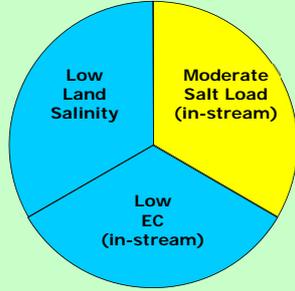


22. South Canberra Hydrogeological Landscape

LOCALITIES	Tuggeranong, Kambah, Wanniasa, Theodore, Greenway Woden, Weston, Farrer, Isaacs, Duffy, Lyons, Curtin, Fisher Fyshwick, Kingston, Capital Hill, Yarralumla, Red Hill	
MAP SHEET	Canberra 1:100 000	
CONFIDENCE LEVEL	Moderate	

OVERVIEW

The South Canberra Hydrogeological Landscape (HGL) extends from the southern shoreline of Lake Burley Griffin to the southern edge of Tuggeranong, and from the Lower Molonglo Valley in the northwest to the Symonston HGL boundary on the east (Figure 1). The HGL covers an area of 146 km² and receives 600 to 750 mm of rain per annum.

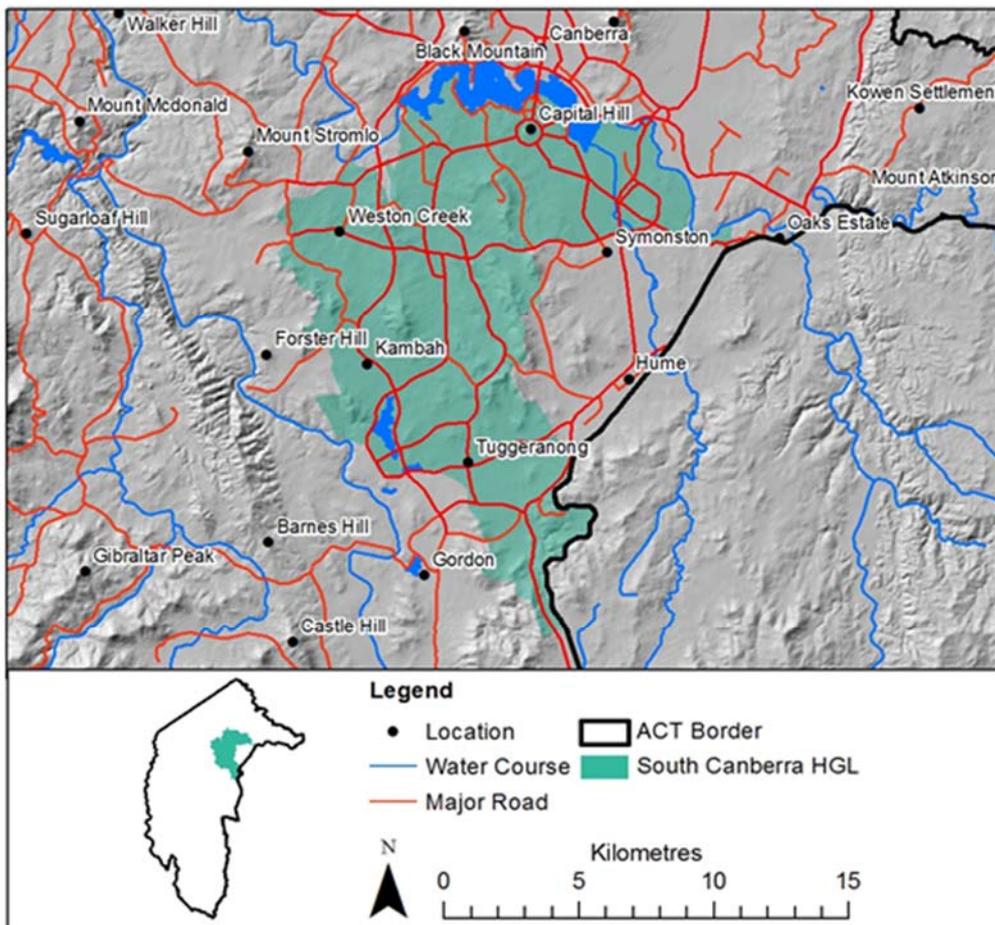


Figure 1: South Canberra HGL distribution map.

South Canberra HGL is characterised by sub-catchment based landscapes in Woden, Tuggeranong and around Capital Hill (Figure 2). Generally the ridgelines are heavily vegetated (Wanniassa Hills, Mt Taylor, Farrer Ridge Nature Reserves, Red Hill, Isaacs Ridge and Mt Stromlo) with little urban encroachment. The upper slope elements are cliff-forming in some areas and heavily vegetated with native forest and commercial forestry in some locations.

The catchments are highly urbanised and there is rapid urban development in the north-western Weston Creek and Lower Molonglo Valley areas. Considerable areas of bare earth are in the urban development stage with massive earthworks and infrastructure installation. Appropriate sediment and erosion control works is necessary through this development stage.

A feature of all landscapes is the waterways, concrete lined drainage channels and lakes constructed to handle large storm-water flows. These drainage reserves in the lower landscape are relatively wide and add to the green space of the area.

The Jerrabomberra Wetlands are of international significance. Waterlogging is an issue on associated floodplain are turf farms and irrigation areas, with a range of endangered species living in this habitat.

In other areas there is little evidence of waterlogging or salinity, but there is a moderate salt load in the streams emanating from the felsic volcanics. Soil erosion associated with earlier urban development is stable. The area contributes large volumes of runoff which act as dilution flows for the wider catchment.

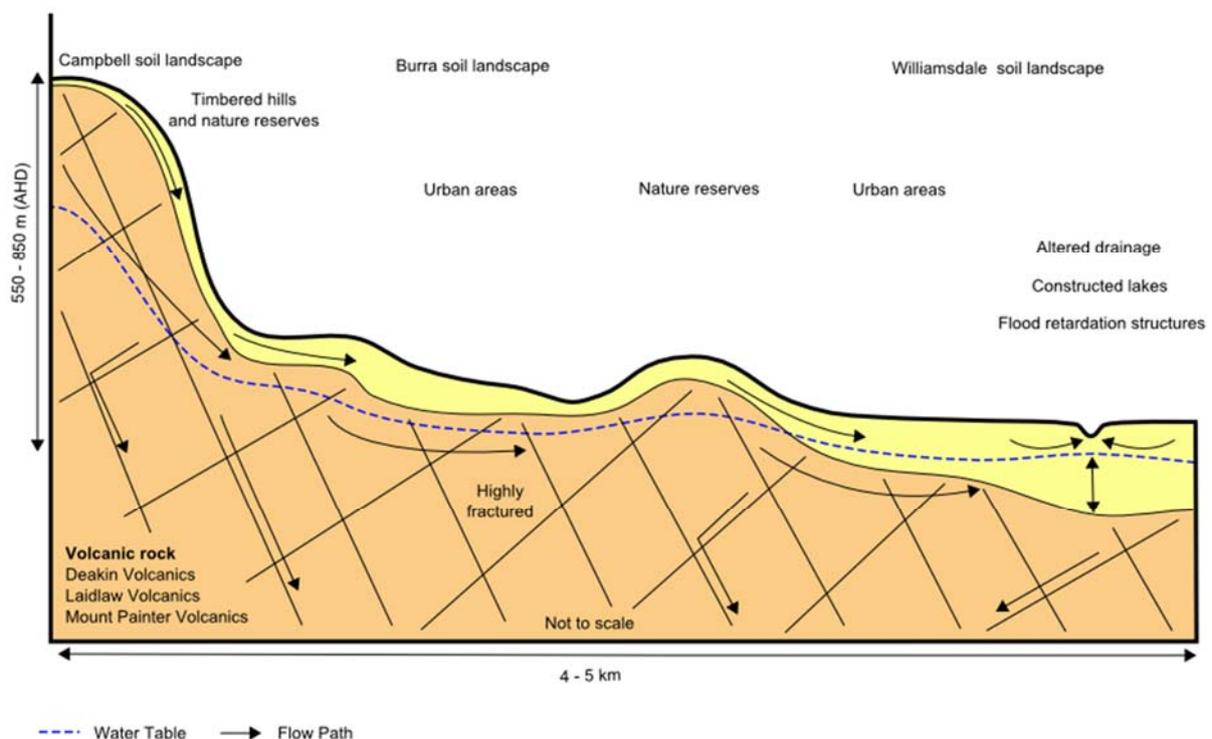


Figure 2: Conceptual cross-section for South Canberra HGL showing the distribution of regolith and landforms, salt sites if present, and flow paths of water infiltrating the system.

Salinity expression in this HGL is in the form of stream salt load (Table 1).

Table 1: South Canberra HGL salinity expression.

SALINITY EXPRESSION	
Land Salinity (Occurrence)	Low – no salt land observed
Salt Load (Export)	Moderate – small volumes of salt in large volumes of water.
EC (Water Quality)	Low – dilution flow with high runoff from the landscape

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 South Canberra HGL has moderate mobility. There is a moderate salt store that has moderate availability (Table 2).

Table 2: South Canberra HGL salt store and availability.

SALT MOBILITY			
	Low availability	Moderate availability	High availability
High salt store			
Moderate salt store		South Canberra	
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 South Canberra 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 South Canberra HGL.

OVERALL SALINITY HAZARD			
	Limited potential impact	Significant potential impact	Severe potential impact
High likelihood of occurrence			
Moderate likelihood of occurrence	South Canberra		
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: Wide road reserves adjacent to constructed waterways in South Canberra HGL (Photo: DPI / A Nicholson).



Photo 2: Undeveloped land adjacent to Monks Creek (Photo: DPI / A Nicholson).



Photo 3: New housing development in South Canberra HGL indicating vegetated ridge lines with no development on upper landscapes (Photo: DPI / A Nicholson).



Photo 4: Sediment control lake in Weston Creek, with ACT Parks Depot in the foreground (Photo: DPI / A Nicholson).



Photo 5: New development in Weston/Wright (Lower Molonglo Valley), indicating new infrastructure and large amounts of bare earth in development phase, and Mt Stromlo in the background (Photo: DPI / A Nicholson).



Photo 6: Constructed and lined channel adjacent to Athlon Drive in Woden (Photo: DPI / A Nicholson).



Photo 7: Vegetated steep slopes of Isaacs Ridge, with pine plantation and native vegetation interspersed (Photo: DPI / A Nicholson).



Photo 8: Jerrabomberra Wetlands (Photo: DPI / A Nicholson).



Photo 9: Turf farms in lower landscape (Photo: DPI / A Nicholson).



Photo 10: Urban landscape of South Canberra Valley (Photo: DPI / A Nicholson).



Photo 11: Landscape view across the urban area of South Canberra from Mt Ainslie (Photo: DPI / A Nicholson).



Photo 12: Cutting of State Circle Shale and Black Mountain Sandstone on State Circle, adjacent to Parliament House (Photo: DPI / A Nicholson).

Table 4: Summary of information used to define South Canberra HGL

<p>Lithology <i>(Raymond et al. 2007; Geoscience Australia 2015)</i></p>	<p>This HGL comprises felsic volcanics and unconsolidated sediments. Key lithologies include:</p> <ul style="list-style-type: none"> • Laidlaw Volcanics • Deakin Volcanics • Mount Painter Volcanics • Yarralumla Volcanics • Alluvium and colluvium
<p>Annual Rainfall</p>	<p>600–750 mm</p>
<p>Regolith and Landforms</p>	<p>Soil generally <1 m deep higher in the landscape and >1 m deep on lower slopes and in drainage lines. Deeper soil and imperfect drainage in the lower landscape provide moderate potential for salt store.</p> <p>Slope class 0–10% in valley, 10–32% on slopes.</p> <p>Elevation range 550 – 850 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 • Burra • Campbell <p>Normal distribution of soils in this HGL has been modified by earthworks in urban areas. The following classifications describe the soil types in their undisturbed (pre-urbanised) condition. Many of the properties attributed to these soil types will remain despite the high degree of disturbance. 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, with 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"> • urban development • grazing • nature reserves • minor pine plantations
<p>Key Land Degradation Issues</p>	<ul style="list-style-type: none"> • erosion, sheet and gully • stormwater management • water erosion • mass movement • soil acidity

Native Vegetation <i>(Keith 2004; Gellie 2005; Dept. of Environment 2012)</i>	<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 and Dry Sclerophyll Forest</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 South Canberra 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 Range: <10–30%
Groundwater Salinity	Fresh Range: <800 µS/cm
Depth to Watertable	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	Medium (years)
Responsiveness to Change	Medium (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 – South Canberra 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 – South Canberra HGL

Appropriate strategies pertinent to this landscape:

- **Maintain or maximise runoff (10).**

Key Management Focus – South Canberra HGL

This landscape is seen as an urban landscape. The key salinity management focus should be to manage urban development, associated runoff, sporting fields and public space.

The focus should also be to manage stormwater in the landscape and constructed wetland areas. Sediment and erosion control are major issues in all stages of development, as is infrastructure design and planning.

Specific Land Management Opportunities

Specific opportunities for this HGL:

- significant green space
- drainage systems may be able to be retrofitted
- new development – opportunity for good planning
- drainage development and constructed wetlands can be well planned and designed
- native vegetation on ridges and in nature reserves.

Specific Land Management Constraints

Constraints on land management in this HGL include:

- older urban areas that have been developed
- erodible soils which have high bed loads of suspended matter
- stormwater management

- drainage of landscape and impedance of flow
- high density housing.

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.

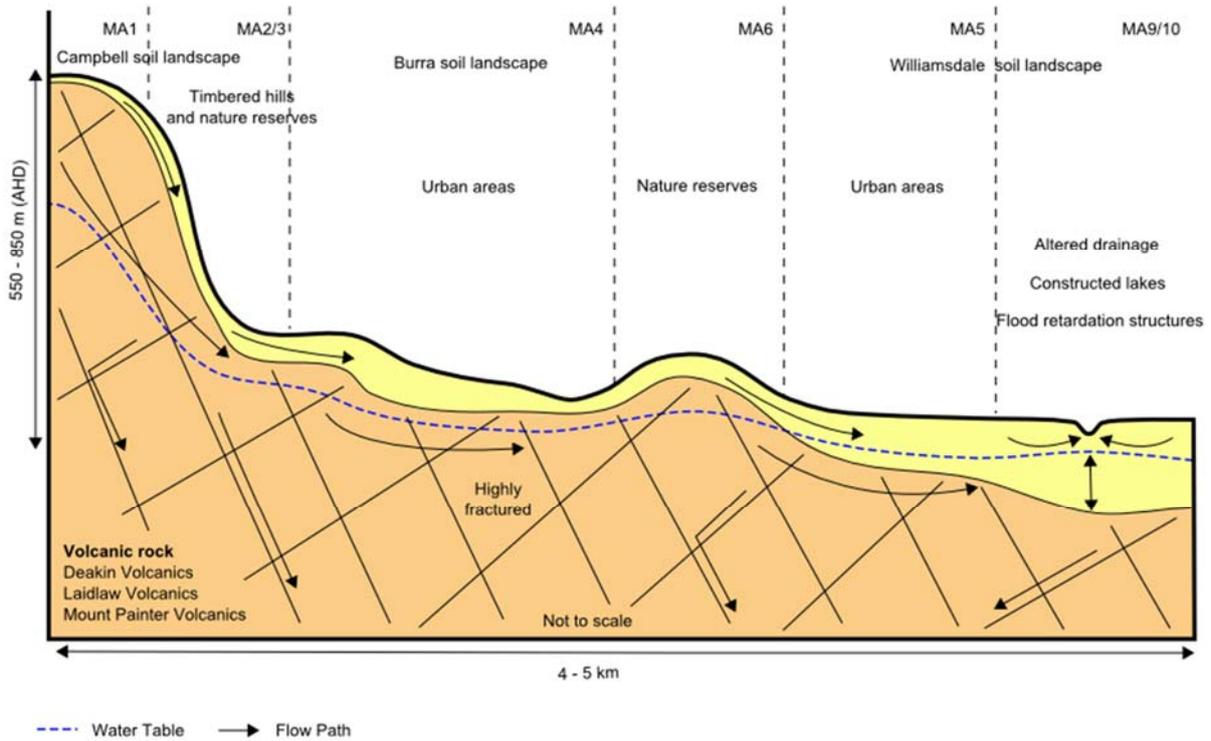


Figure 3: Management cross-section for South Canberra HGL showing defined management areas.

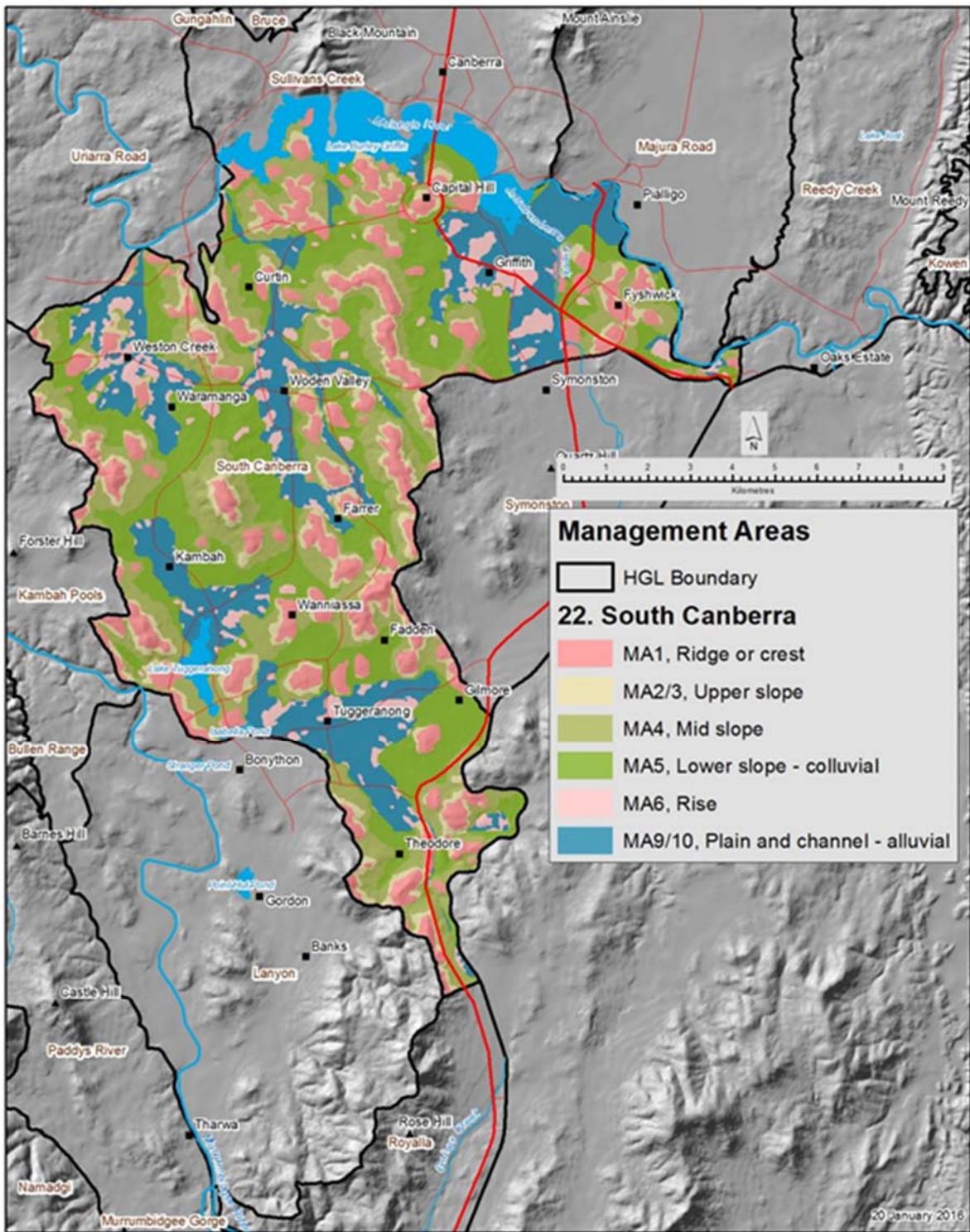


Figure 4: Spatial distribution of management areas for South Canberra HGL.

Table 6: Specific management actions for management areas within South Canberra 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 2/3 (UPPER SLOPE – EROSIONAL & COLLUVIAL)</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>Urban management actions as appropriate</p>
<p>MA 4 (MID SLOPE)</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)</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>Urban management actions as appropriate</p>

Management Area (MA)	Action
MA 5 (LOWER SLOPE – COLLUVIAL)	<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)</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>Urban management actions as appropriate</p>
MA 6 (RISES)	<p>Vegetation for ecosystem function Maintain and improve existing native woody vegetation to reduce discharge (VE3)</p>
MA 9 (LAKE AREAS & FLOODPLAIN)	<p>Urban management actions as appropriate</p> <p>Vegetation for ecosystem function Maintain and improve existing native woody vegetation to reduce discharge (VE3) Interception planting of native woody species to target shallow groundwater (VE2) Maintain and improve riparian native vegetation to reduce discharge to streams (VE4)</p> <p>Irrigation Systems Manage on-farm irrigation to achieve best practice (IS1)</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 South Canberra HGL.

At Risk Management Areas	Action
MA 1, 2, 3, 4, 5 & 6	<p>Poor management of grazing pastures (DLU2) Clearing and poor management of native vegetation (DLU4)</p>

At Risk Management Areas	Action
MA 9/10	Locating infrastructure on discharge areas (DLU7) Poor irrigation practises (DLU13) Loading of soils with salt through irrigation and flow management (DLU15)

Urban Management Strategy Objectives – South Canberra HGL

The following list (in priority order) details the appropriate urban strategies pertinent to 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):** Input of water into the landscape (from 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) to manage 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 infiltration of water into soils.

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

MANAGEMENT AREA (MA)	ACTION (URBAN)
<p>MA 2/3/4/6/5</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 retention and establishment of deep rooted vegetation that maximises water use in new urban development areas (UV2)</p>
<p>MA 9/10</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>Riparian Management</p> <p>Retain or re-establish areas of 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 South Canberra HGL.

AT RISK MANAGEMENT AREAS	ACTION
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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