DWLBC REPORT

Review of Mallee Clearing saltloads to the River Murray in SA - 2005

2006/08

Government of South Australia
Department of Water, Land and Biodiversity Conservation

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Department of Water, Land and Biodiversity Conservation

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FOREWORD

South Australia's unique and precious natural resources are fundamental to the economic and social wellbeing of the State. It is critical that these resources are managed in a sustainable manner to safeguard them both for current users and for future generations.

The Department of Water, Land and Biodiversity Conservation (DWLBC) strives to ensure that our natural resources are managed so that they are available for all users, including the environment.

In order for us to best manage these natural resources it is imperative that we have a sound knowledge of their condition and how they are likely to respond to management changes. DWLBC scientific and technical staff continues to improve this knowledge through undertaking investigations, technical reviews and resource modelling.

Rob Freeman
CHIEF EXECUTIVE
DEPARTMENT OF WATER, LAND AND BIODIVERSITY CONSERVATION

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1. INTRODUCTION

The River Murray is both an important water resource and the discharge area for the regional aquifer systems of the Murray Basin. From early this century, the clearing of native vegetation has upset a delicate balance and has resulted in increased recharge to the groundwater system. This in turn leads to rising watertables and a subsequent increase in saline groundwater inflows to the river and the floodplain, and unfortunately, an increase in salinity of this vital resource.

Previous modelling exercises to predict the impacts of vegetation clearance on the river (Barnett 1990, Barnett et al 2001), were carried out with the best recharge information available at the time (Cook, 1989), but were ultimately hampered by the use of broad landscape units and recharge rates derived from measurements carried out in other wetter areas of the Murray Basin.

A National Action Plan SMMSP project (Cook et al., 2004) has provided much improved recharge estimates and predicted lag times between clearing and watertable response. This work obtained point estimates within the study area and derived improved drainage equations that take into account the presence of the Blanchetown Clay. The project used airborne geophysical techniques described in Munday (2004), to produce a more accurate map of the extent and thickness of the Blanchetown Clay. More detailed soil landscape mapping has also been carried out at a finer resolution than used previously.

This report brings together the results from three models that have been constructed to provide a sound technical basis for evaluating salt loads to the Murray River. They are the Tailem Bend to Morgan model, the Morgan to Lock 3 model and the Lock 3 to Border model (Fig. 1).

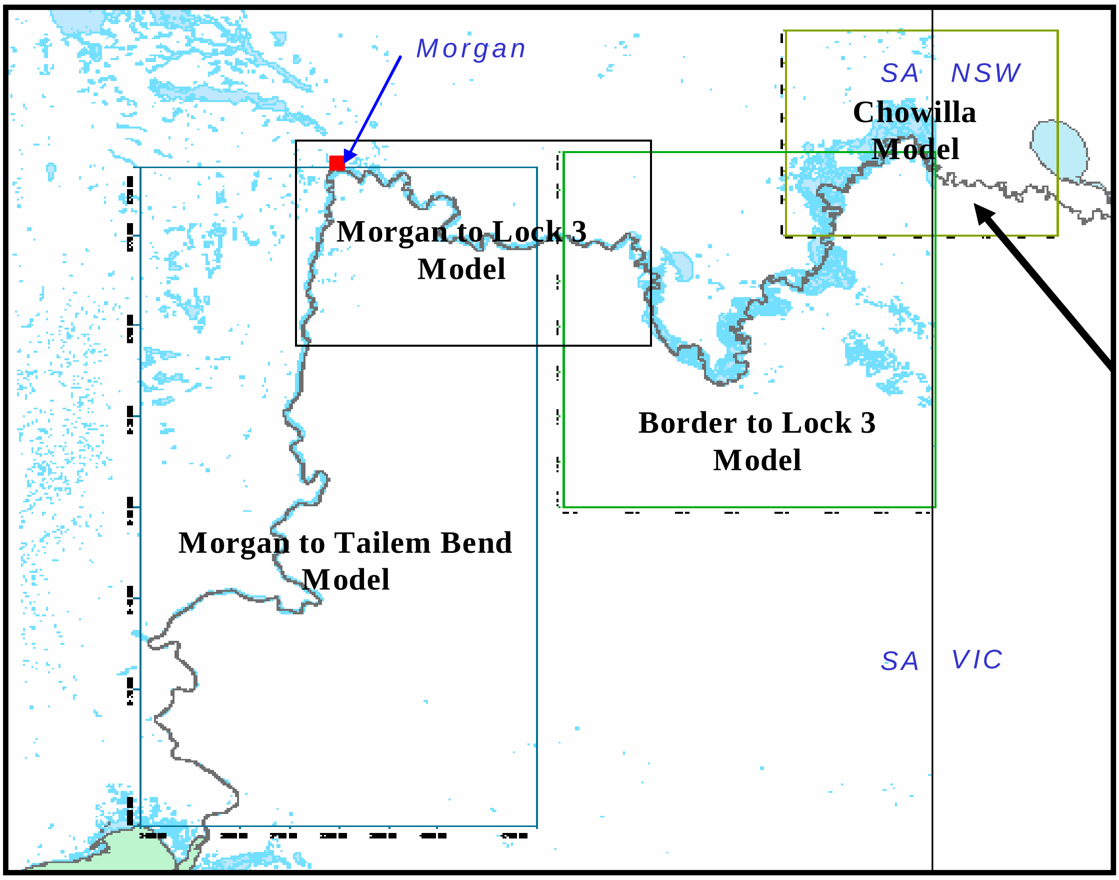


Figure 1. Location of model areas

2. RECHARGE RATES

The increase in recharge rates following clearing is the key process driving the increase in salt loads to the river. These rates are dependent on several factors:

- time elapsed since clearing,
- the depth to the water table,
- soil type, particularly the clay content in the top two metres,
- thickness of Blanchetown Clay.

There are a number of different methods that can be used to provide point estimates of the rates of deep drainage following clearing of native vegetation. For the National Action Plan project, the chloride peak displacement method was used as it is most appropriate when drainage rates are likely to be less than 20 mm/yr. In summary, this method involves measuring the amount of water that has entered the soil profile since the land was cleared of native “mallee” vegetation (as recorded by the downward movement of the ‘salt bulge’ that in pre-clearing times would have remained directly below the mallee rootzone). The average rate of deep drainage is then determined by dividing this amount of soilwater by the time since clearing occurred (Cook et al, 2004).

A total of 14 cored holes were drilled in the Riverland study area, to depths ranging between 12 and 57 m. Estimates of drainage obtained from chloride and water content measurements on these cores ranged between less than 1 and approximately 15 mm/yr, although most estimates were less than 2 mm/yr.

The extension of the point estimates of deep drainage to a regional scale required regional information on drainage rates, water table depths and unsaturated zone soil properties. For this exercise, it was assumed that the unsaturated zone can be represented by two layers with uniform soil properties: a sandy loam and a clay layer. Variations in thickness of the clay layer (Blanchetown Clay) have been determined from stratigraphic mapping and surface and aerial electromagnetic mapping (Munday et al., 2004). The watertable depth has been calculated as the difference between the potentiometric surface (interpolated from bore records) and the land surface elevation. The data have been combined using the SIMPACT GIS which uses a 250 m × 250 m grid size.

The time delay between clearing and the increase in aquifer recharge is one of the uncertainties in projections of rates of increase in Murray River salinity. Cook et al (2004) developed new equations that can be used to calculate this time delay to allow for the presence of Blanchetown Clay. In particular, these new equations show that for each metre of Blanchetown Clay in the profile, the timelag will increase by between 2 and 5 years.

Over 40 recharge zones were delineated in this investigation, but in order to make the modelling process workable, these zones were aggregated down as shown in Figure 2. Table 1 shows how the rate (in mm/year) varies over time in these simplified recharge zones. Recharge values were modelled in 10 yearly time steps.

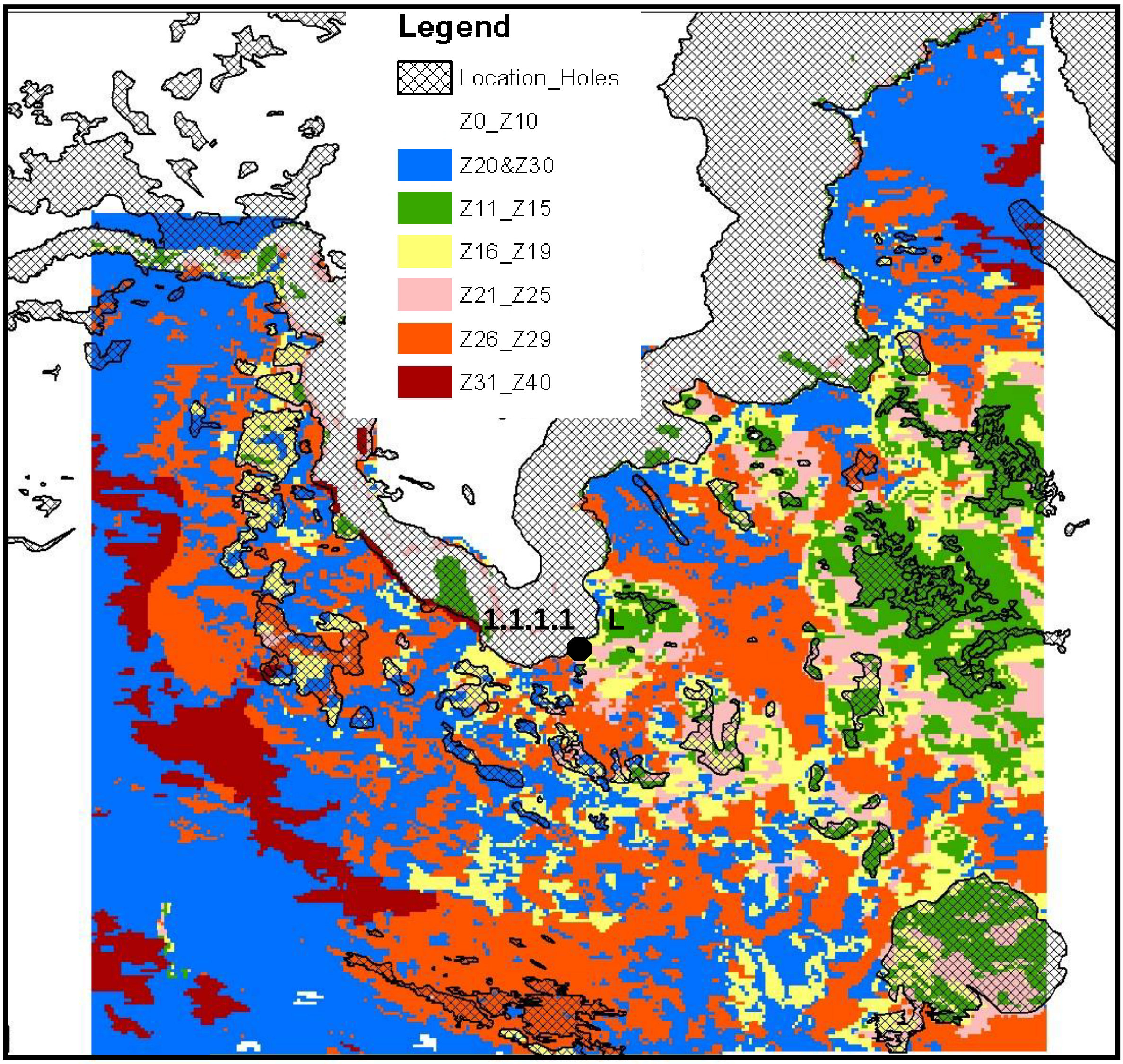


Figure 2. Example of simplified recharge zones

Table 1. Variation in recharge rates following clearing (mm/yr)

Year	Z 0-10	Z 20 & 30	Z 11-15	Z 16-19	Z 21-25	Z 26-29	Z 31-40
1920	0.00	0.10	0.14	0.10	0.10	0.10	0.10
1940	0.00	0.10	0.80	0.10	0.10	0.10	0.10
1960	0.00	0.10	1.38	0.10	1.32	0.10	0.10
1980	0.00	0.10	1.99	0.13	3.84	0.12	0.10
2000	0.00	0.11	2.58	0.29	5.96	0.36	0.13
2020	0.00	0.13	2.81	0.80	6.95	1.53	0.76
2040	0.00	0.22	2.85	1.52	7.16	3.34	2.94
2060	0.00	0.46	2.85	2.25	7.19	5.13	5.98
2080	0.00	0.99	2.85	2.83	7.20	6.45	8.46
2100	0.00	1.81	2.86	3.16	7.20	7.15	9.78

3. HYDROGEOLOGICAL FRAMEWORK

The hydrogeology of the Murray Basin in South Australia has been well documented and is summarised below. There are three main aquifers separated by two confining layers. The geological units are, in order of increasing depth below the surface:

- **Monoman Formation aquifer (alluvium)**:- consists of medium to coarse alluvial sand overlain by thin silts and clay. It is restricted to the river valley and is in direct hydraulic contact both with the River Murray and the surrounding unconfined aquifer (Pliocene Sands or Murray Group Limestone).
- **Pliocene Sands aquifer**:- an unconfined aquifer which is saturated only upstream of Overland Corner. The unit comprises unconsolidated to weakly cemented fine to coarse sand. The groundwater flow is generally towards the river under low gradients, except where watertable mounds exist beneath irrigation areas. The salinity in the aquifer is generally over 20 000 mg/L.
- **Bookpurnong Beds (confining layer)**:- this unit occurs only upstream of Overland Corner where it dips down gradually to the east and increases in thickness to a maximum of about 30 m. It consists of poorly consolidated plastic silts and shelly clays which confines the underlying limestone aquifer.
- **Cadell Marl (confining layer)**:- a calcareous clay which occurs only in the Waikerie – Morgan area. It is part of the Murray Group and confines the underlying limestone aquifer.
- **Murray Group Limestone aquifer**:- comprises a consolidated, highly fossiliferous, fine to coarse limestone, and is unconfined downstream of Overland Corner. The groundwater movement is mainly to the west and toward the river under fairly low gradients. Its salinity varies between 5000–20 000 mg/L. Although considered one aquifer regionally, detailed investigations for salt interception schemes has enabled a more detailed subdivision based on Lukasik and James (1998).
- **Ettrick Formation (confining layer)**:- a low permeable layer between the Murray Group Limestone and the underlying confined aquifer, consisting of a glauconitic and fossiliferous marl;
- **Renmark Group aquifer**:- a confined aquifer comprising unconsolidated carbonaceous sands, silt and clay. Groundwater flow is generally from the basin margins toward the river.

Structure contours for these layers are available from the Murray Basin Hydrogeological Map series, but this data has been heavily modified to reflect more recent drilling and some new interpretations of borehole logs.

The Morgan to Lock 3 model and the Lock 3 to Border model incorporate the more detailed subdivision of the Murray Group Limestone aquifer, which is important for the detailed interception scheme investigations, but is less relevant on a regional scale away from the river.

4. PREVIOUS MODELLING

Barnett (1990) carried out a previous modelling exercise using a ‘pseudo three-dimensional’ five layer finite element model (the Golder Package) and the Cook (1989) recharge values, but with important differences from recent modelling exercises. The model grid was a much coarser 25 km that extended as far east as Mildura, and the irrigation areas adjacent to the river were not included. It was also assumed that all inflows reached the river, with no salt storage on the floodplain. The model predicted an increase of 50 EC at Morgan by the year 2020 (100 years since clearing occurred).

The next exercise (Barnett et al, 2001) used two models – from Morgan to Tailem Bend by DWLBC described later in this report, and Morgan to the SA Border by Australian Water Environments. Recharge estimates from Cook (1989) were also used.

5. MORGAN – TAILEM BEND MODEL

5.1 MODEL CONSTRUCTION

The Morgan – Tailem Bend model is a fairly simple model because of the uncomplicated geology, with land clearing the only major change which has affected the groundwater levels. The model area extends 80 km east to west by 145 km north to south (Fig. 3), with the AMG co-ordinates of the model domain Eastings 340 000–420 000 and Northings 6 090 000–6 235 000.

The uniformly rectangular shaped model grid has been discretised into 248 rows and 248 columns within the model domain. The grid size is uniformly 585 m (north - south direction) by 323 m (east - west direction) which is sufficiently small to be able to model river floodplain processes. The same grid size was applied into all three model layers resulting in a total of 184 512 finite difference cells in the model.

Layer 1 – Murray Group Limestone

An unconfined aquifer in this model where the northern and southern edges of the model area were assumed to be no-flow boundaries as they are parallel to groundwater flow toward the river (Fig. 3).

The eastern edge of the model area was represented as a general head boundary to allow lateral groundwater flow into this layer. The River Murray, was simulated as constant head boundaries corresponding with the appropriate river pool level ie 3.2 m AHD upstream of Lock 1, and 0.7 m AHD downstream of Lock 1.

To the west of the river, outcrops of basement in the model layer were simulated as inactive cells. Wall model cells were used along the Morgan Fault zone to simulate the very low transmisivity zones in this area. General heads along the western model edge simulated the lateral flow due to recharge from the Mt Lofty Ranges.

Layer 2 – Ettrick Formation confining layer

A low permeability layer, and as only very low volumes of water flow in and out from this layer, no flow boundaries surround the model edges.

Layer 3 - Renmark Group

This layer is a confined aquifer with transmissivity values calculated by multiplying the saturated thickness by the uniform hydraulic conductivity of 1 m/day. Fixed head cells were used to simulate the potentiometric head distribution observed in the aquifer.

Table 2 displays the initial hydraulic parameters applied in the model.

Table 2. Morgan – Tailem Bend model initial hydraulic parameters

Layer	K_{hor} (m/day)	K_{vert} (m/day)	Sy	Ss
Murray Group Limestone	5.0		0.1	
Ettrick Formation		10^{-6}		
Renmark Group	1.0			0.00001

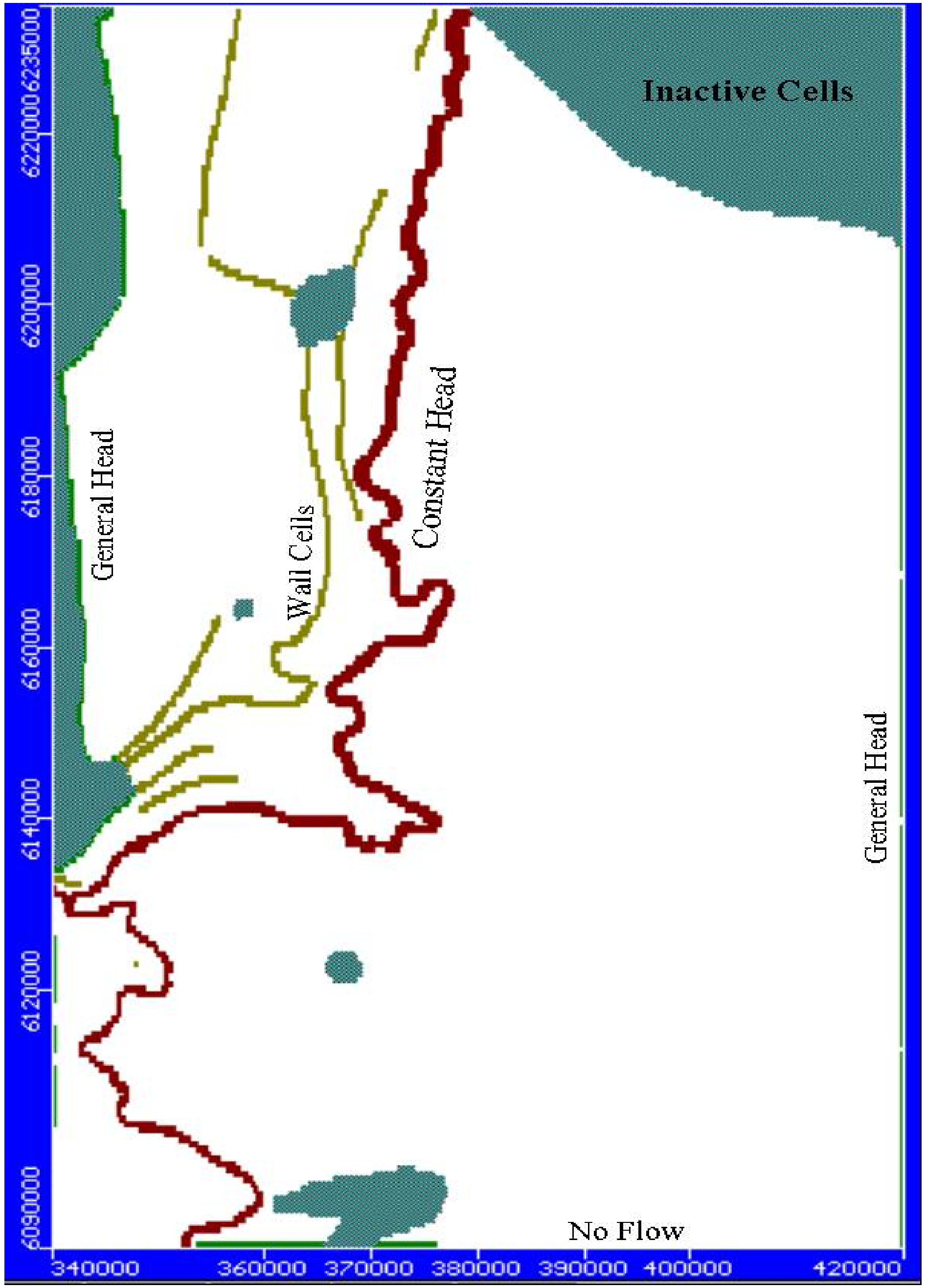
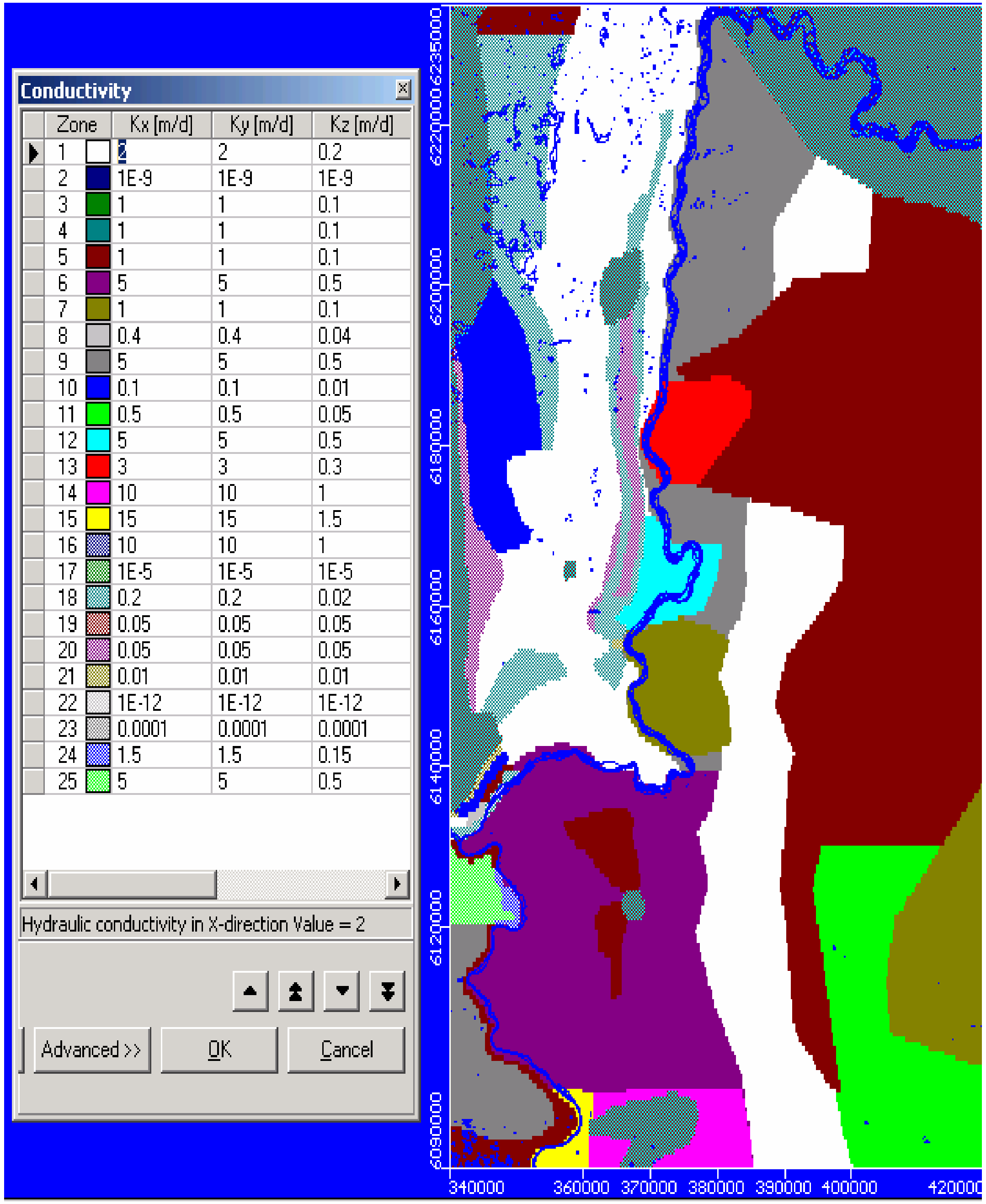


Figure 3. Model boundary conditions for Layer 1 (MGL)



Zone	Kx [m/d]	Ky [m/d]	Kz [m/d]
1	2	2	0.2
2	1E-9	1E-9	1E-9
3	1	1	0.1
4	1	1	0.1
5	1	1	0.1
6	5	5	0.5
7	1	1	0.1
8	0.4	0.4	0.04
9	5	5	0.5
10	0.1	0.1	0.01
11	0.5	0.5	0.05
12	5	5	0.5
13	3	3	0.3
14	10	10	1
15	15	15	1.5
16	10	10	1
17	1E-5	1E-5	1E-5
18	0.2	0.2	0.02
19	0.05	0.05	0.05
20	0.05	0.05	0.05
21	0.01	0.01	0.01
22	1E-12	1E-12	1E-12
23	0.0001	0.0001	0.0001
24	1.5	1.5	0.15
25	5	5	0.5

Figure 4. Hydraulic conductivity zones for Layer 1

5.2 STEADY STATE CALIBRATION

The first stage involved a steady state run undertaken over the entire model domain to simulate the water levels before clearing. As part of this process, the above boundary conditions and hydraulic parameters were applied with pre-clearing recharge rates (less than 0.1 mm/year). The hydraulic conductivity of Layer 1 was then adjusted until the calculated regional water levels agreed reasonably closely to the observed water levels. The resultant zones of hydraulic conductivity are shown in Figure 4.

These steady state calibrated water levels were then used as initial groundwater levels (pre-clearing) for later transient simulations.

5.3 TRANSIENT CALIBRATION

The transient calibration was undertaken on Layer 1 (MGL unconfined aquifer) which represents the groundwater system transmitting the changes in recharge flux from the ground surface to inflows into the Murray River.

The transient simulation started from 1920 and ran for 80 years to simulate current conditions as at 2000. Recharge was applied to the zones in ten year time steps. Adjustments were made in the specific storage, leakage (upward from Renmark Group) and hydraulic conductivity values within reasonable limits to achieve an acceptable match between the calculated and observed water level hydrographs (Fig. 5) and water level contours (Fig. 6). Prediction results continued the recharge application until 2100.

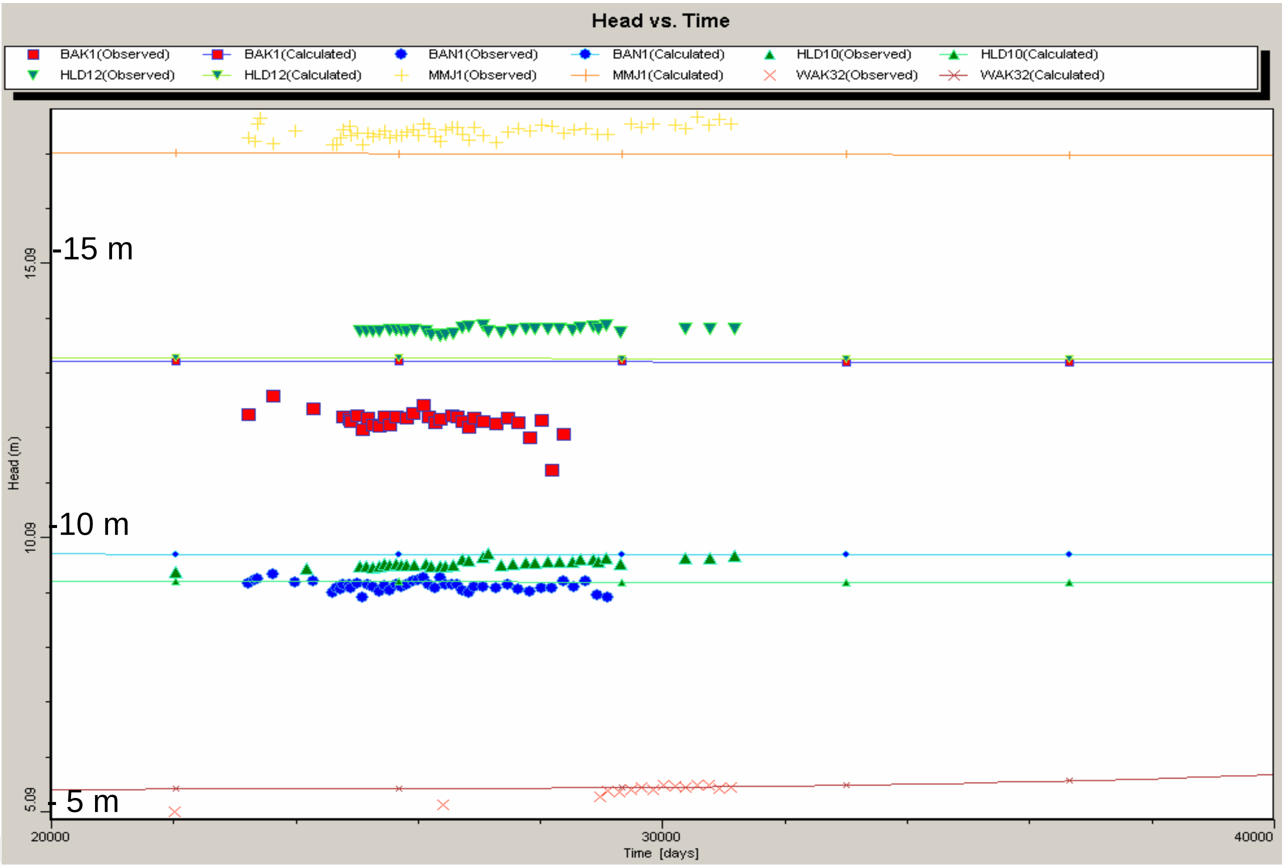


Figure 5. Model calibration with observed hydrographs

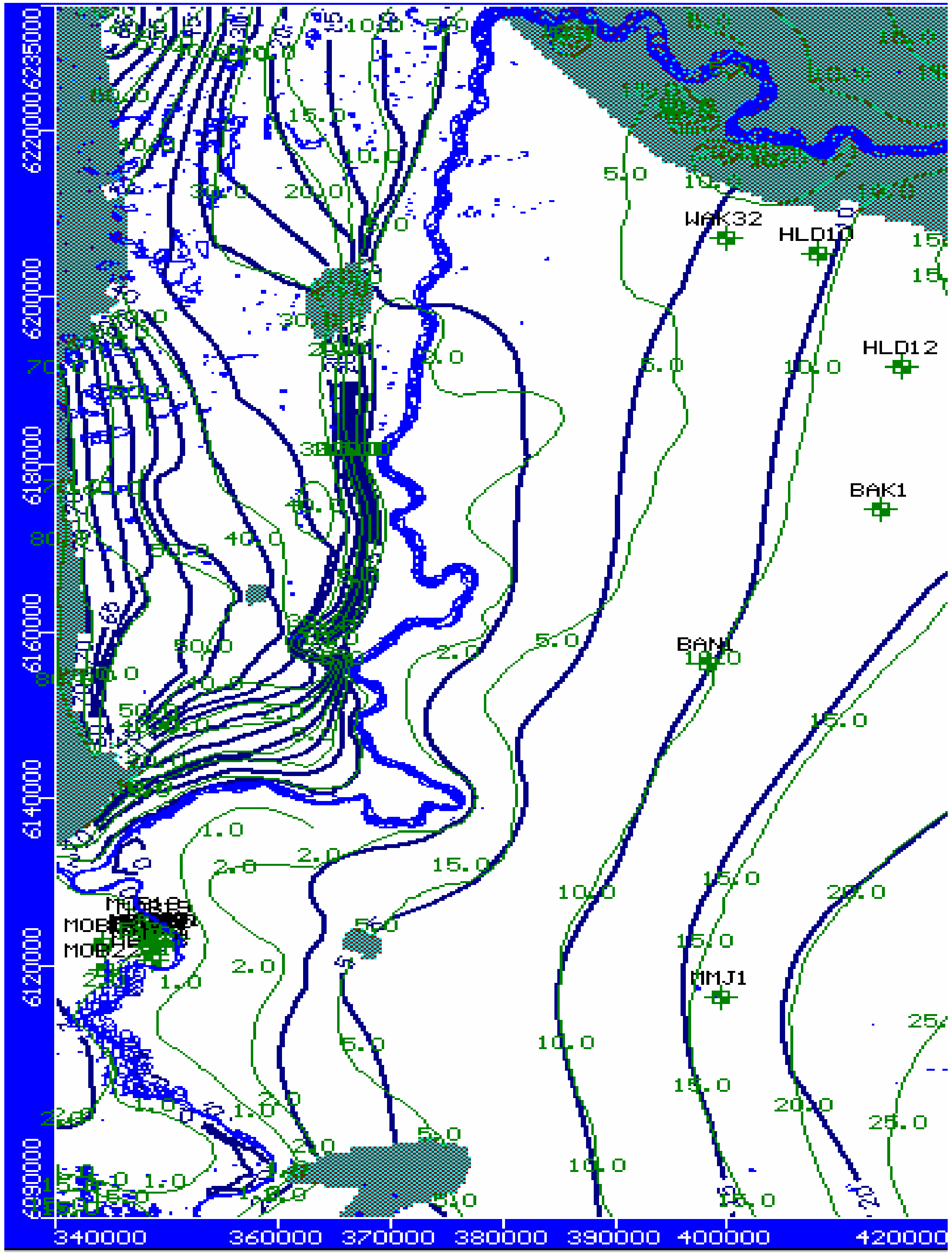


Figure 6. Model calibration with observed watertable contours

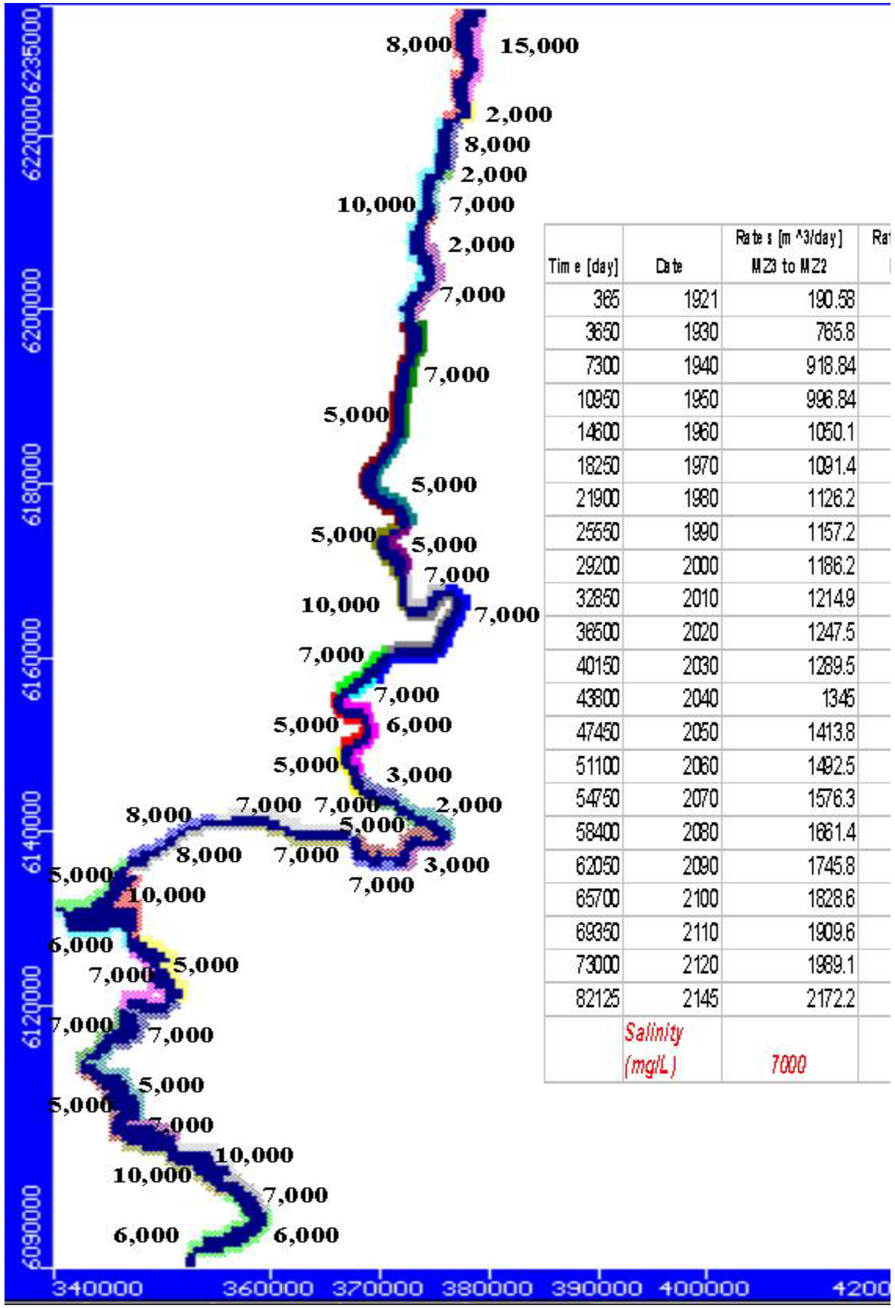


Figure 7. Regional groundwater salinity zones for saltloads

In order to convert the groundwater discharge calculated by the model into saltloads to the river floodplain, salinities were assigned to the regional groundwater in various zones along the river. Figure 7 shows the various salinity zones for this modelled area.

5.4 MODEL SENSITIVITY ANALYSIS

As mentioned earlier, a steady-state solution was obtained by adjusting hydraulic parameters (hydraulic conductivities, recharge to the top layer, inter-aquifer leakage) and boundary conditions. In this model, the water levels in the Murray Group Limestone unconfined aquifer were found to be very sensitive to the recharge rate and hydraulic conductivities in that layer.

The water level calibration for the confined aquifers in the model was found to be sensitive to vertical hydraulic conductivity, which controls rates of leakage between layers. The sensitivity analysis was also undertaken during the transient calibration processes. The water level changes are more likely dominated by increased recharge and are quite sensitive to specific yield and storativity values.

5.5 LIMITATIONS OF THE MODEL

The calculated inflows to the river valley are very sensitive to the chosen values of hydraulic conductivity for the unconfined aquifer close to the river. For instance, an increase of only 1 m/day in the Murray Group Limestone aquifer hydraulic conductivity from 1–2 m/day, would result in a doubling of the inflows. However, it is considered that the values chosen are consistent with current knowledge.

6. MORGAN TO LOCK 3 MODEL

The Morgan to Lock 3 model covers the area on both sides of the River between Morgan and Lock 3, and is designed with features to represent the irrigation, drainage, salt interception and disposal schemes in these areas, as well as the river and the floodplain aquifer (Middlemis et al, 2005). The model was developed with a layer to represent each major unit of the Murray Group (below the water table), plus one layer to represent the underlying Renmark Group:

Layer 1. Loxton Sands (aquifer)

Layer 2. Cadell Formation (aquitard)

Layer 3. Glenforslan Formation (aquifer)

Layer 4. Finniss Formation (aquitard)

Layer 5. Mannum Formation (aquifer)

Layer 6. Ettrick Formation (aquitard)

Layer 7. Renmark Group (aquifer)

Because this model has been submitted separately to the MDBC for accreditation, a detailed description will not be presented in this report. However, it should be noted that the outputs for the Lock 2 to Lock 3 (Woolpunda) reach are affected by some problems simulating the watertable mound caused by upward leakage from the Renmark Group confined aquifer. A proper steady state run could not be completed, but a pseudo- steady state run was carried out (a repeated set of long term transient runs, recycling the final heads to the initial heads for the next run).

The saltloads used in this study were obtained by assuming a 2000 value based on the salt loads in the other reaches. This does not affect the other reaches in the model area in the same way because the Woolpunda reach has extremely long lag times, whereas the other reaches do not.

7. LOCK 3 TO BORDER MODEL

7.1 MODEL CONSTRUCTION

Beneath the modelled area, there are four main aquifers separated by three confining layers. Figure 8 shows the regional hydrogeology along an east-west section through the model area (Fig. 1). The more detailed subdivision of the Murray Group is incorporated.

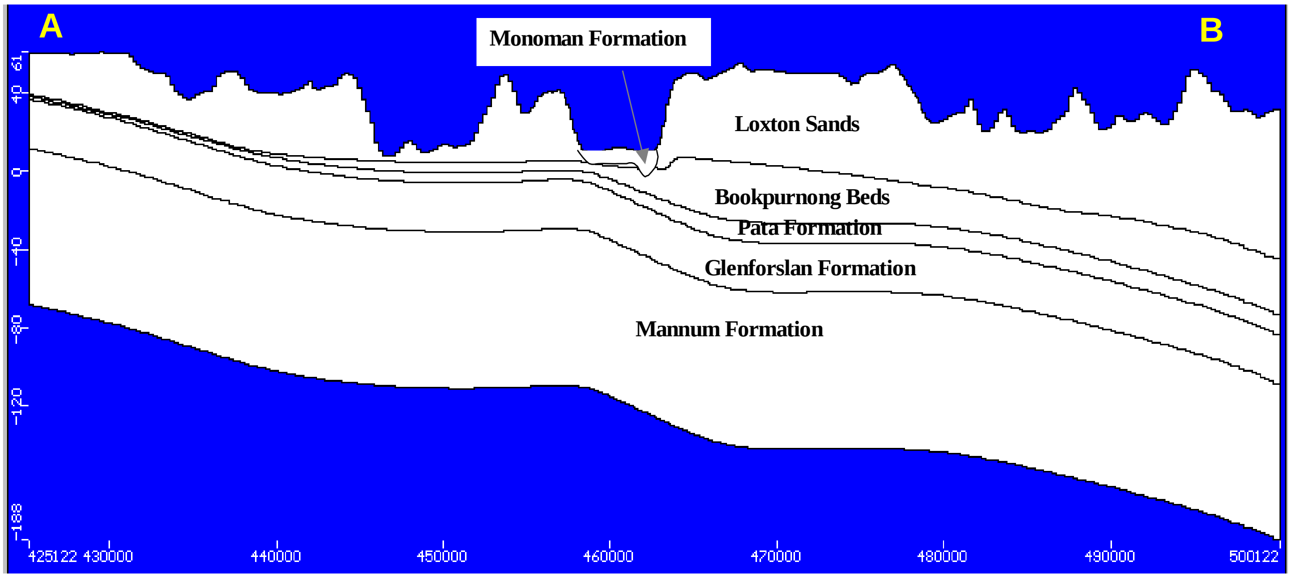


Figure 8. Hydrgeological cross-section – Lock 3 to Border model

The model domain covers an area of 75 km (east west) by 78 km (north south). The bounding AMG coordinates of the model domain are southwest E 425122 N 6160180, and northeast E 500122 N 6238500 (Fig. 1). The rectangular model grid was divided into 359 rows and 398 columns. The minimum grid size is 125 x 125 m in the Loxton area. The maximum grid size is 250 x 250 m in the remaining model area.

7.1.1 LAYER 1: LOXTON SANDS AND MONOMAN FORMATION

Layer 1 simulates the Loxton Sands unconfined - semi-unconfined aquifer over most of the model area, and the Monoman Formation semi-unconfined aquifer in the river floodplain. The Blanchetown Clay has not been modelled, as the effect of this aquitard in perching water is accounted for by controlling the recharge rate to the Loxton Sands, where the true watertable occurs.

This layer only exists in the eastern half of the model area, because to the west, the Loxton Sands is structurally elevated above the watertable and is unsaturated. To simulate this situation, the model cells in the western half for Layer 1 are inactive cells.

The regional groundwater flow within the model domain is toward the River Murray from the east, south and west. Discharge occurs directly from the Loxton Sands to the river at cliff sections, or via the Monoman Formation beneath the floodplain.

The following boundary conditions were applied (Fig. 9):

- No-flow boundaries where groundwater flow is parallel to the model boundary.
- General head boundaries to simulate groundwater flow on the model boundaries where flow occurs into and out of the model.
- Constant head boundaries to simulate hydraulic communication between the unconfined aquifer and both the River Murray and the Noora Disposal Basin.
- River cells to simulate anabranch creek systems on the floodplain.
- Drainage cells to simulate groundwater seepage from the highland to the floodplain in the Loxton area.

7.1.2 LAYER 2: LOWER LOXTON SANDS, BOOKPURNONG FORMATION AND PART PATA FORMATION

Layer 2 simulates the impermeable clays at the base of the Loxton Sands (Lower Loxton Clay and Shells) and the Bookpurnong Formation aquitards. This layer only exists in the eastern half of the model area as the Bookpurnong Beds confining layer is absent in the west, and is represented by inactive cells. Very small volumes of water move laterally into and out of this layer due to its low permeability.

The following boundary conditions were applied to Layer 2:

- No-flow boundaries were used at the model boundaries.
- Some constant head boundaries were used along the River Murray in areas where the river is in hydraulic communication with the Pata Formation.
- River cells were used to simulate Lake Bonney.

7.1.3 LAYER 3: PATA FORMATION

Layer 3 simulates the regionally distributed Pata Formation semi-confined low permeability aquifer. This layer is only saturated in the eastern half of the model area, and is represented by inactive cells to the west. Regional groundwater flow is from the northeast to southwest within the model domain.

The following boundary conditions were applied to Layer 3:

- No-flow boundaries where groundwater flow is parallel to the model boundaries.
- General head boundaries were used at the model boundaries to simulate groundwater flow into and out of the model.
- Constant head boundaries were used in the western area of the model where the River Murray is in hydraulic communication with the Pata Formation.

7.1.4 LAYER 4: GLENFORSLAN FORMATION

Layer 4 simulates the regionally distributed Glenforslan Formation confined aquifer, which averages 25 m in thickness. The Winnambool Formation aquitard averages around 3 m in thickness and lies between the Glenforslan Formation and the overlying Pata Formation. This aquitard was simulated in the model by using vertical leakage, which is controlled by the vertical hydraulic conductivity in Layers 3 and 4.

The regional groundwater flow in this aquifer is from the northeast to the southwest within the model domain. The following boundary conditions were applied to Layer 4.

- Constant head boundaries were used at the model boundaries to simulate groundwater flow into and out of the model
- No-flow boundaries where groundwater flow is parallel to the model boundaries.
- General head boundaries were used at the model edges to simulate groundwater flow into and out of the model.
- General head boundaries were used at part of the western model edge to simulate upward leakage from deeper Renmark Group confined aquifer into the Murray Group Limestone aquifer.
- Constant head boundaries were used in the western area of the model where the River Murray is in hydraulic communication with the Glenforslan and Mannum Formation.

7.1.5 LAYER 5: MANNUM FORMATION

This layer simulates the regionally distributed Mannum Formation confined limestone aquifer, which has a moderate permeability and a thickness of 80 m. It is directly overlain by the Finnis Formation, a three metre thick aquitard which was simulated using vertical hydraulic conductivities in both Layers 4 and 5. The same boundary conditions as Layer 4 apply.

Table 3 displays the initial hydraulic parameters applied to the various layers in the model.

Table 3. Lock 3 to Border model initial hydraulic parameters

Unit	Layer	K_{hor} (m/day)	K_{vert} (m/day)	Sy	Ss
Loxton Sands	1	0.5–10	0.05–0.1	0.15	
Monoman Formation	1	15	0.15	0.15	
Loxton/Bookpurnong	2	0.006	0.0005–0.0006		0.0001
Pata Formation	3	0.5	0.01		0.0001
Glenforslan Formation	4	1.0–1.5	0.0003–0.0005		0.0001
Mannum Formation	5	2.0	0.2–0.0002		0.00001

7.2 STEADY STATE CALIBRATION

The first model is the steady-state pre-irrigation model, which aimed to reproduce the groundwater levels and estimated salt loads to the river thought to occur before irrigation commenced and after the river was regulated by locks. Pre-clearing recharge rates of 0.1 mm/year were applied throughout the model area. Figure 10 shows the simulated steady-state potentiometric heads in Layer 1 (Loxton Sands), and the reasonable agreement obtained with the estimated pre-European regional watertable contours away from the locks.

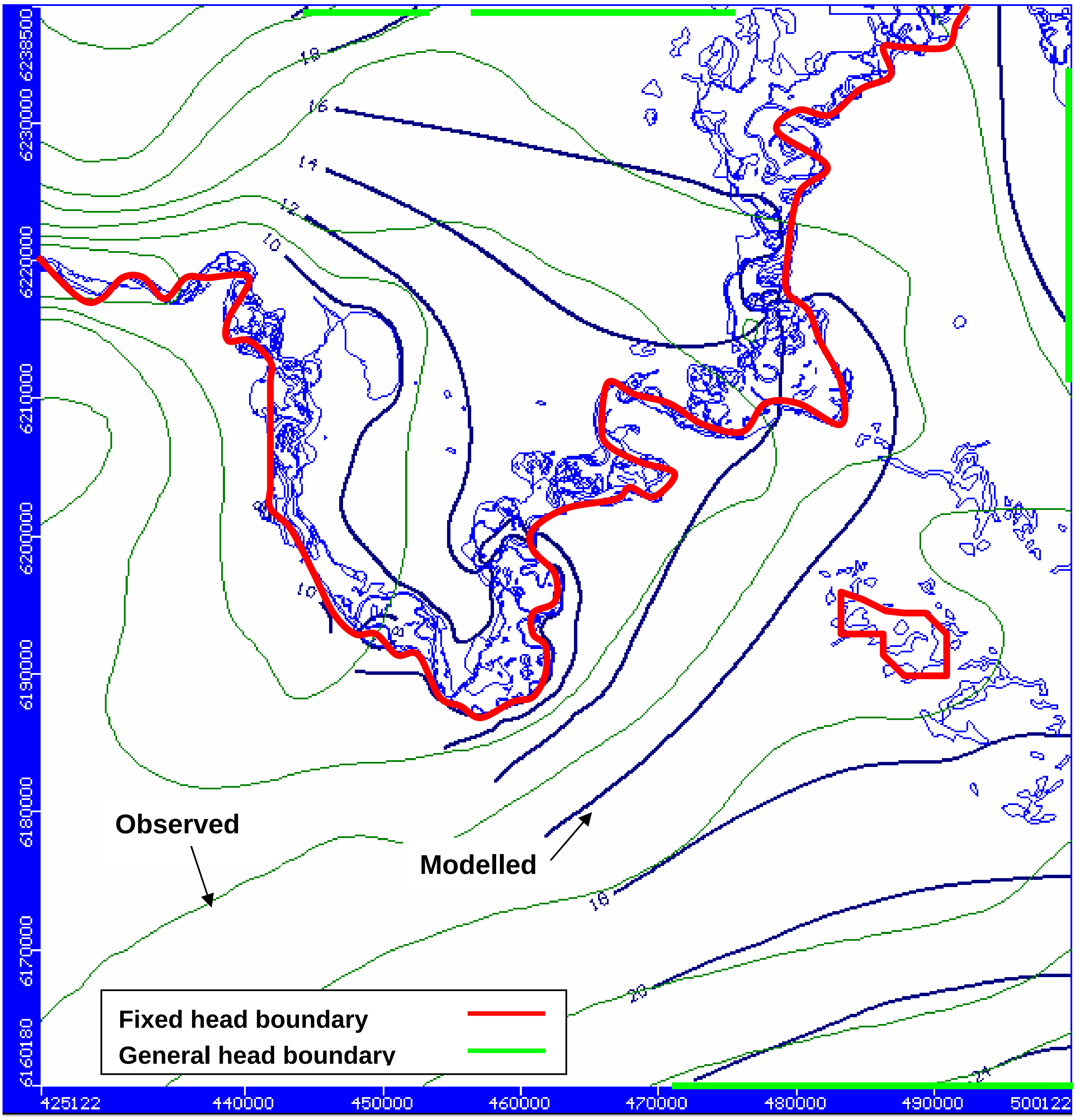
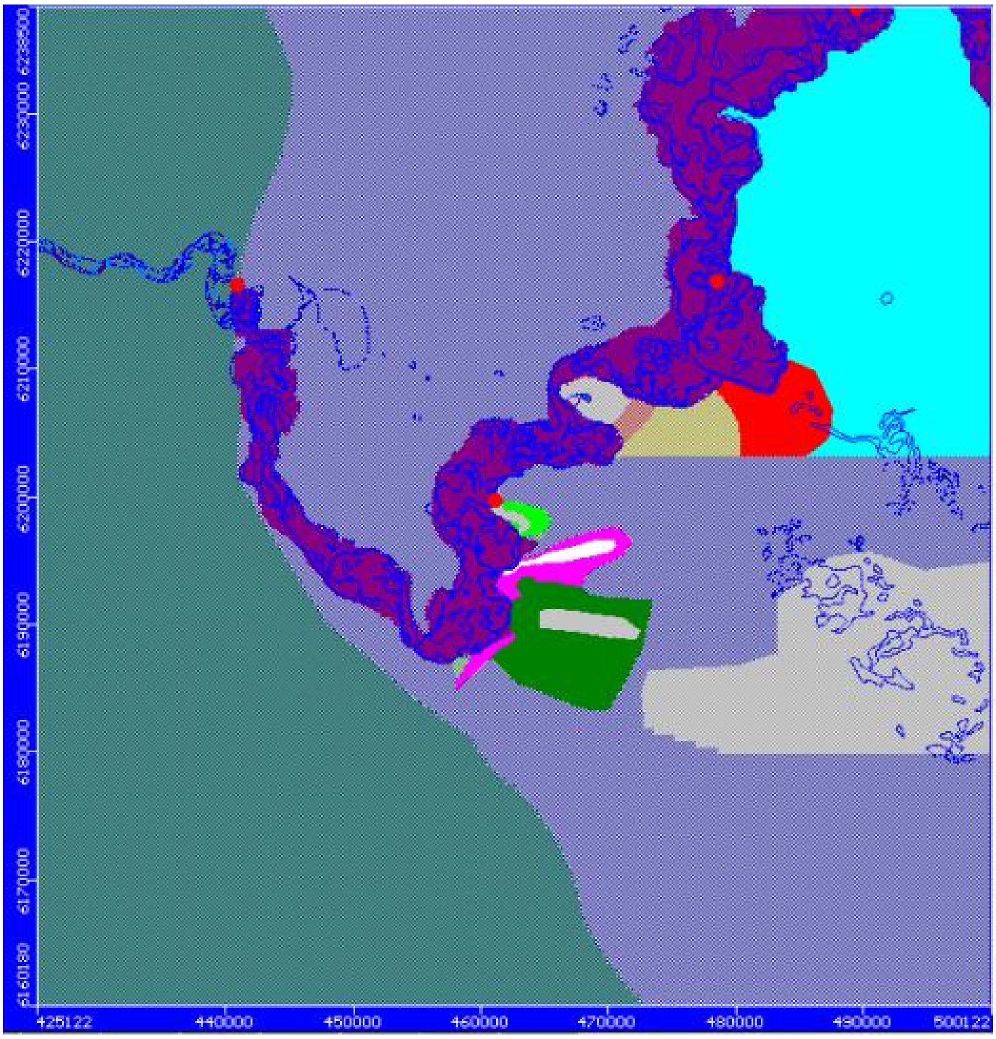


Figure 9. Steady state calibration and boundary conditions – Loxton Sands aquifer

7.3 TRANSIENT CALIBRATION

The model was calibrated in some areas where there is data available from intensive investigations. A recent investigation by DWLBC and Australian Water Environments (AWE, 2003) has detailed the pre-irrigation and current salt loads to the river in Loxton and Bookpurnong areas. The calibration was based on the observed groundwater levels and the measured salt load from 'Run the River' surveys. The final aquifer parameters chosen for Layer 1 are are shown in Figure 10.



Zone	Kx [m/d]	Ky [m/d]	Kz [m/d]
1	1	1	0.01
2	1E-5	1E-5	1.6E-6
3	10.01	10.01	0.1
4	1.1E-5	1.1E-5	1.6E-6
5	1.5	1.5	0.0005
6	15	15	1.5
7	2	2	0.0002
8	20	20	0.035
9	1.51	1.51	0.4
10	25	25	2.5
11	3	3	0.03
12	3.01	3.01	0.05
13	3.022	3.022	0.05
14	3.5	3.5	0.035
15	0.4	0.4	0.4
16	5	5	0.05
17	0.5	0.5	0.0001
18	0.05	0.05	0.006
19	0.5001	0.5001	0.05
20	0.006	0.006	0.002
21	7	7	0.05
22	2.01	2.01	0.4
23	2	2	0.05
24	0.5	0.5	0.0002
25	0.5	0.5	10
26	0.5	0.5	5E-7
27	1E-5	1E-5	0.00016
28	0.006	0.006	2E-7
29	0.006	0.006	2E-8
30	0.5	0.5	5E-5
31	2	2	0.2

Figure 10. Hydraulic conductivity zones for Layer 1 – Loxton Sands aquifer

The groundwater discharge to the river floodplain calculated by the model was converted into saltloads using salinity zones (in mg/L) assigned to the regional groundwater as shown in Figure 11.

7.4 MODEL SENSITIVITY ANALYSIS

As mentioned earlier, a steady-state solution was obtained by adjusting hydraulic parameters (hydraulic conductivities, recharge to the top layer, inter-aquifer leakage) and boundary conditions. In this model, the water levels in the unconfined aquifers (Pliocene Sands or Murray Group Limestone), were found to be very sensitive to the recharge rate and hydraulic conductivities in that layer.

The water level calibration for the confined aquifers in the model was found to be sensitive to vertical hydraulic conductivity, which controls rates of leakage between layers. The sensitivity analysis was also undertaken during the transient calibration processes. The water level changes are more likely dominated by increased recharge and are quite sensitive to specific yield and storativity values.

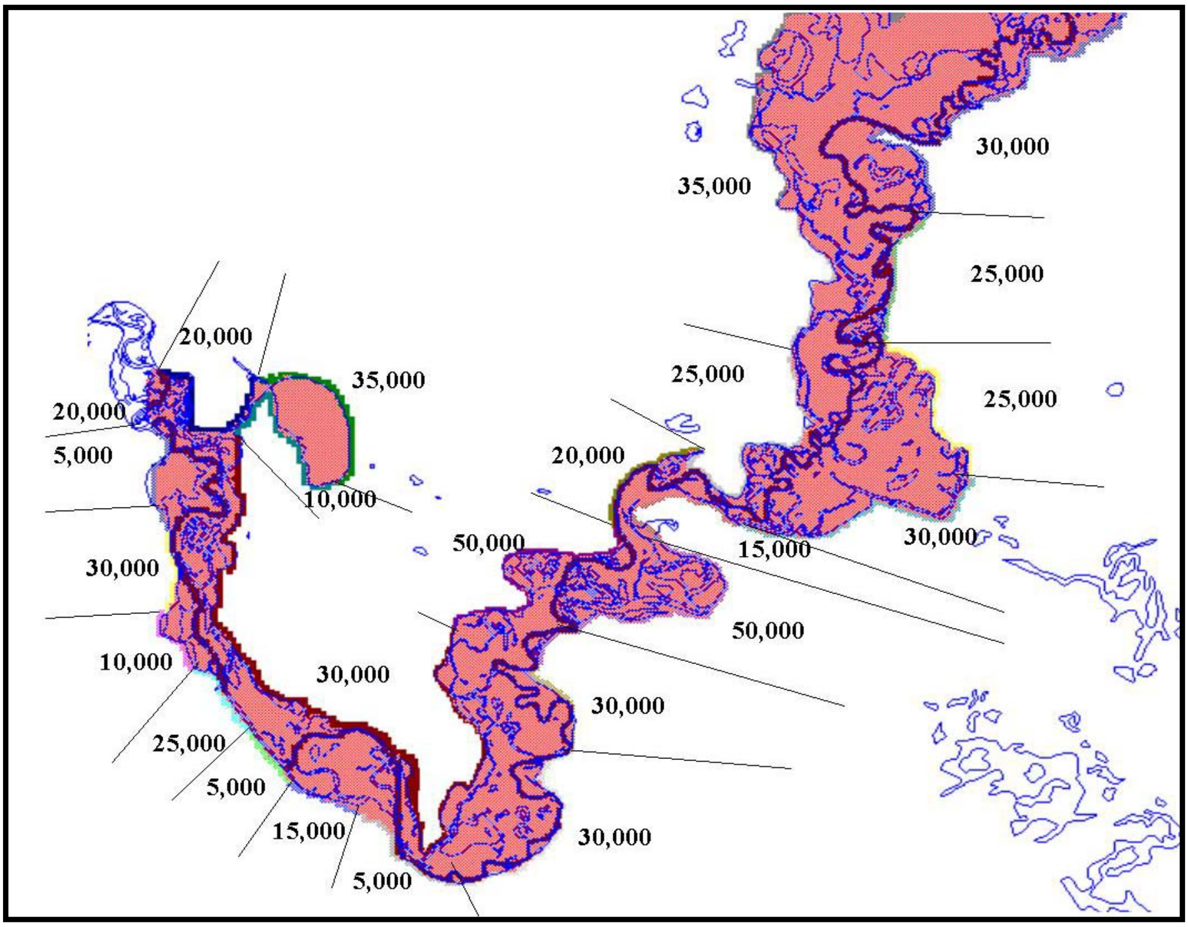


Figure 11. Regional groundwater salinity zones for calculation of saltloads

7.5 LIMITATIONS OF THE MODEL

The calculated inflows to the river valley are very sensitive to the chosen values of hydraulic conductivity for the unconfined aquifer close to the river. For instance, an increase of only 1 m/day in the Loxton Sands aquifer hydraulic conductivity from 1–2 m/day, would result in a doubling of the inflows. However, it is considered that the values chosen are consistent with current knowledge.

8. MODELLING RESULTS

Table 4 shows the modelled increase in salt loads to edge of river valley due to vegetation clearance only, from 2000 levels. The numbers are an amalgamation of outputs from the three models and are a significant decrease from previous estimates and are due solely to better model design and most importantly, improvements in the estimation of recharge and lag times.

These results assume that all increases in saltloads at the edge of the floodplain actually reach the river, and therefore is an overestimate. This is because the floodplains store significant amounts of salt that would otherwise reach the river due to evapotranspiration. It is estimated that up to 30% of the saltloads from regional groundwater are intercepted by the floodplain.

Table 4. Total modelled saltload increase due to clearing since 2000 (tonnes/day)

River Reach	2025	2050	2100
Tailem Bend – Lock 1	9	18	41
Lock 1 – Morgan	7	21	42
Morgan – Lock 2	2	9	24
Lock 2–3	12	36	84
Lock 3–4	4	9	30
Lock 4–5	7	18	51
Lock 5–Border	2	7	32
Total	**43**	**118**	**304**
2000 Modelled Total	160	300	608
1990 Modelled Total	120	180	307

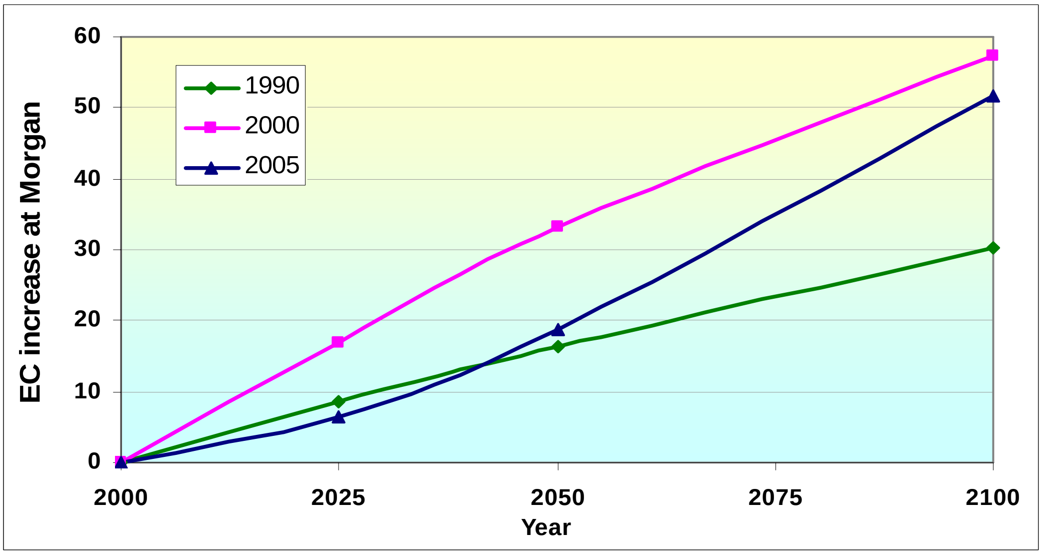


Figure 12. Modelled EC impact at Morgan

Figure 12 shows the EC impact at Morgan as calculated by the Salt Impact Ready Reckoner. The difference between the 2000 and 2005 results is mainly due to the improved recharge and lag time estimates. The 2000 curve appears to be slowly approaching an equilibrium whereas the 2005 curve displays a more delayed response which is gradually increasing in EC impact. The 1990 results, despite the drawbacks of a crude model and simplistic recharge inputs, are surprisingly close to the more refined model outputs.

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