FY16 NM WRRI Statewide Water Assessment
Quarterly Progress Report

Report Due Date: January 1, 2016

1. Project Title: New Mexico statewide water assessment: Recharge quantification and recharge model assessment for the state of New Mexico

2. Investigators (names, university/agency): Talon Newton, New Mexico Bureau of Geology and Mineral Resources and Fred Phillips, Department of Earth and Environmental Science, New Mexico Tech. **Other Researchers**: Alex Rhinehart, New Mexico Bureau of Geology and Mineral Resources, New Mexico Tech.

3. Brief description of project, research objectives, and impacts on New Mexico (provide performance measures and outcomes):

Quantification of groundwater recharge by precipitation is the most important gap in current understanding of the New Mexico water balance. Previous studies have used disparate methods and have left significant gaps in estimates across the state. To date, work on the statewide recharge assessment has focused on the compilation of previous recharge estimates and on the identification of potential recharge areas statewide. Identification of potential recharge areas was completed by this group using the Evapotranspiration and Recharge Model (ETRM), which was developed specifically for this purpose.

The objective of this study is to move from identification of relative recharge potential to a quantification of recharge. Two important advances in our effort must be made in order to quantify recharge: we must make improvements to our computational recharge model and make independent recharge estimates based on data from the field. Improvements to the ETRM include taking into account water storage as snow, implementing a high resolution energy input, and accounting for modeled runoff. The method by which we will make independent estimates of recharge is the chloride mass balance (CMB) technique. A web-accessible fact sheet describing statewide recharge estimates, sources of recharge, and estimates of uncertainty will be prepared to facilitate public access to our results. Results of this year's study will improve the understanding of the quantity and location of groundwater recharge, allowing resource managers to make more informed water use decisions.

4. Brief description of methodology: To accurately estimate annual recharge rates, it is necessary to utilize sophisticated data inputs and modeling techniques that can account for the many complexities encountered in New Mexico. We will continue development of the ETRM designed to complete the first year goals of the recharge assessment project.

- Currently, the energy component of the model is driven by the National Land Data Assimilation System (NLDAS), which provides a daily 12 km gridded reference evapotranspiration layer, or the ET that would occur from a well-watered reference crop (tall alfalfa) given that day's meteorological conditions. The coarse 12 km resolution of this dataset hinders a realistic representation of New Mexico's extremely heterogeneous topography. We will build a module into the ETRM that uses a fine-scale topographic correction, the development of

which is under way by the soil water balance for statewide evapotranspiration assessment group under WRRI's Statewide Water Assessment.

- The second step in improving the ETRM will be to add a module that is capable of storing water temporarily as snow. The SNOW-17 model was developed by Anderson (1976) to compute the mass and energy balance across the snow-air interface using only temperature and precipitation. This model will be adapted to better represent soil conditions in the mountainous regions of New Mexico in the spring and early summer, when snowmelt is the principal contribution to soil water.

- Runoff estimates made by the ETRM will be used to estimate focused recharge along stream channels. Empirical methods developed by Waltemeyer (2001) and Hearne and Dewey (1985) will be tested for suitability in large basins statewide. Runoff routing algorithms will be explored to assess the feasibility for daily, statewide runoff analysis.

- As with any model, we need to provide some sort of calibration/validation in order to maximize the quality of information that is being produced. Using data from CMB analysis, bias of the ETRM will be identified and sensitivity to controls on recharge (e.g. precipitation, ET, geology, vegetation, and soils) will be analyzed.

5. Brief description of results to date and work remaining: Results to date include CMB analysis of the first round of spring samples from around the state and preparation and delineation of the watersheds that will potentially be used in the analysis of runoff in our model.

- We have created custom-delineated watersheds above 20+ USGS gauges with data covering up to 30 years (1984 to 2014) of measurements. This data will be compared with precipitation data from the same time period and will provide an estimate of the magnitude of runoff relative to precipitation and modeled evapotranspiration and recharge.

- We have begun the implementation of the new high resolution reference evapotranspiration product under development by another WRRI Statewide Water Assessment team at New Mexico Tech. This product improves the resolution of our modeled energy input from 12 km to 250 m. Initial results indicate that this product effectively represents the extremely heterogeneous topography of the state, allowing for more spatially precise modeling of the water balance.

- Initial CMB results suggest that recharge in the mountains of New Mexico approaches and in some cases exceeds 50% of precipitation in the spring. Results show that recharge rates (measured as a fraction of precipitation) decline with total precipitation and elevation. Three rounds of samples have now been collected from 20+ mountainous sites and are awaiting analysis.

- A simple snow module has been added to the ETRM Point Version. This model uses PRISM daily minimum and maximum temperature to sequester precipitation on the surface as snow pack, and allows melting according to an established algorithm used at Yucca Mountain (Hevesi, 2003). Calibration efforts have begun using data from 23 SNOTEL snow observation sites covering 2005 to 2013.

6. **Student participation:**
   David Ketchum, Master of Science in Hydrology.

7. **Provide special recognition awards or notable achievements as a result of the research. Include publications in progress (all published work supported wholly or in part of NM WRRI must bear an acknowledgment of support):**

8. **Include references as needed (limit to one additional page):**

Hearne, Glenn A, and Dewey, J.D. 1988. Hydrologic analysis of the Rio Grande Basin North of Embudo, New Mexico; Colorado, and New Mexico. U.S. Geological Survey Scientific Investigations Report 86-4113.

Waltemeyer, S.D. 2001. Estimates of mountain-front streamflow available for potential recharge to the Tularosa Basin, New Mexico. U.S. Geological Survey Water-Resources Investigations Report no. 2001-4013.

Hevesi, J. A., Flint, A. L., & Flint, L. E. (2003). Simulation of net infiltration and potential recharge using a distributed-parameter watershed model of the Death Valley region, Nevada and California. US Department of the Interior, US Geological Survey.

9. **Provide a few sentences on progress toward uploading data to a common/standardized platform, if applicable:** We are working to maintain common geographic data formats. These include the use of ArcGIS software georeferenced to the North American Datum (1983) UTM 13N in the highest (where applicable) possible raster resolution.

10. Provide two PP slides that provide summary information on your project appropriate for viewing by state legislators.