

CRC LEME

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AVON CATCHMENT ACIDIC GROUNDWATER - GEOCHEMICAL RISK ASSESSMENT

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EXECUTIVE SUMMARY

Saline groundwaters are extensive in the Western Australian (WA) Wheatbelt and the area affected by shallow saline water tables is expected to increase in future decades. Deep (2-3m) open drains are increasingly being used by farmers to manage shallow groundwaters in valley floors and protect lowlying land from salinisation or rehabilitate marginally saline lands. Although they discharge saline waters, some drains also contain acidic waters. There is increasing interest in expanding areas managed using artificial drains and increasing the regionalisation of existing drainage systems. This requires assessment of the risks, and development of appropriate management strategies, particularly geochemical risks and potential impacts on receiving environments.

In considering the feasibility of deep drainage options, landholders, community, local government authorities and land management agencies have raised concerns about the possibility of increased downstream inundation and flooding and water quality impacts. These concerns are being addressed in WA by the Department of Water Engineering Evaluation Initiative (EEI) and the Wheatbelt Drainage Evaluation Project, both commissioned as part of the National Action Plan for Salinity and Water Quality (NAPSWQ). This report presents the findings of a regional hydrochemical survey of groundwaters, drainage waters and lakes in the Wheatbelt region of the Avon basin, Western Australia.

This report presents results from a multi-agency EEI research project involving the Cooperative Research Centre for Landscape Environments and Mineral Exploration (CRC-LEME), CSIRO Land and Water, the Department of Water (WA) and the Department of Agriculture and Food (WA) to quantify the geochemical risks associated with deep drainage options at regional scales designed to manage rising saline groundwaters in the Avon Basin. Outcomes of the first regional assessment of geochemical risks of acidic groundwaters in the agricultural zone of WA are presented with respect to the implications for management of drainage and those environments receiving drainage.

Acidic groundwaters can be found in all agricultural regions of the Avon catchment. Occurrences increase from the higher rainfall, steeper areas to the drier, flatter areas. Although geology, regolith and depth play some role in explaining the spatial patterns of acidic groundwater, it is not possible to use these to reliably map the spatial distribution of the waters.

More than 45% of baseflows in drains in the central eastern Wheatbelt (east of a line from Dumbleyung to Dalwallinu) were found to contain acidic ($\text{pH} < 4.5$), saline waters (at least $40\,000\text{ mg l}^{-1}$ TDS), with over half containing high concentrations of soluble iron ($>5\text{ mg l}^{-1}$ and up to $>200\text{ mg l}^{-1}$), aluminium ($>80\text{ mg l}^{-1}$ and up to $>200\text{ mg l}^{-1}$) and manganese ($>5\text{ mg l}^{-1}$ and up to $>40\text{ mg l}^{-1}$).

Some acidic waters also contained high concentrations ($>0.5\text{ mg l}^{-1}$) of trace metals such as lead (Pb), copper (Cu), zinc (Zn), nickel (Ni), uranium (U) and rare earth elements (REE).

Similar salinity, acidity, and concentrations of elements were also found to be present in the regional groundwater (not directly impacted by drainage). The trace element chemistry of the acidic drain waters is dominated by dissolved iron and aluminium, with iron considered to play a major role in the formation of low pH in groundwaters, drains and lakes.

Complex geochemical processes also occur within drains that play a role in influencing the acid and trace metal transport within drains. Several key processes identified by soil studies include: formation of sulfidic sediments that can store acidity (but may subsequently release this); precipitation of iron and/or aluminium oxyhydroxide and oxyhydroxysulfate minerals (e.g. akaganéite, schwertmannite, jarosite) that can store acidity and influence trace metal concentrations in drain waters; and precipitation of a range of sodium (Na), calcium (Ca) and magnesium (Mg) salts, some of which contain high concentrations of trace metals. These processes play a major role in influencing transport of acidity and trace metals from the drains and vary with season and drain ageing processes. For example, during summer-autumn, drain pH can decrease due to a combination of evaporation of drainage waters (confirmed by modelling) and minerals forming or dissolving.

Geochemical modelling showed that there may be limited neutralisation of acidic drainage waters (and acidic waters stored in lakes) by high pH floodwaters, typically the volume of floodwater needs to be up to 99 times that of drainage waters to achieve a neutral pH.

Over 50% of the reference lakes and lakes receiving acidic drainage in the Avon contained acidic waters frequently less than pH 4. Some acidic reference lakes may have been acidic since before landclearing began, however there is evidence in the sediments that some lakes may have only acidified in recent times, most likely because of increased regional acidic groundwater discharge. This increase may be continuing in some parts of the Avon catchment. Those Lakes which receive acidic drainage waters were all acidic, however these appear to be geochemically similar to acidic reference lakes (not receiving acidic drainage). A characteristic of all acidic lakes was that a lot of acidity is stored in bed sediments and soils of the beach zones.

The risks outlined in this project contain a number of implications for the management of drains intercepting acidic groundwaters. The broad distribution of acidic groundwaters highlights that any activity involving drainage or pumping of saline groundwater from the palaeodrainage systems of the Avon catchment should consider the likelihood of acidification or the interception of acidic groundwaters and the risks that these may carry. It is recommended that on-site characterisation of acidic groundwater risk be carried out as part of preliminary investigations. The design of drains in areas with acidic groundwaters should focus on maintaining minimal flow velocities and avoid flushing of acidity and trace metals. It will also be necessary to consider management of sediments removed during maintenance of drains to minimise transport back into the drain or surface waterways during rainfall run-off events. Selection of disposal sites for acidic drainage waters will need to consider the storage of acidity that will occur in sites and the risks to down-stream environments should acidity and trace metals be flushed downstream. Floodwaters may provide some capacity to neutralise acidic drainage waters, though only if present in substantial volumes and if the flooding occurs frequently to minimise accumulation of acidity in the soils of storage sites. Treatment of waters may be necessary in the context of managing risks of acidity and trace metals to downstream environments.