West Crane Buried Valley Aquifer: A Hidden Resource

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Information Pamphlet 13

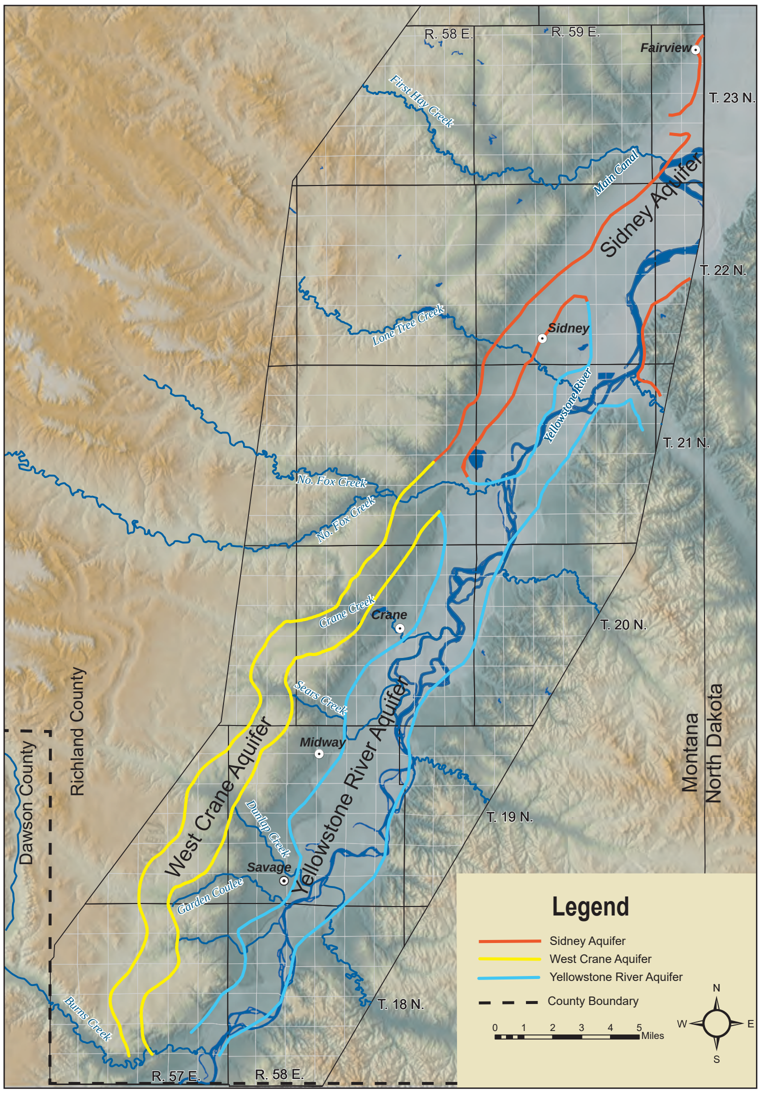

Figure 1. The West Crane aquifer extends northward to the Sidney aquifer (Reiten, 2014 Rocky Mountain GSA).

Rapid irrigation development in the West Crane area prompted this study of hydrologic conditions in the aquifer. A Ground Water Investigation Program (GWIP) project began in 2016, with goals to define the aquifer size, water quality, and groundwater development potential. This report is first in a series of project results and focuses on the physical characteristics of the aquifer, including its dimensions and the direction of groundwater flow. The computer-generated bedrock surface shows the West Crane buried valley. The ancestral stream flowed north indicated by the higher valley elevation at Burns Creek as compared to where it passes under present-day Fox Creek (fig. 2).

The West Crane aquifer is part of the Lower Yellowstone buried valley (LYBV) aquifer system in Richland County, Montana. The aquifer system, identified through a series of recent studies by the Montana Bureau of Mines and Geology (MBMG), includes the West Crane aquifer, the Sidney aquifer to the north, and the Yellowstone River aquifer underlying the present-day river valley east of Sidney and Savage (fig. 1). These aquifers supply water for domestic, municipal, industrial, and irrigation use.

The LYBV aquifer system lies within ancestral river valleys cut into the Fort Union bedrock (fig. 2). These ancient valleys were filled with glacial deposits during the ice ages, and hidden by the erosion and deposition of modern streams.

Test drilling south of Fox Creek has confirmed that the West Crane aquifer continues 22 mi southward to Burns Creek and roughly parallels the Yellowstone River (fig. 1). Sand and gravel filling the base of the buried valley store ample groundwater to support well yields from 500 to 1,500 gallons per minute (gpm). High-yield irrigation wells completed in the West Crane aquifer allow farmers to grow a variety of crops in areas that were previously dryland farmed.

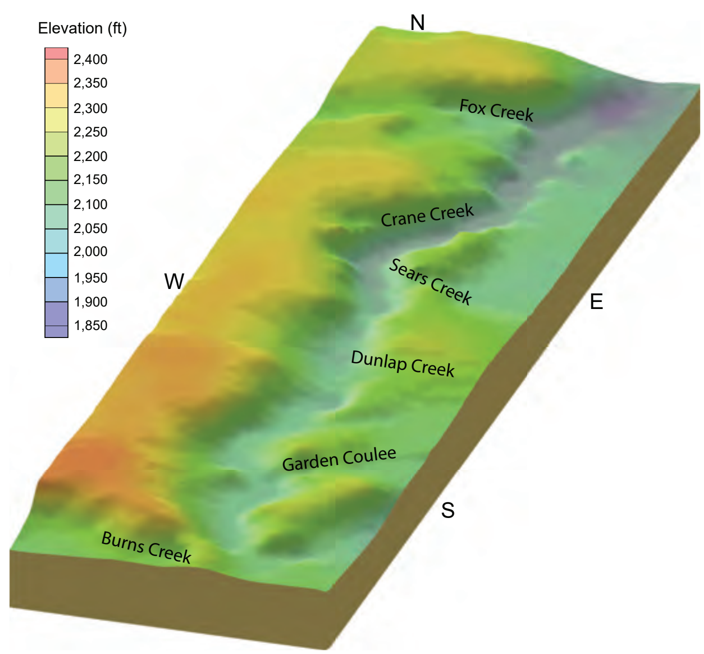

Figure 2. Computer-generated image of the buried valley bedrock surface; color shades indicate bedrock elevation.

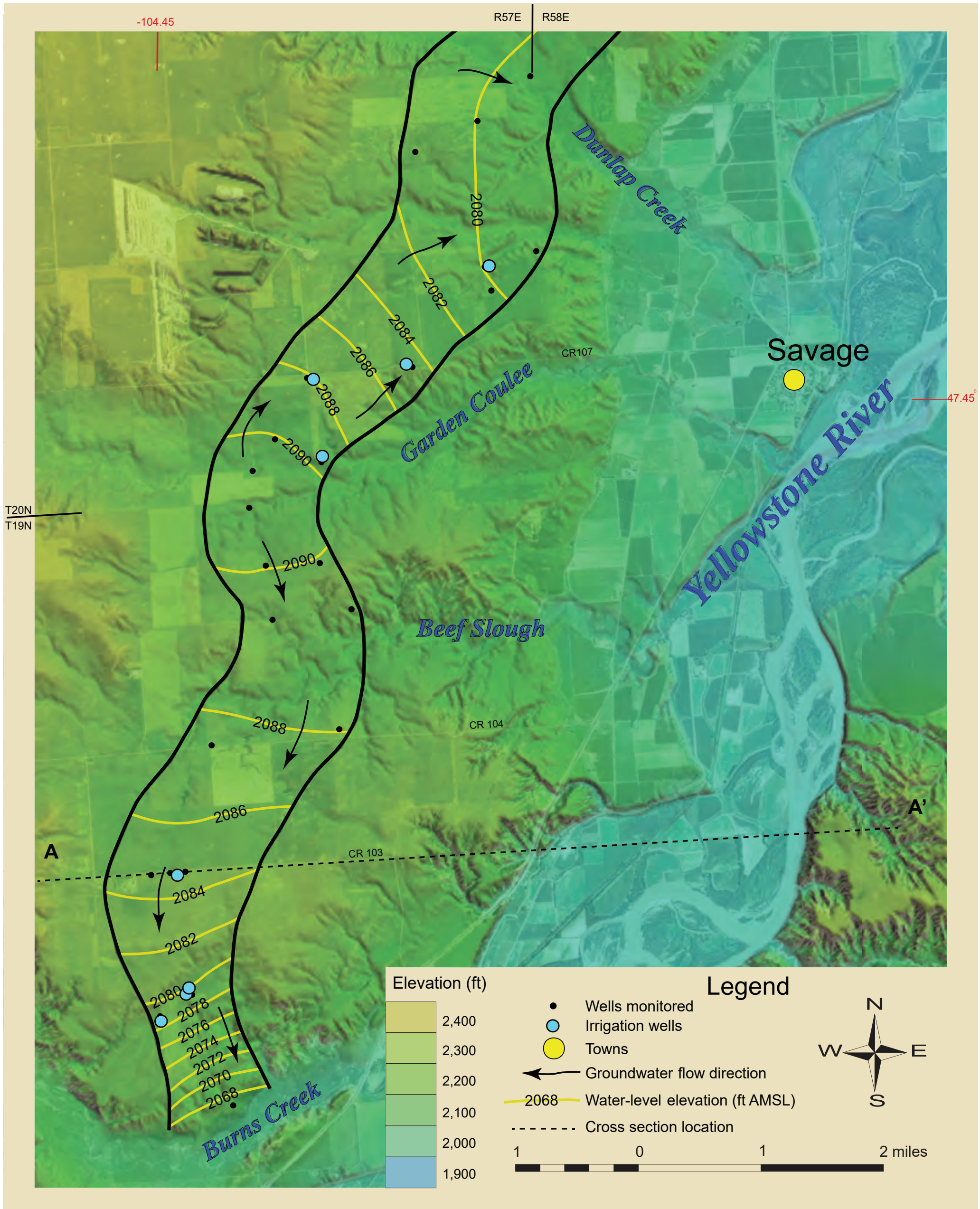

Figure 3. South section of the West Crane aquifer; color shading to show surface elevation.

South

The south section of the West Crane aquifer has a groundwater divide southwest of Savage, Montana. From this high point in the aquifer, groundwater flows north towards Fox Creek and south towards Burns Creek. The hydraulic gradient is very low, as indicated by the small change in water levels over long distances (fig. 3). The gradient increases near Burns Creek, with a 60 ft drop between the last contour and the creek 600 ft away.

There are eight irrigation wells in this area as of 2019. Water quality in the aquifer is compatible for irrigation in most locations, although sampling has indicated poor water quality with higher salinity west of Dunlap Creek.

The dashed line in figure 3 indicates the location of the cross section showing the West Crane aquifer relative to the Yellowstone River (fig. 4). At this cross section, the groundwater level in the West Crane aquifer (2,085 ft) exceeds that in the Yellowstone River alluvium (1,955 ft) by 130 ft. Fort Union bedrock acts as a barrier, restricting flow from the buried valley aquifer to the lower elevation streams or groundwater.

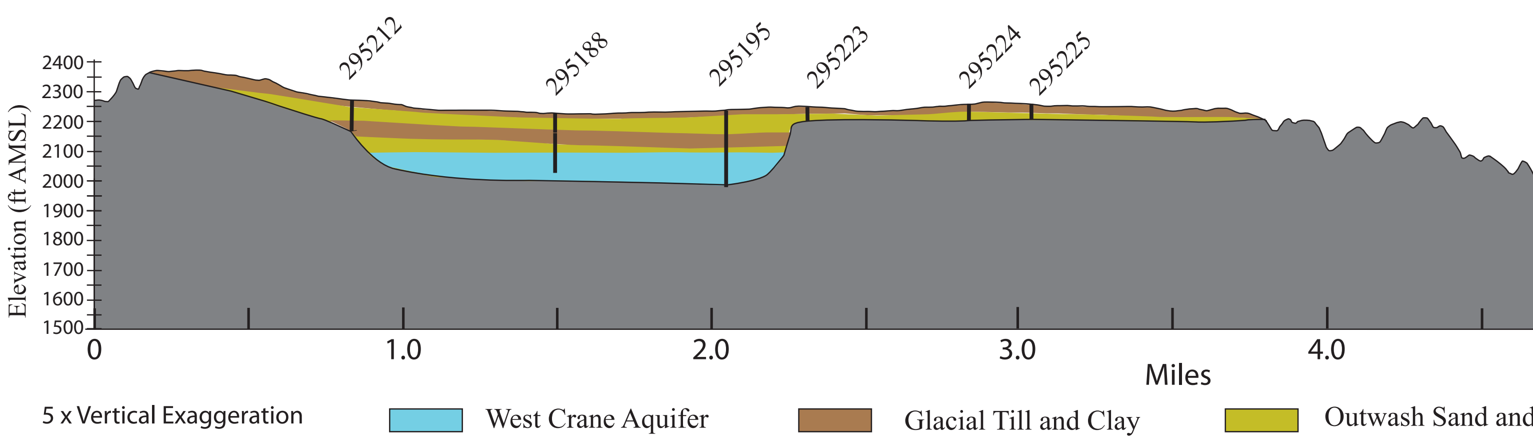

Figure 4. Cross section of the West Crane aquifer and its relation to the Yellowstone River Valley.

North

Groundwater in the north section of the West Crane aquifer flows northward with alternating gradients (fig. 5). Steep gradients typically indicate areas where the aquifer has lower transmissivity (ability to transmit water), compared to locations where the gradient is relatively flat, and the aquifer has greater transmissivity.

As of 2019, the north area has eight irrigation wells, with seven of the eight located between Sears Creek and Fox Creek. All groundwater samples collected in the north section indicate good irrigation water quality.

Recharge and Discharge

The aquifer is recharged through direct infiltration of rainfall and snowmelt. The stream channels crossing the aquifer are dry, with surface flow only during large runoff events from rapid snowmelt or exceptional rain events. The extensive gravel and sand deposits exposed in these channels allow for the rapid infiltration of runoff into the aquifer. The watersheds drained by these tributary streams cover an area many times greater the land overlying the aquifer.

Groundwater discharges from the aquifer as irrigation well withdrawals, stream flow, and through evapotranspiration (groundwater use by plants) in riparian areas.

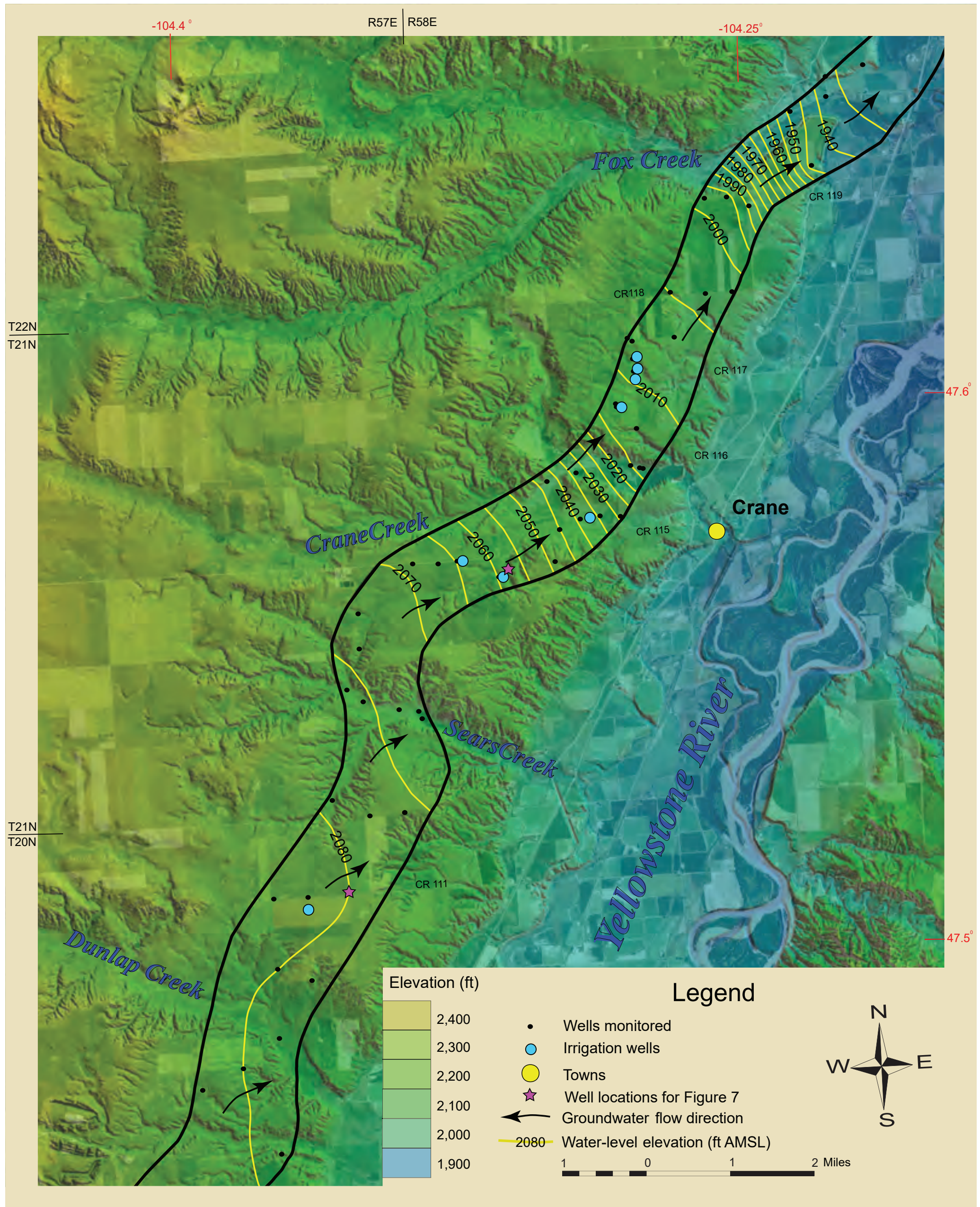

Figure 5. North section of West Crane aquifer, color shading to show surface elevation.

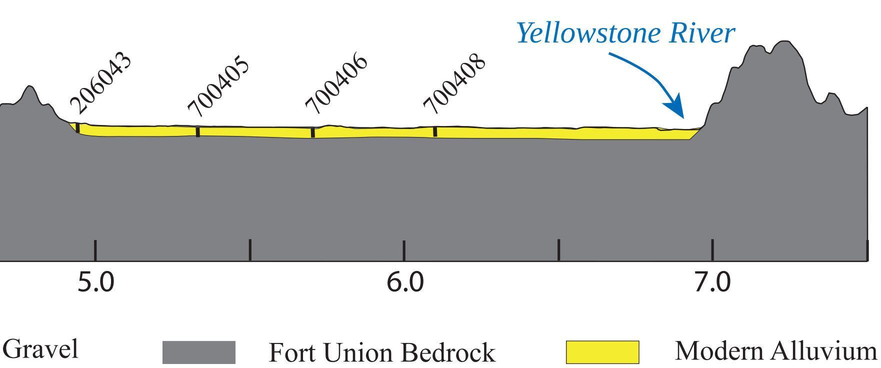

Figure 6. Monitoring well installation north of Burns Creek.

Monitoring Current Conditions

We monitored 102 wells in the West Crane aquifer in 2019, and about 65 of these are dedicated monitoring wells equipped with water-level data loggers (fig. 6). The loggers provide a continuous record showing groundwater levels and their response to use and recharge. The two representative hydrographs shown here are from wells with long monitoring records (fig. 7). Water levels in well 273796, located along CR111, show the background water-level trend in an area without irrigation development, from 2012 to 2019. Well 234024, south of CR 115, is near the longest operating irrigation well in the aquifer, operational since 2011. The hydrograph shows how groundwater draws down with irrigation pumping, then recovers annually. This long-term hydrograph documents water-level rises related to recharge from the 2010–2011 snow pack and subsequent wet years. The water levels continued to rise during the first 4 years of irrigation pumping (2011–2015) and remain higher than 2009–2010 pre-irrigation levels.

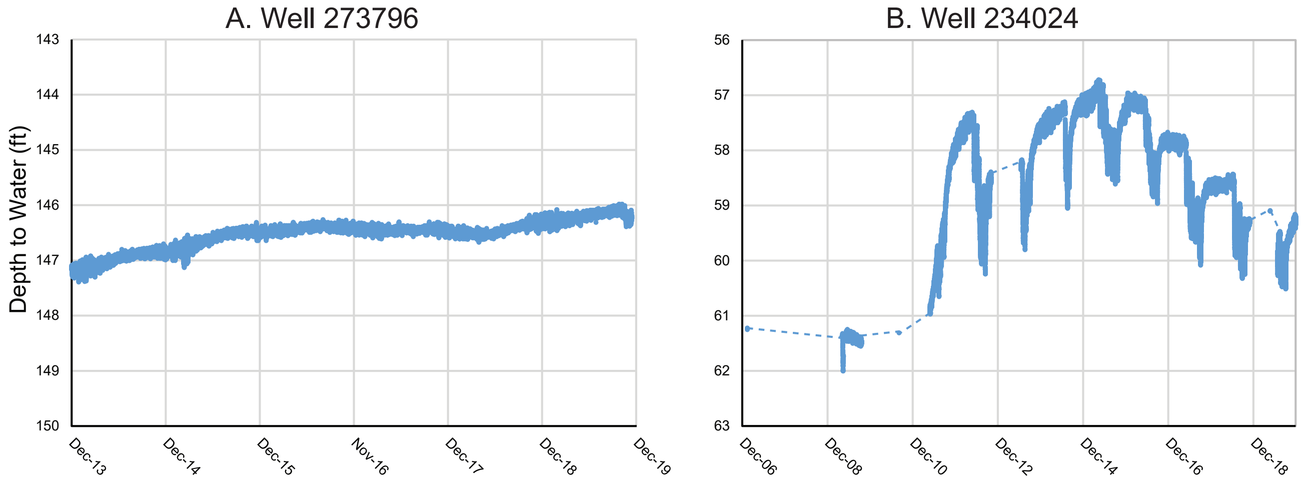

Figure 7. (A) The hydrograph of well 273796 shows increasing groundwater levels before irrigation development. (B) The well 234024 hydrograph shows water-level changes from precipitation recharge in 2010–2011, and irrigation pumping (dashed lines indicate periods of missing data).

Planning for the Future

As the West Crane aquifer is developed for irrigation, monitoring data will be critical for evaluating the cumulative effects of pumping. The hydrograph in figure 7B would show a very different view of the water-level trends if only 2016–2018 data were available. Long-term, continuous records provide data necessary for evaluation of irrigation pumping and recharge events. We recommend continued monitoring of water levels at select wells to support management of this groundwater resource.

The areas where dry streambeds cross the aquifer have good potential for aquifer storage and recovery (ASR). ASR refers to surface modification to increase aquifer recharge and store water for later use. If flood water is temporarily impounded or spread in the channels above the aquifer, a larger amount of streamflow could infiltrate, and be stored as groundwater for later use, or to increase groundwater discharge to streamflow during dry periods.

More Information

For more information on the West Crane aquifer, contact:

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Ground Water Investigation Program, http://mbmg.mtech.edu/research/gwip/gwip.asp

For water rights information:

DNRC Water Resource, Glasgow Regional Office, 222 Sixth Street South, Glasgow, MT 59230

(406) 228-2561

http://dnrc.mt.gov/divisions/water/water-rights/water-resources-regional-offices

For well location, well logs, water quality, and hydrographs, go to:

Montana’s Ground Water Information Center, (GWIC) at: https://mbmggwic.mtech.edu/