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MEMORANDUM ON THE GROUND-WATER RESOURCES OF THE HORSE CREEK AND CHERRY CREEK DRAINAGE BASINS, WYOMING

By H. M. Babcock

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MEMORANDUM ON THE GROUND-WATER RESOURCES OF THE HORSE CREEK AND CHERRY CREEK DRAINAGE BASINS, WYOMING

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INTRODUCTION

This report is one of several that are being made by the United States Geological Survey as part of the program of the Department of the Interior for the control, conservation, development, and use of the water resources of the Missouri River basin. The purpose of this report is to present an annotated bibliography of all existing reports pertaining to ground-water supplies in the area reported upon; to collect and analyze all data on public, industrial, and irrigation pumping from wells that are not covered by previous reports; to indicate areas where additional large-scale pumping might be undertaken; to estimate the possibility of depletion of stream flow by ground-water pumping from the developed areas and from areas where large-scale pumping may be undertaken in the future; to point out areas where aquifers might be artificially recharged; and to recommend areas where detailed ground-water studies should be made, indicating the studies needed.

The writer spent approximately 2 weeks in the field during June 1952 evaluating the results of previous studies to determine their adequacy with respect to the purpose of this report. It was found that the previous studies in the area adequately covered the ground-water conditions for this purpose; consequently, the following discussion is abstracted largely from reports covering those studies.

Bibliography

Figure 1 is an index map showing the area covered by this report and the areas covered by other reports that contain information on the source, occurrence, and quality of ground water. An annotated bibliography of those reports follows:

1. Geology and water resources of the Patrick and Goshen Hole quadrangles in eastern Wyoming and western Nebraska, by G. I. Adams; U. S. Geol. Survey Water-Supply Paper 70, 50 pp., 1902.

   Describes the geology and contains some information on springs and wells in the two quadrangles; contains maps showing the geology and the areas under irrigation.

2. Description of the Laramie and Sherman quadrangles, Wyo., by N. H. Darton, Eliot Blackwelder, and C. E. Siebenthal: U. S. Geol. Survey Geol. Atlas 173, 17 pp., 1910.

   Describes the geology and contains a very brief discussion of the water-bearing properties of some of the geologic formations.

3. The Torrington member of the Lance formation and a study of a new Triceratops: Contributions to the stratigraphy and paleontology of the Goshen Hole area, Wyo., by E. M. Schlaikjer: Harvard Coll. Mus. Comp. Zoology Bull., vol. 76, no. 2, pp. 31-68, 1935.

   Gives a detailed discussion of the character of the materials making up the Lance formation, complete with logs of test holes and measured sections.

4. A new basal Oligocene formation: Contributions to the stratigraphy and paleontology of the Goshen Hole area, Wyo., by E. M. Schlaikjer: Harvard Coll. Mus. Comp. Zoology Bull., vol. 76, no. 3, pp. 69-97, 1935.

   Describes the character of the materials making up the "Yoder formation."

5. New vertebrates and the stratigraphy of the Oligocene and early Miocene: Contributions to the stratigraphy and paleontology of the Goshen Hole area, Wyo., by E. M. Schlaikjer: Harvard Coll. Mus. Comp. Zoology Bull., vol. 76, no 4, pp. 97-189, 1935.

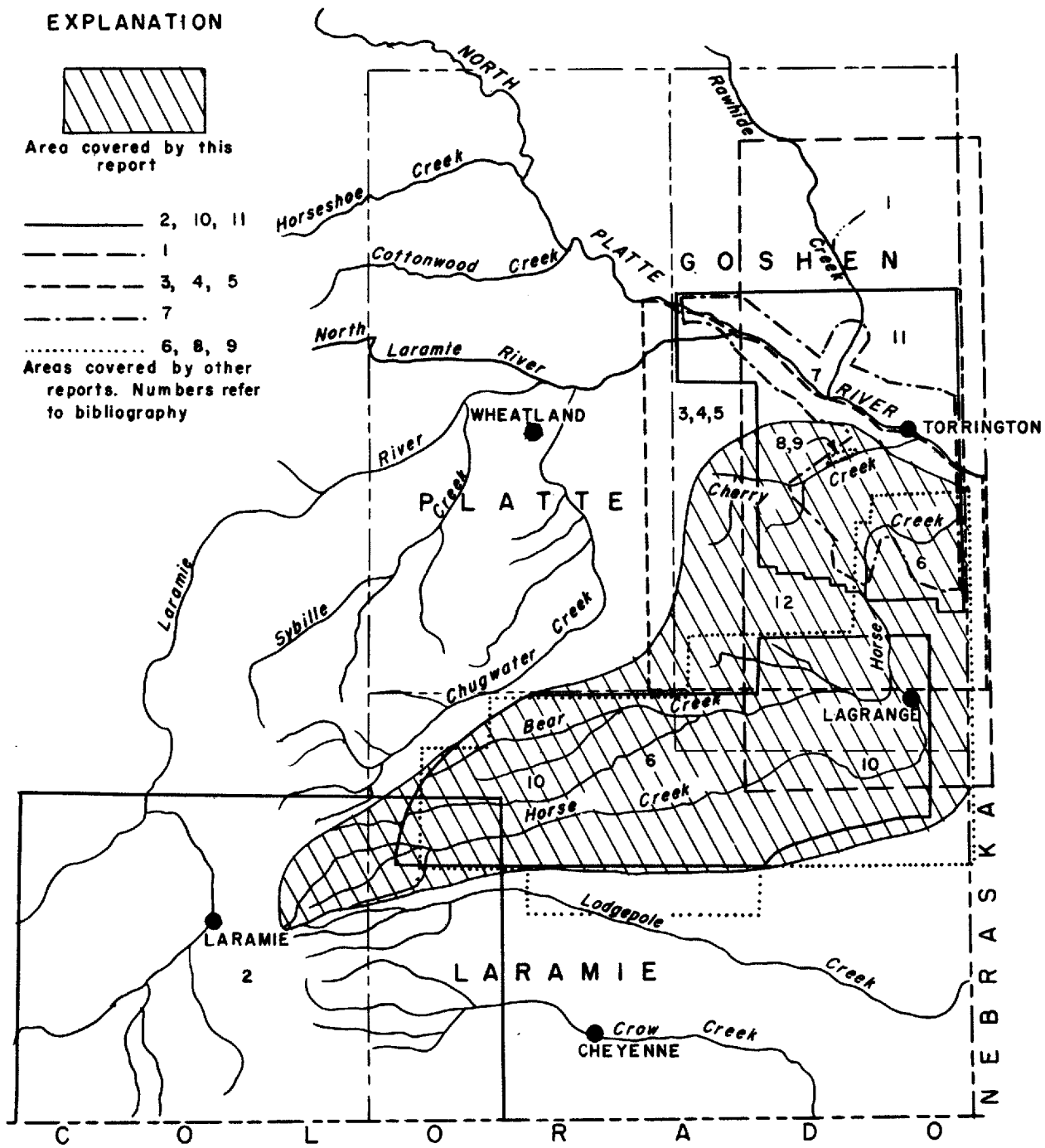

Figure 1.– Index map of southeastern Wyoming showing area of this report and other areas in which ground-water studies have been made.

AGR. S. C. S. CARTOGRAPHIC DIV.
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Gives a detailed description of the Chadron and Brule formations and of the Miocene deposits in the Goshen Hole area.

6. Underground water resources of Horse Creek and Bear Creek valleys, southeastern Wyoming, by W. L. Dockery: Wyoming Geol. Survey Bull. 30, 31 pp., 1940.

Discusses the ground-water resources of an area of 1,355 square miles in Goshen, Laramie, and Platte Counties in southeastern Wyoming. Describes the topography and drainage, structure, stratigraphy, precipitation, and surface and ground water. It includes maps showing geology, location of wells, and depth to water table, and a table of well data. Points out that large amounts of gravel are present in the alluvium and the development of irrigation wells from the alluvium is most feasible in the vicinity of Lagrange.

7. Detailed status report of the North Platte Project, Soil and Moisture Conservation Program: U. S. Bur. Reclamation, 59 pp., 1949.

Gives results of seepage measurements made on the main canals in the North Platte Irrigation District.

8. Seepage measurements . . . lower cost canal lining program . . . North Platte Project, Wyo.-Nebr.: U. S. Bur. Reclamation, 30 pp., 1951.

Gives results of ponding tests to determine seepage losses from a section of the Fort Laramie Canal.

9. Ground-water conditions in the Soil and Moisture Conservation Demonstration Area near Torrington, Goshen County, Wyo., by F. N. Visher and H. M. Babcock, with a section on the chemical quality of the ground water, by W. H. Durum and R. A. Krieger: U. S. Geol. Survey administrative report (mimeographed), 103 pp., 1952. In preparation for publication as a Geological Survey circular.

Discusses the cause of waterlogging of a part of the Goshen Irrigation District adjacent to the Fort Laramie Canal. Gives data showing effects of lining and grouting of canal banks on loss of water from canal. Gives tables of water-level measurements, logs of test holes, and physical and hydrologic properties of the slope-wash material.

10. Reconnaissance of the geology and ground-water resources of the Horse Creek-Bear Creek area, Laramie and Goshen Counties, Wyo., by H. M. Babcock and J. R. Rapp, with a section on the chemical quality of the water, by W. H. Durum: U. S. Geol. Survey Circ. 162, 28 pp., 1952.

Describes an area in northern Laramie and southern Goshen Counties, Wyo., where reconnaissance of the geology and ground-water resources was made along Horse and Bear Creeks to determine the possibilities of developing ground-water supplies for irrigation. Describes the geology and water-bearing properties of the geologic formations in the area. Discusses the occurrence, source, movement, and chemical character of the ground water. Discusses the present and potential development of ground water for irrigation. Contains a map showing the geology and location of wells and springs. Includes tables of well records, logs, water levels in observation wells, and chemical analyses.

11. Geology and ground-water resources of the North Platte Irrigation Project in Goshen County, Wyo., by F. N. Visher, J. R. Rapp, and H. M. Babcock, with a section on the chemical quality of the ground water, by W. H. Durum: U. S. Geol. Survey administrative report, 1952. To be prepared for publication as a Geological Survey circular.

Describes the geology of the area and contains a discussion of the water-bearing properties of the geologic formations. Special attention is given to the alluvium and terrace deposits. Discusses results of laboratory and field tests made to determine the physical and hydrologic properties of the geologic formations. Includes geologic map, ground-water contour map, depth-to-water map, and saturated-thickness map. Contains tables of chemical analyses, water-level measurements, logs of wells and test holes, and well records.

12. Geology and ground-water resources of Goshen County, Wyo., by J. R. Rapp, F. N. Visher, R. T. Littleton, and H. M. Babcock: U. S. Geol. Survey Water-Supply Paper (in preparation).

Discusses the geologic formations exposed in Goshen County, and their water-bearing properties. Special reference is made to the terrace deposits and the alluvial deposits. Discusses also recharge, discharge, seepage, and irrigation. Includes geologic map, profile sections, depth-to-water map, ground-water contour map, and saturated-thickness map of the alluvium along the valley of the North Platte River. Contains tables of physical and hydrologic properties, well records, water-level measurements, logs of wells and test holes, and chemical analyses.

13. Water levels and artesian pressure in observation wells in the United States: U. S. Geol. Survey Water-Supply Papers 990, 1020, 1047, 1075, 1100, 1130, and 1160, for the years 1943-49, inclusive. Reports for later years in preparation.

Annual publications giving water levels and artesian pressures in observation wells.

General Description

The area lies mainly in the extreme western part of the High Plains section of the Great Plains physiographic province but overlaps into the southern Rocky Mountains section of the Rocky Mountain system. The highest point, which lies in the extreme western part of the area, is about 8,750 feet above sea level; the lowest point, where Horse Creek crosses the Wyoming-Nebraska State line, is about 4,050 feet above sea level. The relief of the area, therefore is about 4,700 feet.

The extreme western part of the area consists of the eastern slope of the Laramie Range, comprising the higher mountains, which are made up of crystalline rocks, and the foothills, which are made up of beds of sandstone, limestone, and shale of Paleozoic and early Mesozoic age. East of the foot-

hills is a well-defined lowland, 2 to 5 miles wide, which in part is made up of the valley of Horse Creek. The valley floor is a gently rolling surface cut into sedimentary rocks of late Mesozoic and Tertiary age. A westward-facing escarpment, which rises about 500 feet above the valley floor, bounds the valley on the east. From the crest of this escarpment, the gently rolling High Plains slope eastward from an altitude of about 7,100 feet to about 5,300 feet at the Wyoming-Nebraska State line. These highlands are incised by the valleys of Horse Creek and its tributaries. In the northeastern part of the area the continuity of the High Plains is ended abruptly by Goshen Hole, a nearly semicircular erosional basin. The floor of Goshen Hole is a gently rolling surface of low relief cut in Oligocene and Cretaceous rocks. The basin is bounded by a nearly continuous escarpment 400 to 1,000 feet high.

Horse Creek and its principal tributary, Bear Creek, drain a long, narrow east-west segment of the upland area which lies east of the Laramie Range; this segment is bounded on the south by the drainage basin of Lodgepole Creek and on the north by the drainage basins of Chugwater and Cherry Creeks. About 4 miles west of the Wyoming-Nebraska State line Horse Creek turns northward, flows across Goshen Hole, then eastward to its confluence with the North Platte River. Cherry Creek, which rises at the base of the Goshen Hole escarpment in the northeastern part of the report area, drains most of the western part of Goshen Hole. It flows in a generally eastward direction to its junction with the North Platte River in the vicinity of Torrington, Wyo.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

A rather detailed discussion of the geologic formations and their water-bearing properties is given in the report on the Horse Creek-Bear Creek area by Babcock and Rapp (1952). Although the above-mentioned report covers

only part of the area included in this study, the same geologic formations are present, and their water-bearing properties are similar. The following brief summary of the water-bearing properties of the geologic formations in the area is taken from the abstract of the above-mentioned report, and the reader is referred to the report for a more complete discussion of the subject:

> The outcrop areas of the formations exposed in the Horse Creek-Bear Creek area are shown on a geologic map included in the report. These formations range in age from Early Cretaceous to Recent. The Lower and Upper Cretaceous formations are not considered important aquifers in the area. The Tertiary formations include the Chadron, Brule, and Arikaree. The Chadron formation is not an important aquifer in the area; the Brule formation, a siltstone, yields small to moderate amounts of water to wells and springs through fissures; and the Arikaree sandstone, consisting mainly of sandstone, yields small quantities of water to wells and springs. Many small springs and seeps occur along the Brule and Arikaree contact. The Quaternary alluvium, which is the principal water-bearing formation in the area, consists of stream-laid deposits of coarse sand and gravel, which contain beds and lenses of silt and clay. The alluvium readily yields water to wells.

A geologic map showing the outcrop areas of the formations exposed in Goshen is included in the report on the geology and ground-water resources of Goshen County by Rapp, Visher, Littleton, and Babcock (in preparation). The geologic maps contained in the two reports mentioned cover almost the entire area of this study. Missing is the small triangular section of the area lying within the southeast corner of Platte County, which will be included in a geologic map of Platte County on which was started recently.

OCCURRENCE OF GROUND WATER

Unconfined ground water is contained in the alluvium of the valleys of Horse Creek and Bear Creek in quantities sufficient for irrigation or other large water uses. Near the town of Lagrange, in the southeastern part of the area, irrigation wells yielding 450 to 900 gallons per minute obtain water

from the alluvium and fractured Brule formation. Additional irrigation wells having comparable yields could be developed from the alluvium and fractured Brule formation in this area and also from other places along Horse and Bear Creeks upstream from Lagrange. Downstream from Lagrange, where Horse Creek crosses Goshen Hole, the stream has cut a shallow, narrow channel into the bedrock formations and only a thin, narrow section of alluvium is present. Consequently, there is no possibility that wells of large discharge could be developed from the alluvium in that part of the area.

The Arikaree sandstone, which underlies the upland area, yields water to many domestic and stock wells, but normally the yield is small. The formation is high topographically and hence is well drained, the depth to water generally being 100 feet or more. It is possible that if the water table in the formation could be raised by artificial recharge, a sufficient saturated thickness of the material could be maintained to yield moderate quantities of water to wells. However, it is doubtful whether these wells would be capable of producing as much water as can be presently developed from wells in the alluvium.

It is doubtful that wells of large discharge could be developed economically from any of the remaining geologic formations in the area, or from the alluvium along the valley of Cherry Creek.

GROUND WATER FOR IRRIGATION

Present Development of Ground Water

At present there are only eight wells of large discharge in the area. These all lie within the valleys of Horse and Bear Creeks. Six of the wells obtain water from the alluvium and two obtain water from both the alluvium and the Brule formation. The yields of these wells range from 450 to 900 gallons per minute.

Potential Development

The alluvium is the only geologic formation in the area in which additional wells of large discharge could be developed, and the only areas where the alluvium could be expected to yield large quantities of ground water are in the valleys of Horse and Bear Creeks in the vicinity of Lagrange and upstream. The following quotation from the report on the Horse Creek-Bear Creek area, by Babcock and Rapp (1952) sums up the possibilities of additional large-scale development in the area reported upon:

> The amount of water that can be withdrawn from a ground-water reservoir without causing excessive permanent lowering of the water table depends upon the capacity of, and the recharge to, the reservoir. When water is pumped continuously from a ground-water reservoir faster than it is being replenished, the water levels in wells decline and the supply eventually may be depleted. Water can be pumped from a ground-water reservoir in excess of the rate of recharge for short periods of time without depleting the reservoir if there is sufficient recharge during the nonpumping period to replace the water removed.
>
> In parts of the Horse Creek-Bear Creek area ground water in sufficient quantities for irrigation could be obtained from properly constructed wells in the alluvium. The best possibilities for developing successful irrigation wells are in the alluvium near the town of Lagrange. Wells that would yield 500 to 1,000 gpm probably could be developed in some places if selection of the sites were preceded by adequate test drilling to determine the maximum thickness of the saturated alluvium. In some places where sufficient

water cannot be obtained from the alluvium alone, additional water may be obtained by drilling into the underlying Brule formation. Irrigation wells also could be developed in the alluvium in places along the valleys of Horse and Bear Creeks to supply water for some of the small plots of irrigable land along these valleys. Pumping tests should be made to determine the yield and the proper spacing of wells and to assist in determining the safe yield of the aquifer. If additional ground water is developed for irrigation, records should be kept of the amount of water pumped, and water-level measurements should be continued to warn against the possibility of overdevelopment.

CHEMICAL QUALITY OF GROUND WATER

The chemical quality of the ground water in the area is discussed in considerable detail in both the report on Goshen County by Rapp, Visher, Littleton, and Babcock (in preparation) and the report on the Horse Creek-Bear Creek area, by Babcock and Rapp (1952).

The following quotation is from the abstract of the report by Babcock and Rapp:

> Ground water from different sources in the area is similar in mineral content but differs considerably in chemical character. Water in the alluvium and Arikaree sandstone is principally of the calcium bicarbonate type, whereas water in the Brule formation is essentially of the sodium bicarbonate type. The range in dissolved solids of the samples analyzed is from 206 to 584 ppm, in hardness from 82 to 257 ppm, and in percent sodium from 8 to 77. Although the water in both unconsolidated and bedrock aquifers is hard, it is generally satisfactory for domestic use. Residual sodium carbonate in samples of water from the Brule formation may limit use of this water for irrigation.

ADDITIONAL STUDIES NEEDED

The completed reports and those in preparation present sufficient data to show the areas where wells of large discharge can be developed, and they indicate the approximate quantities of water that could be developed from individual wells. These areas are in the valleys of Horse

and Bear Creeks. The studies do not, however, give data on the perennial yield of the aquifer; consequently, a detailed study of the alluvium, especially in the vicinity of Lagrange, would be needed to determine the perennial yield. This study would include drilling test holes to determine the saturated thickness of the aquifer, and running pumping tests to determine the yield and proper spacing of wells. The pumping test should be supplemented by laboratory tests of the hydrologic properties of the alluvium.

Also, a study of the regimen of the surface streams should be made to determine the effect that future ground-water development would have on the flow of the streams. It is anticipated that additional large-scale development of ground water would cause a decrease in the flow of the streams in the area.