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# MEMORANDUM

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Date: September 5, 2007

To: The Honorable Chairman and Members  
Pima County Board of Supervisors

From: C.H. Huckelberry  
County Administrator

A handwritten signature in black ink, appearing to read "C.H. Huckelberry", is written over the typed name and title.

Re: Rosemont Mine - Water

Enclosed please find a very preliminary review of the possible hydrologic impacts of the Rosemont Mine on the Cienega watershed. These impacts are unacceptable and are beyond what had been anticipated regarding mine water usage. In essence, the size, location and depth of the proposed open pit will significantly alter and intercept both surface water flows as well as groundwater subflow, diverting and/or intercepting approximately 650 acre feet of water per year flowing to Davidson Canyon and the Cienega watershed. These interceptions and/or diversions will have an unacceptable impact on the Cienega Creek watershed.

While this information is preliminary, we will request that the Forest Service conduct the detailed hydrologic investigations and other actions described in both the attached memorandum from the Flood Control District Director as well as our hydrologic consultant on Rosemont.

CHH/jj

Attachment

c: John Bernal, Deputy County Administrator - Public Works  
Suzanne Shields, Regional Flood Control District Director  
Tom Helfrich, Water Resources Division Manager, Regional Flood Control District  
Julia Fonseca, Environmental Planning Manager, Regional Flood Control District

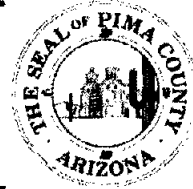


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# MEMORANDUM


Director's Office  
Regional Flood Control District

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DATE: August 27, 2007

TO: C. H. Huckelberry  
County Administrator

FROM:   
Suzanne Shields, P.E.  
Director and Chief Engineer

SUBJECT: **Rosemont Mine – Hydrologic Studies for the Environmental Impact Statement**

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Augusta Resources Corporation proposes to construct the Rosemont Mine project in the northern Santa Rita Mountains, which would affect up to 4,415 acres of Coronado National Forest, state and private lands including the area of mountain front recharge for the upper and lower Cienega basins. In the Cienega groundwater basins where the Rosemont Mine is located, groundwater availability for riparian ecosystems is of critical concern.

The report was prepared by Dr. Tom Myers who is a Nevada-based hydrologist with experience in examining the hydrologic effects of open pit mining in bedrock settings. His report is a reconnaissance analysis of the hydrogeologic setting and overall water balance in the area. It provides a basis for identifying additional studies that are needed to fully analyze, disclose and mitigate the potential impacts of the Rosemont Mine as required for the Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA).

The proposed mine would impact groundwater and surface water by dewatering pits, diverting or blocking surface runoff, decreasing natural recharge by covering areas with tailings and overburden, and the production well to withdraw water for use in the mining and refining process.

The proposed open pit, which would cover about 700 acres and extend some 1,800 to 2,900 feet deep, could lower the groundwater table by 1,500 feet affecting the volume and direction of groundwater flows in the Cienega Watershed. Dr. Myers estimates that the proposed pit may intercept about 650 af/y of flow to the Davidson Canyon or approximately 0.8 cfs, which is approximately the same amount of flow that reaches lower Cienega Creek from Davidson Canyon. The proposed project would also intercept substantial amounts of groundwater flowing toward the upper Cienega Creek near and within the Las Cienegas National Conservation Area.

Depending on the exact depth to pre-mine water levels and where the measurement occurs, the pit could lower the regional water table by up to 1,500 feet. This would create a drawdown cone that would draw in the regional groundwater similar to pumping from a large diameter well. This substantial drawdown may draw groundwater from a significant distance if the adjoining aquifers are hydraulically connected to the bedrock aquifer of the pit. Of special concern is the alluvial aquifer southeast of the site, which drains toward the upper Cienega Creek. If the drawdown cone expands into the alluvial aquifer, groundwater would be drawn north toward the pit (see Figure 12 of the report). This would reduce the flow to upper Cienega Creek by an uncertain amount, which would depend on the distance that the drawdown cone will extend to the south.

C. H. Huckelberry, County Administrator

**Rosemont Mine – Hydrologic Studies for the Environmental Impact Statement**

August 27, 2007

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Prior to considering whether to construct this proposed mine, the U.S. Forest Service (USFS) should require the project proponent to collect a large amount of data and to complete numerous analyses. Only with this additional data can decision makers adequately consider the project. These data would help substantiate Augusta's stated position to avoid impacts to Cienega Creek water resources.

So far, the information Augusta has provided to the USFS about groundwater conditions is deficient for an EIS. Dr. Myers' report tells us that the impacts of the pit construction and dewatering will extend geographically beyond the boundaries of what Augusta has examined to date. He recommends that substantial data needs to be collected in order to evaluate the proposed mine. Without pump tests and other investigations, there are substantial uncertainties in recharge, runoff, evapotranspiration, and storage properties of the aquifer. Augusta should be required to reduce these uncertainties through field data collection in order to calibrate hydrologic and hydrogeologic models for existing conditions and run sensitivity analyses.

Augusta should provide a detailed groundwater model to simulate the drawdown cone and the amount of water to be drawn towards the pit. The groundwater model should extend far enough into the Cienega drainage that the model boundary does not influence or control the predicted flows. Pump tests sufficient to estimate transmissivity and storage coefficients for the aquifers must be completed throughout the model domain. This basic data is needed prior to completing the groundwater modeling of the project's impacts.

The results of the modeling would include estimates of recharge, evapotranspiration, and channel flow within and downstream of the project site. The models then should incorporate proposed mine and water use to estimate the effects of the proposed project on the flows. Such models would also provide the foundation for water quality impact analysis.

Dr. Myers will be developing a simple three dimensional groundwater model based on this Phase 1 report. Dr. Myers' Phase 2 model would in no way be a substitute for the detailed model analyses required for an EIS; however, it would provide Pima County and the USFS with a better tool to request more studies and better mitigation outcomes from Augusta Resources. Dr. Myers notes the need for a detailed surface water runoff model of the area. I will assign District staff to develop the appropriate scope of such an effort to ensure that the impacts of changes in transmission losses and overbank flood storage are understood.

SS/TJH/JF/tj

Attachments

- c: John Bernal, Deputy County Administrator – Public Works
- Nicole Fyffe, Executive Assistant – County Administrator's Office
- Chris Cawein, Deputy Director – Regional Flood Control District
- Thomas Helfrich, Manager – Water Resources Division
- Julia Fonseca, Environmental Planning Manager – Water Resources Division

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Tom Myers, Ph.D.  
Hydrologic Consultant  
6320 Walnut Creek Road  
Reno, NV 89523  
775-530-1483  
tommyers@gbis.com

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August 13, 2007

Julia Fonseca, Environmental Planning Manager  
Pima County Regional Flood Control District  
97 E. Congress, 2nd floor  
Tucson, AZ 85701-1797

Re: Hydrologic Analysis of the Proposed Rosemont Ranch Mine  
Recommendations for Forest Service EIS analysis and for the Phase 2 study

Dear Julia:

Under a separate letter, I have sent you the updated version of my phase 1 report on Rosemont hydrology and the potential impacts of constructing the proposed Rosemont Ranch Mine. This letter provides recommendations for data and analyses for Pima County to request from the Forest Service. It also provides recommended amendments to our Phase 2 study.

The production well should be analyzed in more detail. Augusta proposes to recharge CAP water at three sites to make up the water proposed to be pumped across the Santa Rita Mountains to the project site. However, the recharge sites are far from the production site. The recharge would not replenish the depletion at the production site. A detailed groundwater model of the pumping site should be completed to determine impacts on local well owners and the environment near the production well.

The project would affect ephemeral channel surface water flow and recharge downstream from the project site. The pit and tailings impoundment will intercept surface water flow and prevent it from reaching downstream drainages. Determining runoff was beyond the scope of Phase 1. Surface runoff estimates for ephemeral channels should be made because most of this runoff becomes recharge to Davidson Canyon. A detailed surface water runoff model should be completed. This would not be a standard rainfall/runoff analysis commonly done for flood control. Rather, this should be a daily water balance model designed to estimate daily flows and recharge from the channels.

The Forest Service should complete a detailed groundwater model of flow through the site. The objectives are the same as our Phase 2 study, but they should collect better data to parameterize the model and perhaps to allow better discretization than will be possible in the recon model. As part of the groundwater model, Pima County should request the Forest Service collect sufficient data to calibrate the model for both steady state and transient conditions.

- 1) Sufficient pump tests to estimate transmissivity and storage properties around the site.

- 2) Begin to monitor the wells on site monthly to determine seasonal changes. At least two years of this type of data is needed for transient analysis of the site prior to completion of the model and the EIS. This type of data is necessary to overcome the problems identified in the report concerning Nelson's (2007) inability to do steady state analysis.
- 3) The FS should install shallow wells and temporary gages in the channels to collect sufficient seasonal flow and water level data to calibrate the recharge/flow model discussed in the report. Approximately two years of data would likely be necessary.
- 4) Drill new wells to improve knowledge of the geology at the site. The Phase 2 study performed under this contract will help Pima County identify where additional geologic information is needed.
- 5) Geochemical tests of water samples in deep and shallow wells across the proposed mine site, and in the perennial portions of Cienega Creek. This will help to determine the age of the water and, with knowledge of its age, its likely recharge source. This could be very important in Cienega Creek.

### **Proposed Phase 2 Study**

The Phase 2 study is primarily the completion of a reconnaissance level groundwater model. Building on phase 1, phase 2 would estimate of the changes in flow and groundwater levels the proposed project could have on the watershed. The study would estimate the magnitude and extent of drawdown that would occur in the project area and Cienega Creek basin. It will also estimate the changed baseflow in Davidson Canyon and Cienega Creek. The study will estimate the time for groundwater conditions in the area to return to pre-project levels. If the pit is not backfilled, conditions will not likely ever recover. The model could be used to simulate different recovery times and conditions for the with- and without backfill condition.

The County will find the result of Phase 2 valuable for several reasons. First, it will provide an accurate quantitative estimate of the changes that are qualitatively discussed in the Phase 1 report. Phase 2 will help the County quantitatively understand how the mine could affect flows in Cienega Creek. Second, by showing these potential impacts, the County will use the Phase 2 results to force the Forest Service to perform a better analysis of the proposed project. Third, it will provide the County with a tool to request specific mitigation strategies, such as pit backfill. Fourth, the County will be able to use the Phase 2 results to assess the accuracy of the analysis the FS does perform. I have seen agency models in support of an EIS that are much less detailed than proposed here for Phase 2; the completion of Phase 2 would help the County advance its case for a better model. And fifth, Phase 2 will provide a stronger argument for additional data; without Phase 2 the County can just argue that more data is needed but with Phase 2 the County can point to areas where the model has higher uncertainty as areas where better data is needed.

The primary strategy for this estimate would be the development and application of a simple three dimensional groundwater model based on the conceptual model and water balance developed in phase 1. I propose that the model domain as anticipated in the proposal be

extended into the Cienega basin because of the findings of the Phase 1 report. At the reconnaissance level, this could be accomplished by establishing a parameter zone for each layer in the model and testing the sensitivity to different conductivity values; additional zones would be added if the calibration indicates this is necessary. The analysis will estimate the drawdown into Cienega basin and the amount of groundwater diverted from that basin. All water diverted toward the pit will eventually not discharge to Cienega Creek. By use of a river boundary, the model will estimate the change in baseflow on Cienega Creek and the change in ET discharge to phreatophytes near the creek. The decreased flow will be reflected in a decreased flow at the "near Sonoita" gage. The extended recon model will estimate these flow changes.

Several small changes will be made to the modeling proposed for Phase 2, as follows.

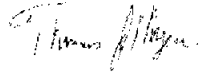
- 1) The recharge applied to the recon model will be based on the values estimated in the Phase 1 analysis. However, the recharge will be distributed so that more occurs through the ephemeral channels.
- 2) Steady state calibration will be completed using annual average values. However, the seasonal variations must be considered. A transient calibration of varying the recharge seasonally to simulate the rise and fall in the monitoring wells will supplement the steady state calibration.
- 3) Faults will be added to the model but without data the sensitivity of flow to the faults will be the primary consideration.
- 4) There will also be a sensitivity analysis of the conductivity values completed. This will help to determine which of the conductivity zones cause the most variation in water levels. It will help to focus recommendations for additional data.

The recon model will also help to predict whether a pit lake will form. Based on the amount of water that recharges in the basin, I doubt there will a lake. However, if sufficient groundwater is pulled from Cienega basin, it could be sufficient to allow pit inflow to exceed the outflow (through evaporation) and form a pit lake. If a lake does not form, the groundwater levels will remain drawn down to the bottom of the pit in perpetuity; the diversion of groundwater from Cienega basin will continue. The model will simulate this.

The recon level groundwater model would not be completed to the level that the Forest Service should complete their model. That is because the Phase 2 activities would not include pump tests or the drilling of new wells, as the FS should perform. Phase 2 would provide Pima County with a valuable tool for publicizing in advance the expected changes to be caused by the mine including flow changes in Cienega Creek and the possible presence of a pit lake. It will also help assess the accuracy of the FS model or even provide a baseline to model they would create.

If you have any questions, please contact me.

Sincerely,

A handwritten signature in cursive script that reads "Tom Myers".

Tom Myers, Ph.D.  
Hydrologic Consultant