U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Prepared in cooperation with the
UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY,
DIVISION OF WATER QUALITY;
U.S. ENVIRONMENTAL PROTECTION AGENCY; AND
TWIN M SOIL CONSERVATION DISTRICT

INTRODUCTION

The basin-fill aquifer in the Milford area (fig. 1) is the principal source of water for municipal, rural domestic, and agricultural use. Ground-water withdrawals from the basin-fill aquifer are causing water-level declines in some areas and land subsidence in isolated areas. The demands on ground-water resources in the basin-fill aquifer are expected to continue from existing uses and from new, proposed agribusiness. Water quality in the basin-fill aquifer is changing in some areas as concentrations of dissolved solids increase (Allen and others, 1994). The areas where water-quality changes are occurring are not well documented, and insufficient data are available to determine trends in water quality throughout the Milford area. Dissolved-solids concentrations in water in the basin-fill aquifer range from about 250 to 7,840 mg/L, and nitrogen as nitrate plus nitrite concentrations range from less than 0.1 mg/L to 30 mg/L (Mower and Cordova, 1974). Many area residents withdraw water from the basin-fill aquifer for domestic use, and further changes of water quality in the basin-fill aquifer could adversely affect these residents. If significant water-quality changes occur, residents might need to drill new and deeper wells or rely on bottled water. The background ground-water quality of the Milford area is not well documented, thus making it difficult to monitor and determine causes of changes in water quality. The water-quality data collected in this study are needed to document the baseline water quality in the basin-fill aquifer for monitoring water-quality changes.

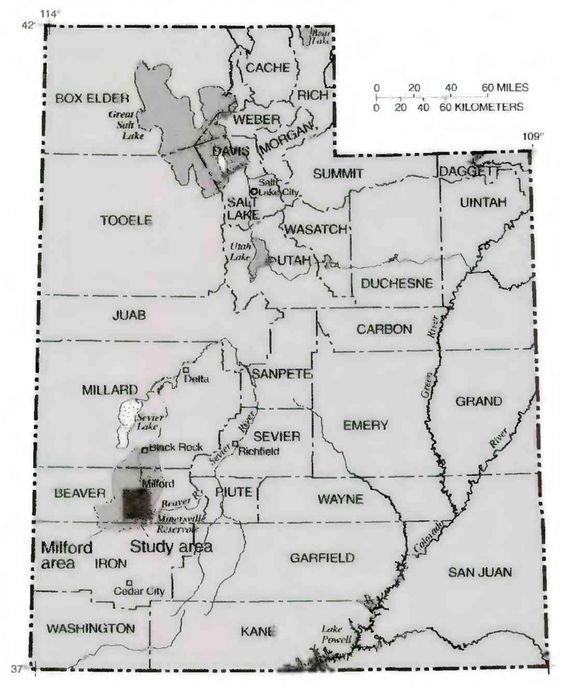

Figure 1. Location of Milford and study area, Utah.

Preservation of ground-water quality is one of the primary concerns of the Utah Department of Environmental Quality, Division of Water Quality. This study was a cooperative investigation between the U.S. Geological Survey, the Utah Department of Environmental Quality, Division of Water Quality, and the U.S. Environmental Protection Agency to determine the chemical characteristics of water from the basin-fill aquifer in the Milford area.

Purpose and Scope

This report describes the chemical quality of water collected from the basin-fill aquifer in the Milford area in a map and table, and graphs of historical dissolved-solids and nitrate concentrations are shown for selected sites. The sample collection for the study focused on the inhabited, agricultural part of the Milford area and on the upper 400 ft of the basin-fill aquifer. Historical data for dissolved-solids and nitrate plus nitrite concentrations are presented for selected sites with sufficient data to develop a time series.

Acknowledgments

The water-sample analyses done by the Utah Department of Health Laboratory were greatly appreciated. Recognition and thanks are extended to all the well and property owners who allowed access to their wells for sampling.

HYDROLOGIC SYSTEM

The Milford area in southwestern Utah (fig. 1) is a 1,160 mi^2 basin in the Basin and Range Physiographic Province (Fenneman, 1931). The principal water-yielding aquifer is the basin-fill aquifer. Sediments that make up the basin-fill aquifer range in age from late Tertiary to Quaternary and consist of multiple, discontinuous layers of silt, sand, and gravel separated by less permeable layers of clay and silt. The less permeable layers are lacustrine or fluvial sediments. The basin-fill deposits are about 900 ft thick in the basin center and thin toward the basin margins. The mountain ranges adjacent to the basin are composed of carbonate rocks of Paleozoic age and volcanic and intrusive rocks of Tertiary age. Large coalescing alluvial fans extend into the valley.

The Beaver River enters the south end of the basin and exits to the north. The river is usually completely diverted for irrigation as it enters the valley, and only in extremely wet years is there flow in the channel at Milford. Water level in two wells; cumulative departure from annual precipitation at Black Rock, about 22 mi north of Milford; and annual discharge of the Beaver River at Rocky Ford Dam, located about 5 mi east of Minersville; are shown in figure 2 (Allen and others, 1994). Water levels in some wells in the Milford area have experienced significant declines (fig. 2). Average annual precipitation at Black Rock is 9.02 in. (1952–94) and average annual discharge of the Beaver River at Rocky Ford Dam is 29,100 acre-ft for 1931–94. Annual average ground-water withdrawal for the Milford area is 38,900 acre-ft (1931–94). Ground-water withdrawals increased from about 10,000 acre-ft in 1931 to about 70,000 acre-ft in 1974. Since 1974, annual withdrawals have decreased to the 40–50,000 acre-ft range because farmers have been using more efficient irrigation methods. Large ground-water withdrawals can affect water quality in ground-water aquifers by changing ground-water flow directions and by leaching as irrigation water is recycled in the basin.

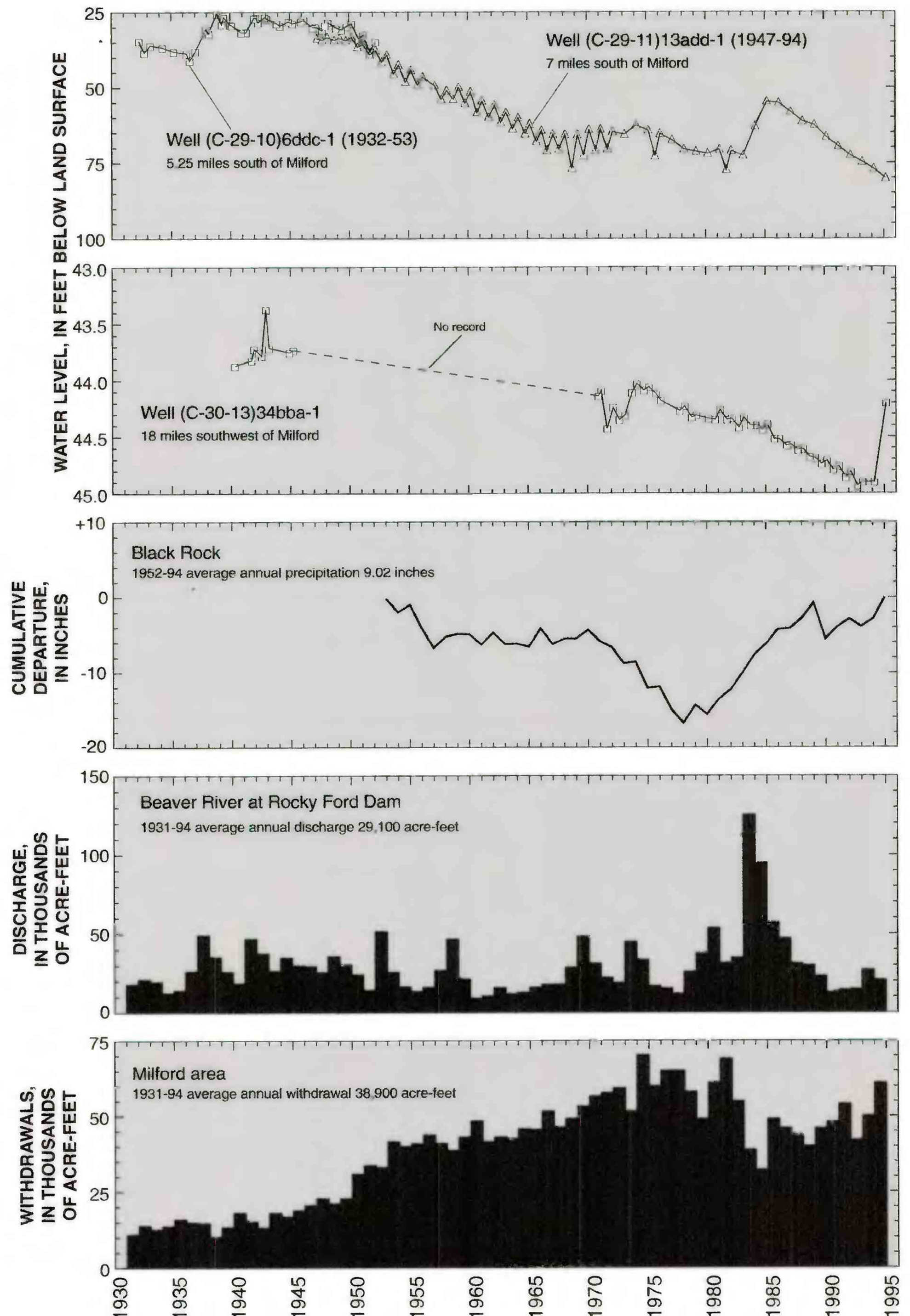

Figure 2. Relation of water levels in selected wells in the Milford area to cumulative departure from the average annual precipitation at Black Rock, to discharge of the Beaver River at Rocky Ford Dam, to annual withdrawals from wells, Milford area, Utah, 1931 – 94.

SAMPLE SITE SELECTION AND SAMPLING METHODS

Sampling sites selected for this study were existing domestic, irrigation, and stock wells in the U. S. Geological Survey database. The criteria used to select the sampling sites were well depth, perforated interval and completion, and water use. The sampling sites were divided into groups based on well depth with 50 samples from wells completed less than 150 ft below land surface and the remaining 25 samples from wells completed 150 to 400 ft below land surface. The weighting of the samples to the shallower part of the basin-fill aquifer is because the shallow parts of the aquifer would be affected first from surface contamination. Many of the wells were completed for maximum production and had perforated intervals extending from near the surface to the bottom of the well. This is not an ideal well completion for water-quality sampling, but these were the only wells available. Preference was given to domestic wells in the sample site selection because of possible human health effects of the consumption of water from these wells.

Water from 75 wells was sampled for common ions, nutrients, and metals. Field measurements of specific conductance, water temperature, and pH were obtained from each well. Laboratory analyses were done by the Utah Department of Health Laboratory and six duplicate quality-assurance samples were analyzed by the U.S. Geological Survey National Laboratory. The sampling was done according to the guidelines in the State of Utah, Department of Environmental Quality, Division of Water Quality, Quality-Assurance Project Plan Guidance: Ground Water Program. In many cases, wells less than 150 ft deep selected for sampling had been deepened because of declining water levels. Alternative sites were sampled when available; however, in many areas there were no wells less than 150 ft deep. In these cases, the shallowest wells in the area were sampled. Only 12 wells less than 150 ft deep were sampled because of the deepening of many of the wells originally selected for sampling. However, 42 of the 75 wells were less than 250 ft deep and provided data from the upper part of the basin-fill aquifer.

CHEMICAL QUALITY OF WATER IN THE BASIN-FILL AQUIFER

The quality of water in the basin-fill aquifer in the Milford area is represented by the chemical analyses listed in table 1 (on the reverse side of the sheet). The samples were collected in July and August 1994. Well depth, and dissolved-solids and nitrate plus nitrite concentrations, are shown next to the well location in figure 3. If a value is missing, there are no data for that parameter. The sampled well depths ranged from 72 to 863 ft with most of the wells in the 150 to 350 ft range. Dissolved-solids concentrations ranged from 180 to 3,382 mg/L and nitrate plus nitrite concentrations ranged from 0.042 to 25.6 mg/L (table 1, fig. 3).

Well depth is plotted against dissolved-solids concentrations and nitrate plus nitrite concentration (fig. 4) to determine if well depth and water quality are related. There is not a linear relation between well depth and dissolved-solids or nitrate plus nitrite concentration. Absence of such a relation may, in part, be because many of the wells are perforated for most of the well depth and, therefore, the samples are a vertical composite of the water in the basin-fill aquifer. The dissolved-solids concentrations generally are greater than 1,000 mg/L south of Milford and east of the Beaver River (T.28S. R.10W.) (fig. 3). Ground-water recharge from the Beaver River and Low Line Canal may affect the quality of water in wells near the river and canal, but samples were not collected from surface waters to investigate this relation.

The remainder of the Milford area generally has dissolved-solids concentrations less than 1,000 mg/L. Areas of croplands (fig. 3) show the relation of the agricultural lands to wells and water quality. Nitrate plus nitrite concentrations in the central part of the Milford area are generally in the 3 to 6 mg/L range.

Graphs of dissolved-solids concentration (fig. 3) are derived from historical specific conductance and dissolved-solids concentration. Wells in the Milford area did not have complete time series of dissolved-solids concentrations data; however, nine wells had sufficient specific-conductance measurements to develop dissolved-solids concentration time series. Dissolved-solids concentrations were estimated from specific-conductance values by using the relation shown in figure 5. Concentrations of dissolved solids increase in water from wells (C-28-11)25dcd-1, (C-29-10)5cdd-2 and (C-29-11)14cdb-1 and decrease in water from well (C-29-11)27add-1 (fig. 3). Water from the other five wells did not show a trend. Concentrations of nitrate plus nitrite (fig. 3) have similar trends to the dissolved-solids concentrations with the exception of water from well (C-29-11)14cdb-1, in which the dissolved-solids concentration is increasing and the nitrogen as nitrate plus nitrite concentration is decreasing.

Split samples of water from six wells were analyzed for common ions and nutrients by the Utah Department of Health Laboratory and the U.S. Geological Survey Laboratory. Split-sample analyses for selected constituents are shown in figure 6. If the concentrations from the analyses from each laboratory were equal, the data would plot on the line of equal concentration. The values in figure 6 are all near the line with the exception of a potassium value and indicate that the split-samples analyzed by the two laboratories yielded similar results.

The State of Utah has established water-quality standards for ground water (table 2) (Utah Department of Environmental Quality, Division of Water Quality, 1995). Concentrations of inorganic constituents and metals were less than the State standards in all the samples. Nitrogen as dissolved nitrate plus nitrite exceeded the State standard for nitrate of 10 mg/L in three samples.

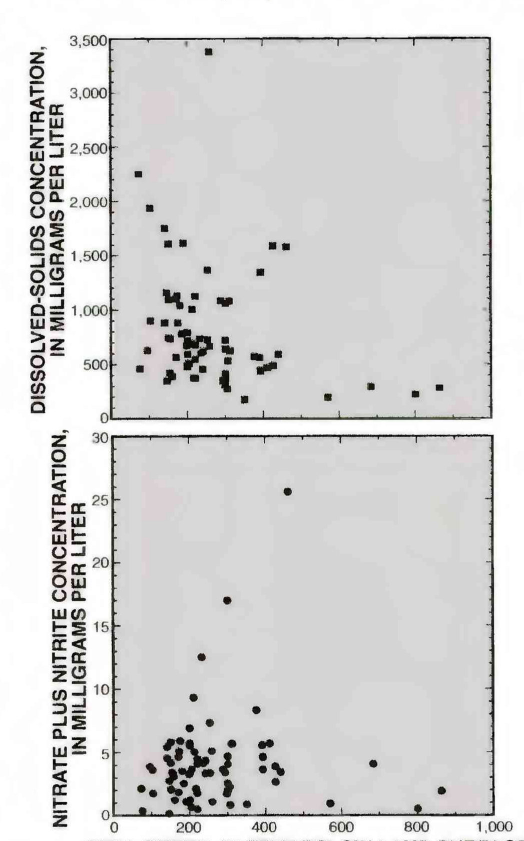

Figure 4. Relation of dissolved-solids and nitrate plus nitrite concentration to well depth, Milford area, Utah.

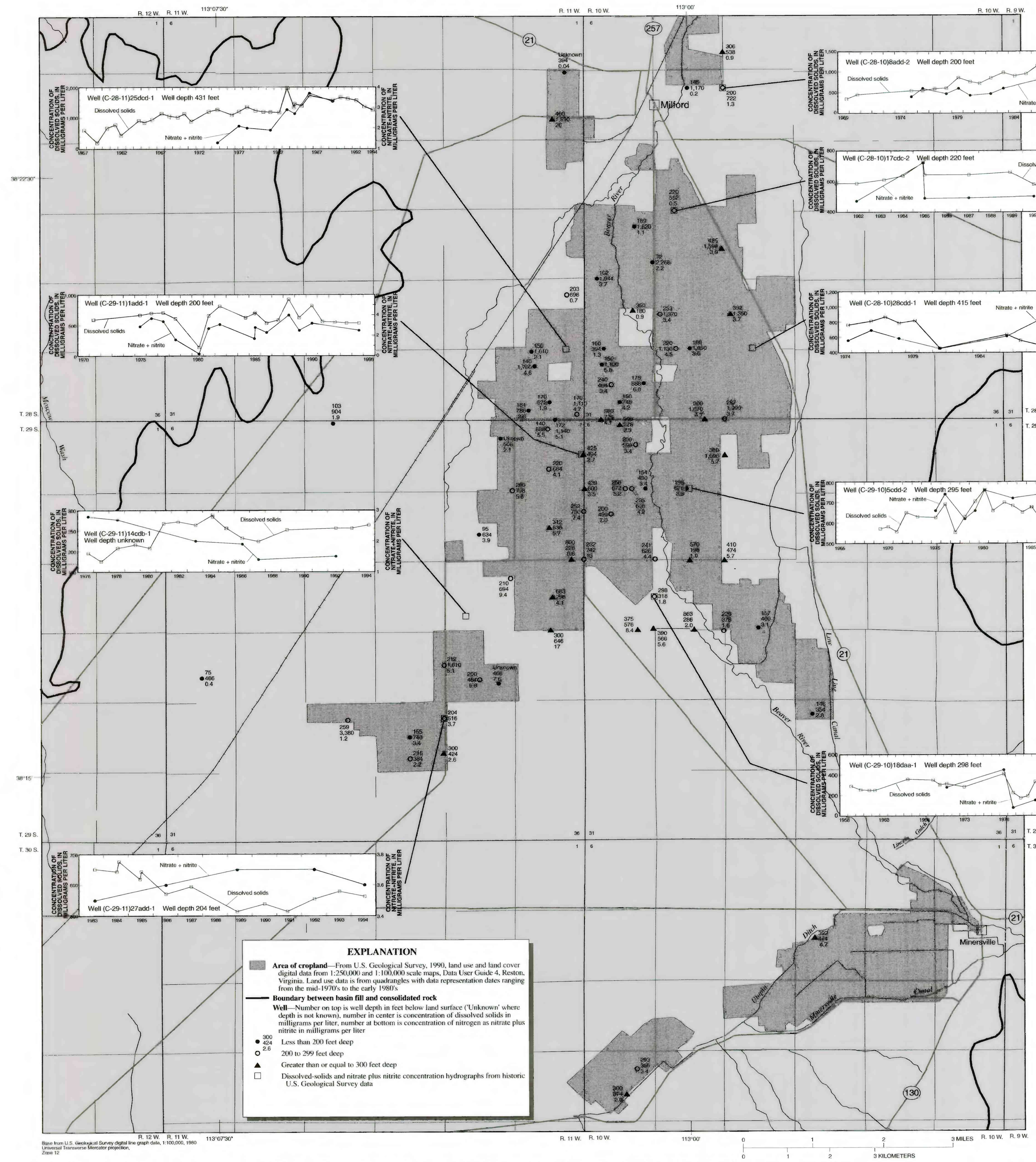

Figure 3. Well location and depth, dissolved-solids and nitrogen concentration, and hydrographs of dissolved-solids and nitrate plus nitrite concentration for water from selected wells in the study area, Milford, Utah.

Chemical quality of water in the basin-fill aquifer, Milford area, Utah, July and August 1994

By
David D. Susong
1996

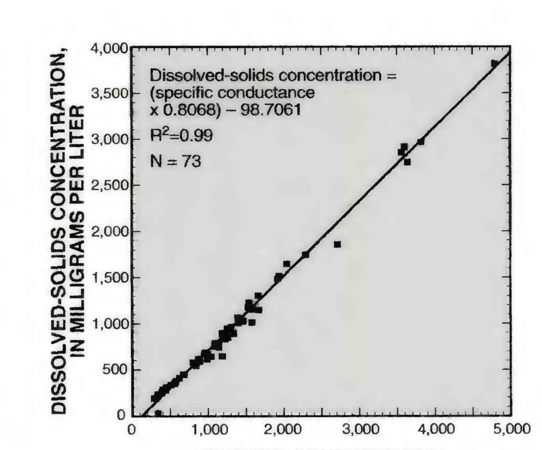

Figure 5. Relation between dissolved-solids concentration and specific conductance, Milford area, Utah.

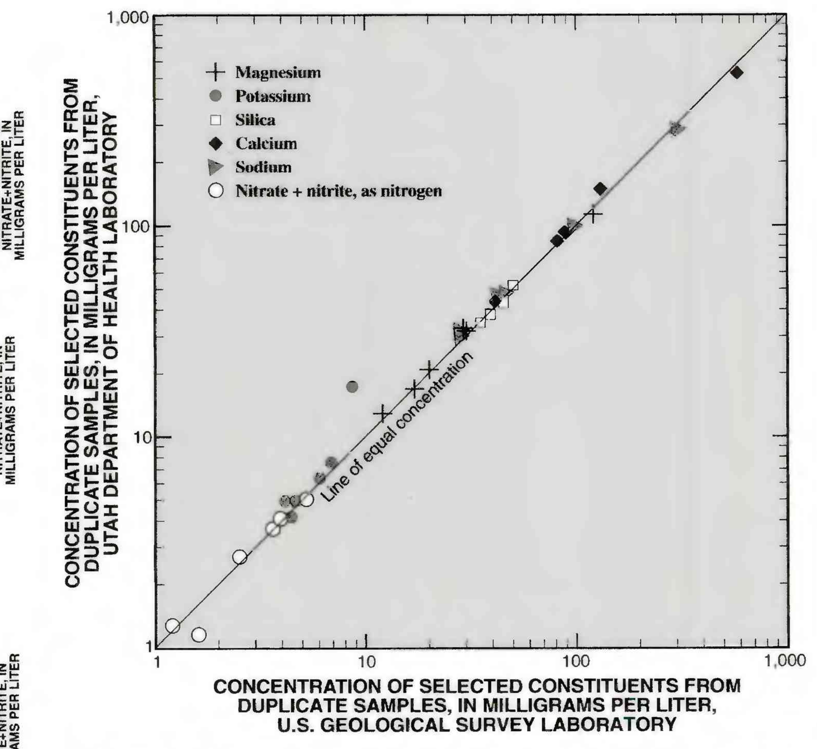

Figure 6. Relation between split water samples from the basin-fill aquifer, Milford area, Utah, analyzed by the Utah Department of Health Laboratory and the U.S. Geological Survey Laboratory.

Table 2. State of Utah water-quality standards

Constituent or characteristic	Maximum allowable concentration, in micrograms per liter, unless noted otherwise
Metals	
Arsenic	50
Barium	2,000
Cadmium	5
Chromium	100
Copper	1,300
Lead	15
Mercury	50
Selenium	50
Silver	100
Zinc	5,000
Inorganic chemicals	
Fluoride	4.0 milligrams per liter
Nitrate plus nitrite (as nitrogen)	10.0 milligrams per liter

SUMMARY

The basin-fill aquifer in the Milford area of Utah is the principal source of water for municipal, rural domestic, and agricultural use. The quality of water in 75 wells was sampled and analyzed for common ions, nutrients, and metals. Dissolved-solids concentrations ranged from 180 to 3,382 mg/L, and nitrate plus nitrite concentrations, as nitrogen, ranged from 0.042 to 25.6 mg/L. A relation between well depth and dissolved-solids concentration cannot be determined because wells are commonly perforated from the surface to the bottom of the well. There is an area of dissolved-solids concentration greater than 1,000 mg/L south of Milford and east of the Beaver River. Graphs of dissolved-solids concentrations derived from measurements of specific conductance for water from nine wells indicate that concentrations of dissolved solids are increasing in three wells, decreasing in one well, and did not change significantly in the remaining wells. Nitrate plus nitrite concentrations, as nitrogen, in water from the nine wells show similar trends to the dissolved-solids concentrations. Three samples collected in July and August 1994 exceeded the State standards for nitrate plus nitrite.

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