Tuscan Aquifer INVESTIGATION

Final Report Excerpt:
Evaluation of Recharge Mechanisms

A primary goal of the Lower Tuscan Aquifer (LTA) Project was to conduct a scientific field investigation to improve the scientific understanding of recharge mechanisms of the LTA system and interactions with other aquifer systems. Detailed discussions of the methods and procedures and analysis conducted for the field investigation is presented in three primary technical reports:

- The Field Investigation Report (Brown and Caldwell, 2012)
- The Aquifer Performance Test Report (Brown and Caldwell, 2013a)
- The Groundwater Recharge Assessment Report (Brown and Caldwell, 2013b).

Studies conducted to assess recharge mechanisms of the LTA included stream gauging, temperature gradient profiling, and analysis of stable isotopes of hydrogen and oxygen from groundwater and surface water samples. Stream gauging and temperature gradient profiling were conducted to assess if surface waters from local streams, such and Butte Creek and Big Chico Creek, recharged the LTA directly in areas where the streams crossed outcrops of the Lower Tuscan Formation. Prior to conducting the LTA Project, this mechanism was thought to be a major contributor to recharge of the LTA. Analysis of stable isotopes of hydrogen and oxygen from groundwater and surface water samples was conducted to assess the source of the recharge water. The analyses of general chemical parameters and stable isotopes for water samples from the groundwater observation wells and surface water samples were not part of the original LTA Project scope, but provided critical insights into the recharge mechanisms and interactions with other aquifer systems for the LTA. In addition, aquifer performance tests conducted for the LTA Project also provided important insights for recharge mechanisms of the LTA including through interaction with other aquifers and possible recharge from the Sacramento River. Each of the recharge mechanisms and aquifer interactions assessed by these studies were critical to evaluating recharge mechanisms.

The recharge analysis of stream flow for all five creeks indicate that if recharge is occurring within the reaches of the channel it is within the calculated accuracy of the instrumentation used for instantaneous stream flow measurements and thus cannot be assessed with developed estimates of continuous stream flow. This indicates that, for any given measurement, the losses or gains within the stream reach cannot be attributed to recharge with any certainty and cannot be quantified based upon the subtle differences in stream flow between upstream and downstream measurements. These results indicate that recharge along these reaches are minimal and not a significant source of water for the LTA.

The results of the infiltrometer testing also suggests that movement of water within the vadose zone (unsaturated portions) of Tuscan Formation as a whole, does not follow a straight vertical pathway downward towards the groundwater aquifers. Instead, water moving vertically downward from the surface will follow a sinous path flowing horizontally along finer grained units with low permeabilities then vertically when encountering coarser material. Horizontal flow was observed at shallow depths during the double ring infiltrometer tests within the shallow soils borings completed next to the test area.

Water samples and isotopic analysis from wells and streams were analyzed to assess recharge characteristics. The data for samples from all three depths of the Hackett Property monitoring well (MW-HP-1), which are located close to the LTA outcrop on the east edge of the valley, are similar and are indicative of precipitation from elevations that are not far above the valley floor. There is a slight trend of increasing elevation with greater aquifer depth, which is what would be expected from recharge at the outcrop along the edge of the valley.

The data for the CSU Farm monitoring wells (MW-CSU-1) indicates a divergent source of recharge for the shallow interval compared to the intermediate and deep intervals. The shallow CSU interval has an isotope signature that suggests recharge may be occurring locally from Butte Creek or its diversions, through the shallow alluvium, and into the upper part of the LTA. The CSU deep interval has an isotope signature that is similar to those from the MW-HP-1 location, suggesting the deep interval at CSU Farms is recharged primarily from local precipitation near the east edge of the valley and lower foothills. The MW-CSU-1 intermediate interval is indicative of a somewhat higher recharge elevation than the deep zone, but may be the result of mixing between zones, with influence from both the shallow and deep zones.

The data from the M&T Ranch monitoring wells (MW-MT-1) indicates that the recharge source decreases in elevation with increasing depth in the aquifer. This is the opposite pattern than what occurs in the MW-HP-1 wells. The MW-MT-1 wells are located in the central part of the valley, near the Sacramento River. Thus, recharged water in the area of these wells may be due to a mixture of lower-elevation precipitation along the basin perimeter and mid-elevation precipitation from the

Sacramento River. The source of Sacramento River water would be at a location north of the M&T Ranch near Red Bluff where the LTA outcrops or extends to shallower depths that would be connected with waters from the river. The MW-MT-1 intermediate zone isotope values could also result from mixing between the shallow and deep intervals. The stable isotope data and water-level interpretations suggest that much of the water in the upper zone at M&T Ranch may be from the Sacramento River, though this warrants further investigation.

The Esquon Ranch irrigation wells, PW-ESQ-39 and PW-ESQ-40, have isotopic signatures that suggest most of the recharge is from local, low elevation precipitation.

The initial, limited sampling of surface water and groundwater for stable hydrogen and oxygen isotopes provides important insight into the sources of runoff in the streams and potential recharge sources within different parts of the study area and at different depths in the LTA. The data and discussion presented should be considered preliminary and provisional at this time. Additional isotope studies are recommended to verify the initial sampling results and provide further details and insights.