IDAHO GEOLOGICAL SURVEY MEMORANDUM

TO: Craig Tesch, Technical Hydrogeologist, IDWR, Boise

FROM: Virginia Gillerman, Research Geologist, Idaho Geological Survey, Boise

DATE: December 23, 2011

SUBJECT: East Ada Project Summary

This memo, the paper/pdf Mayfield geologic map (Phillips, et al., 2012), digital data/GIS disk, and paper/pdf copy of Dr. Welhan's report, "Preliminary Hydrogeologic Analysis of the Mayfield Area, Ada and Elmore Counties, Idaho," constitute the deliverables for our Idaho Geological Survey contract with Idaho Department of Water Resources under Agreement #CON00827 (UI Number: 09Z40-R), ending December 31, 2011.

Cross-sections, chemical analyses, age dates, interpretations, and other information specified in the agreement are contained within the map and reports. Of course, we will be happy to discuss all of this work with you and IDWR staff in the coming weeks and to answer any questions or address concerns you may have after reviewing the deliverable products. It is our intention to publish the map and hydrogeologic report as IGS official publications in early 2012, after you have had a chance to review them. The discussion below highlights a few points and most relevant discoveries from the project.

Summary Geology of the East Ada Project Area

The eastern (Indian Creek, Bowns Creek area) and western (Blacks Creek drainage) portions of the map area have different geological units exposed at the surface, and possibly in the subsurface. The Slaters Flat basalt volcano is approximately near this transition.

Granitic bedrock of the range front is intruded by both Eocene age (~45 Ma) dikes that typically trend NE and newly recognized Miocene rhyolite dikes (age dated at ~ 14 Ma) with a distinctive NS orientation and localized distribution. To my knowledge, they are not found elsewhere along the Boise or Western Snake River Plain (WSRP) Front, though more regional mapping is needed.

The eastern area is where most of the proposed developments are located. A thin surficial unit of granule-size sand and small pebbles (QTs), interpreted as colluvium and small alluvial fans derived from eroding granitic highlands, overlies stratified sandy sediments (Ts) that correlate with deposits of Lake Idaho. To the northwest, down-dropped sediments of Lake Idaho form a major aquifer in the subsurface beneath Boise. However, limited numbers of deep wells in the East Ada area seem to have lower and more erratic specific capacities (see Welhan's report) than

in the Boise deep aquifer. The Slaters Flat basalt overlies the QTs and is dated at about 900,000 years old.

On the southwest portion of the map, Quaternary basalts of the Snake River Group overlie and interfinger with the poorly exposed surficial units. Older basalts from the central portion of the Western Snake River Plain vents are found in the subsurface as determined from the water well drillers logs, but the subsurface northeast of I-84 is dominated by the Tertiary sedimentary section.

Evidence for faulting was difficult to find during mapping. The sediment contact with the granitic bedrock appears to be primarily a depositional one. The "interstate fault", a northwest-trending structure shown on state scale maps and apparently coinciding with IDWR's contoured steepening of the water table was not evident in surface outcrops. However, most, if not all of the surficial units are younger than the major faulting to form the WSRP at approximately 10-12 Ma. Review of color enhanced DEM images (Lee Liberty, personal communication, 2011; Figure 1) did show at least two NW-trending linears across the young Slaters Flat basalt and influencing topography in the eastern portion of the map area. Liberty's re-interpretation of migrated seismic lines delineates a couple of offsets of the basement, and those are shown in cross-sections on the geologic map and in the hydrogeologic report. We interpret the NW-trending linears as slight faulting of the Ts sediments, Qbsf (Slater's Flat basalt) and perhaps QTs unit. However, the major offset seems to be at depth and the linears probably represent only minimal Quaternary movement or mantling of fault-influenced paleotopography.

East Ada Hydrogeology

Principal observations, conclusions and recommendations of Dr. Welhan's hydrogeology study are summarized in the Executive Summary in his report. However, they are mentioned in brief here for completeness.

Ground water in the East Ada study area is hosted principally in sedimentary rocks that underlie most of the study area. Geometrically, water is found in both shallower perched zones and a more continuous, unconfined deep aquifer below the water table. Well driller's logs alone do not reveal sufficient detail to map marker horizons in the subsurface, as the stratigraphy is fairly non-unique and similar, particularly in rotary chips.

East Ada ground water is recharged from three sources: infiltration to shallow aquifers from surface water in and near local streams, meteoric recharge to perched and deep aquifers from local watersheds, and deep geothermal waters, rising along faults or fractures somewhere in the basin. Elevated ground-water temperatures up to 70^{o}F in the deeper wells in the East Ada area are compatible with a mixture of up to 20% geothermal water (170 ^{o}F) like that in the Boise geothermal system and the Idaho batholith.

The steepest hydraulic gradients on the deep water table are located about 4-5 miles southwest of the range front. Using Darcy's Law and the available data on aquifer transmissivity from specific capacities and well tests, the change in gradient places limits on aquifer transmissivity

and recharge. Estimates of recharge range from about 7,000 acre-ft/year to 12,600 acre-ft/year. Those estimates are significantly lower than previous estimates by SPF Engineering but seem consistent with the geology, topography, and climate of the study area.

Additional information and study is recommended to more adequately describe and constrain the East Ada aquifer system. This includes:

- Improved estimates or measurements of watershed precipitation, runoff, and evapotranspiration.
- Additional pump tests to constrain aquifer transmissivity and analysis of additional well data to segregate water-level information into perched and deep aquifer subsets.
- Additional logging and analysis of chips from deep wells as near the zone of steep hydraulic gradient or in areas of postulated buried faults.
- Better information on ground-water temperatures and pump tests of geothermally influenced wells.

Concluding Observations

The geologic history and structural development of the Boise Valley and Mayfield area have controlled the regional landscape evolution over a long period of time. As a result, the upper Boise River drains a very large, mountainous watershed (approximately 2800 square miles). In contrast, the Mayfield area contains only three local watersheds (Indian Creek, Sand Hollow Creek, and Bowns Creek) with a relatively modest surface area (~ 35 square miles), as mapped in the hydrogeologic report. These streams drain south-facing slopes in an arid climate, and the higher ridgelines are lower in elevation than those which form the Boise River, or even Blacks Creek, watersheds. Thus, potential recharge from high-elevation snowpack into the Mayfield area is significantly lower than recharge into the west-flowing Boise River system. This has likely been true for at least a million years.

Comments of IDWR staff familiar with the East Ada study area and Boise Valley aquifer are welcome and solicited. IGS has not yet had an opportunity to review a final geophysical report by Lee Liberty of Boise State University. Discussions with him and viewing of the migrated seismic profile and his DEM images were instrumental in the subsurface interpretation of NW-trending faults shown on the geologic map and cross-section.

An overall conclusion from IGS's geologic and hydrogeologic work is that there are real and significant differences between the geologic setting and hydrogeologic architecture of the Boise area (with its highly productive deep aquifer) and the East Ada study area. Additional work is needed to address many questions and refine interpretations, but the IGS map and report provide a good starting point.

Figure 1. 10-meter DEM image generated by Lee Liberty using GeoMapApp software, and oblique sun angle. Shows seismic lines in red and black dots along Indian Creek. Liberty's yellow arrows mark NW-trending linears, interpreted as faults. Purple arrows pointing approximately along 116 degrees of longitude mark more subtle N-S trending linear which is here interpreted as older buried basement fault that divided Boise structural block from East Ada block, in segmented WSRP graben.