GROUND WATER
RESOURCES

IOWA GEOLOGICAL SURVEY
Research and Service 1855-1858 1866-1869 1892- Water—Minerals—Environment

Dallas County

GROUND WATER RESOURCES OF DALLAS COUNTY

Introduction

Approximately 90 percent of the residents of Dallas County rely on ground water as the source of their drinking water. It is estimated that the use of ground water currently approaches 1.5 billion gallons per year. For comparison, this amount would provide each resident with 158 gallons of water a day during a year. Actually, few if any households use this much water, and the rather large annual per capita use reflects the greater water requirements of the county's industries, agribusinesses, and municipalities.

The users of ground water in the county draw their supplies from several different geologic sources. Several factors must be considered in determining the availability of ground water and the adequacy of a supply source:

<u>distribution</u> - having water where it is needed,

<u>accessibility</u> - effects the costs for drilling wells and pumping water,

<u>yield</u> - relates to the magnitude of the supply that can be sustained,

<u>quality</u> - determines for what purposes the water can be used.

In terms of these factors, there are few locations in Dallas County where the availability of ground water is not limited to some degree. The most common limiting factor is poor water quality, that is, highly mineralized ground water. Secondary limitations are generally related to poor distribution, small yields from some sources, and poor accessibility due to the great depths to adequate sources.

Occurrence of Ground Water in Dallas County

The occurrence of ground water is influenced by geology -- the position and thickness of the rock units, their ability to store and transmit water, and their physical and chemical make-up. Geologic units that store and transmit water and yield appreciable amounts to wells are called aquifers. The best aquifers are usually composed of sand and gravel, porous sandstone, and porous or fractured limestone and dolomite. Other units with materials such as clay and silt, shale, siltstone, and mudstone yield little or no water to wells. These impermeable units are called aquicludes and commonly separate one aquifer unit from another.

In Dallas County there are four principal aquifers from which users obtain water supplies. The loose, unconsolidated materials near the land surface comprise the surficial aquifer. Below this there are three major rock aquifers -- the Mississippian aquifer, the Silurian-Devonian aquifer, and the Cambro-Ordovician aquifer. The vertical sequence of aquifers and intervening aquicludes is shown in Table 1. Each of the aquifers has its own set of geologic, hydrologic, and water quality characteristics which determine the amount and potability (suitability for drinking) of water it will yield.

Table 1

GEOLOGIC AND HYDROGEOLOGIC UNITS IN DALLAS COUNTY

Age	Rock Unit	Description	Hydrogeologic Unit	Water-Bearing Characteristics
Quaternary	Alluvium	Sand, gravel, silt, and clay	Surficial aquifer	Fair to large yields (25 to 100 gpm)
	Glacial drift (undifferentiated)	Predominantly till containing scattered irregular bodies of sand and gravel		Low Yields (less than 10 gpm)
	Buried channel deposits	Sand, gravel, silt and clay		Small to large yields
Pennsylvanian	Missouri Series	Shale and limestone	Aquiclude	Low yields only from limestone and sandstone
	Des Moines Series	Shale; sandstones, mostly thin		
Mississippian	Meramec Series	Limestone, sandy	Mississippian aquifer	Fair to low yields
	Osage Series	Limestone and dolomite, cherty		
	Kinderhook Series	Limestone, oolitic, and dolomite, cherty		
Devonian	Maple Mill Shale Sheffield Formation Lime Creek Formation	Shale; limestone in lower part	Devonian aquiclude	Does not yield water
	Cedar Valley Limestone; Wapsipinicon Formation	Limestone and dolomite; contains evaporites in southern half of Iowa	Silurian-Devonian aquifer	Fair to low yields*
Silurian	Undifferentiated	Dolomite, locally cherty		
Ordovician	Maquoketa Formation	Shale and dolomite	Maquoketa aquiclude	Does not yield water
	Galena Formation	Limestone and dolomite	Minor aquifer	Low yields
	Decorah Formation Platteville Formation	Limestone and thin shales; includes sandstone in SE Iowa	Aquiclude	Does not yield water
	St. Peter Sandstone	Sandstone	Cambrian-Ordovician aquifer	Fair yields*
	Prairie du Chien Formation	Dolomite, sandy and cherty		High yields (over 500 gpm)
Cambrian	Jordan Sandstone	Sandstone		
	St. Lawrence Formation	Dolomite	Aquitard	Low yields
	Franconia Sandstone	Sandstone and shale		
	Dresbach Group	Sandstone	Dresbach aquifer	High to low yields*
Precambrian	Undifferentiated	Coarse sandstones; crystalline rocks	Base of ground-water reservoir	Not known to yield water

*saline in Dallas County

Surficial Aquifers

Unconsolidated deposits at the land surface are comprised of mixtures of clay, silt, sand, gravel, and assorted boulders. Water-yielding potential of the surficial deposits is greatest in units composed mostly of sand and/or gravel. Three types of surficial aquifers are used: the alluvial aquifer, the drift aquifer, and the buried channel aquifer. The alluvial aquifer consists mainly of the sand and gravel transported and deposited by streams and makes up the floodplains and terraces in major valleys.

The drift aquifer is the thick layer of clay to boulder size material deposited over the bedrock by glacial ice which invaded the county at least twice in the last two million years. The composition of the glacial drift varies considerably and in many places does not yield much water. There are, however, lenses, or beds, of sand and gravel within the drift which are thick and large enough to serve as dependable water sources. These lenses are difficult to locate because they are irregular in shape and buried within the drift deposits.

The buried channel aquifer consists of stream alluvium that filled valleys that existed before the glacial period. The valleys were overriden by the glaciers and are now buried under glacial and recent alluvial deposits.

The distribution, yields, and water quality characteristics for the surficial aquifers are summarized in Figures 1, 2, and 11. An indication of accessibility can be obtained by comparing the elevations of the top (the land surface) and the bottom (the bedrock surface) of the surficial deposits from Figures 3 and 4. The thickness of the glacial drift and the depth of the buried channels are determined by subtracting the elevations at selected locations.

Rock Aquifers

Below the surficial materials is a thick sequence of layered rocks formed from deposits of rivers and shallow seas that have covered the state within the last 600 million years. The geologic map (Figure 5) shows the geologic units which form the top of this rock sequence. These rocks are Pennsylvanian in age and are mainly shales. Although the Pennsylvanian rocks usually act as an aquiclude, there are locally some sandstone and limestone layers (particularly in the central and southwest portions of the county) which supply small yields to domestic wells. The thickness of the Pennsylvanian rocks varies from over 500 feet in the south to 0 feet around Perry.

Underlying the Pennsylvanian aquiclude is a series of older rocks, parts of which form the three major rock aquifers in Dallas County. This sequence and the water-bearing characteristics of the aquifers and aquicludes are described in Table 1. The general ranges of thickness for the units are:

Mississippian	300-400 feet
Devonian	650-700
Silurian	25- 75
Ordovician	925-975
Cambrian	600-650

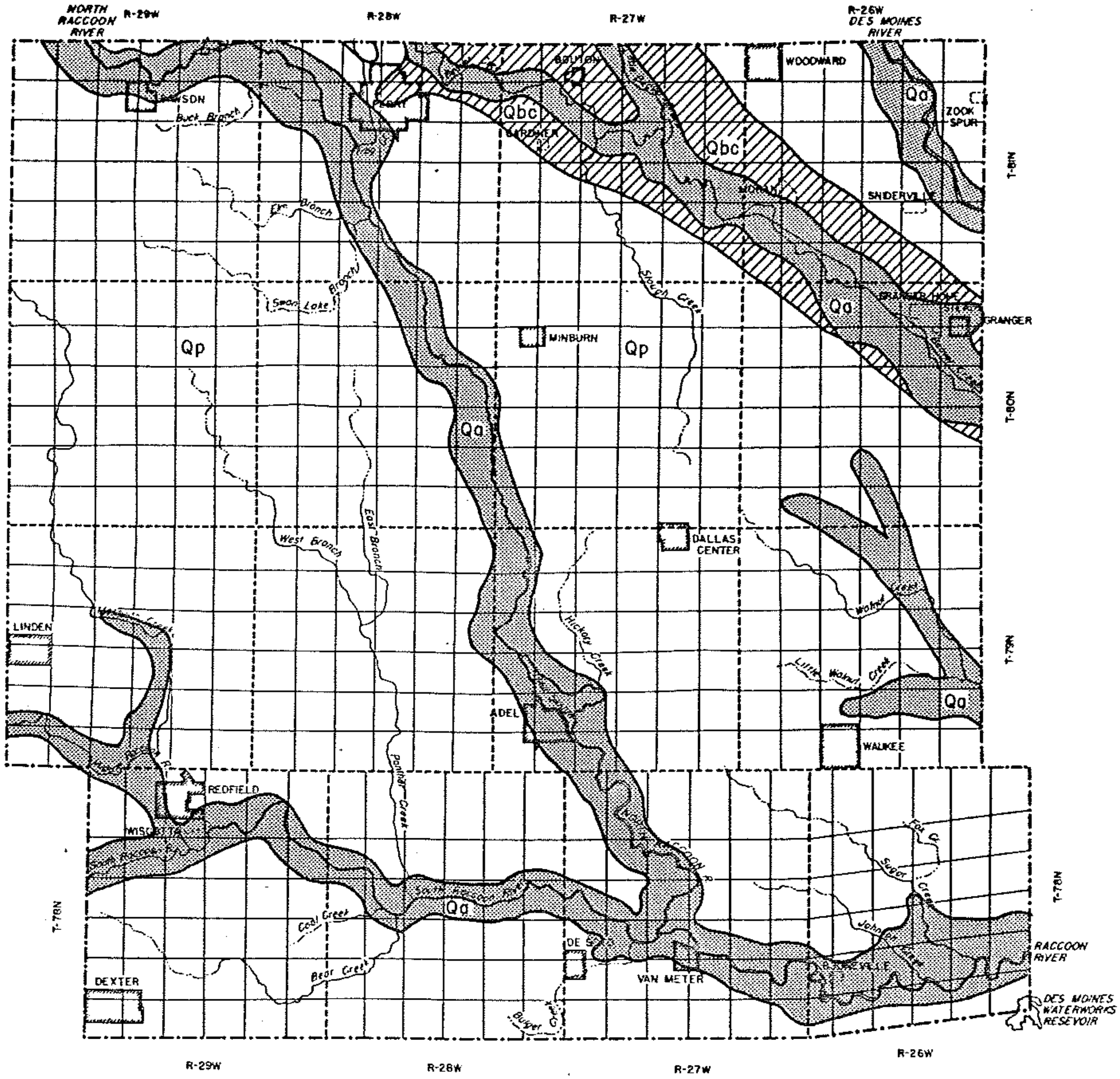
Examples of the geologic sequence, or section, encountered in drilling existing wells at various locations in Dallas County are illustrated in Figure 6. The geologic unit that supplies ground water and the amount of water yielded to the well are shown next to each of the well "logs".

The accessibility of ground water in the rock aquifers depends first on the depth to the aquifer. The deeper a well must be, the greater the costs for well construction and pumping. The depths to and thicknesses of units at specific sites will vary somewhat because of irregularities in the elevation of the land surface and in the elevation of the tops of the underlying rock units. Estimates of depths and thicknesses can be made by comparing Figure 3 with the maps of aquifer elevations in Figures 8, 9, and 10.

The second factor which affects accessibility is the level to which the water will rise in the well (the static water level). Since water in the rock aquifers is under pressure, the water rises in the well once it penetrates the aquifer. This rise in water level can reduce the cost of pumping. Average static water levels in wells are shown in Figures 8, 9, and 10.

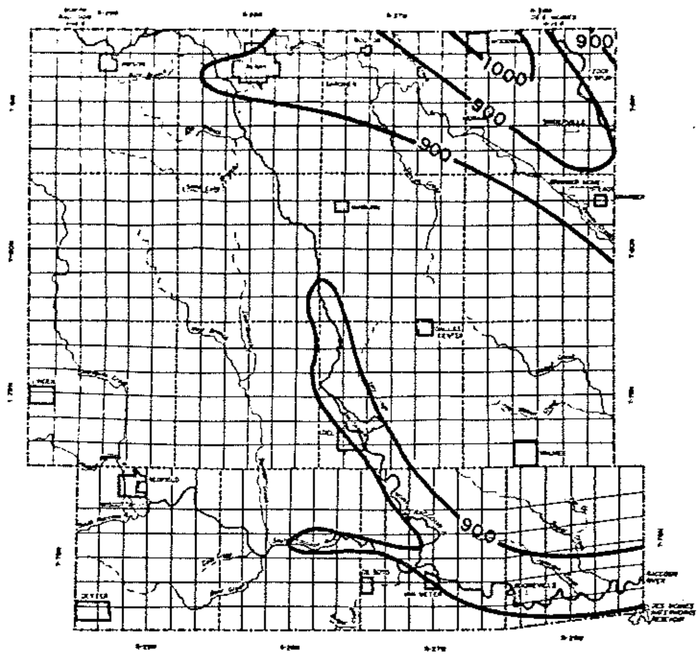
Average yields and water quality characteristics throughout the county for each of the aquifers are also summarized in the maps in Figures 8, 9, 10, and 11.

Figure 1
SURFICIAL MATERIALS

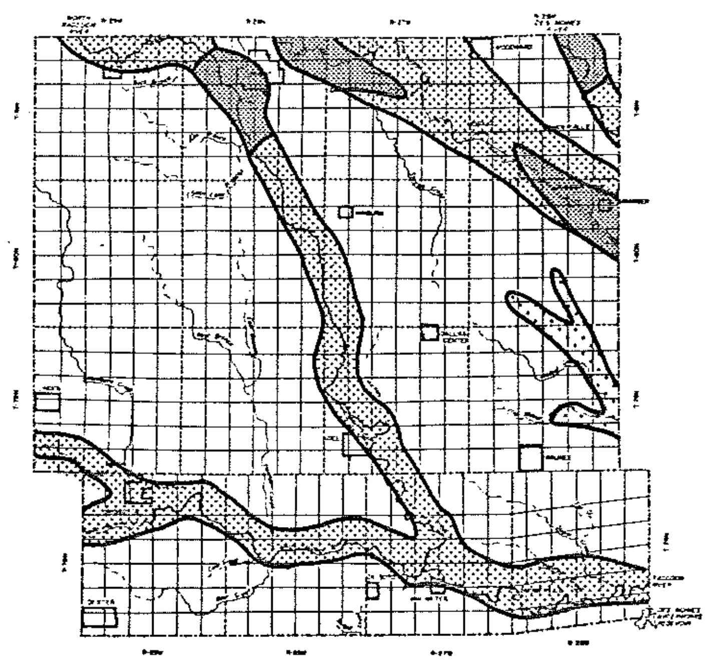


Qa	Alluvium
Qp	Glacial Drift
Qbc	Buried Channels

Figure 2
SURFICIAL AQUIFERS



Water levels in wells in feet above mean sea level



Water yields to wells in gallons per minute

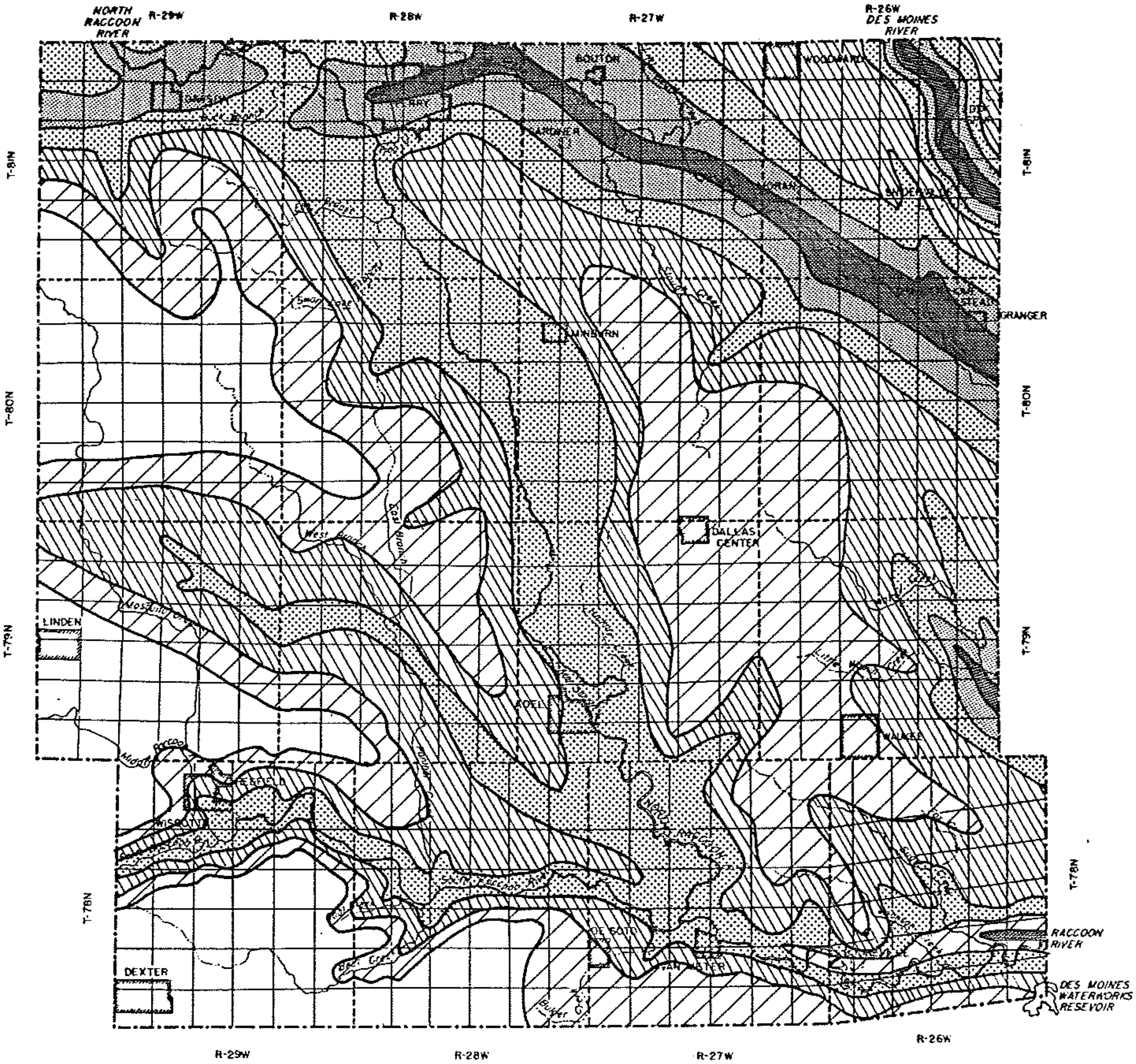
Below 20

100-500

20-100

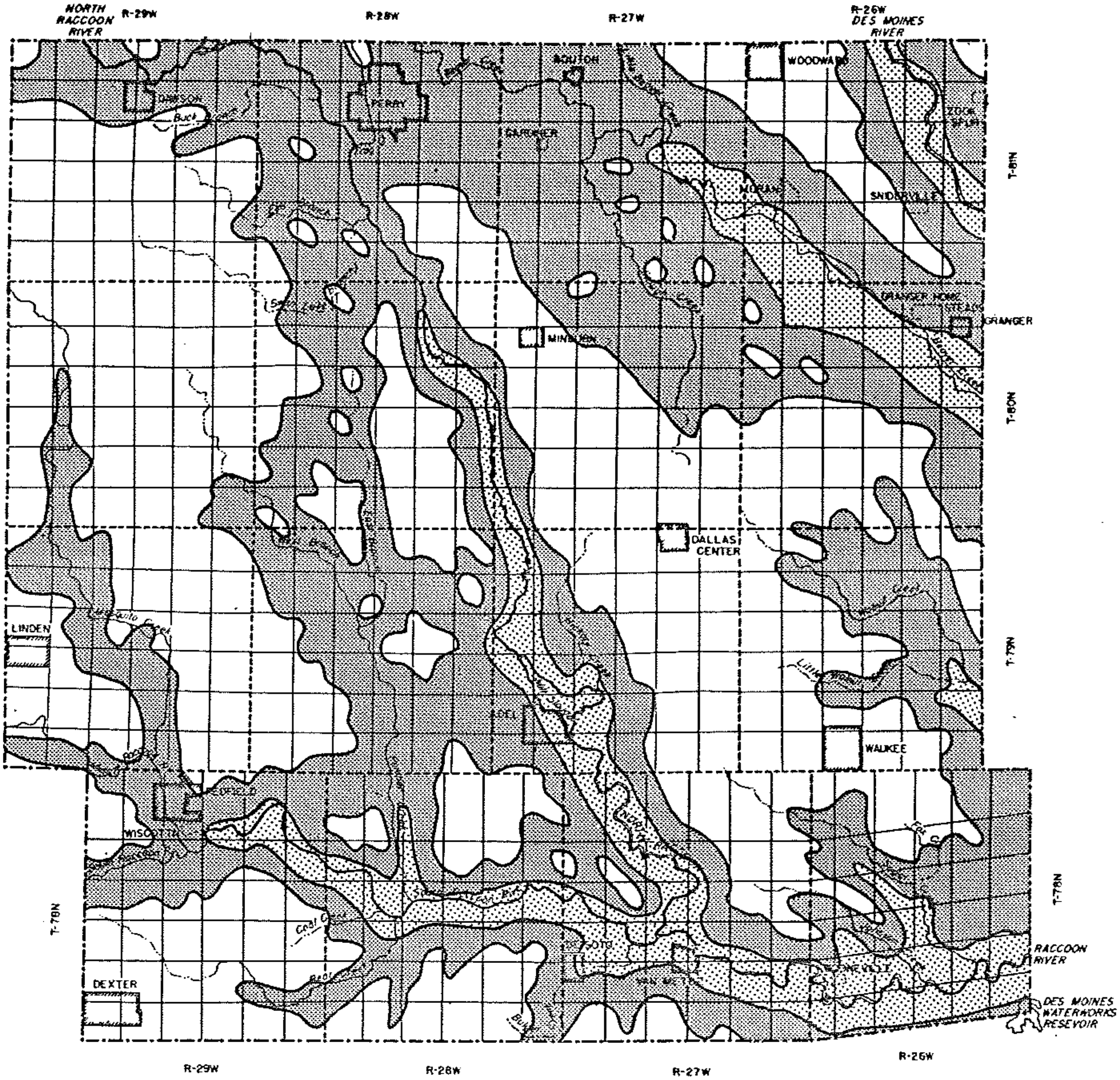
Above 500

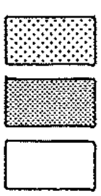
Figure 3
ELEVATION OF LAND SURFACE IN FEET ABOVE MEAN SEA LEVEL



Below 800 feet
800-850
850-900
900- 950
950-1000
Over 1000

Figure 4
ELEVATION OF BEDROCK SURFACE IN FEET ABOVE MEAN SEA LEVEL



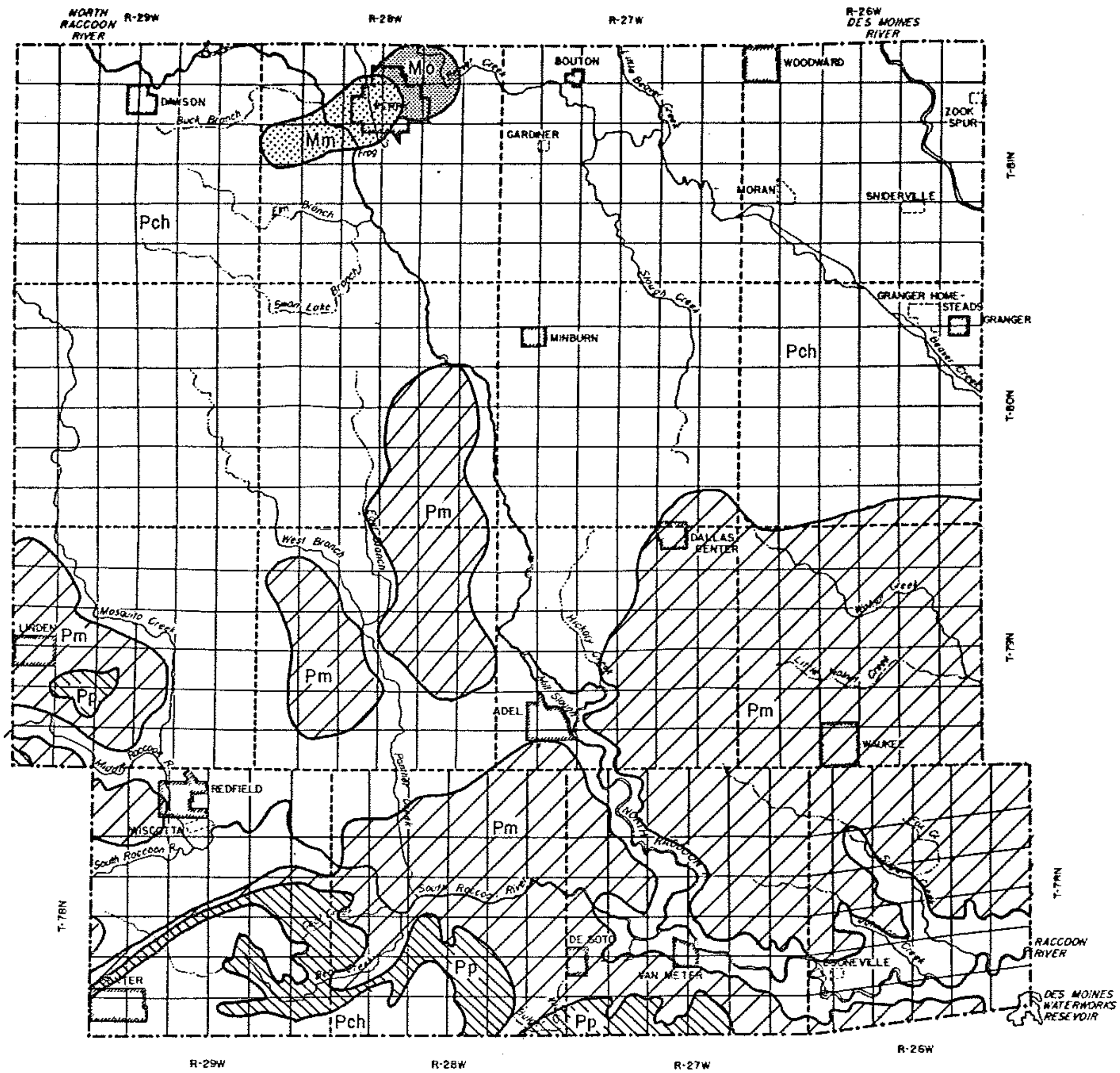


800- 900

900-1000

Over 1000 feet

Figure 5
GEOLOGIC MAP



Pennsylvanian Age Rock Units

Pp	Pleasanton Group
Pm	Marmaton Group
Pch	Cherokee Group

Mississippian Age Rock Units

Mm	Meramec Series
Mo	Osage Series

Figure 6
TYPICAL WELLS IN DALLAS COUNTY

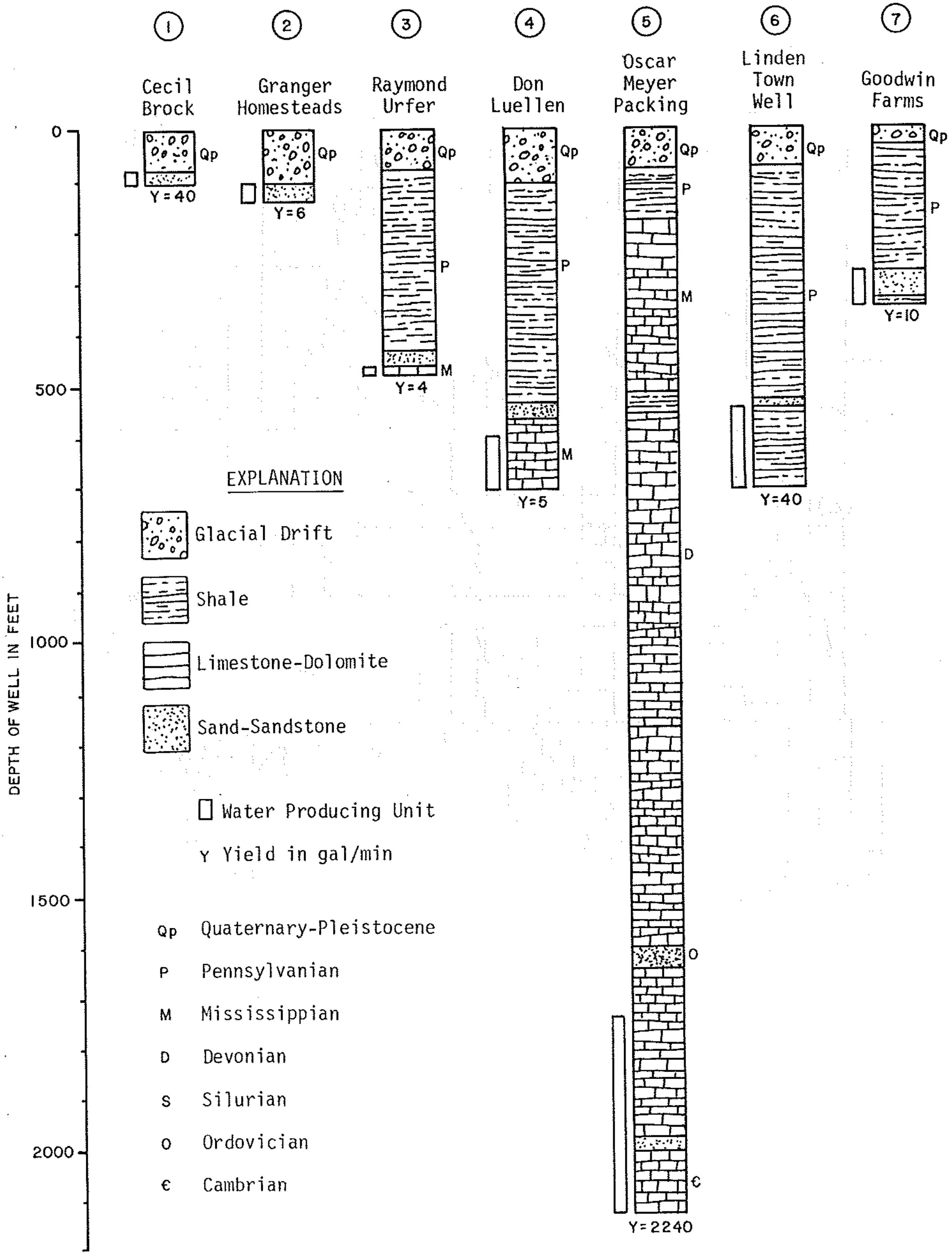
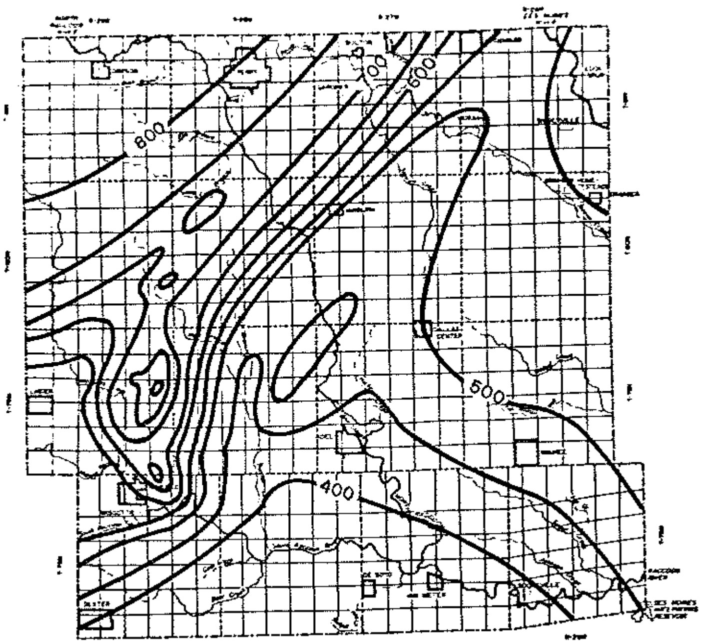
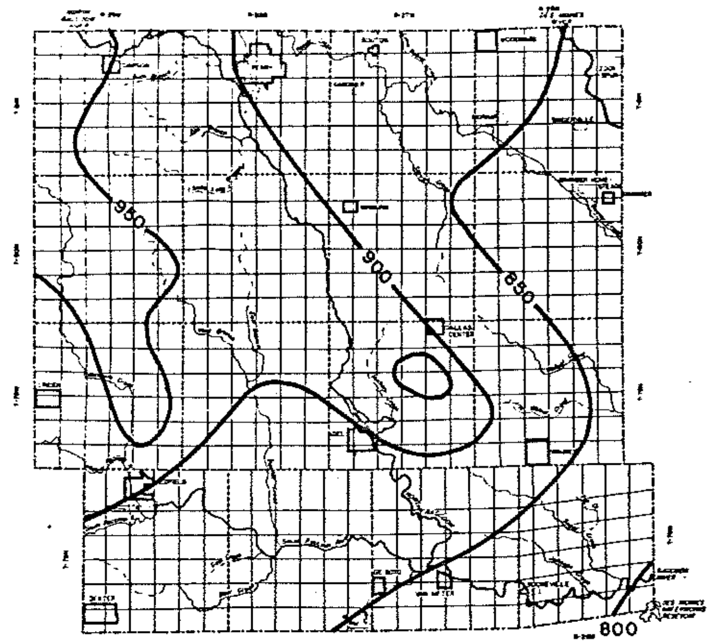


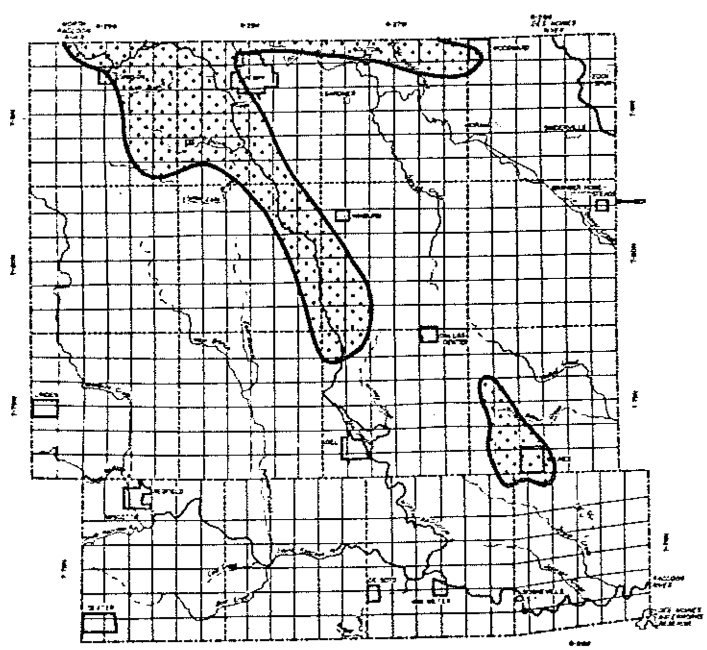
Figure 8
MISSISSIPPIAN AQUIFER



Elevation of Mississippian Aquifer in feet above mean sea level



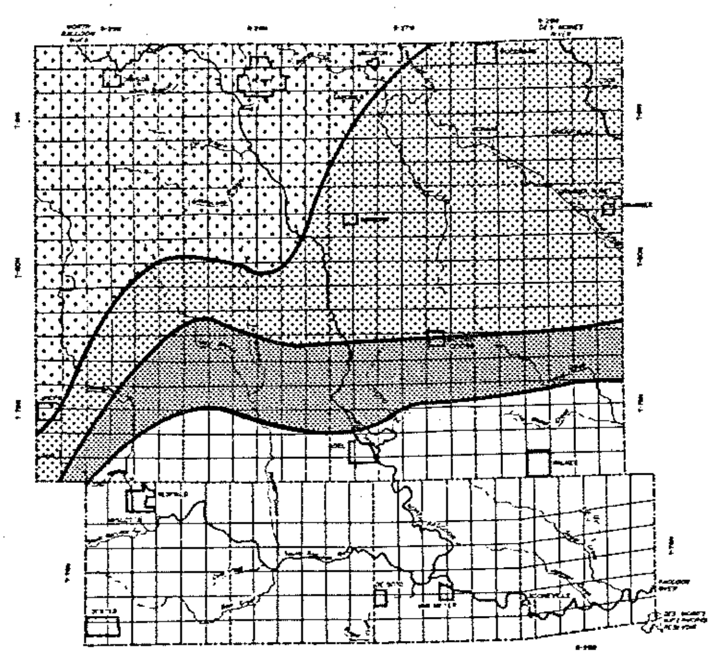
Water levels in wells in feet above mean sea level



Water yields to wells in gallons per minute

Below 20

20-50



Dissolved solids content in milligrams per liter (mg/l)*

500-1000

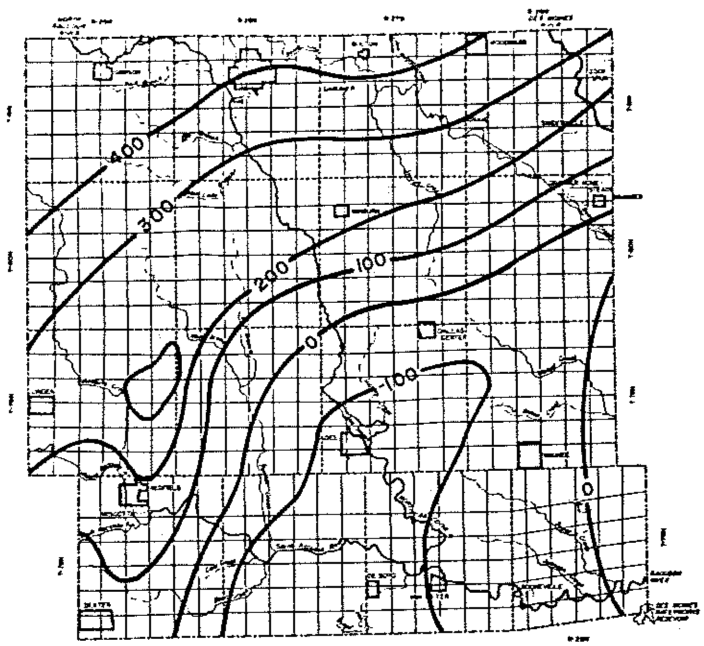
1500-2500

1000-1500

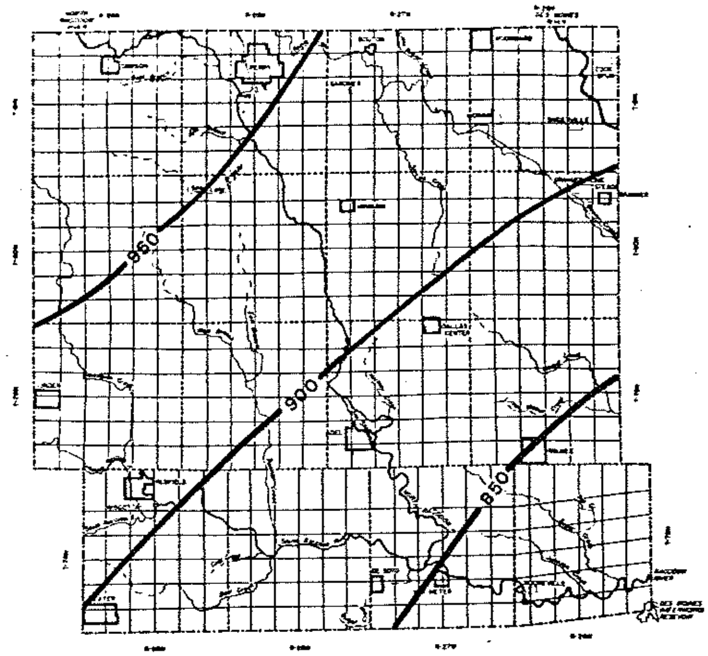
Over 2500

*Other water quality data in Figure 11

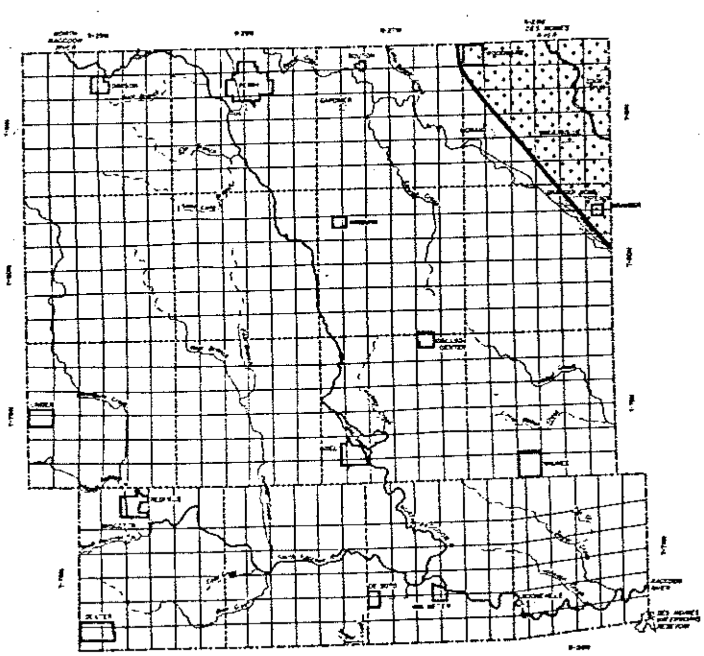
Figure 9
SILURIAN-DEVONIAN AQUIFER



Elevation of Devonian Aquifer in feet above mean sea level



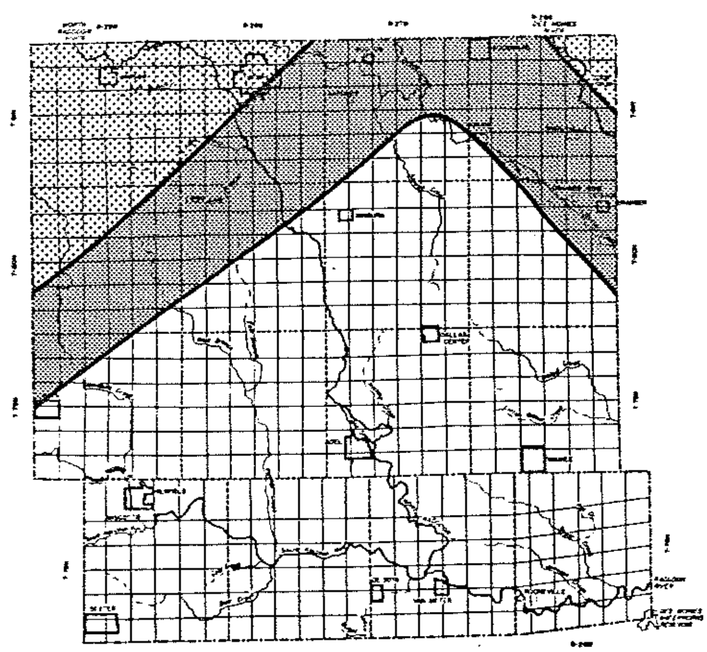
Water levels in wells in feet above mean sea level



Water yields to wells in gallons per minute

Below 20

20-50



Dissolved solids content in milligrams per liter (mg/l)*

1000-1500

Over 2500

1500-2500

*Other water quality data in Figure 11

Table 2

SIGNIFICANCE OF MINERAL CONSTUENTS AND PHYSICAL PROPERTIES OF WATER

Constituent or Property	Maximum Recommended Concentration	Significance
Iron (Fe)............	0.3 mg/l..........	Objectional as it causes red and brown staining of clothing and porcelain. High concentrations affect the color and taste of beverages.
Manganese (Mn)......	0.05 mg/l.........	Objectionable for the same reasons as iron. When both iron and manganese are present, it is recommended that the total concentration not exceed 0.3 mg/l.
Calcium (Ca) and Magnesium (Mg).....		Principal causes for hardness and scale-forming properties of water. They reduce the lathering ability of soap.
Sodium (Na) and Potassium (K)........		Impart a salty or brackish taste when combined with chloride. Sodium salts cause foaming in boilers.
Sulfate (SO_4).........	250 mg/l..........	Commonly has a laxative effect when the concentration is 600 to 1,000 mg/l, particularly when combined with magnesium or sodium. The effect is much less when combined with calcium. This laxative effect is commonly noted by newcomers, but they become acclimated to the water in a short time. The effect is noticeable in almost all persons when concentrations exceed 750 mg/l. Sulfate combined with calcium forms a hard scale in boilers and water heaters.
Chloride (Cl).........	250 mg/l..........	Large amounts combined with sodium impart a salty taste.
Fluoride (F)..........	2.0 mg/l..........	In central Iowa, concentrations of 0.8 to 1.3 mg/l are considered to play a part in the reduction of tooth decay. However, concentrations over 2.0 mg/l will cause the mottling of the enamel of children's teeth.
Nitrate (NO_3)........	45 mg/l...........	Waters with high nitrate content should not be used for infant feeding as it may cause methemoglobinemia or cyanosis. High concentrations suggest organic pollution from sewage, decayed organic matter, nitrate in the soil, or chemical fertilizer.
Dissolved solids.......	500 mg/l..........	This refers to all of the material in water that is in solution. It affects the chemical and physical properties of water for many uses. Amounts over 2,000 mg/l will have a laxative effect on most persons. Amounts up to 1,000 mg/l are generally considered acceptable for drinking purposes if no other water is available.
Hardness (as $CaCO_3$)..		This affects the lathering ability of soap. It is generally produced by calcium and magnesium. Hardness is expressed in milligrams per liter equivalent to $CaCO_3$ as if all the hardness were caused by this compound. Water becomes objectionable for domestic use when the hardness is above 100 mg/l; however, it can be treated readily by softening.
Temperature.........		Affects the desirability and economy of water use, especially for industrial cooling and air conditioning. Most users want a water with a low and constant temperature.

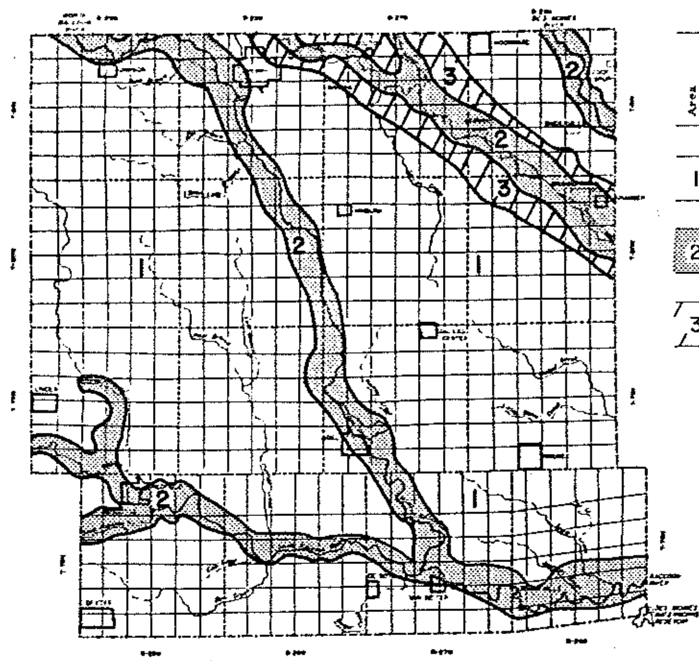
To the user, the quality of ground water is as important as the amount of water that an aquifer will yield. As ground water moves through soil and rock materials, it dissolves some of the minerals which, in turn, affect water quality. In addition to mineral content, bacterial and chemical contamination may be introduced through poorly constructed wells and seepage from other pollution sources.

Recommended standards for common water constituents are described in the table above. These are nationally accepted as guidelines for acceptable drinking water supplies. Limits for uses other than drinking often differ from these. For instance, water that is unacceptable for drinking and household use may be completely satisfactory for industrial cooling.

From analyses of ground water, averages and ranges of values for several mineral constituents are summarized in Figure 11 for the 4 major aquifers in Dallas County. Recommended concentrations for some constituents are often exceeded without obvious ill effects, although the water may be unpalatable. Water quality analyses for individual wells should be obtained to determine if concentrations of constituents that affect health are exceeded.

Figure 11
CHEMICAL CHARACTER OF GROUND WATER

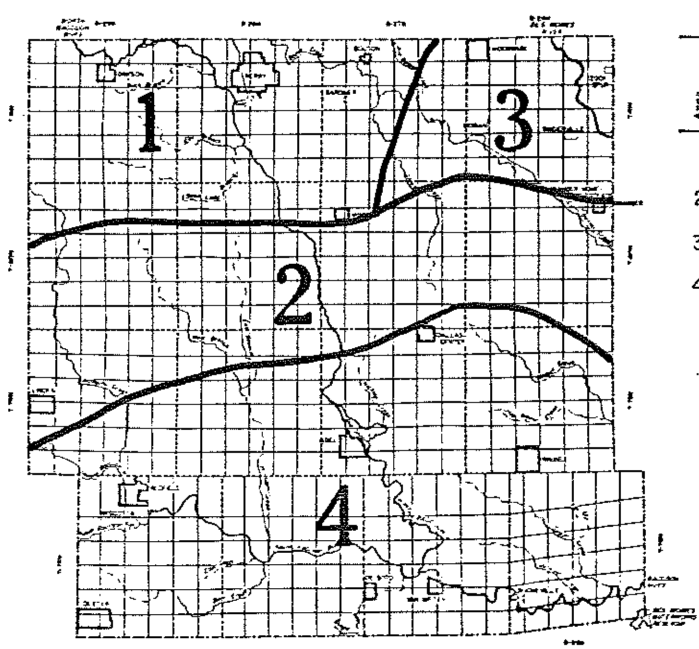
Surficial Aquifers



Area	Average and Range	Calcium (Ca)	Magnesium (Mg)	Sodium & potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Dissolved Solids	Hardness (as $CaCO_3$)	Number of analyses
Water from the drift aquifer											
1	A	99	28	27	451	41	6	0.5	462	375	12
	R	78-118	23-42	12-66	312-594	8-113	0.5-18	0.2-0.9	330-632	295-468	
Water from the alluvial aquifer											
2	A	101	32	20	356	102	12	0.4	497	384	56
	R	64-147	19-54	8-48	224-471	7-248	1-37	0.2-1.3	305-769	236-590	
Water from the buried-channel aquifer											
3	A	77	35	92	483	122	7	1.0	600	365	4
	R	63-104	30-54	60-129	400-545	26-291	1-13	0.3-1.6	469-794	281-480	

The alluvial and drift aquifers yield good quality water. Water from buried channels has a higher dissolved solids content, but it is less than that from rock aquifers. Water temperatures average 52°F and normally do not vary more than 3°.

Mississippian Aquifer

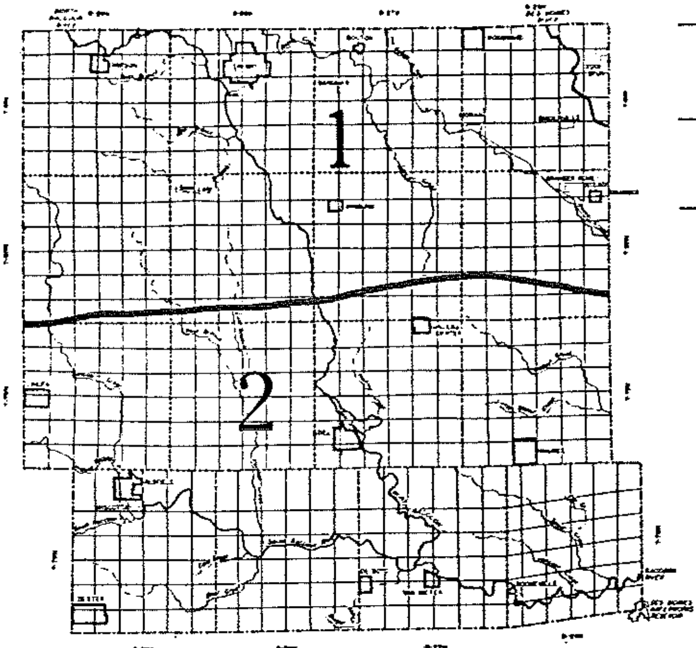


Area	Average and Range	Calcium (Ca)	Magnesium (Mg)	Sodium & Potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Dissolved Solids	Hardness (as $CaCO_3$)	Number of Analyses
1	A	64	29	137	305	286	19	1.9	715	261	3
	R	58-74	20-43	118-155	256-337	241-345	11-30	1.5-2.7	642-812	236-360	
2	A	34	13	421	454	615	40	5.6	1388	139	13
	R	11-85	6-25	201-563	312-593	192-844	10-88	3.0-9.0	628-1806	53-246	
3	A	133	65	246	317	722	67	2.7	1486	600	2
	R	114-152	51-79	220-272	295-339	551-885	59-75	2.4-3.0	1230-1742	496-705	
4	A	301	85	531	311	1820	87	2.9	3325	1107	4
	R	264-310	72-97	312-760	222-345	1469-2311	11-132	2.6-3.0	2973-3996	1010-1224	

Water in the Mississippian aquifer is more highly mineralized than that typically found in surficial aquifers and is usually very hard. The dissolved solids content is high, especially in the southern half of the county. For most of the county, sulfate and fluoride concentrations exceed the recommended standards. Average water temperature is 53°F with a range of 50-55°.

CHEMICAL CHARACTER OF GROUND WATER

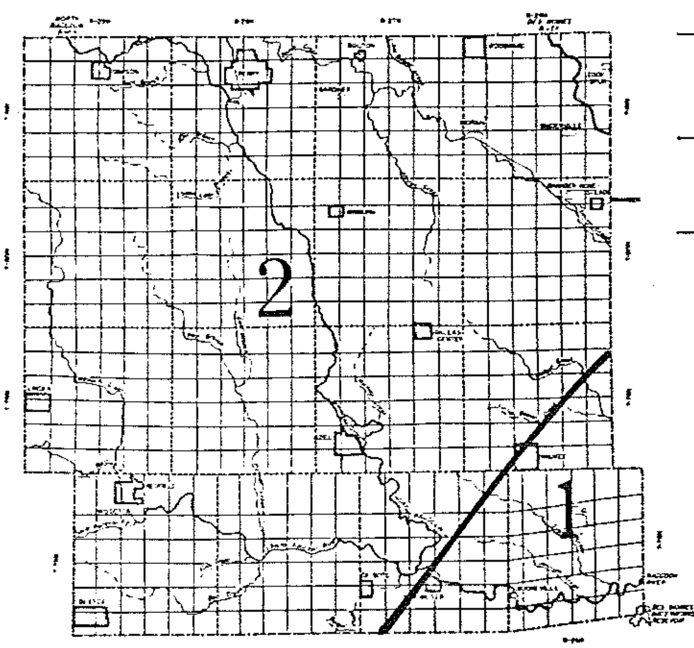
Silurian - Devonian Aquifer



Area	Average and Range	Calcium (Ca)	Magnesium (Mg)	Sodium & Potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Dissolved Solids	Hardness (as $CaCO_3$)	Number of Analyses
1	A	111	48	320	265	858	40	3.1	1620	481	5
	R	61-141	38-68	266-446	207-320	655-1160	5-110	0.9-6.5	1182-2035	309-660	
2	A	386	112	373	177	1714	196	2.1	3067	1429	8
	R	96-560	43-169	191-654	56-232	978-2850	84-331	1-3.5	1840-4786	417-2061	

Water in the Silurian-Devonian aquifer is highly mineralized and objectionally hard, especially in the southern half of the county. Fluoride concentrations are commonly above recommended standards. Over most of the county excessive amounts of sulfate make the water unsuitable for drinking. Average water temperature is 54°F with a range of 50-57°.

Cambro-Ordovician Aquifer



Area	Average and Range	Calcium (Ca)	Magnesium (Mg)	Sodium & Potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Dissolved Solids	Hardness (as $CaCO_3$)	Number of Analyses
1	A	79	32	341	341	263	30	2.0	735	330	4
	R	69-84	20-40	119-371	325-371	245-280	21-36	1.4-2.6	722-752	266-362	
2	A	144	55	377	248	773	181	2.4	1712	596	5
	R	128-162	32-70	264-394	215-300	740-871	92-240	1.8-2.8	1470-1866	451-693	

This deep aquifer yields water of relatively good quality compared to the other rock aquifers. However, the water is noticably hard and exceeds recommended standards for sulfate, fluoride, and dissolved solids. The temperature of water, unlike that in other aquifers has a wide range--from 63°F in the northwest to 75°F in the southeast.

RECOMMENDATIONS FOR PRIVATE WATER WELLS

Contracting for Well Construction

To protect your investment and guarantee satisfactory well completion, it is a good idea to have a written agreement with the well driller. The agreement should specify in detail:

size of well, casing specifications, and types of screen and well seal

methods of eliminating surface and subsurface contamination

disinfection procedure to be used

type of well development if necessary

test pumping procedure to be used

date for completion

itemized cost list including charges for drilling per foot, for materials per unit, and for other operations such as developing and test pumping

guarantee of materials, workmanship, and that all work will comply with local and state well regulations

liability insurance for owner and driller

Well Location

A well should be located where it will be least subject to contamination from nearby sources of pollution. The Iowa State Department of Health recommends minimum distances between a new well and pollution sources, such as cesspools (150 ft.), septic tanks (50 ft.), and barnyards (50-100 ft. and down slope from well). Greater distances should be provided where possible.

The well location should not be subject to flooding or surface water contamination. Select a well-drained site, extend the well casing a few feet above the ground, and mound earth around it. Diversion terraces or ditches may be necessary on slopes above a well to divert surface runoff around the well site.

In the construction of all wells care should be taken to seal or grout the area between the well bore and the well casing (the annulus) so that surface water and other pollutants cannot seep into the well and contaminate the aquifer.

Locate a well where it will be accessible for maintenance, inspection, and repairs. If a pump house is located some distance from major buildings and wired separately for

Hicks Well Co.
Scranton, Iowa 51462

Beemer Well Co.
R.R. #2
Webster City, Iowa 50595

Lester Vinson
Stratford, Iowa 50249

Doyle Van De Krol
Sully, Iowa 50251

Whalen Well Co.
1407 1st Avenue West
Newton, Iowa 50208

Huff Well Drilling Co.
R.R. #1
Winterset, Iowa 50273

Douglas Bruinekool
Pella, Iowa 50219

Dwayne Bruinekool
R.R. 3
Oskaloosa, Iowa 52577

Brooks Well and Pump Co.
Knoxville, Iowa 50138

Thorpe Well Co.
Ankeny, Iowa 50021

Tom Hughes Well Co.
4120 73rd St.
Des Moines, Iowa 50322

Stanley Well Co.
Massena, Iowa 50853

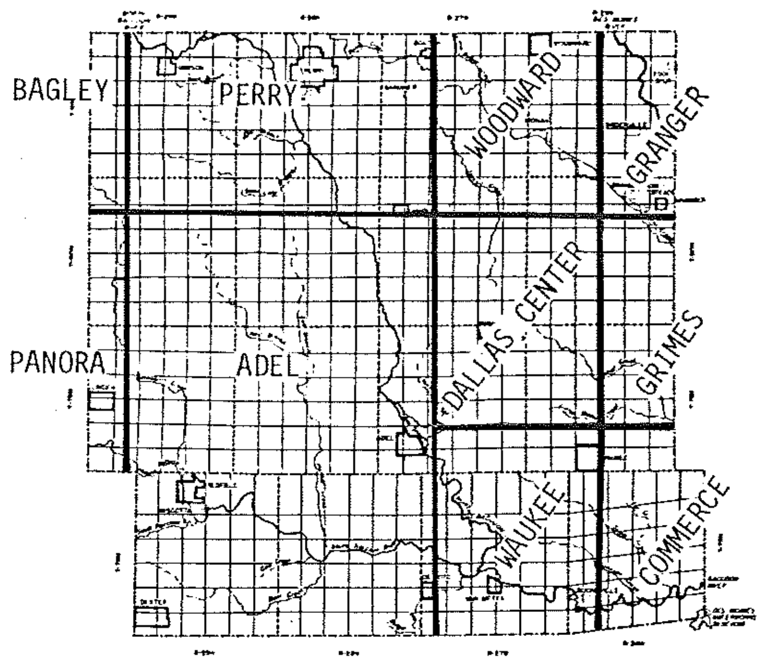
Dewey Well Co.
Box 177
Slater, Iowa 50244

Larson Well Co.
Roland, Iowa 50236

Layne-Western
705 S. Duff St.
Ames, Iowa 50010

Jerry Reiwertz
1133 9th Street
Nevada, Iowa 50201

Topographic Maps (Available from the Iowa Geological Survey)



Map Title	Date	Scale	Contour Interval
Bagley	1954	1:62,500	20 ft.
Panora	1952	1:62,500	20 ft.
Perry	1949	1:62,500	20 ft.
Adel	1949	1:62,500	20 ft.
Woodward	1965	1:24,000	10 ft.
Dallas Center	1965	1:24,000	10 ft.
Waukee	1965	1:24,000	10 ft.
Granger	1965	1:24,000	10 ft.
Grimes	1965	1:24,000	10 ft.
Commerce	1965	1:24,000	10 ft.

Useful Reference Materials

Horick, P.J., and Steinhilber, W.L., 1973, Mississippian aquifer of Iowa, Iowa Geological Survey, Misc. Map Series No. 3.

Horick, P.J., and Steinhilber, W.L., 1978, Jordan aquifer of Iowa, Iowa Geological Survey, Misc. Map Series No. 6.

Iowa State Department of Health, 1971, Sanitary standards for water wells, State Department of Health, Environmental Engineering Service.

Twenter, F.R., and Cable, R.W., 1965, The water story in Central Iowa, Iowa Geological Survey Water Atlas No. 1.

Van Eck, O. J, 1971, Optimal well plugging procedures, Iowa Geological Survey Public Information Circular No. 1.