ELLISON, SCHNEIDER & HARRIS L.L.P.

CHRISTOPHER T. ELLISON
ANNE J. SCHNEIDER
JEFFERY D. HARRIS
DOUGLAS K. KERNER
ROBERT E. DONLAN
ANDREW B. BROWN
GREGGORY L. WHEATLAND
CHRISTOPHER M. SANDERS
LYNN M. HAUG
PETER J. KIEL

ATTORNEYS AT LAW
2600 CAPITOL AVENUE, SUITE 400
SACRAMENTO, CALIFORNIA 95816
TELEPHONE (916) 447-2166 FAX (916) 447-3512

ELIZABETH P. EWENS, OF COUNSEL
BRIAN S. BIERING
TERESA W. CHAN
SHANE E. CONWAY
KATHRYN C. COTTER
JEDEDIAH J. GIBSON
CHASE B. KAPPEL
SAMANTHA G. POTTENGER

December 23, 2009

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Commissioner Julia Levin, Presiding Member
Vice Chair James D. Boyd, Associate Member
Mr. Craig Hoffman, Project Manager
Abengoa Mojave Solar Project (09-AFC-5)
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Re: Abengoa Mojave Solar Project (09-AFC-5): Supplemental Written Response to Data Request Set 1B (nos. 1-86)

Dear Commissioners Levin and Boyd:

Abengoa Solar Inc. (the “Applicant”) hereby files these written responses to certain Data Requests in Set 1B promulgated by Staff on October 26, 2009. The Applicant requested additional time to respond to several Data Requests in Set 1B regarding Soils and Water Resources in a Notice filed on November 16, 2009. This supplemental response contains responses to those requests including: Data Requests 21, 22, 23, 30, 31, 34, 35, 38, 40, 41, 42, 43, 44, and 45. Several groundwater modeling files were also requested and will be submitted as electronic files under separate cover.

In addition, the Applicant requested additional time to respond to several Data Requests in Set 1B regarding Cultural Resources, including Data Requests 10, 11, 12, 13, 15, 16, 17, and 20. The Applicant is working to complete the requested field work and reports as soon as possible. The Applicant discussed a projected date of submittal of January 4, 2010 for these remaining responses with the Project Manager who agreed with this schedule.

The Applicant appreciates Staff’s time and efforts reviewing the enclosed materials. The Applicant looks forward to working with Staff to achieve complete and satisfactory resolution of all issues in a timely manner.

Thank you for your time and consideration of this matter.

Sincerely,

Christopher Ellison

Christopher T. Ellison
Shane E. Conway
Ellison, Schneider & Harris, L.L.P.

Attorneys for Abengoa Solar Inc.

Attachment

Soils and Water Resources (21-61)

Background

The questions raised regarding the previous modeling study may be categorized as follows:

- Issues that are related to the boundary conditions assigned at the model perimeter;
- Issues that are related to the sources and quantity of recharge applied to the model;
- Issues related to the limited time scale (and thus long-term calibration) of the model.

Rather than reconfigure and recalibrate the existing model, requiring a major investment of time in the development of regional data sets, and given that it would be necessary to extend the model far to the south and southwest to fully understand the effects of development inside and outside the Harper Lake basin on flows into the basin, we have decided to make use of the USGS model of the Mojave River basin WRIR-01-4002 [Stamos et al., 2001] as the basis for responses to the CEC data request. This decision by no means indicates that the original model was fundamentally flawed; it is a practical choice that provides us with a much more complete understanding of the regional hydrologic processes that control flows at the project site. Furthermore, the USGS scientists performed a detailed study of the water withdrawals throughout the Mojave River basin and that information is clearly relevant to the data requests. Because this is a closed desert basin, an understanding of aquifer withdrawals is particularly important. Groundwater flow models of large, desert basins are very often controlled by the initial conditions (that is, the amount of water in the basin) and the timing, strength, and duration of anthropogenic withdrawals and return flows. Fortunately, the USGS model was calibrated over the period 1931-1992, and a validation run for 1993-1999 confirmed the calibration. Therefore, the USGS model provides the best tool for understanding the long-term dynamics of groundwater flow in the Mojave River basin.

Adapting the USGS model

The USGS model was executed on a Sun workstation running a variant of the Unix operating system. We were able to run the original model, unmodified, on an Apple Macbook, running OS X 10.6 and the g77 FORTRAN-77 compiler. The model used the USGS code MODFLOW-88 (the “original” MODFLOW) with some specialized non-standard packages. Most of the specialized packages were simply repackaged MODFLOW-88 packages (e.g. a “mountain recharge” package that simply creates a second copy of the standard RCH package under a new name). This was done to accommodate the inclusion of several different sink and source components in the model in a manner that allowed them to be accounted for separately.

For our work, we needed the ability to view and modify the model, and also to integrate the data sets with our GIS system. We chose the MODFLOW preprocessor Groundwater Vistas [ESI 2009] to facilitate the modeling. For most of the MODFLOW packages, input files were easily imported into Groundwater Vistas, however, we needed to take additional steps for certain packages.

- The USGS model had separate "well" packages for pumping wells, return flows, sewage and artificial recharge. They were each imported separately.
- The USGS model had separate "recharge" packages for mountain front and mountain block recharge, and septic recharge (the regional recharge from precipitation was assumed to be zero). These package inputs could not be superimposed in Groundwater Vistas by importing them. We developed a Python script that read the two RCH package inputs, added the recharge arrays, and wrote the combined recharge for each stress period into a single file for import into Groundwater Vistas.
- The USGS model made use of a nonstandard "hydrograph" package. We did not convert that package for our use. Instead, we applied the Groundwater Vistas "monitoring well" option.

Once the models were operational in Groundwater Vistas, we ran the steady-state model using MODFLOW-96 and compared results to those in the USGS WRIR for confirmation (Figure B-1). The output of the steady model was used as the initial condition for the transient model. A comparison of 1992 potentiometric contours for the updated model and the original USGS report is provided in Figure B-2.

Extending the time period for the model

Our modeling analysis simulates 32 years of operation, with 2 years at the design maximum pumping rate for construction, followed by 30 years at the average pumping rate during operation. We extended the model in two steps, first using historical data to extend the "historical" model time period to 2008, and then extending the model to run predictive scenarios until 2050.

Extending the historical time period to 2008

We extended the time period of historical pumping in the model by adding wells according to a data set compiled from Mojave Water Agency and the USGS model, as follows:

1. The original USGS model had a single well in each of the model cells that represented all of the pumping for all wells in that cell for each stress period in the model.
2. We retained each of the original "well cells" and manually edited the input file for the MODFLOW WEL package to add the additional stress periods to extend the model to 2008.
3. We also acquired a GIS coverage of wells within Harper Valley with pumping totals for 2000-2008. The wells in the GIS coverage are more accurately located than the MODFLOW wells and reflect the actual pumping data for each well, so used the new well locations, and set the pumping rate for MODFLOW well cells that lie within the area covered by the new GIS coverage to zero for the time period 2000-2008.
4. We then added the new wells to the data set, with pumping assigned for each of the years 2000-2008.

By this approach, we maintain the integrity of the original MODFLOW model, while adding the newer information. Importantly, for the predictive simulations, the wells in Harper Valley are located precisely within the Groundwater Vistas preprocessor. This means that if the local domain requires a more refined grid, wells in the refined model will be properly placed in the model grid. Local inaccuracies that arise from the original USGS model's misplacement of the wells in a refined local model should be eliminated by the end of the 2000-2008 historical period.

For all other package inputs (e.g. recharge, stream flow, return flows, and septic) we simply duplicated the 1999 model input over the additional stress periods to extend out to 2008.

Extending the model time over the predictive period

After 2008, we simply copied the 2008 input for each model package forward into 42 additional years, extending the entire simulation to operate from the steady-state assumed initial condition of 1931 to 2050. Assuming that the project period in the model begins in 2010, this allows for the operating schedule in the predictive model as outlined in Table B-1:

Table B-1. Operating schedule for predictive modeling.

Time period	Description
1931-2008	Historical scenario
2009	Extend 2008 operations, pre-development
2011-2012	Project construction (pump project wells at maximum design rate of 1,172 gpm per well)
2013-2042	Operational life of the project (pump project wells at average design rate of 670 gpm per well)
2043-2050	Post-project

All other transient stresses in the model, e.g. pumping from wells outside Harper Valley, stream flows, and recharge components, are derived by duplicating the 1999 values from the USGS model.

Item 21:

Information Required:

A. Using available data, please provide a graphical analysis of the historical relationship of groundwater pumping to TDS concentrations at the proposed project site over time.

B. Similarly, please provide historical groundwater TDS (or electrical conductivity [EC]) data for wells within the Harper Valley Groundwater Basin (HVGB) during the peak decades of pumping for alfalfa irrigation (1950s to 1980s).

C. Evaluate the data for pumping-induced trends.

Response:

A. Figure 21-1 shows the historical relationship of groundwater pumping to TDS concentrations for a 5-mile radius around the proposed site. A 5-mile radius was chosen for this analysis for two reasons: 1) there is no data available at the project site over the 1950-2009 time period so a larger area was needed to look at the entire time period; and 2) TDS concentrations will be impacted by outsidewells, up-gradient of the proposed site, so including wells that are up-gradient allows for a more complete analysis.
B. Figure 21-2 shows the historical relationship of groundwater pumping to TDS concentrations for the entire Harper Valley Groundwater Basin (HVGB).
C. Figures 21-1 and 21-2 appear to have a downward trend in TDS concentrations as pumping rates increase within the HVGB and in the vicinity of the project site. However, the regression analysis for both areas showed a very weak correlation between these two parameters as shown by the R^2 displayed in each graph. Therefore, these data do not provide great predictive insight into future water quality. Nonetheless, the data is consistent with the conclusion that the project's proposed pumping will not significantly impact groundwater quality.

Item 22:

Information Required:

A. Please evaluate the potential for high TDS groundwater beneath the dry lake to be drawn towards the project's proposed pumping wells. Please use the maximum expected groundwater pumping rate for this evaluation.
B. Similarly, please assess potential changes in the leakage rate from the perched groundwater table to the deeper water table resulting from the maximum expected groundwater pumping rate.

Response:

A. We modified the model to make use of the maximum pumping rate for the 2-year construction period, followed by 30 years of operation. This reflects the manner in which the resource would be used over the life of the project. Performing this analysis based on 30 years' pumping at the maximum design rate would overstate impacts.

   We used the calibrated USGS model to trace particles from starting points that surround the lake, starting at the beginning of the construction period. The results are shown in Figure 22A-1. In general, both without and with the Abengoa Solar Energy Project proposed wells, water from the Harper Lake area is moving from the Lake towards the wells (Figure 22A-2). However, the water that is moving from the Lake area towards the wells is not all originating as flow from directly under the Lake but some water is coming from up-gradient sources. In response to previous and current groundwater withdrawals in the vicinity of Harper Dry Lake, water levels have fallen sufficiently so that the Lake no longer acts as a boundary condition for groundwater flow. Therefore, although some high-TDS water is probably lost from the shallow sediments underlying Harper Lake, much of the water flows underneath the Lake from up-gradient sources.

B. If the water table is perched, the water table in the lower aquifer becomes “disconnected” from the semi-confining layer above. When this occurs, the rate of leakage into the aquifer beneath the aquiclude is not a function of the potentiometric head in the lower aquifer, and additional pumping will not affect the seepage rate.

Assuming Dupuit-Forchheimer flow in each aquifer, the rate of seepage across an aquiclude at a specific location in the horizontal plane may be computed as

$$q_z = \frac{K_z}{d} \times (h_{above} - h_{below}) \quad (22-1)$$

where q_z $\left[\frac{L^3}{T}\right]$ is the volumetric rate of seepage between the cells, K_z $\left[\frac{L}{T}\right]$ is the vertical hydraulic conductivity of the aquiclude, d $[L]$ is the thickness of the aquiclude, h_{above} $[L]$ is the potentimetric head at the top of the aquiclude (head in the upper aquifer), and h_{below} $[L]$ is the head at the bottom of the aquiclude. The “potentiometric head” is defined to be

$$h = z + \frac{p}{\rho g} \quad (22-2)$$

where z is the elevation of the point where the head is measured, p is the pore pressure in the fluid, ρ is the density of the fluid, and g is the acceleration due to gravity. In equation 22-2, z is commonly referred to as the “elevation head” and $\frac{p}{\rho g}$ as the “pressure head”.

Figure 22B-1 illustrates the “non-perched” and “perched” flow conditions. In (a) the lower aquifer’s potentiometric head is higher than the elevation of the bottom of the aquiclude; thus the head difference across the aquiclude is $h_{above} - h_{below}$ and the seepage rate is a linear function of the head in the lower layer. In (b), the lower aquifer’s potentiometric head is lower than the bottom of the aquiclude; the pore pressure (and the pressure head) just below the aquiclude is therefore assumed to be zero, and the potentiometric head at that point is equal to the elevation head. In the perched setting, the seepage rate is therefore independent of the water level beneath the aquiclude. The h_{below} is irrelevant to the seepage rate and therefore the hydraulics are independent of h_{below}.

Item 23:

Information Required:

Please provide results of a MODPATH or similar particle tracking analysis to show the capture zones of the project wells (with simultaneous operation of wells at Luz Solar Energy Generation

System (SEGS) XI and XII power plants) with continuous pumping at the maximum annual production rate for periods of 10, 20, and 30 years.

Response:

As shown in Figure 22A-1, path lines that travel from and beneath Harper Lake terminate in the near vicinity of the proposed Abengoa wells. By tracking particles in the reverse direction from the Abengoa wells, MODPATH predicts that water moves from the southwest, across the Lockhart Fault, towards the Abengoa wells (not shown). These outcomes are understandable, since the Abengoa wells lie within a local region where groundwater withdrawals are locally concentrated. However, the nature of those withdrawals makes it unrealistic to simply eversetrace from the wells.

The simulated capture zones are highly dependent on the rates of withdrawals in the wells that lie between the Abengoa wells and Harper Lake. Those rates were assumed by Layne, based on the 2008 pumping rates. A decrease in pumping rates might lead to a dramatically different outcome. As a result, we believe that in practice it may be just as likely that the well receives ambient upgradient water from the southwest as from the direction of Harper Lake.

It is noted that, even if the Abengoa wells receive water that originated in the Harper Lake sediments or came from the east-southeast under Harper Lake, there are many wells that lie between the Abengoa wells and the lake. As a result, even if the capture zones could be securely and responsibly predicted, the water-quality implications would be highly uncertain.

Item 30:

Information Required:

Please estimate the potential omissions introduced in the drawdown and water budget analyses due to excluding HVGB areas from the domain.

Response:

In the original model, the aquifer was bounded by no-flow conditions throughout the Harper Valley region. Recharge at the surface from rainfall, return flows, and sewage recharge were ignored. Up-gradient inflows through Hinkley Gap were not specified as a model input, but arise from the boundary conditions at the Mojave River (general-head boundaries) and Harper Lake (drains). If one assumes that the omitted regions contributed virtually no recharge, an assumption that is consistent with the rest of the model assumptions, then the effects of omitting a portion of the basin on the overall water budget is negligible. However, by omitting a portion of the aquifer while maintaining the same overall water budget, the model will tend to overstate water level declines at the project site. Therefore, the results are conservative with respect to water level declines.

The USGS model has a more complete representation of the water budget. It includes return flows, septic recharge, and other features of the flow system. Furthermore, it has been calibrated to more than 60 years of water-level data. The regional model has the potential to provide a more accurate representation of the water level declines in the vicinity of the project site.

Item 31:

Information Required:

Please provide a revised drawdown and water budget analysis derived from a 640 sq mile basin

Response:

Table 31-1 provides the simulated water budget analysis for the HVGB basin for pre-development conditions (2010), at the end of the construction period (2012), and at the end of the operational life of the project (2042).

Drawdown contours at the end of the construction period (2012), at the end of the operational life of the project (2042), and with a 10% increase in pumping (2042), relative to the predevelopment (2010) water levels are shown in Figures 31-1, 31-2, and 31-3, respectively.

Table 31-1. Harper Valley Groundwater Basin water budget in acre-feet/year.

	2010 (Current)		2012 (End of Construction)		2042 (End of Production)	
Description	**Inflow**	**Outflow**	**Inflow**	**Outflow**	**Inflow**	**Outflow**
West Edge	750	0	751	0	758	0
East Edge	700	11,630	720	11,624	791	11,571
North Edge	0	0	0	0	0	0
South Edge	9,204	284	9,221	281	9,300	274
Recharge	1,100	0	1,100	0	1,100	0
Evapotranspiration	0	1,114	0	1,114	0	1,114
Drain	0	0	0	0	0	0
GHB	0	0	0	0	0	0
Well	5,506	21,279	5,506	18,044	5,506	13,731
Stream	3,885	1,839	3,883	1,842	3,867	1,863
Change in Storage	8,096	983	6,032	577	4,994	1,879

Item 34:

Information Required:

Please compile information from previous studies and the literature and provide a table with reference citations that summarizes the ranges in Transmissivity and Storativity values by layer for the HVGB.

Response:

Table 34-1. Transmissivity and Storage Coefficient values for Harper Valley Groundwater Basin.

Citation	Range
Transmissivity[a]	

ERT, Inc., 1988	2,500 - 100,000 gpd/ft
Hardt, 1971	50,000 - 100,000 gpd/ft
Stamos et al, 2001	[*]Layer 1: 1,000 - 60,000 ft^2/d [+]Layer 1: 50 - 2,500 ft^2/d [¥]Layer 2: 300 - 17,000 ft^2/d
The Mark Group, 1989	10,000 - 100,000 gpd/ft
Storage Coefficient	
ERT, Inc., 1988	0.12
Hardt, 1971	0.12
Stamos et al, 2001	Layer 1: 0.12 Layer 2: 0.0007
The Mark Group, 1989	0.12

Note. Where no layer information is presented, the authors did not differentiate between layers.
[a]Conversion factor: gallons per day per ft (gpd/ft) ÷7.48 = feet squared per day (ft^2/day). [*]Deposits in the floodplain aquifer. [+]Deposits in the regional aquifer. [¥]Regional aquifer.

References

ERT, Inc. 1988. Application for Certification for SEGS VIII Harper Lake, California. pg 5-17.

Hardt, W.F. 1971. Hydrologic Analysis of the Mojave River Basin, California Using Electric Analog Model. United States Department of the Interior, Geological Survey, Water Resources Division.

Stamos, C.L., P. Martin, T. Nishikawa, and B.F. Cox. 2001. Simulation of Ground-Water Flow in the Mojave River Basin, California. U.S. Geological Survey. Water-Resources Investigations Report 01-4002 Version 3.

The Mark Group. 1989. Final Report - Hydrogeologic Assessment Report Harper Lake, California for Luz Development, 88-03219.18.

Item 35:

Information Required:

Please provide the justification and rationale for excluding valley floor, mountain front, and mountain block recharge from the MODFLOW model.

Response:

The explanation of the recharge assumptions in the USGS model is provided in WRIR-01-4002 pages 58-60 (Appendix 35-1).

Item 38:

Information Required:

A. Please assess the sensitivity of the MODFLOW calibration and simulated water budget by assuming a flow of 1,468 AFY through the Hinkley Gap, which is the most recent estimate of inflow from the Mojave River area (AST 2007).
B. Continue to omit rainfall recharge from direct precipitation on the valley floor but add the 850 AFY of mountain front and mountain block recharge. The model should be recalibrated as appropriate to minimize the residual errors (consider a reduction in the layer 1 zone 5 hydraulic conductivity and adjust the GHB and DRN conductances accordingly).

Response:

A. The original model and the USGS model both predict the flow through the Hinkley Gap as a model result, and not as an input value. The USGS report indicates that the simulated flow through the gap in 1931 averaged 3,336 (acre-ft)/yr over the 1931-1998 study period. Neither model has a mechanism for directly specifying the flow rate through the gap. Based on the long-term calibration results for the model, we believe these estimates to be realistic.
B. Calibration of the USGS model covers the need for recalibration.

Item 40:

Information Required:

Please test the model calibration using longer-term pumping and water level transients (i.e., the 1950-2009 period). Include simulated and observed water level hydrographs for well locations throughout the domain (a number of potentially useful hydrographs are shown in Figure 1-14).

Response:

The USGS model assumes a predevelopment steady-state condition in 1931 and has been calibrated to water levels over the time period 1931-1992, and furthermore validated by comparison to 1998 water levels (in the USGS report) and 2008 water levels (as part of this response).

Item 41:

Information Required:

A. Please conduct a cumulative impact simulation that includes pumping from SEGS VIII and IX supply wells and irrigation, and municipal and domestic wells in the modeled area.
B. Provide a tabulation of the simulated construction period and 30-year project pumping drawdown at key existing wells shown in *Figure 1-2*.

Response:

A. Our cumulative impact simulation includes all the wells in the HVGB region as provided in the response to Data Request 42. Figures 31-1 and 31-2 show the drawdowns in the HVGB and Figures 41A-1 and 41A-2 show drawdowns in the vicinity of the Abengoa Mojave Solar Project site.
B. Table 41B-1 provides a tabulation of drawdown at key wells near the project site. Locations of these wells are shown in Figure 41B-1. Hydrographs for these same key existing wells are found in Figures 41B-2 through 41B-6.

Table 41B-1. Drawdown at key existing wells near the Abengoa Solar Energy Project site.

Well	Drawdown at end of construction (calibrated)	Drawdown at end of production (calibrated)	Drawdown at end of construction (10% more pumping)	Drawdown at end of production (10% more pumping)
11N04W19E1	3.7	14.1	5.4	17.6
11N04W19E2	3.3	13.7	4.9	17.1
11N04W19J	6.2	15.7	9.0	20.4
11N04W19Q	7.3	16.5	9.4	20.5
11N04W32A	13.3	19.8	15.3	23.8

Item 42:

Information Required:

Please quantify the potential water use by all existing and reasonably foreseeable projects within the HVGB and provide the rationale for why particular projects may not be included in this listing.

Response:

Current Use

To quantify current groundwater production within the Harper Valley Groundwater Basin (HVGB), we used the Mojave Water Agency's (MWA) Watermaster 2007-08 Fifteenth Annual Report. Appendix L of the Annual Report provides total water production for all individual wells within the Mojave Basin Area. We eliminated wells outside the HVGB using each well's state well number. Wells within the HVGB and their 2008 production are provided in Table 42-1.

The Watermaster reports production annually for those users that use more than 10 acre-feet per year (ac-ft/yr). According to Mr. Lance Eckhart, Principal Hydrogeologist for the MWA, water users producing less than 10 ac-ft/yr are not required by law to report their production; consequently, the Watermaster does not collect their production data.

Since the USGS model (Stamos et al, 2001) included withdrawals that were less than 10 ac-ft/yr and possibly other withdrawals that are not reported to the MWA, Layne used the 1999 pumping data for any cell within the model that did not include well/production data obtained from MWA for all future years in the simulation. Using the well cells found in the USGS model allowed us to account for both the spatial distribution and quantity of water for those users who do not report to the MWA.

Future Use

We contacted San Bernardino County Planning and spoke with Mr. John Schatz, Principal Planner and Intake Supervisor with the San Bernardino County Land Use Department, about future projects within the HVGB. Mr. Schatz told us that San Bernardino County does not have a Master Plan that projects future development or water use; also, the County does not maintain a list of incoming or anticipated projects.

We also contacted the MWA Watermaster about future water use in the HVGB and were told the Watermaster collects only current production data and does not project future use.

Consequently, we consulted the 2004 Mojave Water Agency Regional Water Management Plan. The plan does give water use projections; however, the projections are for the entire Centro Subarea, not HVGB; and are aggregated by category (e.g. Industrial, Municipal, Golf Course, Recreational, and Agricultural), not by individual well. As a result, the Management Plan is not useful for quantifying foreseeable projects' potential water use within the HVGB.

In the model, each well was assigned the 2008 production rate obtained from the MWA's Watermaster 2007-08 Fifteenth Annual Report for each future year. For those cells where no well was accounted for by the MWA but the USGS model included pumping, the 1999 pumping from the USGS model (Stamos et al, 2001) was used for all future years.

Table 42-1. 2008 groundwater production for wells within the Harper Valley Groundwater Basin, California. Data was obtained from the Mojave Water Agency's Watermaster 2007-08 Fifteenth Annual Report and Stamos et al, 2001.

California State Well Number	**2008 Production (acre-feet/year)**	**California State Well Number**	**2008 Production (acre-feet/year)**
08N/04W-10G01	24	09N/03W-02J01	3
08N/04W-10G02	2	09N/03W-02J02	0
08N/04W-15A04	0	09N/03W-02J03	0
08N/04W-15A05	0	09N/03W-02J06	79
08N/04W-15A07	0	09N/03W-02K01	0
08N/04W-15A08	0	09N/03W-02K03	11
08N/04W-15C01	0	09N/03W-02M02	11
08N/04W-15E01	0	09N/03W03Q04	0
08N/04W-15E02	0	09N/03W03R03	0

California State Well Number	2008 Production (acre-feet/year)	California State Well Number	2008 Production (acre-feet/year)
08N/04W-15F03	63	09N/03W03R04	0
08N/04W-15F04	62	09N/03W-21J04	6
08N/04W-15G01	0	09N/03W-21J05	13
08N/04W-15G02	0	10N/02W-30N05	1
08N/04W-15G03	0	10N/02W-30N06	103
08N/04W-15M01	0	10N/02W-31G01	0
08N/04W-15M03	0	10N/02W-31P01	805
09N/03W01501	0	10N/02W-31Q02	701
09N/03W-01C01	1,082	10N/03W-04J01	5
09N/03W-01F01	62	10N/03W-04J02	0
09N/03W-01F02	0	10N/03W-14D01	0
09N/03W-01J03	2	10N/03W-14E01	0
09N/03W-01K01	0	10N/03W-14E02	0
09N/03W-01Q01	0	10N/03W-14E03	0
09N/03W-01Q03	0	10N/03W-14E04	0
09N/03W-01Q04	0	10N/03W-14E05	0
09N/03W-01Q05	0	10N/03W-14E06	0
09N/03W-02A01	0	10N/03W-23H06	0
09N/03W-02A02	0	10N/03W-23H07	0
09N/03W-02A04	0	10N/03W-23H08	0
09N/03W-02A05	0	10N/03W-23K01	199
09N/03W-02A06	0	10N/03W-23M01	0
09N/03W-02A07	0	10N/03W-23M02	0
09N/03W-02B02	0	10N/03W-23M04	1
09N/03W-02B03	0	10N/03W-23Q01	0
09N/03W-02B04	0	10N/03W-23Q02	200
09N/03W-02B06	0	10N/03W-23Q03	1
09N/03W-02B07	0	10N/03W-23Q04	0
09N/03W-02B08	0	10N/03W-26C01	0
09N/03W-02G01	0	10N/03W-26E01	5
09N/03W-02G02	0	10N/03W-26P02	0
09N/03W-02G03	0	10N/03W-26P03	0
09N/03W-02G06	0	10N/03W-26P04	0
09N/03W-02G07	0	10N/03W-26P07	0
09N/03W-02H01	0	10N/03W-26P08	0
09N/03W-02H02	0	10N/03W-26P14	0
09N/03W-02H03	93	10N/03W-26P15	0
09N/03W-02H05	0	10N/03W-26Q01	0
10N/03W-26F18	155	10N/03W-26Q05	0

California State Well Number	2008 Production (acre-feet/year)	California State Well Number	2008 Production (acre-feet/year)
10N/03W-26F19	28	10N/03W-27J02	0
10N/03W-26F20	57	10N/03W-27J03	0
10N/03W-26G01	0	10N/03W-27M01	1
10N/03W-26F08	0	10N/03W-27M02	0
10N/03W-26F09	0	10N/03W-27M03	13
10N/03W-26F11	0	10N/03W-27P03	6
10N/03W-26F12	0	10N/03W-27P04	1
10N/03W-26F13	0	10N/03W-30Q04	0
10N/03W-26F14	0	10N/03W-30Q06	0
10N/03W-26F15	0	10N/03W-30Q07	0
10N/03W-26F16	135	10N/03W-30Q08	0
10N/03W-26F17	266	10N/03W-34A02	0
10N/03W-26G02	0	10N/03W-34A03	0
10N/03W-26G03	0	10N/03W-34A04	1
10N/03W-26K02	0	10N/03W-34A05	0
10N/03W-26K03	0	10N/03W-34A07	0
10N/03W-26L03	0	10N/03W-34B01	0
10N/03W-26L08	0	10N/03W-34B03	0
10N/03W-26L11	0	10N/03W-35A01	0
10N/03W-26L12	0	10N/03W-35A02	0
10N/03W-26M02	0	10N/03W-35C01	0
10N/03W-26M04	0	10N/03W-35F01	0
10N/03W-26N02	0	10N/03W-35F04	0
10N/03W-26N04	0	10N/03W-35F05	0
10N/03W-26N05	0	10N/03W-35H01	0
10N/03W-26N06	0	10N/03W-35H02	0
10N/03W-26N07	0	10N/03W-35H03	0
10N/03W-26N08	0	10N/03W-35H04	0
10N/03W-26P01	0	10N/03W-35J01	0
10N/03W-35J09	0	10N/03W-35J02	0
10N/03W-35J11	0	10N/03W-35J03	0
10N/03W-35J12	0	10N/03W-35J04	0
10N/03W-35J13	0	10N/03W-35J05	0
10N/03W-35J14	0	10N/03W-35J06	0
10N/03W-35J15	0	10N/03W-35J07	0
10N/03W-35K02	0	10N/03W-35J08	0
10N/03W-35K03	0	10N/03W-36P02	0
10N/03W-35K05	0	10N/03W-36P05	0
10N/03W-35K06	0	10N/03W-36P06	0

California State Well Number	2008 Production (acre-feet/year)	California State Well Number	2008 Production (acre-feet/year)
10N/03W-35K07	0	10N/03W-36Q02	0
10N/03W-35K08	0	10N/03W-36Q04	0
10N/03W-35K09	0	10N/06W-05E17	3
10N/03W-35Q01	0	11N/03W-33G01	0
10N/03W-35Q02	0	11N/03W-33G02	0
10N/03W-35Q03	0	11N/03W-33H03	10
10N/03W-35Q04	0	11N/04W-19E01	21
10N/03W-35Q05	0	11N/04W-19E02	274
10N/03W-35Q09	0	11N/04W-19J01	681
10N/03W-35Q10	0	11N/04W-19Q02	56
10N/03W-35Q11	0	11N/04W28R01	0
10N/03W-30K02	0	10N/03W-35Q12	0
10N/03W-35Q13	0	11N/04W-29P01	0
10N/03W-35Q14	0	11N/04W-30B01	0
10N/03W-35Q15	0	11N/04W-30D01	0
10N/03W-35R01	0	11N/04W-30E01	0
10N/03W-35R02	0	11N/04W-30M01	0
10N/03W-35R04	0	11N/04W-30N06	0
10N/03W-35R07	0	11N/04W-30N07	0
10N/03W-35R08	0	11N/04W-30P02	0
10N/03W-35R09	0	11N/04W-30Q03	0
10N/03W-35R10	0	11N/04W-33J01	0
10N/03W-35R11	0	11N/05W-24L01	0
10N/03W-36F02	0	11N/04W-31J03	18
10N/03W-36F03	0	11N/04W-32A02	697
10N/03W-36K02	0	11N/04W-32D03	0
10N/03W-36M01	0	11N/04W33B02	0
10N/03W-36M02	1	11N/04W-33C02	0
10N/03W-36M03	1	11N/05W-24P02	0
10N/03W-36M04	0	11N/05W-24Q02	0
10N/03W-36M05	0	11N/06W-31Q01	0
10N/03W-36M06	0	11N/06W-31R02	17
11N/04W-33G04	0	USGS model	4,219
11N/04W-29J01	0	***Total Production***	***10,195***

Item 43:

Information Required:

Please discuss the potential incremental and cumulative impact to the HVGB water quality and water supply by the projects within the listing.

Response:

As shown in Table 41B-1, the proposed project results in water level declines of 19 ft or less at wells in the vicinity of the project. In the event that the regional water levels continue to “rebound” as they have been in recent years, the largest water level declines resulting from the proposed project will be less than the 19 ft prediction. As shown in the water level hydrographs (Figures 41B-2 through 41B-6), an overall regional increase of 10% in total withdrawals will result in 29 ft or less of additional water level declines. These declines should have a minimal impact on the reliability of water supplies. Figures 43-1 through 43-6 show the groundwater contours for the incremental and cumulative impacts to groundwater levels in the HVGB.

As discussed in the responses to data requests 21 and 22, predictions of pumping-induced water quality changes will be difficult. However, the data suggest that it is unlikely that additional withdrawals will have a major negative impact on water quality in neighboring wells

Item 44:

Information Required:

Please identify and explain the thresholds employed to conclude impact significance (or lack thereof).

Response:

When considering the importance of a water level decline on the order of 15-20 ft, it is important to consider that decline in the context of operational decision making by the neighboring water user. We reviewed the available data for the elevation of the tops of screens in wells near the project site. Although data were available for only a few wells, all had screen elevations in the 1850-1880 ft MSL range. Given current water levels, there is about 100 ft of available drawdown before major declines in well capacity will result. A reduction of 15-20 ft in ambient water levels will leave 80 ft or more of available drawdown. This should not result in any major operational issues.

Item 45:

Information Required:

Please provide a table that summarizes the range in simulated impacts at the existing wells tabulated above to represent a plausible range in aquifer property values from previous studies, the literature, and model calibration.

Response:

The USGS model is well-calibrated over the period of record from 1931-present. Given the complexity of that model and that it represents all of the important components of the groundwater budget for the region, it is the best resource that is currently at our disposal.

However, in a setting such as this, the amount of water pumped from the wells is the critical variable in the calibration. In fact, the main reason why the USGS model is a good choice for this review is that the USGS scientists were able to develop a reliable data set over the period of record, including estimates for unreported withdrawals. Even so, the pumping estimates for the entire basin may increase or decrease with time.

Since the rate of future withdrawals is the most important source of uncertainty for this analysis, we have re-run the model to examine the impact of a 10% increase in pumping within Harper Valley. Figures 41B-2 through 41B-6 and Figures 43-5 and 43-6 illustrate this.

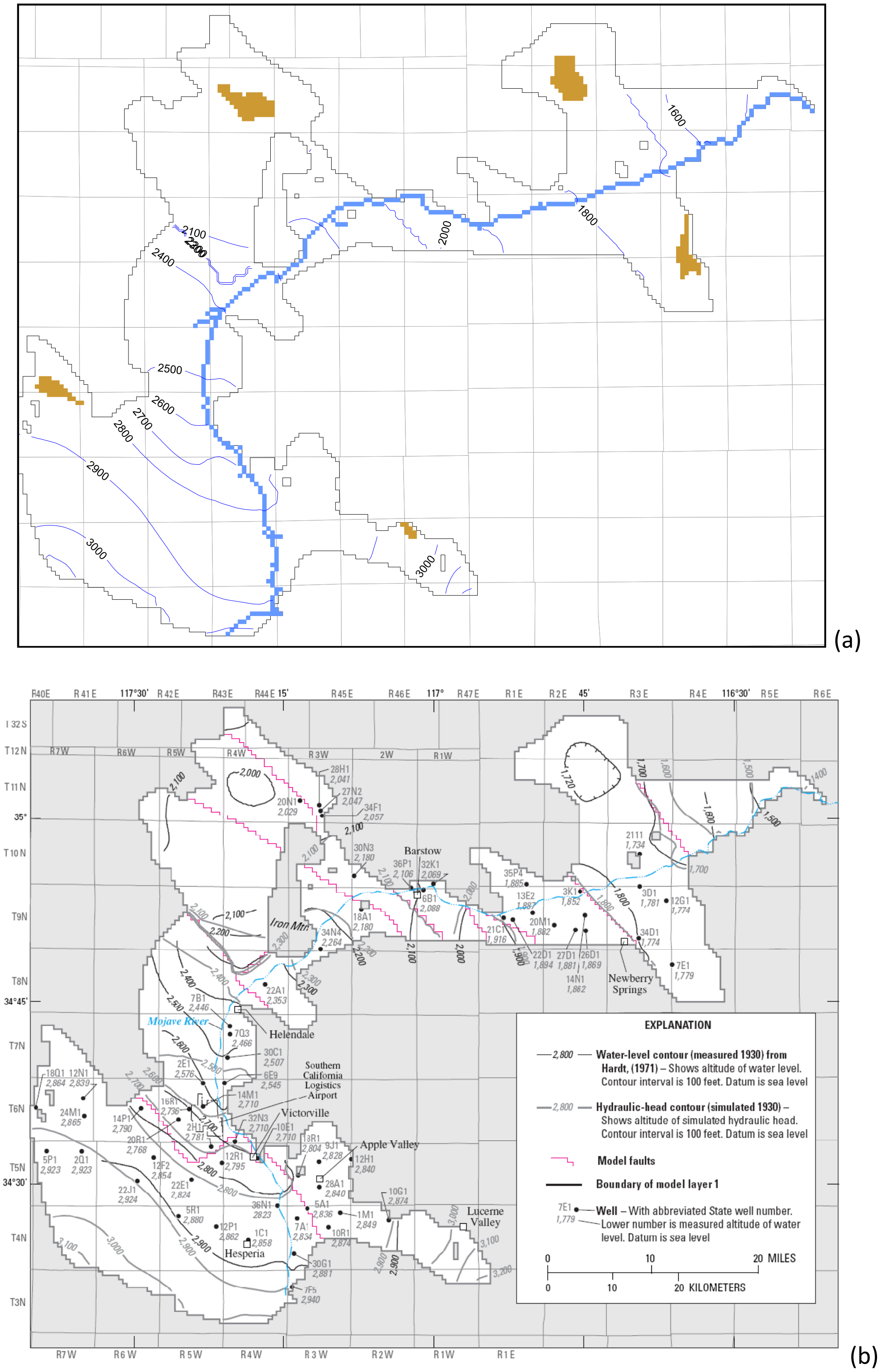

Figure B-1. Comparison of steady-state model results for 1931: (a) from the updated model in Groundwater Vistas; (b) from Stamos et al. (2001).

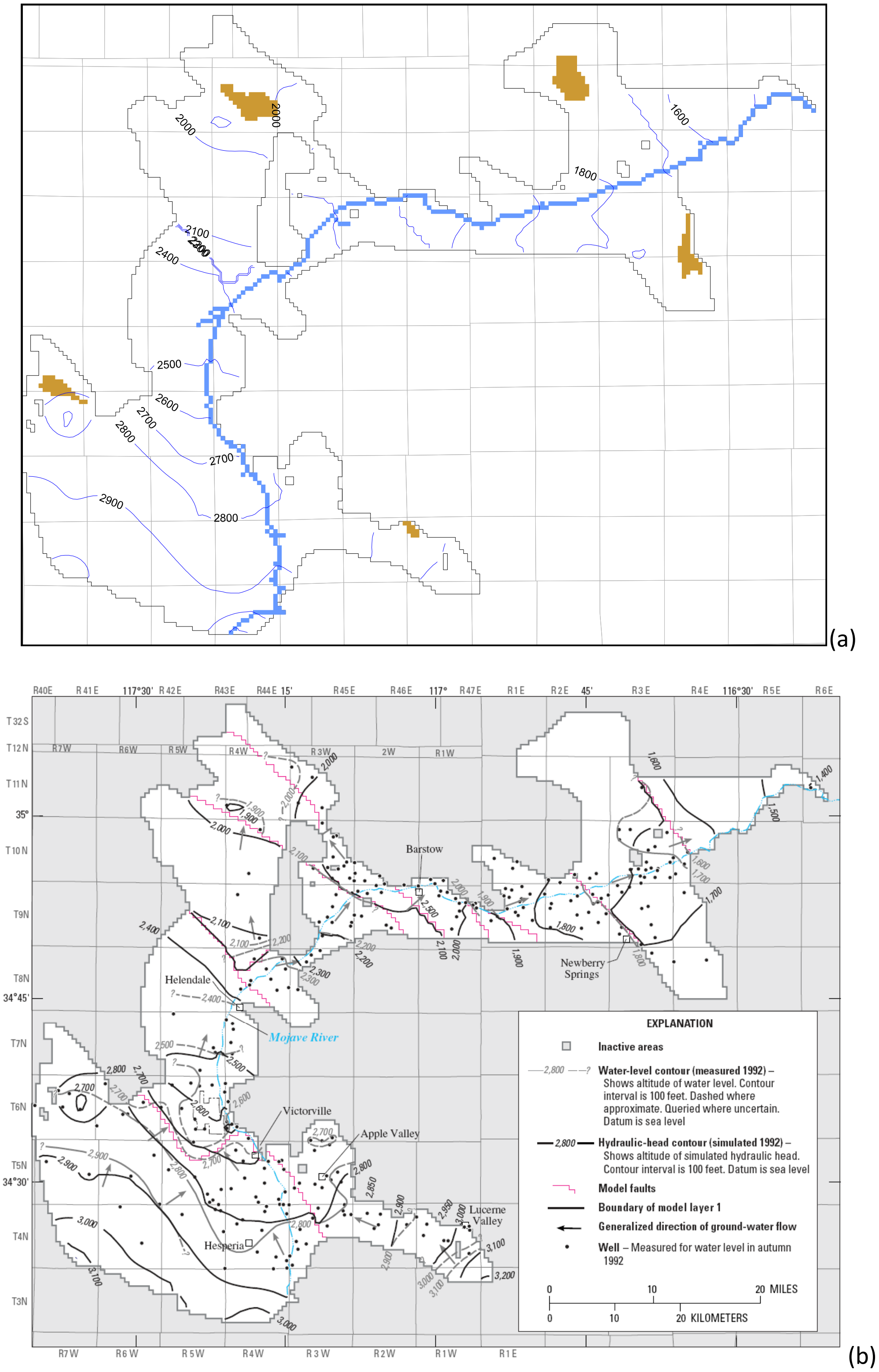

Figure B-2. Comparison of transient model results for 1992: (a) from the updated model in Groundwater Vistas; (b) from Stamos et al. (2001).

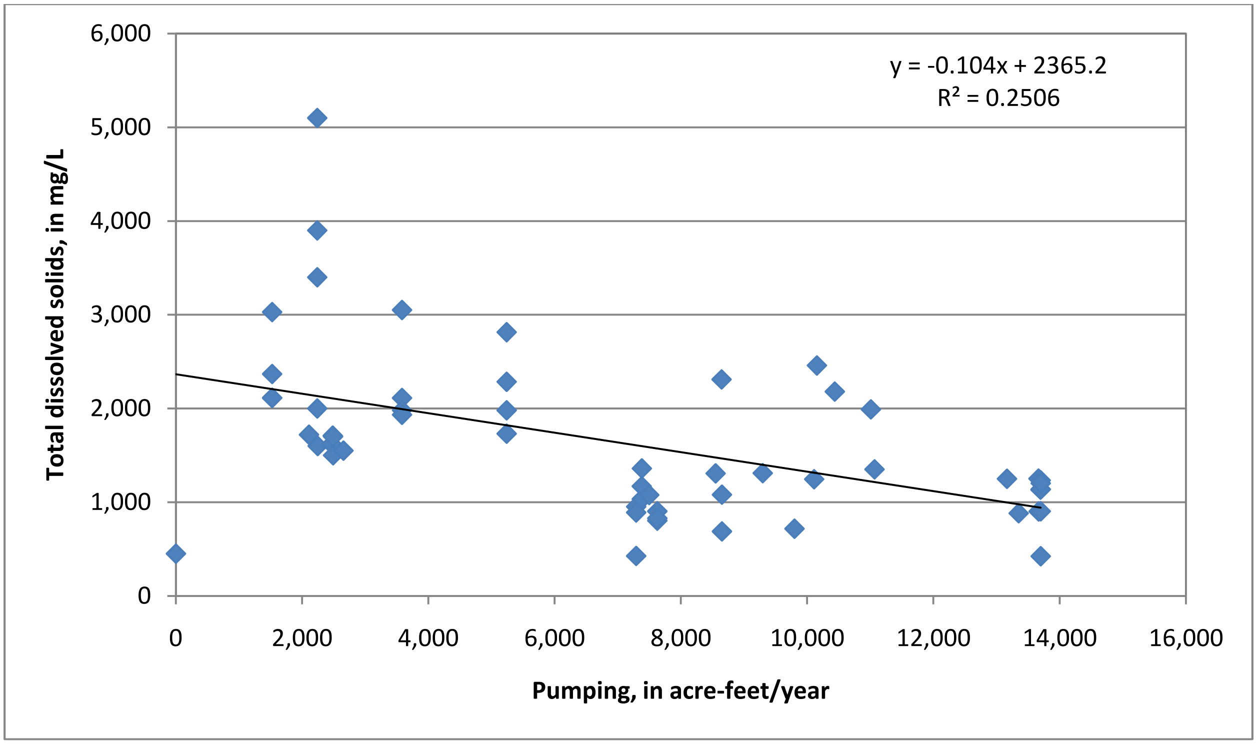

Figure 21-1. Total dissolved solids versus pumping rates for a 5-mile radius around the proposed Abengoa Solar Energy Project site.

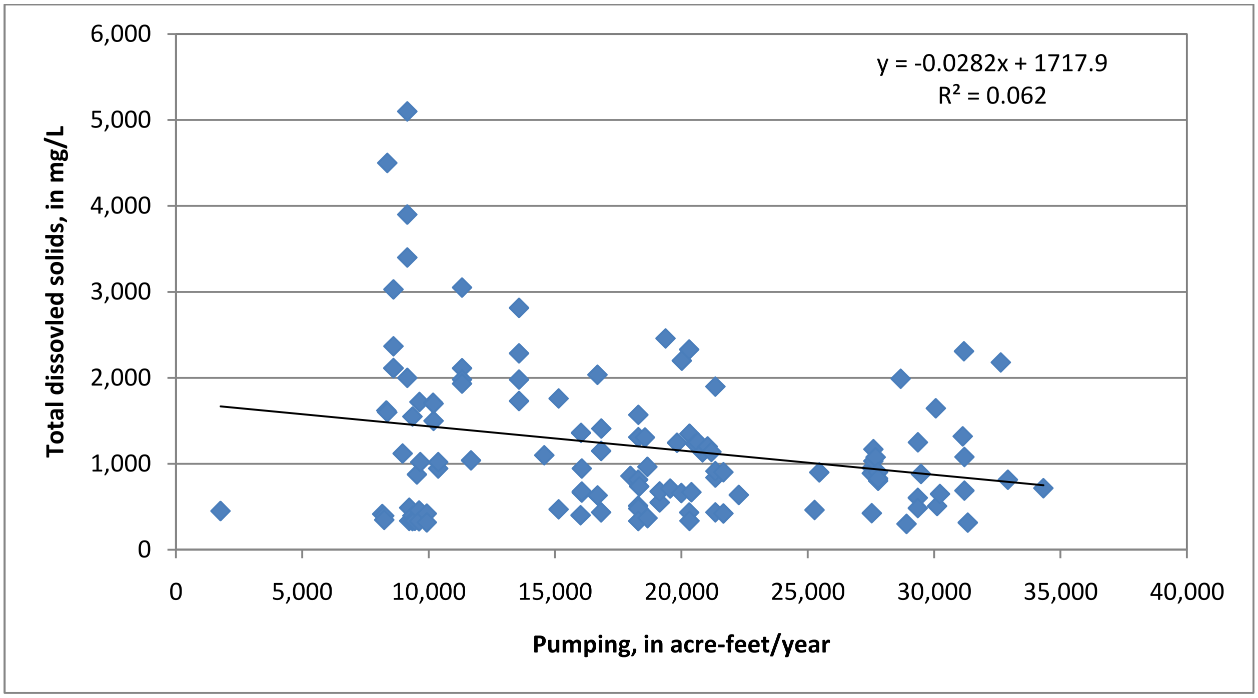

Figure 21-2. Total dissolved solids versus pumping rates for the Harper Valley Groundwater Basin.

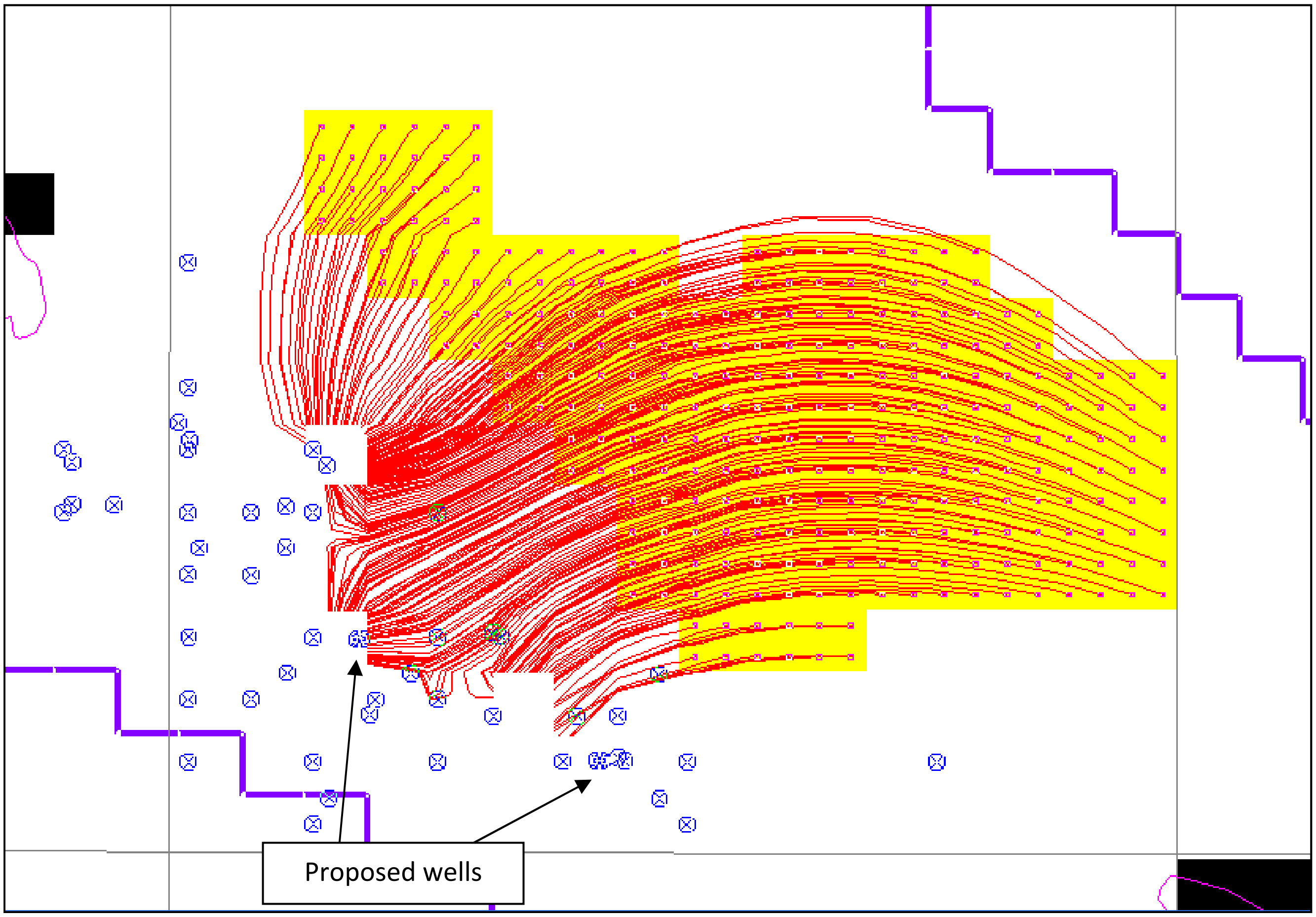

Figure 22A-1. Pathlines originating from Harper Dry Lake (yellow area) to Abengoa Solar Energy Project proposed wells.

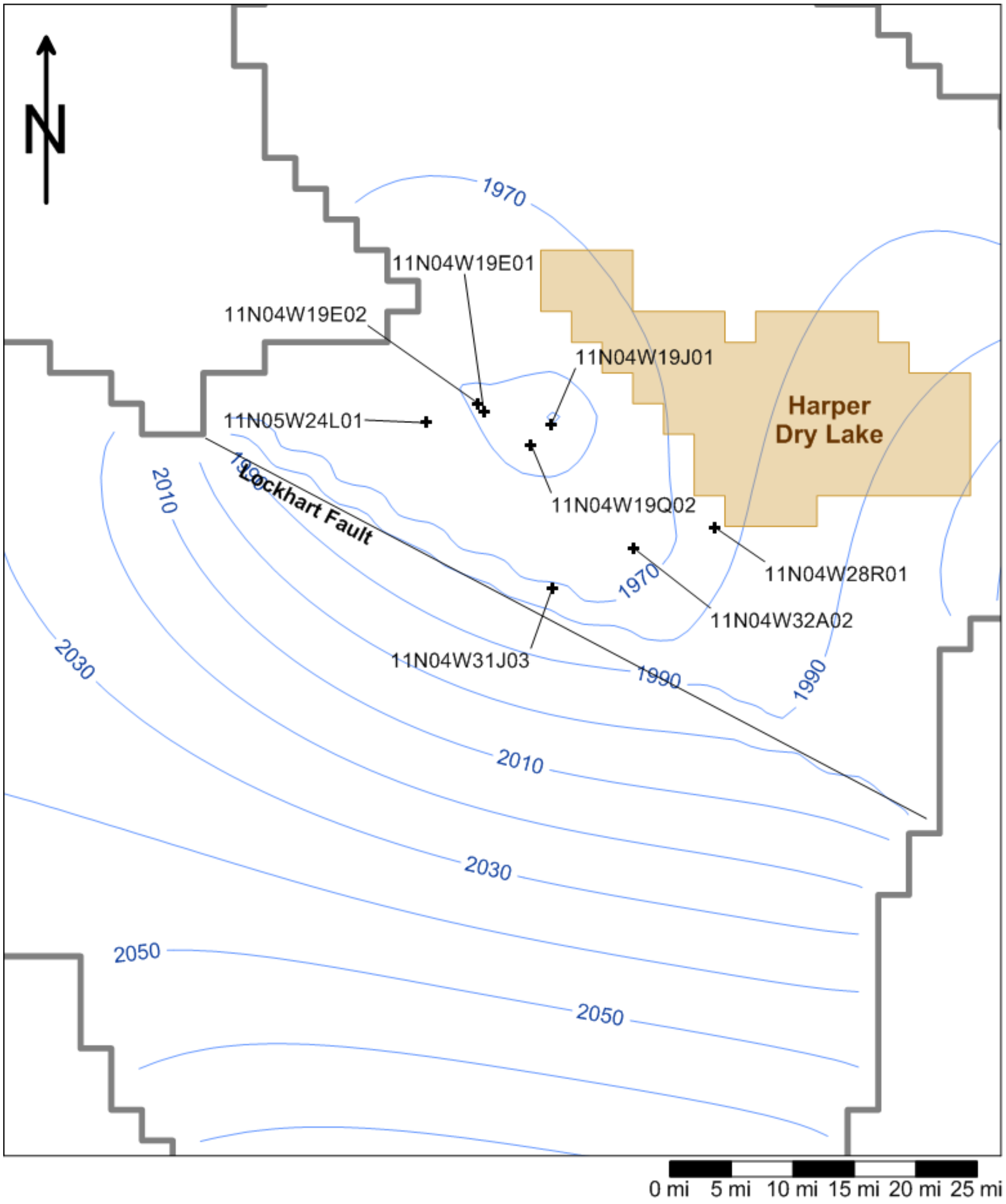

Figure 22A-2. Groundwater levels in the Harper Valley Groundwater Basin without the Abengoa Solar Energy Project proposed wells. This figure shows that groundwater is flowing from beneath the Harper Dry Lake even without the proposed Abengoa wells.

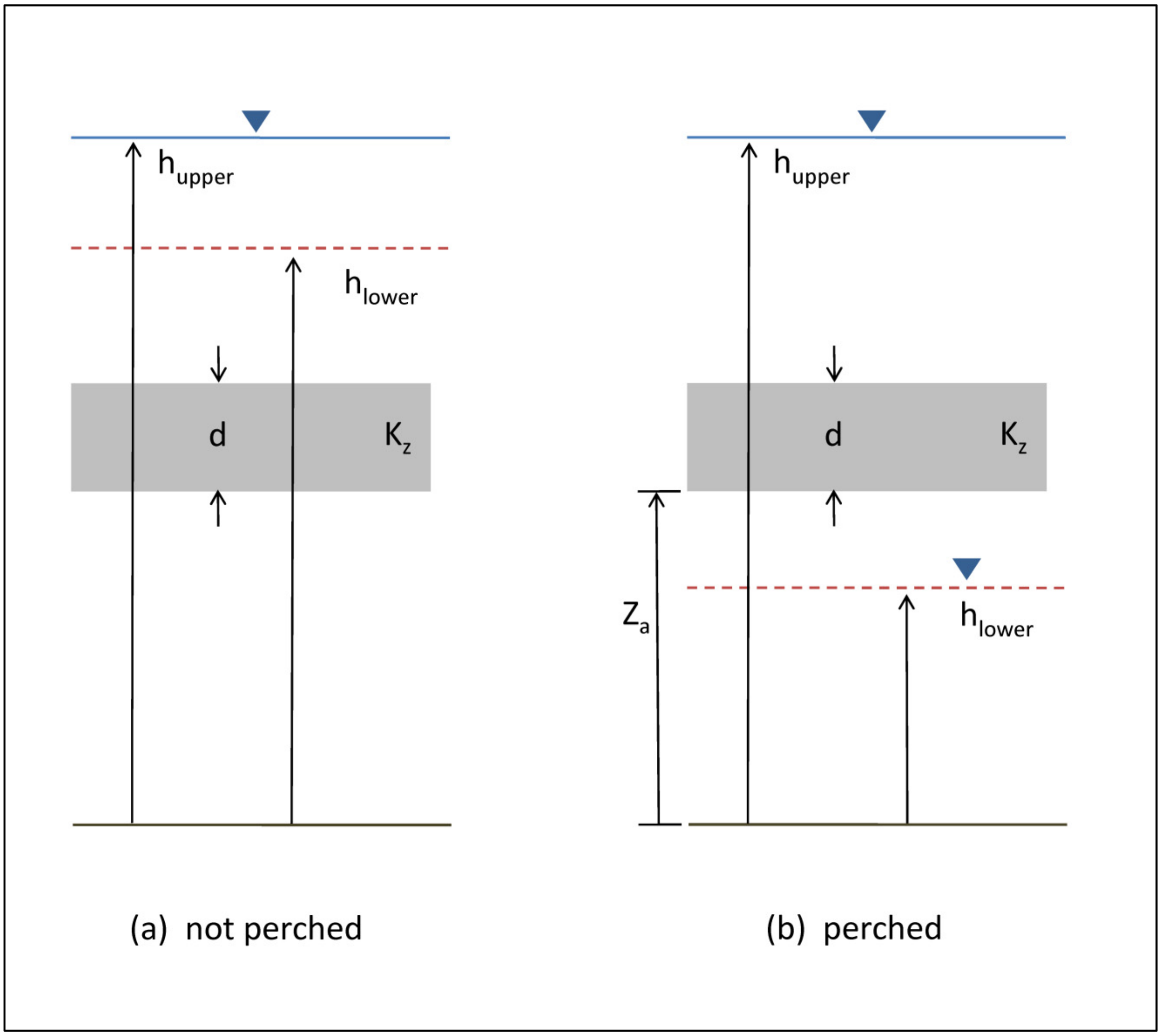

Figure 22B-1. Explanation of perched and non-perched flow conditions.

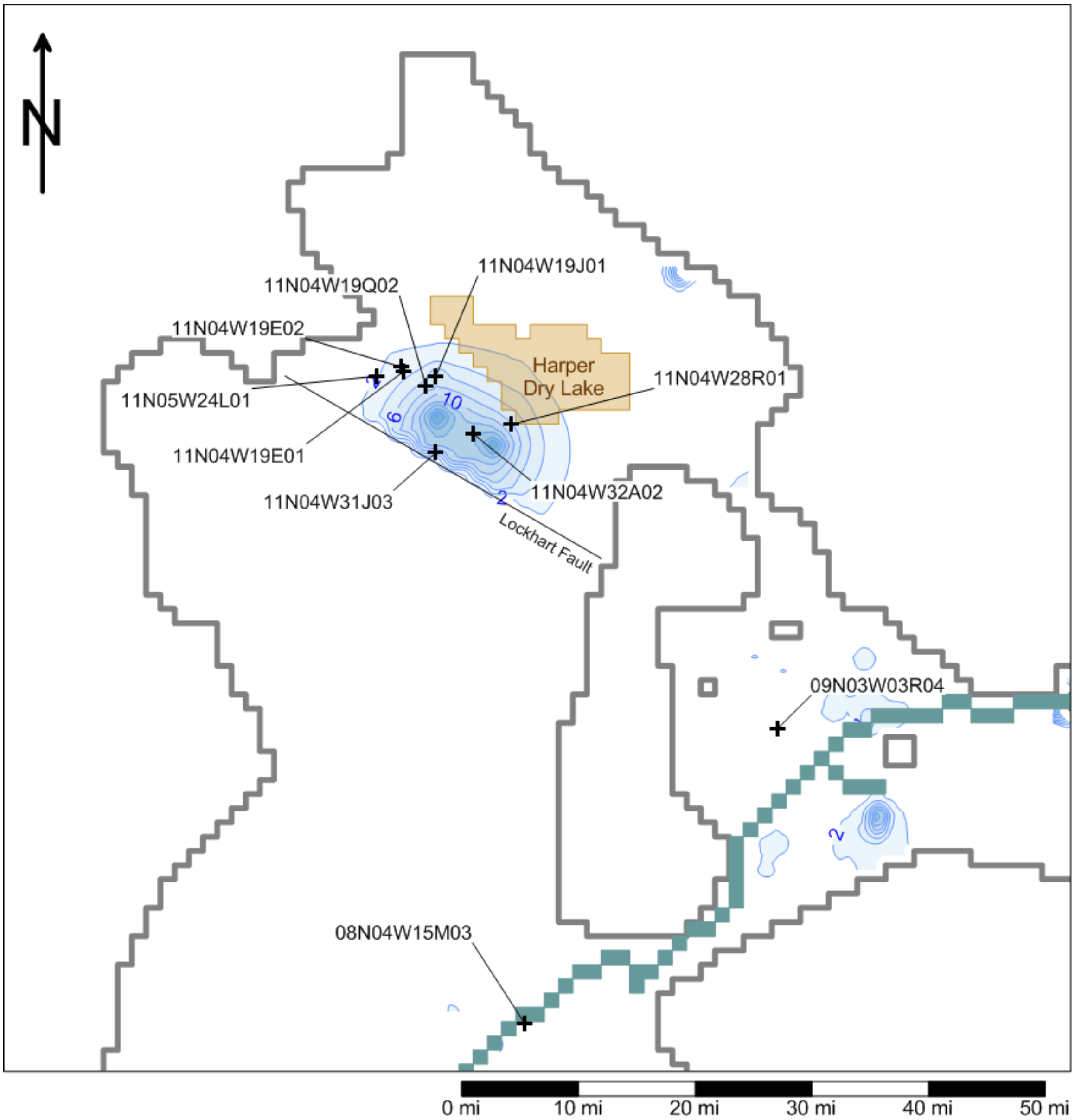

Figure 31-1. Drawdowns relative to predevelopment (2010) water levels at the end of 2012 (end of construction period) with all existing wells and the Abengoa Solar Energy Project proposed wells pumping.

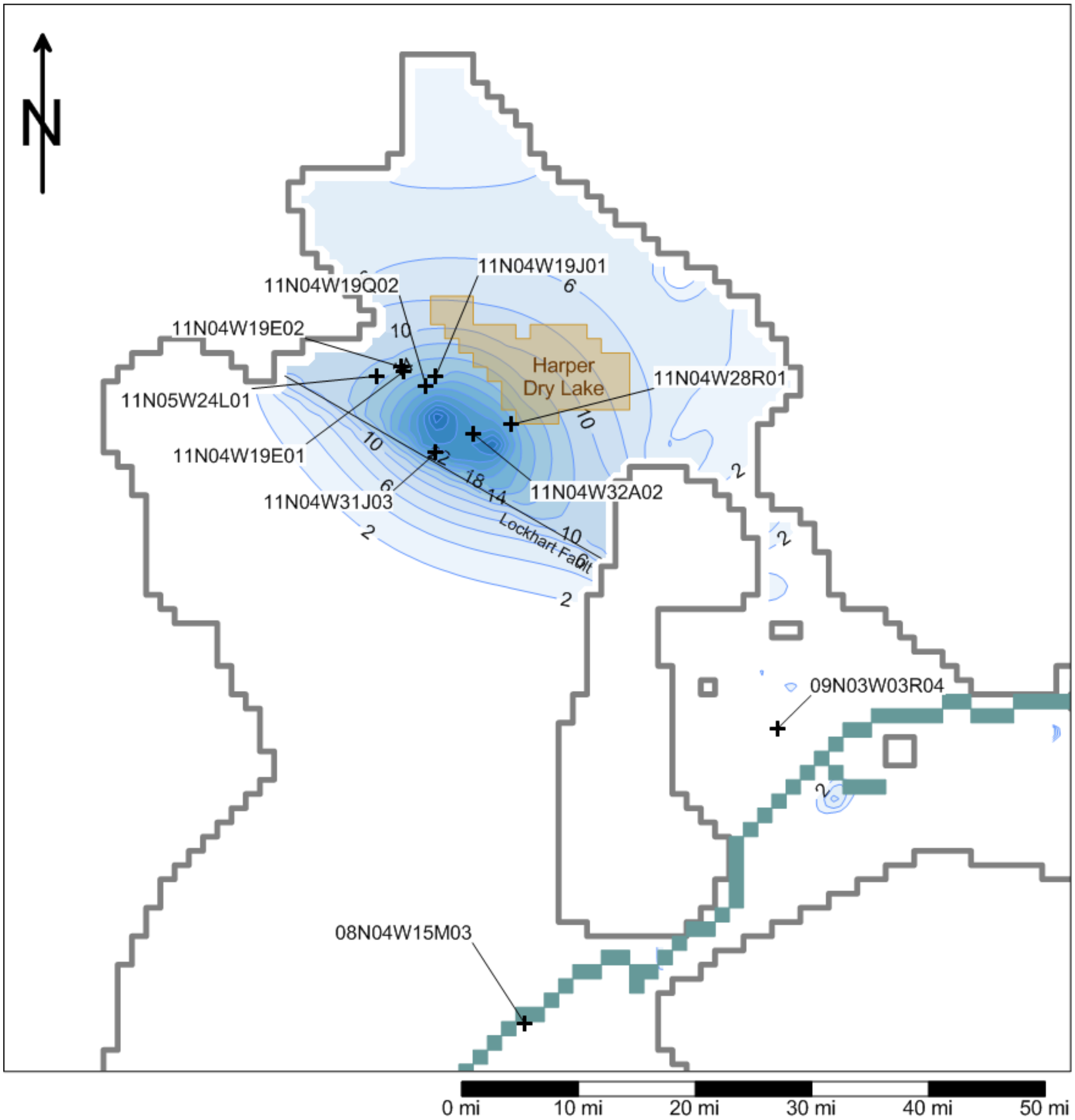

Figure 31-2: Drawdowns relative to predevelopment (2010) water levels at the end of 2042 (end project life) with all existing wells and the Abengoa Solar Energy Project proposed wells pumping.

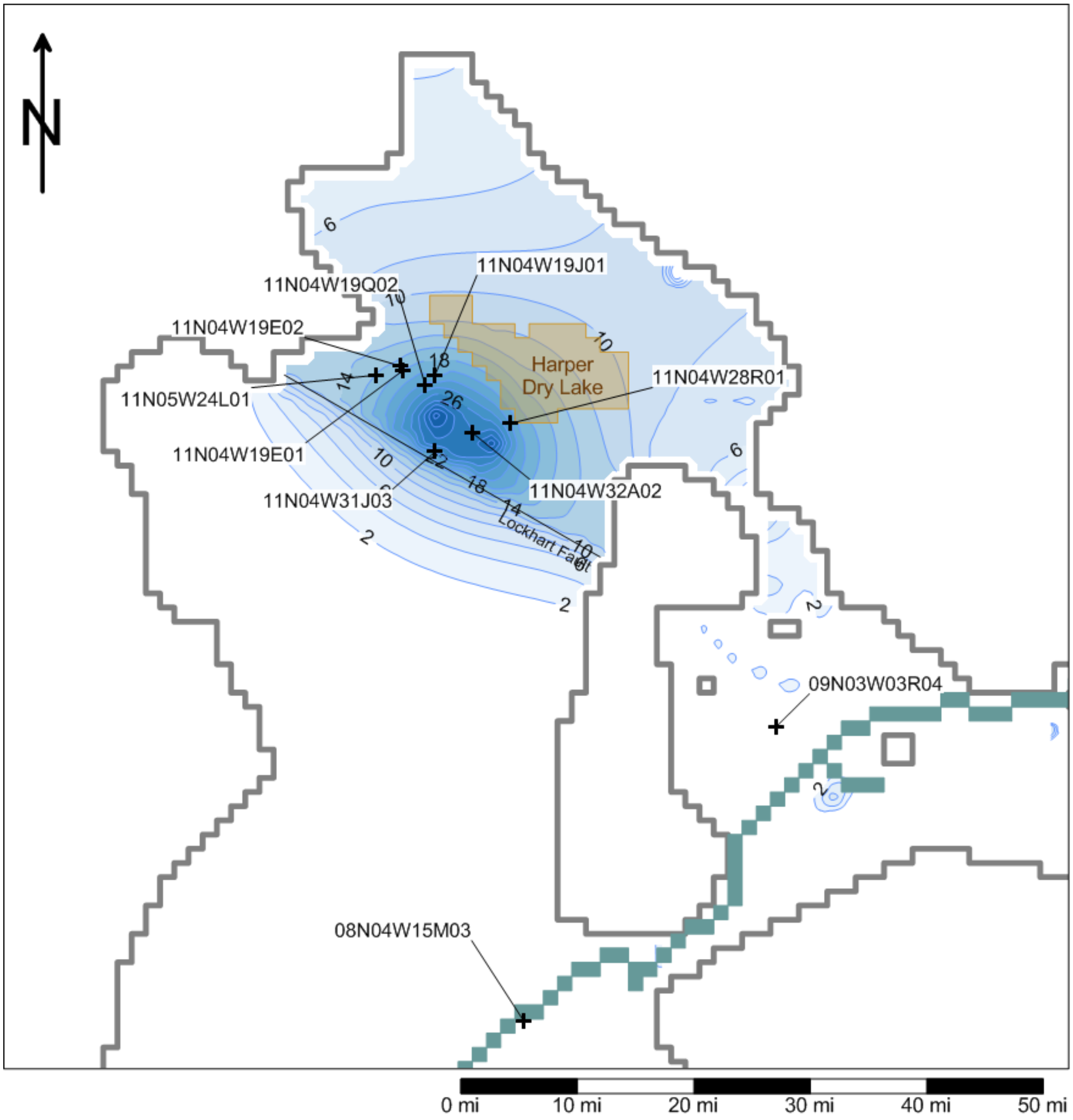

Figure 31-3: Drawdowns relative to predevelopment (2010) water levels at the end of 2042 (end project life) with all existing wells pumping an additional 10 percent and the Abengoa Solar Energy Project proposed wells pumping at their average rate of 670 gpm.

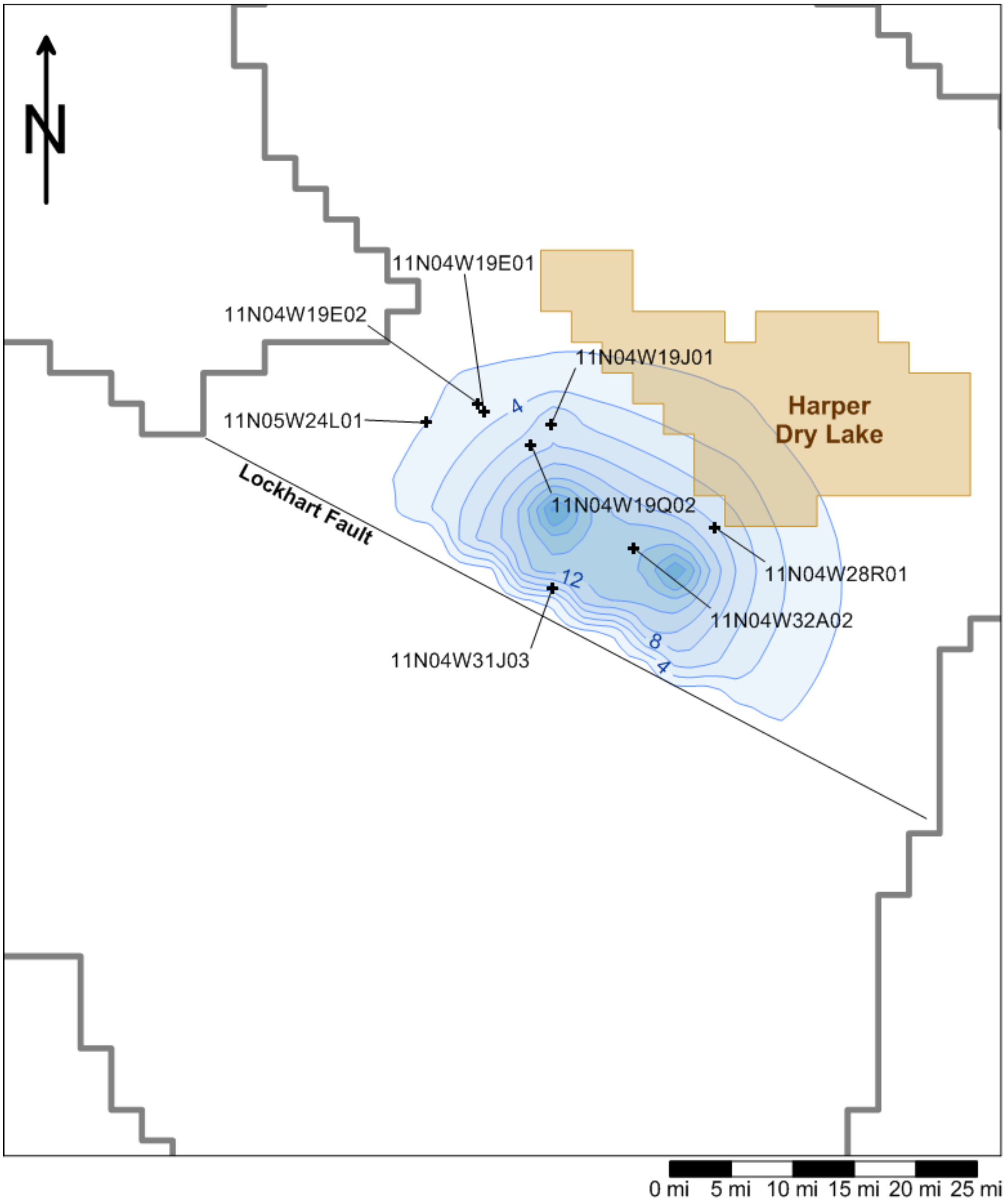

Figure 41A-1: Drawdowns relative to predevelopment (2010) water levels at the end of 2012 (end of construction period) with all existing wells and the Abengoa Solar Energy Project proposed wells pumping.

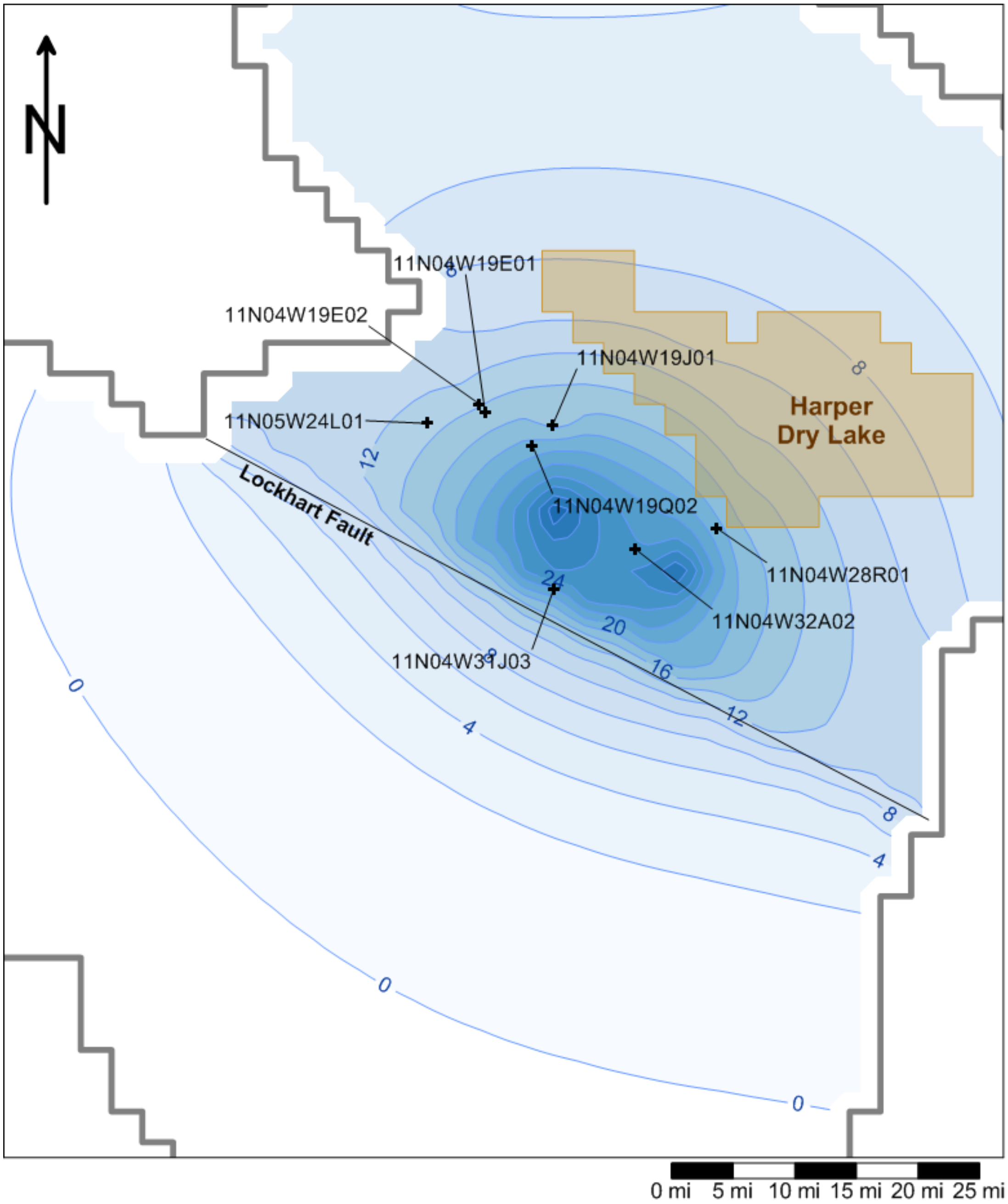

Figure 41A-2: Drawdowns relative to predevelopment (2010) water levels at the end of 2042 (end project life) with all existing wells and the Abengoa Solar Energy Project proposed wells pumping.

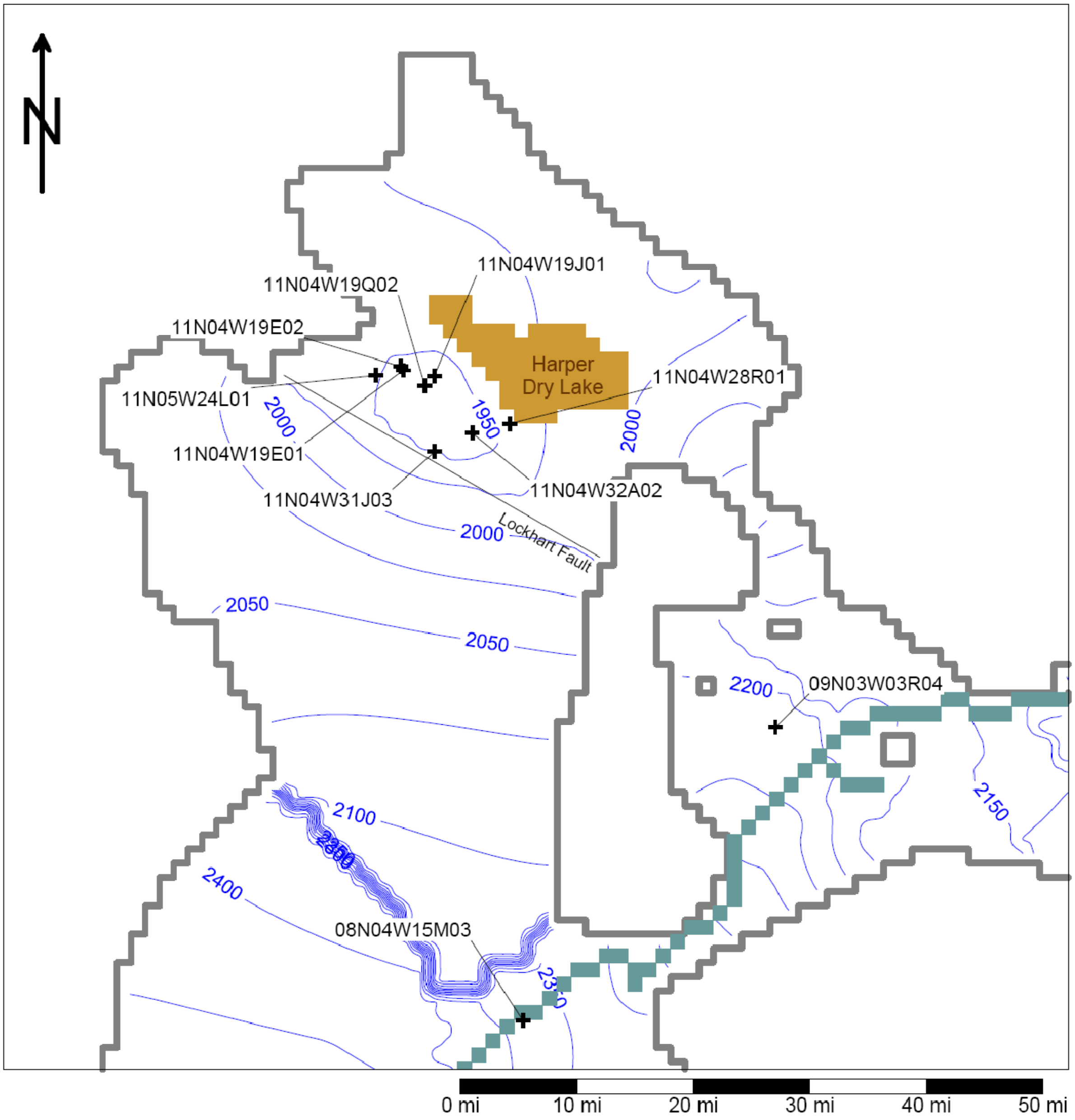

Figure 41B-1. Location of key existing wells near the Abengoa Solar Energy Project site. Hydrographs of select wells are found in Figures 41B-2 through 41B-6.

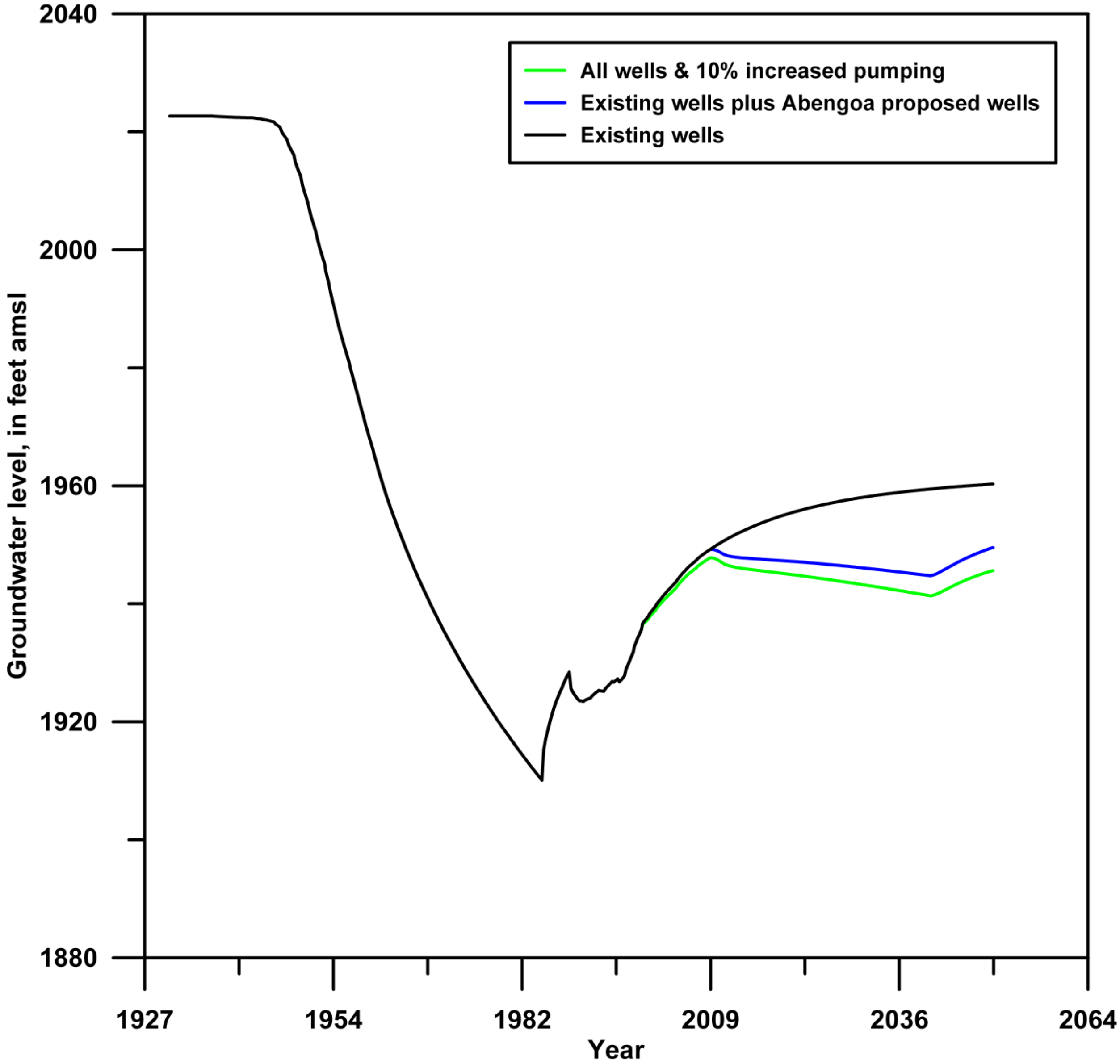

Figure 41B-2. Hydrograph of well 11N04W19E01 from 1931 through 2050.

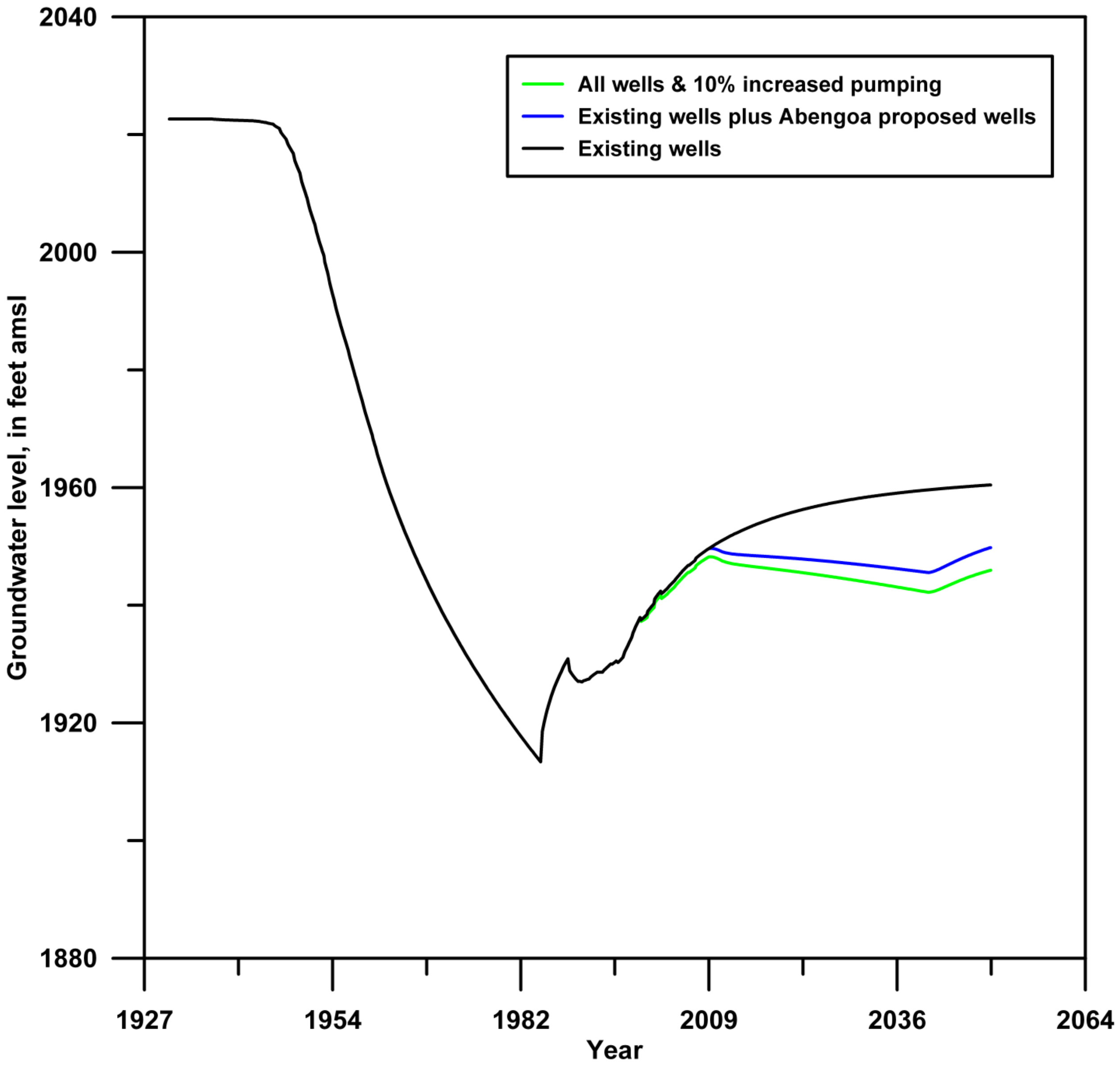

Figure 41B-3. Hydrograph of well 11N04W19E02 from 1931 through 2050.

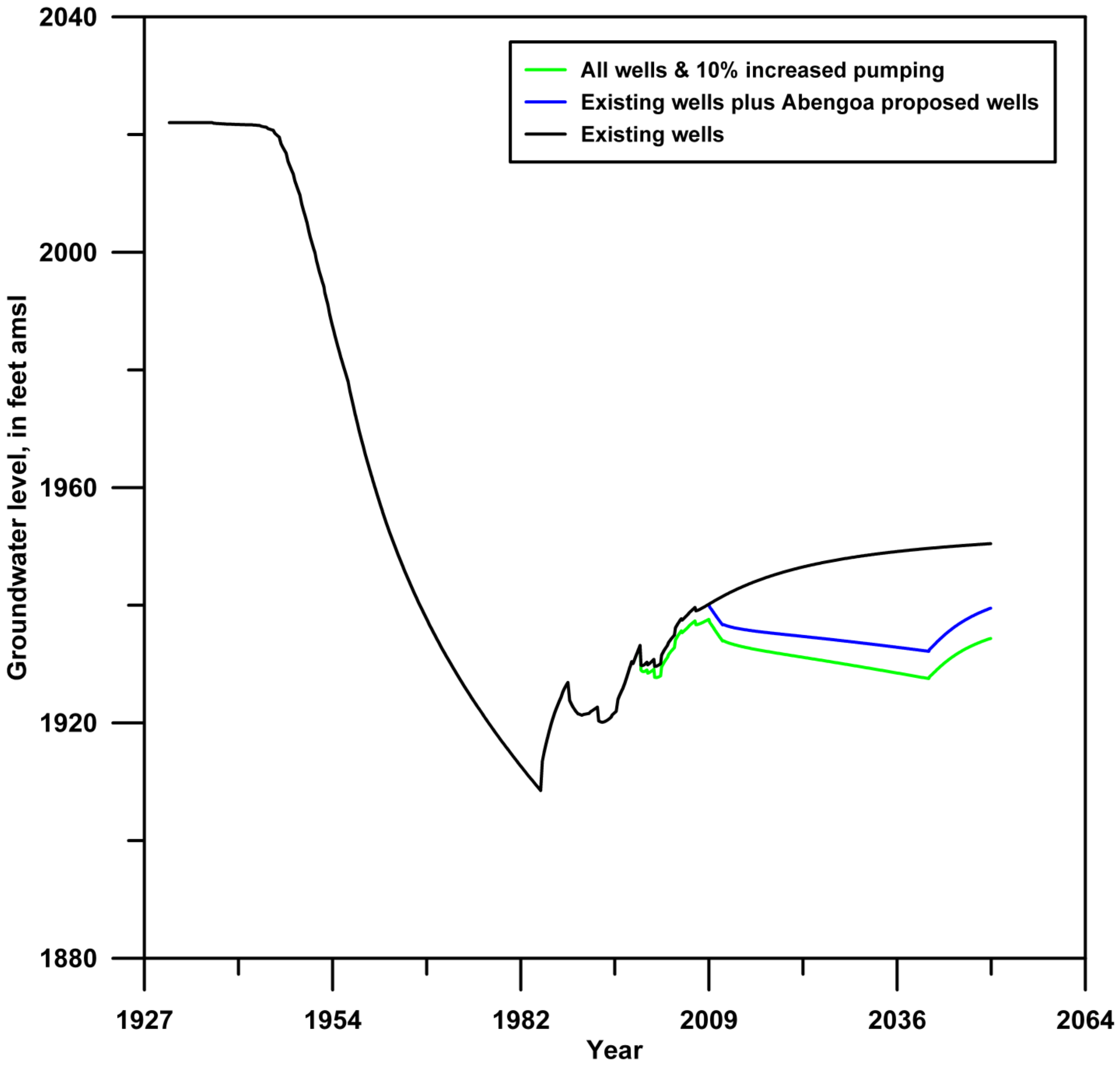

Figure 41B-4. Hydrograph of well 11N04W19J01 from 1931 through 2050.

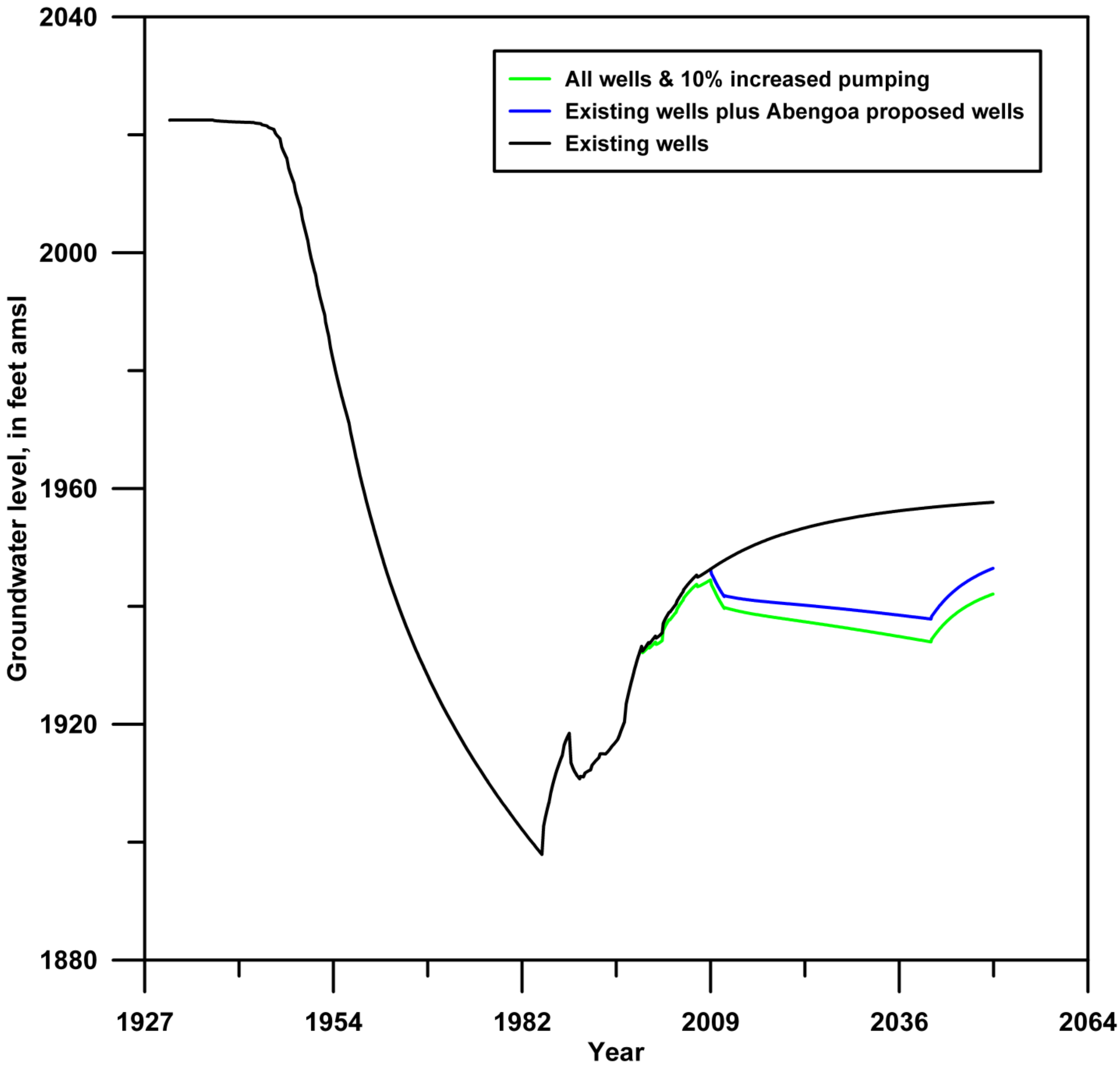

Figure 41B-5. Hydrograph of well 11N04W19Q02 from 1931 through 2050.

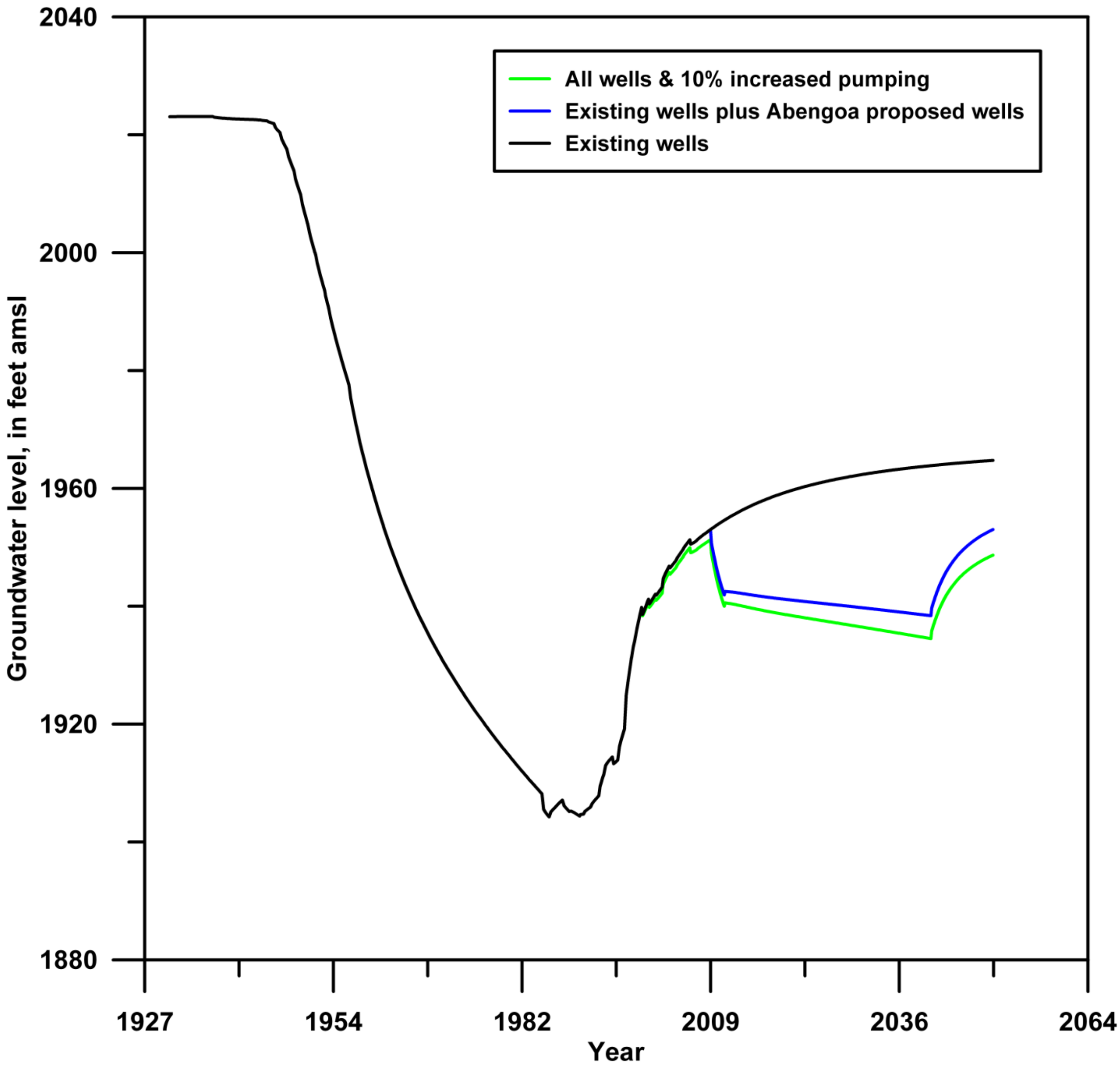

Figure 41B-6. Hydrograph of well 11N04W32A02 from 1931 through 2050.

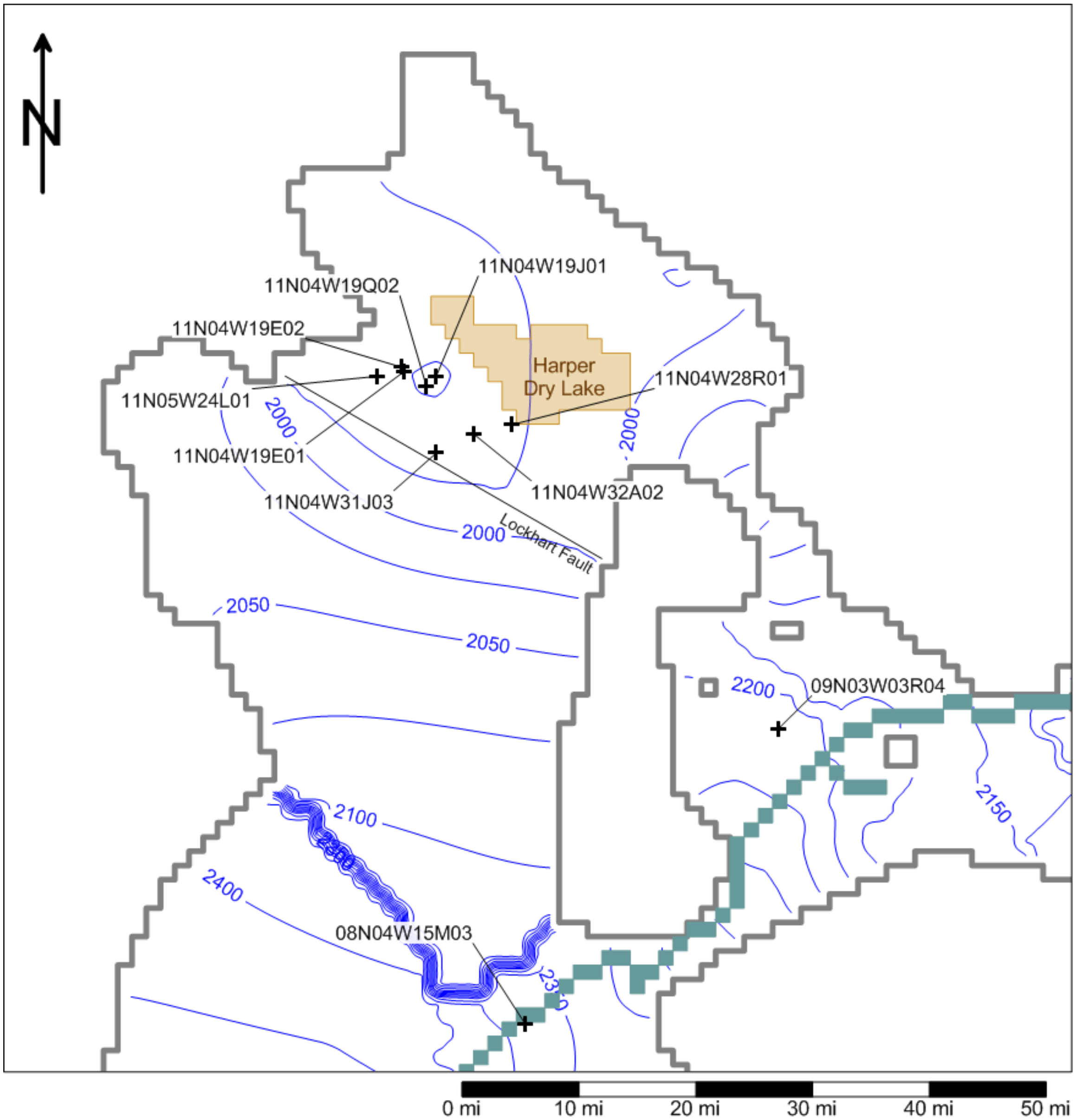

Figure 43-1. Groundwater elevations at the end of 2012 (end of construction period) with all existing wells pumping but excluding the Abengoa Solar Energy Project proposed wells.

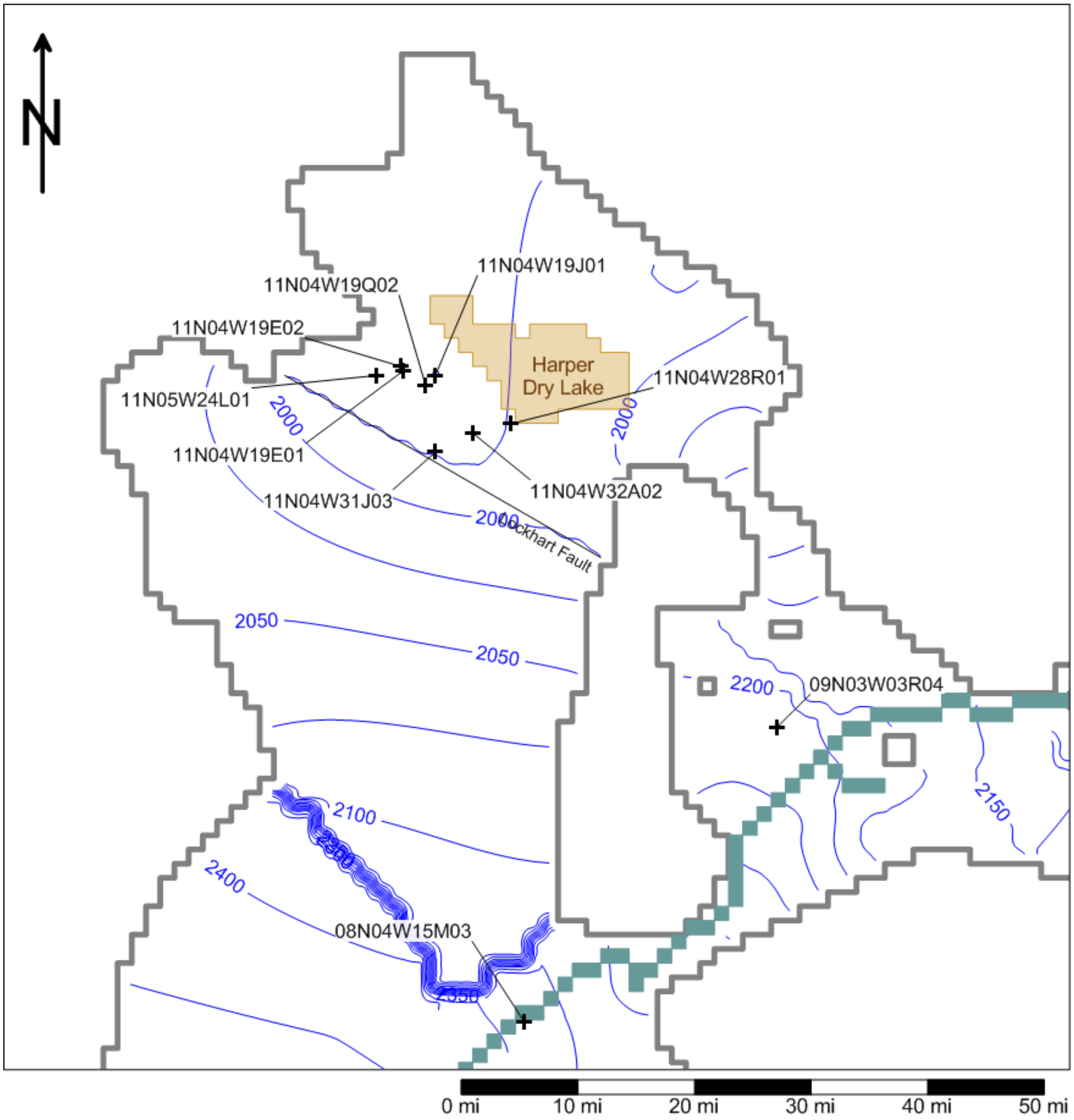

Figure 43-2. Groundwater elevations at the end of 2042 (end of project life) with all existing wells pumping but excluding the Abengoa Solar Energy Project proposed wells.

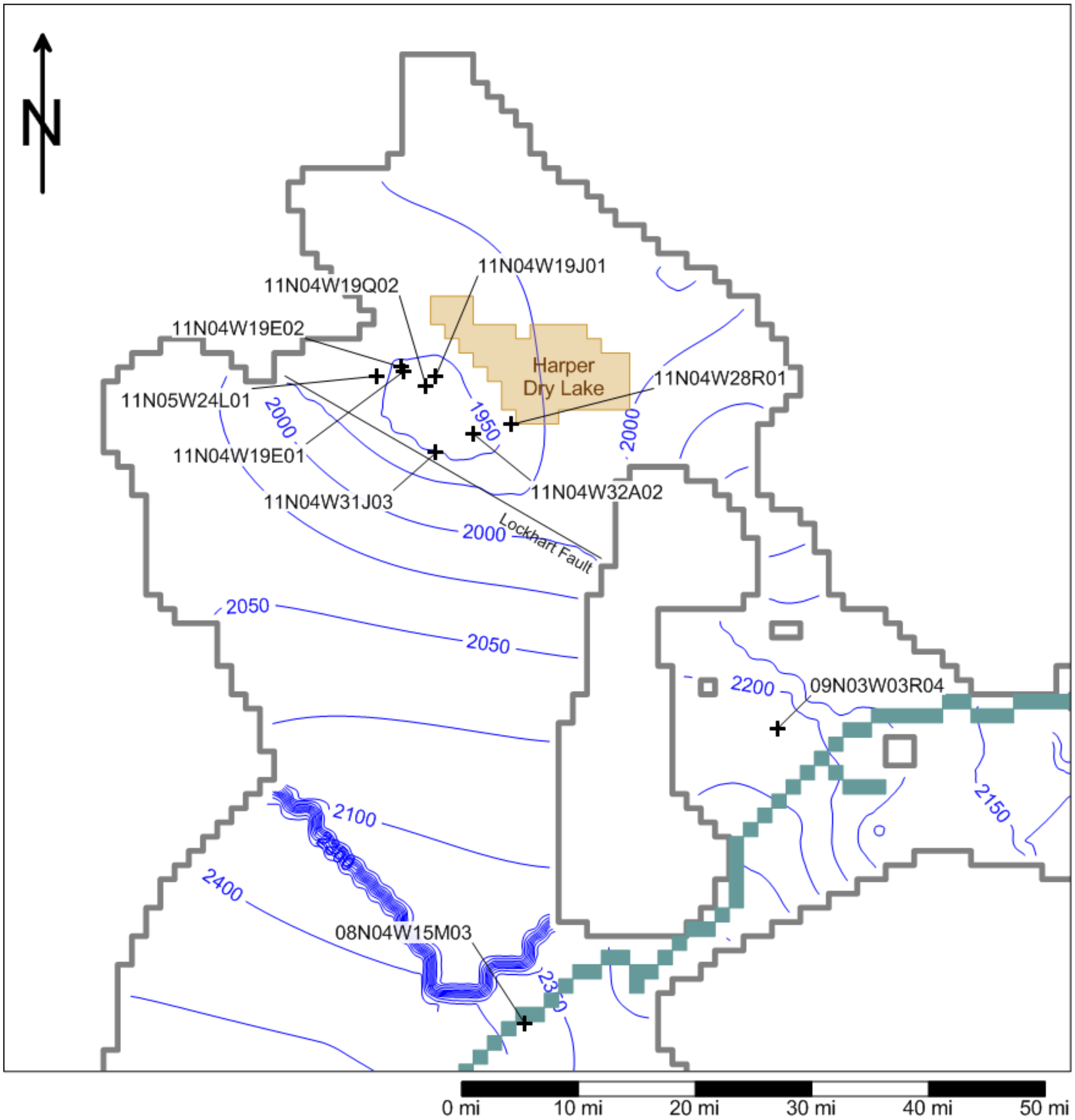

Figure 43-3. Groundwater elevations at the end of 2012 (end of construction period) with all existing wells and the Abengoa Solar Energy Project proposed wells pumping.

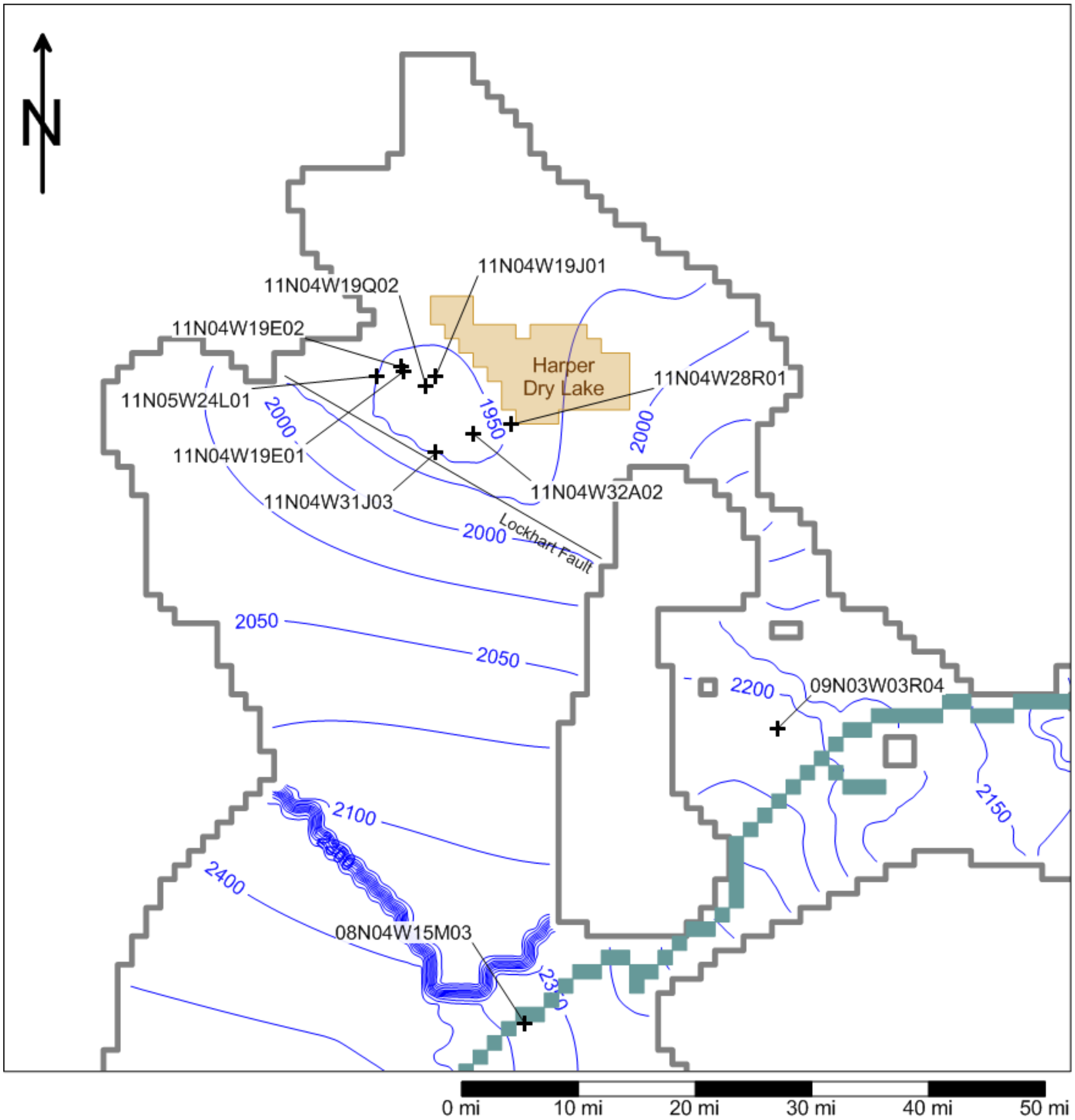

Figure 43-4. Groundwater elevations at the end of 2042 (end of project life) with all existing wells and the Abengoa Solar Energy Project proposed wells pumping.

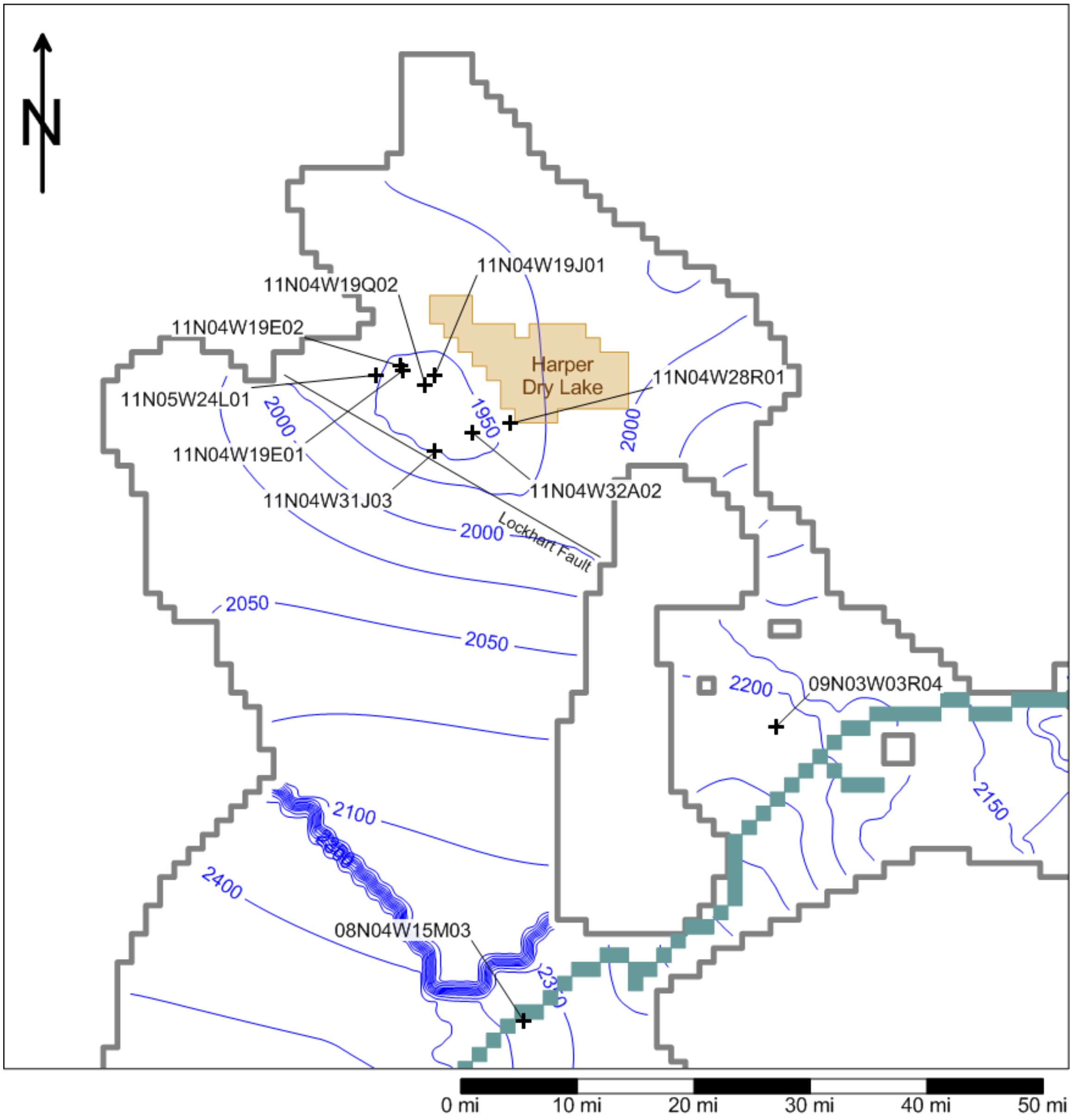

Figure 43-5. Groundwater elevations at the end of 2012 (end of construction period) with all of the existing wells pumping rates increase by 10% and the Abengoa Solar Energy Project proposed wells pumping at 670 gpm.

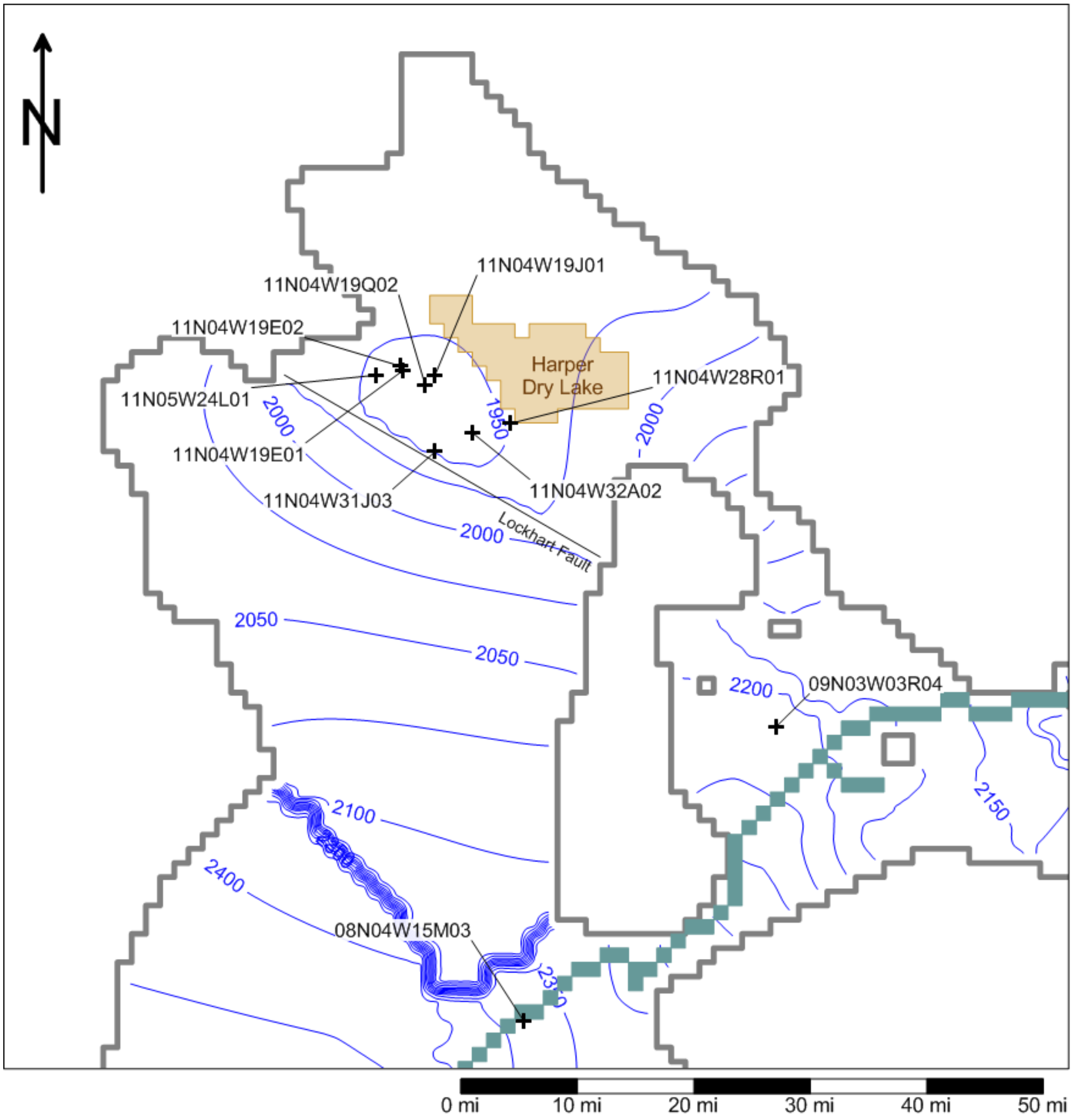

Figure 43-6. Groundwater elevations at the end of 2042 (end of project life) with all of the existing wells pumping rates increase by 10% and the Abengoa Solar Energy Project proposed wells pumping at 670 gpm.

Appendix 35-1

days that the mean daily inflow from The Forks exceeded 200 ft^3/s during the year (sections 3–5), (2) the number of days that inflow from The Forks exceeded 200 ft^3/s during the year and whether there was inflow from ungaged tributaries (sections 13–18), and (3) whether there was inflow from ungaged tributaries (sections 19–27). (See "Simulation of Transient-State Conditions" for further discussion of the stress periods). Years with similar flow regimes were grouped together in an effort to determine a relation between inflow and stream conductance. In doing so, the results of the model simulations may not duplicate exactly the actual system for every year; therefore, these streambed conductance values should be considered approximations to be improved upon by future studies.

Simulation of Recharge

Recharge to the ground-water system includes seepage loss from the Mojave River (discussed in the preceding section), mountain-front recharge (infiltration of runoff from selected washes and mountains along the southern boundaries) and artificial recharge (irrigation-return flow, fish hatchery return flow, imported water, treated sewage, and septic effluent).

Mountain-Front Recharge

Most mountain-front recharge occurs during wet years as storm runoff infiltrates the alluvial fan deposits of the regional aquifer. Recharge occurs mostly in the upper reaches of ephemeral streams and washes that lie

Table 7. Streambed-conductance values and associated flow conditions for stress periods used in the streamflow-routing package in the model of the Mojave River ground-water basin, southern California

[See figure 22 for location of river sections. na, not applicable because flow conditions affecting streambed-conductance values during wet stress periods pertain only to river sections 3–5 and 13–18; ft^2/s, square foot per second; ft^3/s, cubic foot per second; acre-ft, acre-foot; ≥, greater than or equal to]

River section	Streambed conductance (ft^2/s)		Flow conditions affecting streambed-conductance values during wet stress periods			Comments
	Wet stress period	Dry stress period	Number of days of inflow from The Forks (mean daily discharge ≥200 ft^3/s)	Total inflow from The Forks (acre-ft)	Average daily inflow from The Forks (acre-ft)	
1,2	0.2	0.2	na	na	na	
3–5	.1	.8	0	1,800–3,600	10–20	
	.7	.8	1–3	400–1,400	400–700	
	.6	.8	1–10	1,400–10,000	450–2,650	
	3.0	.8	3–8	11,000–19,000	1,500–3,800	
	1.5	.8	15–20	10,000–23,000	600–1,100	
	1.8	.8	24–103	25,000–204,000	780–2,500	
	2.5	.8	108–138	245,000–400,000	1,980–3,700	
6,7	1.0	.1	na	na	na	
8,9	.1	.1	na	na	na	
10	3.1	3.0	na	na	na	
11,12	1.1	.1	na	na	na	
13–18	3.5	2.5	0–6	na	na	
	2.5	2.5	na	na	na	Years with ungaged tributary flow to the river
	2.0	2.5	na	na	na	All other years
19–24	3.0	.1	na	na	na	Years with ungaged tributary flow to the river
	2.0	.1	na	na	na	All other years
25–27	2.0	.1	na	na	na	Years with ungaged tributary flow to the river
	.2	.1	na	na	na	All other years

between the headwaters of the Mojave River and Sheep Creek. In the Baja subarea, some recharge occurs near Coyote Lake and from Kane Wash (near Troy Lake) (fig. 1). Mountain-front recharge was simulated as areal recharge to layer 1; the locations of the recharge cells are shown in figure 18. According to concurrent studies by the USGS (Izbicki and others, 1995; John A. Izbicki, U.S. Geological Survey, oral commun., 1996; Michel, 1996; Gregory C. Lines, U.S. Geological Survey, oral commun., 1996), mountain-front recharge occurs primarily in the upper reaches of the ephemeral streams and washes and, therefore, recharge was simulated in parts of the southern boundaries of the Este, Alto, and Oeste model subareas (fig. 18). Recharge also was applied to the Coyote Lake area and at a few cells near the mouth of Kane Wash. Areal recharge was applied at a constant rate and was determined by model calibration. The model-calibrated areal recharge values, in acre-ft/yr, for the following are Oeste, 1,940; Alto, 7,760; Este, 1,030; Coyote Lake, 260; and Kane Wash, 650.

Artificial Recharge

The main sources of artificial recharge to the basin have been irrigation-return flow, fish hatchery return flow, imported SWP water at the MWA Morongo basin pipeline turnout, treated sewage effluent, and seepage from septic systems.

Irrigation-Return Flow

Recharge from irrigation-return flows was simulated in layer 1 using injection wells in the same areal location that the pumping occurred. For example, when pumping for irrigation occurred in layer 2, row 125, column 60, the return-flow recharge was simulated in layer 1, row 125, column 60. No return-flow recharge was applied to areas of perched water (fig. 11).

As discussed earlier, Hardt (1971) reported only net pumpage for 1931–50 and, therefore, 1931–50 irrigation-return flows were assumed to be 40 percent of the total agricultural pumpage in the Alto subarea and 50 percent in all other subareas. For 1951–94, the return-flow percentages were based on the method used to calculate total agricultural pumpage for 1986–94 (Robert Wagner, James C. Hanson Engineering, written commun., 1995) and consumptive-use rates in each model subarea (U.S. Department of Agriculture, 1967). The estimated return flows were 46 percent for the Alto, Transition zone, and Este model subareas; 35 percent for the Centro and Harper Lake model subareas; and 29 percent for the Baja and Coyote Lake model subareas. For 1951–73, the estimated return flow for the area along the Mojave River between the Jess Ranch and Mojave River Fish Hatcheries in the Alto model subarea was 70 percent. These higher estimates were based on comparisons of land-use data from historical areal photographs, consumptive-use rates of alfalfa (7.0 ft/yr), reported pumpage, and model calibration.

Recharge from irrigation-return flows to the regional-aquifer system was not estimated for the Oeste model subarea because of perched water-table conditions (fig. 11). Smith and Pimentel (2000) reported the mounding of ground water in a perched aquifer system which probably is the result of irrigation-return flow. Although this water eventually may reach the regional aquifer system, model calibration results indicate that the perched water is not a significant source of recharge to the regional system.

Fish Hatchery Discharge and Imported Water

Discharge from the Mojave River and Jess Ranch Fish Hatcheries, and imported water from the MWA pipeline is released directly to the river, therefore, these sources were simulated in the model using the Streamflow-Routing package and treated as artificial tributaries (figs. 18 and 22). The annual release rates for the fish hatchery return flows and the imported water are presented in table 4.

Treated Sewage Effluent

Treated sewage effluent from VVWRA that is discharged directly to the Mojave River in the Transition zone model subarea was simulated using the Streamflow-Routing package and treated as an artificial tributary (figs. 18 and 22). Sewage effluent that is routed to the VVWRA seepage ponds and thus not discharged directly to the river was simulated as injection wells at the corresponding model cells in layer 1.

Injection wells also were used to simulate the sewage discharged to seepage ponds from the city of Barstow in the Centro model subarea, and sewage effluent in the USMC Nebo and Yermo Annexes in the Baja model subarea. The annual discharge rates for sewage effluent are shown in table 4.

Septic Systems

Effluent from the septic systems in the Alto subarea was simulated as areal recharge to layer 1. Areal recharge was applied to the number of acres necessary to accommodate the population estimated for a 10-year period (fig. 18 and table 5).

Simulation of Discharge

The principal components of ground-water discharge from the aquifer system are pumpage, evapotranspiration, seepage to the Mojave River, and underflow through Afton Canyon out of the basin. Seepage of ground water to the Mojave River is discussed in the "Stream-Aquifer Interactions" section of this report, and underflow at Afton Canyon is discussed in the "Model Boundary Conditions" section.

Pumpage

Ground-water pumpage is the principal source of discharge from the aquifer system. For this report, pumpage is divided into five main categories of usage: (1) agricultural, all water pumped for irrigation in the basin; (2) municipal and industrial, water pumped by the various cities, individual water districts, and the military; (3) fish hatcheries, water pumped for circulation in fish-rearing ponds; (4) lakes, recreational lakes in the Baja subarea; and (5) domestic. Generally, domestic pumpage is not a significant component of the total annual ground-water production and thus is considered negligible for modeling purposes. All simulated pumpage was extracted from layer 2 in the model. In areas where layer 2 did not exist, pumpage was extracted from layer 1. Along the river, both layers have similar hydrologic properties and most wells are perforated in the younger alluvium (Qya) which extends to layer 2 (fig. 9).

The estimated total annual pumpage from wells in each of the model subareas in the Mojave River ground-water basin for 1931–99 is shown in figure 23. Annual pumpage in the Mojave River ground-water basin was estimated during several previous studies; however, the reports of these studies do not cover all

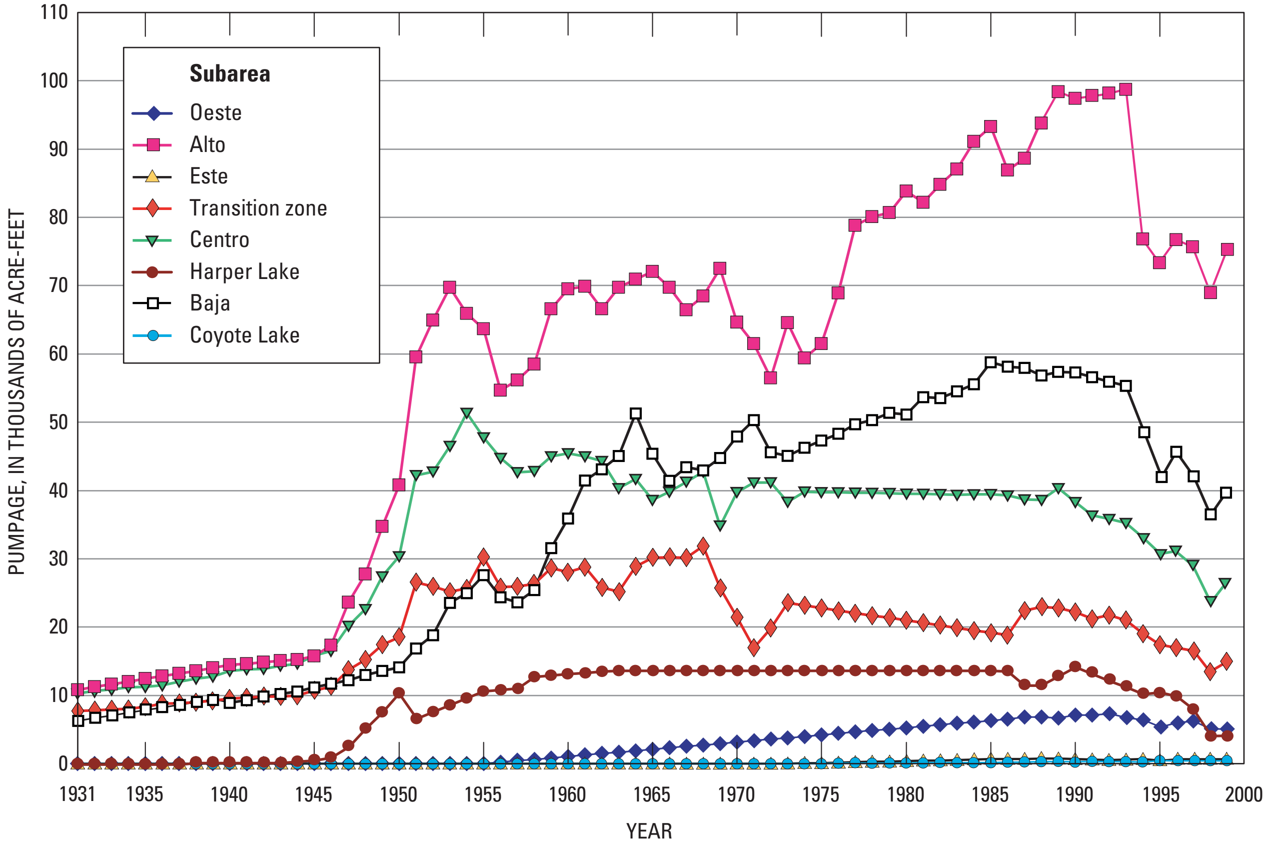

Figure 23. Total pumpage by model subarea for the Mojave River ground-water basin, southern California, 1931–99. (See figure 18 for location of model subareas.)

STATE OF CALIFORNIA

Energy Resources Conservation
and Development Commission

Application for Certification for the ***ABENGOA MOJAVE SOLAR POWER PLANT***	))))	Docket No. 09-AFC-5

PROOF OF SERVICE

I, Karen A. Mitchell, declare that on December 23, 2009, I served the attached *Supplemental Responses to CEC Data Requests, Set 1B* via electronic mail and United States Mail to all parties on the attached service list.

I declare under the penalty of perjury that the foregoing is true and correct.

Karen A. Mitchell

Karen A. Mitchell

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT
COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228 – WWW.ENERGY.CA.GOV

APPLICATION FOR CERTIFICATION
FOR THE *ABENGOA MOJAVE*
SOLAR POWER PLANT

Docket No. 09-AFC-5

PROOF OF SERVICE

(Revised 11/10/09)

APPLICANT

Emiliano Garcia Sanz
General Manager
Abengoa Solar Inc.
11500 West 13th Avenue
Lakewood, CO 80215
emiliano.garcia@solar.abengoa.com

Scott D. Frier
Chief Operating Officer
Abengoa Solar Inc.
13911 Park Ave., Ste. 206
Victorville, CA 92392
scott.Frier@solar.abengoa.com

Tandy McMannes
2030 Addison Street, Suite 420
Berkeley, CA 94704
tandy.mcmannes@solar.abengoa.com

APPLICANT'S CONSULTANTS

Frederick H. Redell, PE
Redell Engineering, Inc.
1820 E. Garry Ave., Ste. 116
Santa Ana, CA 92705
fred@redellengineering.com

COUNSEL FOR APPLICANT

Christopher T. Ellison
Ellison, Schneider & Harris
2600 Capitol Ave.
Sacramento, CA 95816
cte@eslawfirm.com

INTERESTED AGENCIES

California ISO
e-recipient@caiso.com

INTERVENORS

***California Unions for Reliable Energy ("CURE")**
Tanya A. Gulesserian
Marc D. Joseph
Adams Broadwell Joseph & Cardozo
601 Gateway Boulevard, Suite 1000
South San Francisco, CA 94080
tgulesserian@adamsbroadwell.com

ENERGY COMMISSION

JULIA LEVIN
Commissioner and
Presiding Member
jlevin@energy.state.ca.us

JAMES D. BOYD
Vice Chairman and
Associate Member
jboyd@energy.state.ca.us

Paul Kramer
Hearing Officer
pkramer@energy.state.ca.us

Chris Hoffman
Project Manager
choffman@energy.state.ca.us

Christine Hammond
Staff Counsel
chammond@energy.state.ca.us

Public Adviser's Office
publicadviser@energy.state.ca.us

*indicates change