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# UMTRA PROJECT WATER SAMPLING AND ANALYSIS PLAN

# RIVERTON, WYOMING

March 1994

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# UMTRA PROJECT WATER SAMPLING AND ANALYSIS PLAN RIVERTON, WYOMING

March 1994

Prepared for
U.S. Department of Energy
UMTRA Project Office
Albuquerque, New Mexico

Prepared by
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Albuquerque, New Mexico

# EXECUTIVE SUMMARY

Surface remediation was completed at the former uranium mill site in Riverton, Wyoming, in 1990. Residual radioactive materials (contaminated soil and debris) were removed and disposed of at Union Carbide Corporation's (Umetco) nearby Gas Hills Title II facility.

Ground water in the surficial and semiconfined aquifers (known collectively as the "uppermost aquifer") below the former mill and tailings site has been contaminated. No contamination has been detected in the deeper, confined sandstone aquifer. The contaminant plume extends off site to the south and east. The plume is constrained by surface wetlands and small streams to the east and west of the site and by the Little Wind River to the south.

Fifteen monitor wells installed in 1993 were sampled to better define the contaminant plume and to provide additional water quality data for the baseline risk assessment. Samples also were collected from domestic wells in response to a request by the Wyoming Department of Environmental Quality in January 1994. No contamination attributable to the former uranium milling operations have ever been detected in any of the domestic wells used for potable supplies.

The following sampling and monitoring activities are planned for the remainder of fiscal year 1994:

- Collection and analysis of ground water samples from 27 monitor wells to observe trends in ground water quality since the processing plant was demolished and the tailings were removed. The samples will be analyzed for the same constituents as in 1993.

- Collection and analysis of surface water samples at eight locations to evaluate the potential impacts of contaminated ground water on human health and the environment.

- Measurement of ground water levels in all monitor wells when sampled, and installation of pressure transducers and data recorders in 10 existing monitor wells and in new, hand-installed wells at the two culverts carrying surface water under State Highway 138 (12 probes and three data loggers). The water level data will be used to enhance understanding of the ground water flow regime and the ground water/surface water interactions. The information collected at the culverts will be used to calculate the quantity of water flowing in the surface streams and the relative impact of ground water discharge. This data will be required to characterize the site as part of the upcoming UMTRA ground water program site observational work plan and to assess the feasibility of possible remedial alternatives.

- Evaluation of the reasons for the apparent downward gradient near the northwest corner of the former tailings pile.

- Collection of missing information on the domestic wells in the vicinity of the site.

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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ac | acre |
| DOE | U.S. Department of Energy |
| DQO | data quality objective |
| EPA | U.S. Environmental Protection Agency |
| ft | foot |
| FY | fiscal year |
| g | gallon |
| ha | hectare |
| km | kilometer |
| m | meter |
| $m^3$ | cubic meter |
| MCL | maximum concentration limit |
| mi | mile |
| MSL | mean sea level |
| pCi/g | picocuries per gram |
| pCi/L | picocuries per liter |
| QA | quality assurance |
| SOP | standard operating procedure |
| Umetco | Uranium Carbide Corporation |
| UMTRA | Uranium Mill Tailings Remedial Action |
| WDEQ | Wyoming Department of Environmental Quality |
| WSAP | water sampling and analysis plan |
| $yd^3$ | cubic yard |

# 1.0 INTRODUCTION

## 1.1 PURPOSE

This water sampling and analysis plan (WSAP) describes the ground water and surface water sampling efforts planned for fiscal year (FY) 1994. It identifies and provides justification for the sampling locations, analytical parameters, detection limits, and sampling frequencies for the monitoring stations in the vicinity of the U.S. Department of Energy's (DOE) former Uranium Mill Tailings Remedial Action (UMTRA) Project site in Riverton, Wyoming.

The regulatory requirements for monitoring ground water and surface water at UMTRA Project sites are based on the U.S. Environmental Protection Agency (EPA) regulations in 40 CFR Part 192 (1993) and the proposed EPA standards of 1987 (52 FR 36000). This WSAP bases monitoring decisions on these regulations, on UMTRA Project standard operating procedures (SOP) (JEG, no date), and on the *Technical Approach Document* for the UMTRA Project (DOE, 1989).

Ground water samples will be collected from monitoring wells to observe trends in water quality since completion of the surface remedial actions. The samples will also be analyzed to more completely distinguish the constituents and concentrations in the background ground water from those within the contaminant plume.

Surface water will be collected to evaluate the potential impacts of contaminated ground water on human health and the environment.

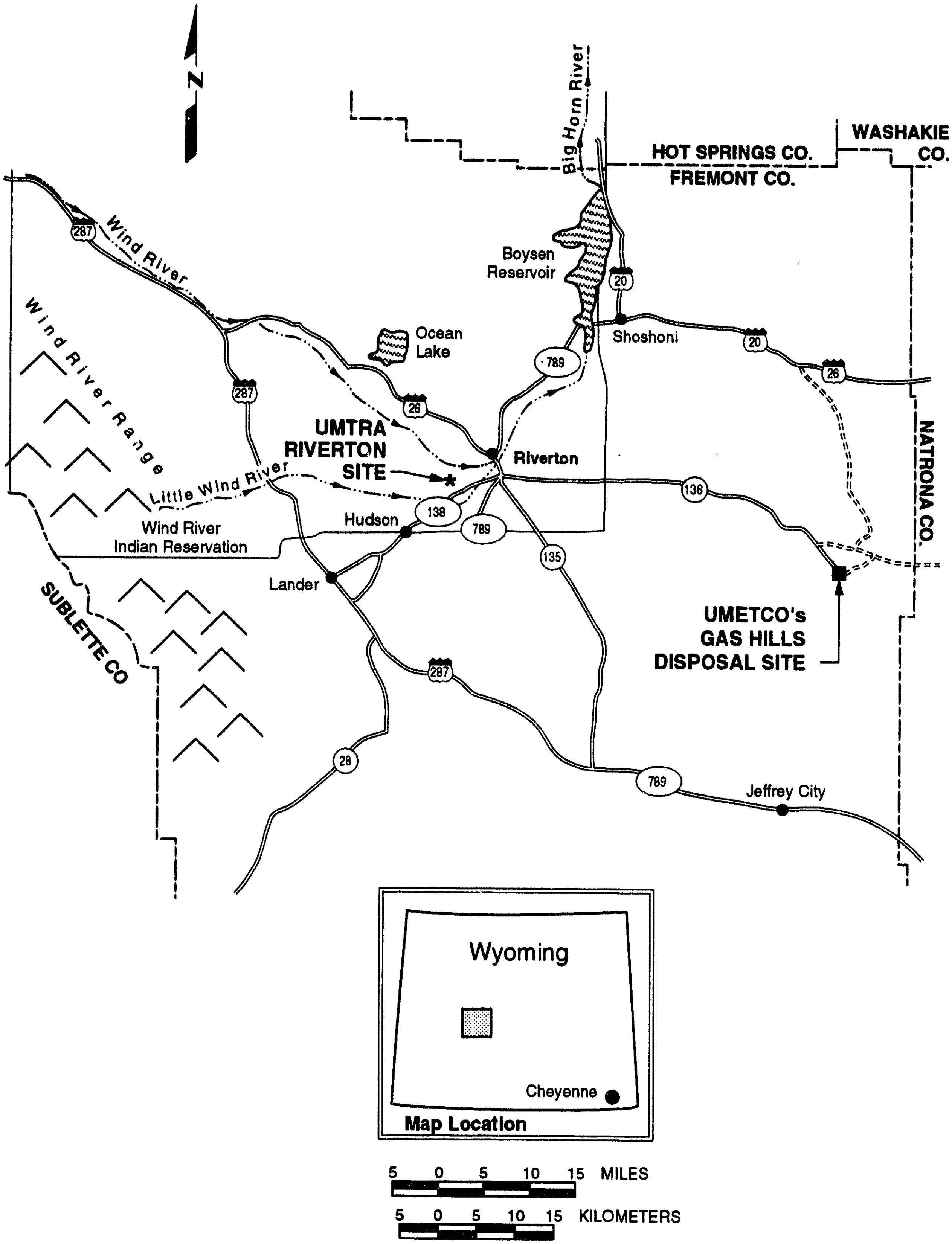
Water levels will be measured in the monitor wells and surface water bodies to delineate the direction and gradient of ground water movement and the interaction of the ground water and surface water regimes. Measurements of the flow in surface streams will be made to assess the relative significance of contaminated ground water discharging into the surface waters.

## 1.2 SITE LOCATION

The Riverton site, including the former mill site and tailings pile area, is located approximately 2.3 miles (mi) (3.7 kilometers [km]) southwest of the center of Riverton on the north side of Highway 138 in Fremont County, Wyoming (Figure 1.1). The site is on private land within the boundaries of the Wind River Indian Reservation (Northern Arapaho and Shoshone Indian Tribes). It is located in Township 1 South, Range 4 East, Sections 4 and 9 (Figure 1.2).

## 1.3 SURROUNDING LAND AND WATER USES

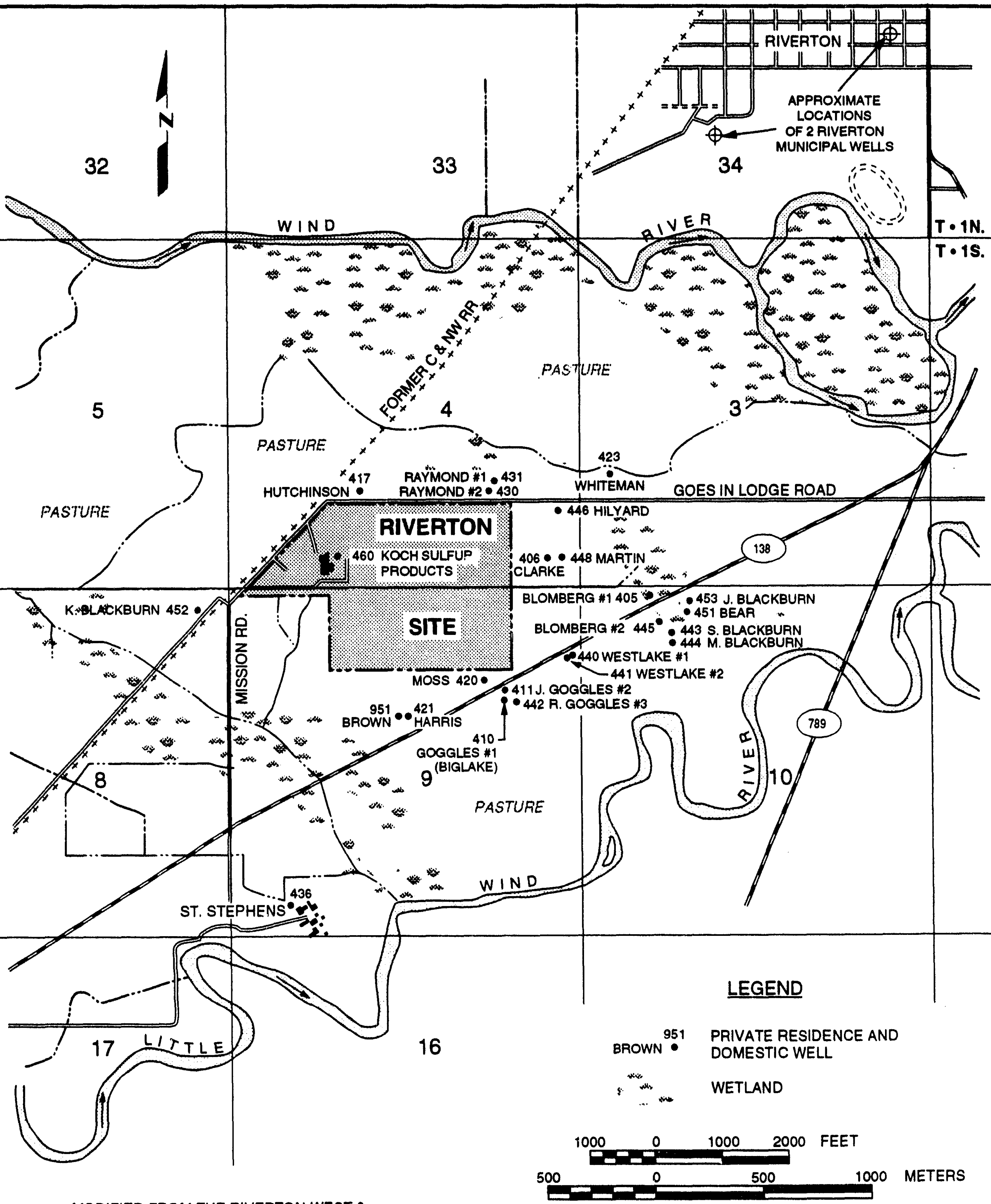
The predominant land use in the vicinity of the site is agricultural. Much of the area is used as pasture for cattle and horses. The primary crop in the area is hay. Some of the residences have vegetable gardens.




FROM DOE, 1987

**FIGURE 1.1**
**RIVERTON SITE LOCATION MAP**

MAC: SITE/RVT/WSAP/SITELOC




MODIFIED FROM THE RIVERTON WEST & ARAPAHOE 7.5 MIN. USGS QUADRANGLES TOWNSHIPS 1N AND 1S RANGE 4E

**FIGURE 1.2**
**LAND USE AND WATER WELL LOCATION MAP**
**RIVERTON, WYOMING**

MAC: SITE/RVT/WSAP/BASE-LANDUSEMAP

Water used for livestock, agricultural, and domestic purposes is withdrawn from wells. The locations of residences with wells are shown in Figure 1.2. Available information on the ownership of the wells, their total depths, casing depths, supply aquifers, and the uses of the water are presented in Table 1.1. Table 1.1 also includes the dates when these wells were sampled. All the wells used for potable water are at least 100 feet (ft) (50 meters [m]) deep and end in the confined sandstone aquifer.

Goes in Lodge Road borders the northern boundary of the former Riverton mill site (Figure 1.2). Three residences near the site are located on the north side of this road and one is on the south side. The land immediately adjacent to the eastern edge of the site appears on 1976 aerial photographs and during more recent site visits to have been used for pasture or crops continuously during and after site remediation. Three houses are located within approximately 1000 ft (300 m) of the eastern boundary of the site. These three houses share two wells.

The parcel immediately south of the site consists mostly of pasture land, but there are three residences between the southern edge of the site and State Highway 138 (also known as Rendezvous Road). There is one other residence on the north side of the highway and eight on the south side between the southeastern corner of the site and the first drainage channel to the east, approximately 3000 ft (915 m) east of the site. These residences all have private domestic wells completed in the confined sandstone bedrock.

St. Stephens Mission is also located south of State Highway 138, approximately 3200 ft (975 m) southeast of the site. St. Stephens has two wells: a bedrock well used for potable and domestic water, and a shallow alluvial well used for watering the recreational fields.

The Koch Sulfur Products Company plant is located near the northwest corner of the site. This facility previously made acid for the uranium process mill and is still in production. It uses the same water supply well that supplied the uranium mill. This well is 345 ft (105 m) deep and produces an average of 80 gallons per minute. Used process water from this facility flows into a retention pond south of the plant and then into a drainage ditch that runs to the south under State Highway 138 and into the Little Wind River.

The city of Riverton is located approximately 2 mi (3 km) northeast of the site. The city draws water from an irrigation canal fed by the Wind River during the summer growing season (May through September). It pumps water from wells during the rest of the year. There are a total of 12 active wells located between 1.5 mi (2 km) and 9 mi (15 km) from the site. Only two of these wells are within 2 mi (3 km) of the site (Figure 1.2).

All the Riverton wells are completed in the confined aquifers of the Wind River Formation and are commonly 400 to 900 ft (120 to 270 m) deep (Anderson and Kelly, 1976). The city has total water rights from the wells of 4.5 million gallons per day. In 1993, the city pumped a total of approximately 330 million gallons (1.25 billion liters) from the municipal well field (JEG, 1994).

**Table 1.1 Owners of domestic wells, TAC ID numbers, sampling dates, and well details, Riverton, Wyoming**

| Domestic wells[a] | TAC ID | Date sampled | Total/casing depth (ft) | Aquifer | Water use[b] |
|---|---|---|---|---|---|
| Blomberg #1<br>??? Rendezvous Rd. | 405 | 1981 83<br>84(2X) 85<br>90 91(3X)<br>92(2X) 93 | 274/? | Conf.<br>SS<br>bedrock | Potable |
| Don Clarke & Alfred Knowles<br>901/899 Rendezvous Rd.<br>(Well is shared by 2 houses) | 406 | 81 90<br>91(3X)<br>92(2X) 93 | 350/? | Conf.<br>SS<br>bedrock | Potable |
| Ruth Biglake<br>(also Goggles #1)<br>882 Rendezvous Rd.<br>Box 281<br>St. Stephens, WY 82524 | 410 | 1982 83<br>84(3X)<br>90(2X)<br>92(2X) 93 | 100/? | Conf.<br>SS<br>bedrock | Domestic |
| Joseph Goggles Sr.<br>(Goggles #2)<br>888 Rendezvous Rd.<br>Box 281<br>St. Stephens, WY 82524 | 411 | 1985 88<br>90 91(3X)<br>92(2X) 93 | 270/261 | Conf<br>SS | Domestic |
| Melvin Hutchinson<br>(formerly Schlotter)<br>170 Goes In Lodge Rd.<br>H.C. 64 Box<br>Riverton, WY 82501 | 417 | 1981 90 91<br>92 93 | 400/350 | Conf.<br>SS<br>bedrock | Potable? |
| ??Moss<br>??? Rendezvous Rd | 420 | 1981 83<br>84(3X) 85<br>90(2X)<br>91(3X)<br>92(2X) | 273/228 | Conf.<br>SS<br>bedrock | Potable |
| *Harris<br>House was unoccupied. Unable to locate well in Jan. 1994. Source of sample may have been well #951. Identity of house needs to be confirmed. | 421 | 1981 85 | 200/? | Conf.<br>SS<br>bedrock | Potable? |
| Whiteman #1<br>??? Goes In Lodge Rd | 423 | 1984 85 88<br>90<br>91(3X)<br>92(2X) 93 | 290/? | Conf.<br>SS<br>bedrock | Potable |

**Table 1.1 Owners of domestic wells, TAC ID numbers, sampling dates, and well details, Riverton, Wyoming (Continued)**

| Domestic wells[a] | TAC ID | Date sampled | Total/casing depth (ft) | Aquifer | Water use[b] |
|---|---|---|---|---|---|
| Raymond #2<br>Lawrence Raymond<br>H.C. 64 Box 3021<br>208 Goes In Lodge Rd.<br>Riverton, WY 82501 | 430 | 1981 83<br>84(2X) 85<br>90 91(2X)<br>92(2X) 93 | 284/320 | Conf.<br>SS<br>bedrock | Potable |
| Raymond #1 (Sampled at least once as well #447)<br>Lawrence Raymond<br>H.C. 64 Box 3021<br>208 Goes In Lodge Rd.<br>Riverton, WY 82501 | 431 | 1984 85<br>92 93 | Approx. 15/? (installed with back-hoe) | Surficial | Stock |
| *St. Stephens Mission (There are 2 wells. The deep well, #436, pumps into a storage cistern and supplies all the buildings. A shallow well is used to water the football field. Shallow well never sampled.) | 436 | 1982<br>91(3X)<br>92(2X) 93 | 525/? | Conf.<br>SS<br>bedrock | Potable |
| Westlake #1 Clinton Westlake<br>Box 667<br>Riverton, WY 82501 | 440 | 1984<br>85(2X) 88<br>90(2X) | 267/? | Conf.<br>SS<br>bedrock | Potable? |
| Westlake #2 (windmill)<br>Clinton Westlake<br>Box 667<br>Riverton, WY 82501 | 441 | 1985 | 100/? | Conf.<br>SS<br>bedrock | N/A |
| Rupert Goggles<br>(Goggles #3)<br>892 Rendezvous Rd.<br>Box 281<br>St. Stephens, WY 82524 | 442 | 1994 | 405/? | Conf.<br>SS<br>bedrock | Domestic |
| Sarah Blackburn<br>938 Rendezvous<br>Arapaho Route Box 3286<br>Riverton, WY 82501 | 443 | 1994 | 397/356.5 | Conf.<br>SS<br>bedrock | Potable |
| Margaret Blackburn<br>940 Rendezvous Rd.<br>Arapaho Route 3286<br>Riverton, WY 82501 | 444 | 1994 | 375/365 | Conf.<br>SS<br>bedrock | Domestic |

**Table 1.1 Owners of domestic wells, TAC ID numbers, sampling dates, and well details, Riverton, Wyoming (Continued)**

| Domestic wells[a] | TAC ID | Date sampled | Total/casing depth (ft) | Aquifer | Water use[b] |
|---|---|---|---|---|---|
| Blomberg #2<br>Current tenant is<br>Delbert Jennings<br>105 N. 10th East<br>Riverton, WY 82501<br>(h) 307-856-9543<br>(w) 307-856-9830 | 445 | 1994 | 35/? | Surficial | Stock |
| Hilyard #1<br>Connie Hilyard<br>219 Goes In Lodge Rd.<br>H.C. 64 Box 3002<br>Riverton, WY 82501<br>856-2150 | 446 | 1994 | 410/370 | Conf.<br>SS<br>bedrock | Potable |
| Gary Martin<br>(formerly Weber #1)<br>903 Rendezvous Rd.<br>P.O. Box 1120<br>Riverton, WY 82501<br>(307) 857-6804 | 448 | 1985 | 405/? | Conf.<br>SS<br>bedrock | Potable |
| Mary Bear<br>942 Rendezvous Rd.<br>Box 132<br>Arapaho, WY 82510 | 451 | 1994 | 360/338 | Conf.<br>SS<br>bedrock | Potable |
| Ken Blackburn<br>113 Goes In Lodge Rd.<br>Box 277<br>St. Stephens, WY 82524 | 452 | 1994 | ?/? | ? | Potable |
| Joanne Blackburn<br>950 Rendezvous Rd.<br>P.O. Box 1672<br>Riverton, WY 82501 | 453 | 1994 | ?/? | ? | Potable |
| Koch Sulfur Products<br>(Freemont Minerals)<br>Mission Rd. | 460 | 1993 | 450/? | Conf.<br>SS<br>bedrock | Process |
| *Danny Brown or Annie Brown<br>(Owner? Well info based on<br>Danny Brown as owner. This<br>needs to be confirmed.)<br>Last known tenant was Lonebear | 951 | 1988<br>92(2X) | 273/246 | ? | Potable? |

**Table 1.1 Owners of domestic wells, TAC ID numbers, sampling dates, and well details, Riverton, Wyoming (Concluded)**

| Domestic wells[a] | TAC ID | Date sampled | Total/casing depth (ft) | Aquifer | Water use[b] |
|---|---|---|---|---|---|
| *Whiteman #2 (Need to confirm whether there actually is a Whiteman #2 well.) | --- | No data | ?/? | ? | Irrigate |

[a]See Figure 1.2 for well locations.
[b]Water uses:

| | | |
|---|---|---|
| Potable | = | Drinking and other uses. |
| Domestic | = | Bathing, washing dishes and other uses, but not drinking. |
| Stock | = | Watering livestock, irrigation, but not drinking or domestic. |
| Irrigate | = | Crop irrigation but no drinking or domestic. |
| ? | = | Information needs to be collected or confirmed. Where water use is not certain, suggest potable to be conservative. |
| Process | = | Industrial use. |

Water use from interviews with resident or inferred from well characteristics.

*Other information that needs to be confirmed.

SS - sandstone

## 1.4 SITE HISTORY

The mill at the Riverton tailings site was constructed in 1958 and operated initially by Fremont Minerals, Inc., to treat a variety of uranium ores from the surrounding area. A sulfuric acid plant that used sulfur made from sour gas was also part of the mill facilities. The milling company's name was subsequently changed to Susquehanna-Western, Inc. The uranium mill was closed in mid-1963. The sulfuric acid plant is still being operated by Koch Sulfur Products Company.

The mill included both sulfuric acid and carbonate circuits to provide flexibility for the many types of uranium ore received. Clarified solutions from the acid leaching process were fed to a solvent extraction circuit that used an amine-decanol-kerosene extractant that was subsequently stripped with caustic soda to precipitate the uranium. During its 4 years of operation, approximately 900,000 tons (800,000 metric tons) of ore were processed at the mill. The waste solids from the milling of the uranium ores were transferred to a tailings pile located adjacent to and southeast of the mill.

The rectangular tailings pile covered about 70 acres (ac) (30 hectares [ha]), and contained approximately 1 million cubic yards ($yd^3$) (800,000 cubic meters [$m^3$]) of tailings. Approximately 140 ac (56 ha) within the designated area, including the pile site, were contaminated. Dispersion of the tailings by wind resulted in contamination of about 50 additional ac (20 ha) outside the site boundaries, especially to the southeast (Figure 1.3).

## 1.5 SITE STATUS

Between 1988 and 1990 the uranium mill was demolished and the tailings pile and contaminated soils were removed from the site and surrounding area. The soils were excavated until the radium concentrations were less than 5.0 picocuries per gram (pCi/g) in the first 15 centimeters (cm) in accordance with UMTRA Project guidelines (DOE, 1989; 40 CFR § 192.12).

Approximately 1.8 million $yd^3$ (1.4 million $m^3$) of contaminated material were removed from the site and disposed at Umetco's Gas Hills disposal site (Figure 1.1). The excavation was backfilled with clean fill. The finished land surface was graded to form a crown and planted with rye grass. Remediation was completed in November 1989.

## 1.6 PREVIOUS SAMPLING

Ground water quality sampling has been performed at the Riverton site since the mid-1970s. Previous field studies and investigations particularly pertinent to this WSAP are referenced in Section 5.0 (FBD, 1983; FBDU, 1981; GECR, 1983; LBL, 1984). Most of the monitor wells installed during previous field studies were decommissioned during the surface remedial actions at the site.

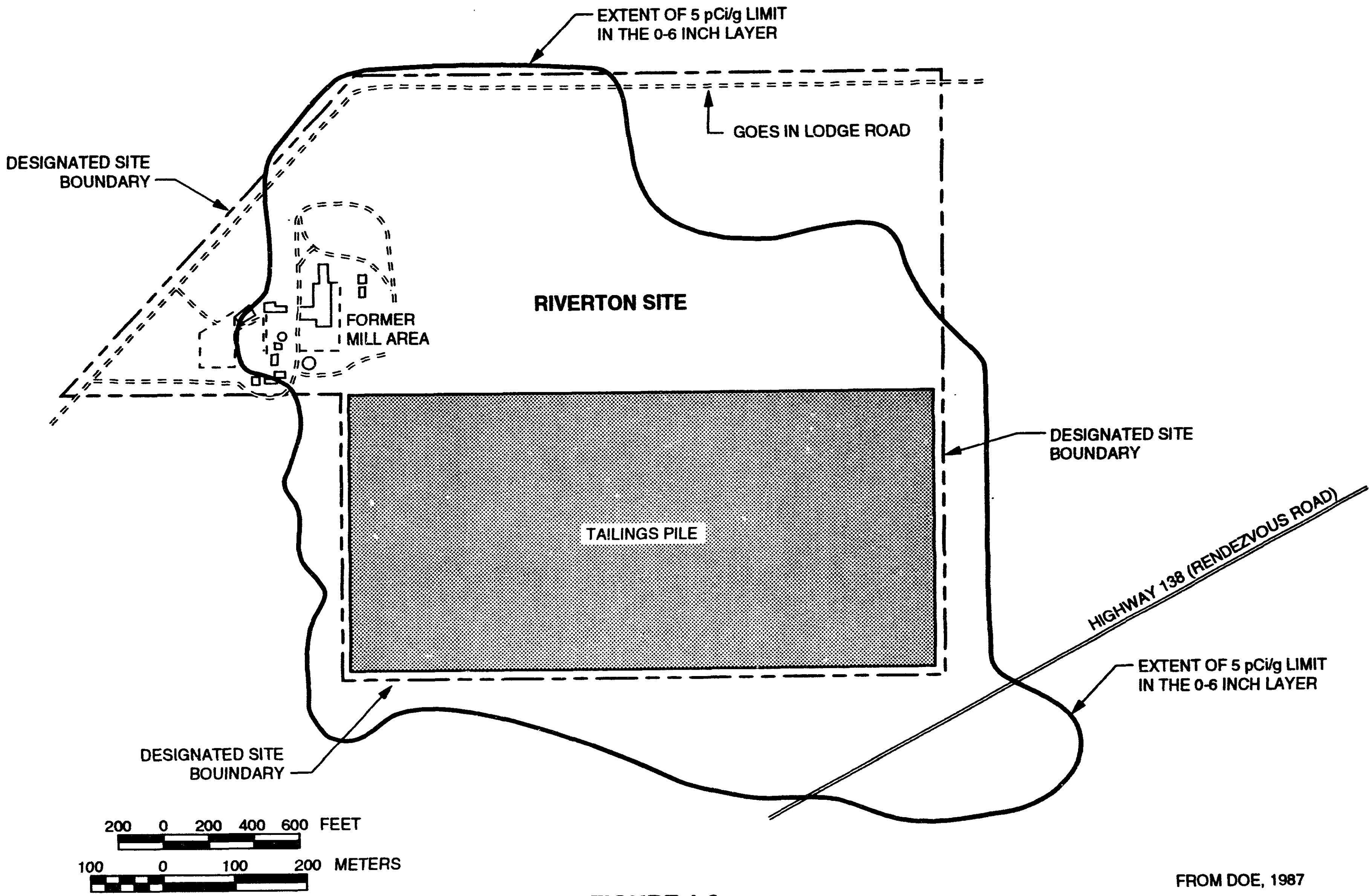



**FIGURE 1.3**
**EXTENT OF WINDBLOWN CONTAMINATION, RIVERTON SITE**
**RIVERTON, WYOMING**

MAC: SITE/RVT/BRA/EXTOFCONTAM

The monitor wells presently available for sampling were installed by the DOE in three separate drilling programs. The first drilling was initiated in the fall of 1983 near the original mill site north of the northern edge of the former tailings pile. Fourteen wells, identified as wells 100-113 in Figures 1.4 and 1.5, were installed at this time.

The second DOE drilling program was completed in 1985. Nine wells were installed southeast of the southeastern corner off the former tailings pile (wells 701-709 shown in Figures 1.4 and 1.6). Wells 701-703, 705, and 707-709 were installed in a cluster, with the screened intervals spanning different depths. Well 704 was installed near State Highway 138, and well 706 was drilled on the south side of the Little Wind River. Six other monitor wells (710-715 in Figure 1.4) were installed during this second DOE drilling program along a former railroad right of way to the northwest of the site.

The third drilling program was conducted in February and March 1993 and resulted in the installation of six wells to monitor changes in water quality near the center of the plume (wells 716-719, 722, and 723 in Figure 1.4) and nine monitor wells around the perimeter of the plume to define its edges to the north, east, and west of the site (wells 720-721 and 724-730).

Selected monitor wells from each of these programs have been sampled during the last several years and will continue to be sampled in the future to monitor changes in ground water quality and water levels. Construction details for these wells are presented in Table 1.2. Data on the other wells are given in DOE, 1987.

In March 1993, ground water samples from seven domestic wells (406, 410, 411, 417, 431, 430, and 460) (Figure 1.2) and two monitor wells (722 and 723) (Figure 1.4) were analyzed for radon in response to a request by the Wyoming Department of Environmental Quality (WDEQ).

During 1993, DOE began preparing a draft baseline risk assessment for the site. As part of this draft study, surface water and sediment samples were collected at the locations shown in Figure 1.7. A qualitative ecological survey that included visual observations of plants and wildlife, but no tissue sample collection or analysis, also was conducted in the vicinity of the site.

In January 1994, water samples were collected from nine domestic wells (442-446, 448, and 451-453) (Figure 1.2) to analyze for the presence of contaminants attributable to former milling operations. These wells had not previously been sampled during the UMTRA Project. Water samples also were collected from the 15 new monitor wells (716-730) installed during 1993 and analyzed for selected constituents to increase the statistical water quality data base and to facilitate the identification of trends in water quality.

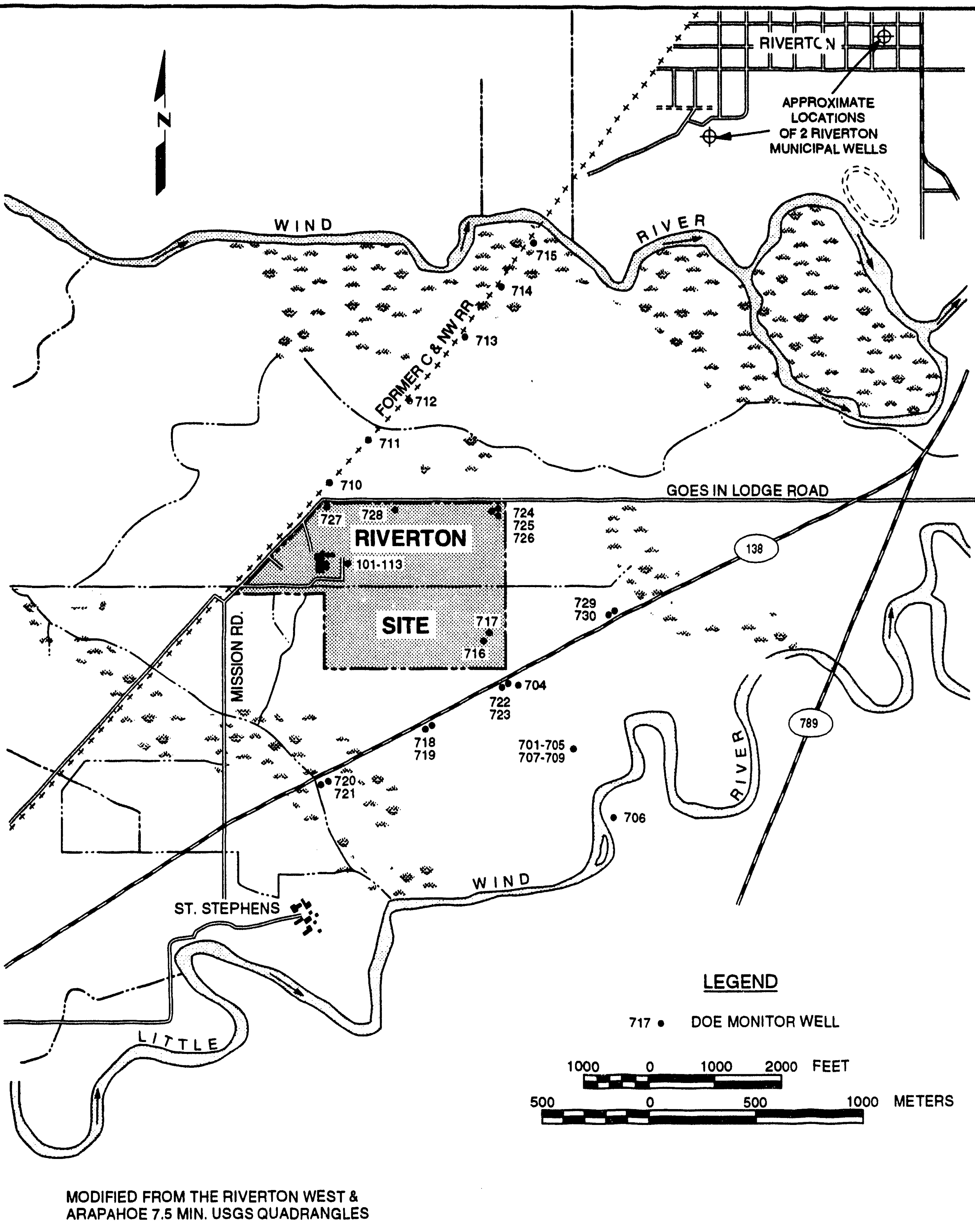



**FIGURE 1.4**
**MONITOR WELL LOCATIONS**
**RIVERTON, WYOMING**

MAC: SITE/RVT/WSAP/BASE-MONITORWELLLOC

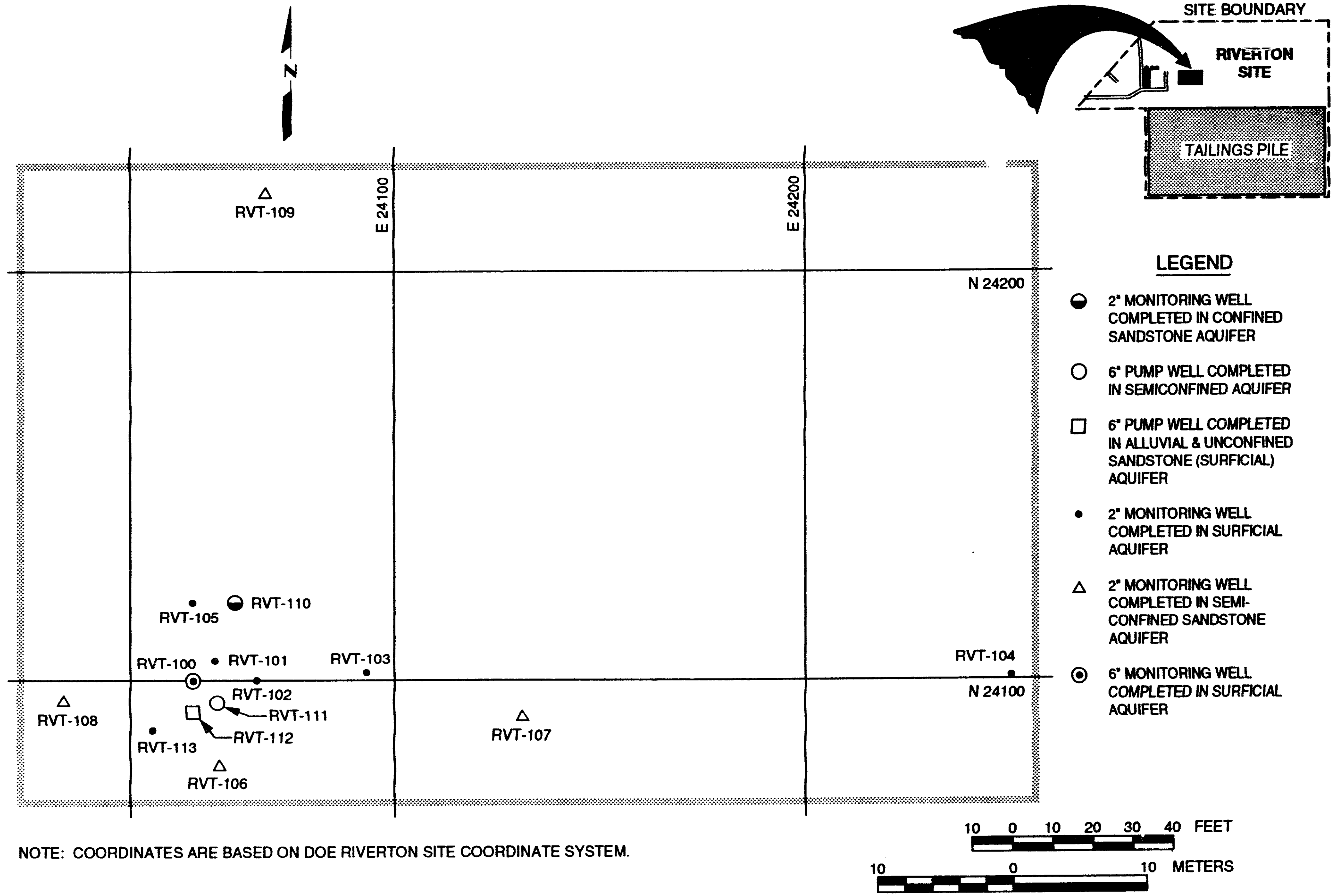



**FIGURE 1.5**
**ENLARGEMENT OF FIRST DOE DRILLING PROGRAM WELL LOCATIONS, (100 - 113), RIVERTON, WYOMING**

FROM DOE, 1987

MAC: SITE/RVT/WSAP/FIRSTDRILL

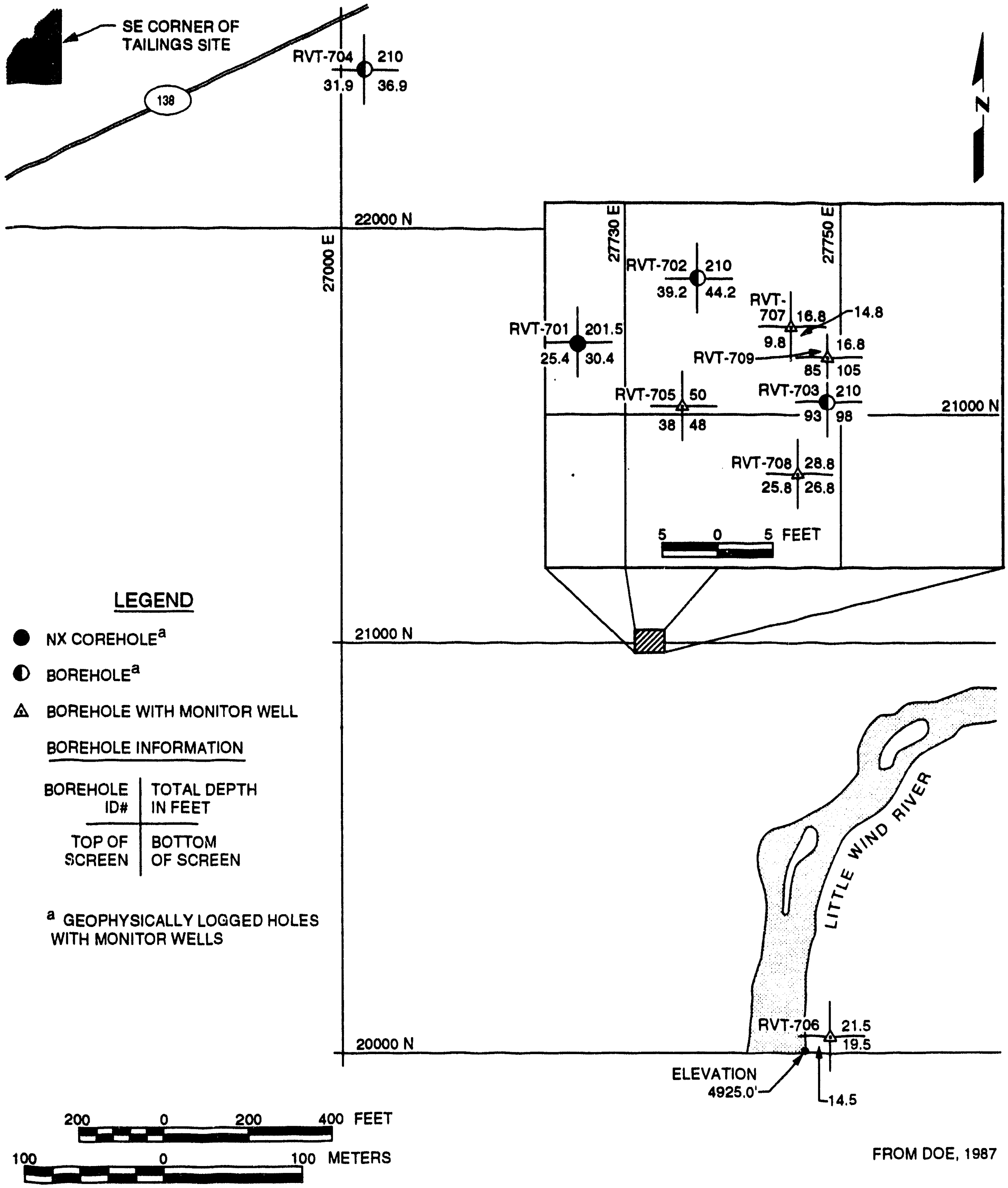


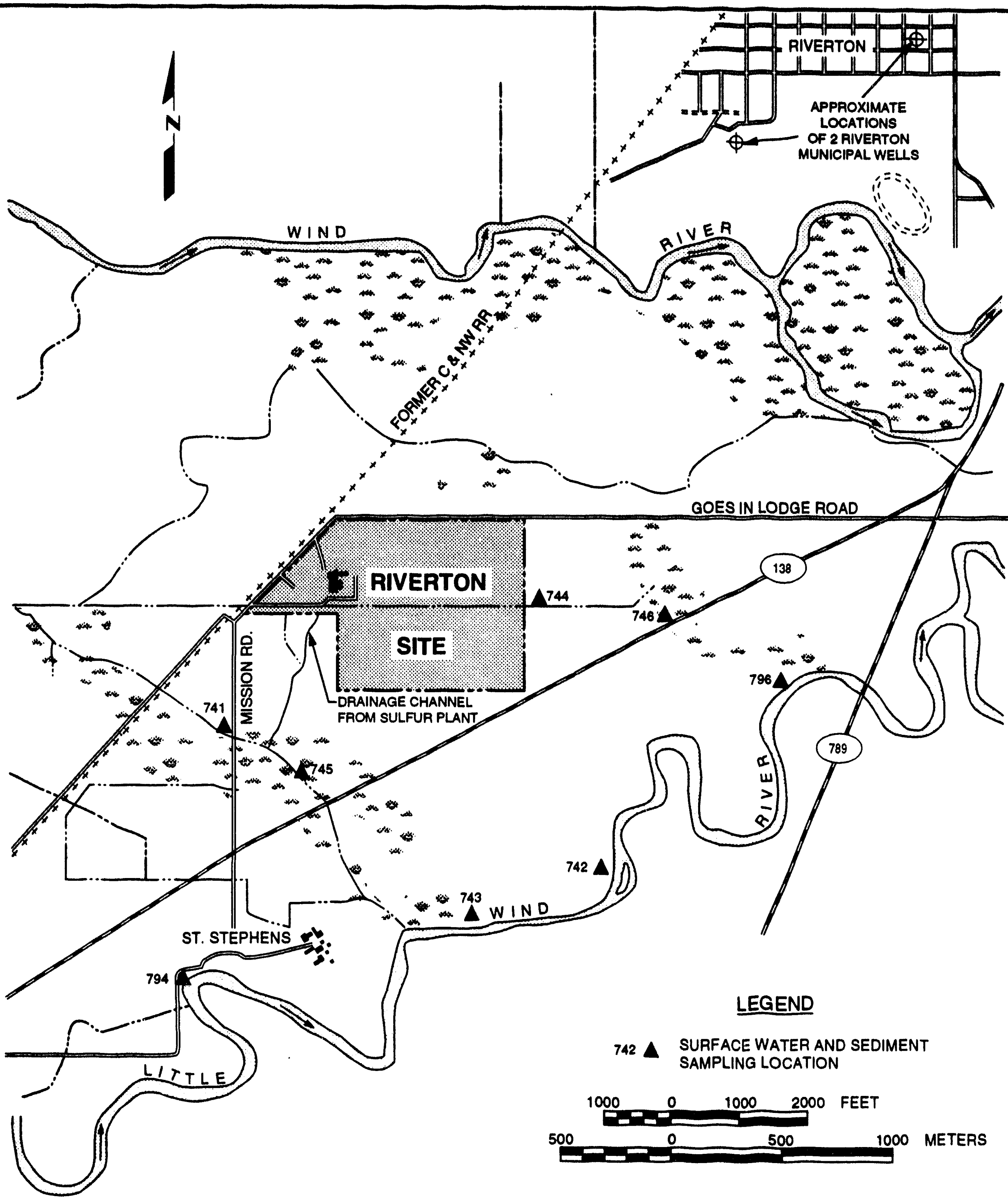

**FIGURE 1.6**
**ENLARGEMENT OF PART OF SECOND DOE DRILLING PROGRAM WELL LOCATIONS (701 - 709), SOUTH AND EAST OF THE RIVERTON SITE RIVERTON, WYOMING**

**Table 1.2 Monitor well information, Riverton, Wyoming**

| Well ID | Ground elevation | Borehole depth | Borehole diameter | Casing elevation | Casing diam. | Screened interval | Filter pack | Aquifer |
|---|---|---|---|---|---|---|---|---|
| 101 | 4946.2 | 17.5 | 6.0 | 4946.58 | 2.0 | 10.5-15.5 | 5.5-17.5 | Surficial |
| 104 | 4945.3 | 15.5 | 6.3 | 4945.90 | 2.0 | 8.5-13.5 | 6.5-15.5 | Surficial |
| 108 | 4946.2 | 56.0 | 6.0 | 4946.02 | 2.0 | 48.5-53.5 | 35.5-56.5 | Semiconf. SS |
| 110 | 4946.2 | 72.0 | 6.0 | 4946.44 | 2.0 | 61.3-66.5 | 59.0-72.0 | Confined SS |
| 705 | 4930.1 | 50.0 | 10.0 | 4930.80 | 6.0 | 38.0-48.0 | 35.5-50.0 | Semiconf. SS |
| 706 | 4931.1 | 21.5 | 6.0 | 4932.00 | 2.0 | 14.5-19.5 | 12.8-21.5 | Surficial |
| 707 | 4930.4 | 18.0 | 6.0 | 4931.00 | 2.0 | 9.8-14.8 | 7.5-16.8 | Surficial |
| 709 | 4930.2 | 111.0 | 10.0 | 4930.70 | 6.0 | 85.0-105.0 | 84.0-111.0 | Confined SS |
| 710 | 4947.2 | 20.0 | 6.0 | 4947.90 | 2.0 | 11.2-16.2 | 8.0-20.0 | Surficial |
| 711 | 4943.5 | 21.5 | 6.0 | 4944.50 | 2.0 | 10.8-15.8 | 6.0-21.5 | Surficial |
| 712 | 4943.5 | 19.5 | 6.0 | 4944.50 | 2.0 | 10.6-15.6 | 10.0-19.5 | Surficial |
| 716 | 4936.4 | 12.5 | 6.0 | 4939.12 | 2.0 | 7.5-12.5 | 5.5-12.5 | Surficial |
| 717 | 4936.4 | 50.0 | 6.0 | 4938.80 | 2.0 | 37.5-47.5 | 29.0-49.5 | Semiconf. SS |
| 718 | 4937.0 | 18.0 | 6.0 | 4937.18 | 2.0 | 13.0-18.0 | 10.0-18.0 | Surficial |
| 719 | 4936.8 | 40.0 | 6.0 | 4936.94 | 2.0 | 28.0-38.0 | 23.0-40.0 | Semiconf. SS |
| 720 | 4937.9 | 10.5 | 6.0 | 4940.46 | 2.0 | 5.5-10.5 | 3.5-10.5 | Surficial |
| 721 | 4937.9 | 49.0 | 6.0 | 4940.47 | 2.0 | 37.0-47.0 | 27.0-49.0 | Semiconf. SS |
| 722 | 4935.2 | 18.0 | 6.0 | 4935.35 | 2.0 | 6.0-16.0 | 4.0-18.0 | Surficial |
| 723 | 4935.0 | 49.0 | 6.0 | 4935.26 | 2.0 | 35.5-45.5 | 31.0-47.5 | Semiconf. SS |
| 724 | 4939.4 | 16.0 | 6.0 | 4941.36 | 2.0 | 11.0-16.0 | 6.0-16.0 | Surficial |
| 725 | 4939.4 | 38.0 | 6.0 | 4941.36 | 2.0 | 24.5-34.5 | 19.5-36.5 | Semiconf. SS |
| 726 | 4939.5 | 133.0 | 6.0 | 4942.00 | 2.0 | 121.0-131 | 80.0-133.0 | Confined SS |
| 727 | 4949.5 | 40.0 | 6.0 | 4951.69 | 2.0 | 27.0-37.0 | 21.5-39.0 | Semiconf. SS |
| 728 | 4943.9 | 24.0 | 6.0 | 4946.01 | 2.0 | 12.0-22.0 | 9.0-24.0 | Surficial |
| 729 | 4932.1 | 17.0 | 6.0 | 4932.07 | 2.0 | 9.0-14.0 | 8.0-14.0 | Surficial |
| 730 | 4932.5 | 40.0 | 6.0 | 4932.48 | 2.0 | 28.0-38.0 | 21.0-40.0 | Semiconf. SS |

NOTE: Elevations in feet relative to mean sea level (MSL); depths in feet; diameters in inches.

SS - sandstone




MODIFIED FROM THE RIVERTON WEST & ARAPAHOE 7.5 MIN. USGS QUADRANGLES

**FIGURE 1.7**
**SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS**
**RIVERTON, WYOMING**

MAC: SITE/RVT/WSAP/BASE-SW&SAMPLOCS

# 2.0 SITE CONCEPTUAL MODEL

## 2.1 PHYSIOGRAPHIC SETTING

The former Riverton uranium mill tailings site is located on a nearly level alluvial terrace between the Wind River to the north and the Little Wind River to the south (Figure 2.1). These two rivers join approximately 2.5 mi (4.0 km) to the east of the site.

The land surface at the site averages approximately 4950 ft (1510 m) above mean sea level (MSL). The land slopes at less than 0.5 percent to the southeast.

## 2.2 CLIMATE

The climate in the Riverton area is semi-arid to arid (DOE, 1987). The average annual precipitation during the 30-year period from 1951 to 1980 was 8 inches (20 cm). The greatest amount of precipitation occurs from April through June in the form of showers and thundershowers.

Riverton is influenced both by cold air masses from Canada and by the prevailing, warm westerly winds. The highest and lowest temperatures recorded in Riverton from 1951 to 1980 were 104°F (40°C) and -46°F (-43°C), and an average of 207 days per year with minimum temperatures less than or equal to 32°F (0°C), and an average of 37 days per year with maximum temperatures of 90°F (32°C) or greater.

## 2.3 GROUND WATER HYDROGEOLOGY

There are five hydrogeologic units of interest underlying the Riverton site. They are, in descending order: a surficial, unconfined alluvial and sandstone aquifer; a leaky shale aquitard; a semiconfined sandstone aquifer; a second, more impermeable shale aquitard; and a confined sandstone aquifer (Figures 2.1 and 2.2).

### 2.3.1 Surficial unconfined aquifer

The surficial unconfined aquifer consists of 15 to 20 ft (5 to 6 m) of alluvial sand and gravel underlain by a discontinuous layer of sandstone (Figure 2.2). The sandstone layer exists both to the north and south of the former tailings pile, but pinches out and is absent for approximately 1500 ft (500 m) southward from the southern edge of the pile. There is no aquitard between the alluvial sediments and this sandstone layer.

The water table in the surficial aquifer in March 1993 ranged from approximately 10 ft (3 m) below the ground surface near the northwest corner of the former tailings pile (elevation 4936 ft [1504 m] MSL) to about 6 ft (2 m) below land surface near the southeast corner of the site (elevation 4930 ft [1503 m] MSL). The ground water flows toward the east-southeast with a gradient of approximately 0.002 as shown in Figure 2.3. Aquifer tests conducted in the surficial aquifer indicate an average hydraulic conductivity of approximately 56 ft (17 m) per day. Using an assumed

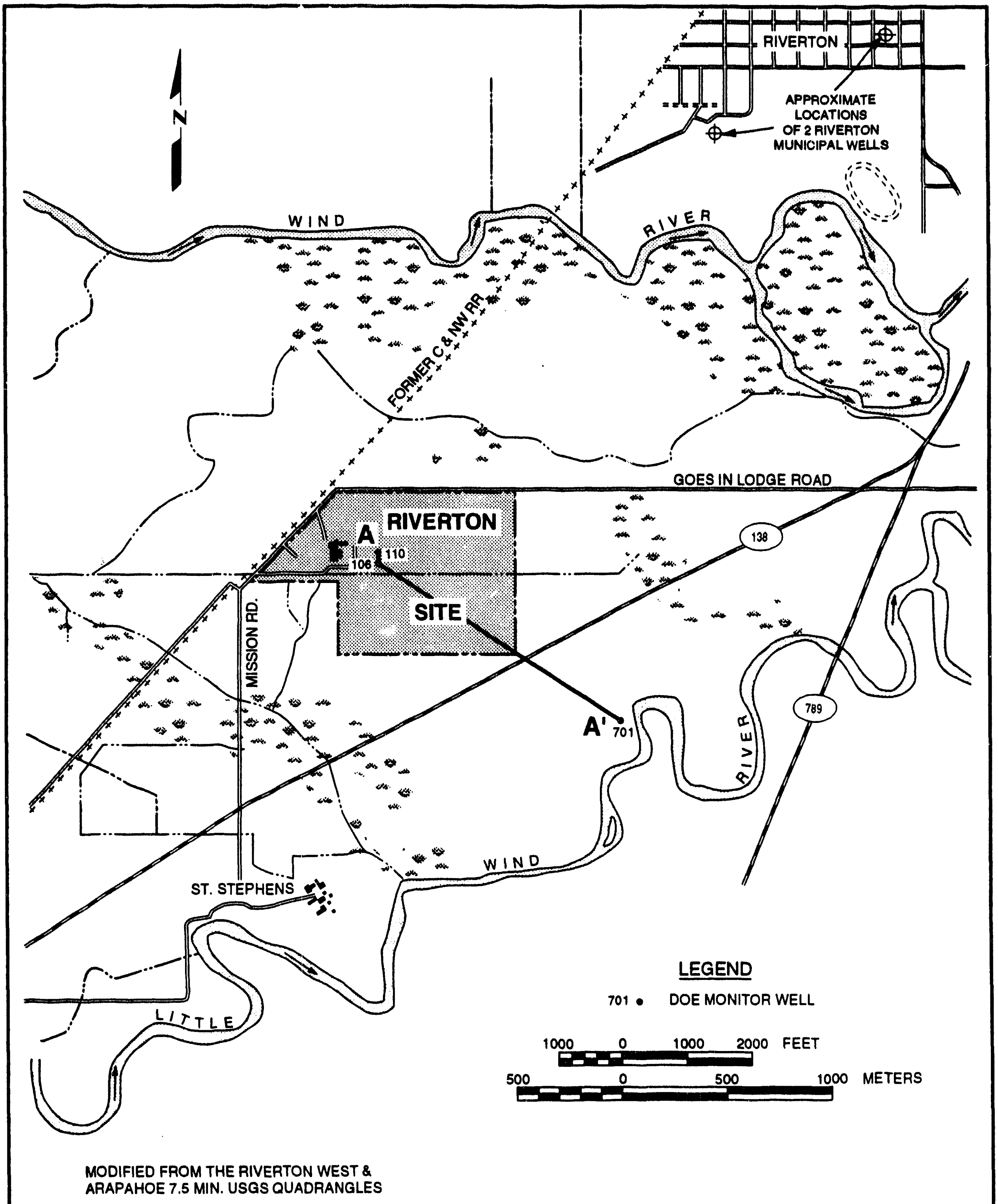



**FIGURE 2.1**
**LOCATION OF GEOLOGIC CROSS SECTION**
**RIVERTON, WYOMING**

MAC: SITE/RVT/WSAP/BASE-GEOX-SEC

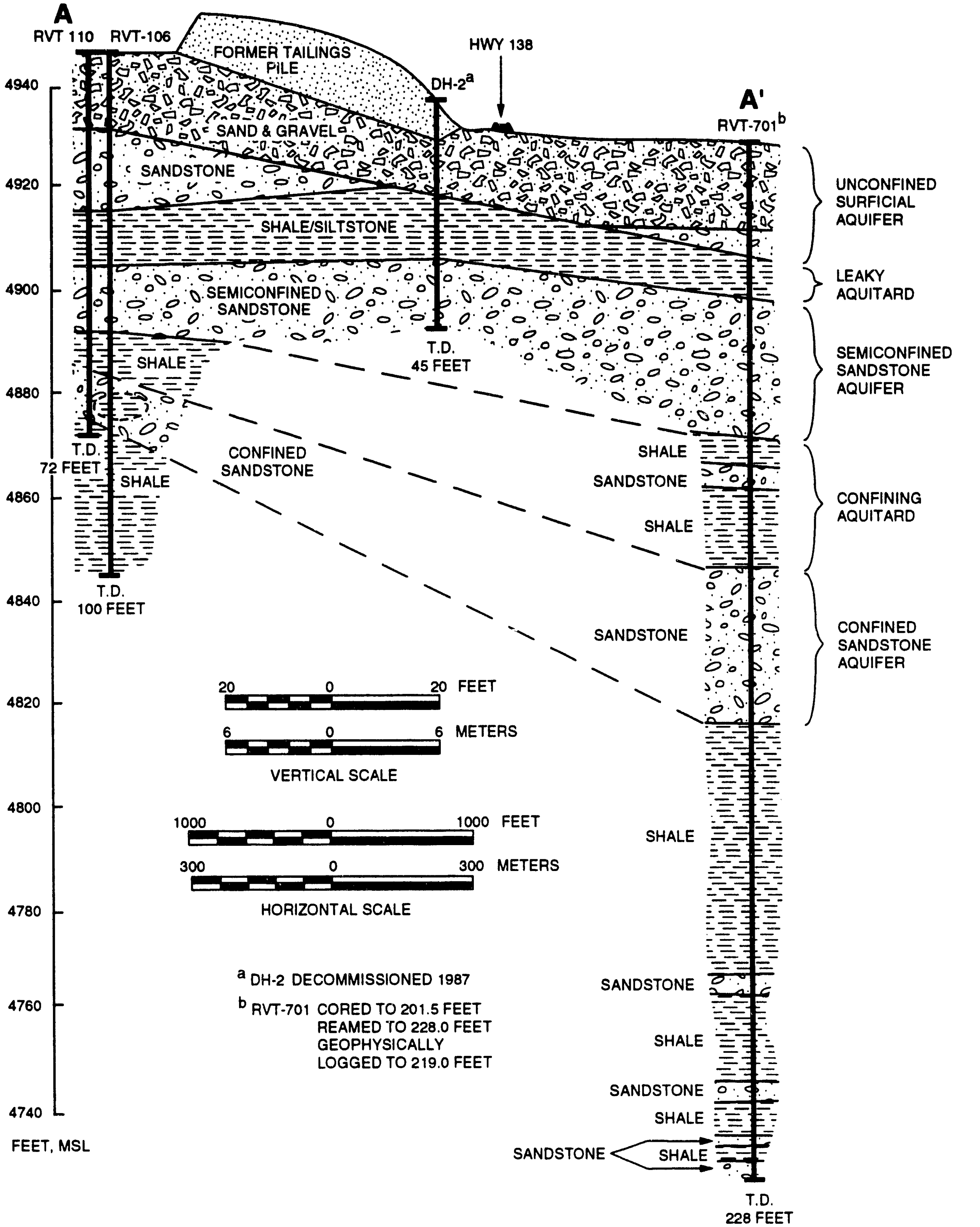



**FIGURE 2.2**
**GEOLOGIC CROSS SECTION**
**RIVERTON, WYOMING**

FROM DOE, 1987

MAC: SITE/RVT/WSAP/GEOLOGIC

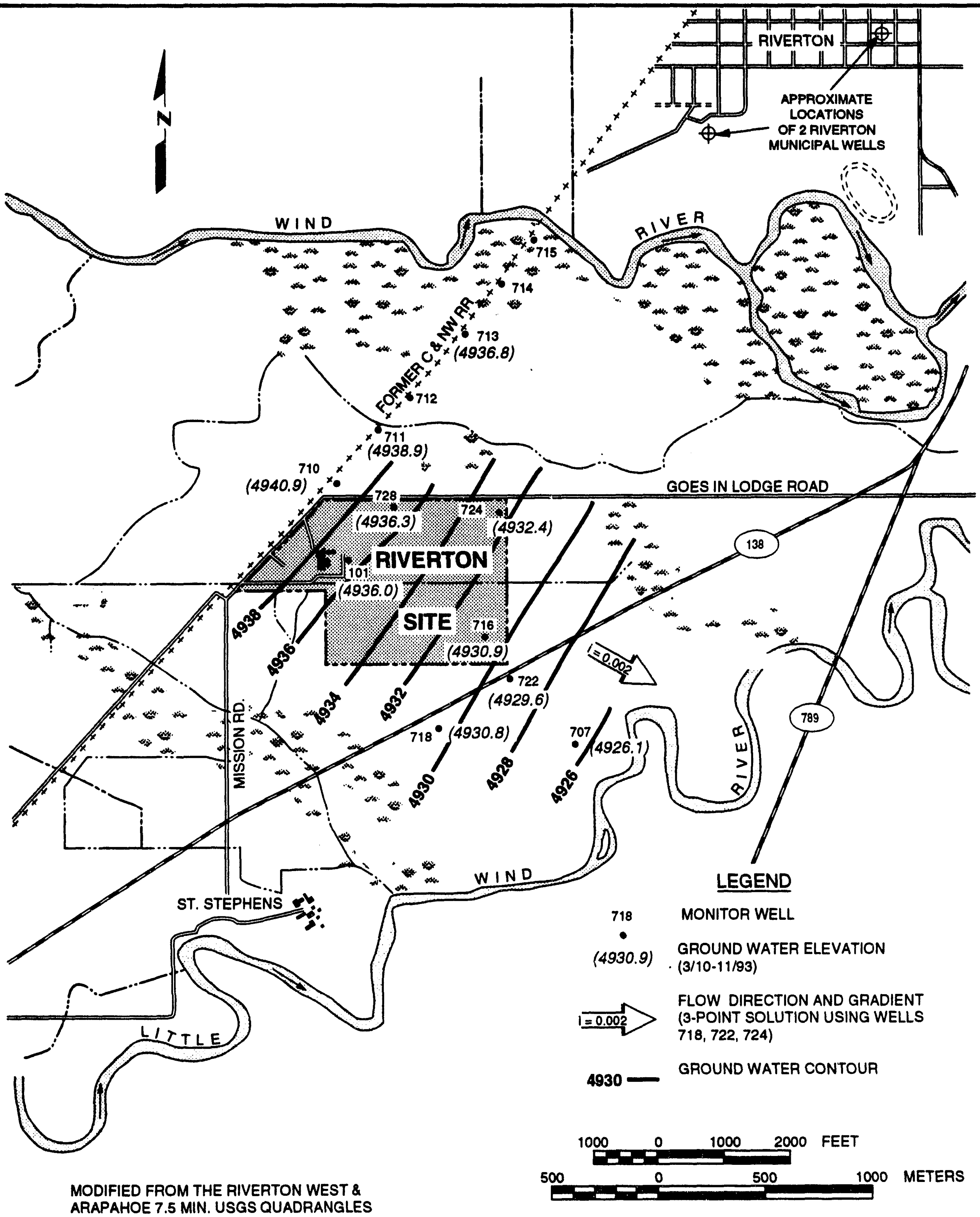



**FIGURE 2.3**
**GROUND WATER ELEVATIONS IN THE SURFICIAL AQUIFER**
**RIVERTON, WYOMING**

porosity of 0.25 for the alluvium and unconfined sandstone, the calculated ground water flow velocity is approximately 16 ft (5 m) per year.

### 2.3.2 Leaky shale aquitard and semiconfined sandstone

Underlying the surficial aquifer is a semiconfining shale unit (Figure 2.2). This leaky aquitard ranges in thickness from 5 to 10 ft (2 to 3 m). The semiconfined sandstone underlies this shale layer. This unit ranges in thickness from 15 to 30 ft (5 to 9 m) and is continuous throughout the Riverton site.

The ground water flow direction in the semiconfined unit in March 1993 was slightly more easterly than in the overlying surficial aquifer as shown in Figure 2.4. At other times of year, the flow is more to the south. In March 1993, the gradient in the semiconfined sandstone was approximately 0.002. In the well cluster located to the northwest and upgradient of the former tailings pile, there was a downward gradient from the surficial aquifer into the semiconfined sandstone. The water elevations in all the other surficial and semiconfined sandstone wells near the southern and eastern boundaries of the former tailings pile were nearly identical. The reason for the apparent downward gradient in this area is not known and needs to be verified. The contours on Figure 2.4 do not reflect this inconsistency. Additional investigations will be conducted during FY1994 to address this condition.

Aquifer tests in the semiconfined sandstone indicate a hydraulic conductivity of about 40 ft (12 m) per day. Assuming a porosity of 15 percent, ground water will move with an approximate velocity of 140 ft (43 m) per year.

### 2.3.3 Shale aquitard and confined sandstone

Approximately 40 ft (12 m) of shale with discontinuous sandstone lenses underlies the semiconfined sandstone (Figure 2.2). The confined sandstone unit underlies this confining unit. The sandstone is at least 50 ft (15 m) thick.

A 1968 U.S. Geological Survey map (Whitecomb and Lowry, 1968) suggested that the regional hydraulic gradient in this sandstone is influenced by pumping at the Riverton municipal water supply well fields and the flow could be towards the northeast. However, water level data from the monitor wells completed in the confined sandstone near the northwestern corner of the former tailings pile site (monitor well 110), at the northeastern corner of the property (well 726), and to the southeast of the site (well 703) show that the ground water flow in the confined sandstone is towards the south with a gradient of approximately 0.002 (Figure 2.5).

Water levels in these wells also indicate that there is an upward gradient between the deep, confined sandstone and both the semiconfined sandstone and the surficial aquifer at both the downgradient sampling location (wells 705, 707, and 709) and at the northeast corner of the property (wells 724-726). This upward gradient will preclude movement of contaminants from the upper two aquifers down into the confined sandstone or deeper aquifers which serve as the supply aquifers for the domestic wells in the area.

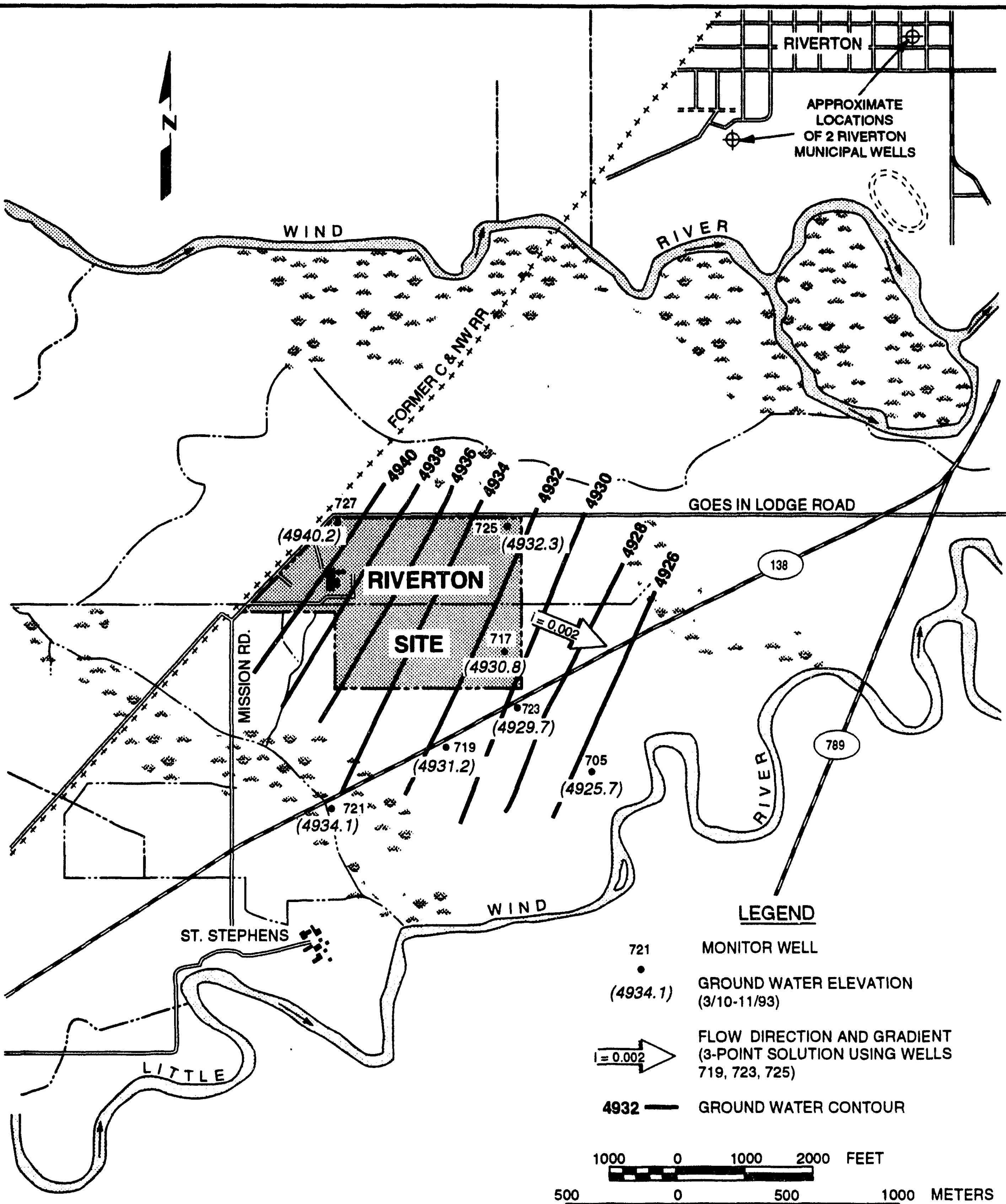



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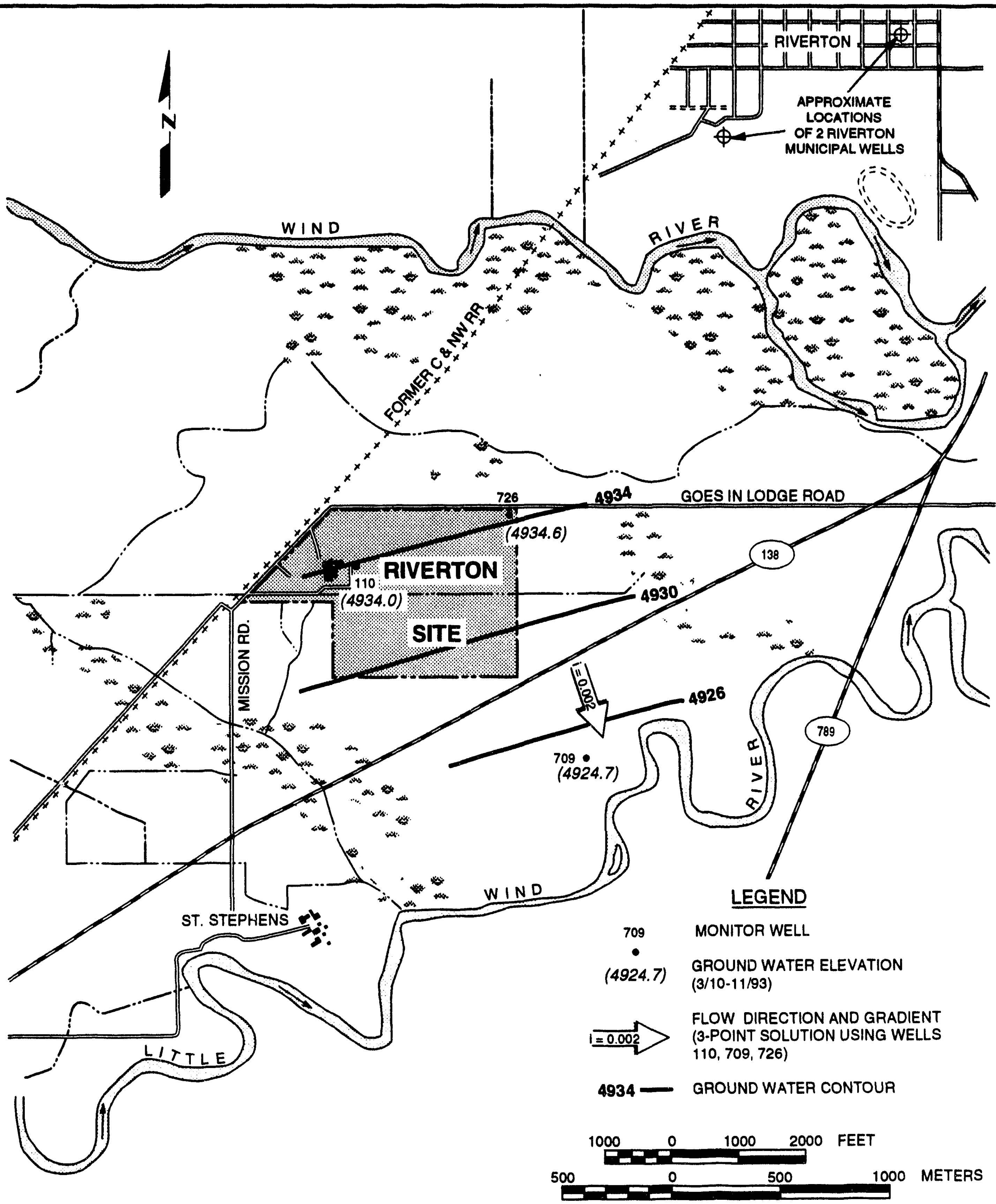
**FIGURE 2.4**
**GROUND WATER ELEVATIONS IN THE SEMICONFINED SANDSTONE AQUIFER**
**RIVERTON, WYOMING**

MAC: SITE/RVT/WSAP/BASE-GWELEVS-SEMI




MODIFIED FROM THE RIVERTON WEST & ARAPAHOE 7.5 MIN. USGS QUADRANGLES

**FIGURE 2.5**
**GROUND WATER ELEVATIONS IN THE CONFINED SANDSTONE AQUIFER**
**RIVERTON, WYOMING**

MAC: SITE/RVT/WSAP/BASE-GWELEVS-CONF.

The piezometric head in the deep well near the northwest corner of the former tailings pile (well 110) is also higher than the head in the semiconfined sandstone (well 106), but the water table elevation in the surficial aquifer (well 105) is higher than the head in either the semiconfined or the confined sandstones. The lower head in the confined aquifer relative to the surficial aquifer may be due to the pumping well that extracts water to supply the Koch Sulfur Products plant located near the western edge of the site. The influence of this pumping could also be the cause of the more southerly ground water flow direction calculated in the deep aquifer. The influence of the pumping of this well does not, however, appear to have caused any contaminants to migrate into the deep aquifer, as documented by the water quality samples from monitor well 110 and the Koch well, neither of which have ever shown any impacts associated with the former milling operations.

## 2.4 SURFACE WATER HYDROLOGY

The Wind River is approximately 4000 ft (1000 m) north of the former uranium mill and tailings site and the Little Wind River is approximately 3000 ft (900 m) southeast of the site. A drainage channel excavated through a natural wetland area is located along the western side of the property (Figure 1.7). This channel is joined by the channel that carries discharge water from the sulfur processing site at the western edge of the property. These channels pass under State Highway 138 and join the Little Wind River approximately 3500 ft (1100 m) due south of the property.

A second wetland area is located to the east of the site. Drainage from this wetland passes under State Highway 138 approximately 2500 ft (760 m) east of the southeast corner of the property.

A system of former irrigation canals and ditches are located along the northern and eastern sides of the property. Surface water flow in these channels is seasonal and may or may not be reflective of ground water conditions, depending on whether the channel is designed to drain the adjoining land or carry irrigation water.

A stream and wetland area is also located approximately 1000 ft (300 m) to the north of the northern property line. This stream joins the Wind River approximately 5500 ft (1700 m) east of the northeastern corner of the site.

The natural wetland areas, streams, rivers and some of the man-made ditches and channels should intercept the shallow ground water in the alluvium and form hydraulic barriers. These barriers should restrict the migration of the contaminant plume in the surficial aquifer.

## 2.5 WATER QUALITY

### 2.5.1 Ground water contaminants

The former uranium milling operations at the Riverton site have resulted in contamination of the ground water in the surficial and semiconfined sandstone aquifers beneath and to the southeast downgradient of the site. No contaminants have been detected in the confined sandstone aquifer.

Data indicates that the neutralization capacity of the ground water and the natural soils beneath the site have been effective in removing much of the expected suite of radionuclides, metals, and toxic non-metals (CSU, 1983), thus limiting the migration of many constituents within the contaminant plume. The draft baseline risk assessment has identified seven contaminants of potential concern to human health and the environment that may be attributable to the former milling operations: arsenic, manganese, molybdenum, nickel, sulfate, vanadium, and uranium.

### 2.5.2 Background ground water quality

Background water quality is defined as the quality of water if uranium milling activities had not taken place. Background ground water quality in the surficial aquifer, as measured in monitor wells 710 and 711, is a moderately oxidizing, calcium-sulfate-bicarbonate type ground water with a slightly basic pH of 7.1 to 7.6. The background ground water in the semiconfined aquifer, as measured in monitor wells 725 and 727, has a similar, slightly basic pH, and is a moderately oxidizing sulfate-bicarbonate-calcium-sodium type.

The ground water in the deep, confined aquifer, as defined by well 726, is a moderately oxidizing sodium-sulfate type water with an alkaline pH. Contamination from the former uranium milling operations has not been detected in the confined sandstone aquifer.

Information on the domestic wells sampled for radon and the analytical results are presented in Table 2.1. All the wells, except domestic well 431 and the two DOE wells, are deep wells completed in the confined sandstone and exhibit similar levels of radon activity, regardless of their upgradient or downgradient locations. Note that the levels are higher in well 423 upgradient of the site than in any other wells. Even the shallow DOE wells within the plume downgradient of the site have low levels of radon activity.

Similarly, the water samples collected from the deep domestic wells during 1994 did not indicate the presence of any other contaminants attributable to the former milling operations (Table 2.2). One shallow well (445), screened in the surficial aquifer, did contain elevated levels of uranium and arsenic, but at concentrations less than half of the maximum concentration limits (MCL).

### 2.5.3 Contaminant plume

Isopleths showing the concentrations of uranium, molybdenum, and sulfate in the surficial aquifer and sulfate in the semiconfined sandstone aquifer are shown in Figures 2.6, 2.7, 2.8, and 2.9 respectively. Figure 2.10 delineates the maximum probable extent of the contaminant plume in the surficial aquifer.

**Table 2.1 Radon survey, Riverton, Wyoming, March 1993**

| Owner (other names) address | TAC ID | Total/ casing depth | Aquifer | Water use | Analytical results (pCi/L) |
|---|---|---|---|---|---|
| Don Clarke and Alfred Knowles (shared well) 901/899 Rendezvous Rd | 406 | 350'/NA | Conf SS | Potable | 280<br>310 |
| Ruth Biglake (also Goggles #1) 882 Rendezvous Rd | 410 | 100'/NA | Conf SS | Domestic (Nonpotable) | 340<br>400 |
| Joseph Goggles Sr. (formerly Goggles #2) 888 Rendezvous Rd | 411 | 270'/260' | Conf SS | Domestic (Nonpotable) | 1200<br>1300 |
| Melvin Hutchinson (formerly Schlotter) 170 Goes In Lodge Rd | 417 | 400'/350' | Conf SS | Potable | 470<br>480 |
| Lawrence Raymond #1 (formerly well #447) 208 Goes In Lodge Rd | 431 | 15'/NA | Alluvium | Stock No human consump. | 760<br>740 |
| Lawrence Raymond #2 208 Goes In Lodge Rd | 430 | 320'/284' | Conf SS | Potable | 700<br>930 |
| Whiteman Goes In Lodge Rd | 423 | 290'/NA | Conf SS | Potable | 1460<br>1340 |
| Koch Sulfur Products (Fremont Minerals) Mission Road | 460 | 450'/NA | Conf SS | Process (industry) | 856<br>910 |
| DOE monitor well Rendezvous Rd | 722 | 18'/6' | Alluvium | Quality monitoring | 340 |
| DOE monitor well Rendezvous Rd | 723 | 45.5'/31' | Semi-Conf SS | Quality monitoring | 245 |

pCi/L-picocuries per liter.

SS - sandstone

**Table 2.2 Water quality data for domestic wells and monitor wells, January 1994, Riverton, Wyoming**

| Domestic well | As | Mn | Mo | Ni | $SO_4$ | Se | TDS | U | V |
|---|---|---|---|---|---|---|---|---|---|
| Goggles #3 Well 442 | BDL | BDL | BDL | BDL | 264 | BDL | 550 | BDL | BDL |
| SBlackburn Well 443 | BDL | 0.03 | BDL | BDL | 209 | BDL | 470 | BDL | BDL |
| MBlackburn Well 444 | BDL | 0.02 | BDL | BDL | 221 | BDL | 510 | BDL | BDL |
| Blomberg #2 Well 445 | 0.008 | BDL | BDL | BDL | 152 | BDL | 600 | 0.016 | 0.02 |
| Hilyard Well 446 | BDL | BDL | BDL | BDL | 138 | BDL | 420 | BDL | BDL |
| Martin Well 448 | BDL | BDL | BDL | BDL | 174 | BDL | NA | BDL | BDL |
| Bear Well 451 | BDL | BDL | BDL | BDL | 206 | BDL | 460 | BDL | BDL |
| KBlackburn Well 452 | BDL | BDL | BDL | BDL | 106 | BDL | 450 | BDL | BDL |
| JBlackburn Well 453 | BDL | BDL | BDL | BDL | 220 | NA | NA | BDL | BDL |

| Monitor well | As | Mn | Mo | Ni | $SO_4$ | Se | TOC | U | V |
|---|---|---|---|---|---|---|---|---|---|
| DOE well 716 | BDL | 0.74 | 0.24 | BDL | 775 | NA | 6 | 0.718 | BDL |
| DOE well 717 | BDL | 0.24 | BDL | BDL | 707 | NA | 9 | BDL | BDL |
| DOE well 718 | BDL | 3.28 | 0.15 | 0.06 | 2480 | NA | 20 | 0.328 | BDL |
| DOE well 719 | BDL | 0.22 | 0.02 | BDL | 512 | NA | 10 | 0.003 | BDL |
| DOE well 720 | BDL | 1.15 | BDL | BDL | 411 | NA | 1 | 0.008 | BDL |
| DOE well 721 | BDL | BDL | BDL | BDL | 274 | NA | 6 | BDL | BDL |
| DOE well 722 | BDL | 2.71 | 0.11 | BDL | 1720 | NA | 18 | 1.57 | BDL |
| DOE well 723 | BDL | 0.72 | BDL | BDL | 1740 | NA | 23 | BDL | BDL |

**Table 2.2 Water quality data for domestic wells and monitor wells, January 1994, Riverton, Wyoming (Concluded)**

| Monitor well | As | Mn | Mo | Ni | $SO_4$ | Se | TOC | U | V |
|---|---|---|---|---|---|---|---|---|---|
| DOE Well 724 | BDL | 0.07 | BDL | BDL | 225 | NA | 13 | 0.028 | BDL |
| DOE Well 725 | BDL | 0.06 | BDL | BDL | 1940 | NA | 18 | 0.009 | BDL |
| DOE Well 726 | BDL | BDL | BDL | BDL | 159 | NA | 5 | BDL | BDL |
| DOE Well 727 | BDL | 0.02 | BDL | BDL | 141 | NA | 7 | 0.001 | BDL |
| DOE Well 728 | BDL | BDL | BDL | BDL | 97 | NA | 8 | 0.014 | BDL |
| DOE Well 729 | BDL | BDL | BDL | BDL | 143 | NA | 22 | 0.018 | BDL |
| DOE Well 730 | BDL | 0.11 | BDL | BDL | 371 | NA | 15 | BDL | BDL |

Parameters and detection limits in mg/L.

| | | | | | |
|---|---|---|---|---|---|
| As | - arsenic | 0.005 | U | - uranium | 0.001 |
| Mn | - manganese | 0.01 | V | - vanadium | 0.01 |
| Mo | - molybdenum | 0.01 | Se | - selenium | 0.005 |
| Ni | - nickel | 0.04 | $SO_4$ | - sulfate | 1.0 |
| TDS | - total dissolved solids | 10.0 | | | |

BDL - below detection limits.

NA - not analyzed.

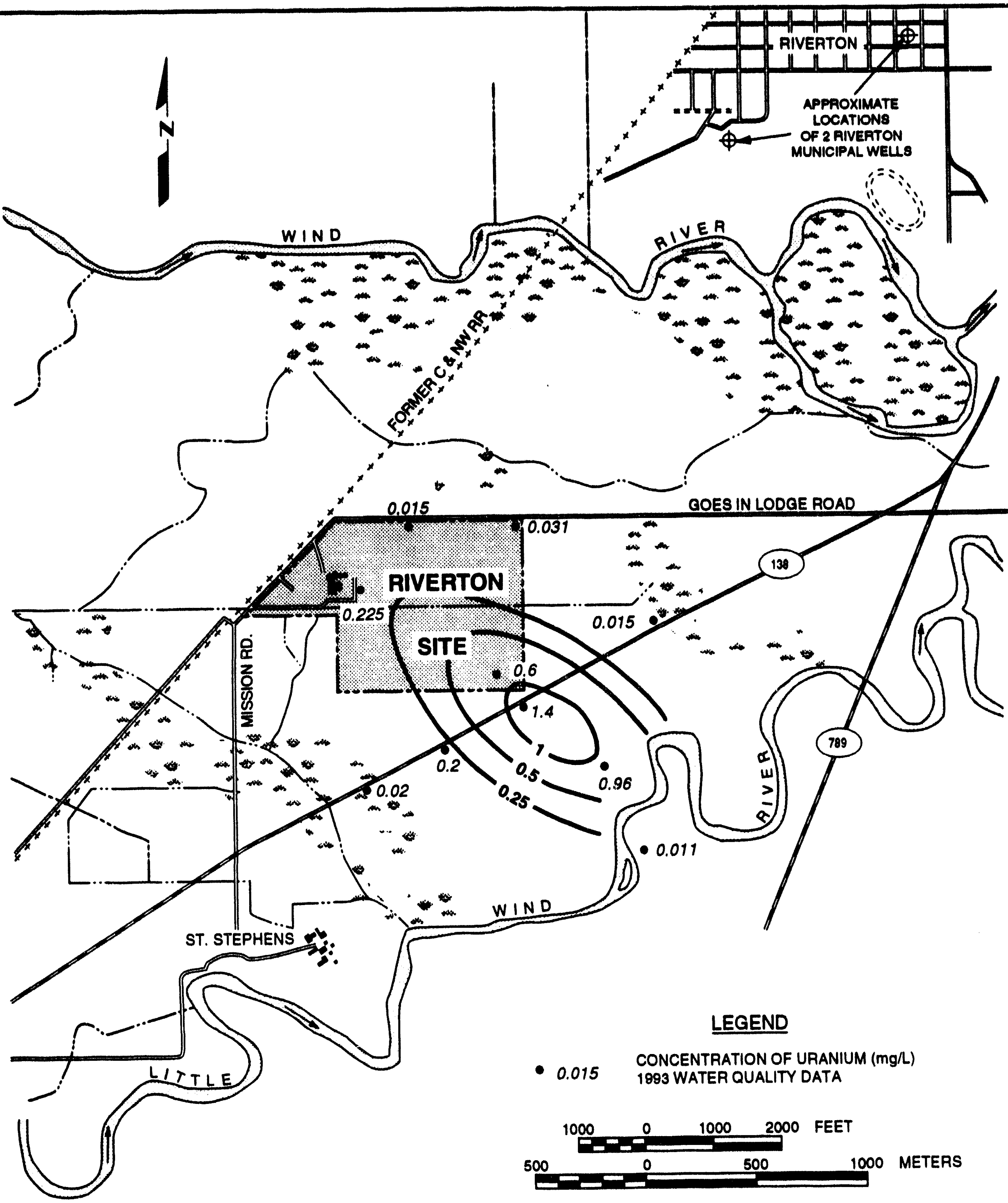



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**FIGURE 2.6**
**ISOPLETHS SHOWING URANIUM CONCENTRATIONS IN THE SURFICIAL AQUIFER**
**RIVERTON, WYOMING**

MAC: SITE/RVT/WSAP/BASE-ISOURANIUM

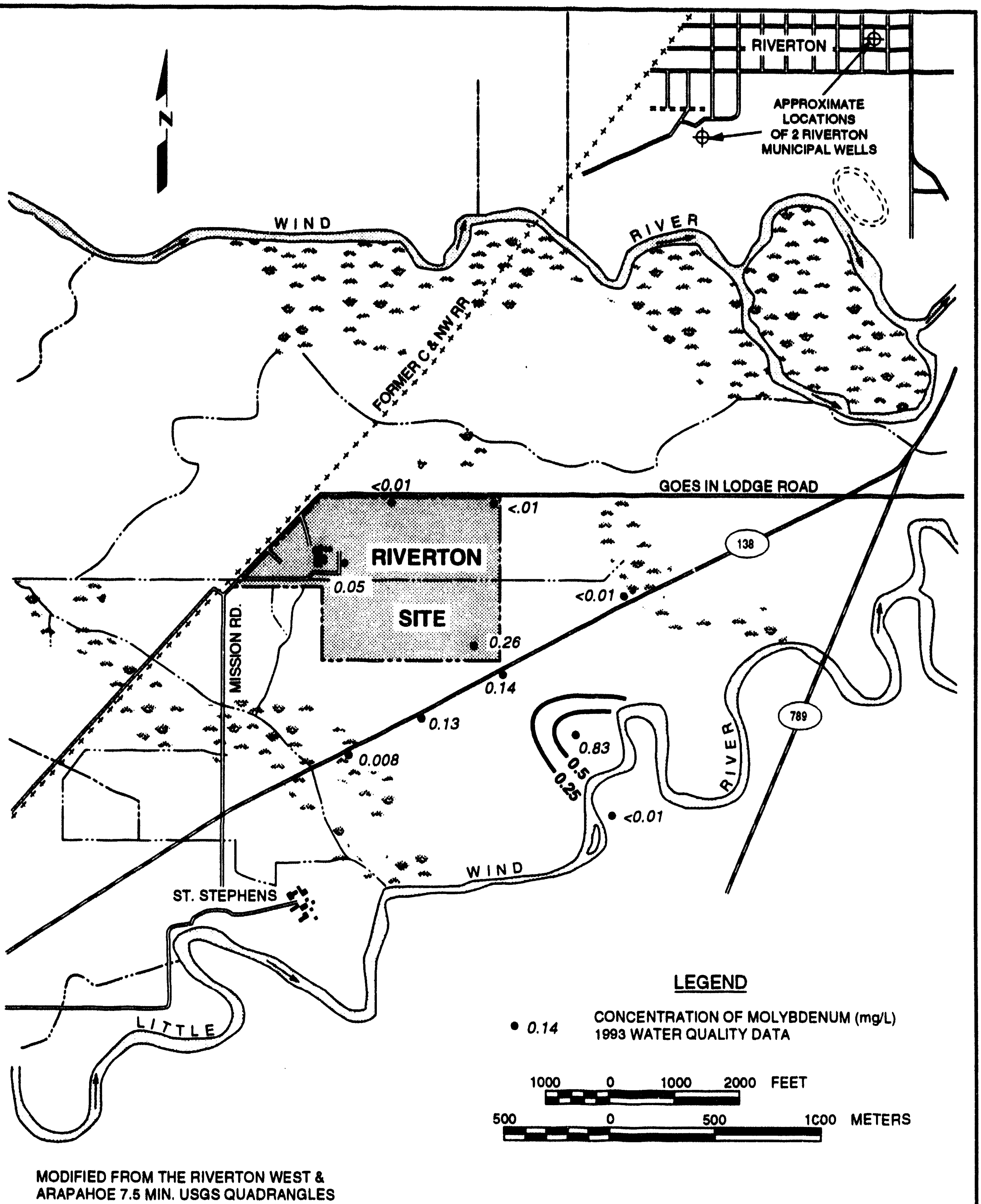



**FIGURE 2.7**
**ISOPLETHS SHOWING MOLYBDENUM CONCENTRATIONS IN THE SURFICIAL AQUIFER RIVERTON, WYOMING**

MAC: SITE/RVT/WSAP/BASE-ISOMOLY

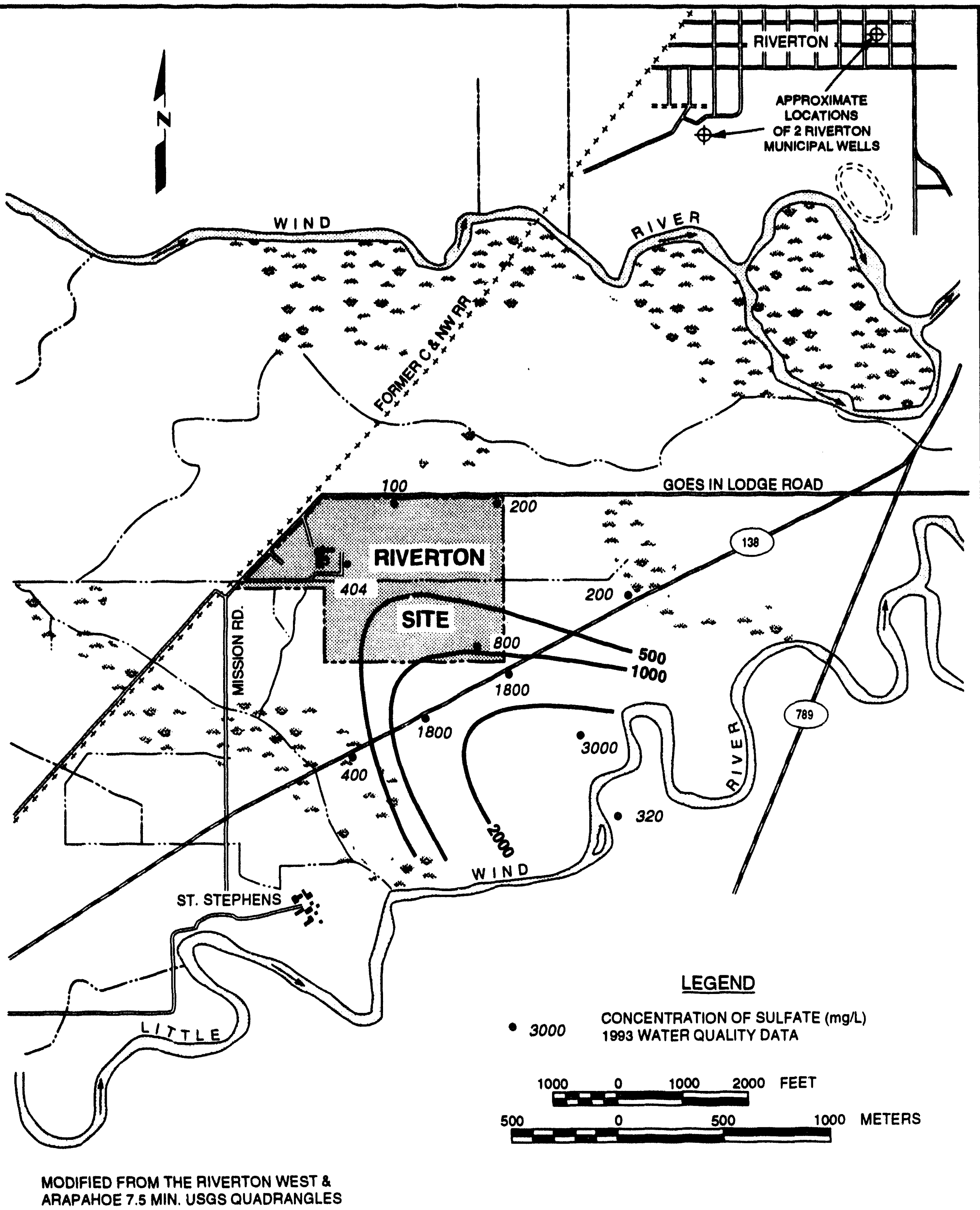
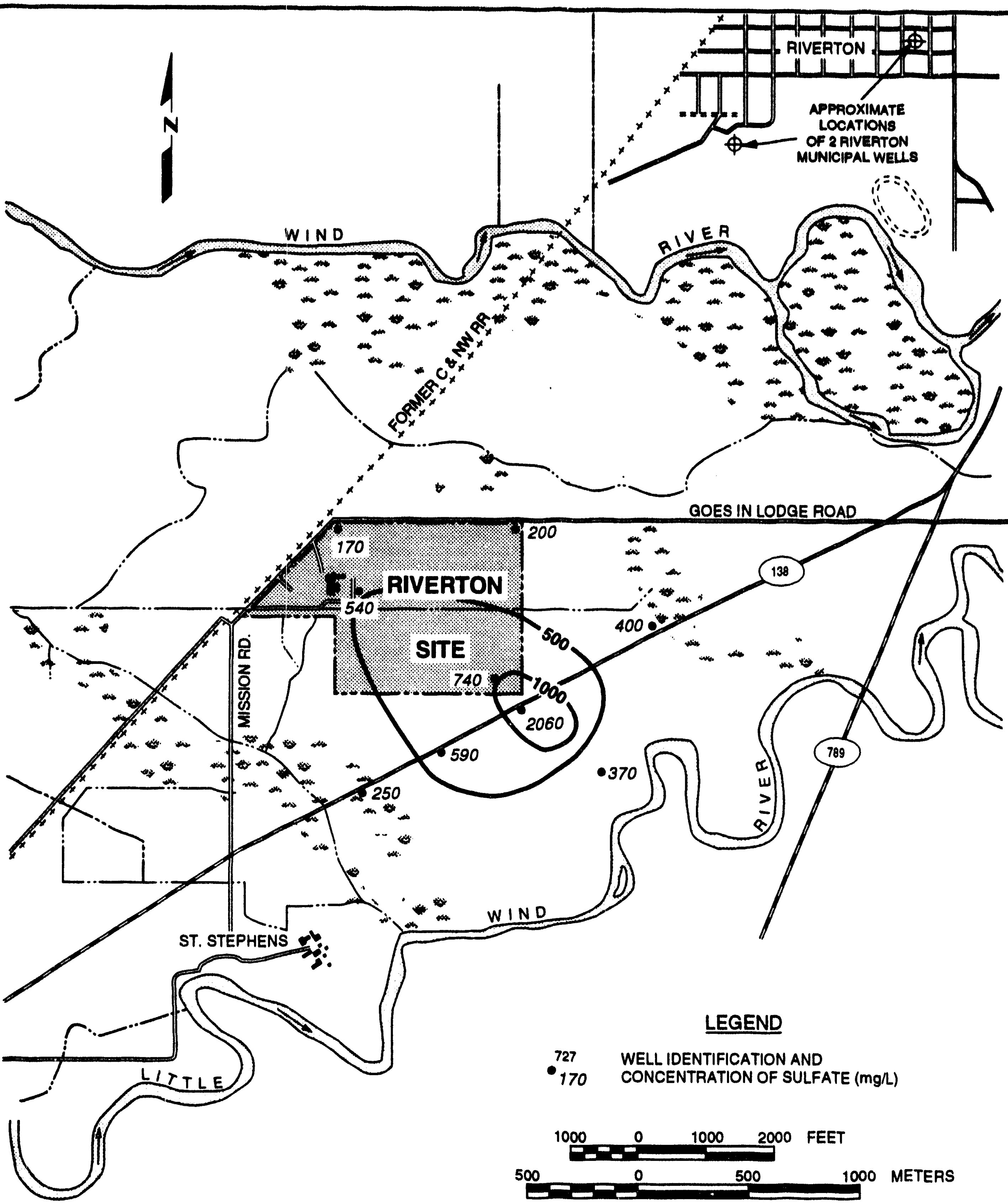



**FIGURE 2.8**
**ISOPLETHS SHOWING SULFATE CONCENTRATIONS IN THE SURFICIAL AQUIFER**
**RIVERTON, WYOMING**

MAC: SITE/RVT/WSAP/BASE-ISOSUL

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NOTE: WATER QUALITY DATE 3/93 FOR ALL WELLS EXCEPT 108 (8/92).

**FIGURE 2.9**
**ISOPLETHS SHOWING SULFATE CONCENTRATIONS IN THE SEMICONFINED AQUIFER RIVERTON, WYOMING**

MAC: SITE/RVT/WSAP/BASE-ISOSULSEMI

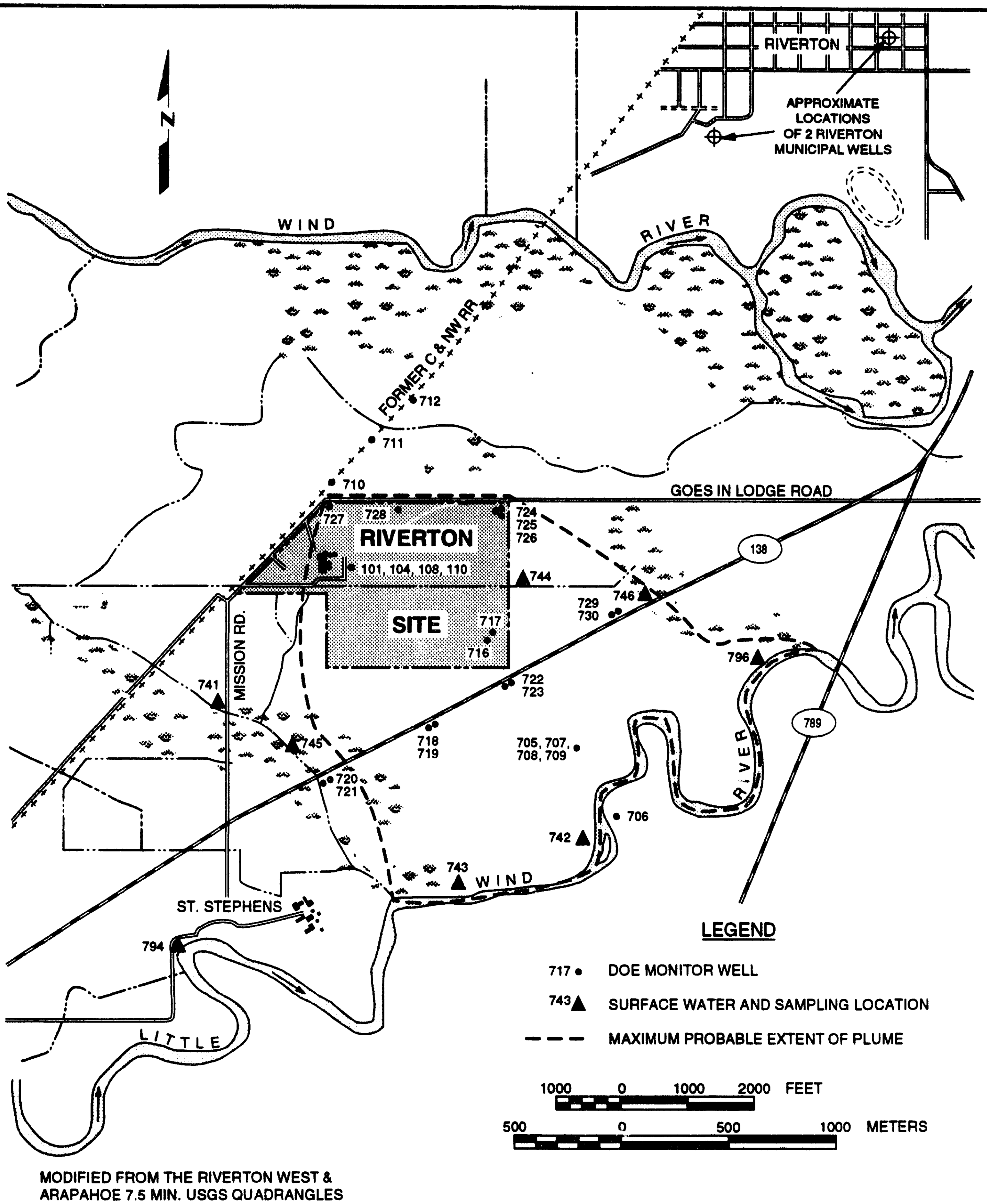


**FIGURE 2.10**
**MAXIMUM PROBABLE EXTENT OF PLUME**
**MONITOR WELL AND SURFACE WATER LOCATIONS TO BE SAMPLED IN FY 1994**
**RIVERTON, WYOMING**

MAC: SITE/RVT/WSAP/BASE-MAXPROBOFPLUME

This plume does not extend much farther north than the northern boundary of the site and is constrained to the east and west by the natural wetland areas that act as hydrologic boundaries. The plume extends to the southeast as far as the Little Wind River but has not moved under the river.

### 2.5.4 Surface water quality

Contaminated ground water probably discharges to the Little Wind River to the southeast of the site and may discharge to the wetland areas to the southwest and east of the site.

Elevated uranium concentrations in the surface water sample collected from the Little Wind River in 1993 at location 742 in Figure 2.10 suggest that discharging ground water may be affecting the water quality. The uranium concentration measured at the river location was approximately 1 order of magnitude higher than the background location (794). Farther downstream (location 796), the uranium concentrations decline to background levels.

The samples from the wetland areas to the west (745) and east (746) of the site, from the drainage ditch along the eastern edge (744), and from the unnamed tributary to the Little Wind River (741) were analyzed for calcium, iron, magnesium, manganese, molybdenum, lead, and uranium. Water quality criteria for protection of aquatic life are not available for all of these constituents, but the concentrations detected in surface samples did not exceed those that are available. Nor did any of the samples contain concentrations of these constituents that exceeded maximum background concentrations (represented by site 741) by more than a factor of 2 to 2.5. No clear trend exists in the surface water data that would suggest discharge of contaminated ground water is influencing the water quality in these water bodies.

# 3.0 WATER SAMPLING PLAN

## 3.1 DATA COLLECTION OBJECTIVES

The water quality sampling planned for the remainder of FY1994 will be a continuation of the sampling program conducted in previous years and in January 1994. Ground water samples will be collected from selected DOE wells to continue monitoring changes in ground water quality following the surface remediation.

Ground water elevations will be measured to define the direction of ground water flow and to assess the magnitude of water table fluctuations at different times of year. Surface water levels will be measured to assess the ground water/surface water interactions. The flow rates in the surface streams will also be measured to evaluate the potential impact of ground water discharge. The reasons for the apparent downward gradient near the northwest corner of the former tailings pile will be evaluated.

Surface water samples will be collected from selected locations to continue monitoring the interaction between ground water and surface water. The surface water samples obtained during 1993 were collected during a period of high river flow and after a precipitation event. Surface water samples should be collected twice during the year: once at the same time as in 1993 to confirm the data, and once during a low-flow period to monitor the influence of ground water discharge on the surface water quality. The low-flow sampling should be in October, which is actually FY1995.

The sampling plan is designed to meet data quality objectives and regulatory requirements. The information collected will provide a data base to assist in the site characterization and will be used to further define the risks that may be associated with ground water contamination and to develop remediation strategies for the site.

During the 1994 sampling, local residents will be interviewed in an attempt to collect the missing data about residential wells identified in Table 1.1.

### 3.1.1 Data quality objectives

Data quality objectives (DQO) define the manner in which samples are collected, handled, and analyzed, including defining analytical support levels; following standard procedures for water sampling, preservation, transport, and other field procedures; performing DQOs in accordance with quality assurance (QA) and quality control protocols; and validating analytical data. DQOs that will be followed during data collection and evaluation activities are stated in the WSAP guidance document (DOE, 1993), the UMTRA Project QA implementation plan currently being prepared, and the applicable SOPs (JEG, n.d.) listed below.

14.5.1 "Procedures for Handling and Shipping of Geotechnical Samples"
16.1.6 "Soil-Water Sampler Installation and Sample Collection"

16.1.10 "Field Measurements for Temperature, Conductivity, pH, Alkalinity, and Total Acid"
16.1.11 "Sample Collection for Organic Substances"
16.1.13 "Field Measurement of Oxidation/Reduction Potential in Water Samples"
16.1.14 "Field Determination of Dissolved Oxygen in Water Samples"
16.1.16 "Alternate Method for Determination of Dissolved Oxygen"
16.1.21 "Measurement of Water Turbidity"
16.2.1 "Sample Collection, Preservation, and Shipment of Water Samples"
16.2.2 "Water Sampling for Tritium Analysis"
16.2.4 "Sampling Radon in Water"
16.2.5 "Monitor Well Sampling with an Electric Submersible Pump"
16.2.6 "Monitor Well Sampling with a Bladder Pump"
16.2.7 "Monitor Well Sampling with a Peristaltic Pump"
16.2.8 "Quality Control Samples for Water Sampling"
16.2.9 "Monitor Well Sampling with a Bailer"
16.3.1 "Inventory and Documentation of Damage and Repair of UMTRA Project Wells"

The sequence in which water quality samples will be collected will be prioritized so the least contaminated samples are collected first and the most contaminated samples are collected last.

### 3.1.2 Regulatory requirements

The regulatory requirements for ground water and surface water sampling at the Riverton site are specified in 40 CFR Part 192 (1993) and in the state of Wyoming regulations (WDEQ, 1980).

### 3.1.3 Compliance monitoring

The tailings, contaminated soils, and contaminated debris from the former milling operations have been removed and disposed of at the Gas Hills facility. Therefore, no compliance monitoring is required at the Riverton site.

### 3.1.4 Site characterization

Ground water characterization is scheduled to begin at the Riverton site in 1995. The ground water quality and flow data to be collected during FY1994 will be useful in accomplishing that characterization.

### 3.1.5 Risk assessment

A baseline risk assessment was started in 1993 for the Riverton site. The data to be collected in 1994 will increase the data base used for this assessment and will assist in assessing the need for remediation and, if needed, in selecting an appropriate remedial strategy.

## 3.2 1994 SAMPLING PLAN

### 3.2.1 Ground water sampling

Filtered ground water samples will be collected from the same monitor wells that were sampled in 1993 (Figure 2.10):

- Wells to be sampled in the 100 cluster northwest of the former tailings pile include: 101 and 104 screened in the surficial aquifer, 108 screened in the semiconfined sandstone, and 110 screened in the confined sandstone.
- Wells to be sampled in the 700 cluster downgradient of the site include: 707 in the surficial aquifer, 705 in the semiconfined sandstone, and 709 in the confined sandstone.
- Well 706 screened in the surficial aquifer on the south side of the Little Wind River.
- Wells installed in 1993: 716, 718, 720, 722, 724, 728, and 729 in the surficial aquifer; 717, 719, 721, 723, 725, 727, and 729 in the semiconfined sandstone; and 726 finished in the confined sandstone.

The wells will be sampled in order of increasing expected contamination:

- Wells outside the contaminant plume: 706 on the south side of the river; 710-712 along the railroad right of way.
- Wells in the deep, confined sandstone aquifer: 110, 709, and 726.
- Wells outside of the plume: 720, 721, 724, 725, 727, 728, 729, and 730.
- Wells within the plume: 101, 104, 705, 707, 708, 716-719, 722, and 723.

The samples will be analyzed in the laboratory for the constituents listed in Table 3.1. Aluminum, fluoride, barium, chromium, lead-210, net gross alpha, nitrate, polonium-210, selenium, and thorium-230 were found to occur only in concentrations similar to or below background concentrations. Because only one analysis has been conducted on samples from the wells installed in 1993, however, these parameters will be reanalyzed in 1994. If they still are not found at elevated concentrations, they may be deleted from the FY1995 sampling. Alkalinity, dissolved oxygen, temperature, conductivity, pH, and oxidation/reduction potential will be measured in the field.

### 3.2.2 Surface water sampling

Surface water samples will be collected at approximately the same locations as those collected in 1993 (Figure 2.10). They will be analyzed for calcium, iron, magnesium, manganese, molybdenum, lead, sulfate, and uranium. These are the same constituents that were analyzed in 1993, with the addition of sulfate as a possible indicator of ground water discharging into the surface waters.

**Table 3.1 Water quality sampling analyte list, Riverton, Wyoming**

| | Constituents | | | |
|---|---|---|---|---|
| **Location** | **With MCLs** | **Without MCLs*** | **For risk assessment** | **For water chemistry** |
| Monitor wells | As, Ba, Cr, Mo, Ni, Pb $NO_3$, Se, U, Net Gross Alpha | Al, Fl, V | Pb-210, Mn, Po-210, Th-230, $SO_4$ | Ca, Cl, Fe, K, Mg, Na, $SiO_2$, TDS |
| Surface water | Mo, Pb, U | | Mn, $SO_4$ | Ca, Fe, Mg |

*Constituents without MCLs listed in Appendix IX, 40 CFR Part 264 (1987).

**KEY**

| | | | |
|---|---|---|---|
| As | - arsenic | Mn | - manganese |
| Al | - aluminum | Mo | - molybdenum |
| Ba | - barium | Na | - sodium |
| Ca | - calcium | Ni | - nickel |
| Cl | - chloride | $NO_3$ | - nitrate |
| Cr | - chromium | Pb | - lead |
| Fe | - iron | Pb-210 | - lead-210 |
| Fl | - fluoride | Po-210 | - polonium-210 |
| K | - potassium | Se | - selenium |
| Mg | - magnesium | $SiO_2$ | - silica |
| $SO_4$ | - sulfate | | |
| Th-230 | - thorium | | |
| TDS | - total dissolved solids | | |

### 3.2.3 Water level and surface flow measurements

To understand the ground water flow regime and the interaction between the ground water and the surface water system, long-term monitoring of ground water elevations and stream flows and elevations will be initiated during FY1994. Precipitation and temperature data will also be collected.

Water level recorders, using submersible probes and data recorders, will be used at four of the well clusters. The purposes of these readings will be to measure the amount of variations in the hydrologic heads in the aquifers. It is important to know if the vertical gradients change during the year and to learn how much the aquifers are recharged by local precipitation. To ascertain these latter data, an on-site weather station containing a recording precipitation gauge and thermometer will be established. Information on rainfall and snowmelt will be compared to fluctuations in water levels.

- Probes will be installed in wells 101, 108, and 110 near the northwest corner of the former tailings pile. One data recorder will be used to measure water levels in all three wells. These three wells are each in a different aquifer, so the piezometric heads can be compared. The pumping records from the Koch Sulfur Products Company production well will also be reviewed to assess the influence pumping from this well has on the confined sandstone aquifer at the former tailings pile.

- Probes will be installed in wells 705, 707, and 709 to measure water elevations in the three aquifers in the plume downgradient of the site. Changes in the water levels in these wells will also be compared to the precipitation and infiltration data and to changes in the water level in the Little Wind River as reported by the U.S. Geological Survey for the gauging station 1.8 mi (2.9 km) upstream of the confluence with the Wind River. The river level data will be used to assess the rate and seasonal variations in ground water discharge to the Little Wind River and the possibility of a reversal in flow from the Little Wind River into the banks during times of high stream flow. The flow rate in the Little Wind River will also be used to estimate the potential impacts of contaminated ground water discharging to the river.

- Probes will be installed in wells 729 and 730 and in a new hand-installed water level monitoring well at the culvert where the stream flowing through the wetland to the east of the site goes under State Highway 138. The variations in water levels in the wells will be compared to the precipitation/infiltration data and to the surface water elevation to assess the interaction between the surface water and ground water regimes. The elevation at the culvert will also be used to calculate the rate of flow in the surface stream to evaluate the potential environmental impacts of ground water discharging to the stream.

- Probes will be installed in wells 720 and 721 and in a new hand-installed water level monitoring well at the culvert where the stream flowing through the wetland to the east of the site goes under State Highway 138. The variations in water levels in the wells will be compared to the precipitation/infiltration data and to the surface water elevation to assess the interaction between the surface water and ground water regimes. The elevation at the culvert will also be used to calculate the rate of flow in the surface stream to evaluate the potential environmental impacts of ground water discharging to the stream.

- The reason for the apparent downward gradient near the northwestern corner of the former tailings pile will be evaluated. The elevations of the well casings will be surveyed to confirm the accuracy of the readings, and if necessary the wells will be pumped to assess the hydraulic connection to the aquifer. Information on the construction details and pumping rates and drawdowns of the Koch Sulfur Products Inc. production well also will be collected to evaluate the possible influence of this pumping on water levels in the different aquifers.

### 3.2.4 Frequency

Ground water samples will be collected from the DOE monitor wells between May 30 and June 10, 1994. Surface water samples will be collected at the same time, and then again in October 1994, the low-flow period of the year.

### 3.2.5 Data interpretation

Water sampling data collected during 1994 will be analyzed and evaluated according to prescribed UMTRA Project procedures and compared with the existing data base. Trend analyses will be performed to detect variations in ground water flow conditions and surface and ground water quality. Variations will be evaluated and modifications to the sampling plan will be noted, justified, and implemented as appropriate.

### 3.2.6 Anomalous data validation

In the event that results from the water sampling are beyond the range of expected values, the suspect data will be evaluated to determine the cause of the deviation. The sampling procedures will be reviewed, the analyzing laboratory will be contacted and, if needed, the sample will be reanalyzed. If the cause of the deviation cannot be determined, the location may be resampled.

# 4.0 LIST OF CONTRIBUTORS

The following individuals contributed to the preparation of this report.

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