URNRD Groundwater Modeling Project

Annual Report, March 2022

Water Sustainability Fund Application #5184

The Upper Republican Natural Resources District (URNRD) was awarded a $243,000 grant by the Natural Resources Commission in late 2017 and executed a contract with DNR in January 2018. The purpose of the project is to develop a groundwater model to predict future groundwater elevations within our District and to develop water management plans to minimize the effect that future irrigation pumping has within our District. There are several groundwater models that have already been developed for our area, so our original plan was to modify and use one of these models for our District. When we discovered that using the existing models to model our District would not work, we began to create our own groundwater model.

Progress

Significant progress was made in 2021 and the project is nearing completion with the model in a usable form that in recent months has begun being used to help guide groundwater-related decisions for the URNRD.

Model calibration was essentially completed during the reporting period and an initial base model for the District was created. A key development was being able to align the model's groundwater surface elevations with actual groundwater surface elevations. The URNRD has one of the highest, if not the highest, concentrations of measured groundwater wells to track groundwater-level changes – about 400 are measured annually. Getting modeled groundwater levels and observed levels from those measurements to match had been a challenge during the initial phase of the project when we attempted to use the Republican River Compact Administration (RRCA) model. We modified input data, programs, the modeling process, etc., specifically for the URNRD. Because of the changes that we made to the model and modeling process, we tried to re-calibrate the model but could not get the model's groundwater elevation to move much during the calibration process. After discussions with the RRCA model authors, it was discovered that certain input data was fixed and could not be changed.

We next attempted to use a Modflow model developed for the District by the USGS in 1995 but chose not to use it because of difficulty modifying the model caused by technical difficulties related to the age of programs used by the model. Additionally, there was no documentation on how to use the model, how it was developed, or the assumptions that went into its creation. We next tried to use the 2016 USGS regional groundwater model, which had several advantages, but the area it applied to is bigger than was needed, covering the Northern High Plains Aquifer across five states.

Ultimately, that process and the ultimate determination we could not modify any of the existing models to suit our needs led to us creating our own Modflow model from scratch using the Groundwater Vistas modeling program. We created a model grid which consisted of cells one mile by one mile and the model boundary extending a minimum of five miles outside of the

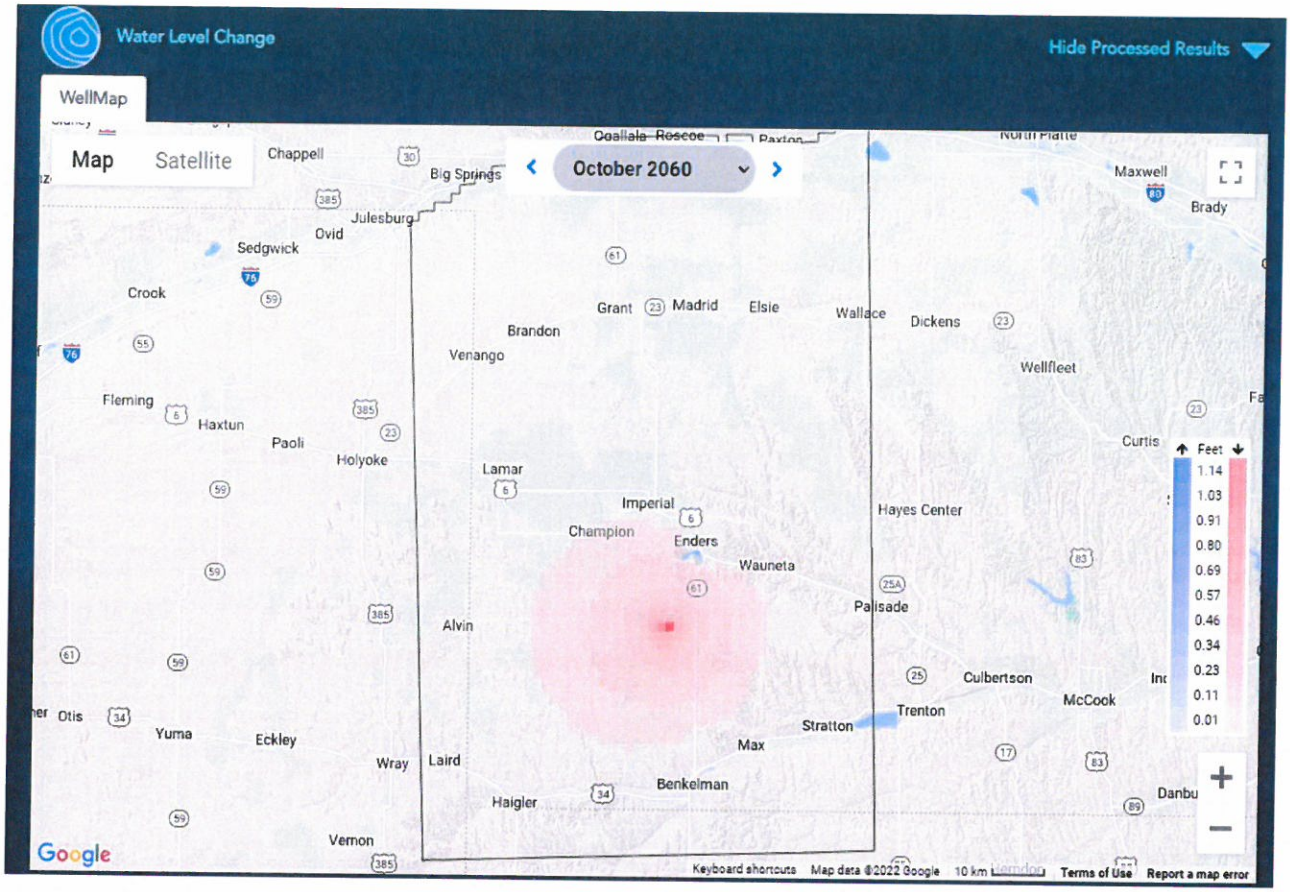
District boundary. We acquired hydrogeologic parameters (K, Ss, and Sy) for each cell and aquifer characteristic parameters for each cell (ground surface elevation and aquifer bottom elevation). We created the Stream (STR) package for the model to model the various streams within the model boundary and collected groundwater surface elevations within seven miles of the District boundary from 1950 to the present to generate the initial conditions water surface elevation and the model boundary conditions. Irrigation and crop type information to generate well pumping data (WEL package) was collected, as was soil information and precipitation data to generate groundwater recharge data (RCH Package). We also collected weather data and plant type (crop and phreatophytes) information to generate the evapotranspiration data (ET Package) used in the model. We also ran the model from 1955 to 2016 using hypothetical data to make sure that Groundwater Vistas and Modflow could run a model of this size.

In 2020, we switched from using Modflow in Groundwater Vistas to using Modflow in Olsson Associates Groundwater Evaluation Toolbox (GET). Groundwater Vistas would not read several of the Modflow input files created outside of the Groundwater Vistas interface. This created numerous problems and inaccuracies. Our input files were created for the RRCA model and would run in the RRCA's Modflow program and were formatted according to the USGS' version of Modflow. Unfortunately, these input files would either cause the Groundwater Vistas program to crash, or we would have to continually modify the input files to make the program work.

Olsson Associates created a groundwater modeling program (GET) that uses the USGS Modflow program and has pre- and post-processors to input and view the data. We sent our Modflow input files to Olsson, and they used them to create our model in GET. The model runs faster and without problems. GET also has the ability to create "zones" in our District so we can evaluate separate groundwater management scenarios for areas that may need different requirements than the remainder of the District.

During the reporting period, Olsson and The Flatwater Group calibrated the model to match groundwater elevation records and stream flows.

Since the model was calibrated, we have used it to evaluate approximately four landowner requests to transfer groundwater use from one location to another. Our rules allow the transfer of certified irrigated acres between locations in close proximity to one another, but distant transfers are subject to evaluation and approval by the Board of Directors. Primary factors they can take into consideration are impacts transfers have on aquifer life and neighboring wells at both the point where water use is proposed to be transferred from, and the location to which the transfer is proposed to occur. The model greatly enhances our ability to evaluate transfers. Below is a screen shot of an illustration of the modeled effects on groundwater levels over 40 years caused by a transfer of certified acres to a new location. Not shown are modeled impacts showing slightly increasing water levels over the same time period in the location where the same amount of water use would be transferred from.



Future Efforts for URNRD model

We are now and will be working on updating the model to a multilayer model, due to some issues that were identified during the calibration process.

Importantly, we'll begin using the model in a variety of ways and educating constituents and board members about its construction, applications, strengths and limitations as a tool in making management and policy decisions. We expect it to be used, for instance, this year as the board considers rules changes regarding water use and considers the next five-year groundwater allocation for irrigators that will begin in 2023.

Thank you and feel free to contact us for additional information.

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