UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SELECTIVE ANNOTATED BIBLIOGRAPHY OF GEOLOGY AND GROUND-WATER RESOURCES FOR THE MONTANA PART OF THE NORTHERN GREAT PLAINS REGIONAL AQUIFER-SYSTEM ANALYSIS

by Julianne F. Levings, Gary W. Levings, R. D. Feltis,
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ILLUSTRATION

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METRIC CONVERSION TABLE

The following factors can be used to convert inch-pound units in this report to the International System (SI) of metric units.

Multiply inch-pound unit	By	To obtain SI unit
acre	0.4047	hectare
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
gallon per minute (gal/min)	0.06309	liter per second
inch (in.)	25.40	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

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ABSTRACT

Increasing demand for water to meet needs for energy, industry, irrigation, domestic, and municipal uses has resulted in a study of the geology and hydrology of rocks of Mesozoic and Cenozoic age. This report presents the results of a literature search for the part of the study area in Montana. It consists of an annotated listing of pertinent published reports, a partial subject and area index of the reports, and a correlation chart of geologic and aquifer units listed in the annotations.

INTRODUCTION

The increasing demand for water resulting from continuing development of energy resources, power generation, industry, irrigation, and domestic and municipal water supplies in the northern Great Plains area of Montana will require that additional ground-water supplies be used at some time in the future. Consequently, in 1978 the U.S. Geological Survey began a 4-year study of aquifers of Mesozoic and Cenozoic age to define the hydrologic system, to determine the availability and chemical quality of ground water, and to predict the effects of various water-use management plans on the system. The study area includes most of Montana east of the Rocky Mountains (see report cover).

During the initial phase, an extensive literature search was made of all previously published work relating to geology and water resources for the study area. The purpose of this bibliography is: (1) To provide under one cover the results of that literature search for use as background information in writing future interpretive reports and (2) to acquaint interested readers with historic reports for the area.

The bibliography has been subdivided into three major headings: geology, hydrology, and chemical quality of water. If a reference is pertinent to more than one topic, the citation and annotation appear under each applicable

heading. For a reference to be included under more than one heading, a significant part of the report must be applicable to the additional topic. The annotations consist mainly of a description of the publication contents, such as maps, tables, or logs.

A partial subject and area index has been provided at the end of this bibliography. The index subjects were derived from publication titles and their respective annotations. For instance, a report is not indexed by county unless the county name appears in the title or the annotation. Letters in the index inform the reader which of the major subdivisions contain the annotated reference: G, geology bibliography; H, hydrology bibliography; Q, chemical-quality bibliography.

A correlation chart (table 1) of selected geologic and aquifer units for five major geographic subdivisions of the northern Great Plains of Montana is included in a pocket at the back of this report. The purpose of the generalized stratigraphic columns is to acquaint the reader with the geologic age, distribution, and relative stratigraphic placement of geologic or aquifer units mentioned in the annotations.

BIBLIOGRAPHY

GEOLOGY

Alverson, D. C., 1965, Geology and hydrology of the Fort Belknap Indian Reservation, Montana: U.S. Geological Survey Water-Supply Paper 1576-F, p. F1-F59.

[This report contains a geologic map at a scale of 1:62,500, two geologic sections, and a generalized section describing the lithologic character and water-bearing properties of the map units; map units include the Ellis Group through the Bearpaw Shale. The text describes the geologic formations and their water-bearing properties, the geologic structure, and the hydrology.]

Baker, A. A., 1929, The northward extension of the Sheridan coal field, Big Horn and Rosebud Counties, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 806-B, p. 15-67.

[This report describes the stratigraphy of the Fort Union and Wasatch Formations and the occurrence, distribution, and correlation of coal beds, township by township, for about 700 mi^2. Included are two measured sections of part of the Fort Union Formation (900 ft) and one measured section of the Wasatch Formation (472 ft). Two maps at a scale of 1:62,500 show the outcrop of the coal and the 735 sites where coal was measured. Diagrams in the text show the correlation of the coal beds.]

Balster, C. A., 1973, Structure contour map, Upper Cretaceous, southeastern Montana: Montana Bureau of Mines and Geology Special Publication 60, scale about 1:317,000.

[This report consists of a map showing structure contours of the top of a peristent bentonite marker bed below the Greenhorn Formation, and an electric log depicting the typical resistivity of this marker bed.]

_____1980, Stratigraphic nomenclature chart for Montana and adjacent areas: Montana Bureau of Mines and Geology Geologic Map 8.

[This chart correlates Precambrian through Cenozoic stratigraphic units for 27 subdivisions of central and southern Montana, the northern Montana plains, Montana west of the Continental Divide, and Canada north of Montana.]

Barnett, V. H., 1917, Geology of the Hound Creek district of the Great Falls coal field, Cascade County, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 641-H, p. 215-232.

[This report describes the stratigraphy, structure, and occurrence of coal in 180 mi^2 on the northwest side of the Little Belt Mountains. Rocks from the Madison Limestone (Madison Group) through the Colorado

Shale (Colorado Group) are described. Coal occurs locally in what is now (1981) considered to be the Morrison Formation. The report includes a tabular summary of stratigraphy and a geologic map at a scale of 1:125,000.]

Bass, N. W., 1932, The Ashland coal field, Rosebud, Powder River, and Custer Counties, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 831-B, p. 19-105.

[This report describes the stratigraphy of the Fort Union Formation and the geomorphology of about 975 mi^2 in southeastern Montana. It includes a detailed township-by-township description of the coal resources, and a geologic map at a scale of 1:62,500 showing the outcrop of coal beds and the location of 839 measured coal sections.]

Bauer, C. M., 1914, Lignite in the vicinity of Plentywood and Scobey, Sheridan County, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 541-H, p. 293-315.

[This report describes the stratigraphy of the Fort Union Formation and the occurrence of lignite in parts of Tps. 33 to 35 N., R. 48 E.; parts of Tps. 33 and 34 N., Rs. 54 and 55 E.; and T. 35 N., Rs. 52 to 55 E. Maps of these two areas at a scale of 1:125,000 show lignite outcrops, burned areas, and sites where lignite sections were measured. The report includes 8 measured stratigraphic sections of the Fort Union Formation, 49 measured lignite sections, and 5 analyses of lignite samples. The occurrence of lignite is described township by township.]

_____1925, The Ekalaka lignite field, southeastern Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 751-F, p. 231-267.

[This report describes the stratigraphy and lignite resources of 3,000 mi^2 in the southeast corner of Montana. The rocks exposed in the area are Late Cretaceous and Tertiary in age. Eight measured sections show 1,014 ft of rock. The occurrence of lignite is described township by township. One hundred fifty-six coal sections were measured. The report includes a detailed geologic map of the northeast part of the report area at a scale of 1:125,000 and shows the outcrop of the lignite with locations of the measured lignite sections. Also included are three analyses of lignite from the Ekalaka field.]

Beekly, A. L., 1912, The Culbertson lignite field, Valley County, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 471-D, p. 319-358.

[This report is mostly a township-by-township description of the exposures, character, and thickness of lignite for the northeast corner of Montana. The report area, which is north of the Missouri River and east of Big Muddy Creek, encompasses Tps. 33 to 37 N., Rs. 56 to 58 E. Much of the area is covered by glacial deposits but the maps show outcrops of

lignite, burned areas, and measured-section sites. The report includes 5 descriptive sections of rocks and lignite and 13 chemical analyses of lignite samples.]

Blackstone, D. L., Jr., 1949, Structural pattern of the Powder River basin *in* Wyoming Geological Association Guidebook 4th Annual Field Conference, Powder River basin, 1949: p. 35-36.

[This report describes, in general terms, the structural complexities of the Powder River basin and marginal areas.]

_____1975, Geology of the East Pryor Mountain quadrangle, Carbon County, Montana: Montana Bureau of Mines and Geology Special Publication 69, scale 1:24,000.

[This report contains a geologic map and three geologic sections. A short text accompanying the map includes a description of the stratigraphy, including the Ellis Group and Cloverly Formation equivalent, and a detailed discussion and interpretation of the regional structural geology, the Sage Creek fault system, and the East Pryor Mountain fault block.]

Blankennagel, R. K., Howells, L. W., Miller, W. R., and Hansen, C. V., 1979, Preliminary data for Madison Limestone test well 3, NW1/4SE1/4 sec. 35, T. 2 N., R. 27 E., Yellowstone County, Montana: U.S. Geological Survey Open-File Report 79-745, 186 p.

[This report provides the preliminary data for the Madison Limestone (Madison Group) test well 3 including test-well history, geology penetrated by the test well, hydrologic testing, and geochemistry. Geologic interval penetrated is from the Eagle Sandstone to rocks of Precambrian age.]

Blixt, J. E., 1933, Geology and gold deposits of the North Moccasin Mountains, Fergus County, Montana: Montana Bureau of Mines and Geology Memoir 8, 25 p.

[This report contains a description of the stratigraphy, structure, petrography of igneous rocks, economic geology of gold mining, and occurrence and character of ores. The report contains five analyses of intrusive rocks; measured sections of undivided Cambrian and Devonian (?) rocks, Madison Limestone (Madison Group), Ellis Formation (Ellis Group), and Kootenai Formation; and illustrations showing underground mine workings. The geologic map at a scale of about 1:32,000 includes two geologic sections.]

Bowen, C. F., 1912, The Baker lignite field, Custer County, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 471-D, p. 202-226.

[This report consists of a township-by-township description of the occurrence of coal in the Fort Union Formation for the area of Tps. 5 to 8 N.,

Rs. 54 to 61 E. Included are descriptions of 43 coal sections and 1 analysis of a coal sample. A map at a scale of 1:125,000 shows the geology and the outcrops of coal and burned areas.]

_____1914a, Coal discovered in a reconnaissance survey between Musselshell and Judith, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 541-H, p. 329-337.

[This report describes the occurrence of coal in an area that ranges from less than 1 mi to about 30 mi in width between the towns of Musselshell on the Musselshell River and Judith on the Judith River, a distance of about 125 mi. A generalized section of the sedimentary rocks is given for the upper part of the Colorado Shale (Colorado Group) through the Lance Formation equivalent. Four sections of coal were measured in the Eagle Sandstone and 11 sections were measured in the Judith River Formation. A geologic map at a scale of 1:500,000 shows the formation outcrops and the structural features from Devil Basin to the Cat Creek anticline and for the areas north of the Judith and North Moccasin Mountains. One analysis of a coal sample is given.]

_____1914b, The Cleveland coal field, Blaine County, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 541-H, p. 338-355.

[This report describes the stratigraphy from the Madison Limestone (Madison Group) through the Bearpaw Shale and the occurrence and distribution of coal in the upper part of the Judith River Formation. A geologic map of T. 28 N., Rs. 19 to 22 E., and Tps. 29 to 31 N., Rs. 20 to 22 E., at a scale of 1:125,000 shows formation outcrops, coal outcrops, and measured-coal-section sites. Included are 28 measured coal sections and 7 analyses of coal samples.]

_____1914c, The Big Sandy coal field, Chouteau County, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 541-H, p. 356-378.

[This report describes the stratigraphy and occurrence of coal in the area of Tps. 25 and 26 N., Rs. 13 to 15 E., and Tps. 27 and 28 N., Rs. 13 and 14 E. Coal occurs in the Eagle Sandstone, Judith River Formation, and Fort Union Formation. Twenty-five measured coal sections are given for the Eagle Sandstone, 6 for the Judith River Formation, and 11 for the Fort Union Formation. A geologic map at a scale of 1:125,000 shows the outcrops of coal and the measured-coal-section sites. Three analyses of coal from this field are used to compare coal from the Havre and Great Falls fields.]

_____1919, Anticlines in a part of Musselshell Valley, Musselshell, Meagher, and Sweet Grass Counties, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 691-F, p. 185-209.

[This report describes the stratigraphy of rocks of Early Cretaceous through Eocene age and the series of anticlines and domes from Tps. 6 to 11 N. and Rs. 11 to 24 E. Included is a geologic map with structure contours depicting the base of the Eagle Sandstone and five geologic sections.]

_____1920 [1921], Gradations from continental to marine conditions of deposition in central Montana during the Eagle and Judith River epochs: U.S. Geological Survey Professional Paper 125-B, p. 11-21.

[This report consists primarily of a discussion of the stratigraphy of the rocks of Cretaceous and Paleocene age in the vicinity of Porcupine dome and the conditions of their deposition. The text is supplemented by a descriptive drill log, a geologic map and geologic sections at a scale of about 1:250,000, a table summarizing the characteristics and thickness of the geologic units from the Kootenai Formation through the Lance Formation equivalent, and a diagrammatic section illustrating the sequence of sediments resulting from transgressions and regressions of the sea through central Montana during Late Cretaceous time.]

Brown, D. L., Blankennagel, R. K., Busby, J. F., and Lee, R. W., 1977, Preliminary data for Madison Limestone test well No. 2, SE1/4SE1/4 sec. 18, T. 1 N., R. 54 E., Custer County, Montana: U.S. Geological Survey Open-File Report 77-863, 135 p.

[This report provides the preliminary data for the Madison Limestone (Madison Group) test well 2 including test-well history, geology of the test well, hydrologic testing, and geochemistry. The drilling of the well started in the Bearpaw Shale and bottomed in Precambrian rocks].

Brown, Andrew, Culbertson, W. C., Dunham, R. J., Kepferle, R. C., and May, P. R., 1954, Strippable coal in Custer and Powder River Counties, Montana: U.S. Geological Survey Bulletin 995-E, p. 151-200.

[This report describes the locations most suitable for strip mining in an area of about 2,300 mi^2. The report contains analyses of 8 coal samples, generalized columnar sections showing correlation of coal beds, and 88 measured coal sections. Included are four maps at a scale of 1:24,000 showing areas of strippable coal and the amount of overburden. Six page-size maps of various scales show selected areas of strippable coal, the thickness of the beds, and the amount of overburden.]

Bryant, Bruce, Schmidt, R. G., and Pecora, W. T., 1960 [1961], Geology of the Maddux quadrangle, Bearpaw Mountains, Blaine County, Montana: U.S. Geological Survey Bulletin 1081-C, p. 91-116.

[This report contains a geologic map at a scale of 1:31,680 with brief lithologic descriptions of the igneous and sedimentary map units from the Rierdon through the Wasatch Formations, and two geologic sections. The text consists mainly of a discussion of the igneous rocks and structural geology of the map area which is situated within two structural

provinces -- the Bearpaw Mountains structural arch and the southern volcanic field.]

Bryson, R. P., 1952, The Coalwood coal field, Powder River County, Montana: U.S. Geological Survey Bulletin 973-B, p. 23-106.

[This report contains a geologic map at a scale of 1:63,360 for a large area along the crest and western flank of the Black Hills uplift. Shown on the map are the outcrop areas of 30 coal beds. Also included are analyses of two coal samples; measured stratigraphic sections for the 1,320 ft of exposed Hell Creek and Fort Union Formations; a table of fossil-collection sites; and diagrams showing correlations, ranges in thickness, and average intervals between coal beds. The text describes the stratigraphy of the geologic units and the characteristics of the coal beds. A township-by-township discussion of coal resources and estimated reserves is accompanied by 264 graphic coal sections.]

Bryson, R. P., and Bass, N. W., 1973 [1974], Geology of Moorhead coal field, Powder River, Big Horn, and Rosebud Counties, Montana: U.S. Geological Survey Bulletin 1338, 116 p.

[This report contains a geologic map (2 sheets) at a scale of 1:63,360 of the Hell Creek, Fort Union, and Wasatch Formations for a large area along the northeast flank of the Powder River Basin. Shown on the map are the outcrop and burned area for 33 coal beds more than 2 ft thick. Also included are analyses of 10 coal samples, measured stratigraphic sections for the entire 2,250-ft column of exposed rocks in the map area, and a diagram showing the stratigraphic positions of the coal beds. The text describes the major structural features and stratigraphy of the map units. A township-by-township discussion of the coal resources and reserves is accompanied by more than 1,000 graphic coal sections.]

Calvert, W. R., 1909, Geology of the Lewistown coal field, Montana: U.S. Geological Survey Bulletin 390, 83 p.

[This report is the first comprehensive study of the geology of the Judith Basin of central Montana, which encompasses an area of about 1,500 mi^2. The stratigraphy of rocks from the Madison Limestone (Madison Group) through the Claggett Shale is described, as well as travertine and terrace deposits of Tertiary and Quaternary age. Eleven stratigraphic sections were measured and described. The major structural features of the Little Belt, Big Snowy, Judith, and Moccasin Mountains are described as well as numerous other folds, domes, and related faults. Seven coal districts are described individually in terms of location, extent, character, and thickness of the coal, and importance of mines and their development. Six measured coal sections are given and chemical analyses for 22 coal samples are listed. (The coal that was reported to be in the Kootenai Formation is now considered to be in the Morrison Formation.) The report includes a geologic map at a scale of 1:125,000 with four geologic sections.]

_____1912a, Geology of certain lignite fields in eastern Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 471-D, p. 187-201.

[This report is the introductory report for the Baker, Terry, Glendive, Sidney, and Culbertson lignite field reports that are in U.S. Geological Survey Bulletin 471. The report mostly describes the stratigraphy of the area and includes descriptions of the Pierre Shale, Lance Formation equivalent, and Fort Union Formation. Included are lists of fossils and three sections of rocks with lithologic descriptions.]

_____1912b, The Livingston and Trail Creek coal fields, Park, Gallatin, and Sweetgrass Counties, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 471-E, p. 384-405.

[This report describes the stratigraphy of the area in general and the coal-bearing beds in the Eagle Sandstone in particular. Most mining preceded the writing of the report and much of the development was abandoned. The report includes six descriptive sections of coal and chemical analyses of nine coal samples. A map at a scale of 1:125,000 shows geology for the area of T. 2 S., Rs. 7 to 13 E., and the Trail Creek area of T. 3 S., Rs. 7 and 8 E.]

_____1912c, The Electric coal field, Park County, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 471-E, p. 406-422.

[This report describes the stratigraphy of parts of Tps. 8 and 9 S., Rs. 7 and 8 E., with emphasis on the coal-bearing rocks in the lower part of the Montana Group. The report contains a description of a 4,970-ft measured section of sedimentary rock from the top of the Madison Limestone (Madison Group) to the top of the undifferentiated Montana Group, and a geologic map and a geologic section at a scale of 1:62,500. Descriptions of two coal sections and five analyses of coal samples are given.]

_____1917, Geology of the Upper Stillwater Basin, Stillwater and Carbon Counties, Montana, with special reference to coal and oil, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 641-G, p. 199-214.

[This report describes the general geology and coal resources of about 300 mi^2 along the north flank of the Beartooth Mountains. The purpose of the study was to determine if coal in the Stillwater basin was an extension of that at Red Lodge, Montana. The Eagle Sandstone, the Livingston Formation (Livingston Group), and Fort Union Formation are described, as well as the coal that occurs in each. One stratigraphic and three coal sections, and six analyses of coal samples are given. Included is a geologic map at a scale of about 1:158,000 that shows topographic contours and outcrops of coal beds.]

Collier, A. J., 1925, The Scobey lignite field, Valley, Daniels, and Sheridan Counties, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 751-E, p. 157-230.

[This report has resulted from a comprehensive study of the stratigraphy and occurrence of lignite in northeast Montana. A township-by-township description of the occurrence of coal is accompanied by 169 graphic sections of coal and analyses of 12 coal samples. Included is a generalized geologic map at a scale of 1:250,000 showing the coal outcrops, mines, and measuring sites.]

_____1930, The Kevin-Sunburst oil field and other possibilities of oil and gas in the Sweetgrass arch, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 812-B, p. 57-189.

[This report describes the general stratigraphy, structure, and oil and gas possibilities in the area of Tps. 17 to 37 N. and Rs. 7 W. to 9 E., but gives more specific details of the Kevin-Sunburst Dome area in the area of Tps. 32 to 37 N., Rs. 1 to 3 W. Structure-contour maps of the top of the Madison Limestone (Madison Group) were made for both areas. A history of the discovery, development, and extent of the oil field and producing "sand" is given by townships. The locations of, and producing formations for, about 1,200 wells are listed. Production trends of the field are described and seven analyses of oil are given.]

Collier, A. J., and Knechtel, M. M., 1939, The coal resources of McCone County, Montana: U.S. Geological Survey Bulletin 905, 80 p.

[This report contains a generalized stratigraphic section of the exposed rocks from the top of the Bearpaw Shale through the Tongue River Member of the Fort Union Formation, a regional-scale structure map, a geologic map of the area at a scale of 1:125,000, and three geologic sections. The text describes the general structural features and the stratigraphy of the map units although formation terminology has since been revised. A lengthy township-by-township discussion of coal resources for the county is accompanied by 531 graphic sections of 11 coal beds.]

Colton, R. B., 1955, Geology of the Wolf Point quadrangle, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-67, scale 1:62,500.

[This report consists of a geologic map and two geologic sections accompanied by a short text that describes the structure, geologic history, economic geology, and stratigraphy of the map units exposed in the area, which include the Bearpaw Shale through the Fort Union Formation.]

_____1962, Geology of the Otter Creek quadrangle, Montana: U.S. Geological Survey Bulletin 1111-G, p. 237-288.

[This report describes in detail the stratigraphy of the Fort Union and Flaxville Formations and Wiota Gravel. Lignite beds in the Fort Union are described and relative stratigraphic position shown. Included is a

geologic map with three geologic sections; a map showing the location of coal beds and coal-section sites; a chart showing measured sections at 53 sites; and two maps and three geologic sections showing glacial features of Pleistocene age for the study area and adjacent areas in northeastern Montana.]

_____1963a, Geologic map of the Brockton quadrangle, Roosevelt and Richland Counties, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-362, scale 1:62,500.

[This report consists of a map showing the geology and structure of the area near Brockton, Montana. The explanation contains brief lithologic descriptions of all map units from the Bearpaw Shale through the Fort Union Formation.]

_____1963b, Geologic map of the Chelsea quadrangle, Roosevelt and McCone Counties, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-363, scale 1:62,500.

[This report consists of a geologic map, three geologic sections, and an explanation containing brief lithologic descriptions of all the map units from the Bearpaw Shale through the Fort Union Formation.]

_____1963c, Geologic map of the Cuskers quadrangle, Roosevelt County, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-364, scale 1:62,500.

[This report consists of a geologic map and an explanation containing brief lithologic descriptions of all the map units from the Bearpaw Shale through the Fort Union Formation.]

_____1963d, Geologic map of the Hay Creek quadrangle, Roosevelt County, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-365, scale 1:62,500.

[This report consists of a geologic map and an explanation containing brief lithologic descriptions of all the map units from the Bearpaw Shale through the Fort Union Formation.]

_____1963e, Geologic map of the Oswego quadrangle, Valley, Roosevelt, and McCone Counties, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-366, scale 1:62,500.

[This report consists of a geologic map and an explanation containing brief lithologic descriptions of all the map units from the Bearpaw Shale through the Fort Union Formation.]

_____1963f, Geologic map of the Poplar quadrangle, Roosevelt, Richland, and McCone Counties, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-367, scale 1:62,500.

[This report consists of a geologic map, a geologic section, and an explanation containing brief lithologic descriptions of all the map units from the Bearpaw Shale through the Fort Union Formation.]

_____1963g, Geologic map of the Porcupine Valley quadrangle, Valley County, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-368, scale 1:62,500.

[This report consists of a geologic map and an explanation containing brief lithologic descriptions of all the map units from the Bearpaw Shale through the Fort Union Formation.]

_____1963h, Geologic map of the Spring Creek quadrangle, Valley County, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-369, scale 1:62,500.

[This report consists of a geologic map and an explanation containing brief lithologic descriptions of all the map units from the Bearpaw Shale through the Fort Union Formation.]

_____1963i, Geologic map of the Todd Lakes quadrangle, Valley and Roosevelt Counties, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-370, scale 1:62,500.

[This report consists of a geologic map and an explanation containing brief lithologic descriptions of all the map units from the Bearpaw Shale through the Fort Union Formation.]

_____1963j, Geologic map of the Tule Valley quadrangle, Roosevelt County, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-371, scale 1:62,500.

[This report consists of a geologic map and an explanation containing brief lithologic descriptions of all the map units from the Bearpaw Shale through the Fort Union Formation.]

_____1964, Geologic map of the south half of the Baylor, Larslan West Fork, Police Creek, Kahle and Lundville quadrangles, Valley, Roosevelt, and Daniels Counties, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-361, scale 1:62,500.

[This report consists of a map showing the geology and structure in the vicinity of the Fort Peck Indian Reservation. The explanation contains brief lithologic descriptions of all the map units from the Bearpaw Shale through the Fort Union Formation.]

Colton, R. B., and Bateman, A. F., Jr., 1956, Geologic and structure contour map of the Fort Peck Indian Reservation and vicinity, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-225, scale 1:125,000.

[This report consists of a geologic map showing structure contours of the top of the Greenhorn Formation, two generalized geologic sections, a composite stratigraphic log, and a summary of the development of the Poplar oil field.]

Culbertson, W. C., 1954, Three deposits of strippable lignite west of the Yellowstone River, Montana: U.S. Geological Survey Bulletin 995-H, p. 293-332.

[This report describes three lignite deposits that are suitable for strip mining in an area of about 700 mi^2. The lignite is mapped on the basis of overburden in categories of less than 60 ft, 60 to 90 ft, and 90 to 120 ft. Nine analyses of lignite samples are given. A columnar section shows the stratigraphic position and correlation of lignite beds. Thirty-seven coal sections were measured. Included are three maps that show the coal deposits, the amount of overburden, and the coal-section sites.]

Culbertson, W. C., and Klett, M. C., 1976, Geologic map and coal sections of the Browns Mountain quadrangle, Rosebud County, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-814, 2 sheets.

[Sheet 1 consists of a short text clarifying the current coal-bed nomenclature and correlation, and of a geologic map at a scale of 1:24,000 of the Tongue River Member of the Fort Union Formation and deposits of Quaternary age; the map shows the outcrop area of 12 coal beds and the extent of burned area for each. Sheet 2 contains tables of identified coal resources under less than 200 ft, less than 1,000 ft, and 1,000 to 2,000 ft of overburden; analyses of 4 coal samples; a correlation section for the coal beds; and 336 measured sections of the coal beds.]

_____1979, Geologic map and coal sections of the Quietus quadrangle, Big Horn and Powder River Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-1087, 2 sheets.

[This report shows outcrops of coal on a geologic map at a scale of 1:24,000, measured and correlated coal sections, the quality of coal, and the quantity of the coal under various amounts of overburden.]

Culbertson, W. C., Mapel, W. J., and Klett, M. C., 1976, Geologic map and coal sections of the Stroud Creek quadrangle, Rosebud and Big Horn Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-822, 2 sheets.

[Sheet 1 consists of a short text clarifying the current coal-bed correlations and nomenclature; a geologic map at a scale of 1:24,000 of the Tongue River Member of the Fort Union Formation and deposits of Quaternary age showing the outcrop area of 12 coal beds and the extent of burned area for each; and correlation sections of these coal beds for the area. Sheet 2 contains analyses of 8 coal samples, tables of identified and inferred coal resources under less than 200 ft and under less than 1,000 ft of overburden, and 216 sections of coal beds.]

Dobbin, C. E., 1930, The Forsyth coal field, Rosebud, Treasure, and Big Horn Counties, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 812-A, p. 1-55.

[This report describes the stratigraphy and the 13 coal beds in this 800-mi^2 coal field. It also describes the occurrence of coal township by township. The physical and chemical character of 4 samples is compared with 10 samples elsewhere in Montana, North Dakota, Ohio, and Pennsylvania. Eleven stratigraphic sections from the Hell Creek and Fort Union Formations, totaling about 4,270 ft, are given. There are 255 measured coal sections. Included is a map showing the geology, outcrops of coal, measured-section sites, and areas where coal is suitable for strip mining.]

Dobbin, C. E., and Erdmann, C. E., 1955, Structure contour map of the Montana Plains: U.S. Geological Survey Oil and Gas Investigations Map OM-178B, scale 1:1,000,000.

[This report consists of a map showing the configuration of the present or restored base of the Colorado Shale (Colorado Group) and a generalized stratigraphic diagram of the sedimentary bedrock units recognized in the Montana Plains.]

Ellis, A. J., and Meinzer, O. E., 1924, Ground water in Musselshell and Golden Valley Counties, Montana: U.S. Geological Survey Water-Supply Paper 518, 92 p.

[This report contains a geologic map at a scale of 1:250,000, a geologic section, and columnar sections of the Lance Formation equivalent and Fort Union Formation. The text describes water quality, ground water by townships, and the lithology and water-bearing properties of the map units from the Kootenai Formation through the Fort Union Formation. Formation terminology for the Fort Union and Lance equivalent has since been revised.]

Erdmann, C. E., 1948, Geology of the Lothair area, Liberty County, Montana: U.S. Geological Survey Oil and Gas Investigations Map 87, scale 1:48,000.

[This report consists of a geologic map showing the distribution of Upper Cretaceous formations cropping out along the Marias River, and the location of the high-water flood level of the proposed Tiber Dam.]

Feltis, R. D., 1973, Geology and water resources of eastern part of Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 87, 51 p.

[This report contains a geologic map of the Judith basin east of Ross Fork and south of North Moccasin Mountain at a scale of about 1:96,000. Structure contours are shown for the top of the Madison Group, as are arrows representing the inferred direction of water movement in the aquifers. The text consists of a discussion of the geology and water-bearing properties of formations from the Madison Group through the Judith River Formation that contain potential or proven aquifers, as

well as a discussion of water resources, quality of water, and aquifer characteristics. Supplemental information in the report includes maps of well and spring locations and chemical quality, well and spring records, chemical analyses of ground water, drillers' logs of 53 wells with some formation names added by the author, logs from 4 oil wells, and aquifer-test data.]

_____1977, Geology and water resources of northern part of Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 101, 65 p.

[This report contains a geologic map of the Judith basin north and west of the Judith River and east of Windham, Montana, at a scale of about 1:96,000. Structure contours are shown for the top of the Madison Group. Another map shows the configuration of the tops of the Swift and Kootenai Formations. The text consists of a discussion of the stratigraphy and water-bearing properties of formations from the Madison Group through the Eagle Sandstone that contain potential or proven aquifers, as well as a discussion of water resources, aquifer characteristics, and quality of water. Supplemental material in the report includes drillers' logs of 45 wells with some formation names added by the author, a correlation diagram for rocks of Mississippian through Jurassic age, well and spring records, and chemical analyses of surface and ground water.]

_____1979, Water resources of shallow aquifers in the upper Poplar River basin, northeastern Montana: U.S. Geological Survey Water-Resources Investigations 79-51, 23 p.

[Although this report is primarily concerned with the hydrology of the area, it contains a geologic map at a scale of about 1:50,000 with descriptions of the map units of Cenozoic age from the Fort Union Formation to alluvium. The text includes a tabular summary of the stratigraphy of the formation above the Bearpaw Shale and a diagrammatic cross section across the northern part of the study area.]

_____1980, Water resources of the Judith Basin, central Montana: Montana Bureau of Mines and Geology Hydrogeologic Map 1, 3 sheets.

[Sheet 1 of this report consists of a hydrogeologic map at a scale of 1:250,000 showing the configuration of the top of the Madison Group, and a table summarizing the generalized stratigraphy and water-bearing properties of the principal aquifers from the Madison Group through the Judith River Formation and alluvial deposits. Sheets 2 and 3 pertain exclusively to the water resources.]

Fisher, C. A., 1909, Geology of the Great Falls coal field, Montana: U.S. Geological Survey Bulletin 356, 85 p.

[This report comprehensively describes the stratigraphy and coal resources of 1,500 mi^2 south and southeast of Great Falls, Montana, and along the north flank of the Little Belt Mountains. The stratigraphy from the Madison Limestone (Madison Group) to the Colorado Shale (Colorado

Group) is described with the aid of eight geologic sections and three columnar sections that show the correlation of rock units. The coal that occurs in what is now (1981) considered to be the Morrison Formation is described according to character and thickness of beds, and amount of development in several mining districts. Also included are 56 measured coal sections, 16 analyses of coal samples, and a geologic map at a scale of 1:500,000 with three geologic sections.]

Fox, R. D., 1966, Geology and ground-water resources of the Cascade-Ulm area, Montana: Montana Bureau of Mines and Geology Bulletin 52, 64 p.

[This report resulted from an investigation to determine the potential sources and availability of ground water in a 415-mi^2 area in the vicinity of Cascade and Ulm, Montana. The report describes the stratigraphy of the following geologic units: Morrison Formation, Kootenai Formation, Blackleaf Formation, Marias River Shale, Telegraph Creek Formation, Virgelle Sandstone, and deposits of Quaternary age. The principal aquifers, particularly the Flood Member of the Blackleaf Formation, the Virgelle Sandstone, and the Kootenai Formation, are briefly discussed in a separate section. The report also contains three measured stratigraphic sections, six abbreviated logs of deep oil-test holes, and a geologic map at a scale of about 1:88,000 accompanied by four geologic sections.]

Gardner, L. S., 1950, Geology of the Button Butte-Forestgrove area, Fergus County, Montana: U.S. Geological Survey Oil and Gas Investigations Map 106, scale 1:63,360.

[This report consists of a geologic map showing structure contours of the top of the Madison Limestone (Madison Group), a table of wells drilled for oil and gas, a short description of the geologic units from Mississippian to Cretaceous age, and a columnar section of the exposed rocks.]

_____1959, Geologic map of the Lewistown area, Fergus County, Montana: U.S. Geological Survey Oil and Gas Investigations Map OM-199, scale 1:63,360.

[This report consists of a geologic map showing structure contours of the top of the Madison Group, a table of wells drilled for oil and gas, a brief discussion of the structural geology and mineral resources of the area, a short description of the geologic map units from the Madison Group through the Colorado Shale (Colorado Group), and a columnar section of the exposed rocks.]

Gardner, L. S., Hendricks, T. S., Hadley, H. D., and Rogers, C. P., 1946, Stratigraphic sections of upper Paleozoic and Mesozoic rocks in south-central Montana: Montana Bureau of Mines and Geology Memoir 24, 100 p.

[This report contains 33 measured stratigraphic sections from locations near the Bridger, Gallatin and Madison Ranges; Castle, Little Belt, Big Snowy, Beartooth, Pryor and Big Horn Mountains; and the Three Forks, Montana, area. These sections are preceded by a brief discussion of the

general characteristics of all the formations studied. The Mesozoic section includes all or part of the following: lower part of the Ellis Group, Sundance Formation, Morrison Formation, Cloverly Group (Cloverly Formation equivalent), Kootenai Formation, and Colorado Shale (Colorado Group).]

Gill, J. R., and Cobban, W. A., 1973, Stratigraphy and geologic history of the Montana Group and equivalent rocks, Montana, Wyoming, and North and South Dakota: U.S. Geological Survey Professional Paper 776, 37 p.

[This report describes the stratigraphic, paleontologic, and radiometric data used to determine the paleogeography for part of the Upper Cretaceous rocks. It describes the sequence of rocks deposited during several transgressions of the sea during about 14 million years. Included is a discussion of ammonite sequences, location of control points, and stratigraphic diagrams showing ammonite zones, unconformities, and major lithologic and nomenclature changes.]

Gosling, A. W., and Pashley, E. F., Jr., 1973, Water resources of the Yellowstone River valley, Billings to Park City, Montana: U.S. Geological Survey Hydrologic Investigations Atlas HA-454, scale 1:48,000, 2 sheets.

[Sheet 1 contains a geologic map, three geologic sections, a brief geologic discussion of the deposits of Cretaceous and Quaternary age, and a table showing the geologic units and their water-bearing and lithologic characteristics. Sheet 2 contains a topographic map showing water-table contours and altitude of bedrock in the valley.]

Gries, J. P., 1953, Upper Cretaceous stratigraphy of the Little Rocky Mountain area *in* Billings Geological Society 4th Annual Field Conference, 1953, Little Rocky Mountains--Montana and southwestern Saskatchewan: p. 102-105.

[This report describes the stratigraphy of the Colorado Group above the Mowry Shale, and the Montana Group. Included is a correlation chart for Montana and South Dakota and a diagrammatic correlation section for the Williston Basin.]

Groff, S. L., 1965, Reconnaissance ground-water and geologic studies of western Meagher County, Montana: Montana Bureau of Mines and Geology Special Publication 35, 23 p.

[This report contains brief descriptions of the geologic units from the Madison Group through the Livingston Formation (Livingston Group) that are potential aquifers and a table of stratigraphic units with their water-bearing characteristics. The geology of the area is briefly described in conjunction with a geologic map of western Meagher County at a scale of 1:125,000. The author associates the presence of numerous springs in the study area to the proximity of cavernous limestone and thrust faults of the Disturbed Belt.]

Hadley, H. D., and Milner, R. L., 1953, Stratigraphy of Lower Cretaceous and Jurassic, northern Montana--southwestern Saskatchewan *in* Billings Geological Society 4th Annual Field Conference, 1953, Little Rocky Mountains--Montana and southwestern Saskatchewan: p. 85-87.

[This report correlates the Piper Formation through the First Cat Creek sandstone with their Saskatchewan counterparts. Included is a north-south electric-log correlation section of these units.]

Hall, G. M., and Howard, C. S., 1929, Ground water in Yellowstone and Treasure Counties, Montana: U.S. Geological Survey Water-Supply Paper 599, 118 p.

[This report contains a geologic map of the area at a scale of 1:250,000, two geologic sections, and a generalized section of the geologic formations from the Madison Limestone (Madison Group) through the Fort Union Formation. The text describes the lithology and water-bearing capabilities of the map units, although some formation terminology has been significantly revised. Other than a brief mention of the conspicuous Lake Basin fault zone, the structure of the area is described strictly in general terms with relation to water supply.]

Hamilton, L. J., and Paulson, Q. F., 1968, Geology and ground-water resources of the lower Bighorn Valley, Montana: U.S. Geological Survey Water-Supply Paper 1876, 39 p.

[This report contains a hydrologic map at a scale of 1:125,000 and a generalized section describing the lithologic character and water-bearing properties of the map units from the Rierdon Formation through the Hell Creek Formation.]

Hance, J. H., 1912, The Glendive lignite field, Dawson County, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 471-D, p. 271-283.

[This report consists of a township-by-township description of the occurrence of coal in the Fort Union Formation for the areas delineated by Tps. 13 and 14 N., Rs. 53 to 60 E.; Tps. 15 and 16 N., Rs. 53 to 58 E; and T. 17 N., Rs. 53 to 57 E. The physical properties and chemical composition are given for six coal samples. Included is a map at a scale of 1:125,000 showing geology and the outcrops of coal and burned areas.]

Hancock, E. T., 1918, Geology and oil and gas prospects of the Lake Basin field, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 691-D, p. 101-147.

[This report describes the stratigraphy of rocks of Late Cretaceous and Eocene age in a 1,000-mi^2 area northwest of Billings, Montana. Included are 15 measured sections and a list of fossils for the formations exposed in the area. The surface structural features are described in detail and pictures show major faults and domes. Also included is a geologic

map of a scale of 1:125,000 that shows the structure contours of the base of the Eagle Sandstone and the individual faults along the Lake Basin fault zone.]

Heald, K. C., 1927, The geology of the Ingomar anticline, Treasure and Rosebud Counties, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 786-A, p. 1-37.

[This report contains a geologic map at a scale of about 1:63,000 showing structure contours on the top of the Judith River Formation. The text consists of a discussion of the stratigraphy of the exposed Bearpaw Shale and Judith River Formation; the unexposed rocks down to the Madison Limestone (Madison Group); and igneous rocks, structural geology, and oil possibilities in the strata of Mesozoic and Paleozoic age.]

Hearn, B. C., Jr., 1976 [1977], Geologic and tectonic maps of the Bearpaw Mountains area, north-central Montana: U.S. Geological Survey Miscellaneous Investigations Map I-919, scale 1:125,000, 2 sheets.

[Sheet 1 consists of a geologic map of about 2,000 mi^2 of the Bearpaw Mountains and surrounding plains, descriptions of all the map units from the Madison Group through the volcanics of Tertiary age, a correlation chart of the map units, three geologic sections, and a summary of the geology and structure of the area. The complex structure is the result of igneous activity and shallow gravity-sliding of sedimentary and volcanic rocks off the Bearpaw Mountain uplift in middle Eocene time. Sheet 2 is a tectonic map showing structure contours of the top of the Greenhorn Formation.]

Hearn, B. C., Jr., Pecora, W. T., and Swadley, W. C., 1964 [1965], Geology of the Rattlesnake quadrangle, Bearpaw Mountains, Blaine County, Montana: U.S. Geological Survey Bulletin 1181-B, p. B1-B66.

[This report contains a geologic map at a scale of 1:31,680; four geologic sections; and measured stratigraphic sections of parts of the Sawtooth Formation, Bearpaw Shale, Fox Hills Sandstone, Hell Creek Formation, and Fort Union Formation. The text includes detailed descriptions of the stratigraphy of the sedimentary map units from the Mission Canyon Limestone through the Wasatch Formation, of the petrography of the igneous rocks, and of the structural geology. The complicated structural pattern in the map area is a result of its location in three structural provinces: the eastern edge of the Bearpaw Mountains arch, part of the southern volcanic field, and the northern edge of the Missouri Breaks plains area.]

Heffern, E. L., 1980, Coal stratigraphy of the Tongue River Member, Northern Cheyenne Reservation, Montana, *in* Proceedings of the 1980 symposium on Rocky Mountain coal, Colorado Geological Survey and U.S. Geological Survey: p. 76-80.

[This report describes the Tongue River Member of the Fort Union Formation and its 12 major coal beds for the 500,000-acre Northern Cheyenne Indian Reservation. It also contains a geologic map, two geologic sections, and a short description of clinker deposits.]

Herald, F. A., 1912, The Terry lignite field, Custer County, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 471-D, p. 227-270.

[This report consists of a towship-by-township description of the occurrence of coal in the Fort Union Formation for a strip of land in Tps. 9 to 12 N. that is bounded on the west by the Powder and Yellowstone Rivers and one the east by the State line. Included are stratigraphic sections of the Lance Formation equivalent and Fort Union Formation as well as descriptions of 21 coal sections. One coal sample was analyzed. Included is a map at a scale of 1:125,000 showing geology, coal outcrops, and burned areas.]

Hopkins, W. B., 1973, Water resources of the Northern Cheyenne Indian Reservation and adjacent area, southeastern Montana: U.S. Geological Survey Hydrologic Investigations Atlas HA-468, scale 1:125,000, 2 sheets.

[Sheet 1 contains a geohydrologic map showing the altitude of water in the Tongue River Member of the Fort Union Formation and in the alluvium, a summary of geologic formations and their water-bearing properties, a precipitation graph, and a geologic section across the Tongue River valley. Sheet 2 describes the water resources.]

_____1976, Water-resources data for deep aquifers of eastern Montana: U.S. Geological Survey Water-Resources Investigation Open-File Report 76-40, 37 p.

[This report principally describes water quality for deep aquifers in eastern Montana. Accompanying a brief discussion of the geology is a table identifying the lithology, thickness, and hydrologic characteristics of all geologic units in the Montana part of the Williston Basin from the Madison Group through the Fort Union Formation and surficial deposits.]

Howard, A. D., 1960 [1961], Cenozoic history of northeastern Montana and northwestern North Dakota with emphasis on the Pleistocene: U.S. Geological Survey Professional Paper 326, 107 p.

[This report primarily describes the Pleistocene stratigraphy and geologic history of northeastern Montana; it also contains a geologic map at a scale of about 1:634,000 for the pre-Pleistocene rocks in the area bounded by 47° and 49°N. latitude, 104° and 106°W. longitude.]

Imlay, R. W., Gardner, L. S., Rogers, C. P., Jr., and Hadley, H. D., 1948, Marine Jurassic formations of Montana: U.S. Geological Survey Oil and Gas Investigations Preliminary Chart 32.

[This report contains a detailed description of the stratigraphy and geologic history of the Sawtooth, Piper, Rierdon, and Swift Formations. A map shows the margins of deposition, a table gives thicknesses of outcropping marine Jurassic rocks at 45 different sites, and 3 columnar sections and 34 generalized geologic sections illustrate nomenclature and correlation for rocks of Jurassic age throughout Montana.]

Jensen, F. S., and Varnes, H. D., 1964, Geology of the Fort Peck area, Garfield, McCone, and Valley Counties, Montana: U.S. Geological Survey Professional Paper 414-F, p. F1-F49.

[This report describes the geology of 600 mi^2 in the vicinity of Glasgow and Frazer, Montana. It contains a geologic map at a scale of 1:48,000, seven geologic sections, a bedrock geologic map showing structure contours on top of the Judith River Formation, a detailed columnar section of the surficial deposits and bedrock units from the Judith River Formation through Hell Creek Formation, and a detailed geologic map of the structurally complex Tiger Butte area at a scale of about 1:5,000. The text includes a thorough discussion of the distribution, topography, thickness, age, stratigraphic position, lithology, and engineering considerations of each map unit and of the intense structural deformation at Tiger Butte.]

Johnson, W. D., Jr., and Smith, H. R., 1964, Geology of the Winnett-Mosby area, Petroleum, Garfield, Rosebud, and Fergus Counties, Montana: U.S. Geological Survey Bulletin 1149, 91 p.

[This report contains a geologic map at a scale of 1:63,360 showing structure contours of the base of the Colorado Shale (Colorado Group), a geologic section, a structure map of central Montana, an electric-log correlation section through the Cat Creek anticline, and measured stratigraphic sections of all the map units from the First Cat Creek sandstone through the Hell Creek Formation. The text includes a discussion of the stratigraphy. Folding and associated faulting and oil and gas production are discussed in terms of the two dominant structural features of the area: the Cat Creek anticline and oil field and the Flat Willow-Rattlesnake Butte anticlines.]

Kepferle, R. C., 1954, Selected deposits of strippable coal in central Rosebud County, Montana: U.S. Geological Survey Bulletin 995-I, p. 333-381.

[This report describes seven coal deposits that are suitable for strip mining in an area of about 1,680 mi^2. The coal is mapped on the basis of overburden thickness in catagories of less than 60 ft, 60 to 90 ft, and 90 to 120 ft. Nine analyses of coal samples are given. A columnar section shows the stratigraphic position and correlation of coal beds. Seventy-seven coal sections were measured. The report contains two page-size thickness maps of selected areas, and three page-size maps and four maps at a scale of about 1:4,000 that show the coal deposits, the amount of overburden, and the coal-section sites.]

Kerr, J. H., Pecora, W. T., Stewart, D. B., and Dixon, H. R., 1957, Preliminary geologic map of the Shambo quadrangle, Bearpaw Mountains, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-236, scale 1:31,680.

[This report consists of a geologic map and a discussion of the igneous rocks, structure, and economic geology. The explanation contains lithologic descriptions of all the map units from the Kootenai Formation through igneous rocks of Tertiary age.]

Kleinkopf, M. D., and Mudge, M. R., 1972, Aeromagnetic, Bouguer gravity, and generalized geologic studies of the Great Falls-Mission Range area, northwestern Montana: U.S. Geological Survey Professional Paper 726-A, p. A1-A19.

[This report describes the structural framework and distribution of near-surface crystalline rocks of about 12,200 mi^2 from Great Falls, Montana, west through the Disturbed Belt and Mission Range in the Rocky Mountains. The report describes the onsite measurement methods of aeromagnetic surveys, rock properties, magnetic-field and gravity-field configurations, and the interpretation of geophysical data. Included is a generalized geologic and aeromagnetic map at a scale of 1:250,000, a Bouguer gravity map, and an east-west structural section and magnetic and gravity profile across the area.]

Knappen, R. S., and Moulton, G. F., 1931, Geology and mineral resources of parts of Carbon, Big Horn, Yellowstone, and Stillwater Counties, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 822, p. 1-70.

[This report describes in detail the stratigraphy of rocks from Mississippian through Eocene age, with a measured section from each formation. The general features of the geologic structure and exploration or development of oil and gas, coal, gypsum, and ground water are also discussed. Included is a geologic map at a scale of 1:125,000 showing structure contours of the top of the Greybull Sandstone Member of the Cloverly Formation equivalent.]

Knechtel, M. M., 1959 [1960], Stratigraphy of the Little Rocky Mountains and encircling foothills, Montana: U.S. Geological Survey Bulletin 1072-N, p. 723-752.

[This report contains a geologic map at a scale of 1:48,000; a generalized geologic section of the rocks exposed in the map area; and electric, gamma, neutron, and sample logs from a well penetrating the same geologic section about 10 mi to the southeast. The text consists of descriptions of the stratigraphy of all outcropping geologic map units from the undifferentiated rocks of Jurassic age through the Bearpaw Shale.]

Lemke, R. W., 1977, Geologic map of the Great Falls quadrangle, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-1414, scale 1:62,500.

[This report consists of a geologic map, a correlation chart of the map units, and brief lithologic descriptions of all units from the Kootenai Formation through the Marias River Shale.]

Lewis, B. D., and Hotchkiss, W. R., 1981, Thickness, percent sand, and configuration of shallow hydrogeologic units in the Powder River Basin, Montana and Wyoming: U.S. Geological Survey Miscellaneous Investigations Map I-1317 (in press).

[This report consists of maps showing thickness, percentage of sand, and structure contours of the Fox Hills-lower Hell Creek, upper Hell Creek, Tullock, Lebo, and Fort Union-Wasatch hydrologic units in the Powder River Basin. Also included are geologic descriptions of the units and a representative electric log showing the relationship of hydrogeology to geology.]

Lewis, B. D., and Roberts, R. S., 1978, Geology and water-yielding characteristics of rocks of the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Miscellaneous Investigations Map I-847-D, 2 sheets.

[Sheet 1 is a geologic map at a scale of 1:250,000 showing structure contours of the top of the Bearpaw Shale. A general description of each unit and its water-yielding characteristics are given in the description of map units. Sheet 2 contains a short text describing the geology, the subsurface identification of geologic units, the configuration of the top of the Bearpaw Shale, and the thickness of the units above the Bearpaw Shale. Five geologic sections accompany the text.]

Lindvall, R. M., 1953 [1954], Geology of the Eagleton quadrangle, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-29, scale 1:62,500.

[This report consists of a geologic map and a brief discussion of the stratigraphy, structure, and economic geology. It also contains three geologic sections; four coal sections in the Judith River Formation and Eagle Sandstone; and a table with generalized descriptions of the engineering properties of all the map units from the Colorado Shale (Colorado Group) to the Judith River Formation.]

_____1956a, Geology of the Kenilworth quadrangle, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-129, scale 1:62,500.

[This report consists of a geologic map and a discussion of the stratigraphy, structure, and economic geology. It also contains a geologic section and a table with generalized descriptions of the engineering properties of all the map units from the Colorado Shale (Colorado Group) through the Judith River Formation.]

_____1956b, Geology of the Big Sandy quadrangle, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-130, scale 1:62,500.

[This report consists of a geologic map and a discussion of the stratigraphy, structure, and economic geology. It also contains 3 geologic sections, 20 coal sections in the Judith River Formation and Eagle Sandstone, and a table with generalized descriptions of the engineering properties of all the map units from the Colorado Shale (Colorado Group) through the Hell Creek Formation.]

_____1961 [1962], Geology of the Boxelder quadrangle, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-338, scale 1:62,500.

[This report consists of a geologic map and a brief discussion of the stratigraphy, structure, and economic geology. It also contains a table with generalized descriptions of the engineering properties of the Claggett Shale and the Judith River Formation.]

_____1962a, Geology of the Eagle Buttes quadrangle, Chouteau County, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-349, scale 1:62,500.

[This report contains a geologic map accompanied by a short text describing the structure and stratigraphy of the outcropping geologic units of Late Cretaceous and Quaternary age, and a table of generalized descriptions of the engineering properties of these map units.]

_____1962b, Geology of the Eskay quadrangle, Chouteau and Blaine Counties, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-353, scale 1:62,500.

[This report consists of a geologic map and a discussion of the igneous and sedimentary rocks, structure, and economic geology. It also contains a table with generalized descriptions of the engineering properties of all the map units from the Marias River Shale through the Fort Union Formation.]

McGrew, L. W., 1977a, Geologic map of the Black Butte Mountain quadrangle, Meagher County, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-1381, scale 1:24,000.

[This report consists of a geologic map, three geologic sections, a correlation chart of the map units, and lithologic descriptions of all the units from the Ellis Group through the Sedan Formation.]

_____1977b, Geologic map of the Ringling quadrangle, Meagher County, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-1382, scale 1:24,000.

[This report consists of a geologic map, two geologic sections, a correlation chart of the map units, and lithologic descriptions of all the units from the Ellis Group through the Billman Creek Formation.]

_____1977c, Geologic map of the Sixteen quadrangle, Gallatin and Meagher Counties, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-1383, scale 1:24,000.

[This report consists of a geologic map, two geologic sections, a correlation chart of the map units, and lithologic descriptions of all the units from the Ellis Group through the Sedan Formation.]

_____1977d, Geologic map of the Sixteen NE quadrangle, Meagher, Gallatin, and Park Counties, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-1384, scale 1:24,000.

[This report consists of surficial-geologic, tectonic, and bedrock-geologic maps of the area; two geologic sections; a correlation chart of the map units; and lithologic descriptions of all the units from the Ellis Group through the Billman Creek Formation.]

McKay, E. J., 1976a, Preliminary geologic map and coal sections of the Willow Crossing quadrangle, Rosebud and Powder River Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-802, scale 1:24,000.

[This report consists of a geologic map of Quaternary deposits and Tongue River Member of the Fort Union Formation showing the outcrop area of seven coal beds, and the extent of burned area for each. Also included are a measured stratigraphic section, analyses of five coal samples, a table of identified and inferred coal resources under less than 1,000 ft of overburden, and eight coal sections.

_____1976b, Preliminary geologic map and coal sections of the Fort Howes quadrangle, Rosebud and Powder River Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-807, scale 1:24,000.

[This report consists of a geologic map of Quaternary deposits and Tongue River Member of the Fort Union Formation showing the outcrop area of seven coal beds, and the extent of burned area for each. Also included are a measured stratigraphic section, a table of identified and inferred coal resources under less than 1,000 ft of overburden, and 49 coal sections of the major beds.]

_____1976c, Preliminary geologic map and coal sections of the King Mountain quadrangle, Rosebud and Powder River Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-817, 2 sheets.

[This report shows the outcrop of coal on a geologic map at a scale of 1:24,000, measured coal sections, and the quantity of coal under less than 1,000 ft of overburden.]

McKay, E. J., and Mason, F. W., 1975a [1976], Preliminary geologic map and coal sections of the Morehouse Creek quadrangle, Prairie and Custer Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-724, scale 1:24,000.

[This report consists of a geologic map of the Quaternary deposits and Tongue River Member of Fort Union Formation showing the outcrop area of the Haughins and Rogers coal beds and the extent of burned area for each. Also included are 14 coal sections and 2 geologic sections showing the correlation and thickness of the Haughins and Rogers coal beds as inferred from the gamma-ray logs of 10 drill holes.]

_____1975b [1976], Preliminary geologic map and coal sections of the Twin Buttes quadrangle, Prairie and Custer Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-725, scale 1:24,000.

[This report consists of a geologic map of the Quaternary deposits and Tongue River Member of the Fort Union Formation showing the outcrop area of two coal beds and the extent of burned area for each. Also included are four coal sections from Tps. 12 and 13 N., Rs. 45 and 46 E., and a geologic section showing the correlation of the Haughins coal beds as inferred from the gamma-ray logs of four drill holes.]

Mapel, W. J., 1958, Coal in the Powder River basin, *in* Wyoming Geological Association Guidebook 13th Annual Field Conference, 1958; p. 218-224.

[This report describes coal in the Lakota Sandstone, Lance Formation equivalent, Fort Union and Wasatch Formations, its quality, and the estimated reserves by area. Included with the report is a stratigraphic section showing the relations and thicknesses of some of the coal beds of Tertiary age between coal fields within the basin.]

_____1976, Geologic map and coal sections of the Birney quadrangle, Rosebud County, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-813, 2 sheets.

[Sheet 1 of this report consists of a geologic map at a scale of 1:24,000 of deposits of Quaternary age and Tongue River Member of the Fort Union Formation showing the outcrop area of 14 coal beds and the extent of burned area for each. Also included are composite stratigraphic sections showing names and correlations for these beds. Sheet 2 contains analyses of 11 coal samples, tables of identified and inferred coal resources under less than 1,000 ft and under less than 200 ft of overburden, and 305 measured sections of the coal beds.]

_____1978, Geologic map and coal sections of the Pine Buttes School quadrangle, Big Horn County, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-1014, 2 sheets.

[Sheet 1 of this report consists of a geologic map at a scale of 1:24,000 of Tongue River Member of the Fort Union Formation, Wasatch Formation, and Quaternary deposits showing the outcrop area of five coal beds and the extent of burned area for each. Also included is a geologic section showing the thickness and correlation of coal beds in shallow drill holes and surface sections. Sheet 2 contains analyses of 7 coal samples; a geologic section showing the thickness and correlation of coal beds as

interpreted from the logs of oil and gas wells; tables of identified coal resources under less than 200 ft, less than 1,000 ft, 1,000 to 2,000 ft, and 2,000 to 3,000 ft of overburden; and 141 measured sections of coal beds.]

Mapel, W. J., Robinson, C. S., and Theobald, A. K., 1959, Geologic and structure contour map of the northern and western flanks of the Black Hills, Wyoming, Montana, and South Dakota: U.S. Geological Survey Oil and Gas Investigations Map OM-191, scale 1:96,000, 2 sheets.

[This report consists of a geologic map (2 sheets) showing structure contours of the top of the Fall River Sandstone. The mapped area in Montana encompasses only southern Carter and southeastern Powder River Counties.]

Matson, R. E., 1969, The strippable coal fields in eastern Montana *in* Montana Geological Society 20th Annual Conference, Eastern Montana Symposium, 1969: Billings, Montana, p. 219-225.

[This report gives estimates of the total strippable reserves of lignite and subbituminous coal for eastern Montana. A discussion also is included on the economics of strip mining relative to the rank and the sulfur, moisture and ash contents of the coal. The report contains a table and location map of 43 strippable coal fields showing representative analyses and estimated reserves at each. Also included are 16 coal analyses.]

Maughan, E. K., 1961, Geology of the Vaughn quadrangle, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-135, scale 1:62,500.

[This report consists of a geologic map, a geologic section, and a composite columnar section of the Blackleaf Formation and Marias River Shale. The accompanying text describes the surficial deposits, lithology, and stratigraphy of each member of the Blackleaf Formation and Marias River Shale; economic and engineering geology; and structure of the area, which is located on the southern end of the Sweet Grass arch.]

May, P. R., 1954, Strippable lignite deposits in the Wibaux area, Montana and North Dakota: U.S. Geological Survey Bulletin 995-G, p. 255-292.

[This report describes two lignite deposits that are suitable for strip mining in an area of about 1,200 mi^2. The lignite is mapped on the basis of overburden thickness in categories of less than 60 ft, 60 to 90 ft, and 90 to 120 ft. The report contains 4 analyses of lignite samples, 90 measured coal sections, and a columnar section showing the stratigraphic position and correlation of lignite beds. Also included are three maps that show the coal deposits, the amount of overburden, and the coal-section sites.]

Meyboom, Peter, 1960, Geology and groundwater resources of the Milk River sandstone in southern Alberta [Canada]: Alberta Research Council Memoir 2, 89 p.

[This report describes the regional structure of the Sweet Grass arch in Alberta and north-central Montana as it relates to the thickness and configuration of the top of the Milk River Sandstone. The Milk River Sandstone of Canada is correlated with the Virgelle Sandstone Member of the Eagle Sandstone in Montana.

Miller, R. N., 1959, Geology of the South Moccasin Mountains, Fergus County, Montana: Montana Bureau of Mines and Geology Memoir 37, 44 p.

[This report comprehensively describes the stratigraphy and structure of about 42 mi^2 in the South Moccasin Mountains. The stratigraphy of the sedimentary rocks of Cambrian and Cretaceous age and the petrology of the igneous core of the mountains are described in detail with the use of 16 measured stratigraphic sections and 4 petrographic thin sections. The structure of the mountain is described in 10 subdivisions or structural blocks. A geologic map at a scale of about 1:32,000 with two geologic sections are part of the report.]

Miller, W. R., 1979a, Water resources of the central Powder River area of southeastern Montana: Montana Bureau of Mines and Geology Bulletin 108, 65 p.

[This report deals primarily with the hydrology of the area; it also contains maps at a scale of 1:126,720 and sections showing the generalized geology and the thickness and configuration of the base of the Fox Hills-lower Hell Creek aquifer. The text includes a short discussion of the geologic map units from the Pierre Shale through the surficial deposits. This discussion is supplemented by a table summarizing the stratigraphy and ground-water resources for all rocks of Paleozoic, Mesozoic, and Cenozoic age underlying the area.]

_____1979b, Water resources of the southern Powder River area of southeastern Montana: U.S. Geological Survey Open-File Report 79-343, 97 p.

[This report describes the geology and water-bearing characteristics of the Madison Group through the Fort Union Formation and alluvial deposits, and the hydrology. It contains logs of 22 wells and test holes; maps at a scale of 1:126,720 of the generalized geology, and the thickness and configuration of the base of the Fox Hills-lower Hell Creek aquifer; a correlation section of rocks above the Pierre Shale; and a table summarizing the stratigraphy and the availability and chemical quality of water for all the geologic units described in the text.]

Moulder, E. A., Torrey, A. E., and Koopman, F. C., 1953, Ground-water factors affecting the drainage of Area IV, First Division, Buffalo Rapids irrigation project, Montana: U.S. Geological Survey Circular 198, 46 p.

[This report resulted from a study to collect and interpret the geologic and hydrologic data that are needed for the design and construction of proper drainage facilities on waterlogged land. The investigation, conducted in 1950, included the drilling of 85 test holes. The report includes a limited geologic discussion of the Fort Union Formation, terrace deposits, and alluvium and a table of lithologic logs from wells and test holes.]

Mudge, M. R., 1972 [1973], Structural geology of the Sun River Canyon and adjacent areas, northwestern Montana: U.S. Geological Survey Professional Paper 663-B, p. B1-B52.

[This report describes an area of exceptionally well exposed thrust faults and associated structures in the Sun River Canyon area of the Montana disturbed belt. The uppermost crustal layer has been shortened more than 29 mi in this area. The report contains 26 plates and page-size illustrations showing various structural features and interpretations of the fault mechanisms. Also included are three block diagrams showing the generalized geologic structure, a tectonic map at a scale of 1:48,000, a stratigraphic column illustrating zones of weakness along which thrusting occurs, a series of geologic sections showing the sequential stages of development of structures along a thrust plain, and two geologic sections at a scale of 1:48,000. The rocks range in age from Precambrian to Late Cretaceous.]

Nordquist, J. W., 1955, Pre-Rierdon Jurassic stratigraphy in northern Montana and Williston Basin *in* Billings Geological Society 6th Annaul Field Conference, 1955, Sweetgrass Arch-Disturbed Belt, Montana: p. 96-106.

[This report places the location of the axis of the Sweet Grass arch as the divide separating the correlative Sawtooth Formation on the west from the Piper Formation on the east. The stratigraphy of these units and the Nesson Formation is described and differentiated in detail. Included is a stratigraphic cross section through northern Montana and North Dakota showing the relationship of these units with underlying and overlying units.]

Osterkamp, W. R., 1968, Occurrence of ground water in the Judith River Formation, north-central Montana: U.S. Geological Survey Hydrologic Investigations Atlas HA-308, scale 1:250,000.

[This report consists of a geologic map showing potentiometric-surface and structure contours of the top of the Judith River Formation, a brief description of the physiographic and structural features that relate to the occurrence and availability of water in the aquifer, two geologic sections, and a generalized stratigraphic section of the Montana Group.]

Page, N. J., Simmons, F. S., and Dohrenwend, J. C., 1973a, Reconnaissance geologic map of the Mount Douglas quadrangle, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-488, scale 1:62,500.

[This report consists of a map showing geology of the Beartooth Mountains and the adjacent plains. Included are brief descriptions of the sedimentary, igneous, and metamorphic rocks.]

_____1973b, Reconnaissance geologic map of the Mount Wood quadrangle, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-491, scale 1:62,500.

[This report consists of a map showing the geology of the Beartooth Mountains and the adjacent plains. Included are brief descriptions of the sedimentary, igneous, and metamorphic rocks.]

Parker, F. S., 1936, The Richey-Lambert coal field, Richland and Dawson Counties, Montana: U.S. Geological Survey Bulletin 847-C, p.121-174.

[This report describes the coal resources of a 900-mi^2 area. It includes a description of the geologic structure and stratigraphy and a township-by-township description of the occurrence of coal. Two hundred seventy-six coal sections were measured, and generalized geologic sections show the relative position of the coal beds with respect to one another. The geologic map at a scale of 1:62,500 shows outcrops of coal beds, burned areas, and sites of measured coal sections.]

Parker, F. S., and Andrews, D. A., 1939 [1940], The Mizpah coal field, Custer County, Montana: U.S. Geological Survey Bulletin 906-C, p. 85-133.

[This report contains a geologic map and three geologic sections at a scale of about 1:62,500 of the Fort Union and Hell Creek Formations, whose boundaries have since been revised. Shown on the map are the outcrop and burned area for 24 coal beds. Also included are analyses of seven coal samples and a correlation chart for the coal beds with those in adjacent fields. The text discusses the stratigraphy of the map units and characteristics of the coal beds. A township-by-township description of coal resources is accompanied by more than 1,300 graphic coal sections.]

Patterson, E. D., 1963, Geologic map of the Roscoe NE quadrangle, Stillwater and Carbon Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-267, scale 1:24,000.

[This report consists of a geologic map and a composite stratigraphic section for an area northeast of Roscoe, Montana. The Fort Union Formation is mapped as two members, 'b' and 'c', which may correspond, respectively, to the Lebo Shale Member and Tongue River Member of the Fort Union Formation.]

_____1966, Geologic map of the Montaqua quadrangle, Carbon and Stillwater Counties, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-580, scale 1:24,000.

[This report contains a geologic map showing structure contours of the top of the Telegraph Creek Formation, a geologic section, a generalized

columnar section of rocks of Cretaceous and Quaternary age, and a brief discussion of the occurrence and development of coal, oil, and gas.]

Pecora, W. T., Witkind, I. V., and Stewart, D. B., 1957, Preliminary general geologic map of the Laredo quadrangle, Bearpaw Mountains, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-234, scale 1:31,680.

[This report consists of a geologic map and a discussion of the igneous rocks and economic features. The explanation contains lithologic descriptions of all the map units from the Judith River Formation to the igneous rocks of Tertiary age.]

Pecora, W. T., and others, 1957, Preliminary geologic map of the Warrick quadrangle, Bearpaw Mountains, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-237, scale 1:31,680.

[This report consists of a geologic map and a discussion of the igneous and sedimentary rocks, complex structural features, and economic geology. The explanation contains lithologic descriptions of all the map units from the Ellis Group to the igneous rocks of Tertiary age.]

Pepperberg, L. J., 1910, The Milk River coal field, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 381-A, p. 82-107.

[This report contains a geologic map at a scale of 1:63,360 of an area inclusive of Tps. 32 to 34 N., and Rs. 14 to 23 E.; shown are outcrops of Bearpaw Shale, Judith River Formation, Claggett Shale, glacial drift, and alluvium. Descriptions of 25 coal sections in the Judith River Formation and analyses of 17 coal samples are given.]

_____1912, The southern extension of the Milk River coal field, Chouteau County, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 471-E, p. 359-383.

[This report describes the geology in T. 31 N., Rs. 16 to 19 E., and T. 30 N., Rs. 17 and 18 E. Included are lithologic descriptions of the Colorado Shale (Colorado Group), Montana Group, and Fort Union Formation. Descriptions of 40 coal sections (1 in the Fort Union Formation and 39 in the Judith River Formation) and analyses of 8 coal samples are given.]

Perry, E. S., 1932, Ground-water resources of Judith Basin, Montana: Montana Bureau of Mines and Geology Memoir 7, 30 p.

[This report contains a geologic map of the Judith basin at a scale of about 1:277,000, four geologic sections, and a stratigraphic column of the exposed geologic units from the Madison Group through the Judith River Formation and terrace deposits. The text describes the lithology and water-bearing capabilities of these units (although some formation

terminology has since been revised) and discusses regional and local structure and the effect of faulting on ground-water circulation.]

_____1934, Geology and artesian water resources along Missouri and Milk Rivers in northeastern Montana: Montana Bureau of Mines and Geology Memoir 11, 35 p.

[This report describes the geologic structure, stratigraphy, and occurrence and quality of ground water in a 13,800-mi^2 area. Special emphasis is given to the principal water-bearing beds, the Judith River Formation, and the differences in water quality. The area is divided into seven geographic districts and the geography, geology, and development of water wells are described. A geologic map at a scale of 1:697,000 shows the geology, configuration of the top of the Judith River Formation, and locations of 94 water wells. Thirty-eight chemical analyses of well water and 2 analyses of river water are tabulated. Ten generalized sections show the attitude and relationship of the formations across the area.]

_____1935, Geology and ground-water resources of southeastern Montana: Montana Bureau of Mines and Geology Memoir 14, 67 p.

[This report describes an area of about 17,000 mi^2 in southeastern Montana, from Sidney to west of Forsyth. The stratigraphy and structural geology of southeastern Montana are discussed briefly; formation terminology is no longer current.]

_____1960, Oil and gas in Montana: Montana Bureau of Mines and Geology Bulletin 15, 86 p.

[This report was designed as a prelude to a complete description of oil and gas fields in Montana; it contains a summary of the geologic history, stratigraphy, and structure of the Montana Plains. The text is supplemented by maps showing the approximate distribution of sedimentary rocks by geologic periods, maps showing anticlinal trends and oil fields throughout the Plains, a stratigraphic correlation chart of Montana and adjacent areas, and a structure-contour map of the Montana Plains (Dobbin and Erdmann, 1955).]

Pierce, W. G., 1936, The Rosebud coal field, Rosebud and Custer Counties, Montana: U.S. Geological Survey Bulletin 847-B, p. 43-120.

[This report describes the coal resources for a 1,050-mi^2 area. It includes a description of the stratigraphy including 10 measured sections in the Tullock, Lebo Shale, and Tongue River Members of the Fort Union Formation. The township-by-township description of the occurrence of coal includes 700 measured coal sections and the physical and chemical properties of 5 coal samples. The geologic map at a scale of 1:62,500 shows the outcrops of coal beds, burned areas, and sites of measured coal sections. Two generalized sections show the relative position of the coal beds with respect to one another.]

Pierce, W. G., and Hunt, C. B., 1937, Geology and mineral resources of north-central Chouteau, western Hill, and eastern Liberty Counties, Montana: U.S. Geological Survey Bulletin 847-F, p. 225-270.

[This report mostly describes the stratigraphy but includes some interpretation of structural geology for an area of 2,600 mi^2. Also presented are three measured stratigraphic sections for the Claggett Shale and Judith River Formation and one measured section each for the Judith River Formation, Colorado Shale (Colorado Group) through Eagle Sandstone, and Eagle Sandstone. Thrust faults similar to those in the Bearpaw Mountains are described. Fifty sections of coal in the Judith River Formation have been measured. Included is a geologic map showing the configuration of the top of the Eagle Sandstone, the outcrop area of coal in the Judith River Formation, and coal-bed measurement sites.]

Prichard, G. E., and Landis, E. R., 1975, Coal resources and Cenozoic geology of the Girard coal field, Richland County, Montana: U.S. Geological Survey Bulletin 1310, 89 p.

[This report contains a geologic map at a scale of 1:62,500 for a 1,035-mi^2 area on the western flank of the Williston Basin. Shown on the map are structure contours of the base of the H coal bed and the outcrop areas of 10 other coal beds in the Fort Union Formation. Also included are analyses of eight coal samples, a table of estimated coal reserves by township, and a 230-ft measured stratigraphic section of part of the Tongue River Member of the Fort Union Formation. The text describes the stratigraphy of the geologic map units and the characteristics of the coal beds. A township-by-township description of coal is accompanied by more than 600 graphic sections of the coal.]

Reeves, Frank, 1925, Geology and possible oil and gas resources of the faulted area south of the Bearpaw Mountains, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 751-C, p. 71-114.

[This report describes the stratigraphy and structure in approximately 2,200 mi^2 south of the Bearpaw Mountains. Included are descriptions of four measured sections of the Eagle Sandstone and one measured section each of the Colorado Shale (Colorado Group), the Kootenai Formation, and the Ellis Group. The structure is described in terms of the origin of faults and folds and their topographic expression. The structure adjacent to faults is described and illustrations depict interpretations of the geology.]

_____1927, Geology of the Cat Creek and Devils Basin oil fields and adjacent areas in Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 786-B, p. 39-95.

[This report contains a geologic map at a scale of 1:125,000 with structure contours drawn on the top of the First Cat Creek sandstone, a detailed map of the Cat Creek oil field, and two geologic sections. Also included are logs of five deep wells with the author's interpre-

tation of formation boundaries, a columnar section of formations penetrated down to the Madison Limestone (Madison Group), and a structure-contour map of the First Cat Creek sandstone for central Montana. The text discusses the stratigraphy of exposed and buried sedimentary rocks, igneous rocks, structural geology, and oil and gas development and production for the Devils Basin and Cat Creek fields.]

_____1929, Thrust faulting and oil possibilities in the plains adjacent to the Highwood Mountains, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 806-E, p. 155-195.

[This report describes the thrust faulting north and east of the Highwood Mountains that is of the same type that occurs in the vicinity of the Bearpaw Mountains. The faulting occurs along beds ranging from 600 to 900 ft below the top of the Colorado Shale (Colorado Group) but always above the Mowry Shale. Also described are the surface expression, areal extent, trend and depth of the faults, curvature of the fault planes, and attitude of the upthrust strata. Six diagrammatic sections show interpretation of subsurface structure. Included is a geologic map for Tps. 18 to 25 N. and Rs. 7 to 16 E. that shows thrust faults and the structural configuration of the top of the Kootenai Formation.]

_____1931, Geology of the Big Snowy Mountains, Montana: U.S. Geological Survey Professional Paper 165-D, p. 135-149.

[This report contains a geologic map at a scale of 1:126,720 showing structure contours of the top of the Kootenai Formation. Also included are three geologic sections and a structure-contour map of the top of the First Cat Creek sandstone for central Montana. The text describes the stratigraphy of the exposed geologic section, igneous rocks, economic geology, and structure of the Big Snowy anticlinorium. Measured sections of the Quadrant Formation, Ellis Group, and Colorado Shale (Colorado Group) supplement the text.]

Renick, B. C., 1929, Geology and ground-water resources of central and southern Rosebud County, Montana, with chemical analyses of the waters, by H. B. Riffenburg: U.S. Geological Survey Water-Supply Paper 600, 140 p.

[This report contains a geologic map at a scale of 1:250,000, five geologic sections, and a generalized table of the lithologic and water-bearing characteristics of the exposed rocks. The text describes structural geology, quality of ground water, and water-bearing properties and stratigraphy of the geologic map units; formational boundaries for the Fort Union and Hell Creek Formations have since been revised. The latter one-half of the text is a township-by-township description of the aforementioned geologic and hydrologic properties.]

Rice, D. D., 1976a, Correlation chart of Cretaceous and Paleocene rocks of the northern Great Plains: U.S. Geological Survey Oil and Gas Investigations Chart OC-70.

[This chart correlates the Cretaceous and Paleocene faunal zones with the corresponding formations for the southern Alberta Plains; northwestern, central, and south-central Montana; eastern North and South Dakota; and the northern flank of the Black Hills uplift, Montana.]

_____1976b, Stratigraphic sections from well logs and outcrops of Cretaceous and Paleocene rocks, northern Great Plains, Montana: U.S. Geological Survey Oil and Gas Investigations Chart OC-71, 3 sheets.

[This report contains three electric-log correlation sections of wells in the eastern two-thirds of Montana. One section spans T. 36 N., R. 9 W., to T. 30 N., R. 50 E., across the northern part of the State; one spans T. 2 S., R. 8 E., to T. 8 S., R. 55 E., across the southern part; and the last spans T. 37 N., R. 12 E., to T. 7 S., R. 36 E. through north and south-central Montana. Each well log consists of spontaneous potential and resistivity curves with generalized lithologies from American Stratigraphic Company logs where available.]

_____1976c, Revision of Cretaceous nomenclature of the northern Great Plains in Montana, North Dakota, and South Dakota, *in* Changes in stratigraphic nomenclature by the U.S. Geological Survey, 1975 (Contributions to stratigraphy): U.S. Geological Survey Bulletin 1422-A, p. A66-67.

[This report presents some current revisions of nomenclature reflected in plate 1. Specifically, the Muddy Sandstone Member of the Thermopolis Shale has been raised to formation rank; the name "Thermopolis Shale" has been restricted from usage in Montana; and the name "Cloverly Formation" has been abandoned from use.]

Richards, P. W., 1955 [1956], Geology of the Bighorn Canyon-Hardin area, Montana and Wyoming: U.S. Geological Survey Bulletin 1026, 93 p.

[This report contains a map (2 sheets) of the geology between the Bighorn Mountains and Hardin at a scale of 1:62,500; two geologic sections; a generalized columnar section of the map units; a surface-subsurface correlation section from Cody, Wyoming, to Hardin, Montana; and a sketch map showing basins, mountains and principal areas of folding. A lengthy description of the stratigraphy is supported by measured sections of all the exposed formations from the Rierdon Formation through the Bearpaw Shale. The text also describes structure and economic geology.]

_____1957, Geology of the area east and southeast of Livingston, Park County, Montana: U.S. Geological Survey Bulletin 1021-L, p. 385-438.

[This report contains a geologic map (2 sheets) of parts of six 7-1/2' quadrangles showing structure contours of the base of the Boulder River Sandstone Member of the Colorado Shale (in Frontier Formation); two geologic sections; and a composite and a generalized stratigraphic column of the Precambrian, Paleozoic, and Mesozoic rocks exposed near Livingston. A lengthy description of the stratigraphy of all the sedimentary map units, from the Rierdon Formation through the Livingston Formation (Liv-

ingston Group), is supplemented by several measured sections. The text also describes igneous rocks, economic geology, and the complex structural geology.]

Richards, P. W., and Rogers, C. P., Jr., 1951, Geology of the Hardin area, Big Horn and Yellowstone Counties, Montana: U.S. Geological Survey Oil and Gas Investigations Map OM-111, 2 sheets.

[Sheet 1 consists of a geologic map of more than 1,120 mi^2 at a scale of 1:63,360 showing structure contours of the top of the Mowry Shale. Sheet 2 contains a columnar section of rocks of Paleozoic and Mesozoic age exposed in Bighorn River Canyon; one lithologic and geophysical log for an oil well; and a brief discussion of the structural highs, mineral deposits, and oil and gas exploration.]

Richards, R. W., 1910, The central part of the Bull Mountain coal field, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 381-A, p. 60-81.

[This report describes coal in the Fort Union Formation (24 named beds) and contains 22 coal sections and analyses of 8 coal samples. Two maps at a scale of 1:63,360 for the areas Tps. 5 and 6 N., Rs. 28 and 29 E.; T. 7 N., Rs. 25 to 29 E.; and T. 8 N., Rs. 25 to 28 E., show the locations of coal outcrops and the thickness of the beds. A generalized columnar section on the maps show the relationships of the coal beds to one another.]

Roberts, A. E., 1964a, Geology of the Brisbin quadrangle, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-256, scale 1:24,000.

[This report consists of a geologic map and an explanation that contains brief lithologic descriptions of all the map units from the Piper Formation through the Cody Shale.]

_____1964b, Geology of the Chimney Rock quadrangle, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-257, scale 1:24,000.

[This report consists of a geologic map and an explanation that contains brief lithologic descriptions of all the map units from the Piper Formation through the Eagle Sandstone.]

_____1964c, Geology of the Hoppers quadrangle, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-258, scale 1:24,000.

[This report consists of a geologic map and an explanation that contains brief lithologic descriptions of all the map units from the Kootenai Formation through the Fort Union Formation.]

_____1964d, Geology of the Livingston quadrangle, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-259, scale 1:24,000.

[This report consists of a map showing the geology and structure of the Livingston, Montana, area. The explanation contains brief lithologic descriptions of all the map units from the Morrison Formation through the Fort Union Formation.]

_____1964e, Geologic map of the Maxey Ridge quadrangle, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-396, scale 1:24,000.

[This report consists of a geologic map of an area southwest of Livingston, Montana, and an explanation containing brief lithologic descriptions of all the map units from the Madison Group through the Livingston Group.]

_____1964f, Geologic map of the Fort Ellis quadrangle, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-397, scale 1:24,000.

[This report consists of a geologic map of an area northeast of Bozeman, Montana, and an explanation containing brief lithologic descriptions of all the map units from the Flathead Quartzite through the Fort Union Formation.]

_____1964g, Geologic map of the Mystic Lake quadrangle, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-398, scale 1:24,000.

[This report consists of a geologic map of an area southeast of Bozeman, Montana, and an explanation containing brief lithologic descriptions of all the map units from the Flathead Quartzite through the Cody Shale.]

_____1964h, Geologic map of the Bozeman Pass quadrangle, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-399, scale 1:24,000.

[This report consists of a geologic map and an explanation containing brief lithologic descriptions of all the map units from the Swift Formation through the Fort Union Formation.]

_____1965, Correlation of Cretaceous and lower Tertiary rocks near Livingston, Montana, with those in other areas of Montana and Wyoming: U.S. Geological Survey Professional Paper 525-B, p. B54-B63.

[This report correlates the following Cretaceous and Tertiary rocks exposed on the southern flank of the Crazy Mountain basin near Livingston with rocks in other areas of Montana and Wyoming: the Kootenai Formation, Thermopolis Shale, Mowry Shale, Frontier Formation, Cody Shale, Telegraph Creek Formation, Eagle Sandstone, Cokedale Formation, and Fort Union Formation. The stratigraphic relations and correlation of the rock units with other areas are also shown graphically.]

_____1966, Geology and coal resources of the Livingston coal field, Gallatin and Park Counties, Montana: U.S. Geological Survey Professional Paper 526-A, p. A1-A56.

[This report appraises the coal resources in an area of about 420 mi^2 at the juncture of the Gallatin and Bridger Ranges and the Crazy Mountain basin. It describes the structural geology and the stratigraphy of the coal-bearing Eagle Sandstone. Two detailed stratigraphic sections of 645 ft and 613 ft of the Eagle Sandstone are given. Included are 145 chemical analyses of coal compiled from several sources. Estimates of coal reserves are given. Included is a map at a scale of 1:48,000 showing structural geology and the location of coal beds, mines, and prospects in the Eagle Sandstone. In addition, 4 maps show 14 mines at scales of 1:100, 1:200, and 1:400; 2 plates show 103 measured coal sections; and 1 plate shows the correlations and lateral variations of coal beds.]

_____1972, Cretaceous and early Tertiary depositional and tectonic history of the Livingston area, southwestern Montana: U.S. Geological Survey Professional Paper 526-C, p. C1-C120.

[This report describes a marine and continental sequence of sedimentary and volcanic rocks more than 20,000 ft thick. Twelve formations from the Kootenai Formation through the Fort Union Formation are described in detail. The report contains extensive lithologic descriptions and fossil identification for each formation. Twenty sedimentary sections totaling 20,065 ft were measured, described, and sampled for stratigraphic and paleontologic control. Also included is a geologic map at a scale of 1:62,500, a stratigraphic column, and a tectonic map of the Crazy Mountain basin and adjacent areas at a scale of 1:250,000.]

Robinson, C. S., Mapel, W. J., and Bergendahl, M. H., 1964, Stratigraphy and structure of northern and western flanks of the Black Hills uplift, Wyoming, Montana, and South Dakota: U.S. Geological Survey Professional Paper 404, 134 p.

[This report contains a geologic map (2 sheets) showing structure contours of the top of the Fall River Sandstone; stratigraphic sections of the Sundance, Gypsum Spring, Lakota and Morrison Formations, and Newcastle Sandstone; a correlation section of the Pierre Shale between Montana and Wyoming; and a generalized section of the sedimentary rocks exposed in the map area. The text consists mainly of a detailed description of the stratigraphy and structural geology. The bedrock units exposed in the Montana area of the map are the Mowry Shale and the Fort Union Formation.]

Rogers, G. S., 1913, The Little Sheep Mountain coal field, Dawson, Custer, and Rosebud Counties, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 531-F, p. 159-227.

[This report is mostly a township-by-township description of the occurrence of coal in an area of 1,440 mi^2. The lithologic description of the Fort Union Formation is supported with three measured sections totaling 711 ft of parts of the formation. Included in the report are 377 measured coal sections and a map at a scale of 1:125,000 showing the outcrop of the coal, burned areas, and the sites of the measured sections.]

_____1914, Geology and coal resources of the area southwest of Custer, Yellowstone, and Big Horn Counties, Montana: U.S. Geological Survey Bulletin 541-H, p. 316-328.

[This report describes the stratigraphy and occurrence of coal in a 125-mi^2 area of which only about 6 mi^2 is underlain by coal. Five measured stratigraphic sections across the coal bed and 23 measured coal sections are given. A map at a scale of 1:125,000 shows the outcrop of the coal and the coal-section sites.]

Rogers, G. S., and Lee, Wallace, 1923, Geology of the Tullock Creek coal field, Rosebud and Big Horn Counties, Montana: U.S. Geological Survey Bulletin 749, 181 p.

[This report contains a geologic map of the Fort Union and Hell Creek Formations whose boundaries have since been revised, a coal-resources map, and thickness maps of six coal beds all at a scale of 1:125,000. The text describes the structure, characteristics of coal beds, and stratigraphy of the area. A township-by-township description of coal resources is accompanied by more than 500 coal sections.]

Sandberg, C. A., 1962, Geology of the Williston Basin, North Dakota, Montana, and South Dakota, with reference to subsurface disposal of radioactive wastes: U.S. Geological Survey Trace Elements Investigations Report 809, 148 p.

[This report consists principally of a comprenhensive description of the stratigraphy and structure of rocks in the Williston Basin from the metamorphic rocks of Precambrian age through the top of the Pierre Shale. It contains 21 page-size structure-contour and thickness maps of selected intervals in the section, as well as a correlation chart of pre-Tertiary formations, a generalized stratigraphic section for the central Williston Basin, and an east-west electric-log correlation section.]

Sandberg, D. T., 1959, Structure contour map on top of the middle member of the Piper Formation of Middle Jurassic age in the Williston Basin and adjacent areas in Montana, North Dakota, and South Dakota: U.S. Geological Survey Oil and Gas Investigations Map OM-179, scale about 1:760,000.

[This report consists of a map showing the major structural features and structure contours of the top of the middle member of the Piper Formation in the Williston Basin and the northern part of the Powder River Basin. Also included are a discussion of the regional stratigraphic and structural variations in the Piper Formation; a correlation chart of formation names for the Jurassic System of eastern Montana, North Dakota, and western South Dakota; a sample log from Roosevelt County, Montana, with lithologic descriptions of part of the Jurassic System; and a section of nine well logs correlating the Rierdon and Piper Formations.]

Sarnecki, J. C., 1977, Geologic map and coal sections of the Lacey Gulch quadrangle, Big Horn and Rosebud Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-832, 2 sheets.

[Sheet 1 consists of a geologic map at a scale of 1:24,000 of the Tongue River Member of the Fort Union Formation, Wasatch Formation, and deposits of Quaternary age on which is shown the outcrop area of 11 coal beds and the extent of burned area for each, and a section showing the probable correlation of coal beds and zones in drill holes. Sheet 2 contains analyses of 9 coal samples; tables of identified, inferred, and hypothetical coal resources under less than 200 ft, less than 1,000 ft, and 1,000 to 2,000 ft of overburden; and 153 sections of coal beds.]

Schmidt, R. G., Pecora, W. T., Bryant, Bruce, and Ernst, W. G., 1961, Geology of the Lloyd quadrangle, Bearpaw Mountains, Blaine County, Montana: U.S. Geological Survey Bulletin 1081-E, p. 159-188.

[This report contains a geologic map at a scale of 1:31,680 with brief lithologic descriptions of the igneous and sedimentary map units from the Sawtooth Formation through the Wasatch Formation, three geologic sections, and a measured stratigraphic section of the Fox Hills Sandstone and top of the Bearpaw Shale. The text mainly describes the igneous rocks and structural arch, the northern volcanic field, and the plains area and associated Bowes dome.]

Schmidt, R. G., Pecora, W. T., and Hearn, B. C., Jr., 1964, Geology of the Cleveland quadrangle, Bearpaw Mountains, Blaine County, Montana: U.S. Geological Survey Bulletin 1141-P, p. P1-P26.

[This report contains a geologic map at a scale of 1:31,680 and two geologic sections. The text briefly describes the structure, igneous rocks, and stratigraphy of the surficial deposits and sedimentary bedrock units from the Sawtooth Formation through the Bearpaw Shale.]

Silverman, A. J., and Harris, W. L., 1967, Stratigraphy and economic geology of the Great Falls-Lewistown coal field, central Montana: Montana Bureau of Mines and Geology Bulletin 56, 20 p.

[This report describes the occurrence of coal in the Morrison Formation. The stratigraphy of the Swift, Morrison, and Kootenai Formations is described. The unconformity between rocks of Jurassic and Cretaceous age is discussed and the presence or absence of this unconformity is shown in 38 measured sections. Two analyses of coal and the reserves of the area are described. Included is a geologic map at a scale of about 1:253,000.]

Skipp, Betty, 1977 [1978], Geologic map and cross section of the Wallrock quadrangle, Gallatin and Park Counties, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-1402, scale 1:24,000.

[This report consists of a geologic map, a geologic section, a correlation chart of the map units, and lithologic descriptions of all the units from the Ellis Group through the Billman Creek Formation.]

Skipp, Betty, and Hepp, Mary-Margaret, 1968, Geologic map of the Hatfield Mountain quadrangle, Gallatin County, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-729, scale 1:24,000.

[This report consists of a geologic map, a geologic section, and a discussion of the structural relationships at the west edge of the Crazy Mountain basin. The explanation contains lithologic descriptions of all the map units from the Madison Group through the Eagle Sandstone and volcanic rocks equivalent to Livingston Group.

Skipp, Betty, and McGrew, L. W., 1977, The Maudlow and Sedan Formations of the Upper Cretaceous Livingston Group on the west edge of the Crazy Mountains basin, Montana: U.S. Geological Survey Bulletin 1422-B, p. B1-B68.

[This report adopts two formation names for the largely rhyodacitic primary volcanic and volcaniclastic rocks of the lower part of the Livingston Group in parts of Gallatin, Meagher, and Park Counties, Montana. Areal extent, measured sections, petrographic descriptions and chemical analyses are given, and correlations are made with the type Livingston Group. Potassium-argon ages are used to date the volcanism.]

Slagle, S. E., and Stimson, J. R., 1979, Hydrogeologic data for the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Open-File Report 79-1332, 111 p.

[This report primarily contains hydrogeologic data. A generalized section for the geologic units in the northern Powder River Basin from the Bearpaw Shale through the Wasatch Formation and alluvium, and drillers' logs of several hundred wells and test holes also are included.]

Smith, C. D., 1910, The Fort Peck Indian Reservation lignite field, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 381-A, p. 40-59.

[This report mostly describes the lignite deposits in the Fort Union Formation. Descriptions of 19 coal sections and an analysis of 1 coal sample are presented. Included is a map showing the outcrop of the Pierre Shale, Fox Hills Sandstone, Fort Union Formation, and the outcrop of lignite beds at a scale of about 1:285,000.]

Smith, H. L., 1963, Geologic map of the Castagne quadrangle, Carbon County, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-264, scale 1:24,000.

[This report consists of a geologic map showing the trace of the Nye-Bowler fault zone and a list of four wells drilled for oil and gas. The explanation contains lithologic descriptions of the surficial deposits and members 'b' and 'c' of the Fort Union Formation, which may correspond, respectively, to the Lebo Shale and Tongue River Members.]

Smith, H. R., 1962, Geology of the Melstone-Sumatra area in central Montana: U.S. Geological Survey Oil and Gas Investigations Map OM-211, scale 1:63,360.

[This report consists of a geologic map showing structure contours of the top of the Judith River Formation. Also included are a stratigraphic column and well records for 178 oil wells.]

Smith, J. F., Jr., 1956, Geology of the Cartersville and Hathaway quadrangles, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-155, scale 1:62,500.

[This report consists of a geologic map and a discussion of the structure, economic geology, and stratigraphy of the Hell Creek Formation, Fort Union Formation, and Quaternary deposits. It also contains a summary of physical characteristics and a generalized columnar section of these strata, as well as a stratigraphic section of the Lebo Shale Member of the Fort Union Formation, and another of a part of the Tullock Member of the Fort Union Formation.]

Smith, J. F., Jr., Witkind, I. J., and Trimble, D. E., 1959 [1960], Geology of the lower Marias River area, Chouteau, Hill, and Liberty Counties, Montana: U.S. Geological Survey Bulletin 1071-E, p. 121-155.

[This report deals primarily with Quaternary stratigraphy and geologic history; it also contains a description and a stratigraphic section of the exposed consolidated sedimentary strata from the Colorado Shale (Colorado Group) through the Judith River Formation. The geologic map shows the area of outcrop of these rocks.]

Soward, K. S., 1975, Geologic map of the Rocky Reef quadrangle, Cascade County, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-1240, scale 1:24,000.

[This report consists of a geologic map of the area, two geologic sections, a correlation chart of the map units, and lithologic descriptions of all the units from the Blackleaf Formation through the Two Medicine Formation.]

Stanton, T. W., Hatcher, J. B., and Knowlton, F. H., 1905, Geology and paleontology of the Judith River beds, with a chapter on the fossil plants, by F. H. Knowlton: U.S. Geological Survey Bulletin 257, 174 p.

[This report establishes the age of the Judith River Formation and the stratigraphic succession of the Upper Cretaceous section from the Eagle Sandstone through the Bearpaw Shale for the type area south of the Bearpaw Mountains and for north-central Montana.]

Stebinger, Eugene, 1912, The Sidney lignite field, Dawson County, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 471-D, p. 284-318.

[This report is mostly a township-by-township description of the exposures, character, and thickness of lignite for the area: T. 17 N., Rs. 58 to 60 E.; Tps. 18 and 19 N., Rs. 56 to 60 E.; T. 20 N., Rs. 57 to 60 E.; Tps. 21 and 22 N., Rs. 58 to 60 E.; and T. 23 N., Rs. 59 and 60 E. Included are 2 descriptive sections of lignite beds and 5 tables with 34 locations and thicknesses of lignite beds. Maps at a scale of 1:62,500 show the outcrop of lignite and burned areas.]

_____1919, Oil and gas geology of the Birch Creek-Sun River area, northwestern Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 691-E, p. 149-184.

[This report describes the stratigraphy of rocks of Mississippian through Eocene age in a strip along the front of the Rocky Mountains from Tps. 20 to 29 N., and Rs. 6 to 8 W., at the south end to Rs. 8 to 10 W. at the north end. Numerous anticlines are located and described. Included is a geologic map at a scale of 1:125,000 with four geologic sections.]

Stewart, D. B., Pecora, W. T., Engstrom, D. E., and Dixon, H. R., 1957, Preliminary geologic map of the Centennial Mountain quadrangle, Bearpaw Mountains, Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-235, scale 1:31,680.

[This report consists of a geologic map and a discussion of the igneous rocks, structure, and economic geology. The explanation contains lithologic descriptions of all the map units from the Kootenai Formation through the igneous rocks of Tertiary age.]

Stewart, J. C., 1959, Geology of the Dryhead-Garvin Basin, Big Horn and Carbon Counties, Montana: Montana Bureau of Mines and Geology Geologic Map 2, scale 1:63,360.

[This report consists of a geologic map; two geologic sections; a columnar section of the map units; and a discussion of the structural geology, geologic history, economic geology, and stratigraphy of all the map units from the Piper Formation through the Cloverly Formation equivalent.]

Stoner, J. D., and Lewis, B. D., 1980, Hydrogeology of the Fort Union coal region, eastern Montana: U.S. Geological Survey Miscellaneous Investigations Map I-1236, 2 sheets.

[This report consists of a hydrogeologic map at a scale of 1:500,000 showing the configuration of the top of the Bearpaw confining layer, a regional-scale map showing the structural features of eastern Montana, three geologic sections, a table describing the stratigraphy and water-yielding characteristics of the map units from the Bearpaw confining layer through the alluvial aquifer, and representative electric logs correlating geologic and hydrogeologic units.]

Swenson, F. A., 1957 [1958], Geology and ground-water resources of the Lower Marias irrigation project, Montana, *with a section on* Chemical quality of

the ground water, by H. A. Swenson: U.S. Geological Survey Water-Supply Paper 1460-B, p. 41-98.

[This report primarily describes the stratigraphy of the rocks of Cretaceous age and the deposits of Pleistocene and Recent (Holocene) age in relation to ground-water supply, development, and the effect of applying irrigation water to those rocks. Included are 25 chemical analyses of water, 29 well logs, water-level measurements for 20 observation wells, and well records for 119 water wells. In addition, a map at a scale of about 1:95,000 shows areal geology and ancestral drainage courses, a plate shows graphic logs of test holes, and 2 plates show hydrographs for 14 observation wells from 1945 to 1953.]

Swenson, F. A., Miller, W. R., Hodson, W. G., and Visher, F. N., 1976, Map showing configuration and thickness, and potentiometric surface and water quality in the Madison Group, Powder River Basin, Wyoming and Montana: U.S. Geological Survey Miscellaneous Investigations Map I-847-C, 2 sheets.

[Maps at a scale of 1:1,000,000 show the configuration of the top and generalized thickness of the Madison Group. Sheet 1 includes a brief discussion of the structure, lithology, and stratigraphic relationship of the Madison Group to adjacent geologic units. Sheet 2 pertains to the hydrology.]

Taylor, O. J., 1965, Ground-water resources along Cedar Creek anticline in eastern Montana: Montana Bureau of Mines and Geology Memoir 40, 99 p.

[This report deals primarily with the water resources; it also contains a short description of the formations from the Pierre Shale through the Fort Union Formation that are exposed along the Cedar Creek anticline. Accompanying the text is a geologic map showing the structure contours of the base of the Fox Hills Sandstone.]

_____1968, Ground-water resources of the northern Powder River valley, southern Montana: Montana Bureau of Mines and Geology Bulletin 66, 34 p.

[This report primarily describes the hydrology; it also contains a short discussion of the geologic formations from the Pierre Shale through the Fort Union Formation. Accompanying the text is a geologic map showing structure contours of the approximate altitude of the base of the Fox Hills Sandstone.]

Thom, W. T., Jr., and Dobbin, C. E., 1924, Stratigraphy of Cretaceous-Eocene transition beds in eastern Montana and the Dakotas: Geological Society of America Bulletin, v. 35, p. 481-505.

[This report details the stratigraphy of the Fox Hills Sandstone, Lance Formation equivalent, Fort Union Formation, and Wasatch Formation of the northern Plains. A diagrammatic section from the Crazy Mountains of Montana east to Bismarck, North Dakota, illustrates the interrelationship of these units to adjacent, correlative formations. The report also

contains a structural sketch map on the First Cat Creek Sandstone for Montana, Wyoming, Arizona, New Mexico, and the western Dakotas, and a table giving thicknesses of the aforementioned formations at 20 different localities in Montana, Wyoming, and North Dakota.]

Torrey, A. E., and Kohout, F. A., 1956, Geology and ground-water resources of the lower Yellowstone River valley, between Glendive and Sidney, Montana, *with a section on* Chemical quality of the water, by H. A. Swenson: U.S. Geological Survey Water-Supply Paper 1355, 92 p.

[This report contains a geologic map at a scale of about 1:27,000 and a table describing the stratigraphy and the water-bearing characteristics of the Fox Hills Sandstone, the Hell Creek and Fort Union Formations, and the Quaternary deposits. Except for a short discussion of geology, the text primarily describes the hydrology and chemical quality of ground and surface waters.]

Torrey, A. E., and Swenson, F. A., 1951, Ground-water resources of the lower Yellowstone River valley between Miles City and Glendive, Montana, *with a section on* The chemical quality of the water, by H. A. Swenson: U.S. Geological Survey Circular 93, 72 p.

[This report describes the geology and hydrology of exposed bedrock and alluvial deposits in the Yellowstone River valley. The text contains a description and a generalized section of the lithology and water-bearing properties of the Pierre Shale through the Fort Union Formation and alluvial deposits. Included is a geologic map of the Yellowstone River valley at a scale of 1:63,360.]

Tourtelot, H. A., 1962, Preliminary investigation of the geologic setting and chemical composition of the Pierre Shale, Great Plains region: U.S. Geological Survey Professional Paper 390, 74 p.

[This report mostly describes the geochemistry of the Pierre Shale and equivalent rocks in the Great Plains of Montana, North Dakota, South Dakota, and Wyoming. The stratigraphy of the rocks is considered in terms of a historical summary and the correlation and description of units. The geochemistry is considered in terms of geologic processes, sampling techniques, and the physical and chemical composition of the rocks. The report presents the data to measure the range in variation in chemical and mineralogical composition and related characteristics.]

Vine, J. D., 1956, Geology of the Stanford-Hobson area, central Montana: U.S. Geological Survey Bulletin 1027-J, p. 405-470.

[This report contains a geologic map (2 sheets) at a scale of 1:62,500 showing contours of the top or projected top of the Kootenai Formation. Other supplements to the report are a generalized columnar section of the exposed rocks, columnar sections of the Big Snowy through Ellis Groups, a sample log from the Colorado Shale (Colorado Group) at the surface to the Madison Limestone (Madison Group), and a table illustra-

ting the variations in thickness of the Kootenai and pre-Kootenai intervals throughout the map area. The text describes the stratigraphy of the bedrock formations from the Madison Limestone (Madison Group) through the Judith River Formation; the structural relations and lithology of the igneous rocks; the significant anticlines, faults, and secondary structural trends evident on the map; and the mineral resources.]

Wanek, A. A., 1963a, Geologic map of the Cooney Reservoir quadrangle, Carbon and Stillwater Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-265, scale 1:24,000.

[This report consists of a geologic map, a geologic section, a composite stratigraphic section of the Fort Union and Hell Creek Formations, and an explanation containing brief lithologic descriptions of all the map units from the Hell Creek Formation through the surficial deposits. The Fort Union Formation is divided into three mappable units, members 'a', 'b', and 'c', which may correspond, respectively, to the Tullock, Lebo Shale, and Tongue River Members.]

_____1963b, Geologic map of the Rapids quadrangle, Carbon and Stillwater Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-270, scale 1:24,000.

[This report consists of a geologic map, a geologic section, and a composite stratigraphic section for an area southeast of Columbus, Montana. The explanation contains brief lithologic descriptions of all the map units from the Eagle Sandstone through the Fort Union Formation.]

Warren, W. C., 1959 [1960], Reconnaissance geology of the Birney-Broadus coal field, Rosebud and Powder River Counties, Montana: U.S. Geological Survey Bulletin 1072-J, p. 561-585.

[This report contains a geologic map (2 sheets) at a scale of 1:63,360 showing coal outcrops and the extent of clinker in the coal beds; a composite stratigraphic section showing the positions of the beds; and analyses of seven coal samples. The text describes the stratigraphy of the Fort Union Formation, the structure, the properties of coal, and the distribution of coal. More than 700 graphic coal sections and tables of township-by-township estimates of coal reserves are given.]

Wegemann, C. H., 1910, Notes on the coals of the Custer National Forest, Montana, Part 2 *of* Contributions to economic geology: U.S. Geological Survey Bulletin 381-A, p. 108-114.

[This report briefly describes the occurrence of coal in the Fort Union Formation in 8 of 15 townships in the area of Tps. 1 to 3 S., Rs. 44 to 48 E.]

Weimer, R. J., 1963, Stratigraphy of the upper Judith River Formation (Late Cretaceous), central and southeast Montana, *in* Wyoming Geological Association

and Billings Geological Society 1963 Joint Field Conference, Northern Powder River Basin, Wyoming and Montana: p. 108-111.

[This report describes the important facies changes evident in the Judith River Formation of Montana. It contains a map at a scale of about 1:1,680,000 showing the outcrop area of the Judith River Formation as well as environments of deposition and thicknesses of the upper sandstone of the Judith River, and an electric-log correlation section across these deltaic deposits.]

Witkind, I. J., 1971, Geologic map of the Barker quadrangle, Judith Basin and Cascade Counties, Montana: U.S. Geological Survey Geologic Quadrangle Map GQ-898, scale 1:62,500.

[This report consists of a geologic map; four geologic sections; and an explanation that contains brief lithologic descriptions of each Precambrian through Cenozoic map unit, including the Kootenai Formation, Morrison Formation, and Ellis Group.]

Woolsey, L. H., Richards, R. W., and Lupton, C. T., 1917, The Bull Mountain coal field, Musselshell and Yellowstone Counties, Montana: U.S. Geological Survey Bulletin 647, 218 p.

[This report contains a geologic map at a scale of 1:125,000 of the Fort Union and Hell Creek Formations, whose boundaries have since been revised. Also included are analyses of 27 coal samples and a series of columnar sections through the coal field showing the stratigraphic succession of the 24 coal beds in the Tongue River Member of the Fort Union Formation. The text describes the stratigraphy and structure of the map units and the characteristics of the coal beds. A township-by-township description of geology and coal resources is accompanied by more than 1,700 coal sections and 25 township maps showing the coal-outcrop area and locations of the coal sections.]

Zeller, H. D., 1963, Geologic map of the Roberts quadrangle, Carbon County, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-266, scale 1:24,000.

[This report consists of a geologic map; a geologic section; a stratigraphic section of the Fort Union and Hell Creek Formations in T. 7 S., R. 21 E.; a list of five wells drilled for oil and gas; and an explanation containing brief lithologic descriptions of all the map units from the Lennep Sandstone (Fox Hills Sandstone) through the surficial deposits. The Fort Union Formation is divided into three mappable units, members 'a', 'b', and'c', which may correspond, respectively, to the Tullock, Lebo Shale, and Tongue River Members.]

Zimmerman, E. A., 1956, Preliminary report on the geology and ground-water resources of parts of Musselshell and Golden Valley Counties, Montana *with a section on* The chemical quality of the water by R. H. Langford: Montana Bureau of Mines and Geology Information Circular 15, 13 p.

[This report resulted from an investigation to determine the occurrence and availability of the ground-water resources in a 650-mi^2 area northwest of the Musselshell River between Lavina and Roundup, Montana. The report briefly discusses the geology and the following principal aquifers: Kootenai Formation, Eagle Sandstone, Judith River Formation, Lance Formation equivalent, Fort Union Formation, terrace deposits, and alluvium. The text is supported by a geologic map at a scale of 1:126,720 and a table of stratigraphic units and their water-bearing properties.]

_____1960, Preliminary report on the geology and ground-water resources of northern Blaine County, Montana: Montana Bureau of Mines and Geology Bulletin 19, 19 p.

[This report contains a geologic map at a scale of 1:126,720 and a table describing the lithologic and water-bearing characteristics of the rocks from the Judith River Formation through the Hell Creek Formation and surficial deposits.]

_____1962, Preliminary report on the geology and ground-water resources of southern Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 32, 23 p.

[This report contains a geologic map of a 450-mi^2 area between Hobson and Judith Gap, Montana, at a scale of 1:126,720. The text mainly describes the stratigraphy and water-bearing characteristics of the exposed sedimentary rocks from the Madison Limestone (Madison Group) through the Judith River Formation. This information also is summarized in a table in the text.]

_____1964, Geology and water resources of the Bluewater Springs area, Carbon County, Montana: U.S. Geological Survey Water-Supply Paper 1779-J, p. J1-J24.

[This report describes the geology and water-bearing characteristics of the Madison Limestone (Madison Group) through the Colorado Group, the faulted nature of the rocks and their relation to ground water, and chemical quality of water from wells and springs. Included in the discussion of geology are measured sections of the Amsden Formation (Amsden Group), Tensleep Sandstone, and Chugwater Formation. The report also contains a geologic map at a scale of 1:24,000.]

_____1966a, Geology and ground-water resources of western and southern parts of Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 50-A, 33 p.

[This report contains a geologic map (2 sheets) of the Judith basin west of Windham and south of Hobson, Montana, at a scale of 1:75,000. Structure contours are shown for the top of the Kootenai Formation. The text describes the thickness, lithology, and water-bearing properties of all the geologic units from the Madison Group through the Judith River Formation, and ground water and its chemical quality. Included in the text are tables summarizing the lithologic and water-bearing characteristics

of the geologic units, and a thickness map of the Amsden Formation (Amsden Group).]

_____1966b, Basic water data report no. 2, western and southern parts of Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 50-B, 40 p.

[This report contains the data -- including logs of wells, oil-test holes, and test holes -- for the preceding reference.]

_____1967, Water resources of the Cut Bank area, Glacier and Toole Counties, Montana: Montana Bureau of Mines and Geology Bulletin 60, 37 p.

[A geologic map at a scale of about 1:72,000 shows surficial geology and structure of the top of the Colorado Group. A glacial map for the Cut Bank vicinity also is included. The report describes the character, thickness, and areal extent of the principal water-bearing formations (Virgelle Sandstone and Two Medicine Formation), and drillers' logs for 24 wells are given in a table. The report also describes in detail the water resources and the chemical quality of the water.]

HYDROLOGY

Alverson, D. C., 1965, Geology and hydrology of the Fort Belknap Indian Reservation, Montana: U.S. Geological Survey Water-Supply Paper 1576-F, p. F1-F59.

[This report resulted from a reconnaissance study to determine the potential for obtaining adequate supplies of ground water of good quality for domestic and stock-watering purposes and to examine the extensive gravel terraces and other formations around the north flank of the Little Rocky Mountains as possible sources of irrigation water. The text includes a detailed discussion of the geologic units from the Cambrian through the surfical deposits and their water-bearing properties. The Judith River Formation is the most important bedrock aquifer. A geologic map accompanies the report.]

Blankennagel, R. K., Howells, L. W., Miller, W. R., and Hansen, C. V., 1979, Preliminary data for Madison Limestone test well 3, NW1/4SE1/4 sec. 35, T. 2 N., R. 27 E., Yellowstone County, Montana: U.S. Geological Survey Open-File Report 79-745, 186 p.

[This report provides the preliminary data for the Madison Limestone (Madison Group) test well 3 including test-well history, geology penetrated by the test well, hydrologic testing, and geochemistry. It also describes the preliminary results and future testing plans. Geologic interval penetrated is from the Eagle Sandstone to rocks of Precambrian age.]

Brown, D. L., Blankennagel, R. K., Busby, J. F., and Lee, R. W., 1977, Preliminary data for Madison Limestone test well No. 2, SE1/4SE1/4 sec. 18, T. 1 N., R. 54 E., Custer County, Montana: U.S. Geological Survey Open-File Report 77-863, 135 p.

[This report provides the preliminary data for the Madison Limestone (Madison Group) test well 2 including test-well history, geology penetrated by the test well, hydrologic testing, and geochemistry. It also describes the preliminary results and future testing plans. The drilling of the well started in the Bearpaw Shale and bottomed in Precambrian rocks.]

Coffin, D. L., Reed, T. E., and Ayers, S. D., 1977, Water-level changes in wells along the west side of the Cedar Creek anticline, southeastern Montana: U.S. Geological Survey Water-Resources Investigations 77-93, 11 p.

[This report presents water levels for 1962-64, 1969, and 1975 in observation wells along the west side of the Fox Hills-Hell Creek aquifer and water-level-decline maps for 1962-64 to 1975, 1962-64 to 1969, and 1969 to 1975. Withdrawals for industrial wells for 1964-74 are listed.]

Ellis, A. J., and Meinzer, O. E., 1924, Ground water in Musselshell and Golden Valley Counties, Montana: U.S. Geological Survey-Water Supply Paper 518, 92 p.

[This report describes the following formations and their water-bearing characteristics: Kootenai Formation, Colorado Shale (Colorado Group), Eagle Sandstone, Claggett Formation, Judith River Formation, Bearpaw Shale, Lance Formation equivalent, Fort Union Formation, terrace deposits, and alluvium. The geology of the area is described in the text and supported with a geologic map. The chemical quality of the water is described, and 51 analyses of ground water are listed. Ground-water conditions are described by township for the entire area. Records of 34 wells and springs are listed.]

Feltis, R. D., 1973, Geology and water resources of eastern part of Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 87, 51 p.

[This report describes the availability, quantity, and quality of water from the Madison Group, Kibbey Sandstone, Amsden Group, Swift Formation, Morrison Formation, Kootenai Formation, Colorado Shale (Colorado Group), Eagle Sandstone, Judith River Formation, terrace deposits, and alluvium. The report includes estimates of recharge and discharge, hydrographs for three shallow wells, an aquifer test for the Kootenai Formation, 2 aquifer tests for the Swift Formation, records for 110 wells and springs, drillers' logs for 53 wells, and logs from 4 oil wells. Chemical analyses from 61 wells and springs and discharge data for several streams are also presented.]

_____1977, Geology and water resources of northern part of Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 101, 65 p.

[This report appraises the availability, quantity, and quality of ground and surface water in the northern part of the Judith basin to determine the availability and suitability of water for irrigation. Aquifers described are the Madison Group, Kibby Sandstone, Amsden Group, Swift Formation, Kootenai Formation, Colorado Shale (Colorado Group), Eagle Sandstone, terrace deposits, and alluvium. The ground-water discussion includes a limited description of recharge and discharge, a hydrograph for a well in terrace deposits, and an aquifer test of one well tapping the Kootenai Formation. The chemical quality of ground and surface water is described based on 38 and 24 analyses, respectively. Additional information includes records of 104 water wells, oil wells, springs, and drains; drillers' logs for 20 wells; and logs for 25 oil wells.]

_____1979, Water resources of shallow aquifers in the upper Poplar River basin, northeastern Montana: U.S. Geological Survey Water-Resources Investigations 79-51, 23 p.

[This report describes: (1) The occurrence and movement of ground water, (2) the extent of interchange between ground water and surface water, and (3) the chemical quality of the water. Aquifers discussed are the Fox Hills-Hell Creek aquifer, Fort Union Formation, sand and gravel of glacial deposits, Wiota Gravel, Flaxville Formation, and alluvium. The text is supplemented by a geologic map, a map showing potentiometric surface and quality of water in shallow aquifers, tables of constituents

from chemical analyses, and a table summarizing low-flow discharge measurements.]

_____1980, Water resources of the Judith Basin, central Montana: Montana Bureau of Mines and Geology Hydrogeologic Map 1, 3 sheets.

[Sheet 1 contains a generalized stratigraphic section; a hydrogeologic map of the Madison Group showing structure contours, water levels, chemical-constituent diagrams, and low-flow discharge measurements; and a potentiometric-surface map for the Madison Group. Sheet 2 contains a map showing chemical quality of water from several aquifers in the Judith basin; a map showing average flow and chemical quality of water at stations in the Judith River basin for the 1970 water year; and mean monthly precipitation and depth and water content of snow for selected sites. Sheet 3 contains hydrographs, flow-duration curves, and low-flow recurrence intervals for selected streamflow sites in the basin.]

Fox, R. D., 1966, Geology and ground-water resources of the Cascade-Ulm area, Montana: Montana Bureau of Mines and Geology Bulletin 52, 64 p.

[This report resulted from an investigation to determine the potential sources and availability of ground water in a 415-mi^2 area. The principal aquifers -- Kootenai Formation, Virgelle Sandstone, and Flood Member of the Blackleaf Formation -- are described in detail. Tables containing data for 173 wells and springs and analyses of major chemical constituents from 7 wells and springs are presented.]

Gosling, A. W., and Pashley, E. F., Jr., 1973, Water resources of the Yellowstone River valley, Billings to Park City, Montana: U.S. Geological Survey Hydrologic Investigations Atlas HA-454, scale 1:48,000, 2 sheets.

[Sheet 1 contains a geologic map, three geologic sections, a brief geologic discussion, a table showing the geologic units and their water-bearing and lithologic characteristics, and bar graphs showing total annual and average monthly precipitation at Billings, Montana. The ground-water resources, with major emphasis on alluvium, is described on Sheet 2 along with a map showing water-table contours and altitude of bedrock. Results of four aquifer-test and water-quality analyses are listed. A bar graph of water consumption for Billings for 1934-68 is presented. Annual discharge, flood-frequency curves, and low-flow frequency curves for the Yellowstone River at Billings are shown.]

Groff, S. L., 1958, A summary report of the ground-water situation in Montana with a chapter on Montana and the law on ground water, by Albert Stone: Montana Bureau of Mines and Geology Information Circular IC-26, 45 p.

[This report summarizes the extent of present (1958) knowledge regarding the ground-water resources of Montana. It presents some of the basic concepts of ground-water science; no attempt was made to present detailed scientific analysis of conditions in any particular area. The report

outlines basic information for legislators considering possible ground-water controls.]

_____1962a, Reconnaissance ground-water studies, Wheatland, eastern Meagher, and northern Sweet Grass Counties, Montana: Montana Bureau of Mines and Geology Special Publications 24, Ground-Water Report 1, 31 p.

[The text of this report is divided into two parts: the Wheatland basin and northern Sweet Grass County. The geography and principal aquifers of each area are described in detail. Geologic units discussed are the Kootenai Formation through the surficial deposits. Records for 168 wells and 3 springs are listed. Chemical analyses from three springs and one well are listed. A geologic map (revised from the Geologic Map of Montana) accompanies the report.]

_____1962b, Reconnaissance ground-water studies, northern Park County, Montana: Montana Bureau of Mines and Geology Special Publication 26, Ground-Water Report 2, 15 p.

[This report describes the geology of the area briefly in conjunction with a geologic map and table showing stratigraphic units and water-bearing properties. The principal aquifers are the Livingston Formation (Livingston Group), Pleistocene and Pliocene sediments, and alluvium. Hunter Hot Springs is discussed briefly. Records from 101 wells and 11 springs and chemical analyses of water from the springs also are presented.]

_____1965, Reconnaissance ground water and geological studies, western Meagher County, Montana: Montana Bureau of Mines and Geology Special Publication 35, Ground-Water Report 3, 23 p.

[This report resulted from a reconnaissance study to inventory the ground-water resource and to evaluate it in terms of potential use. The geology of the area is briefly described in conjunction with a geologic map and a table of stratigraphic units and their water-bearing properties. The principal aquifers are noted and described. Several springs are described individually with some discharge figures given. Tables containing data on 89 wells and analyses of major chemical constituents from 8 wells and springs are presented.]

Ground-water Subgroup, Water Work Group, Northern Great Plains Resources Program, 1974, Shallow ground water in selected areas in the Fort Union coal region: U.S. Geological Survey Open-File Report 74-371, 132 p.

[This report resulted from an investigation to describe briefly the occurrence of water in shallow aquifers (units overlying the Pierre Shale) in selected areas in the Fort Union coal region (Birney-Decker area in Montana, Gascoyne area in North Dakota, and Gillette area in Wyoming); to provide preliminary answers to questions posed by the Water Work Group regarding the impact of surface mining on those aquifers; and to formulate studies that would provide solutions to inferred problems.

The geologic and hydrologic setting for each area is discussed in conjunction with maps showing geology, potentiometric surface of ground water, direction of ground-water movement, and hydrographs of water levels in selected wells. Tables of selected wells and springs and chemical analyses of water are given.]

Hackett, O. M., Visher, F. N., McMurtrey, R. G., and Steinhilber, W. L., 1960, Geology and ground-water resources of the Gallatin Valley, Gallatin County, Montana, *with a section on* Surface-water resources, by Frank Stermitz and F. C. Boner, *and section on* Chemical quality of the water, by R. A. Krieger: U.S. Geological Survey Water-Supply Paper 1482, 282 p.

[This report was prepared to evaluate the total water resources of the Gallatin Valley. As part of the project about 775 wells were inventoried and pertinent data compiled in table format; monthly water-level measurements were collected for 123 wells; water-level recorders were installed on 12 wells for continuous water-level measurements; 14 rain gages were installed; 20 test holes were drilled; "single-well" aquifer tests were made at 4 sites; 103 samples of water for chemical analysis were collected from selected wells, springs, test holes, and streams, and reconnaissance geologic mapping was completed. The text is supported by maps showing geology; piezometric (potentiometric) surface of ground water; depth to water; chemical characteristics of ground water and surface water; locations of wells, test holes, stream-gaging stations, and precipitation stations; hydrographs; and surface-water resources. In addition about 60 drillers' logs are listed.]

Hall, G. M., and Howard, C. S., 1929, Ground water in Yellowstone and Treasure Counties, Montana: U.S. Geological Survey Water-Supply Paper 599, 118 p.

[This report describes geology in conjunction with a geologic map. Rock units and their water-bearing properties are described for units from the Madison Limestone (Madison Group) to the alluvium. Ground-water conditions are discussed in detail on a township basis. Water-quality data are presented in the discussion of each geologic unit as well as for the 101 sites listed in well tables.]

Hamilton, L. J., and Paulson, Q. F., 1968, Geology and ground-water resources of the lower Bighorn Valley, Montana: U.S. Geological Survey Water-Supply Paper 1876, 39 p.

[This report resulted from a study to investigate the geology and ground-water hydrology as they relate to the availability and quality of ground water for domestic and stock use and as they may affect drainage of presently irrigated land and lands proposed for irrigation. Data supporting the text include chemical analyses of water from 33 wells, specific-conductance values for 145 wells, hydrographs from 8 observation wells, and aquifer-test data from 5 wells penetrating alluvium. The text contains little discussion of geology but includes a geologic map of the valley.]

Hopkins, W. B., 1973, Water resources of the Northern Cheyenne Indian Reservation and adjacent area, southeastern Montana: U.S. Geological Survey Hydrologic Investigations Atlas HA-468, scale 1:125,000, 2 sheets.

[Sheet 1 includes a geohydrologic map showing altitude of water in the alluvium and Tongue River Member of the Fort Union Formation; summary of geologic formations and their water-bearing properties; precipitation graph; and geologic section across the Tongue River valley. Sheet 2 includes a map showing bar graphs of hardness and specific conductance; laboratory analyses of hardness, dissolved solids, and specific conductance; patterns representing concentrations of major cations and anions; chemical analyses of ground water from six sites; and a flow-duration curve, low-flow frequency curves, average monthly discharge, and chemical quality of water in the Tongue River.]

_____1976, Water-resources data for deep aquifers of eastern Montana: U.S. Geological Survey Water-Resources Investigations 76-40, 37 p.

[This report primarily describes the chemical quality of water from aquifers at depths greater than 1,500 ft. In December 1970, more than 30 oil fields were using water flooding at an estimated rate of 6,200 gal/min, with most of the water coming from the interval Fox Hills-lower Hell Creek aquifer to the Madison Group. Geologic formations and their water-bearing properties are identified. Several maps show diagrams of selected chemical analyses of water for different age rocks.]

Hopkins, W. B., and Taylor, O. J., 1963, Drainage and domestic water-supply investigations in Milk River unit, Blaine County, Montana: U.S. Geological Survey Open-File Report, 112 p.

[This report describes an area of about 30 mi^2 within the Milk River valley on the Fort Belknap Indian Reservation. The purpose of the investigation was to study and to determine alternatives for resolving the problem of water logging and salt deposition and to study the feasibility of individual wells or one central water supply for domestic use on the reservation. The area is underlain by unconsolidated rocks of Pleistocene(?) and Recent (Holocene) age, except for an outcrop of Judith River Formation in the eastern part. The general discussion is centered on the irrigation problems associated with the unconsolidated deposits. About 100 logs of piezometer test holes, wells, and seismic shot holes are included in tables. Information shown on maps includes piezometric (potentiometric) surface of water in the Milk River unit; locations of wells; locations of piezometers, test holes, seismic shot holes; and specific-conductance data.]

Hopkins, W. B., and Tilstra, J. R., 1966, Availability of ground water from the alluvium along the Missouri River in northeastern Montana: U.S. Geological Survey Hydrologic Investigations Atlas HA-224, scale 1:96,000.

[This report includes a map showing surficial geology, location of wells and test holes, geologic sections, and diagrams of chemical analyses

of ground water. A text supplement describes the geologic setting; occurrence, recharge, movement, and discharge of ground water; aquifer testing; and water quality. The report contains tables of aquifer-test data and chemical analyses.]

Konikow, L. F., 1976, Preliminary digital model of ground-water flow in the Madison Group, Powder River Basin and adjacent areas, Wyoming, Montana, South Dakota, North Dakota, and Nebraska: U.S. Geological Survey Water-Resources Investigations 63-75, 44 p.

[This report resulted from a study to provide preliminary quantitative descriptions of water flow in rocks of the Madison Group that could be used as input for, and guidance in, developing a plan for future investigations of the aquifer. The report describes in detail the development, calibration, and analysis of the digital simulation model of water flow in the Madison Group in and adjacent to the Powder River Basin. The model was the 1975 Trescott-Pinder version, which uses the strongly implicit procedure. The model was used to simulate existing steady-state flow.]

LaRocque, G. A., Jr., 1966, General availability of ground water and depth to water level in the Missouri River basin: U.S. Geological Survey Hydrologic Investigations Atlas HA-217, scale 1:2,500,000.

[This report consists of maps of the Missouri River basin showing generalized areas of ground-water availability in amounts of less than 50, 50-500, and more than 500 gal/min and depths to water level of less than 50, 50-100, 100-200, and more than 200 ft.]

Lewis, B. D., and Roberts, R. S., 1978, Geology and water-yielding characteristics of rocks of the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Miscellaneous Investigations Map I-847-D, scale 1:250,000, 2 sheets.

[Sheet 1 is a geologic map showing structure contours of the top of the Bearpaw Shale. A general description of each unit and its water-yielding characteristics are given in the description of map units. Sheet 2 contains text describing the geology, subsurface identification of geologic units, configuration of top of Bearpaw Shale, and thickness of units above the Bearpaw Shale. Five geologic sections are also shown.]

McMurtrey, R. G., and Reed, T. E., 1968, Water levels and artesian pressures in observation wells in Montana through 1967: Montana Bureau of Mines and Geology Bulletin 65, 40 p.

[This report presents the data collected from the State observation-well network. The locations of the observation wells are shown on maps; hydrographs for 8 wells and the description and water-level measurements for about 125 observation wells are included.]

Meinzer, E. O., 1927, Large springs in the United States: U.S. Geological Survey Water-Supply Paper 557, 94 p.

[This report describes large springs in the United States and establishes a classification based on average discharge. Four springs in Montana--Giant Springs, Lewistown Big Springs, Warm Spring, and Toston Big Spring--are described in detail.]

Miller, M. R., Bermel, W. M., Bergantino, R. N., Sonderegger, J. L., Norbeck, P. M., and Schmidt, F. A., 1977a, Compilation of hydrogeological data for southeastern Montana: Montana Bureau of Mines and Geology Open-File Report HY77-1, 295 p.

[This report is a compilation of selected ground-water data for southeastern Montana (45 to 47° N latitude and 104 to 108° W longitude). The data in the report are presented on page-size maps covering 30 minutes of latitude by 30 minutes of longitude. A series of maps showing geology, well-appropriation rating, total well depth, static water level, sodium-adsorption ratio, and dissolved solids are overlain on a topographic base map.]

_____1977b, Well appropriation data for southeastern Montana--Big Horn, Carter, Custer, Fallon, Powder River, Rosebud, and Treasure Counties: Montana Bureau of Mines and Geology Open-File Report HY77-2, 171 p.

[This report contains well-appropriation data on file with the Montana Bureau of Mines and Geology, an appendix listing geologic sources and codes, and an appendix listing licensed water-well contractors in Montana as of July 1977.]

Miller, W. R., 1976, Water in carbonate rocks of the Madison Group in southeastern Montana--A preliminary evaluation: U.S. Geological Survey Water-Supply Paper 2043, 51 p.

[This report identifies the sources and types of available data, summarizes selected geohydrological data, and briefly describes the methods and results of interpreting drill-stem tests and geophysical logs. Yield and recovery data and estimated transmissivities from 20 drill-stem tests are tabulated. Yields from supply wells and drill-stem tests also are tabulated. The text is supplemented by two plates showing the generalized potentiometric surface, dissolved-solids concentration, general chemical character of the water, configuration of the top of the Madison Group, generalized thickness of the Madison Group, and correlation sections of Mississippian rocks in southeastern Montana.]

_____1979a, Water resources of the central Powder River area of southeastern Montana: Montana Bureau of Mines and Geology Bulletin 108, 65 p.

[This report describes the occurrence, quantity, and chemical quality of the water resources of the central Powder River area in southeastern Montana. Geologic units described in detail are the Pierre Shale through

the terrace and alluvial deposits. Subsurface units are described in a table summarizing the stratigraphy and ground-water resources. Aquifer transmissivity values based on data from 14 wells and estimates of recharge and discharge for the Fox Hills-lower Hell Creek aquifer and alluvium are listed; chemical analyses for 22 wells and records of 131 wells are presented in table format. Maps show geology, structure contours of the base of the Fox Hills-lower Hell Creek aquifer, potentiometric surface of the Fox Hills-lower Hell Creek, and thickness of Fox Hills-lower Hell Creek aquifer. Geologic sections and geophysical log interpretation accompany the report.]

_____1979b, Water resources of the southern Powder River area of southeastern Montana: U.S. Geological Survey Open-File Report 79-343, 97 p.

[This report describes the occurrence, quantity, and chemical quality of the water resources. A generalized section describes the stratigraphy and ground-water resources for geologic units from the Precambrian rocks through the terrace and alluvial deposits. Transmissivities and storage coefficients for several aquifers; chemical analyses from 49 wells and 1 spring; records of 114 wells and 1 spring; and drillers' logs from 22 wells are presented. Maps show geology, configuration of the base of the Fox Hills-lower Hell Creek aquifer, thickness of the Fox Hills-lower Hell Creek aquifer, and potentiometric surface of the Fox Hills-lower Hell Creek aquifer. Surface-water data for several streamflow-gaging stations describe water-level fluctuation, flow duration, magnitude and frequency of annual low flow, and magnitude and frequency of floods.

Montana Water Resources Board, 1969a, Ground water in Montana: Montana Water Resources Board Inventory Service Report 16, 145 p.

[This report describes ground-water conditions for the State on an area-by-area basis. Most of the report describes unconsolidated aquifers. Well depth, depth to water, and yields of wells completed in bedrock aquifers are discussed in general terms.]

_____1969b, Groundwater inventory, Carbon County, Montana: Montana Water Resources Board Report, 40 p.

[This report resulted from a reconnaissance study of the ground-water availability for 1968; it describes areas where data are lacking or inadequate. The report has a brief section on the geology of all units overlying the basement rocks. The report includes a geologic map and a table of wells and springs yielding water from the interval Chugwater-Formation through the Madison Group. Chemical analyses of water from about 25 wells are given.]

Moulder, E. A., Klug, M. F., Morris, D. A., and Swenson, F. A., 1960, Geology and ground-water resources of the lower Little Bighorn River valley, Big Horn County, Montana, with special reference to the drainage of waterlogged lands, *with a section on* Chemical quality of the water by R. A. Krieger: U.S. Geological Survey Water-Supply Paper 1487, 223 p.

[This report resulted from a study to collect and interpret geologic and hydrologic data pertinent to the design and construction of proper drainage facilities on land that was irrigated or proposed for irrigation. A secondary purpose was to evaluate the present and potential development of the ground-water resources of the area. Pertinent data on about 200 wells, water-level measurements in about 180 wells, logs of about 250 jetted wells, test holes, and seismic shotholes, and drillers' logs of 10 wells completed in bedrock are listed. Maps show geology, piezometric (potentiometric) surface, depth to water, and chemical quality of water.]

Moulder, E. A., and Kohout, F. A., 1958, Ground-water factors affecting drainage in the First Division, Buffalo Rapids irrigation project, Prairie and Dawson Counties, Montana, *with a section on* Chemical quality of the water, by E. R. Jochens: U.S. Geological Survey Water-Supply Paper 1424, 198 p.

[This report primarily describes the ground-water problems in the unconsolidated deposits along the Yellowstone River. Geologic discussion is brief. Aquifer tests were conducted at 10 sites. Chemical analyses of 41 samples of ground and surface waters are presented. Logs of about 250 wells and test holes are given. Periodic water-level measurements in about 200 observation wells and well records of about 325 wells are listed.]

Moulder, E. A., Torrey, A. E., and Koopman, F. C., 1953, Ground-water factors affecting the drainage of Area IV, First Division, Buffalo Rapids irrigation project, Montana: U.S. Geological Survey Circular 198, 46 p.

[This report resulted from a study to collect and interpret the geologic and hydrologic data that are needed for the design and construction of proper drainage facilities on waterlogged land. The investigation, conducted in 1950, included the drilling of 85 test holes, of which 60 were cased for permanent use as water-level observation wells. The geologic description is limited to the Fort Union Formation, terrace deposits, and alluvium. Records of wells, logs of wells and test holes, measurements of depth to water in observation wells, and data for an aquifer test are listed.]

Osterkamp, W. R., 1968, Occurrence of ground water in the Judith River Formation, north-central Montana: U.S. Geological Survey Hydrologic Investigations Atlas HA-308, scale 1:250,000.

[This report briefly describes the relationship of geology to ground water. The report contains a well table of 114 wells; chemical analyses from 6 wells; a generalized stratigraphic section of the Montana Group; and a geologic map showing piezometric (potentiometric) surface of water in the Judith River Formation, structure contours on the top of the Judith River Formation, and two geologic sections.]

Perry, E. S., 1931, Ground water in eastern and central Montana: Montana Bureau of Mines and Geology Memoir 2, 59 p.

[This report extensively describes the principles of ground-water occurrence before describing the geology and water-bearing characteristics of most geologic units overlying the Madison Limestone (Madison Group). The text contains a generalized table of geologic formations in addition to numerous maps showing the areal extent of individual units. A short section of text describes the quality of ground water.]

_____1932a, Ground-water resources of Judith Basin, Montana: Montana Bureau of Mines and Geology Memoir 7, 30 p.

[This report resulted from a ground-water reconnaissance study made during the early 1930's. The geology, with respect to ground water, is discussed for the units from Cambrian rocks to the surface. Maps show geology and structure contours of the top of the Kootenai Formation. The chemical quality of ground water is described briefly and chemical analyses from two springs and seven wells are given. The water potential is described individually for most of the communities in the study area.]

_____1932b, Artesian wells as a source of water for the Winnett irrigation project, Montana: Montana Bureau of Mines and Geology Miscellaneous Contributions No. 1, 5 p.

[This report describes the potential for obtaining ground water to supplement surface water for irrigation. The water-bearing properties of formations from the Quadrant Formation through the Colorado Shale (Colorado Group) are described. A structure-contour map of the top of the Third Cat Creek sandstone for the area northwest of Winnett, Montana, is shown. Anticipated conditions for wells tapping either the Third Cat Creek sandstone or the Quadrant Formation at selected locations are discussed.]

_____1932c, Possibilities of ground-water supply for certain towns and cities of Montana: Montana Bureau of Mines and Geology Miscellaneous Contributions No. 2, 49 p.

[This report describes the potential for ground-water development at 74 cities and towns in Montana.]

_____1932d, Shallow wells near Terry, Montana, as a source of irrigation water: Montana Bureau of Mines and Geology Miscellaneous Contributions No. 3, 7 p.

[This report describes the potential for obtaining water from shallow terrace deposits along the Yellowstone River for irrigation. The discussion is general in nature.]

_____1932e, Artesian wells as a source of water for municipal supply at Fort Benton, Montana: Montana Bureau of Mines and Geology Miscellaneous Contributions No. 4, 7 p.

[This report indicates that the Sunburst Sandstone Member of the Kootenai Formation might be a source of water for Fort Benton. A structure-contour map of the top of the Kootenai Formation is shown for an area south of Fort Benton.]

_____1934, Geology and artesian water resources along Missouri and Milk Rivers in northeastern Montana: Montana Bureau of Mines and Geology Memoir 11, 35 p.

[This report describes the occurrence of ground water in a 13,800-mi^2 area with special emphasis on the principal water-yielding beds of the Judith River Formation. The area is divided into seven geographic districts and the geography, geology, and development of water wells are described. A geologic map at a scale of about 1:697,000 shows the locations of 94 water wells.]

_____1935, Geology and ground-water resources of southeastern Montana: Montana Bureau of Mines and Geology Memoir 14, 67 p.

[This report describes an area of about 17,000 mi^2 in southeastern Montana from near Sidney, Montana, to west of Forsyth, Montana. The stratigraphy and structural geology of southeastern Montana are described briefly (formation terminology is not current). Ground water is described in the text in general terms with respect to yield, water level, temperature, and natural gas concentrations. The chemical quality of the ground water is described in more detail and about 50 analyses are given. A more detailed description of the ground-water conditions on a geographical area basis is given in the text.]

Rediske, Tom, 1979, Trip Report--Alzada, Montana--In situ solution uranium mining, May 22-25, 1979: Montana Department of Natural Resources and Conservation Technical Report 79-TR-1, 49 p.

[This report resulted from a reconnaissance made to investigate allegations by local residents of the Alzada area that the activities of the uranium exploration companies were creating a potential for ground-water contamination, damaging existing wells, and violating existing water rights. Many violations observed by the author are documented in the report. A brief description of the geology and hydrology is presented. A detailed description of in situ leaching (solution mining) of uranium also is included.]

Reed, T. E., and McMurtrey, R. G., 1969, Water levels and artesian pressures in observation wells in Montana through 1968: Montana Bureau of Mines and Geology Bulletin 71, 30 p.

[This report presents the data collected from the State observation-well network. Maps showing the locations of observation wells, hydrographs for 8 wells, and a description and water-level measurements for about 150 observation wells are included.]

_____1970, Water levels and artesian pressures in observation wells in Montana, 1966-69: Montana Bureau of Mines and Geology Bulletin 76, 36 p.

[This report presents data collected from the State observation well network for 1966-69. Maps showing the locations of observation wells, hydrographs for 8 wells, and a description and water-level measurements for about 150 observation wells are included.]

Renick, B. C., 1929, Geology and ground-water resources of central and southern Rosebud County, Montana, with chemical analyses by H. B. Riffenberg: U.S. Geological Survey Water-Supply Paper 600, 140 p.

[This report describes the geology and includes a geologic map. Rock units and their water-bearing properties are described for units from the Kootenai Formation to the alluvium. Ground-water conditions are described in detail on a township basis. Chemical analyses of 123 sites are listed. No well tables are given; however, well data are included in the description of the ground water by township.]

Rioux, R. P., and Dodge, K. A., [1980], Hydrologic data from the Bull Mountains area, south-central Montana: U.S. Bureau of Land Management report, 146 p.

[This report contains data describing the ground water, surface water, and water quality. The report contains records for 337 wells and 117 springs; flow data for 7 streamflow-gaging stations, 13 crest-stage gages, 5 water-quality stations, and 5 miscellaneous sites; and water-quality data for 133 wells, 13 springs, 5 streamflow-gaging stations, 5 water-quality stations, and 5 miscellaneous sites. Locations of data-collection sites are shown on maps at a scale of 1:250,000.]

Roberts, R. S., 1980, Hydrogeologic data for selected coal areas, east-central Montana: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-329, 63 p.

[This report contains well records for 916 domestic, stock, public-supply, commercial, and test wells. Lithologic logs also are included for 149 wells. Chemical analyses of water samples from selected wells consist of 167 samples analyzed for major cations and anions and 24 samples analyzed for miscellaneous constituents. The locations of the wells are shown on a map at a scale of 1:250,000.]

Slagle, S. E., and Stimson, J. R., 1979, Hydrogeologic data from the northern Powder River Basin of southeastern Montana: U.S. Geological Survey Water-Resources Investigations Open-File Report 79-1332, 111 p.

[This report contains well records for 1,924 stock, domestic, irrigation, public-supply, industrial, and test wells. Lithologic logs of 373 wells and test holes also are included. Locations of the wells are shown on a map at a scale of 1:500,000.]

Swenson, F. A., 1955 [1956], Geology and ground-water resources of the Missouri River valley in northeastern Montana, *with a section on* The quality of the ground water, by W. H. Durum: U.S. Geological Survey Water-Supply Paper 1263, 128 p.

[This report describes an area 5 to 15 mi wide along the Missouri River between Nashua, Montana, and the Montana-North Dakota State line that has been proposed for irrigation under the Missouri River basin development plan. The report describes the bedrock aquifers, but mostly concentrates on the shallow alluvial deposits. The locations of wells and surfical geology are shown on maps. Records of wells, logs of wells and test holes, and water levels in observation wells are listed. Several hydrographs for shallow observation wells are shown.]

_____1957 [1958], Geology and ground-water resources of the lower Marias irrigation project, Montana, *with a section on* Chemical quality of the ground water, by H. A. Swenson: U.S. Geological Survey Water-Supply Paper 1460-B, p. 41-98.

[This report resulted from an investigation to obtain and interpret data on the occurrence and chemical quality of the ground water and to relate these data to the geology. Data were collected for 207 wells, 18 test holes were drilled in alluvium, 25 samples of water were collected for analysis, and water levels in 18 wells were measured periodically. These data and drillers' logs of 29 test holes and wells are tabulated. Units of Cretaceous age from the Colorado Shale (Colorado Group) through the Judith River Formation along with glacial deposits and alluvium are described. Maps showing the geology and location of wells, hydrographs of water levels in observation wells, and graphic logs of test holes drilled in the unconsolidated material accompany the report.]

Swenson, F. A., Miller, W. R., Hodson, W. G., and Visher, F. N., 1976, Maps showing configuration and thickness, and potentiometric surface and water quality in the Madison Group, Powder River Basin, Wyoming and Montana: U.S. Geological Survey Miscellaneous Investigations Map I-847-C, scale 1:1,000,000.

[This report consists of a series of maps showing configuration of the top of the Madison Group, generalized thickness of the Madison Group, preliminary potentiometric surface of water in the Madison Group, and dissolved-solids concentration in water from the Madison Group. The maps are supported by a brief text and a table of specific capacities of selected wells in the Madison Group.]

Taylor, O. J., 1965, Ground-water resources along Cedar Creek anticline in eastern Montana: Montana Bureau of Mines and Geology Memoir 40, 99 p.

[This report resulted from an investigation to determine and describe the hydrologic system and its operation, the chemical quality and suitability of the ground water for domestic and agricultural use, and the probable effects of present and proposed withdrawals from the system. Geologic units from the Pierre Shale through the Fort Union Formation are described

briefly. Values for transmissibility (transmissivity) and storage coefficient from about 30 aquifer tests are listed. The chemical quality of water is discussed and selected analyses are listed. Maps include geology, structure contours, location of water wells, and piezometric (potentiometric) surface of water in Fox Hills-Hell Creek aquifer. Depression-contour maps show the piezometric (potentiometric) surface of the Fox Hills-Hell Creek aquifer for 1968, 1973, and 1974.]

_____1968, Ground-water resources of the northern Powder River valley, southeastern Montana: Montana Bureau of Mines and Geology Bulletin 66, 34 p.

[This report describes the hydrologic system in terms of the following aquifers: Fox Hills Sandstone, Hell Creek Formation, Fort Union Formation, terrace deposits, and alluvium. An estimate of discharge from these units to the Yellowstone River, well records for 54 wells, transmissibility (transmissivity) and permeability (hydraulic conductivity) values for several wells tapping the Fox Hills-basal Hell Creek aquifer, piezometric (potentiometric)-surface contours for the Fox Hills-basal Hell Creek, and a structure-contour map of the base of the Fox Hills Sandstone are presented. Chemical analyses from 26 wells and the related discussion of water quality also are included.]

_____1978, Summary appraisals of the Nation's ground-water resources--Missouri Basin region: U.S. Geological Survey Professional Paper 813-Q, 41 p.

[This report describes the known occurrence and characteristics of the ground-water resources in the Missouri Basin region; indicates areas of the region in which hydrologic data and interpretative investigations of ground water are needed; indicates preliminary ways to broaden water management to include additional use of ground water; and explains proven methods for investigating and using ground-water supplies. The text is supported by numerous maps showing precipitation, evaporation, and geology. Tables present data on aquifer thickness, ground-water storage, well yield, and well location.]

Torrey, A. E., and Kohout, F. A., 1956, Geology and ground-water resources of the lower Yellowstone River valley, between Glendive and Sidney, Montana, *with a section on* Chemical quality of the water, by H. A. Swenson: U.S. Geological Survey Water-Supply Paper 1355, 92 p.

[This report resulted from a study, begun in 1949, to evaluate the recharge, discharge, storage, and direction of movement of ground water and to correlate these factors with existing and potential irrigation problems. A total of 359 wells completed in alluvium, terrace deposits, Fort Union Formation, Hell Creek Formation, and Fox Hills Sandstone were inventoried. Water levels in 211 wells were determined by periodic measurements, some continuing through 1952. Hydrographs for three wells completed in the terrace deposits are shown. Thirty analyses of ground and surface water are listed with accompanying discussion for each aquifer.]

Torrey, A. E., and Swenson, F. A., 1951, Ground-water resources of the lower Yellowstone River valley between Miles City and Glendive, Montana, *with a section on* The chemical quality of the water, by H. A. Swenson: U.S. Geological Survey Circular 93, 72 p.

[This report resulted from a reconnaissance study to collect data on ground water and to relate its occurrence to existing and proposed irrigation in the area. The Pierre Shale and overlying units are briefly described in the text. The chemical quality of ground water is described in detail with respect to individual aquifers. Methods to prevent waterlogging of land due to irrigation are described. Water-level measurements in about 90 shallow wells and records of about 265 wells are listed. A geologic map shows well locations.]

U.S. Geological Survey, 1975, Plan of study of the hydrology of the Madison Limestone and associated rocks in parts of Montana, Nebraska, North Dakota, South Dakota, and Wyoming: U.S. Geological Survey Open-File Report 75-631, 35 p.

[This report summarizes the present (1975) knowledge of the geohydrology of the Madison and associated rocks, identifies the need for additional data, and outlines a 5-year plan for a comprehensive study of the hydrology of these rocks.]

Van Lewen, M. C., and King, N. J., 1971, Prospects for developing stock-water supplies from wells in northeastern Garfield County, Montana: U.S. Geological Survey Water-Supply Paper 1999-F, 38 p.

[This report resulted from a reconnaissance study to determine the areal extent of the aquifers that can be reached at economic drilling depths; aquifer depth and thickness; the artesian rise, if any, in water level that might occur during drilling; and the general chemical character of the ground water. The geology of the units overlying the Bearpaw Shale and a generalized geologic section showing thickness, description, and water-yielding properties are described. Records for 83 wells, drillers' logs for 8 wells, and chemical analyses for 46 wells are listed. A map shows the geology, well and spring locations, and altitude of the base of the Fox Hills Sandstone.]

Van Voast, W. A., and Hedges, R. B., 1974, Hydrology of area of Westmoreland Resources tract III coal reserves near Sarpy Creek, southeastern Montana: Montana Bureau of Mines and Geology Open-File Report, 10 p.

[This report describes a hydrologic investigation begun in the Sarpy Creek area by the Montana Bureau of Mines and Geology. The geology and hydrology of the shallow aquifers (less than 600 ft below land surface) and the observation-well network (17 wells) are described. Tables include data for wells, quality of ground and surface water in the area, and hydrographs of observation wells. A map shows the potentiometric surface of water in the different aquifer zones.]

_____1975a, Hydrogeologic conditions and projections related to mining near Colstrip, southeastern Montana: Montana Bureau of Mines and Geology Bulletin 102, 43 p.

[This report presents a summary of hydrologic data and interpretations that have been generated in studies of the mining operations at the Rosebud Mine and Big Sky Mine since 1973. Records of wells and springs are listed. Hydrographs of several wells are shown as well as measurements on September 9, 1976, for all observation wells. The chemical analyses of ground water from wells and springs and observation wells are tabulated. Maps show geology, location of wells and springs, water-quality-sample locations and dissolved-solids concentrations, and piezometric (potentiometric) surface and ground-water flow patterns for the Rosebud coal aquifer.]

_____1975b, Hydrogeologic aspects of existing and proposed strip coal mines near Decker, southeastern Montana: Montana Bureau of Mines and Geology Bulletin 97, 31 p.

[This report describes hydrologic conditions near Decker, Montana, where a coal strip mine has been in operation since early 1972. The report describes the pre-mining hydrology, hydrology during the 3-year mining period, hydrology during future mining, and hydrology when mining operations have been completed. Data and interpretations are applied to the proposed ultimate area of the existing mine and the proposed East Decker and North Decker mines. Records of wells, chemical analyses of waters from wells, and water-level data from observation wells near Decker are listed. Plates show geologic sections, ground-water flow, the observation-well network, and water-level changes in selected wells.]

Zimmerman, E. A., 1956, Preliminary report on the geology and ground-water resources of parts of Musselshell and Golden Valley Counties, Montana, *with a section on* The Chemical quality of the water by R. H. Langford: Montana Bureau of Mines and Geology Information Circular 15, 13 p.

[This report resulted from an investigation to determine the occurrence and availability of the ground-water resources. A brief discussion of the geology is supported by a geologic map and a table showing stratigraphic units and their water-bearing properties. The principal aquifers are described briefly. Chemical quality is described briefly and is accompanied by a table of major chemical constituents for 20 wells.]

_____1960, Preliminary report on the geology and ground-water resources of northern Blaine County, Montana: Montana Bureau of Mines and Geology Bulletin 19, 19 p.

[This report resulted from an investigation to appraise the ground-water resources of northeastern Blaine County. The geologic discussion of the area is limited to those units that crop out, with the oldest being the Judith River Formation. A table gives the stratigraphic units and their water-bearing properties and a geologic map supports the text. The

chemical quality of the ground water is described and 18 analyses of ground water and surface water are listed.]

_____1962, Preliminary report on the geology and ground-water resources of southern Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 32, 23 p.

[This report resulted from an investigation to determine: (1) The character, thickness, and extent of water-bearing materials; (2) the source, occurrence, and direction of movement of the ground water; and (3) the quantity and availability of the ground water. The geologic discussion describes units from the Madison Limestone (Madison Group) through the alluvium. A geologic map and table showing stratigraphic units and their water-bearing characteristics accompany the text. Records of 67 wells are listed.]

_____1964, Geology and water resources of the Bluewater Springs area, Carbon County, Montana: U.S. Geological Survey Water-Supply Paper 1779-J, p. J1-J24.

[This report assesses the availability of water for a large fish-rearing station. Geologic units from the Madison Limestone (Madison Group) through the Colorado Group and tufa of Quaternary age are discussed in detail. A geologic map of the area accompanies the report. Water-quality analyses from several springs and one well are described. Records for 1 well and 20 springs are listed.]

_____1966a, Geology and ground-water resources of western and southern parts of Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 50-A, 33 p.

[This report describes the following geologic units and their water-bearing properties: Madison Group, Big Snowy Group, Amsden Formation (Amsden Group), Ellis Group, Morrison Formation, Kootenai Formation, Colorado Shale (Colorado Group), Telegraph Creek Formation, Eagle Sandstone, Claggett Shale, Judith River Formation, intrusive rocks, extrusive rocks, terrace deposits, and alluvium. Flow-recovery test data for 5 wells in the Kootenai Formation are shown and 40 chemical analyses for ground and surface water are listed. Maps show location of wells, springs, test holes, oil-test holes, piezometric (potentiometric) surface in the Kootenai Formation, and geology.]

_____1966b, Basic water data report No. 2, western and southern parts of Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 50-B, 40 p.

[This report contains the basic data--including water levels in observation wells; logs of wells, oil-test holes, and test holes; records of wells and springs; and temperature and specific conductance of water from wells and springs--for the preceding reference.]

_____1967, Water resources of the Cut Bank area, Glacier and Toole Counties, Montana: Montana Bureau of Mines and Geology Bulletin 60, 37 p.

[This report describes the quantity of water available from surface and ground-water sources; the character, thickness, and areal extent of the principal water-bearing formations (Virgelle Sandstone and Two Medicine Formation); the source, occurrence, and direction of movement of ground water; the present and potential development of the water resources; and the chemical quality of the water. The ground-water section describes the geologic units, transmissibility (transmissivity) for five aquifer tests, hydrographs for six wells, and estimates of pumpage. Tables of records of wells and springs, measurements of water levels in 21 wells, drillers' logs for 24 wells, and chemical analyses for 76 wells supplement the text. Maps show geology and structure of the study area, location of wells and springs, contours on the piezometric (potentiometric) surface of water in the Virgelle Sandstone, and chemical quality of water.]

 (page 71 follows)

Alverson, D. C., 1965, Geology and hydrology of the Fort Belknap Indian Reservation, Montana: U.S. Geological Survey Water-Supply Paper 1576-F, p F1-F59.

[This report resulted from a reconnaissance study to determine the potential for obtaining adequate supplies of ground water of good quality for domestic and stock-watering purposes and to examine the extensive gravel terraces and other formations around the north flank of the Little Rocky Mountains as possible sources of irrigation water. Water chemistry information is limited to generalizations on chemical quality in the table describing rock units and their water-bearing properties.]

Blankennagel, R. K., Howells, L. W., Miller, W. R., and Hansen, C. V., 1979, Preliminary data for Madison Limestone test well 3, NW1/4SE1/4 sec. 35, T. 2 N., R. 27 E., Yellowstone County, Montana: U.S. Geological Survey Open-File Report 79-745, 186 p.

[This report provides the preliminary data for the Madison Limestone (Madison Group) test well 3 including test-well history, geology penetrated by the test well, hydrologic testing, and geochemistry. Ten chemical analyses of water samples are tabulated: three pre-Mississippian zones; one Mississippian and pre-Mississippian composite zone; one each from the lower and middle parts of the Mission Canyon Limestone (Madison Group); three from the upper part of the Mission Canyon; and one from the Amsden Group and Tensleep Sandstone composite zone: These analyses also are depicted as Stiff diagrams.]

Brown, D. L., Blankennagel, R. K., Busby, J. F., and Lee, R. W., 1977, Preliminary data for Madison Limestone test well No. 2, SE1/4SE1/4 sec. 18, T. 1 N., R. 54 E., Custer County, Montana: U.S. Geological Survey Open-File Report 77-863, 135 p.

[This report provides the preliminary data for the Madison Limestone (Madison Group) test well 2 including test-well history, geology penetrated by the test well, hydrologic testing, and geochemistry. Seven analyses are tabulated including samples of formation water from three pre-Mississippian zones, one Mississippian-pre-Mississippian composite zone, the Mission Canyon Limestone, the Minnelusa Sandstone, and the Lakota Sandstone.]

Crawford, J. G., 1942, Oil-field waters of Montana Plains: American Association of Petroleum Geologists Bulletin, v. 26, no. 8, p. 1317-1374.

[This report contains 279 tabulated chemical analyses from the following oil and gas producing zones: Madison Group (18), Tensleep Formation (5), Quadrant Formation (10), Ellis Group (49), Cloverly Formation equivalent (10), Kootenai Formation (79), Colorado Shale (Colorado Group) (34), and Montana Group (74). In addition chemical constituent diagrams are presented. The characteristics of some of the producing zones are indicated.]

Custer, S. G., 1976, Ground-water salinization in dryland farm areas of Montana (near Rapelje): Missoula, Montana, University of Montana, Ph. D. dissertation, 214 p.

[This report resulted from an investigation to characterize the geology and geochemistry of Upper Cretaceous to Quaternary rocks for an area of about 100 mi^2. Six chemical analyses are included and geochemical data from Montana Bureau of Mines and Geology files are analyzed. Reactions of pyrite and gypsum, ion exchange on clay minerals, and sulfate reduction are described.]

Dockins, W. S., Olson, G. J., McFeters, G. A., Turbak, S. C., and Lee, R. W., 1980, Sulfate reduction in ground water of southeastern Montana: U.S. Geological Survey Water-Resources Investigations 80-9, 13 p.

[This report resulted from an investigation of ground water from 26 selected sites to determine if sulfate reduction was bacterially mediated. Bacteria were detected at all but one site, whereas sulfate reduction was observed in only one sample.]

Ellis, A. J., and Meinzer, O. E., 1924, Ground water in Musselshell and Golden Valley Counties, Montana: U.S. Geological Survey Water-Supply Paper 518, 92 p.

[This report resulted from a ground-water study encompassing an area of about 1,000 mi^2 in the vicinity of Roundup and contains tables of 51 analyses of water from Musselshell and Golden Valley Counties and vicinity. A township-by-township description of water supply, geology, and water quality is given. The number of water-quality analyses for each geologic source include Kootenai Formation (1), Colorado Shale (Colorado Group) (2), Eagle Sandstone (6), Judith River Formation (3), Bearpaw Shale (6), Lance Formation equivalent (9), Fort Union Formation (2), alluvium (1), and unknown (22). In addition, 10 analyses of water from the Musselshell River are tabulated.]

Feder, G. L., Lee, R. W., Busby, J. F., and Saindon, L. G., 1977, Geochemistry of ground waters in the Powder River coal region *in* 4th Annual Progress Report in Geochemical Survey of the Western Energy Regions: U.S. Geological Survey Open-File Report 77-872, p. 173-179.

[This report contains 20 ground-water chemical analyses including trace elements and radiochemical determinations from the northern part of the Powder River Basin. Statistical analysis of variance of the parameters is also shown.]

Feltis, R. D., 1973, Geology and water resources of eastern part of Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 87, 51 p.

[This report resulted from a study to sample 61 wells and springs in an area of about 850 mi^2. Aquifers sampled include most of the units from the Madison Group to terrace deposits. Seventy-three water samples

have been analyzed and are tabulated. The chemical quality of water is described under two topics: domestic and irrigation use. A geochemical map with Stiff diagrams also is presented.]

_____1977, Geology and water resources of northern part of Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 101, 65 p.

[This report resulted from a study to collect and analyze water samples from 38 wells, springs, and drains and 24 surface-water sites in an area of about 650 mi^2. Aquifers studied ranged from the Madison Group to the Eagle Sandstone as well as terrace deposits and alluvium. Discussion of ground-water quality by aquifer is supported by a geochemical map with Stiff diagrams.]

_____1979, Water resources of shallow aquifers in the upper Poplar River basin, northeastern Montana: U.S. Geological Survey Water-Resources Investigations 79-51, 23 p.

[This report describes: (1) The occurrence and movement of ground water, (2) the extent of interchange between ground water and surface water, and (3) the chemical quality of the water. Aquifers discussed are the Fox Hills-Hell Creek aquifer, Fort Union Formation, sand and gravel of glacial deposits, Wiota Gravel, Flaxville Formation, and alluvium. Twenty-one analyses of ground-water samples and 12 analyses of surface-water samples are tabulated. A map showing diagrams of selected chemical analyses augments discussion of chemical quality in the text.]

_____1980, Water resources of the Judith River Basin, central Montana: Montana Bureau of Mines and Geology Hydrogeologic Map 1, 3 sheets.

[This report presents the results of a study to plan the use and conservation of ground-water resources of the area. Sheet 1 contains a table of generalized stratigraphy and water-bearing properties of principal aquifers giving general water-quality statements for each aquifer. In addition, Sheet 1 contains a map showing Stiff diagrams of selected water samples from wells producing water from the Madison Group and a discussion of interaquifer water chemistry. Sheet 2 contains maps showing diagrams of selected chemical analyses of water samples from several non-Madison aquifers and surface-water sources.]

Fisher, C. A., 1909, Geology and water resources of the Great Falls Region, Montana: U.S. Geological Survey Water-Supply Paper 221, 89 p.

[This report contains onsite chemical analyses of water samples from 79 wells and springs in an area of about 3,600 mi^2.]

Fox, R. D., 1966, Geology and ground-water resources of the Cascade-Ulm area, Montana: Montana Bureau of Mines and Geology Bulletin 52, 64 p.

[This report resulted from an investigation to determine the potential sources and availability of ground water in a 415-mi^2 area. The princi-

pal aquifers -- Kootenai Formation, Virgelle Sandstone Member of the Eagle Sandstone, and Flood Member of the Blackleaf Formation -- are described in detail. Analyses of major chemical constituents from seven wells and springs are presented.]

Gosling, A. W., and Pashley, E. F., Jr., 1973, Water resources of the Yellowstone River valley, Billings to Park City, Montana: U.S. Geological Survey Hydrologic Investigations Atlas HA-454, scale 1:48,000, 2 sheets.

[This report resulted from an investigation of water resources along the Yellowstone River to determine the adequacy and suitability of the water supply for the projected growth of the greater Billings area. Sheet 1 contains a table indicating the geologic units and their water-bearing characteristics with general statements on water quality of the Cloverly Formation equivalent through the river-channel alluvium. Sheet 2 contains a table of water-quality analyses for 2 wells and averages for 20 samples. Record maximum and minimum concentrations of standard chemical parameters as well as annual range and average value of chemical constituents also are tabulated for the Yellowstone River.]

Groff, S. L., 1962a, Reconnaissance ground-water studies, Wheatland, eastern Meagher, and northern Sweet Grass Counties, Montana: Montana Bureau of Mines and Geology Special Publications 24, Ground-Water Report 1, 31 p.

[The text of this report is divided into two parts: the Wheatland basin and northern Sweet Grass County. Geologic units described are Kootenai Formation through surficial deposits. Chemical analyses from three springs and one well are listed.]

_____1962b, Reconnaissance ground-water studies, northern Park County, Montana: Montana Bureau of Mines and Geology Special Publication 26, Ground-Water Report 2, 15 p.

[This report describes the geology of the area briefly in conjunction with a geologic map and table showing stratigraphic units and water-bearing properties. The principal aquifers are the Livingston Formation (Livingston Group), sediments of Pleistocene and Pliocene age, and alluvium. Hunter and Clyde Park Hot Springs are discussed briefly. Chemical analyses of water from 11 springs are tabulated.]

_____1965, Reconnaissance ground water and geological studies, western Meagher County, Montana: Montana Bureau of Mines and Geology Special Publication 35, Ground-Water Report 3, 23 p.

[This report resulted from a reconnaissance study to inventory the ground-water resource and to evaluate it in terms of potential use. The geology of the area is briefly described in conjunction with a geologic map and a table of stratigraphic units and their water-bearing properties. A table containing chemical analyses of water from nine wells and springs is presented.]

Ground-Water Subgroup, Water Work Group, Northern Great Plains Resources Program, 1974, Shallow ground water in selected areas in the Fort Union coal region: U.S. Geological Survey Open-File Report 74-371, 132 p.

[This report resulted from an investigation to describe briefly the occurrence of water in shallow aquifers (units overlying the Pierre Shale) in selected areas in the Fort Union coal region (Birney-Decker area in Montana, Gascoyne area in North Dakota, and Gillette area in Wyoming); to provide preliminary answers to questions posed by the Water Work Group regarding the impact of surface mining on those aquifers; and to formulate studies that would provide solutions to inferred problems. A table describing the hydrologic setting of subareas contains general statements about water quality in the aquifers of the Birney-Decker area of Montana. A table of chemical analyses of water from 74 wells and springs in the Birney-Decker area also is given. Similar information is given for the Powder River Basin of Wyoming and the Gascoyne area of North Dakota.]

Hall, G. M., and Howard, C. S., 1929, Ground water in Yellowstone and Treasure Counties, Montana: U.S. Geological Survey Water-Supply Paper 599, 118 p.

[This report contains chemical analyses of water from 97 wells in Yellowstone and Treasure Counties. Descriptions of water quality are given for water occurring in the Madison Group, Amsden Group, Tensleep Formation, Chugwater Formation, Sundance Formation, Morrison Formation, Cloverly Group (Cloverly Formation equivalent), Colorado Shale (Colorado Group), Telegraph Creek Formation, Eagle Sandstone, Claggett Shale, Judith Formation, Bearpaw Shale, Lennep Formation (Fox Hills Sandstone), Lance Formation equivalent, and alluvium. Water quality is described by township.]

Hamilton, L. J., and Paulson, Q. F., 1968, Geology and ground-water resources of the lower Bighorn Valley, Montana: U.S. Geological Survey Water-Supply Paper 1876, 39 p.

[This report contains chemical analyses of water from 33 wells -- 6 penetrating bedrock and 27 penetrating alluvium -- along the Bighorn River from Yellowtail Dam to its confluence with the Yellowstone River. Aquifers include Madison Limestone (Madison Group), Amsden Group, Cloverly Group (Cloverly Formation equivalent), Bearpaw Shale, and Hell Creek Formation. Description of water quality in the text and tables is augmented by chemical-constituent diagrams on a map.]

Hopkins, W. B., 1973, Water resources of the Northern Cheyenne Indian Reservation and adjacent area, southeastern Montana: U.S. Geological Survey Hydrologic Investigations Atlas HA-468, scale 1:125,000, 2 sheets.

[This report presents water-quality data in the form of Stiff diagrams and histograms of hardness and specific conductance for wells and springs from Muddy Sandstone, Hell Creek Formation, Tongue River Member of Fort Union Formation, clinker, and alluvium for about 2,500 mi^2. Representative analyses are tabulated for each aquifer.]

_____1976, Water-resources data for deep aquifers of eastern Montana: U.S. Geological Survey Water-Resources Investigations 76-40, 37 p.

[This report contains 212 chemical analyses of water from wells in an area of about 70,000 mi^2. Ninety-three water analyses from Mississippian aquifers, 52 from Pennsylvanian aquifers, and 67 from Cretaceous aquifers are tabulated. Maps show selected Stiff diagrams for water samples from rocks of Mississippian, Pennsylvanian, and Cretaceous age.]

Hopkins, W. B., and Tilstra, J. R., 1966, Availability of ground water from the alluvium along the Missouri River in northeastern Montana: U.S. Geological Survey Hydrologic Investigations Atlas HA-224, scale 1:96,000.

[This report is the result of an investigation to determine the feasibility of obtaining as much as 2 ft^3/s of ground water suitable for irrigation, industrial, or municipal uses from individual wells along the Missouri River between the confluence of the Milk River and the State boundary. In addition to geologic and hydrologic data, chemical analyses of water from 73 alluvial wells adjacent to the Missouri River and 5 surface-water sites are tabulated. Chemical-constituent diagrams also are presented on a map showing surficial geology, location of wells and test holes, and cross sections.]

Lee, R. W., 1979, Ground-water-quality data from the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Open-File Report 79-1331, 55 p.

[This report contains 667 standard chemical analyses and 65 trace-element and radiochemical analyses of water samples from the Fox Hills-lower Hell Creek aquifer, coal spoil banks, and alluvium.]

_____1980, Geochemistry of water in the Fort Union Formation of the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-336, 17 p.

[This report contains ground-water data for a 10,000-mi^2 area and describes cation exchange, pyrite oxidation, and gypsum dissolution processes thought to control ground-water quality. It also describes changes in water quality as related to numerous local geochemical cells. The mean values of chemical-constituent concentrations are presented for springs, water from wells less than 200 ft deep, and water from wells greater than 200 ft deep. In addition, changes in water chemistry are depicted in several flow-path diagrams.]

Miller, M. R., Bermel, W. M., Bergantino, R. N., Sonderegger, J. L., Norbeck, P. M., and Schmidt, F. A., 1977, Compilation of hydrogeological data for southeastern Montana: Montana Bureau of Mines and Geology Open-File Report HY77-1, 295 p.

[This report presents ground-water data for southeastern Montana (about 28,000 mi^2) as a series of overlays on a 1:250,000 base map. Chemical

overlays of sodium-adsorption ratio and dissolved-solids concentrations are shown for unnamed aquifers, pre-Judith River Formation, Judith River Formation, Fox Hills-lower Hell Creek aquifer, and deposits of Quaternary age.]

Miller, W. R., 1976, Water in carbonate rocks of the Madison Group in southeastern Montana--A preliminary evaluation: U.S. Geological Survey Water-Supply Paper 2043, 51 p.

[This report identifies the sources and types of available data, summarizes selected geohydrological data, and briefly describes the methods and results of interpreting drill-stem tests and geophysical logs. A brief section of text on water quality is supplemented by two maps showing dissolved-solids concentration and general chemical character of the water.]

_____1979a, Water resources of the central Powder River area of southeastern Montana: Montana Bureau of Mines and Geology Bulletin 108, 65 p.

[This report describes the occurrence, quantity, and chemical quality of the water resources of the central Powder River area in southeastern Montana. Geologic units described in detail are the Pierre Shale through the terrace and alluvial deposits. Chemical analyses of water from 22 wells are presented in table format.]

_____1979b, Water resources of the southern Powder River area of southeastern Montana: U.S. Geological Survey Open-File Report 79-343, 97 p.

[This report describes the occurrence, quantity, and chemical quality of the water resources. A generalized section describes the stratigraphy and ground-water resources for geologic units from the Precambrian rocks through the terrace and alluvial deposits. Chemical analyses of water from 49 wells and 1 spring are presented.]

Montana Water Resources Board, 1969b, Groundwater inventory, Carbon County, Montana: Montana Water Resources Board Report, 40 p.

[This report has resulted from a reconnaissance study of the ground-water availability in 1968; it describes areas where data are lacking or inadequate. Geologic units include the Madison Group through the Chugwater Formation. Chemical analyses of water from 30 wells and 2 surface-water sites are given.]

Moulder, E. A., Klug, M. F., Morris, D. A., and Swenson, F. A., 1960, Geology and ground-water resources of the lower Little Bighorn River valley, Big Horn County, Montana, with special reference to the drainage of waterlogged lands, *with a section on* Chemical quality of the water, by R. A. Krieger: U.S. Geological Survey Water-Supply Paper 1487, 223 p.

[This report presents chemical analyses from 53 wells. Water samples from the Cloverly Group (Cloverly Formation equivalent), Parkman Sand-

stone, Claggett Shale, and alluvium along the Little Bighorn River were analyzed.]

Moulder, E. A., and Kohout, F. A., 1958, Ground-water factors affecting drainage in the First Division, Buffalo Rapids irrigation project, Prairie and Dawson Counties, Montana, *with a section on* Chemical quality of the water, by E. R. Jochens: U.S. Geological Survey Water-Supply Paper 1424, 198 p.

[This report contains 39 chemical analyses of water from 27 wells and springs in unconsolidated material, 5 wells in bedrock aquifers, and 7 composite wells.]

Osterkamp, W. R., 1968, Occurrence of ground water in the Judith River Formation, north-central Montana: U.S. Geological Survey Hydrologic Investgations Atlas HA-308, scale 1:250,000.

[This report includes chemical analyses from six wells penetrating the Judith River Formation in north-central Montana.]

Perry, E. S., 1931, Ground water in eastern and central Montana: Montana Bureau of Mines and Geology Memoir 2, 59 p.

[This report extensively describes the principles of ground-water occurrence before describing the geology and water-bearing characteristics of most geologic units overlying the Madison Limestone (Madison Group). A brief section of text describes the quality of ground water.]

_____1932, Ground-water resources of Judith Basin, Montana: Montana Bureau of Mines and Geology Memoir 7, 30 p.

[This report includes 10 chemical analyses from artesian wells and springs. The sources of water are Madison Formation (Madison Group), Quadrant Formation, Kootenai Formation, Colorado Shale (Colorado Group), and terrace deposits.]

_____1934, Geology and artesian water resources along Missouri and Milk Rivers in northeastern Montana: Montana Bureau of Mines and Geology Memoir 11, 35 p.

[This report contains chemical analyses of water from 37 wells, springs, and 2 surface-water sites. The description of chemical quality in the text is supported by a map showing characteristic types of water in the Judith River Formation.]

_____1935, Geology and ground-water resources of southeastern Montana: Montana Bureau of Mines and Geology Memoir 14, 67 p.

[This report resulted from a study of about 17,000 mi^2 of the northern part of the Powder River Basin and a contiguous area north of the Yellowstone River. The report contains 50 selected chemical analyses of water from the Judith River Formation and overlying aquifers. Five samples were analyzed for gases.]

Renick, B. C., 1924a, Base exchange in ground water by silicates as illustrated in Montana: U.S. Geological Survey Water-Supply Paper 520-D, p. 53-72.

[This report resulted from a study of part of Rosebud County around Forsyth, Montana. Thirty water analyses are displayed as Collins diagrams. Mineral descriptions and water chemistry are described for waters from the Fort Union Formation and Lance Formation equivalent.]

_____1924b, Some geochemical relations of ground water and associated natural gas in the Lance Formation, Montana: Journal of Geology, v. 32, p. 668-684.

[This report contains chemical and gas analyses of water samples from 10 artesian wells.]

_____1929, Geology and ground-water resources of central and southern Rosebud County, Montana, with chemical analyses by H. G. Riffenberg: U.S. Geological Survey Water-Supply Paper 600, 140 p.

[This report presents gas analyses for 10 wells from the Lance Formation equivalent. Chemical analyses are presented for soluble constituents from rocks and soils of the area.]

Riffenburg, H. B., 1926, Chemical character of ground waters of the Northern Great Plains: U.S. Geological Survey Water-Supply Paper 560-B, p. 31-52.

[This report presents ground-water-quality data from the northern Great Plains four-State province. Included are interpretations of analyses previously published, 400 previously unpublished complete analyses, and 700 previously unpublished partial analyses. The report contains 7 analyses from the "Dakota" and Lower Cretaceous and 10 from the Fort Union Formation and Lance Formation equivalent in Montana and North Dakota. Average, maximum, and minimum values are given for: 57 analyses (sodium, bicarbonate, sulfate, chloride) from the "Dakota" and Lower Cretaceous, 83 analyses (sodium, sulfate, bicarbonate) from the Montana Group, and 118 analyses (sodium, bicarbonate, sulfate) from the Fort Union Formation and Lance Formation equivalent. Some rainwater-quality data are given and the results of leach tests performed on the Lance Formation equivalent, Eagle Sandstone, and Fort Union Formation are shown. Evaporation, base exchange, adsorption, sulfate reduction by bacteria or carbonaceous material, and mixing are all described as possible mechanisms affecting water chemistry.]

Rioux, R. P., and Dodge, K. A., [1980], Hydrologic data from the Bull Mountains area, south-central Montana: U.S. Bureau of Land Management report, 146 p.

[This report presents the results of a well inventory and analysis of water-quality samples from selected wells in this area of potential coal mining. Analyses are tabulated for 133 wells and 13 springs. In addition, water-quality analyses are tabulated for 14 surface-water sites. Maps show locations of well and spring sampling sites.]

Roberts, R. S., 1980, Hydrogeologic data for selected coal areas, east-central Montana: U.S. Geological Survey Water-Resources Investigations Open-File Report 80-329, 63 p.

[This report contains well records for 916 domestic, stock, public-supply, commercial, and test wells. Chemical analyses are shown for water samples from selected wells: 167 analyses for major cations and anions and 24 analyses for miscellaneous constituents. The locations of the wells are shown on a map at a scale of 1:250,000.]

Swenson, F. A., 1955 [1956], Geology and ground-water resources of the Missouri River valley in northeastern Montana, *with a section on* The quality of the ground water, by W. H. Durum: U.S. Geological Survey Water-Supply Paper 1263, 128 p.

[This report contains analyses of water from the following units: Judith River Formation (4), Hell Creek Formation (1), Hell Creek Formation/Fort Union Formation (3), Fort Union Formation (3) and alluvium (11).]

_____1957 [1958], Geology and ground-water resources of the lower Marias irrigation project, Montana, *with a section on* Chemical quality of the ground water, by H. A. Swenson: U.S. Geological Survey Water-Supply Paper 1460-B, p. 41-98.

[This report resulted from an investigation to obtain and interpret data on the occurrence and chemical quality of the ground water and to relate these data to the geology. Twenty-five water samples were analyzed and are tabulated by geologic unit: 13 in the Virgelle Sandstone Member of the Eagle Sandstone, 1 in the upper member of the Eagle Sandstone, 1 in the Judith River Formation, and 10 in Quaternary deposits. In addition, selected analyses are presented as chemical-constituent diagrams and a map showing increases in dissolved-solids concentration in the Virgelle Sandstone Member of the Eagle Sandstone.]

Swenson, F. A., Miller, W. R., Hodson, W. G., and Visher, F. N., 1976, Maps quality in the Madison Group, Powder River Basin, Wyoming and Montana: U.S. Geological Survey Miscellaneous Investigations Map I-847-C, scale 1:1,000,000.

[This report consists of a series of maps showing configuration of the top of the Madison Group, generalized thickness of the Madison Group, preliminary potentiometric surface of water from the Madison Group, and dissolved-solids concentration of water from the Madison Group. The maps are supported by a brief text.]

Taylor, O. J., 1965, Ground-water resources along Cedar Creek anticline in eastern Montana: Montana Bureau of Mines and Geology Memoir 40, 99 p.

[This report resulted from an investigation to determine and describe the hydrologic system and its operation, the chemical quality and suitability of the ground water for domestic and agricultural use, and the probable effects of present and proposed withdrawls from the system. Geologic

units from the Pierre Shale through the Fort Union Formation are described briefly. The chemical quality of water is described and 26 analyses are listed.]

_____1968, Ground-water resources of the northern Powder River valley, southeastern Montana: Montana Bureau of Mines and Geology Bulletin 66, 34 p.

[This report describes the hydrologic system in terms of the following aquifers: Fox Hills Sandstone, Hell Creek Formation, Fort Union Formation, terrace deposits, and alluvium. Chemical analyses of water from 26 wells and the related discussion of water quality are included. In addition, four analyses are shown for gases from the Fox Hills-basal Hell Creek aquifer.]

_____1978, Summary appraisals of the Nation's ground-water resources--Missouri Basin region: U.S. Geological Survey Professional Paper 813-Q, 41 p.

[This report describes the known occurrence and characteristics of the ground-water resources in the Missouri Basin region; indicates areas of the region in which hydrologic data and interpretive investigations of ground water are needed; indicates preliminary ways to broaden water management to include fuller use of ground water; and explains proven methods for investigating and utilizing ground-water supplies. The text briefly describes saline-water uses and gives general maximums of dissolved-solids concentrations.]

Thorstenson, D. C., Fisher, D. W., and Croft, M. G., 1979, The geochemistry of the Fox Hills-basal Hell Creek aquifer in southwestern North Dakota and northwestern South Dakota [and Montana]: Water Resources Research, v. 15, no. 6, p. 1479-1498.

[This report resulted from a study to identify: (1) The processes that produce large concentrations of alkalinity in ground water in the recharge area just northeast of the Cedar Creek anticline and (2) redox reactions responsible for downgradient changes in the study area to the east. Selected standard and trace-element analyses are presented for nine areas and generalized chemical-constituent diagrams illustrate water types and downgradient changes. The text describes various chemical reactions and model simulations as the ground water moves along assumed flow paths from areas of recharge to areas of discharge.]

Torrey, A. E., and Kohout, F. A., 1956, Geology and ground-water resources of the lower Yellowstone River valley, between Glendive and Sidney, Montana, *with a section on* Chemical quality of the water, by H. A. Swenson: U.S. Geological Survey Water-Supply Paper 1355, 92 p.

[This report resulted from a study, begun in 1949, to evaluate the recharge, discharge, storage, and direction of movement of ground water and to correlate these factors with present and potential irrigation problems. A total of 359 wells completed in Fox Hills Sandstone, Hell Creek Formation, Fort Union Formation, terrace deposits, and alluvium were inventor-

ied. Thirty analyses of ground and surface waters are listed, with accompanying discussion for each aquifer.]

Torrey, A. E., and Swenson, F. A., 1951, Ground-water resources of the lower Yellowstone River valley between Miles City and Glendive, Montana, *with a section on* Chemical quality of the water, by H. A. Swenson: U.S. Geological Survey Circular 93, 72 p.

[This report resulted from a reconnaissance study to collect data on ground water and to relate its occurrence to present and proposed irrigation in the area. The Pierre Shale and overlying units are briefly described in the text. The chemical quality of ground water is described in detail with respect to individual aquifers. Analyses of water samples from 17 wells, 3 seeps, 3 drains, and 2 sites on the Yellowstone River are tabulated. In additon, a trilinear diagram and selected chemical-constituent diagrams are presented.]

Van Lewen, M. C., and King, N. J., 1971, Prospects for developing stock-water supplies from wells in northeastern Garfield County, Montana: U.S. Geological Survey Water-Supply Paper 1999-F, 38 p.

[This report resulted from a reconnaissance study to determine the areal extent of the aquifers that can be reached at economic drilling depths; aquifer depth and thickness; the artesian rise, if any, in water level that might occur during drilling; and the general chemical character of the ground water. The units discussed are those overlying the Bearpaw Shale. Chemical analyses for 46 wells are listed.]

Van Voast, W. A., 1974, Hydrologic effects of strip coal mining in southeastern Montana--emphasis: one year of mining near Decker: Montana Bureau of Mines and Geology Bulletin 93, 24 p.

[This report briefly describes the hydrogeology of the Decker area and the changes occurring after 1 year of strip mining coal. The study involves the Tongue River Member of the Fort Union Formation. Chemical analyses of water are presented for eight wells, six mine-effluent sites, and four surface-water sites upstream from the mine.]

Van Voast, W. A., and Hedges, R. B., 1974, Hydrology of area of Westmoreland Resources tract III coal reserves near Sarpy Creek, southeastern Montana: Montana Bureau of Mines and Geology Open-File Report, 10 p.

[This report describes a hydrologic investigation begun in the Sarpy Creek area by the Montana Bureau of Mines and Geology. The geology and hydrology of the shallow aquifers (less than 600 ft below land surface) and the observation-well network (17 wells) are described. Tables list the quality of ground and surface waters in the area.]

_____1975a, Hydrogeologic conditions and projections related to mining near Colstrip, southeastern Montana: Montana Bureau of Mines and Geology Bulletin 102, 43 p.

[This report presents chemical analyses for 164 wells, observation wells, and springs deriving water from the Tongue River Member of the Fort Union Formation in the Colstrip, Montana, area. In addition, 23 analyses of streamflow are tabulated. Maps show water-quality-sample locations and concentrations of dissolved solids. Mineralization of waters in older and younger spoils were compared with mineralization of water from undisturbed aquifers.]

_____1975b, Hydrogeologic aspects of existing and proposed coal mines near Decker, southeastern Montana: Montana Bureau of Mines and Geology Bulletin 97, 31 p.

[This report describes the water quality for 18 wells and 16 observation wells near the Decker strip mine. Coal aquifers, clinker, and sandstone of the Tongue River Member of the Fort Union Formation are described in addition to alluvium. In addition, 13 analyses of mine effluent are tabulated. Predictions of post-mining water-quality conditions are given.]

Zimmerman, E. A., 1956, Preliminary report on the geology and ground-water resources of parts of Musselshell and Golden Valley Counties, Montana, *with a section on* The chemical quality of the water by R. H. Langford: Montana Bureau of Mines and Geology Information Circular 15, 13 p.

[This report resulted from a study to make information available to those interested in developing the ground-water resource. The report contains a table of 20 chemical analyses of water from Upper Cretaceous units, the Fort Union Formation, alluvium, and the Musselshell River. Water chemistry is described briefly in the text.]

_____1960, Preliminary report on the geology and ground-water resources of northern Blaine County, Montana: Montana Bureau of Mines and Geology Bulletin 19, 19 p.

[This report contains the chemical analyses of water samples from 16 ground-water sites, 1 lake, and 1 surface-water site in an area of 830 mi^2. The ground-water samples are from the Judith River Formation, Hell Creek Formation, Flaxville Formation, and alluvium. Generalized statements also are given about water quality in the table of stratigraphic units and their water-bearing properties.

_____1964, Geology and water resources of the Bluewater Springs area, Carbon County, Montana: U.S. Geological Survey Water-Supply Paper 1779-J, p.J1-J24.

[This report contains two chemical analyses of water from the Tensleep Formation in an area of 16 mi^2. Specific conductance and water temperature were measured at 19 other ground-water sites.]

_____1966, Geology and ground-water resources of western and southern parts of Judith Basin, Montana: Montana Bureau of Mines and Geology Bulletin 50-A, 33 p.

[This report contains 37 standard ground-water analyses from: pre-Mississippian rocks, Madison Group, Otter Formation, Ellis Group, Morrison Formation, Kootenai Formation, Colorado Shale (Colorado Group), Eagle Sandstone, extrusive rocks, terrace deposits, and alluvium. The study area encompasses about 1,100 mi^2. Estimates of water quality are general and pertain only to stock, domestic, and irrigation uses.

_____1967, Water resources of the Cut Bank area, Glacier and Toole Counties, Montana: Montana Bureau of Mines and Geology Bulletin 60, 37 p.

[This report describes the quantity of water available from surface and ground-water sources; the character, thickness, and areal extent of the principal water-bearing formations (Virgelle Sandstone and Two Medicine Formation); the source, occurrence, and direction of movement of ground water; and the chemical quality of the water. Chemical analyses of water samples from 76 wells are tabulated by aquifer. A map showing pie diagrams illustrates ground-water and surface-water chemical quality.]

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Balster, 1980 (G); Groff, 1958 (H); Imlay and others, 1948 (G); McMurtrey and Reed, 1968 (H); Montana Water Resources Board, 1969a (H); Perry, 1932c (H), 1960 (G); Reed and McMurtrey, 1969 (H), 1970 (H); Renick, 1924b (Q); Rice, 1976b (G); Roberts, 1965 (G), 1972 (G).

Stillwater County

Calvert, 1917 (G); Knappen and Moulton, 1931 (G); Patterson, 1963 (G), 1966 (G); Wanek, 1963a, b (G).

Sweet Grass arch

Collier, 1930 (G); Meyboom, 1960 (G, H, Q); Nordquist, 1955 (G).

Sweet Grass County

Bowen, 1919 (G); Calvert, 1912b (G); Groff, 1962a (H, Q).

Toole County

Zimmerman, 1967 (G, H, Q).

Treasure County

Dobbin, 1930 (G); Hall and Howard, 1929 (G, H, Q); Heald, 1927 (G); Miller and others, 1977b (H).

Valley County

Beekly, 1912 (G); Collier, 1925 (G); Colton, 1963e, g, h, i (G), 1964 (G); Jensen and Varnes, 1964 (G).

Wheatland County

Groff, 1962a (H, Q).

Williston Basin

Balster, 1980 (G); Gries, 1953 (G); Nordquist, 1955 (G); Prichard and Landis, 1975 (G); Sandberg, 1959 (G); Sandberg, 1962 (G).

Yellowstone County

Blankennagel and others, 1979 (G, H, Q); Hall and Howard, 1929 (G, H, Q); Knappen and Moulton, 1931 (G); Richards and Rogers, 1951 (G); Rogers, 1914 (G); Woolsey and others, 1917 (G).

Yellowstone River basin

Culbertson, 1954 (G); Gosling and Pashley, 1973 (G, H, Q); Perry, 1932d (H); Perry, 1935 (G, H, Q); Torrey and Kohout, 1956 (G, H, Q); Torrey and Swenson, 1951 (G, H, Q).

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