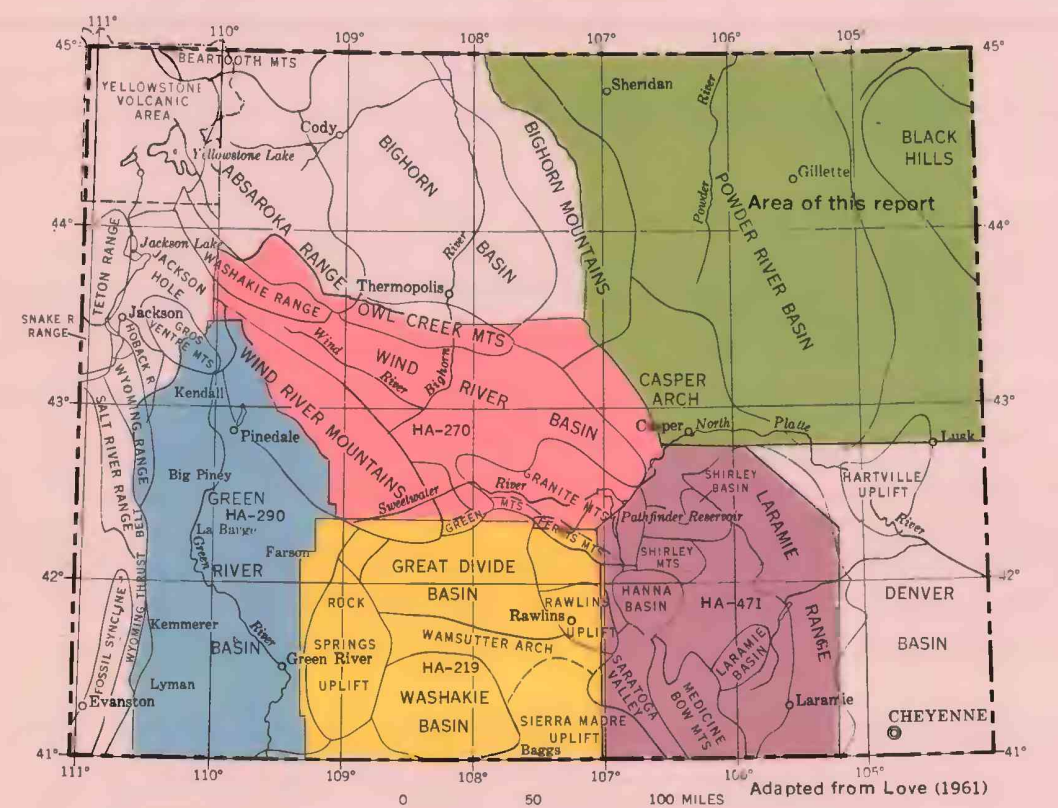
PREPARED IN COOPERATION WITH THE
WYOMING STATE ENGINEER



STRUCTURAL FEATURE MAP OF WYOMING SHOWING THE AREA OF THIS INVESTIGATION AND PUBLISHED REPORTS IN THE HYDROLOGIC ATLAS SERIES

INTRODUCTION

This report describes the results of one of several water-resources investigations of large areas in Wyoming that are being made by the U.S. Geological Survey in cooperation with the Wyoming State Engineer. Each area coincides in general with structural features that form relatively independent ground-water systems. The purpose of these investigations is to obtain general information concerning the availability and quality of ground-water resources and to assess the development potential. In this report, flow characteristics and quality of water in the principal streams are summarized also.

The report area consists of about 24,000 square miles in northeastern Wyoming. It includes the area from the summit of the Bighorn Mountains and crest of the Casper arch eastward to the Wyoming-Nebraska and Wyoming-South Dakota State lines, and the area from the base of T. 33 N. northward to the Wyoming-Montana State line.

Several ground-water investigations have been made that include parts of the report area. These are Crist and Lowry (1972); Kohout (1957); Littleton (1950); Lowry and Cummings (1966); Rapp (1953); Whitcomb (1960, 1963, 1965); Whitcomb, Cummings, and McCullough (1966); Whitcomb and Gordon (1964); Whitcomb and Morris (1964); Warner (1946, 1947); and Williams (1948, 1963). Data from the above reports have been used in addition to data collected during this investigation. Data for more than 7,000 wells and springs and more than 500 chemical analyses of water from wells and springs were studied; only representative data, however, are shown in this report.

WELL-NUMBERING SYSTEM

Wells and springs referred to in this report are numbered according to their location within the Federal system of land subdivision. The first numeral of the well or spring number denotes the township; the second numeral the range; the third numeral the section, which is followed by one or more letters designating the location within the section. Subdivisions within a section are lettered a, b, c, and d in a counterclockwise direction beginning in the northeast quarter (a - NE¼, b - NW¼, c - SW¼, d - SE¼). The first letter denotes the quarter section; the second letter, if shown, denotes the quarter-quarter section; etc. Well 50-72-21acc2, for example, is in the SW¼ of the SW¼ of the NE¼ of section 21, Township 50 North, Range 72 West. The number 2 indicates it is the second well assigned a number in that quarter-quarter-quarter section.

GENERAL GEOLOGY

The Powder River Basin is a structural and topographic basin bounded on the west by the Bighorn Mountains, on the southwest by the Casper arch, on the east by the Black Hills, and on the south by the Laramie Range and Hartville uplift. The northern limits of the basin are in Montana, outside the report area, and are the Miles City arch on the northeast, and an unnamed low arch on the northwest.

The basin is asymmetric and its deepest part is on the west side near, and approximately parallel to, the Bighorn Mountains and Casper arch. The west side of the basin is strongly deformed, especially along the east front of the Bighorn Mountains where Paleozoic and Mesozoic strata have been folded into a narrow belt of steeply dipping rocks. Dips on the west side of the basin commonly range from about 30 degrees eastward to vertical, and locally beds are overturned. On the east side of the basin, the rocks dip 3 to 5 degrees basinward at most places. This dip is interrupted by the Black Hills monocline, a belt of steeply dipping rocks 1½ to 6 miles wide that extends from near Newcastle northwestward about 90 miles to near the Wyoming-Montana State line (Pierce and Girard, 1945; Robinson and others, 1964, p. 109).

As much as 18,000 feet of sedimentary strata ranging in age from Cambrian to Holocene are present in the deepest part of the basin. The older rocks crop out within or near the Bighorn Mountains and the Black Hills, and successively younger rocks are exposed at increasingly greater distances from the uplifted areas. Igneous and metamorphic rocks of Precambrian age are exposed in the uplifted areas. Paleozoic and Mesozoic rocks crop out along the flanks of the mountains and in the Black Hills and dip basinward into the subsurface. As much as 4,500 feet of Cenozoic rocks underlie the surface of the central part of the basin.

Many geologic formations, particularly those of Paleozoic and Mesozoic ages, change greatly in the subsurface from the east side of the basin to the west side, and to a lesser extent from north to south. Different nomenclature for equivalent rocks is used for a number of geologic units because of differences in both lithology and ages of the rock units.

GROUND WATER

AVAILABILITY OF WATER

The occurrence of ground water within the report area is controlled chiefly by climate and geology. Mean annual precipitation decreases basinward from 16.32 inches at Sundance and 15.91 inches at Sheridan to 14.00 inches at Gillette and 11.80 inches at Casper. Potential evaporation is high, especially in the Powder River Basin, and is several times the precipitation; consequently, much snow, surface water, and soil moisture evaporate to the atmosphere.

A balance between recharge and discharge of ground water is indicated by slight annual water-level fluctuations in observation wells. Recharge to Cenozoic rocks in most of the Powder River Basin is almost entirely from precipitation. Recharge to Mesozoic and Paleozoic rocks in the Black Hills and along the front of the Bighorn Mountains is from precipitation and from streams that cross outcrops permeable enough for the infiltration of water. Alluvium along irrigated valleys is recharged in part from irrigation water. Some movement of water between formations probably occurs in the subsurface. Discharge is mainly by evaporation, seepage to springs and lakes, transpiration by plants, and pumpage from wells.

More than 50 geologic formations of sedimentary strata younger than Precambrian age are present in the report area. Some of these formations are hundreds of feet thick and contain many water-bearing zones; others consist mostly of shale or siltstone through which little or no water moves. Secondary permeability from fracturing and solution has increased the water-yielding capabilities of some formations. Ground water in many formations is under artesian pressure and many wells flow at the surface.

Most ground-water development has been for stock and domestic purposes, and wells are usually drilled and developed to supply water sufficient for these needs only. In many places, larger yielding wells may be possible by drilling into a greater thickness of the saturated rock and by improved well construction and development. Potential yields of water from most formations are poorly known, but estimates are possible, based on available well data.

Paleozoic rocks having the greatest potential for ground-water development are the Pahasapa and Madison Limestones of Mississippian age, and the Minnelusa Formation and Tensleep Sandstone of Pennsylvanian and Permian ages. Other Paleozoic rocks having potential for ground-water development are the Bighorn Dolomite of Ordovician age and the Flathead Sandstone of Cambrian age. These formations are deeply buried in most of the basin, however, and their ground-water possibilities at greater depths are unknown.

Mesozoic rocks having the greatest potential for ground-water development are the Cloverly, Lakota, and Fall River Formations of Early Cretaceous age, and the Mesaverde Formation, Fox Hills Sandstone, and Lance Formation of Late Cretaceous age. Depths to these rocks are inferred by structure contours on the geologic map and by the stratigraphic section and formation thicknesses given in the table of geologic formations.

Cenozoic rocks having the greatest potential for ground-water development are the Fort Union and Wasatch Formations of Tertiary age in the central part of the basin, and the Arikaree and White River Formations of Tertiary age in the southeast part of the basin. Alluvium of Quaternary age, although restricted in areal extent to stream valleys, has considerable potential for development, particularly along larger valleys. Yields and quality of water from rock formations are discussed in the table of geologic formations and potential water supply.

EXPLANATION

QUATERNARY

Pleistocene and Holocene
- Qal Alluvium
- Qls Landslide deposits
- Qs Windblown sand

Pleistocene
- Qg Glacial deposits

TERTIARY

Oligocene Miocene
- Taw, Twr Arikaree and White River Formations
  - Twr, *White River Formation*

Eocene
- Tw, Twm, Twk Wasatch Formation
  - Twm, *Moncrief Member*
  - Twk, *Kingsbury Conglomerate Member*

Pliocene
- Tf Fort Union Formation

TERTIARY (?)

Pliocene(?)
- Tl Intrusive rocks

CRETACEOUS

Upper Cretaceous
- Kl Lance Formation
- Kfh Fox Hills Sandstone *Lewis Shale included along west side of basin*
- Klf Lance Formation and Fox Hills Sandstone *Lewis Shale included along west side of basin*
- Kp Pierre Shale
- Kmv Mesaverde Formation
- Kc Cody Shale
- Kn Niobrara Formation
- Kcl Carlile Shale
- Kncl Niobrara Formation and Carlile Shale, undivided
- Kg Greenhorn Formation
- Kf Frontier Formation

Lower Cretaceous
- Kbm Belle Fourche and Mowry Shales
- Knc Newcastle Sandstone
- Ksc Skull Creek Shale
- Kbs Belle Fourche and Mowry Shales, Newcastle Sandstone and Skull Creek Shale, undivided
- Kmt Mowry and Thermopolis Shales, undivided
- Kft Frontier Formation, Mowry and Thermopolis Shales, undivided

JURASSIC

Upper Jurassic
- KJim Inyan Kara Group and Morrison Formation
- KJcm Cloverly and Morrison Formations

Middle Jurassic
- Jsg Sundance and Gypsum Spring Formations

PERMIAN AND TRIASSIC
- ŦPs Spearfish Formation
- ŦPcg Chugwater and Goose Egg Formations and equivalent rocks

PERMIAN
- Pmo Minnekahta Limestone and Opeche Shale

PENNSYLVANIAN AND PERMIAN
- PIPm Minnelusa Formation
- PIPh Hartville Formation

MISSISSIPPIAN, PENNSYLVANIAN, AND PERMIAN
- PMta Tensleep Sandstone and Amsden Formation

DEVONIAN AND MISSISSIPPIAN
- MDpe Pahasapa Limestone and Englewood Formation
- MDg Guernsey Formation

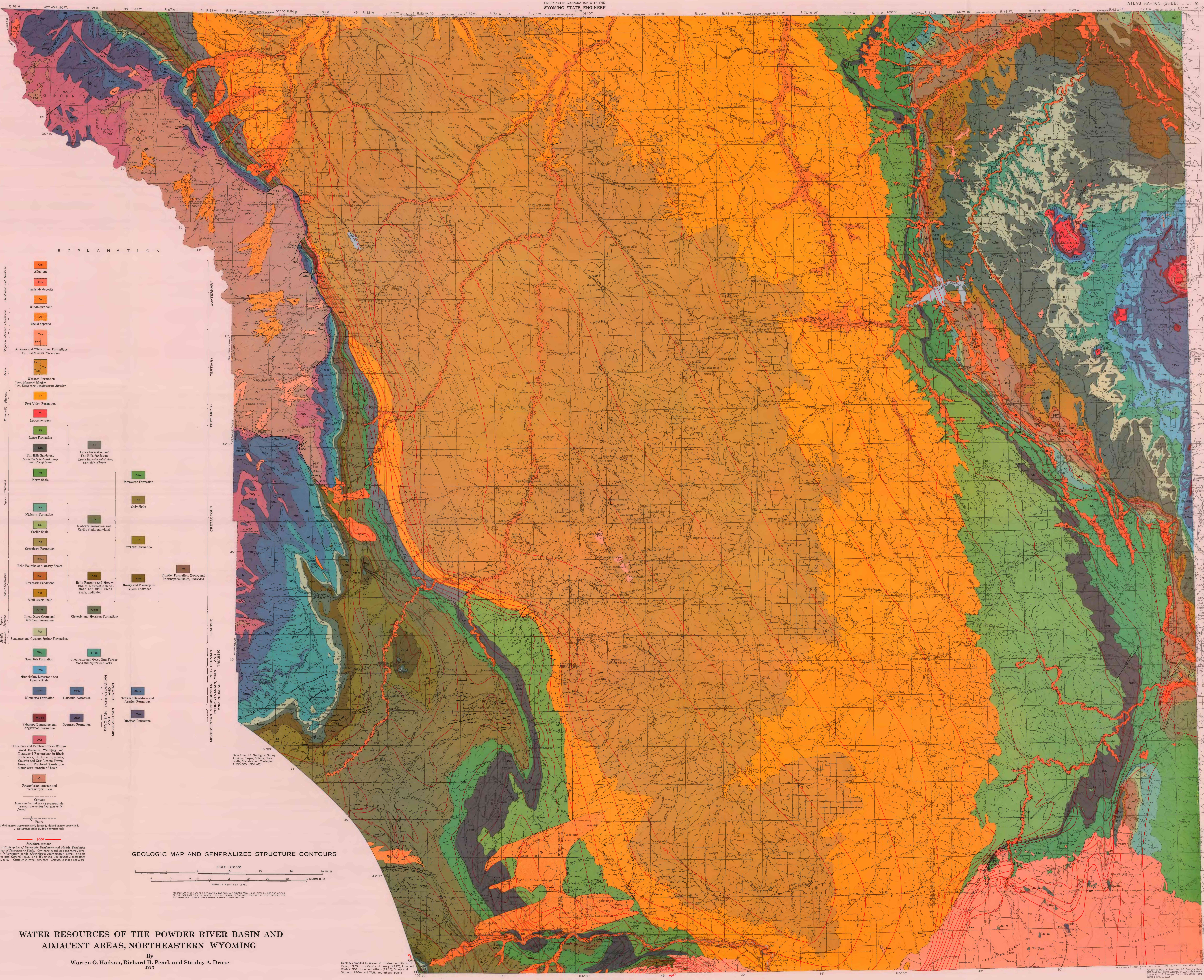
MISSISSIPPIAN
- Mm Madison Limestone

- O€r Ordovician and Cambrian rocks. Whitewood Dolomite, Winnipeg and Deadwood Formations in Black Hills area; Bighorn Dolomite, Gallatin and Gros Ventre Formations, and Flathead Sandstone along west margin of basin
- p€r Precambrian igneous and metamorphic rocks

Contact
Long-dashed where approximately located; short-dashed where inferred

U/D Fault
Dashed where approximately located; dotted where concealed. U, *upthrown side;* D, *downthrown side*

— 2000 —
Structure contour
Shows altitude of top of Newcastle Sandstone and Muddy Sandstone Member of Thermopolis Shale. Contours based on data from Petroleum Information cards (Petroleum Information Corp.) and on Pierce and Girard (1945) and Wyoming Geological Association (1957, 1961). Contour interval 1000 feet. Datum is mean sea level



Base from U.S. Geological Survey Arminto, Casper, Gillette, Newcastle, Sheridan, and Torrington 1:250,000 (1954-62)

GEOLOGIC MAP AND GENERALIZED STRUCTURE CONTOURS

SCALE 1:250 000
5 0 5 10 15 20 25 MILES
5 0 5 10 15 20 25 30 35 KILOMETERS
DATUM IS MEAN SEA LEVEL

APPROXIMATE 1955 MAGNETIC DECLINATION FOR THIS MAP RANGED FROM 14°00' EASTERLY FOR THE CENTER OF THE EAST EDGE TO 15°30' EASTERLY FOR THE CENTER OF THE WEST EDGE AND TO 16°15' EASTERLY FOR THE NORTHWEST CORNER. MEAN ANNUAL CHANGE IS 0°03' WESTERLY

WATER RESOURCES OF THE POWDER RIVER BASIN AND ADJACENT AREAS, NORTHEASTERN WYOMING

By
Warren G. Hodson, Richard H. Pearl, and Stanley A. Druse
1973

Geology compiled by Warren G. Hodson and Richard H. Pearl, 1970, from Crist and Lowry (1972), Love and Weitz (1951), Love and others (1955), Sharp and Gibbons (1964), and Weitz and others (1954)

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