

Technical Memorandum

To: Matt Petersen
SWCA

From: Barnett Intermountain Water Consulting
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Subject: Review Emigration Canyon Hydrogeology and Potential Impact to Stream Flows
from Proposed Well Drilling

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1.0 INTRODUCTION

Emigration Canyon is located in a complex geologic setting. In general, the ground water in the canyon is in communication with Emigration Creek and its tributaries **B** however that communication varies in the canyon with ground water discharging to the creeks in some reaches and the creeks losing water to the ground water in other reaches.

The Emigration Improvement District is concerned about preserving and protecting the flows of Emigration Creek. In 1995 EID adopted a creek protection policy. That policy recognizes the process that water consumption in the canyon ultimately reduces stream flow or ground-water discharge to the Salt Lake Valley. Most of the 325 residences in the canyon not in the Emigration Oaks and Emigration Place developments receive water from individual domestic wells. All of the homes use septic systems for waste discharge. Most of the homes are located along Emigration Creek or its tributaries and their often shallow domestic wells pump ground water which is in fairly direct communication with the streams.

The District desires to replace these individual wells with larger diameter, deeper public water supply wells. These wells are to be drilled at locations generally further removed from the stream

environs and potential contamination sources, cased to greater depths to remove or reduce communication with surface sources, and drilled at angles back under the mountain masses. A typical individual domestic well in the canyon might now be located 50' from the creek, sealed to a depth of 20', and be 60' to 100' deep. The two proposed wells will be drilled at angles away from the streams, sealed to depths of approximately 200', and drilled to depths of approximately 1,200'. The goals in drilling such wells are to provide a clean and dependable culinary water supply while reducing the impact of current and future homes to the canyon's streams.

2.0 CANYON HYDROGEOLOGY

The District has been involved in observing and studying the canyon's hydrogeology for a number of years. In 1998 Barnett Intermountain Water Consulting began a study of the canyon with Dr. Adolph Yonkee, Chairman of the Department of Geosciences at Weber State University. In July, 2000, the study entitled *Geologic and Hydrogeologic Setting of the Upper Emigration Canyon Area* was published. Much of the information in this section comes from that study.

Emigration Canyon is a synclinal (down warp) feature. The axis of the syncline strikes generally east-west and is located nearly along the bottom of the canyon. The syncline plunges slightly eastward. The two existing Emigration Improvement District wells and the two proposed new wells are located along the north limb of the syncline (see attached geologic map). The bedrock in this area dips in a south to southeasterly direction. In the area of the two existing wells the beds dip at an angle of approximately 60° whereas the dip at the proposed Brigham Fork Well is nearly 70° and the beds at the Nugget Well are nearly vertical.

Emigration Creek runs along the bottom of the canyon and nearly parallels the axis of the syncline. The second order drainages flow southeasterly nearly perpendicular to the strike of the bedrock. Hence, these drainages cut across the various bedrock formations. The two formations of interest for the proposed wells are the Nugget Sandstone and the Twin Creek Limestone. The two existing EID wells were completed in the Twin Creek Limestone Formation.

The Nugget Sandstone underlies the Twin Creek Formation. At the base of the Twin Creek is a fairly impermeable layer of rock known as the Gypsum Springs Member. Because the beds have been tilted up, the older and stratigraphically lower Nugget Formation is physically found outcropping on the north side of the canyon at a higher elevation than the younger Twin Creek Formation. As ground water moves down the canyon through the Nugget Formation it runs into the less permeable Gypsum Springs Member at the base of the Twin Creek Formation and is forced to the land surface. Thus in the canyon there are a series of springs found at the contact between the Nugget and the Twin Creek Formations. In instances such as Burr Fork where there is a perennial stream flowing across the Nugget Formation there are not discrete springs, but the stream is found to be gaining in this reach. Thus the second order drainages act as ground water drains as they cut across the Nugget Formation.

As the streams flow further down the canyon across the Twin Creek Limestone along the north limb of the Emigration Canyon Syncline, the opposite phenomena has been observed **B** the streams lose water to the formation. Though the point of discharge from the Twin Creek has not been determined, it is believed that the ground water moves down canyon through the formation.

3.0 PROPOSED WELLS

Though test wells will need to first be drilled, EID proposes to drill two additional wells in the canyon. One is to be located on the west side of Brigham Fork in the S½ NE¼ of Section 28, T1N, R2E, SLB&M. The well will be constructed solely in the Leeds Creek Member of the Twin Creek Limestone. This is the same member that the two existing EID wells were completed in. The well will be located approximately 150 feet away from Brigham Fork stream. Brigham Fork is an ephemeral stream which has been observed to lose water to the Twin Creek Formation. The well will be drilled at an angle northwesterly and away from the stream. It is proposed that the well will be sealed to 200 feet below land surface and then drilled to a total depth of 1200 feet.

The second proposed well will be drilled into the top of the Nugget Formation along the west side of Burr Fork. The well will be located approximately 300 feet from the stream in Burr Fork and like the Brigham Fork Well, it will be drilled on an angle to the northwest away from the stream, sealed to 200 feet below ground surface, and then completed to a total depth of approximately 1200 feet.

4.0 EFFECT ON STREAM FLOW

In general, the net impact of the pumping of the proposed two wells will have less of an impact to the stream flow than the wells they are to replace. As indicated above, the typical individual domestic well in Emigration Canyon is shallow and located in close proximity to Emigration Creek or one of the tributary streams. As such, they are in close communication with the creek. It is believed that unless replaced by a water system, future wells in the canyon will be constructed in much the same manner.

It is believed that there will be negligible impact to the stream flow in Brigham Fork due to the pumpage of the Brigham Fork well. Brigham Fork is an ephemeral stream which loses water to ground as it flows across the Twin Creek Formation. As such, the ground-water table is believed to be generally below the stream elevation. Thus, seepage from the stream is a function of the stream bed characteristics and independent of the depth of the water table. The depth of the water

table, either due to natural causes or pumpage from the well, will not effect the rate of seepage from the stream channel. Thus, through the Brigham Fork reach there is not anticipated a reduction in stream flow due to the pumpage of the proposed well.

In the spring of 2001 a Microscopic Particulate Analysis (MPA) test was performed on Freeze Creek Well #1. This is a 15 year old well which produces from the Leeds Creek Member of the Twin Creek Formation. The well is located approximately 50 feet from Freeze Creek and is cased only to 100 feet below land surface. The test was conducted to determine if the well was operating under the influence of the stream. The test results showed no indicators of surface water influence. Though the test doesn't indicate absolute isolation between the sources, it does indicate that the communication between the stream and the well is not direct. The Brigham Fork well is to be constructed in this same formation but cased and drilled to greater depths. Further, the well location is farther from the stream and to be drilled at an angle away from the stream. Hence, its potential communication will be even less than that of Freeze Creek Well #1.

The Twin Creek Formation crops out lower in Emigration Canyon. Whether a portion of the pumped water will reduce the stream flow in this reach is unclear. Certainly due to a dampening effect in the ground water and the ability to use the formation as a storage reservoir, the effect will not be one to one. However, with time there is the potential that there could be a negligible reduction in discharge from the Twin Creek Formation to the stream in the lower portions of the canyon. However, this will be more than offset by the removal of the impact from the existing and future wells below this point in the canyon. Hence, pumpage from the Brigham Fork Well in lieu of pumpage from other wells is believed to ultimately improve the stream flow in Emigration Canyon.

The second proposed well, the Nugget Well, is to be located up Burr Fork high in Emigration Canyon. As discussed above, in this area the formation is fully saturated and discharges to Burr Fork stream. The Nugget Formation is more porous than many other formations in the canyon and hence has greater reservoir properties. Though no large wells have been constructed in the Nugget

in Emigration Canyon, in nearby Summit Park and Park City the formation has been shown to be less influenced by seasonal changes in recharge. It is this better reservoir characteristic which makes this a desirable well target.

As discussed above, Burr Fork acts as a drain to this formation as it cuts through it. On 6/15/01 two Cutthroat Flumes were placed in Burr Fork stream: one at the upstream end of the Nugget Formation and one at the downstream end. A flow in Burr Fork of 402 gpm was observed at the upstream flume. The stream then gained through the Nugget Formation such that at the downstream end the flow was 534 gpm, or a gain of 132 gpm. On 6/19/01 the flows were 368 gpm and 475 gpm, respectively. Hence, an average gain of 120 gpm or 24% was observed from the Nugget Formation.

The proposed Nugget Well is to be located on the west side of Burr Fork. Based on the geography, it is estimated that 40% of the gain in the stream flow of Burr Fork in the Pinecrest area is contributed by the area west of the stream and 60% from the area east of the stream. With dampening effects of the aquifer it might be estimated that the pumpage of the Nugget Well could take away 50% of the stream discharge from the west side and thus it would reduce the flow of the stream by 24 gpm, or 5%. However, there are approximately 45 homes in the Pinecrest area which divert from shallow wells and a spring along Burr Fork. These sources are believed to be in direct communication with the stream. In the EID creek protection policy, it was estimated that during the critical month of August, the average residence would deplete the stream flow by 0.22 gpm. Thus the homes in the Pinecrest area may currently be reducing the flow of the stream by about 10 gpm. If these sources were to be replaced by well water, the impact would be reduced to 14 gpm, or 3% of the flow observed in mid-June in the Pinecrest area. The replacement of wells future wells to be drilled in the Pinecrest area would further reduce the net impact to the stream.

Another way to estimate the potential impact to Burr Fork stream is to look at the anticipated total annual production from the well. It is anticipated that this well will be produced similar to the existing FCW#2. Last year total production from this well was 22,085,600 gallons (June 27, 2000

to June 27, 2001). It is believed that this well will be similar. If 50% of the production were to come from the stream than the average discharge would be reduced by 21 gpm. As above, if this production offsets 10 gpm of existing impact, the net impact would be a reduction in stream flow of 11 gpm, or 2% of the flow observed in mid-June.

By using waters from this source, water demands lower in Burr Fork, Killyons and elsewhere are further reduced. If the average impact to the stream is between 11 to 14 gpm, then once one moves down the canyon past 57 homes (below Pinecrest) which are currently depleting the stream the net impact would be zero. Further down the canyon the impact would be a net increase in Emigration Creek flow.

On June 15, 2001, the observed flow in Emigration Creek at the flume just below the confluence of Burr Fork and Emigration Canyon was 1,135 gpm. There are approximately 80 homes in the canyon above this gage. If the impact to the stream flow of the pumpage of the Nugget Well is between 21 to 24 gpm but it were to replace the depletion from these 80 homes, then the net impact to the stream would be 5 gpm, or 0.4% of the flow observed in mid-June.

It is important to note that the flow of the streams in Emigration Canyon vary dramatically during the year and from year to year. This is a very dry year, however, the mid-June measurements were not made at the driest time of the year. The impact to the stream during April, May, and June will be negligible. However, based on historic data from the flume below the confluence of Burr Fork and Killyon Canyon, the flow in the creek in August or September may be 1/5th the average June flow. If this were to be the case this year then the net impact from the pumpage of the proposed Nugget Well would increase to 2-3% of the flow at this gage.

5.0 SUMMARY

It is important to remember that the purpose for drilling the proposed wells is to replace existing or future wells which surely in general have a greater impact on the stream flows in the canyon. However, the location of the wells may move the impact from one area to another. Due to the

anticipated lack of direct impact to Brigham Fork from the pumpage of the Brigham Fork well, the impact to the stream flow is believed to be negligible, and such impact, if any, will be down the canyon below the wells this well is to replace such that the net impact will be an increase in stream flow.

Similarly, the net impact from pumpage of the proposed Nugget Well will be a net increase in flows in the canyon in general. Further, the flows in Killyons canyon will be increased by replacing the existing shallow wells and sumps with water from the Nugget Well. However, in the Burr Fork reach between Pinecrest and the confluence with Killyon Canyon, the net impact may be on the order of 2-3% during the drier portions of the year.

Geologic Map of Upper Emigration Canyon

Figure 3. Geologic Map of Upper Emigration Canyon Area

Mapping by
Adolph Yankau
1997

