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HAZARDOUS WASTE IN OGLE AND WINNEBAGO COUNTIES: POTENTIAL RISK VIA GROUNDWATER DUE TO PAST AND PRESENT ACTIVITIES

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1) Prepared under contract with the Illinois Department of Energy and Natural Resources as project number 83/4001; from the State Water Survey Division, Champaign, Illinois.

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ABSTRACT

Current and identifiable historical hazardous waste activities in Ogle and Winnebago Counties have been tabulated from an exhaustive search of available data sources. A total of 88 and 805 active and 3 and 170 inactive or abandoned sites were identified in Ogle and Winnebago Counties, respectively. Accompanying data on the types, quantities, and management practices of hazardous wastes also were gathered. The legal locations and dates of operation of each site also were tabulated.

A preliminary rating scheme was developed to prioritize areas or sites that merit more detailed study and evaluation. The focus of the rating scheme is the assessment of a site's "threat to human health via groundwater." The ranking scheme is divided into four factors: I - Health risk of waste and handling mode; II - Population at risk; III - Proximity of waste to public water supply wells or potable aquifers; and IV - Aquifer susceptibility.

Application of the rating scheme resulted in scores ranging from 23 to 94 of a possible 100. Mapping of rating scores by locations permitted the delineation of potential problem areas, "hot spots," within the two-county study area. A large potential problem (primary) area was delineated in the metropolitan Rockford area. Secondary potential risk areas were delineated also in the Rockford area and at Pecatonica, Rockton, and South Beloit, all in Winnebago County. One primary risk area was identified at Rochelle in Ogle County.

INTRODUCTION

Hazardous waste generation and disposal have become a major environmental issue of the 1980s. Environmental catastrophes similar to those at Love Canal, Times Beach, and other prominent sites of chemical contamination have drawn public attention to the increasing problems associated with hazardous waste management. Public sentiment in opposition to the land disposal of hazardous waste is creating increased pressures on regulatory agencies to develop reasonable strategies to control the disposal of hazardous wastes and to protect human health. More specifically, federal regulations (Resource Conservation and Recovery Act) require permitting, monitoring, and inspection of hazardous waste generators and transporters, as well as treatment, storage and disposal facilities.

The responsibility for administering these regulations falls largely on the states. The policies of the Reagan administration are forcing states to assume this responsibility with decreasing federal assistance. To comply with these regulations, states must develop an overall planning approach to maximize the returns from the limited resources available to address these issues.

In addition, it is essential to develop a management strategy that incorporates the potential risks posed by hazardous waste activities over the past 50 to 75 years. Control of current activities provides a degree of protection for future generations but has only limited impact on present water quality conditions. The relatively slow rates of groundwater movement from most pollution sources result in a significant time lag before the effects of the pollution are experienced. Therefore it is necessary to document past activities, estimate rates of groundwater/pollution solute movement, and delineate areas of potential adverse impact. It is essential to the protection of public health that the scientific and regulatory communities progress beyond the "knee-jerk" emergency response mode into a technically sound predictive prioritization management strategy.

This pilot project was undertaken to develop a planning approach that would enable prioritization of hazardous waste site investigation in Illinois.

Scope of the Problem

The responsible management of hazardous waste is vital to a technologically advanced civilization. As population and industry grow, so do the volumes of their products and by-products. Efforts to protect air and water resources while maintaining the production of a staggering diversity of consumer goods further increase solid waste output. These efforts also lead to the concentration of hazardous materials removed from process waste streams which must be carefully handled to minimize release into the

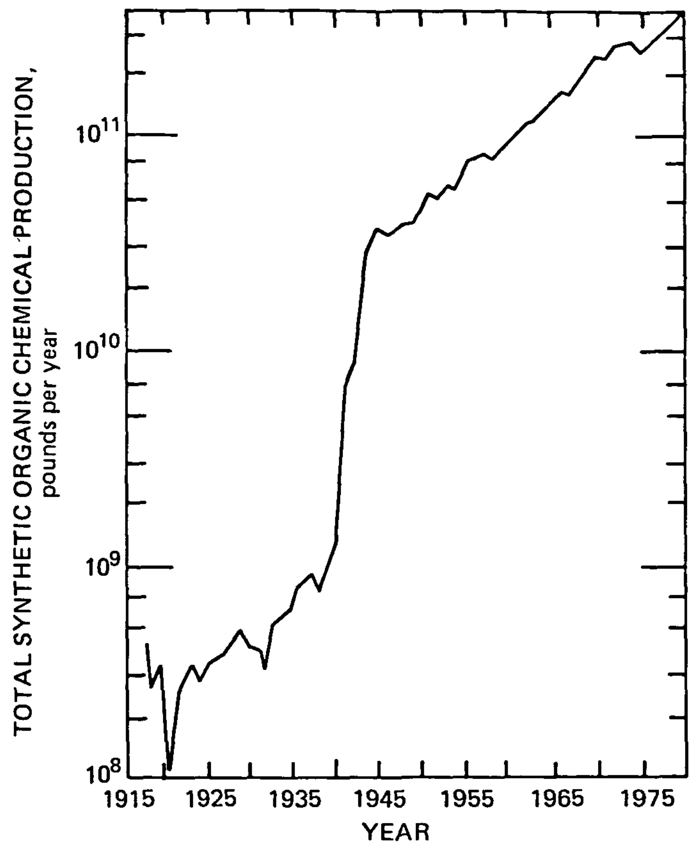


Figure 1. Historical growth of the synthetic organic chemistry industry in the United States

environment. Hazardous wastes make up about 10 to 15 percent of the total industrial waste generated in the United States.1 Data on the growth of the synthetic organic chemistry industry indicate the increasing magnitude of the hazardous waste problem (see Figure 1).

Illinois is a major industrial state which, over the past 60 years, has contributed from 7 to 9 percent of the national manufacturing output.3 It is not coincidental that the State generates about 7 percent of the national output of hazardous wastes. Ohio shares second place with Illinois, while New Jersey leads the nation at 8 percent of the estimated total of 25 to 60 million tons per year.4,5 Recent Illinois Environmental Protection Agency (IEPA) surveys of Illinois industrial waste generators indicate that the current annual production of hazardous wastes-is approximately 3 million tons.6,7

In general, the data on recent waste generation are very sketchy and few estimates prior to 1970 exist. Therefore, assumptions must be made concerning waste generation on a national basis. By assuming that 10 percent of total industrial wastes are hazardous; one can apportion Illinois' share on the basis of the state's contribution (about 7 percent)

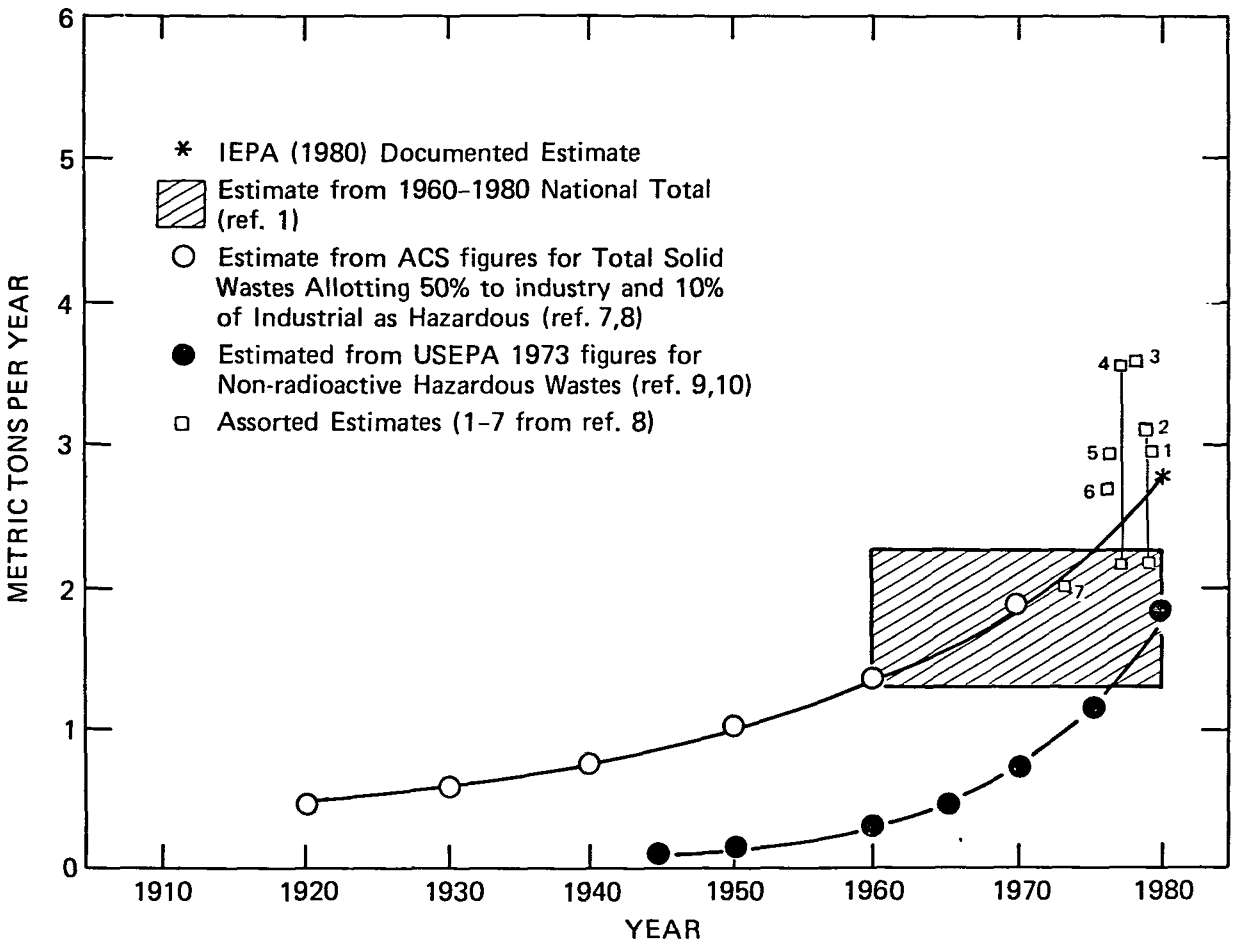


Figure 2. Estimated hazardous waste generation in Illinois 1920-1980

to the U.S. total value. Conservative estimates of Illinois' hazardous waste generation in the past HO to 50 years have been made (see Figure 2). All of the estimates of Illinois' hazardous waste generation in the 1975-1980 period are within 30 percent of the documented value for 1980 from the IEPA. This is understandable, since both state and federal regulatory frameworks were in force during this period and all estimates other than those labeled MSDGC (Metropolitan Sanitary District of Greater Chicago), IEPA and Booz-Allen were derived from national figures. However, for the period 1960 to 1980 we must rely solely on cumulative national estimates[1] and either show a range of average annual waste generation rates (shaded area) or extrapolate back from a documented estimate using some annual percentage growth rate (designated by the curves). The solid curve in Figure 2 represents extrapolated estimates from the 1980 figure using annual growth rates projected in American Chemical Society publications for total solid waste production in the U.S.[8,9] The trend shown by this curve reflects a growth rate of 8 percent per annum and generally is in agreement with the net production estimates from 1960 and

1980. Total Illinois production of hazardous wastes since 1 920 may be estimated from the area under this curve at 76 million tons. Of this amount, nearly 60 million tons (79 percent) were generated and handled before 1975 with little or no regulatory control. The most conservative figures for production of nonradioactive hazardous wastes available[10,11] yield the dashed curve (10 percent annual rate of growth). We predict from this curve that at least 20 million tons or 62 percent of the post-World War II production of hazardous waste was handled before 1975.

This analysis demonstrates that the bulk of hazardous waste generation in Illinois occurred prior to the establishment of regulatory controls when the need for environmental protection was barely recognized. We presume that these materials were treated as nuisances and not handled with the care or reasoned stewardship which would be demanded today. Even in this era of environmental protection by regulation, estimates indicate that from 26 to 80 percent of the 1980 production of hazardous wastes was disposed of on-site by the generators using unaudited, discretionary methods.[6,11] An example is the approximately 250,000 tons of metal and cyanide wastes of which about 99 percent is "disposed of" in unlined surface impoundments by "percolation/evaporation" methods.[6] By their toxic, reactive, and persistent nature, it must be concluded that the full history of hazardous wastes cannot yet be written. We must prepare ourselves for their inevitable discovery as they are acted upon by physical, chemical, and biological processes (and redistributed) in the environment .

Acknowledgments

This project was funded by the Department of Energy and Natural Resources (ENR Contract No. HW 14) . Data tapes and information were obtained from the Illinois Environmental Protection Agency (Divisions of Land and Water Pollution Control), Ogle and Winnebago County Assessors Offices, Rockford Chamber of Commerce, and the Rockford County Planning Department. Maichle Bacon of the Winnebago County Health Department and Michael J. William of the Ogle County Health Department reviewed the final lists of generators and disposers for errors or omissions.

Water Survey personnel assisting in the project include: Vern Carty, Marsha Conover, Tami Kilgore, Joe Ritchey, and Jack Tuschall who assisted with records searches and legal location determinations; Anna Zahn who assisted with data manipulation and report preparation; and Allen Wehrmann and Adrian Visocky who assisted in calculating time related capture zones. In addition, Pamela Lovett typed the manuscript, and Linda Riggin drafted the figures.

OBJECTIVES OF STUDY

The objectives of this project were to: 1) identify and locate past and present hazardous wastes generators and disposers in two northern Illinois counties; 2) identify and characterize their waste streams; 3) identify the locations and modes of disposal; 4) develop time-related capture zones for public water supply wells in the study area; 5) determine zones of recharge for untapped shallow groundwater resources; 6) apply a structured rating scheme using the ranked health risk of disposed constituents, classes of public water supply usage, and aquifer susceptibility data; and 7) identify and rank potential "hot spots" or problem areas in the study region.

The problems associated with hazardous waste disposal are large and complex. Still, the long-term threat to environmental health via groundwater pollution by hazardous wastes generated in the past, or mismanaged today, is clear. Therefore, the conservative position that hazardous waste production and disposal sites pose a threat to human health via subsurface drinking water supplies, unless it can be proven to the contrary, was chosen. Site-specific hazard assessment schemes, such as the "Mitre" model applied under Superfund regulations, require expensive data collection programs for their successful application. Because of a lack of data, a more pragmatic method of assessment was chosen. The first step was the identification and location of past and present sites of hazardous waste generation and disposal. Waste generators and disposal sites were rated on the basis of the relative hazard of the waste involved. The susceptibility of the subsurface environment to surface sources of contamination was taken into account and the populations at risk were determined. By evaluating the direction and relative rates of groundwater flow, worst-case estimates of the time required for a mobile hazardous material to impact a drinking water source were calculated. Using this approach, a basis for ranking areas posing greater risk within the study region was developed and areas posing the greatest potential threat were identified as "hot spots."

DESCRIPTION OF STUDY AREA

Two counties in north-central Illinois were selected for study. Ogle County is predominantly an agricultural county producing and disposing of minimal amounts of hazardous wastes. Winnebago County, on the other hand, is heavily industrialized in the urban areas and deals with considerable quantities of hazardous waste. Figure 3 illustrates the manifested hazardous wastes generated in these counties in 1982. Of the 67 million gallons of hazardous waste generated and manifested in Illinois in 1982, Ogle and Winnebago Counties reported 0.06 and 2.74 percent, respectively. Winnebago County was the eighth largest producer of hazardous waste in Illinois in 1982.

Demographic Data

Ninety percent of the land area in Ogle County is designated as farm land.[13] Sixty-one percent of Ogle County's 46,338 population[12] live outside urban areas. The major urban areas in Ogle County are Rochelle, Oregon, and Byron (see Figure 4). Thirty-one percent of the county's total population live in these communities. The county had a population density of 61 people per square mile in 1980.

In contrast, Winnebago County had only 65 percent of its land area designated as agricultural in 1978.[13] Eighty-four percent of its 250,884 population lived in urban areas.[14] Rockford, South Beloit, Pecatonica, and Rockton are the major urban areas in Winnebago County (see Figure 5). They account for 66 percent of the county's total population. Winnebago's 1980 population density was 487 people per square mile.

Physical Setting

Topography and Drainage

The two-county study area is characterized by gently rolling uplands overlooking alluvial valleys. Although past glacial invasions are evident, current topography primarily is controlled by preglacial bedrock surface erosion patterns. Modern day topographic relief locally exceeds 100 feet. However, on the uplands, slopes are generally smooth and gentle. Drift thickness on the uplands is thin (0 to 100 feet) but thick outwash deposits (200 to 300 feet) occupy the major preglacial bedrock valleys.

The study area also is characterized by a well dissected drainage system. The major drainage way is the Rock River. The river flows generally southward within the eastern portion of Winnebago County (Figure 5) and through the middle of Ogle County (Figure 4). Major tributaries consist of the Pecatonica River which flows generally west to east across

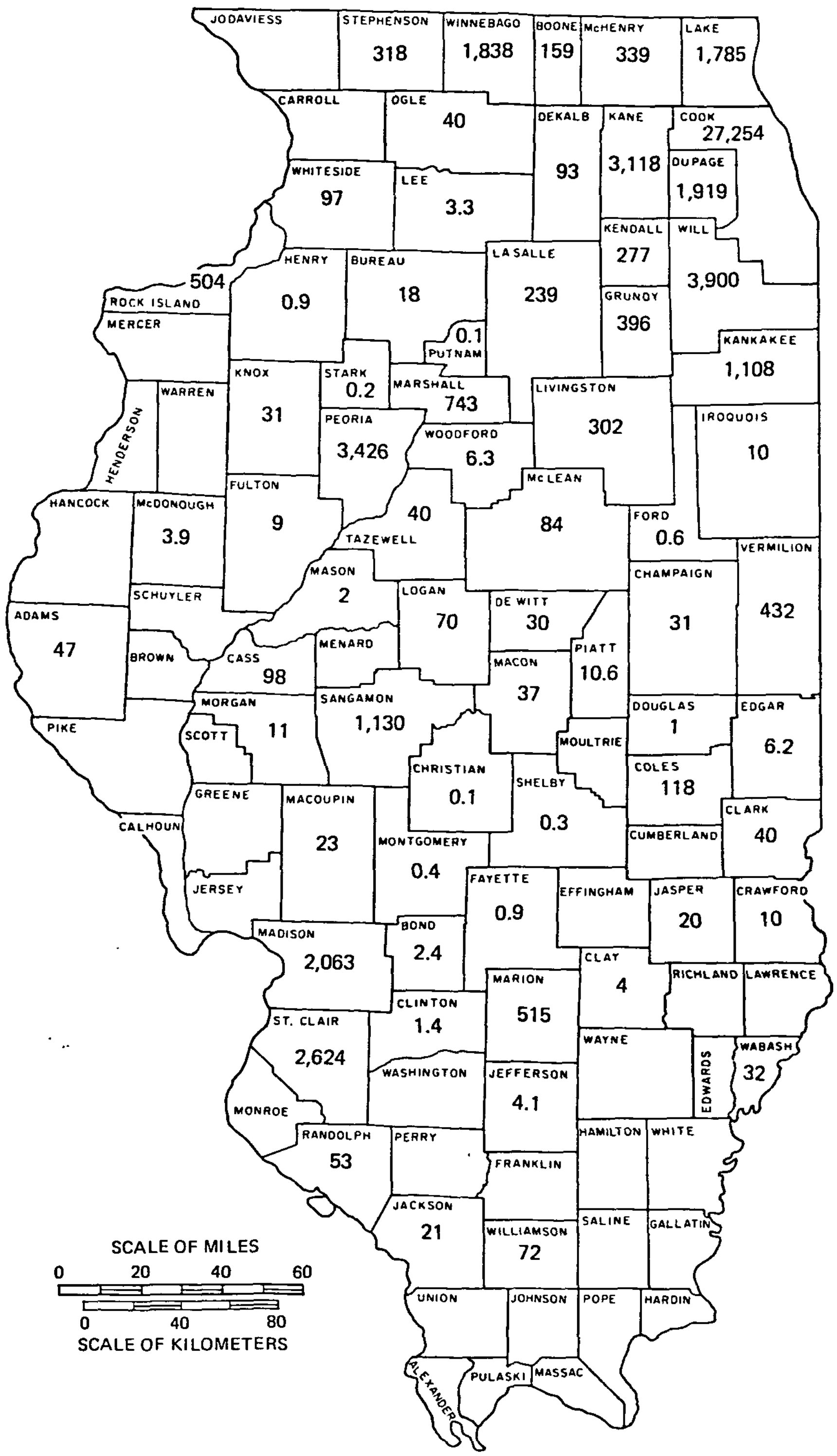


Figure 3. Manifested hazardous waste generation (in million gallons) in 1982 by counties

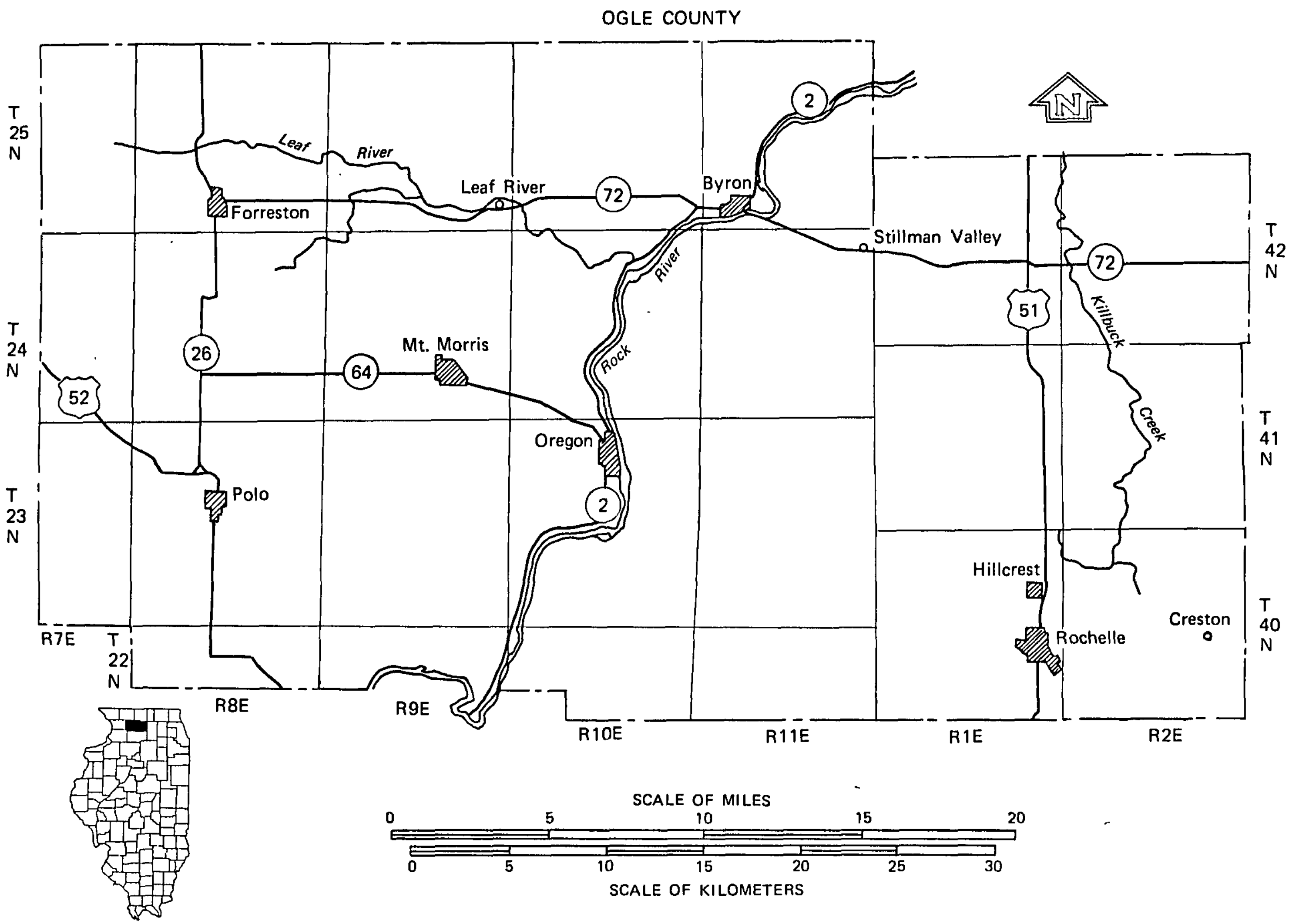


Figure 4. Location of urban areas in Ogle County

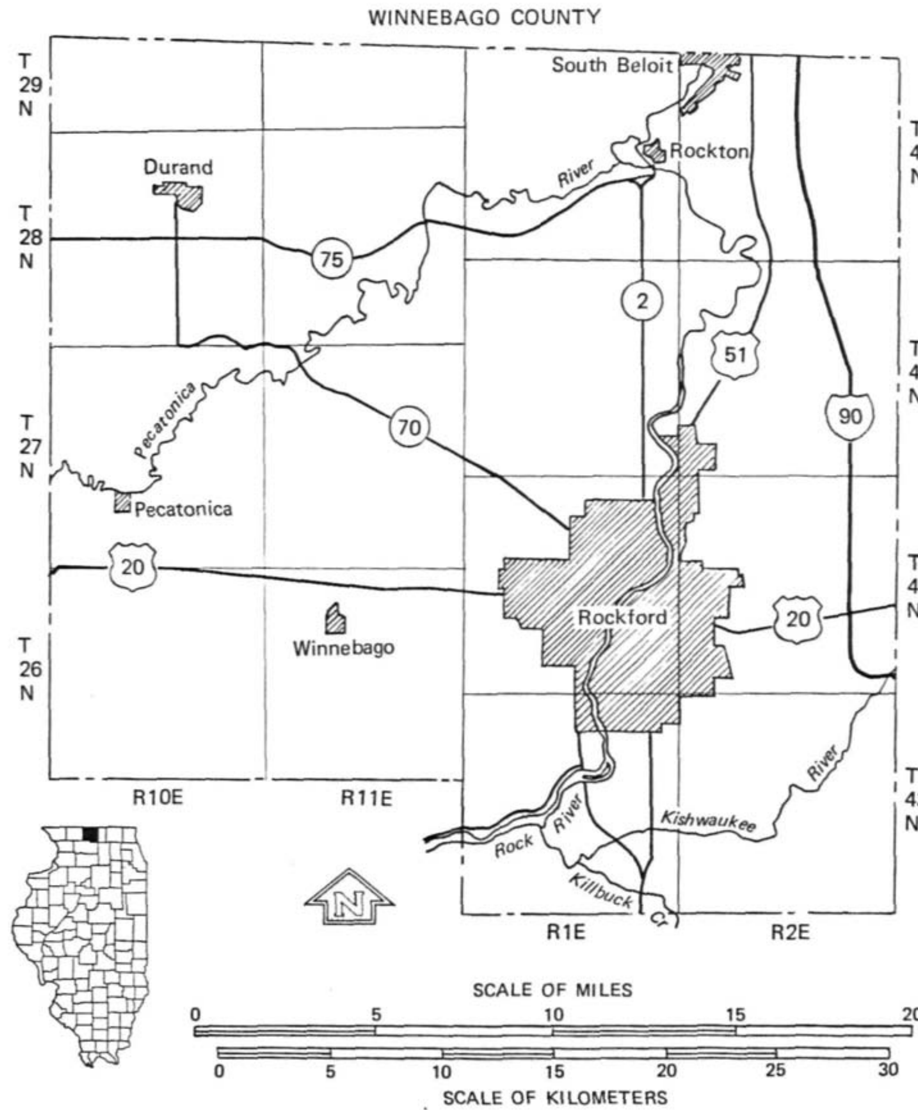


Figure 5. Location of urban areas in Winnebago County

northern Winnebago County and joins the Rock River at Rockton. The Kishwaukee River enters southeastern Winnebago County and joins the Rock River just north of where the Rock River enters Ogle County. The Leaf River flows eastward across northern Ogle and enters the Rock River below Byron. The present day Rock River and its major tributaries ocoupy valleys which roughly coincide with the preglacial bedrock valleys.

Hydrogeology

Large quantities of groundwater used for industrial, domestic, and municipal purposes are obtained from several aquifers which underlie the entire region of northern Illinois, including the two-county study area. There are four major aquifers in the study region: sand and gravel, shallow dolomite, a series of sandstones and dolomites known collectively as the Cambrian-Ordovician deep sandstone, and the Elmhurst-Mt. Simon. Figure 6 is a general stratigraphic sequence illustrating the vertical relationship of the aquifers with respect to the geologic regime. The following information concerning the area's hydrogeology is summarized from Hackett15 and Berg et al.16

The deeper-lying sandstone aquifers include the St. Peter Sandstone, the Ironton-Galesville Sandstone and the Elmhurst-Mt. Simon Sandstone. These deep sandstone aquifers are the principal bedrock aquifers of the region and are used by high capacity wells (up to 2000 gallons per minute). Wells finished in the Elmhurst-Mt. Simon aquifer are relatively few because of the high cost of construction and maintenance. Most wells, however, are finished in the productive units at shallower depths. Water quality for the most part is good with potable water obtainable to 2000 feet below land surface. Throughout the region, these units behave as one geohydrologic unit.

The shallow dolomite aquifer is composed of the Platteville-Galena and Silurian formations. Groundwater in the aquifer exists in joints and fractures and to some extent in solution openings. The aquifer is the main source of groundwater for domestic use with many wells obtaining suitable quantities of fresh water from 20 to 100 feet into the aquifer.

The glacial drift aquifers are characterized as highly variable and consist of well-sorted coarse sands and gravels. The aquifers generally are limited to the major bedrock valleys where the thickness of the deposits are greatest (see Figures 7 and 8) and may yield large quantities of water. Water quality normally is considered good. High capacity wells generally are finished in the basal part of the outwash material and range from 150 to 300 feet deep.

Public Water Supplies

All public water supplies in Ogle and Winnebago Counties are obtained from groundwater sources. In 1980 an estimated 5.723 million gallons per day (mgd) and 38.126 mgd were pumped for public water supplies in Ogle and Winnebago Counties, respectively.17 of these totals, 0.1 and 57 percent were pumped from shallow sand and gravel wells, respectively. The remaining 99.9 and 43 percent were obtained from deep sandstone wells. Fifty-six and 76 percent of the populations of Ogle and Winnebago Counties are served by public water supplies, respectively. Figures 9 and 10 illustrate the locations and types of wells used for public water supplies for Ogle and Winnebago Counties. Appendix A lists public water supply well data for Ogle and Winnebago Counties.

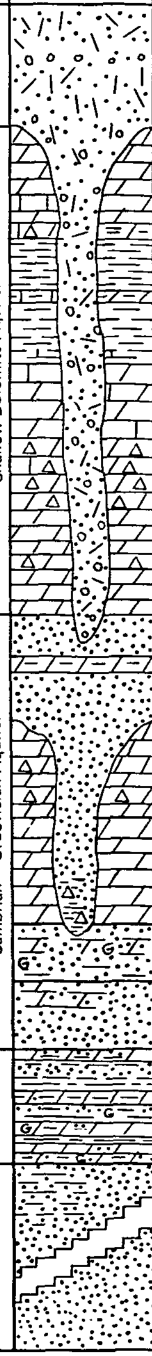
SYSTEM	SERIES	GROUP OR FORMATION	AQUIFER		LOG	THICKNESS (FT)	GENERALIZED DESCRIPTION
QUATER-NARY	PLEISTOCENE		Sands and Gravels			0 -150	Till, gravel, sand, silt, peat, loess
SILURIAN	NIAGARAN	Hunton	Silurian	Shallow Dolomite Aquifer		0 - 50	Dolomite, crystalline, vesicular, white to gray, partly cherty
	ALEXANDRIAN						Dolomite, dense to vesicular, silty and sandy in lower part
ORDOVICIAN	CINCINNATIAN	Maquoketa				0 - 140	Shale, dolomitic, green to gray, some dolomite
	CHAMPLAINIAN	Galena	Galena–Platteville			0 - 250	Dolomite and limestone, medium–grained, cherty in lower part
		Platteville				0 - 100	Dolomite, fine–grained, cherty
		Ancell: Glenwood–St. Peter	Glenwood–St. Peter	Cambrian – Ordovician Aquifer		125 - 400	Sandstone, medium–grained, friable, mostly white
	CANADIAN	Prairie du Chien				0 - 200	Dolomite, light gray to brownish gray, fine to coarse grained, cherty
CAMBRIAN	CROIXAN	Eminence	Eminence–Potosi			0 - 210	Dolomite, light colored, sandy, thin sandstones
		Potosi					Dolomite, fine–grained, gray to brown, drusy quartz
		Franconia	Franconia			60 - 100	Dolomite, sandstone and shale, glauconitic, green to red, micaceous
		Ironton	Ironton–Galesville			100 - 150	Sandstone, fine to coarse grained, well sorted; upper part dolomitic
		Galesville					
		Eau Claire					Shale and siltstone, dolomitic, glauconitic; sandstone, dolomitic, glauconitic
		Elmhurst Member	Elmhurst–Mt. Simon			1050 - 1500	Sandstone, coarse–grained, white, red in lower half; lenses of shale and siltstone, red, micaceous
		Mt. Simon					
PRE-CAMBRIAN							Granitic rocks

Figure 6. Stratigraphic sequences of geologic units and aquifers in northern Illinois

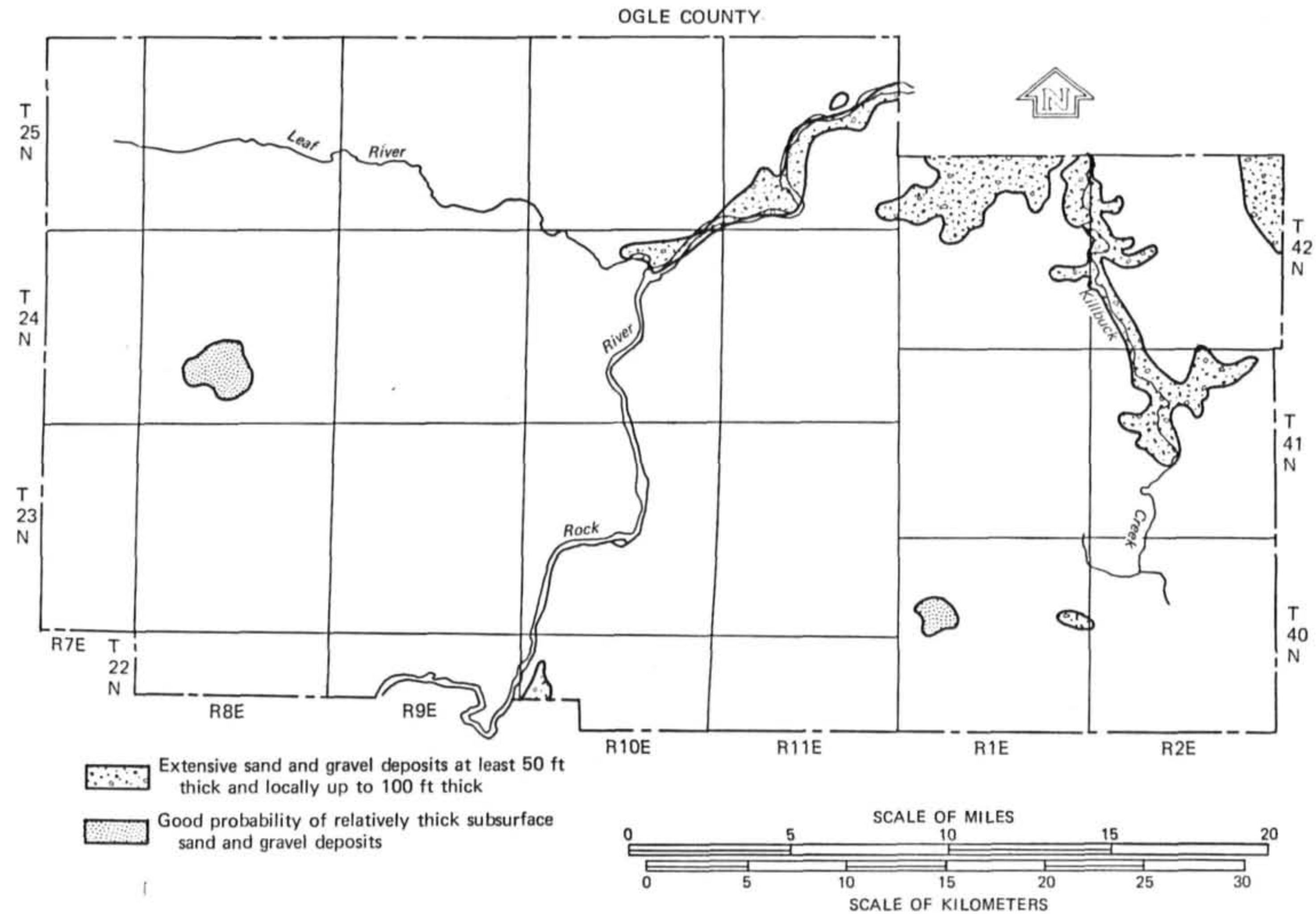


Figure 7. Sand and gravel aquifers in Ogle County

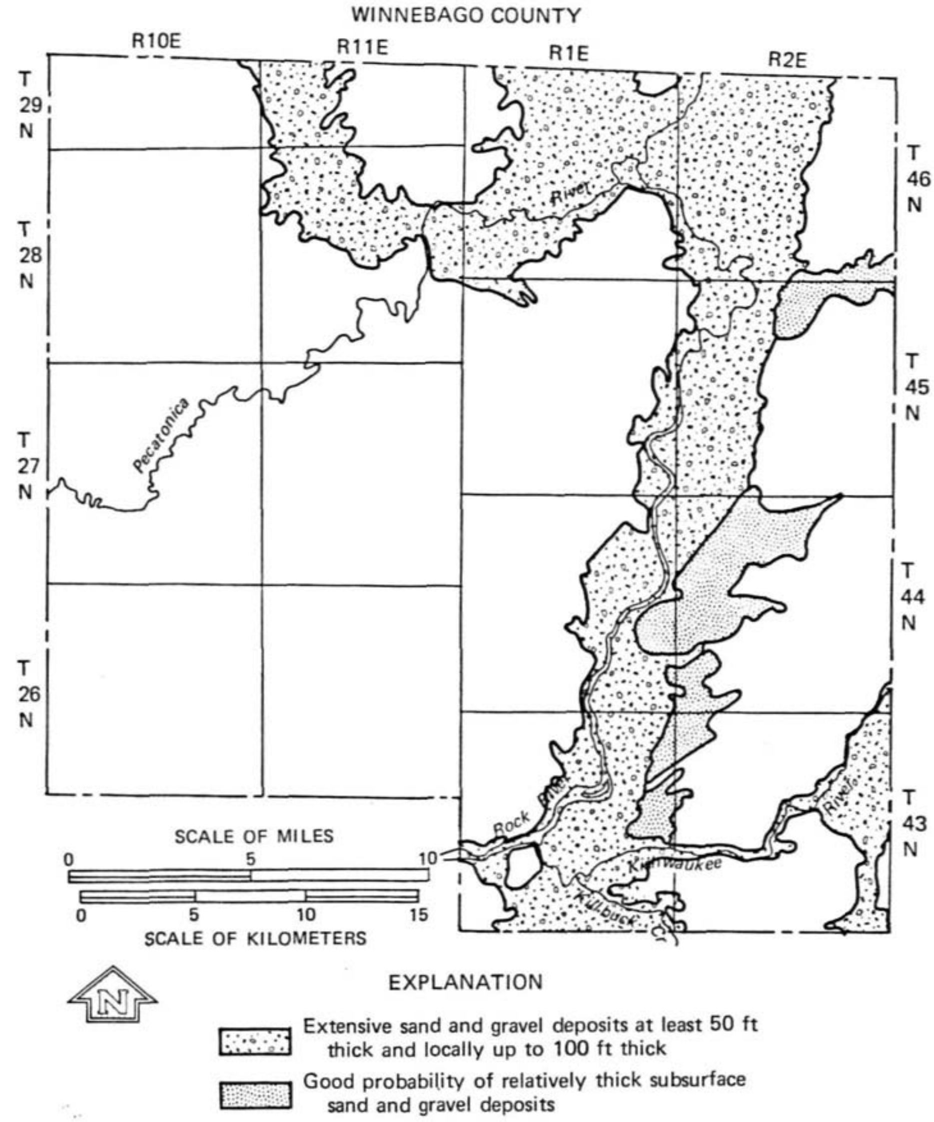


Figure 8. Sand and gravel aquifers in Winnebago County

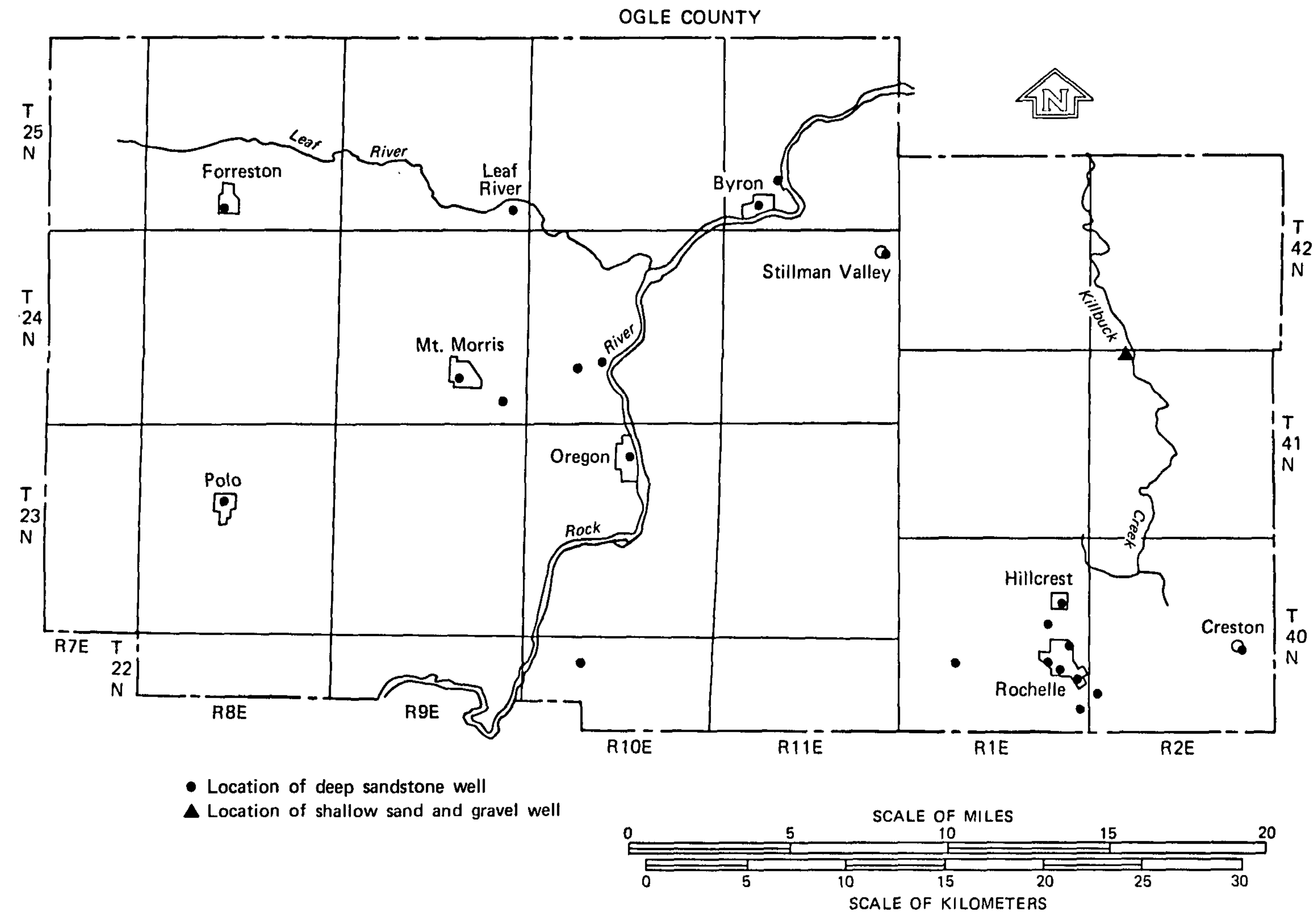


Figure 9. Public water supply in Ogle County

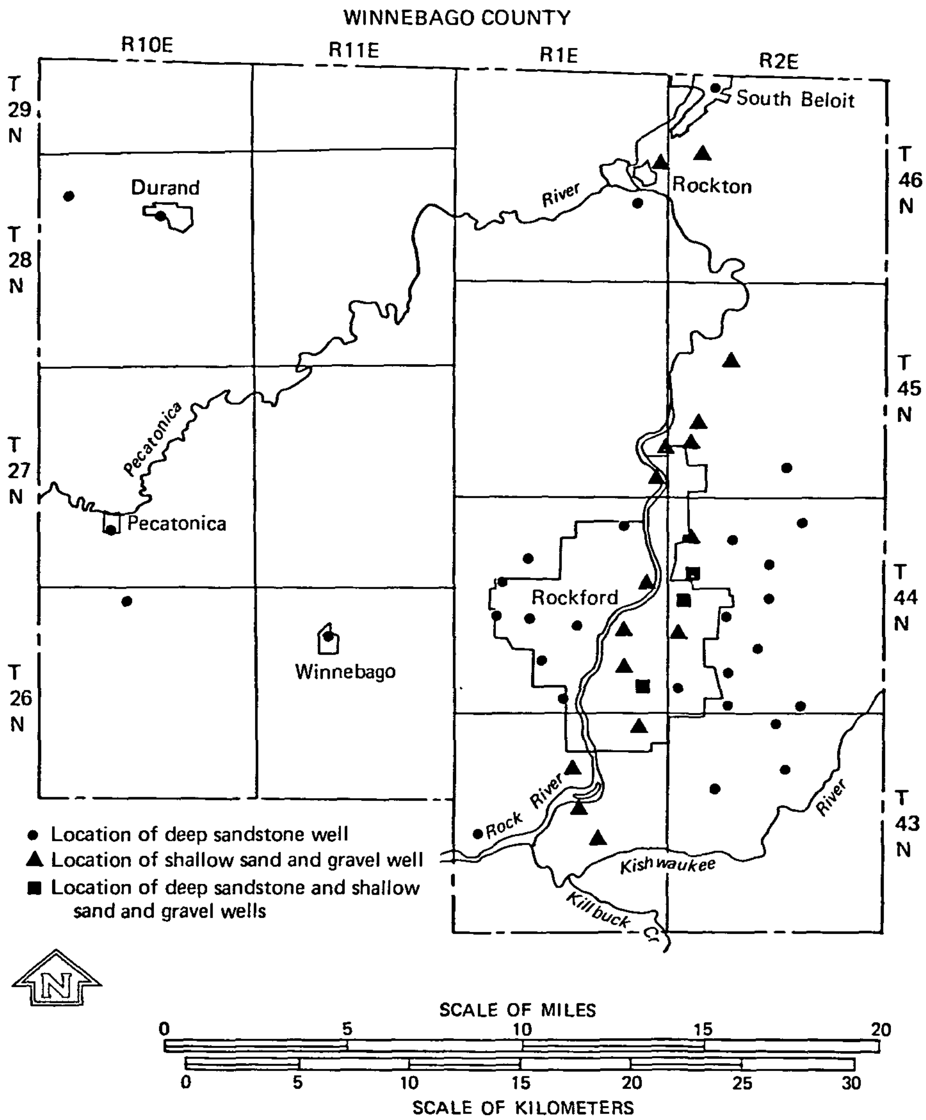


Figure 10. Public water supply wells in Winnebago County

DATA SOURCES FOR HAZARDOUS WASTE ACTIVITIES

One of the initial aspects of this project was to make use of data which had been collected previously by other agencies and projects. This approach was chosen to facilitate data collection efforts and to assess the viability of using data from other sources for the development of a preliminary ranking scheme. The use of "old," readily available data reduced the costs in time and money of initial data collection. The developed rating scheme using available data also is a more practical tool for use by communities and municipalities with limited resources.

To this end, numerous possible sources of data were explored. Table 1 lists the sources which were used in this study as either primary information or as cross checks or verification.

Table 1. Sources of Data Used to Develop the Hazardous Waste Activity Master File

Data Type	Source	Media
Generator File	IEPA	tape
Disposers Inventory	IEPA	tape
Disposal Applications	IEPA	tape
Generator-disposer correlation	IEPA	microfiche
GCA Consultants Report	IEPA	tape
Superfund Data	NTIS	tape
RCRA Data	NTIS	tape
Industrial Manufacturers Directory	County Library	books
Assessors Files	County Assessors	tape
Populations	Census	tape
Water Supply Information	ISWS-GWS	disk file
Legal Descriptions	ISWS-GWS	files,maps,books
Disposal Sites—Winnebago	Rockford Planning Comm.	report
SIC	SWS Library	manual
Types of Activity	Revenue Dept.	tape
City Directories	U of I Library	books
City Directories	Rockford Chmb. Commerce	books
Business Directories	Rockford Chmb. Commerce	books

Before discussing the data elements used in the ranking scheme, it is necessary to establish some definitions used during data evaluation. Hazardous wastes are defined by regulatory criteria including the -ability to be detected by reasonable means. Wastes may be classified as hazardous if they cause or contribute to increased mortality, serious irreversible illness, incapacitating reversible illness, or if they pose a substantial hazard to human health or the environment if improperly managed.

Hazardous wastes are products or by-products of industrial activities. In this study, these activities are categorized as either generators or disposers. The word generator is defined as any site on which current or past activities have taken place that use or create hazardous materials. Disposers are defined as sites where hazardous materials are or have been stored or discarded.

Each activity is described by a Standard Industrial Code (SIC). The SIC is a four-digit code classifying the economic activity of each site. Each site was assigned one or more SICs which described the activity on that site.

Combining all sources of information on past and present sites produced a preliminary list of about 2500 entries. After eliminating duplications due to the non-standard data entry methods among the various information sources, 1500 sites remained. This list was developed using SICs for activities whose products and by-products potentially could create adverse impacts on groundwater. These SICs are listed in Table 2 along with the degree of hazard rating scores for the SICs encountered in the study area. Because of the limited time available to perform this study, the scores for those SICs which did not occur in the two-county area were not developed. When an industry had more than one SIC assigned to it, the SIC with the highest score was used. All sites that had one or more designated SICs were used to develop the final list of 1064 sites.

The most significant task encountered in the use of the data collected was the compilation of the list of sites that met the criteria discussed above. These sites included both currently active and inactive or abandoned sites. Disposal areas and sites of generation also were included.

The most difficult data to find were the inactive or abandoned sites of both disposers and generators. This kind of information generally is not readily available from most information sources. Closed or abandoned disposal areas often are not recorded. Records dating back *HO* to 50 years frequently had been lost, if they ever existed at all. Generators have often moved from one location to another, sometimes repeatedly. For the purposes of this project, it was important to determine, wherever possible, the location and the duration of each activity at each site. Some sites had several different types of activities during different time periods, all potentially hazardous.

Generator File

One very useful source of generator information was the Illinois Environmental Protection Agency (IEPA) generator file. The file contained names, addresses, SICs, and some site characteristics. Of the data used to compile the preliminary list of sites, some 18 percent came from the generator file. About 11 percent of the sites in the final revised list appeared in the generator file.

Table 2. SICs Included in the Hazardous Waste Activity Master File and Potential Hazard Rating Based on SICs

Rank	SIC	Industry or Service
10	0711	Soil Preparation Services
*	0721	Crop Planting, Cultivating, and Protection Services
	0843	Extraction of Pine Gum
	0849	Gathering of Forest Products not elsewhere classified
	0851	Forestry Service
	1011	Mining Iron Ore
4	1021	Mining Copper Ore
	1031	Mining Lead and Zinc Ores
	1041	Mining Gold Ore
	1044	Mining Silver Ore
	1051	Mining Bauxite and other Aluminum Ores
	1061	Mining Ferroalloy, except Vanadium
	1092	Mining Mercury Ores
	1094	Mining Uranium, Radium, Vanadium Ores
	1099	Mining Metal Ores not elsewhere classified
	1311	Crude Petroleum and Natural Gas Extraction
	1321	Natural Gas Liquids Extraction
4	1381	Drilling Oil and Gas Wells
	1389	Oil and Gas Field Services not elsewhere classified
	1411	Quarrying Dimension Stone
	1422	Quarrying Crushed and Broken Limestone
	1429	Quarrying Crushed and Broken Stone, not elsewhere classified
	1453	Mining Fire Clay
	1454	Mining Fuller's Earth
	1455	Mining Kaolin and Ball Clay
	1459	Mining Clay, Ceramic, and Refractory Minerals not elsewhere classified
	1472	Mining Barite
	1477	Mining Sulfur
	1479	Chemical and Fertilizer Mining not elsewhere classified
4	1521	General Contractors, Single family houses
	1611	Highway and Street Construction, except Elevated Highways
	2261	Finishers of Broad Woven Fabrics of Cotton
	2262	Finishers of Broad Woven Fabrics of Man-made Fiber and Silk
	2269	Finishers of Textiles not elsewhere classified
	2295	Coated Fabrics, not Rubberized
5	2431	Millwork
5	2435	Hardwood Veneer and Plywood
	2436	Softwood Veneer and Plywood
4	2439	Structural Wood Members, not elsewhere classified
10	2491	Wood Preserving
	2492	Particle Board

* Unrated groups have been considered hazardous by state and federal definitions, but were not considered in this study because they do not occur in the study area.

Table 2. Continued

7	2511	Wood Household Furniture, except upholstered
	2514	Metal Household Furniture
5	2541	Wood Partitions, Shelving, Lockers, and Store Fixtures
7	2542	Metal Partitions, Shelving, Lockers, and Office and Store Fixtures
	2611	Pulp Mills
5	2621	Paper Mills, except Building Paper Mills
5	2631	Paperboard Mills
7	2641	Paper Coating and Glazing
	2642	Envelopes
	2643	Bags, except Textile Bags
5	2645	Die-cut Paper and Paperboard and Cardboard
6	2649	Converted Paper and Paperboard Products not elsewhere classified
9	2661	Building Paper and Building Board Mills
8	2711	Newspapers: Publishing and Printing
8	2721	Periodicals: Publishing, Publishing and Printing
8	2732	Book Printing
12	2751	Commercial Printing, Letterpress and Screen
12	2752	Commercial Printing, Lithographic
10	2753	Engraving and Plate Printing
12	2754	Commercial Printing, Gravure
	2761	Manifold Business Forms
	2771	Greeting Card Publishing
9	2782	Blankbooks, Looseleaf Binders and Devices
9	2789	Bookbinders and Related Work
9	2793	Photoengraving
	2794	Electrotyping and Stereotyping
8	2795	Lithographic Platemaking and Related Services
12	2812	Alkalines and Chlorine
8	2813	Industrial Gases
12	2816	Inorganic Pigments
10	2819	Industrial Inorganic Chemicals, not elsewhere classified
12	2821	Plastic Materials, Synthetic Resins, and Non-vulcanizable elastomers
	2822	Synthetic Rubber (Vulcanizable Elastomers)
6	2823	Cellulosic Man-made Fibers
	2824	Synthetic Organic Fibers, except Cellulosic
	2831	Biological Products
10	2833	Medicinal Chemicals and Botanical Products
12	2834	Pharmaceutical Preparations
	2841	Soap and Other Detergents, except Specialty Cleaners
12	2842	Specialty Cleaning, Polishing, and Sanitation Preparations
	2843	Surface Active Agents, Finishing Agents, Sulfonated Oils and Assistants
8	2844	Perfumes, Cosmetics, and Other Toilet Preparations
10	2851	Paints, Varnishes, Lacquers, Enamels, and Allied Products
9	2861	Gum and Wood Chemicals
12	2865	Cyclic (Coal Tar) Crudes, and Cyclic Intermediates, Dyes, and Organic Pigments (Lakes and Toners)

Table 2. Continued

12	2869	Industrial Organic Chemicals, not elsewhere classified
10	2873	Nitrogenous Fertilizers
10	2874	Phosphatic Fertilizers
7	2875	Fertilizers, Mixing Only
12	2879	Pesticides and Agricultural Chemicals, not elsewhere classified
8	2891	Adhesives and Sealants
9	2892	Explosives
10	2893	Printing Ink •
9	2895	Carbon Black
10	2899	Chemicals and Chemicals Preparations, not elsewhere classified
9	2911	Petroleum Refining
10	2951	Paving Mixtures and Blocks
11	2952	Asphalt Felts and Coatings
7	2992	Lubricating Oils and Greases
10	2999	Products of Petroleum and Coal, not elsewhere classified
8	3011	Tires and Inner Tubes
8	3021	Rubber and Plastics Footwear
8	3031	Reclaimed Rubber
12	3041	Rubber and Plastics Hose and Belting
12	3069	Fabricated Rubber Products, not elsewhere classified
7	3079	Miscellaneous Plastic Products
12	3111	Leather Tanning and Finishing
9	3211	Flat Glass
12	3229	Pressed and Blown Glass and Glassware, not elsewhere classified
7	3259	Structural Clay Products, not elsewhere classified
8	3261	Vitreous China Plumbing Fixtures, and China and Earthenware Fixtures and Bathroom Accessories
11	3269	Pottery Products, not elsewhere classified
4	3271	Concrete Block and Brick
5	3272	Concrete Products, Except Block and Brick
4	3273	Ready-mix Concrete
4	3281	Cut Stone and Stone Products
3	3293	Gaskets, Packing and Sealing Devices
7	3295	Minerals and Earths, Ground or Otherwise Treated
4	3299	Nonmetallic Mineral Products, not elsewhere classified
11	3312	Blast Furnaces(Including Coke Ovens)Steel Works and Rolling Mills
8	3315	Steel Wire Drawing and Steel Nails and Spikes
8	3317	Steel Pipe and Tubes
8	3321	Gray Iron Foundries
8	3322	Malleable Iron Foundries
8	3324	Steel Investment Foundries
8	3325	Steel Foundries, not elsewhere classified —
5	3351	Rolling, Drawing and Extruding of Nonferrous Metals, except copper and aluminum
8	3356	Rolling, Drawing and Extruding of Copper
8	3357	Drawing and Insulating of Nonferrous Wire
10	3361	Aluminum Foundries (casting)
10	3362	Brass, Bronze, Copper, Copper Base Alloy Foundries (casting)
11	3369	Nonferrous Foundries (casting), not elsewhere classifed

Table 2. Continued

9	3398	Metal Heat Treating
11	3399	Primary Metal Products, not elsewhere classified
8	3411	Metal Cans
8	3412	Metal Shipping Barrels, Drums, Kegs and Pails
8	3421	Cutlery
8	3423	Hand and Edge Tools, Except Machine Tools and Hand Saws
8	3425	Hand Saws and Saw Blades'
8	3429	Hardware, not elsewhere classified
10	3432	Plumbing Fixture Fittings and Trim (Brass Goods)
8	3433	Heating Equipment, Except Electric and Warm Air Ovens
12	3441	Fabricated Structural Metal
10	3442	Metal Doors, Sash, Frames, Molding, and Trim
10	3443	Fabricated Plate Work (Boiler Shops)
9	3444	Sheet Metal Work
10	3451	Screw Machine Products
10	3452	Bolts, Nuts, Screws, Rivets, and Washers
10	3462	Iron and Steel Forgings
10	3463	Nonferrous Forgings
8	3465	Automotive Stampings
8	3469	Metal Stampings,not elsewhere classified
12	3471	Electroplating, Plating, Polishing, Anodizing and Coloring
12	3479	Coating, Engraving, and Allied Services, not elsewhere classified
12	3482	Small Arms Ammunition
12	3489	Ordinance and Accessories, not elsewhere classified
12	3493	Steel Springs, Except Wire
11	3494	Valves abd Pipe Fittings, Except Plumbers Brass Goods
12	3496	Miscellaneous Fabricated Wire Products
11	3497	Metal Foil and Leaf
12	3499	Fabricated Metal Products, not elsewhere classified
12	3511	Steam, Gas, and Hydraulic Turbines and Turbine Generator Set Units
12	3523	Farm Machinery and Equipment
11	3524	Garden Tractors and Lawn and Garden Equipment
12	3531	Construction Machinery and Equipment
11	3534	Elevators and Moving Stairways
12	3537	Industrial Trucks, Tractors, Trailers, and Stockers
12	3541	Machine Tools, Metal Cutting Type
12	3542	Machine Tools, Metal Forming Type
10	3544	Special Dies, Tools, Die Sets, Jigs, Fixtures, Industrial Molds
10	3545	Machine Tool Accessories and Measuring Devices
9	3546	Power Driven Hand Tools
12	3549	Metal Working Machinery, not elsewhere classified
11	3551	Food Products Machinery
11	3552	Textile Machinery
10	3553	Woodworking Machinery
10	3554	Paper Industries Machinery
9	3555	Printing Trades Machinery and Equipment
8	3559	Special Industry Machinery not elsewhere classified
9	3561	Pumps and Pumping Equipment
9	3563	Air and Gas Compressors

Table 2. Continued

9	3564	Blowers and Exhaust and Ventilation Fans
9	3565	Industrial Patterns
12	3566	Speed Changers, Industrial High Speed Drives, and Gears
11	3567	Industrial Process Furnaces and Ovens
10	3568	Mechanical Power Transmission Equipment not elsewhere classified
10	3569	General Industrial Machinery and Equipment not elsewhere classified
8	3574	Calculating and Accounting Machines, except Electronic Computing Equipment
9	3576	Scales and Balances, except Laboratory
9	3579	Office Machines not elsewhere classified
9	3581	Automatic Merchandising Machines
9	3582	Commercial Laundry, Dry Cleaning, and Pressing Machines
10	3585	Air Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment
10	3589	Service Industries Machines not elsewhere classified
9	3592	Carburetors, Pistons, Piston rings, and Valves
12	3599	Machinery, Except Electrical, not elsewhere classified
9	3621	Motors and Generators
12	3622	Industrial Controls
9	3623	Welding Apparatus, Electric
10	3629	Electrical Industrial Apparatus, not elsewhere classified
9	3635	Household Vacuum Cleaners
11	3639	Household Appliances, not elsewhere classified
12	3643	Current-carrying Wiring Devices
12	3648	Lighting Equipment, not elsewhere classified
10	3651	Radio and TV receiving sets, except communication types
9	3652	Phonograph Records and Pre-recorded Magnetic Tapes
10	3662	Radio, TV transmitting, signal and detection equip and apparatus
12	3674	Semi-conductors and related devices
12	3677	Electronic coils, transformers and other inducers
12	3679	Electronic components, not elsewhere classified
10	3691	Storage Batteries
8	3694	Electrical Equip for internal combustion engines
12	3699	Elec Machinery, Equip and Supplies, not elsewhere classified
	3721	Aircraft
	3724	Aircraft Engines and Engine Parts
12	3728	Aircraft Parts and Auxiliary Equipment not elsewhere classified
	3732	Boat Building and Repairing
12	3743	Railroad Equipment
12	3751	Motorcycles, Bicycles, and Parts
	3761	Guided Missiles and Space Vehicles
	3764	Guided Missiles and Space Vehicle Propulsion Units and Propulsion Unit Parts
12	3769	Guided Missiles and Space Vehicle Parts and Auxiliary Equipment not elsewhere classified
	3792	Travel Trailers and Campers
	3795	Tanks and Tank Components
12	3799	Transportation Equipment not elsewhere classified

Table 2. Concluded

10	3823	Industrial Instruments for Measurement, Display and Control of Process Variables; and Related Products
12	3861	Photographic Equipment and Supplies
11	3911	Jewelry, Precious Metals
	3914	Silverware, Plated Ware, and Stainless Steel Ware
	3951	Pens, Mechanical Pencils, and Parts
10	3953	Marking Devices
	3955	Carbon Paper and Inked Ribbons
9	3964	Buttons
	3996	Linoleum, Asphalted-Felt-Base, and Other Hard Surface Floor Coverings not elsewhere classified
10	3999	Miscellaneous Manufacturing Industries, not elsewhere classified
	4011	Railroad, Line-Haul Operating
12	4212	Local Trucking without Storage
12	4214	Local Trucking with Storage
	4226	Special Warehousing and Storage not elsewhere classified
11	4911	Electric Services
	4931	Electric and Other Services Combined
	4932	Gas and Other Services Combined
11	4952	Sewerage Systems
11	4953	Refuse Systems
11	5093	Scrap and Waste Materials
12	5161	Chemicals and Allied Products - Wholesale
11	5171	Petroleum Bulk Stations and Terminals
12	5191	Farm Supplies - Wholesale
9	5199	Nondurable Goods, not elsewhere classified
	5983	Retail Fuel Oil Dealers
11	5984	Liquified Petroleum Gas(Bottled Gas) Dealers
10	7216	Dry Cleaning Plants, except Rug Cleaning
	7217	Carpet and Upholstery Cleaning
8	7218	Industrial Launderers
	7332	Blueprinting and Photocopying Services
4	7333	Commercial Photography, Art, and Graphics
12	7342	Disinfecting and Exterminating Services
11	7391	Research and Development Laboratories
12	7395	Photofinishing Laboratories
	7397	Commercial Testing Laboratories
4	7399	Business Services, not elsewhere classified
	7534	Tire Retreading and Repair Shops
7	7692	Welding Repair
	8221	Colleges, Universities, and Professional Schools
	8222	Junior Colleges and Technical Institutes
7	9511	Air and Water Resource and Solid Waste Management
	9711	National Security (Armed Forces)

Disposers Inventory

The disposers inventory file also was obtained from the IEPA. It contained location, ownership, activity status, and some waste-type and site information. For the two counties studied, 29 percent of the preliminary sites and 11 percent of the companies in the final list appeared in the disposal inventory file.

GCA Consultant Report

Another large source of data from the IEPA was the GCA consultants report.7 An accompanying data tape listed names, addresses, owner information, some waste-type data, and up to 6 SICs for some sites. Multiple SICs provide a profile of the activities at the site at the time of the report. Ninety percent of the preliminary sites and 57 percent of the sites on the final list were on the GCA list.

RCRA-CERCLA

The National Technical Information Service was the source of the Resource Conservation and Recovery Act (RCRA) report and the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), also known as "Superfund" information.

The RCRA file was very valuable as it contained the "RCRA hazardous waste stream codes" which designate waste types and chemical compounds. The RCRA codes were correlated with SICs in Factor I of the ranking scheme. It also contained site names and addresses. The tape contained no county names and no SICs. Therefore, data for the two counties had to be sorted by zip codes and city or village names. Company names and SICs were correlated at a later point, after additional data sources were used. RCRA data also provided some information concerning the waste management procedures used at reporting sites. However, only 4 percent of the preliminary site compilation were RCRA reporters and 8 percent of the final list were RCRA reporters.

Superfund information for the two counties of interest contributed less than 1 percent of the sites in both the preliminary and final list. However, this is not surprising since the file contained only those hazardous material storage, treatment or disposal sites which had been identified nationally by June 1981.

Industrial Manufacturers Directory

The Industrial Manufacturers Directory volumes for 1920 to 1981 were a significant source of information for companies which no longer exist and for the duration of operation of both active and inactive companies. The volumes were reviewed for all locations within the two-county area.

Industries were considered on the basis of their activity types. If the activities included hazardous waste, they were added to the list, and the year of the volume in which it was found was noted. The duration of each site activity was bracketed by the absence of company listings before and after its appearance in the directory volume. Twenty-five percent of the final tally of sites were listed in the Industrial Manufacturers Directories.

City Directories

A city directory for the Rockford metropolitan area was published for almost every year for the last 90 to 100 years. This valuable resource lists the occupant of every street and lot in the metropolitan area in alphabetical and numerical order. Another section of the directory lists all businesses by categories in a "yellow pages" format. By searching both sections for each year of the period covered by the study, it was possible to document the locations and moves of activities as well as their duration. In addition, the "yellow pages" section provided information on sites of activities in the categories of interest which was not obtainable from all of the other data sources. The Rockford Chamber of Commerce provided several recent volumes of the directories for our use. The rest were located in the University of Illinois library.

Water Supply Data-Census Information

Census information and data from the State Water Survey's water use files permitted calculation of populations potentially impacted by each well. The census data were broken down by political units while the water use data were organized by geographic units. Therefore, hand calculation of population figures was necessary.

Planning Commissions

The Rockford-Winnebago County Planning Commission collected data and published a 1982 report on possible active and inactive dump sites in Winnebago County with locations and comments.27 This report was a valuable source for cross-referencing and original data on disposers which otherwise would not have been found.

Others

The other sources of data given in the list at the beginning of this section (Table 1) were used to supplement and/or verify previously gathered information.

DESCRIPTION OF RATING SCHEME

Numerous groundwater pollution or hazardous waste ranking schemes have been developed. However, these schemes usually are site specific and require more data than those available for regional planning type prioritization studies. Several schemes have been reviewed: LeGrand,18 National Center for Ground Water Research,19 Cherry,20 and U.S. Environmental Protection Agency.21 Application of these types of evaluation approaches requires input of many site-specific factors that entail extensive preliminary investigation. These methods also are expensive and do not address the population at risk.

The scheme developed for this study is a screening tool designed to identify and prioritize potential problem areas. The focus of the system is the assessment of hazardous waste activities' "threat to human health via groundwater." The determination of threat to human health is considered most important in initial planning.[22] The assessment is based on the evaluation of several factors: 1) the identification and location of past and present generators and disposers of hazardous waste, 2) the health hazards presented by individual constituents of hazardous waste streams, 3) current water use patterns and the resulting groundwater capture zones, and 4) aquifer susceptibility.

Figure 11 shows the ranking scheme developed for this project. The ranking scheme is divided into four factors: I - Health risk of waste and handling mode; II - population at risk; III - proximity of waste activity to public water supply wells or potable aquifer; and IV - aquifer susceptibility. Factors I, II, and III were assigned possible scores from 0 to 100. Factor IV was assigned a possible score of 0 to 50. The site total score was normalized to 100 by summing the factor scores and dividing by 3.5.

Factor I - Health risk and handling

There were three possible cases to be examined in Factor I: active industrial sites; active landfills; and abandoned industrial sites, landfills, dumps or spills. Each site was to be evaluated in terms of 1) the quantity of waste handled, 2) the recorded management of hazardous waste, and 3) the potential hazard of the waste. These considerations were assigned 0 to 10 points (tables 3 and 4), 0 to 10 points (tables 5, 6, and 7), and 0 to 80 points, respectively.

For the active industrial and landfill sites, the quantity of waste handled was scored according to Table 3. for abandoned sites, the quantity of waste handled was scored as shown in Table 4. Table 5 shows the management scores for hazardous waste active industrial sites. Active landfill management scores were determined as shown in Table 6, and the known historical management of abandoned sites was scored as shown in Table 7.

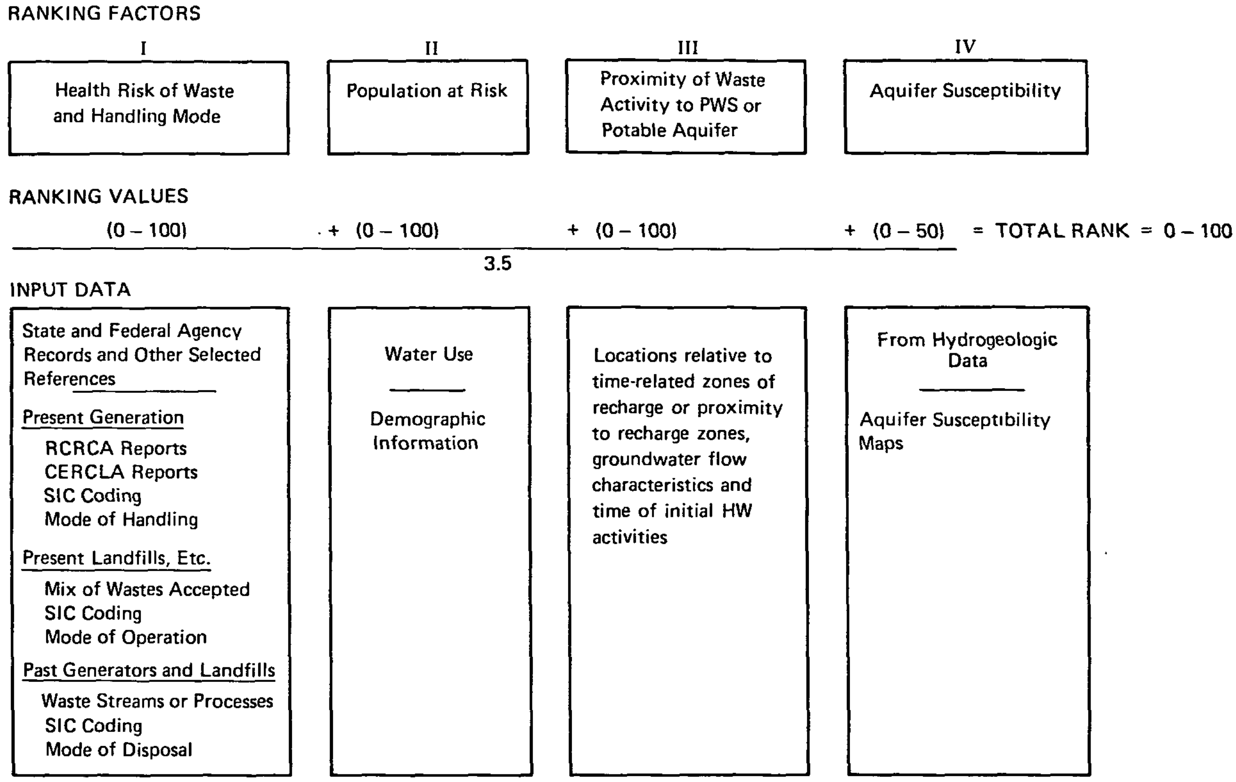


Figure 11. Schematic diagram of ranking factors, values, and input data

Table 3. Rating Scores for Quantity of Hazardous Waste Handled by Active Sites Annually (0-10 pts)

Rating	Quantity (tons/year)
0	<0.1
1	>0.1 and <1.0
2	1-5
3	6-10
4	11-25
5	26-100
6	100-500
7	501-1000
8	>1,000
9	>10,000
10	>50,000

Table 4. Rating Scores for Quantity of Hazardous Waste Handled by Abandoned Industrial Sites, Landfills, Dumps, or Spills (0-10 pts)

Rating	Total Quantity of Wastes Handled (use tons and cubic yards interchangeably)
0	(only used if it is known that no HW activity occurred)
2	<100,000 tons
4	>100,000 tons but <250,000 tons
6	>250,000 tons but <500,000 tons
8	>500,000 tons but <1,000,000 tons
10	>1,000,000 tons; or unknown quantity

Table 5. Rating Scores for Hazardous Waste Management of Active Industrial Sites (0-10 pts)

Rating	Principal On-site Storage or Disposal Method
0	Incineration
2	Secure Containers
4	Treatment/Discharge
6	Land Application
8	Landfill
10	Surface Impoundments

Table 6. Rating Scores for Hazardous Waste Management of Active Landfill Sites (0-10 pts)

Rating	Operational History
0	No Violations whatsoever; operated up to best expectations.
2	No Violations; generally well operated.
4	No Violations of a serious nature; generally well operated.
6	Some Violations of a serious nature; history doubtful
8	Selected Violations of a serious nature; past history unknown.
10	History of Serious Violations; essentially uncontrolled for periods of time.

Table 7. Known Historical Hazardous Waste Management of Abandoned Sites (0-10 pts) (If known, use rating system; otherwise assign a rating of 10)

Rating	Operational History
0	Controlled Operation; solely municipal wastes involved.
2	Controlled Operation; predominantly municipal wastes involved.
4	Controlled Operation; municipal and industrial wastes involved.
6	Uncontrolled Operation; municipal and industrial wastes involved.
8	Uncontrolled Operation; predominantly industrial wastes involved.
10	Uncontrolled Operation; wastes of all types probably present.

The third portion of Factor I relates to the potential hazard of the waste types. Among the characteristics to be considered were the material's solubility, its mobility and persistence, its reactivity with other constituents, and its toxicity, carcinogenicity, or mutagenicity. Similar waste component ranking procedures have been evaluated by numerous investigators.[23,24]

For the purposes of this study the scheme developed by ICF, Inc.[25] was used. Most other approaches rely on the use of fundamental chemical or toxicological data on individual components of a particular waste stream. Then, they presume that a suite of components make up a large portion of the dissolved material present, and may assign an average ranking based on the major components to the waste stream. These approaches demand reliable information on the characteristics of the waste as well as concentrations of individual waste components. Unfortunately, this type of data was not available for the vast majority of hazardous waste generators in the two-county area. Waste stream identifications were limited to generic categorizations of the physical nature of the waste, sometimes with a subjective modifier indicative of the major waste components. For example, waste oil denoted oil or oil/water mixture from food processing as well as crankcase oil re-refining with no indication of the type of oil or contaminants. Obviously, these generic categories of waste streams were insufficient to objectively rank individual waste streams from specific generators. The situation is not unique to Illinois by any means.

ICF, Inc., under contract with the USEPA Office of Solid Waste, developed a ranking of potential hazard in groundwater for 140 priority pollutants.[25] They then analyzed a large body of detailed data on specific components in RCRA-coded waste streams. The RCRA codes for various waste streams include: D codes - nonlisted wastes denoted by ignitability, corrosivity, reactivity, or toxicity; F codes - hazardous wastes from nonspecific sources; K codes - hazardous wastes from specific sources; and P or U codes - chemicals manufactured/formulated for commercial or manufacturing use. With the detailed information on specific components of RCRA-coded waste streams, it was then possible to rate the waste streams based on principal components. The chief drawbacks of this methodology stem from the variability of waste streams from some processes in time and the fact that segregation of waste streams from large disposers is not a general practice. These drawbacks limited the results of the ICF study to planning purposes. However, it was the only option open to the investigators.

A slight modification of this approach was used in this study to establish a basis for assessing the hazard potential of waste streams generated in the two-county area. The waste streams which were RCRA-listed in our original set of sites of hazardous waste handling activities were given a rank based on the ICF methodology. This subset (8 percent) of the total generators, handlers, and disposers was used to assign hazard potential ratings to the other sites. Given the lack of hard data on specific components of the waste streams, a conservative approach was followed. Thus, the highest ranked RCRA-waste stream for a particular generator was assigned to that generator's Standard Industrial Codes (SICs). All other activities were rated relative to the ranked SIC most similar to the specific industrial or service activity.

This procedure, establishing correspondence between RCRA-listed waste stream rankings and SIC activities, was inexact. As the work progressed, however, it became clear that the highly ranked SIC groups in our final list corresponded quite well with the major hazardous waste generating SICs on a national basis.[1] In particular, these SICs are in major groups 34 (Fabricating metal products, except machinery and transportation equipment, 28 (Chemicals and allied product), 33 (Primary metals industries), and 36 (Electrical and electronic machinery, equipment, and supplies), in decreasing order of importance. Furthermore, these major groups in Illinois together with groups 35 (Machinery except electrical) and 37 (Transportation equipment) have RCRA-ranked waste components in over 70 percent of the waste streams generated. On this basis, it is presumed that the magnitude of the hazard ratings particularly for high-volume generators has not been grossly underestimated.

Factor II - Population at risk

In Factor II, it first must be determined if the site of interest potentially could affect a public water supply well. Calculated time-related capture zones for each public water supply well were extended outward to 75 years for this purpose. The methods for calculating time related capture zones are presented later (see page 39). Once the location of the site being evaluated was determined with respect to the public water supply capture zones the scores were assigned as shown in Table 8.

Table 8. Population at Risk—Rating Scores for Sites within Public Water Supply Well Capture Zones (Scale 0-100 pts)

Rating	Total Population Served by PWS
0	
10	60
20	500
40	1,000
60	2,000
80	5,000
100	10,000

Most public water supply distribution systems are hydraulically connected to all wells supplying water to the system. Therefore, the entire population served by the public water supply was considered to be at risk if one well potentially could be impacted. The population served was obtained from data collected by Kirk et al.17

For sites not within the defined time-related capture zones of public water supply wells, population-at-risk scores were determined as' shown in Table 9.

Table 9. Population at Risk—Rating Scores for Sites Outside Public Water Supply Capture Zones (0-100 pts)

Rating	Population/sq mi
0	<30
10	30
20	250
40	500
60	1,000
80	2,500
100	5,000

The population numbers used as input to Table 9 include only those persons not served by public water supply systems. Private wells tapping shallow sand and gravel and dolomite aquifers are used for domestic water supply purposes in the study area. Population data from the 1980 U. ST Census Bureau[14] was used for this portion of the rating scheme.

Factor III - Proximity of waste to PWS or potential aquifer

Factor III relates the age of the activity to its location within a public water supply capture zone, or the relative density of hazardous waste activity if it is not within a public water supply well capture zone. Within the zones, higher priority is placed on those sites which have existed longer than or equal to the time it would take groundwater to flow to the well. Outside the zones, higher scores were assigned to sites in dense areas of hazardous waste activities. Higher densities of hazardous waste activities offer greater potential for mixing of wastes, mobilization, and possible production of even more toxic by-products. Tables 10 and 11 show the rating scores for the two possible cases in Factor III.

Table 10. Age-Related Rating Scores for Sites within PWS Time-Related Capture Zones (0-100 pts)
(Compare duration of activity with time-related recharge zones)

Rating	
0	Age of hazardous waste activity is more than 25 years greater than the capture zone time at the site
25	Age of hazardous waste activity is 10 to 25 years more than the capture zone time at the site
50	Age of hazardous waste activity is 5 to 10 years more than the capture zone time at the site
75	Age of hazardous waste activity is 0 to 5 years more than the capture zone time at the site
100	Age of major hazardous waste activity is equal to or less than the capture zone time at the site

Table 11. Age-Related Rating Scores for Sites outside PWS Time-Related Capture Zones (0-100 pts)

Rating	
0	No sites
25	1 to 8 sites of hazardous waste activity per square mile
50	9 to 16 sites of hazardous waste activity per square mile
75	17 to 21 sites of hazardous waste activity per square mile
100	21 or more sites of hazardous waste activity per square mile

Factor IV- Aquifer susceptibility

The susceptibility of aquifers to surface sources of pollution was determined to be of lesser importance than the population at risk. Therefore, only 50 points were assigned to Factor IV. Detailed surficial geologic mapping by the Illinois State Geologic Survey (ISGS) has been completed for the entire state. Using map stacking techniques the ISGS also has produced aquifer susceptibility maps for Illinois.16,26

Figures 12 and 13 are modified versions of the ISGS aquifer susceptibility maps which show the scores assigned to hazardous waste sites within delineated areas. Lower scores were given to areas where thick sequences of silty clay or till overlie the aquifers of interest. These finer grained materials retard or slow the downward migration of surface sources of pollution. They also may retain certain types of pollutants by filtering, cation exchange, or other mechanisms. Conversely, higher rating scores were applied where thin coarse grain materials will permit rapid downward migration of pollutants with little or no attenuation.

Sample Site Evaluation

To illustrate how the rating scheme just described is applied, consider a generic or sample site located in Section 25.3d, T.45N., R.1E., Winnebago County. The site is an electroplating/metal finishing industry that has been in operation for 25 years. The industry is a RCRA reporter with a primary SIC 3471, and secondary SICs 3398, 3332, and 3333.

Factor I--Health Risk and Waste Handling

The waste streams noted on the RCRA manifests for 1982 were:

Waste Stream		Generic Description
#1	F002	Halogenated solvent and recovery of still bottoms
#2	F006	Electroplating treatment sludge
#3	F019	Metallic sludge low toxicity
#4	F007	Electroplating or Cyanide containing sludge

Factor I ratings were based on the hazard potential of the waste stream (80 points), the quantity of waste (10 points), and the waste management techniques (10 points) for a total of 100 points. Each waste stream was first ranked according to its major hazardous and toxic constituents present or likely to be present at levels above 1000 ppm.

Waste Stream		Components	ICF Rating of Inherent Hazard to GW
#1	F002	Trichloroethylene	9
		Tetrachloroethylene	8

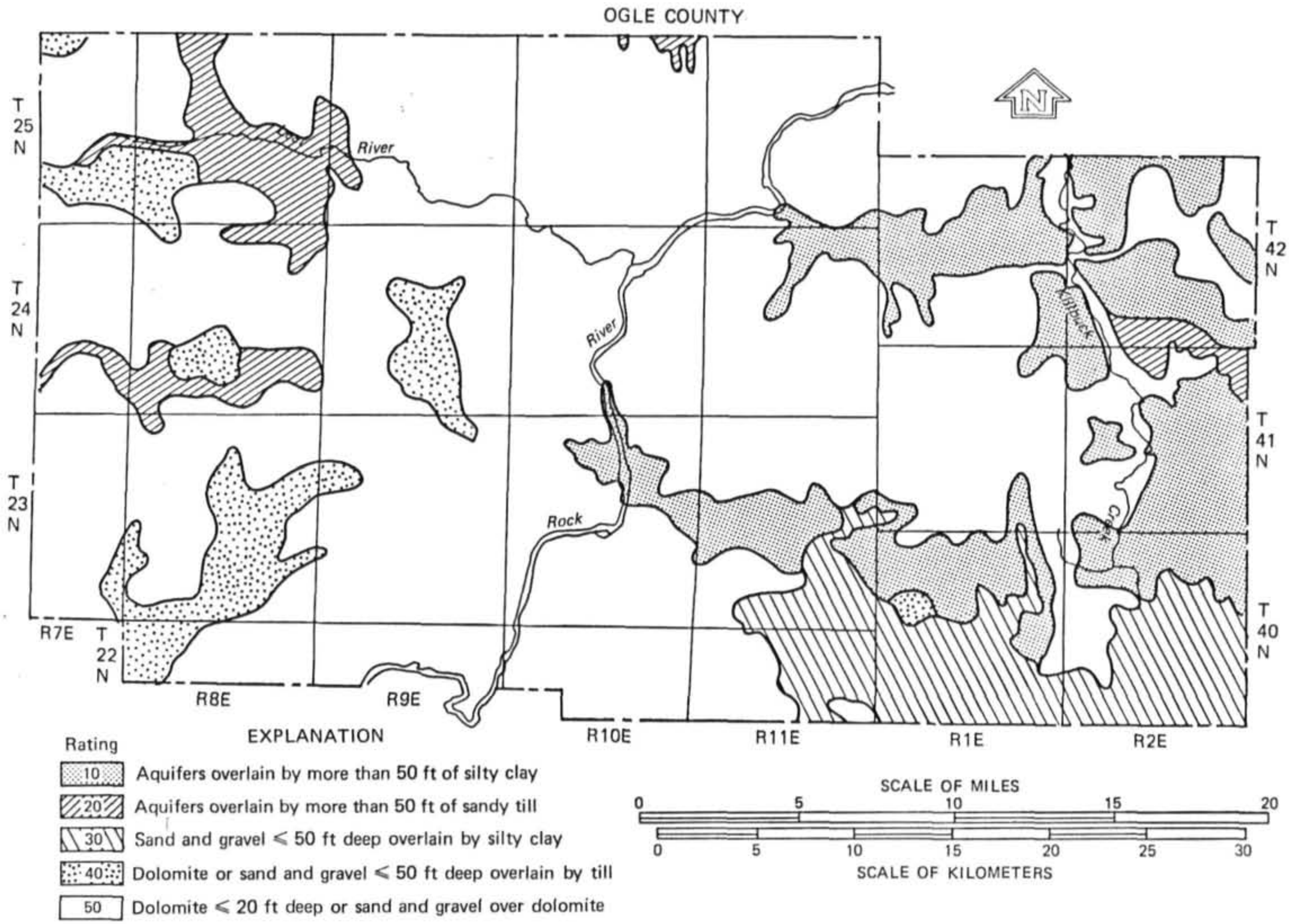


Figure 12. Aquifer susceptibility rankings in Ogle County

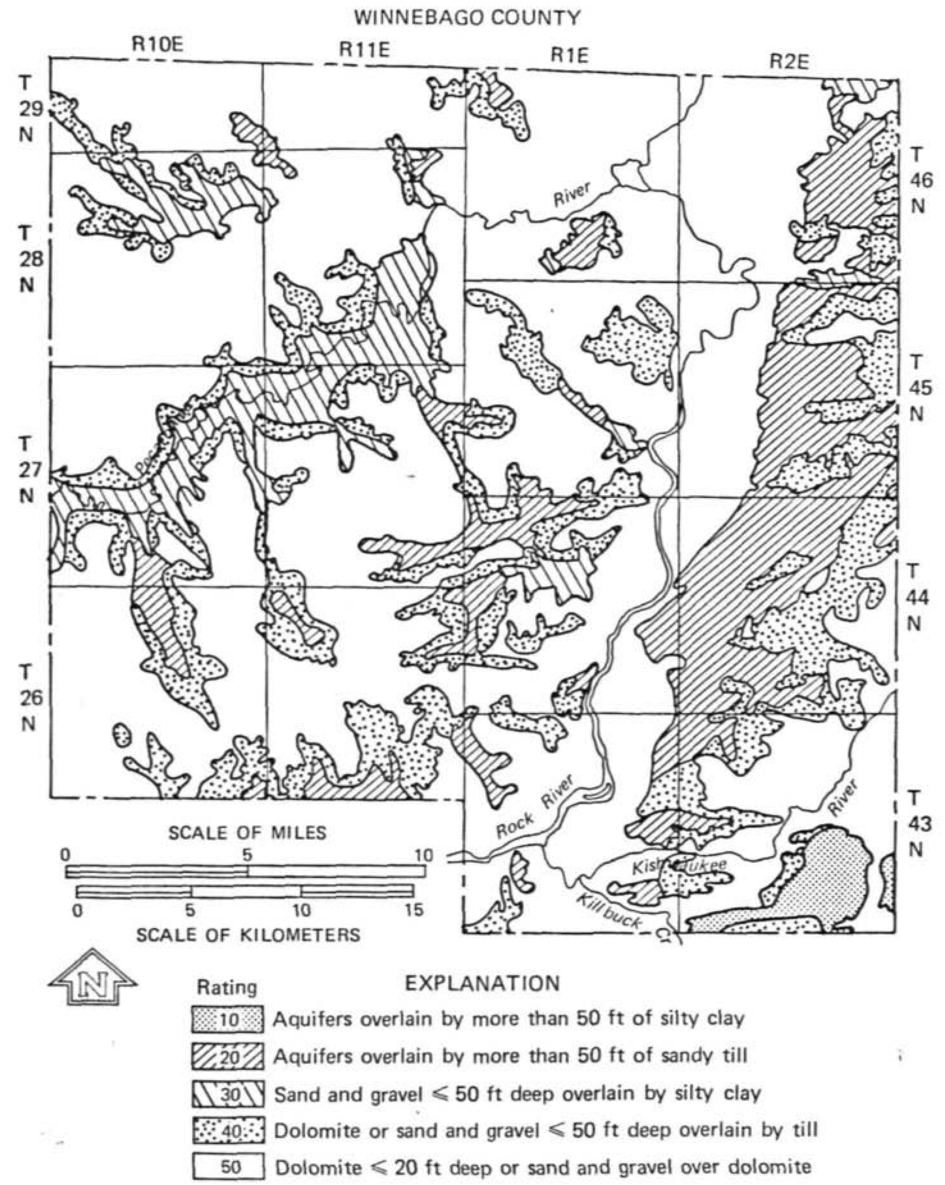


Figure 13. Aquifer susceptibility rankings in Winnebago County

The greatest inherent hazard for the waste stream was 9 on a log scale from 3 to 12. The scale includes factors such as exposure, mobility, toxicity, persistence, mutagenicity, and solubility.

Waste Stream	Components	ICF Rating of Inherent Hazard to GW
#2 F006	Chromium VI	12
	Cyanide	11

The highest inherent hazard was 12.

Waste Stream		Components	ICF Rating of Inherent Hazard to GW
#3	F019	Zinc	6
#4	F007	Cyanide	11

Now all four major waste streams have been rated as follows:

Waste stream		Inherent Hazard to GW
#1	F002	9
#2	F006	12
#3	F019	6
#4	F007	11

The highest hazard rating for this generator's waste streams was 12 on a scale of 3 to 12. Therefore, for this generator and all others with a 3471 SIC in this study, the waste hazard rating is 12. Where there were two or more generators with the same primary SIC and much the same waste output (RCRA streams), the highest common hazard rating was applied to all of them. To arrive at a waste stream potential hazard source, the potential hazard rating of the waste stream was then scaled from 0 to 80 points as follows:

Maximum Inherent Hazard Rating	Waste Stream Potential Hazard Score
3,4,5,6	11
7	23
8	34
9	46
10	57
11	69
12	80

In this case the waste stream potential hazard score was 80.

Since this generator was active, the IEPA and RCRA generator files were consulted to determine the quantity of the waste and the mode of management. In this case (as in most others) the quantity and the mode of management were not known. Therefore the maximum rating was applied to both of the other components of Factor I, 10 points each.

The overall rating for Factor I therefore was the sum of tHe three scores.

Waste Stream Potential Hazard Score	80
Waste Quantity	10
Waste Management	10
Total Score	100

Factor II—Population at Risk

To determine the Factor II scores for this site, its location was plotted on maps containing the time-related capture zones for the public water supply wells in the area of interest. This was to determine if the site could potentially affect a public water supply system. In the case of the selected sample site, it was located within the time-related capture zone of a public water supply well (see Figure 16). The population served by the public water supply system was determined from ISWS water withdrawal data.17 In this case the population served was >10,000. From Table 8, a Factor II score of 100 was obtained.

If the site had not been within the time related capture zone of a public water supply well, the population per square mile at the location of interest would have had to be determined. This would be accomplished by using township population data and subtracting the population served by public water supplies in the township of interest. The remaining population number would be divided by the number of square miles in the township. That value would then be used to obtain a Factor II rating score using Table 9.

Factor III—Proximity to PWS or Aquifer

The sample site was located between the 50- and 75-year time lines on the time-related capture zone for the well that could potentially be impacted. By interpolation, it appeared to lie near the 65-year time line. Since the site was in operation for only 25 years, it theoretically would take another 40 years before the activity at this site could potentially affect the public water supply well. Entering this value into Table 10 yielded a Factor III rating score of 0.

In the case of sites located outside the time-related capture zones of public water supply wells, the proximity of the site to other hazardous waste activities would be considered. The density of hazardous waste sites per square mile would be entered into Table 11 to obtain a Factor III rating score.

Factor IV—Aquifer Susceptibility

The sample site location was plotted on the appropriate aquifer susceptibility map to determine the Factor IV rating score. In this case Figure 13 was used. The site was located in an area where dolomite aquifers less than 20 feet from land surface or sand and gravel overlying a dolomite aquifer was present. This geologic setting had been assigned a rating score of 50.

The total scores for this sample site are:

Factor I	100
Factor II	100
Factor III	0
Factor IV	50
Total Raw Score	250

Normalized total Score = 25/350 = 71.

According to the distribution of scores in the two-county study area, this site was considered a secondary potential risk site. Its potential for affecting the aquifer and large numbers of people was high, but its age and location place it in a secondary rating category. Other sites have similar potential hazard but are of more immediate concern.

TIME-RELATED CAPTURE ZONES

One of the purposes of this study was to determine the risk a hazardous waste generator or disposer would have on human health via groundwater. Time-related capture areas for public water supply wells were calculated to provide a means of incorporating the element of time into the determination of the level of risk. Higher risks are associated with imminent or unavoidable exposure of large populations.

Concepts and Definition

The concept of time-related capture areas can best be explained with the help of Figures 14 and 15. When a well that fully penetrates an aquifer is pumped, a depression in the piezometric or water table surface is formed around the well (Figure 14). The depression has the shape of an inverted cone and defines the area of influence or "capture area" of the well. A pollutant intercepting the cone at some point will proceed along the surface at an ever-increasing velocity toward the well. The increasing velocities are due to steeper hydraulic gradients that are the result of decreasing cross sections through which water must flow before reaching the well. The time it takes for a conservative pollutant to move to a well can be calculated from the flow velocities. Knowledge of the flow directions and velocities forms the foundation for constructing the time-related capture areas.

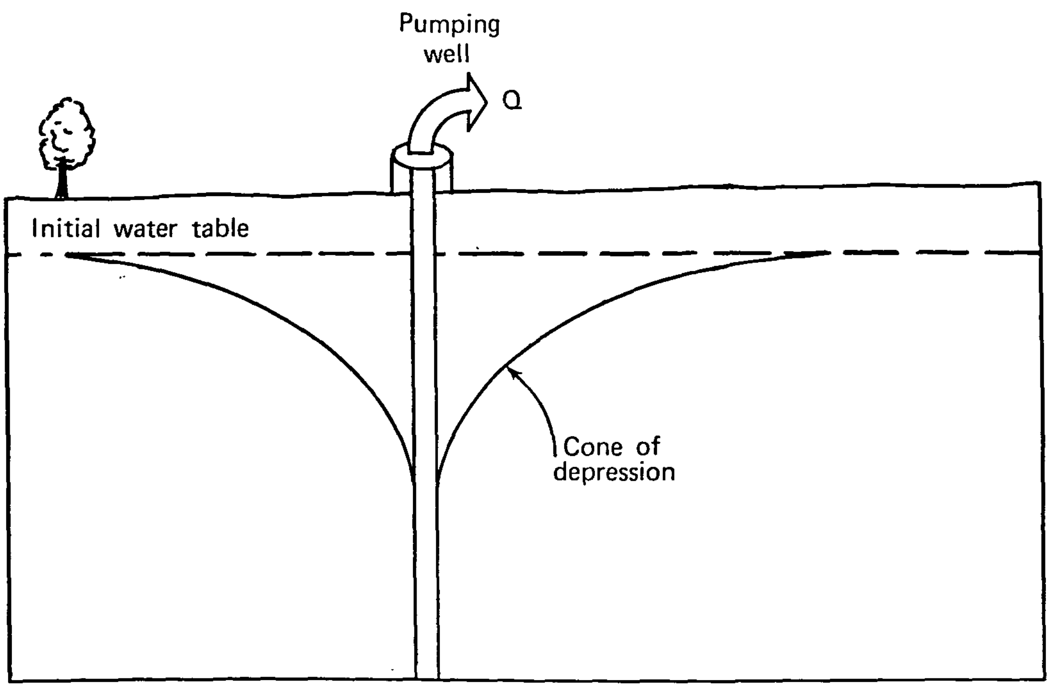


Figure 14. Diagram of the "capture area" of a pumping well

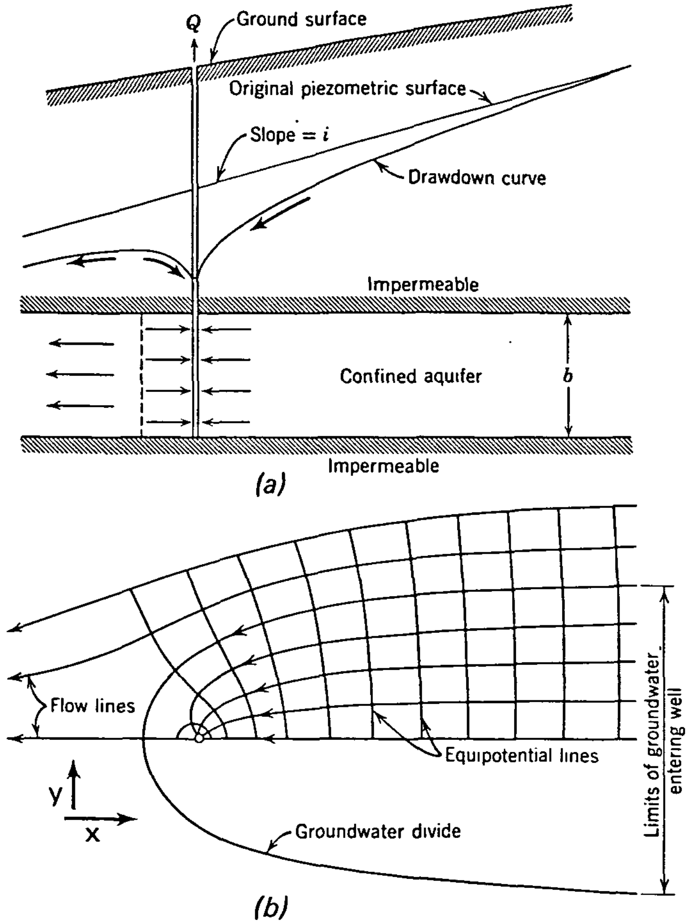


Figure 15. Resulting change of a capture area due to regional flow (after Todd, 1980)[28]

The above discussion assumes negligible effects due to regional flow. In most instances this assumption is not realistic. The effects of regional flow should be taken into account to obtain a more representative picture of actual capture areas and estimates of flow velocities. Under a uniform flow field the circular shape of the capture area is distorted into a parabolic shape with the vertex pointed downgradient (see Figure 15).28 Furthermore, the effects of regional gradients will steepen the slopes upgradient from the well and flatten the slopes downgradient (Figure 15). This results in more rapid flow velocities toward the well on the upgradient side and slower velocities on the downgradient side. The capture area is bounded by a groundwater divide as groundwater inside the boundary is diverted toward the pumping well. Outside the capture area of the well, groundwater continues its path with the regional flow. Time-related capture areas can be defined as: The area from which a pumping well obtains water and for which groundwater travel times are calculated to predict the time required for water to reach the well from points within the capture zone. The calculation and delineation of these areas are invaluable in assessing the risk to human health from hazardous waste sites situated within the capture area. They also could serve as a basis for land use zoning decisions or as a groundwater educational tool.

Determining Flow Velocities

Two important assumptions are made for computing the flow velocities within the capture areas. First, steady-state conditions exist and the size of the capture area will be at a maximum. This provides a "worst case" situation. Second, the flow velocities from which the travel times are computed must be actual flow velocities instead of Darcian bulk velocity. Darcian bulk velocity assumes that flow occurs through the entire cross section of aquifer material without regard to solids and pores. Actually, flow is limited to the interconnected pore space. The variable that describes the interconnection of pore spaces is called effective porosity and is incorporated into the Darcian Bulk Velocity equation to render the actual flow velocity.

$$v = KI/7.48n \quad (1)$$

where: v = velocity of flow in groundwater, fpd
K = hydraulic conductivity, in gpd/sq ft
I = hydraulic gradient, in ft/ft
η = effective porosity, in percent

To calculate actual flow velocities three variables must be known: the hydraulic conductivity (K) of the aquifer, the hydraulic gradients (I) within the capture area, and the effective porosity (η).

Delineation of Time-Related Capture Areas

To this point, the discussion of time-related capture areas has been general. The actual delineation of the capture areas is a difficult process that depends on the aquifer conditions at the well in question. The public water supply wells in the two-county study area are completed either in bedrock or sand and gravel aquifers, each under different aquifer conditions. For the sake of clarity, the following discussion detailing the construction of the related capture areas is separated into two sections.

Deep Sandstone Wells

Figures 9 and 10 show the locations of the deep sandstone wells in the two-county area. The deep sandstone bedrock aquifer underlying the region is, for the most part, under leaky artesian conditions.

Since leaky artesian conditions exist, and the wells were assumed to have been pumped to steady-state conditions, the distance-drawdown curves were constructed using Jacob's Leaky Artesian equation:

$$s = [229QK_o(r/B)]/T \qquad (2)$$

where:

$r/B = r/\sqrt{T/(P'/m')}$

s = drawdown in observation well, in ft

r = distance from pumped well to observation well, in ft

Q = discharge, in gpm

T = coefficient of transmissivity, in gpd/ft

P' = coefficient of vertical permeability of confining bed, in gpd/sq ft

m' = thickness in confining bed through which leakage occurs, in ft

$K_o(r/B)$ = modified Bessel function of the second kind and zero order

Construction of the distance-drawdown curves requires knowing the transmissivity (T) of the aquifer and leakage coefficient (k'/b') of the confining bed. Where pump test data were not available to determine the transmissivity and leakage coefficient, reasonable estimates of the aquifer parameters were selected on the basis of regional values. In the study area, a transmissivity of 20,000 gpd/ft and a value of 0.002 for the leakage coefficient were estimated from values published in earlier reports.[29,30] Standard type-curve fitting procedures as described in Walton[31] were used to construct distance-drawdown curves on log-log paper for different pumpages. From these curves the hydraulic gradients were determined. The drop in head over the distance of one log cycle defined the hydraulic gradient inside the capture areas. The extent of the capture areas was set at distances from the wells where the drawdowns were equal to 1/10 of a foot.

Thus far, the effect of regional flow on the hydraulic gradients has been neglected. To determine the influence of regional flow, comparisons were made between the hydraulic gradients farthest from the wells (but still within the capture areas) and the regional hydraulic gradients. If the regional gradients were the larger of the two, then regional flows were significant and were assumed to affect all gradients within the capture areas. Regional flow gradients were added to the capture area gradients in the upgradient direction and subtracted from them in the downgradient direction.

After the hydraulic gradients were computed, the hydraulic conductivity and effective porosity were applied to determine flow velocities. Hydraulic conductivity values were obtained using the relation T = Kb. The variable b, or saturated thickness of the aquifer, was defined as the length of the open bore hole portion of each well. Saturated thickness traditionally is defined as the thickness of a porous medium that is completely saturated. For this study, redefinition was necessary to eliminate the problem of determining aquifer properties of saturated units above the deep sandstone aquifer. With this redefinition, the hydraulic conductivity values correspond to only that interval of the aquifer over which the well is open to the aquifer system. Hydraulic conductivity values averaged 76.6 gpd/sq ft for the two-county area.

Based on reported ranges of effective porosities for sandstone formations, a conservative approach was taken and a value of 5 percent was used. The selected 5 percent effective porosity value results in slightly higher calculated velocities than normally would be expected in this sandstone aquifer. Since the flow velocity is large, travel times are minimal, and the "worst case" estimate is established.

The actual flow velocities were calculated for selected hydraulic gradient intervals. On the basis of this information, the travel times were computed for each interval, and the total travel times determined for parcels of water beginning at the edge of each capture area and traveling down to each well. Finally, distances to specific time lines (i.e., 5, 10, 20 years) were computed.

Sand and Gravel Wells

The process for constructing the time-related capture areas for sand and gravel wells was somewhat different from that for deep sandstone wells. The major difference results from the limited areal extent of the sand and gravel aquifers in the study area. Figures 7 and 8 delineate the extent of the sand and gravel aquifers for Winnebago and Ogle Counties. The capture areas of sand and gravel wells in this type of geologic setting normally extend beyond the aquifer limits into the adjacent glacial material. Therefore, the area extending from the aquifer boundary to the water table divide was included in the analysis. For the sake of simplicity, the water table divide and the topographic divide were considered coincident.

The approach outlined above was used to obtain the hydraulic gradients by considering the drop in head from the water table divide, to the aquifer boundary and from the aquifer boundary to the well. To accomplish this, the head must be known at the aquifer boundary, the water table boundary, and the well. An algorithm was devised to calculate the head at the aquifer boundary. The heads at the water table boundary and the well were derived from the elevations of water levels in perennial streams near the two points.

To test the validity of the above approach, the Theis and Theim equations were applied for wells with the greatest pumping rates to determine distance-drawdown values and to calculate several hydraulic gradients. Travel time based on these hydraulic gradients were within 21 days of those calculated using the regional gradients. Considering the relatively long travel times involved, the difference was considered insignificant and the more simplistic regional gradient approach was used for calculating flow velocities.

Hydraulic conductivities for the sand and gravel aquifers were obtained from a report by Stanley Consultants.30 All sand and gravel wells in the two-county area but one are located in the Rockford area (the one exception is located in Ogle County; see Figures 9 and 10). The Stanley report[30] characterized the hydraulic conductivities for the Rockford area using data from sand and gravel wells. Values of hydraulic conductivity range from 3000 gpd/sq ft in the northern Rockford area to 1600 gpd/sq ft in the southern portions of Rockford. Data from the Illinois State Water Survey files were used to approximate the conductivity for the sand and gravel aquifer in Ogle County.

Again, a conservative approach was taken in estimating the effective porosity of the sand and gravel aquifer. Based on the range of possible effective porosities for sand and gravel, a value of 15 percent was considered appropriate.

Size, Shape, and Direction of Time-Related Capture Zones

The general shape of time-related capture zones was mentioned briefly at the beginning of the section. Todd[28] analyzed the effects of regional flow on a circular pumping cone. He found that the circular shape is distorted into a parabolic feature. He also was able to mathematically define the boundary of the region producing flow to the well. The expression for the boundary of the region producing inflow is defined as follows:

$$-(y/x) = \tan[(2\pi KbI/Q)y] \qquad 3)$$

where: the rectangular coordinates are as shown in Figure 14 with the origin at the well
K = hydraulic conductivity, in gpd/sq ft
b = aquifer thickness, in ft
I = hydraulic gradient, in ft/ft
Q = pumping rate, in gpm

This mathematical expression was used to delineate the capture areas. Figures 16 through 19 illustrate time-related capture areas for 3 deep sandstone wells and 2 sand and gravel wells in the study area.

The sizes of the capture areas are dependent on the pumping rate and to some extent the regional hydraulic gradient. For example, Figures 16, 17, and 18 depict the capture zones for 3 deep sandstone wells, pumping 866 gpm, 194 gpm, and 239 gpm, respectively. The same aquifer parameters, transmissivity of 20,000 gpd/ft and leakage coefficient of 0.002, were used to construct the distance-drawdown curves for these wells. These curves were used to calculate the hydraulic gradients, which were added to the regional gradient. Then, a hydraulic conductivity of 22 gpd/sq ft and an effective porosity of 5 percent were used to delineate the capture zones for all three wells. The effects of pumping rate on capture area size are obvious when comparing Figures 16 and 17. Larger pumping rates are directly related to larger capture areas. However, the capture area in Figure 18, with the same general parabolic shape, had a somewhat short

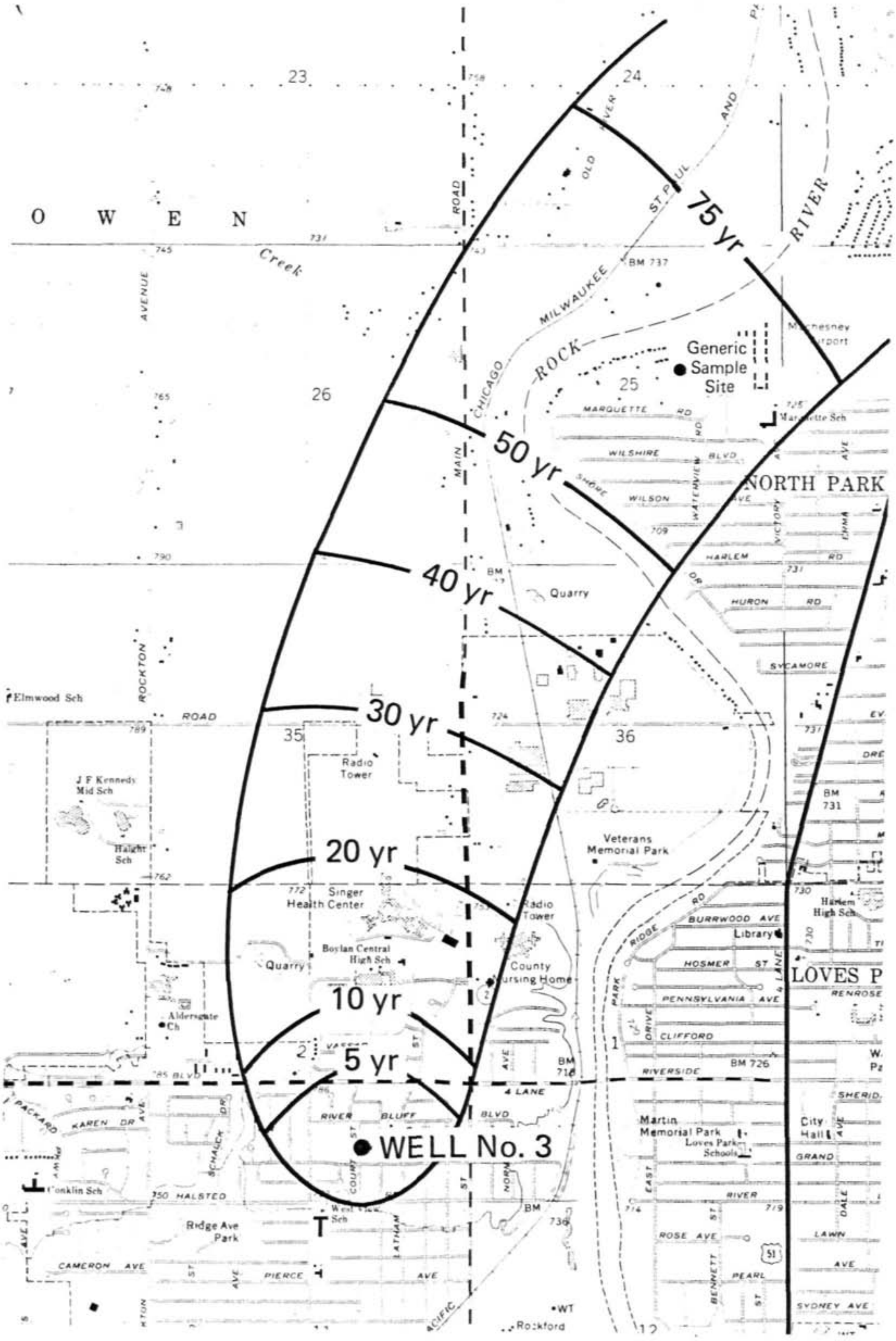


Figure 16. Capture area of a well in the deep sandstone aquifer pumping 866 gpm

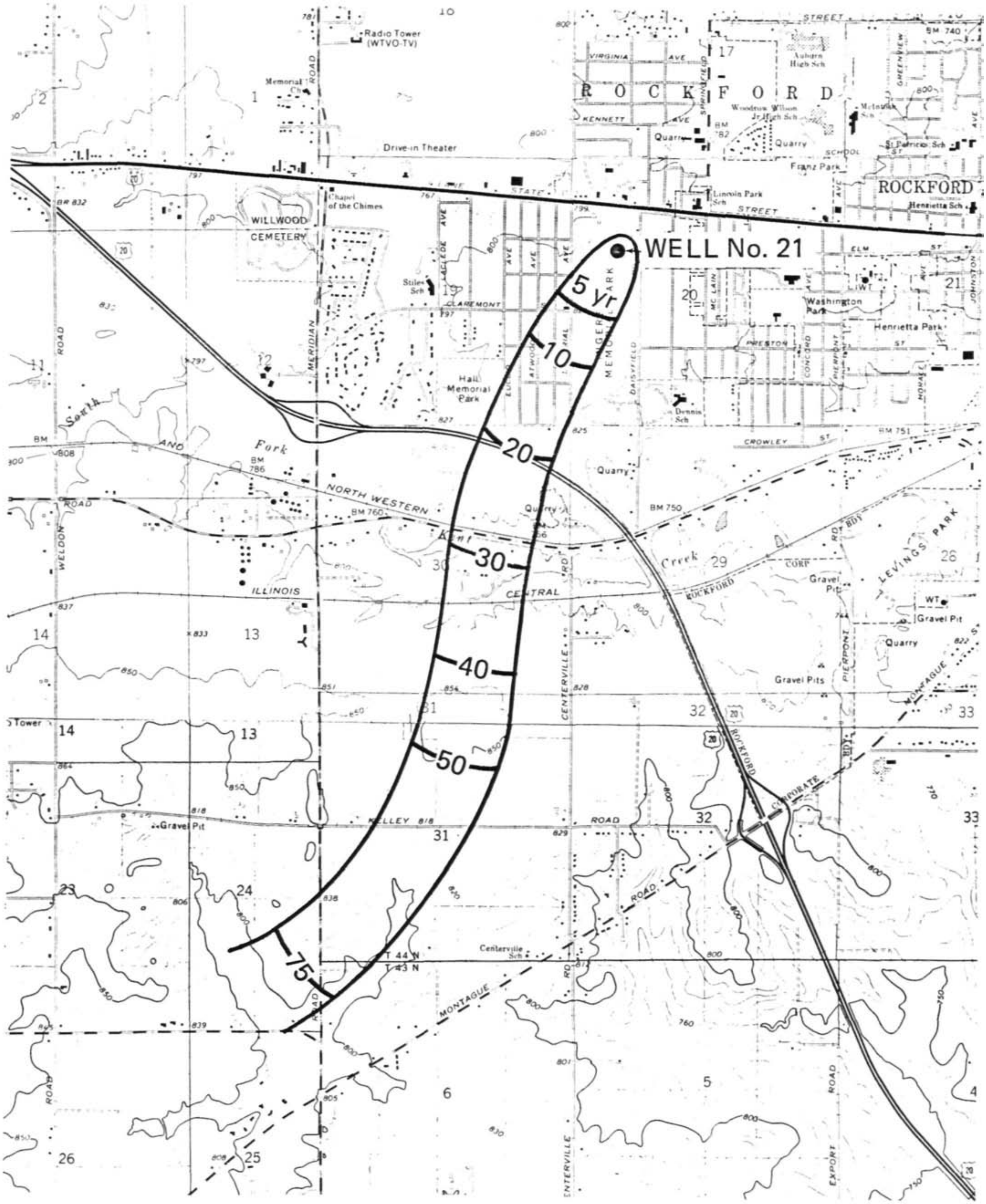


Figure 17. Capture area of a well in the deep sandstone aquifer pumping 194 gpm

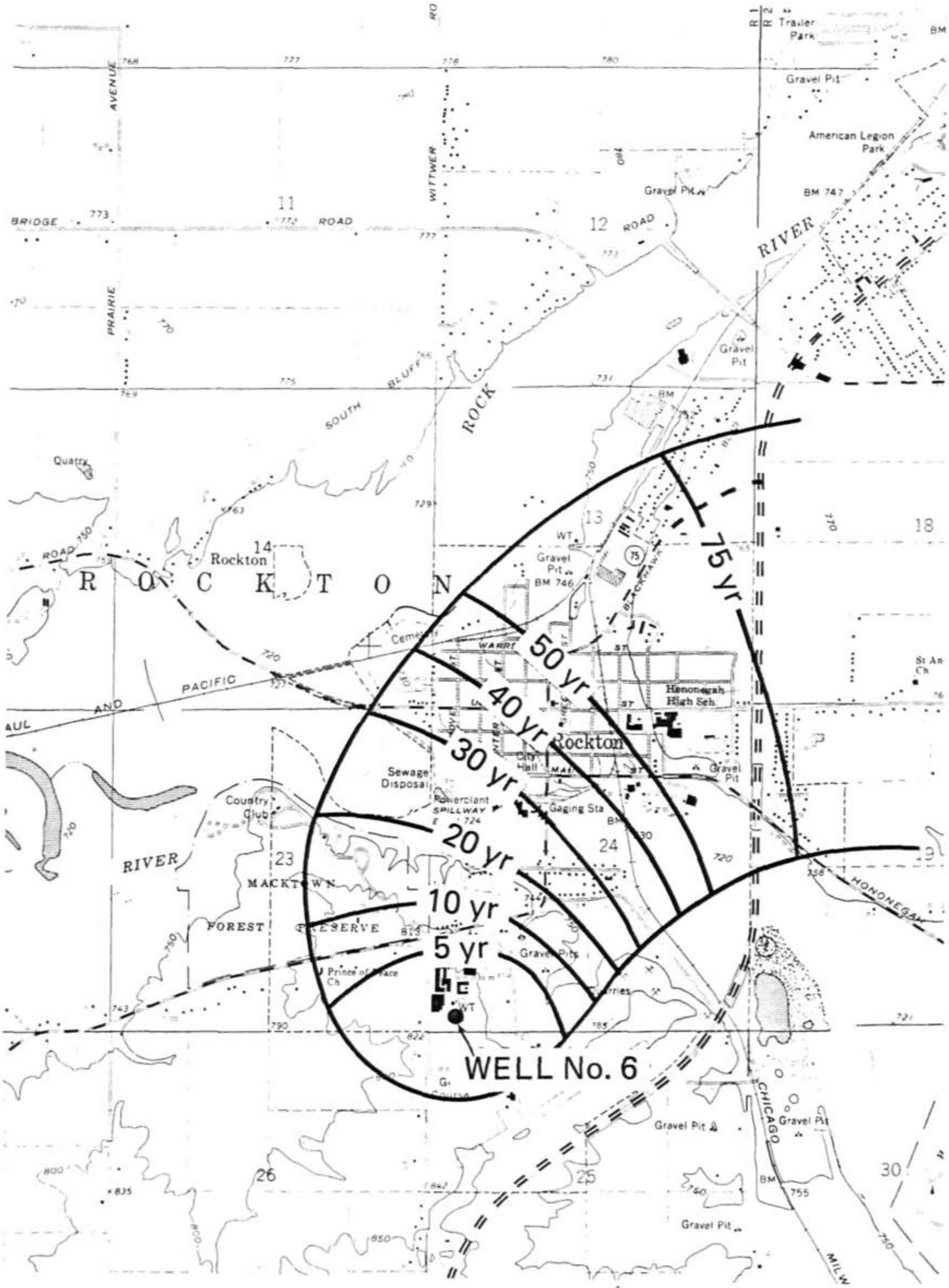


Figure 18. Capture area of a well in the deep sandstone aquifer pumping 239 gpm

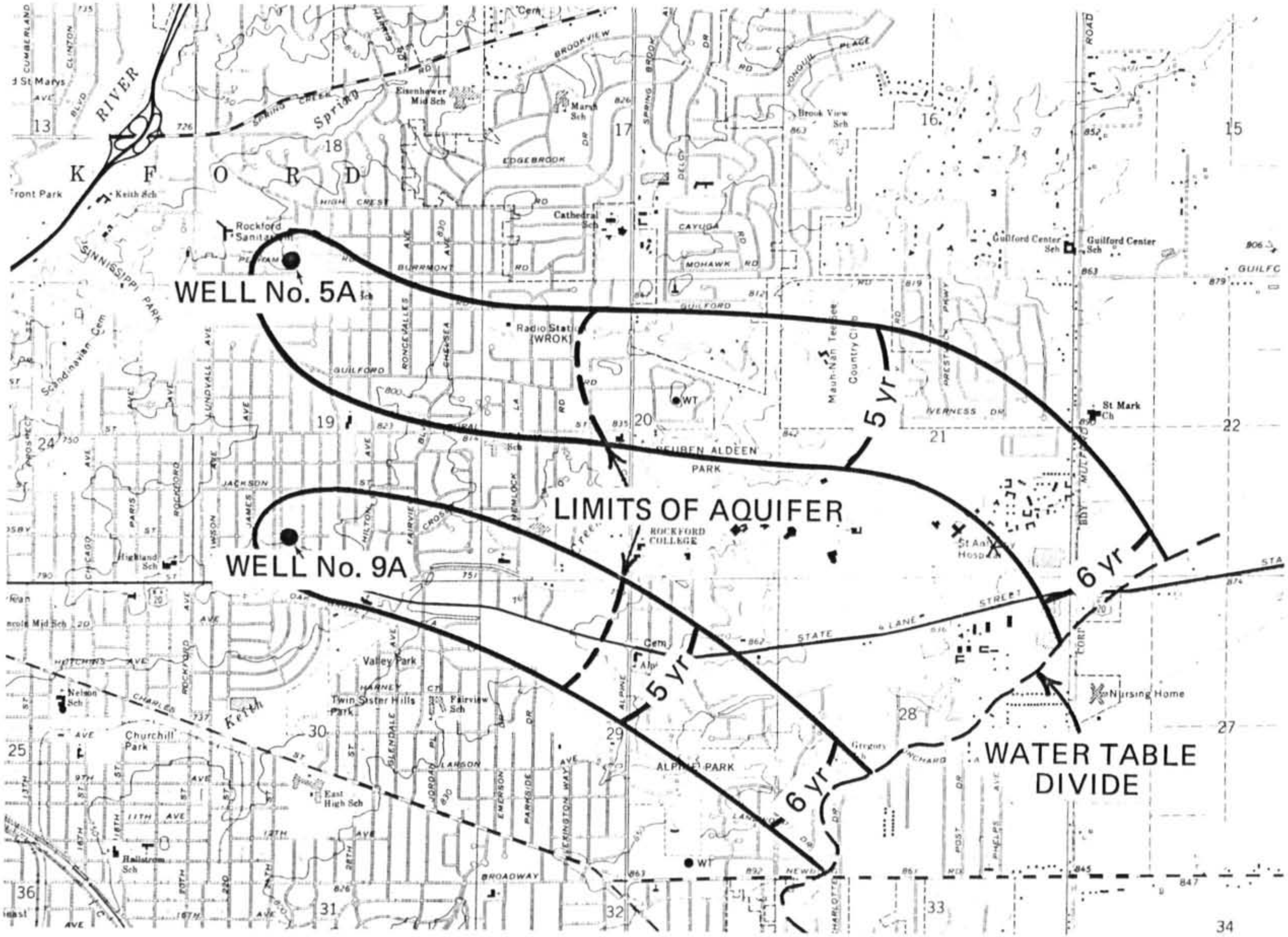


Figure 19. Capture area of two wells finished in the sand and gravel aquifer

and squat appearance compared with the elongated capture areas in Figures 16 and 17. The difference primarily is due to different regional gradients. The capture areas in Figures 16 and 17 are located where regional hydraulic gradients are steep (approximately 0.01 ft/ft). The capture area in Figure 18 is located where regional gradients are relatively flat (approximately 0.002 ft/ft). The differences in distances separating the time demarcations for all three capture areas are the result of pumping-induced hydraulic gradients rather than the regional gradients.

Figure 19 illustrates a time-related capture area for two public water supply wells finished in a sand and gravel aquifer system. Wells 5A and 9A pump 1530 and 875 GPL, respectively. In these cases the time-related capture areas did not extend beyond the 6-year mark. Calculations indicated that water falling close to the water table divide and flowing toward these wells required only 6 years to arrive at the well. In the case of the time-related capture areas for the deep sandstone wells (Figures 16, 17, and 18) no groundwater divides were intercepted and time calculations extended out to 75 years. Theoretically, the capture areas extend until a physical boundary, such as a groundwater divide, is encountered.

The direction and amount of curvature of the capture areas are related to the configuration of the piezometric surface of the aquifer tapped by the well of interest. Published maps32 of the regional piezometric surfaces at a scale of 1 :250,000 were used for determining the curvature and directions of time-related capture areas for deep sandstone wells. Maps detailing the water table surface for the sand and gravel aquifers were not available. Water table surfaces generally are subdued replicas of the land surface topography. In the Rockford region, where most of the sand and gravel wells are located, the topographic slopes generally are gentle_and smooth. Based on topographic information, a contour map of the water table surface was developed for the unconsolidated deposits surrounding the Rockford region. This map was used to determine the direction of the capture areas of the sand and gravel wells.

One important aspect of the time-related capture areas needs to be emphasized. Calculated time-related capture areas merely depict conditions at the time of delineation. If the pumping rate for the well of interest is changed, the shape and time of travel to that well will also change. Furthermore, if regional pumping patterns change in any way, by addition or deletion of wells, the size, shape, and direction of the capture areas also will be altered.

Vertical Infiltration Times

In delineating time-related capture areas, the assumption was made that pollutants have immediate access to the aquifers in question. For the deep sandstone aquifer there were additional factors to be considered.

Stratigraphically, the deep sandstone aquifer is overlain by several bedrock units and the unconsolidated glacial (drift and outwash) materials. The bedrock units immediately above the sandstone aquifer are part of the shallow dolomite aquifer and probably are hydraulically connected to the deeper-lying sandstones. The glacial drift, on the other hand, may act as a retardant of pollutants percolating downward to the bedrock aquifers. Although the glacial outwash (sand and gravel) is not as effective as the glacial drift in retarding pollutants, some retardation will result because of the thickness of the sand and gravel.

To bracket the possible range of times involved in pollution incidents, the estimated times for pollutants to percolate through the overlying glacial materials were added to the time demarcations of the capture areas. Vertical travel times were calculated for each public water supply well based on the type of glacial materials, thickness of the glacial materials, an estimated vertical hydraulic conductivity, an effective porosity, and vertical hydraulic gradient. Published maps16 showing the distribution and thickness of glacial material were used to determine these factors. Vertical hydraulic conductivities were estimated from a report by Walton29 in which he reports the hydraulic conductivities for several different types of glacial materials throughout the state. Effective porosities were estimated on the basis of the type of material penetrated by the well. Finally, the vertical hydraulic gradient was determined by subtracting the elevation of the piezometric surface of the sandstone formations from the elevation of the water table surface. Elevations of the water table surface were derived from the elevation of the water levels in perennial streams near the wells.

An average vertical travel time of 5 years was calculated and added to the time demarcations of the capture areas in Figure 20 to illustrate the range of times that are involved. The horizontal travel times for each time demarcation line is shown in brackets. The unbracketed number includes the vertical travel time.

No vertical travel times were added in the case of sand and gravel wells. In the study area, surface pollutants have immediate access to the sand and gravel aquifers.

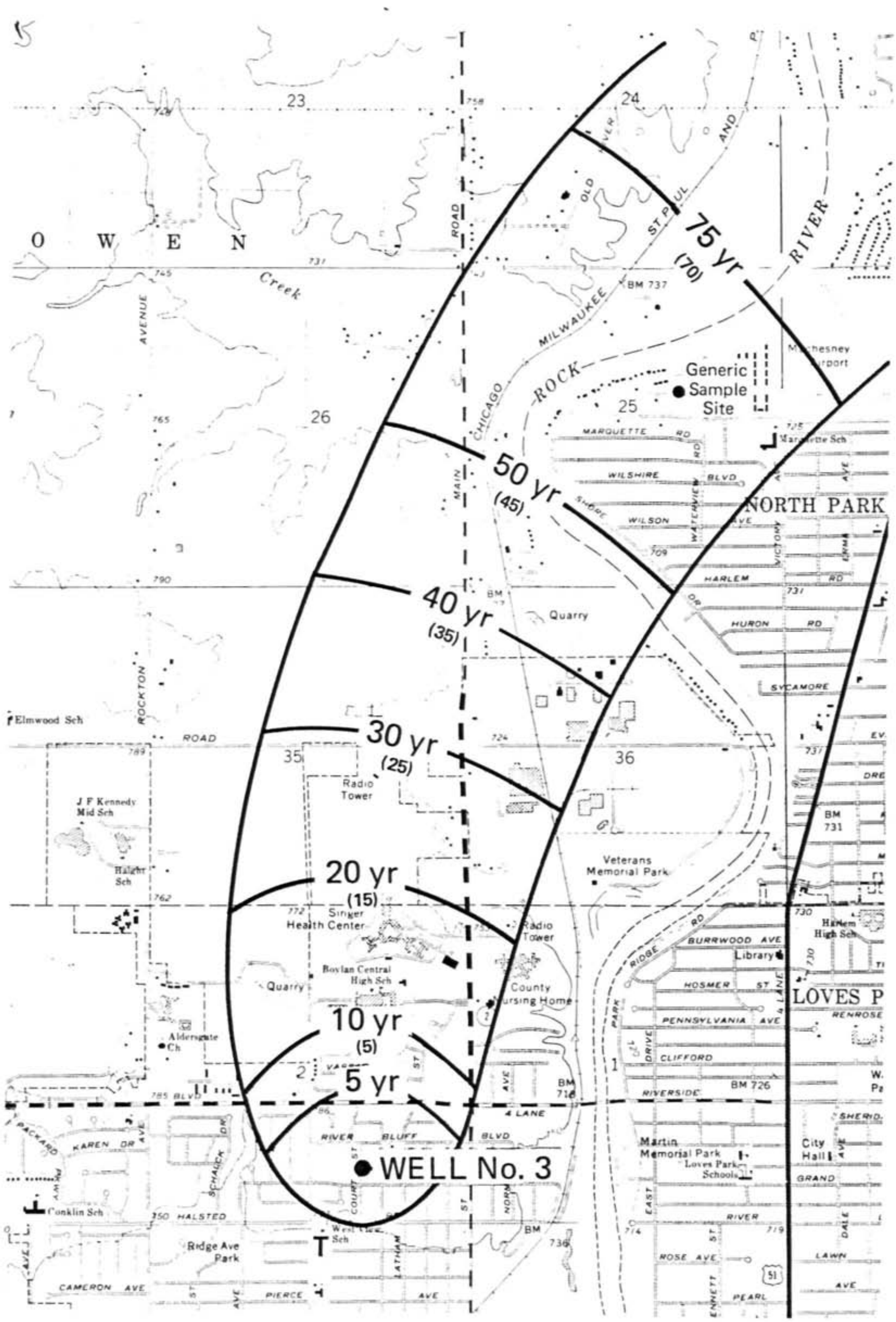


Figure 20 Diagram of a capture area with horizontal travel times (bracketed number) and vertical travel times added (unbracketed number)

SUMMARY OF RESULTS

Figures 21 and 22 illustrate the locations of the hazardous waste activities identified in this study for Ogle and Winnebago Counties, respectively. Figure 23 illustrates the location of those sites identified in the Rockford metropolitan area. A total of 88 and 805 active and 3 and 170 inactive and abandoned sites were identified in Ogle and Winnebago Counties, respectively.

The ranking scheme was applied to all sites resulting in total scores from about 25 to 100. Sites with scores from 0 through 50, approximately 18 percent of the total sites, were classified as low potential risk sites. Sites with scores from 51 through 69, about 30 percent, were classified as moderate potential risk sites. Sites with scores from 70 through 79, about 22 percent, were classified as secondary potential risk sites. Finally, sites with scores from 80 through 100, about 30 percent, were classified as primary potential risk sites. The site scores and locations were plotted and generalized maps of potential "hot spots" or problem areas were prepared (see Figures 24, 25, and 26).

Because of the relatively sparse distribution of hazardous waste sites in Ogle County, only very limited generalization of total rating scores was attempted. A small area on the south side of Polo was designated as a low risk area. Scattered primary and secondary potential risk sites are shown at Byron, Forreston, Oregon, and Rochelle (see Figure 2k).

Figure 25 graphically summarizes the potential risk scores in the rural portions of Winnebago County (this does not include the 4 township area surrounding the City of Rockford). A primary risk area or "hot spot" is located northeast of Rockford and east of Route 51. Secondary risk areas were delineated at Pecatonica, Rockton, South Beloit, and northeast of Rockford. Moderate risk areas are located along Illinois Route 51 and the Rock River and near the confluence of the Rock and Pecatonica Rivers. Other sites with secondary- to low-risk scores are scattered throughout the remainder of the rural portions of Winnebago County (see Figure 25).

Figure 26 graphically summarizes the potential risk scores for the 4 township area surrounding the City of Rockford. Because of the high density of hazardous waste activity sites, the large withdrawals of groundwater (large populations at risk), and other rating factors in the Rockford area, a large potential "hot spot" was delineated within the City of Rockford. Isolated primary site ratings also are scattered around the City of Rockford. The entire area along Route 51 from the northern Rockford city limits to about 2 miles south of Rockford has been delineated as a moderate- or higher-risk area.

Individual site locations, names, and potential risk scores are not presented in this report. Available data on hazardous waste type, composition, and handling practices were not adequate to assess the relative potential hazard between individual sites. However, the rating scores

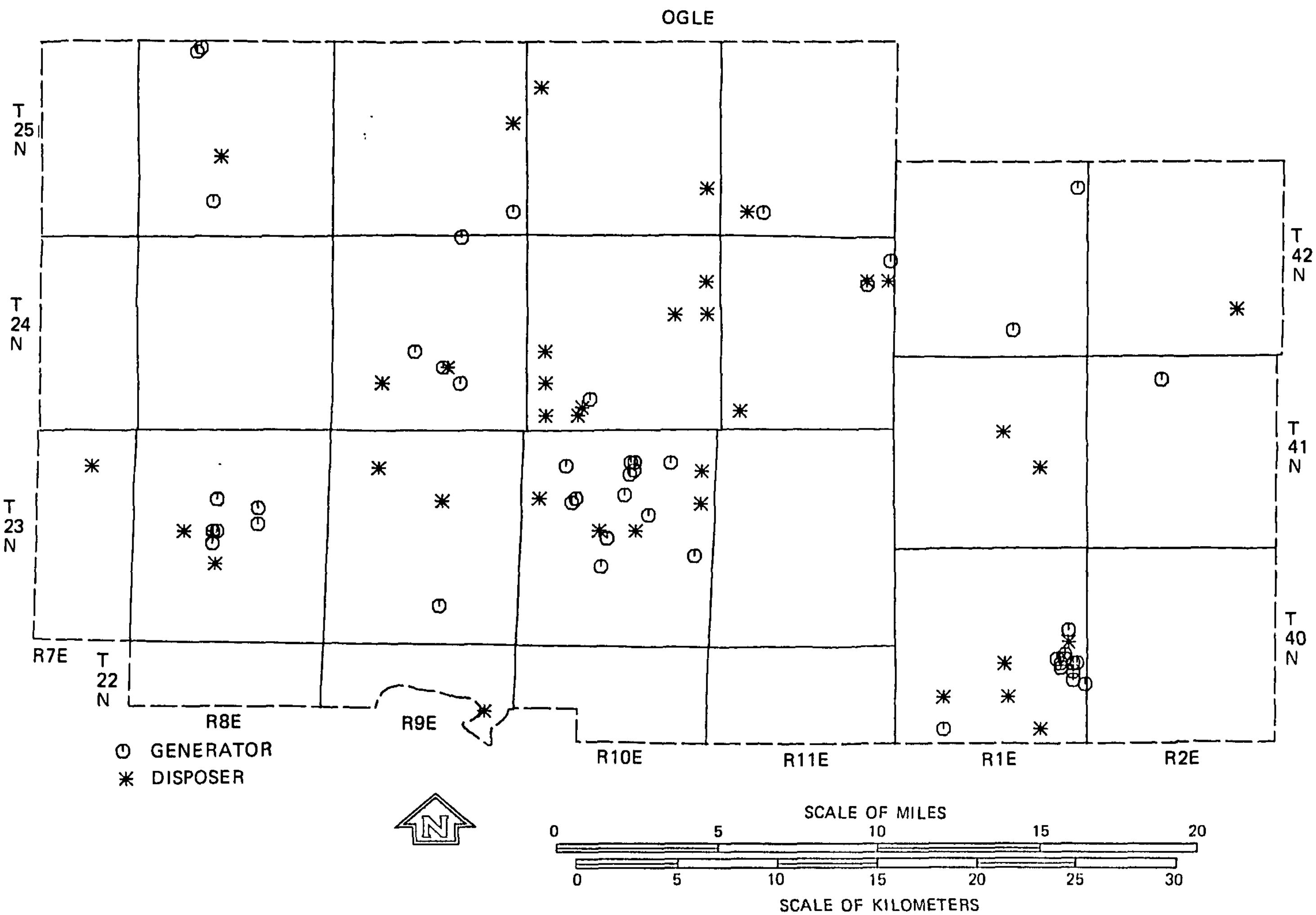


Figure 21. Location of hazardous waste sites in Ogle County

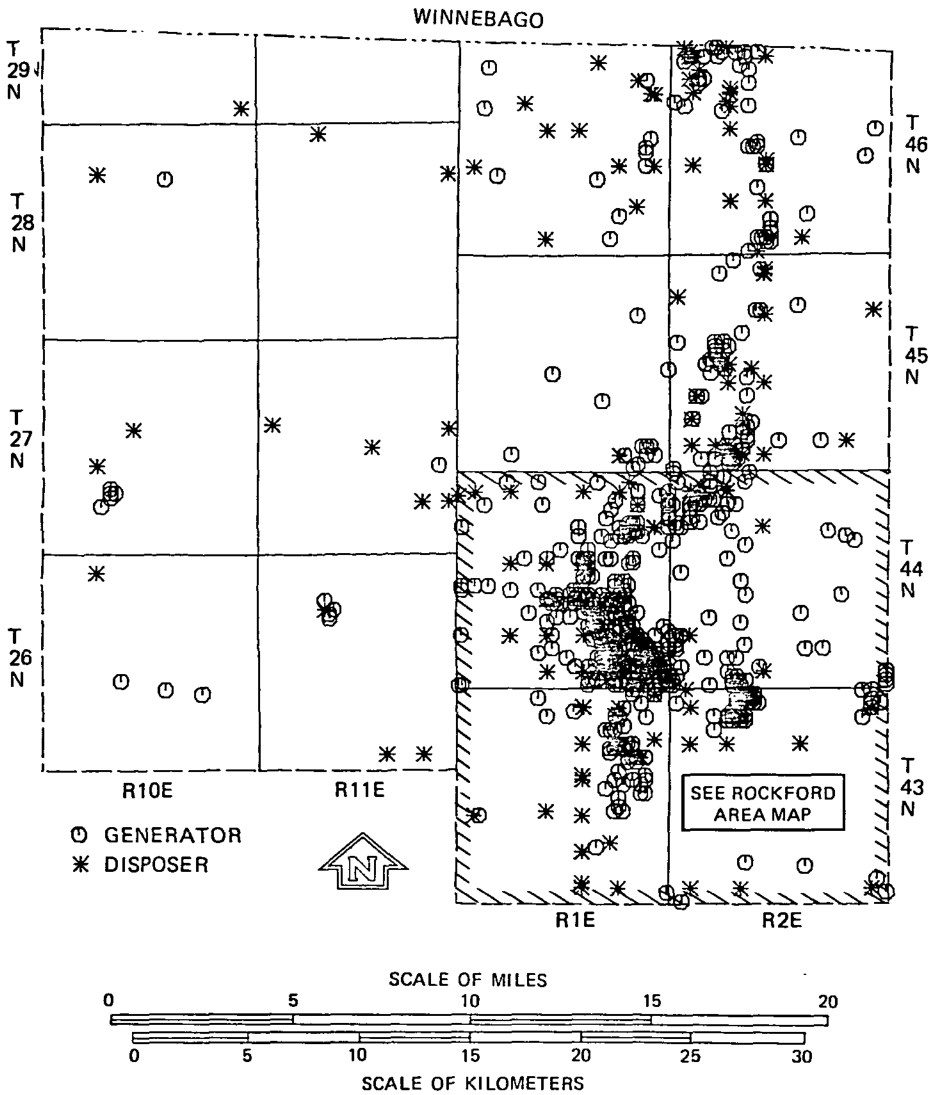


Figure 22. Location of hazardous waste sites in Winnebago County

represent valuable starting points for more intensive studies by regulatory agencies with the mandated powers to obtain detailed data from site operators. Tables containing site information have been forwarded to the Illinois Environmental Protection Agency Division of Land Pollution Control for more detailed site evaluation.

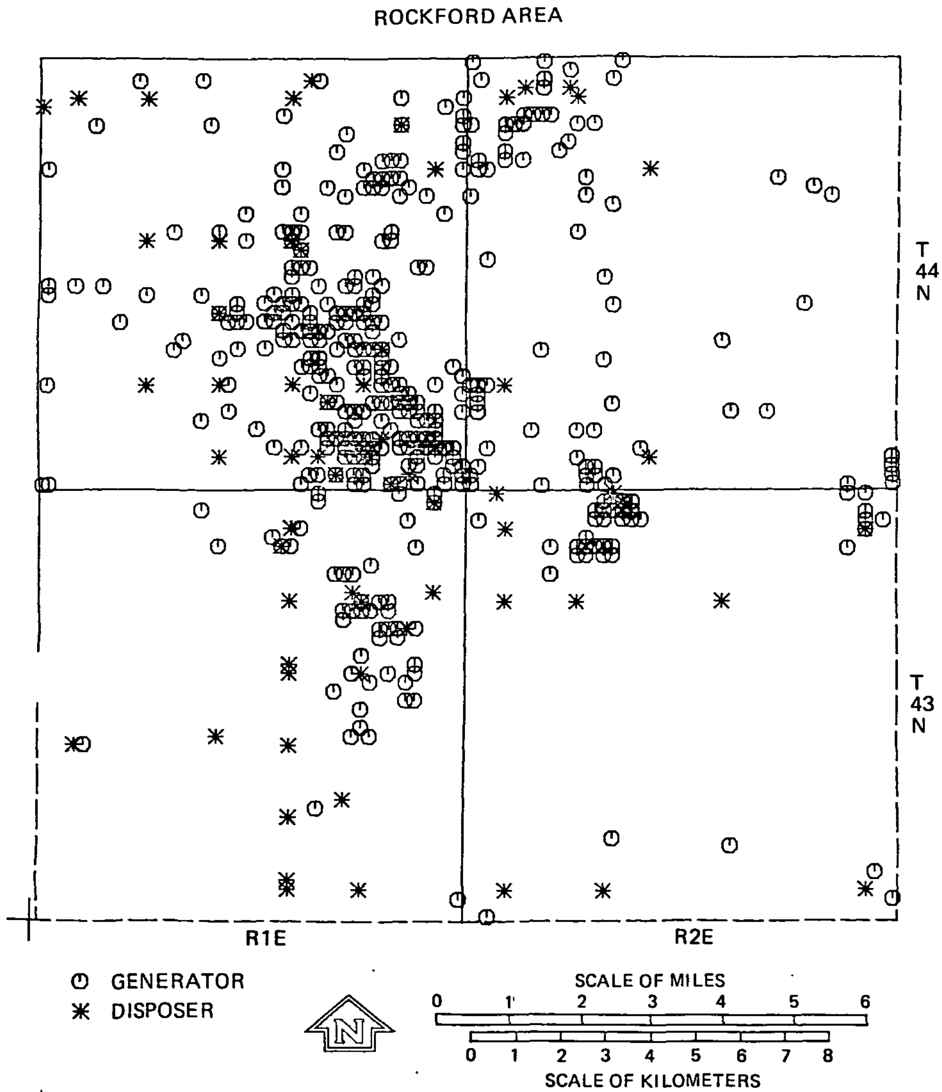


Figure 23. Location of hazardous waste sites in the Rockford metropolitan area

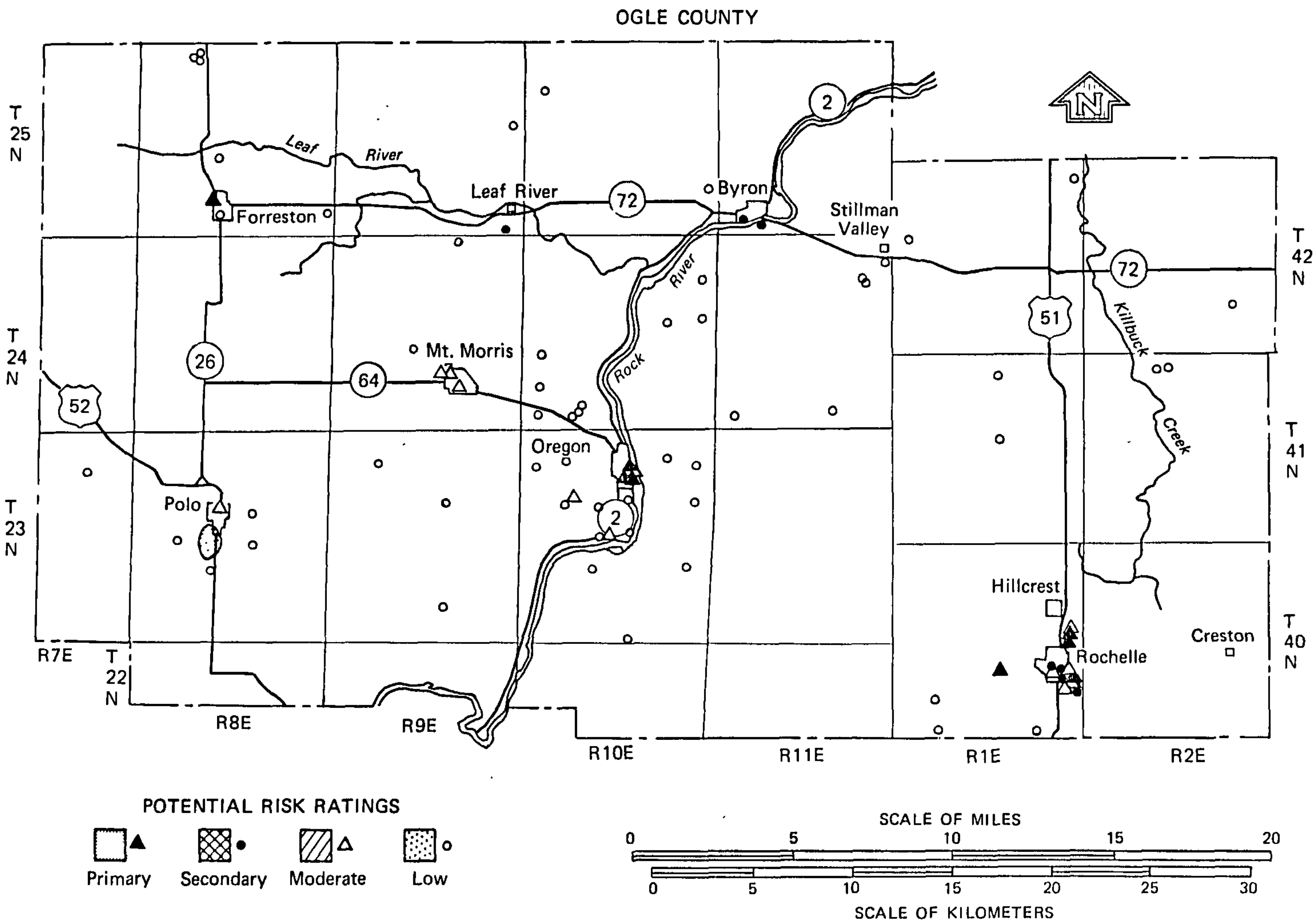


Figure 24. Potential hazardous waste problem areas in Ogle County

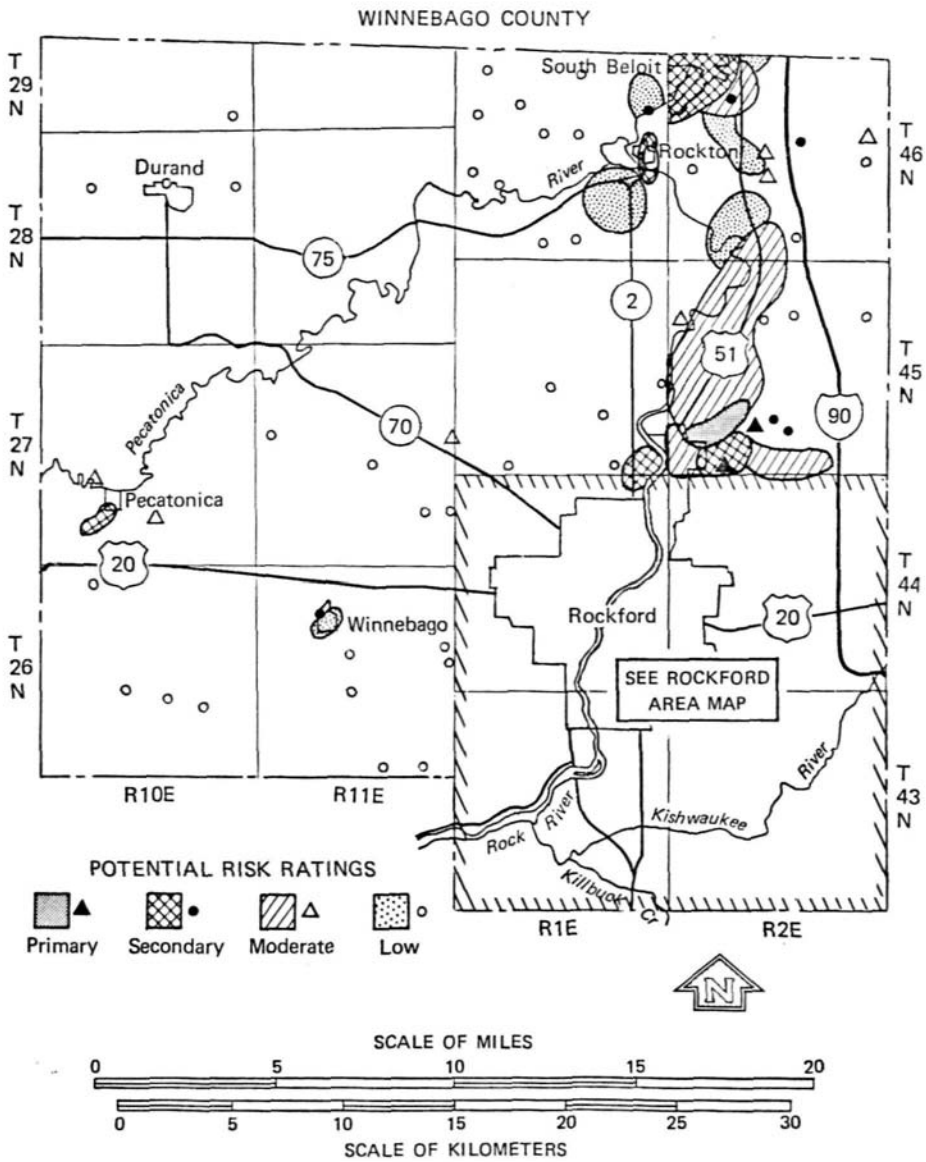


Figure 25. Potential hazardous waste problem areas in Winnebago County

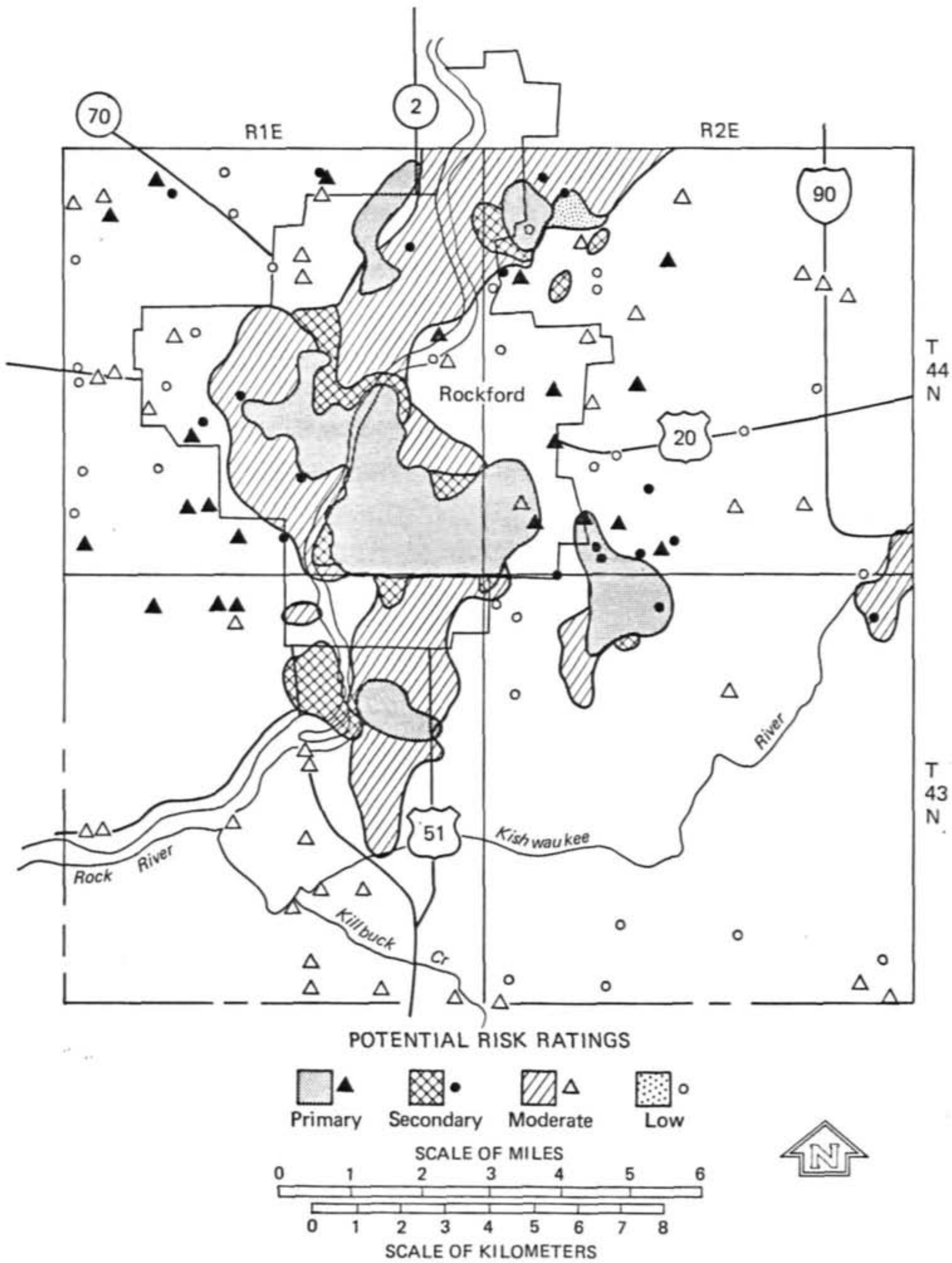


Figure 26. Potential hazardous waste problem areas in the Rockford metropolitan area

CONCLUSIONS AND RECOMMENDATIONS

The rating scheme developed in this study has been used to prioritize areas of concern for planning purposes prior to more detailed evaluation. The identified "hot spots" should be considered for detailed site or region specific rating schemes. The rating methodology as implemented in this study could be used more effectively when reliable site-specific information on waste type, composition, and handling practices becomes available. In addition, public and private water supply wells within these areas should be monitored closely. More frequent sampling or analyses for additional chemical constituents should be considered.

The proximity and age of hazardous waste site activity within time-related public water supply well capture zones also should be considered in anticipated monitoring plans. Use of the concept of time vs location and age of potential polluting activity can provide a rational basis for determining when increased monitoring should be initiated. It can help eliminate the crisis, "knee-jerk", response to pollution incidences by providing timely information and allowing for planning and anticipation of a crisis.

Data contained in various agency files and archives generally are incompatible and incomplete. Standard data formatting within individual departments and among agencies would greatly enhance the utility of the collective data base. Checking of data as received to determine its source, validity, and completeness also is essential. Thousands of dollars are being spent to develop environmental or waste management data bases. However, few or no attempts are being made to enhance the quality, compatibility or utility of the data contained within them.

To minimize the problems, some conventions should be kept in mind when data are accumulated and entered into a computer. The following is a partial listing of recommended conventions:

1. Names
   - A. Companies—actual company site names should be given. Parent companies are really another field. Abbreviations such as "Co" and "Corp" and "Inc" should be standardized.
   - B. People—last name first, first name, initial if any. Titles are not names, they require their own field.

2. Addresses
   - A. Addresses—number, direction, and street name are each specified fields. Standardized abbreviations for" Street" or "Avenue," and "Lane" should be used.
   - B. City names should always be included.
   - C. County name or number should be used when dealing with data where more than one county is involved or where data for one county may be used outside that county.

3. No slashes or odd characters should be imbedded in fields. Dots and commas seldom are needed.

4. Right justify or left justify, but be consistent.

5. When coding data if a question can have one of several answers, those answers can be assigned letters, numbers, or acronyms which all appear in the same field. If the answer can have more than one of the coded responses, that should be stated clearly in the documentation and the structure described.

6. Units should be consistent and documented clearly (i.e., acres, cubic yards, or gallons) throughout.

7. Dates
   A. Dates—if all data occurs in the same century, say so in the documentation and drop the "19."
   B. Standardize day, month, year, or month, day, year, but be consistent.

If tapes of data are created, it is best to create unlabeled tapes with record lengths which do not vary. If labeled tapes are made, a complete documentation of all file names and file parameters should be made . Examples of listings should always accompany any file or tape given to another researcher or agency.

The content of waste management data bases largely is inadequate for in-depth evaluation of potential impacts of individual industrial or service activities. On-site activities are very difficult to monitor effectively yet indications suggest that on-site disposal and storage, particularly of liquid wastes, may increase as landfilling of these materials is restricted. Reporting requirements on permits, manifest documents, and plant records should be reviewed with and include data from periodic detailed analyses for RCRA listed hazardous components. Improved knowledge of the actual waste stream composition would permit more exact assessments of potential risk in subsequent storage, transport, or disposal, and a better understanding of viable alternatives to landfilling. Incentives for the segregation of waste streams with reuse or recycling potential also should be developed.

Several potential "hot spots" have been delineated in Ogle and Winnebago Counties. More detailed evaluation of sites within these "hot spots" should be undertaken. This report provides a rational basis for hazardous waste monitoring and management in the two counties. Similar efforts should be undertaken in other parts of Illinois where industrial or service business activities involved with highly rated wastes are conducted. Priority areas for studies of this type should include all counties with more than 20,000 gallons manifested hazardous waste generated in 1982 (see Figure 3). This would encompass 42 of Illinois' 102 counties and account for approximately 99.2 percent of the 1982 manifested waste. The successful application of the developed rating scheme will vary in other areas with the availability of historical data and level of industrial activity. For areas of comparable industrial activity and locally available historical data, similar studies could be accomplished in 1 year at a cost of about $90,000.

This study has focused on past and present sites of known or suspected hazardous material handling. Because of the short time frame, the state of available data bases, and limited manpower support, there was not time to visit specific sites of present activity to confirm elements of current data bases. Obviously, the identified "hot spots" should be the object of more intensive evaluation of potential risk to human health via groundwater, surface water, or atmospheric routes.

Significant sources of potential impacts on human health via groundwater are posed by aging underground gasoline and fuel oil storage tanks. These sources are numerous, widely distributed, and have frequently been identified as serious problems after releases impact drinking water supplies. Evaluation of the potential risk to human health from these sources was beyond the scope of the study.

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Appendix A. Location and Description of Public Water Supply Wells

OGLE COUNTY

Owner	Well No.	Location: Township	Range	Section	Well Depth in Ft	Aquifer Type	1980 Pumpage Thous. gal/day
Askvig Homeowners Ass. (No. 1)	1	40N	01E	14.1F	135	Deep Ss	8.1
Askvig Homeowners Ass.(No.2)	2	40N	01E	14.1G	120	Deep Ss	8.1
Askvig Homeowners Ass. (1st)	1	40N	01E	14.2E	83	Deep Ss	4.4
Askvig Homeowners Ass (1st)	2	40N	01E	14. IE	94	Deep Ss	44
Byron	1	25N	HE	32.8E	2000	Deep Ss	125.
Byron	2	25N	HE	32.8E	673	Deep Ss	125.
Byron	3	25N	HE	32.6G	715	Deep Ss	205.
Country View Ests Subd	1	41N	02E	05.5F	186	S & G	4.9
Creston	2	40N	02E	23.IF	732	Deep Ss	62.5
Forreston	1	25N	08E	33.4H	300	Deep Ss	14
Forreston	2	25N	08E	33.4E	1000	Deep Ss	169
Hillcrest	1	40N	01E	12.4B	395	Deep Ss	94.8
Lakeview MHP	1	25N	HE	29.2E	95	Deep Ss	48
Leaf River	2	25N	09E	36.5D	325	Deep Ss	73.5
Mt Morris	3	24N	09E	27. IF	1807	Deep Ss	94.0
Mt. Morris	4	24N	09E	27.1 A	1452	Deep Ss	148.
Mt. Morris Ests. MHP	1	24N	09E	36.7H	389	Deep Ss	15.3
New Landing Subd-Lost Nation	9	22N	10E	05 IB	675	Deep Ss	32.2
Oregon	2	23N	10E	03 6G	1250	Deep Ss	195.
Oregon	3	23N	10E	03.7G	1200	Deep Ss	228.
Polo	2	23N	08 E	09.4C	1200	Deep Ss	6.5
Polo	3	23N	08E	09.4C	1260	Deep Ss	254.
Rochelle	5	40N	01E	23.2D	502	Deep Ss	316
Rochelle	4	40N	01E	24.7A	1450	Deep Ss	779.
Rochelle	7	40N	01E	24.5H	925	Deep Ss	39.8
Rochelle	9	40N	01E	25.21	888	Deep Ss	421.
Rochelle	0	40N	01E	36.2H	920	Deep Ss	619.
Rochelle	8	40N	02E	30.4C	935	Deep Ss	106.
Rockvale Corp	1	24N	10E	21 5A	429	Deep Ss	6.7
Rockvale Corp	2	24N	10E	29.4H	450	Deep Ss	2.6
Stillman Valley	1	24N	11E	01 2B	300	Deep Ss	12.0
Stillman Valley	2	24N	11E	01.3A	460	Deep Ss	70.5
Woodlawn Acres Subd (Woodln Ul)	2	40N	01E	20.2B	250	Deep Ss	26.0

WINNEBAGO COUNTY

Owner	Well No.	Location: Township	Range	Section	Well Depth in Ft	Aquifer Type	1980 Pumpage Thous. gal/dav
American MHP	1	43N	01E	01.8A	148	S & G	9.7
Balcitis Subd	2	44N	01E	33.1C	325	Deep Ss	8.0
Balcitis Subd	1	44N	01E	34.8B	300	Deep Ss	6.5
Bradley Hgts Subd	1	44N	02E	18.4H	185	S & G	6.4
Bradley Hgts Subd	2	44N	02E	18.4H	500	Deep Ss	6.4
Bradley Hgts Subd	3	44N	02E	18.3G	132	S & G	64
Clark's MHP	1	44 N	01E	33.	255	Deep Ss	1.4
Coventry Creek Subd	1	43N	02E	10.7D	520	Deep Ss	22.6
Coventry Hills Subd-East	1	43N	02 E	03.7E	600	Deep Ss	49.6
Durand	2	28N	10E	10 8B	385	Deep Ss	35.4
Durand	3	28N	10E	10.4B	585	Deep Ss	86 5
Gem Suburban MHP	1	43N	01E	10 4C	75	S & G	19.8
Gem Suburban MHP	2	43N	01E	10.4C	75	S & G	21 8
Gem Suburban MHP	3	43N	01E	10 4C	75	S & G	192
Gem Suburban MHP	4	43N	01E	10.4C	75	S & G	20.1
Goldie B Floberg Ctr	1	46N	02E	18.1D	85	S & G	2.4
Goldie B Floberg Ctr	2	46N	02E	18.1D	75	S & G	2.4

WINNEBAGO COUNTY (concluded)

Owner	Well No.	Location: Township	Location: Range	Location: Section	Well Depth in Ft	Aquifer Type	1980 Pumpage Thorn. gal/day
Harrington Brothers Subd	1	43N	01E	19.3E	310	Deep Ss	10.0
Holiday Acres Subd	1	43N	02E	04.3 H	590	Deep Ss	9.6
Larchmont Subd	1	44N	02E	18.1G	600	Deep Ss	8 9
Leanna Lakeside Well 2	2	45N	01E	13.2H	275	Deep Ss	1.8
Leanna Lakeside Well 7	7	45N	01E	13.3H	275	Deep Ss	2.2
Leanna Lakeside Well-1	1	45N	01E	13.1H	275	Deep Ss	2.4
Leanna Lakeside Well-3	3	45N	0IE	13.3H	275	Deep Ss	2.6
Legend Lakes Wtr Assn	1	46N	02E	24.8D	279	Deep Ss	1 4
Loves Park	2	44N	02E	06.4C	190	S & G	2166.
Loves Park	1	44N	02 E	07.4H	198	S & G	292.
Loves Park	3	45N	02 E	34.7G	865	Deep Ss	263.
Mulfoed's Wildwood Subd	1	44N	02E	34.4A	531	Deep Ss	35.5
North Park PWD	2	45N	01E	25. IB	195	S & G	110.
North Park PWD	5	45N	02E	17.3F	250	S & G	804.
North Park PWD	3	45N	02E	30.2G	238	S & G	392.
North Park PWD	4	45N	02 E	30.5D	240	S & G	259.
Newburg Landowners Assoc	1	44N	02 E	33.5H	400	Deep Ss	5.2
Otter Creek Uutlity Dist	1	28N	10E	07.1G	277	Deep Ss	55.7
Pecatonica	1	27N	10E	28.8C	449	Deep Ss	185.
Pecatonica	2	27N	10E	29. ID	750	Deep Ss	275
Rainbow Lane MHP	1	45N	02E	19.3A	75	S & G	6.1
Rockford (Unit Well 03)	3	44N	01E	02.3B	1120	Deep Ss	1247.
Rockford (Unit Well 04)	4	44N	01E	34 6H	1219	Deep Ss	1212
Rockford (Unit Well 05)	5	44N	02E	18.6A	1312	Deep Ss	34.7
Rockford (Unit Well 06)	6	44N	02E	31.7F	1372	Deep Ss	652.
Rockford (Unit Well 07)	7	44N	01E	36.6F	1503	Deep Ss	251.
Rockford (Unit Well 07A)	7	44N	01E	36.6F	200	S & G	2721
Rockford (Unit Well 08A)	8	44N	01E	13.6E	243	S & G	971.
Rockford (Unit Well 09A)	9	44N	02E	19.6B	237	S & G	1262.
Rockford (Unit Well 10)	0	44N	02 E	29.3A	1426	Deep Ss	910.
Rockford (Unit Well 11)	1	44N	01E	26. 1D	245	S & G	986.
Rockford (Unit Well 12)	2	44N	01E	23.2C	245	S & G	1253.
Rockford (Unit Well 13)	3	44N	02 E	20.3E	1457	Deep Ss	526.
Rockford (Unit Well 15)	5	44N	01E	21.7E	1355	Deep Ss	169.
Rockford (Unit Well 16)	6	44N	02E	32.4A	1310	Deep Ss	992.
Rockford (Unit Well 17)	7	44N	02 E	17.6G	1195	Deep Ss	1025.
Rockford (Unit Well 18)	8	44N	01E	28.5C	1380	Deep Ss	517.
Rockford (Unit Well 20)	0	44N	01E	09.8C	1200	Deep Ss	1079.
Rockford (Unit Well 21)	1	44N	01E	20.7F	1205	Deep Ss	279.
Rockford (Unit Well 22)	2	44N	01E	17.3D	1380	Deep Ss	582.
Rockford (Unit Well 23)	3	45N	01E	36.2D	94	S & G	764.
Rockford (Unit Well 24)	4	43N	01E	23.8E	222	S & G	1981.
Rockford (Unit Well 25)	5	44N	02E	09.2A	1290	Deep Ss	1322.
Rockford (Unit Well 26)	6	44N	02E	28.5G	1326	Deep Ss	1384.
Rockford (Unit Well 27)	7	44N	02E	16.2A	1280	Deep Ss	540.
Rockford (Unit Well 28)	8	43N	01E	15.5E	233	S & G	543
Rockford (Unit Well 30)	0	44N	02E	03.4C	1325	Deep Ss	969.
Rockford (Unit Well 35)	5	43N	01E	01.8E	214	S & G	1212.
Rockford (Unit Well 36)	6	43N	02E	17.7H	1505	Deep Ss	885
Rockford (Unit Well 38)	8	44N	01E	26 4B	235	S & G	971.
Rockford (Unit Well 5A)	5	44N	02E	18.6A	298	S & G	2206.
Rockford (Tay St Group Well 2)	2	44N	01E	22.5C	1600	Deep Ss	17.3
Rockford (Tay St Group Well 4)	4	44N	01E	22.5C	1633	Deep Ss	17.3
Rockford (Tay St Group Well 5)	5	44N	01E	22 6C	1605	Deep Ss	17.3
Rockford (Tay St Group Well 6)	6	44N	01E	22.6D	1608	Deep Ss	17.3
Rockford (Tay St Group Well 1)	1	44N	01E	22.6C	1600	Deep Ss	17.3
Rockford (Unit Well 29)	9	44N	02E	08 2G	1357	Deep Ss	90.8
Rockton	5	46N	01E	13.2B	120	S & G	213.
Rockton	6	46N	01E	24 8A	728	Deep Ss	344.
South Beloit	3	46N	02 E	05.7D	1190	Deep Ss	950.
Six Oaks MHP	1	26N	10E	04.7G	275	Deep Ss	5.2
Timberlane MHP		43N	01E	19.4E	650	Deep Ss	4.5