United States Department of the Interior

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Jim Upchurch, Forest Supervisor
Coronado National Forest
300 W. Congress St. 85701
Tucson, AZ

Dear Mr. Upchurch:

As requested, our hydrologists Stan Leake, Jesse Dickinson, Don Pool, and Nick Paretti have conducted a technical review of WestLand Resources report "Rosemont Copper Project: Potential Effects of the Rosemont Project on Lower Cienega Creek." The report documents an analysis of the potential impacts of the Rosemont mine on the hydrology of lower Cienega Creek. The potential impacts described in the report are changes in base flow and length of wetted stream length. The approach used to assess the impacts include regression models with groundwater level as the explanatory variable and base flow and wetted length as response variables.

As requested, our comments on the report are limited to the regression approach to predict changes in base flow and wetted length due to groundwater level drawdown.

1. The regressions capture some of the relation between groundwater levels in the Jungle Well to the wetted length of Lower Cienega Creek. The models presented here have R^2s of 0.49 and 0.43, which indicates that a majority of the relation between groundwater depth and wetted length is not being explained by the models. It might be that the uncertainty in the models limit their use for predicting future changes in wetted stream length. The uncertainty in the models should be considered if they are for predicting future changes in wetted stream length.

2. The data used in the regression (from 1999 to 2011) represent a recent period of relatively shorter wetted lengths of Lower Cienega Creek. Figure 6 provides a plot the percent of stream flow extent from the 1980s to 2011. The percent of stream flow extent was between approximately 70% to 100% in the 1980s and early 1990s. However, the percent flow extent is much less—from approximately 10% to 55%—from the late 1990s to 2011. These changes seem consistent with an overall shift to drier conditions starting

around 2000. The regressions were based on the data from the more recent, drier period. It could be that the regressions would predict a different response of base flow and wetted stream length to groundwater levels if data were also available for the wetter period as well. The regression equations could be more appropriate for the current drier conditions, and the equations may be less reliable if conditions become wetter. Perhaps some aspect of the climate, such as recent and antecedent seasonal precipitation or stream flow, and landscape changes such as the amount of vegetation cover, would improve the regressions predictions of future changes in wetted length.

3. Part of the segmented regression between water levels in the Cienega well and wetted length in Lower Cienega Creek (Fig 3) indicates that the regression model will predict very little change in the wetted length if water level variations occur below 18 feet of depth. In other words, there is effectively no relation between groundwater depth and wetted length below this depth. However, this relation is the basis for the regression approach used here—that is, the processes that vary groundwater levels in a single well are also affecting stream flow conditions. Here, the regression approach provides a result that contradicts the assumption that in these areas, stream flow and groundwater levels vary in concert. This result may suggest that the regression approach is not reliable for predicting the future changes in wetted stream length.

4. Bootstrapping is an effective method for determining ranges of regression coefficient values; however a measure of error of the model would be very useful. From a visual inspection of the plots, the residuals of the data appear to be quite large. The uncertainty in these models may affect the ability to estimate changes in the 10s of feet of extent when the spread of the data could be an order of magnitude greater.

5. There is a justification that the Cienega Well was not used because of its distance from the confluence of Davidson Canyon and Cienega Creek. However, it may be useful to include multiple wells that are both relatively close and distant from the stream in the regressions. Water levels from distant wells may be useful for indicating differences in groundwater head gradients near the stream. Ultimately the direction of the groundwater-level gradients control whether the stream is either gaining or losing. Gradients may also be useful in assessing the impact of mine withdrawals on drawdowns, which may affect the direction of the gradients near the stream.

6. The method of applying the Jungle well model to the entire study area may oversimplify this complex hydrologic system. It may be worthwhile to consider additional factors that could affect this relation. The observation that the relations between groundwater and wetted length are not consistent at the other sites should raise concerns about applying the changes in water levels at one well to entire watershed. Some of the considerations

should include timing of data collection, depth of well, subsurface substrate type, hydrologic response in the subsurface, distance from the stream, losing or gaining reaches, contributing watersheds, vegetation changes, and data collection methods.

Thank you for requesting the input of our scientists to help with some of the challenging technical issues facing the Coronado National Forest. Providing scientific information and expertise to benefit resource management decisions is an important part of the USGS mission. If you or your staff has technical questions regarding these review comments, please contact Stan Leake, Jesse Dickinson, Don Pool or Nick Paretti.

Best Regards,

James Leenhouts
Director, USGS Arizona Water Science Center