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Shallow drains for reducing waterlogging and salinity on clay flats

By Don McFarlane, Tim Negus and Arjen Ryder

Flooding, waterlogging and salinity are problems which commonly occur together on the broad valleys of the wheatbelt.

Drainage lines often become poorly defined once they reach the valleys and flood waters spread out, causing inundation and waterlogging.

This excess water needs to be controlled because it contributes to salinity.

Managing surface water on large catchments

The methods that have been tried to manage flood waters in valleys have included stopping the water before it reaches the flats, using levees to channel the water through the flats and draining surface ponded water after it has accumulated on the flats.

A recent study (Davies et al. 1988) has shown that level and absorption banks need to be close together and strategically located to have much effect on flooding during the largest floods (for example, one year in ten). As these banks are now known to increase salinity (see 'Level banks used to decrease waterlogging can increase salinity' on page 74), this makes it both expensive and hazardous to try to stop the flood waters from entering the valleys.

The study found that levee banks can be effective in controlling flood waters. However, the banks need to be high, continuous and well designed to withstand large floods. Confining the flood waters increases their velocity, which can cause problems at road and rail crossings. However, spacings can be widened at these sites. Scouring and silting are also common inside the channels.

Successful examples of the use of levee banks can be seen in the Wogerlin Creek catchment near Wickepin. Levee banks are expensive and require the cooperation of all landholders as well as local and State Government authorities. They are warranted when valuable assets such as buildings are threatened.

Given the difficulties in preventing flood waters entering the valleys or of confining them inside levee banks, we often accept that the valleys will be periodically flooded and install drains to remove the water after ponding. Even if flood waters are controlled, local waters that build up from rainfall on the flats may need drainage.

W and spoon drains

W drains have an excavated channel on either side of a central spoil bank (Figure 1). Water enters the channels from both sides. While vehicle access can be disrupted by the bank, it is possible to flatten it to form a roadway which improves access on the flats in wet weather.
Spoon drains have the spoil from the channel spread or scattered away from it so that the soil does not prevent water from flowing into the channel (Figure 1). If a scraper is used to construct broad spoon drains the excavated soil can be used to fill in depressions. Machinery can be worked across the drains which helps water flowing down cultivation furrows to enter the channel.

Areas requiring drains are best marked out when there is water lying in ponds on the flats. The low points are marked and the best layout of W or spoon drains planned. The high points along the drains are surveyed to determine the amount of excavation to achieve a sufficient grade between the low points (Negus 1984).

If water ponds on the flats in thin sheets then it is possible to install parallel spoon drains oriented in the direction of maximum fall. These drains (called laterals) discharge their water into collector drains which in turn discharge into main drains. Further details of parallel drains and bedding drains are provided in McFarlane et al. (1985).

Drain flows
At Mt Barker, Cox (1989) found that a spoon drain removed 5 per cent of annual rainfall in a below average rainfall year (535 mm), 19 per cent in a slightly wetter year (548 mm) and 29 per cent in an above average rainfall year (710 mm). The percentages of rainfall removed by the spoon drain exceeded that removed by seepage interceptor drains in the same catchment (see ‘Seepage interceptor drains for reducing waterlogging and salinity’ on page 66). As for interceptor drains, the percentage of rainfall removed by spoon drains increases rapidly as rainfall increases.

At Wickepin, flow in a spoon drain on a grade of 0.25 per cent was monitored for three years, all of which had rainfall below the average of 415 mm.

In 1986, 1.5 per cent of the 345 mm of annual rainfall was removed by the drain. The corresponding figures for 1987 and 1988 were 1.3 per cent (352 mm rainfall) and 1.5 per cent (366 mm rainfall). Although these percentages are small, the run off takes place in one or two storms and represents a lot of water when spread over a large area. These percentages are similar to those reported for seepage interceptor drains at Narrogin in a higher rainfall area (see ‘Seepage interceptor drains for reducing waterlogging and salinity’ on page 66).

Effect of the drains on waterlogging
Oat yields around a spoon drain at Mt Barker were variable, which reflected variations in soil properties. However, beside the drain the yields ranged from 2 to more than 4 t/ha, whereas several areas more than 20 m from the drain yielded 1 to 2 t/ha.

At Wickepin, the drains did not have a significant effect on wheat yields in three below average rainfall years when waterlogging was not a problem. Importantly, the areas of disturbed soil around the drains did not reduce crop yields.

Effect of the drains on salinity
By removing large volumes of water at Mt Barker, the spoon drain must be reducing the amount of recharge to underlying groundwaters. Draining the water that perches on the clay subsoil reduces the likelihood that it will drain down old root channels to the groundwater.

Reducing the waterlogging will increase the amount of water used by both crops and pastures, which will also reduce the amount of recharge.
At Wickepin, the possibility that the drains will reduce recharge was closely examined. Saline groundwaters are within two metres of the soil surface under the drainage site (Figure 2).

The levels under one area rose within hours of rain. In this area the watertable had a large seasonal rise and fall in level of 1.2 m and the salinity of the upper metre of the groundwater fell each winter. All these factors are signs that fresh water is recharging the groundwater each winter, bringing the saline groundwaters closer to the surface.

To test this suggestion, soil pits were dug in this area (Site A) and in another area (Site B) where there was a lower seasonal rise and fall in groundwater levels and salinities.

The soil at Site A had zones of very low and very high soil salinities. This may be the result of recharge occurring down pathways such as old root channels. At Site B, the soil salinities were more uniform. Recharge may be occurring in this area as slowly moving wetting fronts. Plant roots may be able to take up this slow moving water more easily than the rapidly moving water in pathways at Site A.

In areas where there is rapid recharge and saline groundwater within two metres of the soil surface, drains must be installed to remove ponded water. The drains are worthwhile if they delay or prevent the site going saline.

In the USA, drains are recommended to remove any water that ponds for more than 24 hours on recharge sites for salinity. Recharge occurs in most upland and lowland areas in Western Australia, so extensive drainage would be needed here to meet the USA criteria.

Groundwater levels at the Wickepin drainage site have risen appreciably since 1985 and areas are now salt-affected (Figure 2). This shows that the present drains were installed too late, were not close enough or could only delay the onset of salinity.
Now that the site is salt-affected, waterlogging control is even more important if plants are to grow. (See 'Plant growth and survival on saline, waterlogged soils' on page 56.)

Conclusions
Although there is still little quantitative information about the effect of W and spoon drains on waterlogging and salinity, there is enough information to recommend them when waterlogging is a problem on poorly drained flat land.

The fact that the ponded water may be contributing to salinity is an added incentive to remove it.

The application of gypsum to responsive clays can reduce ponding and increase plant growth, which will reduce the need for drains.

There are legal implications associated with the disposal of drainage waters which need to be carefully considered when planning drainage schemes (see Robertson, 1985). It is a good idea to involve neighbours at an early stage and to design the drains by first choosing a safe outlet, then working back from this outlet to higher points in the catchment.

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References


