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Drainage prospects for saline wheatbelt soils

By P. R. George, Research Officer, Salinity and Hydrology Research Branch

Sub-surface or groundwater drainage by buried tube drains or open ditches can reclaim saltland in the Western Australian wheatbelt. However, this method is expensive and not all sites can be drained cost-effectively. Each drainage site is unique, so careful investigation of each site is essential before recommendations on drainage method and design can be made.

The site topography should be suitable for the proposed drainage system. Effective outlets and safe disposal of drain effluent should be available or able to be created.

Soils that have been salty for a long time and seriously degraded by the removal of topsoil through wind and water erosion will respond extremely slowly to drainage. Where there is a choice of sites, priority should be given to draining sandy surfaced soils and marginal or newly salinised areas.

Permeable zones should be present to ensure adequate water flow to the drains and the drains should be placed in these zones. In some salty soils permeable layers will be too shallow to allow drains to adequately control the watertable. In other areas installation of drains will not be feasible because the permeable layers are too deep. These areas, however, may respond to pumping the aquifer.

Drainage to control the watertable is a starting point in saltland reclamation. To be effective, reclamation will require a combination of:
• surface soil improvement to improve infiltration through cultivation, the addition of gypsum or the establishment of plant cover;
• improved surface water control on both flat land and on slopes; and
• controlled grazing.

Critical depth

Soil salinity results from the movement of salts from a shallow, salty watertable towards the surface. Sub-surface drainage can reclaim saltland by draining off excess sub-surface water (called groundwater) to keep the watertable below a critical depth.

The critical depth is the distance that the watertable must be below the surface to prevent capillary action from bringing salt into the surface soil. When the watertable is kept at or near this depth, the soil is sufficiently well drained to allow rainfall to leach salt from the surface.

The critical watertable depth is not constant but varies with soil type, watertable salinity and plant cover. In the Western Australian wheatbelt the watertable should generally be about 1.5 metres below the surface during late spring to avoid salt problems. For coarse sands
and some heavy clays, 1.0 to 1.2 m may be sufficient. For some silty or loamy soil types, however, the watertable may have to be kept three or four metres below the surface.

When plant cover is good and can be maintained, or mulches are used, the watertable can be closer to the surface.

Sub-surface drains, therefore, must be deeper than the critical depth to control the watertable and allow leaching of salts.

Site assessment
Site assessment for drainage must consider the following site characteristics:
- disposal of effluent,
- topography,
- soil types and soil horizons, and
- groundwater conditions.

Before tube drains were laid at this Northam site, drainage lines and grade controls were surveyed with laser equipment.

Disposal of effluent
In the early stages of planning, consideration must be given to disposal of drain effluent with the likely depth of drain in mind. Deciding on suitable disposal methods includes both the physical and legal aspects of disposal.

In flat valleys long disposal drains which may involve works in neighbouring farms will be needed to obtain a gravity outlet. Written agreements from neighbours should be obtained before proceeding with any works. Inadequate drain depth forced by deficient disposal arrangements can negate the benefits of drainage. Because effective disposal may require the pumping of highly saline water, maintenance and running costs must be included in the budget.

Seepage flows from drainage systems will be a low volume, continuous supply and frequently highly saline. Local salt lakes can be useful evaporation basins for the disposal of this water, although in the long term, problems could arise with isolated salt lakes. Initial planning should include the feasibility of using these areas for disposal.

Early drainage planning should ensure that effluent disposal arrangements will be satisfactory, and that legal responsibilities have been met before you proceed further with drainage investigation and installation.

Topography
The topographic survey provides the framework for all aspects of the site assessment and is the basis for the specific drainage plan for the site. Investigation of the topography should include a reconnaissance survey of the surrounding catchment using aerial photographs and a contour plan of the site.

The topographic survey determines whether gravity outlets are available and thus what limitations are imposed on drain depth. In many flat valleys, pumped outlets which lift drain effluent to the surface will be needed to enable adequate drain depth. This will affect both the initial and the running costs of the drainage project.

For tube drains minimum grades of between 0.2 per cent (1 in 500) and 0.1 per cent (1 in 1000) are needed. In flat land the drainage pipe will have to be installed at grades steeper than
the natural fall. A contour grid is needed to ensure that the available fall is used. Once the decision to drain the site has been made, each drain line should be surveyed so that the correct grade can be set to maintain adequate drain depth. Water from the surrounding catchment will affect the wetness of a salt-affected area. A saline site can rarely be drained effectively unless some of this runoff is controlled. Excess surface water on the site will overload a tube drainage system and can cause severe silting of open drains. Improved surface water control, by such things as grade banks on the surrounding slopes and by improved surface drainage of the site, is a vital part of the whole catchment approach to reclaiming saline areas.

Soils
The soil survey should include an examination of surface soils and sub-surface soils. Experience has shown that sandy surfaced soils are more responsive to drainage than the heavier soil types. Soil salts leach readily from sandy soils but clay surface soils have low infiltration rates and these may decrease because of loss of soil structure after salts have been removed. Deep cultivation combined with gypsum treatment may be needed to improve the permeability of the clay topsoil. Such treatments add to the cost of drainage but are essential for improved drainage on heavy soils. Clay soils which have been saline for a long time will be exceedingly difficult to reclaim because of severe degradation from the effects of salt and erosion by wind and water. Sites that respond to drainage are thus likely to be sandy surfaced soils and sites which are just beginning to show the effects of salinity.

A sub-soil investigation is important to determine the profile characteristics that will affect groundwater flow, such as soil hydraulic conductivity, soil texture and the depth of permeable or impermeable layers. This information is essential for calculating the best spacing and depth of a system of parallel drains. Back-hoe pits two to three metres deep are an ideal way of investigating the sub-soil horizons. Permeable layers where water rapidly seeps into the back-hoe pits are readily detected and drains should be placed in these layers. If the permeable zones are deeper than about 1.8 m, open drains built with an excavator will be required because tube drains are difficult to install at such depths. Inspection of the pits will also indicate layers above and below the intended drain depth that may restrict flow to the drains. An impermeable layer above the drain may need treatment to improve leaching and infiltration. The depth of an impermeable layer below the intended drain depth is needed to calculate drain spacings. During these careful soil investigations, naturally occurring hardpans, shallow rock and wet areas that may interfere with installation (especially of tube drains) will be noted and allowed for in the design. In this way costly installation problems and delays can be avoided.

Groundwater
Groundwater investigations should determine watertable depths and salinity and whether the site is affected by artesian seepage. Knowledge of watertable depths and seasonal fluctuations will help determine an appropriate drain depth. Groundwater salinity should be checked to determine whether effluent disposal will be a problem or whether the drainage water is suitable for stock use.

The presence of strong upward seepage should be checked if necessary by deep drilling. The presence of continuously wet seeps is an indication of artesian conditions. Such areas are difficult to drain with tube or open drains. Drains usually have to be installed deep and at close spacings to intercept seepage water before it reaches the surface. Seepage waters frequently contain high levels of iron which will precipitate in pipes and block them. Costly maintenance by regular flushing of drains will be required to keep them working.

The formation of iron films (which look like oil films) on water issuing from seepage areas or iron and corrosion problems with nearby windmills and bores, are indications of potential iron problems.