Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

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Ms. Jane Hedges
Perimeter Areas Section Manager
Nuclear Waste Program
State of Washington
Department of Ecology
1315 W. Fourth Avenue
Kennewick, Washington 99336

Dear Ms. Hedges:

TRITIUM CONCENTRATIONS IN WELLS 699-13-1A AND 699-13-1B

This letter is in response to the State of Washington Department of Ecology (Ecology) letter to me from Dib Goswami and Alex Stone, "Identification of a New Site-Wide Tritium Plume Based on Concentration Data Upgradient and Downgradient from the 618-11 Burial Ground during the 1970s and 1980s," dated February 15, 2000. In that letter, Ecology requested an evaluation to be performed of the tritium concentrations and occurrences in relation to wells located at and around the 618-11 Burial Ground. Specifically, Ecology requested the evaluation to determine if the elevated tritium observations of the 1970s and 1980s occurring in wells 699-13-1A and 699-13-1B are attributed to releases from the 618-11 Burial Ground or from the 200 Area Plateau. 52583

The Pacific Northwest National Laboratory technical staff has reviewed a considerable amount of data to provide the requested information. Attached is the report of this evaluation. At this time, it is not possible to conclusively discriminate the source of the historically high tritium values in well 699-13-1A and 699-13-1B. The proximity of these wells to the 618-11 Burial Ground and the potential for significant pumping rates from construction purposes that could conceivably draw groundwater into these wells has probably effected past interpretations of the data. Tritium migration from the 200 East Area cannot be ruled out either. Additional work is required.

This evaluation will continue to be refined throughout Phases I and II Tritium Investigation, and in particular, this evaluation will support the Phase II Tritium Investigation Data Quality Objective process. I received the Phase II Plan from the Integration Team on April 3, 2000. This plan will be disseminated to the interested parties for review and comment. The U.S. Department of Energy, Richland Operations Office, intends to work with the U.S. Environmental Protection Agency Hanford Project Office, as lead regulatory agency, to address comments on the plan.

APR 1 3 2000

If you want to discuss this matter further or require additional information, please contact me at (509) 373-0750.

Sincerely,

K. Michael Thompson, Acting Program Manager
Groundwater/Vadose Zone Program

GWVZ:KMT

Attachment

cc w/attach:
J. R. Wilkinson, CTUIR
D. N. Goswami, Ecology
A. B. Stone, Ecology
M Goldstein, EPA
M. B. Reeves, HAB
S. Sobczyk, NPT
P. Sobotta, NPT
M. L. Blazek, Oregon Energy
R. Jim, YN
Admin Record (300-FF-2)

Source of elevated tritium concentrations in wells 699-13-1A and 699-13-1B

In the past, elevated tritium concentrations in wells 699-13-1A and 699-13-1B, located near the Energy Northwest complex in the east-central Hanford site, have been interpreted as being coincident with the arrival of the leading edge of the site-wide tritium plume emanating from 200-East Area. That interpretation has been questioned because tritium concentrations near 8,000,000 pCi/L have been recently detected in well 699-13-3A and recently re-evaluated inventory records indicate that the 618-11 Burial Ground, located immediately upgradient of the well, could have received tritium bearing waste. These new data indicate that the 618-11 Burial Ground, active from 1962 to 1967, is a likely local source for the recently detected elevated tritium concentrations and may be the source for elevated levels in the late 70s and early 80s. The purpose of this section is to present historical tritium data pertinent to this matter, to discuss the two postulated source interpretations, and to discuss the data needed to distinguish between the two interpretations.

Samples collected from wells 699-13-1A and 699-13-1B have historically contained elevated levels of tritium (Figure 1). In the first year that it was sampled, 1973, tritium concentration in well 699-13-1A averaged 121,000 pCi/L and rose to a maximum of 390,000 pCi/L in 1974. In 1975 and 1976, tritium concentrations dropped to a low of 8,800 pCi/L, after which they began to rise in the last half of 1976 to another high of 200,000 pCi/L in 1977. Beginning in 1978, tritium concentrations fluctuated ranging from 12,000 to 1,100,000 pCi/L in 1978 alone. These fluctuations occurred from 1978 through 1980 reaching a maximum value of 1,400,000 pCi/L. The well was not sampled after June 1981 until February 2000. Tritium concentrations in well 699-13-1B are similar to those in well 699-13-1A, but the rise in tritium concentrations in 1974 and 1975 is absent in well 699-13-1B and peak tritium concentrations in well 699-13-1B are only half the levels in well 699-13-1A.

Before the source of historical tritium in wells 699-13-1A and 699-13-1B is discussed, well construction and history need to be considered. The wells were drilled in 1973, approximately 370 feet apart and approximately 1,400 feet from the 618-11 Burial Ground. Both wells were constructed to supply water for construction of Energy Northwest (formerly know as Washington Public Power Supply System) facilities. The wells are 8-in. diameter, 235 and 245 feet deep, respectively, with multiple screened sections and extending approximately 180 feet below the water table. As-built drawings of the wells are presented in Figure 2. Well 699-13-1A was constructed with three screen sections, the upper section 15 feet long and the lower two each 10 feet long. The top of the upper screen section was located approximately 20 feet below the water table at the time it was drilled. Well 699-13-1B has four screen sections with the upper section 20 feet long and lower three each 10 feet long. The top of the upper screen was located approximately 25 feet below the water table.

Details of the historical use of wells 699-13-1A and 699-13-1B for water supply are unknown. The location of the pump in the wells during their use and sampling, the volumes of water and rate at which it was withdrawn, and the continuity of withdrawals is unknown. In addition, the effects of the pumping on the groundwater flow directions and velocities in the area are unknown. It is likely that the wells were used on a demand basis resulting in a variable pumping schedule. A fluctuating withdrawal regime could be responsible for the fluctuating tritium concentrations in the two wells. If the trend that tritium concentrations are generally higher in the upper portion of the groundwater system (Eddy et. al., 1978) and the pumps were set in the middle or lower screen sections as might be expected for a water supply well, high tritium concentrations could have been drawn into the well from the upper part of the aquifer when the well was pumped at a high rate. As the pumping rate dropped, more of the water could have been produced from the lower

screened sections where the pump was located and where tritium concentrations were low. This would explain the higher tritium levels during the active reactor construction period that dropped to low levels at the end of construction when withdrawals would likely have been reduced. Reactor WPN-2 went critical in January 1984. It is probable that a major Columbia River water supply was developed in the early 1980s, eliminating the need for these two water supply wells, which is the reason they were not sampled after mid-1981. Currently WNP-2 uses the Columbia River for its water supply. Whatever the source of tritium, historical tritium fluctuations in wells 699-13-1A and 699-13-1B could be explained by the variable pumping history of the two wells.

The next issue that must be addressed is the source of the tritium arriving at the well. Two sources of tritium have been postulated:

1. The site-wide tritium plume migrating from 200-East Area
2. The 618-11 Burial Ground

Site-wide Tritium Plume Source

The tritium plume that extends southeast from 200-East Area has its source in early separations operations in 200-East Area. Historical interpretations of the growing site-wide tritium plume are shown in Figures 3 through 13 depicting tritium plumes from 1968 through 1981. The reason these plumes were selected is to show how it was believed the tritium migrated into and beyond the area around the 618-11 Burial Ground. Figure 3 shows a narrow, southerly limb of the plume extending to well 699-1-18 and between wells 699-8-17 and 699-8-32 in 1968. In the next year, 1969, the leading edge of the plume has migrated further east to wells 699-2-3 and 699-8-17 (see Figure 4). The slow easterly and southern migration of this limb was believed by the authors to have continued until 1973 when the plume apparently reached well 699-13-1A. It is unknown if tritium was present in this area prior to 1973 because well 699-13-1A was not drilled until 1973. Figure 3 shows that the migration of tritium into this area from the west was not likely before 1969 because tritium had not arrived at well 699-8-7. Between 1973 and 1978, the depiction of the plume extent and distribution changed little on this southern boundary. In reality, tritium concentrations were peaking at 390,000 pCi/L in well 699-13-1A, but the annual average values were less than the 300 pCi/mL (300,000 pCi/L) contour level. As a result, the plume maps do not indicate this rise until 1979 (Figure 11), at which time the average reached 905,000 pCi/L. The 1978 plume map, Figure 10, should have indicated that well 13-1A was greater than 300,000 pCi/L because the reported mean was 301,000 pCi/L. Actually, the mean should have been 460,000 pCi/L because an analysis of 1,100,000 pCi/L was not included in the average. This datum resides in the HEIS database and in project records, but for some reason, it was not included in the evaluation. Regardless, the 1979 interpretation extended the 300,000 pCi/L tritium contour beyond well 699-13-1A as depicted on Figure 11.

Interpretations of tritium plume distributions differed between 1979 and 1980 in a very important and fundamental way and yet were based on a common assumption. The common assumption was that there was a continuum of contamination between the well 699-20-20 area and the vicinity of the 618-11 Burial Ground. Because there are no data in the intervening area, this assumption cannot be verified. The major difference is the flow path that connected the two areas. Because the investigators connect these two areas of high tritium concentration, it is reasonable to conclude that the authors had no indication that another source of tritium existed near wells 699-13-1A and 699-13-1B. The 1979 plume was based on the notion that contamination in the vicinity of well 699-13-1A migrated into the area through a narrow flow path from the west, south of well 699-15-15B and north of well 699-8-17. There are no intermediate control points along this narrow flow path to support this interpretation. In 1980, the data were interpreted to indicate that contamination was reaching the area through a narrow flow

path from the northwest, east of well 699-15-15B and west of well 699-17-5, both of which had lower tritium concentrations. As in the 1979 interpretation, there are no intermediate wells along this flow path to support the interpretation.

The problem with the 1980 plume depiction is that three critical data were incorrectly accounted for in the interpretation. Data for wells 699-20-20 (583 pC/ml) and 699-15-26 (250 pCi/ml) were incorrectly included in regions of lower concentration and the mean tritium concentration for well 699-13-1A was determined to be 297 pCi/ml (297,000 pCi/L), slightly below the 300 pCi/ml contour. If these data are factored into the plume depictions, a significantly different plume is the result (Figure 13). This redrawn plume is similar to that shown for 1981 (Figure 14) with the exception that the 1981 tritium concentrations in well 699-13-1A dropped below 30 pCi/ml. If this flow path is correct, wells upgradient of the 618-11 Burial Ground area should have contained tritium concentrations at least as high or higher than 1,100,000 pCi/L. One well (699-26-15A) in this flow path and upgradient contained tritium as high as 1,600,000 pCi/L in 1970 and remained above 1,000,000 pCi/L until 1979. This indicates that a source of tritium existed at levels sufficient to explain high levels that appeared later in wells 699-13-1A and 699-13-1B.

Geologic and well completion data must be used to help judge the merits of either interpretation. In 1979, data from wells 699-15-15B and 699-17-5 may have been used to infer an apparent barrier to southern migration of the plume. This interpretation is supported by the geology at these locations. Both wells are screened across the water table but the water table is near the Hanford formation/Ringold Formation contact. The wells recover slowly after removing water, indicating that the hydraulic conductivity is low, consistent with the Ringold Formation characteristics. The 1979 interpretation is consistent with an assumption that the low hydraulic conductivity region is continuous between wells 699-15-15B and 699-17-5, forming a hydrologic barrier to groundwater flow and contaminant migration. The 1980 interpretation may have assumed that the low conductivity regions are isolated to the vicinity of the wells and a higher conductivity zone exists between the two wells. The Ringold Formation has a shallow dip from east to west through the area and it outcrops along the eastern bank of the Columbia River east of the area. Recent interpretations show the Ringold Formation at the water table in an area east of the Energy Northwest Reactors (Figure15). However, since the saturated part of the Hanford formation is thin, and the dip of the contact is shallow, the zone of lower transmissivity may extend for a considerable distance to the west. As contaminants moved southeast out of 200-East Area in fairly high transmissive sediments, they reached this lower transmissive Ringold sediment high where they split into two flow paths, directly east to the river and around the west side where the Ringold sediments dipped below the water table. See Figures 3, 4 and 5 for an indication of this phenomenon.

The Ringold Formation is not encountered in shallow wells located just north of this area apparently due to erosion associated with the Ringold and Koontz Coulees visible east of the river. The top of the Ringold Formation was eroded to a lower elevation north of wells 699-15-15B and 699-17-5 by floodwaters moving from east to west across the area. Erosional features associated with the braided floodwater streams as seen in the coulees to the northeast likely extend onto the Hanford Site and could provide a flow path to the area of the 618-11 Burial Ground. At present no data has been found to support or refute the presence of an erosionally controlled flow path.

The ancestral Columbia River flowed through this area, in a southeast to southerly direction and may also have resulted in high transmissivity. This accounts for this same orientation of topographic features that we now see on the ground surface (Figure 16). If the river eroded into the Ringold sediment between wells 699-15-15B and 699-17-5, a transmissive zone may exist,

allowing the tritium plume to continue migrating into the 618-11 Burial Ground area from the northwest. The presence of such a zone that is continuous is, however, speculative.

The conceptual models are based on the information that well 699-17-5 is in an area of low transmissivity and, therefore not in a dynamic portion of the groundwater flow system. This explains why historical tritium concentrations in the well have been low. A major anomaly is that the well has consistently contained elevated levels of nitrate. The site-wide tritium and nitrate plumes had a common source and emanated from 200-East Area together with little chance that they would be separated by natural reactions in the groundwater system. Because tritium concentrations have been low in the well, the nitrate must be from a different source that contained no tritium. At the current time, there are no explanations for this observation.

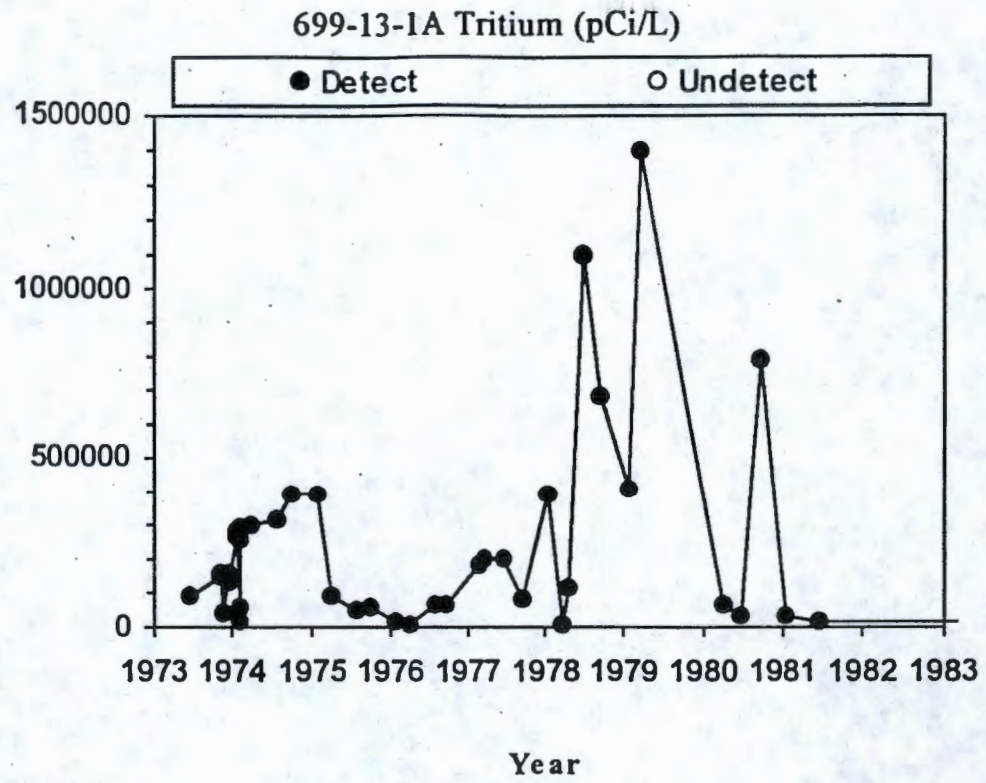
618-11 Burial Ground Source

The second model that could explain the elevated tritium concentrations in wells 699-13-1A and 699-13-1B is based on a 618-11 Burial Ground source. These wells are 1,400 feet downgradient from a burial ground that received waste possibly containing tritium at unknown concentration. The burial ground began receiving waste 10 years before and stopped receiving waste 6 years before the first samples were collected in the two wells. This is sufficient time for any tritium released to the groundwater to migrate the 1,400 feet to the wells. In addition, the type of waste disposed into the burial ground could reasonably be expected to easily supply tritium at levels found in the two wells. Finally, this model is the simplest model to explain the historical values because of its close proximity and upgradient position to the wells. It does not require a sophisticated and lengthy, narrow flow path to explain the results. This is further supported by the recent high tritium concentrations detected just downgradient of the burial ground, but not upgradient.

Summary

Two conceptual models have been proposed to explain historical elevated tritium concentrations in wells 699-13-1A and 699-13-1B. The first model consists of the migration of a site-wide tritium plume emanating from 200-East Area that arrived at the time the elevated tritium levels were observed in the wells. Two differing pathways have been presented in historical reports, but on further examination and consideration of more recent data, only a pathway from the northwest is considered credible. It is difficult to confirm the validity of the first model without additional geologic evidence, although the timing of the tritium detection in the wells is consistent with a 200-East Area source. The second model consists of tritium released from wastes disposed in the 618-11 Burial Ground reaching the groundwater beneath the site, and then migrating 1,400 feet to the wells.

Both models explain the timing and high level of the historical elevated tritium concentrations. The arrival of the site-wide tritium plume and active period of the 618-11 Burial Ground are both consistent with historical tritium levels in wells 699-13-1A and 699-13-1B. The level of tritium in the wells is consistent with high tritium concentrations in wells "upgradient" in the site-wide plume (699-26-15 and 699-27-8). Suspected tritium levels in burial ground waste would also be sufficient to account for the elevated levels in the wells. Whatever the source, the fluctuating tritium concentrations are probably related the pumping history of the wells rather than fluctuations in the source.



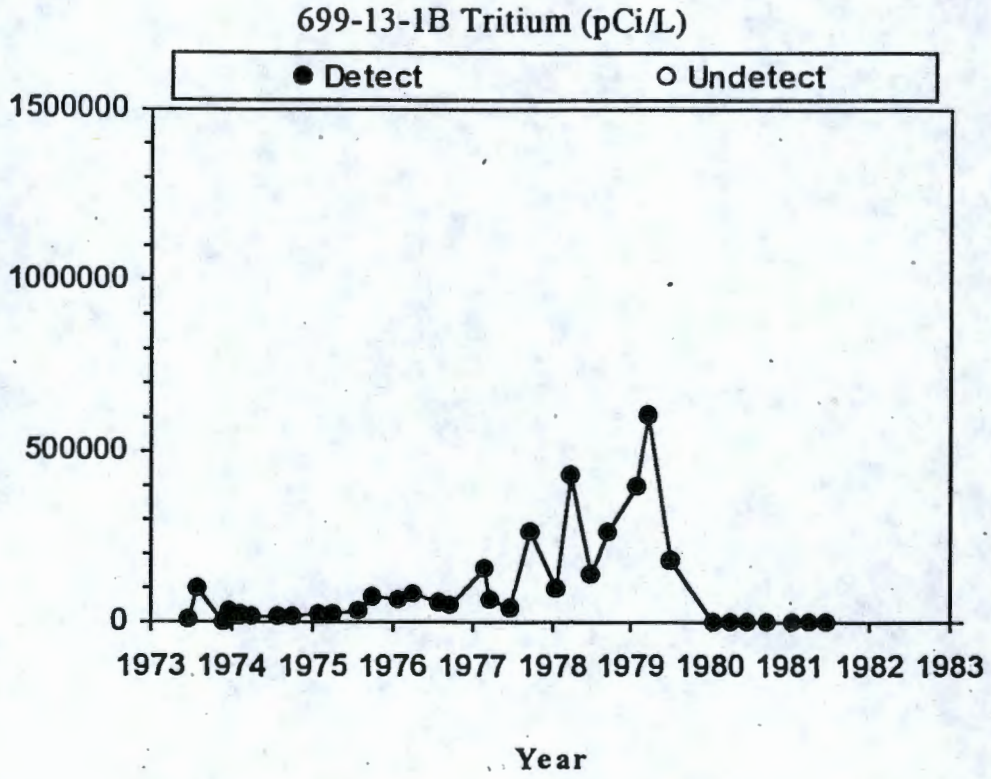


Figure 1. Historical Tritium Concentrations in Wells 699-13-1A and 699-13-1B.

ENGINEERING WORKSHEET

Prepared By:	Date:	Project:

Title/Subject:

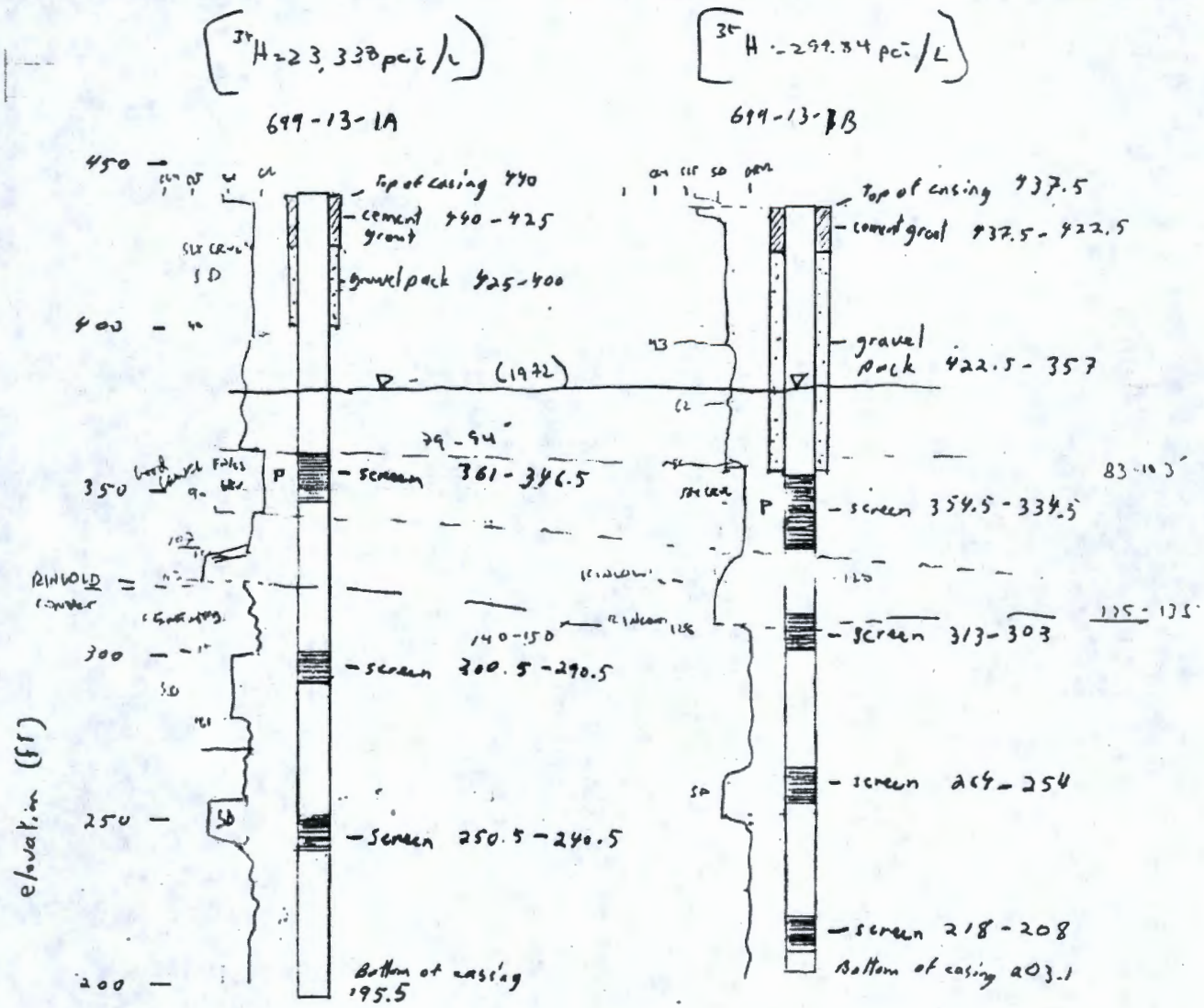


Figure 2. As-built Diagrams and Geology for Wells 699-13-1A and 699-13-1B.

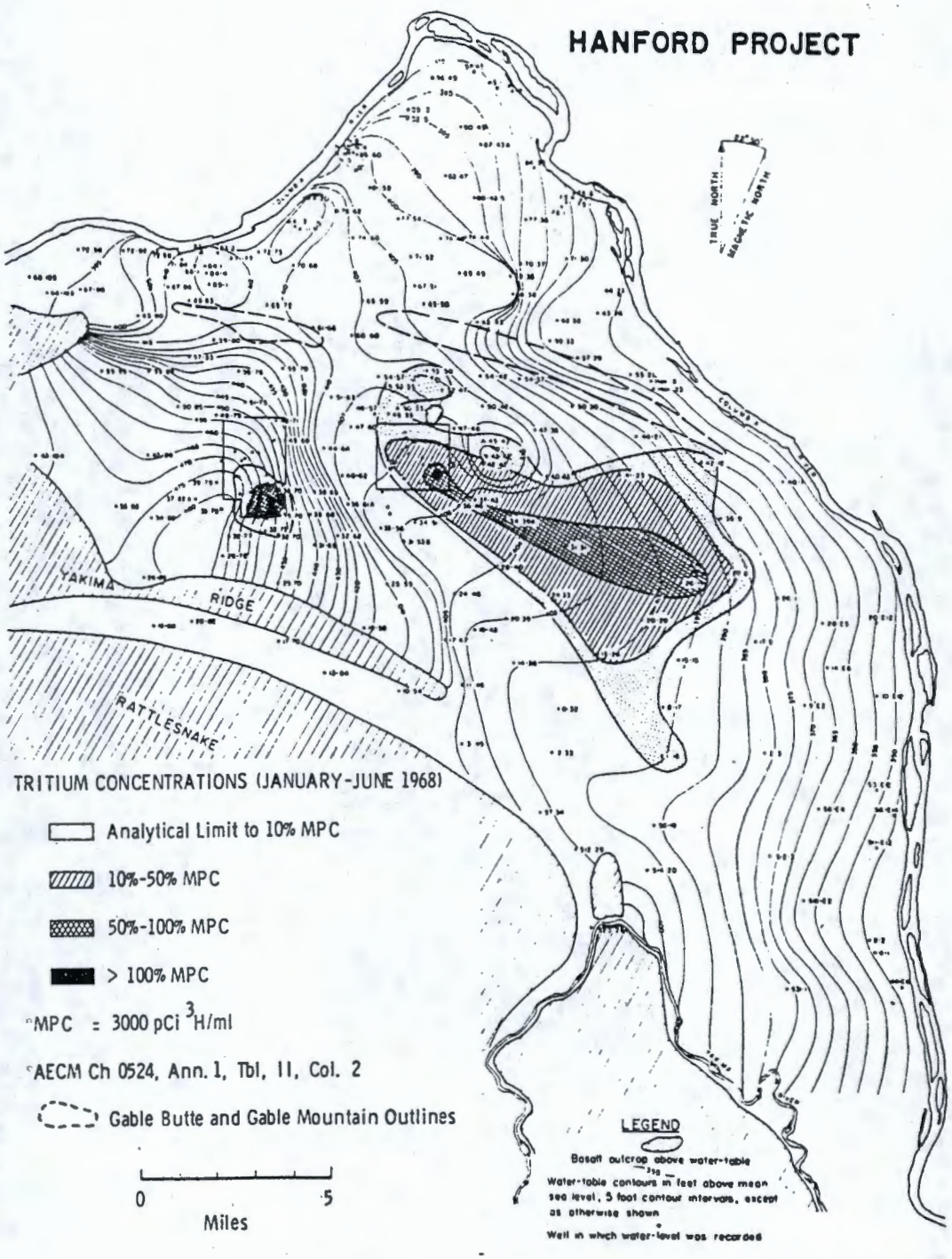


Figure 3. Tritium Concentrations in Unconfined Groundwater Beneath the Hanford Project, 1968.

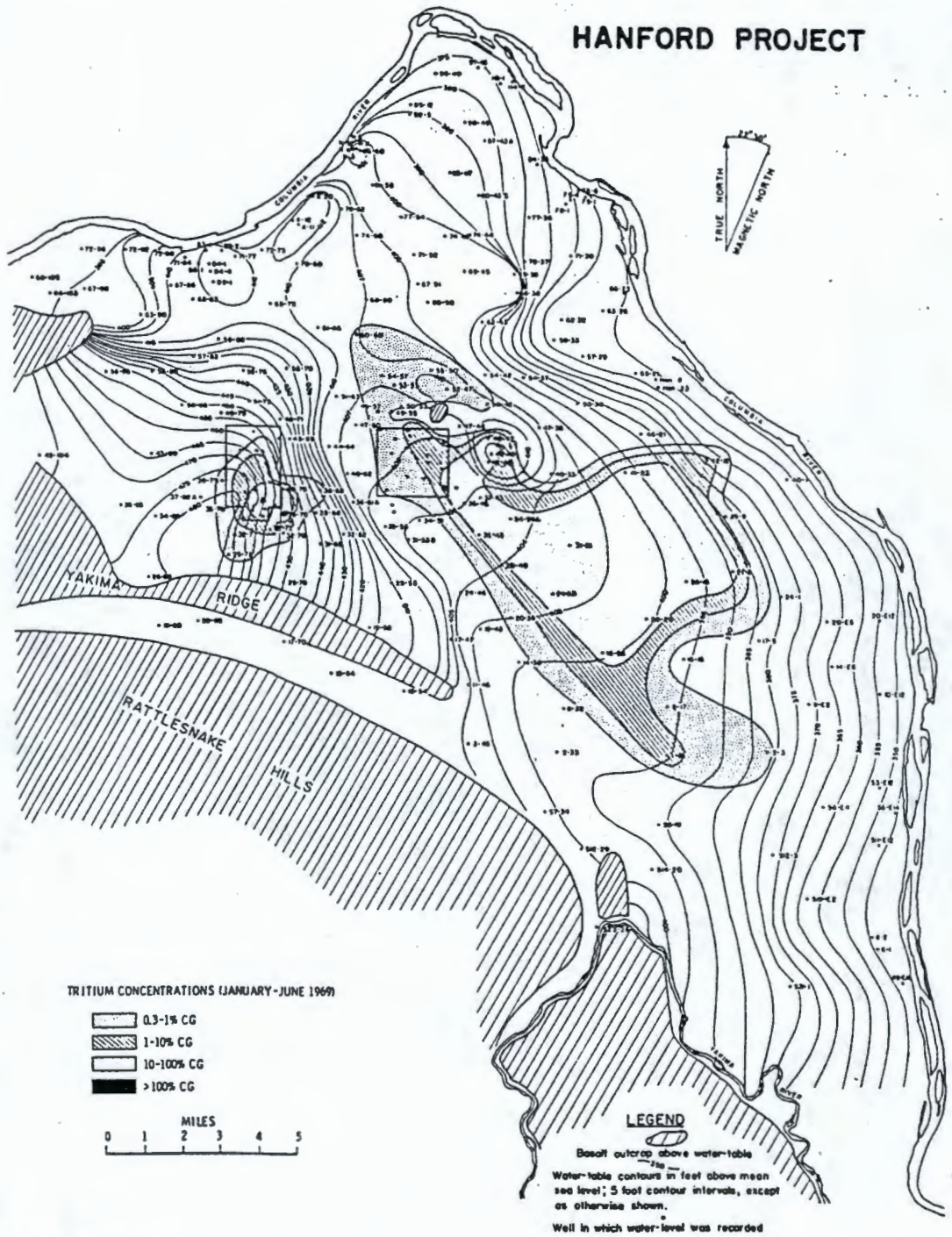


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Figure 4. Tritium Concentrations in Unconfined Groundwater Beneath the Hanford Project, 1969. Expressed as Percent of the Tritium Concentration Guide (3,000 pCi/ml).

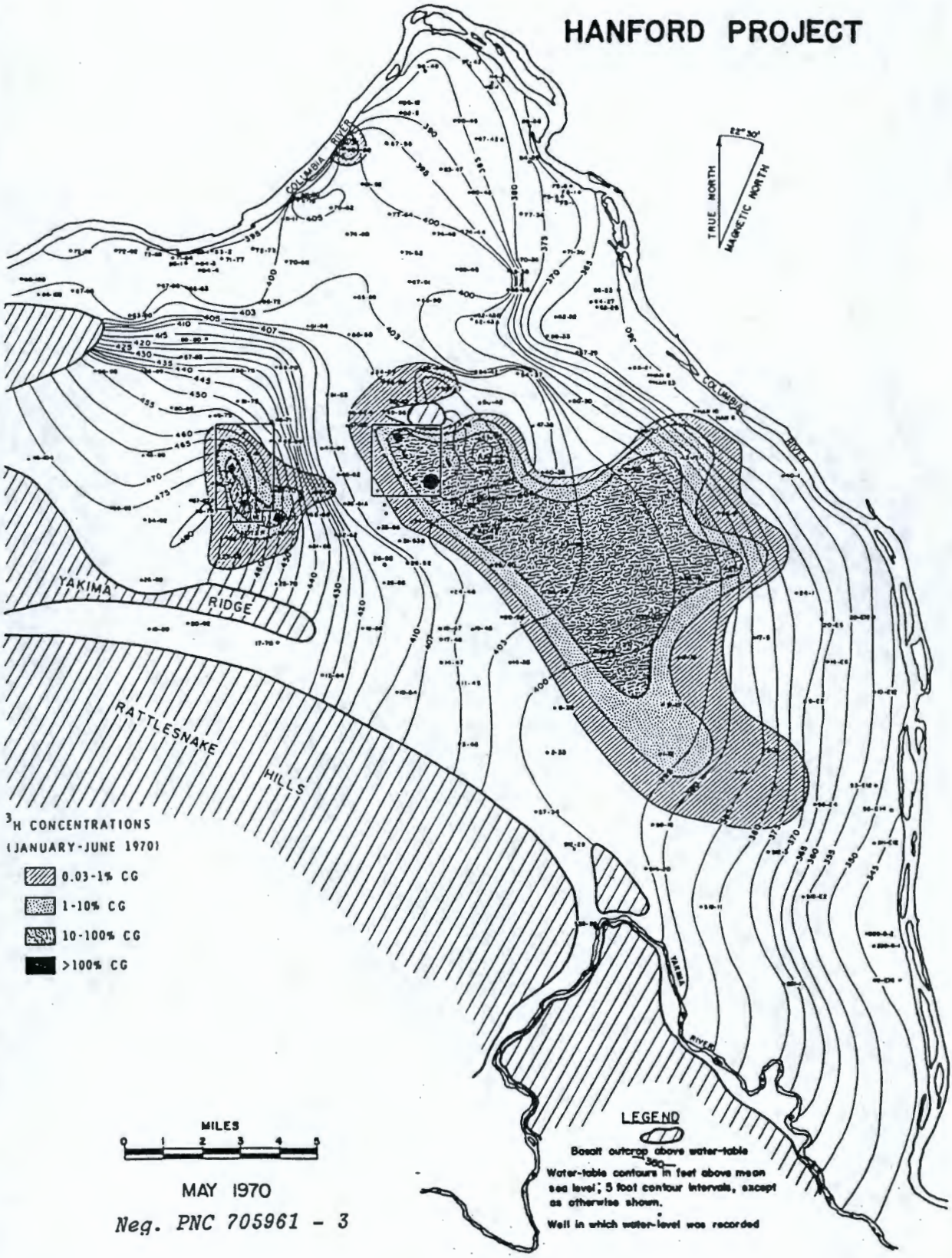

Figure 5. Tritium Concentrations in Unconfined Groundwater Beneath the Hanford Project. 1970. Expressed as Percent of the Tritium Concentration Guide (3.000 pCi/ml).

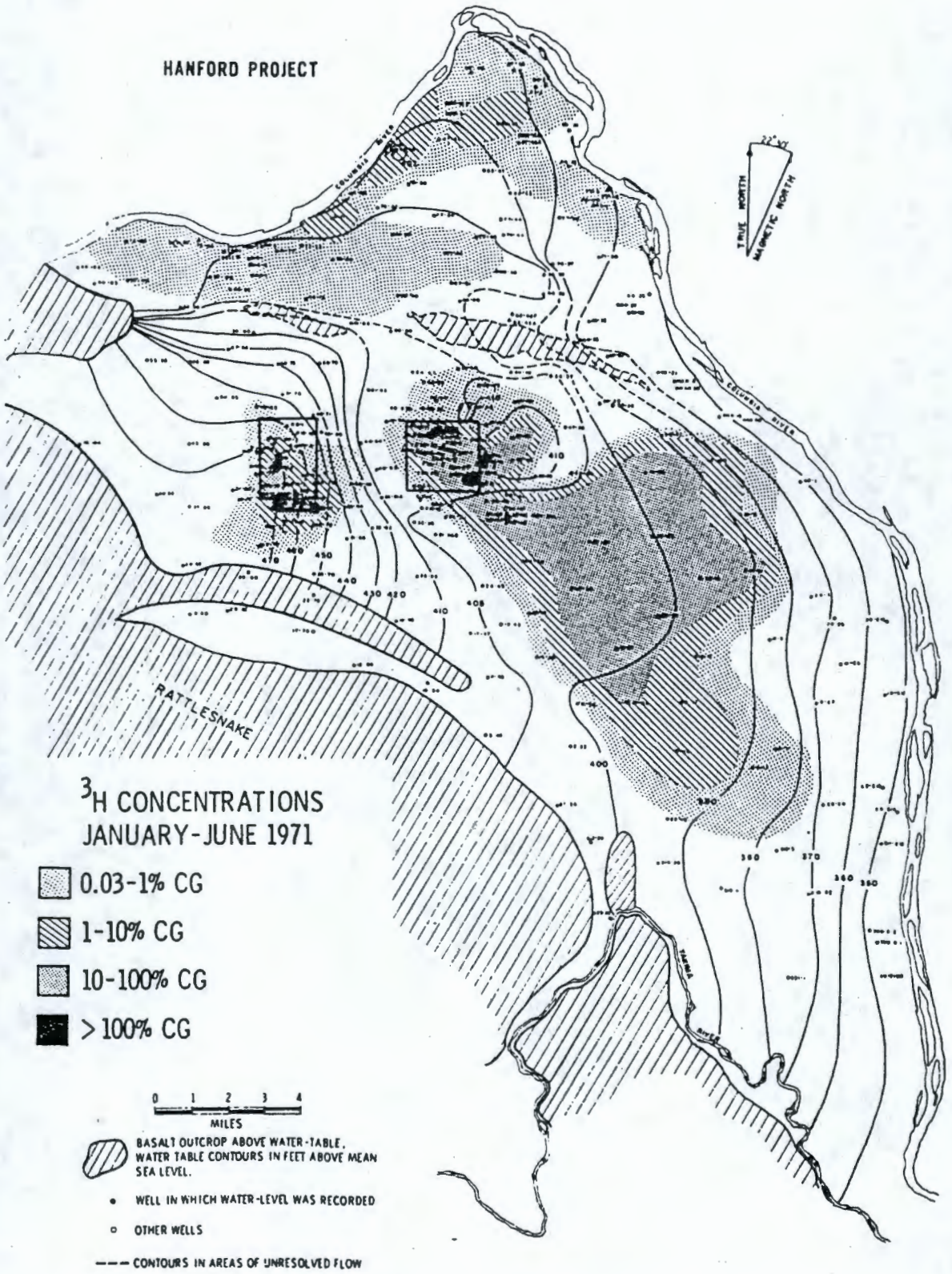

Figure 6. Tritium Concentrations in Unconfined Groundwater Beneath the Hanford Project, 1971. Expressed as Percent of the Tritium Concentration Guide (3,000 pCi/ml).

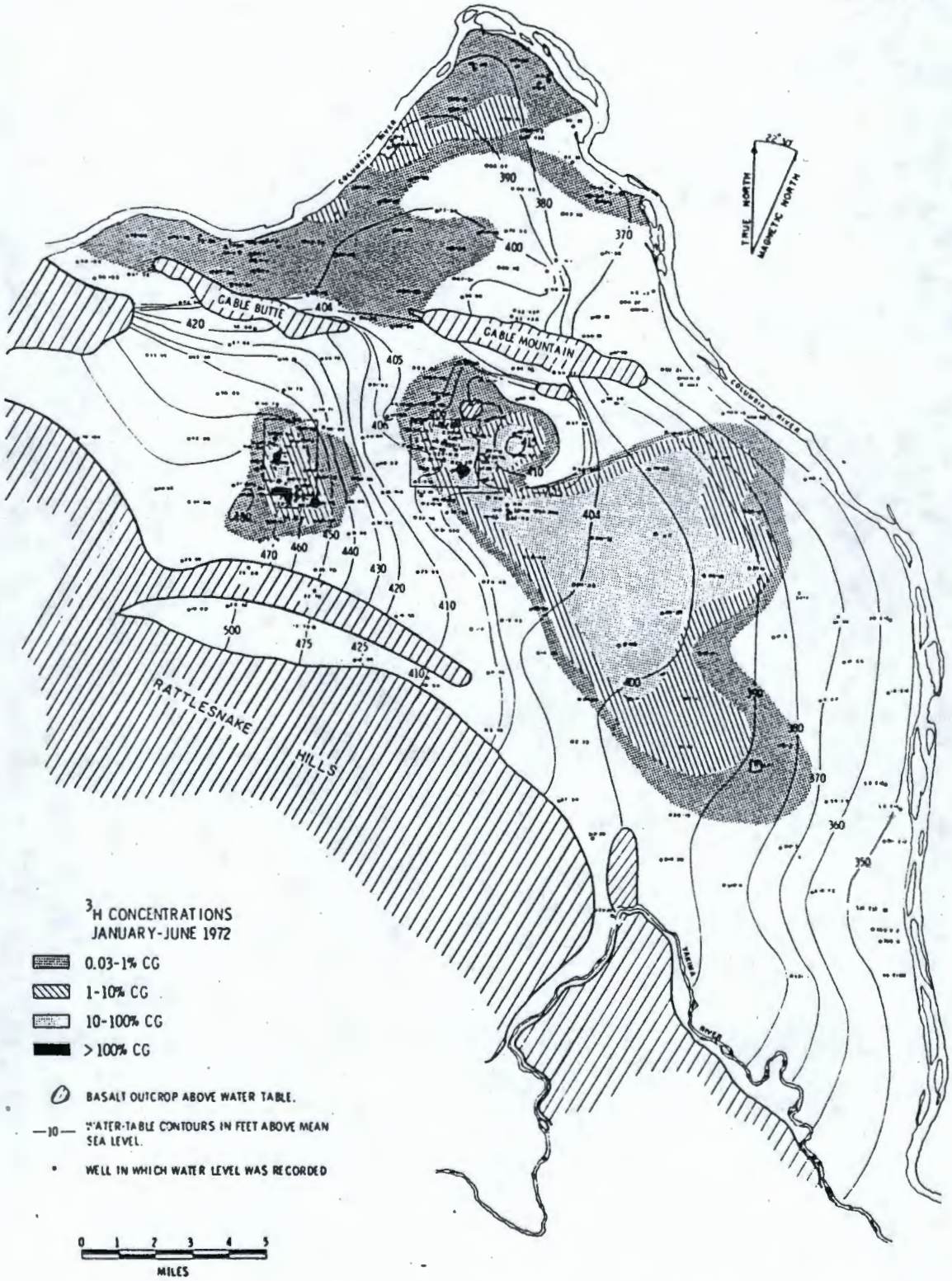

Figure 7. Tritium Concentrations in Unconfined Groundwater Beneath the Hanford Project. January-June, 1972. Expressed as Percent of the Tritium Concentration Guide (3,000 pCi/ml).

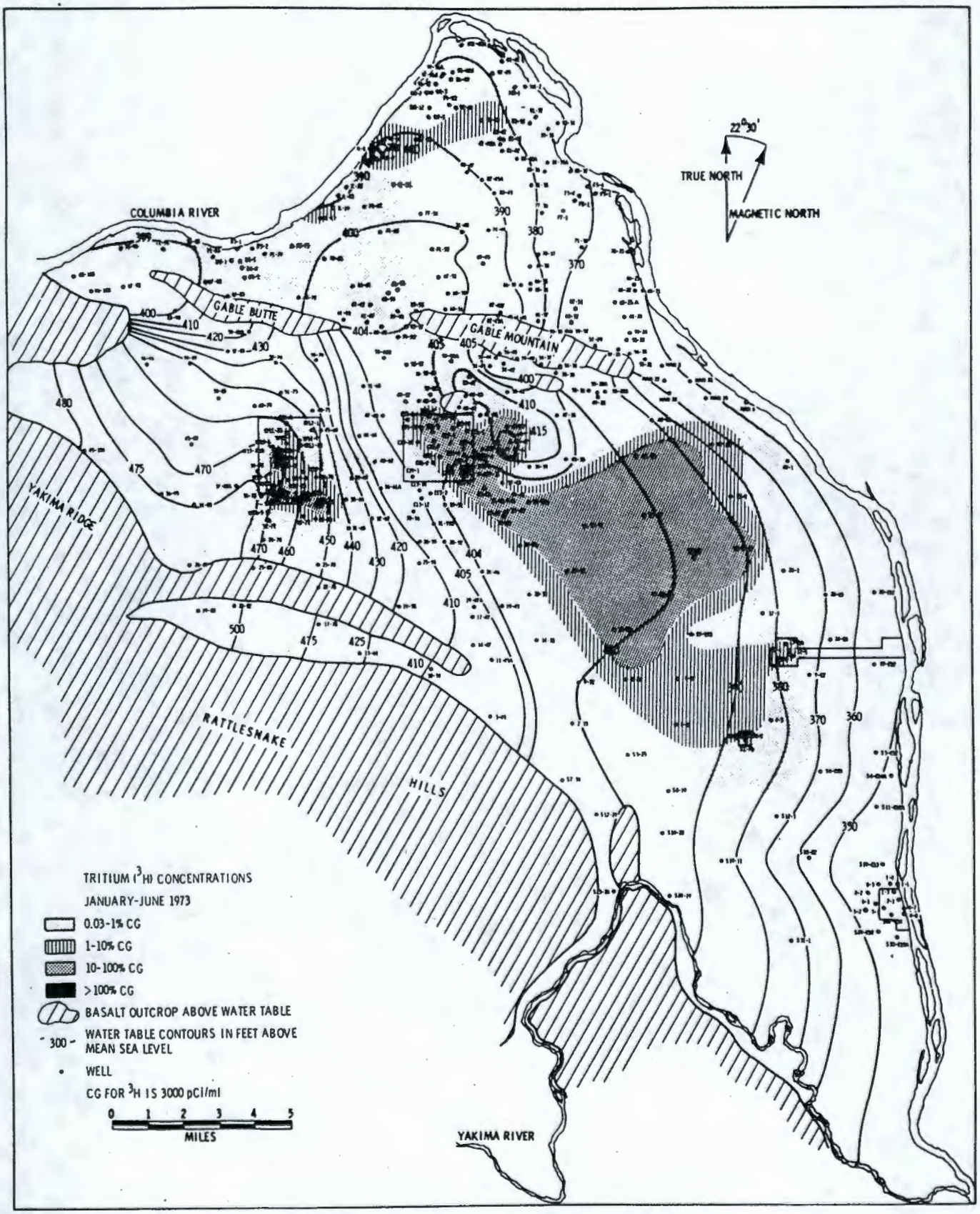

Figure 8. Tritium Concentrations in Unconfined Groundwater Beneath the Hanford Project, January-June, 1973. Expressed as Percent of the Tritium Concentration Guide (3,000 pCi/ml).

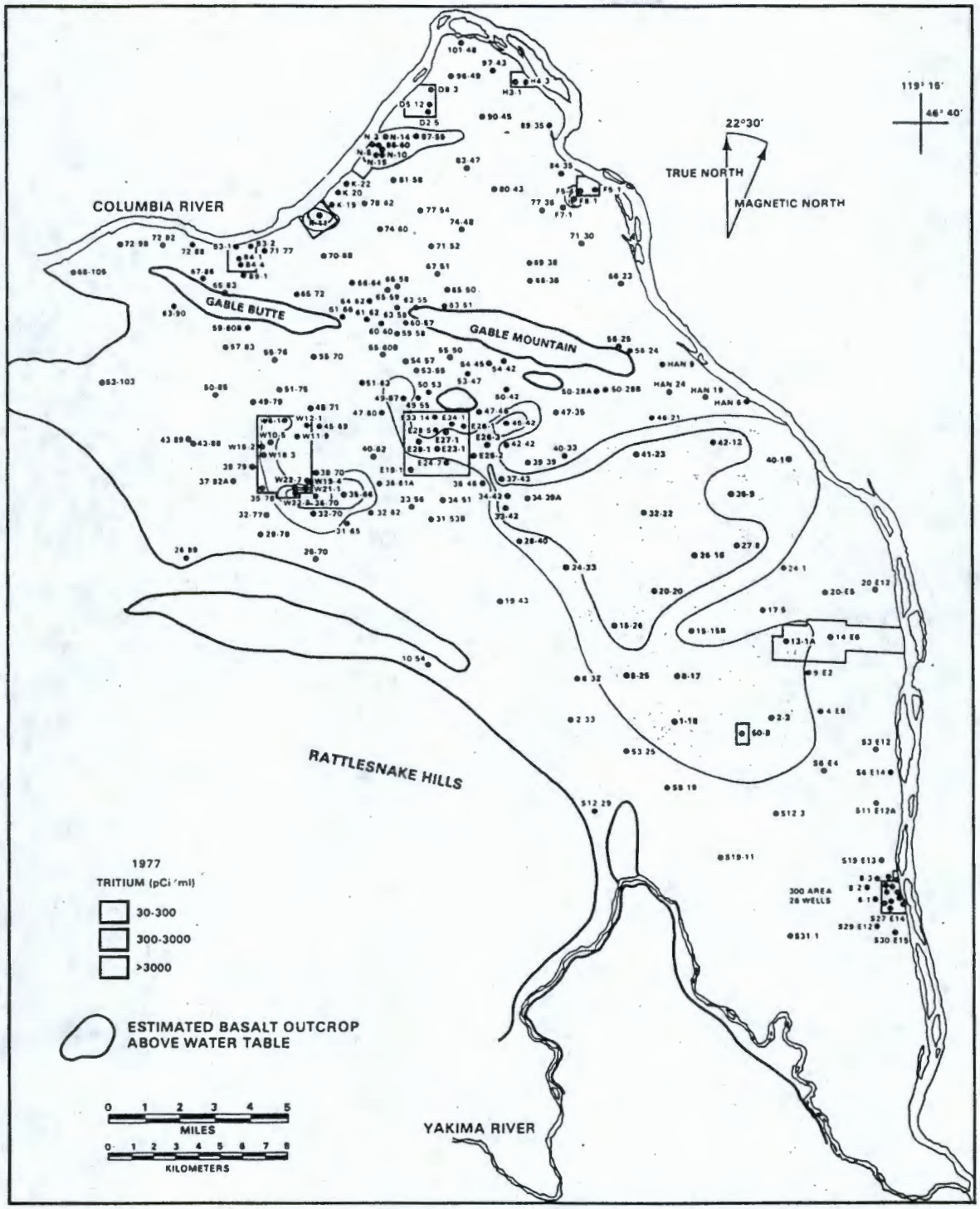

Figure 9. Tritium Concentrations in Unconfined Groundwater Beneath the Hanford Project, 1977.

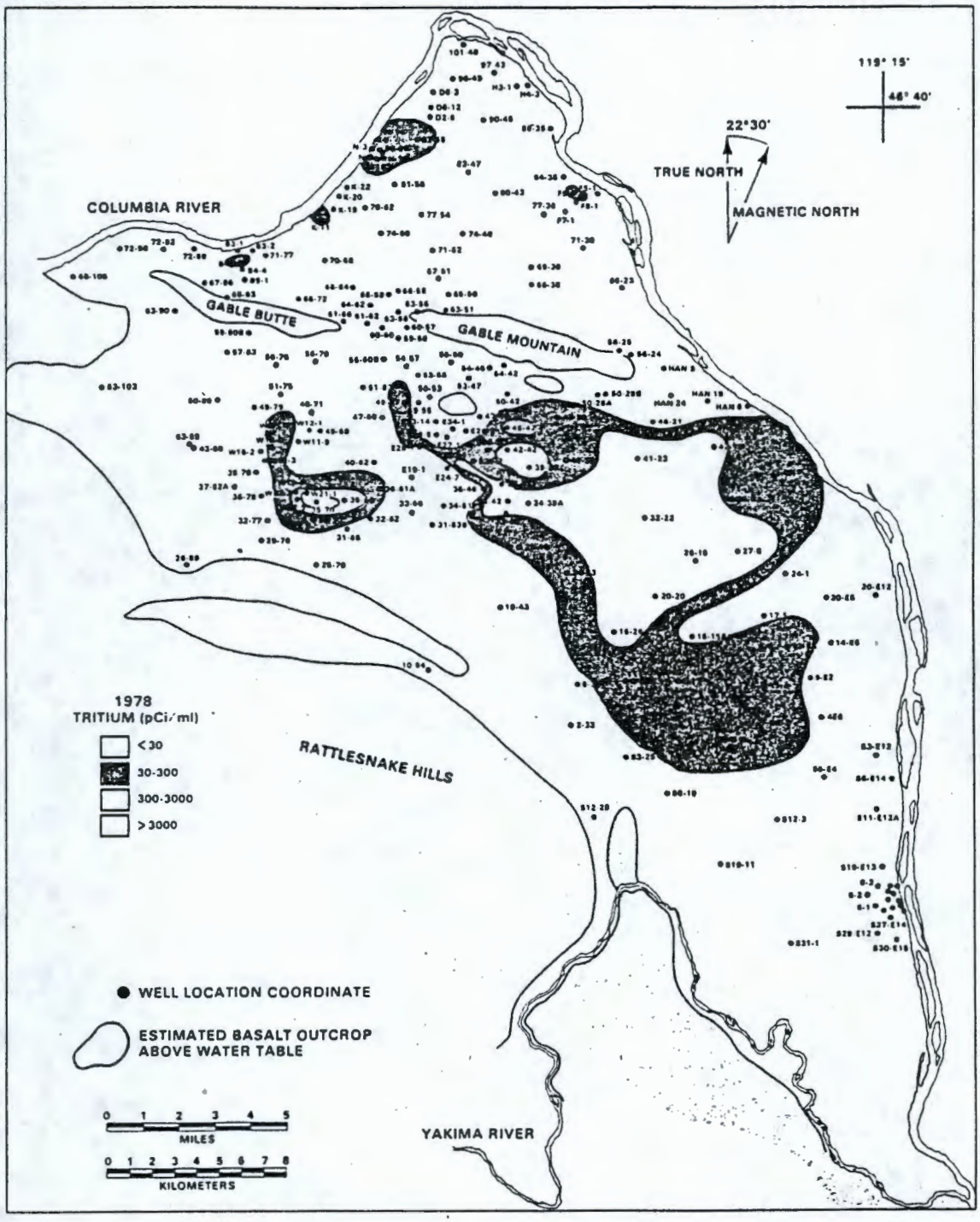

Figure 10. Tritium Concentrations in Unconfined Groundwater Beneath the Hanford Project, 1978.

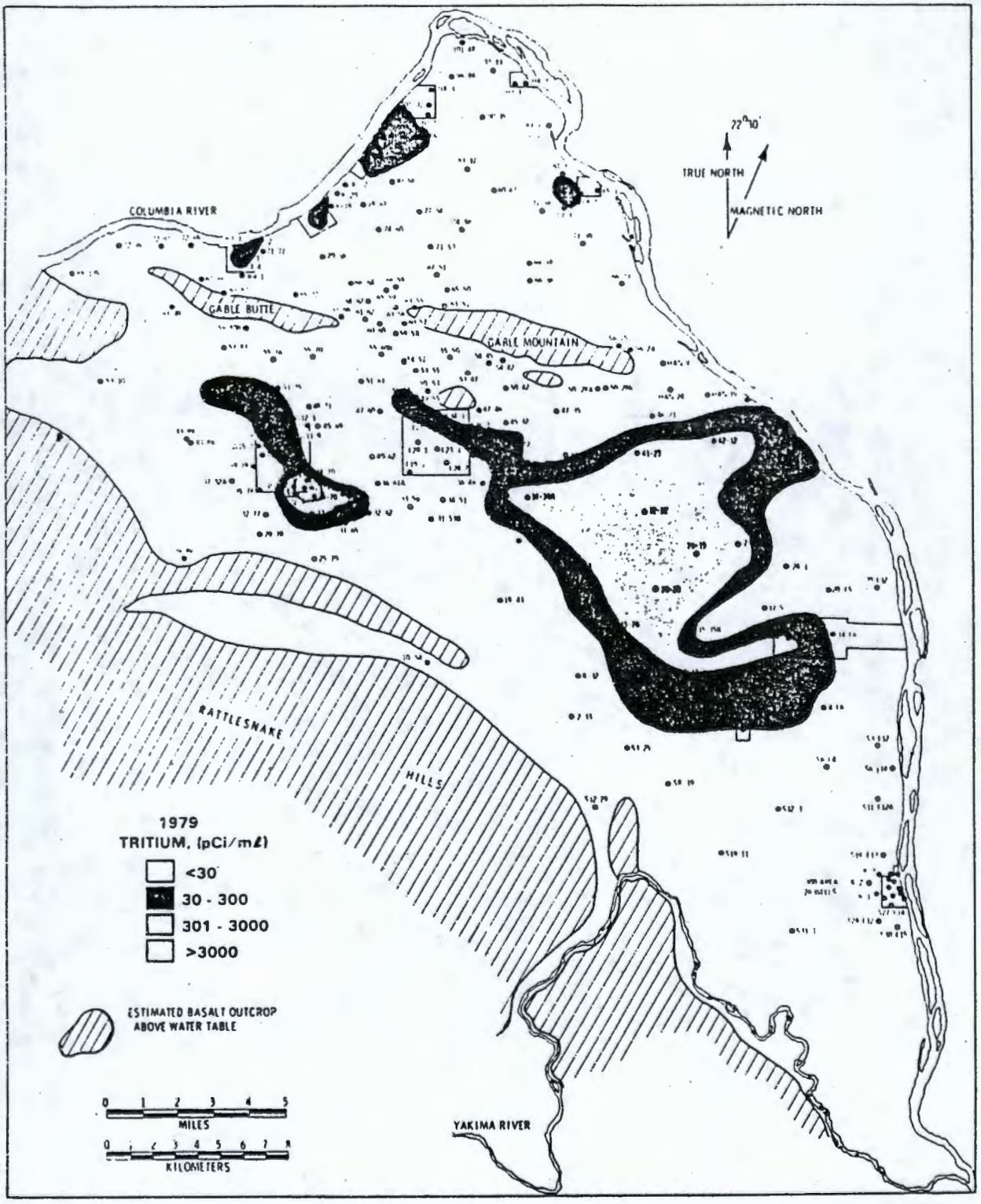

Figure 11. Tritium Concentrations in Unconfined Groundwater Beneath the Hanford Project, 1979.

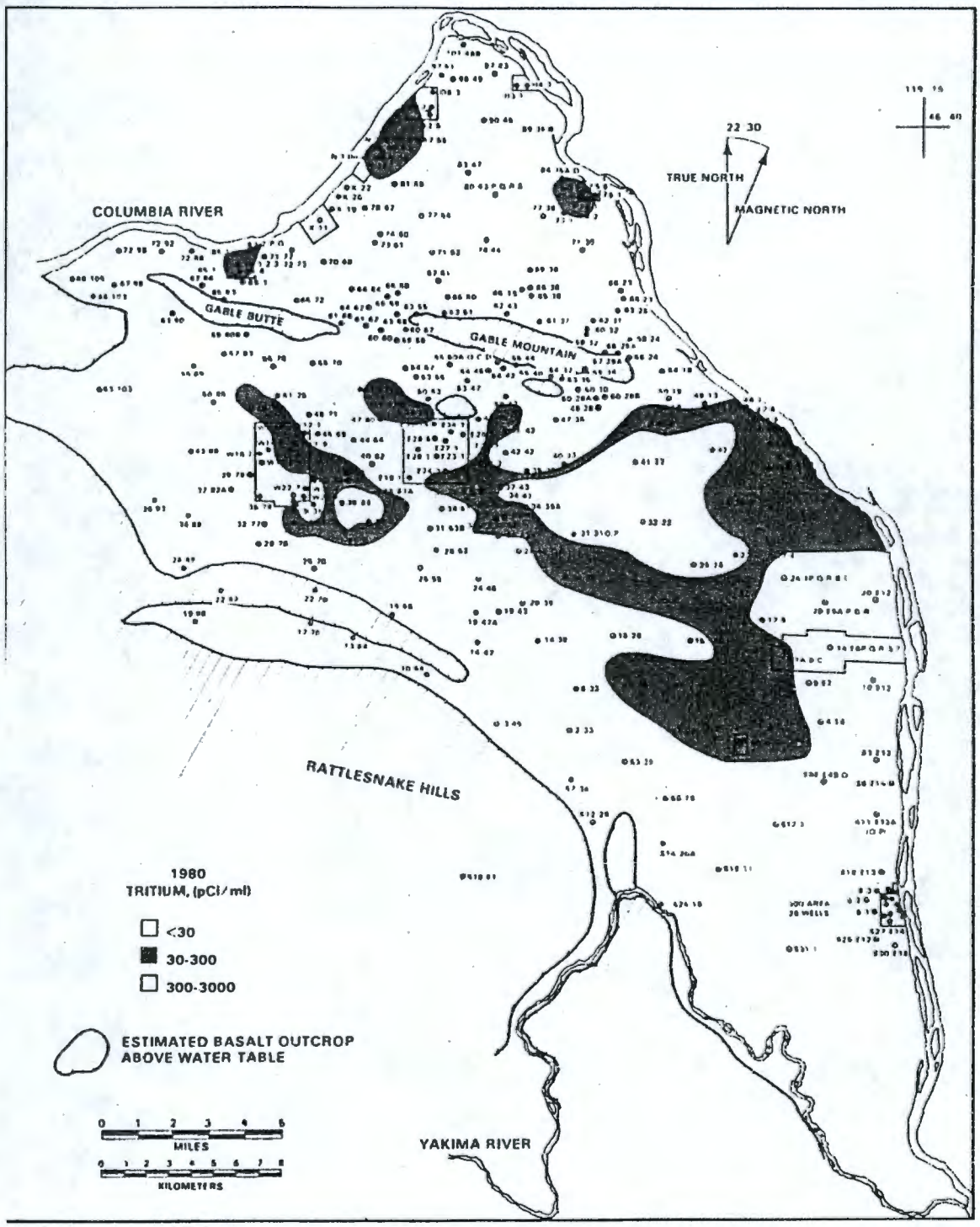

Figure 12. Tritium Concentration in Unconfined Groundwater Beneath the Hanford Project, 1980.

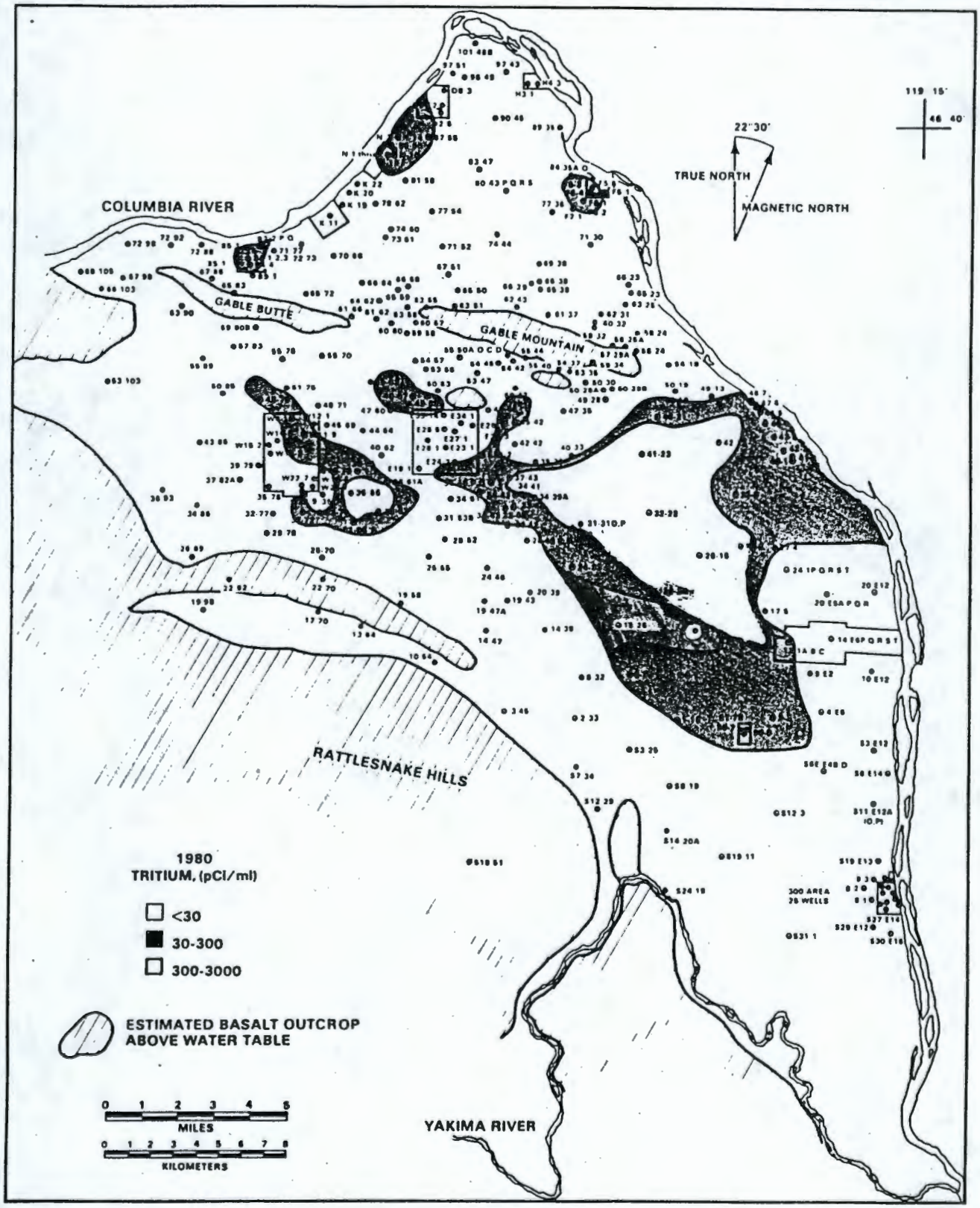

Figure 13. Re-drawn Tritium Concentrations in Unconfined Groundwater Beneath the Hanford Project, 1980.

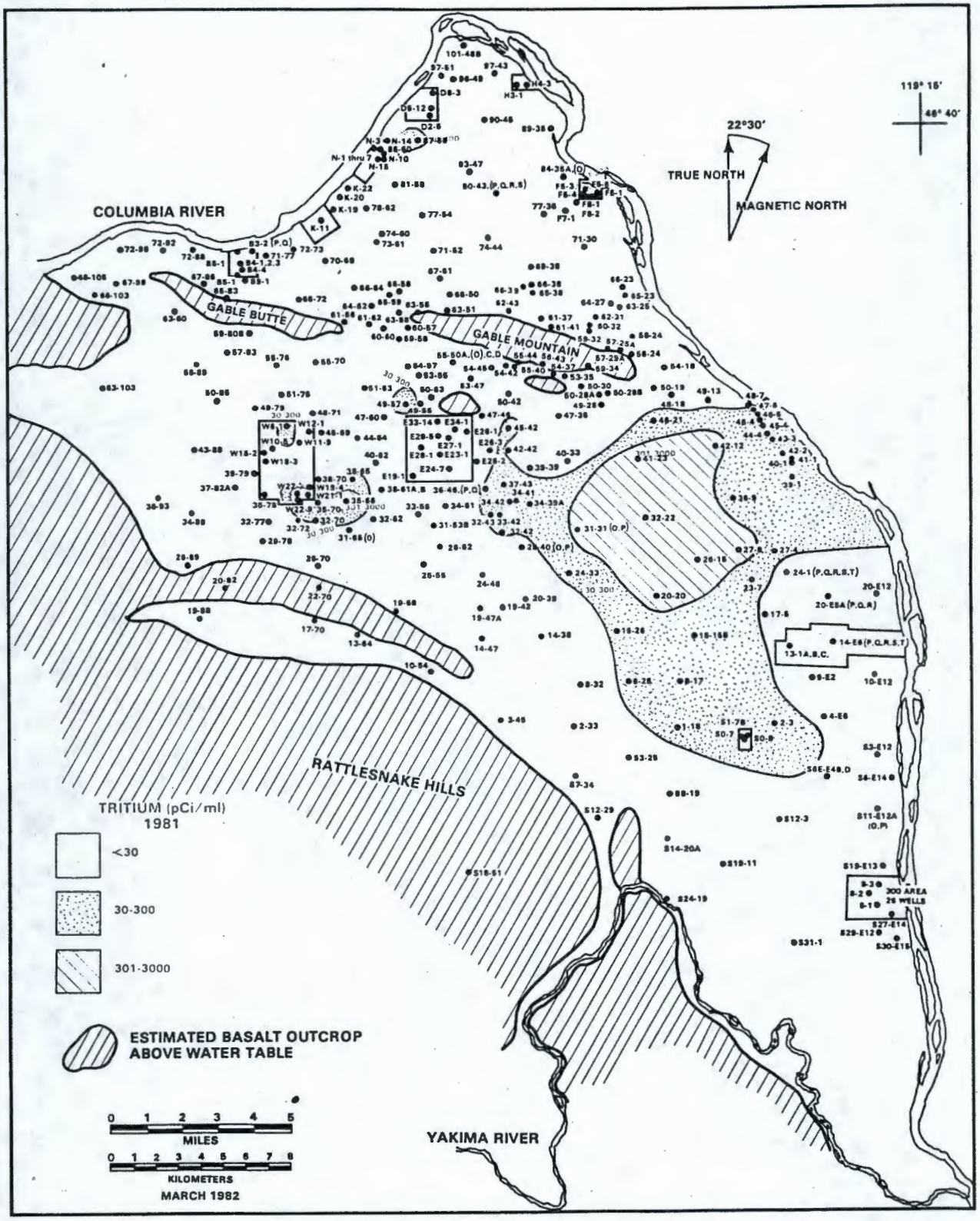

Figure 14. Tritium Concentrations in Unconfined Groundwater Beneath the Hanford Project, 1981.

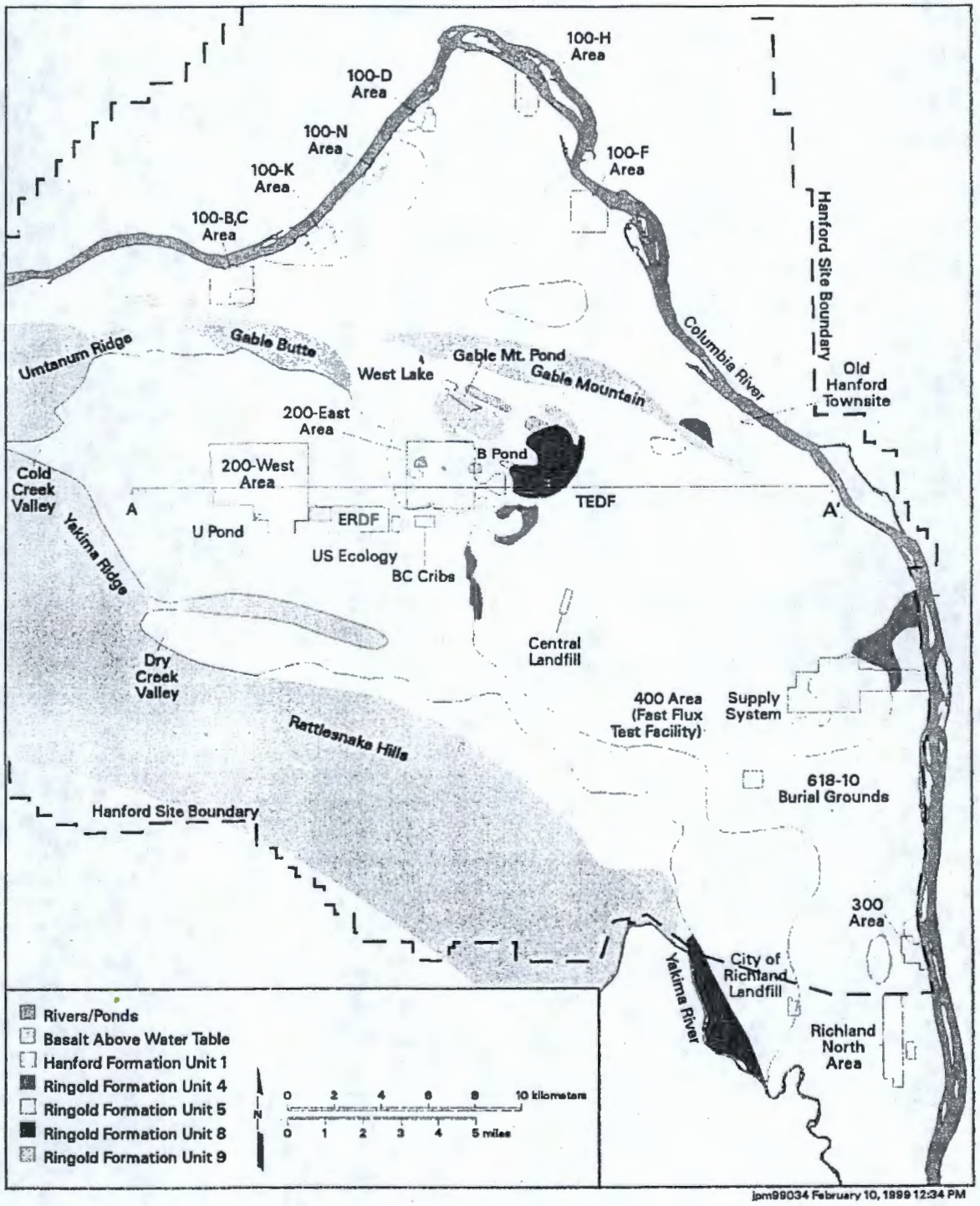

Figure 15. Hydrologic Units Present at the Water Table, 1998

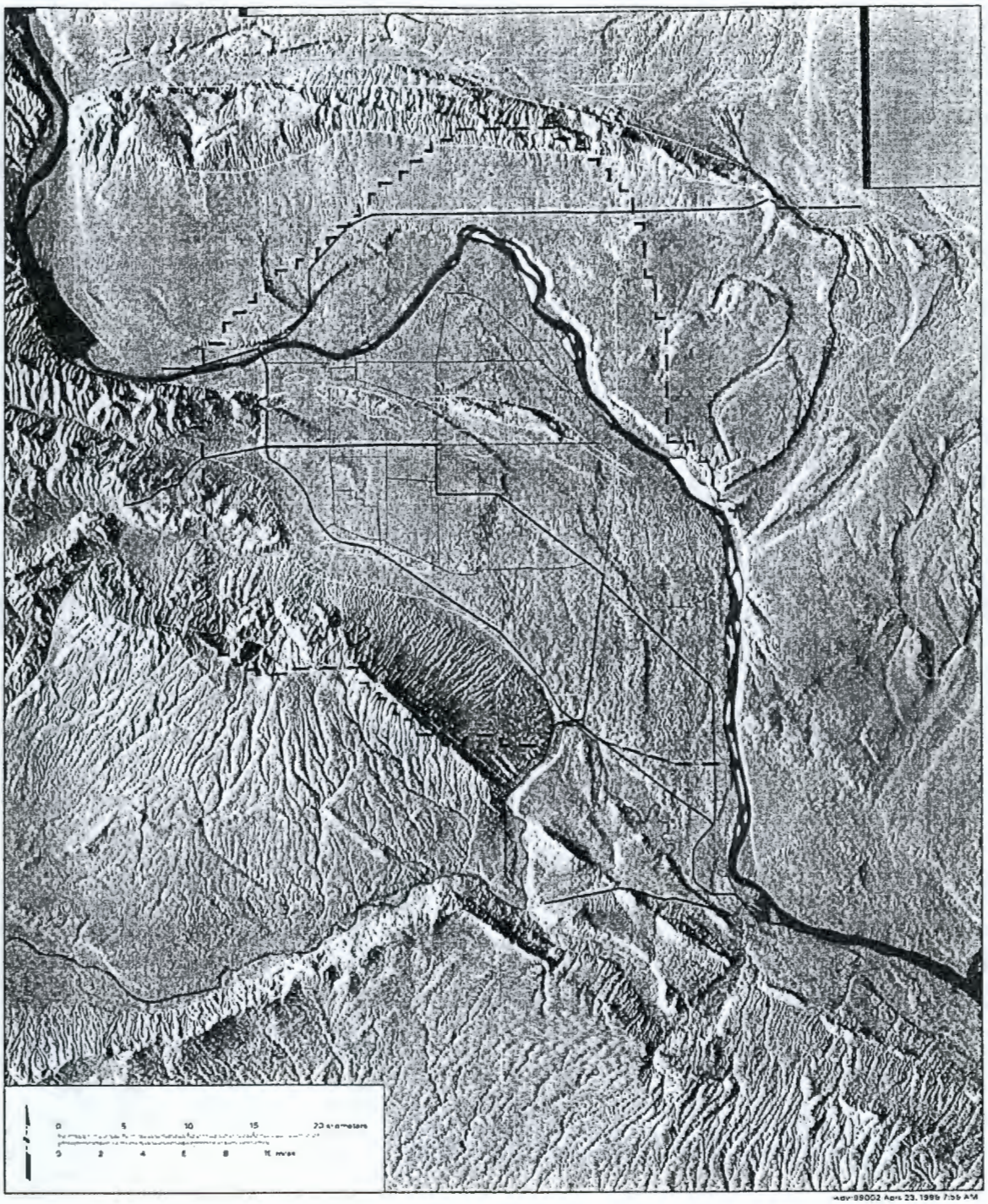

Figure 16. Digital Terrain Map of the Hanford Site and Surrounding Areas.