FY16 NM WRRI Quarterly Report Form

Report Due Date: 1 April 2016

(prepare in 12 pt Times Roman with 1" margin, report should be no longer than two single-spaced pages)

1. Project Title: Groundwater level and storage changes in alluvial basins along the Rio Grande, New Mexico

2. Investigators (names, university/agency): Alex Rinehart, Brigitte Felix-Kludt, Ethan Mamer, Cathryn Pokorny, and Stacy Timmons. New Mexico Bureau of Geology and Mineral Resources. Nathan Myers. USGS Albuquerque WRC. Mike Johnson, NM Office of the State Engineer, Hydrology Bureau.

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

To better understand the changing water budget in New Mexico, we are providing an estimate of groundwater storage changes in the alluvial aquifers that occur in the groundwater basins along the Rio Grande. The alluvial aquifers in the Rio Grande basins from the southern San Luis Valley through the Mesilla Valley are the primary source of groundwater for most of the metropolitan areas and much of the most intensive agricultural areas of New Mexico. Using high quality groundwater level measurements from the USGS, NMOSE and NMBGMR, the storage change estimates deliver three sets of products: an understanding of the scale of groundwater storage changes and aquifer connectivity through variogram analysis of groundwater level measurements; maps of changes in water levels using several different statistical perspectives; and time series of total changes in stored groundwater for each basin.

We will provide an internally consistent view of the changes in groundwater storage in some of the most socially important aquifers in New Mexico. Additionally, the variogram analysis will give unified metrics on differences in aquifer geometry and compartmentalization between the different groundwater basins. Our estimates use a range of internal comparators to assess data quality. The primary impact is to provide unified initial estimates of groundwater storage changes. Groundwater storage change maps can then be attributed to changing societal water use or natural recharge variability at a later date. The total changes and the maps can then be post-processed and used in the statewide water budget model.

4. Brief description of methodology

In order to estimate the groundwater storage changes in all of the alluvial aquifers in New Mexican Rio Grande basins, we use a combination of data compilation and review, combined time series and spatial analysis, spatial interpolation, and change in water volume based on the interpolations and literature-derived aquifer properties. More specifically, we follow the steps below:

1. Update our database of with recent groundwater level measurements.
2. Define groundwater basins and subbasins through comparison with USGS Hydrological Units (HUC 8) boundaries.
3. Review literature on alluvial aquifer properties in each study area.

4. Quality assurance
    a. Review data for each basin to remove low quality data or data from the active irrigation season. If this leads to too sparse of a well network, then,
    b. Review data for each basin to remove low quality data, remove wells from within agricultural areas based on NLDS coverage, and keep records collected during the irrigation season. Most of the sparsely measured basins contain little irrigated area, so the groundwater withdrawals are less sensitive to seasonal pumping and infiltration. Comparison storage estimates using of (4b) with (4a) using the Mimbres basin shows a greater estimated decline, but within 10-20% of the estimated change from the original method.
5. Define time intervals over which to interpolate depth to groundwater levels.
6. Determine correlation distances of groundwater level measurements through variogram analysis.
7. Perform interpolations of depth to groundwater levels using ordinary kriging (OK) and inverse distance weighting (IDW) schemes, restricting the interpolated area to be in alluvium, within the correlation distances.
8. Find changes in water levels within each interpolation.
9. Summing the various groundwater level differences, estimate the total changes in water storage in the aquifers through time. This leads to at least four estimates of storage change per basin.

Additional complications will likely include changing sampling rates in more populated areas, recognition of mis-identified aquifers that are actually in bedrock, and the possibility of poor correlation of groundwater levels either due to a strong anthropogenic signal or to sparse spatial data.

5. Brief description of results to date and work remaining

We have finalized the analysis of changes in depth to water (interpolations and differences) in all of the proposed HUCs. The Albuquerque, Las Cruces-El Paso, Mimbres, Playas Lake, Santa Fe, Tularosa, Upper Rio Grande, and Western Estancia HUCs had dense enough coverage to allow full analysis using the original method without modification. The modified analysis incorporating summer season data and clipping by NLDS coverage was successfully used on the Pecos Headwater, Salt, Jornada Draw (may be possible to get a more robust estimate with reanalysis), Arroyo Chico, San Agustin Plains, Rio Puerco, Rio San Jose, and Rio Chama basins. The remaining basins (Caballo, Conejos, Eastern Estancia, Elephant Butte, Jemez, Jornada del Muerto North Basin, and Rio Salado) were too sparsely sampled to provide reliable estimates. Interpolation patterns show the importance of river connectivity to stable aquifer levels, and of the balance of recharge vs. pumping.

6. Student participation - List all students participating in the project, their classification level (undergraduate, master's, Ph.D., post doc) and their field of study (degree major). *None.*
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). *None.*
8. Include references as needed (limit to one additional page). *None.*
9. Provide a few sentences on progress toward uploading data to a common/standardized platform, if applicable. *N/A*.
10. Provide two PP slides that provide summary information on your project appropriate for viewing by state legislators. *See attached.*