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Discussion of the influence of hydrogeology on measured changes in groundwater elevation.

SUMMARY:
At the May 2025 meeting of the Basin Management Advisory Committee (BMAC), staff was asked to prepare an informational presentation on the differences between confined and unconfined aquifers, with a focus on how groundwater levels respond in each type of aquifer as a result of changing conditions in the water balance such as groundwater pumping or recharge. In response, Monterey County Water Resources Agency (Agency) staff is providing the following summary and an accompanying presentation that will be reviewed at the July 9, 2025 BMAC meeting.

DISCUSSION:
The potential of a geologic formation to store and yield water as a productive aquifer depends on the type of geologic material (lithology) and layering of the geologic material (stratigraphy) within the distinct geologic unit (formation). Properties of the sediment or rock constituting the aquifer, as well as the presence and properties of any confining layers, will change how the aquifer stores and transmits water, how it recharges, and how its water table or potentiometric surface responds to pumping.

A confined aquifer is one in which the aquifer below land surface is completely saturated with water. A confined aquifer has layers of impermeable material above and below it, causing it to be under pressure. When a confined aquifer is penetrated with a well, groundwater in the well will rise to a level that is above the top of the aquifer surface, though not necessarily above the land surface. The level to which water rises in a well that is screened (i.e., open to receiving groundwater) in a confined aquifer is referred to as the potentiometric surface.1,2

An unconfined aquifer, sometimes referred to as a “water table” aquifer” is one in which the upper water surface is at atmospheric pressure.1 The aquifer materials of an unconfined aquifer are only partially filled with water and the groundwater surface freely rises and falls along the boundary between the unsaturated and saturated zone.2

When confined aquifers are pumped, groundwater is released from storage by slightly compressing the aquifer material, or by the expansion of water molecules. In other words, there is no loss of saturated thickness when water is released from storage under confined conditions, rather there is only a decrease in the fluid pressure. The measure of how much water a confined aquifer releases from storage per unit surface area of the aquifer per unit decline in hydraulic head is the “storativity” of the aquifer. Confined aquifers, such as the Deep Aquifers in the Salinas Valley Groundwater Basin, have a low storativity value which means that less water is released from aquifer storage per unit of change in

the elevation of the groundwater surface, than would occur in an unconfined aquifer. This results in much larger drawdown and a wider cone of depression when wells are pumped and a significant drawdown of the potentiometric surface seasonally when regional pumping increases. As extractions decline, the potentiometric surface rebounds. This recovery in the potentiometric surface occurring after extractions were reduced for a prolonged period was observed in the Deep Aquifers when the CSIP project came online in 1998. Similarly, seasonal recovery of groundwater levels was observed in the Deep Aquifers in Water Year 2023, following substantial decreases in groundwater pumping following a very wet winter period.

When pumping occurs in an unconfined aquifer, the aquifer materials are dewatered through gravity drainage of the space between grains or cracks in the aquifer material. The pumped groundwater is replaced by air entering the drained space from above.

Unconfined aquifers are more closely connected to the land surface and, therefore, often show fluctuations in groundwater level in response to rain or drought conditions. Conversely, groundwater levels in a confined aquifer are not as responsive to short-term variations in precipitation.5 Depending upon the depth and nature of the geologic materials comprising the confined aquifer, it may take millennia for surface precipitation to reach a confined aquifer.

In summary, the distinctions between confined and unconfined aquifers have implications for reasons including, but not limited to: the spatial extent of an aquifer that is impacted by groundwater pumping; the residence time of water within the aquifer; and the degree of responsiveness, if any, to variations in precipitation.

Discussion of the concepts associated with groundwater level monitoring aligns with Agency Strategic Plan Goals B7, *Use of data and analysis to make informed decisions based on science* and E1, *Improve public outreach to increase transparency, communication, education and information about Agency projects and programs*.

OTHER AGENCY INVOLVEMENT:
No other agencies were involved with preparation of this report.

FINANCING:
The collection and analysis of groundwater level data, and preparation of this report, that occurred during Fiscal Year 2024-2025 were funded by Fund 116. For Fiscal Year 2025-2026 (FY26), which begins on July 1, 2025, there are no appropriations in the Agency's Adopted Budget to pay for the Groundwater Monitoring Program, which includes groundwater level monitoring activities.

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U.S. Geological Survey.
<https://www.usgs.gov/faqs/what-difference-between-a-confined-and-unconfined-water-table-aquifer>
North Carolina Division of Water Resources via Utah Division of Water Rights
<https://waterrights.utah.gov/wellinfo/theis/hydrogeology_discussion.asp>

Kansas Geological Survey <https://www.kgs.ku.edu/Publications/Bulletins/239/Macfarlane/>
Poehls, D.J. and G.J. Smith (2009) Encyclopedic Dictionary of Hydrogeology.
The Groundwater Project
<https://books.gw-project.org/groundwater-in-our-water-cycle/chapter/aquifer-storage/>
Based on graphic from U.S. Bureau of Reclamation
<https://www.usbr.gov/lc/yuma/programs/YAWMS/GROUNDWATER_aquifer.html>