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North West Growth Centre Salinity Study

Department of Planning and Environment

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Document tracking

Revision	Details	Date	Prepared by	Reviewed by
1	First draft NWGC report	29 May 2015	N. Philps	D. Saunders
2	Final NWGC report	26 June 2015	N. Philps	C. Masters

Please note that Land Use and Infrastructure Strategy (the Strategy), as referred to in this report, is now called Land Use and Infrastructure Implementation Plan (the Implementation Plan).

EXECUTIVE SUMMARY

The Department of Planning and Environment is undertaking a review of the North West Growth Centre (NWGC) Structure Plan in partnership with relevant councils, Sydney Water, Transport for NSW, and other relevant agencies. The primary purpose of this review is to update the strategic level land use and infrastructure delivery plan in order to improve support of coordinated delivery of the area and deliver on Metropolitan Growth strategies identified for housing and employment, upon implementation of the plan. Salinity advice is required to determine whether this will be a determining factor in producing the revised plans.

There are 16 precincts within the NWGC, with Shanes Park and West Schofields remaining unreleased. It is expected that there will be around 70,000 new dwellings in the NWGC when it is completed.

Salinity is an issue that has become increasingly apparent with urban expansion across Australia, affecting buildings, infrastructure and the environment. It is a complex problem that can operate at both a local and regional scale. Salinity has long been recognised in Western Sydney as an issue in both groundwater and surface conditions, and can potentially cause significant economic, environmental and social costs.

A range of policies and guidelines are available which relate to salinity management and investigations. The primary document is the Western Sydney Region of Councils (WSROC) *Salinity Code of Practice,* released in 2003 to provide information on the current best practice in salinity management for use in Western Sydney. A review of best practice guidelines was undertaken in order to develop a set of key criteria for the evaluation of salinity controls in development control plans (DCPs) in place for precincts within the NWGC. These criteria comprise:

- Clear identification of principles
- Clear identification of salinity risk generating activities
- Clarity of management measures for stage of development (ie strategic/rezoning/ DA/construction)
- Clarity of management measures for types of development (eg resident, industrial, infrastructure, open space, etc)
- Requirements for site-specific investigations
- Addresses soil and groundwater migration
- Interrelationship with other policies or controls that impact on salinity, eg on-site wastewater, stormwater, flooding, diversity
- Adequate identification of salinity potential (clear mapping)
- Clear requirements for when a salinity management plan is required
- Addresses cumulative impacts.

Currently there are four DCPs which contain salinity management measures for precincts within the NWGC.

A review of the controls in the DCPs against the identified criteria found that the DCPs would benefit from a restructure and added detail to make them easier to use and provide a more

representative salinity risk rating to be properly applied. The controls for existing release areas could be strengthened to better manage ongoing risks. It was found that controls may be insufficient in detail to manage some land use activities in very high salinity hazard risk areas and their margins. Site investigations are likely to be required in these locations to inform the development of site-specific management measures.

The Blacktown City Council (BCC) Growth Centres Precincts DCP applies to the majority of precincts in the NWGC. Controls are contained both in the main body of the DCP and in Appendix C – Salinity Management Guidelines.

It was recommended that all DCPs be updated to include a revised Salinity Management Guideline as an appendix to the respective DCP. Suggestions to improve and strengthen the salinity management controls were also made. The recommendations to revise and restructure the guidelines comprise the following:

- Identify what phase of development various controls apply – a clear distinction between the considerations that should be addressed at the planning stage, the DA/construction phase and the post-construction phase needs to be made
- Identify what type of development various controls should be used for – a clear identification of appropriate controls for roads, utilities, open space and recreation, etc
- Consideration of landscape scale issues of salinity risk generating activities such as broadscale vegetation clearing and earthworks
- Upfront identification of investigation and reporting requirements
- Consistent reference to all relevant guidelines and standards
- Reference to the relevant detailed investigations in order to draw out the additional management measures and practices
- Clearer identification of the impacts of salinity on different land use types and the impacts of different land use activities on future salinity issues
- Reference to considerations of cumulative impacts in order to ensure these are considered at the precinct level.

An examination of the mapping available for informing salinity management was also undertaken. The Department of Infrastructure, Planning and Natural Resources (DIPNR) *Salinity Potential in Western Sydney Map* (2002) is currently the primary source of salinity risk mapping used in Western Sydney. The majority of the NWGC is considered to have moderate salinity potential with high potential along the creek lines.

More recently, the Department of Environment, Climate Change and Water (now Office of Environment and Heritage) undertook a range of extremely detailed hydrogeological landscape (HGL) characterisations to help understand the way in which water moves through the landscape and the configuration of soil materials and other structural features in the landscape. The HGL concept provides a structure for the understanding of how salinity manifests itself in the landscape and how differences in salinity are expressed across the landscape.

The HGL framework includes a risk analysis component which allows the landscape impacts and hazards of each area to be determined and an overall salinity hazard and resultant priority to be inferred. This gives a better understanding of the salinity issues at a more localised landscape scale that can be used in all phases of development to identify potential

salinity risks and proactively manage the issues. The framework also provides a clearer understanding of the salinity function in each HGL which is essential to understanding the salinity processes on a site.

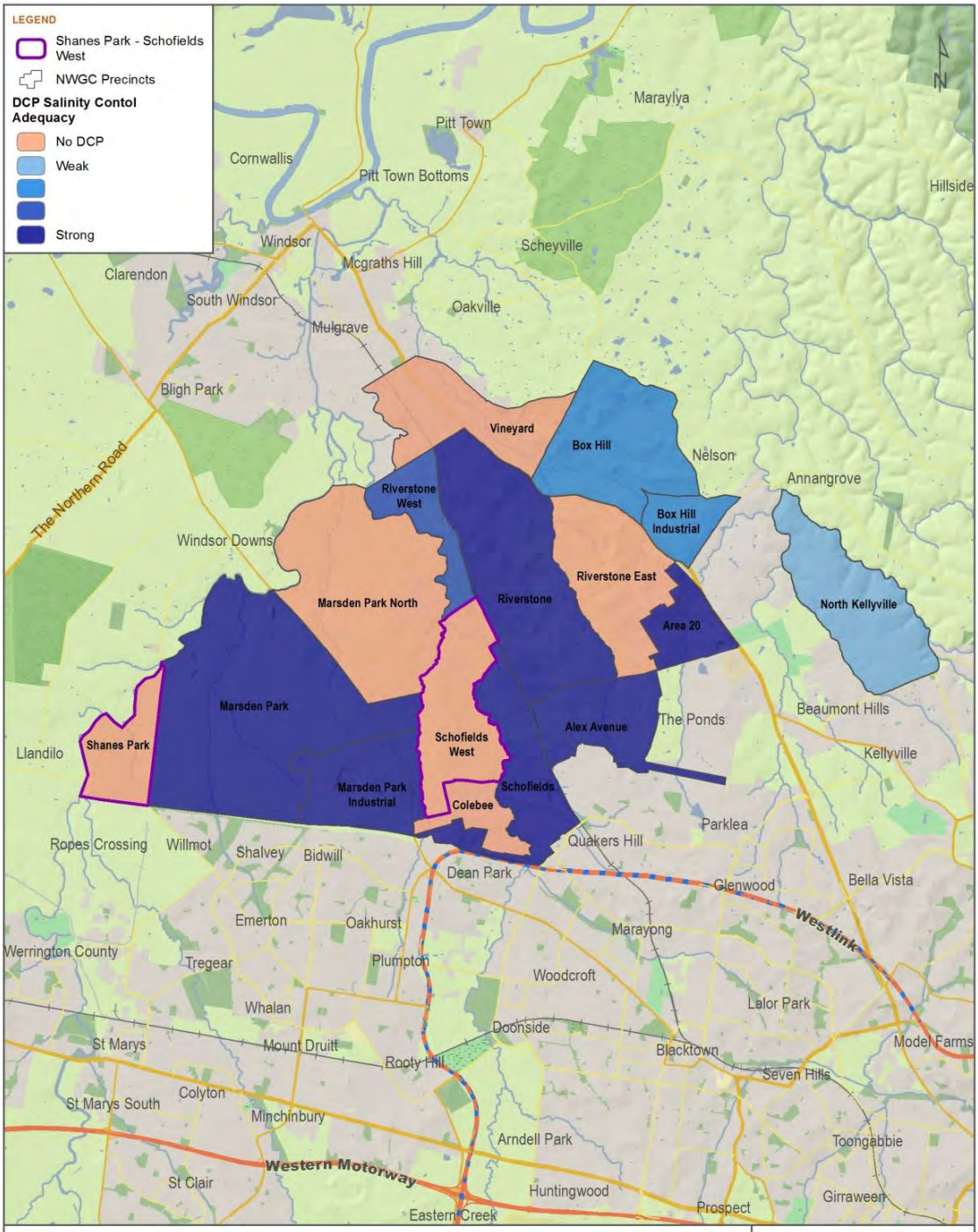
The HGL salinity hazard potential mapping for the NWGC shows that the overall salinity risk through a number of HGLs, in particular Schofields West, Marsden Park industrial, Marsden Park North and the northern half of Riverside are all rated as 'very high', indicating a higher overall risk than previously identified for the area.

Based on this more detailed understanding of potential salinity hazards in the NWGC and the review of the DCPs against the key criteria for salinity management, the four DCPs were given a ranking from strong to weak. Whilst this is a high level and subjective review, it gives a useful overall picture of where potential concerns with the level of controls may lie. This also assists in showing the importance of considering salinity issues at the landscape scale. Figure 7-1 (from the main report) presents an overview of where the highest concerns for current DCP controls in the NWGC occur.

The recommendations for the revisions to the DCP Salinity Management Guidelines include the suggestion that reference to the HGL frameworks and mapping should be incorporated into the DCP Salinity Management Guidelines in order to improve the accuracy of the early identification of potential issues and risks in planning development across the NWGC.

Implications for the land use structure plan for unreleased areas were also considered in the review. Shanes Park is proposed to comprise largely low density (detached) housing in an area of moderate salinity hazard. The existing DCP controls would be adequate to manage the proposed development in this area.

Schofields West is proposed to comprise low to high density residential development as well as the North West Rail Line (NWRL) extension and several neighbourhood centres. Schofields West is located in the Shale Plains HGL which is identified as a high salinity hazard. Particularly severe risks are associated with the upper slopes below ridgelines, which comprise the area to the north of Schofields Road and the NWRL extension. There may be constraints in this area with regard to high density development, deep ground engagement, and major infrastructure presenting barriers to groundwater movement. Further investigations should be considered in this area, given the high salinity hazard potential.


LEGEND
Shanes Park - Schofields West
NWGC Precincts
DCP Salinity Contol Adequacy
No DCP
Weak
Strong
N
Maraylya
Pitt Town
Cornwallis
Pitt Town Bottoms
Hillside
Windsor
Scheyville
Mcgraths Hill
Clarendon
South Windsor
Oakville
Mulgrave
Bligh Park
Vineyard
Box Hill
Nelson
Annangrove
The Northern Road
Riverstone West
Box Hill Industrial
Windsor Downs
Riverstone East
Marsden Park North
Riverstone
North Kellyville
Area 20
Marsden Park
Alex Avenue
The Ponds
Beaumont Hills
Shanes Park
Schofields West
Llandilo
Kellyville
Marsden Park Industrial
Schofields
Colebee
Parklea
Ropes Crossing
Willmot
Shalvey
Bidwill
Quakers Hill
Dean Park
Glenwood
Bella Vista
Westlink
Emerton
Oakhurst
Marayong
Werrington County
Tregear
Plumpton
Woodcroft
Whalan
Lalor Park
Doonside
St Marys
Mount Druitt
Blacktown
Model Farms
Rooty Hill
Seven Hills
Colyton
St Marys South
Minchinbury
Arndell Park
Toongabbie
Western Motorway
St Clair
Huntingwood
Girraween
Prospect
Eastern Creek
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PROJECT NO. 30012389
PROJECT TITLE Priority Growth Areas Salinity Study
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1. BACKGROUND

1.1. Project background

The Department of Planning and Environment (DP&E) is undertaking a review of the *North West Growth Centre Structure Plan* (Structure Plan) in partnership with relevant councils, Sydney Water, Transport for NSW, and other relevant agencies. The primary purpose of this review is to update the strategic level land use and infrastructure delivery plan in order to improve support of coordinated delivery of the area and deliver on Metropolitan Growth strategies identified for housing and employment, upon implementation of the plan. Advice is required to determine whether salinity will be a determining factor in producing the revised plans.

The North West Growth Centre (NWGC) is located across three Local Government Areas (LGAs): The Hills, Blacktown and Hawkesbury. There are 16 precincts within the NWGC. Those remaining unreleased include Shanes Park and West Schofields, both located within Blacktown LGA.

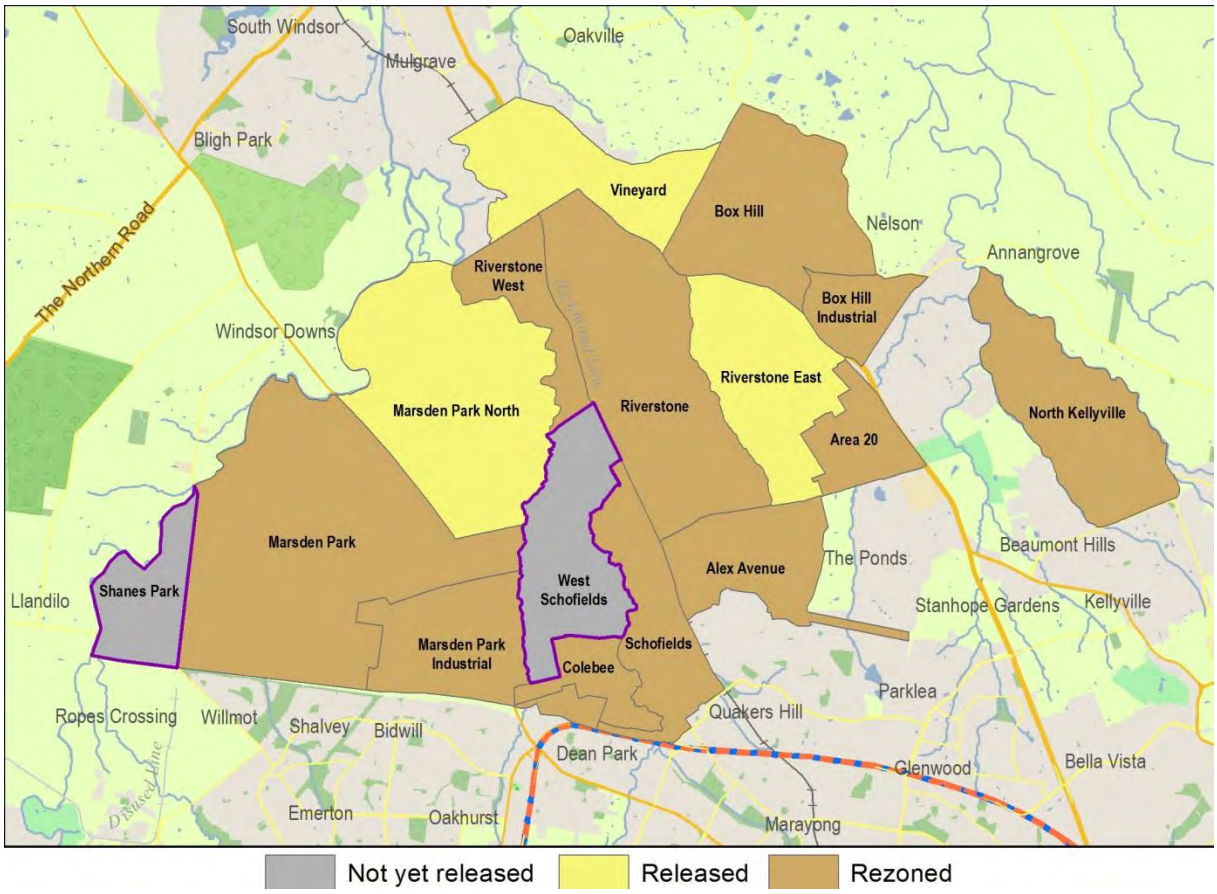


Figure 1-1: Precinct release status for the NWGC

Salinity is an issue that has become increasingly apparent with urban expansion across Australia, affecting buildings, infrastructure and the environment. It is a complex problem that can operate at both a local and regional scale. Salinity has long been recognised in Western Sydney as an issue in both groundwater and surface conditions and can potentially cause significant economic, environmental and social costs. Salinity affects land use planning in

urban areas and land use planning can affect salinity processes in turn. It is an ongoing and iterative process that requires management and research at every stage.

1.2. Report purpose

This report has been prepared to review the salinity controls in all development control plans (DCPs) that apply within the NWGC. The intention is to identify whether the standards within the DCPs are an adequate response to dealing with the level of salinity risk within these areas at the rezoning stage. The outcomes of this study will be used to inform the review of the Structure Plan currently underway and to ensure the land use and infrastructure strategies that are being developed for the remaining unreleased precincts are compatible with the salinity constraints present.

1.3. Objectives

There are two primary objectives for this report:

1. To identify any land use implications of salinity for unreleased areas
2. To review the adequacy of land use planning controls for salinity across the NWGC, identify areas of high concern where controls are inadequate and to provide advice on alternative or additional controls.

1.4. Growth Centres planning process

The Growth Centres are planned according to *State Environmental Planning Policy (Sydney Region Growth Centres) 2006* (the Growth Centres SEPP), that establishes the planning rules and objectives for the Growth Centres.

In *A Plan For Growing Sydney* (Department of Planning and Environment, 2014), the NSW Government has identified the North West Growth Centre as a priority growth area for the creation of more opportunities in Western Sydney for homes and employment. Growth Centre Structure Plans were released in 2005, outlining a broad framework for the development of the area including the location of future urban development, employment land, centres and road and transport corridors.

In the past 10 years several precincts have been released and rezoned in addition to the development of new infrastructure plans and strategies.

DP&E is currently undertaking a review of the Growth Centres Structure Plans in order to assess if the land use and infrastructure strategy is adequately integrated and continues to be appropriate for the projected needs for the region as well as to “realise the full potential of investment in new infrastructure”.

The objectives of the structure plan review are to:

- Better define how much growth is possible in each area and the potential rate at which growth will occur
- Align the amount and location of land that is rezoned with the efficient delivery of infrastructure and rates of demand for new housing and jobs
- Streamline statutory approvals by dealing with issues more strategically and reducing the complexity and timeframes for development approvals

- Be transparent about the land release process and how information is accessed
- Be accessible through a digital platform with an interactive mapping tool to make information more readily available and to enable updates as information changes.

The strategic planning of the Growth Centres is being managed through a process of precinct planning which coordinates the planning and delivery of utilities, infrastructure and transport and other services in time to service new communities.

Precinct planning analyses in detail the development potential of each of the precincts in the Growth Centres and is intended to streamline the rezoning and assessment processes, improve efficiency, reduce complexity and schedule infrastructure and services delivery when required for urban development. It involves detailed investigations into appropriate land use options, physical environment constraints (topography, vegetation, bushfire risk, watercourses, etc) and infrastructure requirements. Understanding salinity forms one component of these investigations.

The Department prepares a Land Use and Structure Plan to guide development scenarios and inform the establishment of zoning controls. By doing this at the precinct level, it saves the need to revisit many issues at the Development Application (DA) stage.[1]

During precinct planning, the Department also prepares the local planning documents such as DCPs and Section 94 contributions plans, ensuring that these are prepared and ready for use in the development assessment process.

The consent authority for most development within the precincts is the relevant council however development assessment processes are streamlined because protocols for wider assessment for specialised areas are finalised by working with councils during precinct planning.

Further detail on the precinct planning and growth centre development process can be found on the Department's website.

1.5. Methodology

This desktop assessment has been prepared with reference to *Site Investigations for Urban Salinity* (DIPNR, 2002) and has adopted the following approach:

- Literature review of best practice salinity management guidelines
- Identification of key best practice criteria
- Review of existing salinity potential mapping (GIS) and hydrogeological mapping
- Review of DCP controls
- Review of management controls in precinct studies for release areas
- Gap analysis across these three areas
- Overlay salinity potential mapping with proposed structure plan to identify areas of high concern where controls or information are inadequate
- Identification of additional controls or changes.
- Identification of implications for the NWGC Land Use and Infrastructure Strategy.

[1] Source : http://growthcentres.planning.nsw.gov.au/PrecinctPlanning.aspx

1.6. Limitations and assumptions

The findings of this report have been limited to the scope in client brief. Investigations have been limited to a desktop study of existing available information and no field investigations or verification of data has been undertaken.

This report has been prepared for the sole benefit of DP&E. The findings of this report are based solely on the information and findings contained in this report.

Where this report indicates that information has been provided to SMEC by third parties, SMEC has made no independent verification of this information except as expressly stated in the report. SMEC assumes no liability for any inaccuracies in or omissions to that information.

2. SALINITY MANAGEMENT

2.1. Why manage salinity

Salt is an inherent part of the Australian landscape. The salts originate from either the weathering of salt-bearing rocks, or are deposited on the land by wind, or rain transfer from the ocean. These salts are cycled throughout a catchment on a continuous basis, accumulating in the lower parts of the landscape.[2] Soil salinity refers to the amount of dissolved salts in the soil solution.

Watertables, either natural or induced, can increase the potential of salinity to occur. When changes in land uses result in an impediment to drainage in the soil profile or an overall upward movement of water in the soil profile, these salts are brought into the root zone.[3] Salinity processes are complex and are related to land use, geology, soil, climate, hydrology, vegetation, landscape, soil, and surface water and groundwater systems.[4]

Soil structural stability is affected by soil exposed to salt accumulation. Soil structure is essential for macroporosity, the pathway of water movement through soil (drainage), while microporosity functions by capillary action, holding plant-available water. Both these processes are important for maintaining vegetative ground cover and a stable soil profile. The salt concentration in the soil at which salt is hazardous to vegetation varies with soil texture and plant species. Urban salinity, like dryland and irrigation salinity, occurs where salt in the landscape is mobilised and redistributed closer to the soil surface and/or into waterways. Salt mobilisation is largely due to increased leakage which creates an imbalance in the hydrology of the landscape resulting in watertable rise. The rising watertable dissolves salt in the soil and moves it toward the soil surface.

Salt accumulation in soils can have a profound and devastating effect on urban land developments causing damage to building foundations, the breaking up of road pavements, and the corrosion of pipes and underground services. It can cause non salt-tolerant vegetation to die and, because of the greatly reduced ground cover, result in a dramatic lowering of the cover factor with consequent increases in erosion hazards. Erosion hazard increases can also come about through high levels of salts in the soil changing soil structural characteristics, thereby preventing water infiltration and leading, in turn, to increased levels of runoff. Ecosystem health in streams downslope from saline lands can be adversely affected.[5] Development may also have an impact on landscape processes and therefore the expression of salinity. Salinity is a dynamic process with the potential for the movement and accumulation of salts to change over time as a result of past, present or future land uses and management. Changes in land use will alter the way water moves through the landscape and may contribute to salinity problems.

Salinity in urban areas is typically a result of a combination of dryland processes and over-irrigation. Salinity can be exacerbated by:

- Broadscale clearing and vegetation removal for urban development

[2] (IPWEA, 2002)
[3] (Landcom (2004) *Managing Urban Stormwater: Soils and Construction* - Volume 1, ("Blue Book") Section 3.2.13)
[4] (WSROC, 2004).
[5] (Blue Book Section 3.2.13).

- (Over) watering of gardens, parks and sporting fields and facilities
- Degraded sub-surface infrastructure in leakage from water, drainage and sewerage reticulation systems
- Interference with or modification to surface and sub-surface drainage paths
- Town layouts that can cause drainage problems.

The resulting elevated saline groundwater can adversely affect and shorten the useful life of infrastructure, including buildings, roads, bridges, and pipe systems. It can also seriously damage local vegetation and sporting fields.

The landscape may respond to these changes slowly or quickly. The location of the impact may be close to or distant from the cause, depending on the landscape characteristics.

2.2. Best practice guidelines

In reviewing the existing policies and guidelines relating to salinity management, a number of references were identified, including:

- *Western Sydney Salinity Code of Practice* (Western Sydney Regional Organisation of Councils (WSROC), 2004) ('WSROC Code of Practice')
- Guidelines to Accompany Map of Salinity Potential in Western Sydney (Department of Infrastructure, Planning and Natural Resources (DIPNR), 2002)
- Land Use Planning and Urban Salinity - Local Government Salinity Initiative No. 11 (DIPNR, 2005)
- Local Government Salinity Management Handbook – A Resource Guide for the Public Works Professional (Institute of Public Works Engineering Australia, 2002)
- Site Investigation for Urban Salinity – Local Government Salinity Initiative (Department of Land and Water Conservation, 2002)
- *Managing Urban Stormwater – Soils and Construction,* 4th edition (Landcom, 2004) (the 'Blue Book')
- Building in a Saline Environment – Local Government Salinity Initiative No. 6 (DIPNR, 2003)
- Australian Standards.

The first four relate more broadly to land use planning and management and a summary of the key findings from these guidelines is presented below. The review of these guidelines (refer Appendix B) was used to formulate the key criteria identified in Section 2.3. The remaining guidelines relate more specifically to investigations and management measures and will be considered in later chapters where relevant.

2.3. Key criteria

Based on a review of the WSROC Code of Practice, other best practice guidelines, and a consideration of the purpose and use of DCPs, the following elements have been identified as key criteria for evaluating the salinity control measures in the DCPs for the NWGC:

- Clear identification of principles
- Clear identification of salinity risk generating activities

- Clarity of management measures for stage of development (ie strategic/rezoning/DA/construction)
- Clarity of management measures for type of development (eg resident, industrial, infrastructure, open space, etc)
- Requirements for site specific investigations
- Addresses soil and ground water migration
- Interrelationship with other policies or controls that impact on salinity, eg on site waste water, stormwater, flooding, diversity
- Adequate identification of salinity potential (clear mapping)
- Clear requirements for when a salinity management plan is required
- Addresses cumulative impacts.

2.4. Existing salinity risk mapping

The impact of salinity on urban development in Western Sydney was first detailed in the report *Salinity in the South Creek Catchment* by the Department of Land and Water Conservation (DLWC) in August 1997.

The DIPNR *Salinity Potential in Western Sydney map* (2002) depicts localised salinity hazard for all the areas of Western Sydney with a Wianamatta shales geology and identifies areas of more extensive salinity hazard where water naturally accumulates in the landscape, eg riparian corridors.[6]

The salinity risk mapping only indicates potential in Western Sydney and does not guarantee that salinity will not develop, even where all possible precautions are taken.[7]

The mapping shows four classifications of salinity:

- Areas of known salinity
- Areas of high salinity potential
- Areas of moderate salinity potential
- Areas of very low salinity potential.

The guidelines emphasise that salinity has the potential to occur everywhere in Western Sydney. The guidelines also note that salinity has been found to affect buildings in areas of moderate salinity potential, usually due to localised factors that have combined to create a salinity problem at a particular site.[8]

Figure 1 in Appendix A shows the existing DIPNR mapping as it relates to the NWGC. According to this mapping, the majority of the NWGC is considered to have moderate salinity potential with high potential along the creek lines.

[6] (WSROC, 2005)
[7] (DIPNR, 2002)
[8] (DIPNR, 2002 pg 8)

The map boundaries are at 1: 100 000 scale and should therefore not be used at a property scale and appropriate investigation should be undertaken on a site-specific basis. The map of potential salinity is not a substitute for on-site investigation.[9]

Furthermore, the scale of existing mapping can sometimes provide spatial inconsistencies when overlaid with other urban salinity soil risk related databases like the soil landscape mapping and contouring information. These spatial inconsistencies may cause interpretive errors resulting in incorrect scales of investigation being engaged and incorrect risk assessments being conducted.

The existing salinity mapping does not represent the hydrological cycle as relevant to the movements of salts in the landscapes. The missing elements of the hydrological cycle are representation of the surface recharge areas and the subsequent risk of water table rise up-gradient of the discharge areas. When groundwater is at or near the soil surface, discharge occurs as seepage under houses or roads, baseflow to streams and stormwater systems. Groundwater is key to understanding the movement of salts in the landscape.

Recommendations from the NSW Coastal Salinity Audit identify that urban salinity in Western Sydney is a large and pressing issue and requires a more detailed quantification of the magnitude of the problem through more targeted and robust salinity hazard mapping in Western Sydney.[10]

2.5. Hydrogeological landscape mapping

Hydrogeological landscape (HGL) characterisation helps to understand the way in which water moves through the landscape and the configuration of soil/regolith materials and other structural features in the landscape. Water is the principal agent in the weathering of rocks to form soils and soils/regolith is the principle substrate that stores salt in the landscape.[11]

The HGL concept provides a structure for the understanding of how salinity manifests itself in the landscape and how differences in salinity are expressed across the landscape. An HGL spatially defines areas of similar salt stores and pathways to salt mobilisation. The process of HGL determination relies on the integration of a number of factors: geology, soils, slope, regolith depth, and climate; an understanding of the differences in salinity development ("plumbing"); and the impacts (land salinity/ salt load/eclectic conductivity) in landscapes. Information sources such as soils maps, site characterisation, salinity site maps, hydrogeological data and surface and groundwater data are incorporated into standard templates.[12]

The Office of Environment and Heritage (OEH) has undertaken a range of extremely detailed HGL mapping across the Hawkesbury-Nepean catchment, including areas of the Growth Centres, as shown in Figure 2 in Appendix A. The Shanes Park Precinct contains predominantly Shanes Park HGL, with some areas of Ropes Crossing HGL to the south. The Schofields West Precinct comprises predominantly Shale Plains HGL, with small areas of Box Hill and Ropes Crossing to the north.

[9] (DIPNR, 2002)
[10] (DIPNR, 2004)
[11] (Moore, nd)
[12] (DECCW, 2011)

The HGL framework includes a risk analysis component which allows the landscape impacts and hazards of each area to be determined and an overall salinity hazard and resultant priority to be inferred, as shown in Table 2-1 below.

Table 2-1: Summary of salinity impacts for each HGL for Western Sydney

HGL	Land Impact	Salt load Export Impact	Impact on water quality	Overall hazard
Kurrajong	Moderate	Low	Low	Low
Currency Creek	Moderate	Low	Moderate	Low
Richmond Lowlands	Moderate	Moderate	Moderate	Medium
Londonderry	Low	Low	Moderate	Medium
Agnes Banks Sands	Low	Low	Low	Very Low
Ropes Crossing	High	High	High	Very High
Box Hill	High	Moderate	Moderate	High
Shale Plains	High	High	High	Very High
Upper South Creek	High	High	High	Very High
Mount Vernon	Moderate	Moderate	High	Medium
Mulgoa	Moderate	Moderate	Moderate	Medium
Mid-Nepean River	Low	Low	Low	Low
Camden Park	Moderate	Moderate	Moderate	High
Cawdor	High	High	High	Very High
Razorback	Low	Low	Low	Very Low
Hawkesbury	Low	Low	Low	Very Low
Picton	Moderate	Moderate	Moderate	Medium
Glenhaven	Low	Low	Low	Low
Greendale	Moderate	Low	Moderate	High
Shanes Park	Moderate	Low	Moderate	Medium

Source: DECCW (2011)

The HGL framework identifies the salinity function that each HGL provides at a catchment level. The first key principle of the WSROC Code of Practice is to understand the salinity processes on the site. The information contained in the HGLs provides a good context for understanding these functions and processes which can then be used to identify the appropriate measures to manage issues within different landscapes. Many strategies and management actions could have negative off-site impacts to catchment management unless their application to functions is understood.[13]

Catchment scale management involves understanding and managing how these functions are maintained, improved or degraded. It is important to consider this full range of salinity and hydrology characteristics to understand which mix of strategies and management actions are most appropriate for salinity management.

All site investigation studies should be informed by this information as it would streamline the reporting, provide consistency and accuracy.

An HGL contains areas of land that exhibit salinity in a manner that may be managed relatively uniformly. The salinity response and salinity management options will differ from

[13] (DECCW, 2011 pg 20)

one HGL to the next. For ease of comparison and consistency each HGL follows the same structure.

The HGL management framework has been structured in a cascading approach to inform the attribution of “the right action, in the right place”. This allows different management to be applied to different landscapes, and different actions within each landscape.

Table 2-2 outlines the high level management strategies recommended across the Western Sydney HGLs landscape level that would be relevant to the NWGC.

Table 2-2: Summary of management options for Western Sydney

	Management Strategy
Strategy 1	Buffer the salt store – keep it dry and still
Strategy 2	Intercept the shallow lateral flow and shallow groundwater
Strategy 3	Stop discrete landscape recharge
Strategy 4	Discharge rehabilitation and management
Strategy 5	Increase agricultural production to dry out the landscape and reduce recharge
Strategy 6	Dry out the landscape with diffuse actions over most of the landscape
Strategy 7	Access and use of groundwater to change water balance
Strategy 8	Maximising recharge to dilute water tables with engineering actions
Strategy 9	Minimising recharge with engineering actions
Strategy 10	Maintaining and maximising runoff
Strategy 11	Manage and avoid acid sulfate hazards

Source: DECCW (2011)

The management options recognise the need for diffuse and specific activities within the landscape that are required to impact on salinity issues. The priority of management objectives will vary both from landscape to landscape, and in respect to each other.

3. LAND USE IMPLICATIONS OF SALINITY

In order to inform the review of the NWGC Structure Plan, it is important to understand how salinity can or will impact on different types of proposed land uses as well as how land uses may impact on salinity processes.

Salinity in Western Sydney is a reflection of the hydrological balance in a region with known salt stores and a significant salt input from the atmosphere. Any change in this balance, either natural or induced, is likely to affect the extent and severity of salinity occurring in the future. Predicting the direction of change is difficult and in the absence of certain knowledge, it is recommended to apply a precautionary approach to management and aim for the least possible disruption of the hydrological cycle.[14]

Salinity cannot be managed effectively by responses limited to any one stage of development; it requires an integrated approach throughout the life and the scope of land use planning and development for an area.[15] It is also only one of a range of integrated land and water issues to be considered in planning including soil erosion, vegetation management and water management. Salinity therefore should not be considered in isolation from other land and water issues, and planning responses need to link these issues together effectively.[16]

Urban land uses can have a large impact on salinity processes through for example:

- Exposure of saline subsoils through deep site cuts and earthworks
- Changes to the water cycle through various components of potable water, stormwater and sewerage systems
- Changes to surface and subsurface natural drainage patterns.[17]

Urban salinity affects built infrastructure due to the chemical and physical impact of salt on concrete, bricks and metal. It also degrades 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'.[18]

Salinity also creates cross-boundary issues, that is, it has the potential to manifest its effects in a different area to that where the factors contributing to the problem occur. This can be at the local scale, eg between building sites, and at the regional scale such as between LGAs. For example, at the local scale, construction of a road may change groundwater flow conditions by causing an impediment to flow. This can result in groundwater discharging or collecting on adjacent properties, potentially creating salinity problems for that property.[19]

At the regional scale there are cumulative impacts on a new development that significantly increase the amount of water in the system (due to changed drainage, increased infiltration

[14] (DIPNR, 2002)
[15] (DIPNR, 2002)
[16] (DIPNR, 2002)
[17] (DIPNR, 2002)
[18] (WSROC, 2004)
[19] (WSROC, 2004)

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.[20]

The NWGC will contain a range of land uses once fully developed, as shown in Figure 3-1.

Appendix C provides a summary that illustrates the implications of different land use activities on salinity and also how salinity can impact on different land uses. It is important to understand both sides of the process particularly due to the long lead time in impacts emerging.

An understanding of these differing impacts and management needs will inform the review of DCP controls in the next section.

[20] (WSROC 2004)

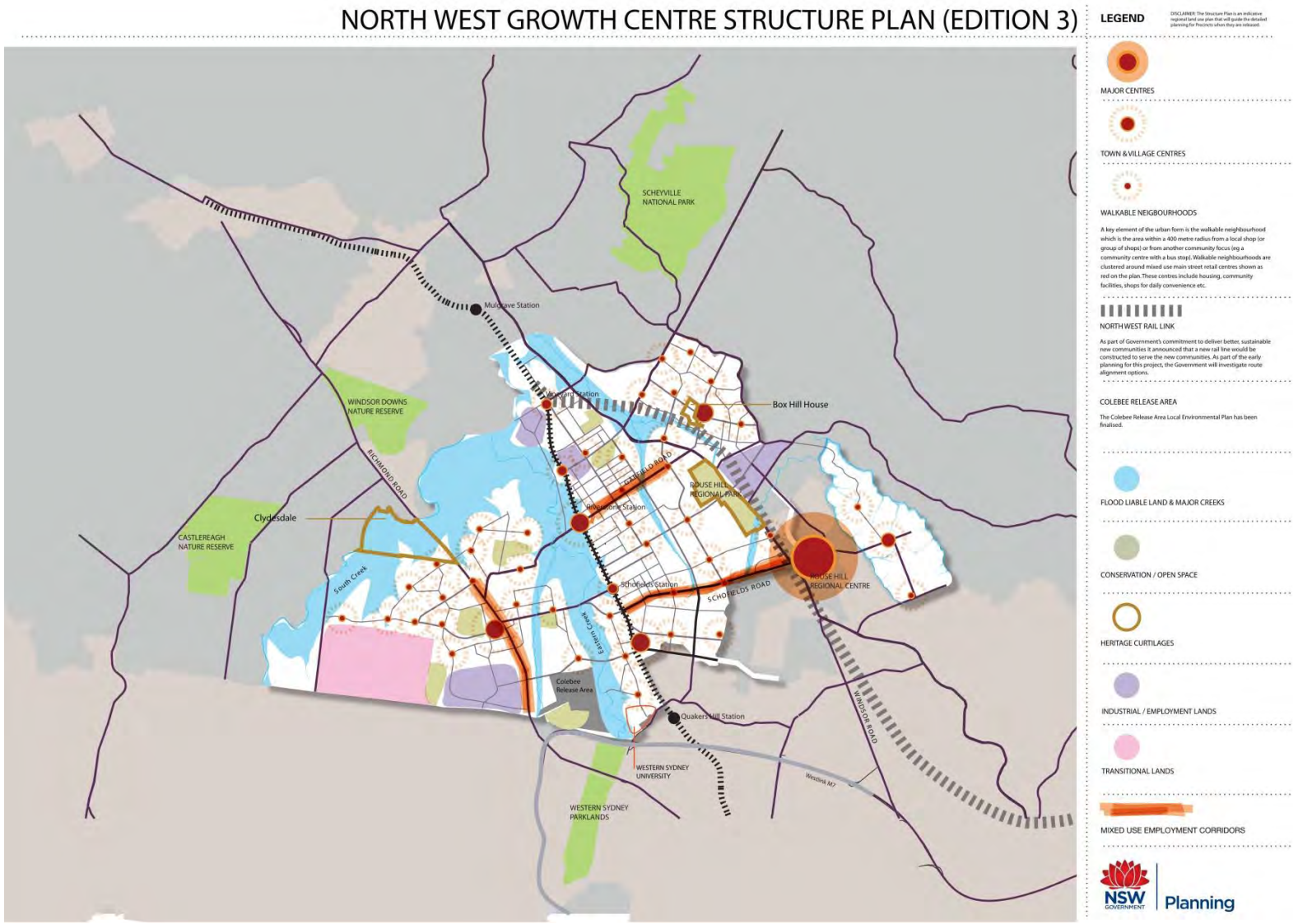


Figure 3-1: North West Growth Centre Structure Plan

4. REVIEW OF DCP CONTROLS

DCPs set out the planning, design and environmental objectives and controls that councils use to assess DAs within a defined site or precinct, or the entire LGA.

DCPs provide specific, more comprehensive guidelines for certain types of development. They therefore assist developers and landowners in the preparation of development proposals and applications.

The following table summarises where development controls for each precinct are documented.

Table 4-1: Summary of DCP controls for NWGC

Precincts	BCC Growth Centres Precincts DCP	(Hills Shire) Box Hill and Box Hill Industrial DCP	(BCC) Riverstone West DCP	(Hills Shire) North Kellyville DCP	Hawkesbury Growth Areas DCP
Alex Avenue	Yes				
Area 20	Yes				
Box Hill & Box Hill Industrial		Yes			
Colebee*					
Marsden Park Industrial	Yes				
Marsden Park	Yes				
Marsden Park North	Under preparation				
North Kellyville				Yes	
Riverstone	Yes				
Riverstone East	Under preparation				
Riverstone West			Yes		
Schofields	Yes				
Vineyard					Under preparation
Shanes Park	Not yet released				
Schofields West	Not yet released				

* Colebee was released early in the development of the Growth Centres and has been managed by Council under their existing LEP and DCP. Consequently, the controls for salinity in this release area have not been further examined.

While the majority of precincts are contained within the BCC Growth Centre Precincts DCP, three of the earlier release areas have standalone DCPs with differing formats and contents. Box Hill, Box Hill Industrial and North Kellyville are located in The Hills LGA.

Using the key criteria developed from the best practice guidelines, the four DCPs were broadly assessed for the adequacy of their salinity management controls, as shown in Table 4-2.

Generally, the DCPs were found to contain a range of management measures that do serve to manage salinity and reflect best practice. However the management measures are not necessarily clearly grouped as to land use activity or phase of development, leading to potential for confusion in application or adoption. Furthermore, there was no consistency across the DCPs, it was not always clear where and when the various controls apply as well as some confusion as to which guidelines prevail.

Table 4-2: Review of DCP controls in NWGC

Key criterion	GA DCP	BH&I DCP	RW DCP	NK DCP
Clear identification of principles	Manage in accordance with WSROC Code of Practice and Salinity Management Guidelines (SMG) (Appendix C)	Manage in accordance with WSROC Code of Practice	Manage in accordance with WSROC Code of Practice	No
Clear identification of salinity risk generating activities	Not specifically - 'all subdivision, earthworks and building works'. 'All development including infrastructure'	No	No	No -only with reference to fill
Clarity of management measures for stage of development (ie strategic/rezoning/DA/ construction)	Some - Subdivision and residential	Some - DA/construction	Some - Precinct wide/ subdivision and DA	No
Clarity of management measures for type of development (eg residential, infrastructure, industrial, etc)	Refers to WSROC Code of Practice and SMG	No	No	No
Requirements for site-specific investigations	Yes - In accordance with WSROC Code of Practice	No - "demonstrate an understanding"	Yes - In accordance with WSROC Code of Practice	No
Addresses soil and groundwater migration	No	No	No	No
Interrelationship with other policies or controls that impact on salinity eg on-site waste water, stormwater, flooding, diversity	Yes, particularly water sensitive urban design (WSUD)	Not specifically but indirectly	Yes	No
Adequate identification of salinity potential (clear mapping)	Yes - areas of potential salinity and soil aggressivity risk figure for each precinct in respective schedules	No	No	No
Clear requirements for when a salinity management plan is required	Yes - Subdivision	No	Yes	No
Addresses cumulative impacts	No	No	No	No

General comments on each of these issues are presented below. Recommendations for updates to the DCPs are provided in Section 6 and in Appendix D.

Clear identification of principles

Clear objectives and principles are an important component of any investigation and management process. Three of the DCPs include specific objectives for the management of impacts of, and on, salinity, in addition to making reference to the WSROC Code of Practice, which sets out the principles of salinity management. The North Kellyville DCP does not contain specific objectives and principles for salinity management.

Clear identification of salinity risk generating activities

None of the DCPs clearly set out what activities are considered to be more likely to generate risk in relation to salinity. This would help in guiding the application of the DCP to projects.

Controls by development phase

As identified in the *Land Use Planning and Urban Salinity - Local Government Salinity Initiative No. 11* (DIPNR, 2005), there is benefit in dividing controls into the following three phases:

- Strategic or plan making phase
- Development or plan implementation phase
- Management or post construction phase

This has not been done consistently or comprehensively in any of the DCPs.

Controls by land use

A close examination of the management measures identified that most relate quite generally to any development activity, or focus on residential development at the local scale. There is not always a clear distinction for different land use types (refer Table 4-3).

Table 4-3: Overview of categorisation of land use controls

Land use	DCP	WSROC	Detailed studies	HGL
Residential	Yes	Yes	Yes	Yes
Infrastructure (utilities)	Limited	Yes	Yes	Yes
Roads/Rail	Limited	Yes	Yes	Yes
Industrial	No	Limited	Yes	
Open space/planting	Limited	Yes	Yes	Yes
Environmental management	Limited	No	Limited	Yes

Requirements for site specific investigations

Two of the DCPs state that investigations should be undertaken in accordance with the WSROC Code of Practice, however the other two DCPs do not make this requirement clear. It is important that investigation and reporting requirements are clearly outlined in the primary control document.

Address soil and water migration

None of the DCPs directly discuss the issue of soil and water migration and how upstream or upslope activities can influence salinity conditions in other locations further downstream or downslope. This has important implications at all phases of development, but particularly when considering landscape scale activities such as broadscale clearing for new subdivisions.

Interrelationship with other controls or policies

Two of the DCPs discuss the interrelationship of salinity with other policies or controls. This is important to emphasise as these complex issues cannot be managed in isolation.

Identification of salinity potential

The Salinity Management Guidelines in the BCC Growth Areas DCP refer to salinity risk maps for each precinct. This is based on the DIPNR salinity potential mapping which considers the majority of the area to have a moderate salinity classification and identifies creek lines as having high salinity potential. The other three precinct-specific DCPs do not contain reference to any risk mapping.

Requirements for salinity management plan

Only two of the DCPs make it clear that a comprehensive Salinity Management Plan must be prepared based on the findings of the site specific investigations and prepared in accordance with the WSROC Code of Practice. There is value in ensuring that reporting requirements are clearly outlined in the primary control document in order to ensure consistent compliance.

Address cumulative impacts

None of the DCPs make reference to the issue of cumulative impacts and how they should be managed or addressed.

Guidelines

As discussed in Section 2.2, there are a number of guidelines and policies relevant to salinity management that are referenced in the DCPs. Table 4-4 provides a summary of references that were identified, noting that the correct guideline references are used in this table, details may differ in the DCPs.

Table 4-4: Summary of guidelines referenced by DCP

Guidelines referenced	GA DCP	BH&I DCP	RW DCP	NK DCP
WSROC Code of Practice (2004)	Y	Y	Y	Y
Site Investigation for Urban Salinity (DLWC, 2002)	Y	Y		Y
The Blue Book (Landcom, 2004)	Y	Y		
Site specific investigation studies		Y		
Building in a saline environment (DIPNR, 2003)			Y	
Australian Standards	Y	Y	Y	

Ensuring that correct reference to the relevant guidelines is included is important to ensure consistency of investigations and management across the NWGC.

4.1. Summary of findings

- The application of the proposed management measures to each phase of development is not always clear, ie strategic planning, DA, post construction.
- The salinity measures and processes focus primarily on residential development and are not clearly grouped to reflect the relevance of measures to all potential land use activities within a precinct.
- Not all information sits in the DCPs and requires reference to other codes, policies and studies as well as an appendix to the Growth Areas DCP. This is not consistent across each DCP and also presents some confusion due to multiple documents.
- Impacts of land use on salinity are not considered, eg downstream migration.
- Cumulative issues around broadscale development and salinity changes are not considered at all.
- Reporting and investigations requirements are not clear. The WSROC Code of Practice sets out procedures for site investigations, the DA stage and the subdivision stage, however not all DCPs make these requirements clear in the primary document.

5. REVIEW OF DETAILED INVESTIGATIONS AND MANAGEMENT RESPONSES

Once a precinct has been released, detailed investigations into appropriate land use options, physical environment constraints and infrastructure requirements are undertaken. These are informed by a broad range of background studies including land capability and contamination, biodiversity.

A brief review of the available studies was completed to identify the types of controls and management activities that were recommended in these studies for each precinct. There is value in utilising relevant information in these reports to inform ongoing planning and design, building up a body of salinity knowledge across the region.[21]

Reference to salinity management issues is typically contained in a land capability and contamination assessment. The following studies have been prepared to date for precincts in the NWGC:

- *Area 20 Precinct - Land Capability and Contamination Assessment* (WSP, 2009)
- *Land Capability, Salinity and Contamination Project - Box Hill Precinct* (WSP, 2011)
- *Land Capability, Salinity and Contamination Project - Schofields Precinct* (WSP, 2011)
- *Preliminary Report for Marsden Park Industrial Precinct - Salinity Assessment* (GHD, 2009)
- *Report on Land Capability and Contamination Assessment - North Kellyville Precinct* (Douglas Partners, 2008)
- *Land Capability, Salinity & Contamination Investigation - Riverstone East Precinct* (Douglas Partners, 2014)
- *Alex Avenue Precinct - Land Capability and Contamination Report* (SMEC, 2007)
- *Riverstone Precinct - Land Capability and Contamination Report* (SMEC, 2007)
- *Land Capability, Salinity and Contamination Assessments Report - Marsden Park Precinct* (Geotechnique, 2012)
- *Draft Report on Land Capability, Salinity and Contamination Assessment – Marsden Park North* (Cardno, 2015).

The DCPs, with the exception of Box Hill and Box Hill Industrial, do not acknowledge these more detailed studies.

The precinct studies typically contain a salinity management plan prepared in accordance with the WSROC Code of Practice, or at a minimum more detailed mitigation measures that are relevant to the site conditions within the precinct. Generally the precinct studies identify more landscape scale investigations, and also identify appropriate salinity management measures at the different phases of development, including post-development monitoring.

There would be value in the DCP controls specifically referencing these detailed investigations in order to ensure that the site specific management measures are clearly linked back to development planning.

[21] WSROC pg 36

6. RECOMMENDATIONS FOR DEVELOPMENT CONTROL PLANS

The DCPs will continue to be used to manage development and redevelopment in the precincts already planned and released. Salinity issues can take time to emerge and there are new issues that can evolve and development progresses (migration). There is therefore benefit in identifying opportunities to improve the existing DCPs to achieve greater consistency in controls, improve useability for all users and improve the implementation of the controls.

A considerable amount of work has been done on salinity issues in Western Sydney and a substantial body of information is available on how to best manage it. However the information is documented in different places and in different ways. This may make it confusing to follow best practice guidelines and manage salinity risks on the ground.

Furthermore, given the mobility characteristics of salinity, each precinct cannot be treated in isolation. While it is outside the scope of this investigation, there may be merit in discussions with the relevant councils to consider standardising salinity management controls across council areas outside of the Growth Centres.

Generally, the DCPs for the NWGC need to be simplified, streamlined and standardised.

As identified in Section 1.4, one of the intentions of the structure plan review is to identify ways to manage issues more strategically. Early identification of salinity issues facilitates more effective and timely management of potential risks.

6.1. DCP structure and controls

The DCPs would benefit from a restructure and added detail to make them easier to use and to provide a more representative salinity risk rating to be properly applied. The controls for existing release areas could be strengthened to better manage ongoing risks. Generally the DCPs address residential development adequately but would benefit from additional salinity management measures around other land use types not currently identified comprehensively, like public open space and recreational settings.

Clear objectives and principles are an important component of any investigation and management process. The five key management principles identified in the WSROC Code of Practice should be emphasised clearly in all control documents:

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

The BCC Growth Centres Precincts DCP applies to the majority of precincts in the NWGC. Controls are contained both in the main body of the DCP and in Appendix C – Salinity Management Guidelines.

The salinity management guidelines in the DCP should be revised and restructured to include the following:

- What phase of development various controls apply – a clear distinction between the considerations that should be addressed at the planning stage, the DA/construction phase and the post-construction phase needs to be made
- What type of development various controls should be used for, ie a clear identification of appropriate controls for roads, utilities, open space and recreation etc
- Consideration of landscape scale issues of salinity risk generating activities, such as broadscale vegetation clearing and earthworks
- Upfront identification of investigation and reporting requirements
- Consistent reference to all relevant guidelines and standards
- Reference to the relevant detailed investigations in order to draw out the additional management measures and practices
- Clearer identification of the impacts of salinity on different land use types and the impacts of different land use activities on future salinity issues
- Reference to considerations of cumulative impacts in order to ensure these are considered at the precinct level.

Controls may be insufficient in detail to manage some land use activities in very high salinity hazard risk areas and their margins. Site investigations are likely to be required in these locations to inform the development of site specific management measures.

Recommendations for revisions to the Salinity Management Guidelines (Appendix C to the BCC Growth Centres Precincts DCP) are included in Appendix D to this report.

Table 6-1: Summary of recommendations of revisions to salinity controls in NWGC precinct DCPs

DCP	Main DCP	Appendix
BCC Growth Centres Precincts DCP	Consider updating the salinity risk mapping in precinct schedules to reflect the more detailed HGL mapping.	Update Appendix C – Salinity Management Guidelines with reference to recommendations in Appendix D to this report
(Hills Shire) Box Hill and Box Hill Industrial DCP	Include reference to new appendix.	Include an appendix to the DCP similar to the main BCC Growth Centres Precincts DCP (see above).
(BCC) Riverstone West DCP	Include reference to new appendix.	Include an appendix to the DCP similar to the main BCC Growth Centres Precincts DCP (see above).
(Hills Shire) North Kellyville DCP	Update Section 6 to include a sub-section on salinity management for all development activities, not	Include an appendix to the DCP similar to the main BCC Growth Centres Precincts

DCP	Main DCP	Appendix
	just residential. Section 7.9 from the Box Hill DCP would be suitable. Include reference to new appendix.	DCP (see above).

6.2. Salinity risk mapping

As identified in Section 2.4, there are limitations to the DIPNR mapping. This shows salinity potential at a high level scale and is less suitable from a detailed spatial perspective. Salinity potential is assigned primarily through identification of creek lines and does not consider other factors that contribute to how salinity is expressed across the landscape. The salinity risk map does not provide an interpretation of the amount of salt stored in the landscape, its potential for export, and what hydrogeological factors may contribute to its mobility.

Considerable work to better understand salinity risks and hazards has been undertaken since the DIPNR map was prepared, incorporating a range of other landscape factors to provide a more nuanced picture of salinity hazards, of which salinity potential plays only one part. With this more detailed understanding of salinity hazards, risks at the regional level can begin to be more accurately identified.

The HGL templates for each landscape provide a range of detailed information including description of salinity processes, management strategies to improve or maintain function and specific management actions to deliver on appropriate strategies. The detail includes cross-sectional diagrams and characteristic landscape photos to inform decision making. It is recommended that the DCPs be updated to include appropriate reference to the HGL work undertaken by DECCW. Figure 3 in Appendix A shows the HGL salinity hazard mapping as it relates to the NWGC.

It is important to emphasise that any mapping will only identify potential salinity issues and there is no substitution for detailed local site investigations to inform design development and construction methods.

However by understanding at the regional level what the natural salinity processes are and where the higher salinity hazards may occur, then strategic decisions about whether to intervene, how to intervene or whether it is worth doing so can be made.

Utilising the more detailed mapping would be particularly useful at the early phases of precinct planning and subdivision planning in order to incorporate landscape level management measures, such as vegetation retention and planning the location of future land use activities in order to proactively manage potential risks.

When the DIPNR mapping is overlaid with the HGL data, a more nuanced picture of salinity hazards emerges (refer Figure 4 in Appendix A). This also highlights one of the biggest risk areas for the Department with regards to existing controls. The existing controls have been based on the assumption that the majority of the NWGC comprises moderate salinity potential, with the exception of the creek lines. However the overall salinity hazard shown through the HGL reveals much higher issues, in particular across the majority of West Schofields.

7. IMPLICATIONS FOR THE NWGC LAND USE AND INFRASTRUCTURE STRATEGY

The second objective of this report was to identify where the current salinity controls may present a risk to the NWGC Land Use and Infrastructure Strategy.

This risk could present in a number of different ways:

- Controls do not adequately address the proposed land use activities, eg residential, infrastructure, open space, etc
- Controls do not adequately address the severity of salinity risk in some locations
- Controls do not consider the downstream/downslope or cumulative impacts of salinity.

To better understand the nature of these risks, the HGL mapping has been overlain with the preliminary land use infrastructure strategy for the NWGC to identify areas of potential concern. As discussed in Section 3, land use that requires deep cuts and ground engagement are going to be more vulnerable to both exposure to salinity as well as more likely to cause further downstream/downslope issues.

7.1. North West Growth Centre

Figure 7-1 presents an overview of where the highest concerns for current DCP controls in the NWGC occur. From a more holistic consideration of the proposed land use activities and their associated ground engaging components; the more detailed HGL mapping identifying salinity hazard potential; and the existing DCP controls (in particular the BCC Growth Centre Precincts DCP), some key areas begin to emerge.

To determine this, the review of the four relevant DCPs against the key criteria for salinity management (refer Table 4-2) were given a ranking from strong to weak. While this is a high level and subjective review, it gives a useful overall picture in relative terms of where potential concerns with the adequacy of levels of controls may lie. This also assists in showing the importance considering salinity at the landscape scale.

The recommendations for improving and strengthening the existing DCPs presented in Section 4 and Appendix D would facilitate a more holistic management of salinity risks across the NWGC. Through the incorporation of more site specific salinity risk terminology and salinity risk management strategies from the HGL framework and consideration of landscape scale issues, where appropriate, a new level of salinity risk management could be achieved across the NWGC.

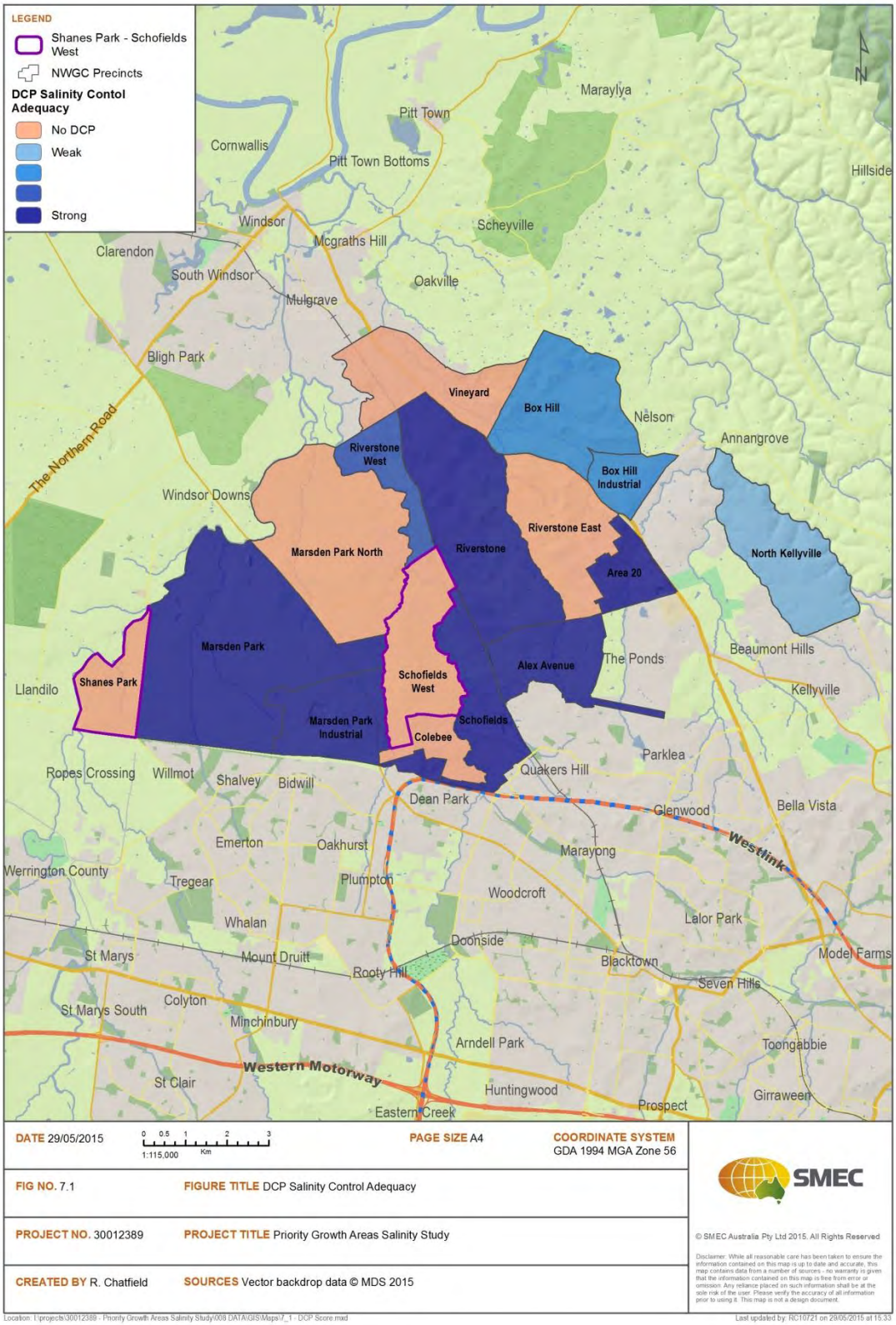


Figure 7-1: Adequacy ranking of DCPs across the NWGC

7.2. Precincts not yet released

For the remaining unreleased precincts (Shanes Park, West Schofields), key land use assumptions[22] have been identified to inform the preliminary evaluation of the potential issues. It has been assumed that the DCPs for these precincts would be prepared as new schedules to the BCC Growth Centre Precincts DCP.

7.2.1. Shanes Park

The preliminary structure plan suggests that Shanes Park will contain the following land uses:

- Largely residential (around 500 dwellings)
- The proposed Outer Sydney Orbital and Castlereagh Freeway could potentially run through Shanes Park
- A local centre may be established in the south west corner of the precinct.

Shanes Park is identified as being of moderate salinity hazard. On the scale of risk activities, low density (ie detached) residential development is usually manageable with appropriate salinity risk measures applied through development design.

7.2.2. Shanes Park recommendations

In order to improve the management of salinity risk in the future Shanes Park DCP, it is recommended that the controls for infrastructure development be strengthened and that more site-specific salinity risk terminology and salinity risk management strategies from the HGL framework be incorporated into the DCP.

7.2.3. Schofields West

The preliminary structure plan suggests that Schofields West will contain the following land uses:

- Conservation zone along Eastern Creek
- Largely residential (around 2,000 dwellings)
- 2-3 neighbourhood centres
- Highly constrained by flood prone land
- Large lot owned by CSR may require remediation of site contamination before redevelopment
- North West Rail Line extension would cut through the centre of the precinct (adjacent to Schofields Road which is proposed to be upgraded to a transit boulevard)
- Potential for medium-high density along the central corridor and around the Marsden Park and Schofields Stations.

Schofields West is located in the Shale Plains HGL which is identified as a high salinity hazard. Particularly severe risks are associated with the upper slopes below ridgelines. Based on the Department of Lands two metre terrain contours (refer Figure 6 in Appendix A),

[22] Source: http://growthcentres.planning.nsw.gov.au/TheGrowthCentres/NorthWestGrowthCentre/RemainingPrecincts.aspx

this would suggest that the area to the north of Schofields Road and the NWRL extension could potentially be highly constrained. One of the DECCW (2012) management measures suggests that 'in badly affected areas, consideration should be given to rehabilitating salt affected land, building above ground or consideration of open space options.' This suggests that perhaps high density development with deep ground engagement may generate some issues in this location. A similar examination of the terrain in Shanes Park precinct (refer Figure 5 in Appendix A) did not reveal the same level of concern. The landscape is more gently undulating and the HGL does not contain the same level of restrictive management measures.

7.2.4. Schofields West recommendations

In order to improve the management of salinity risk through the future Schofields West DCP and implications for future development, further investigations in this area should be considered given the high salinity hazard potential. Substantial issues are likely to be associated broadscale clearing, and cut and fill levelling associated with large subdivision activities. A clearer articulation of the site-specific salinity investigation requirements in the DCP would assist in managing this risk at the strategic planning phase.

Controls for infrastructure development, for both road and rail, should be strengthened. Stronger controls to address high density development should be included and more site specific salinity risk terminology and salinity risk management strategies from the HGL framework should be incorporated.

8. CONCLUSION

This report has been prepared to review the salinity controls in the four DCPs relevant to the NWGC to identify whether the application of the existing standards in the DCPs are an adequate response to dealing with the level of salinity risk within these areas at the rezoning stage.

Generally, the DCPs contain a range of management measures that serve to manage salinity and reflect best practice. However the management measures are not necessarily clearly grouped according to land use activity or phase of development, leading to potential for confusion in application or adoption. Furthermore, there is no consistency across the DCPs, and it is not always clear where and when the various controls apply as well as some confusion as to which guidelines prevail. Controls may be insufficient in detail to manage some land use activities in very high salinity hazard risk areas and their margins.

It is recommended that all DCPs be updated to include a revised Salinity Management Guideline as an appendix to the respective DCPs, as outlined in Appendix D to this report. Consideration should also be made to include reference to the detailed HGL framework and mapping. This would assist in a better understanding of salinity migration issues and management as well as landscape scale issues and potential impacts.

The outcomes of this study will be used to inform the review of the Structure Plan currently underway and to ensure the land use and infrastructure strategies that are being developed for the remaining unreleased precincts are compatible with the salinity constraints present.

9. REFERENCES

Department of Environment, Climate Change and Water (2011) *Hydrogeological Landscapes for the Hawkesbury-Nepean Catchment Management Authority, Western Sydney Study Area, Volume 4 – Guidelines for Managing the Salinity in the Landscape*.

Department of Infrastructure, Planning and Natural Resources (2005) *Landuse Planning and Urban Salinity: Local Government Salinity Initiative – Booklet No. 11*.

Department of Infrastructure, Planning and Natural Resources (2004) *NSW Coastal Salinity Audit*.

Department of Infrastructure, Planning and Natural Resources (2002) *Guidelines to Accompany Map of Salinity Potential in Western Sydney.*

Department of Infrastructure, Planning and Natural Resources (2002a) *Salinity Potential in Western Sydney map.*

Department of Planning and Environment (2015) *A Plan for Growing Sydney.*

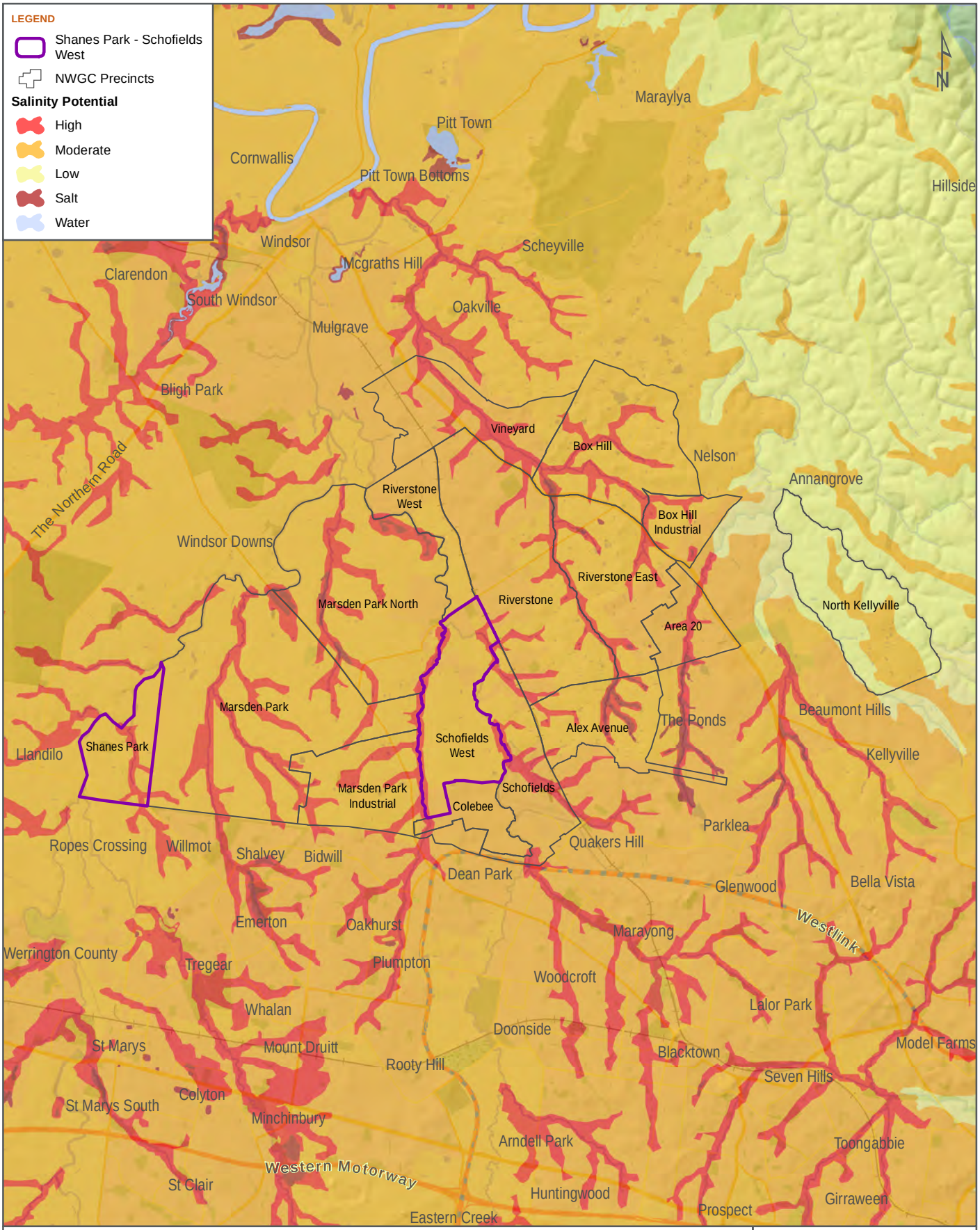
Institute of Public Works Engineering Australia (2002) *Local Government Salinity Management Handbook – A Resource Guide for the Public Works Professional*.

Landcom (2004) *Managing Urban Stormwater: Soils and Construction* - Volume 1, 4th Edition.

Moore, Leah (nd) *Understanding Hydrogeological Landscapes: How water moves through landscape materials*, presentation as part of the Dryland Salinity Hazard Mitigation Program.

Western Sydney Region of Councils (2005) *Inquiry into the extent and economic impact of salinity – Response to the Environment, Communications, Information Technology and the Arts References Committee*, October 2005.

APPENDIX A MAPS



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COORDINATE SYSTEM GDA 1994 MGA Zone 56

FIG NO. 1

FIGURE TITLE DIPNR Salinity Potential mapping and the NWGC

PROJECT NO. 30012389

PROJECT TITLE Priority Growth Areas Salinity Study

CREATED BY R. Chatfield

SOURCES Vector backdrop data © MDS 2015
Salinity Potential - DIPNR

SMEC

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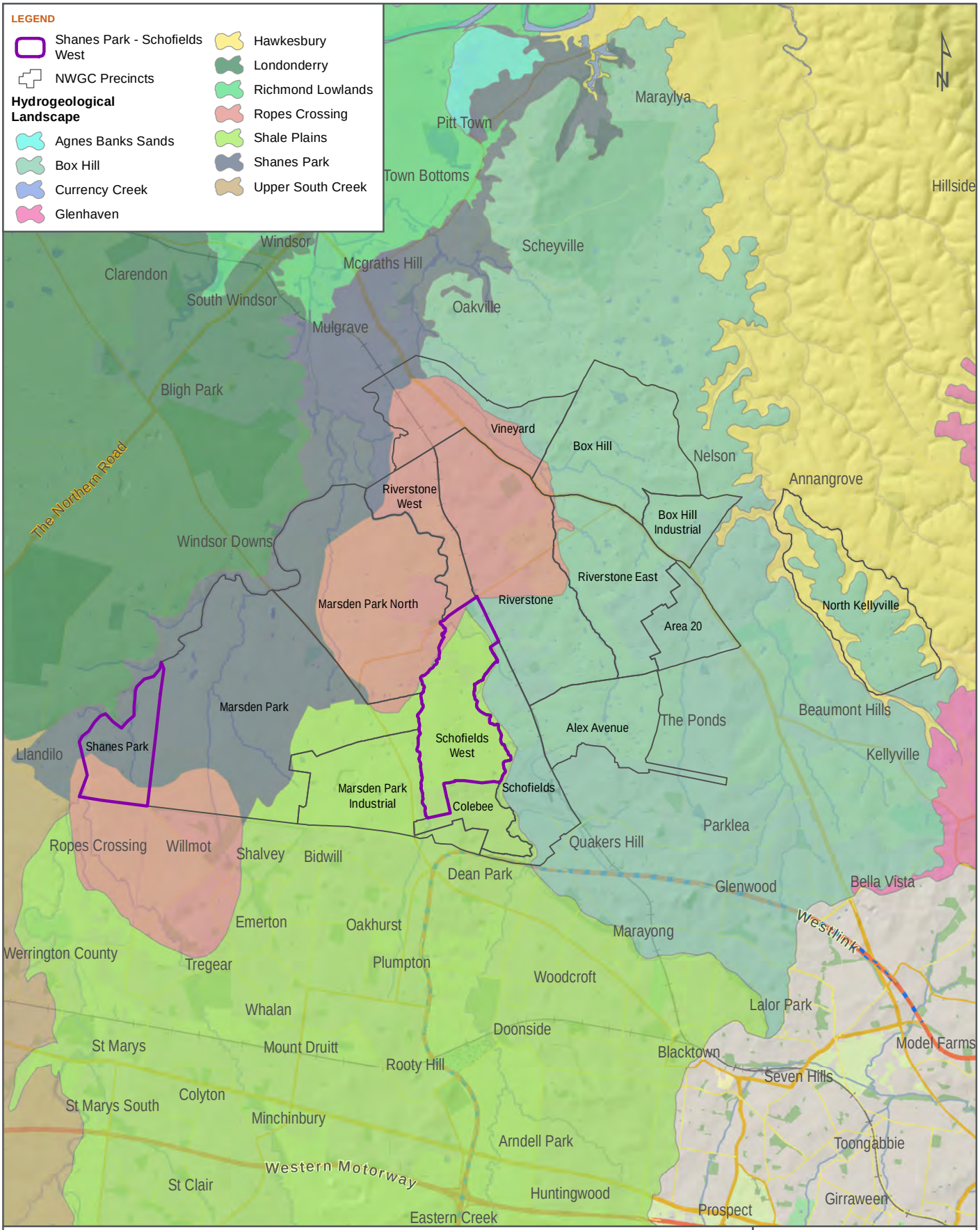

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COORDINATE SYSTEM GDA 1994 MGA Zone 56

FIG NO. 2

FIGURE TITLE HGLs within the NWGC

PROJECT NO. 30012389

PROJECT TITLE Priority Growth Areas Salinity Study

CREATED BY R. Chatfield

SOURCES Vector backdrop data © MDS 2015
HGLs - OEH

SMEC

Location: I:\projects\30012389 - Priority Growth Areas Salinity Study\008 DATA\GIS\Maps\2 - HGL.mxd

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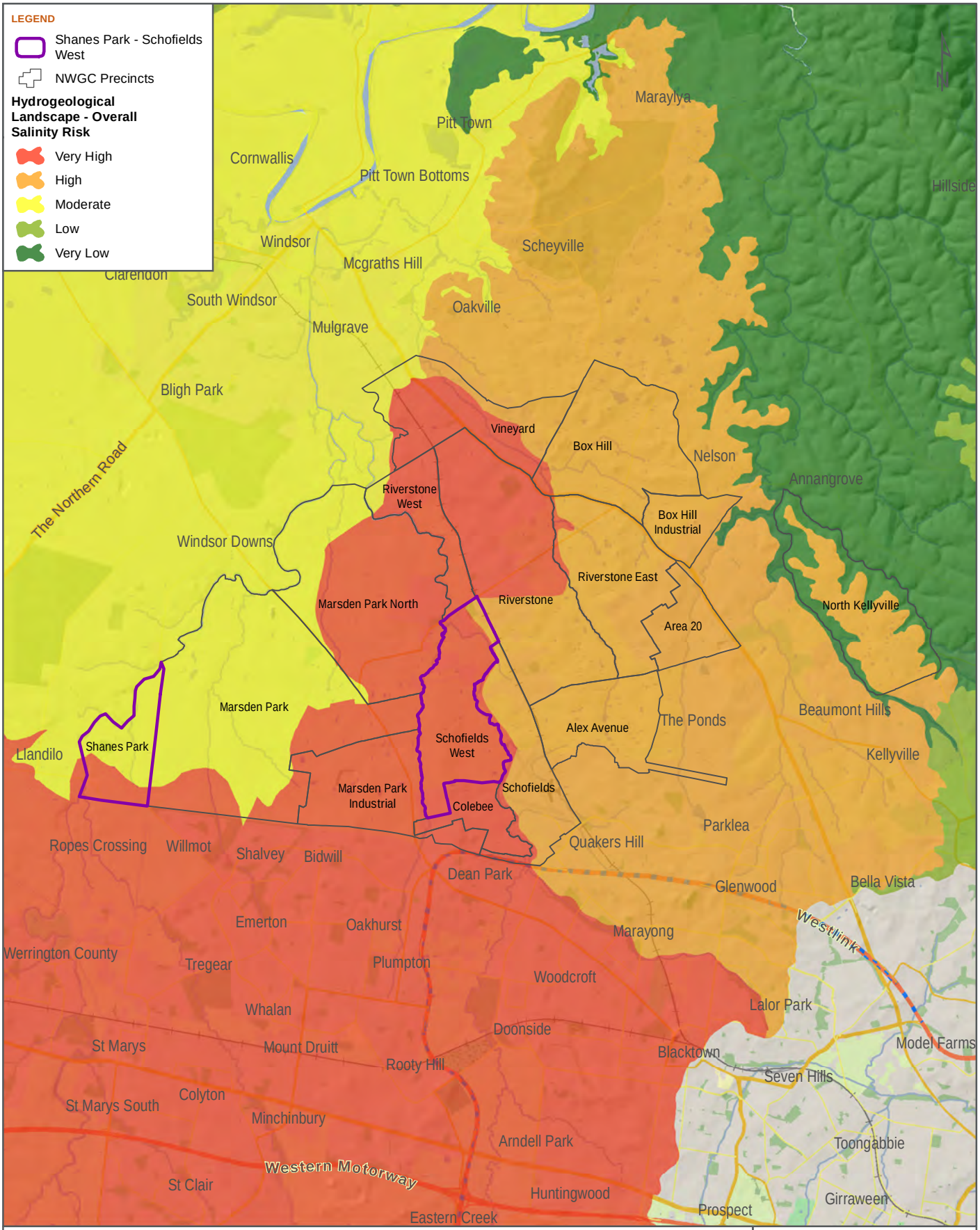

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FIG NO. 3

FIGURE TITLE HGL salinity hazard mapping within the NWGC

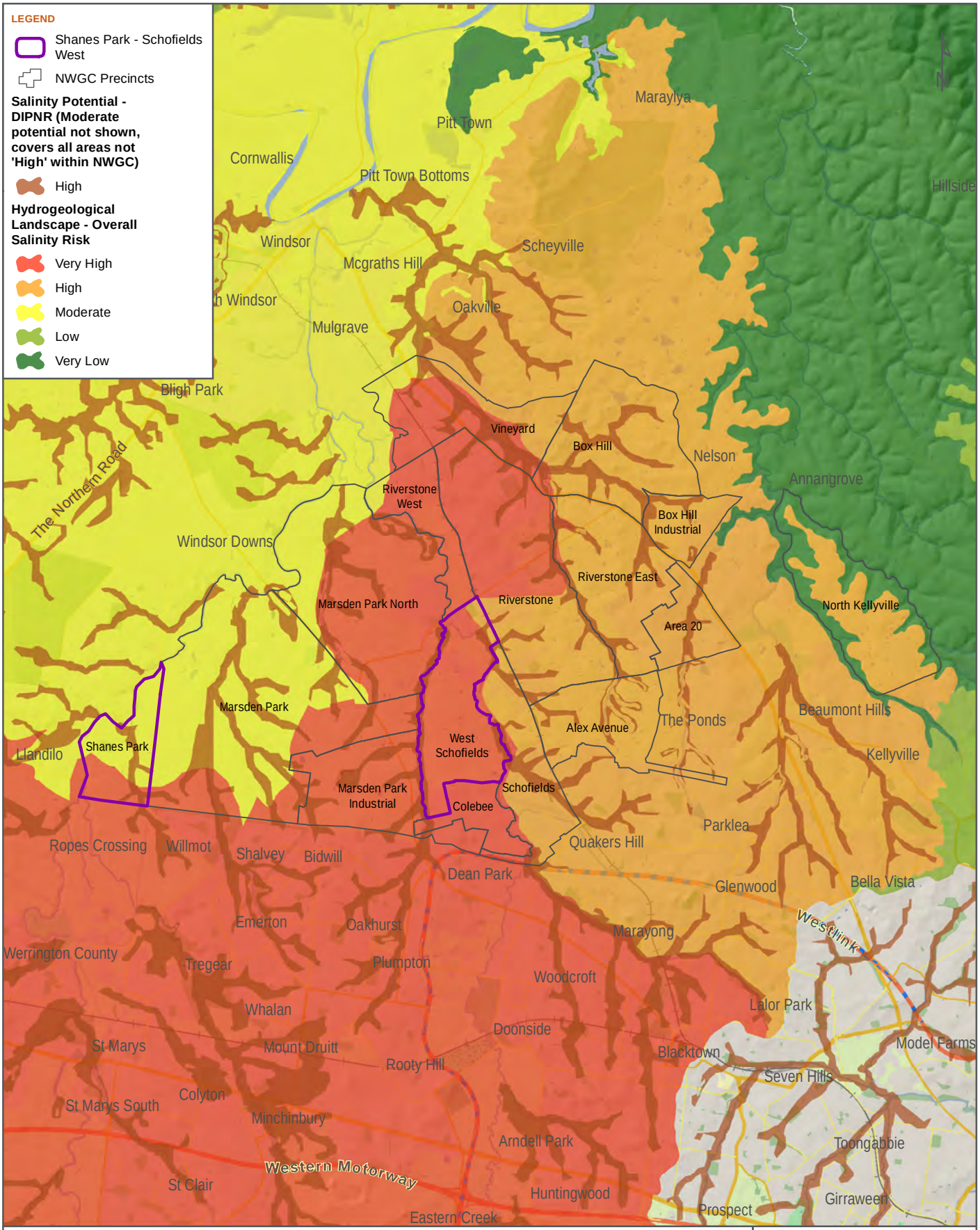
PROJECT NO. 30012389

PROJECT TITLE Priority Growth Areas Salinity Study

CREATED BY R. Chatfield

SOURCES Vector backdrop data © MDS 2015
HGLs - OEH

SMEC



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COORDINATE SYSTEM GDA 1994 MGA Zone 56

FIG NO. 4

FIGURE TITLE HGL salinity hazard mapping overlaid with DIPNR salinity mapping within the NWGC

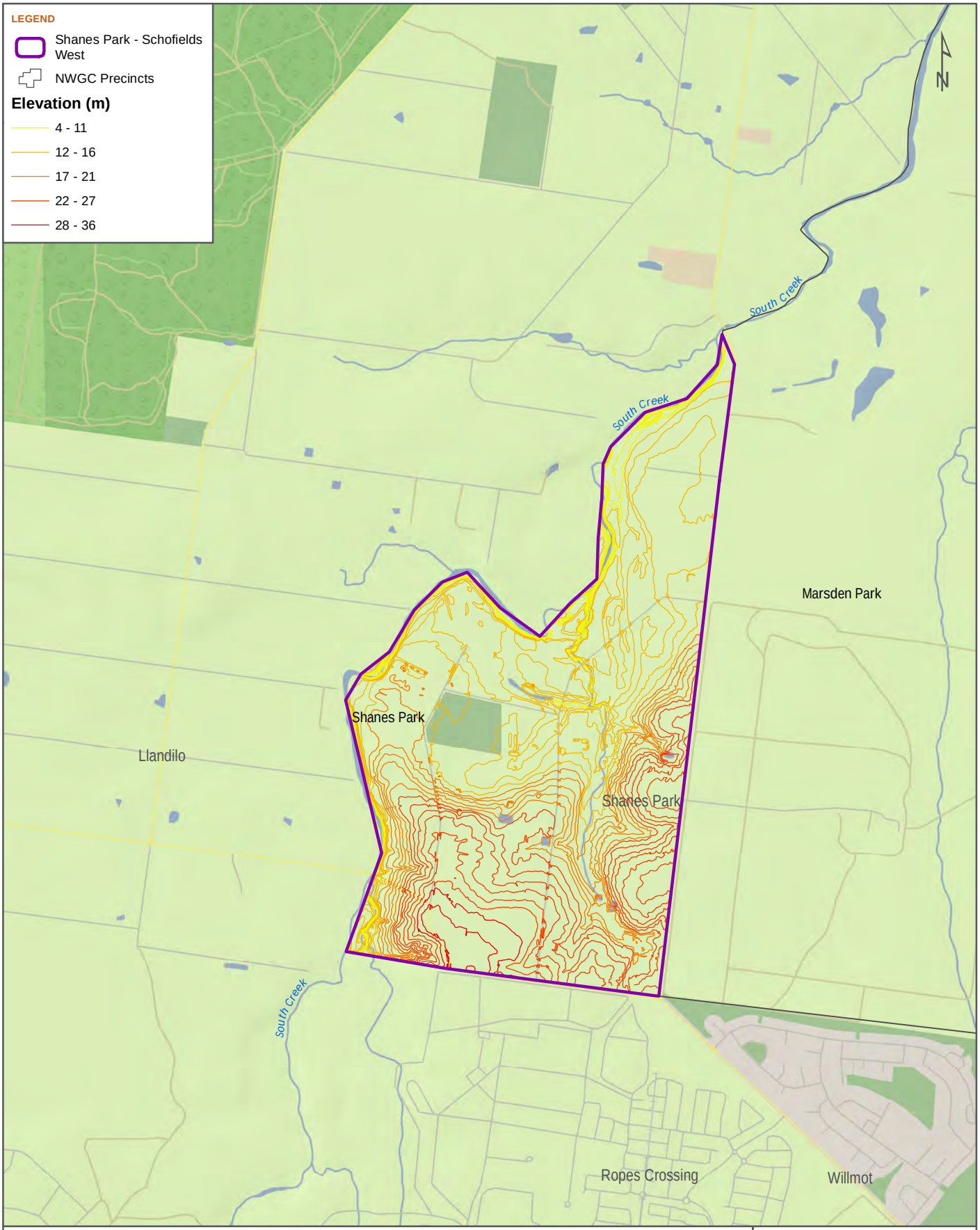
PROJECT NO. 30012389

PROJECT TITLE Priority Growth Areas Salinity Study

CREATED BY R. Chatfield

SOURCES Vector backdrop data © MDS 2015
Salinity Potential - DIPNR; HGLs - OEH

SMEC



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COORDINATE SYSTEM GDA 1994 MGA Zone 56

FIG NO. 5

FIGURE TITLE Terrain in Shanes Park

PROJECT NO. 30012389

PROJECT TITLE Priority Growth Areas Salinity Study

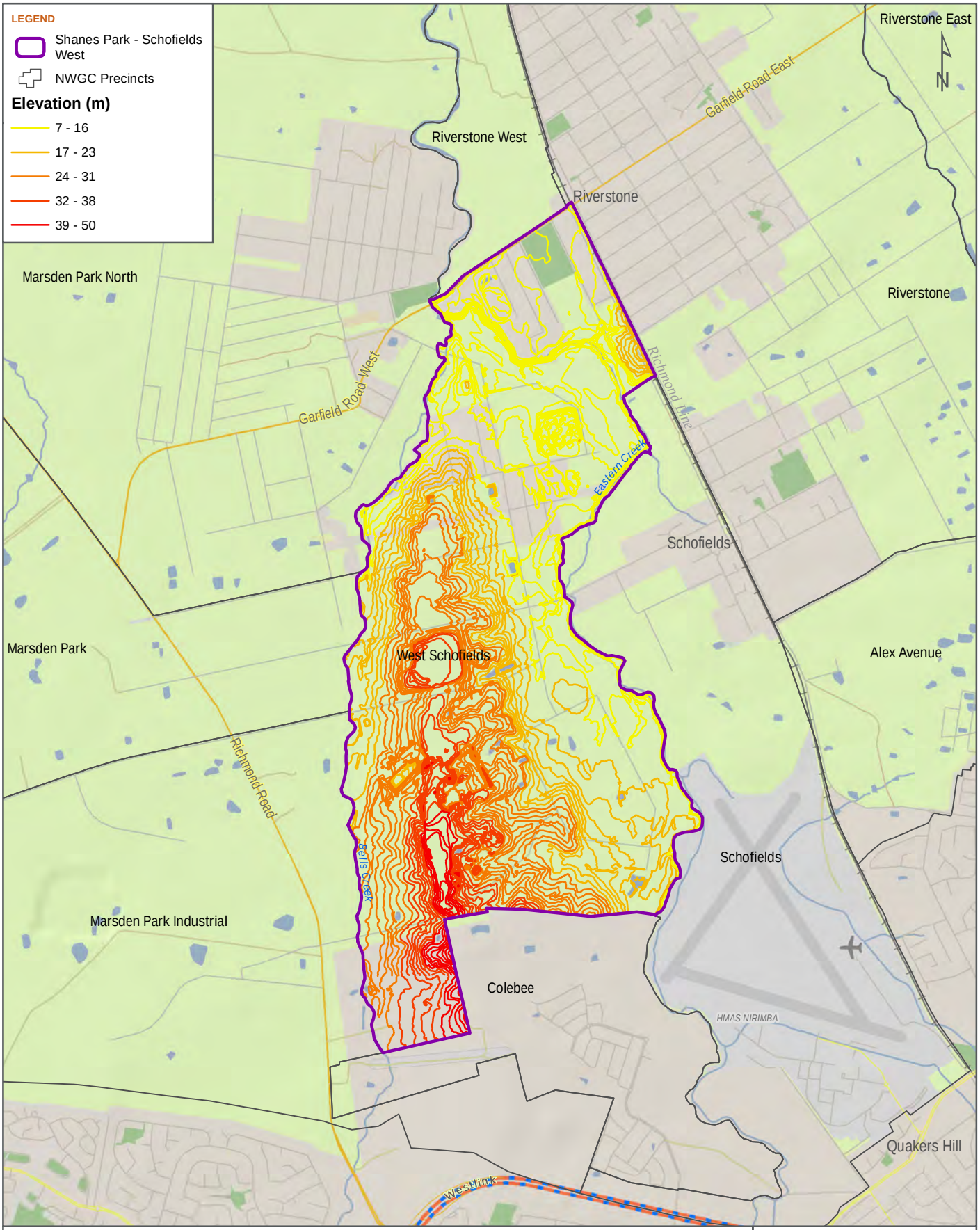
CREATED BY R. Chatfield

SOURCES Vector backdrop data © MDS 2015
HGLs - OEH

SMEC

Location: I:\projects\30012389 - Priority Growth Areas Salinity Study\008 DATA\GIS\Maps\5 - Terrain Shanes Park.mxd

Last updated by: RC10721 on 18/06/2015 at 10:55



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COORDINATE SYSTEM GDA 1994 MGA Zone 56

FIG NO. 6

FIGURE TITLE Terrain in West Schofields

PROJECT NO. 30012389

PROJECT TITLE Priority Growth Areas Salinity Study

CREATED BY R. Chatfield

SOURCES Vector backdrop data © MDS 2015
HGLs - OEH

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Location: I:\projects\30012389 - Priority Growth Areas Salinity Study\008 DATA\GIS\Maps\6 - Terrain West Schofields.mxd

Last updated by: RC10721 on 18/06/2015 at 10:55

APPENDIX B REVIEW OF BEST PRACTICE GUIDELINES

Western Sydney Salinity Code of Practice

The *Western Sydney Salinity Code of Practice* was released in 2003 to serve as a guide to the options available to local government to address salinity problems. The Code of Practice aims to provide information on the current best practice in salinity management for use in Western Sydney.

It acknowledges that there are limits to the present knowledge of salinity and that there are variations in salinity problems and potential across the region. It identifies the need for each local government area to identify and develop those aspects that best suit their situation and adopt area specific salinity management strategies.

The key principles of salinity management identified in the Code of Practice are:

- Know the salinity process on the site
- Maintain natural water balance
- Maintain good drainage
- Avoid disturbance or exposure of sensitive soils
- Retain or increase vegetation in strategic areas
- Implement building controls and/or engineering responses where appropriate

The Code of Practice is intended as a guide for the preparation of salinity management strategies. It notes that the strategic planning stage and the DA stage require different levels of investigation, assessment and management.

The Code of Practice suggests that 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.[23]

Guidelines to Accompany Map of Salinity Potential in Western Sydney

The Guidelines were prepared to support the Department of Infrastructure, Planning and Natural Resources (DIPNR) map of salinity potential in Western Sydney that was developed in 2002. Further discussion on the mapping is provided in Section 2.4.

General management options in the guidelines suggest that:

- A catchment approach to the management of salinity should be taken in new areas of greenfield development
- Deep infiltration and throughflow should be minimised in susceptible landscapes to reduce mobilisation of salt stores in the soil
- Identify limitations for the purpose of providing solutions or exclusion of site from further development. Avoid construction in susceptible locations. Avoid disturbance of natural flow lines

[23] (WSROC pg 37)

- Maximise tree planting and good management of deep rooted vegetation. Stabilise saline areas with appropriate salt-tolerant plant species
- Ensure buffer zones and retention of native vegetation along water courses
- Regional salinity processes and land characteristics identified to provide a context for land use decisions
- Identify possible limitations on different land uses due to salinity potential
- Consider salinity when making broad location decisions eg not placing 'leaky' land uses in recharge areas
- Consider the impact of potential salinity on roads and infrastructure when deciding on locations eg not placing a road where it will impede groundwater movement
- Consider salinity in the pattern and density of land use eg compare the benefits of a high density development with salt affected areas kept undisturbed to low density with greater opportunity for vegetation on individual blocks.

Land use planning and urban salinity

These guidelines were prepared by DIPNR as part of a suite of targeted guidelines to inform and educate local government processes.

The guidelines identify that:

- Urban salinity affects both urban development processes and natural resources management. Therefore a salinity management strategy may involve a potentially complex relationship between various laws, policies and plans
- The links between land use planning tools and other activities and responsibilities needs to be considered
- The consideration of salinity in land use planning responses needs to address both the effect of salinity on development and the impact development will have on salinity.
- Each stage of the planning and development process there needs to be appropriate and consistent salinity measures that recognise local and regional variability in salinity processes and development practice
- Salinity impacts often develop slowly over long periods, salinity is usually not static or related to distinct events.

The guidelines note that it is useful to differentiate between the three land use planning phases, namely:

- Strategic or plan making phase
- Development or plan implementation phase
- Management or post construction phase.

Local Government Salinity Management Handbook

The Handbook was prepared as a resource guide for public works professionals describing salinity issues in Australia and suggesting mitigating measures that can be employed. The handbook highlights that the hidden long-term impacts from salinity on public infrastructure through reduced life spans will be enormous.

Strategies relevant to strategic land use planning include:

- Manage, protect and enhance areas of remnant native vegetation across entire catchments, but particularly in identified recharge areas
- Integrate native vegetation into landscape design
- Allow residential and other development without adversely impacting on vegetation cover and drainage patterns.

APPENDIX C LAND USE ACTIVTIES AND SALINITY

Land use category	Why it causes salinity problems/exacerbates salinity	How salinity can impact on land use
Low density residential/commercial development	Cut and fill changes the flow of water can upset the natural water balance and contribute to rising groundwater and salt mobilisation.	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.
Road/rail	Compaction of soil during road construction and across drainage lines reduces soil permeability and water through flow resulting in shallow groundwater ponding, evaporation and salt accumulation. Impacts on subsurface flows.	Road base can be physically and chemically degraded becoming more susceptible to cracking, pot-holing and eventual failure.
Infrastructure (utilities)	Increased leaking from pipes and corroded joints can drive the salinization process further.	Underground service pipes may be damaged through corrosion.
Industrial	Large areas of impermeable surface decrease filtration.	Similar to residential/commercial.
Open space/planting	Clearing, overgrazing, drought or fire can remove vegetation, leaving the soil bare and prone to erosion. Erosion of the topsoil can expose saline or sodic sub-soils resulting in the formation of a hard soil crust, increased saline run-off and poor soil structure. Increased volumes of water added to the natural system through irrigation and concentrated infiltration of stormwater can intensify the processes which cause salinity.	Damage to lawns, playing fields and private and public gardens.
Environmental management	Retaining native vegetation is important in keeping naturally occurring salinity in check.	Can place additional stress on remnant natural areas such as bushlands, wetlands, rivers and creeks.

Further detail can be found in the WSROC Code of Practice (Section 6.2).

APPENDIX D RECOMMENDED DCP REVISIONS

Recommended updates to the BCC Growth Centres Precincts DCP Appendix C Salinity Management Guidelines

Section 1 – Introduction

This section of the 'Salinity Management Guidelines' refers to the document as a 'Salinity Management Plan'. This creates confusion as to whether the document is intended to be a salinity management plan required under the WSROC Code of Practice for specific development sites or a general guideline intended to inform all development activities. References to 'Salinity Management Plan' should be removed and replaced with 'Salinity Management Guidelines".

Ensure introduction makes it clear that the guidelines are relevant for all growth centre precincts and not just Alex Avenue.

Ensure introduction to guidelines makes it clear that they apply to all development and not just residential development.

Include statement that:

- Development must comply with the Western Sydney Salinity Code of Practice (WSROC, 2004) as amended or superseded.
- Development must be in accordance with the following salinity guidelines:
    - Local Government Salinity Initiative documents, including Building in a Saline Environment (DIPNR, 2003)
    - Australian Standards relevant for construction in a saline environment

A statement of the objectives of salinity management should be included in the introduction. Clear objectives and principles are an important component of any investigation and management process. The five key management principles identified in the WSROC Code of Practice should be emphasised clearly in all control documents:

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

Move section 1.1.2 to section 2.1 in order to consolidate discussion on mapping and minimise confusion.

Section 2 – Salinity hazard assessment

Section should be revised to remove references to Alex Avenue and to make it relevant to all precincts addressed by the DCP.

Section should emphasise the importance of understanding the land capability in relation to salinity prior to development commencing.

Section should be revised to clearly state the investigation requirements for different types of development, in accordance with the WSROC Code of Practice. Ensuring the upfront identification of investigation and reporting requirements are for all types of development would assist in ensuring best practice is implemented consistently across the growth centre.

Section 2.1 – Salinity risk map

Incorporate section 1.1.2 into this section to consolidate discussion on mapping and minimise confusion.

Terminology for Level 1 Areas and Level 2 areas of salinity risk is confusing for two reasons:

- not shown as such on the relevant figures in the Precinct Schedules. The figures use "Higher salinity risk" and "lower salinity risk"
- the WSROC Code uses Level 1 – 3 to refer to type of salinity investigation required. This could be confusing.

Precautionary measures are only recommended as "may be considered" for 'Level 1' areas.

Mapping and references should be revised to make terminology clear and consistent.

Precautionary measures should be required for all areas.

Consideration as to the inclusion of reference to the HGL data should be made. This would assist in a better understanding of salinity migration issues and management as well as landscape scale issues and potential impacts.

Section 3 – Salinity management guidelines

Ensure that it is clear that the guidelines relate to all development activities in all phases of development.

Include cross reference the relevant detailed land use capability assessments done for the released precincts.

Section 3.2 – General measures

The list of general measures should be grouped by land use activity, ie roads, drainage, earthworks, building construction in order to make it easier to use.

The following management strategies should be emphasised:

	Management Strategy
Strategy 1	Buffer the salt store – keep it dry and still
Strategy 2	Intercept the shallow lateral flow and shallow groundwater
Strategy 3	Stop discrete landscape recharge
Strategy 4	Discharge rehabilitation and management
Strategy 5	Increase agricultural production to dry out the landscape and reduce recharge
Strategy 6	Dry out the landscape with diffuse actions over most of the landscape
Strategy 7	Access and use of groundwater to change water balance
Strategy 8	Maximising recharge to dilute water tables with engineering actions
Strategy 9	Minimising recharge with engineering actions

	Management Strategy
Strategy 10	Maintaining and maximising runoff
Strategy 11	Manage and avoid acid sulfate hazards

Source: DECCW (2011)

Section 3.3 – Groundwater

Measures should be grouped into strategic and development phases.

The following measure could be added:

- The use of capillary-evaporation break/filter layers in areas subject to potential water-logging should be considered, in order to reduce any saline migration towards the ground surface, to assist in maintaining any dispersed clays under the filter layer, and to promote vegetative growth.

A new subsection for monitoring should be added and the following controls considered for inclusion:

- As a part of a salinity management plan, groundwater quality across the study area should be monitored to determine the effectiveness of any adopted management changes. Groundwater monitoring events should occur on at least a 6 monthly basis to account for seasonal variation until it is considered that the effects of the development on salinity have stabilised (likely to be 2-5 years). Pre-development groundwater data should be collected and compiled to allow the assessment against post-development groundwater quality.
- An interpretive review of the post-development groundwater quality data should be undertaken annually to determine if any changes to the management plan are necessary or if continuation of groundwater monitoring is required.
- The installation of additional groundwater monitoring wells should be considered as it would provide a greater understanding of the hydrogeological setting and allow for a more robust data set of pre-development groundwater quality. The installation of any replacement or new groundwater monitoring wells should avoid private property.
- Typically such monitoring wells would be primarily located in the lower landscape with a couple of piezometers located higher in the landscape for groundwater profiling purposes.
- The monitoring results should be assessed by a geotechnical engineer experienced in salinity management.

Section 3.4 – High risk areas

Measures are generally consistent with best practice guidelines.

Consideration should be given to including reference to the HGL frameworks to ensure the more detailed landscape functions are understood and the management options are adopted.

Section 3.5 – Site design

Measures are consistent with best practice guidelines.

Section 3.6 – Residential and other buildings

Measures are generally consistent with best practice guidelines.

The following additional measures could be considered:

- Durability of construction materials including concrete and use of exposure class bricks should be consistent with Australian Standards and in accordance with Building Codes for building in saline soils and environments.
- Areas of cut and fill on sites should be restricted to building envelope.
- Further information of aggressiveness and corrosivity towards concrete and steel should be completed on a site specific basis, consistent with *Site Investigations for Urban Salinity* (DLWC, 2002), for the selection of appropriate construction materials.

Section 3.7 – Measures for specific assets

These tables provide a breakdown by asset, stage and measure, which is consistent with the best practice guidelines.

Following additional measures could be added to the relevant asset section:

- Consideration should be given to salinity and infiltration when designing and installing swimming pools.
- The recommendations for road and pavement construction in the WSROC Code of Practice should be carefully considered in the planning and design of roads and other major infrastructure.
- Earthworks plans should limit cuts to significantly above the saline water table (where possible) and that provide filling rather than cuts in lower landscape areas.
- The maximisation and/or replacement of native tree cover and deep-rooted plants should be encouraged, particularly in areas of known or potential slope instability.
- Where vegetation cover is not adequate to control erosion, soil resistance to erosion should be improved by the addition of lime and gypsum (the proportion to be determined by site specific testing).
- Ensure an appropriate maintenance regime for rehabilitated areas is implemented, including watering of lands established with grass cover until an effective cover has been established. Where there has been inadequate vegetation establishment, further application of seed should be carried out. During establishment, trafficking of the treated areas should be minimised.
- Consider regional recharge/discharge patterns when planning water intensive developments such as intensive agriculture, effluent disposal, sporting fields, major gardens/landscaping, golf courses etc.