Hydrogeology of the West Bench Aquifer



Beartooth Front Community Forum Webinar, December 9, 2021

West Bench





1980 – 2005 12 wells/yr



2005 - 2012 19 wells/yr



Source: Reiten, 2020

2000 – Kirk Waren DNRC

Groundwater Levels at the South End of the Red Lodge Bench Near Red Lodge, Montana

Kirk Waren Montana Department of Natural Resources and Conservation

March, 2000

2014 Carstarphen, Patton, LaFave MBMG



Ground Water Assessment Program

Information Pamphlet 8

WATER LEVELS IN THE UPPER WEST BENCH ALLUVIAL AQUIFER,

RED LODGE, MONTANA

Camela Carstarphen, Thomas Patton, and John I. LaFave





HYDROGEOLOGY OF THE ROCK CREEK BENCHES, CARBON COUNTY, MONTANA

Jon Reiten

With a section on Groundwater Quality by Jon Reiten and Shawn Kuzara

Montana Bureau of Mines and Geology, Montana Technological University, Butte, Montana



2020 Reiten MBMG





West to East Cross Section Near Red Lodge



Figure 8. Transverse cross-section D-D' depicting physiographic and stratigraphic relationships between alluvial deposits.

Source: Reiten, 2020

West Bench Aquifer



Figure 8. Transverse cross-section D–D' depicting physiographic and stratigraphic relationships between alluvial deposits.

West Bench Aquifer



Figure 8. Transverse cross-section D–D' depicting physiographic and stratigraphic relationships between alluvial deposits.

"Green Line" showing Groundwater Discharge from West Bench Aquifer near the Airport





South to North Cross Section Red Lodge to Roberts



Figure 2. Longitudinal cross-section WB–WB', depicting the profile of the West Bench surface (Qat2) and the thickness of terrace deposits. Note decreasing thickness of the terrace deposits to the north. Source: Reiten, 2020

Natural Surface Hydrology



Figure 3. Comparison of Irrigated and non-Irrigated land on the East and West Benches of Rock Creek.

~ 4 miles of Willow Creek



Figure 3. Comparison of irrigated and non-irrigated land on the East and West Benches of Rock Creek.

Man-made Surface Water



Source: Reiten, 2020

>40 miles of Irrigation Canals on West Bench

Sub-Surface Hydrology

Where is the Water Going?

Where is the Water Coming From?

Why is the Water Level Stable?

Groundwater Budget \$\$

Groundwater Discharge (Expenses)

- Uptake by plants
- Spring Discharge
- Discharge into streams
- Pumpage from wells

• Groundwater Recharge (Income)

- Direct Precipitation (Rain Snowmelt)
- Seepage from Perennial Streams (Willow Creek) and Ponds
- Irrigation Return Flow
- Seepage from Irrigation Canals
- Seepage from Septic Drain Fields

Aquifer Storage (Account Balance)

- Increases if recharge (income) exceeds discharge (expenses)
- Decreases if discharge exceeds recharge

Groundwater Budget \$\$

Groundwater Discharge (Expenses)

- Uptake by plants
- Spring Discharge
- Discharge into streams
- Pumpage from wells

Groundwater Recharge (Income)

- Direct Precipitation (Rain Snowmelt)
- Seepage from Perennial Streams (Willow Creek) and Ponds
- Irrigation Return Flow
- Seepage from Irrigation Canals
- Seepage from Septic Drain Fields

Aquifer Storage (Account Balance)

- Increases if recharge exceeds discharge
- Decreases if discharge exceeds recharge

When the Ditches are Running (April to October)

When the Ditches <u>Stop</u> Running (November to mid-April)

Effects of Land Use Changes

Source: Reiten, 2020

Figure 3. Locations of irrigated and non-irrigated land on the East and West Benches of Rock Creek. Wells are locations of long-term water-level monitoring.

Figure 4. Hydrographs showing water-level fluctuations in selected West Bench alluvial aquifer wells.

Hydrograph of Well Near Double Ditch Dog Park 2009-2019

Hydrograph of Well Near Double Ditch Dog Park 2009-2019

Figure 4. Hydrographs showing water-level fluctuations in selected West Bench alluvial aquifer wells.

Most Significant Land Use Change on the West Bench in Human History?

Introduction of Irrigation at the Turn of the Last Century

What did the West Bench Look Like in 1850?

JA1

Dry Gravel

Saturated Gravel

Sedimentary Bedrock

Photo Credit: Jeff DiBenedetto

JA1 Joel Adams, 12/8/2021

After Irrigation

Dry Gravel

Saturated Gravel

Sedimentary Bedrock

Saturated Gravel

Sedimentary Bedrock

Waren 2000, MT DNRC

Conclusions

Groundwater beneath the high terrace, or bench west of Red Lodge is a readily accessible fresh water supply for the growing number of residents and businesses located on the bench. At this time, this sand and gravel aquifer is in part artificially recharged by the irrigation canals traversing the area, and by irrigation. This aquifer is preferable in some ways to deeper bedrock aquifers. It is shallower and less expensive to reach with wells, it is highly productive, and groundwater may be less mineralized than that in deeper aquifers. If this aquifer can be maintained, more expensive water supply systems – deeper wells or piped water - may never be needed on the bench.

The future of the irrigation canals should be of great interest to anyone using the terrace gravel aquifer and to anyone involved with planning urban expansion. Leakage of water from these canals may be the principal source of water in the terrace aquifer. If canals are ever abandoned because all the lands serviced by them come out of irrigation, it would be wise to tentatively plan to keep the canals, easements, and structures in place, at least temporarily. If the aquifer receives adequate groundwater recharge from other sources, such as other canals or natural recharge, the canal could be abandoned. If not, then the canal could be used to artificially recharge the aquifer either by continuing normal operations and routing the water back to its source, or by developing a more sophisticated artificial recharge system.

Carstarphen et al 2014, MBMG

Carstarphen, Patton, and LaFave

Summary

At the time of sampling, water quality in the alluvial aquifer is very good, despite the dense development on the Upper West Bench. TDS and nitrate concentrations are low. The aquifer is dependent upon canal leakage for a large part of its recharge (also a finding of Waren, 2000). While there were no signs of aquifer-wide depletion, the Ground Water Assessment Program retained well 170571 as a state-wide monitoring network well. Based on data from this well, there are no indications of long-term water-level decline (fig. 9).

Reiten 2020, MBMG

Conclusions

Hydrographs can provide information on sources and timing of recharge and discharge to an aquifer. This review describes several of these interpretations and shows the importance of high-frequency, long-term monitoring on the Rock Creek benches. Infrequent water-level measurements and relatively short duration of monitoring can limit interpretation of the aquifer response in areas such as this, where multiple factors (increase in the number of wells, changes in the extent and methods of irrigation, short-term climatic conditions) can affect the hydrologic system. In this case, hourly measurements collected with transducers and data loggers provided good definition of water-level changes. Nearly identical patterns of annual water-level cycles repeat over several years of monitoring. These cycles suggest leakage from irrigation ditches and return water from flood irrigation are primary sources of recharge to the West Bench of Rock Creek.

Data collected through 2018 indicate that leakage from irrigation ditches appears to adequately recharge the West Bench alluvial aquifer. The volume of water pumped for subdivision housing through this time period does not appear to affect groundwater levels, as there are not obvious declines in the long-term hydrographs. Water supply problems may occur near the edge of the Bench where the depth to water in early spring approaches the total well depth.

What Could Affect Irrigation Canals?

- Climate Change Extended Drought
 Junior water rights were shut off last summer
- Residential Development Pushing out Ag
- Sale of Water Rights for Other Uses
- Ditch Improvements/Lining
- Changes in Points of Diversion

What can be done to secure water for the future?

- Secure/Acquire Water Rights for Groundwater Recharge
- Keep Agriculture Viable
- Continue Monitoring
- Other Thoughts?