Resource Management Technical Report

A REVIEW OF GEOGRAPHIC PRIORITY AREAS FOR AGRICULTURAL LAND IN THE NORTHERN AGRICULTURAL REGION FOR FUTURE NACC INVESTMENT

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nacc
managing natural resources
in WA's Mid West

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Acknowledgement

As indicated in the introduction, this report built on the previous work on “Determining geographic priority areas for agricultural land in the Northern Agricultural Region for NACC investment” conducted by the DAFWA NRM team in 2006. Therefore, acknowledgement for the invaluable and in-depth work by the following persons is unavoidable:
Jennifer Bairstow, Angela Stuart-Street, John Bruce, Russell Speed and Mike Clarke.

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Common Acronyms used in this report

AOCLP	Areas of consistently Low productivity
AHAVF	Average height above valley floor
DAFWA	Department of Agriculture and Food Western Australia
DoW	Department of Water
GFS	Groundwater Flow System
NACC	Northern Agricultural Catchments Council
NAP	National Action Plan
NAR	Northern Agricultural Region
NHT	National Heritage Trust
NRM	Natural Resource Management
SIF	Salinity Investment Framework

1. Purpose of the Review

This paper is to update the Bairstow report (on determining geographic priority areas for agricultural land in the Northern Agricultural Region) in the light of the recent information on the existing and future salinity risks in the NAR, and describe those areas in which groundwater trends are rising and/or falling as a result of the prolong dry season. This information is important as it will guide the Northern Agricultural Catchments Council decision on where future investment will be directed. It will also address the key issue of the extent to which identified priority areas are reflected in NHT/NAP funding for salinity and water quality, as well as it will help in our program improvement.

The report will commence with a background to prioritizing specific geographic areas for investment; followed by the methodology used (as identified in Bairstow report). The report will then give a brief analysis (update) of the soil landscape zones based on the current hydrological trends in the NAR. It must be underlined that this report should be read in conjunction with the above mentioned Bairstow et al (2006) report.

2. Background to prioritizing specific geographic areas for investment

Prioritization of geographic areas for investment is an important process of the National Action Plan for salinity and water quality. It identifies the natural resources assets of the region and the risks or threats to those assets.

The SIF was commissioned by the WA State Government to guide public investment in salinity management initiatives at State, Regional and Catchment levels (State Salinity Council 2000). Its objective is to ensure that public investment is directed towards projects with best potential to protect or restore assets of higher public value that are more threatened by salinity (Sparks et al 2006).

There are eight principles which underpin the SIF (Sparks *et al* 2006):

- The top-priority public investments are those which generate the greatest public benefits per dollar of public investment.
- Direct financial assistance to landholders to undertake salinity action should be strategic and should not exceed the public benefits that result.
- Where the priority is high and the net public benefits are sufficient, government should be prepared to take strong action to ensure protection of the asset.
- Where the public priority is low but there are extensive private asset risks, public investment should be aimed at industry development.
- Inevitably, a targeted investment strategy in salinity management will result in unequal distribution of investment across the state.
- Government must fulfill its statutory obligations for land, natural resources and functions (such as research) when it sets its priorities for investment in salinity action.
- The process required for priority setting will involve continued learning and need constant feedback.
- Setting priorities must proceed even when there is only limited or imperfect information on prevailing environmental, social and economic circumstances.

The NAR as one of the NAP regions has embarked on supporting the concept of geographic targeting investment. The main proviso was that a clear, transparent and defensible process was used to identify the priority investment areas and to set the level of funds available for each of these prioritized areas. The asset-based approach inherent in the SIF Report (George *et al* 2005) was use by the NAR NRM team to develop its geographic priority area for agricultural land for NACC investment. Geographic priority areas for investment in *existing*- and *future salinity threats* have been identified after careful consideration of the salinity hazard and distribution of natural resource assets (as identified in Bairstow report).

3. Methodology

The analysis was based on the spatial framework of soil-landscape zones defined by the Natural Resource Assessment Group of the DAFWA. There are 31 zones described for south-western Australia, nineteen of which fall within the NAR. These zones have been utilized for this process as they best reflect areas with similar hydro geological and farming-system attributes (Schoknecht *et al.,* 2004; Bairstow *et al* 2006).

In addition, aspects of the SIF analysis such as an urgency rating (timing of salinity) for each zone was used and then combined with the topological outputs from Land Monitor mapping (George *et al* 2005). The AOCLP outlined by this mapping reflect potentially shallow watertables in valley floors and the AHAVF data surrogates for future salinity risk. This then was used for determining priority areas for managing existing salinity (Bairstow et al 2006).

To ensure the SIF analysis was regionally relevant, each soil-landscape zone was assessed for its current hydrological trend based on the DAFWA's AgBores database as well as local expert knowledge of the regional hydrologist. The current hydrological trends for each soil-landscape zone were then described and assigned a future risk category. These categories are based on the general depth to groundwater and consideration of trends. The rating scale for future salinity risk comprises 4 categories (Bairstow *et al* 2006):

- **High** *Groundwater shallow* (<5m) (salty or fresh) and rising;
- **Moderate** *Groundwater shallow* (<5m) (salty or fresh) and not rising (no imminent risk);
- ***Low*** *Groundwater deep* (>5m) (fresh or salty), or reached equilibrium; and
- **Unknown** Inadequate data to make a reasonable statement of risk.

Furthermore on the basis of SIF analysis, the process was directed to three types of salinity response: recovery, containment and adaptation.

Recovery – this is where actions are undertaken to improve the condition and function of assets threatened by shallow water tables and/or saline groundwater discharge (e.g. agricultural land, wetland, terrestrial vegetation remnant, river reach) from their original state. It involves funded projects based on engineering works such as surface and sub-surface drainage and groundwater pumping. According to Knight Merz the cost of such interventions often means that they are confined to recovering high value assets, particularly important water resources and some very high value and highly threatened wetlands or terrestrial vegetation (Knight Merz 2005).

Containment – In some landscape (existing saline- land, wetlands, and estuaries), salinity is a natural feature of the environment. With this type of response, natural resource managers seek to maintain an appropriate salinity condition in these areas to maintain assets values. Interventions would typically seek to manage the water regime of such areas so that water quality remains in an acceptable range. This may involve maintaining surface water inflows to prevent excessive salt accumulation.

Adaptation – This type of response is typically applied where salinity issues are considered intractable due to the scale or unresponsiveness of the GFS or lack of widely adoptable land management options (e.g. valley floor areas in the WA wheatbelt). Efforts are typically to adapt farming or vegetation systems by establishing salt tolerant plants on salt affected land. Where infrastructure assets are threatened by salinity (e.g. roads, buildings), their construction or operation may be modified to reduce damage and maintenance expenditure.

The table 1 shows the details of the soil landscape zones and associated status for future salinity risk.

Prioritisation of Soil Landscape Zones (Source: Bairstow 2006)

Soil Landscape Zones **Priority based on salinity risk/threats**	**Justifying Comments (Insert Hydrogeology summary notes)**	**Recovery**	**Containment**	**Adaptation**	**Clarifying Comments**
211 Perth Coastal Zone High risk	➢ Shallow, salty ➢ Still at risk regardless of clearing, e.g. Low-lying points ➢ High confidence ➢ Have data to cause concern – processes showing support to arguments in 221 Zone (Geraldton Coastal Zone) with interesting bore trends in similar geology ➢ Confirmed by Jason Carter's report ➢ Also confirmed by ground truthed data ➢ There are expressions of surface salt ➢ REGIONAL & SALTY therefore difficult to manage ➢ Deal with discharge areas – treat symptoms ➢ Be concerned even for uncleared areas	Forestry Regional (R)	Forestry GW (Irrigation)	Saltbush to Evergreen mix	Groundwater resource issues – maintain recharge
212 Bassendean Zone High risk	➢ Shallow, salty ➢ Still at risk regardless of clearing, e.g. Low-lying points ➢ High confidence ➢ Have data to cause concern – processes showing support to arguments in 221 Zone (Geraldton Coastal Zone) with interesting bore trends in similar geology ➢ Confirmed by Jason Carter's report	Forestry	Forestry GW (Irrigation)	Saltbush to Evergreen mix	Groundwater resource issues – maintain recharge

	➢ Also confirmed by ground truthed data ➢ There are expressions of surface salt ➢ REGIONAL & SALTY therefore difficult to manage ➢ Deal with discharge areas – treat symptoms ➢ Be concerned even for uncleared areas				
213 Pinjarra Zone High risk	➢ Shallow, salty ➢ Still at risk regardless of clearing, e.g. Low-lying points ➢ High confidence ➢ Have data to cause concern – processes showing support to arguments in 221 Zone (Geraldton Coastal Zone) with interesting bore trends in similar geology ➢ Confirmed by Jason Carter's report ➢ Also confirmed by ground truthed data ➢ There are expressions of surface salt ➢ REGIONAL & SALTY therefore difficult to manage ➢ Deal with discharge areas – treat symptoms ➢ Be concerned even for uncleared areas	Forestry	Forestry	Saltbush to Evergreen mix	Groundwater resource issues – maintain recharge
220 Southern Victoria Plateau Zone Low risk	➢ Much deeper, regional and likely to be rising ➢ Ranges from fresh to brackish ➢ Groundwater is a resource – part of Allanooka area ➢ Existing swamps are likely to be perched ➢ New perched systems may develop		Tagasaste Woody perennials Evergreen		Low salinity priority as watertable is deeper
221 Geraldton Coastal Zone Moderate risk	➢ Future problem??? Appear to be either observing some groundwater rise, or bores are still reflecting impact of 1999 flooding ➢ REGIONAL, shallow to the south ➢ Is a problem when cleared	Forestry	Forestry Surface Water Management	Forestry Surface Water Management	

	➢ Lake Logue conservation park is a concern ➢ Variable, fresh or salty ➢ Many wetlands were seasonally perched – now some are exhibiting inundation from regional groundwater ➢ Watch the northern part of the West Midlands				
222 Dandaragan Plateau Zone High risk	➢ Yalallie impact crater – surface expression of regional groundwater ➢ Mix of perched fresh and regional fresh ➢ Rising at ~0.2- 0.6m/yr ➢ High value agricultural land ➢ High confidence shallow and fresh ➢ Can't say what is happening beneath uncleared areas ➢ It IS rising below cleared areas ➢ Some perched systems rising, and some are static (static ones are likely recharging the regional system)	Forestry	Forestry Surface Water Management	Saltbush to Evergreen mix Surface Water Management	Groundwater resource issues – maintain recharge
223 Northern Victoria Plateau Zone High risk	➢ Extreme salinity risk if average climate maintained ➢ Regional aquifer salty (brackish) ➢ In spots western part shallow and eastern part deep and brackish ➢ No water resource for stock (poor quality) ➢ Has been steadily rising – future is climate driven ➢ Discharge north to Murchison River needs to be considered a threat ➢ Need to have a better understanding of groundwater movement here	No options	No options	Salt tolerant species	
224 Arrowsmith Zone	➢ Seems deep ➢ Occurs west of Otorowiri siltstone	Forestry Woody	Forestry Woody	Forestry Woody	

Moderate risk	➢ There are problems around Hill river/Cockleshell Gully – salt ➢ Further north in the zone groundwater is probably deep ➢ Hill River, especially around Cockleshell Gully has problems ➢ Irwin River discharges appear to be fresh. ➢ Some interest in horticulture here, but the water reserves are not as good as many would like to be of real potential	perennials Perennial pastures	perennials Perennial pastures	perennials Perennial pastures	
225 Chapman Zone Low risk	➢ Most parts appear to have reached equilibrium ➢ Quality varies from brackish to fresh ➢ Supplies generally limited- domestic OK / commercial limited. ➢ Chapman and Greenough River flow through this zone. Chapman River (annual river) in pretty good health. Greenough River more affected by sediment- hasn't flowed for 5 years doesn't flow annually. ➢ In Chapman River groundwater contributes to flow ➢ Greenough River has isolated windows to regional groundwater (pools) but doesn't generate a flow. ➢ Subdivision a threat for intensive purposes- there isn't the groundwater water for intensive production ➢ Chapman Valley is a safe/secure food and fibre area and must keep its integrity ➢ Area of high productive land ➢ Has potential to support diverse enterprises (niche opportunities incl. tourism))	Forestry Woody perennials Perennial pastures Surface Water Management Drainage GW Pumping	Not applicable	Saltbush to Evergreen mix GW Pumping Surface Water Management	

	➢ Areas of degradation generated by fresh water which could be easily fixed (high reclamation feasibility) ➢ Get a better return for dollar investment here than anywhere else in the region.				
226 Lockier Zone Low Risk	➢ Complex geology ➢ Groundwater tends to be brackish to saline with discrete fresh areas ➢ Don't know for sure whether groundwater is rising. Rapid rise in the nineties and now the net rise is minimal to zero. ➢ Increasing salinity may be an issue in the future? ➢ Don't spend money on salinity mitigation at the moment – keep monitoring- keep drilling a few more holes ➢ Dissected by some deep trenches e.g. Irwin and Lockier- possibility of groundwater draining into river systems and therefore drainage lines may be facilitating removal of groundwater and so fencing them off is a priority. ➢ Flats are productive however there is no groundwater as a resource. ➢ Possibly engineering solutions for drainage to test effectiveness.	Not applicable	Not applicable	Saltbush to Evergreen mix Surface Water Management	
227 Tenindewa Zone Moderate Risk	➢ Sandplain over sediments. Where sediments outcrop the result is a hostile environment ➢ Anecdotal evidence suggests lakes popping up in sandplain valleys ➢ Localized groundwater systems ➢ Kockatea Gully saline ➢ No extractable groundwater	Not applicable	Maintain vegetation cover through regulation	Saltland agronomy	

	➢ Occurs between the Darling and Urella Faults ➢ Unsure if groundwater rising and expect similar response to 226				
231 Port Gregory Coastal Zone Low Risk	➢ Similar to Zone 221 ➢ REGIONAL, shallow ➢ Is a problem when cleared ➢ Variable, fresh or salty ➢ Many wetlands were seasonally perched – now some are exhibiting inundation from regional groundwater	Not applicable	Not possible	Not applicable	
232 Kalbarri Sandplain Zone Unknown Risk	➢ Seems deep and reasonable size aquifer, fresh and potential for water resources ➢ Possibly significant water resources ➢ Kalbarri water supplies come from here – good quality ➢ There are seepage areas and areas of salinity associated with discharge from regional aquifer (no monitoring bores) ➢ Suspect watertable rising, depth to watertable unknown ➢ Main aquifer is Tumblagooda Sandstone and perhaps the recharge is from area of outcrop adjacent to Northampton Block ➢ Issues with Jurassic sediments- Sodic Clays ➢ Some areas with artesian head fed by the recharge off crystalline? ➢ Hutt River is in this zone				Potential Water Supply
234 Victoria Red Sandplain Zone Moderate Risk	➢ Hutt Regional aquifer (system extending from approx Yuna north – salty aquifer) close to Murchison river in low lying areas is a concern in the future ➢ Same as Zone 223	Not applicable	Not applicable	Saltland agronomy	

	➢ Riverside area at risk				
253 Eastern Darling Range Zone Moderate Risk	➢ Lots of these areas looks the same ➢ Areas of Tertiary sediments high in the landscape ➢ Some evidence of rising groundwater in tertiary sediments. These are potentially a water resource target for say 4 to 5 farms. ➢ Tertiary sediments cause seepages high in the landscape with associated land degradation ➢ Watertables rising in Tertiary sediments due to sandy soils ➢ Extent of tertiary sediments is unknown ➢ Moore River RCA shows evidence of groundwater equilibrium. (shallow regolith, seasonal fluctuations but no overall rising trend) ➢ Approx 9% of landscape affected by salt ➢ Localised gradient ➢ Moore River dramatically affected by agriculture ➢ Similar to Zone 256	No options	Forestry Forestry Woody perennials Perennial pastures	Forestry Forestry Woody perennials Perennial pastures	
256 Northern Zone of Rejuvenated Drainage Moderate Risk	➢ Lots of these areas looks the same ➢ Areas of Tertiary sediments high in the landscape ➢ Some evidence of rising groundwater in tertiary sediments. These are potentially a water resource target for say 4 to 5 farms. ➢ Tertiary sediments cause seepages high in the landscape with associated land degradation ➢ Watertables rising in Tertiary sediments due to sandy soils ➢ Extent of tertiary sediments is unknown	No options	Forestry Forestry Woody perennials Perennial pastures	Forestry Forestry Woody perennials Perennial pastures	

	➢ Moore River RCA shows evidence of groundwater equilibrium. (shallow regolith, seasonal fluctuations but no overall rising trend) ➢ Approx 9% of landscape affected by salt ➢ Localised gradient ➢ Moore River dramatically affected by agriculture ➢ Similar to Zone 253				
258 Northern Zone of Ancient Drainage Moderate Risk	➢ Broad valley floors ➢ Areas of classic dryland salinity with shallow basement rock and high salt storage ➢ Seen most severe expressions of salinity (primary salinity is a feature of these zones and there is lots of secondary) ➢ Where primary occurs it is likely to coincide with paleodrainage/paleochannels. ➢ In 10-15 years of data there is scant evidence to support watertable rise. (rises of the 1990's have turned to falls this decade) ➢ Hypothesise it is climate driven – had significant influence on watertable levels ➢ Approx 10% affected by secondary salinity ➢ Be good to see more intense transects of bores to monitor drains and their effects. ➢ Similar to Zones 270 and 271	Awaiting EEI study, drainage benchmarking and Yarra Yarra demonstrations on deep drains	Surface Water Management Oil Mallees	Surface Water Management Saltland agronomy	
270 Karara Zone Moderate Risk	➢ Broad valley floors ➢ Areas of classic dryland salinity with shallow basement rock and high salt storage ➢ Seen most severe expressions of salinity (primary salinity is a feature of these zones and there is lots of secondary)	Awaiting EEI study, drainage benchmarking and Yarra Yarra demonstrations	Surface Water Management Oil Mallees	Surface Water Management Saltland agronomy	

	➢ Where primary occurs it is likely to coincide with paleodrainage/paleochannels. ➢ In 10-15 years of data there is scant evidence to support watertable rise. (rises of the 1990's have turned to falls this decade) ➢ Hypothesise it is climate driven – had significant influence on watertable levels ➢ Approx 10% affected by secondary salinity ➢ Be good to see more intense transects of bores to monitor drains and their effects. ➢ Similar to Zones 258 and 271	on deep drains			
271 Irwin River Zone Moderate Risk	➢ Broad valley floors ➢ Areas of classic dryland salinity with shallow basement rock and high salt storage ➢ Seen most severe expressions of salinity (primary salinity is a feature of these zones and there is lots of secondary) ➢ Where primary occurs it is likely to coincide with paleodrainage/paleochannels. ➢ In 10-15 years of data there is scant evidence to support watertable rise. (rises of the 1990's have turned to falls this decade) ➢ Hypothesise it is climate driven – had significant influence on watertable levels ➢ Approx 10% affected by secondary salinity ➢ Be good to see more intense transects of bores to monitor drains and their effects. ➢ Similar to Zones 258 and 270	Awaiting EEI study, drainage benchmarking and Yarra Yarra demonstrations on deep drains	Surface Water Management Oil Mallees	Surface Water Management Saltland agronomy	

Localised watertable and salt can be locally managed. Regional salinity threats require broader.

4. An analysis of the soil landscape zones based on current changing hydrological trends in the region

Altered hydrology either currently affects or threatens large areas of agricultural land and the degree of hydrological variability is high between zones (Bairstow et al 2006).

4.1 Priority for managing future salinity risk

As indicated earlier there are 31 soil-landscape zones in the south-west region of Western Australia, 19 of which were identified in the Northern Agricultural Region. From these 19 soil-landscape zones, five of them were identified as the highest priority zones based on *future salinity risk*. These include the Dandaragan Plateau Zone (222), Perth Coastal Zone (211), Bassendean Zone (212), Pinjarra Zone (213) and the Northern Victoria Sandplain Zone (223) (see the Maps in Appendix 1). These zones have water tables that are typically shallow, rising with variable quality. The current data of the DAFWA monitoring bores supports the previous findings as there is no significant change observed in the hydrological trend for these zones, except in the Northern Victoria Sandplain Zone where the evidence shows a slight rising trend of watertables.

In terms of future investment direction, the Dandaragan Plateau Zone has been considered for the future salinity investment plan as it is an area with the highest value natural resources that are at high risk from the future salinity or rising water levels (George et al 2005). Moreover, it is an area with a number of options to manage the future salinity risks compared to the rest of the zones.

According to Philip Commander of the DoW the geological features of the aquifers underlying Dandaragan Plateau Zone (i.e. Parmelia Formation and Otorowiri Siltstone) are understood to be consistent compared to the rest of the major aquifers in Northern Perth Basin, such as the Yarragadee, Cattamarra and the Leederville aquifers which occupy most of the Perth Coastal Zone (211), Bassendean Zone (212), and Pinjarra Zone (213). The Parmelia Formation and Otorowiri Siltstone do not require a deep understanding of geological features as there is little complexity to the geology of this regional aquifer and it represents a good area to target incentives (Commander pers comm 2007).

4.2 Priority for managing existing salinity

The soil-landscape zones with highest priority for investment are those that occur on the valley floors on the Yilgarn Craton including: Eastern Darling Range Zone (253), Northern Zone of Rejuvenate Drainage (256), Northern Zone of Ancient Drainage (258), Karara Zone (270) and Irwin River Zone (271) (see the Maps in Appendix 1a and b). These areas are more accurately seen by using the Land Monitor product of AOCLP and correspond with the Yarra Yarra, Eastern Moore and Irwin River Catchments (Bairstow *et al* 2006). Currently, the amount of land affected by salinity in this province is about 10% (Alderman and Clarke 2003, Clarke 2001, Bairstow *et al* 2006). While watertables did rise during the 1990’s, recent studies by Hydrologist Russell Speed of the DAFWA reported falling groundwater levels in monitoring bores in several areas since 2000, linked to drier seasons. This reverses the trend noted from 1995 to 1999. This is evidenced by the following hydrograph information compiled by Jessica Hasleby of DAFWA (in the period between Jan 2005 – Jan 2007):

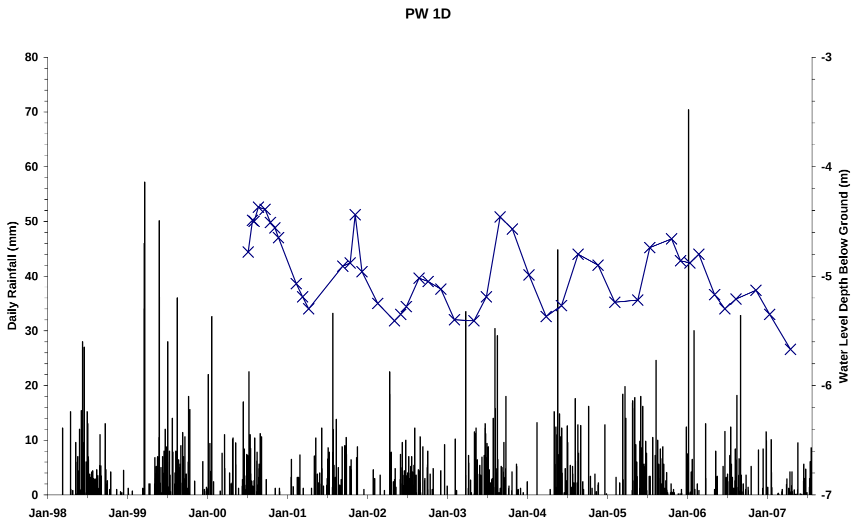

Figure 1: Groundwater hydrograph for an observation bore located at Piawanning (Hasleby 2007).

As can be seen in the above hydrograph of areas in north-eastern wheatbelt, there has been a dramatic watertable rise on two occasions in the past decade, in 1996 and again in 1999. Despite these two large rainfall events, there has been a declining trend in the watertable of 8 cm/year. This is most likely due to groundwater loss by both evaporation and natural drainage. The rainfall received in the years after 1999 has also been much steadier with no large events records, which has also contributed to the declining trends (Hasleby 2005).

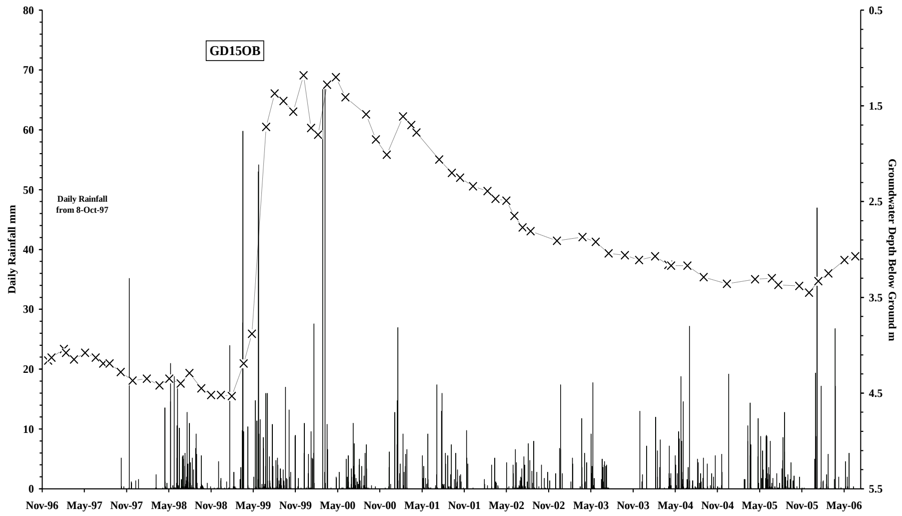

Figure 2: Groundwater hydrograph for observation bore GD15OB on a cleared valley floor in the Dalwallinu Shire. Columns show daily rainfall from the Goodlands area (Hasleby 2006).

In hydrograph GD15OB above, before 1999 the water table was around 4.5m below ground. Due to the very wet period in 1999, episodic recharge caused significant groundwater rise, bringing the water table to within a metre of the surface. A gradual decline has been observed until January 2006. The decline of the water table is primarily due to evaporation. The limiting depth of evaporation from the water table for this soil profile appears to be about 3.5m. The rate of decline tapered as the water table approached the limiting depth of evaporation. There has been negligible recharge to the watertable in this area since 2000 due to reduced rainfall. It appears that rainfall events since 2000 have failed to exceed a threshold value required to initiate recharge. This area is typical of valley floors in the wheatbelt that have a high risk of future salinity. The risk of future salinity depends on a return to sustained wet conditions. This is unlikely with current climate change predictions. Similar scenario can also been seen in the below hydrograph.

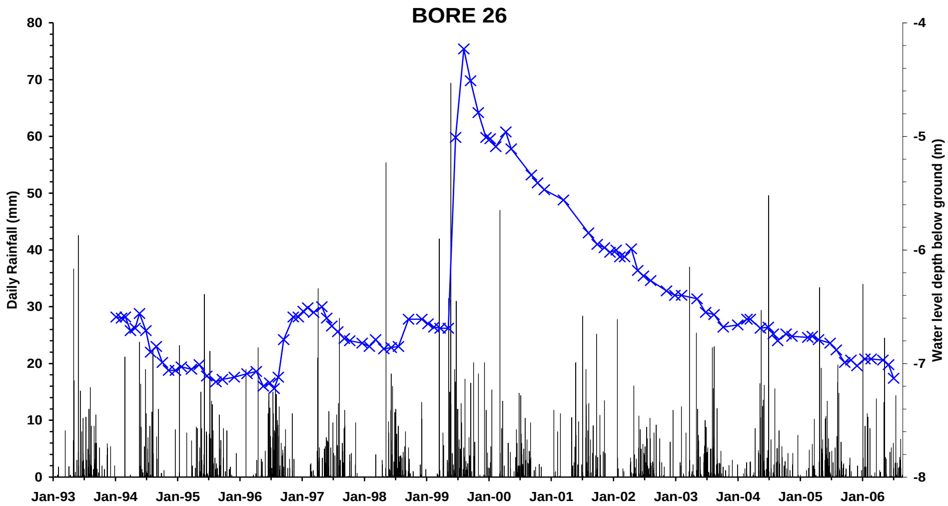

Figure 3: Groundwater hydrograph for observation bore CA26OB on a valley floor in the Carnamah Shire (Hasleby 2006).

When monitoring began in 1993, the watertable in the above hydrograph (bore 26) was approximately 6.7 m below ground. Water level rose and fell with seasonal rainfall until 1999 when it rose to within 4m of the surface. Since then the water table has fallen steadily to a point where it is now lower than when monitoring began. According to Hasleby, there are a couple of reasons to which this is attributed: First, the bore is in an area cut by swarms of dolerite dykes-intrusions of magma into the granite bedrock. These dykes can isolate cells of groundwater with restricted drainage, and it is possible this bore is in these cells. Second, the greater depth to the water table (>8m) is possibly also responsible for the muted seasonal water table response. Thirdly, the watertable decline is mainly due to natural drainage and reduced recharge since 2000 (Hasleby 2006).

Although the findings indicate rising hydrological trends in some areas around Yilgarn Craton, this cast no doubt on the fact that this province still has the largest area affected by the current salinity in both NAR and the State.

4.3 Moderate priority area

According to Bairstow, approximately half of the NAR is considered to be of a moderate priority. That is the groundwater in these zones is shallow, of variable quality and generally does not have rising trends and no imminent risk. To the west of the region these ground watertables are of variable quality and the current extent of salinity in these zones is low. For example, in soil landscape zone 224 there is a rising trend in watertable, although watertable still remains deep (see the hydrograph below). However, the opposite is true for the soil landscape zone 221 which shows a declining trend since 2000. According to Russell Speed, if such declining trend persists, the moderate risk will be reduced to low risk. The hydrograph below shows a rising trend in watertable, but deep watertable.

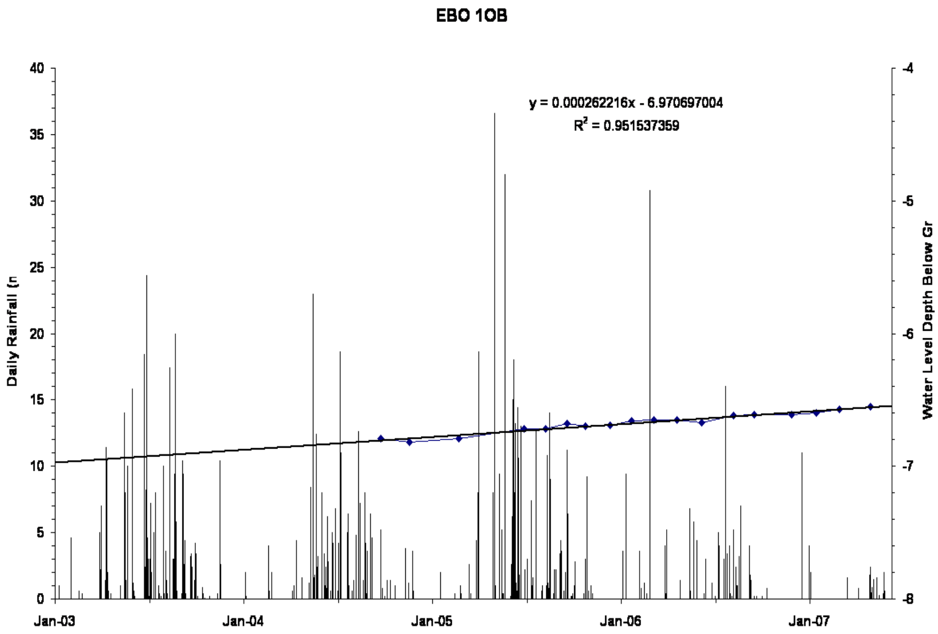

Figure 4: Groundwater hydrograph for observation bore EBO10B located Leeman area west of Brand Highway

4.4 Low priority area

The soil-landscape zones that have been allocated a low priority are situated towards the north and centre of the Region. The groundwater table levels in these zones appear to have reached equilibrium and the areas of degradation are generally generated by fresh water.

4.5 Unknown hydrological trend

The hydrological trend for the Kalbarri Sandplan Zone 232 is still unknown; however the DAFWA recently has installed bores in 7 sites which will soon generate data for monitoring in this zone. As indicated in Bairstow report, it was suspected that the watertable is rising, although the depth to watertable is unknown. It also seems to be reasonable size aquifer, which could prove to be a possible water resource in the future.

5. Management Options

Generally, the adoption of plant-based practices such as farm forestry and the deep-rooted perennials into the farming system may assist with stabilising the hydrological balance in many of the zones. Forestry is probably more effective than perennial pastures when a regional groundwater system is encountered associated with a high rainfall zone. Some engineering practices maybe suited to soil-landscape zones to the east of the Region; however the real effectiveness of these is still being assessed. Fundamentally, however, the feasibility of any salinity management practice within a soil-landscape zone will depend on the particular management strategy, namely recovery, containment or adaptation (Bairstow *et al* 2006).

6. Recapitulation

The Dandaragan Plateau Zone has been considered as a high priority area for the future salinity investment. This area is suited to incentives that focused on minimizing recharge (e.g. tree plantations, high water use perennial pastures and fodder shrubs, and surface water management and agronomic options such as stubble retention and soil treatment with gypsum).

As far as priority area for managing existing salinity is concerned, evidence has shown declining trends in watertable in some area around Yilgarn Craton. Despite the difference in water table movements in these areas, they have cast some doubt that rising groundwater and associated expanding salinity is an issue in some parts of the northern wheatbelt. However this province still has the largest area affected by the existing salinity in the region. Hence, there is need for incentives that are focused on recovering the salt affected land for production. For example engineering works such as surface and sub-surface drainage and pumping, surface water management, revegetation and regeneration through fencing.

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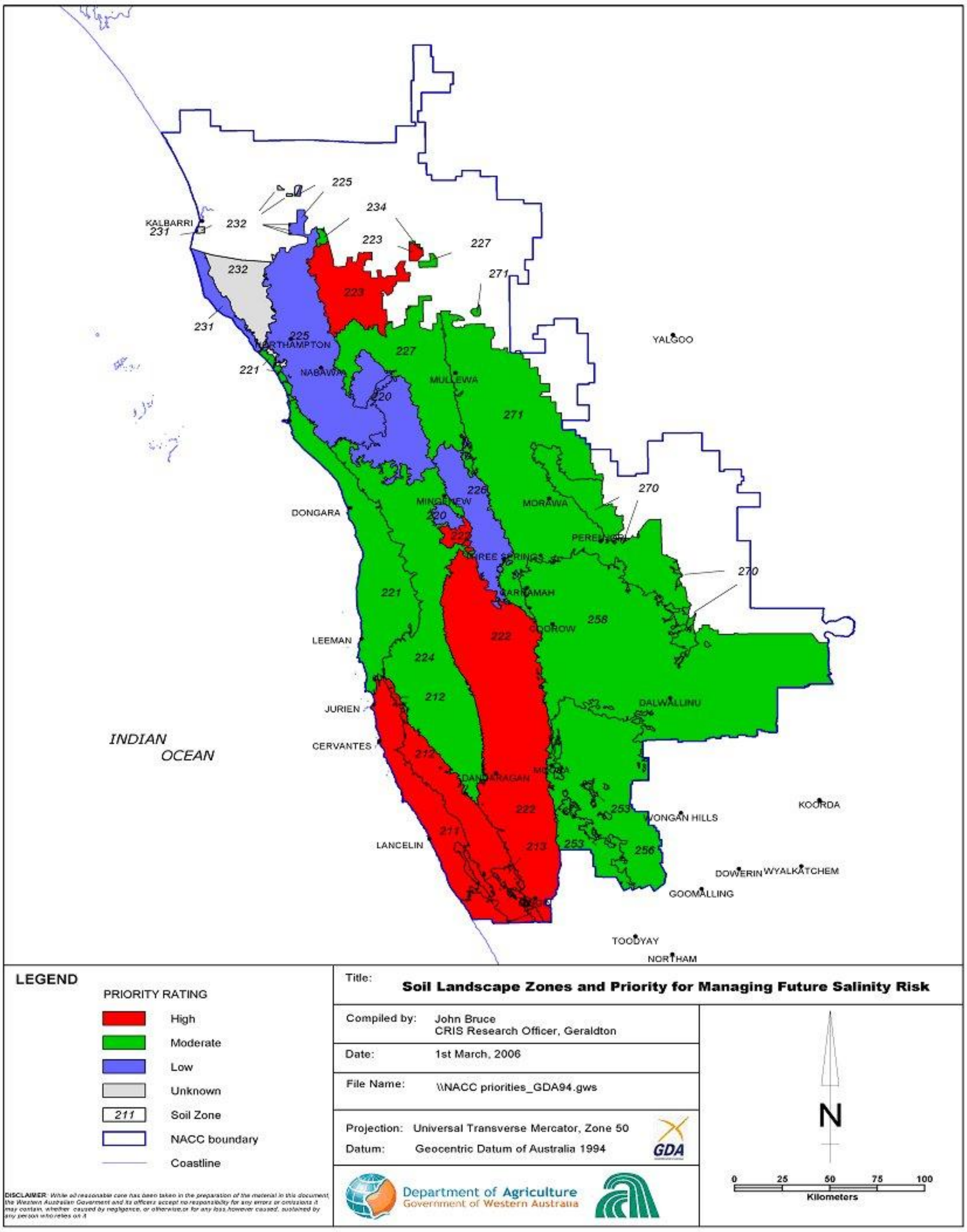
Appendix 1a: Map showing Soil Landscape Zones and priority for managing the existing and future Salinity risk



Appendix 1b: Map showing priority soil-landscape zones for agricultural land for the NACC salinity investment in the NAR.