WHAT IS CAUSING SALINITY ON THE WIMMERA PLAINS?

January 1999

CENTRE FOR LAND PROTECTION RESEARCH

Technical Report No. 53

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Department Natural Resources and Environment

Hocking, Mark, 1973 - .
What is causing salinity on the Wimmera Plains?

Bibliography.
ISBN 0 7311 4292 6.
ISSN 1038-216X

1.Salinisation – Victoria – Wimmera River Watershed. 2. Hydrogeology – Victoria – Wimmera River Watershed. 3. Wimmera River Watershed (Vic.). I Victoria. Dept. of Natural Resources and Environment. II. Centre for Land Protection Research (Vic.). III. Title. (Series: Technical report (Centre for Land Protection Research (Vic)) ; no. 53).

551.483099459

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WHAT IS CAUSING SALINITY ON THE WIMMERA PLAINS?

January 1999

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ABSTRACT

Increasing areas of land on the Wimmera Plains in north-western Victoria are showing signs of salt stress. This is believed to be due to the effects of the localised groundwater perching. The regional watertable is at such a depth that it has no influence on salinity processes. Areas of salinisation tend to be at the base of rises within depressions. The process that is believed to be causing salinity is attributed to a combination of environmental factors. They are; clayey soils, low water using plant species, poor surface drainage, low rainfall and high evaporation rates. Currently, there is no up to date record of the extent of salinity, but anecdotal evidence suggests the area affected is slowly increasing.

INTRODUCTION

The Wimmera Plains are located east and north of the Wimmera River, west of the Richardson River and approximately south of Birchip, in north-western Victoria. In recent years, anecdotal evidence suggests that there has been an increase in land salinisation.

The aim of this report is to provide some insight into the land salinisation processes of the Wimmera Plains. The Centre for Land Protection Research (CLPR), undertook this work as part of project R219: Hydrogeological research and investigation in support of the Wimmera Salinity Management Plan (WSMP).

The Wimmera Catchment Coordination Group (1992) defines the Wimmera Plains as “the sandy clay and cracking clay dunes”. These are present approximately north and east of the Wimmera River, south of the remnant Lowan Sand deposits (south of Birchip) and to the west of the Richardson River.

Soils of the Wimmera Plains (e.g. red sodic soils and grey cracking clays) are well suited for cereal cropping which is the dominant land use in the region.

PREVIOUS STUDIES

Salting of the plains is generally restricted to the base of the north-south trending ‘red rises’. Rowan (1971) conducted land surveys in the late 1960s to early 1970s and did not recollect any visual presence of salinity south of Birchip (J. Rowan[1], pers. comm.).

Groundwater drilling in the 1970s by Lawrence (1974) at Lascelles identified the presence of salt at the base of the inter-dune rises. The NRE corporate GIS soil salinity layer (formerly known as the salinity discharge layer) has not identified the Wimmera Plains as having any significant dryland salinity. This may be due to its localised nature and relatively recent occurrence in this area.

CLIMATE

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[1] J. Rowan (Soil surveyor, formerly Soil Conservation Authority) July 1998.

The influence the climate has on salinity in the Wimmera Plains is significant. The two dominant climatic factors are rainfall and evaporation. The inter-relationship between rainfall and evaporation (along with drainage and soil permeability) determine the entry and movement of rainwater into the sediment profile.

The mean annual rainfall at Warracknabeal is approximately 420 mm and the months May through to October have a mean of more than 40 mm/month of rainfall. On average, between 80 and 100 kg/hectare/year (Shugg[2], pers. comm.) of salt falls on the Wimmera Plains. Evaporation is greatest in summer months, with the months November to February having the potential to evaporate more than 200 mm of water on average per month.

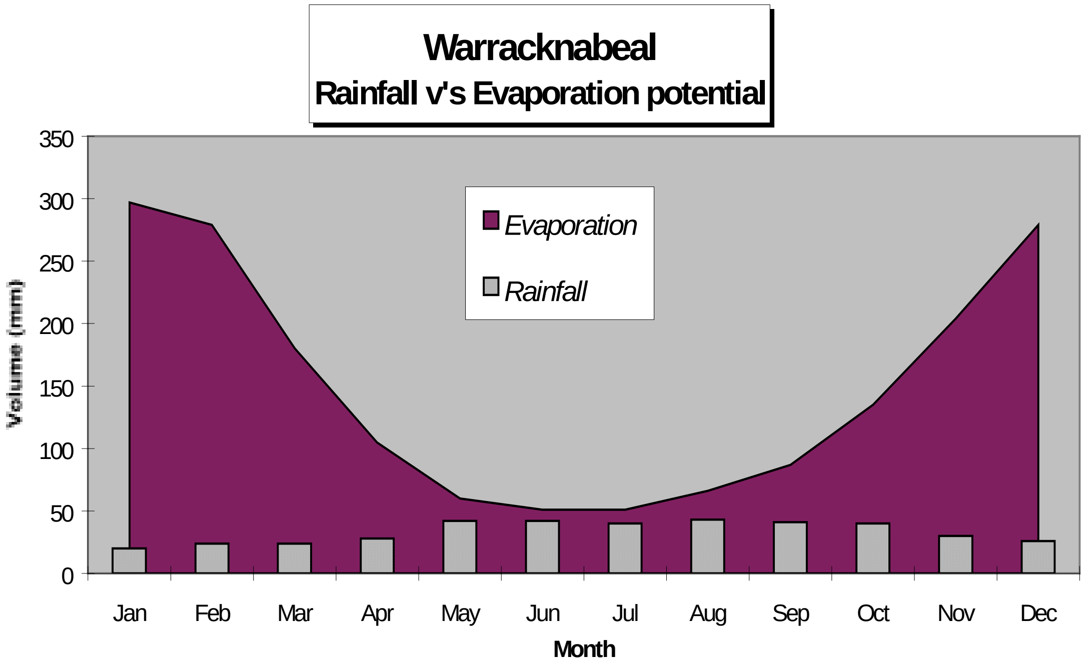

Figure 1 **Mean monthly rainfall and evaporation at Warracknabeal.**

The Warracknabeal weather composite (Figure 1) shows that rainfall on a mean monthly basis never exceeds potential evaporation. That is, rainfall on the Wimmera Plains is rarely great enough to allow long term surface flow from rainfall. The result of this environmental condition is that there is rarely any flushing of salt from the area. This results in an accumulation of salt (generally in the low lying areas). On a daily basis, rainfall does sometimes exceed evaporation, allowing some localised salt flushing. This salt ultimately moves to low lying areas and creates a salt affected area.

[2] A. Shugg (Water Resources & Salinity Infrastructure, CM&SA) July 1998.

HYDROLOGY

Surface drainage on the Wimmera Plains is poor. The majority of rainwater that is not evaporated either infiltrates into the deep soils of the plains or flows to localized low lying areas where it then pools.

The surface drainage of the Wimmera Plains generally trends to the north. Two major creeks flow through the region, the Yarriambiack and Dunmunkle creeks. These are intermittent and both are fed by overflow from the Wimmera River and by direct run-off from the surrounding area.

Yarriambiack Creek

The Yarriambiack Creek rises south of Murtoa, and flows through Warracknabeal and then Hopetoun where it enters Lake Coorong, finally terminating at Lake Lascelles. In wetter times (such as the Tertiary period), the system may have once flowed further north-west, possibly through Dattuck, Patchewollock, Walpeup and beyond. The deposition of the Lowan Sand (discussed in the geomorphology section) appears to have reduced the hydrologic system to its current extent.

Dunmunkle Creek

Smaller than the Yarriambiack Creek system, the Dunmunkle Creek originates nears Glenorchy. It flows through Rupanyup and would normally terminate into the area of Beolite. However, the northern section of the creek is now used as a channel supply for the Wimmera - Mallee. Similar to Yarriambiack Creek, the Dunmunkle Creek once flowed much further, possibly through Watchem West to Lake Tyrrell and beyond.

GEOMORPHOLOGY

The geomorphic development of the Wimmera Plains comprises of three distinct geomorphic phases, the deposition of the Parilla Sand, Lowan Sand and recent Quaternary deposits.

Discussed in the hydrogeology section, the Parilla Sand is a fine to coarse grained sand formation. In the Late Tertiary period, the Wimmera Plains was part of a shallow marine environment. This saw the deposition of cross-bedded fine to coarse grained sands. Towards the end of the Tertiary period there was a significant change in the climate, resulting in a fall of sea level. With this fall, north-northwest strand-line beach ridges formed, marking the final stage in the deposition of the Parilla Sand.

Following the shallow marine sequence of the Tertiary period, the Wimmera Plains was then a terrestrial environment in the Quaternary period, and with it a different kind of sediment deposition occurred. The Lowan Sand is a fine grained sand unit which was deposited by aeolian (wind blown) processes, the sand being derived from the reworking of the Parilla Sand. The ridges of Lowan Sand trend west-east, suggesting the predominant wind direction in the Wimmera during this time was from west to east. The drifts of Lowan Sand moved slowly to the east burying any topographic feature in their path, including drainage lines. This had a significant influence on the hydrology of the Wimmera River and Yariambiack Creek systems, causing them to be blocked and thereby causing the formation of Lakes Hindmarsh and Albacutya and the lake system in the Hopetoun area. There are few remaining surface deposits of Lowan Sand on the Wimmera Plains, the main occurrence being east of Beulah. In general, the Lowan Sand occurs to the north of the Wimmera Plains, which defines the Wimmera Plains to the south of it. The Woorinen and Yamba formations are aeolian deposits like the Lowan Sand but with a higher clay content. The well drained sandy clay of these formations has allowed ferruginous discolouration to occur. These deposits generally have sodic soils, giving origin to the name ‘red rises’.

More recent Quaternary deposits include the Shepparton Formation and the Coonambidgal Formation. Both of these units have fluvial origins and are derived from the erosion and dissection of the up-catchment landscape.

HYDROGEOLOGY

Salinity causing processes

The majority of salinity in the Wimmera region is associated with a shallow regional watertable (i.e. < 2 metres). The dominant influencing aquifer associated with the salinity is the Parilla Sand Aquifer. In the Wimmera Plains, however, the depth to the Parilla Sand (the regional watertable) is approximately 20 to 25 metres below ground surface. Piezometers on the Wimmera Plains suggest the Parilla Sand Aquifer is showing a falling water level trend (Appendix 1, bores 101109 and 70222), whereas water levels to the east of the Wimmera Plains suggest a significant rising water level trend (Appendix 1, bore 158)

The large depth to watertable suggests the Parilla Sand Aquifer has no influence on salinity processes in the Wimmera Plains.

In some areas, the Wimmera Plains experiences localised waterlogging. That is, water ponds in low lying areas and causes the saturation of the underlying geology (Woorinen Formation), and therefore seasonal perching. Appendix 2 shows a gamma log of piezometer 2532 (west of Warracknabeal). It shows a relatively high clay content between 7 and 15 metres, suggesting a low permeability zone, thus restricting downward movement of water.

Discussed previously in the climate section, potential evaporation on the Wimmera Plains is relatively high and is rarely less than rainfall. So far, evidence points to a lack of both surface and deep drainage, this causes water to tend to evaporate rather than infiltrate deeply, which helps to concentrate salt in the soil profile. Salt that occurs in the rainwater and Woorinen Formation accumulates in areas where water pools, and hence increases the salt concentration over time. This process is believed to have been occurring for many years, and is gradually increasing the concentration of salt in the low lying areas.

Quaternary fluvial deposits are generally restricted to flood plains and drainage lines of the Yarriambiack, and to a lesser extent, the Dunmunkle creeks, where some localised aquifer perching may occur due to flooding of the plains. Currently, there are no visual effects of salinisation in these areas. However, no monitoring of the Quaternary fluvial deposits is occurring, thus salinity risk is unknown.

Extent of salinity

In recent years a growing number of crops on the Wimmera Plains are beginning to show signs of soil salinity. Appendix 3 is a guide to the tolerances of various plants to soil salinity. This guide shows lupins and peas are the first crop species to show signs of salt stress, which is usually followed by a decrease in yield within the crop.

Saline areas on the Wimmera Plains are generally located at the base of ‘red rises’ and in low lying areas. However, only five areas of salinisation have been mapped on the Wimmera Plains in the NRE corporate soil salinity layer (formerly known as the salinity discharge layer) (Appendix 4). This suggests there is a much greater area of land salinisation than has been previously mapped.

Field observations suggest some ‘red rises’ contribute greater loads of salt relative to others, however this is yet to be confirmed.

Currently, there is no visible salt affected land on the flood plains of the Yarriambiack and Dunmunkle creeks. However, salinity could potentially occur on the flood plains if current land management practices change (i.e. tree clearance, impeding drainage, irrigation).

CONCLUSIONS

Land salinisation on the Wimmera Plains is not influenced by the regional Parilla Sand Aquifer. This makes identifying the salinity difficult as it cannot be correlated with a shallow regional watertable. The salinity on the plains is caused by a suite of environmental conditions. These are:

- relatively high potential evaporation rates;
- poor surface drainage features; and
- the lack of high water using vegetation to seasonally increase the soil moisture deficit.

These conditions have led to the concentration of salt in low lying areas, which over the past 120 years has led to salt ‘scalds’ forming at the base of ‘red rises’.

The duration of saturation of the localised perched aquifer is difficult to accurately measure. This subsequently makes it extremely difficult to estimate a trend of saturation and salinity over a number of years.

Decreasing the surface runoff and sub-surface flows from the ‘red rises’ would assist in reducing the transport of salt to the low lying areas below the rises.

RECOMMENDATIONS

The following recommendations have been made from research undertaken for this report:

- Map the extent of land salinisation to measure the area affected by salt, which then can be ‘bench marked’ to determine a rate of increase/decrease over time.
- Construct piezometers on the flood plains. These may give some indication of the likelihood for salinity to occur.
- Construct shallow piezometers ($\cong$ 4 - 10 metres) to monitor the duration of saturation at and adjacent to the salt affected sites. This may provide more of an understanding of the salinity mechanism, thus providing possible treatment options to control/reduce the area affected by salt.
- Encourage and monitor salinity treatment options such as alley farming and the incorporation of perennial pastures into cropping regimes (e.g. phalaris and lucerne).
- Determine the optimum density and type of plant species in salt affected sites.
- Identify which ‘red rises’ contribute high salt loads, and why it is so.

ACKNOWLEDGMENTS

The author would particularly like to thank the following for their assistance in the production of this report:

Robert Clark (CLPR, Bendigo), Jim Rowan (formerly Soil Conservation Authority), Andy Shugg (formerly Catchment Management & Sustainable Agriculture, Melbourne), Jacqui George (NRE, Horsham), Matt Coffey (VIDA, Horsham), Ian Glasgow (Robert Smith & Company Pty. Ltd., Warracknabeal), Mark Reid (CLPR, Bendigo) and Julie Gequillana (CLPR, Bendigo). A special thanks to Kath Ferrari (CLPR, Bendigo) for formating and nurturing this report.

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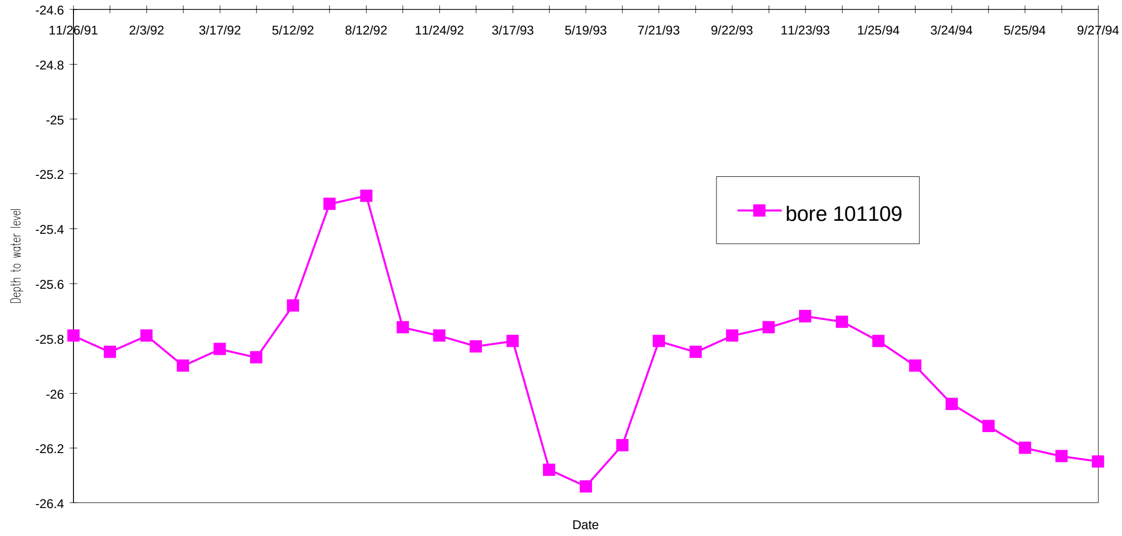
Lawrence, C. R. (1974). Summary of drilling investigation into salting at Lascelles. Geological survey of Victoria. Unpublished report 1974/85.

Rowan, J. (1971). Salting on dryland farms in North-Western Victoria. Soil Conservation Authority (Victoria). Publication TC 7.

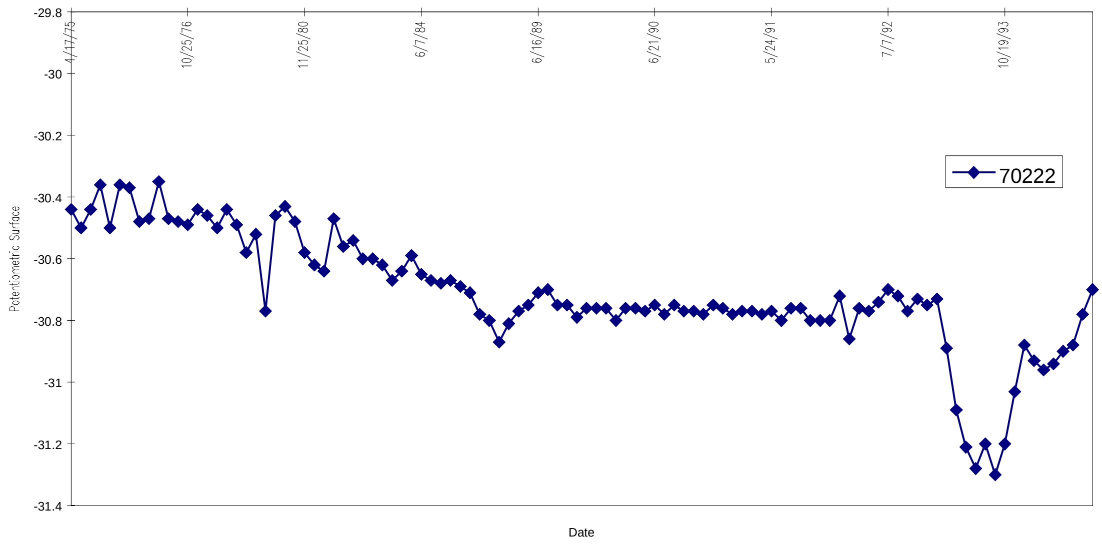
WCCG (1992). Wimmera Catchment - Draft Salinity Management Plan. Department of Conservation and Natural Resources, Horsham.

APPENDIX 1 REPRESENTATIVE BORE HYDROGRAPHS ON THE WIMMERA PLAINS.

Bore 101109, located 20km north east of Warracknabeal (monitoring the Parilla Sand Aquifer/watertable).

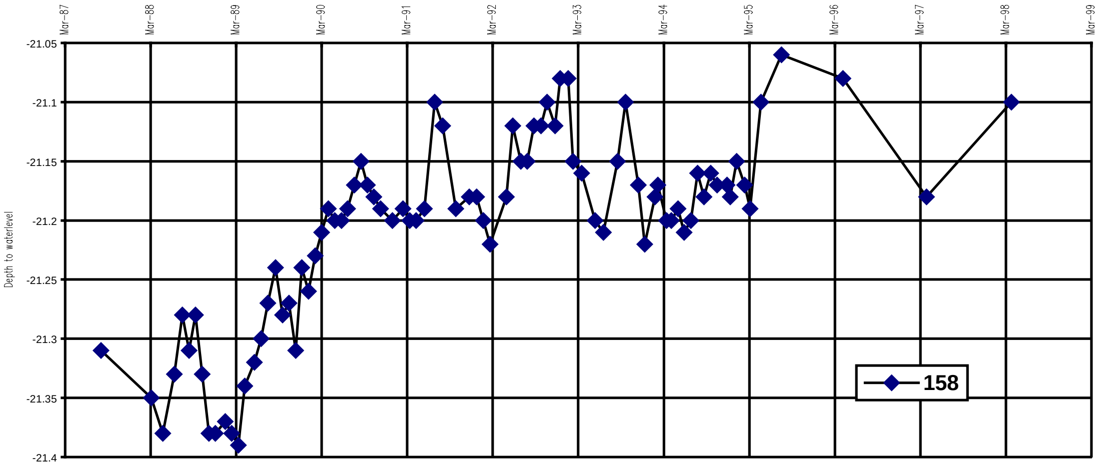


Bore 70222, located 40km south of Warracknabeal (monitoring the Parilla Sand Aquifer/watertable).

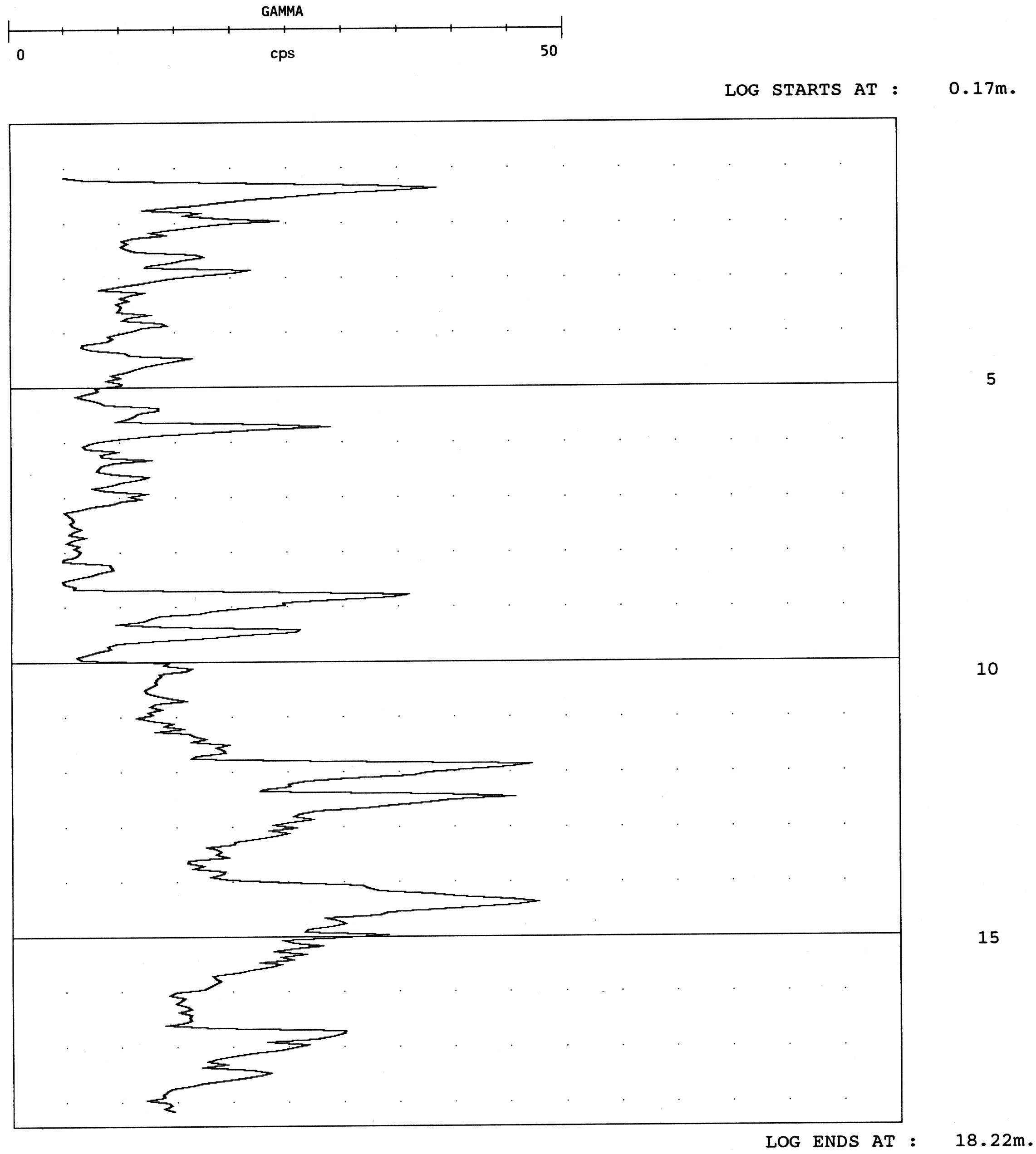


APPENDIX 1 continued

Bore 158, located 2km south of Watchem (monitoring the Parilla Sand Aquifer/watertable).

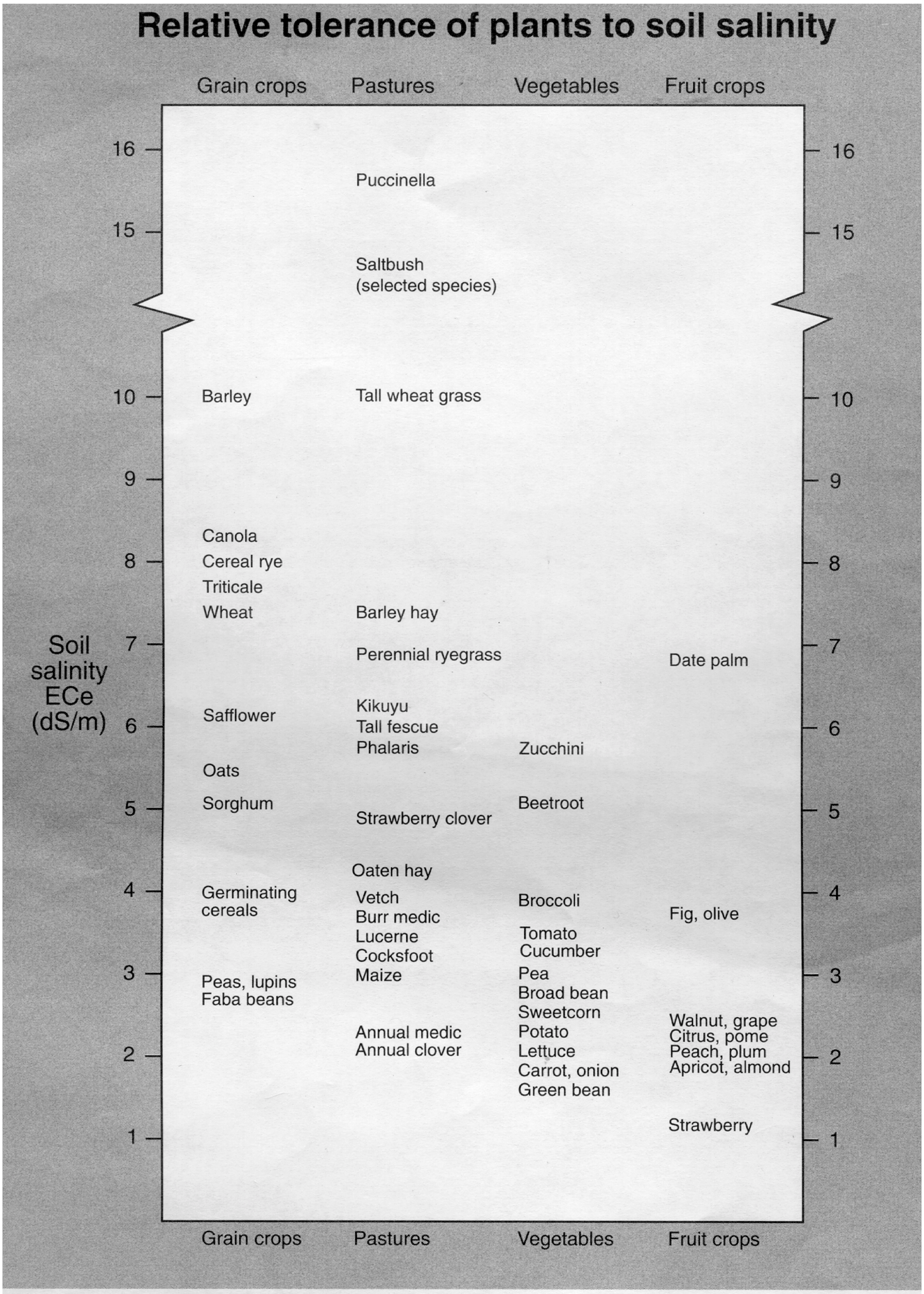


APPENDIX 2: GAMMA LOG OF PIEZOMETER 2532



APPENDIX 3 RELATIVE TOLERANCE OF PLANTS TO SOIL SALINITY.

Compiled by Herrmann & Solomon (1994).



Plant names are positioned at the soil salinity figure which will cause a 10% yield reduction. Higher soil salinities than those shown will cause a greater yield loss for that plant. Germinating plants will suffer more than indicated by this chart. Waterlogging will also increase salinity effects.

APPENDIX 4 MAPPED EXTENT OF SALINITY ON THE DNRE SOIL SALTING LAYER ON THE WIMMERA PLAINS (1998).