



Natural Heritage Trust
Helping Communities Helping Australia
A Commonwealth Government Initiative



Department of
Infrastructure, Planning and Natural Resources

Western Sydney Salinity Code of Practice

March 2003
(Amended January 2004)

Prepared by
Rebecca Nicolson
for the
Western Sydney Salinity Working Party

Western Sydney Regional
Organisation of Councils Ltd



Western Sydney Regional Organisation of Councils Ltd

Level 1, WSROC House, 49 Campbell Street

PO Box 63, Blacktown, NSW 2148

Tel (02) 9671 4333 Fax (02) 9621 7741

Email admin@wsroc.com.au www.wsroc.com.au

ABN 16 053 399 983

**Auburn
Bankstown
Baulkham Hills
Blacktown**

**Blue Mountains
Fairfield
Hawkesbury
Holroyd**

**Liverpool
Parramatta
Penrith**

The Macarthur Regional Organisation of Councils also participated in the development of this Salinity Code of Practice.



**Camden
Campbelltown
Wollondilly**

ACKNOWLEDGEMENTS

The Natural Heritage Trust of Australia which provided the funding to undertake this project, the project partners, the Department of Infrastructure, Planning & Natural Resources and the many staff from the councils in the region who assisted in the preparation of this document. The support of the following organisations represented on the Western Sydney Salinity Working Party is also acknowledged: Department of Infrastructure, Planning & Natural Resources, Penrith; Sydney Water; Department of Environment & Conservation; Housing Industry Association; Upper Parramatta River Catchment Trust; Office of Western Sydney and the member councils of WSROC and MACROC, as listed above.

Western Sydney Salinity Code of Practice, March 2003

Author: Rebecca Nicolson

Copyright © 2003 WSROC Ltd

ISBN 1 86271 297 2

Disclaimer

Any representation, statement, opinion or advice, expressed or implied in this publication is made in good faith but on the basis that WSROC Ltd, MACROC and their member Councils are not liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement or advice referred to here.

INTRODUCTION TO THE SALINITY CODE OF PRACTICE

The Salinity Code of Practice has been developed over the past two years for use by the Councils of Greater Western Sydney. The Councils of the region contributed to the document's preparation through the Western Sydney Salinity Working Party, with the assistance of the WSROC Salinity Project Officer and the Department of Infrastructure, Planning & Natural Resources. The Code of Practice is part of a regional project that was funded by a Commonwealth Government Natural Heritage Trust grant.

Following endorsement by the WSROC Board at its meeting on 20th February 2003, the Salinity Code of Practice is now available for adoption by the Councils of Greater Western Sydney. It is hoped that it will provide the basis of a coordinated and consistent salinity management response by the councils in the region. Through the implementation of the ideas presented in the Code councils should be able to develop a framework by which they can better consider the implications of the salinity potential in the region, both in relation to their own activities and as an issue for new developments.

Other organisations are also encouraged to make use of the Code of Practice and apply its framework when planning activities or developments in areas with salinity potential in Western Sydney.

It is hoped that as a consequence of the cooperative and consultative development approach taken over the past two years the final document is found to be effective, consistent and practical.

On-going comments on the content and use of the Salinity Code of Practice are welcomed and should be directed to the WSROC Environment Project Officer.

1. TABLE OF CONTENTS

1.	TABLE OF CONTENTS	4
2.	GLOSSARY.....	6
3.	ABBREVIATIONS.....	8
4.	THE WESTERN SYDNEY SALINITY CODE OF PRACTICE.....	9
5.	BACKGROUND TO URBAN SALINITY.....	10
5.1	Introduction	10
5.2	Urban salinity.....	10
5.3	Managing urban salinity.....	13
5.4	Salinity as a Cross Boundary issue.....	14
5.5	Cumulative Impacts and Salinity.....	14
5.6	Salinity in Western Sydney.....	15
5.7	Salinity Processes in Western Sydney.....	16
6.	SALINITY AND DEVELOPMENT.....	20
6.1	The impact of urban development.....	20
6.2	The relationship between salinity and different developments	20
6.3	Salinity and the Planning System.....	23
6.4	Regional Environmental Plans (REPs).....	23
6.5	Local Environmental Plan (LEP's)	24
6.6	Zoning for Salinity Management	26
6.7	Development Control Plans.....	26
6.8	Salinity Policies and Guidelines.....	26
6.9	Notification under s.149 Certificates.....	28
6.10	Considering Salinity in the Development Process.....	30
7.	DEVELOPMENT ASSESSMENT GUIDELINES.....	33
7.1	Multi-lot Developments or Rezoning	33
7.2	Single lot development application.....	34
7.3	Map of Salinity Potential in Western Sydney.....	35
7.4	Identification of site locality	35
7.5	Consideration of existing reports or plans	36
7.6	Considerations for 'Medium' sized sites	36
7.7	Salinity Risk Activities	37
7.8	Voluntary On-site confirmatory assessments.....	37
7.9	The need for Site Specific Investigations	37
7.10	Recommended Salinity Investigations	38
7.11	Western Sydney Regional Salinity Information	39
8.	DEVELOPMENT MANAGEMENT GUIDELINES	40
8.1	Salinity Management Principles.....	40
8.2	The Role of Innovation in Salinity Management.....	40
8.3	Salinity Management Response	41
8.4	Use of Level One and Level Two Salinity Management Response checklists.....	41
8.5	Developing conditions of consent for sites in Areas with Salinity Potential	42
8.6	Use of Level Three Salinity Management Response	43
8.7	Suggested Management Strategies for each Western Sydney Salinity Process	44
8.8	Building Requirements for Areas with Salinity Potential	46
8.9	Vegetation and Landscaping Requirements for Areas with Salinity Potential	48
8.10	Road and Pavement Requirements for Areas with Salinity Potential.....	50
8.11	Stormwater and Drainage Requirements in Salinity Hazard areas.....	52
9.	IMPLEMENTING THE SALINITY CODE OF PRACTICE.....	56
9.1	Staff Salinity Training Sessions	56
9.2	Council Salinity Working Party (internal).....	56
9.3	Model Code of Practice Implementation Strategy.....	57
9.4	Alternative Adoption Strategies.....	58
10.	FUTURE DIRECTIONS AND RECOMMENDATIONS	59
10.1	On-going actions and future directions.....	59
10.2	Recommendations for Salinity Management in Western Sydney.....	62
11.	APPENDICES	66
11.1	Salinity Management Response Checklists.....	66
11.2	Map of Salinity Potential in Western Sydney.....	70

11.3	<i>Species List for Salt Affected Areas in Western Sydney</i>	71
11.4	<i>Western Sydney Education/ Awareness Brochures</i>	73
11.5	<i>FAQ (Frequently Asked Questions) Sheet</i>	74
11.6	<i>Salinity Information Databases (SALIS and Groundwater)</i>	76
12.	REFERENCES	78
13.	CONTACTS	80

List of Figures

Figure 1: Salinity Hazard for Australia, 2050.....	10
Figure 2: Salt affected land in Western Sydney.....	11
Figure 3: Salt affected buildings in Western Sydney.....	11
Figure 4: Salt affected roads in Western Sydney.....	12
Figure 5: Cost of Urban Salinity	12
Figure 6: Localised Salinity Model, Mitchell 2000	18
Figure 7: Shale Soil Landscape Model, Mitchell 2000.....	18
Figure 8: Deep Groundwater Model, Mitchell 2000	19
Figure 9: Deeply Weathered Soil Landscape Model, Mitchell 2000.....	19
Figure 10: Development and salinity (Figure: DIPNR 2002).....	20
Figure 11: Multi lot salinity assessment flow chart	33
Figure 12: Single lot salinity assessment flow chart.....	34
Figure 13: Salinity and slab on ground construction	46
Figure 14: Salinity and the damp proof course.....	47
Figure 15: The impact of roads on salinity processes.....	51
Figure 16: Salinity and Stormwater channels	54
Figure 17: Council Implementation Table.....	57

2. GLOSSARY

Capillary Rise: the movement of soil moisture through fine soil as the result of surface tension forces between the water and individual soil particles.

Connate salt: salt that is released from or stored in the parent rock material of a landscape.

Corrosivity: a measure of the ability of a soil, for example to deteriorate concrete, metal or other building materials.

Cyclic salt: salt that arrives in a landscape in the rainfall.

Discharge area: an area where groundwater seeps to the surface or to a waterway.

Dispersible: describes structural breakdown of soil into individual suspended particles in water.

Ecologically Sustainable Development: using, conserving and enhancing natural resources to maintain ecological processes and therefore quality of life, now and into the future.

Ephemeral: a stream or watercourse that runs only intermittently, for example during storm events.

Erodibility: the susceptibility of a soil to erosion, i.e. the removal of soil by water, rain, wind etc.

Groundwater: water beneath the land surface held in or moving through layers of soil, sediment or rock.

Hydrogeology: the study of water in or moving through soils and rock formations and the transport of materials (such as salt) that are either in suspension or dissolved in the water.

Perched water table: the upper surface of a localised watertable that is separated from the lower main body of groundwater due to rocks or impermeable soils.

pH: a measure of acidity or alkalinity.

Piezometer: a groundwater monitoring bore that can be used to measure groundwater height, as well as the types and levels of salts in the water.

Podsollic: a term applied to acid soils with strong texture contrast between loamy topsoils and clayey subsoils.

Reactive soil: a term used especially in the construction industry to describe clay soils that change volume with changes in moisture content. This can damage foundations.

Recharge: the portion of rainfall or river flow that percolates down through the soil and rock formations to reach the groundwater system.

Salinisation: the process by which land, or water, becomes salt affected.

Salinity: a term that refers to the soluble salt content of soil or water

Salinity Hazard: the inherent ability of a site to have a salinity problem due to its geology, soil characteristics, topography, catchment position and climate.

Salinity Potential: is used in this document to refer to the relative salinity hazard levels in Western Sydney as determined by a wetness model. The salinity potential map of Western Sydney also includes some known salinity sites where salinity hazard has combined with land use change to result in a salinity risk.

Salt: are compounds formed when the hydrogen ion of an acid has been replaced by a metal. Salts usually dissolve in water and form crystals when solid. Eg. common salt or sodium chloride, sulphates and carbonates of sodium or magnesium.

Sodicity: a measure of exchangeable sodium in the soil. High levels adversely affect soil stability, plant growth and land use.

Soil landscape: an area of land that has a recognisable and describable topography and soils that are capable of being represented on a map and being described by concise statements.

Soil Water: the water that is held in the soil in the spaces between the individual soil particles. When all the spaces are full of water the water is known as groundwater.

Surface water: water that moves across the land's surface, such as in creeks or rivers.

Water cycle: the process by which water moves through the environment, incorporating rain, surface water, groundwater and evapo-transpiration by plants.

Water table: the level below which the rock or soil is saturated with water. In some areas the top of this saturated zone can be at the ground surface.

Wiannamatta Group Shales: a group of shales found in Western Sydney that include those formed below or beside the prehistoric ocean and which therefore contain some connate salt.

3. ABBREVIATIONS

ABC	Australian Building Codes
BCA	Building Code of Australia
DCP	Development Control Plan
DIPNR	Department of Infrastructure, Planning & Natural Resources (formerly Department of Land & Water Conservation DIPNR & Planning NSW)
DEC	Department of Environment & Conservation
DPC	Damp Proof Course
ESD	Ecologically Sustainable Development
LEP	Local Environment Plan
LGSI	Local Government Salinity Initiative
NAP	National Action Plan for Salinity & Water Quality
REP	Regional Environment Plan
WSROC	Western Sydney Regional Organisation of Councils
WSUD	Water Sensitive Urban Design

4. THE WESTERN SYDNEY SALINITY CODE OF PRACTICE

This Code of Practice is intended to be a management tool for the Councils of Greater Western Sydney and to provide a guide to the options available to Local Government to address salinity problems.

The Code of Practice was produced as a guide rather than a model policy in recognition of the individual needs of Councils, the limits of our present knowledge and the variations in salinity problems and potential across the region. It is intended that each Council will identify and develop those aspects that best suit their situation and adopt these as their own Salinity Management Strategy.

The Code of Practice also provides information on urban salinity in Western Sydney, which may be of use to State Agencies and those involved in the development industry to assist in the development of better management practises.

The Salinity Code of Practice therefore aims to:

- ◆ **Provide information on the current best practise in Salinity Management for use in Western Sydney**
- ◆ **Encourage the adoption of a pro-active approach to Salinity Management**
- ◆ **Facilitate a coordinated, cohesive and cooperative approach to Salinity Management across Western Sydney**
- ◆ **Ensure salinity is considered as a land management issue throughout the land development process**

The Code of Practice recognises that any activity or development occurring in Western Sydney, which interacts with soil, vegetation, groundwater or surface hydrology, has the potential to contribute to and be affected by salinity. While the focus is on managing new development, it should be recognised that existing developments and activities in the region are also contributing to and being affected by salinity. These should also be considered in Salinity Management Strategies.

This document is intended as a guide only. The use of any options suggested here are no guarantees that salinity problems will not occur, or worsen. Information is based on current best knowledge and practise for general situations. Further investigations and professional advice should be sought when developing Salinity Management Strategies for a specific site.

5. BACKGROUND TO URBAN SALINITY

5.1 Introduction

Salt is a natural part of the Australian landscape and areas of naturally high soil or water salinity exist throughout the country. However, it has been increasingly recognised that land management practises are resulting in expansion of the areas of land affected by salinity. Correspondingly, salinity is having a greater impact on human activities and development.

Salinity has been recognised as a nationally significant environmental problem for some time. The Salinity Action Funding Program commenced in 1990 and the National Dry land Salinity Program was established in 1993. More recently a number of national and state reports and forums have highlighted the significant hazard of salinity across Australia. In response to this and public concerns, the National Action Plan for Salinity and Water Quality was announced by the Commonwealth Government in 2000 and the NSW State Salinity Strategy was launched in August 2000.

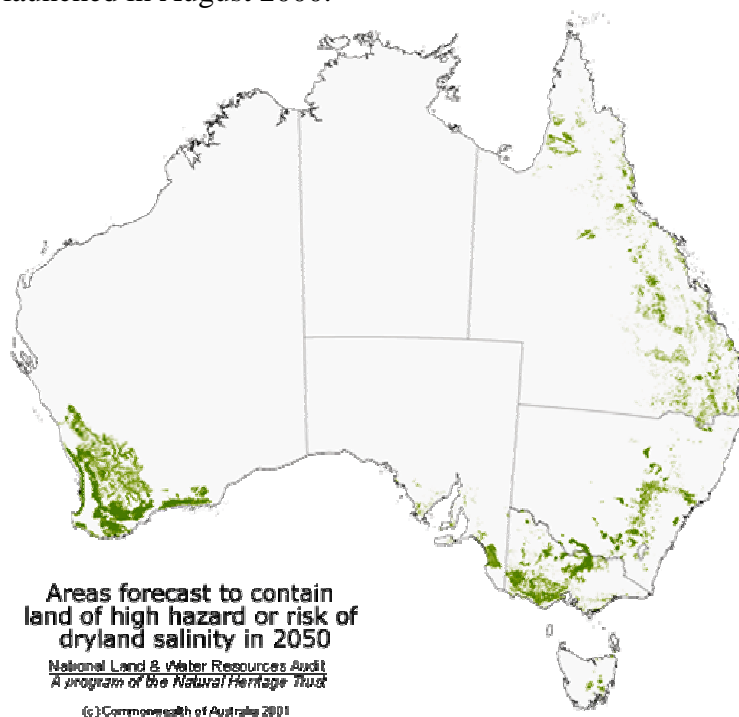


Figure 1: Salinity Hazard for Australia, 2050

While salinity is widely recognised as a problem in agricultural areas, the impacts of salinity are also being felt in urban areas. Urban salinity is now recognised as a growing problem with potentially high costs to the communities affected. The impacts go beyond the degradation of vegetation and soils and if unmanaged urban salinity can result in significant problems for a variety of urban infrastructure including buildings, roads, underground services, parks and gardens.

5.2 Urban salinity

Salinity occurs when salts naturally found in soil or groundwater mobilise, allowing capillary rise and evaporation to concentrate the salt at the ground's surface. Such movements are

caused by changes in the natural water cycle. In these areas, activities, infrastructure and resources on and above the soil surface may be affected.

In urban areas the processes which cause salinity are intensified by the increased volumes of water added to the natural system in urban areas. Additional water comes from the irrigation of gardens, lawns and parks, from leaking underground pipes and pools and from the concentrated infiltration of stormwater. Urban salinity can also be related to sub-surface water flows being impeded by structures such as roads and by poor drainage conditions on a site.

The surface impacts of urban salinity may include damage to vegetation similar to that observed in rural areas and may affect lawns, playing fields and private and public gardens. Potentially salinity in urban areas could also place additional stress on remnant natural areas such as bushland, wetlands, rivers and creeks.



(Photos: WSROC files, Western Sydney Sites)

Figure 2: Salt affected land in Western Sydney

Urban salinity affects built infrastructure, due to the chemical and physical impact of salt on concrete, bricks and metal. The Salt moves with water into the pores of bricks and concrete when they are exposed to damp, salt-laden soils. As the water is evaporated from the material, the salt concentrates and over time this can be substantial enough to cause corrosion and damage the material's structure. This is seen as crumbling, eroded or powdering mortar or bricks, the flaking of brick facing and the cracking or corrosion of concrete. The salt within the material can also have a corrosive effect on steel reinforcing. The long-term consequences can be structural damage.



(Photos: WSROC files, Western Sydney Sites)

Figure 3: Salt affected buildings in Western Sydney

Underground service pipes, such as those used for sewer or water supplies may also be damaged. Increased leakage from the pipes and corroded joints can drive the salinisation processes further.

Additionally, the waterlogging and salts associated with urban salinity have a considerable impact on roads and pavements. The road base can be physically and chemically degraded, becoming more susceptible to cracking, pot-holing and eventual failure.



(Photos: WSROC files, Western Sydney Sites)

Figure 4: Salt affected roads in Western Sydney

Such impacts on public infrastructure contribute to the high community costs from salinity. In the Murray Darling Basin it is estimated that approximately 60% of non-agricultural costs due to salinity are from road damage (Murray-Darling Basin Salinity Audit 1999).

Much of the cost of urban salinity will be borne by local authorities in the form of increased infrastructure repair and replacement, decreased useability of assets and environment, increased environmental obligations and a potentially reduced rate base. While cost figures cannot be directly transferred from one area to another, the following table from Wagga Wagga City Council gives a general indication of the potential magnitude of costs in urban areas. The figures are the annual recurring costs for approximately 1/9th of the Local Government Area, if nothing is done.

Roads	\$ 226, 000
Footpaths	\$ 4, 400
Parks	\$ 103, 400
Houses	\$ 72, 500
Industrial	\$ 6,000

Source: Annual recurring costs of Salinity in Wagga Wagga, Christiansen 1995

Figure 5: Cost of Urban Salinity

5.3 Managing urban salinity

Salinity is a complex problem that can operate at both a local and regional scale. With the changes to surface flow and groundwater systems related to urban development, mapping the occurrence and impacts of urban salinity is difficult. Additionally, salinity is a process with lags between cause and effect, both in time and distance, which make it difficult to model.

Salinity problems can change substantially over time. It is difficult to predict exactly where salinity will occur and how it will respond to the changing environmental conditions. It is important that management strategies reflect the level of uncertainty.

Approaches to urban salinity management need to be pro-active and precautionary, with efforts focused on avoiding potential salinity problems when development occurs, rather than trying to treat salinity problems once they are identified. This means that some activities will need to be managed on the basis that they may contribute to a salinity problem, without having certainty of how they do contribute. This approach is in keeping with the principles of ESD, as included in the Local Government Act amendment of 1999.

At its most fundamental, urban salinity management is about sustainability, both of the development being proposed, and of the locality and region where the development is situated. The costs and damage associated with urban salinity not only affect the individual property owners, but are also transferred on to the community as a whole through damage to roads, infrastructure and recreation facilities and even potentially through declining land values. Urban salinity and the damage it causes can be seen as a potential future cost that needs to be incorporated into the cost of the urban development process.

Nationally, a number of areas have been managing urban salinity for years and programs exist which may provide guidance for the best practice management of urban salinity in Western Sydney. Western Australia has recognised the impact of dry land salinity on rural towns and established a Rural Towns Program in 1997. Wagga Wagga City Council acknowledged that they had a problem with urban salinity in 1994 and as a result they have developed and implemented a series of Salinity Action Plans. Dubbo City Council has also recognised that there is an urban salinity problem in their city and has developed a Salinity Management Strategy. Additionally many towns in the irrigation districts of NSW and Victoria have been managing urban impacts from irrigation salinity.

At the Federal and State level, initiatives to address urban salinity are more recent. The Commonwealth National Action Plan does recognise urban salinity impacts, but does not treat it as a separate issue. The NSW State Salinity Strategy specifically recognises urban salinity and has established an Urban Salinity Team to develop management options. This includes a Local Government Initiative to assist Councils in managing urban salinity. There is also a move to review the Australian Building Code in order to provide a national standard for building in salt-affected environments.

This Code of Practice attempts to link National, State and local initiatives within a regional management framework to provide a coordinated response to urban salinity in Western Sydney.

5.4 Salinity as a Cross Boundary issue

A cross boundary issue is one that has the potential to manifest its effects in a different area to that where the factors contributing to the problem occur. Due to the relationship between salinity and the water cycle, salinity is an issue with the potential to cross boundaries. This can be at the local scale, eg, between building sites and at the regional scale, such as between local government areas.

An example of a local scale impact is the construction of a road which may change groundwater flow conditions by causing an impediment to flow. This can result in groundwater discharging or collecting on adjacent property, potentially creating salinity problems for that property.

At a regional scale there are the cumulative impacts of a new development that significantly increases the amount of water in the system (due to changed drainage, increased infiltration and increased water use). Such a development may contribute to an accumulation of groundwater lower in the catchment, increasing the salinity problem in this area.

Cross boundary problems may have implications for liability and for on-going management strategies. The potential for cross boundary impacts needs to be carefully considered as part of the assessment of urban salinity and effectively addressed in any Salinity Management responses or plans for a site.

Through regional cooperation and coordination, such as involvement in the Western Sydney Salinity Working Party and the use of the Salinity Code of Practice, councils in Western Sydney can better understand and manage such cross boundary issues.

5.5 Cumulative Impacts and Salinity

Cumulative impacts are an important part of natural resource management and, increasingly, best practice management seeks to find ways to address them. Cumulative impacts refer to the way in which a problem may be caused gradually, due to the accumulation of effects from several contributing factors, or events. These factors, or events, may be separated by space, such as cross boundary issues, or by time, and may be a series of different and seemingly unrelated occurrences. In some cases the individual events or factors may be relatively small and seemingly insignificant. It is the way in which the effects combine over time and space and interact with each other and the environment that produces a cumulative impact.

Cumulative impacts can be difficult to anticipate through the standard assessment processes due to:

- the potential for multiple contributing factors,
- their removal in time and space from the effect and each other, and
- the complexity of the interactions involved.

Special consideration should be given to developments where salinity has the potential to involve cumulative impacts. The most obvious is the often-used example of the role of vegetation in the rising groundwater model. The cumulative effects of vegetation loss in a catchment contribute to a changed water cycle, which can result in a salinity problem. The removal of each individual tree is not sufficient to create the problem, it is the cumulative effect of the removal of many trees over time and across the whole catchment, plus the effect

of regularly cropping or grazing. This example is simplistic, but shows clearly the role of cumulative impacts in relation to salinity.

A more relevant urban example is found in the role of increased water input contributing to salinity. Factors such as increased urban water use, irrigation of gardens and playing fields, infiltration of stormwater and leakage from sewer and water pipes all result in substantially increased water input in the water cycle. However, on any one site the total increase in water may seem minor. It is the cumulative impact of the increased water inputs on all sites over time that results in the problem.

It is therefore important that when the potential salinity impacts of a development are considered, the potential cumulative impacts are also assessed. It will be necessary to develop salinity management responses or plans that not only address the immediate impacts, but also address the potential for cumulative impacts. A site which is in an area of moderate salinity potential may seem to have little potential to create a salinity problem on the site, but will still need to address the possible contribution to off-site and regional salinity problems. An example may be by limiting water use on the site, therefore limiting its contribution to changes in the local and regional water balance.

5.6 Salinity in Western Sydney

Salinity has long been recognised in Western Sydney, with references being made to saline groundwater and brackish creeks in historical accounts from the early 1800s (Mitchell 2000). The ecosystems of the region, particularly the Cumberland Plain Woodlands and Riverflat forests contain a number of salt tolerant species. This suggests that the region has naturally high levels of salt in the groundwater and that in places this groundwater is naturally close to the surface. A list of salinity indicator species is included in Appendix (11.3).

The possible sources of salt in Western Sydney are from the region's geology and climate. The main geological formations of Western Sydney are the Wianamatta Shales, which formed in coastal and marine environments and have a naturally high fossil (connate) salt content (McLean and Jankowski 1999). As well as Western Sydney being close to the coast, approximately 10 to 20 kilograms per year of salt are added to each hectare of land, primarily by rainfall (Mitchell 2000). Most of this salt is flushed through and transported away from the area. However, some is added to the soil and groundwater where it accumulates.

In 1942 a paper was produced by the Department of Agriculture (Old 1942) describing the occurrence of saline groundwater across the region and hypothesising that this was related to the distribution of Wianamatta Group shales. This paper explored why groundwater bores in the region were generally unsuitable for agriculture or domestic use.

Salinity was recognised as a surface environmental problem in the region by the former Soil Conservation Service in the 1960s. However, it was not widely acknowledged as an urban issue until 1997, when the Department of Infrastructure, Planning & Natural Resources released the report *"Salinity in the South Creek Catchment"* (Dias and Thomas 1997). This report found that approximately 5% (4500ha) of land in the study area was affected by salinity and that a further 20% (19000ha) of land in the study area could potentially be affected. In association with this DIPNR appointed a Salinity Awareness Officer and a research program was developed with particular focus on urban salinity.

The Western Sydney Salinity Working Party, hosted by WSROC, was established in 1999. This group has representatives from each of the 14 Councils in Greater Western Sydney, as well as from relevant agencies and the development industry. The Working Party is raising the awareness of urban salinity problems in Western Sydney and is a forum where the stakeholders involved can discuss management options and develop opportunities for regional cooperation. WSROC, in partnership with DIPNR, received funds from the Commonwealth's Natural Heritage Trust, to develop this Code of Practice for Salinity Management in Western Sydney and the working party has assisted in the development of this document. Beyond this project the Western Sydney Salinity Working Party will continue to have a role as a regional forum for the discussion of salinity management issues, the balancing of conflicts and the identification of opportunities for cooperation and information exchange.

In 2000 the Western Sydney Environment Taskforce identified salinity as one of the top five key environmental issues for the region, following a survey of 200 stakeholders. The Taskforce therefore created a Salinity Working Group, chaired by DIPNR, to formulate a strategic regional response to managing the issue. This group has facilitated regional salinity potential and monitoring projects and has an on-going role to ensure a comprehensive and coordinated approach in the region.

A Draft Salinity Hazard Map was released in December 2000 and a larger Map of Salinity Potential in Western Sydney in 2003. The map covers most of Western Sydney and depicts potential salinity zones as well as some areas with known salinity problems. It provides a management tool to better conceptualise salinity problems and a basis from which to develop management strategies. The map and the models behind it show that salinity may occur right across the region and the map confirms that salinity is associated with the Wianamatta Group shales and their derived soil materials. It also indicates that there is likely to be more than one mechanism driving the problem and emphasises the importance of poor drainage and waterlogging in determining the severity of salinity problems. (For more information on the Salinity Potential map and its limitations see s7.3.). Currently this mapping is being extended and reviewed in light of some of the early data available from the piezometric monitoring program being conducted by DIPNR. It should be available to the councils in the region by mid-2003.

5.7 Salinity Processes in Western Sydney

Over the last decade there has been a widespread reliance on a single model to explain salinity process, based on Northern Victorian studies. This model uses the concept that the removal of vegetation from hills and slopes results in an increased flow of water to saline groundwater ('recharge'). This groundwater then begins to rise, emerging at lower lying areas in the landscape ('discharge').

The acceptance of this model has been behind most of our assumptions about how to best manage salinity. In particular, this model promotes the belief that planting deep rooted vegetation in key 'recharge' areas will address the low-land problems. However, questions are now being raised as to this model's applicability to all sites and the suitability of management strategies based on this model for all salinity problems.

There are several models that may explain salinity processes and as our conceptualisation of salinity problems determines the types of strategies we develop to manage the problem, it is

essential that we develop models that reflect the actual processes and experiences in each situation. It is also important that we recognise the limitations of such models and that we remain prepared to amend them as new knowledge is developed.

In producing the Salinity Potential Map, the Department of Infrastructure, Planning & Natural Resources developed a number of alternative models of processes by which salinity may be occurring in Western Sydney. These are based on the work of Mitchell (2000) and are discussed in a technical report "Salinity Process in Western Sydney" available from DIPNR later this year.

In these models separate 'recharge' and discharge' areas are not defined. All of the landscape could be considered to be recharge areas and the particular processes operating on that site at a particular time could determine the locations of discharge areas.

Identifying the processes causing salinity is necessary when assessing a site to allow the most appropriate and effective management responses to be identified.

In summary, there are a number of processes and indicators associated with salinity in Western Sydney and these may occur on a site individually, or in combination with each other. Some of the key salinity processes are described as follows;

Localised concentration of salinity

On a number of sites in Western Sydney salinity problems have been observed that are caused by localised concentration of salts due to the relatively high evaporation rates. The salt source is probably cyclic salts delivered in the rainfall (approx. 12-15 kg/ha/yr) and the problem is usually associated with waterlogged soil and poor drainage. For example, in areas where surface and sub-surface flow is blocked by an impervious surface such as foundations, walls, paving or concrete. Where frequently wet/damp soil is in contact with bricks or concrete these materials act as a 'wick' to the water and salt and as the water evaporates, the salts concentrate within them. This salt can cause damage in susceptible material over relatively short periods of time.

This process can also cause salinity problems in areas of porous soils adjacent to more permanent water bodies eg. Stormwater basins or artificial lakes. It should be noted that this process is not associated with particularly high salinity levels and the increased water use associated with urban developments can exacerbate the problem. Management of this process on sites needs to focus on reducing water use and improving drainage. Buildings and structures need to be designed to minimise the interference with natural water flow on the site and to minimise rising damp and evaporation through bricks, pavers and concrete. Particular attention should be given to the proper installation of damp courses.

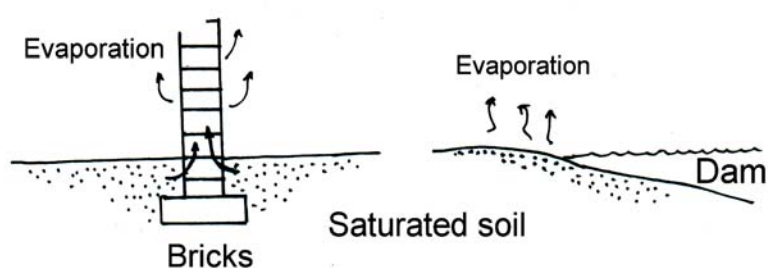


Figure 6: Localised Salinity Model, Mitchell 2000

Shale Soil Landscapes

A number of soil landscapes in Western Sydney have poorly drained duplex (texture contrast) soils. The topsoil (A horizon) is usually a loam and subsoil (B Horizon) is typically clay. As water moves more easily through loams than clays, in many of these soils, shallow soil water flows laterally across the upper B-horizon. Salt therefore usually accumulates in the clayey B-Horizon section of the soil.

The surface expression of this salinity occurs in areas where the soil water accumulates and seeps to the surface and where evaporation causes the salts to concentrate. This is common on lower slopes, or on natural and constructed flats in mid-slope across much of Western Sydney.

Salinity can also cause sodic soils and is a problem in a number of the soil landscapes of Western Sydney. These soils are defined by the dominance of sodium in the exchangeable ions of the sub-soil or B Horizon. These soils also tend to be highly dispersive, erodible and poorly drained. Sites containing sodic soils require careful management in order to minimise disturbance and avoid salinity and erosion problems.

Additionally, when sub soils are exposed by the depth of the cut, or when buildings or infrastructure are placed in a way that exposes them to the B- horizon or causes water accumulation, salinity can become a problem. Where the saline soil is exposed re-vegetation can be very difficult and on-going erosion can result in the further exposure of saline material. Information on the soil salinity at various depths and the depth of the B-horizon is needed to determine the depth of cut and the necessary exposure classification of structures. On affected sites the impeding of sub-surface water flows and disturbance of the B-horizon needs to be minimised. It should be noted that on some of these sites the situation is complicated by deep groundwater interactions.

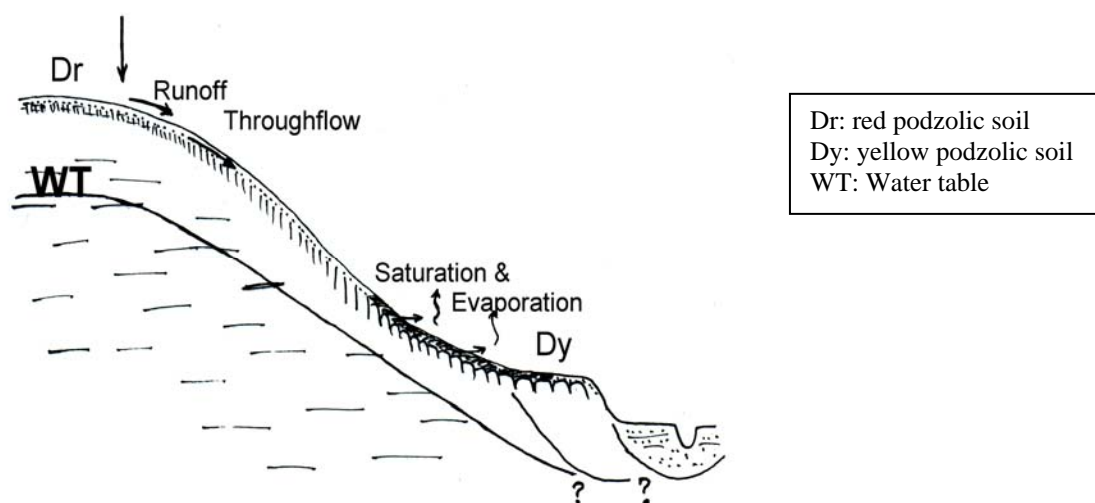


Figure 7: Shale Soil Landscape Model, Mitchell 2000

Deep Groundwater Salinity

This form of salinity is more like that depicted in the traditional salinity model. Salinity problems occur when brackish or saline groundwater rises to a level where capillary action in

the soil allows the water and dissolved salts to reach the surface, where they concentrate over time. Groundwater rises are caused by increased water infiltration and may relate to above average natural rainfall, vegetation loss, irrigation, increased water use in urban areas, or construction of seepage pits or surface water bodies.

When groundwater rises to a level where capillary action brings it in contact with buildings or infrastructure, or where developments intercept the groundwater, damage due to salinity can occur. It should be noted that the depth for capillary movement varies depending on the soil type and may be as great as several metres. Additionally, the rate of groundwater rises associated with urban development can be substantial and often unpredictable. Management strategies need to reduce water infiltration, maintain natural water balance and maintain healthy vegetation in order to address this salinity process. In some cases groundwater drainage may be an option, but careful attention must be given to water quality and disposal.

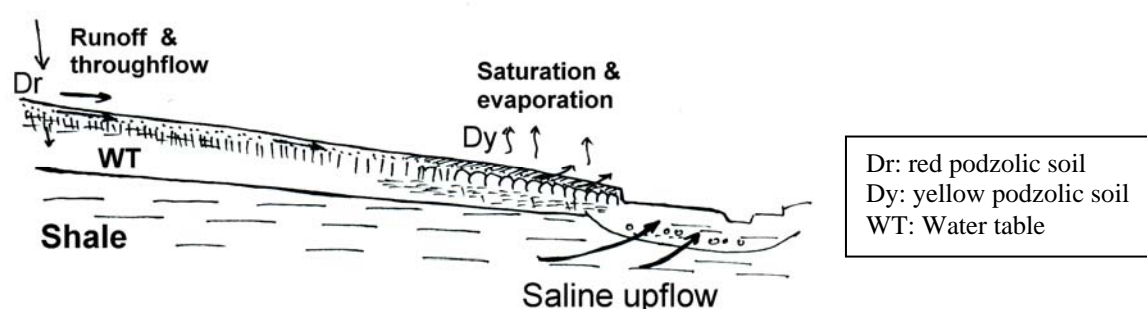


Figure 8: Deep Groundwater Model, Mitchell 2000

Deeply Weathered Soil Landscape

There are a number of sites in Western Sydney which have high salt loads and where the evaporated salts have been found to have high sulphate levels. It is believed that salinity in these areas is related to un-mapped deeply weathered soil landscapes, made up of fluvial gravel, sand and clay. Salinity problems associated with these sites are often mid-slope and hilltops may be affected due to perched saline watertables.

Sulphates are very aggressive in their impact on concrete and brickwork. The identification of areas affected by this type of salinity is very important and the use of building material resistant to sulphates is recommended.

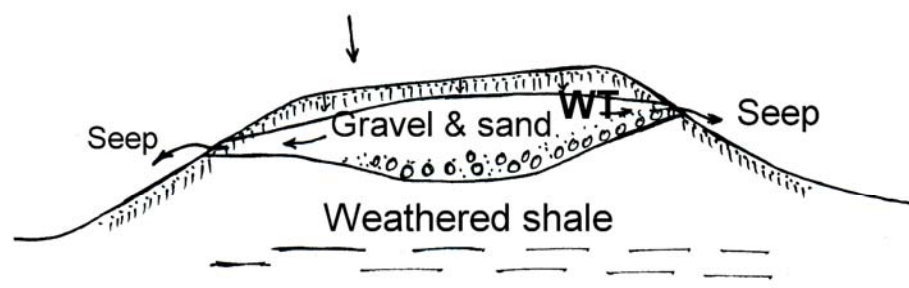


Figure 9: Deeply Weathered Soil Landscape Model, Mitchell 2000

6. SALINITY AND DEVELOPMENT

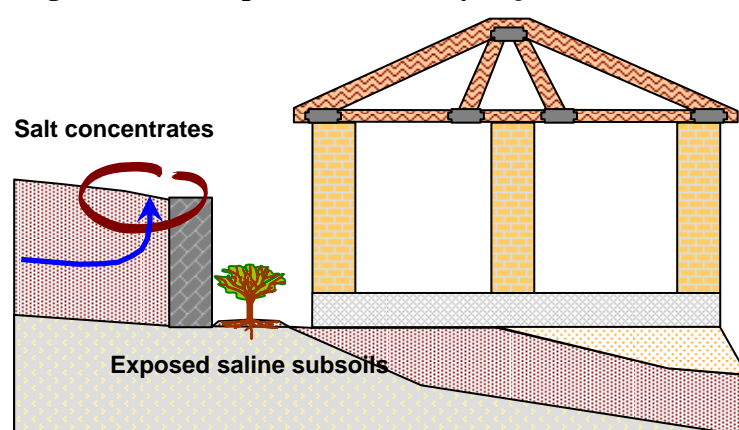
6.1 The impact of urban development

While the impact of salinity on urban development is increasingly being considered in areas with a salinity potential, the potential impacts of development on salinity must also be given equal consideration.

In Western Sydney urban development may contribute to salinity problems in the following ways:

- **By exposing sodic or saline sub-soils.** When areas are developed the processes of cut and fill, particularly for slab on ground construction, disturbs the upper layers of soils. If the lower soil profile has saline or sodic properties, this can result in the occurrence of salinity problems and erosion. This may also lower the surface closer to the water table.
- **By increasing the level of regional groundwater and encouraging the development of perched water tables.** Urban development tends to increase the amount of water entering the natural system, eg, the irrigation of parks and gardens, leaking stormwater and sewer pipes and changes in stormwater flows and concentrations. As well, compaction and fill changes permeability and soil drainage and can contribute to the creation of perched water tables.
- **By changing soil groundwater flow and creating areas of impeded drainage or forced discharge.** This can result in sub-soil salinity being expressed on the surface at these points, eg, where roads, house slabs, retaining walls or trenches impede or intercept the soil water flow, cause compaction, or create hydraulic pressure that raises groundwater.
- **By developing or disturbing areas sensitive to salinity.** Some areas exist in a delicate balance that, once disturbed, are difficult to restore and rapidly deteriorate, eg, removing established salt resistant vegetation in riparian corridors could increase erosion and down stream disturbances.

Figure 10: Development and salinity (Figure: DIPNR 2002)



6.2 The relationship between salinity and different developments

The following table gives some of the main development types or activities in urban areas and outlines the potential salinity impacts and general management options that might be considered in each case.

RELATIONSHIP BETWEEN SALINITY AND DIFFERENT DEVELOPMENTS			
Development/ Activity Type	Potential Impact of Salinity on development	Potential Impact of development on salinity	Management Options for considerations
Sub-division, multi-lot developments eg. Housing estate, industrial estate	<ul style="list-style-type: none"> • May act as a limit on the capability of the land to sustain the development proposed. • Groundwater or soil salinity may result in damage to buildings, infrastructure, eg roads, underground services, as well as parks and reserves. • Waterlogging associated with groundwater or drainage may result in deterioration of infrastructure and accelerate salinity. • Salinity damage may have long term impacts on perceived land/property values and increased maintenance costs to the community. • Salinity may limit the effectiveness of stormwater or wastewater treatment systems. • Flooding due to raised groundwater 	<ul style="list-style-type: none"> • Clearing of native vegetation (trees, shrubs and grasses) may change the rates of evapo-transpiration and therefore the water balance, contributing to increased salinity. • Increased water inputs associated with urban development eg garden watering, leaking pipes, may increase outbreaks of soil salinity and/or rising groundwater. • Changed flow and drainage patterns may result in increased water accumulation and associated salinity in areas of impeded flow eg. drainage lines, retaining walls, footings and roads. • Use of recycled water or on-site waste-water re-use systems may result in increased salt loads in soils and waterways over time, as well as water logging. • Stormwater management systems involving detention or infiltration may contribute to rising groundwater levels, perched watertables or surface expressions of soil salinity. • Exposure of sodic or saline soils. 	<ul style="list-style-type: none"> • Need to understand the land capability in relation to salinity. • Undertake site specific salinity investigations, including hydro geological assessments. • Prepare management plans, precinct plans, DCPs and other guidelines for the site in light of salinity investigations. • Design infrastructure, including roads, pavements, stormwater system, underground services, parks and community facilities to minimise the impact of salinity and reduce the long-term maintenance costs. Should also address the impact of the development on salinity processes. • Good soil management practises to reduce exposure of problem sub-soil material.
Single lot developments eg. Typical house, extensions or renovations to existing properties	<ul style="list-style-type: none"> • Salinity associated with soils or groundwater may result in damage to the property, including driveways, gardens, underground services and paving/fences. • Waterlogging associated with poor drainage or groundwater may result in property damage or contribute to salinity problems. • Building directly exposed to saline sub-soils through building techniques used. 	<ul style="list-style-type: none"> • Increased water inputs from the site due to garden watering, leaking pipes and leaking swimming pools, contributing to increased outbreaks of salinity and/or rising groundwater. • Changed water flow and drainage may result in areas of water accumulation and associated salinity eg, retaining walls, footings, paving, driveway, landscaping. • On-site stormwater or wastewater treatment may contribute to localised salinity, raised water-tables and/or increased salt loads. • Exposure of sodic or saline sub-soil. 	<ul style="list-style-type: none"> • Use of salt resistant materials and construction techniques where necessary, eg, for buildings, driveways, underground services etc. • Development designed and maintained to provide good drainage on the site and avoid waterlogging. • Properly installed and maintained DCP, stormwater drainage and guttering, outdoor taps and irrigation. • Landscaping based on water wise gardening and gardens not placed against the building. Use of appropriate species. • Good soil management practices on the site to reduce sub-soil exposure.

Irrigation Developments eg intensive agriculture, effluent disposal, sporting fields, major gardens/ landscaping, golf courses.	<ul style="list-style-type: none"> Increased salinity may reduce agricultural productivity, or damage sporting fields, landscaping and greens. Could result in increased maintenance and production costs. Salinity in the soil may limit the effectiveness of effluent disposal systems in retaining nutrients and disposing of water. 	<ul style="list-style-type: none"> Increased water inputs may contribute to rising groundwater levels, or the surface expression of soil salinity. Fertilizers and effluent may result in increased salt loads in the soil. 	<ul style="list-style-type: none"> Careful investigation to assess the area's capability and salinity potential. Consideration of regional recharge/ discharge patterns when siting such developments. Water wise agriculture/ gardening practises, including suitable species. 'Smart' irrigation systems. Controlled use of fertilizers and consideration of salt loads when designing effluent disposal system.
Stormwater Management Works	<ul style="list-style-type: none"> Salinity or rising groundwater can affect drainage infrastructure, causing damage to pipes, causeways and detention basins. Reshaping and excavation may place infrastructure below the water table or in contact with saline sub soils. Salinity may limit the effectiveness of infiltration based systems to retain nutrients and dispose of water. Raised water tables and increased water logging associated with salinity may increase flooding. Salinity in soil and water may affect vegetation in wetlands, channels , swales and along creek banks. 	<ul style="list-style-type: none"> Increased water inputs or system leaks may contribute to rising groundwater levels, or the surface expression of soil salinity. Changed water flow patterns and rates may result in increased salinity in areas of water accumulation, eg, riparian zones, poor drainage areas, areas of impeded flow. Stormwater management systems involving detention or infiltration may contribute to rising groundwater levels, perched watertables, or surface expressions of soil salinity. Interception of saline groundwater can result in saline discharge to creeks. 	<ul style="list-style-type: none"> Careful investigation to assess the areas capability for the development proposed. Consideration of regional recharge/ discharge patterns when planning such developments. Limited focus on infiltration and un-lined detention basins in areas with a salinity potential. Careful consideration of proposals associated with an irrigation development. Use of salt resistant materials and construction techniques.
Road Construction/ maintenance	<ul style="list-style-type: none"> Salinity can affect materials in road seals, base and kerbing, causing damage and shortened lifespan. Damage to the seal or edge may allow water to get into the road. Rising water tables, perched water tables, or accumulating soil water can weaken road bases. 	<ul style="list-style-type: none"> Cut of the road may intercept or impede natural drainage, causing areas of water accumulation and associated salinity. Cut of the road may intercept groundwater levels, create a perched watertable, or cause increased recharge to groundwater Cut of the road may expose saline or sodic soil materials, causing salinity and erosion. Compaction of the road may impede natural drainage, or result in an increased pressure and discharge of groundwater. 	<ul style="list-style-type: none"> Road designed to avoid impeded drainage, interception of flow or groundwater, or recharge. Road designed to avoid excessive compaction in areas with raised water-tables. Good soil management practices to minimise exposure of sodic or saline sub-soils post construction. Use of salt resistant concrete and other materials in construction and repairs.

6.3 Salinity and the Planning System

As the problems of salinity and its impact on development are related to land use, the planning system has an important role to play in the effective management of salinity. It is also an important means of managing the changes associated with development that have the potential to cause or exacerbate salinity problems, both on and off site.

Given that Local Government has the primary responsibility for land use planning, planning controls are an important tool that local government needs to consider as part of any Salinity Management strategy. The following section briefly discusses the options available to individual councils for the management of areas with salinity potential within the current legislative planning framework.

The use of the planning system to manage salinity needs to be flexible in its approach to accommodate the dynamic nature of salinity problems, the changing salinity status of land and development of best practice.

This document does not favour any particular route because the choice should be made by the Council concerned in the context of the scale and nature of their particular problems and with due regard to the actions of their neighbouring councils. The examples are not provided as recommended best practice, but rather to illustrate the approach being discussed.

6.4 Regional Environmental Plans (REPs)

REPs should recognise salinity as an important issue and should include general requirements for areas with salinity potential to be identified and properly investigated, and for appropriate management strategies and plans to be produced for developments. These strategies need to recognise both the impact of salinity on the proposed development and the impact the proposed development may have on salinity problems.

The inclusion of salinity in regional planning instruments will provide an important support for local planning mechanisms. This will need to be complemented by consistent responses from statutory authorities in the region.

EXAMPLE from Sydney Regional Environmental Plan No 30-St Marys

Part 7- DEVELOPMENT CONTROLS

Clause 51: Salinity and highly erodible soils

- 1) The consent authority must not grant consent to the development of any land unless it has considered:*
 - a) A detailed soil assessment which indicates whether the land is at risk from salinity or contains soils which are highly erodible; and*
 - b) Whether the proposed development incorporates appropriate building materials, techniques and land management measures to mitigate adverse environmental impacts; and*
- 2) The consent authority must not consent to the development of land so affected unless it is satisfied that appropriate measures have been incorporate or are able to mitigate the potential impacts. (Also identified in Clause 29:Soils).*

When including salinity in regional plans for Western Sydney both soil and groundwater salinity should be identified as issues to be addressed.

The proposed reforms under PlanFirst may be of relevance to salinity management and may result in salinity being better incorporated into the planning system. Relevant government policy on salinity could be incorporated into a single state planning policy and this would then feed into regional strategies and local plans.

6.5 Local Environmental Plan (LEP's)

Salinity could also be addressed as a head of consideration in the Local Environmental Plan for an area.

In areas with a salinity potential the LEP could identify the broad levels of salinity potential and the type of salinity management response that would be required for different types of development for each level. In most cases this would have to lead to further investigations or considerations, as generic salinity management strategies based on the broad scale mapping of salinity potential areas are not likely to be effective. Salinity is a dynamic problem and predictive mapping in a changing urban environment is difficult and often unreliable. The best salinity management strategies for development are based on site specific investigations or considerations. For this reason at the LEP level councils are better indicating the need for further consideration and assessment of the salinity requirements of developments rather than trying to give generic management responses for each site and development type.

EXAMPLE: Dubbo LEP 1997-Rural Areas (Clause 28)

Section 28- Dry land Salinity

- (1) The environmental management objectives of this plan for dry land salinity (and the objectives of this clause) are to prevent further spread of dry land salinity and remedy existing areas of salinity.*
- (2) This clause applies to land within Zone 1 (A) that is identified as “salt outbreak” on the map entitled “Soil Conservation Service of NSW: Soil Erosion Survey- 1:100,000 Narromine”.*
- (3) A person must not, except with the consent of the Council, carry out any development on land to which this clause applies which involves the removal or destruction of native vegetation.*
- (4) This clause does not require consent for any such development if there is a requirement made by or under an Act other than the ‘Environmental Planning and Assessment Act 1979’ for the development to be licensed or approved by a public authority other than the Council.*
- (5) Consent must not be granted for any such development unless the Council has considered a dry land salinity impact assessment that demonstrates how the proposed development is consistent with the objectives of this clause. The dry land salinity impact assessment may address the following matters:*
 - (a) Whether the loss of the vegetation will potentially result in increasing soil salinity,*
 - (b) Any comments furnished by the Department of Land and Water Conservation,*
 - (c) Any mitigation measures to be undertaken.*

This example clearly focused on dry land salinity management in a rural context. However, the basic concepts could be used to develop a clause for urban salinity. In a simple example:

Section XX- Urban Salinity

- (1) The environmental management objectives of this plan for urban salinity (and the objectives of this clause) are to prevent further spread of urban salinity and remedy existing areas of salinity.
- (2) This clause applies to land within Zone 1 (A) that is identified as being within a 'locality' affected by "moderate salinity potential" or "known salinity" on the map entitled "Salinity Potential in Western Sydney (DIPNR 2003)".
- (3) Consent must not be granted for any such development unless the Council has considered urban salinity in the manner detailed in the "Salinity Code of Practice (or Salinity Policy)". The council may particularly consider the following matters:
 - (a) Whether any aspects of the development will potentially result in an increasing occurrence of soil or groundwater salinity, locally or regionally,
 - (b) Whether all aspects of the development are sufficiently protected from potential salinity problems,
 - (c) Any comments furnished by the Department of Infrastructure, Planning & Natural Resources,
 - (d) Any mitigation measures and/or management strategies to be undertaken,
 - (e) Whether any on-going monitoring of conditions on the site is required.

DIPNR is in the process of reviewing LEP provisions for urban salinity. Draft model LEP provisions are being prepared for discussion and should be generally consistent with approaches contained in this code. This would provide further guidance for the development of LEP clauses in the region.

Once salinity has been identified as an issue in the LEP the details of how it is to be further considered and addressed can then be included in associated policy documents. This allows greater flexibility and the opportunity to update the specifics as more is learnt and best practice management develops.

An initial assessment of broad salinity potential could be undertaken as part of local environment studies prior to the LEP development process. The level of such assessment would have to depend on the scale and purpose of the LEP being developed. Alternatively, the LEP could refer to some of the broad-scale salinity assessment tools available, such as soil or geology maps, or the DIPNR Salinity Potential in Western Sydney maps.

The areas of salinity potential identified can then be considered for further investigations, management plans, or generic management responses for various development types in the area. The following section (Section 8) makes suggestions as to how such requirements could be included in the development assessment system.

6.6 Zoning for Salinity Management

It is possible to use some of the zonings in existing LEPs to achieve salinity management objectives.

Riparian corridors are protected under the Rivers and Foreshore Improvements Act 1948. As many of the areas of high salinity potential are along the riparian corridors of the region, this may be an additional reason to consider protected zoning for these areas. Low-lying areas of poor drainage, for example 'swampy' or waterlogged areas, may also be better zoned for environmental protection. The retention of existing native vegetation is also important for salinity management and this gives an additional reason for protecting these areas, which can be done within a general LEP.

The zoning of areas which allow landuses with high water use such as turf farming, golf courses, market gardens, major irrigation, should consider the salinity potential of the area and the likely impact the activities will have on local and regional salinity problems, particularly groundwater and water logging. Areas zoned to allow on-site sewerage treatment, water re-use or disposal, or major stormwater detention/ infiltration also need to consider salinity impacts, both locally and regionally.

Consideration should also be given to the salinity impacts of activities other than urban development, for example agricultural activities. Where it is possible to place controls on these activities, eg under the Native Vegetation Conservation Act 1997, this should be done in a manner that aims to avoid increased clearing or increased water input on land identified as having a salinity potential. This may be particularly important in agricultural zones adjoining urban or future urban release areas.

6.7 Development Control Plans

Rather than include specific investigation and management requirements in the LEP it may be more appropriate to produce DCPs to cover these details. Given the rapidly changing level of information about salinity and its management, it will be easier to up-date these documents to include current best practice.

DCPs could cover salinity investigation requirements, the development of salinity management plans, building and design requirements for areas with salinity potential, stormwater and drainage design in areas with salinity potential, vegetation management strategies, waste-water re-use systems in areas with salinity potential and road and paving requirements. An alternative may be to include a reference to salinity or the Code of Practice in existing DCPs for these issues.

6.8 Salinity Policies and Guidelines

Alternatively, salinity management strategies could be detailed in policies or guidelines, which could be used to support an LEP requirement that salinity be considered. This has been the approach taken by a number of Councils managing salinity in NSW and Victoria

One approach is to develop a separate Salinity Management Policy, which could outline the nature of salinity issues for the council and the responses they intend to take. This is the

approach that has been taken by Tamworth City Council in their *Salinity and Groundwater Management Policy*, November 2002.

Alternatively, other councils have developed policies for specific areas or actions which address salinity issues:

EXAMPLE: Wagga Wagga Rezoning Policy 1998

Purpose of policy: The policy was developed in order to provide information to assess the impact a change in landuse associated with a rezoning application may have on the regional watertable.

Requirement of the Policy:

Applications are required as part of the environmental study for rezoning applications to provide an assessment of the current salinity status of the land and the affect the change in landuse will have on this salinity status. The desktop and field investigations such as observation of vegetation species shall provide details including:

- *Depth to weathered and fractured rock*
- *Soil profile*
- *Location geology*
- *Drainage*
- *Vegetation (existing and proposed)*
- *Erosion*
- *Potential groundwater recharge and discharge areas*
- *Impact the proposed land use change will have on the water cycle of the area*
- *Best management practices to be employed to prevent adverse impacts to groundwater and the impact groundwater may have on surface conditions including structures.*

In the case of Western Sydney any such policy should address soil salinity as well as groundwater salinity. The following are suggested as additional points requiring details to those given above:

- Depth to watertable and electrical conductivity of the groundwater
- Soil profile - including chemical information with regards to salts

DIPNR has produced a booklet containing information on salinity investigations. These could be used as the basis of a policy or DCP requiring specific site investigations.

For Councils who are not yet ready to adopt such specific policies an Interim Salinity Policy may be appropriate, to give a basis to any salinity management guidelines, or to allow consideration of salinity issues when approving developments.

EXAMPLE: Baulkham Hills Shire Council, Interim Salinity Policy, 2000

Objective: To increase awareness in the community of the issue of salinity and to ensure salinity issues are considered in both urban and rural planning and development assessment.

Guidelines:

Council adopt the following strategy to pursue this objective:-

- 1. Take a proactive role in increasing community awareness of salinity and its impact through the preparation of appropriate information;*
- 2. Ensure salinity issues are considered when planning for new release areas and rural areas and in the assessment of development, building and sub-division matters;*
- 3. Carry out an annual review of the status of information on the issue of salinity in the Shire and the need for review of this policy; and*
- 4. That this policy be reviewed in twelve months.*

Specific consideration could also be given to the impact of other policies/controls on areas with a salinity potential eg on-site wastewater policy, stormwater management, flood management and biodiversity plans. These policies may need to be updated to address salinity potential and may also provide opportunities to achieve salinity management objectives.

*EXAMPLE: Fairfield City Council, On-site Sewage Management Strategy, June 2002
Section 1.0: Matters to accompany applications to install or construct sewage management systems*

1.0.3 Site Assessment

The application must be accompanied by details of the topography, soil composition and vegetation of any effluent application areas related to the sewage management system together with an assessment in light of those details.

NOTE: Parts of the Western Sydney Region have been identified as having a soil salinity hazard according to the Draft Salinity Hazard Map (2000).

As an emerging issue Council considers that all applications to install on-site sewage management systems in salinity hazard areas must take into consideration the impact of waste water on soil and groundwater salinity.

A salinity assessment should be undertaken for the site, in accordance with the principles set out in the Western Sydney Draft Salinity Code of Practice (2002).

6.9 Notification under s.149 Certificates

Under s.149 of the Environmental Planning and Assessment Act 1979, a person may request from Council a planning certificate containing advice on matters about land that are prescribed in the Regulation. In a s149(2) certificate any potential hazards affecting a site can be notified. However, while salinity could be considered as a hazard requiring notification, the limitations of mapping do not allow for the identification of current and future levels of salinity on a site and, therefore, limits the ability of councils to notify land-holders of the specific conditions affecting their individual properties. This is particularly exacerbated by

the dynamic nature of salinity processes, which can change over time and with changing land use, making it difficult to predict in a spatial manner.

Another matter requiring notification in s149(2) is the existence of a council policy that restricts the use of land. It may be that the development of salinity policies and a requirement for investigations and management responses may have to be notified on certificates. Legal advice should be sought by councils regarding the need for and implications of notifications for salinity.

S.149 notifications can play an important role in raising the general level of awareness about urban salinity and the need to manage land use practises. A general notification for all areas with any level of salinity potential could be included in s149(5) Certificate, for this purpose. However, the general nature of such notification could result in the issue losing its impact and therefore it could be disregarded.

An example of such a general notification, is that currently used by Wagga City Council. *"The applicant's attention is drawn to the Department of Infrastructure, Planning & Natural Resources, Wagga Wagga Urban Land and Water Management Plan, Depth to Piezometric Surface Map of May 1997 that indicates the potential for urban salinisation at a 1:25,000 scale."*

Legal advice sought by some councils indicates that notification would need to be supported by a clear and consistent approach to salinity management, as demonstrated by Council policies and/or by a Salinity Management Strategy, which should include community education.

There is a risk of causing general alarm about the problem and producing reactionary responses from groups such as buyers, agents, banks and insurers. To manage such concerns councils need to develop comprehensive education and awareness strategies to support the inclusion of salinity on s.149 certificates and to accompany any policies introduced. Such strategies would also be necessary to provide support for council staff responding to increasing volumes of inquiries and requests for advice, which may result from the inclusion of salinity information on certificates. Education and awareness material is available in Appendix 11.4 and a FAQ sheet suitable for use with s149 certificates is in Appendix 11.5.

Regional consistency in any notifications would increase their effectiveness as a tool for salinity management and awareness and would provide some alleviation of the possible problems associated with community confusion or concern.

With this in mind the following *suggested* wording has been developed for use in Western Sydney. It is hoped that any wording adopted by individual Councils would be similar in content and intent and, therefore, contribute to a regional approach. If councils decide to utilise notification as a salinity management tool then it is suggested that the Western Sydney Salinity Working Party continue to be used to facilitate the development of a regionally consistent approach.

Two levels of wording have been suggested, used in a similar way to notification for contaminated lands. The first level is a general notification to raise awareness of the issue and possible land management requirements, which could be used on all areas in LGAs

containing any lands with a level of salinity potential or existing salinity. The second level would bring to notice the existence of a site specific report or study into salinity for the site. The notification wording has been based on existing salinity or contaminated lands notification currently used by councils, however legal advice should be sought prior to adoption by council.

1. General notification

“The applicant’s attention is drawn to the DIPNR ‘Map of Salinity Potential for Western Sydney’ August 2003 that indicates the potential for salinity across the region at the 1:100,000 scale.”

Such a notification would need to be supported by the use of fact sheets that explain the effect of salinity in urban areas, the interpretation of the Salinity Potential Map and current council strategies to manage urban salinity.

2. Previous report on a site

“Councils records indicate that a site specific report (ref #) relating to salinity exists for this location. Applicants are recommended to consider this report in relation to their site and any proposed development.”

This notification would require the use of some form of database to catalogue salinity investigations, reports and management plans received, which can then be searched by Lot number when a s.149 certificate is requested. It also requires that salinity reports be requested in such a way as they are lodged with council and become a public document available to future landholders.

Additionally, Councils may decide to include a notification that indicates the existence of any salinity policies that are adopted. Such a notification could be based on the contaminated lands policy notification. For example:

“Council has adopted by resolution a policy on salinity. This policy will restrict development of land:

- (a) which is affected by salinity;*
- (b) in respect of which there is not sufficient information about salinity;*
- (c) which is proposed to be used for certain purposes; and*
- (d) in other circumstances contained in the policy.”*

6.10 Considering Salinity in the Development Process

Through the development process councils can ensure that salinity is appropriately considered and addressed in a way that both protects the proposed development from salinity and minimises the impact on local or regional salinity processes. There are a number of stages in the development process at which salinity could be considered and addressed. These include rezoning applications, subdivision applications and development applications. The most appropriate methods for salinity assessment and management vary depending on the stage of development and the scale of the area involved.

Rezoning Applications

In areas with salinity potential councils could include salinity as an issue to be considered in Local Environment Studies undertaken at the time a re-zoning application is made. The

consultant's brief should include an outcome that relates to salinity and require that the study provide a detailed salinity report, based on site specific investigations (see sections 7.9, 7.10 and 8.6 for more details). The information in such a report should clarify the level of salinity on the site and identify the processes by which salinity would occur, as well as the potential for on and off site impacts and the key management areas.

The reports may then be used in the development of precinct plans and master plans for the site, to guide subdivision applications and to develop DCPs for the site to guide the on-going development process.

Key areas on a site to be identified and managed for salinity include sites with groundwater discharge, riparian corridors, naturally waterlogged areas (ephemeral and permanent), existing coherent blocks of well established native vegetation, areas where careful water management is necessary and zones where salt resistant building materials or techniques would be necessary. Site-specific investigation would normally be required to identify these areas.

Subdivision Applications

If no study has been undertaken prior to a subdivision application then a similar salinity report to that discussed for a rezoning application could also be required at this stage.

At this stage both the on and off site impacts of the proposed development should be considered, as well as the potential for the development to alter salinity processes. The management of the key areas identified by the investigations should also be considered.

The siting and design of infrastructure such as roads, parks and playing fields, stormwater assets and public buildings would need to be guided by salinity investigations. The aim would be to protect the infrastructure from salinity damage and to minimise potential impacts the infrastructure can have on salinity processes. For example, public infrastructure such as schools and community centres may need to be carefully placed and designed so as to minimise on-going salinity related repair costs for the community.

Areas where salinity will be a problem for buildings etc should be identified and appropriate construction techniques and materials should be detailed in the designs.

Special consideration should also be given to salinity issues when proposals include waste water re-use or treatment systems, artificial water features, high water use landscaping, stormwater infiltration and high water input activities such as market gardens, turf farms and golf courses. Activities which potentially increase the amount of water entering the system can contribute to salinity problems.

Development Applications

As discussed previously salinity could be included by council in an LEP as an issue for consideration when deciding whether the site is suitable for the development proposed. If an LEP requires that salinity be considered prior to a development being approved then each development application would need to address salinity. What this should involve would need to vary depending on the development size, development type and the level of salinity potential identified in the initial assessment.

Even without a specific requirement in a LEP, council policies or guidelines could also require salinity to be addressed in development applications, which could be supported by sections of the *Environmental Planning and Assessment Act (NSW) 1979*.

Section 90(1) lists the matters that council is required to consider in determining a development application. A number could be used to consider salinity potential in an area:

“(b) the impact of that development on the environment (whether or not the subject of an environmental impact statement) and where harm to the environment is likely to be caused, any means that may be employed to protect the environment or mitigate harm;”

“(g) whether the land to which that development application related is unsuitable for that development by reason of its being, or being likely to be, subject to flooding, tidal inundation, subsidence, slip or bushfire or any other risk”; and

“(m1) whether that development is likely to cause soil erosion”.

The same act also identifies designated developments requiring an EIS. In the case of these developments salinity could be addressed as part of the matters specified in cl.34 of the Regulation, although salinity is not directly referred to as a matter for consideration.

“(d) identification and analysis of the likely environmental interactions between the proposed designated development and the environment.”

There are also various reports generally prepared for DAs where salinity issues could be considered. A geo-technical investigation identifies soil type and design requirements and this could also look at corrosivity due to salinity in order to identify the need for special building materials or techniques. There are also Stormwater designs prepared for sites, which usually include a water balance model. These designs should identify salinity issues in areas with a salinity potential and could be used to incorporate some of the water management based strategies discussed in later sections.

In most single lot developments full salinity investigations, such as those discussed above, may not be appropriate. For small sites such investigations will provide only a limited understanding of salinity processes and may be onerous. In any case, on such sites the opportunity to respond to salinity would be limited to on-site actions, such as building and service design, stormwater management and landscaping. These options are outlined in the Salinity Response Checklists in Appendix (12.1).

7. DEVELOPMENT ASSESSMENT GUIDELINES

The following section discusses a model for how salinity assessment, investigation and management strategies could be incorporated into the development approval process. This would need to be considered by each council in light of their areas of salinity potential, existing development assessment processes and resources/opportunities available.

7.1 Multi-lot Developments or Rezoning

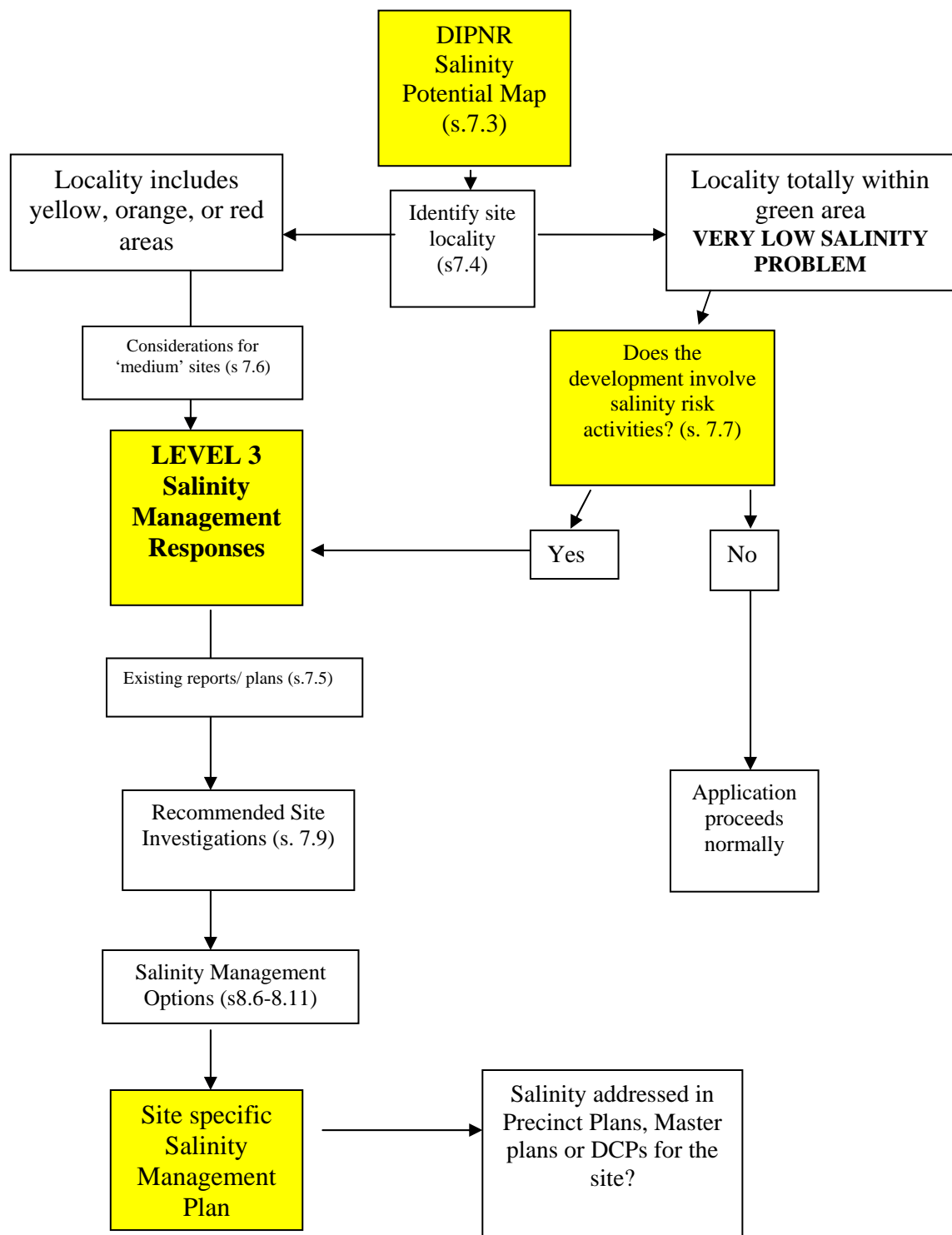


Figure 11: Multi lot salinity assessment flow chart

7.2 Single lot development application

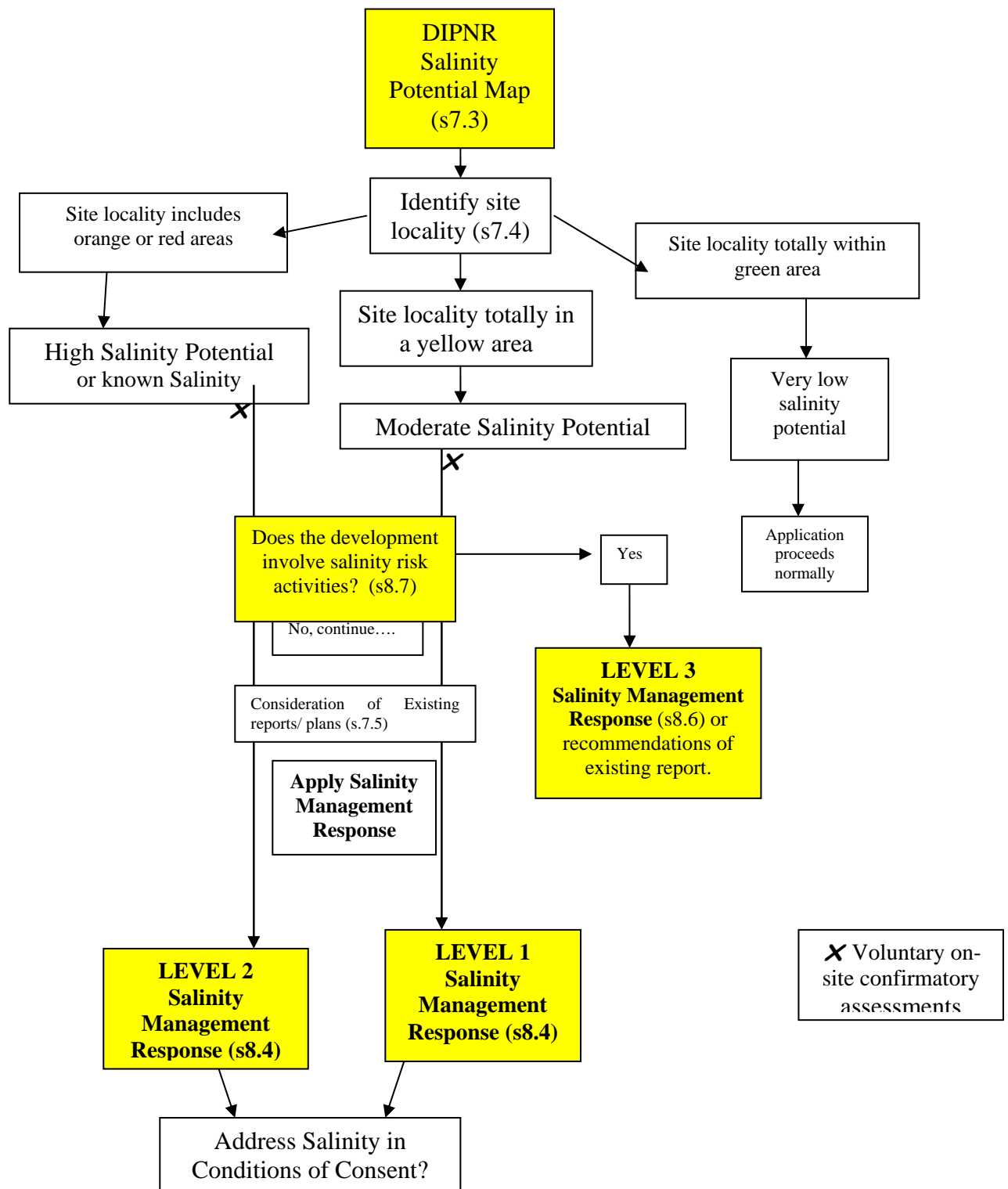


Figure 12: Single lot salinity assessment flow chart

7.3 Map of Salinity Potential in Western Sydney

The Map of Salinity Potential in Western Sydney (1:100,000) was prepared by DIPNR and released in August 2003. Copies are available from the Penrith office of DIPNR. It is essential that the map is used in conjunction with the guidelines that accompany it. These are also available from DIPNR. (See Appendix 11.2).

The 2000 map covered those areas of the Penrith Sheet of the Soil Landscape map. However, the map has been extended to cover all areas of Wianamatta Shale groups in Greater Western Sydney. Areas outside the map may be able to use a broad-scale assessment of geology, soils, climate, vegetation and topography to identify salinity potential. The use of these tools is explained in the DIPNR publication “Broad Scale Resources for Urban Salinity Assessment”.

The map was produced using a combination of aerial photo interpretation, soil landscape information and modelling of ‘wetness’ in the landscape. The maps are therefore not a representation of actual salinity, but instead of the likely distribution of salinity.

The most important information the maps provide land managers is that there is a level of salinity potential for most areas of Western Sydney.

The map is at the scale of 1:100 000, so cannot be used to identify the salinity potential of individual lots. In the development approval process illustrated in the previous diagrams it is used to identify the general level of salinity potential in the locality of the site.

Consideration should be given by the landholder to the possibility of local variations in salinity potential, such that some sites may experience a greater potential than that identifiable at the regional scale. To identify such variations requires on-site investigations. The map is not a substitute for site specific investigations.

The use of the map as outlined in this section is only intended as a guide to assist the landholder in considering salinity potential areas and in identifying appropriate management responses for the development.

7.4 Identification of site locality

In order to identify the salinity potential in the locality of the site being considered, the following method is suggested. It needs to be emphasised that this is not the potential of the particular site in question, but the apparent potential affecting the locality of the site, based on regional mapping. Consideration must be given to the limitations of this mapping, as discussed in the previous section.

To identify the potential of a locality, an area of 1km radius around the site is considered. (At 1:100000, this is the area of a \$2.00 coin or a similar sized disc). This is placed over the approximate location of the site on the poster sized version of the Map of Salinity Potential in Western Sydney and the whole area covered is considered. (Note: resized reproductions of the map will not be accurate for this method). If the entire disc is in the green area of the map, then there is a very low salinity potential for that locality. If the disc includes areas of yellow only then there is a moderate salinity potential for the locality. If the disc includes areas of orange or red, then there is an high salinity potential for the locality.

In order to recognise the limitations and uncertainty associated with using this method the following wording is recommended to describe the potential level:

“Regional evidence indicates that the site is in a locality with (very low/moderate/high) salinity potential. However, local variations can occur and some sites may experience a greater potential than that identified by regional mapping. If you have any concerns it is recommended that you undertake an on-site assessment.”

For single lot developments the process of identifying the salinity potential of a locality may be better undertaken by the applicant in consultation with council, which would allow for explanation of the maps limitations and the potential need for salinity management responses.

7.5 Consideration of existing reports or plans

As salinity is considered in the development assessment process, the number of sites and areas for which investigations and salinity plans have been complete will increase. In addition, for some sites there may be existing reports that either specifically investigated and addressed salinity or looked at other issues and may provide relevant information.

The identification and consideration of existing reports should be part of the development assessment process and the contents of the report should guide on-going planning and design. The date and thoroughness of existing reports needs to be assessed and those aspects relevant to the application need to be identified. Recommendations presented in a Salinity Management Plan for an area should be referred to in subsequent sub-division and development applications. Existing reports or information should also be identified when designing the site specific investigations.

In order to facilitate this assessment there needs to be a system by which Salinity Management Plans and their associated investigations are recorded and filed for future reference.

7.6 Considerations for ‘Medium’ sized sites

It is recognised that there are a number of sites which are slightly larger than a standard single lot, but which are still relatively ‘small’ developments. For some of these sites the requirement to undertake full site investigations and to produce a salinity management plan may be onerous. However for others, the nature of the development and the potential impacts it may have on salinity potential may be better managed by following the Level Three responses, or a variation of this.

In these situations a value judgement on the level of response required will need to be made based on the size of the site, the type of development proposed and the salinity potential of the locality.

Hopefully as more is learnt about salinity management in urban environments it will be possible to develop a standard response that better accommodates these sites. In addition, as Salinity Management Plans are produced for large areas at re-zoning or sub-division they will provide the information necessary to guide these ‘medium’ sized developments.

7.7 Salinity Risk Activities

Some activities are considered to have a greater risk associated with them in areas with salinity potential, based on ground disturbance, water-use, the potential for causing major hydrological change and/or significant salt loads.

Developments which include these activities need to give special consideration to salinity, both in light of the potential to cause problems on site and the potential to contribute to regional salinity problems. Even in areas with very low salinity potential, any major developments of these types may contribute to increased salinity problems in adjacent areas. The impact of the proposed development on local and regional salinity needs to be properly considered and addressed as part of the assessment process. As a result, it is recommended that developments involving such activities should undertake salinity investigations and develop salinity management strategies as part of their development plan.

The types of activities typical for the LGA that involve major ground disturbance, high water use, major hydrological changes, or significant salt loads need to be identified by councils. These may include, but are not limited to, activities such as: quarrying, intensive agriculture, activities involving high levels of irrigation, large scale artificial water bodies, infiltration to soil or groundwater, waste water re-use or treatment systems, or major landscape re-shaping.

7.8 Voluntary On-site confirmatory assessments

All assessment and the associated management responses described above are based on the potential salinity levels likely to be encountered in the locality of a site. **They are not an assessment of individual site conditions.**

As discussed, there is a possibility of local variations in salinity potential, such that some sites may experience a greater salinity potential than that identifiable for the locality at the regional scale. However, it is not possible to identify such variations using the map. Such exact identification of individual site conditions requires on-site investigations.

It is therefore recommended that the land-holder be made aware of the limitations of the regional maps and the salinity management responses based on them and that they be informed of the need to undertake further on-site assessments to confirm the exact nature of on-site conditions if greater certainty is required.

For small single lot developments it may be appropriate to suggest that soil samples be taken as part of the geo-technical report for corrosivity analysis. This would allow the development to be constructed using salt resistant materials and techniques based on current conditions. However this will not highlight future corrosivity due to changing conditions on or off site. For larger sites salinity investigations such as those recommended by DIPNR may be more appropriate and more predictive.

7.9 The need for Site Specific Investigations

In order to manage salinity effectively it is necessary to understand the salinity processes occurring on the site and the potential relationship the proposed development will have.

Salinity processes are complex and are related to landuse, geology, soil, climate, hydrology, vegetation, landscape, soil water and groundwater systems. These factors and the manner in

which they interact vary greatly from site to site, even within a single region such as Western Sydney. In addition, the type of development and the on-going activities on the site influences the impact of each factor.

It is therefore important on larger sites that appropriate investigations are undertaken for each proposed development. The most appropriate management and amelioration strategies can then be adopted. Consideration should also be given to the need for similar site investigations on some smaller sites, particularly where salinity risk activities are involved.

The role of site specific investigations should not be seen as a means of ‘proving’ the existence or absence of salinity on a site. This is not realistic, as salinity is a dynamic problem and the factors contributing to salinity potential react in unpredictable ways to the changes in the natural system that occur with development. Salinity investigations are a management tool, a means of better understanding the constraints of the land which is to be used for the development, similar to investigations for flooding, acid sulphate soils, contamination and geo-technical/engineering issues.

The role of site specific investigations is to establish which strategies are most suitable for the site and for the type of development proposed. Salinity Management Strategies are needed for all large-scale sites in localities with a potential for salinity.

For single lot developments the requirement for such investigations are probably too onerous and, additionally, will only provide limited information and management options at such a small scale. These sites are better managed either with reference to earlier salinity investigations and management plans or by implementing on-site salinity management responses. Such responses are explained in s 8.4 and the response checklists in s.12.1 provide details as to general salinity management strategies suitable for use on single lot developments.

7.10 Recommended Salinity Investigations

The types, methodology and interpretation of salinity investigations suitable for urban development have been detailed in a booklet produced by DIPNR, called “Site Investigations for Urban Salinity”. Copies have been distributed to local government and are available from DIPNR. This booklet is part of the work of the DIPNR Local Government Salinity Initiative for the NSW State Salinity Strategy.

The booklet sets out four phases for a site investigation;

1. Desktop review and initial site walkover.
(Based on existing information detailed in DIPNR’s “Broad-scale Resources for Urban Salinity Assessment” Booklet);
2. Soil and groundwater testing. (Including the number, location, depth and types of tests to be considered);
3. Interpretation and presentation of results. (Including suitable reference standards); and
4. Development of suitable management options to deal with the issues identified.

Investigations should be based on an understanding of the various salinity processes occurring in Western Sydney (s5.7) and should identify the potential for salinity, the processes by which salinity may occur on the site and the relationship of the development to these processes. The interpretation of results should identify impacts both on and off site, as

well as changes over time and with development. Management options should include those to address the impact salinity may have on the development and those to minimise the impact the development has on local and regional salinity processes.

7.11 Western Sydney Regional Salinity Information

It is proposed that the information received by councils in response to investigation requests be added to a database which is compatible and accessible across the region. Such information will improve knowledge of the distribution and levels of existing salinity and salinity potential. This will increase our understanding of the processes operating in the region and will allow improved management strategies to be developed.

At this stage it is proposed that when developers are requested to undertake salinity investigations they also be asked to complete the forms for SALIS and the DIPNR Groundwater Database. More information is included in Appendix 11.6. These databases are available to Local Government and others for regional data.

In addition to this, councils will need to investigate setting up an internal database to keep track of reports and investigations prepared in their LGA. This would make the information collected available to future landholders and developers on the site, provide a baseline for any on going monitoring that is required and would provide good information for regional and local planning.

8. DEVELOPMENT MANAGEMENT GUIDELINES

This section outlines some of the general principles of good salinity management for consideration when assessing or preparing development applications. The information contained in this section is by no means exhaustive given the likely changes to best practice that will come with further research, as well as the need to consider specific site conditions. Current advice and information should also be sought from qualified professionals.

8.1 Salinity Management Principles

The consideration of salinity needs to include not only an assessment of salinity, but also the development of the most appropriate salinity management strategies for each site. These are based on the key principles of salinity management:

- ◆ **Know the salinity processes on the site.**
This assists in the development of management responses and in the identification of specific management areas.
- ◆ **Maintain natural water balance.**
This may include minimising additional water input and avoiding infiltration to soil or groundwater.
- ◆ **Maintain good drainage.**
Changes in the soil profile or permeability due to compaction cut and fill, or man-made barriers may change lateral flow and create areas of groundwater accumulation or saline discharge. Additionally salt loads in the soil can be mobilised or concentrated where water accumulates.
- ◆ **Avoid disturbance or exposure of sensitive soils.**
In Western Sydney salt typically accumulates in the sub-soil (B-horizon). Through concentration salt loads can be fairly high. When these soils are exposed or disturbed salinity problems can occur. Care should also be taken when such soils are transported off site.
- ◆ **Retain or increase vegetation in strategic areas.**
Retaining saline tolerant vegetation in discharge areas or in high salinity potential areas, such as creek lines, may be an effective management strategy. Additionally, vegetation may be of assistance in maintaining a natural water balance.
- ◆ **Implement building controls and/or engineering responses where appropriate**
These may be necessary to manage or protect buildings and infrastructure from existing areas of salinity, or as a precaution against changing salinity levels in the future.

8.2 The Role of Innovation in Salinity Management

Techniques to manage salinity in an urban context are still relatively new. As a result, the most appropriate means to achieve the best salinity management outcomes are very much in the formative stages and many options are still being explored and monitored to establish if the desired results are being achieved.

In addition, due to the number of interacting variables involved the management requirements and options for each site can be very different. What works for one situation, in respect to a particular development, may not be satisfactory in another. In fact there will be no one 'right' way to address salinity. For each site and for each development proposed, an assessment of the salinity potential will need to be made and management strategies

developed that respond to this. Due to both of these features, innovation plays an important role in urban salinity management by allowing us to find the ‘right’ response for each site.

It is therefore important that our development processes encourage innovation and allow a range of management options to be explored for each site.

For these reasons the approach to salinity management in this document has been outcome focused, rather than prescriptive. While suggestions are made as to some of the possible management options these are only intended as guides. The best management options will be the ones developed with a full consideration of the particular site and the development proposed.

8.3 Salinity Management Response

Following the assessment of the site for salinity potential, the appropriate level of salinity response can be identified. There are three different levels of response, ranging from one to three, depending on the salinity potential, the risk associated with the development type and the size of the development.

It is important that a salinity potential assessment of the locality is made prior to choosing a salinity management option, in order to ensure that the strategies adopted for a site are appropriate for the level of potential and types of salinity issues occurring. An assessment of salinity potential can be made using the DIPNR Salinity Potential Map for Western Sydney in the manner described in the previous section, or through a broad scale assessment using geology, soil, topography, climate and vegetation maps and information.

Developments in areas with any salinity potential will need to respond to this potential in the planning, design and management of the development. A salinity potential assessment and appropriate Salinity Management responses should accompany development applications. This response should address both the on-site salinity impacts, as well as the potential for off-site and cumulative impacts.

To assist developers prepare and integrate appropriate management strategies and the assessment of salinity, a checklist to the requirements for each level of Salinity Management response has been prepared. These guides can be distributed to developers and can be used by council staff involved in the approval process. The checklists found in Appendix 11.1 are called:

- *Level One Salinity Management Response Checklist.*
- *Level Two Salinity Management Response Checklist.*
- *Level Three Checklist Response - Salinity Management Plan.*

8.4 Use of Level One and Level Two Salinity Management Response checklists

The Level 1 and Level 2 Salinity Management response checklists are intended as salinity management guides for single lot, small scale developments only, eg, single houses. See the Western Sydney Urban Salinity Brochures and other references contained in Section 12.

It is recognised that on these smaller sites a requirement for full salinity investigations would be onerous and that information gained will provide a limited insight into salinity processes

due to the scale. Additionally, most of the management strategies available at this scale can be applied without such detailed information and with limited implementation costs. However the limitations of salinity mapping should be made clear to applicants, as well the need for further assessment if more detailed information is required. See sections 7.4 and 7.8.

It is suggested that the salinity management response checklists are used in the same way as sediment control guides and distributed to the applicant during the development approval process to provide guidance on some of the possible best practice salinity management strategies that can be used on single sites. The applicant should also be provided with the appropriate background information to assist in using the checklist (Appendix 11.4 and 11.5). These will be included in the Western Sydney Salinity Resource kit and a limited number will be provided to each council in print, as well as an electronic version.

Whether the guides are used as recommendations or are enforced is a matter for individual councils to consider. However their consistent use across the region, in some form, will increase the awareness of salinity issues, the acceptance of salinity management strategies and contribute to wider education and awareness outcomes.

The Level One response applies to small developments involving low risk activities, in areas with a moderate salinity potential according to the DIPNR Salinity Potential Map (yellow areas). It focuses on basic building techniques and ‘good house-keeping’ to manage waterlogging and rising damp.

The Level Two response applies to small developments, involving low risk activities, in areas of high salinity potential or known salinity on the map (orange or red). As well as the strategies identified for Level One, it includes suggestions for variation in building materials and techniques to provide a level of salinity resistance to the development and has more stringent water and damp control measures for the site.

To identify which level of salinity potential is occurring in the locality of a site, it is suggested that the applicant be assisted in using the Salinity Potential map in the manner described in section 7.4. This will ensure the applicant understands the limitations of the map and the need for salinity management strategies. They could also be provided with the salinity management response checklists and the supporting material to consider for their development plans.

It is hoped that in the future, as an increasing number of new releases and re-zonings address salinity, information from salinity reports will be available to guide development at the individual lot scale in a more specific manner. In the meantime the salinity response guides provide developers of single lots with general salinity management information that is applicable to their level of development.

8.5 Developing conditions of consent for sites in Areas with Salinity Potential

Councils may wish to address salinity in the conditions for consent for a development. The items listed in the Level One and Two Salinity Management Response checklists may be useful in developing these. Additionally, DIPNR is producing planning guidelines for urban salinity and these should include information regarding appropriate conditions of consent. It is also worth noting that the Building Codes of Australia is being reviewed and may incorporate provisions for building in areas with salinity potential.

8.6 Use of Level Three Salinity Management Response

The Level 3 Salinity Management Response is intended for multiple lot developments and rezoning in areas with a moderate or high salinity potential, or for developments involving salinity risk activities (See sections 7.1, 7.2 and 7.7).

As was discussed in Section 5.7 (Salinity Processes in Western Sydney), to effectively manage salinity it is necessary to understand not only the level of salinity potential but also the possible processes by which salinity may occur. This is best done through site-specific investigations, looking at soil, groundwater and the water cycle of the site.

Site specific investigations may be based on the methodology outlined in the DIPNR “Site Investigations for Urban Salinity” and the salinity management options discussed in this section. To give an idea of what information may be needed in a comprehensive Salinity Management Report a checklist of the key points to be addressed by a Level Three Salinity Management Response has been developed (Appendix 11.1).

A salinity management report should not only contain the results of investigations, but should also interpret this data to explain site conditions and processes, identify the relationship between salinity and the development and should also provide strategies for the on-going development process. These strategies should aim to protect the future development from salinity damage and minimise the impacts development will have on any salinity processes. The strategies should address the salinity management principles identified in Section 8.1.

In many cases salinity may be better integrated into plans such as a Total Water-cycle Management Plan for the site, rather than addressed in a separate Salinity Management Plan. However, these other plans should still address the key points of a salinity plan and be based on site specific salinity investigations.

The baseline assessment of the site conditions and particular development requirements with regards to salinity are best determined at the preliminary stages, along with similar pre-development studies to assess the site’s capability and suitability for the development proposed. It is at this stage that constraints can best be considered and effectively addressed in the plans for the site.

The investigations and plans prepared at this stage should inform all stages of the development, from the design and layout of the lots, services and infrastructure, to the construction of roads and other assets, right down to the building of individual houses or other property.

It is therefore important that the information collected and the plans prepared at this initial stage are incorporated in the on-going planning and development process and are made available, in some form, to guide the decisions of the successive developers and property owners involved in the site. For this reason it may be necessary for Salinity Management Plans to be available as a public document and for a record to be kept of areas with such plans for future reference.

In some cases the developer may make a case to apply standard building controls to the whole site, rather than undertake salinity investigations. However this approach does not

consider the salinity processes or water cycle operating on the site and it does not provide strategies to address the impact the proposed development may have on localised and regional salinity processes, which could result in off-site impacts.

The salinity management response should be based on the site and the development proposed and should include not only controls to protect buildings, but also strategies to protect infrastructure, including roads and underground service and to manage the water cycle. Responses should assume a worst case scenario for salinity on the site. The development plan should also demonstrate no net increase in hydrologic load or water inputs and should maintain the natural water balance.

8.7 Suggested Management Strategies for each Western Sydney Salinity Process

The different types of processes associated with salinity in Western Sydney determine the specific management requirements for each site. Once the processes operating on a site have been identified, management strategies need to be developed that are specific for the processes and the type of development occurring. It is important to consider that there may be more than one process operating on a site. Some examples of strategies suitable for each key process are summarised.

All sites, all salinity processes:

- **Practise good soil management techniques during construction;**
- **Use all soils and landscapes within their urban capability;**
- **Minimise water inputs, maintain natural water balance, use caution in implementing infiltration technique;**
- **Carefully manage areas of existing salinity or likely discharge areas; and**
- **Avoid clearing, retain and establish significant native vegetation.**

Shale Soil Landscape

- Avoid exposure and disturbance of saline subsoil material, minimise cut and fill;
- Avoid reversing soil profile materials during essential cut and fill, replace soils in original order;
- Consider soil management and exposure of material when placing roads and services, as well as during construction;
- Consider exposure of building materials and infrastructure to saline soil materials, use salt resistant materials where necessary or consider alternative construction techniques;
- Stabilise existing areas of erosion, treat existing salinity with gypsum;
- Establish salt tolerant species in existing or potential salinity problem area;
- Retain vegetation and avoid construction/disturbance in riparian zones and poorly drained areas; and
- Retain and establish vegetation in areas susceptible to erosion or disturbance.

Localised concentrations of Salinity

- Maintain good site drainage, install additional drainage mechanisms (after assessing the site for reactive soils);
- Properly install and maintain damp proof courses, do not breach with gardens, paving or extensions;
- Minimise water use on site;
- Avoid the use of susceptible bricks or highly porous material in contact with the soil; and

- In areas of poor soil infiltration or high soil salinity it may be necessary to use salt proof building materials.

Deeply Weathered Soil landscapes

- In seepage areas or areas with perched water tables - use sulphate resistant bricks, cement and other materials in footings and foundations and for infrastructure;
- Consider establishing or retaining vegetation at discharge points;
- In 'recharge' areas- minimise water inputs; and
- On-going monitoring of perched water tables.

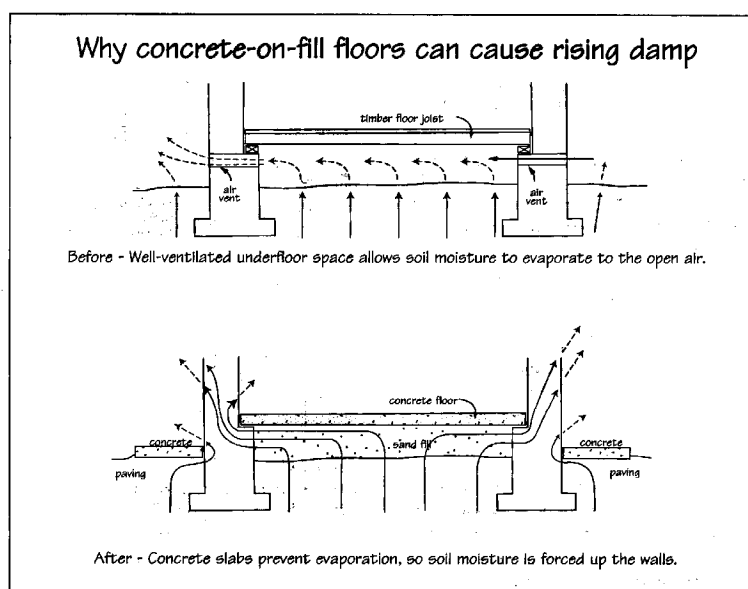
Deep Groundwater salinity

- Avoid clearing. Retain and establish significant native vegetation;
- Minimise water inputs, maintain natural water balance;
- In discharge areas maintain or establish salt tolerant vegetation;
- In areas of raised water-tables, consider the use of salt proof building techniques;
- Avoid high water input activities eg. Golf course, turf farms, water recycling systems;
- On-going ground water monitoring;
- Use sulphate resistant material for underground services and roads/paving ; and
- In discharge areas, use sulphate resistant bricks and cement in footings and foundations and other soil contact areas.

8.8 Building Requirements for Areas with Salinity Potential

This section outlines some of the basic principles for building in areas with salinity potential, for consideration when preparing management strategies for developments. This information is of a general nature and detailed advice should be sought from a certified structural engineer. The following information has been collected as general recommendations, but investigation and assessment should be undertaken prior to building to ensure it is appropriate for the individual situation. Salinity resistance should be considered in all aspects of the structure.

In areas with sodic or saline B-horizons there is a need to reduce the disturbance of the sub-soil and to minimise the exposure of building materials to the corrosive elements in these soils. Where such soils or severe dampness is a problem consideration may need to be given to the suitability of slab on ground and the possibility of alternative housing construction methods, such as suspended slab or pier and beam.



(DENR1997.)

Figure 13: Salinity and slab on ground construction

In South Australia to protect the house slab from salinity a damp-proof membrane rather than vapour proof membrane is required to be laid under the slab. Damp proof membranes are more resistant to punctures than vapour proof membrane. It is possible to source thicker membrane than those currently required by the BCA. To be effective the membrane needs to extend up to ground level at the edges and other precautions such as taping and overlapping of joints should also be considered. It is also important that this membrane is not damaged or punctured during installation.

Across the whole of Western Sydney there is a potential for localised salinity problems. As this type of salinity is related to the evaporation of soil water containing salts through the bricks and mortar, the management of drainage and damp on all sites is very important.

Buildings require a properly installed damp proof course (DPC). Extra care should be taken to ensure that the DPC is properly installed and not left short of corners and the outer wall for aesthetic reasons. Care should also be taken that continued building work, later additions,

paving, rendering or landscaping does not breach it. In buildings where the parts of the floor are significantly above the ground level a second damp proof course may be necessary to protect rows of bricks between the ground surface and the required DPC.

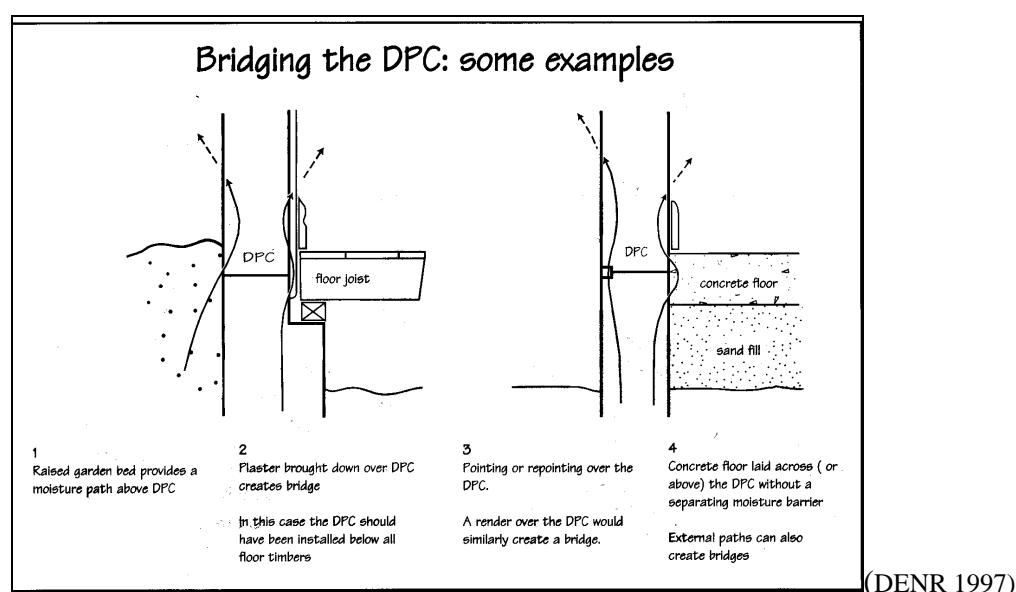


Figure 14: Salinity and the damp proof course

Salt resistant bricks and concrete are available and are more suitable for use in saline environments. Salt resistant bricks are generally referred to as ‘exposure quality bricks’. The Australian Standard 4456.1 Masonry Units and Segmental Pavers includes a method for determining resistance to salt attacks and is used to class bricks as exposure class or general purpose. To identify the most suitable materials for a site, professional advice should be sought. The salt and water resistance of materials to be used needs to be considered at the design stage.

In the case of all building material, including brick, cement and concrete, the manufacturer’s advice should be sought regarding durability and correct use. In some cases the concrete and mortar used on structures requiring salt resistance may require a waterproof admixture. On sites where salts containing sulphate are a problem sulphate resisting (SR) concrete may be needed. The risk of corrosion of any concrete reinforcing also needs to be considered.

It may not be necessary to utilise these materials for the whole structure, in some cases it may be possible to use resistant materials in susceptible or exposed areas only, such as below the DPC.

Salinity resistance also needs to be considered when choosing materials for underground services and other infrastructure. Metal pipes are susceptible to corrosion, so plastic pipes, such as polybutylene or polyethylene may be a better choice for water supply in areas with a salinity problem. For plumbing pipes unplasticised Polyvinyl Chloride (UPVC) is suggested. Salinity may also need to be considered when designing sheds, paths, paving and driveways. Construction may need to use salt resistant materials and the brick and concrete requirements discussed above, including the use of DPCs and membranes.

The corrosivity of the soil is also important on larger sites in the choice of materials for power supply, including power poles, steel foundations and underground cables. This is discussed in the booklet “Corrosion in the Electrical Supply Industry” available from the Electricity Association of NSW.

The salts found in Western Sydney include both sulphate and chloride and therefore the concentrations of both these compounds should be considered when assessing the potential corrosivity of the soil for the building materials to be used. The AS2159 Piling Design and Installation has useful information for this.

Wagga Wagga City Council has produced a booklet “Building in a Saline Environment” which provides a guide to building techniques and materials for use in a saline environment. This can be downloaded from the council’s website: www.wagga.nsw.gov.au. Also available, from the Department of Environment and Natural Resources in South Australia is the booklet “Rising Damp and Salt Attack”, which contains information on the construction and maintenance of buildings in areas with salinity. This booklet can be ordered from the department, or downloaded from their website, www.denr.sa.gov.au (heritage section). Additionally, a booklet on building in saline environment was produced by the DIPNR Local Government Salinity Initiative.

Variations to the Australian Building Code for salinity are also being considered and this may result in national provisions. Users of the Western Sydney Salinity Code of Practice are recommended to seek further information and advice from suitably qualified professionals.

Further information is also be available from:

- the Cement and Concrete Association of Australia;
- the Clay Brick and Pavers Association;
- the CSIRO Division of Building Construction and Engineering;
- Various Australian Standards; AS2870 for Residential slabs and footings, the AS3700 Masonry Structures, the AS2159 Pilings- design and installation, AS3798 Guidelines for earthworks for commercial and residential developments, AS3660 Termite Management; and
- Australian Building Codes (sections relating to Masonry, Mortar and DPCs) particularly the State and Territory variations for South Australia.

8.9 Vegetation and Landscaping Requirements for Areas with Salinity Potential

The vegetation and landscaping plans for sites in areas with a potential for salinity should also consider salinity, both in terms of the potential impact from salinity on the plants, and in regard to the role of vegetation and landscaping in good salinity management.

The strategic retention or restoration of vegetation in key areas may need to be considered as a salinity management strategy. Areas of saline discharge, high salinity potential and saline sub-soils areas susceptible to disturbance and erosion could be managed in this way. These areas typically include riparian corridors, natural or constructed drainage basins and permanent or ephemeral swamps. Native vegetation found in these areas tends to be adapted to the conditions and be more or less salt tolerant. If vegetation is removed in these areas the saline conditions make it very susceptible to erosion and increasing salinity problems and rehabilitation can be extremely difficult.

In discharge areas where vegetation is being restored the use of appropriate locally indigenous salt tolerant species is recommended. (See the species list in Appendix 11.3). The use of these species may also be necessary for landscaping in areas with saline soils, where current groundwater discharges occur, or in areas that potentially will be affected by increasing salinity in the future. In areas with an existing salinity problem special planting and establishment techniques may be required.

In areas with a salinity potential or to assist in regional salinity management the use of waterwise gardening is recommended for gardens and landscaping, including public parks and golf courses. Between 35% and 50% of household water is used outside the home and the application of Waterwise principles can reduce this and therefore reduce the additional water inputs to the watercycle.

The main Waterwise gardening techniques for consideration in the planning and design of new developments are:

- the use of low water requiring species, such as those included in Appendix 11.3 and in the booklet “Local plants for your garden” (“Michaelis 2000”), available from DIPNR Windsor;
- ‘smart’ irrigation systems that respond to soil moisture and climate conditions to reduce over-watering;
- Careful installation of irrigation systems to avoid over-spray, drift or ponding affecting built structures;
- Grouping of plants with similar water needs;
- Checking irrigation systems for leaks;
- Mulching garden beds; and
- Reduced lawn areas.

It should also be noted that recycled water and treated effluent tend to contain elevated salt levels. In areas where salinity is a problem, where salt loads in the soil are borderline, or where the salt may be concentrated at the surface, the impact of these additional salts should be taken into account.

This information is just a general overview of some of the basic principles for good salinity outcomes. It is recommended that professional advice is sought and that options are considered on the basis of site specific conditions and requirements.

Some of the key contacts for further information;

- Royal Botanic Gardens, Mt Annan.
- Sydney Water, “Every Drop Counts” program.
- Department of Agriculture’s Regional Waterwise Program, Sydney and South Coast Regional Offices.
- Department of Infrastructure, Planning & Natural Resources, www.dipnr.nsw.gov.au, under Waterwise.

8.10 Road and Pavement Requirements for Areas with Salinity Potential

The impact of salinity on roads can be a major cost to councils and communities. In some catchments up to 30% of regional roads are being affected by salinity (McRobert and Robinson, 2001). The impact on local roads and in urban areas has not yet been thoroughly investigated. However, a study into the costs of salinity to Wagga Wagga City council identified that the annual recurring costs due to road damage for 1/9th of the LGA was more than \$225,000. The costs of salinity damage to roads are also assessed in an audit of the cost of salinity for the Murray Darling Basin.

Observations of a number of roads in Western Sydney suggest that salinity damage may be an issue. However, awareness of the impact of salinity and groundwater on roads is low and therefore not commonly recognised as a cause of road deterioration in the region. It is also difficult to define the exact impacts of high water-tables and salinity on road assets, since there are a range of issues, such as construction methods, or heavy traffic, which may contribute to the failure of pavements and the premature deterioration of the structure. More detailed assessment is needed in the region to understand the impact of salinity on roads and identify necessary management strategies.

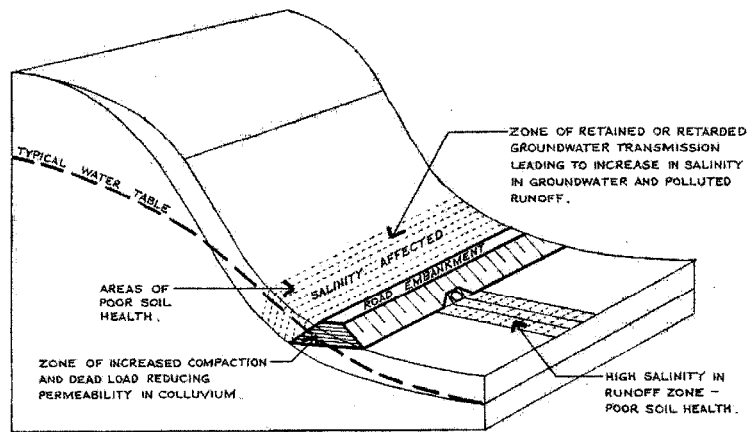
The types of damage seen in roads affected by salinity and waterlogging, based on a Western Australian Study (McRobert and Foley 1999) includes:

1. Inundation.
2. Pavement and surface distress, including:
 - Rutting
 - Bleeding and flushing of sprayed bitumen seals
 - Ravelling and developing potholes
 - Major patching
 - Pavement distress of a stabilised pavement
 - Loss of seal, blisters and potholes
3. Structural distress.
4. Damage to the roadside environment, eg erosion.

Damage is also seen in structures such as reinforced concrete bridges and culverts, kerbing and sidewalks. The damage can be caused by waterlogging due to raised water tables, water entering the road due to the deterioration of the seal, or damage to the materials used in construction due to the corrosivity of the salts.

The key to building salt resistant roads is in keeping water and salt out of the layers that make up a road. This may be done by addressing salinity in road location, design, construction and maintenance.

The construction of roads can also create areas of salinity, due to the interaction with groundwater and salinity processes. Salinity has been observed to be affecting roads or adjacent areas as a result of soil compaction, impeded flow, or the concentration of saline discharge. Unfortunately there is a limited consideration of groundwater and salinity when planning, designing and constructing roads.



(Porter & Clifton, 2001)

Figure 15: The impact of roads on salinity processes

Specific guidelines for road design, construction and maintenance in areas with salinity potential are not yet available. However a number of studies are looking at this issue and there are sources of information that could be considered for use on Western Sydney developments. These include:

- ARRB Transport Research Special Report #57 “The impacts of Waterlogging and Salinity in Road Assessment: A Western Australian case study” (available from www.arrb.com.au/pubs/recpub, under Environment). This site also has publications on corrosivity and sulphate resistance in materials.
- RTA/ DIPNR demonstration project on the Olympic Highway in Young Shire (www.ndsp.gov.au for more information),
- RTA/ Wagga Wagga City Council project on the Sturt Highway, Yarragundry (contact the RTA office in Wagga) and
- DIPNR Local Government Salinity Initiative booklet - Roads and Salinity.

Some basic do's and don't suggested by this material are as follows (adapted from Porter and Clifton 2001):

- DO consider terrain, water flows (surface and sub-surface) and climate when siting and designing roads.
- DO provide well designed sub-surface drainage, suitable for the site conditions.
- DO assess the site for sodic or saline sub-soils and use best practice management techniques to reduce the exposure and disturbance of these materials.
- DO consider soil corrosivity and choose appropriate materials to resist the salts present.
- DO consider limiting the addition of salts in the materials, fill or water used during construction.
- DO consider using a water-proof seal to minimise evaporation and therefore the concentration of salt.
- DO seek further advice and information from specialists regarding suitable design, materials and construction techniques for areas with a salinity potential.
- DON'T design road alignments to intercept known salt affected or waterlogged areas.
- DON'T design drainage that discharges to groundwater or salinity affected areas, that causes increased waterlogging adjacent to road, or that concentrates surface runoff.

- DON'T design detention basins, sedimentation basins, or bio-retention zones, without ensuring that they will not leak and cause localised damp soil conditions or recharge to the groundwater, thereby contributing to salinity problems.
- DON'T design roads with cut, fill or compaction that impedes the sub-soil flow, or creates hydraulic pressure causing groundwater discharge, thereby contributing to salinity problems.

It seems that this area of salinity damage needs a great deal more assessment and research in general, as well as in relation to Western Sydney. Given the costs associated with shortened road life spans and the high density of roads in the region, it seems to be a necessary direction for future salinity management strategies. The increased awareness of salinity issues in the region will hopefully lead to further discussion about this section amongst the relevant staff in councils.

The investigation of specific site conditions as proposed in the Development Assessment Guidelines (Section 7) will provide detailed information at the planning stage of new developments that could assist in the design of roads that are salt resistant and do not contribute to salinity problems. This should manage some of the on-going maintenance costs for the council and the community due to salinity damage. For this to occur it is important to ensure that information from salinity assessments is integrated into all aspects of the design, construction and maintenance of a development.

8.11 Stormwater and Drainage Requirements in Salinity Hazard areas

Due to the role of water in all salinity problems the management of water and site drainage on sites with salinity potential is very important. It may also be one of the easiest and least expensive measures available to householders trying to manage salinity. The information provided here is general and it is highly recommended that a professional be consulted about drainage and stormwater requirements or alterations on a site. This is particularly important in areas with reactive clay, where changes in the water content of the soil can cause serious damage to structures.

On individual sites correct drainage helps protect foundations, footings and walls from salt attack. Salinity problems generally occur in the areas where water accumulates, or which are subject to continuous wetting and drying cycles. This can be where natural through flow or surface flow is impeded by buildings, or by associated retaining walls or land resurfacing. Where water does not drain away from the property due to the slope of the ground or paving on the site, or where the landscaping or garden is sited against the property. Areas adjacent to downpipes, guttering or outdoor taps may also be susceptible to salinity problems particularly if leaking. In Western Sydney the design and maintenance of properties should take these factors into account.

Leaking water pipes may also contribute to damp soils around properties and therefore cause salinity problems in areas with even mildly saline soils. Additionally the corrosivity of the soils may weaken pipes and joints creating leaks which in turn lead to further salinity problems. In areas where salinity is a problem the maintenance of underground water and sewer pipes is very important. Water pipes can be checked for leaks by reading the meter before and after a period of nil water use, eg, over-night or when the property is vacant.

Sewer pipes need to be checked by a professional. It may be worth considering a check of property pipes at the time of purchase, such as that proposed by the “Pipecheck” system. Other sources of water leaks should also be considered and carefully maintained, particularly swimming pools or water features.

Areas with salinity potential also need to be carefully considered when developing on-site stormwater or wastewater treatment options. Waterlogged or damp soils are important in driving much of the salinity experienced in Western Sydney. Therefore, the use of infiltration and irrigation to manage water should be reviewed with consideration of a site’s salinity processes.

In areas with rising watertables and groundwater salinity the recharge from such systems may be undesirable. In most cases, to effectively predict the impact of such water management strategies some site-specific investigations will be needed, as recommended in the Development Assessment Guidelines, Section 7. In the case of on-site wastewater treatment the salt load of the water and its impact on potential soil or groundwater salinity also needs to be well investigated.

Stormwater detention structures or artificial wetlands with some holding capacity need to be constructed with impermeable linings to avoid the infiltration of water to the surrounding landscape or to groundwater. When choosing a lining the possibility that on-site clays may be saline should be investigated before they are used for this purpose. In these situations an impermeable geotech fabric may be a better choice.

It is also important to consider the impact of any earth movement or reshaping required in the design of stormwater infrastructure. In areas with potential for salinity this may result in exposure of saline or sodic sub-soils. Once disturbed these soils are very hard to stabilise and problems associated with tunnel erosion and poor revegetation may result.

In creeks such reshaping lowers the surface closer to the watertable and removes vegetation believed to be important in maintaining a lowered watertable in these areas. As a result discharge or capillary rise may cause surface concentration of salts.

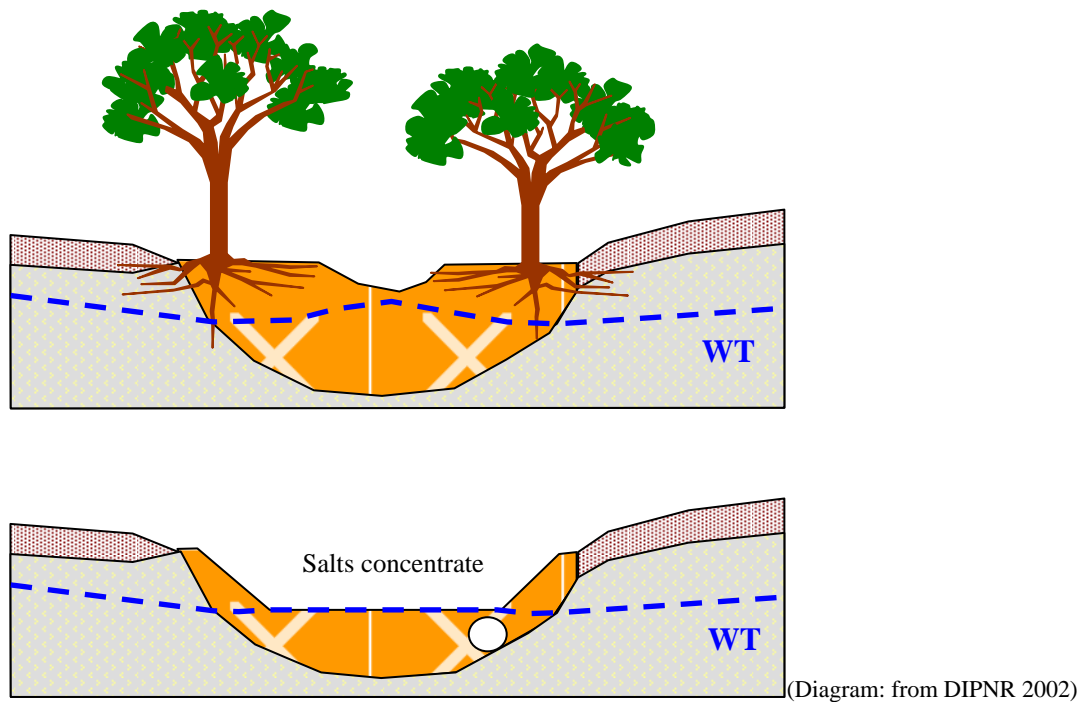


Figure 16: Salinity and Stormwater channels

The relationship between the proposed stormwater system and the sub-surface and groundwater system also needs to be considered. It is possible for pipes or channels to impede flow causing the accumulation of water and the concentration of salts. Stormwater infrastructure may also cause areas of groundwater discharge due to compaction or may intercept the groundwater resulting in a saline discharge through the system.

Finally consideration needs to be given to the impacts that salt in the soil and water will have on stormwater infrastructure. Damage to concrete, pipes and vegetation used in stormwater systems may result in increased maintenance cost and reduced effectiveness.

The following are recommended when designing and constructing stormwater management structures in Western Sydney:

- 1 Assess the site for sodic or saline sub-soils and use best practice management techniques to reduce the exposure and disturbance of these materials.
- 2 Maintain or restore riparian vegetation where possible.
- 3 Avoid areas of impeded sub-surface flow and the interception of groundwater.
- 4 Minimise infiltration, waterlogging, or wetting/drying cycles.
- 5 Consider soil corrosivity and choose appropriate construction materials and vegetation to resist the salts present.
- 6 Seek further advice and information from specialists regarding suitable design, materials and construction techniques for areas with a salinity potential.

While some Water Sensitive Urban Design (WSUD) techniques emphasise infiltration as a means of managing stormwater quantity and quality, it is not the only concept involved. The basic principles of WSUD - reducing water input, water output and water demand and maintaining a natural water-cycle balance, are important principles for good salinity management. Techniques that achieve these outcomes, without increasing infiltration or damp soils may be very suitable for sites with a potential for salinity and may achieve a dual outcome.

Options that reduce the import of potable water to a site, such as rainwater collection and water re-use, may have a role to play in salinity management. However it is important that these systems do not place the emphasis on irrigation to utilise this water, but instead focus on reducing overall water usage by utilising the water for toilet flushing, laundry use and hot water systems. The use of lined detention and filtration systems may also be a possibility, eg, lined detention ponds, wetlands, or bio-ribbons. WSUD emphasises the need to understand the site and develop site specific solutions, which is a very sound basis for good salinity management outcomes.

The preliminary investigations and modelling for good WSUD should look at the watercycle, including groundwater and the capability of the sites soils, including salinity and permeability. Salinity management should not be seen as being fundamentally in conflict with WSUD. Rather they are both part of a holistic approach to watercycle management.

Best practise techniques for good stormwater management in areas with a salinity problem are still evolving. The information is not yet available for reliable guidelines, but as more sites are designed to meet salinity management objectives, the techniques and this information will continue to develop. Consideration may need to be given in the future to developing guidelines for stormwater management in saline environments.

9. IMPLEMENTING THE SALINITY CODE OF PRACTICE

This section makes some suggestions as to how councils might consider the implementation of all or parts of the Salinity Code of Practice.

9.1 Staff Salinity Training Sessions

As part of the Stage Two Western Sydney Salinity Management Project each council was offered a salinity training session, run by DIPNR and WSROC, which:

- Provided an introduction to salinity issues; and
- Explained the use of some of the tools available to assist council manage salinity.

These training sessions were attended by over 250 staff, from a wide range of sections, including environment, planning, engineering, building, roads, parks and stormwater. This training has increased the level of awareness and understanding of salinity amongst the region's local government staff and has improved their capacity to use the various salinity management tools that will soon be available to them. Training material will be distributed to councils to support an on-going internal training process.

9.2 Council Salinity Working Party (internal)

An internal council salinity working party can be an effective way to consider and address urban salinity. Such a salinity working party would benefit by including representatives from all relevant sections including planning, approvals, construction/building, environment, risk management, roads, parks and recreation. This would support the integration of salinity into council's management plans and would provide links to internal and external council activities.

Such a committee also needs the appropriate authority or process to allow it to effect changes in council management practices. This may require higher-level staff being involved, or a reporting process to involve managers and directors in the working party's work.

A salinity working party can guide the development of a Salinity Management Strategy for the council and address issues such as:

- Using the Western Sydney Salinity Code of Practice.
- Auditing salinity impacts in the LGA.
- Necessary monitoring by council.
- Development requirements and assessment.
- Risk management protocols.
- Asset management guidelines.
- Staff training and education.
- Industry training, education and awareness.
- Community education and awareness.
- Resources and contacts to assist staff or community.

It could also provide a forum for the identification and discussion of on-going salinity issues experienced by different sections of the council, as well as input into the review of salinity management plans for major developments.

9.3 Model Code of Practice Implementation Strategy

Step	Action
1	Provide briefing to Council on Salinity and the Code of Practice
2	Seek approval to review salinity management within council
3	Establish an internal salinity working party, involving representatives from all relevant sections
4	Allocate staff time and suitable resources for the committee
5	‘Snapshot’ of current salinity problems and potential in LGA
6	Audit current salinity management strategies used by council
7	Identify areas where salinity management strategies are required
8	Identify knowledge gaps, areas for further assessment, monitoring, review, or understanding.
9	Draft a broad policy for salinity management and seek feedback from key internal and external stakeholders
10	Instigate updates of existing policies and planning instruments as necessary to address salinity
11	Develop an action plan to address salinity issues, in consultation with internal and external stakeholders
12	Seek appropriate commitments and resources to implement the action plan, identify external funding opportunities.
13	Identify progress review process, including links to SOE, Council Plan of Management and Annual Report
14	Education and Awareness plan to communicate about Salinity Management to the local community
15	Implement Salinity Management Strategy

Figure 17: Council Implementation Table

9.4 Alternative Adoption Strategies

In lieu of a full adoption of the Salinity Code of Practice, or parts thereof, it is suggested that some councils will use the Code as a basis for internal consideration and discussion and develop an initial three-part response to salinity issue:

1. **Develop an internal salinity policy, based on the code, for council activities and practices,** eg, roads, assets, community buildings, stormwater, parks and reserves. This could also include the review of existing policies for the need to include salinity considerations.
2. **Develop a community education and awareness strategy to address the issue** with local residents, businesses and developers, providing information about the issue and some general ‘good practice’ guidelines. Coordinated with wider regional strategies, eg. use of salinity display, distribution of brochures, targeted forums/ events, partnerships with community or industry groups.
3. **Explore ways to incorporate the consideration of salinity information into new development and re-zoning applications,** under existing policies and planning instruments.

Such an approach will at least provide councils with an initial response to the recognised potential for salinity in the region and a system of salinity management that has coordination and consistency.

Councils are also reminded that the Western Sydney Salinity Working Party will continue to provide a network and support at the regional level and representatives are encouraged to include implementation issues on the agenda for discussion.

10. FUTURE DIRECTIONS AND RECOMMENDATIONS

10.1 On-going actions and future directions

This table provides an outline of some of the other actions that are currently under way, which may provide important salinity management information or direction to Western Sydney Councils in the future.

Action	Description	Responsibility	Scale	Proposed date of release/ completion
Western Sydney Salinity Working Party	<ul style="list-style-type: none"> A regional group, facilitated by WSROC, which includes representatives of the 13 councils with potential salinity areas, as well as relevant state agencies and industry. Forum to discuss salinity issues, coordinate regional responses, facilitate networks and partnerships and provide access to information. Develop and support regional projects to address the key issues identified in the Regional Salinity Strategy (10.2). 	WSROC, member councils	Regional	On-going
Local Government Salinity Initiative (LGSi)	<ul style="list-style-type: none"> Under the NSW State Salinity Strategy a Local Government Salinity Initiative was proposed. A series of booklets with information to assist councils in considering and managing urban salinity issues. These include: <ul style="list-style-type: none"> - Broad scale Resources for Urban Salinity Assessment - Site Investigations for Urban Salinity - Building in a Saline Environment - Roads and Salinity - Indicators of Urban Salinity. - Introduction to Urban Salinity. - Others to be confirmed in future The LGSi Booklets provide complementary information to support the use of the Salinity Code of Practice. 	DIPNR	State	The first training sessions were delivered in 2002. The first six booklets were delivered in 2003
Salinity Potential Mapping	<ul style="list-style-type: none"> A Draft Salinity Hazard Map was released for Western Sydney in 2000. This map has been extended to cover all areas of Wianamatta Shale and the revised map was released in August 2003. The map provides a tool to assist councils in identifying and conceptualising salinity potential both in the LGA and in the wider region. 	DIPNR	Regional	2003

WS Groundwater studies	<ul style="list-style-type: none"> DIPNR have installed a number of piezometers in Western Sydney. The purpose of these studies is to provide more information about regional salinity processes. The information being collected will be made available to councils and will assist in understanding and therefore effectively managing salinity processes. 	DIPNR	Regional	On-going
Planning Guidelines	<ul style="list-style-type: none"> Under the NSW State Salinity Strategy a Model LEP for Salinity was proposed. Work has commenced on planning guidelines for urban salinity. This will provide further guidance for councils regarding the use of planning instruments to plan for salinity. 	DIPNR	State	2003
Select Committee into Salinity	<ul style="list-style-type: none"> In early 2001 this committee was appointed to inquire and report on a number of terms of reference, including salinity management options for councils and barriers to the adoption of salinity management strategies by councils. Their "Report on Local Council Management of Salinity" was released in May 2002. It includes 51 recommendations to improve salinity management by local councils. If implemented these recommendations could lead to new options for councils. 	Parliament	State	On-going
Review of Australian Building Codes	<ul style="list-style-type: none"> Last year at the national meeting of the Australian Building Codes Board Review Committee it was agreed to review the ABC provisions for building in a saline environment. This process may result in either a national variation to the ABC for salt affected areas, or possibly a state based variation. 	ABC Review Board	National	Possibly late 2003
Water Sensitive Urban Design projects	<ul style="list-style-type: none"> Two separate projects have been funded, including a Sydney capacity building project and a demonstration project for Western Sydney. These projects provide opportunities to further explore best practice for WSUD in areas with salinity potential. 	WSROC/SCCG/UPRCT	Regional	Mid 2003
Stormwater Extension Officer	<ul style="list-style-type: none"> This project has appointed an officer to assist the councils in the region in reviewing, implementing and further developing their Stormwater Management Plans (SMP). This project will provide opportunities to identify salinity issues in SMPs and develop best practice for salinity hazard areas. 	Dept of Environment and Conservation	Regional	2003
National Action Plan (NAP)	<ul style="list-style-type: none"> Although Western Sydney is not listed as one of the priority catchments under the NAP, it is hoped that research and information developed for other areas may be of assistance in Western Sydney. 	Commonwealth Government	National	On-going

NHT 2	<ul style="list-style-type: none"> Few details are yet available regarding NHT 2. This funding will be delivered via the regional Catchment Management Authorities, based on the Catchment Blueprints. This may offer opportunities for further funding to support salinity management by local councils in Western Sydney. 	Commonwealth Government	National/Regional	2004
-------	---	-------------------------	-------------------	------

10.2 Recommendations for Salinity Management in Western Sydney



REGIONAL SALINITY STRATEGY FOR WESTERN SYDNEY – NOVEMBER 2002

This strategy has been developed by the Western Sydney Salinity Working Party and endorsed by the WSROC Board but not the other stakeholders listed. It is intended to guide future salinity projects and actions in the region.

Note: Organisations identified as stakeholders or having lead roles are suggestions only and will be consulted prior to any projects being developed. Lead role refers to the organisation that could primarily coordinate and drive the actions and stakeholders are those organisations with an interest or who should be involved in any projects.

AREA	3	Key issues	Lead role	Stakeholders
1. Education and awareness	3 3 3 3	General community Industry Councils (see details below)	Working Party	Dept of Infrastructure, Planning & Natural Resources (DIPNR), Local Government, WSROC, Housing Industry Assoc (HIA), Urban Dev Institute of Australia (UDIA), Master Builders Assoc (MBA), other professional organisations, TAFE Colleges, Schools, Community Groups, Landcare /Bushcare
2. Stormwater and Wastewater Management	3	Best Practice Guidelines	LG, Working Party	Dept of Environment & Conservation, Sydney Water, Stormwater Industry Assoc (SIA), HIA, WSROC
	3	Research into relationship with salinity -Flood management -Infiltration -Role of riparian vege. -Recycled/ Wastewater treatment	DIPNR	Local Govt, Universities, Sydney Water, SIA, Water Sensitive Urban Design Project (WSUD), A
	3	Awareness of Total Water Cycle management	LG, Working Party	DEC, Sydney Water, Upper Parramatta River Catchment Trust (UPRCT)
3. Road and Infrastructure Management	3	Best Practice Construction Techniques	Working Party	RTA, CSIRO, Institute of Engineers (IEA), Institute of Public Works & Engineer Aust) IPWEA)

AREA	3	Key issues	Lead role	Stakeholders
	3	Implications for surface drainage and groundwater	DIPNR	Local Government
	3	Maintenance and repair guidelines	LG	RTA , Dept of Transport, CSIRO, IEA, Road Contractors, IPWEA
	3	Underground services	Working Party	Sydney Water, Integral, Telstra, AGL, Sydney Water Contractor, Plumbers
4. Notification	3 3 3	Methods Implications Liability	WSROC Board	OWS, Working Party, LG, Dept LG, DIPNR, Select Committee
5. Rural Areas	3	Vegetation Retention and Management	DIPNR	Dept Environment & Conservation
	3	Onsite Waste Water Treatment	DEC	HN-working group, DIPNR, LG
	3	Irrigation and Water Management	Dept Agric	DIPNR, NSW Farmers Federation
	3	Agricultural Productivity, impacts of salinity on food production.	Dept of Agriculture	DIPNR, NSW Farmers Federation
	3	Future Release areas	DIPNR	State Govt, Local Govt, WSROC Board
6. Managing Existing Property Damage	3	Awareness to facilitate the identification of salinity	LG	Private Certifiers, Building Inspectors, Aust Clay Brick & Pavers Assoc (ACBPA), Dept of Housing, Dept of Public Works, Dept of Education, DIPNR
	3	Best Practice Management Guidelines	Working Party, LG	CSIRO, HIA, TAFE, DIPNR
	3	Building Repair Techniques	Working Party, LG	CSIRO, Building Industry, TAFE, ACBPA, Dept Public Works, Trades Industry
7. Links to Regional Strategies/ Plans	3 3 3 3 3 3 3	PlanFirst Catchment Blueprints Model LEP Metropolitan Development Program Cumberland Plain TEC Recovery Plan Regional Parklands Sydney Basin Sustainable Agriculture	Working Party	WSROC Board, DIPNR, Office of Western Sydney (OWS), Cabinet Office, Dept of Ageing, NPWS, Local Gov Advisory Group, UDIA

AREA	3	Key issues	Lead role	Stakeholders
		Plan		
8. Investigation and on-going monitoring	3	Audits (existing damage, affected assets)	LG	DIPNR, Landowners/Developers, Universities
	3	Piezometers and Soil Studies	DIPNR	LG, Developers, Universities
9. Further Research		Processes, GW, Soils	DIPNR	ANSTO, Cooperative Research Centre (CRC), Landscape Environment & Mineral Exploration (LEME), Salinity CRC
		Building Techniques and Practises	HIA/ MBA	CSRIO, LG, DIPNR, Universities, ACBPA, Cement & Concrete Association
	3	Economic Impacts	OWS	DIPNR, University of NSW (UNSW), HIA, UDIA, EPA, CSIRO, Universities, DIPNR Coastal and Urban Team Leaders
	3	Stormwater Impacts (see above)	DIPNR	University of Western Sydney (UWS), Wollongong University, SIA, WSUD Projects, EPA, UPRCT
10. Regional Coordination and Cooperation	3	Project Coordination	Working Party	WSROC Board, DIPNR, LG, Indigenous Resource Management Forum, OWS, relevant Catchment Management Boards.
	3	Lobbying		
	3	Awareness		
	3	Salinity Working Party		

EDUCATION and AWARENESS STRATEGY

AREA	Target Groups	Tools(*italics indicate tools not yet developed)	Delivery
General Community	3 Schools 3 Landcare/ Bushcare groups 3 Homeowners 3 NESB community	Good Housekeeping Brochure, General Salinity Brochure, Salinity Display, 'Waterwise', DEC NESB program, Education Curriculum, Ethnic Communities Council environmental educations	1.LG 2. Working Party, WSROC, DIPNR, DEC, Dept Education /TAFE 3. Non-Govt Organisations (NGOs), Community Groups, Indigenous Resource Management Forum, Ethnic Communities Council 4. Via Commercial outlets for hardware and gardening supplies.
Industry	3 Developers 3 Consultants 3 Professional Bodies 3 Building Industry	<i>Training</i> , General Salinity Brochure, Code of Practice, <i>Best Practice Guidelines</i> , LGI Building Guides, Builders Breakfasts/ Developers Forums	1. LG 2. HIA, UDIA, Working party, WSROC, DIPNR, Professional Organisations, SIA
	3 Nurseries 3 Horticulturalists 3 Landscapers and LS Architects 3 Tradesmen (Plumbers, Brickies Handymen, Damp Specialists, Electricians, Painters, Renderers, Pavers)	Good Housekeeping Brochure, General Salinity Brochure, Salinity Display, 'Waterwise' Material, Sydney Water Plumbers Training	1. Working Party 2. LG, DIPNR, Industry Associations, Sydney Water
	3 Education/ Training Institutions	<i>Best Practice Guidelines</i> , General Awareness Material, LGI, Sydney Water Plumbers Training	1. Working Party 2. DIPNR, LG, TAFE, University, Industry Associations, Professional Bodies
	3 Staff 3 Managers 3 Elected Representatives	1. Capacity Building and Partnerships 2. Awareness and Understanding of Salinity issues and management 3. <i>Identify Staff Allocate Resources</i> 4. <i>Develop and Implement LGA Salinity Strategy</i>	1. Working Party 2. LG, DIPNR 3. WSROC Board, LGSA
Local Government and Agencies			

11. APPENDICES

11.1 Salinity Management Response Checklists

LEVEL ONE SALINITY MANAGEMENT RESPONSE CHECKLIST

Single lot developments in localities with a **moderate salinity potential**, based on the DIPNR Draft Salinity Potential Map (2002), should address the following management requirements in the development application. To identify the levels of salinity potential in the locality of your site please consult your local council.

When completing the following checklist please refer to the Western Sydney Urban Salinity brochures and references in Section 12. If you have any questions or need more information please contact your local council.

Salinity Potential areas

- 3 -Local variations in salinity potential can occur and therefore some sites may experience a greater potential than that identifiable at the regional scale using the Salinity Potential Map. Are you satisfied that there is only a moderate salinity potential on this site? Are you satisfied you do not need to conduct site specific investigations?

Water inputs

- 3 -Infiltration of stormwater avoided.
- 3 -Permanent water storage (e.g. water features, ponds, dams) lined and regularly maintained to limit infiltration.
- 3 -Underground water carrying pipes and any on-site sewerage system properly installed to eliminate leaks, (on established sites existing pipes and systems checked for damage/ leaks).
- 3 -Consideration given to salinity when designing and installing swimming pools.

Drainage

- 3 -Disturbance of natural drainage patterns minimised.
- 3 -Slab, foundations and retaining walls all designed to allow good drainage and minimise water logging.
- 3 -Existing areas of waterlogging and poor drainage remediated.
- 3 -Design and layout of retaining walls, driveways and service connections reduces cut, minimises impediment of natural groundwater flows and provides for good drainage.
- 3 -Guttering and down pipes properly connected and maintained.

Vegetation

- 3 -Areas of established vegetation maintained.
- 3 -Landscaping plans apply Waterwise gardening principles.
- 3 -Gardens designed so that they are not adjacent to the property.
- 3 -Irrigation properly installed to avoid leakage and 'smart' sprinkler systems considered.

Building/ Engineering

- 3 -Damp Proof Courses properly installed and maintained throughout construction, landscaping and finishing.
- 3 -Susceptible construction materials avoided, eg. Seconds, porous material
- 3 -Consideration given to the need for salt resistant bricks and construction materials

LEVEL TWO SALINITY MANAGEMENT RESPONSE CHECKLIST

Single lot developments in localities with a **high salinity potential**, based on the DIPNR Salinity Potential Map (2002), should address the following management requirements in the development application. To identify the levels of salinity potential in the locality of your site please consult your local council.

When completing the following checklist please refer to the Western Sydney Urban Salinity brochures and references in Section 12. If you have any questions or need more information please contact your local council.

Hazard areas

- 3 - Local variations in salinity potential can occur and therefore some sites may experience a greater potential than that identifiable at the regional scale using the Salinity Potential Maps. Are you satisfied that there is only a moderate salinity potential on this site? Are you satisfied you do not need to conduct site specific investigations?
- 3 -Areas of existing salinity identified and remediation/ management strategies considered.

Water inputs

- 3 -Infiltration of stormwater eliminated.
- 3 -Water features and permanent water bodies lined to eliminate infiltration.
- 3 -Underground water carrying pipes properly installed to eliminate leaks and on established sites existing pipes checked for damage/ leaks.
- 3 -Swimming pools designed to eliminate leakage and an on-going maintenance plan developed.

Drainage

- 3 -Disturbance of natural drainage patterns avoided.
- 3 -Areas of cut and fill on sites restricted to building envelope.
- 3 -Necessary slab, foundations and retaining walls all must be designed for good drainage and to avoid water logging.
- 3 -Existing areas of waterlogging and poor drainage avoided or remediated, with consideration of shrink swell hazard.
- 3 -Stormwater management eliminates infiltration.
- 3 -Retaining walls, driveways and service connections designed to avoid cut, minimises impediment of natural groundwater flows and provides for good drainage.
- 3 -Guttering and down pipes properly connected and maintained.

Vegetation

- 3 -Areas of established vegetation maintained.
- 3 -Landscaping plans - apply Waterwise gardening principles.
- 3 -Gardens designed so that they are not adjacent to the property.
- 3 -Erosion/disturbance minimised and revegetated with appropriate species.
- 3 -Irrigation properly installed to avoid leakage and 'smart' sprinkler systems used.

Building/ Engineering

- 3 -Damp Proof Courses properly installed and maintained throughout construction, landscaping and finishing.
- 3 -Damp Proof membrane installed under slab.
- 3 -Reduce the exposure of materials to corrosive soils, eg. raised slab or pier and beam designs, with consideration of shrink swell hazard.
- 3 -Construction techniques minimise site disturbance and the exposure of sensitive soil material.
- 3 -Soil management plan addresses the management of saline and sodic soil
- 3 -Susceptible construction materials avoided, eg. porous material
- 3 -Utilise appropriate salt resistant bricks and construction materials
- 3 -Design and layout of drives and service connections minimises disturbance and exposure of susceptible soil and uses corrosive resistant material

- 3 -Disturbance of soil on the site minimised and properly rehabilitated

LEVEL THREE SALINITY MANAGEMENT RESPONSE CHECKLIST

A comprehensive Salinity Management Plan should be based on site specific investigation and address the following:

- ✓ Description of site, including geology, soils, hydrogeology, topography and climate.
- ✓ Description of proposed development.
- ✓ Summary of investigations undertaken (see DIPNR Site Investigations for Urban Salinity).
- ✓ Interpretation of results, including potential for impacts on buildings, not just vegetation and the likely impact of the development on local and regional salinity processes.
- ✓ Mapping of site to show salinity potential, areas of existing salinity, recharge/ discharge areas.
- ✓ Identification and discussion of salinity processes potentially occurring on the site now and in the future.
- ✓ Discuss and model the water cycle processes on the site and including natural drainage systems and groundwater conditions, especially perched or raised watertables.
- ✓ Discuss and model potential cumulative impacts and cross-boundary issues.
- ✓ Water cycle management strategies (including potable water use, stormwater management techniques, water demand levels, changes to local flow regimes, groundwater interactions and the maintenance of a natural water balance).
- ✓ Soil management strategies (including management of sensitive soil materials, corrosivity, dispersability, pH and Erodibility)
- ✓ Groundwater management strategies (including how to decrease the hydrological load and maintain a natural water balance)
- ✓ Vegetation management strategies
- ✓ Salinity issues addressed in site design and layout, covering the long-term impact on development, recharge/discharge and the mobilisation of salts. Should include location of roads, stormwater management structures, dwellings, community facilities, recreation areas and vegetation reserves.
- ✓ Salinity issues addressed in road/ infrastructure planning and design, including impacts on road life, recharge/ discharge and the mobilisation of salts.
- ✓ Strategies that address the exposure of building materials to corrosive soils and salinity.
- ✓ On-going salinity management options for the site
- ✓ On-going monitoring of soil and groundwater salinity, for the impact of the development and success of management strategies, including a plan to realise this.
- ✓ Remediation plans for areas of existing salinity, erosion and poor drainage
- ✓ Implementation plan for the life of the development, including training and induction of all the teams involved, including sub-contractors.

The Salinity Management Plan should be accompanied by the full salinity investigations undertaken.

It may be preferable on some sites to address salinity as part of an integrated planning process, rather than develop a separate salinity plan. However, the same issues would need to be addressed.

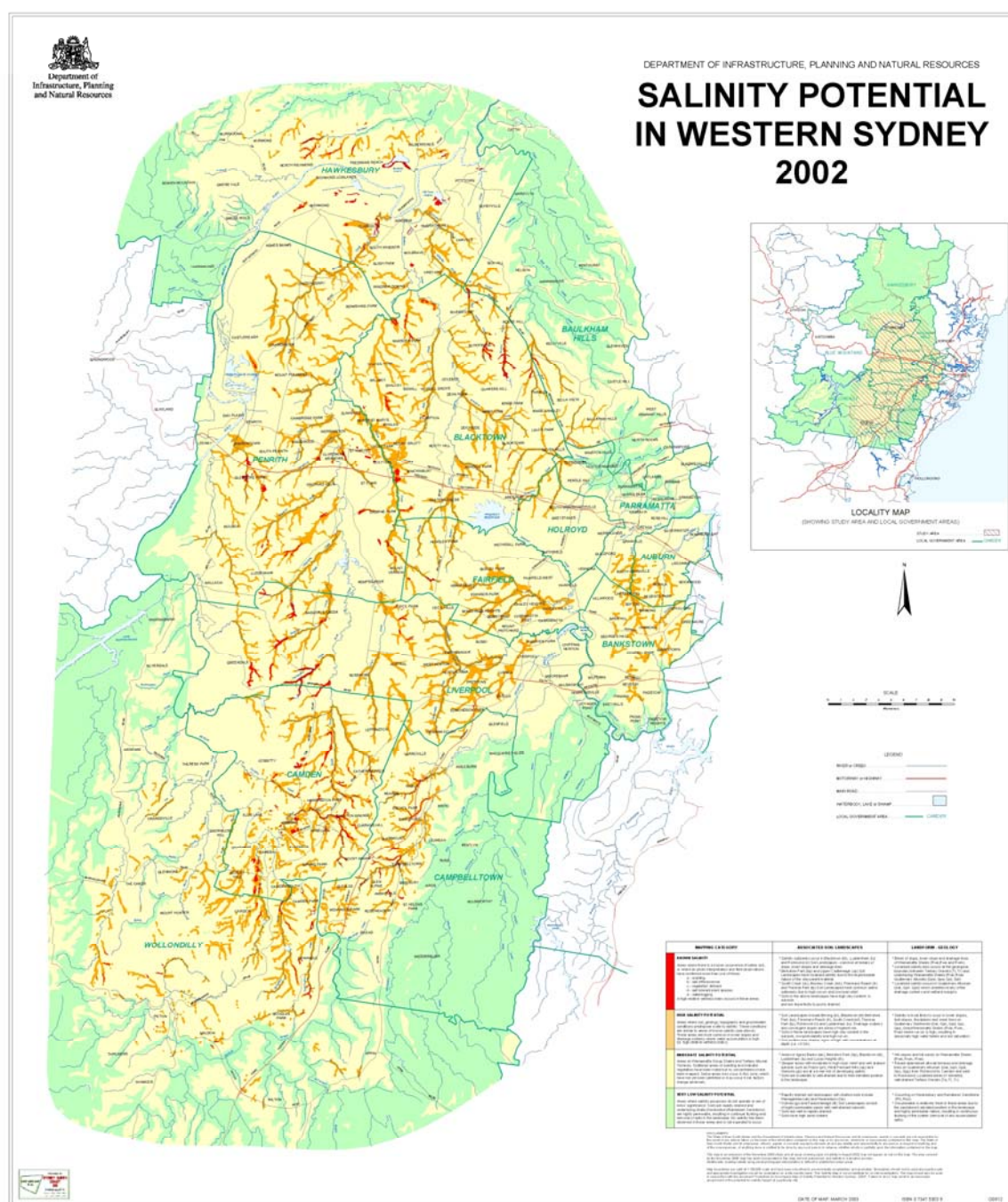
The strategies developed in the salinity management plan should be reflected in other plans associated with the on-going development, eg DCP, master plan, designs, etc.

For large developments individual precincts may need specific investigations and plans.

11.2 Map of Salinity Potential in Western Sydney

Copies of the Salinity Potential Map are available in electronic format from the Department of Infrastructure, Planning & Natural Resources. The map should only be used at the 1:100,000 scale and should always be read in conjunction with the “Draft Guidelines to accompany the Salinity Potential Mapping for Western Sydney”.

Councils should be aware that the 2000 map has been extended to cover all areas in Western Sydney located on Wianamatta Shale. This map was launched in August 2003 and with accompanied by updated guidelines.



11.3 Species List for Salt Affected Areas in Western Sydney

The plants listed below are thought to be some of the more salt tolerant species of Western Sydney. However, the salt tolerance of species is highly variable, even within species. You may also find further information and planting stock from organisations such as Greening Australia and State Forests at Pennant Hills though not all these species may be readily available.

It is recommended that a vegetation “community” rather than a few trees be created. The herbs, grasses and sedges maybe particularly useful for the revegetation and/or stabilisation of drainage lines. Trees and shrubs could be planted on higher areas to stabilise creek banks and assist reducing localised watertables. It may be best to plant around the edges of any scalds and over some years gradually work towards the centre (worst areas) as the local water table level drops.

Botanical Name	Common Name	Salt Tolerance	Comments
Aquatic			
<i>Bolboschoenus fluviatilis</i>	Marsh Clubrush		
<i>Phragmites australis</i>			
<i>Typha orientalis</i>			
Semi aquatic			
<i>Alternanthera denticulata</i>	Lesser joyweed		
<i>Bolboschoenus caldwellii</i>	(rush)		
<i>Carex appressa</i>			
<i>Eleocharis cylindrostachys</i>			
<i>Eleocharis dietrichiana</i>			
<i>Eleocharis gracilis</i>	Slender spike rush		
<i>Goodenia paniculata</i>	Swamp goodenia		
<i>Juncus kraussii</i>			
<i>Juncus usitatus</i>			
<i>Paspalum distichum</i>	Salt-water Couch		Grass that tolerates severely saline soils
<i>Sporobolus virginicus</i>	Sand Couch, Salt-grass	Extremely saline (1)	Grass that tolerates severely saline soils
Herbs and Grasses			
<i>Brunoniella australis</i>	Blue trumpet		
<i>Centella asiatica</i>			
<i>Commelina cyanea</i>			
<i>Cynodon dactylon</i>	Common Couch		Grass for highly saline soils
<i>Danthonia spp.</i>	Wallaby grass		
<i>Einadia hastata</i> (formerly <i>Rhagodia hasata</i>)			
<i>Lomandra longifolia</i>	Mat rush		
<i>Themeda australis</i>	Kangaroo grass		
Trees and Shrubs			
<i>Acacia longifolia</i> var <i>sophorae</i>	Sydney Golden Wattle		
<i>Allocasuarina littoralis</i>	Black she-oak	Slightly saline (1)	Drier areas, ie adjacent to drainage channel
<i>Allocasuarina torulosa</i>	Forest oak	Slightly saline (1)	Drier sites
<i>Angophora floribunda</i>	Rough-barked Apple		
<i>Angophora subvelutina</i>	Broad-leaved Apple		
<i>Atriplex semibaccata</i>	Half-berried salt bush	Extremely Saline (1)	This species may be an indicator of saline soils.

<i>Atriplex cinerea</i>	Gray Saltbush	Extremely Saline (1)	Not a native to the area
<i>Baeckea virgata</i>			
<i>Bursaria spinosa</i>	Blackthorn		This plant is very tough and pretty much vandal proof (Spiky)
<i>Callistemon linearis</i>	Narrow-leaved Bottlebrush	High (2)	
<i>Casuarina cunninghamiana</i>	River she-oak	High (2)	Adjacent to drainage channel, including banks if possible. <i>C. glauca</i> is more salt tolerant than <i>C. cunninghamiana</i> .
<i>Casuarina equisetifolia</i> var <i>incana</i>		Very Saline (1) Moderate (2)	
<i>Casuarina glauca</i>	Swamp she-oak	Extremely saline (1) Very High (2)	
<i>Corymbia maculata</i>	Spotted Gum	Slightly saline (1) High (2)	
<i>Eucalyptus amplifolia</i>	Cabbage Gum		
<i>Eucalyptus bosistoana</i>	Coast Grey Box		
<i>Eucalyptus elata</i>	River peppermint, River white gum	Slightly saline (1)	
<i>Eucalyptus moluccana</i>	Grey box	Moderate Saline (1) High (2)	
<i>Eucalyptus robusta</i>	Swamp Mahogany	Moderate Saline (1)	Not a native to the area
<i>Eucalyptus sideroxylon</i>	Red Ironbark	Slightly saline (1) High (2)	
<i>Eucalyptus tereticornis</i>	Forest Red Gum	Moderate saline (1) High (2)	
<i>Leucopogon virgatus</i>			
<i>Melaleuca armillaris</i>		Moderate saline (1) Moderate (2)	
<i>Melaleuca decora</i>	White feather honeymyrtle		
<i>Melaleuca ericifolia</i>	Swamp paperbark	Moderate saline (1)	Very wet sites or moist slopes – clumping/ suckering species
<i>Melaleuca hypericifolia</i>			Not a native to the area
<i>Melaleuca linariifolia</i>	Snow-in-summer	Moderate saline (1) Moderate (2)	
<i>Melaleuca nodosa</i>	Ball honey myrtle	Moderate (2)	These plants will add variety as well as being able to tolerate some level of soil salinity.
<i>Melaleuca quinquenervia</i>	Broad-leaved paperbark	Moderate saline (1) Moderate (2)	Small to medium tree that should tolerate some salt and will add to species diversity.
<i>Melaleuca styphelioides</i>	Prickly-leaved paperbark	Moderate saline (1)	

1. Salinity tolerance of plants for agriculture and revegetation. Agriculture WA
http://www.agric.wa.gov.au/environment/salinity/measurement/Plant_salt_tolerance.htm
 Extremely Saline Ece > 16 dS/m
 Very Saline Ece 8-16 dS/m
 Moderate Saline Ece 4-8 dS/m
 Slightly saline Ece 2-4 dS/m

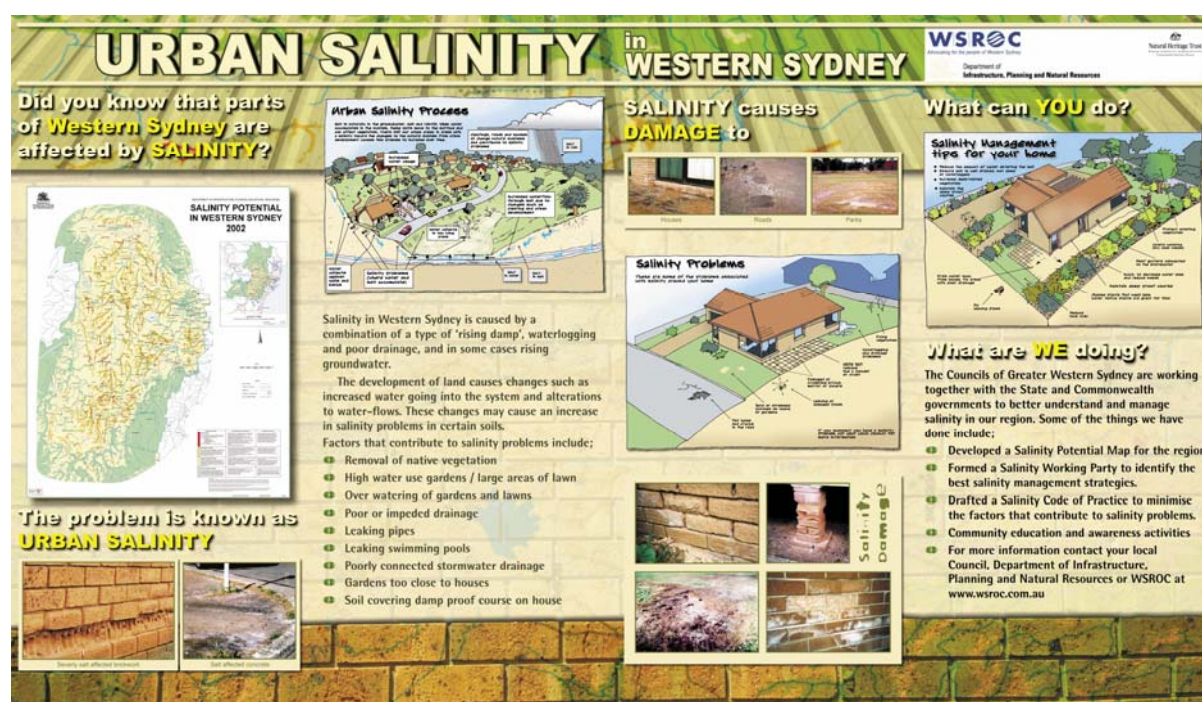
2. Salinity Management Handbook Department of Natural Resources Queensland (1997)

11.4 Western Sydney Education/ Awareness Brochures

The following brochures have been developed to assist councils in implementing the Code of Practice and in developing education and awareness strategies for the community and industry in their LGA. A short run of copies will be available from WSROC and councils will also receive the originals in pdf format.

- **‘Urban Salinity in Western Sydney’**
2 page brochure - General introduction to salinity in Western Sydney
- **‘Western Sydney Salinity Potential Map and Guidelines’**
2 page brochure -Explains the use and interpretation of the Salinity Potential Map
- **‘Good Housekeeping Guide’**
B5 Booklet - Information for householders. Including; identifying, managing and preventing salinity around the home.

Also available is an Urban Salinity Display. This has been produced by the WSROC project officer and a copy will be provided to each council, along with a ‘Salt Bag’ salinity test kit with EC meter, for use at community events and in public displays within their LGA.



11.5 FAQ (Frequently Asked Questions) Sheet

The following information has been developed for use as a frequently asked question sheet for use with Section 149 Certificates containing notifications regarding salinity.

Frequently Asked Questions (FAQ)

What is salinity?

Salt is a natural part of the landscape in Western Sydney. When the salts accumulate and concentrate at or near the land surface, salinity can become a problem causing dieback in vegetation, poor water quality and in urban areas, damage to buildings, roads and parks. Salinity in an urban area is referred to as Urban Salinity

Why do we have salinity in Western Sydney?

Salt is naturally found in the rocks, soil and shallow groundwater in Western Sydney. Additional salt arrives with the rainfall. Changes in land use over time has changed the way water moves through the environment. Salts that are normally stored in soils and rocks can be dissolved and brought to the surface due to increased water inputs in urban areas. In Western Sydney, this problem is complicated if the surface or sub-surface drainage of water is blocked on a site. Salt accumulates with the water and overtime as the water is evaporated the salt concentrates, reaching levels that may cause problems for vegetation or the built environment.

Why is salinity a problem?

The concentration of salts in soil or groundwater near the surface can result in the dieback of trees, lawns, gardens and playing fields. Also, as salt is corrosive, it can affect bricks and concrete causing damage to roads, buildings such as homes, underground pipes, paving and walls. If not properly protected and managed for salinity, the damage to these assets can result in increasing costs to property owners, councils and the community.

What does salinity look like?

The assessment of existing salinity and salinity potential is best done by experts; however there are some easily recognised indicators that may assist in identifying possible salinity problems around your property. These include;

- Salt crystals/ white residue on bricks or soil
- Flaking, crumbling or corroded bricks
- Mortar that has become soft and powdery, or gaps where the mortar should be.
- Concrete and pavers that are 'wearing' quickly or which seem to be corroding. Salt crystals may also form in any cracks.
- Bare patches in the lawn, areas dominated by couch.
- Trees or shrubs suffering dieback for no other reasons.
- Cracking and salt 'halos' on the road.

More information is available in the booklet "Indicators of Urban Salinity" which is produced by the Department of Infrastructure, Planning & Natural Resources and is available from councils.

What is the salinity potential map?

The Western Sydney Salinity Potential Map was produced by the Department of Infrastructure, Planning & Natural Resources. It shows salinity potential across Western Sydney. Salinity potential is an indication of the likelihood of a site having a salinity problem due to its geology, soils, topography, climate and catchment position. The Western Sydney Salinity Potential Map was produced using modelling and aerial photography interpretation.

The map identifies land as being one of four levels, Red- known salinity, Orange- high Salinity Potential, Yellow- Moderate Salinity Potential and Green- Very Low Salinity Potential. It is important to realise that in a yellow area- Very Low Salinity Potential there is still the potential for salinity to

occur and that management strategies are equally important as in the areas with extensive salinity potential or known salinity problems.

More information about the map is available in the brochure “Western Sydney Salinity Potential Map and Guidelines” and in the guidelines which accompany the map, both of which are available from councils. It is recommended that members of the public seek assistance in using the maps.

What should I do if I think salinity is a problem on my site?

If you suspect salinity is a problem on your site the primary contact is your local council. An officer within council will be able to assist you in understanding the issues and finding more information about the appropriate responses for your site. It may be necessary to consult an expert, particularly if you suspect damage has already occurred. Geotechnical Engineers, building surveyors and building specialists may be able to help determine the cause of the problem and necessary repair/ management strategies for your particular site. Check that the person you have chosen has experience in dealing with salinity related problems. These professionals may discuss the problem in terms of corrosivity or aggressive soils, rather than as salinity

How do you manage salinity around a home?

Homeowners can undertake many actions to manage salinity or minimise the risk of salinity damage on their individual properties. These include often simple and inexpensive things such as reducing garden irrigation, moving gardens away from walls, maintaining downpipes and outdoor taps, addressing drainage problems (with consideration for reactive soils) and ensuring the Damp Proof Course is not breached by garden beds, pavers, rendering or other activities. Local Councils can provide more information about these actions.

In some cases it may be necessary to consider ‘salt-proofing’ new homes as a safe-guard eg. using exposure class bricks for parts of the property exposed to the ground. Information about the best building practices can be obtained from your local council.

More information about managing a property in a salinity hazard area is contained in the booklet “Good Housekeeping in Salinity Hazard Areas” which was developed by WSROC and is available from your local council.

What is being done about salinity in Western Sydney?

State and Local Government have undertaken a number of projects to address salinity issues in Western Sydney based on a regionally coordinated and proactive approach. These projects have included:

- Studies into salinity and salinity processes eg. Dias and Thomas ‘Salinity in the South Creek Catchment’ and the DIPNR Investigations and Options project, which has seen groundwater monitoring bores installed in strategic areas.
- DIPNR Salinity Potential Mapping. This has been extended to cover all of greater Western Sydney, based on modelling and aerial photos. The maps depict the areas where a potential exists for salinity (not where salinity is or will be occurring!) 1:100,000 scale.
- Western Sydney Salinity Management Project. A cooperative project by the 14 councils of Greater Western Sydney, to develop a framework for local government in the region to use when managing and assessing salinity potential. The project also provided training and information to council staff to assist them in addressing salinity issues

More information about these projects is available from your local councils.

Where can I get more information?

More information is available from your local council, the Department of Infrastructure, Planning & Natural Resources, or on the WSROC website, www.wsroc.com.au.

11.6 Salinity Information Databases (SALIS and Groundwater)

SALIS

The NSW Soil and Land Information System (SALIS) is a database available from DIPNR. It contains soil data from a wide range of sites and sources and is therefore a useful reference point. Site profile information is publicly available and free of charge on the internet. Consultants requesting bulk data will incur a fee.

Currently this database contains more than 50 000 soil profiles. Their location can be identified using the Soil Profile Attribute Data Environment (SPADE) which is attached to the SALIS database.

Soil profiles can provide a detailed analysis of the soil at depth. Those that have undergone laboratory testing provide information on the level and chemical composition of any salts present. This information can be of assistance when selecting appropriate species for revegetation, identifying any subsurface salinity that may need to be managed and selecting suitable building materials.

SALIS contains profiles gathered for a range of purposes, from normal land assessment surveys through to specific topsoil chemical test results.

Because of this there is variation in the level of detail held for each sample and not all have undergone laboratory testing. In all cases however, the information provided identifies the soil type, describes the site and soil layers (to a depth of 4m in some cases). A qualified soils expert may be necessary to satisfactorily interpret this data.

DIPNR recommends that all soil profile descriptions, gathered as part of an investigation, are recorded on the data cards of SALIS (see example in this section). The cards should then be mailed to:

SALIS Coordinator
Soil and Land Information System
Department of Infrastructure, Planning & Natural Resources,
Level 4 Macquarie Tower
10 Valentine Avenue (PO Box 3720)
Parramatta 2174

The data can then be entered onto the central database. Credit is given for submitting the cards and this is offset against any cost of obtaining other site profile information held on the system. Soil data cards are available from the SALIS Coordinator at the above address or by phone; 9895 7988.

How to access SALIS....

1. Go to the DIPNR website at <http://www.dipnr.nsw.gov.au> then natural resources management
2. Click on "Soils Data Online"
3. Follow the instructions to check if there are any soil profiles for your town
 - Those undertaking soil investigation are encouraged to send their data to SALIS to be stored for future use. Soils landscape data will also be available through SALIS.

\$\$\$ Soil profiles can be downloaded free for small sites and non-commercial users.

Groundwater Information

Groundwater information is extremely valuable for understanding salinity but can be quite expensive to obtain. However the local community may already have information on the groundwater situation that can be utilised. In particular this can include information from piezometers or test wells, old and disused bores and wells, observations of groundwater movement in cellars, mine shafts, quarries, dams or records from nearby bores.

Piezometers are deep bores (usually more than 3metres in depth) carefully constructed to measure groundwater pressure at selected depths but usually not water quality. Test wells on the other hand are more common (because they cost less to construct), are usually less than 3 metres and are more responsive to seasonal influences as unconfined groundwater system responsiveness to climate usually decreases with depth. The term 'monitoring bore' is used to describe bores installed for water quality monitoring. Some monitoring bores are in excess of 100 metres deep. Often these three terms are used interchangeably. For example it is common practise in many parts of the state to call shallow monitoring bores piezometers.

Groundwater monitoring can be undertaken from existing water extraction bores and wells, provided they are in a safe condition to do so. They may also provide valuable historical information. For example, it may be recorded that they were unused because they became too salty, or were continually deepened to access good quality water. These bores and wells may be located in town or the nearby rural area. They could be identified following a public notice, review of DIPNR bore records and/or review of older town maps. Speak with retired and active private drillers, windmill repairers and the local water delivery authority.

Local organisations that are involved in managing cellars, quarries and other below surface structures could also provide valuable anecdotal evidence of groundwater movement and watertable rise.

DIPNR also maintains a state wide groundwater database and provides information from the developing database to the public and to private companies for a fee that covers the time it takes an officer to extract and provide the information. The data available can include bore location, construction details, bore depth, rock/sediment type, standing water level, yield, salinity etc. However, the level of information for each bore varies. Requests for raw data should be directed to the Regional Resource Information Manager in each DIPNR region. Hydro-geological information may also be obtained from the DIPNR regional hydro-geologists.

The new Water Act requires all groundwater piezometers and bores to be registered with DIPNR. In many cases (for example, high and low yield bores), a licence is also required prior to construction of the bore. Drillers operating in NSW must also hold a valid driller's licence to help ensure correct construction of bores. Information thus obtained, as well as from other sources, is being entered into the groundwater database.

12. REFERENCES

- AANRM, 1998, Urban Salinity: A snapshot of the future, Conference Proceedings.
- Department of Environment and Natural Resources, 1997, Rising Damp and Salt Attack, State Heritage Branch, DENR, City of Adelaide.
- DIPNR, 2000, Guidelines for the Map of Salinity Potential in Western Sydney, (Penrith Office).
- Local Government Salinity Initiative Booklets, (Penrith Office).
- DIPNR, 2002, Indicators of Urban Salinity, (Penrith Office).
- DIPNR, 2002, Broadscale Resources for Urban Salinity Assessment, (Penrith Office).
- DIPNR, 2002, Site Investigation for Urban Salinity, (Penrith Office).
- DIPNR, 2003, Building in a Saline Environment, (unpublished) (Penrith Office).
- DIPNR, 2003, Roads and Salinity, (unpublished) (Penrith Office).
- Dias and Thomas, 1997, Salinity in the South Creek Catchment, Department of Infrastructure, Planning & Natural Resources, Goulburn.
- Electricity Association of NSW Corrosion in the Electrical Supply Industry.
- Gill, 2001, The Use of Planning Controls in Salinity Management, Proceedings of the National Local Government Salinity Summit, MDA Inc.
- Hill, 2000, Urban Salinity Economic Study, DIPNR, Socio-Economic Services Unit.
- McLean, W. and Jankowski, J. 1999 Hydrochemical processes associated with the occurrence of dryland salinity in the Longneck Creek catchment, near Windsor, NSW, Proceedings of the Murray-Darling Basin Groundwater Workshop, Griffith, NSW, 14-16 September 1999, 249-254.
- McRobert and Foley, 1999, The Impacts of Waterlogging and Salinity in Road Assets: A Western Australian Case Study, ARRB Transport Research, Special Report 57.
- McRobert and Robinson, 2001, Salinity Impacts on Local Roads, excerpt from Draft Report, ARRB Transport Research, for DNRE, in Proceedings of the National Local Government Salinity Summit, MDA Inc.
- Michaelis, 2000, Local plants for your garden – A guide for the Cumberland Plain, DIPNR Windsor.
- Mitchell, 2000, Salinity Hazard Mapping and Concept Modelling on the Cumberland Plain, Final Report, Groundtruth Consulting, unpublished. (Produced for DIPNR Penrith).

Murray Darling Basin Ministerial Council The Salinity Audit of the Murray Darling Basin, produced by the Murray Darling Basin Commission.

NSW Recycled water Coordination Committee, 2001, Draft NSW Guidelines for Urban and Residential Use of Recycled water, (unpublished).

Old, 1942, The Wianamatta Shale Waters of the Sydney District: their Salinity and a suggested geological explanation, NSW Department of Mines.

Patterson, 2001, Consideration of soil salinity when assessing land application of effluent, Department of Local Government, Technical Sheet 01/6.

Porter and Clifton, 2001, Practical Measures within Road Reserves to avoid development of Catchment Salinity Problems, Proceedings of the National Local Government Salinity Summit, MDA Inc.

Sinclair Knight and Mertz, 2001, Local Government Planning Support Tool for Salinity, overview, SKM, RPDG, MDA Inc.

Sitewise, 1999, Urban Soil Erosion and Sediment Control Resource Pack, DIPNR and WSROC.

SSROC Environmental Management Group, 1999, Model Policy on Contaminated Land, SSROC.

Sydney Water, 2000, Recycled Water in Sydney's Northwest, Fact sheet, Publication Number CSD2.

Vorobieff, Wallis and Murphy, 2001, Maintaining the Road Infrastructure in saline prone areas, Proceedings of the National Local Government Salinity Summit, MDA Inc.

Wagga Wagga City Council, 2000, Urban Salinity in Wagga Wagga, Council Publication.

Wagga Wagga City Council, 2000, Waterwise and Salt Tolerant Plants for the Wagga Wagga Region, Booklet, City of Wagga Wagga.

Wagga Wagga City Council, 2000, Building in a Saline Environment, Booklet, City of Wagga Wagga.

WSROC, 1996, Model Stormwater Management System, WSROC Ltd.

13. CONTACTS

WSROC- Western Sydney Salinity Working Party

Officer	Organisation	Phone	Fax
John Gould	Auburn Council	9735 1228	9643 1120
Mark Colburt	Baulkham Hills Council	9843 0555	9843 0411
Lee Morgan	Blue Mountains Council	4780 5555	47 805 555
Jane Peacock	Blacktown Council	9839 6000	9831 1961
	Bankstown Council	9707 9400	9707 9587
Jeff Bell	Camden Council	4655 2455	4655 2770
Andrew Houguet	Campbelltown Council	4645 4000	46 201496
Andrew Mooney	Fairfield Council	9725 0222	9725 4249
Dianne Tierney	Hawkesbury Council	4560 4444	45 604400
Brendan Govers	Holroyd Council	9840 9840	9840 9734
Tamsin Martin	Liverpool Council	9821 9222	9821 9153
	Penrith Council	4732 7777	47 32 7958
James Carey	Parramatta Council	9806 5000	9806 5903
	Wollondilly Council	4677 1177	4677 1831
Peter Morison	UPRCT	9891 4633	9689 2537
	DIPNR – Penrith	4722 1188	47 210181
Rachel Short	HIA	8878 0400	9807 8186
Susanna Savolainen	EPA	9995 6849	9995 6900
Robyn Sim	Sydney Water	9551 4634	