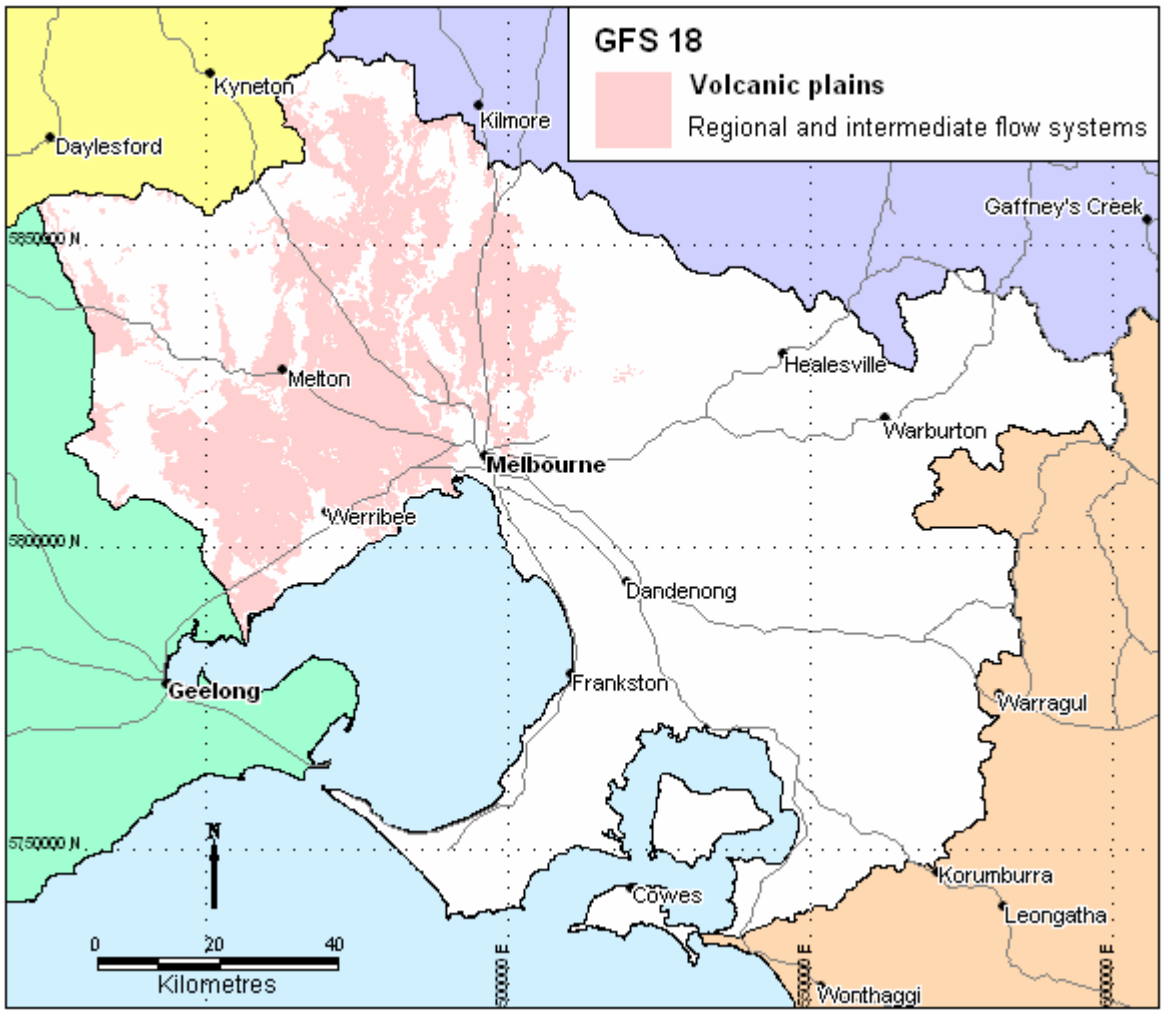
Regional and intermediate flow systems in the Volcanic Plains

Region: Western PPWP CMA region

Type areas: Melton, Rockbank, Donnybrook, Sunshine, Little River

Brief description: The basalt rocks in the western PPWP CMA region were formed by volcanic eruptions between 6 million and less than one million years ago. In the earlier phase eruptions, lava flowed over the pre-existing landscape, following drainage lines and spilling out across the coastal plains (GFS 10). The individual lava flows cooled to form lobes or tongues of basalt, generally less than 5 metres thick. Over the lengthy period of volcanic eruptions the overlapping lobes of basalt have built up to form the extensive basalt plains cover. In places, soils that had developed on the basalt were buried by the subsequent lava flows often several hundreds of thousand years later, now forming discontinuous confining layers in the basalt aquifer. The uppermost fractured, fine-grained crystalline rocks have rapidly weathered, forming a blanket of clay soil of variable thickness.

Groundwater moves through the fractured rocks at highly variable rates in both regional and intermediate flow systems. Saline groundwater discharges in lakes, streams, swamps, and over broad depressions in the landscape.



Problem statement: In places, salinity and shallow watertables are natural features of this landscape. It is unclear how much hydrologic change there has been due to land-use change. Significant areas of salinity are mapped north of Rockbank.

Landscape attributes

Geology: Newer Volcanics basalt (Qvn, Qvt) and scoria (Qvs) of Quaternary age.

Topography: Undulating plains and low rises, volcanic cones.

Land Systems:

Western Victorian Volcanic Plains

7.1 Undulating Plains – Western District

7.2 Stony Undulating Plains – Western District

Central Victorian Uplands

1.1 East Victorian Dissected Uplands

2.1 West Victorian Dissected Uplands - Midlands

Regolith: Varied. Duplex soils and heavy clay soil developed on weathered basalt of variable thickness, occasional scoria and pyroclastic deposit.

Annual rainfall: 500 mm to 1200 mm

Dominant mid-1800s vegetation type: Grassland, Woodland and Forest

Current dominant land uses: Cropping, grazing, horticulture, urban, conservation

Mapping method: Outcrop geology

Salinity (S2, S3) adjacent to Kororoit Creek, Leakes Road, Rockbank.

Salinity (S1, S2) along Kororoit Creek, Beattys Road, Rockbank

Hydrogeology

Aquifer type (porosity): Fractured rock (secondary porosity), scoria and soil (primary porosity).

Aquifer type (conditions): Unconfined and semi-confined.

Hydraulic Conductivity (lateral permeability): Extremely variable. The rock varies from 10^{-3} m/d (tight fractures) to greater than10^{2} m/d (open fractures, scoria and lava tubes); soil varies from 10^{-6} m/d (heavy clay) to 10^{-2} m/d (clayey loams).

Aquifer Transmissivity: Highly variable in the moderate to high range. Estimated to be generally less than 200 m^2/d,

Aquifer Storativity: Variable. Estimated to be <0.03 to >0.05 for the fractured rock.

Hydraulic gradient: Estimated to be very low (0.0001) in regional systems and low (0.001) in intermediate systems. Locally steep around volcanic cones.

Flow length: Generally <50 km for regional systems and <10 km for intermediate systems.

Catchment size: Large (≤100000 Ha) for regional systems and moderate (≤5000 Ha) for intermediate systems.

Recharge estimate: Unknown, but thought to be between 10 mm and 25 mm annually.

Temporal distribution of recharge: Seasonal (winter and spring), with significantly more recharge in wetter years, when extensive soil waterlogging can occur.

Spatial distribution of recharge: Catchment wide but varies with the soil thickness, slope and waterlogged areas in the landscape. More recharge can occur through where overlain by younger volcanic rocks and scoria.

Aquifer uses: Significant use for stock and domestic purposes, some irrigation.

Salinity

Groundwater salinity (TDS): Generally in the range of 2000 mg/L to 10000 mg/L.

Salt store: Moderate.

Salinity occurrence: Lakes, swamps, drainage lines, broad depressions in the landscape, boundaries of basalt flows.

Soil Salinity Rating: S2 and S3.

Salt export: Both baseflow to streams and wash-off from surface.

Salt impacts: Both on-site and off-site.

Risk

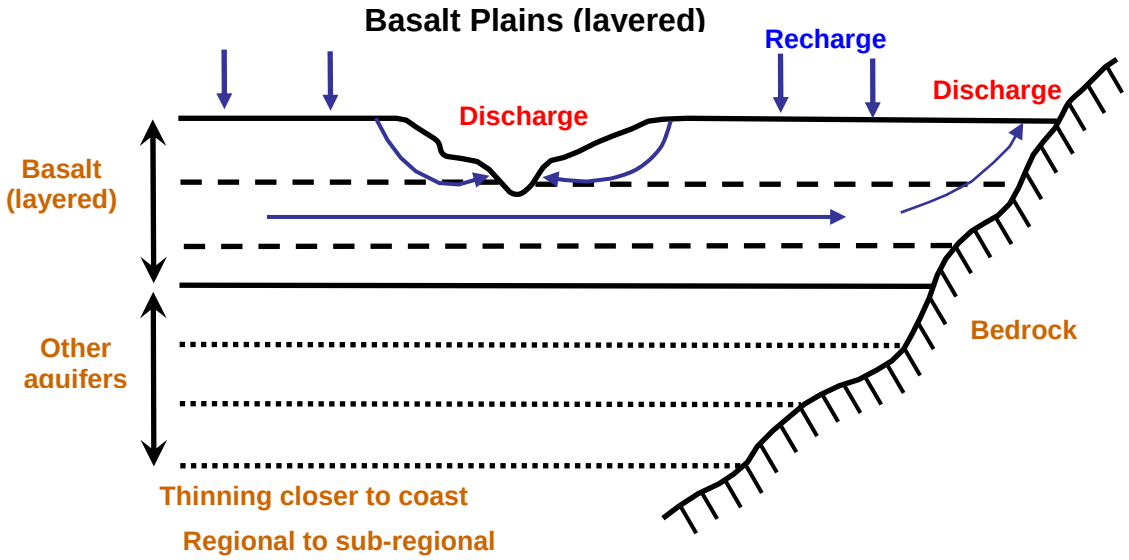
Soil salinity hazard: Uncertain, but thought to be high in some areas.

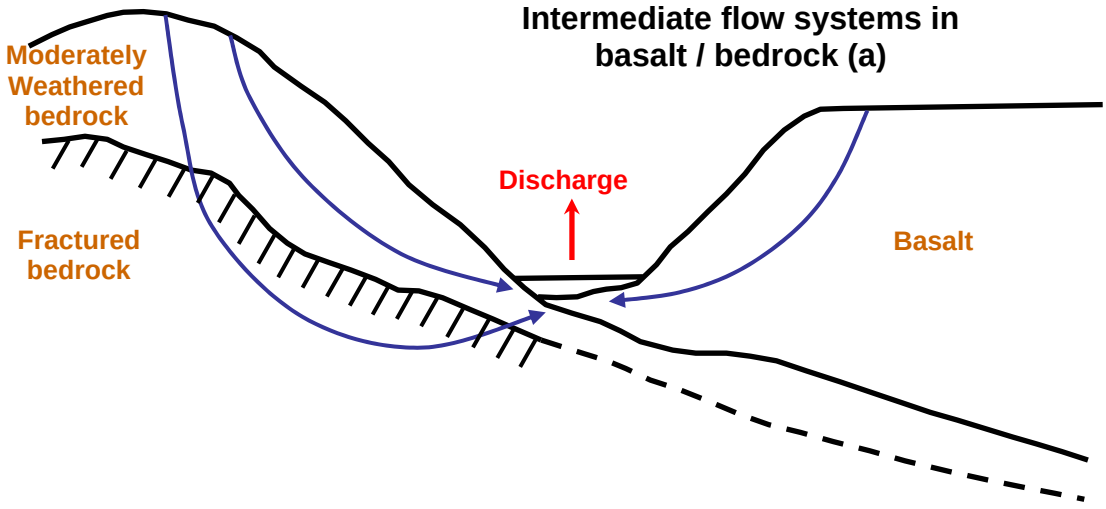
Water salinity hazard: High.

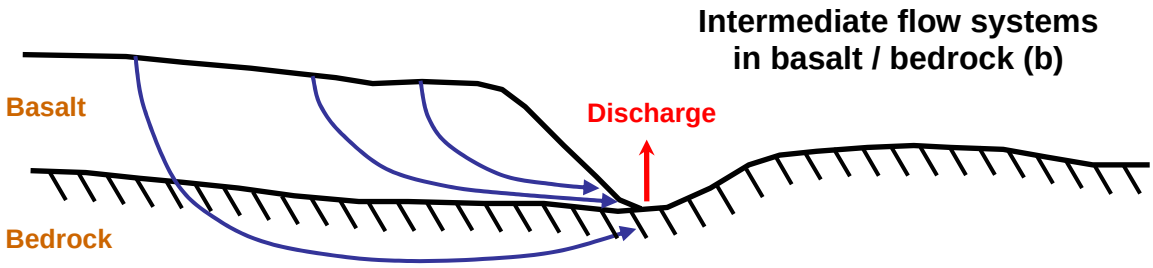
Assets at risk: Maribyrnong River, Merri Creek, Plenty River, Kororoit Creek, Werribee River, Little River, agricultural land, urban and engineering infrastructure, conservation areas.

Responsiveness to land management: Largely unknown, but thought to be slow.

Conceptual models







Management Options

On the Volcanic Plain salinity may be primary in origin, with expansion of the area affected due to secondary salinity exacerbated by modern land use change. Given that the vegetation of the early nineteenth century comprised grasslands and open woodlands, significant landscape recharge possibly occurred. Saline discharge was reported as seeps in depressions or occurring as baseflow into more deeply incised streams (assisted where basalt thins over bedrock). On this basis management strategies may somewhat control or reduce salinity discharge, but not eliminate it.

The regional nature and slow response of the flow system will inhibit significant impacts from practical recharge control strategies.

Dryland agriculture options for managing regional and intermediate flows of the **volcanic plains**

Salinity focus: Rockbank

Options	Treatments	Comments
Biological Management of recharge	Perennial pastures	Low impact– typically slow response, regional flow system. Productive perennial pastures will at least assist with run-off and waterlogging control
	Crop management	Low impact– as above
	Trees/woody vegetation	Low to moderate impact– where practical to incorporate into overall land use system to reduce gross recharge, runoff and waterlogging
Engineering intervention	Surface drainage	Low impact– disposal issues
	Groundwater pumping	Low impact– cost and disposal issues. Variable permeability makes pumping problematic. Specific asset protection only.
Productive uses of saline land and water	Salt tolerant pastures	Moderate to high impact– to stabilise and aesthetically improve salt affected areas
	Halophytic vegetation	Low to moderate impact– better suited in drier temperate zone
	Saline aquaculture	Low impact– discharge sites only minor in extent
	Salt harvesting	Low impact– groundwater is not sufficiently saline
	Others	See OPUS database (NDSP)

Management implications given projected land use

Salinity management strategies in the volcanic plains GFS will need to consider prescribed urban or industrial growth corridors, in addition to waste water reuse in the west. Both forms of development should be avoided in the defined hazardous areas. Where there is irrigation development this should be sited according to land suitability criteria. Additional excess recharge and waterlogging should be avoided by optimising the efficiency of irrigation applications.