6 Soil and Water Salinity Threat in North East Victoria

6.1 Dryland Salinity in the Region

The term 'dryland salinity' describes land degradation problems arising from increases in the salt content of soil and water resources associated with rising groundwater. Dryland salinity refers to all salinity in non-irrigated areas. Soil salinity is an area of soil salinised by rising watertables and include those areas referred to as discharge sites. Water salinity relates to the salinity levels in rivers, creeks, dams, groundwater and wetlands. Across the region there is approximately 240 saline discharge sites on private and public land (Figure 10). There are emerging saline discharge areas associated with urban development for example, in the Baranduda area near Wodonga. The nature of urban environments further contributes to rising watertables. Things such as applying excessive amounts of water to gardens and lawns, leaking water pipes and altered drainage patterns all contribute to increased groundwater levels. The potential impact of urban salinity in the region requires further investigation. There is already considerable evidence from other regions that urban development can contribute adversely to groundwater recharge and dryland salinity.

6.2 Drivers of Salinity in the North East- Land Use & Climate Change

Changes in land use or land management that impose an increase in groundwater recharge eventually cause an increase in groundwater discharge. The most dramatic change in landscape hydrology causing increased recharge was the clearing of native vegetation for agriculture. This almost certainly initiated an immediate widespread filling of groundwater systems throughout the region.

By the middle of last century most smaller groundwater systems throughout Victoria had either attained equilibrium with the new recharge regime or were rapidly approaching it. At this time saline groundwater discharge areas began to appear in the lower landscape, and saline base flows increased within streams. Small saline discharge zones appeared in the 1950s and rapidly expanded over one or two decades to accommodate groundwater inflows from upper catchments.

The pattern of salinity development in response to land use change was not incremental. It was an event-based phenomenon. Clearing of the land realised increased recharge, filling of the aquifers, and ultimately a substantial increase in the area of saline land. The ultimate extent of salinity related to the extent of increased recharge realised by the original clearing of native vegetation. The manifestation of salinity, however, was a function of the nature of the geomorphic properties of the different rock types, the extent to which streams were incised, topographic relief, and the amount of salt stored within the landscape.

The majority of clearing occurred more than a hundred years ago. Many scientists argue that in small to medium sized groundwater systems, there has been a shift in the water balance associated with clearing of native vegetation. These changes in the water balance are believed to have lead to an equilibrium between groundwater recharge and discharge. If this is true then the salinity status of most catchments comprising small to medium groundwater systems should not change. Except through climatic aberrations, additional land use change (clearing) or through more subtle changes in recharge resulting from variations in land management.

Evidence from the NE monitoring network (Figure 11) suggests that equilibrium between land use, groundwater discharge and the general climatic conditions throughout the region should have begun to occur around the middle of the last century and persisted through to the early 1990s. There is however, some evidence from groundwater monitoring that secondary dryland salinity may have taken longer to develop in the NE than it has in other regions of Victoria. In some areas of the NE data from groundwater observation bores reveal a steady rising trend. This has been sustained through to the onset of the current dry/drought conditions commencing post 1996. This rising groundwater phenomenon in the NE clouds the understanding of salinity risk. It remains unclear whether hydrological equilibrium between recharge and discharge had been attained prior to the onset of low rainfall conditions or whether it has been influenced by drought (Figure 12 & 13).

Figure 10 – Map of the location of saline discharge sites in the North East.

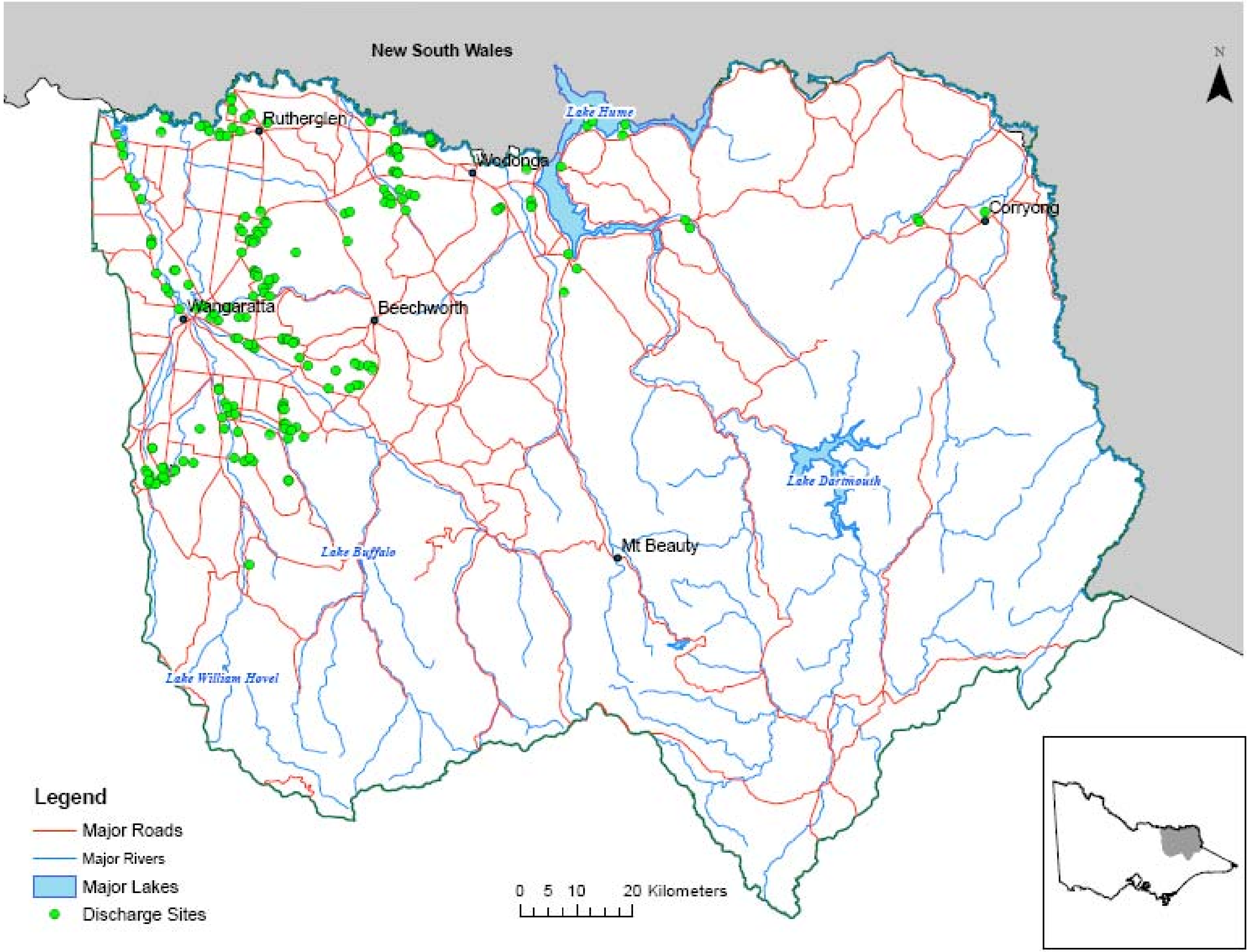


Figure 11 – Map of the monitoring bores, continuous stream monitoring sites and monthly stream monitoring sites in the North East.

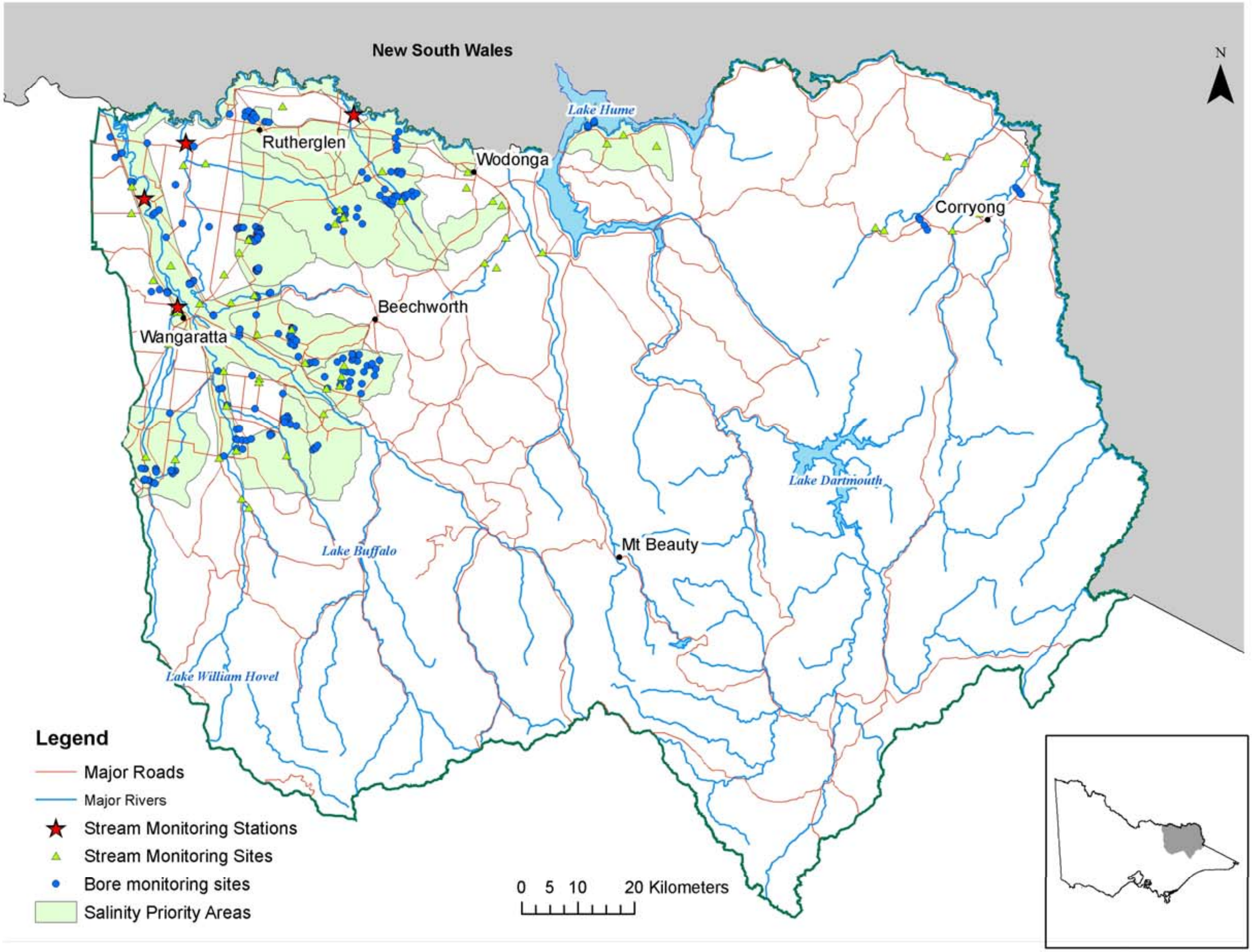
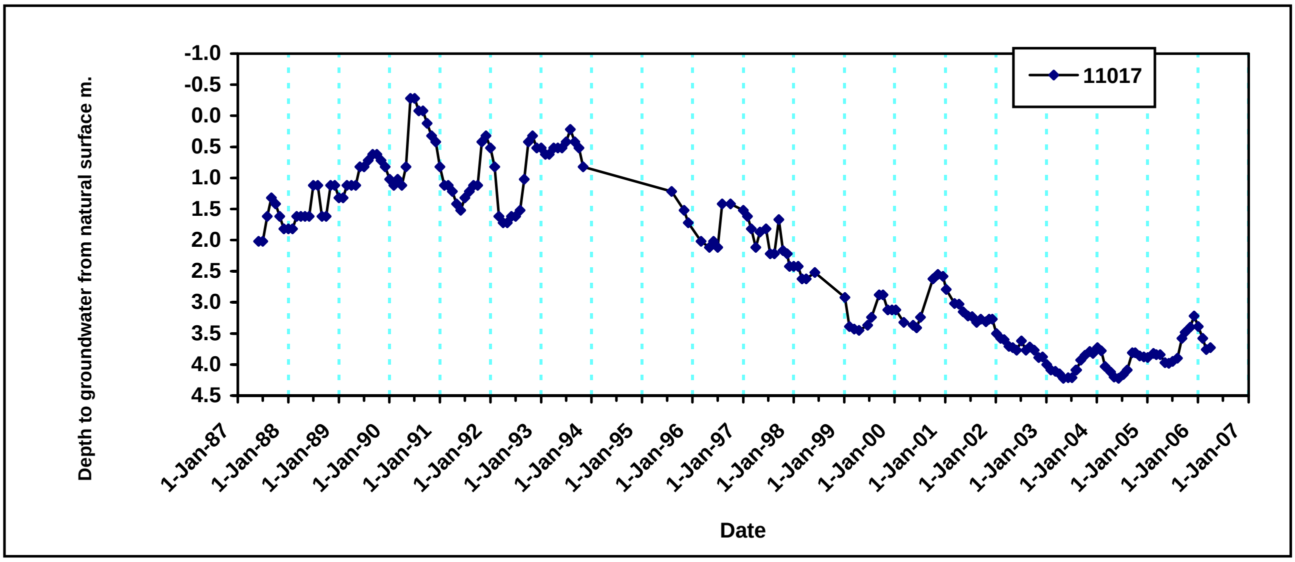
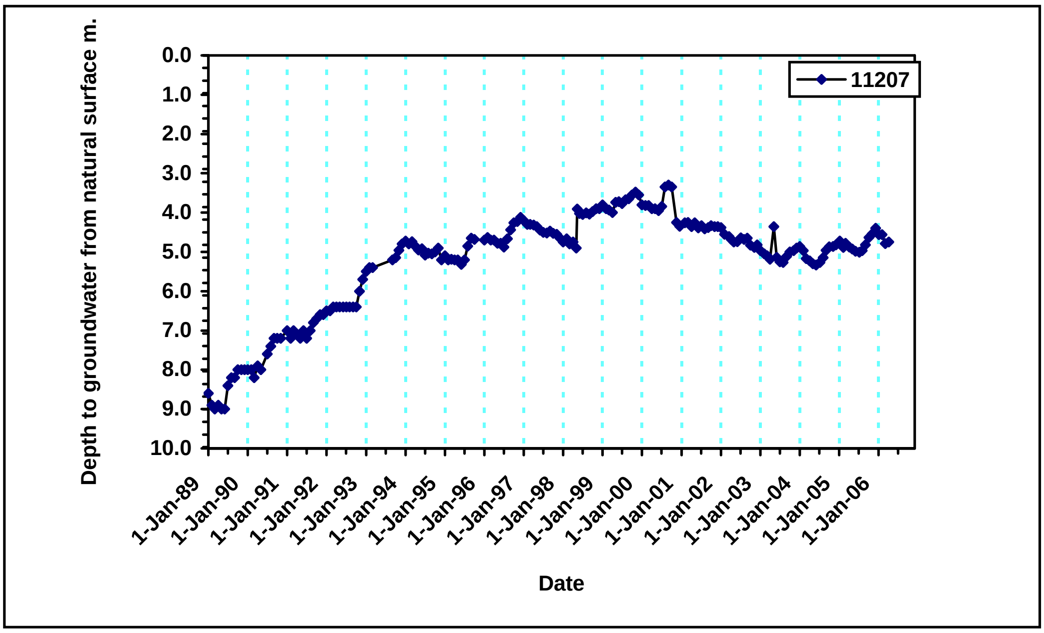


Figure 12 - Demonstrates climate/ dry conditions post 1996 and its influence, this hydrograph illustrates groundwater trends in bore 11017 at Springhurst. It shows a steep rise from 1987 through to the middle of the 1990's. From late 2000 until mid 2003 there was a falling trend, reaching it lowest reading of 4.22m in May 2003. More recently the trend is a normal seasonal rise and fall, although still impacted upon by the relatively dry years



Evidence from the hydrograph of a local fractured rock aquifer at Everton Upper (Figure 13) reveals a rapid rise in groundwater elevation for the time of the first records in 1989 through to 1994. This trend is consistent with higher annual rainfall throughout the 1980s and the early 1990s. Field observations of salinity at Everton Upper throughout the 1980s and early 1990s are consistent with the rapid rise in groundwater observed in the late 1980s (Figure 13). Salinity observed in the same sub-catchment as the observation bore revealing the rapid rising trend measured less than 0.5 hectares in 1982, and by the late 1990s had expanded to more than 20 hectares (Figure 14).

Figure 13- Everton Upper hydrograph revealing rising groundwater during the late 1980s and early 1990s.



The Everton hydrograph illustrates the issues in assessing salinity risk in North East Victoria. The rapidly rising groundwater in the first half of the hydrograph may be an artefact of above average rainfall occurring throughout the late 1980s or it could represent a delayed response to the original clearing and development for agriculture. Equally, there is no way of knowing whether the pre-drought 96/97 peak in the hydrograph represents the attainment of equilibrium or whether the groundwater system would have continued to rise causing either an increase in salt affected land or additional saline groundwater discharge through existing salt affected sites.

Figure 14 - More than 20 hectares of dryland salinity now occurs in this sub-catchment at Everton. Less than one hectare was present in 1982.

The extent to which the Everton hydrograph represents the filling of fractured rock aquifers in other parts of the region also remains largely unknown. The question can then be asked:

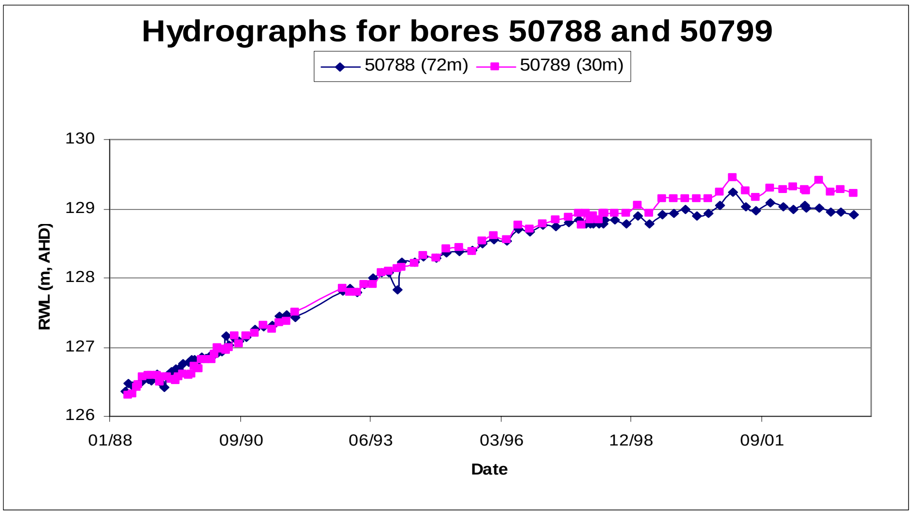
- Is the Everton hydrograph unique or does it represent similar patterns in the region or state?
- Could a similar salinity situation have occurred in other fractured rock systems in the absence of drought?
- Does the general condition of equilibrium between recharge and discharge in this rock type indicate future development of salinity in sub-catchments of a similar scale to that evident at Everton?

The late onset of salinity is evident at both Everton and other sites in the NE when compared to different regions in Victoria. Similar observations with the onset of salinity were made at Rutherglen in the early 1980s. Small areas of saline land generally less than a hectare in size had expanded to more than 20 hectares by the late 1990s (Figure 15).

Figure 15 – Evidence of Dryland salinity in the Rutherglen region.

The threat of dryland salinity is also evident within the much larger regional groundwater systems of the Riverine Plains. Hydrographs from groundwater observation bores located within the north-eastern sector of the Ovens Valley show a rising groundwater trend prior to the onset of the current drought in 1996 (Figure 16).

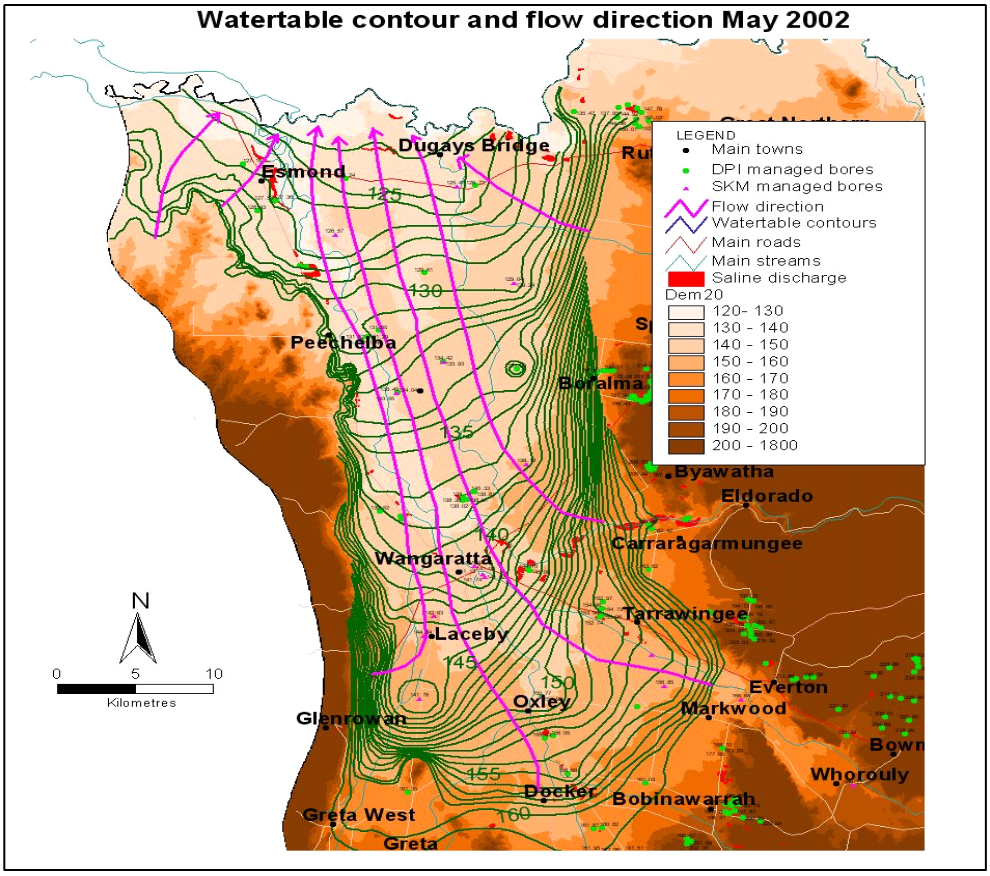
Figure 16 - Groundwater rising beneath the alluvial sediments of the Riverine Plains.



Source: Cheng 2004

Once again the reason for the rising trend in groundwater within the north-eastern section of the plains is uncertain. There is a view amongst some hydrogeologists that this may represent a re-adjustment in water levels in an area that has been slower to fill because it comprises lower permeability sediments. This is akin to suggesting that the area represents a depression in the watertable that is filling in response to higher elevation groundwater within the surrounding plain (Figure 17). This assertion, however, has not been investigated and, accordingly, there is no data to verify its validity.

Figure 17 –Watertable contour and flow direction in the Oven Valley



Watertables throughout large areas of the Riverine Plains and within the floodplain alluvium of the upland river valleys occur within two to five metres of the land surface. Once again, the knowledge of whether this situation constitutes a salinity risk remains uncertain. If the climate reverts to that which prevailed last century it is possible salinity may develop where shallow saline groundwater rises within 2metres of the land surface. At this depth groundwater will interact with the land surface via capillary action. Depth to watertable has been mapped to identify were this salinity risk might be (Figure 18). Groundwater bores are also monitored to determine the salinity levels in the groundwater (Figure 19).

Shallow saline groundwater present in the alluvial plains constitutes a salinity hazard. The close proximity of the groundwater to the land surface and indications that in some areas there may be an upward trend under the longer-term climate scenario, suggest it is possible that the area be pre-disposed to salinity occurring at some stage in the future. Insufficient understanding exists, however, to make the claim that salinity will occur in the future, hence the risk of salinity remains uncertain. Salinity in the plains is, thus, best described in terms of high 'hazard' and uncertain 'risk'.

6.3 No Plan Scenario - Potential for Increased Salinity in North East Victoria

The threat of future dryland salinity occurring in South-eastern Australia is best described in terms of 'hazard' as opposed to 'risk'. Risk implies salinity can be described with some certainty in statistical terms illustrating the likelihood of a change in status over a specified timeframe. Hazard, on the other hand suggests the presence of a number of predisposing factors indicating the potential for a change in salinity status at some stage in the future.

The difficulty in being precise in defining the future salinity status of a region stems from understanding that it results from a number of biophysical processes and involves complex interactions between climate, vegetation, soils, land use, land management, landscapes and groundwater systems.

The understanding of future salinity status is also underpinned by concepts of hydrological equilibrium. A change in land use, land management, or climate may result in increased recharge causing groundwater levels to rise resulting in additional flow down- catchment flow. This in turn may realise an expansion of saline discharge zones as groundwater discharge increases to accommodate the additional groundwater changed water balance.

Where climate, land use, and land management are stable over long periods of time the groundwater discharge may eventually equilibrate with groundwater discharge. The time required for equilibration to occur (response time) is a function of the scale and hydraulic capacity of each GFS. In very large groundwater systems response times may be measured in terms of hundreds of years, whilst in small moderately permeable fractured rock systems they may be as short as ten to twenty years.

In order to assess the future salinity status of a region one must first understand the equilibrium status of the groundwater system. The questions focus on understanding whether the groundwater system is still responding to:

(a) changes in land management or land use including the original clearing of land for the development of agriculture, or;
(b) whether it is responding to changes in climate such as the combined effects of a number of successive years of high rainfall.

Examining the hydrograph from groundwater observation bores located in mid to lower catchment positions often indicates the equilibrium status of a groundwater system. A hydrograph displaying an obvious rise over several successive years indicates a system that has not reached equilibrium with increased recharge. Conversely a hydrograph displaying a falling trend over several years may indicate a system that has not yet equilibrated with a reduction in groundwater recharge. Hydrographs that show no obvious rising or falling trend over many years possibly indicate equilibrium has been established.

Figure 18- Depth to watertable across the North East region.

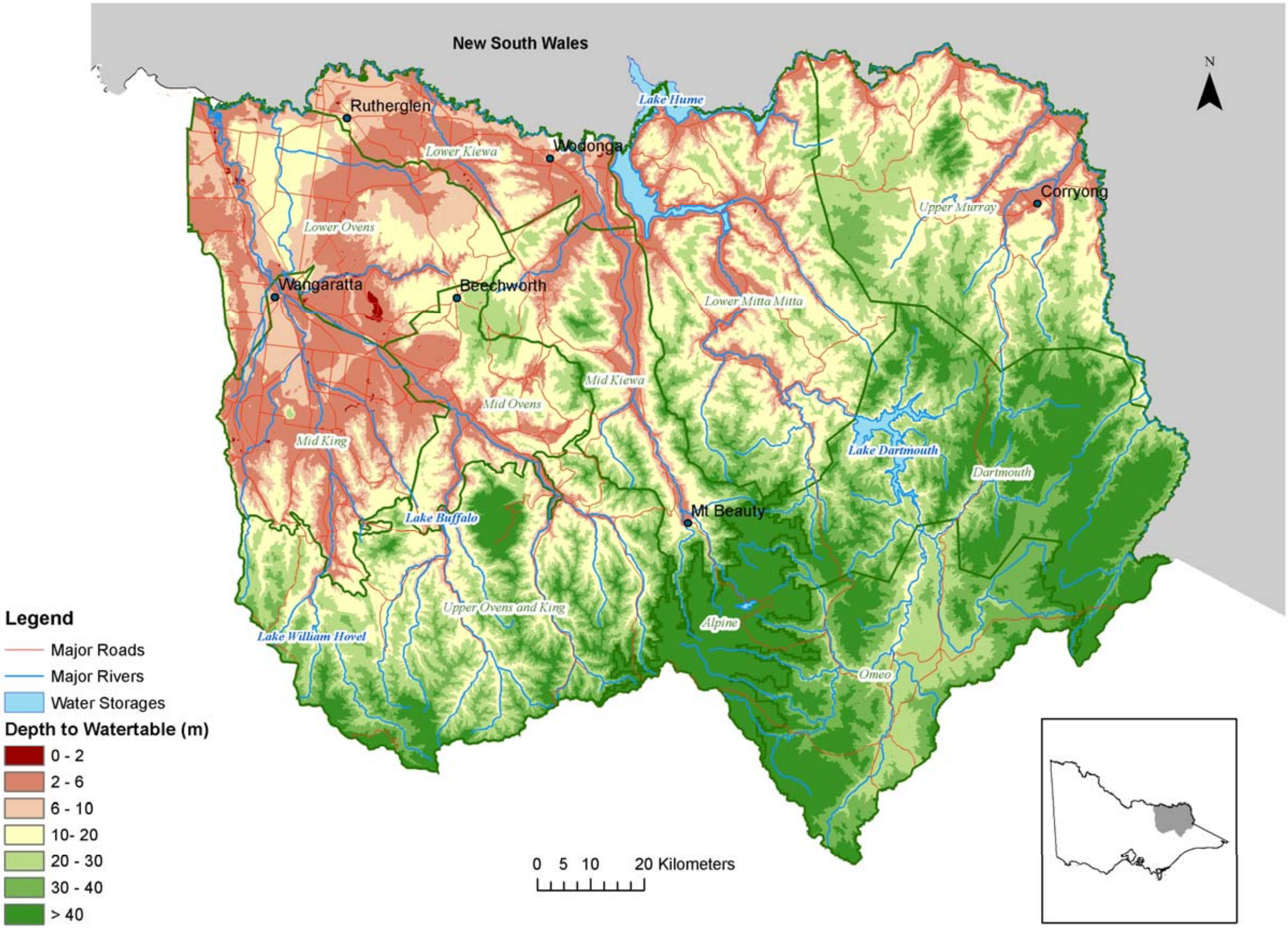


Figure 19 – Salinity levels of water in groundwater bores in the region (excludes Talgarno and Upper Murray).