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INFORMAL REPORT

PRELIMINARY ASSESSMENT OF THE HYDROGEOLOGY AT THE RADIOACTIVE WASTE MANAGEMENT COMPLEX, IDAHO NATIONAL ENGINEERING LABORATORY

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Geosciences Unit,
Biotechnology & Geosciences Group

EG&G Idaho

Work performed under DOE Contract No. DE-AC07-76ID01570

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PRELIMINARY ASSESSMENT OF THE HYDROGEOLOGY AT THE RADIOACTIVE WASTE MANAGEMENT COMPLEX, IDAHO NATIONAL ENGINEERING LABORATORY

INTRODUCTION

This document is a preliminary assessment of the hydrogeology of the Radioactive Waste Management Complex (RWMC) at the Idaho National Engineering Laboratory (INEL). Its purpose is to summarize and evaluate hydraulic data associated with the Snake River Plain aquifer in the vicinity of the RWMC in order to estimate the level of effort needed to characterize the aquifer. As such, it is an interim report that may be included in subsequent documents characterizing the aquifer near the RWMC. It does not evaluate the distribution of contaminants in the aquifer. The recommendations made in this report for additional wells and tests will provide an estimate of the level of activity needed for the characterization program. This document will allow adequate time for planning and writing contracts in preparation for the characterization program activities in the summer of 1990.

It is anticipated that subsequent documents on the groundwater hydrology of the RWMC will be written containing details and background on the facility relevant to potential contamination of the Snake River Plain aquifer. Since this document is an interim report written to satisfy planning needs for the 1990 drilling season, much of the detailed discussions which would typically be included in a ground water report have not been included herein. Numerous documents by the United States Geological Survey (USGS) discuss in general terms the movement of groundwater in the Snake River Plain aquifer and provide excellent background information for a detailed study such as this one. USGS papers include Nace et al., 1959, Mundorff et al., 1964, Barraclough et al., 1976.

Geology

The RWMC is located on a thin layer of eolian, lacustrine and alluvial sediments deposited by the Big Lost River. These sediments are composed of silt, sand, clay and gravel, and range in thickness from 2 to 24 ft (Anderson and Lewis, 1989). Below the surface sediments is a complex sequence of interlayered basalt flows and occasional sedimentary interbeds.

Basalt flows at the INEL characteristically occur as layers of pahoehoe lava a few feet to tens of feet in thickness. Based on the work by Anderson and Lewis (1989) the average flow thickness for 22 flows is about 30 to 40 ft, and ranges from 10 to 120 ft. The basalt flows are interlayered with unconsolidated sediments, cinders, and breccia. Considerable variation in texture occurs within individual basalt flows. In general, the bases of basalt flows are glassy to fine grained and minutely vesicular. The mid portions of the basalt flows are typically coarser grained with fewer vesicles than the top or bottom of the flow. The upper portions of flows are fine-grained, highly fractured with many vesicles. This pattern is the result of rapid cooling of the upper and lower surfaces, with slower cooling of the interior of the basalt flow. The massive interiors of basalt flows are sometimes jointed, with vertical joints in a hexagonal pattern formed during cooling.

During quiescent periods, between volcanic eruptions, sediments were laid down on the surface of the basalt flows. These sedimentary deposits display a wide range of grain size distributions depending on the mode of deposition (eolian, lacustrine, or fluvial), the source rock, and length of transport. Because of the irregular topography of the basalt flows, sedimentary materials commonly accumulate in isolated depressions. A number of extensive sedimentary interbeds have been identified in the stratigraphy beneath the RWMC.

WELLS

The USGS operates a groundwater monitoring network at the INEL. The purpose of the groundwater monitoring system is to record water levels and to monitor for contaminant migration. Seven wells have been drilled to monitor the Snake River Plain aquifer in the immediate area of the RWMC. These wells include; USGS 87, 88, 89, 90, 117, 119 and 120. The location of the aquifer wells and the spreading areas near the RWMC are given in Figure 1. Two production wells, the RWMC production well and EBR-1, are in the area of the RWMC. Several wells outside the immediate vicinity of the RWMC have been drilled to the aquifer, including USGS 8, 9, 86, 105 and 109 and Hwy 3. In addition, many wells have been drilled and cored in the vadose zone near the RWMC and data from the shallow wells have been used for lithologic correlation (Anderson and Lewis, 1989); however, these wells are not shown in Figure 1 since they do not provide data on the aquifer. Well logs, water levels, and water chemistry data are available in files at the INEL office of the USGS and much of these data have been published in USGS reports. Geological and geophysical logs from these wells and the RWMC production well have been used to characterize the stratigraphy at the RWMC.

Well construction data have been summarized in Table 1. The total depth of the wells ranges from 626 feet to 1075 feet and the approximate depth to water is about 580 feet. Well construction has varied over the years, with the earlier wells being open to the formation through perforated casing or open hole. More recently, wells have been completed with stainless steel screen.

In the early 1970's four wells were drilled to the aquifer as part of the USGS groundwater monitoring network in the vicinity of the RWMC. The wells include 87, 88, 89 and 90, which were drilled north, south, west and east of the RWMC, respectively. These wells were drilled to establish the

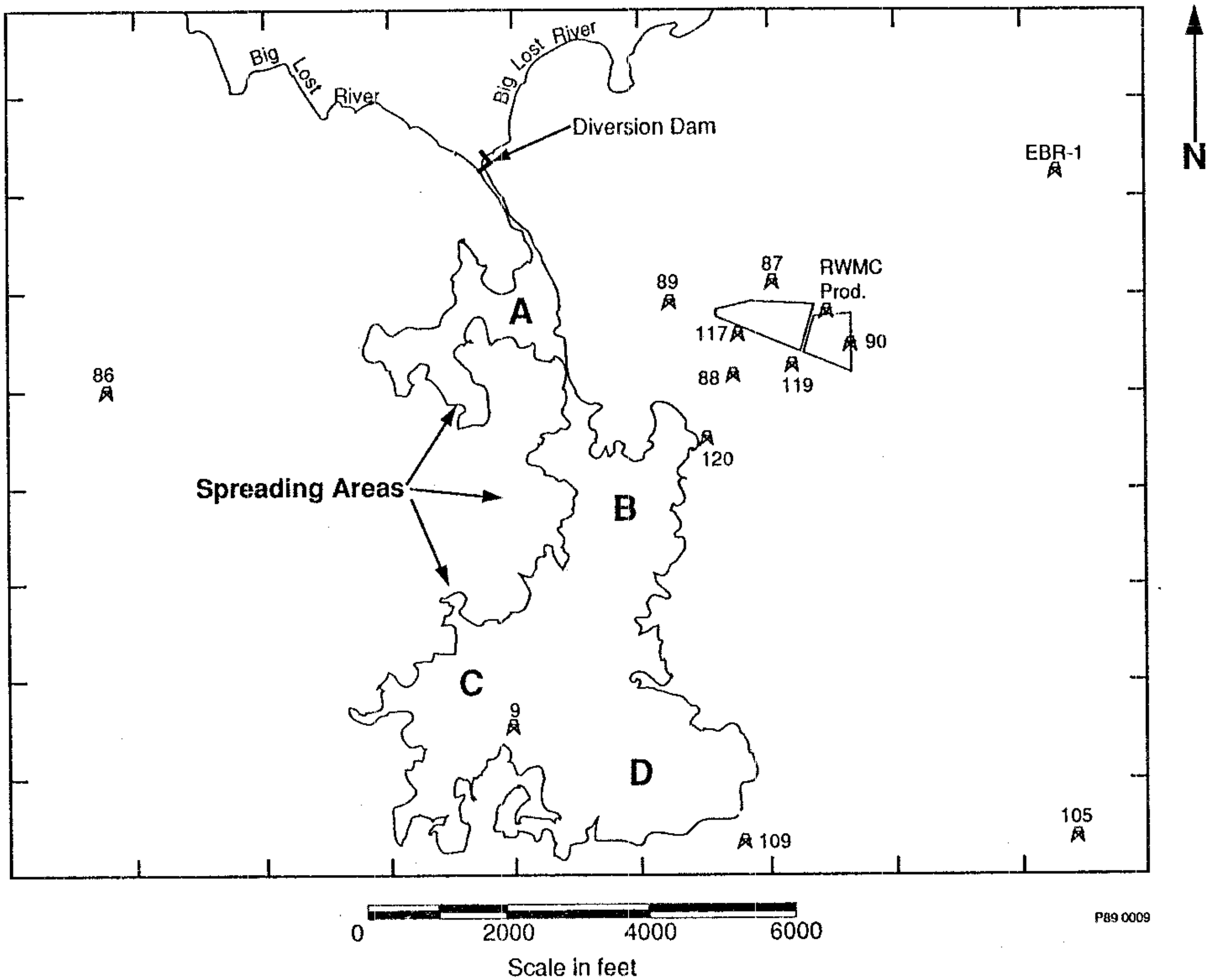

Figure 1. Location of wells in the RWMC area and Spreading Areas A, B, C and D.

Table 1. Summary of well construction for wells in the RWMC area.

Well Name	Year Drilled	Total Depth	Casing Construction: Material	Casing Construction: Cased Interval	Casing Construction: Screened and/or Open Interval(s)	Casing Construction: Screen Type	Well Logs: Geologist Log	Well Logs: Geophysical Logs	Depth to Water When Drilled
EBR-1	1949	1075	Steel	0 - 750	600 - 750 750 - 1075	Perforated Open Hole	Yes	Yes	596.00
RWMC Production Well	1974	683	Steel	0 - 660	590 - 610 625 - 635	Perforated Perforated	Yes	Yes	571.00
USGS-9	1951	654	Steel	0 - 652	618 - 652 652-654	Slotted Open	Yes	Yes	601.00
USGS-86	1966	691	Steel	0-48	48 - 691	Open	Yes	Yes	643.70
USGS-87	1971	640	Steel	0 - 585	585 - 607 Caved to 607	Open Hole	Yes	Yes	582.70
USGS-88	1971	635	Steel	0 - 587	587 - 635	Open Hole	Yes	Yes	583.65
USGS-89	1972	646	Steel	0 - 576	576 - 646	Open Hole	Yes	Yes	590.64
USGS-90	1972	626	Steel	0 - 580	580 - 609 Caved to 609	Open Hole	Yes	Yes	574.62
USGS-105	1980	800	Steel	0 - 400	400 - 800	Open	Yes	Yes	668.83
USGS-109	1980	800	Steel	0 - 800	600 - 800	Slotted	Yes	Yes	619.72
USGS-117	1987	655	Steel/SS	0 - 555	555 - 653	Perforated	Yes	Yes	581.30
USGS-119	1987	705	Steel	0 - 639	639 - 705	Perforated	Yes	Yes	600.80
USGS-120	1987	705	Steel/SS	0 - 638	638 - 705	Perforated	Yes	Yes	611.45

subsurface stratigraphic sequence beneath the RWMC and to determine the slope and direction of groundwater movement in the vicinity of the RWMC (Barraclough et al., 1976). Wells 87, 88, 89 and 90 were drilled to approximately 50 ft below the water table (total depth of 626 to 646) in order to monitor the upper portion of the Snake River Plain aquifer for contamination. The RWMC production well was drilled in 1974 to a depth of 683 ft.

USGS wells 117, 119 and 120 were installed in the summer of 1987 to supplement the USGS groundwater monitoring network in the vicinity of the RWMC. Wells 119 and 120 are deeper than the four previously drilled wells, about 700 ft, and, therefore, tap a deeper interval of the Snake River Plain aquifer than 87, 88, 89 and 90. Well 117 is 653 ft deep, about the same depth as wells 87 through 90.

Geophysical well logs for these wells can be found in the RFI report for the RWMC.

Stratigraphy

A recent USGS report (Anderson and Lewis, 1989) correlates the stratigraphy at the RWMC based on 40 wells, including 9 wells to the aquifer. Utilizing geophysical well logs, well cuttings, cores, K-Ar (potassium-argon) ages, and geomagnetic properties the USGS report shows cross sections, maps and tables of the stratigraphy for the RWMC. Four cross sections from the USGS report by Anderson and Lewis (1989) have been reproduced and are used in this report. Figures 2, 3, 4 and 5 show the general stratigraphy of the RWMC. The cross sections show that the stratigraphic units are relatively continuous in the vicinity of the RWMC and folding and/or faulting are not apparent.

The stratigraphic units A through I are defined based on flow group nomenclature established by Kuntz et al., (1980). The nomonclature was based on the study of 600 ft of core from well 77-1, near well 86, and 4 other shallow wells. Kuntz et al., (1980) defined flow groups as one or

EXPLANATION

B — BASALT — Basalt-flow group composed of one or more related flows. Letter, B, indicates sequence of group from top to bottom of section. Locally includes cinders and thin layers of sediment

CLAY, SILT, SAND, AND GRAVEL — Major sedimentary interbed between volcanic flow groups. Locally includes cinders and basalt rubble

GEOLOGIC CONTACT — Queried where uncertain

89 — WELL — Entry, 89, is local well identifier. Arrow indicates water level in aquifer in June, 1988. Water level in well RWMC not measured

Location of Section

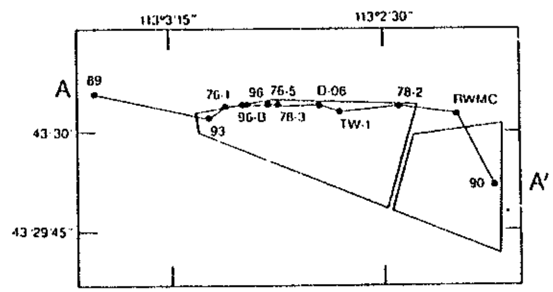

Figure 2. Geologic section A-A′ at the Radioactive Waste Management, from Anderson and Lewis, 1989.

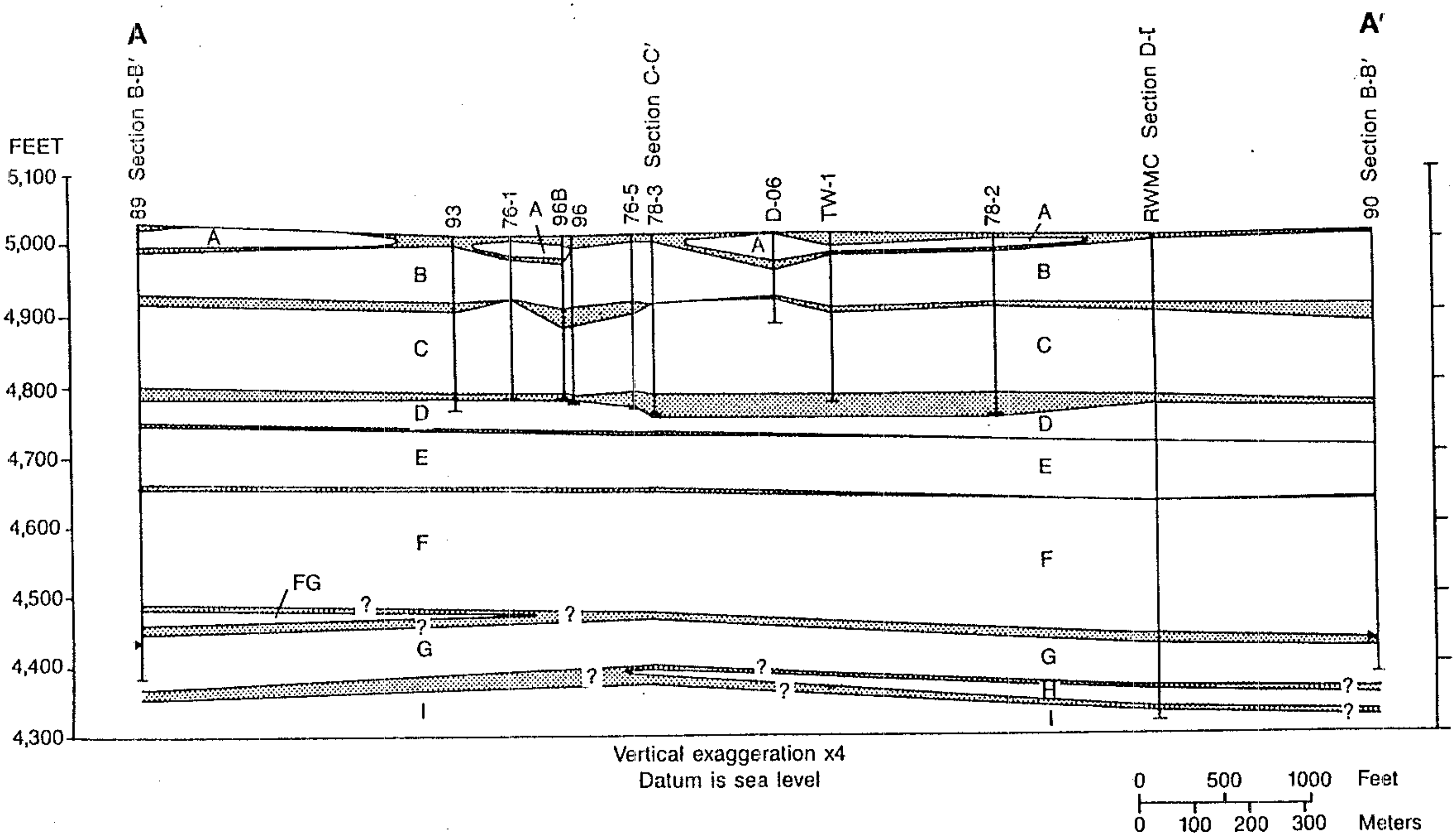

Figure 2. (Continued)

EXPLANATION

B	BASALT — Basalt-flow group composed of one or more related flows. Letter, B, indicates sequence of group from top to bottom of section. Locally includes cinders and thin layers of sediment
	CLAY, SILT, SAND, AND GRAVEL — Major sedimentary interbed between volcanic flow groups. Locally includes cinders and basalt rubble
	GEOLOGIC CONTACT — Queried where uncertain
89	WELL — Entry, 89, is local well identifier. Arrow indicates water level in aquifer in June, 1988

Location of Section

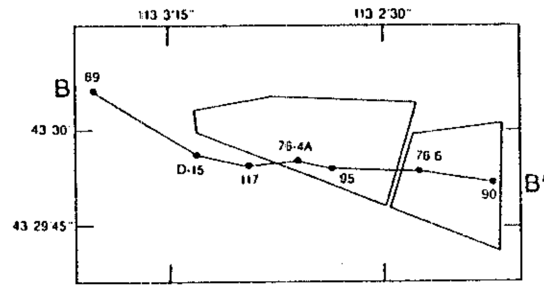

Figure 3. Geologic section B-B′ at the Radioactive Waste Management Complex, from Anderson and Lewis, 1989.

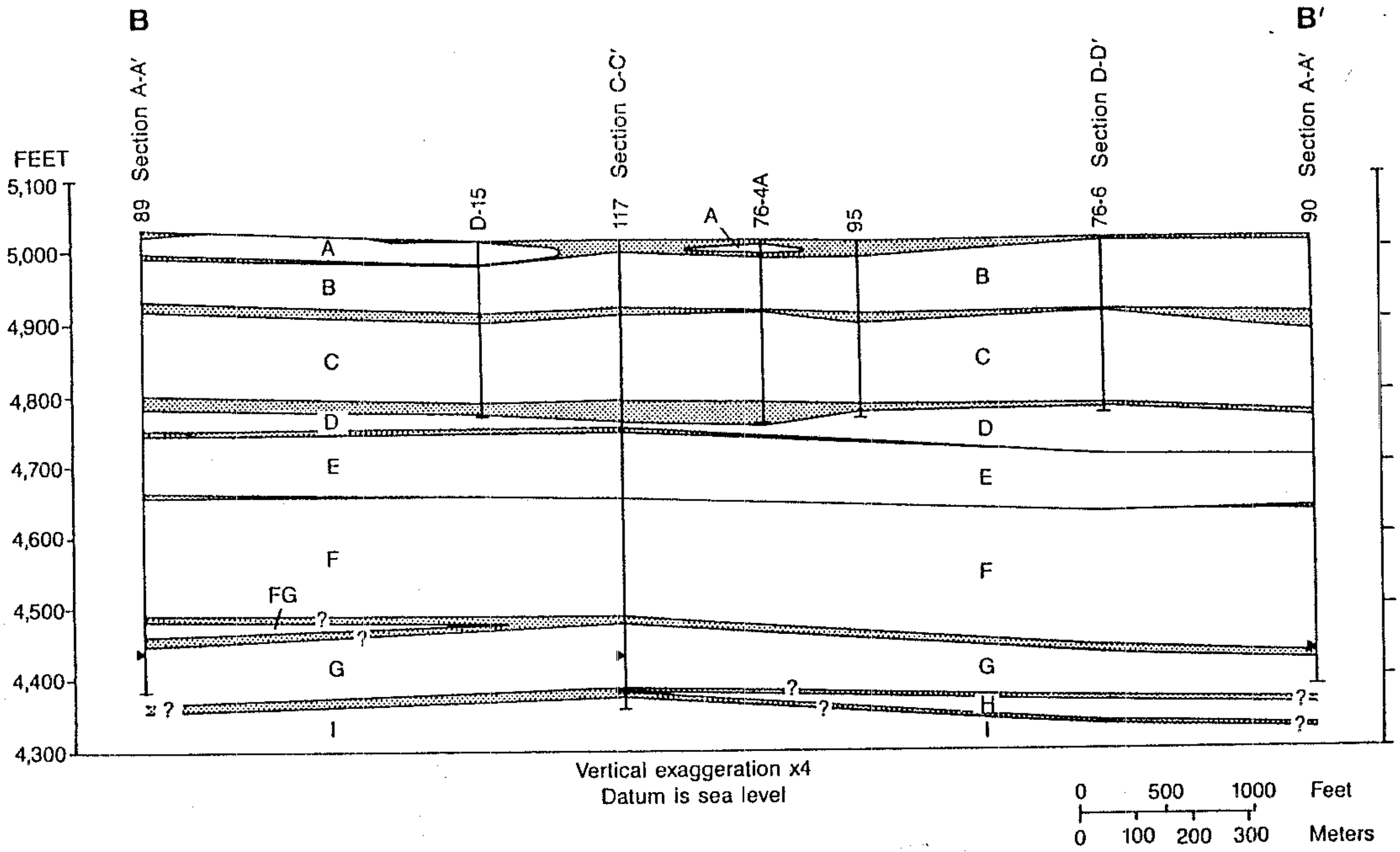

Figure 3. (Continued)

EXPLANATION

B — BASALT — Basalt-flow group composed of one or more related flows. Letter, B, indicates sequence of group from top to bottom of section. Locally includes cinders and thin layers of sediment

CLAY, SILT, SAND, AND GRAVEL — Major sedimentary interbed between volcanic flow groups. Locally includes cinders and basalt rubble

GEOLOGIC CONTACT — Queried where uncertain

88 — WELL — Entry, 88, is local well identifier. Arrow indicates water level in aquifer in June, 1988

Location of Section

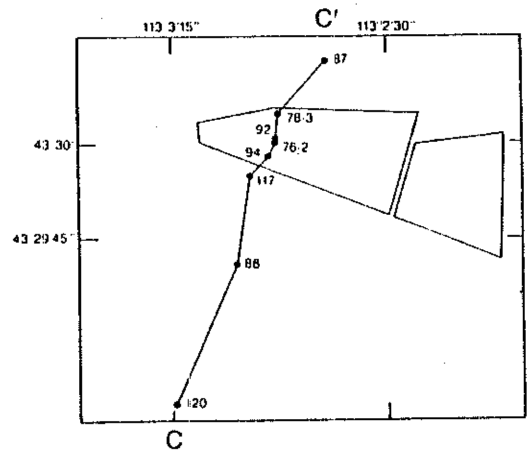

Figure 4. Geologic section C-C′ at the Radioactive Waste Management Complex, from Anderson and Lewis, 1989.

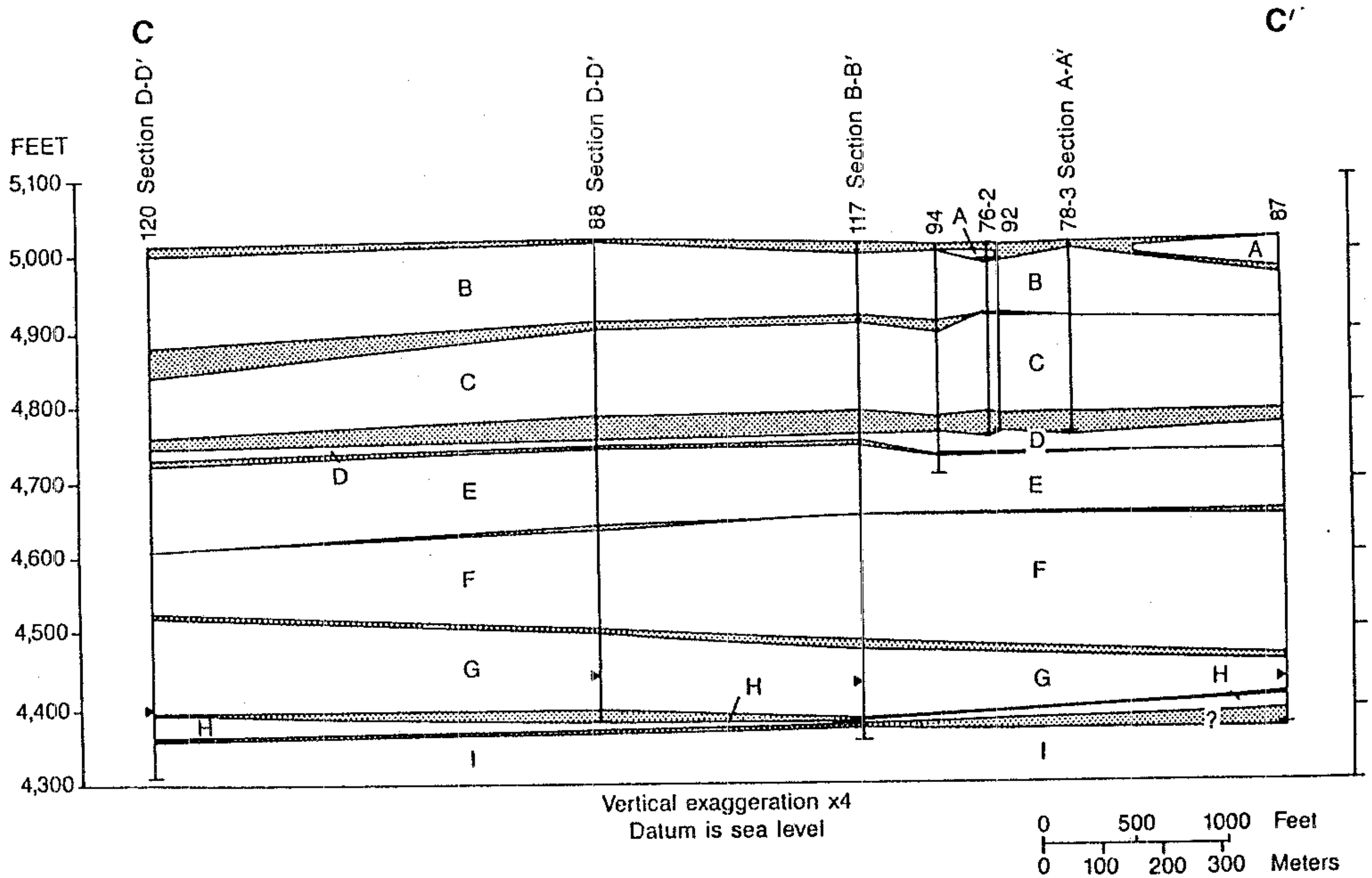

Figure 4. (Continued)

EXPLANATION

B — BASALT — Basalt-flow group composed of one or more related flows. Letter, B, indicates sequence of group from top to bottom of section. Locally includes cinders and thin layers of sediment

CLAY, SILT, SAND, AND GRAVEL — Major sedimentary interbed between volcanic flow groups. Locally includes cinders and basalt rubble

GEOLOGIC CONTACT — Queried where uncertain

88 — WELL — Entry, 88, is local well identifier. Arrow indicates water level in aquifer in June, 1988. Water level in well RWMC not measured

Location of Section

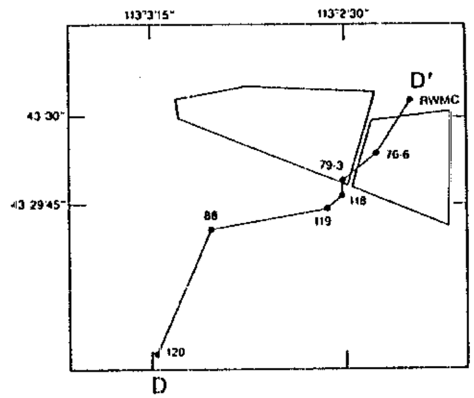

Figure 5. Geologic section D-D′ at the Radioactive Waste Management Complex, from Anderson and Lewis, 1989.

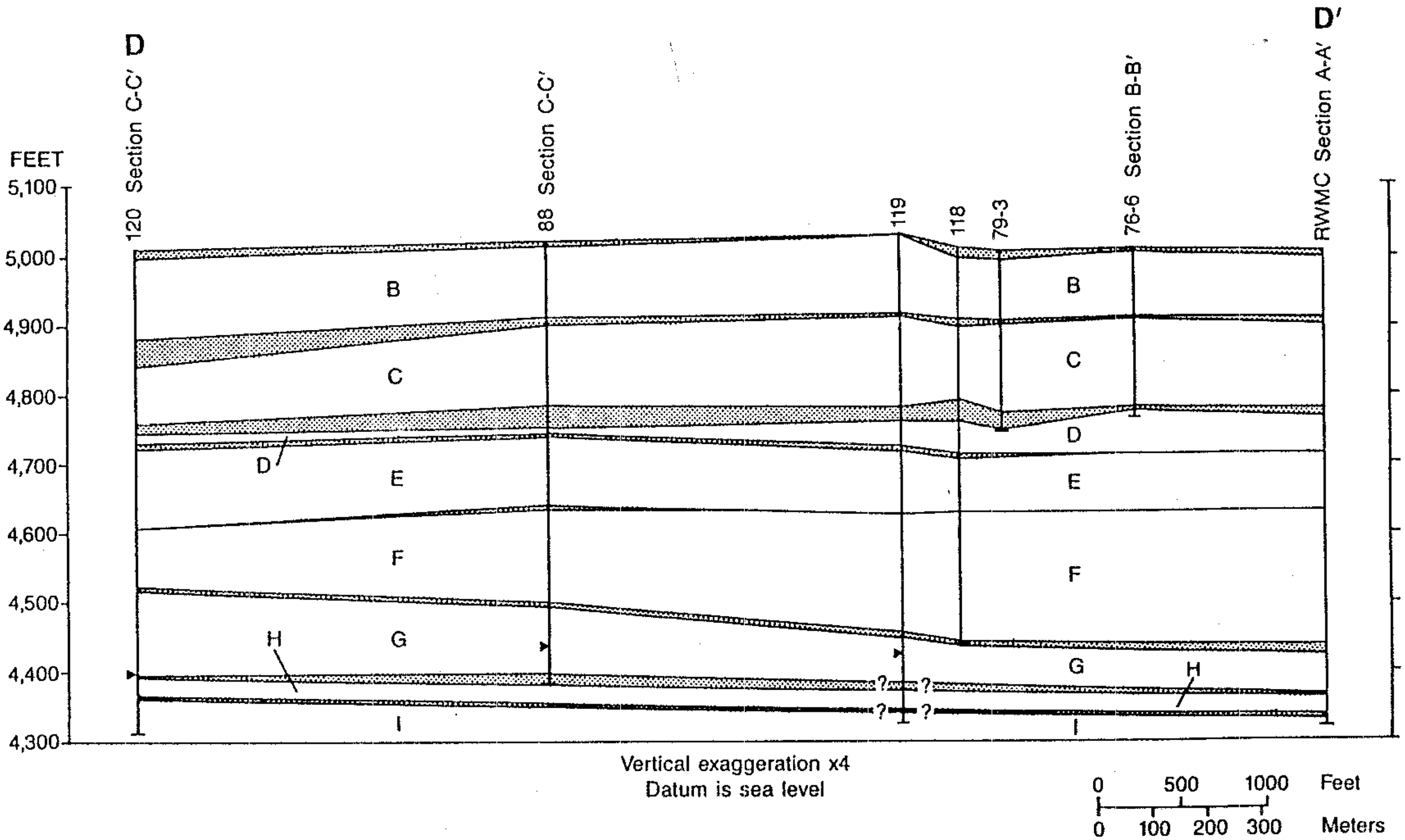

Figure 5. (Continued)

more petrographically similar flows or flow units extruded from the same vent or magma source from a single eruption or multiple eruptions during a relatively short interval of time. Generally, successive flow groups are separated by sedimentary interbeds. The interpretation by Kuntz et al., (1980) and Anderson and Lewis (1989) suggests the flow groups represent eruptions from the same source vent or flows erupted from several source vents that tapped the same magma source. This interpretation was based on variations in natural gamma activity between groups but consistent for flows within a group. Paleomagnetic and K-Ar age dating was also used to establish this interpretation. Kuntz et al., (1980) considered the eruptive events to be episodic with many thousands of years between eruptive events, based largely on K-Ar ages and the presence of sedimentary interbeds between flow groups. However, it was admitted that the absence of sedimentary interbeds between flows only suggests, but does not prove, that the flows were implaced over short time intervals of perhaps days, weeks, months, or possibly a few years. Sedimentary interbeds are generally considered to represent quiescent periods between volcanic episodes, when the top most lava flow was covered by accumulations of eolian and alluvial sediments. An alternative depositional history might have occurred when lava flows dammed local drainages, and floods may have deposited alluvial and lacusterine sediments during periods as short as a few months.

The cross sections (Figures 2 through 5) represent straight line correlations between wells based on the identification of basalt flow groups and sedimentary interbeds. In earlier work by Barraclough et al., (1976) 4 basalt series were identified based on natural gamma log differences. Basalt flow groups identified by Kuntz et al., (1980) and Anderson and Lewis (1989) are similar to the basalt series correlated by Barraclough et al., (1976). Groups A through I (Figures 2 through 5) may be associated with single or multiple eruptive events of lava with similar chemical and physical characteristics. Individual flows or flow units within groups are more difficult to distinguish based on the geophysical well logs. This is particularly true for the deeper flow groups where less stratigraphic control is available. Furthermore, although the lateral continuity of flow groups is relatively continuous based on the geologic cross sections, the horizontal continuity of individual flows within the flow groups may be limited, complicating the correlation of individual flows from well to well.

Further examination of the cross sections in Figures 2, 3, 4 and 5 show that stratigraphic control exists for only about the upper 100 ft of the Snake River Plain aquifer in the vicinity of the RWMC. Previous studies indicate that the active portion of the aquifer may be much thicker than this, estimates range from 250 ft (Robertson et al., 1974) to over 400 ft (Mann, 1986). To obtain stratigraphic control to the base of the Snake River Plain aquifer near the RWMC requires well depths of 1000 ft or more.

HYDROGEOLOGY

The RWMC lies on the Eastern Snake River Plain. The Snake River Plain aquifer is defined as the series of basalt flows and interlayered pyroclastic and sedimentary materials that underlie the Eastern Snake River Plain east of Bliss. It extends from Bliss and the Hagerman Valley on the west, to Ashton and the Big Bend Ridge on the northeast. Its lateral boundaries are formed at the contacts of the aquifer with less permeable rocks at the margins of the plain (Mundorff et al., 1964).

Aquifer permeability is controlled by the distribution of highly fractured basalt flow tops and interflow zones with some additional permeability contributed by fractures, vesicles and intergranular pore spaces. The variety and degree of interconnected water bearing zones complicates the direction of groundwater movement locally throughout the aquifer (Barraclough et al., 1981). The permeability of the aquifer varies considerably over short distances, but generally, a series of flows will include several excellent water-bearing zones. If the sequence of lava flows beneath the Snake River Plain is considered to constitute a single aquifer, it is one of the world's most productive (Mundorff et al., 1964).

Structural and textural characteristics of individual flows within flow groups control, to a large degree, the movement of ground water through the Snake River Plain aquifer. Vesicular, highly fractured flow tops and fractured flow bases combine to form what is generally the most permeable part of the aquifer (unless fractures near this interface are filled with sediment). The dense, massive central portion of a flow can have very low permeability. The thickness and extent of these flow features is known to vary widely over relatively short distances in the Snake River Plain basalts and departure from the idealized case is common (Mundorff et al., 1964). The difficulty of identifying and correlating individual flows limits the development of a conceptual hydrogeological model at the RWMC because the distribution of the flows within flow groups effects the vertical and horizontal aquifer properties. Sedimentary interbeds also have a significant impact on aquifer properties. Clay rich interbeds impede the movement of groundwater and coarse grained interbeds may be more permeable than some dense basalts. In general, sedimentary interbeds are thought to have relatively less hydraulic conductivity than the surrounding basalts. It appears there will always be some uncertainty associated with the correlation of permeable zones in the basalts, particularly when small areas are examined in detail. However, taken as a whole, the inhomogenaities of the basalts and sediments of the Snake River Plain aquifer tend to average out and groundwater movement is predictable using standard methods when large areas of the aquifer are examined (i.e. distances measured in thousands of feet).

The altitude of the water table for the Snake River Plain aquifer and the general direction of groundwater movement in the vicinity of the INEL are depicted in Figure 6. The regional flow is to the south-southwest, although, locally, the direction of groundwater flow is affected by recharge from rivers, surface water spreading areas, and inhomogeneities in the aquifer. Across the INEL, the average gradient of the water table is approximately 4 ft/mile. Depth to water varies from about 200 ft in the northeast corner of the INEL to 1000 ft in the southeast corner.

Drilling information from a 10,365-ft deep geothermal test well, INEL-1, drilled about 10 miles northeast of the RWMC, indicates there are at least 2000 ft of basalt underlying the INEL (Prestwich and Bowman, 1980). However, not all of this thickness participates in the active flow system. Mann (1986) interpreted hydrologic data from INEL-1 to indicate that the effective base of the Snake River Plain aquifer is 840 to 1220 ft below land surface at the INEL-1 site. The data that Mann based his interpretation on include: the loss of drilling fluids in the upper 1511 ft; a thick sequence of mostly sedimentary deposits between 840 and 1530 ft; a transition from a calcium bicarbonate to sodium bicarbonate type of chemical composition

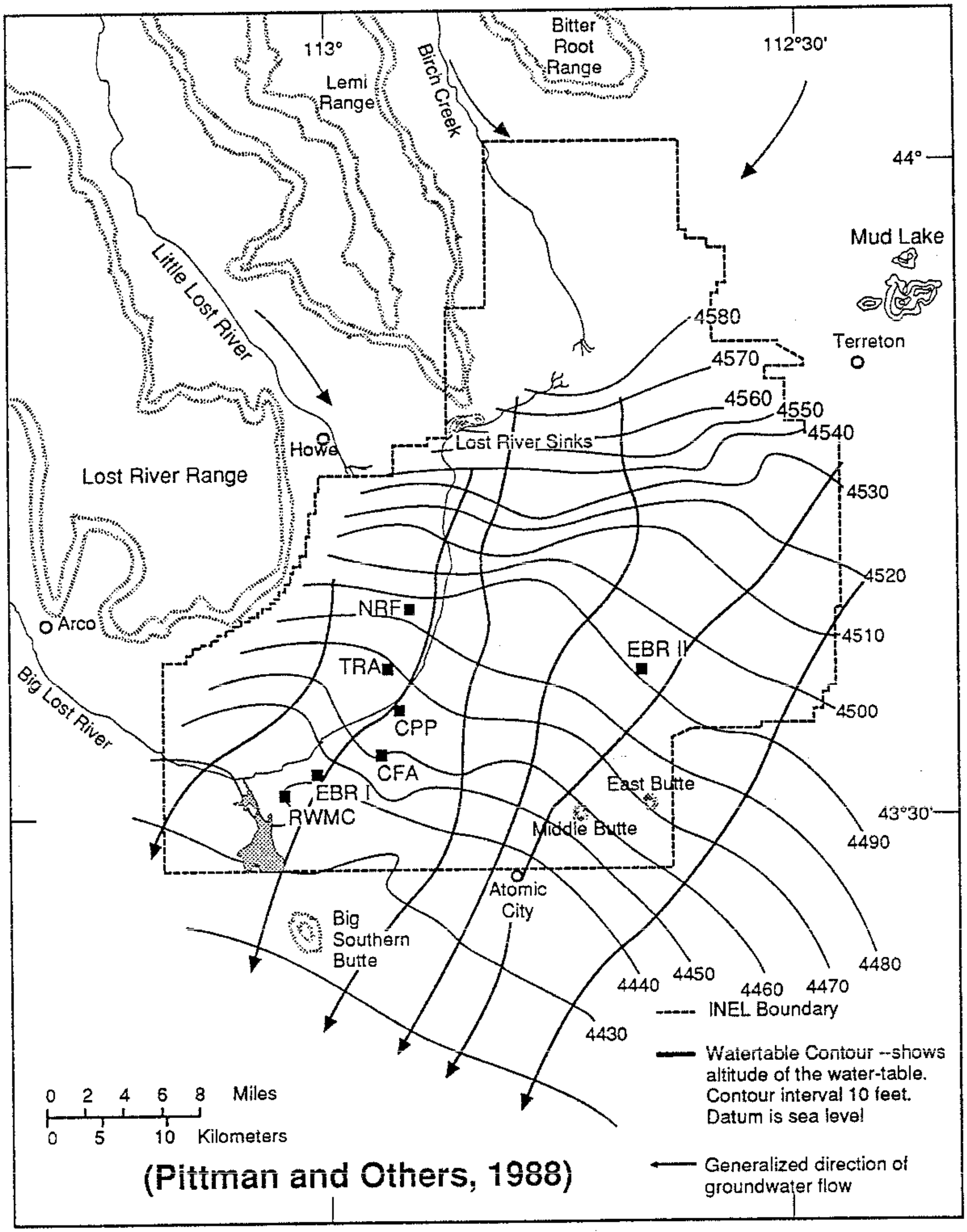

Figure 6. Altitude of the water table for the Snake River Plain aquifer and general direction of groundwater movement, July 1985 (from Pittman et al., 1988).

between 595 ft and 1511 ft; carbon-14 age dating and an increase in hydraulic head with depth. Depth to water near INEL-1 is about 400 ft; this suggests that the active portion of the Snake River Plain aquifer is between 440 and 820 ft thick. Mann's interpretation is for the immediate vicinity of INEL-1 and the same sedimentary units, which act as a lower boundary for the active portion of the aquifer, may or may not be present near the RWMC. However, he indicated that similar deposits have been penetrated in other deep holes drilled at the INEL and may correlate to this sequence. An earlier study estimated the thickness of the active portion of the aquifer to be less than that estimated by Mann (1986). Based on a mass balance of tritium disposal from INEL facilities, Robertson et al., (1974) estimated the thickness of the active portion of the aquifer to be about 250 ft. This thickness is based on the depth to which disposed tritium mixed with water in the aquifer and from the geology. The thickness of the aquifer will vary with different areas and there probably is not a distinct boundary. Based on the available information it appears that the aquifer becomes less and less active with depth because of decreasing hydraulic conductivity. The hydraulic conductivity is anticipated to decrease with depth because of secondary mineralization, infilling of fractures by sediment, and increasing overburden pressure and compaction.

Aquifer Tests

Pumping tests have been conducted on the Snake River Plain aquifer to determine its suitability as a water supply and for regional studies conducted by the USGS (Mundorff et al., 1964). Many of these tests were conducted by the USGS during the 1950s. In prolific aquifers such as the Snake River Plain aquifer, it is essential to apply a large stress during testing, otherwise negligible drawdown will occur. At most locations in the Snake River Plain aquifer, a good pumping test would involve a pumping rate of approximately 1000 gpm for 72 h. To provide the best estimate of the aquifer parameters, a pumping rate of 1000 to 2000 gpm for 15 to

25 days would be required (Mann, oral communication, 1989). However, adequate tests have been conducted in some of the monitoring wells near the RWMC using relatively low capacity submersible sampling pumps (Table 2). From the pumping test data it is apparent that even at the low discharge rates used for the tests (2 to 20 gpm), sufficient stress was applied to the aquifer in some wells to obtain reasonable estimates of the aquifer properties. The fact that these tests were successful at low pumping rates indicates that several of the wells near the RWMC have relatively low transmissivity compared to regional transmissivity. This is probably due to the short open interval in the wells rather than a local decrease in transmissivity near the RWMC. The opposite situation was observed in well USGS 120 where a pumping rate of 20 gpm only produced drawdown of 0.01 ft. These data show the variability in transmissivity between wells, which are open to short intervals in the aquifer.

Table 2 summarizes transmissivity values determined from a number of tests. To convert the transmissivity values given in ft^2/day to gallons/day/ft, multiply the former by 7.48. The range in transmissivity is from 4.05 to 2.1×10^5 ft^2/day (30.3 to 1.6×10^6 gallons/day/ft). Based on regional studies of the transmissivity at the INEL, the transmissivity near the RWMC is estimated to be approximately 173,000 ft^2/day (1.3×10^6 gallons/day/ft) (Robertson et al., 1974). Calculations using Robertson's value of 173,000 ft^2/day and an aquifer thickness of 250 ft give a hydraulic conductivity of about 700 ft/day at the RWMC. Estimates of the effective porosity of the aquifer range from 5 to 15%, with 10% being the most accepted value (Robertson et al., 1974). This porosity estimate is a spatial average over a large volume of the aquifer since the aquifer is composed of massive basalt with an effective porosity of only a few percent and fractures and cinder zones with very high porosity.

Table 2. Well parameters for wells in the RWMC area based on tests conducted by the USGS

Well	Date	Discharge Rate gals/min	Saturated Thickness ft	Maximum Drawdown ft	Specific Capacity gpm/ft	Transmissivity ft^2/day	Hydraulic Conductivity ft/day	Analytical Method
Well 87*	7/14/87	2.20	24 (approx)	0.13	16.90	700	30	Theis
Well 88*	7/8/87	5.00	51 (approx)	28.70	0.17	23.40	0.46	Jacobs
						3.11	0.061	Theis
Well 89*	7/21/87	4.41	56	6.32	0.70	52.90	0.95	Jacobs
	7/22/87	4.39	56	6.69	0.66	55.30	0.99	Jacobs
Well 90	7/15/87	3.81	34 (approx)	0.53	7.20	733	22	est. Theim
Well 117*	12/17/87	6.79	72	20.35	0.34	15.7	0.22	Theis
Well 119*	12/16/87	3.15	104	68.81	0.046	4.05	0.04	Theis
Well 120	12/15/87	20.7	94	0.01	2070	211,000	3,200	est. Theim
RWMC Production Well	07/24/74	412.0	30	5.50	75	7,600	254	est. Theim
EBR-1	08/12/49	800.0	475	17	47	4,800	10	est. Theim

* Pumping test data evaluated by the U.S. Geological Survey.

The calculated transmissivities listed in Table 2 range over 5 orders of magnitude reflecting the variable water bearing characteristics of the Snake River Plain aquifer. Wells with the lowest transmissivity listed in Table 2 are open to the aquifer over relatively short intervals. Wells open over large intervals usually have high transmissivity in the Snake River Plain aquifer. This phenomenon has been observed for many years, and it is common knowledge among experienced drillers on the Eastern Snake River Plain that with continued drilling most wells will eventually tap a zone with enough permeability to produce water for domestic and other uses (R. G. Jensen, oral communication, 1989). This is consistent with the anticipated distribution of permeable flow tops and dense flow interiors with low perambulating.

WATER LEVELS IN WELLS

The USGS has collected water levels from a number of wells on the INEL for over 40 years. Water level data for 16 wells in the southwest corner of the INEL have been compiled from USGS field records. Table 3 shows the wells and the years for which data were compiled and used in this report. The compiled data files are given in Appendix A and B.

Hydrographs for the wells are given in Figures 7 through 10. The hydrographs are broken out by location and year drilled. Figure 7 shows USGS Wells 87, 88, 89 and 90, which were drilled in 1971 and 1972 and are located near the RWMC. Figure 8 shows USGS Wells 117, 119 and 120, which were drilled in 1987 and are in the vicinity of the RWMC. Figure 9 shows the water levels in USGS-86, which is on the opposite side of the spreading area from the RWMC. Figure 10 shows the water levels for USGS Well 9 from 1965 to 1989. USGS well 9 is on the southern side of the spreading area.

Well hydrograph data are useful for defining the hydrologic communication between wells, recharge areas, and the relationship between recharge and water levels in wells. A later section in this report will discuss the interpretations of the well hydrographs.

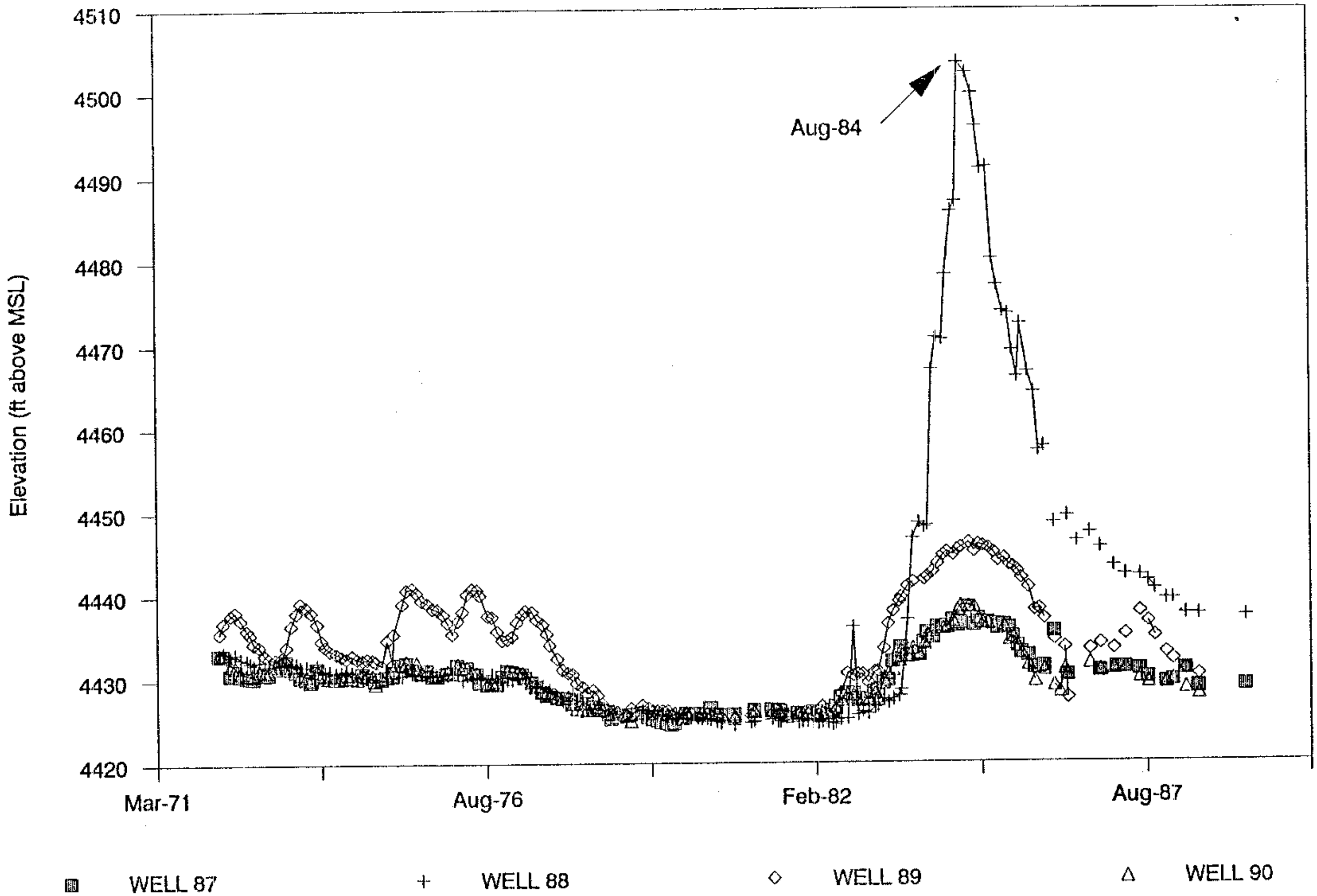

Figure 7. Well hydrographs for USGS Wells 87, 88, 89 and 90, 1972 through 1989. Based on USGS water level data.

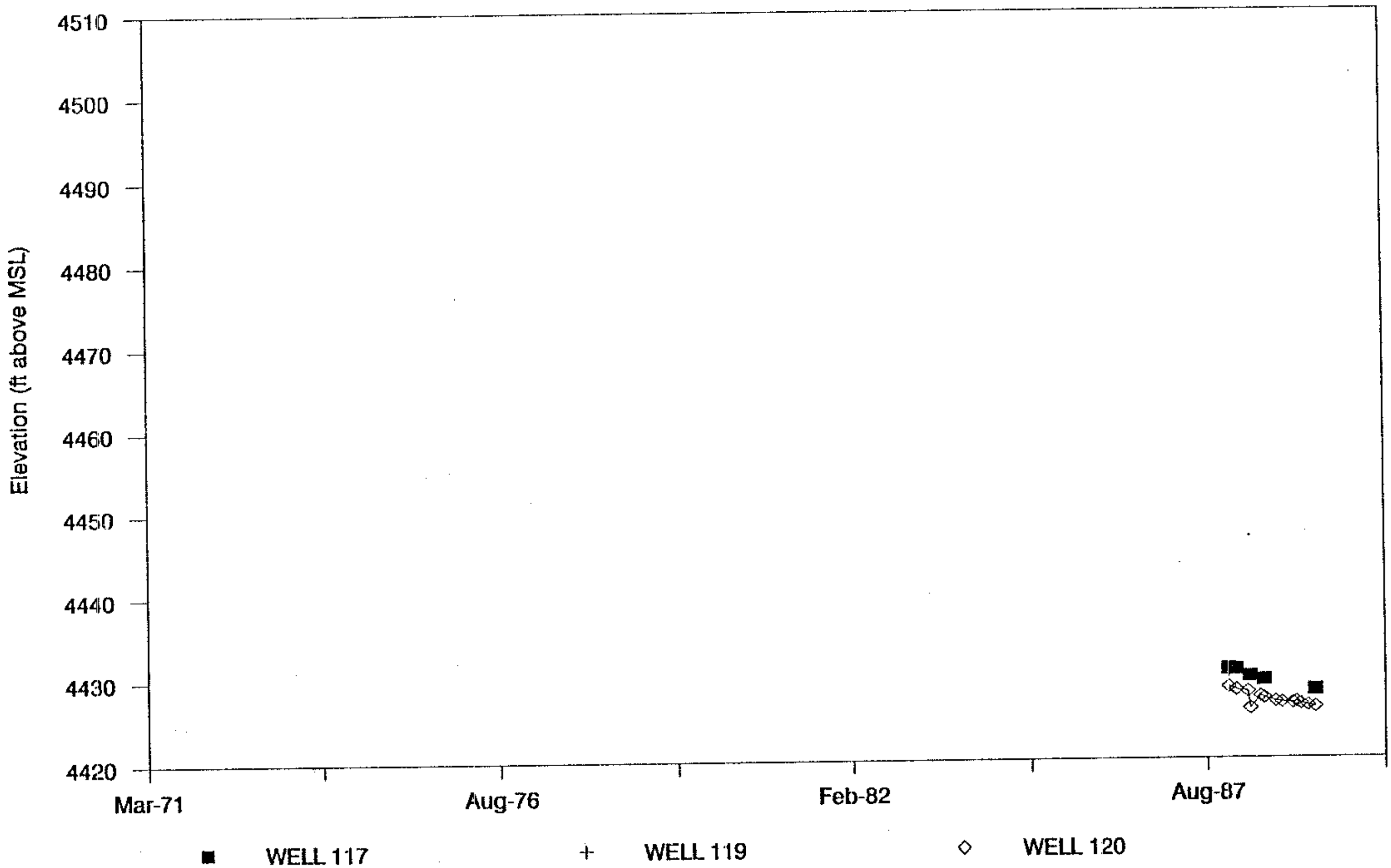

Figure 8. Well hydrographs USGS Wells 117, 119, and 120, August 1987 through January 1989. Based on USGS water level data.

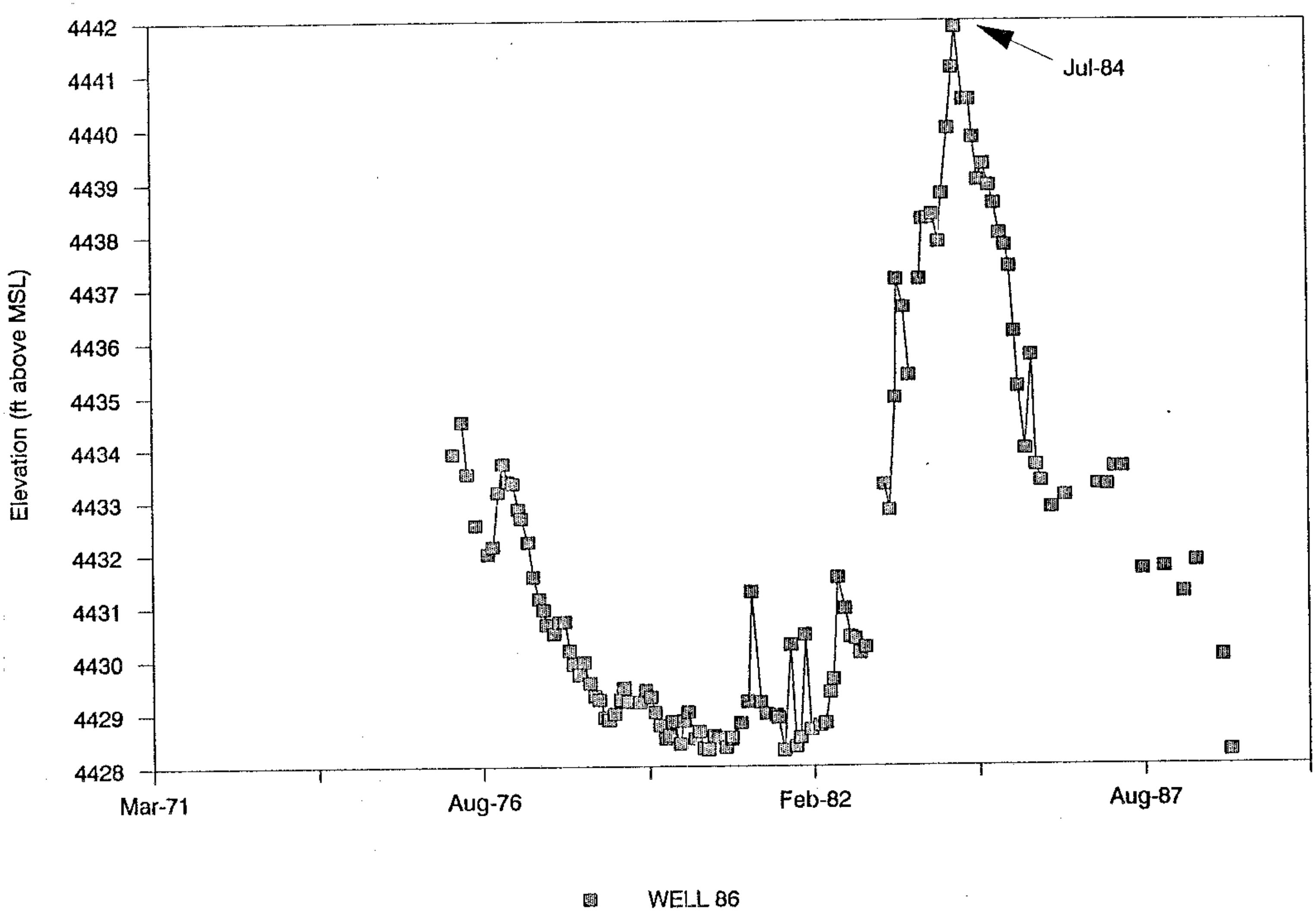

Figure 9. Well hydrograph for USGS well 86, 1975 through January 1989. Based on USGS water level data.

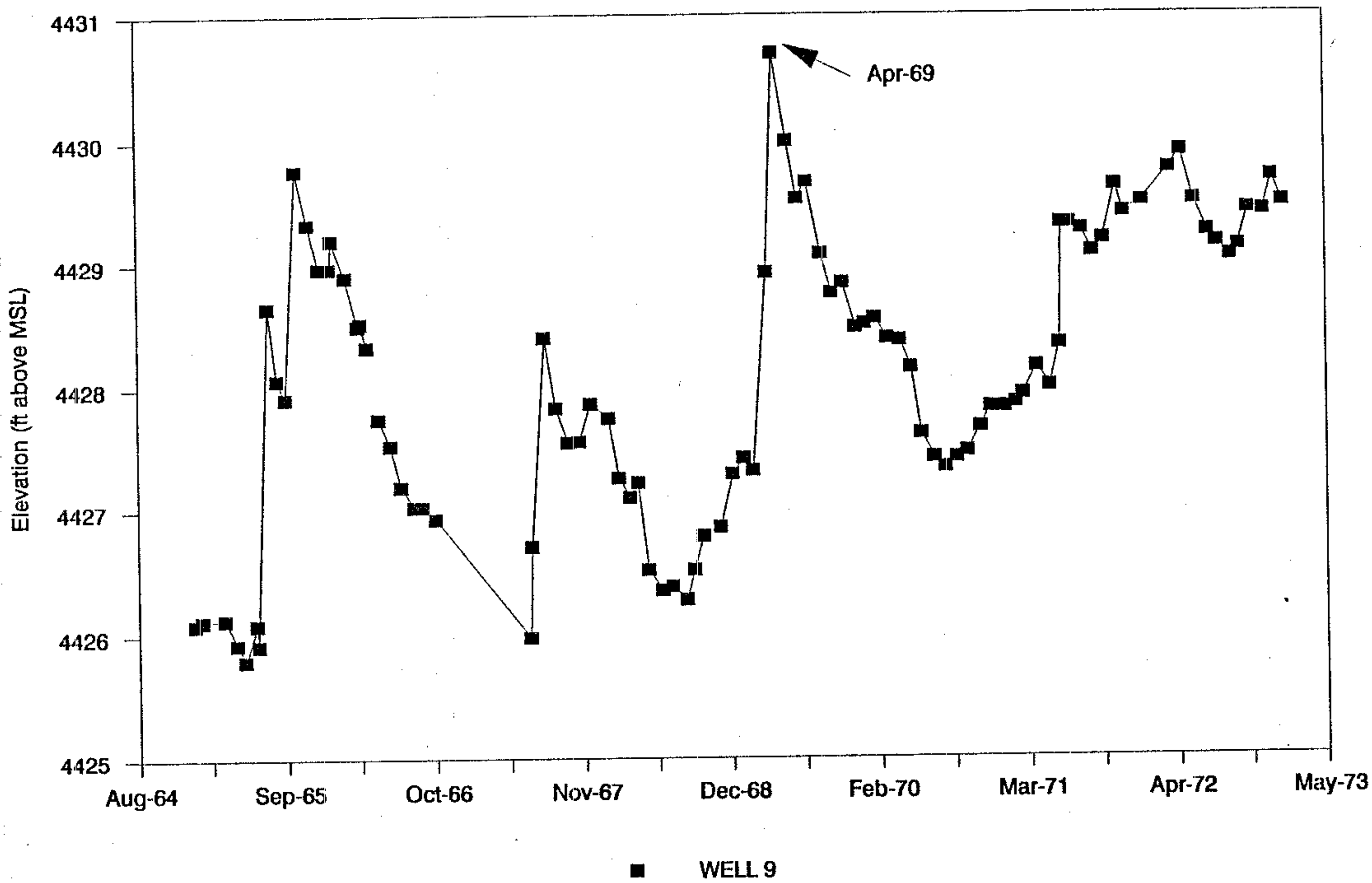

Figure 10. Well hydrograph for well 9, 1965 through 1989. Based on USGS water level data.

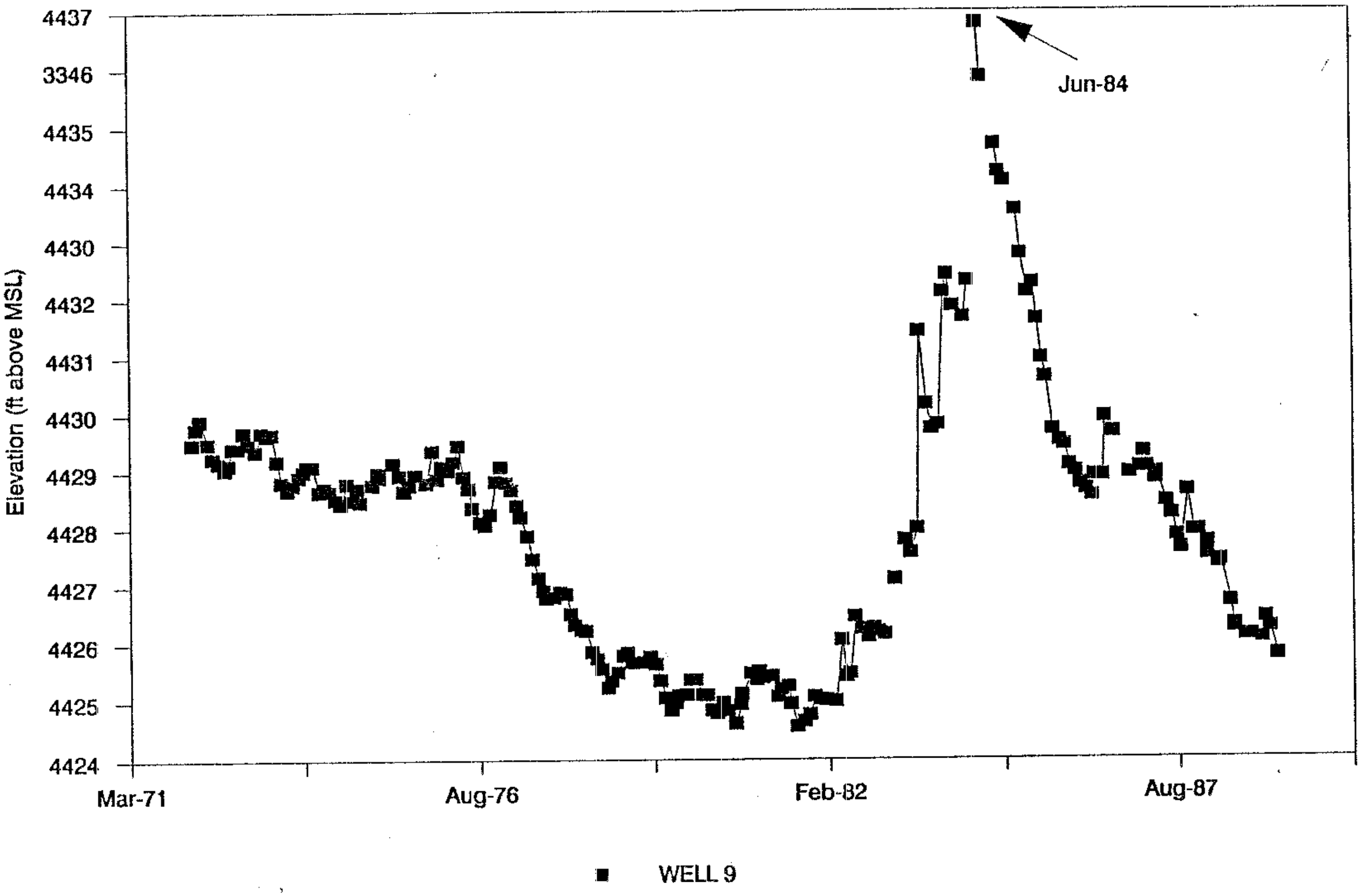

Figure 10. (Continued)

Table 3. List of INEL wells used to measure water levels in the Snake River Plain aquifer near the RWMC and the years for which data were compiled for this report.

Well	Year Drilled	Years of Water Levels Compiled for this Report
USGS-8	1950	1965 - 1989
USGS-9	1951	1965 - 1989
USGS-84	1962	1980 - 1989
USGS-85	1962	1980 - 1989
USGS-86	1966	1976 - 1989
USGS-87	1971	1972 - 1989
USGS-88	1971	1972 - 1989
USGS-89	1972	1972 - 1989
USGS-90	1972	1972 - 1989
USGS-105	1980	1980 - 1989
USGS-106	1980	1980 - 1989
USGS-108	1980	1980 - 1989
USGS-109	1980	1980 - 1989
USGS-117	1987	1987 - 1989
USGS-119	1987	1987 - 1989
USGS-120	1987	1987 - 1989

Discharge to Spreading Areas

The INEL diversion system was constructed in 1958 to provide flood protection for the facilities at the INEL. By diverting water from the main channel of the Big Lost River, water is spread out or ponded on the Eastern Snake River Plain where it either evaporates or infiltrates to the aquifer. Most of the water infiltrates to the aquifer. The diversion area is separated into 4 spreading areas, A, B, C, and D. Area A holds about 2300 acre-ft, and the other three areas hold about 5000 acre-ft each (Barraclough et al., 1967).

The capacity of the diversion area was increased in 1982 or 1983 by raising the dikes and dam, the combined capacity of the system is about 38,000 ac-ft. The diversion system was not used until 1965 because of low flow in the Big Lost River. In 1965 the diversion channel to the spreading areas was equipped with a water level recorder, which enabled the monitoring of discharge to the spreading areas (R. G. Jensen, oral communication, 1989). Monthly discharges to the spreading areas have been compiled for this report and the hydrograph is shown in Figure 11. The amount of water discharged to the spreading areas is dependent upon two factors, the available runoff water flowing in the Big Lost River, and the setting of the diversion gate. In the 1960's the operating policy was to divert as much water as possible down the channel of the Big Lost River in order to enhance dilution and flushing of the aquifer (Barraclough, oral communication, 1989). In recent years, including the high water years of the 1980's, this operating procedure has apparently changed and more water has been diverted to the spreading areas.

Figure 1 shows the locations of the spreading areas. Spreading Area A fills first and must be about two-thirds full before water will flow from it to Spreading Area B. Figure 11 shows the total discharge to the spreading areas; the volumes of water flowing to the individual spreading areas, A through D, are not known for most of the years on record.

Discharge to the spreading areas was highest during the mid to late 1960's and the mid-1980's. Based on historic flow in the Big Lost River, these periods were much higher than normal flow. Runoff measured at the station below Mackay Reservoir during 1965 was the highest for the 49 years on record prior to 1965 (Barraclough et al., 1967). The amount of water flowing in the Big Lost River in 1965 is reflected in the high flows diverted to the spreading areas (see Figure 11). The volume of water discharged to the spreading areas for 1967 and 1969 approached the flow of 1965. After 1969, the discharge to the spreading areas was much less, until the mid 1980's when again, a few years of high runoff were recorded. Starting in 1982, discharge to the spreading areas increased for several years and peaked in 1984. The discharge to the spreading

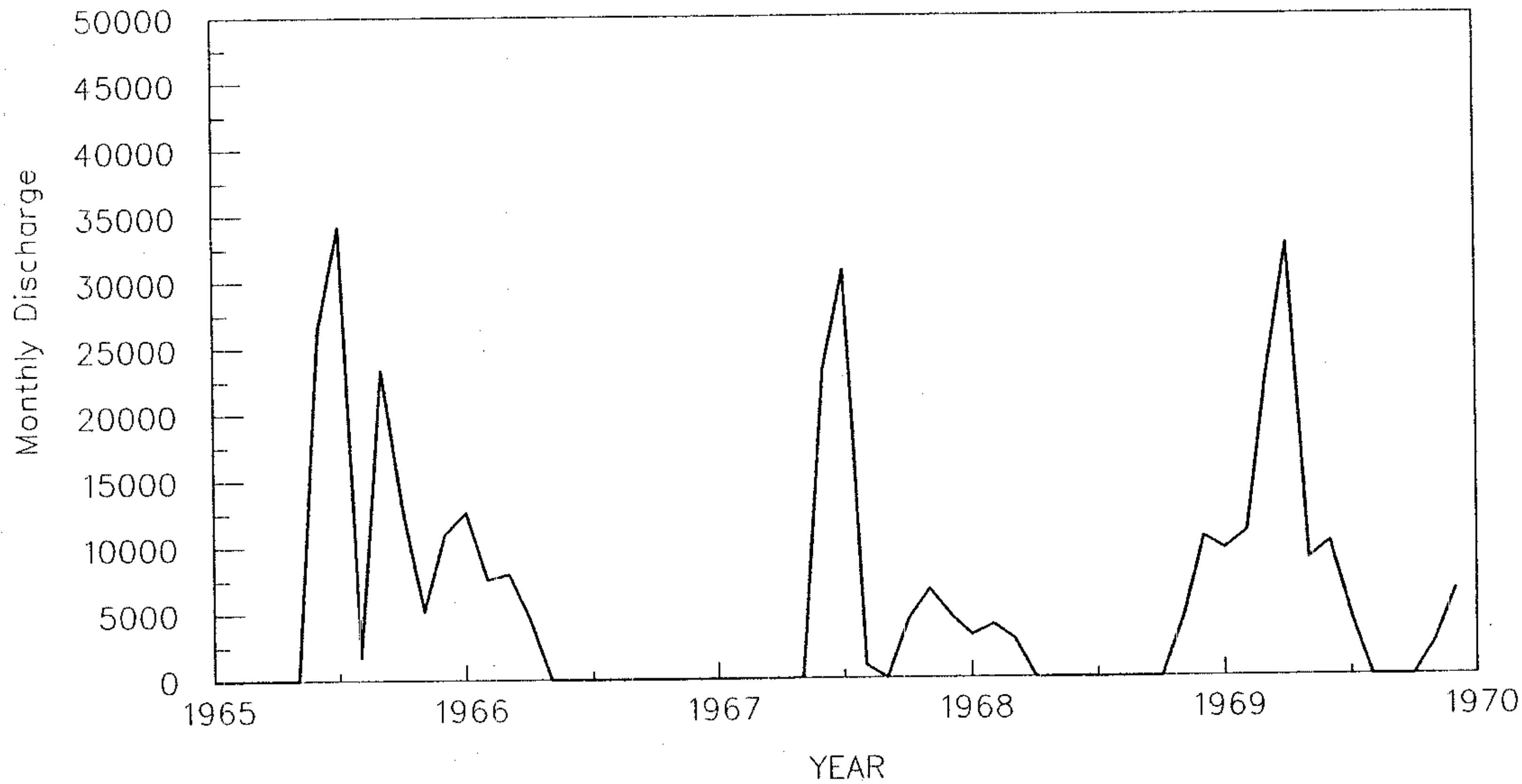

Figure 11. Monthly discharge in acre feet for INEL Diversion.

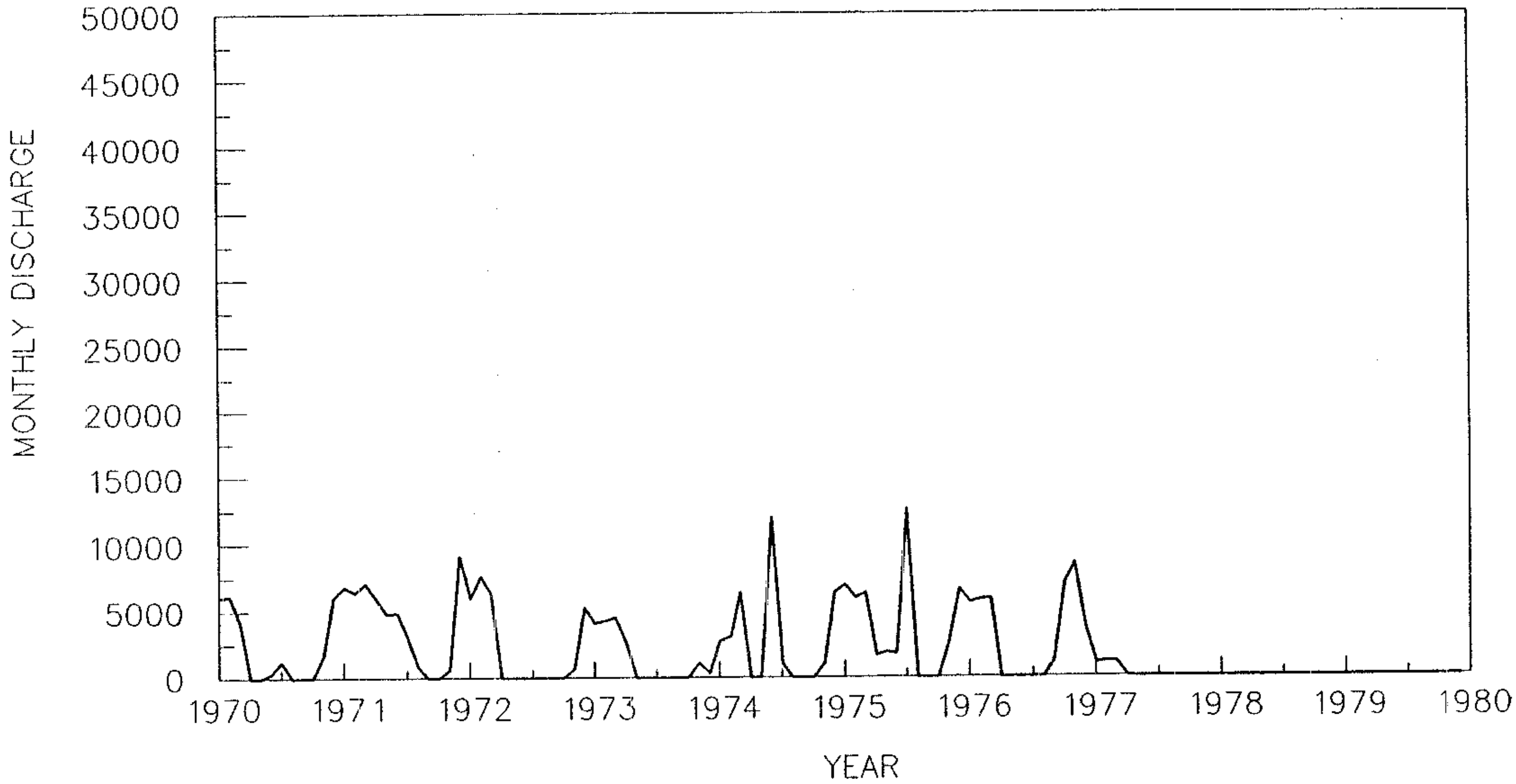

Figure 11. (Continued)

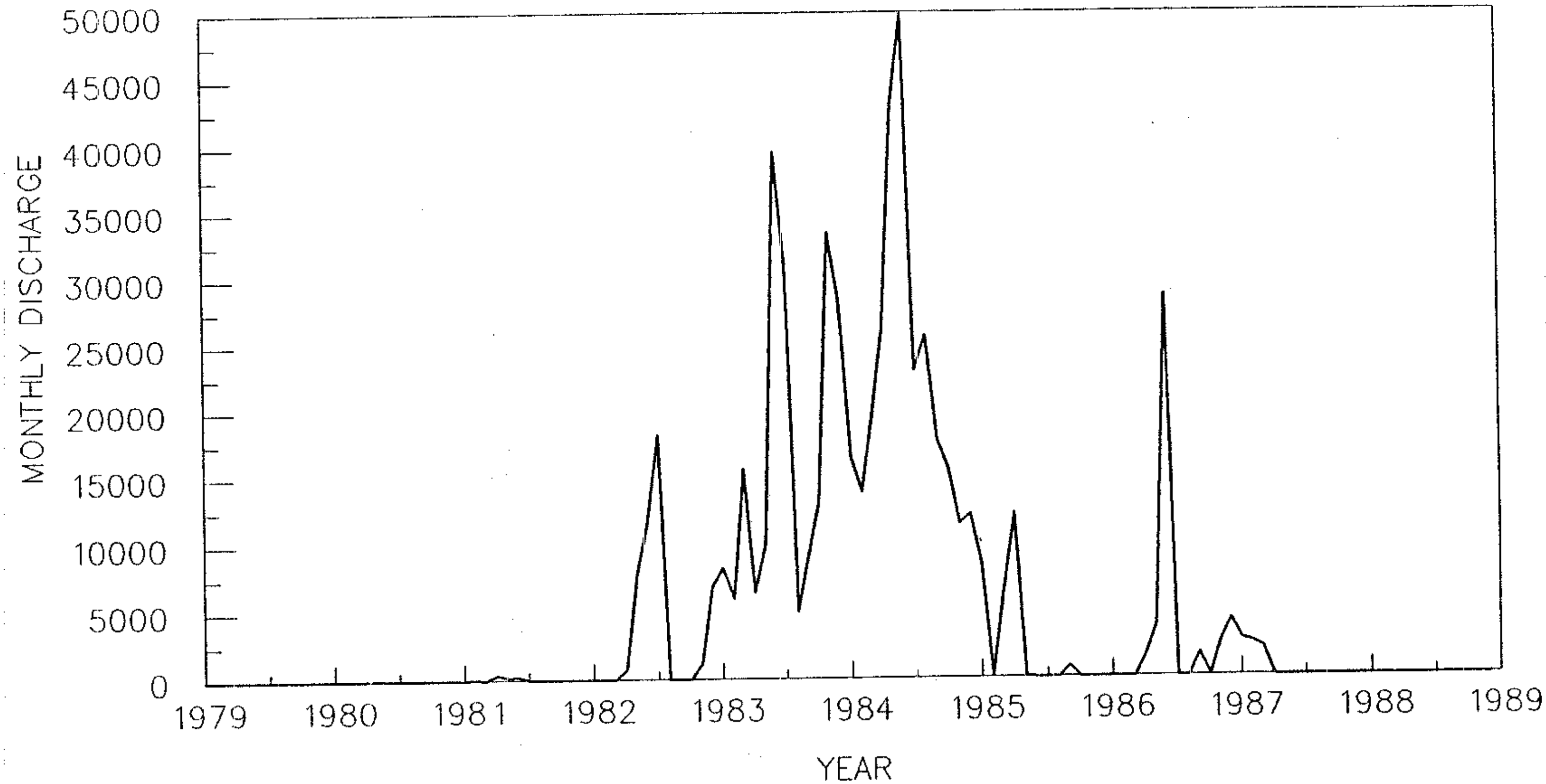

Figure 11. (Continued)

areas in 1984 was considerably higher than the previously high year of 1965. In summary, the diversion hydrograph shows two wet periods; the mid-1960's and the mid-1980's and the intervening years have had moderate to no flow.

RESPONSE OF WATER LEVELS TO RECHARGE

A comparison of Figures 7 through 10 to Figure 11 shows the clear relationship between discharge to the spreading areas and the corresponding rise in water levels in nearby wells. Figure 7 shows the wells in the closest proximity to the RWMC with the longest record, including Wells 87, 88, 89 and 90. During the 1970's the water levels in wells 87, 88 and 90 tracked essentially the same path, all showing a gradual decline in water levels, which was probably associated with a net decline in the regional water table during the dry years of the 1970's. Well 89 is the exception to this, showing fluctuations in water levels of about 8 feet from 1972 to 1977 (see Figure 7). These fluctuations correlate to relatively small discharges to the spreading areas during the same time period. Starting in the latter part of 1982 and continuing to 1984, there was a tremendous rise in water levels recorded in wells as shown in Figure 7, 9 and 10. The most spectacular rise was recorded in well 88, with a rise of over 60 ft relative to nearby wells. The peak of this activity occurred in 1984, corresponding to the highest discharge year on record. After 1984, the wells show a net decline in water levels, with the exception of 89, which showed a rise in water levels associated with the small discharge to the spreading areas in 1987. Figure 8 shows the water levels for the wells drilled in 1987, including 117, 119 and 120. Unfortunately, these wells were installed after the high water years of the 1980's and the net water table rise in the vicinity of the wells cannot be determined. However, it is clear that the water levels in these wells are declining at a similar rate and are at about the same elevation as wells 87, 89 and 90. The scale is the same for both Figures 7 and 8 for comparison purposes and the water levels for Wells 117, 118 and 120 overlay the water levels for Wells 87, 89 and 90, showing the strong correlation in water levels among these 6 wells.

Figure 7 illustrates the complexities of the aquifer in the vicinity of the RWMC. Four wells completed to similar depths with similar construction may show marked variations in water level fluctuations. Wells 87 and 90 are apparently in good hydraulic communication since the water levels track almost identically through wet and dry cycles. Well 89 may be associated with this same system since its overall response to recharge stress is similar to that of Wells 87 and 90. However, Well 89 is clearly more affected by recharge to Spreading Area A than Wells 87, 88 and 90 because it responds to moderate inflow to the spreading areas when only Spreading Area A is filled while the other wells are not (see the early 1970's data). It is affected to a lesser extent by recharge to the rest of the spreading areas. This is probably because it is closer to Spreading Area A, or it may be situated along a zone that is good hydraulic communication with Spreading Area A.

It appears that USGS Well 88 taps a zone that is in poor hydraulic communication with the rest of the wells. This interpretation is based on two observations; 1) the apparent lag in response to recharge compared to nearby wells and 2) the anomalous rise in water levels compared to nearby wells. Figure 7 shows that the rise in water levels in Well 88 lagged behind the rise in Wells 87, 89 and 90 by several months. During the peak year 1984, water levels in Well 88 were about 60 feet higher than nearby wells. This implies a steep water table gradient between wells and therefore low transmissivity to maintain that gradient. The tremendous rise in water levels for this well appears to be real as hydrogeologic assessment of the available data and testing of the well indicates that the water levels measured in this well are representative of the interval of the aquifer which the well is open to, and that the well is probably not damaged or silted up. The lag time and the steep hydraulic gradient suggest that communication between Well 88 and the other wells is restricted, possibly by a zone with low transmissivity.

Several scenarios were evaluated to determine if Well 88 was damaged in some manner so that the water level data were not valid. The first scenario assumed the well was silted up as suggested by Jaacks et al., (1989). In order to evaluate the well, it was assumed that the well was slugged with water and that its declining water level was a simple recovery, similar to a slug test. The hydrograph of Well 88 (Figure 7) was treated as a slug test and evaluated by the Bouwer and Rice Method (see Appendix B for calculations). The calculated hydraulic conductivity for this case is 7.8 x 10^{-7} ft/day (10^{-11} cm/sec). This value is near the lower end of hydraulic conductivity values for natural materials, roughly equivalent to unfractured metamorphic and igneous rock or shale of the lowest hydraulic conductivity (Freeze and Cherry, 1979). It is unlikely that silting up of the well would reduce the hydraulic conductivity to this low value. Furthermore, a pumping test was conducted in the well in July of 1987, after the highest water level, (see Table 2) and the calculated transmissivity is on the order of 23.4 ft/day, 9 orders of magnitude greater than that needed to maintain the head measured at the peak in 1984. To confirm the previous pumping test of 1987, a pumping test was conducted in October of 1989 during routine sampling of Well 88. The results of the 1989 test confirm the previous test (see Appendix C for calculations).

The second case assumed the well was being recharged from a perched groundwater zone, perhaps through a hole in the casing. Using a steady state solution based on the Theim equation, a calculation was made to determine how much inflow to the well would be required to maintain a water elevation 50 ft above the water table. With a transmissivity of 23 ft^2/day it would require a flow of 11 gpm. It is unlikely that USGS personnel would not hear this volume of water cascading in the well during monitoring operations. However, another possibility, which would be difficult to assess, would be the downward movement of water near the well through a fracture system.

It appears Well 88 is not damaged and that it must reflect natural potentiometric conditions at its location, based on the calculations presented and the regular nature of the water level data as shown in Figure 7 (that is, no sudden change in trends which might imply tampering). Well 88 probably does not tap the main portion of the Snake River Plain aquifer, but rather, a limited zone near the top of the aquifer. Additional characterization of the aquifer is required in the vicinity of this well.

The hydrograph for USGS Wells 9 and 86 have been included to show the response of the aquifer on the south and west side, respectively, of the spreading areas. Similar to water levels on the east side of the spreading areas, the highest water levels in Well 86 were recorded in 1984 corresponding to the highest discharge year on record. The net water table rise in Well 86 from 1980 to 1984 was about 13 ft, which is comparable to an average rise in Wells 87, 89 and 90 of about 12 to 15 ft for the same period. Well 86 is about 10,000 ft west of Spreading Area A, compared to well 89, which is about 4,000 ft east of Spreading Area A (Figure 1). It is difficult to explain the small fluctuations in Well 86 in 1981 and the early part of 1982. These fluctuations occurred when no water was diverted to the spreading areas. There is not an apparent reason for this based on the data presented in this report. These fluctuations may be associated with local snowmelt and recharge.

USGS Well 9 is the oldest well in the vicinity of the spreading areas, located at the southern boundary of Spreading Area C (see Figure 1). Figure 10 shows the hydrograph for this well back to 1965 when water was first diverted to the spreading areas. There appears to be a direct correspondence between the discharge to the spreading areas and the water levels recorded well 9.

The correlation of flow to the discharge areas and rising water levels in wells is apparent throughout the area of the RWMC. Any long term groundwater monitoring program must consider the influence that the spreading area has on the water table, and the direction of groundwater movement.

Recharge from the Big Lost River

Infiltration, via recharge from the Big Lost River, was estimated as the difference in measured flow at two gauging stations. The upstream station is located on the Big Lost River below the RWMC Diversion Dam and the downstream gauging station is located at the Lincoln Avenue bridge, about 8 miles below the diversion dam (USGS Gaging Stations #132520 and #132535). Because of the high infiltration rate from the river (Barraclough et al., 1967), it was assumed that all of the loss between the gaging stations was available as recharge to the aquifer. The difference between the flow measured at the two gauging stations or infiltration from the Big Lost River is plotted from 1965 to 1989 in Figure 12.

It is apparent from the hydrographs that recharge from the Big Lost River is much less than flow to the spreading areas. Recharge from the Big Lost River was not as significant, in terms of volume, as the discharge into the spreading areas. From 1982 to 1984, the discharge from to the spreading areas was over one order of magnitude larger than the estimated recharge from the Big Lost River.

The Big Lost River recharge was compared to discharge from to the spreading areas and to water levels in the wells near the spreading areas and the RWMC (USGS Wells 9, 87, 88, 89, and 90). Recharge from the Big Lost River into the subsurface coincide with the high water levels seen in RWMC area wells <u>only</u> when discharge into the spreading areas is high. This suggests discharge into the spreading areas is more influential on water level changes in the aquifer near the RWMC than recharge from the Big Lost River. The higher volumes of water in the spreading areas probably overshadow any influences the Big Lost River recharge may have on the aquifer in the area near the RWMC.

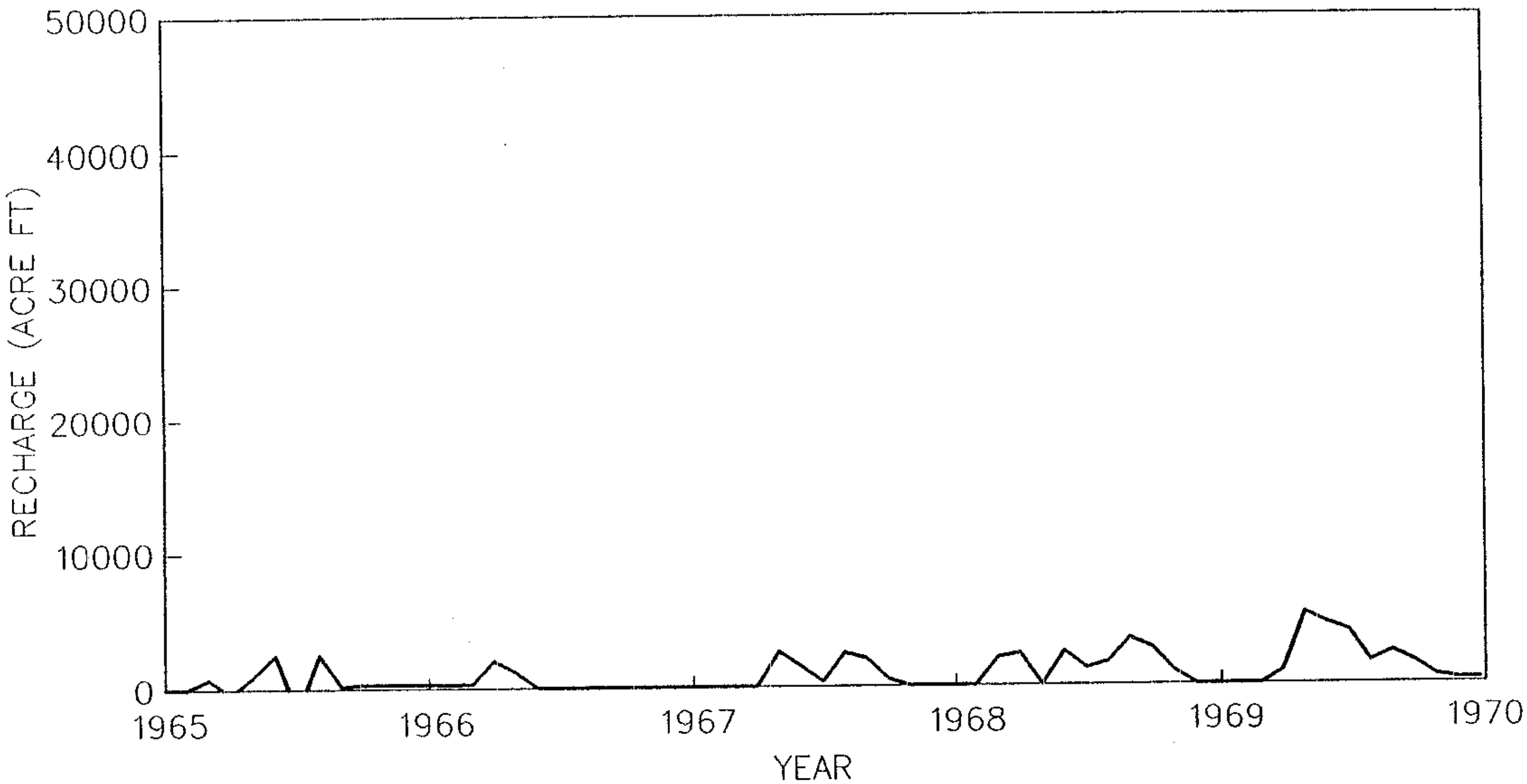

Figure 12. Recharge from the Big Lost River between USGS gauging stations numbers 132520 and 132535.

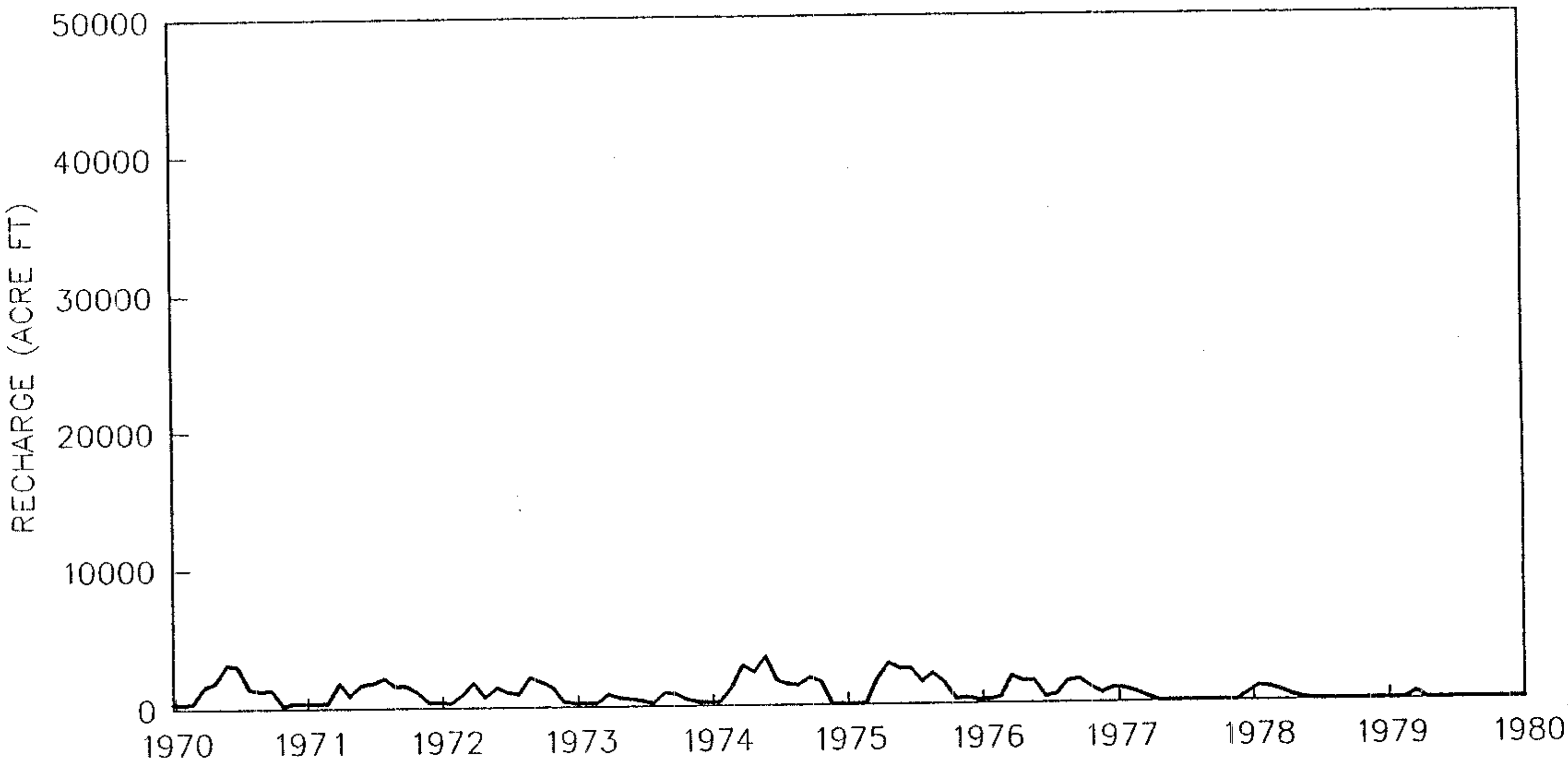

Figure 12. (Continued).

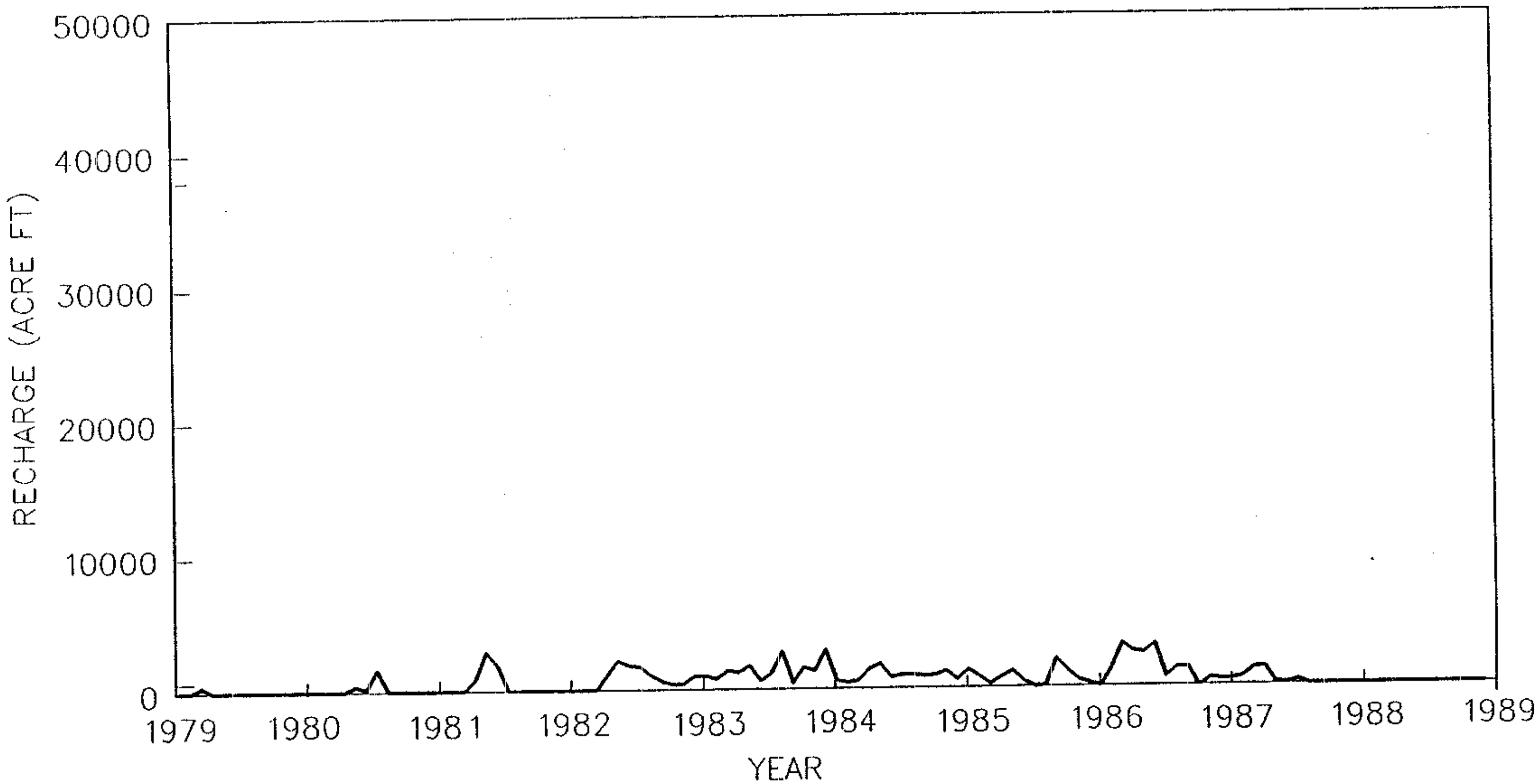

Figure 12. (Continued).

GROUNDWATER MOVEMENT

WATER TABLE MAPS

The direction of groundwater movement in the vicinity of the RWMC can be estimated from the gradient of the water table. It is apparent from the well hydrographs that the surface of the water table changes over time in response to discharge to the spreading areas and other factors. In order to track the changes in the water table over time, quarterly water table maps were generated for the RWMC area from the 1st quarter of 1980 through the first quarter of 1989. Water level elevations for 16 wells in the southeast corner of the INEL were entered into the database and contoured using the SURFER computer graphics program. Maps for these plots and the associated data values are provided in Appendix D. Because of the uncertainty associated with Well 88, two plots of each quarter were generated; one map with Well 88 and one without. All well locations were plotted for all years even though Wells 117, 119 and 120 were not installed until 1987. Because of the large volume of data, a computer program was selected to contour the quarterly water table data. The computer plotting had the additional ability to utilize data points from wells outside the mapped area in order to correlate the water levels near the RWMC to the regional water table. Because of the large distances between wells, pseudo wells were added outside of the mapped area in order to smooth the contours near the boundaries of the maps. The pseudo wells had little or no effect on contours near the RWMC.

In the early 1980's, the water table in the vicinity of the RWMC was flat with regular contours, apparently because of the low runoff years of the late 1970's (see Appendix D). This regular contour interval continued until the 2nd quarter of 1983 when recharge began to affect water levels in Well 89. During this quarter, Well 88 was the low point for the water table map. The water level high recorded in Well 88 compared to surrounding wells was not apparent prior to the 4th quarter of 1983. Before the 4th quarter of 1983 the plots with and without Well 88 are similar. This observation confirms the previously discussed hydrograph data that shows Well 88 tracking Wells 87 and 90 until about 1982.

The maps presented in Appendix D show the development and decline of a water table mound west of the RWMC. Since the well coverage is limited to just 7 wells near the RWMC, the shape and extent of the mound is only approximate. Recent water table maps indicate that the aquifer is recovering from the mounding condition and the contours are returning to the configuration of the early 1980's.

Well 88

It appears that historically Well 88 has tracked or followed changes in the regional water table fluctuations, but in the later part of 1984, the water level in this well rose anomalously. There is a direct correlation between the rise of water in Well 88 and discharge to Spreading Areas B and C.

Conceptually there appears to be two potential ways to account for the rise of water in Well 88. The first hypothesis is that Well 88 taps an isolated zone in the Snake River Plain aquifer. This might possibly occur if Well 88 were set in a dike swarm, where vertical dikes served as hydraulic barriers to groundwater flow. In this case, recharge would occur suddenly from flooding of the spreading areas, and the decline in water levels would occur over a long period of time as groundwater moved through the hydraulic barriers. The anticipated hydrograph would be steep on the recharge side as the system took on water, and more gradual as water slowly passed through the dikes. This hypothesis has been discarded since the hydrograph of Well 88 (see Figure 7) is more or less regular, taking almost as much time to rise to the peak as it did to decay. The second hypothesis is that Well 88 taps a zone with low transmissivity that is recharged from the spreading areas. The anticipated hydrograph from this second subsystem would be gradual both on the recharge side and on the discharge side, giving a regular appearance to the curve. This would occur because the subsystem would take a relatively long time to recharge and a relatively long time to discharge. The plot of Figure 7 resembles the hypothesis of Well 88 monitoring a portion of the aquifer with low transmissivity. This assessment is a non-quantitative evaluation of two possible explanations for the exceptionally high water levels recorded in Well 88. There are a number of other possibilities for the rise in water in Well 88, but further discussion should be postponed until more data have been collected to evaluate the aquifer in this vicinity.

It appears that water levels in Well 88 are representative of a localized area in the aquifer near Well 88, and should be treated separately from those water levels measured in other wells, at least until the zone has had time (several years based on the presented data) to come to equilibrium with the main aquifer. This is based on the anomalous water table high centered around this well discussed previously. The water level high is apparent during the peak water year of 1984, but prior to that, water levels in Well 88 were similar to nearby wells. Therefore, maps of the Snake River Plain aquifer in the area of the RWMC will not include water levels from Well 88 after 1983.

Rate and Direction of Groundwater Flow

Figures 13, 14 and 15 are water table contour maps based on data for the 1st quarter of 1989, the 3rd quarter of 1984 and the 4th quarter of 1980, respectively. These time periods represent the current configuration of the water table near the RWMC, the water table under recharge stress from the spreading areas and steady state conditions during a period of low runoff, respectively. Well data are correlated to the regional aquifer based on water levels measured in wells around the area of the RWMC. Flow lines have been added to show the approximate direction of groundwater flow. Because Well 88 may be in poor communication with the other wells near the RWMC, it was not used in Figures 13 and 14 but was used in Figure 15 since it appeared to fit the steady state conditions of the aquifer in the early 1980's. The present configuration of the water table correlates with the regional direction of flow to the south-southwest. Prior to the wet years starting in 1983, the direction of flow in the aquifer near the RWMC was to the south-southwest (see Figure 15). The water table maps indicate that the aquifer is recovering from the recharge stress caused by diversion of water to the spreading areas in the mid-1980's. Based on this trend, if little or no water is diverted to the spreading areas then the water table gradient will continue to flatten out and approach the gradient of 1980 (see Figure 15). If significant amounts of water are diverted to the spreading areas, another water table mound will develop under the spreading areas and the direction of groundwater flow will swing to the east as illustrated in Figure 15. It is clear that the direction of ground water flow is dynamic in the RWMC area, dependent upon the amount of water diverted to the spreading areas and possibly upon flow in the Big Lost River.

Earlier work by Barraclough et al. (1976) showed that during 1972 the flow direction was to the northwest. This is consistent with the mapping done for this report since the water levels in 1972 represent the recovery of the water table from discharge to the spreading areas during the late 1960's. Barraclough et al. (1976) contoured the water level from USGS 88 for their mapping, not aware that water levels from this well might be questionable based on data collected in the 1980's.

The rate and direction of groundwater flow is directly influenced by the hydraulic gradient. In the area of the RWMC, the water table gradient changes markedly over time in response to recharge from the spreading areas. Since the direction and magnitude of the hydraulic gradient varies with time, calculating the direction of flow and the rate of flow is not a straight forward procedure, it is dependent on the time period under consideration. The down gradient direction from the RWMC ranges from southwest to east, with the direction under low recharge conditions being to the south-southeast, depending on the amount of water diverted to the spreading areas. However, since conditions are transient, measured water levels may be the result of a pressure wave rather than physically moving the water from one point to another, complicating the net direction of groundwater movement even over short time intervals. Groundwater flow is additionally complicated by the heterogeneous and anisotropic character of the Snake River Plain aquifer. Fracture flow conditions undoubtedly

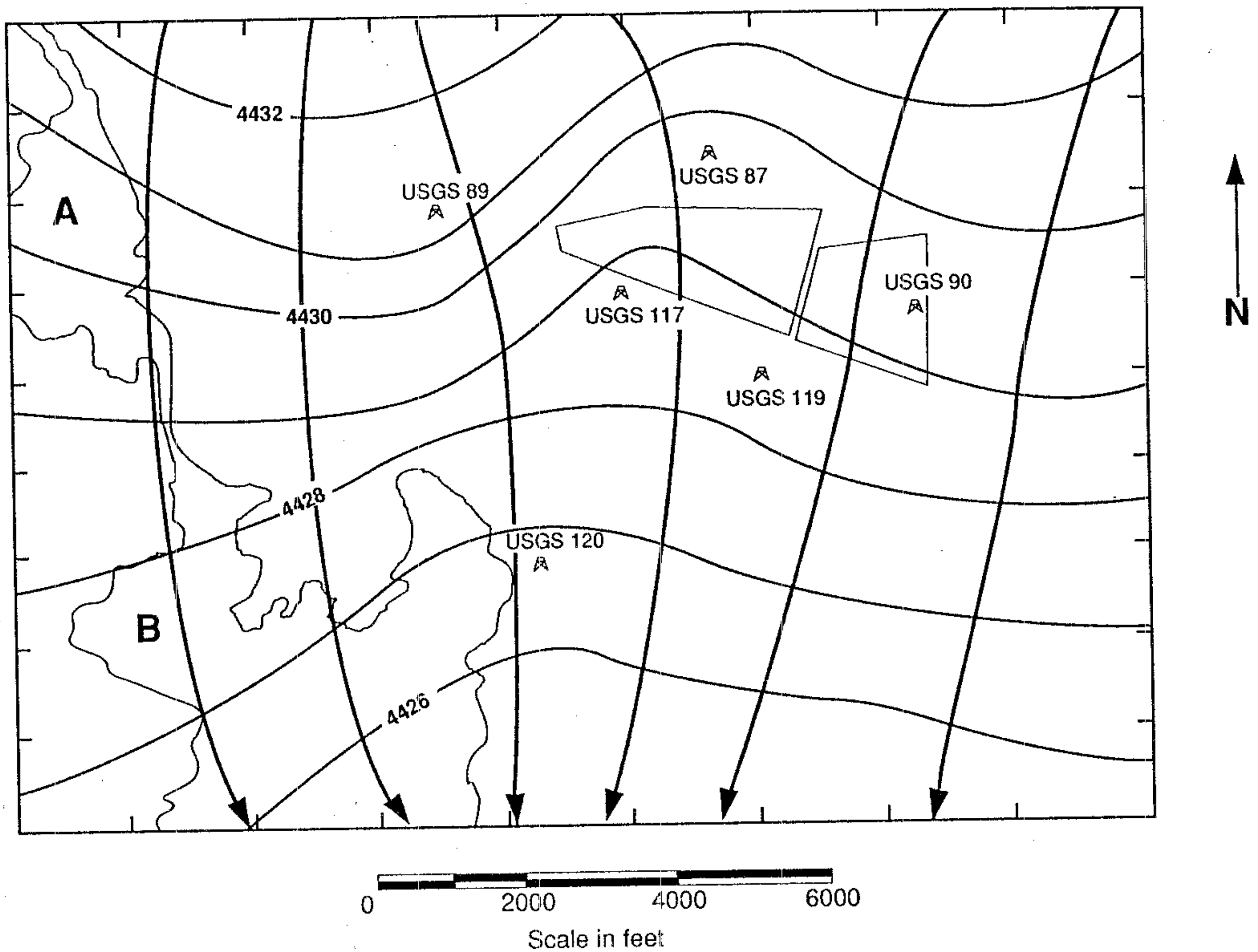

Figure 13. Altitude of the water table for the Snake River Plain aquifer and general direction of groundwater movement, 1st quarter of 1989 (Well 88 data not plotted).

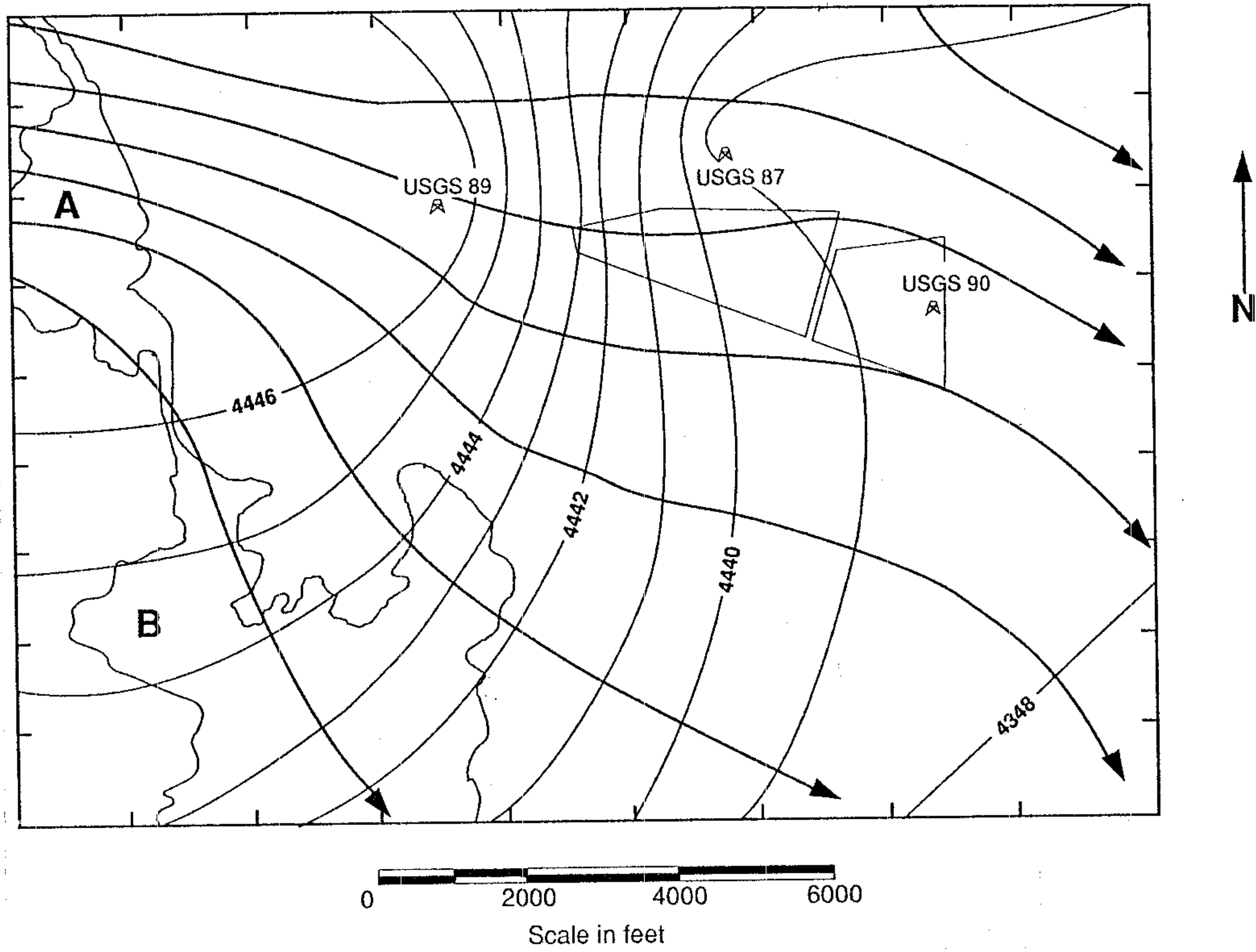

Figure 14. Altitude of the water table for the Snake River Plain aquifer and general direction of groundwater movement, 3rd quarter of 1984 (Well 88 data not plotted).

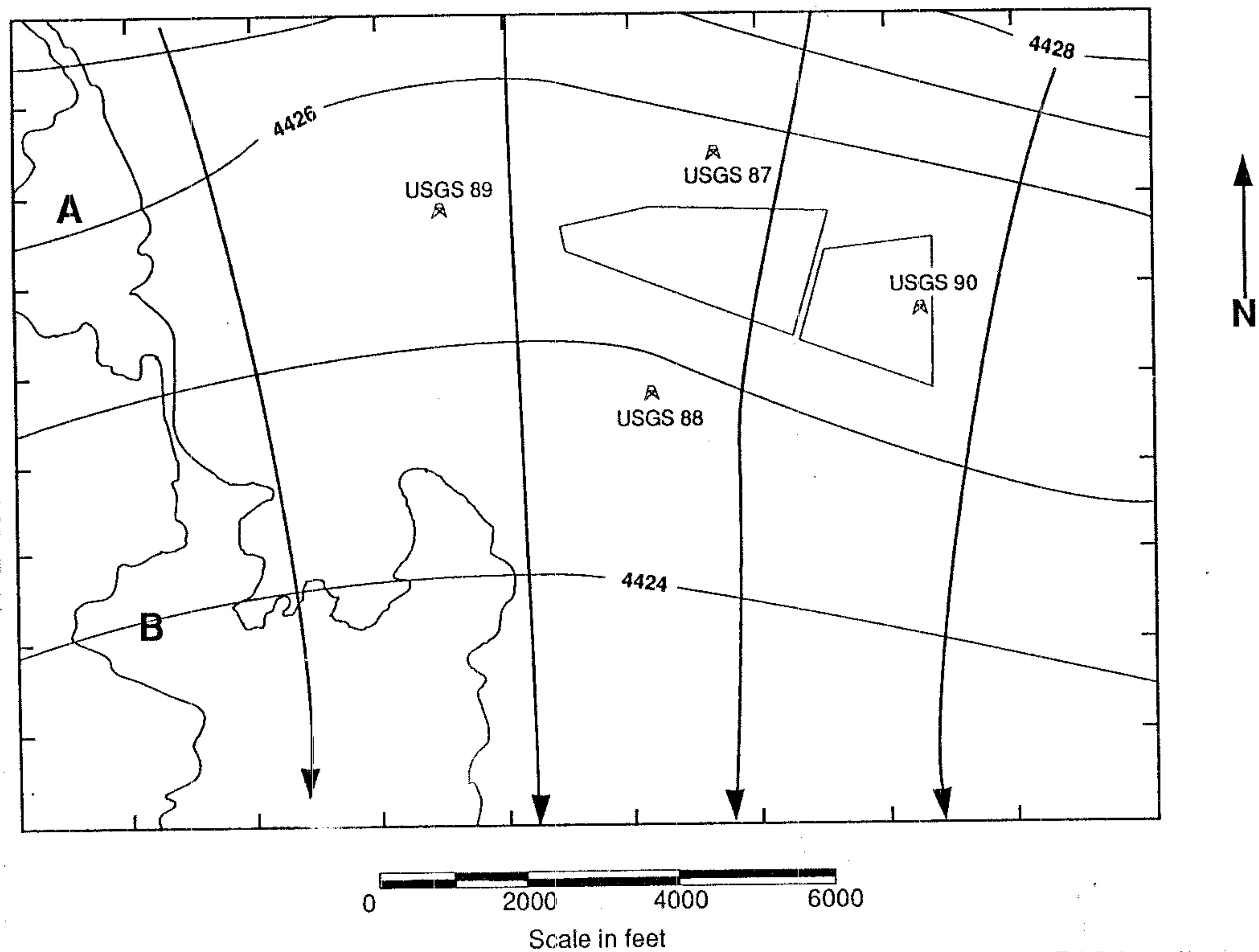

Figure 15. Altitude of the water table for the Snake River Plain aquifer and general direction of groundwater movement, 4th quarter of 1980.

control the movement of groundwater at a local scale. The effects of heterogeneities and anisotropies are probably reduced on a regional scale. For the purposes of calculating groundwater flow direction and rate, for this report, it will be assumed that the simplifying assumptions of Darcy's law are valid. Calculations based on the simplifying assumptions in Darcy's law have been used at a number of locations at the INEL. In one example, near the Idaho Chemical Processing Plant (ICPP) and the Central Facilities Area (CFA) the calculated flow rates compared favorably to direct measurements of groundwater flow rates between wells. The direct method involved monitoring the travel time of tritium peaks between wells. Groundwater flow rates ranging from 11 to 25 ft/day were determined using tritium slugs injected into the groundwater at ICPP (Barraclough et al., 1967). This is in agreement with the calculated flow rate from water level data of 13 ft/day at CFA, 3 miles south of ICPP (Wood et al., 1989). ICPP is approximately 8 miles northeast of the RWMC. Tritium from TRA or ICPP arrived at the RWMC in 1975 for a flow rate of about 5 ft/day.

Estimating the direction and rate of groundwater flow near the RWMC is complicated by the anisotropic and inhomogeneous nature of the Snake River Plain Basalts. From the discussion on Well 88 it is clear that at least one zone within the aquifer may be hydraulically isolated from the active portion of the aquifer. Using standard methods for calculating flow in the Snake River Plain aquifer may only be appropriate and accurate on a regional scale where local anomalies are averaged out over a larger area. Standard methods used to describe groundwater flow are based on an ideal case where flow takes place in a homogeneous medium. Basalt aquifers are classified as heterogeneous because the internal distribution of fractured zones and massive basalt can change substantially over relatively short distances. Defining the thickness and extent of a basalt aquifer is difficult. Yet, the lack of a complete understanding of a basalt aquifer need not discourage analyses using standard methods. Much may be learned about the groundwater system by examining the departure of the field data from the idealized case.

With the previous discussion in mind, groundwater flow velocities have been calculated using Darcy's law and the continuity equation. The equation for flow, corrected for porosity is as follows:

$$v = \frac{i\,K}{n}$$

where: v = the seepage velocity
i = the hydraulic gradient (dependent on date of map)
K = the hydraulic conductivity (700 ft/day (Robertson, 1974))
n = effective porosity (assumed 10%)

The gradient was estimated from each of the 3 maps presented in Figures 13, 14 and 15. For the 1st quarter of 1989, the gradient is 5.6 ft/mile in a south-southeast direction. The calculated flow rate is 7 ft/day. For the recharge case, the 3rd quarter of 1984, the gradient was 13.2 ft/mile in an easterly direction. The calculated flow rate for the period is 18 ft/day. For the stable water table case, 4th quarter 1980, the water table gradient was 3.3 ft/mile to the south-southwest at a rate of 5 ft/day.

The calculated values are approximations based on limited data, however, these values provide a preliminary assessment of the rate and direction of groundwater flow. Tracer tests or tracking contaminant migration is the best method for measuring groundwater flow rates. This has been used successfully in the area of ICPP (Barraclough et al., 1967) where tritium peaks were measured between wells.

Evaluation of Existing Data

Data collected by the USGS over the past 40 years has been invaluable in developing a conceptual model of the response of the Snake River Plain aquifer near the RWMC to recharge from the spreading areas. Water level data from wells in the area clearly show that: 1) the aquifer responds to the influx of water to the spreading areas; 2) there may be two hydrostratigraphic units in the area; and 3) that the direction and rate of groundwater flow changes depending on diversion to the spreading areas. However, these data are inadequate to provide the resolution and detail recommended for designing a groundwater monitoring system for a hazardous waste site. The RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD) (EPA, 1986) states that factors which may substantiate an increased density of boreholes include (among others); fracture zones encountered during drilling and suspected zones of high permeability that would not be defined by drilling at large intervals. The aquifer in the vicinity of the RWMC has both of these factors and additionally, is complicated by recharge from the spreading areas. The TEGD also recommends defining the vertical and horizontal hydraulic gradient. There are no available well data to provide control on the vertical gradient.

Contour maps presented in this report are based on a limited number of wells and additional wells are warranted to provide control for defining the water table and therefore, the direction of flow and the downgradient direction. This preliminary assessment indicates that because of water table mounding caused by diversion to the spreading areas, the downgradient direction can vary by about 90^{o}. Early work by Barroclough et al., (1976) showed that mounding in the early 70's caused reversals in the groundwater gradient of almost 180^{o}. Additional characterization wells are needed to define appropriate locations for the downgradient and upgradient (background) monitoring wells.

The stratigraphic control is limited to about 700 ft in the area of the RWMC. Additional characterization wells would provide more stratigraphic control at depth in the aquifer.

The thickness of the uppermost aquifer is not known in the vicinity of the RWMC. One or more wells should be cored or drilled to define the aquifer thickness this will satisfy EPA guidelines and be useful for estimating groundwater flux in the aquifer. However, the base of the Snake River Plain aquifer is not a distinct boundary and it will be difficult to determine the thickness of the aquifer over a large area.

A high stress, aquifer pumping test with observation wells has not been performed near the RWMC. This is critical for estimating the aquifer transmissivity. At a minimum, a test of about 3 days should be conducted. The RWMC production well may be suitable for the pumping well and at least one observation well needs to be installed. The suitability of the RWMC production well as a pumping well and USGS 90 for an observation needs to be evaluated.

Recommended Future Activities to Complete Aquifer Characterization

Wells

Characterization of a groundwater system is usually an iterative process where data and observations derived from previous boreholes are used to guide the placement of future ones. The USGS has basically completed what the TEGD identifies as the first and second iterations of the site characterization program with the wells drilled in 1972 and 1987. The proposed boreholes will fill gaps and supplement wells currently being monitored by the USGS.

Figure 16 shows recommended locations for characterization wells. Where possible, the recommended well locations have a dual purpose; first, to refine the geology and hydrology and second, to be useful for RCRA groundwater monitoring wells.

The recommended wells are discussed below:

Well M1 is a deep well (+700 ft) that will be offset from Well 88 by approximately 100 feet. It will be drilled to a permeable zone below the bottom of Well 88 to evaluate the potentiometric surface at depth. This well will also monitor the active portion of the Snake River Plain aquifer at this location.

Well M2 is proposed in a down gradient location from the RWMC during periods of high runoff; that is, when water table mounding conditions exist from recharge to the spreading areas. It will provide water table elevations near the eastern boundary of the RWMC. Aqueous chemistry data collected from this well will help delineate concentrations of volatile organics in this area. Well M2 will be completed in the first permeable zone in the aquifer (approximately 630 ft).

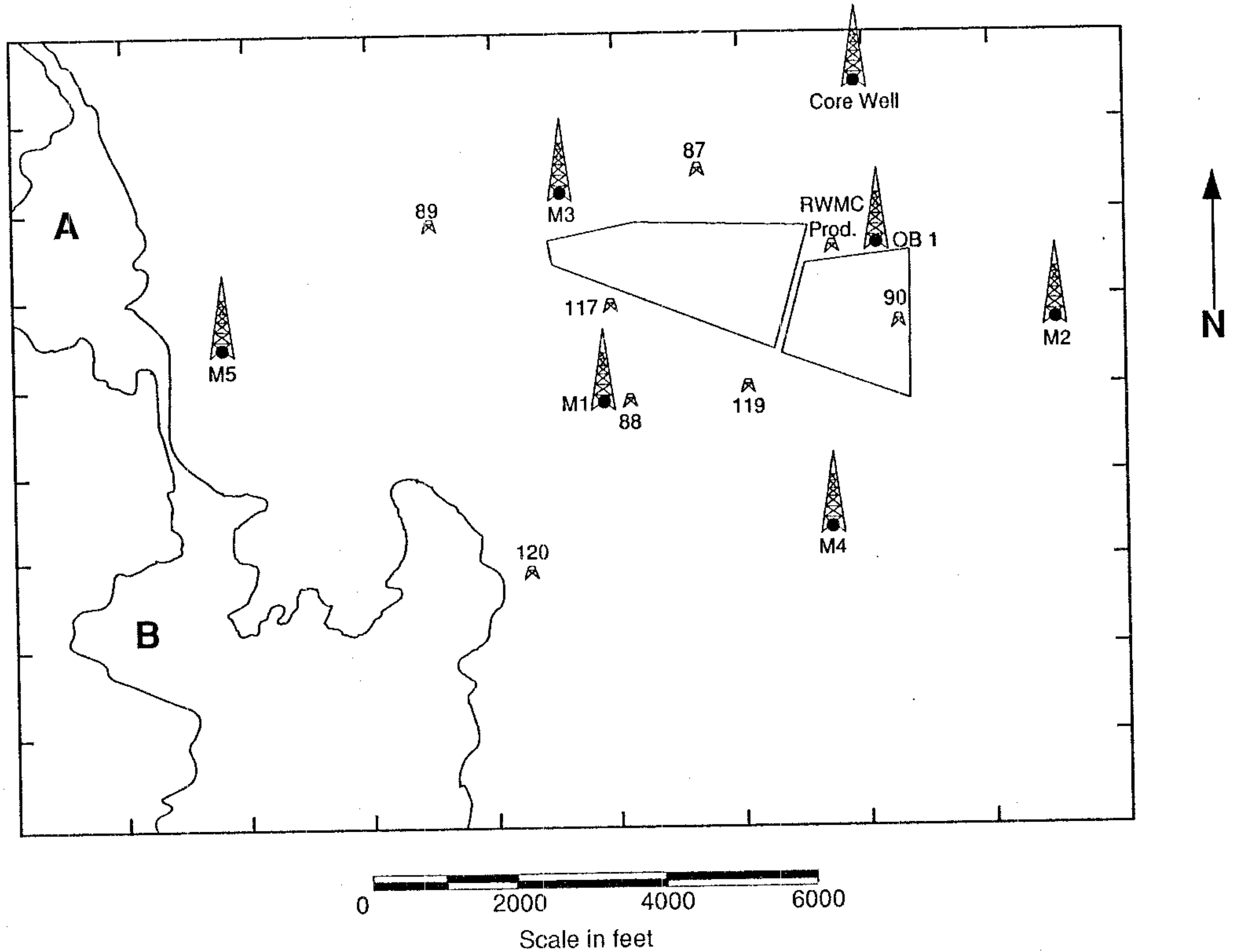

Figure 16. Map showing the recommended well locations for groundwater monitoring wells at the RWMC.

Well M3 is proposed in a current upgradient location of the RWMC and will provide water table control between Wells 89 and 87. It will also help define the extent of organic contaminants west of Well 87. It is scheduled to tap the upper 50 ft of the aquifer. (630 ft)

Well M4 is proposed in a down gradient location of the RWMC and will provide well control in an area with no control. It will also help define the down gradient extent of organic contamination in the upper 50 ft of the aquifer. (630 ft)

Well M1 will be drilled to a depth of about 700 ft below land surface and be completed in a permeable zone. Wells M2, M3 and M4 will be completed in the upper portion of the aquifer, approximately the upper 50, in the first permeable zone encountered the in aquifer.

Well C1 is a proposed deep corehole (1200 ft). It will provide stratigraphic and hydrologic data at depth in the aquifer. 1200 ft was selected as the target depth because of research by Mann (1986) that indicates the base of the aquifer may be 400 ft below the water table at a site ten miles northeast of the RWMC. However, some wells at the INEL show high permeabilities as deep as 1100 ft (J. T. Barraclough, oral communication, 1989). The proposed well location is tentative and the final location of the well will be dependent on input from basalt stratigraphers working in this area who are aware of locations where additional stratigraphic control is needed. Straddle-packer tests will be conducted to estimate the hydraulic conductivity with depth.

Well OB1 will be the observation well for the pumping test of the RWMC Production Well and located at a horizontal offset from the RWMC Production well of about 200 ft, or as appropriate based on calculations of the pumping rate and measurable drawdown. OB1 will be situated in a downgradient location of the RWMC during years of high discharge to the spreading areas and will be in an upgradient location during years of low recharge.

The designated names of the proposed wells are subject to change in order to match nomenclature now used to label wells at the RWMC.

TESTS

A pumping test with one or more observation wells should be performed in the RWMC Production Well to provide transmissivity and storitivity data on the aquifer. During the development of the RWMC Production Well, the USGS monitored drawdown, but the collected data were not suitable for calculating transmissivity because of a variable pumping rate and infrequent water level readings. Tests where data were collected for transmissivity analyses were conducted from monitoring wells using small capacity sampling pumps over short sections of the aquifer. The RWMC production system needs to be evaluated for this test, if the pumping and storage capacity are sufficient to stress the aquifer during a test, then OB1 will be installed nearby. The optimum offset of the observation well needs to be determined. In addition to OB1, it might be possible to utilize USGS 90 as an observation well, since about 0.2 ft of drawdown were observed during the 24 hour pumping test of the RWMC production well in 1974 (J. T. Barraclough, written communication, 1974).

Wells in the USGS monitoring system need to be evaluated. Some of the older wells have caved (Barraclough et al., 1976) and the amount of caving needs to be measured. This may involve pulling the dedicated pumps and surveying wells with a downhole TV video camera and other probes. Repair and cleaning of the wells should be accomplished as appropriate. It may be feasible to retrofit some of the wells with well screen to keep the well bore open. Deepening some of the wells should be evaluated, although based on this assessment it appears that the wells open to the upper portion of the aquifer are suitable for monitoring for contaminant migration from the RWMC. Deepening the wells might dilute collected samples with water flowing under the RWMC below the upper part of the aquifer.

Straddle-packer tests in the core well should provide a data on the hydraulic head at depth. These data can be used to estimate the vertical hydraulic gradient.

Data Evaluation

To supplement the recommendations made in this report, the aqueous chemistry data needs to be formally evaluated and summarized. Contour maps of contaminant concentrations would show the optimum location of wells proposed in this report.

The effect of localized snowmelts needs to be evaluated. All three floods of the RWMC, 1962, 1969 and 1982, came from melting snow and runoff from the surrounding topographic basin, not from the Big Lost River or Diversion Area. It is unclear what effect, if any, local recharge has on the aquifer, although, flooding probably has a significant effect on contaminant migration.

Summary

Groundwater flow near the RWMC is dominated by recharge to the spreading areas. It is apparent from mapping in this report that changes in the direction of flow occur after significant recharge events. The direction of groundwater flow is dependent on the amount of water diverted to the spreading areas. The groundwater monitoring system must account for variations in the direction of groundwater flow. This will involve monitoring downgradient locations during high recharge and low recharge conditions, which may vary as much as 90°.

Wells have been proposed to supplement the USGS monitoring network for water level information and water chemistry data. The wells recommended have not been prioritized or evaluated for regulatory compliance. The current monitoring system samples only the upper 120 ft of the aquifer and additional characterization of the aquifer at depth is needed to evaluate potential vertical pathways in the aquifer. A few deeper wells in addition to those recommended would provide more stratigraphic, potentiometric, and water quality data at depth in the aquifer.

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APPENDIX A

WATER LEVEL DATA FOR USGS WELLS BY WELL

WELL 8.00 Date	8.00 S.W.L.	WELL 9.00 Date	9.00 S.W.L.	WELL 86.00 Date	86.00 S.W.L.	WELL 87.00 Date	87.00 S.W.L.	WELL 88.00 Date	88 S.W.L.	WELL 89.00 Date	89 S.W.L.	WELL 90.00 Date	90 S.W.L.	WELL Date	117 S.W.L.	WELL Date	119 S.W.L	WELL Date	120 S.W.L.
		06/30/86	4429.94			06/12/86		06/12/86	4446.37	06/12/86		06/12/86							
		07/26/86	4429.67			07/30/86		07/30/86		07/30/86		07/30/86							
						08/31/86		08/11/86	4447.44	08/11/86	4433.42	08/11/86	4431.80						
						09/30/86		09/30/86		09/30/86		09/30/86							
						10/31/86	4430.88	10/31/86		10/31/86		10/31/86							
11/04/86	4435.25	11/01/86	4428.95	11/04/86	4433.29	11/03/86		11/03/86	4445.64	11/04/86	4434.05	11/03/86	4430.92						
12/19/86	4435.24	12/19/86	4429.05	12/22/86	4433.28	12/31/86		12/31/86		12/31/86		12/31/86							
		01/23/87	4429.31			01/22/87		01/22/87	4443.41	01/22/87	4433.44	01/22/87	4431.14						
02/25/87	4435.57	02/25/87	4429.05	02/25/87	4433.62	02/11/87	4431.25	02/11/87		02/11/87		02/11/87							
		03/27/87	4428.85			03/31/87		03/31/87		03/31/87		03/31/87							
04/06/87	4435.58	04/08/87	4428.95	04/08/87	4433.62	04/01/87	4431.25	04/01/87	4442.33	04/01/87	4435.15	04/01/87	4431.22						
		05/27/87	4428.45			05/31/87		05/31/87		05/31/87		05/31/87							
		06/26/87	4428.23			06/30/87	4431.04	06/30/87	4442.27	06/30/87	4437.87	06/30/87	4430.13						
07/29/87	4434.15	07/30/87	4427.84	08/03/87	4431.67	07/31/87		07/31/87		07/31/87		07/31/87							
		09/03/87	4427.62			08/20/87	4430.05	08/20/87	4441.53	08/20/87	4436.66	08/05/87	4429.44						
		09/24/87	4428.63			09/30/87		09/30/87	4440.57	09/30/87	4434.94	09/30/87							
10/30/87	4433.91	11/02/87	4427.94			10/31/87		10/31/87		10/31/87		10/31/87							
		12/08/87	4427.94			11/30/87		11/30/87		11/30/87		11/30/87							
12/09/87	4434.13			12/08/87	4431.71	12/08/87	4429.46	12/14/87	4439.37	12/14/87	4432.96	12/08/87	4429.47	12/08/87	4430.77	12/08/87	4430.42	12/08/87	4428.55
		01/20/88	4427.73			01/20/88		01/20/88		01/20/88		01/20/88						01/20/88	4428.25
		02/29/88	4427.51			01/19/88	4429.69	01/20/88	4439.43	01/20/88	4432.15	01/19/88	4429.82	02/01/88	4430.72	02/01/88	4430.62	02/29/88	4428.14
		03/22/88	4427.37			03/22/88												03/22/88	4427.99
04/05/88	4433.36	04/13/88	4427.41	04/13/88	4431.24	04/06/88	4431.02	04/05/88	4437.58	04/05/88	4430.92	04/06/88	4428.76	04/05/88	4429.91	04/05/88	4429.88	04/05/88	4425.98
		05/31/88	4426.70			05/31/88												05/31/88	4427.36
		06/23/88	4426.26			06/23/88												06/23/88	4427.25
07/28/88	4432.47	07/25/88	4426.30	06/22/88	4431.82	06/22/88	4428.89	06/22/88	4437.52	06/24/88	4430.31	06/22/88	4428.11	06/27/88	4429.43	06/27/88	4429.37	06/27/88	4427.20
		08/27/88	4426.12			08/25/88												08/25/88	4426.80
		09/26/88	4426.12			09/26/88												09/26/88	4426.63
10/27/88	4432.07	11/29/88	4426.07	11/02/88	4430.05	11/29/88												11/29/88	4426.58
		12/19/88	4426.42			12/19/88												12/19/88	4426.74
01/31/89	4432.08	01/31/89	4426.25	01/31/89	4428.26	01/12/89												01/12/89	4426.47
		02/21/89	4425.77			02/21/89												02/21/89	4426.26
						04/05/89	4429.11	04/04/89	4437.29	04/04/89	4430.62	04/05/89	4427.27	04/03/89	4428.17			04/04/89	4426.05

WELL 8.00 Date	8.00 S.W.L.	WELL 9.00 Date	9.00 S.W.L.	WELL 86.00 Date	86.00 S.W.L.	WELL 87.00 Date	87.00 S.W.L.	WELL 88.00 Date	88 S.W.L.	WELL 89.00 Date	89 S.W.L.	WELL 90.00 Date	90 S.W.L.	WELL Date	117 S.W.L.	WELL Date	119 S.W.L	WELL Date	120 S.W.L.
						02/26/82	4425.89	02/26/82	4424.69	03/24/82	4425.71	02/26/82	4425.69						
03/19/82	4430.82	03/19/82	4425.00	03/19/82	4428.77	03/24/82	4426.10	03/24/82	4424.85	04/26/82	4426.69	03/24/82	4425.91						
04/15/82	4430.94	04/15/82	4426.06	04/15/82	4428.82	04/26/82	4425.91	04/26/82	4424.79	05/24/82	4425.39	04/08/82	4425.80						
05/26/82	4431.22	05/26/82	4425.43	05/26/82	4429.40	05/24/82	4426.25	05/24/82	4424.60	06/15/82	4425.63	05/24/82	4426.02						
06/23/82	4431.47	06/23/82	4425.48	06/23/82	4429.64	06/15/82	4426.77	06/15/82	4424.81	07/15/82	4426.29	06/15/82	4426.45						
07/28/82	4432.87	07/28/82	4426.47	07/28/82	4431.54	07/15/82	4427.83	07/15/82	4425.16	08/24/82	4428.20	07/15/82	4427.46						
08/26/82	4432.77	08/17/82	4426.26	08/27/82	4430.96	08/24/82	4428.34	08/24/82	4425.25	09/28/82	4430.60	08/24/82	4428.08						
10/04/82	4432.34	10/04/82	4426.12	10/04/82	4430.43	09/28/82	4428.23	09/28/82	4436.14	10/27/82	4430.37	09/28/82	4428.06						
10/29/82	4433.21	10/29/82	4426.27	10/29/82	4430.39	10/27/82	4427.61	10/27/82	4425.72	11/09/82	4430.53	10/27/82	4427.40						
11/24/82	4432.14	11/24/82	4426.21	11/24/82	4430.12	11/22/82	4427.53	11/08/82	4426.12	11/22/82	4430.46	11/09/82	4427.69						
01/11/83	4432.22	01/11/83	4426.16	01/11/83	4430.23	12/29/82	4427.61	12/29/82	4425.81	12/29/82	4429.43	11/22/82	4427.40						
						02/04/83	4428.42	01/24/83	4426.62	02/04/83	4430.75	02/04/83	4428.17						
		03/11/83	4427.11			02/24/83	4428.75	02/26/83	4426.73	02/25/83	4430.80	02/25/83	4427.80						
						03/31/83	4429.51	03/31/83	4427.52	03/31/83	4433.53	03/31/83	4429.83						
04/14/83	4435.02	04/14/83	4427.79	04/14/83	4433.31	04/28/83	4429.85	04/28/83	4427.20	04/28/83	4436.43	04/28/83	4430.56						
05/17/83	4434.52	05/17/83	4427.57	05/17/83	4432.82	05/29/83	4432.02	05/27/83	4427.57	05/27/83	4437.99	05/27/83	4431.00						
06/29/83	4435.87	06/10/83	4427.99	06/29/83	4434.95	07/05/83	4432.56	07/05/83	4427.95	06/30/83	4439.15	07/05/83	4432.12						
07/21/83	4437.92	08/01/83	4431.43	07/21/83	4437.18	07/14/83	4433.75	07/14/83	4428.66	07/14/83	4439.62	07/14/83	4433.25						
08/24/83	4437.78	08/24/83	4430.17	08/24/83	4436.65	08/25/83	4432.62	08/29/83	4436.97	08/25/83	4441.00	08/25/83	4433.47						
09/29/83	4436.94	09/29/83	4429.74	09/29/83	4435.37	09/26/83	4432.73	09/28/83	4446.80	09/23/83	4441.48	09/26/83	4433.56						
		11/07/83	4429.81			11/02/83	4433.04	11/02/83	4448.63	11/02/83		11/02/83	4432.79						
12/02/83	4438.14	12/02/83	4432.12	12/02/83	4437.18	12/01/83	4434.31	12/01/83	4448.05	12/01/83	4441.79	12/01/83	4434.11						
12/29/83	4439.31	12/29/83	4432.43	12/29/83	4438.30	12/20/83	4435.46	12/20/83	4448.39	12/20/83	4442.08	12/20/83	4435.15						
01/27/84	4439.58	01/27/84	4431.88	01/27/84	4438.33	01/26/84	4434.84	02/21/84	4467.03	01/26/84	4442.69	01/26/84	4435.57						
02/21/84	4439.70	02/21/84		02/21/84	4438.39	02/22/84	4436.11	03/26/84	4470.84	02/22/84	4443.64	02/22/84	4435.88						
03/20/84	4439.18	03/14/84	4431.68	03/20/84	4437.87	03/26/84	4436.02	04/26/84	4470.67	03/26/84	4444.73	03/26/84	4435.87						
04/27/84	4439.84	04/16/84	4432.32	04/27/84	4438.78	04/17/84	4436.23	05/25/84	4478.40	04/26/84	4445.06	04/17/84	4436.05						
05/30/84	4440.92	05/29/84		05/30/84	4440.00	05/26/84	4436.94	06/20/84	4485.93	05/25/84	4444.71	05/25/84	4436.77						
06/22/84	4441.98	06/20/84	4436.79	06/22/84	4441.11	06/20/84	4436.23	07/16/84	4487.16	06/20/84	4445.32	06/20/84	4438.08						
07/24/84	4443.00	07/24/84	4435.86	07/24/84	4441.87	07/10/84	4436.55	08/17/84	4503.60	07/16/84	4445.59	07/16/84	4438.62						
08/27/84	4442.42	08/27/84		08/27/84	4440.52	08/27/84	4438.45	09/13/84	4502.39	08/27/84	4446.20	08/27/84	4438.57						
09/24/84	4441.91	09/28/84	4434.71	09/24/84	4440.52	09/28/84	4436.35	09/28/84	4500.00	09/28/84	4445.14	09/28/84	4438.43						
10/31/84	4441.39	10/18/84	4434.23	10/31/84	4439.84	10/23/84	4437.16	10/23/84	4496.08	10/23/84	4445.94	10/23/84	4437.04						
11/27/84	4440.81	11/27/84	4434.08	11/27/84	4439.04	11/20/84	4436.63	11/29/84	4491.09	11/28/84	4445.80	11/29/84	4436.56						
12/27/84	4440.89			12/27/84	4439.35	12/20/84	4436.63	12/20/84	4491.24	12/20/84	4445.53	12/20/84	4436.47						
01/18/85	4440.49	01/18/85	4433.57	01/18/85	4438.94	01/25/85	4436.42	01/25/85	4480.33	01/25/85	4444.96	01/25/85		440.00					
02/25/85	4440.23	02/22/85	4432.78	02/25/85	4438.60	02/21/85	4435.99	02/21/85	4477.19	02/21/85	4444.02	02/21/85							
		03/28/85	4432.13	03/28/85	4438.03	03/28/85	4436.39	03/28/85	4474.03	03/27/85	4444.26	03/27/85	4436.12						
04/17/85	4439.43	04/18/85	4432.28	04/17/85	4437.81	04/29/85	4436.04	04/29/85	4473.74	04/29/85	4443.44	05/14/85	4434.54						
05/30/85	4439.33	05/29/85	4431.64	05/30/85	4437.41	05/23/85	4434.99	05/23/85	4469.29	05/20/85	4443.27	05/23/85	4434.83						
06/19/85	4438.34	06/21/85	4430.96	06/19/85	4436.17	06/21/85	4433.83	06/21/85	4466.18	06/21/85	4442.69	06/21/85	4433.74						
07/17/85	4437.31	07/17/85	4430.63	07/17/85	4435.14	07/11/85	4433.05	07/11/85	4472.55	07/11/85	4441.88	07/24/85	4432.92						
08/29/85	4436.20	09/05/85	4429.72	08/29/85	4433.98	08/23/85	4432.69	08/23/85	4466.78	08/23/85	4440.80	08/23/85	4431.58						
09/26/85	4435.91	09/26/85	4429.52	09/26/85	4435.73	09/30/85	4431.22	09/30/85	4464.29	09/30/85	4438.04	09/30/85	4429.64						
10/22/85	4435.67	10/22/85	4429.45	10/22/85	4433.66	10/27/85	4431.26	10/22/85	4457.26	10/22/85	4438.20	10/22/85							
11/27/85	4436.70	12/04/85	4429.10	12/04/85	4433.36	11/25/85	4431.42	12/05/85	4457.79	11/25/85	4437.03	11/26/85	4430.99						
		12/24/85	4428.99			12/31/85		12/31/85		12/31/85		12/31/85							
02/06/86	4435.08	02/06/86	4428.76	02/06/86	4432.86	01/27/86	4435.55	01/27/86	4448.61	01/27/86	4434.55	01/27/86	4429.08						
		03/04/86	4428.67			02/28/86		02/28/86		02/28/86		01/27/86	4428.40						
		03/25/86	4428.55			03/31/86		03/31/86		04/18/86	4433.58	04/18/86	4431.09						
04/22/86	4435.15	04/22/86	4428.91	04/22/86	4433.08	04/18/86	4430.34	04/18/86	4449.45	04/18/86	4427.62	04/18/86	4430.41						
		06/02/86	4428.90			05/31/86		05/31/86		05/31/86		05/31/86							

WELL 8.00	8.00	WELL 9.00	9.00	WELL 86.00	86.00	WELL 87.00	87.00	WELL 88.00	88	WELL 89.00	89	WELL 90.00	90	WELL	117	WELL	119	WELL	120
Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L	Date	S.W.L.
10/25/77	4432.62	10/25/77	4426.81	10/25/77	4430.50	10/28/77	4427.98	10/28/77	4428.16	10/28/77	4432.51	10/28/77	4428.09						
11/22/77	4432.66	11/22/77	4426.89	11/22/77	4430.71	11/28/77	4427.82	11/28/77	4427.46	11/28/77	4431.16	11/28/77	4427.90						
12/22/77	4432.65	12/22/77	4426.86	12/22/77	4430.73	01/03/78	4427.86	01/03/78	4427.66	01/03/78	4430.83	01/03/78	4427.97						
01/25/78	4432.29	01/25/78	4426.52	01/25/78	4430.19	01/31/78	4427.19	01/31/78	4428.37	01/31/78	4430.68	01/31/78	4427.28						
02/23/78	4432.05	02/23/78	4426.33	02/23/78	4429.93	02/23/78	4427.51	02/23/78	4427.60	02/23/78	4429.55	02/23/78	4426.61						
04/03/78	4431.83	03/31/78	4426.25	04/03/78	4429.74	03/29/78	4427.28	03/29/78	4427.43	03/29/78	4429.13	03/29/78	4426.60						
04/20/78	4431.97	04/20/78	4426.23	04/20/78	4429.97	04/26/78	4427.18	04/26/78	4427.19	04/26/78	4428.39	04/26/78	4426.41						
05/24/78	4431.55	05/24/78	4425.86	05/24/78	4429.57	05/30/78	4426.89	05/30/78	4426.61	05/30/78	4428.76	05/30/78	4426.48						
06/28/78	4431.40	06/28/78	4425.74	06/28/78	4429.33	06/30/78	4426.70	06/30/78	4427.20	06/30/78	4428.14	06/30/78	4426.84						
07/18/78	4431.36	07/18/78	4425.56	07/18/78	4429.27	07/26/78	4426.46	07/26/78	4426.47	07/26/78	4427.17	07/26/78	4426.47						
08/25/78	4430.99	08/25/78	4425.24	08/25/78	4428.93	08/31/78	4426.36	08/31/78	4426.13	08/31/78	4426.36	08/31/78	4425.99						
09/21/78	4430.98	09/21/78	4425.36	09/21/78	4428.88	09/20/78	4425.43	09/20/78	4425.94	09/20/78	4426.34	09/20/78	4426.07						
10/19/78	4431.12	10/19/78	4425.50	10/19/78	4429.00	10/25/78	4425.62	10/25/78	4425.93	10/25/78	4426.20	10/25/78	4426.20						
		12/02/78	4425.79	12/02/78	4429.27	11/30/78		11/30/78		11/30/78		11/30/78							
12/28/78	4431.36	12/28/78	4425.84	12/28/78	4429.49	12/21/78	4425.86	12/21/78	4425.21	12/21/78	4425.85	12/21/78	4425.71						
01/23/79	4431.24	01/22/79	4425.67	01/23/79	4429.22	01/18/79	4425.91	01/18/79	4426.06	01/18/79	4426.56	01/18/79	4425.09						
03/31/79	4431.32	03/31/79	4425.68	03/31/79	4429.21	03/29/79	4426.11	03/29/79	4426.41	03/29/79	4426.97	03/29/79	4426.13						
04/27/79	4431.55	04/27/79	4425.77	04/27/79	4429.44	05/03/79	4425.65	05/03/79	4426.01	05/03/79	4426.58	05/03/79	4425.95						
05/23/79	4431.35	05/23/79	4425.64	05/23/79	4429.31	06/01/79	4425.37	06/01/79	4425.68	06/01/79	4426.27	06/01/79	4426.24						
06/26/79	4431.12	06/26/79	4425.36	06/26/79	4429.03	06/27/79	4425.22	06/27/79	4425.65	06/27/79	4426.29	06/27/79	4426.27						
07/23/79	4430.77	07/23/79	4425.06	07/23/79	4428.77	07/27/79	4425.03	07/27/79	4425.82	07/27/79	4426.31	07/27/79	4426.04						
08/27/79	4430.47	08/27/79	4424.85	08/27/79	4428.53	08/29/79	4424.85	08/29/79	4425.69	08/29/79	4426.25	08/29/79	4425.87						
09/25/79	4430.38	09/25/79	4424.98	09/25/79	4428.58	09/26/79	4424.72	09/26/79	4425.34	09/26/79	4425.83	09/26/79	4425.71						
10/11/79	4430.50	10/11/79	4425.10	10/11/79	4428.85	10/12/79	4424.87	10/12/79	4425.48	10/12/79	4425.98	10/12/79	4425.92						
11/27/79	4430.44	11/27/79	4425.11	11/27/79	4428.43	11/28/79	4425.41	11/28/79	4425.59	11/28/79	4425.98	11/28/79	4425.57						
12/19/79	4430.71	12/19/79	4425.37	12/19/79	4428.86	12/17/79		12/17/79		12/17/79		12/17/79	4425.91						
						12/20/79	4426.02	12/20/79	4425.41	12/20/79	4425.85	12/20/79	4426.09						
01/25/80	4430.79	01/25/80	4425.37	01/25/80	4429.03	01/16/80	4425.99	01/17/80	4425.39	01/17/80	4425.91	01/16/80	4426.00						
03/01/80	4430.50	03/01/80	4425.11	03/01/80	4428.53	02/26/80	4425.81	02/26/80	4425.39	02/26/80	4425.48	02/26/80	4425.86						
03/19/80	4430.56	03/19/80	4425.10	03/19/80	4428.66	03/21/80	4426.01	03/21/80	4425.38	03/21/80	4425.87	03/21/80	4426.04						
04/16/80	4430.33	04/16/80	4424.85	04/16/80	4428.34	04/21/80	4425.93	04/21/80	4425.38	04/21/80	4425.88	04/21/80	4425.97						
05/26/80	4430.24	05/26/80	4424.80	05/26/80	4428.32	05/16/80	4426.67	05/16/80	4425.20	05/16/80	4425.66	05/16/80	4425.70						
06/25/80	4430.45	06/25/80	4424.98	06/25/80	4428.58	06/20/80	4425.89	06/20/80	4424.93	06/20/80	4425.48	06/20/80	4425.90						
07/21/80	4430.54	07/21/80	4424.84	07/21/80	4428.55	07/16/80	4425.81	07/16/80	4424.75	07/16/80	4425.31	07/16/80	4425.77						
08/19/80	4430.39	08/19/80	4424.62	08/19/80	4428.36	08/31/80		08/31/80		08/31/80		08/31/80							
09/26/80	4430.55	09/26/80	4424.95	09/26/80	4428.52	09/30/80		09/30/80		09/30/80		09/30/80							
10/08/80	4430.64	10/08/80	4425.13	10/08/80	4428.55	10/06/80	4425.85	10/01/80	4424.62	10/06/80	4425.23	10/01/80	4425.60						
12/11/80	4430.88	12/01/80	4425.48	12/11/80	4428.82	11/30/80		11/30/80		11/30/80		11/30/80							
		12/11/80	4425.38			12/31/80		12/31/80		12/31/80		12/31/80							
01/27/81	4431.23	01/27/81	4425.52	01/27/81	4429.22	01/13/81		01/13/81	4424.87	01/16/81	4425.64	01/16/81							
02/25/81	4431.23	02/25/81	4425.40	02/25/81	4431.27	02/05/81	4426.34	02/05/81	4424.96	02/05/81		02/05/81	4426.13						
04/09/81	4431.25	04/02/81	4425.43	04/09/81	4429.21	03/31/81		03/31/81		03/31/81		03/31/81							
04/30/81	4431.10	04/30/81	4425.08	04/30/81	4429.00	04/30/81		04/30/81		04/30/81		04/30/81							
		05/30/81	4425.21			05/22/81	4426.41	05/22/81	4425.18	05/22/81	4425.88	05/22/81	4426.16						
06/26/81	4431.08	06/26/81	4425.26	06/26/81	4428.97	06/30/81	4426.36	06/30/81	4424.92	06/30/81	4425.74	06/30/81	4426.16						
07/11/81	4430.93	07/11/81	4424.96	07/11/81	4428.92	07/13/81	4426.23	07/13/81	4424.96	07/13/81	4425.83	07/13/81	4426.08						
08/26/81	4430.42	08/26/81	4424.57	08/26/81	4428.31	08/21/81	4425.81	08/21/81	4425.40	08/21/81	4425.67	08/21/81	4425.52						
09/23/81	4430.35	09/23/81	4424.66	09/23/81	4430.28	09/30/81		09/30/81		09/30/81		09/30/81							
10/09/81	4430.43	10/09/81	4424.77	10/09/81	4428.38	10/29/81	4426.00	10/29/81	4424.87	10/29/81	4425.81	10/29/81	4425.82						
11/19/81	4430.62	11/19/81	4425.08	11/19/81	4428.54	11/25/81	4426.04	11/25/81	4424.89	11/25/81	4425.69	11/25/81	4425.84						
12/22/81	4430.79	12/22/81	4425.03	12/22/81	4430.47	12/28/81	4426.04	12/28/81	4424.95	12/28/81	4425.71	12/28/81	4425.87						
02/02/82	4430.83	02/02/82	4425.02	02/02/82	4428.69	01/28/82	4426.10	01/28/82	4424.89	02/26/82	4425.44	01/28/82	4425.91						

WELL	8.00	WELL	9.00	WELL	86.00	WELL	87.00	WELL	88	WELL	89	WELL	90	WELL	117	WELL	119	WELL	120
8.00		9.00		86.00		87.00		88.00		89.00		90.00							
Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L	Date	S.W.L.
		06/30/73	4429.19			06/29/73	4431.11	06/29/73	4432.05	05/29/73	4438.01	06/29/73	4431.50						
07/25/73	4435.20	07/25/73	4428.82			07/24/73	4430.46	07/24/73	4431.61	06/29/73	4439.21	07/24/73	4430.81						
08/28/73	4434.90	08/28/73	4428.68			08/29/73	4430.28	08/29/73	4431.62	07/24/73	4438.70	08/29/73	4430.58						
		09/25/73	4428.78			09/26/73	4429.92	09/26/73	4431.18	08/29/73	4438.03	09/26/73	4430.18						
10/17/73	4434.89	10/17/73	4428.91			10/31/73	4431.42	10/31/73	4431.85	09/26/73	4436.67	10/31/73	4431.11						
11/28/73	4435.04	11/28/73	4429.00			11/29/73	4430.41	11/29/73	4431.23	11/29/73	4434.65	11/29/73	4430.72						
12/21/83	4435.14	12/21/83	4429.09			12/20/73	4430.29	12/20/73	4430.95	12/20/73	4433.95	12/20/73	4430.63						
01/25/74	4435.22	01/25/74	4429.10			01/18/74	4430.34	01/18/74	4431.06	01/18/74	4433.52	01/18/74	4430.72						
02/21/74	4434.96	02/21/74	4428.65			02/25/74	4430.24	02/25/74	4430.83	02/26/74	4433.15	02/25/74	4430.61						
03/28/74	4434.89	03/28/74	4428.71			03/27/74	4430.27	03/27/74	4430.95	03/27/74	4432.85	03/27/74	4430.61						
04/25/74	4434.95	04/25/74	4428.65			04/24/74	4430.49	04/24/74	4431.00	04/25/74	4432.61	04/24/74	4430.83						
05/28/74	4434.80	05/28/74	4428.52			05/29/74	4430.39	05/29/74	4430.93	05/29/74	4432.91	05/29/74	4430.74						
06/26/74	4434.60	06/24/74	4428.43			06/29/74		06/29/74	4430.33	06/28/74	4432.52	06/29/74	4430.21						
07/23/74	4435.12	07/23/74	4428.79			08/02/74	4430.80	08/02/74	4430.40	08/01/74	4432.35	08/02/74	4430.78						
		08/27/74	4428.50			08/27/74	4430.59	08/27/74	4430.36	08/27/74	4432.47	11/22/74	4430.62						
09/26/74	4434.91	09/26/74	4428.71			09/30/74	4430.38	09/30/74	4430.19	09/30/74	4432.37	11/24/74	4430.64						
10/24/74	4434.51	10/24/74	4428.47			10/17/74	4430.02	10/16/74	4430.00	10/16/74	4432.21	12/16/74	4429.59						
						11/26/74	4430.20	11/26/74	4429.96	11/26/74	4431.73	12/16/74	4430.31						
12/19/74	4434.93	12/19/74	4428.78			12/27/74	4430.45	12/27/74	4430.47	12/27/74	4434.72	12/27/74	4430.80						
		01/24/75	4428.97			01/31/75	4430.63	01/31/75		02/01/75	4431.95	01/31/75							
02/25/75	4435.92	02/25/75	4428.90			02/01/75	4431.07	02/01/75	4430.40	03/27/75	4435.47	02/07/75	4431.49						
						03/27/75	4431.94	03/27/75	4430.54	04/25/75	4439.04	03/27/75	4431.97						
05/01/75	4435.94	05/01/75	4429.15			04/25/75	4432.15	04/25/75	4431.05	05/31/75	4440.74	04/25/75	4432.28						
05/28/75	4435.57	05/28/75	4428.93			05/30/75	4431.35	05/30/75	4430.80	06/25/75	4440.96	05/30/75	4431.50						
		06/25/75	4428.67			06/25/75		06/25/75		07/25/75	4440.38	07/02/75	4432.07						
07/16/75	4435.21	07/16/75	4428.76			07/25/75	4430.87	07/25/75	4430.69	08/28/75	4439.49	07/25/75	4430.97						
08/26/75	4435.44	08/26/75	4428.94			08/28/75	4431.21	08/28/75	4430.74	09/29/75	4439.09	08/28/75	4431.28						
						09/29/75	4430.56	09/29/75	4430.42	10/28/75	4438.53	09/26/75	4430.75						
10/10/75	4435.06	10/10/75	4428.80			10/28/75	4430.54	10/28/75	4430.53	11/26/75	4438.37	10/28/75	4430.57						
		11/26/75	4429.37			12/04/75	4430.76	12/04/75	4430.80	12/04/75	4437.81	12/04/75	4430.87						
12/20/75	4434.98	12/20/75	4428.88			12/30/75	4430.94	12/30/75	4430.62	12/30/75	4436.84	12/30/75	4431.07						
01/23/76	4435.41	01/23/76	4429.09			01/27/76	4430.88	01/27/76	4430.89	01/27/76	4435.45	01/27/76	4430.86						
02/27/76	4435.67	02/27/76	4429.02	02/27/76	4433.91	03/01/76	4431.81	03/01/76	4430.77	03/01/76	4437.04	03/01/76	4431.93						
		03/26/76	4429.17			03/30/76	4431.53	03/30/76	4430.01	03/30/76	4438.14	03/30/76	4431.54						
04/15/76	4436.11	04/15/76	4429.46	04/15/76	4434.52	04/27/76	4431.49	04/27/76	4430.55	04/27/76	4440.23	04/27/76	4431.60						
05/25/76	4435.44	05/25/76	4428.91	05/25/76	4433.52	05/26/76	4430.86	05/26/76	4430.27	05/26/76	4440.83	05/26/76	4430.97						
		06/28/76	4428.70			06/24/76	4430.76	06/24/76	4430.36	06/24/76	4440.72	06/24/76	4430.88						
07/23/76	4434.73	07/23/76	4428.36	07/23/76	4432.55	07/13/76	4429.78	07/13/76	4430.63	07/13/76	4440.09	07/13/76	4430.47						
		08/25/76	4428.12			08/31/76	4429.58	08/31/76	4429.98	08/31/76	4437.58	08/31/76	4429.69						
09/23/86	4434.09	09/23/86	4428.06	09/23/76	4432.00	09/27/76	4429.65	09/27/76	4430.73	09/24/76	4437.47	09/27/76	4429.66						
10/28/76	4434.21	10/28/76	4428.25	10/28/76	4432.14	10/27/76	4429.57	10/30/76	4429.80	10/30/76	4435.77	10/29/76	4429.89						
11/24/76	4434.91	11/24/76	4428.83	11/24/76	4433.18	11/29/76	4430.51	11/29/76	4429.47	11/29/76	4434.70	11/29/76	4430.46						
12/23/76	4435.45	12/23/76	4429.08	12/23/76	4433.72	12/27/76	4431.12	12/27/76	4430.00	12/27/76	4434.79	12/27/76	4431.16						
01/20/77	4435.28	01/20/77	4428.81	01/20/77	4433.39	01/26/77	4431.01	01/26/77	4430.03	01/26/77	4435.11	01/26/77	4431.06						
02/22/77	4435.19	02/22/77	4428.68	02/22/77	4433.35	02/24/77	4430.85	02/24/77	4430.26	02/24/77	4436.85	02/24/77	4430.92						
03/22/77	4434.94	03/22/77	4428.41	03/22/77	4432.86	03/28/77	4430.70	03/28/77	4430.43	03/28/77	4437.78	03/28/77	4430.81						
04/20/77	4434.72	04/20/77	4428.21	04/20/77	4432.68	04/18/77	4430.29	04/18/77	4430.07	04/18/77	4438.21	04/18/77	4430.40						
05/25/77	4434.28	05/25/77	4427.87	05/25/77	4432.23	05/27/77	4429.75	05/27/77	4429.36	05/27/77	4438.07	05/27/77	4429.89						
06/24/77	4433.82	06/24/77	4427.47	06/24/77	4431.57	06/27/77	4429.23	06/27/77	4429.01	06/27/77	4437.08	06/27/77	4429.33						
07/25/77	4433.37	07/25/77	4427.14	07/25/77	4431.16	08/01/77	4428.60	08/01/77	4429.35	08/01/77	4436.57	08/01/77	4428.67						
08/23/77	4433.05	08/23/77	4426.92	08/23/77	4430.95	08/26/77	4428.26	08/27/77	4428.51	08/27/77	4435.47	08/26/77	4428.61						
09/20/77	4432.74	09/20/77	4426.79	09/20/77	4430.67	09/13/77	4428.34	09/14/77	4428.81	09/14/77	4434.12	09/14/77	4428.51						

WELL	8.00	WELL	9.00	WELL	86.00	WELL	87.00	WELL	88	WELL	89	WELL	90	WELL	117	WELL	119	WELL	120
8.00		9.00		86.00		87.00		88.00		89.00		90.00							
Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L	Date	S.W.L.
01/29/69	4434.80	01/29/69	4427.42																
02/24/69	4435.75	02/24/69	4427.32																
04/04/69	4436.32	04/02/69	4428.93																
04/23/69	4438.32	04/23/69	4430.69																
05/29/69	4438.80	05/29/69	4430.00																
06/26/69	4438.03	06/26/69	4429.53																
07/21/69	4437.96	07/21/69	4429.67																
08/25/69	4437.02	08/27/69	4429.08																
09/25/69	4436.42	09/25/69	4428.76																
10/22/69	4436.15	10/24/69	4428.84																
11/28/69	4435.67	11/28/69	4428.48																
12/22/69	4435.66	12/22/69	4428.51																
01/19/70	4435.95	01/19/70	4428.55																
02/21/70	4435.91	02/21/70	4428.39																
03/26/70	4435.97	03/26/70	4428.37																
04/25/70	4435.85	04/25/70	4428.15																
05/22/70	4435.17	05/22/70	4427.62																
06/25/70	4434.68	06/25/70	4427.42																
07/24/70	4434.49	07/24/70	4427.34																
08/24/70	4434.52	08/24/70	4427.42																
09/22/70	4434.48	09/22/70	4427.47																
10/27/70	4434.48	10/27/70	4427.67																
11/23/70	4434.65	11/23/70	4427.83																
12/30/70	4434.79	12/30/70	4427.83																
01/30/71		01/30/71	4427.87																
02/17/71	4435.23	02/17/71	4427.94																
03/26/71	4435.54	03/26/71	4428.16																
04/30/71	4435.66	04/30/71	4428.00																
05/27/71	4435.92	05/27/71	4428.34																
06/02/71		06/02/71	4429.32																
06/26/71	4435.82	06/26/71	4429.32																
07/28/71	4435.76	07/28/71	4429.27																
08/25/71	4435.52	08/25/71	4429.09																
09/23/71	4435.45	09/23/71	4429.19																
10/26/71	4435.74	10/26/71	4429.63																
11/17/71	4435.48	11/17/71	4429.41																
01/06/72	4435.70	01/06/72	4429.50			02/28/72		02/28/72		02/28/72		02/28/72							
03/20/72	4436.72	03/20/72	4429.77			03/18/72	4433.09	03/18/72	4433.21	03/10/72	4435.59	03/18/72	4433.16						
04/20/72	4436.88	04/20/72	4429.91			04/12/72	4433.02	04/12/72	4433.36	04/12/72	4436.85	04/12/72	4433.30						
05/25/72	4436.19	05/25/72	4429.51			05/29/72	4430.73	05/29/72	4432.85	05/29/72	4437.81	05/29/72	4431.86						
06/30/72	4435.90	06/30/72	4429.25			06/23/72	4431.30	06/23/72	4433.15	06/23/72	4438.17	06/23/72	4431.65						
07/25/72	4435.45	07/25/72	4429.16			07/27/72	4430.69	07/27/72	4432.64	07/27/72	4437.18	07/27/72	4431.04						
08/30/72	4435.15	08/30/72	4429.05			09/01/72	4430.42	09/01/72	4432.39	08/01/72	4435.99	09/01/72	4430.77						
09/22/72	4435.21	09/22/72	4429.13			09/20/72	4430.34	09/20/72	4432.14	08/20/72	4435.47	09/20/72	4430.66						
10/19/72	4435.42	10/19/72	4429.43			10/12/72	4430.33	10/12/72	4431.90	10/12/72	4434.37	10/12/72	4430.64						
11/28/72	4435.45	11/28/72	4429.42			11/14/72	4430.93	11/14/72	4432.31	11/14/72	4434.01	11/14/72	4431.21						
12/22/72	4435.72	12/22/72	4429.70			12/18/72	4430.70	12/18/72	4431.79	12/18/72	4432.96	12/18/72	4431.05						
		01/19/73	4429.49			01/11/73	4430.78	01/11/73	4431.71	01/11/73	4432.58	01/11/73	4431.05						
02/21/73	4435.78	02/21/73	4429.37			02/24/73	4431.52	02/24/73	4431.80	02/23/73	4432.53	02/24/73	4431.82						
		04/09/73	4429.70			03/30/73	4432.01	03/30/73	4431.90	02/24/73	4432.68	03/30/73	4432.26						
04/26/73	4436.43	04/26/73	4429.64			04/30/73	4432.32	04/30/73	4432.10	03/30/73	4433.97	04/30/73	4432.56						
05/25/73	4436.34	05/25/73	4429.67			05/29/73	4431.49	05/29/73	4431.74	04/30/73	4436.48	05/29/73	4431.81						

WELL	8.00	WELL	9.00	WELL	86.00	WELL	87.00	WELL	88	WELL	89	WELL	90	WELL	117	WELL	119	WELL	120
8.00		9.00		86.00		87.00		88.00		89.00		90.00							
Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L.	Date	S.W.L	Date	S.W.L.
01/11/65		01/11/65	4426.09																
01/29/65		01/29/65	4426.12																
03/31/65		03/31/65	4426.13																
05/03/65	4432.65	05/03/65	4425.93																
05/25/65	4432.57	05/25/65	4425.80																
06/25/65		06/25/65	4426.09																
06/29/65		06/29/65	4425.92																
07/29/65	4435.07	07/29/65	4428.65																
08/30/65	4435.21	08/23/65	4428.07																
09/14/65	4435.21	09/14/65	4427.92																
10/22/65	4436.92	10/14/65	4429.77																
11/23/65	4437.19	11/15/65	4429.33																
12/23/65	4436.59	12/16/65	4428.97																
01/18/66	4436.92	01/13/66	4428.97																
03/02/66	4436.93	01/18/66	4429.20																
03/22/66	4436.24	02/25/66	4428.90																
03/30/66		03/30/66	4428.50																
04/06/66	4436.42	04/06/66	4428.52																
04/22/66	4436.36	04/22/66	4428.33																
05/02/66	4436.28	05/02/66																	
05/23/66	4435.69	05/23/66	4427.75																
06/23/66	4435.04	06/23/66	4427.53																
07/21/66	4434.53	07/21/66	4427.19																
08/17/66		08/24/66	4427.03																
09/14/66	4433.94	09/14/66	4427.03																
10/21/66	4433.59	10/21/66	4426.93																
11/21/66	4433.70	11/21/66																	
12/18/66	4433.64	12/18/66																	
01/26/67	4433.57	01/26/67																	
02/24/67	4433.36	02/24/67																	
04/24/67	4432.88	04/24/67																	
05/25/67	4432.59	05/25/67																	
06/25/67	4432.45	06/30/67	4425.98																
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12/13/67	4435.01	12/13/67	4427.87																
01/30/68	4435.07	01/30/68	4427.75																
02/28/68	4434.67	02/27/68	4427.26																
03/27/68	4434.52	03/27/68	4427.10																
04/18/68	4434.59	04/18/68	4427.22																
05/15/68	4434.01	05/15/68	4426.52																
06/21/68	4433.44	06/21/68	4426.36																
07/19/68	4433.47	07/19/68	4426.39																
08/27/68	4433.21	08/27/68	4426.28																
09/17/68	4433.33	09/17/68	4426.52																
10/12/68	4433.57	10/12/68	4426.79																
11/27/68	4433.60	11/27/68	4426.86																
12/31/68	4433.98	12/31/68	4427.29																

APPENDIX B

WELL CALCULATIONS

Steady State Flow

USGS 88

$$KD = \frac{Q \log {}^{r}max/{}^{r}w}{2 \pi S_{mw}}$$

KD	=	transmissivity of the aquifer
Q	=	well discharge
r_w	=	radius of the pumped well
r_{max}	=	radius of influence
S_{mw}	=	maximum drawdown of the well

Assume log ${}^{r}max/{}^{r}w$ approx. 3.33

Substituting into equation above yields

$$KD = \frac{0.53\ Q}{S_{mw}}$$

$$Q = \frac{S_{mw}\ KD}{0.53} = \frac{(50\ ft)\ (23\ ft^2/day)}{0.53} = 2{,}170\ ft^3/day$$

$$= 16{,}230\ gal/day$$

$$= 11.2\ gal/min$$

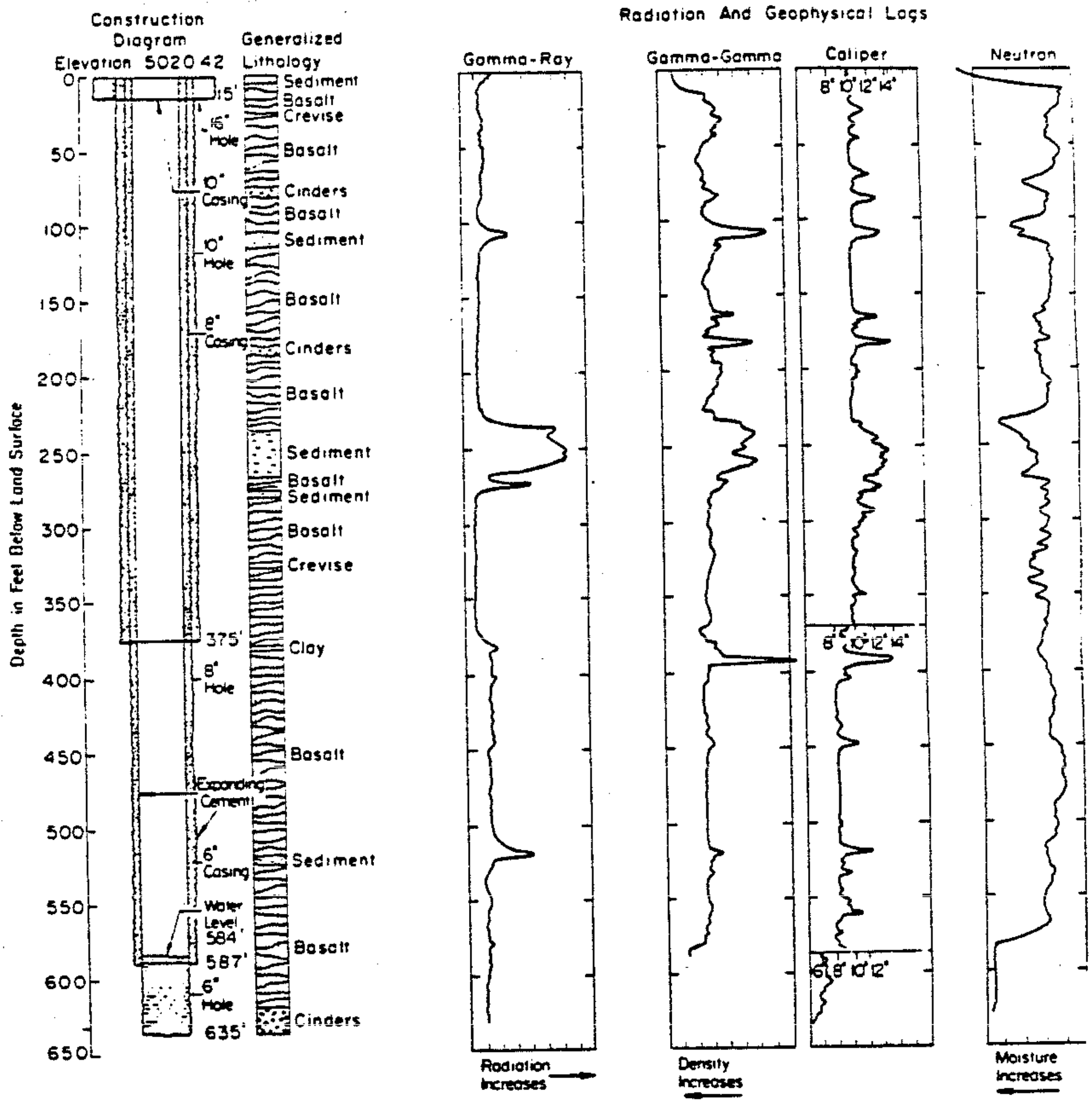


Figure 6. Graphs showing well construction, geology, and geophysical logs for well 88.

Steady State Flow

USGS 90

$$KD = \frac{Q \log {}^{r}max/{}^{r}w}{2 \pi S_{mw}}$$

KD = t

Q = discharge

r_w = radius of pumped well

S_{mw} = max drawdown of the well

Assume log $^{r}max/^{r}w$ approx. 3.33

Substituting into equation above yields

$$KD = \frac{0.53\ Q}{S_{mw}} = \frac{0.53\ (733\ ft^3/day)}{(0.53)} = 733\ ft^3/day$$

Steady State Flow
USGS 120

$$KD = \frac{Q \log {}^{r}max/{}^{r}w}{2\pi S_{mw}}$$

KD = t

Q = discharge

r_w = radius of pumped well

r_{max} = radius of influence

S_{mw} = max drawdown of the well

Assume log $^{r}max/^{r}w$ approx. 3.33

Substituting into equation above yields

$$KD = \frac{0.53\ Q}{S_{mw}} = \frac{0.53\ (3985\ ft^3/day)}{0.01}$$

$T = 211{,}206\ ft^2/day$

K = 2,011 ft/day

Steady State Flow
RWMC Production Well

$$KD = \frac{Q \log {}^{r}max/{}^{r}w}{2 \pi S_{mw}}$$

KD	=	transmissivity of the aquifer
Q	=	discharge
r_w	=	radius of pumped well
r_{max}	=	maximum drawdown of the well

Assume log ${}^{r}max/{}^{r}w$ approx. 3.33

Substituting into equation above yields

$$KD = \frac{0.53\ Q}{S_{mw}} = \frac{0.53\ (79,315\ ft^3/day)}{5.5\ ft} = 7,643\ ft^2/day$$

Roger Jensen--8/9/89

- Water spilled to the spreading area first year flooded 1965, a visibly new channel, installed recorders with J. Barraclough 1965 because 300% snowpack.

- Spreading Area A partially fills first, then B fills as A fills a little water flows to west-central part of B.

- Pumping test on USGS 88 earlier than 1987 pumped at 2-3 gpm with 30 feet of drawdown. Water level recovered to original level--within one day.

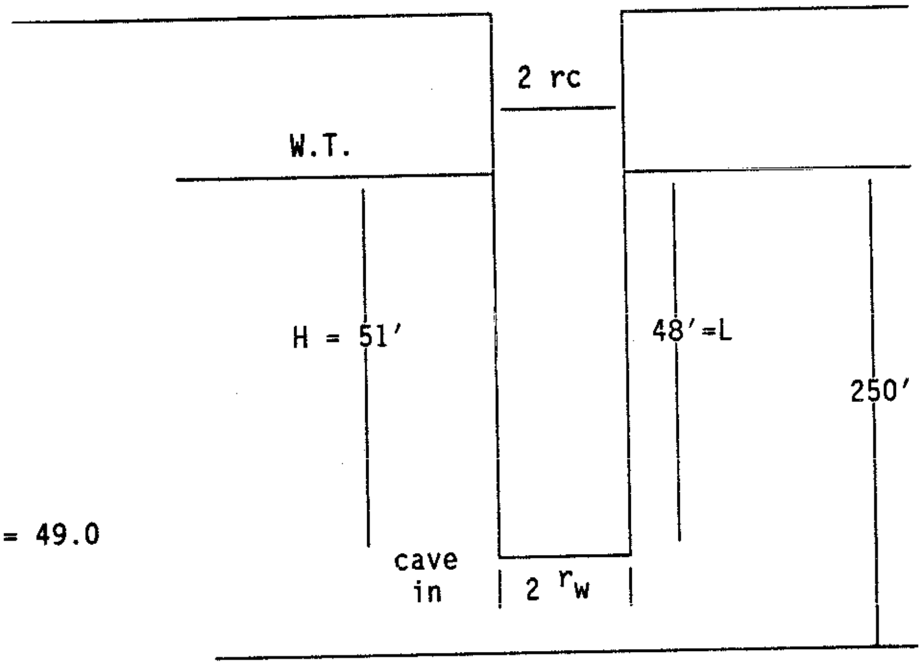
- 87-90 sealed to ground surface.

- 117-120 sealed only partially up the annular space.

Assumed Slug Test

USGS

Bouwer and Rice Method



r_c = 0.25

r_w = 0.25

Aug. 84 4491'

Aug. 87 4492'

Aug. 82 4425' ref.

Yo = 66.0'

Yt = 17.0

Aug 84 Aug 87

Yo-Yt = 66.0-17.0 = 49.0

t = 1095 days

(Yt) ln Yo/Yt = 0.0012

$L/r_w = \frac{48}{0.25} = 192$

From Figure 3 (Bouwer and Rice) B = 1.1

A = 6.0

$\ln[D-H/r_w]>6$ (46) so use 6 below

$$\ln R_e/r_w = \left[\frac{1.1}{\ln(h/r_w)} + \frac{A+B\ln[(D-H)/r_w]}{L/r_w}\right]^{-1} = 3.67 \qquad (8)$$

0.201 +

$$K = \frac{r_c^2 \ln (Re/r_w)}{2L} \; 1/t \ln Yo/Yt = 7.8 \times 10^{-7} \text{ ft/day}$$

7.8×10^{-7} ft/day

5.8×10^{-6} gal/day/ft^2

This plots at the lower end of the range of Hydraulic Conductivity and Permeability (Freeze and Cherry) roughly equivalent to unfractured metamorphic and igneous rock or shale of the lowest hydraulic conductivity.

10^{-11} cm/sec

EBR-1

Steady State Flow

$$KD = \frac{Q \log {}^{r}max/{}^{r}w}{2 \pi S_{mw}}$$

S_{mw} = maximum drawdown

KD = transmissivity

Q = discharge

r_w = radius of pumped well

r_{max} = maximum drawdown of the well

Assume log ${}^{r}max/{}^{r}w$ approx. 3.33

Substituting into equation above gives

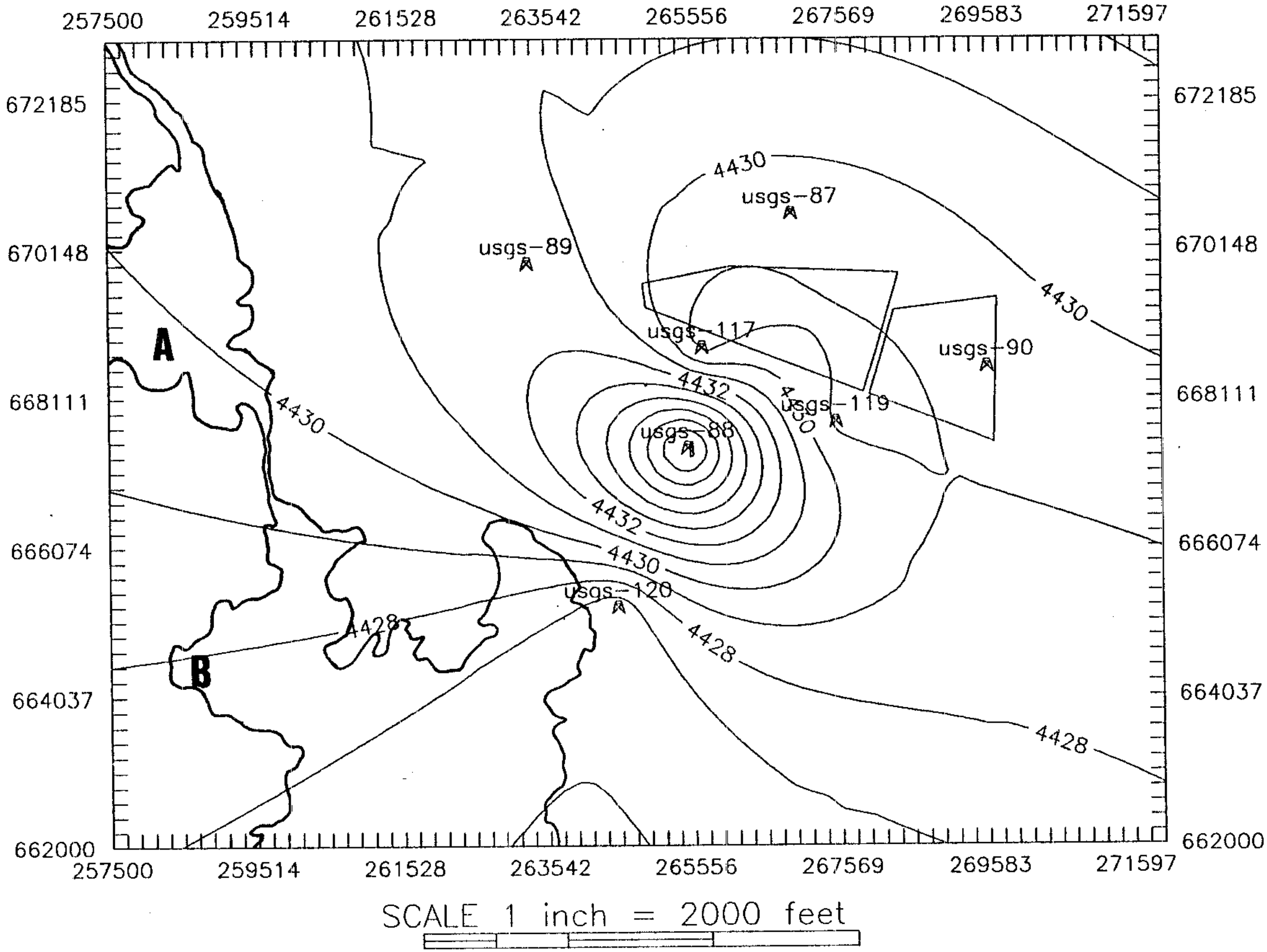
KD =

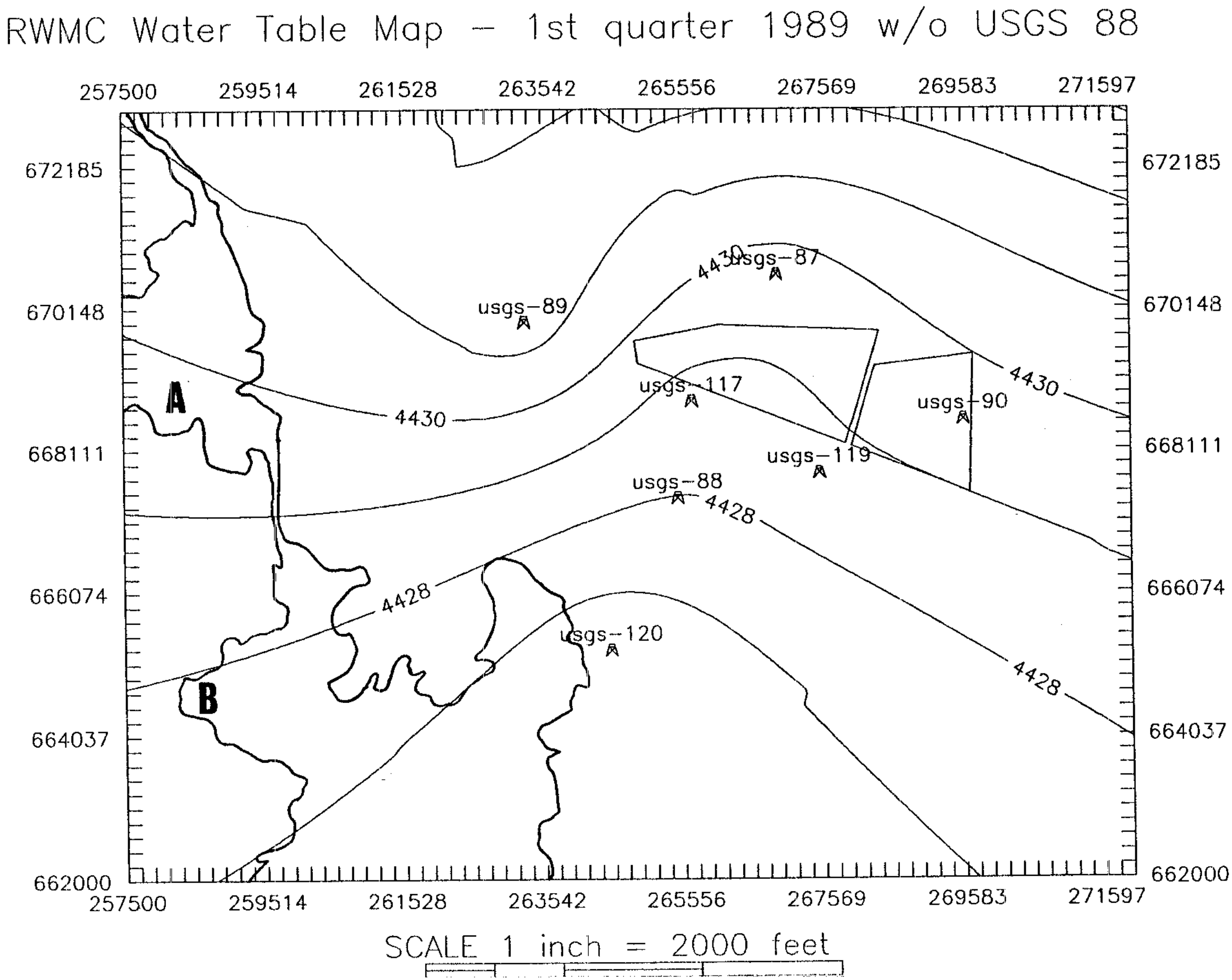
$$= \frac{0.53\ Q}{S_{mw}} = \frac{0.53\ (154{,}000\ ft^3/day)}{17\ ft} = 4{,}800\ ft^2/day$$

APPENDIX C

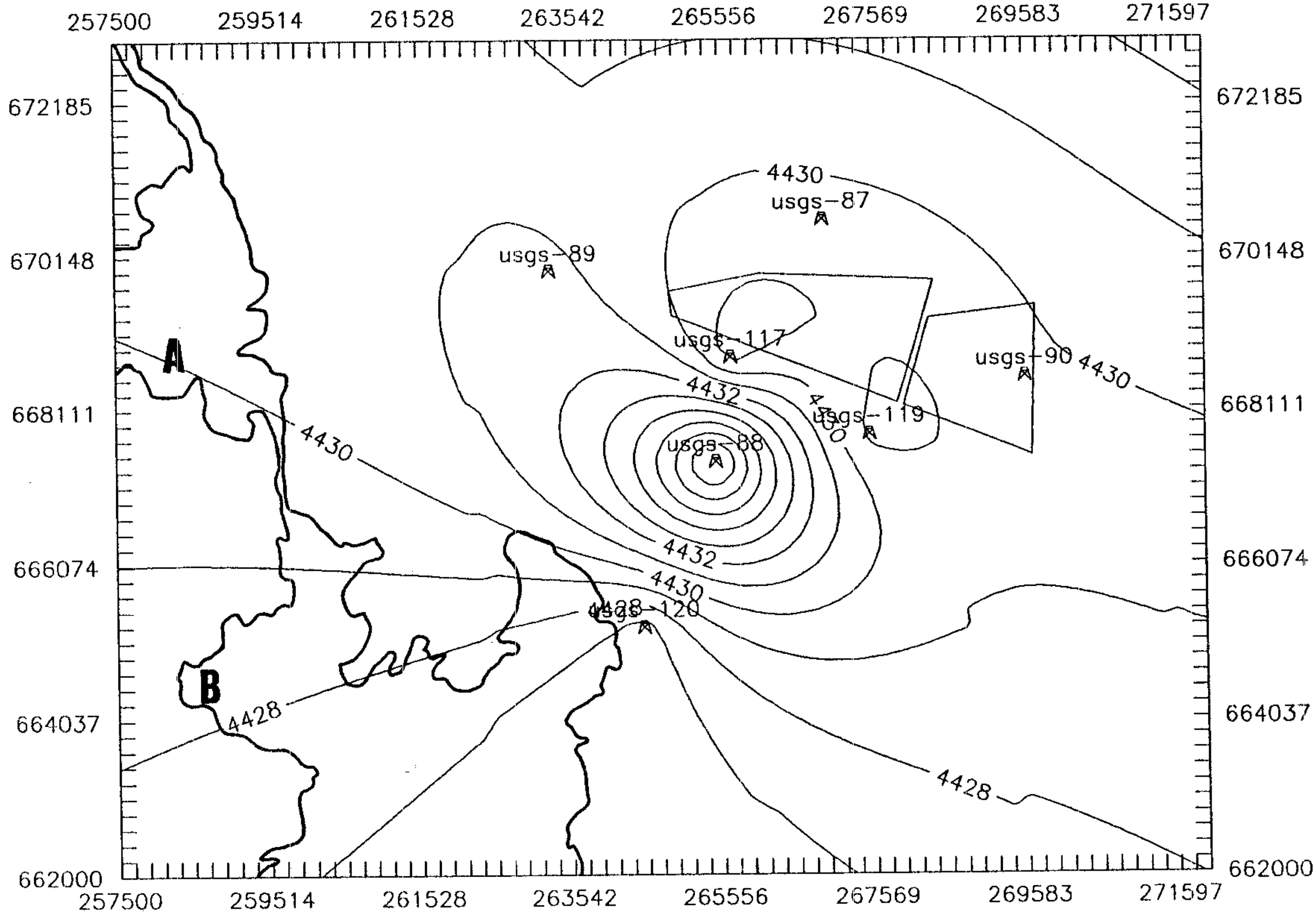
QUARTERLY WATER TABLE MAPS

RWMC Water Table Map – 1st quarter 1989



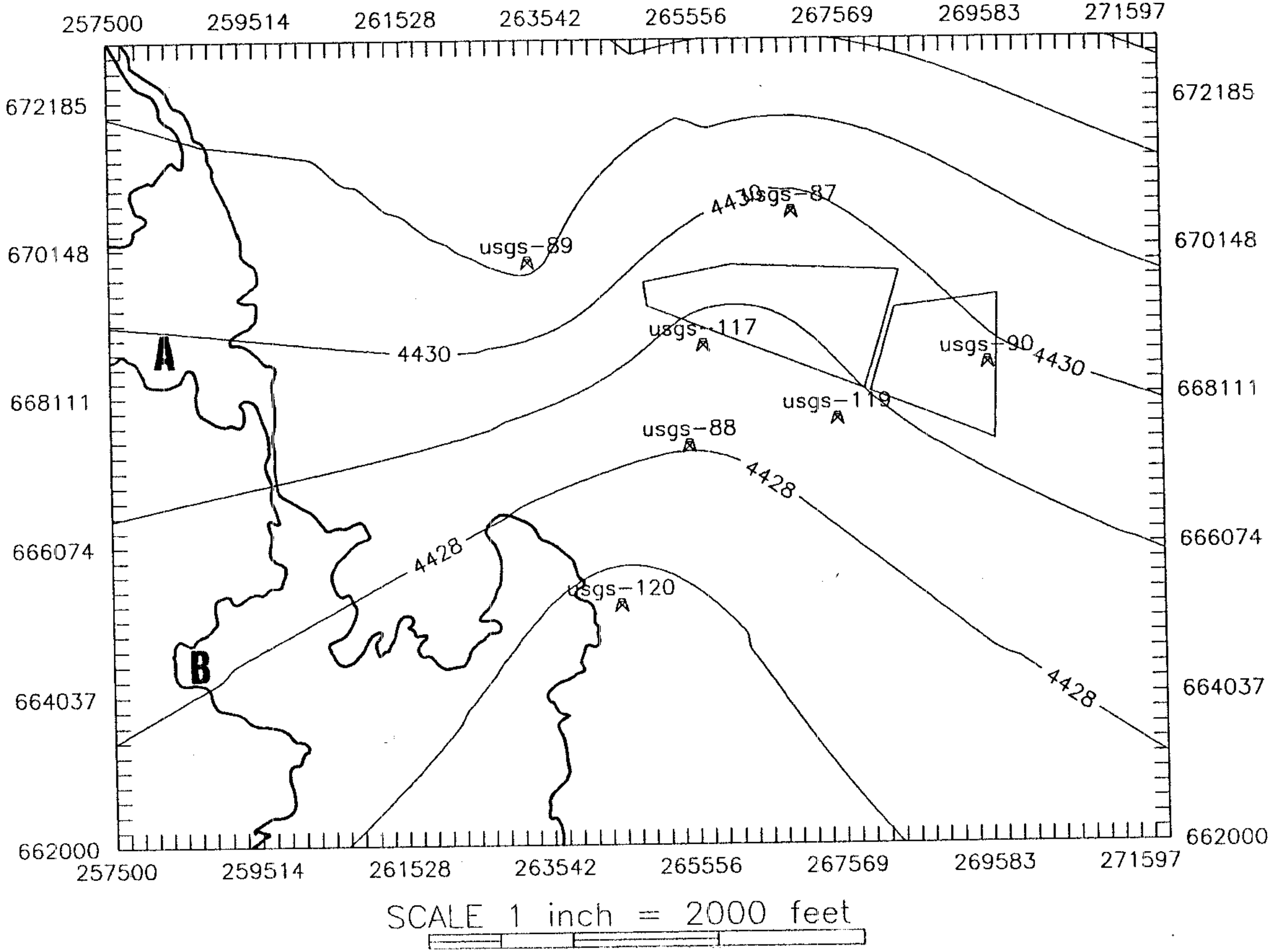

RWMC Water Table Map - 1st quarter 1989 w/o USGS 88
257500
259514
261528
263542
265556
267569
269583
271597
672185
670148
668111
666074
664037
662000
4430
4428
usgs-87
usgs-89
usgs-117
usgs-90
usgs-119
usgs-88
usgs-120
A
B
SCALE 1 inch = 2000 feet

RWMC Water Table Map — 4th quarter 1988



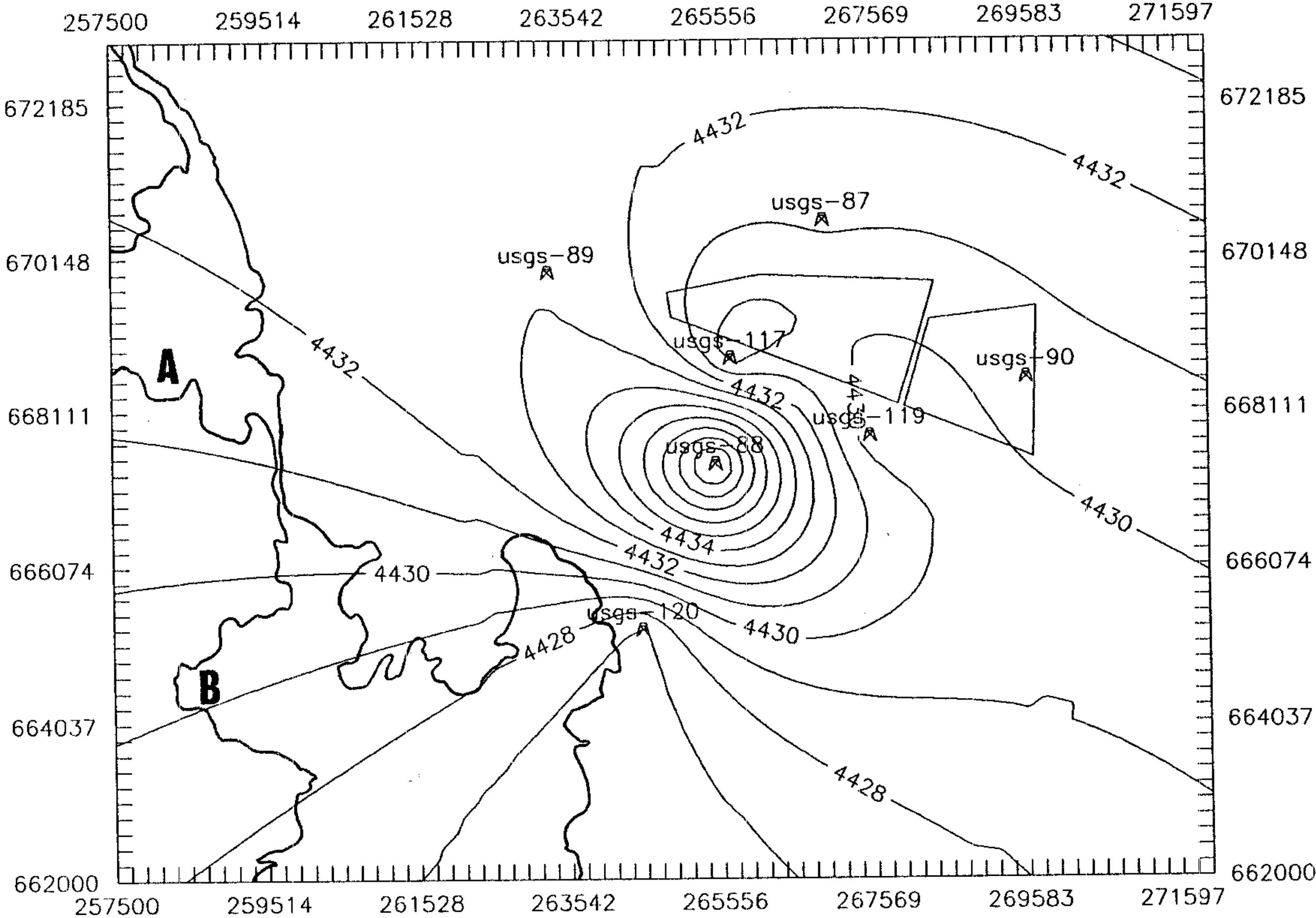
SCALE 1 inch = 2000 feet

RWMC Water Table Map - 4th quarter 1988 w/o USGS 88



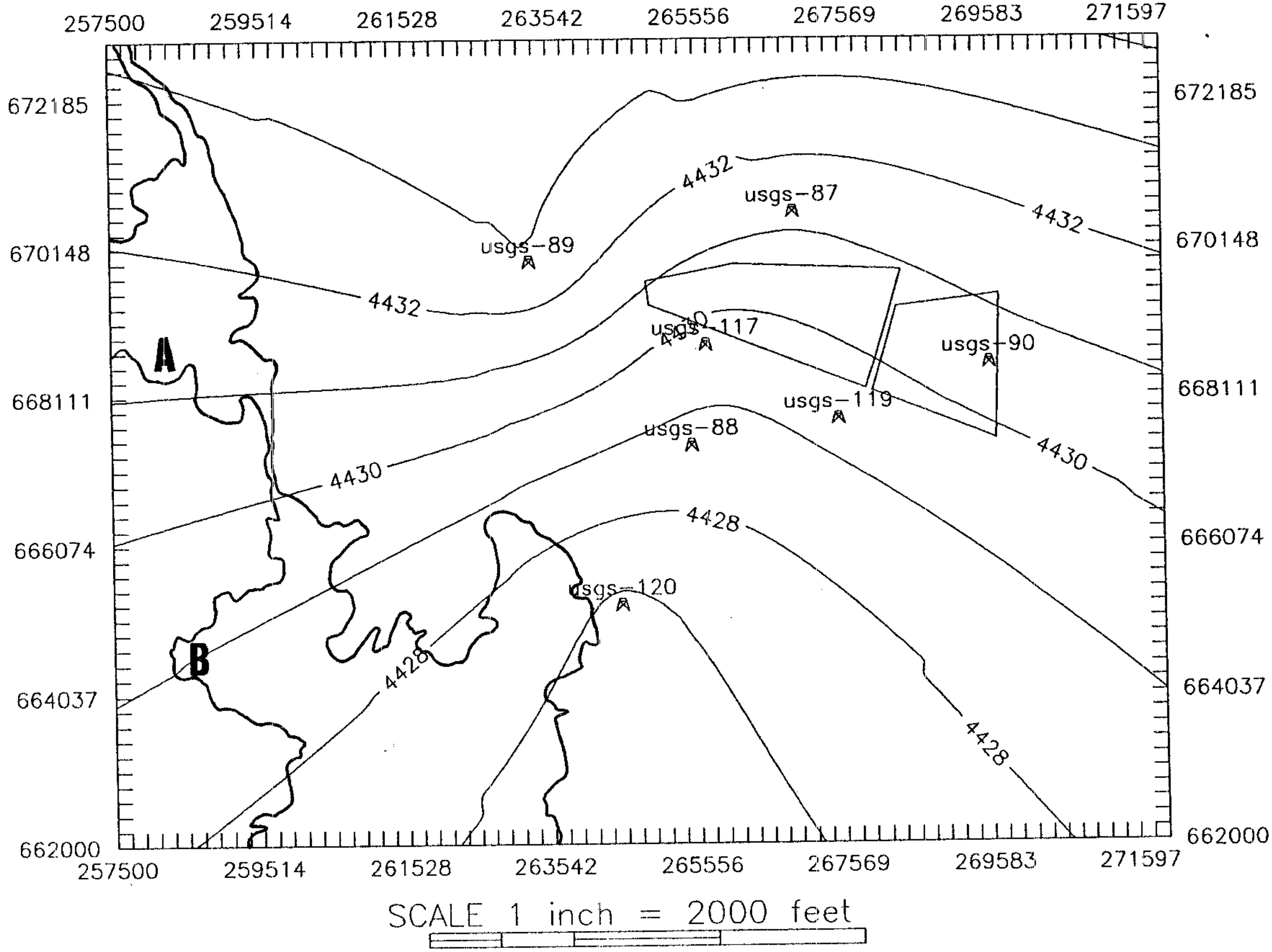
C-5

RWMC Water Table Map – 3rd quarter 1988



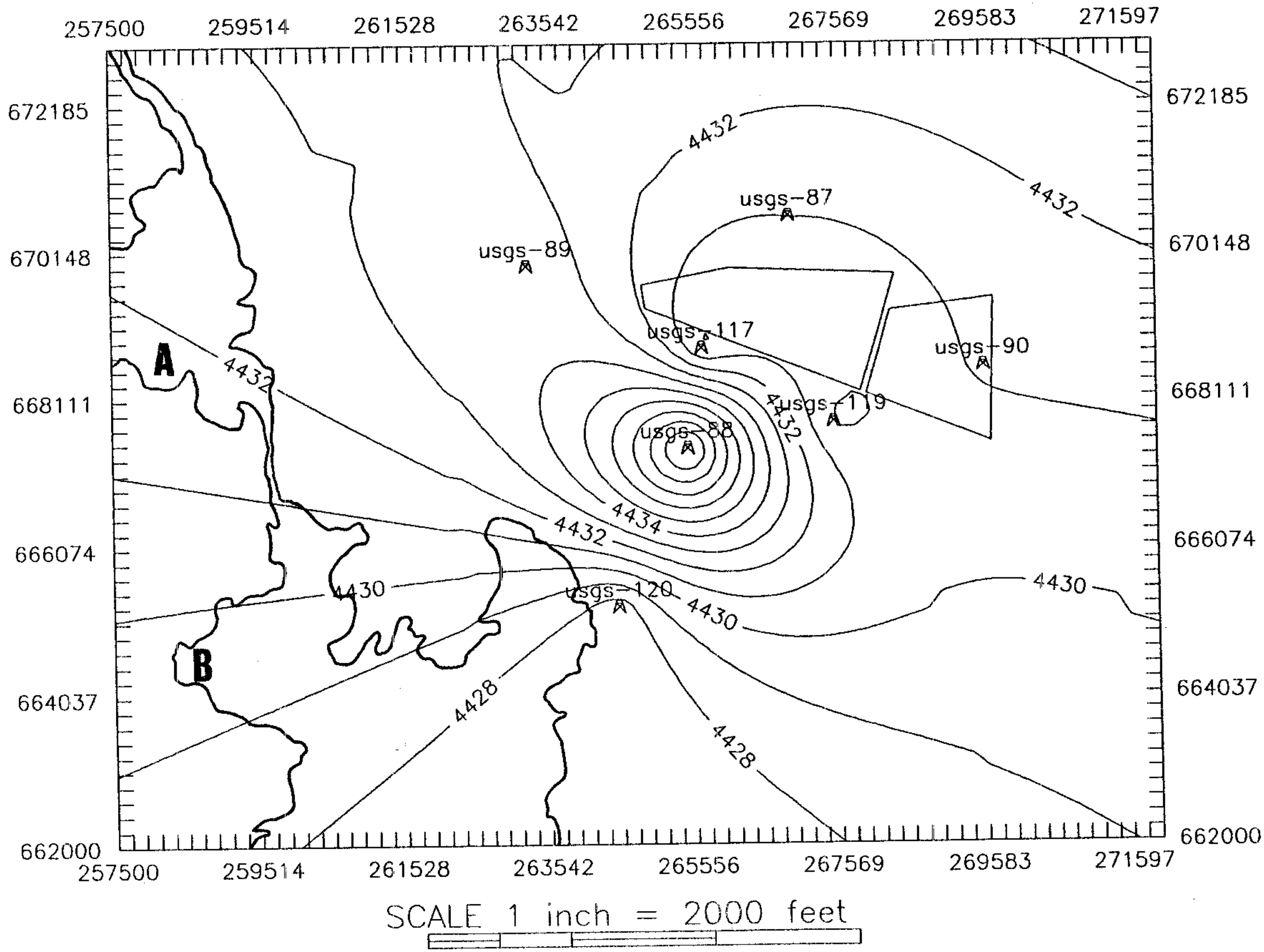
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 3rd quarter 1988 w/o USGS 88

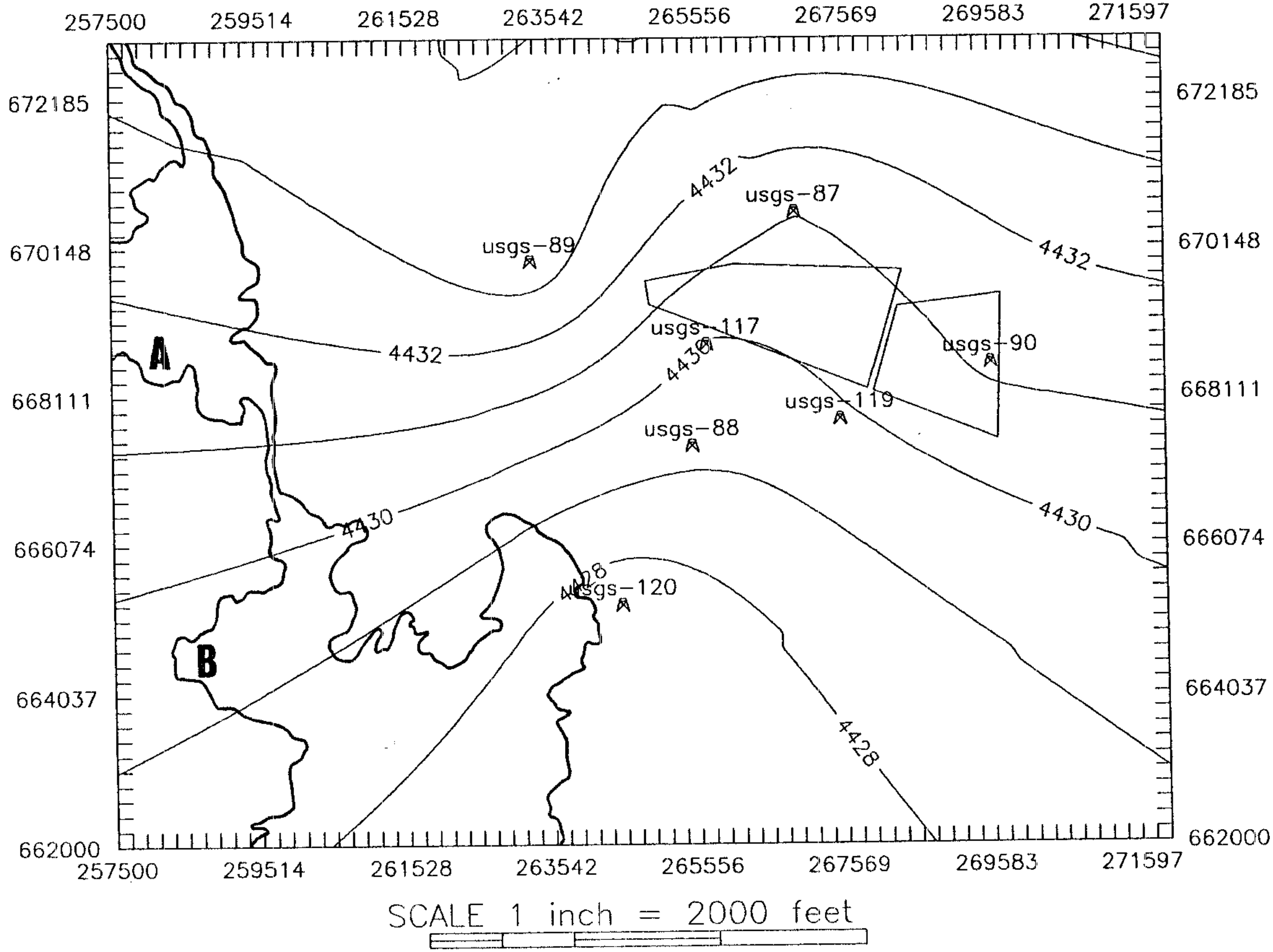


C-7

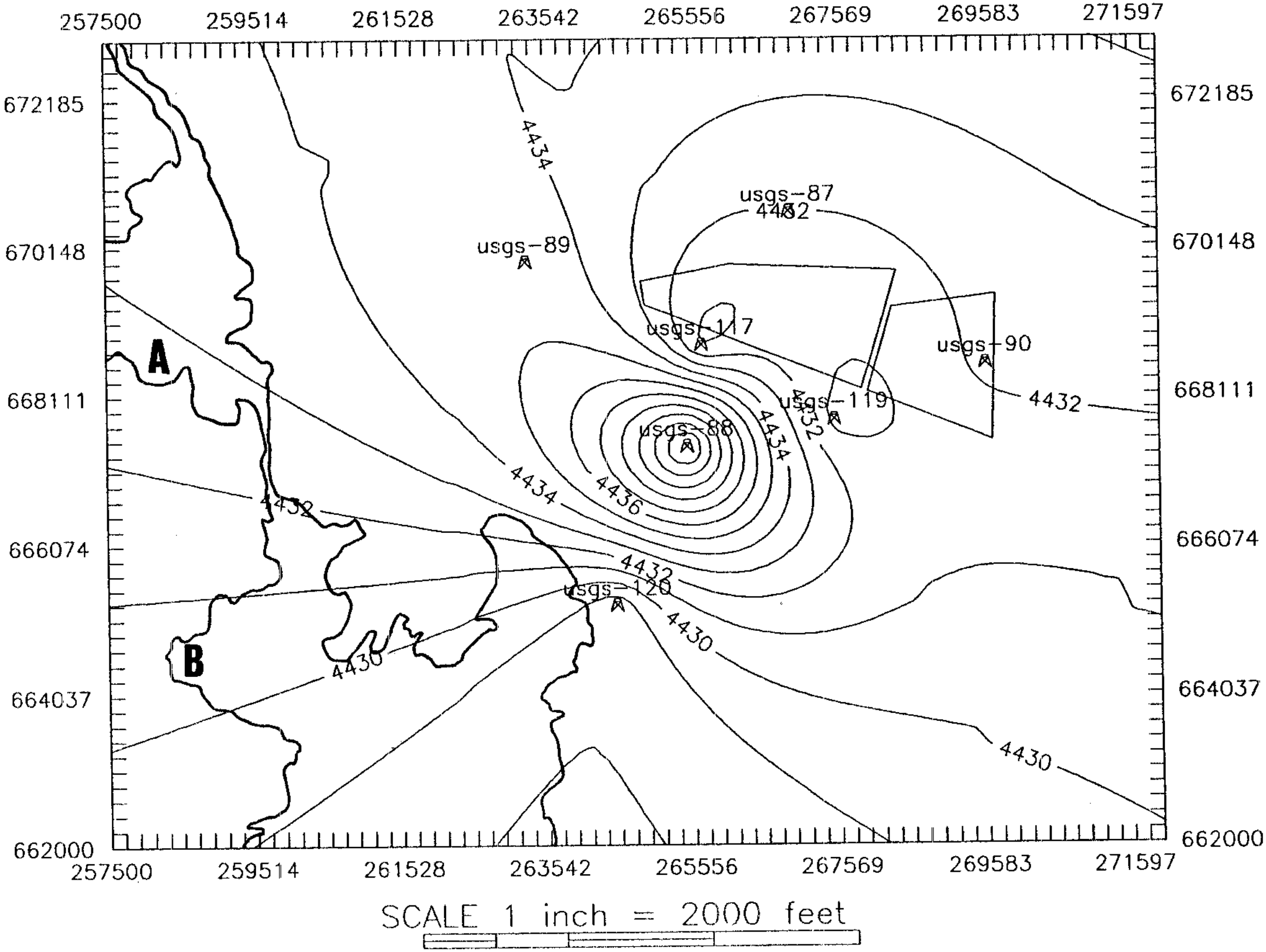
RWMC Water Table Map – 2nd quarter 1988



RWMC Water Table Map - 2nd quarter 1988 w/o USGS 88

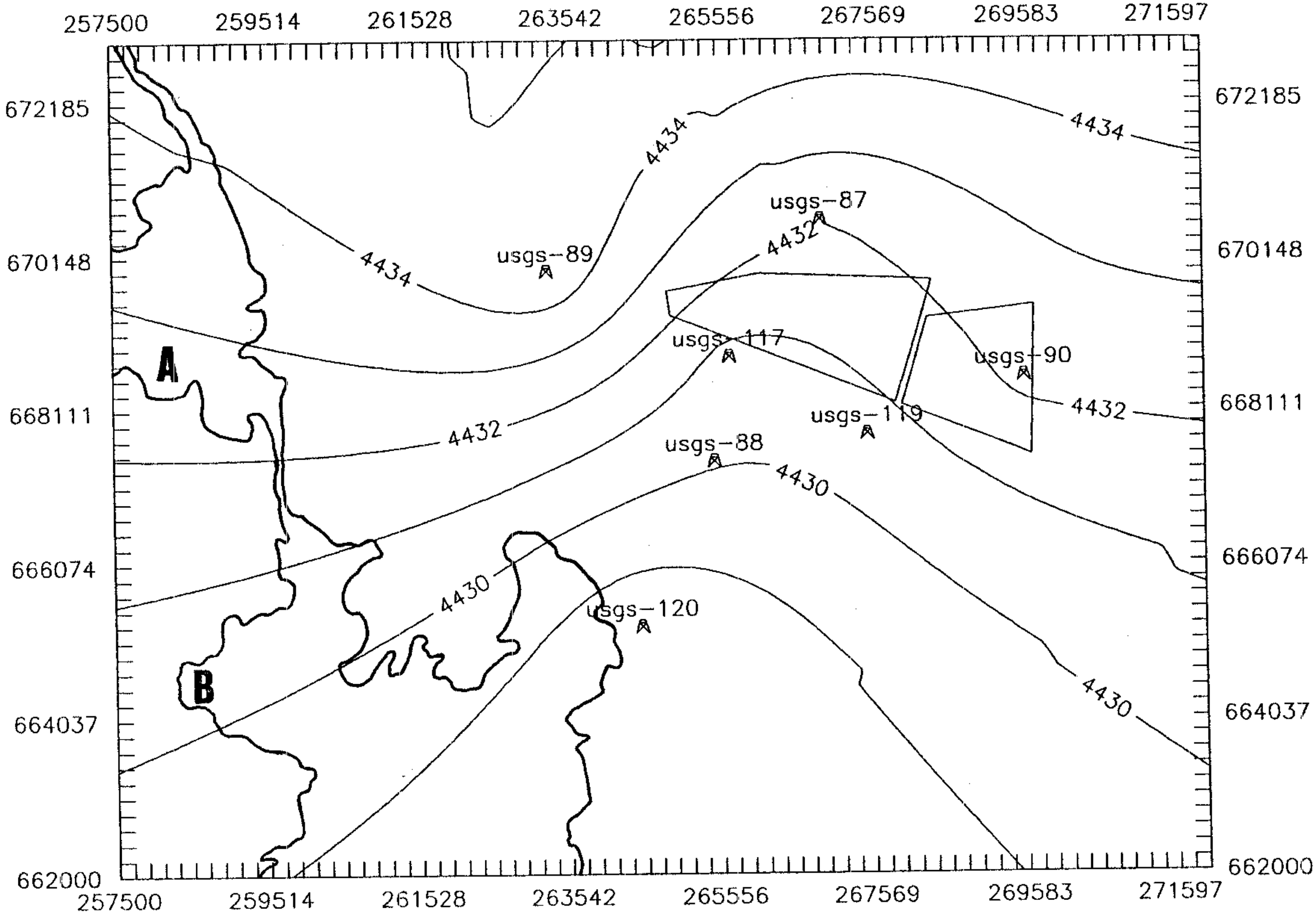


RWMC Water Table Map — 1st quarter 1988



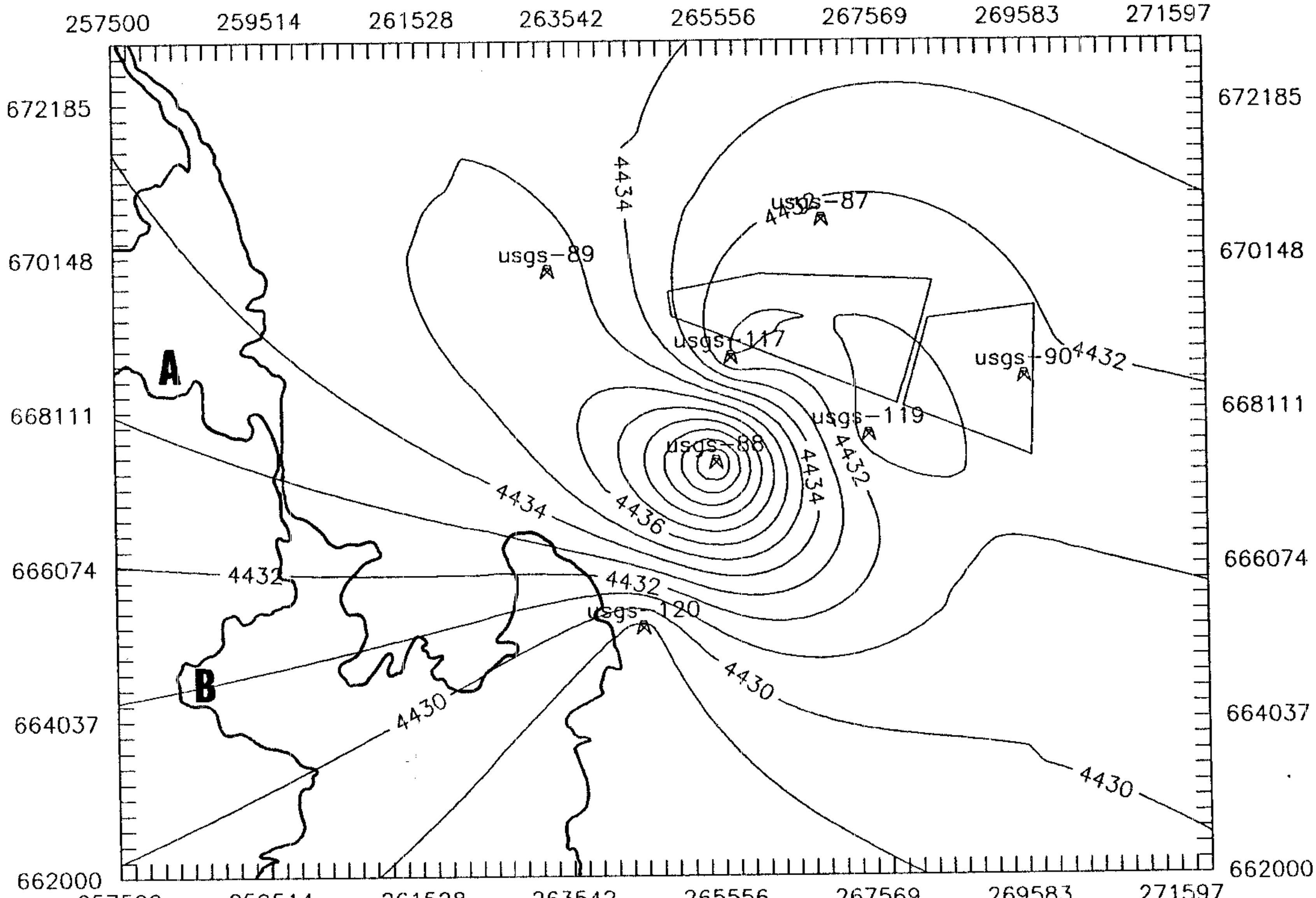
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 1st quarter 1988 w/o USGS 88



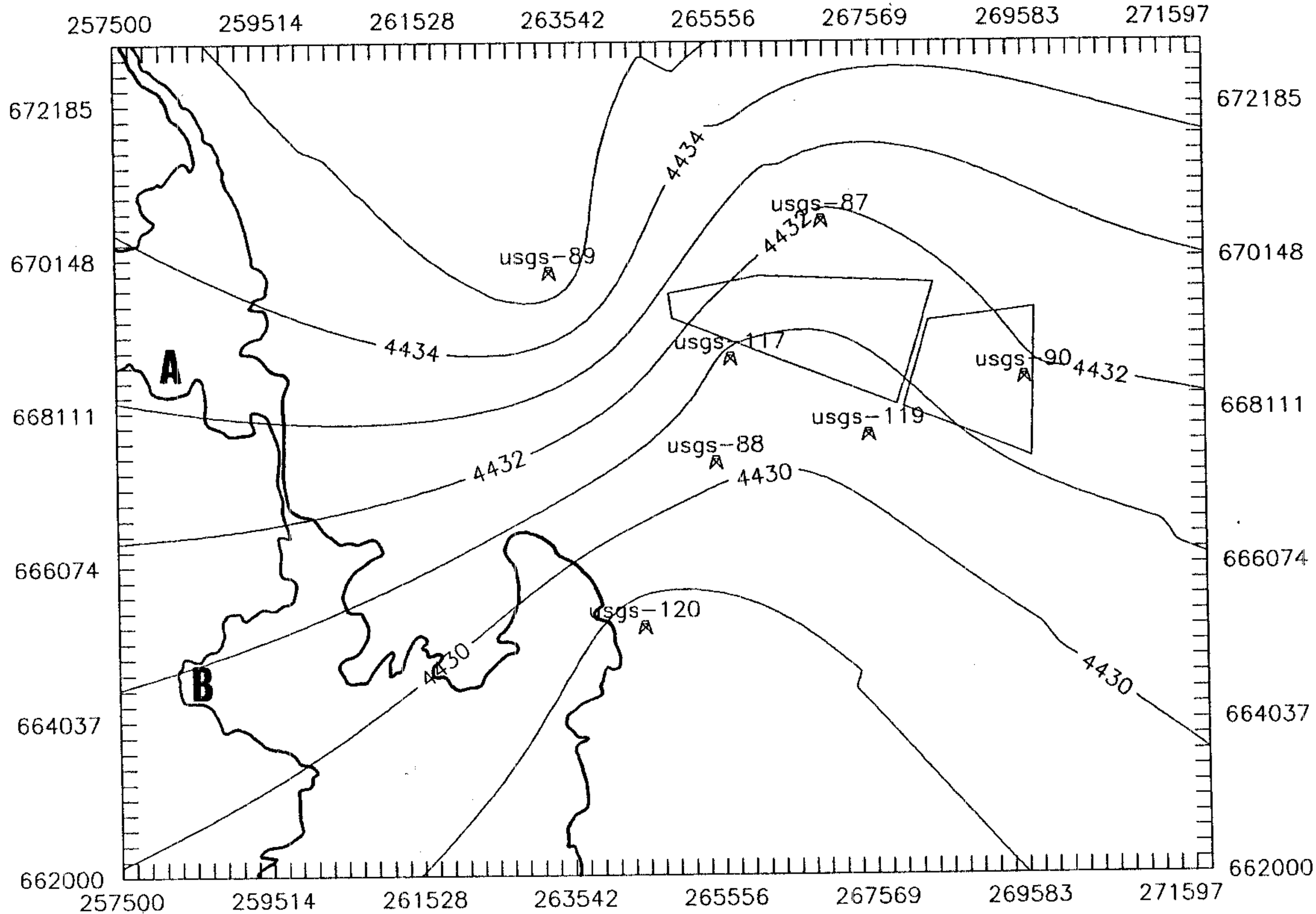
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 4th quarter 1987



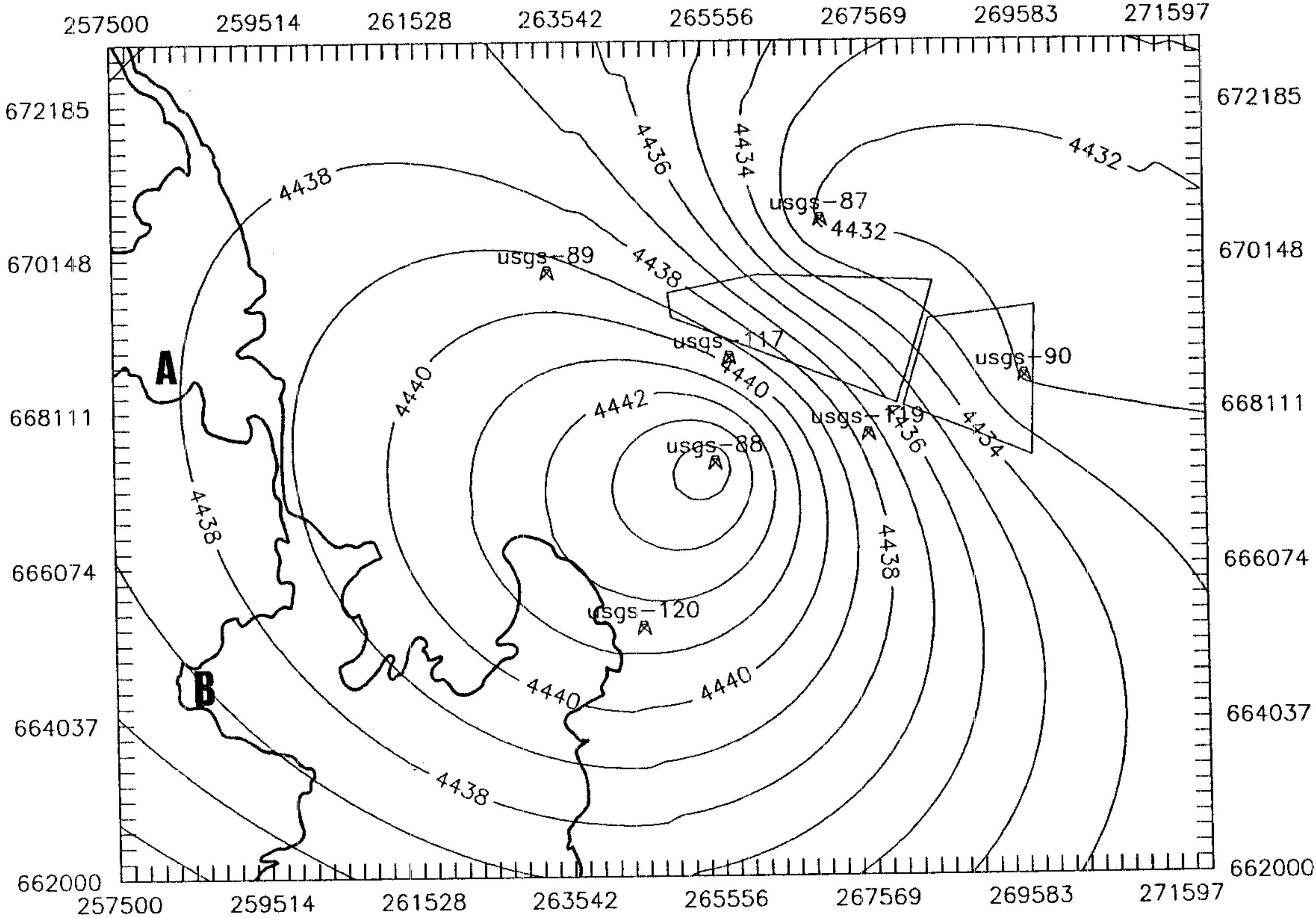
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 4th quarter 1987 w/o USGS 88



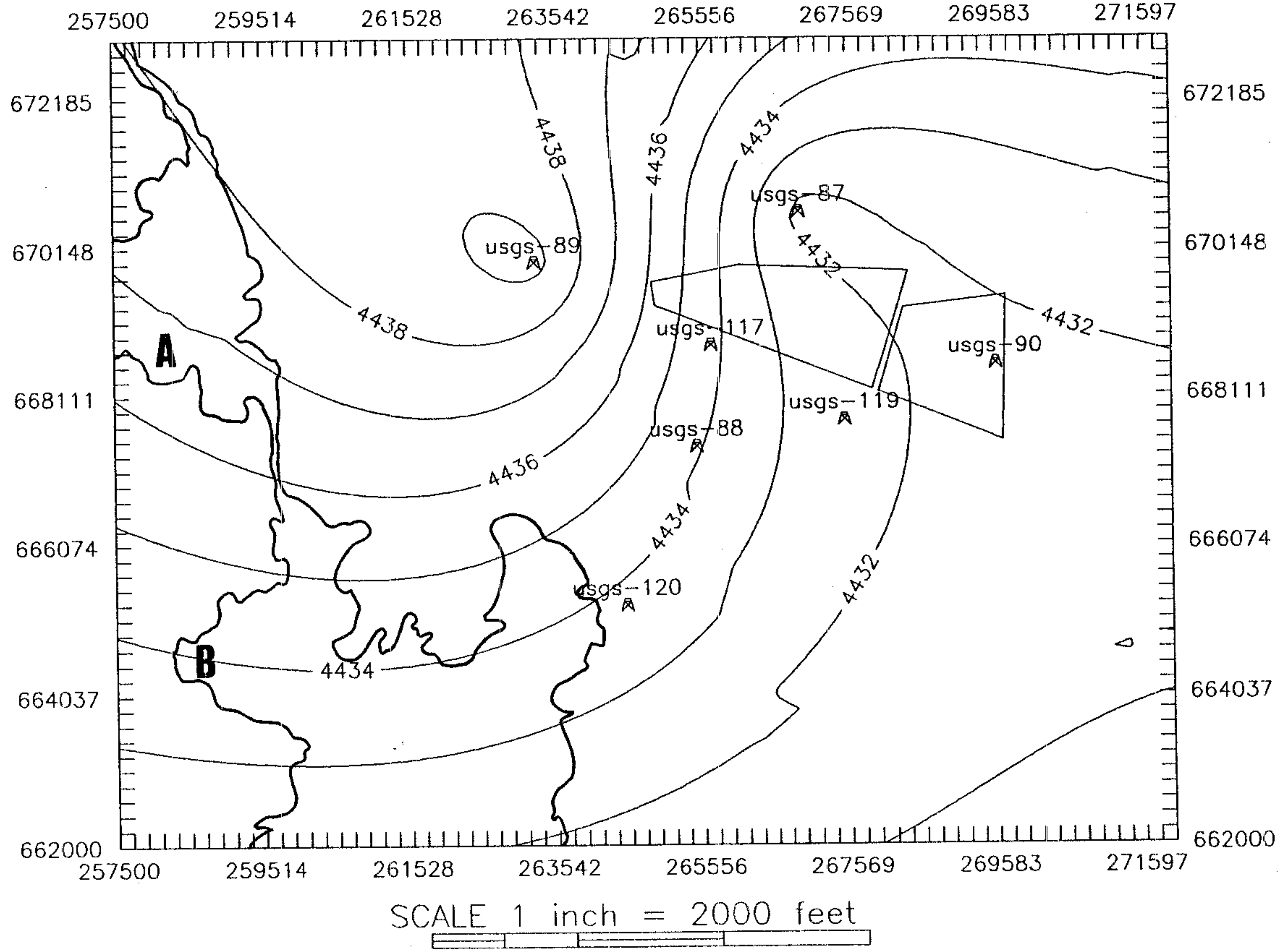
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 3rd quarter 1987

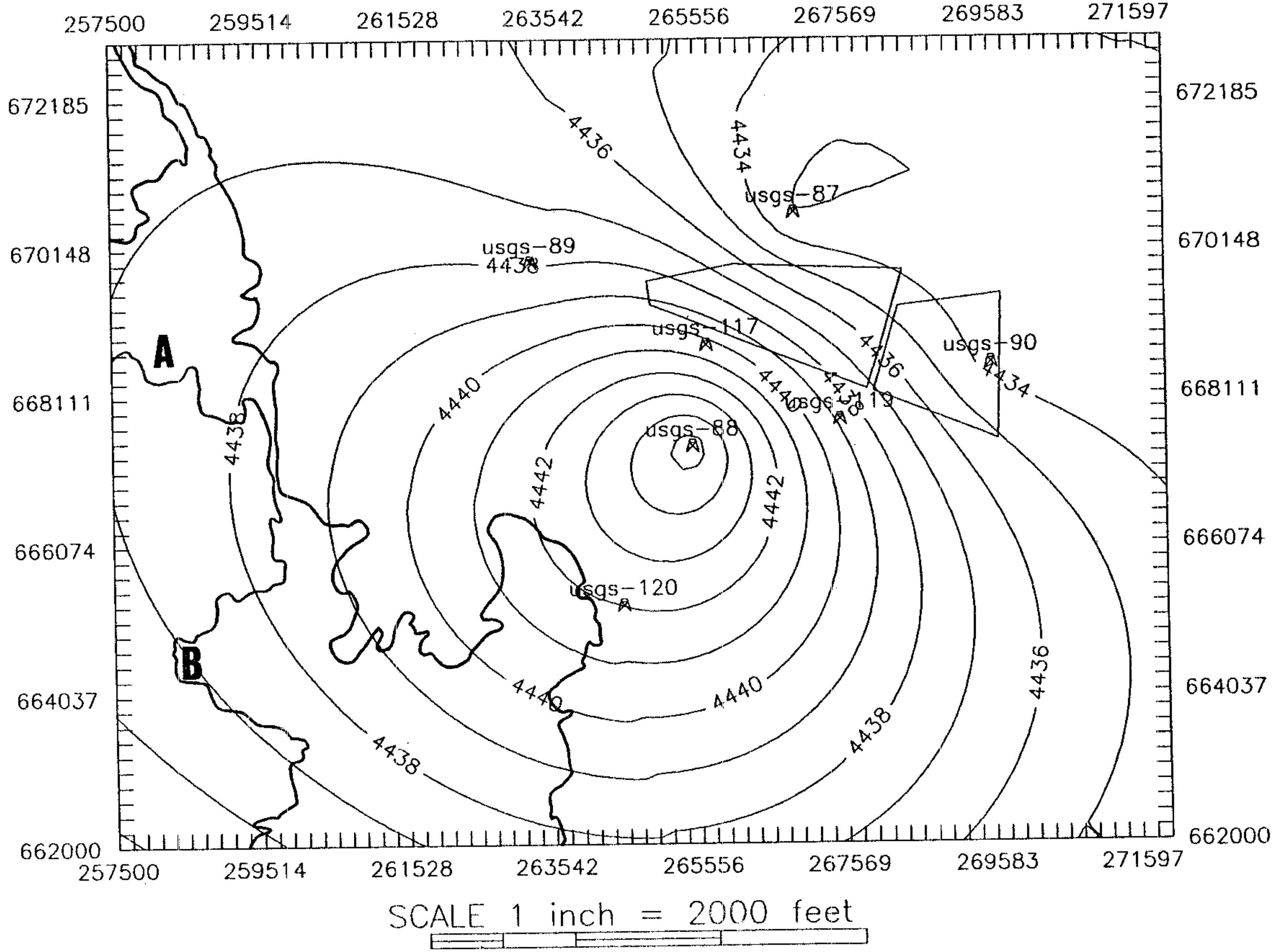


SCALE 1 inch = 2000 feet

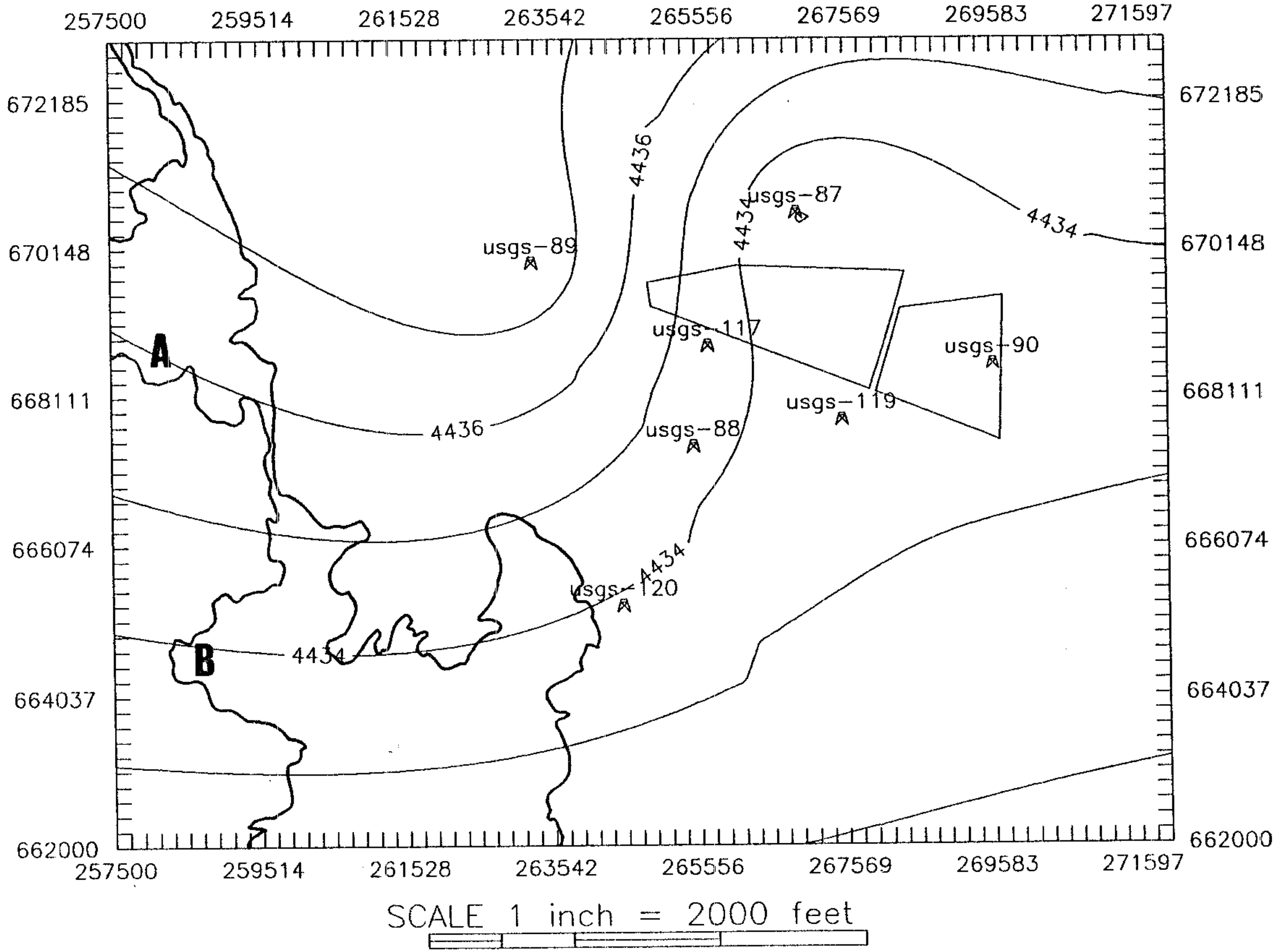
RWMC Water Table Map – 3rd quarter 1987 w/o USGS 88



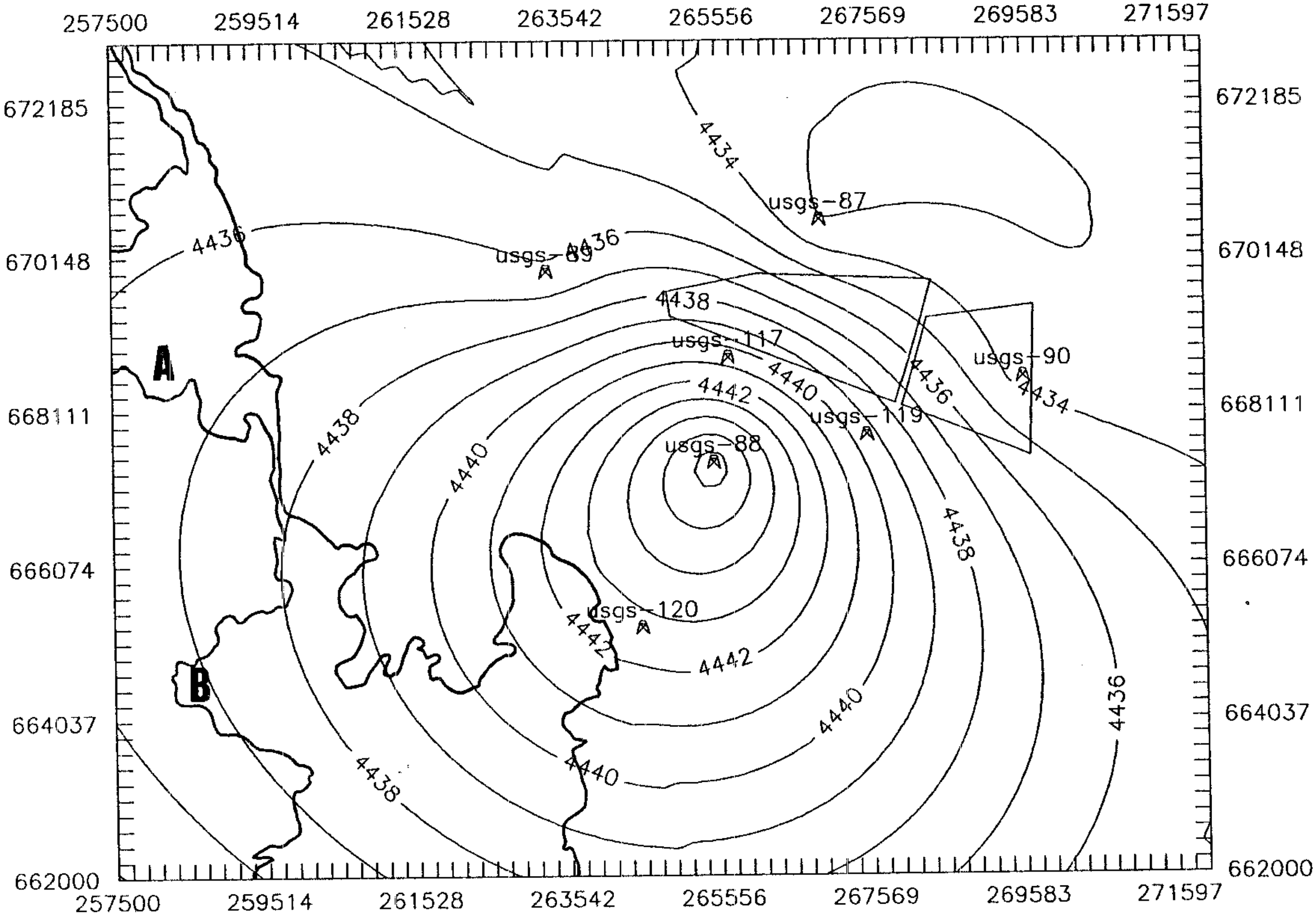
RWMC Water Table Map – 2nd quarter 1987



RWMC Water Table Map - 2nd quarter 1987 w/o USGS 88

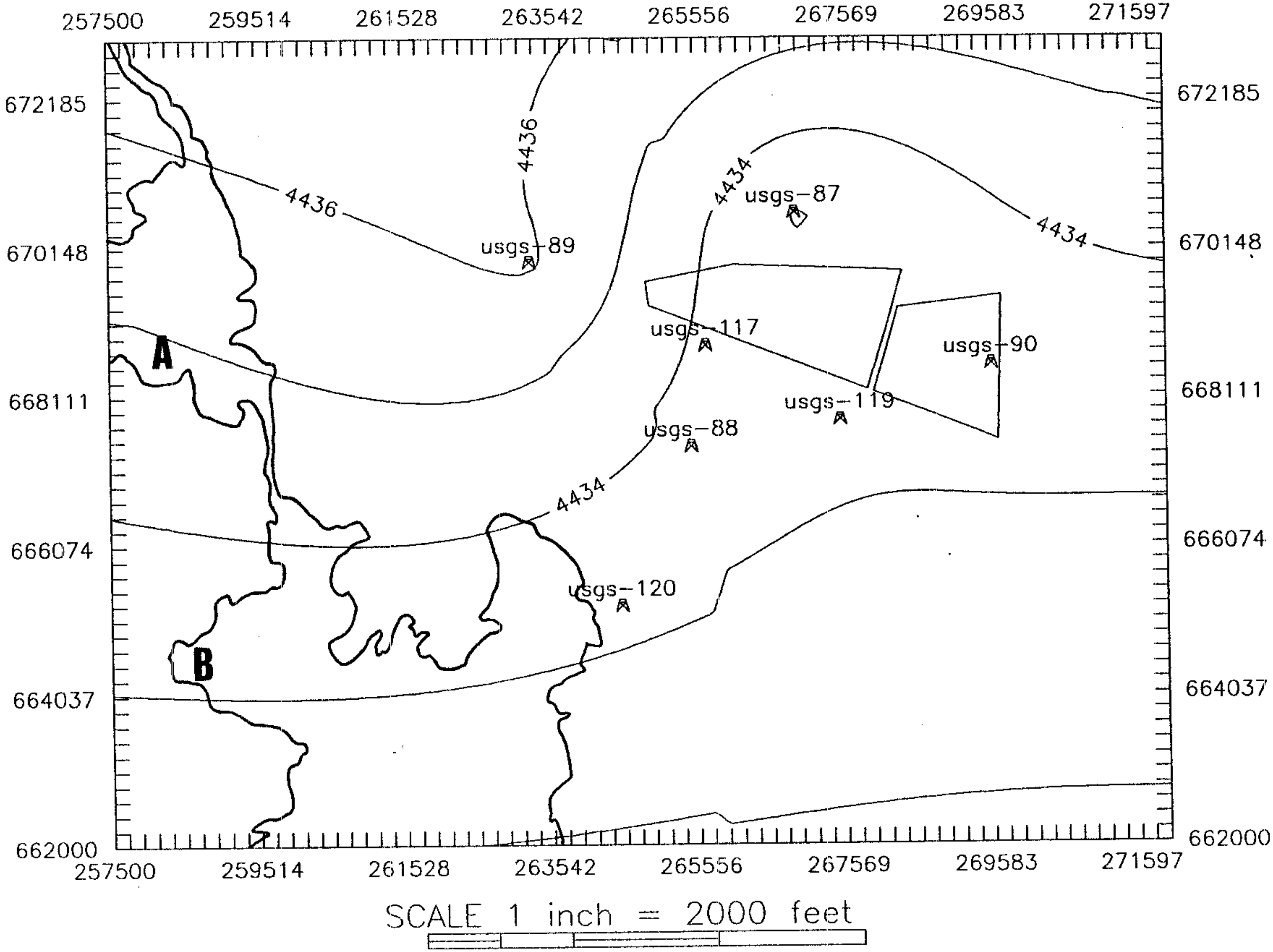


RWMC Water Table Map – 1st quarter 1987

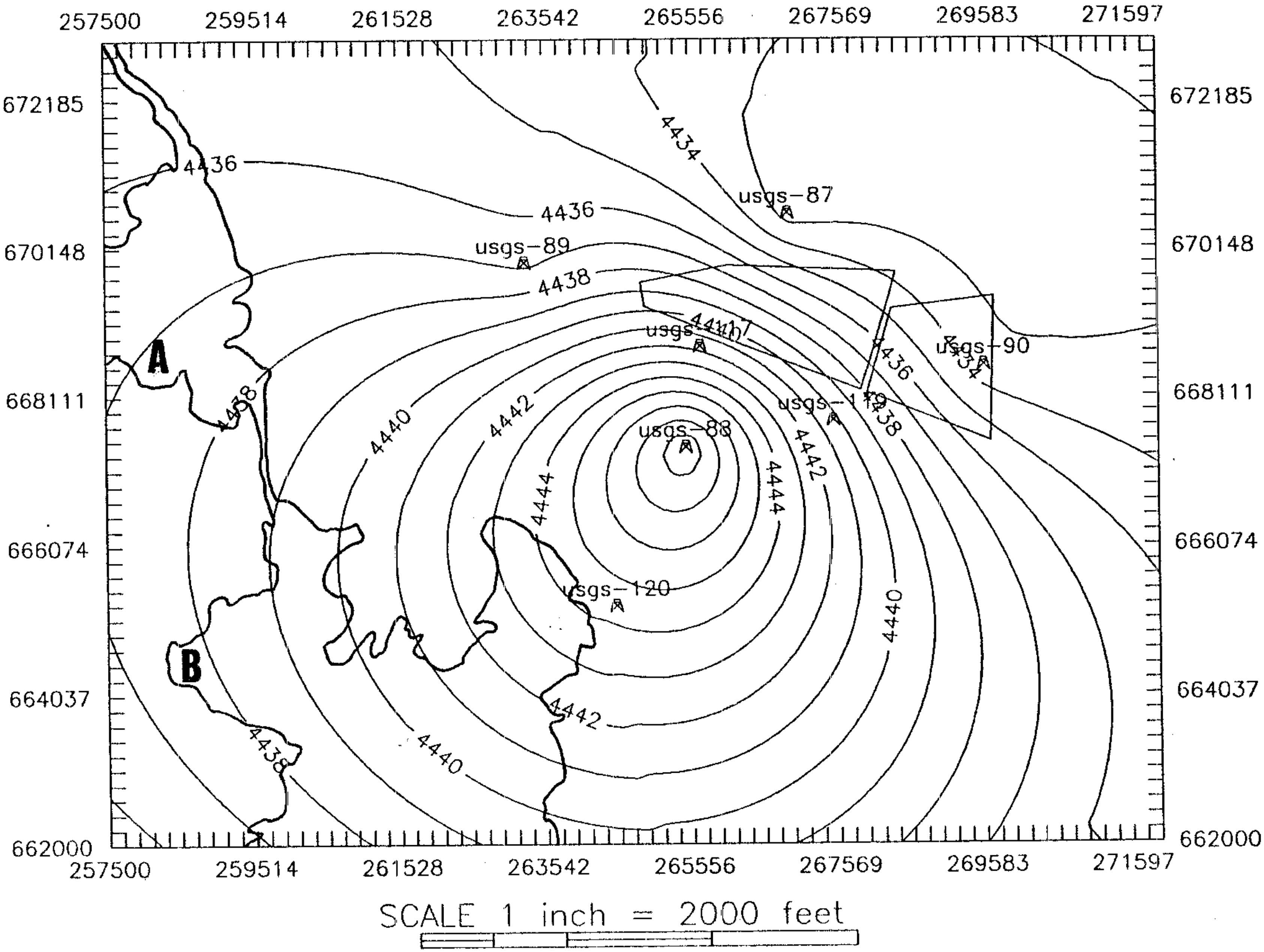


SCALE 1 inch = 2000 feet

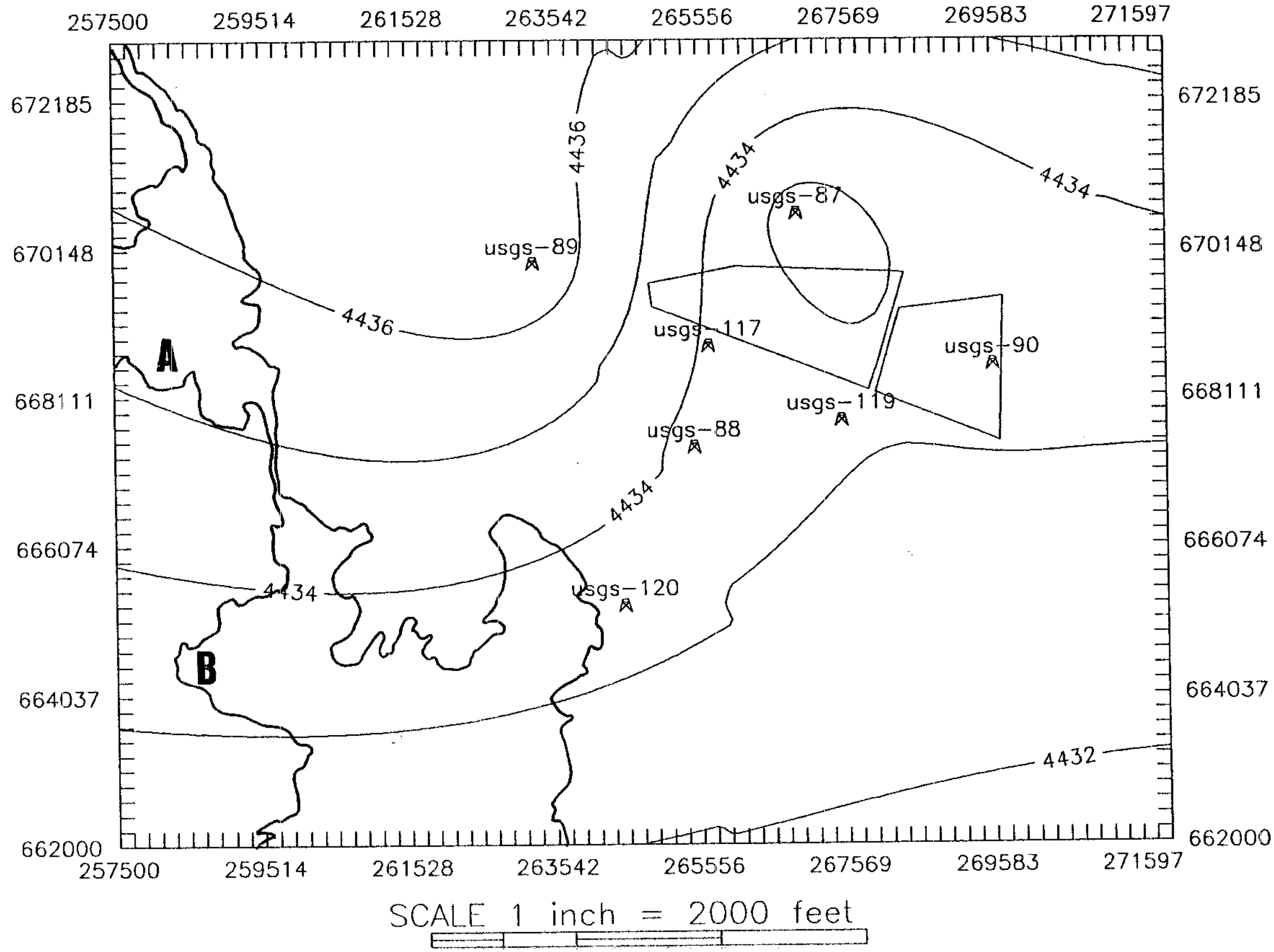
RWMC Water Table Map — 1st quarter 1987 w/o USGS 88



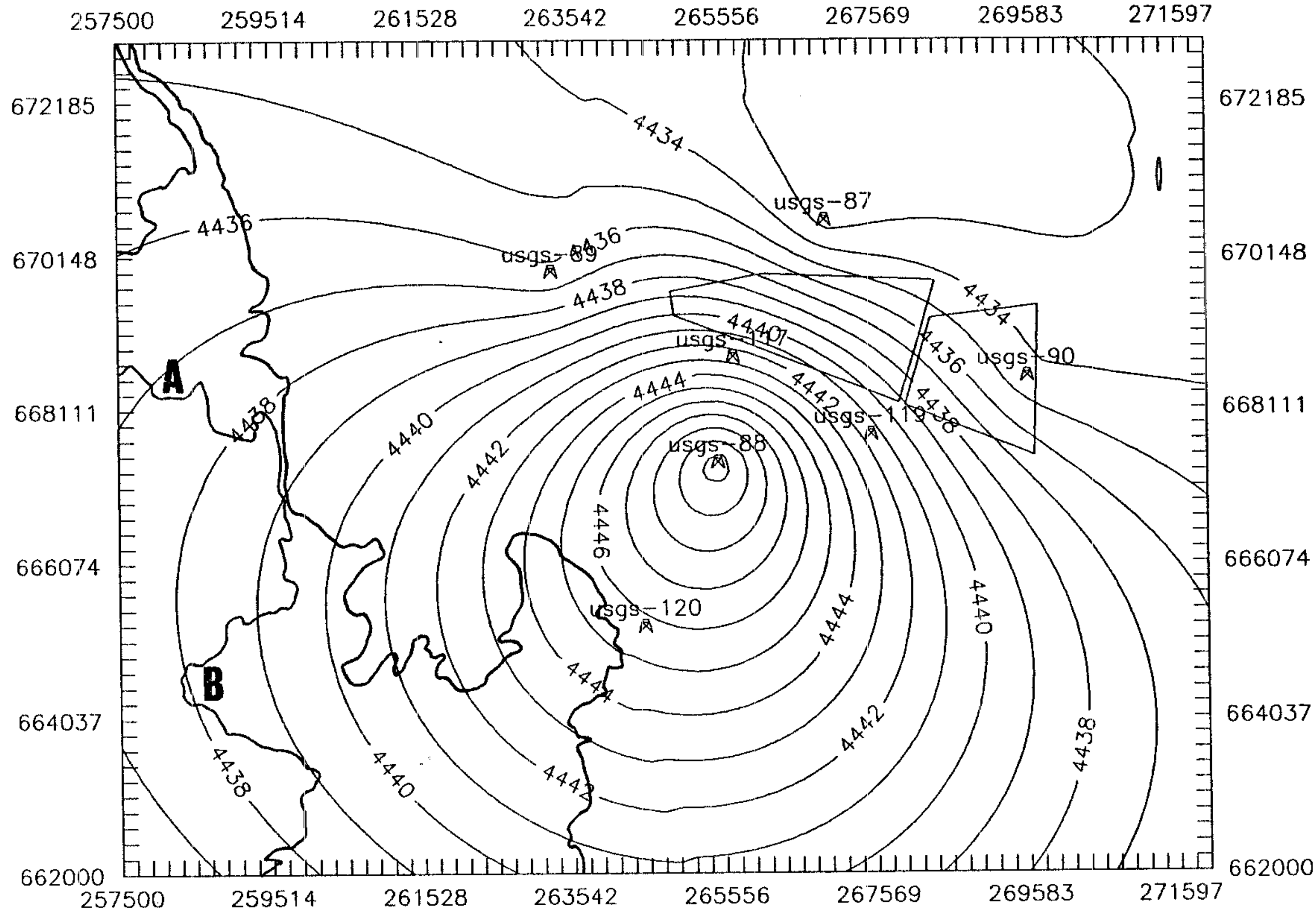
RWMC Water Table Map – 4th quarter 1986



RWMC Water Table Map - 4th quarter 1986 w/o USGS 88

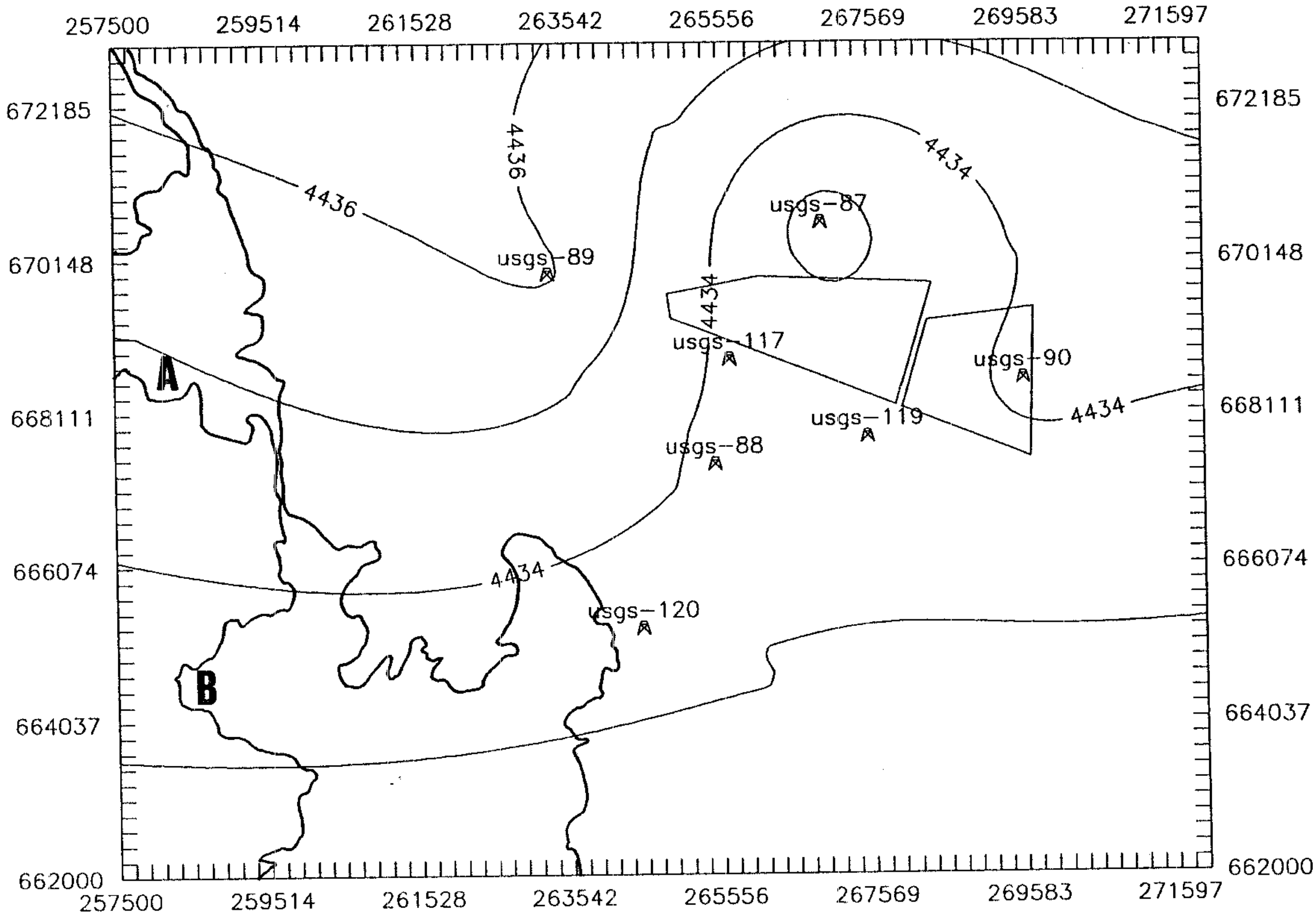


RWMC Water Table Map - 3rd quarter 1986



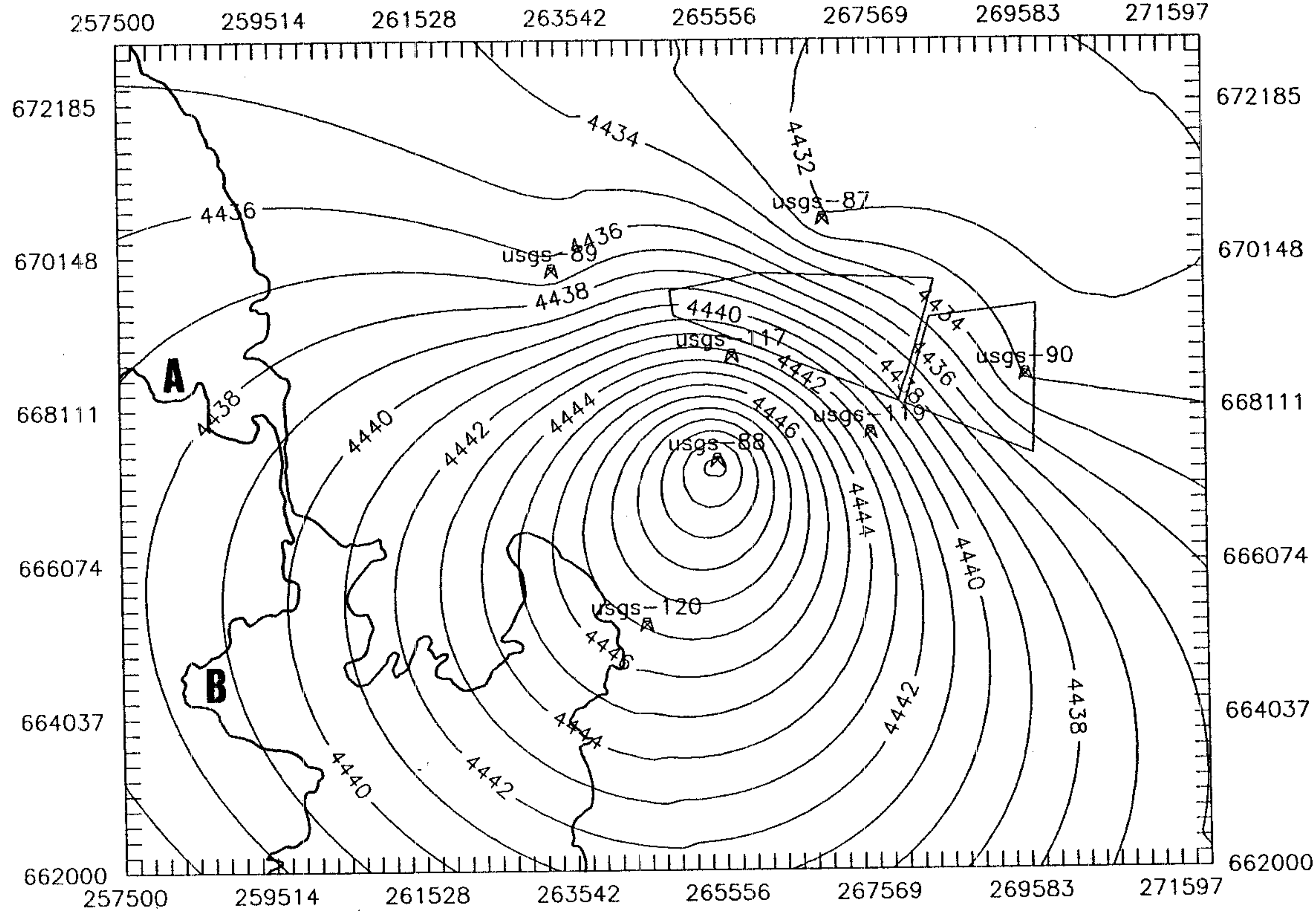
SCALE 1 inch = 2000 feet

RWMC Water Table Map -- 3rd quarter 1986 w/o USGS 88



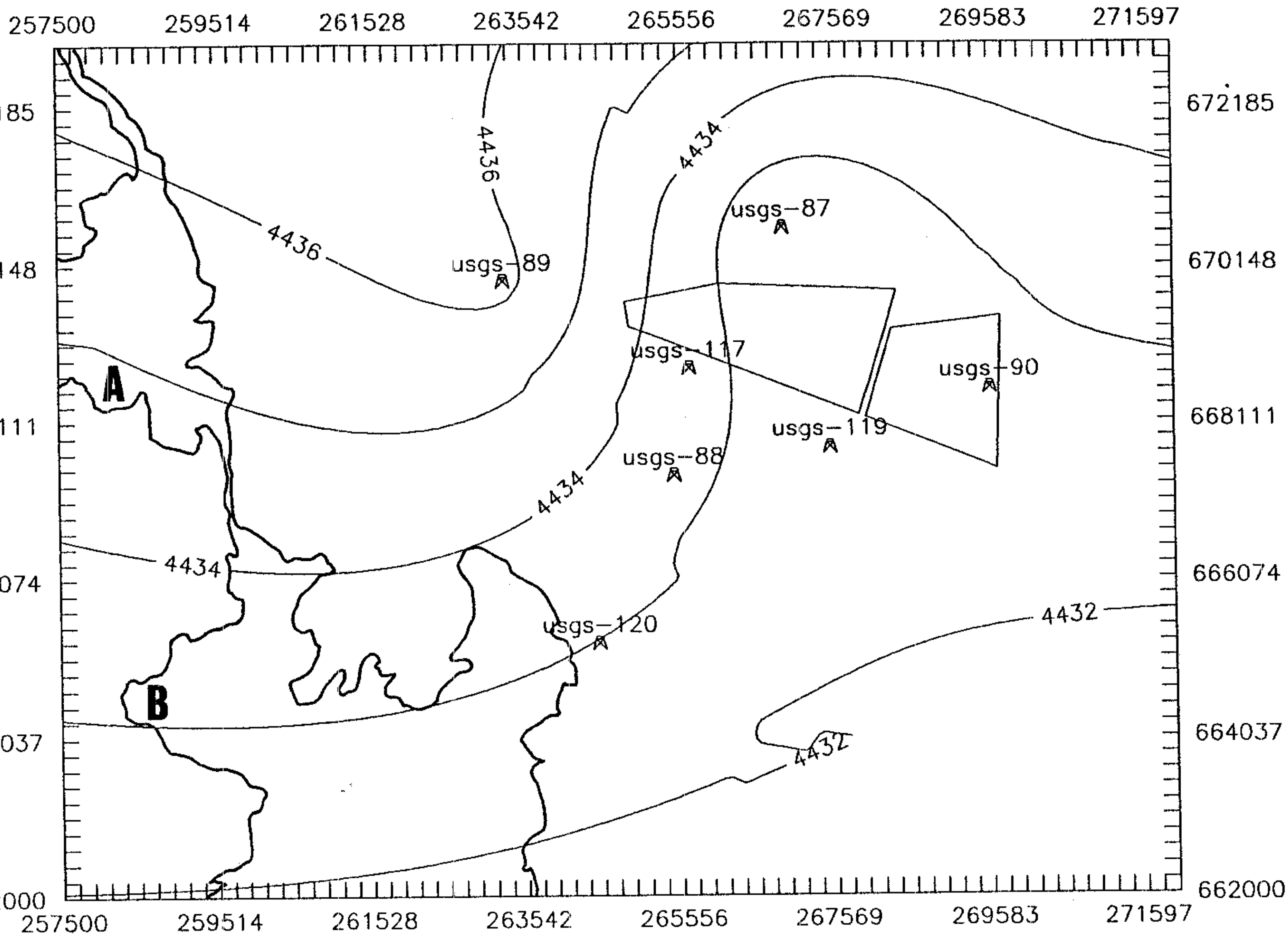
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 2nd quarter 1986



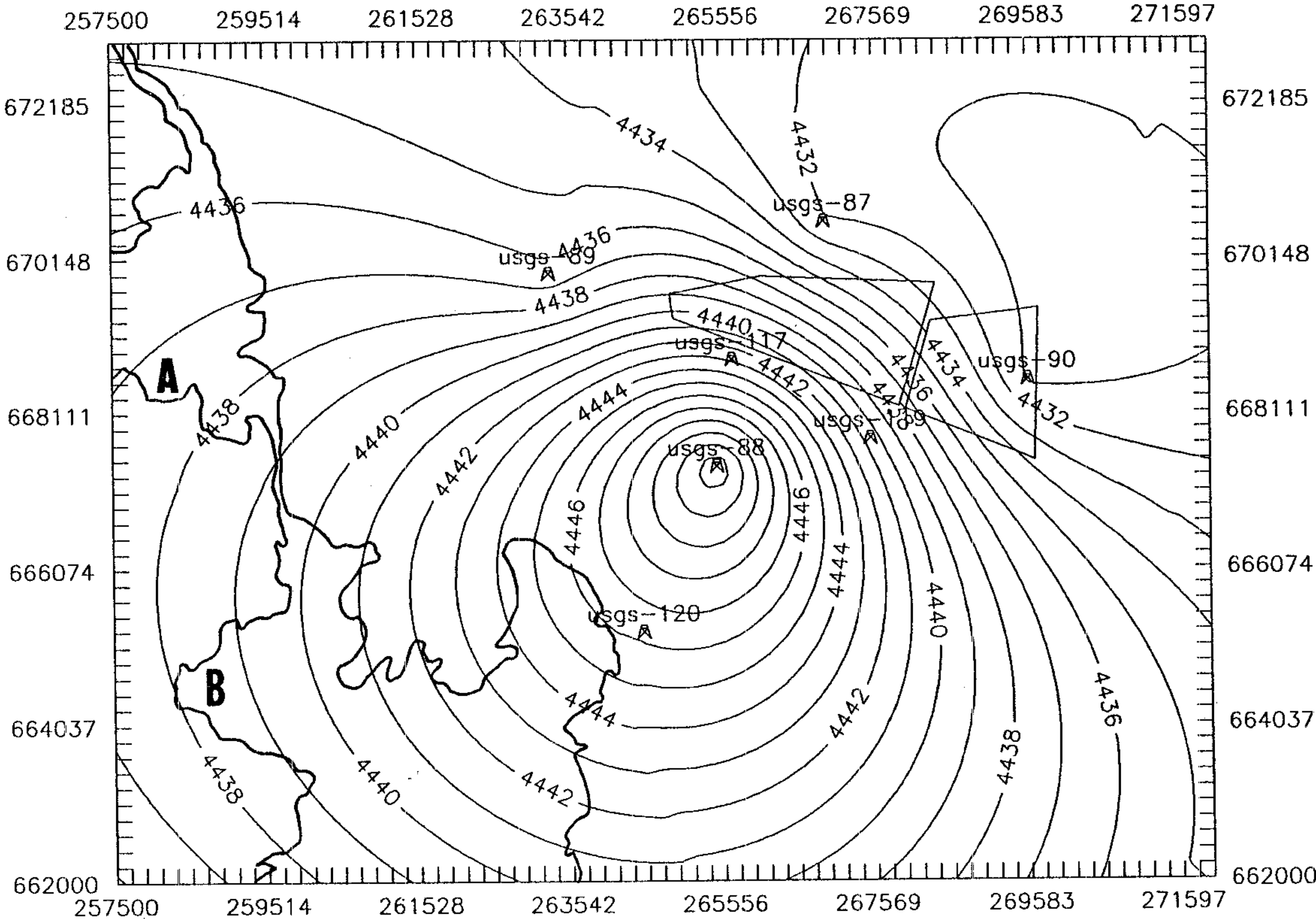
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 2nd quarter 1986 w/o USGS 88



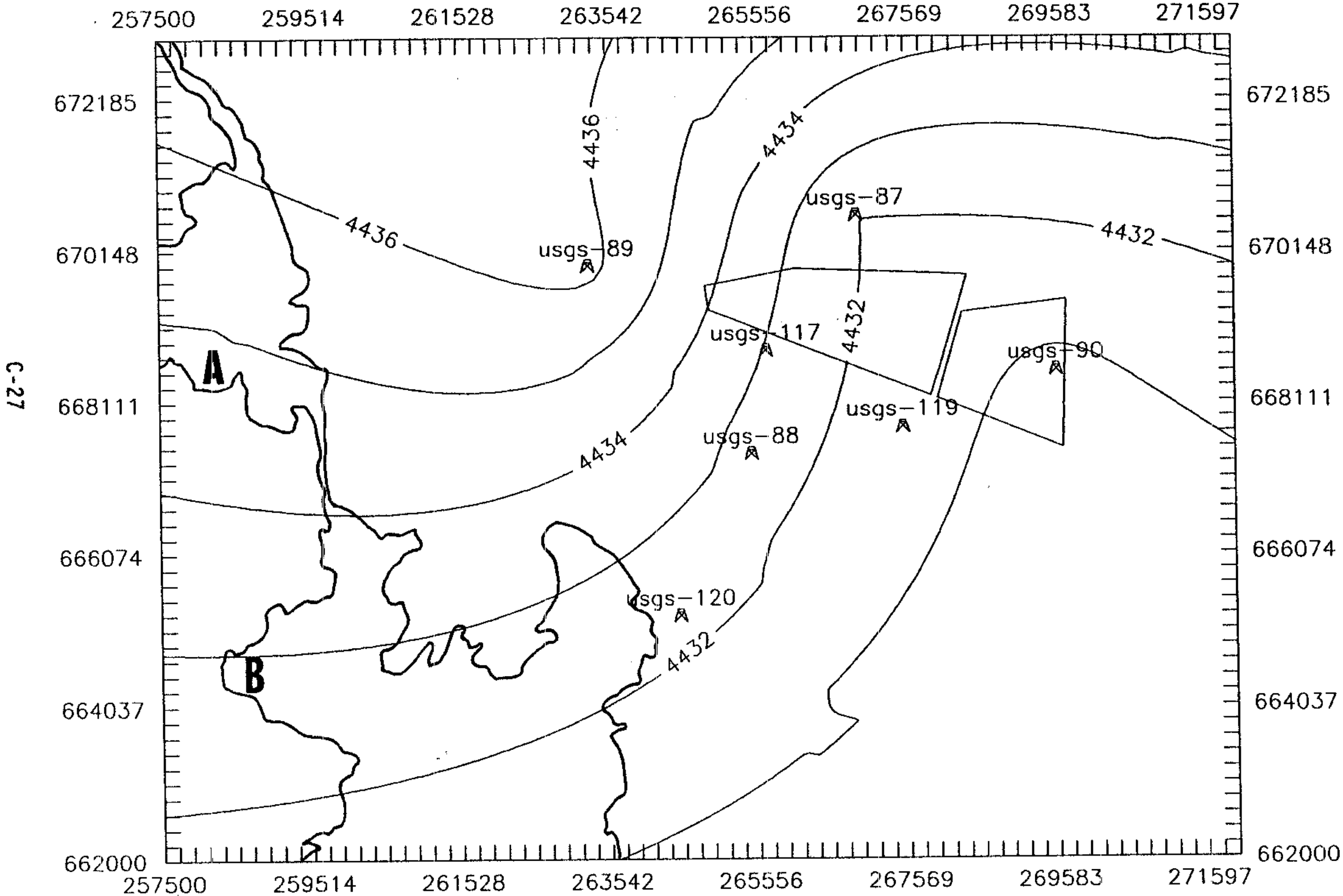
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 1st quarter 1986



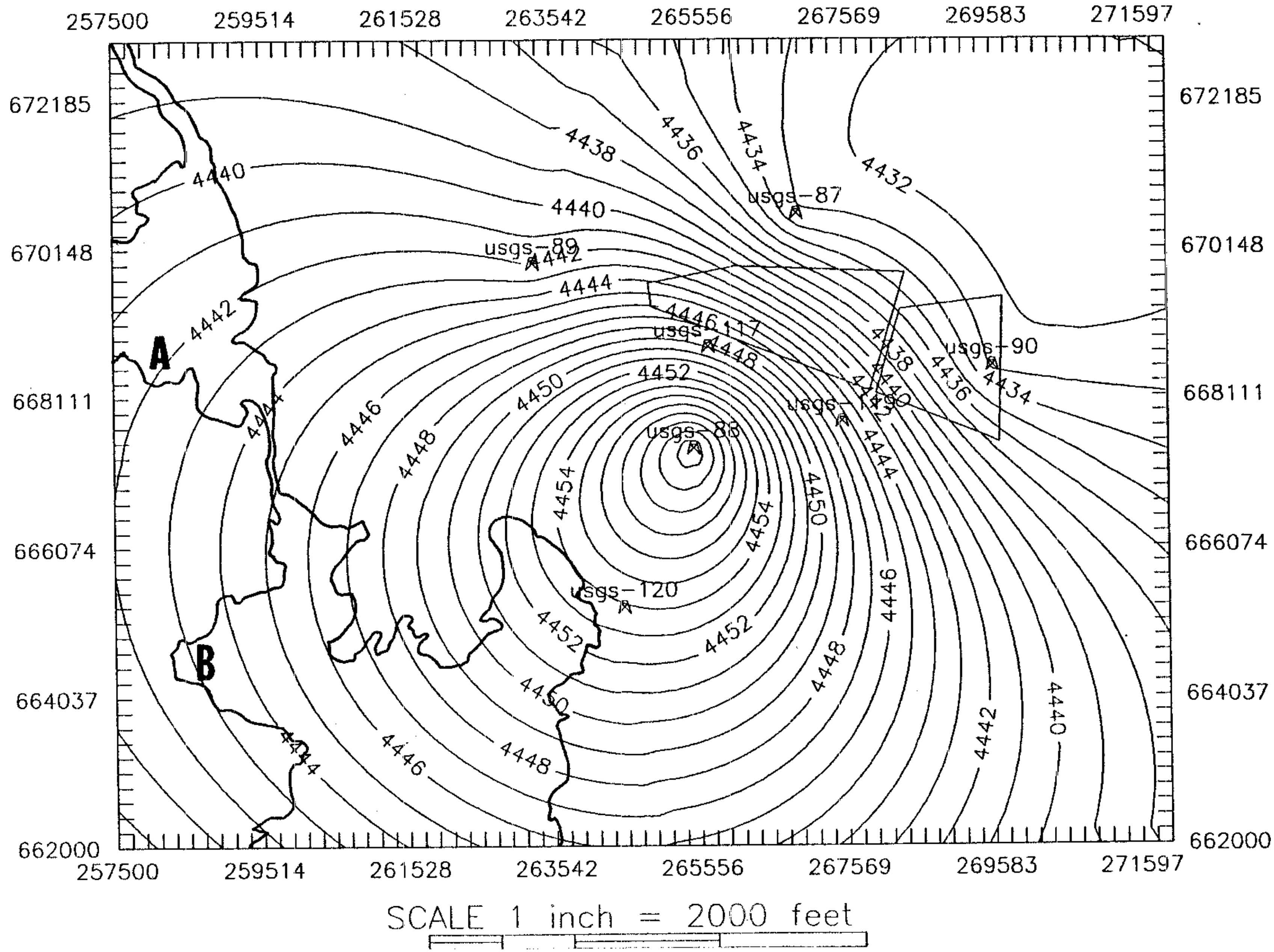
SCALE 1 inch = 2000 feet

RWMC Water Table Map - 1st quarter 1986 w/o USGS 88

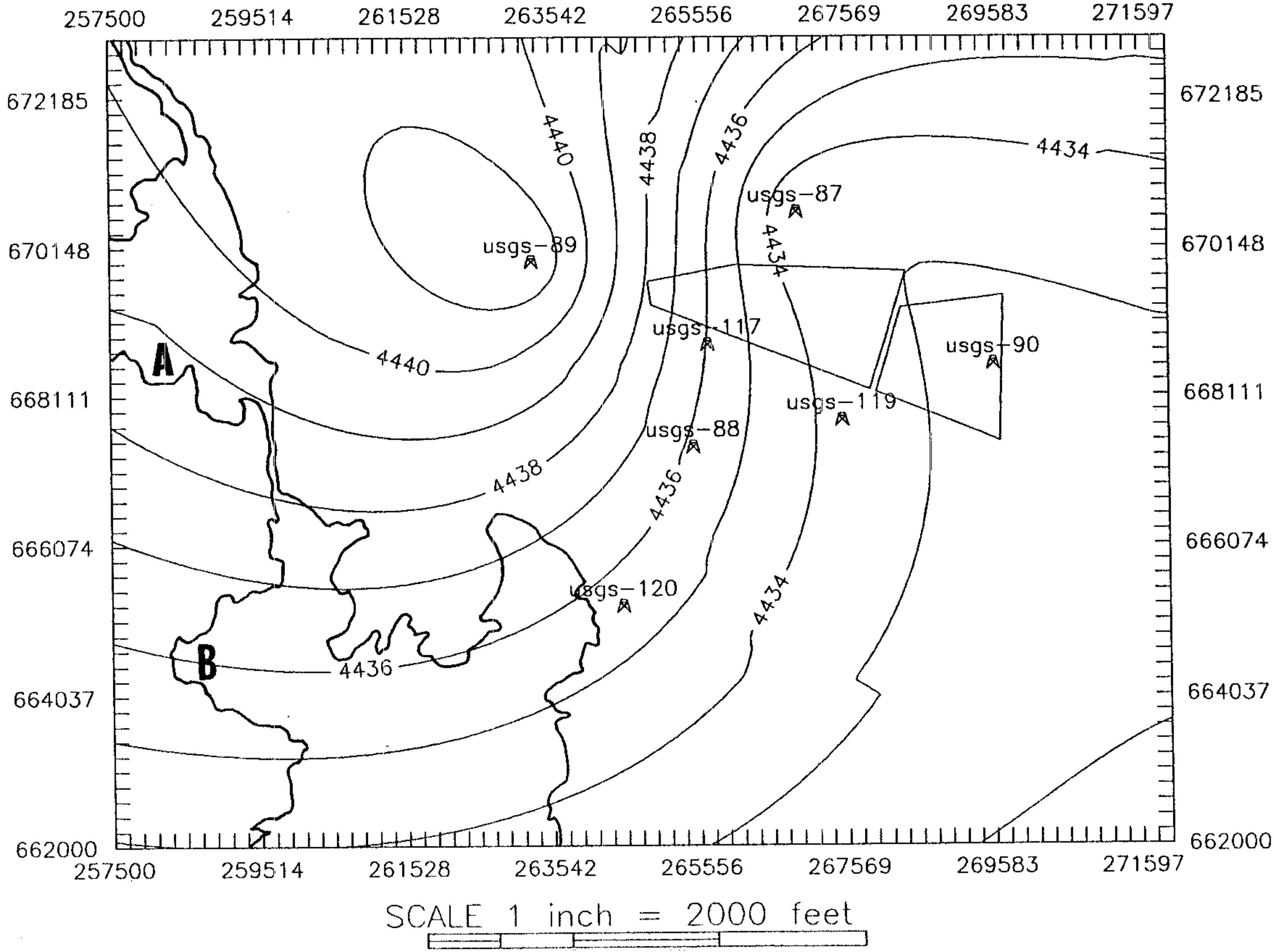


SCALE 1 inch = 2000 feet

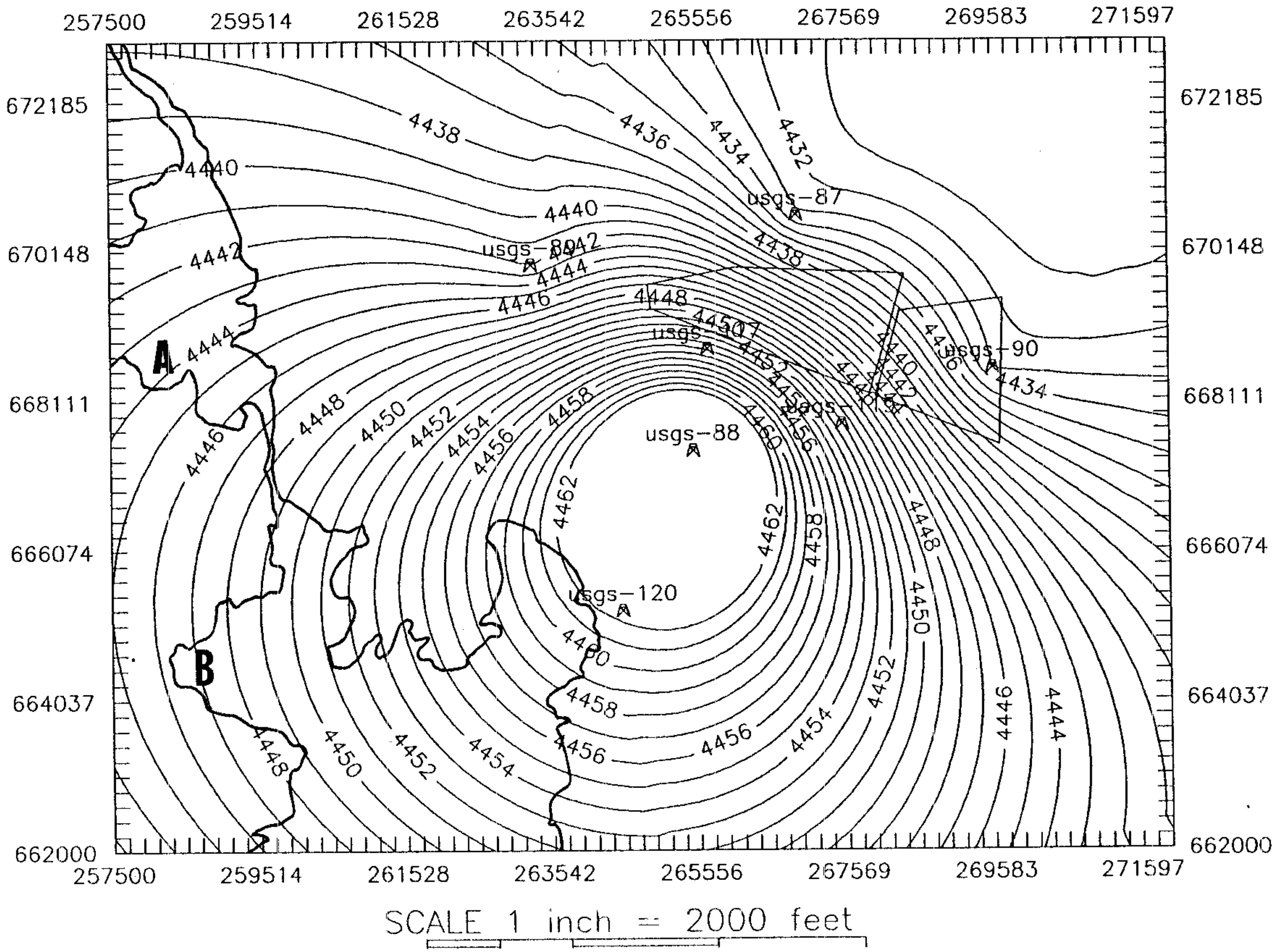
RWMC Water Table Map – 4th quarter 1985



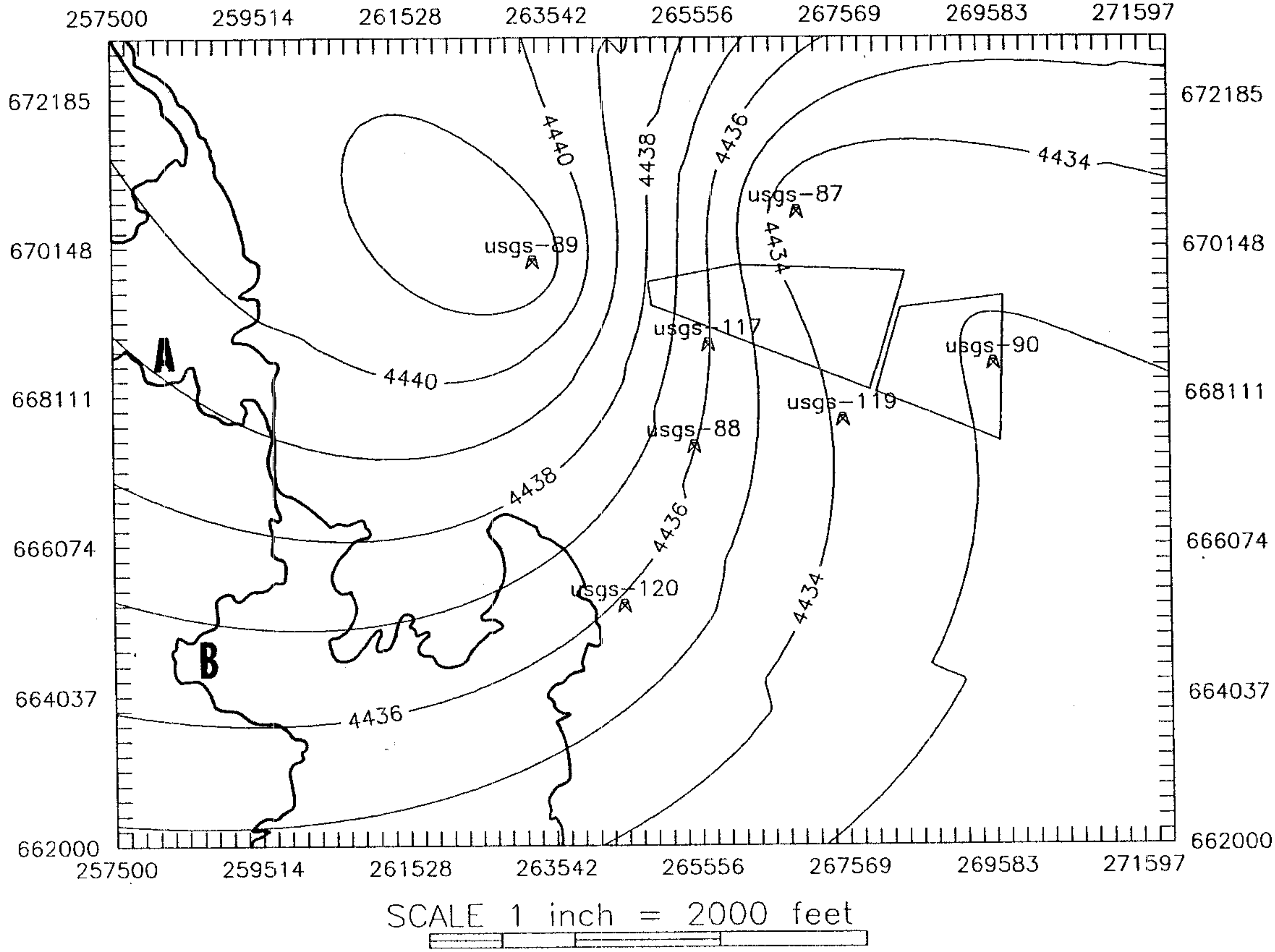
RWMC Water Table Map – 4th quarter 1985 w/o USGS 88



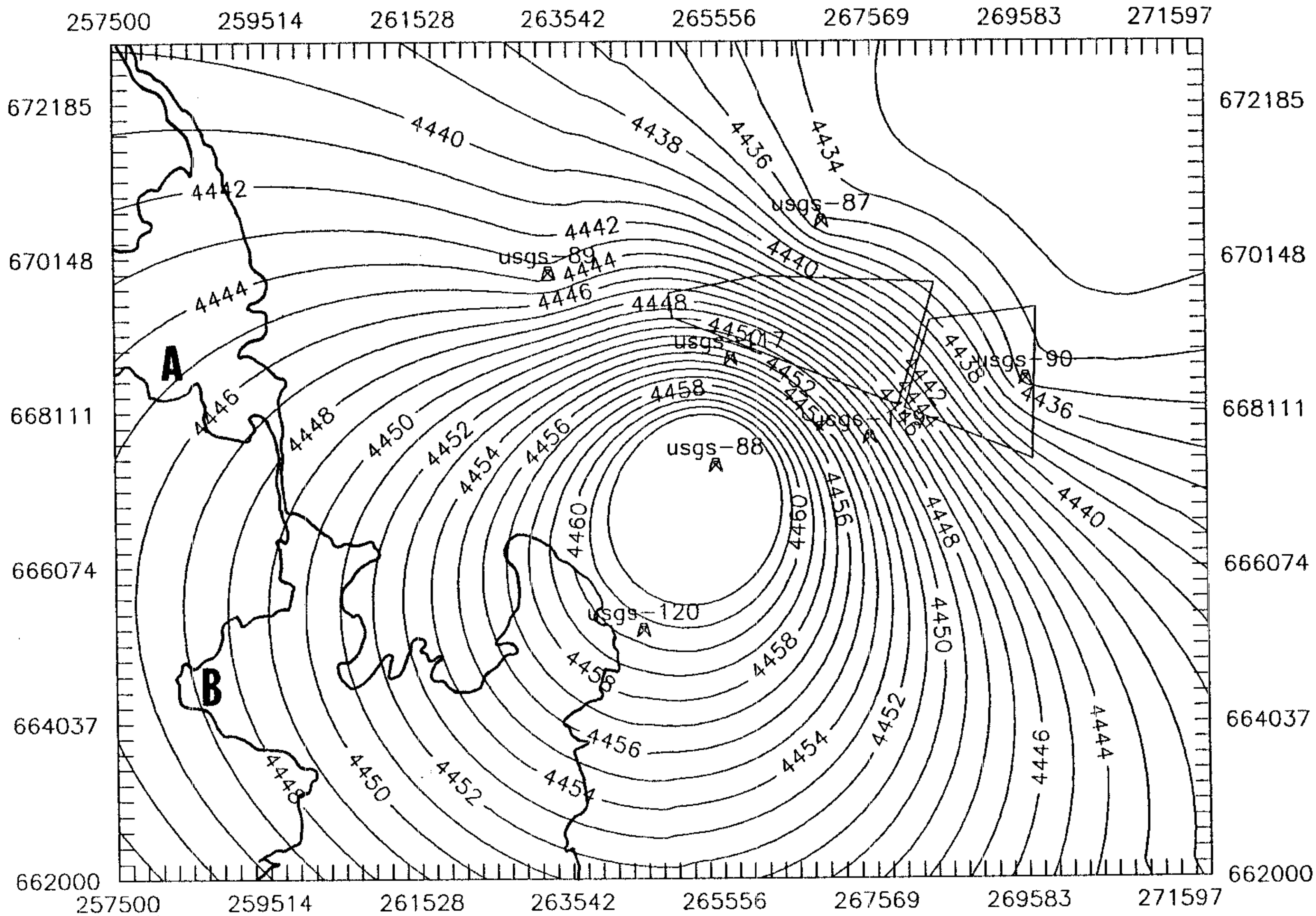
RWMC Water Table Map – 3rd quarter 1985



RWMC Water Table Map – 3rd quarter 1985 w/o USGS 88

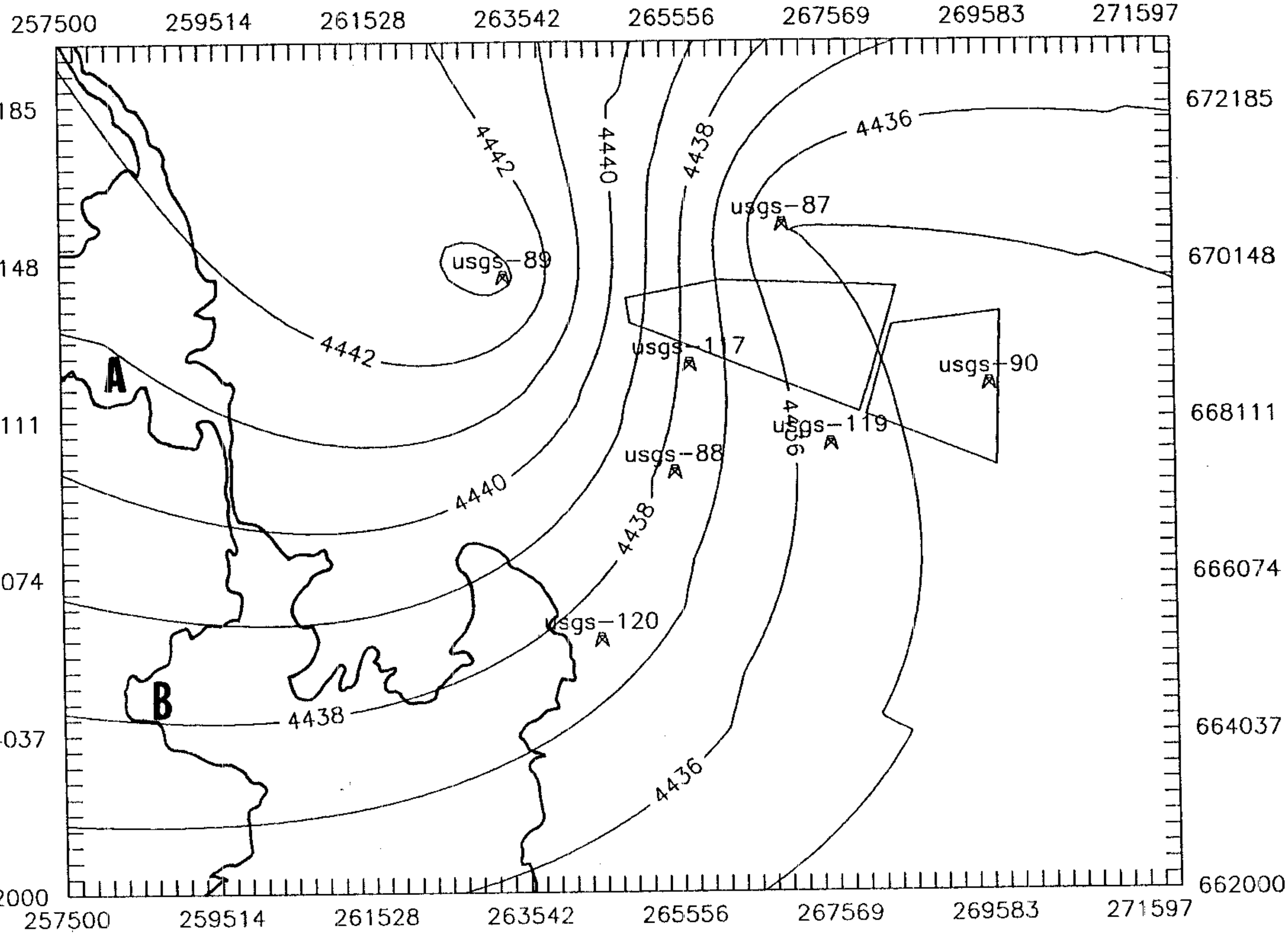


RWMC Water Table Map – 2nd quarter 1985



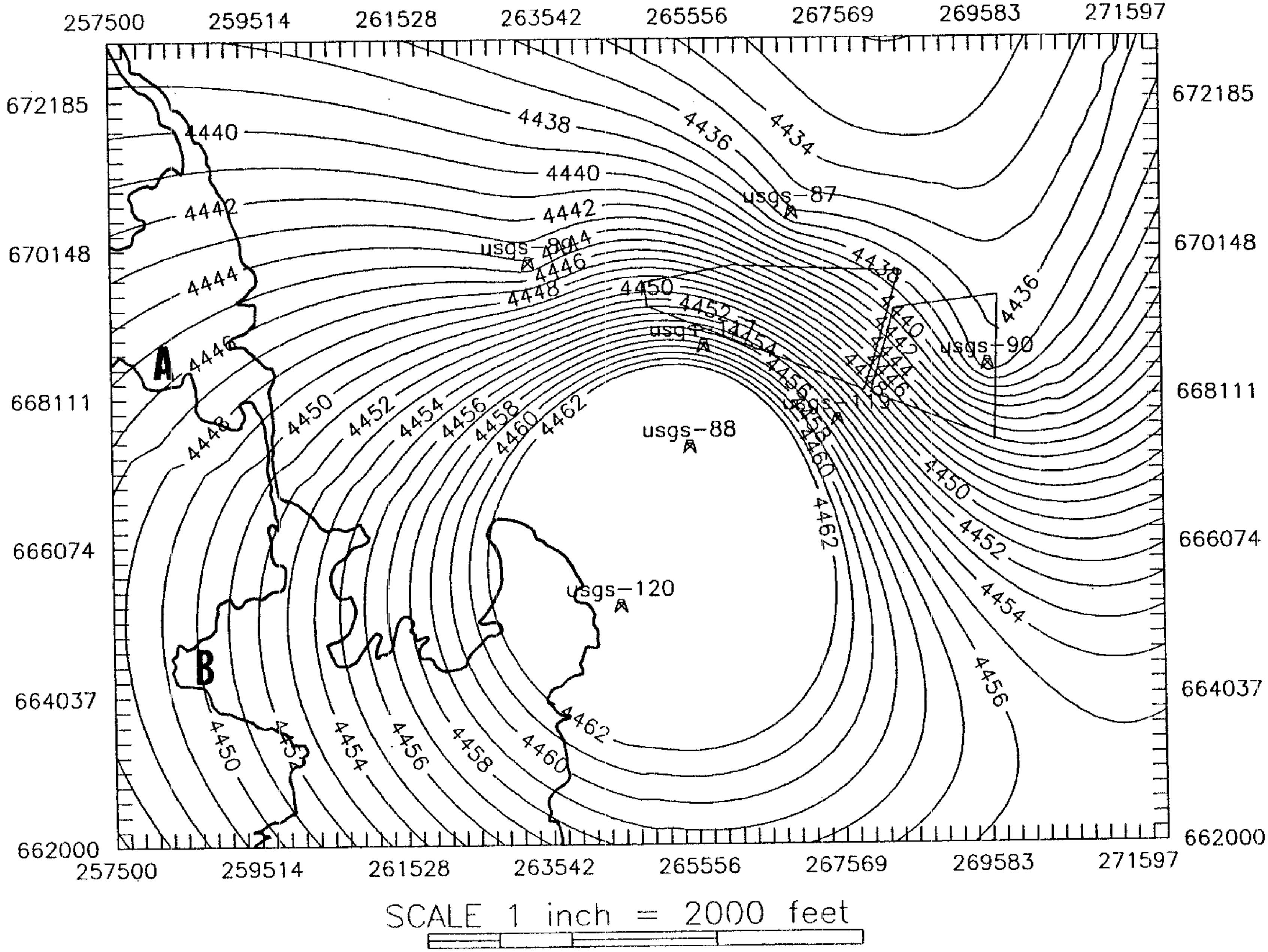
SCALE 1 inch = 2000 feet

RWMC Water Table Map - 2nd quarter 1985 w/o USGS 88

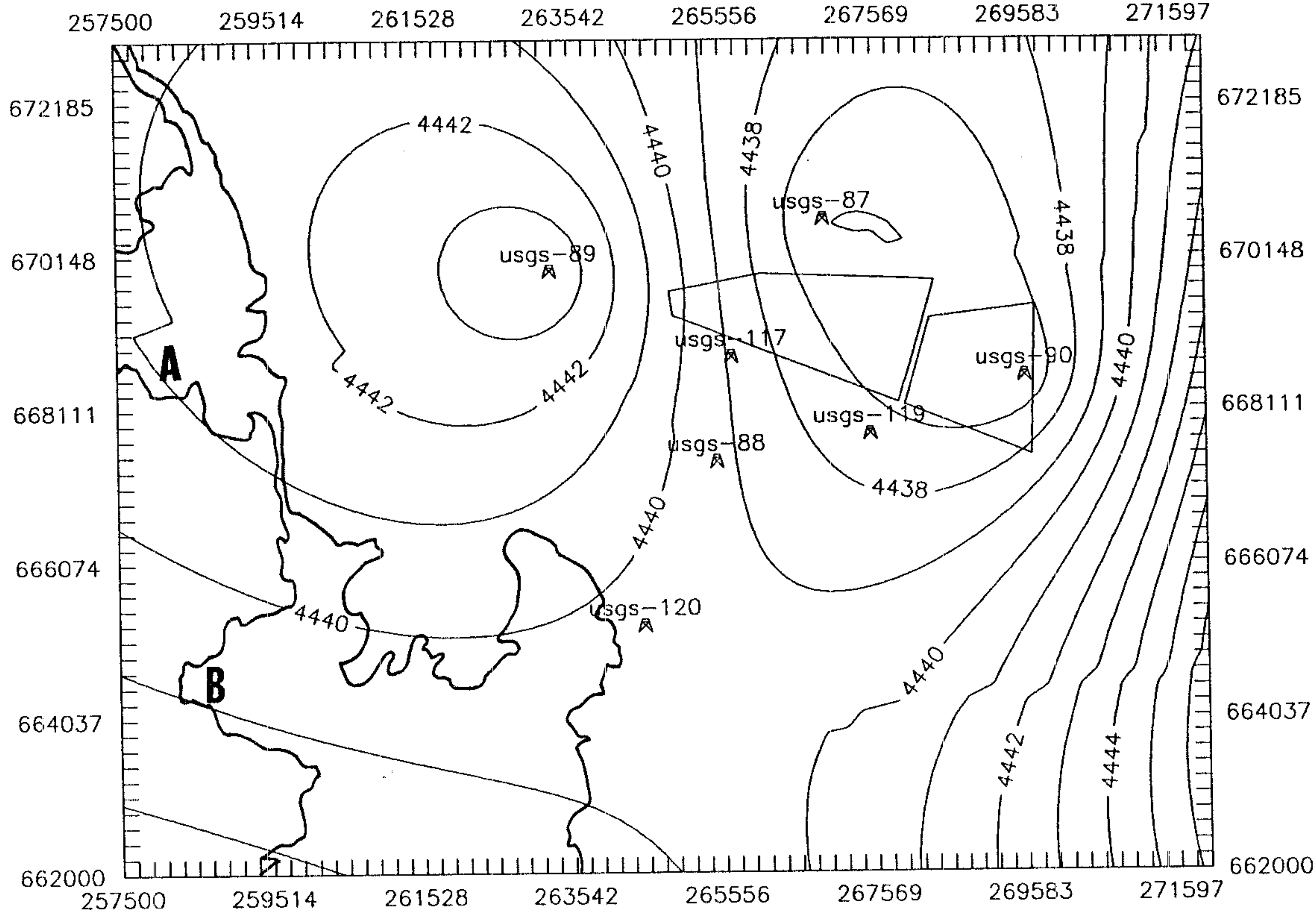


SCALE 1 inch = 2000 feet

RWMC Water Table Map — 1st quarter 1985

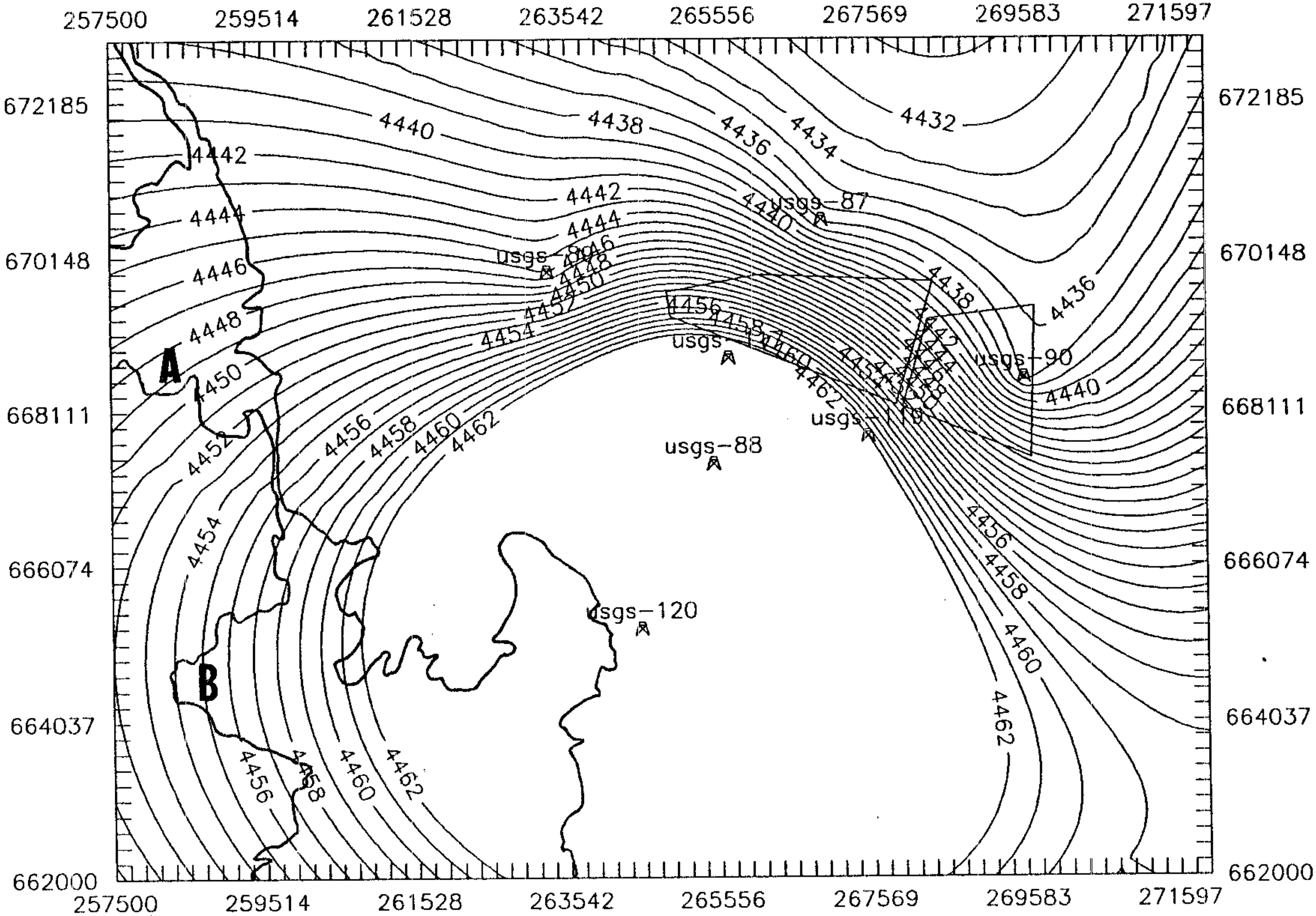


RWMC Water Table Map - 1st quarter 1985 w/o USGS 88



SCALE 1 inch = 2000 feet

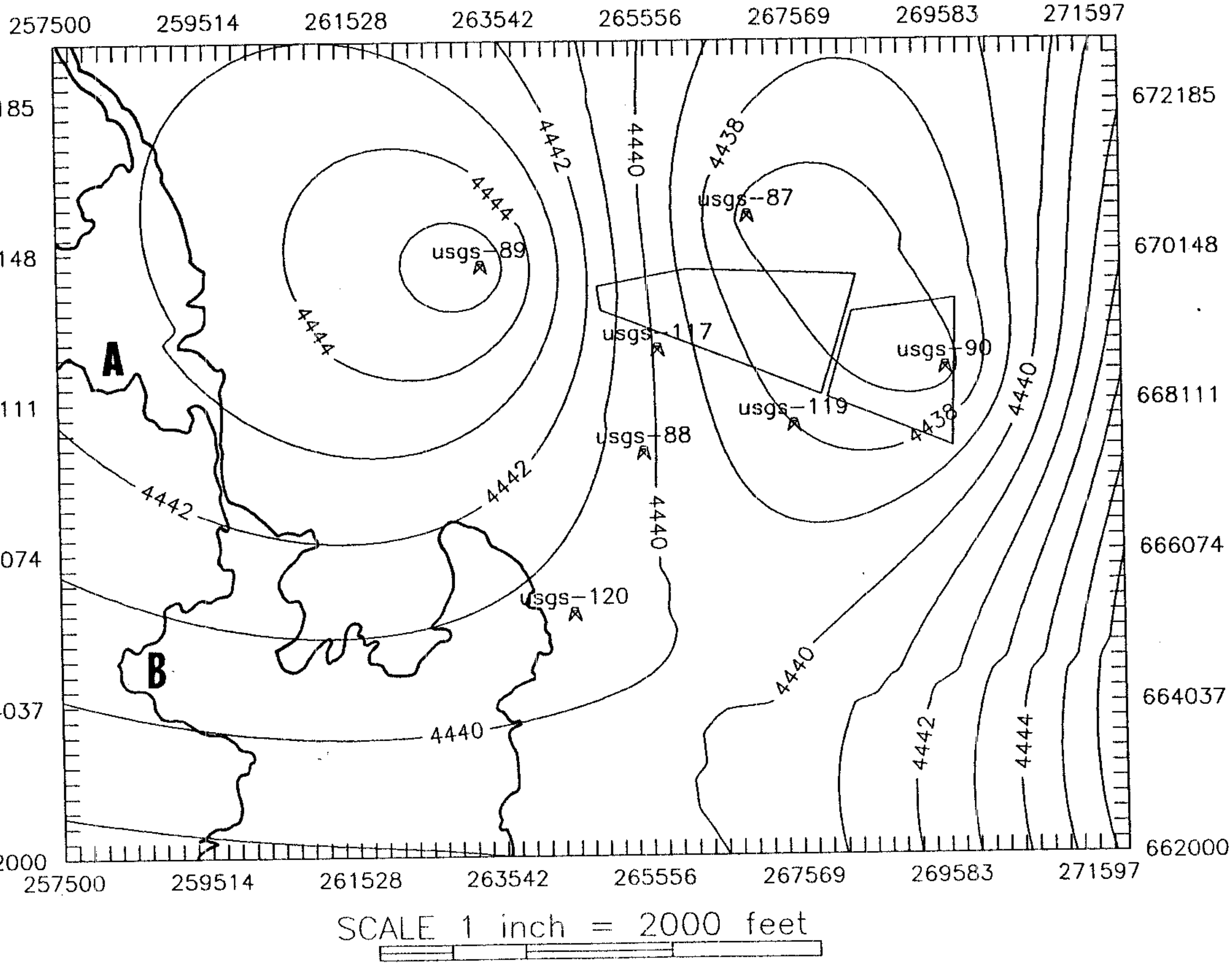
RWMC Water Table Map – 4th quarter 1984



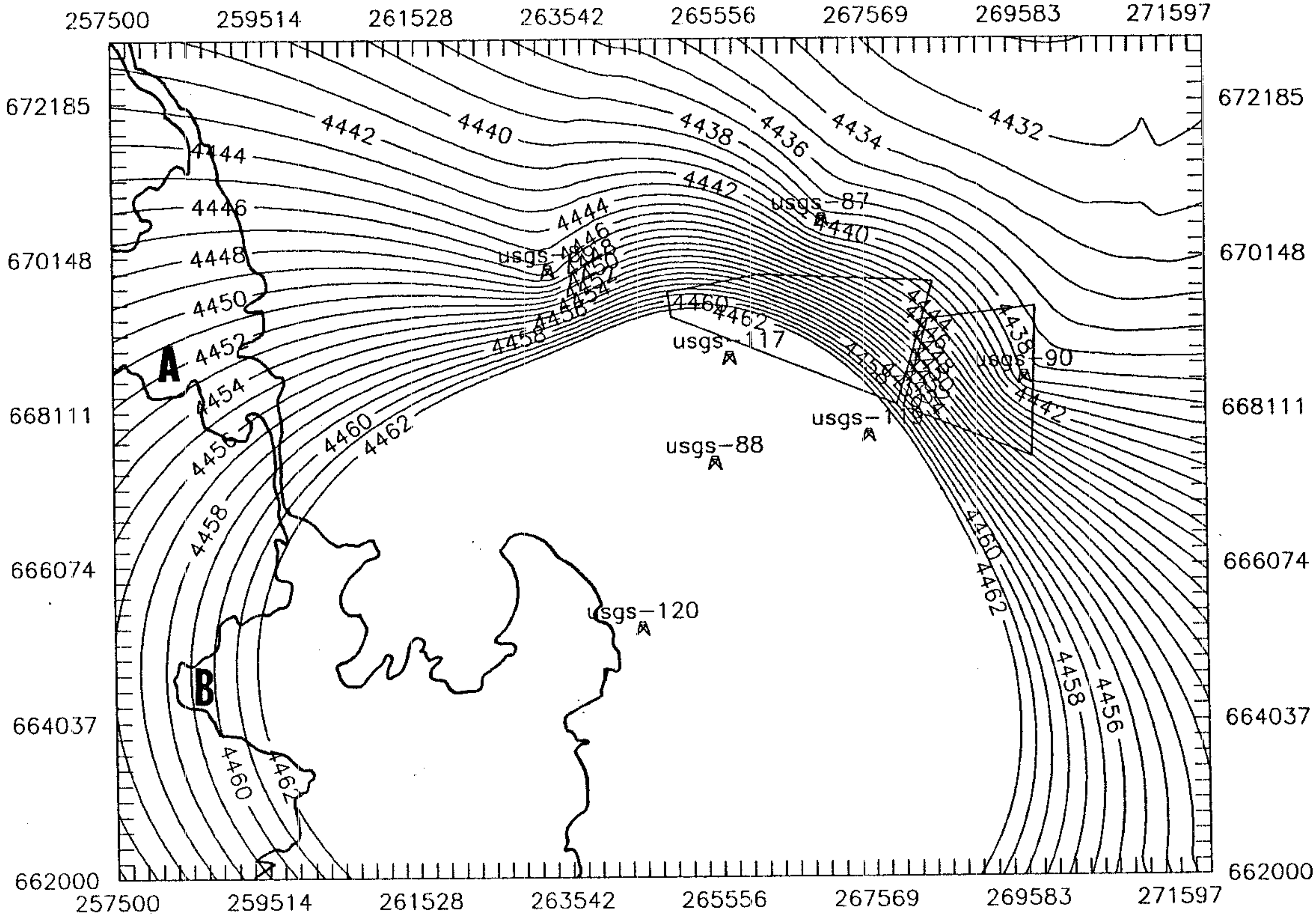
SCALE 1 inch = 2000 feet

C-36

RWMC Water Table Map – 4th quarter 1984 w/o USGS 88

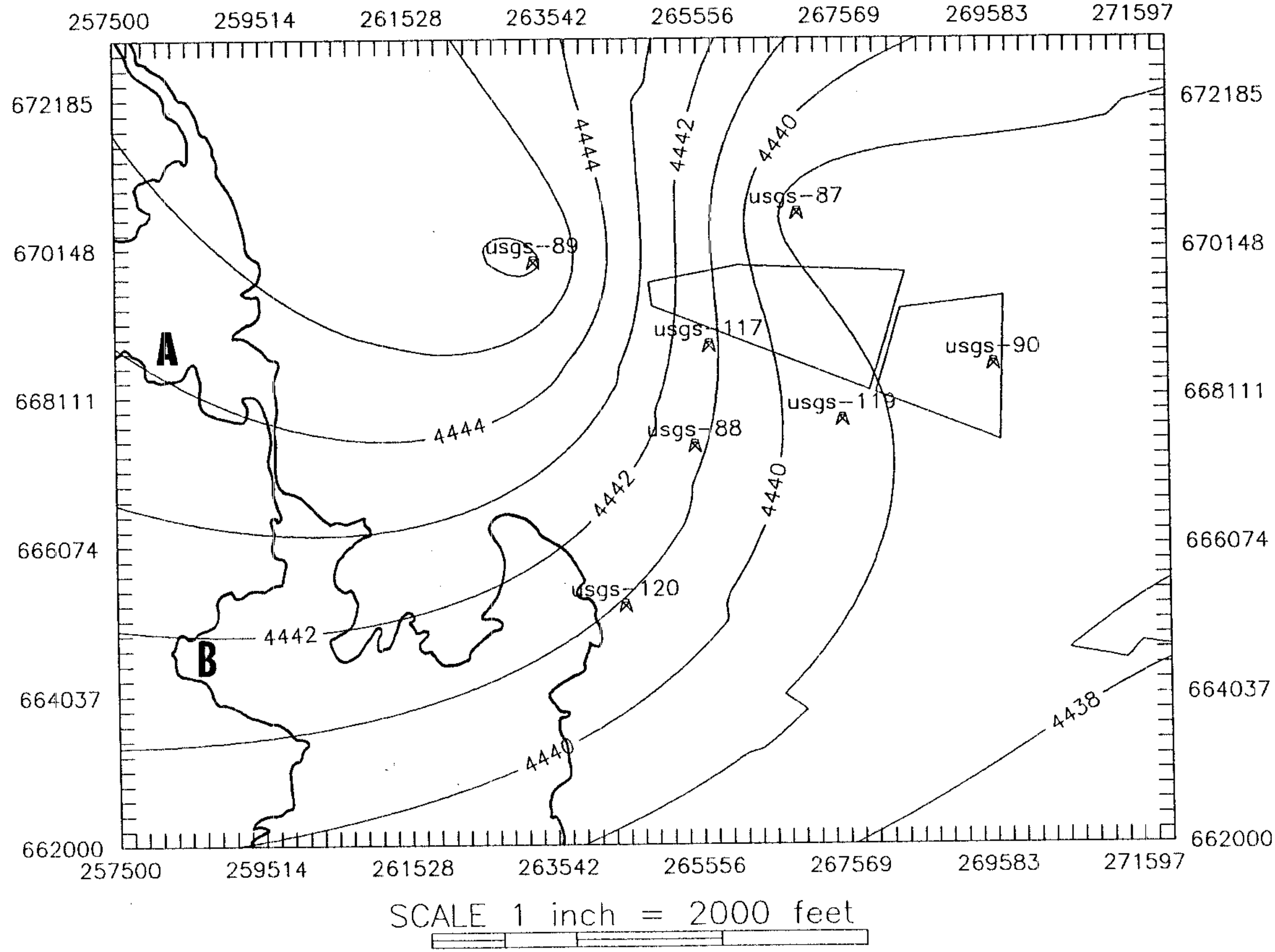


RWMC Water Table Map — 3rd quarter 1984



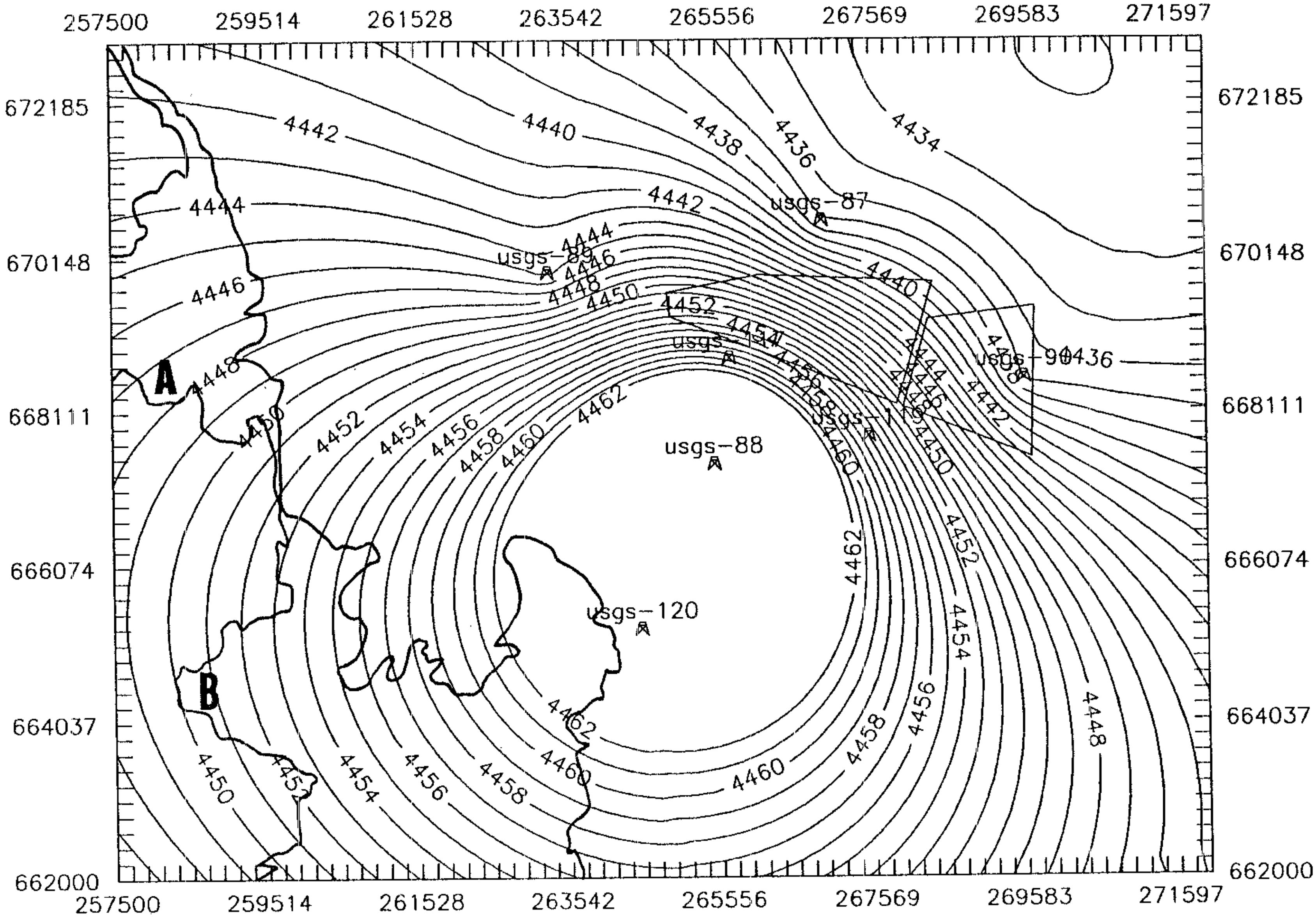
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 3rd quarter 1984 w/o USGS 88



C-39

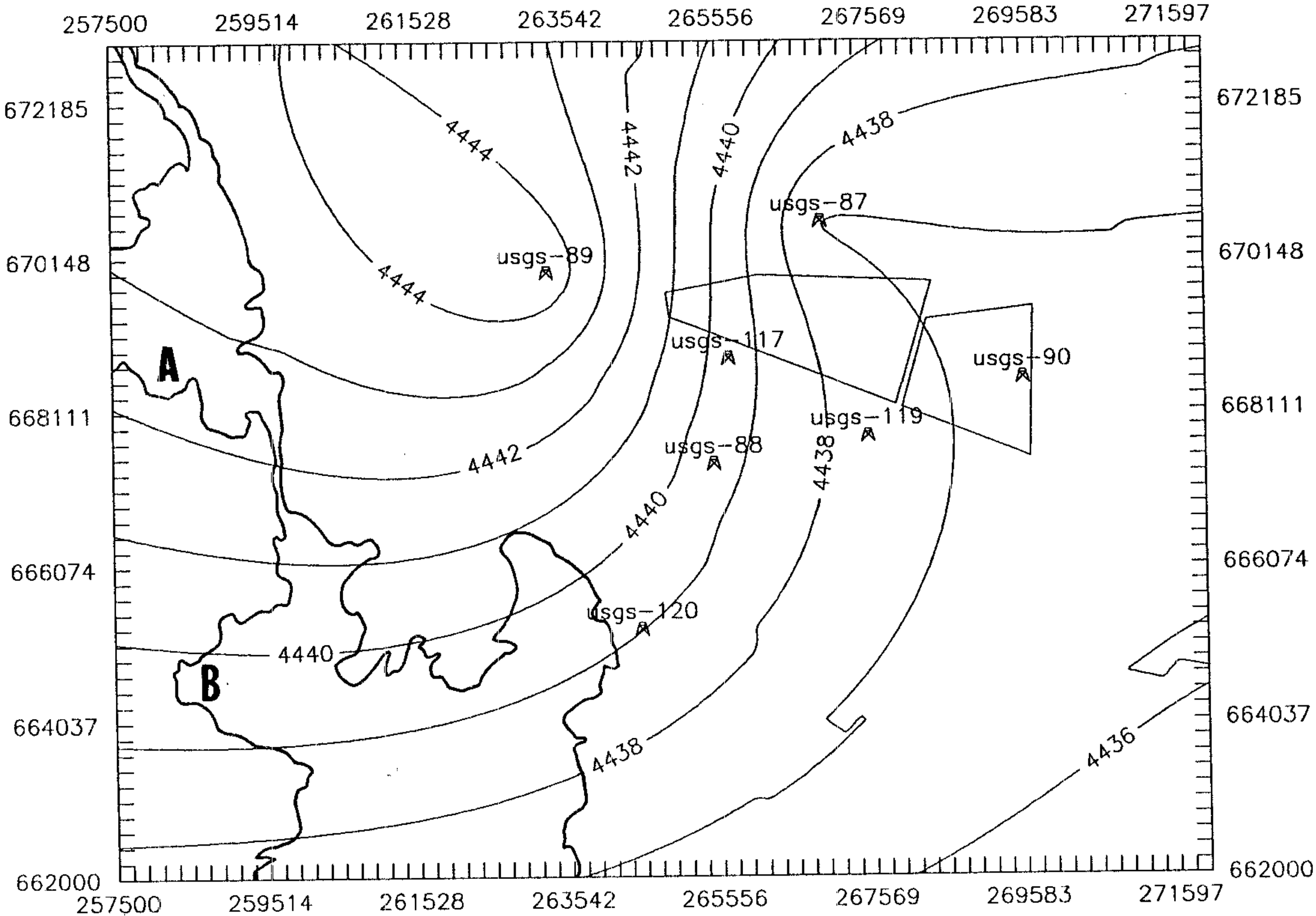
RWMC Water Table Map — 2nd quarter 1984



SCALE 1 inch = 2000 feet

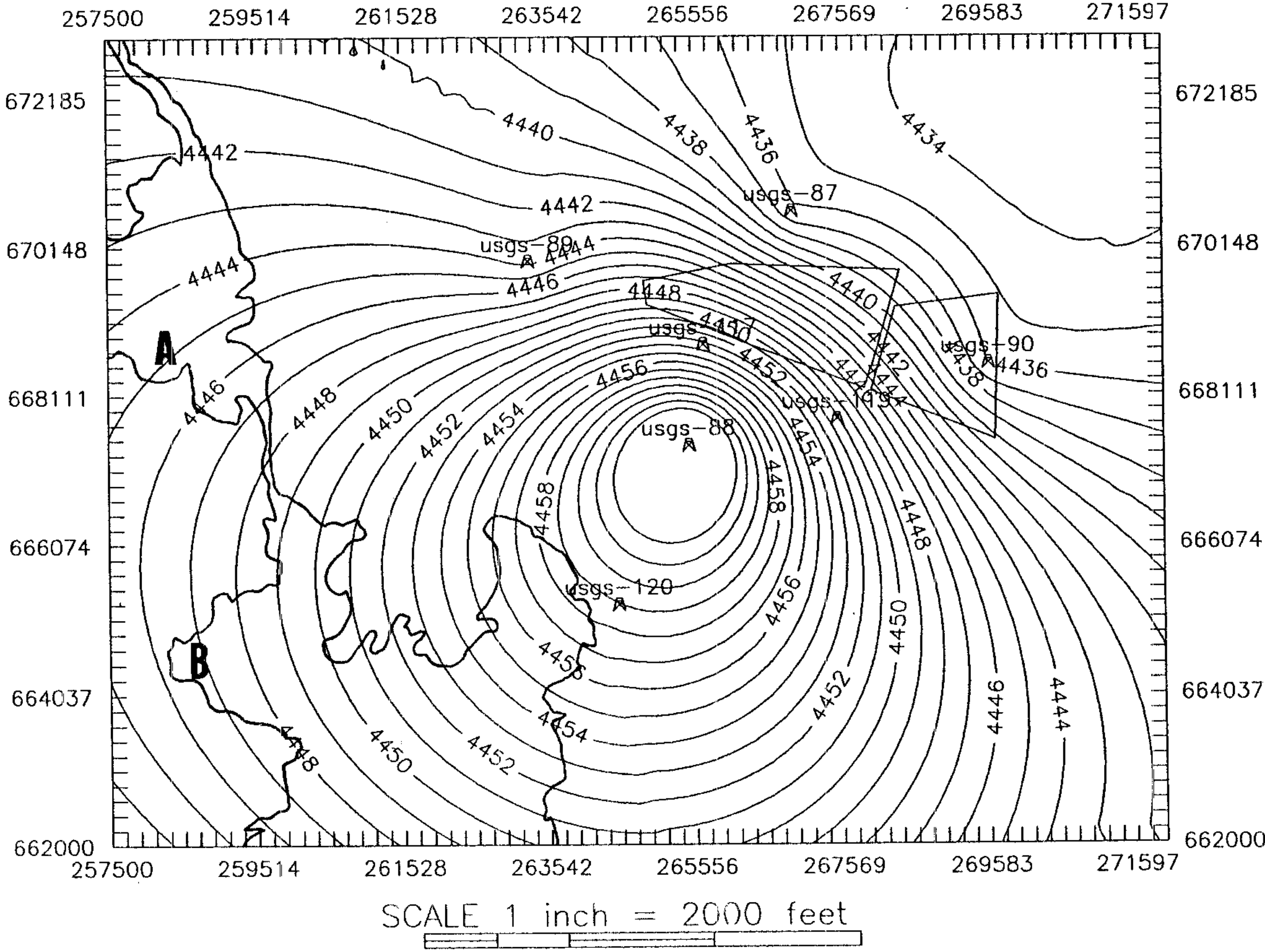
C-40

RWMC Water Table Map – 2nd quarter 1984 w/o USGS 88

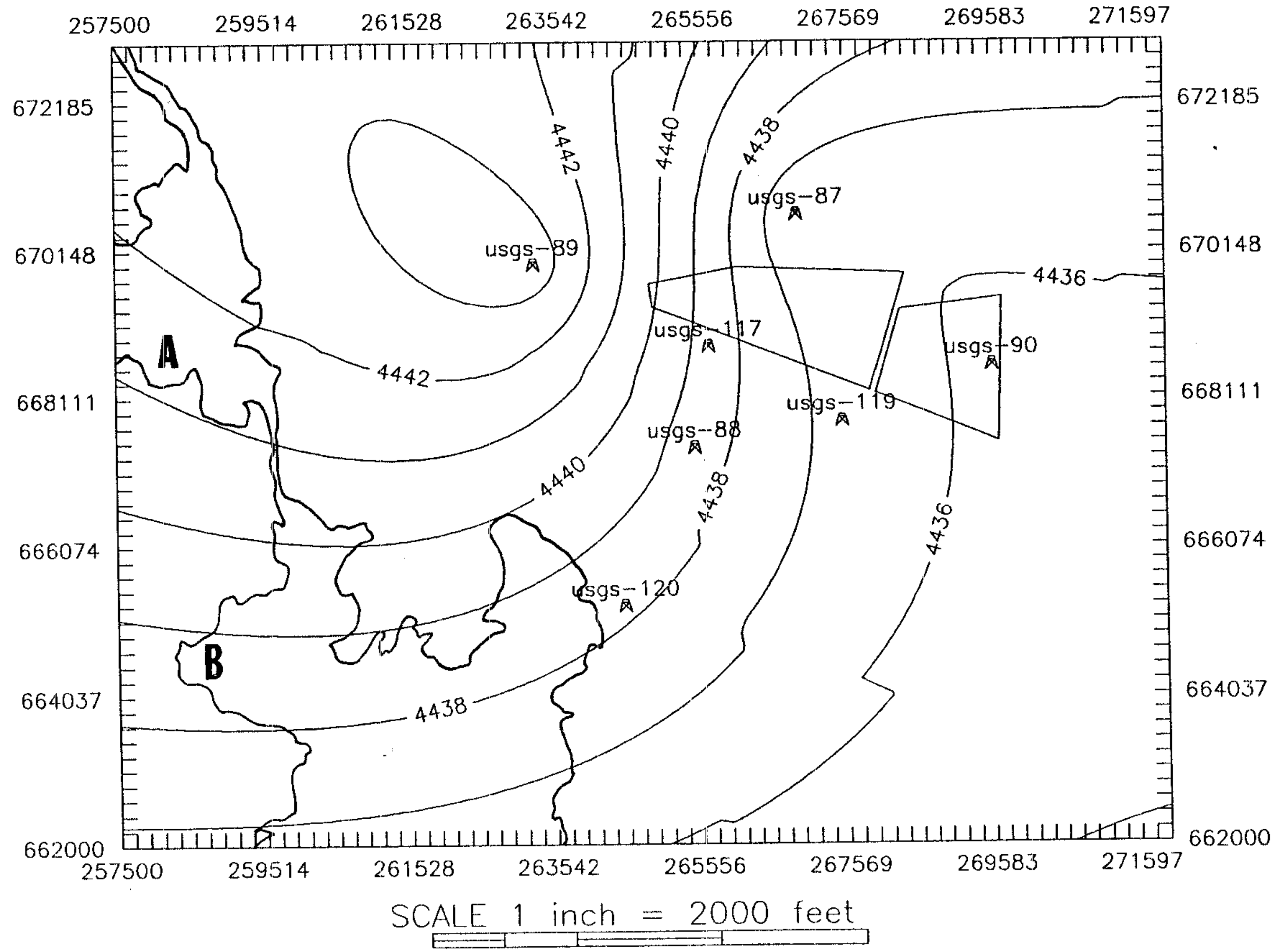


SCALE 1 inch = 2000 feet

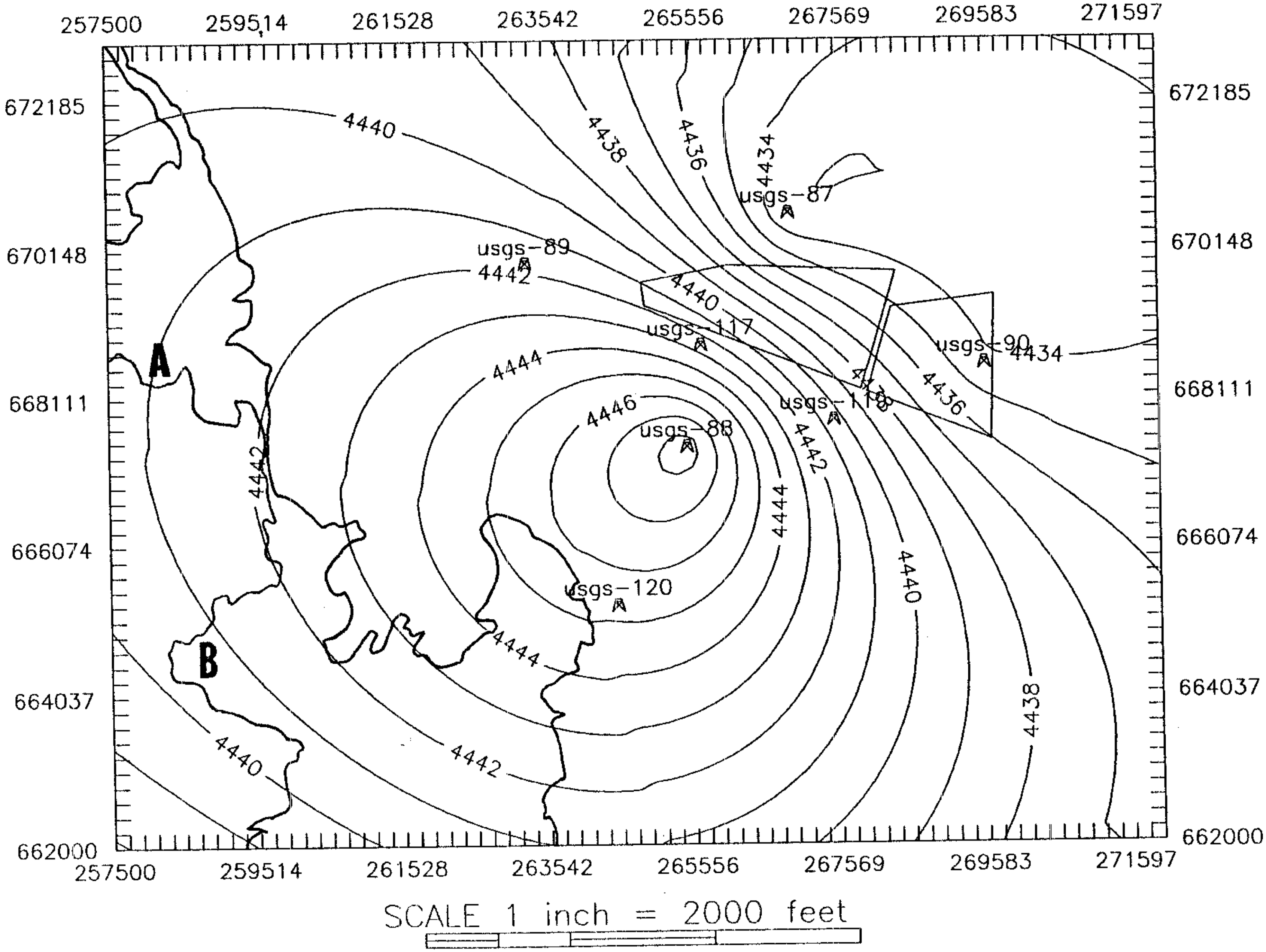
RWMC Water Table Map — 1st quarter 1984



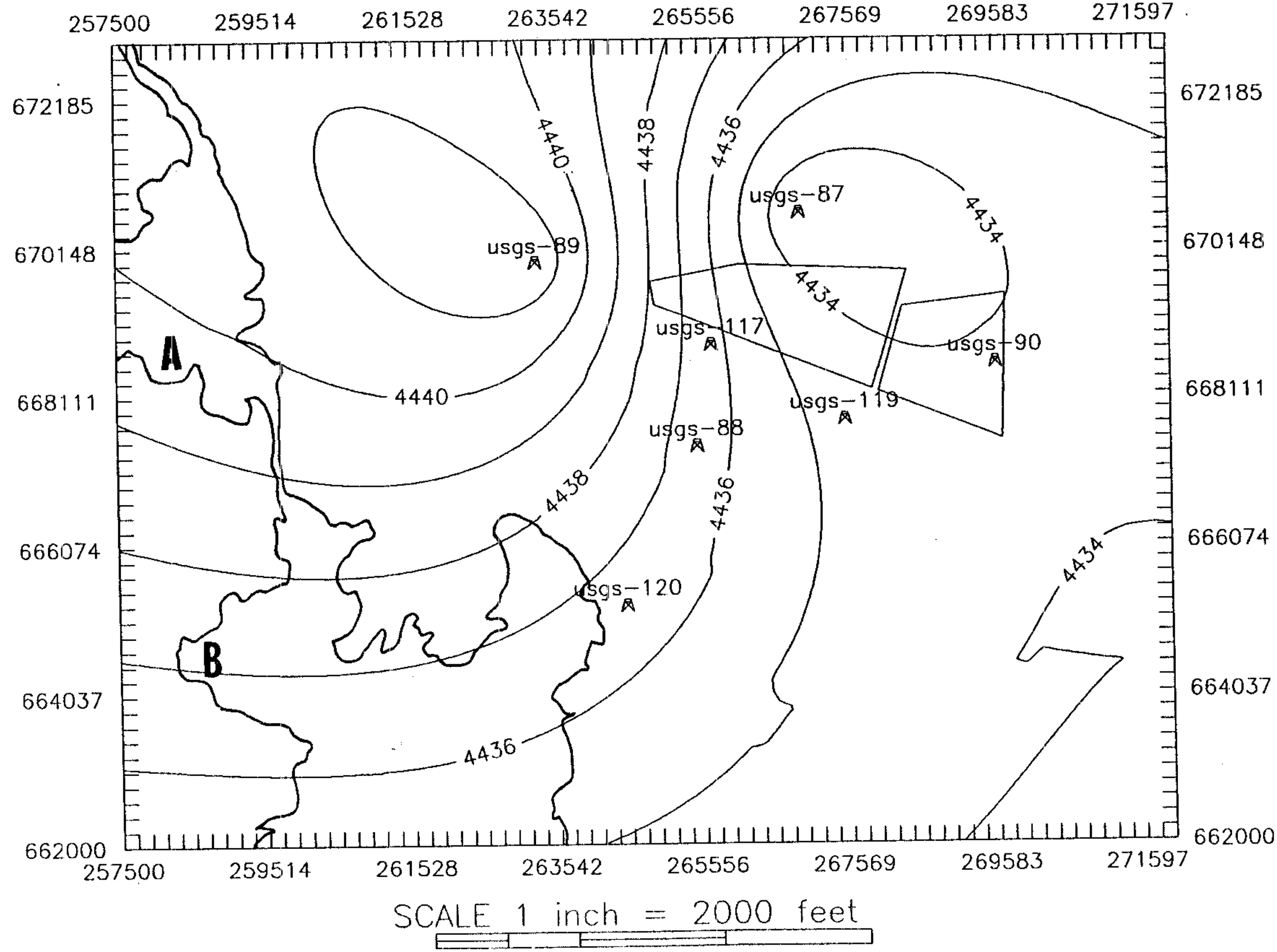
RWMC Water Table Map – 1st quarter 1984 w/o USGS 88



RWMC Water Table Map — 4th quarter 1983

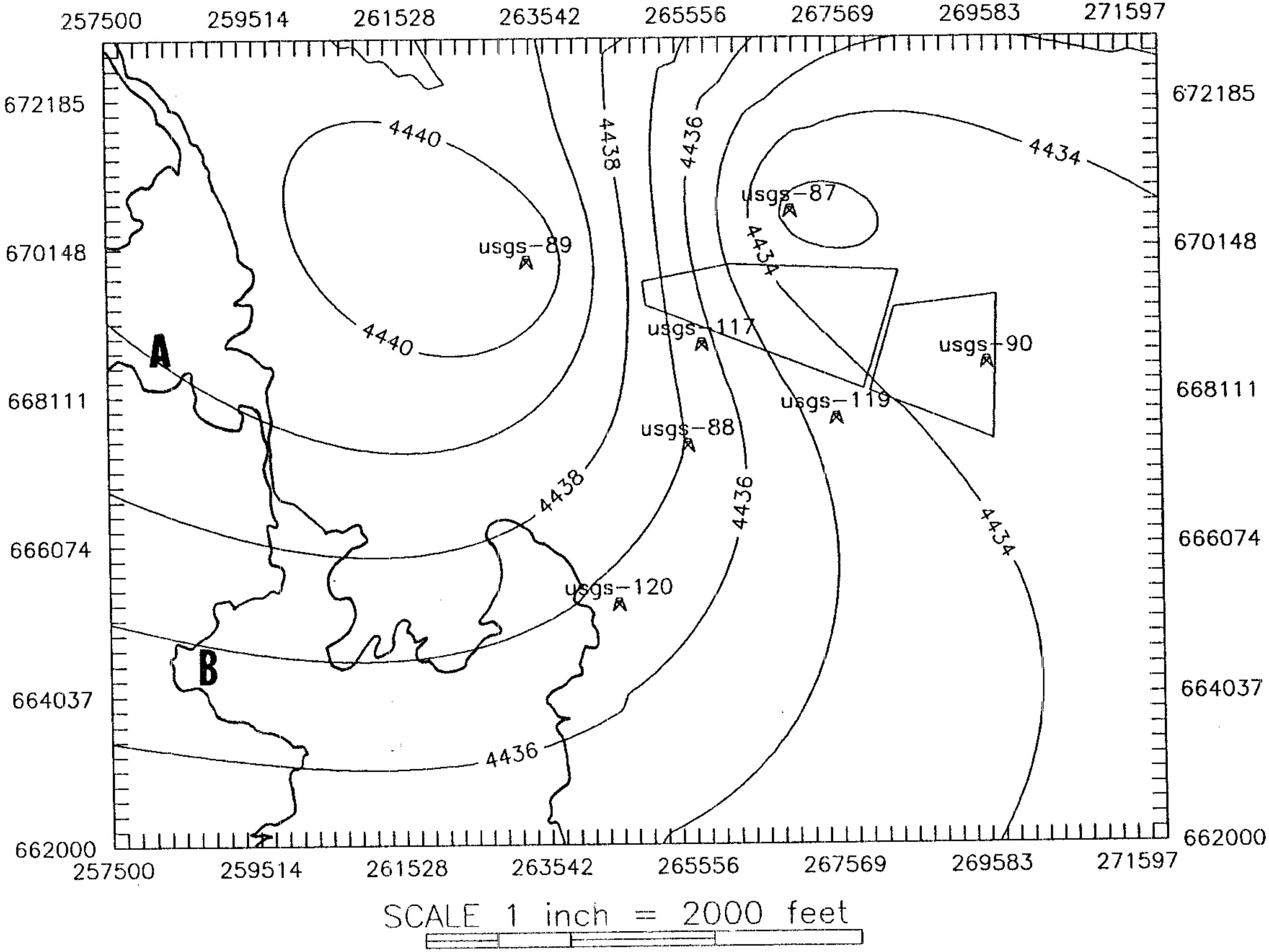


RWMC Water Table Map - 4th quarter 1983 w/o USGS 88

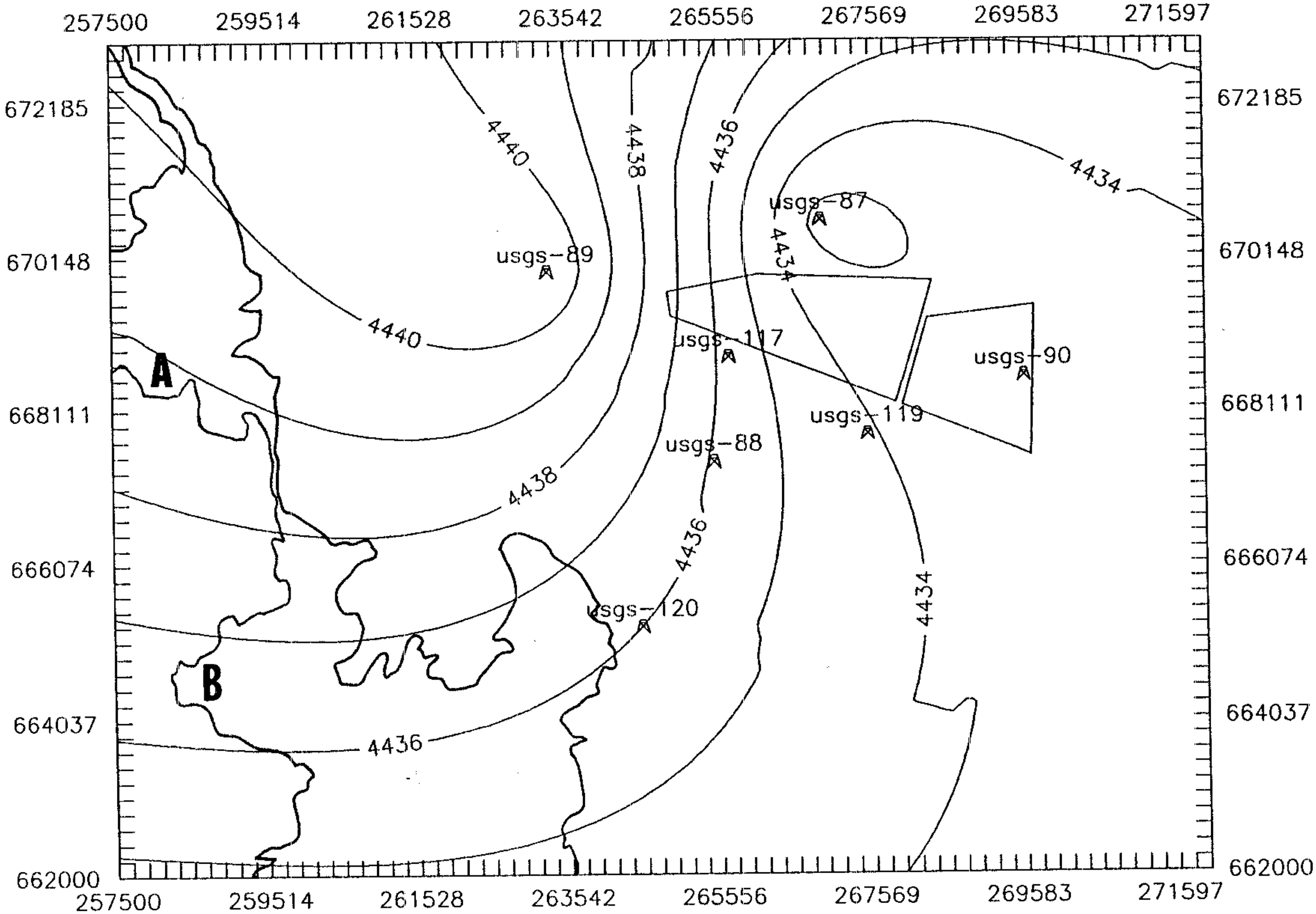


C-45

RWMC Water Table Map – 3rd quarter 1983

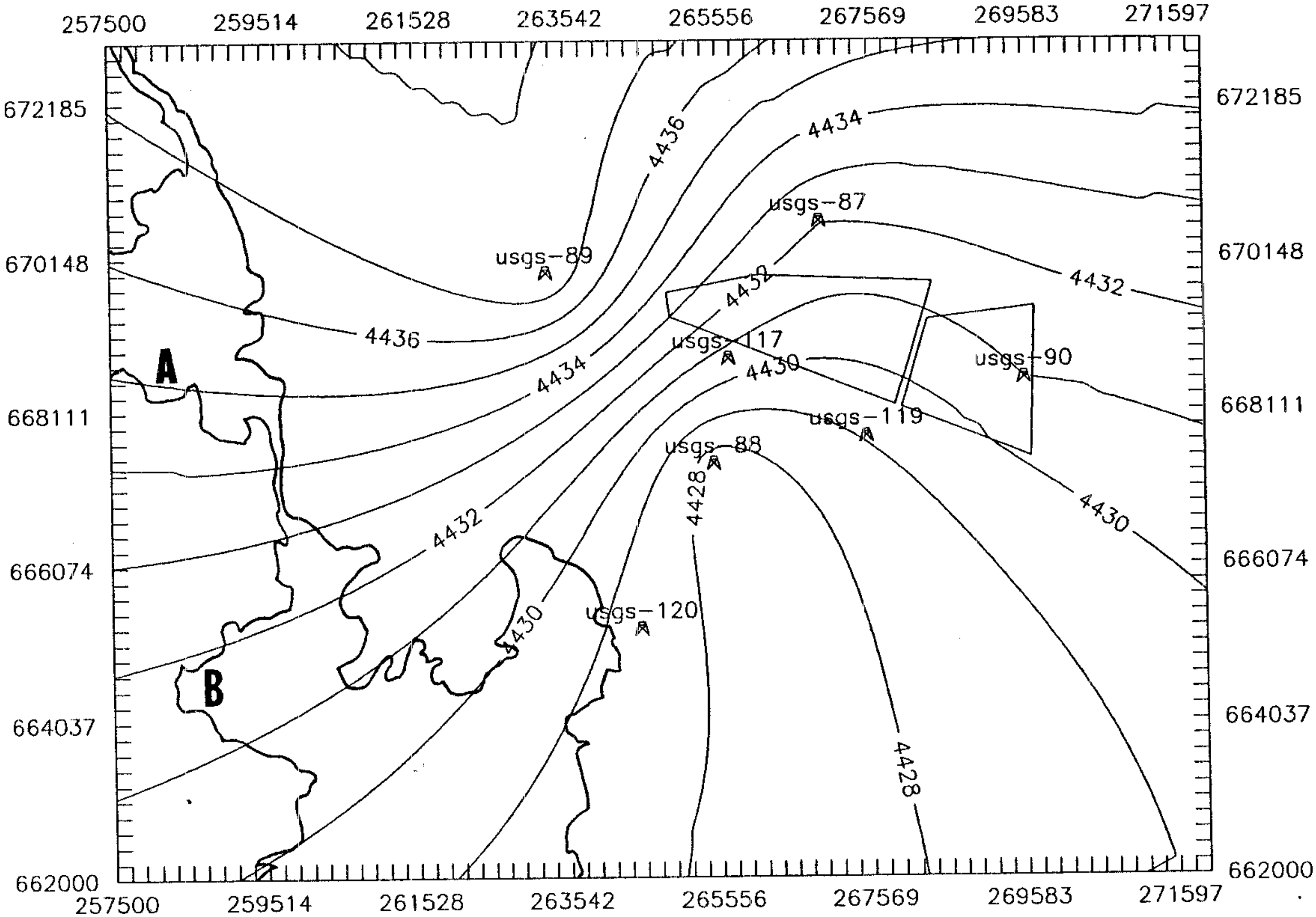


RWMC Water Table Map – 3rd quarter 1983 w/o USGS 88



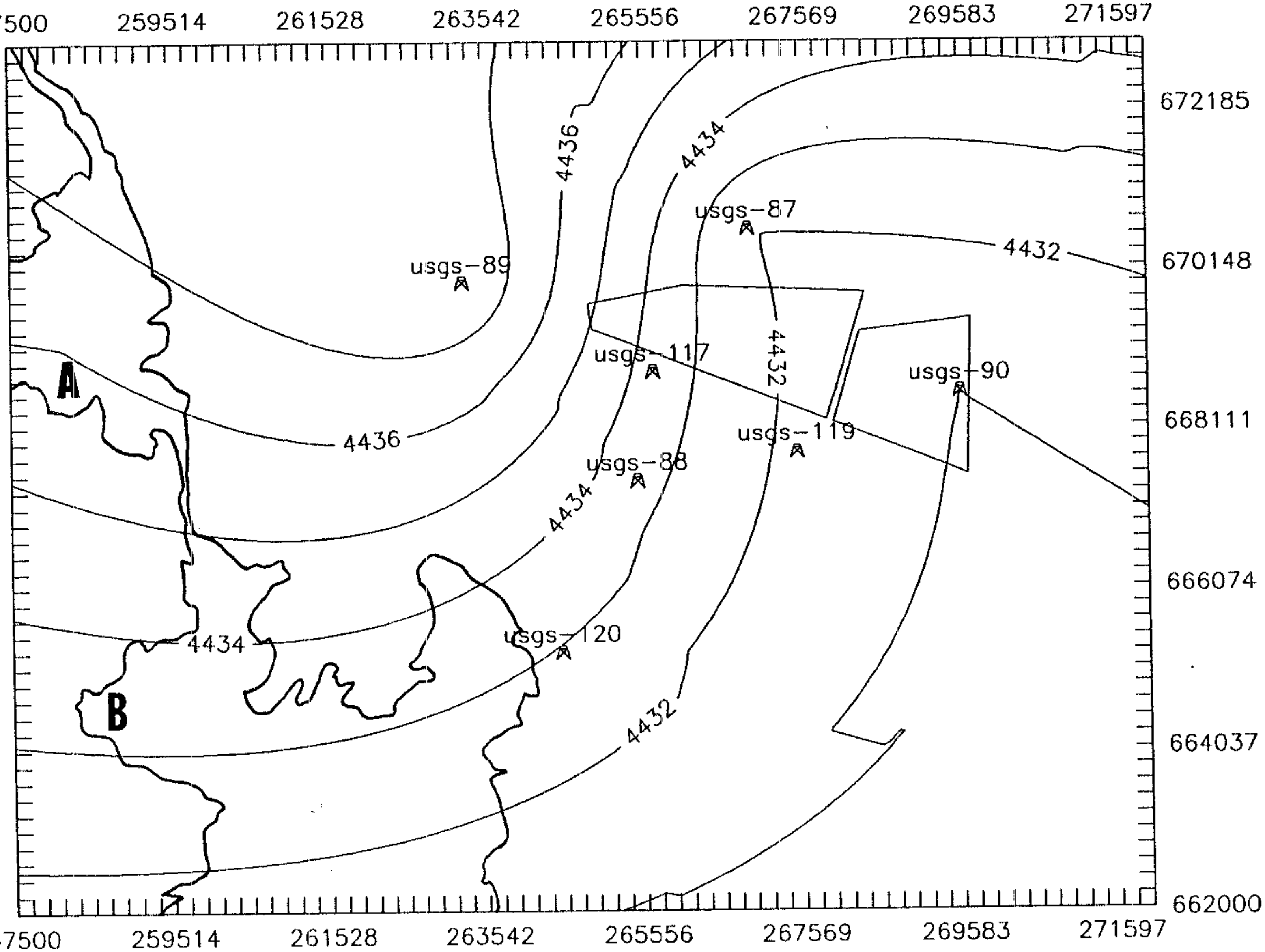
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 2nd quarter 1983



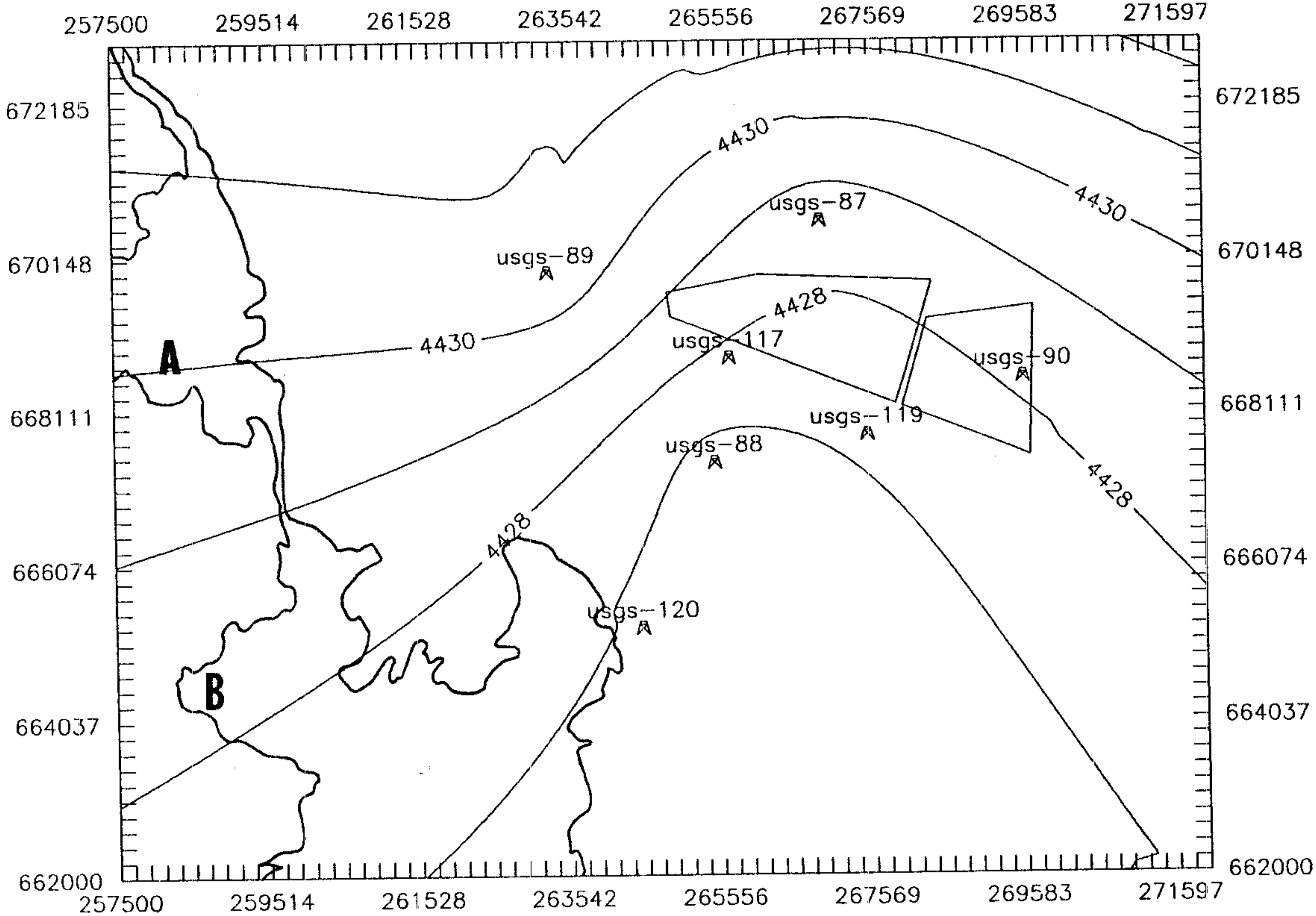
SCALE 1 inch = 2000 feet

RWMC Water Table Map - 2nd quarter 1983 w/o USGS 88



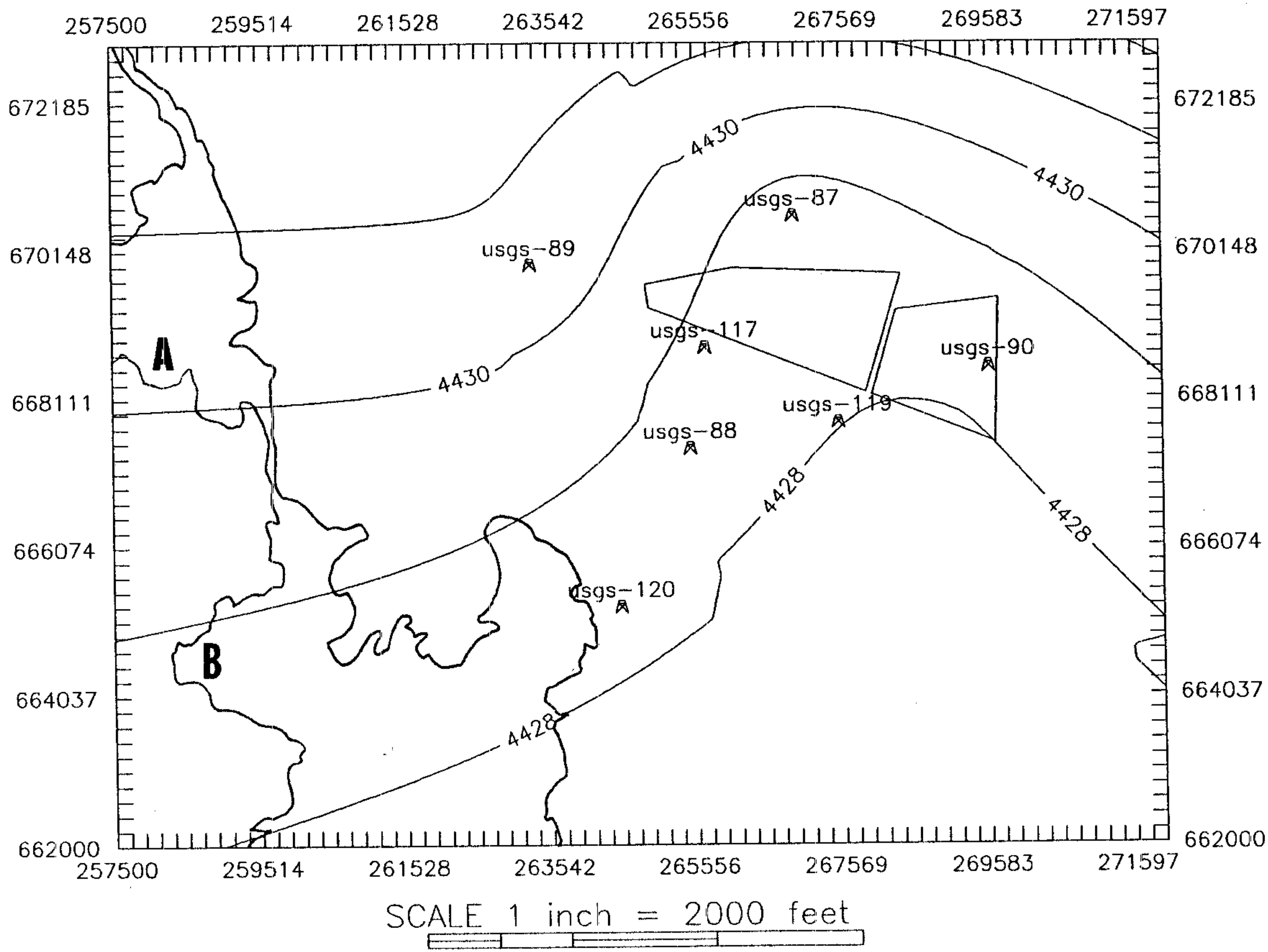
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 1st quarter 1983

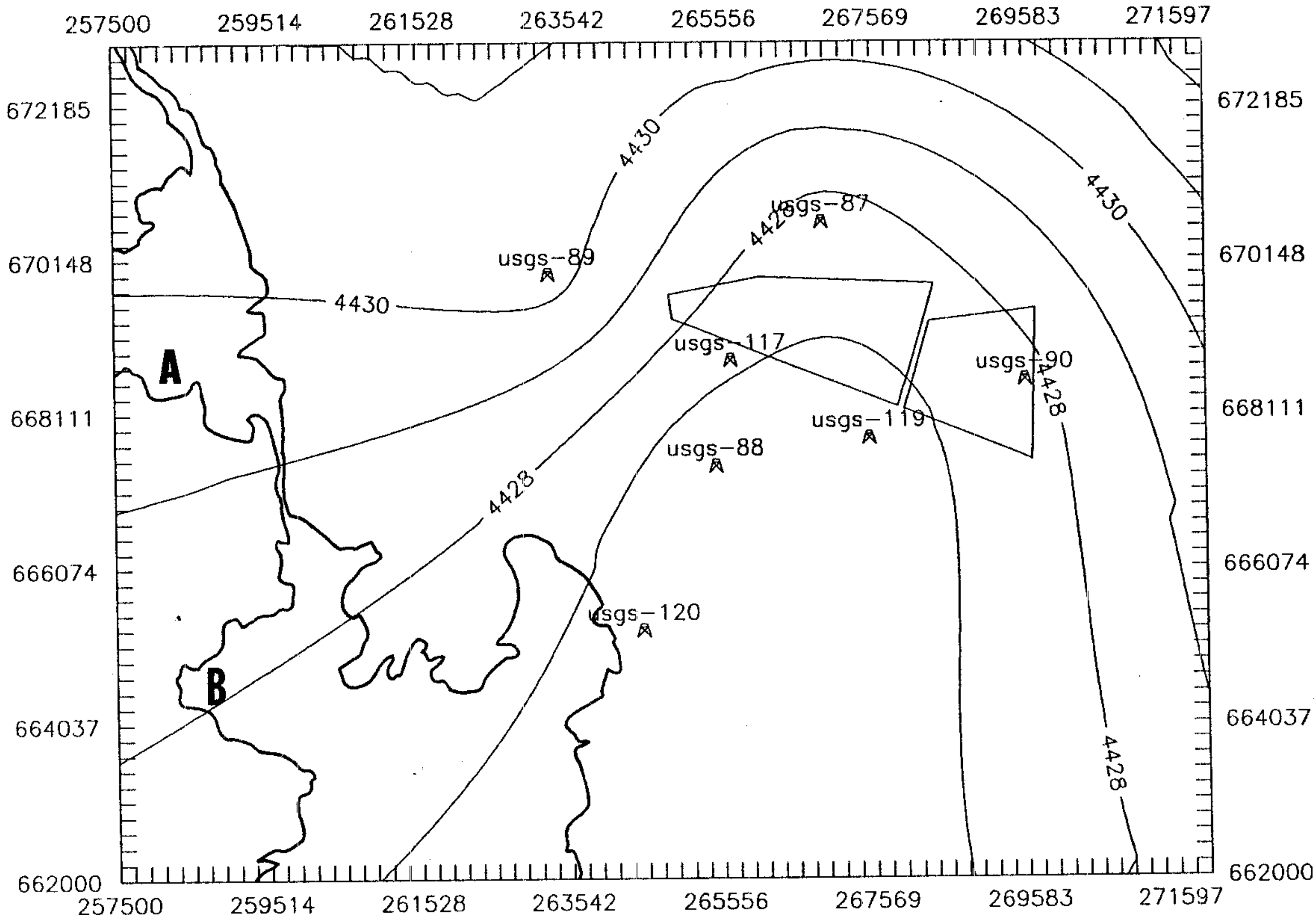


SCALE 1 inch = 2000 feet

RWMC Water Table Map – 1st quarter 1983 w/o USGS 88

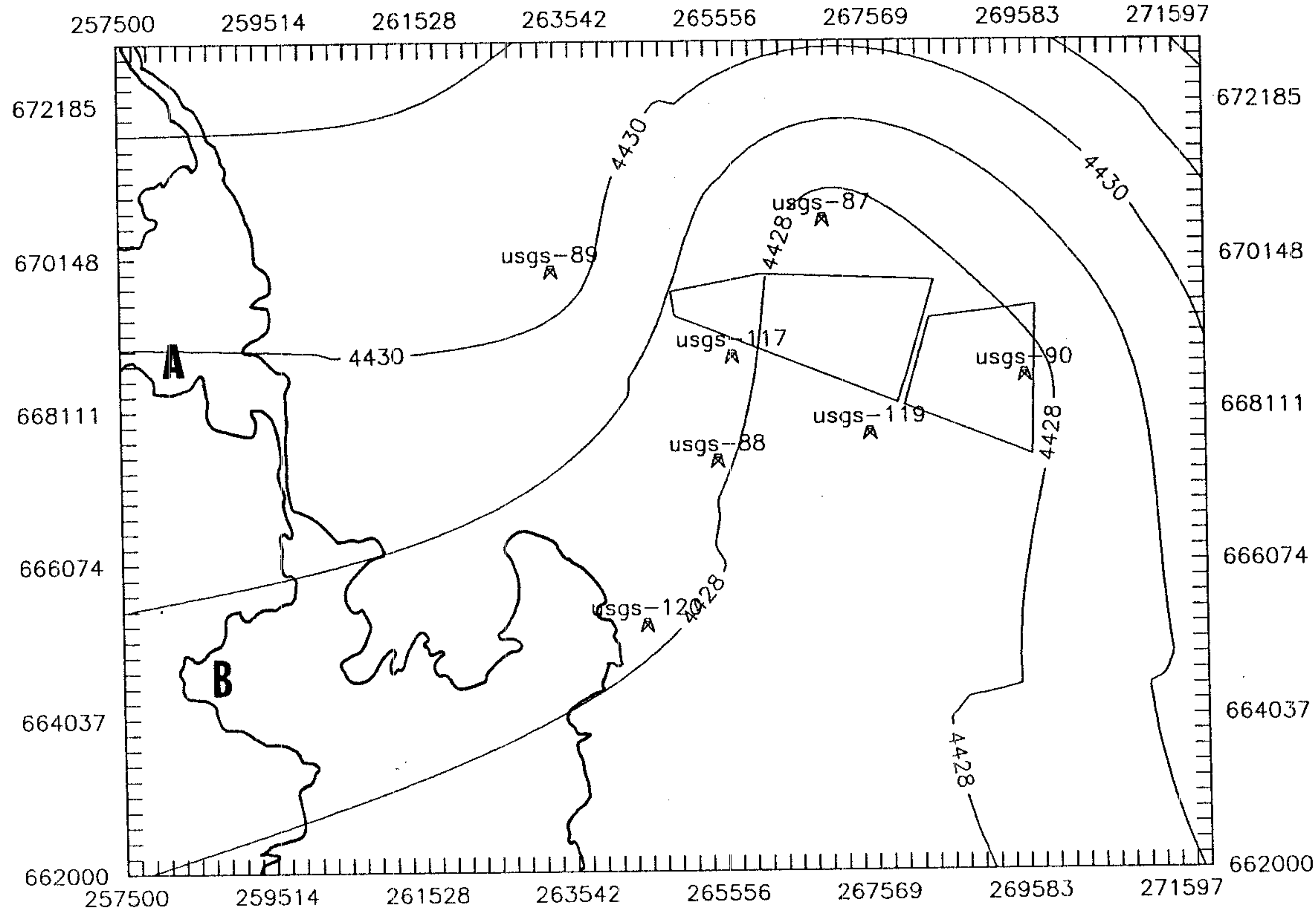


RWMC Water Table Map – 4th quarter 1982



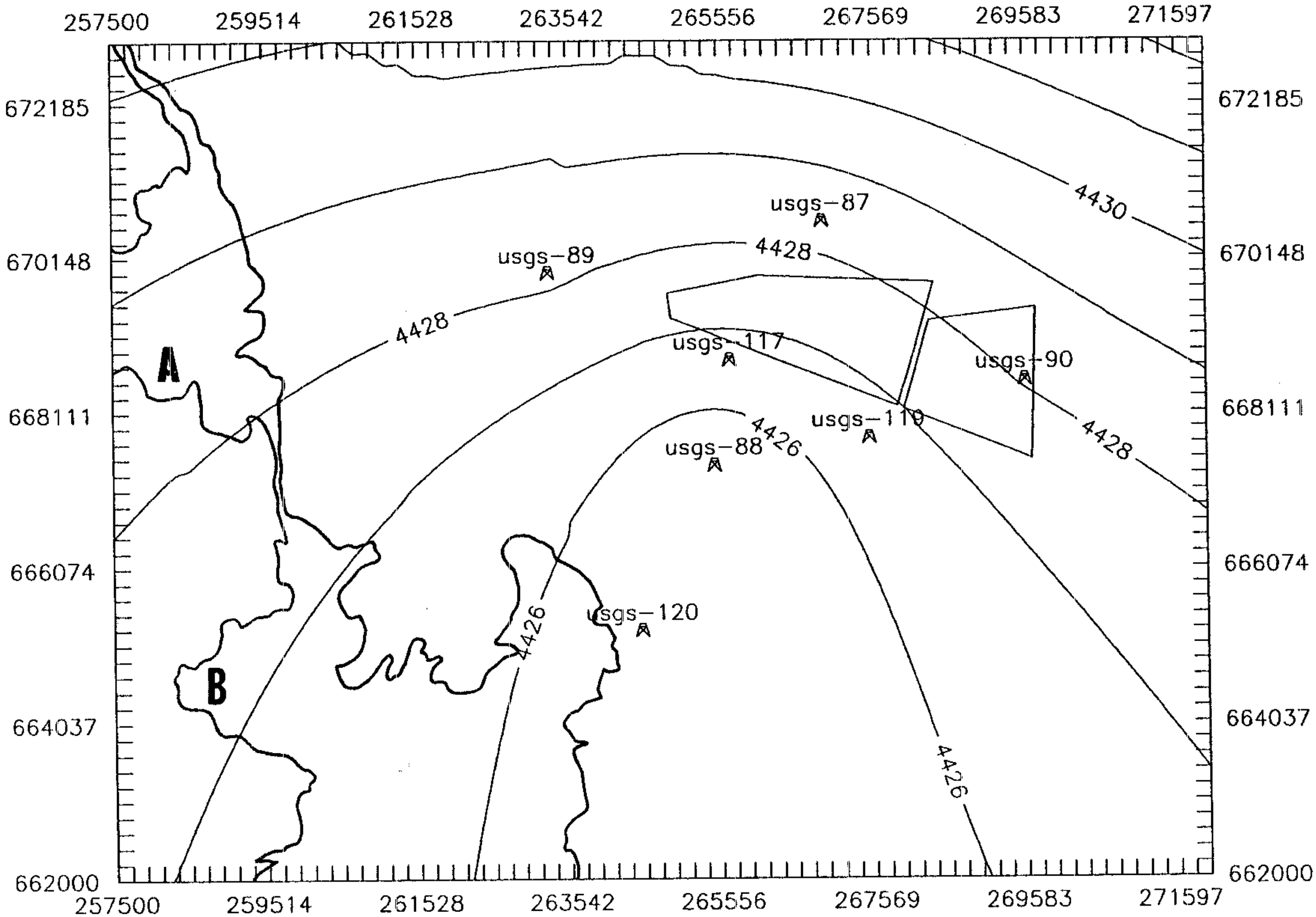
SCALE 1 inch = 2000 feet

RWMC Water Table Map - 4th quarter 1982 w/o USGS 88



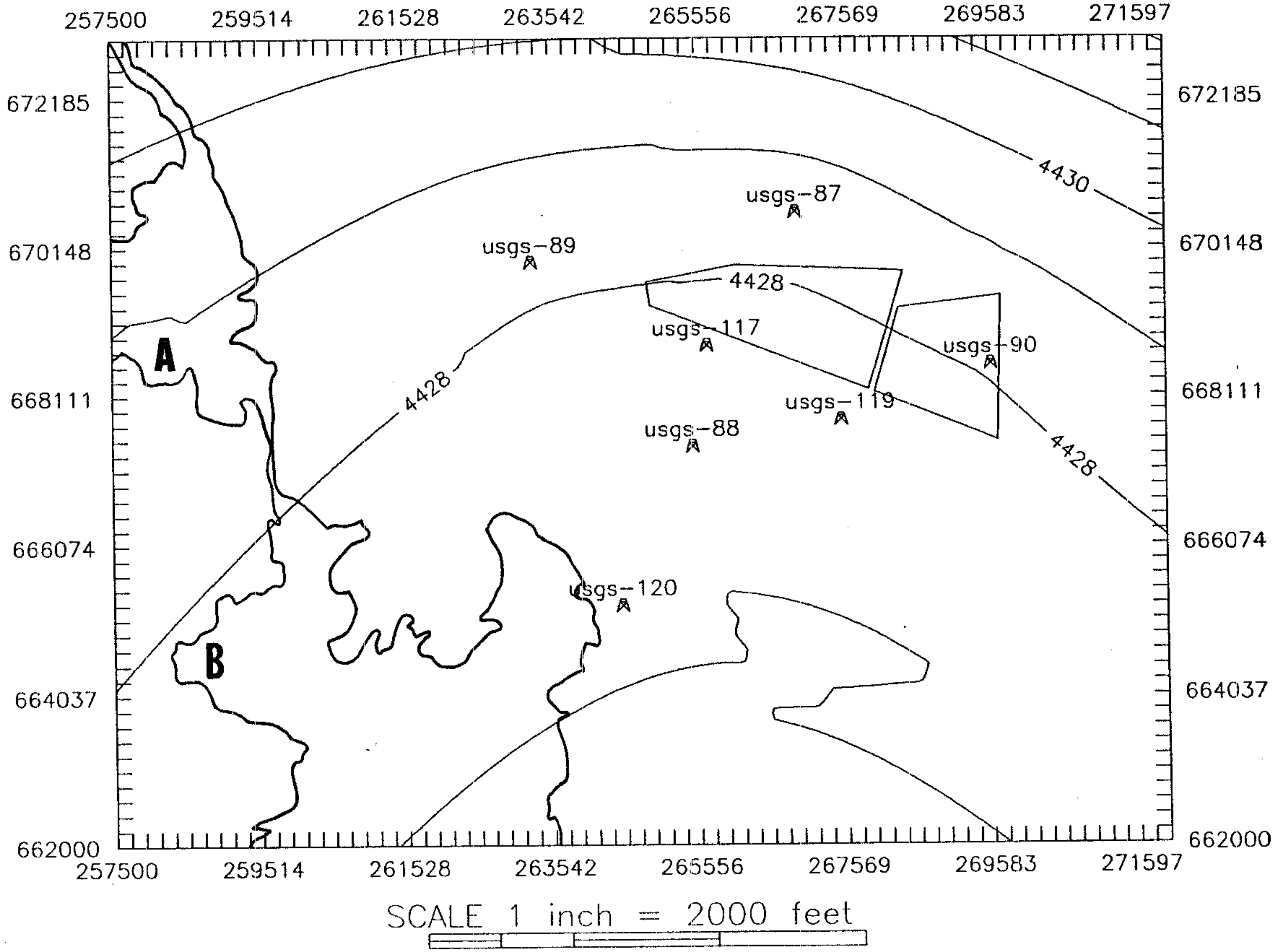
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 3rd quarter 1982

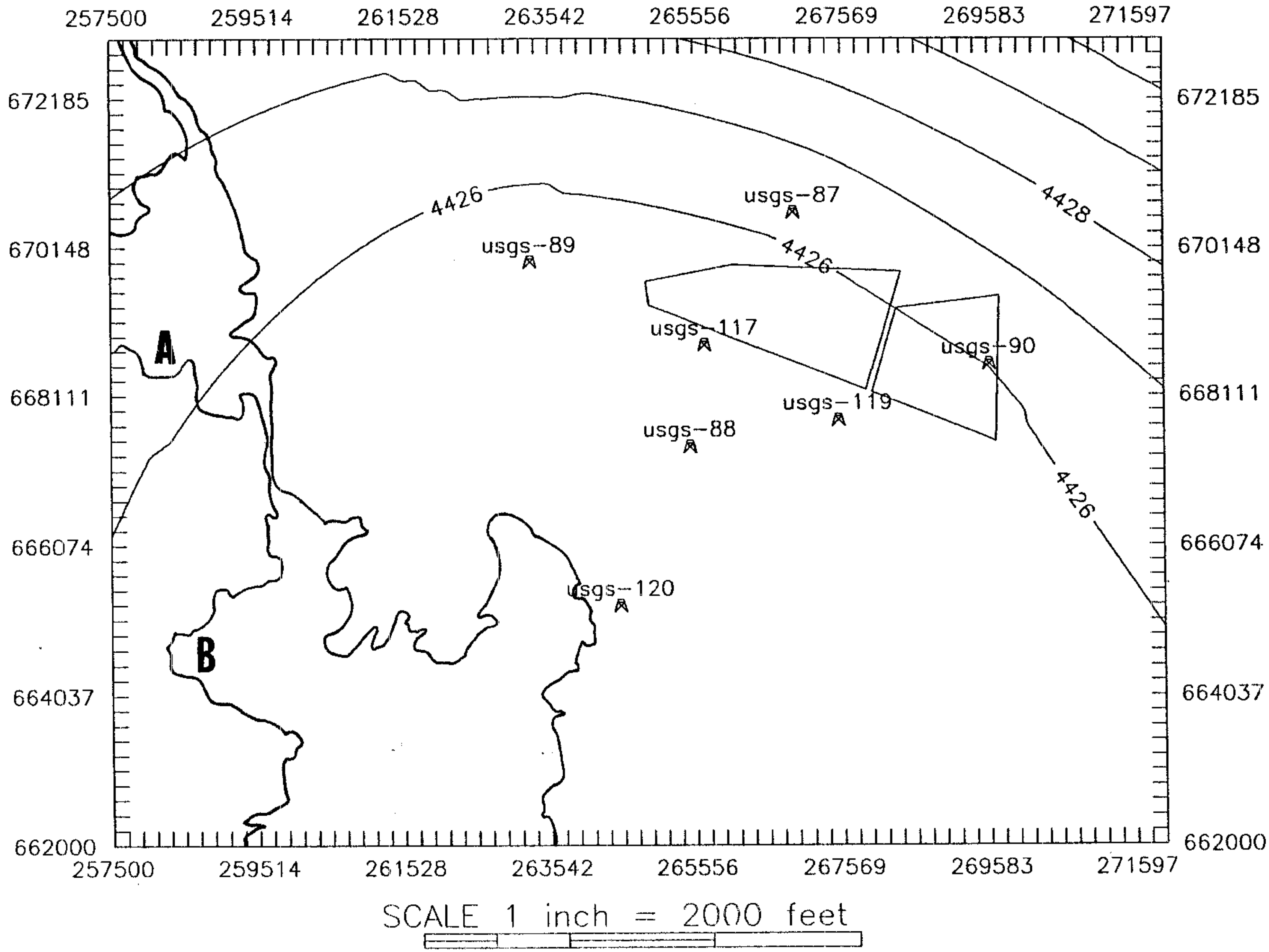


SCALE 1 inch = 2000 feet

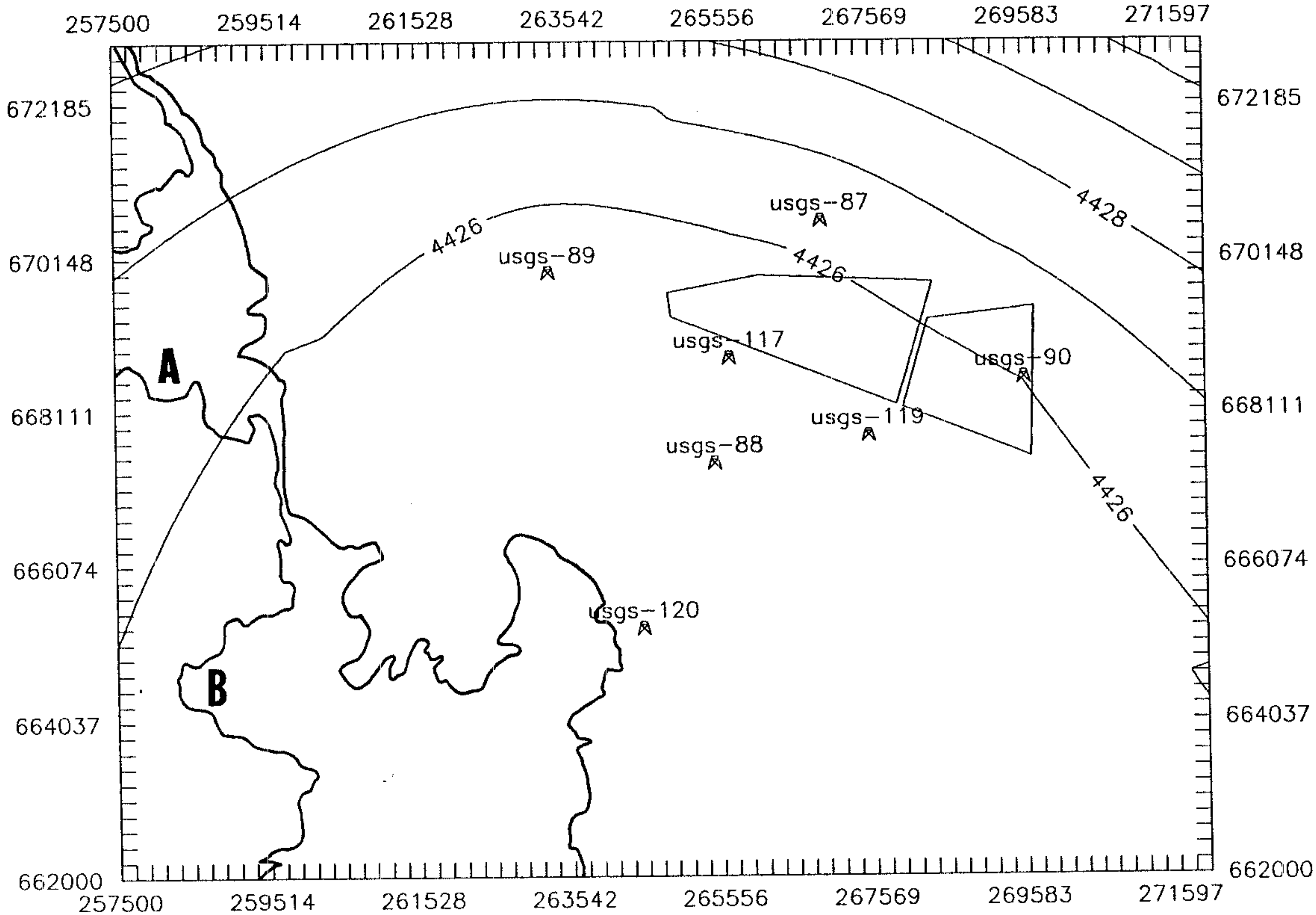
RWMC Water Table Map - 3rd quarter 1982 w/o USGS 88



RWMC Water Table Map — 2nd quarter 1982

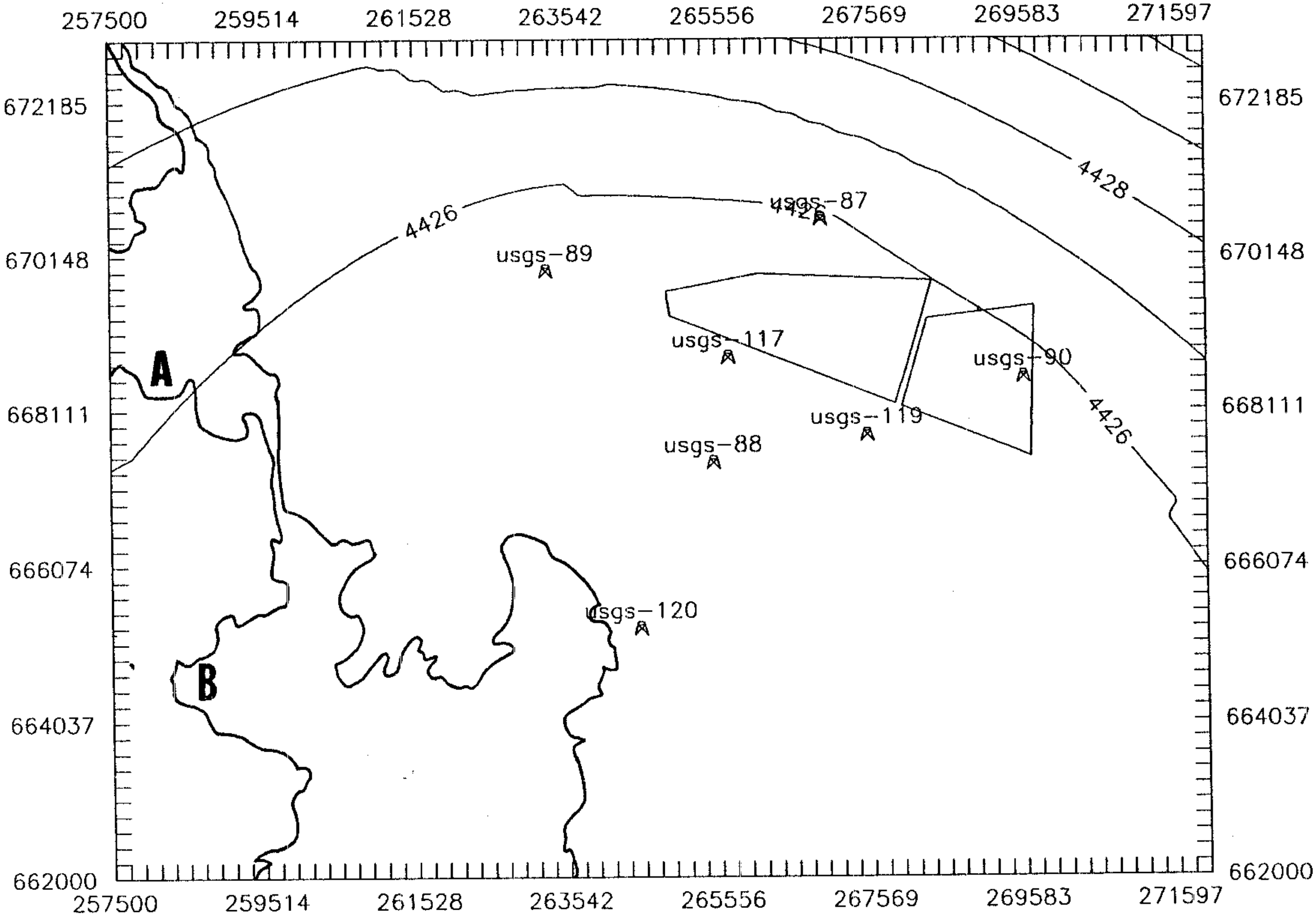


RWMC Water Table Map - 2nd quarter 1982 w/o USGS 88



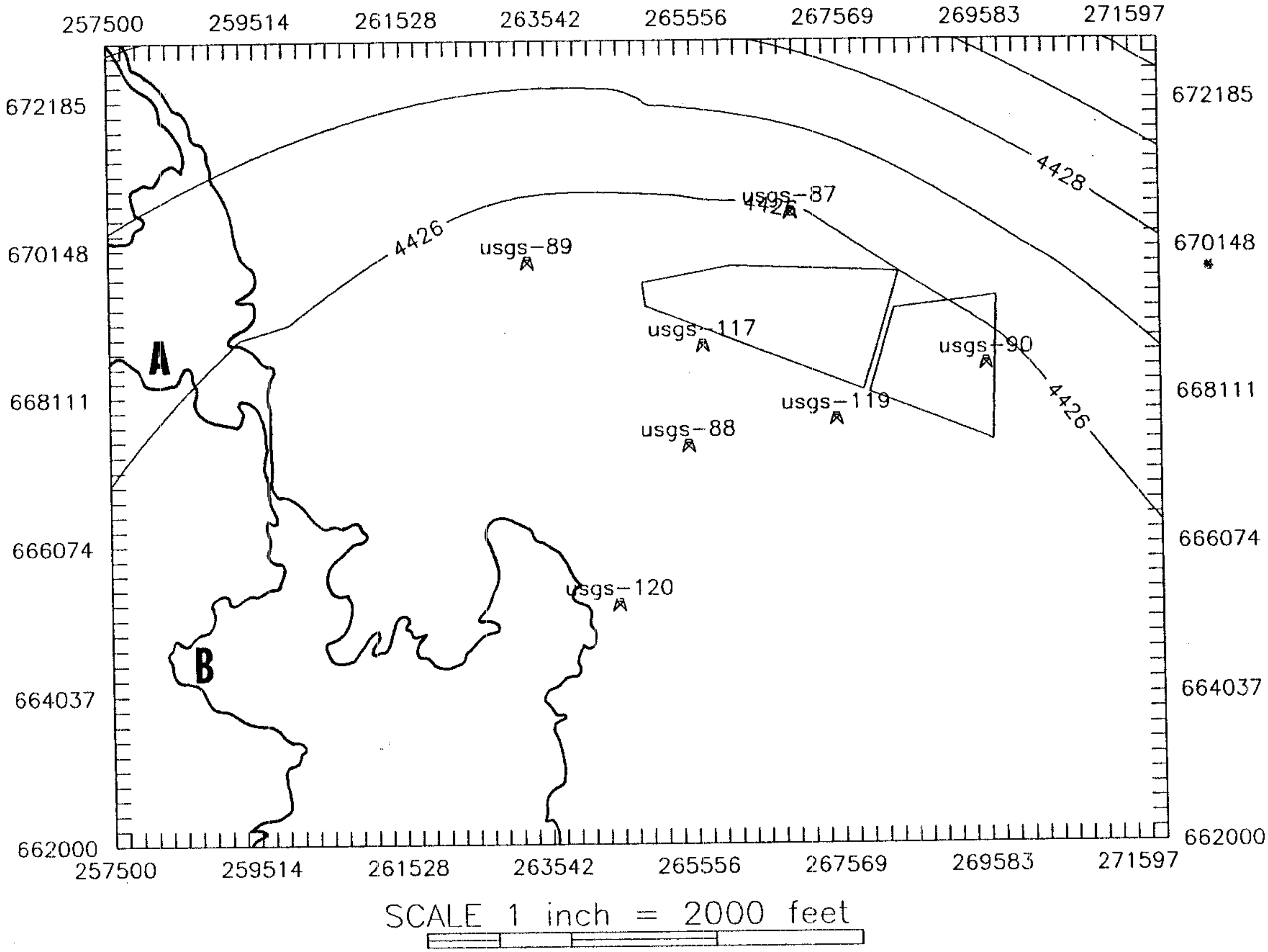
SCALE 1 inch = 2000 feet

RWMC Water Table Map – 1st quarter 1982



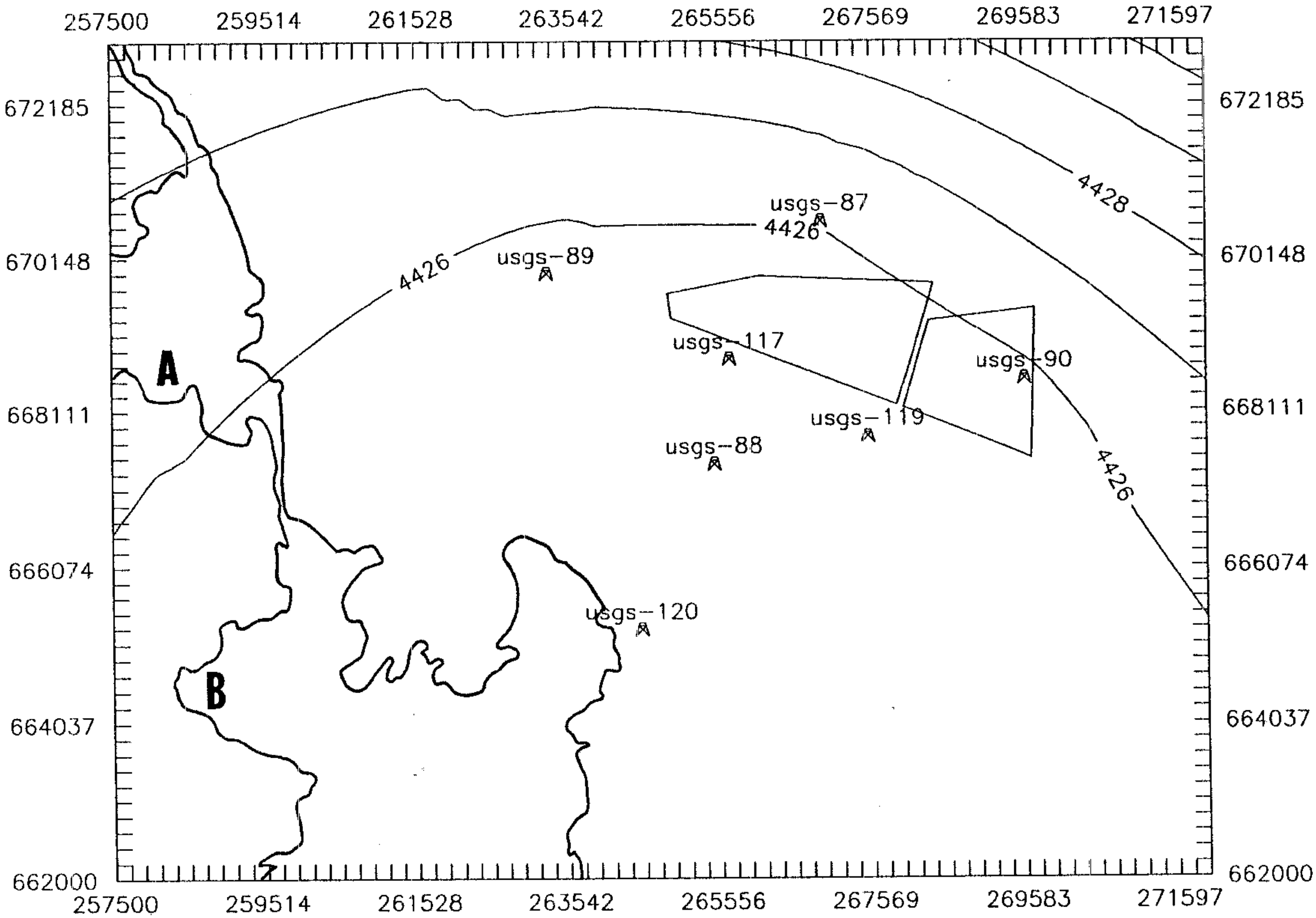
SCALE 1 inch = 2000 feet

RWMC Water Table Map -- 1st quarter 1982 w/o USGS 88



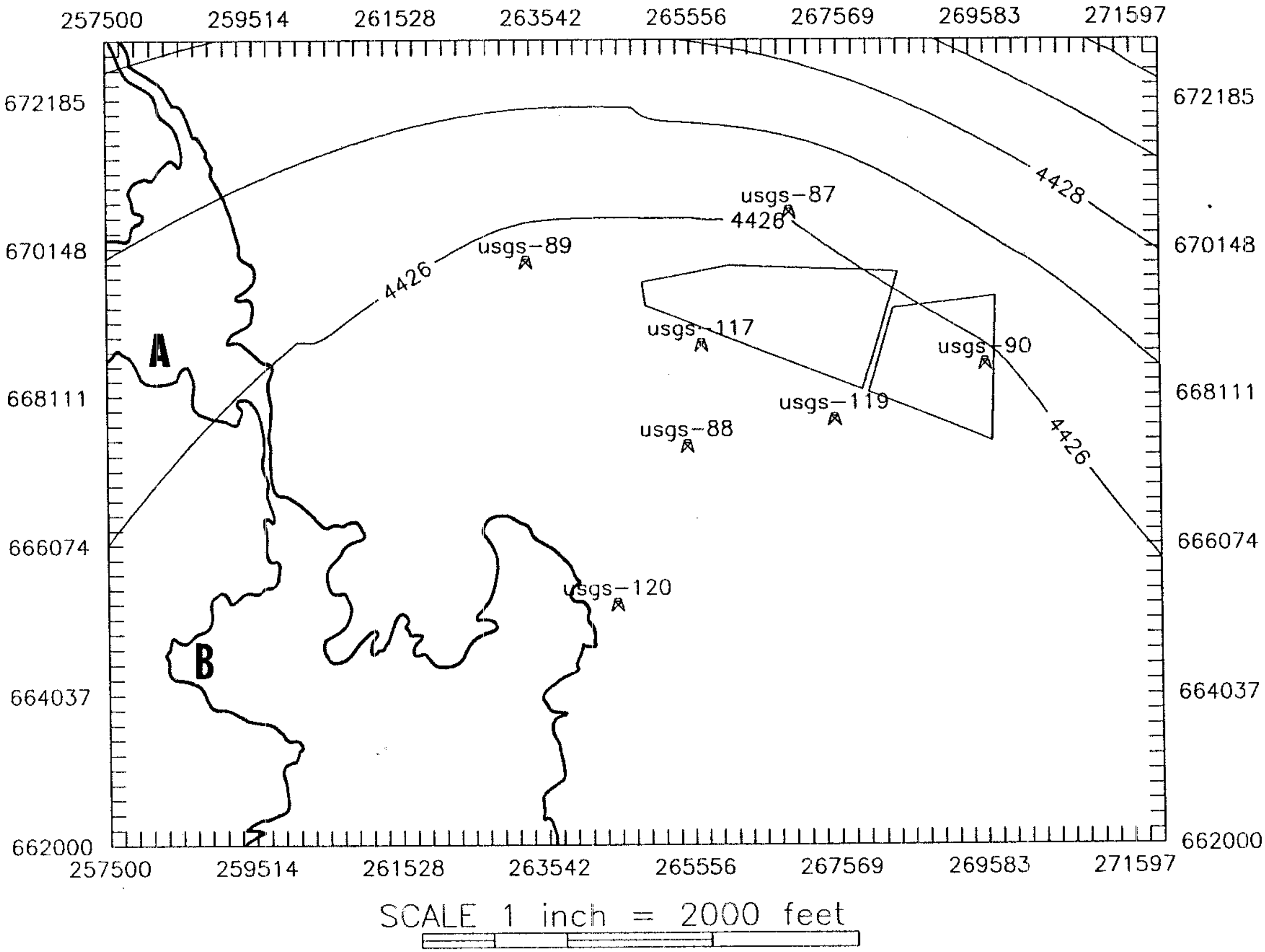
C-59

RWMC Water Table Map — 4th quarter 1981

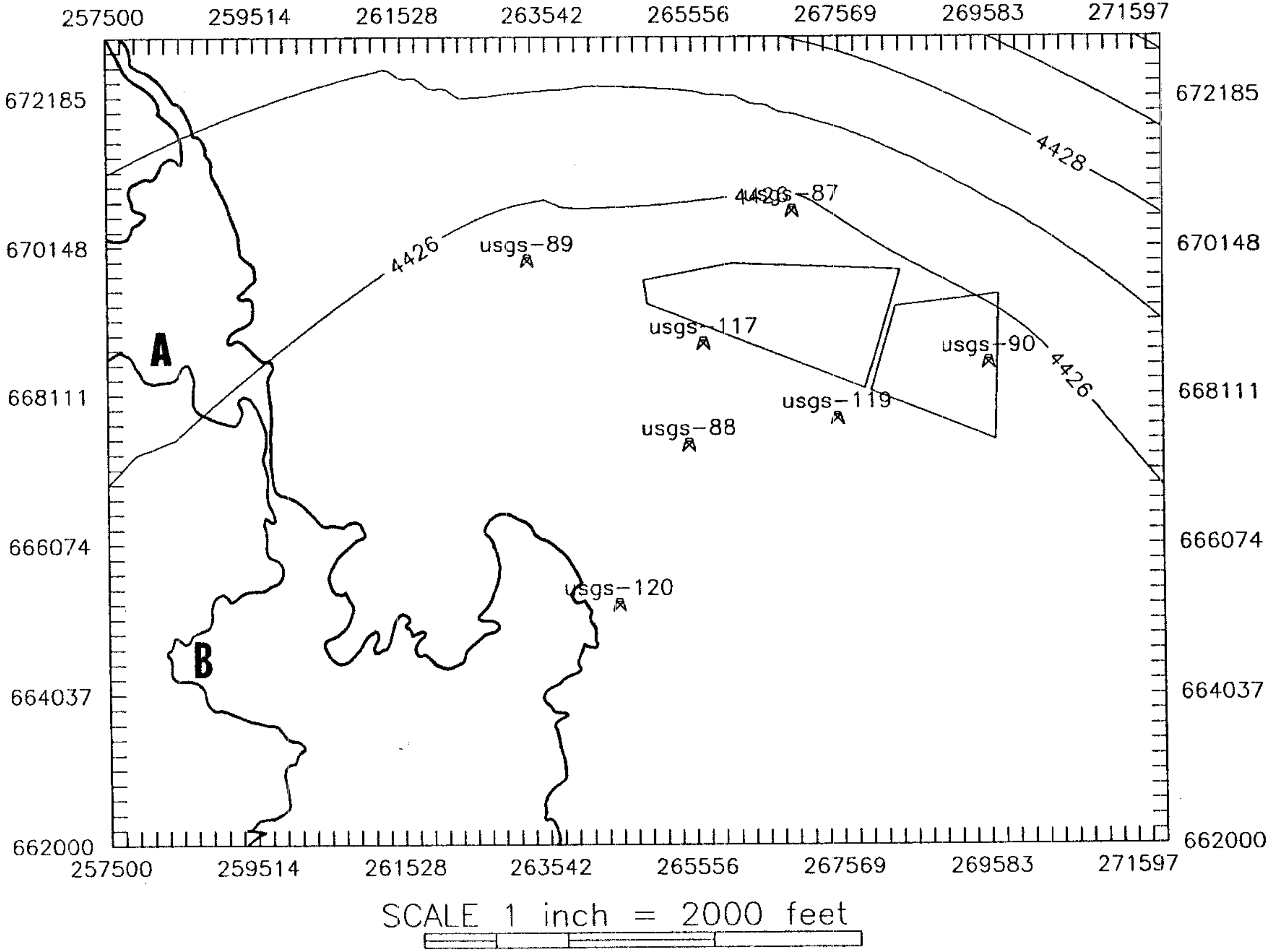


SCALE 1 inch = 2000 feet

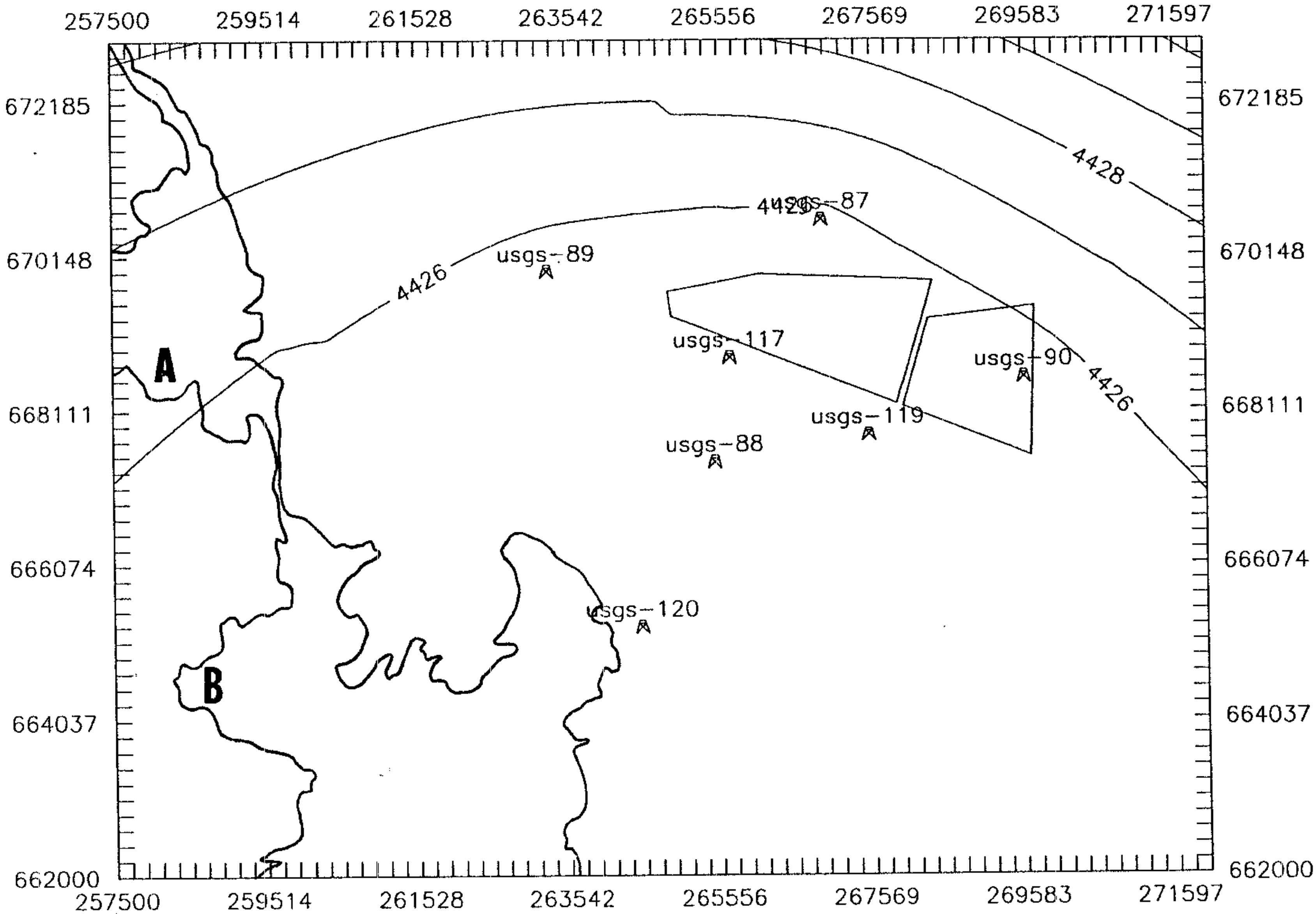
RWMC Water Table Map -- 4th quarter 1981 w/o USGS 88



RWMC Water Table Map – 3rd quarter 1981

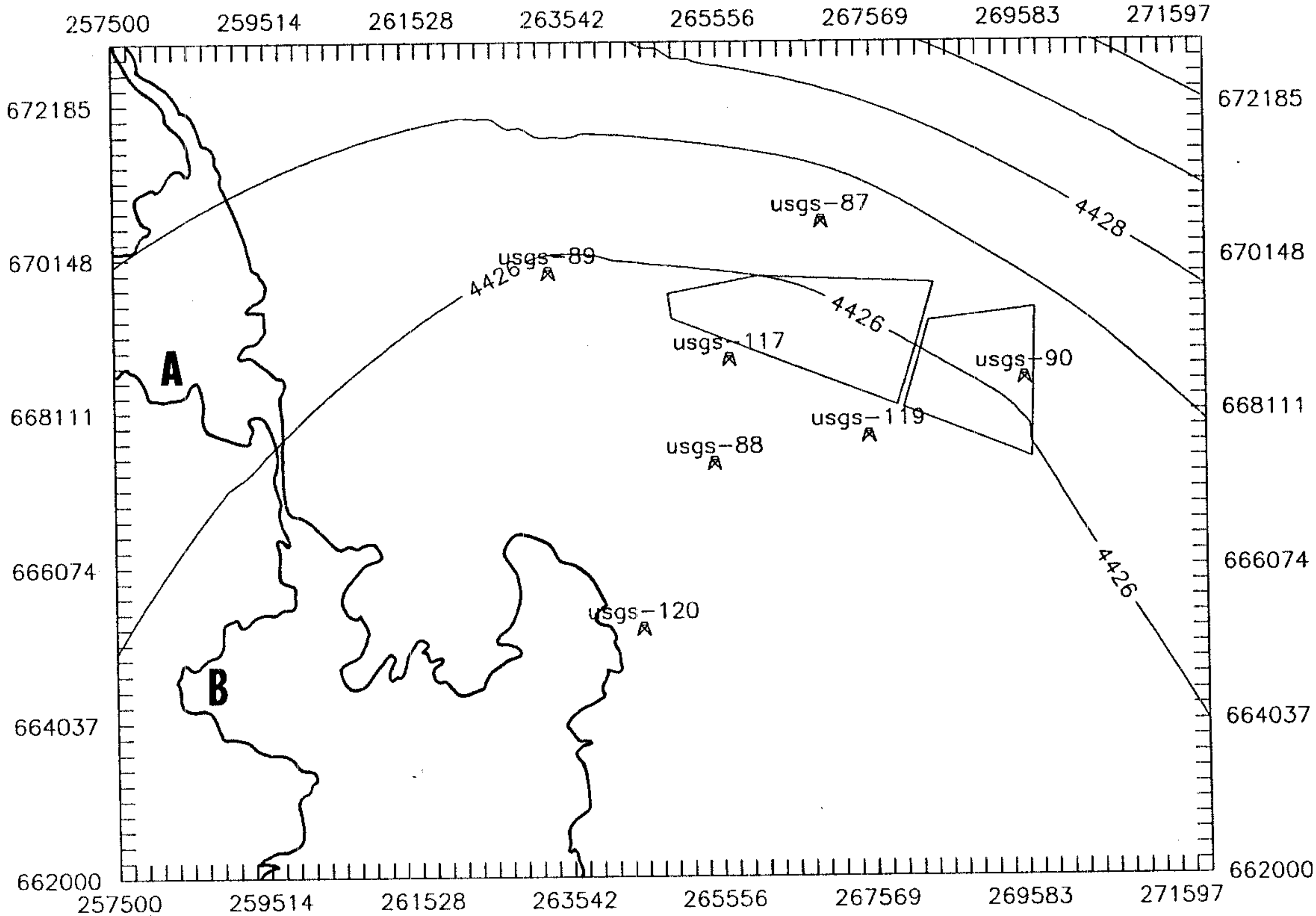


RWMC Water Table Map – 3rd quarter 1981 w/o USGS 88



SCALE 1 inch = 2000 feet

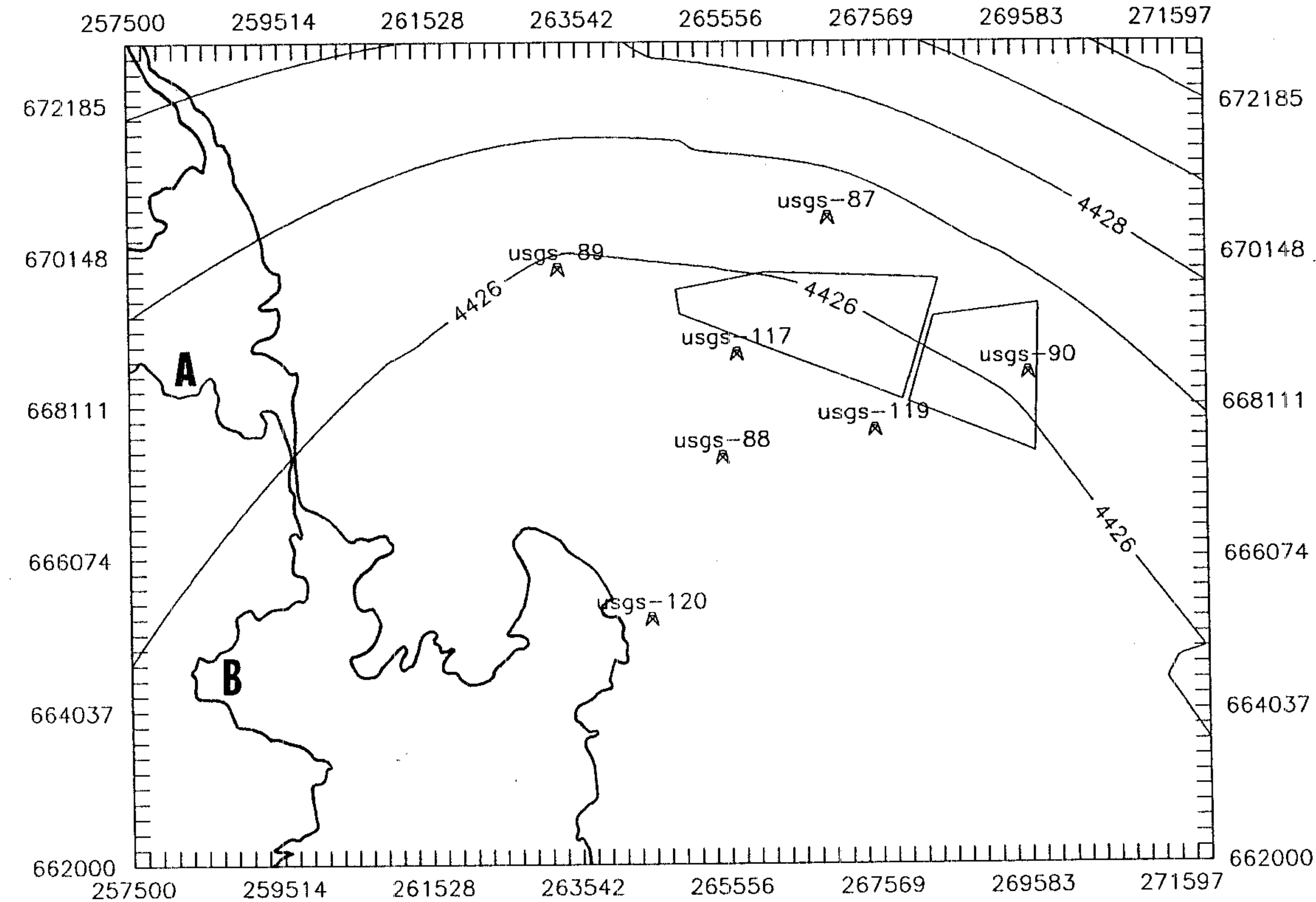
RWMC Water Table Map – 2nd quarter 1981



SCALE 1 inch = 2000 feet

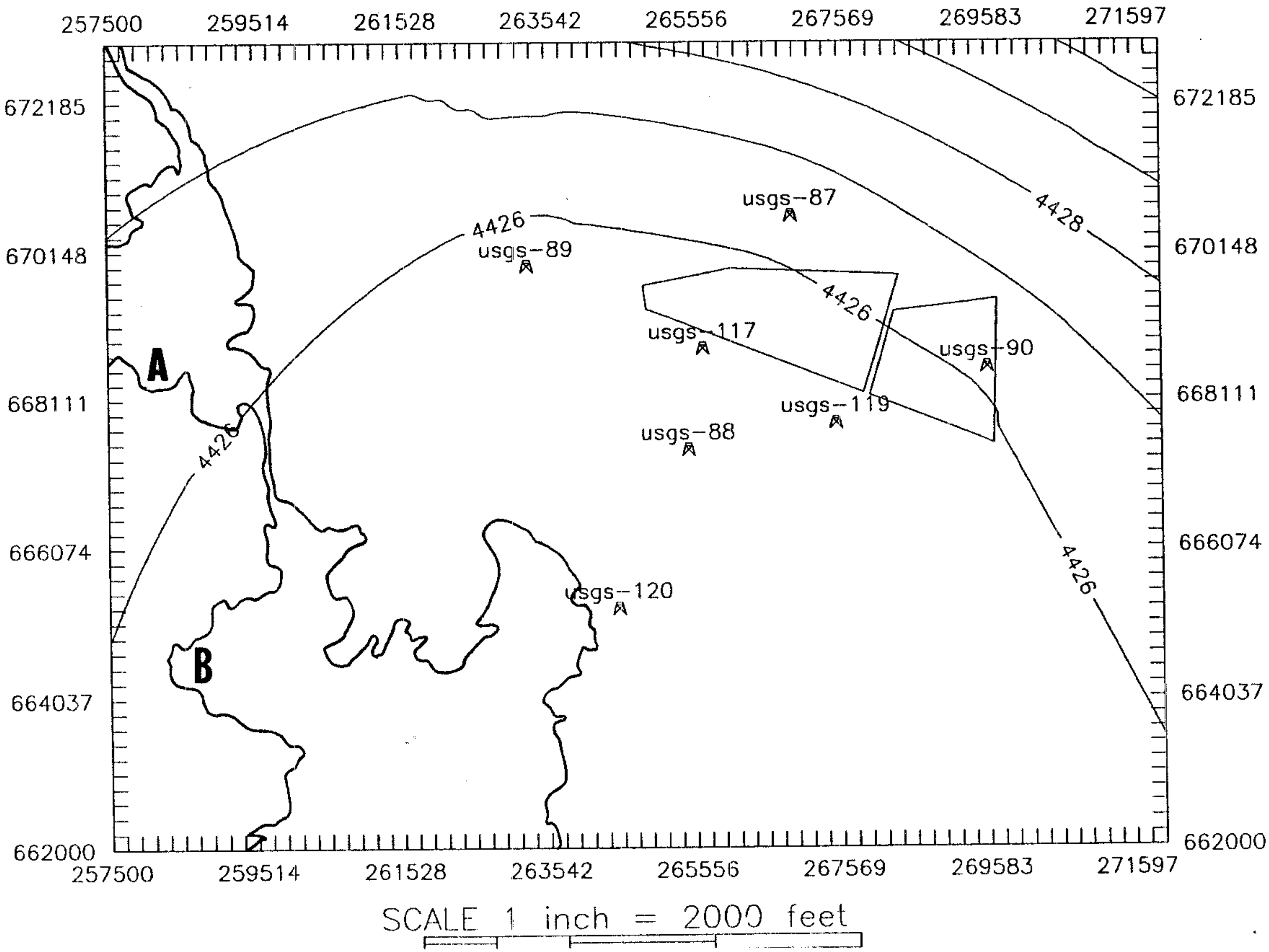
C-64

RWMC Water Table Map - 2nd quarter 1981 w/o USGS 88

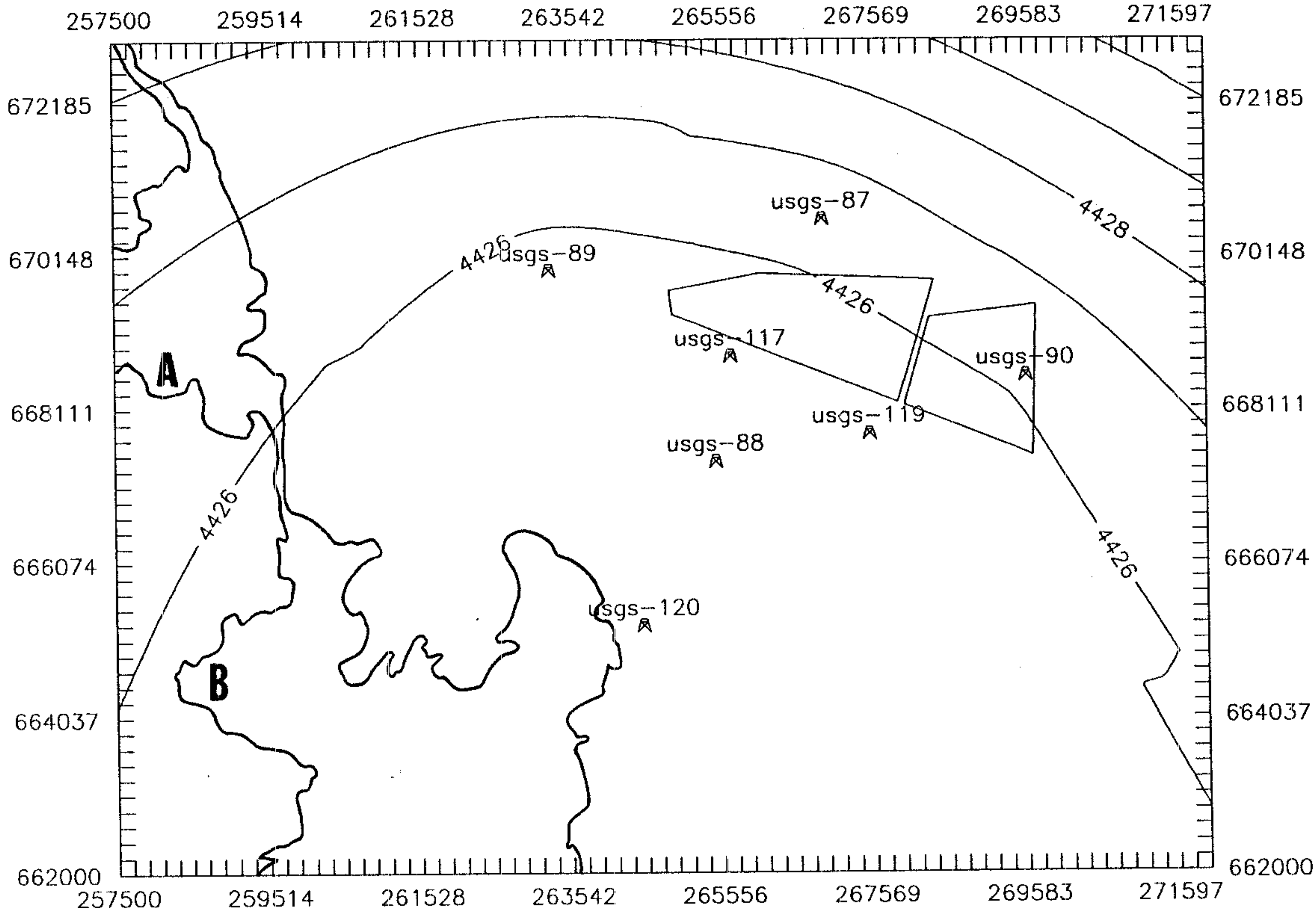


SCALE 1 inch = 2000 feet

RWMC Water Table Map - 1st quarter 1981

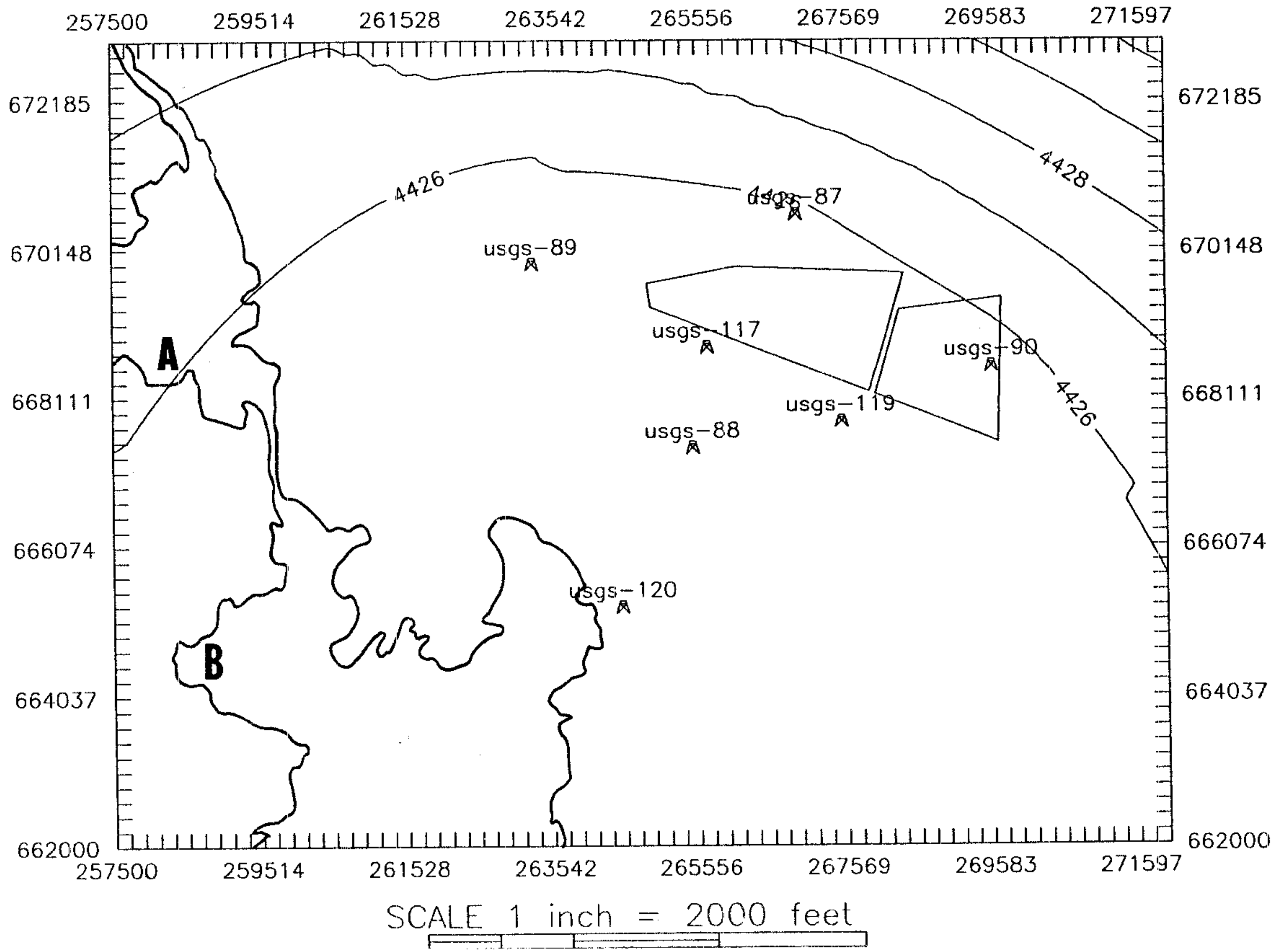


RWMC Water Table Map -- 1st quarter 1981 w/o USGS 88

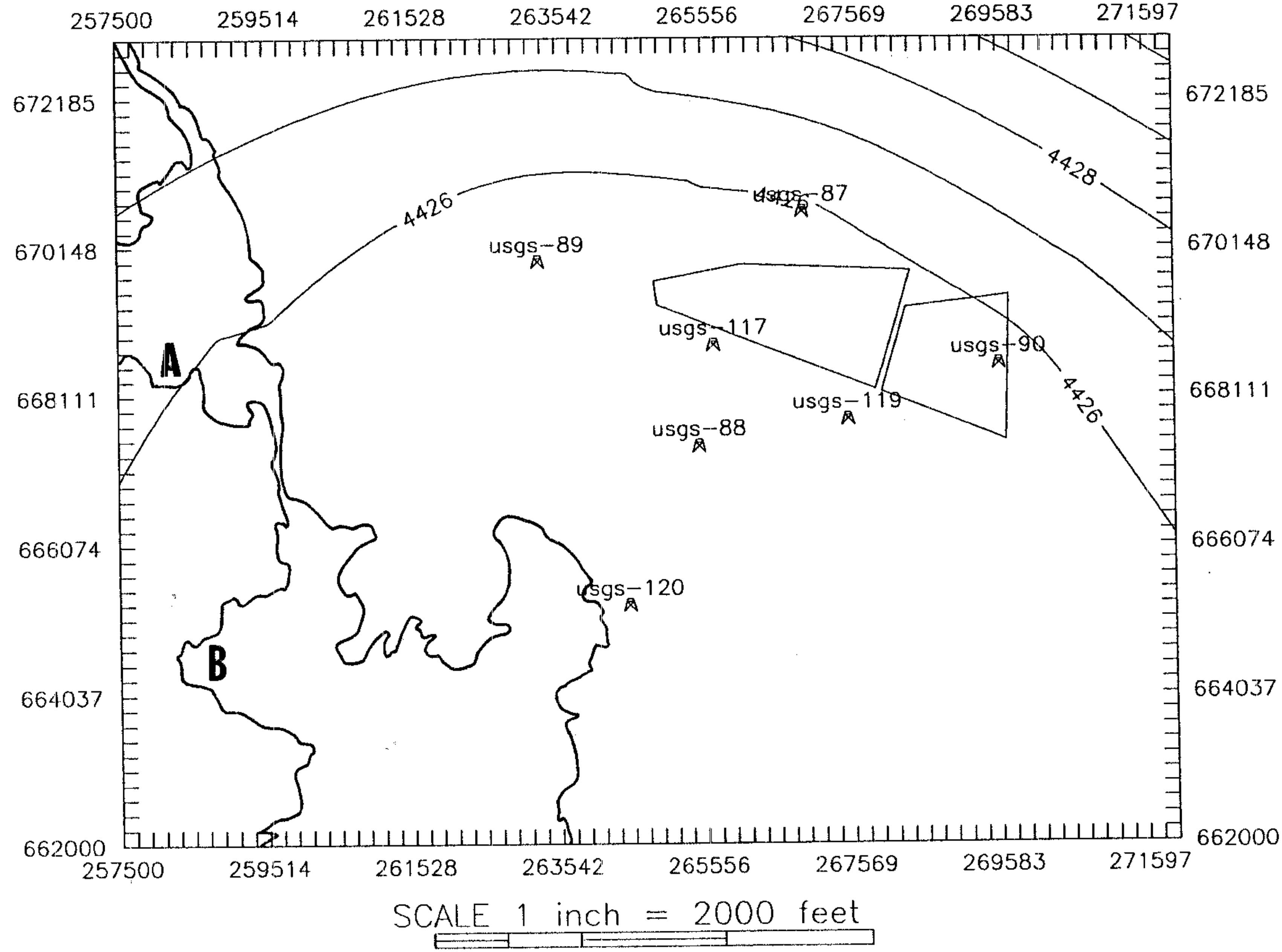


SCALE 1 inch = 2000 feet

RWMC Water Table Map — 4th quarter 1980

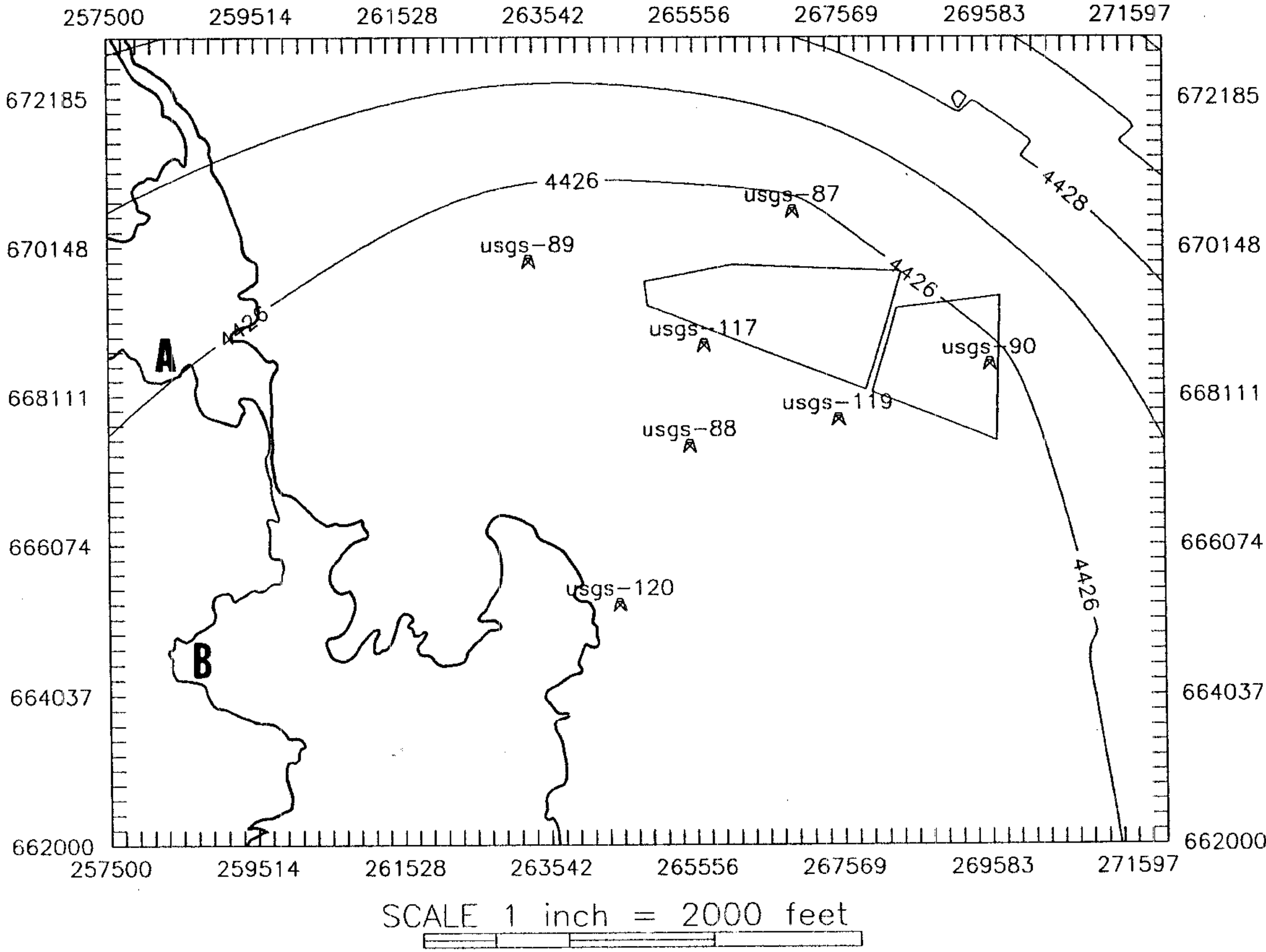


RWMC Water Table Map — 4th quarter 1980 w/o USGS 88

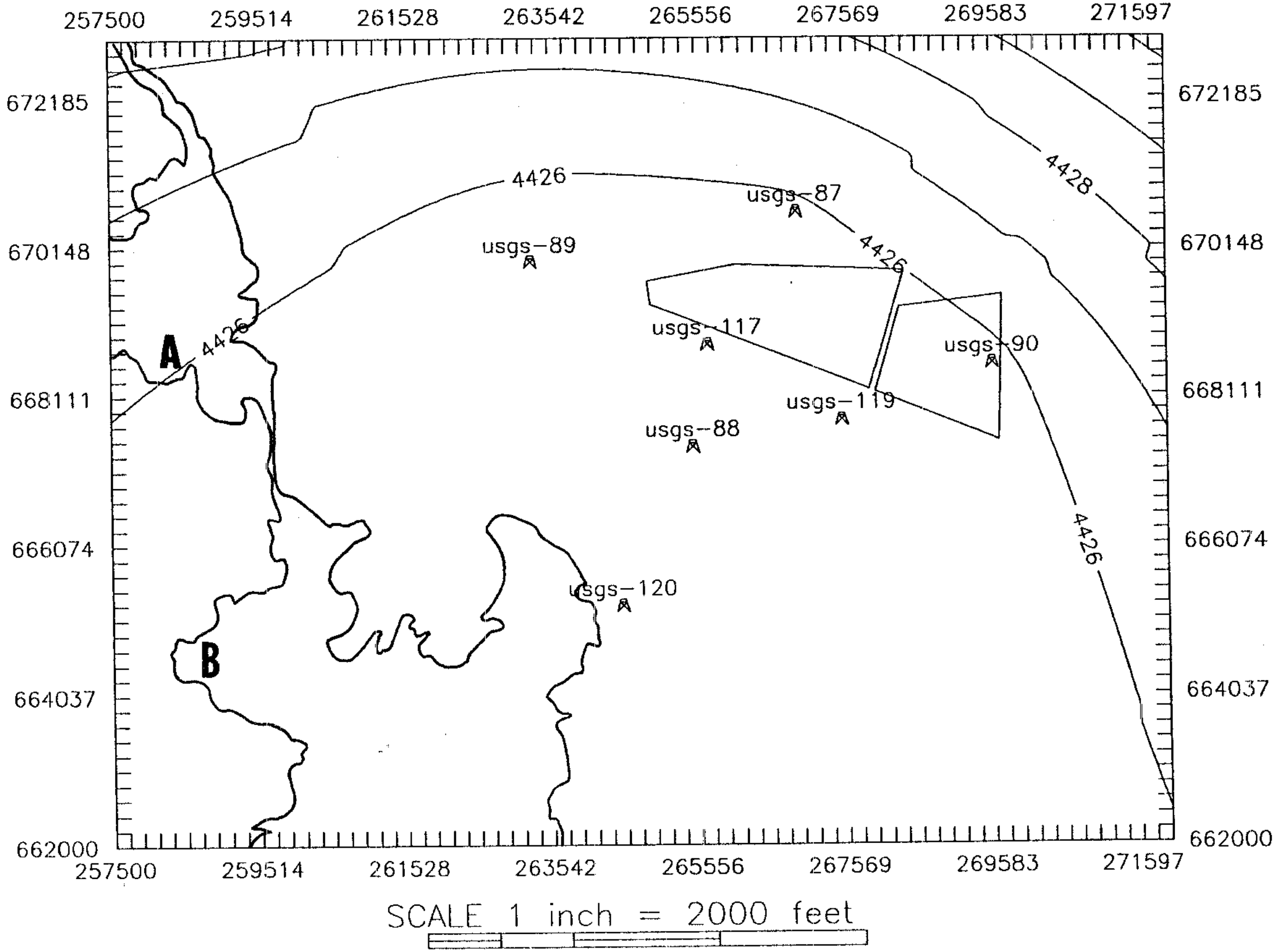


C-69

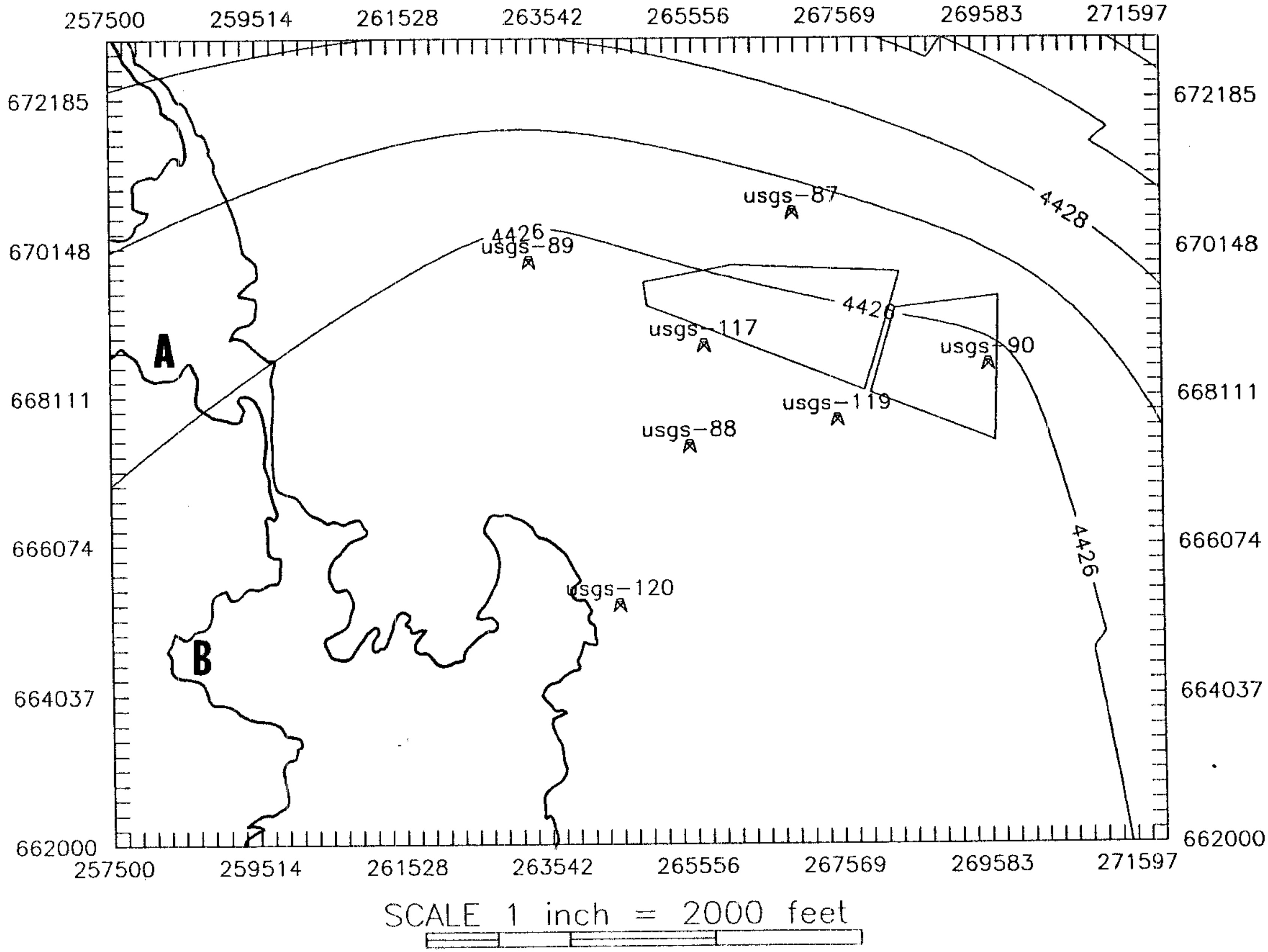
RWMC Water Table Map – 3rd quarter 1980



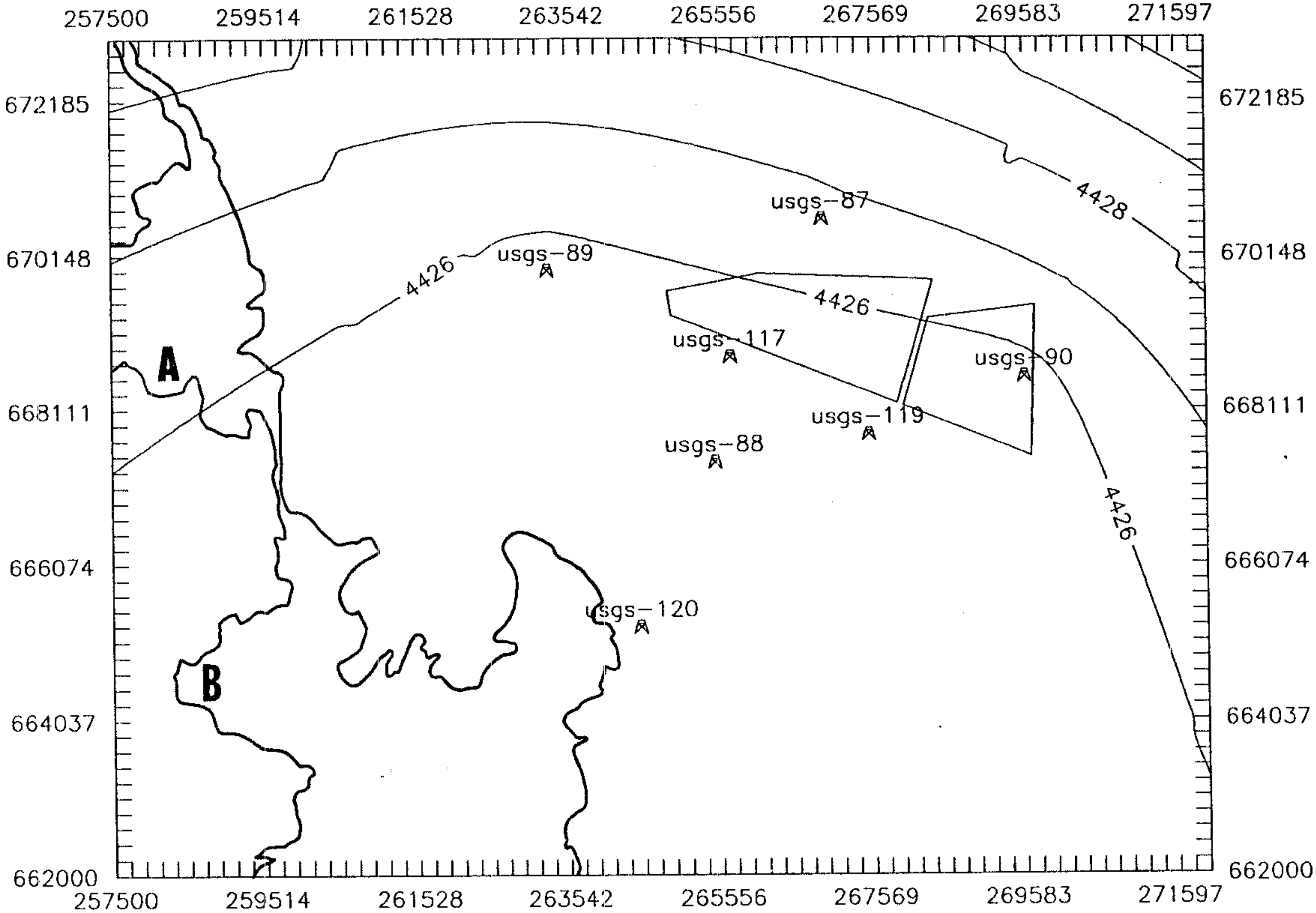
RWMC Water Table Map -- 3rd quarter 1980 w/o USGS 88



RWMC Water Table Map – 2nd–quarter 1980

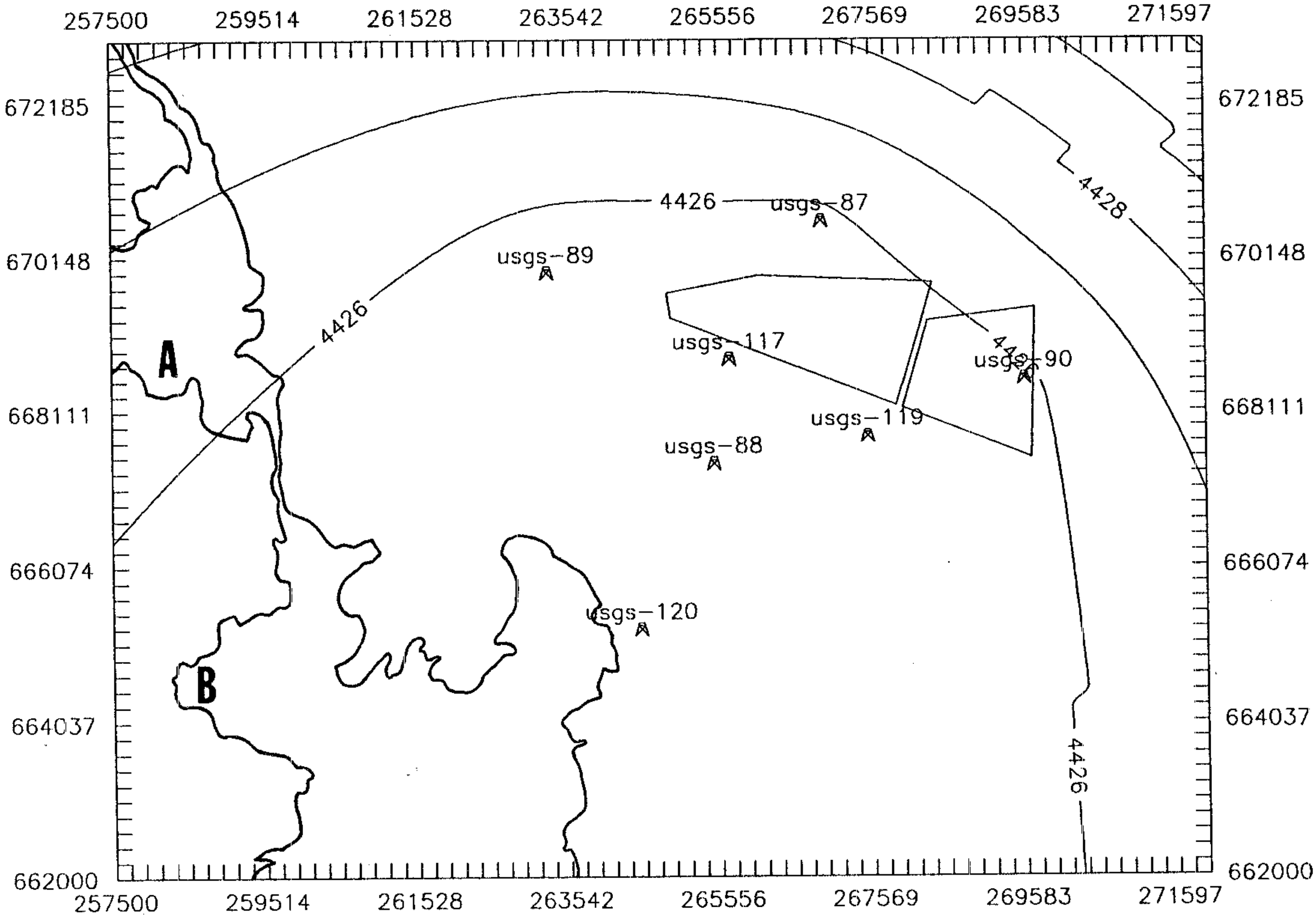


RWMC Water Table Map - 2nd quarter 1980 w/o USGS 88



SCALE 1 inch = 2000 feet

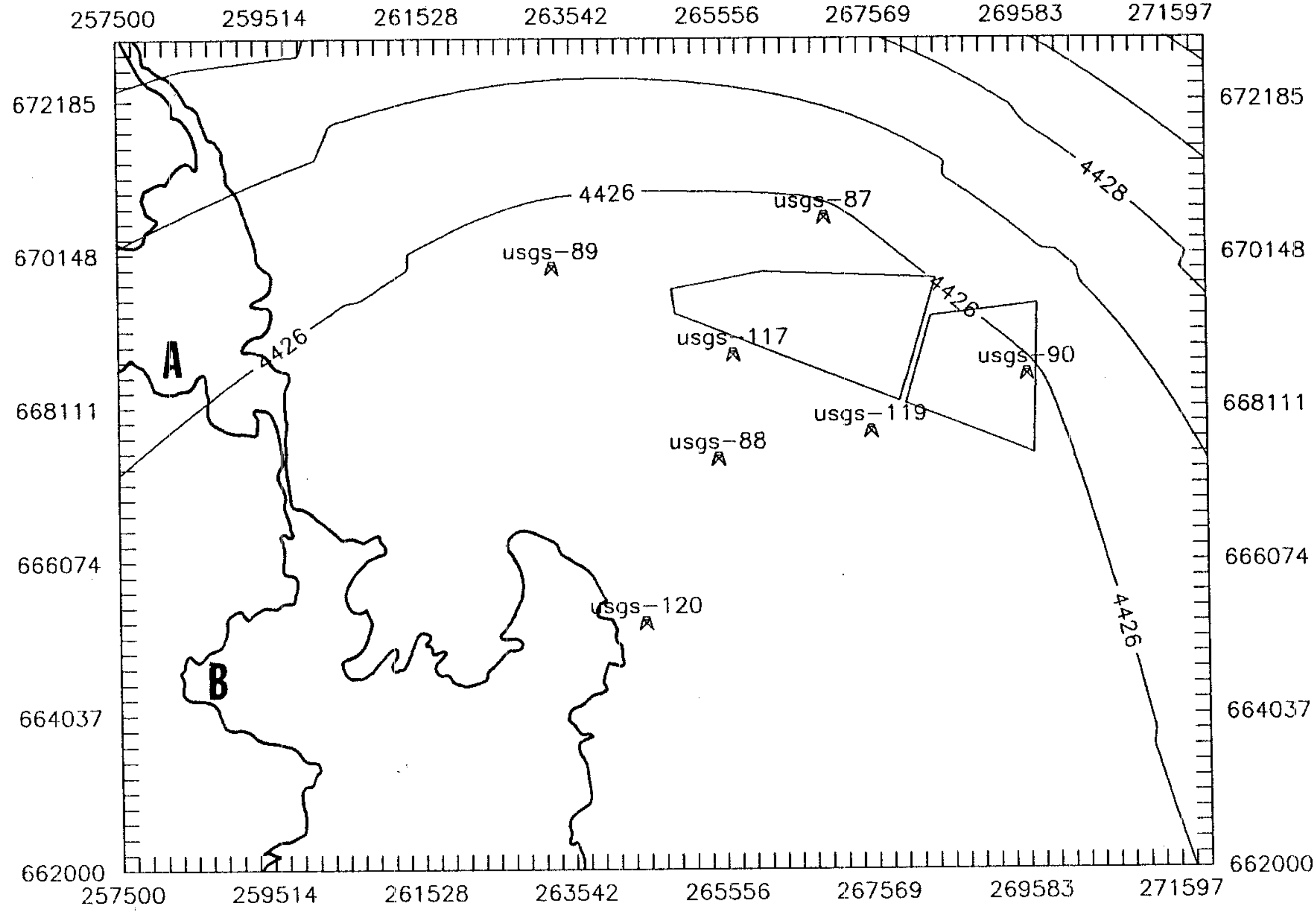
RWMC Water Table Map – 1st quarter 1980



SCALE 1 inch = 2000 feet

C-74

RWMC Water Table Map – 1st quarter 1980 w/o USGS 88



SCALE 1 inch = 2000 feet

1st Quarter 1989

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4432.08	5197.77	765.69	01/31/89	USGS-8
257724.5	655267.7	4426.01	5034.41	608.40	02/21/89	USGS-9
289285.5	693016.7	4461.01	4940.72	479.71	02/16/89	USGS-84
291427.2	685908.4	4460.67	4942.45	481.78	01/19/89	USGS-85
243477.9	667073.3	4428.26	5079.02	650.76	01/31/89	USGS-86
266922.2	670620.7	4429.52	5018.19	588.67	01/04/89	USGS-87
265487.7	667415.9	4438.87	5023.67	584.80	01/03/89	USGS-88
263281.1	669950.7	4431.59	5031.59	600.00	01/04/89	USGS-89
269588.1	668535.3	4429.54	5012.64	583.10	01/18/89	USGS-90
277389.9	651362.7	4426.28	5097.57	671.29	11/02/88	USGS-105
280997.4	669059.7	4431.11	5018.51	587.40	01/19/89	USGS-106
285604.9	650810.6	4424.92	5032.96	608.04	11/02/88	USGS-108
265738.6	651253.0	4424.48	5046.27	621.79	02/21/89	USGS-109
265696.5	668804.3	4428.54	5014.14	585.60	01/11/89	USGS-117
267521.0	667773.8	4428.73	5033.32	604.59	10/17/88	USGS-119
264506.9	665248.3	4426.26	5041.60	615.34	02/21/89	USGS-120
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

4th Quarter 1988

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4432.07	5197.77	765.70	10/27/88	USGS-8
257724.5	655267.7	4426.31	5034.41	608.10	11/29/88	USGS-9
289285.5	693016.7	4461.31	4940.72	479.41	11/01/88	USGS-84
291427.2	685908.4	4463.04	4942.45	481.38	11/06/88	USGS-85
243477.9	667073.3	4430.05	5079.02	648.97	11/02/88	USGS-86
266922.2	670620.7	4429.68	5018.19	588.51	10/17/88	USGS-87
265487.7	667415.9	4438.77	5023.67	584.90	09/26/88	USGS-88
263281.1	669950.7	4431.20	5031.59	600.39	10/18/88	USGS-89
269588.1	668535.3	4429.84	5012.64	582.80	10/18/88	USGS-90
277389.9	651362.7	4426.28	5097.57	671.29	11/02/88	USGS-105
280997.4	669059.7	4431.21	5018.51	587.30	10/19/88	USGS-106
285604.9	650810.6	4424.92	5032.96	608.04	11/02/88	USGS-108
265738.6	651253.0	4425.17	5046.27	621.10	11/02/88	USGS-109
265696.5	668804.3	4428.54	5014.14	585.60	10/17/88	USGS-117
267521.0	667773.8	4428.73	5033.32	604.59	10/17/88	USGS-119
264506.9	665248.3	4426.58	5041.60	615.02	11/29/88	USGS-120
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

3rd Quarter 1988

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4432.47	5197.77	765.30	07/28/88	USGS-8
257724.5	655267.7	4426.54	5034.41	607.87	08/26/88	USGS-9
289285.5	693016.7	4461.92	4940.72	478.80	07/26/88	USGS-84
291427.2	685908.4	4463.65	4942.45	480.81	07/25/88	USGS-85
243477.9	667073.3	4431.82	5079.02	647.20	06/22/88	USGS-86
266922.2	670620.7	4431.20	5018.19	586.99	06/22/88	USGS-87
265487.7	667415.9	4440.77	5023.67	582.90	06/22/88	USGS-88
263281.1	669950.7	4432.99	5031.59	598.60	06/24/88	USGS-89
269588.1	668535.3	4430.54	5012.64	582.10	06/22/88	USGS-90
277389.9	651362.7	4427.52	5097.57	670.05	06/25/88	USGS-105
280997.4	669059.7	4432.96	5018.51	585.55	07/06/88	USGS-106
285604.9	650810.6	4424.92	5032.96	608.04	11/02/88	USGS-108
265738.6	651253.0	4425.17	5046.27	621.10	11/02/88	USGS-109
265696.5	668804.3	4429.43	5014.14	584.71	06/27/88	USGS-117
267521.0	667773.8	4429.37	5033.32	603.95	06/27/88	USGS-119
264506.9	665248.3	4426.80	5041.60	614.80	08/25/88	USGS-120
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

2nd Quarter 1988

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4433.36	5197.77	764.41	04/05/88	USGS-8
257724.5	655267.7	4426.97	5034.41	607.44	05/31/88	USGS-9
289285.5	693016.7	4462.74	4940.72	477.98	04/04/88	USGS-84
291427.2	685908.4	4462.47	4942.45	479.98	04/08/88	USGS-85
243477.9	667073.3	4431.24	5079.02	647.78	04/13/88	USGS-86
266922.2	670620.7	4431.02	5018.19	587.17	04/06/88	USGS-87
265487.7	667415.9	4440.83	5023.67	582.84	04/05/88	USGS-88
263281.1	669950.7	4433.67	5031.59	597.92	04/05/88	USGS-89
269588.1	668535.3	4431.19	5012.64	581.45	04/06/88	USGS-90
277389.9	651362.7	4428.17	5097.57	669.40	04/13/88	USGS-105
280997.4	669059.7	4431.91	5018.51	586.60	04/13/88	USGS-106
285604.9	650810.6	4425.82	5032.96	607.14	04/13/88	USGS-108
265738.6	651253.0	4426.06	5046.27	620.21	04/13/88	USGS-109
265696.5	668804.3	4429.91	5014.14	584.23	04/05/88	USGS-117
267521.0	667773.8	4429.88	5033.32	603.44	04/05/88	USGS-119
264506.9	665248.3	4427.36	5041.60	614.24	05/31/88	USGS-120
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

1st Quarter 1988

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4434.13	5197.77	763.64	12/09/87	USGS-8
257724.5	655267.7	4427.75	5034.41	606.66	02/29/88	USGS-9
289285.5	693016.7	4463.21	4940.72	477.51	01/19/88	USGS-84
291427.2	685908.4	4462.92	4942.45	479.53	01/19/88	USGS-85
243477.9	667073.3	4431.71	5079.02	647.31	12/08/87	USGS-86
266922.2	670620.7	4432.02	5018.19	586.17	01/19/88	USGS-87
265487.7	667415.9	4442.68	5023.67	580.99	01/20/88	USGS-88
263281.1	669950.7	4434.83	5031.59	596.76	01/20/88	USGS-89
269588.1	668535.3	4432.25	5012.64	580.39	01/19/88	USGS-90
277389.9	651362.7	4429.10	5097.57	668.47	12/02/87	USGS-105
280997.4	669059.7	4432.77	5018.51	585.74	01/07/88	USGS-106
285604.9	650810.6	4426.62	5032.96	606.34	12/02/87	USGS-108
265738.6	651253.0	4426.44	5046.27	619.83	01/20/88	USGS-109
265696.5	668804.3	4430.72	5014.14	583.42	02/01/88	USGS-117
267521.0	667773.8	4430.62	5033.32	602.70	02/01/88	USGS-119
264506.9	665248.3	4428.25	5041.60	613.35	01/20/88	USGS-120
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

4th Quarter 1987

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4433.91	5197.77	763.86	10/30/87	USGS-8
257724.5	655267.7	4428.18	5034.41	606.23	11/02/87	USGS-9
289285.5	693016.7	4463.45	4940.72	477.27	10/21/87	USGS-84
291427.2	685908.4	4465.18	4942.45	479.35	10/21/87	USGS-85
243477.9	667073.3	4431.71	5079.02	647.31	12/08/87	USGS-86
266922.2	670620.7	4431.77	5018.19	586.42	12/08/87	USGS-87
265487.7	667415.9	4442.62	5023.67	581.05	12/14/87	USGS-88
263281.1	669950.7	4435.64	5031.59	595.95	12/14/87	USGS-89
269588.1	668535.3	4431.90	5012.64	580.74	12/08/87	USGS-90
277389.9	651362.7	4429.10	5097.57	668.47	12/02/87	USGS-105
280997.4	669059.7	4432.94	5018.51	585.57	12/02/87	USGS-106
285604.9	650810.6	4426.62	5032.96	606.34	12/02/87	USGS-108
265738.6	651253.0	4426.63	5046.27	619.64	11/02/87	USGS-109
265696.5	668804.3	4430.77	5014.14	583.37	12/08/87	USGS-117
267521.0	667773.8	4430.42	5033.32	602.90	12/08/87	USGS-119
264506.9	665248.3	4428.55	5041.60	613.05	12/08/87	USGS-120
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

3rd Quarter 1987

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4578.13	5197.77	763.62	07/29/87	USGS-8
257724.5	655267.7	4427.86	5034.41	606.55	09/03/87	USGS-9
289285.5	693016.7	4465.00	4940.72	475.72	08/20/87	USGS-84
291427.2	685908.4	4466.73	4942.45	478.71	08/20/87	USGS-85
243477.9	667073.3	4431.67	5079.02	647.35	08/03/87	USGS-86
266922.2	670620.7	4431.73	5018.19	586.46	08/20/87	USGS-87
265487.7	667415.9	4444.78	5023.67	578.89	08/20/87	USGS-88
263281.1	669950.7	4439.34	5031.59	592.25	08/20/87	USGS-89
269588.1	668535.3	4431.87	5012.64	580.77	08/05/87	USGS-90
277389.9	651362.7	4429.18	5097.57	668.39	07/28/87	USGS-105
280997.4	669059.7	4432.76	5018.51	585.75	07/17/87	USGS-106
285604.9	650810.6	4426.15	5032.96	606.81	07/28/87	USGS-108
265738.6	651253.0	4426.63	5046.27	619.64	07/30/87	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

2nd Quarter 1987

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4434.15	5197.77	763.62	04/06/87	USGS-8
257724.5	655267.7	4428.69	5034.41	605.72	05/27/87	USGS-9
289285.5	693016.7	4464.98	4940.72	475.74	04/29/87	USGS-84
291427.2	685908.4	4466.71	4942.45	477.95	04/09/87	USGS-85
243477.9	667073.3	4433.62	5079.02	645.40	04/08/87	USGS-86
266922.2	670620.7	4432.93	5018.19	585.26	04/01/87	USGS-87
265487.7	667415.9	4445.58	5023.67	578.09	04/01/87	USGS-88
263281.1	669950.7	4437.83	5031.59	593.76	04/01/87	USGS-89
269588.1	668535.3	4433.65	5012.64	578.99	04/01/87	USGS-90
277389.9	651362.7	4429.59	5097.57	667.98	04/20/87	USGS-105
280997.4	669059.7	4433.41	5018.51	585.10	04/20/87	USGS-106
285604.9	650810.6	4426.92	5032.96	606.04	04/20/87	USGS-108
265738.6	651253.0	4427.65	5046.27	618.62	04/06/87	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

1st Quarter 1987

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4579.56	5197.77	762.20	02/25/87	USGS-8
257724.5	655267.7	4429.29	5034.41	605.12	02/25/87	USGS-9
289285.5	693016.7	4465.07	4940.72	475.65	02/27/87	USGS-84
291427.2	685908.4	4466.80	4942.45	477.93	02/27/87	USGS-85
243477.9	667073.3	4433.62	5079.02	645.40	02/25/87	USGS-86
266922.2	670620.7	4432.93	5018.19	585.26	02/11/87	USGS-87
265487.7	667415.9	4446.66	5023.67	577.01	01/22/87	USGS-88
263281.1	669950.7	4436.12	5031.59	595.47	01/22/87	USGS-89
269588.1	668535.3	4433.57	5012.64	579.07	01/22/87	USGS-90
277389.9	651362.7	4429.85	5097.57	667.72	02/26/87	USGS-105
280997.4	669059.7	4434.01	5018.51	584.50	10/30/86	USGS-106
285604.9	650810.6	4427.54	5032.96	605.42	02/26/87	USGS-108
265738.6	651253.0	4428.06	5046.27	618.21	01/23/87	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

4th Quarter 1986

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4435.24	5197.77	762.53	12/19/86	USGS-8
257724.5	655267.7	4429.29	5034.41	605.12	12/19/86	USGS-9
289285.5	693016.7	4464.83	4940.72	475.89	12/22/86	USGS-84
291427.2	685908.4	4466.56	4942.45	477.90	12/22/86	USGS-85
243477.9	667073.3	4433.28	5079.02	645.74	12/22/86	USGS-86
266922.2	670620.7	4432.56	5018.19	585.63	10/31/86	USGS-87
265487.7	667415.9	4448.89	5023.67	574.78	11/03/86	USGS-88
263281.1	669950.7	4436.73	5031.59	594.86	11/04/86	USGS-89
269588.1	668535.3	4433.35	5012.64	579.29	11/03/86	USGS-90
277389.9	651362.7	4429.80	5097.57	667.77	11/10/86	USGS-105
280997.4	669059.7	4433.70	5018.51	584.81	10/30/86	USGS-106
285604.9	650810.6	4427.31	5032.96	605.65	11/01/86	USGS-108
265738.6	651253.0	4428.06	5046.27	618.21	01/23/87	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

3rd Quarter 1986

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4435.25	5197.77	762.52	11/04/86	USGS-8
257724.5	655267.7	4429.91	5034.41	604.50	07/26/86	USGS-9
289285.5	693016.7	4465.04	4940.72	475.68	07/21/86	USGS-84
291427.2	685908.4	4466.77	4942.45	478.00	11/18/86	USGS-85
243477.9	667073.3	4433.29	5079.02	645.73	11/04/86	USGS-86
266922.2	670620.7	4432.56	5018.19	585.63	10/31/86	USGS-87
265487.7	667415.9	4450.69	5023.67	572.98	08/11/86	USGS-88
263281.1	669950.7	4436.11	5031.59	595.48	08/11/86	USGS-89
269588.1	668535.3	4434.23	5012.64	578.41	08/11/86	USGS-90
277389.9	651362.7	4429.80	5097.57	667.77	11/01/86	USGS-105
280997.4	669059.7	4434.01	5018.51	584.50	08/04/86	USGS-106
285604.9	650810.6	4427.31	5032.96	605.65	11/01/86	USGS-108
265738.6	651253.0	4427.47	5046.27	618.80	06/09/86	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

2nd Quarter 1986

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4435.15	5197.77	762.62	04/22/86	USGS-8
257724.5	655267.7	4429.15	5034.41	605.26	04/22/86	USGS-9
289285.5	693016.7	4464.75	4940.72	475.97	05/01/86	USGS-84
291427.2	685908.4	4466.48	4942.45	478.65	01/21/86	USGS-85
243477.9	667073.3	4433.08	5079.02	645.94	04/22/86	USGS-86
266922.2	670620.7	4432.02	5018.19	586.17	04/18/86	USGS-87
265487.7	667415.9	4452.70	5023.67	570.97	04/18/86	USGS-88
263281.1	669950.7	4436.26	5031.59	595.33	04/18/86	USGS-89
269588.1	668535.3	4432.84	5012.64	579.80	04/18/86	USGS-90
277389.9	651362.7	4429.80	5097.57	667.77	11/10/86	USGS-105
280997.4	669059.7	4433.15	5018.51	585.36	04/19/86	USGS-106
285604.9	650810.6	4426.86	5032.96	606.10	04/19/86	USGS-108
265738.6	651253.0	4427.60	5046.27	618.67	04/22/86	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

1st Quarter 1986

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4435.08	5197.77	762.69	02/06/86	USGS-8
257724.5	655267.7	4429.00	5034.41	605.41	02/06/86	USGS-9
289285.5	693016.7	4463.98	4940.72	476.74	01/21/86	USGS-84
291427.2	685908.4	4463.80	4942.45	478.65	01/21/86	USGS-85
243477.9	667073.3	4432.86	5079.02	646.16	02/06/86	USGS-86
266922.2	670620.7	4432.02	5018.19	586.17	04/18/86	USGS-87
265487.7	667415.9	4451.86	5023.67	571.81	01/27/86	USGS-88
263281.1	669950.7	4436.26	5031.59	595.33	04/18/86	USGS-89
269588.1	668535.3	4430.83	5012.64	581.81	01/27/86	USGS-90
277389.9	651362.7	4430.17	5097.57	667.40	10/21/85	USGS-105
280997.4	669059.7	4433.15	5018.51	585.36	04/19/86	USGS-106
285604.9	650810.6	4426.86	5032.96	606.10	04/19/86	USGS-108
265738.6	651253.0	4426.55	5046.27	619.72	02/04/86	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

4th Quarter 1985

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4436.70	5197.77	761.07	11/27/85	USGS-8
257724.5	655267.7	4429.34	5034.41	605.07	12/04/85	USGS-9
289285.5	693016.7	4464.15	4940.72	476.57	10/30/85	USGS-84
291427.2	685908.4	4464.14	4942.45	478.31	12/02/85	USGS-85
243477.9	667073.3	4433.36	5079.02	645.66	12/04/85	USGS-86
266922.2	670620.7	4433.05	5018.19	585.14	07/11/85	USGS-87
265487.7	667415.9	4461.04	5023.67	562.63	12/05/85	USGS-88
263281.1	669950.7	4441.88	5031.59	589.71	07/11/85	USGS-89
269588.1	668535.3	4432.74	5012.64	579.90	11/26/85	USGS-90
277389.9	651362.7	4430.17	5097.57	667.40	10/21/85	USGS-105
280997.4	669059.7	4434.01	5018.51	584.50	11/26/85	USGS-106
285604.9	650810.6	4428.08	5032.96	604.88	10/21/85	USGS-108
265738.6	651253.0	4427.75	5046.27	618.52	12/04/85	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

3rd Quarter 1985

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4436.20	5197.77	761.57	08/29/85	USGS-8
257724.5	655267.7	4430.87	5034.41	603.54	07/17/85	USGS-9
289285.5	693016.7	4464.33	4940.72	476.39	08/22/85	USGS-84
291427.2	685908.4	4464.07	4942.45	478.38	08/22/85	USGS-85
243477.9	667073.3	4433.98	5079.02	645.04	08/29/85	USGS-86
266922.2	670620.7	4433.05	5018.19	585.14	07/11/85	USGS-87
265487.7	667415.9	4472.55	5023.67	551.12	07/11/85	USGS-88
263281.1	669950.7	4441.88	5031.59	589.71	07/11/85	USGS-89
269588.1	668535.3	4432.92	5012.64	579.72	07/24/85	USGS-90
277389.9	651362.7	4431.02	5097.57	666.55	07/16/85	USGS-105
280997.4	669059.7	4434.56	5018.51	583.95	08/20/85	USGS-106
285604.9	650810.6	4429.39	5032.96	603.57	07/16/85	USGS-108
265738.6	651253.0	4428.23	5046.27	618.04	08/29/85	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

2nd Quarter 1985

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4439.33	5197.77	758.44	05/20/85	USGS-8
257724.5	655267.7	4431.88	5034.41	602.53	05/29/85	USGS-9
289285.5	693016.7	4465.01	4940.72	475.71	05/21/85	USGS-84
291427.2	685908.4	4464.74	4942.45	477.71	05/21/85	USGS-85
243477.9	667073.3	4437.41	5079.02	641.61	05/20/85	USGS-86
266922.2	670620.7	4434.99	5018.19	583.20	05/23/85	USGS-87
265487.7	667415.9	4469.29	5023.67	554.38	05/23/85	USGS-88
263281.1	669950.7	4443.27	5031.59	588.32	05/20/85	USGS-89
269588.1	668535.3	4434.54	5012.64	578.10	05/14/85	USGS-90
277389.9	651362.7	4432.95	5097.57	664.62	04/18/85	USGS-105
280997.4	669059.7	4436.93	5018.51	581.58	05/20/85	USGS-106
285604.9	650810.6	4433.38	5032.96	599.58	04/18/85	USGS-108
265738.6	651253.0	4430.91	5046.27	615.36	04/16/85	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

1st Quarter 1985

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4440.23	5197.77	757.54	02/25/85	USGS-8
257724.5	655267.7	4433.02	5034.41	601.39	02/22/85	USGS-9
289285.5	693016.7	4464.95	4940.72	475.77	02/28/85	USGS-84
291427.2	685908.4	4464.28	4942.45	478.17	02/28/85	USGS-85
243477.9	667073.3	4438.60	5079.02	640.42	02/25/85	USGS-86
266922.2	670620.7	4435.99	5018.19	582.20	02/21/85	USGS-87
265487.7	667415.9	4477.19	5023.67	546.48	02/21/85	USGS-88
263281.1	669950.7	4444.02	5031.59	587.57	02/21/85	USGS-89
269588.1	668535.3	4436.12	5012.64	576.52	03/27/85	USGS-90
277389.9	651362.7	4432.95	5097.57	664.62	04/18/85	USGS-105
280997.4	669059.7	4487.83	5018.51	530.68	03/01/85	USGS-106
285604.9	650810.6	4433.38	5032.96	599.58	04/18/85	USGS-108
265738.6	651253.0	4435.97	5046.27	610.30	05/01/85	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

4th Quarter 1984

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4440.82	5197.77	756.95	11/27/84	USGS-8
257724.5	655267.7	4434.32	5034.41	600.09	11/27/84	USGS-9
289285.5	693016.7	4464.15	4940.72	476.57	11/27/84	USGS-84
291427.2	685908.4	4463.89	4942.45	478.56	11/27/84	USGS-85
243477.9	667073.3	4439.04	5079.02	639.98	11/27/84	USGS-86
266922.2	670620.7	4436.63	5018.19	581.56	11/20/84	USGS-87
265487.7	667415.9	4491.09	5023.67	532.58	11/29/84	USGS-88
263281.1	669950.7	4445.80	5031.59	585.79	11/28/84	USGS-89
269588.1	668535.3	4436.56	5012.64	576.08	11/29/84	USGS-90
277389.9	651362.7	4434.93	5097.57	662.64	10/09/84	USGS-105
280997.4	669059.7	4488.50	5018.51	530.01	11/27/84	USGS-106
285604.9	650810.6	4432.29	5032.96	600.67	10/09/84	USGS-108
265738.6	651253.0	4430.91	5046.27	615.36	04/16/84	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

3rd Quarter 1984

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4442.42	5197.77	755.35	08/27/84	USGS-8
257724.5	655267.7	4436.10	5034.41	598.31	07/24/84	USGS-9
289285.5	693016.7	4463.63	4940.72	477.09	08/31/84	USGS-84
291427.2	685908.4	4463.42	4942.45	479.03	08/31/84	USGS-85
243477.9	667073.3	4441.16	5079.02	637.86	08/27/84	USGS-86
266922.2	670620.7	4438.45	5018.19	579.74	08/27/84	USGS-87
265487.7	667415.9	4503.60	5023.67	520.07	08/17/84	USGS-88
263281.1	669950.7	4446.20	5031.59	585.39	08/27/84	USGS-89
269588.1	668535.3	4438.57	5012.64	574.07	08/27/84	USGS-90
277389.9	651362.7	4436.29	5097.57	661.28	07/18/84	USGS-105
280997.4	669059.7	4439.69	5018.51	578.82	08/27/84	USGS-106
285604.9	650810.6	4433.12	5032.96	599.84	07/18/84	USGS-108
265738.6	651253.0	4430.91	5046.27	615.36	04/16/84	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

2nd Quarter 1984

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4440.92	5197.77	756.85	05/30/84	USGS-8
257724.5	655267.7	4432.56	5034.41	601.85	04/16/84	USGS-9
289285.5	693016.7	4462.63	4940.72	478.09	05/28/84	USGS-84
291427.2	685908.4	4462.26	4942.45	480.19	05/22/84	USGS-85
243477.9	667073.3	4440.01	5079.02	639.01	05/30/84	USGS-86
266922.2	670620.7	4436.94	5018.19	581.25	05/26/84	USGS-87
265487.7	667415.9	4478.40	5023.67	545.27	05/25/84	USGS-88
263281.1	669950.7	4444.71	5031.59	586.88	05/25/84	USGS-89
269588.1	668535.3	4436.77	5012.64	575.87	05/25/84	USGS-90
277389.9	651362.7	4433.29	5097.57	664.28	04/30/84	USGS-105
280997.4	669059.7	4437.48	5018.51	581.03	05/25/84	USGS-106
285604.9	650810.6	4430.57	5032.96	602.39	04/13/84	USGS-108
265738.6	651253.0	4430.91	5046.27	615.36	04/16/84	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

1st Quarter 1984

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4439.70	5197.77	758.07	02/21/84	USGS-8
257724.5	655267.7	4432.12	5034.41	602.29	01/27/84	USGS-9
289285.5	693016.7	4462.17	4940.72	478.55	02/23/84	USGS-84
291427.2	685908.4	4461.90	4942.45	480.55	02/23/84	USGS-85
243477.9	667073.3	4438.39	5079.02	640.63	02/21/84	USGS-86
266922.2	670620.7	4436.11	5018.19	582.08	02/22/84	USGS-87
265487.7	667415.9	4467.03	5023.67	556.64	02/21/84	USGS-88
263281.1	669950.7	4443.64	5031.59	587.95	02/22/84	USGS-89
269588.1	668535.3	4435.88	5012.64	576.76	02/22/84	USGS-90
277389.9	651362.7	4433.29	5097.57	664.28	04/30/84	USGS-105
280997.4	669059.7	4437.10	5018.51	581.41	02/22/84	USGS-106
285604.9	650810.6	4430.57	5032.96	602.39	04/13/84	USGS-108
265738.6	651253.0	4430.91	5046.27	615.36	04/16/84	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

4th Quarter 1983

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4438.14	5197.77	759.63	12/02/83	USGS-8
257724.5	655267.7	4430.46	5034.41	603.95	11/07/83	USGS-9
289285.5	693016.7	4460.99	4940.72	479.73	11/22/83	USGS-84
291427.2	685908.4	4460.85	4942.45	481.60	12/01/83	USGS-85
243477.9	667073.3	4437.18	5079.02	641.84	12/02/83	USGS-86
266922.2	670620.7	4433.04	5018.19	585.15	11/02/83	USGS-87
265487.7	667415.9	4448.63	5023.67	575.04	11/02/83	USGS-88
263281.1	669950.7	4441.79	5031.59	589.80	12/01/83	USGS-89
269588.1	668535.3	4434.11	5012.64	578.53	11/02/83	USGS-90
277389.9	651362.7	4429.67	5097.57	667.90	10/06/83	USGS-105
280997.4	669059.7	4436.50	5018.51	582.01	12/01/83	USGS-106
285604.9	650810.6	4428.34	5032.96	604.62	10/07/83	USGS-108
265738.6	651253.0	4433.23	5046.27	613.04	06/24/83	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

3rd Quarter 1983

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4437.78	5197.77	759.99	08/24/83	USGS-8
257724.5	655267.7	4430.41	5034.41	604.00	08/24/83	USGS-9
289285.5	693016.7	4460.15	4940.72	480.57	08/01/83	USGS-84
291427.2	685908.4	4460.10	4942.45	482.35	08/22/83	USGS-85
243477.9	667073.3	4436.65	5079.02	642.37	08/24/83	USGS-86
266922.2	670620.7	4432.62	5018.19	585.57	08/25/83	USGS-87
265487.7	667415.9	4436.97	5023.67	586.70	08/29/83	USGS-88
263281.1	669950.7	4441.00	5031.59	590.59	08/25/83	USGS-89
269588.1	668535.3	4433.47	5012.64	579.17	08/25/83	USGS-90
277389.9	651362.7	4432.28	5097.57	665.29	07/21/83	USGS-105
280997.4	669059.7	4435.14	5018.51	583.37	08/26/83	USGS-106
285604.9	650810.6	4429.46	5032.96	603.50	07/21/83	USGS-108
265738.6	651253.0	4433.23	5046.27	613.04	06/24/83	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

2nd Quarter 1983

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4434.52	5197.77	763.25	05/17/83	USGS-8
257724.5	655267.7	4427.81	5034.41	606.60	05/17/83	USGS-9
289285.5	693016.7	4460.02	4940.72	480.70	04/29/83	USGS-84
291427.2	685908.4	4459.40	4942.45	483.05	05/27/83	USGS-85
243477.9	667073.3	4432.82	5079.02	646.20	05/17/83	USGS-86
266922.2	670620.7	4432.02	5018.19	586.17	05/29/83	USGS-87
265487.7	667415.9	4427.47	5023.67	596.20	05/27/83	USGS-88
263281.1	669950.7	4437.99	5031.59	593.60	05/27/83	USGS-89
269588.1	668535.3	4431.00	5012.64	581.64	05/27/83	USGS-90
277389.9	651362.7	4432.28	5097.57	665.29	07/21/83	USGS-105
280997.4	669059.7	4432.68	5018.51	585.83	05/27/83	USGS-106
285604.9	650810.6	4429.46	5032.96	603.50	07/21/83	USGS-108
265738.6	651253.0	4426.31	5046.27	619.96	05/17/83	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

1st Quarter 1983

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4432.22	5197.77	765.55	01/11/83	USGS-8
257724.5	655267.7	4426.40	5034.41	608.01	01/11/83	USGS-9
289285.5	693016.7	4459.12	4940.72	481.60	02/28/83	USGS-84
291427.2	685908.4	4458.20	4942.45	484.25	02/02/83	USGS-85
243477.9	667073.3	4430.23	5079.02	648.79	01/11/83	USGS-86
266922.2	670620.7	4428.42	5018.19	589.77	02/04/83	USGS-87
265487.7	667415.9	4426.62	5023.67	597.05	01/24/83	USGS-88
263281.1	669950.7	4430.75	5031.59	600.84	02/04/83	USGS-89
269588.1	668535.3	4428.17	5012.64	584.47	02/04/83	USGS-90
277389.9	651362.7	4427.07	5097.57	670.50	10/05/82	USGS-105
280997.4	669059.7	4431.87	5018.51	586.64	02/22/83	USGS-106
285604.9	650810.6	4424.65	5032.96	608.31	10/05/82	USGS-108
265738.6	651253.0	4424.93	5046.27	621.34	01/11/83	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

4th Quarter 1982

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4432.14	5197.77	765.63	11/24/82	USGS-8
257724.5	655267.7	4426.45	5034.41	607.96	11/24/82	USGS-9
289285.5	693016.7	4457.72	4940.72	483.00	10/27/82	USGS-84
291427.2	685908.4	4457.56	4942.45	484.89	11/22/82	USGS-85
243477.9	667073.3	4430.12	5079.02	648.90	11/24/82	USGS-86
266922.2	670620.7	4427.53	5018.19	590.66	11/22/82	USGS-87
265487.7	667415.9	4426.12	5023.67	597.55	11/08/82	USGS-88
263281.1	669950.7	4430.46	5031.59	601.13	11/22/82	USGS-89
269588.1	668535.3	4427.69	5012.64	584.95	11/09/82	USGS-90
277389.9	651362.7	4427.07	5097.57	670.50	10/05/82	USGS-105
280997.4	669059.7	4439.78	5018.51	578.73	11/22/82	USGS-106
285604.9	650810.6	4424.65	5032.96	608.31	10/05/82	USGS-108
265738.6	651253.0	4424.81	5046.27	621.46	11/25/82	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

3rd Quarter 1982

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4432.87	5197.77	764.90	07/28/82	USGS-8
257724.5	655267.7	4426.71	5034.41	607.70	07/28/82	USGS-9
289285.5	693016.7	4457.80	4940.72	482.92	06/16/82	USGS-84
291427.2	685908.4	4457.60	4942.45	484.85	07/19/82	USGS-85
243477.9	667073.3	4431.54	5079.02	647.48	07/28/82	USGS-86
266922.2	670620.7	4428.34	5018.19	589.85	08/24/82	USGS-87
265487.7	667415.9	4425.25	5023.67	598.42	08/24/82	USGS-88
263281.1	669950.7	4428.20	5031.59	603.39	08/24/82	USGS-89
269588.1	668535.3	4428.08	5012.64	584.56	08/24/82	USGS-90
277389.9	651362.7	4426.96	5097.57	670.61	07/16/82	USGS-105
280997.4	669059.7	4430.92	5018.51	587.59	08/24/82	USGS-106
285604.9	650810.6	4424.64	5032.96	608.32	08/17/82	USGS-108
265738.6	651253.0	4424.96	5046.27	621.31	08/17/82	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

2nd Quarter 1982

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4432.87	5197.77	764.90	05/26/82	USGS-8
257724.5	655267.7	4425.67	5034.41	608.74	05/26/82	USGS-9
289285.5	693016.7	4457.80	4940.72	482.92	06/16/82	USGS-84
291427.2	685908.4	4457.66	4942.45	484.79	05/25/82	USGS-85
243477.9	667073.3	4429.40	5079.02	649.62	05/26/82	USGS-86
266922.2	670620.7	4426.25	5018.19	591.94	05/24/82	USGS-87
265487.7	667415.9	4424.60	5023.67	599.07	05/24/82	USGS-88
263281.1	669950.7	4425.39	5031.59	606.20	05/24/82	USGS-89
269588.1	668535.3	4426.02	5012.64	586.62	05/24/82	USGS-90
277389.9	651362.7	4425.93	5097.57	671.64	04/08/82	USGS-105
280997.4	669059.7	4429.81	5018.51	588.70	05/24/82	USGS-106
285604.9	650810.6	4423.65	5032.96	609.31	04/08/82	USGS-108
265738.6	651253.0	4424.17	5046.27	622.10	05/26/82	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

1st Quarter 1982

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4430.83	5197.77	766.94	02/02/82	USGS-8
257724.5	655267.7	4425.26	5034.41	609.15	02/02/82	USGS-9
289285.5	693016.7	4457.53	4940.72	483.19	01/28/82	USGS-84
291427.2	685908.4	4457.21	4942.45	485.24	02/26/82	USGS-85
243477.9	667073.3	4428.69	5079.02	650.33	02/02/82	USGS-86
266922.2	670620.7	4425.89	5018.19	592.30	02/26/82	USGS-87
265487.7	667415.9	4424.69	5023.67	598.98	02/26/82	USGS-88
263281.1	669950.7	4425.44	5031.59	606.15	02/26/82	USGS-89
269588.1	668535.3	4425.69	5012.64	586.95	02/26/82	USGS-90
277389.9	651362.7	4425.66	5097.57	671.91	10/01/81	USGS-105
280997.4	669059.7	4429.72	5018.51	588.79	02/26/82	USGS-106
285604.9	650810.6	4423.33	5032.96	609.63	10/07/81	USGS-108
265738.6	651253.0	4423.69	5046.27	622.58	02/03/82	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

4th Quarter 1981

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4430.62	5197.77	767.15	11/19/81	USGS-8
257724.5	655267.7	4425.32	5034.41	609.09	11/19/81	USGS-9
289285.5	693016.7	4457.40	4940.72	483.32	12/24/81	USGS-84
291427.2	685908.4	4456.97	4942.45	485.48	11/25/81	USGS-85
243477.9	667073.3	4428.54	5079.02	650.48	11/19/81	USGS-86
266922.2	670620.7	4426.04	5018.19	592.15	11/25/81	USGS-87
265487.7	667415.9	4424.89	5023.67	598.78	11/25/81	USGS-88
263281.1	669950.7	4425.69	5031.59	605.90	11/25/81	USGS-89
269588.1	668535.3	4425.84	5012.64	586.80	11/25/81	USGS-90
277389.9	651362.7	4425.66	5097.57	671.91	10/07/81	USGS-105
280997.4	669059.7	4429.90	5018.51	588.61	11/25/81	USGS-106
285604.9	650810.6	4423.33	5032.96	609.63	10/07/81	USGS-108
265738.6	651253.0	4423.73	5046.27	622.54	11/19/81	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

3rd Quarter 1981

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4430.42	5197.77	767.35	08/26/81	USGS-8
257724.5	655267.7	4424.81	5034.41	609.60	08/26/81	USGS-9
289285.5	693016.7	4457.51	4940.72	483.21	08/24/81	USGS-84
291427.2	685908.4	4457.24	4942.45	485.21	08/24/81	USGS-85
243477.9	667073.3	4428.31	5079.02	650.71	08/26/81	USGS-86
266922.2	670620.7	4425.81	5018.19	592.38	08/21/81	USGS-87
265487.7	667415.9	4425.40	5023.67	598.27	08/21/81	USGS-88
263281.1	669950.7	4425.67	5031.59	605.92	08/21/81	USGS-89
269588.1	668535.3	4425.52	5012.64	587.12	08/21/81	USGS-90
277389.9	651362.7	4425.82	5097.57	671.75	07/11/81	USGS-105
280997.4	669059.7	4429.30	5018.51	589.21	08/24/81	USGS-106
285604.9	650810.6	4423.42	5032.96	609.54	07/10/81	USGS-108
265738.6	651253.0	4423.25	5046.27	623.02	08/26/81	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

2nd Quarter 1981

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4431.10	5197.77	766.67	04/30/81	USGS-8
257724.5	655267.7	4425.32	5034.41	609.09	04/30/81	USGS-9
289285.5	693016.7	4457.93	4940.72	482.79	04/24/81	USGS-84
291427.2	685908.4	4457.53	4942.45	484.92	04/17/81	USGS-85
243477.9	667073.3	4429.00	5079.02	650.02	04/30/81	USGS-86
266922.2	670620.7	4426.41	5018.19	591.78	05/22/81	USGS-87
265487.7	667415.9	4425.18	5023.67	598.49	05/22/81	USGS-88
263281.1	669950.7	4425.88	5031.59	605.71	05/22/81	USGS-89
269588.1	668535.3	4426.16	5012.64	586.48	05/22/81	USGS-90
277389.9	651362.7	4426.19	5097.57	671.38	04/02/81	USGS-105
280997.4	669059.7	4429.84	5018.51	588.67	05/27/81	USGS-106
285604.9	650810.6	4423.86	5032.96	609.10	04/02/81	USGS-108
265738.6	651253.0	4424.01	5046.27	622.26	04/02/81	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

1st Quarter 1981

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4431.23	5197.77	766.54	02/25/81	USGS-8
257724.5	655267.7	4425.64	5034.41	608.77	02/25/81	USGS-9
289285.5	693016.7	4457.94	4940.72	482.78	03/31/81	USGS-84
291427.2	685908.4	4457.52	4942.45	484.93	01/31/81	USGS-85
243477.9	667073.3	4429.27	5079.02	649.75	02/25/81	USGS-86
266922.2	670620.7	4426.34	5018.19	591.85	02/05/81	USGS-87
265487.7	667415.9	4424.96	5023.67	598.71	02/05/81	USGS-88
263281.1	669950.7	4425.64	5031.59	605.95	01/16/81	USGS-89
269588.1	668535.3	4426.13	5012.64	586.51	02/05/81	USGS-90
277389.9	651362.7	4426.22	5097.57	671.35	01/05/81	USGS-105
280997.4	669059.7	4430.38	5018.51	588.13	02/24/81	USGS-106
285604.9	650810.6	4423.98	5032.96	608.98	12/29/80	USGS-108
265738.6	651253.0	4424.09	5046.27	622.18	02/25/81	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

4th Quarter 1980

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4430.88	5197.77	766.89	12/11/80	USGS-8
257724.5	655267.7	4425.72	5034.41	608.69	12/01/80	USGS-9
289285.5	693016.7	4457.30	4940.72	483.42	10/27/80	USGS-84
291427.2	685908.4	4457.09	4942.45	485.36	10/13/80	USGS-85
243477.9	667073.3	4428.82	5079.02	650.20	12/11/80	USGS-86
266922.2	670620.7	4425.85	5018.19	592.34	10/06/80	USGS-87
265487.7	667415.9	4424.62	5023.67	599.05	10/01/80	USGS-88
263281.1	669950.7	4425.23	5031.59	606.36	10/06/80	USGS-89
269588.1	668535.3	4425.60	5012.64	587.04	10/01/80	USGS-90
277389.9	651362.7	4426.37	5097.57	671.20	11/14/80	USGS-105
280997.4	669059.7	4429.93	5018.51	588.58	11/14/80	USGS-106
285604.9	650810.6	4423.46	5032.96	609.50	11/14/80	USGS-108
265738.6	651253.0	4424.12	5046.27	622.15	11/14/80	USGS-109
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

3rd Quarter 1980

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4430.54	5197.77	767.23	07/21/80	USGS-8
257724.5	655267.7	4425.08	5034.41	609.33	07/21/80	USGS-9
289285.5	693016.7	4457.77	4940.72	482.95	07/24/80	USGS-84
291427.2	685908.4	4457.40	4942.45	485.05	07/28/80	USGS-85
243477.9	667073.3	4428.55	5079.02	650.47	07/21/80	USGS-86
266922.2	670620.7	4425.81	5018.19	592.38	07/16/80	USGS-87
265487.7	667415.9	4424.75	5023.67	598.92	07/16/80	USGS-88
263281.1	669950.7	4425.31	5031.59	606.28	07/16/80	USGS-89
269588.1	668535.3	4425.77	5012.64	586.87	07/16/80	USGS-90
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

2nd Quarter 1980

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4430.24	5197.77	767.53	05/26/80	USGS-8
257724.5	655267.7	4425.04	5034.41	609.37	05/26/80	USGS-9
289285.5	693016.7	4458.08	4940.72	482.64	05/21/80	USGS-84
291427.2	685908.4	4457.82	4942.45	484.63	05/21/80	USGS-85
243477.9	667073.3	4428.32	5079.02	650.70	05/26/80	USGS-86
266922.2	670620.7	4426.67	5018.19	591.52	05/16/80	USGS-87
265487.7	667415.9	4425.20	5023.67	598.47	05/16/80	USGS-88
263281.1	669950.7	4425.66	5031.59	605.93	05/16/80	USGS-89
269588.1	668535.3	4425.70	5012.64	586.94	05/16/80	USGS-90
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

1st Quarter 1980

X	Y	Elevation of Water Table	Elevation of Measuring Point	Depth to Measuring Point	Date	
226067.3	678016.2	4430.50	5197.77	767.27	03/01/80	USGS-8
257724.5	655267.7	4425.35	5034.41	609.06	03/01/80	USGS-9
289285.5	693016.7	4458.12	4940.72	482.60	02/26/80	USGS-84
291427.2	685908.4	4457.90	4942.45	484.55	02/25/80	USGS-85
243477.9	667073.3	4428.53	5079.02	650.49	03/01/80	USGS-86
266922.2	670620.7	4425.81	5018.19	592.38	02/26/80	USGS-87
265487.7	667415.9	4425.39	5023.67	598.28	02/26/80	USGS-88
263281.1	669950.7	4425.48	5031.59	606.11	02/26/80	USGS-89
269588.1	668535.3	4425.86	5012.64	586.78	02/26/80	USGS-90
226067.3	670248.3	4437.00				pseud-wl 1
226067.3	675248.0	4441.00				pseud-wl 2
226067.3	680248.0	4445.00				pseud-wl 3
226067.3	685248.0	4449.00				pseud-wl 4
226067.3	690248.0	4453.00				pseud-wl 5
226067.3	695248.0	4457.00				pseud-wl 6
281000.0	674000.0	4436.00				
281000.0	677500.0	4440.00				
281000.0	682000.0	4446.00				
281000.0	687000.0	4451.00				
295000.0	655000.0	4428.00				
295000.0	660000.0	4432.00				
295000.0	665000.0	4435.00				
225000.0	655000.0	4426.00				
225000.0	665000.0	4428.00				
225000.0	675000.0	4432.00				
225000.0	685000.0	4444.00				
225000.0	694000.0	4450.00				

APPENDIX D
USGS WELL 88 PUMPING TEST

USGS Well 88 pumping test
October 17, 1989

AN INFORMAL LETTER REPORT

19 DECEMBER, 1989

K.L. Ruebelmann, Geosciences Unit

Introduction

Water levels in USGS Well 88, located southwest of the Subsurface Disposal Area (SDA), tracked essentially the same path as other RWMC area wells until 1984. In 1984, a tremendous rise in water levels in all area wells was recorded, the largest of these occurring in Well 88, with a rise of over 60 ft. In an evaluation of the RWMC hydrology Jaacks and others (1989) suggest the anomalous rise in water levels may be due to silting up of the well or damage of some sort to the well. An evaluation of the RWMC hydrology in this report proposes that Well 88 is in communication with the aquifer and is not damaged or silting up. Based on testing of the well and analysis of the well hydrograph, Well 88 probably does not tap the main portion of the aquifer, but rather, a limited zone near the top of the aquifer.

Pumping Tests

Pumping tests on Well 88 were performed by the U. S. Geological Survey in 1987 and 1984. The pumping rate for each of these tests was 5 gpm. The 1987 test was conducted for a period of 6 hrs, 45 min.; the 1984 test was conducted for a period of 1 hr, 30 min. The data from these tests and plots of the drawdown and recovery data are presented below. The data from these tests indicate the well is in good communication with the aquifer. However, because of uncertainty over the condition of the well an additional pumping test was performed in October of 1989.

During the October, 1989 pumping test the well was pumped using the dedicated submersible pump at a discharge rate of approximately 1.5 gpm and the water level was monitored throughout the test using a pressure transducer and a data logger. The total length of the test was 6 hours and 50 minutes. The pumping rate fluctuated from 1 gpm to 2 gpm and was difficult to stabilize. The pump shut off early in the test which is reflected in the plot of the drawdown data. The generator was adjusted, the pump came back on and the test continued. The pumping rate increased to 2 gpm and then stabilized at 1.5 gpm. An attempt to increase the pumping rate above 1.5 gpm was unsuccessful.

After the pump was turned off, the well was monitored for recovery. The valve to the discharge pipe was closed to prevent a rush of water cascading back into the well and to allow the water to slowly recover into the well. After several minutes, the valve was opened allowing the remaining water in the pipe to drain back into the well. The water level rose above the original water table elevation, then declined, and continued to recover.

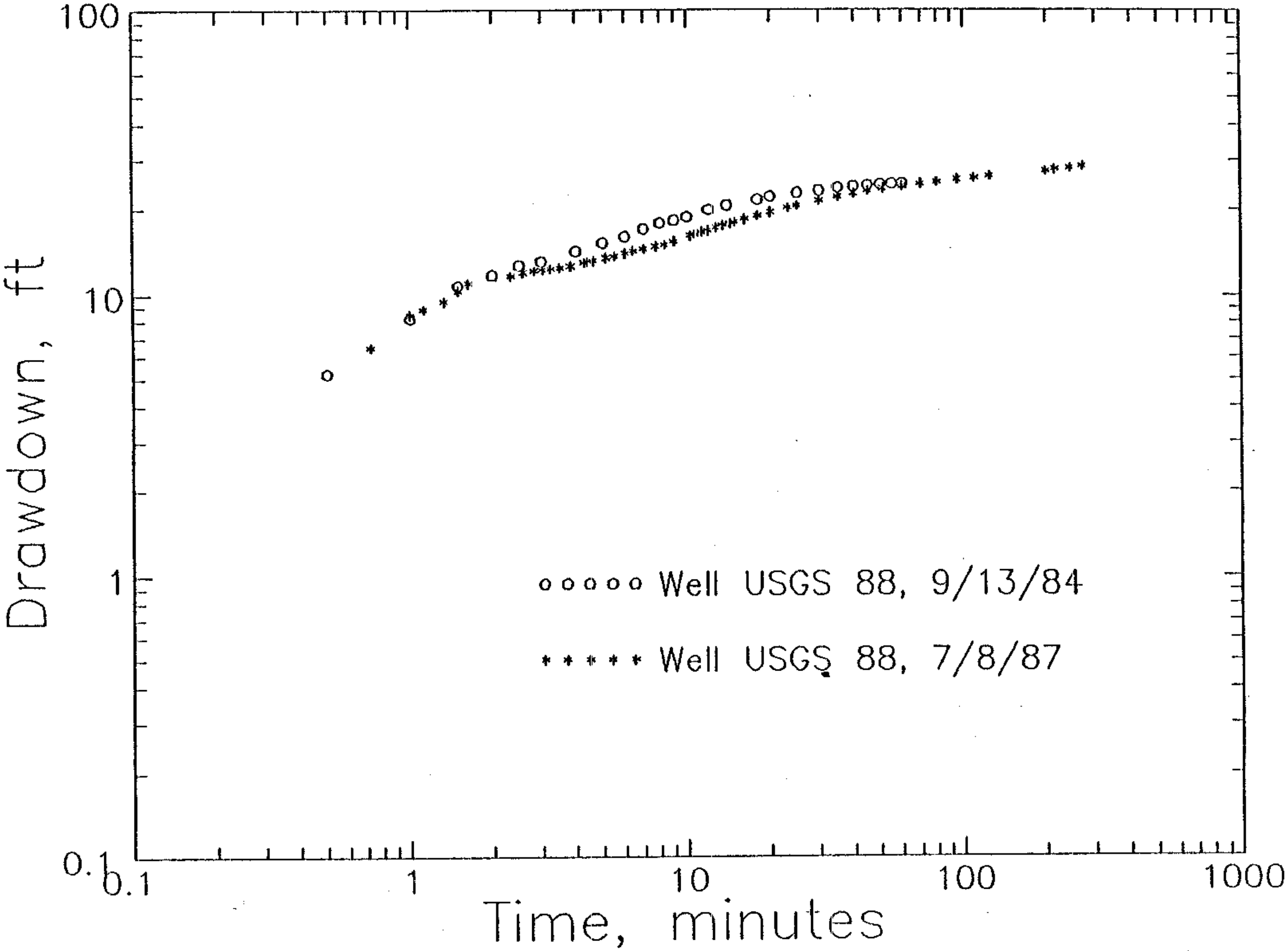
Transmissivity

Transmissivities were difficult to calculate from the 1989 pumping test of Well 88 due to the fluctuations in the discharge rate and problems with the pump. The Jacob-Hantush method was used to evaluate the data and the calculated transmissivity was 7.65 ft^2/day. Transmissivities calculated by the USGS for the 1987 pumping test ranged from 23.40 ft^2/day (Jacob method) to 3.11 ft^2/day (Theis method).

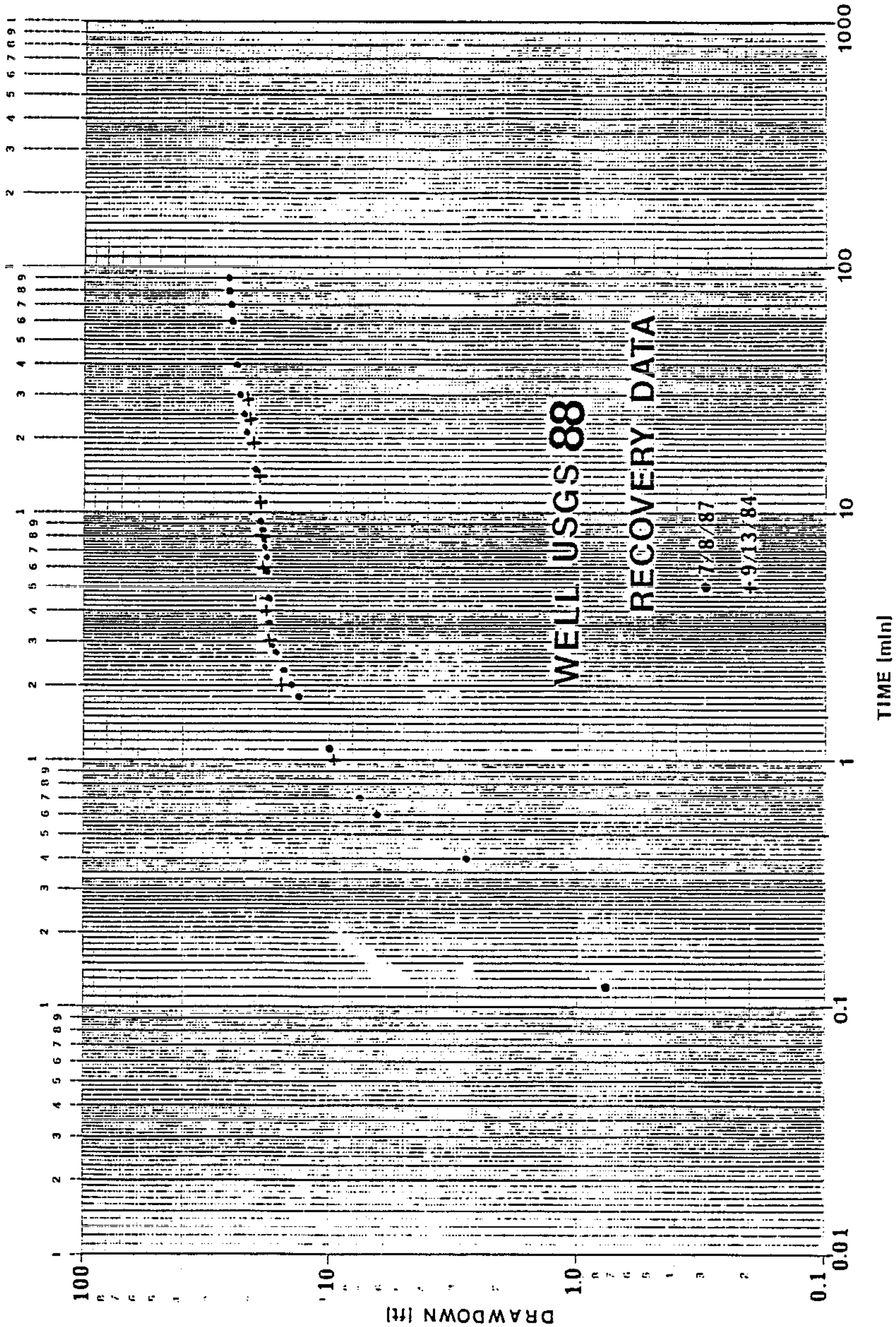
Well evaluation and conclusions

The October 1989 pumping test data confirms that Well 88 is in communication with the aquifer and is not damaged or silting up (based on drawdown and good recovery of the well).

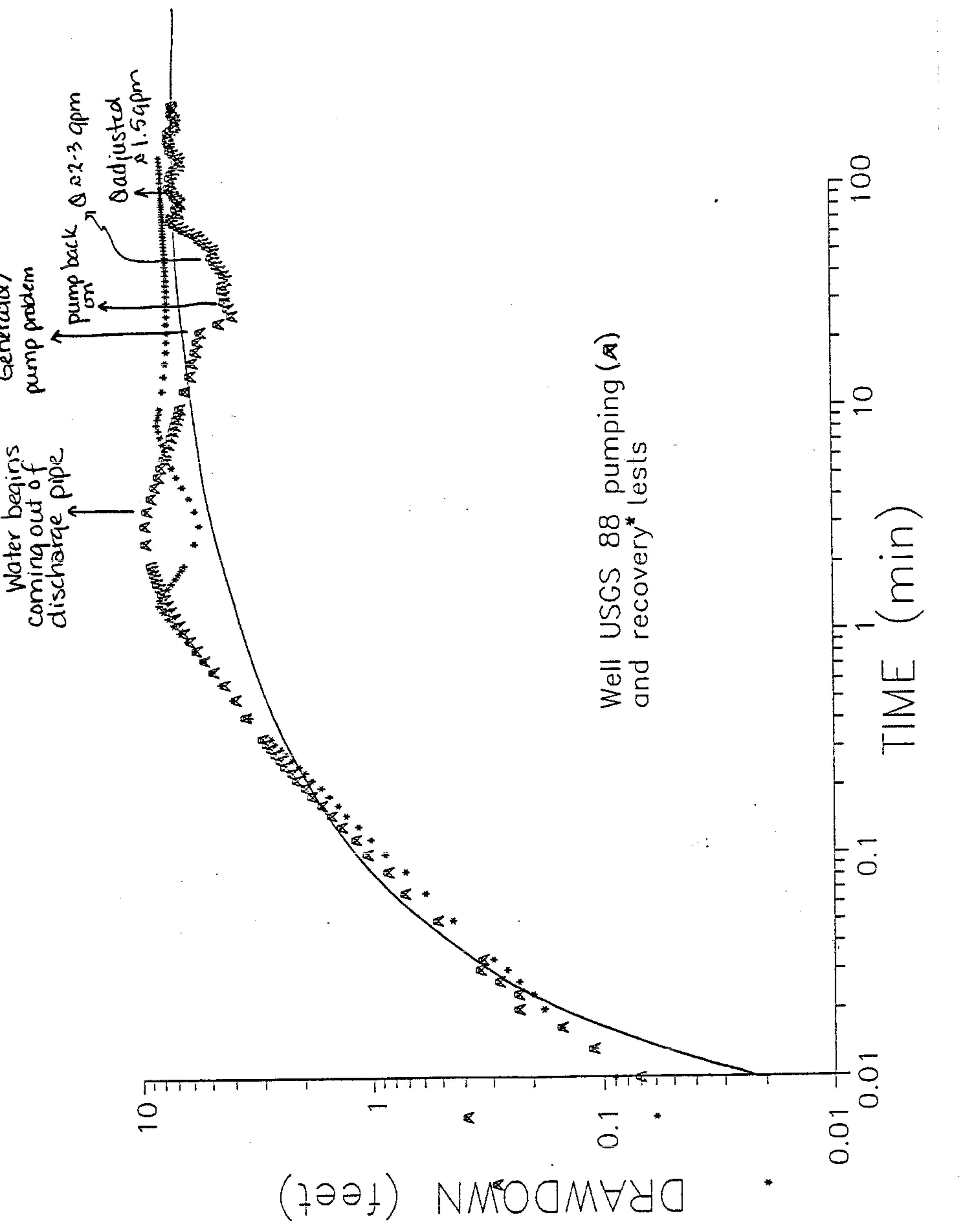
Because of the irregular discharge rates and inability of the pump to pump at a rate higher than 2 gpm, it is possible the pump is wearing out or the intake on the pump is clogged.



Plots of 1987, 1984 pumping test data (drawdown) for USGS Well 88.



Plots of 1987, 1984 pumping test data
(recovery) for USGS Well 88.



Plots of 1989 pumping test data (drawdown) and recovery) for USGS Well 88.

AQUIFER TEST FIELD DATA SHEET

Date: 10-17-89

Pumped Well 88

Location: Big Southern Butte 7'.5" - 02N 29E 18ccd1

Observation Well None

Observers: Tom Wood, Kerry Ruebelmann, Dan Ackerman (USGS)

Measuring point is Top of 2" coupler which is 3.25 feet

above/below land surface or other surveyed reference mark.

Elevation of reference mark, if known ________ ft above MSL.

Elevation of land surface, if known ________ ft above MSL.

Static water level 590.23 below measuring point.

Distance to pumped well NA feet.

Discharge rate of pumped well 1.5 gpm (gallons per minute).

Total number of observation wells None.

Weather conditions: Sunny and clear, cold.

Barometric pressure: beginning of test ________

end of test ________

Depth of well ________

Open interval ________

Field Notes:

Top of pump 612 ft. Bottom of pump 616 ft.

Neptune flow meter. Serial #33978888. Initial reading 1684.95.

Hermit data logger. Serial #1KB-406. Water level 20.57.

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89	10:20	0.0000	590.23	0.00	Pump on
		0.0033		0.29	
		0.0066		0.39	Brown water
		0.0099		0.07	
		0.0133		0.11	
		0.0166		0.15	
		0.0200		0.23	
		0.0233		0.23	
		0.0266		0.28	
		0.0300		0.34	
		0.0333		0.33	
		0.0500		0.52	
		0.0666		0.72	
		0.0833		0.85	
		0.1000		1.05	
		0.1166		1.18	
		0.1333		1.37	
		0.1500		1.52	
		0.1666		1.67	
		0.1833		1.85	
		0.2000		1.97	
		0.2166		2.15	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89	10:20:23	0.2333		2.26	
		0.2500		2.42	
		0.2666		2.53	
		0.2833		2.66	
		0.3000		2.78	
		0.3166		2.90	
		0.3333		3.02	
		0.4167		3.56	
		0.5000		3.92	
		0.5833		4.36	
		0.6667		4.87	
		0.7500		5.32	
		0.8333		5.73	
		0.9167		6.11	
		1.0000		6.49	
		1.0833		6.80	
		1.1667		7.10	
		1.2500		7.37	
		1.3333		7.62	
		1.4166		7.84	
		1.5000		8.05	
		1.5833		8.24	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89	10:21:66	1.6667		8.43	
		1.7500		8.60	
		1.8333		8.74	
		1.9167		8.87	
		2.0000		8.98	
		2.5000		9.48	
		3.0000		9.55	
		3.5000		9.36	
		4.0000		8.96	
		4.5000		8.63	
		5.0000		8.30	
		5.5000		8.08	
		6.0000		7.83	
		6.5000		7.65	
		7.0000		7.47	
		7.5000		7.28	
		8.0000		7.15	
		8.5000		7.02	
		9.0000		6.87	
		9.5000		6.77	
		10.0000		6.68	
		12.0000		6.35	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89	10:34	14.0000		6.03	
		16.0000		5.89	
		18.0000		5.72	
		20.0000		5.61	
		22.0000		5.45	No water coming out - pump off
		24.0000		4.55	
		26.0000		4.00	Water coming out ~ 1 gpm
		28.0000		4.14	Increased voltage on generator
		30.0000		4.30	from 200 to 240
		32.0000		4.30	Water looks slightly cleaner
		34.0000		4.39	
		36.0000		4.38	
		38.0000		4.23	
		40.0000		4.33	
		42.0000		4.47	~ 2 gpm
		44.0000		4.63	
	11:06	46.0000		4.75	~ 3 gpm, 5 gallon bucket test
		48.0000		4.87	
		50.0000		4.79	
		52.0000		4.82	
		54.0000		5.09	
		56.0000		5.31	

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89	11:18	58.0000		5.51	
		60.0000		5.65	
		62.0000		6.05	
	11:24	64.0000		6.41	Pumping rate increased
		66.0000		6.72	~ 1.4 gpm
		68.0000		7.06	
		70.0000		7.26	
		72.0000		7.36	
		74.0000		7.23	
		76.0000		6.72	
		78.0000		6.74	
		80.0000		6.91	
		82.0000		6.80	
		84.0000		6.58	
	11:46	86.0000		6.65	~ 1.4 gpm
		88.0000		6.82	
		90.0000		6.98	
		92.0000		7.07	
		94.0000		7.20	
	11:56	96.0000		7.31	~ 1.5 gpm
		98.0000		7.42	
		100.0000		7.40	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89		105.000		7.20	
		110.000		7.31	
		115.000		7.21	
	12:20	120.000		7.01	~ 1 gpm
		125.000		6.72	
		130.000		6.65	
		135.000		6.77	
		140.000		7.10	
		145.000		7.31	
		150.000		7.32	
		155.000		7.42	
	13:00	160.000		7.53	
		165.000		7.47	
		170.000		7.36	
	13:15	175.000		7.48	~ 1.3 gmp
		180.000		7.26	
		185.000		7.06	USGS onsite to collect samples
		190.000		6.93	pH 8.24; SC 597; Temp. 14.7°C
		195.000		6.98	
		200.000		6.96	
		205.000		7.12	
		210.000		7.26	Large air bubbles coming up

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89	13:55	215.000		7.23	
		220.000		7.09	Smaller air bubbles
		225.000		7.17	
	14:15	230.000		7.26	Pump off -- shut valve
		0.0000		8.47	Recovery
		0.0033		8.46	
		0.0066		8.41	
		0.0099		8.38	
		0.0133		8.36	
		0.0166		8.32	
		0.0200		8.29	
		0.0233		8.27	
		0.0266		8.24	
		0.0300		8.21	
		0.0333		8.17	
		0.0500		8.02	
		0.0666		7.88	
		0.0833		7.75	
		0.1000		7.59	
		0.1166		7.45	
		0.1333		7.31	
		0.1500		7.15	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89		0.0666		7.04	
		0.1833		6.90	
		0.2000		6.77	
		0.2166		6.61	
		0.2333		6.47	
		0.2500		6.35	
		0.2666		6.19	
		0.2833		6.06	
		0.3000		5.94	
		0.3166		5.78	
		0.3333		5.67	
		0.4167		5.02	
		0.5000		4.42	
		0.5833		3.92	
		0.6667		3.54	
		0.7500		3.10	
		0.8333		2.63	
		0.9167		2.15	
		1.0000		1.70	
		1.0833		1.26	
		1.1667		0.85	
		1.2500		0.47	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89		1.3333		0.12	
		1.4166		-0.20	
		1.5000		-0.53	
		1.5833		-0.83	
		1.6667		-1.10	
		1.7500		-1.35	
		1.8333		-1.57	
		1.9167		-1.78	
		2.0000		-1.95	
		2.5000		-2.61	
		3.0000		-2.86	
		3.5000		-2.64	
		4.0000		-2.31	
		4.5000		-1.87	
		5.0000		-1.46	
		5.5000		-1.15	
		6.0000		-0.88	
		6.5000		-0.64	
		7.0000		-0.44	
		7.5000		-0.28	
		8.0000		-0.14	
		8.5000		-0.03	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89		9.0000		0.07	
		9.5000		0.17	
		10.0000		0.25	
		12.0000		0.47	
		14.0000		0.63	
		16.0000		0.72	
		18.0000		0.80	
		20.0000		0.83	
		22.0000		0.85	
		24.0000		0.81	
		26.0000		0.83	
		28.0000		0.83	
		30.0000		0.83	
		32.0000		0.81	
		34.0000		0.81	
		36.0000		0.78	
		38.0000		0.78	
		40.0000		0.75	
		42.0000		0.74	
		44.0000		0.72	
		46.0000		0.70	
		48.0000		0.69	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89		50.0000		0.67	
		52.0000		0.66	
		54.0000		0.64	
		56.0000		0.63	
		58.0000		0.61	
		60.0000		0.59	
		62.0000		0.58	
		64.0000		0.56	
		66.0000		0.55	
		68.0000		0.55	
		70.0000		0.53	
		72.0000		0.52	
		74.0000		0.50	
		76.0000		0.50	
		78.0000		0.48	
		80.0000		0.47	
		82.0000		0.45	
		84.0000		0.45	
		86.0000		0.44	
		88.0000		0.42	
		90.0000		0.42	
		92.0000		0.42	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
10-17-89		94.0000		0.40	
		96.0000		0.39	
		98.0000		0.39	
		100.0000		0.39	
		105.0000		0.36	
		110.0000		0.34	
		115.0000		0.33	
		120.0000		0.31	
		125.0000		0.29	
		130.0000		0.25	
		135.0000		0.22	End of test

AQUIFER TEST FIELD DATA SHEET

Date: 07/08/87 Page 1 of 5

Pumped Well 88

Location: Big Southern Butte 7'.5", 02N 29E 18ccd1

Observation Well None

Observers: L. Beem, USGS

Measuring point is Top of 2" coupler which is 3.25 feet above/below land surface or other surveyed reference mark.

Elevation of reference mark, if known ______ ft above MSL.

Elevation of land surface, if known ______ ft above MSL.

Static water level 57.02 below land surface.

Distance to pumped well NA feet.

Discharge rate of pumped well 5.0 gpm (gallons per minute).

Total number of observation wells 0.

Weather conditions: ______

Barometric pressure: beginning of test ______

end of test ______

Depth of well ______

Open interval ______

Field Notes:

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
07-08-87	09:55	0.00	576.02	0.00	Pump on
		0.72	582.50	6.48	Brown, silty water
		1.00	584.50	8.48	
		1.12	584.90	8.88	
		1.33	585.84	9.46	
		1.50	586.36	10.34	
		1.63	587.00	10.98	
		2.33	587.70	11.68	
		2.58	588.05	12.03	
		2.83	588.20	12.18	
		3.03	588.30	12.28	
		3.06	588.40	12.38	
		3.50	588.50	12.48	
		3.83	588.65	12.63	
		4.30	589.00	12.98	
		4.42	589.10	13.08	
		4.62	589.20	13.18	
		5.13	589.50	13.48	
		5.50	589.70	13.68	
		6.00	590.00	13.98	
		6.43	590.30	14.28	
		7.00	590.50	14.48	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
07-08-87		7.75	590.80	14.78	
		8.33	591.00	14.98	
		9.00	591.40	15.38	
		10.30	592.10	16.08	
		10.67	592.30	16.28	
		11.33	592.60	16.58	
		11.93	592.80	16.78	Still brownish-tan silty water
		12.72	593.20	17.18	
		13.50	593.50	17.48	
		14.33	593.80	17.78	
		14.93	594.00	17.98	
		16.16	594.40	18.38	
		18.00	594.91	18.89	
		20.00	595.45	19.43	
		23.20	596.21	20.19	
		25.00	596.54	20.52	
		30.00	597.47	21.45	5 gpm
		35.00	598.13	22.11	
		40.00	598.79	22.77	
		45.00	599.30	23.28	
		51.00	599.78	23.76	
		60.00	600.12	24.10	~ 5 gpm 10-gal bucket test

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
07-08-87		70.00	600.70	24.68	
		80.00	601.05	25.03	
		95.00	601.57	25.55	
		110.00	601.98	25.96	
		125.00	602.39	26.37	Lunch
		200.00	603.49	27.47	~ 5 gpm 10-gal bucket test
		215.00	603.87	27.85	
		245.00	604.18	28.16	
		270.00	604.68	28.66	
		0.00	604.68	0.00	Pump off
		0.12	603.90	0.78	
		0.40	601.83	2.85	
		0.63	598.00	6.68	
		0.76	596.90	7.78	
		1.15	594.31	10.37	
		1.82	591.10	13.58	
		2.05	590.00	14.68	
		2.38	589.10	15.58	
		2.73	588.00	16.68	
		2.96	587.50	17.18	
		3.56	587.00	17.68	
		4.66	586.90	17.78	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
07-08-87		5.93	586.67	18.01	
		6.65	586.48	18.20	
		7.28	586.28	18.40	
		7.86	585.09	18.59	
		8.45	585.90	18.78	
		9.06	585.70	18.98	
		15.00	583.96	20.72	
		21.00	582.50	22.18	
		25.00	581.75	22.93	
		30.00	580.95	23.73	
		40.00	580.10	24.58	
		60.00	579.01	25.67	
		70.00	578.64	26.04	
		80.00	578.40	26.28	
		90.00	578.16	26.52	End of test

AQUIFER TEST FIELD DATA SHEET

Date: 09-13-84

Pumped Well 88

Location: ____________________

Observation Well None

Observers: ____________________

____

Measuring point is ____________________ which is __________ feet

above/below land surface or other surveyed reference mark.

Elevation of reference mark, if known __________ ft above MSL.

Elevation of land surface, if known __________ ft above MSL.

Static water level 514.78′ below land surface.

Distance to pumped well -- feet.

Discharge rate of pumped well 5 gpm (gallons per minute).

Total number of observation wells None.

Weather conditions: --

Barometric pressure: beginning of test --

end of test --

Depth of well 662 ft

Open interval 587 ft to 635 ft

Field Notes:

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
09-13-84	14:30	0.0	514.78	0.00	Pump on
		0.5	520.0	5.22	
		1.0	523.0	8.22	
		1.5	525.0	10.72	
		2.0	526.5	11.72	
		2.5	527.5	12.72	
		3.0	527.9	13.12	
		4.0	529.0	14.22	
		5.0	530.0	15.22	
		6.0	530.8	16.02	
		7.0	531.8	17.02	
		8.0	532.6	17.82	
		9.0	533.0	18.22	
		10.0	533.5	18.72	
		12.0	534.6	19.82	
		14.0	535.4	20.62	
		18.0	536.4	21.62	
		20.0	537.0	22.12	
		25.0	537.7	22.82	
		30.0	538.2	23.32	
		35.0	538.5	23.82	
		40.0	538.8	24.12	

Pumped well 88

AQUIFER TEST FIELD DATA SHEET

Date	Clock time	Elapsed time since pumping started/stopped (minutes)	Depth to water, below measuring pt/ land sfc (feet)	Drawdown or recovery (feet)	Remarks
09-13-84		45.00	539.00	24.32	
		50.00	539.20	24.52	
		55.00	539.40	24.62	
		60.00	539.50	24.72	
		61.00 0.00	-	0.00	Pump off
		62.00 1.00	530.00	9.50	500' of 1" pipe drained back
		63.00 2.00	524.00	15.50	into well
		64.00 3.00	521.80	17.70	
		65.00 4.00	521.40	18.10	
		67.00 6.00	521.20	18.30	
		69.00 8.00	520.80	18.70	
		72.00 11.00	520.20	19.30	
		75.00 14.00	519.70	19.80	
		80.00 19.00	519.00	20.50	
		85.00 24.00	518.40	20.10	
		90.00 29.00	518.10	21.40	End of test