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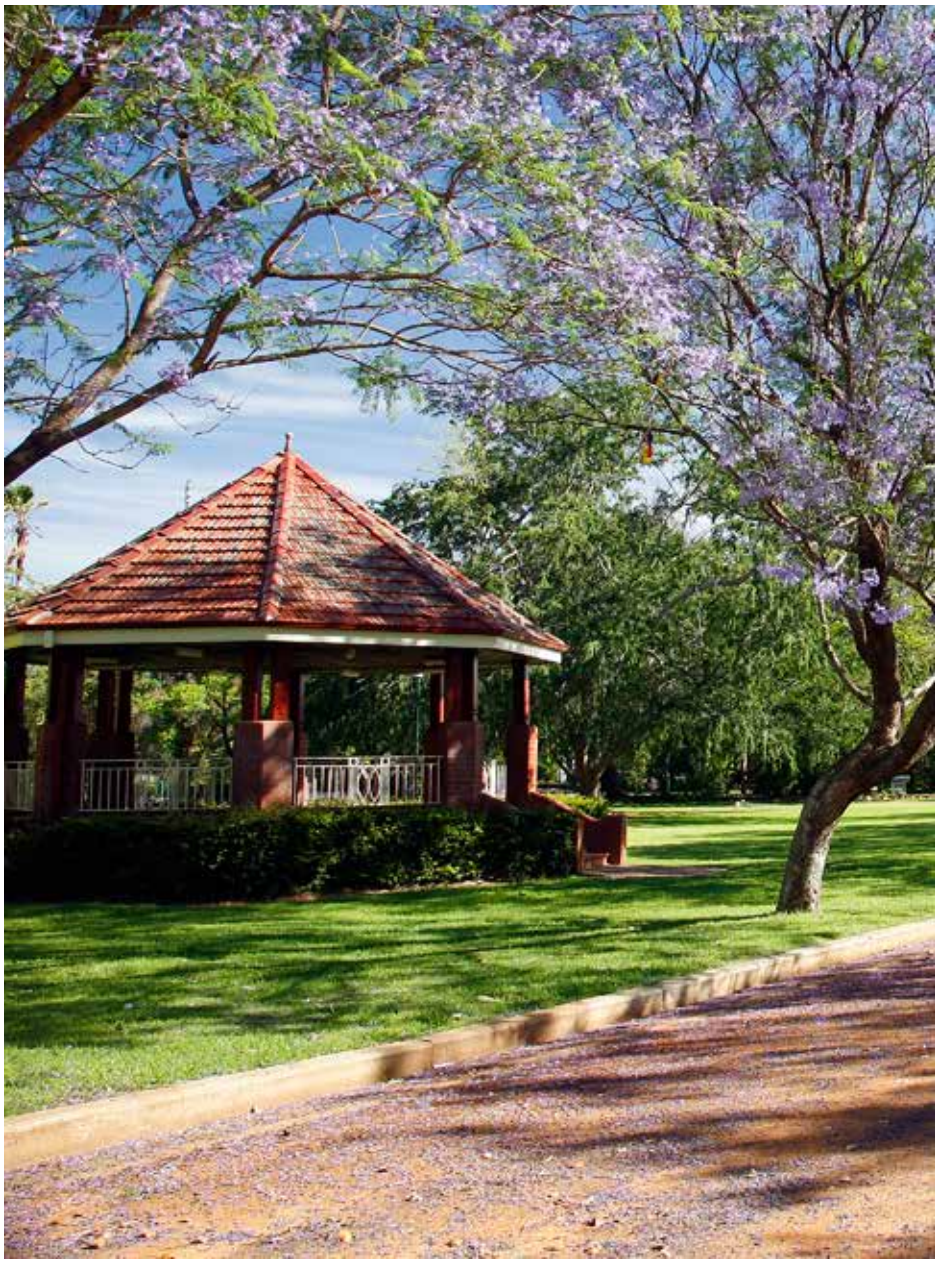


Dubbo City Urban Salinity Implementation Plan

Table of Contents:

1.0 Introduction

The Salinity Management Strategy aims to minimise the current and future impacts of land degradation, inappropriate land use practices and climate change on production and the environmental and indigenous heritage values of land within the Dubbo urban area.

The Strategy will provide for the ongoing monitoring and management of salinity which will contribute to increasing the understanding of salinity within the urban area of Dubbo and allow for the proper management of salinity affected areas and landscapes at risk of impact by salinity.

The Strategy structures the factors of urban salinity into individual strategies and provides strategic outcomes as a template for salinity management. The individual strategies address:

1. Salt impact: The type and quantity of salt present within the landscape.
2. Groundwater Recharge: The amount of water mobilising and concentrating salts in particular areas of the landscape.
3. Land use: Use of the landscape and associated practises.
4. Infrastructure: Construction material and method used and maintenance of infrastructure.
5. Monitoring: Further investigation and management.

The Strategy will act as the main planning tool for salinity management, guiding salinity management actions. Salinity management actions are applied to the priority Hydro-geological Landscapes (HGLs), identified as the landscapes that contribute significantly to rising salinity, locations that are important in the functioning and our understanding of salinity processes in the LGA and those areas that are significant in order to protect local assets and values.

The HGLs identified in this context are detailed in Table 1 and include the Macquarie Alluvium, Central Business District, Orana Heights, West Dubbo, Dubbo Basalt, Troy Creek Constriction, Dunedoo Road, Fitzroy Upland Alluvium, Richmond Estate, Brocklehurst, South Dubbo, Eulomogo Estate, Kintyre, and Firgrove HGLs.
The groundwater bore sites prioritised in this context include those with extreme, high and medium concern salinity hazard trends (2009-2012) as detailed in Table 2 and those within the Central Business District HGL. The priority Hydro-geological Landscapes and Bore Sites are further detailed in Section 2.0 of this Plan.

The Implementation Plan provides the identified requirements and actions necessary for achieving the strategic outcomes of the Strategy. These requirements inform the development of Council Delivery and Operational Plans and act as a tool for developers and the community in determining the measures associated with salinity management within particular landscapes.

2.0 Priority Landscapes and Bore Sites

The Salinity Implementation Plan delivers actions specific to the Hydro-geological Landscapes with a focus on addressing the salinity hazard in the landscapes identified with an overall hazard of Very High, High or Medium. Further, the actions address bore sites determined as extreme, high and medium based on water quality and groundwater height over the period 2009 to 2012, as assessed by the Impax Group in February 2013 as part of the annual monitoring of the Urban Salinity Network.

The landscapes identified as a focus for the Strategy are detailed in the following tables. Table 1 identifies the assessed salinity data for each of the Hydro-geological Landscapes determined in the Dubbo Urban Landscape Interpretation Project (2010). A detailed account of the landscapes prioritised for salinity management in this Plan is included in Table 3. Table 2 identifies the bore sites with extreme, high and medium concern. A map identifying the location of these bores is attached as Appendix A. The background data for the bore hazard assessment is provided as Appendix C.

Table 1. Dubbo Urban Areas Hydro-geological Landscapes (April 2010)

Hydro-geological Landscapes		Land Impact	Salt Load Export Impact	Impact on Water Quality	Overall Hazard
1	Macquarie Alluvium	Low	Moderate	Low	Medium
2	Central Business District	High	High	High	Very High
3	Orana Heights	High	Moderate	Moderate	High
4	West Dubbo	Moderate	Moderate	Moderate	Medium
5	Dubbo Basalt	Moderate	Moderate	Low	Medium
6	Troy Creek Constriction	High	High	High	Very High
7	Dunedoo Road	High	Moderate	High	High
8	Whylandra Creek	Low	Low	Low	Low
9	Fitzroy Upland Alluvium	High	High	Moderate	High
10	Cumboogle	Moderate	Low	Low	Low
11	Richmond Estate	Moderate	High	High	High
12	Brocklehurst	Moderate	Moderate	Moderate	Medium
13	South Dubbo	High	Moderate	Moderate	High
14	Eulomogo Estate	High	High	High	Very High
15	Old Dubbo Road	Low	Moderate	Low	Low
16	Wongarbon Basalt	Low	Low	Low	Very Low
17	Kintyre	Moderate	Moderate	Moderate	Medium
18	Peachville	Low	Moderate	Low	Low
19	Firgrove	Low	Moderate	Low	Medium
20	Talbgagar Alluvium	Low	Moderate	Moderate	Low

2.0 Priority Landscapes and Bore Sites

Table 2.Extreme, High, Medium Concern Bore Sites (2009-2012)

Hydro-geological Landscape		Bore ID	Bore Monitoring Assessment
3	Orana Heights	GW24	Medium
		GW59	Medium
		GW62	Medium
4	West Dubbo	GW34	Medium
		GW85	Medium
		GW98	Medium
		GW109	Medium
		GW110	Medium
5	Dubbo Basalt	GW73	Medium
6	Troy Creek Constriction	GW107	Medium
		GW T129	Medium
		GW T130	Medium
		GW T132	Medium
9	Fitzroy Upland Alluvium	GW72	High
		GW T103	Medium
		GW T104	Medium
11	Richmond Estate	GW8	High
		GW7	Medium
		GW106	Medium
13	South Dubbo	GW75	High
		GW78	High
14	Eulomogo Basalt	GW114	Extreme
		GW128	Extreme
18	Peachville	GWT302	High
		GW43	Medium
		GW T303	Medium
		GW T307	Medium
19	Firgrove	GW1	High
		GW5	Medium

2.0 Priority Landscapes and Bore Sites

Table 3. Priority Landscapes for Salinity Management

Hydro-geological Landscapes		Land Impact	Salt Load Export Impact	Impact on Water Quality	Overall Hazard
1	Macquarie Alluvium	Low	Moderate	Low	Medium
	The Macquarie Alluvium HGL is dominated by the Macquarie River and its floodplain, covering the area of land north to south through the western side of Dubbo. The HGL is characterised by flat to gently undulating alluvial systems including floodplains, alluvial plains, anabranches, alluvial fans, terraces, levees, swamps, channels and closed depressions. Soils in the landscape are loose dark brown, weakly structured sandy loam to loam stratified with loamy sandy (topsoil). The subsoil consists of silt loam interlayed with loamy sand and clayey sand. In this HGL water moves vertically though the alluvial soils to the water table and then laterally to the drainage lines. Seasonal flooding on the floodplain and water-logging in drainage depressions and back swamps is common. Salt flow in to this landscape is dependent on the areas adjacent to it; generally the HGL is relatively non-saline as water flows remove salts from the landscape. The landscape received and stores salt load through irrigation or surface flow and provides important base flow to local streams.				
2	Central Business District	High	High	High	Very High
	The Central Business District HGL is located in the centre of the City precinct and has a high density of urban infrastructure. The landscape contains important land based assets which are being impacted by salinity processes. The landscape is characterised by wide-scale urban salinity and consists of low lying lightly undulating areas of levee banks, terraces, depressions, relict channels, closed depressions, former swamps and drainage lines running parallel to the modern channel of the Macquarie River. Significant salinity is identified in this HGL causing widespread damage to homes, infrastructure, public buildings and parks. Key land degradation issues include moderate erosion in areas of high water flow, slightly acidic topsoil, moderate shrink and swell potential in subsoils, flooding, large saline sites, high hydraulic head, groundwater discharge and overwater of gardens, parks and fields. The landscape generates salt loads which enter the streams and are redistributed in the catchment. Salt loads are received and stored through irrigation or surface flow. The landscape contains high hazard for generating sodic and saline sediment.				
3	Orana Heights	High	Moderate	Moderate	High
	The Orana Heights HGL is located in the central area of Dubbo. The landscape is characterised by a plateau exhibiting a high salt store, high groundwater conditions and urban salinity. The landscape generates salt loads which enter the streams and are redistributed in the catchment. Salt load is stored and received through irrigation or surface flow. The landscape generates high salinity concentration water and contains important land based assets which are being impacted by salinity processes. A high number of localised sites have been identified with minor impacts to vegetation and infrastructure, generally occurring at the edges of the plateau landform.				

2.0 Priority Landscapes and Bore Sites

Table 3. Priority Landscapes for Salinity Management

4	West Dubbo	Moderate	Moderate	Moderate	Medium
	The West Dubbo HGL is located around the Dubbo Airport and West Dubbo area. The landscape consists of low flat broad valleys, undulating long sloping hills and low rises. Minor salinity is identified sloping easterly to the Macquarie River. The western and central soils have a moderate to high fertility and are moderately textured with a good water holding capacity. Soils in the southern and eastern parts of the HGL are lightly textured with a low infiltration rate and low water holding capacity. These are more susceptible to structural degradation. The HGL has a low level of observed salinity though localised sites are known. Salt storage is in the landscape is moderate, though is identified at a depth which is currently not mobilised by land use. It is identified, however that the salt stores being redistributed throughout the catchment through streams. The landscape currently provides fresh water runoff as an important water source and as an important dilutions flow source.				
5	Dubbo Basalt	Moderate	Moderate	Low	Medium
	The Dubbo Basalt HGL incorporates narrow areas running parallel to the Macquarie River, east of the Dubbo City Centre and includes a broad area north of Troy Creek. The landscape contains a high density of moderate to high water use development types; predominantly dry land cropping, improved pastures to the north and urban development expanding to the south. Soils in the Dubbo Basalt HGL are moderately fertile, generally thin, friable and have a high water holding capacity with moderate shrink-swell potential. Surface flow from this HGL contributes saline flows to the Troy Creek Constriction HGL and throughout the catchment, increasing the significant salinity damage. The landscape provides fresh water runoff as an important dilutions flow source.				
6	Troy Creek Constriction	High	High	High	Very High
	The Troy Creek Constriction HGL is located to the north east of Dubbo City and incorporates the mid to lower reaches of the Troy Creek system. The landscape has been recognised as an area of urban salinity since the early 1990's. Significant research and investigation over time has provided a sound understanding of the landscape character and nature of the salinisation. The land consists predominantly of permeable clay soils which, combined with the large catchment area and intermediate groundwater system forces saline groundwater to the surface. This is further exacerbated with high local water use, the construction of roadways across the drainage line, catchment vegetation clearance and urban development. The landscape generates salt loads which enter the streams and are redistributed in the catchment. Salt loads are received and stored through irrigation or surface flow. The landscape generates high salinity concentration water and contains important land based assets which are being impacted by salinity processes. Large saline sites have been recently improved with the implantation of rehabilitation practises including extensive tree planting, drainage programs further enhanced by the recent dry climatic conditions.				
7	Dunedoo Road	High	Moderate	High	High
	The Dunedoo Road HGL is located parallel with the Talbragar River from its Junction with the Macquarie River to west of Beni. The HGL is characterised by undulating long slopes with high surface water runoff on upper slopes and high recharge zones around basalt areas. In the HGL, water moves quickly through the landscape in two ways: firstly as runoff over surface soils due to their hydrophobic nature and also vertically through the regolith with increased recharge over mid -slope basalts. The HGL has a shallow saline water table and a deeper saline water table in the lower catchment. Salinity problems are generally seasonal, mostly found lower down the slope below the highway. Basalt areas are high recharge zones and are located high in the landscape. The landscape generates salt loads which enter the streams and are redistributed in the catchment. Additional salt load is received through irrigation or surface flow.				

2.0 Priority Landscapes and Bore Sites

Table 3. Priority Landscapes for Salinity Management

9	Fitzroy Upland Alluvium	High	High	Moderate	High
	The Fitzroy Upland Alluvium HGL is located around the Troy Creek junction area in the Dubbo City Precinct. It consists of broad alluvial floodplains, relict terraces, drainage channels, levees, depressions and river banks of recent alluvial deposits. The HGL contains a high density of urban infrastructure including the Senior High School Campus and Charles Sturt University (Dubbo) Campus. These developments combined with road and rail infrastructure influence water movement in the landscape forcing the water table to rise which is creating discharge sites on either side of the constrictions. The HGL is subject to extreme flooding, erosion, seasonal water logging and contains acidic soils and sites of major salinity. The landscape provides important base flow to local streams. It generates and stores salt loads which enter the streams and are redistributed in the catchment. Additional salt load is received through irrigation or surface flow.				
11	Richmond Estate	Moderate	High	High	High
	The Richmond Estate HGL is located on the eastern side of Dubbo City and is characterised by rural residential development. The HGL experiences increasing salinity symptoms in lower elements of the drainage system as a result of development. Further, rural residential development in the area contributes to salinity through the loss of native woodland vegetation and the overwatering of lawns. The HGL features a bowl shaped landscape of gently undulating rises and low hills. This landform shape and increased clay in the lower drainage lines subjects the landscape to salinity in low areas and in drainage lines. Salinity in the HGL is subject to seasonal climatic changes and human intervention. The landscape generates and stores salt loads which enter the streams and are redistributed in the catchment. Additional salt load is received through irrigation or surface flow.				
12	Brocklehurst	Moderate	Moderate	Moderate	Medium
	The Brocklehurst HGL is located to the north of the junction of Macquarie and Talbragar Rivers in the Brocklehurst area. The landscape consists of low undulating hills and rises formed on tertiary basalt with some stony hillocks. The soils are characteristically moderately fertile, typically deep, friable and have a high water holding capacity. In this HGL water moves vertically to the water table, as well at laterally to drainage lines or discharge sites. The landscape is extensively clear open woodland and grassland, dominated by white and yellow box and white cypress pine. Saline sites are highly seasonal and arise due to structural changes in the upper drainage line elements of the landscape. The landscape provides important base flow to streams. The landscape generates and stores salt loads which enter the streams and are redistributed in the catchment. Additional salt load is received through irrigation or surface flow.				
13	South Dubbo	High	Moderate	Moderate	High
	The South Dubbo HGL incorporates a large part of South Dubbo to the east of the Macquarie River. The HGL is highly developed for residential use and is extensively cleared. The area has been revegetated and landscaped with exotic plants and vegetation. Numerous large sites of salinity are identified in the HGL, occurring mostly on the geologically controlled contours and have a significant impact on urban buildings and infrastructure. The soils have been highly disturbed through the process of urban development and are fragile, lightly textured and have a low infiltration rate. Pooling of water is common in the HGL due to the low infiltration rate. The landscape generates and stores salt loads which enter the streams and are redistributed in the catchment. The landscape provided fresh water runoff as an important dilutions flow source. Additional salt load is received through irrigation or surface flow.				

2.0 Priority Landscapes and Bore Sites

Table 3. Priority Landscapes for Salinity Management

14	Eulomogo Estate	High	High	High	Very High
	The Eulomogo Basalt HGL is located southwest of the Mitchell Highway between Butler's Falls and Eulomogo. The landscape consists of gently undulating rises, low hills and some stony hillocks. Soils in the HGL have a moderate to high fertility, a friable surface with a high water holding capacity and a moderate to high shrink-swell potential. In this HGL water infiltrates the soil at a slow to medium rate, moving vertically through the water table; The landscape generates high salinity concentration water. A large number of salt sites are identified within the HGL along drainage lines and depressions. Water from the upper catchment (Firgrove HGL) comes to the surface in this location. Further, the constriction at the north-eastern edge of the HGL influences the water table and seasonal flooding in the area. The landscape generates and stores salt loads which enter the streams and are redistributed in the catchment. Additional salt load is received through irrigation or surface flow.				
17	Kintyre	Moderate	Moderate	Moderate	Medium
	The Kintyre HGL is situated south west of Dubbo, north of the Newell Highway, running from the Macquarie River near the Zoo to the west of the upper catchment of Whylandra Creek in the central west of Dubbo. Soils are very sandy having formed on quartz sandstone with some clay rich soil found in depressions which usually have sodic sub-soils. Water in the HGL moves vertically through regolith until it reaches the water table or bedrock, it then moves laterally to drainage lines. Generally, the HGL is relatively non-saline in the upper areas and shows moderate urban salinity in the lower elements of the landscape. The upper elements of the landscape are vegetated with regrowth in some areas and the remaining has been cleared for grazing and is now experiencing increasing urbanisation. The landscape provides fresh water runoff as an important dilutions flow source. The landscape generates and stores salt loads which enter the streams and are redistributed in the catchment. Salt load is stored and received through irrigation or surface flow.				
19	Firgrove	Low	Moderate	Low	Medium
	The Firgrove HGL is partially located in the Beni State Forest area south east of Dubbo, although it predominantly covers the area to the north of the Mitchell Highway incorporating the upper catchment of Wongarbon Creek. The HGL is a flat-lying geological landscape characterised by its bowl shaped constrictions and large areas of native vegetation. The HGL contains areas of extensively cleared woodlands and grasslands with a moderate building density and level of existing rural residential development. The HGL experiences seasonal water logging in low lying areas and drainage depressions. Salinity in this HGL is identified as being a product of the landform characteristics and climatic conditions. Most saline sites are found where shallow groundwater is constricted and forced to discharge, at a change of slope or where the water table discharges to low lying areas, near creeks and streams. The landscape provides fresh water runoff as an important water source and as an important dilutions flow source. The landscape generates salt loads which enter the streams and are redistributed in the catchment.				

3.0 Implementation Plan

STRATEGY ONE: SALT IMPACT

To ensure the salt impact on the landscape is minimised and managed.

STRATEGIC OUTCOME		REQUIREMENTS		APPLICABLE HGL
1.1	The discharge of saline water into the groundwater system, river and streams is minimised.	1.1.1	Rehabilitate discharge sites with the strategic planting of salt tolerant species matched to the site salt intensity.	• Eulogmogo Basalt • Firgrove • Richmond Estate • Fitzroy Upland Alluvium • Kintyre • Macquarie Alluvium
		1.1.2	Vegetation management in riparian areas to minimise salt export to streams.	• Firgrove • Richmond Estate • Fitzroy Upland Alluvium • South Dubbo • Peachville • Orana Heights • West Dubbo • Dubbo Basalt • Troy Creek • Kintyre • Macquarie Alluvium
1.2	Salt stores are buffered to limit their interaction with shallow groundwater.	1.2.1	Strategic planting of vegetation to buffer the salt stores in the upper colluvial areas of the HGL.	• Firgrove • Richmond Estate • Fitzroy Upland Alluvium • Kintyre
		1.2.2	Installation of sub-surface drains where required to intercept saline water discharge into the groundwater system, rivers and streams.	• Firgrove • Richmond Estate • Fitroy Upland Alluvium • South Dubbo • Peachville • Orana Heights • West Dubbo • Dubbo Basalt • Troy Creek

3.0 Implementation Plan

STRATEGY TWO: GROUNDWATER RECHARGE

The volume of water with the potential to enter in to and contaminate the natural system is minimised.

STRATEGIC OUTCOME		REQUIREMENTS		APPLICABLE HGL
2.1	Lateral flow of shallow groundwater is intercepted and reduced.	2.1.1	Strategic planning of vegetation of native vegetation in intercept and lateral flow of saline water and reduce volume of flow.	• Eulomogo • Firgrove • Richmond Estate • Fitzroy Upland Alluvium • Kintyre • Dunedoo Road
2.2	Excess soil moisture within the landscape is utilised.	2.2.1	Strategic planting of native vegetation within the landscape to reduce the volume of shallow groundwater and dry out the landscape.	• Eulomogo • Firgrove • Richmond Estate • Fitzroy Upland Alluvium • Kintyre • Dunedoo Road
		2.2.2	Productive use of groundwater to dry out the landscape.	• Fitzroy Upland Alluvium
2.3	Ponding of water on discharge sites is minimised.	2.3.1	Identification of discharge sites and subsequent management of water input.	• Firgrove • Richmond Estate • Fitzroy Upland Alluvium • South Dubbo • Peachville • Orana Heights • West Dubbo • Dubbo Basalt • Troy Creek • Kintyre • Dunedoo Road • Macquarie Alluvium

3.0 Implementation Plan

STRATEGY TWO: GROUNDWATER RECHARGE (CONTINUED)

		2.3.2	The size and location of future urban development is influenced by the location of discharge sites.	• Firgrove • Richmond Estate • Fitzroy Upland Alluvium • South Dubbo • Peachville • Orana Heights • West Dubbo • Dubbo Basalt • Troy Creek • Brocklehurst • Dunedoo Road • Macquarie Alluvium
2.4	Discharge to the groundwater system is minimised.	2.4.1	Protect and manage native vegetation.	• All HGLs
		2.4.2	Strategic planting of native vegetation in public open space, sites with high groundwater recharge potential and where protecting salt affected land.	• All HGLs
		2.4.3	Elements of the landscape identified as recharge points are managed to eliminate discrete groundwater recharge.	• Central Business District • Richmond Estate • South Dubbo • Dubbo Basalt • Kintyre
2.5	Discharge of water into the landscape is minimised	2.5.1	Urban management of water use (lawns, gardens, sporting fields) encourages the establishment of spaces with low water requirements.	• Firgrove • Richmond Estate • Fitzroy Upland Alluvium • South Dubbo • Peachville • Orana Heights • West Dubbo • Dubbo Basalt • Troy Creek • Kintyre • Brocklehurst • Dunedoo Road • Macquarie Alluvium

3.0 Implementation Plan

STRATEGY THREE: LAND USE

Water usage and land use activities are appropriate for the soil landscape in managing urban salinity and do not contribute to an increase in the assessed salinity hazard of the landscape.

STRATEGIC OUTCOME		REQUIREMENTS		APPLICABLE HGL
3.1	The use of salinity affected land is undertaken in accordance with best practice management principles.	3.1.1	Best practise management principals are applied on land affected by salinity.	• All HGLs
3.2	Salinity risk is considered in the land use planning process.	3.2.1	Salinity risk is considered in Structure Planning of Urban Release Areas.	• Firgrove • Richmond Estate • Fitzroy Upland Alluvium • South Dubbo • Peachville • Orana Heights • West Dubbo • Dubbo Basalt • Troy Creek • Brocklehurst
		3.2.2	The impact of land use on salinity is address in strategic planning processes within the relevant Hydro-geological Landscapes.	• All HGLs
3.3	The extent to which land use activities and practises contribute to salinity hazard is understood.	3.3.2	Increase agricultural production to dry out the landscape and reduce recharge.	• West Dubbo

3.0 Implementation Plan

STRATEGY FOUR: INFRASTRUCTURE

Public and private infrastructure development and maintenance is consistent with the salinity hazard of the landscape.

STRATEGIC OUTCOME		REQUIREMENTS		APPLICABLE HGL
4.1	Construction techniques are responsive and appropriate for the salinity risk of the landscape.	4.1.1	Design, construction materials, method, depth of cut and fill and location of roads and infrastructure including underground utilities is suited to the landscape salinity hazard.	• Firgrove • Richmond Estate • Fitzroy Upland Alluvium • South Dubbo • Peachville • Orana Heights • West Dubbo • Dubbo Basalt • Troy Creek • Kintyre • Brocklehurst • Dunedoo Road • Macquarie Alluvium
4.2	Urban development on at risk landscapes specifically addresses the impacts of salinity.	4.2.1	Site specific assessment and investigation is a part of the development assessment process.	• All HGLs
		4.2.2	Existing salt affected areas are remediated and monitored as a condition of consent where determined as necessary in the site specific assessment and investigation.	• All HGLs
4.3	Existing infrastructure is maintained to minimise salinity impacts on the landscape.	4.3.1	Stormwater infrastructure is evaluated for contribution to groundwater recharge.	• All HGLs
		4.3.2	A pipe replacement program is developed where necessary to reduce input of water into the landscape.	• All HGLs

3.0 Implementation Plan

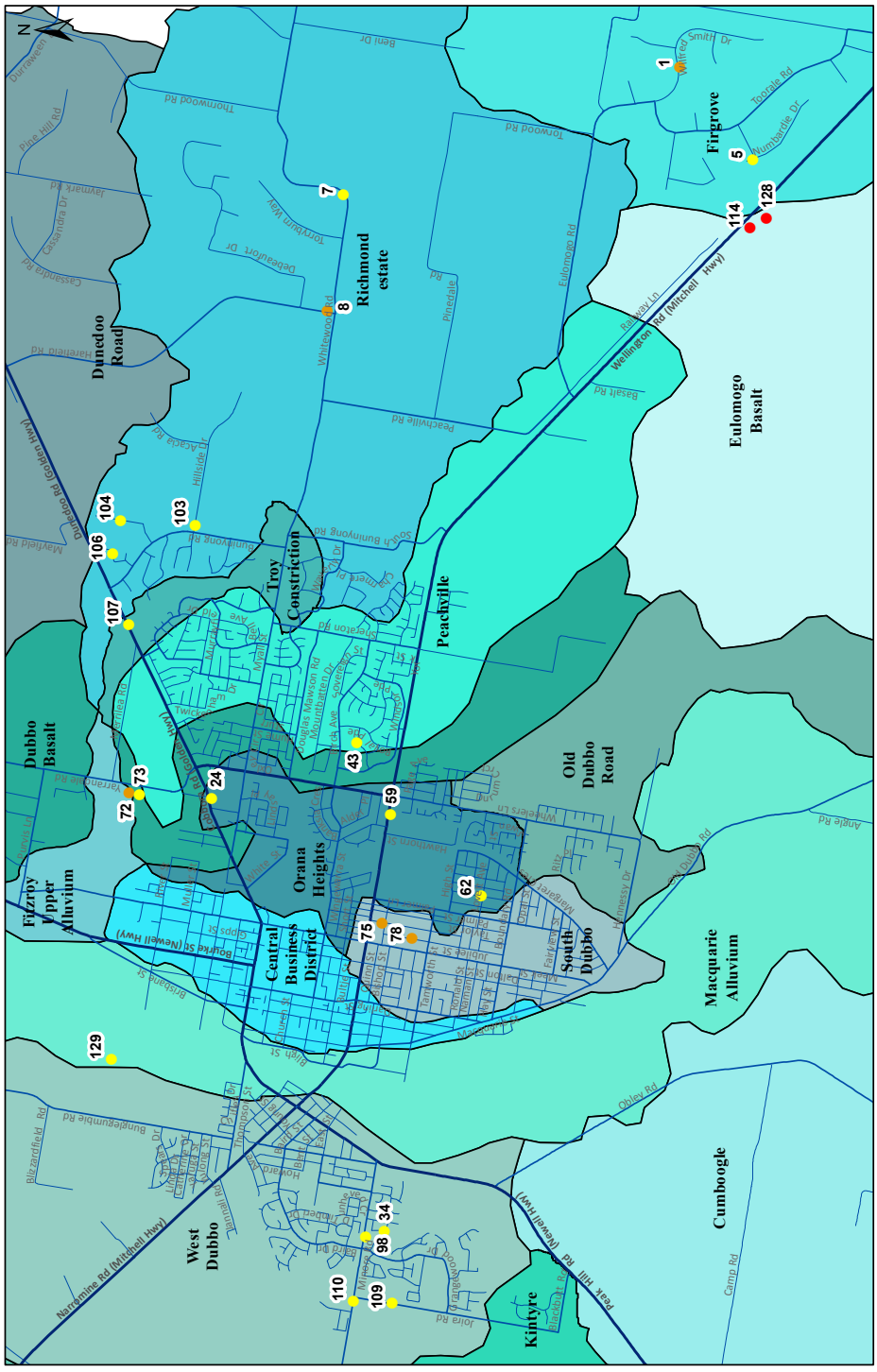
STRATEGY FIVE: MONITORING

The capacity to predict and monitor salinity impacts on land resources and biodiversity is maintained.

STRATEGIC OUTCOME		REQUIREMENTS		APPLICABLE HGL
5.1	The impacts of development on groundwater and salinity are recognised, measured and monitored.	5.1.1	Urban Investigation of areas with extreme salinity and areas that may impact on extreme areas.	• Firgrove • Richmond Estate • Fitzroy Upland Alluvium • South Dubbo • Peachville • Orana Heights • West Dubbo • Dubbo Basalt • Troy Creek
		5.1.2	Evaluation of the Urban Salinity Network; any groundwater bores which are identified to increase in salinity concern are further investigated.	• All HGLs
		5.1.3	Installation of additional groundwater bores suitable for incorporation in to the Urban Salinity Network are considered during new developments.	• Richmond Estate • West Dubbo • Peachville • South Dubbo • Troy Creek Constriction • Eulomogo Basalt • Fitzroy Upland Alluvium
5.2	The overall situation of salinity in Dubbo is understood.	5.2.1	Groundwater bore sites identified in Table 3 of the Salinity Management Strategy are further evaluated.	• Richmond Estate (GW 25) • West Dubbo (GW 34) • Peachville (GW 43) • South Dubbo (GW 78) • Troy Creek (GW107) • Eulomogo Basalt (GW 128 & GW114) • Fitzroy Upland Alluvium (GW 72)
		5.2.2	Salinity trends are monitored annually.	• All HGLs.
5.3	Groundwater modelling is provided in a spatial capacity	5.3.1	The groundwater modelling map is updated using the average SWL data calculated for each groundwater bore for the period 2009-2012.	• All HGLs.

4.0 Appendix

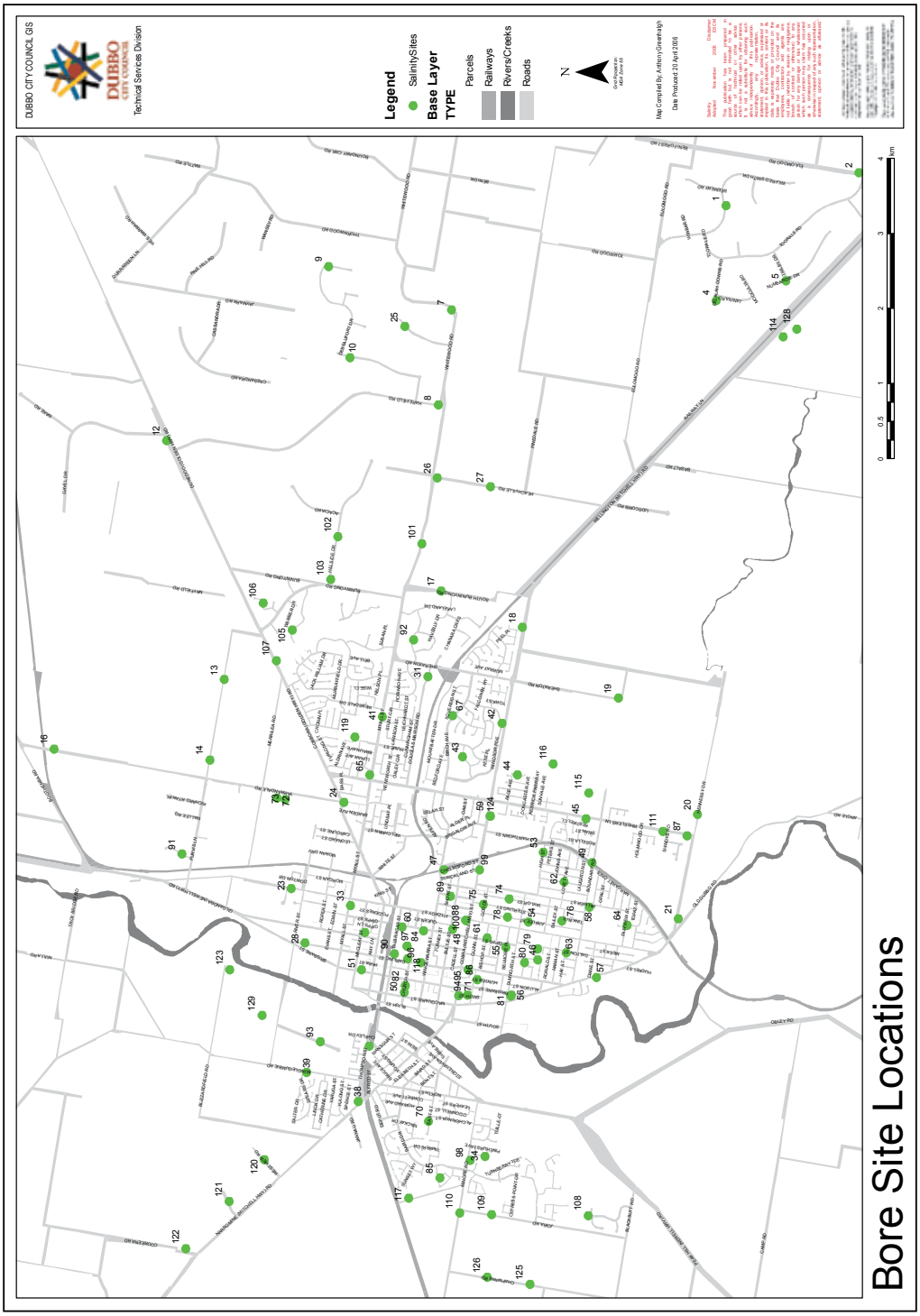
APPENIDIX A. GROUNDWATER MONITORING BORES (EXTREME, HIGH AND MEDIUM BORE HAZARD CONCERN 2009 – 2012)



Dubbo HGL & Bore Concern

4.0 Appendix

APPENDIX B. GROUNDWATER MONITORING BORES DUBBO LOCAL GOVERNMENT AREA.



4.0 Appendix

APPENDIX C. USING TRENDS IN SALINITY RISK AND SALINITY CLASS TO EVALUATE SALINITY POTENTIAL AT BORE SITES

Salinity Risk and Salinity Class are used to evaluate the Salinity potential of each monitoring bore, as detailed in the following tables.

Table 1. Guidelines on Salinity Risk Determination

Standing Water Level	Salinity Risk
0.00m-2.00m	High Risk
2.01m – 5.00 m	Moderate Risk
5.01m – 10.00m	Low Risk
>10.00	Minimal Risk

Table 2. Guidelines on Salinity Class Determination

Electrical Conductivity (dS/m)	Salinity Class
>15.00 dS/m	Extreme Salinity
6.01-15.00 dS/m	High Salinity
2.01-6.00 dS/m	Moderate Salinity
0.00-2.00 dS/m	Low Salinity

Table 3. Salinity Hazard

Salinity Risk	Salinity Class	Salinity Hazard
High	Extreme	Extreme Concern
High	High	
Moderate	Extreme	
High	Moderate	High Concern
Moderate	High	
Low	Extreme	
High	Low	Medium Concern
Moderate	Moderate	
Low	High	
Minimal	Extreme	
Minimal	High	
Moderate	Low	Least Concern
Low	Moderate	
Low	Low	
Minimal	Moderate	
Minimal	Low	

Note: The salinity class definition is for a texture compensated soil AC reading.

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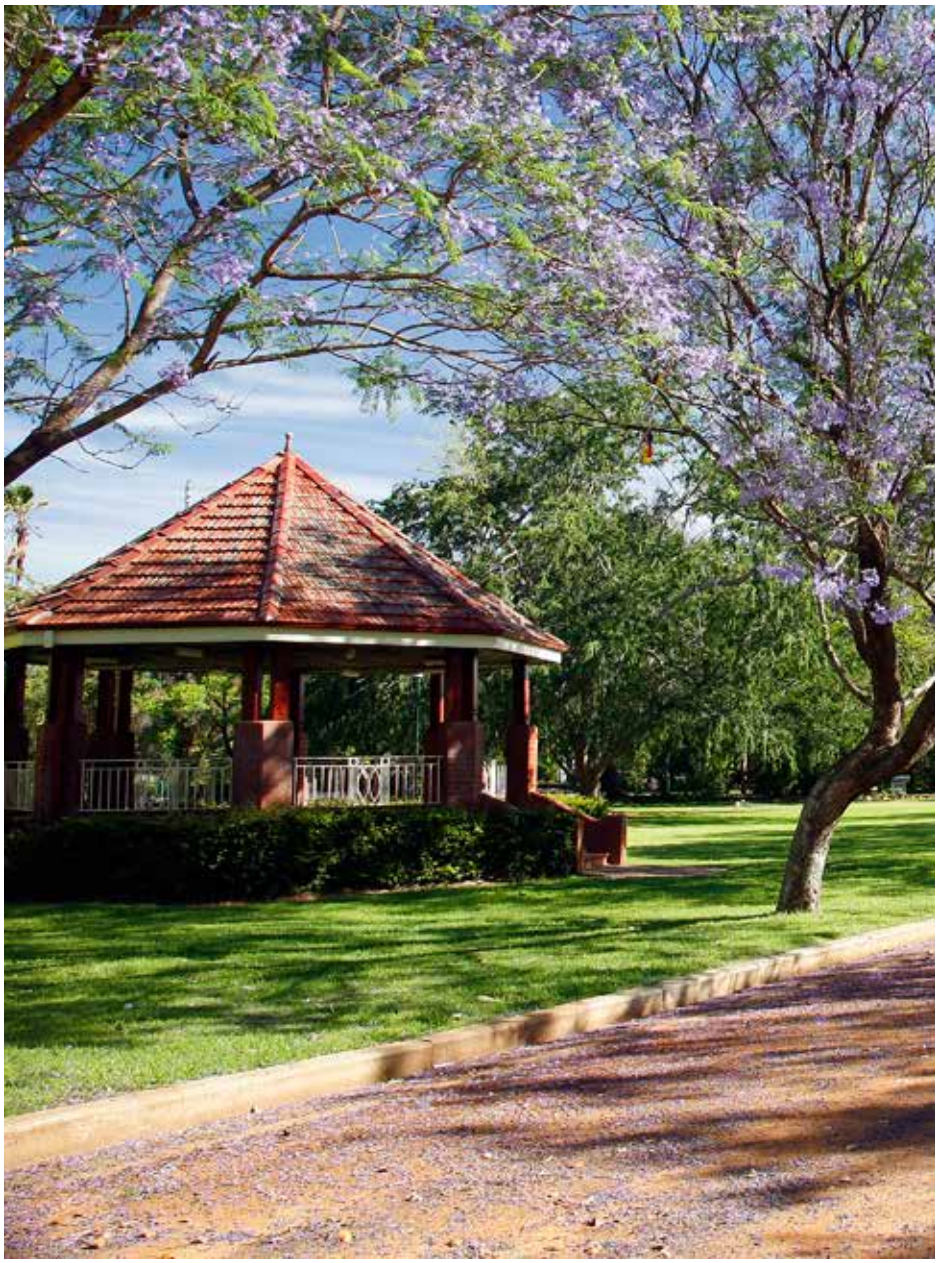

Dubbo City Urban Salinity Management Strategy

Vision

To minimise the current and future impacts of land degradation, inappropriate land use practices and climate change on production and the environmental and indigenous heritage values of land within the urban area of Dubbo.

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Part one: The Salinity Context

1.0 Introduction

Dubbo is situated in the Central West of New South Wales and is one of the largest inland cities supporting a resident population of 40,882 and a catchment area of more than 120,000 people. The main activities in the Dubbo area include construction, health care, government administration, education and training, retail, agriculture and tourism.

The Dubbo Local Government Area is located within the Macquarie – Bogan catchment and is part of the Murray Darling Basin. The Macquarie River is one of the major rivers running through the catchment. Salinity is an issue for the Local Government Area, occurring in various localised areas throughout the urban and rural landscapes. To monitor the impacts of salinity Council has established an extensive bore monitoring network consisting of 129 within the urban area. Council has also developed urban salinity hazard modelling to assess the risk of salinity to future developments.

The Salinity Management Strategy aims to minimise the current and future impacts of land degradation, inappropriate land use practices and climate change on production and the environmental and indigenous heritage values of land within the Dubbo Local Government Area.

The community's vision to prioritise environmental sustainability and management for the City was highlighted during the development of the Dubbo Community Strategic Plan 2036. The community identified the need for the principles of Ecologically Sustainable Development to be implemented, the importance of the community being supported to become environmentally sustainable and the need for the environmental impact from Council's activities and operations to be reduced in achieving these targets.

Through delivering the components of Dubbo Council's Corporate and Delivery Plan strategies, Dubbo City Council, in partnership with State Government and the community of Dubbo aims:

- To promote an integrated landscape management approach to urban salinity management consistent with the principles of ecologically sustainable development.
- To manage the collection and use of reliable baseline data to quantify the saline status and ensure future monitoring, management and planning is adequate, effective, scientifically justified and cost effective.
- To ensure that urban salinity identification, management and education is in accordance with best practice and is central to sound, responsible environmental and land use planning.

Part one: The Salinity Context

The Salinity Management Strategy has been developed with an aim to minimise the current and future impacts of land degradation, inappropriate land use practices and climate change on production and the environmental and indigenous heritage values of land within the Dubbo Local Government Area.

Council has significant knowledge in the location, extent and spatial implications of urban salinity in the Dubbo Local Government Area due to the bore monitoring network, ongoing research investigations and community involvement. The Strategy will provide for the ongoing monitoring and management of salinity which will contribute to increasing the understanding of salinity within the urban area of Dubbo and allow the impacts of salinity to be minimised, particularly within the landscapes most at risk of impact by salinity.

The Strategy structures the factors of urban salinity into individual strategies and provides strategic outcomes as a basis for salinity management.

The Salinity Management Strategy incorporates the following individual strategies:

1. **Salt impact** – The type and quantity of salt present within the landscape is managed.
2. **Groundwater Recharge** – The amount of water mobilising and concentrating salts in the landscape is managed.
3. **Land use** – Use of the landscape and associated practises consider and manage salinity processes.
4. **Infrastructure** – Construction materials and methods are suited to the salinity hazard of the landscape.
5. **Monitoring** – Ongoing investigation and management of salinity processes and impacts.

The Strategy will act as the main planning tool for salinity management, guiding salinity management actions. Salinity management actions will be applied to the priority Hydro-geological Landscapes (HGLs), identified in the Dubbo Urban Landscapes Interpretation Project which was carried out in 2010. The priority HGL are those landscapes that contribute significantly to rising salinity, locations that are important in the functioning and our understanding of salinity processes in the urban area and those areas that are significant in order to protect local assets and values. These HGLs are detailed in the Implementation Plan.

The Implementation Plan sets out the actions and tasks for achieving the strategic objectives under the individual strategies, as listed above. The management actions are allocated to specific hydro-geological landscapes with the aim to address the areas that are most at risk of salinity.

Part one: The Salinity Context

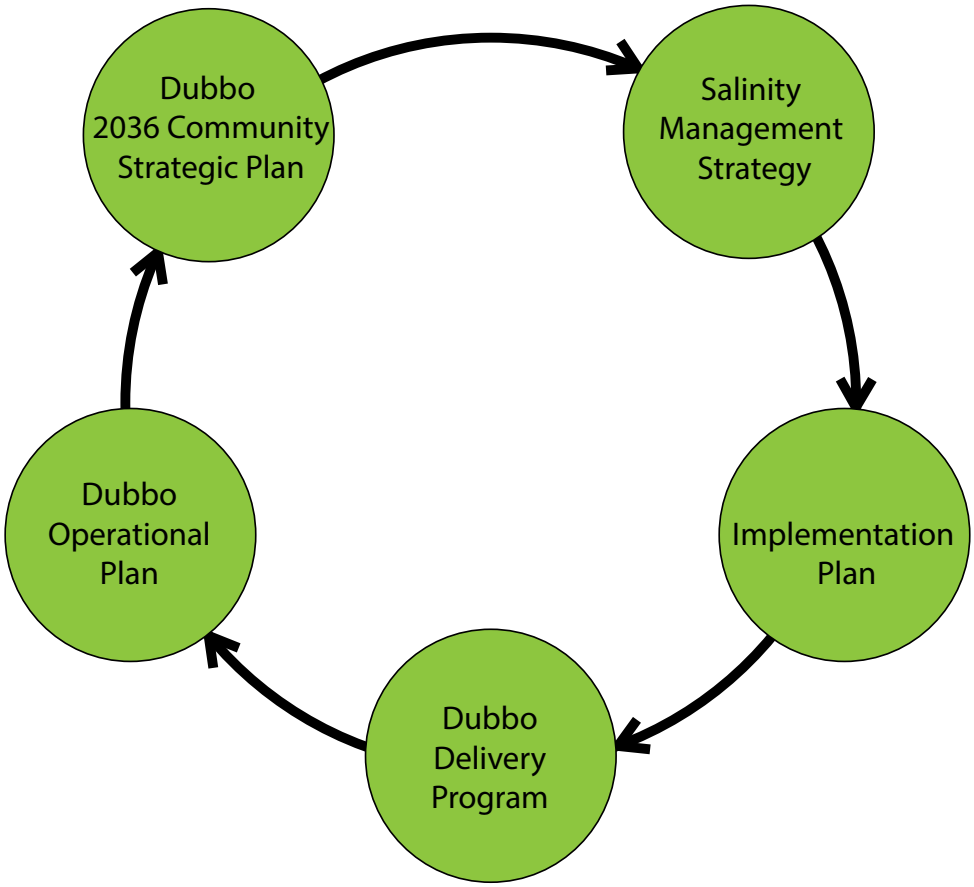
1.1 Relationship with Other Plans

Community Strategic Plan

The Dubbo 2036 Community Strategic Plan (CSP) was originally adopted in June 2012, as the new planning and reporting framework for Council. The Salinity Management Strategy is designed to support the achievement of numerous CSP outcomes ensuring environmental sustainability is a priority in the management of built and natural assets within the City.

The Community Strategic Plan provides a number of themes relating to strategic goals for future urban development and management. Each theme has specific aspirations or outcomes that also provide guiding principles for the Salinity Management Strategy. Figure 1 shows the link between the Salinity Management Strategy, Salinity Management Implementation Plan and Dubbo 2036.

The community requirements identified in the CSP will continue to guide the direction and scope of this Strategy. Dubbo 2036 is required to be reviewed every four (4) years or within 12 months of the election of a new Council. The Salinity Management Strategy will be reviewed in line with a review of Dubbo 2036 and will include any new principles the community identifies as being important in the future conservation, growth and development of the Dubbo's urban area.



Part one: The Salinity Context

The Salinity Strategy will support the achievement of numerous Strategic Outcomes within Council's planning framework, as outlined in Table 1.

Table 1. Salinity Strategy Delivery of Strategic Outcomes

Plan	Theme	Strategic Outcome
Dubbo Community Strategic Plan	Our Place	2.1 Environmental Sustainability and Management is a priority for the City
		2.2 Land use management to improve and to sustain the City's built and natural environment.
		2.3 Dubbo's rural areas continue to have the capacity to be a significant contributor to the local, regional and national economy.
		2.4 Sufficient residential, industrial, recreational, commercial and institutional land zones are available to meet business, retails and lifestyle needs.
	Our Infrastructure	3.2 The Dubbo community has a high standard of living through the provision of a superior water supply
	Our Leadership	5.3 Sound management of the resources of Council is undertaken
		5.4 Statutory requirements are met and services are provided to the organisation in a cost effective and timely manner.
Dubbo ALIVE	Land	2.1 Identify, protect, enhance and actively manage priority soil landscapes, environmentally sensitive areas and salinity impacts.
Dubbo Local Environmental Plan 2011	Aims to ensure development and land management practises do not further exacerbate the impact of urban salinity or result in new salinity outbreaks.	
Dubbo Development Control Plan	Aims to ensure development does not exacerbate the incidence of urban salinity; does not increase the risk of urban salinity; that incompatible development is not located in areas at risk of salinity; that suitable construction materials are used that will withstand salinity; that the impact of urban salinity on private and public infrastructure is minimised and that the development of land is undertaken in a manner which will facilitate the rehabilitation of any identified salinity outbreak.	

Part one: The Salinity Context

1.2 Understanding Urban Salinity

Salinity is term used to define the accumulation of salt in land and water to a level that impacts on the natural and built environment. While the term Salinity is used to describe the processes and impacts associated with the interaction of salt and water in a landscape, it is also used to describe the measure of salt in soil or water.

Salt is a naturally occurring mineral which is produced through the weathering of rocks, particularly marine sedimentary rocks. Salt may be carried inland from marine environments with wind and dispersed on the soil surface. Salt deposits on soil may be buried, but later exposed by erosion or mobilised by groundwater.

The Australian landscape contains large amounts of salt from the ocean, introduced through rainfall and the chemical weathering of rock. Clearing of native vegetation for urban development facilitates an increase of rainfall seepage into the groundwater systems of these landscapes, which causes the water tables to rise and brings saline ground water close to the land surface.

Water entering the soil through processes of irrigation as well as diversion and detention of stormwater can impact on soil and water processes and can contribute to urban salinity. The impacts of household irrigation of gardens as well as pipe leakage, sewer losses, rubble pits, stormwater inputs, and irrigation of sporting fields and parks are identified as significant in contributing to urban salinity.

Figure 2. shows how changed environmental conditions may alter the groundwater level through increased infiltration (input) and reduced transportation (output) increasing the exposure of salt to the soil surface.

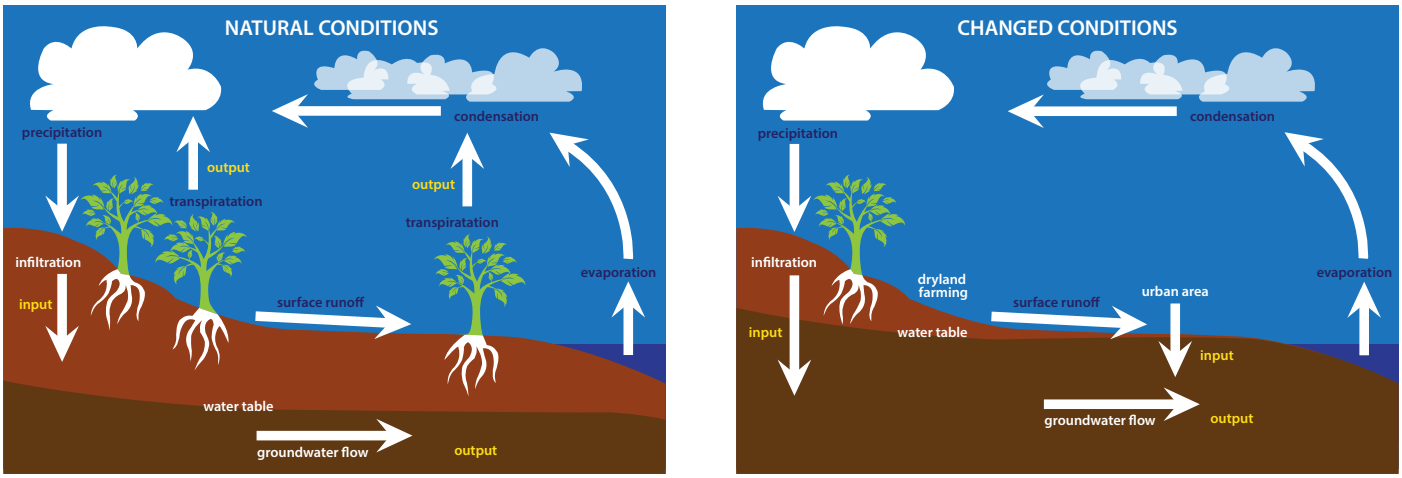


Figure 2. The Salinity Process

Part one: The Salinity Context

1.3 Salinity Snapshot

1.3.1 The local setting

Urban Salinity is evident across Dubbo in various localised areas causing significant damage to homes, vegetation, water quality, infrastructure and amenities. It is often very site specific and occurs as a result of a very complex relationship between soil, surface water, ground water, climate, geology, water balance, vegetation, land use history, management and development. A number of sites have been identified, showing visual indicators of urban salinity including salt precipitate on soil surface, loss of vegetation, bare or damp soil, damage to brickwork, road damage and high or rapidly fluctuating water tables.

The physical and chemical properties of soil play a major role in the development of urban salinity in the Dubbo area. The local geological formations of the Dubbo area are include a mixture of flat lying sediments, intrusive units, tertiary basalts and quaternary alluvium. The geological influences and inter-relationships strongly determine the salinity situation of the area.

Further, the accessibility of water in Dubbo due to its proximity to the Macquarie and Talbragar Rivers, has allowed significant application of water to residential areas over a significant period of time. This is identified as having a significant contribution to the urban salinity issue within Dubbo.

The Dubbo Urban Landscape Interpretation Project, undertaken in April 2010 identifies the following as the key causes of salinity in the wider Dubbo area:

- Changes in water balance;
- Sources of salt and redistribution in the landscape;
- Varieties of groundwater processes;
- Dry scald which expose salinity soils.

The Project contributes the increased occurrence of salinity in Dubbo to:

- A decrease in deep rooted vegetation;
- Over irrigation of crops, improved pastures and private gardens and lawns;
- Alteration of natural drainage patterns by the construction of houses, roads, railways and channels;
- Creation of wet zones of waterlogged soil by impeded drainage;
- Leaking standing water bodies, pools, lakes and service pipes;
- Expose of susceptible soils;
- Irrigation of sports grounds, golf courses, parks and gardens.

Part one: The Salinity Context

1.3.2 History of Salinity Management in Dubbo

Council has engaged in various landscape investigations across the Dubbo Local Government Area since 1995 and specifically in response to the recognition of significant salinity in the Troy Gully area in 1994. A report to Council, detailing the findings of an initial site inspection of the Troy Gully area (1994) is recorded as the first identification of urban salinity in Dubbo.

Council took a proactive approach to the collection of background data, providing an increase in the understanding of cause and effect, the geological situation and the impacts of urban salinity in the area with the formation of the 'Troy Gully Urban Salinity Working Group' and recent completion of the Dubbo Urban Salinity Landscape Interpretation Project.

Through the extensive investigative work carried out over time and through a range of seasonal patterns and through changes in land use, Council has gained a significant level of understanding in regards to the location, extent and spatial implications of urban salinity management. Notably, the Dubbo Urban Landscape Interpretation Project and Groundwater Monitoring Network have provided significant data contributing to the current understanding of urban salinity within Dubbo.

Dubbo Urban Landscape Interpretation Project (April 2010)

The Dubbo Urban Landscape Interpretation Project was initiated by Council in 2010 with a purpose to interrogate, interpret, model and review existing data to produce outputs and products, to further enhance the understanding of urban salinity in the Dubbo context. The key areas of work included in the project are as follows:

- Detailed soil/texture map for the Dubbo area, utilising the data from the construction logs of the peizometers established across Dubbo;
- Development of a depth to bedrock map for the Dubbo urban area, utilising data from the construction logs of the peizometers established across Dubbo;
- Development of Hydro-geological Landscapes (HGLs) for the Dubbo urban area;
- Detailed analysis of the Victoria Park Project;
- Modelling of groundwater using time series data to develop and understanding of groundwater and salinity through time and across the City;
- Development of a Salinity Risk and prediction map for the Dubbo Urban area.

The Hydro-Geological Landscapes developed as part of the project are incorporated in the Strategy as a means of allocating and prioritising actions for salinity management. As part of the Dubbo Urban Landscape Project, the HGLs were developed based on the geology and groundwater characteristics of the various landforms present in the urban area. A map identifying the boundaries of each of the Hydro-geological landscapes is shown as Figure 3.

The salinity hazard for each landscape was assessed based on salt impact, salt load export impact and impact on water quality. Table 2 details each Hydro-geological Landscape and the assessed salinity hazard (April 2010).

The Salinity Implementation Plan delivers actions specific to the Hydro-geological Landscapes with a focus on addressing the salinity hazard in the landscapes identified with an overall hazard of Very High, High or Medium. Further, the actions address bore sites determined as extreme, high and medium based on water quality and groundwater height over the period 2009 to 2012, as assessed by the Impax Group in February 2013 as part of the annual monitoring of the Urban Salinity Network.

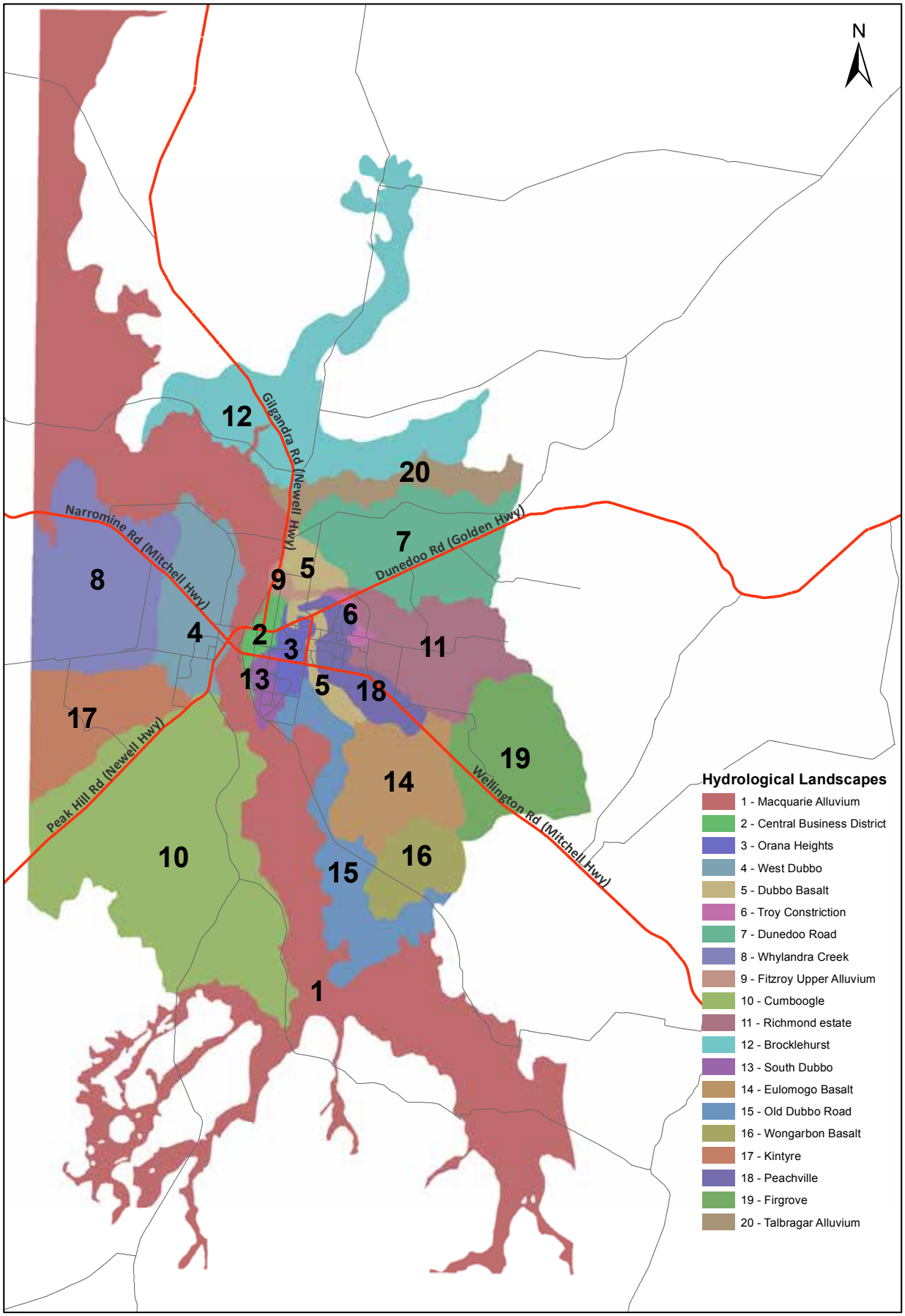
Part one: The Salinity Context

Table 2. Dubbo Urban Areas Hydro-geological Landscapes (April 2010)

Hydro-geological Landscapes		Land Impact	Salt Load Export Impact	Impact on Water Quality	Overall Hazard
1	Macquarie Alluvium	Low	Moderate	Low	Medium
2	Central Business District	High	High	High	Very High
3	Orana Heights	High	Moderate	Moderate	High
4	West Dubbo	Moderate	Moderate	Moderate	Medium
5	Dubbo Basalt	Moderate	Moderate	Low	Medium
6	Troy Creek Constriction	High	High	High	Very High
7	Dunedoo Road	High	Moderate	High	High
8	Whylandra Creek	Low	Low	Low	Low
9	Fitzroy Upland Alluvium	High	High	Moderate	High
10	Cumboogle	Moderate	Low	Low	Low
11	Richmond Estate	Moderate	High	High	High
12	Brocklehurst	Moderate	Moderate	Moderate	Medium
13	South Dubbo	High	Moderate	Moderate	High
14	Eulomogo Estate	High	High	High	Very High
15	Old Dubbo Road	Low	Moderate	Low	Low
16	Wongarbon Basalt	Low	Low	Low	Very Low
17	Kintyre	Moderate	Moderate	Moderate	Medium
18	Peachville	Low	Moderate	Low	Low
19	Firgrove	Low	Moderate	Low	Medium
20	Talbgagar Alluvium	Low	Moderate	Moderate	Low

Part one: The Salinity Context

Figure 3. Dubbo Hydro-geological Landscapes



Part one: The Salinity Context

Groundwater Monitoring Network (October 2004)

The Groundwater Monitoring Network was initiated in October 2004 and established 129 bores, of which 110 have been converted to long term monitoring bores with the dual purpose of sampling monthly for standing water level (SWL) and salinity (EC). The location of Groundwater Monitoring Bores with the Dubbo Local Government Area is attached as Appendix B.

The Groundwater Salinity Monitoring Network is a valuable resource in documenting soil factors, depth to rock, shallower water table assessment and soil salinity profiles through detailed profile descriptions throughout the Dubbo urban area.

The Project assists Council in meeting the objectives of its strategic plans by targeting, monitoring and providing the baseline trend analysis data for scientifically supporting the strategic management of urban induced salinisation and identifying areas of naturally occurring salinity. Data collection is ongoing and allows Council to monitor the changes in groundwater resulting from changes in land use practices over time. It also allows Council to identify specific salinity management requirements for urban expansion areas and on future development areas.

The Groundwater Monitoring Network assists Council with:

- Strategic Planning
- Development assessment
- Assisting private developers through the provision of baseline data for strategic assessment and planning
- Assisting the community in the better management and protection of the built and natural environment of the City
- Infrastructure planning and maintenance

The Groundwater Monitoring Network assists in the preparation of the following information:

- Identification of naturally saline areas (groundwater and/or soils)
- Identification of shallow water tables
- Identification of urban development induced salinity
- Monitoring of the impacts of changed land use practices on groundwater
- Creation of baseline data for trend analysis over time
- Creation of baseline data for areas zoned for future development
- Creation of data for determining:
  - groundwater flow rates and directions
  - groundwater lateral and vertical head distributions
  - hydraulic gradients within single and between layered aquifers
- Creation of baseline scientific data to generate strategic planning tools including:
  - maps identifying areas of existing salinity
  - maps of areas with a potential salinity threat
  - maps of salinity sensitive lands
- Definitions for information for inclusion with development applications
- Community education of the impacts of land management techniques on salinity
- Community education of the impacts of land management techniques on groundwater
- Sufficient data to support environmental monitoring of groundwater

Part one: The Salinity Context

In February 2013, Council commissioned an evaluation report of the Program including a data audit and salinity risk and class of each groundwater bore for the period 2009-2012. The evaluation included an audit of the groundwater bore data for the period 2009-2012. The average annual level of salinity risk and class were assessed to determine annual trends by comparing average annual data for the period. Appendix A details the groundwater bore sites identified with extreme, high or medium concern salinity hazard trends within the associated Hydro-geological Landscapes.

- 132 groundwater bores were monitored monthly for standing water level (SWL) and electrical conductivity (EC) for the period 2009-2012;
- For the period 2009-2012, the salinity hazard trends were as follows:
  - Extreme Concern – 2 groundwater bores (1.5% of total);
  - High Concern – 6 groundwater bores (4.5% of total);
  - Medium Concern – 21 groundwater bores (15.9% of total); and
  - Least Concern or dry/excluded – 103 groundwater bores (78.1% of total).
- Groundwater data was generally consistent with assessed HGL salinity hazards and modelled SWLs, and
- Groundwater bores that had a higher salinity hazard trend than their assessed HGL salinity hazard were GW 1 (Firgrove HGL), GW T302, GW 43, GW T303 and GW T307 (Peachville HGL).

The Evaluation Report made policy recommendations and actions and provided management directions for salinity. The Implementation Plan supports the recommendations of the Evaluation Report which actions strategies at groundwater bores with extreme, high and medium concern salinity hazard trends. Groundwater bore sites with an extreme, high or medium concern salinity hazard trend over the period 2009-2012 are located in the HGLs detailed in Table 3.

The HGLs identified in Table 3 are commonly identified as having a significant overall salinity hazard. The Peachville HGL is an exception, as it has a low overall salinity hazard concern though contains one bore identified as high and three bores identified as medium concern. This is an example of how one HGL and influence another.

Peachville has salt stores in the soil profile and ground water is generally deep, this will impact adjoining downstream units.

Accordingly, while the groundwater is saline it may not be at a depth that has the potential to cause salinity impacts within the HGLs itself, but rather in other HGLs.

Table 3. Extreme, High, Medium Concern Bore Sites (2009-2012)

Hydro-geological Landscape		Bore ID	Bore Monitoring Assessment
3	Orana Heights	GW24	Medium
		GW59	Medium
		GW62	Medium
4	West Dubbo	GW34	Medium
		GW85	Medium
		GW98	Medium
		GW109	Medium
		GW110	Medium
5	Dubbo Basalt	GW73	Medium
6	Troy Creek Constriction	GW107	Medium
		GW T129	Medium
		GW T130	Medium
		GW T132	Medium
9	Fitzroy Upland Alluvium	GW72	High
		GW T103	Medium
		GW T104	Medium
11	Richmond Estate	GW8	High
		GW7	Medium
		GW106	Medium
13	South Dubbo	GW75	High
		GW78	High
14	Eulomogo Basalt	GW114	Extreme
		GW128	Extreme
18	Peachville	GWT302	High
		GW43	Medium
		GW T303	Medium
		GW T307	Medium
19	Firgrove	GW1	High
		GW5	Medium

Part one: The Salinity Context

1.3.3 Cost of Salinity

A report commissioned by Dubbo City Council in 2003, 'Audit of current impacts and costs of dryland and urban salinity in the Dubbo LGA', detailed an estimated cost of $7.47M per annum for both urban and dryland salinity within the Dubbo Local Government Area as follows:

- Rural and urban households ($4.94M per annum)
- Commerce and Industry ($1.94M per annum)
- Dryland agricultural producers ($671,150 per annum)
- Local Government ($379,130 per annum)
- State Government agencies and infrastructure based utilities ($546,110 per annum)

While the costs to roads and infrastructure are not fully realised, it is estimated that the repair and maintenance costs for urban roads was $2,400 per kilometre per year.

1.3.4 Salinity as a regional issue

Salinity has been recognised as a critical environmental issue in the Central West of NSW for over 80 years. As a fundamental land management issue, salinity has been the focus of government agencies, organisations and the community, increasing the opportunities available to further explore the salinity situation.

In March 2000, the New South Wales Government hosted a Salinity Summit in Dubbo to discuss the regional issue of salinity with key stakeholders including land managers, scientists, conservationists and representatives from indigenous groups and government bodies. In a response to the Summit recommendations the NSW Government prepared 'Taking on the challenge: NSW Salinity Strategy'. The Strategy is a long term commitment to slow down the increase in salinity within the State.

In addition, the 'Basin Salinity Management Strategy 2001-2015' was prepared by the Murray Darling Basin Authority to guide communities and Government in working together towards salinity management within catchments. The Strategy establishes clear end-of-valley salinity targets for each tributary valley within the Murray-Darling Basin system.

The Central West Local Land Service (CWLLS) is a statutory authority reporting directly to the Minister for Primary Industries, responsible for the management of natural resources, decision making and investment within the catchment.

The CWLLS strategic direction is provided by two key documents, the 'Strategic Plan' providing broad direction towards June 2015 and the 'Central West Catchment Action Plan' directing natural resource management outcomes towards 2021. This Strategy has been developed to integrate and support these overarching planning documents.

Salinity management is a major natural resource management objective of the Central West Local Land Services. Council currently maintains an active ongoing relationship with the Central West Local Land Services and is a member of the Salinity and Water Quality Alliance which is coordinated by the CWLLS.

Part one: The Salinity Context

2.0 Strategic Vision

To minimise the current and future impacts of land degradation, inappropriate land use practices and climate change on production and the environmental and indigenous heritage values of land within the urban area of Dubbo.

Council has significant knowledge in the location, extent and spatial implications of urban salinity in the Dubbo Local Government Area due to the bore monitoring network, ongoing research investigations and community involvement. The Strategy will provide for the ongoing monitoring and management of salinity which will contribute to increasing the understanding of salinity within the urban area of Dubbo and allow the impacts of salinity to be minimised, particularly within the landscapes most at risk of impact by salinity.

2.1 Strategic Framework

This Strategy structures the factors of urban salinity into individual strategies and provides strategic outcomes as a template for salinity management. The individual strategies address:

1. Salt impact – The type and quantity of salt present within the landscape.
2. Groundwater Recharge – The amount of water mobilising and concentrating salts in particular areas of the landscape.
3. Land use – Use of the landscape and associated practises.
4. Infrastructure – Construction material and method used and maintenance of infrastructure.
5. Monitoring –Further investigation and management.

The Strategy will act as the main planning tool for salinity management, guiding salinity management actions. Salinity management actions will be applied to the priority Hydro-geological Landscapes (HGLs), identified as the landscapes that contribute significantly to rising salinity, locations that are important in the functioning and our understanding of salinity processes in the LGA and those areas that are significant in order to protect local assets and values. The groundwater bore sites prioritised in this context include those with extreme, high and medium concern salinity hazard trends (2009-2012) and those within the Central Business District HGL.

The Implementation Plan sets out the actions and tasks for achieving the strategic objectives under the individual strategies, as listed above. The management actions are allocated to specific hydro-geological landscapes with the aim to address the areas that are most at risk of salinity. The landscapes that are most at risk of salinity are defined as the HGLs identified with an overall hazard of Very High, High or Medium (April 2010) as detailed in Table 2, and includes the Macquarie Alluvium, Central Business District, Orana Heights, West Dubbo, Dubbo Basalt, Troy Creek Constriction, Dunedoo Road, Fitzroy Upland Alluvium, Richmond Estate, Brocklehurst, South Dubbo, Eulomogo Estate, Kintyre, and Firgrove HGLs.

Part two: Strategy

STRATEGY ONE: SALT IMPACT

To ensure the salt impact on the landscape is minimised and managed.

Rationale

The term Salinity is used to describe the processes and impacts associated with the interaction of salt and water in a landscape. It is also used to describe the measure of salt in soil or water.

Excess salt within a landscape can cause damage to infrastructure, impact on plant communities leading to further soil degradation, reduce water quality and damage building materials and urban infrastructure.

Where salinity is present within the landscape, or where site investigations have established a high level of electrical conductivity in the soil or groundwater, action is required to reduce the impacts of salt.

Strategic Outcomes

1.1	**The discharge of salt into the groundwater system, river and streams is minimised.** Employment of salt interception schemes and discharge management contribute to effectively minimise the introduction of salt into the landscape and water system. The discharges of saline water will be minimised through the implementation of these principles.
1.2	**Salt stores are buffered to limit their interaction with shallow groundwater.** Salt may exist within the landscape as a deposit or store from a previous land use. Salt stores interact with shallow groundwater in the colluvial elements of the Firgrove, Richmond Estate and Fitzroy Upland Alluvium Hydro-Geological Landscapes. Within these landscapes the salt stores comprise a significant percentage of the area. Strategic planting of a vegetation buffer around the salt stores can limit the salinity impact through managing the interaction of the salt with shallow groundwater.

[1] Loose earth material of all sizes that accumulate at the bottom of slopes

Part two: Strategy

STRATEGY TWO: GROUNDWATER RECHARGE

The volume of water with the potential to enter into and contaminate the natural system is minimised.

Rationale

All water entering the water table is referred to as recharge. Groundwater receives recharge from rainfall, rivers, lakes, valleys and is affected by flooding, irrigation and leakage from stormwater, sewer and water supply systems.

Urban development has a significant impact on the groundwater system and recharge through interference with the natural movement of water above and below the soil; removal of vegetation can result in less transpiration and increased infiltration, installation of impervious surfaces can decrease evaporation and the compaction of soil for development alters decreases the void spaces between soil particles affecting the speed and direction of water movement.

The recharge of the water table and its rise is followed by increased rates of evaporation and therefore an increase in salt concentration. Further, a higher water table can mobilise salt stores that were previously deposited in the landscape and transport them to a discharge area in the lower elements of a landscape.

Dubbo is characterised by a shallow groundwater environment in which the management of water input in to the groundwater system is vital for salinity management. The water table will rise and fall in response to an increase or decrease in recharge, therefore reductions in recharge can have major impact on the water table and on salinity processes within Dubbo.

Strategic Outcomes

2.1	Lateral flow of shallow groundwater is intercepted and reduced.
2.2	Excess soil moisture within the landscape is utilised. Maximising plant growth and water use is effective in order to use existing excess soil moisture and shallow groundwater. Further, vegetation can act as a buffer to groundwater accessions in wet seasonal conditions.
2.3	Ponding of water on discharge sites is minimised.
2.4	Discharge to the groundwater system is minimised. Vegetation can act as a buffer and plays a vital role in managing excess water input in to the groundwater system.
2.5	Discharge of water into the landscape is minimised

Part two: Strategy

STRATEGY THREE: LAND USE

Water usage and land use activities are appropriate for the soil landscape in managing urban salinity and do not contribute to an increase in the assessed salinity hazard of the landscape.

Rationale

The land use processes occurring within a landscape influence the interaction of salts and water and can result in the expression of salinity. Landscapes exhibit different symptoms as a result of salinity and may respond to the changes at different rates. Further, the location of the impact may not be within close proximity of the cause, dependant on the landscape characteristics.

Urban land use has a significant influence over the natural movement of water above and below the soil and plays a significant role in the development of salinity; removal of vegetation can result in less transpiration and increased infiltration, installation of impervious surfaces can decrease evaporation and the compaction of soil for development alters decreases the void spaces between soil particles affecting the speed and direction of water movement.

Effective planning of land at risk of salinity and land affected by salinity is vital to the sustainability of the landscape. Land use planning must consider the interaction between land use and geology.

Strategic Outcomes

3.1	The use of salinity affected land is undertaken in accordance with best practice management principles.
3.2	Salinity risk is considered in the land use planning process.
3.3	The extent to which land use activities and practises contribute to salinity hazard is understood.

Part two: Strategy

STRATEGY FOUR: INFRASTRUCTURE

Public and private infrastructure development and maintenance is consistent with the salinity hazard of the landscape.

Rationale

The development of infrastructure including roads, railway, buildings and services can act as barriers to water movement within the landscape. The compaction of soil for development further impacts on the landscape through decreasing the void spaces between soil particles affecting the speed and direction of water movement.

Infrastructure within a saline environment is impacted by salinity through decomposition of building materials, weathering of roads and decay of stormwater and sewer servicing pipes.

Management strategies are required to minimise the impact of infrastructure construction on salinity and the impacts of the saline landscape on infrastructure.

Strategic Outcomes

4.1	Construction techniques are responsive and appropriate for the salinity risk of the landscape. The National Construction Code enables the achievement of nationally consistent, minimum necessary standards providing a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia. It allows for variations in climate and geological or geographic conditions.
4.2	Urban development on at risk landscapes specifically addresses the impacts on salinity.
4.3	Existing infrastructure is maintained to minimise salinity impacts on the landscape and ongoing maintenance requirements.

Part two: Strategy

STRATEGY FIVE: MONITORING

The capacity to predict and monitor salinity affected land resources and biodiversity is maintained.

Rationale

To effectively manage salinity, it is vital to understanding the overall situation in the region and the process and interactions within the landscapes influencing the movement of salt causing the saline environments.

Ongoing monitoring is required to further understand the salinity within the Dubbo Hydro-geological Landscapes and the interaction between land use practises within landscapes and the resulting salt and water impacts in other landscapes.

Further monitoring and investigation is an ongoing priority for salinity management in the Dubbo Local Government Area. The processes for monitoring actions and evaluating performance are contained within Part Three: Monitoring Performance of the Salinity Management Strategy.

Strategic Outcomes

5.1	**The impacts of development on groundwater and salinity are recognised, measured and monitored.** The landscapes of Dubbo contain significant salinity and geological situations that predispose salinity development. Assessment of the location, intensity and scale of salinity is important in managing salinity in the landscape.
5.2	**The overall situation of salinity in Dubbo is understood.**
5.3	**Groundwater modelling is provided in a spatial capacity.**

Part three: Monitoring and Evaluation

3.0 Monitoring Salinity Targets and the Impact of Actions

Monitoring salinity targets involves the observation and recording of data that compares performance against baseline indicators. Council maintains the Urban Salinity Monitoring Network as a means of targeting, monitoring and providing baseline and trend analysis data for the strategic management of urban inducted salinisation in the Dubbo Urban Area.

Council maintains salinity monitoring through monthly sampling for each of the groundwater network bores Standing Water Level (SWL) and Electrical Conductivity (EC). The first round of monitoring was conducted on 26 March 2005 and is used as baseline data for the network.

Monitoring the impact of actions across time and through varying climatic conditions requires the consideration of external factors, including changes in the extent and condition of native vegetation and changes in land management practises. Accordingly, additional data is required to support the groundwater salinity monitoring to adequately monitor the impact of salinity targets and actions. In previous studies climatic conditions obtained from the Bureau of Meteorology and household water consumption rates captured through Councils water billing system have been utilised as additional data sources.

The Central West Local Land Services, the Office of Environment and Heritage and the Office of Water monitor rural salt affected land and waterways as the responsible statutory authorities for natural resource management in New South Wales.

3.1 Evaluating Performance

Performance targets and strategic outcomes will be set in Councils Delivery and Operational Plans to guide the allocation of actions included in the Implementation Plan for each HGL. The actions and will be periodically evaluated through an analysis of bore monitoring data in association with social and economic data to determine the success or otherwise of the actions meeting the performance targets and strategic outcomes.

A number of external factors can influence the performance of set actions including land use management decisions, the financial capacity of land managers and unexpected actions in the catchment, including weather, impacting on salinity. Further, the mix of actions selected to meet targets may have a smaller impact than predicted or be delayed in influencing the salinity hazard in the area.

Part three: Monitoring and Evaluation

3.2 Recording Data and Periodic Review

To progressively improve performance, it is necessary to evaluate data periodically and review recommended actions. Council maintains the groundwater salinity monitoring network as a means of monitoring and providing baseline and trend analysis data for the strategic management of urban inducted salinisation in Dubbo. Periodic reviews of the network data are undertaken and reported in accordance with the commitments in Council's strategic framework.

Table 2. Periodic review of progress towards Strategic Outcomes

Frequency	Report	Description
At least every six months	Progress Reports on Delivery Program 2013-2017	Report on progress with respect to the principles activities detailed in the Delivery Program
Annually (March)	Action of Delivery Program 2013-2017	Report on monitoring of the groundwater network
Annually (June)	Action of the Delivery Program 2013-2017	Review of the groundwater monitoring network in respect of salinity impacts on public open space
Annually (September)	Annual Report	Report provided to the community on Council's progress in the delivery of Dubbo 2036
Annually (October)	Annual Report	Annual report to the General Manager on progress with Dubbo 2036
Annually (November)	State of the Environment Report and Annual Dubbo Snapshot	Report on environmental issues. Every four years a comprehensive report is prepared in accordance with the Local Government Act 1993 guidelines.
Four Yearly (November)	End of Term Report	Report on Council's achievements in implementing the CSP over the previous four years.