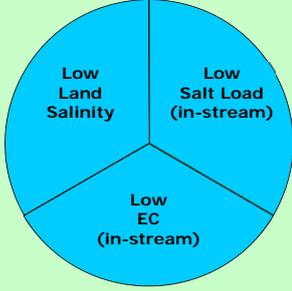


13. Lanyon Hydrogeological Landscape

LOCALITIES	Tharwa, Banks, Gordon, Lanyon Homestead	
MAP SHEET	Canberra 1:100 000 Michelago 1:100 000	
CONFIDENCE LEVEL	Moderate	

OVERVIEW

The Lanyon Hydrogeological Landscape (HGL) extends over mixed geologies from Tharwa in the south to Bullen Range in the north (Figure 1). The HGL covers an area of 68 km² and receives 600 to 850 mm of rain per annum.

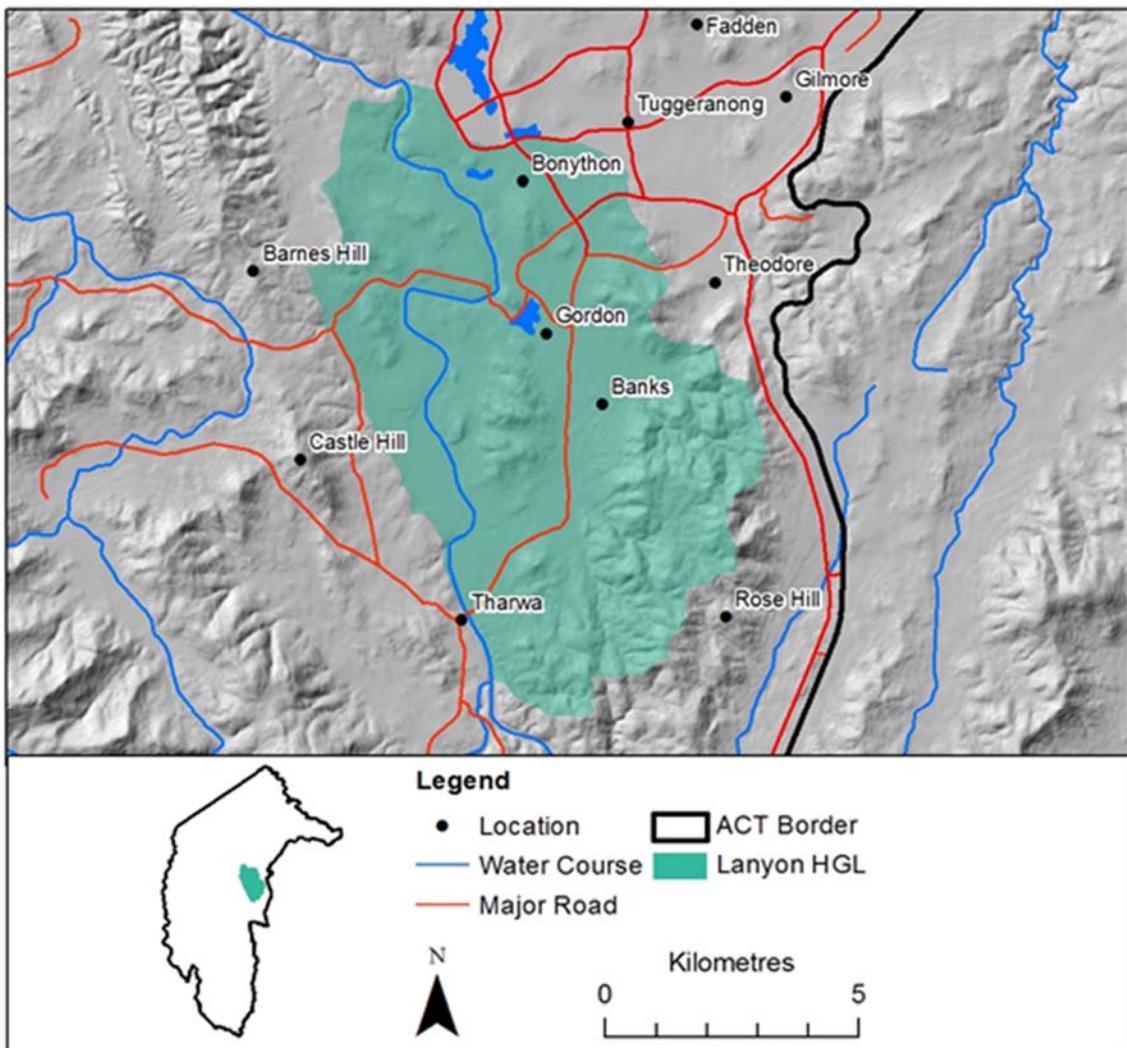


Figure 1: Lanyon HGL distribution map.

Lanyon HGL comprises a catchment based landscape boundary and includes the Murrumbidgee River corridor (Figure 2). The area is mostly grazing lands, heavily cleared, with some peri-urban and urban areas and there are also steeply wooded ridges and rolling slopes. The historic Lanyon Homestead is within the area.

Gully erosion and stream-bank erosion are features of the landscape, and there are minor areas of waterlogging in the Lanyon area, There is currently little evidence of salinity. A number of past demonstration sites for tree planting and gully control occur across the landscape. The area is of mixed geology and has areas of coarse textured soils.

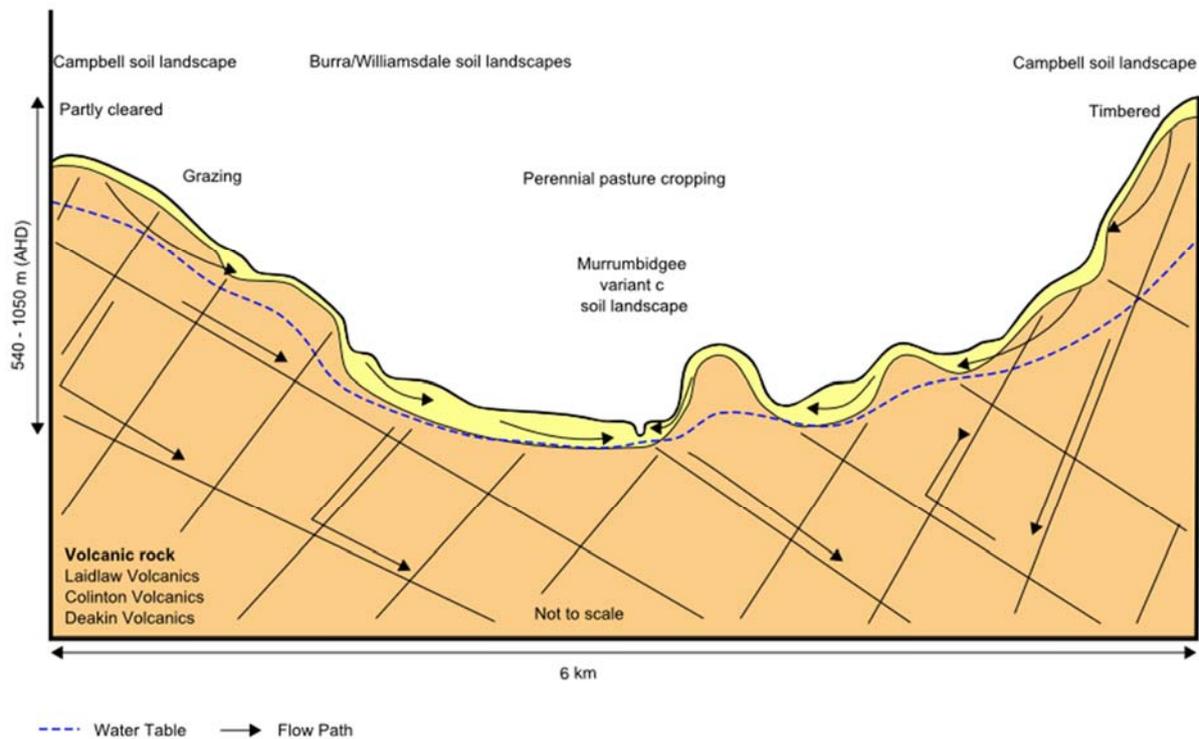


Figure 2: Conceptual cross-section for Lanyon HGL showing the distribution of regolith and landforms, salt sites if present, and flow paths of water infiltrating the system.

There is little evidence of salinity in this HGL (Table 1).

Table 1: Lanyon HGL salinity expression.

SALINITY EXPRESSION	
Land Salinity (Occurrence)	Low – no salt land observed
Salt Load (Export)	Low
EC (Water Quality)	Low – little indication of salinity in Waterwatch data

Salt store refers to the amount of salt stored in soil and geology materials. Salt availability refers to how easily this salt can be moved by water. Salt stored within Lanyon HGL has moderate mobility. There is a moderate salt store that has moderate availability (Table 2).

Table 2: Lanyon HGL salt store and availability.

SALT MOBILITY			
	Low availability	Moderate availability	High availability
High salt store			
Moderate salt store		Lanyon	
Low salt store			

Overall salinity hazard is based on the likelihood of salinity occurring and how much impact it would have. The overall salinity hazard in Lanyon HGL is low. This is due to the moderate likelihood that salinity issues will occur and that they would have potentially limited impacts (Table 3).

Table 3: Likelihood of salinity occurrence, potential impact and overall hazard of salinity for Lanyon HGL.

OVERALL SALINITY HAZARD			
	Limited potential impact	Significant potential impact	Severe potential impact
High likelihood of occurrence			
Moderate likelihood of occurrence	Lanyon		
Low likelihood of occurrence			

LANDSCAPE FEATURES

The following photographs illustrate landscapes and specific features observed in this HGL. Information used to define the HGL is summarised in Table 4.



Photo 1: Gully erosion typical of Lanyon HGL (Photo: OEH / R Muller).



Photo 2: View to the south west from Lanyon Drive looking across lower landform units (Photo: OEH / R Muller).



Photo 3: Rolling landform of Lanyon HGL (Photo: DPI / A Nicholson).



Photo 4: Upper landscape elements of Lanyon HGL (Photo: DPI / A Nicholson).



Photo 5: View to the west from mid area of HGL (Photo: DPI / A Nicholson).



Photo 6: Soil profile on the edge of Lanyon HGL and Paddys River HGL (Photo: DPI / A Nicholson).



Photo 7: Rural landscape upper landscape component looking north from Tharwa Drive (Photo: DPI / A Nicholson).



Photo 8: View to the south west from Tuggeranong Hill Nature Reserve into Lanyon HGL in the background (Photo: DPI / A Nicholson).

Table 4: Summary of information used to define Lanyon HGL.

<p>Lithology <i>(Raymond et al. 2007; Geoscience Australia 2015)</i></p>	<p>This HGL comprises felsic volcanic rocks and unconsolidated sediments. Key lithologies include:</p> <ul style="list-style-type: none"> • Laidlaw Volcanics • Deakin Volcanics • Colinton Volcanics • Colluvium and alluvium
<p>Annual Rainfall</p>	<p>600–850 mm</p>
<p>Regolith and Landforms</p>	<p>Soil generally <1 m deep higher in the landscape and >1 m on lower slopes and in drainage lines. Deeper soil and imperfect drainage in the lower landscape provide moderate potential for salt store.</p> <p>Slopes generally 10–32%; 32–56% in highest areas; 0–10% in valley bottoms.</p> <p>Elevation range is 530–1100 m</p>
<p>Soil Landscapes <i>(Jenkins 1993; Jenkins 2000; Cook & Jenkins in prep)</i></p>	<p>The following soil landscapes are dominant in this HGL:</p> <ul style="list-style-type: none"> • Williamsdale • Campbell • Burra • Murrumbidgee (variant C) • Luxor (variant B) <p>Clastic Rudosols occur on crests, generally along the catchment divide that forms the margin of this HGL. Well drained Red and Brown Kandosols (Red and Yellow Earths) are found on upper slopes. Red Chromosols and Red Kurosols (Red Podzolic Soils) occur on mid slopes. Brown Chromosols (Yellow Podzolic Soils and Brown Kandosols (Yellow Earths) on better drained lower slopes. Poorly drained Sodosols (Solodic Soils) in the lowest slope positions. Due to sodicity, slope position and imperfect drainage the Sodosols have the greatest potential for land degradation and dryland salinity within this HGL.</p>
<p>Land and Soil Capability</p>	<p>Class 5</p>
<p>Land Use</p>	<ul style="list-style-type: none"> • grazing • urban development • native timber
<p>Key Land Degradation Issues</p>	<ul style="list-style-type: none"> • water erosion • shallow soils • soil acidity • soil sodicity

Native Vegetation (Keith 2004; Gellie 2005; Dept. of Environment 2012)	<p>This HGL is situated within the IBRA7 South Eastern Highlands (Murrumbateman subregion)</p> <p>The HGL is extensively cleared with remaining vegetation formations comprising Grassy Woodland, Wet and Dry Sclerophyll Forest and Forested Wetlands</p> <p>Local vegetation is described by Gellie (2005)</p>
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HYDROGEOLOGY

Typical values for the hydrogeological parameters of this HGL are summarised in Table 5.

Table 5: Summary of values for typical hydrogeological parameters of Lanyon HGL.

Aquifer Type	Unconfined to semi-confined in fractured rock and saprolite Lateral flow through unconsolidated colluvial sediments on lower slopes and in flow lines
Hydraulic Conductivity	Moderate Range: 10 ⁻² –10 m/day
Aquifer Transmissivity	Moderate Range: 2–100 m ² /day
Specific Yield	Moderate Range: 5–15%
Hydraulic Gradient	Gentle to moderate Range: <10–30%
Groundwater Salinity	Fresh Range: <800 µS/cm
Depth to Watertable	Shallow to intermediate (localised waterlogging) Range: <2–8 m
Typical Sub-Catchment Size	Small (<100 ha)
Scale (Flow Length)	Local Flow length: <5 km (short)
Recharge Estimate	Moderate
Residence Time	Short to medium (months to years)
Responsiveness to Change	Fast to medium (months to years)

MANAGEMENT OPTIONS

Overarching salinity management strategies have specific biophysical outcomes. These are achieved by implementing a series of targeted land management actions that take into account the opportunities and constraints of the particular HGL. The actions recognise the

need for diffuse and specific activities within the landscape to impact on salinity. Further explanation of land management functions, strategies and actions can be found in Wooldridge *et al.* (2015).

Salinity is driven by interactions between water-use capacity of vegetation, physical soil properties and hydrogeological processes within the HGL.

Actions that influence the way water is used by vegetation or stored in the soil profile will have impacts on recharge. The influence of both continual and episodic recharge and the impacts of extreme weather events should be considered when deciding on appropriate management actions. Short and long-term climate cycles also should be considered as they have a bearing on salinity processes, particularly salt load and land salinity.

Landscape Functions – Lanyon HGL

Functions this landscape provides within a catchment scale salinity context:

- **A.** The landscape provides fresh water runoff as an **important water source**.
- **B.** The landscape provides fresh water runoff as an **important dilution flow source**.

Landscape Management Strategies – Lanyon HGL

Appropriate strategies pertinent to this landscape:

- **Maintain or maximise runoff (10).**
- **Dry out the landscape with diffuse actions over most of the landscape (6):**
Encourage plant growth and increase plant water use to use excess soil moisture and shallow groundwater. Healthy, actively growing vegetation will also buffer groundwater accessions in wet seasonal conditions.

Key Management Focus – Lanyon HGL

This landscape is mostly grazed, which generates high quality water which acts as a dilution source for other catchments. There are major sediment sources in the catchment and a key management focus should be to introduce perennial components into the landscape and farming systems.

Urban focus should recognise the positive and negative outcomes of constructed storm water management.

Specific Land Management Opportunities

Specific opportunities for this HGL:

- perennial pasture management in farming areas
- WSUD in new developments
- native pastures have wide diversity of species.

Specific Land Management Constraints

Constraints on land management in this HGL include:

- existing storm water systems need to function hydraulically and ecologically
- grazing management exposes erodible soils.

Specific Targeted Actions

Management areas for this HGL are illustrated in Figures 3 and 4. The specific management actions for these areas are described in Table 6. Management actions for urban areas are given in Table 8.

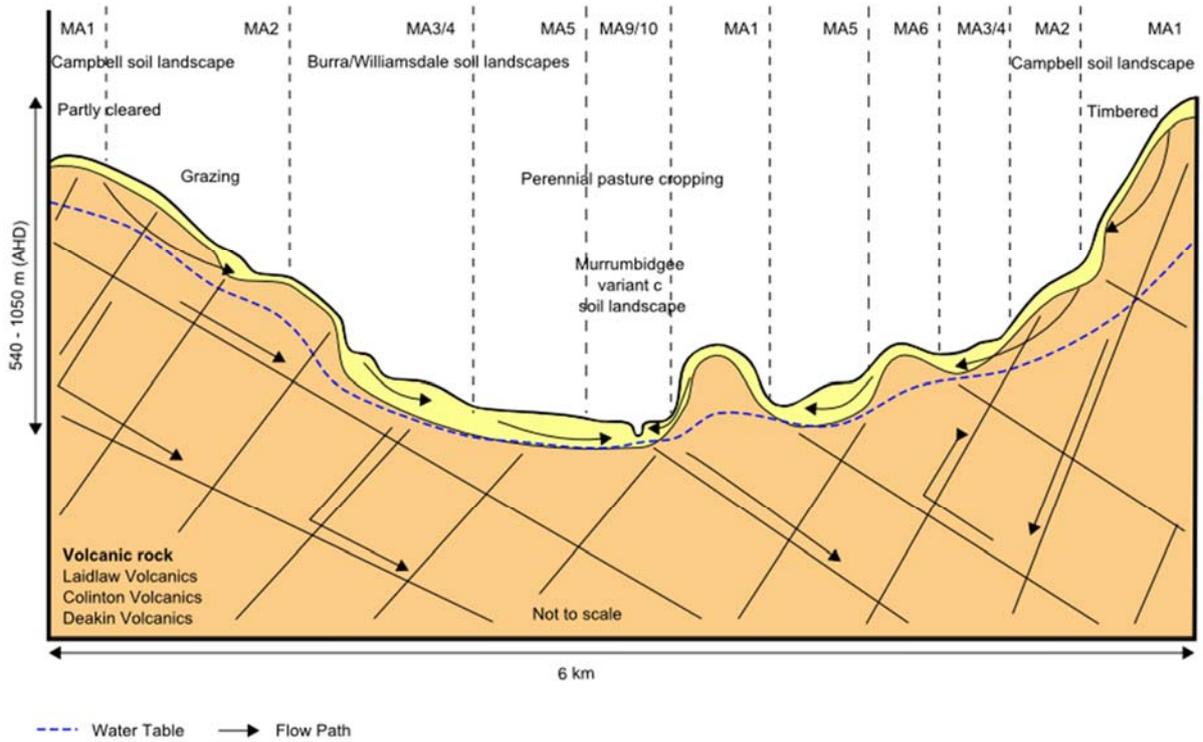


Figure 3: Management cross-section for Lanyon HGL showing defined management areas.

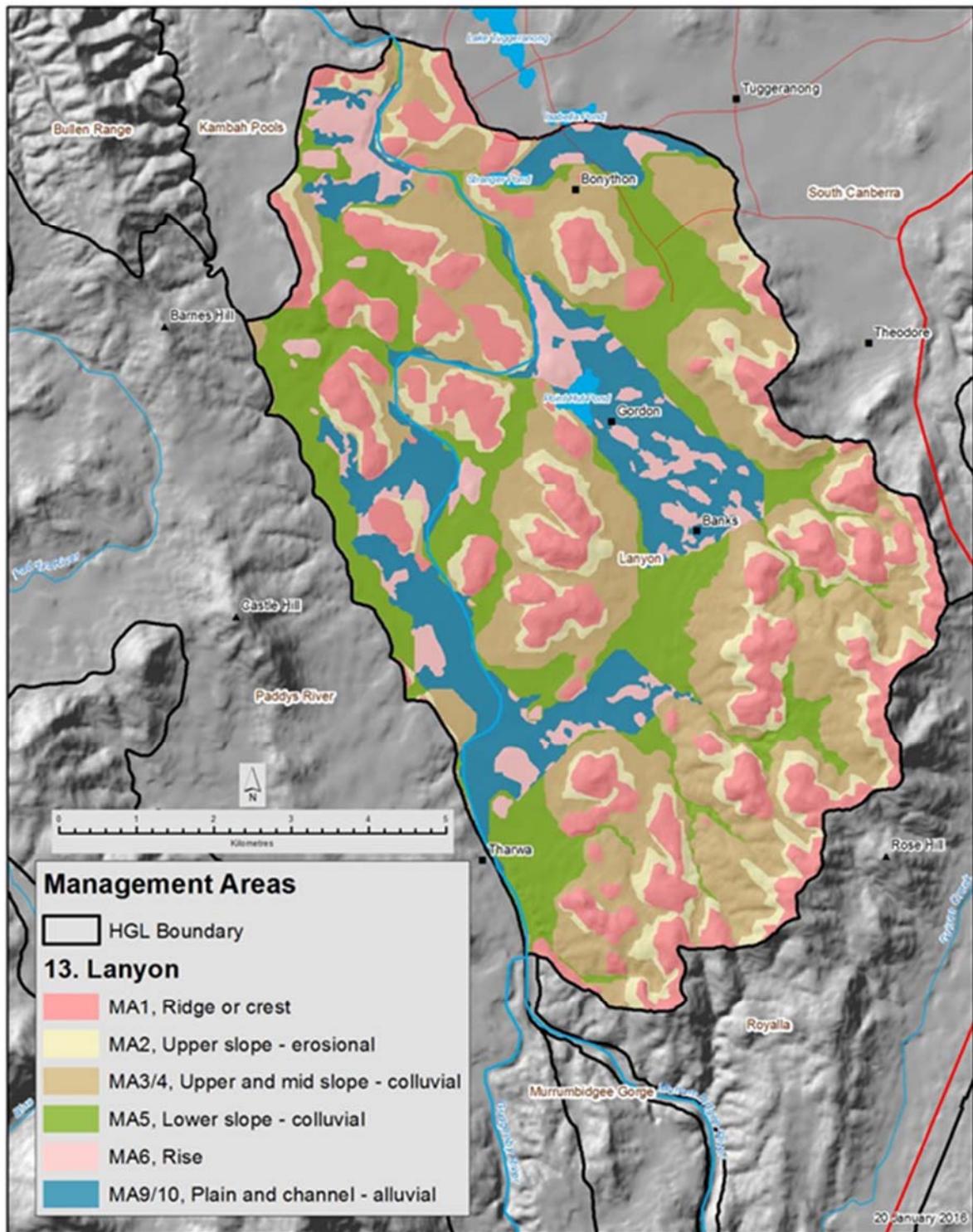


Figure 4: Spatial distribution of management areas for Lanyon HGL.

Table 6: Specific management actions for management areas within Lanyon HGL.

Management Area (MA)	Action
<p>MA 1 (RIDGES)</p>	<p>Vegetation for ecosystem function Maintain and improve existing native woody vegetation to reduce discharge (VE3)</p> <p>Vegetation for production Improve grazing management of existing perennial pastures to manage recharge (VP1) Improve grazing management to improve or maintain native pastures to manage recharge (VP5)</p>
<p>MA 2 (UPPER SLOPES – EROSIONAL)</p>	<p>Vegetation for ecosystem function Maintain and improve existing native woody vegetation to reduce discharge (VE3)</p> <p>Vegetation for production Improve grazing management of existing perennial pastures to manage recharge (VP1) Improve grazing management to improve or maintain native pastures to manage recharge (VP5)</p> <p>Urban management actions as appropriate</p>
<p>MA 3/4 (UPPER SLOPES-COLLUVIAL & MID SLOPES)</p>	<p>Vegetation for ecosystem function Maintain and improve existing native woody vegetation to reduce discharge (VE3) Establish and manage trees to integrate into existing farming infrastructure and logistics and for multiple outcomes including reduced recharge (VE5) Interception planting of native woody species to target shallow groundwater (VE2)</p> <p>Vegetation for production Improve grazing management of existing perennial pastures to manage recharge (VP1) Establish and manage perennial pastures to manage recharge (VP2) Improve grazing management to improve or maintain native pastures to manage recharge (VP5)</p> <p>Farming Systems Pasture cropping with annual cereals into perennial pastures to manage recharge (FS1) Phase farming with perennial component-crop rotations to manage recharge (FS3)</p> <p>Urban management actions as appropriate</p>

Management Area (MA)	Action
MA 6 (RISE)	<p>Vegetation for ecosystem function Maintain and improve existing native woody vegetation to reduce discharge (VE3)</p> <p>Vegetation for production Improve grazing management of existing perennial pastures to manage recharge (VP1) Improve grazing management to improve or maintain native pastures to manage recharge (VP5)</p> <p>Urban management actions as appropriate</p>
MA 5 (LOWER SLOPE – COLLUVIAL)	<p>Vegetation for production Improve grazing management of existing perennial pastures to manage recharge (VP1) Establish and manage perennial pastures to manage recharge (VP2) Improve grazing management to improve or maintain native pastures to manage recharge (VP5)</p> <p>Farming Systems Pasture cropping with annual cereals into perennial pastures to manage recharge (FS1) Phase farming with perennial component-crop rotations to manage recharge (FS3)</p> <p>Urban management actions as appropriate</p>
MA 9/10 ALLUVIAL CHANNEL	<p>Vegetation for ecosystem function Maintain and improve riparian native vegetation to reduce discharge to streams (VE4)</p>

High Hazard Land Use

There are some management actions that should be discouraged in this HGL as they will have negative impacts on salinity (Table 7). High hazard management actions for urban areas are given in Table 9.

Table 7: Management actions having negative salinity impacts in Lanyon HGL.

At Risk Management Areas	Action
MA 1, 2, 3, 5 & 6	<p>Poor management of grazing pastures (DLU2) Clearing and poor management of native vegetation (DLU4) Locating infrastructure on discharge areas (DLU7)</p>
MA 3 & 5	<p>Annual Cropping (DLU3) Poor soil management with the loss of surface soil layers (DLU10)</p>
MA 9/10	<p>Clearing and poor management of native vegetation (DLU4) Locating infrastructure on discharge areas (DLU7)</p>

Urban Management Strategy Objectives – Lanyon HGL

The following list (in priority order) details the appropriate urban strategies for this landscape:

Highest priority

- **Urban Planning (UP):** Planning of sub-division layout and design is required to manage salinity consequences. Development and re-development should not increase the salinity hazard of the natural and built environment. Layout and design should consider locations of roads, infrastructure and green-space as well as building allotments, and WSUD.
- **Riparian Management (RM):** Vegetation management in riparian areas will assist in minimising salt export to streams.
- **Urban Management (UM):** The input of water into the landscape (lawns, gardens, sporting fields) including the management of recycled water, requires careful management.

Medium priority

- **Urban Construction (UC):** Construction and re-development on saline land will require salt resistant/resilient materials. The salinities encountered in this HGL require careful consideration of construction method, depth of cut and location of roads and all infrastructure including underground utilities.
- **Urban Vegetation (UV):** Maintain and enhance vegetation (including remnant vegetation) for the management of recharge and as a buffer to excess water input. Water-wise gardening should be encouraged in residential areas.

Specific Land Management Opportunities

There is a range of specific opportunities for this HGL:

- water demand management can have a localised impact
- trees and salt tolerant vegetation are likely to have a moderate to high impact in this landscape if correct species are selected based on salinity/waterlogging tolerance. There is an abundance of shallow groundwater moving through the landscape.

Specific Land Management Constraints

Constraints on land management in this HGL include:

- sodic and dispersive subsoils
- avoid excessive water infiltration into soils

Table 8: Specific urban management actions for management areas within Lanyon HGL.

MANAGEMENT AREA (MA)	ACTION (URBAN)
<p>MA 2/3/4/6</p>	<p>Urban Planning</p> <p>Prior to starting earthworks, sodic/saline soils should be identified (UP1)</p> <p>Minimise use of infiltration and detention of stormwater in hazard areas; consider lining of detention systems to prevent infiltration (i.e. reconsider WSUD implications in relation to salinity management) (UP2)</p> <p>Maximise the size of impervious surfaces to prevent recharge of (perched) groundwater tables. Constructed pervious surfaces may need to be lined and drained to stormwater outlets (UP4)</p> <p>Urban Construction</p> <p>Deep drainage should be minimised by maximising surface water runoff and drainage (UC2)</p> <p>Ensure road construction is suitable for conditions (UC5)</p> <p>Minimise depth of cut and exposure of susceptible soils during development. Ensure fill material interface is not saline (UC1)</p> <p>Urban Management</p> <p>Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns (UM2)</p> <p>Minimise leakage of standing water bodies, pools, lakes and service pipes (UM1)</p> <p>Urban Vegetation</p> <p>Develop native landscaping and water-wise gardens to reduce over-irrigation and water usage (UV3)</p> <p>Promote the retention and establishment of deep rooted vegetation that maximises water use in new urban development areas (UV2)</p>
<p>MA 5</p>	<p>Urban Management</p> <p>Employ deficit irrigation principles to prevent over-irrigation of sports grounds, golf courses, parks, private gardens and lawns (UM2)</p> <p>Minimise leakage of standing water bodies, pools, lakes and service pipes (UM1)</p> <p>Urban Vegetation</p> <p>Develop native landscaping and water-wise gardens to reduce over-irrigation and water usage (UV3)</p>
<p>MA 9/10</p>	<p>Riparian Management</p> <p>Retain or re-establish effectively vegetated riparian buffer zones to manage discharge areas (preferably salt tolerant indigenous vegetation) (RM1)</p> <p>Maintain/re-establish effective vegetated riparian buffer zones (RM2)</p>

Table 9: Urban management actions having negative salinity impacts in Lanyon HGL.

AT RISK MANAGEMENT AREAS	ACTION (URBAN)
MA 2, 3, 4, 5, 6, 9, & 10	Avoid: <ul style="list-style-type: none"> • overwatering of parks and gardens • ponding water on lower landform units • deep cut and exposure of susceptible soils during development when establishing infrastructure and dwellings • input of extra recharge from delivery and stormwater systems

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