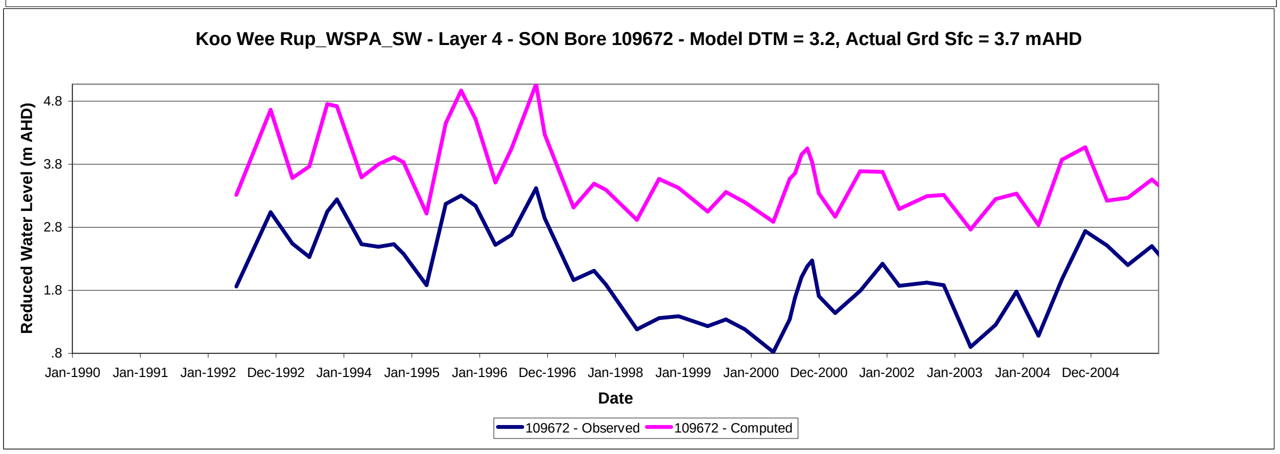

Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 91078 - Model DTM = 2, Actual Grd Sfc = 2 mAHD
Reduced Water Level (m AHD)
.7
-.3
-1.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
91078 - Observed
91078 - Computed


Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 91079 - Model DTM = 2, Actual Grd Sfc = 2.7 mAHD
Reduced Water Level (m AHD)
1.6
.6
-.4
-1.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
91079 - Observed
91079 - Computed


Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 109668 - Model DTM = 6.7, Actual Grd Sfc = 3.7 mAHD
Reduced Water Level (m AHD)
1.0
.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109668 - Observed
109668 - Computed


Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 109669 - Model DTM = 6.7, Actual Grd Sfc = 16.1 mAHD
Reduced Water Level (m AHD)
1.0
.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109669 - Observed
109669 - Computed


Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 109671 - Model DTM = 3.2, Actual Grd Sfc = 3.2 mAHD
Reduced Water Level (m AHD)
4.1
3.1
2.1
1.1
.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109671 - Observed
109671 - Computed


Koo Wee Rup_WSPA_SW - Layer 4 - SON Bore 109672 - Model DTM = 3.2, Actual Grd Sfc = 3.7 mAHD
Reduced Water Level (m AHD)
4.8
3.8
2.8
1.8
.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109672 - Observed
109672 - Computed

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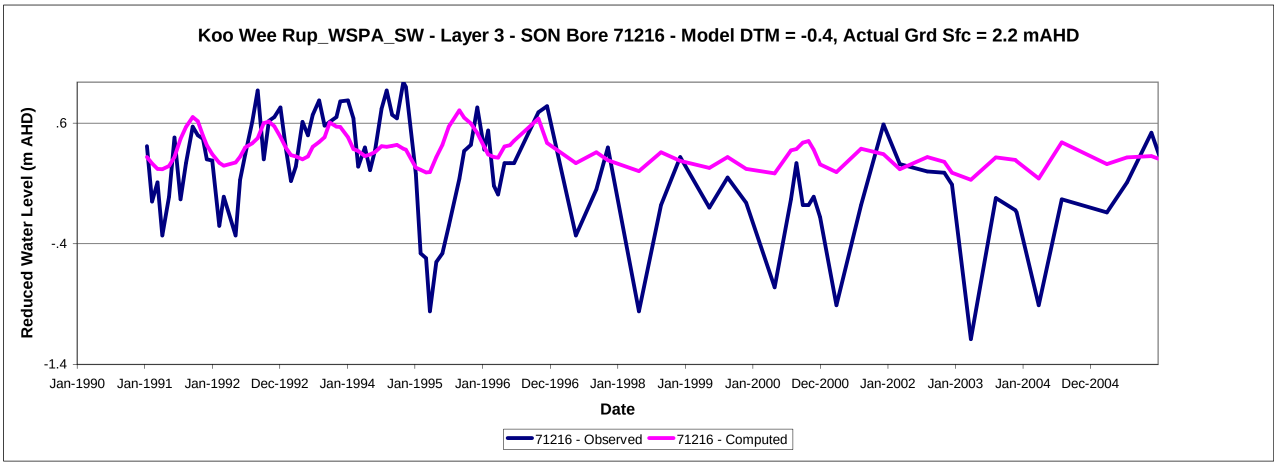
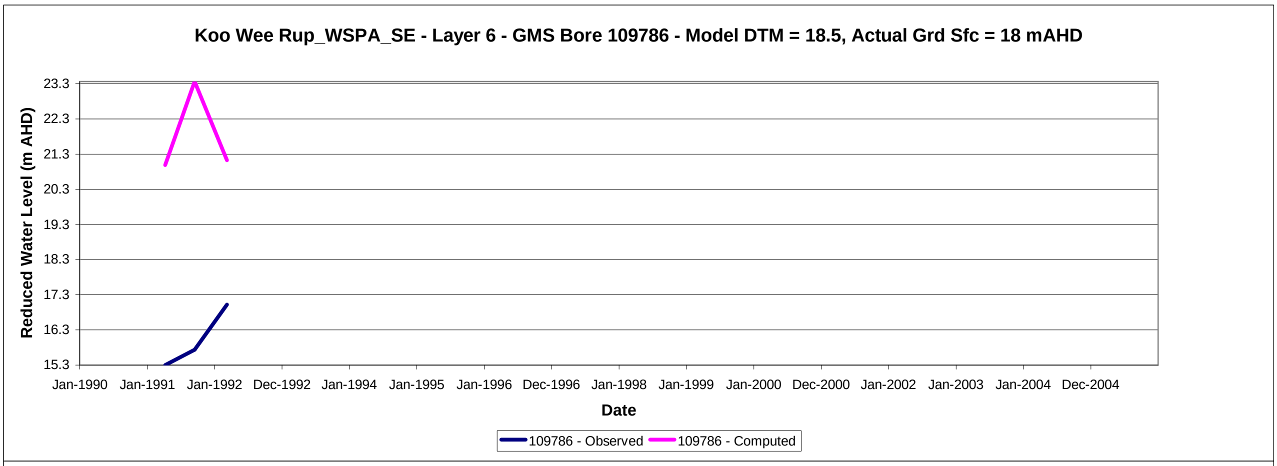
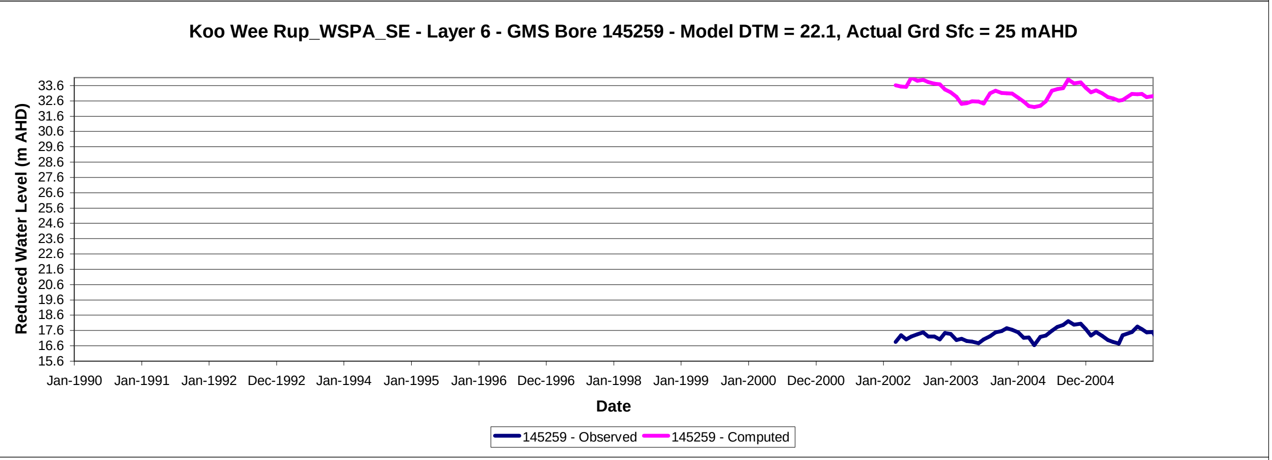
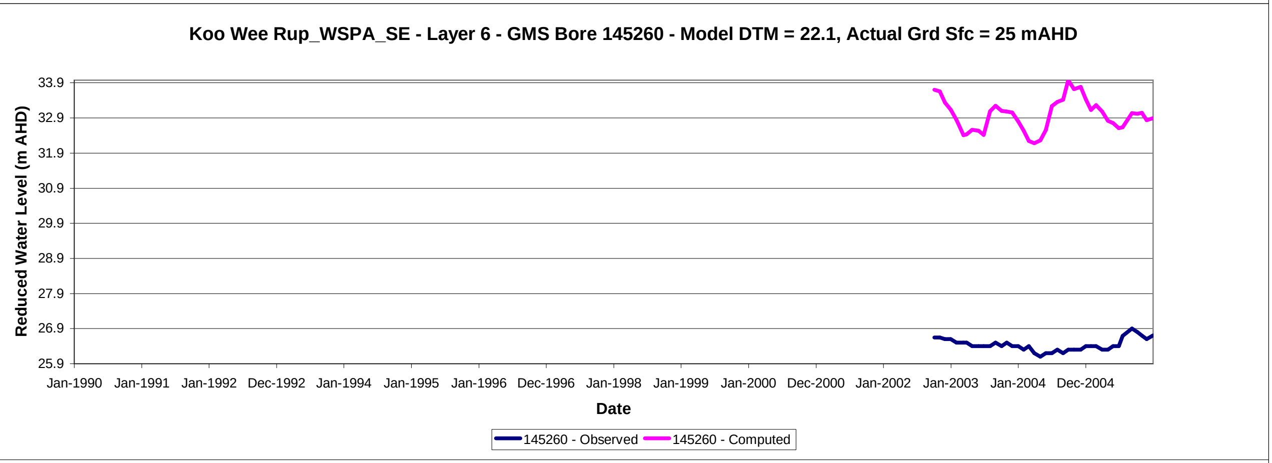
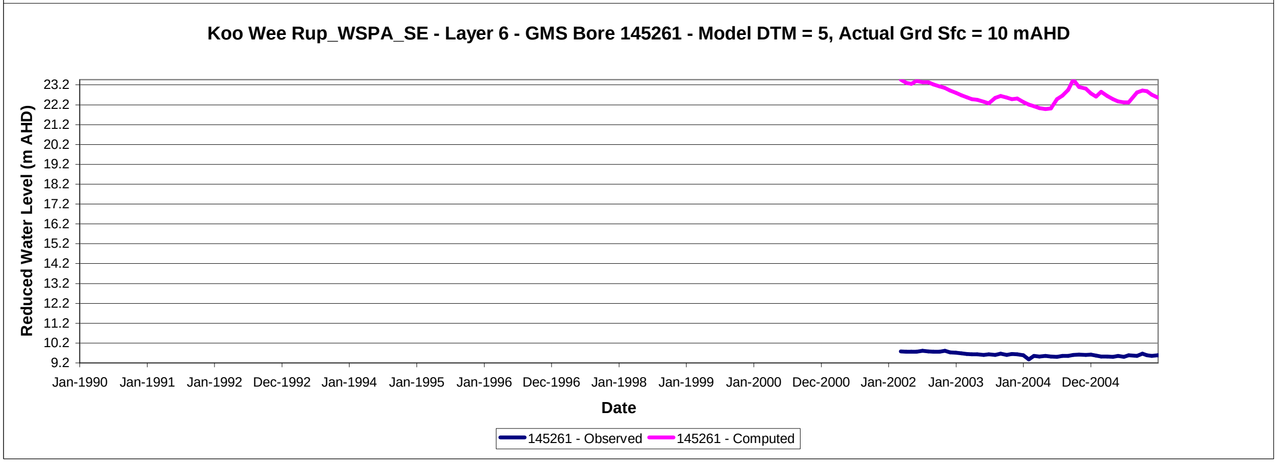
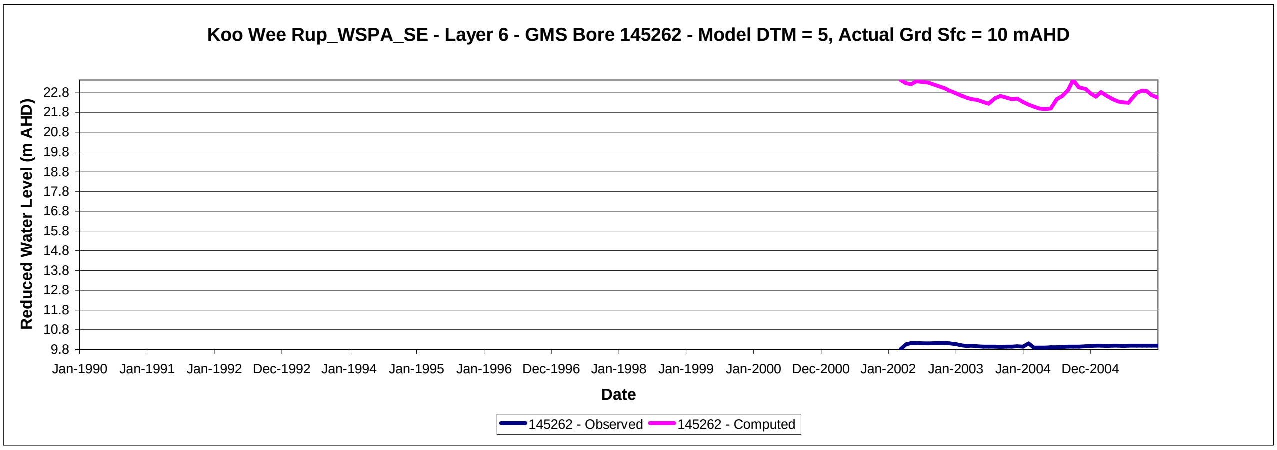



Koo Wee Rup_WSPA_SE - Layer 6 - GMS Bore 109786 - Model DTM = 18.5, Actual Grd Sfc = 18 mAHD
Reduced Water Level (m AHD)
23.3
22.3
21.3
20.3
19.3
18.3
17.3
16.3
15.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109786 - Observed
109786 - Computed


Koo Wee Rup_WSPA_SE - Layer 6 - GMS Bore 145259 - Model DTM = 22.1, Actual Grd Sfc = 25 mAHD
Reduced Water Level (m AHD)
33.6
32.6
31.6
30.6
29.6
28.6
27.6
26.6
25.6
24.6
23.6
22.6
21.6
20.6
19.6
18.6
17.6
16.6
15.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
145259 - Observed
145259 - Computed


Koo Wee Rup_WSPA_SE - Layer 6 - GMS Bore 145260 - Model DTM = 22.1, Actual Grd Sfc = 25 mAHD
Reduced Water Level (m AHD)
33.9
32.9
31.9
30.9
29.9
28.9
27.9
26.9
25.9
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
145260 - Observed
145260 - Computed


Koo Wee Rup_WSPA_SE - Layer 6 - GMS Bore 145261 - Model DTM = 5, Actual Grd Sfc = 10 mAHD
Reduced Water Level (m AHD)
23.2
22.2
21.2
20.2
19.2
18.2
17.2
16.2
15.2
14.2
13.2
12.2
11.2
10.2
9.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
145261 - Observed
145261 - Computed


Koo Wee Rup_WSPA_SE - Layer 6 - GMS Bore 145262 - Model DTM = 5, Actual Grd Sfc = 10 mAHD
Reduced Water Level (m AHD)
22.8
21.8
20.8
19.8
18.8
17.8
16.8
15.8
14.8
13.8
12.8
11.8
10.8
9.8
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
145262 - Observed
145262 - Computed

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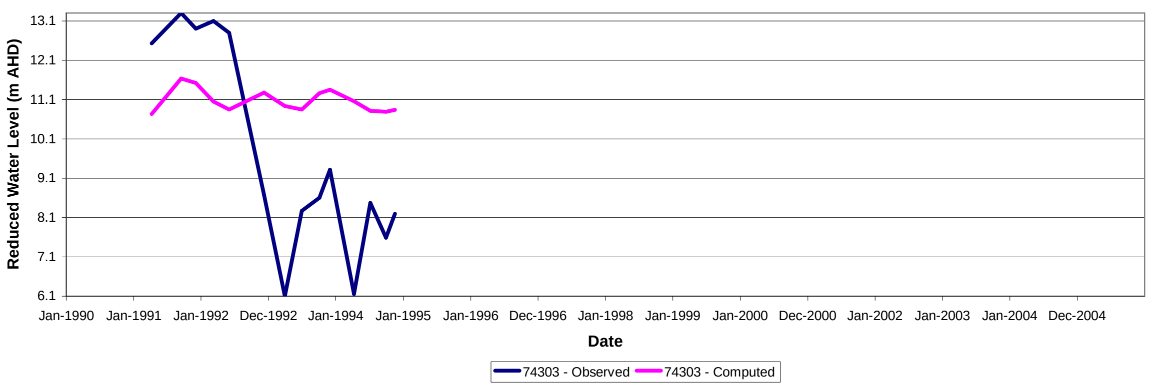
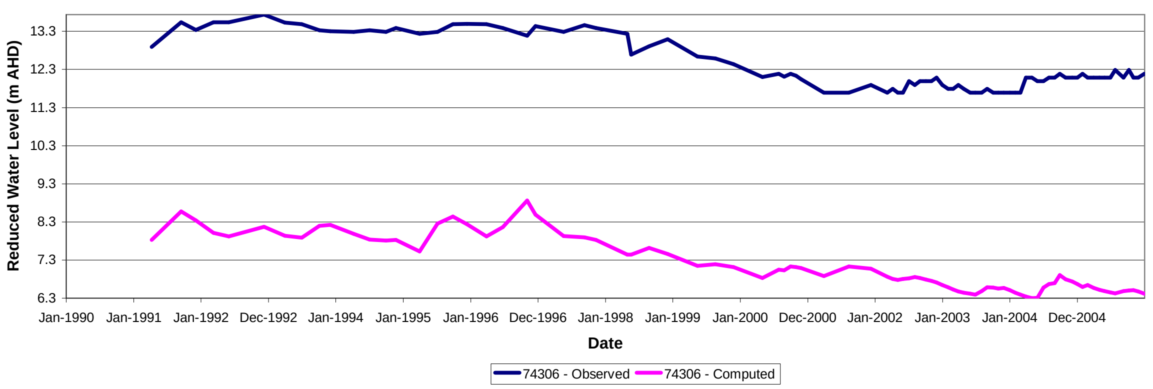
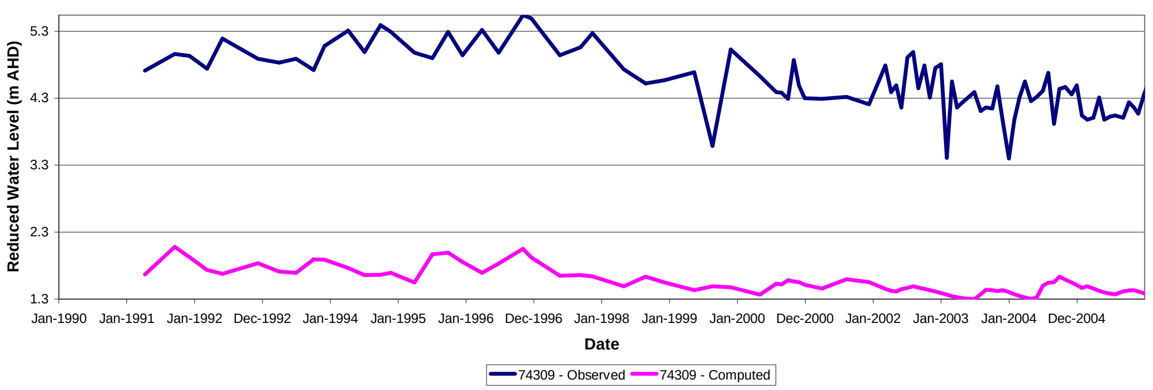
Koo Wee Rup_WSPA_SE - Layer 5 - SON Bore 74303 - Model DTM = 16.1, Actual Grd Sfc = 15.1 mAHD



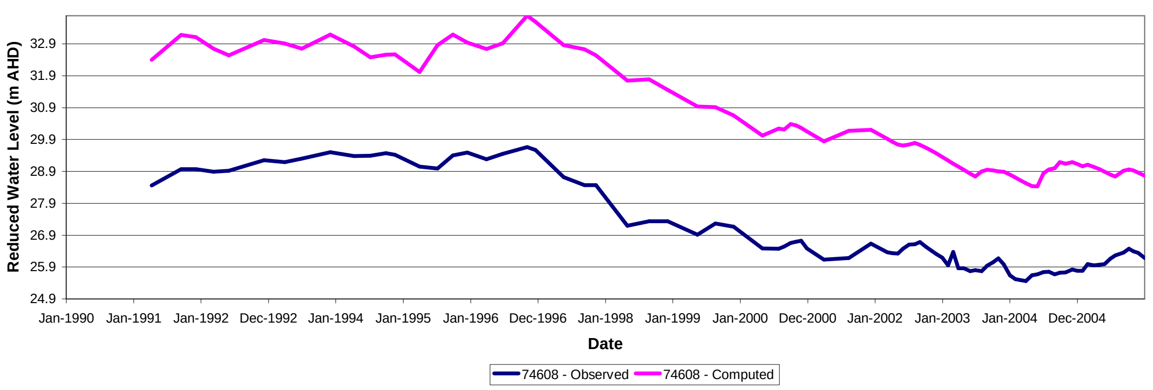
Koo Wee Rup_WSPA_SE - Layer 5 - SON Bore 74306 - Model DTM = 8.3, Actual Grd Sfc = 5.7 mAHD

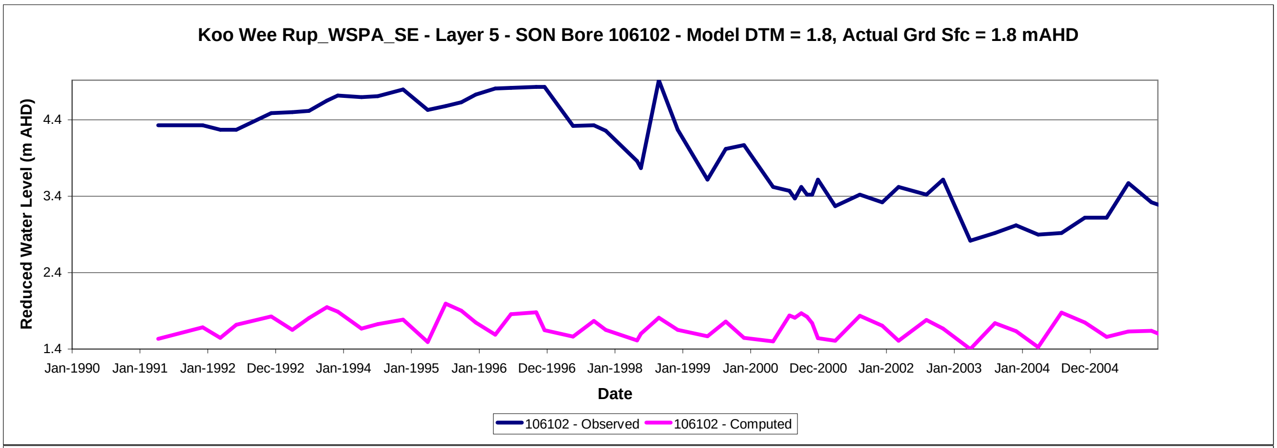


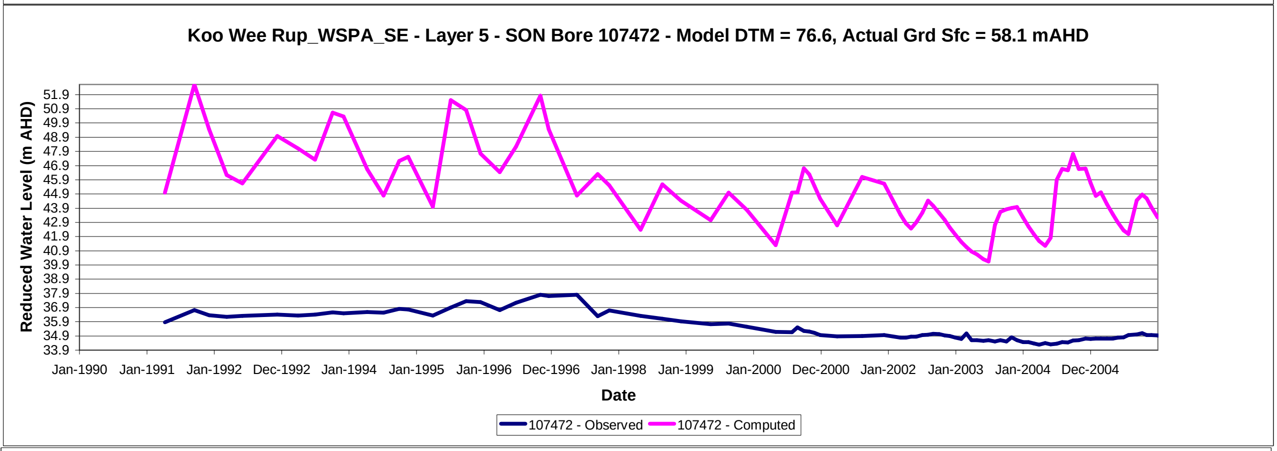
Koo Wee Rup_WSPA_SE - Layer 5 - SON Bore 74309 - Model DTM = 12.2, Actual Grd Sfc = 13.1 mAHD

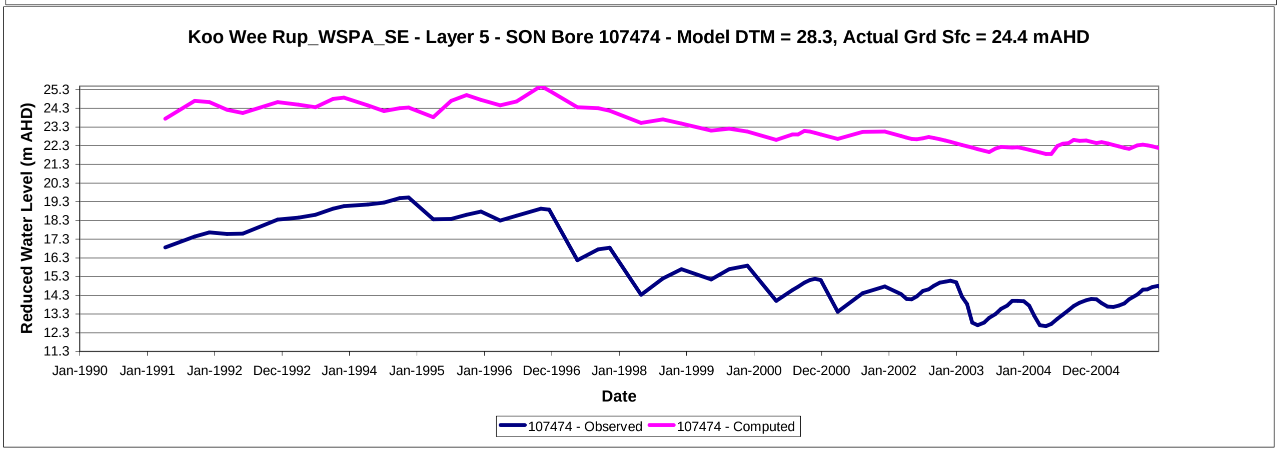


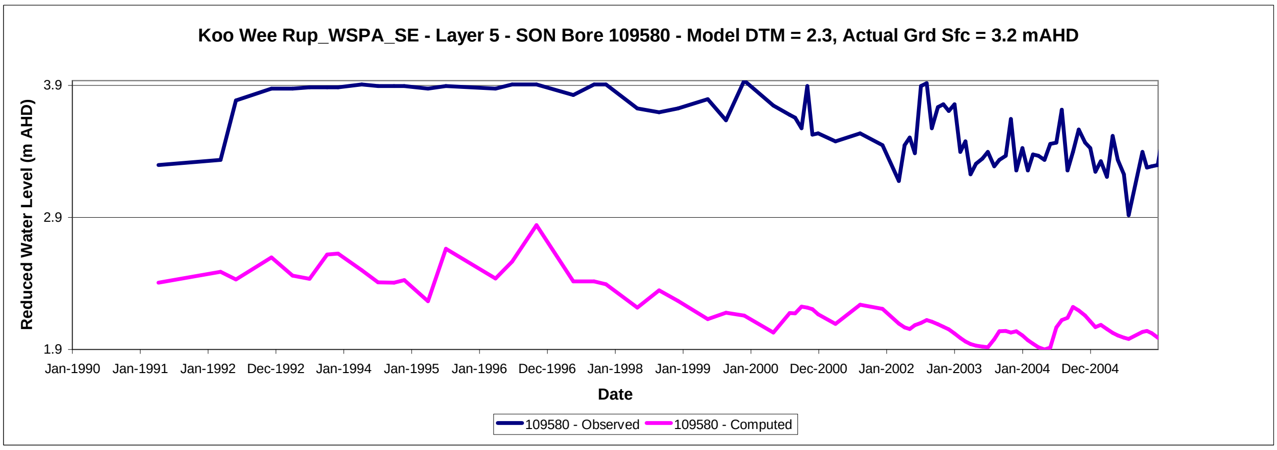
Koo Wee Rup_WSPA_SE - Layer 5 - SON Bore 74608 - Model DTM = 38.3, Actual Grd Sfc = 36.4 mAHD

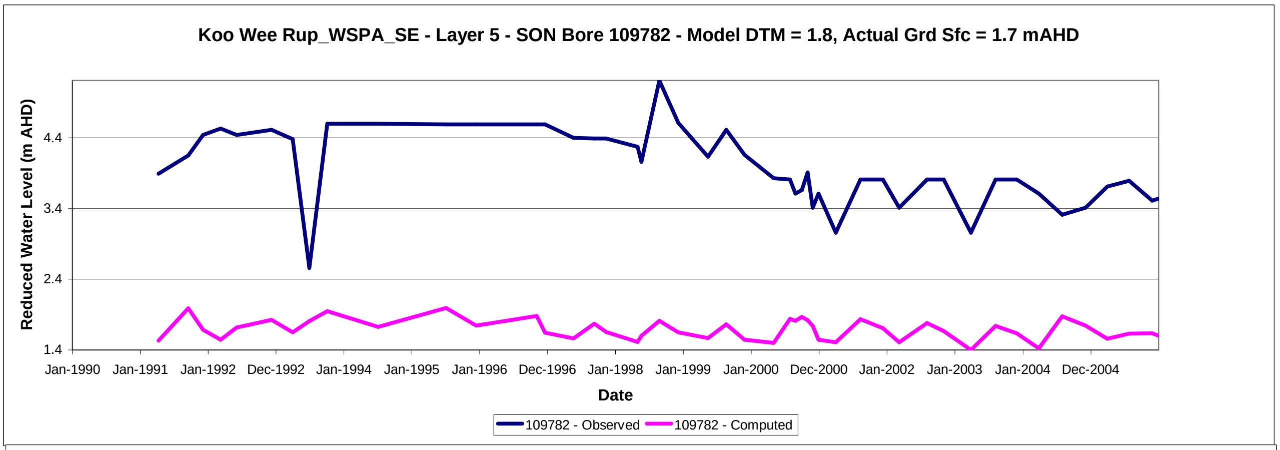


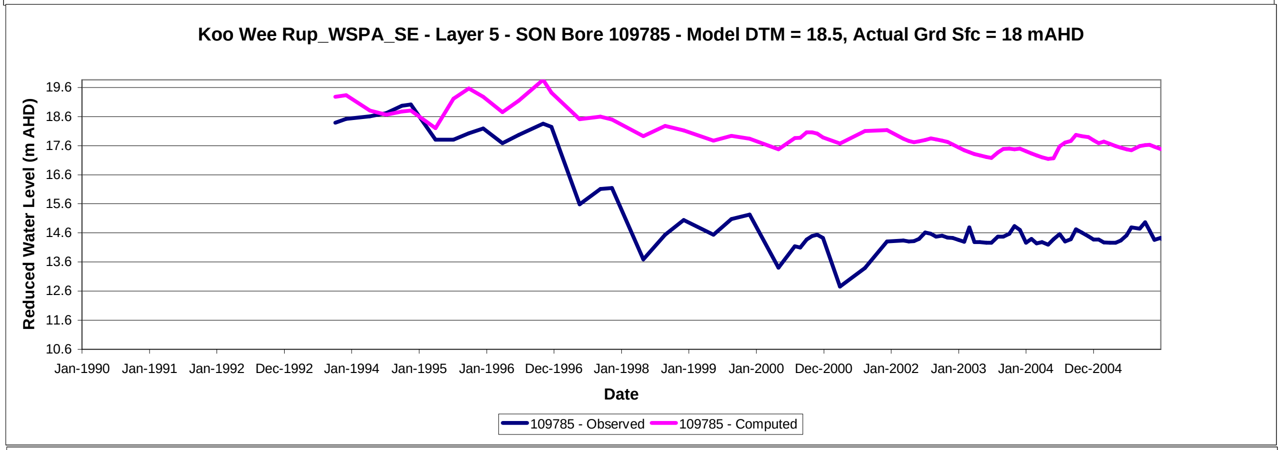

Koo Wee Rup_WSPA_SE - Layer 5 - SON Bore 106102 - Model DTM = 1.8, Actual Grd Sfc = 1.8 mAHD
Reduced Water Level (m AHD)
4.4
3.4
2.4
1.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
106102 - Observed
106102 - Computed

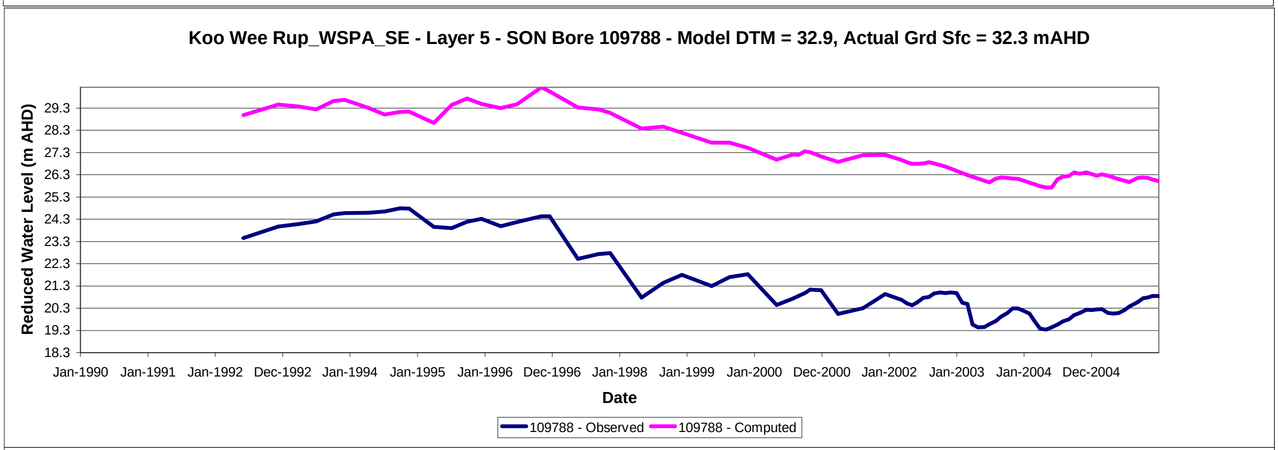

Koo Wee Rup_WSPA_SE - Layer 5 - SON Bore 107472 - Model DTM = 76.6, Actual Grd Sfc = 58.1 mAHD
Reduced Water Level (m AHD)
51.9 50.9 49.9 48.9 47.9 46.9 45.9 44.9 43.9 42.9 41.9 40.9 39.9 38.9 37.9 36.9 35.9 34.9 33.9
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
107472 - Observed
107472 - Computed

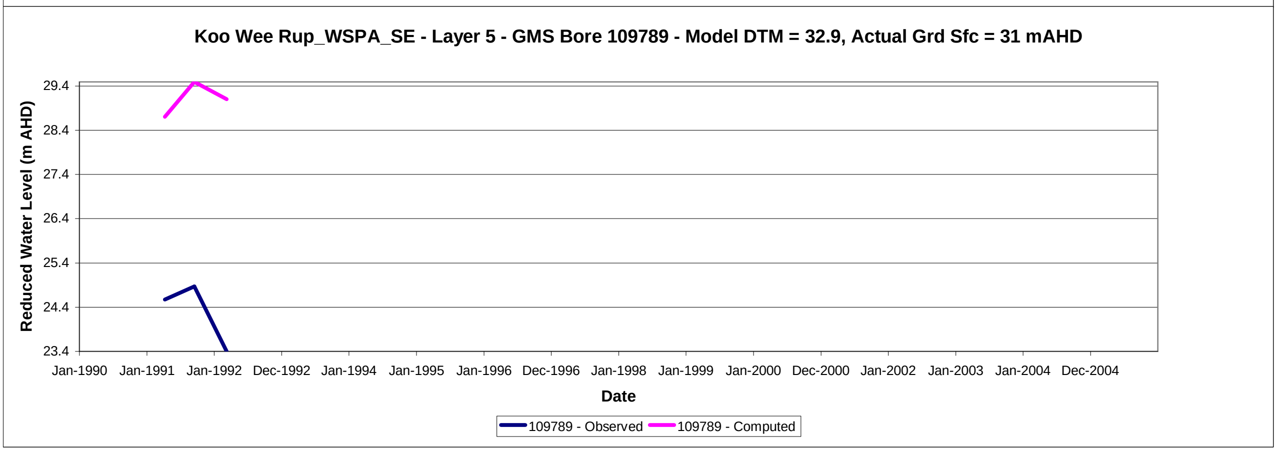

Koo Wee Rup_WSPA_SE - Layer 5 - SON Bore 107474 - Model DTM = 28.3, Actual Grd Sfc = 24.4 mAHD
Reduced Water Level (m AHD)
25.3 24.3 23.3 22.3 21.3 20.3 19.3 18.3 17.3 16.3 15.3 14.3 13.3 12.3 11.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
107474 - Observed
107474 - Computed


Koo Wee Rup_WSPA_SE - Layer 5 - SON Bore 109580 - Model DTM = 2.3, Actual Grd Sfc = 3.2 mAHD
Reduced Water Level (m AHD)
3.9
2.9
1.9
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109580 - Observed
109580 - Computed


Koo Wee Rup_WSPA_SE - Layer 5 - SON Bore 109782 - Model DTM = 1.8, Actual Grd Sfc = 1.7 mAHD
Reduced Water Level (m AHD)
4.4
3.4
2.4
1.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109782 - Observed
109782 - Computed


Koo Wee Rup_WSPA_SE - Layer 5 - SON Bore 109785 - Model DTM = 18.5, Actual Grd Sfc = 18 mAHD
Reduced Water Level (m AHD)
19.6
18.6
17.6
16.6
15.6
14.6
13.6
12.6
11.6
10.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109785 - Observed
109785 - Computed


Koo Wee Rup_WSPA_SE - Layer 5 - SON Bore 109788 - Model DTM = 32.9, Actual Grd Sfc = 32.3 mAHD
Reduced Water Level (m AHD)
29.3
28.3
27.3
26.3
25.3
24.3
23.3
22.3
21.3
20.3
19.3
18.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109788 - Observed
109788 - Computed


Koo Wee Rup_WSPA_SE - Layer 5 - GMS Bore 109789 - Model DTM = 32.9, Actual Grd Sfc = 31 mAHD
Reduced Water Level (m AHD)
29.4
28.4
27.4
26.4
25.4
24.4
23.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109789 - Observed
109789 - Computed

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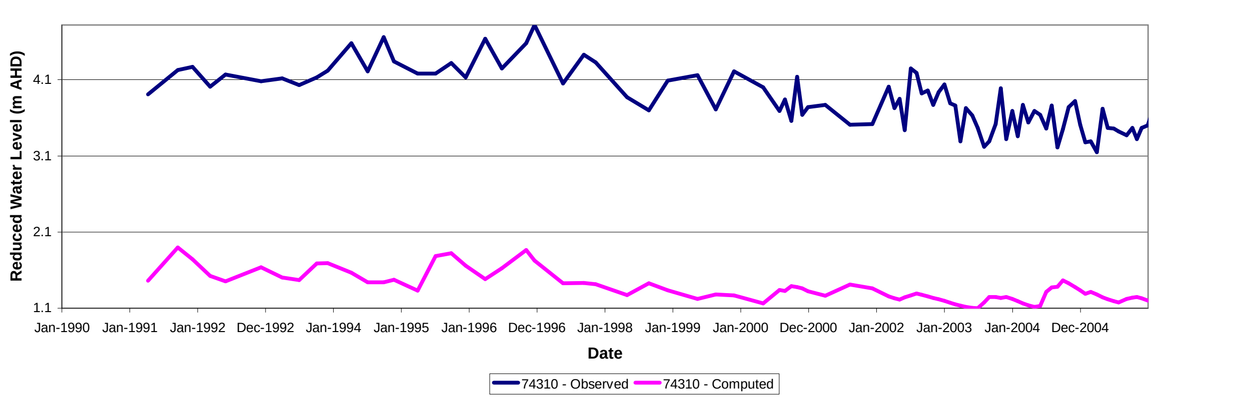
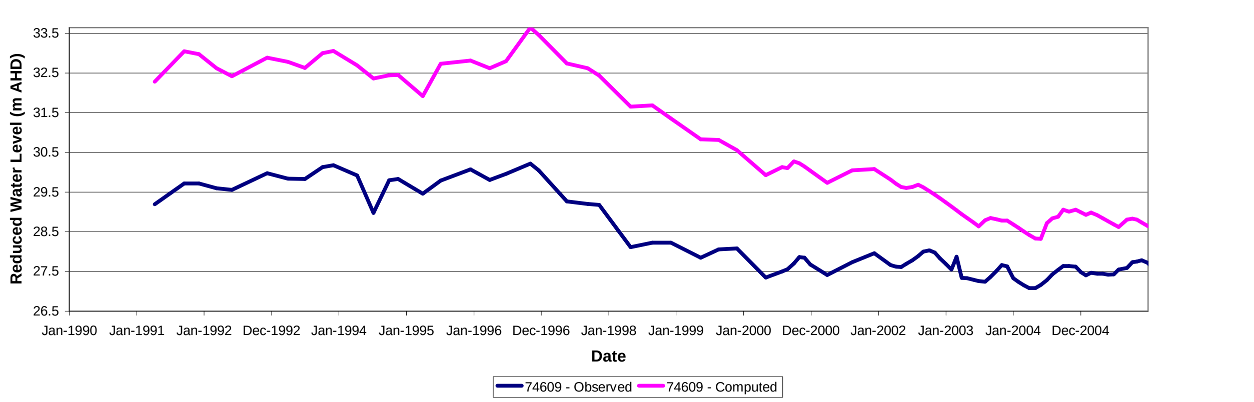
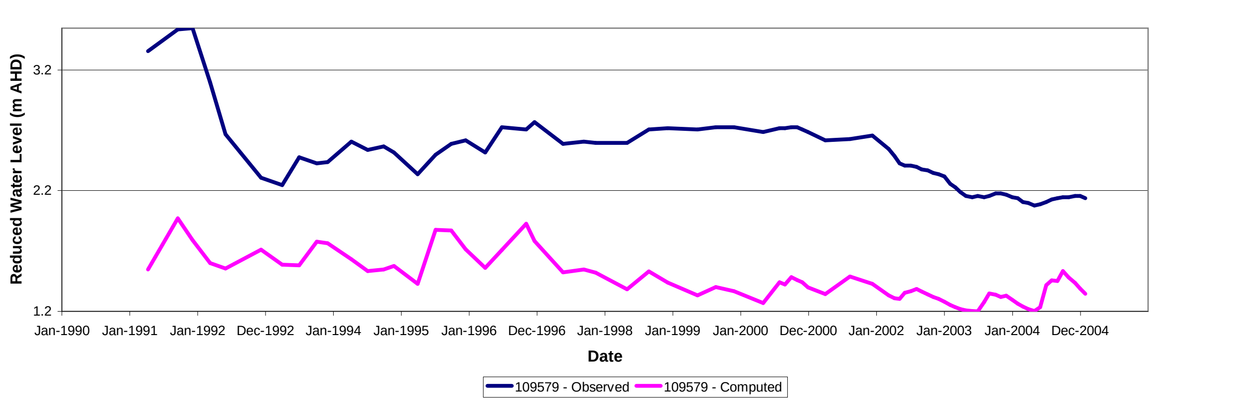
Koo Wee Rup_WSPA_SE - Layer 4 - SON Bore 74310 - Model DTM = 12.2, Actual Grd Sfc = 12.7 mAHD



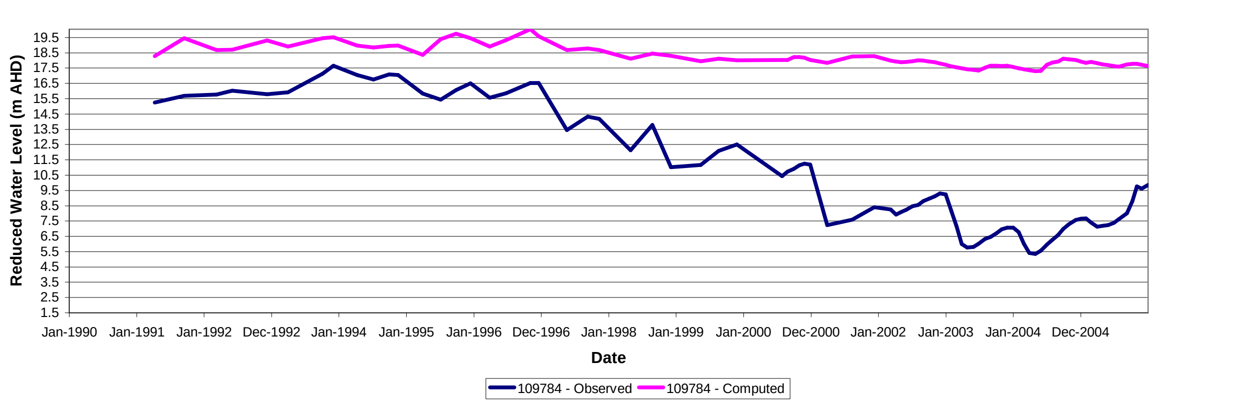
Koo Wee Rup_WSPA_SE - Layer 4 - SON Bore 74609 - Model DTM = 38.4, Actual Grd Sfc = 36.3 mAHD

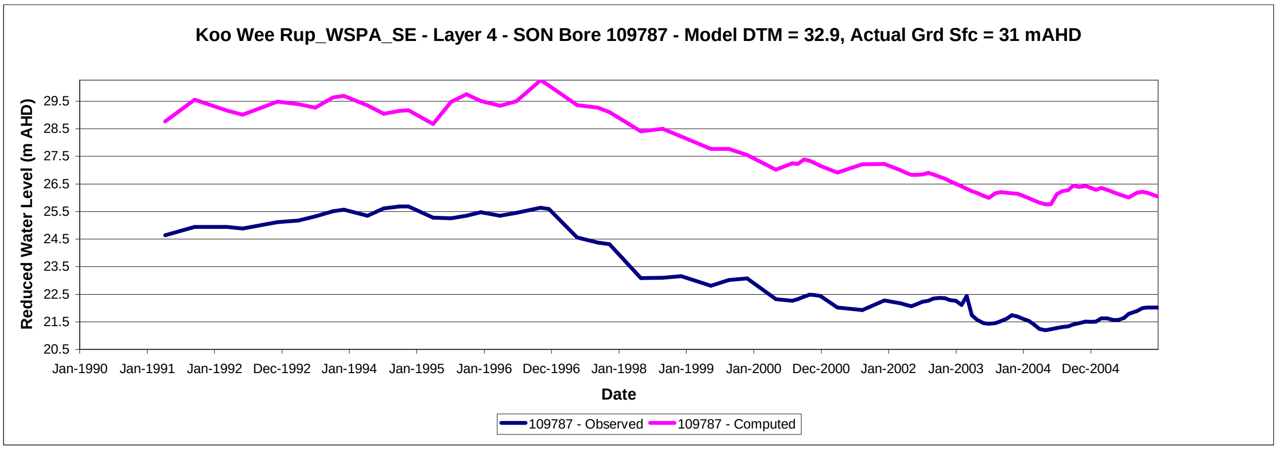


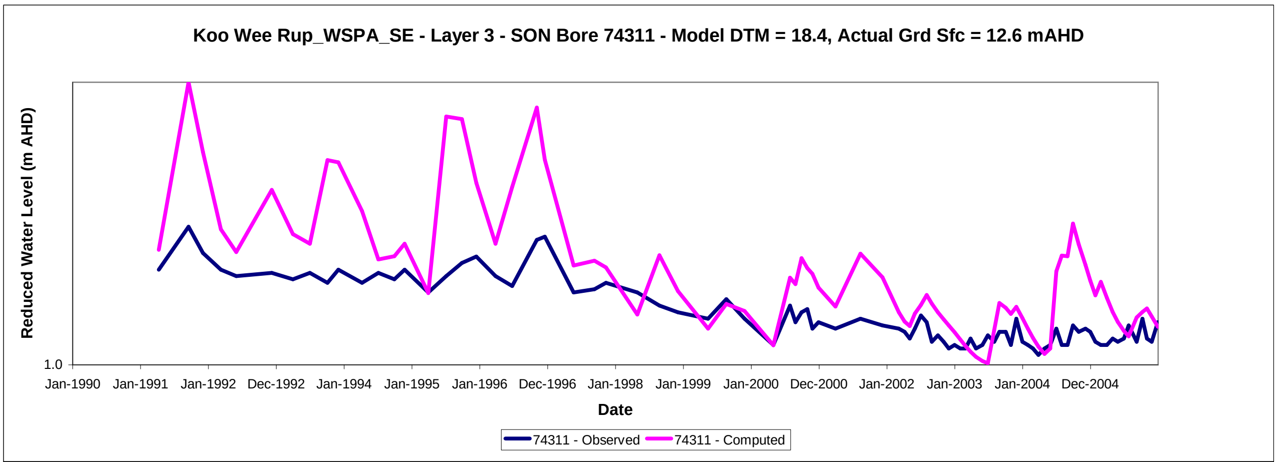
Koo Wee Rup_WSPA_SE - Layer 4 - SON Bore 109579 - Model DTM = 2.3, Actual Grd Sfc = 3.2 mAHD

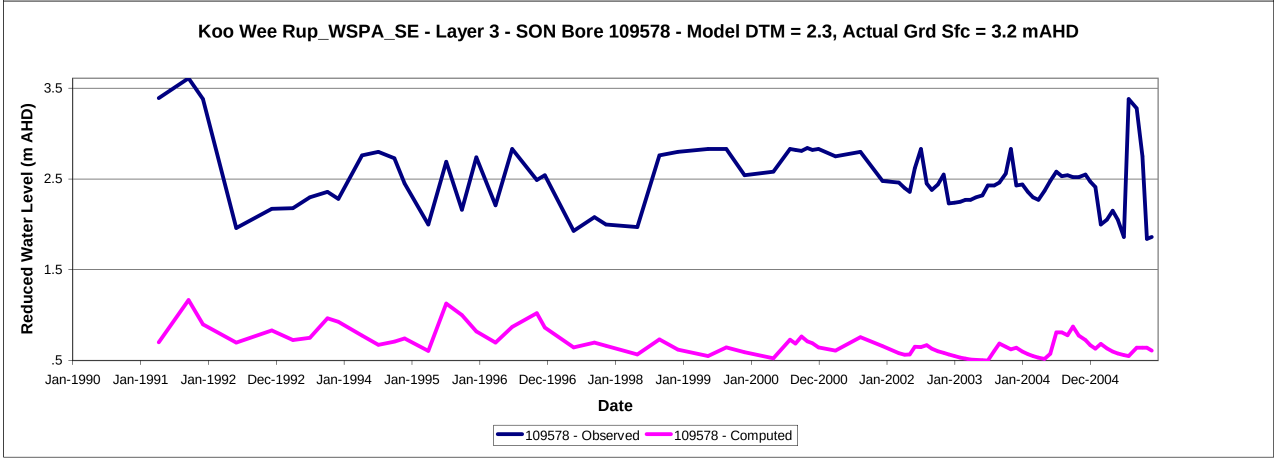


Koo Wee Rup_WSPA_SE - Layer 4 - SON Bore 109784 - Model DTM = 18.5, Actual Grd Sfc = 18 mAHD




Koo Wee Rup_WSPA_SE - Layer 4 - SON Bore 109787 - Model DTM = 32.9, Actual Grd Sfc = 31 mAHD
Reduced Water Level (m AHD)
29.5
28.5
27.5
26.5
25.5
24.5
23.5
22.5
21.5
20.5
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109787 - Observed
109787 - Computed


Koo Wee Rup_WSPA_SE - Layer 3 - SON Bore 74311 - Model DTM = 18.4, Actual Grd Sfc = 12.6 mAHD
Reduced Water Level (m AHD)
1.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
74311 - Observed
74311 - Computed


Koo Wee Rup_WSPA_SE - Layer 3 - SON Bore 109578 - Model DTM = 2.3, Actual Grd Sfc = 3.2 mAHD
Reduced Water Level (m AHD)
3.5
2.5
1.5
.5
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109578 - Observed
109578 - Computed

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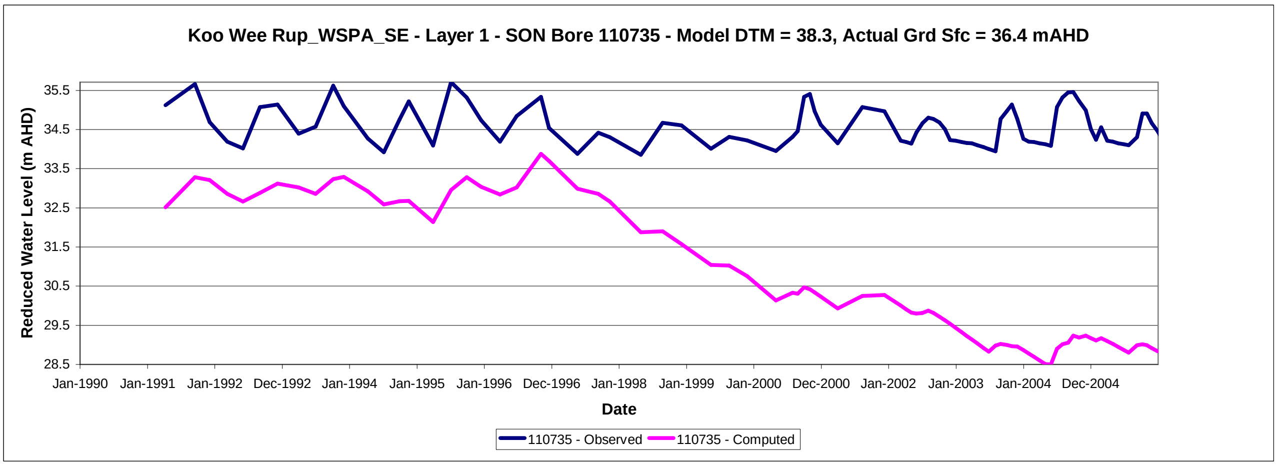
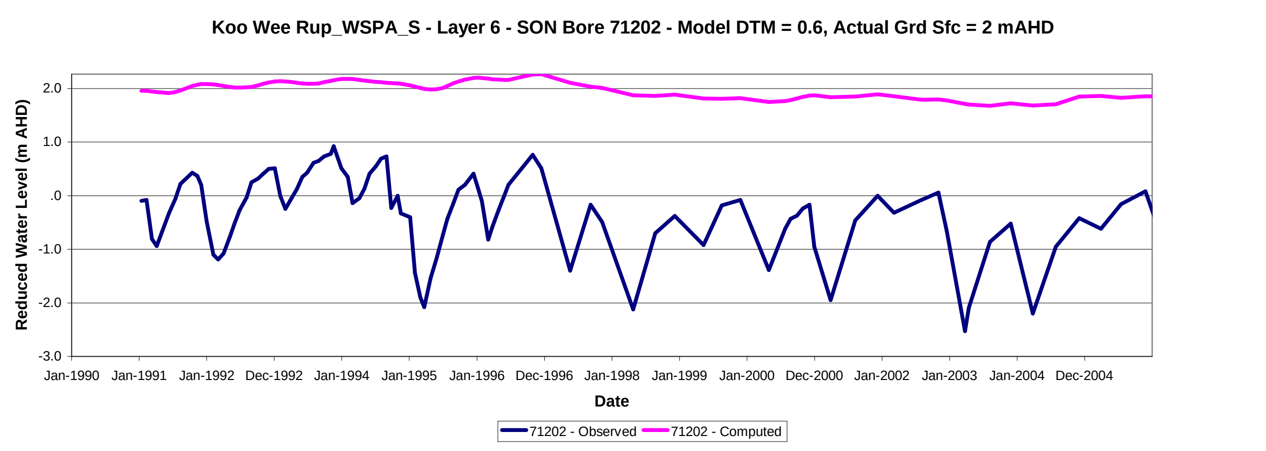
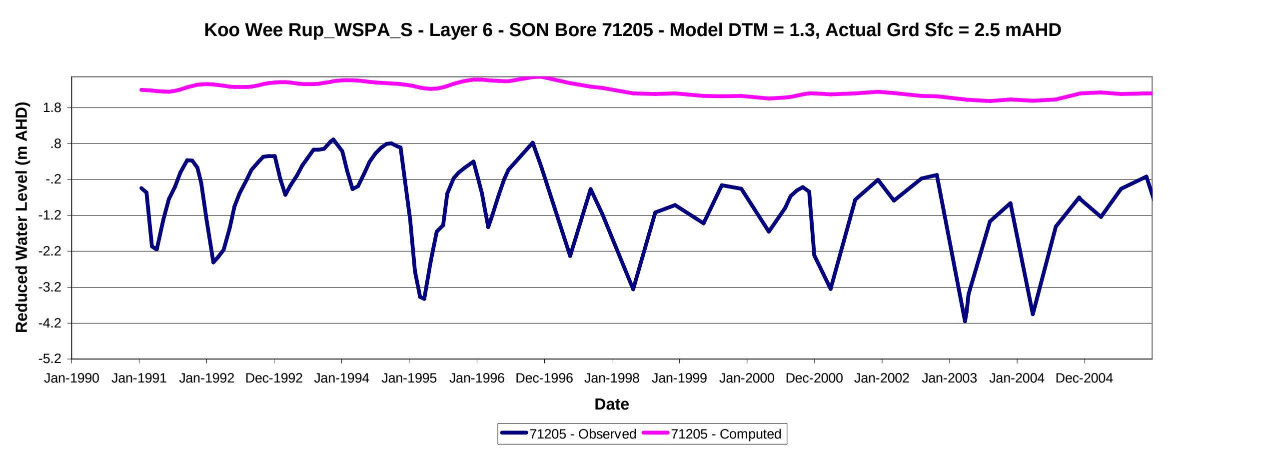
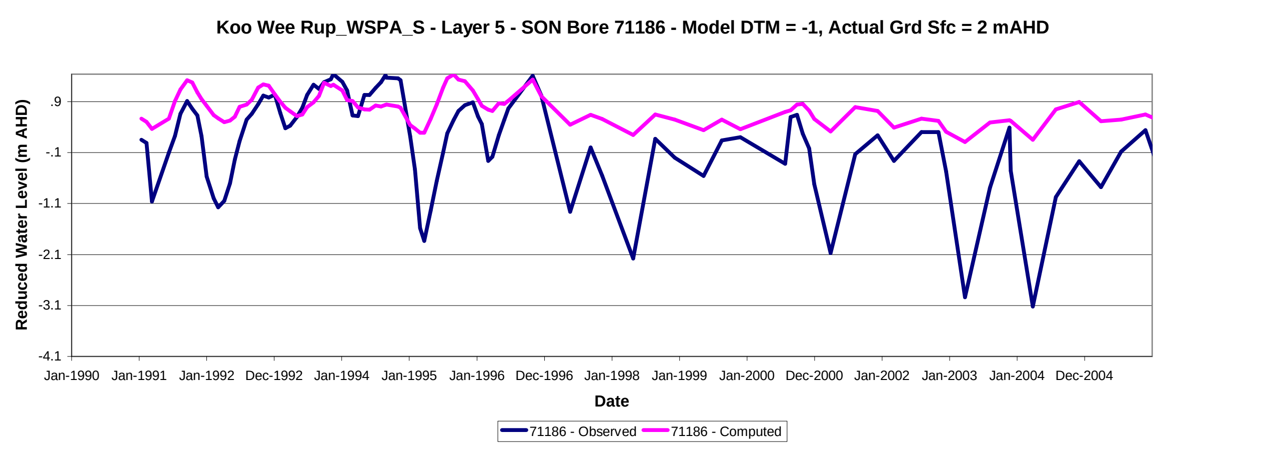
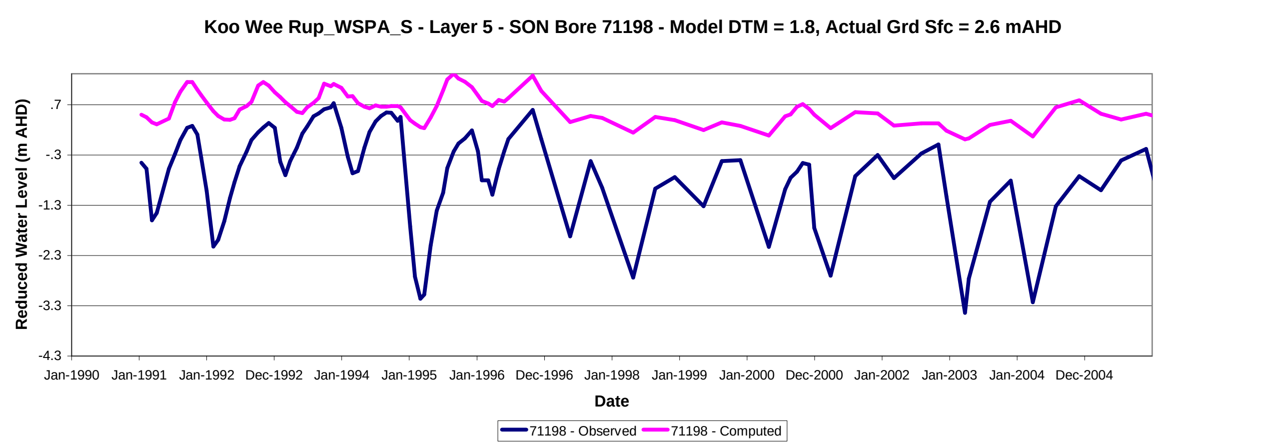
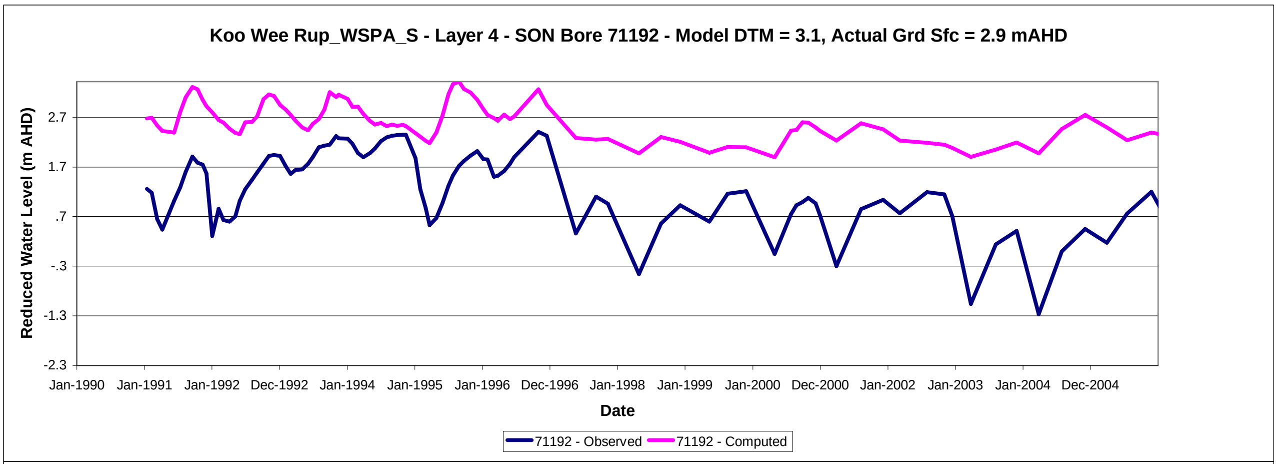


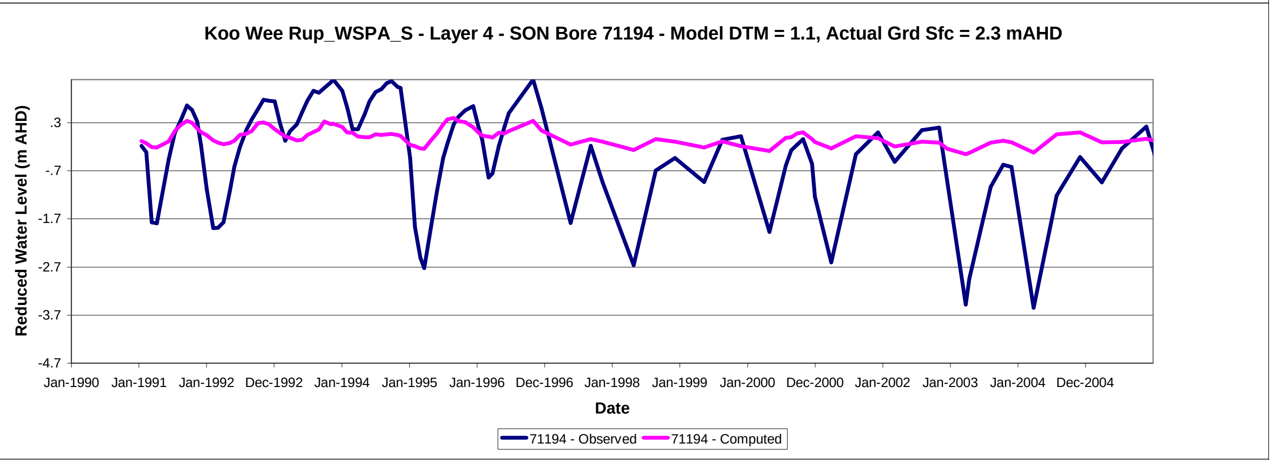

Koo Wee Rup_WSPA_S - Layer 6 - SON Bore 71202 - Model DTM = 0.6, Actual Grd Sfc = 2 mAHD
Reduced Water Level (m AHD)
2.0
1.0
.0
-1.0
-2.0
-3.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71202 - Observed
71202 - Computed

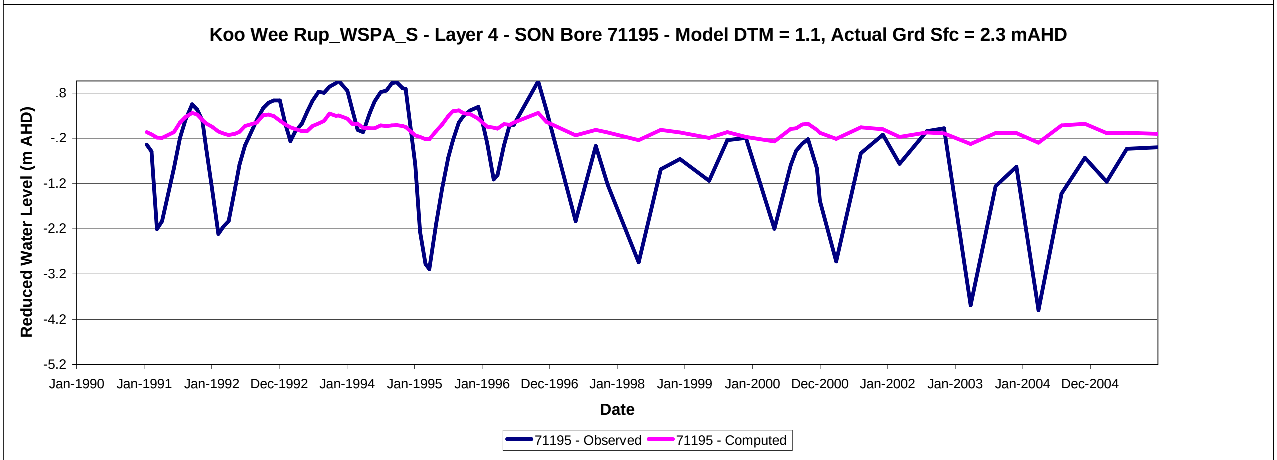

Koo Wee Rup_WSPA_S - Layer 6 - SON Bore 71205 - Model DTM = 1.3, Actual Grd Sfc = 2.5 mAHD
Reduced Water Level (m AHD)
1.8
.8
-.2
-1.2
-2.2
-3.2
-4.2
-5.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71205 - Observed
71205 - Computed

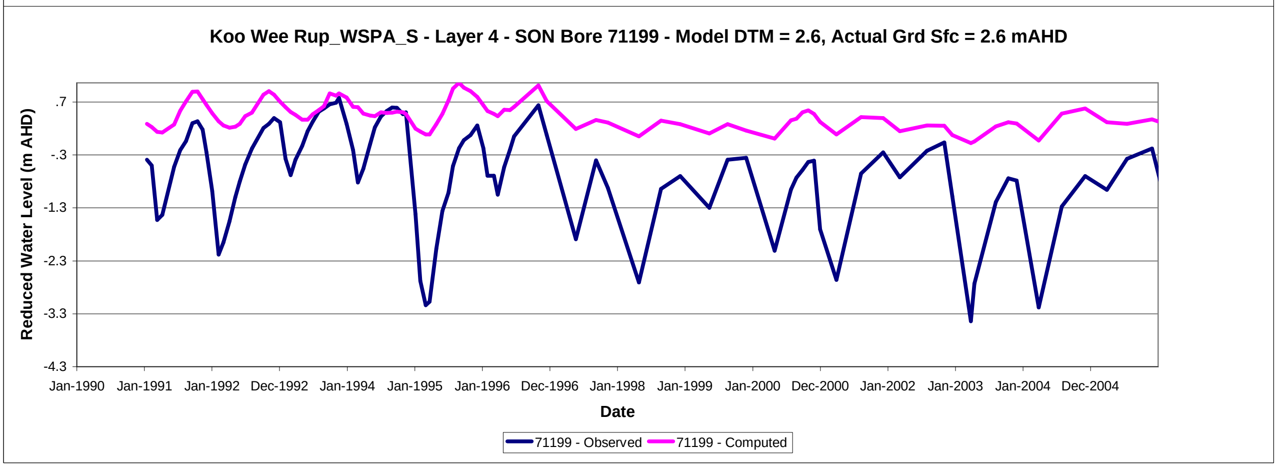

Koo Wee Rup_WSPA_S - Layer 5 - SON Bore 71186 - Model DTM = -1, Actual Grd Sfc = 2 mAHD
Reduced Water Level (m AHD)
.9
-.1
-1.1
-2.1
-3.1
-4.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71186 - Observed
71186 - Computed

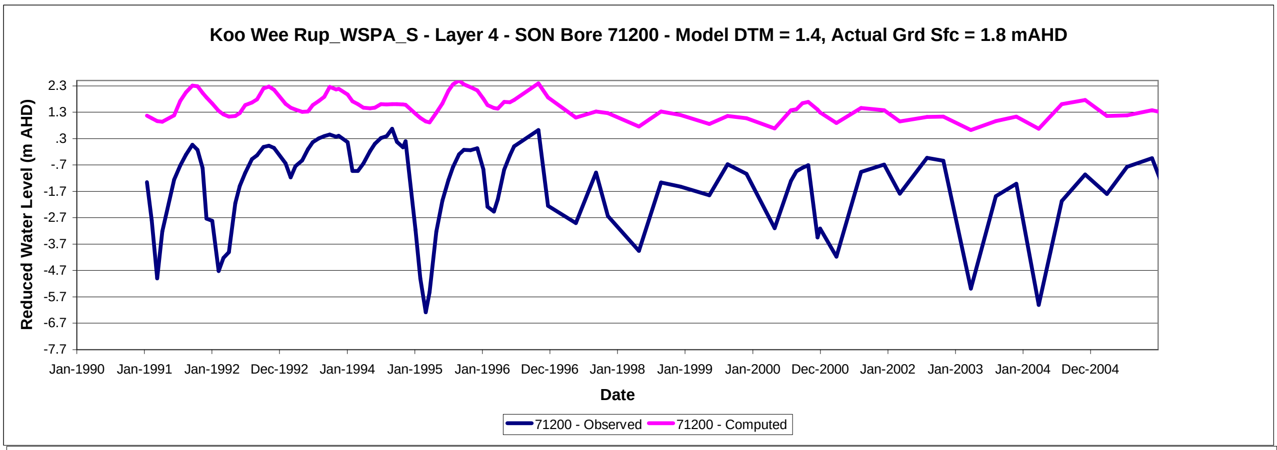

Koo Wee Rup_WSPA_S - Layer 5 - SON Bore 71198 - Model DTM = 1.8, Actual Grd Sfc = 2.6 mAHD
Reduced Water Level (m AHD)
.7
-.3
-1.3
-2.3
-3.3
-4.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71198 - Observed
71198 - Computed

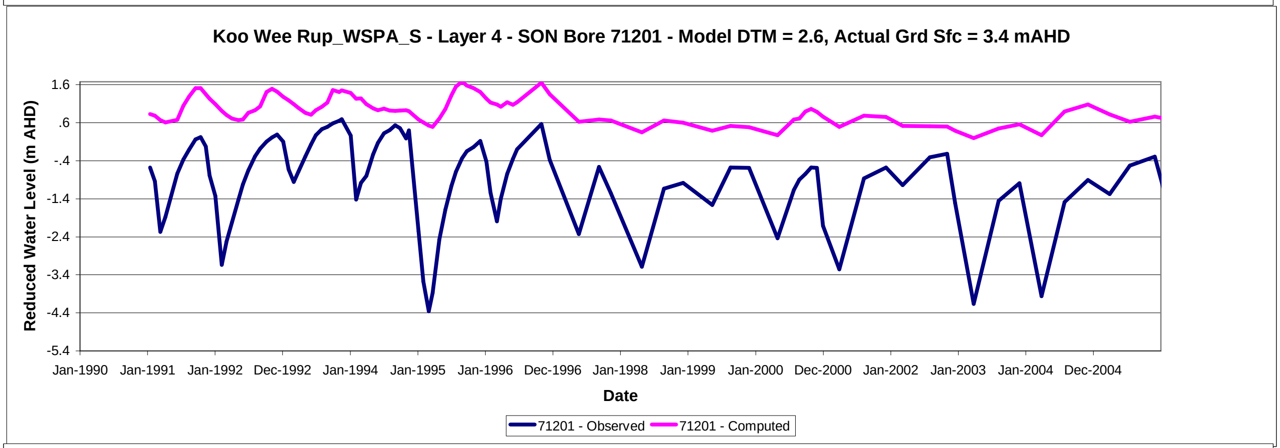

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71192 - Model DTM = 3.1, Actual Grd Sfc = 2.9 mAHD
Reduced Water Level (m AHD)
2.7
1.7
.7
-.3
-1.3
-2.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
71192 - Observed
71192 - Computed

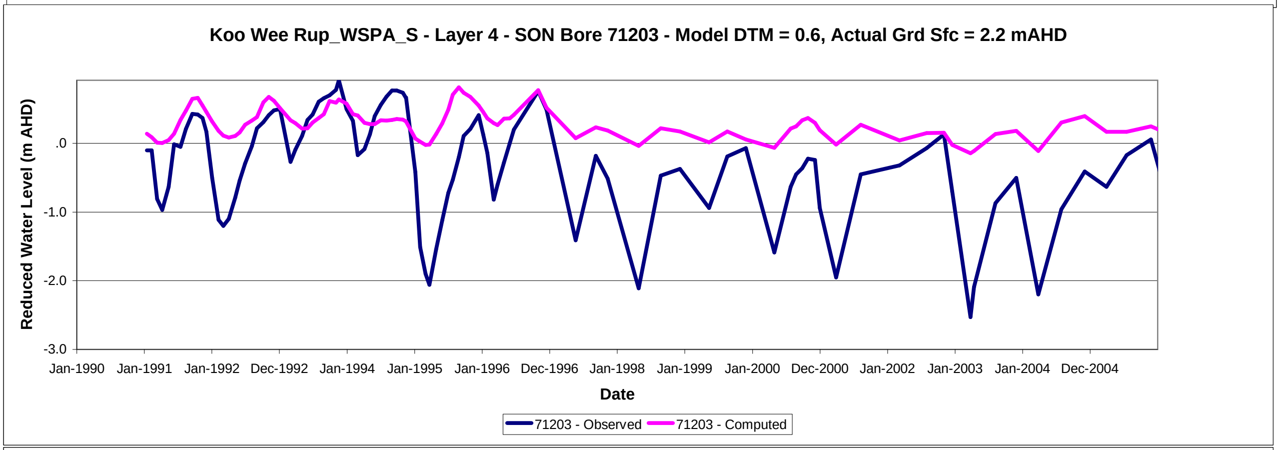

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71194 - Model DTM = 1.1, Actual Grd Sfc = 2.3 mAHD
Reduced Water Level (m AHD)
.3
-.7
-1.7
-2.7
-3.7
-4.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
71194 - Observed
71194 - Computed

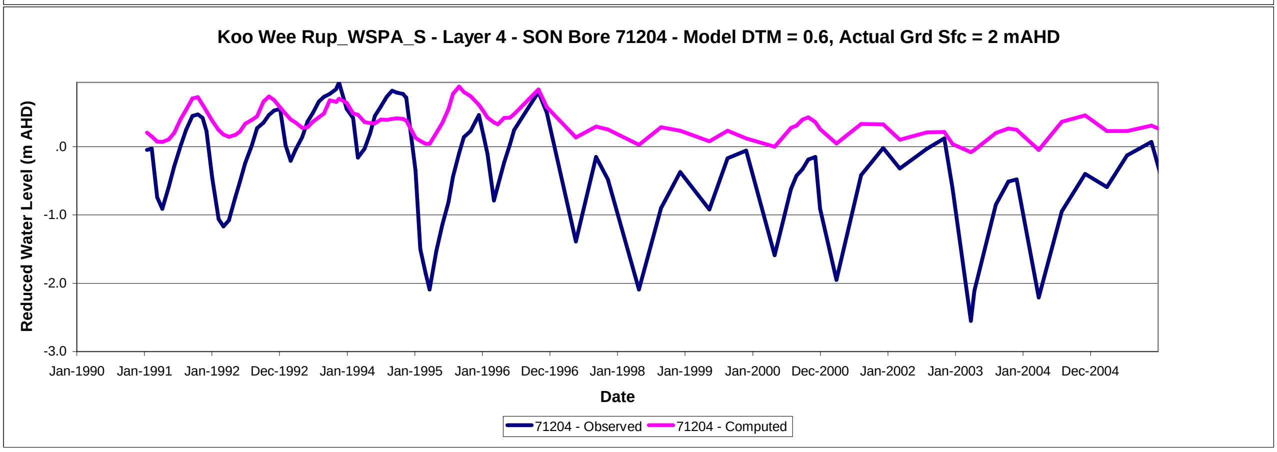

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71195 - Model DTM = 1.1, Actual Grd Sfc = 2.3 mAHD
Reduced Water Level (m AHD)
.8
-.2
-1.2
-2.2
-3.2
-4.2
-5.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
71195 - Observed
71195 - Computed

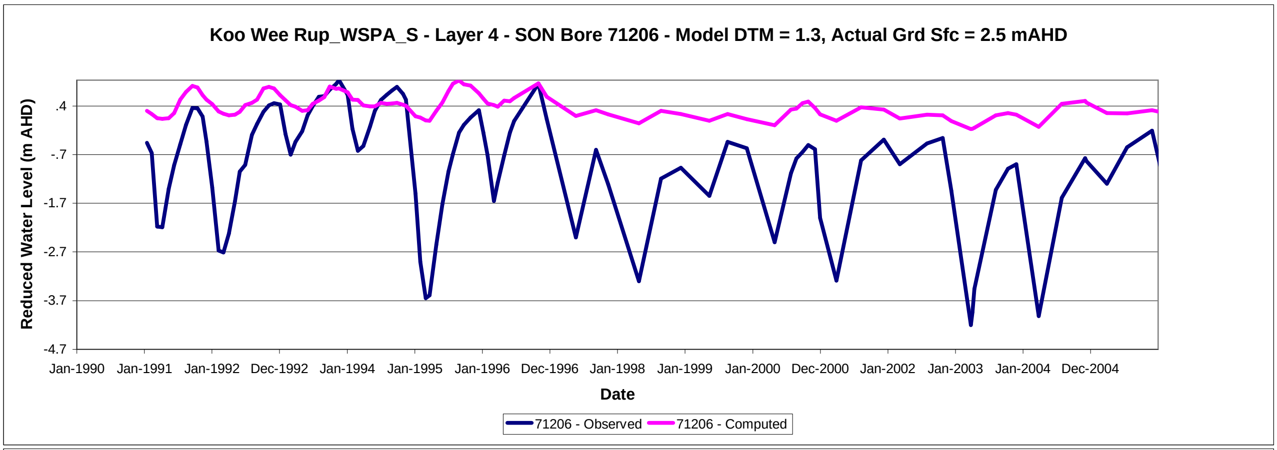

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71199 - Model DTM = 2.6, Actual Grd Sfc = 2.6 mAHD
Reduced Water Level (m AHD)
.7
-.3
-1.3
-2.3
-3.3
-4.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
71199 - Observed
71199 - Computed

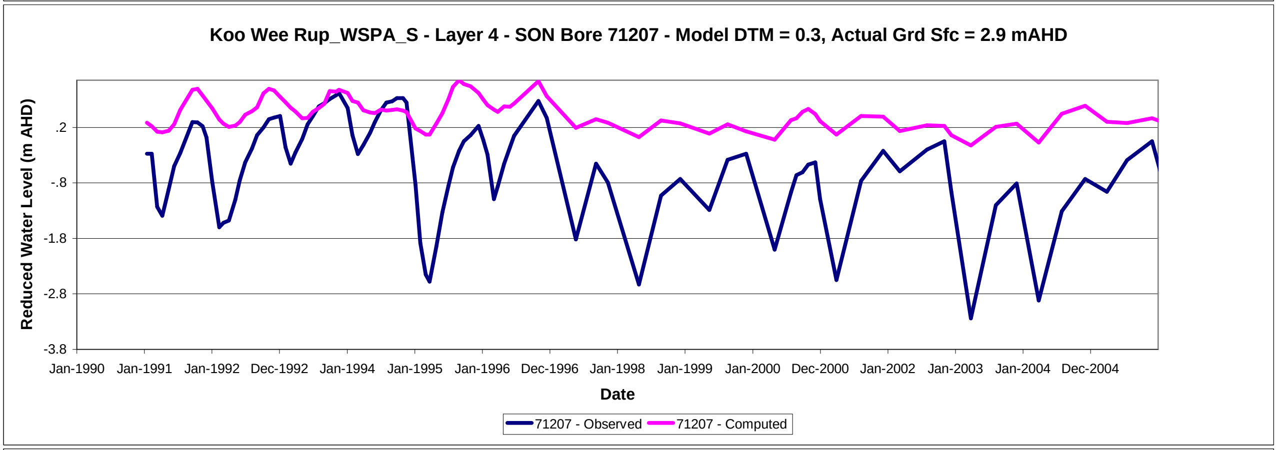

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71200 - Model DTM = 1.4, Actual Grd Sfc = 1.8 mAHD
Reduced Water Level (m AHD)
2.3
1.3
.3
-.7
-1.7
-2.7
-3.7
-4.7
-5.7
-6.7
-7.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71200 - Observed
71200 - Computed

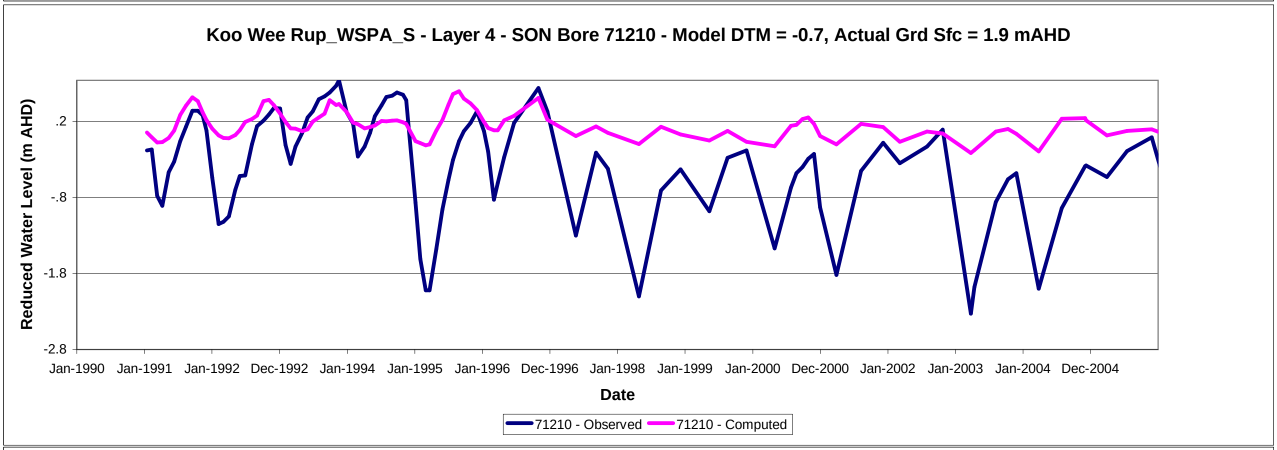

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71201 - Model DTM = 2.6, Actual Grd Sfc = 3.4 mAHD
Reduced Water Level (m AHD)
1.6
.6
-.4
-1.4
-2.4
-3.4
-4.4
-5.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71201 - Observed
71201 - Computed

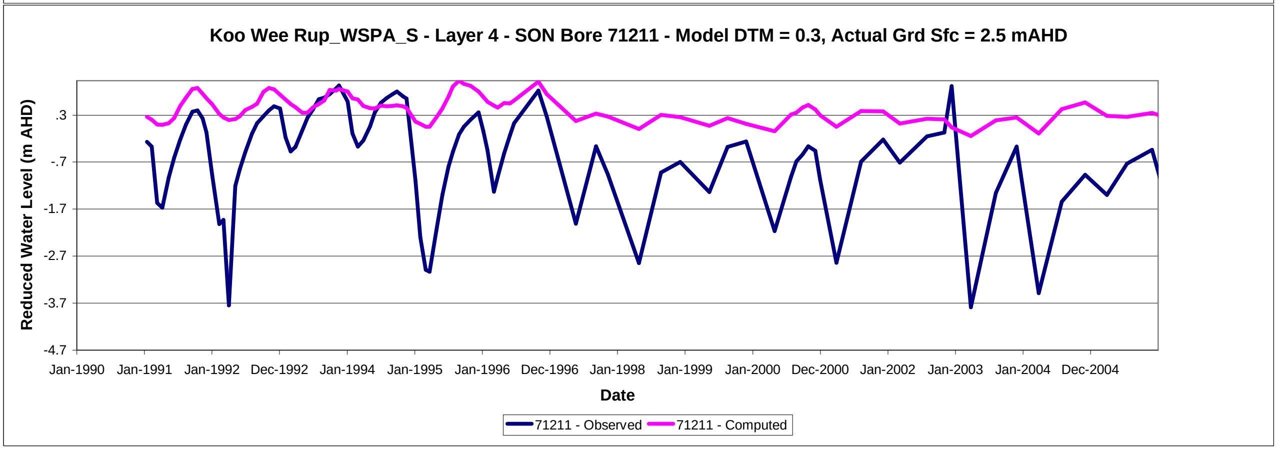

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71203 - Model DTM = 0.6, Actual Grd Sfc = 2.2 mAHD
Reduced Water Level (m AHD)
.0
-1.0
-2.0
-3.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71203 - Observed
71203 - Computed

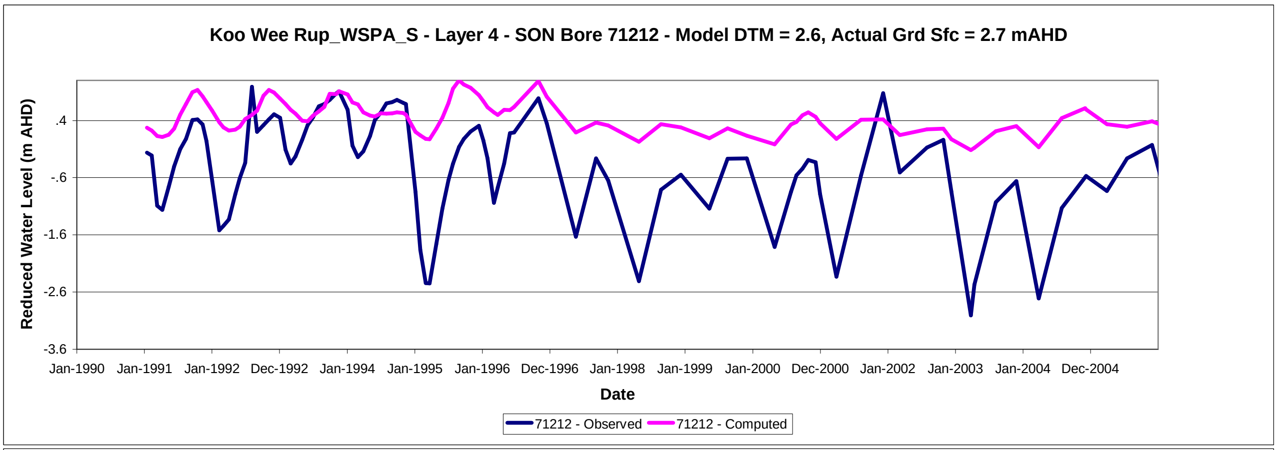

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71204 - Model DTM = 0.6, Actual Grd Sfc = 2 mAHD
Reduced Water Level (m AHD)
.0
-1.0
-2.0
-3.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71204 - Observed
71204 - Computed

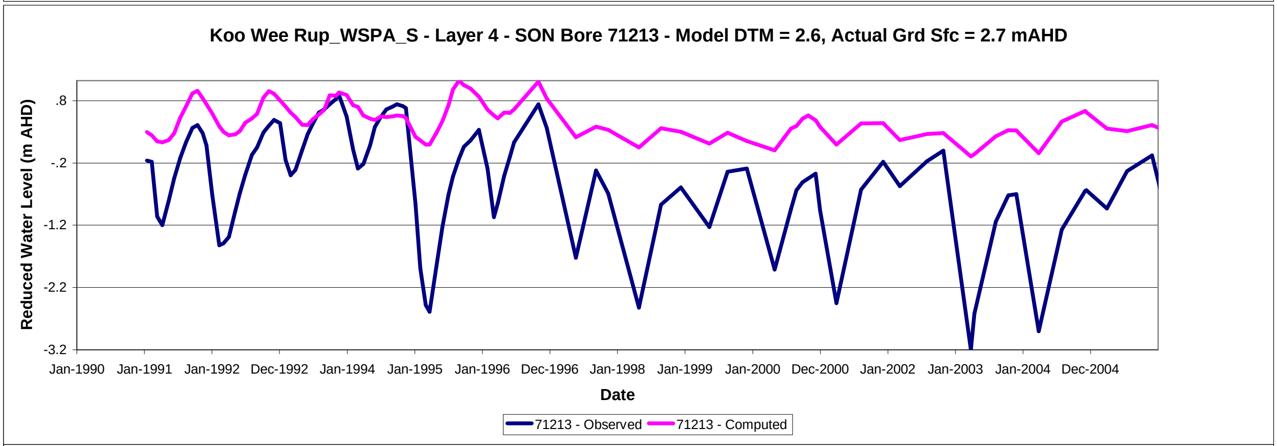

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71206 - Model DTM = 1.3, Actual Grd Sfc = 2.5 mAHD
Reduced Water Level (m AHD)
.4
-.7
-1.7
-2.7
-3.7
-4.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
71206 - Observed
71206 - Computed

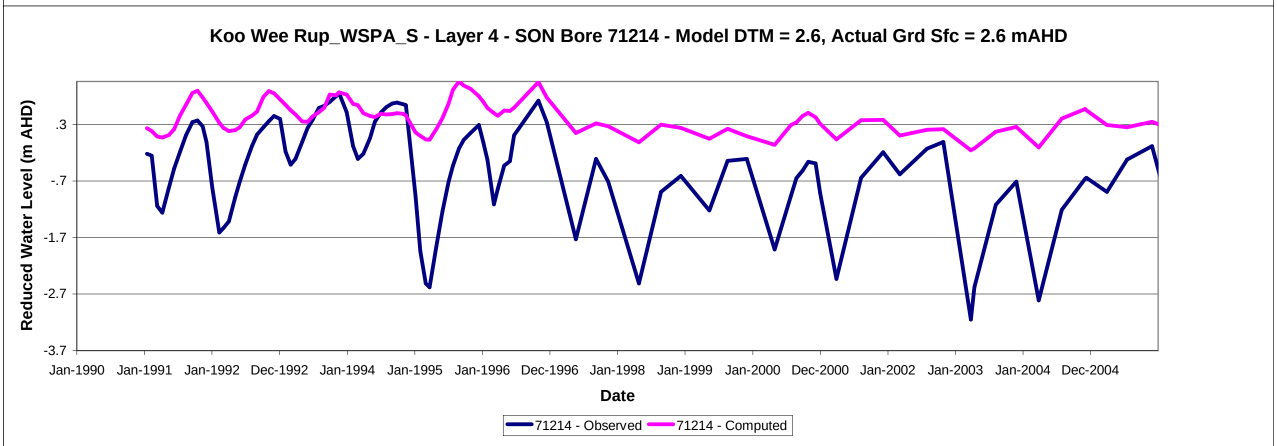

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71207 - Model DTM = 0.3, Actual Grd Sfc = 2.9 mAHD
Reduced Water Level (m AHD)
.2
-.8
-1.8
-2.8
-3.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
71207 - Observed
71207 - Computed

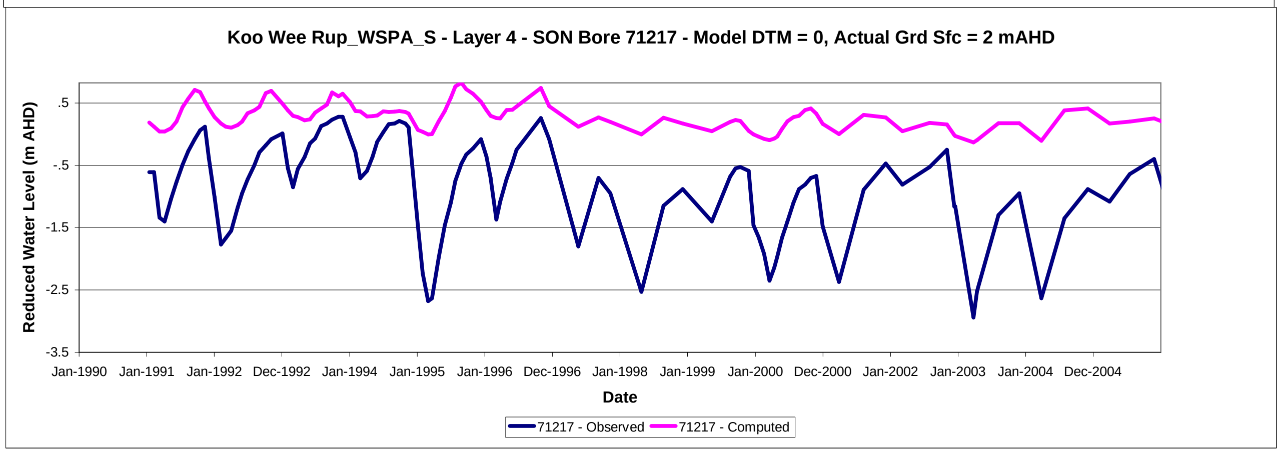

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71210 - Model DTM = -0.7, Actual Grd Sfc = 1.9 mAHD
Reduced Water Level (m AHD)
.2
-.8
-1.8
-2.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
71210 - Observed
71210 - Computed

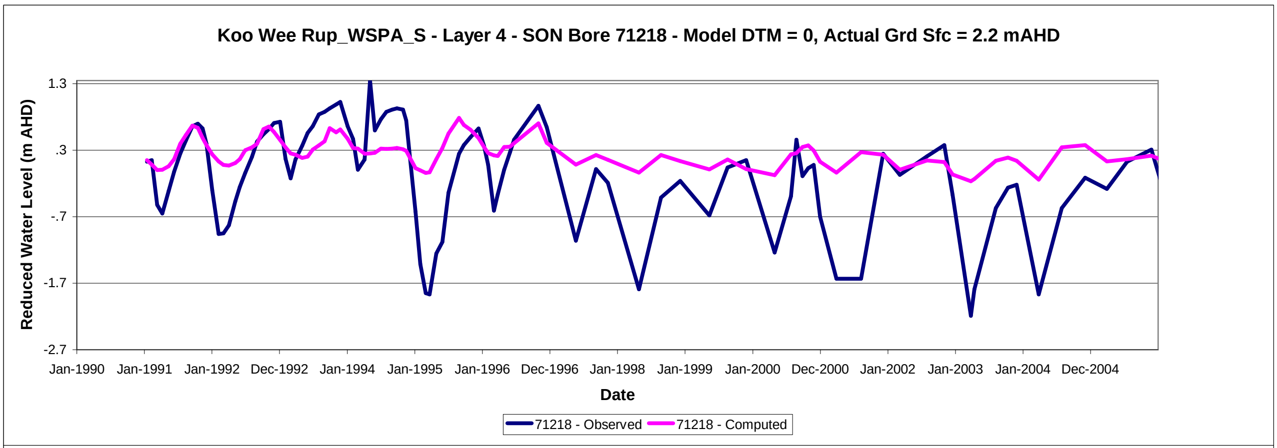

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71211 - Model DTM = 0.3, Actual Grd Sfc = 2.5 mAHD
Reduced Water Level (m AHD)
.3
-.7
-1.7
-2.7
-3.7
-4.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
71211 - Observed
71211 - Computed

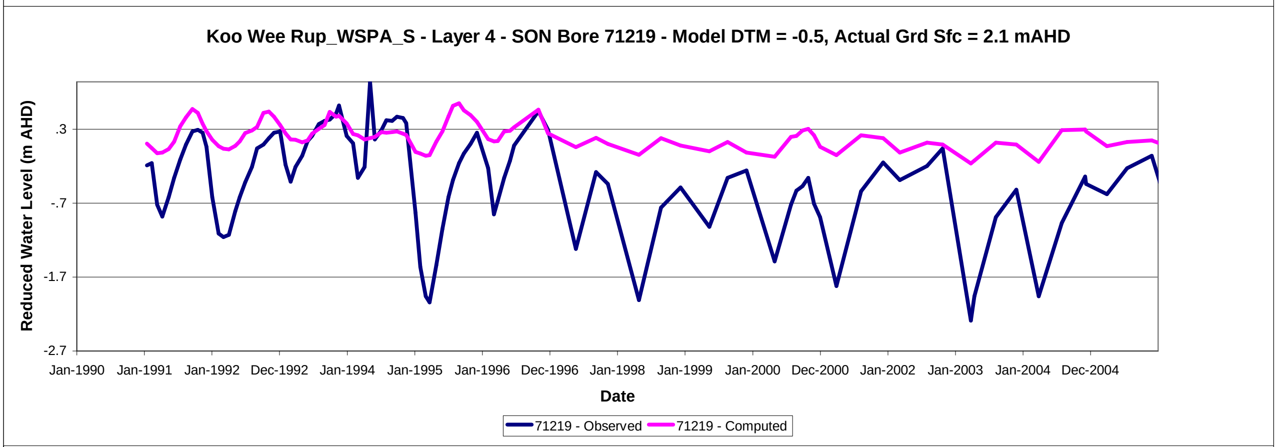

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71212 - Model DTM = 2.6, Actual Grd Sfc = 2.7 mAHD
Reduced Water Level (m AHD)
.4
-.6
-1.6
-2.6
-3.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71212 - Observed
71212 - Computed

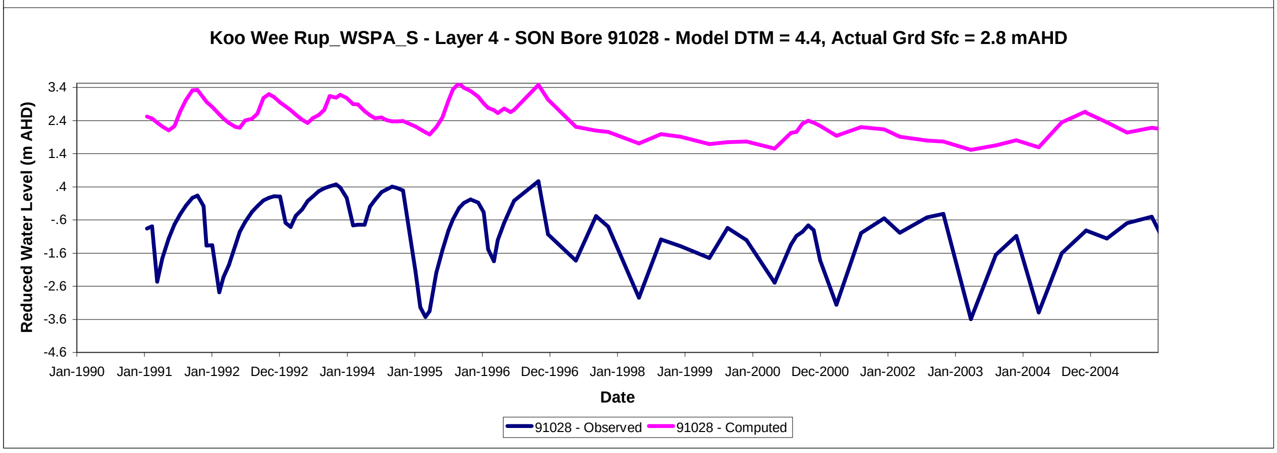

Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71213 - Model DTM = 2.6, Actual Grd Sfc = 2.7 mAHD
Reduced Water Level (m AHD)
.8
-.2
-1.2
-2.2
-3.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71213 - Observed
71213 - Computed


Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71214 - Model DTM = 2.6, Actual Grd Sfc = 2.6 mAHD
Reduced Water Level (m AHD)
.3
-.7
-1.7
-2.7
-3.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71214 - Observed
71214 - Computed


Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71217 - Model DTM = 0, Actual Grd Sfc = 2 mAHD
Reduced Water Level (m AHD)
.5
-.5
-1.5
-2.5
-3.5
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71217 - Observed
71217 - Computed


Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71218 - Model DTM = 0, Actual Grd Sfc = 2.2 mAHD
Reduced Water Level (m AHD)
1.3
.3
-.7
-1.7
-2.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
71218 - Observed
71218 - Computed


Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 71219 - Model DTM = -0.5, Actual Grd Sfc = 2.1 mAHD
Reduced Water Level (m AHD)
.3
-.7
-1.7
-2.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
71219 - Observed
71219 - Computed


Koo Wee Rup_WSPA_S - Layer 4 - SON Bore 91028 - Model DTM = 4.4, Actual Grd Sfc = 2.8 mAHD
Reduced Water Level (m AHD)
3.4
2.4
1.4
.4
-.6
-1.6
-2.6
-3.6
-4.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
91028 - Observed
91028 - Computed

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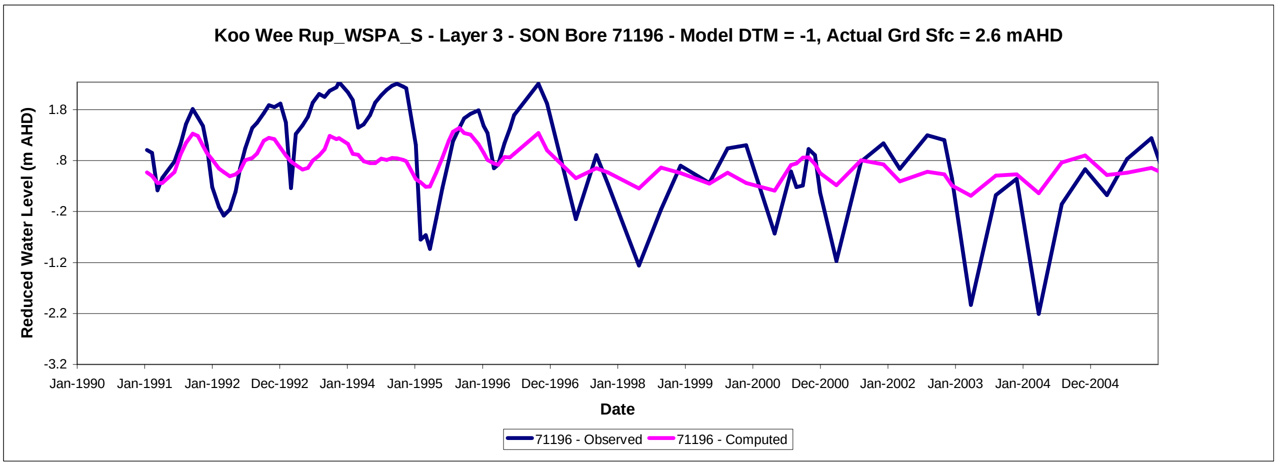

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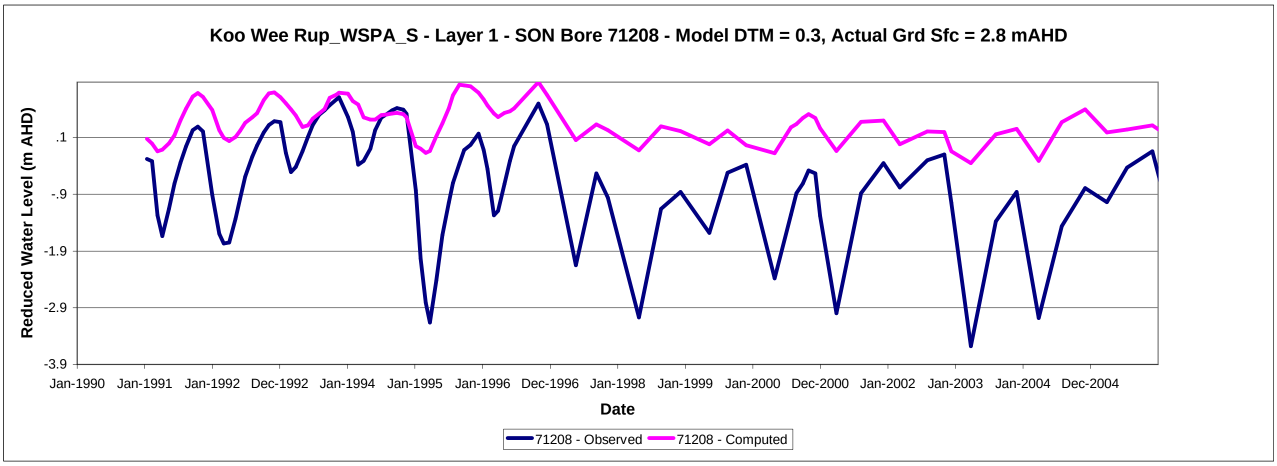
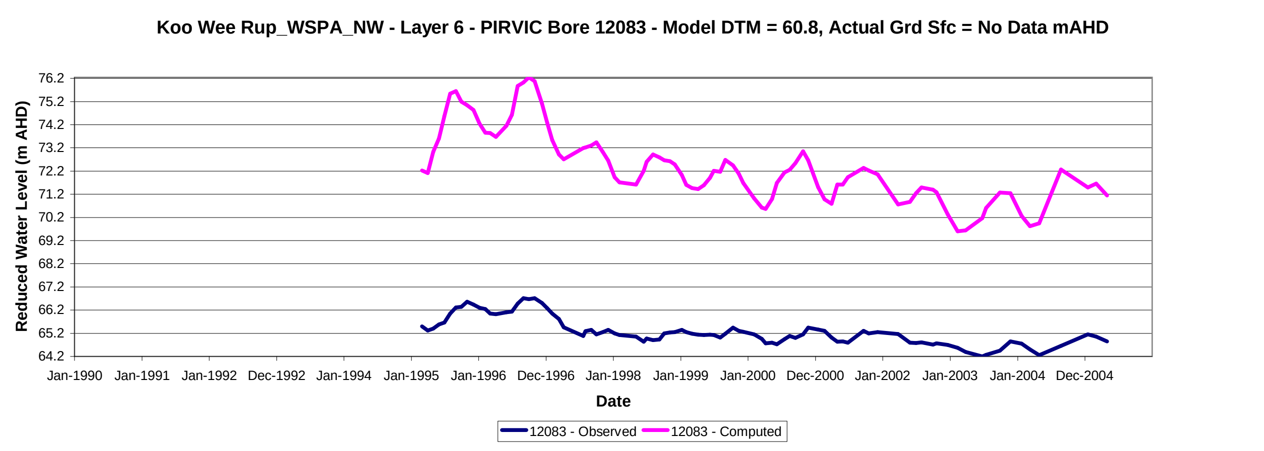
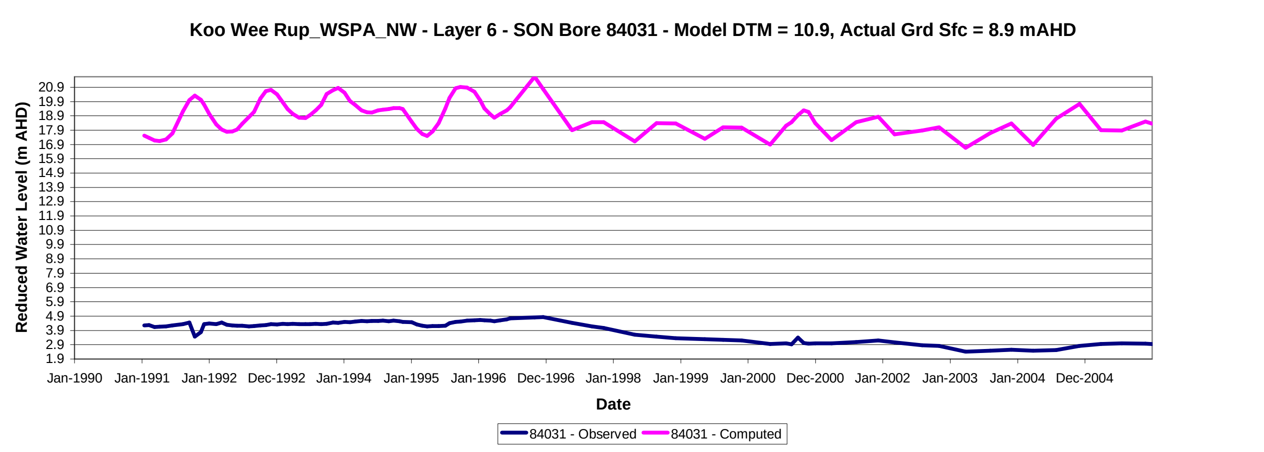
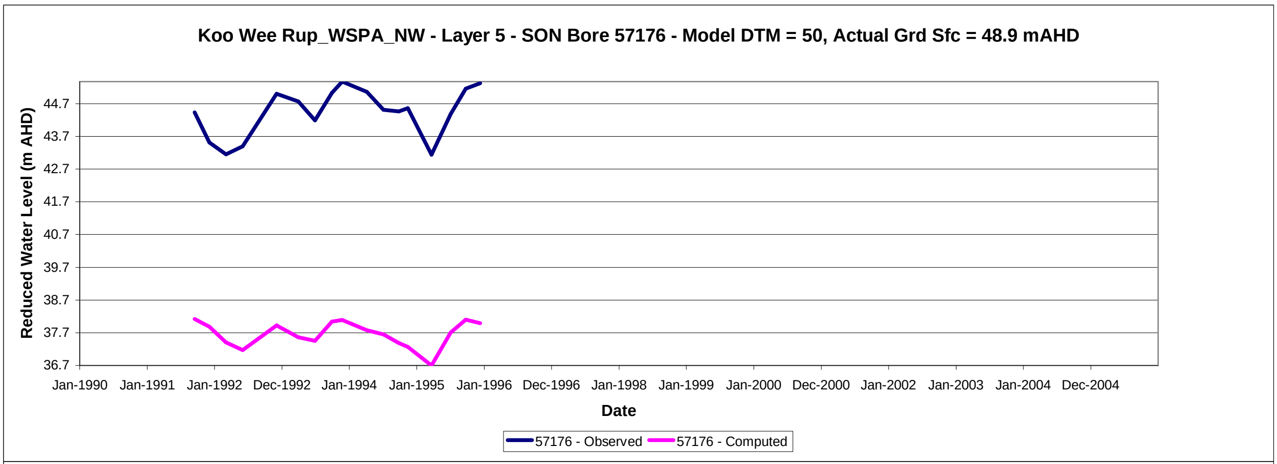
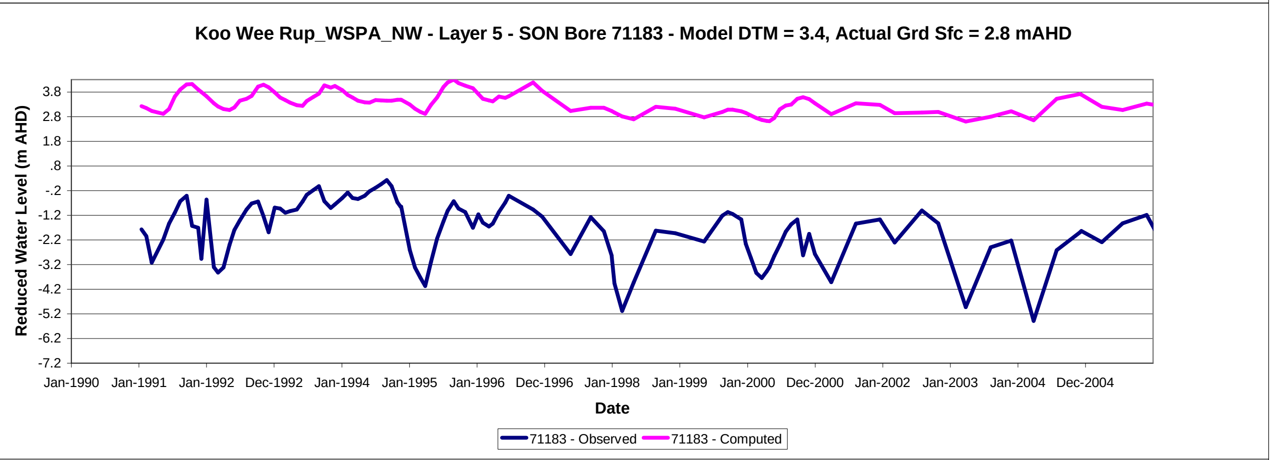
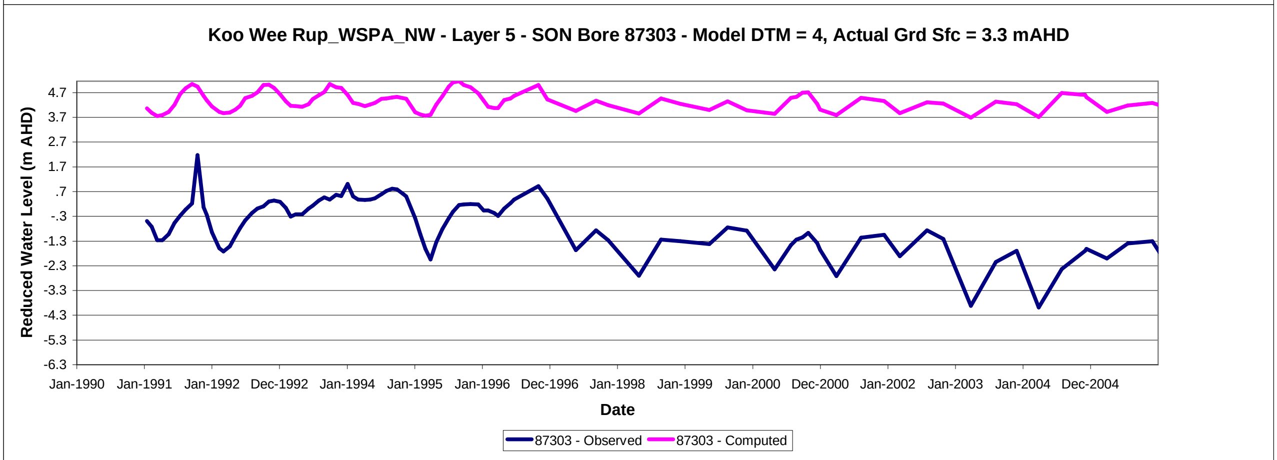


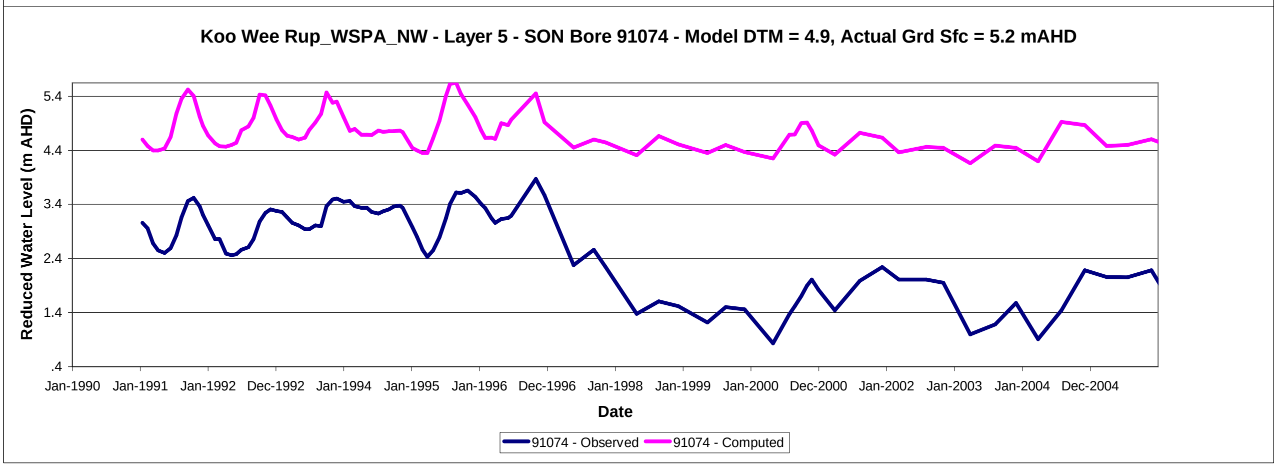

Koo Wee Rup_WSPA_NW - Layer 6 - PIRVIC Bore 12083 - Model DTM = 60.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
76.2
75.2
74.2
73.2
72.2
71.2
70.2
69.2
68.2
67.2
66.2
65.2
64.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12083 - Observed
12083 - Computed

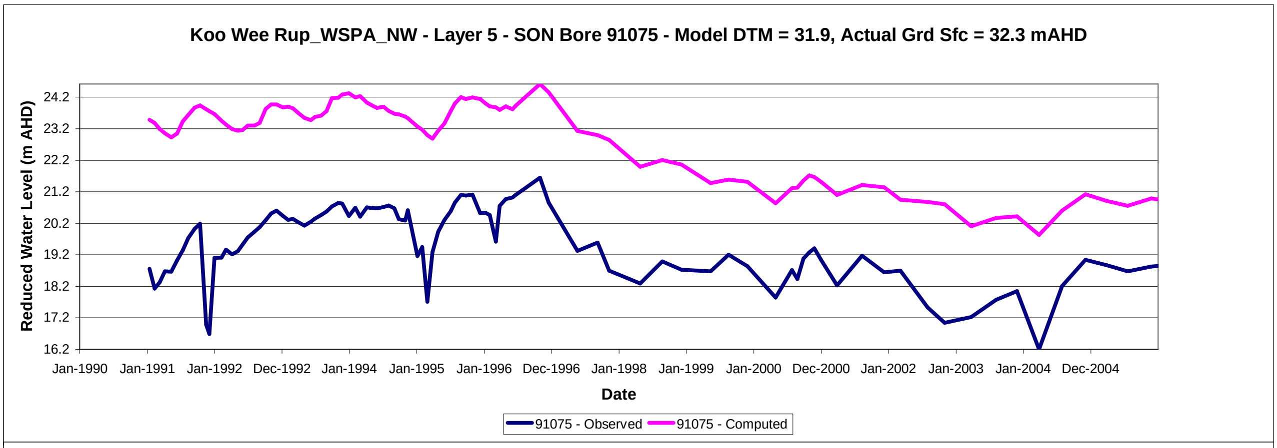

Koo Wee Rup_WSPA_NW - Layer 6 - SON Bore 84031 - Model DTM = 10.9, Actual Grd Sfc = 8.9 mAHD
Reduced Water Level (m AHD)
20.9
19.9
18.9
17.9
16.9
15.9
14.9
13.9
12.9
11.9
10.9
9.9
8.9
7.9
6.9
5.9
4.9
3.9
2.9
1.9
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
84031 - Observed
84031 - Computed

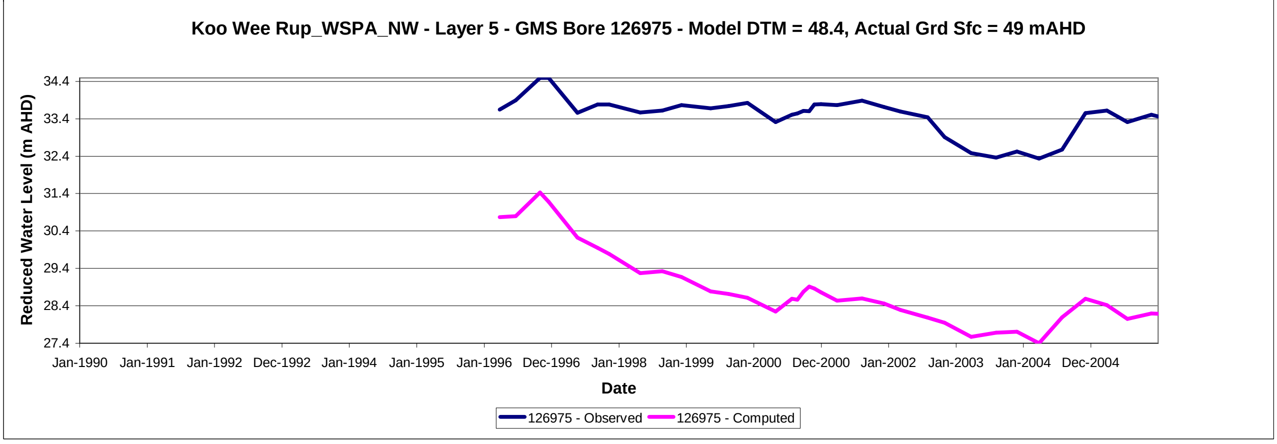

Koo Wee Rup_WSPA_NW - Layer 5 - SON Bore 57176 - Model DTM = 50, Actual Grd Sfc = 48.9 mAHD
Reduced Water Level (m AHD)
44.7
43.7
42.7
41.7
40.7
39.7
38.7
37.7
36.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
57176 - Observed
57176 - Computed


Koo Wee Rup_WSPA_NW - Layer 5 - SON Bore 71183 - Model DTM = 3.4, Actual Grd Sfc = 2.8 mAHD
Reduced Water Level (m AHD)
3.8
2.8
1.8
.8
-.2
-1.2
-2.2
-3.2
-4.2
-5.2
-6.2
-7.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
71183 - Observed
71183 - Computed


Koo Wee Rup_WSPA_NW - Layer 5 - SON Bore 87303 - Model DTM = 4, Actual Grd Sfc = 3.3 mAHD
Reduced Water Level (m AHD)
4.7
3.7
2.7
1.7
.7
-.3
-1.3
-2.3
-3.3
-4.3
-5.3
-6.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
87303 - Observed
87303 - Computed


Koo Wee Rup_WSPA_NW - Layer 5 - SON Bore 91074 - Model DTM = 4.9, Actual Grd Sfc = 5.2 mAHD
Reduced Water Level (m AHD)
5.4
4.4
3.4
2.4
1.4
.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
91074 - Observed
91074 - Computed


Koo Wee Rup_WSPA_NW - Layer 5 - SON Bore 91075 - Model DTM = 31.9, Actual Grd Sfc = 32.3 mAHD
Reduced Water Level (m AHD)
24.2
23.2
22.2
21.2
20.2
19.2
18.2
17.2
16.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
91075 - Observed
91075 - Computed


Koo Wee Rup_WSPA_NW - Layer 5 - GMS Bore 126975 - Model DTM = 48.4, Actual Grd Sfc = 49 mAHD
Reduced Water Level (m AHD)
34.4
33.4
32.4
31.4
30.4
29.4
28.4
27.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
126975 - Observed
126975 - Computed

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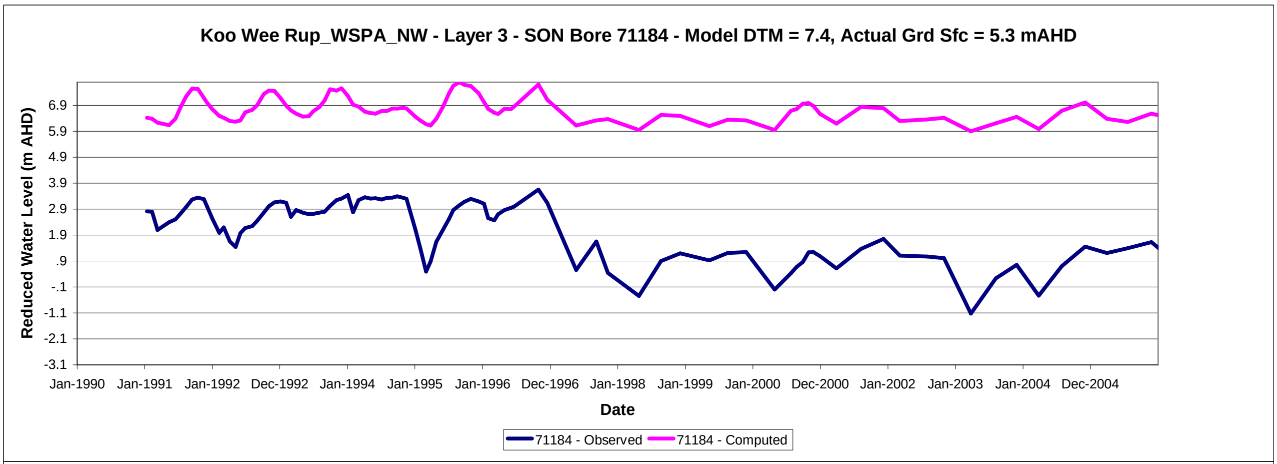
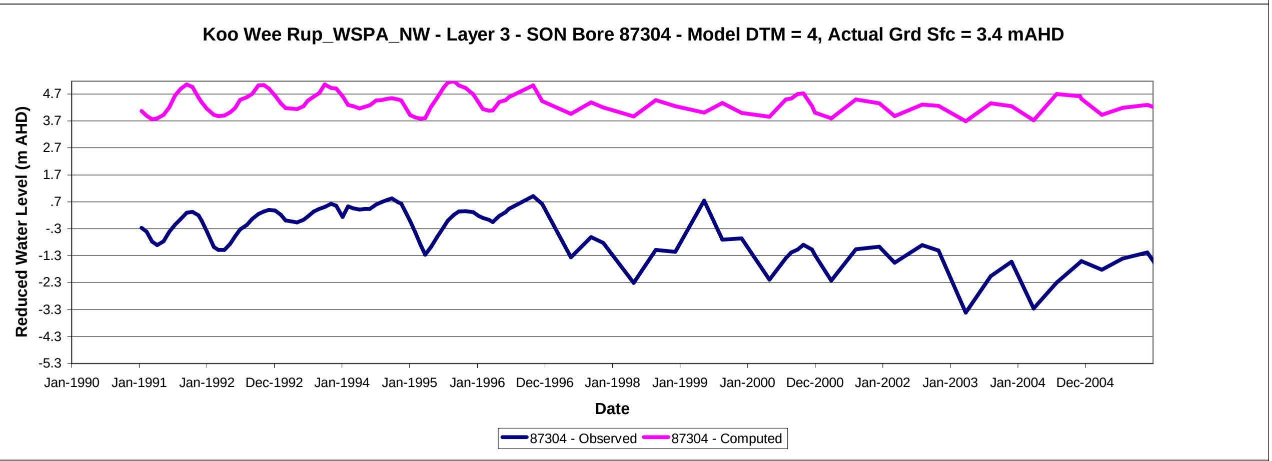
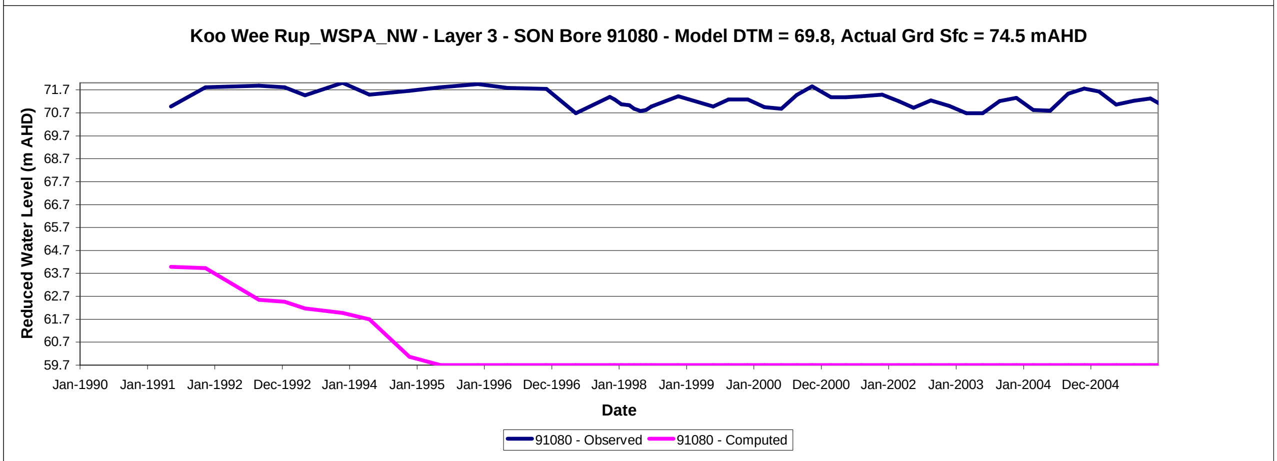
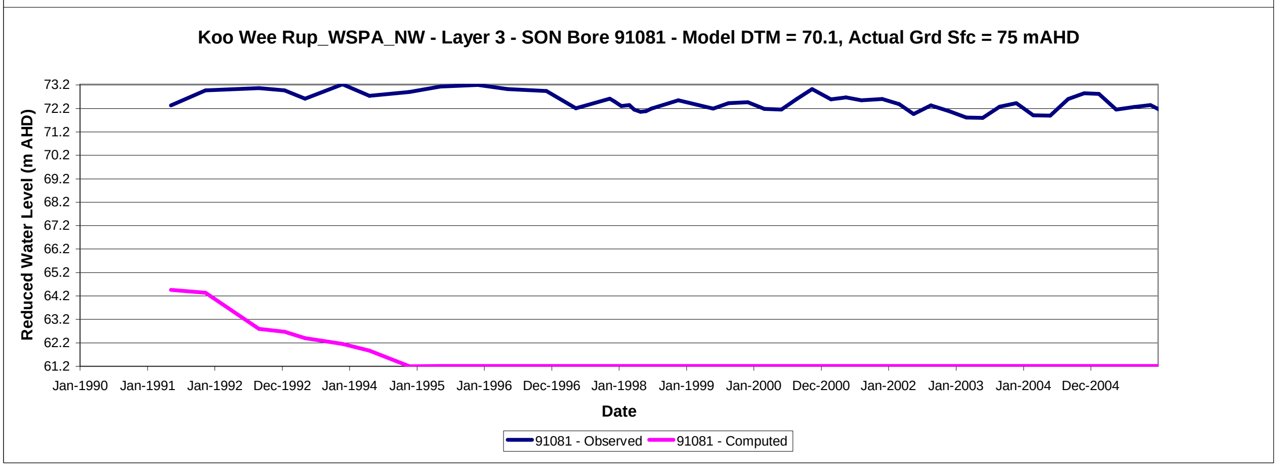
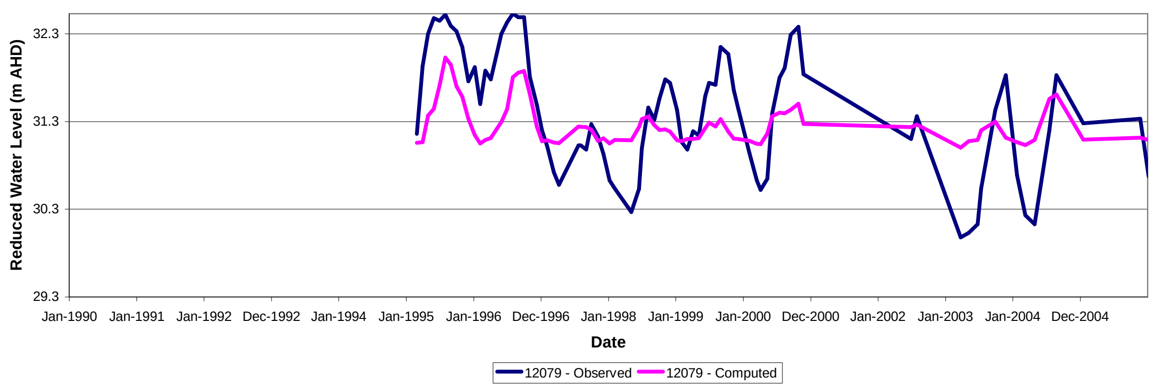




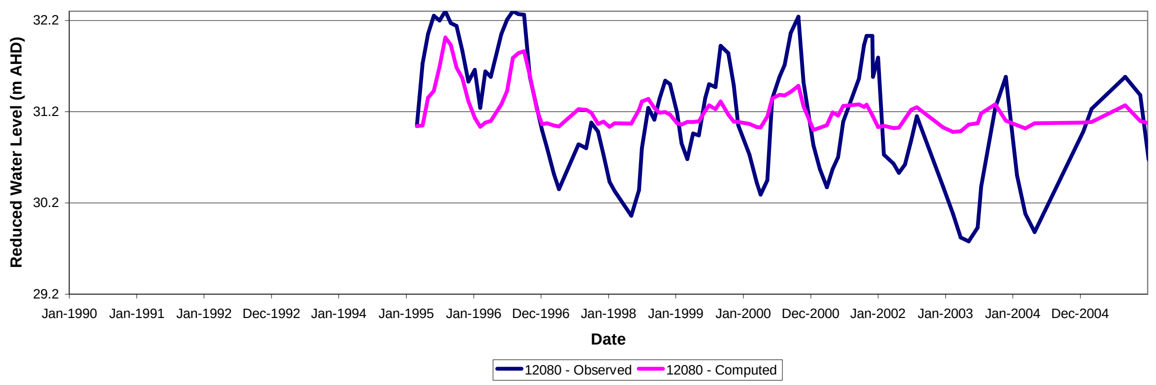




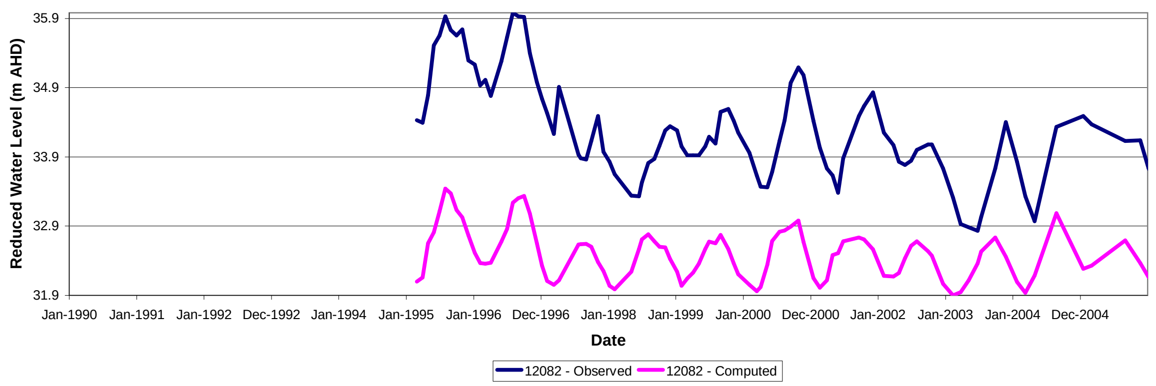
Koo Wee Rup_WSPA_NW - Layer 1 - PIRVIC Bore 12079 - Model DTM = 31.2, Actual Grd Sfc = No Data mAHD



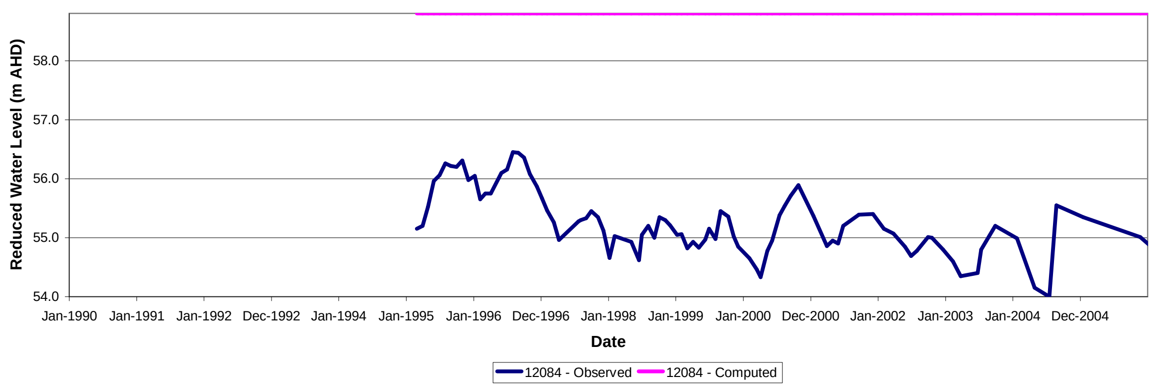
Koo Wee Rup_WSPA_NW - Layer 1 - PIRVIC Bore 12080 - Model DTM = 31.2, Actual Grd Sfc = No Data mAHD

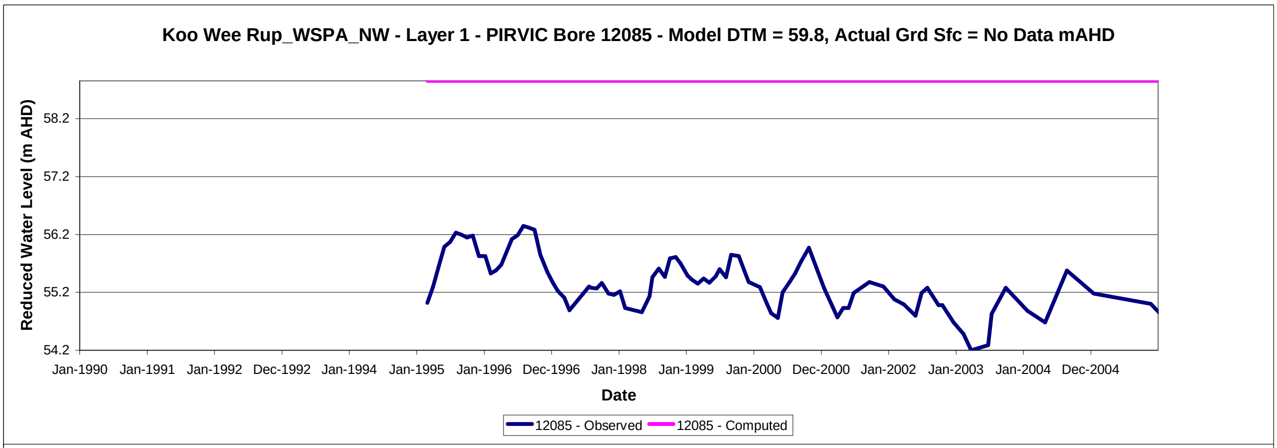


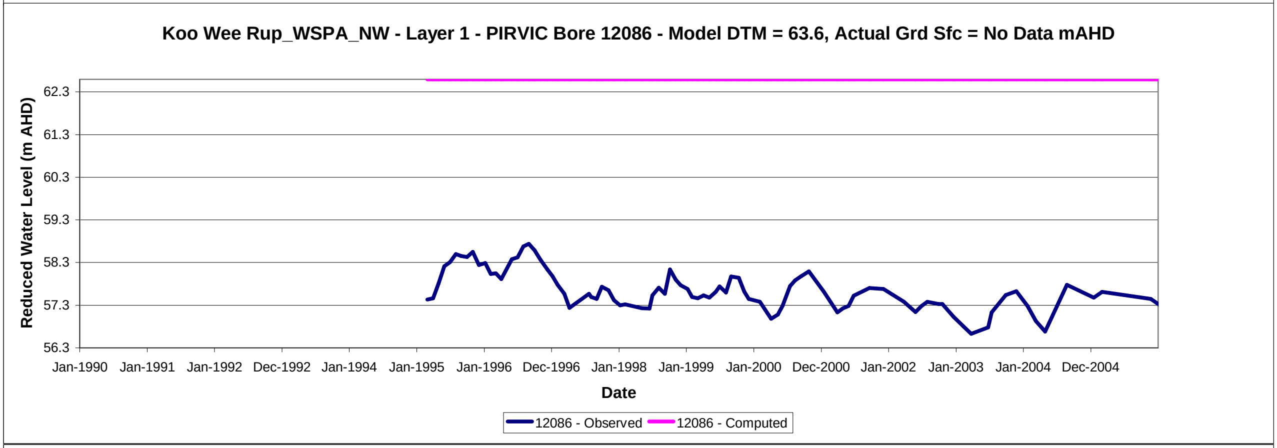
Koo Wee Rup_WSPA_NW - Layer 1 - PIRVIC Bore 12082 - Model DTM = 31.2, Actual Grd Sfc = No Data mAHD

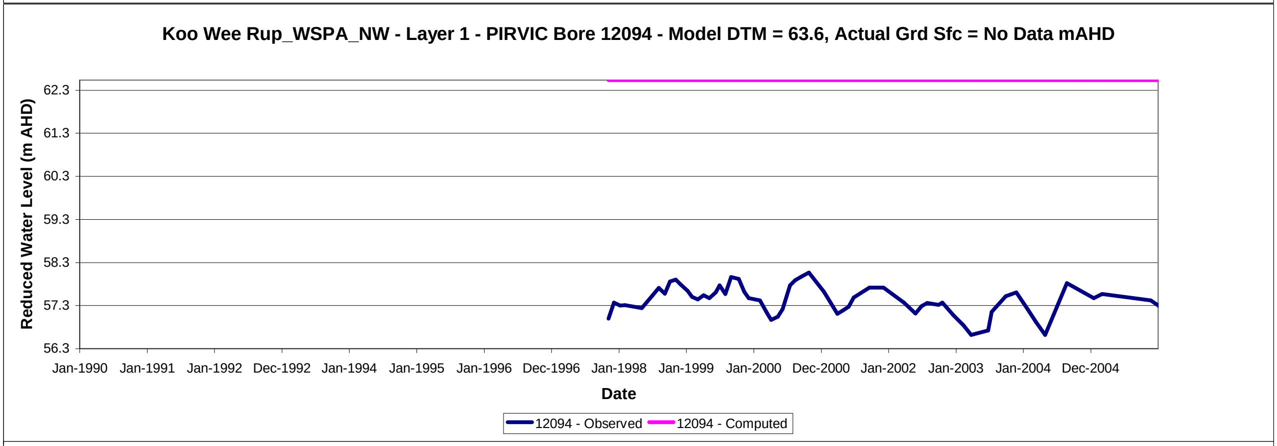


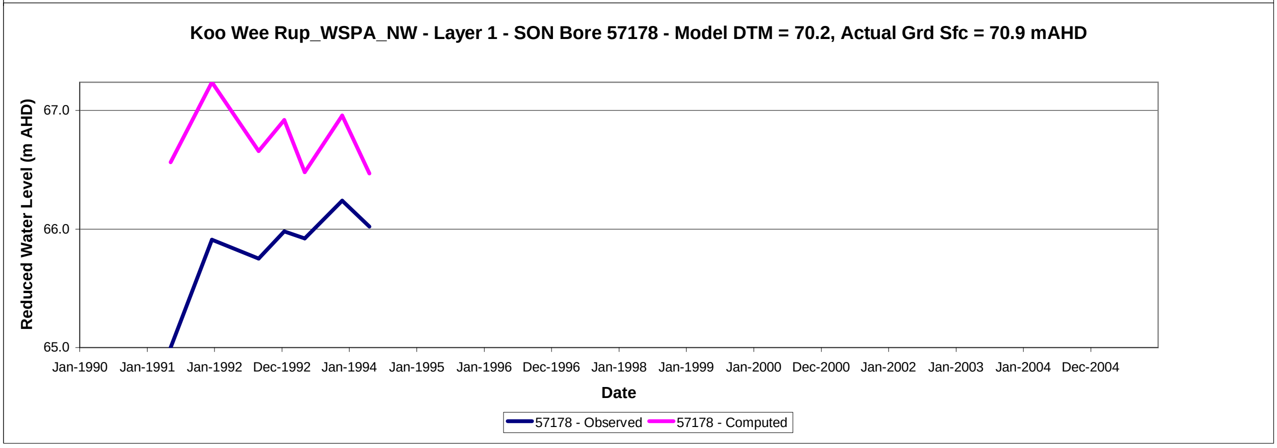
Koo Wee Rup_WSPA_NW - Layer 1 - PIRVIC Bore 12084 - Model DTM = 59.8, Actual Grd Sfc = No Data mAHD

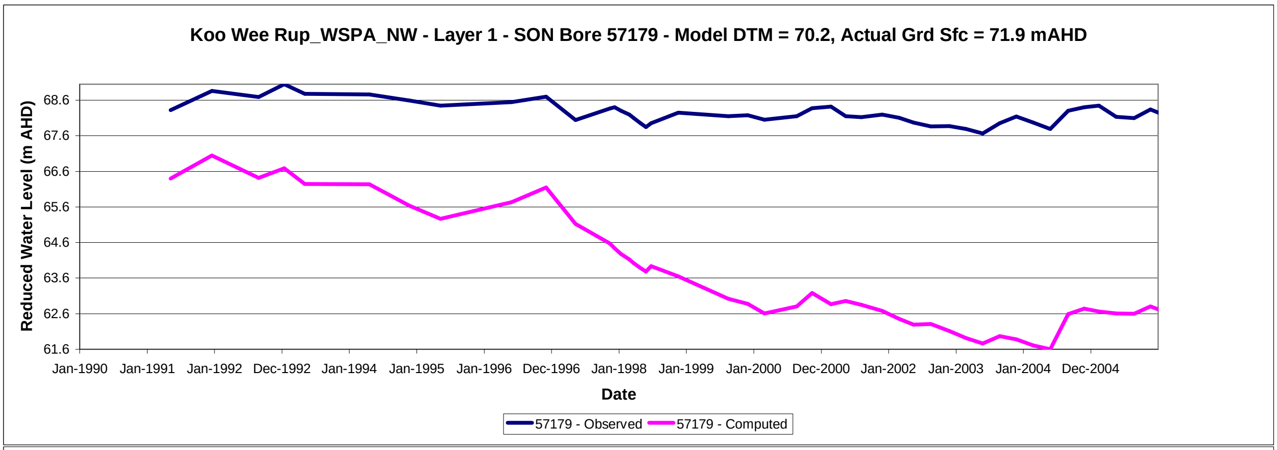


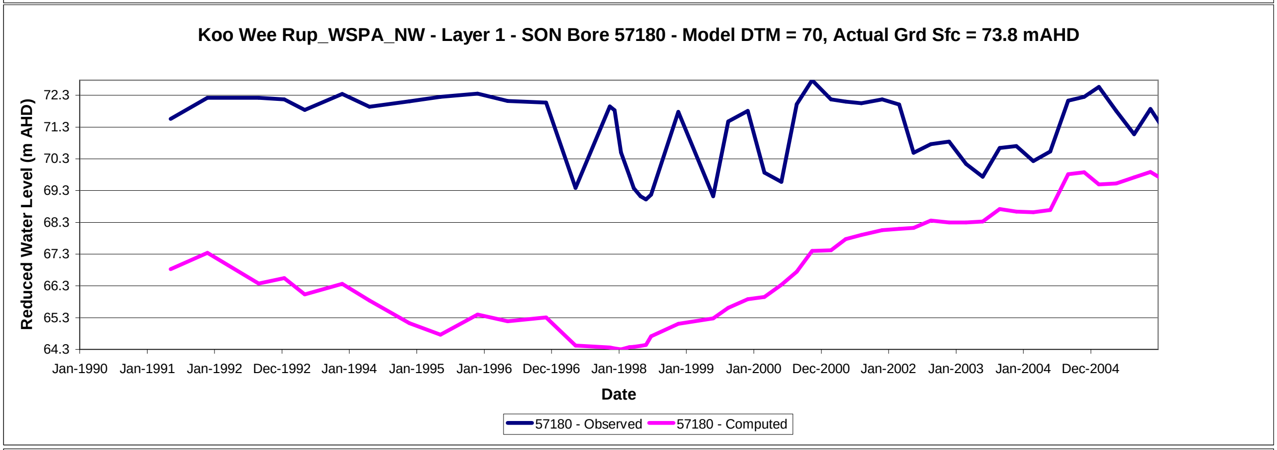

Koo Wee Rup_WSPA_NW - Layer 1 - PIRVIC Bore 12085 - Model DTM = 59.8, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
58.2
57.2
56.2
55.2
54.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12085 - Observed
12085 - Computed

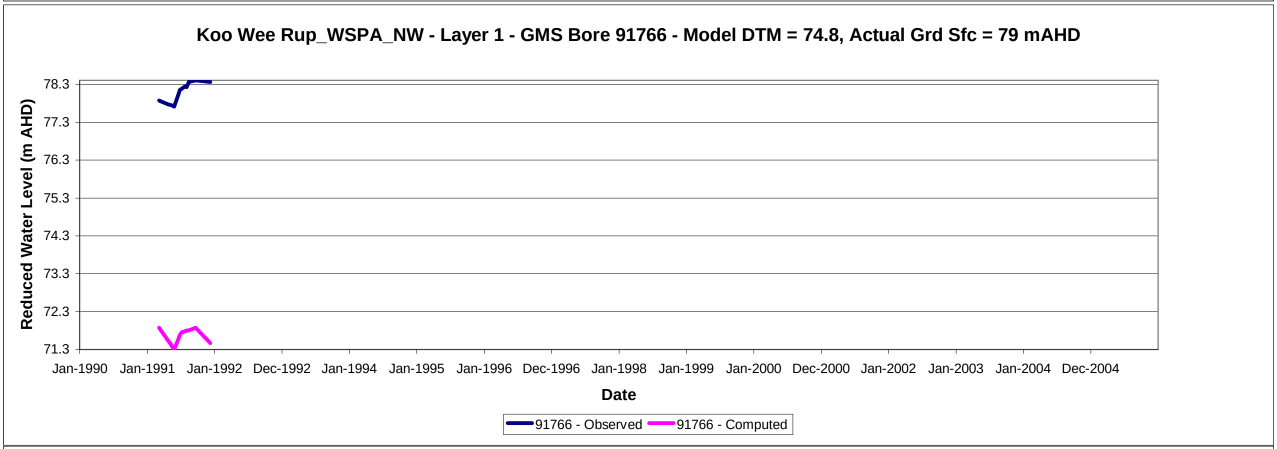

Koo Wee Rup_WSPA_NW - Layer 1 - PIRVIC Bore 12086 - Model DTM = 63.6, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
62.3
61.3
60.3
59.3
58.3
57.3
56.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12086 - Observed
12086 - Computed

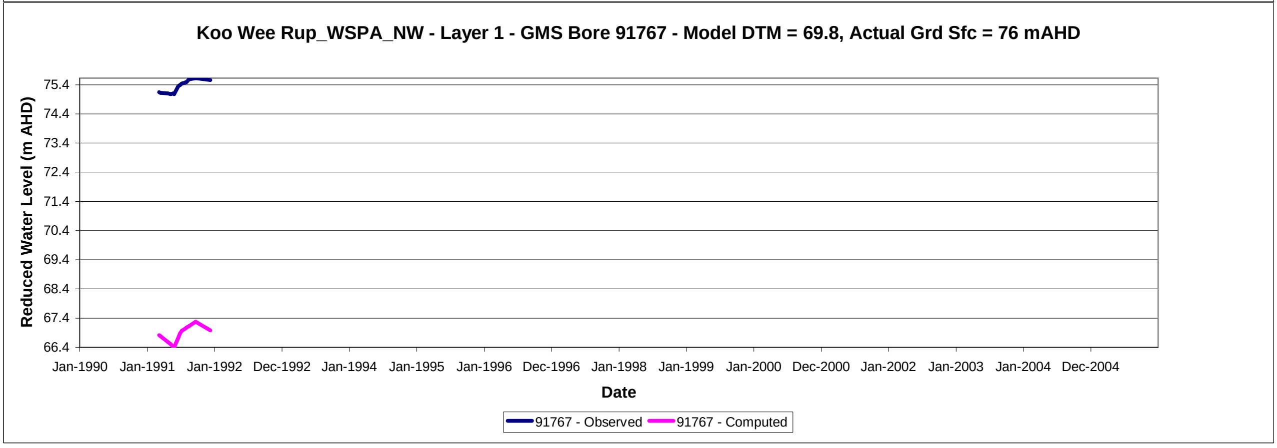

Koo Wee Rup_WSPA_NW - Layer 1 - PIRVIC Bore 12094 - Model DTM = 63.6, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
62.3
61.3
60.3
59.3
58.3
57.3
56.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12094 - Observed
12094 - Computed

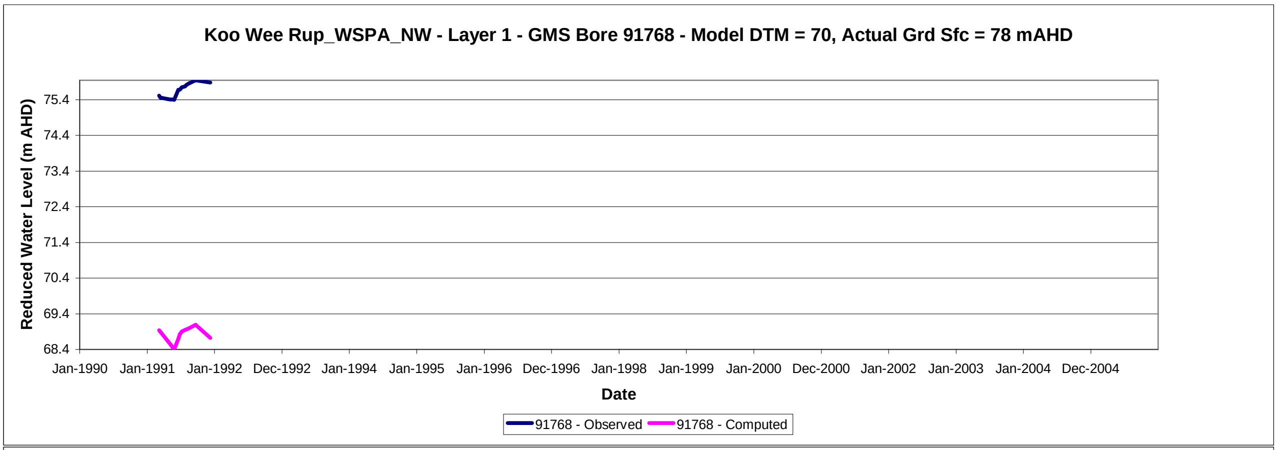

Koo Wee Rup_WSPA_NW - Layer 1 - SON Bore 57178 - Model DTM = 70.2, Actual Grd Sfc = 70.9 mAHD
Reduced Water Level (m AHD)
67.0
66.0
65.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
57178 - Observed
57178 - Computed

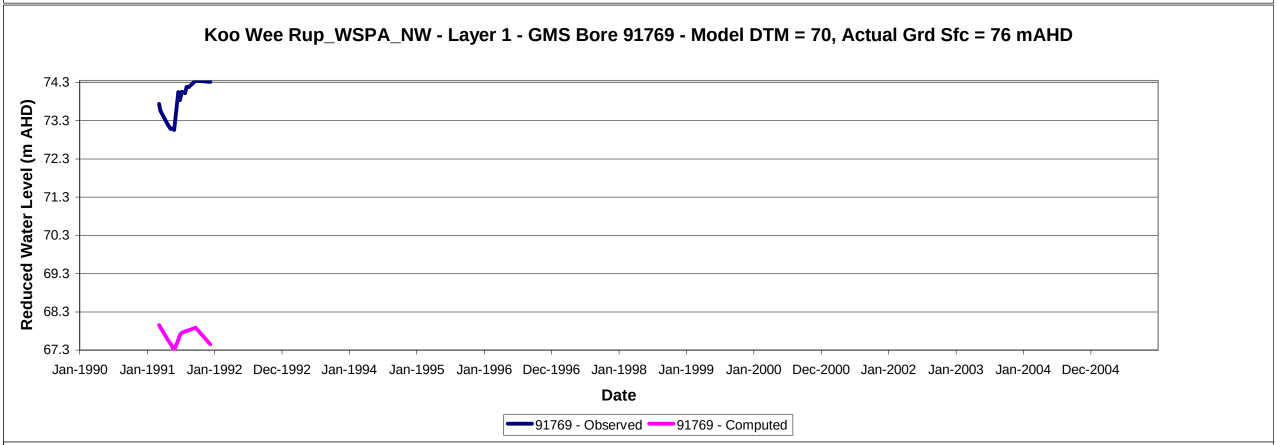

Koo Wee Rup_WSPA_NW - Layer 1 - SON Bore 57179 - Model DTM = 70.2, Actual Grd Sfc = 71.9 mAHD
Reduced Water Level (m AHD)
68.6
67.6
66.6
65.6
64.6
63.6
62.6
61.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
57179 - Observed
57179 - Computed

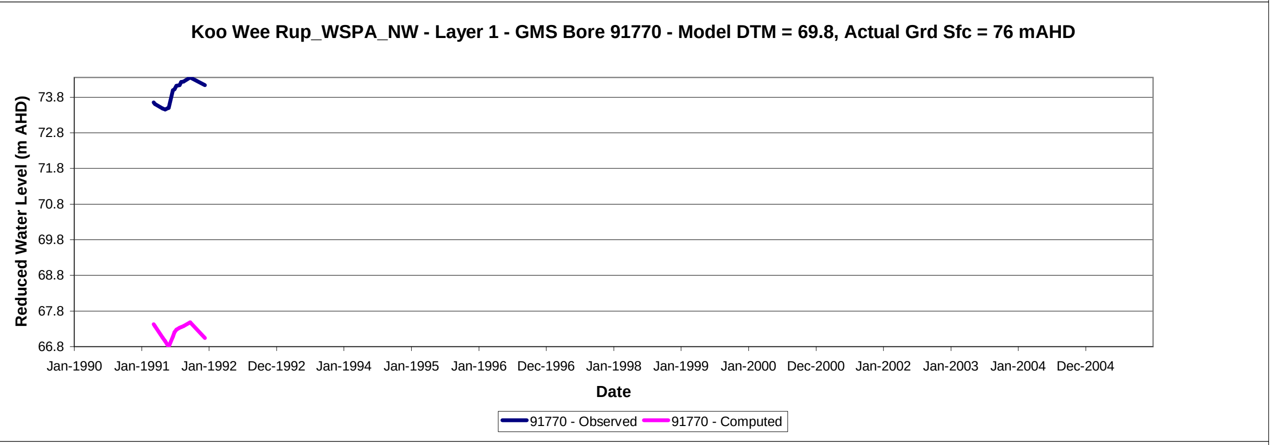

Koo Wee Rup_WSPA_NW - Layer 1 - SON Bore 57180 - Model DTM = 70, Actual Grd Sfc = 73.8 mAHD
Reduced Water Level (m AHD)
72.3
71.3
70.3
69.3
68.3
67.3
66.3
65.3
64.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
57180 - Observed
57180 - Computed

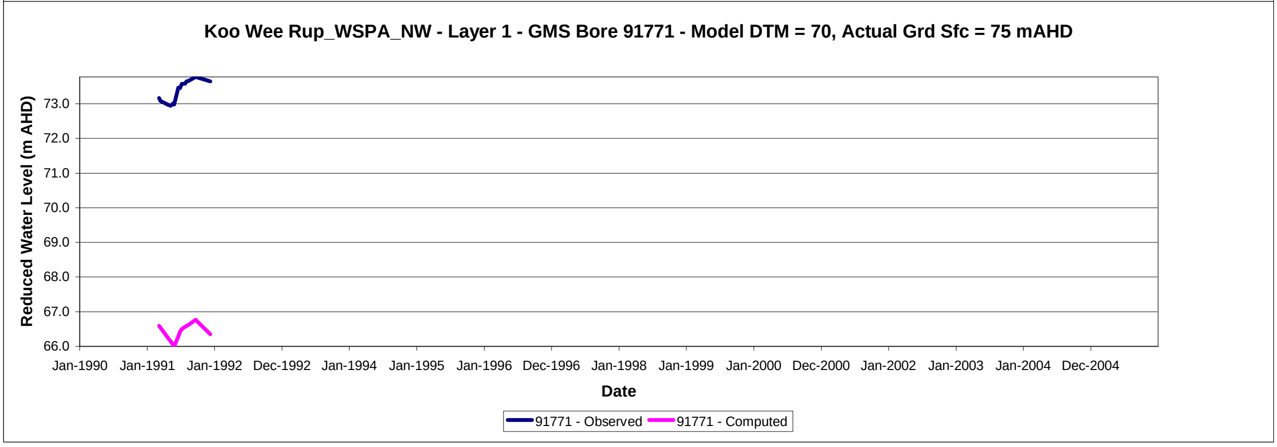

Koo Wee Rup_WSPA_NW - Layer 1 - GMS Bore 91766 - Model DTM = 74.8, Actual Grd Sfc = 79 mAHD
Reduced Water Level (m AHD)
78.3
77.3
76.3
75.3
74.3
73.3
72.3
71.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
91766 - Observed
91766 - Computed

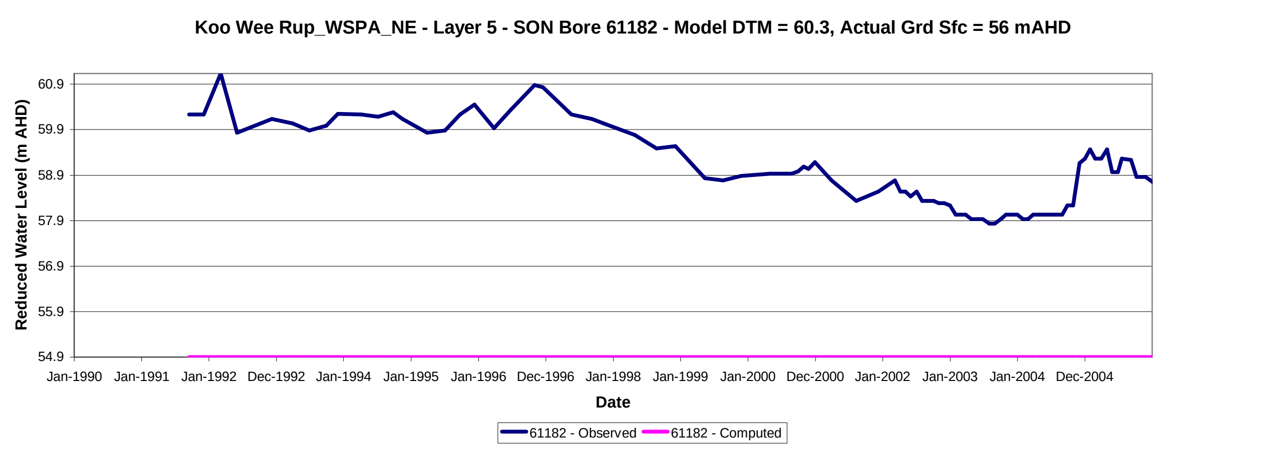

Koo Wee Rup_WSPA_NW - Layer 1 - GMS Bore 91767 - Model DTM = 69.8, Actual Grd Sfc = 76 mAHD
Reduced Water Level (m AHD)
75.4
74.4
73.4
72.4
71.4
70.4
69.4
68.4
67.4
66.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
91767 - Observed
91767 - Computed

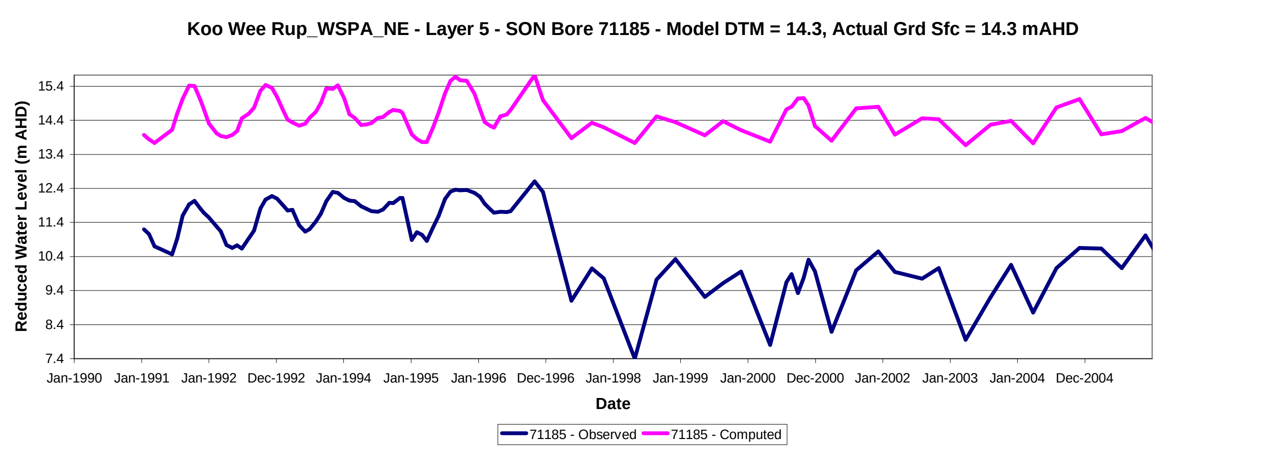

Koo Wee Rup_WSPA_NW - Layer 1 - GMS Bore 91768 - Model DTM = 70, Actual Grd Sfc = 78 mAHD
Reduced Water Level (m AHD)
75.4
74.4
73.4
72.4
71.4
70.4
69.4
68.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
91768 - Observed
91768 - Computed

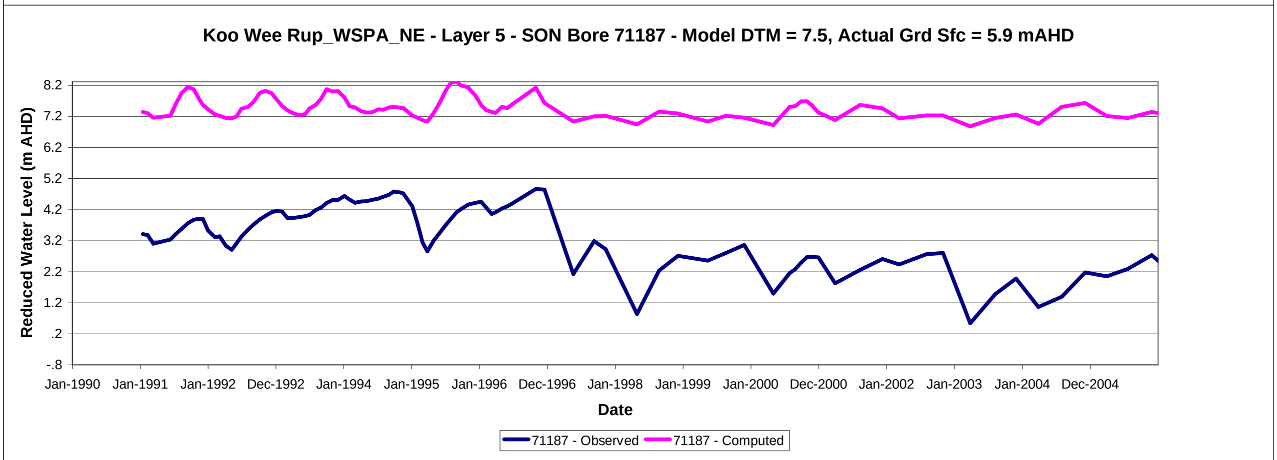

Koo Wee Rup_WSPA_NW - Layer 1 - GMS Bore 91769 - Model DTM = 70, Actual Grd Sfc = 76 mAHD
Reduced Water Level (m AHD)
74.3
73.3
72.3
71.3
70.3
69.3
68.3
67.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
91769 - Observed
91769 - Computed

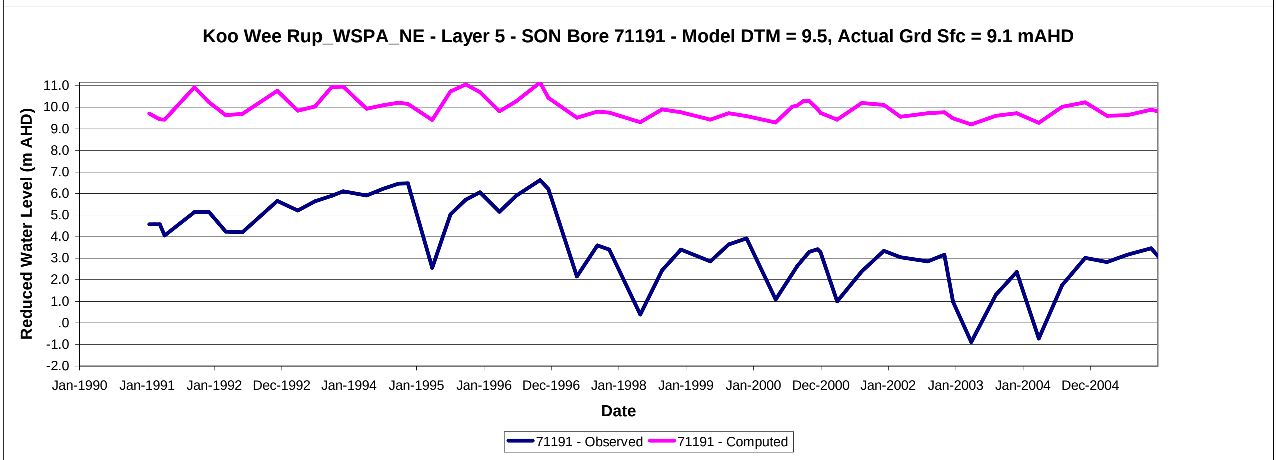

Koo Wee Rup_WSPA_NW - Layer 1 - GMS Bore 91770 - Model DTM = 69.8, Actual Grd Sfc = 76 mAHD
Reduced Water Level (m AHD)
73.8
72.8
71.8
70.8
69.8
68.8
67.8
66.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
91770 - Observed
91770 - Computed

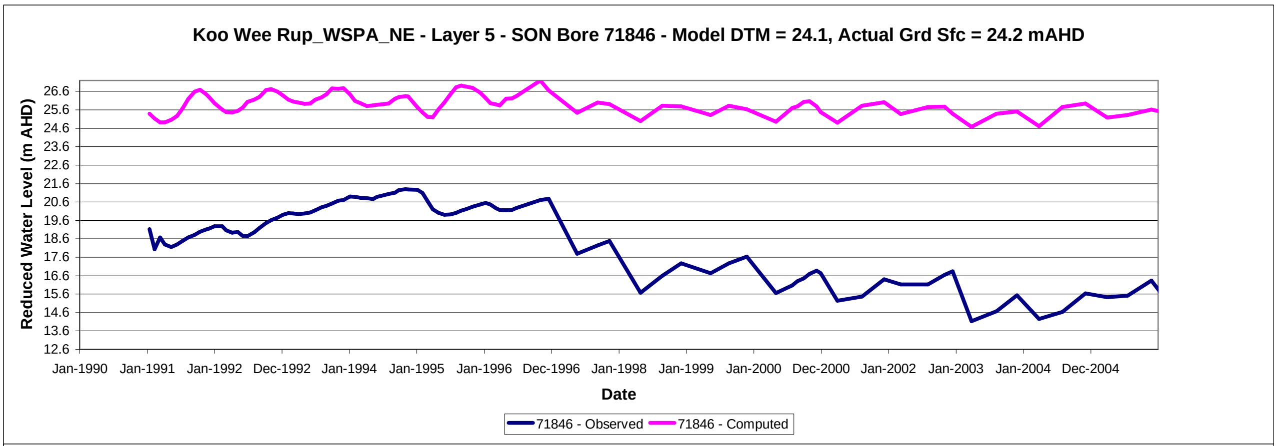

Koo Wee Rup_WSPA_NW - Layer 1 - GMS Bore 91771 - Model DTM = 70, Actual Grd Sfc = 75 mAHD
Reduced Water Level (m AHD)
73.0
72.0
71.0
70.0
69.0
68.0
67.0
66.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
91771 - Observed
91771 - Computed

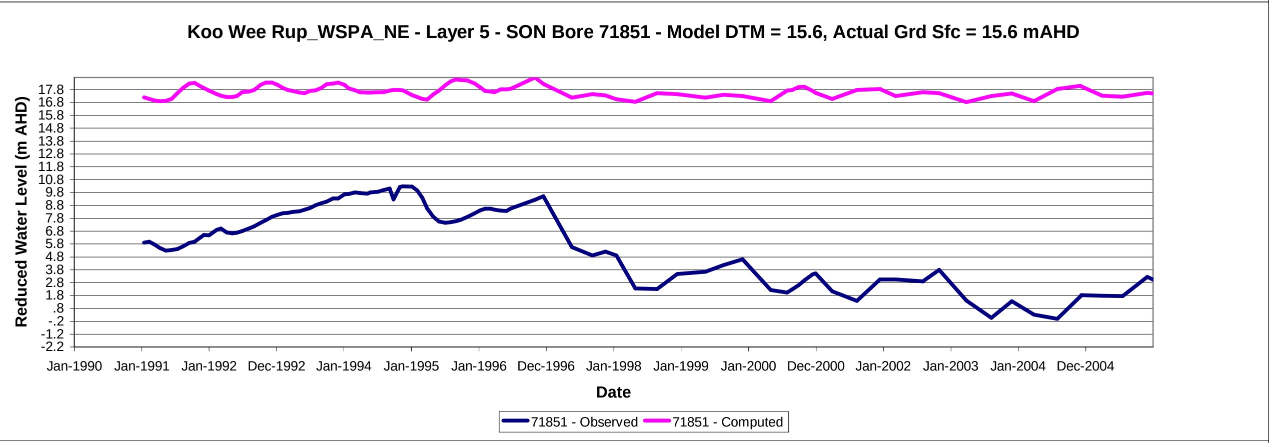

Koo Wee Rup_WSPA_NE - Layer 5 - SON Bore 61182 - Model DTM = 60.3, Actual Grd Sfc = 56 mAHD
Reduced Water Level (m AHD)
Date
61182 - Observed
61182 - Computed

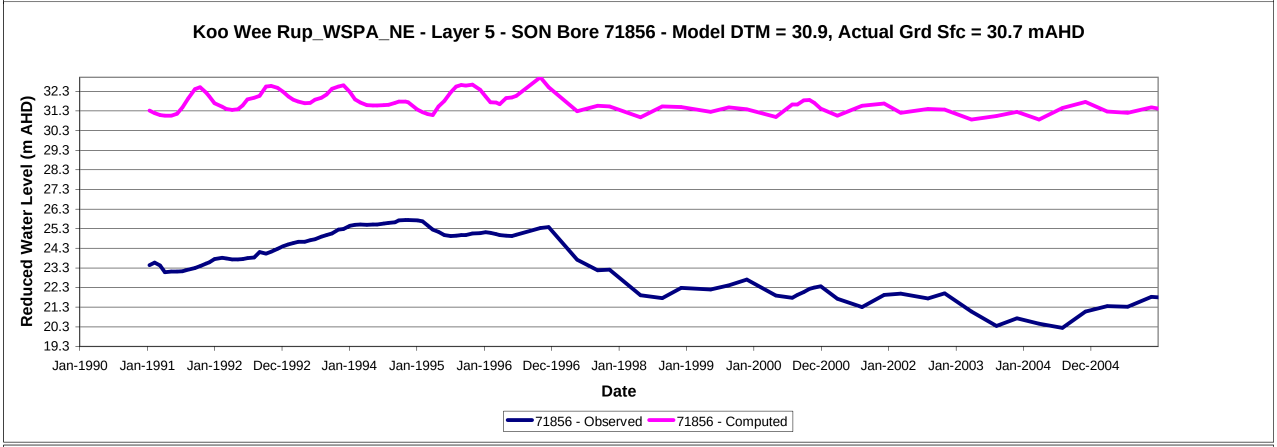

Koo Wee Rup_WSPA_NE - Layer 5 - SON Bore 71185 - Model DTM = 14.3, Actual Grd Sfc = 14.3 mAHD
Reduced Water Level (m AHD)
Date
71185 - Observed
71185 - Computed

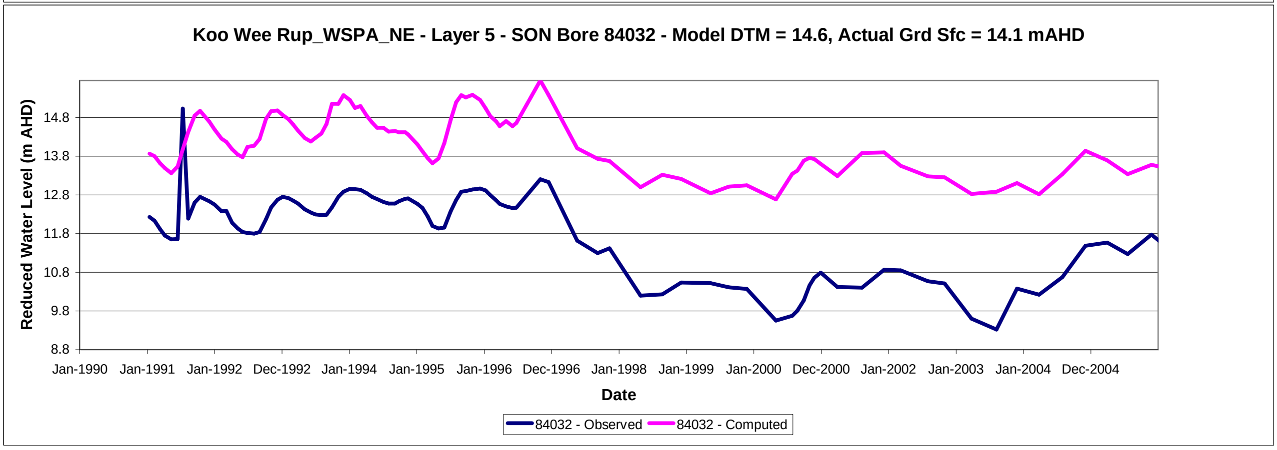

Koo Wee Rup_WSPA_NE - Layer 5 - SON Bore 71187 - Model DTM = 7.5, Actual Grd Sfc = 5.9 mAHD
Reduced Water Level (m AHD)
Date
71187 - Observed
71187 - Computed

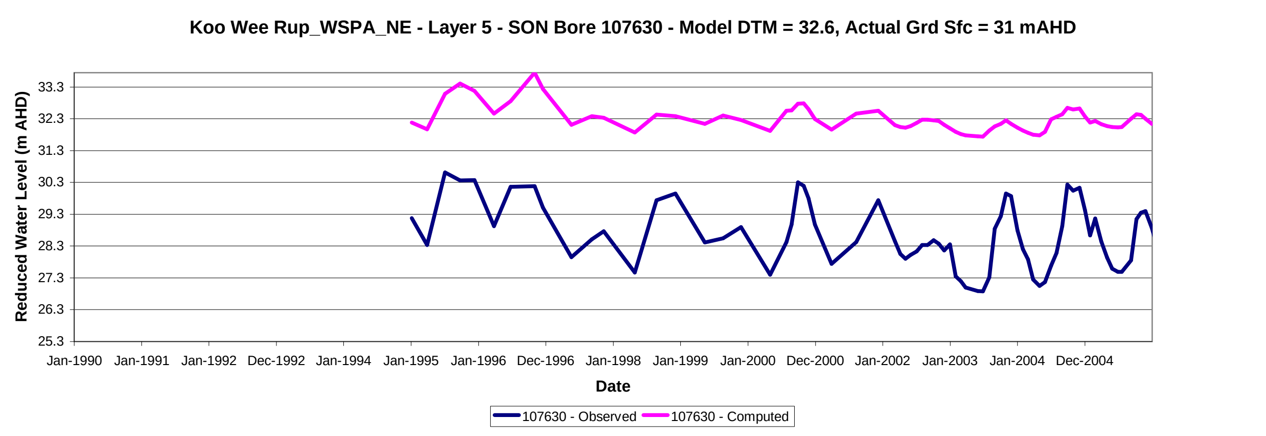

Koo Wee Rup_WSPA_NE - Layer 5 - SON Bore 71191 - Model DTM = 9.5, Actual Grd Sfc = 9.1 mAHD
Reduced Water Level (m AHD)
Date
71191 - Observed
71191 - Computed

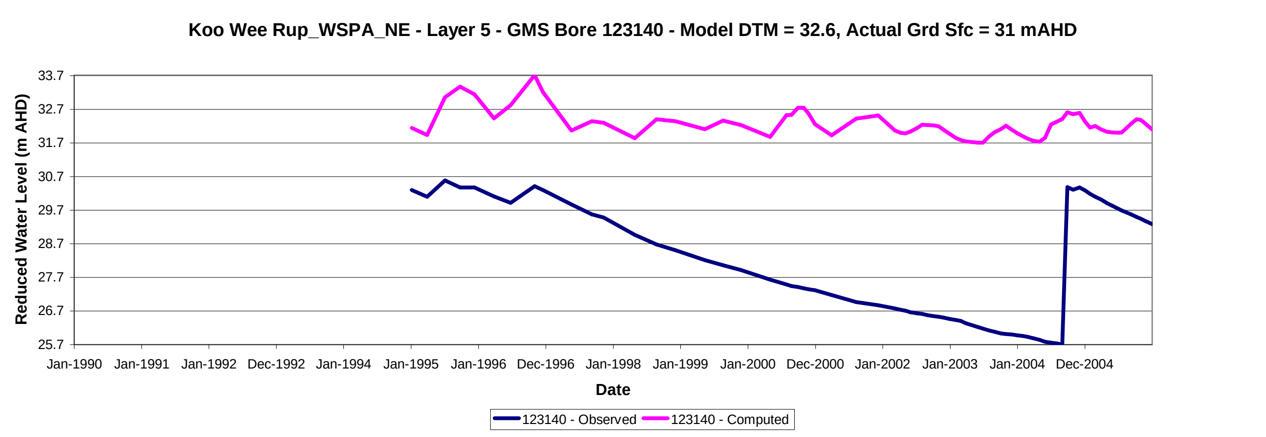

Koo Wee Rup_WSPA_NE - Layer 5 - SON Bore 71846 - Model DTM = 24.1, Actual Grd Sfc = 24.2 mAHD
Reduced Water Level (m AHD)
Date
71846 - Observed
71846 - Computed


Koo Wee Rup_WSPA_NE - Layer 5 - SON Bore 71851 - Model DTM = 15.6, Actual Grd Sfc = 15.6 mAHD
Reduced Water Level (m AHD)
Date
71851 - Observed
71851 - Computed

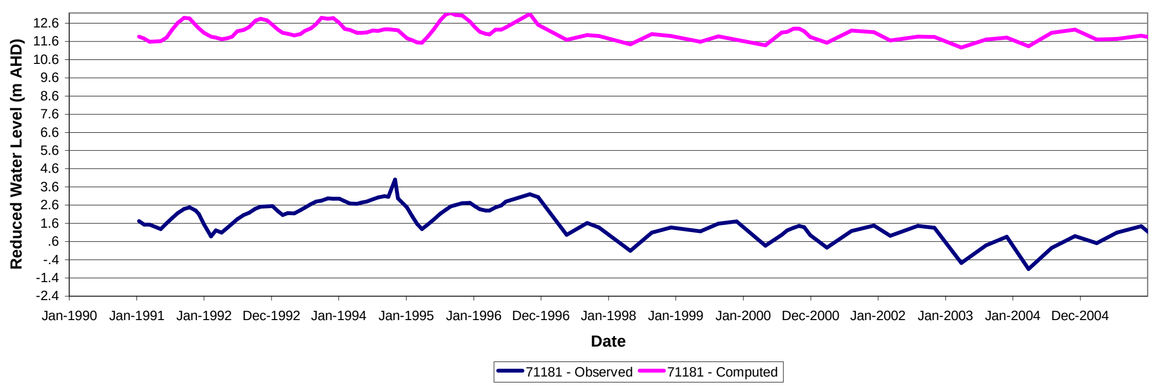

Koo Wee Rup_WSPA_NE - Layer 5 - SON Bore 71856 - Model DTM = 30.9, Actual Grd Sfc = 30.7 mAHD
Reduced Water Level (m AHD)
Date
71856 - Observed
71856 - Computed


Koo Wee Rup_WSPA_NE - Layer 5 - SON Bore 84032 - Model DTM = 14.6, Actual Grd Sfc = 14.1 mAHD
Reduced Water Level (m AHD)
Date
84032 - Observed
84032 - Computed

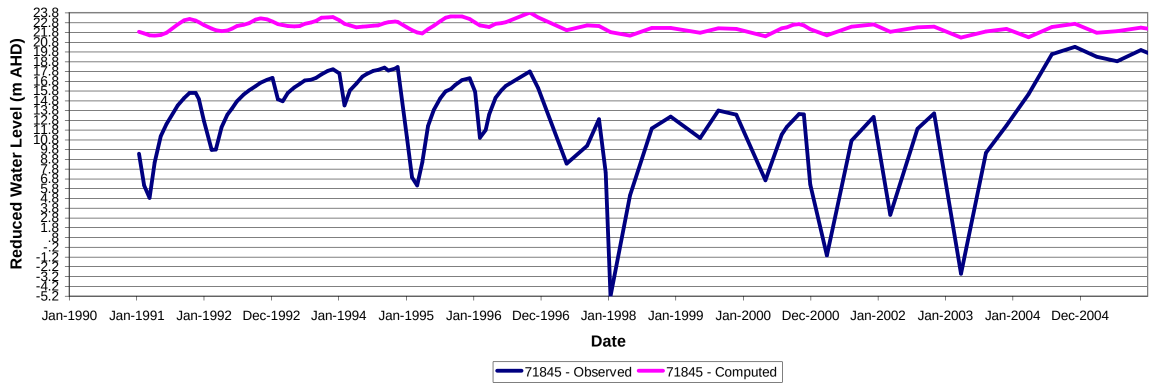

Koo Wee Rup_WSPA_NE - Layer 5 - SON Bore 107630 - Model DTM = 32.6, Actual Grd Sfc = 31 mAHD
Reduced Water Level (m AHD)
33.3
32.3
31.3
30.3
29.3
28.3
27.3
26.3
25.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
107630 - Observed
107630 - Computed


Koo Wee Rup_WSPA_NE - Layer 5 - GMS Bore 123140 - Model DTM = 32.6, Actual Grd Sfc = 31 mAHD
Reduced Water Level (m AHD)
33.7
32.7
31.7
30.7
29.7
28.7
27.7
26.7
25.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
123140 - Observed
123140 - Computed

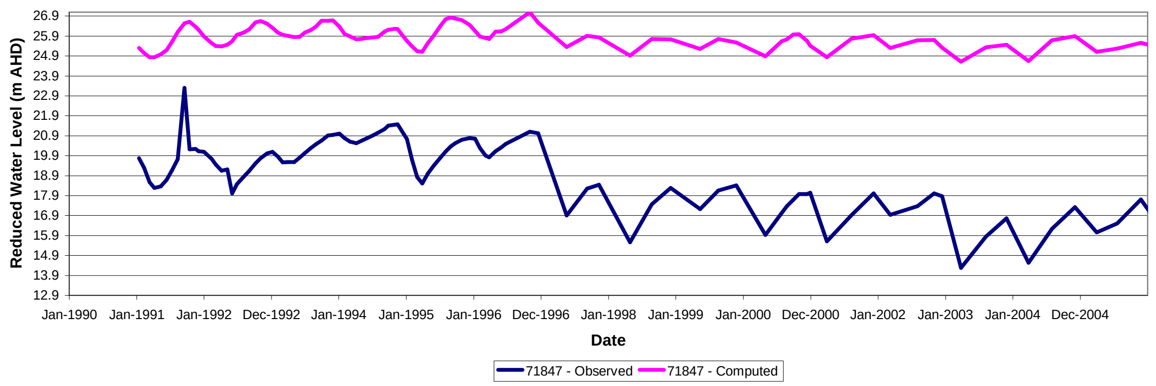
Koo Wee Rup_WSPA_NE - Layer 4 - SON Bore 71181 - Model DTM = 11.3, Actual Grd Sfc = 4.7 mAHD



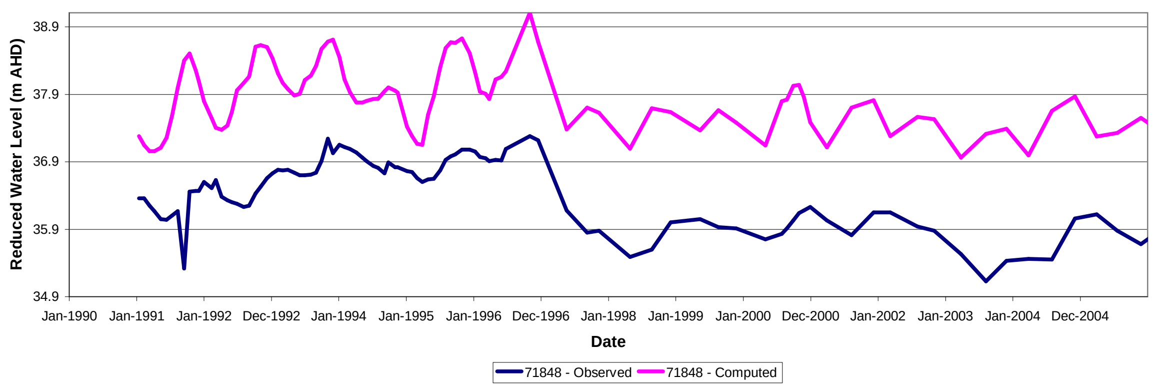
Koo Wee Rup_WSPA_NE - Layer 4 - SON Bore 71845 - Model DTM = 21.3, Actual Grd Sfc = 21.7 mAHD

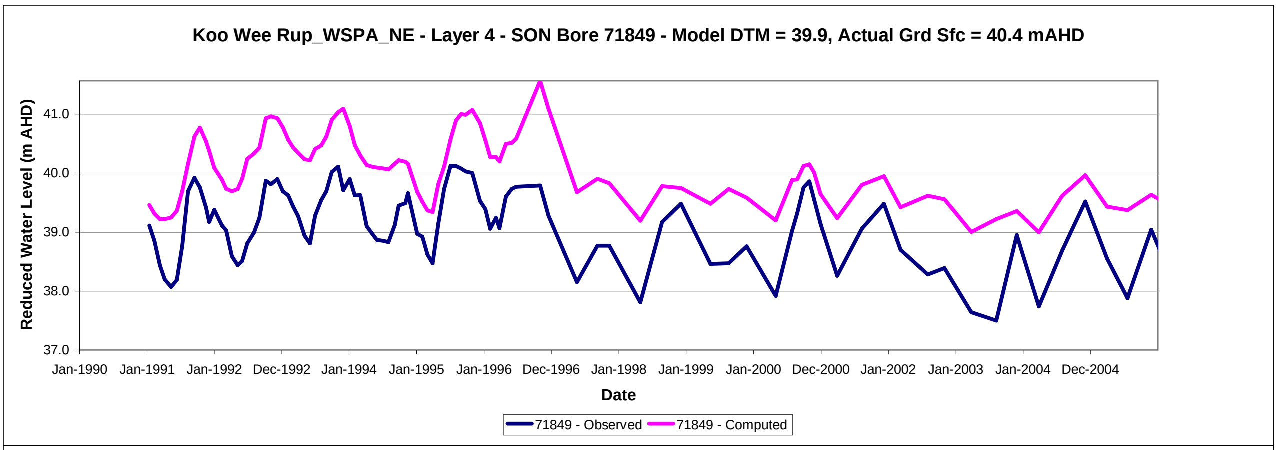


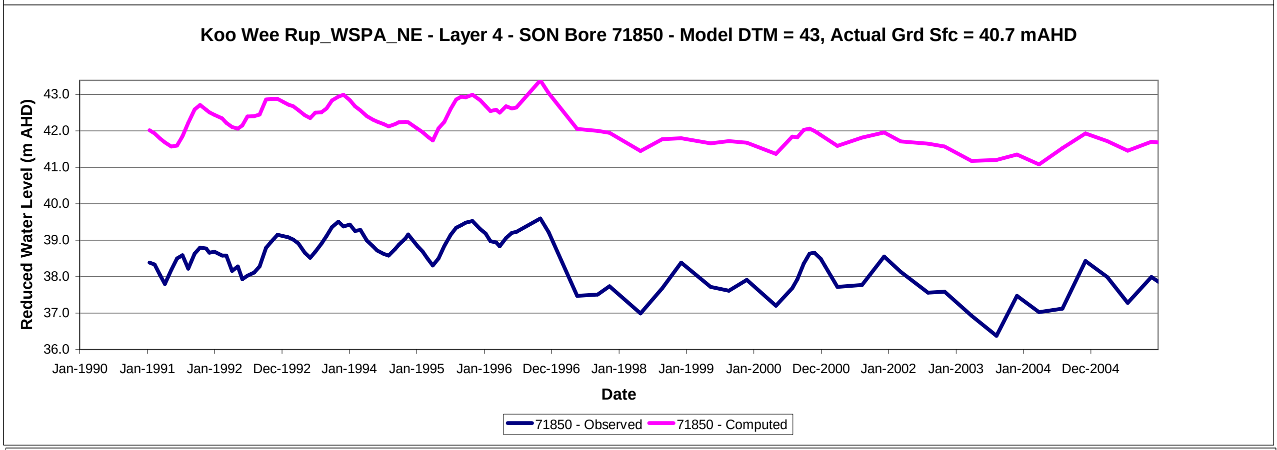
Koo Wee Rup_WSPA_NE - Layer 4 - SON Bore 71847 - Model DTM = 24.1, Actual Grd Sfc = 24.1 mAHD

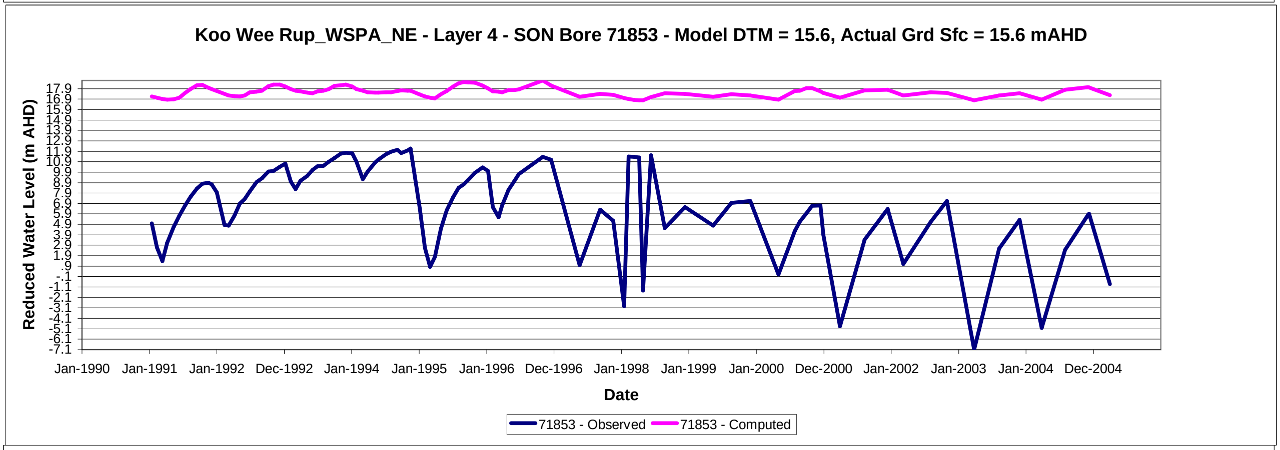


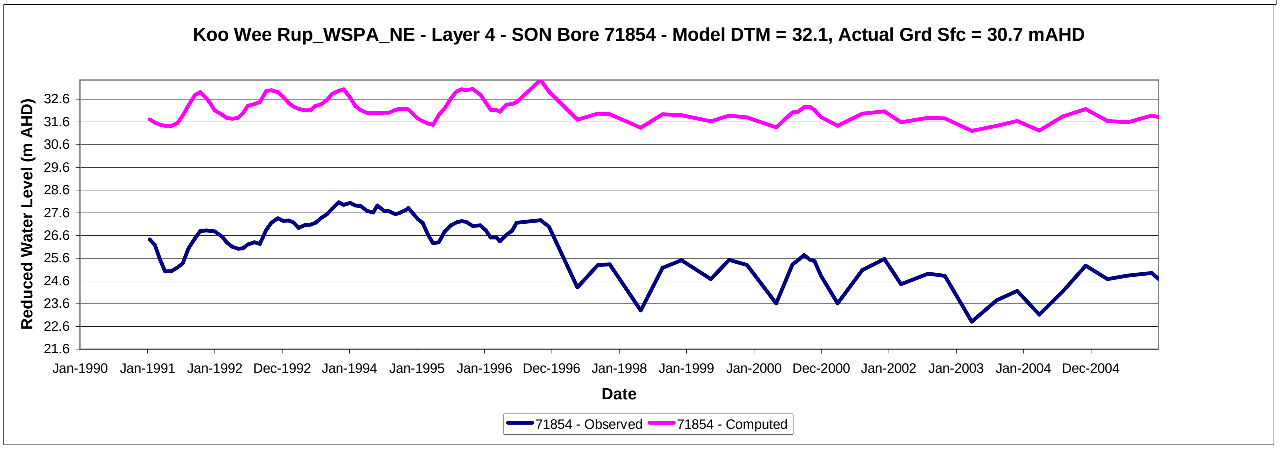
Koo Wee Rup_WSPA_NE - Layer 4 - SON Bore 71848 - Model DTM = 37.8, Actual Grd Sfc = 38.9 mAHD




Koo Wee Rup_WSPA_NE - Layer 4 - SON Bore 71849 - Model DTM = 39.9, Actual Grd Sfc = 40.4 mAHD
Reduced Water Level (m AHD)
Date
71849 - Observed
71849 - Computed


Koo Wee Rup_WSPA_NE - Layer 4 - SON Bore 71850 - Model DTM = 43, Actual Grd Sfc = 40.7 mAHD
Reduced Water Level (m AHD)
Date
71850 - Observed
71850 - Computed


Koo Wee Rup_WSPA_NE - Layer 4 - SON Bore 71853 - Model DTM = 15.6, Actual Grd Sfc = 15.6 mAHD
Reduced Water Level (m AHD)
Date
71853 - Observed
71853 - Computed


Koo Wee Rup_WSPA_NE - Layer 4 - SON Bore 71854 - Model DTM = 32.1, Actual Grd Sfc = 30.7 mAHD
Reduced Water Level (m AHD)
Date
71854 - Observed
71854 - Computed

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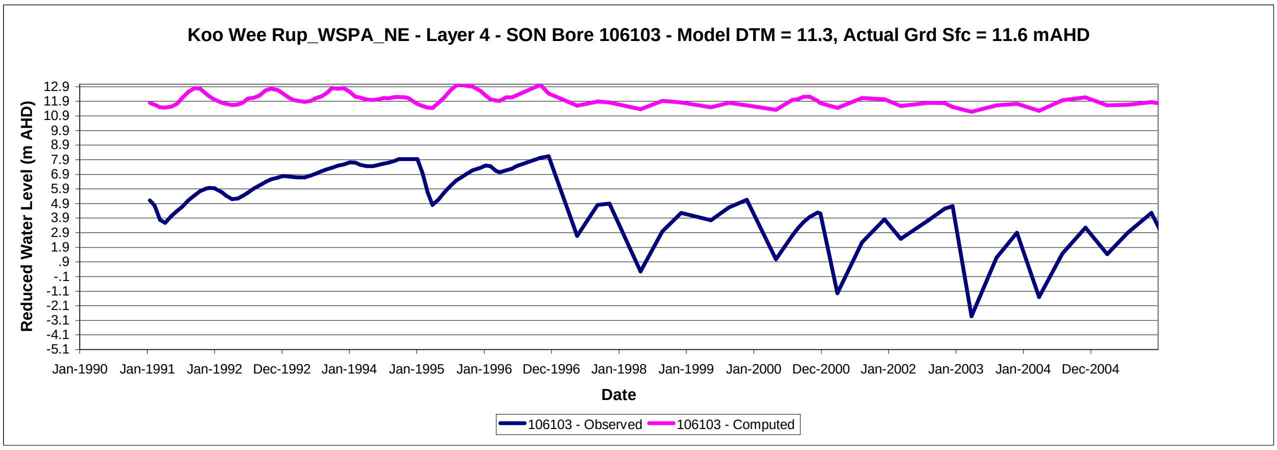
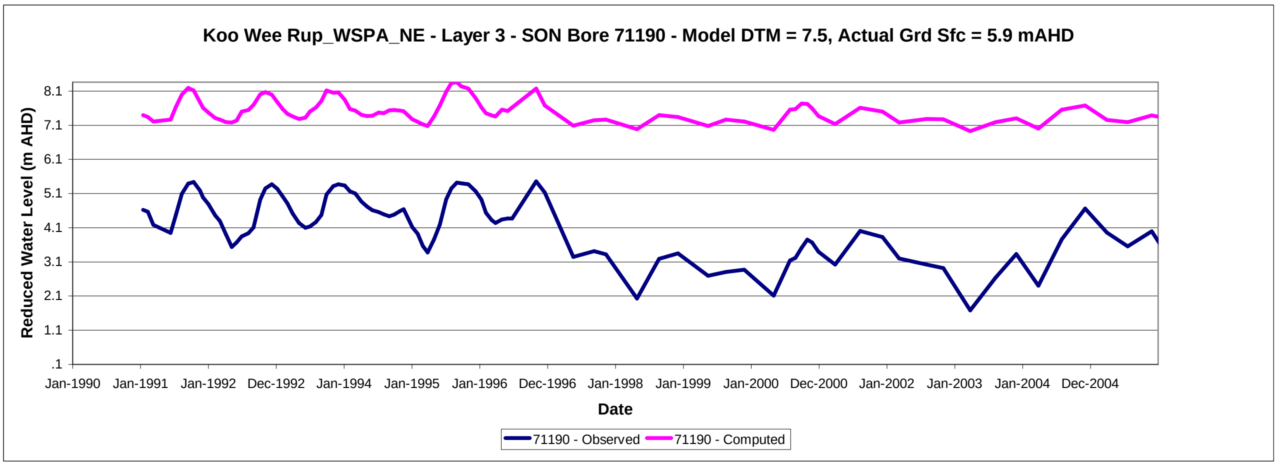
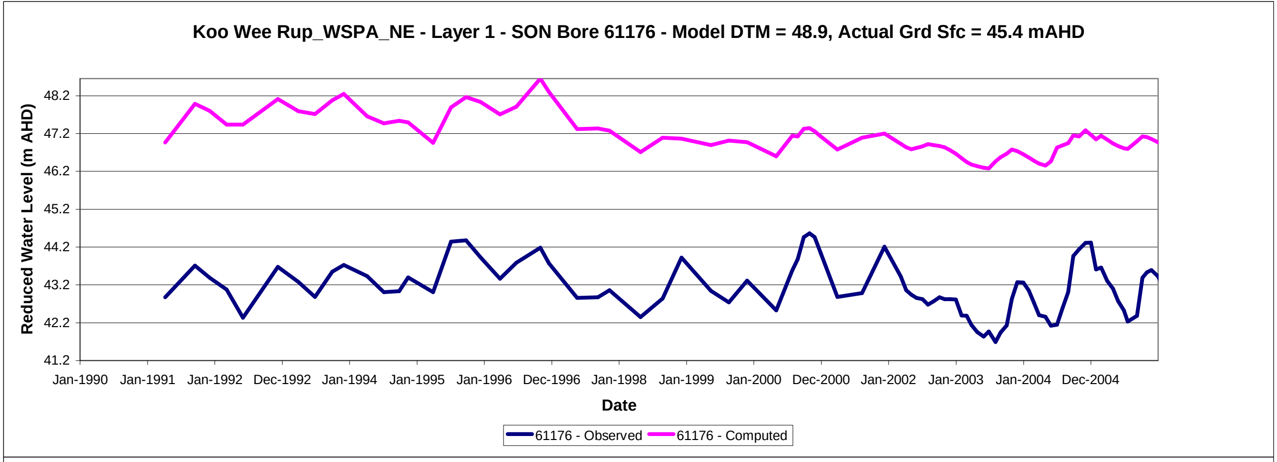
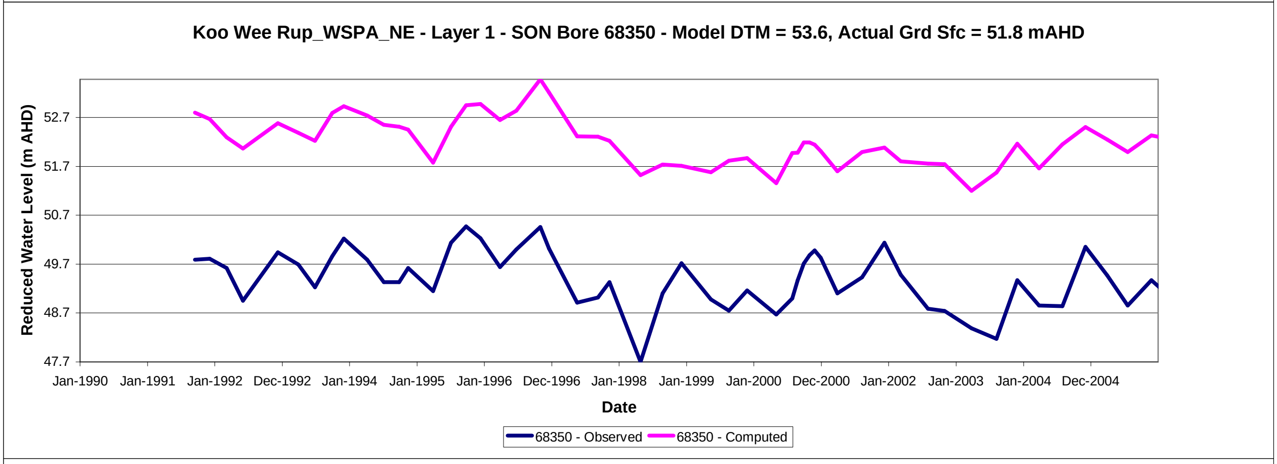
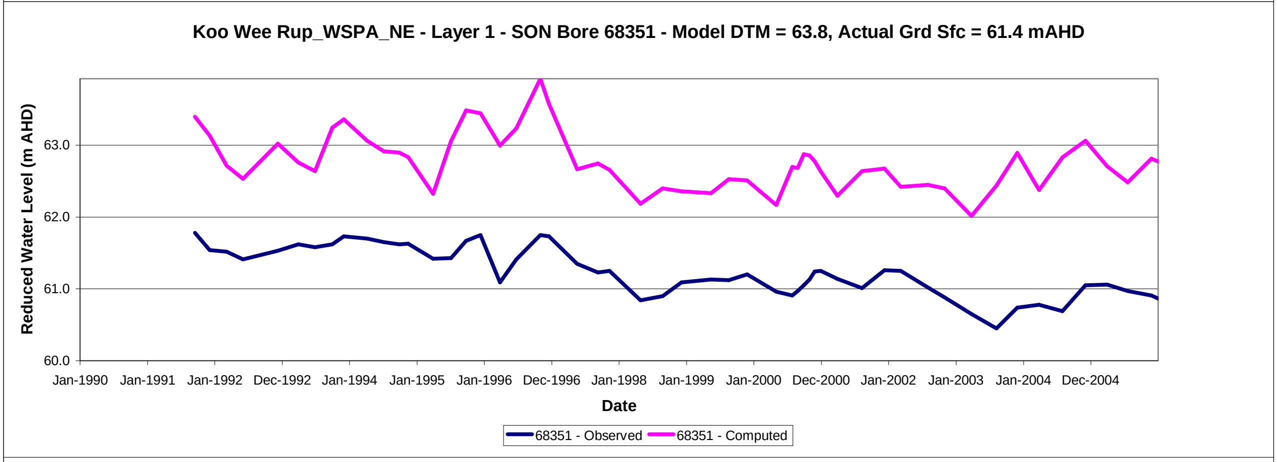
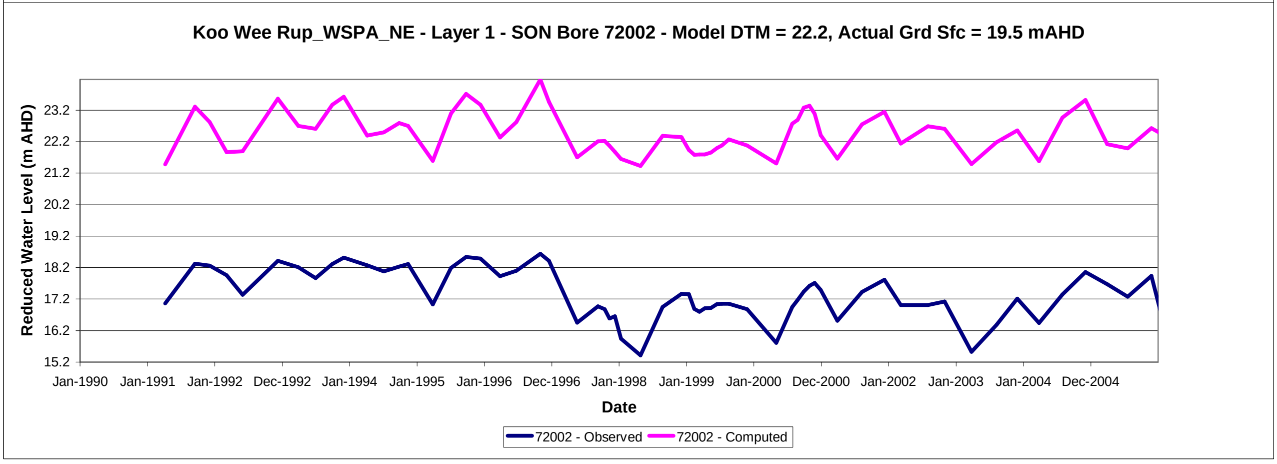


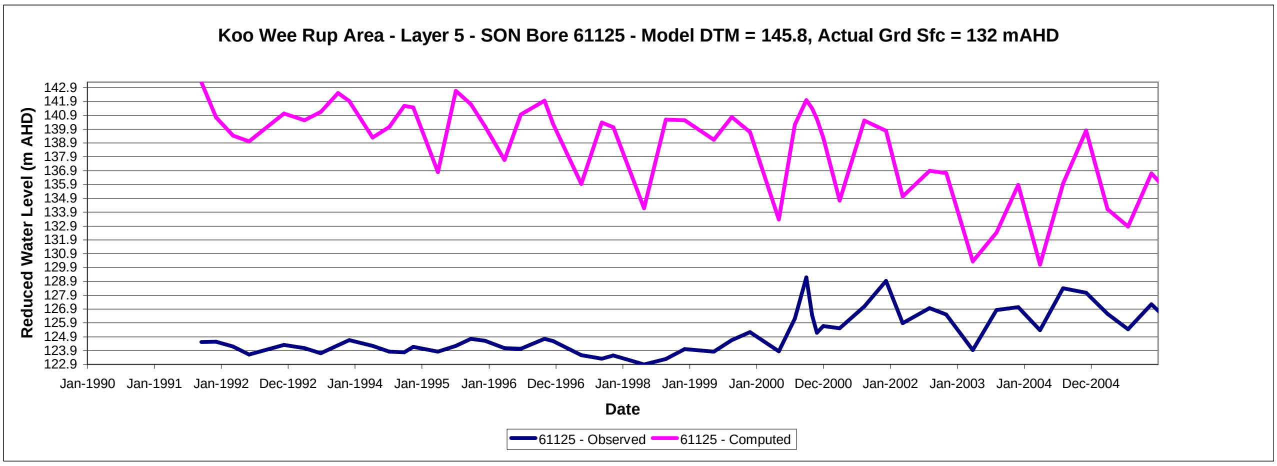

Koo Wee Rup_WSPA_NE - Layer 3 - SON Bore 71190 - Model DTM = 7.5, Actual Grd Sfc = 5.9 mAHD
Reduced Water Level (m AHD)
8.1
7.1
6.1
5.1
4.1
3.1
2.1
1.1
.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
71190 - Observed
71190 - Computed

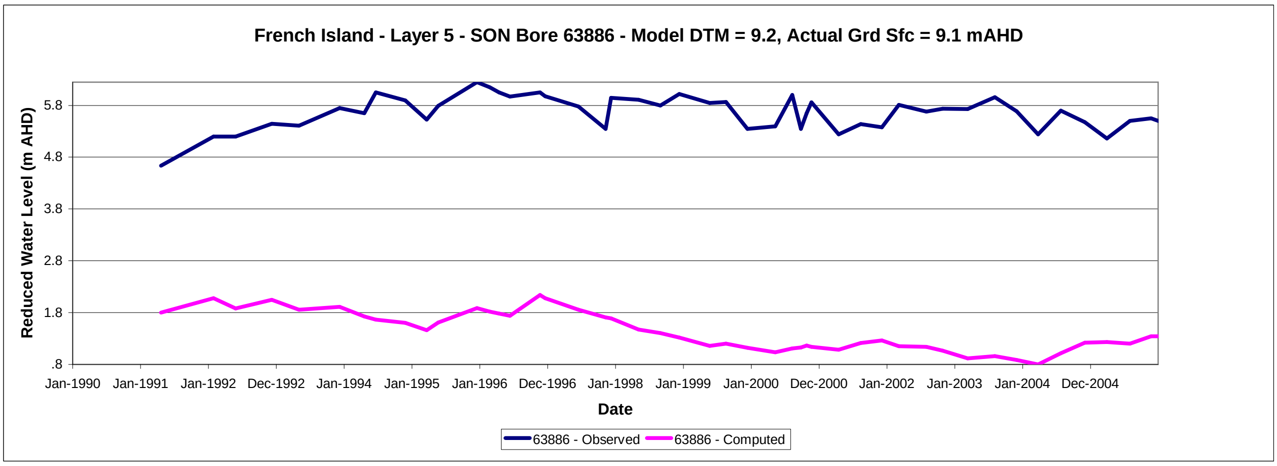

Koo Wee Rup_WSPA_NE - Layer 1 - SON Bore 61176 - Model DTM = 48.9, Actual Grd Sfc = 45.4 mAHD
Reduced Water Level (m AHD)
48.2
47.2
46.2
45.2
44.2
43.2
42.2
41.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
61176 - Observed
61176 - Computed

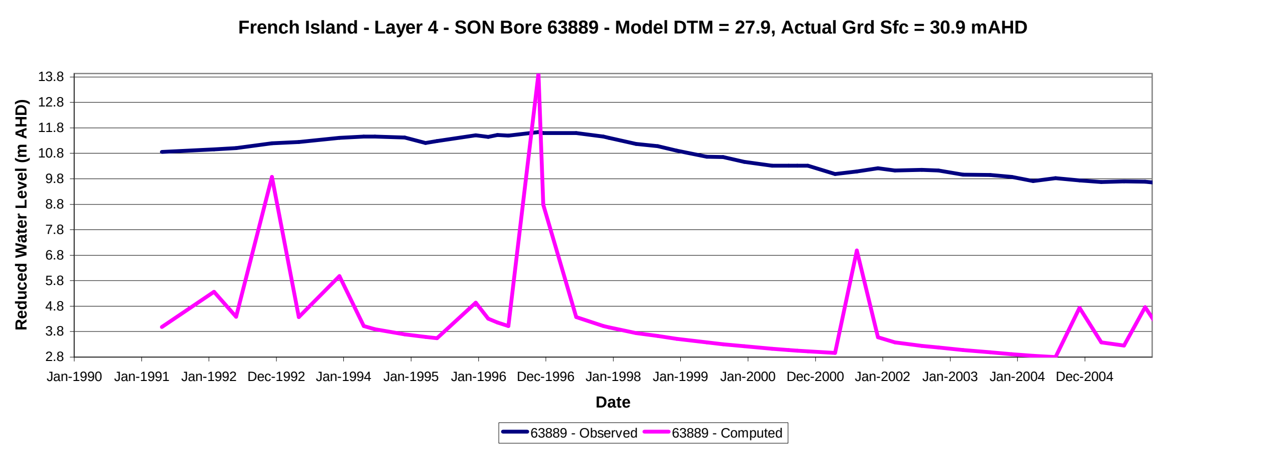

Koo Wee Rup_WSPA_NE - Layer 1 - SON Bore 68350 - Model DTM = 53.6, Actual Grd Sfc = 51.8 mAHD
Reduced Water Level (m AHD)
52.7
51.7
50.7
49.7
48.7
47.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
68350 - Observed
68350 - Computed

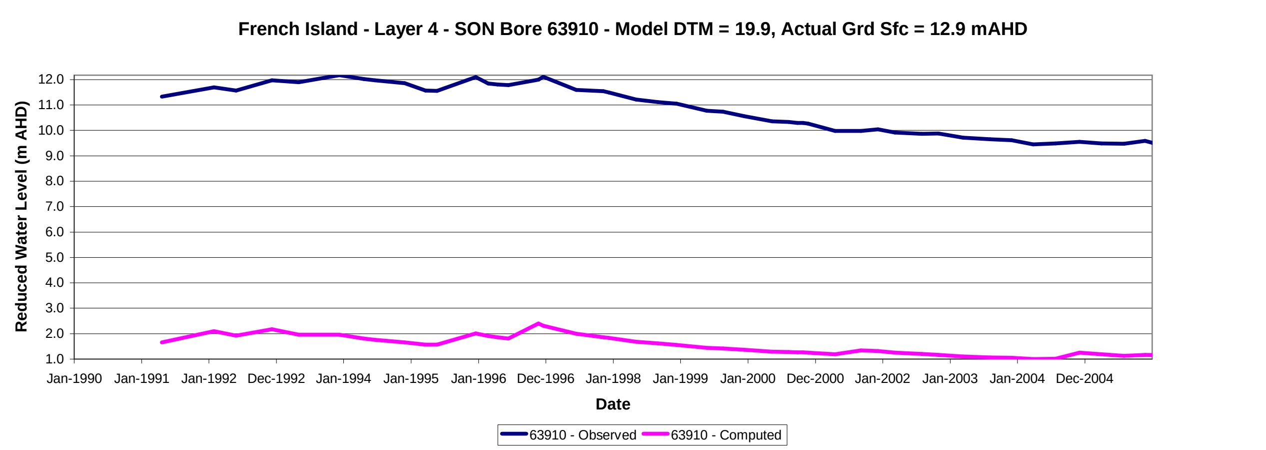

Koo Wee Rup_WSPA_NE - Layer 1 - SON Bore 68351 - Model DTM = 63.8, Actual Grd Sfc = 61.4 mAHD
Reduced Water Level (m AHD)
63.0
62.0
61.0
60.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
68351 - Observed
68351 - Computed

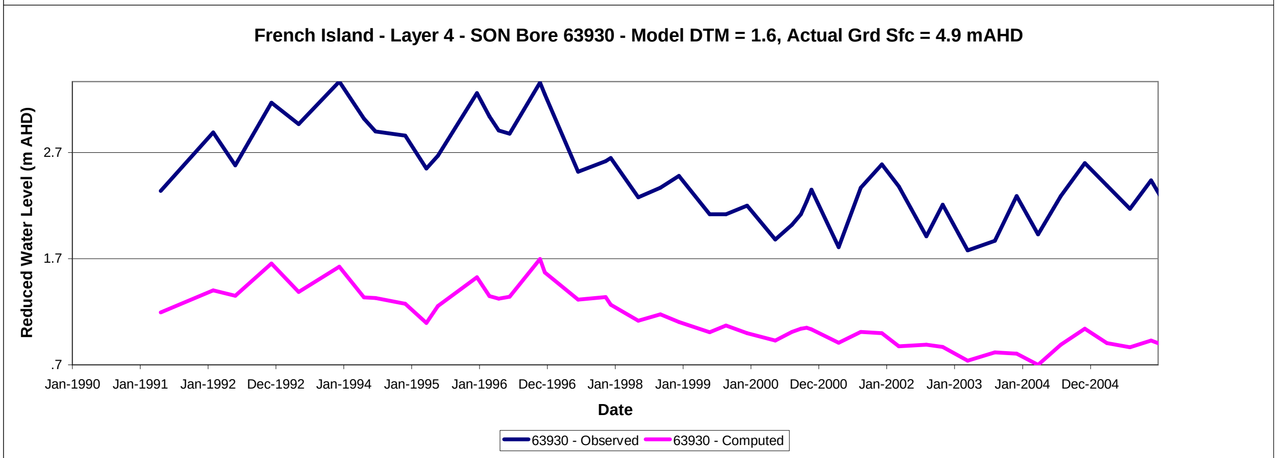

Koo Wee Rup_WSPA_NE - Layer 1 - SON Bore 72002 - Model DTM = 22.2, Actual Grd Sfc = 19.5 mAHD
Reduced Water Level (m AHD)
23.2
22.2
21.2
20.2
19.2
18.2
17.2
16.2
15.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
72002 - Observed
72002 - Computed

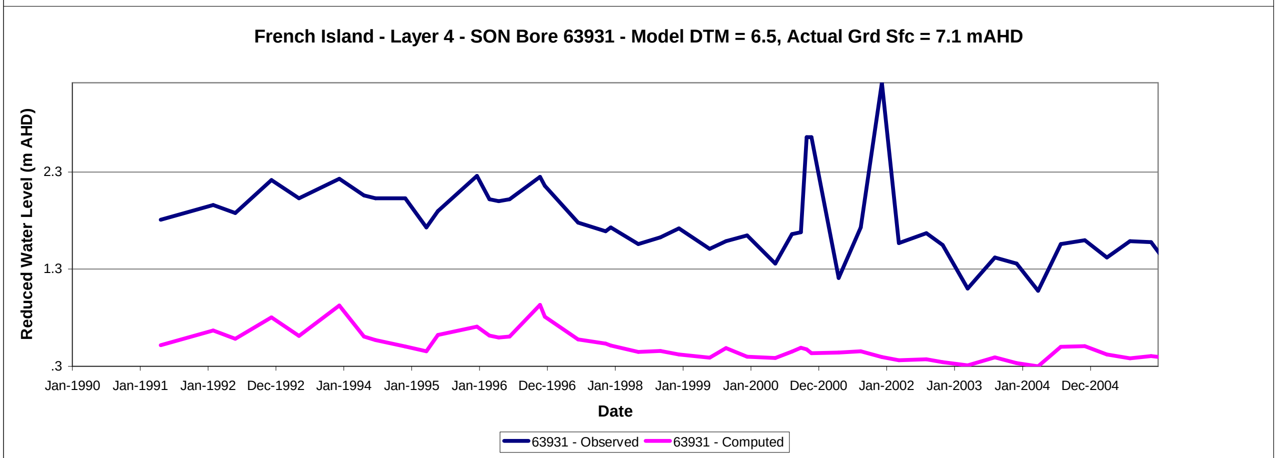

Koo Wee Rup Area - Layer 5 - SON Bore 61125 - Model DTM = 145.8, Actual Grd Sfc = 132 mAHD
Reduced Water Level (m AHD)
142.9
141.9
140.9
139.9
138.9
137.9
136.9
135.9
134.9
133.9
132.9
131.9
130.9
129.9
128.9
127.9
126.9
125.9
124.9
123.9
122.9
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
61125 - Observed
61125 - Computed

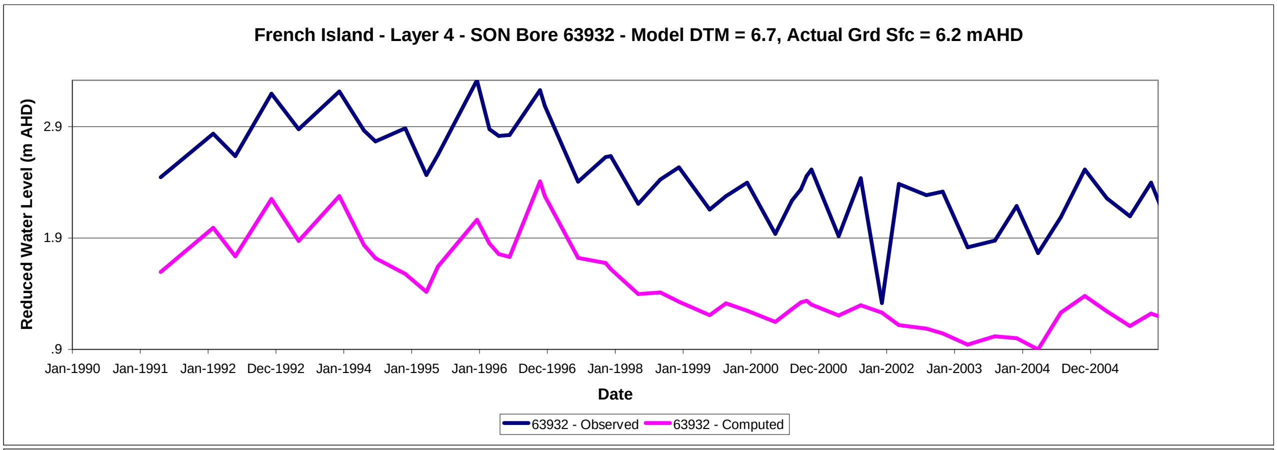

French Island - Layer 5 - SON Bore 63886 - Model DTM = 9.2, Actual Grd Sfc = 9.1 mAHD
Reduced Water Level (m AHD)
5.8
4.8
3.8
2.8
1.8
.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
63886 - Observed
63886 - Computed

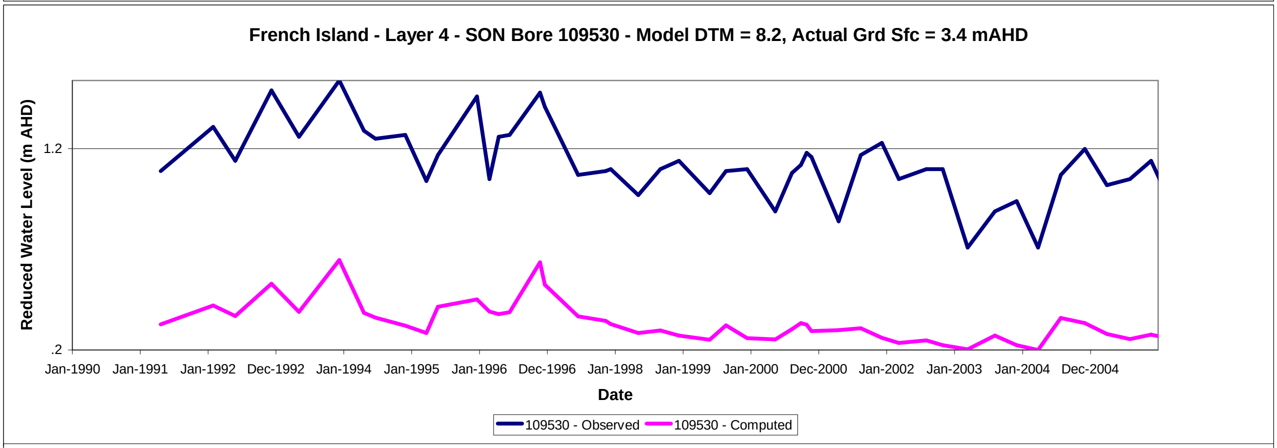

French Island - Layer 4 - SON Bore 63889 - Model DTM = 27.9, Actual Grd Sfc = 30.9 mAHD
Reduced Water Level (m AHD)
Date
63889 - Observed
63889 - Computed

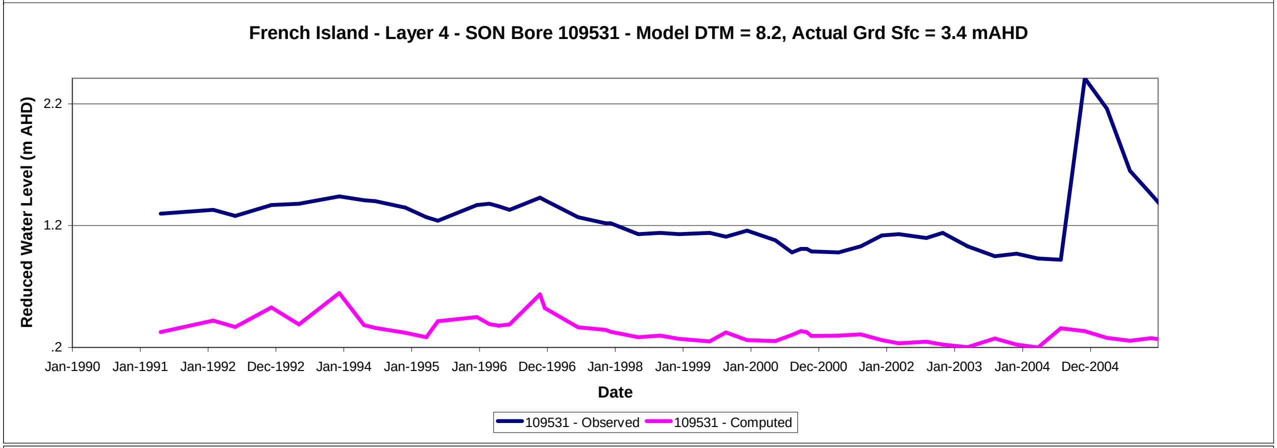

French Island - Layer 4 - SON Bore 63910 - Model DTM = 19.9, Actual Grd Sfc = 12.9 mAHD
Reduced Water Level (m AHD)
Date
63910 - Observed
63910 - Computed

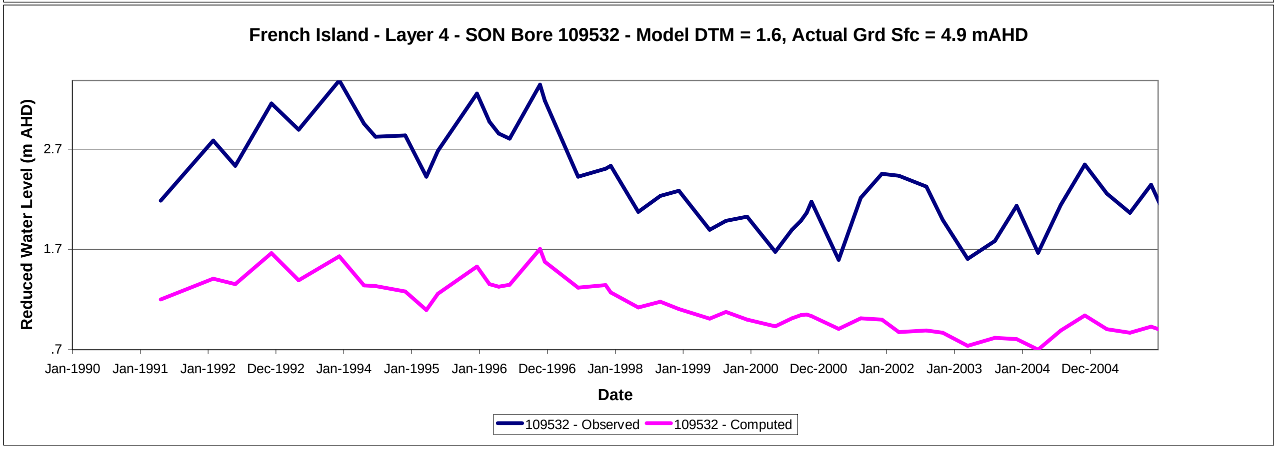

French Island - Layer 4 - SON Bore 63930 - Model DTM = 1.6, Actual Grd Sfc = 4.9 mAHD
Reduced Water Level (m AHD)
Date
63930 - Observed
63930 - Computed

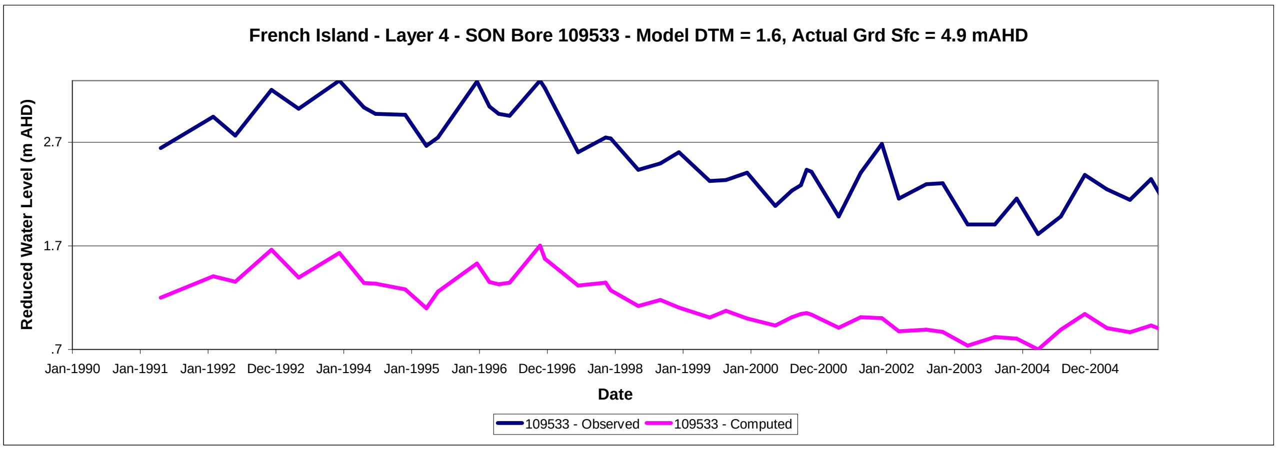

French Island - Layer 4 - SON Bore 63931 - Model DTM = 6.5, Actual Grd Sfc = 7.1 mAHD
Reduced Water Level (m AHD)
Date
63931 - Observed
63931 - Computed

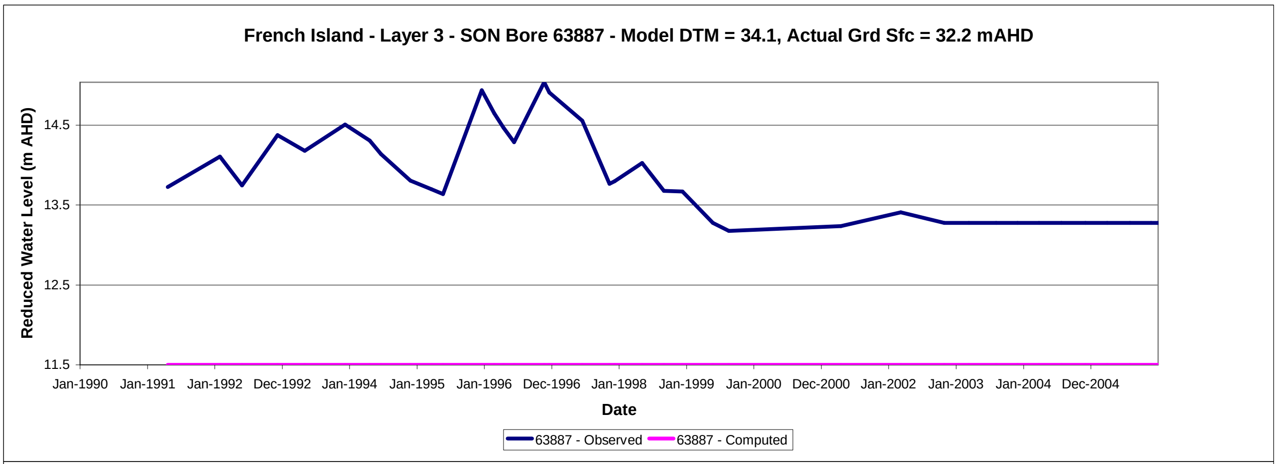

French Island - Layer 4 - SON Bore 63932 - Model DTM = 6.7, Actual Grd Sfc = 6.2 mAHD
Reduced Water Level (m AHD)
2.9
1.9
.9
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
63932 - Observed
63932 - Computed

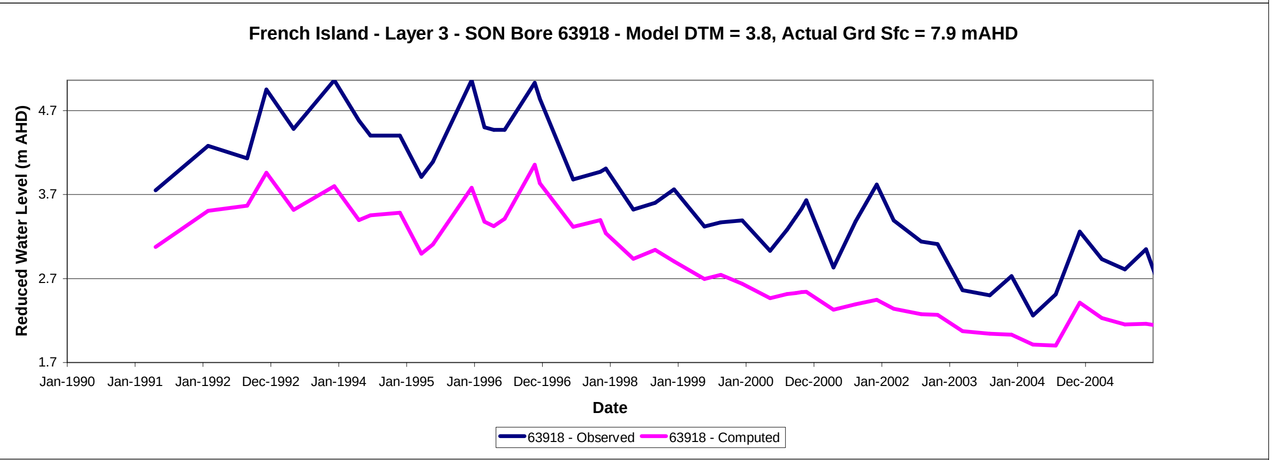

French Island - Layer 4 - SON Bore 109530 - Model DTM = 8.2, Actual Grd Sfc = 3.4 mAHD
Reduced Water Level (m AHD)
1.2
.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109530 - Observed
109530 - Computed

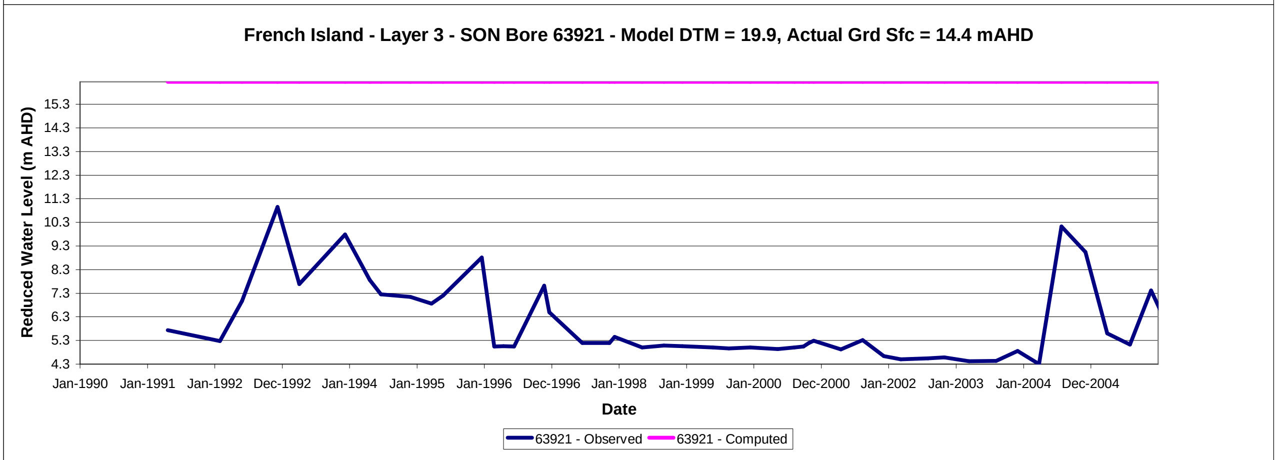

French Island - Layer 4 - SON Bore 109531 - Model DTM = 8.2, Actual Grd Sfc = 3.4 mAHD
Reduced Water Level (m AHD)
2.2
1.2
.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109531 - Observed
109531 - Computed

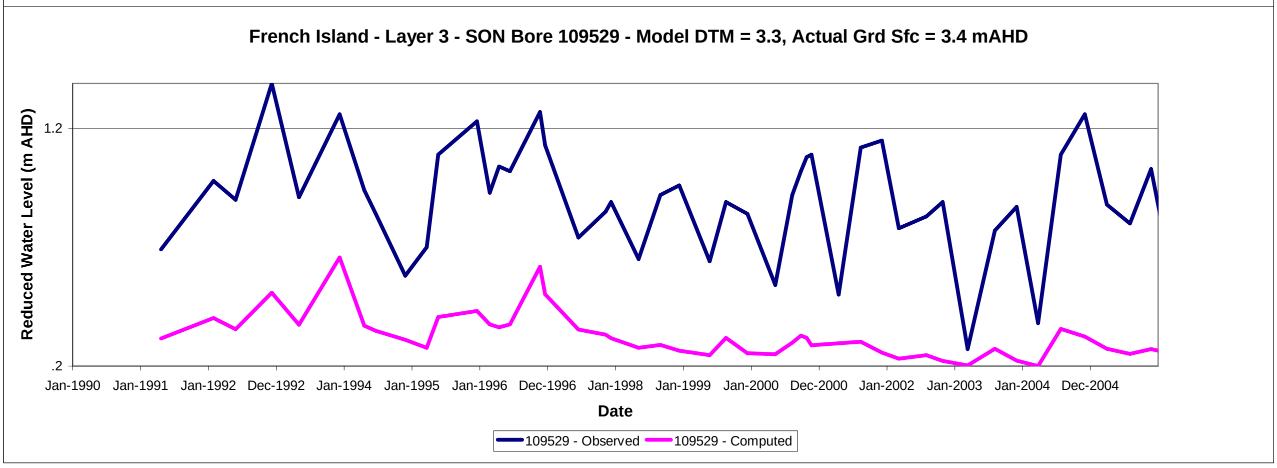

French Island - Layer 4 - SON Bore 109532 - Model DTM = 1.6, Actual Grd Sfc = 4.9 mAHD
Reduced Water Level (m AHD)
2.7
1.7
.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109532 - Observed
109532 - Computed

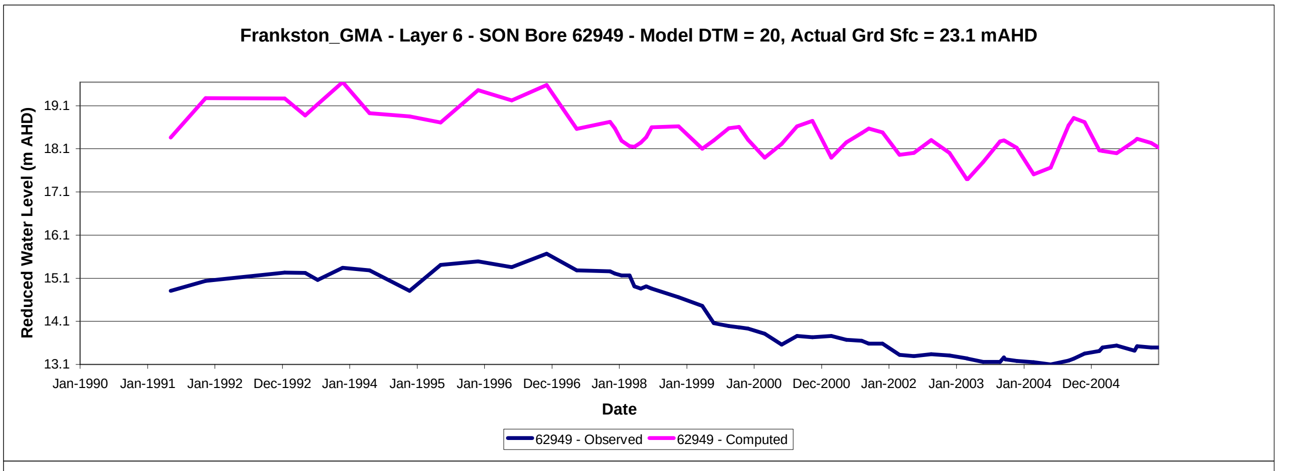

French Island - Layer 4 - SON Bore 109533 - Model DTM = 1.6, Actual Grd Sfc = 4.9 mAHD
Reduced Water Level (m AHD)
2.7
1.7
.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109533 - Observed
109533 - Computed

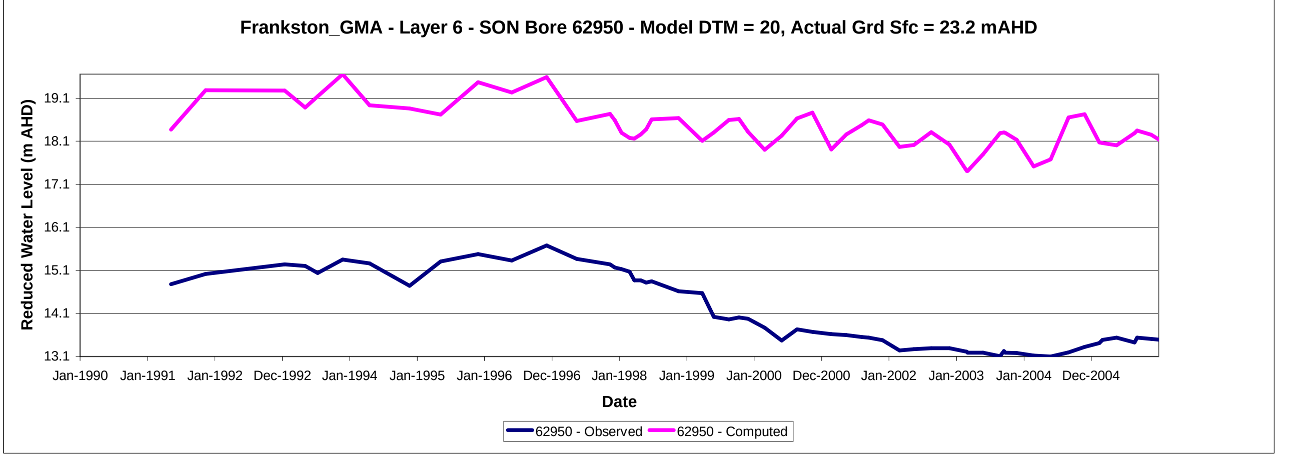

French Island - Layer 3 - SON Bore 63887 - Model DTM = 34.1, Actual Grd Sfc = 32.2 mAHD
Reduced Water Level (m AHD)
14.5
13.5
12.5
11.5
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
63887 - Observed
63887 - Computed

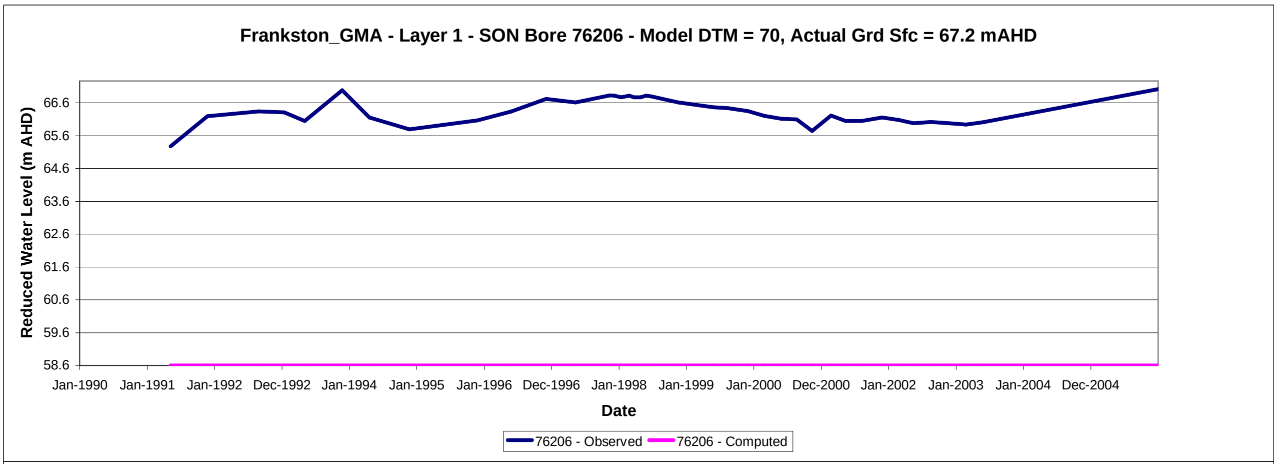

French Island - Layer 3 - SON Bore 63918 - Model DTM = 3.8, Actual Grd Sfc = 7.9 mAHD
Reduced Water Level (m AHD)
4.7
3.7
2.7
1.7
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
63918 - Observed
63918 - Computed

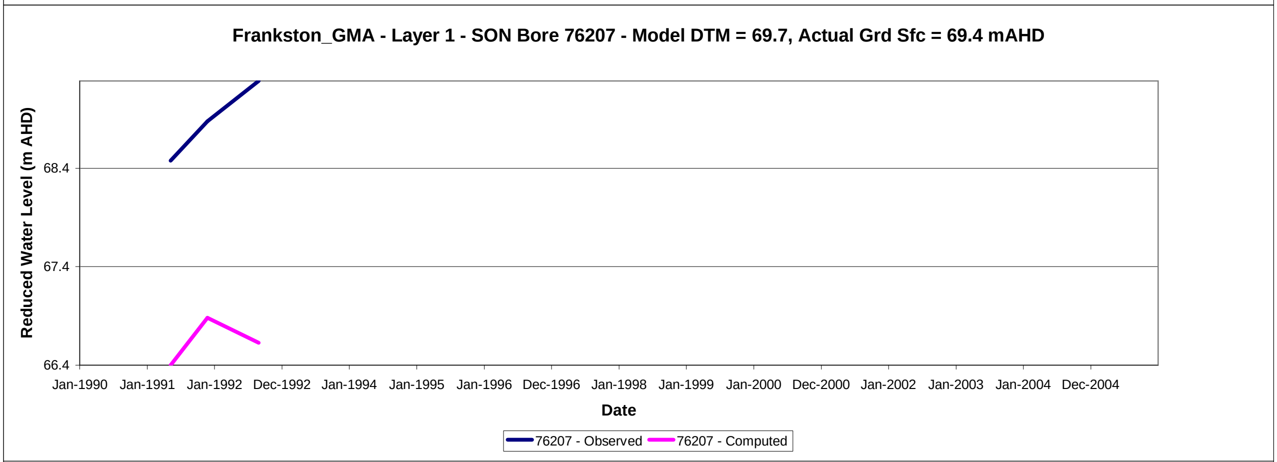

French Island - Layer 3 - SON Bore 63921 - Model DTM = 19.9, Actual Grd Sfc = 14.4 mAHD
Reduced Water Level (m AHD)
15.3
14.3
13.3
12.3
11.3
10.3
9.3
8.3
7.3
6.3
5.3
4.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
63921 - Observed
63921 - Computed

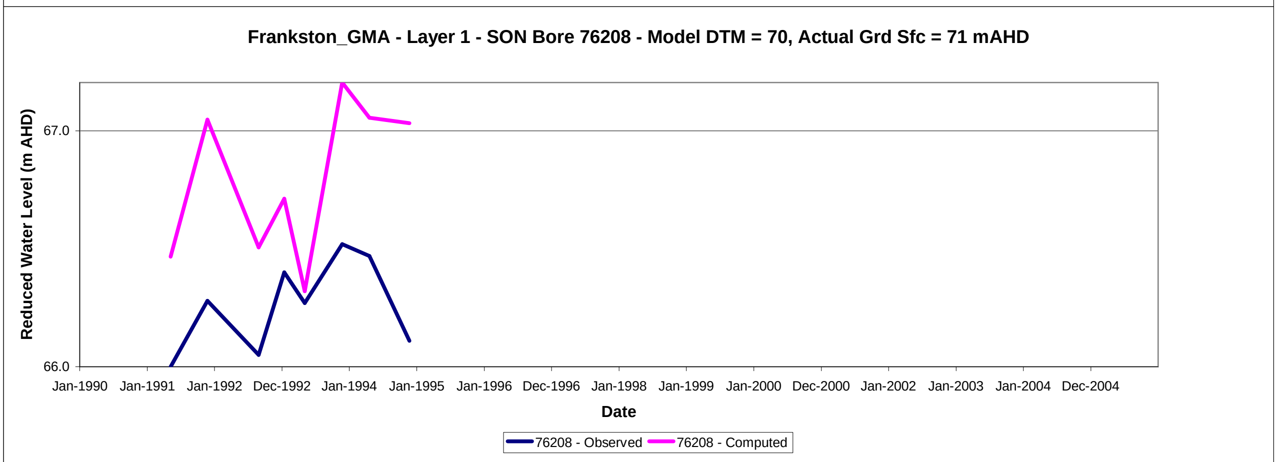

French Island - Layer 3 - SON Bore 109529 - Model DTM = 3.3, Actual Grd Sfc = 3.4 mAHD
Reduced Water Level (m AHD)
1.2
.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
109529 - Observed
109529 - Computed

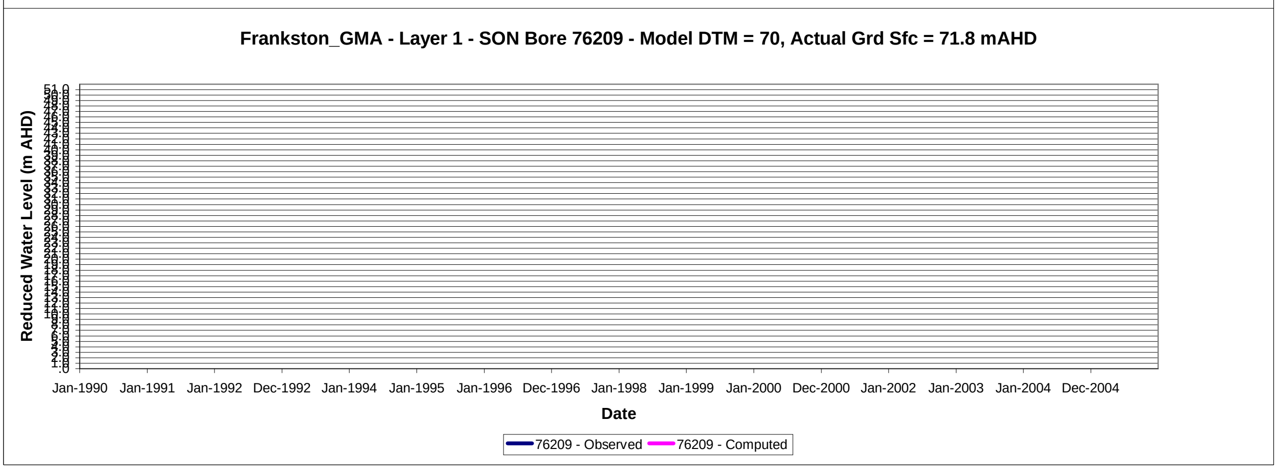

Frankston_GMA - Layer 6 - SON Bore 62949 - Model DTM = 20, Actual Grd Sfc = 23.1 mAHD
Reduced Water Level (m AHD)
19.1
18.1
17.1
16.1
15.1
14.1
13.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
62949 - Observed
62949 - Computed


Frankston_GMA - Layer 6 - SON Bore 62950 - Model DTM = 20, Actual Grd Sfc = 23.2 mAHD
Reduced Water Level (m AHD)
19.1
18.1
17.1
16.1
15.1
14.1
13.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
62950 - Observed
62950 - Computed


Frankston_GMA - Layer 1 - SON Bore 76206 - Model DTM = 70, Actual Grd Sfc = 67.2 mAHD
Reduced Water Level (m AHD)
66.6
65.6
64.6
63.6
62.6
61.6
60.6
59.6
58.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
76206 - Observed
76206 - Computed


Frankston_GMA - Layer 1 - SON Bore 76207 - Model DTM = 69.7, Actual Grd Sfc = 69.4 mAHD
Reduced Water Level (m AHD)
68.4
67.4
66.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
76207 - Observed
76207 - Computed


Frankston_GMA - Layer 1 - SON Bore 76208 - Model DTM = 70, Actual Grd Sfc = 71 mAHD
Reduced Water Level (m AHD)
67.0
66.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
76208 - Observed
76208 - Computed


Frankston_GMA - Layer 1 - SON Bore 76209 - Model DTM = 70, Actual Grd Sfc = 71.8 mAHD
Reduced Water Level (m AHD)
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
76209 - Observed
76209 - Computed

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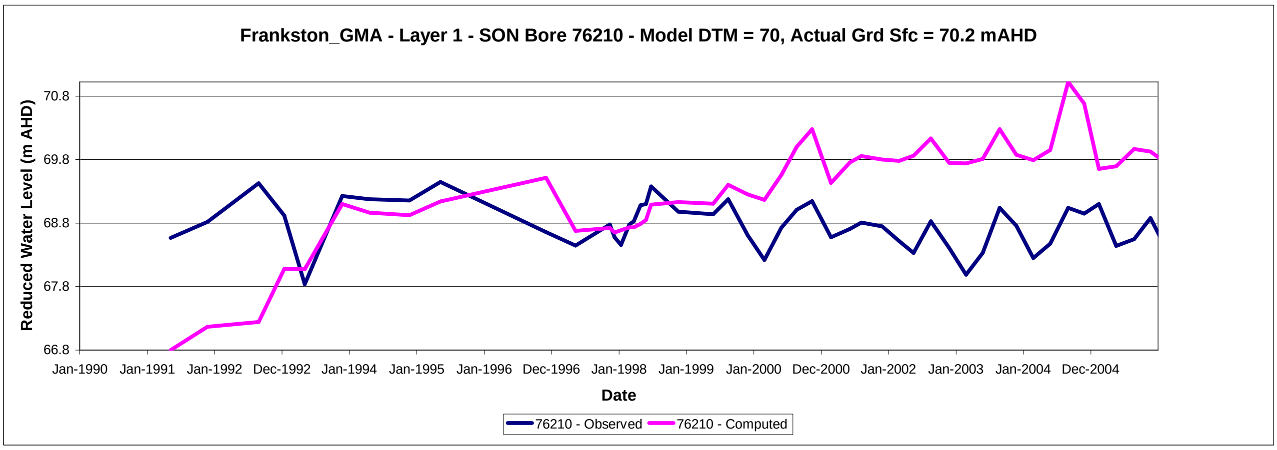
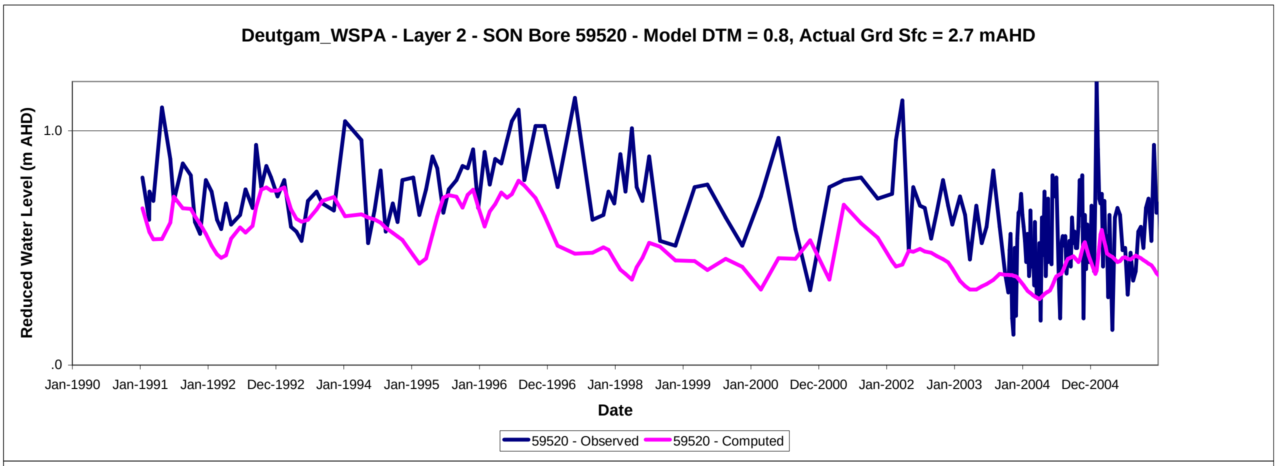
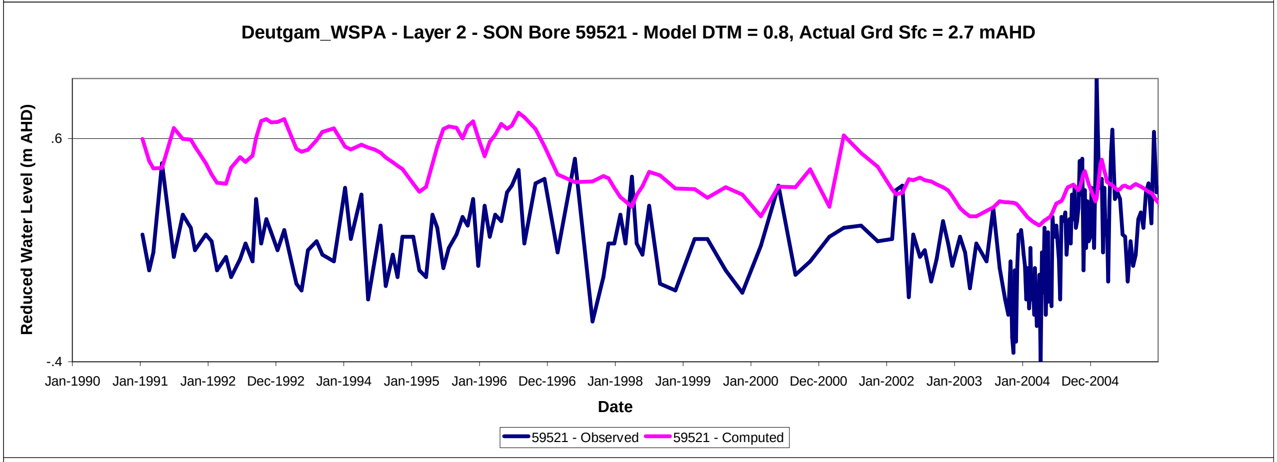
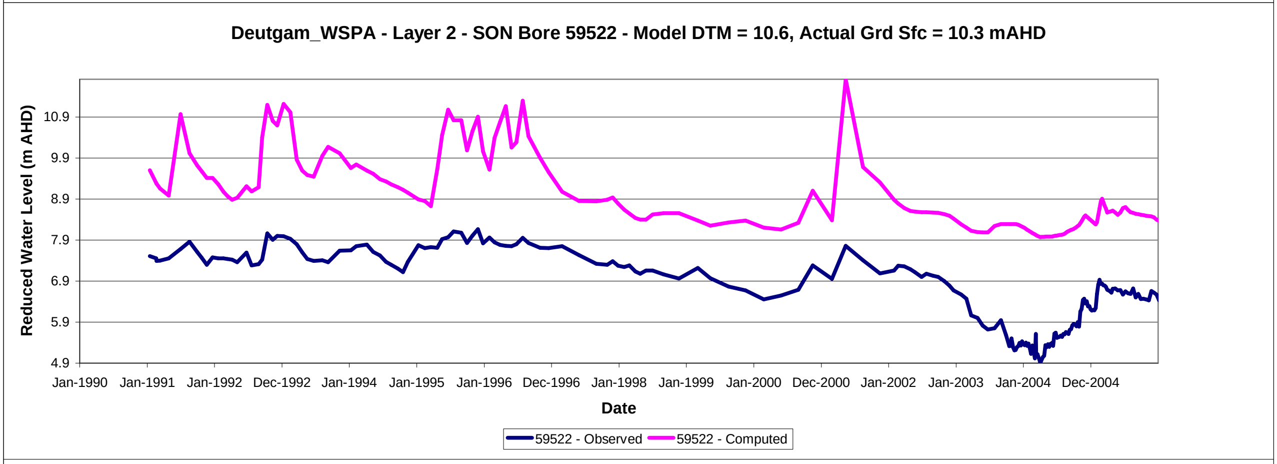
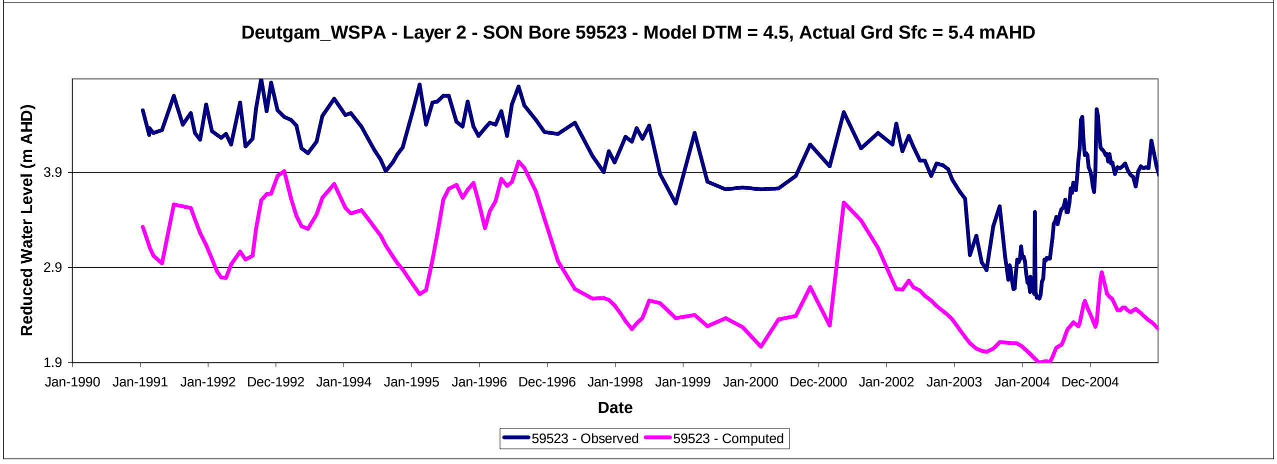
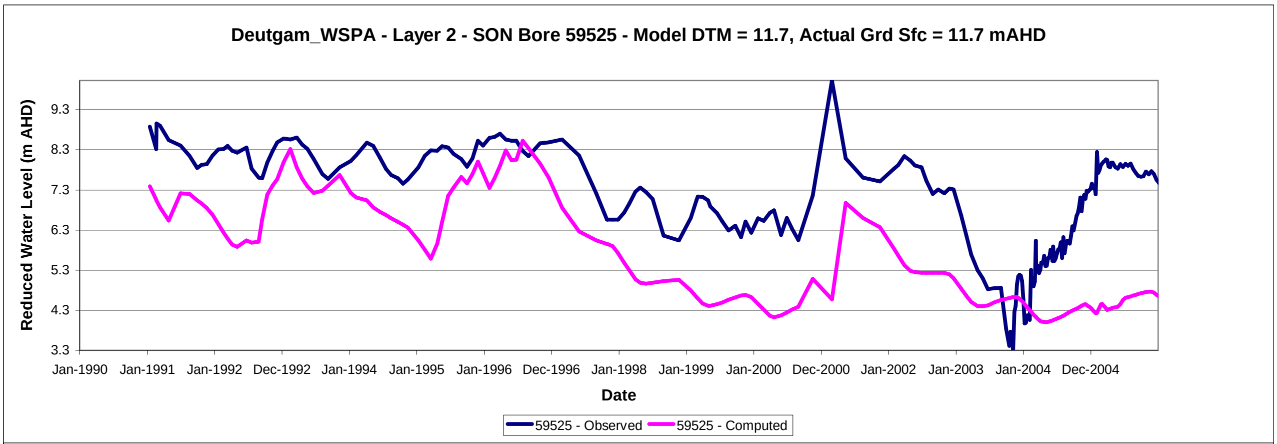


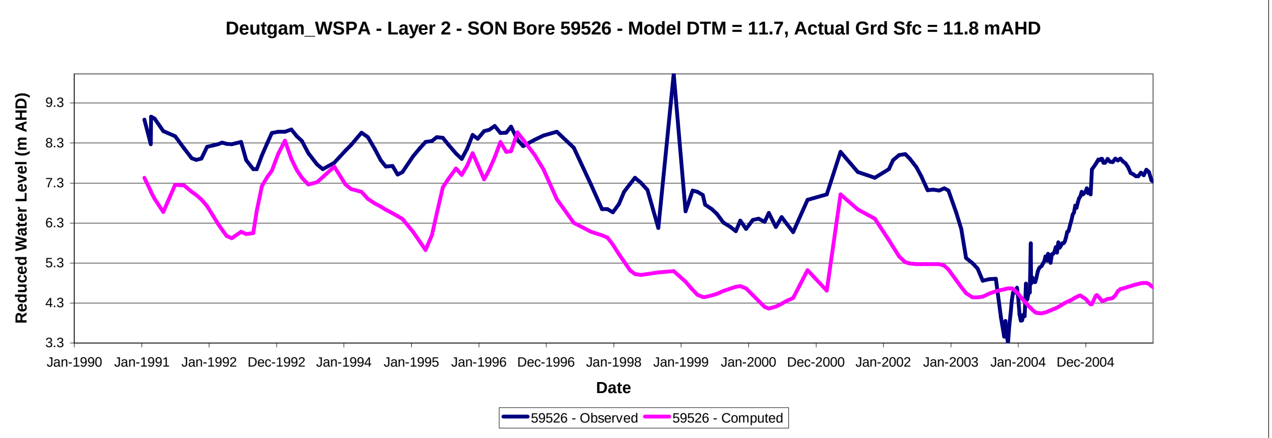

Deutgam_WSPA - Layer 2 - SON Bore 59520 - Model DTM = 0.8, Actual Grd Sfc = 2.7 mAHD
Reduced Water Level (m AHD)
1.0
.0
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
59520 - Observed
59520 - Computed

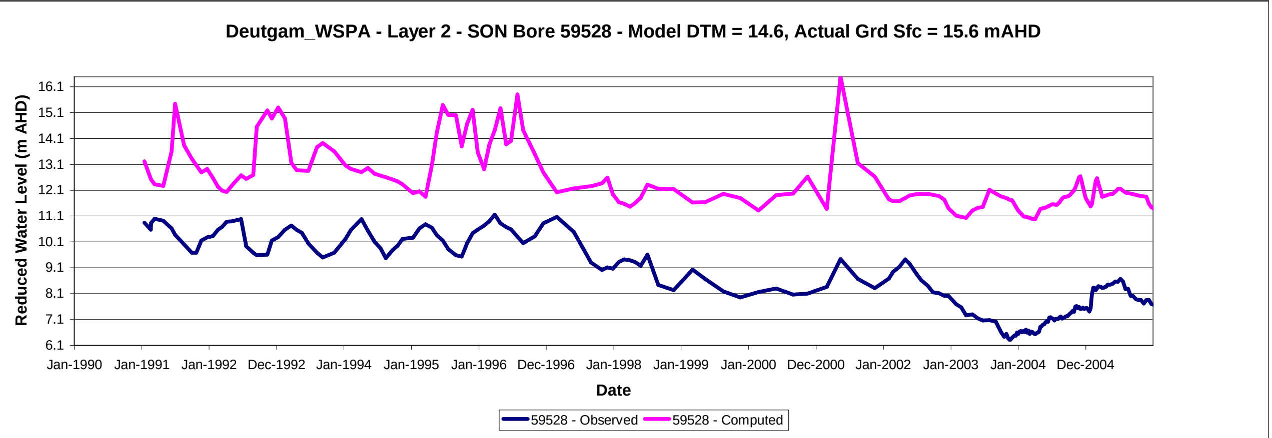

Deutgam_WSPA - Layer 2 - SON Bore 59521 - Model DTM = 0.8, Actual Grd Sfc = 2.7 mAHD
Reduced Water Level (m AHD)
.6
-.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
59521 - Observed
59521 - Computed

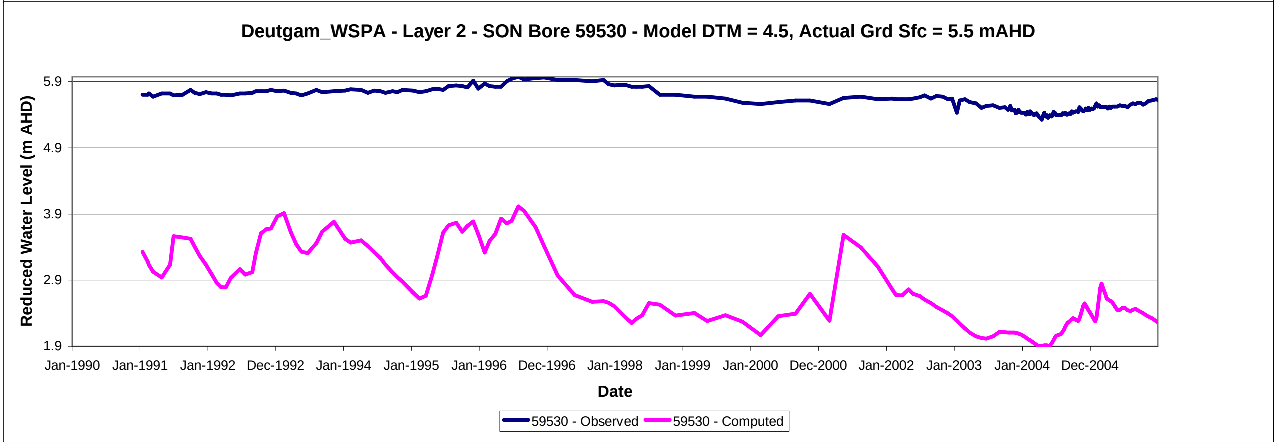

Deutgam_WSPA - Layer 2 - SON Bore 59522 - Model DTM = 10.6, Actual Grd Sfc = 10.3 mAHD
Reduced Water Level (m AHD)
10.9
9.9
8.9
7.9
6.9
5.9
4.9
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
59522 - Observed
59522 - Computed


Deutgam_WSPA - Layer 2 - SON Bore 59523 - Model DTM = 4.5, Actual Grd Sfc = 5.4 mAHD
Reduced Water Level (m AHD)
3.9
2.9
1.9
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
59523 - Observed
59523 - Computed


Deutgam_WSPA - Layer 2 - SON Bore 59525 - Model DTM = 11.7, Actual Grd Sfc = 11.7 mAHD
Reduced Water Level (m AHD)
Date
59525 - Observed
59525 - Computed


Deutgam_WSPA - Layer 2 - SON Bore 59526 - Model DTM = 11.7, Actual Grd Sfc = 11.8 mAHD
Reduced Water Level (m AHD)
Date
59526 - Observed
59526 - Computed


Deutgam_WSPA - Layer 2 - SON Bore 59528 - Model DTM = 14.6, Actual Grd Sfc = 15.6 mAHD
Reduced Water Level (m AHD)
Date
59528 - Observed
59528 - Computed


Deutgam_WSPA - Layer 2 - SON Bore 59530 - Model DTM = 4.5, Actual Grd Sfc = 5.5 mAHD
Reduced Water Level (m AHD)
Date
59530 - Observed
59530 - Computed

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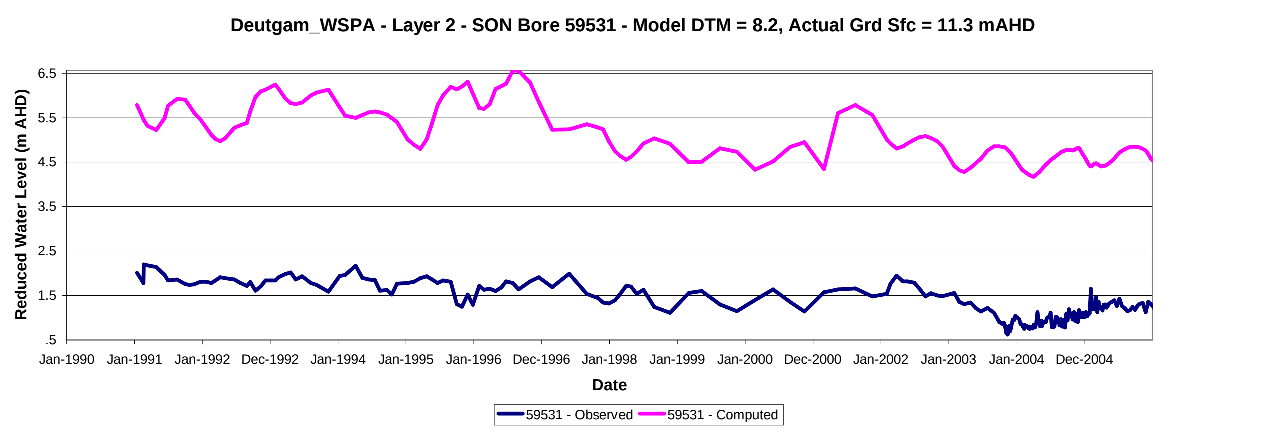
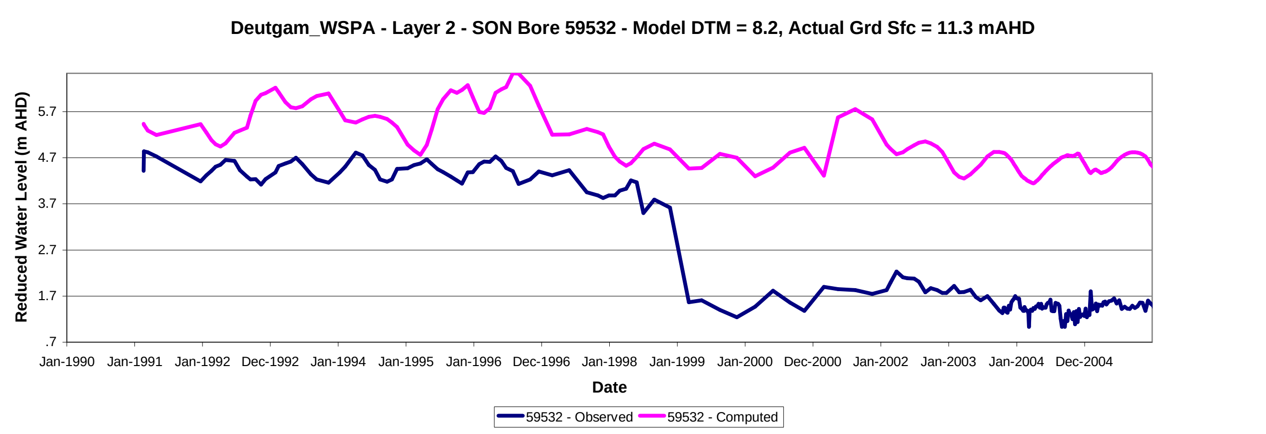
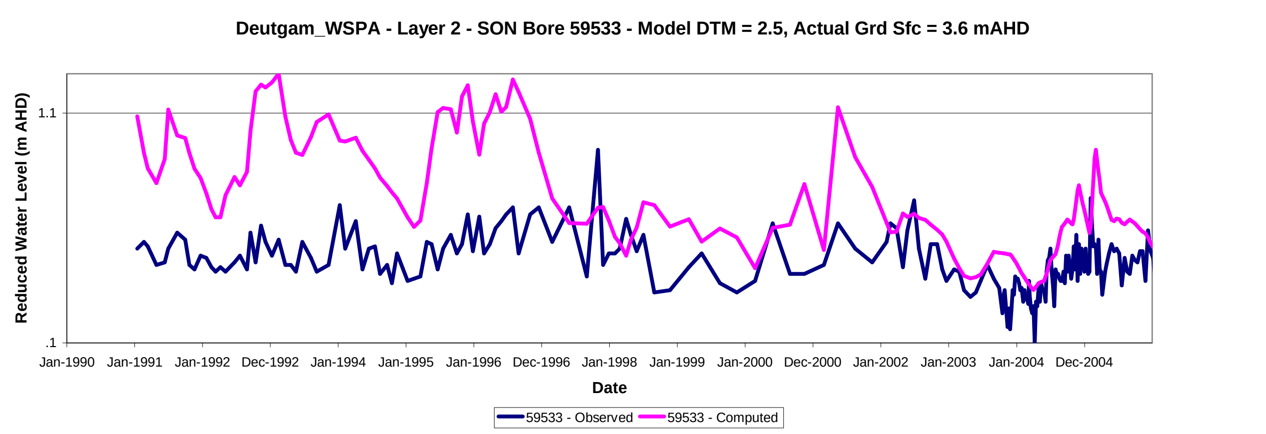
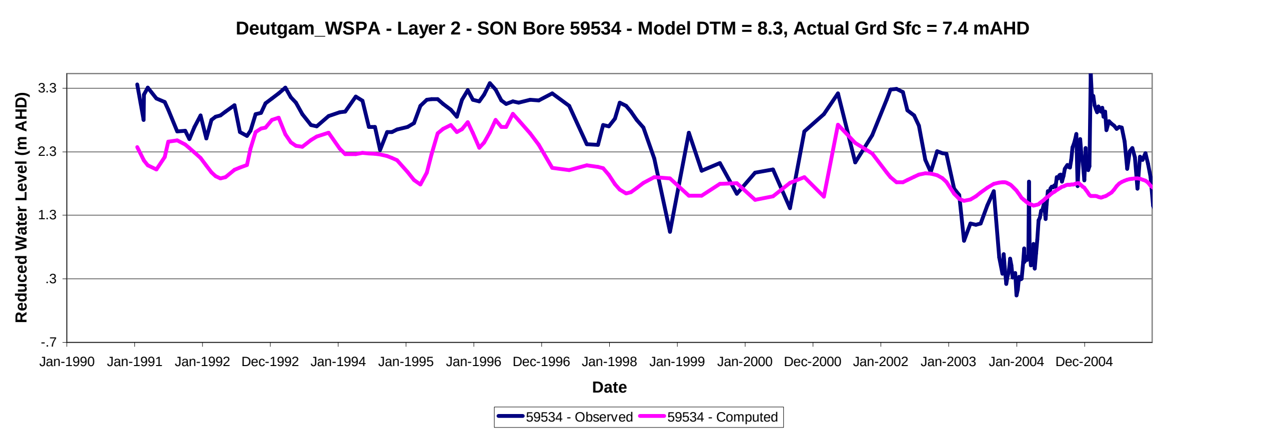
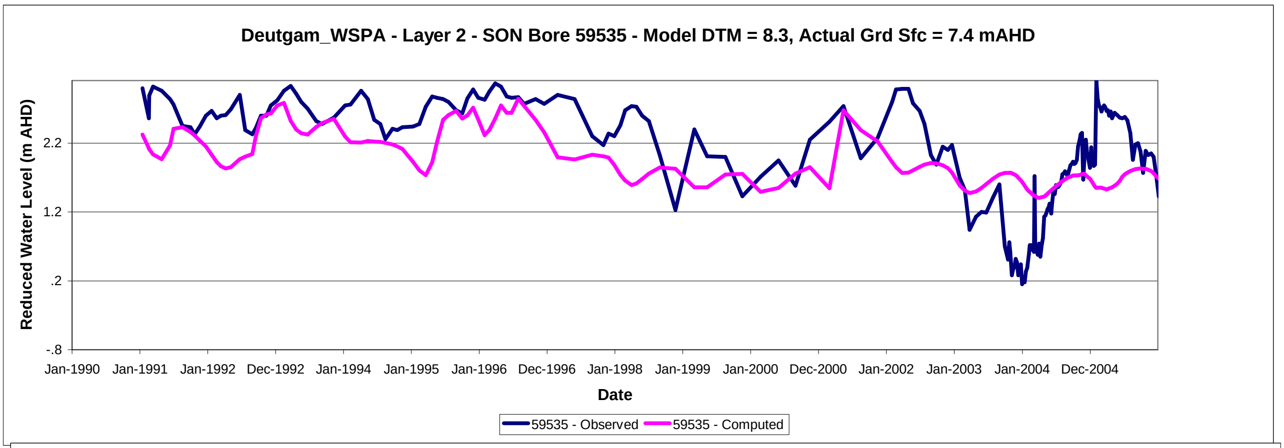
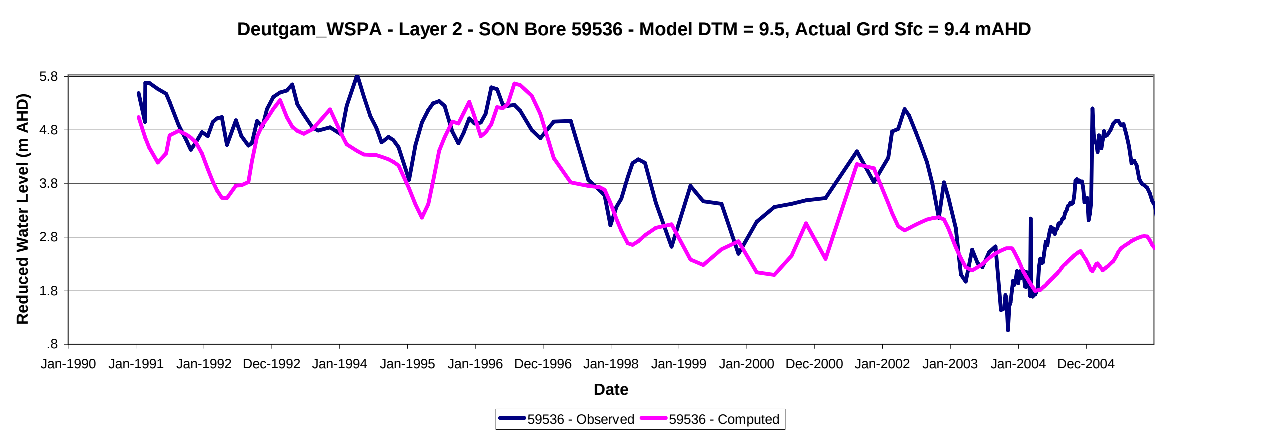


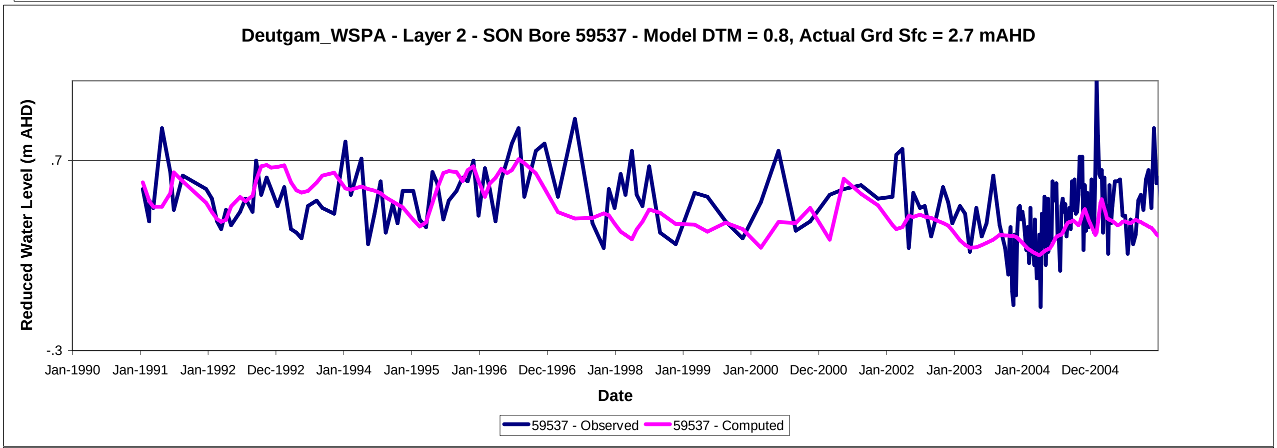


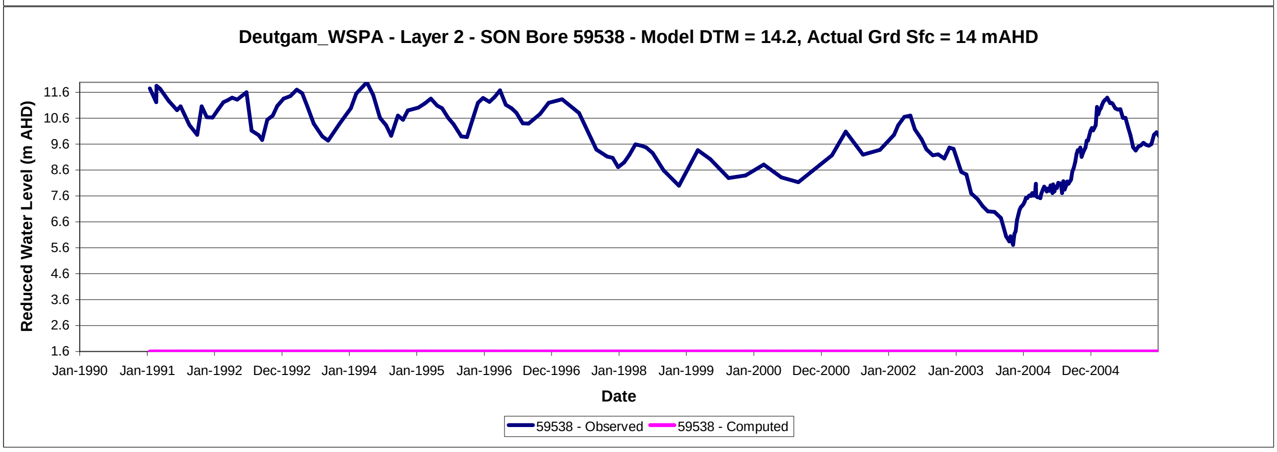


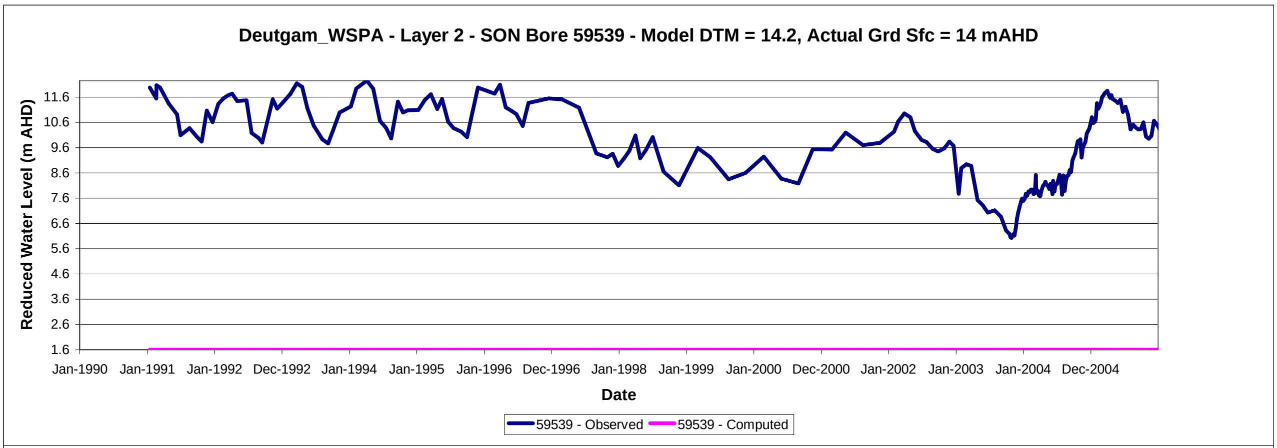


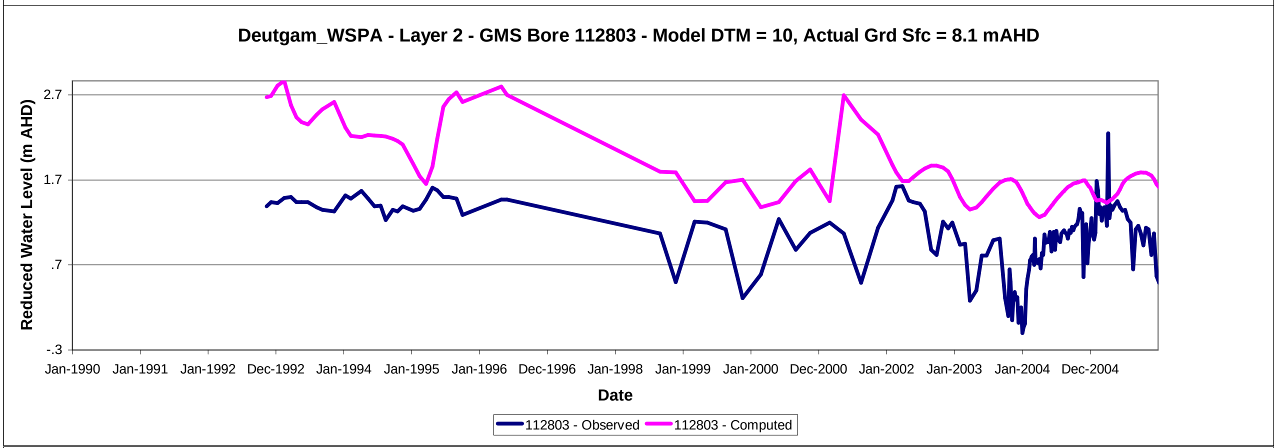

Deutgam_WSPA - Layer 2 - SON Bore 59535 - Model DTM = 8.3, Actual Grd Sfc = 7.4 mAHD
Reduced Water Level (m AHD)
2.2
1.2
.2
-.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
59535 - Observed
59535 - Computed

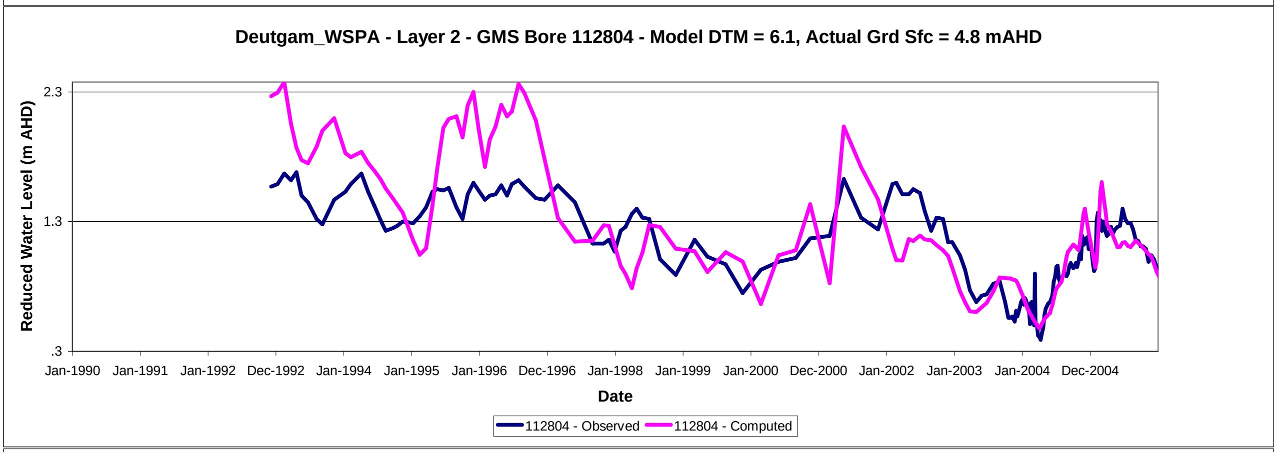

Deutgam_WSPA - Layer 2 - SON Bore 59536 - Model DTM = 9.5, Actual Grd Sfc = 9.4 mAHD
Reduced Water Level (m AHD)
5.8
4.8
3.8
2.8
1.8
.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
59536 - Observed
59536 - Computed

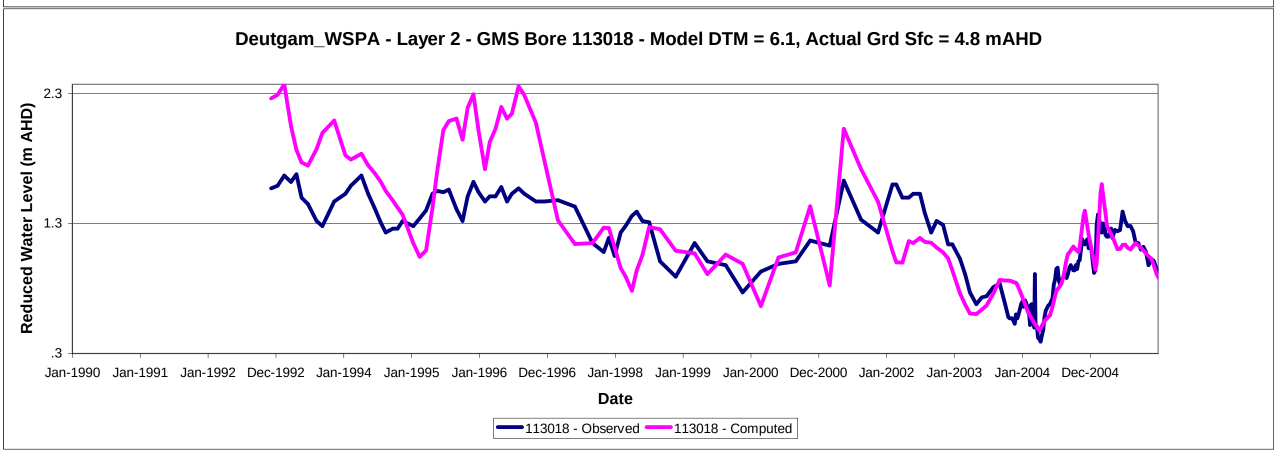

Deutgam_WSPA - Layer 2 - SON Bore 59537 - Model DTM = 0.8, Actual Grd Sfc = 2.7 mAHD
Reduced Water Level (m AHD)
.7
-.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
59537 - Observed
59537 - Computed

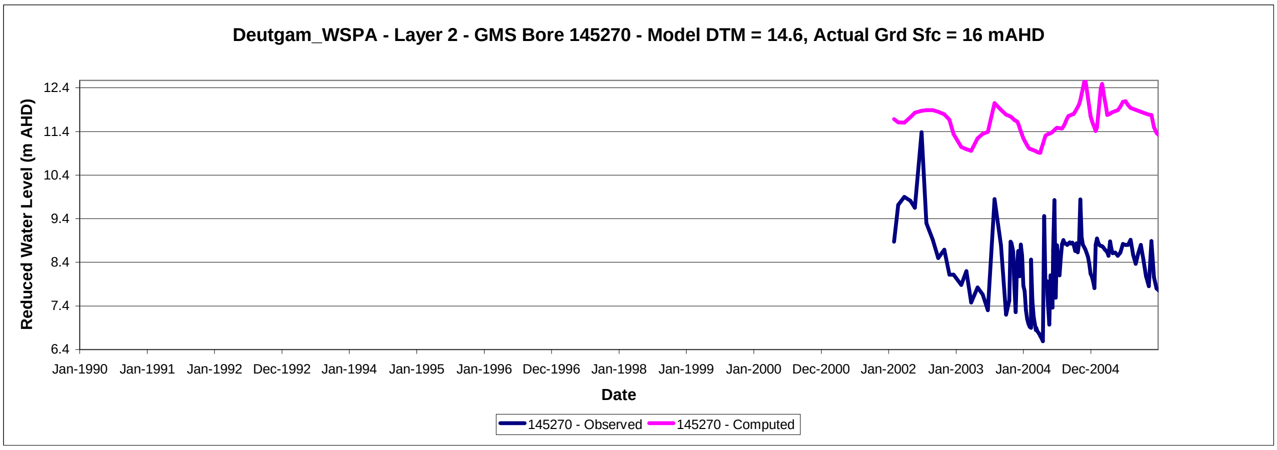

Deutgam_WSPA - Layer 2 - SON Bore 59538 - Model DTM = 14.2, Actual Grd Sfc = 14 mAHD
Reduced Water Level (m AHD)
11.6
10.6
9.6
8.6
7.6
6.6
5.6
4.6
3.6
2.6
1.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
59538 - Observed
59538 - Computed

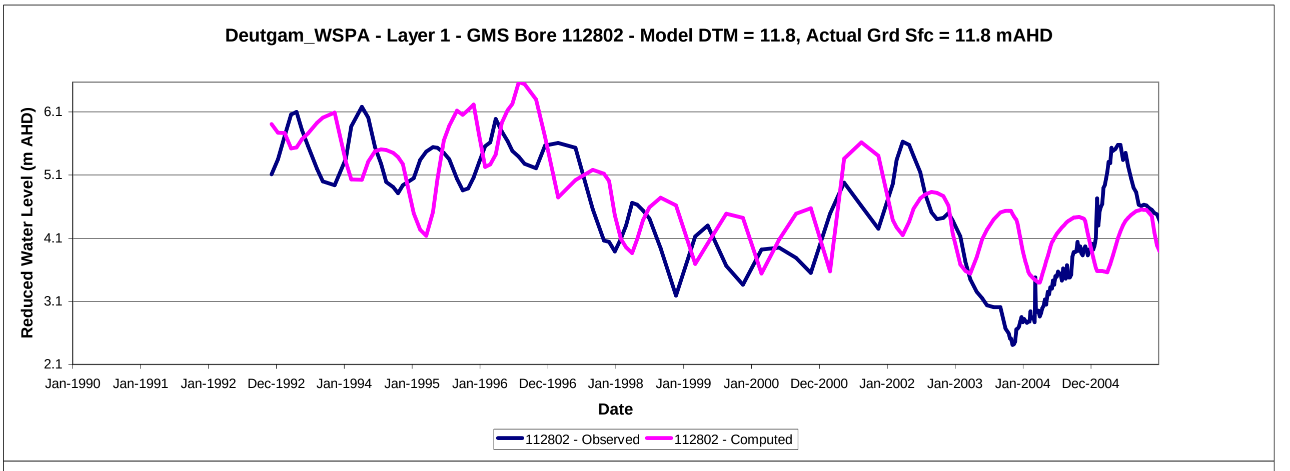

Deutgam_WSPA - Layer 2 - SON Bore 59539 - Model DTM = 14.2, Actual Grd Sfc = 14 mAHD
Reduced Water Level (m AHD)
11.6
10.6
9.6
8.6
7.6
6.6
5.6
4.6
3.6
2.6
1.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
59539 - Observed
59539 - Computed

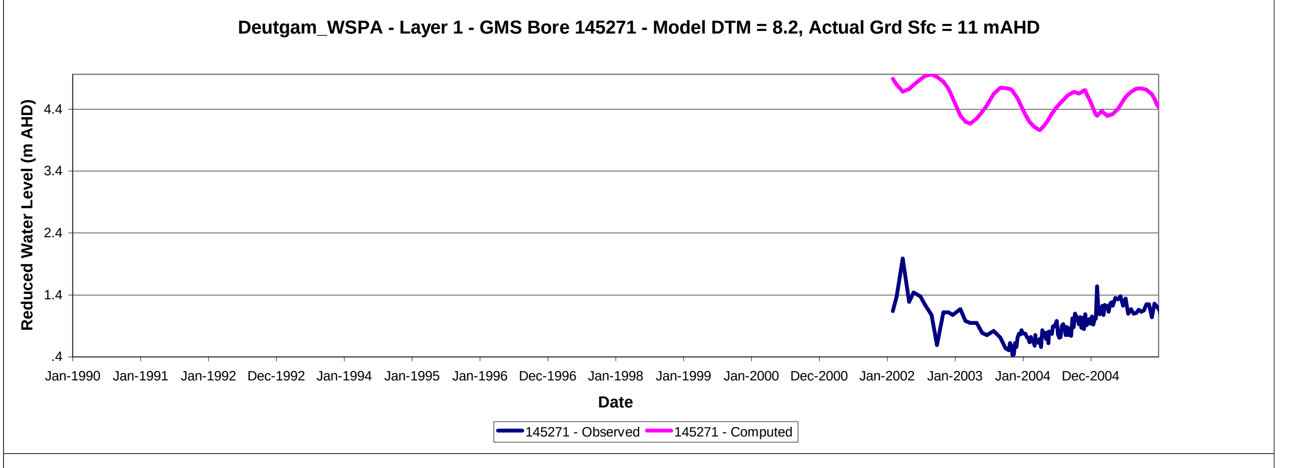

Deutgam_WSPA - Layer 2 - GMS Bore 112803 - Model DTM = 10, Actual Grd Sfc = 8.1 mAHD
Reduced Water Level (m AHD)
2.7
1.7
.7
-.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
112803 - Observed
112803 - Computed

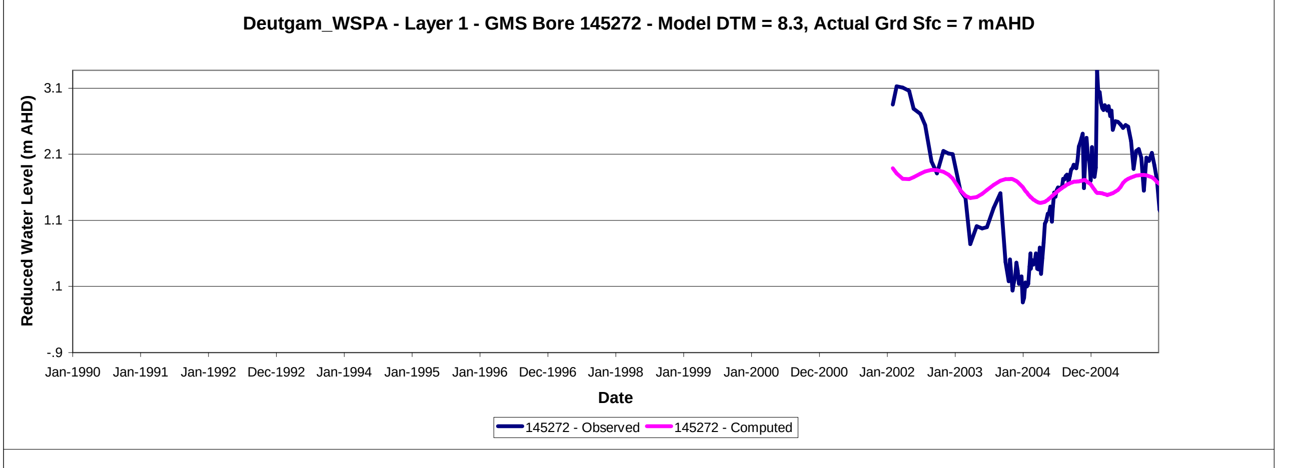

Deutgam_WSPA - Layer 2 - GMS Bore 112804 - Model DTM = 6.1, Actual Grd Sfc = 4.8 mAHD
Reduced Water Level (m AHD)
2.3
1.3
.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
112804 - Observed
112804 - Computed

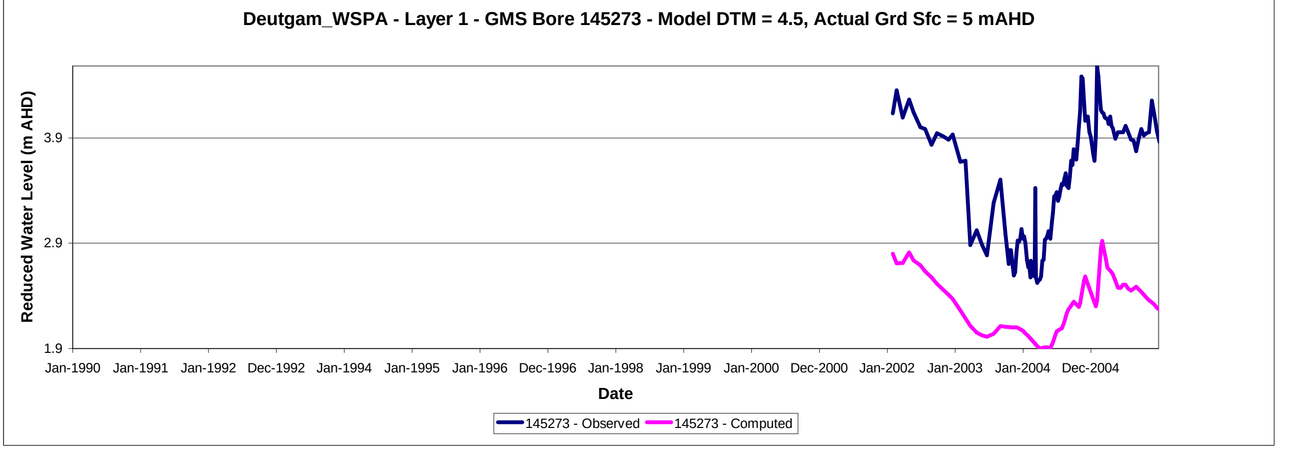

Deutgam_WSPA - Layer 2 - GMS Bore 113018 - Model DTM = 6.1, Actual Grd Sfc = 4.8 mAHD
Reduced Water Level (m AHD)
2.3
1.3
.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
113018 - Observed
113018 - Computed

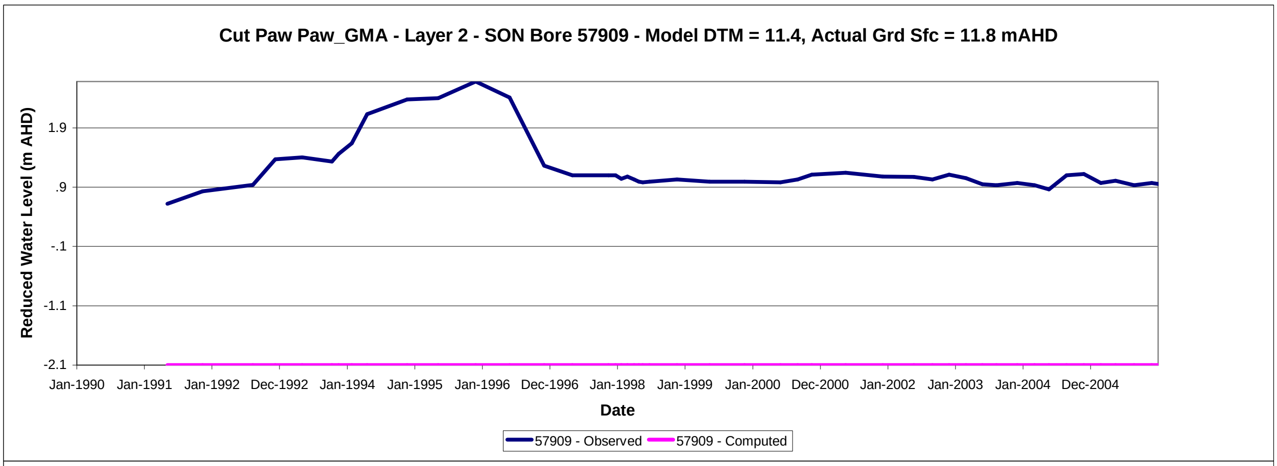

Deutgam_WSPA - Layer 2 - GMS Bore 145270 - Model DTM = 14.6, Actual Grd Sfc = 16 mAHD
Reduced Water Level (m AHD)
12.4
11.4
10.4
9.4
8.4
7.4
6.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
145270 - Observed
145270 - Computed

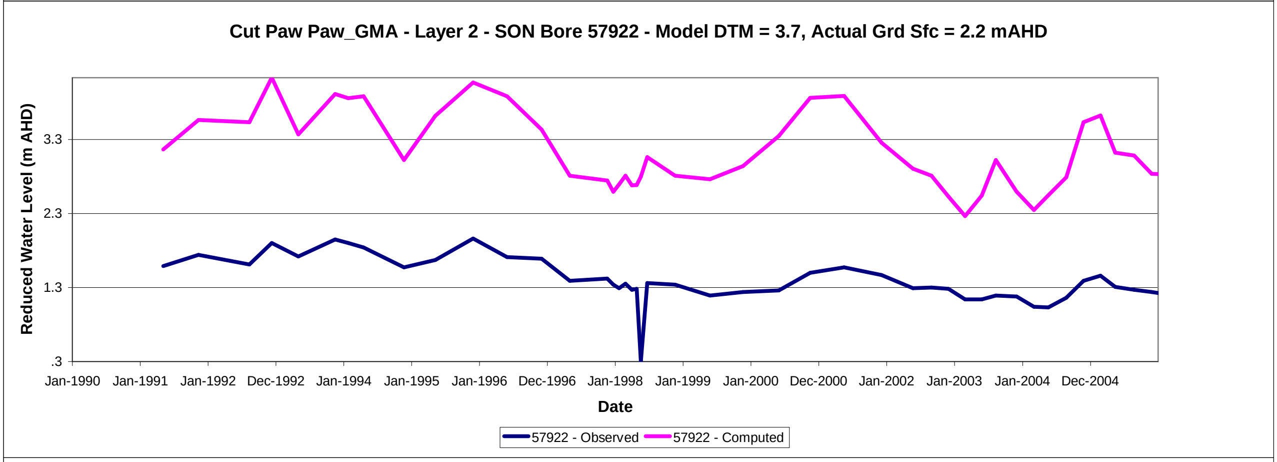

Deutgam_WSPA - Layer 1 - GMS Bore 112802 - Model DTM = 11.8, Actual Grd Sfc = 11.8 mAHD
Reduced Water Level (m AHD)
6.1
5.1
4.1
3.1
2.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
112802 - Observed
112802 - Computed

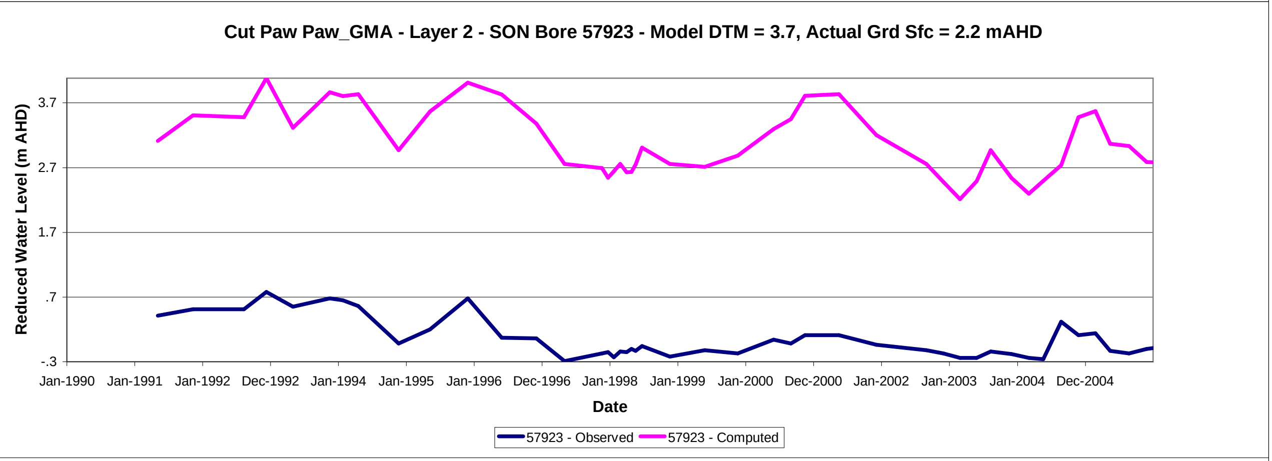

Deutgam_WSPA - Layer 1 - GMS Bore 145271 - Model DTM = 8.2, Actual Grd Sfc = 11 mAHD
Reduced Water Level (m AHD)
4.4
3.4
2.4
1.4
.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
145271 - Observed
145271 - Computed

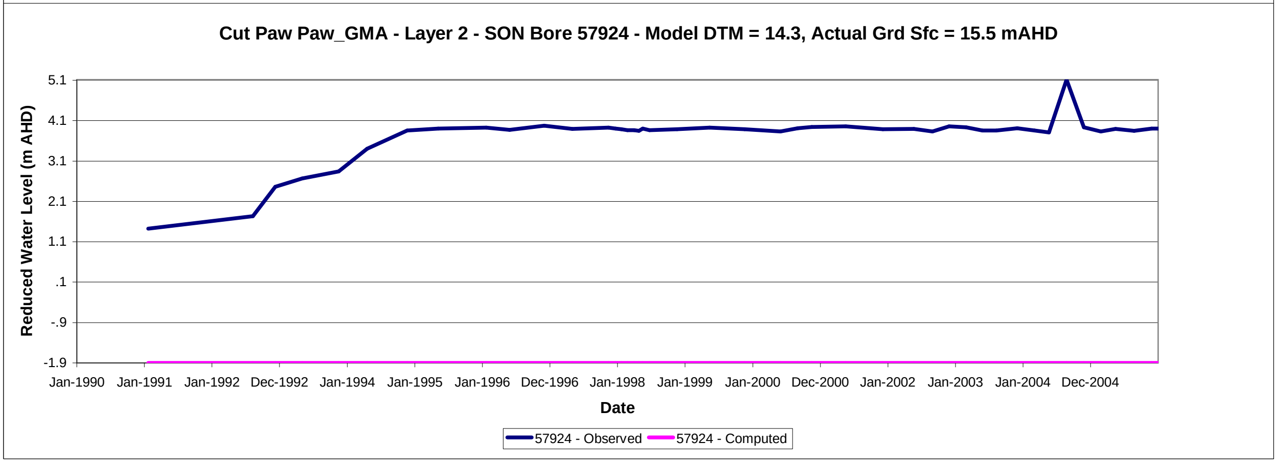

Deutgam_WSPA - Layer 1 - GMS Bore 145272 - Model DTM = 8.3, Actual Grd Sfc = 7 mAHD
Reduced Water Level (m AHD)
3.1
2.1
1.1
.1
-.9
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
145272 - Observed
145272 - Computed

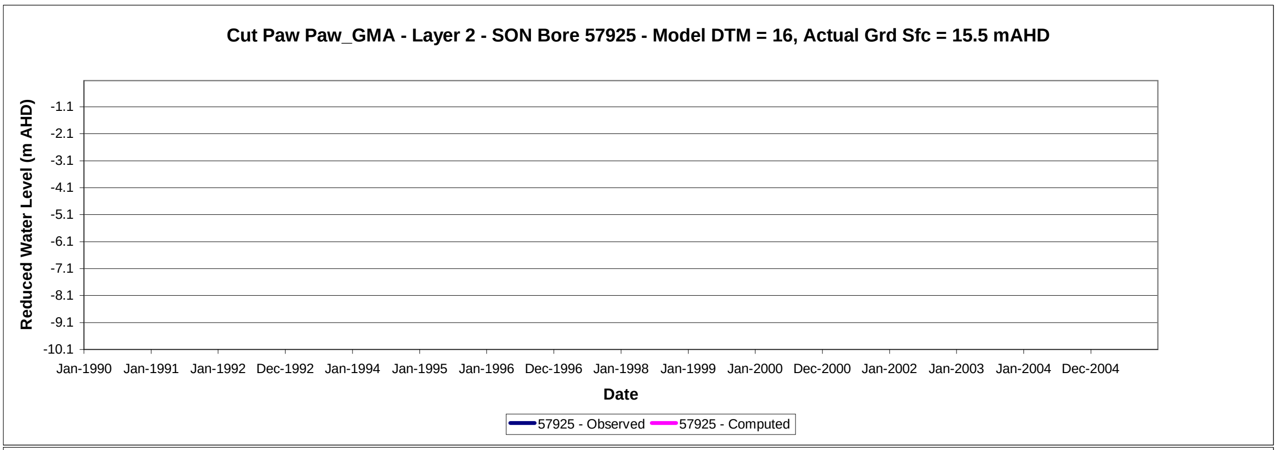

Deutgam_WSPA - Layer 1 - GMS Bore 145273 - Model DTM = 4.5, Actual Grd Sfc = 5 mAHD
Reduced Water Level (m AHD)
3.9
2.9
1.9
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
145273 - Observed
145273 - Computed

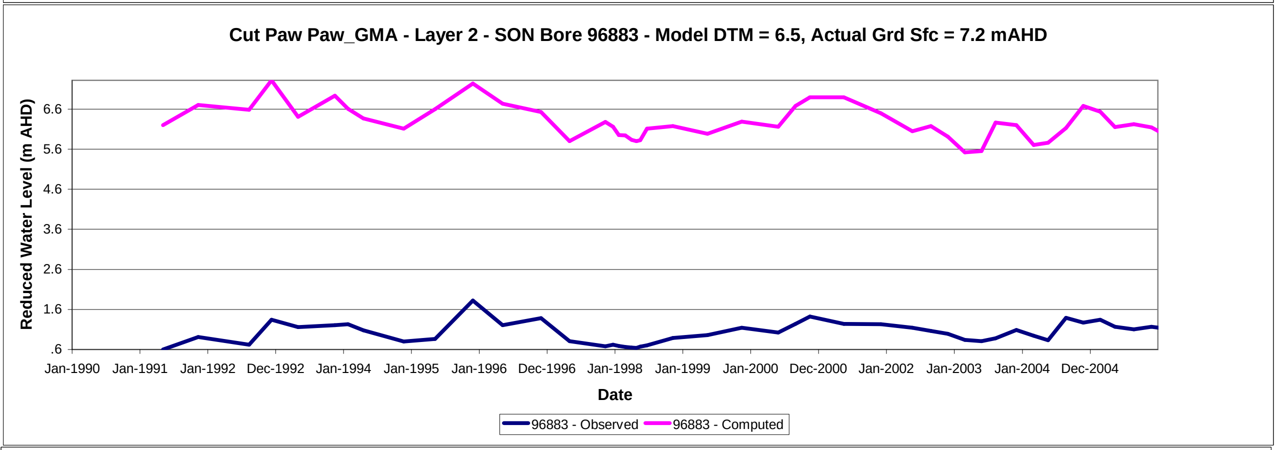

Cut Paw Paw_GMA - Layer 2 - SON Bore 57909 - Model DTM = 11.4, Actual Grd Sfc = 11.8 mAHD
Reduced Water Level (m AHD)
1.9
.9
-.1
-1.1
-2.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
57909 - Observed
57909 - Computed

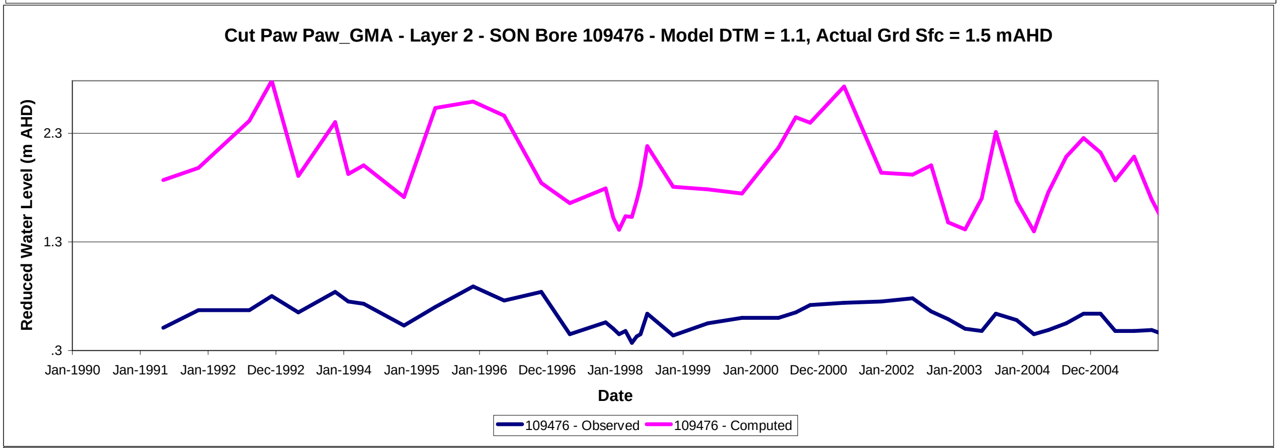

Cut Paw Paw_GMA - Layer 2 - SON Bore 57922 - Model DTM = 3.7, Actual Grd Sfc = 2.2 mAHD
Reduced Water Level (m AHD)
3.3
2.3
1.3
.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
57922 - Observed
57922 - Computed

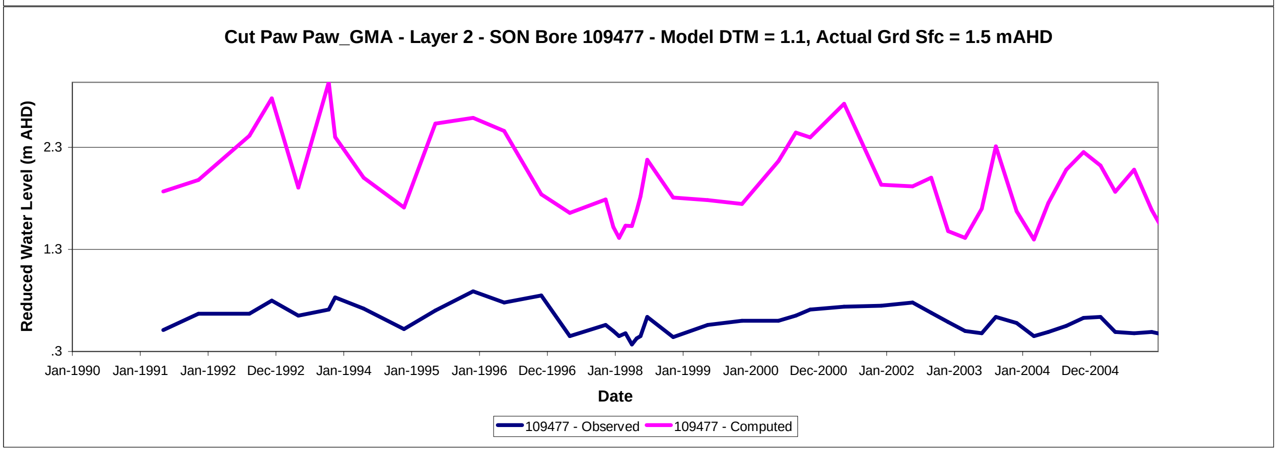

Cut Paw Paw_GMA - Layer 2 - SON Bore 57923 - Model DTM = 3.7, Actual Grd Sfc = 2.2 mAHD
Reduced Water Level (m AHD)
3.7
2.7
1.7
.7
-.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
57923 - Observed
57923 - Computed

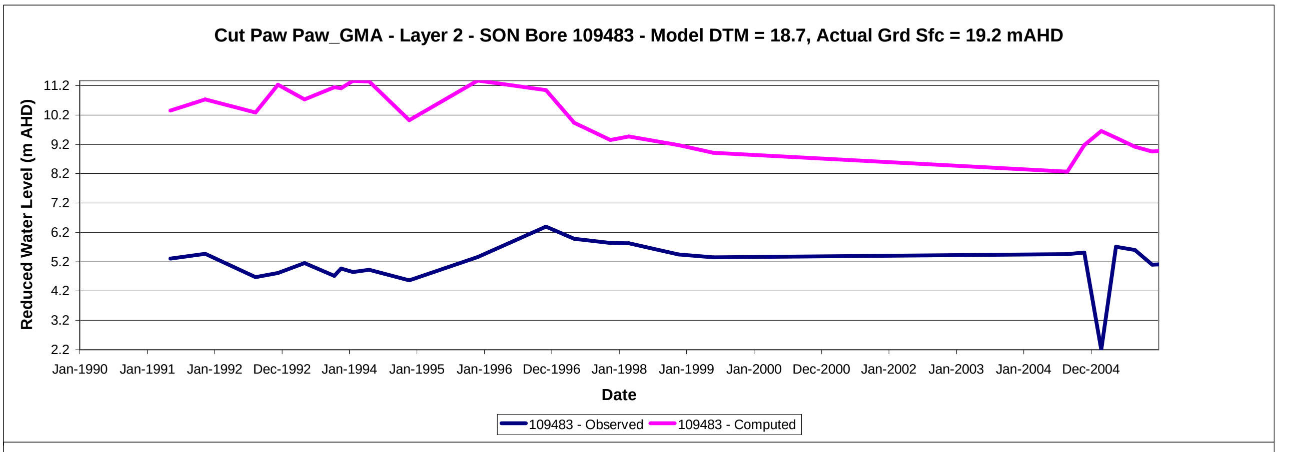

Cut Paw Paw_GMA - Layer 2 - SON Bore 57924 - Model DTM = 14.3, Actual Grd Sfc = 15.5 mAHD
Reduced Water Level (m AHD)
5.1
4.1
3.1
2.1
1.1
.1
-.9
-1.9
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
57924 - Observed
57924 - Computed

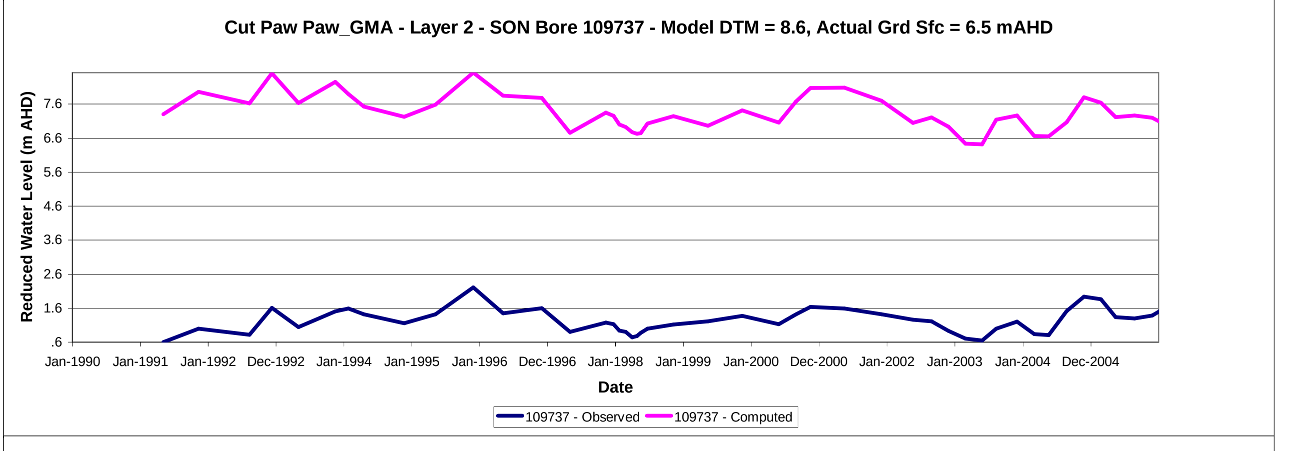

Cut Paw Paw_GMA - Layer 2 - SON Bore 57925 - Model DTM = 16, Actual Grd Sfc = 15.5 mAHD
Reduced Water Level (m AHD)
-1.1
-2.1
-3.1
-4.1
-5.1
-6.1
-7.1
-8.1
-9.1
-10.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
57925 - Observed
57925 - Computed

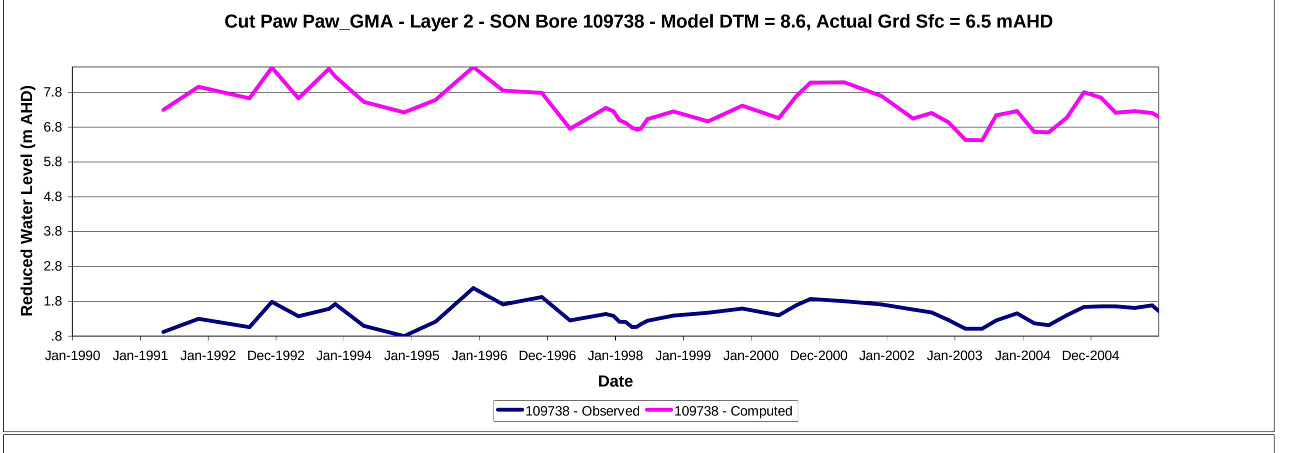

Cut Paw Paw_GMA - Layer 2 - SON Bore 96883 - Model DTM = 6.5, Actual Grd Sfc = 7.2 mAHD
Reduced Water Level (m AHD)
6.6
5.6
4.6
3.6
2.6
1.6
.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
96883 - Observed
96883 - Computed

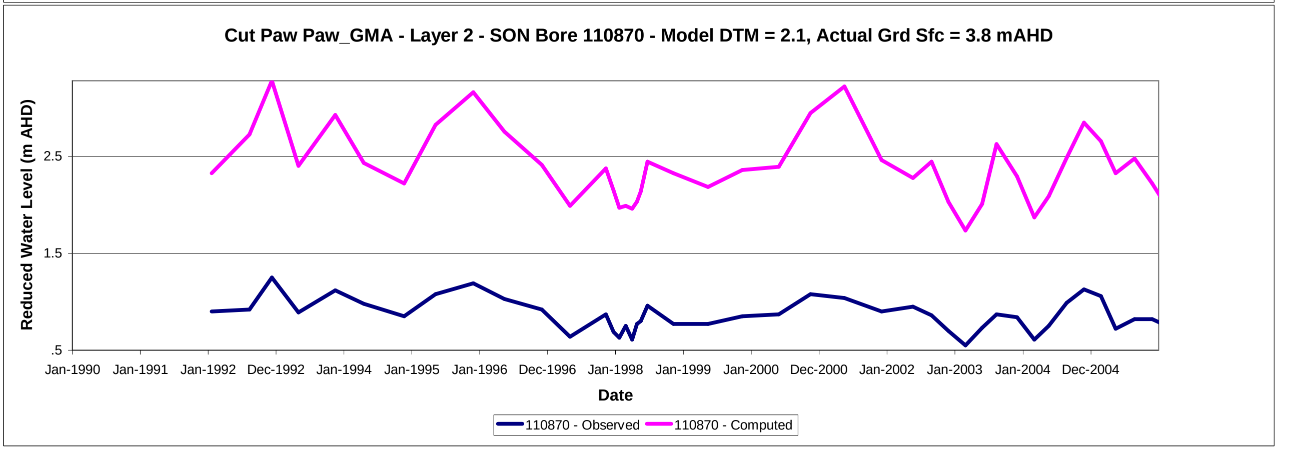

Cut Paw Paw_GMA - Layer 2 - SON Bore 109476 - Model DTM = 1.1, Actual Grd Sfc = 1.5 mAHD
Reduced Water Level (m AHD)
2.3
1.3
.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109476 - Observed
109476 - Computed


Cut Paw Paw_GMA - Layer 2 - SON Bore 109477 - Model DTM = 1.1, Actual Grd Sfc = 1.5 mAHD
Reduced Water Level (m AHD)
2.3
1.3
.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109477 - Observed
109477 - Computed

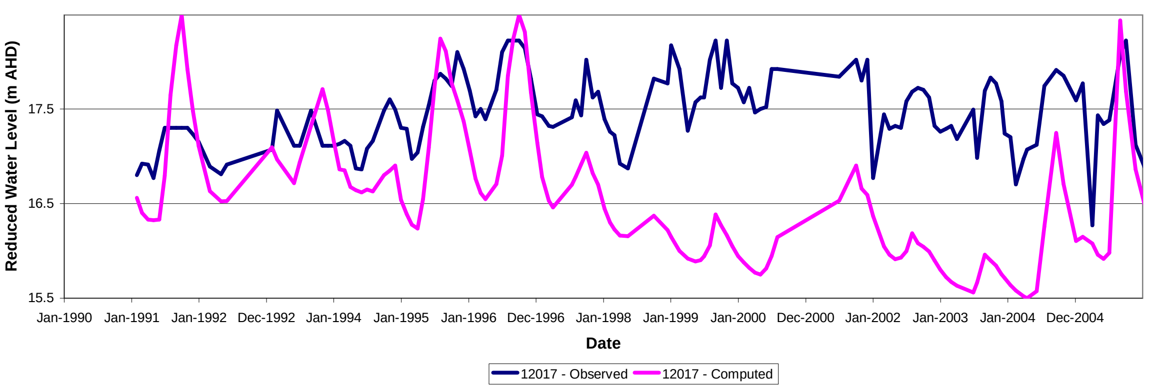

Cut Paw Paw_GMA - Layer 2 - SON Bore 109483 - Model DTM = 18.7, Actual Grd Sfc = 19.2 mAHD
Reduced Water Level (m AHD)
11.2
10.2
9.2
8.2
7.2
6.2
5.2
4.2
3.2
2.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109483 - Observed
109483 - Computed


Cut Paw Paw_GMA - Layer 2 - SON Bore 109737 - Model DTM = 8.6, Actual Grd Sfc = 6.5 mAHD
Reduced Water Level (m AHD)
7.6
6.6
5.6
4.6
3.6
2.6
1.6
.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109737 - Observed
109737 - Computed

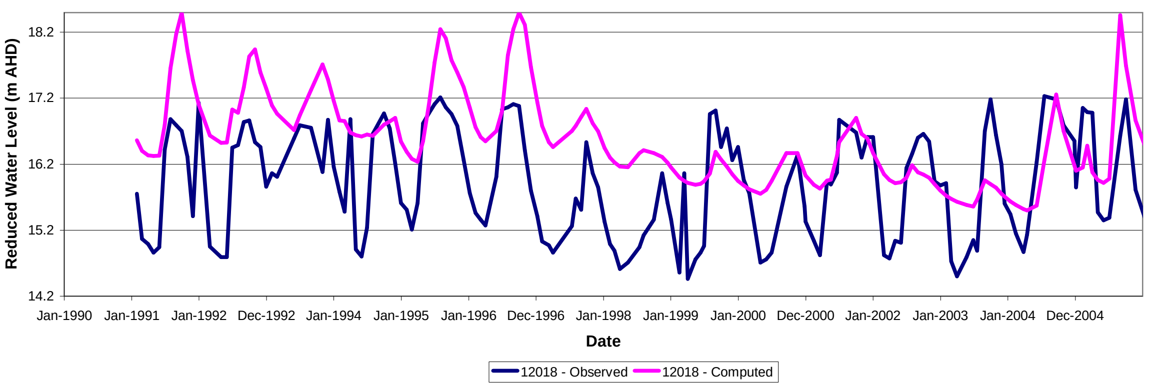

Cut Paw Paw_GMA - Layer 2 - SON Bore 109738 - Model DTM = 8.6, Actual Grd Sfc = 6.5 mAHD
Reduced Water Level (m AHD)
7.8
6.8
5.8
4.8
3.8
2.8
1.8
.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
109738 - Observed
109738 - Computed


Cut Paw Paw_GMA - Layer 2 - SON Bore 110870 - Model DTM = 2.1, Actual Grd Sfc = 3.8 mAHD
Reduced Water Level (m AHD)
2.5
1.5
.5
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
110870 - Observed
110870 - Computed

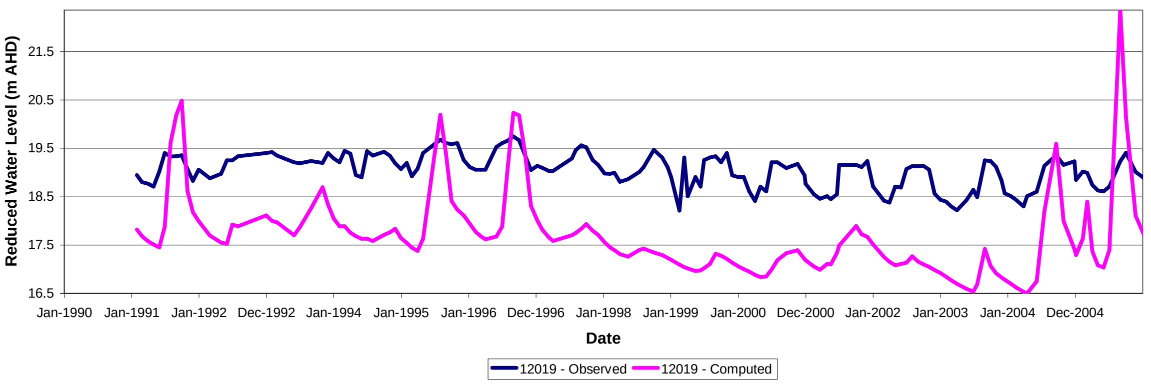
Corinella_GMA - Layer 5 - PIRVIC Bore 12017 - Model DTM = 17.2, Actual Grd Sfc = No Data mAHD



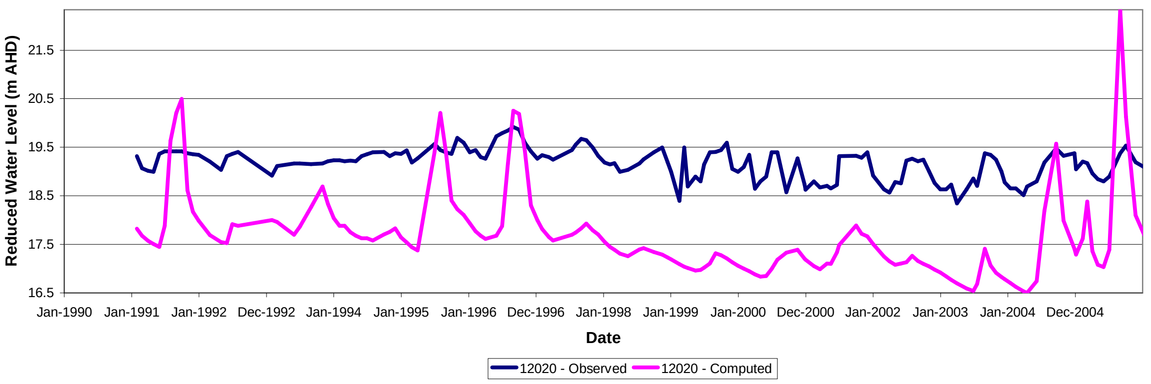
Corinella_GMA - Layer 5 - PIRVIC Bore 12018 - Model DTM = 17.2, Actual Grd Sfc = No Data mAHD

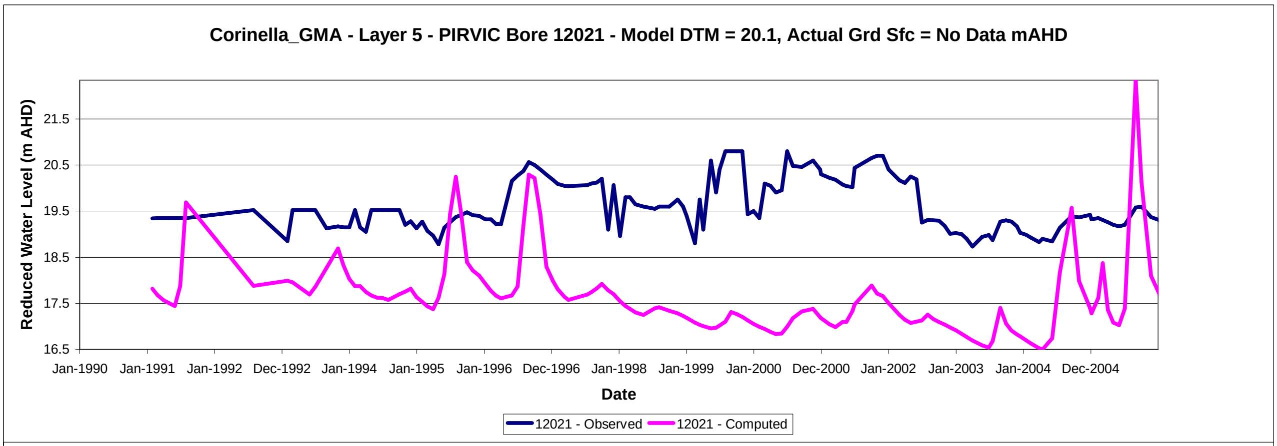


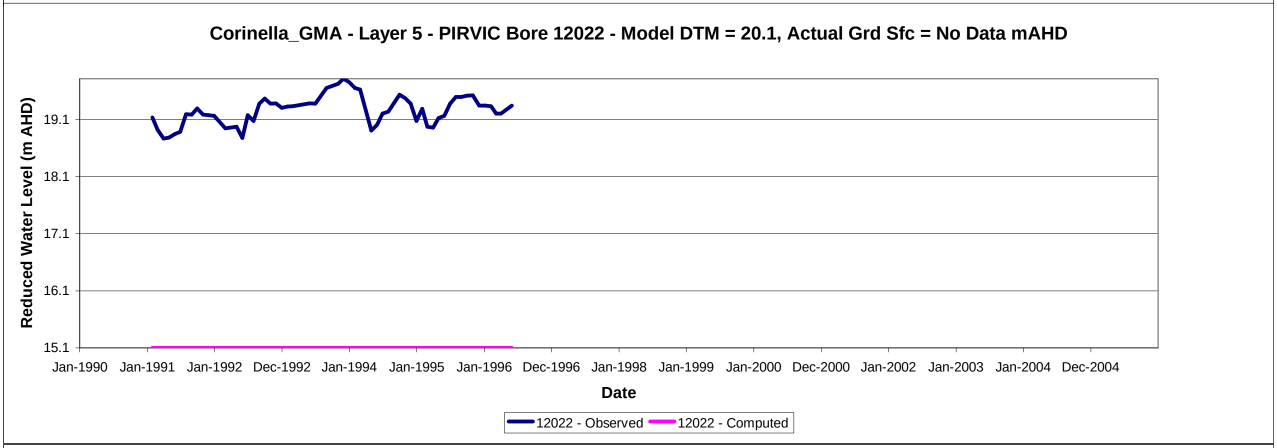
Corinella_GMA - Layer 5 - PIRVIC Bore 12019 - Model DTM = 20.1, Actual Grd Sfc = No Data mAHD

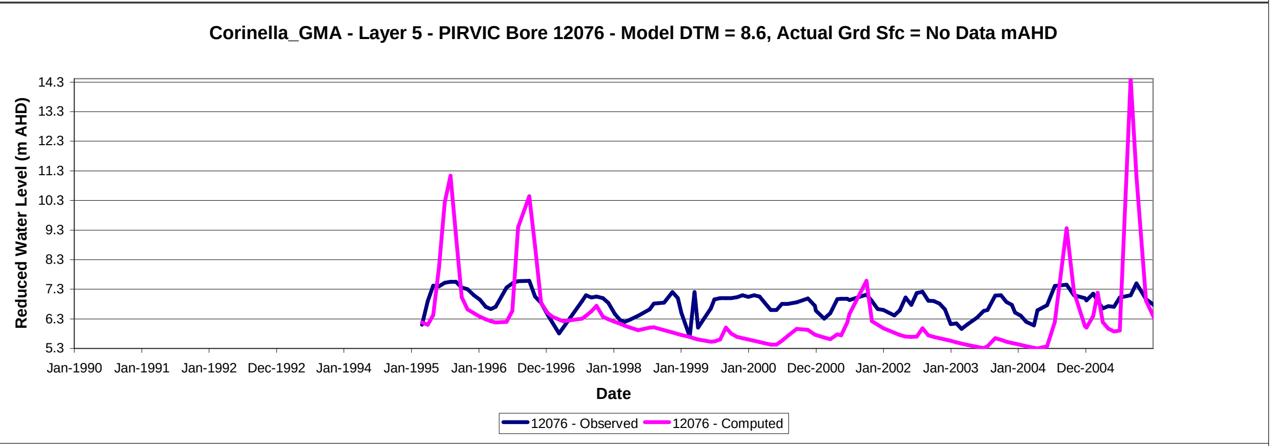


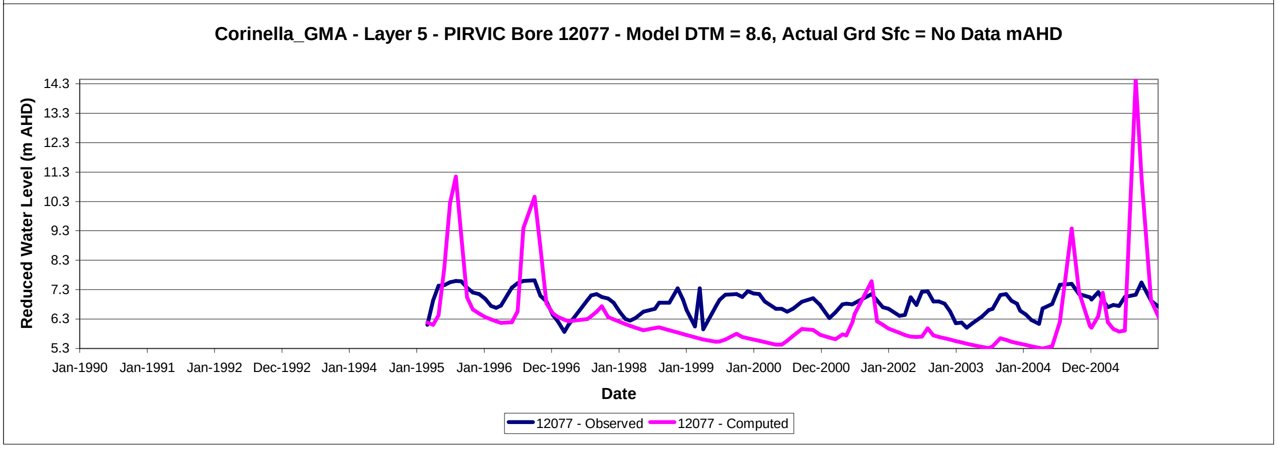
Corinella_GMA - Layer 5 - PIRVIC Bore 12020 - Model DTM = 20.1, Actual Grd Sfc = No Data mAHD

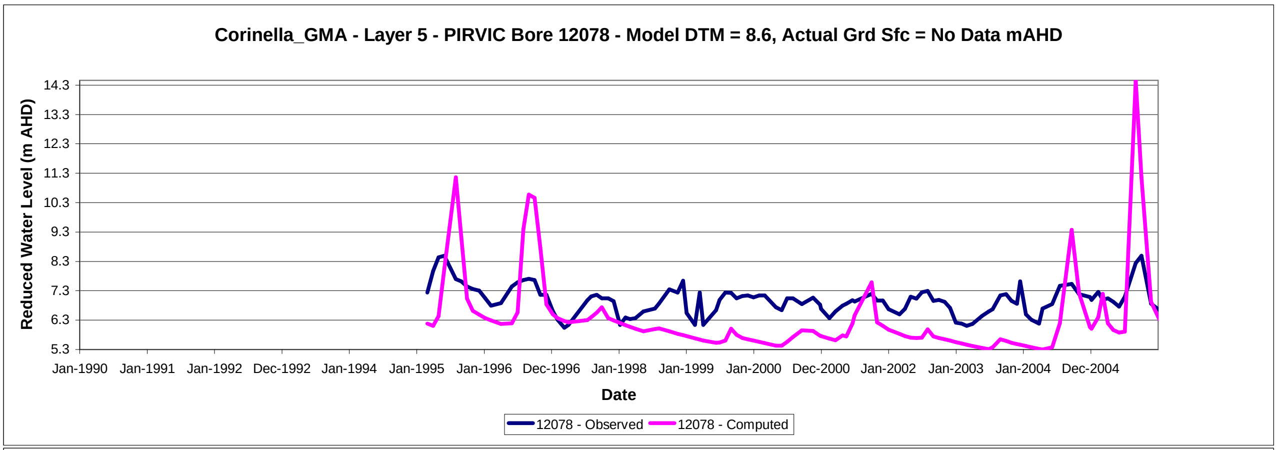


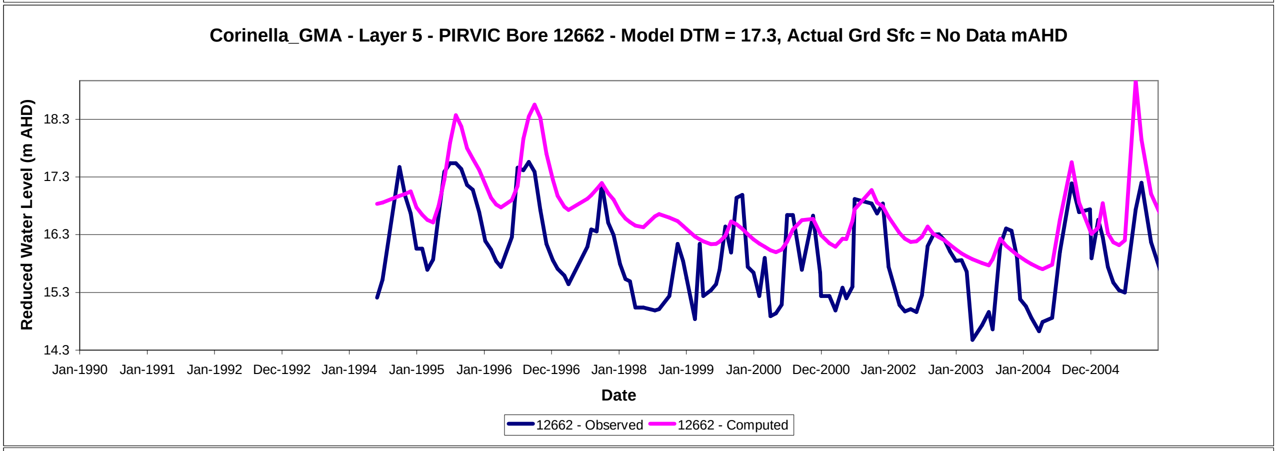

Corinella_GMA - Layer 5 - PIRVIC Bore 12021 - Model DTM = 20.1, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
21.5
20.5
19.5
18.5
17.5
16.5
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12021 - Observed
12021 - Computed

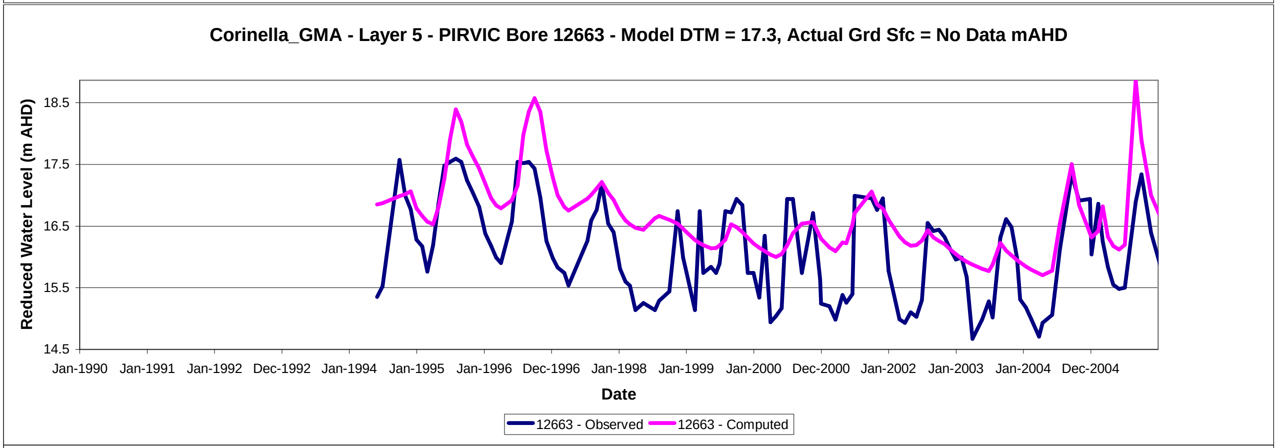

Corinella_GMA - Layer 5 - PIRVIC Bore 12022 - Model DTM = 20.1, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
19.1
18.1
17.1
16.1
15.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12022 - Observed
12022 - Computed

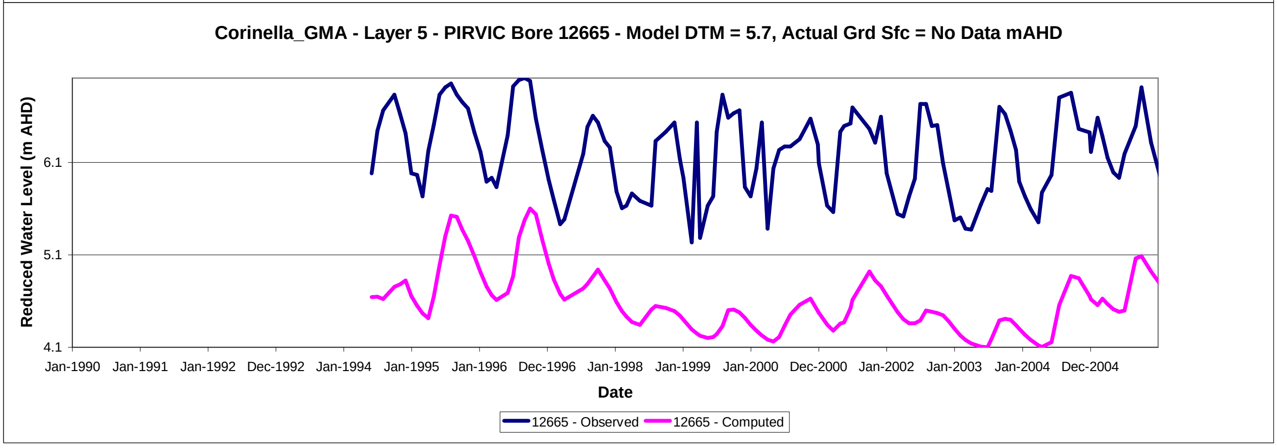

Corinella_GMA - Layer 5 - PIRVIC Bore 12076 - Model DTM = 8.6, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
14.3
13.3
12.3
11.3
10.3
9.3
8.3
7.3
6.3
5.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12076 - Observed
12076 - Computed

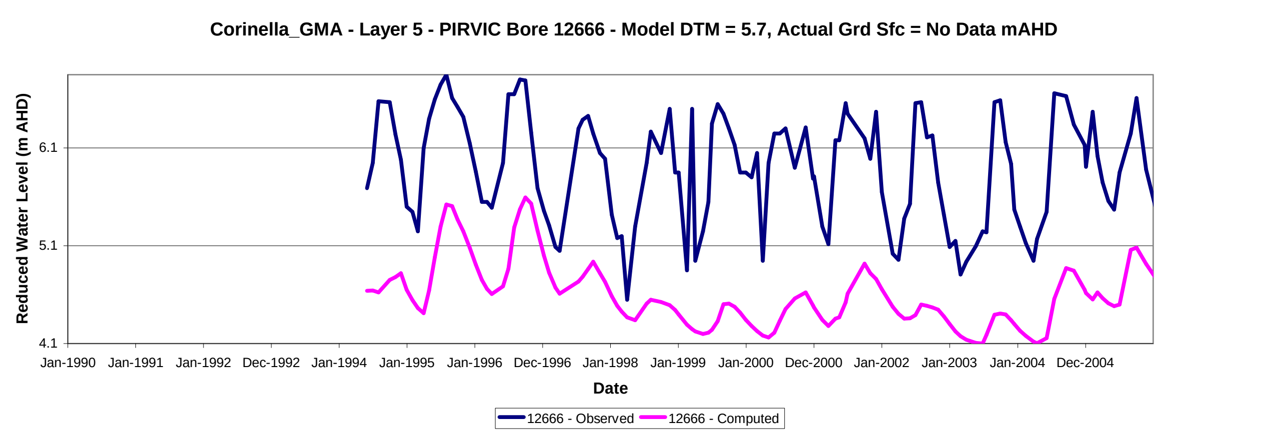

Corinella_GMA - Layer 5 - PIRVIC Bore 12077 - Model DTM = 8.6, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
14.3
13.3
12.3
11.3
10.3
9.3
8.3
7.3
6.3
5.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12077 - Observed
12077 - Computed

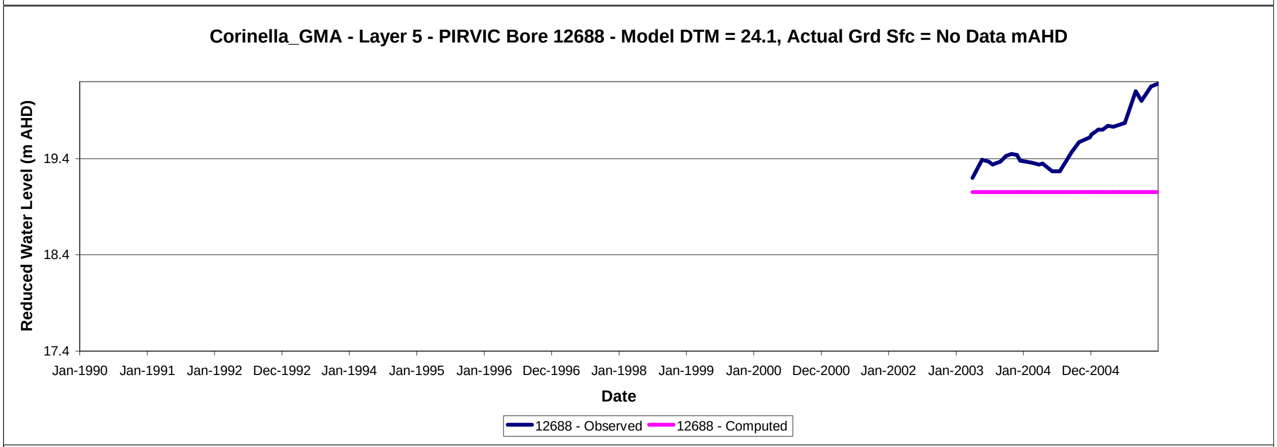

Corinella_GMA - Layer 5 - PIRVIC Bore 12078 - Model DTM = 8.6, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
14.3
13.3
12.3
11.3
10.3
9.3
8.3
7.3
6.3
5.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12078 - Observed
12078 - Computed

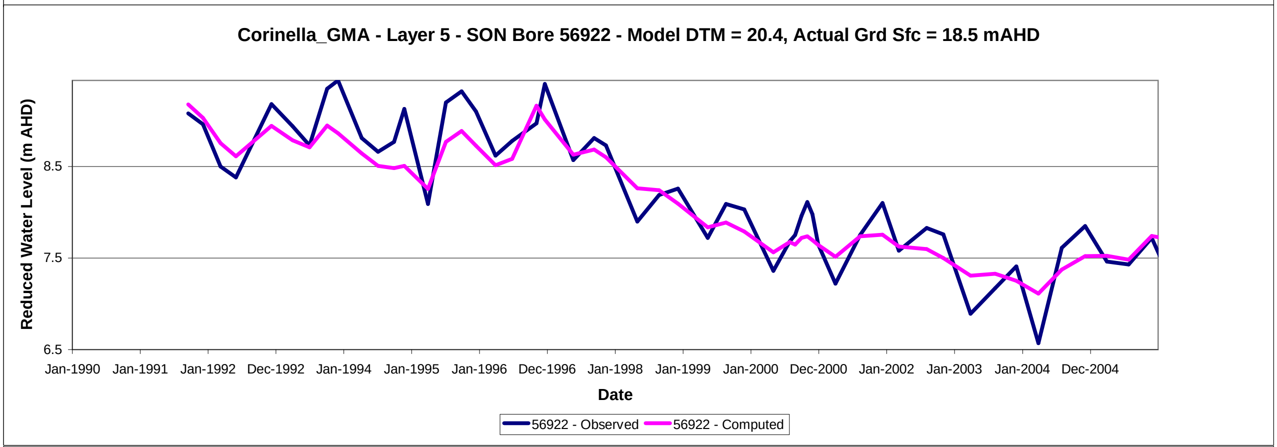

Corinella_GMA - Layer 5 - PIRVIC Bore 12662 - Model DTM = 17.3, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
18.3
17.3
16.3
15.3
14.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12662 - Observed
12662 - Computed

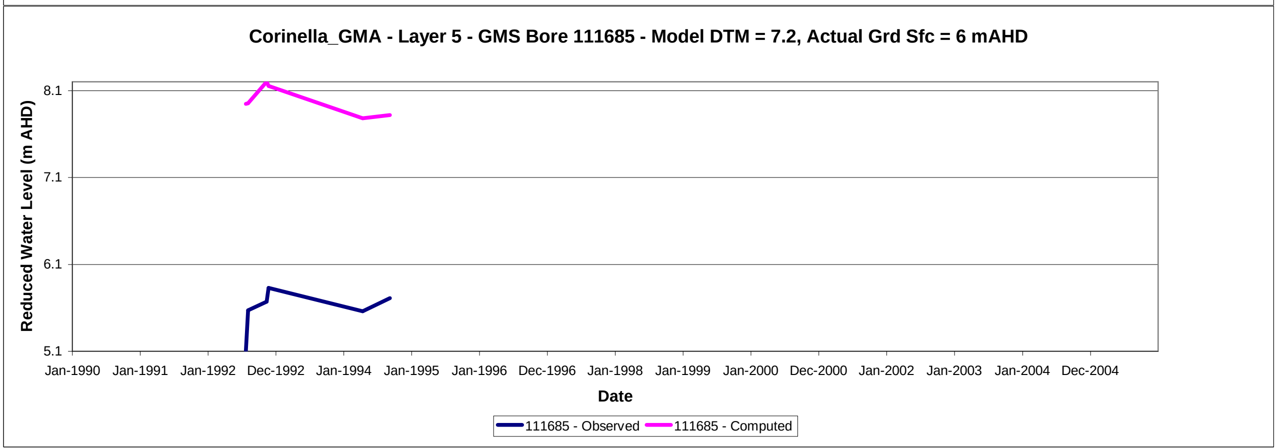

Corinella_GMA - Layer 5 - PIRVIC Bore 12663 - Model DTM = 17.3, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
18.5
17.5
16.5
15.5
14.5
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12663 - Observed
12663 - Computed

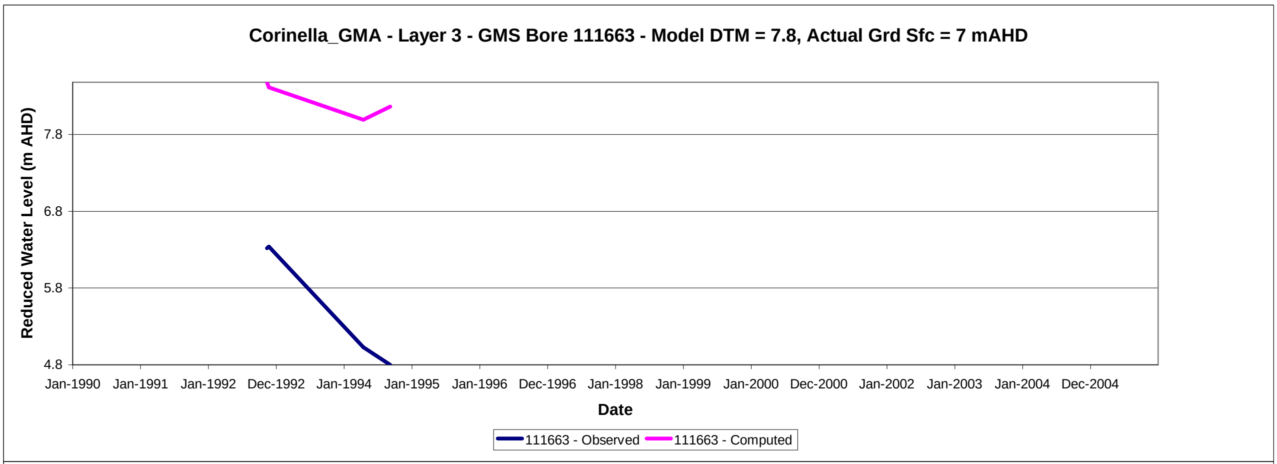

Corinella_GMA - Layer 5 - PIRVIC Bore 12665 - Model DTM = 5.7, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
6.1
5.1
4.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
12665 - Observed
12665 - Computed

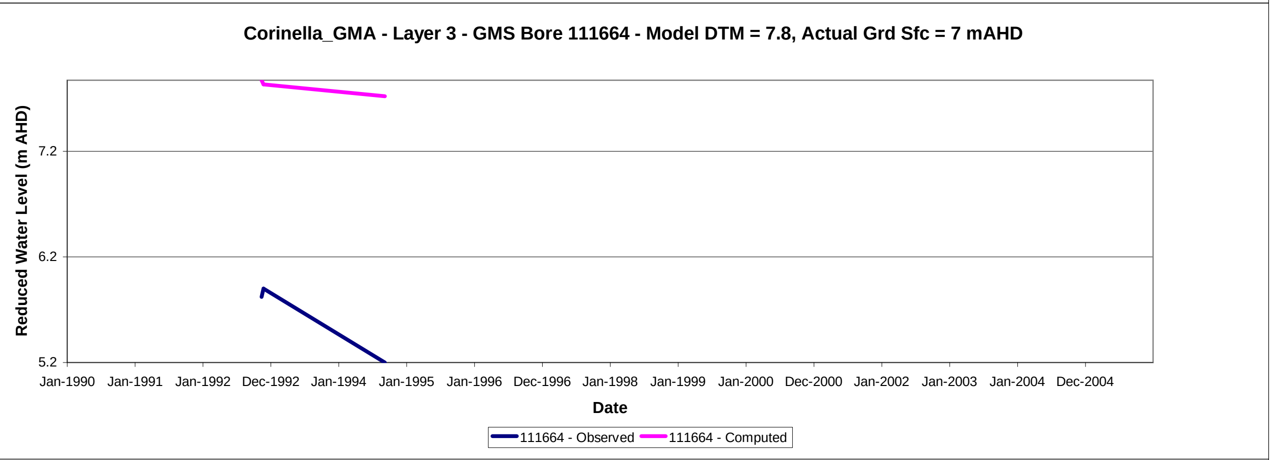

Corinella_GMA - Layer 5 - PIRVIC Bore 12666 - Model DTM = 5.7, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
6.1
5.1
4.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12666 - Observed
12666 - Computed

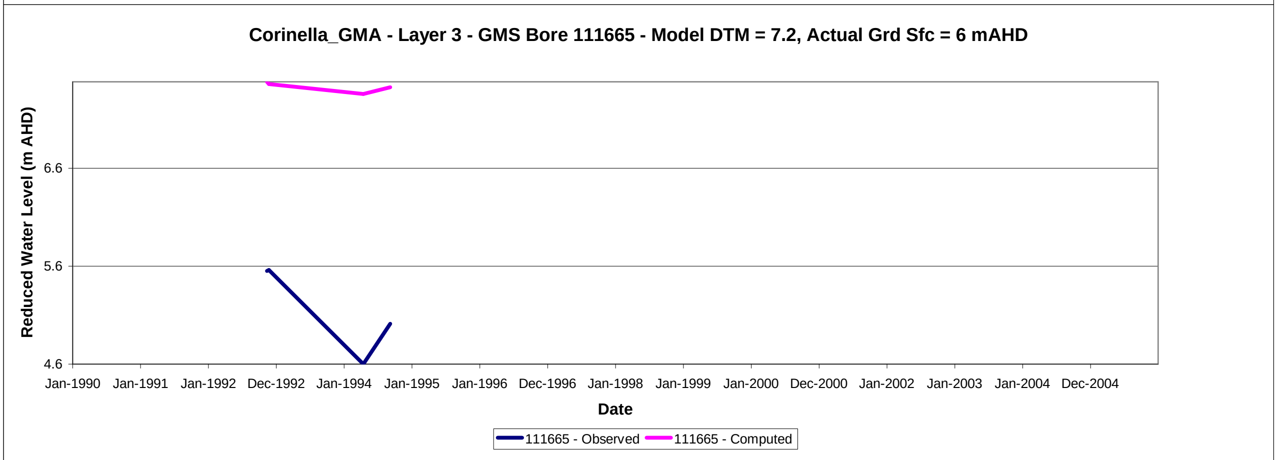

Corinella_GMA - Layer 5 - PIRVIC Bore 12688 - Model DTM = 24.1, Actual Grd Sfc = No Data mAHD
Reduced Water Level (m AHD)
19.4
18.4
17.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
12688 - Observed
12688 - Computed

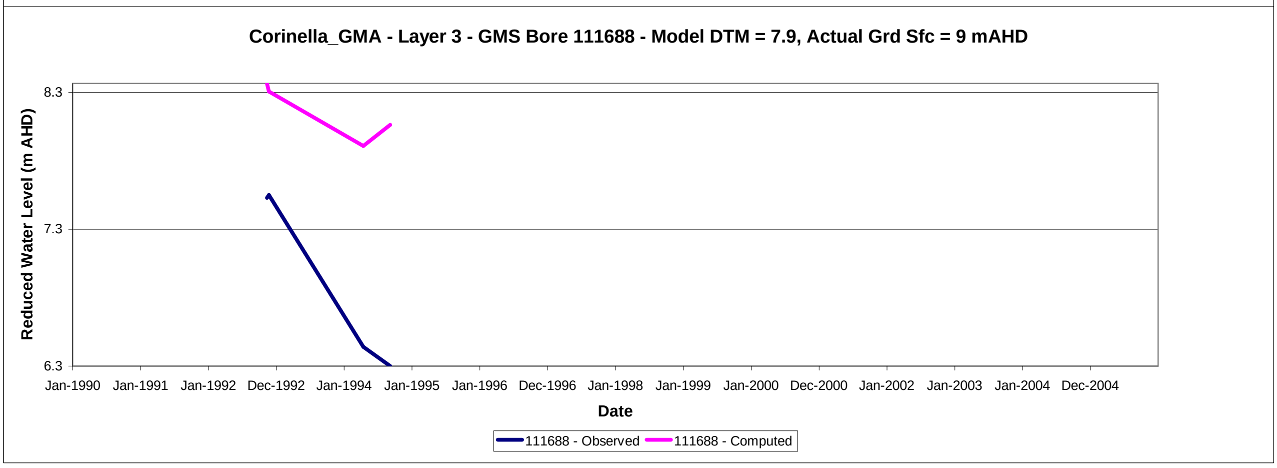

Corinella_GMA - Layer 5 - SON Bore 56922 - Model DTM = 20.4, Actual Grd Sfc = 18.5 mAHD
Reduced Water Level (m AHD)
8.5
7.5
6.5
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
56922 - Observed
56922 - Computed

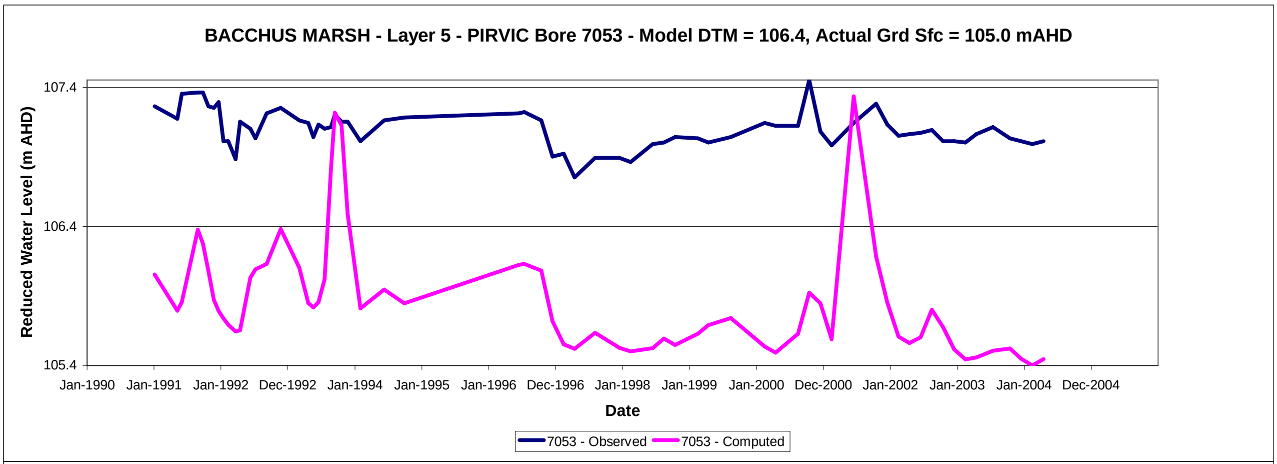

Corinella_GMA - Layer 5 - GMS Bore 111685 - Model DTM = 7.2, Actual Grd Sfc = 6 mAHD
Reduced Water Level (m AHD)
8.1
7.1
6.1
5.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
111685 - Observed
111685 - Computed

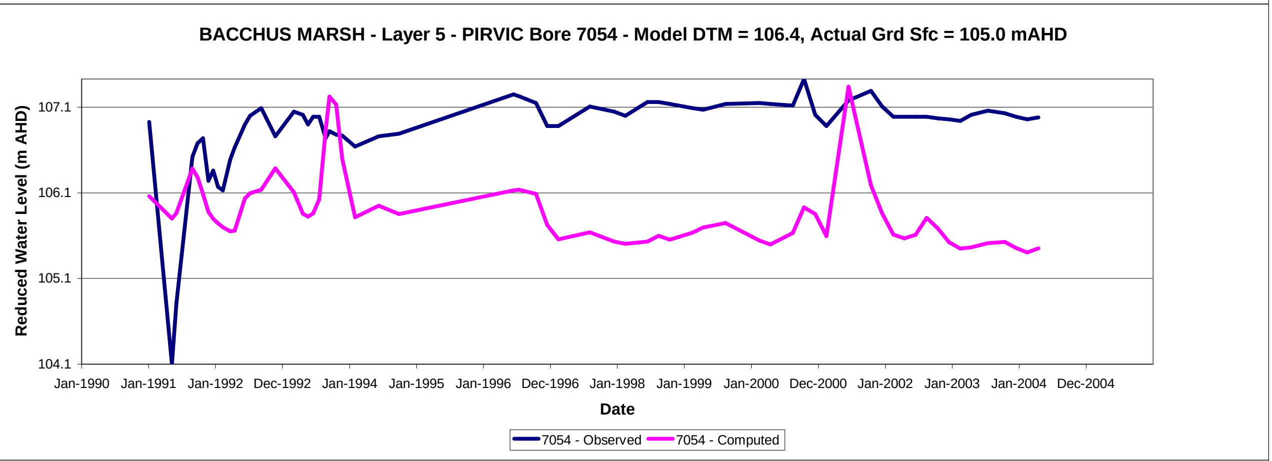

Corinella_GMA - Layer 3 - GMS Bore 111663 - Model DTM = 7.8, Actual Grd Sfc = 7 mAHD
Reduced Water Level (m AHD)
7.8
6.8
5.8
4.8
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
111663 - Observed
111663 - Computed

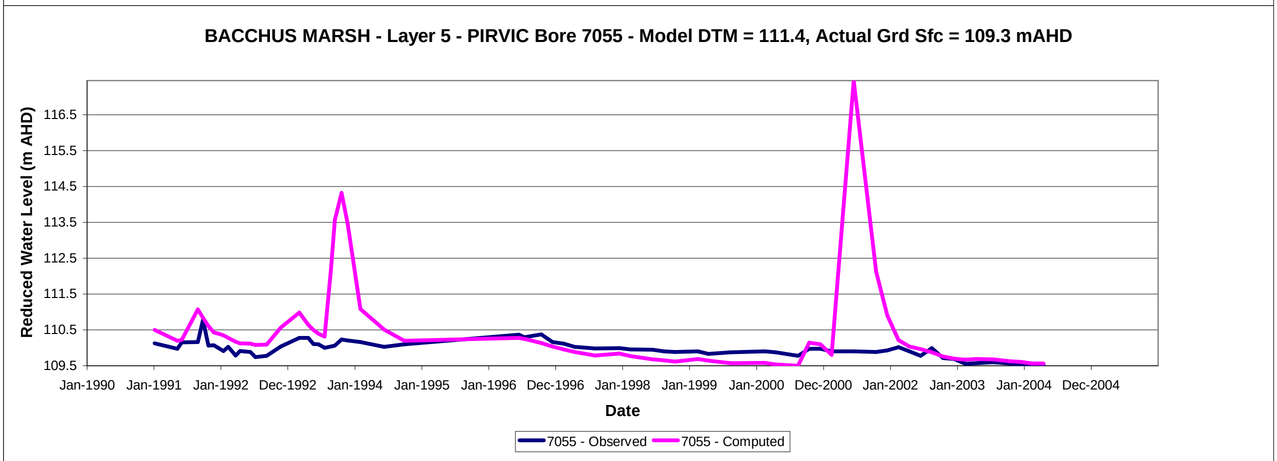

Corinella_GMA - Layer 3 - GMS Bore 111664 - Model DTM = 7.8, Actual Grd Sfc = 7 mAHD
Reduced Water Level (m AHD)
7.2
6.2
5.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
111664 - Observed
111664 - Computed

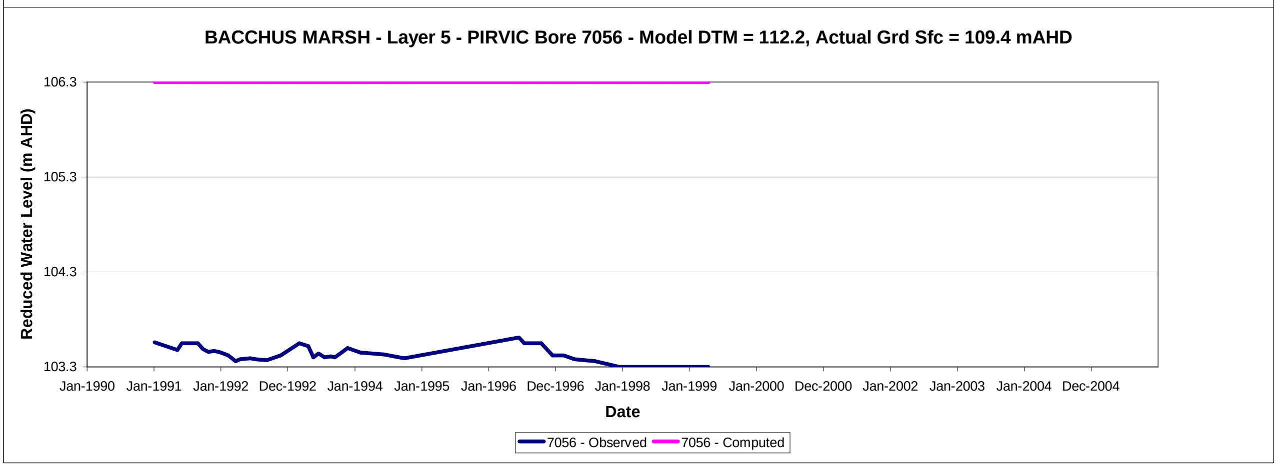

Corinella_GMA - Layer 3 - GMS Bore 111665 - Model DTM = 7.2, Actual Grd Sfc = 6 mAHD
Reduced Water Level (m AHD)
6.6
5.6
4.6
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
111665 - Observed
111665 - Computed

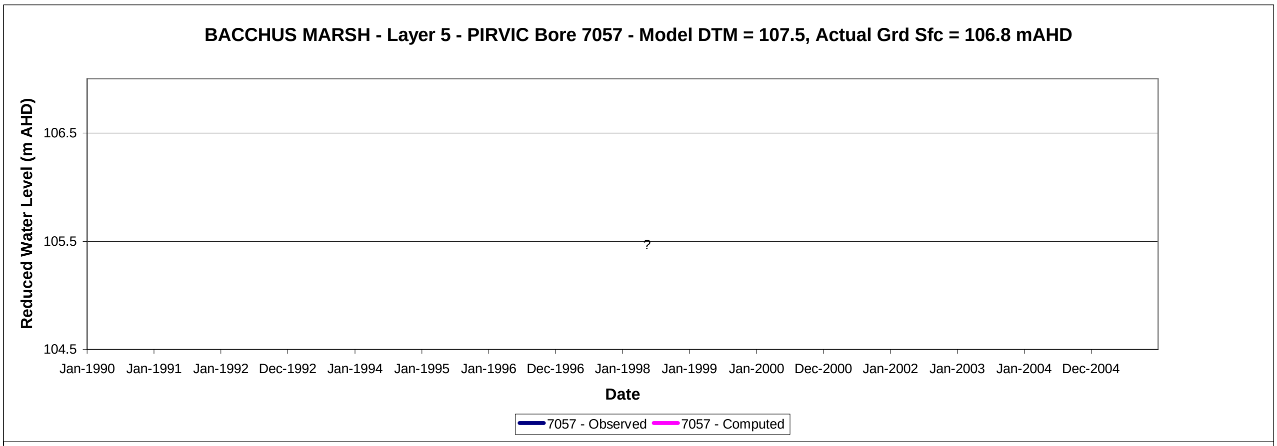

Corinella_GMA - Layer 3 - GMS Bore 111688 - Model DTM = 7.9, Actual Grd Sfc = 9 mAHD
Reduced Water Level (m AHD)
8.3
7.3
6.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
111688 - Observed
111688 - Computed

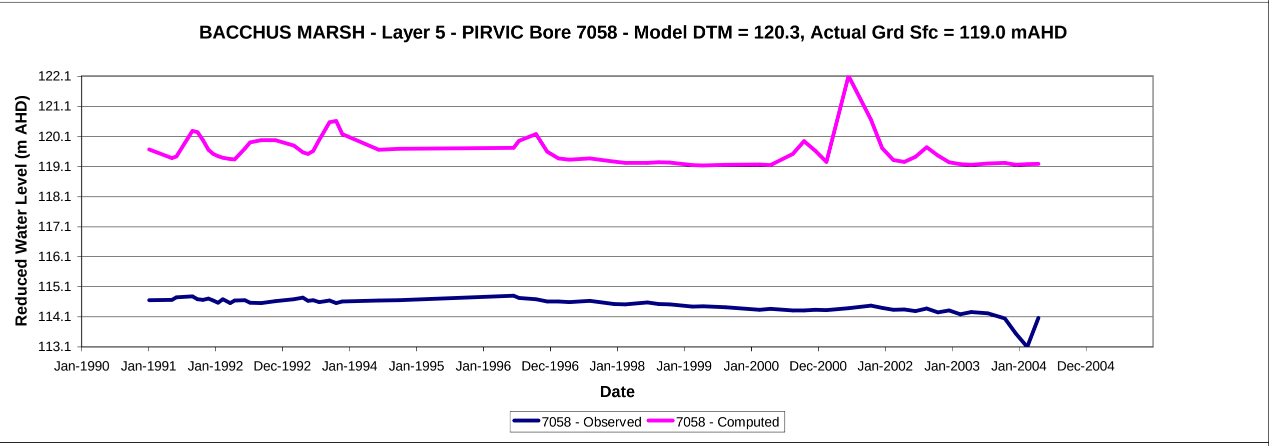

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7053 - Model DTM = 106.4, Actual Grd Sfc = 105.0 mAHD
Reduced Water Level (m AHD)
107.4
106.4
105.4
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7053 - Observed
7053 - Computed

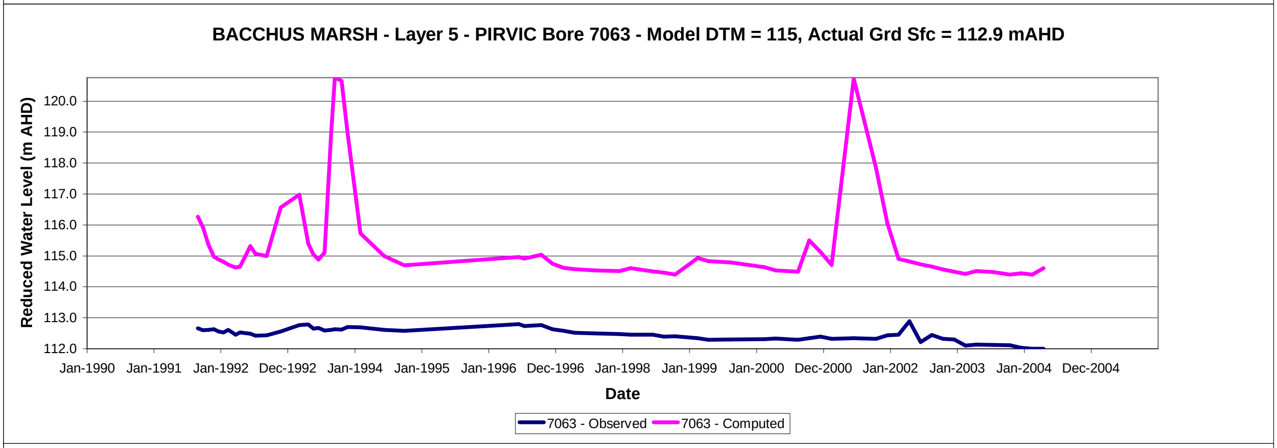

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7054 - Model DTM = 106.4, Actual Grd Sfc = 105.0 mAHD
Reduced Water Level (m AHD)
107.1
106.1
105.1
104.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7054 - Observed
7054 - Computed

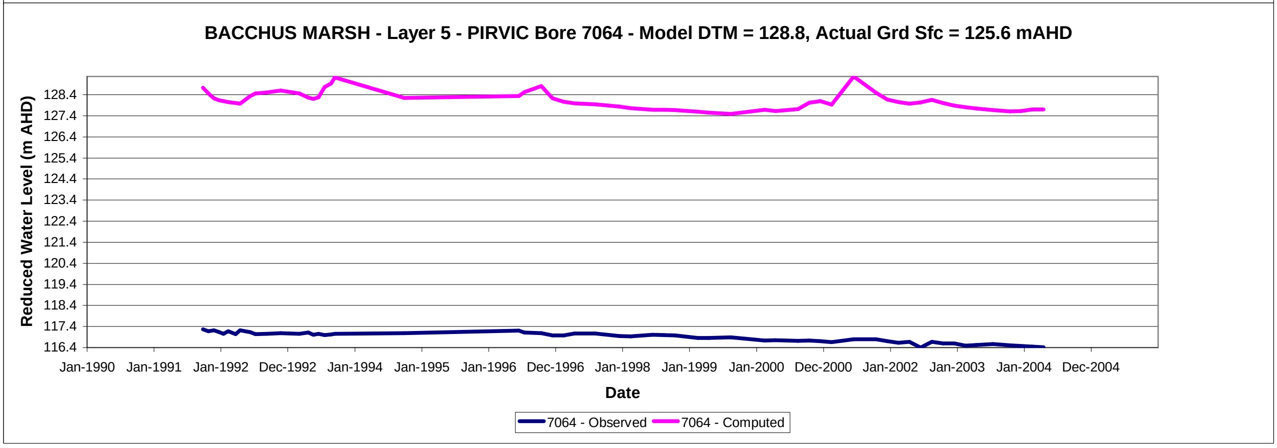

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7055 - Model DTM = 111.4, Actual Grd Sfc = 109.3 mAHD
Reduced Water Level (m AHD)
116.5
115.5
114.5
113.5
112.5
111.5
110.5
109.5
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7055 - Observed
7055 - Computed

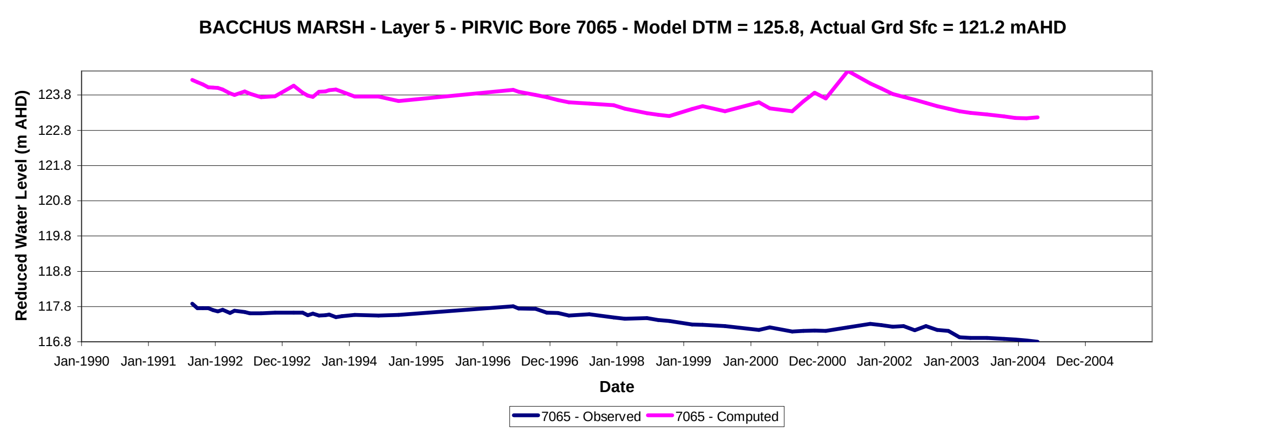

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7056 - Model DTM = 112.2, Actual Grd Sfc = 109.4 mAHD
Reduced Water Level (m AHD)
106.3
105.3
104.3
103.3
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7056 - Observed
7056 - Computed

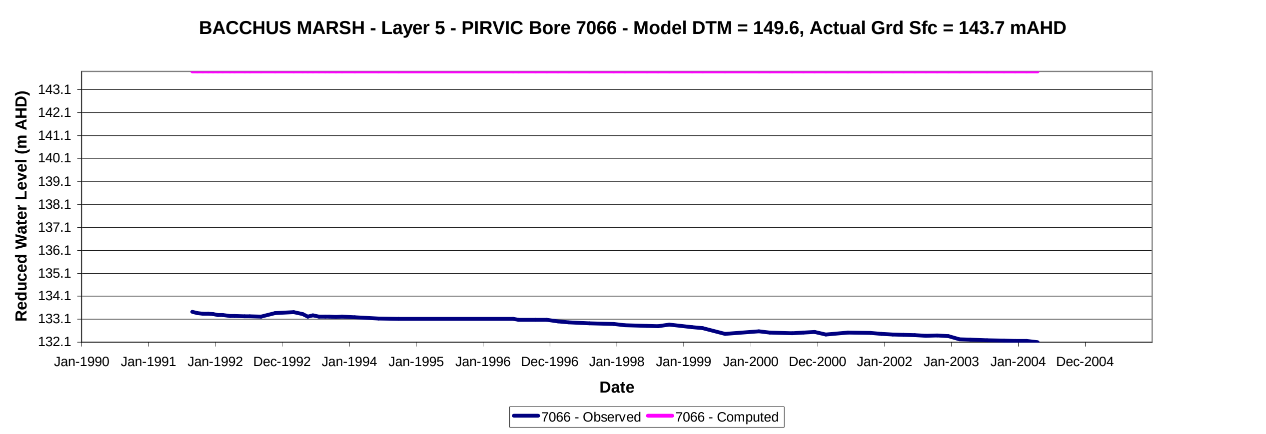

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7057 - Model DTM = 107.5, Actual Grd Sfc = 106.8 mAHD
Reduced Water Level (m AHD)
106.5
105.5
104.5
?
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7057 - Observed
7057 - Computed

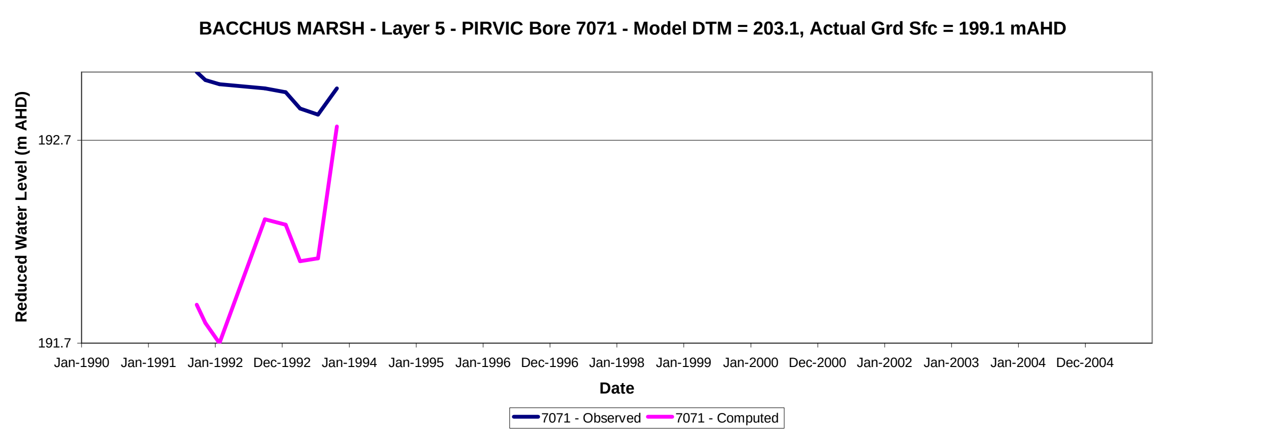

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7058 - Model DTM = 120.3, Actual Grd Sfc = 119.0 mAHD
Reduced Water Level (m AHD)
122.1
121.1
120.1
119.1
118.1
117.1
116.1
115.1
114.1
113.1
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7058 - Observed
7058 - Computed

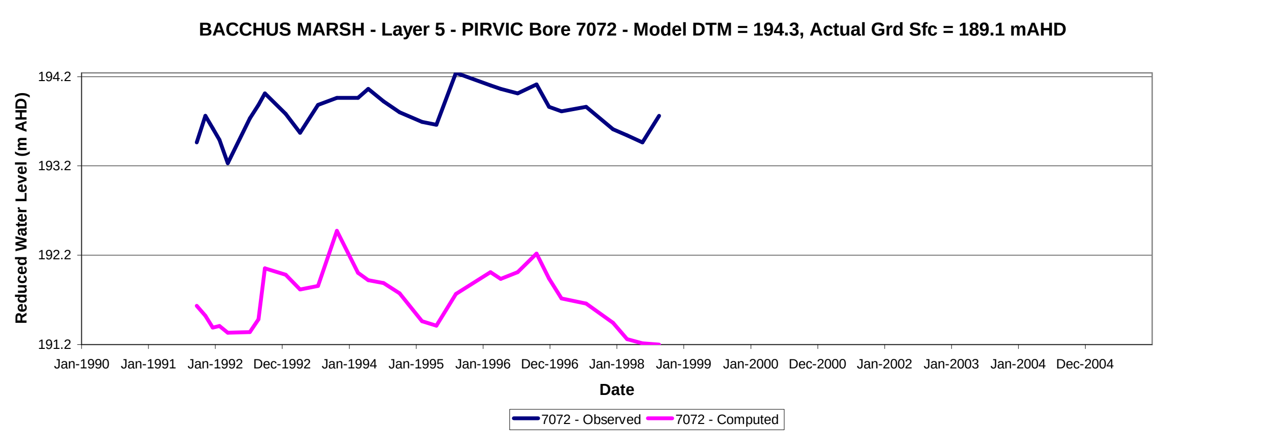

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7063 - Model DTM = 115, Actual Grd Sfc = 112.9 mAHD
Reduced Water Level (m AHD)
120.0
119.0
118.0
117.0
116.0
115.0
114.0
113.0
112.0
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7063 - Observed
7063 - Computed

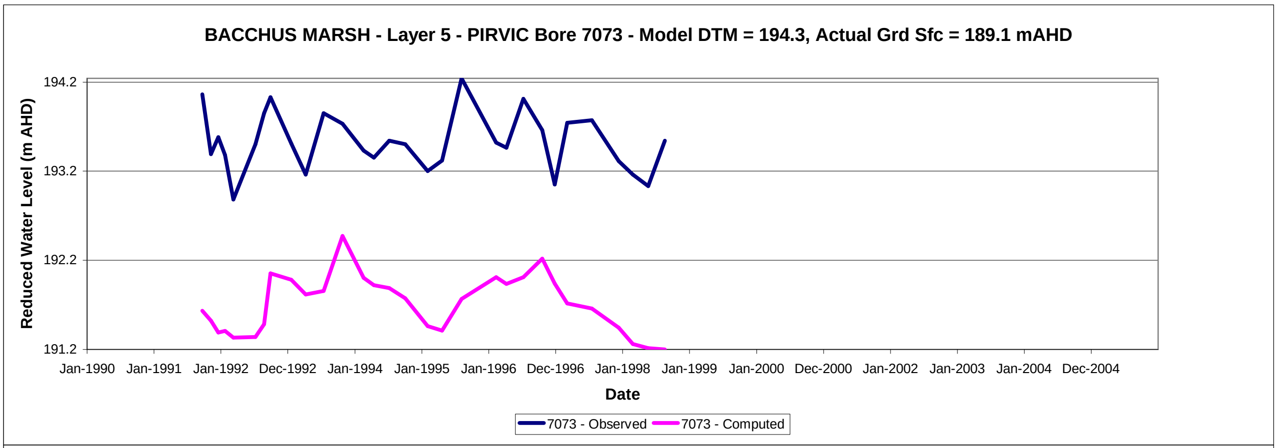

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7064 - Model DTM = 128.8, Actual Grd Sfc = 125.6 mAHD
Reduced Water Level (m AHD)
128.4
127.4
126.4
125.4
124.4
123.4
122.4
121.4
120.4
119.4
118.4
117.4
116.4
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7064 - Observed
7064 - Computed

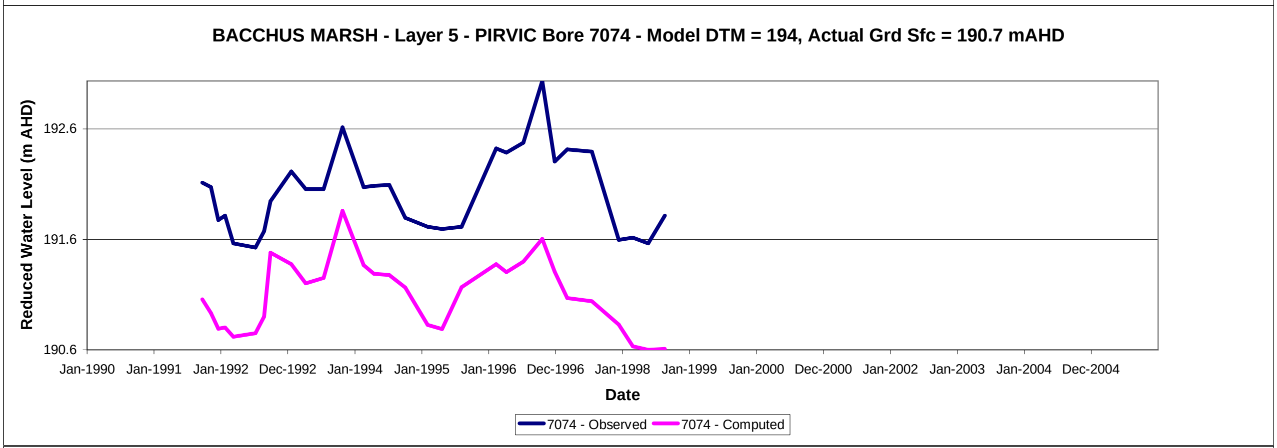

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7065 - Model DTM = 125.8, Actual Grd Sfc = 121.2 mAHD
Reduced Water Level (m AHD)
123.8
122.8
121.8
120.8
119.8
118.8
117.8
116.8
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7065 - Observed
7065 - Computed

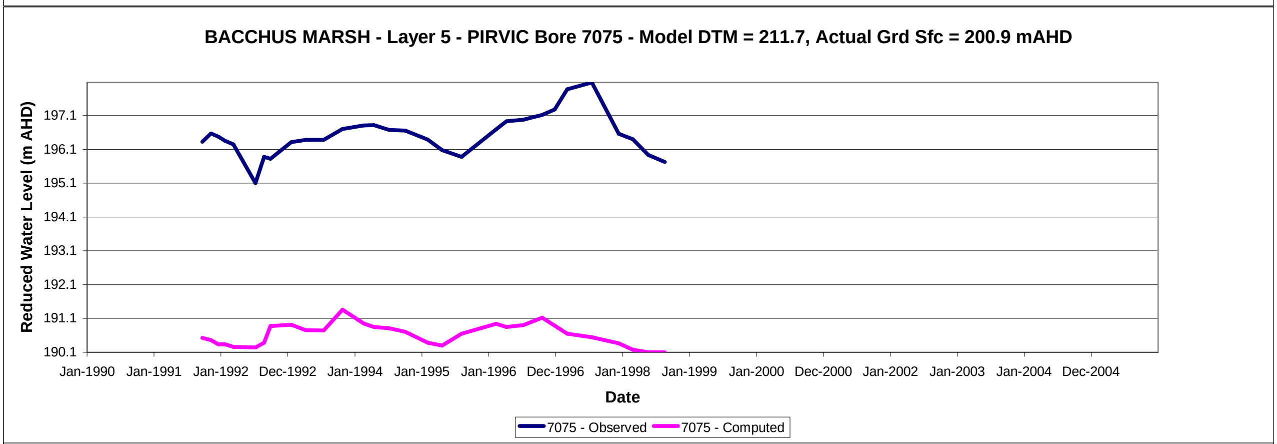

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7066 - Model DTM = 149.6, Actual Grd Sfc = 143.7 mAHD
Reduced Water Level (m AHD)
143.1
142.1
141.1
140.1
139.1
138.1
137.1
136.1
135.1
134.1
133.1
132.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7066 - Observed
7066 - Computed

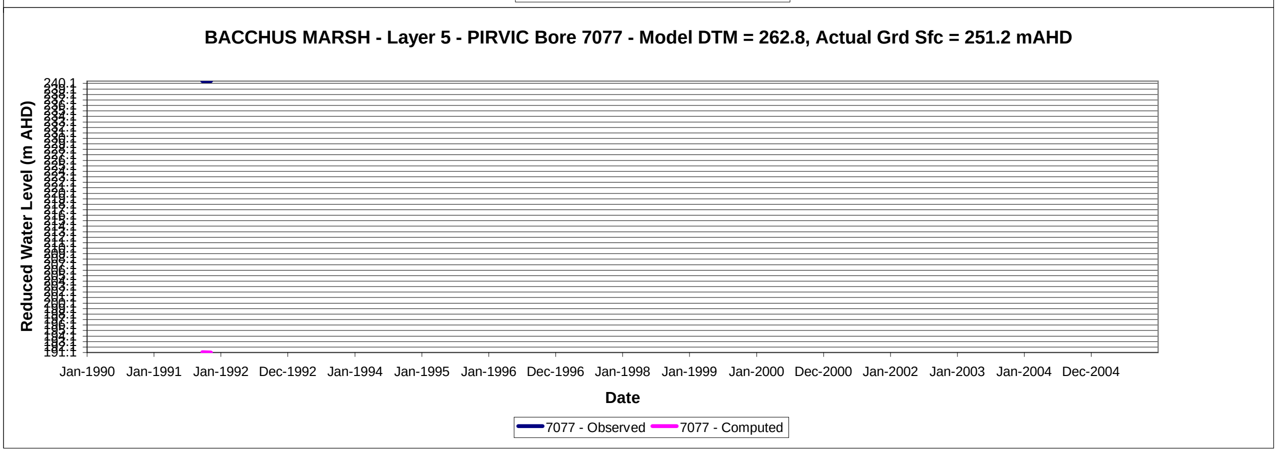

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7071 - Model DTM = 203.1, Actual Grd Sfc = 199.1 mAHD
Reduced Water Level (m AHD)
192.7
191.7
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7071 - Observed
7071 - Computed

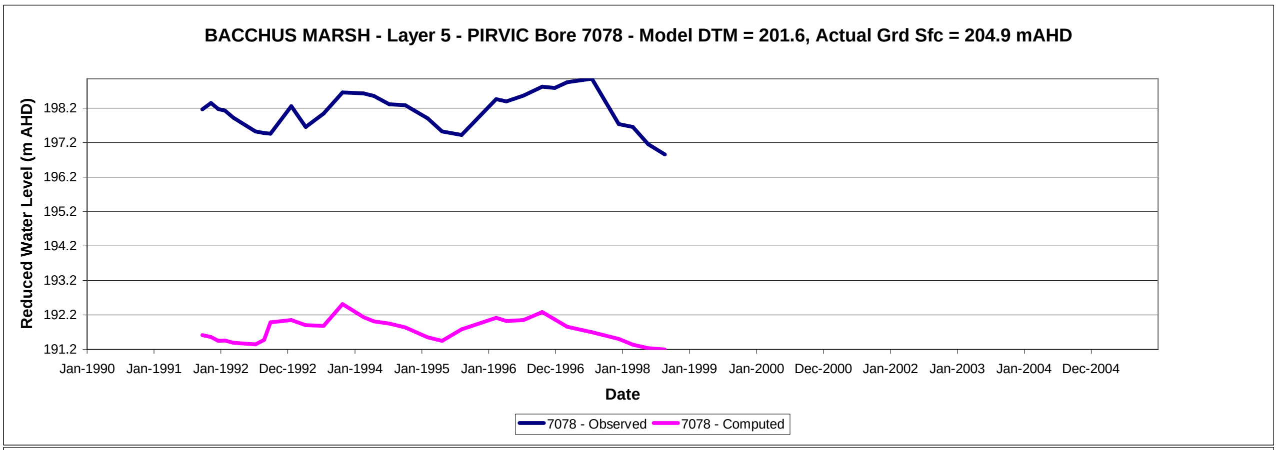

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7072 - Model DTM = 194.3, Actual Grd Sfc = 189.1 mAHD
Reduced Water Level (m AHD)
194.2
193.2
192.2
191.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7072 - Observed
7072 - Computed

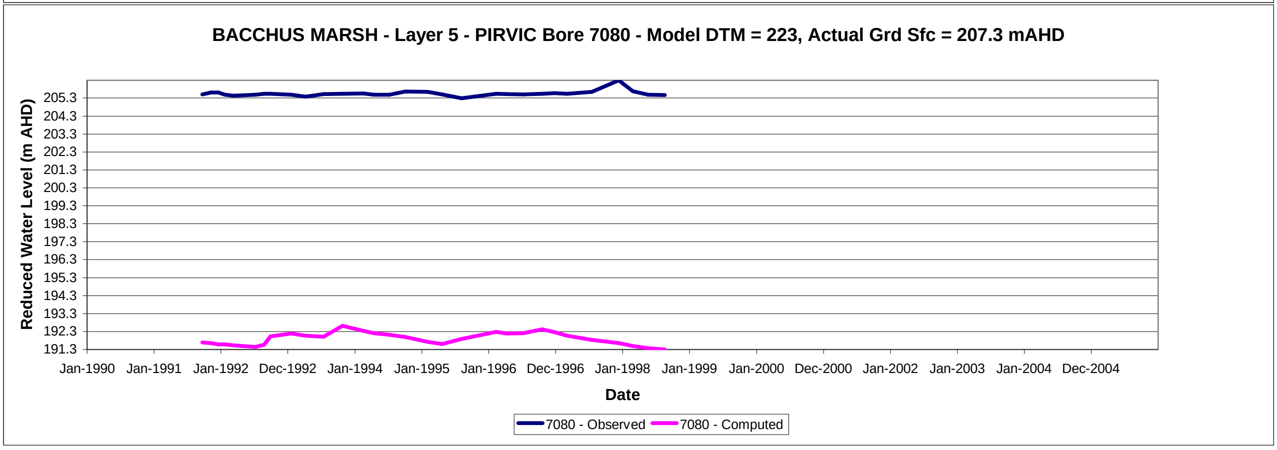

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7073 - Model DTM = 194.3, Actual Grd Sfc = 189.1 mAHD
Reduced Water Level (m AHD)
194.2
193.2
192.2
191.2
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7073 - Observed
7073 - Computed


BACCHUS MARSH - Layer 5 - PIRVIC Bore 7074 - Model DTM = 194, Actual Grd Sfc = 190.7 mAHD
Reduced Water Level (m AHD)
192.6
191.6
190.6
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7074 - Observed
7074 - Computed


BACCHUS MARSH - Layer 5 - PIRVIC Bore 7075 - Model DTM = 211.7, Actual Grd Sfc = 200.9 mAHD
Reduced Water Level (m AHD)
197.1
196.1
195.1
194.1
193.1
192.1
191.1
190.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7075 - Observed
7075 - Computed

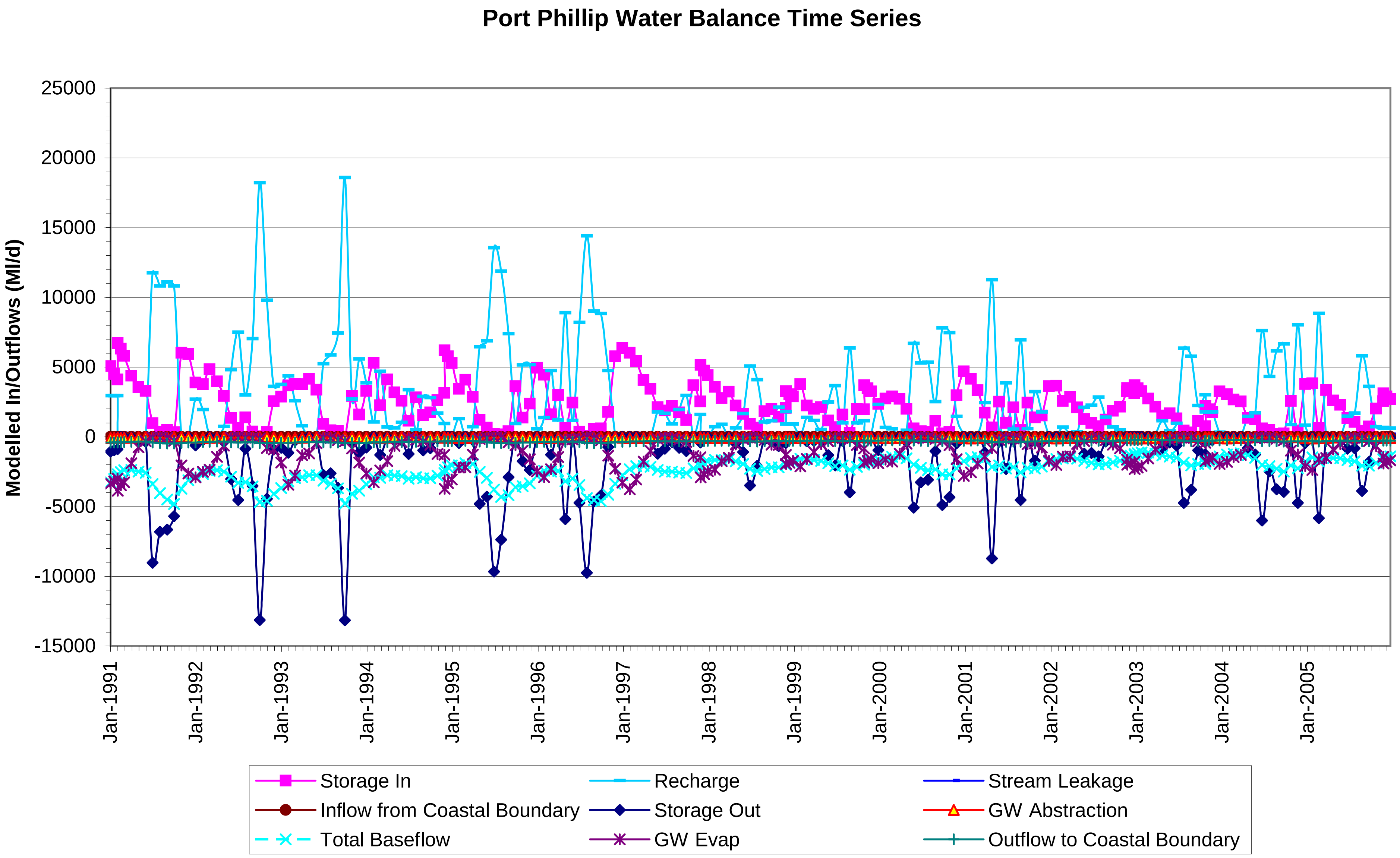

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7077 - Model DTM = 262.8, Actual Grd Sfc = 251.2 mAHD
Reduced Water Level (m AHD)
240.1
Jan-1990 Jan-1991 Jan-1992 Dec-1992 Jan-1994 Jan-1995 Jan-1996 Dec-1996 Jan-1998 Jan-1999 Jan-2000 Dec-2000 Jan-2002 Jan-2003 Jan-2004 Dec-2004
Date
7077 - Observed
7077 - Computed


BACCHUS MARSH - Layer 5 - PIRVIC Bore 7078 - Model DTM = 201.6, Actual Grd Sfc = 204.9 mAHD
Reduced Water Level (m AHD)
198.2
197.2
196.2
195.2
194.2
193.2
192.2
191.2
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7078 - Observed
7078 - Computed

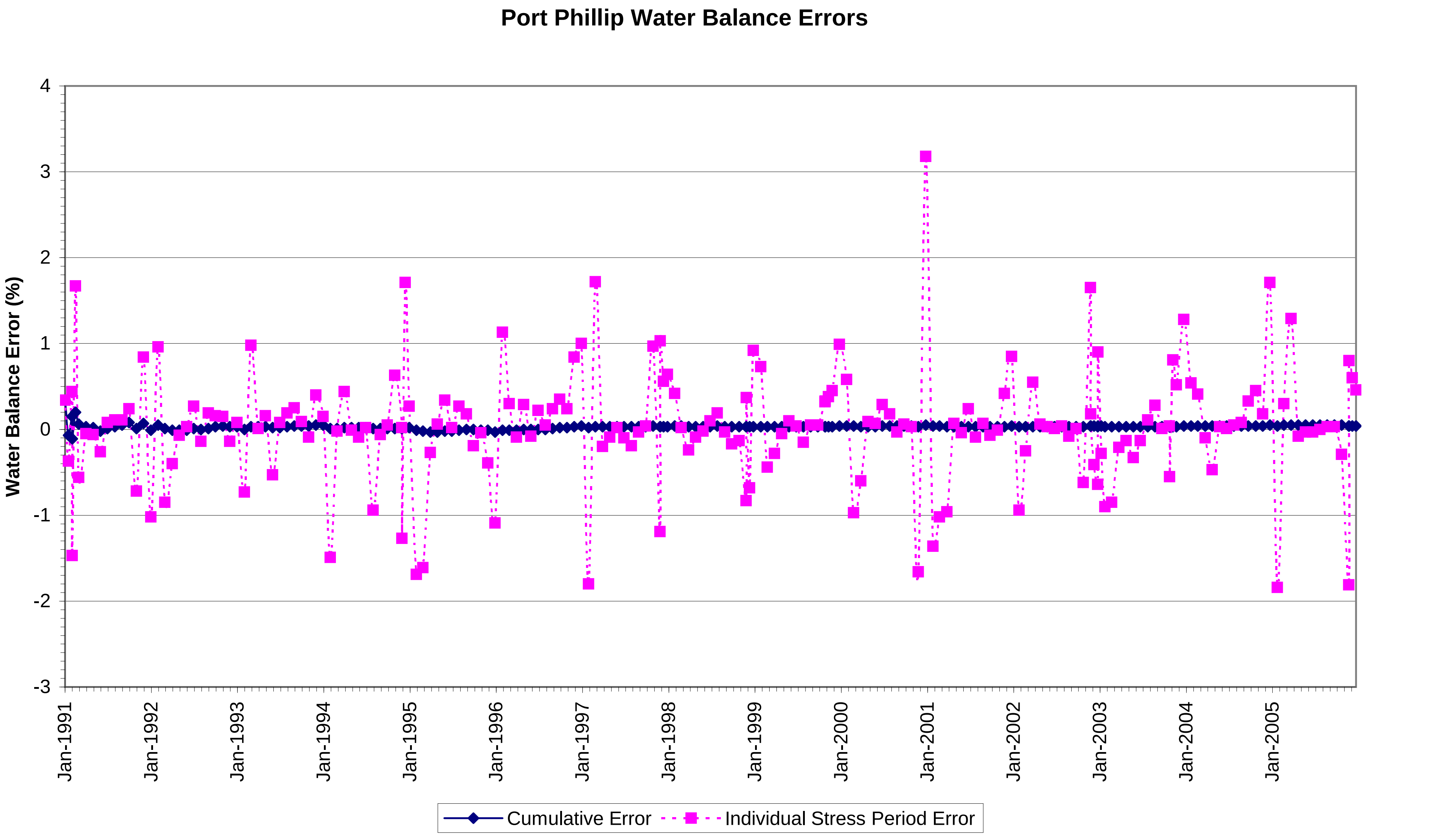

BACCHUS MARSH - Layer 5 - PIRVIC Bore 7080 - Model DTM = 223, Actual Grd Sfc = 207.3 mAHD
Reduced Water Level (m AHD)
205.3
204.3
203.3
202.3
201.3
200.3
199.3
198.3
197.3
196.3
195.3
194.3
193.3
192.3
191.3
Jan-1990
Jan-1991
Jan-1992
Dec-1992
Jan-1994
Jan-1995
Jan-1996
Dec-1996
Jan-1998
Jan-1999
Jan-2000
Dec-2000
Jan-2002
Jan-2003
Jan-2004
Dec-2004
Date
7080 - Observed
7080 - Computed

Appendix I

Transient Water Balance Results



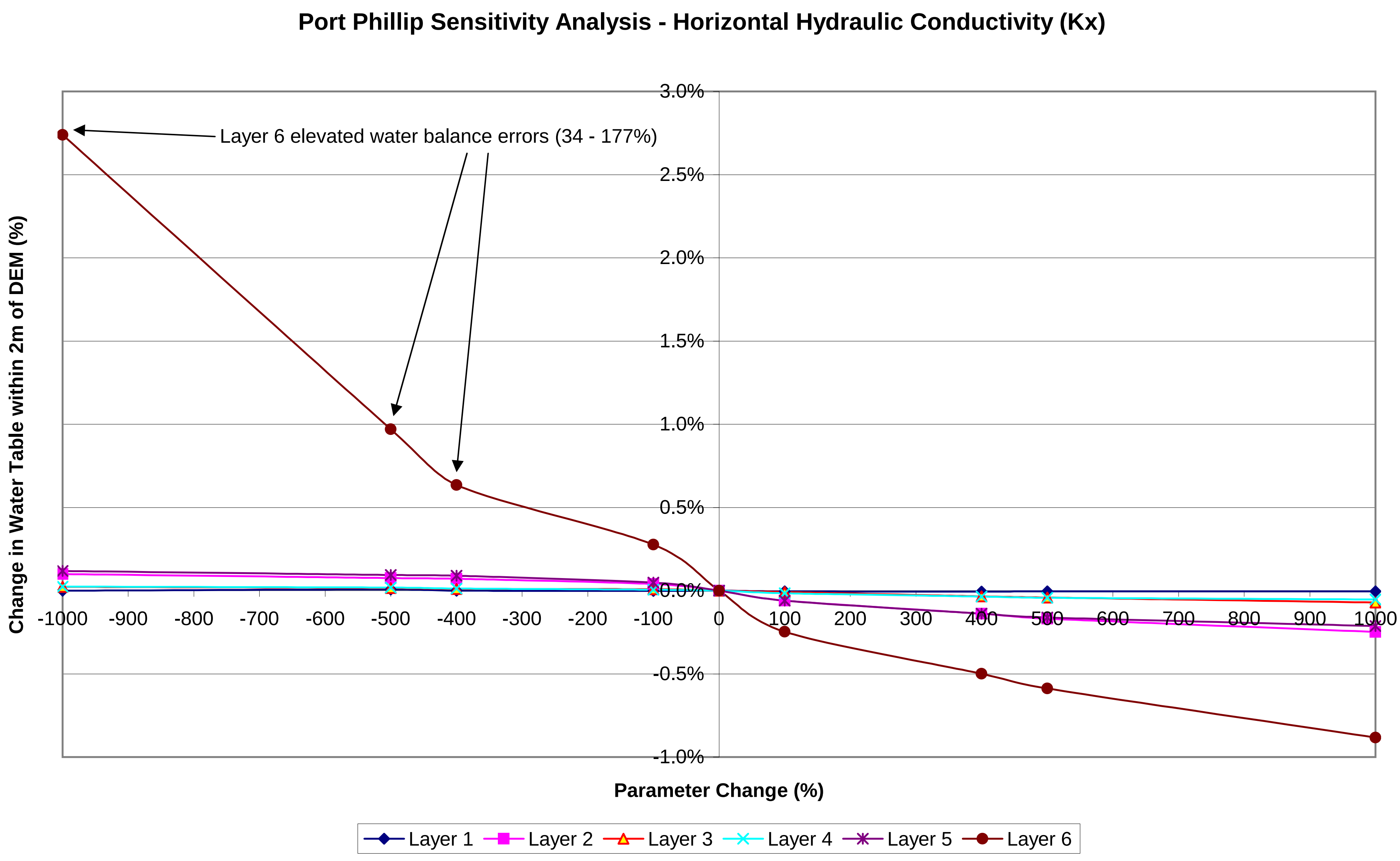
G:\31\22410\Tech\GWModel\PortPhillip\PPv1TR\Processing\PPv4TR026_WaterBalance.xls



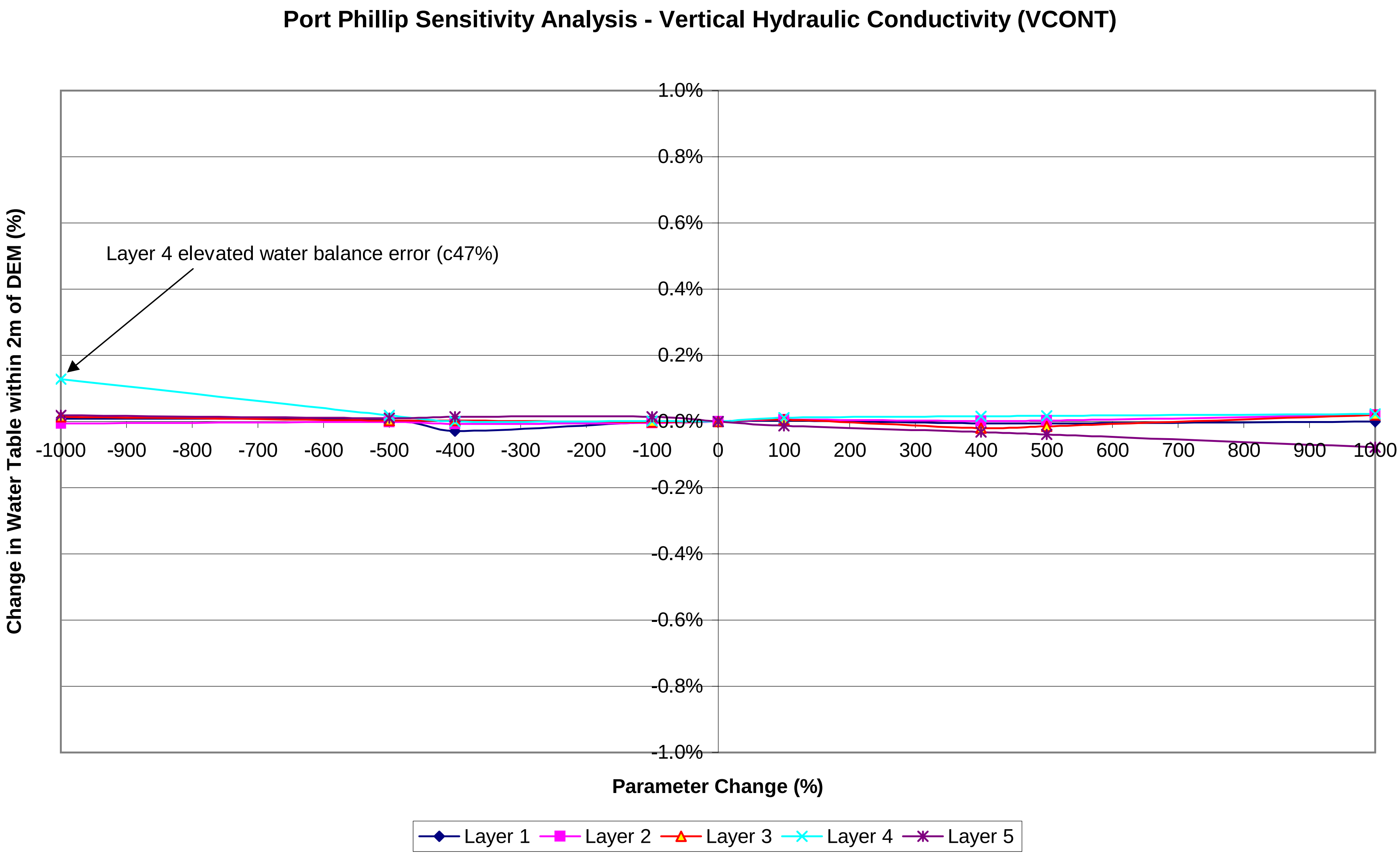
G:\31\22410\Tech\GWModel\PortPhillip\PPv1TR\Processing\PPv4TR026_WaterBalance.xls

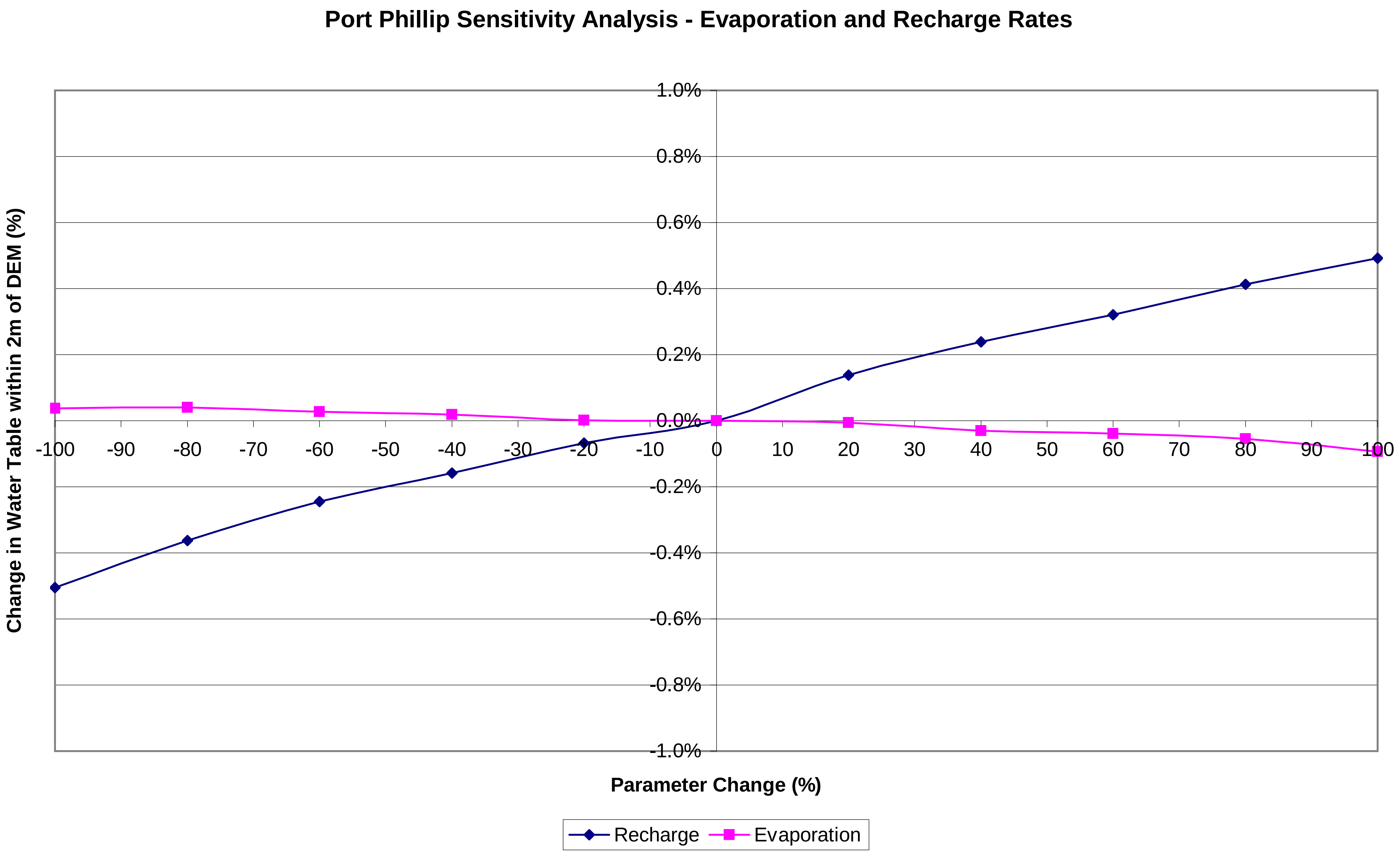
Appendix J

Sensitivity Analysis Results

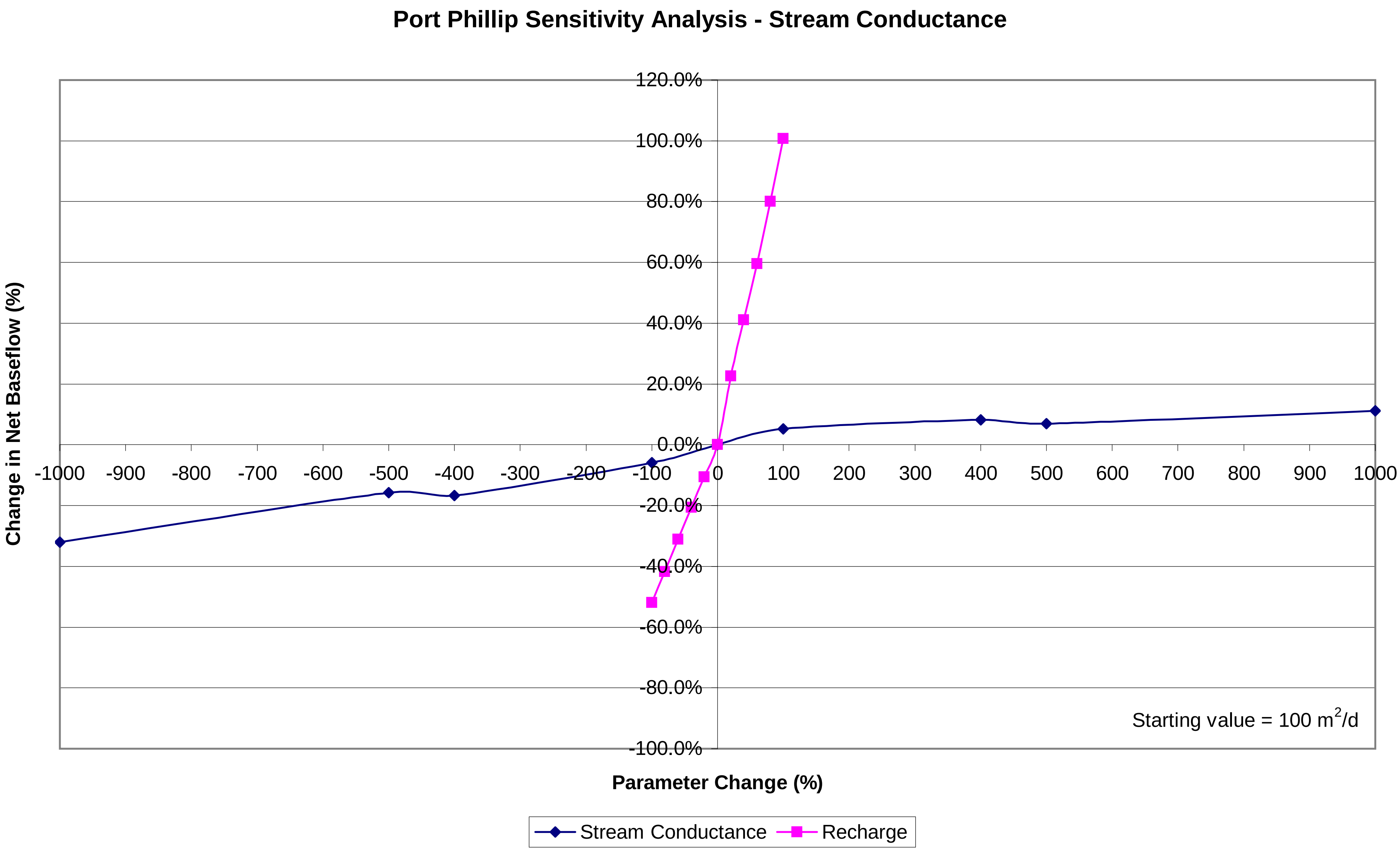


Port Phillip Sensitivity Analysis - Horizontal Hydraulic Conductivity (Kx)
Layer 6 elevated water balance errors (34 - 177%)
3.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
-0.5%
-1.0%
-1000
-900
-800
-700
-600
-500
-400
-300
-200
-100
0
100
200
300
400
500
600
700
800
900
1000
Change in Water Table within 2m of DEM (%)
Parameter Change (%)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6

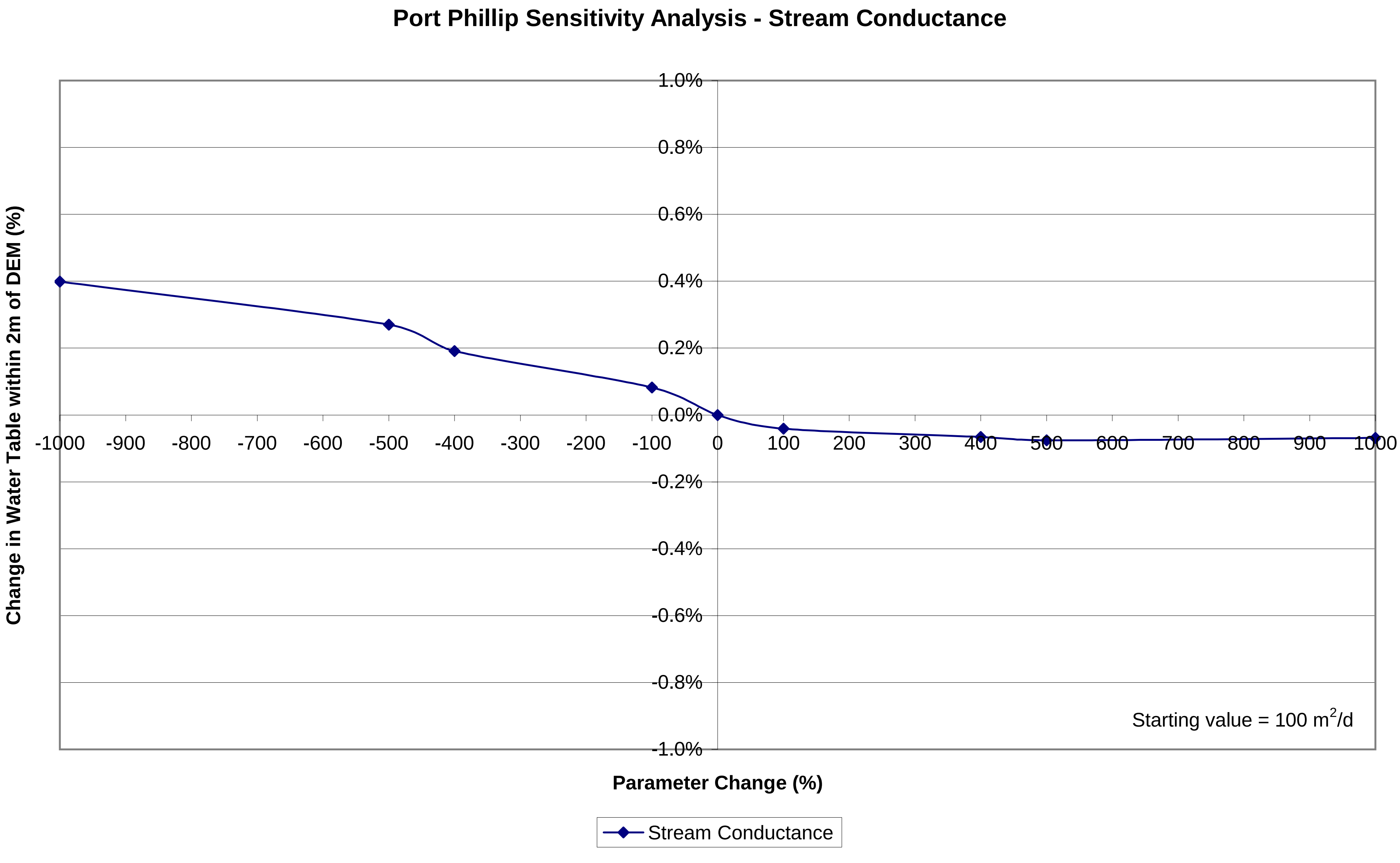

Port Phillip Sensitivity Analysis - Vertical Hydraulic Conductivity (VCONT)
Layer 4 elevated water balance error (c47%)
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
-0.2%
-0.4%
-0.6%
-0.8%
-1.0%
-1000
-900
-800
-700
-600
-500
-400
-300
-200
-100
0
100
200
300
400
500
600
700
800
900
1000
Change in Water Table within 2m of DEM (%)
Parameter Change (%)
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



Port Phillip Sensitivity Analysis - Evaporation and Recharge Rates
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
-0.2%
-0.4%
-0.6%
-0.8%
-1.0%
-100
-90
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
50
60
70
80
90
100
Change in Water Table within 2m of DEM (%)
Parameter Change (%)
Recharge
Evaporation



Port Phillip Sensitivity Analysis - Stream Conductance
Change in Net Baseflow (%)
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
-20.0%
-40.0%
-60.0%
-80.0%
-100.0%
-1000 -900 -800 -700 -600 -500 -400 -300 -200 -100 0 100 200 300 400 500 600 700 800 900 1000
Parameter Change (%)
Starting value = 100 m2/d
Stream Conductance
Recharge



Port Phillip Sensitivity Analysis - Stream Conductance
Change in Water Table within 2m of DEM (%)
1.0%
0.8%
0.6%
0.4%
0.2%
0.0%
-0.2%
-0.4%
-0.6%
-0.8%
-1.0%
-1000
-900
-800
-700
-600
-500
-400
-300
-200
-100
0
100
200
300
400
500
600
700
800
900
1000
Starting value = 100 m2/d
Parameter Change (%)
Stream Conductance

Appendix K

Project Data Sets

Project	CMA Groundwater models
Project number	31 22410
Project Manager	Keith Phillipson
other contacts	Chris Nicol
	Will Minchin
Server / office	Melbourne

Type	
c	communication
d	data
m	management
pr	proposal
r	report
f	finance

Delivery	
e	email
f	fax
l	letter / post
p	phonecall

	Type	Delivery	DocID	Date GHD sent/received	Sender	Recipient	Description	file types	Model Area	Data List	Use
002	d	l	d002	21/08/2008	Charlie Showers	GHD	surface water flow / EC / salt load data	Text files	All	Yes	Catchment yield and baseflow analysis, model calibration
003	d	e	d003	21/08/2008	Charlie Showers	GHD	SRW groundwater usage data on GMA/WSPA basis	Excel	All	Yes	Groundwater model.
004	d	l	d004	15/08/2008	Charlie Showers	GHD	SRW groundwater licence and bore info	Text files	All	Yes	Groundwater model.
005	d	e	d005	28/08/2008	Charlie Showers	GHD	SRW surface water usage by GMA / WSPA	Excel	All	Yes	Insufficient information to be useable (no location information).
007	d	l	d007	1/09/2008	Charlie Showers	GHD	surface water flow data for all sites in state with some flow data recorded	.CSVs	All	Yes	Catchment yield and baseflow analysis, model calibration
012	d	e	d012	16/09/2008	Charlie Showers	Will Minchin	Sustainable diversion limts data - catchment & basin scale	shapefiles	All	Yes	Catchment yield and baseflow analysis, model calibration
022	d	l	d022	13/02/2008	Jill McNamara	Chris Nicol	GMS Data dump from August 2007.	Text files	All	Yes	estimates).
023	d		d023	1/03/2008	Chris Nicol	File	CMA model-specific Access database of GMS data dump (d022).	Access	All	Yes	estimates).
024	d		d024	1/03/2008	Chris Nicol	File	State-wide Access database of GMS data dump (d022) and GEDIS database	Access	All	Yes	Groundwater model conceptualisation, construction and calibration (groundwater levels, geological logs, transmissivity estimates).
025	r	l/e	r025	12/03/2008	Jill McNamara	Chris Nicol	DSE Groundwater Management Plans and associated technical reports	Various	All	Yes	Groundwater model conceptualisation.
026	d	l/e	d026	7/04/2008	Jill McNamara	Chris Nicol	Melbourne Hydrogeological Map Sheet (Database, pdf maps, DRAFT ONLY)	Various	PtPhillip	Yes	Groundwater model conceptualisation and construction (geological interpretations).
029	d	e	d029	27/06/2008	Craig Hamilton / Craig Beverly (DSE)	Chris Nicol	DSE GIS files - wetlands, bathymetry, index of stream condition	shapefiles	All	Yes	Groundwater model conceptualisation and construction.
040	d	l/e	d040	20/03/2008	PIRVIC (Mark Reid / ??)	Chris Nicol	PIRVIC (CLPR) bore database for Port Phillip, West Gippsland and East Gippsland CMAs	Excel	All	Yes	Groundwater model conceptualisation, construction and calibration (groundwater levels, geological logs).
042	r	e	r042	14/08/2008	SRW	Chris Nicol	Werribee Delta (Deutgam) Groundwater Model Report	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
043	r	e	r043	14/08/2008	SRW	Chris Nicol	Werribee recycled water re-use information	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
044	d	e	d044	22/08/2008	DSE (Charlie Showers) / SRW (Terry Flynn)	GHD	Metered groundwater usage by GMU only (!!??!!) 03/04, 04/05, 05/06	Excel	All	Yes	Groundwater model.
045	d	e	d045	26/08/2008	DSE (Charlie Showers) / SRW (Terry Flynn)	GHD	Total Metered Annual Groundwater usage 07/08 license by license, per GMU	Excel	All	Yes	Groundwater model.
046	d	e	d046	28/08/2008	DSE (Charlie Showers) / SRW (Terry Flynn)	GHD	Total Metered Annual Surface Water usage 07/08 license by license, per river/stream	Excel	All	Yes	Insufficient information to be useable (no location information).
047	r		r047	29/02/2008	Keith Phillipson	File	Leonard, J.G. 1992. Groundwater Resources in the Port Phillip Region.	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
048	r	e	r048	12/03/2008	Jill McNamara	Chris Nicol	SKM, 2004. Werribee Irrigation District Groundwater Investigations	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
049	r	e	r049	12/03/2008	Jill McNamara	Chris Nicol	Various Koo Wee Rup reports and GMP	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
050	r	e	r050	12/03/2008	Jill McNamara	Chris Nicol	SKM, 2003. Wandin Yallock WSPA: Part 2 - Technical Requirements Discussions Paper	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
051	r		r051	12/03/2008	Chris Nicol	File	Port Phillip and Western Port Groundwater Flow Systems - documentation	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
052	r		r052	12/03/2008	Chris Nicol	File	Thompson, B.R. 1972. A Review of the Aquifer Systems Near Melbourne and the Possibility of Using Treated Effluent for Artificial Recharge. Geological Survey Report 1972/1.	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
053	r		r053	12/03/2008	Chris Nicol	File	Barnes, C.P. et al. 1972. Extractive Industries Resources in the Metropolitan Area. Geological Survey Report 1972/2	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
054	r		r054	12/03/2008	Chris Nicol	File	Thompson, B.R. and Harris, I.F. 1972. A Survey of the Groundwater Resources in the Southeastern Suburbs of Melbourne. Geological Survey Report 1972/3	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
055	r		r055	12/03/2008	Chris Nicol	File	Brumley, J.C., 1974. Explanatory Notes on the 1:5000 Stratigraphic Map of Melbourne's Central Business District. Geological Survey Report 1974/7	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
056	r		r056	12/03/2008	Chris Nicol	File	Harris, I.F. 1974. Hydrogeology of the Melbourne Region. Geological Survey Report 1974/11	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
057	r		r057	12/03/2008	Chris Nicol	File / Keith Phillipson	Geological Survey Offshore Port Phillip Well Completion Reports	PDF	PtPhillip	Yes	Groundwater model conceptualisation and construction (geological logs).
058	r		r058	12/03/2008	Keith Phillipson	File	Smart Water Fund, SKM, CSIRO. 2006. Developing Aquifer Storage and Recovery (ASR) Opportunities in Melbourne. Report on Broad Scale Map of ASR Potential for Melbourne.	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
059	r		r059	12/03/2008	Keith Phillipson	File	Leonard, J.G. 1979. Preliminary assessment of the groundwater resources in the Port Phillip region. Geological Survey Report no. 66.	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
060	r		r060	12/03/2008	Keith Phillipson	File	Lakey, R. and Tickell, S. 1981. Explanatory Notes on the Western Port Groundwater Basin 1:100000 Hydrogeological Map. Geological Survey Report No. 69.	PDF	PtPhillip	Yes	Groundwater model conceptualisation.
061	r		r061	12/03/2008	Keith Phillipson	File	Mudd, G.M. et al. 2004. A Review of Urban Groundwater in Melbourne : Considerations for WSUD.	PDF	PtPhillip	Yes	Groundwater model conceptualisation.

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