How to design a network of piezometers on your farm

Key messages

- A network of piezometers enables the measurement of groundwater level and nitrogen across an area/farm.
- The pattern of the piezometers depends on the ground topography.
- Designing a network of piezometers can be difficult, and professional advice is recommended.

Introduction

Installing a network (series) of piezometers on your farm allows the regular monitoring of groundwater levels and nitrogen across an area. Refer to "**6. How to construct piezometers for monitoring groundwater on your farm**" and "**3. How to monitor groundwater quality on your farm**" for further information on piezometer construction and groundwater monitoring. Groundwater level monitoring helps in assessing groundwater flow direction, whereas groundwater sampling for nitrogen analysis helps to determine whether nitrogen losses may be occurring. Knowing the groundwater flow direction and the nitrogen content in groundwater helps you understand how the nitrogen leached to groundwater is moving.

What is an aquifer?

Groundwater flows in aquifers that are sediment reservoirs (e.g., sandy loam, sand, gravel) with relatively high hydraulic conductivity (where water easily moves through soil pores).

Aquifers (Figure 1) are:

- bounded at the bottom by low-permeability layers (e.g., clay)
- can have variable depth and thickness
- can be directly recharged by rainfall.

When aquifers are directly recharged by rainfall, they are called unconfined aquifers.

What needs to be considered?

This factsheet refers to installing a piezometer network in unconfined aquifers that are less than 2.5-3.0 m from the ground level. Deeper installations may require specific machinery and a licenced bore driller, which are not discussed in this fact sheet. Refer to "**7. How to install piezometers on your farm**" for further information on the installation of piezometers.

Installing a network of piezometers requires a preliminary investigation that can be performed using online databases containing information on the aquifer type and water levels of existing groundwater bores (e.g., Queensland Globe).

However, a hydrogeologist or extension officer should be consulted for a preliminary investigation, to design a piezometer network, and to determine the direction of groundwater flow.

How to assess the site

A site investigation is required to assess a farm's suitability for installing a piezometer monitoring network. The site investigation needs to consider the following factors:

1. *Source of the nitrogen:*

When designing a piezometer network, it is critical to understand where the nitrogen is coming from. This ensures at least one piezometer is installed in a 'source area' to monitor the variability of nitrogen concentration in groundwater at the source over time. Refer to "**1. How to tell if you are losing nitrogen from your farm**" to identify the nitrogen loss source areas. Additional piezometers should be installed in control areas upslope of the 'source area', plus downslope areas of the farm that are likely to receive the groundwater flow.

2. *Soil type, aquifer thickness, presence of low permeability layers, and groundwater depth:*

Sandy soils with high infiltration rates might indicate the presence of an unconfined aquifer that can host seasonal groundwater. It is important to know the thickness of the aquifer and the potential presence of low permeability layers (e.g., clay), which may affect the groundwater depth, the installation depth of the piezometers, and the length of their screens.

3. *Ground surface topography:*

The ground surface topography should be considered because groundwater often traces the topography in superficial unconfined aquifers.

4. *Presence of surface water bodies (e.g., dams, creeks and drains):*

Surface water bodies can interact with groundwater, resulting in groundwater discharge or recharge. For this reason, installing piezometers upslope and downslope of water bodies can help determine whether there is a surface water-groundwater interaction.

5. *Ease of access to the site of potential piezometer installation:*

Finally, it is essential to consider where the piezometers will be installed to ensure comfortable and safe access for the drilling and sampling operations.

How many piezometers are needed for a monitoring network?

At least three piezometers are required to understand the direction of groundwater flow. The total number needed will depend on the size of the farm, the availability of land to install piezometers, and the slope/topography (see next section). More piezometers enable more comprehensive data collection, helping to increase understanding of groundwater and nitrogen movement.

Which pattern should be used?

On hilly farms, piezometers should be installed in transects (alignments) perpendicular to the slope. For example, if a valley separates two NW-SE hill ridges, the transects should run perpendicularly in a NE-SW direction (Figure 2), with one piezometer on the hill ridge, one on the slope, and one in the valley. This will monitor the highest and lowest groundwater levels and ensure that one piezometer is installed in the nitrogen source area.

Designing a piezometer network on hilly farms is easier as groundwater generally traces the slope/topography, so it is often assumed that this will be the groundwater flow direction. On flat farms, where it is not possible to assume the groundwater flow direction, piezometers should be installed in a triangular pattern to identify the direction of groundwater flow. One piezometer should be installed within the area of your farm where nitrogen losses are expected, and the remaining two should be installed around the central piezometer to form a triangle.

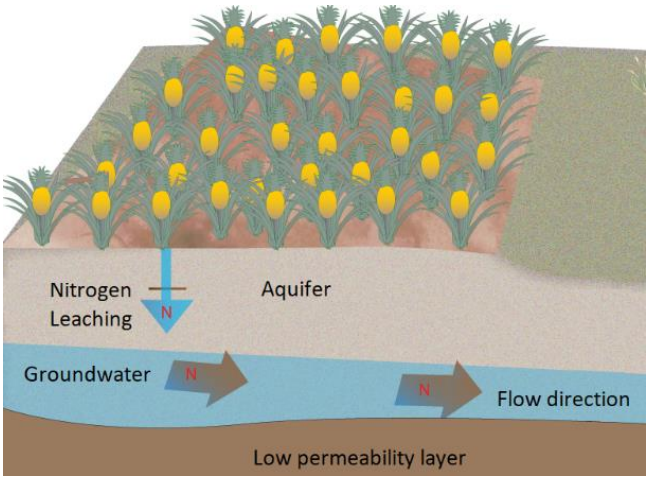

Figure 1: Illustration of an aquifer and how nitrogen can leach through the soil profile into groundwater.

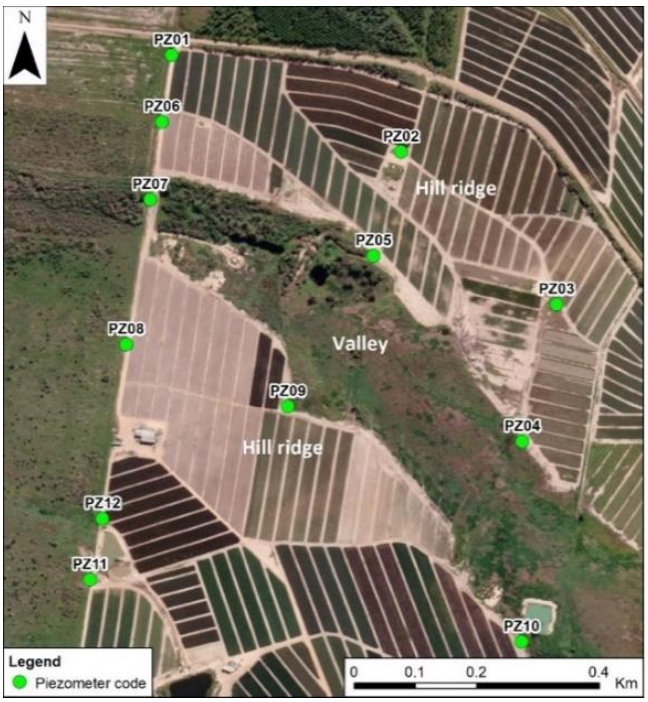

Figure 2: Map of a farm showing piezometers (green dots) installed in three transects.

These factsheets were developed as part of the Agriculture Water Treatment Project funded through the Queensland Government's Queensland Reef Water Quality Program and the Resilient Rivers 3 Project funded by Department of Environment, Science and Innovation.

September 2024