Water Budgets (or Water Balance)

A Water Budget is Like a Checking Account

$ in → **Checking Account** *(or Yellowstone River Basin, tributary, channel segment or hay field)* - $ out = Account Balance

Over time (daily, weekly, monthly or when balanced), the account balance also represents the change in $ stored in the account

Concept of a Water Budget

Water in – Water Out = Water Balance

(Precip. + Inflow) - (Cons. use - outflow) = change in storage

Because water is stored as groundwater and in surface reservoirs, the water balance represents the change in stored water over time (daily, monthly, annually)

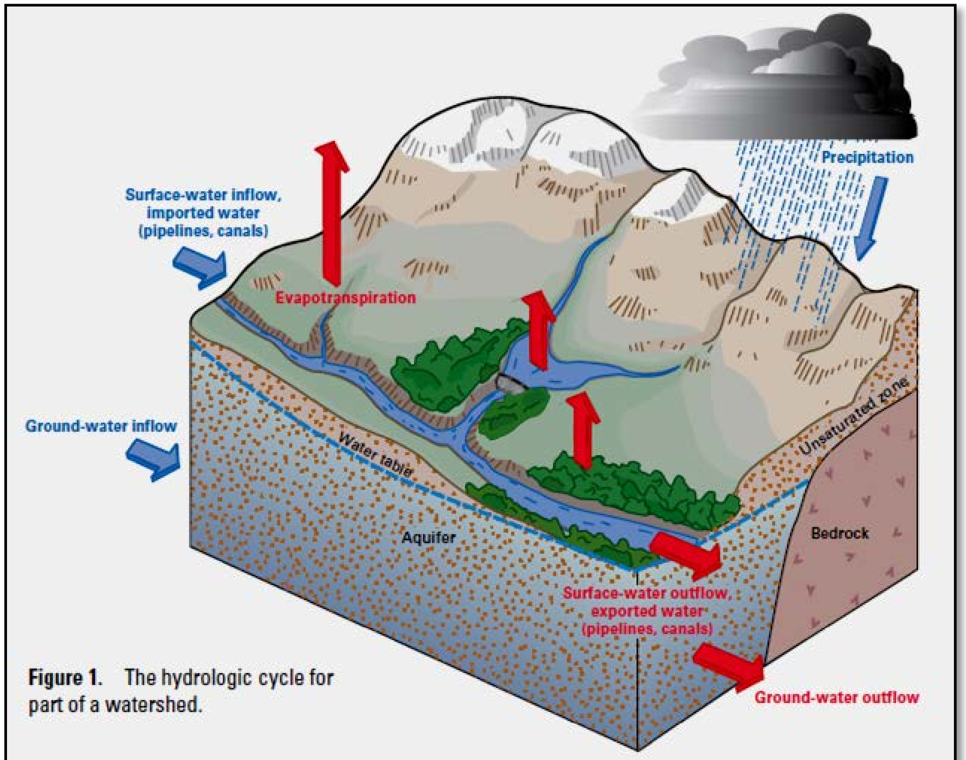

Figure 1. The hydrologic cycle for part of a watershed.

Basic equation governing inflow-outflow canal seepage studies:

Water budgets can be created at any scale: A watershed, a tributary, a river segment, a wetland, or an agricultural field.

The example at the left illustrates a water budget for a canal-seepage study for a one-mile canal segment.

Stream gages were established at the upstream and downstream ends to measure water inflow and outflow. Evaporation and transpiration (ET) losses were estimated using remote-sensing (Landsat satellite information) and diversions (lateral canals off the main canal) were also measured.

After accounting for ET and diversions, the difference between water in and water out is the **seepage loss** to shallow groundwater.

Stream gage measurements at the upper and lower end of the canal were estimated at 15-minute intervals and summed to provide daily estimates of seepage loss.

Water budgets form the basis for water accounting and management models and much of surface and groundwater science. The easiest components to measure accurately are surface water inflows and outflows (we can see and touch them, and they are generally confined to a measurable channel). The most difficult components to measure are consumptive use (evaporation and transpiration by vegetation: ET), precipitation (including snowpack), and changes in stored groundwater. Part of the problem is the expense of taking measurements, especially at the scale of a large watershed like the Upper Yellowstone.

Satellite-based remote-sensing of consumptive use, snowpack and precipitation is currently expanding the capability to develop accurate water budgets and water balance models. But these models remain expensive to develop and require specialized expertise in hydrology, computer modeling and programming, analysis of satellite imagery, and geographic information systems (GIS). Montana is fortunate to have that expertise within the Montana University System.