

Connected & disconnected streams



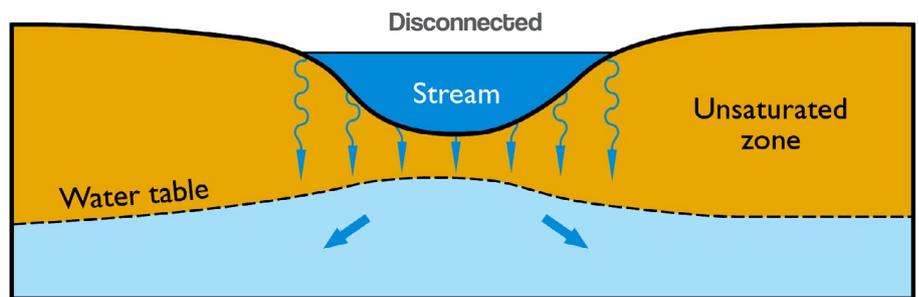
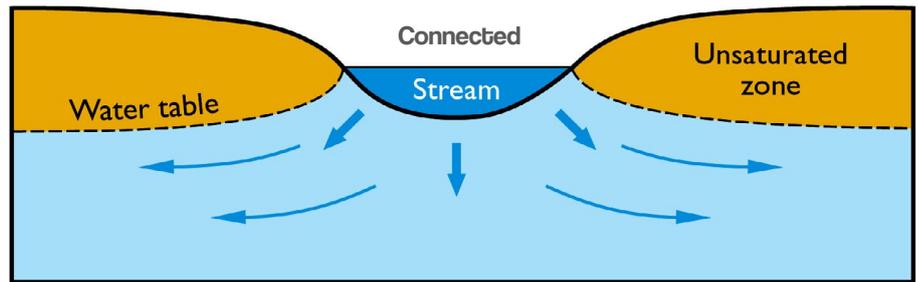
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This resource introduces connected and disconnected streams and discusses techniques for assessing whether a stream is connected or disconnected. Connectivity is important, as it can affect infiltration, streamflow and the movement of contaminants.

WHAT IS THE DIFFERENCE BETWEEN CONNECTED AND DISCONNECTED STREAMS?

Losing streams can be classified as either 'connected to' or 'disconnected from' from the aquifers that underlie them.

As shown right, in a connected stream-aquifer system (above right), the stream forms an expression of the groundwater table. That is, there is no unsaturated zone underneath the stream, and water infiltrates directly from the stream into the groundwater. In contrast, an unsaturated zone always exists beneath a disconnected stream (below right), and infiltrating water must pass through this zone before reaching the water table.



Disconnected stream systems usually occur where a layer of lower permeability lines the streambed (known as a 'clogging layer'). In some streams, this layer develops naturally through sedimentation of fine material during low flow periods or from biofilm growth.

Disconnected streams can also occur where the water table is located a considerable depth below the streambed, such as in many arid regions. Of course, streams are likely to change from connected to disconnected along their length, and can also change over time. Often disconnected streams occur where intense groundwater pumping has lowered watertables.

HOW DO WE DETERMINE WHETHER A STREAM IS CONNECTED OR DISCONNECTED?

To date, there is no accepted, foolproof method for discerning whether a stream or a reach of a stream is connected or disconnected at a particular site. Where the depth to the water table is large, it is likely that the stream is disconnected from the aquifer. However, there is no threshold water table depth below which a stream can be considered disconnected, making this characteristic difficult to apply in practice.

The connection status may be determined by collecting streambed cores and checking for an unsaturated zone beneath the streambed (such as

by measuring the matric potential). In many cases, particularly if the streambed is heterogeneous, the unsaturated zone may be present below some areas of the streambed and not others, making it complicated to conclusively decide upon a connection status.

Brunner et al. (2009) developed a theoretical criterion to determine whether a given system can potentially be disconnected, based on the ratio of the clogging layer and aquifer hydraulic conductivities compared to the ratio of clogging layer thickness and depth of water above the streambed. If this condition is not met, the unsaturated zone beneath the streambed is fully saturated and thus the system is

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connected. Unfortunately, this requires good knowledge of clogging layer and aquifer conductivities, which can be highly spatially variable and difficult to accurately measure.

WHY IS IT IMPORTANT TO KNOW IF A LOSING STREAM IS CONNECTED OR DISCONNECTED?

The rate at which water is exchanged between the surface water in the stream and the groundwater is controlled by a stream's connectivity.

In a connected stream system, the infiltration rate is proportional to the hydraulic head gradient between the stream and aquifer; that is, the rate of infiltration increases as the distance to the water table becomes greater.

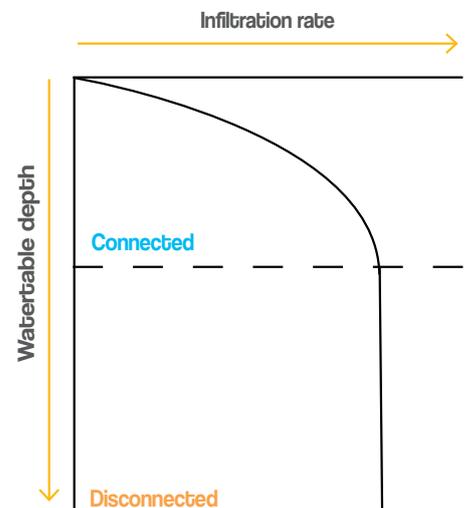
Once the stream is fully disconnected from the aquifer, the infiltration rate is no longer a linear relationship between infiltration rate and depth to the groundwater level. Instead, for any particular depth of water in the stream, there will be a relatively constant rate of infiltration. Therefore, knowing the connection status of a stream-aquifer system is essential for understanding annual recharge from the stream to the aquifer.



Where groundwater pumping lowers watertables in the vicinity of a connected stream, then this will increase the leakage rate from the stream and can therefore reduce streamflow.

Where a stream is disconnected, additional groundwater pumping will not further increase the leakage rate at that location. However, it can increase the length of stream that is disconnected, and hence increase the leakage rate in upstream and downstream regions. The presence of a disconnected stream should not be used to justify separate management of surface water and groundwater resources.

The connection status of a particular stream and aquifer will also affect contaminant transport. In case of a potential contaminant spill, the presence of an unsaturated zone beneath the streambed may result in the occurrence of biogeochemical reactions and will influence the timing and form of the contaminant that reaches the aquifer. In a connected system, the absence of this unsaturated zone makes it easier to predict contaminant movement and speciation.



Want to know more?

Brunner, P, Cook PG, & Simmons, CT 2010, 'Disconnected surface water and groundwater: from theory to practice', Ground Water, vol. 49.4, pp. 460-467.

Brunner, P, Simmons, CT & Cook PG 2009, 'Hydrogeologic controls on the disconnection between surface water and groundwater', Water Resources Research, vol. 45.