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GEOHYDROLOGIC DATA FOR THE ST. CHARLES COUNTY WELL FIELD AND PUBLIC-WATER SUPPLY, 1985-91, AND PROJECTED PUBLIC-WATER SUPPLY, 1995 AND 2000, FOR ST. CHARLES COUNTY, MISSOURI

U.S. GEOLOGICAL SURVEY
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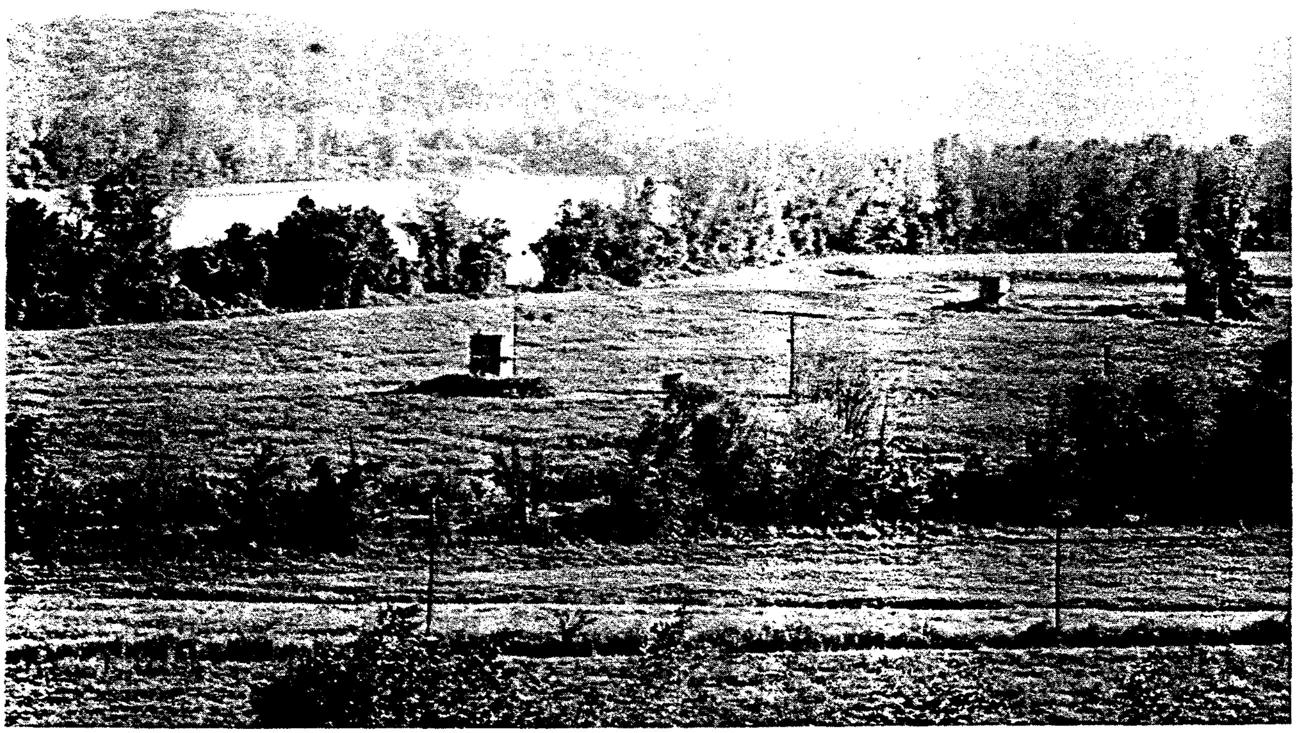

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CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
gallon per minute (gal/min)	0.06308	liter per second
foot squared per day (ft^2/d)	0.09290	meter squared per day
million gallons per day (Mgal/d)	0.04381	cubic meter per day
foot per day (ft/d)	0.3048	meter per day
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter

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

GEOHYDROLOGIC DATA FOR THE ST. CHARLES COUNTY WELL FIELD AND PUBLIC-WATER SUPPLY 1985-91, AND PROJECTED PUBLIC-WATER SUPPLY, 1995 AND 2000, FOR ST. CHARLES COUNTY, MISSOURI

By
Douglas N. Mugel

ABSTRACT

Geohydrologic data for the St. Charles County well field and public-water supply data for St. Charles County were compiled to assist the U.S. Department of Energy in developing the St. Charles County Well Field Contingency Plan. This plan was prepared to ensure a supply of water in the event that the well field becomes contaminated from wastes stored in the Weldon Spring quarry. Except for some projected water-supply data that were calculated for this report, the data presented in this report are a compilation of data collected or supplied by consultants or other agencies.

The St. Charles County well field consists of 8 wells which penetrate the entire thickness of the Missouri River alluvial aquifer, and range from 98 to 116 feet deep. The lower 40 feet of each well is screened and open to the aquifer. The specific capacities of the wells calculated soon after well completion ranged from 115 to 248 gallons per minute per foot of drawdown.

Aquifer tests were conducted on three occasions at three different locations in the well field to determine aquifer characteristics. The calculated transmissivities range from 900 to 60,200 feet squared per day. The calculated hydraulic conductivities ranged from 23 to 602 feet per day. The calculated or estimated storage coefficients ranged from 0.005 to 0.2. A tracer test determined effective porosity ranging from 0.21 to 0.32. A point dilution test determined a ground-water velocity of 0.83 foot per day.

From 1985-91, the average daily water supply from the St. Charles County well field and water-treatment plant increased from 5.76 to 10.23 million gallons per day, an increase from 36.2 to 42.2 percent of the total quantity of water supplied by major public-water suppliers in St. Charles County. The average daily water supply from the well field and water-treatment plant is projected to increase to 11.0 million gallons per day in 1995 and to 12.2 million gallons per day in 2000. The St. Charles County Water Department's projections of peak daily demands from customers indicate that these demands will exceed the capacity of the water-treatment plant in 1995 and will exceed the capacities of the well field and water-treatment plant during 2000.

INTRODUCTION

During 1990, an estimated 85 percent of the 212,907 people living in St. Charles County (U.S. Department of Commerce, written commun., 1991) obtained water from major public-water suppliers (data on file at the U.S. Geological Survey office, Rolla, Missouri). The St. Charles County well field provided approximately 42 percent of the public-water supply in the county (fig. 1). Water is pumped from wells completed in the Missouri River alluvial aquifer in the southern part of the county.

Radioactive, nitroaromatic, and other wastes are stored in the abandoned Weldon Spring quarry (fig. 2), which is excavated in a limestone ridge overlooking the alluvial bottom of the Missouri River. The U.S. Department of Energy (USDOE) and St. Charles County residents are concerned that these

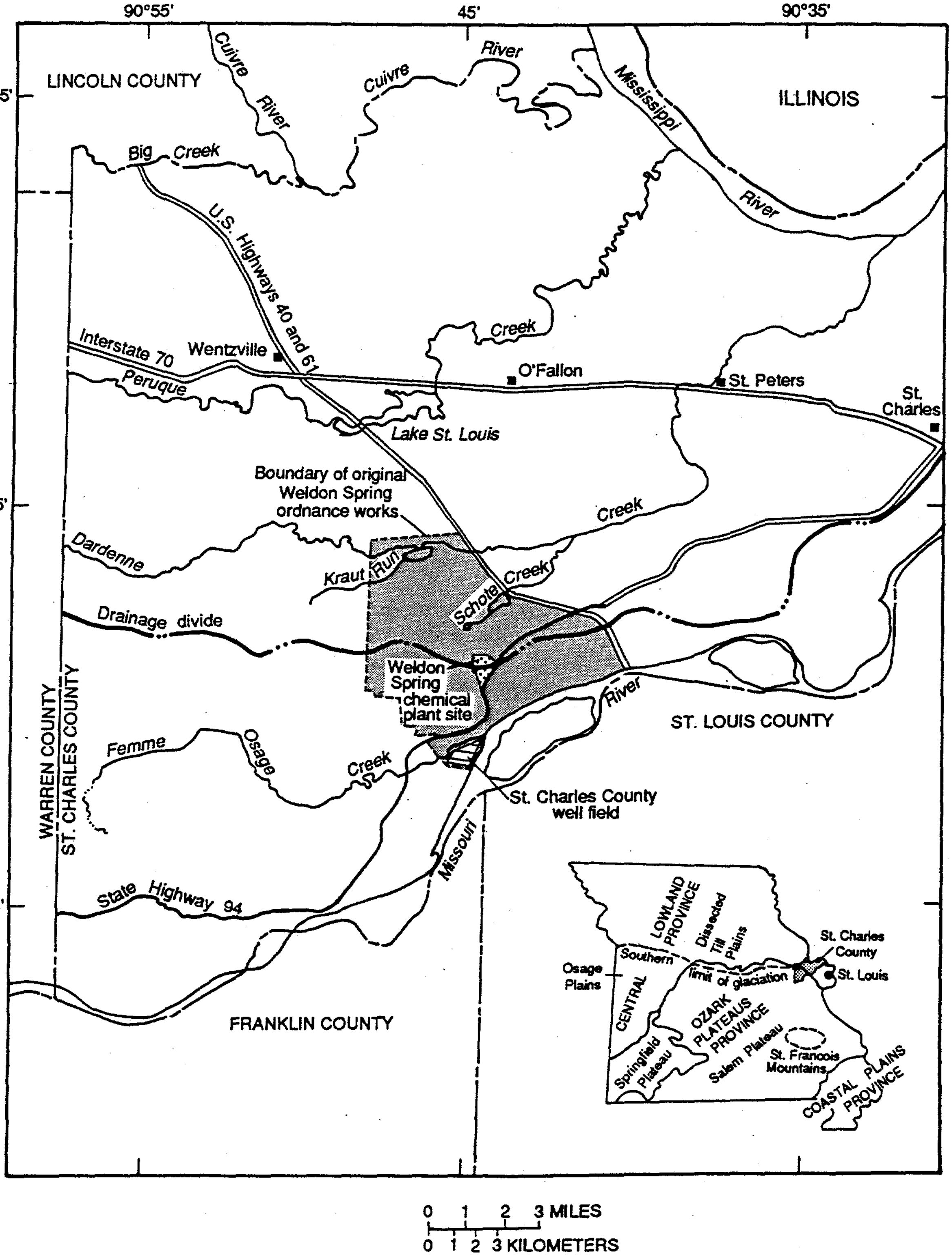

Figure 1. Location of the St. Charles County well field, Weldon Spring chemical plant site, and boundary of the original Weldon Spring ordnance works in western St. Charles County (physiography from Fenneman, 1938).

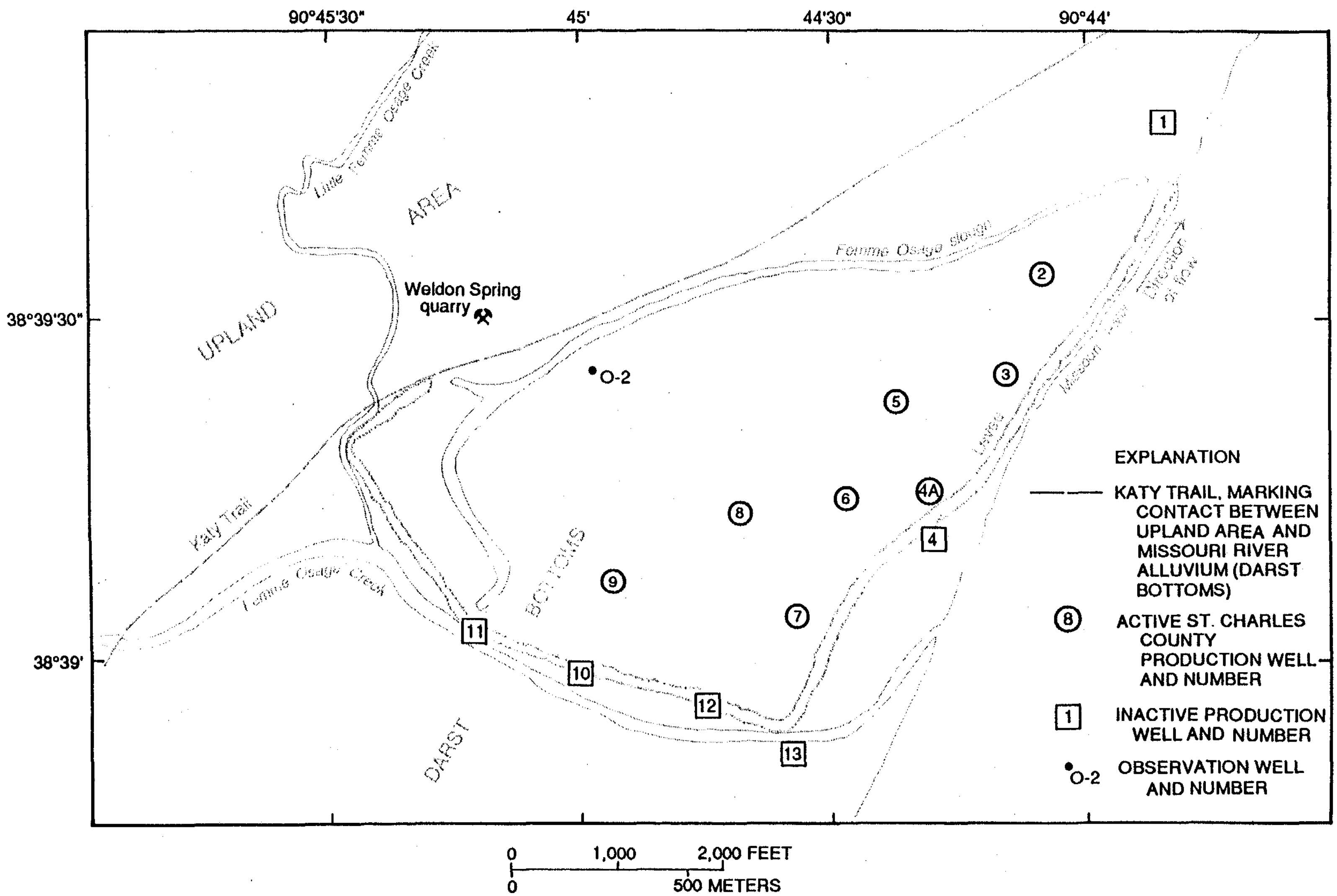

Figure 2. Location of the St. Charles County well field production wells and observation well O-2.

wastes might migrate into the alluvial aquifer and contaminate the well field. The USDOE and St. Charles County have been monitoring the ground water in the vicinity of the quarry, including the alluvial aquifer, for several years. The results of ground-water monitoring by the USDOE indicate that the water quality of the well field has not been affected by the contaminants in the quarry (MK-Ferguson Company, 1992). However, there has been no plan to ensure the supply of water to St. Charles County residents, businesses, and industries if it becomes necessary to shut down part or all of the well field because of possible future contamination. During 1991, the U.S. Geological Survey (USGS), in cooperation with the USDOE, compiled data to be used in the preparation of the USDOE St. Charles County Well Field Contingency Plan (MK-Ferguson Company and Jacobs Engineering Group, Inc., 1992). The foundation for a preliminary plan was developed in January 1992 in an Alternatives Evaluation (AE) session. This report summarizes data that were compiled for the AE session.

Background

The St. Charles County well field originally was operated by the U.S. Department of Army from 1941-45 as a water supply for the Weldon Spring ordnance works. As much as 48 to 50 Mgal/d of water were reported to have been pumped from the well field during full operation (Roberts, 1951). The well field was used from 1957-66 to supply a much smaller quantity of water to the U.S. Atomic Energy Commission Weldon Spring feed materials plant (Weldon Spring chemical plant). Water was supplied to the plant on an "as necessary" basis from 1967 until January 1970 (Haskins, Sharp, and Ordelheide, 1971, p. 8). The city of St. Charles then operated the well field and water-treatment plant for a part of one day per week (Haskins, Sharp, and Ordelheide, 1971, p. 8) until 1972 when St. Charles County purchased and began operating both the well field and the water-treatment plant. The land on which the wells and collection system are located is owned by the Missouri Department of Conservation.

The Weldon Spring quarry was used for the disposal of various wastes from before 1958 to 1969. These wastes consisted of trinitrotoluene (TNT) residues and TNT-contaminated debris from the Weldon Spring ordnance works; thorium residues of unknown origin; demolition debris and radioactive-contaminated barium sulfate cake from the Destrehan Street uranium processing plant in St. Louis, Missouri; uranium and thorium wastes from the U.S. Army Granite City Arsenal in Granite City, Illinois; thorium residues from a defense contractor's plants in the Cincinnati, Ohio, area; and uranium- and thorium-contaminated demolition debris from the U.S. Atomic Energy Commission Weldon Spring chemical plant (Berkeley Geosciences Associates, 1984; Kleeschulte and Emmett, 1986).

Purpose and Scope

The purpose of this report is to present both geohydrologic data pertaining to the St. Charles County well field and water-supply data for St. Charles County. Geohydrologic data consist of well-field data (well construction and specific-capacity data), alluvial aquifer characteristics, (transmissivity, hydraulic conductivity, storage coefficient, and effective porosity), and ground-water velocity and travel-time data. Water-supply data consist of past and projected water supplies from several major public-water suppliers in St. Charles County. These data present a framework with which to evaluate the past and future importance of the St. Charles County well field to the water supply of St. Charles County.

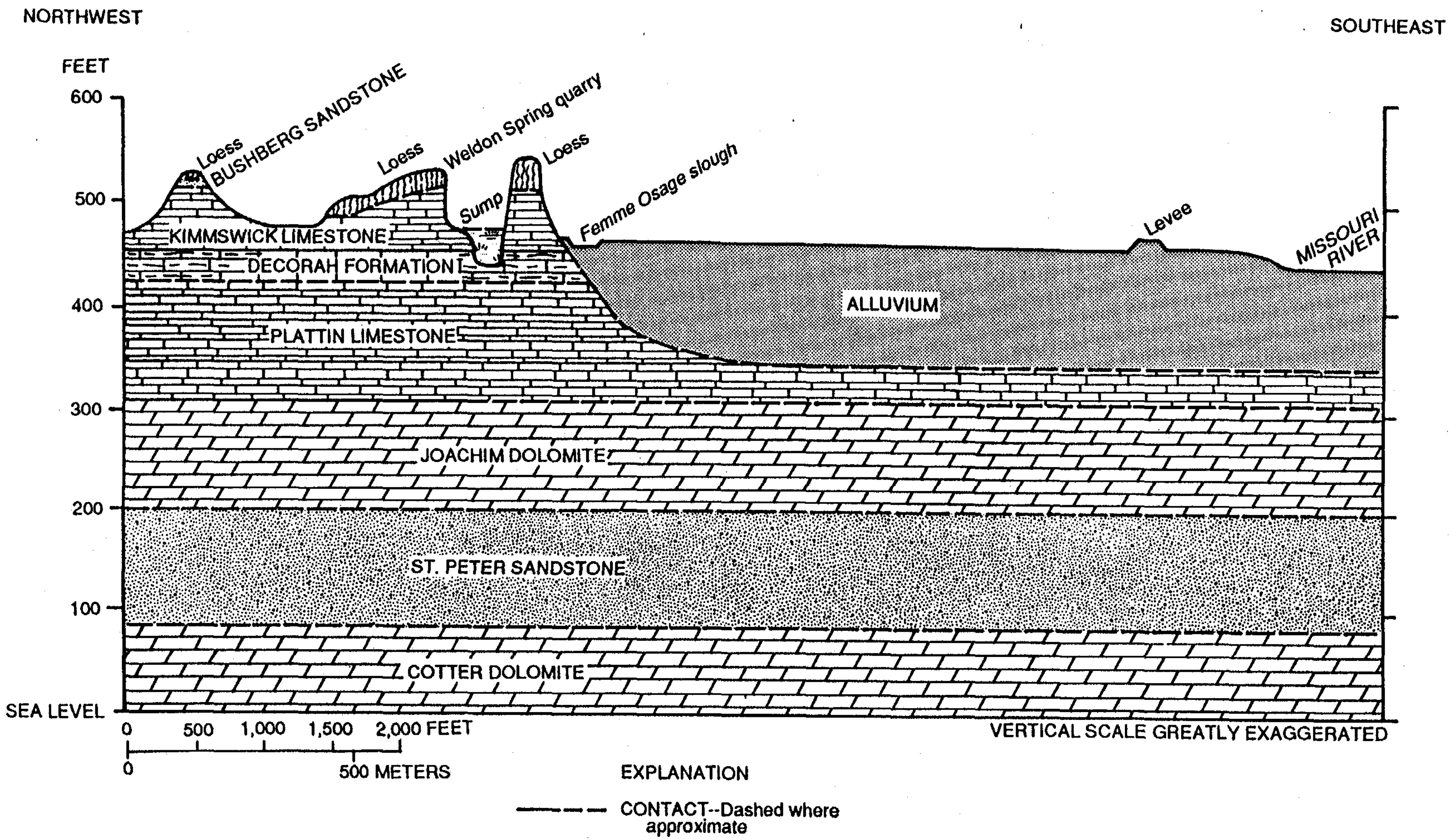

Figure 3. Generalized northwest-trending geologic section through the Weldon Spring quarry area (modified from Berkeley Geosciences Assoc., 1984, Kleeschulte and Emmett, 1987).

Location and Description of the Well Field

The St. Charles County well field is located in southern St. Charles County in eastern Missouri (fig. 1). It is in the most downstream part of an approximately 6 mi long alluvial bottom of the Missouri River, known as Darst Bottoms (fig. 2). Surficial hydrologic features, the Weldon Spring quarry, the individual production wells that comprise the well field, observation well O-2, and the Katy Trail are shown in figure 2. The Katy Trail is an abandoned railroad bed at the foot of the limestone bluff at the Missouri River valley wall and marks the contact between the upland and the Missouri River alluvium. The well field is bounded to the east and southeast by the Missouri River, to the south by the diverted channel of Femme Osage Creek, and to the west and north by Femme Osage slough, an abandoned channel of Femme Osage Creek. A levee surrounds the well field and provides protection from floods.

The St. Charles County well field consists of eight wells. Of the 13 wells that originally composed the well field, 7 presently (1993) are in operation. Well 4A was constructed during 1987 as a replacement of the original well 4 that was located outside the levee and was lost because of flooding during 1952 or 1954 (Haskins, Sharp, and Ordelheide, 1971, appendix VI, p. 13). Wells 10, 11, 12, and 13 have not been used since the ordnance works was shut down and probably would require extensive rehabilitation to be put back into service. Well 1 was shut down during 1985 after continued clogging of the well screen (Tom Aaron, St. Charles County, oral commun., 1991).

St. Charles County operates the well field on a monthly schedule. During periods of normal water demand, five wells are operated and three are kept in reserve. The five wells in operation are pumped periodically throughout the day for a combined pumpage of 12 to 14 hours a day. A different set of five wells is used each month, so that during the year the pumping load is spread evenly among the eight wells. During periods of peak demand, seven and sometimes eight wells are pumped continuously to supply water. The county is considering the construction of a new well as a backup for periods of peak demand (J.R. Nichols, oral commun., 1991).

Geohydrologic Setting

The St. Charles County well field is located at the northern edge of the Salem Plateau of the Ozarks Physiographic Province, only a few miles south of the boundary between the Salem Plateau to the south and the Dissected Till Plains to the north (fig. 1; Fenneman, 1938). Bedrock formations in St. Charles County generally dip about 1° (degree) to the northeast (Kleeschulte and Emmett, 1987). Ordovician dolomites and sandstones crop out in the southernmost part of the county. Surficial bedrock formations become progressively younger to the north, where, except for isolated outliers of Pennsylvanian age, limestones of the Meramecian Series of Mississippian age are the youngest exposed rocks in the county. The regional surface-water divide, which approximately coincides with a regional ground-water divide, is located a few miles north of the well field (fig. 1). Both divides separate northerly flow to the Mississippi River from southerly flow to the Missouri River. A detailed description of the hydrology of St. Charles County is given in a report by Kleeschulte and Emmett (1987).

The Weldon Spring quarry is located in a ridge underlain by the Kimmswick Limestone of Ordovician age (fig. 3). The deepest part of the quarry (the quarry sump) is in limestone and shale of the Decorah Formation of Ordovician age. Below the Decorah Formation is the Plattin Limestone of Ordovician age, which is the formation underlying the alluvium of the well field. Beneath the Plattin Limestone are, in descending order, the Joachim Dolomite, the St. Peter Sandstone, and the Cotter Dolomite, all of Ordovician age (fig. 3). Older Ordovician and Cambrian formations underlie these formations. The water level of the quarry sump is several feet above the water level of wells in the alluvium and constitutes a local hydraulic high. This hydraulic head difference provides the potential for ground-water flow from the quarry to the Missouri River, but because the water in the quarry also is higher than water levels in wells north of the quarry, there also is the potential for local shallow ground-water flow to the north (MK-Ferguson Company and Jacobs Engineering Group, Inc., 1989). Berkeley Geosciences Associates (1984) mapped vertical fractures, some of which were solution-enlarged, in the quarry face and in the limestone bluff facing the river and determined a major set of fractures were oriented N. 70° W., and minor sets were oriented N. 60° E. and also north. Ground-water flow from the quarry probably is through the vertical fractures and horizontal fractures (Berkeley Geosciences Associates, 1984).

The thickness of the Missouri River alluvium at the well field production wells ranges from 89 to 116 ft (table 1). All wells were completed to top of bedrock and penetrate the entire alluvial sequence. Although the alluvial stratigraphy varies in detail throughout the well field, generally the alluvium grades upward from sand, gravel, and boulders at depth to sand, silt, or clay at the surface. Confined conditions probably exist where the upper 10 to 20 ft predominantly are clay, and unconfined conditions probably exist where sand predominates. Well 1 intersected mostly clay from the surface to 34 ft, wells 2 and 3 intersected sandy clay in the upper 8 to 10 ft, and wells 4 through 10 intersected mostly sand at the surface with increasing grain size with depth (Haskins, Sharp, and Ordelheide, 1971). Sediment thickness decreases away from the well field in the direction of the valley wall. Monitoring wells installed by Berkeley Geosciences Associates (1984) indicate 10 to 26 ft of alluvium north of Femme Osage slough, where the sediments predominantly are silts and clays, with minor quantities of sand (MK-Ferguson Company and Jacobs Engineering Group, Inc., 1988).

Where the Missouri River flows parallel to a valley wall for a considerable distance, as it does along Darst Bottoms, ground water flows in a downstream direction through the alluvial aquifer before discharging to the Missouri River (Grannemann and Sharp, 1979). During periods of high river stage, ground-water flow reverses and water from the Missouri River flows into the alluvial aquifer (Emmett and Jeffery, 1968). Ground-water pumpage has affected the pattern of ground-water flow at the St. Charles County well field. The altitude of the water table in the vicinity of the quarry and the well field, as measured on October 30, 1984, is shown in figure 4 (Kleeschulte and Emmett, 1986). The water-table contours indicate an overall movement of ground water from the quarry toward the river and also show a large, shallow cone of depression surrounding several wells. Induced recharge of water from the Missouri River is inferred from the water-table contours that intersect the river. The Layne Western Company, Inc. reported the results of different simulations by their electric analog model of the well field and stated that as much as 75 percent of the water pumped from the well field is induced recharge from the Missouri River (Layne Western Company, Inc., 1986). Calculations of the quantity of induced recharge from the Missouri River for numerous model simulations are contained in the St. Charles County Water Department files. A report by Soil Consultants, Inc. indicates that induced recharge from the Missouri River ranges from 42.3 to 70.8 percent of the total quantity of water pumped from the well field, and that the percentage depends on the quantity of water pumped, what wells are being used, and river stage (Soil Consultants, Inc., 1988, p. 9 and table 21).

Femme Osage slough (fig. 2) was created between 1960 and 1963 when the channel of Femme Osage Creek was diverted to its present course (Soil Consultants, Inc., 1988, p. 3). Femme Osage slough is considered to generally mark the contact between highly permeable sediments south of the slough and much less permeable alluvial sediments north of the slough, although a thick sequence of coarse-grained, permeable sediments exists at well 1 north of the east end of the slough (Haskins, Sharp, and Ordelheide, 1971). The water of Femme Osage slough and the ground water in some areas north of the slough are contaminated by quarry wastes (Morrison-Knudsen Engineers, Inc., 1988). The low permeability sediments in the area of the slough may be a barrier to the migration of contaminated ground water from north of the slough into the well field (Argonne National Laboratory, 1989), although the details of ground-water movement and contaminant migration in the vicinity of the slough are not well understood.

Table 1.--*St. Charles County well field production well data*

[Original construction and production data were recorded or calculated soon after well completion; ft, feet; gal/min, gallon per minute; (gal/min)/ft, gallon per minute per foot of drawdown; --, no data; ++, partial data; original construction and production data for all wells except well 4A from Haskins, Sharp, and Ordelheide (1971); data for well 4A and June 1988 to November 1991 specific capacity data for all wells from Tom Aaron (St. Charles County, written commun., 1991 and 1993)]

Well number (fig. 2)	Original construction and production data							June 1988 to November 1991 data	
								Specific capacity	
	Depth (ft)	Test date	Static water level (ft)	Pumping water level (ft)	Drawdown (ft)	Pumping rate (gal/min)	Specific capacity [(gal/min)/ft]	High [(gal/min)/ft]	Low [(gal/min)/ft]
1	103	2-28-41	18.33	35.00	16.67	2,300	138	--	--
2	106	3-11-41	14.75	29.92	15.17	2,200	145	175	70
3	110	3-24-41	15.42	30.25	14.83	2,400	162	127	53
4	109	4-29-41	17.25	27.25	10.00	2,480	248	--	--
4A	116	7-03-87	19	29	10	2,200	220	260	143
5	109	4-10-41	13.92	28.50	14.58	2,480	170	158	93
6	109	9-16-41	23	40	17	2,590	152	153	83
7	108	8-22-41	23	35	12	2,835	236	221	69
8	104	10-24-41	23	47	24	2,755	115	120	66
9	98	12-23-41	22	40	18	2,610	145	++	++
10	100	12-16-41	22	42	20	2,690	135	--	--
11	89	8-01-42	32	56	24	2,150	90	--	--
12	99	8-25-42	32	44	12	2,535	211	--	--
13	107	8-14-42	37	48	11	2,480	225	--	--

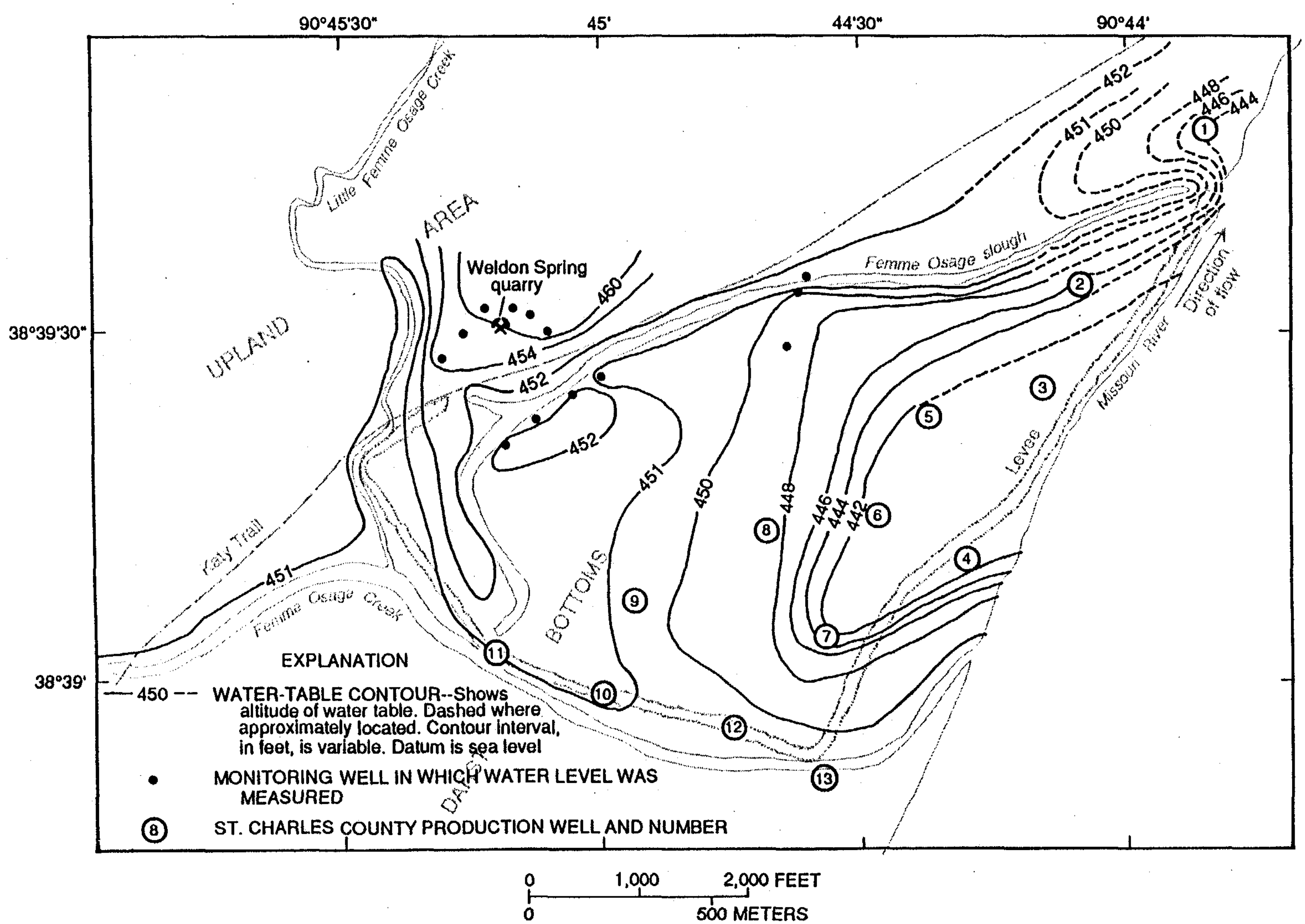

Figure 4. Altitude of the water table for the Weldon Spring quarry and the St. Charles County well field area, October 30, 1984 (modified from Kleeschulte and Emmett, 1986).

Method of Study

Geohydrologic data were collected from published USGS, USDOE, and other reports, and from unpublished data in USGS and St. Charles County Water Department files. Water-supply data were collected by interviews with St. Charles County Water Department personnel, county public-water suppliers, a management company for two public-water suppliers, and consultants to public-water suppliers. In cases where suppliers did not have projected water-supply data, past rates of increase or projected rates of increase provided by consultants were used to calculate projections. These new data were reviewed by the public-water suppliers or their management company. More details concerning methods of calculating projected water-supply data are given in the section titled "Projection Methods".

Previous Investigations

The St. Charles County well field first became a subject of interest when the U.S. Department of the Army developed the well field as a water supply in the early 1940's. More recently, a number of reports have been written concerning contamination of the quarry and the migration of contaminants into surrounding areas (for example, Berkeley Geosciences Associates, 1984; Morrison-Knudsen Engineers, Inc., 1988). Only those reports in which geohydrologic or water-supply data are presented are mentioned in this section. Geohydrologic data for only the alluvial aquifer are included in this report, because geohydrologic data for the limestone at the quarry and beneath the alluvium are considered beyond the scope of this report.

The earliest known compilation of well-field data is in the form of unpublished tabulated data from 7-day well completion tests, on three separate occasions during 1941 and 1942 (data on file at the U.S. Geological Survey, Rolla, Missouri). These tests consisted of simultaneously pumping wells to determine yield, drawdown, and specific capacity. The first test consisted of pumping wells 1 through 5, the second test consisted of pumping wells 1 through 10, and the third test consisted of pumping wells 11 through 13 (data for wells 10-13 are unavailable). These tests probably were performed by the well contractor or by the U.S. Department of Army when the wells were completed. Some general well construction data are contained in a report written by the U.S. Department of Army (written commun., 1942). Haskins, Sharp, and Ordelheide (1971) investigated the applicability of the ordnance works well field and water-treatment system as a public-water supply. Their report contains geologic well logs, well construction details, schematic well drawings, and maintenance records with periodic specific capacity values. More recent drawdown, yield, and specific capacity data are contained in the St. Charles County Water Department files located at the county water-treatment plant.

Emmett and Jeffery (1968) performed an aquifer test at the well field using one of the production wells as the pumped well. They reported transmissivity, hydraulic conductivity, and storage coefficients of the aquifer, and estimated the specific capacity of the pumping well. Berkeley Geosciences Associates (1984) reported the results of investigations that included testing for aquifer properties for both the alluvial aquifer and the underlying limestone. Observation wells were constructed and used to perform aquifer, tracer, and point-dilution tests to determine hydraulic conductivity, storage coefficient, effective porosity, and ground-water velocity. Testing of the alluvial aquifer was restricted to south of Femme Osage slough. Layne Western Company, Inc. (1986) reported the results of an aquifer test using one of the production wells as the pumped well. Transmissivity, hydraulic conductivity, and storage coefficient were determined. These values were used in the design of an electric analog model that was used to evaluate the effects of various pumping scenarios, the results of which also are given in their report. The model is located at the St. Charles County water-treatment plant, where it continues to be used by the county to evaluate various pumping scenarios.

Kleeschulte (1991) compiled water-supply data for St. Charles County for 1962 through 1985. He presented both public-supply data and domestic (self-supplied) data, and also showed water supply by source (by aquifer and from river sources). The Missouri Department of Natural Resources periodically publishes the Census of Missouri Public Water Supplies, which shows water supplied by public-water suppliers with related information (Missouri Department of Natural Resources, 1985; 1987).

Acknowledgments

The author thanks Gene Valett of MK-Ferguson Company and Jeff Carman of Jacobs Engineering Group Inc. for access to their files. Particular gratitude is expressed to Tom Aaron, St. Charles County Water Department Manager, and Joe Nichols, St. Charles County Engineer, for granting access to their files and for answering numerous well-field-related questions. Appreciation also is extended to Michael Dougherty, Mid Missouri Engineers, Inc.; Max Wells and John Dennison, Missouri Cities Water Company; James Karll, city of St. Peters; John Buehrle, city of St. Charles; Gary Miller, city of Wentzville; Wayne Montgomery, WVP Corporation; and Karen Archer, Black and Veatch Engineers, for providing water-supply data and for answering many questions.

GEOHYDROLOGIC DATA FOR THE ST. CHARLES COUNTY WELL FIELD

This section reports the geohydrologic data for the St. Charles County well field that have been compiled as part of this study. Described are well data, including specific capacity, characteristics of the Mississippi River alluvial aquifer, and the results of a point-dilution test to determine ground-water velocities.

Well Data

The original 13 wells in the St. Charles County well field were constructed from February 1941 to August 1942, and all wells have similar construction details. The bottom 40 ft of each well is an 18-in. diameter stainless steel screen set in a gravel pack that generally extends 10 to 20 ft above the top of the screen. An 18-in. diameter steel casing extends from the top of the screen to the land surface. A 38-in. diameter steel outer casing extends from the surface to below the top of the gravel pack. The wells have a steel plate or a concrete plug at the bottom, resting on bedrock. A discussion of well-construction data, including schematic drawings, is given in Haskins, Sharp, and Ordelheide (1971). Well depths for the original 13 wells and for replacement well 4A are shown in table 1.

Results of tests performed on the wells soon after completion are listed in table 1. These tests were performed to determine well yield and specific capacity, which is a measure of well productivity (Todd, 1980, p. 155). Specific capacity is the rate of discharge of water from a well divided by the drawdown of water within the well (Lohman and others, 1972). The original specific capacities of the eight wells presently (1993) being used ranged from 115 to 248 (gal/min)/ft of drawdown. The static water levels, the pumping water levels, the drawdowns, and pumping rates also are shown in table 1.

Because the aquifer and the well screen become clogged with iron and calcium deposits, the specific capacities of the wells decrease with time (Haskins, Sharp, and Ordelheide, 1971). Chemical treatment has been performed periodically on the well-field wells to restore specific capacity. The variation for specific capacities is listed for some of the wells from June 1988 to November 1991 in table 1. Other data from the St. Charles County Water Department also indicate that specific capacities increase after chemical treatment. Other variations in specific capacity may be attributed to variable transmissivities because of a lowering of the water table (Todd, 1980, p. 157).

Aquifer Characteristics

An aquifer test at the St. Charles County well field was conducted by the USGS (Emmett and Jeffrey, 1968). Production well 4 (fig. 2) was pumped for 47 hours from March 7, 1967, to March 9, 1967, at a rate of 2,650 gal/min. Water levels were measured in the pumped well and in four observation wells. The observation wells were located 261 ft and 502 ft approximately east-southeast of the pumped well, and 244 ft and 484 ft approximately northwest of the pumped well. These wells ranged from 40 to 57 ft deep, and were all screened in the bottom 2 ft. This test determined a transmissivity of 36,000 ft^2/day, a hydraulic conductivity of 400 ft/day, and a storage coefficient of 0.2 (table 2). The value of the storage coefficient is within the range of 0.01 to 0.30 for the specific yield of an unconfined aquifer given by Freeze and Cherry (1979, p. 61). The analytical methods used to determine these aquifer characteristics were not reported. The well field was not used extensively during this period, so there probably was little, if any, interference from the pumping of other wells.

Several aquifer tests using observation well O-2 as the pumped well (fig. 2) were conducted by Berkeley Geosciences Associates (1984). Drawdown was measured in three other observation wells, located from 10.0 to 21.5 ft from the pumped well. The pumping rate ranged from 23.5 to 30.3 gal/min, but was held constant for each test. Berkeley Geosciences Associates (1984) reported that steady-state conditions were reached after 15 to 20 minutes of pumping and that water levels recovered to within 90 percent of their pre-pumping water levels within 15 to 20 minutes after the termination of pumping. They reported that these well characteristics qualitatively indicate a confined aquifer, a small storativity, and possibly the presence of a boundary. Both transient and steady-state analyses were performed. They concluded that the transmissivity is about 900 ft^2/day, and the storage coefficient is about 0.005 (table 2). However, the results of individual tests were highly variable. This storage coefficient value places it at the upper end of the range for confined aquifers given by Freeze and Cherry (1979, p. 60). Assuming an effective flow thickness of 40 ft (Berkeley Geosciences Associates, 1984, p. 4-65), the hydraulic conductivity corresponding to this transmissivity is 23 ft/day (table 2).

Table 2.--*Aquifer characteristics of the Missouri River alluvial aquifer, St. Charles County well field, determined by aquifer tests*

[ft^2/day, feet squared per day; ft/day, feet per day; >, greater than]

Source of data	Pumping well	Transmissivity (ft^2/day)	Hydraulic conductivity (ft/day)	Storage coefficient (dimensionless)
Emmett and Jeffery (1968)	4	36,000	400	0.2
Berkeley Geosciences Associates (1984)	O-2	900	23	.005
Layne Western Company, Inc. (1986)	8	50,400-60,200	535-602	>.01

The results of an aquifer test performed at the St. Charles County well field during 1985 are given in a report by Layne Western Company, Inc. (1986). Production well 8 (fig. 2) was pumped for 83 hours at 1,500 gal/min, and water levels were recorded frequently at three observation wells about 80, 150, and 750 ft from the pumping well. Water levels were measured less frequently at several other observation wells throughout the well field. Production wells 1, 2, 3, and 5 were pumped for various times during the test as part of the normal operation of the well field. The stage of the Missouri River varied by about 4 ft during the test. Steady-state analyses determined a transmissivity range of 50,400 to 60,200 ft^2/day (table 2). An average saturated thickness of 100 ft was used to estimate a hydraulic conductivity of 535 to 602 ft/day. The storage coefficient was estimated to be greater than 0.01, which is the lower end of Freeze and Cherry's (1979, p. 61) range of specific yields for unconfined aquifers. Nonsteady-state analyses did not yield satisfactory results (Layne Western Company, Inc., 1986). A transmissivity variation map of the alluvial aquifer was prepared (Layne Western Company, Inc., 1986, fig. 10), using the transmissivity test results combined with information contained on boring logs, and grain-size distribution and laboratory permeability test results at several locations throughout the alluvial bottom, including north of Femme Osage slough (Layne Western Company, Inc., 1986, table 5). Based on these calculated transmissivity values, the transmissivity decreases from south to north toward Femme Osage slough. The calculated transmissivities north of Femme Osage slough range from 1,100 to 25,900 ft^2/day.

The results of a tracer test performed in the alluvial aquifer at well O-2 (fig. 2) are given in the report by Berkeley Geosciences Associates (1984). Rhodamine WT and lithium bromide were injected in an observation well 10 ft from well O-2. Pumps were set in well O-2 at 22 and 70 ft depths, and ground-water samples were collected from these depths. The pumping rates were not reported. The times of peak concentrations of tracers were used to determine an effective porosity ranging from 0.21 to 0.32.

Ground-Water Velocity

Point-dilution tests to determine approximate ground-water velocities in the alluvial aquifer south of Femme Osage slough were conducted by Berkeley Geosciences Associates (1984). Tests were conducted in two observation wells close to the slough and in one observation well at a greater, but unspecified, distance from the slough. The tests used packers to isolate discrete intervals of the screened sections of the wells. Rhodamine WT and lithium bromide were introduced into the isolated intervals, and the concentrations of these tracers were monitored for several hours. Analysis of the concentration-time data for the well farthest from the slough resulted in a calculated ground-water velocity of 0.83 ft/day. The ground-water velocity at the two wells near the slough was less than the resolution of the test (Berkeley Geosciences Associates, 1984).

PUBLIC-WATER SUPPLY, ST. CHARLES COUNTY, 1985-91

This section presents a compilation of water-supply data obtained from the major public-water suppliers for St. Charles County from 1985-91. No data were complied for water provided by other public-water suppliers, such as subdivisions and mobile home parks, or by self-supplied sources. The data represent quantities of water supplied to the public for domestic, industrial, and commercial purposes and include both line losses and water use.

Population Served by Public-Water Suppliers

The population of St. Charles County increased from 172,800 during 1985 (St. Charles County Planning Department, 1990) to 212,907 during 1990 (U.S. Department of Commerce, written commun., 1991), a 23.2 percent increase (fig. 5). Based on the number of water supply hook-ups, an estimated 121,500 people (70 percent of the population of St. Charles County) were served by public-water suppliers during 1985, accounting for an estimated 76 percent of the total domestic, industrial, and commercial water use (fig. 5) in St. Charles County (data on file at the U.S. Geological Survey, Rolla, Missouri). During 1990, an estimated 180,500 people (85 percent of the population of St. Charles County) were served by public-water suppliers, accounting for an estimated 84 percent of the total domestic, industrial, and commercial water use in St. Charles County (data on file at the U.S. Geological Survey, Rolla, Missouri). This represents an estimated increase of 49 percent in the number of people served by public-water suppliers from 1985-90.

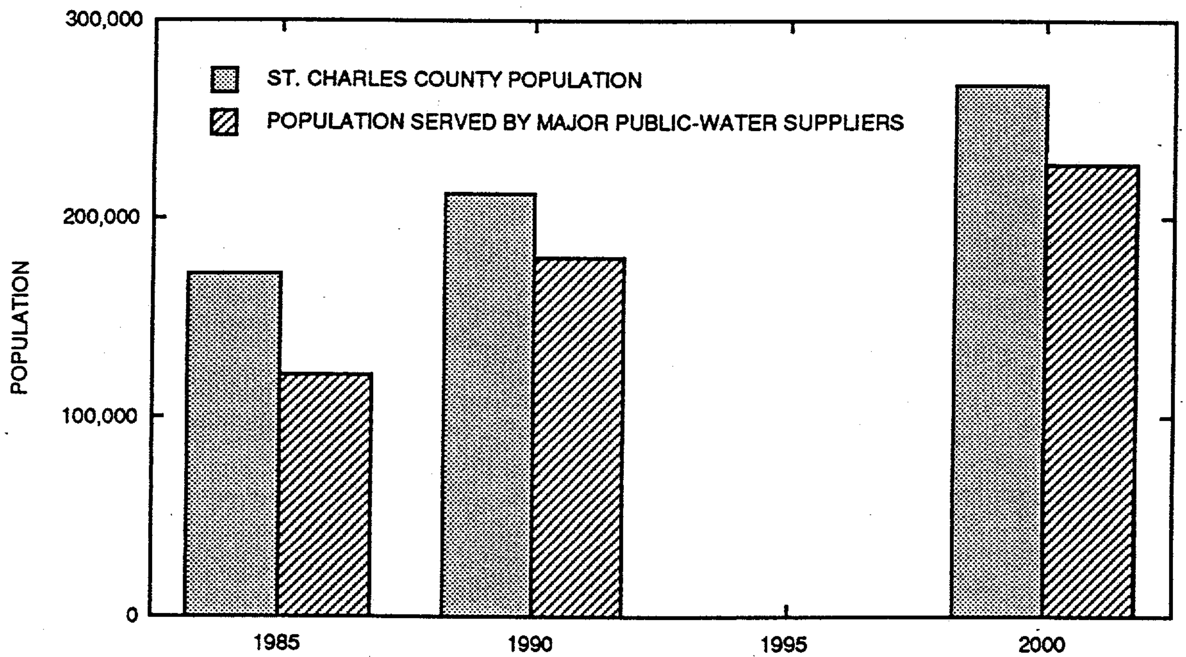

Figure 5. Population of St. Charles County, 1985 and 1990, projected population in 2000, estimated population served by major public-water suppliers, 1985 and 1990, and projected population in 2000 (1985 population data from St. Charles County Planning Department, 1990; 1990 population data from U.S. Department of Commerce, written commun., 1991; 2000 population data based on rate of increase from St. Charles County Planning Department, 1990; data for estimates of population served by major public-water suppliers on file at the U.S. Geological Survey, Rolla, Missouri).

Public-Water-Supply Network

The public-water-supply network consists of five suppliers: Public Water Supply District No. 2, Missouri Cities Water Company, and the cities of O'Fallon, St. Peters, and St. Charles (fig. 6). Four sources of water supply this network (fig. 6). The St. Charles County well field is developed in the Missouri River alluvial aquifer and supplies water to Public Water Supply District No. 2, Missouri Cities Water Company, and directly to water users, which during 1991 included the St. Francis High School, the Missouri Department of Conservation August. A. Busch Memorial Wildlife Area, the Weldon Spring training area, the USDOE Weldon Spring Site Remedial Action Project, and the city of New Melle. Both the city of O'Fallon and Public Water Supply District No. 2 own wells ranging from 890 to 1,700 ft deep, which withdraw ground water from one or both of two bedrock aquifers. These aquifers are the middle aquifer, which is the Ordovician Kimmswick Formation, and the deep aquifer, which includes all the formations from the top of the Ordovician St. Peter Sandstone to the base of the Potosi Dolomite of Cambrian age (Kleeschulte, 1991). St. Peters and St. Charles each own a well field developed in the Mississippi River alluvial aquifer and also purchase water from the city of St. Louis Howard Bend water-treatment plant. Water is withdrawn from the Missouri River, treated, and a part of it transported to St. Charles County through a pipeline underneath the Missouri River. The average daily water supplied by these sources to the public-water suppliers and the direct customers of the St. Charles County water-treatment plant during 1991 is shown in figure 6.

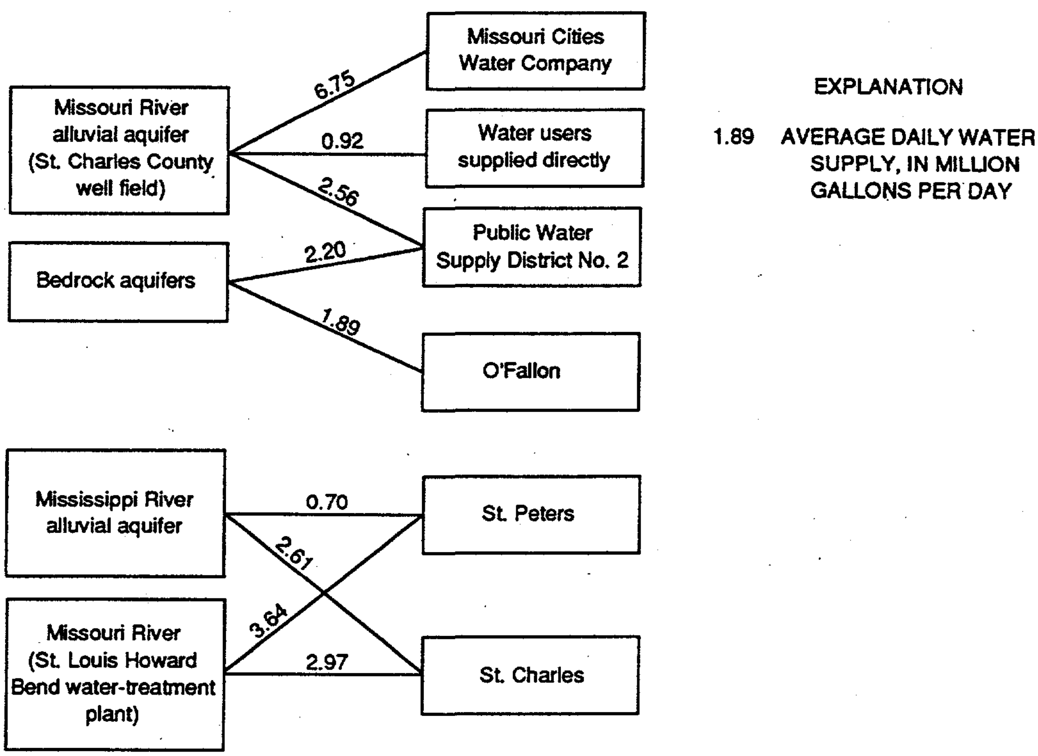

Figure 6. Schematic flow chart of the public-water-supply network, St. Charles County, 1991 (data supplied by Michael Dougherty, Mid Missouri Engineers, Inc., written and oral commun., 1991 and 1992; Tom Aaron, St. Charles County, written and oral commun., 1991 and 1992; John Dennison and Max Wells, Missouri Cities Water Company, written and oral commun., 1991 and 1992; John Buehrle, city of St. Charles, written and oral commun., 1991 and 1992; and James Karll, city of St. Peters, written and oral commun., 1991).

The average daily-water supply to the public-water suppliers from these four sources from 1985-91 is presented in table 3, including the changes in the water-supply network that have taken place during this period. After 1986, Public Water Supply District No. 2 assumed operation of the supply network of Public Water Supply District No. 1. Before 1985 to the present (1993), the water provided to the city of Wentzville was supplied by Public Water Supply District No. 2, and until 1987 Wentzville also supplied their customers with water withdrawn by their own wells developed in the bedrock aquifers. Operation of these wells has since ceased. The city of St. Charles withdrew and treated water from the Missouri River until 1987 when this operation ceased and purchase of water from St. Louis began. With this additional water supply, the quantity of water withdrawn by St. Charles from the Mississippi River alluvial aquifer decreased. The city of St. Peters also began purchasing water from St. Louis during 1987, and, consequently, the quantity of water withdrawn by St. Peters from the Mississippi River alluvial aquifer also decreased.

Average Daily Water Supply, 1985-91

The average daily public-water supply in St. Charles County increased from 15.90 Mgal/d during 1985 to 21.14 Mgal/d during 1990, a 33.0 percent increase, and to 24.24 Mgal/d during 1991, a 52.5 percent increase from 1985 (table 4). The 33.0 percent increase in public-water supply from 1985-90 is somewhat greater than the 23.2 percent increase in the population of St. Charles County from 1985-90, but is less than the estimated 49 percent growth in the number of customers supplied by the public-water suppliers for the same period.

From 1985-91, the average daily public-water supply from the St. Charles County well field increased from 5.76 to 10.23 Mgal/d (table 5; fig. 7), a 77.6 percent increase. The role of this water supply to St. Charles County is demonstrated by its percentage of the total public-water supply in the county, which increased from 36.2 during 1985 to 42.2 during 1991. The well field was the largest single public-water supply during this time (fig. 7). The average daily pumpage from the St. Charles County well field, including water used by the water-treatment plant, increased from 5.84 Mgal/d during 1985 to 10.65 Mgal/d during 1991 (table 5).

The quantity of water withdrawn from the bedrock aquifers for public-water supply gradually increased from 2.66 Mgal/d during 1985 to 4.09 Mgal/d during 1991 (table 3). During this time, public-water supply from the bedrock aquifers ranged from 14.1 to 17.7 percent of the total county public-water supply.

The average daily public-water supply from the two well fields developed in the Mississippi River alluvial aquifer peaked during 1986 at 8.07 Mgal/d, 43.7 percent of the total county public-water supply (table 3). This source decreased to a low of 2.92 Mgal/d during 1989, 13.9 percent of the total county public-water supply (table 3). This change reflects the initiation of sales of Missouri River water from St. Louis during 1987, which increased sharply from 3.88 Mgal/d during 1987 to 6.53 Mgal/d during 1988 and has remained fairly constant since (table 3). From 1988-91, this water supply ranged from 27.2 to 30.4 percent of the total county public-water supply.

The average daily water supply from public-water suppliers from 1985-91, from all sources, is presented in table 4. The city of St. Charles was the largest public-water supplier from 1985-87, but during this time their supply decreased from 29.6 to 27.6 percent of the total county public-water supply. From 1988 through 1991 the largest public-water supplier was Missouri Cities Water Company, which supplied from 26.1 to 27.8 percent of the total county public-water supply, and obtained all its water from the St. Charles County well field. The city of St. Peters supplied from 17.4 to 19.0 percent of the total county public-water supply from 1985-91. The quantity of water from Public Water Supply District No. 2 increased from 14.1 to 20.6 percent of the total county public-water supply from 1985 to 1990, then dropped to 19.6 percent in 1991. The quantity of water supplied by the city of

Table 3.--*Sources of public-water supply, St. Charles County, 1985-91*

[All values are average million gallons per day (Mgal/d)]

Source of water	Public-water supplier or water user	1985	1986	1987	1988	1989	1990	1991
Missouri River alluvial aquifer (St. Charles County well field)	Public Water Supply District No. 2[a,b]	1.42	1.84	2.20	2.33	2.33	2.28	2.56
	Missouri Cities Water Company[b,c]	4.12	4.56	5.34	6.25	5.61	5.52	6.75
	Water users supplied directly[b]	.22	.57	.30	.77	.78	.66	.92
	Subtotal	**5.76**	**6.97**	**7.84**	**9.35**	**8.72**	**8.46**	**10.23**
Bedrock aquifers	Public-Water Supply District No. 1[a]	0.08	0.08	0	0	0	0	0
	Public-Water Supply District No. 2[a]	.82	1.18	1.60	1.87	1.49	2.07	2.20
	City of O'Fallon[a]	1.17	1.37	1.48	1.52	1.48	1.67	1.89
	City of Wentzville[d]	.59	.30	0	0	0	0	0
	Subtotal	**2.66**	**2.93**	**3.08**	**3.39**	**2.97**	**3.74**	**4.09**
Mississippi River alluvial aquifer	City of St. Charles[e]	4.27	4.85	3.48	2.66	2.56	2.86	2.61
	City of St. Peters[f]	2.77	3.22	2.15	.73	.36	.34	.70
	Subtotal	**7.04**	**8.07**	**5.63**	**3.39**	**2.92**	**3.20**	**3.31**

Table 3.--*Sources of public-water supply, St. Charles County, 1985-91*--Continued

Source of water	Public-water supplier or water user	1985	1986	1987	1988	1989	1990	1991
Missouri River								
City of St. Charles Main Street water-treatment plant	City of St. Charles[e]	0.44	0.48	0	0	0	0	0
City of St. Louis Howard Bend water-treatment plant	City of St. Charles[e]	0	0	2.16	2.95	2.81	2.25	2.97
	City of St. Peters[f]	0	0	1.72	3.58	3.57	3.49	3.64
	Subtotal	**.44**	**.48**	**3.88**	**6.53**	**6.38**	**5.74**	**6.61**
	Total	**15.90**	**18.45**	**20.43**	**22.66**	**20.99**	**21.14**	**24.24**

[a] Data from Michael Dougherty, Mid Missouri Engineers, Inc., written and oral commun., 1991 and 1992.
[b] Data from Tom Aaron, St. Charles County, written and oral commun., 1991 and 1992.
[c] Data from John Dennison and Max Wells, Missouri Cities Water Company, written and oral commun., 1991 and 1992.
[d] Data from Gary Miller, city of Wentzville, oral commun., 1991.
[e] Data from John Buehrle, city of St. Charles, written and oral commun., 1991 and 1992.
[f] Data from James Karll, city of St. Peters, written and oral commun., 1991.

Table 4.--*Average daily water supply, 1985-91, and peak daily water supply, 1991, from major public-water suppliers, St. Charles County*

[All values are million gallons per day (Mgal/d); --, no data]

Public-water supplier	1985	1986	1987	1988	1989	1990	1991	1991 (peak)
Public Water Supply District No. 1[a]	0.08	0.08	0	0	0	0	0	0
Public Water Supply District No. 2[a,b]	2.24	3.02	3.80	4.20	3.82	4.35	4.76	5.70
St. Charles County[b] (direct to water users)	.22	.57	.30	.77	.78	.66	.92	--
Missouri Cities Water Company[b,c]	4.12	4.56	5.34	6.25	5.61	5.52	6.75	14.90
City of O'Fallon[a]	1.17	1.37	1.48	1.52	1.48	1.67	1.89	3.50
City of Wentzville[d]	.59	.30	0	0	0	0	0	0
City of St. Charles[e]	4.71	5.33	5.64	5.61	5.37	5.11	5.58	9.92
City of St. Peters[f]	2.77	3.22	3.87	4.31	3.93	3.83	4.34	--
Total	**15.90**	**18.45**	**20.43**	**22.66**	**20.99**	**21.14**	**24.24**	--

[a] Data from Michael Dougherty, Mid Missouri Engineers, Inc., written and oral commun., 1991 and 1992.
[b] Data from Tom Aaron, St. Charles County, written and oral commun., 1991 and 1992.
[c] Data from John Dennison and Max Wells, Missouri Cities Water Company, written and oral commun., 1991 and 1992.
[d] Data from Gary Miller, city of Wentzville, oral commun., 1991.
[e] Data from John Buehrle, city of St. Charles, written and oral commun., 1991 and 1992.
[f] Data from James Karll, city of St. Peters, written and oral commun., 1991.

Table 5.--*Average daily well field pumpage and water supply, 1985-91, and peak daily well field pumpage and water supply, 1991, from the St. Charles County well field and water-treatment plant*

[All values are million gallons per day (Mgal/d); data from Tom Aaron, St. Charles County, written and oral commun., 1991 and 1992]

	1985	1986	1987	1988	1989	1990	1991	1991 (peak)
Well field pumpage	5.84	7.06	8.15	9.53	9.19	8.84	10.65	20.95
Water-treatment plant water use	.08	.09	.31	.18	.47	.38	.42	2.00
Water supply from water-treatment plant	5.76	6.97	7.84	9.35	8.72	8.46	10.23	18.95

O'Fallon ranged from 6.7 to 7.9 percent of the total county public-water supply from 1985-91. The quantity of water supplied directly to water users from the St. Charles County well field and water-treatment plant ranged from 1.4 to 3.8 percent of the total county public-water supply from 1985-91.

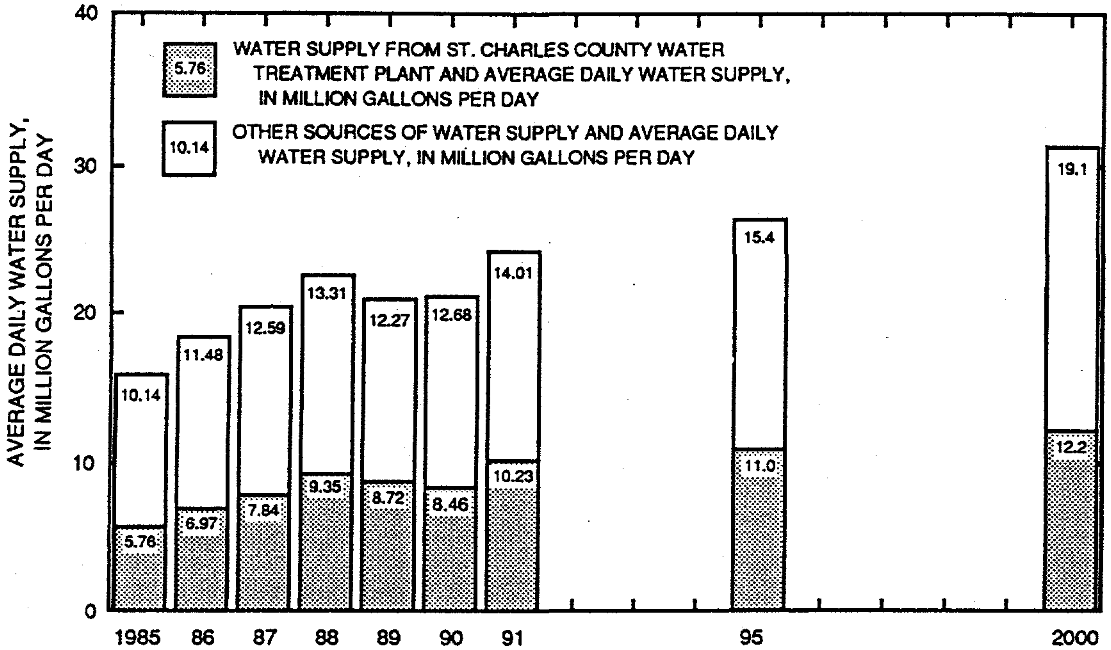

Figure 7. Total county water supply from major public-water suppliers and water supply from the St. Charles County water-treatment plant, 1985-91, and projected water supply for 1995 and 2000 (data supplied by Michael Dougherty, Mid Missouri Engineers, Inc., written and oral commun., 1991 and 1992; Tom Aaron, St. Charles County, written commun., 1991 and 1992; John Dennison and Max Wells, Missouri Cities Water Company, written and oral commun., 1991 and 1992; Gary Miller, city of Wentzville, oral commun., 1991; John Buehrle, city of St. Charles, written and oral commun., 1991 and 1992; James Karll, city of St. Peters, written and oral commun., 1991; Wayne Montgomery, WVP Corporation, oral commun., 1991; and Karen Archer, Black and Veatch Engineers, oral commun., 1991 and 1992).

Peak Daily Water Supply, 1991

Peak daily water supply is the largest quantity of water provided in a given day during the year. This occurs in the summer during periods of largest demand, and generally is a different day for each supplier. Peak days represent the greatest stress on the public-water-supply network.

The 1991 peak daily water supplies from the public-water suppliers are presented in table 4. Because peak supply days are different for each supplier, no total peak daily water supply is given. The peak daily water supply from the St. Charles County water-treatment plant was 18.95 Mgal/d during

1991 (table 5). Plant water-use increases to about 2.0 Mgal/d during periods of large water production (Tom Aaron, oral commun., 1991). The peak daily water pumpage from the St. Charles County well field was 20.95 Mgal/d during 1991.

PROJECTED PUBLIC-WATER SUPPLY, ST. CHARLES COUNTY, 1995 AND 2000

This section presents average daily and peak daily water supply projections for 1995 and 2000 for the major public-water suppliers in St. Charles County. These estimates indicate the projected role of the St. Charles County well field in the future water supply of St. Charles County.

Estimated Population in 2000

The population of St. Charles County has been projected to grow 25.65 percent from 1990 to 2000 (St. Charles County Planning Department, 1990). The projected 2000 population of 250,797 (St. Charles County Planning Department, 1990) was based on a then-projected 1990 population of 199,598. Using a 1990 population of 212,907 (U.S. Department of Commerce, written commun., 1991) and a 25.65 percent rate of growth from 1990 to 2000, the projected 2000 population is 267,500 (fig. 5). Applying this same rate of growth to the estimated 180,500 people served by public-water suppliers during 1990 yields an estimated population of 227,000 served by major public-water suppliers during 2000 (fig. 5).

Projection Methods

Projected average daily and peak daily water supplies were compiled by different methods for each supplier. Projections of daily water supply from the St. Charles County well field and water-treatment plant were supplied by the St. Charles County Water Department (Tom Aaron, oral commun., 1991). Projections of average daily water supply from the St. Charles County well field and water-treatment plant directly to water users during 1995 and 2000 were calculated at 8.5 percent of the projected water supply from the plant, which is the approximate percentage from 1988-91. Projections of peak daily water supply from the St. Charles County well field and water-treatment plant directly to water users were not calculated because no actual data for 1985-91 existed as a basis for calculations. The projected water-supply data for Public Water Supply District No. 2 were calculated by applying rates of increase supplied by WVP Corporation (Wayne Montgomery, WVP Corporation, oral commun., 1991), consultant to Public Water Supply District No. 2, to the 1990 water-supply data. The projected water-supply data for Missouri Cities Water Company are from WVP Corporation (Wayne Montgomery, oral commun., 1991), consultant to Missouri Cities Water Company. Projected average daily water supply data for 1995 and 2000 and projected peak daily water supply data for 1995 for the city of O'Fallon were supplied by Mid Missouri Engineers, Inc., the management company for the city of O'Fallon's water supply system (Mike Dougherty, oral commun., 1992). Because the projected 1995 peak daily water supply is 48 percent greater than the projected 1995 daily average water supply, the projected 2000 average daily water supply was multiplied by 1.48 to calculate the projected peak daily water supply for O'Fallon during 2000. The projected water-supply data for the city of St. Charles were calculated by applying rates of increase supplied by Black and Veatch Engineers (Karen Archer, Black and Veatch Engineers, oral commun., 1991), consultant to the city of St. Charles, to the 1990 water-supply data. The projected water-supply data for the city of St. Peters were provided by Black and Veatch Engineers (Karen Archer, oral commun., 1992), consultant to the city of St. Peters.

Average Daily Water Supply, 1995 and 2000

Projected average daily water supplies from each public-water supplier are presented in table 6. The average daily public-water supply for the county is projected to be 26.4 Mgal/d during 1995, a 24.9 percent increase from1990 and an 8.9 percent increase from 1991 (fig. 6). The total county public-water supply is projected to be 31.3 Mgal/d in 2000 (table 6), a 48.1 percent increase from 1990, a 29.1 percent increase from 1991, and an 18.6 percent increase from 1995 (fig. 7).

Projected average daily water supply from the St. Charles County well field and water-treatment plant in 1995 and 2000 is presented in table 7. The average daily water supply in 1995 is projected to be 11.0 Mgal/d, a 30 percent increase from 1990 and a 7.6 percent increase from 1991. The average daily water supply during 2000 is projected to be 12.2 Mgal/d, a 44.2 percent increase from 1990, a 19.4 percent increase from 1991, and a 10.9 percent increase from 1995. The St. Charles County well field is projected to supply 41.7 percent of the total county public-water supply during 1995 and 39.0 percent of the total county public-water supply during 2000 (fig. 7).

Peak Daily Water Supply, 1995 and 2000

The projected peak daily water supplies from each public-water supplier during 1995 and 2000 are presented in table 6. Because peak supply days are different for each supplier, a total peak daily water supply is not given.

The projected peak daily demand from the St. Charles County water-treatment plant and peak daily pumpage from the St. Charles County well field during 1995 and 2000 based on anticipated customer demands (Tom Aaron, oral commun., 1991) are presented in table 7. The capacity of the well field is approximately 27 Mgal/d, but production is limited by the capacity of the water-treatment plant, which is approximately 22 Mgal/d (Tom Aaron, written commun., 1993). Projected peak daily demand for 1995 exceeds the capacity of the water-treatment plant, and projected peak daily demand for 2000 exceeds the capacities of both the well field and water-treatment plant. These quantities are, therefore, regarded as peak daily demands rather than peak daily supplies (Tom Aaron, oral commun., 1991).

Table 6.--*Projected average daily and peak daily water supply from major public-water suppliers, St. Charles County, 1995 and 2000*

[All values are million gallons per day (Mgal/d); --, no data]

Public-water supplier	1995 (average)	1995 (peak)	2000 (average)	2000 (peak)
Public Water Supply District No. 2[a]	6.5	8.5	7.6	10.2
St. Charles County (direct to water users)[b]	.9	--	1.0	--
Missouri Cities Water Company[c]	6.4	17.4	7.6	19.6
City of O'Fallon	[d]2.5	[d]3.7	[d]3.8	[e]5.6
City of St. Charles[f]	6.1	11.4	7.1	13.4
City of St. Peters[g]	4.0	10.5	4.2	11.0
Total	**26.4**		**31.3**	

[a] Rates of increase from 1990 to 1995 and from 1995 to 2000 supplied by Wayne Montgomery, WVP Corporation, oral commun., 1991.
[b] Calculated at 8.5 percent of the projected water-supply from the St. Charles County water-treatment plant.
[c] Data supplied by Wayne Montgomery, WVP Corporation, oral commun., 1991.
[d] Data supplied by Mike Dougherty, Mid Missouri Engineering Company, oral commun., 1992.
[e] Calculated by multiplying 2000 average daily water-supply by 1.48.
[f] Rates of increase from 1990 to 1995 and from 1995 to 2000 supplied by Karen Archer, Black and Veatch Engineers, oral commun., 1991.
[g] Data supplied by Karen Archer, Black and Veatch Engineers, oral commun., 1992.

Table 7.--*Projected average daily and peak daily demand from the St. Charles County well field and water-treatment plant, 1995 and 2000*

[All values are million gallons per day (Mgal/d); data from Tom Aaron, St. Charles County, oral commun., 1991]

	1995 (average)	1995 (peak)	2000 (average)	2000 (peak)
Well field pumpage	12.2	26.4	13.6	[a]29.0
Water-treatment plant water use	1.2	2.0	1.4	2.0
Water supply from water-treatment plant	11.0	[a]24.4	12.2	[a]27.0

[a] St. Charles County Water Department's anticipation of demand exceeds water-treatment plant or well-field capacity.

SUMMARY

The St. Charles County well field, located in an alluvial bottom of the Missouri River, supplies water to residents, businesses, and industries in St. Charles County, Missouri. Radioactive, nitroaromatic, and other wastes are stored in the abandoned Weldon Spring quarry, which is excavated in a limestone ridge above the well field. Well field geohydrologic and county-wide water-supply data were compiled to assist the U.S. Department of Energy in developing the St. Charles County Well Field Contingency Plan. This plan was prepared to ensure a supply of water in the event that the well field becomes contaminated in the future. Except for some projected water-supply data that were calculated for this report, the data presented in this report are a compilation of data collected or supplied by consultants or other agencies.

Eight wells are used to supply water from the Missouri River alluvial aquifer. These all penetrate the entire thickness of the aquifer, and range from 98 to 116 ft deep. The lower 40 ft of each well is 18-in. diameter stainless steel screen. Specific capacity of the wells calculated soon after well completion ranged from 115 to 248 (gal/min)/ft of drawdown.

Aquifer pumping tests were performed on three occasions to determine the hydraulic characteristics of the aquifer. One of the wells at the well field was pumped at 2,650 gal/min for 47 hours. The transmissivity was determined to be 36,000 ft^2/day, the hydraulic conductivity was determined to be 400 ft/day, and a storage coefficient of 0.2 was determined. Several aquifer tests were performed using an observation well as a pumped well close to and south of Femme Osage slough. The transmissivity was determined to be about 900 ft^2/day, the hydraulic conductivity was determined to be about 23 ft/day, and the storage coefficient was determined to be about 0.005. Another aquifer test used one of the wells at the well field as a pumped well. The transmissivity was determined to range from 50,400 to 60,200 ft^2/day, the hydraulic conductivity was determined to range from 535 to 602 ft/day, and the storage coefficient was estimated to be greater than 0.01. Aquifer transmissivity was determined to decrease from south to north toward Femme Osage slough. A tracer test determined an effective porosity that ranged from 0.21 to 0.32.

Point dilution tests were used to determine the approximate ground-water velocity. Results from tests near Femme Osage slough indicated that ground-water velocities were less than the resolution of the test. A test an unspecified distance south of Femme Osage slough determined a ground-water velocity of 0.83 ft/day.

Data for the quantities of water supplied to St. Charles County by major public-water suppliers from 1985-91 were compiled. Public-water supply is obtained from four sources; the Missouri River alluvial aquifer (St. Charles County well field), bedrock aquifers, the Mississippi River alluvial aquifer, and the Missouri River.

The average daily public-water supply in St. Charles County increased from 15.90 Mgal/d during 1985 to 24.24 Mgal/d during 1991, a 52.5 percent increase. The average daily water supply from the St. Charles County well field and water-treatment plant increased from 5.76 Mgal/d during 1985 to 10.23 Mgal/d during 1991, a 77.6 percent increase. This represents an increase from 36.2 to 42.2 percent of the total public-water supply in St. Charles County. The peak daily water supply from the St. Charles County water-treatment plant was 18.95 Mgal/d during 1991, and the peak daily pumpage from the well field was 20.95 Mgal/d during 1991.

Water supply projections were made for major public-water suppliers in St. Charles County for 1995 and 2000. The total county average daily public-water supply is projected to be 26.4 Mgal/d during 1995, an 8.9 percent increase from 1991, and 31.3 Mgal/d during 2000, a 29.1 percent increase from 1991. The average daily water supply from the St. Charles County water-treatment plant is projected to be 11.0 Mgal/d during 1995, a 7.6 percent increase from 1991, and 12.2 Mgal/d during 2000, a 19.4 percent increase from 1991. The St. Charles County well field and water-treatment plant

are projected to supply 41.7 percent of the total county public-water supply during 1995 and 39.0 percent during 2000. The projected peak daily water demands from customers of the St. Charles County well field and water-treatment plant during 1995 and 2000 indicate that these demands will exceed the water-treatment plant capacities during 1995 and will exceed both the well field and water-treatment plant capacities during 2000.

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