RHR
ROCA HONDA RESOURCES LLC

August 10, 2012

Diane Tafoya
Cibola National Forest
2113 Osuna Road NE
Albuquerque, NM 87113-1001

RE: Revised Assessment of Potential Groundwater Level Changes from Dewatering at the Proposed Roca Honda Resources Mine, McKinley County, New Mexico

Dear Ms. Tafoya:

On November 7, 2011 Roca Honda Resources, LLC (RHR) provided a groundwater flow model, documented in the report (INTERA, 2011), to the US Forest Service (USFS) and the NM State Engineer Office (OSE). RHR subsequently provided an Addendum to the modeling report (dated March 8, 2012) produced to address specific questions of the USFS and the third party contractor Mangi Environmental (Mangi).

In May, 2012, the USFS provided RHR with comments on the INTERA model and model documentation. In addition to these comments, the OSE provided comments on May 1, 2012 in response to RHR's pending dewatering permit application. On June 11, 2012 representatives of the Interagency Groundwater Work Group, INTERA and RHR consulting hydrologist, Maryann Wasiolek, met to discuss the USFS, Mangi and OSE comments, recommendations, and questions regarding the model. Consensus was reached on changes that INTERA and RHR needed to make to the model and the model report in order for the model to be considered an adequate tool for assessing the potential effects of the proposed dewatering on area water resources. That consensus was outlined in a memorandum on June 20, 2012, wherein INERA and RHR agreed to change the RHR groundwater flow model to address the group's comments and concerns.

Enclosed for your review and distribution are five (5) packages containing the revisions to the "Assessment of Potential Groundwater Level Changes from Dewatering at the Proposed Roca Honda Mine, McKinley County, New Mexico", for your review and disbursement. The package contains a letter of transmittal from INTERA which, in turn, provides detailed instructions on where to remove and insert replacement pages in the document. It also contains a table which

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cross-references the revisions outlined in the June 20, 2012 memorandum. Finally, also in each package is a DVD containing the PDF files for the report and the input files for the model.

Please note that RHR is also providing separate copies of this submittal to the Office of State Engineer in Santa Fe and Albuquerque, the New Mexico Environment Department, the New Mexico Mining and Minerals Division and the New Mexico State Land Office. Consistent with our last submittal, we have also sent a package directly to Mangi.

We look forward to continuing to work with you and the other agencies represented in the Groundwater Working Group to resolve any issues. Please contact us if you have any questions or require additional information.

Sincerely,

Juan R. Velasquez

cc: Kurt Vollbrecht – NMED (1 Copy)
David Clark – NMMMD (2 Copies)
Michael Mariano – NMSLO (1 Copy)
NMOSE – (3 Copies)

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August 8, 2012

Mr. Juan Velasquez, M.Sc. and Mr. John DeJoia
Strathmore Minerals Corporation
4001 Office Court Drive
Suite 102
Santa Fe, NM 87507

Re: Transmittal of 30 packets of replacement pages for *Assessment of Potential Groundwater Level Changes from Dewatering at the Proposed Roca Honda Mine McKinley County, New Mexico* and Cross-Reference Table of Recommendations and Report Revisions

Dear Mr. Velasquez and Mr. DeJoia,

We are pleased to convey to you 30 packets of replacement pages and files for our report, ***Assessment of Potential Groundwater Level Changes from Dewatering at the Proposed Roca Honda Mine McKinley County, New Mexico***, for the revision dated 7 August 2012. At your direction, we prepared this report to evaluate potential changes to groundwater levels in the three aquifers that will be temporarily dewatered during the construction and operation of the proposed Roca Honda mine. The report demonstrates that dewatering at the Roca Honda mine will not adversely affect the water resources of the Village of Milan, Acoma Pueblo, Laguna Pueblo, the City of Grants, the community of San Mateo, the Crownpoint area, or the City of Gallup. The report also shows that mine dewatering will not adversely affect area springs or rivers, including Horace Spring and the Rio San Jose.

Each packet contains the replacement pages that are to be added to the Roca Honda Resources (RHR) groundwater model report after the original pages are removed. Each packet also includes a DVD that contains PDF files for the entire revised report as well as Groundwater Vistas and MODFLOW-SURFACT input files for the RHR groundwater model. Files with simulated groundwater levels from the input files are included for those wishing to check our simulations.

As you requested, the list below describes the steps that each recipient should follow to update their copy of the RHR model report.

1. Remove existing report title page and spine from the three-ring binder itself and replace with new report title page (does not have punched holes) and spine.
2. Remove the existing cover page from document titled "Assessment of Potential Groundwater Level Changes from Dewatering at the Proposed Roca Honda Mine" and insert new cover page and list of replacement pages.
3. Remove the original executive summary pages i and ii. Insert new executive summary pages i to iii.
4. Remove existing pages iii to x from Table of Contents, List of Figures, List of Tables, List of Appendices, Abbreviations, and Definitions. Insert new pages iv to xi.

5. Remove existing pages 1, 4, 6, and 7 from Section 1 and insert new pages 1, 4, 6, and 7.
6. Remove existing Section 2 pages 15, 21 to 29, and 31. Insert new pages 15, 21 to 29, and 31.
7. Remove existing Section 3 pages 34 to 37, 39 to 50 and 53 to 54. Insert new pages 34 to 37, 39 to 50 and 53 to 54.
8. Remove existing Section 4 pages 59 to 73, 75 to 77 and 79 to 82. Insert new pages 59 to 73, 75 to 77 and 79 to 82.
9. Remove existing pages in their entirety from Section 5. Insert new Section 5 pages (numbered 83 to 117).
10. Remove existing pages in their entirety from Section 6. Insert new Section 6 pages (numbered 118 to 120).
11. Remove existing pages in their entirety from Section 7. Insert new Section 7 pages (numbered 121 to 126).
12. Remove existing pages in their entirety from Appendix A. Insert 11 new Appendix A pages.
13. Remove existing pages in their entirety from Appendix B. Insert 12 new Appendix B pages.
14. Remove existing pages in their entirety from Appendix C. Insert 28 new Appendix C pages.
15. Remove existing pages in their entirety from Appendix D. Insert four new Appendix D pages.
16. Insert tab insert (divider) and 19 new pages for Appendix E behind Appendix D.

Please find attached to this letter the table titled *Roca Honda Resources Implementation of Recommended Changes to RHR Groundwater Flow Model - INTERA Technical Memorandum to USFS, Inter-Agency Technical Team, and RHR*. This table cross-references the latest RHR model report revisions to the recommendations from the US Forest Service, the inter-agency technical team, INTERA, and RHR.

This report is the product of many months of effort from INTERA and the RHR team. We gratefully acknowledge the support that we have received from you, RHR staff, and Ms. Maryann Wasiolek of Hydroscience Associates in carrying out this work.

We appreciate the opportunity to work on this challenging project. Please do not hesitate to contact me at (505) 246-1600 if we can assist you in any way.

Sincerely,

John M. Sigda, Ph.D.
Senior Hydrogeologist
INTERA Inc.

Attachments
Cc: STR-001-01-01

Replacement Text, Figures, Tables, and Appendices for Recommended Changes to RHR Groundwater Flow Model

Recommendation No.	Page No.	Figure No.	Table No.	Appendix	Recommendation
1.					Improve the model's ability to simulate impacts on Horace Spring (HS) and support the choices made in detailed documentation of the geology in the area of the spring.
INTERA Response	7, 15, 21-22, 24, 35, 36, 61, 62, 72, 75, 85, 89, 96, 98,103,107-108, 112-113, 118-125	2.6 – 2.10; 3.1, 3.5-3.7; 4.1-4.16; 5.2-5.16	4.1-4.3; 5.1, B.1	A, B, C, D, E	**The model has been extended to include Horace Spring and the Rio San Jose (see below). The impact of proposed mine dewatering on the spring has been assessed. The geology of Horace Spring and a conceptual model of the hydrogeology of the spring have been documented in Appendix E to the RHR model report. A discussion of the approach INTERA has used to model the spring vs. the approach used in previous models has been included Section 5.5.**
2.					Improve the model's ability to represent flow in the Rio San Jose.
INTERA Response	6, 7, 15, 21-22, 25, 26, 35, 36, 44, 61, 62, 72, 75, 85, 89, 96, 98,103,107-108, 112-113, 118-125	2.6 – 2.10; 3.1, 3.5-3.7; 4.1-4.16; 5.2-5.16	4.1-4.3; 5.1, B.1	A, B, C, D, E	**The model has been extended to include the Rio San Jose and represent it using the MODFLOW River package.**
3.					Implement model improvements that will result in dampening of oscillations in river fluxes.
INTERA Response	36, 52, 98-99, 102	3.1; 4.1-4.16; 5.2-5.16	4.1-4.3; 5.1, B.1	A, B, C, D	**Model cell size along the San Juan River has been decreased and cell aspect ratio reduced by splitting river cells. The hydraulic conductivity for streambed conductance for the rivers in the model has been revised**

Replacement Text, Figures, Tables, and Appendices for Recommended Changes to RHR Groundwater Flow Model

Recommendation No.	Page No.	Figure No.	Table No.	Appendix	Recommendation
					from 100 ft/day to 20 ft/day in order to reduce the fluctuation of river fluxes and comport with values used by Kernodle.
4.					Explain the effect or non-effect of the San Mateo fault on groundwater flow.
INTERA Response	39				**The reasons that the faults do not appear to block groundwater flow are discussed in revised Section 3.4.**
5.					Defend the choice of permeability used in the model to represent the properties of the Mt. Taylor volcanic core or increase hydraulic conductivities to the low end of known hydraulic conductivities.
INTERA Response	52, 61, 62, 72, 75, 102-103	4.1-4.16; 5.2-5.16	4.1-4.3; 5.1, B.1	A, B, C, D	**The hydraulic conductivity of the Gallup, Dakota, and Westwater Canyon in the area of the volcanic cores has been increased to the low end of their known range of hydraulic conductivity. The sensitivity analysis varies the hydraulic conductivity of the volcanic core area by factors of 10 and 0.1 from these new values.**
6.					Provide further documentation of the model's water balance.
INTERA Response	98-99, 102-103, 107		5.2a,b,c, d		**Total water balances that account for all water produced during pumping and recovery periods have been provided for all aquifers.** **Qualitative and quantitative documentation of the impacts that historical dewatering had on water levels and stream flows have been provided to support the model's projection that most of the groundwater that will be pumped during dewatering will be removed from the Morrison Formation, and that little impact will be felt on aquifers stratigraphically above the Mancos Shale. A discussion has been included of the relative size of proposed RHR pumping to historical pumping by past uranium mines (Section 5.1.5).**

Replacement Text, Figures, Tables, and Appendices for Recommended Changes to RHR Groundwater Flow Model

Recommendation No.	Page No.	Figure No.	Table No.	Appendix	Recommendation
7.					Change the GHB package at Mt. Taylor and Chuska Mountains to specified flux boundaries.
INTERA Response	47, 62, 72, 75	3.7	4.1-4.3	A, B	**The model has been revised so that mountain-front recharge at all locations is defined with specified flux boundaries rather than the GHB package.**
8.					Discuss why the cumulative impacts represented in the model over-estimate the amount of predicted water level declines.
INTERA Response	103, 107				**The difference between the volume of water removed from the Westwater Canyon Member using the conservatively simulated RHR pumping rates has been compared to the volume that must actually be removed to safely and cost-effectively mine at RHR.**
9.					Increase groundwater mountain-front recharge at Mt. Taylor area.
INTERA Response	47, 61, 62, 72, 75	3.7; 4.1-4.16; 5.2-5.16	4.1-4.3; 5.1, B.1	A, B, C, D	**Mountain-front recharge has been added in the model to other areas around Mt. Taylor.**

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MEMORANDUM

TO:	Mr. Kevin Myers, Hydrologist, Hydrology Bureau, New Mexico Office of the State Engineer
FROM:	INTERA, Inc.
RE:	Response to New Mexico Office of the State Engineer May 1, 2012 comments on the Roca Honda mine groundwater flow model
DATE:	August 22, 2012

In November 2011, Roca Honda Resources, LLC (RHR) provided a groundwater flow model, documented in the report (INTERA, 2011) by INTERA Incorporated (INTERA), to the NM State Engineer Office (OSE) in support of RHR's application to dewater an underground mine pending before the OSE. The purpose of the model is to provide a tool for calculating the potential impacts of RHR mine dewatering at the proposed RHR underground uranium mine on area groundwater and surface water resources. RHR subsequently provided revisions to the modeling report (INTERA, 2012a) and an Addendum to the modeling report (INTERA, 2012b) written to address specific questions of the United States Forest Service and the third-party contractor, Mangi Environmental (Mangi).

This memorandum provides INTERA's responses to your May 1, 2012 comments about the Report and Addendum. Each response begins with the text of your comment (shown in boldface) and ends with our response, including specific changes made to the revised groundwater model report (INTERA, 2012c).

1. **Page 4, Section 1.0 – Table 1. Does simulating the Westwater Canyon Member (WCM) wells and shaft pumping cause numerical convergence issues? Did INTERA consider a fixed elevation drain for simulating mine de-watering?**

Simulating the Westwater Canyon Member (Westwater) wells and shaft pumping does not cause numerical convergence issues. A fixed-elevation drain was not considered appropriate to simulate mine dewatering because the MODFLOW Drain Package does not constrain the flow rate. The purpose of the model and the simulation was to assess the impact of pumping the full amount of water specified in the dewatering application for the time period specified, making it necessary and appropriate to use the Well Package, which allows simulation of the withdrawal of groundwater from the aquifer at specified rates over specified periods of time.

2. **Page 4, Table 1.1. The mine dewatering pumping periods in the table sum to a total of 14 years, but the text indicates that there will be 13 years of mine dewatering. Assuming some overlap pumping during shaft construction, clarify which of the pumping periods overlapped in the simulation to produce a total of 13 years of pumping.**

Summing the pumping periods in Table 1.1 will not give a correct final pumping duration. The pumping periods for the Dakota Sandstone (Dakota) and the Westwater during the shaft construction overlap. Pumping of the Dakota will commence after three of the four Gallup Sandstone (Gallup) wells are deepened into the Dakota and will occur during the same timeframe as pumping of the Westwater, although pumping in the Dakota will cease after one year. The Westwater will be pumped for a total of 12 years (2 years during shaft construction and 10 years during mining operations). The Gallup Sandstone will be pumped for one year except as noted above and in response to OSE Comment no. 3. Therefore, total pumping will occur over a 13-year period.

Please note that Table 1.1 has a typographical error. Shaft construction in the Westwater will take 730 days, not 720 days as listed. The revised INTERA modeling report (INTERA, 2012c) contains the corrected Table 1.1 on page 4.

3. **Page 4, Table 1.1. The text indicates that 30 gpm will be pumped from the Gallup aquifer for the life of the mine, but this is not shown in Table 1.1. Please clarify that this pumping is also simulated in the model.**

The Gallup will be pumped at 30 gallons per minute (gpm) for the life of the mine as described in more detail in Section 6, "ADDITIONAL STATEMENTS OR EXPLANATIONS," OF RHR's permit application of September 8, 2011. INTERA inadvertently turned off the pumping of this well in the simulations that produced the results presented in the original report (INTERA, 2011 and 2012a, b) and it was, therefore, not simulated in the model. The model has been re-run and the changes have been compiled. Inclusion of the 30 gpm of pumping from the Gallup in the simulation resulted in the following changes to the discussions of impacts in the revised INTERA model report (INTERA, 2012c) submitted to the OSE on August 10, 2012:

- On page 85 of the INTERA (2011) report, the first paragraph in Section 5.1.1 has been replaced with two paragraphs on page 85 of INTERA (2012c). The first paragraph in Section 5.1.1 describes drawdown in the Gallup, with the revised text, *"After one year of depressurization pumping at a rate of 502 gpm (Table 1.1), drawdown in the Gallup reaches a maximum of 366 feet at the production shaft, but the 10-foot contour of drawdown does not extend beyond the RHR permit area (Figure 5.2). Drawdown in the Gallup equals 10 feet during the second year after the end of mining, and decreases to 1 foot 100 years after the end of mining (Figure 5.4)."*

- Figure 5.4 in the INTERA (2011) report, which shows the drawdown in the Gallup and Dakota at the RHR production shaft, has been replaced by a new Figure 5.4 on page 88 of INTERA (2012c).

- Page 96, Section 5.1.2, line 3, of the INTERA (2011) report, *"Maximum drawdown is predicted to be 4.8 inches (0.4 feet) at Bridge Spring 113 years after the start of mine construction."*, has been replaced with the following sentence "*Maximum drawdown is predicted to be 8.8 inches (0.73 foot) at Bridge Spring 113 years after the start of mine construction.*" on page 96, fourth line of the first paragraph under Section 5.1.2 in INTERA (2012c).

- Table 5.1 (page 97 in INTERA (2012c) and Table D.1 (Appendix D in INTERA, 2012c), which show predicted changes at springs and wells, respectively, have been revised.

4. Page 21, Section 2.2.1., last paragraph. There is a sentence which indicates that the Rio San Jose has perennial reaches upstream of Grants – it should also say downstream.

The information regarding the presence of perennial reaches in the Rio San Jose upstream of Grants provided in INTERA's 2011 report was incorrect. RHR reviewed the U.S. Geological Survey (USGS) gauge records and confirmed that the presence of perennial reaches of the Rio San Jose are only downstream of Grants. This sentence noted by the OSE in the INTERA (2011) report has been replaced in INTERA (2012c) with the following text in the last paragraph of page 21: *"The largest river near the Roca Honda permit area is the Rio San Jose (Figure 2.6),* *which flows along the southern margin of the San Juan Basin, and has ephemeral flow along most of its length, with perennial flow between Horace Spring and Laguna Pueblo (Risser, 1982). Most of the Rio San Jose is located on surficial geologic units that are older and stratigraphically lower than the Westwater aquifer, but a roughly 12-mile-long reach from Horace Springs to Acomita is in contact with younger geologic units and roughly 150 to 300 feet of Westwater (Risser, 1982; Baldwin and Anderholm, 1992; Frenzel, 1992; Appendix E).*" The perennial reach of the Rio San Jose is now depicted on Figures 2.6 to 2.10, 3.5 to 3.8, 4.1 to 4.3, 5.2, 5.3, 5.5, 5.7, 5.9, and 5.11 to 5.15 in INTERA (2012c).

5. **Page 22, Figure 2.6. Why were the perennial segments of the Rio San Jose not included?**

Figure 2.6 of the INTERA (2011) report did not identify the perennial segments of the Rio San Jose because the figure was sourced from the U.S. National Atlas Water Feature Lines Database, which does not depict the Rio San Jose as having perennial reaches. As noted in our response to comment 4 above, data show that there is a perennial reach of the Rio San Jose downstream of Grants.

6. **Page 26, Section 2.2.2.3. In the section on regional flow patterns, the Report mentions groundwater discharge to the lower San Juan River or to the Rio Puerco (and a minor amount to the Puerco River). Why is the Rio San Jose not listed as a possible discharge location?**

The perennial reach of the Rio San Jose is located along the southeastern edge of the San Juan Basin within the McCartys Syncline. Our examination of that area's hydrogeology indicated that the main source of water to the perennial reaches of the Rio San Jose is Horace Spring (Risser, 1983) and that there was likely no significant hydraulic connection between the river and the Westwater and Dakota aquifers, leading us to the conclusion that the river was more likely an area of potential recharge. The Rio San Jose was therefore not included in the original model domain.

On further review, the groundwater flow model has been revised to include the perennial reach of the Rio San Jose and Horace Spring. Appendix E (INTERA, 2012c), which describes in detail the geology and hydrogeology of the river and the spring, demonstrates that the Westwater and Dakota aquifers have a very limited hydraulic connection with the Rio San Jose. The revisions to the groundwater flow model were made so that groundwater from the Dakota and Westwater aquifers does discharge into the perennial reach of the Rio San Jose at rates commensurate with previous studies: see the last paragraph of page 21, the second paragraph of page 42, paragraph 1 of page 98, conclusions 4 and 8 in Section 6, and Appendix E in INTERA (2012c).

7. **Page 30, Figure 2.11. Provide references for underground mine workings illustrated in this figure.**

Figure 2.11 was constructed using the map shown as Figure 1 in Chenoweth (1989), Ambrosia Lake, New Mexico – A Giant Uranium District, *in:* Southeastern Colorado Plateau, NMGS Fortieth Annual Field Conference, September 28–October 1, 1989, pages 297 to 302. This source depicts locations of historical uranium mine workings.

8. **Page 35, Section 3.4. Please include a description of the location of the model grid (x, y coordinates of the origin of the model and the map projection used to define the grid).**

The origin of the model is (2014342 feet, 1847082 feet) (southwest corner of row 1, column 1 of model grid), and the map projection used to define the grid is NAD 1983 State Plane New Mexico West. Figure 3.1 on page 36 (INTERA, 2012c) has been revised to show the origin of the model.

9. **Page 37. For the Roca Honda Area and the southern San Juan Basin, what are the most significant faults and how much offset occurs on them? Does the Roca Honda area have structure controlled flow?**

Figure 7-2 "Regional Structural Map Ambrosia Lake Subdistrict" and Figure 7-3 "Geologic Map of the Roca Honda Permit Area," from Section 7 of the Roca Honda Resources Baseline Data Report (revised January, 2011) depict the faults in this area. For the OSE's convenience, these maps are attached. As is discussed on page 7-2 of Section 7 of the RHR BDR:

> *The San Juan basin and bounding structures were largely formed during the Laramide orogeny near the end of the Late Cretaceous through Eocene time (Lorenz and Cooper 2003). This Laramide tectonism produced compression of the San Juan basin between the San Juan and Zuni uplifts, resulting in faults and fold axes oriented north to north-northeast. The more intensively faulted east part of the Chaco slope may be related to the development of the McCartys syncline, which lies just east of the faulted Fernandez monocline (Kirk and Condon 1986). The San Rafael fault zone cuts the Fernandez monocline and has right-lateral displacement (Figure 7–2) as evidence of shear near the San Juan basin margin.*

Other faults in or near the permit area are mostly normal with dip-slip displacement and vertical movement less than 40 ft. The large, northeast-striking San Mateo normal fault about 2 miles west of the Roca Honda permit area has vertical displacement of as much as 450 ft (Santos 1970). Strata in the permit area along the Fernandez monocline dip east to southeast at 4 to 8 degrees toward the McCartys syncline, an expression of the Acoma sag (Santos 1966a and 1966b).

Data collected during the Westwater aquifer test performed within the RHR Permit Area do not indicate structure-controlled flow, and the available data create a piezometric surface in the Westwater aquifer that is continuous (see Figure 9-6 of the BDR), indicating that there is no evidence of structure-controlled flow. A copy of Figures 7-2, 7-3, and 9-6 from the BDR are attached in support of this response. In addition, the last paragraph of page 37 in INTERA (2102c) has been revised to include a more detailed discussion of the two large-displacement faults nearest to the RHR permit area.

10. Page 39, Figure 3.2. Provide legend and units (scale) for this figure. Note that this figure is difficult to see as it is shown and it may be easier to view if it were plotted differently.

The purpose of the figure is to illustrate that the data sets used to construct the bottom of the Dakota are consistent and provide coverage over the full model domain, and that a sufficient density of information beneath the RHR Permit Area is available. Where the yellow and red contours coincide, they have the same elevation values. Figure 3.2 on page 39 of INTERA (2012c) has been revised to clarify these issues.

11. Page 40, Figure 3.3. This cross-section is difficult to follow, particularly in the Roca Honda area. The coloring of the geologic units near and in the permit area looks off (e.g. the Westwater Canyon member does not appear in the region outlined as the Permit Area on the cross-section) or it is hard to identify the layers if the colors are changing. It is recommended that this figure be improved so that it is easier to view.

Figure 3.3 on page 40 of INTERA (2012c) has been revised to include an inset that enlarges the permit area of the figure and a legend that explains the hydraulic conductivity zones. Please note that the Westwater has several hydraulic conductivities that are represented as different colors in Figure 3.3. For additional clarity, any of the revised .GWV model files (distributed with INTERA, 2102c) can be opened in Groundwater Vistas, enabling views at various scales.

12. Page 43, Figure 3.5. Why are the Puerco River and Rio Puerco simulated as River Cells, but not the Rio San Jose?

The INTERA (2011) model was constructed with the understanding that the three aquifers of interest – the Gallup, the Dakota, and the Westwater – likely have a far greater degree of hydraulic connection with the Puerco River and Rio Puerco than the Rio San Jose. As explained in INTERA's response to comment 6, the Rio San Jose is now included in the revised RHR groundwater flow model.

13. Pages 44 & 46; Figure 3.6 and 3.7. Provide better figure that clearly shows recharge boundaries in the Roca Honda Mine area.

Figures 3.6 and 3.7 have been revised to provide an expanded view of the recharge zones in the RHR permit area (pages 44 and 46 of INTERA, 2012c). These figures demonstrate that there are no recharge boundaries in the Roca Honda Mine area and provide more clarity. Recognizing that pictorial representations of complex models are subject to interpretation and may not always provide sufficient clarity for every reader, INTERA also recommends viewing the revised .GWV model files (distributed with INTERA, 2012c) in Groundwater Vistas for views at various scales.

14. Page 48, Figure 3.9. What are the aquifers (either Dakota or Westwater Canyon) for the wells shown in the figure based on? RHR should provide a table or citation for Figure 3.9 wells with well names and diversion amounts. Provide explanation whether the well locations are approximate or surveyed locations.

Figure 3.9 is meant to illustrate how the model was calibrated in the Ambrosia Lake area. The "wells" shown in Figure 3.9, in red for the Dakota and in yellow for the Westwater, do not exist. They are meant to represent in the model a system of interconnected mine workings in the Ambrosia Lake area. Their basis is simply a hypothetical set of points of diversion to represent "locations of dewatering from historic mining activities." As such, there are no well names or diversion amounts. The "wells" are placed on a map simply to be able to represent dewatering of the mines and illustrate the locations as inputs to the model. INTERA did not use the MODFLOW Drain package to represent historical dewatering because the Drain package needs inputs of fixed water level elevations over time and these inputs are not available.

The "wells" in Figure 3.9 have been changed to "specified flux" boundary condition cells to represent the specified flux locations in the model that were used to simulate the dewatering of the Ambrosia Lake area through shafts and dewatering wells (see page 48 of INTERA, 2012c).

The Fracture Well Package of MODFLOW SURFACT was used to bring the water levels down to the levels of the mine workings. The flow rates in the wells varied so that the water level did not drop below the bottom of any cell. The goal was to match historical withdrawal rates from mine dewatering in the Ambrosia Lake area. Information about these historical rates is not extensive for every mine, but is fairly consistent from source to source. Figures 4.13 to 4.16 on pages 79–82 of INTERA (2012c) compare simulated and historical pumping in the Ambrosia Lake area.

15. Page 53, Table 3.4. The table shows the groundwater withdrawals for the major diversions during the historical period. What aquifer or aquifers are each of these entities pumping from and how much is coming from each aquifer?

Table 3.4 has been revised on page 53 of INTERA (2012c) to correct some typographical errors. INTERA has expanded the revised table to address the OSE's request. This expanded version of Table 3.4 is attached to this memorandum.

16. Page 53, Table 3.4; and pages 79-82, Figures 4.12 thru 4.16. OSE requests specific references and tabular historical pumping data that were used as the basis for well pumping in the model.

The historical pumping amounts used in the model were obtained from a number of sources, principally Stone et al. (1983). The revised Table 3.4 (see INTERA's response to comment 15) lists all references used. More detailed information is provided in the Hydroscience memoranda that were listed in the references as Hydroscience 2009a, b, and c, and provided by email on March 22, 2012, to the OSE in response to an earlier request.

17. Page 54, Table 3.5. Why are NM OSE files G-90, G-91, G-92 and G-95 not included with their respective water rights of 6.5, 29, 16.1 and 16.1 acre-feet per year, respectively? Explain why WATERS shows approximately 2,070.2 af/yr (consumptive use) to 2,232 af/yr, while Table 3.5 has 2,425 af/yr for water rights file numbers G-87, G-88, and G-89. Explain why point of diversion SJ-118 (625 af/yr) was included, yet SJ-118A (25 af/yr) was not included. Explain why file number G-11 has 1140 af/yr in WATERS instead of 794 af/yr reported in Table 3.5. Explain why file number G-11A has a point of diversion reported as 17N, 16W Section 35 in WATERS not 16N, 16W, Sections 8 & 17 as shown in Table 3.5. Explain why township range for SJ-949 is 22N, 8W in WATERS and not 21N, 9W as indicated in Table 3.5. RHR should verify if SJ-

949 at 1000 af/yr is located in the correct model cell. If another source of information (other than WATERS) was used or WATERS does not have the correct location or diversion amount, RHR should cite or footnote references used for table.

The wells associated with G-90, G-91, G-92, and G-95 are located far from the proposed RHR dewatering and have small declared water rights. For these reasons, they were not included in the simulations for Scenarios 3 and 4. Well G-90 is a declared well reportedly located in 16N 20W Section 17.231, over 60 miles from the RHR Permit Area. It has a reported production rate of 4 gpm. Well G-91 is a declared well reportedly located in 16N 20W Section 26.131, over 60 miles from the RHR Permit Area. It has a reported production rate of 18 gpm. G-92 is a declared well reportedly located in 16N 20W Section 4.223, over 60 miles from the RHR Permit Area. It has a reported production rate of 10 gpm. G-95 is a declared well reportedly located in 16N 20W Section 14.314, over 60 miles from the RHR Permit Area. It has a reported production rate of 10 gpm. Inclusion of these wells in model calibration would not affect calibration, and water level declines associated with the RHR dewatering will not approach these wells.

Regarding the second part of OSE comment #17, G-87, G-88, and G-89: The "Supplement to Application for Permit" filed with the NM OSE on January 11, 1983 for G-88-S states that "The total declared annual use for the above three wells is 2,425 AFY."

SJ-118 is a declaration filed for exploration and drilling of coal. It has passed through a number of owners as Cherokee & Pittsburg became Santa Fe Pacific Mining, then Hanson Natural Resources Company, then Peabody Natural Resources Company. Mustang Energy acquired 625 ac-ft/yr of the 650 ac-ft/yr water right claim in August of 2001, which the OSE numbered SJ-118A. The remaining 25 ac-ft/yr and the SJ-118 well (Gallo Wash Well #1, a 5,075-foot well completed in the Jmw), is still held by Peabody. Mustang filed an application to transfer the water right claim to wells under SJ-120, but the application was protested by the Navajo Nation and various individuals, and was eventually withdrawn prior to hearing. It appeared likely to INTERA that the SJ-118A right was much more likely to be exercised. The additional withdrawal of 25 ac-ft/yr would have no effect on drawdown near the RHR Mine.

Regarding G-11, WATERS does not include the documents associated with this water right, so it is not possible to determine why the discrepancy exists. INTERA's assessment of the quantity of G-11 is as follows:

In 1967, UNC began sinking the NE Church Rock mine shaft for the purpose of underground mining of uranium ore. The shaft penetrated 1,788 feet in depth and went through the Gallup, Mancos, Dakota, and Brushy Basin to the Westwater. In a declaration filed in 1969, and numbered G-11 after declaration of the Gallup Basin, UNC reported beneficially using for industrial and domestic purposes 1,850 gpm (2,986 ac-ft/yr) of the water discharged from the shaft. UNC amended G-11 in 1981, filing G-11-Supplemental. G-11-Supplemental stated:

> *All of the water pumped is appropriated and put to beneficial use in UNC's ion exchange plant, where the uranium is extracted and subsequently processed through the mill. The rate of 2850 gallons per minute computes to approximately 4600 acre feet per annum. The highest annual discharge was for 1975 at approximately 2,431.2 acre feet per year. After the water is put through ion exchange, a certain portion of it is fed to the mill process water system for beneficial use. Based upon mill production figures, as much as 104 acre feet per month has been fed to the mill water process system. This computes to 1248 acre feet per year. The highest recorded annual mill water usage was 1979, approximately 878.9 acre feet.*

In 1986, UNC sold 400 gpm (650 ac-ft/yr) of water rights under G-11 Supplemental to HRI. In 1993, HRI filed an application with the OSE to transfer the 650 ac-ft/yr consumptive use to the site of a proposed in-situ uranium leach project in the Church Rock area. The application was granted in 1998 after a hearing before the OSE hearing examiner, Bob Rogers, did not make a determination of the full extent of UNC's water rights, but who did make the following Proposed Findings of Fact:

> *PFF No. 6: The Applicant put a total of 551 acre feet per annum of water to consumptive beneficial use for mill uses other than grinding of ore and domestic uses in the 12-month period from July 1978 to June 1979;*
>
> *PFF No. 7: The Applicant put 858 acre feet per annum of water to consumptive beneficial use for grinding of uranium ore in the 12-month period from July 1978 to June 1979;*
>
> *PFF No. 8: The Applicant put 32 acre feet per annum of water to beneficial use for domestic uses from a domestic well, not from the point of diversion which is the move-from location in this Application.*

UNC's water rights established from beneficial consumptive use at the Northeast Church Rock mine and mill therefore totaled at least 855 +551 or 1,406 ac-ft/yr (1,409 ac-ft/yr). After selling HRI 650 ac-ft/yr, at least 759 ac-ft/yr would have remained. The additional 35 acre-feet are domestic use claimed under that right for a total of the 794 acre-feet used in the model.

UNC may have 1,140 ac-ft/yr as listed in WATERS. INTERA relied on the above-described documentation.

G-11-A has a point of diversion of 16N, 16W, Sections 8 & 17; G-11 has a point of diversion of 17N 17W Section 35.

The location noted by the reviewer of SJ-949 at 22N 8W as listed in WATERS is the correct location. The 21N 9W location shown in Table 3.5 is a place of intended use. This well pumps from the La Ventana Tongue of the Cliff House Sandstone that is simulated in model layer 5, not the Westwater. The error will be corrected. Table 3.5 has been revised to correct this error and is attached to this document.

18. **Page 54, Table 3.5. Which aquifers are these wells pumping from? p. 57 – An INTERA database and data compilations by Hydroscience are mentioned as sources for the calibration targets. Please provide electronic (EXCEL) data tables of these calibration targets.**

Table 3.5 is a table of stresses for predictive scenarios 3 and 4, not calibration targets. Please refer to Section 4 for calibration target information (INTERA, 2012c). Table 3.5 (see INTERA's response to comment 17) has been expanded to show the amount of pumping specified for each aquifer, as requested by the OSE. The expanded Table 3.5 is attached to this memorandum. The Hydroscience files (Hydrosciences 2009a, b, and c) were provided to the OSE by email on March 22, 2012, in response to an earlier request.

19. **Pages 61-63, Figures 4.1-4.3. There are no historical contours to match to in the Roca Honda area for the Gallup sandstone.**

OSE's comment is correct as there are no historical data for this area. INTERA used water levels from Stone et al. (1983) to develop general contours for flow within the Gallup aquifer for the rest of the model and successfully calibrated the model to them. Flow directions in the RHR area were determined to be consistent with these contours.

20. Pages 61-63, Figures 4.1-4.3. For the Dakota and the Westwater, the simulated water levels in the Mount Taylor area are much higher (sometimes 500 to 1000 ft higher) than is shown on the historical water level contours.

The predevelopment head contours on Figures 4.1 to 4.3 of INTERA (2011) were developed using sparse potentiometric surface data, including data and contours (where available) from Stone, et al. (1983), Craigg, et al. (1989), Kernodle, et al. (1989), and Dam, et al. (1989). Simulated groundwater level contours from Kernodle (1996) were also used to guide the contouring. There are relatively few data around Mt. Taylor and the elevation varies steeply over short distances, increasing the difficulty in contouring groundwater levels. Even so, the simulated predevelopment groundwater levels from the revised groundwater model (INTERA, 2012c) for these three aquifers provide a good match to the historical water level contours, shown by the revised Figures 4.1 to 4.3 (see pages 61 to 63 in INTERA, 2012c). The 6250-foot contour for historical water levels in the Westwater was inadvertently removed from Figure 4.3, but it closely matches the simulated groundwater level contour, as shown in a corrected Figure 4.3 that is attached to this memorandum.

21. Pages 61-63, Figures 4.1-4.3. Provide smaller area maps of the Roca Honda area with a contour interval that is smaller than 250 feet.

The contour interval and map area used for Figures 4.1 through 4.3 were chosen based on data availability. Given the small amount of available data, there is no basis for creating the measured water level contours with a smaller interval or smaller area.

22. Pages 75-77, Figures 4.10, 4.11, 4.12. Please show data that were used to make the measured water-level contours shown on these maps of the Roca Honda area.

The measured groundwater level contours in Figure 4.10 were adapted from Kelly et al. (1980). Figures 4.11 and 4.12 have been revised to include the data used to make the measured water level contours (see pages 76 and 77 of INTERA, 2012c).

23. Page 78, Section 4.2.2. Table 3.4 and Table 3.5. Indicates that pumping from the Gallup aquifer is not represented in the model – why not? How much pumping from the Gallup aquifer is not included?

Pumping from the Gallup is included. Table 3.4 includes all large stresses in the transient calibration, including pumping from the Gallup aquifer. Table 3.5 includes all large stresses in predictive scenarios 3 and 4, including pumping from the Gallup aquifer. However, the sentence on page 78, lines 11-13, *"Similarly, comparison of measured and simulated groundwater levels at three locations in the Gallup (Figures C.25 to C.27) show that pumping in the Gallup, demonstrated by the changes in measured groundwater levels, is not represented in the model"* is not clear and has been revised at the end of the first paragraph on page 78 of INTERA (2012c) to read, *"Similarly, comparison of measured and simulated groundwater levels at three locations in the Gallup (Figures C.25 to C.27) show that pumping in the Gallup, demonstrated by the changes in measured groundwater levels, is not represented in the model. All three sets of measurements are located more than 20 miles from the Roca Honda permit area. Simulated groundwater levels in the Gallup are lower than measured groundwater levels at two of the three locations, indicating that overall the model yields a conservative estimate of groundwater levels at those time periods and locations in the Gallup."*

24. Page 89, Section 5.1.1. What radius from the Roca Honda area was used to determine the nearby wells for which impacts would be calculated?

INTERA used a 5-mile radius to determine nearby wells and relied on RHR BDR Table A-1 and Figure A-1 which compile wells within a 5-mile radius of the RHR Project.

25. Page 98, Section 5.1.3. Lower Westwater Canyon Member (WCM) storage was unsuccessful as sensitivity run because model cells went dry (i.e. 4,500 gpm maximum dewatering rate unsustainable). In order to verify the worst case scenario, RHR should consider sensitivity runs that adjust the flow rate lower in order to complete the simulations of lower storage properties.

The impact analysis focused on assessing the impact of pumping at the permitted rate for the entire permitted period of time. Lowering the pumping rate would defeat the purpose of the sensitivity analysis. The sensitivity assessment was "unsuccessful" because only a narrow range of storage properties can sustain maximum pumping. If storage is actually lower, then the amount of water that will be withdrawn from the mine area will also be lower.

26. Page 106, Section 5.3. RHR should provide a map for wells that RHR claims are affected by scenarios 2, 3 and 4.

Three additional maps, labeled as Figures 5-17, 5-18, and 5-19, have been created and are attached to this document in response to the OSE's request. Each map represents the simulated water level declines under a particular pumping scenario and shows the potentially impacted wells.

27. **Page 109, Section 6.0. Conclusion Number 5) indicates the maximum extent of the ten-foot drawdown contour in the Westwater aquifer is predicted to be 17 miles. To which scenario does this apply?**

The scenario to which Conclusion Number 5 applies is Scenario 2, which is described in Section 5.1 on page 85 of INTERA (2012c).

28. **Page 110, Section 6.0. Conclusion Number 8) discusses the differences between Scenario 4 and 3. Provide calculation of differences between Scenarios 4 and 3.**

The two rightmost columns, "Scenario 3 Maximum Drawdown (ft)" and "Scenario 4 Maximum Drawdown (ft)," of Appendix D, Table D-1 "Potential changes in groundwater levels at wells with water supply uses," of the INTERA (2011) report provide the information requested. An expanded version of Table D.1 in Appendix D of INTERA (2012c) is attached to this memorandum to show the differences between Scenarios 4 and 3 (see the rightmost column).

29. **Appendix A, Figures. It would be helpful to see not only the boundary type, but for wells, which model cells are pumping and which are injecting.**

Figure 3.7 on page 46 of INTERA (2012c) shows all of the injection wells, which provide mountain front recharge, labeled as specified flux into aquifer. All other wells are extraction wells.

30. **Appendix B, Table B.1. Layer 6 is labeled as Mancos, but it appears to also be the Gallup. Is the information for Layer 6 a typo? It looks like the Mancos is mostly in layer 7 and half in Layer 6.**

There are some typographical errors in Tables 4.1 and B.1 of the INTERA (2011) report. Table 4.1 on page 60 of INTERA (2012c) and Table B.1 (Appendix B in INTERA, 2012c) have been revised.

31. **Appendix B, Figures B.X. – if there is not a color represented, but it is within the model domain boundary, does that mean it is an area of no flow boundaries?**

The OSE is correct. Where there is no color represented in Figure B.X, it is an area in the model domain which is inactive (i.e., a no flow boundary).

32. **Appendix B, Figures B.6 – B.10. What was the basis for defining the extent of Tmv, Tnv geologic units and how representative are those units of the intrusive rocks in the**

subsurface? When reviewing cross-sections shown on page 19, Figure 2.5a and page 20, Figure 2.5b, it suggests that the intrusive bodies may not be continuous in the subsurface area that was modeled as "Mt. Taylor volcanic rocks." Please provide more explanation for how the extent of the low permeability area was determined.

In brief, Mt. Taylor is part of a larger volcanic field that includes Mesa Chivato to the northeast and Grants Ridge to the southwest. Mesa Chivato is an area of hundreds of fissure vents through which lava erupted onto land. The vents are typically a few meters wide by many kilometers long (Kelley, 2008). Hundreds of basalt vents that are oriented both northeast and west-northwest are also present on the mesa (Kelley, 2008). These features were conduits or pipes that connected the deep lava source to the land surface and allowed lava to flow vertically through the intervening sedimentary rocks, including the Westwater, the Dakota, the Gallup, the Point Lookout, the Crevasse Canyon, and the Menefee. When the flows and eruptions ceased, the lava in the pipes and fissures solidified. Section 5 of the Addendum (INTERA, 2012b) provides additional information.

33. Appendix D, Table D.1. Why are certain wells shaded?

They are shaded to make it easier for readers to differentiate the wells in different aquifers.

34. Appendix D, Table D.1. For what time period does "maximum drawdown" represent? Does it vary depending on the well? If so, it would be helpful to see the timing of the maximum drawdown in addition to the value.

The maximum drawdown for Scenarios 3 and 4 does not vary by well, but it may vary by well for Scenario 2. For Scenario 2, the time for the maximum drawdown in the Gallup wells occurs in the first year of Roca Honda dewatering (page 85 of INTERA, 2012c). The time for the maximum drawdown in the Dakota wells occurs two years after the start of Roca Honda dewatering (page 85 of INTERA, 2012c). The time for the maximum drawdown in the Westwater wells occurs at these wells between 14 and 29 years after the start of Roca Honda dewatering (page 96 of INTERA, 2012c). For Scenarios 3 and 4, the time for the maximum drawdown is the end of the simulations (pages 108 and 112 in INTERA, 2012c).

35. Appendix D, Table D.1. It would be helpful to see the simulated (non net) drawdown data, and then in a separate table report the net drawdown, or the difference between the scenarios.

By definition, there are no head or drawdown data for the predictive simulations' results presented in Table D.1 in Appendix D because these simulations estimate future conditions. The RHR model predicts a groundwater level in each model cell at each time step for each scenario, not drawdown. Drawdown for Scenario 2 is computed as a separate step after groundwater levels have already been simulated for Scenarios 1 and 2. There is no drawdown for Scenario 1 because groundwater levels from Scenario 1 are the reference or baseline water levels used to compute drawdown for Scenario 2. Drawdown values for Scenario 2, including those shown in Table D.1, are calculated by subtracting the Scenario 2 water level for a cell at each time step from the Scenario 1 water level for the same cell and time step. Drawdown defined in this manner provides the most accurate representation of the changes in groundwater levels induced by RHR dewatering in aquifers that are now rebounding from historical mine dewatering. Defining drawdown as the difference between a future level and that at some arbitrary initial time will yield misleading results for these three aquifers because there is no clearly correct or "best" time for the continually increasing water levels in the three aquifers. Changing the choice of initial time will change the drawdown value. Defining drawdown relative to some initial time, for example, the start of the simulation, will lead to smaller drawdown values from RHR dewatering than using drawdown defined relative to Scenario 1 levels because levels are slowly but continually increasing in the aquifers overall, with or without RHR dewatering. Defining drawdown as the difference between Scenario 2 and 1 groundwater levels (or the difference between Scenario 4 and 3 levels) yields higher drawdown values that are unique and most accurately reflect the changes from RHR dewatering.

NOTE: The comments 36 to 49 are for the INTERA addendum (2012b).

36. Page 5, Section 1.3. The stated question to be addressed by the model is incomplete for OSE purposes in terms of evaluating the mine dewatering permit. In addition to impacts to local groundwater levels and springs, the OSE also needs to know impacts of the proposed mine dewatering on other water sources such as the San Juan River in order to determine whether water rights will be impaired and whether a plan of replacement is needed.

The results of the calculations of changes in groundwater discharge to each perennial river for the revised RHR groundwater model are described in the first two paragraphs of page 98 in INTERA (2012c). Text from the first paragraph of page 98 that describes the simulated changes to groundwater discharge into the San Juan River reads, *"Similarly, groundwater discharge to the San Juan River is estimated to show a negligibly small net gain of 91 ac-ft (0.05% of net discharge) during the first 13 years and 162 ac-ft (0.01% of net discharge) during the last 100 years."*

Calculated differences in groundwater discharge to each perennial river are summarized below in the following tables. The percentage differences below are summarized in the first paragraph of page 98 in INTERA (2012c).

Discharge to the San Juan River for Scenarios 1 and 2

Time Period	Volume (ac-ft)			
	Scenario 1 Net Flux	Scenario 2 Net Flux	Difference	Difference
During 2012 to 2026	165,241	165,332	-91	-0.06%
During 2026 to 2125	1,279,662	1,279,824	-162	-0.01%

Puerco River discharges to the Aquifers for Scenarios 1 and 2

Time Period	Volume (ac-ft)			
	Scenario 1 Net Flux	Scenario 2 Net Flux	Difference	Difference
During 2012 to 2026	3,467	3,410	57	1.66%
During 2026 to 2125	42,379	42,387	-8	-0.02%

Discharge to the Rio Puerco River for Scenarios 1 and 2

Time Period	Volume (ac-ft)			
	Scenario 1 Net Flux	Scenario 2 Net Flux	Difference	Difference
During 2012 to 2026	29,581	29,530	51	0.17%
During 2026 to 2125	227,329	227,236	93	0.04%

Discharge to the Rio San Jose River for Scenarios 1 and 2

Time Period	Volume (ac-ft)			
	Scenario 1 Net Flux	Scenario 2 Net Flux	Difference	Difference
During 2012 to 2026	2,677	2,679	-2	-0.07%
During 2026 to 2125	20,999	20,955	44	0.21%

37. Page 10, Section 2.0. In the second paragraph, there is a sentence that reads "The only difference in boundary conditions is that the Roca Honda mine model includes pumping that varies over time to represent historical mine dewatering, whereas the USGS model [Kernodle (1996)] focused only on steady flow (unchanging with time)." This is not the only difference in boundary conditions between the INTERA (2011) model and the Kernodle (1996) model.

OSE's statement is true; the driving forces are the same, but the parameterization of the driving forces is necessarily different because Kernodle's model (1996) is steady state and INTERA's model is transient. On page 10, lines 8-11 of the second paragraph of the Addendum's Section 2.0 (INTERA, 2012b), the text reads, *"The only difference in boundary conditions is that the Roca Honda mine model includes pumping that varies over time to represent historical mine dewatering, whereas the USGS model focused only on steady flow (unchanging with time)."* It should read, *"The difference in boundary conditions is that the Roca Honda mine model includes pumping that varies over time to represent historical mine dewatering, whereas the USGS model focused only on steady flow (unchanging with time). However, the driving forces for both models are the same, but the parameterization of the driving forces is necessarily different."* This change will be made in a subsequent revision to the Addendum.

38. Page 11, Section 2.1. In the first paragraph, there is a sentence that reads "At a GHB, either a groundwater level or a flux is specified." A flux is not specified at a general head boundary.

OSE's statement is true; at a GHB, only a groundwater head can be specified. The sentence referred to by the OSE should have read, *"At a GHB, a groundwater level is specified."* GHBs had been used to represent mountain-front recharge in the INTERA (2011) model. All GHBs have been replaced with specified flux boundary conditions in the revised RHR groundwater model. The use of specified flux boundary conditions for mountain-front recharge is described in the first paragraph of page 45 in INTERA (2012c).

39. Page 13, Section 2.1. How were the specified amounts and model locations for mountain-front recharge determined?

Mountain front recharge rates were determined based on the model calibration as constrained by the conceptual model and the original Kernodle (1996) model.

40. Page 13, Section 2.2. The term intermittent streams are described as "flow in some places along the stream course but not others." This is not the correct definition for intermittent. Stream flow descriptions must be time relative in order to distinguish between ephemeral, intermittent and perennial.

There are a number of definitions of intermittent streams. The simplest is one by Leopold and Miller (1956) in USGS Prof. Paper 282-A, which states, "An intermittent stream is one which, at low flow, dry reaches alternate with flowing ones along the stream reach." Low flow and dry reaches are not always time-relative, although they may be if hydraulic head in the aquifer that is feeding the stream is recharged by precipitation.

41. Page 14, Section 2.2. In the second paragraph on this page of Addendum, it says "River conductance, a parameter needed for the boundary condition, was calculated using the river dimensions in the grid block and a hydraulic conductivity value of 100 feet/day, which was the same value used by Kernodle (1996) in his USGS groundwater flow model for the San Juan Basin." However, Kernodle (1996) indicates on page 74 of his report when discussing the parameters used to simulate stream aquifer interaction that "The bed thickness for all streams was arbitrarily assumed to be 1 foot and the hydraulic conductivity of the bed material was assumed to be 20 feet per day."

OSE is correct. Kernodle (1996) used 20 feet/day for the hydraulic conductivity of the river bed material. The revised RHR groundwater model uses 20 feet/day for the hydraulic conductivity of the river bed material, as is described on the second paragraph of page 50 in INTERA (2012c).

42. Page 14, Section 2.2. OSE was unable to find where in the Kernodle (1996) report does it indicate that he used drains.

The OSE is correct; Kernodle (1996) did not use drains. Kernodle (1996, page 70) represented evaporation in areas of groundwater discharge using stream boundaries, which are head-dependent boundary conditions. Kernodle (1996) also used the same stream boundary condition to simulate the interactions between the perennial rivers and aquifers. INTERA decided to distinguish between the perennial streams and ephemeral drainages, which are important components of the overall basin water balance, using a different type of head-dependent boundary condition for each component. INTERA simulated perennial and intermittent river-aquifer interactions with the MODFLOW river package (a head-dependent boundary condition very similar to that used by Kernodle). INTERA simulated ephemeral drainages using the

MODFLOW drain package. The drain boundary condition is an appropriate way to simulate head-dependent outflows from a groundwater flow model. In this manner, INTERA was able to efficiently keep track of the contribution each component made to the water balance over time.

The fourth sentence of the last paragraph on page 34 in INTERA (2011) and INTERA (2012c) should be revised to read, *"The flow model simulated areal recharge as a boundary condition and surface water-groundwater interactions using the river boundary condition."* This change will be made in subsequent revisions of the groundwater model report.

43. Page 17, Section 2.3. The second paragraph on this page has a sentence that indicates a 14-year mining period. Should it read "13-year mining period"?

The mining period will be 13 years, not 14 years as stated on page 17 (INTERA, 2012b). Pages 6, 32, 98, 99, and 118 of INTERA (2102c) correctly state that the mining period is 13 years.

44. Page 17, Section 2.3. The fourth paragraph indicates that the Fracture Well Package "was used in the model to simulate pumping from the mine." Is the mine referred to the proposed Roca Honda mine? Is this correct?

The fracture well package is used to simulate the historical pumping from the historical mines, not the proposed RHR mine. This issue is addressed in INTERA (2012c), Section 3.5, page 45, lines 12-14, *"MODFLOW-SURFACT's Fracture Well Package was used to represent mine dewatering at the Ambrosia Lake sub-district mines, the Church Rock Mine, the Gulf Mt. Taylor Mine, and the Johnny M Mine in the 1930-2012 transient calibration model (Figure 3.9)."*

45. Page 21, Section 3.0. Table 3.1 indicates that there does not appear to be much data available to support the specific yield values used in the model.

The OSE is correct. Very limited data regarding specific yields are available for the area.

46. Pages 38-39, Section 5. RHR evaluated higher hydraulic conductivity values for volcanic core. What hydraulic conductivity values were used? Did these values correspond to appropriate Cretaceous and Jurassic rocks?

Table 4.1 "Calibrated Hydraulic Conductivity Values for Hydrostratigraphic Units" in INTERA (2011) includes hydraulic conductivity values for all rocks, including the Tertiary volcanics. The values used are discussed in Section 5.0 of the Addendum (INTERA 2012b) and the sensitivity analysis described in Section 5.1.3 of the INTERA (2011) report and in Section 5.1.4 of

INTERA (2012c). The Cretaceous and Jurassic rocks of the area are sedimentary. The sensitivity analysis included simulations in which the hydraulic conductivity of the Tertiary volcanics was increased to values 10, 100, and 1000 times larger. That is, the calibrated hydraulic conductivity of the Tertiary volcanics was 0.0001 feet/day, and the hydraulic conductivity values tested in the sensitivity analysis were 0.001, 0.01, and 0.1 feet/day. All of these values are commensurate with the range of hydraulic conductivity values expected for the Jurassic and Cretaceous sediments simulated in the RHR model (INTERA 2011, 2012c).

47. **Pages 44-45, Section 7.0. This section is titled the "Source of groundwater removed during Roca Honda dewatering and source of water during recovery of groundwater levels". However, the focus of the section appears to be only on inflows and outflows to the Westwater aquifer and not the entire model. A water balance of the entire model area would also be important to know, particularly since there is also pumping from the Gallup Sandstone and Dakota Sandstone. Furthermore, an additional calculation will be of interest to the OSE to assess the net annual impacts (the difference between regional pumping plus Roca Honda pumping and only regional pumping) of the Roca Honda Resources application on surface waters over time. Impacts on net flux to the San Juan River are of particular interest to OSE. In addition to Tables 7.1 and 7.2, mass plots through time of both Westwater and model-wide inflows and outflows are needed.**

The water balances for the Westwater, Dakota, and Gallup aquifers and for the entire model domain have been calculated for Scenarios 1 and 2 and are provided in Tables 5.2a-d, pages 100-101 of INTERA (2012c).

The OSE's comment regarding impact on the net flux to the San Juan River due to Roca Honda dewatering is addressed in INTERA's response to comment 36.

Plots of fluxes over time for both the Westwater aquifer and the entire model domain show the time-varying inflows and outflows. Figures that illustrate this are attached to this document and are labeled as Figures 47a-d.

48. **Pages 44-45, Section 7.0. The water balance information in the Addendum shows that because of the way that the Brushy Basin Member is simulated it is a major source of water to the Westwater aquifer in this model. Although Kernodle (1996) did not simulate the Brushy Basin Member separately, most of the confining units in that**

model were simulated using vertical conductance terms rather than as separate layers with storage properties that could contribute flow (Figure 36, p. 73). Was this difference in approach to simulating confining units evaluated to determine whether it could have a significant impact on results?

INTERA considers such an evaluation unnecessary. Leakage from the Brushy Basin aquitard under Scenario 1 for the first 13 years simulated is 46,649 ac-ft, whereas the leakage is only slightly greater for Scenario 2 with 48,226 ac-ft (Table 5.2a in INTERA, 2012c). The net increase in leakage from the Brushy Basin is only 1,600 ac-ft over 13 years, which is only 2% of total inflow to the Westwater (last bullet point on page 99 of INTERA, 2012c). The only major source of groundwater for RHR dewatering is the change in Westwater storage, approximately 97% of total inflow (first two bullet points on page 99 of INTERA, 2012c). Therefore, leakage from the Brushy Basin is a minor, not major, source of water for RHR dewatering.

The uncertainty in specifying the vertical conductance in the Brushy Basin is, in our professional judgment, much larger than the uncertainty in the Brushy Basin hydraulic conductivity or thickness. Vertical conductance is a thickness-averaged measure of the vertical hydraulic conductivity between two adjacent layers scaled by the cross-sectional area for flow. Thus, calibrating a model to vertical conductance requires several extra computational steps before re-running the simulation, whereas calibrating to actual hydraulic conductivity requires only changing the value and running the simulation. Kernodle had no choice but to specify vertical conductance in his 1996 model given the version of MODFLOW he used. INTERA's approach allows for a more complete representation of aquifer-aquitard dynamics since the aquitard properties, including storage properties, are explicitly simulated.

49. Page 48, Section 8

a. The first sentence of the second paragraph indicates that the value of conductance used in the RHR model is 100 feet per day. It appears that this number is representing the hydraulic conductivity that was used as part of the conductance calculation (this is made clear later in the paragraph). (Also as noted in an earlier bullet, Kernodle (1996) based his conductance calculation on a streambed hydraulic conductivity of 20 ft/day).

INTERA agrees; please refer to INTERA's response to comment 41 for additional discussion.

b. Were changes to river boundary condition conductance, solver criteria and time stepping also explored in the steady state and historical simulations?

Yes. Use of the lower riverbed conductance has an insignificant effect on steady state and historical calibrations. Lower riverbed conductance results in lower river infiltration and groundwater discharge to the rivers. The flux rates are different for higher and lower riverbed conductance, but the net fluxes, i.e., river infiltration and groundwater discharge to the river cells under both conditions, are very similar. Changes in solver criteria and time stepping do not affect the steady state and historical simulations.

c. If changes to the river conductance (based on a hydraulic conductivity of 100 feet per day to 1 foot per day) produced less variability in mass balance error for all scenarios, how does using a river conductance based on a streambed hydraulic conductivity of 1 foot per day affect drawdown estimates for all scenarios? What are the calculated impacts to surface water for all scenarios?

The hydraulic conductivity used to compute river conductance was decreased from 100 feet/day to 20 feet/day in the revised RHR model (INTERA, 2012c) to match the value used in Kernodle (1996); also see INTERA's response to comment 48. The revised model was recalibrated to both predevelopment and transient conditions.

Drawdown estimates from the revised model show negligible to small changes (see Table 5.1 and Table D.1 in INTERA, 2012c) relative to the drawdown values estimated by the INTERA (2011) model after several significant changes to the model. Revisions made to the INTERA (2011) model include reducing the river conductance by 80%, decreasing the size of large cells with river boundary conditions, replacing general head boundary cells with specified flux cells, and increasing the hydraulic conductivity of aquifer units in the volcanic core areas by a thousand fold. INTERA concludes that reducing the river conductance from 100 feet/day to 20 feet/day had a negligible effect on drawdown estimates for all scenarios, and therefore reducing it further will not affect the drawdown estimates.

The revised model report (INTERA, 2012c) contains detailed descriptions of potential impacts to the perennial reach of the Rio San Jose, the Rio Puerco, the Puerco River, and the San Juan River (page 98 of INTERA, 2012c). Impacts are defined as changes in net groundwater discharge to river boundary condition cells. INTERA's response to comment 36 provides calculated tables of the net groundwater discharge to each river for Scenarios 1 and 2. As is discussed on page 98 of

INTERA (2012c) and in the response to comment 36, the RHR model, calibrated to a 20 feet/day hydraulic conductivity for river beds, predicts that RHR dewatering will have negligible impacts on discharge to rivers.

References

Chenoweth, 1989. Ambrosia Lake, New Mexico – A Giant Uranium District, *in:* Southeastern Colorado Plateau, NMGS Fortieth Annual Field Conference, September 28 – October 1, 1989, pages 297 to 302.

Craigg, S.D., Dam, W.L., Kernodle, J.M., and Levings, G.W. 1989. Hydrogeology of the Dakota Sandstone in the San Juan Structural Basin, New Mexico, Colorado, Arizona, and Utah. U.S. Geological Survey Hydrologic Investigations Atlas HA-720-I.

Dam, W.L., Kernodle, J.M., Levings, G.W., and Craigg, S.D., 1989. *Hydrogeology of the Morrison Formation in the San Juan Structural Basin, New Mexico, Colorado, Arizona, and Utah.* U.S. Geological Survey Hydrologic Investigations Atlas HA-720.

Hydroscience, 2009a. Historical Mine Dewatering Data Provided Through Personal Communication.

———. 2009b. Historical Pump Test Data Provided Through Personal Communication.

———. 2009c. Historical Water Levels Provided Through Personal Communication

INTERA Incorporated (INTERA), 2011. Assessment of Potential Groundwater Level Changes from Dewatering at the Proposed Roca Honda Mine, McKinley County, New Mexico. Prepared for Roca Honda Resources, LLC. November 4, 2011

———, 2012a. Assessment of Potential Groundwater Level Changes from Dewatering at the Proposed Roca Honda Mine, McKinley County, New Mexico. Prepared for Roca Honda Resources, LLC. November 4, 2011, Revised March 8, 2012.

———, 2012b. Addendum: Assessment of Potential Groundwater Level Changes from Dewatering at the Proposed Roca Honda Mine, McKinley County, New Mexico. Prepared for Roca Honda Resources, LLC. March 8.

———, 2012c. Assessment of Potential Groundwater Level Changes from Dewatering at the Proposed Roca Honda Mine, McKinley County, New Mexico. Prepared for Roca Honda Resources, LLC. November 4, 2011, Revised March 8 and August 7, 2012.

Kelley, S.A. 2008. Mt. Taylor Volcanic Field. New Mexico Bureau of Geology and Mineral Resources web page, last revised 12 November 2008. accessed 20 February 2012. http://geoinfo.nmt.edu/tour/landmarks/mt_taylor/home.html.

Kelly, T.E., R.L. Link, and M.R. Schipper, 1980. "Effects of Uranium Mining on Ground Water in Ambrosia Lake Area, New Mexico," in *Geology and Mineral Technology of the Grants Uranium Region 1979,* New Mexico Bureau of Mines and Mineral Resources Memoir 38, p. 313–319.

Kernodle, J. M., 1996. Hydrogeology and Steady-State Simulation of Ground-Water Flow in the San Juan Basin, New Mexico, Colorado, Arizona, and Utah. U.S. Geological Survey Water-Resources Investigations Report 95-4187.

Kernodle, J.M., Levings, G.W, Craigg, S.D., and Dam, W.L., 1989. *Hydrogeology of the Gallup Sandstone in the San Juan Structural Basin, New Mexico, Colorado, Arizona and Utah.* USGS Series Hydrologic Atlas Report Number 720-H, Originating Office USGS Library Call Number M(200) Hy 720-H.

Kirk, A.R., and Condon, S.M., 1986. Structural Control of Sedimentation Patterns and the Distribution of Uranium Deposits in the Westwater Canyon Member of the Morrison Formation, Northwestern New Mexico – A Subsurface Study, in A Basin Analysis Case Study: The Morrison Formation, Grants Uranium Region, New Mexico, American Association of Petroleum Geologists Studies in Geology No. 22, p. 105–143.

Leopold, L.B., and Miller, J.P., 1956. Ephemeral Streams – Hydraulic Factors and Their Relation to the Drainage Net. U.S. Geological Survey Professional Paper 282-A.

Lorenz, J.C., and Cooper, S.P., 2003. Tectonic Setting and Characteristics of Natural Fractures in Mesaverde and Dakota Reservoirs of the San Juan Basin, New Mexico Geology, v. 25, no. 1, p. 3–14.

Risser, D.W., 1983. Estimated Natural Streamflow in the Rio San Jose Upstream from the Pueblos of Acoma and Laguna, New Mexico. U.S. Geological Survey Water Resources Investigations 82-4096.

Santos, E.S., 1966a. Geologic Map of the San Mateo Quadrangle, McKinley and Valencia Counties, New Mexico, U.S. Geological Survey Map GQ-517, scale 1:24,000.

———, 1966b. Geologic Map of the San Lucas Dam Quadrangle, McKinley County, New Mexico, U.S. Geological Survey Map GQ-516, scale 1:24,000.

———, 1970. Stratigraphy of the Morrison Formation and Structure of the Ambrosia Lake District, New Mexico, U.S. Geological Survey Bulletin 1272-E.

Stone, W.J., Lyford, F.P., Frenzel, P.F., Mizell, N.H., and Padgett, E.T., 1983. Hydrogeology and Water Resources of the San Juan Basin, New Mexico. New Mexico Bureau of Mines and Mineral Resources Hydrologic Report 6.

INTERA created a table to summarize the items requested by OSE:

Item ID	Item Requested by NMOSE	INTERA response
A	A shapefile of the wells and information about nearby wells that is displayed in Figure 1.3 (or the Regional Groundwater Database referenced on the figure).	Figure 1.3 shows the wells near the RHR permit area. This figure is adapted from Figure A-1 in Section 9 of the BDR report. All data displayed in both figures can be found in the BDR.
B	Water-level data that were used for this project (e.g., data that were used to make water level contours, hydrographs, and that were calibration targets) and the source of the data. Where available, the data should include x, y coordinates for the wells that were used, the well depth, the aquifer the well is producing from, the date of the water level measurement, depth to water, and the land surface elevation. For the calibration targets, please indicate the model location (layer, row, column) that each target is located in.	The water level data were provided to OSE in March 2012 (see Hydroscience, 2009c).
C	Groundwater Vistas files for the models that INTERA developed and described in the report and temporary access to MODFLOW SURFACT.	The Groundwater Vistas files were provided to OSE in August 2012 with the revised model report.
D	A shapefile of the model grid, x, y coordinates of the origin of the model, and the map projection used to define the grid.	INTERA will provide this shapefile electronically.
E	Data and the source of those data that were used to define the top and bottom of each simulated geologic unit.	Refer to the top and bottom elevation properties for each layer in any of the Groundwater Vistas files.
F	x, y coordinates, aquifer well is producing from, model location (layer, row, column), and pumping rates for well pumping simulated in the model (for the historical period and for the future scenarios).	Refer to the MODFLOW WELL package or to the well boundary condition view in each of the Groundwater Vistas files.
G	A map showing the locations of all of the wells that would be affected by scenarios 2, 3, and 4 with information about the timing of the effects, and the amount of effect.	Refer to Figures 5-17, 5-18, and 5-19 attached to this memorandum.

Table 3.4
1930-2012 Transient Model Groundwater Withdrawals

	Groundwater Withdrawal (ft³/day)											
Stress Period	Ambrosia Lake Mining Area		Church Rock Mining Area		Johnny M Mine	Gulf Mt. Taylor Mine	Coal Mines	Crownpoint Water Supply			City of Gallup Water Supply	
	Kd	Jmw	Kd	Jmw	Jmw	Jmw	Kmf	Kg	Kd	Jmw	Kg	Jmw
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	1,500	1,500	30,000	192,500	0
3	166,347	1,942,154	0	0	0	0	0	1,500	1,500	30,000	192,500	0
4	99,316	1,189,055	60,000	600,000	0	80,000	24,000	1,500	1,500	30,000	192,500	0
5	78,525	994,347	60,000	600,000	152,000	589,520	24,000	1,500	1,500	30,000	438,900	61,600
6	67,027	897,100	60,000	600,000	0	866,240	24,000	1,500	1,500	30,000	438,900	61,600
7	0	0	0	0	0	288,800	24,000	1,500	1,500	30,000	438,900	61,600
8	0	0	0	0	0	0	41,026	1,950	1,950	35,100	438,900	61,600
9	0	0	0	0	0	0	13,475	1,950	1,950	35,100	438,900	61,600
10	0	0	0	0	0	0	13,475	1,950	1,950	35,100	438,900	61,600
11	0	0	0	0	0	0	13,475	1,950	1,950	35,100	438,900	61,600

References:
* Ambrosia lake mining area: Stone et al. (1983)
* Church Rock mining area: Stone et al. (1983)
* Johnny M mining area: Hydroscience (2009a)
* Gulf Mt. Taylor mining area: Hydroscience (2009a)
*Crownpoint water supply and City of Gallup supply: Stone et al. (1983)
* Coal mines: data from meter records filed with OSE and 1/9/2004 Table 3 in OSE memo re Lee Ranch Coal Mine App. For Extension of Time RG-35275-Enlgd

Table 3.5
Groundwater Withdrawals for Scenarios 3 and 4

Water Right	Location	Permitted Diversion (ac-ft/yr)				
		Total	Kmf	Kg	Kd	Jmw
SJ-109-A et al.	18N 12W Section 1 19N 12W Sections 32 & 36	2,300	0	206	114	1,980
SJ-118	21N 9W Section 16	625	0	0	0	625
SJ-949, SJ-949-S	21N 9W Sections 3 & 4	1,000	1,000	0	0	0
SJ-120	16N 10W Section 2	650	0	650	0	0
G-87, G-88, G-89	16N 20W Sections 5 & 17 17N 20W Section 29	2,425	0	2,425	0	0
G-11 (UNC right)	17N 16W Section 35	794	0	0	0	794
G-11-A (HRI)	16N 16W Sections 8 & 17	650	0	0	0	650
G-14	15N 9W Sections 3, 4, 9, 10	200	0	200	0	0
B-993	14N 9W Sections 35, 36, 22, 24 14N 10W Sections 17, 19, 30, 33, 35, 36	4,735	0	0	0	4,735
B-994	14N 9W Sections 30, 33, 17, 19, 22, 24 14N 10W Sections 17, 19, 30, 33, 35, 36, 24	5,227	0	0	0	5,227
B-375	14N 9W Section 28	93.55	0	0	0	93.55
B-376	14N 9W Section 28	371	0	0	0	371
B-516 (Gulf Mt. Taylor)	13N 8W Section 24	640	0	0	0	640
B-1442	13N 8W Section 23	305.6	0	305.6	0	0
B-1085	13N 8W Section 22	16	16	0	0	0
B-0428S	13N 8W Section 26	26	26	0	0	0

Legend

- Simulated Groundwater Level (ft amsl)
- Historical Groundwater Level (ft amsl)
- Roca Honda Permit Area
- Model Domain
- State Boundary
- County Boundary

0 11 22 44

Miles

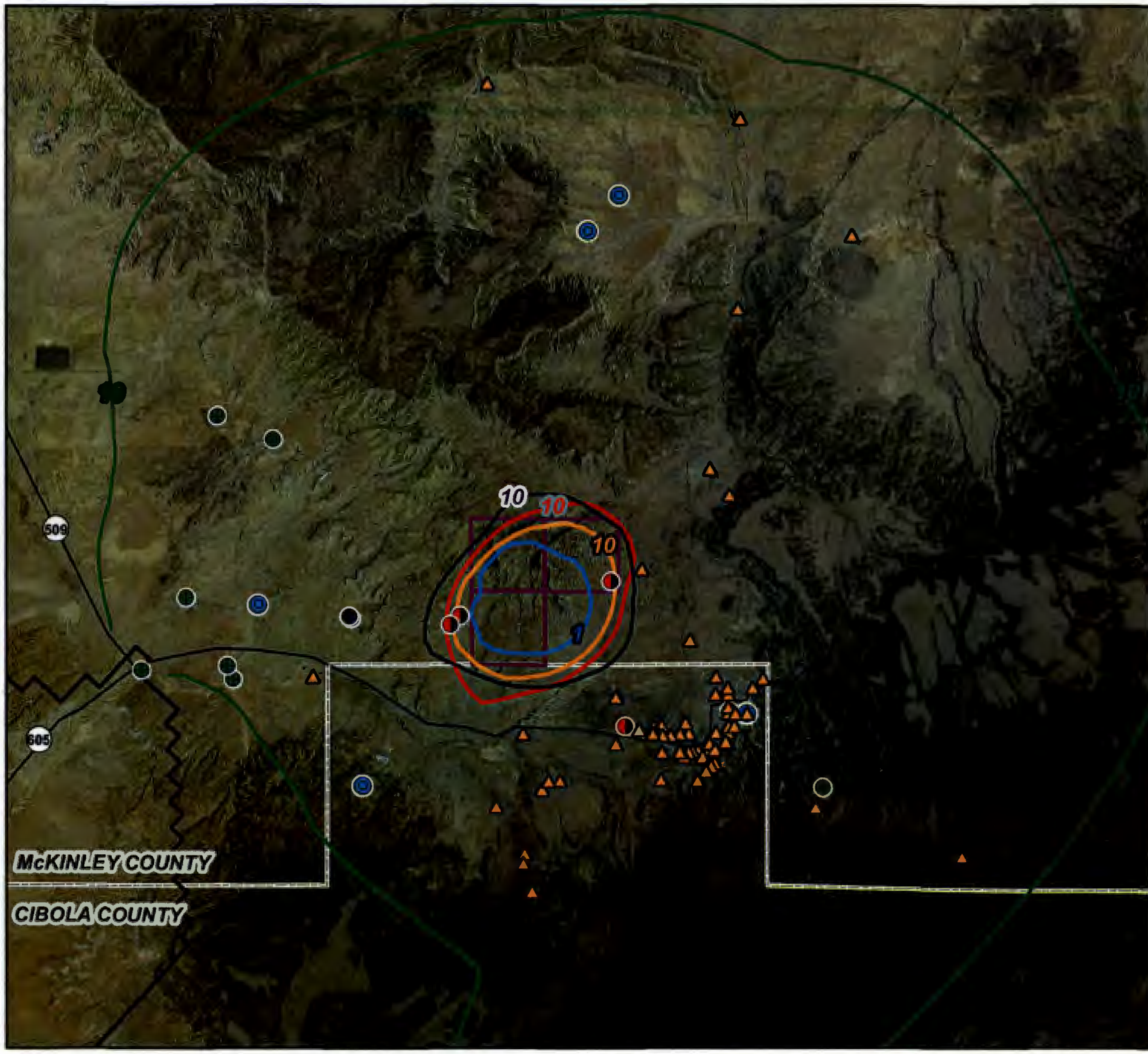
N

Historical and Simulated Predevelopment Groundwater Levels in Westwater Aquifer

INTERA

Figure 4.3

File: S:\Projects\STR-001_Strathmore_Modeling\GIS\Mapdocuments\FinalModelReport_201207\Chapter4\Figure04_03_PreDevWestwater.mxd 8/22/2012

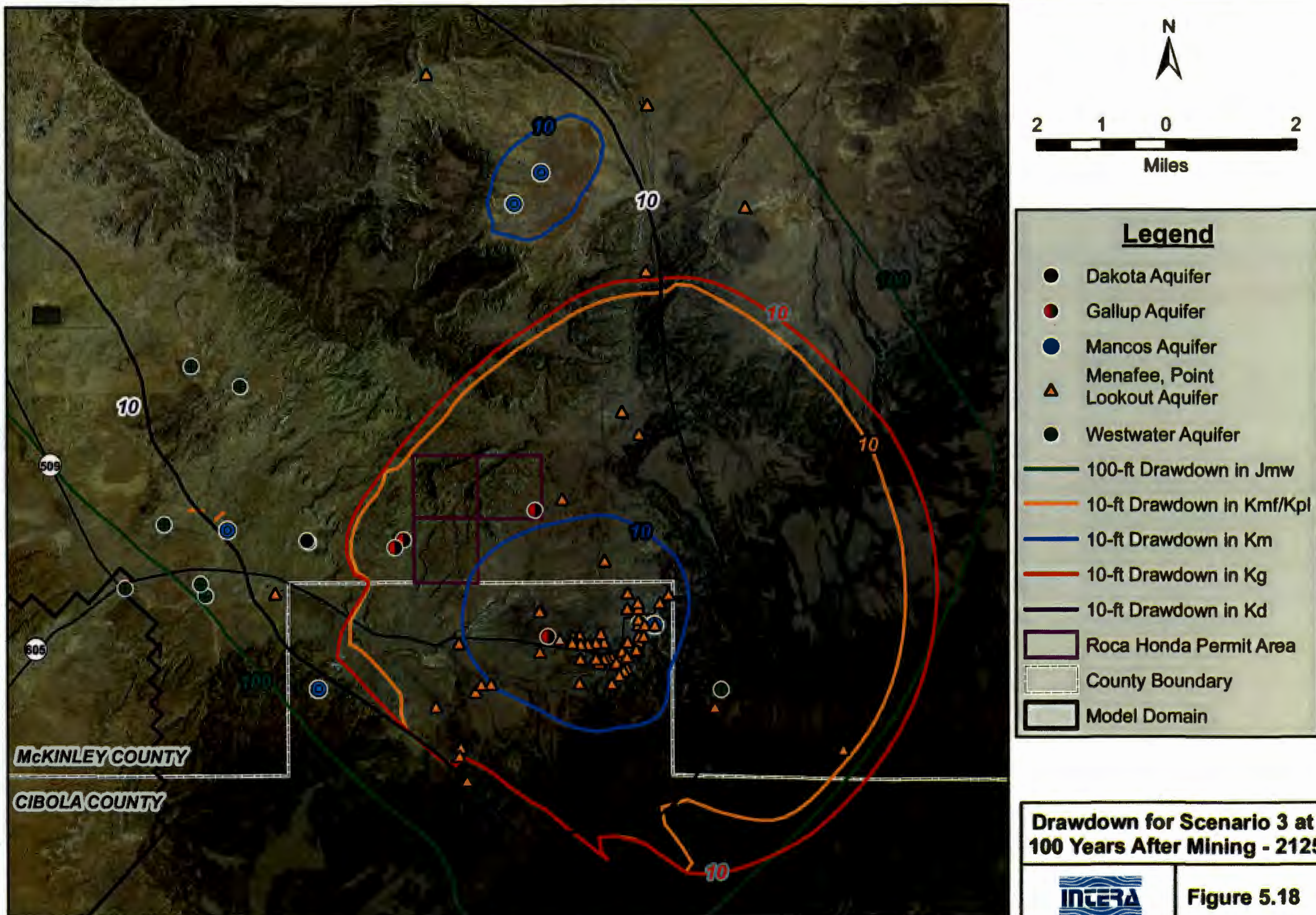


Drawdown for Scenario 2 at End of Mining - 2025

INTERA

Figure 5.17

File: S:\Projects\STR-001_Strathmore_Modeling\GIS\Mapdocuments\FinalModelReport_201207\Chapter5\Figure05_17.mxd 8/10/2012

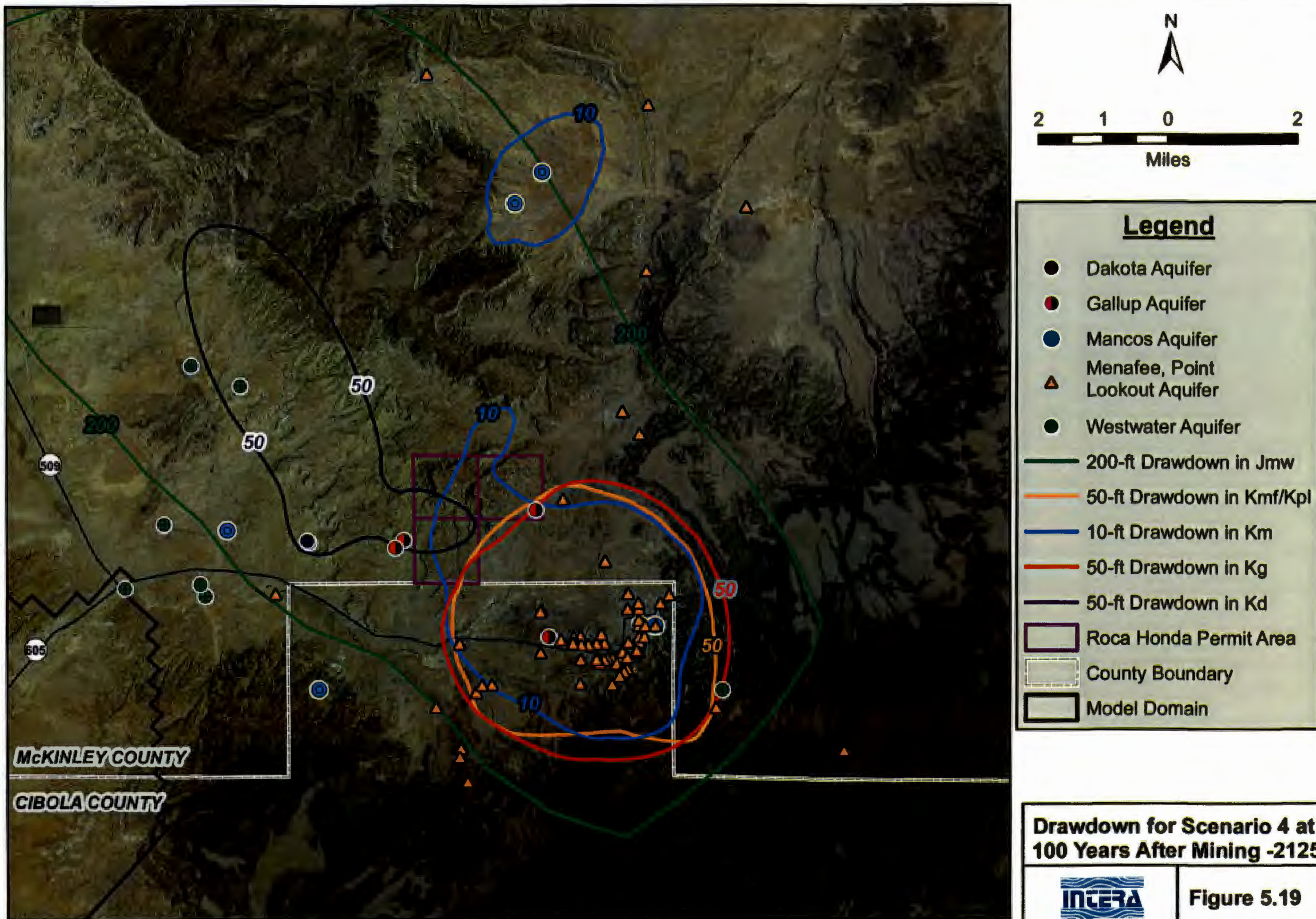


Drawdown for Scenario 3 at 100 Years After Mining - 2125

INTERA

Figure 5.18

File: S:\Projects\STR-001_Strathmore_Modeling\GIS\Mapdocuments\FinalModelReport_201207\Chapter5\Figure05_18.mxd 8/10/2012



Drawdown for Scenario 4 at 100 Years After Mining -2125

INTERA

Figure 5.19

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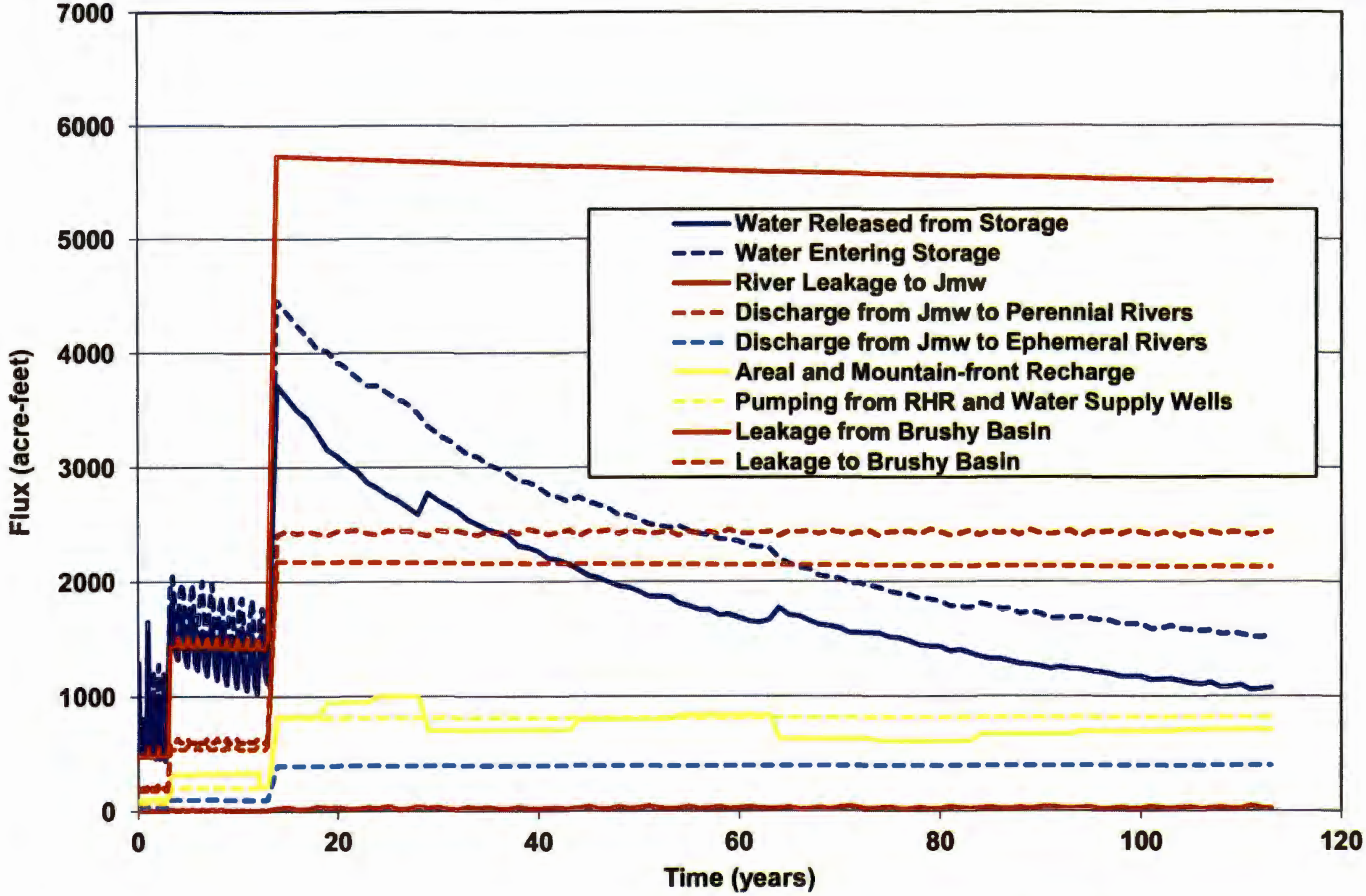
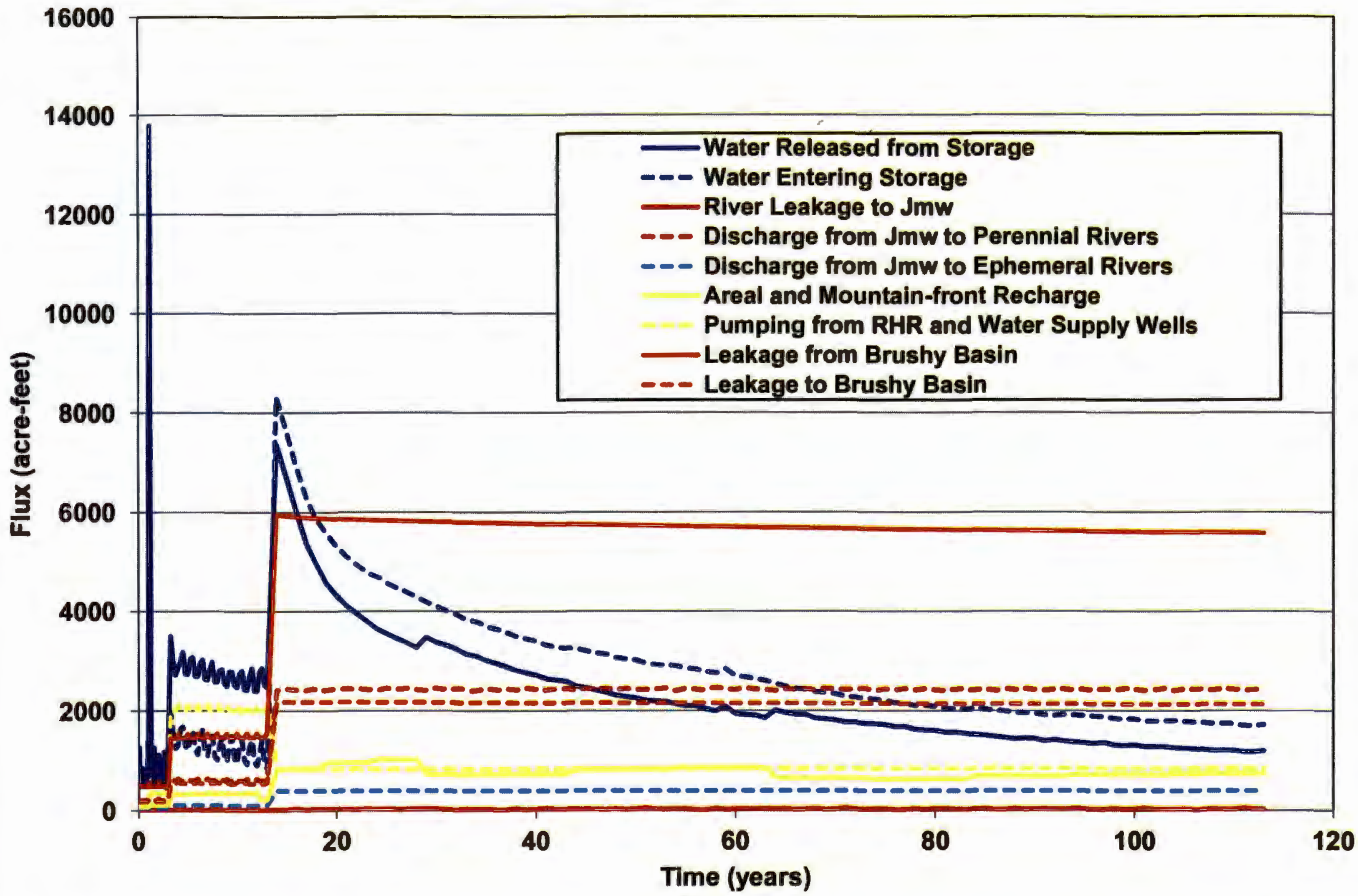
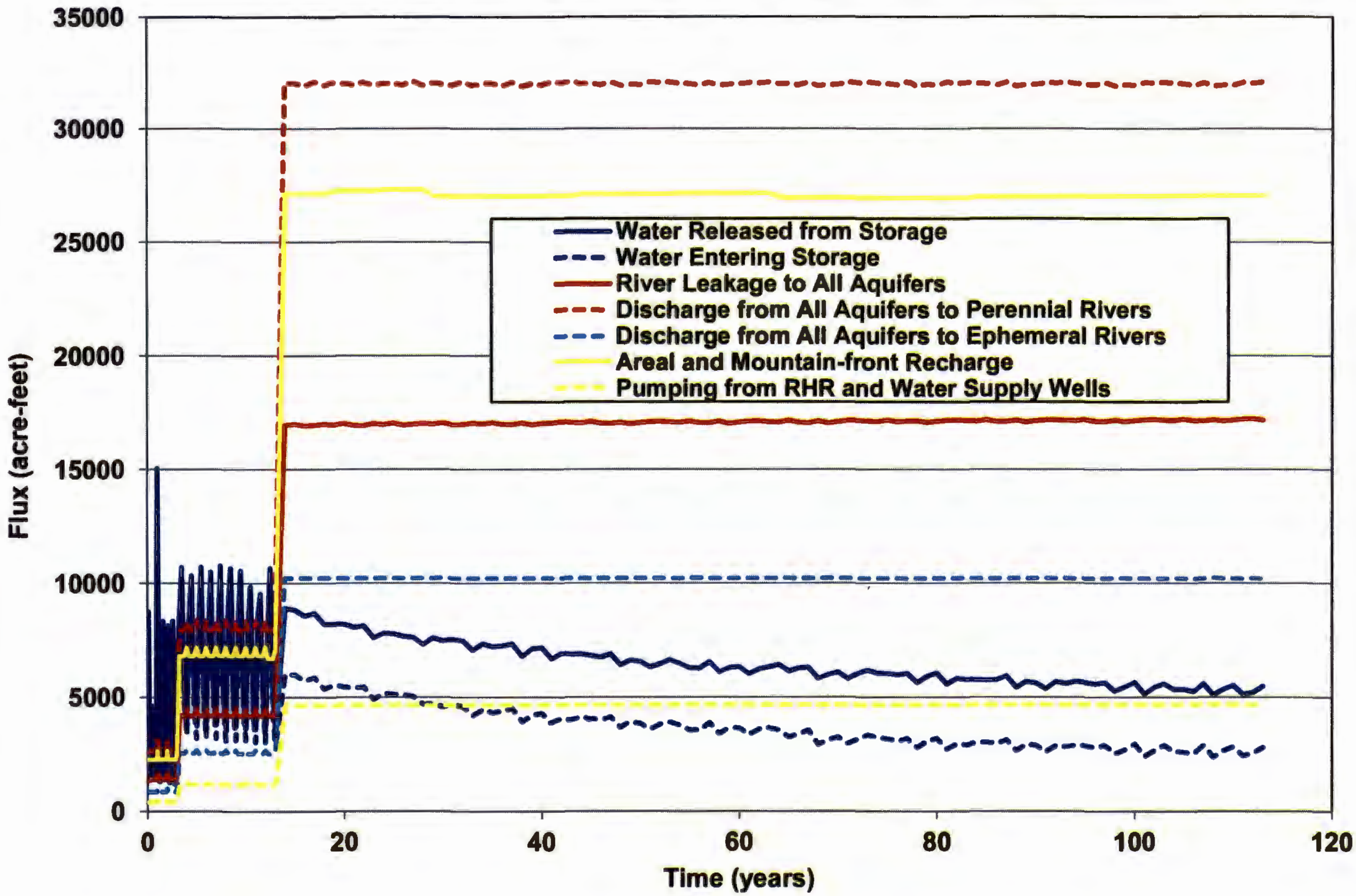


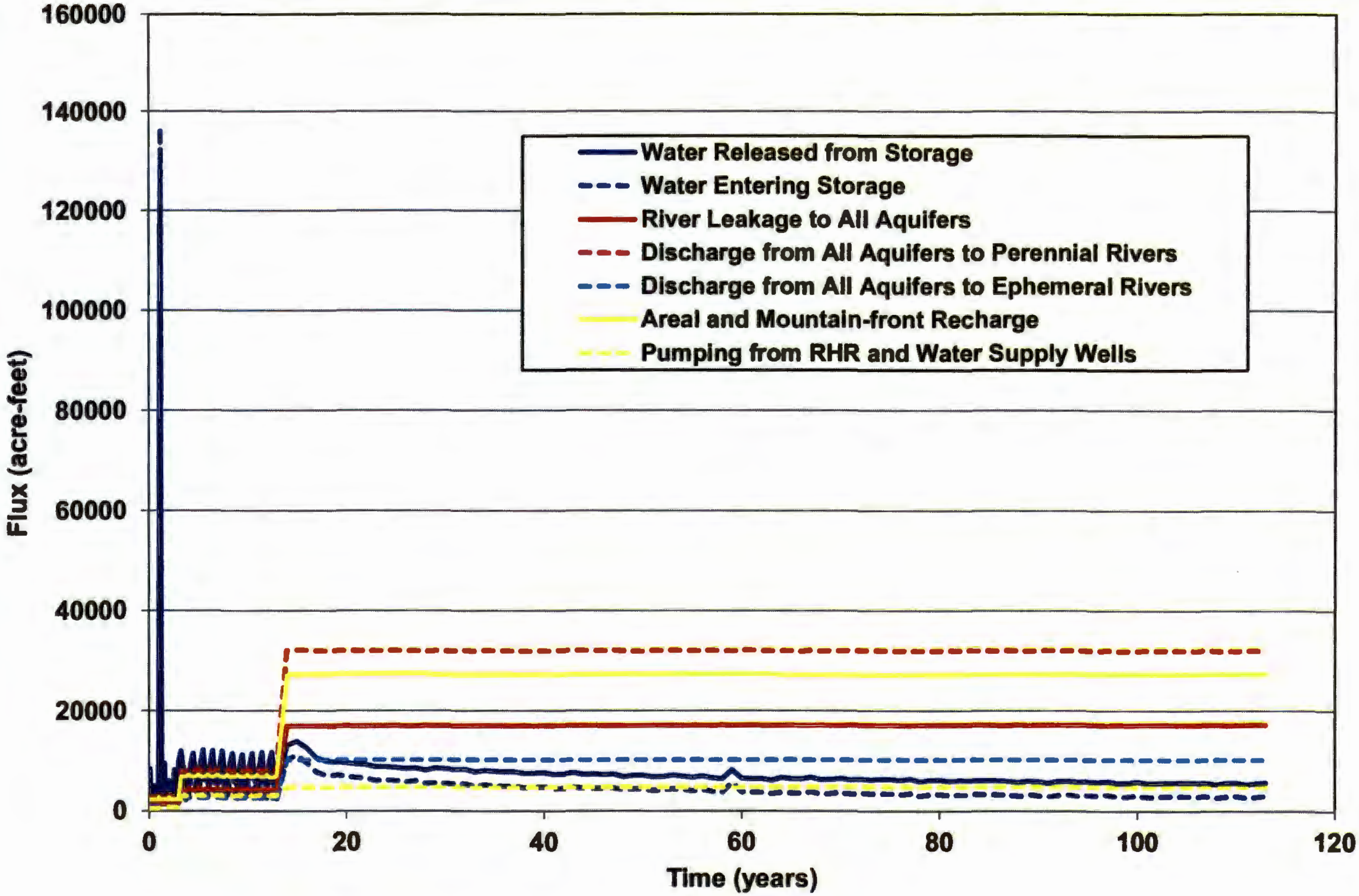
Inflows and Outflows in the Westwater Aquifer for Scenario 1	INTERA	Figure 47a



Inflows and Outflows in the Westwater Aquifer for Scenario 2	INTERA	Figure 47b



Inflows and Outflows of the Whole Model Domain for Scenario 1	INTERA	Figure 47c



Inflows and Outflows of the Whole Model Domain for Scenario 2	INTERA	Figure 47d

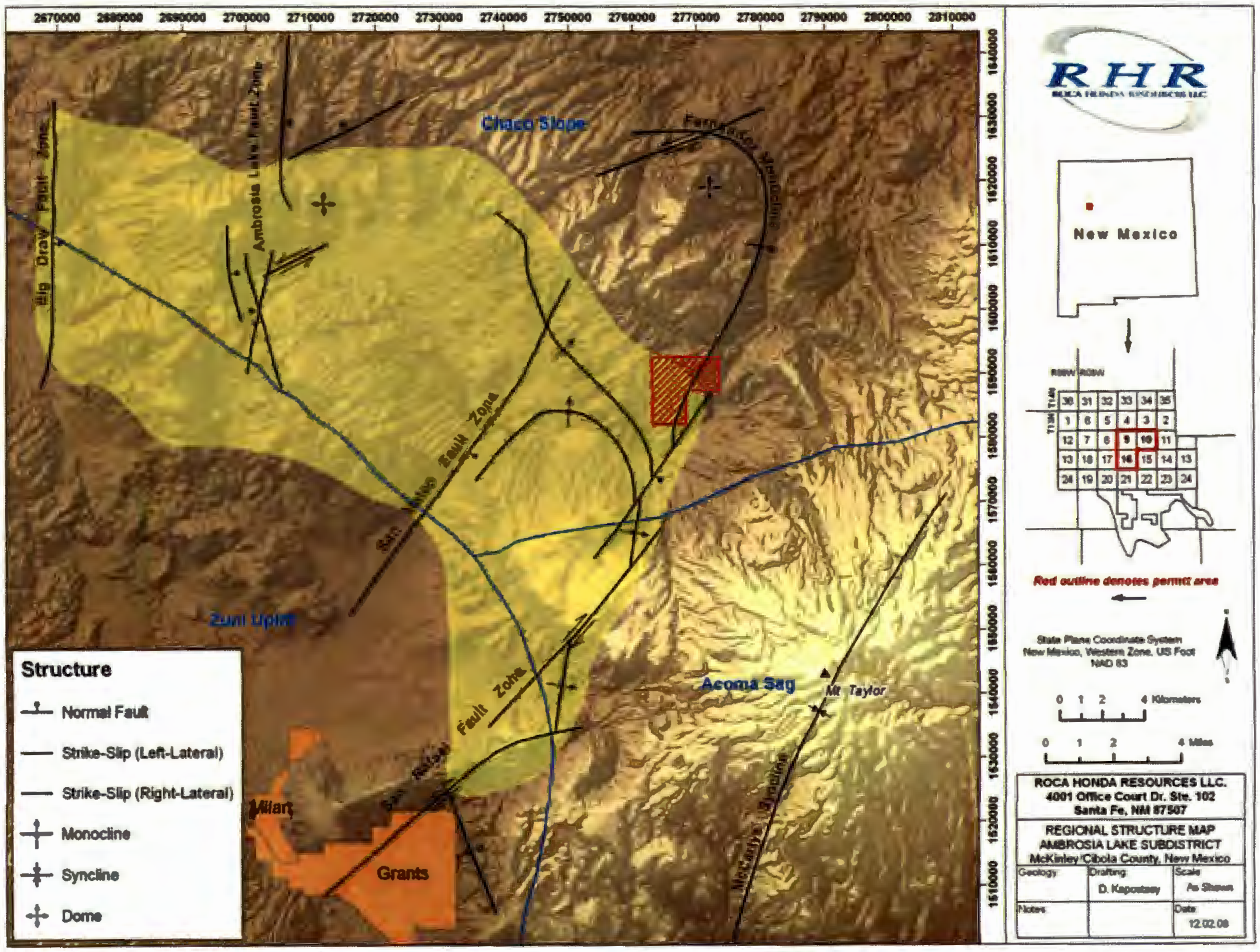


Figure 7-2. Regional Structural Features

Table D.1. Potential changes in groundwater levels at wells with water supply uses.

BDR Well ID	NAD 1983 UTM 13N Easting (m)	NAD 1983 UTM 13N Northing (m)	Well Location in Model Row	Well Location in Model Column	Well Location in Model Layer	Depth of Well (ft)	Well Elevation (ft)	OSE File No.	Use	Aquifer	Scenario 2 Maximum Drawdown (ft)	Scenario 3 Maximum Drawdown (ft)	Scenario 4 Maximum Drawdown (ft)	Difference between Scenarios 3 and 4 (ft)
73	260350	3913856	75	125	10	3535	7300	B-00516	MIN	Jmw	257.9	255.1	372.8	117.7
143	252142	3916113	100	93	10	940	7010	B-1778	DOM	Jmw	190.8	208.1	242.6	34.5
1	262362	3912136.2	73	127	10	4207	8209			Jmw	151.0	174.6	210.9	36.3
137	250527	3920058	94	84	10	1553	7133	B-00993-S	MIN	Jmw	109.5	352.9	379.9	27.0
136	249310.1	3920610.5	96	80	10	1398	7077	B-00993	MIN	Jmw	65.2	422.1	450.4	28.3
119	249502.1	3914856	107	91	10	280	6867			Jmw	50.2	126.3	139.4	13.1
109	249372	3915145	107	90	10	303	6890	B-01104	DOM	Jmw	45.8	126.4	138.6	12.2
106	248512	3916669	106	86	10	390	6900	B-01190	STK	Qal/Jmw	44.8	137.2	149.1	12.0
111	247479	3915109	110	87	10	478	6847	B-01115	DOM	Jmw	27.5	63.0	67.0	3.9
17	252103	3916155	100	93	8	715	7041	B 01544	DOM	Kd	12.8	53.9	66.0	12.0
129	258241.4	3925189.3	55	89	8	830	7201			Kd	5.3	19.4	24.6	5.2
128	258241.4	3925189.3	55	89	7	1320	7201			Km	2.2	354.4	354.4	0.0
130	257531.2	3924423.1	55	89	7	1320	7247			Km	2.2	354.4	354.4	0.0
67	260736	3913769.8	73	126	7	2000	7352			Km	0.8	9.2	10.0	0.8
72	260727.7	3913778.1	73	126	7	2000	7349			Km	0.8	9.2	10.0	0.8
107	250096.7	3916461.4	103	89	7	155	6942			Km	0.2	113.2	113.2	0.0
101	252287	3912456	107	109	7		7267	B-00997	MUL	Km	0.1	115.4	115.4	0.0
10	254510.3	3916097.2	94	100	6		7174			Kg	53.4	29.8	54.3	24.5
146	257834	3916765	71	118	6	1420	7170	B1786 Exp	EXP	Kg	54.0	49.2	54.4	5.2
16	254295	3915909	96	100	6	320	7152	B 01084	STK	Kg	27.8	30.8	32.8	2.0
32	258063	3913591	91	124	6	1150	7123	B 01442 EXP L-2	EXP	Kg	4.8	454.4	454.9	0.4
7	258514.1	3917001.6	65	120	5	192.3	7198			Kmf	9.4	64.6	65.1	0.5
19	255825	3913453	99	121	5		7037	B 00557	PUB	Qal	8.3	49.1	49.8	0.8
20	257901.8	3914231.9	89	123	5	157.3	7103			Kmf	7.6	229.6	230.2	0.5
22	257866	3914204	89	123	5	476	7103	B 01085	IRR	Kpl	7.6	229.6	230.2	0.5
33	258355	3913491	90	124	5	68	7152	B 00544	SAN	Qal	4.0	250.6	251.0	0.4
25	257845	3913200	93	124	5	620	7136	B 01442	EXP	Kpl	3.7	222.3	222.7	0.4
8	259531.5	3915409.5	69	124	5		7185			Kmf	3.3	99.8	100.2	0.4
9	259531.5	3915409.5	69	124	5	200	7185			Kmf	3.3	99.8	100.2	0.4
4	260080.1	3919137.6	58	118	5	400	7162			Kmf	2.4	27.7	28.0	0.3
99	256604	3912429	99	124	5	300	7080	RG-43456	STK	Kmf	1.8	113.0	113.4	0.5
5	260480.2	3918556.4	58	121	5	394	7231	RG 33107 EXPL	EXP/DOM	Kmf, Kpl	2.1	35.9	36.2	0.3
37	259448	3913362	85	125	5		7247	B 00736	DOM	Qal	1.8	236.0	236.3	0.3
38	259448	3913362	85	125	5	80	7247	B 00737	DOM	Qal	1.8	236.0	236.3	0.3
75	259881.5	3912990	84	125	5	150	7303			Kmf	1.8	240.4	240.7	0.3
29	259385.7	3913592	83	125	5	100	7224			Qal	1.8	249.8	250.1	0.3
56	259898.1	3913126.6	83	125	5	200	7297			Kmf	1.8	249.8	250.1	0.3
57	259898.1	3913128.6	83	125	5	140	7297			Kmf	1.8	249.8	250.1	0.3
61	259898.1	3913131	83	125	5	120	7297			Kmf	1.8	249.8	250.1	0.3
62	259898.1	3913131	83	125	5	200	7297			Kmf	1.8	249.8	250.1	0.3
35	259248	3913362	86	125	5	73	7224	B 00734	DOM	Qal	1.8	235.8	236.1	0.3
36	259248	3913362	86	125	5	65	7224	B 00735	DOM	Qal	1.8	235.8	236.1	0.3
79	259632.6	3912981.7	86	125	5	21	7287			Qal	1.8	235.8	236.1	0.3
85	259733	3912847	86	125	5	230	7300	B-00906	DOM	Kmf,Qal	1.8	235.8	236.1	0.3
28	258857.4	3913552.2	87	125	5	79	7178			Qal	1.8	239.7	240.0	0.3
92	259508.2	3912990	87	125	5	57.5	7277			Kmf	1.8	239.7	240.0	0.3
63	260039.1	3913371.6	81	125	5	500	7280			Kmf	1.9	200.3	200.6	0.3
31	259048.8	3913331.9	88	125	5	92	7205			Kmf	1.8	248.6	248.9	0.3

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Table D.1. Potential changes in groundwater levels at wells with water supply uses.

BDR Well ID	NAD 1983 UTM 13N Easting (m)	Northing (m)	Well Location in Model Row	Column	Layer	Depth of Well (ft)	Well Elevation (ft)	OSE File No.	Use	Aquifer	Scenario 2 Maximum Drawdown (ft)	Scenario 3 Maximum Drawdown (ft)	Scenario 4 Maximum Drawdown (ft)	Difference between Scenarios 3 and 4 (ft)
96	259431	3912957	88	125	5	80	7274	B-00738	DOM	Qal	1.8	248.6	248.9	0.3
58	260321.2	3913363.3	79	125	5	250	7316			Kmf	1.9	167.6	167.9	0.3
64	260312.9	3913363.3	79	125	5	250	7316			Kmf	1.9	167.6	167.9	0.3
65	260312.9	3913363.3	79	125	5		7316			Kmf	1.9	167.6	167.9	0.3
26	258686.9	3913537.5	89	125	5		7172			Kmf	1.7	269.3	269.6	0.3
27	258686.9	3913396.5	89	125	5	305	7175			Kmf	1.7	269.3	269.6	0.3
30	258867.2	3913340.1	89	125	5		7185			Qal	1.7	269.3	269.6	0.3
90	259251	3913006.6	89	125	5	336	7254			Kpl	1.7	269.3	269.6	0.3
91	259251	3913006.6	89	125	5	200	7254			Kmf	1.7	269.3	269.6	0.3
93	259231	3912957	89	125	5	703	7251	B-00428 S	MDW	Kpl	1.7	269.3	269.6	0.3
94	259332	3912858	89	125	5	185	7270	B-01185	DOM	Kmf	1.7	269.3	269.6	0.3
95	259231	3912957	89	125	5	707	7251	B-00385	EXP	Kpl	1.7	269.3	269.6	0.3
54	260321.2	3913496	78	125	5	prob.60	7310			Qal	1.8	156.8	157.0	0.3
34	258652	3913380	90	125	5	300	7175	B 00815	DOM	Kmf	1.7	270.3	270.6	0.3
53	260321.2	3913786.4	76	125	5	44	7303			Qal	1.8	139.3	139.6	0.3
55	260321.2	3913786.4	76	125	5	prob.60	7303			Qal	1.8	139.3	139.6	0.3
88	258846.4	3912971	91	125	5	40	7215			Kmf,Qal	1.6	221.2	221.5	0.3
89	258848.9	3912971	91	125	5	180	7215			Kmf	1.6	221.2	221.5	0.3
45	260329.5	3913919.1	75	125	5	160	7290			Kmf	1.8	132.5	132.8	0.3
46	260329.5	3913919.1	75	125	5	160	7290			Kmf	1.8	132.5	132.8	0.3
69	260478.8	3913769.8	75	125	5	32.5	7326			Qal	1.8	132.5	132.8	0.3
41	260055.7	3914201.1	74	125	5	285	7257			Kmf	1.8	127.0	127.3	0.3
42	260055.7	3914201.1	74	125	5	250	7257			Kmf	1.8	127.0	127.3	0.3
43	260329.5	3914201.1	73	125	5	60	7277			Qal	1.8	122.4	122.7	0.3
44	260329.5	3914201.1	73	125	5	65	7277			Qal	1.8	122.4	122.7	0.3
39	260072.3	3914591.1	72	125	5	63	7257			Kmf	1.8	118.8	119.1	0.3
40	260329.5	3914333.9	72	125	5	65	7274			Qal	1.8	118.8	119.1	0.3
97	258812	3912368	93	125	5		7261		STK	Kmf	1.5	157.4	157.6	0.3
48	260877	3914317.3	68	125	5		7323			Kmf	1.7	100.5	100.8	0.3
23	256194	3912240	100	124	5	32	7070	B 00415 O-3	DOM	Qal	1.1	66.5	66.9	0.4
24	256194	3912240	100	124	5	32	7070	B 00415 O-3	DOM	Qal	1.1	66.5	66.9	0.4
98	256355.8	3912417.6	100	124	5		7070			Kmf	1.1	66.5	66.9	0.4
47	261109.5	3914516.1	65	125	5	245	7425	B 01429	DOM	Kmf	1.6	81.2	81.4	0.3
66	260736	3913769.8	73	126	5	800	7352			Kpl	0.6	67.2	67.4	0.2
68	260736	3913769.8	73	126	5		7352			Kpl	0.6	67.2	67.4	0.2
70	260453.9	3913496	77	126	5	47.5	7326			Qal	0.6	77.4	77.6	0.2
59	260304.6	3913122.7	80	126	5	46	7362			Qal	0.6	88.8	88.9	0.2
60	260304.6	3913122.7	80	126	5		7362			Qal	0.6	88.8	88.9	0.2
74	260251	3913154	81	126	5	520	7349	B-00524	DOM	Kpl?	0.6	92.6	92.8	0.2
83	260006	3912990	84	126	5		7313			Kpl	0.5	97.2	97.4	0.2
76	259889.8	3912699.6	86	126	5	120	7339			Kmf,Qal	0.5	101.3	101.5	0.2
77	259889.8	3912699.6	86	126	5	250	7339			Kmf	0.5	101.3	101.5	0.2
78	259889.8	3912699.6	86	126	5		7339			Kpl	0.5	101.3	101.5	0.2
80	259881.5	3912699.6	86	126	5	35	7339			Kmf	0.5	101.3	101.5	0.2
81	259881.5	3912699.6	86	126	5		7339			Kmf	0.5	101.3	101.5	0.2
82	259997.7	3912716.2	86	126	5	325	7392	B-00428	MDW	Kpl,Kmf	0.5	101.3	101.5	0.2
131	260782.9	3922629.1	55	101	5	50	7021			Qal	0.5	8.7	8.8	0.2
132	260782.9	3922629.1	55	101	5	230	7021			Kpl	0.5	8.7	8.8	0.2

Table D.1. Potential changes in groundwater levels at wells with water supply uses.

	NAD 1983 UTM 13N		Well Location in Model											
BDR Well ID	Easting (m)	Northing (m)	Row	Column	Layer	Depth of Well (ft)	Well Elevation (ft)	OSE File No.	Use	Aquifer	Scenario 2 Maximum Drawdown (ft)	Scenario 3 Maximum Drawdown (ft)	Scenario 4 Maximum Drawdown (ft)	Difference between Scenarios 3 and 4 (ft)
133	260782.9	3922629.1	55	101	5	260	7021			Kmf	0.5	8.7	8.8	0.2
84	259920	3912641	87	126	5	420	7349	B-00839	STK	Kmf	0.5	103.8	103.9	0.2
87	259818	3912539	88	126	5	210	7402	B-00829	DOM	Kmf,Qal	0.4	98.3	98.5	0.2
100	255202	3911899	103	123	5	210	7070	B-01086	STK	Kmf	0.6	22.3	22.7	0.4
86	259618	3912339	90	126	5		7333	B-00729	STK	Kmf	0.4	84.3	84.4	0.2
102	255740.2	3910867.1	104	124	5	600	7169			Kpl	0.3	15.1	15.4	0.3
103	255791.7	3910857.9	104	124	5	500	7169			Kpl	0.3	15.1	15.4	0.3
104	255750	3910641	104	124	5	320	7192	RG-43457	DOM	Kmf	0.3	15.1	15.4	0.3
123	263316.3	3924150	54	107	5		6913			Kpl	0.2	9.8	9.9	0.1
105	255937	3910028	105	125	5		7402	B-01046	PUB	Tb	0.5	11.0	11.4	0.4
120	251266.1	3914846.1	104	94	5	80	6913		STK	Qal	0.1	0.2	0.4	0.1
121	251266.1	3914846.1	104	94	5	80	6913		EXP	Qal	0.1	0.2	0.4	0.1
2	262181	3911688.6	78	127	5	>1980	8304				0.2	22.8	22.9	0.1
127	260941.7	3926787.1	53	91	5		6972			Kmf,Kpu	0.0	4.9	5.0	0.0
3	265362.3	3910526.5	65	128	5	~1500	8520				0.0	2.3	2.3	0.0
124	255438.2	3927730.8	55	79	5		7133			Kcda	0.0	0.1	0.1	0.0
126	255438.2	3927730.8	55	79	5		7133			Kcda	0.0	0.1	0.1	0.0

Note:

Use: DOM-Domestic; EXP-Exploration; IRR-Irrigation; MDW-Community type use; MIN-Mining; MUL-Multiple domestic households; PUB-Public supply; SAN-Sanitary in conjuction with a commercial use; STK-Livestock watering.

Aquifer: Jmw-Westwater Canyon Member; Kcda-Dalton Sandstone Member of the Crevasse Canyon Formation; Kd-Dakota aquifer; Kg-Gallup aquifer; Km-Mancos Shale; Kmf-Menefee Formation; Kpl-Point Lookout Sandstone; Kpu-Upper Point Lookout Sandstone; Qal-Quaternary alluvium; Tb-Basalt and andesite flows.

Depth of Well: "prob.60" indicates probably 60 ft; ">1980" indicates deeper than 1980 ft; "~1500" indicates about 1500 ft.

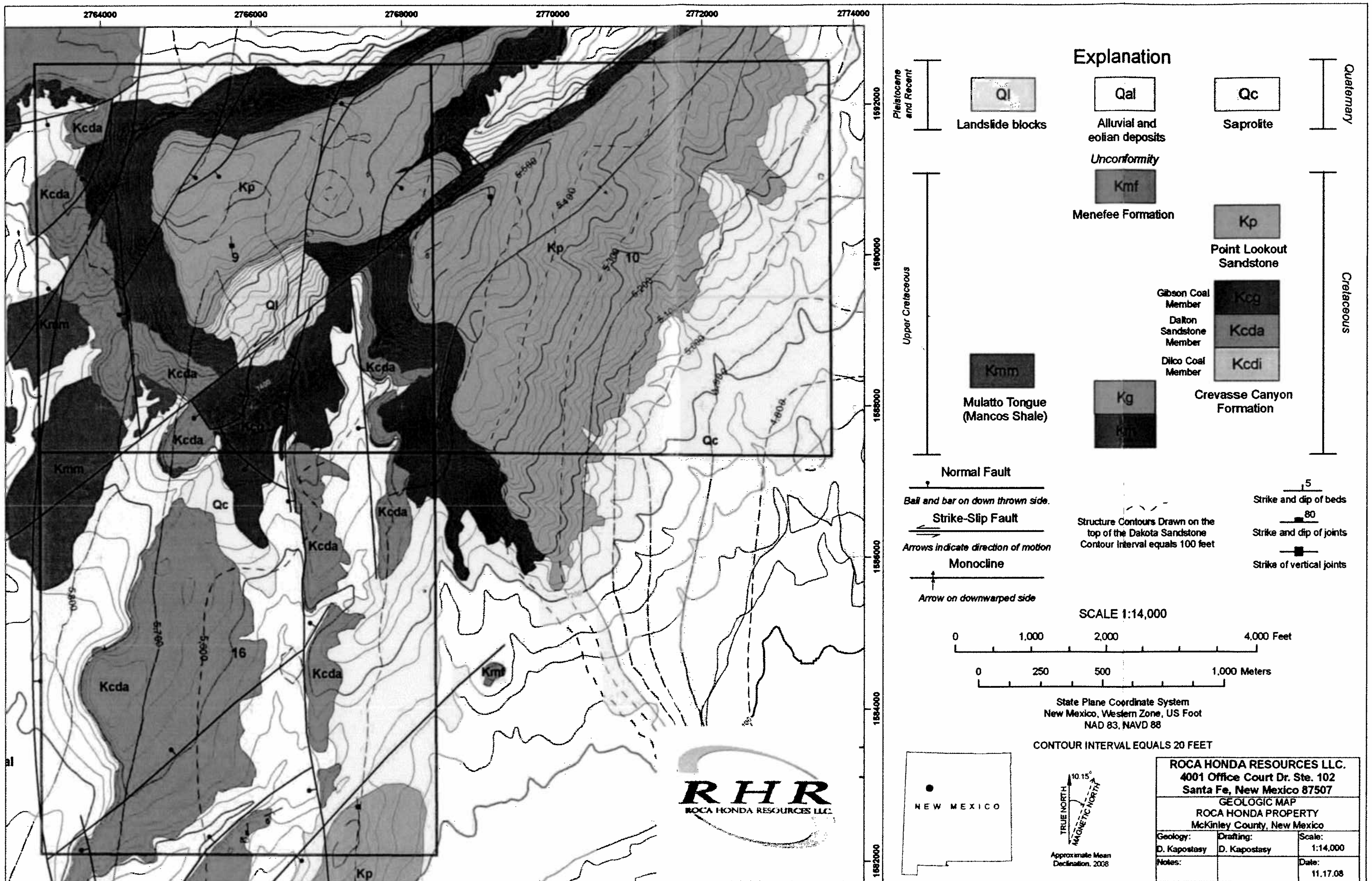
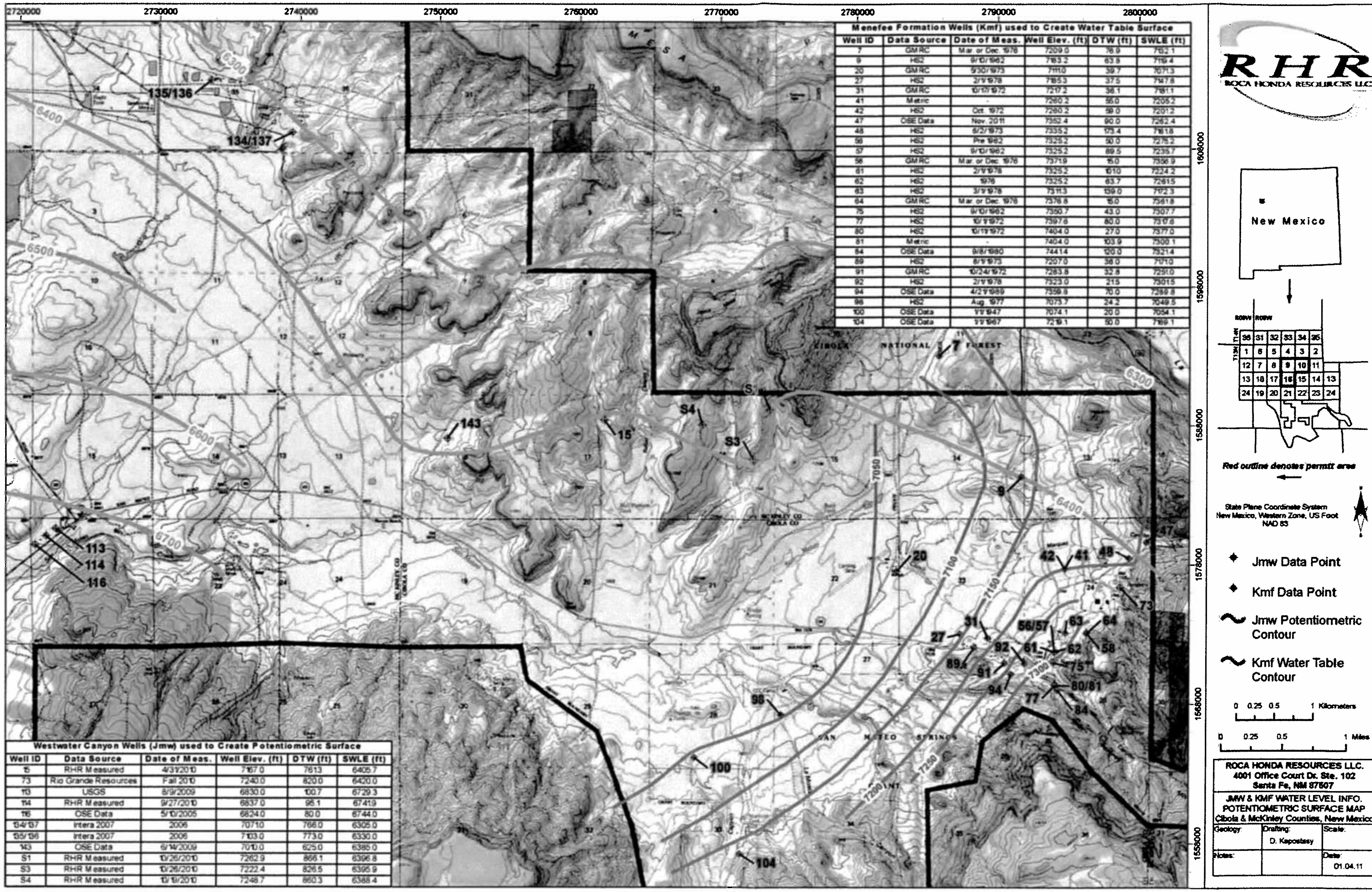


Figure 7-3. Geologic Map of the Roca Honda Permit Area



Menefee Formation Wells (Kmf) used to Create Water Table Surface

Well ID	Data Source	Date of Meas.	Well Elev. (ft)	DTW (ft)	SWLE (ft)
7	GMRC	Mar. or Dec. 1976	7209.0	78.9	7132.1
9	HS2	9/10/1962	7183.2	63.8	7119.4
20	GMRC	5/30/1973	7111.0	39.7	7071.3
27	HS2	2/1/1978	7185.3	37.5	7147.8
31	GMRC	10/17/1972	7217.2	36.1	7181.1
41	Metric	-	7260.2	55.0	7205.2
42	HS2	Oct. 1972	7260.2	59.0	7201.2
47	OSE Data	Nov. 2011	7352.4	90.0	7262.4
48	HS2	6/2/1973	7335.2	173.4	7161.8
56	HS2	Pre 1962	7325.2	50.0	7275.2
57	HS2	9/10/1962	7325.2	89.5	7235.7
58	GMRC	Mar. or Dec. 1976	7371.9	15.0	7356.9
61	HS2	2/1/1978	7325.2	101.0	7224.2
62	HS2	1976	7325.2	63.7	7261.5
63	HS2	3/1/1978	7311.3	139.0	7172.3
64	GMRC	Mar. or Dec. 1976	7376.8	15.0	7361.8
75	HS2	9/10/1962	7350.7	43.0	7307.7
77	HS2	10/1/1972	7397.6	80.0	7317.6
80	HS2	10/11/1972	7404.0	27.0	7377.0
81	Metric	-	7404.0	103.9	7300.1
84	OSE Data	9/8/1980	7441.4	120.0	7321.4
89	HS2	8/1/1973	7207.0	36.0	7171.0
91	GMRC	10/24/1972	7283.8	32.8	7251.0
92	HS2	2/1/1978	7323.0	21.5	7301.5
94	OSE Data	4/21/1989	7359.8	70.0	7289.8
98	HS2	Aug. 1977	7073.7	24.2	7049.5
100	OSE Data	1/1/1947	7074.1	20.0	7054.1
104	OSE Data	1/1/1967	7219.1	50.0	7169.1

Westwater Canyon Wells (Jmw) used to Create Potentiometric Surface

Well ID	Data Source	Date of Meas.	Well Elev. (ft)	DTW (ft)	SWLE (ft)
15	RHR Measured	4/31/2010	7167.0	761.3	6405.7
73	Rio Grande Resources	Fall 2010	7240.0	820.0	6420.0
113	USGS	8/9/2009	6830.0	100.7	6729.3
114	RHR Measured	9/27/2010	6837.0	95.1	6741.9
116	OSE Data	5/10/2005	6824.0	80.0	6744.0
134/137	Intera 2007	2006	7071.0	766.0	6305.0
135/136	Intera 2007	2006	7103.0	773.0	6330.0
143	OSE Data	6/14/2009	7010.0	625.0	6385.0
S1	RHR Measured	10/26/2010	7262.9	866.1	6396.8
S3	RHR Measured	10/26/2010	7222.4	826.5	6395.9
S4	RHR Measured	10/19/2010	7248.7	860.3	6388.4

Figure 9-6. Potentiometric Surface of Westwater Canyon Member and Water Table Surface for the Menefee Formation – Roca Honda/San Mateo Area