Date: January 30, 2018

From: Kurt Walker and Chris Perra (Technical Unit)

To: Trevor Hutton, John Kirk, and the File

RE: Update to Ecology's 1991 Beaver Creek – Methow River Closed Tributary Report

**Background & Purpose**

Under WAC 173-548 (the Rule), 15 tributary streams and 17 lakes within the Methow River Basin are closed to further consumptive appropriations unless the specified reservation applied. This closure included "all groundwaters hydraulically connected" to these streams and lakes. The Department of Ecology (Ecology) investigated the groundwater resources within the tributary basins from the headwaters to the main Methow River valley margin. In 1991, Ecology staff assembled broad technical findings into a collection of small reports. However, these reports failed to describe the stream reach behavior and controls from the mouth of each tributary bedrock canyon to the confluence with the Methow River. Ecology is now providing additional information in an effort to update the record and provide a more complete understanding of the hydraulic relationship between surface and groundwater near Beaver Creek.

The occurrence and behavior of groundwater within the main Methow River Valley has been evaluated by many including Ecology and the U.S. Geologic Survey. The reader is directed to these works for a more holistic description of the hydrogeology of the main Methow River Valley. The focus of this report will be on the local hydrologic conditions and behavior in the lower Beaver Creek watershed primarily between the previously described restricted area and the confluence with the Methow River.

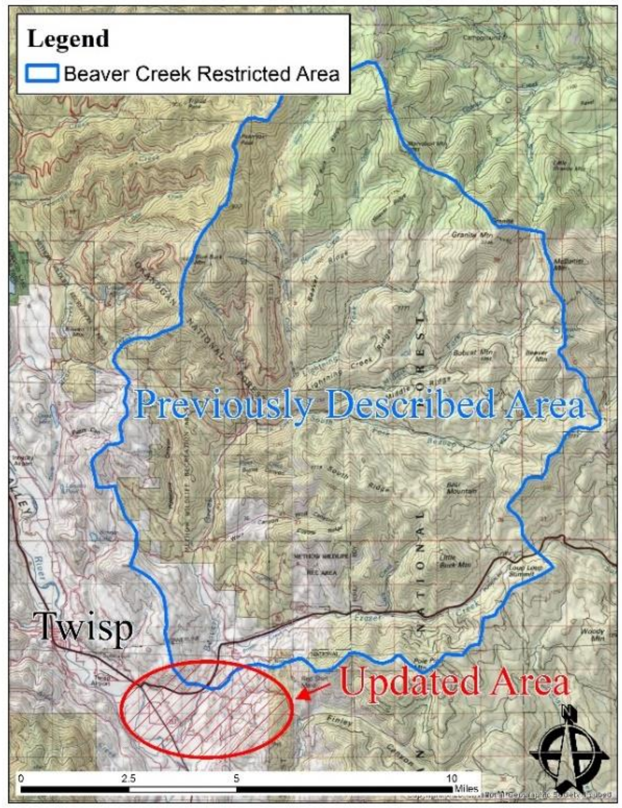


*Figure 1 – Previously evaluated and described area of the Beaver Creek watershed in blue outline. Area of study and updated assessment within red hatched ellipse.*

**Investigation**

Among the key conclusions of the 1991 closed tributary reports, Ecology found that groundwater within the unconsolidated sediments outside the main Methow River Valley are, more likely than not, in hydraulic continuity with the tributary stream (Peterson and Larson 1991). Groundwater within the bedrock units was generally not considered to be in hydraulic continuity with the stream. There is currently no effort to re-investigate these conclusions. However, Ecology recognizes the need to extend our understanding beyond the previously described areas to also include the lower most reaches of some closed streams.

The Beaver Creek watershed, including Frazer Creek, is the largest of the listed closed tributary streams under the Methow Rule. Historically, Ecology has not considered groundwater in the lowest portion of the watershed, approximately two stream miles, to be part of the restricted area under rule. Ecology staff (Chris Perra and Kurt Walker) performed a field investigation and collected data within Beaver Creek basin on November 7 – 9, 2017. Geologic information was attained, wells near the creek were identified, and two sites were selected to measure streamflow.

**Geologic – Hydrogeologic Conditions**

Beaver Creek and its tributaries, including Frazer Creek, drain a large and diverse area of rugged mountains, rolling hills, and narrow fertile valleys. The complex of bedrock strata that underlies the basin is exposed along numerous ridges and creek channels (see Figure 2). While the highlands are largely forested, the lowlands largely lack trees outside the drainage bottoms. Glacial-fluvial sediments and soils covering the land are often thicker than many Methow Valley tributaries, but are still typically thin (less than 200 feet) throughout the watershed.

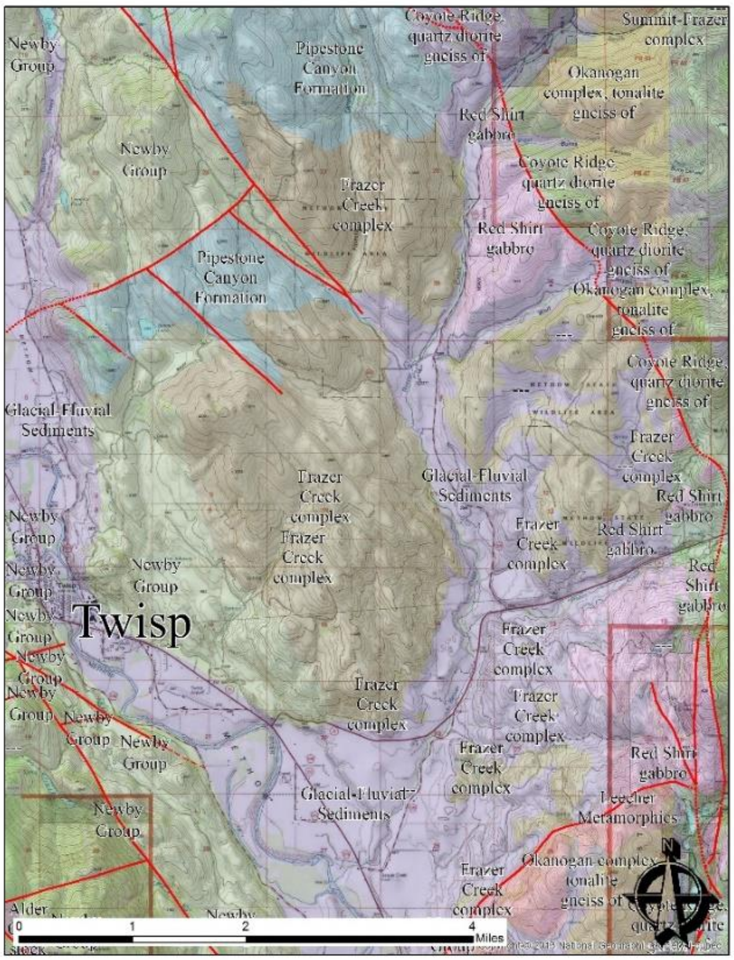

*Figure 2 – Geologic map with major faults shown in red.*

In contrast, the landscape of the main Methow River Valley consists of gentle slopes, broad terraces, and wide plains. Bedrock in the main valley has been scoured by glaciers into a U-shape with steep walls and a deep floor (Barksdale, 1941). Upstream from the main Methow River Valley, Beaver Creek is closely constrained by bedrock walls and floor. Under this condition, groundwater within the glacial-fluvial sediments has a direct recharge/discharge relationship with Beaver Creek and other surface waters. At the margin of the main Methow River Valley, the valley opens up and the groundwater relationship with Beaver Creek changes.

As the creek enters the main valley it is no longer constrained by near surface bedrock but flows over and cuts into prominent glacial terraces before discharging to the Methow River. Depth to bedrock quickly increases from a few feet near the intersection of Highway 20 and Lower Beaver Creek Road to more than 250 feet along the main trace of the Methow Valley (Konrad and others, 2003). Many tens of wells have been drilled within the lower reaches of the watershed, mostly for domestic purposes. Well logs were analyzed in order to better understand the local hydraulic conditions. While wells drilled on the upland slopes are completed exclusively into bedrock, wells near the Beaver Creek are often constructed into the overlying glacial-fluvial sediment deposits. Near the bedrock uplands/main valley transition, drilling records show that the static water levels within sediment wells closely correlate with the elevation of Beaver Creek (see Figure 5). Downstream where the bedrock is considerably deeper, static water levels appear more closely correlated with the elevation of the Methow River.

The glacial-fluvial aquifer within the main Methow River Valley has been thoroughly studied by the US Geological Survey, Ecology, and many others. The aquifer (the main valley aquifer) is distinguished in part due the limited amount of fine material, unlike the upland deposits which often contain more silts and clays (Konrad et al, 2003). It is broadly accepted that the glacial-fluvial main valley aquifer and the Methow River are in a high degree of hydraulic continuity. Exact exchange of water (gains and losses) between surface and groundwater will vary by location and season, but the condition is well documented.

*Figure 3 – Lower Beaver Creek watershed oblique view looking northeast with Methow River in foreground. Google Maps Image.*

The hydraulic conductivity of the main valley aquifer is generally regarded as high with the river gaining flow between Twisp and Beaver Creek (Konrad et al, 2003). This aquifer and river condition results in a relatively flat groundwater water table that extends across the width of the main valley aquifer with a steady gradient down river. Groundwater elevation may be slightly elevated along the margins of the main valley aquifer as result of side drainage sub-surface recharge. Konrad and others (2003) note the widespread but intermittent occurrence of lacustrian deposits between Twisp and Benson Creek. While these fine grain units may hinder well performance, it does not appear that they result in confining conditions.

Ecology maintains two gauging stations (48F150 and 48F060) which measure streamflow along Beaver Creek. On November 8, 2017, additional streamflow measurements were taken at two locations (one on Beaver Creek and one from Frazer Creek) both upstream of the main Methow Valley (see Figure 4). No known surface water diversions were active while streamflow was being measured. Field measurements and gauge station data suggests that Beaver Creek gains flow along the shallow bedrock reach and is approximately neutral to slightly gaining from the Frazer Creek confluence to the Methow River (see Table 1 – flow data). Near surface lacustrian deposits and/or stream bed armoring may be partially protecting streamflow from measurable seepage losses in the lower reach.

*Figure 4 – Ecology staff taking stream measurements of Beaver Creek flow near Finley Canyon Road on November 8, 2017.*

Table 1 – Beaver Creek Basin Streamflow Observations on November 8, 2017

| Location | Avg. Flow (cfs) | Temperature (F) |
|---|---|---|
| Ecology Station – 48F150 | Not Recorded | Not Recorded |
| Frazer Creek near Beaver Creek confluence | 4.3 ± 1.4% | 39.8 |
| Beaver Creek near Finley Canyon Road | 21.8 ± 9.2% | 37.4 |
| Ecology Station – 48F060 | *23.4 | *37.4 |

*Daily Average

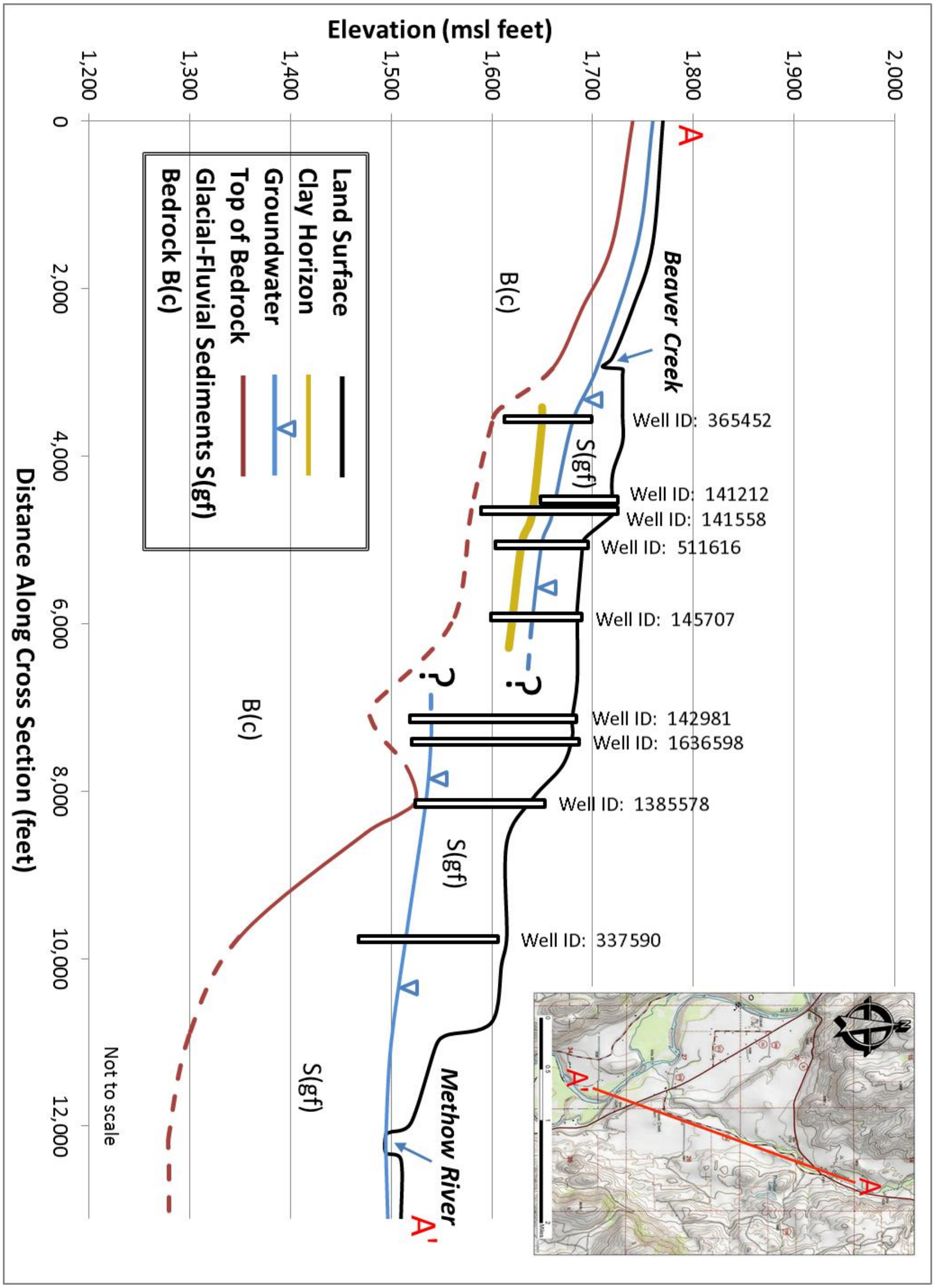


*Figure 5 – Lower Beaver Creek cross section.*

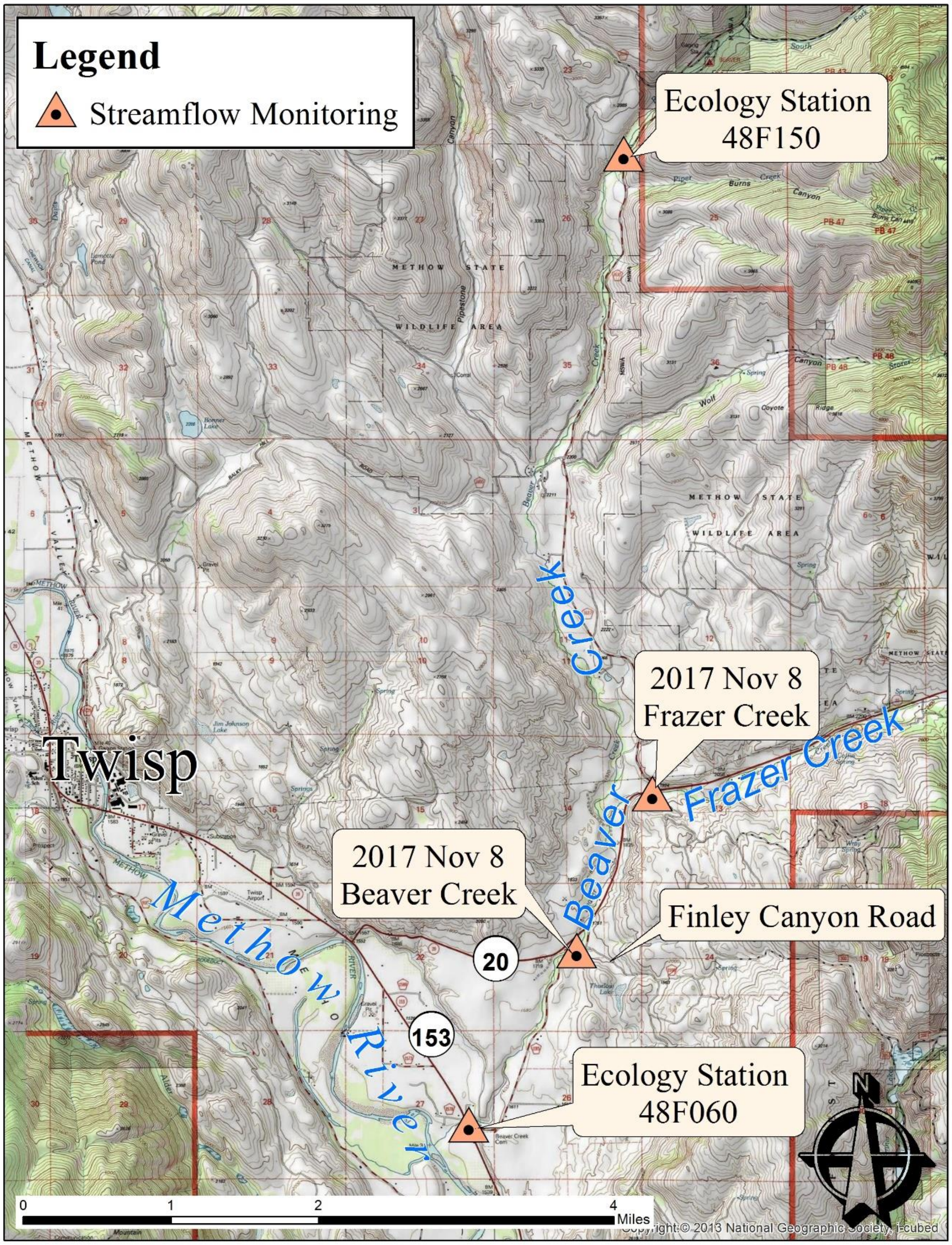


*Figure 6 – Ecology stream flow monitoring locations in Beaver Creek watershed.*

**Updates to Restricted Area Map**

It appear that the historic restricted groundwater use area mapping did not identify all areas where groundwater is likely to be hydraulically connected to Beaver Creek (see Figure 7). Previously, an unnamed drainage along Finley Canyon Road, which holds springs and carries flow into Beaver Creek, was unexplainably not included as a Beaver Creek tributary. The geology and available well log information clearly implies that the groundwater within the glacial-fluvial sediments remains hydraulically connected to Beaver Creek as it enters the main Methow Valley. However, as the creek flows over areas of increased depth to bedrock, the creek becomes disconnected from groundwater and is not reconnected before reaching the Methow River. The updated restricted area map (Figure 7) reflects a best estimate of where withdrawal of groundwater within the glacial-fluvial sediments may impact Beaver Creek flows.

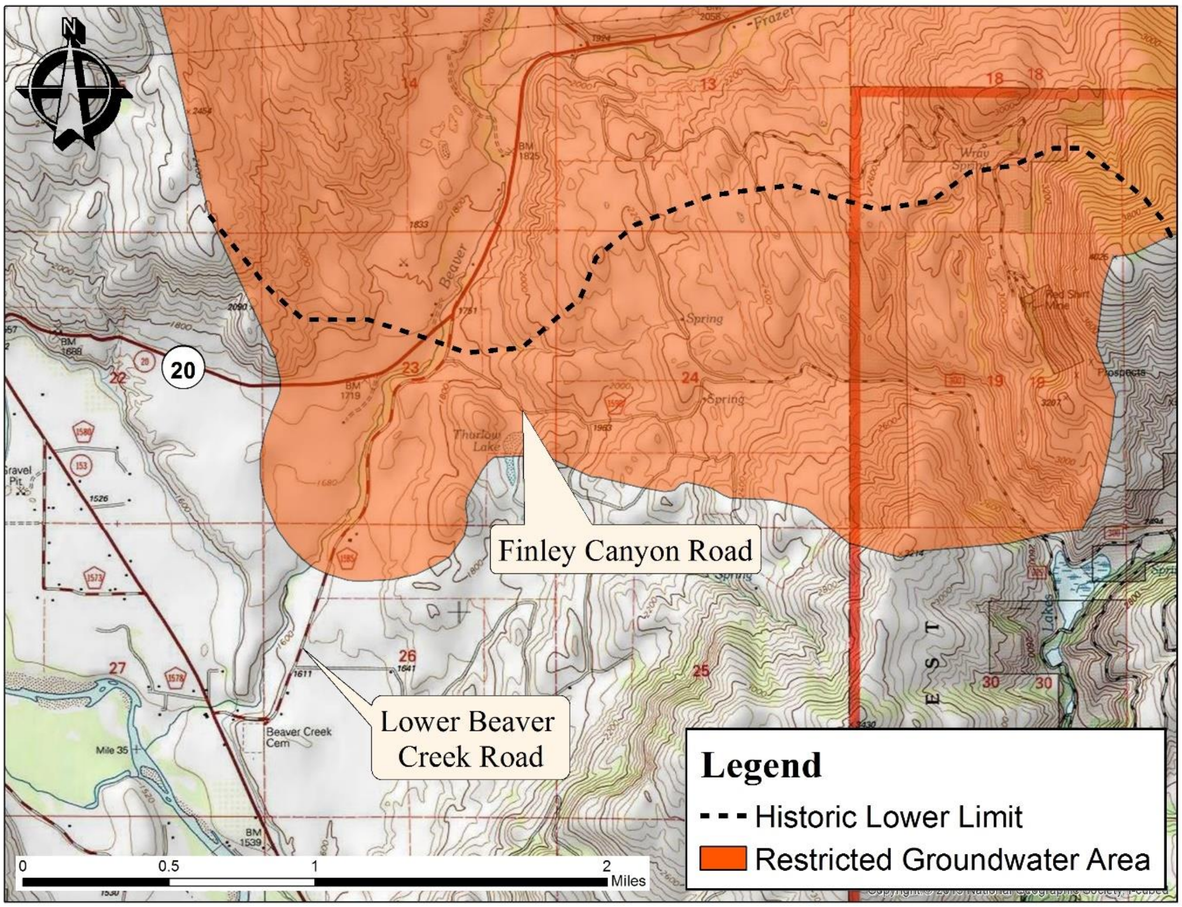


*Figure 7 – Beaver Creek restricted groundwater area. Showing only lower watershed.*

**Findings**

Considering the stratigraphic setting, recorded static water levels, measured streamflow, recent field observations, and previous technical reports, it is strongly evident that groundwater in the glacial-fluvial sediments from the uplands to the margin of the main Methow Valley are hydraulically connected to Beaver Creek. However, in approximately the lowest mile of Beaver Creek where bedrock becomes increasingly deep, creek flow becomes disconnected and hydraulically separated from the deeper groundwater of the main valley aquifer. In other words, Beaver Creek is not hydraulically connected to the underlying main valley aquifer from the Methow River to edge of the restricted groundwater area as depicted in Figure 7. Where disconnected from the streamflow of Beaver Creek, groundwater within the main valley aquifer is undoubtedly hydraulically connected to the Methow River.

**Limitations**

Ecology has conducted this work with the intent of providing a general description and interpretation of the subsurface stratigraphy and hydraulic behavior within the aforementioned study area containing Beaver Creek. While we hope this work will be useful to Ecology managers and other parties considering water management decisions, we caution that additional investigation may be warranted depending on the degree of certainty needed and the information available in site specific cases.

This technical analysis has been prepared in effort to update our understanding of groundwater and surface water interactions in the lower Beaver Creek drainage, WRIA 48, Okanagan County, Washington. Because each hydrogeologic study is unique, each hydrogeologic analysis is unique and is based on conditions that existed at the time the investigation was performed. The findings and conclusions of this analysis may, however, be affected by the passage of time as a result of either manmade or natural events.

The practice of geology, geological engineering and hydrogeology are far less exact than other engineering and natural science disciplines. Interpretations of subsurface conditions presented in this report are based on available data. Professional judgment was applied to form an opinion about subsurface conditions throughout the area of interest. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Thus, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

**References**


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