Monitoring groundwater and soil salinity

Why monitor salinity

Salinity in Tasmania is generally visible by the loss of improved pasture species and an increasing density of Sea Barley Grass, Buck's Horn Plantain and salt scalds in drainage lines. In cropping areas, we see lower density and reduced vigour of crops. However, because the changes in salinity occur slowly, over decades, it is often difficult to determine whether the area of salt-affected land is changing.

Irrigators in the drier areas of the State are also concerned about the effects of cropping and irrigation on soil salinity, such as slow increases in subsoil salinity levels that will not be apparent for some years. This is particularly so in Tasmania, where clay subsoils with lower hydraulic conductivity will slow the process and expression of salinity.

Soil salinity can be measured accurately, so changes in salinity can be monitored objectively. We recommend that farmers concerned about the possibility of long-term increases in salinity levels implement monitoring using one or more of the techniques described in this Technote.

There are three types of monitoring techniques: soil sampling and analyses; groundwater (depth and salinity); and electromagnetic (EM) surveying.

1. Soil sampling and analysis

Soil sampling and analysis provides a direct measure of changes in the salt content of the soil. Key issues are where and when to sample.

Where to take samples. The salinity of surface soils is generally very variable, so it is best to take samples within 1 m of the same place at each sampling. Select 3–4 sites that you can relocate, using either pegs or fixed reference points. A hand-held GPS unit could also help, although the accuracy is less than desirable. Keep all samples separate and clearly labelled in preparation for analysis.

When monitoring to assess whether the saline area is expanding, avoid sampling in the most saline areas. Preferably, take samples near the perimeter of scalds and into nearby land that appears unaffected by salt.

Sample depth. Take a surface sample, either 0–7.5 cm or 0–10 cm. Also sample the subsoil, either from a selected depth (say 40–50 cm), or the surface of the clay in a duplex soil profile. A 50 mm Jarrett auger is ideal for sampling the subsoil, although a spade and tape measure will do. Alternatively sampling at 10–20 cm increments to 1.5 metres and analysing all the samples is the ideal, as it can show the movement of salt through the profile over time. This is a laborious procedure but use it if detailed monitoring is required.

When to sample. It is important to sample at the same time each year. The best times are early autumn before opening rains (when salinity levels will be highest), or early spring (salinity levels at their lowest). If the subsoils are likely to be saturated in spring, then early autumn will be best simply because it is difficult to sample saturated soils.

Measuring salinity. Salt levels in soil are easily measured by determining the electrical conductivity (EC) of a soil-water suspension. The recommended procedure is to dry, then grind or crush a small sample of soil (a teaspoon is sufficient volume), then mix it with distilled or rain water in proportions of 1 part soil to 5 parts water (by volume). Make sure the sample is thoroughly dispersed, allow the suspension to stand so that heavier minerals can settle, then measure the EC with a hand-held Conductivity Meter (retail for around $150). Make sure you allow a minute or so for the meter to stabilise. The result is called an $EC_{1:5}$ level.

Alternatively, laboratories that handle soil samples routinely conduct $EC_{1:5}$ analyses for around $15/sample or less.

Changes in the $EC_{1:5}$ reading will directly represent changes in soil salinity levels. However, interpretation of the impacts of the $EC_{1:5}$ level is not as straightforward. The impacts depend heavily on the soil texture. The same $EC_{1:5}$ level will have a much more severe effect on plant growth in a sandy soil than in a clayey soil (see DPIWE Saltpak[1]).

2. EM surveys

Researchers have developed techniques for measuring the salt load of soils to various depths using Electromagnetic induction techniques. An EM31 machine will measure apparent conductivity (ECa) to around 5 metres and an EM38 to around 1.5 metres.

[1] McMahon, S. and Bell, I. Saltpak Tasmania. DPIWE

The EM signal is affected by many factors including soil moisture, so measurement at the same time of the year is recommended. Soil sampling is usually conducted to calibrate the machine and reduce variation from other influencing factors. As EM equipment allows rapid surveying of large areas, it is appropriate to survey entire paddocks or transects across salt-affected areas to nearby land that is not affected. Measurement at intervals of 3 years is appropriate.

This technique is used by specialist consultants, and the instruments are expensive. As a result, EM is at present being used mainly for investigations.

3. Groundwater monitoring

The most significant salinity risk in Tasmania is associated with a gradual long-term rise in the level of a saline water table, bringing salt into the root zone of crops and pastures. Monitoring groundwater levels is therefore a reasonable and practical way of assessing changes in salinity risks.

Groundwater levels are best measured with a piezometer. This is a type of bore where water can only enter from selected zones below the soil surface. A typical construction is shown in Figure 1.

For monitoring in agricultural situations the piezometer should be around 5 metres total depth. Bores are generally drilled with a rotary auger with a 100 mm drilling bit. A 50 mm PVC pipe slotted with a fine hacksaw over the lowest 1 metre section is capped and placed in the hole, then backfilled with gravel (8–10 mm screening) to the top of the slotted section. Use a tape or measuring stick to ensure the gravel backfill is to the top of the slotted section of pipe.

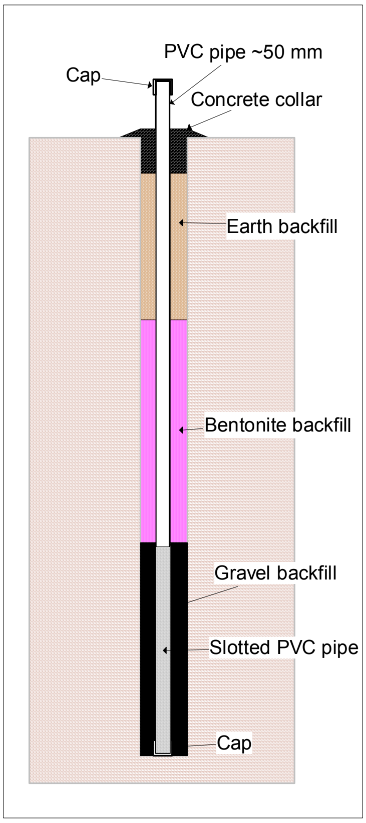
About 5 litres of granular or pelleted bentonite (sealing clay) should then be placed around the pipe; this will stop any water from higher in the soil profile leaking into the gravel layer. The bentonite should be wetted with some water to initiate swelling, and earth then used to backfill to the surface.

A concrete collar is recommended around the pipe at the surface to help shed water away. The PVC pipe should then be capped and labelled and finally protected from stock with fencing, car tyres or a steel disc. Any water poured down the exterior of the PVC pipe to activate the swelling of bentonite, which then seeps in to the bore, needs to be baled out before commencement of monitoring.

Groundwater levels fluctuate during the year, so either read the levels at the same time each year (late summer when levels are lowest, and early spring when highest), or read regularly at intervals of 1–3 months.

Levels are easily measured with a “plopper” on a tape (consult NRM staff for advice on making or buying a plopper). The plopper can also be used to take a water sample for conductivity measurement. Ideally the water in the piezometer should be bailed out several times and allowed to stabilize before taking a sample for EC measurement. Simple bailers can be purchased.

Figure 1. Piezometer installation



Piezometers provide short-term information about the groundwater, but their main use is for long-term monitoring. Groundwater levels and salinity need to be monitored over many years to determine trends, so only install piezometers if you are prepared to take readings for a number of years. Remember, record the depth of the water below ground level, allowing for the PVC pipe that protrudes above the ground.

Other monitoring procedures

Photopoints are simply reference points that are photographed regularly (say every 2 years at the same time each year), so that changes in the extent of salt-tolerant plants, for example, can be documented.

GPS survey of salt-tolerant pasture areas. It is sometimes considered possible to map the boundary of salt-tolerant pasture species (e.g. Sea Barley Grass) with a hand-held GPS unit. The inherent variability of soil salinity does, however, result in this being an unreliable and difficult procedure.

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