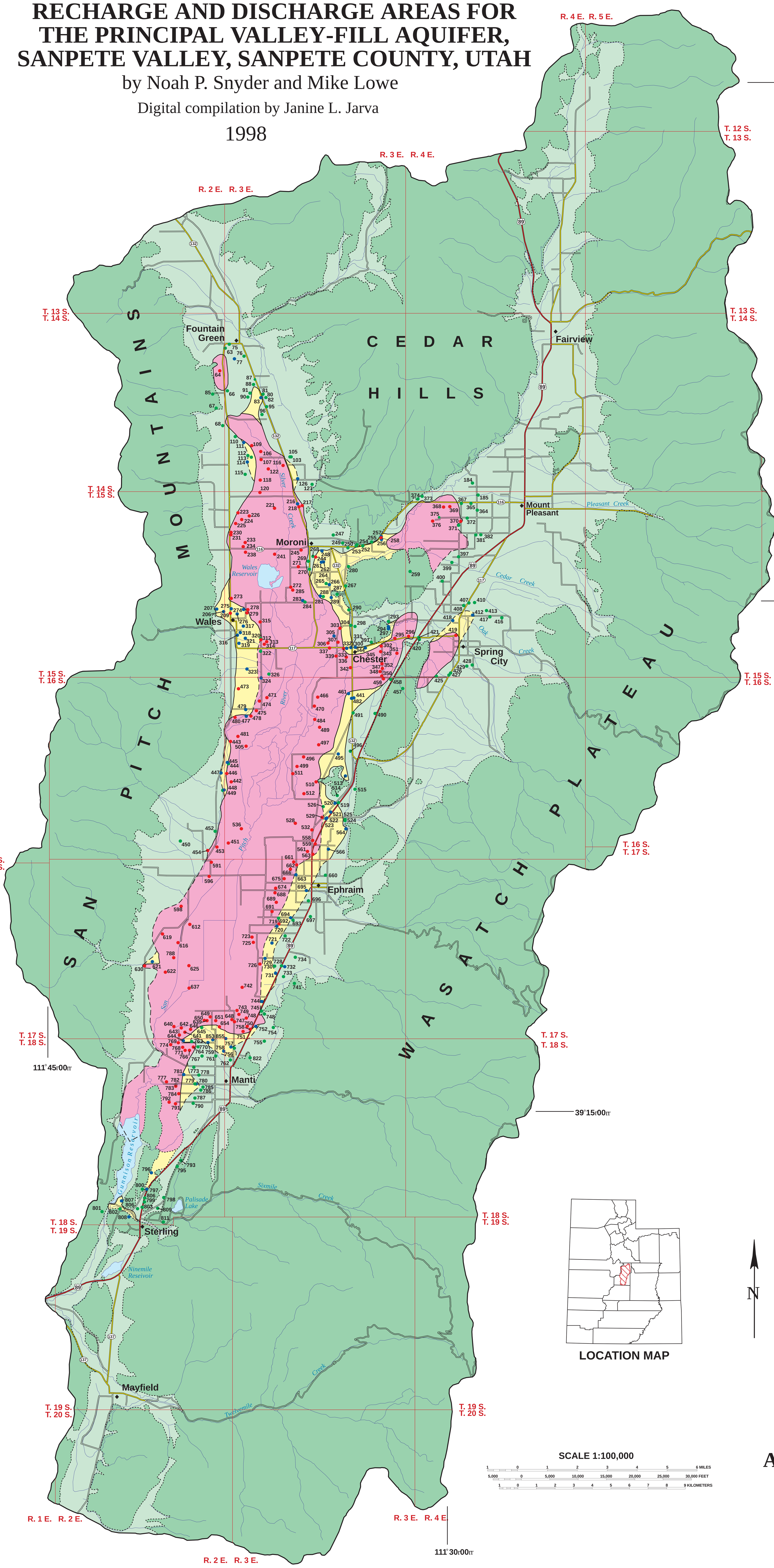
RECHARGE AND DISCHARGE AREAS FOR THE PRINCIPAL VALLEY-FILL AQUIFER, SANPETE VALLEY, SANPETE COUNTY, UTAH

by Noah P. Snyder and Mike Lowe

Digital compilation by Janine L. Jarva

1998



EXPLANATION

- PRIMARY RECHARGE AREA
  Consolidated rock, usually uplands
- PRIMARY RECHARGE AREA
  Unconsolidated valley fill
- SECONDARY RECHARGE AREA
- DISCHARGE AREA
- Boundary between recharge areas and discharge areas, dashed where approximate
- Boundary of valley fill
- Boundary of study area

WELLS Number refers to site number in appendix

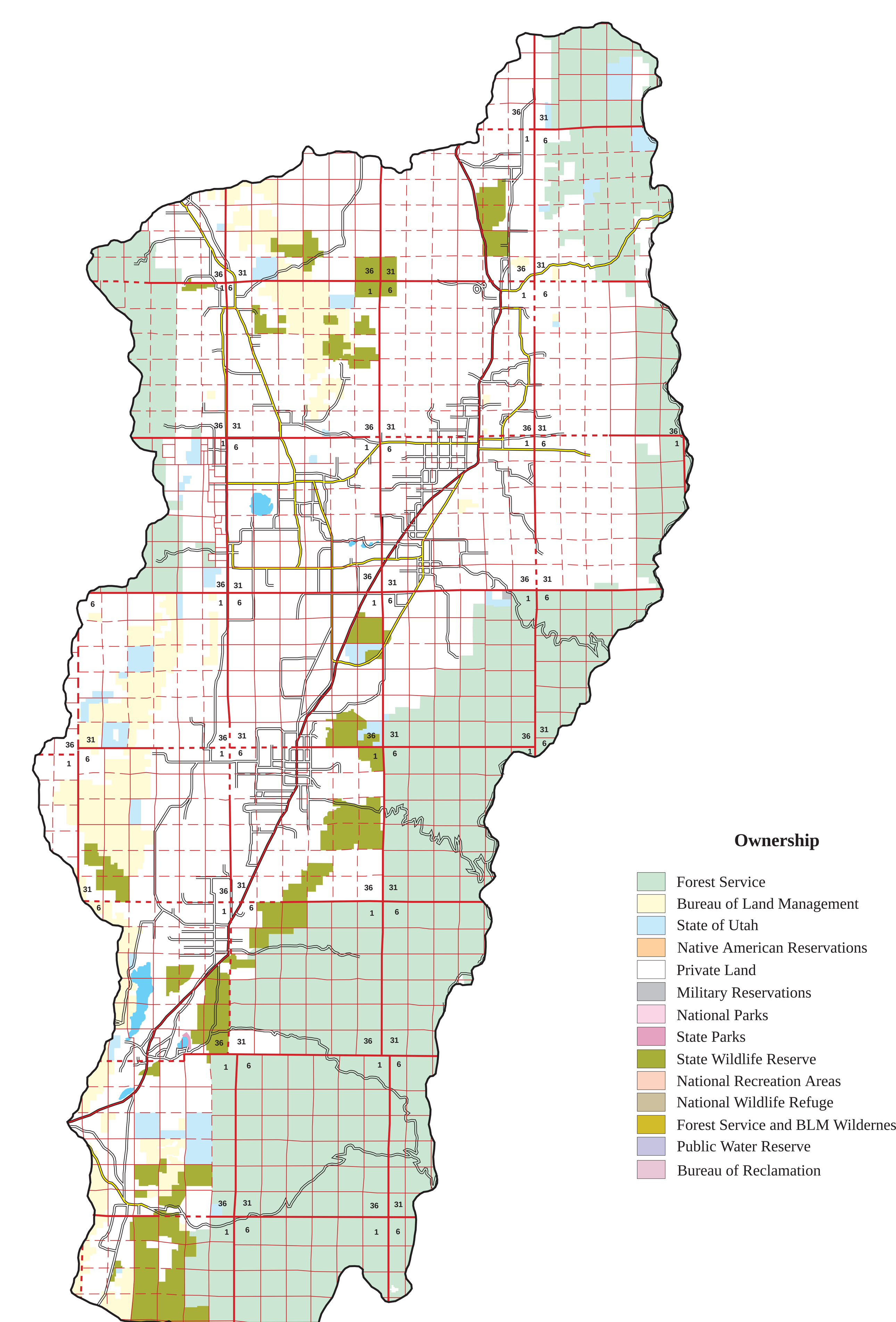
- PRIMARY RECHARGE WELL
  Confining layers not present; wells completed in principal aquifer; hydraulic gradient is downward
- SECONDARY RECHARGE WELL
  Confining layers present; wells completed in principal aquifer; hydraulic gradient is downward
- DISCHARGE WELL
  Confining layers present; wells completed in principal aquifer; hydraulic gradient is upward from principal aquifer to shallow unconfined aquifer
- Wells completed in shallow unconfined aquifer

- US Highways
- State Highways
- County and City Roads

This map was partially funded by the U.S. Environmental Protection Agency under the Clean Water Act, Section 319, nonpoint source program, and by the Utah Department of Environmental Quality, Division of Water Quality.

LOCATION MAP

SCALE 1:100,000



ADMINISTRATIVE OWNERSHIP INSET MAP

Digital data from the State Geographic Information Database (SGID)

Snyder, Lowe

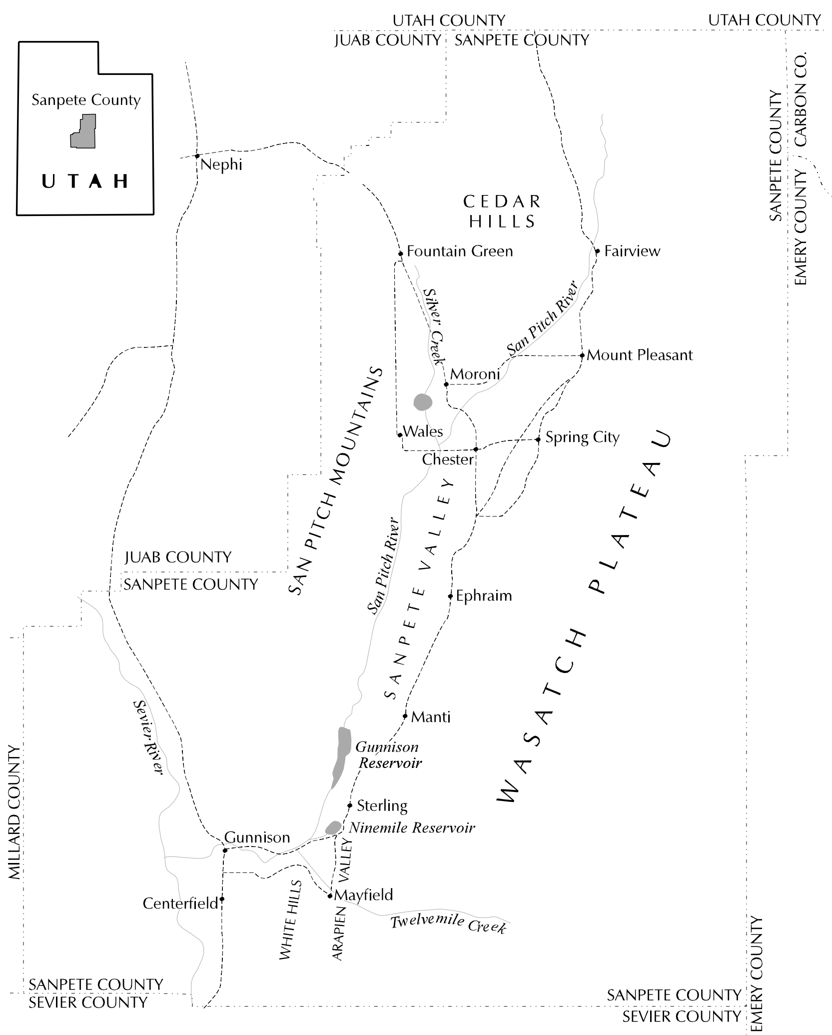
Recharge and discharge areas, Sanpete Valley, Sanpete County, Utah

UGS Map 174

MAP OF RECHARGE AND DISCHARGE AREAS FOR THE PRINCIPAL VALLEY-FILL AQUIFER, SANPETE VALLEY, SANPETE COUNTY, UTAH

by

Noah P. Snyder and Mike Lowe



ISBN 1-55791-619-5

MAP 174 1998

UTAH GEOLOGICAL SURVEY

a division of

Utah Department of Natural Resources

in cooperation with

Utah Department of Environmental Quality

Division of Water Quality

UTAH GEOLOGICAL SURVEY

The **UTAH GEOLOGICAL SURVEY** is organized into five geologic programs with Administration, Editorial, and Computer Resources providing necessary support to the programs. The **ECONOMIC GEOLOGY PROGRAM** undertakes studies to identify coal, geothermal, uranium, hydrocarbon, and industrial and metallic resources; initiates detailed studies of these resources including mining district and field studies; develops computerized resource data bases, to answer state, federal, and industry requests for information; and encourages the prudent development of Utah's geologic resources. The **APPLIED GEOLOGY PROGRAM** responds to requests from local and state governmental entities for engineering-geologic investigations; and identifies, documents, and interprets Utah's geologic hazards. The **GEOLOGIC MAPPING PROGRAM** maps the bedrock and surficial geology of the state at a regional scale by county and at a more detailed scale by quadrangle. The **GEOLOGIC EXTENSION SERVICE** answers inquiries from the public and provides information about Utah's geology in a non-technical format. The **ENVIRONMENTAL SCIENCES PROGRAM** maintains and publishes records of Utah's fossil resources, provides paleontological and archeological recovery services to state and local governments, conducts studies of environmental change to aid resource management, and evaluates the quantity and quality of Utah's ground-water resources.

The UGS Library is open to the public and contains many reference works on Utah geology and many unpublished documents on aspects of Utah geology by UGS staff and others. The UGS has several computer data bases with information on mineral and energy resources, geologic hazards, stratigraphic sections, and bibliographic references. Most files may be viewed by using the UGS Library. The UGS also manages a sample library which contains core, cuttings, and soil samples from mineral and petroleum drill holes and engineering geology investigations. Samples may be viewed at the Sample Library or requested as a loan for outside study.

The UGS publishes the results of its investigations in the form of maps, reports, and compilations of data that are accessible to the public. For information on UGS publications, contact the Natural Resources Map/Bookstore, 1594 W. North Temple, Salt Lake City, Utah 84116, (801) 537-3320 or 1-888-UTAH MAP. E-mail: nrugs.geostore@state.ut.us and visit our web site at http://www.ugs.state.ut.us.

UGS Editorial Staff

J. Stringfellow	Editor
Vicky Clarke, Sharon Hamre	Graphic Artists
Patricia H. Speranza, James W. Parker, Lori Douglas	Cartographers

Printed on recycled paper 10/98

MAP OF RECHARGE AND DISCHARGE AREAS FOR THE PRINCIPAL VALLEY-FILL AQUIFER, SANPETE VALLEY, SANPETE COUNTY, UTAH

by Noah P. Snyder and Mike Lowe

ABSTRACT

The most important source of drinking water in Sanpete County is ground water from the principal valley-fill aquifer in Sanpete Valley. In this study we mapped recharge and discharge areas for the principal aquifer to aid in management of potential contaminant sources to help protect the quality of ground water.

Sanpete Valley is along the San Pitch River between the Wasatch Plateau and the San Pitch Mountains in central Utah. The principal valley-fill aquifer of Sanpete Valley consists of alluvial-fan and stream deposits. The aquifer is confined by thick, fine-grained sediments in much of the main valley and in the northwestern arm along Silver Creek. Water-table conditions are found in the northeastern arm along the upper San Pitch River. The mountains that surround Sanpete Valley and the upper parts of alluvial fans along the margins of the valley make up the primary recharge areas. Secondary recharge areas are mostly east of the San Pitch River, between the primary recharge areas and the discharge area in the central part of the valley. Water quality is generally high, although a local nitrate-contamination problem merits further study.

INTRODUCTION

Background

Sanpete County requires a clean supply of drinking water for its expanding population. The most important source is ground water in the principal valley-fill aquifer in Sanpete Valley. Recharge to this unconsolidated aquifer is from infiltration of precipitation and surface water in recharge areas and underflow from consolidated rock along the margins of the basin. Recharge areas are typically underlain by fractured rock and/or coarse-grained sediment with relatively little ability to inhibit infiltration or renovate contaminated water. Ground-water flow in recharge areas has a downward component and relatively fast rate of movement. Because contaminants can readily enter an aquifer system in recharge areas, management of potential contaminant sources in these areas deserves special attention to protect ground-water quality. Ground-water recharge-area mapping defines these vulnerable areas.

Ground-water recharge-area maps typically show: (1) primary recharge areas, (2) secondary recharge areas, and (3) discharge areas (Anderson and others, 1994). Primary recharge areas, commonly the uplands and coarse-grained unconsolidated deposits along valley margins, do not contain thick, continuous, fine-grained layers and have a downward ground-water gradient. Secondary recharge areas, commonly valley benches, have fine-grained layers thicker than 20 feet (6 m) and downward ground-water gradients. Ground-water discharge areas are generally in valley lowlands. Discharge areas for unconfined aquifers are where the water table intersects the ground surface, causing springs or seeps. Discharge areas for confined aquifers are where the ground-water gradient is upward and water is discharging to a shallow unconfined aquifer above the upper confining bed, or to a spring. Water from wells which penetrate confined aquifers may flow to the surface naturally. The extent of both recharge and discharge areas may vary seasonally and from dry years to wet years.

Purpose and Scope

The purpose of this study is to help state and local government officials and local residents protect the quality of ground water in Sanpete Valley by defining areas where ground-water aquifers are vulnerable to contamination. The study is a cooperative effort among the Utah Geological Survey (UGS), the Utah Division of Water Quality (DWQ), and the U.S. Environmental Protection Agency (EPA).

The scope of work included a search for well-log data, a literature review, and field reconnaissance to define general geologic and hydrologic conditions in Sanpete Valley. Logs for water wells drilled in the valley prior to June 1995 were collected from the State Engineer's office. Well-log information was entered into a database and well locations were plotted on 1:24,000-scale base maps. Generalized recharge- and discharge-area boundaries were then drawn and digitized, along with well locations, into the State Geographic Information Database.

Setting

The study area includes most of the 600 square-mile (1,500 km^2) watershed of the San Pitch River in Sanpete County (figure 1). The primary focus of this study is on Sanpete Valley, a Y-shaped valley about 40 miles (60 km) long and as much as 13 miles (21 km) wide. The study area is in central Utah, about 90 miles (150 km) south of Salt Lake City.

Physiography and Drainage

The San Pitch River drainage basin is in the northwestern corner of the Colorado Plateau physiographic province (Stokes, 1977). It is bordered on the east by the Wasatch Plateau (figure 1), which reaches elevations at the drainage divide of more than 11,000 feet (3,350 m). The western boundary is the San Pitch Mountains (also known as the Gunnison Plateau), which reaches a maximum elevation of 9,700 feet (3,000 m) near the northern end. The valley is divided in the north by the Cedar Hills, which form the center of the Y. The headwaters of the San Pitch River are in the eastern arm of Sanpete Valley. South of Moroni, the river is joined by Silver Creek, an intermittent stream that drains the western arm of the valley. The San Pitch River flows south through the center of Sanpete Valley to Gunnison Reservoir, where the valley narrows, and then into the Sevier River west of Gunnison (figure 1). The southern part of the study area includes the drainage of Twelvemile Creek, which flows west from the Wasatch Plateau across Arapien Valley and into the San Pitch River about 2 miles (3.2 km) southwest of Ninemile Reservoir (figure 1). Arapien Valley is separated from the central Sevier River basin at its southernmost point by a low divide about 4 miles (6.4 km) south of Mayfield.

Climate

Climate in the San Pitch River drainage basin ranges from semiarid in Sanpete and Arapien Valleys to subhumid in the surrounding uplands (Robinson, 1971). Generally, most of the precipitation in the study area falls as snow in the mountains, particularly the Wasatch Plateau, from November to April. The summer months are generally the driest, although intense thunderstorms can locally produce large precipitation totals. Average annual precipitation ranges in the valley from 9.85 inches (25.0 cm) in Moroni to 13.74 inches (34.9 cm) in Manti (Ashcroft and others, 1992). At elevations above 8,000 feet (2,500 m), the Wasatch Plateau receives an average of 24 inches (60 cm) of precipitation per year (Ashcroft and others, 1992). Average annual evaporation in the San Pitch River drainage basin is 3.5 times greater than average annual precipitation (Robinson, 1971).

Land Use

Sanpete Valley is a rural area that is experiencing growth in residential development and agriculture. Sanpete County had a population of 16,259 in 1990. Most of the residents live and farm on the unconsolidated valley-fill deposits that serve as the principal drinking-water aquifer for the area. Most irrigated cropland is in southern Sanpete Valley east of the San Pitch River (Robinson, 1971). The eastern and western margins of the valley are mostly rangeland for sheep and cattle.

Turkey farms are common, particularly on the northwestern arm of upper Sanpete Valley between Moroni and Fountain Green.

Previous Studies

Robinson (1968) compiled selected hydrologic data for the San Pitch River drainage basin. A more extensive study summarizing available long-term data on ground water in the San Pitch River drainage basin was published three years later (Robinson, 1971). Horns (1995) examined nitrate contamination around Moroni. Wilberg and Heilweil (1995) summarized the hydrology, and modeled ground-water flow in Sanpete Valley.

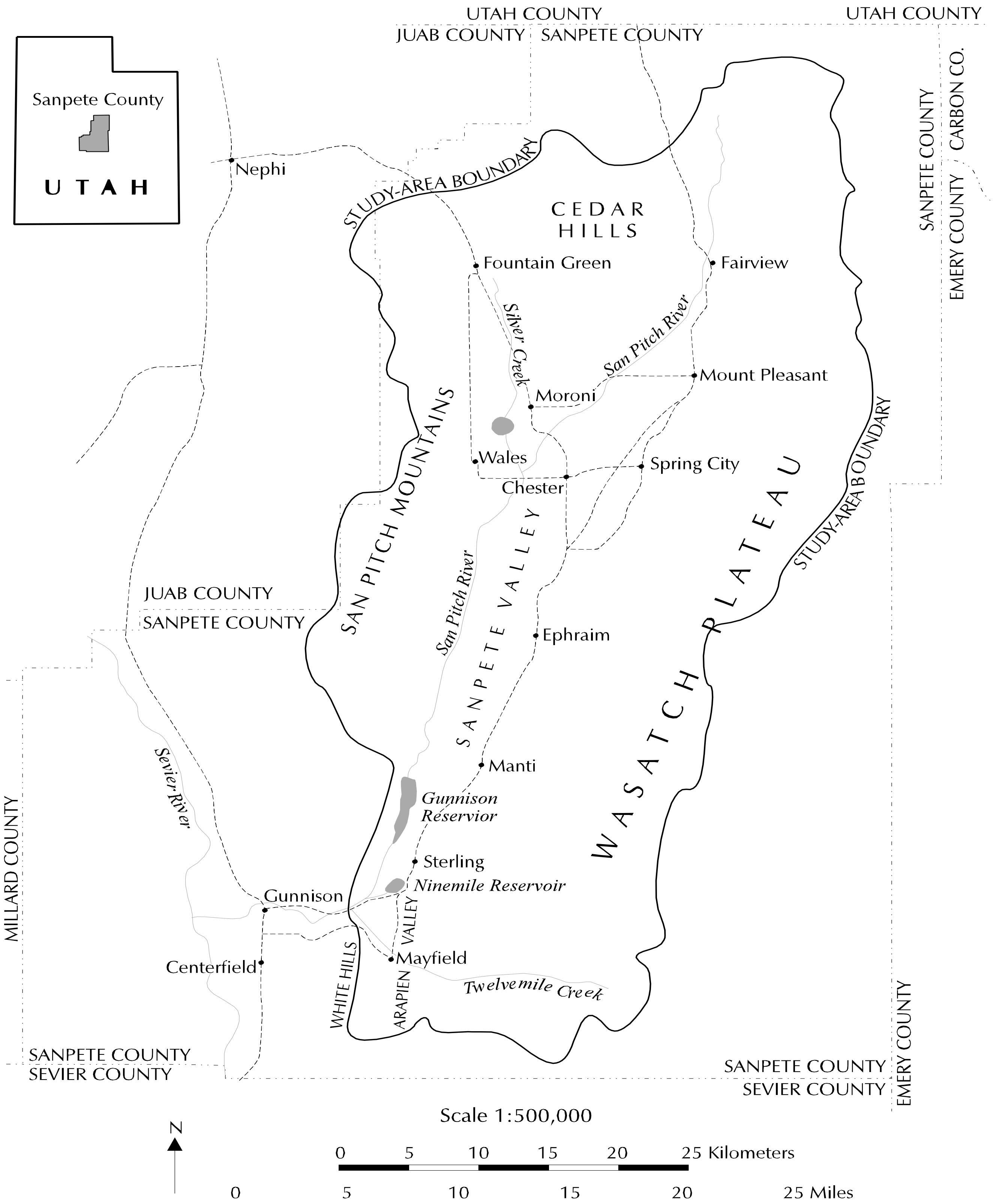


Figure 1. Sanpete Valley study area.

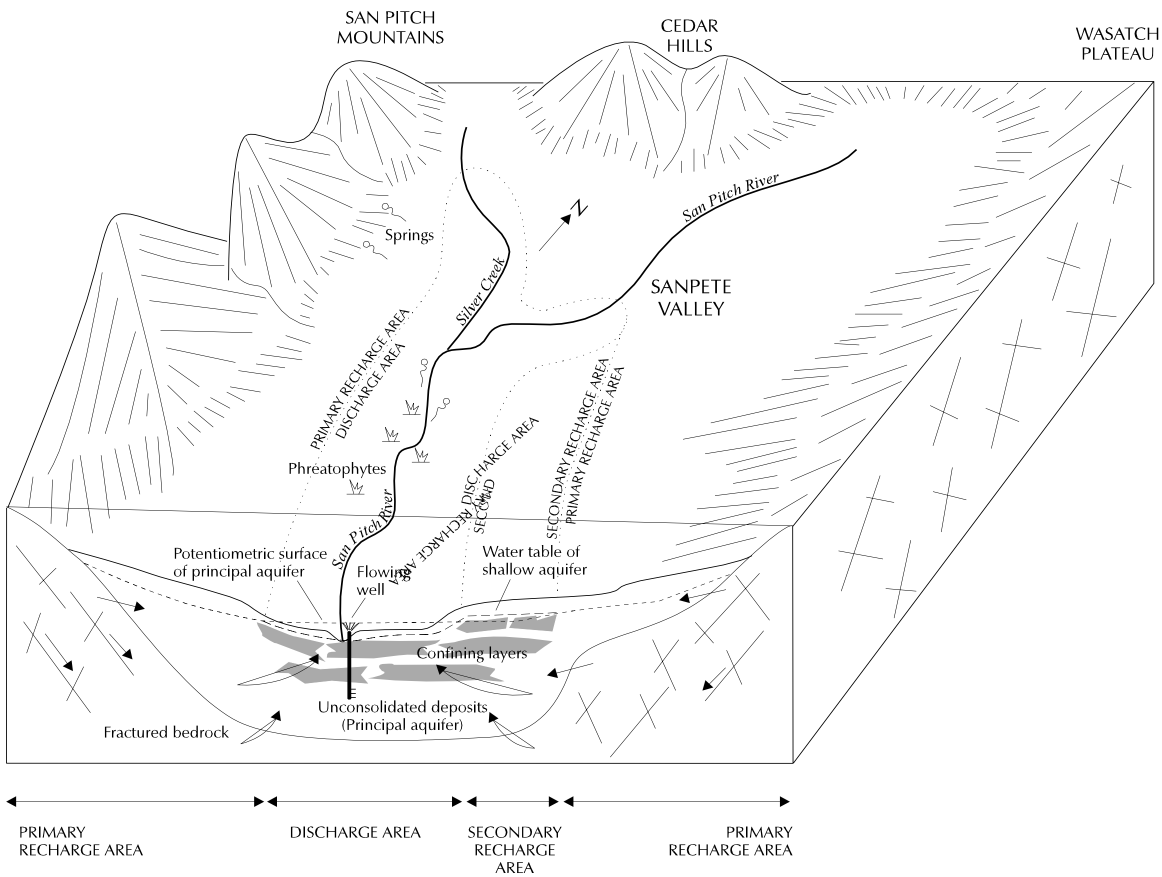


Figure 2. Schematic block diagram showing recharge areas and direction of ground-water flow in Sanpete Valley.

The geology of the Nephi 30' × 60' quadrangle, which includes the northern part of the study area, was mapped by Witkind and Weiss (1991). Witkind and others (1987) mapped the Manti 30' × 60' quadrangle, which includes the southern part of the study area. Recently published 7.5-minute geologic quadrangle maps within the study area include Banks (1991), Fong (1995), Jensen (1993), Lawton and Weiss (1994), and Weiss (1994).

METHODS

The methods used in this study for identifying confining layers, classifying aquifers, and delineating recharge and discharge areas are modified from those of Anderson and others (1994). This study is concerned with the principal aquifer and local overlying shallow unconfined aquifers (figure 2). The principal aquifer is the most important source of ground water, and may be confined or unconfined. The principal aquifer begins at the mountain front on either side of the valley where coarse-grained alluvial-fan sediments predominate and ground water is generally unconfined. Valleyward, fine-grained silt and clay strata may form confining layers above and within the principal aquifer. Water in sediments above the top confining layer is in a shallow, unconfined aquifer. This is generally a less important source of drinking water.

We used drillers' logs of water wells to delineate primary or secondary recharge areas and discharge areas, based on the presence of confining layers and relative water levels in the principal and shallow unconfined aquifers. We compiled a database of well-log information (appendix). The use of drillers' logs requires interpretation because of the variable quality of the logs. Correlation of geology from well logs is difficult because lithologic descriptions are generalized and commonly inconsistent among various drillers. The use

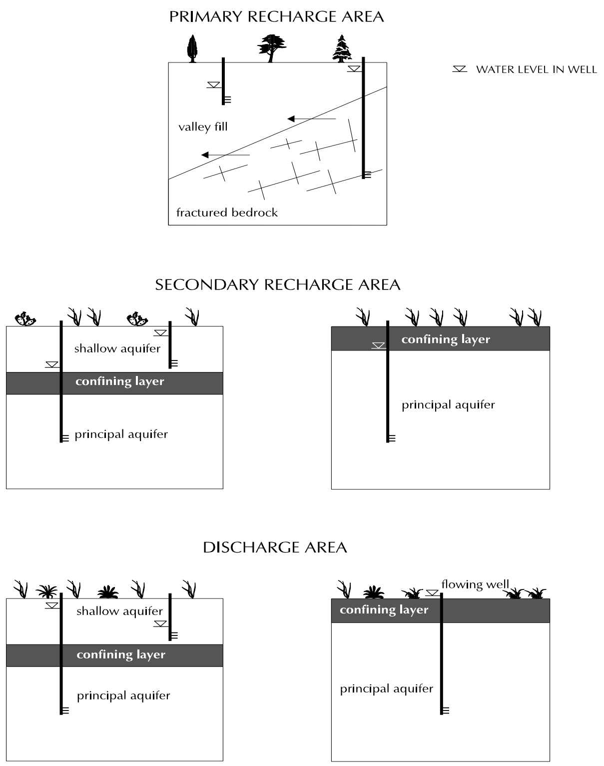


Figure 3. Relative water levels in wells in recharge and discharge areas.

of water-level data from well logs is also problematic because levels in the shallow unconfined aquifer are often not recorded and because water levels were measured during different seasons and years.

Confining layers are any fine-grained (clay and/or silt) layer thicker than 20 feet (6 m) (Anderson and others, 1994). Sometimes a driller will note both clay and sand along the same interval on logs, without giving relative percentages; these are not classified as confining layers (Anderson and others, 1994). If both are checked and the word "sandy" is written in the remarks column, then the layer is assumed to be a primarily clay confining layer (Anderson and others, 1994). Sometimes a driller will mark clay and gravel, cobbles, or boulders; these units also are not classified as confining layers, although, in some areas in Sanpete Valley, they behave as confining layers.

The primary recharge area for the principal aquifer is the uplands surrounding the valley, and valley fill not containing thick clay layers, generally along valley margins (figure 3). Ground-water flow in primary recharge areas has a downward component. If present, secondary recharge areas begin where clay layers are thicker than 20 feet (6 m), still with a downward hydraulic gradient, and extend toward the valley center until the gradient is upward (figure 3). The hydraulic gradient is upward when the potentiometric surface of the principal aquifer is higher than the water table in the shallow unconfined aquifer (Anderson and others, 1994). Water-level data for the shallow unconfined aquifer are not common, but can be found on some well logs. Where the confining layer extends to the ground surface, secondary recharge areas are where the potentiometric surface in the principal aquifer is below the ground surface.

Ground-water-discharge areas are at lower elevations than recharge areas. In discharge areas, the water in confined aquifers discharges to the land surface or to a shallow unconfined aquifer (figure 3). For this to happen, the hydraulic head in the principal aquifer must be higher than the water table in the shallow unconfined aquifer. Otherwise, downward pressure from the shallow aquifer will exceed the upward pressure from the confined aquifer, creating a net downward gradient indicative of secondary recharge areas. Flowing (artesian) wells are marked on drillers' logs and sometimes on U.S. Geological Survey 7.5'

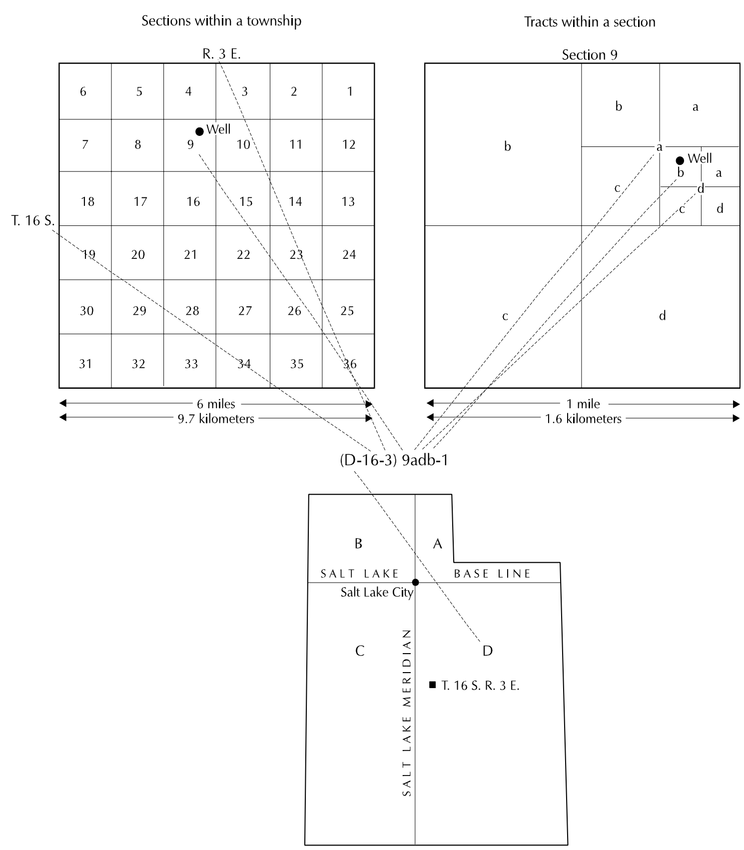


Figure 4. Numbering system for wells in Utah.

quadrangle maps. Wells with potentiometric surfaces above the top of the confining layer can be identified from well logs. Surface water, springs, or phreatophytic plants (wetlands) can be another indicator of ground-water discharge. However, in some instances this discharge may be from a shallow unconfined aquifer. It is necessary to understand the topography, surficial geology, and ground-water hydrology before using these wetlands to indicate discharge from the principal aquifer.

We generally did not map small secondary recharge or discharge areas defined by local clay layers in only a few wells where surrounded completely by primary recharge areas. Contaminants entering the aquifer system above these clay layers of local extent still have a high potential to reach primary recharge areas.

The numbering system for wells in this study is based on the U.S. government cadastral land-survey system that divides Utah into four quadrants (A-D) separated by the Salt Lake Base Line and Meridian (figure 4). The study area is entirely within the southeast quadrant (D). The wells are numbered with this quadrant letter D, followed by township and range enclosed in parentheses. The next set of characters indicates the section, quarter section, quarter-quarter section, and quarter-quarter-quarter section designated by letters a through d, indicating the northeastern, northwestern, southwestern, and southeastern quadrants, respectively. A number after the hyphen corresponds to an individual well within a quarter-quarter-quarter section. For example, the well (D-16-3) 9adb-1 would be the first well in the northwest quarter of the southeastern quarter of the northeastern quarter of section 9, Township 16 South, Range 3 East (NW¼SE¼NE¼ section 9, T. 16 S, R. 2. E).

GEOLOGY

Bedrock

The San Pitch Mountains and Wasatch Plateau both consist of Tertiary to Jurassic sedimentary rocks (figure 5). Tertiary limestones and mudstones cap both ranges. Cretaceous sandstones and conglomerates underlie the Tertiary rocks and are folded by the Wasatch monocline in the Wasatch Plateau on the eastern side of the valley. Beneath the Cretaceous units is the Jurassic Arapien Shale, a less competent unit that is believed to have been eroded away during creation of Sanpete Valley (Standlee, 1982; Witkind and Weiss, 1991). The Arapien contains evaporite deposits which are mobile and will deform plastically when buried or subjected to tectonic stresses. Upward-moving evaporite diapirs have deformed Quaternary sediments near Gunnison Reservoir, and near Redmond, southwest of the study area (Hecker, 1993). Witkind and Weiss (1991) propose that diapirism with subsequent dissolution and collapse is responsible for the emplacement and erosion of the Arapien Shale in Sanpete Valley. Others propose westward-trending (east-dipping) thrusts causing tectonic thickening as a structural mechanism to explain the rise of the Arapien from beneath the overlying Cretaceous and Tertiary sediments (Standlee, 1982).

The Cedar Hills (figure 5) largely consist of the Tertiary volcaniclastic and pyroclastic Moroni Formation. Tuffs and andesites in the formation weather to clay, as do Tertiary shales, mudstones, and claystones in the Wasatch Plateau and San Pitch Mountains. Erosion of these fine-grained rocks is the likely source of the clay confining layers in Sanpete Valley.

Unconsolidated Sediments

Sanpete Valley is filled with Pleistocene and Holocene alluvial-fan deposits, and stream and floodplain alluvium (Robinson, 1971). In the widest part of Sanpete Valley, from Ephraim to Moroni, valley fill is as much as 500 feet (150 m) thick (Robinson, 1971). The alluvial-fan deposits consist of interfingered and interbedded layers of boulder- to clay-sized sediment (Robinson, 1971). Alluvial-fan sediments get finer toward the valley center and interfinger with stream and floodplain alluvium along the San Pitch River. The stream alluvium generally includes cobbles to clay (Robinson, 1971). Clay deposits, possibly of lacustrine origin, are found in the south-central part of Sanpete Valley near Gunnison Reservoir (Robinson, 1971; Weiss, 1994). These clays could have been deposited in a small, shallow lake created by a landslide dam near the southern end of what is now Gunnison Reservoir. If continuous, this fine-grained layer could be an important confining bed.

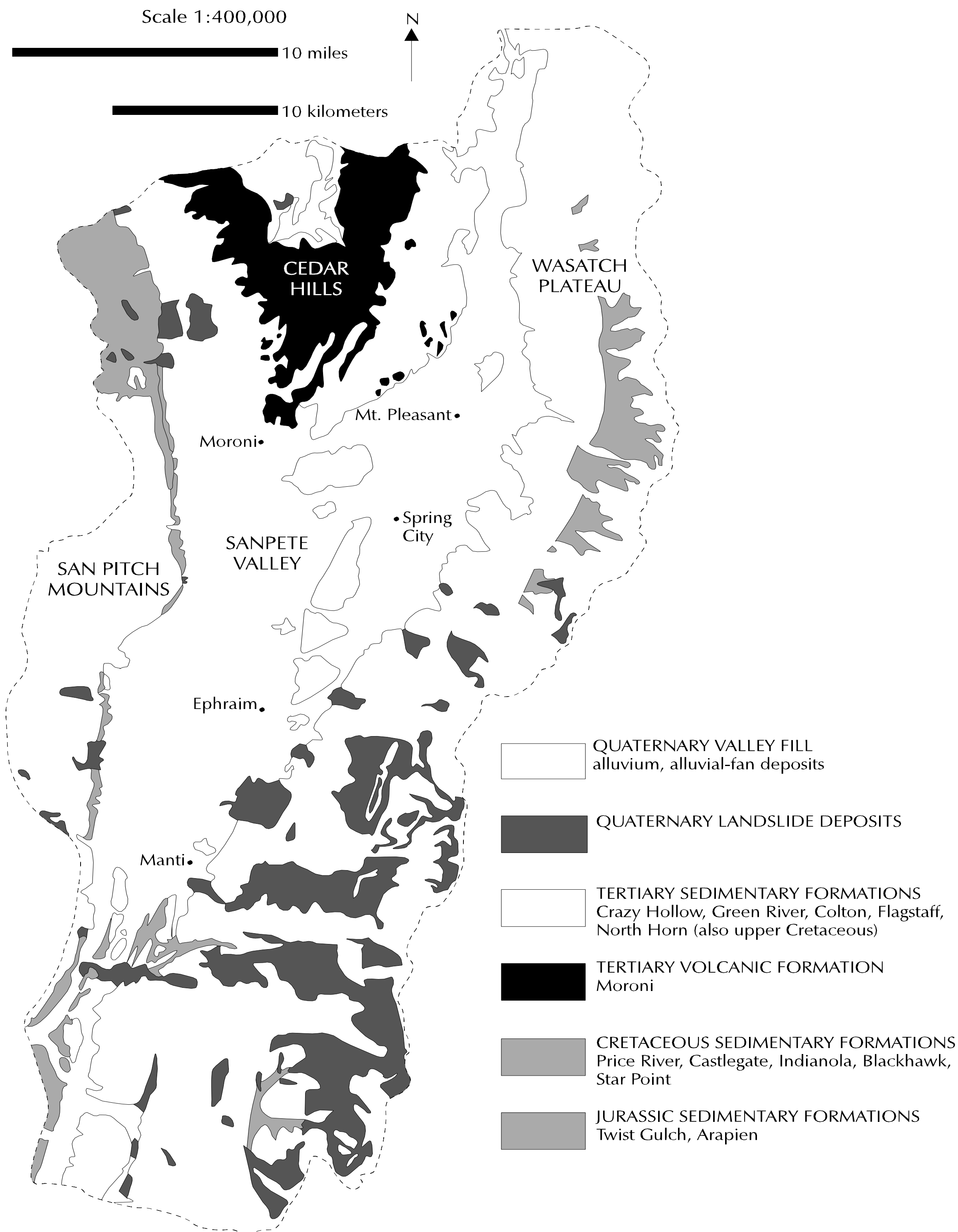


Figure 5. Geologic map of the San Pitch River drainage basin (after Witkind and others, 1987; Witkind and Weiss, 1991).

GROUND WATER

Ground water is in both fractured bedrock and unconsolidated deposits in Sanpete Valley. The source of most ground water in the study area is from precipitation. An annual average 800,000 acre-feet (1 billion m^3) of precipitation falls in the San Pitch River drainage basin (Robinson, 1971). A small amount of water reaches the basin through diversions from the Colorado River drainage to the east. Due to the east-dipping strata of the San Pitch Mountains, some water may also enter the drainage basin through bedrock west of the divide.

The quality of ground water in Sanpete Valley is high, except for local nitrate contamination. Protection regulations for drinking water and ground water in Utah classify ground water, based largely on total-dissolved-solids concentrations, as follows: class IA (pristine), less than 500 mg/L; class II (drinking water quality), 500 to 3,000 mg/L; class III (limited use), 3,000 to 10,000 mg/L; and class IV (saline), more than 10,000 mg/L. Class IA and II waters are considered suitable for drinking, provided concentrations of individual contaminants do not exceed state and federal ground-water-quality standards. Any water with total-dissolved-solids concentrations in the higher part of the class II range is generally suited for drinking water only if treated, but can be used for some agricultural or industrial purposes without treatment. Most water in Sanpete Valley is class IA and II.

Fractured-Rock Aquifers

Water is found in the fractured bedrock beneath and surrounding Sanpete Valley. Few wells are drilled into the fractured-rock aquifer, mostly because the valley-fill aquifer in Sanpete Valley is so productive (Robinson, 1971). However, the fractured-rock aquifers are responsible for some of the recharge to the valley-fill aquifer.

Aquifer Characteristics

Bedrock wells provide water for agricultural and culinary uses in only a few places in Sanpete Valley. Fractured-rock aquifers are both unconfined and confined in the mountains, but are generally under confined conditions beneath the valley fill (Robinson, 1971). Bedrock artesian wells drilled through valley sediments into limestone and sandstone of the Green River Formation are an important source of irrigation water near Manti, and from Spring City to Fairview (Robinson, 1971). An oil well 9,000 feet (2,700 m) deep drilled from an elevation of 7,364 feet (2,245 m) through the west-dipping rocks of the Wasatch Plateau had artesian pressure (Robinson, 1971). Water is found locally in almost all of the bedrock formations in the San Pitch River drainage basin.

Water in bedrock travels in fractures, pore spaces, and dissolution channels (in carbonate rocks). In Sanpete Valley, most ground-water flow in bedrock is in fractures. Aquifer characteristics such as transmissivity, storativity, and hydraulic conductivity are variable in fractured-rock aquifers. Robinson (1971) reports a wide range of transmissivities for different formations. The Green River Formation ranges from 400 feet squared per day (125 m^2/day) to 134,000 feet squared per day (41,000 m^2/day). The higher value is assumed to be the result of the well intersecting solution channels in oolitic limestone (Robinson, 1971). In general, other formations have transmissivities less than 7,800 square feet per day (2,400 m^2/day) (Robinson, 1971).

Recharge and Discharge

Precipitation in the San Pitch Mountains, Cedar Hills, and Wasatch Plateau either runs off in streams or percolates through the thin surficial deposits and recharges fractured-rock aquifers. Water then travels through fractures and pore spaces generally toward the valley. In the San Pitch Mountains, some bedrock ground water discharges in springs at the edge of the valley fill. A notable example is Big Springs, one mile (1.6 km) west of Fountain Green, thought to be supplied by water traveling downdip in the Indianola Group (Robinson, 1971). In the folded rocks of the Wasatch monocline, water also travels toward the valley. Water in the monocline discharges to the surface at numerous springs that contribute to mountain streams, as well as to springs along the mountain front.

Ground water in bedrock that is not discharged to the surface as springs flows into or under the valley fill, and becomes a source of recharge to the valley-fill aquifer (Robinson, 1971). The confined water beneath the valley fill contributes to the artesian pressure in the valley-fill aquifer near the center of the valley. Robinson (1971) cited three examples of evidence for ground-water flow and local confined conditions in bedrock: (1) sinkholes and solution channels in the Wasatch Plateau, (2) artesian wells in bedrock on the Wasatch Plateau, and (3) artesian wells drilled into bedrock underlying valley fill near Manti and Spring City.

Water Quality

Water quality from fractured-rock aquifers in the San Pitch River drainage varies widely. Water in mountain recharge areas has little opportunity for contamination, due to the relative lack of human activity. However, dissolved constituents from rock can make the water too saline for culinary use. Water from wells in the Green River and Crazy Hollow Formations, below the valley fill, have yielded water that is at the saline end of Class II (Robinson, 1971), and as a result is not suitable for culinary use. Evaporites from the Arapien Shale beneath the San Pitch Mountains are thought to be the cause of increased ground-water salinity in this area (Wilberg and Heilweil, 1995).

Unconsolidated Valley-Fill Aquifer

The unconsolidated valley-fill aquifer is the most important source of water for wells in Sanpete Valley.

Aquifer Characteristics

The valley fill consists of interfingered layers of clay, silt, sand, and gravel. In general, the coarser grained material is in alluvial fans along the mountain fronts, and the finer grained material is in the central portions of the valley. Thick, fine-grained layers extend up to the base of the San Pitch Mountains at the western edge of Sanpete Valley. On the eastern edge, alluvial-fan sand and gravel extend farther into the valley.

Artesian conditions exist where clay overlies coarser sediments along the San Pitch River below its confluence with Silver Creek, and along Silver Creek in the northwestern arm of the valley. In the northern part of the discharge area, from about 3 miles (5 km) south of Wales, there is one generally uniform confined aquifer, 100 to 200 feet (30-60 m) deep (Robinson, 1971). To the south, several distinct confining layers are present in the principal valley-fill aquifer, and wells of different depths in close proximity can have different hydraulic heads (Robinson, 1971). These distinct confining layers are of limited extent, but overlap and combine to form a generally continuous confining layer (figure 2). Water-table conditions exist in the northeastern arm, north of Fairview, and along the base of the Wasatch Plateau on the eastern side of Sanpete Valley. In these areas, depths to ground water range from 100 feet (30 m) in alluvial fans to 10 to 30 feet (3-9 m) near the San Pitch River (Robinson, 1971). The principal aquifer is unconfined only in a narrow band along the western side of Sanpete Valley, where water is less than 60 feet (18 m) beneath the surface of the alluvial fans (Robinson, 1971). Water-table conditions are found in Arapien Valley (Robinson, 1971).

Transmissivity varies widely within the valley-fill aquifer. Robinson (1971) reported a range of 550 to 50,000 square feet per day (170 to 15,600 m^2/day). Low values are typically from artesian aquifers with thin sand and gravel layers or aquifers with clay and silt mixed throughout. High values are from the upper reaches of alluvial fans where the sediments are coarser.

Recharge and Discharge

From mountain recharge areas, ground water generally moves toward the center of the valley, where it flows south with the San Pitch River and Silver Creek (Robinson, 1971). Some ground water is discharged as springs and seeps, which also contributes to surface flow, particularly along Silver Creek north of Wales Reservoir. Additional ground water is discharged for agricultural and domestic use from wells. Southwest of Manti, Sanpete Valley narrows and is constrained by bedrock outcrops which impede most ground-water flow out of the valley (Robinson, 1971). Hence the only outlet is the San Pitch River through Gunnison Reservoir. The confined ground water is forced to the surface and forms a large marshy area that extends as far north as Manti, about 2 miles (3.2 km). This marshy area once reached as far north as Ephraim, about 8 miles (13 km) (Robinson, 1971). Phreatophytic plants thrive in this region of shallow ground water and are responsible for significant discharge into the atmosphere through evapotranspiration (Wilberg and Heilweil, 1995).

Most recharge to the valley-fill aquifer in Sanpete Valley is at the mouths of canyons, mostly due to seepage from streams (Robinson, 1971). Subsurface inflow of water from bedrock along valley margins is also an important source of recharge, although quantification is difficult (Robinson, 1971; Wilberg and Heilweil, 1995). Other sources of recharge include seepage of irrigation water and direct precipitation on the valley floor.

Primary recharge areas are the mountains and alluvial fans surrounding Sanpete Valley (plate 1). Most of the northeastern arm of the valley lacks thick clays to form confining layers and is a primary recharge area. Tertiary mudstones and limestones in the Wasatch Plateau provide fine-grained sediments for alluvial-fan deposits which form a band of secondary recharge areas along the eastern edge of southern Sanpete Valley (figure 5, plate 1). In the northern San Pitch Mountains, coarse-grained Cretaceous conglomerates predominate, therefore alluvial-fan deposits are coarser than those on the eastern side of the valley, and secondary recharge areas are present only near the distal ends of alluvial fans (figure 5; plate 1). Water quality for the principal aquifer west of Moroni is similar to that in the San Pitch Mountains, indicating that recharge is directly from the mountains (Horns, 1995). The main discharge area follows the lowlands along the San Pitch River from 1 mile (1.6 km) west of Mount Pleasant to Gunnison Reservoir. Silver Creek in the northwestern arm is also within the discharge area. Primary recharge areas predominate south of Gunnison Reservoir and in Arapien Valley.

Water Quality

In general, the highest quality water is near mountain recharge areas and in alluvial fans along the base of the Wasatch Plateau. Water entering valley fill from the San Pitch Mountains tends to have a higher concentration of dissolved solids, probably from evaporite layers in the Arapien Shale (Robinson, 1971). Higher concentrations of dissolved solids are also found in the Chester and Spring City area, where recharge comes directly off outcrops of the Green River and Crazy Hollow Formations (Wilberg and Heilweil, 1995). Most of the water in the valley-fill aquifer is class IA or II. Almost all of the ground water in Sanpete Valley is very hard (Robinson, 1971).

High nitrate levels in ground water have been found in Sanpete Valley. State water-quality standards set the maximum contamination level (MCL) for nitrate at 10 mg/L. A number of wells in Sanpete Valley exceed 40 mg/L nitrate (Horns, 1995), and Robinson (1968) documents nitrate concentrations up to 43 mg/L in ground water. Ground water from a city well in Moroni exceeded the MCL in August 1994, and nitrate contaminant plumes in and one mile north of Moroni have been mapped by Horns (1995). Ground water from a city well in Manti contains about 4.5 mg/L nitrate. The origin of the nitrate has not been determined, but possible sources are:

a. Septic-tank soil-absorption systems. Six towns with populations from 1,000 to 5,000 used septic systems for wastewater treatment until the past few years when sewer systems were constructed. Fairview still uses septic systems.

b. Agricultural fertilizer. Agricultural fertilizers are used extensively on irrigated hay fields, small grain fields, and pastures.

c. Feed lots. Feed lots are common in Sanpete Valley. Cattle and poultry (mostly turkey) are the main products and exports for the area. Turkey manure is commonly stored on the ground until dry; then it is bagged.

d. Natural sources. Evaporite deposits of potassium nitrate on rock or in K (caliche) horizons in clayey soils have been found in Sanpete Valley (Mansfield and Boardman, 1932).

No studies have been conducted to determine the valley-wide distribution or seasonal variations in nitrate and total-dissolved-solids concentrations.

Potential for Water-Quality Degradation

The nitrate contamination in some Sanpete Valley wells underscores the need to identify recharge areas and understand the flow of ground water in the valley. Much of the water in the principal valley-fill aquifer comes from the mountains where few pollutants enter the system, but contamination sources in valley recharge areas are common and can cause water-quality degradation. Care must be taken in siting potential contaminant sources, such as feed lots and septic tanks, especially in primary recharge areas. The widespread clay layers in the center of Sanpete Valley may provide some protection to the principal aquifer, but their lateral continuity is not assured. Further study is required to make specific evaluations of sources and effects of contaminants.

SUMMARY AND CONCLUSIONS

The principal valley-fill aquifer of Sanpete Valley consists of coarse-grained alluvial-fan deposits and stream and floodplain alluvium. The aquifer is confined by fine-grained sediments throughout much of the main valley and in the western arm. Water-table conditions are found in the principal aquifer in the northeastern arm of the valley. The mountains that surround Sanpete Valley and the uppermost parts of alluvial fans along the margins of the valley make up the primary recharge area. Secondary recharge areas are mostly at the base of the Wasatch Plateau along the eastern margin of the valley fill. Discharge areas are along Silver Creek and the lower San Pitch River. Ground-water flow is generally from the mountains toward the center of the valley, and then south along the San Pitch River. Water quality is generally very good, class 1A and II, although local nitrate-contamination problems underscore the need to consider the potential for ground-water contamination in land-use decisions.

ACKNOWLEDGMENTS

This study was supported by a grant from the U.S. Environmental Protection Agency, administered by the Utah Division of Water Quality. Thanks to Margie Wilkins at the Utah Division of Water Rights for supplying well logs and digital well data, and the Utah Automated Geographic Reference Center for allowing Janine Jarva to use their digital compilation facilities.

REFERENCES

Anderson, P.B., Susong, D.D., Wold, S.R., Heilweil, V.M., and Baskin, R.L., 1994, Hydrogeology of recharge areas and water quality of the principal aquifers along the Wasatch Front and adjacent areas, Utah: U.S. Geological Survey Water-Resources Investigations Report 93-4221, 74 p., scale 1:100,000.

Ashcroft, G.L., Jensen, D.T., and Brown, J.L., 1992, Utah climate: Utah Climate Center, Utah State University, 127 p.

Banks, R.L., 1991, Provisional geologic map of the Fountain Green North quadrangle, Sanpete and Juab Counties, Utah: Utah Geological Survey Map 134, 21 p., scale 1:24,000.

Fong, A.W., 1995, Geologic map of the Fountain Green South quadrangle, Juab and Sanpete Counties, Utah: Utah Geological Survey Map 95-1, 18 p., scale 1:24,000.

Hecker, Suzanne, 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p.

Horns, D.M., 1995, Nitrate contamination of the Moroni, Utah municipal water supply and hydrologic control on nitrate contamination, *in* Lund, W.R., editor, Environmental and engineering geology of the Wasatch Front region: Utah Geological Association Publication 24, p. 431-442.

Jensen, N.R., 1993, Interim geologic map of the Fairview quadrangle, Sanpete County, Utah: Utah Geological Survey Open-File Report 300, scale 1:24,000.

Lawton, T.F., and Weiss, M.P., 1994, Interim geologic map of the Wales quadrangle: Utah Geological Survey Open-File Report 312, 94 p., scale 1:24,000.

Mansfield, G.R., and Boardman, Leona, 1932, Nitrate deposits in the United States: U.S. Geological Survey Bulletin 838, 107 p.

Robinson, G.B., 1968, Selected hydrologic data San Pitch River drainage basin, Utah: U.S. Geological Survey Utah Basic-Data Release No. 14, 44 p., scale 1:250,000.

----1971, Ground-water hydrology of the San Pitch River drainage basin, Sanpete County, Utah: U.S. Geological Survey Water-Supply Paper 1896, 80 p., scale 1:125,000.

Standlee, L.A., 1982, Structure and stratigraphy of Jurassic rocks in central Utah--their influence on tectonic development of the Cordilleran foreland thrust belt, *in* Powers, R.B., editor, Geologic studies of the Cordilleran thrust belt: Rocky Mountain Association of Geologists, v. 1, p. 357-382.

Stokes, W.L., 1977, Subdivisions of the major physiographic provinces in Utah: Utah Geology, v. 4, no. 1, p. 1-17.

Weiss, M.P., 1994, Geology of the Sterling quadrangle, Sanpete County, Utah: Utah Geological Survey Open-File Report 159, 26 p., scale 1:24,000.

Wilberg, D.E., and Heilweil, V.M., 1995, Hydrology of Sanpete Valley, Sanpete and Juab Counties, Utah, and simulation of ground-water flow in the valley-fill aquifer: Utah Division of Water Rights Technical Publication No. 113, 121 p., scale 1:100,000.

Witkind, I.J., and Weiss, M.P., 1991, Geologic map of the Nephi 30' × 60' quadrangle, Carbon, Emery, Juab, Sanpete, Utah, and Wasatch Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1937, 16 p., scale 1:100,000.

Witkind, I.J., Weiss, M.P., and Brown, T.L., 1987, Geologic map of the Manti 30' × 60' quadrangle, Carbon, Emery, Juab, Sanpete, and Sevier Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1631, scale 1:100,000.

APPENDIX

Records of Wells, Sanpete Valley, Utah

Site number: See plate 1 for well location. Wells not used to define recharge and discharge areas are not plotted.
Local well number: See text for explanation of numbering system.
Elevation: In feet above sea level.
Well depth: In feet below land surface.
Recharge area: Y, primary recharge area; 1, secondary recharge area; N, discharge area; 2, well completed in shallow unconfined aquifer.
Water level: In feet below land surface, or feet above land surface for "+" values; +F, flowing well.
Top of confining layer: Depth to first confining layer, in feet below land surface.
Bottom of confining layer: Depth to bottom of first confining layer, in feet below land surface.
Depth to bedrock: In feet below land surface; N, bedrock not encountered.
Top of perforations: Depth to top of perforations, in feet below land surface.
Bottom of perforations: Depth to bottom of all perforations, in feet below land surface; MI, multiple perforated intervals, below bottom of uppermost perforated interval.

--, no data available

Site Number	Local well number	Year well drilled	Elev-ation (ft)	Well depth (ft)	Re-charge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor-ations (ft)	Bottom of perfor-ations (ft)	Notes
63	(D-14-2) 12aad-1	1948	5870	139	Y	1	04/27/48	--	--	N	15	139	
64	(D-14-2) 12dcd-1	1970	5810	--	N	+F	11/04/70	--	--	--	--	--	no log
65	(D-14-2) 13cad-1	1964	5810	80	Y	63	03/20/64	--	--	N	--	--	
66	(D-14-2) 13daa-1	1994	5750	95	Y	7	04/20/94	--	--	N	--	--	
67	(D-14-2) 24abb-1	1976	5780	120	Y	69	05/22/76	--	--	N	--	--	
68	(D-14-2) 24dac-1	1993	5700	130	Y	24	12/08/93	--	--	N	--	--	
75	(D-14-3) 7bbb-1	1976	5870	344	Y	5	04/07/76	--	--	N	30	280 MI	
76	(D-14-3) 7bdd-1	1951	5800	82	Y	10	05/00/51	--	--	N	8	63 MI	
77	(D-14-3) 7cba-1	1941	5810	150	--	--	--	--	--	--	--	--	no log
80	(D-14-3) 17cbc-1	1967	5670	80	Y	50	04/17/67	--	--	N	--	--	
81	(D-14-3) 17cbc-2	1941	5670	133	Y	37	08/12/41	--	--	N	35	130	
82	(D-14-3) 17cca-1	1978	5665	201	Y	48	05/15/78	--	--	N	50	201	
83	(D-14-3) 17ccb-1	1982	5665	100	1	40	07/17/82	50	85	N	--	--	
87	(D-14-3) 18aac-1	1977	5720	93	Y	46	09/24/77	--	--	N	--	--	
88	(D-14-3) 18adb-1	1940	5695	150	Y	42	06/06/40	--	--	N	42	104 MI	
90	(D-14-3) 18dca-1	1958	5610	132	Y	80	--	--	--	N	--	--	
91	(D-14-3) 18dbd-1	1979	5720	212	Y	110	05/19/79	--	--	140	140	212	
95	(D-14-3) 20bba-1	1934	5645	151	Y	32	12/16/34	--	--	N	40	150	
96	(D-14-3) 20bcb-1	1935	5630	147	Y	32	01/24/35	--	--	N	42	57	
103	(D-14-3) 28cbc-1	1981	5600	160	Y	40	02/09/81	--	--	120	120	160	bedrock well
105	(D-14-3) 28cbc-3	1962	5590	90	Y	32	02/25/62	--	--	N	35	90	
106	(D-14-3) 29cbb-1	1949	5590	82	N	2	04/18/49	51	82	N	--	--	
107	(D-14-3) 29ccb-1	1949	5595	146	N	1	04/21/49	0	22	N	--	--	
109	(D-14-3) 30aca-1	1980	5615	130	N	2	06/07/80	15	50	N	80	130	
110	(D-14-3) 30bba-1	1980	5670	100	Y	30	07/02/80	--	--	N	60	100	
111	(D-14-3) 30bda-1	1949	5635	38	1	38	05/13/49	0	37	N	--	--	
112	(D-14-3) 30dbc-1	1993	5640	90	Y	24	06/14/93	--	--	N	--	--	
113	(D-14-3) 30dbd-1	1965	5630	164	Y	7	10/16/65	--	--	100	122	162 MI	bedrock well
114	(D-14-3) 30dcc-1	1976	5645	61	1	17	05/22/76	0	58	N	--	--	
115	(D-14-3) 31acb-1	1973	5655	147	Y	34	05/15/73	--	--	N	123	129	
116	(D-14-3) 32aab-1	1957	5535	89	N	10	06/19/57	22	89	N	--	--	
118	(D-14-3) 32cbb-1	1985	5595	125	N	8	08/07/85	32	55	N	--	--	
120	(D-14-3) 32ccb-1	1955	5590	45	N	2	06/26/55	--	--	N	--	--	
122	(D-14-3) 32bac-1	1949	5550	65	N	4	05/11/49	33	65	N	--	--	
126	(D-14-3) 33bdc-1	1969	5610	164	1	44	12/21/69	15	76	N	--	--	
127	(D-14-3) 33dba-1	1994	5670	165	Y	100	07/27/94	--	--	N	--	--	
184	(D-14-4) 33cbb-1	1949	5700	45	Y	28	10/10/49	--	--	N	--	--	
185	(D-14-4) 33cdc-1	1986	5735	50	Y	14	10/18/86	--	--	N	--	--	
204	(D-15-2) 13cdc-1	1971	6000	293	1	27	07/29/91	0	38	N	--	--	
206	(D-15-2) 24dbb-1	1993	5640	160	1	--	--	65	104	N	--	--	
207	(D-15-2) 24dbc-1	1994	5700	225	1	100	04/21/94	40	80	N	--	--	
208	(D-15-2) 24ccb-1	1975	6440	318	1	90	01/00/75	60	95	N	--	--	

Site Number	Local well number	Year well drilled	Elev-ation (ft)	Well depth (ft)	Re-charge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor-ations (ft)	Bottom of perfor-ations (ft)	Notes
209	(D-15-2) 24dda-1	1987	5615	120	N	30	05/15/87	--	--	N	--	--	
215	(D-15-3) 4abb-1	1985	5600	145	Y	80	05/08/85	--	--	N	--	--	
216	(D-15-3) 4bbd-1	1979	5560	100	--	--	--	0	40	N	60	100	no water levels
217	(D-15-3) 4bda-1	1955	5580	71	N	--	--	25	46	N	--	--	
218	(D-15-3) 4bdb-1	1955	5550	111	N	+F	--	--	--	N	--	--	
219	(D-15-3) 4daa-1	1953	5700	110	Y	5	06/30/53	--	--	N	75	110	
221	(D-15-3) 5bdd-1	1953	5552	146	N	2	07/15/53	21	66	N	--	--	
223	(D-15-3) 6cab-1	1953	5650	38	N	3	11/06/53	--	--	N	--	--	
224	(D-15-3) 6cad-1	1953	5630	45	N	2	11/20/53	--	--	N	--	--	
225	(D-15-3) 6ccd-1	1951	5630	66	N	7	04/18/51	21	65	N	--	--	
226	(D-15-3) 6dbd-1	1951	5610	71	N	3	06/20/51	--	--	N	--	--	
230	(D-15-3) 7bbc-1	1965	5640	105	N	7	11/10/65	1	50	N	--	--	
231	(D-15-3) 7bbc-2	1971	5635	100	N	1	05/01/71	--	--	N	85	105	
233	(D-15-3) 7caa-1	1953	5590	67	N	2	01/14/53	0	20	N	--	--	
234	(D-15-3) 7cad-1	1953	5590	55	N	4	10/12/53	20	55	N	--	--	
238	(D-15-3) 7dcb-1	1989	5575	222	N	--	--	5	220	N	--	--	
241	(D-15-3) 8cdd-1	1951	5505	63	N	6	12/02/51	40	62	N	--	--	
244	(D-15-3) 9ddc-1	1956	5519	607	N	4	11/15/56	47	90	567	60	340 MI	bedrock well
245	(D-15-3) 9cdb-1	1957	5515	74	N	7	07/15/57	0	20	N	--	--	
247	(D-15-3) 10bda-1	1980	5620	260	Y	--	--	--	--	220	220	260	bedrock well
248	(D-15-3) 10ccb-1	1993	5534	30	1	10	11/17/93	5+	25	N	--	--	
249	(D-15-3) 10dba-1	1991	5570	185	Y	100	12/07/91	--	--	40	145	185	bedrock well
250	(D-15-3) 10dad-1	1966	5560	66	Y	8	11/01/66	--	--	N	--	--	
252	(D-15-3) 11cad-1	1980	5582	103	Y	60	--	--	--	85	80	103	
253	(D-15-3) 11cba-1	1992	5595	65	Y	35	04/20/92	--	--	20	50	--	bedrock well
254	(D-15-3) 11cbd-1	1974	5578	60	Y	15	08/12/74	--	--	50	50	60	bedrock well
255	(D-15-3) 11dba-1	1981	5600	140	Y	118	03/29/81	--	--	20	--	--	bedrock well
256	(D-15-3) 12bcc-1	1992	5583	100	1	6	11/10/92	3	25	N	63	67	
257	(D-15-3) 12bcb-1	1980	5588	100	1	--	--	0	60	N	80	100	
258	(D-15-3) 12bcb-2	1993	5588	104	N	14	11/19/93	36	66	N	--	--	
259	(D-15-3) 13daa-1	1987	5680	101	Y	--	--	--	--	N	60	101	
260	(D-15-3) 15ada-1	1975	5570	80	Y	28	--	--	--	38	47	--	bedrock well
261	(D-15-3) 15bbc-1	1984	5522	215	1	30	11/15/84	100	165	N	--	--	
262	(D-15-3) 15bbc-2	1948	5522	309	1	7	07/02/48	33	61	263	29	223	perf above clay
264	(D-15-3) 15cbd-1	1988	5523	40	2	6	07/17/88	--	--	N	20	40	shallow aquifer
265	(D-15-3) 15ccd-1	1934	5520	151	Y	14	08/26/34	--	--	47	10	40	
266	(D-15-3) 15cdc-1	1994	5519	108	1	--	--	73	94	N	--	--	
267	(D-15-3) 15ddc-1	1976	5580	85	Y	55	05/07/76	--	--	4	--	--	bedrock well
268	(D-15-3) 9ddc-2	1978	5525	340	Y	8	02/06/78	--	--	36	120	340	bedrock well
269	(D-15-3) 16abc-1	1951	5525	245	Y	45	07/12/51	--	--	230	112	230	
270	(D-15-3) 16acd-1	1952	5517	51	Y	4	05/31/52	--	--	N	--	--	
271	(D-15-3) 16bdb-1	1977	5512	425	N	+F	08/26/77	35	65	N	339	393	

Site Number	Local well number	Year well drilled	Elevation (ft)	Well depth (ft)	Recharge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perforations (ft)	Bottom of perforations (ft)	Notes
272	(D-15-3) 17ddd-1	1989	5505	40	N	10	07/17/89	10	32	N	--	--	
273	(D-15-3) 19bcb-1	1976	5575	264	N	3	05/26/76	0	59	N	--	--	
274	(D-15-3) 19cad-1	1973	5570	165	1	2	11/15/73	0	34	N	140	160	
275	(D-15-3) 19cbc-1	1976	5585	103	1	15	07/06/76	0	25	N	--	--	
276	(D-15-3) 19cca-1	1976	5590	92	1	36	07/01/76	65	90	N	--	--	
278	(D-15-3) 19dbc-1	1964	5560	168	N	1	06/10/64	0	41	N	--	--	
279	(D-15-3) 19dcb-1	1977	5565	173	N	2	10/08/77	0	29	N	--	--	
281	(D-15-3) 21ada-1	1952	5505	258	1	2	07/01/52	70	171	N	55	258 MI	
283	(D-15-3) 21bdd-1	1948	5500	139	1	14	06/04/53	35	65	N	131	139	
284	(D-15-3) 21bdd-2	1966	5500	106	Y	6	08/12/66	--	--	82	--	--	
285	(D-15-3) 21bbb-1	1951	5505	82	N	2	09/29/51	36	76	N	--	--	
287	(D-15-3) 22abc-1	1976	5570	135	Y	27	06/17/76	--	--	--	--	--	
288	(D-15-3) 22bcb-1	1961	5507	267	Y	6	03/23/61	--	--	200	45	215 MI	
289	(D-15-3) 22bdb-1	1976	5530	260	1	9	04/05/76	0	100	N	100	--	
290	(D-15-3) 22dad-1	1942	5560	99	Y	42	03/27/42	--	--	N	51	89	
293	(D-15-3) 25bbd-1	1983	5580	97	Y	5	08/20/83	--	--	35	--	--	
294	(D-15-3) 25bca-1	1990	5610	160	1	60	04/19/90	0	40	N	140	160	
295	(D-15-3) 25cad-1	1994	5640	100	N	8	08/29/94	2	60	85	--	--	
296	(D-15-3) 25dad-1	1960	5650	118	N	2	05/16/60	58	98	N	98	118	
297	(D-15-3) 25bcd-1	1970	5600	293	1	23	01/15/70	1	68	246	70	290	
298	(D-15-3) 26bcb-1	1993	5525	85	Y	15	10/05/93	--	--	N	--	--	
300	(D-15-3) 26ccd-1	1934	5515	115	Y	--	--	--	--	61	23	31	
301	(D-15-3) 26dca-1	1987	5539	85	Y	--	--	--	--	15	65	75	
302	(D-15-3) 26ddd-1	1971	5540	76	N	1	11/20/71	25	50	N	10	60	
303	(D-15-3) 27acb-1	1948	5515	120	N	12	09/29/48	56	81	N	--	--	
304	(D-15-3) 27ada-1	1949	5520	310	Y	1	11/12/49	--	--	34	100	100	bedrock well
305	(D-15-3) 27caa-1	1980	5505	100	--	--	--	40+	60	N	80	100	no water levels
306	(D-15-3) 27cca-1	1953	5490	178	N	1	06/04/53	41	82	N	--	--	
307	(D-15-3) 27dcb-1	1994	5497	85	N	1	06/23/80	25	80	N	--	--	
312	(D-15-3) 29cbc-1	1953	5540	85	N	2	11/28/53	21	45	N	--	--	
313	(D-15-3) 29cca-1	1953	5525	31	N	6	06/16/53	0	25	N	--	--	
314	(D-15-3) 29ccc-1	1964	5525	92	N	+F	05/21/64	36	72	N	--	--	
315	(D-15-3) 30aaa-1	1950	5540	47	N	4	09/17/50	10	46	N	--	--	
316	(D-15-3) 30cba-1	1978	5640	120	1	60	--	0	80	N	60	120	
317	(D-15-3) 30bda-1	1992	5590	310	1	27	11/06/92	0	40	N	0	175	
318	(D-15-3) 30bdc-1	1980	5620	120	1	--	--	10	80	N	80	120	
319	(D-15-3) 30cdb-1	1978	5635	120	1	60	08/20/78	0	80	N	80	120	
320	(D-15-3) 30dad-1	1962	5540	60	Y	60	--	--	--	N	--	--	
321	(D-15-3) 30dbc-1	1946	5595	300	1	41	06/30/46	11	37	N	41	295	
322	(D-15-3) 31aaa-1	1952	5530	58	Y	12	06/13/52	--	--	N	--	--	
323	(D-15-3) 31dbc-1	1952	5580	86	1	36	10/14/52	0	26	N	--	--	
324	(D-15-3) 31ddd-1	1953	5510	56	1	25	06/25/53	0	42	N	--	--	

Site Number	Local well number	Year well drilled	Elev-ation (ft)	Well depth (ft)	Re-charge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor-ations (ft)	Bottom of perfor-ations (ft)	Notes
326	(D-15-3) 32cca-1	1952	5490	40	Y	10	05/26/52	--	--	N	--	--	
331	(D-15-3) 34aaa-1	1981	5510	110	I	28	10/28/81	27	50	N	--	--	
332	(D-15-3) 34aab-1	1994	5505	105	I	15	07/08/94	3	40	N	--	--	
333	(D-15-3) 34aba-1	1940	5500	189	N	8	07/20/40	63	84	N	--	--	
336	(D-15-3) 34adb-1	1946	5495	125	N	4	07/08/46	--	--	--	--	--	no log
337	(D-15-3) 34bab-1	1993	5490	105	N	8	05/04/93	45	85	N	--	--	
339	(D-15-3) 34bda-1	1991	5490	81	N	6	12/09/91	45	80	N	--	--	
342	(D-15-3) 34dad-1	1993	5485	98	N	6	03/03/93	42	68	N	--	--	
343	(D-15-3) 35aaa-1	1954	5535	65	N	2	09/01/54	44	66	N	--	--	
344	(D-15-3) 35baa-1	1943	5518	90	I	5	08/04/43	0	29	N	--	--	
345	(D-15-3) 35bba-1	1994	5515	100	I	30	09/19/94	22	82	N	--	--	
347	(D-15-3) 35dad-1	1971	5535	--	N	+F	--	--	--	--	--	--	no log
348	(D-15-3) 35dda-1	1968	5525	68	N	8	10/14/68	22	60	N	--	--	
350	(D-15-3) 35ddd-1	1967	5550	68	N	2	08/28/67	68	108	N	--	--	
351	(D-15-3) 36bad-1	1960	5600	66	N	+F	04/10/60	--	--	N	54	66	
352	(D-15-3) 36cbb-1	1979	5535	409	N	0	09/02/79	--	--	180	250	409	bedrock well
365	(D-15-4) 4bcb-1	--	5725	62	Y	26	--	--	--	N	--	--	
364	(D-15-4) 4cba-1	1948	5741	353	Y	32	09/15/48	--	--	N	40	180	
367	(D-15-4) 5aca-1	--	5695	46	Y	23	--	--	--	N	--	--	
368	(D-15-4) 5bca-1	1995	5660	110	N	4	03/09/95	2	32	N	--	--	
369	(D-15-4) 5bdc-1	1978	5680	102	N	17	03/21/78	3	32	N	80	102	
370	(D-15-4) 5dca-1	1982	5695	72	N	8	02/30/82	21	70	N	--	--	
371	(D-15-4) 5dcd-1	1959	5690	90	Y	15	09/20/59	--	--	N	30	75	
372	(D-15-4) 5dda-1	1979	5710	100	Y	10	04/08/79	--	--	N	60	100	
373	(D-15-4) 6baa-1	1978	5660	120	Y	80	08/24/78	--	--	80	80	140	bedrock well
374	(D-15-4) 6bab-1	1977	5680	60	Y	15	02/05/77	--	--	23	--	--	bedrock well
375	(D-15-4) 6dad-1	1935	5650	70	Y	7	05/10/35	--	--	32	21	42	
376	(D-15-4) 6ddb-1	1993	5630	98	N	17	06/15/93	42	65	N	--	--	
381	(D-15-4) 9bca-1	1946	5735	60	Y	15	02/23/46	--	--	N	--	--	
382	(D-15-4) 9bdb-1	1949	5750	200	Y	30	09/17/49	--	--	N	30	160	
397	(D-15-4) 17abb-1	1949	5716	200	Y	21	05/29/49	--	--	N	25	125	
399	(D-15-4) 17bad-1	1948	5700	55	Y	--	--	--	--	N	--	--	
400	(D-15-4) 17ccb-1	1948	5690	150	Y	12	08/10/48	--	--	140	26	135	
401	(D-15-4) 17cca-1	1935	5692	43	I	24	06/12/35	1	24	N	--	--	
407	(D-15-4) 20daa-2	1976	5800	110	Y	39	10/26/76	--	--	30	90	110	bedrock well
408	(D-15-4) 20dbd-1	1992	5780	80	Y	30	11/13/92	--	--	N	--	--	
410	(D-15-4) 21cba-1	1980	5840	100	Y	--	--	--	--	N	80	100	
412	(D-15-4) 21ccc-1	1983	5840	100	I	60	12/13/83	25	80	N	80	100	
413	(D-15-4) 21cda-1	1952	5900	1200	Y	61	10/02/52	--	--	185	85	174	
416	(D-15-4) 27bbb-1	1976	6020	205	Y	160	12/27/76	--	--	90	185	205	bedrock well
417	(D-15-4) 28abb-1	1976	5940	175	Y	140	04/05/76	--	--	45	165	175	bedrock well
418	(D-15-4) 29bac-1	--	5750	210	I	20	--	0	25	158	32	109	

Site Number	Local well number	Year well drilled	Elev-ation (ft)	Well depth (ft)	Re-charge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor-ations (ft)	Bottom of perfor-ations (ft)	Notes
419	(D-15-4) 29cad-1	1954	5800	200	N	1	12/14/54	11	45	N	--	--	
421	(D-15-4) 30cbd-1	1965	5695	175	Y	14	04/26/65	--	--	50	80	174	bedrock well
422	(D-15-4) 30cac-1	1984	5700	85	Y	30	11/20/84	--	--	18	--	--	bedrock well
423	(D-15-4) 30ddc-1	1955	5745	255	Y	12	01/27/56	--	--	N	--	--	
425	(D-15-4) 31ddc-1	1978	5860	112	Y	30	06/29/78	--	--	N	60	112	
426	(D-15-4) 32cdb-1	1977	5890	160	Y	15	02/10/77	--	--	131	--	--	bedrock well
427	(D-15-4) 32ccd-1	1975	5900	88	Y	35	08/09/75	--	--	N	--	--	
428	(D-15-4) 32daa-1	1974	5960	86	Y	40	08/03/74	--	--	N	--	--	
429	(D-15-4) 32dac-1	1979	5940	100	Y	44	05/17/79	--	--	N	60	100	
441	(D-16-3) 2cbc-1	1984	5480	120	1	7	04/15/84	2	50	110	95	120	
442	(D-16-2) 24add-1	1949	5460	196	N	11	06/24/49	0	20+	N	--	--	
443	(D-16-2) 13aaa-1	1981	5460	263	N	2	09/05/81	0	60	N	--	--	
444	(D-16-2) 13dda-1	1935	5465	324	Y	4	04/25/35	--	--	N	212	320	
445	(D-16-2) 13ddb-1	1993	5470	221	1	12	02/08/93	5	85	N	--	--	
446	(D-16-2) 24aac-1	1950	5455	216	N	10	02/01/50	0	80	N	--	--	
447	(D-16-2) 24aba-1	1959	5480	151	1	40	03/03/59	0	23	N	--	--	
448	(D-16-2) 24dbd-1	1994	5460	251	1	22	07/26/94	10	38	N	--	--	
449	(D-16-2) 24dbd-2	1965	5465	84	Y	16	04/00/65	--	--	N	--	--	
450	(D-16-2) 35bdb-1	1952	5550	96	Y	50	09/10/52	--	--	N	--	--	
451	(D-16-2) 36adc-1	1947	5440	135	N	4	10/29/47	--	--	--	--	--	no log
452	(D-16-2) 36baa-1	1952	5480	102	Y	25	09/10/52	--	--	N	--	--	
453	(D-16-2) 36caa-1	1945	5455	215	N	+F	11/03/45	--	--	--	--	--	no log
454	(D-16-2) 36cbd-1	1955	5470	301	N	18	12/28/55	51	119	N	128	298	
457	(D-16-3) 1acd-1	1977	5470	360	Y	--	--	--	--	320	--	--	bedrock well
458	(D-16-3) 1bab-1	1980	5610	480	Y	48	12/30/79	--	--	8	--	--	
459	(D-16-3) 1bbb-1	1965	5560	107	N	11	05/03/65	24	66	N	95	105	
461	(D-16-3) 3dab-1	1981	5475	100	1	10	07/15/81	5	125	N	--	--	
462	(D-16-3) 3dad-1	1980	5480	100	1	--	--	40	70	N	80	100	no water levels
466	(D-16-3) 4dac-1	1951	5463	128	N	12	09/18/51	18	54	N	--	--	
470	(D-16-3) 4ddc-1	1951	5459	130	N	16	06/10/51	28	59	N	--	--	
471	(D-16-3) 5cbd-1	1952	5477	284	N	2	06/14/52	0	26	N	--	--	
473	(D-16-3) 6bca-1	1947	5590	170	N	20	06/19/47	--	--	--	--	--	no log
474	(D-16-3) 6dad-1	1952	5490	114	N	12	06/15/52	22	56	N	--	--	
475	(D-16-3) 7aaa-1	1948	5472	285	N	11	12/03/48	--	--	--	--	--	no log
477	(D-16-3) 7abc-1	1948	5540	85	1	28	10/26/48	35	78	N	--	--	
478	(D-16-3) 7aca-1	1951	5470	105	N	7	11/08/51	35	98	N	--	--	
479	(D-16-3) 7baa-1	1951	5510	68	1	56	12/05/51	0	30	N	--	--	
480	(D-16-3) 7bca-1	1948	5500	130	N	4	11/18/49	--	--	--	--	--	no log
481	(D-16-3) 7ccd-1	1952	5450	121	N	11	06/23/52	38	83	N	--	--	
484	(D-16-3) 9adb-1	1951	5454	175	N	13	06/12/51	42	104	N	--	--	
489	(D-16-3) 9daa-1	1954	5450	132	N	16	06/10/54	22	54	N	--	--	
490	(D-16-3) 11aac-1	1992	5570	400	Y	43	04/20/92	--	--	80	340	400	bedrock well

Site Number	Local well number	Year well drilled	Elevation (ft)	Well depth (ft)	Recharge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perforations (ft)	Bottom of perforations (ft)	Notes
491	(D-16-3) 11bbc-1	1976	5481	200	Y	12	05/03/76	--	--	105	--	--	bedrock well
495	(D-16-3) 15dbb-1	1994	5490	162	I	20	07/27/94	0	22	N	--	--	
496	(D-16-3) 15add-1	1979	5515	100	Y	50	01/09/79	--	--	N	60	100	
497	(D-16-3) 16aac-1	1963	5449	153	N	8	07/09/63	103	148	N	--	--	
498	(D-16-3) 16caa-1	1941	5448	131	N	3	03/20/41	--	--	N	--	--	
499	(D-16-3) 16ccd-1	1993	5445	125	N	5	08/26/93	22	60	N	--	--	
505	(D-16-3) 18bad-1	1963	5440	222	N	2	10/04/63	26	70	N	--	--	
510	(D-16-3) 21adc-1	1969	5460	147	N	7	08/20/69	0	21	N	--	--	
511	(D-16-3) 21bbc-1	1949	5443	152	N	9	09/15/58	35	62	N	--	--	
512	(D-16-3) 21cda-1	1946	5450	98	N	11	07/01/46	26	91	N	--	--	
513	(D-16-3) 22aac-1	1955	5495	200	I	18	10/27/55	0	30	N	50	200	
514	(D-16-3) 22cdd-1	1986	5520	255	Y	27	03/27/86	--	--	20	--	--	bedrock well
515	(D-16-3) 23cbc-1	1943	5595	208	Y	155	03/13/43	--	--	10	--	--	bedrock well
519	(D-16-3) 27abb-1	1950	5530	92	Y	44	05/11/50	--	--	82	82	92	bedrock well
520	(D-16-3) 27bad-1	1943	5525	103	I	29	03/16/43	10	100	N	--	--	
521	(D-16-3) 27bdc-1	1982	5525	121	I	46	04/14/82	4	40	N	--	--	
522	(D-16-3) 27cba-1	1963	5520	300	I	30	09/21/63	37	70	136	100	297	
523	(D-16-3) 27ccb-1	1982	5500	80	I	42	04/13/82	5	55	N	--	--	
524	(D-16-3) 27dac-1	1982	5585	80	Y	48	04/17/82	--	--	80	--	--	bedrock well
525	(D-16-3) 27dac-2	1985	5585	85	Y	40	05/01/85	--	--	N	--	--	
526	(D-16-3) 28aad-1	1945	5490	267	Y	18	04/01/45	--	--	91	18	153	
528	(D-16-3) 28ccb-1	1974	5452	110	N	14	06/05/74	11	65	N	--	--	
529	(D-16-3) 28daa-1	1985	5505	178	N	9	05/08/85	49	80	105	--	--	bedrock well
532	(D-16-3) 28dcd-1	1950	5475	70	N	12	07/15/50	22	70	N	--	--	
536	(D-16-3) 30cdc-1	1958	5436	186	N	4	01/20/59	0	22	N	--	--	
558	(D-16-3) 33aca-1	1950	5475	201	N	8	07/12/50	21	56	N	--	--	
559	(D-16-3) 33acd-1	1950	5480	200	N	2	07/04/50	22	53	N	--	--	
561	(D-16-3) 33cad-1	1950	5480	147	N	4	07/14/50	26	66	N	--	--	
563	(D-16-3) 33dca-1	1958	5490	147	N	2	06/07/38	0	61	N	--	--	
564	(D-16-3) 34aab-1	1946	5560	58	I	--	--	18	39	N	--	--	no water levels
566	(D-16-3) 34cbd-1	1987	5500	64	I	4	07/10/87	0	25	N	--	--	
591	(D-17-2) 1bab-1	1952	5430	162	N	3	11/20/52	41	86	N	--	--	
595	(D-17-2) 1cbb-1	1952	5445	161	N	7	08/22/52	0	22	N	--	--	
596	(D-17-2) 1cbb-2	1952	5445	182	N	5	08/10/52	32	59	N	--	--	
598	(D-17-2) 11cab-1	1983	5455	195	N	4	07/00/83	5	80	N	--	--	
612	(D-17-2) 14abb-1	1959	5420	230	N	7	10/14/59	6	41	N	--	--	
616	(D-17-2) 14cbc-1	1962	5425	185	N	7	05/18/62	41	90	N	--	--	
619	(D-17-2) 15acc-1	1977	5447	166	N	4	03/01/77	0	160	N	--	--	
620	(D-17-2) 21daa-1	1961	5565	295	N	6	09/30/61	0	150	N	126	295	
621	(D-17-2) 22bdc-1	1993	5520	308	I	33	11/01/93	4	30	N	--	--	
622	(D-17-2) 22dbd-1	1954	5450	345	N	+F	05/17/54	0	32	N	170	320	
625	(D-17-2) 23caa-1	1950	5418	234	N	16	10/25/50	32	56	N	--	--	

Site Number	Local well number	Year well drilled	Elev-ation (ft)	Well depth (ft)	Re-charge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor-ations (ft)	Bottom of perfor-ations (ft)	Notes
637	(D-17-2) 26abc-1	1945	5415	183	N	12	11/02/45	82	125	N	--	--	
639	(D-17-2) 35ada-1	1941	5450	350	N	+F	01/12/42	8	50	N	127	280 MI	
640	(D-17-2) 35cbb-1	1964	5435	147	N	7	07/08/64	0	30	N	141	147	
641	(D-17-2) 35cac-1	1993	5450	145	N	+F	10/15/93	3	30	N	--	--	
642	(D-17-2) 35cba-1	1938	5440	180	N	15	05/20/71	0	34	N	--	--	
643	(D-17-2) 35cca-1	1956	5445	182	N	10	06/18/56	0	22	N	--	--	
644	(D-17-2) 35cdc-1	1956	5450	46	1	4	07/30/56	0	23	N	--	--	shallow
645	(D-17-2) 35daa-1	1977	5455	105	Y	4	07/11/77	--	--	N	85	85	
646	(D-17-2) 35dbb-1	1960	5447	220	N	8	--	0	37	N	--	--	
648	(D-17-2) 36ada-1	1956	5452	87	N	6	08/25/56	0	20	N	--	--	
649	(D-17-2) 36bbd-1	1958	5445	96	N	12	05/16/58	25	55	N	--	--	
650	(D-17-2) 36bcb-1	1969	5450	200	N	11	06/20/69	--	--	--	--	--	no logs- 8 wells
651	(D-17-2) 36bda-1	1977	5450	104	N	2	07/14/77	23	52	N	--	--	
652	(D-17-2) 36caa-1	1954	5465	54	2	15	10/24/54	0	27	N	--	--	shallow
653	(D-17-2) 36cdc-1	1959	5490	353	--	21	11/15/59	--	--	N	140	288	no log
654	(D-17-2) 36dbb-1	1956	5465	124	N	2	09/16/56	0	23	N	--	--	
655	(D-17-2) 36dcd-1	1956	5495	307	1	27	06/07/56	0	30	186	78	193 MI	
660	(D-17-3) 3cbb-1	1949	5550	350	Y	35	07/23/49	--	--	115	45	290 MI	
661	(D-17-3) 4bbb-1	1950	5475	92	N	9	--	0	21	N	--	--	
662	(D-17-3) 4bbc-1	1952	5483	82	N	4	12/15/52	21	52	N	--	--	
663	(D-17-3) 4bcc-1	1936	5486	396	1	17	01/20/36	6	30	N	30	392 MI	
666	(D-17-3) 5ada-1	1950	5475	182	N	7	09/01/50	0	35	N	--	--	
674	(D-17-3) 5cdd-2	1960	5463	149	N	2	10/06/60	46	70	N	--	--	
675	(D-17-3) 5dba-1	1953	5473	229	N	7	09/21/53	94	144	N	--	--	
688	(D-17-3) 8baa-1	1961	5463	235	N	1	04/08/62	91	150	N	--	--	
689	(D-17-3) 8bdd-1	1946	5467	146	N	13	07/21/46	--	--	--	--	--	no log
691	(D-17-3) 8cad-1	1961	5466	142	N	4	10/07/61	54	88	N	--	--	no log
692	(D-17-3) 8dcc-1	1950	5485	278	Y	9	03/09/50	--	--	N	160	273 MI	
693	(D-17-3) 8ddd-1	1975	5530	272	Y	12	02/28/75	--	--	N	108	272 MI	
694	(D-17-3) 8ddd-2	1985	5517	83	1	5	09/08/85	0	60	N	--	--	
695	(D-17-3) 9baa-1	1977	5520	90	1	50	07/12/77	40	83	N	--	--	
696	(D-17-3) 9bda-1	1960	5540	54	Y	--	--	--	--	N	--	--	no water levels
697	(D-17-3) 9dcc-1	1960	5560	95	Y	72	07/07/60	--	--	N	--	--	
719	(D-17-3) 17bad-1	1956	5496	300	N	26	04/16/56	48	74	N	86	86	
720	(D-17-3) 17bad-2	1964	5495	78	1	20	09/20/64	0	40	N	--	--	
721	(D-17-3) 17cbd-1	1955	5497	453	1	16	--	5	29	401	95	430 MI	
722	(D-17-3) 17dba-1	1977	5530	140	Y	70	12/00/77	--	--	N	120	140	
723	(D-17-3) 18dbb-1	1961	5450	186	N	8	06/01/61	--	--	--	--	--	no log
725	(D-17-3) 18dbd-1	1959	5455	136	N	7	06/16/59	0	21	N	--	--	
726	(D-17-3) 18adc-1	1939	5470	178	N	7	11/25/39	?	150	N	--	--	partial log
728	(D-17-3) 20acc-1	1956	5550	436	Y	79	03/05/56	--	--	404	100	100	
729	(D-17-3) 20bbc-1	1941	5490	95	1	22	11/19/41	0	22	N	85	95	

Site Number	Local well number	Year well drilled	Elev-ation (ft)	Well depth (ft)	Re-charge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor-ations (ft)	Bottom of perfor-ations (ft)	Notes
730	(D-17-3) 20bdc-1	1941	5515	70	Y	34	08/29/41	--	--	N	68	69	
731	(D-17-3) 20cdb-1	1961	5525	390	1	65	01/13/61	2	37	375	85	285	
732	(D-17-3) 20dba-1	1978	5555	157	1	90	03/29/78	0	30	N	--	--	
733	(D-17-3) 20dca-1	1960	5550	141	Y	85	10/10/60	102	130	132	132	--	bedrock well
734	(D-17-3) 21bbc-1	1974	5585	135	Y	105	12/02/74	75	95	N	--	--	
738	(D-17-2) 22aad-1	1970	5430	230	N	20	08/01/70	0	23	N	--	--	
741	(D-17-3) 29aaa-1	1943	5720	90	Y	60	02/17/43	--	--	0	65	90	bedrock well
742	(D-17-3) 30bac-1	1959	5433	165	N	10	07/19/59	60	108	N	--	--	
743	(D-17-3) 30ccc-1	1974	5443	160	N	2	11/22/74	2	36	N	--	--	
744	(D-17-3) 30dad-1	1961	5500	195	1	7	10/21/63	15	41	N	--	--	
745	(D-17-3) 30ddd-1	1960	5500	49	Y	12	--	--	--	N	39	49	
746	(D-17-3) 31aaa-1	1960	5520	65	Y	65	12/22/60	--	--	N	100	122	
747	(D-17-3) 31ada-1	1942	5525	77	N	4	03/08/42	7	33	N	--	--	
748	(D-17-3) 31bad-1	1961	5460	126	N	10	07/10/61	0	90	N	--	--	
749	(D-17-3) 31bba-1	1961	5445	186	N	17	11/23/61	0	25	N	--	--	
750	(D-17-3) 31caa-1	1964	5475	100	N	8	08/15/64	0	82	N	95	100	
751	(D-17-3) 31cac-1	1953	5475	126	N	7	12/23/53	21	60	N	--	--	
752	(D-17-3) 31dba-1	1962	5495	74	1	7	09/17/62	0	42	N	--	--	
753	(D-17-3) 31dbb-1	1948	5480	66	N	+F	09/20/48	--	--	N	--	--	
754	(D-17-3) 32cab-1	1950	5600	152	Y	132	09/17/50	--	--	N	132	152	
755	(D-17-3) 32ccc-1	1945	5570	108	Y	74	03/14/45	--	--	N	74	108	
756	(D-18-2) 1aad-1	1961	5520	73	Y	50	--	--	--	N	--	--	
757	(D-18-2) 1aad-2	1942	5505	60	1	38	05/12/42	0	28	N	--	--	
758	(D-18-2) 1aca-1	1969	5530	64	1	35	10/30/69	0	40	N	--	--	
759	(D-18-2) 1bba-1	1950	5487	76	1	12	--	0	40	N	--	--	
761	(D-18-2) 1caa-1	1951	5530	250	Y	60	03/17/51	--	--	N	65	248	
762	(D-18-2) 1daa-1	1935	5550	203	Y	88	04/10/35	--	--	N	95	200 MI	
763	(D-18-2) 2abb-1	1944	5465	50	Y	50	10/23/44	--	--	N	--	--	
764	(D-18-2) 2abd-1	1962	5470	152	N	1	05/10/62	31	53	N	--	--	
766	(D-18-2) 2acb-1	1964	5470	149	N	10	07/26/64	0	36	N	143	148	
767	(D-18-2) 2add-1	1951	5495	154	Y	19	08/00/51	--	--	N	30	154	
768	(D-18-2) 2bac-1	1954	5455	121	N	16	03/26/54	21	58	N	--	--	
769	(D-18-2) 2bba-1	1958	5445	108	N	18	05/27/58	48	82	N	--	--	
770	(D-18-2) 2aac-1	1953	5475	71	Y	5	02/06/53	--	--	N	--	--	shallow
771	(D-18-2) 2bda-1	1963	5460	147	N	12	10/21/63	46	68	N	142	147	
773	(D-18-2) 2dcd-1	1952	5490	41	Y	23	11/26/52	--	--	N	--	--	
774	(D-18-2) 3aac-1	1954	5435	98	N	7	12/30/54	0	21	N	--	--	
777	(D-18-2) 10adc-1	1959	5443	42	N	2	12/03/59	--	--	N	--	--	
778	(D-18-2) 11aac-1	1990	5510	80	Y	60	04/13/90	--	--	N	--	--	
779	(D-18-2) 11acd-2	1975	5503	225	Y	21	09/05/75	--	--	N	115	220	
780	(D-18-2) 11acd-1	1954	5500	63	1	7	12/30/53	0	31	N	--	--	
781	(D-18-2) 11bac-1	1994	5475	145	1	5	06/01/94	2	35	N	--	--	

Site Number	Local well number	Year well drilled	Elev-ation (ft)	Well depth (ft)	Re-charge area	Water level (ft)	Water-level date	Top of confining layer (ft)	Bottom of confining layer (ft)	Depth to bedrock (ft)	Top of perfor-ations (ft)	Bottom of perfor-ations (ft)	Notes
782	(D-18-2) 11bcc-1	1960	5455	39	2	6	12/04/59	--	--	N	29	39	
783	(D-18-2) 11cbb-1	1944	5455	60	N	5	06/08/44	--	--	N	55	59	
784	(D-18-2) 11cca-1	1953	5465	118	N	19	03/17/53	94	118	N	--	--	
785	(D-18-2) 11daa-1	1995	5530	85	Y	50	04/04/95	--	--	N	--	--	
786	(D-18-2) 11dad-1	1994	5520	135	Y	56	06/14/94	--	--	N	--	--	
787	(D-18-2) 11dcd-1	1959	5510	80	Y	10	12/20/59	--	--	N	65	80	
790	(D-18-2) 14aba-1	1967	5510	81	Y	25	06/22/67	--	--	N	76	81	
791	(D-18-2) 14bbb-1	1963	5460	123	N	20	07/12/63	25	98	N	--	--	
792	(D-18-2) 15aab-1	1963	5448	107	N	20	10/18/63	18	68	N	--	--	
793	(D-18-2) 23cdc-1	1972	5540	111	Y	68	05/01/75	--	--	N	44	100	
795	(D-18-2) 26bbd-1	1957	5520	200	Y	60	07/26/57	--	--	15	90	105	
796	(D-18-2) 27bdc-1	1943	5470	75	1	24	03/30/43	0	26	N	65	75	
797	(D-18-2) 27ccd-1	1954	5500	60	1	25	09/17/54	0	48	50	48	52	
798	(D-18-2) 34abd-1	1976	5500	60	Y	10	03/21/77	--	--	N	40	42	
799	(D-18-2) 33aac-1	1983	5520	100	Y	47	08/03/83	--	--	N	--	--	
800	(D-18-2) 28ddd-1	1945	5600	50	Y	30	03/22/45	--	--	N	35	50	
801	(D-18-2) 32bda-1	1986	5720	40	Y	N	--	--	--	N	--	--	no water
802	(D-18-2) 32ada-1	1944	5400	43	Y	12	07/23/44	--	--	N	--	--	
803	(D-18-2) 33abd-1	1983	5500	80	Y	35	05/27/83	--	--	42	--	--	
805	(D-18-2) 33acb-1	1964	5500	63	Y	20	06/05/64	--	--	N	--	--	
806	(D-18-2) 34bcb-2	1970	5560	110	Y	N	--	--	--	14	--	--	no water
807	(D-18-2) 33bbb-1	1980	5410	57	1	27	10/21/80	18	50	N	--	--	
808	(D-18-2) 33cab-1	1989	5525	260	1	200	05/18/89	40	240	N	--	--	
809	(D-18-2) 34bac-1	1961	5580	120	Y	20	03/21/61	--	--	0	100	119	bedrock well
811	(D-18-2) 34cda-1	1975	5720	137	Y	70	05/28/75	--	--	N	60	120	
822	(D-18-3) 6dbb-1	1952	5600	300	Y	95	08/00/53	--	--	48	130	145	bedrock well
826	(D-19-2) 3bbd-1	1974	5700	265	--	--	--	--	--	N	--	--	partial log
828	(D-19-2) 4baa-1	1981	5510	99	1	--	--	10	50	N	--	--	no water levels
829	(D-19-2) 5ada-1	1941	5500	28	--	16	05/04/41	--	--	--	--	--	no log