Upper Klamath Basin, Tule Lake Subbasin

- Groundwater Basin Number: 1-2.01
- County: Modoc, Siskiyou
- Surface Area: 85,930 acres (135 square miles)

An important note on the status of the groundwater resources in the Tule Lake Subbasin, is that, historically, groundwater use in the basin has been relatively minor. Since about 1905, when the Bureau of Reclamation began building the Klamath Project to provide surface water to agriculture on reclaimed land in the Klamath Basin, abundant surface water supplies have been available. In the 2001 Klamath Project Operation, water requirements for two sucker fish species in the upper basin and the coho salmon in the lower basin led the USBR to reduce surface water deliveries to the farmers to 26 percent of normal. The already existing drought conditions were further exacerbated by the operational drought.

In 2001, drought emergencies were declared for the Klamath Basin by the governors of both California and Oregon. Governor Davis called upon California's legislature to fund an Emergency Well Drilling Program in the Tulelake Irrigation District (TID). The governor also requested funding for a Hydrogeologic Investigation to evaluate new and future groundwater development. The emergency measures were taken because the TID had no alternate water supply for the nearly 75,000 acres in the district and farmers were faced with economic disaster.

Ten large-capacity irrigation wells were constructed within the irrigation district for the emergency program. Four of the ten wells produce 10,000 gpm and greater. The lowest yielding well produces 6,000 gpm. At the same time the TID wells were being constructed, individual growers were also having their own wells drilled resulting in an additional 25 to 30 private irrigation wells.

It is unknown what effect the new development of groundwater in the Tule Lake Subbasin will have on the aquifer system. The Hydrogeologic Investigation that DWR is currently conducting will address some of the questions regarding the nature and extent of the aquifer system, sustainable annual yields, the amount and nature of annual recharge, and the possiblities for conjunctive use in the subbasin. A significant amount of new data will be available when a progress report is completed. Because the evaluation of the recently collected data is in progress, and not yet available, the following summary of hydrogeologic and well information is based on published reports.

Basin Boundaries and Hydrology

The Tule Lake Subbasin is a portion of Upper Klamath River Groundwater Basin located in California and Oregon. The subbasin is bounded to the west by the Gillems Bluff Fault which extends beneath and is a major structural feature of the Medicine Lake volcanic highlands (Lavine 1994). The fault forms the steep eastern escarpment of Sheepy Ridge, which separates the Tule Lake and Lower Klamath subbasins. The subbasin is bounded to the east by the Big Crack fault, a north-trending normal fault which forms the western edge of the block faulted mountains between Tule Lake and Clear Lake Reservoir. The reservoir is the headwaters of Lost River, which is the primary surface water entering the Tule Lake Subbasin. Lost River flows north into Oregon, and meanders through the Poe and Langell valleys before it flows south into California and ends at the Tule Lake sump. The subbasin is bounded to the south by the low-lying volcanic fields on the north slope of the Medicine Lake Highlands. Medicine Lake occupies the crater at the peak of this large, relatively young shield volcano. To the north, the basin extends into Oregon and is bounded by northwest trending normal faults on the south side of the mountain block dividing Poe Valley from the Tule Lake Subbasin. Approximately two thirds of the subbasin are in California. For the purposes of this update of Bulletin 118, the subbasin is bounded by to the north by the state boundary of Oregon and California. Average annual precipitation within the basin is estimated to be 11 inches.

Hydrogeologic Information

Water-Bearing Formations

The principal water-bearing formations in the subbasin include Tertiary to Quaternary lake deposits and volcanics

Pleistocene Upper Basalt. This unit is an unweathered, vesicular, olivine basalt that is generally highly permeable due to extensive fracturing. The basalt flows of this unit are generally above the saturated zone in upland areas but serve as recharge areas where fractured. Some areas have exposures of massive, unfractured flows. The fractured flows readily yield water to wells. These flows border the subbasin on the south (to the west of the Peninsula) and outcrop as a subbasin boundary to the southeast of Copic Bay along the north flank of the Medicine Lake Highlands.

Pleistocene Intermediate Basalt. This unit is a series of reddish brown to black, thin-bedded flows of Pleistocene diabasic olivine basalt. These rocks border the subbasin to the south and east and interfinger with lakebed deposits at the edge of the basin. These rocks are generally highly permeable due to well-developed columnar jointing and the abundance of bedding planes. Wells developed in these rocks will often yield moderate to large quantities of water ranging from 2,000- to 4,000-gpm with specific capacities of 50- to 250-gpm per foot of drawdown if sufficient fractures, fracture interconnections, and saturated depths are encountered (Hotchkiss 1968). Some well yields are low where extensive cross faulting has created barriers to groundwater recharge and flow.

In the Panhandle region, the thickness of the unit is greater than 400 feet with well yields ranging up to 9,500 gpm with specific capacity up to 395 gpm per foot of drawdown. In the vicinity of Prisoners Rock and the Peninsula, the unit reaches a thickness of at least 400 feet with estimated well yields of 500- to 3,100-gpm.

Pliocene to Holocene Lake Deposits. The lake deposits consist of sand, silt, clay, ash, lenses of diatomaceous earth, and semi-consolidated shale. Poorly sorted deposits have very low permeability and may act as a confining layer where interfingered with basalts. Wells developed in the sedimentary deposits are usually less than 150 feet deep and yield only small quantities of water in the range of 30 gpm (Hotchkiss 1968).

Pliocene to Miocene Lower Basalt. The older basalt ranges from green-black ophitic olivine basalt to a gray-black porphyritic basalt. It often exhibits weak columnar jointing and fracturing in surface exposures. This is typically a highly permeable aquifer that is commonly confined within the subbasin where it underlies lake sediments. Surface exposure of the unit occurs east and west of the subbasin and forms the northeastern basin boundary. Where exposed in the uplands surrounding the basin, the unit is an important source of recharge.

The depth to the older basalt beneath the lake sediments varies due to the region's extensive block faulting. New deep irrigation wells drilled in 2001 on the California/Oregon border show that the basalt is encountered at depths ranging from 810 feet on the east side of the basin to 1,190 feet several miles to the west, and to 190 feet on the far west side. These differing depths probably represent individual blocks offset by steep, normal faults. The depth to good production zones in these wells varies from 800 feet to 1,200 feet to 245 feet in the same east to west order. On the east side of the subbasin well yields range from 4,000- to 7,000-gpm, whereas, yields mid-basin and on the west side range from 9,000- to 12,000-gpm.

Restrictive Structures

The western boundary of Tule Lake is marked by a prominent north-south trending normal fault, downthrown to the east. The displacement is unknown but is probably is in the range of several hundred feet. The east side of the Tule Lake Subbasin is bounded by a normal fault downthrown to the west. The water-transmitting properties of these faults are not fully understood.

Recharge Areas

Infiltration of surface water from the channels, lakes and sumps of the Lower Klamath and Tule Lake basins along with underflow from the adjacent, rapidly-replenished volcanic rocks are probably the principal sources of recharge in this basin. Because infiltration rates are very slow in the sedimentary deposits, underflow from adjacent volcanics is probably of major significance. The area surrounding this basin and its extension into Oregon primarily consists of Holocene to Miocene volcanic rocks that capture most of the incipient precipitation and intermittent streamflow by infiltration through fractures. These rocks probably function as a single, continuous water-table aquifer that extends across faults and surrounds the basin. Hence, the two principal sources of recharge are: underflow from the rapidly replenished and permeable unconfined system of the adjacent volcanic rocks; and less significantly, the very-slow vertical infiltration of surface water through marginally permeable sedimentary deposits. The general pattern of groundwater movement is from the north to the south.

Groundwater Budget (Type B)

Estimates of groundwater extraction are based on a survey conducted by the California Department of Water Resources during 1997. Surveys included land use and sources of water. Estimates of groundwater extraction for agricultural and municipal/industrial uses are 8,700 and 830 acre-feet respectively. Deep percolation of applied water is estimated to be 9,100 acre-feet.

Groundwater Quality

Characterization. Hotchkiss (1968) reports that the TDS content of groundwater generally increases in proportion to the thickness or proximity of the lake deposits. Waters from wells in volcanic rocks several miles from the lake deposits or from deep wells developed beneath the confining lake deposits typically contain low to moderate TDS.

The water quality of groundwater in the basin ranges widely in response to its source and proximity to sources of surface and subsurface impairment. Water quality for wells constructed in the unconfined volcanic rocks within and adjacent to the subbasin is good with a sodium-bicarbonate character and a total dissolved solids ranging from 150- to 270-mg/L. A shift in water quality is observed with the unconfined volcanics that are proximate to lake sediments. The character shifts to a sodium/calcium/magnesium-bicarbonate/sulfate water that is much higher in total dissolved solids (600- to 800-mg/L), which generally increases in proportion to the penetrated thickness of interfingering lake deposits.

Well Production characteristics

	Well yields (gal/min)	
Irrigation	Range: 15 – 3,380	Average: 1,208 (14 Well Completion Reports)
Well yields from newly constructed wells in the subbasin in 2001 range from 4,000 to 12,000 gallons per minute.		
	Total depths (ft)	
Domestic	Range: 15 – 445	Average: 115 (49 Well Completion Reports)
Irrigation	Range: 28 – 1,170	Average: 239 (15 Well Completion Reports)

Active Monitoring Data

Agency	**Parameter**	**Number of wells /measurement frequency**
DWR	Groundwater levels	40 wells semi-annually
USGS	Groundwater levels	3 wells quarterly
DWR	Miscellaneous Water Quality	8 wells biennial
Department of Health Services	Miscellaneous Water Quality	5

Basin Management

Groundwater management:	Siskiyou County adopted a groundwater management ordinance in 1998. Modoc County adopted a groundwater management ordinance in 2000.
Water agencies	
Public	Tulelake Irrigation District
Private	

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Errata

Changes made to the basin description will be noted here.