

Soil Health for Waterway Health

Why soil health matters

Soil health and water health are closely connected. Healthy soils filter, store and slowly release water across the landscape, supporting cleaner waterways and reducing erosion. A 1% increase in soil organic matter can store up to 0.19 megalitres of extra water per hectare, acting as a natural climate-resilient reservoir in agriculture (Seed IQ). Poor soil health increases runoff which in turn can increase erosion and nutrient loading that pollute streams and rivers. Understanding this connection is essential for sustainable land management and resilient catchments.

Landholders also have a statutory responsibility not to pollute waterways under the *Protection of the Environment Operations Act 1997* (NSW) (POEO Act), “Pollution” includes adding substances to water that change its condition or placing material where it could wash into waterways (e.g. soil runoff, waste, manure, chemicals).

How Water Moves Through the Landscape

The Hydrological (Water) Cycle

All water on Earth is continuously recycled through the hydrological cycle. Water evaporates, condenses into clouds, falls as precipitation, and then either runs off the land surface or infiltrates the soil. Processes associated with the movement of water include:

- Infiltration and percolation: When rain enters healthy soils, it moves slowly downward, recharging groundwater and aquifers
- Runoff: Compacted or bare soils limit infiltration, causing rapid surface runoff, erosion and can contribute to downstream flooding
- Transpiration: Plants take up groundwater and return it to the atmosphere through their leaves, completing the cycle

Although more than 75% of Earth is covered by water, less than 1% is available as freshwater—making protection of soils and catchments critical.

In catchments, water from many creeks and paddocks flows toward rivers. Along the way it can carry sediment, nutrients and contaminants. Improving soil condition upstream reduces risks downstream.

The Role of Healthy Soils

Soil health can be defined as the continued capacity of soil to function as a living ecosystem that sustains plants, animals and people.

Healthy, biologically active soils provide key ecosystem services, such as:

- Regulating, cycling, storing and supplying water and nutrients
- Supporting food and fibre production from agriculture and native vegetation

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- Providing habitat for plants, animals and soil microbes
- Detoxifying pollutants and suppressing pests and diseases
- Reducing greenhouse gases by storing carbon in organic matter

These services are controlled by soil physical (structure, aggregation, infiltration), chemical (nutrients, pH) and biological (microbes, roots, organic matter) properties.

Soil-Related Water Quality Risks

When soils are degraded, nutrients, sediment and contaminants move more easily into waterways.

Key Water Quality Concerns

It's important to note that these water quality concerns are interconnected. A change in one stressor can compound the effects of the others, leading to broader water quality decline.

- Nitrogen (N):
 - Nitrate (NO_3^-) is highly mobile in the landscape, at high levels it can leach into groundwater, which serves as a source of drinking water for many communities. Livestock manure is rich in nutrients particularly nitrogen and phosphorus, when improperly managed these nutrients can runoff into surface waters such as creeks and rivers.
 - Excess nitrate threatens drinking water quality and human and animal health.
- Phosphorus (P):
 - Lost mainly through surface runoff attached to soil particles or dissolved in water.
 - Excess phosphorus loads in waterways contribute to algal blooms, which in turn can lead to oxygen depletion and fish kills.
- Sedimentation:
 - Poor soil health and reduced bank vegetation can lead to increased erosion of the water edge, which in turn increases sedimentation.
 - Soil erosion reduces water clarity and damages aquatic habitats.
 - Through increased sedimentation Nitrogen and Phosphorus are able to enter the waterways and reduce the water quality.
- Pesticides:
 - Can move via runoff such as cracks and macropores, especially in compacted soils. This typically occurs when chemical breakdown is slow.
 - The use of pesticides can result in the release of heavy metals such as cadmium, lead, and zinc, among other metals to runoff into water bodies resulting in a disturbance to aquatic ecosystems.

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- Pathogens:
 - Similarly to pesticides, pathogens can also move into waterways via runoff through cracks and macropores in compacted soils.
 - Livestock manure contains bacteria and pathogens such as (E. coli and Salmonella, and Cryptosporidium). If manure is not adequately contained or treated, it can wash into surface waterways during rainfall events or leach into ground water stores through cracks in the soil. This can result in waterborne diseases for organisms that consume or come into contact with the contaminated water.

Links Between Soil Health and Water Quality

Water quality concern	Typical risk pathway	Key soil health implication
Nitrogen (groundwater)	Nitrate leaching	Excess nitrate leaching reduces soil nutrient cycling efficiency, weakens drainage capacity, and reduces water-holding potential. Leading to poorer soil structure and reduced plant growth.
Phosphorus (surface water)	Dissolved and particulate P in runoff	Phosphorus runoff disrupts soil aggregation and increases P saturation, which can limit microbial activity and reduce the soil's ability to store and filter water effectively.
Sediment (surface water)	Runoff and erosion on bare/compacted soils	Erosion removes topsoil and organic matter, degrading aggregation and infiltration. This reduces soil stability, water absorption, and long-term fertility.
Pesticides	Leaching/runoff when breakdown is slow	Persistent pesticides harm soil biological activity by reducing microbial diversity and enzyme function, slowing organic matter decomposition and nutrient cycling.
Pathogens	Rapid transport via macropores	Pathogen movement through macropores indicates poor soil structure and excessive preferential flow, which bypasses filtration zones and weakens soil filtration.

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Protecting Soil and Water Together

While predicting catchment-scale water outcomes from individual soil indicators remains challenging, strong evidence links good land management with improved soil condition and reduced water risks. Management approaches should always be adapted to local soil types, landscapes and climates.

Healthy Land, Healthy Water Principles

- [Protect groundcover](#) by maintaining vegetation or residue to reduce erosion and improve infiltration.
- [Promote soil health management](#) by building organic matter, you improve soil structure and support biological activity.
- Protect stream corridors by maintaining fringing vegetation to filter runoff and stabilise banks.
- Limit stock access to waterways by fencing and off-stream watering to reduce sediment and nutrient inputs.
- Implement nutrient and pest best practice by matching inputs to plant needs and conditions to minimise losses.

Key Message

Healthy soils act as a natural filter and sponge—slowing, cleaning and storing water. Investing in soil health is one of the most effective ways to protect waterways, improve farm productivity and build resilient landscapes.

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