Cover description:

Landsat thematic mapper mosaic of the Middle Rio Grande Basin. The four scenes used in the image were acquired in September 1993. Bands 1, 4, and 7 are displayed through blue, green, and red filters, respectively. The image has been output at 30-meter resolution by cubic convolution resampling to fit the North American Datum of 1983 (NAD83) in a Universal Transverse Mercator (UTM) projection. A terrain correction was included in the processing using USGS 1:24,000-scale Digital Elevation Model (DEM) data. Image compiled by the USGS Astrogeology Program, Flagstaff Field Center. See Mullins and Hare (1999) for a more complete description of the image.

Mullins, K.F., and Hare, T.M., 1999, Calibration, processing, and production of a Landsat thematic mapper mosaic of the Middle Rio Grande Basin Study area, *in* Bartolino, J.R., ed., U.S. Geological Survey Middle Rio Grande Basin Study—Proceedings of the Third Annual Workshop, Albuquerque, New Mexico, February 24–25, 1999: U.S. Geological Survey Open-File Report 99–203, p. 15–17.

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GROUND-WATER RESOURCES OF THE MIDDLE RIO GRANDE BASIN

By

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Foreword

In 1995, the agency primarily responsible for managing water resources in New Mexico, the Office of the State Engineer, declared the Middle Rio Grande Basin a “critical basin”; that is, a ground-water basin faced with rapid economic and population growth for which there is less than adequate technical information about the available water supply. This declaration was largely the result of studies of the ground-water resources of the Middle Rio Grande Basin by the New Mexico Bureau of Geology and Mineral Resources (formerly the New Mexico Bureau of Mines and Mineral Resources) and U.S. Geological Survey (USGS) in cooperation with the City of Albuquerque that showed conclusively that many aspects of the popular understanding of water resources of the basin were incorrect. The two most important conclusions of these studies were that there is significantly less ground water available for supply than previously thought and that the Rio Grande contributes less water to the Santa Fe Group aquifer system than was previously believed. Both conclusions have had and will continue to have major impacts on how water is used, allocated, and managed in the basin. However, these studies also revealed gaps in the understanding of the water resources of the basin. In an effort to fill some of these gaps, the USGS and other agencies began the Middle Rio Grande Basin Study, a 6-year effort to improve the understanding of the hydrology, geology, and land-surface characteristics of the Middle Rio Grande Basin.

An important aspect of the USGS mission is to provide information that describes the Earth, its resources, and the processes that govern the availability and quality of those resources. With reports such as this Circular, the USGS seeks to broaden public understanding of water resources and the processes that affect those resources. Our hope is that this improved understanding will contribute to another goal of the USGS: the use of this scientific information to enhance and protect our quality of life.

This Circular presents an overview of our current understanding of the water resources of the Middle Rio Grande Basin, with an emphasis on ground water. This report is written for a wide audience of people interested or involved in the use of water resources in the Middle Rio Grande Basin. It is intended to serve as a general educational document rather than a report of new scientific findings, though much of the information it contains is the result of new studies performed as part of the Middle Rio Grande Basin Study. This Circular, coupled with ongoing data collection and research, is the USGS contribution toward a sound scientific basis for water managers and policy makers to make informed decisions about the water resources of the basin with the goal of meeting current needs and assuring a sustainable supply for future generations.

Charles G. Groat
Director, U.S. Geological Survey

Acknowledgments

This report is not only the culmination of the 6-year Middle Rio Grande Basin Study, but also of the work of many preceding scientists and engineers. Some of the most notable scientists in the fields of geology and hydrology have worked in the Middle Rio Grande Basin at some point in their careers, including Kirk Bryan and C.V. Theis. The authors wish to acknowledge the contribution of all those who have contributed to the current understanding of the hydrogeology of the basin. The oft-quoted remark of Lucan (Marcus Annaeus Lucanus, A.D. 39–65) applies: "Pigmies placed on the shoulders of giants see more than the giants themselves."

Technical assistance (in the form of discussions and suggestions) was provided by S.K. Anderholm, J.W. Hawley, D.P. McAda, D.G. Woodward, and all the scientists who worked on the Middle Rio Grande Basin Study. Other nontechnical assistance was provided by L.V. Beal, R.A. Durall, and D.E. Straka.

Primary editorial and technical review of this Circular was provided by H.R. Allen, L.M. Bexfield, P.R. Bowman, J.V. Flager, D.J. Hester, R.J. Olmstead, T.E. Reilly, Seymour Subitzky, and D.G. Woodward of the U.S. Geological Survey; S.D. Connell and Peggy Johnson of the New Mexico Bureau of Geology and Mineral Resources (formerly the New Mexico Bureau of Mines and Mineral Resources); L.M. Logan and Jess Ward of the New Mexico Office of the State Engineer; J.M. Stomp of the City of Albuquerque; and L.A. Bartolino. These reviewers made many excellent suggestions, and any errors that may remain are the sole responsibility of the authors.

In addition to the U.S. Geological Survey, many other Federal, State, and local governments and agencies contributed resources to or cooperated in the characterization of the water resources, geology, and land surface of the Middle Rio Grande Basin. These governments and agencies include the City of Albuquerque, New Mexico Office of the State Engineer, New Mexico Bureau of Geology and Mineral Resources, Albuquerque Metropolitan Arroyo Flood Control Authority, Middle Rio Grande Council of Governments, Middle Rio Grande Conservancy District, Bureau of Reclamation, Pueblo of Cochiti, Pueblo of Isleta, Pueblo of Jemez, Pueblo of Laguna, Pueblo of San Felipe, Pueblo of Sandia, Pueblo of Santa Ana, Pueblo of Santo Domingo, Pueblo of Zia, City of Santa Fe, Village of Los Lunas, Bernalillo County, Santa Fe County, New Mexico Environment Department, Sandia National Laboratories, Los Alamos National Laboratory, U.S. Environmental Protection Agency, and the U.S. Army Corps of Engineers.

Final layout was prepared by A.J. Brogan with design input from R.J. Olmstead, illustration support from J.M. Evans and S.P. Clendening, and editorial review by M.A. Kidd, all of the U.S. Geological Survey, Denver, Colorado. Final versions of all figures were prepared by Alice and J.T. Springfield of Springfield and Springfield, Fort Collins, Colorado. All photographs are by J.R. Bartolino except as noted.

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Conversions

This Circular uses both inch/pound (U.S. customary) and International System of Units (SI metric) units. The conversion factors listed below are provided to convert between inch/pound and SI metric units, or different units in the same systems.

Measurement	Multiply	By	To Obtain
Length	inch	25.4	millimeter (mm)
	foot (ft)	0.3048	meter (m)
	mile (mi)	1.609	kilometer (km)
Area	square mile (mi^2)	2.590	square kilometer (km^2)
	acre (acre)	0.4047	hectare (ha)
Volume	acre-foot (acre-ft)	1,233	cubic meter (m^3)
	gallon	0.003785	cubic meter (m^3)
	cubic foot (ft^3)	0.02832	cubic meter (m^3)
Flow rate	cubic foot per second (ft^3/s)	0.2832	cubic meter per second (m^3/s)
	cubic foot per second (ft^3/s)	723.97	acre-foot per year (acre-ft/yr)
	cubic foot per second (ft^3/s)	448.83	gallon per minute (gal/min)
Hydraulic conductivity	foot per day (ft/d)	0.3048	meter per day (m/d)
Temperature	degree Fahrenheit (°F)	(°F–32)/1.8	degree Celsius (°C)
Tritium activity	tritium unit (TU)	3.24	picocuries per liter (pCi/L)
Magnetism	Tesla (T)	1	weber per square meter (Wb/m^2)
Gravity	gal (Gal)	1	centimeter per second squared (cm/s^2)

Electrical conductivity units are given in siemens (S), which is the preferred unit name under the International System of Units. It is numerically equivalent to the older term mhos.

Electrical resistivity can be converted to electrical conductivity (siemens per meter) by taking its inverse.

Vertical Datum

In this report, “sea level” refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Base Credits

All maps of the Middle Rio Grande Basin in this report are in Lambert Conformal Conic projection with standard parallels 33°00' and 45°00' north latitude, and central meridian 106°00' west longitude. The base for figure 3.1 was compiled from U.S. Department of Commerce, Bureau of Census TIGER/line Precensus Files, 1990, scale 1:100,000.

The base for the maps of the Middle Rio Grande Basin was compiled from several sources. The hydrography is from 1977–78 U.S. Geological Survey digital data, scale 1:100,000. Cultural features are from 1992 City of Albuquerque digital data, scale 1:2,400, and digitized from 1977–78 U.S. Geological Survey maps, scale 1:100,000. Other sources are noted on the maps themselves.