

How does soil become saline?

Salt is present naturally in our soils, surface water and groundwater systems. Changes to the landscape in many areas have resulted in the redistribution and accumulation of salt at or close to the soil surface. Rising water tables carry dissolved salts found in the soil toward the soil surface. When the water table rises to within two metres of the soil surface, water can rise through the plant root zone to the surface by capillary action. As the water evaporates from the moist soil surface, it leaves the salt behind. Over time, this salt accumulates at the soil surface and in the root zone. Where this process occurs in the landscape the area is called a discharge site. Discharge sites display characteristic changes to soil, water, vegetation and infrastructure such as buildings.

What is a saline soil?

A soil is said to be saline when it has enough of any soluble salt to affect plant growth. The salinity status of a soil can be classified using the salinity levels outlined in Table 1. Plants vary in tolerance to salinity.

Table 1: Salinity levels and class

Class	Level of salinity	EC _e (dS/m)
Class 1	Slightly saline	1.5 – 2
Class 2	Moderately saline	2 - 6
Class 3	Highly saline	6 - 15
Class 4	Extremely saline	> 15

Source: NSW Agriculture (2003)

What salts are in soil?

A salt consists of a group of ions with an electrical charge (an ion is an atom that has lost or gained one or more electrons). If positively charged they are called cations and if negatively charged they are anions. Table 2 shows the cations and anions commonly found in soil, the salts they form and the risk they pose to plants. When we measure salt content with an 'EC' meter we are measuring the total salts that are in solution, irrespective of what they are.

Table 2: Salts commonly found in soil and the risk to soil and plants

RISK	Anions				
	Chloride (Cl ⁻)	Sulphate (SO ₄ ²⁻)	Bicarbonate (HCO ₃ ⁻)	Carbonate (CO ₃ ²⁻)	
HIGH MEDIUM LOW					
Cations	Sodium (Na⁺)	Sodium Chloride (NaCl) Table Salt	Sodium Sulphate (Na ₂ SO ₄)	Sodium Bicarbonate (NaHCO ₃) Baking Soda	Sodium Carbonate (Na ₂ CO ₃)
	Magnesium (Mg⁺⁺)	Magnesium Chloride (MgCl ₂)	Magnesium Sulphate (MgSO ₄) Epsom salts	Magnesium Bicarbonate (Mg(HCO ₃) ₂)	Magnesium Carbonate (MgCO ₃)
	Calcium (Ca⁺⁺)	Calcium Chloride (CaCl ₂)	Calcium Sulphate (CaSO ₄) Gypsum	Calcium Bicarbonate (Ca(HCO ₃) ₂)	Calcium Carbonate (CaCO ₃) Lime

Source: Wild, J., Howarth, C. and Conyers, M. (2004)

Some salts are more soluble than others. Chloride is the most soluble anion followed by Sulphate, Bicarbonate and Carbonate. Sodium is the most soluble cation followed by Magnesium and then Calcium. Water table rise and capillary action will lead to the accumulation of the most soluble of these salts on the soil surface. For that reason Sodium Chloride is usually the first salt to accumulate and the most common salt present at saline discharge sites.

How does salt affect plant growth?

Salt of any sort present in sufficient quantities will impact on plant growth. Salt can interfere with plant growth in three ways:

1. **Salt exerts an osmotic effect** preventing plants from taking water from the soil
2. **Specific ions can be toxic** to plants for example high chloride levels in irrigation water can cause leaf burn, particularly with foliar application of water
3. **Specific soil effects** which impact on plant growth by either degrading soil structure or improving it

Which of these three processes affects a plant first depends on the circumstances.

How do I know if my soil is saline?

Look for visual indicators of a potential salinity problem which include: changes to soil structure and appearance (soil becomes white encrusted at the surface, or unusually powdery when dry); changes to vegetation cover, composition and health (decreased growth, bare patches); and the presence of indicator plants (such as strawberry clover and sea barley grass) which are tolerant to waterlogged and saline conditions. Another useful guide in the field is position in the landscape as salinity outbreaks often occur at break of slope and at topographic bottlenecks (constrictions in catchment drainage).

If you suspect you have a problem, initial field investigations can be performed using a pocket 'EC' salinity meter¹. These tests should be undertaken as a **guide** as to whether more intensive investigations and laboratory testing are necessary. Do not rely on just one field indicator or test to conclude salinity. Best to back it up with a lab test on the soil as there are a few circumstances where field appearance can be misleading.

For whatever reasons you conclude salinity, you should follow up with comprehensive and representative sampling over time to identify trends and assess management change.

Where to sample?

The following information, if available, is useful as a guide in selecting sampling sites:

- Visual indicators of salinity
- Aerial photos showing waterlogged or saline areas
- SPOT5 satellite photos (false infrared colours show up reduced plant growth in a paddock well)
- Cut and fill maps showing sodic or saline subsoil
- EM (electromagnetic) maps which are used to estimate and map areas of high and low electrical conductivity (but these can be difficult to interpret without further soil testing)

If none of the above are available an 'x' or 'z' sampling pattern could be used (Figures 3 and 4).

When collecting samples from a potential discharge site take an auger sample from each of the depths indicated in Figure 1. Collect separate samples from the saline and non saline area as shown in Figure 2.

When paddock sampling, collect samples in a defined pattern so that sampling can be repeated over time. Commonly an 'x' or 'z' pattern is used as shown in Figures 3 and 4. Samples can be bulked together for an overall picture or kept separate and tested individually for a more detailed site assessment.

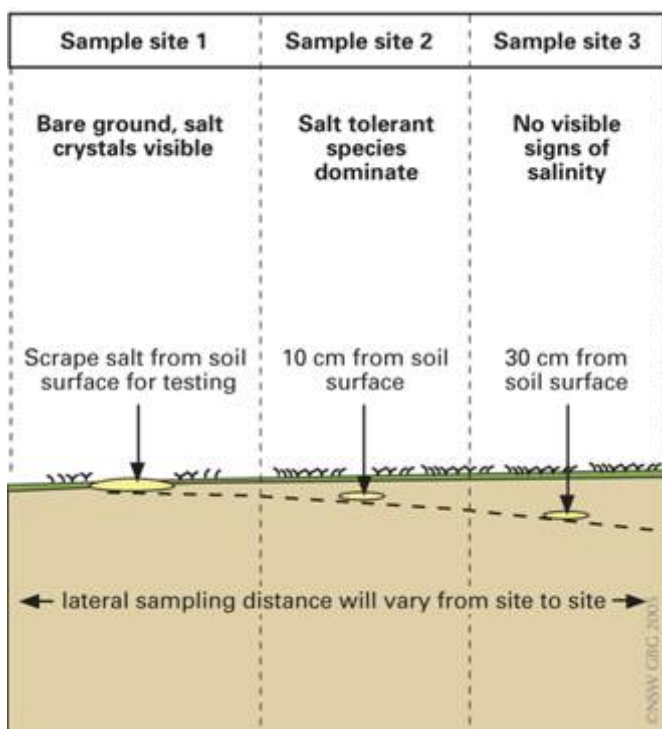


Figure 1: Soil sampling method for potential saline discharge site. **Source:** NSW Agriculture (2003)

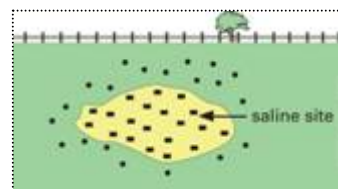


Figure 2: Sampling a potential saline site. **Source:** NSW Agriculture (2003)

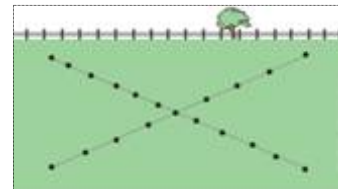


Figure 3: 'X' pattern for bulk sampling. **Source:** NSW Agriculture (2003)

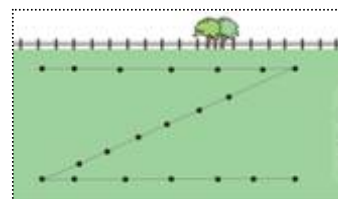


Figure 4: 'Z' pattern for bulk sampling. **Source:** NSW Agriculture (2003)

References:

Information presented in this factsheet has been obtained from and forms a supporting resource to the *The Salinity Glove Box Guide - NSW Murray and Murrumbidgee Catchments* compiled by Deb Slinger and Kathy Tenison as referenced below.
Slinger, D. and Tenison, K. (2005). *Salinity Glove Box Guide - NSW Murray and Murrumbidgee Catchments*. An initiative of the Southern Salt Action Team, NSW Department of Primary Industries.

Wild, J. Howarth, C. and Conyers, M. (2004). *The risk to plants and soil from different salts*. Unpublished.

We recognise the contribution of Janet Wild to editing this document.

Disclaimer: The information in this publication is based on knowledge and understanding at the time of writing (Oct 2005). However, because of advances in knowledge, users should ensure that this information is up to date with the appropriate NSW DPI advisor or an independent adviser.

¹ See Salt Reading 'How to test soil salinity' for further information or seek advice from the appropriate officer with NSW Department of Primary Industries