Proposal for hydrogeologic study of Emigration Canyon, Salt Lake County, Utah

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Introduction

Groundwater in Emigration Canyon provides the entire culinary water supply and a significant component of the secondary supply for the canyon's residents. This supply is produced from wells owned by individuals and small water purveyors along Emigration Creek, and larger production wells in upland parts of the drainage that are part of the Emigration Canyon Improvement District (figure 1).

During a recent drought year, flow along many reaches of Emigration Creek declined and ceased along significant parts of the drainage. The ultimate cause of the reduction in flow is unknown but it has been assumed that groundwater withdrawal and drought have caused the flow reduction. The Utah Division of Water Rights requested that the Utah Geological Survey prepare a proposal to delineate the groundwater system in Emigration Canyon and its connection with streamflow in Emigration Canyon.

Groundwater in Emigration Canyon resides primarily in a series of potentially interconnected bedrock aquifers. These aquifers include successions of limestone, dolomite, sandstone and shale all which have been fractured and folded into the large scale Emigration Canyon syncline (Matyjasik and others, 2010). Overlying the bedrock along Emigration Creek is a thin unconsolidated aquifer (Barnett, 1966). Recharge to the bedrock aquifers occurs primarily from direct infiltration of precipitation . Recharge of the unconsolidated aquifer along Emigration Creek may occur from direct infiltration of precipitation and infiltration of stream flow. Stream flow may also contribute to recharge of the bedrock aquifers. There is no sewer system in Emigration Canyon and septic systems may contribute a component of recharge throughout the canyon particularly along Emigration Creek. Sources of groundwater discharge include well withdrawal, aquifer discharge to Emigration Creek, direct evapotranspiration in areas of shallow groundwater, and possibly groundwater movement beneath drainage basin boundaries. The interaction of groundwater with surface water may be an important part of the total water budget and therefore exert control on streamflow in Emigration Creek.

Previous work in Emigration Canyon has included the general hydrogeology of the area as presented by Barnett (1966) and a series of more recent consultant level reports that were created as part of the drilling of production wells. Because development in Emigration Canyon is largely unsewered, recent studies have attempted to quantify septic loading to Emigration Creek (Kimball and others, 2008; Wilden, 1993). Both of these studies found significant loading of nitrate, E. Coli, and other anthropogenic constituents to Emigration Creek. Kimball and others (2008) also indicate areas where significant surface inflow into Emigration Creek occurs from Burr Fork, Brigham Fork, and Freeze Creek. They also found important diffuse groundwater inflow to Emigration Creek near Blacksmith Hollow and Maple Grove, and near a mapped fault downstream of Pioneer Gulch. Their work also supports Emigration Creek losing flow to groundwater from Rattlesnake Point to near the mouth of the Canyon before regaining flow from a series of springs and diffuse inflow near and downstream of the mouth of the canyon. Below the mouth of Emigration Canyon streamflow in Emigration Creek has been measured since the 1960's by the City of Salt Lake. No continuous monitoring of the creek exists above this point. Just north of Emigration Creek, the Red Butte Creek drainage has long term streamflow measurements from the 1960's to present that represent an analog to observed flow in Emigration Creek.

Proposed Work

The primary goals of the study are: (1) to characterize the hydrogeology of Emigration Canyon by defining the extent and structural orientation of bedrock aquifers and aquicludes and creating a potentiometric surface for aquifers in Emigration Canyon, and (2) to characterize groundwater-surface water interactions and connections using continuous stream gauging, detailed stream seepage and temperature transects, and samples of geochemistry and isotopes in groundwater and surface water.

Hydrogeologic data will be used in conjunction with new potentiometric information, stream seepage measurements, stream gauging, and water chemistry and environmental tracers to determine the relationships between groundwater and streamflow. To complete the tasks below and to account for potential annual variability in climate we propose a two year study.

1) Create **HYDROGEOLOGIC FRAMEWORK.** Create 1:24,000 scale geologic map for Emigration Canyon. Map will be based existing geologic mapping and new mapping of the Emigration Canyon quadrangle completed in a separate study as part of Utah Geological Survey's Statemap program. A series of geologic cross sections will be created that constrain the connection of upland bedrock aquifers with Emigration Creek. A detailed hydrostratigraphy that depicts aquifers and aquicludes will be created.

2) Create **POTENTIOMETRIC SURFACE for bedrock aquifers.** Gather water levels from springs and wells as possible in Spring and Fall. Combine measurements with existing measuring sites to create detailed potentiometric map. Incorporate available long term water level data from wells. These data will help to define the potential for groundwater to interact with surface water. Long term water level data will constrain changes in the volume of groundwater in storage and the potential for water level changes to impact stream flow.

3) Gather and interpret **ENVIRONMENTAL TRACER DATA from groundwater, surface water, and precipitation** Sample wells and springs for general chemistry, select trace elements, and stable isotopes. Sample surface water in Emigration Creek and its tributaries. Interpret results to constrain conceptual model and indicate potential

for groundwater-surface water interaction. Stable isotopes will be collected from two precipitation samplers deployed near the mouth of the drainage and along the upper elevations of the drainage. Stable isotope results from precipitation, streamflow and groundwater will be used to constrain connections between surface water and groundwater using an isotope mass balance approach similar to that used in the recent Ogden Valley study.

4) Measure **STREAM SEEPAGE TRANSECTS and sample stream water** concurrently. Measure stream flow at 10 to 15 sites along Emigration Creek during baseflow and runoff periods. Sample streamflow for stable isotopes, general chemistry, select trace elements, and field parameters including temperature and conductivity. Stable isotope results combined with flow data will be used to constrain relative amounts of groundwater inflow to and outflow from Emigration Creek.

5) Establish **CONTINUOUS STREAM GAUGING and incorporate existing long term records**. At least two continuous gauging sites will be established in Emigration Canyon and measured for the length of the project. These sites will be chosen based on the results of the stream seepage runs and availability of existing structures such as culverts or bridges that can be gauged using vented transducers. Continuous stream gauging will constrain temporal changes in groundwater surface water interactions along Emigration Creek.

6) Gather **LONGTERM FLOW DATA from USGS gauge on Red Butte Creek** and compare with climate and available long term flow data for Emigration Creek. The Red Butte Creek drainage represents an excellent undeveloped analog for Emigration Creek drainage. TIme series analysis of Red Butte Creek and Emigration Creek streamflow will provide the baseline effects of climate on streamflow in Red Butte Creek and how these differ from Emigration Creek.

7) Create **FINAL REPORT.** Write report summarizing results and methodologies employed by this study. Report will include geologic and potentiometric maps and cross sections that define spatial connection of the bedrock aquifers and their relationship to perennial streamflow. Report will include detailed maps of gaining and losing reaches of Emigration Creek and its tributaries.

Budget Considerations and Project Timeline

In order to complete the tasks outlined above we anticipate **2 years of work beginning in FY2020**. Most geologic mapping, stream seepage measurements and geochemical sampling will occur in FY2020. Interpretation of results, creation of cross sections, continuous flow monitoring and report creation will occur in FY2021. The 2 year timeframe should also allow for streamflow and isotopic measurements to capture climatic variability. **Total cost for FY2020 is $103,135**. The UGS will provide a 50% cost share of $51,588 and the **total external funding needed will be $51,568 for**

fiscal year 2020. **Total cost for FY2021 is $96,285**. The UGS will provide a 50% cost share of $47,730 and the **total external funding needed will be $48,143 for fiscal year 2021**.

References

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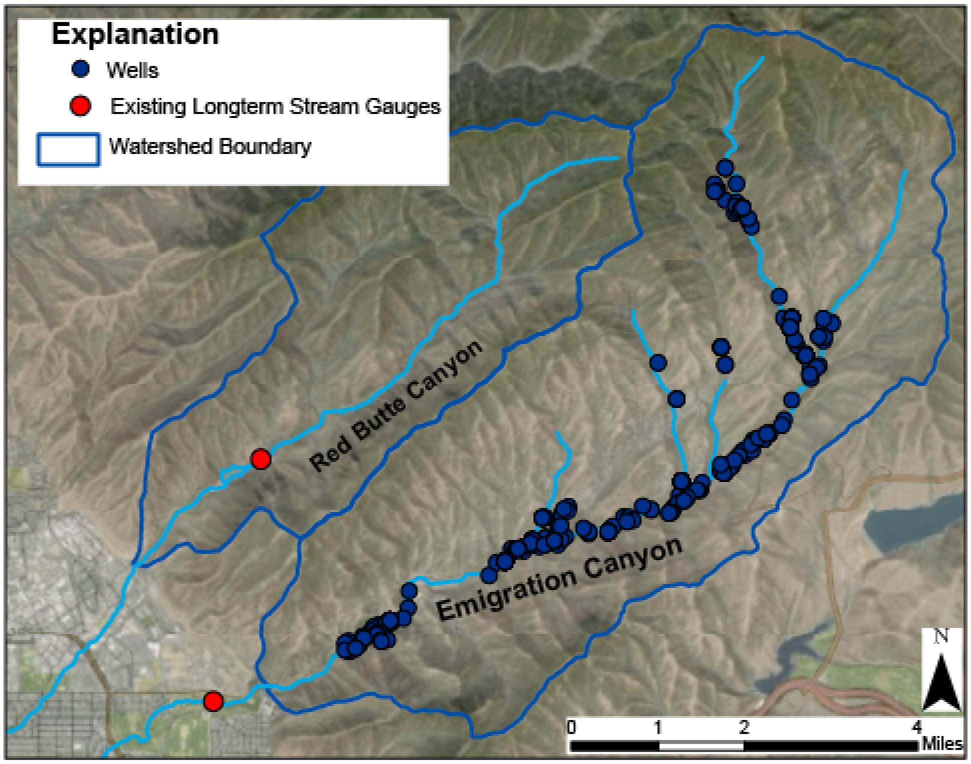

Figure 1. Overview of the Emigration Canyon watershed. Blue dots show well locations taken from the Utah Division of Water Rights. Most wells service individual houses and are located along Emigration Creek . Red dots show the locations of longterm stream gauges. Longterm gauging in Red Butte Canyon is operated by the U.S. Geological Survey and the gauge on Emigration Creek is operated by Salt Lake County.