2127 General

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

DATE: May 4, 1995
IN REPLY REFER TO: ESH-18/WQ&H-95-0208
MAIL STOP: K497
TELEPHONE: (505) 667-0313

Joseph C. Vozella, Chief
Environment, Safety, and Health
DOE/LAAO, MS A316
Los Alamos, NM 87544

SUBJECT: **REPLY TO NMED COMMENTS ON MAIN AQUIFER WATER LEVEL MAPS FOR LOS ALAMOS NATIONAL LABORATORY**

Dear Mr. Vozella:

This letter addresses "New Mexico Environment Department Hazardous and Radioactive Material Bureau response to DOE deliverable, dated December 27, 1994, to EPA on 'Water-Level Maps for Los Alamos National Laboratory (LANL)' ", dated January 23, 1995.

These maps were prepared in response to a letter received July 19, 1994 by Joseph C. Vozella (DOE/LAAO) from William K. Honker (EPA). This letter requested "ground water potentiometric maps which depict actual conditions at the facility" for the main and perched intermediate aquifers. On about August 12, 1994 Bruce Gallaher (LANL ESH-18) telephoned Barbara Driscoll (EPA) to discuss this request. She requested a map depicting current non-pumping water levels in the main aquifer, and a map showing where saturation occurs in wells completed in the intermediate perched zone.

On August 19, 1994 Theodore Taylor (DOE/LAAO) wrote William K. Honker (EPA) to outline how LANL would meet the revised request for a water-level map of the main aquifer. This letter stated that we would "depict, very approximately, the actual conditions of the main aquifer". An enclosure described the best possible main aquifer potentiometric map which could be generated, which would include static water levels measured at the eight test wells, and non-pumping water levels at the operating water supply wells.

Our deliverable "Water-Level Maps for Los Alamos National Laboratory (LANL)", dated January 23, 1995 fulfilled the requirements specified in discussions with EPA, and we stand behind it as being the best possible main aquifer potentiometric map that could be generated with the information at hand. This work was completed in keeping with accepted hydrogeological methodology for producing such maps, and the limitations of the map were fully discussed, both in the accompanying report, and beforehand with EPA.

The ESH-18 Hydrology Team, along with Alan Stoker (SAIC), and Ken Zamora and Bonnie Koch (DOE/LAAO), met with Teri Davis and Susan Hoines of NMED/HRMB on January 30, 1995 to discuss the January 23, 1995 NMED/HRMB response to our water level maps. During this meeting, NMED noted some typographical errors in our report, and mentioned their disagreement on a number of issues, which related to differences in hydrogeological interpretation or to questions which cannot be resolved without additional data. LANL and DOE personnel noted their disagreement with NMED/HRMB on many of these issues.

A subsequent letter from Ron Kern (NMED/HRMB) to Bonnie Koch, dated February 10, 1995 stated that most of HRMB's concerns regarding the water level maps were agreed with by LANL personnel at the meeting. A reply from Theodore Taylor (DOE/LAAO) to Ron Kern, dated March 21, 1995 noted that LANL and LAAO disagreed with many of the NMED/HRMB comments.

In order to clarify the outcome of the January 30, 1995 meeting, our reply to the individual NMED/HRMB comments (dated January 23, 1995) follows. The NMED/HRMB comments are paraphrased in italics.

1) What evidence is there that the White Rock Canyon Springs discharge from the main aquifer? Springs discharge hundreds of feet above the river, which is believed to represent the surface of the main aquifer.

Purtymun et al. (1980) described the hydrogeological setting and chemistry of the White Rock Canyon Springs. They concluded that the springs discharge from the main aquifer because of their geographical setting along the river, and the formations from which they issue. The chemical similarities between the White Rock Canyon Springs and main aquifer waters have also been noted (Purtymun, 1984).

Recent tritium and stable isotope measurements from the White Rock Canyon Springs support Purtymun's (1984) conclusions: the water discharging from the springs apparently has been isolated from the atmosphere for very long time periods (tritium ages are generally 1500 to >10,000 years), and they appear to have been recharged at significantly higher elevations (an average of 7300 ft; the springs are at elevations of 5370 to 5770 ft).

Regarding the relative elevations of the Rio Grande and the main aquifer, Purtymun (1984) notes that above Frijoles Canyon, the river gains in flow through discharge from the aquifer. Below Frijoles Canyon, the river loses flow. Therefore the aquifer elevation is above the river elevation upstream of Frijoles Canyon; downstream the aquifer elevation is below the river.

2) The supply well data represent vertically averaged water levels; it is not accepted practice to contour such data. Compiling such data will probably give a misrepresentative picture of the hydraulic head distribution within the aquifer(s).

It is preferable to use water level data from within a single hydrologic unit when constructing water-level maps. Such information is seldom available, and the hydrologist must make an interpretation based on limited data. Our map was in accordance with our agreement with EPA, that we would produce the best possible main aquifer potentiometric map which could be generated, which would include static water levels measured at the eight test wells, and non-pumping water levels at the operating water supply wells.

In any case, the validity of using potentiometric maps for interpreting flow directions in an aquifer is extremely limited. Freeze and Cherry (1979, p. 49) state that this "traditional concept is not particularly sound but.. is firmly entrenched in usage... The concept of a potentiometric map is only rigorously valid for horizontal flow in horizontal aquifers."

Several examples illuminate what is considered "accepted practice" in constructing regional water table maps, for which there is great latitude. Ortega and Farvolden (1989) analyzed the regional groundwater flow in the basin occupied by Mexico City. They used information from wells, springs, tunnels, highway cuts, and inferences regarding runoff to infer the water table elevation. Meinzer (1923) constructed a water table map for Big Smoky Valley, Nevada. His map was based on (Meinzer, 1923, p. 105) "examining wells and boring holes to the water table, but more largely by interpreting surface indications of shallow water afforded by the moisture in the soil, the soluble salts at the surface, and certain species of native plants". In other areas, water depths were "based on determinations, from the topographic map... of the slope of the land surface and on reasonable assumptions as to the slope of the water table".

Robert Farvolden has served on the faculty at the University of Waterloo, and as Senior Science Counsel for the National Ground Water Association. Oscar Meinzer was the

Ground Water Division Chief of the USGS from 1912 to 1946. In both cases cited, the authors are careful to state the sources and limitations of their information. As more wells are drilled in those areas, the water level maps would be refined.

In order to determine the impact of using water supply wells to draw a water level map, five maps are attached. These maps depict the water table in the Los Alamos area at different times, and using different sets of data. The first shows 1993 main aquifer water levels using springs, test wells, and supply wells; this is the same map that we previously submitted to EPA.

The second map shows 1993 main aquifer water levels using only the test wells. Test Well 1 has been omitted, because it had a 1993 water level 38 ft higher than when it was drilled; this behavior is not understood, and we believe that it may not truly represent conditions at the top of the main aquifer. The maps based only on the test wells also include the elevations of the Rio Grande River at Otowi and Frijoles Canyon, which Purtymun et al. (1980) give as 5512 and 5315 ft. The map based only on test well data differs little from our original 1993 map, which also used the White Rock Canyon springs and water supply wells. The map based only on test wells is extremely limited by lack of areal data coverage, particularly in the area of TW-1. The use of the water supply wells appears to increase the extent of reliable map coverage, without giving different results.

The third and fourth maps show main aquifer water levels using test wells, for 1960 and for 1949-50. The latter map is a hybrid, including the 1960 water levels for TW-8, DT-5A, DT-9, and DT-10. For this reason, the 1960 map is also included. The 1949-50 map includes test well H-19 and the Layne Western well, drilled as a pilot for the Guaje Well Field (Purtymun, 1995). The geographic location of this latter well greatly improves the quality of the map. The 1949-50 and 1960 maps show little difference. Except for the 5700 and 5800 ft contours, these maps also differ little from the USGS pre-development map which we previously submitted to the EPA.

The final map depicts the main aquifer water level decline between 1949 to 1993, based on the test wells. This map is obtained by subtracting the 1949-50 and 1993 maps. The water level decline map is highly speculative: most of the water level decline has occurred in an area where there is no well control on the 1949-50 and 1993 maps, and where the contours on these maps are poorly constrained. The water level decline depicted on this map is consistent with the observations of water level recovery in the former Los Alamos Well Field, and with declines noted for the Pajarito and Guaje Well Fields. Despite a water level decrease of up to 100 ft, the generally east-southeast flow direction suggested by the water level maps has not changed between 1949 and 1950.

3) The reasoning for including the 1949 groundwater elevation data from well H-19 is inadequate, despite the fact that the water level in TW-4, one-half mile to the east, had not changed significantly in the last 45 years... "a change of seven feet in the groundwater level must also be considered not significant". The use of 1949 data for water-level measurements during December 1994 (sic) is not accepted practice.

Regarding the use of the H-19 water level, we stand behind it as being the best possible main aquifer information at hand. For a map with a 100-ft contour interval, and utilizing the sparse data over such a large area, we agree that a seven-foot change in water level is not significant.

4) There are no data to support the 6300 through 6100 ft contour lines. A number of wells have values which are not honored by the contour lines.

First, our agreement with EPA was that we would "depict, very approximately, the actual conditions of the main aquifer". For the 6300 through 6100 ft contour lines, which are a reasonable projection of the information, dashed contours would have been appropriate. Regarding the fact that the contour lines do not fit a number of wells, this is to be expected from the use of both deep and shallower wells to construct the map. A better solution might have been to emphasize test well data in regions where wells have different water levels. Some interpretation and smoothing are required to obtain a reasonable picture of the piezometric surface.

5) Test well 2 is listed as completed in the intermediate perched aquifer.

This was a typographical error; the sentence should have been omitted.

6) The statement "it is apparent that piezometric contour lines in the western and southern portions of the Lab are much closer to their original pre-development positions" can not be made due to lack of control points.

Water level declines are larger in test wells located nearer the water supply well fields. The contours in the southern and western portion of the map, and the statements cited, were based on the observations from Test Wells DT-5A, DT-9, and DT-10, which are located in the southwestern portion of the Laboratory. The water levels in these wells have fallen about 10 to 13 ft since they were drilled in 1960. Production from the nearest water supply wells in the Pajarito Well Field began in 1965; the Guaje and Los Alamos Well Fields were the major sources of water supply prior to 1965.

From 1949 up to 1960, the water level in TW-3, nearest to the Pajarito Well Field, had declined 8.4 ft. Subsequent to 1960, the water level in TW-3 declined an additional 24 ft; the water level decline in TW-8 from 1960 to 1993 was 24.9 ft. The DT series test wells are even further removed from water production at the Guaje and Los Alamos Well Fields, than TW-3. From these facts, it is reasonable to infer that prior to 1960, water levels at the site of the DT series test wells showed less decline than TW-3. Inferences of this sort are consistent with our commitment to EPA that we would "depict, very approximately, the actual conditions of the main aquifer".

7) "... cones of depression can be areally extensive..." The maps do not depict cones of depression. Observation wells are needed to understand flow directions in the main aquifer system.

Barbara Driscoll (EPA) requested a map depicting current non-pumping water levels in the main aquifer. The cones of depression resulting from pumping in the well fields cannot be depicted in a meaningful way given the current information. We offered to address this through numerical modeling, but Barbara Driscoll indicated that the map described would be adequate. We agree that additional observation wells would further define conditions in the main aquifer.

8) The statement "Depth to water in the main aquifer decreases from about 1200 ft along the western margin of the Laboratory, to about 600 ft at the eastern margin" is misrepresentative. Exceptions noted are the near-surface depth of the aquifer along the Rio Grande to the east, and that Well SHB-3 encountered groundwater at 800 ft below the land surface in the west.

The statement refers to the depth of the main aquifer beneath the surface of the Pajarito Plateau, and summarizes our current state of knowledge. The main aquifer lies about 600 ft beneath the rim of White Rock Canyon, at the eastern border of the Laboratory. Groundwater was indeed encountered in Well SHB-3, however Gardner et al. (1993, p. 17) state that "how this groundwater relates to the main aquifer (for example, Purtymun, 1984) will remain uncertain until further tests are performed".

9) The statement "Water within the main aquifer is under artesian conditions" may not *apply to the entire stretch of the river bordering the Lab.*

The statement is consistent with available information from wells, and with Purtymun's (1984) observation that above Frijoles Canyon, the Rio Grande gains flow through discharge from the aquifer. In areas where there is no well control, the main aquifer may indeed not be under artesian conditions.

10) The statement regarding the main aquifer being "under water table conditions in the western and central portions of the Plateau" is inconsistent with Well SHB-3, which encountered water under pressure.

It is not known at present how Well SHB-3 relates to the main aquifer, so it is difficult to apply observations there to the main aquifer.

11) The statement "the recharge area for the main aquifer is located along the western perimeter of the Lab" is too general; and "this hypothesis does not prove that recharge cannot occur from the Pajarito Plateau... LANL's assertion that the main aquifer is only recharged by the western most boundary of the Lab".

These comments result from a misreading of the statement in our report. The rise of the potentiometric surface to the west suggests flow from that direction, and hence recharge from that direction. No claim of a specific recharge source was made; instead, we gave a summary of past views on possible recharge sources, which included the canyons cut into the Plateau.

12) Wells TW-1 and TW-2 should read TW-1A and TW-2A.

This was a typographical error in the text and on the map.

Please call me at (505) 667-0313 or Bruce Gallaher at (505) 667-3040 if further information would be helpful.

Sincerely,

David B. Rogers, Hydrologist,
Water Quality & Hydrology Group

References

Freeze, R. A., and J. A. Cherry, Groundwater, 604 pp., Prentice-Hall, Englewood Cliffs, New Jersey, 1979.

Gardner, J. N., T. Kolbe, and S. Chang, Geology, drilling, and some hydrologic aspects of seismic hazards program core holes, Los Alamos National Laboratory, New Mexico, 19 pp., Los Alamos National Laboratory Report LA-12460-MS, January 1993.

Meinzer, O. E., Geology and water resources of Big Smoky, Clayton, and Alkali Spring Valleys, Nevada, U.S. Geological Survey Water-Supply Paper 423, 167 pp., 1917.

Ortega, A. and R. N. Farvolden, Computer analysis of regional groundwater flow and boundary conditions in the basin of Mexico, Journal of Hydrology, 110, 271-294, 1989.

Purtymun, W. D., R. J. Peters, and J. W. Owens, Geohydrology of White Rock Canyon from Otowi to Frijoles Canyon, 15 pp., Los Alamos National Laboratory Report LA-8635-MS, December 1980.

Purtymun, W. D., Hydrologic characteristics of the main aquifer in the Los Alamos area: development of ground water supplies, 44 pp., Los Alamos National Laboratory Report LA-9957-MS, January 1984.

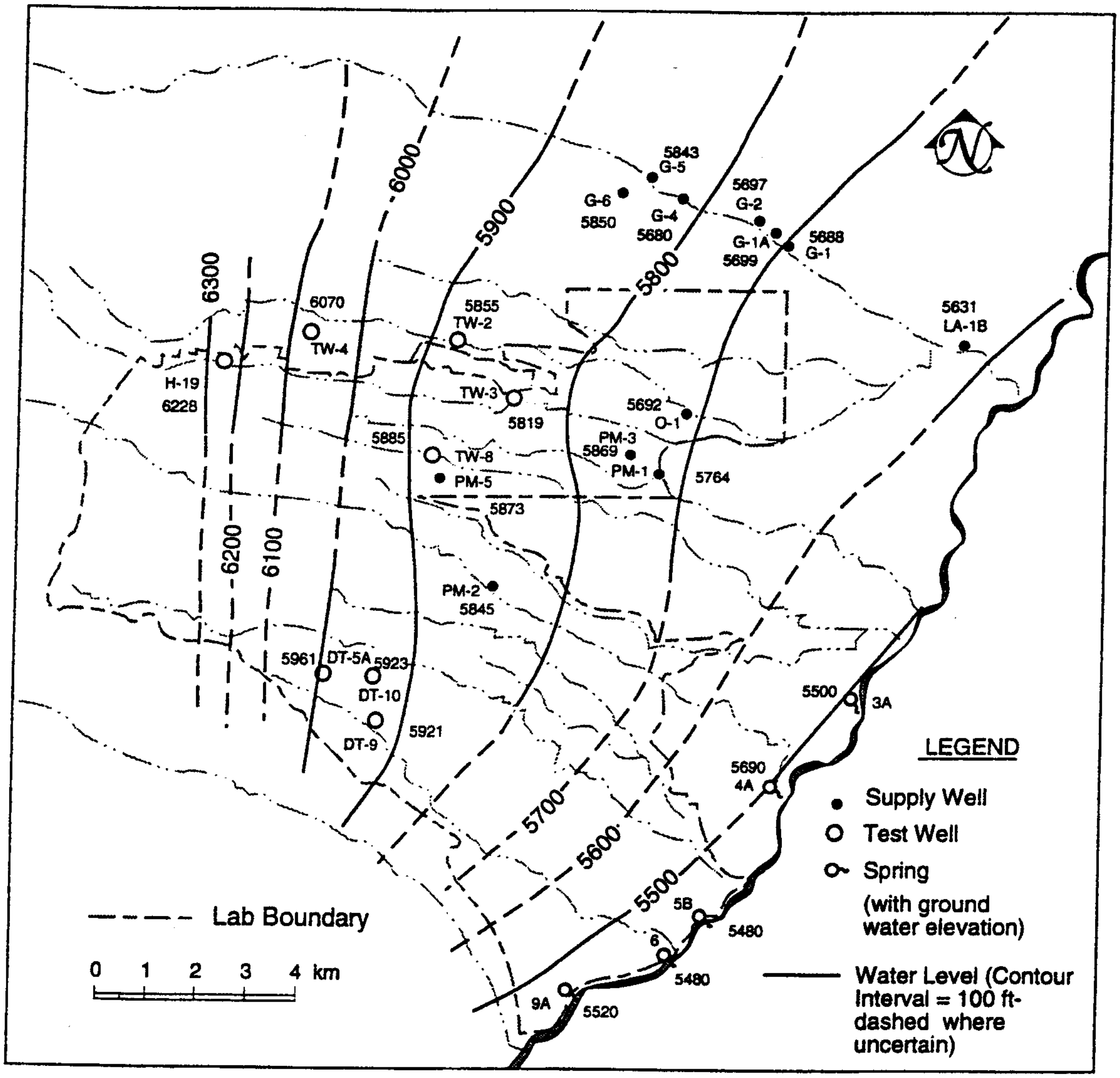
Purtymun, W. D., Geologic and hydrologic records of observation wells, test holes, test wells, supply wells, springs, and surface water stations in the Los Alamos area, 339 pp., Los Alamos National Laboratory Report LA-12883-MS, January 1995.

DBR/dbr

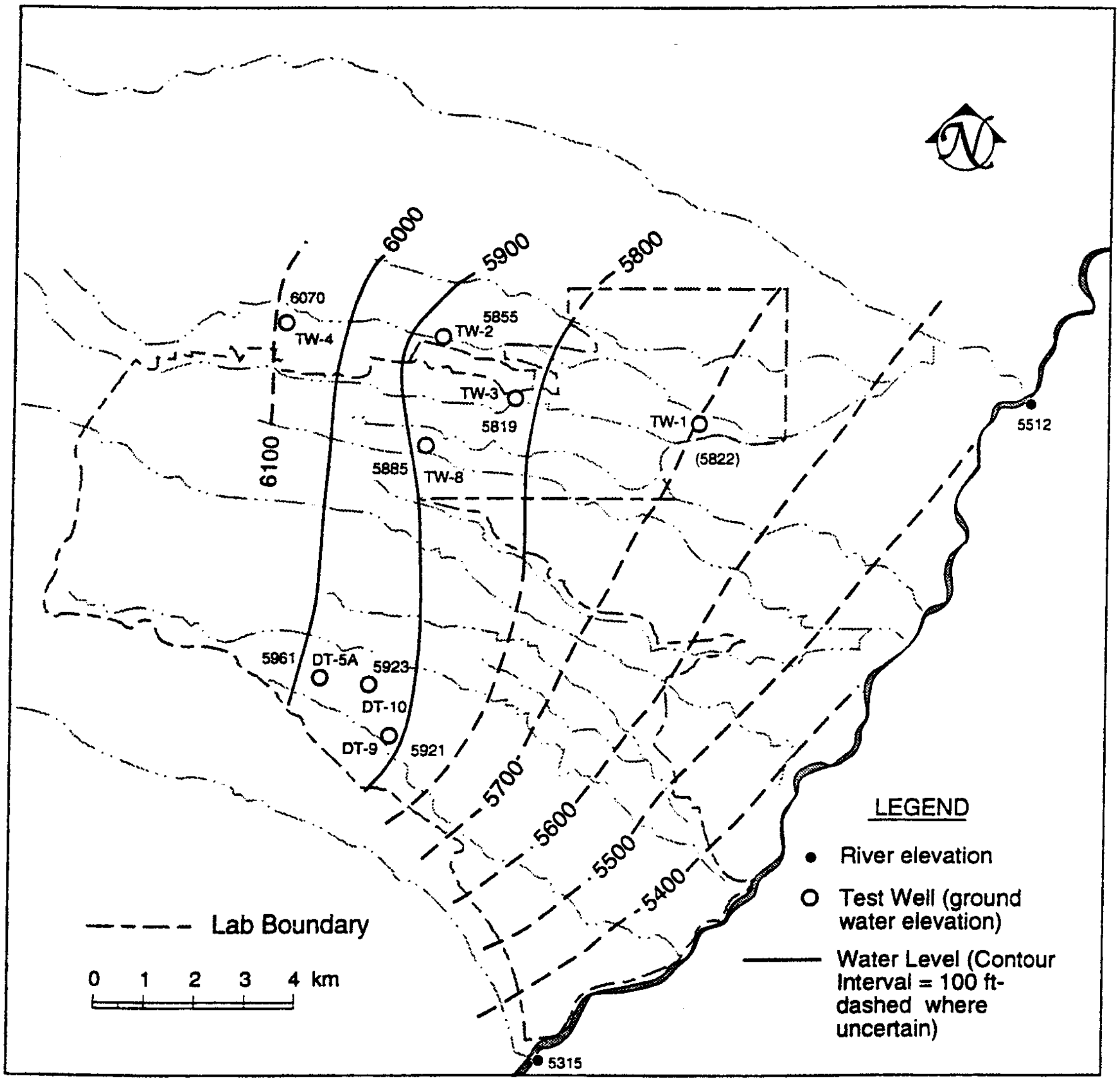
attachments: Map of 1993 main aquifer water levels using springs, test wells, and water supply wells;
Map of 1993 main aquifer water levels using test wells;
Map of 1960 main aquifer water levels using test wells;
Map of 1949-50 main aquifer water levels using test wells;
Map of 1949 to 1993 main aquifer water level decline using test wells.

Cy: WQ&H File, w/att., MS K497

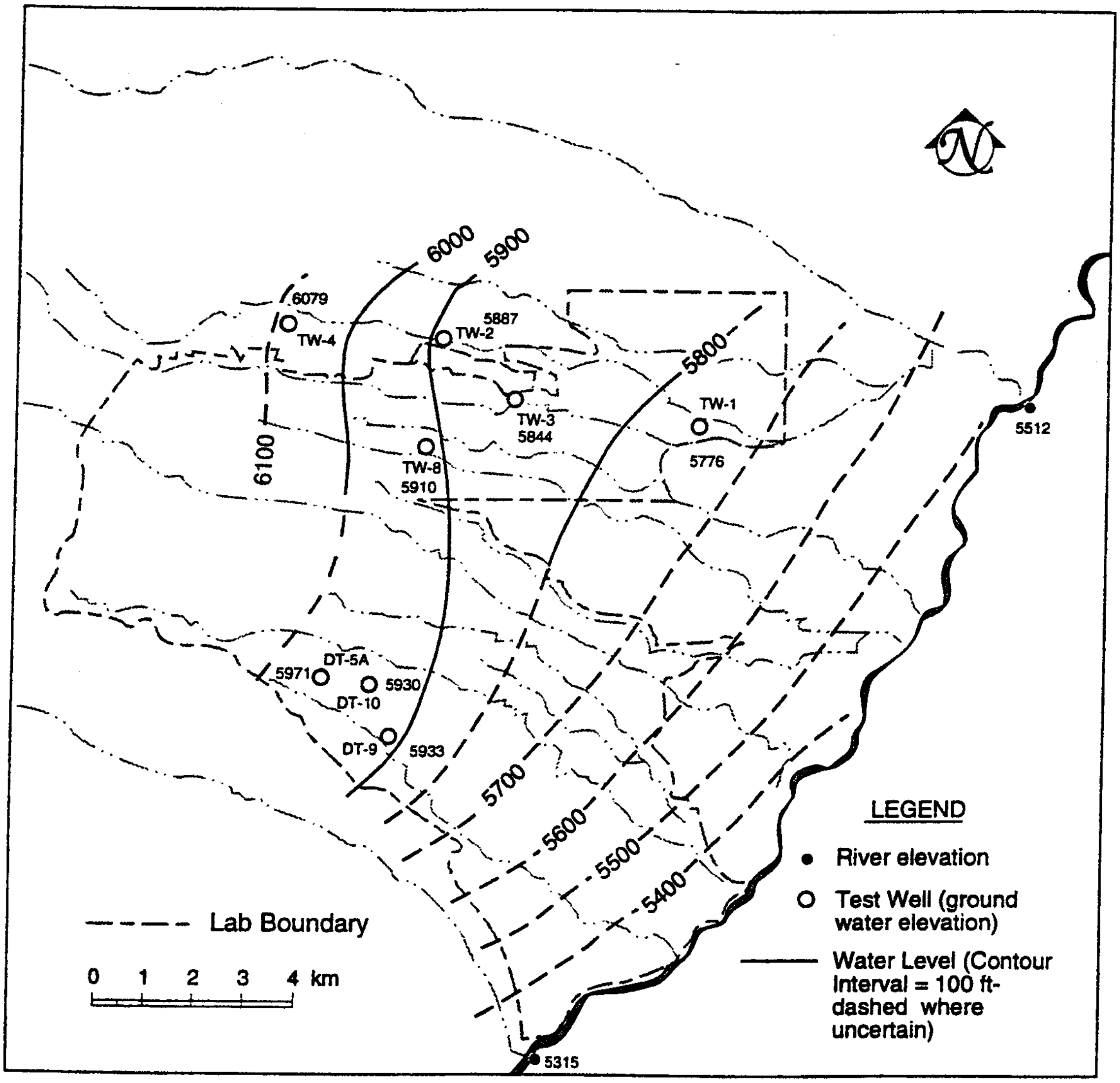
Steve Rae, w/att., ESH-18; MS K497
Bruce Gallaher, w/att., ESH-18; MS K497
Stephen McLin, w/att., ESH-18; MS K497
Bill Purtymun, w/att., ESH-18; MS K497
Pat Shanley, w/att., ESH-19; MS K498
Alan Stoker, w/att., SAIC, MS K497
Bob Hull, w/att., LATA, MS M321
Dave McInroy, w/att., EM/ER/D&D, MS M992
Theodore Taylor, w/att., DOE/LAAO, MS A316
Bonnie Koch, w/att., DOE/LAAO, MS A316
Ken Zamora, w/att., DOE/LAAO, MS A316



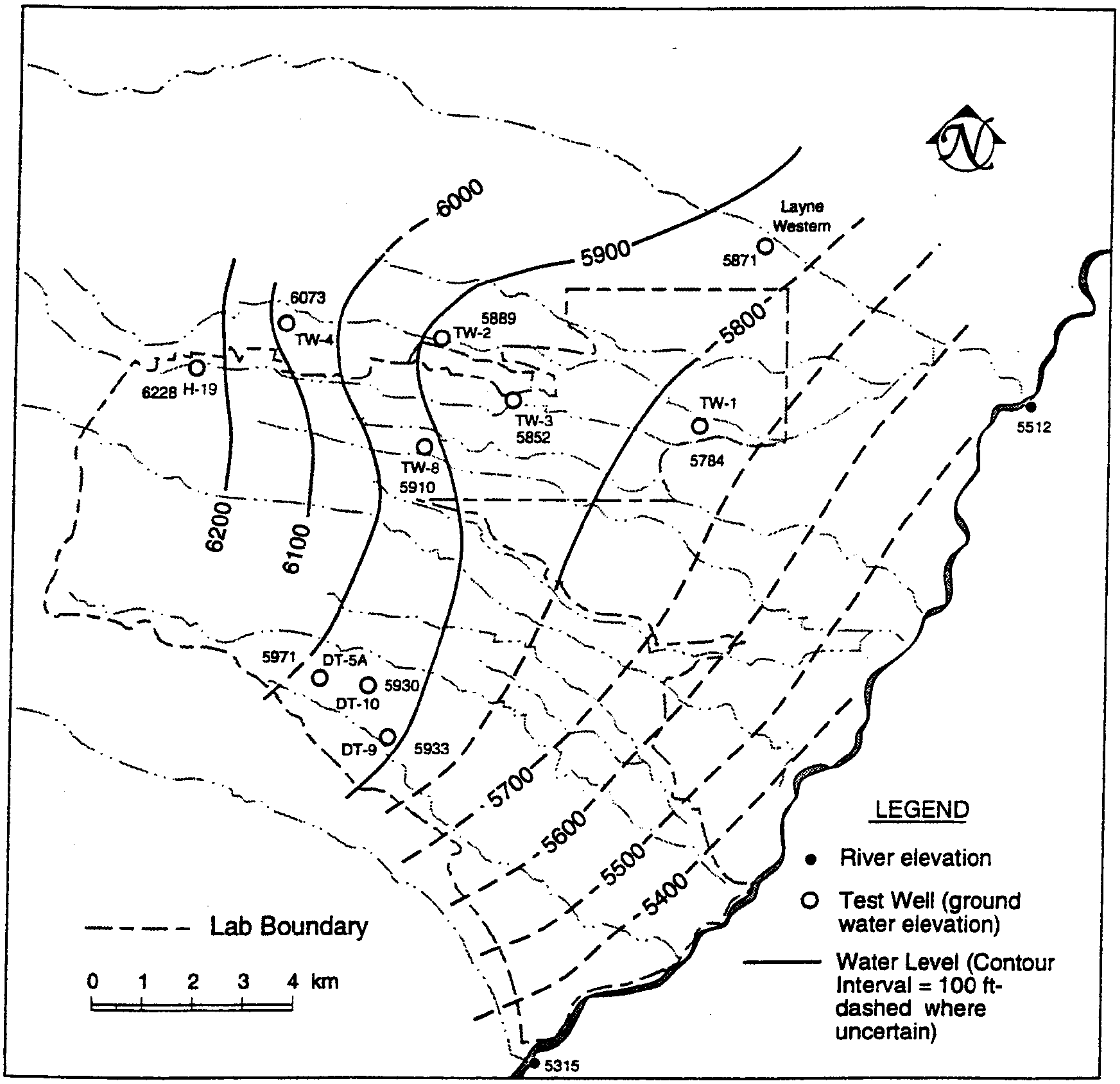
1993 Main Aquifer Water Levels using White Rock Canyon Springs, Test Wells, and Water Supply Wells



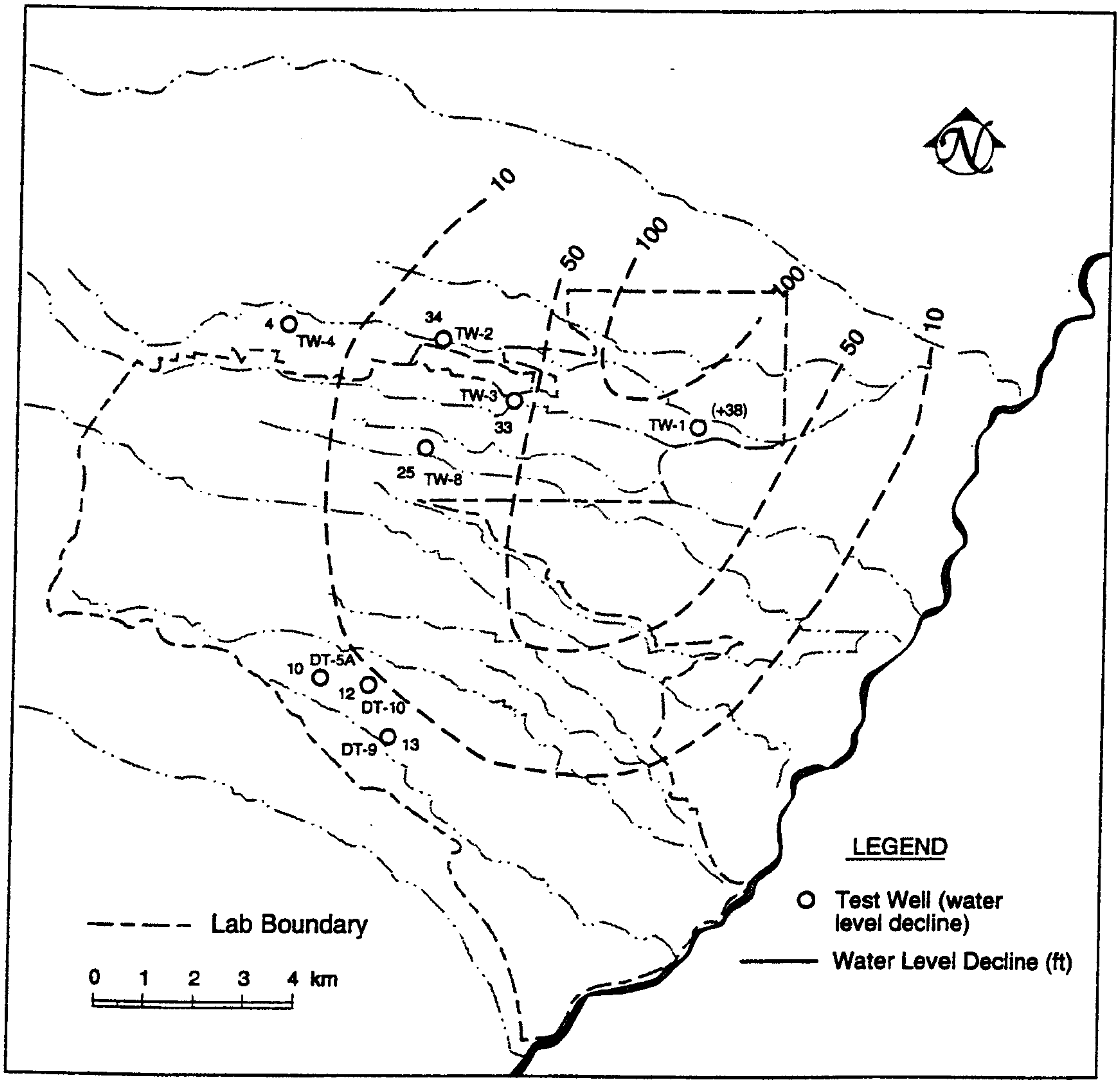
1993 Main Aquifer Water Levels using Test Wells and Rio Grande elevations



1960 Main Aquifer Water Levels using Test Wells and Rio Grande elevations



1949-1950 Main Aquifer Water Levels using Test Wells and Rio Grande elevations- includes 1960 Water Levels for TW-8, DT-5A, DT-9, and DT-10.



Main Aquifer Water Level decline from 1949 to 1993, using Test Wells - decline since 1960 for TW-8, DT-5A, DT-9, and DT-10 - this map is highly speculative!