Sample

GROUND WATER RESOURCES

Lucas County

Open File Report 80-59 WRD

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GROUND-WATER RESOURCES OF LUCAS COUNTY

Introduction

Approximately 50% of the water used in Lucas County comes from ground water sources. It is estimated that the use of ground water in the county currently approaches .33 billion gallons per year. For comparison, this amount would provide each resident with 89 gallons of water a day during the year. These higher per capita figures reflect the larger demands of livestock and commercial uses.

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> - affects 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 Lucas County where the availability of ground water is not limited. The most common limitation 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 of adequate sources.

Occurrence of Ground Water in Lucas County

The occurrence of ground water is influenced by geology -- the position and thickness of 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 unconsolidated sand and gravel, porous sandstone, and porous or fractured limestone and dolostone. 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 or aquitards and commonly separate one aquifer unit from another.

In Lucas County there are two principal sources from which users obtain water supplies: the loose, unconsolidated materials near the land surface that comprise the surficial aquifer, and a deep rock aquifer. Between the surficial aquifer and the deep Cambro-Ordovician aquifer are two other major water-bearing units, the Mississippian and the Devonian aquifer systems. However, throughout Lucas County the water contained in these aquifers is highly mineralized and of too poor quality for human or livestock use. Figure 1 shows the geologic relations of these beneath the county. Each aquifer 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.

Surficial Aquifers

Unconsolidated deposits at the land surface are comprised of mixtures of clay, silt, sand, gravel, and assorted boulders. The water-yielding potential of these deposits is greater in units composed mostly of sand and/or gravel. Three sub-types of surficial aquifers used in the county are: alluvial aquifers, the drift aquifer, and buried channel aquifers.

Alluvial aquifers consist mainly of sand and gravel transported and deposited by modern streams and make up the floodplains and terraces in major valleys. Alluvial deposits are near surface, generally less than 50-60 feet, and because of their near surface position can be contaminated by percolating surface water.

The drift aquifer is the thick layer of soils materials 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 may, however, be lenses or beds of sand and gravel in the drift that are thick and widespread enough to store and furnish dependable water. These may be difficult to locate because of their irregular shape and because they are buried within other drift materials. Usually one or two sand layers can be found in most places that will yield enough water to meet domestic needs.

Buried channels are bedrock stream valleys containing alluvial materials that existed before the glacial period. The valleys were overridden by glaciers and are now buried under the drift and more recent alluvial materials.

The location, yield, and water quality characteristics for the surficial aquifers are summarized in Figures 2 and 9 and Table 3. An indication of general thicknesses can be obtained by comparing the elevations of the land surface and the bottom (the bedrock surface) of the surficial deposits in Figure 4 and 5. The thickness of the glacial drift or the depth of buried channels can be determined by subtracting the elevation of the bedrock surface from the elevation of the land surface.

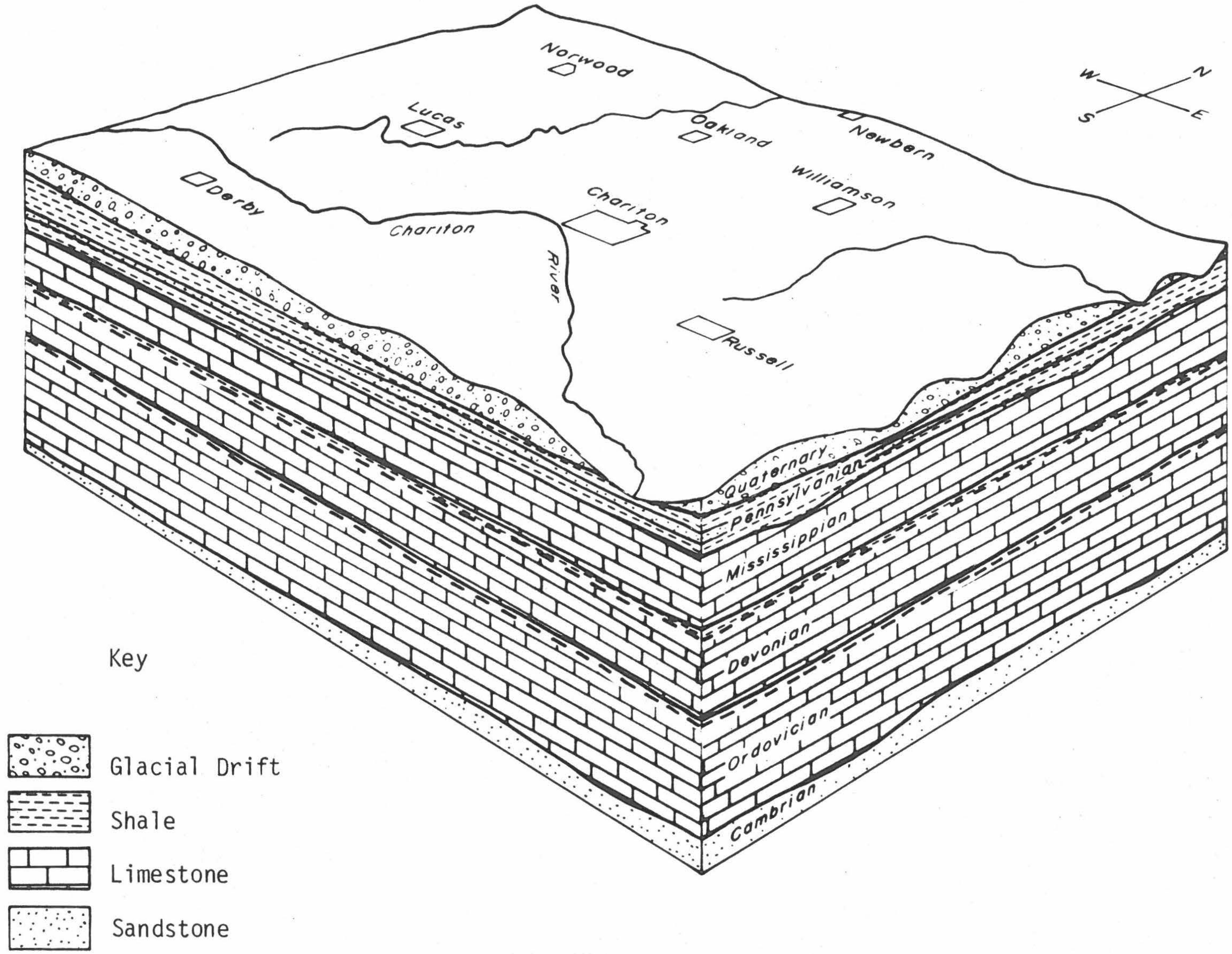


Figure 1

BLOCK DIAGRAM SHOWING THE GEOLOGY OF LUCAS COUNTY

Rock Aquifers

Below the drift and other surficial materials is a thick sequence of layered rocks formed from deposits of rivers and shallow seas that alternately covered the state during the last 600 million years. The geologic map (Figure 3) shows the geologic units which form the surface of this rock sequence. These rocks are Pennsylvanian in age and are mainly shales. Although the Pennsylvanian rocks usually act as an aquiclude, sandstone layers within the Cherokee Group provide several wells in the eastern and southern half of the county with fair yields (5 to 20 gpm). The thickness of these sandstone units are quite variable and the depth of wells drilled into them vary in depth between 300 and 400 feet. The water drawn from these wells is of uniformly poor quality, with total dissolved solids concentrations ranging from 1500 to over 2500 mg/l and sulfate concentrations that generally exceed 1000 mg/l.

Underlying the Pennsylvanian aquiclude is a sequence of older rocks, portions of which form the major rock aquifers beneath Lucas County. This sequence and its water-bearing characteristics are shown in Table 1.

Examples of the rock units encountered in several wells at various locations in Lucas County are indexed and illustrated in Figures 7 and 8. The geologic unit that supplies ground water and the rate of yield are shown for each well.

The accessibility of ground water in rock aquifers depends on the depth to the aquifer. The deeper a well must be, the greater the cost 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 4 with the maps of aquifer elevations in Figures 11, 12, and 13. The range in depth below land surface to the top of the county's principal bedrock aquifers is given for each township in Figure 6.

A second factor which affects ground water accessibility is the level to which the water will rise in a well (the static water level). Throughout the county water in the rock aquifers is under artesian pressure and rises in wells once the aquifer is penetrated. This can reduce the cost of pumping. Average static water levels for Lucas County wells are shown in Figures 11, 12, and 13.

Average rates of yield and water quality characteristics for each of the aquifers are summarized in the maps in Figures 11, 12, 13 and Table 4.

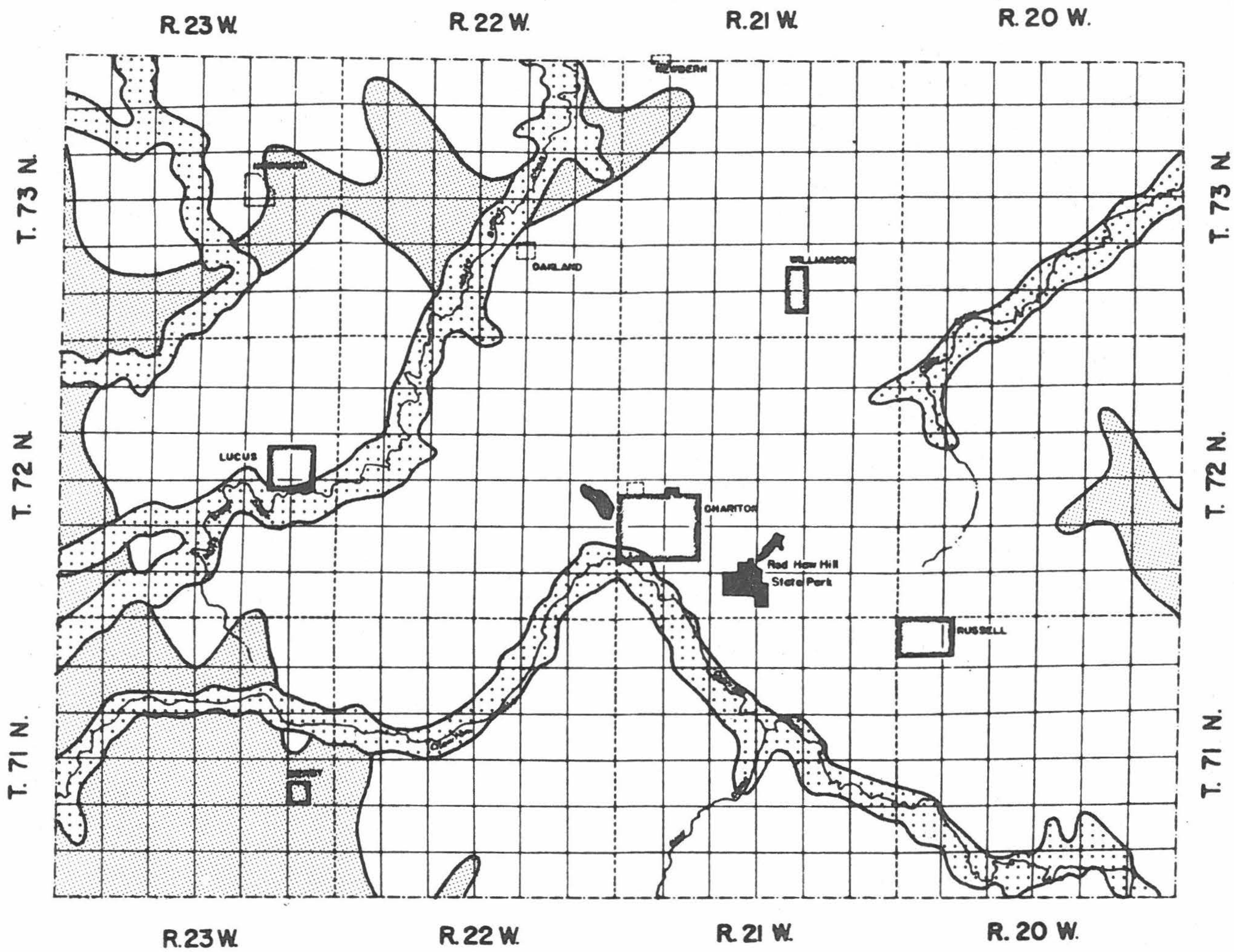
Table 1

GEOLOGIC AND HYDROGEOLOGIC UNITS IN LUCAS COUNTY

Age	Rock Unit	Description	Thickness Range	Hydrogeologic Unit	Water-Bearing Characteristics
Quaternary	Alluvium	Sand, gravel, silt and clay	0-400 (feet)	Surficial aquifer	Fair to large yields (25 to 50 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	Marmaton Group	Alternating shale and limestone; thin coal and sandstone	100-500	Aquiclude	Low yields only from limestone and sandstone
	Cherokee Group	Shale, clay, siltstone, sandstone and coal beds, mostly thin			
Mississippian	Meramec Series	Sandy limestone	400-500	Mississippian aquifer	Fair to low yields
	Osage Series	Limestone and dolostone, cherty; shale			
	Kinderhook Series	Limestone, oolitic, and dolostone, cherty			
Devonian	Maple Mill Shale Sheffield Formation Lime Creek Formation	Shale, limestone in lower part	55-90	Devonian aquiclude	Does not yield water
	Cedar Valley Limestone Wapsipinicon Formation	Limestone and dolostone, contains evaporites (gypsum) in southern half of Iowa	400-500	Devonian aquifer	Fair to low yields
Ordovician	Maquoketa Formation	Shale and dolostone	800-1000	Maquoketa aquiclude	Does not yield water
	Galena Formation	Dolostone and chert		Minor aquifer	Low yields
	Decorah Formation-Platteville Formation	Limestone, dolostone and thin shale, includes sandstone in SE Iowa		Aquiclude	Does not yield water
	St. Peter Sandstone	Sandstone		Cambro-Ordovician aquifer	Fair yields
	Prairie du Chien Formation	Dolostone, sandy and cherty			High yields (over 500 gpm)
Cambrian	Jordan Sandstone	Sandstone	30-50	Aquitard	No data
	St. Lawrence Formation	Dolostone			
	Franconia Sandstone	Sandstone and shale			
	Dresbach Group	Sandstone		Dresbach aquifer	
Precambrian	Undifferentiated	Coarse sandstone: crystalline rocks		Base of ground water reservoir	Not known to yield water

Figure 2

SURFICIAL MATERIALS



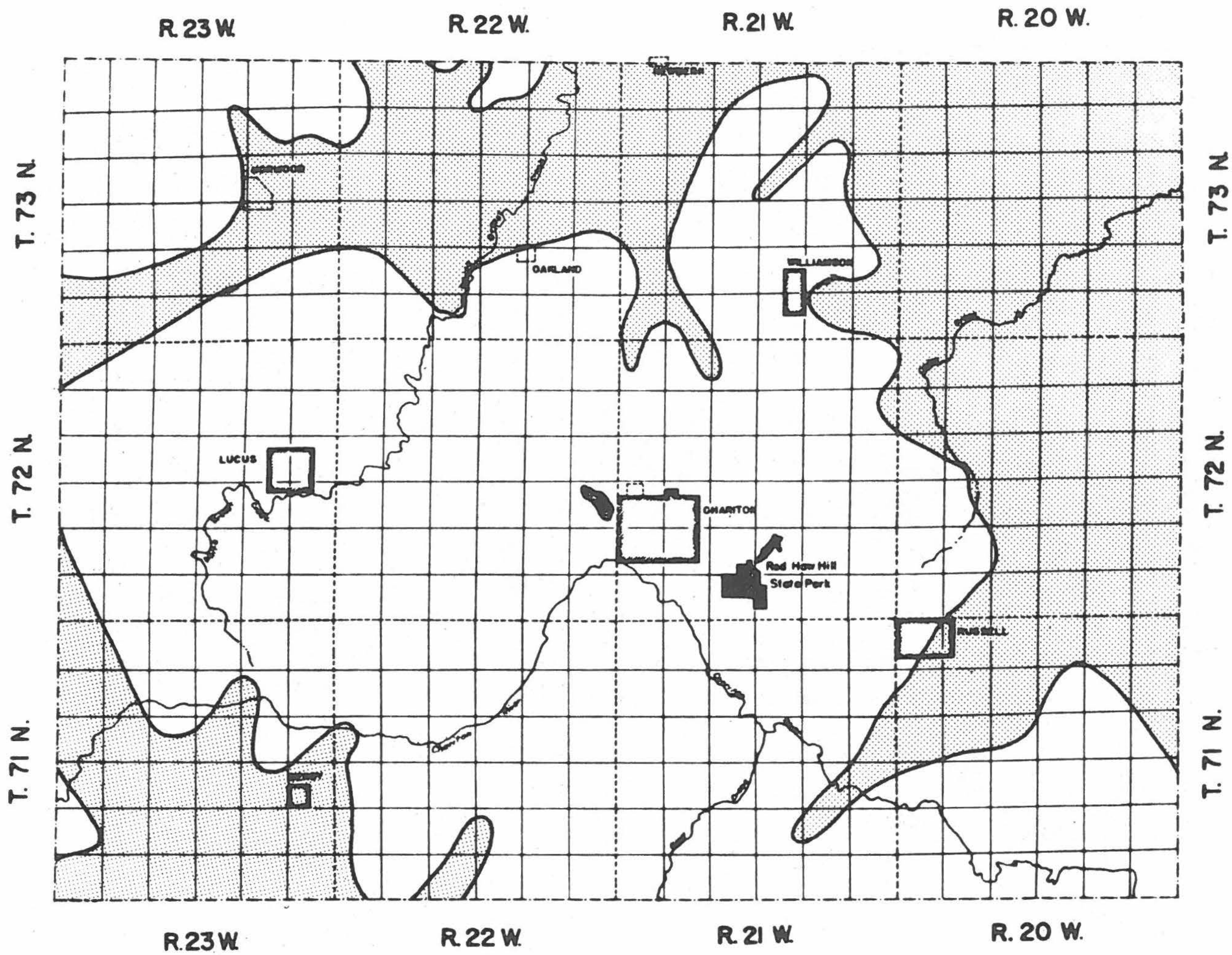
Alluvium

Glacial Drift

Buried Channels

Figure 3

GEOLOGIC MAP



Pennsylvanian

Marmaton Group

Pennsylvanian

Cherokee Group

Figure 4

ELEVATION OF LAND SURFACE IN FEET ABOVE MEAN SEA LEVEL

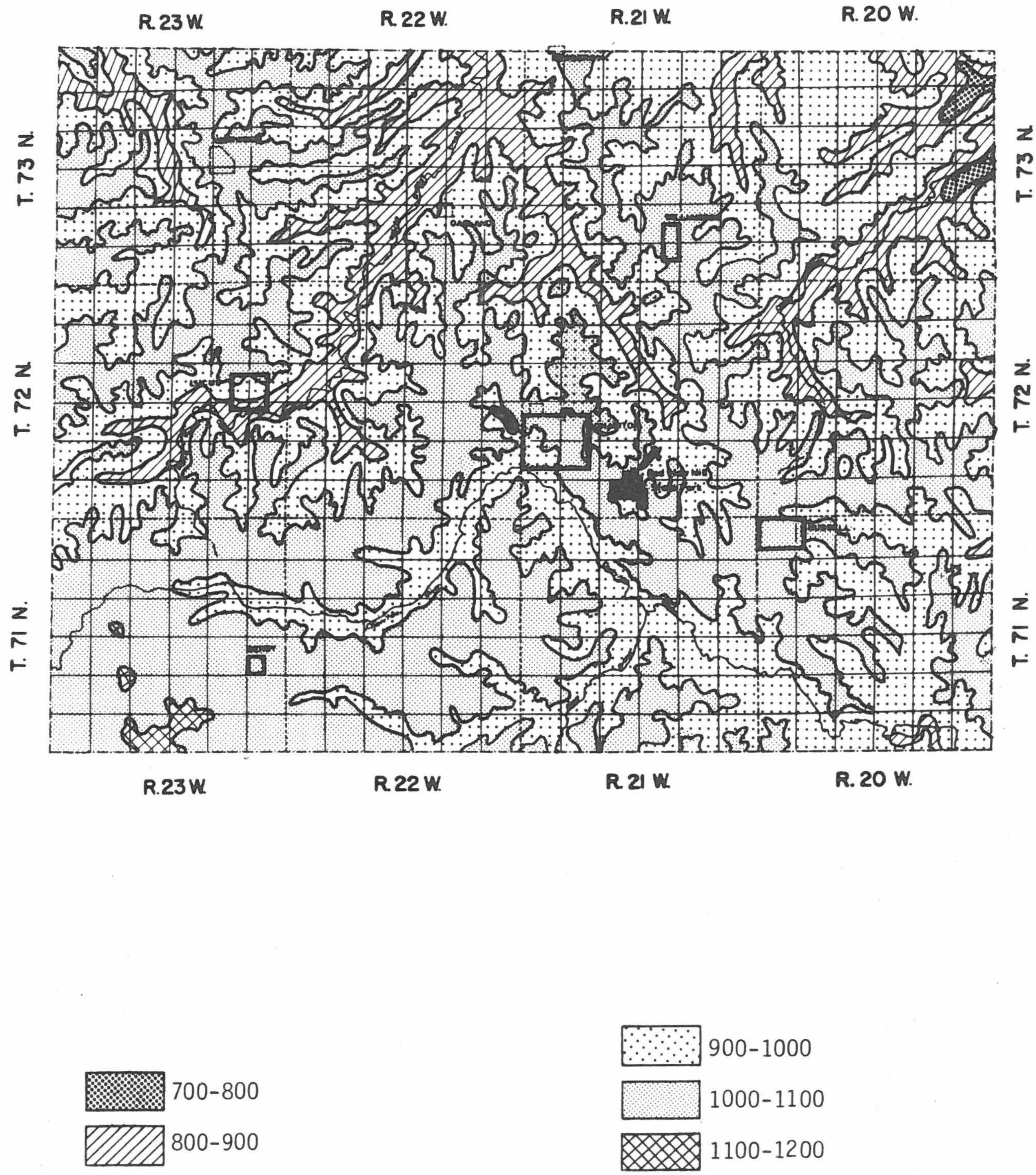


Figure 5

ELEVATION OF BEDROCK SURFACE IN FEET ABOVE MEAN SEA LEVEL

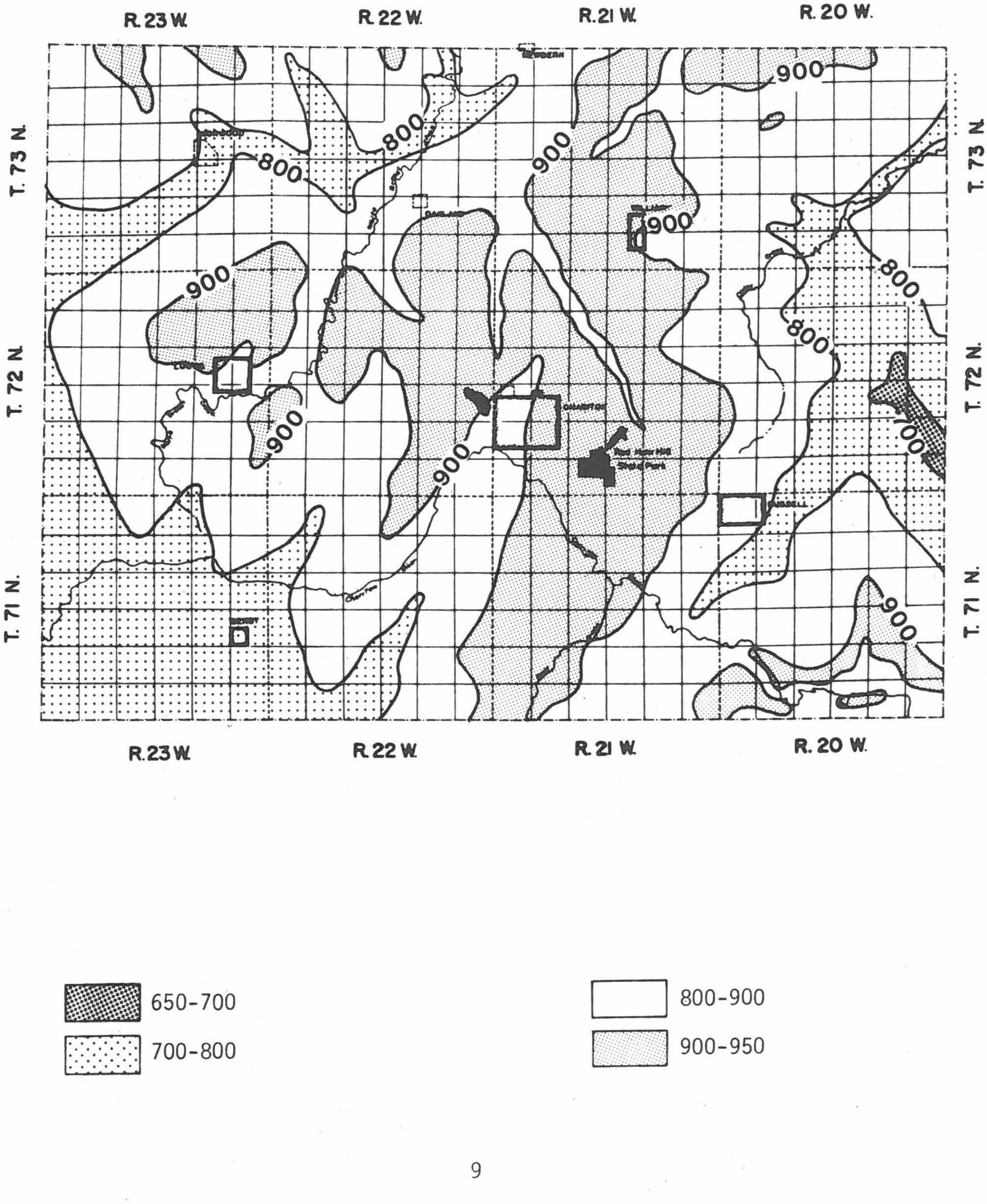


Figure 6

RANGE IN DEPTH TO LUCAS COUNTY'S PRINCIPAL ROCK AQUIFERS

	R. 23 W.	R. 22 W.	R. 21 W.	R. 20 W.	
T. 73 N.	BEDROCK 0-300 MISSISSIPPIAN 400-700 DEVONIAN 950-1150 CAMBRO-ORDOVICIAN 2300-2600	BEDROCK 0-300 MISSISSIPPIAN 200-500 DEVONIAN 900-1200 CAMBRO-ORDOVICIAN 2300-2600	BEDROCK 0-200 MISSISSIPPIAN 200-500 DEVONIAN 850-1050 CAMBRO-ORDOVICIAN 2250-2550	BEDROCK 0-200 MISSISSIPPIAN 100-400 DEVONIAN 750-1100 CAMBRO-ORDOVICIAN 2100-2500	T. 73 N.
T. 72 N.	BEDROCK 0-200 MISSISSIPPIAN 400-700 DEVONIAN 1000-1200 CAMBRO-ORDOVICIAN 2300-2600	BEDROCK 0-200 MISSISSIPPIAN 400-700 DEVONIAN 950-1150 CAMBRO-ORDOVICIAN 2300-2600	BEDROCK 0-200 MISSISSIPPIAN 300-600 DEVONIAN 950-1150 CAMBRO-ORDOVICIAN 2250-2550	BEDROCK 0-300 MISSISSIPPIAN 200-500 DEVONIAN 900-1200 CAMBRO-ORDOVICIAN 2300-2600	T. 72 N.
T. 71 N.	BEDROCK 100-400 MISSISSIPPIAN 500-800 DEVONIAN 1100-1350 CAMBRO-ORDOVICIAN 2400-2700	BEDROCK 100-300 MISSISSIPPIAN 400-700 DEVONIAN 1100-1300 CAMBRO-ORDOVICIAN 2350-2650	BEDROCK 100-300 MISSISSIPPIAN 400-700 DEVONIAN 1050-1250 CAMBRO-ORDOVICIAN 2300-2500	BEDROCK 100-300 MISSISSIPPIAN 300-700 DEVONIAN 1050-1250 CAMBRO-ORDOVICIAN 2150-2500	T. 71 N.
	R. 23 W.	R. 22 W.	R. 21 W.	R. 20 W.	

Figure 7

INDEX MAPS FOR TYPICAL WELLS IN LUCAS COUNTY

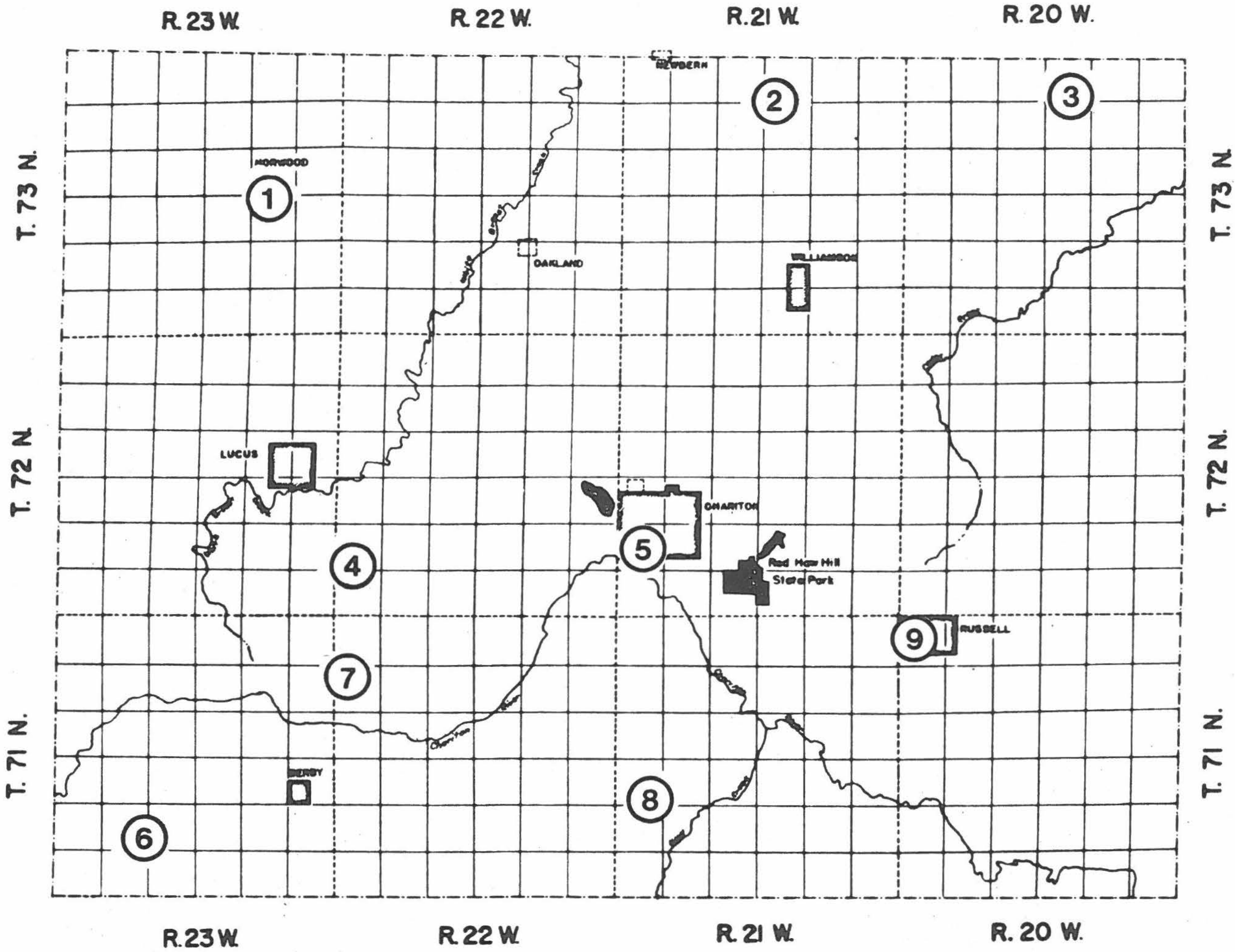


Figure 8

TYPICAL WELLS IN LUCAS COUNTY

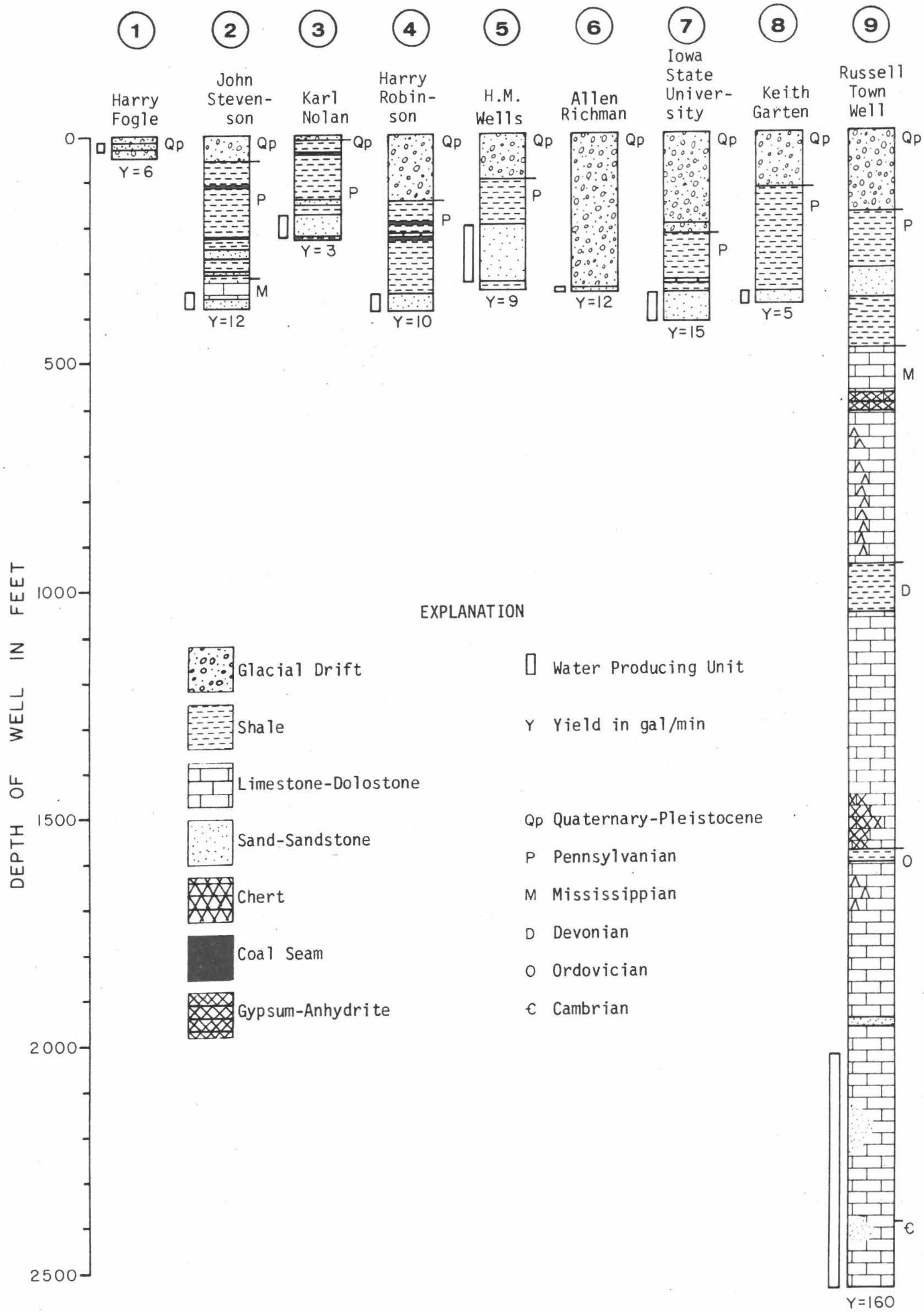


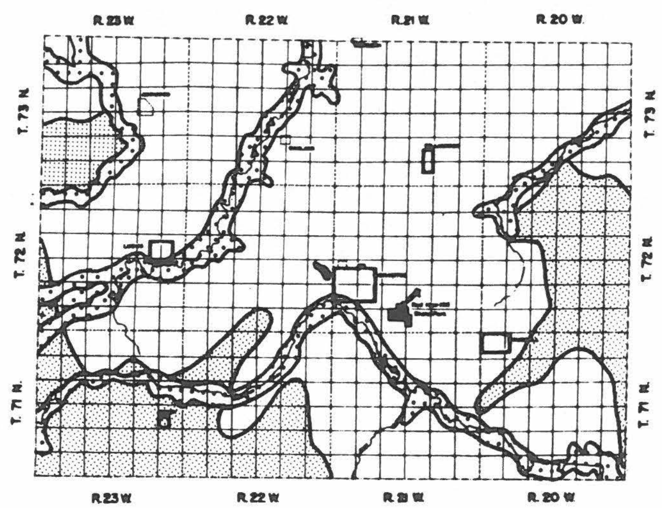
Figure 9

SURFICIAL AQUIFERS

Water Levels

Water levels in the surficial aquifers are difficult to analyze, water rises to different levels in wells drilled into alluvial, buried-channel, and drift aquifers. The water table in the drift aquifer generally slopes from high land areas toward the streams and, changes noticeably throughout the year. Levels in drift and buried-channel aquifers respond rapidly to recharge from precipitation. Water levels in the alluvial aquifer fluctuate somewhat in the same way as those in the drift and buried-channel aquifers; however, the main influence on the alluvial aquifer is the stage (level) of the associated streams. Water levels will be high during periods of high stream stage and low during the low-stage periods.

Water levels in the drift aquifers commonly are from 10 to 50 feet below the land surface, and those in the buried-channel aquifers have been reported to be as low as 150 feet below the land surface. The water levels in alluvial wells are from 4 to 20 feet below the flood-plain surface and the depth to the water surface will be accordingly deeper in wells located on terrace surfaces.



Water yields to wells in gallons per minute

Alluvial aquifers

10-25 (35)*

25-50 (75)

Drift aquifer

1-5 (10)

Buried channel and drift aquifers

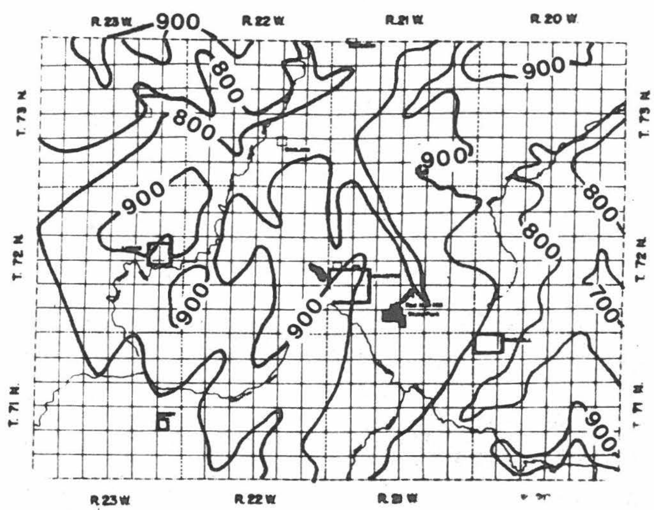
5-10 (25)

*(35) number is maxiumum yield that is occasionally available but probably not on a sustained basis.

Figure 10

Pennsylvanian Aquiclude

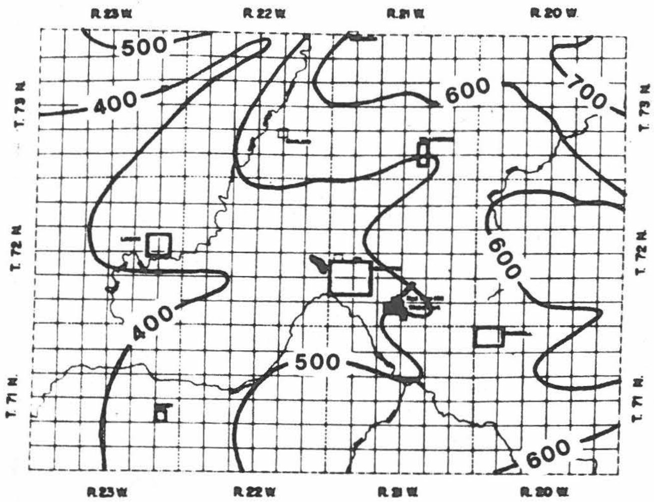
The Pennsylvanian Aquiclude generally underlies the whole county and is thickest in the western and central portions of the county. Pennsylvanian strata consist of a succession of predominantly shale beds of the Marmaton Group and Cherokee Group, with occasional thin layers of sandstone (in the Cherokee) which locally function as aquifers. Coal is present both in the Marmaton and Cherokee groups and is present as thin beds or lenses which range in thickness from a few inches up to 5 feet.



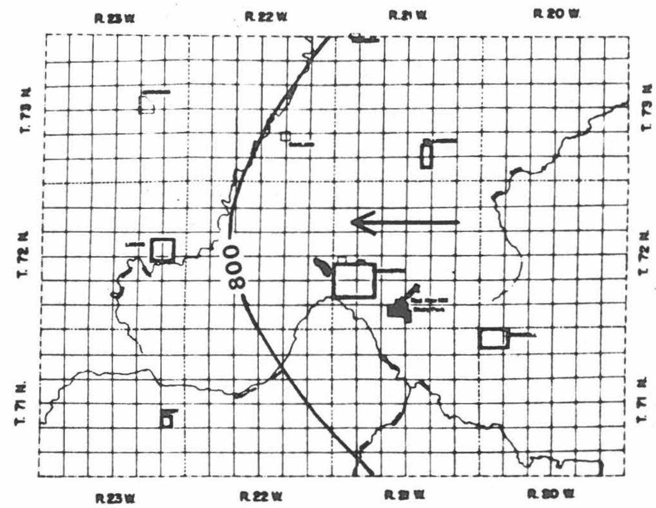
Elevation of the top of the Pennsylvanian Aquiclude in feet above mean sea level

Figure 11

MISSISSIPPIAN AQUIFER

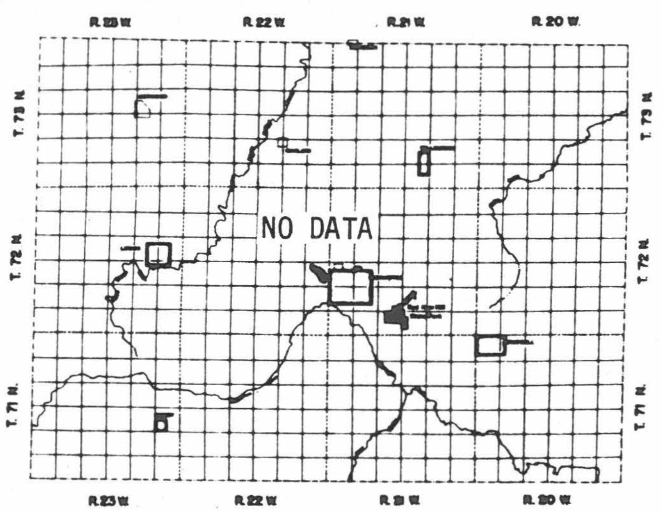


Elevation of Mississippian Aquifer in feet above mean sea level



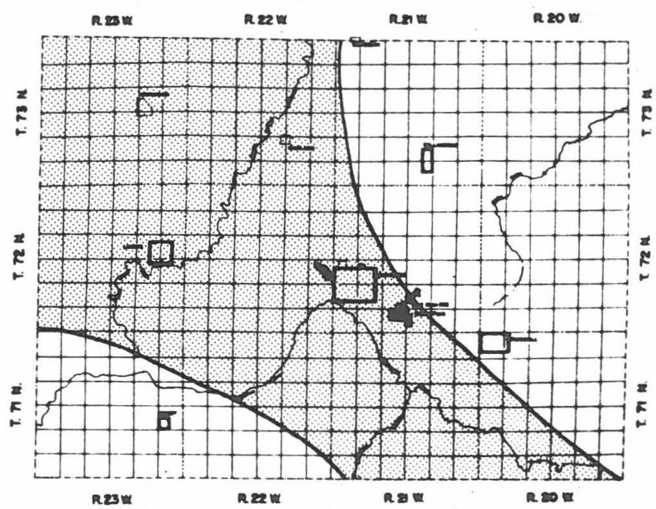
Water levels in wells in feet above mean sea level

←General direction of gradient (water levels in wells) to west, increases to 900' in Clarke and adjacent counties.



Water yields to wells in gallons per minute

Range estimated to be from 5 - 100 gpm



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

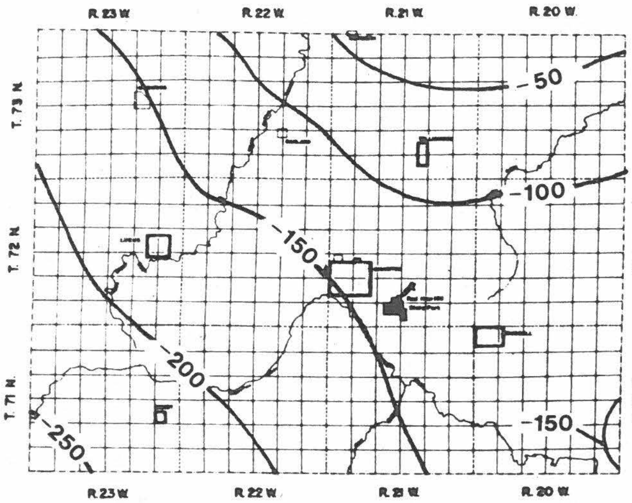
3000-5000

5000

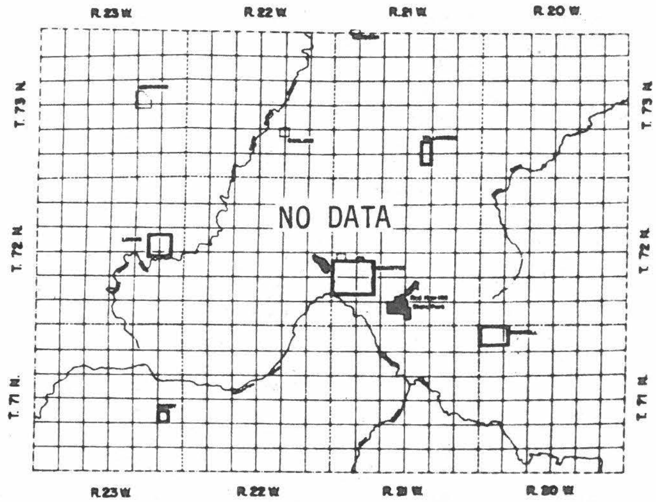
*Other water quality data in Table 4

Figure 12

DEVONIAN AQUIFER

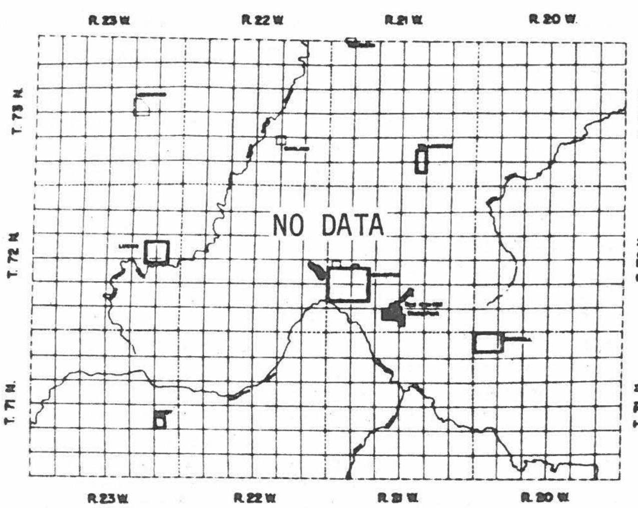


Elevation of Devonian Aquifer in feet above mean sea level

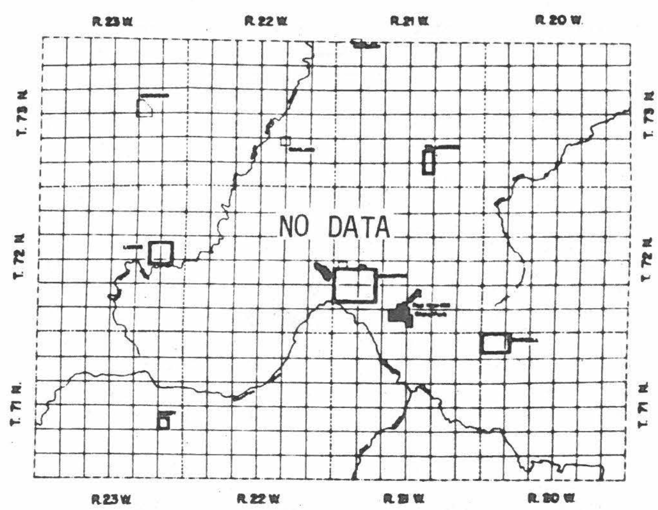


Water levels in wells in feet above mean sea level

Estimated to be in a range between 50 and 75 feet higher than the Cambro-Ordovician aquifer (see Figure 13).



Water yields to wells in gallons per minute

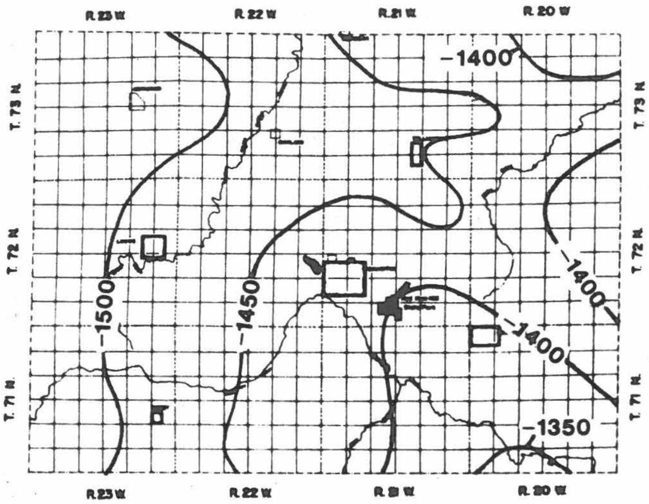


Dissolved solids content in milligrams per liter (mg/l)*

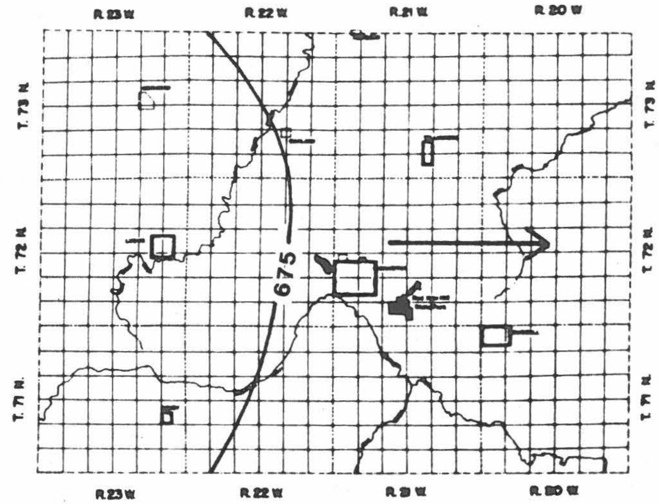
Can be anticipated to range between 5,000 and 10,000.

Figure 13

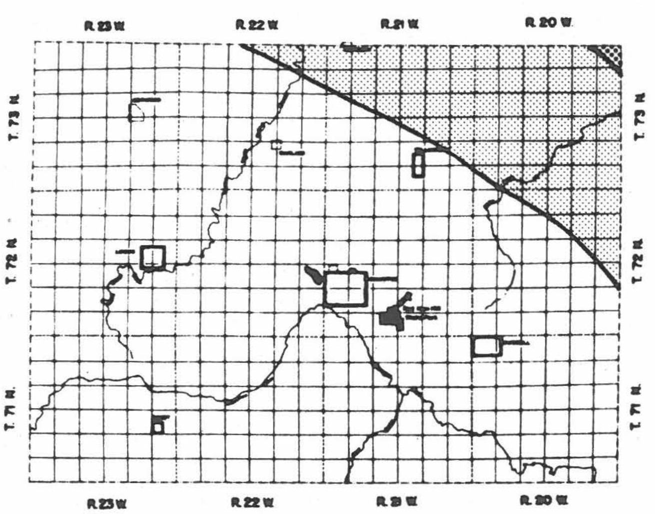
CAMBRO-ORDOVICIAN (JORDAN) AQUIFER



Elevation of Jordan Aquifer in feet above sea level



Water levels in wells in feet above mean sea level
⟶ Water levels gradually decrease to 650 feet in central Monroe County.

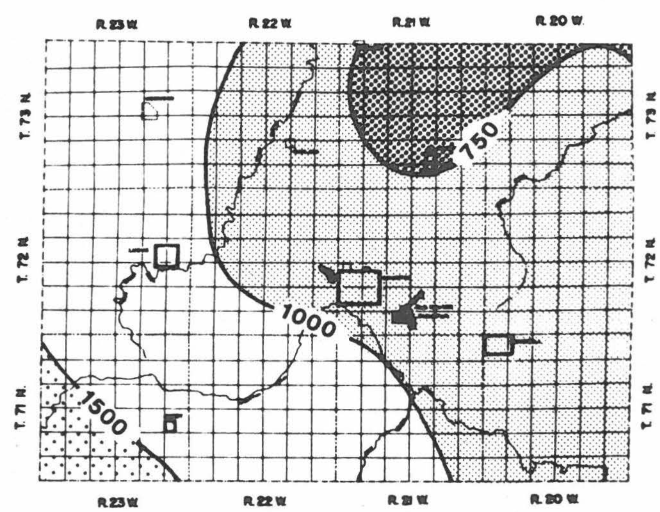


Water yields of wells in gallons per minute

200-500

500-1000

More than 1000



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

Less than 750

1000-1500

750-1000

More than 1500

*Other water quality data in Table 4

Table 2

SIGNIFICANCE OF MINERAL CONSTITUENTS 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 rationally 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 (A) and ranges (R) of values in milligrams per liter (mg/l) for several constituents are summarized in Tables 3 and 4 for the surficial and bedrock aquifers in Lucas 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.

Table 3

CHEMICAL CHARACTER OF GROUND WATER

Surficial Aquifers

Average (A) and range (R)	Dissolved solids	Hardness (as $CaCO_3$)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Sodium (Na)	Iron (Fe)	Manganese (Mn)
				Alluvial Aquifer					
A	417	288	105	13	0.3	4.2	20.2	9.4	1.5
R	165-1000	124-762	3-350	0.5-180	0.1-0.45	0.1-17	4.1-85	0.04-51	0.05-17
				Shallow drift aquifer					
A	736	480	177	37	0.3	81	68	1.1	0.13
R	220-2840	153-1710	12-1470	0.5-200	0.2-0.8	0.1-570	7.3-710	0.02-30	0.05-1.9
				Intermediate drift aquifer					
A	1030	569	397	9	0.5	6	108	5	0.09
R	261-2726	150-1518	7-1520	0.5-49	0.2-1.0	0-44	17-368	0.04-24	0.05-0.37
				Deep drift and Buried-channel aquifers					
A	2346	868	1254	30	0.6	6.7	334	3.4	0.24
R	383-3657	140-1640	42-1990	3-110	0.1-2.0	0-82	54-568	0-18	0-1.4

The alluvial aquifers yield the least mineralized water of all ground water sources in south central Iowa. In the alluvial aquifers, manganese and iron concentrations are well above recommended standards, but all other constituents are well below. Water temperatures average 55°F (13°C) and the range of these temperatures is from 46°F to 60°F (8°C to 16°C).

In the shallow drift aquifers, the water is hard and contains undesirable concentrations of iron, sulfate, chloride and dissolved solids. High concentrations of nitrate, chloride and bacteria are directly due to contamination of wells or the infiltration of agricultural waste water and runnoff into shallow drift aquifers. The water from shallow drift aquifers is usually acceptable for most purposes if wells are constructed properly, and located a suitable distance from sources of contamination. Nitrate content should be checked carefully in these wells, and any water supply containing over 45 mg/l should not be used for infant feeding. Water temperatures average 54°F (12°C) and the range of these temperatures is from 50°F to 60°F (10°C to 16°C).

In the intermediate drift aquifer, water is more highly mineralized than the shallow drift aquifer, with iron concentrations high and nitrate low. The fluoride content, hardness and temperature are similar to the shallow drift aquifer.

In the deep drift and buried-channel aquifers, the water is highly mineralized and contains high concentrations of dissolved solids, sulfate and iron. Water temperatures range between 54°F and 57°F (12°C to 14°C).

Table 4

CHEMICAL CHARACTER OF GROUND WATER

Bedrock Aquifers

Average (A) and range (R)	Dissolved solids	Hardness (as $CaCO_3$)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Sodium (Na)	Iron (Fe)	Manganese (Mn)
				Pennsylvanian (Cherokee Group) aquifers					
A	4531	869	1088	97	1.4	3.5	536	3.2	0.15
R	251-7092	44-1559	22-4139	0.5-780	0.2-4.0	0-50	7-2180	0.1-22	0-4
				Mississippian aquifer					
A	4274	923	2385	176	1.9	8.4	965	7.6	0.11
R	1210-8400	60-1580	521-4500	19-750	1.0-3.6	0-150	270-2100	0.05-23	0-0.34
				Cambro-Ordovician aquifer					
A	1098	370	397	150	2.3	1.2	226	2.4	0.05
R	614-2560	246-1100	190-930	29-620	1.2-3.2	0.08-5.5	100-520	0.04-10	0.01-0.10

Because it is highly mineralized, water in the bedrock aquifers is of limited use in many parts of southeast Iowa. Only under extensive treatment is it suitable for domestic and industrial uses, but without treatment it can be used for washing, cooling and fire fighting.

Pennsylvanian sources in Lucas County yield highly mineralized water. Sulfate concentrations are very high, as are sodium and total dissolved solids. Water temperatures average 56°F (14°C) and range between 52°F to 61°F (11°C to 16°C).

Water from the Mississippian Aquifer is highly mineralized with dissolved solids concentrations generally exceeding 3000 mg/l. Water temperatures average 57°F (14°C) and range between 52°F amd 64°F (11°C to 18°C).

Chemical quality data is available from only two wells in the Devonian Aquifer in the vicinity, but from these some general assumptions can be made. The sulfate content of the aquifer is high, due to the occurrence of evaporite minerals (gypsum and anhydrite). Water obtained from the Devonian Aquifer can be expected to contain dissolved solids concentrations in a range from 5,000 to 10,000 mg/l, with chloride, sodium and sulfate concentrations that are as high as 1,000, 2,000, and 2,500 mg/l respectively or higher.

Water from the Cambrian-Ordovician Aquifer is of consistently better quality than the water from the over-lying bedrock aquifers. Sulfate, iron, and fluoride concentrations are high and temperatures range from 73°F to 76°F (23°C to 24°C).

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 procedures 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 current recommended methods

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 downslope 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) as appropriate 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 building and wired separately for power, continued use of the water supply will not be jeopardized by fire in major buildings.

Water Treatment

Water taken from a private well should ideally be tested every six months. The University Hygienic Laboratory will do tests for coliform bacteria, nitrate, iron, hardness, and iron bacteria in drinking water for private individuals. Special bottles must be used for collecting and sending water samples to the laboratory. A sample kit can be obtained by writing to the University Hygienic Laboratory, University of Iowa, Oakdale Campus, Iowa City, Iowa 52242. Indicate whether your water has been treated with chlorine, iodine, or bromine; as different sample bottles must be used for treated and untreated water. The charge for the bacterial test is $3.00; for iron, hardness and nitrate, it is $3.00; and for iron bacteria, $5.00. If your well is determined to be unsafe, advice for correcting the problem can be obtained from your county or state Department of Health. Several certified private laboratories also run water analyses.

Shock chlorination is recommended following the construction and installation of a well and distribution system and any time these are opened for repairs or remodeling a strong chlorine solution is placed in the well and complete distribution system to kill nuisance and disease-causing organisms. If the first shock chlorination does not rid the water supply of bacteria it should be repeated, if this does not solve the problem the well should be abandoned or the water should be continuously disinfected with proper chlorination equipment.

Since most of the ground waters in Lucas County are mineralized, water softening and iron removal equipment may make water more palatable and pleasant to use. Softened water contains increased sodium; contact your physician before using a softener if you are on a sodium-restricted diet. Chlorination followed by filtration will remove most forms of iron and iron bacteria. Iron bacteria has no adverse effect on health but will plug wells, water lines, and equipment and cause tastes and odors. Iron removal equipment can be used if problems persist.

Well Abandonment

Wells taken out of service provide easy access for pollution to enter aquifers supplying water to other wells in the vicinity. Unprotected wells may also cause personal injury. Proper abandonment procedures should be followed to restore conditions to those that existed before the well was constructed, and to prevent source contamination. Permanent abandonment requires careful sealing. The well should be filled with concrete, cement grout, or sealing clays throughout its entire length. Before dug or bored wells are filled at least the top 10 feet of lining should be removed so surface waters will not penetrate the subsurface through a porous lining or follow cracks in or around the lining. The site should be completely filled and mounded with compacted earth.

ABANDONED WELLS SHOULD NEVER BE USED FOR DISPOSAL OR SEWAGE OR OTHER WASTES.

SOURCES OF ADDITIONAL INFORMATION

In planning the development of a ground water supply or contracting for the drilling of a new well additional or more specific information is often required. This report section lists several sources and types of additional information.

State Agencies That May Be Consulted

Iowa Geological Survey[1]	123 North Capitol Iowa City 52242	(319) 338-1173
State Health Department[2,6]	Lucas Building Des Moines 50319	(515) 281-5787
Iowa Natural Resources Council[3]	Wallace Building Des Moines 50319	(515) 281-5914
Iowa Dept. of Environ. Quality[4]	Wallace Building Des Moines 50319	(515) 281-8854
University Hygienic Laboratory[5]	U. of IA, Oakdale Campus Iowa City 52242	(319) 353-5990
Cooperative Extension Service in[6] Agriculture and Home Economics	110 Curtis Hall, ISU Ames 50011	(515) 294-4569

Functions:

1 Geologic and ground water data repository, consultant on well problems, water development and related services

2 Drinking water quality, public and private water supplies

3 Water withdrawal regulation and Water Permits for wells withdrawing more than 5000 gpd

4 Municipal supply regulation and well construction permits

5 Water quality analysis

6 Advice on water systems design and maintenance

Well Drillers and Contractors

The listing provided here was drawn from an Iowa Geological Survey mailing list and yellow pages of major towns in phone books. Those selected are within an approximate radius of 50 miles of Lucas County. For a statewide listing contact either the Iowa Water Well Drillers Association, 4350 Hopewell Ave., Bettendorf, Iowa 51712, (319) 355-7528 or the Iowa Geological Survey, (319) 338-1173 .

Baker Well Service
Hwy. 169 North
Mount Ayr, IA 50854

Brooks Well and Pump Co.
Knoxville, IA 50138

Douglas Bruinekool
Bruinekool Well Co.
Pella, IA 50219

Dwayne Bruinekool
Bruinekool Well Co.
Oskaloosa, IA 52577

Campbell Well
701 South Columbia
Bloomfield, IA 52537

Huff Well Drilling Co.
RR #1
Winterset, IA 50273

Hughes Well Co.
4120 73rd
Des Moines, IA 50322

Moorhead Well Co.
R.R. 1
Indianola, IA 50125

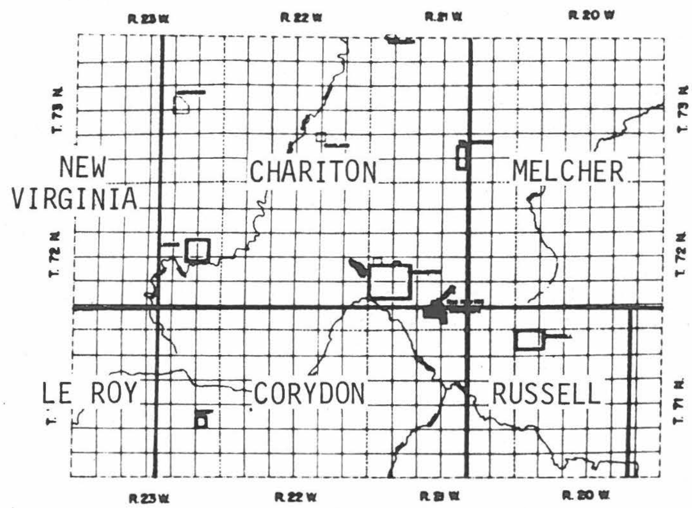
Newton-Whalen Well Co.
1407 1st Ave.
Newton, IA 50208

Snook Well Co.
R.R. 1
Promise City, IA 52583

Doyle Van De Krol
Sully, IA 50251

Verwers Well Co.
Sully, IA 50251

Topographic Maps (Available from the Iowa Geological Survey)



Map Title	Date (Published)	Scale	Contour Interval
Melcher	1916-1922*	1:62,500	20'
Russell	1935	1:62,500	20'
Chariton	1915	1:62,500	20'
Corydon	1934	1:62,500	20'
Le Roy	1965	1:24,000	10'
Russell	1966	1:24,000	10'

Useful Reference Materials

Cagle, Joseph W., and Heinitz, A.J., 1978, Water Resources of South-central Iowa, Iowa Geological Survey, Water Atlas No. 5.

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.

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

Van Eck, O.J, 1978, Plugging procedures for domestic wells, Iowa Geological Survey, Public Information Circular No. 11.