Nevada GDE Water Needs Explorer Tool Documentation

September 2025

https://watersmartgdeapp.streamlit.app/

NOTE: When accessing the tool, it may take a few minutes for the tool to "wake up" if it hasn't been used in awhile. Try refreshing the browser if it takes more than a few minutes.

Groundwater-dependent ecosystems (GDEs) in Nevada play a critical role in sustaining biodiversity and supporting human and nature's water needs. These systems rely on accessible water levels, making them particularly vulnerable to changes in groundwater availability caused by climate variability and human activities.

The Nevada GDE Water Needs Explorer Tool was developed by the Desert Research Institute, The Nature Conservancy, and the University of Wisconsin-Madison in 2025 as part of the U.S. Bureau of Reclamation WaterSMART Applied Science Project R19AP00278 entitled "Quantifying Environmental Water Requirements for Groundwater Dependent Ecosystems for Resilient Water Management." The tool uses model results from observed data to explore the water needs of GDEs in Nevada. This document provides information on how to use the tool.

Tool layout:

- The left panel is the "Control Panel" where users can choose a location to explore (Figure 1). The panel can be widened by hovering on its right edge and dragging the panel to the right.

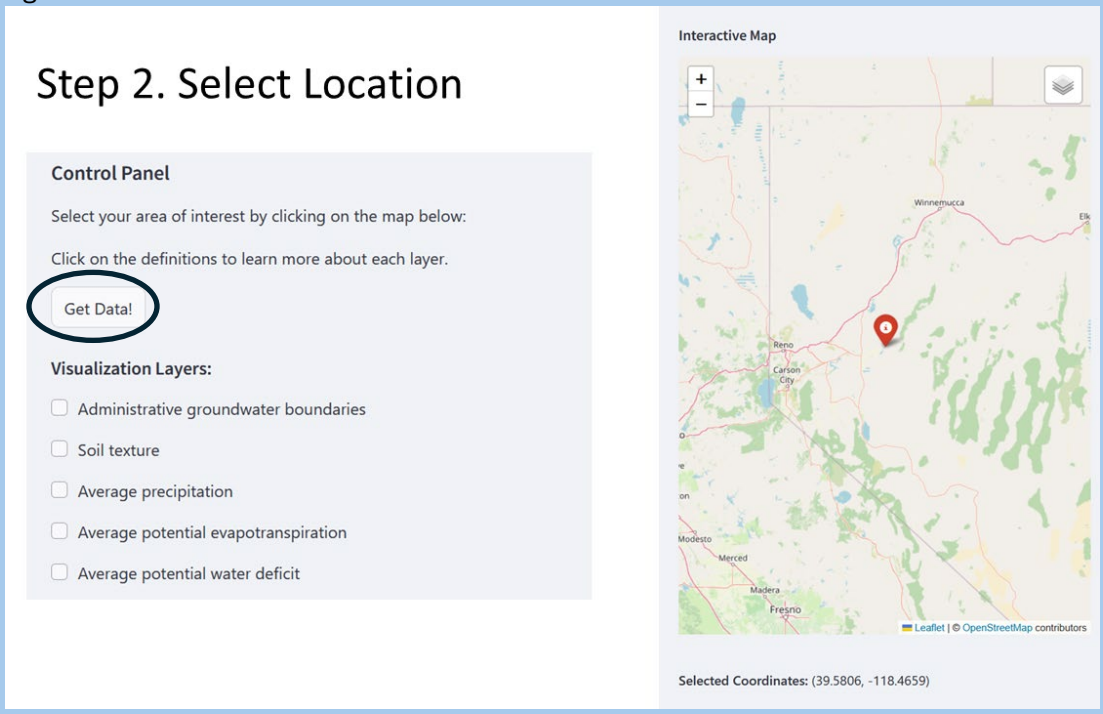

Figure 1. Control panel for Step 2 to select location of interest.

Tool layout (cont.):

- The right panel has two tabs:
  - GDE Explorer Tab is where results will show for the selected location, soil type, and rooting depth (Figure 2).

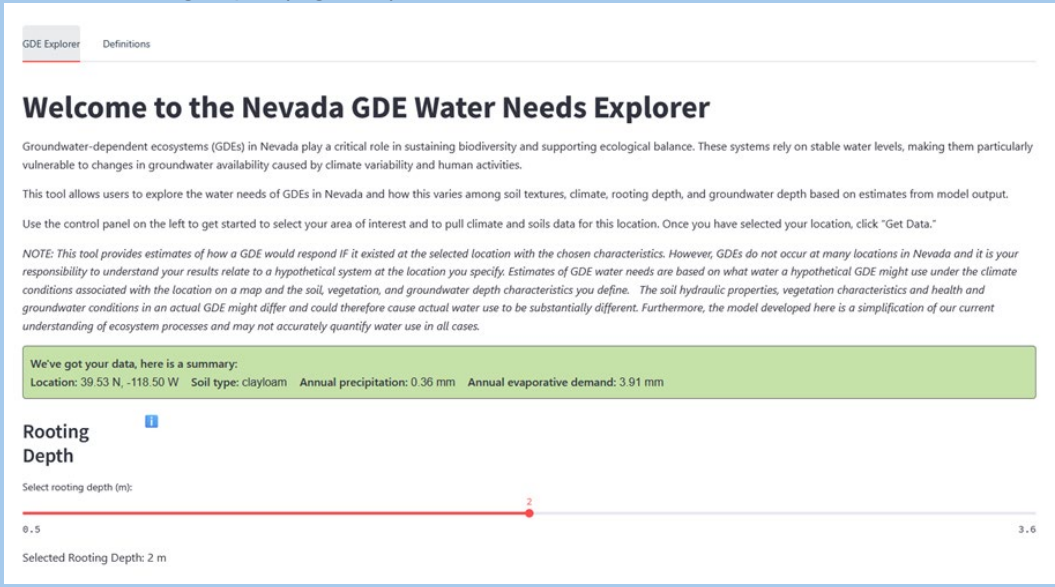

Figure 2. GDE Explorer tab

  - Definitions Tab has definitions of terms used in the tool (Figure 3). To see larger versions of images, hover over the image and click the broken box [ ] in the upper right above the figure.

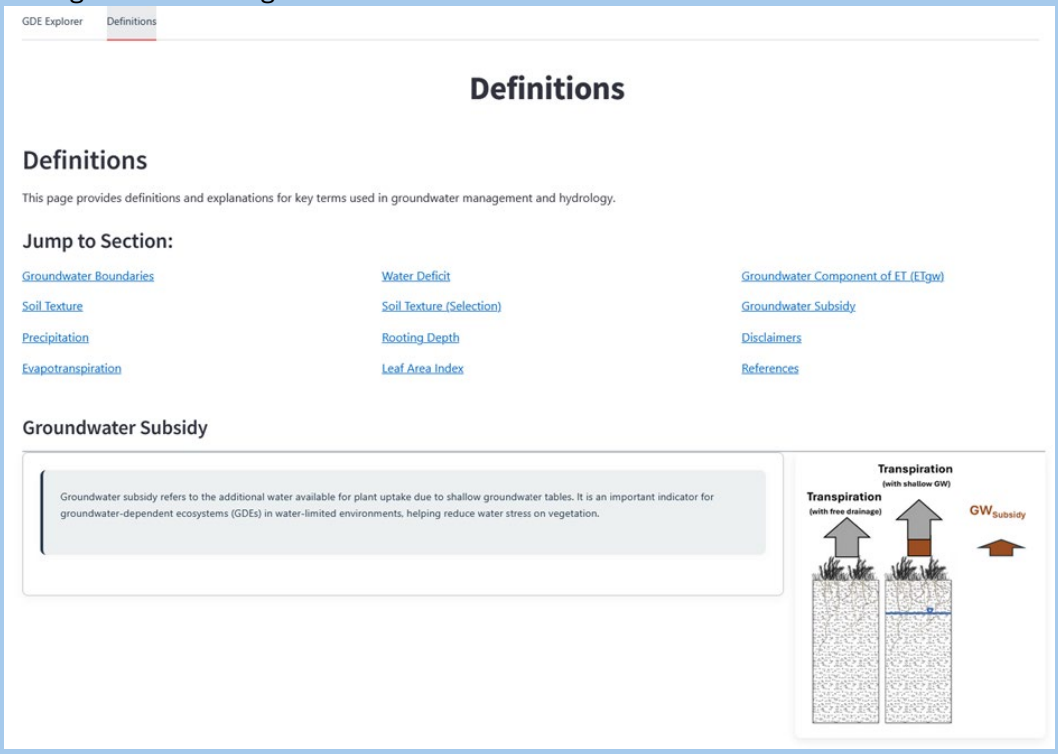

Figure 3. Definitions tab.

To get an estimate of GDE water needs at a particular location, follow these steps:

Step 1: Access the tool

- Go to https://watersmartgdeapp.streamlit.app/.

Step 2: Select your location (Figure 1)

- On the control panel, use the interactive map to place the hand on the location you are interested in.
- You also have the option to view statewide maps that might be of interest or helpful for locating your site (definitions of these options are on the "Definitions" tab on the right panel):
    - Administrative groundwater basins
    - Soil texture (see legend at bottom of control panel)
    - Average annual precipitation (see legend at bottom of control panel)
    - Average annual potential evapotranspiration (see legend at bottom of control panel)
    - Average annual potential water deficit (see legend at bottom of control panel)

Step 3: Get data for the location. Scroll to the top of the control panel to hit the "Get Data!" button (see circled button on Figure 1).

Step 4: View results. On the GDE Explorer tab on the right panel, you will see your results for the default soil for your location based on Walkinshaw et al. (2020), and the rooting depth of 2 m for a grassland (Figure 2). When the button towards the bottom of the tab that says "Download Report as PDF" is active, your results are ready.

- If you would like to see results for a different rooting depth and/or soil texture, you can select different ones; your results will be ready when the "Download Report as PDF" button is active.

Step 5 (optional): Download results. Hit the "Download Report as PDF" button to get a .pdf printout of the results.

DISCLAIMERS

This map tool presents results of modeling for Reclamation Applied Science project R19AP00278 Quantifying Environmental Water Requirements for Groundwater Dependent Ecosystems for Resilient Water Management. See this link to find out more about the project. The paper describing the methods for the modeling is still in preparation but an overview is available on the Nevada TNC website.

This tool provides estimates of how a groundwater-dependent ecosystem (GDE) would respond IF it existed at the selected location with the chosen characteristics. However, GDEs do not occur at many locations in Nevada and it is your responsibility to understand your results relate to a hypothetical system at the location you specify. Estimates of GDE water needs are based on what water a hypothetical GDE might use under the climate conditions associated with the location on a map and the soil, vegetation, and groundwater depth characteristics you define. The soil hydraulic properties, vegetation characteristics and health and groundwater conditions in an actual GDE might differ and could therefore cause actual water use to be substantially different. Furthermore, the model developed here is a simplification of our current understanding of ecosystem processes and may not accurately quantify water use in all cases.

This dataset does not prove or make any claim about the nature and/or extent of groundwater levels or GDEs for any mapped location. The dataset is non-regulatory and no information presented here is intended to imply whether a project can or should be approved or denied, and the data are not legally binding in any way. This tool does not replace the need for field surveys or agency consultation to determine water level status, presence of GDEs, or impacts of groundwater use or climate.

This tool does not contain bias in favor or against any one form of conservation or land use development. This tool does not preempt the authority of local land use agencies.

Features mapped here are not intended for legal uses and no warranty, expressed or implied, is made by The Nature Conservancy or data contributors as to the accuracy of the data. The Nature Conservancy shall not be held liable for improper or incorrect use of the data described and/or contained herein.

Any sale, distribution, loan, or offering for use of these data, in whole or in part, is prohibited. The use of these data to produce other products and services with the intent to use or sell for a profit is prohibited. All parties receiving these data must be informed of these restrictions. This is an aggregate dataset with multiple data contributors.

DEFINITIONS

Administrative Groundwater Boundaries
Nevada has 256 hydrographic areas that are defined by the State Engineer's Office for administering groundwater. These were developed in the 1960s and are the basis for water planning, management and administration of water in Nevada. [Source: Nevada Division of Water Planning (1999); Data: Nevada Division of Water Resources]

Soil Texture
Soil texture (Figure 4) refers to the proportion of sand, silt, and clay particles in the soil. This can influence the ease of working with the soil, the amount of water and air the soil holds, and the rate at which water enters and moves through the soil. For example, clay can hold water more tightly, limiting plant access when dry. [Source for definition: Food and Agriculture Organization, 2006; Source of data layer: Walkinshaw et al. (2020)]

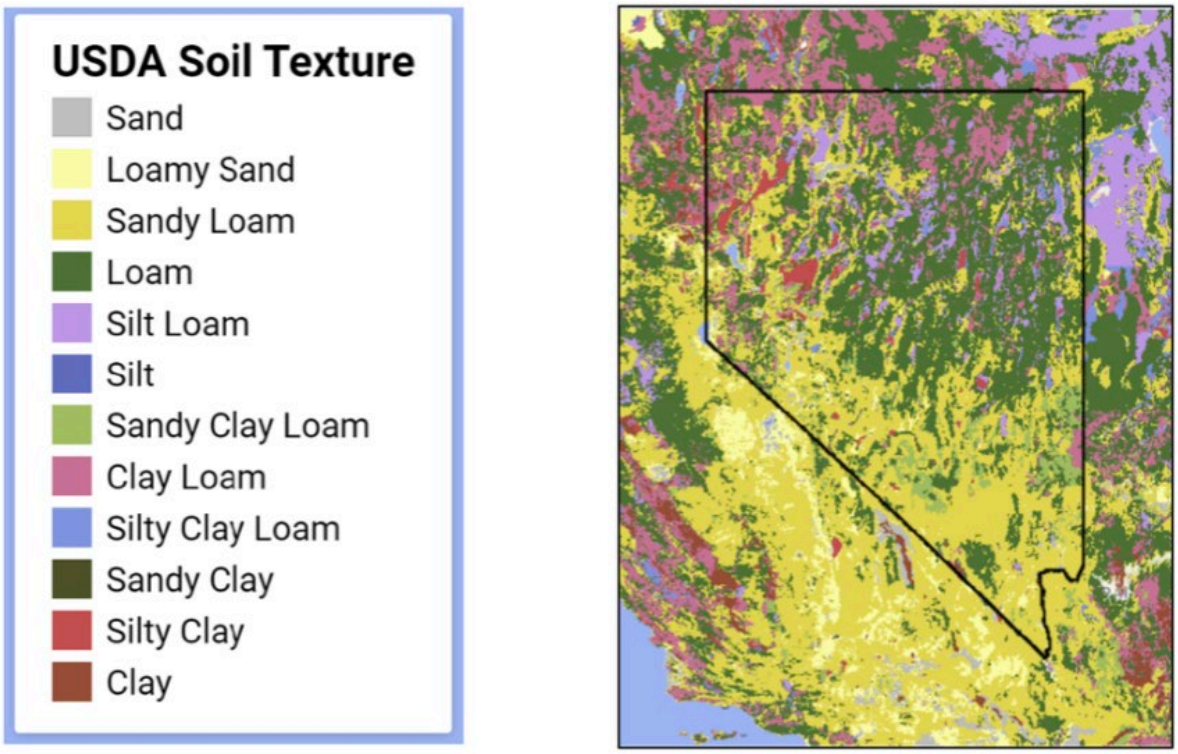

Figure 4. Soil texture map for Nevada.

Average Annual Precipitation (P)
The average precipitation for the area in question is calculated by summing the observed annual precipitation over 1991-2020 and dividing by the number of years for which there were observations. [Source: Abatzoglou (2013)]

Average Annual Potential Evapotranspiration (PET)
Potential evapotranspiration gives an indication of how "thirsty" the atmosphere is. Here, it is represented as the American Society of Civil Engineers' Grass Reference Evapotranspiration (ET_{ref}), calculated using the Penman-Monteith method. ET_{ref} is the amount of water that would evaporate or be transpired from a well-watered grass surface (Figure 5).

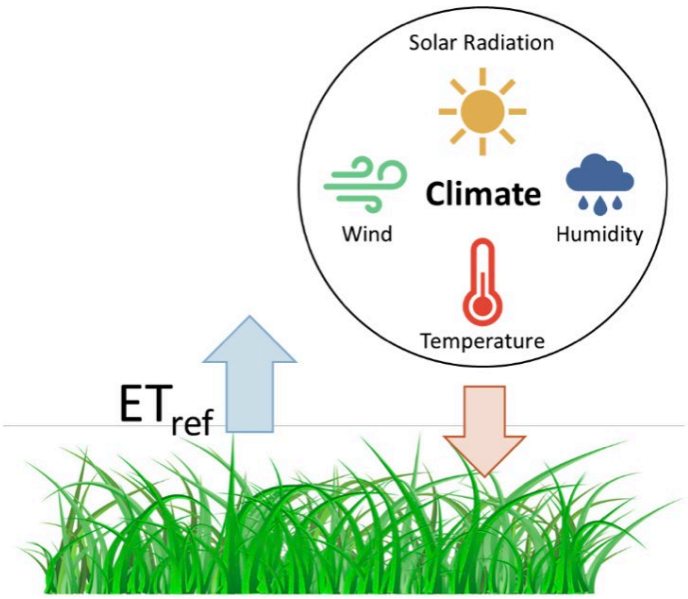

Figure 5. ET_{ref} illustration.

Average Annual Potential Water Deficit (PWD)
The potential water deficit (PWD) represents the difference between annual precipitation (supply) and annual potential evapotranspiration (demand). Negative values indicate that there is more demand for water from the atmosphere than is available from precipitation. PWD is calculated by subtracting potential evapotranspiration from precipitation for a given area. The average annual PWD is calculated by summing observations of annual PWD over 1991-2020 and dividing by the number of years for which there were observations.

Rooting Depth
Groundwater-dependent vegetation can access groundwater through their roots, but rooting depths vary. Meadow and rangeland grasses often have roots within 2 m of the ground surface, whereas some phreatophytic shrubs and trees can have roots as deep as 6 m or more (The Nature Conservancy 2021). can reach depths of 6m or more. Choose from 0.5 m for herbaceous meadow root depths, 2 m for grass root depth, and 3.6 m for phreatophyte shrubland root depths.

Leaf Area Index (LAI)

Leaf area index (LAI) represents the amount of leaf area in an ecosystem and is related to the amount of photosynthesis, evapotranspiration and productivity of an area of interest. LAI is the one-sided green leaf area per unit of ground surface area, and its value can be an indication of the health of an ecosystem (Fang et al. 2019). We have assumed a typical target LAI for a phreatophytic shrubland in Nevada to be 1, whereas a meadow in Nevada would have a typical target LAI of 2, as shown in Figure 6. [LAI Data Source: MODIS]

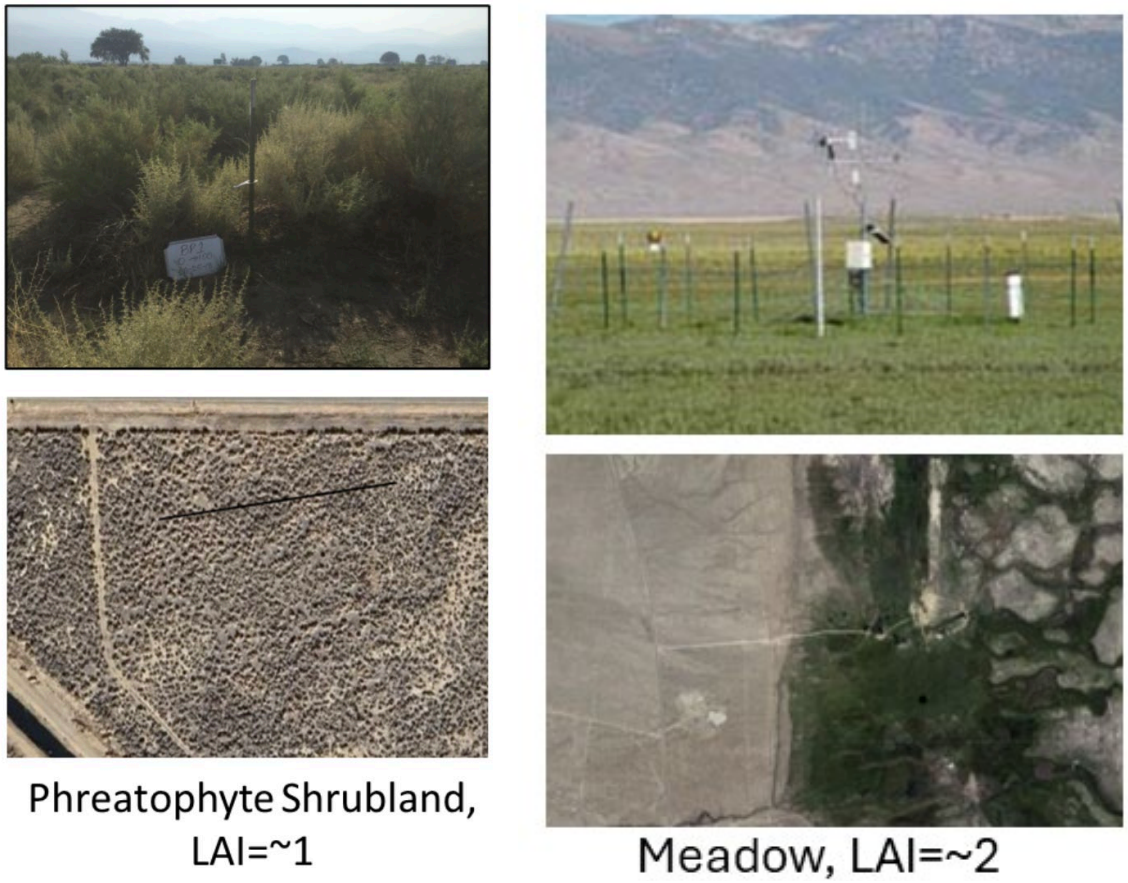

Figure 6. Leaf area index (LAI) examples.

Average Actual Evapotranspiration

Actual evapotranspiration (Actual ET)) is the actual amount of water that is evapotranspired and is limited by the amount of available water. It is always less than or equal to Potential ET.

Groundwater Component of Evapotranspiration (ET_{GW})

The groundwater component of evapotranspiration (Figure 7) is the portion of total evapotranspiration that is extracted from groundwater (i.e., the saturated zone). The remainder of transpiration comes from the vadose (i.e., the unsaturated) zone. If the water table were deeper, the groundwater component might be reduced. The groundwater component is a good indicator of how much groundwater is used by GDEs when calculating the water budget of a groundwater system.

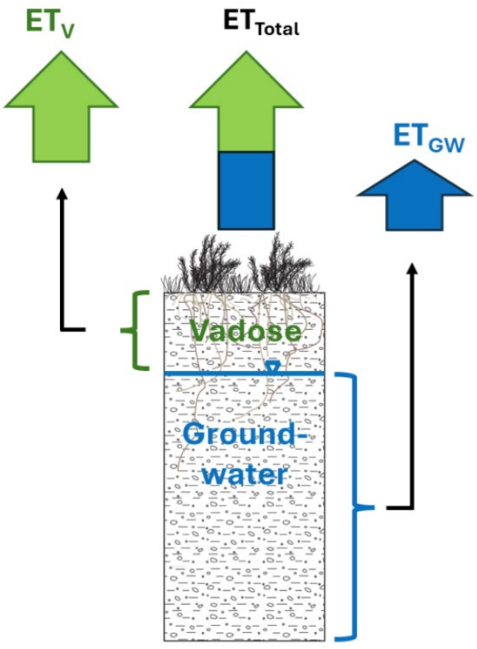

Figure 7. Illustration of groundwater component of evapotranspiration (ET_{GW}). Modified from Lowry and Loheide (2010).

Groundwater Subsidy

Groundwater subsidy (Figure 8) is the additional water available in the vadose (i.e., unsaturated) zone for root water uptake resulting from shallow water table conditions. It is a hypothetical quantity that cannot be measured in the field but is a good indicator of how much GDEs in water-limited environments might benefit from shallow groundwater conditions that reduces the water stress experienced by vegetation.

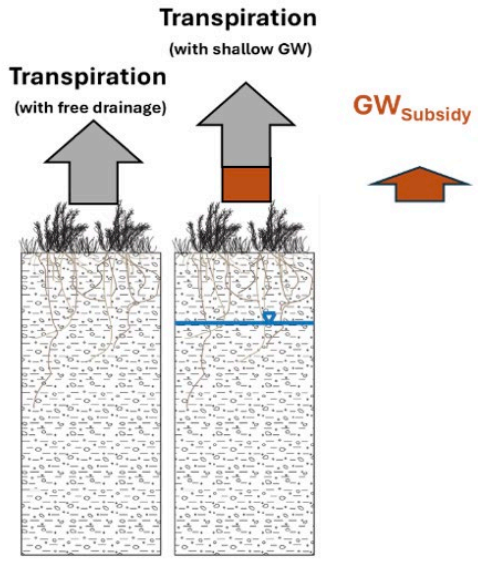

Figure 8. Illustration of groundwater subsidy. Modified from Lowry and Loheide (2010).

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