RURAL WATER DISTRICTS IN ILLINOIS

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ABSTRACT

Research was conducted on the legal-organization, the economic and the spatial aspects of rural water systems. With encouragement from subsidized federal government credit, rural water systems serving farmers, nonfarm residents in the open country and residents of towns under 10,000 people have been developed to meet the demands for a dependable quality domestic water supply. The 59 districts financed in part by the Farmers Home Administration, USDA, and serving only farmers and nonfarm rural residence customers in Illinois were the objects of the research. In general, these systems serve 24,000 customers and maintain 4,200 miles of line. They are located in the southern, the west-central, and the east-central regions of Illinois. The systems received financial assistance from the federal government in the form of construction grants and/or low interest loans authorized initially in 1954. The systems are generally owned and operated by "water supply districts," a special unit of local government and have to comply with all operating procedures and regulations required of public water supplies under Illinois Environmental Protection Agency authority.

In analyzing the costs of rural water service, districts with greater volume and/or higher user density generally had lower operating costs. The median number of users reported was 278. In 1980 dollars, the per user average outlay for operating costs and debt retirement was approximately $16.00 per month.

Only 22 percent of rural water district users were farmers. Consumption levels averaged 4.64 thousand gallons per month at an average price of $5.77. The demand for rural water service was inelastic over much of the relevant range of observations. Little evidence was discovered supporting the contention that rural water service is a major force in the shift of agricultural land to nonfarm residential use.

KEYWORDS: rural water, rural water districts, water service costs, land use and water policy, water rate schedules

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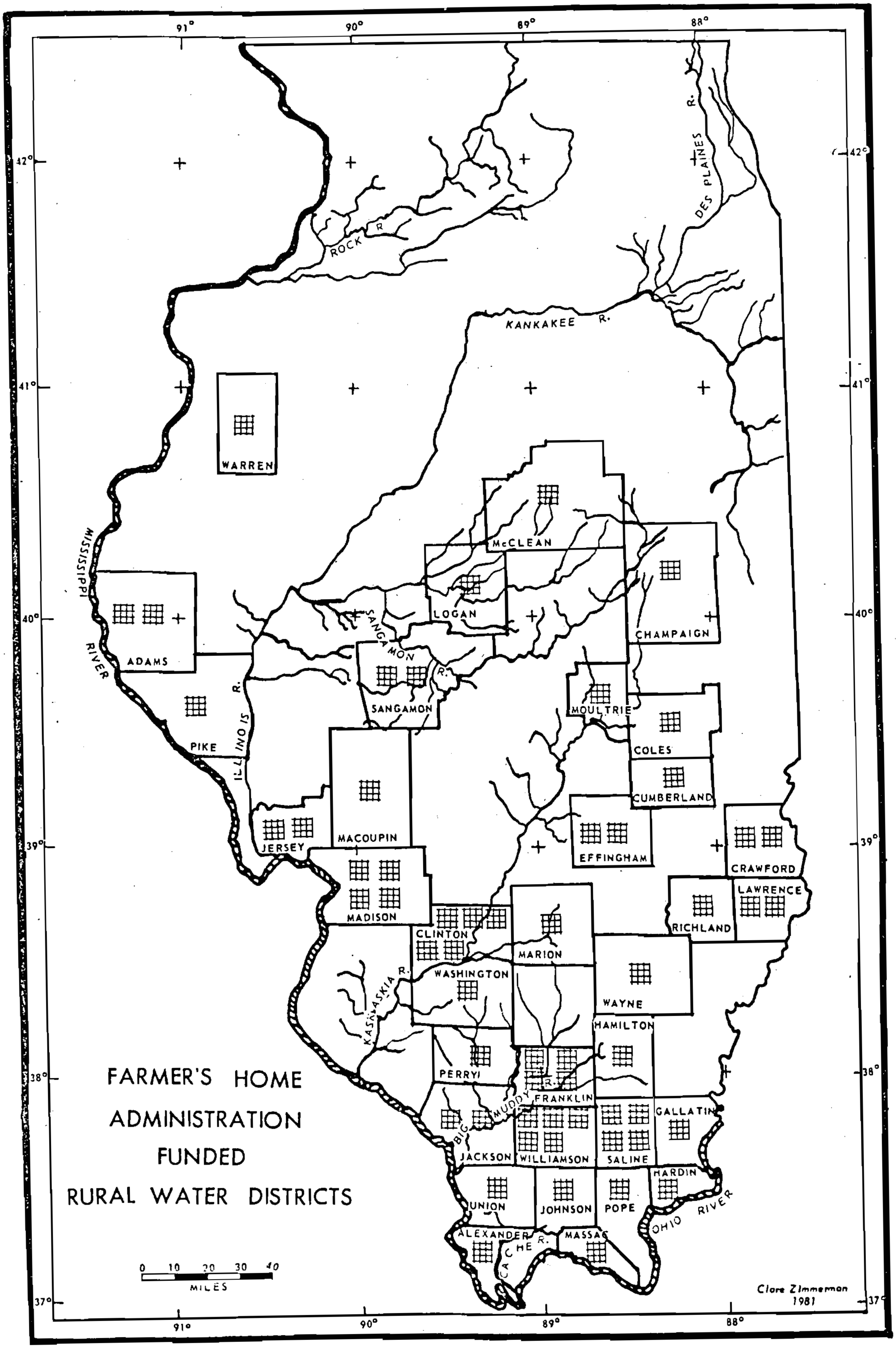
CHAPTER 1

INTRODUCTION

Since 1961, the year the Consolidated Farmers Home Administration Act was passed into law, the federal government has injected hundreds of millions of dollars into public services in rural areas in the United States through the programs of the Farmers Home Administration (FmHA). Through grants alone, small communities and groups of rural residents received over $1.4 billion for water and sewer systems during the 1970s. Loans, at subsidized interest rates, provided an additional $4.9 billion in capital for these services (Gessaman and Janovec, 1982). The water and sewer programs are the dominant FmHA community credit program. Credit is also available to help finance community facilities, recreation, etc.

While a substantial part of the monies have helped finance rural potable water systems in the traditional water shortage areas of the arid west and central plains, a number of water systems have been constructed in the rural midwest, a region generally not perceived as facing water supply problems. For example, Farmers Home Administration loans totaling $109 million had been made in Illinois through September 1983 for rural and small community water systems (Farmers Home Administration, 1984). Of the over 250 systems receiving this federal government financial assistance in Illinois, 59 provide potable water only to farmers and rural residents outside incorporated communities. These systems are located generally in the southern half of Illinois with major concentrations in the southern most counties and in selected west-central and east-central areas (see map). In total these sytems, which are owned and operated by special units of government (water districts) with appointed governing boards, service approximately 24,000 farm and nonfarm users and maintain about 4,200 miles of water line. In addition to water lines, a rural water system generally includes a water supply (ground or surface), pumps, storage facilities, treatment plants and ancillary facilities and equipment required for the procurement of water supplies and the delivery of potable water to users.

Rural water systems are a relatively recent service. The average age of the systems in 1982 approached 9 years with the majority being less than 10 years old.


FARMER'S HOME
ADMINISTRATION
FUNDED
RURAL WATER DISTRICTS
91°
90°
89°
88°
42°
41°
40°
39°
38°
37°
ROCK R.
DES PLAINES R.
KANKAKEE R.
MISSISSIPPI RIVER
ILLINOIS R.
SANGAMON R.
KASKASKIA R.
BIG MUDDY R.
CACHE R.
OHIO RIVER
WARREN
McCLEAN
LOGAN
CHAMPAIGN
ADAMS
PIKE
SANGAMON
MOULTRIE
COLES
CUMBERLAND
MACOUPIN
JERSEY
EFFINGHAM
CRAWFORD
MADISON
LAWRENCE
RICHLAND
CLINTON
MARION
WASHINGTON
WAYNE
HAMILTON
PERRY
FRANKLIN
GALLATIN
JACKSON
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JOHNSON
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Clare Zimmerman
1981

This report presents a study of the 59 rural water systems in Illinois providing potable water service to farm and nonfarm rural residents. The study focuses on legal, organizational, economic and geographic/spatial aspects of collectively providing rural water service in the open countryside outside incorporated communities. The objectives of the study are to provide a better understanding of 1) the legislative history of rural water programs, 2) the organization, formation and operation of rural water districts in Illinois, 3) the general characteristics of Illinois rural water systems and the cost of providing rural water services, 4) rural water district users and the demand for rural water and, finally, 5) the spatial characteristics of districts and the impact of rural water service on land use.[1]

In addition to the introduction and a general summary, the report has two parts. The first three chapters comprise Part I and present the legal-organizational analysis of rural water service supplies in general and how they are provided in Illinois. The three chapters in Part II contain the economic and spatial analysis of Illinois' rural water districts. The legal, economic and spatial analyses were carried out by individual researchers who authored the respective chapters focused on these topics. The chapters were not edited for style differences.

GENERAL SUMMARY

<u>Federal Legislative History</u>. The Community Facility Program of the Farmers Home Administration, a rural credit agency of the United States Department of Agriculture, originated with the enactment of the Water Facilities Act of 1937. This Act authorized long-term, low interest federal government loans to develop water facilities for household and farm use. Initial assistance was restricted to the 17 arid and semi-arid western states. In 1954, the 1937 act was extended to the entire United States and in 1961 was replaced by the Consolidated Farmers Home Administration Act. With the 1961 act, loans were permitted to support water systems serving nonfarm rural residents without regard to the number of farms that shared the water supply.

Subsequent legislative changes were made in 1965 and again in the Rural Development Act of 1972. The legislative authorization is now for loans for facilities including water systems that primarily serve farmers, ranchers, farm tenants, farm laborers, and other rural residents of open country and rural towns and villages of not more than 10,000 population. Grants to cover part of project development costs are authorized.

Local agents such as counties, small municipalities, and special service districts as well as some nonprofit corporations are eligible for program assistance. Loans must be secured and are statutorially limited to a maximum term of 40 years or the useful life of the facility to be financed.

District Organization and Formation. In Illinois, the organizations available for rural water district formation and financial assistance under the Farmers Home Administration's rural water program are public water districts and not-for-profit corporations. Districts are formed through petitioning local circuit courts by any 100 legal voters within the limits of the proposed district. A hearing is held after which the question of public water district formation is submitted to the voters of the proposed district. If a majority of the votes cast favor district creation, the water district becomes a political subdivision of the state.

Districts are governed by a board of seven trustees each serving five year terms. The trustees are appointed officials placed in office either by an elected County Board or Township Board depending on district location. Although not very common, rural water systems may also be owned and operated by a not-for-profit corporation where all users become members of the corporation.

Rural Water District Operation. Rural water districts in Illinois fall within the statutory definition of "public water supplies" and are thus subject to state laws and regulations governing these supplies. The major laws controlling public water supplies in Illinois are the act that regulates the operation of a public water supply and grants regulatory power to the Illinois Pollution Control Board and the part of the Illinois Environmental Protection Act that authorizes Illinois Environmental Protection Agency supervision of public water supplies. Illinois statutes require each public water supply, including rural water districts, to employ at least one person certified competent as a water supply operator. These services may be contracted. To ensure the maintenance of a safe, adequate supply of water for domestic use, districts must submit water samples periodically for analysis and provide reports of operations as requested by the Illinois Environmental Protection Agency.

Districts also must acquire three types of permits (construction, operating, and algicide) from the Illinois Environmental Protection Agency and monthly reports have to be submitted as well as the results of required tests. Illinois law requires public water supplies to add flouride to their water.

District Characteristics and Cost Analyses. Rural water systems serving farms and nonfarm rural residences are small relative to urban water supply systems whether measured by number of customers or volume of output. The median number of customers reported was 278. The systems are characterized by low user density with approximately 5.6 users per mile, on average. Ground and surface water sources are used about equally for raw water supplies and 84 percent of the systems reported buying some water, either raw or treated.

Low user density systems are characterized by relatively more customers and more miles of water line than systems with higher densities. About 40 percent of the average monthly per user expenditure of $16.00 (1980 dollars) by Illinois rural water systems was for debt service. The other 60 percent was for operating and maintenance outlays. In general, systems with more users per mile of water line and those with a larger volume of output had lower average per user and per million gallons of water costs suggesting technical efficiencies in the provision of rural water services.

In statistically analyzing operating costs and construction costs, an inverse relationship between per unit costs and size was identified. On average, per unit operating costs decline by about $9.00 (1978 dollars) for every additional one million gallons of water sold by Illinois' rural water systems. However, an additional supply of four million gallons per year and a concomitant reduction in average user density of one customer per mile of water line would be approximately cost neutral in impact. On the average, the unit price for water lines and elevated storage tanks were inversely related to the quantity of pipe and capacity of tanks contained in construction bids. Both cost aspects suggest the average total cost of water service from rural districts is declining throughout the feasible range of output.

Water Users and Demand. Because rural water services exhibit the characteristics of "natural monopolies" with continuous falling average costs throughout the feasible output range, they are priced following a declining block rate structure. Most rural water districts provide 1,000 gallons of water with the minimum monthly charge that averaged $9.76 in 1982. The number of blocks in the rate schedules ranged from two to seven. Other gallonages entitled with minimum charges included 1,500, 2,000, and 4,000.

On average, Illinois rural water district users purchased 4.64 thousand gallons of water a month at an average price of $5.77 per 1,000 gallons in 1982. Farm customers accounted for 22 percent of all customers and had only slightly higher average consumption rates than their nonfarm counterparts. The average income in 1982 for all users was $16,958 with farm users averaging $14,861, 18 percent below nonfarm residential users.

Expectedly, users with higher incomes had higher monthly water bills and bought more water per month. Other factors influencing water purchases included household size and water price. Household demand was price inelastic over much of the range of quantity purchased with some suggestion that demand became elastic above approximately $9.00 per 1,000 gallons. No seasonal variation in water consumption of any significance was observed with the ratio of summer purchases to winter purchases in 1982 being 1.15. Because of the use of average price in the analysis of rural water service demand, generalizations from the reported results should be done with caution.

Geographic/Spatial Analysis. Case studies of two representative rural water districts provide rich detail on the geographic characteristics of rural water systems. In map form, information on line locations, spatial features and terrain characteristics are presented. In analyzing the impact of rural water services on land use in the two case districts, no evidence was found suggesting the provision of potable water by rural water districts influenced the conversion of farmland to nonfarm uses and the scatteration of residential acreages across the countryside. In one case system only about seven percent of total user population was receiving service and in the 14 rural subdivisions in the district's jurisdiction, only 60 percent of the households purchase water.

There appears to be a stronger suggestion from the analyses of the two study cases that the land use change from agricultural to rural nonfarm residential use occurred first with demands for a higher quality, dependable potable water supply following rather than the presence of the water service encouraging development and land use change. Of course, these conclusions are most valid for districts with locational and physical characteristics similar to those of the case study districts.

Chapter 1 Footnotes

1. A comprehensive assessment of rural water conditions in the United States is found in the five volume national study summarized by Francis (1983).

References

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Francis, Joe D. 1983. *National Statistical Assessment of Rural Water Conditions: Executive Summary.* The Office of Drinking Water, U.S. Environmental Protection Agency, Department of Rural Sociology, Ithaca, NY: Cornell University.

Gessaman, Paul H. and Janovec, Terese M. 1982. *Operational Characteristics of Rural Water Systems in Five North Central States.* Ames, IA: North Central Regional Center for Rural Development (January).

CHAPTER 2

LEGISLATIVE HISTORY OF RURAL WATER PROGRAMS

The Farmers Home Administration (FmHA), a rural credit agency of the United States Department of Agriculture (USDA), has served as one of USDA's major resources in fulfilling the rural development mandate of the Rural Development Act of 1972,[1] which initiated new programs of federal aid to rural communities and residents, expanded several existing rural community development programs, and added rural development as a basic mission of USDA.[2] At present, FmHA is obligating several hundred million dollars annually[3] in long-term low interest loans to finance community facilities[4] in rural areas and communities of not more than 10,000 population.[5] Over 1000 new water supply and waste disposal systems or system improvements in the United States are financed annually for eligible entities,[6] namely public agencies and other organizations operated on a nonprofit basis.

A. History

The Community Facility Program (the Program) originated with the enactment of the Water Facilities Act of 1937, which authorized the Secretary of Agriculture to make direct long-term, low interest loans to develop water facilities for household and farm use, and to assist in the construction of facilities for water utilization and storage.[7] As originally conceived, the program was limited to the "arid and semi-arid areas of the United States."[8] As administered by the Farm Security Administration,[9] FmHA's predecessor agency, assistance was confined to the seventeen western states.[10] The Water Facilities Act further required the loans to benefit farms.[11] By interpretation, loans to associations could not be made without a showing that the major users of the facility were to be farmers.[12]

In 1954 Congress amended the Water Facilities Act to extend it to the entire United States.[13] The 1954 amendments increased project assistance from the unrealistically low spending limits of the original Act to $250,000 in the case of loans to incorporated municipalities and associations.[16]

The passage of the Consolidated Farmers Home Administration Act of 1961[15] was the next major development in the history of the Program. It initiated an era of rapid expansion for this and other FmHA programs. This law was intended to consolidate the programs administered by the FmHA for real estate, farm operating, emergency, and water facility loans.[16] Sections 304 and 306 of the 1961 Act[17] replaced the Water Facilities Act of 1937, as amended, in its entirety.[18] Section 306 expanded USDA authority to make water facility loans. For the first time, loans were permitted to associations serving nonfarming rural residents, without regard to the number of farm families that shared the water supply.[19] Other changes made in 1961 included a new provision to protect the territory served by an FmHA-financed community facility loan from curtailment or limitation resulting from competitive facilities that might be developed with the expansion of boundaries of municipal and other public bodies served by an FmHA-financed system;[20] an increase in the per project spending limits to $1 million in the case of funds borrowed from the Agricultural Credit Insurance Fund and $500,000 for funds borrowed from the U.S. Treasury;[21] the imposition of a maximum repayment period of 40 years;[22] an increase in the maximum interest rate to 5 percent per annum;[23] and an increase in the statutory authorizations of loans from the Agricultural Credit Insurance Fund to an annual limit of $150 million.[24]

The Consolidated Farmers Home Administration Act[25] was amended in 1965.[26] These amendments added waste disposal facilities as an eligible loan purpose.[27] In addition, these amendments gave the USDA authority to make grants of up to 50 percent of the development cost of projects for development, storage, treatment, purification, or distribution of water in rural areas.[28] Other important program changes included the authorization of larger projects by increasing project funding limits from $1 million to $4 million,[29] and an increase in the amount of FmHA loan insurance authority for all real estate programs, including community facilities, from $200 million to $450 million annually.[30] To ensure that the program would not work at cross purposes with local government objectives, the amended law required the review and approval of local municipal planners and state water pollution control agencies.[31] Another important change increased, from 2500 to 5500, the population limits for communities eligible for assistance.[32] The 1965 amendments recognized the special need of rural communities for water and sanitation systems. They attempted to provide rural areas with assistance, comparable to that available to citizens in urban areas, in developing adequate facilities. The assistance was available without regard to whether the rural communities were primarily associated with agriculture.[33]

The Rural Development Act of 1972 (the 1972 Act) added the most recent statutory changes to the Program.[34] Under this Act, Congress substantially increased the number of communities eligible for assistance by raising the population limit in the definition of "rural area" from 5500 to 10,000.[35] Other important changes made in 1972 include an increase from $100 million to $300 million in the annual appropriation authorization for grants for rural water, sewer, and solid waste disposal systems,[36] and elimination of the $4 million ceiling on FmHA assistance to any one community facility project.[37] To fund the expanded program, Congress established the Rural Development Insurance Fund.[38] The 1972 Act adds rural development as a basic mission of USDA, rather than any other agency. It directs the Secretary of Agriculture to establish national goals for all elements of rural community development and to coordinate the activities of all the agencies of the Executive Branch toward attaining the goals of the Act.[39]

B. Present Program

In the years since the passage of the Rural Development Act of 1972,[40] there have been few statutory changes in the Community Facility Program.[41] Pursuant to the Consolidated Farmers Home Administration Act of 1961,[42] the Secretary has promulgated detailed regulations for the administration of the Program.[43] Under the Program, the FmHA is authorized to make loans for community facilities that primarily serve farmers, ranchers, farm tenants, farm laborers, and other rural residents of open country and rural towns and villages of not more than 10,000 population.[44] Funds may be used to construct, enlarge, extend, or improve water service facilities, and also to pay related project costs such as land aquisition and legal fees.[45] Grants for up to 75 percent of project development costs are available for water systems.[46] Grants are made to the most financially needy communities in order to keep rural residents' user rates at reasonable levels.[47]

Loans are available to public bodies such as counties, small municipalities, and special service districts.[48] Nonprofit corporations having significant ties to the local rural community and assured sources of income are also eligible for assistance.[49] In addition, prospective borrowers must be unable to obtain needed funds from other sources at reasonable rates and terms;[50] have legal authority to borrow and repay loans, to pledge security for loans, and to construct, operate, and maintain the facilities or services;[51] be financially sound and able to organize and manage the facility effectively;[52] base the project on taxes, assessments, revenues, fees, or other satisfactory sources of money sufficient to pay for operation and maintenance as well as to retire the debt;[53] plan projects consistent with applicable comprehensive and other development plans for the community; and comply with federal, state, and local laws.[54]

Community facility loans are limited to a maximum term of 40 years,[55] but in no event may they exceed any statutory limits on an entity's borrowing authority or the useful life of the facility to be financed, whichever is less.[56] Loans must be secured in a manner that will adequately protect the FmHA throughout the repayment period of the loan.[57] Specific requirements for security for each loan are negotiated with prospective borrowers. As a general rule, bonds or notes pledging taxes, assessments, or revenues will be accepted as security from public bodies if they meet all statutory requirements.[58] Nonprofit corporations may use notes pledging revenue as acceptable security when the notes are secured by a perfected first lien on real and personal property.[59]

FOOTNOTES

1. Rural Development Act of 1972, Pub. L. No. 92-419, 86 Stat. 657 (codified in scattered sections of 5, 7, 16, 42 U.S.C.).
2. 7. U.S.C. § 2204(b) (1976).
3. Water Newsletter, April 13, 1982, at 4.
4. As used in this report, "community facilities" denotes all facilities eligible for funding under FmHA regulations published at 7 C.F.R. §§ 1942.1-.19 (1982), entitled "Community Facility Loans." Accordingly, it includes programs such as water systems, sanitary sewer systems, and other essential community facilities. The emphasis of this report is water systems.
5. The definition of "rural" and "rural area" as used in the Community Facility Program is provided in 7 U.S.C. § 1926(a)(7) (1976), which states that "rural" and "rural area" do not include any area in any city or town that has a population in excess of 10,000 inhabitants. This section gives no population limit for unincorporated areas.
6. Water Newsletter, April 13, 1982, at 4.
7. Water Facilities Act of 1937, Pub. L. No. 75-399, § 1, 50 Stat. 869, 869.
8. _Id_. § 1.
9. The Farmers Home Administration Act of 1946, Pub. L. No. 79-731, 60 Stat. 1062, reconstituted the Farm Security Administration in the Farmers Home Administration.
10. H.R. Rep. No. 2290, 83d Cong., 2d Sess. 3, _reprinted in_ 1954 U.S. Code Cong. & Ad. News 3047, 3051.
11. Water Facilities Act of 1937, Pub. L. No. 75-399, § 1, 50 Stat. 869, 869.
12. S. Rep. No. 566, 87th Cong., 1st Sess. (1961), _reprinted in_ 1961 U.S. Code Cong. & Ad. News 2243, 2309.
13. Act of August 17, 1954, Pub. L. No. 83-597, §§ 1, 2, 68 Stat. 734, 734-735.
14. _Id_. § 4.
15. Consolidated Farmers Home Administration Act of 1961, Pub. L. No. 87-128, 75 Stat. 307 (codified in scattered sections of 7 U.S.C.) [hereinafter called 1961 Act].

16. S. Rep. No. 566, 87th Cong., 1st Sess. 63, reprinted in 1961 U.S. Code Cong. & Ad. News 2243, 2304.
17. 1961 Act, Pub. L. No. 87-128, § 341, 75 Stat. 307, 318.
18. Water Facilities Act of 1937, Pub. L. No. 75-399, 50 Stat. 869, 869.
19. S. Rep. No. 566, 87th Cong., 1st Sess. 67, reprinted in 1961 U.S. Code Cong. & Ad. News 2243, 2309.
20. 1961 Act, Pub. L. No. 87-128, § 306(b), 75 Stat. 307, 308 (codified at 7 U.S.C. § 1926(b) (1976)).
21. Id. § 306(a).
22. Id. § 307(a) (codified at 7 U.S.C. §§ 1927(a) (1976)).
23. Id.
24. Id. § 308.
25. 1961 Act, Pub. L. No. 87-128, 75 Stat. 307.
26. Act of Oct. 7, 1965, Pub. L. No. 89-240, 79 Stat. 931 (codified at 7 U.S.C. §§ 1926, 1928, 1929).
27. Id. § 1 (codified at 7 U.S.C. § 1926(a) (1976)).
28. Id.
29. Id.
30. Id. § 2.
31. Id. § 1.
32. Id.
33. Id.
34. Rural Development Act of 1972, Pub. L. No. 92-419, 86 Stat. 657.
35. Id. § 109 (codified at 7 U.S.C. 1926(a)(7) (1976)).
36. Id. § 105 (codified at 7 U.S.C. § 1926(a)(2) (1976)).
37. Id. § 110.
38. Id. § 116 (codified at 7 U.S.C. § 1929(a) (1976)).
39. Id. § 603 (codified at 7 U.S.C. § 2204 (1976)).
40. Rural Development Act of 1972, Pub. L. No. 92-419, 86 Stat. 657.
41. The only statutory amendment has been codified at 7 U.S.C. 1926(a)(13)(A) (1976). This amendment established a grant program to assist certain rural volunteer fire departments.
42. 1961 Act, Pub. L. No. 87-128, 75 Stat. 307.

43. 7. C.F.R. §§ 1942.1-.19 (1982). These regulations were authorized by § 339 of the 1961 Act, Pub. L. No. 87-128, 75 Stat. 307, 318.

44. 7 U.S.C. § 1926(a)(1), (7) (1982).

45. 7 C.F.R. § 1942.5 (1982).

46. 7 U.S.C. § 1926(a)(6) (1976). For the 75 percent figure, see the FmHA Instruction 1942.354(f). The Instruction is available to the public in any FmHA office.

47. 7 U.S.C. § 1926(a)(6) (1976).

48. 7 C.F.R. § 1942.1 (1982).

49. Id.

50. Id. § 1942.2 (1982).

51. Id. § 1942.5.

52. Id.

53. Id.

54. Id.

54. Id.

55. 7 U.S.C. § 1927(a) (1976).

56. Id.

57. Id. § 1927(c).

58. Id.

59. Id.

CHAPTER 3

II. ORGANIZATION AND FORMATION OF RURAL WATER DISTRICTS

A. Federal Requirements

1. General Authorization

The Secretary of Agriculture is authorized to make or insure loans to associations, including nonprofit corporations and public and quasi-public agencies, to provide for the establishment of projects for the conservation, development, use, and control of water.[1] These projects must serve rural residents primarily.[2] The Secretary is also authorized to make grants to these associations to finance specific projects for works for the development, storage, treatment, purification, or distribution of water in rural areas.[3] The amount of any such grant may not exceed 75 percent of the development cost of the project, which must be designed to accommodate the area that the association determines can be served feasibly by the facility, plus any reasonably foreseeable growth needs of the area.[4] No grant will be made unless the Secretary determines that the project will serve a rural area that, if the project is carried out, is not likely to decline in population below the level for which the project was designed.[5] Any project receiving a loan or a grant must be necessary for orderly community development and consistent with any comprehensive community water development plan for the area.[6] Any request for financial assistance must be submitted to the appropriate planning authority for review and comment.[7] If two or more applications for financial assistance are received for projects that would serve substantially the same group of residents, and one application is submitted by the unit of local government, this application will be preferred over that of the not-for-profit corporation.[8] Preference is also given to any grant or loan application from a community having a population not in excess of 5500 with a community water supply system that suffers unanticipated deterioration and requires immediate remedial action to ensure adequate water supply.[9]

2. Community Facility Loans

Loan funds may be used to construct, enlarge, extend, or otherwise improve community water facilities.[10] In relation to these facilities, loan funds may be used for reasonable fees, services, and costs;[11] interest on loans;[12] the purchase of existing facilities,[13] land and property rights,[14] and equipment;[15] operating expenses;[16] and refinancing debts.[17] Facilities that obtain loans must be for public use[18] and may not exclude individuals on the basis of race, color, religion, sex, marital status, age, or national origin.[19]

The interest rate for each loan is established by the Farmers Home Administration (FmHA) on the date the loan is approved.[20] This rate is set by FmHA at least each quarter of the fiscal year and is based on the Bond Buyer Index for 20-year rated bonds.[21] Loans at 5 percent interest are available under certain conditions.[22] The interest rate on all loans is increased by 2 percent if the project financed involves the use of or construction on prime farmland.[23]

The loan repayment period may not exceed the useful life of the facility or 40 years from the date of the note, whichever is less.[24] Water system loans are secured by the full faith and credit of the borrower when the debt is evidenced by general obligation bonds[25] and/or pledges of taxes or assessments[26] and/or pledges of facility revenue.[27] In addition, liens will be taken on the interest of the applicant in all land, easements, rights of way, water rights, and similar property rights used or to be used in connection with the facility, whether owned at the time the loan is approved or acquired with loan funds.[28] All applicants must provide a financial feasibility report prepared by a qualified individual or firm not having a direct interest in the management or construction of the facility.[29] Provision for the accumulation of necessary reserves over a reasonable period of time must also be included in the loan documents.[30] Obtaining a loan is further conditioned on the applicant obtaining membership authorization;[31] property,[32] workers' compensation,[33] liability,[34] and malpractice insurance;[35] fidelity bonds;[35] and all necessary agreements to acquire land, easements, water rights, and other property rights.[36]

After financing for a project has been secured, construction may commence. FmHA oversees this phase of the project through supervised bank accounts for any funds furnished under the loan agreement,[37] inspections during the construction operations,[38] and supervision of construction payments.[39] FmHA also specifies the borrower's accounting procedure[40] and requires that the borrower be audited annually[41] and submit annual management reports.[42] In addition, the Community Facility Loan Regulations include nonfinancial requirements.[43]

3. Development Grants for Community Water Systems

FmHA also administers a program of grants to assist in financing the development cost of domestic water systems to rural[44] communities.[45] FmHA makes these grants in a manner that assures maximum support of the state's strategies for development of rural areas.[46] Applications for water development grants are processed in accordance with the procedures outlined for community facility loans.[47] Applicant eligibility and priority for grants are also determined in accordance with loan criteria,[48] with the additional requirement that the water system have sufficient capacity to provide reasonable fire protection.[49] Grant funds may be used only for the installation and improvement of community domestic water facilities,[50] including facilities for the development, storage, treatment, purification, and distribution of water.[51] Grant funds may also be used to acquire land and other property rights,[52] to purchase equipment,[53] to construct buildings and other structures needed for facility maintenance,[54] and to pay costs incidental to the establishment of the facility.[55] Unlike loans, grant funds may not be used for annually recurring operation and maintenance expenses,[56] purchase of existing systems,[57] refinancing existing indebtedness, or interest costs.[58]

As determined by FmHA, grants are used for water projects serving the most financially needy communities to reduce user costs to a reasonable level for rural residents.[59] Ordinarily, an applicant will be considered for grant assistance only when the debt service portion of the average user cost exceeds certain percentages[60] of median income[61] for those users in the applicant service area.[62] If the applicant's users meet this qualification and FmHA determines that a reasonable user cost has not been achieved[63] due to unusually high operation and maintenance, construction, or water acquisition costs or other factors, FmHA may proceed with a grant in an amount necessary to reduce the user cost to a reasonable level.[64]

When an FmHA loan and grant are processed simultaneously, the review procedures applicable to loans[65] must be followed.[66] When a grant only (but no FmHA loan) is being made, FmHA must assure only that the proposed development is completed in accordance with approved plans and specifications;[67] grant funds are expended for authorized purposes;[68] and the terms of the grant agreement are satisfied.[69] Nonfinancial requirements for facilities obtaining grants are the same as those prescribed for facilities receiving loans.[70]

B. State Requirements

As stated above,[71] FmHA grants and loans may be issued either to public agencies or to nonprofit associations. In Illinois, the organizations available for rural water district formation under these categories are public water districts[72] and not-for-profit corporations,[73] respectively.

1. Public Water Districts

Any contiguous area in the state having a population of not more than 500,000 inhabitants,[74] which is so situated that the construction or acquisition by purchase or otherwise and the maintenance, operation, management, and extension of waterworks properties within the area will be conducive to the preservation of public health, comfort, and convenience of the area, may be created into a public water district.[75] Waterworks properties can include wells, springs, streams, and other sources of water supply; water treatment and distribution equipment; fire protection equipment; and lands, easements, rights of way, and other property rights necessary for the proper development and distribution of a water supply.[76] Any 100 legal voters within the limits of any proposed public water district may file a petition in the circuit court for the county in which the proposed district (or the major portion of it) is located.[77] The court must hold a hearing on the petition, in which any person may suggest alterations to the proposed limits and boundaries of the district.[78] The court must take these suggestions into account, and arrange to submit the question of public water district formation to the voters of the proposed district as part of a regular election.[79] If a majority of the votes cast on this question favor creation of the district, the district is deemed an organized public water district, a public corporation, and a political subdivision of the state.[80] It may hold property in its corporate name, sue and be sued, and enter into contracts related to its purposes, including contracts with any city, village, or incorporated town for furnishing a supply of water.[81]

A board of trustees consisting of seven members[82] is created to govern, control, and manage the business affairs of each public water district.[83] The term of each trustee is five years,[84] and each receives a sum not to exceed $600 per year.[85] The trustees serve as the corporate authority of the district, exercise all of its powers, and control its affairs and properties.[86] These powers include submitting to the voters in the district[87] the question of a tax levy; appointing an attorney, engineers, and other necessary officers;[88] appointing a general manager;[89] condemning needed property;[90] and constructing water mains under and across highways.[91] The board has the responsibility of maintaining or disposing of the waterworks property[92] and acquiring such property either by purchase or condemnation.[93] The board must promulgate rules and regulations necessary to its activities, and establish rates and charges for water and water service. Charges must be sufficient to pay for the maintenance, operation, and principal and interest owed on all debts of the district.[94]

The fiscal responsibilities of the board of trustees include amendment and approval of the annual operation and maintenance budget,[95] maintenance of financial records, arrangement for a yearly independent audit,[96] and disbursement of the district treasury.[97] The trustees have significant responsibility with respect to revenue bonds, which they may issue and sell to pay the acquisition, improvement, or extension costs of waterworks property.[98] The revenue bonds may also be used to reimburse or pay the cost of creating the district.[99] These bonds are payable solely from the income and revenue derived from operation of the waterworks properties.[100] The bonds must be authorized by a board ordinance that generally describes the contemplated project; final plans and specifications are not required prior to revenue bond issuance.[101] The ordinance authorizing the issuance of revenue bonds may, in the discretion of the district, provide that the bonds be secured by a trust agreement or a depositary agreement between the district and a trust company or bank having the powers of a trust company.[102]

A public water district may expand its operation to supply water to any city, village, or incorporated town located within the boundaries of the district and not operating a waterworks system of its own.[103] A district may also contract to supply water to any city, village, or incorporated town owning or operating a water works system, whether or not within the district, provided that this activity is merely incidental to the maintenance and operation of waterworks properties for the use and benefit of the inhabitants of the district.[104] A public water district may expand through annexation of contiguous territory,[105] if two-thirds of the legal voters residing in that territory petition the circuit court for annexation.[106] The petition is followed by a court hearing regarding the proposed expansion,[107] and a court order to submit the annexation plan to the district board of trustees.[108] The board of trustees must then meet to discuss the proposed annexation, which requires a two-thirds affirmative vote of the board.[109] Contracting the scope of operations of a public water district may be accomplished through disconnection[110] or dissolution.[111]

2. Not-For-Profit Corporation

The second organizational option[112] available to rural water districts in Illinois is the not-for-profit corporation.[113] One of the permitted purposes of a not-for-profit corporation is ownership and operation of water supply facilities for drinking and general domestic use on a mutual or cooperative basis.[114] A not-for-profit corporation has the power to sue and be sued,[115] and to acquire, hold, and dispose of any interest in real or personal property.[116] It may make contracts and incur liabilities appropriate to the accomplishment of its purposes.[117] The corporation may borrow money to accomplish those purposes[118] and may secure its obligations with its property.[119] The corporation may purchase insurance for its directors or officers against any liability incurred while acting on behalf of the corporation.[120] The corporation may elect or appoint officers or agents, define their duties, and fix their compensation.[121] Bylaws of the corporation may be enacted and altered.[122]

In a rural water district not-for-profit corporation, all users become members of the corporation.[123] A corporation may have one or more classes of members,[124] and the designation of each class and the rights and duties of its members must be set forth in the articles of incorporation or the bylaws.[125] An annual meeting of the members of the corporation must be held at a location specified in the bylaws.[126] Special meetings of the members may be called by the president or the board of directors.[127] Members must have appropriate notice of any meeting[128] and are entitled to vote as provided in the articles of incorporation or bylaws of the corporation.[129]

The legal existence of the corporation begins at the issuance of a certificate of incorporation by the Secretary of State.[130] This occurs following filing of the articles of incorporation, if the Secretary finds that the articles are not defective.[131] After the issuance of the certificate of incorporation, the first meeting of the board of directors must be held for the purpose of adopting the initial bylaws.[132] A corporation may amend its articles of incorporation through submission of the amendment at a meeting of voting members,[133] or through the action of the board of directors if there are no voting members.[134] The articles of amendment must then be executed by the corporation[135] and filed with the Secretary of State.[136] If the Secretary finds that the amendment conforms to law,[137] it becomes effective in changing the articles of incorporation.[138]

The corporation is managed by a board of directors.[139] The qualifications of the directors are prescribed by the articles of incorporation or the bylaws. Although ordinarily the directors need not be members of the corporation, for FmHA financed projects they must be members of the corporation.[140] The number of directors, fixed by the bylaws, must be at least three.[141] The bylaws or the articles of incorporation establish the term of office of directors, their manner of election, and the number of directors constituting a quorum. These can be varied through amendment.[142] As provided in the articles of incorporation and the bylaws, the directors may designate and appoint one or more committees consisting of two or more directors to manage various aspects of the corporation.[143] Meetings of the board of directors must comply with the notice and attendance requirements of the bylaws.[144]

The officers of a not-for-profit corporation must consist of a president, one or more vice-presidents, a secretary, a treasurer, and such other officers and assistant officers as are considered necessary.[145] The election and appointment of officers is governed by the articles of incorporation or the bylaws, but no term of office may exceed three years.[146] Any officer may be removed from office by those authorized to elect or appoint that officer whenever in their judgment the removal would serve the best interests of the corporation[147] A corporation may indemnify its officers, directors, employees, and agents against liability incurred performing the business of the corporation.[148]

Further provisions pertaining to not-for-profit corporations require that the corporation maintain a registered office and a registered agent[149] in the state,[150] keep correct and complete books and records,[151] and file an annual statement.[152] Not-for-profit corporations may not issue shares of stock[153] or provide loans to officers and directors.[154] Not-for-profit corporations may undergo voluntary dissolution[155] or be ordered into involuntary dissolution.[156]

FOOTNOTES

1. Consolidated Farm and Rural Development Act, as amended, 7 U.S.C. § 1926(a) (1976). This section authorizes loans for other community facilities serving rural areas.
2. For the purposes of water facility loans or grants, the term "rural" normally does not include funding to any city or town with a population in excess of 10,000 (according to the latest decennial census of the United States) as per 7 C.F.R. §§ 1942.17(b) (1982).
3. 7 U.S.C. § 1926(a)(2) (1976).
4. Id.
5. Id. § 1926(a)(3)(i).
6. Id. § 1926(a)(3)(iii). The project may not be inconsistent with any state, multijurisdictional, county, or municipal plan approved by the competent authority for the area where the rural community is located.
7. Id. Under this provision, the planning agency has thirty days to determine whether the proposed project is consistent with its area-wide goals and plans.
8. Id. § 1926(a)(8).
9. Id. § 1926(a)(13).
10. 7 C.F.R. § 1942.17(d)(1) (1982).
11. Id. § 1942.17(d)(5)(i). These may include expenditures associated with legal, engineering, architectural, fiscal advisory, recording, or planning services.
12. Id. § (d)(5)(ii).
13. Id. § (d)(5)(iii).
14. Id. § (d)(5)(iv).
15. Id. § (d)(5)(v). This includes the purchase or rent of equipment necessary to install, maintain, extend, protect, or operate the facility.
16. Id. § (d)(5)(vi). This ordinarily includes only initial operating expenses for a period not to exceed one year, when the borrower is unable to pay these expenses. Note, however, that Illinois law does not give water districts in Illinois specific authority to borrow for operating expenses. See Ill. Rev. Stat. ch. 111 2/3, § 203 (1981).

17. 7 C.F.R. § 1942.17(d)(5)(vii) (1982).
18. Id. § (e). Public use is defined in id. § e(1) as affording service to all users living within the area that logically should be served.
19. Id. § (e)(2).
20. Id. § (f)(1).
21. Id.
22. Id. § (f)(2). Loans at 5 percent interest are available only if two conditions exist. The current median income of the project service area must be below the poverty line for a nonfarm family of four and the loan must be to construct or improve facilities to meet applicable health or sanitary standards. The median income of the service area is determined by the U.S. Department of Commerce, Bureau of the Census, id. § (f)(2)(ii)(A). The poverty line is that for a nonfarm family of four, as prescribed by the Office of Management and Budget as adjusted under the Economic Opportunity Act of 1964, § 624, 42 U.S.C. § 2971(d).
23. 7 C.F.R. § 1942.17(f)(3) (1982). Prime, or unique, farmland is defined in accordance with FmHA Instruction 440.1, Exhibits B and J, available to the public from any FmHA office.
24. Id. § (f)(4).
25. Id. § (g)(1)(i)(A).
26. Id. § (g)(1)(i)(B).
27. Id. § (g)(1)(i)(C).
28. Id. § (g)(1)(i)(D).
29. Id. § (h)(1). The financial feasibility reports must include reasonable projections of income from user cash contributions.
30. Id. § (i). Ordinarily, under the federal regulations, the requirements for resources are met through special assessment bonds or general obligation or other bonds that pledge the full faith and credit of the political subdivision. Id. § (i)(1). Reserves must be sufficient to ensure timely payment of loan installments, emergency maintenance, extensions to facilities, and replacement of short-lived assets. A total reserve should equal at least one average loan installment, and should be accumulated at the rate of at least one-tenth of the total each year until the desired level is reached, id. With regard to the more limited taxing authority available in Illinois, however, see infra note 87.

31. 7 C.F.R. § 1942.17(j)(1) (1982).
32. *Id*. § (j)(3)(i).
33. *Id*. § (j)(3)(iii).
34. *Id*. § (j)(3)(iv).
35. *Id*. § (j)(3)(vi).
36. *Id*. § (j)(4).
37. *Id*. § (p)(3).
38. *Id*. § (p)(4).
39. *Id*. § (p)(5).
40. *Id*. § (q). The accrual method of accounting must ordinarily be used, and all records must be retained for a period of at least three years, *id*. § (q)(1).
41. *Id*. § (q)(4).
42. *Id*. § (q)(2). Management reports provide financial information on the borrower to FmHA.
43. These regulations specify that the water systems must have sufficient capacity to provide for reasonable fire protection and growth, *id*. § 1942.18(c)(3)(i); have water pressure between 20 and 90 pounds per square inch, *id*. § (3)(ii); use pipe that conforms to standard, *id*. § (3)(iii); and not leak more than 10 gallons per inch of pipe diameter per mile of pipe per 24 hours, *id*. § 3 (iv). FmHA also provides forms and standards for construction contracts, *id*. § 1942.18(g), procurement contracts, *id*. § (i), and employment contracts, *id*. § (h).
44. See *supra* note 2.
45. 7 C.F.R. §§ 1942.351-1942.372 (1982).
46. *Id*. § 1942.351(a).
47. *Id*. § 1942.2(b).
48. *Id*. § 1942.353. See *supra* text accompanying notes 3-8.
49. *Id*. § 1942.353(a)(2).
50. *Id*. § 1942.354(a).
51. *Id*. § (a)(1).
52. *Id*. § 1942.354(c).
53. *Id*. § (b). The equipment must be necessary to enable the facility to remain in operation.

54. *Id*. § (d).
55. *Id*. § (e).
56. *Id*. § 1942.355(a)(2).
57. *Id*. § (a)(7).
58. *Id*. §§ (a)(8), (10).
59. *Id*. § 1942.356(b). Reasonable user rate is defined as a rate not less than existing prevailing rates in communities being served by an established system constructed at similar cost per user and having similar economic conditions. Exceptions to this reasonable user rate rule may be granted if the median income in the applicant service area is less than $4000.
60. These percentages are .5% when the median family income of the service area is below the poverty line, FmHA Instruction 1942.356(b)(2)(i); 1.0% when the median family income of the service area is not more than 85% of the nonmetropolitan median family income of the state, *id*. (b)(2)(ii). No FmHA grant funds will be used in any project when the median family income of the service area is more than 85% of the nonmetropolitan median family income of the state. *Id*. (b)(2)(iii). FmHA Instruction 1942.356(b).
61. The median income in the applicant community and in the communities used in comparing the proposed system with similar systems is determined from the U.S. Department of Commerce, Bureau of the Census Publication PL (1)-C, as per 7 C.F.R. § 1942.356(b)(6) (1982).
62. 7 C.F.R. § 1942.357(b)(2) (1982).
63. See *supra* note 59.
64. 7 C.F.R. § 1942.356(b)(4) (1982). Costs may not be reduced below a reasonable level.
65. *Id*. §§ 1942.5-1942.8.
66. *Id*. § 1942.357(a).
67. *Id*. § (a)(1).
68. *Id*. § (a)(2).
69. *Id*. § (a)(3).
70. *Id*. § 1942.358-1942.372. Those nonfinancial requirements contained in *id*. § 1942.18 are included in *supra* note 43.

71. See _supra_ text accompanying note 1.
72. Authorized by An Act in Relation to Public Water Districts, Ill. Rev. Stat. ch. 111 2/3, § 188 (1981).
73. Authorized by the General Not For Profit Corporation Act, Ill. Rev. Stat., ch. 32, § 163a3 (1981).
74. Rural water districts must comply with statutory population limits to qualify for FmHA assistance. See _supra_ note 2 and Chapter 2, note 5.
75. Ill. Rev. Stat. ch. 111 2/3, § 188 (1981).
76. _Id_. The statute lists streams specifically among possible waterworks properties.
77. _Id_. § 189. The petition must contain a definite description of the proposed district boundaries.
78. _Id_.
79. _Id_.
80. _Id_.
81. _Id_.
82. The circuit court may appoint a smaller board if justified by the small size of the district, _id_. § 191a.
83. _Id_. § 191. The trustees are appointed by the governing body of the political entity (township, municipality, or county) that wholly contains the district. If the district is located in more than one county, then trustees are proportionately appointed from the appropriate counties based on the distribution of county population within the district. _Id_. § 191(1)-(4).
84. _Id_. § 191(4).
85. _Id_. The maximum is $1200 if sewerage properties are involved.
86. _Id_. § 192.
87. _Id_. § 192a. The tax levy proposal is submitted to the voters of the district during the regular election. The proposition may authorize the board of trustees to levy annually, for a period of not more than ten years, a tax not to exceed .02 % of the value of the taxable property of the district. Those funds are to be used for the corporate purposes of the district.

88. Id. § 193.
89. Id. § 194. The general manager is appointed for a term of five years, at a compensation fixed by the board. He must devote his time exclusively to the affairs of the district. He has the power to employ, discharge, and fix the compensation of all employees of the district, plus other powers conferred by the board of trustees. He is also responsible for submitting a tentative annual operating budget to the board. Id. § 200.
90. Id. § 195. If the construction, acquisition, or improvement of any waterworks property will require that private property be taken or damaged, the district may cause that property to be condemned and ascertain and pay compensation pursuant to the Illinois eminent domain statute, now located in Ill. Rev. Stat. ch. 110, §§ 7-101 to 7-129 (1981).
91. Ill. Rev. Stat. ch. 111 2/3, § 196 (1981).
92. Id. § 198.
93. Id.
94. Id. § 199. The rules and regulations and the rates and charges must be established by ordinance as per id. § 210.
95. Id. § 200.
96. Id. § 201.
97. Id. § 202. Money may be paid out of the treasury only upon an order signed by the chairman and the secretary of the board. The order must indicate clearly the purposes and extent of the expenditure, and the fund from which it is payable.
98. Id. § 203. The bonds may also be used to pay the principal of and interest on any prior revenue bonds and to create an operating fund of reasonable size for the district. Id. § 208.
99. Id. § 203.
100. Id. The revenue bonds must mature at a date not exceeding forty years from their date of issue. The interest rate is regulated by Ill. Rev. Stat. ch. 17, § 6602 (Supp. 1982).
101. Id. ch. 111 2/3, § 204.
102. Id. § 205. The trust agreement may contain provisions concerning the rights and remedies of the bond holders, but the agreement may not convey, mortgage, or create any lien on the waterworks property of the district.

103. Id. § 206. This may be done after adoption of an ordinance by the city, village, or incorporated town requesting the water district to supply water for public and domestic use.

104. Id. § 207.

105. Id. § 212.1.

106. Id.

107. Id. § 212.2.

108. Id. The plan is submitted to the trustees, if the court finds it to be properly submitted.

109. Id. § 212.3.

110. Id. § 212.3-1. The requirements for disconnection from a public water district are difficult to meet. The area that is sought to be disconnected must: not be contiguous in whole or in part to any other public water district; contain twenty or more acres; not be subdivided into municipal lots or blocks; be located on the border of the public water district; and, if disconnected, not result in the isolation of any part of the district from the remainder of the district. If these requirements are met, the owners of the land sought to be disconnected must petition the circuit court alleging facts in support of disconnection. The water district itself or any taxpayer within the district may defend against these allegations. If the court finds that the allegations of the petition are true and sufficient, it must order the disconnection. The disconnection does not, however, exempt the owner of the disconnected land from district taxation accrued prior to the filing of the petition.

111. Id. § 212.4-.9. The procedure for public water district dissolution is similar to the procedure for district formation, requiring petition of the court, id. § 212.5; a hearing on the petition, id. § 212.6; and a majority vote in favor of dissolution, id. § 212.7. A district is also dissolved, id. § 212.15, if all of its territory is annexed by a municipality under the terms of the Illinois Municipal Code, id. ch. 24, § 11-151-4.

112. See supra text accompanying note 1.

113. These organizations are governed by the General Not For Profit Corporation Act, Ill. Rev. Stat. ch. 32, §§ 163a-163a100 (1981), which defines a not-for-profit corporation as a "corporation no part of the income of which is distributable to its members, directors or officers; provided however,

that the payment of reasonable compensation for services rendered and the making of distributions upon dissolution . . . shall not be deemed a distribution of income." Id. § 163a1(c).

114. Id. § 163a3.

115. Id. § 163a4(b).

116. Id. §§ 163a4(d), (e).

117. Id. § 163a4(g).

118. Id.

119. Id.

120. Id. § 163a4(j). The corporation may indemnify its officers, directors, employees, and agents under certain circumstances. Id. § 163a23.1.

121. Id. § 163a4(l).

122. Id. § (m).

123. FmHA Illinois Instruction 1942-AA, § 1942.23.

124. Ill. Rev. Stat. ch. 32, § 163a7 (1981).

125. Id.

126. Id. § 163a12.

127. Id. A special member meeting may also be called by such other persons as provided in the corporate bylaws or articles of incorporation.

128. Id. § 163a13. Notice must be in writing, be timely (not more than 40 days nor less than 5 days before the meeting), and clearly indicate the purpose of the meeting.

129. Id. § 163a14. Under Illinois law, voting may be by proxy; it is not required that each member have one vote. The right to vote may be limited, enlarged, or denied as specified in the articles of incorporation or the bylaws. The bylaws may also provide the number of members constituting a quorum. Id. § 163a15. For an FmHa-financed project, however, each member is to have one vote, and voting may not be cumulative. FmHA Instruction 1942-A (Guide 4).

130. Id. § 163a30.

131. Id. § 163a29. The certificate may be filed by any three or more persons over the age of 21, acting as incorporators. Id. § 163a27.

132. Id. § 163a31.

133. Id. § 163a33(a).

134. Id. § 163a33(b).

135. Id. § 163a34. The articles of amendment must clearly set forth the procedure under which the amendment was adopted. Id. §§ (c), (d).

136. Id. § 163a35.

137. Id.

138. Id. § 163a36.

139. Id. § 163a16.

140. Id.

141. Id. § 163a17. See FmHA Instruction 1942-A (Guide 4).

142. Id. §§ 163a17, 163a19.

143. Id. § 163a20. No such committee may have the authority of the board of directors in reference to amending, altering, or repealing the bylaws; electing, appointing, or removing any member of such committee, director, or officer of the corporation; amending the articles of incorporation; authorizing the sale, lease, or exchange of all or substantially all of the corporation's property and assets; or dissolving the corporation. Id. § 163a20(1)-(7).

144. Id. § 163a21.

145. Id. § 163a22.

146. Id.

147. Id. § 163a23.

148. Id. § 163a23.1. The corporate official must have been acting in good faith and in a manner reasonably believed not to be opposed to the company's best interest in order to qualify for indemnification.

149. The registered agent is the agent of the corporation for the purpose of receiving any process, notice, or demand required or permitted by law to be served on the corporation. Id. § 163a11.

150. Id. § 163a9.

151. Id. § 163a24. These records are subject to inspection by any member or his agent for any proper reason at any reasonable time.

152. Id. §§ 163a62, 163a63.

153. Id. § 163a25.

154. Id. § 163a26.

155. Id. §§ 163a43-163a48. These sections provide for a plan of distribution that will provide that the corporation assets remaining after satisfaction of all creditors may be distributed to the members.

156. Id. §§ 163a49-163a61. Involuntary dissolution occurs by decree of a court upon complaint in equity filed by the Attorney General, when it appears to the court that the franchise of the corporation was procured through fraud; the corporation has continued to violate the provisions of the Act under which it was organized (see supra note 113); the corporation has not fully cooperated with the Secretary of State's misconduct investigation; the corporation has fraudulently solicited money or fraudulently used solicited money; or the corporation has substantially and willfully violated the provisions of the state consumer fraud law (Ill. Rev. Stat. ch. 121 1/2, § 261-272). Id. ch. 32, § 163a49(a)-(e). Involuntary dissolution and subsequent liquidation of assets and satisfaction of creditors may also be ordered if the corporation has failed to file annual reports, maintain a registered agent, or pay fees. Id. § 163a49.1. Suits for involuntary dissolution may be brought by a member or director when the corporation is no longer acting in its best interest, id. § 163a53(a), or by a creditor entitled to a judgment against the corporation, id. § 163a53(b).

CHAPTER 4

OPERATORS AND OPERATION OF RURAL WATER DISTRICTS IN ILLINOIS

An Illinois rural water district is considered a "public water supply" which is defined to include:

> all mains, pipes and structures through which water is obtained and distributed to the public, including wells and well structures, intakes and cribs, pumping stations, treatment plants, reservoirs, storage tanks and appurtenances, collectively or severally, actually used or intended for use for the purpose of furnishing water for drinking or general domestic use and which serves at least 15 service connections or which regularly serves at least 25 persons at least 60 days per year.[1]

The statute distinguishes between community and non-community water supplies. A "community water supply" is a public water supply that "serves or is intended to serve at least 15 service connections used by residents or regularly serves at least 25 residents."[2] A "non-community water supply" is a water supply that is not a community water supply.[3] The Illinois Environmental Protection Agency (IEPA or Agency) regulates only community water supplies.

Illinois rural water districts, which fit within the statutory definition of community water supplies, are thus subject to state laws and regulations. Two statutes are primarily applicable: the Illinois Environmental Protection Act,[4] which establishes IEPA and gives it authority to regulate water supplies, and "an act to regulate the operating of a public water supply."[5] Regulations are promulgated by the Pollution Control Board (PCB), which has rulemaking authority and also hears appeals of IEPA actions.[6] The IEPA exercises supervisory authority over community water supplies, pursuant to the Environmental Protection Act and the PCB rules and regulations.[7] The following discussion summarizes these laws applicable to the operation of community water supplies and describes the regulatory schemes promulgated under their authority.[8]

A. Water Supply Operators

1. Statutory Requirements

a. Operator Requirements

Illinois law requires each non-exempt public water supply, including rural water districts, to employ at least one natural person certified competent as a water supply operator.[9] Each public water supply that includes coagulation, lime softening, or sedimentation as part of its primary treatment must hire a certified Class A[10] water supply operator.[11] Every public water supply that includes filtration, aeration and filtration, or ion exchange equipment as part of its primary treatment must hire[12] a certified Class A or Class B operator.[13] Each public water supply that uses only chemical feeding must hire a certified Class C,[14] Class B, or Class A water supply operator.[15] Those public water supplies in which the facilities are limited to pumpage, storage, or distribution must have Class D,[16] Class C, Class B, or Class A water supply operators.

A public water supply can satisfy these requirements by contracting for the services of a properly qualified certified operator of the required class or higher.[17] The IEPA receives notice of the operator's employment when the water supply files a Notification of Certified Operator in Responsible Charge form with the Agency.[18]

b. Certification of Water Supply Operators

The process of water supply operator certification is the regulatory responsibility of the IEPA; assistance in policy information and program development is provided by the Water Supply Operator Certification Advisory Board (Advisory Board).[19] The Agency conducts certification examinations, issues certificates of competency, and passes on the qualifications of applicants for reciprocal certificates.[20] The Agency may suspend, revoke, or refuse to issue any certificate on grounds of fraud or deceit in attempting to gain a certificate;[21] negligence, misconduct, or incompetency in the operation of a water supply;[22] declaration of insanity or mental illness or deficiency by a court of competent jurisdiction;[23] and failure to comply with any of the rules[24] pertaining to the operation of a water supply.[25] On its own motion, the Agency may investigate the action of a certificate holder.[26] The Agency must investigate the competency of a certified operator upon receipt of a sworn written complaint from any person setting forth charges that, if proved, would constitute grounds for certificate suspension, revocation, or refusal.[27] The Illinois Pollution Control Board will conduct formal hearings or proceedings pertaining to the IEPA's refusal to issue, revocation, or suspension of a certificate, on the sworn written request of the certificate applicant or holder.[28]

The Advisory Board[29] assists in the formulation and review of the policies and program of the Agency regarding Water Supply Operator Certification, and provides technical advice and assistance as requested.[30] It can recommend the waiver of experience requirements as a pre-requisite for admission to a written examination. In addition, the Advisory Board can provide initial review of Agency refusal, suspension, or revocation of a certificate, and advise the agency of suggested action.[31]

Every applicant for certification must demonstrate the ability to maintain and operate properly the structures and equipment in the appropriate classification defined in the certification law.[32] Classification of water supply operators is based on level of competency as determined by examination and in accordance with educational and experience requirements.[33] Appropriate credit, to be applied against the experience requirement, for certain educational endeavors may be granted by the Agency.[34] Certificates are issued for a period of three years[35] and may be renewed.[36] A certificate will be issued to the holder of an unexpired certificate from any state, territory, United States possession, or foreign country with comparable requirements and a similar reciprocity provision.[37]

2. Regulations for Water Supply Operator Certification

Pursuant to the public water supply law, the Environmental Protection Agency has promulgated a set of regulations governing water supply operator certification.[38] These rules specify the frequency and location of water supply operator certification exams[39] and review the certification eligibility requirements[40] as described in the Act.[41] The regulations summarize the characteristics of the written certification examination: the portions of the exam that must be taken,[42] the scoring method,[43] and the procedure for retake of the exam on failure of a section or subsection.[44]

The Agency must also review the qualifications of all applicants for certification[45] and the requests for certification by reciprocity.[46] The regulations further specify the procedure for review of the Agency's action in refusing to issue, suspending, or revoking a certificate.[47] Under this procedure, the applicant may request a preliminary hearing before the Advisory Board; the Board recommends a course of action to IEPA. The Agency then makes a final decision based on this recommendation. If the final Agency decision is not favorable to the petitioner, or if the applicant chooses not to use the Advisory Board review procedure, a formal hearing before the Pollution Control Board may be requested under the provisions of the Act.[48]

B. The Protection of Public Water Supplies

1. The Environmental Protection Act

The Environmental Protection Act[49] provides for Agency supervision of public water supplies[50] both to protect the public from disease and to ensure an adequate supply of potable water.[51] The Act governs submission of plans and specifications for construction, changes, or additions to public water supply installations.[52] Official custodians[53] of public water supplies must submit plans and specifications for Agency approval before initiating any work. Plans must be complete and in sufficient detail to show all construction changes or additions that might affect the quality or the adequacy of the water supply.[54] Plans and specifications meeting these criteria must be approved by the Agency, if they are satisfactory from the standpoint of water quality and adequacy of supply.[55]

The Act further requires official custodians of public water supplies to maintain a continuous safe, adequate supply of water for domestic use.[56] Official custodians must submit water samples for analysis and provide reports of operations as requested by the Agency.[57] The Pollution Control Board has the power to adopt regulations to carry out these statutory directives.[58]

2. Regulations for Public Water Supply Operation

The Illinois Pollution Control Board regulations for public water supplies[59] govern another aspect of rural water districts as community water supplies. The premise of these rules is the finding of the General Assembly that "state supervision of public water supplies is necessary in order to protect the public from disease and to assure an adequate supply of pure water for all beneficial uses."[60] The rules are intended to serve as a guide in the design, preparation, and submission of plan documents for public water supply systems and their operation; to delineate limiting values for items upon which an evaluation of such plan documents will be made; to establish, so far as is practicable, uniformity of practice among the various engineers; and to delineate operation and maintenance procedures as necessary to ensure safe, adequate, and clean water.[61]

a. <u>Permits</u>

The regulations require each public water supply facility to obtain three types of permits: construction, operating, and algicide. No person shall cause or allow the construction of any new public water supply installation, or cause or allow the change of or addition to any existing public water supply, without a construction permit issued by the IEPA.[62] The permit requirement for public water supply installation, change, or addition does not include routine maintenance, service pipe connections, hydrants and valves, or replacement of equipment, pipe and appurtenances with their equivalents; however, all maintenance and replacement work must be performed in accordance with accepted engineering practices.[63]

All applications for construction permits must contain, where applicable, a summary of the basis of design, operational requirements, general layout, detailed plans, and specifications. These plan documents for a public supply or modification of an existing public water supply must be prepared by a person qualified under the appropriate professional registration Acts[64] and must have the necessary professional seal affixed. No construction permit will be granted unless the applicant submits adequate proof that the public water supply conforms to the design criteria promulgated by the Agency, or is based on other criteria that the applicant proves will produce consistently satisfactory results.[65]

Construction permits for public water supply facilities are valid for construction beginning within one year from the date of issuance[66] and may be renewed for additional one-year periods at the discretion of IEPA. Construction, once started, may continue for four years without permit renewal, and may be extended. Liability may result from construction of a public water supply without a permit.[67]

An owner or operator of a public water supply cannot cause or allow the use or operation of any new public water supply, or any new addition to an existing supply for which a construction permit was required without an operating permit issued by the Agency.[68] Applications for operating permits must contain the name and certificate number of the certified operator, as well as the name and location of the supply, the construction permit number, and any other information required by IEPA. Operating permits remain valid until revoked, unless otherwise stated in the permit.[69]

An algicide permit is required for the application of algicide to any stream, reservoir, lake, pond, or other body of water used as a public water supply. Permits issued under this regulation by IEPA are valid for public water supply sources only. Copper sulfate is the only algicide that may be used in public water supplies.[70] Applications for algicide permits must contain the name and certificate number of the certified operator supervising the application of the algicide and sufficient additional information to evaluate properly the dosages and effects of the treatment. Each permit application must include a statement describing the extent of the algae problem, the history of any algae problems and algicide treatments, and a description of any fish kills resulting from past treatments.[71] Algicide permits are valid for the period stated in the permit, with a five-year maximum.[72] Sould there be any major change either in the operation of the water supply, or in the algae growth, which affects the use of copper sulfate as outlined in the permit, the water supply officials shall submit an application for modification of the permit.[73]

Permit applications must be signed by the owner, official custodian, or authorized agent of the public water supply, and must be accompanied by evidence of authority to sign the application.[74] If the IEPA fails to take final action by granting or denying the permit, as requested or with conditions, within 90 days from the filing of the completed application, the applicant may consider the permit granted for a one-year period. The applicant may waive this 90-day final action requirement.[75]

In addition to the specific conditions authorized under the regulations as discussed, the Agency may impose other conditions necessary to accomplish the purposes of the Environmental Protection Act, and not inconsistent with regulations promulgated by the Pollution Control Board.[76] An applicant may consider any condition imposed by the Agency in a permit as a refusal by the Agency to grant a permit, and may appeal the Agency's decision to the Pollution Control Board.[77]

The Agency may adopt criteria, published in the form of technical policy statements, for the design, operation, and maintenance of public water supply facilities as necessary to ensure safe, adequate, and clean water.[78] These criteria may be revised from time to time to reflect current engineering judgment and advances. Technical policy statements are adopted and amended as agency rules in accordance with the requirements of the Illinois Administrative Procedure Act. This law requires publication of proposed rules in the Illinois Register, followed by a 45-day period for public comment; it also specifies other requirements before a proposed rule may be effective.[79]

As of March 1984, the IEPA had in draft form the text of new Public Water Supply Technical Policy Statements.[80] These policy statements, which supplement the regulations, include more comprehensive explanations and additional information, particularly in the area of water supply design. Both the regulations and the Technical Policy Statements should be consulted.

Whenever emergency conditions require immediate action, the Agency may issue construction and operating permits by telephone (to be confirmed in writing), with whatever special conditions the Agency deems necessary to safeguard the health of water consumers. "As-built" plans and specifications covering the work performed under the telephone permit must be submitted to the Agency as soon as reasonably possible. Modifications required by IEPA after review of the submission must be made promptly.[81]

Violation of permit conditions or failure to comply with applicable rules or regulations may result in enforcement actions, including revocation of permit, initiated by filing a complaint with the Pollution Control Board.[82] Any public water supply permit issued under these regulations is not considered valid unless and until applications have been made for all other required permits from state Agencies[83] and permits as needed from other Divisions of the Agency have been obtained.

b. Operation and Maintenance

To assure the continued operation and maintenance of public water supplies, each supply must be under the individual direct supervision of a municipal or private corporation, individual private owners, or a regularly organized body governed by a constitution and bylaws requiring regular election of officers.[84] The body exercising this direct supervision must file with IEPA a statement of ownership before beginning construction of any public water supply facility, and will be considered the owner until IEPA receives a notification of change of ownership.[85] All official operating reports submitted to the Agency are to be signed by a certified operator, who is responsible for the proper operation of the supply. Moreover, all provisions of the Act relating to certification of public water supply operators[86] must be followed.

The PCB regulations contain detailed provisions designed to ensure that a sufficient quantity of water will be available and that its quality will be acceptable. Accordingly, the regulations impose controls on quality and quantity of raw water.[87] Each public water supply must take its raw water from the best available source that is economically reasonable and technically possible, and must act to protect a water source under its control or ownership.[88] The quantity of raw water, whether from a surface supply or groundwater, must be adequate to supply the total water demand of the public water supply from that source, as well as a reasonable surplus for anticipated growth. In the case of a groundwater source, this quantity must be available without excessive depletion of the aquifer.[89]

A number of regulations are designed to ensure that water will be treated properly, and that the quality of the finished water will be acceptable when the water reaches consumers. These regulations recognize the crucial importance of competent day-to-day operation of water supplies. Because the standards are complex and detailed, however, they are treated only briefly in this report.

These operating regulations include exacting specifications for treated water quality in public water supplies.[90] Sampling methods and parameter limits are specified for bacteriological quality,[91] chemical and physical quality,[92] and radiological quality.[93]

The sampling and monitoring requirements are an integral part of the regulatory scheme.[94] Regulations specify the required frequency of sampling, as well as the number of samples required. Bacteriological samples, for example, must be submitted monthly; the number of samples required increases with the size of the population served by the water supply.[95] The regulations require less frequent analysis for chemicals, trihalomethanes, and radioactivity.[96] Official custodians of community water supplies that use surface water sources must perform sampling and turbidity analysis daily.[97]

The rules further require that all public water supplies, except those purchasing treated water containing adequate chlorine or having an exemption, must chlorinate water before it enters the distribution system. IEPA sets levels of chlorine and promulgates procedures for chlorination.[98] Illinois law also requires public water supplies to add flouride to their water.[99]

Reporting requirements and record maintenance are another aspect of public water supply regulation.[100] Monthly reports must be submitted to the Agency by all supplies.[101] In addition, the owner or operator of a public water supply must report to IEPA the results of a required test, measurement, or analysis, and the failure to comply with any requirement in the regulations.[102] Any owner or operator must retain on its premises or at a convenient location near its premises the following records:[103] reports of bacterial and chemical analyses;[104] records of action taken to correct violations of the Environmental Protection Act and regulations;[105] records relating to any sanitary survey of the water supply;[106] and records concerning a variance granted to the supply.[107]

One of the most serious concerns of the public water supply regulations is contamination of the supply. All public supplies undergoing repair work must be adequately protected to prevent contamination of the water system during the work.[108] A disinfection procedure specifically approved by the Agency must be employed at any public water supply that has been repaired, reconstructed, or altered.[109] When contamination persists in a public water supply, as demonstrated by bacteriological analysis, the official custodian must notify consumers to boil all water used for drinking or culinary purposes until corrective action has been effective.[110] The official custodian of a public water supply must protect the supply from danger, including spillage of hazardous substances and water-borne diseases.[111]

To prevent contamination, the PCB rules strictly regulate cross connections. No physical connection is permitted between the potable portion of a public water supply and any other water supply not of equal or better quality.[112] Control of all cross connections to a public water supply is the responsibility of the official custodian. A privately-owned water supply source that meets the applicable criteria may be connected to a public water supply with approval by the official custodian and IEPA.[113]

Public notification, designed to make consumers aware of the condition of their water supply, is required if the supply fails to comply with quality and monitoring requirements.[114] The regulations provide for notice to persons serviced by the water supply; in some situations notice to the general public is required.[115]

Although the operational requirements for water supplies have been presented rather briefly, compliance with these detailed requirements is essential to a well-run water supply. IEPA's Division of Public Water Supplies provides assistance to water supply personnel, so that compliance can be achieved and consumers will have a reliable source of potable water.

FOOTNOTES

1. Ill. Rev. Stat. ch. 111 1/2, § 505(a) (1983). See also the Environmental Protection Act, Ill. Rev. Stat. ch. 111 1/2, § 103(u) (1983).
2. Ill. Rev. Stat. ch. 111 1/2, §§ 505(b), 1003(rr) (1983).
3. Id. §§ 505(c), 1003(ss). Both the public water supply law and the Environmental Protection Act state that their requirements do not apply to non-community water supplies.
4. Id. §§ 1014-1019, 1004(a), (c).
5. Id. §§ 501-523.
6. See, e.g., id. §§ 512 (appeals), 1017 (rulemaking).
7. See, e.g., State of Illinois Rules and Regulations, Title 35; Environmental Protection; Subtitle F: Public Water Supplies; Chapter I: Pollution Control Board and Chapter II: Environmental Protection Agency [Hereinafter cited as Subtitle F].
8. Laws are subject to amendment and regulations are frequently amended. Thus, the reader should consult current versions of the laws and regulations discussed in this report.
9. Id. § 501. A water supply operator is defined as "any natural person trained in the treatment or distribution of water who has practical working knowledge of the chemical, biological, and physical sciences essential to the practical mechanics of water treatment or distribution and who is capable of conducting and maintaining the water treatment or distribution processes in a manner which will provide safe potable water for human consumption." Id. § 504.

   The Illinois water supply operator certification law includes a provision defining an "exempt public water supply." Id. § 509.1. An exempt supply must register with IEPA the person in responsible charge of the supply, as well as the official custodian or owner. The statute provides no experience or examination requirements for the person in responsible charge of an exempt water supply. Id. § 509.2.
10. A "Class A" Water Supply Operator Certificate is issued to persons who demonstrate a practical working knowledge of the coagulation, lime

softening, and sedimentation water treatment methods, and who have fulfilled the Class B, C, D, (see infra notes 13, 14, 16) operator requirements. Id. § 513(a).

11. Id. § 501(a).
12. Id. § 501(b).
13. A Class B Water Supply Operator Certificate is issued to persons who demonstrate a practical working knowledge of filtration, filtration and aeration, and ion exchange water treatment systems, and who have fulfilled the requirements of Class C and D operators (See infra notes 14, 16). Id. § 513(b).
14. A Class C Water Supply Operator Certificate is issued to persons who demonstrate a practical working knowledge of chemical feeding and disinfection water supply treatment and who have met the Class D (see infra note 16) requirements. Id. § 513(c).
15. Id. § 501(c).
16 A Class D Water Supply Operator Certificate is issued to persons who demonstrate a practical working knowledge of water system pumpage, storage, and distribution. Id. § 513(d).
17. Id. § 501(d).
18. See Subtitle F, § 603.103. Although the statute mentions the requirement of a written contract filed with IEPA, the Agency considers the Notification form as a contract between the custodian of the supply and the certified operator.
19. Ill. Rev. Stat. ch. 111 1/2, §§ 510, 511.
20. Id. § 510(a).
21. Id. § 510(d)(1).
22. Id. § 510(d)(2).
23. Id. § 510(d)(3).
24. The rules pertaining to the operation of a public water supply are Subtitle F, supra note 7.
25. Ill. Rev. Stat. ch. 111 1/2, § 510(d)(4).
26. Id. § 510(g).
27. Id.
28. Id. § 512.

29. The Advisory Board consists of the Agency Director and five other members appointed by the Governor. One of the members must be the chief executive officer of a municipality operating its own municipal water plant. All appointed members must have an active interest and background in water supply management and operation. The appointed members of the Advisory Board serve without compensation for a term of five years. Id. § 511.
30. Id.
31. Subtitle F, § 680.703.
32. Ill. Rev. Stat. ch. 111 1/2, § 514.
33. Id.
34. Id. § 515.
35. Id. § 518(a).
36. Id. §§ 518(b)(c), 522.
37. Id. § 520. The statute, § 521, permits IEPA to grant "limited" certificates under certain conditions. IEPA does not currently issue limited certificates.
38. Subtitle F, Part 680.
39. Id. § 680.201-.203.
40. Id. § 680.301-.306.
41. See supra notes 10, 13, 14, 16.
42. Subtitle F, § 680.401.
43. Id. § 680.402.
44. Id. § 680.501-.503.
45. Id. § 680.302-.303.
46. Id. Subpart F.
47. Id. Subpart G.
48. Ill. Rev. Stat. ch. 111 1/2, § 523 (1983).
49. Id. §§ 1001-45.
50. Id. Title IV: Public Water Supplies, §§ 1014-1019.
51. Id. § 1014.
52. Id. § 1015. See also Title X of the Act regarding permits.
53. The "official custodian" of a water supply is "any officer of an organization which is the owner or operator of a public water supply, and who has direct administrative responsibility for the supply." Subtitle F,

§ 601.105. The "owner" has legal ownership of the supply; the "official custodian" is designated by the owner to act on behalf of the supply. The term "official custodian" is used in the text of this report.

54. Ill. Rev. Stat. ch. 111 1/2, § 1015 (1983).
55. Id. § 1016.
56. Id. § 1018.
57. Id. § 1019.
58. Id. § 1017. See Subtitle F, Parts 601-607.
59. Subtitle F, Parts 601-607.
60. Ill. Rev. Stat. ch. 111 1/2, § 1014 (1983).
61. PCB Rules and Regulations, Chapter 6: Public Water Supplies, § 102 (1979) (omitted from current rules in Subtitle F).
62. Subtitle F, §§ 602.101-.120.
63. Id. § 602.101.
64. These include the laws regulating architects, Ill. Rev. Stat. ch. 111, §§ 1201-1236 (1983); professional engineers, id. §§ 5101-5137; and structural engineers, id. §§ 6501-6530.
65. Subtitle F, §§ 602.105, 602.115.
66. Id. § 602.113.
67. According to id. § 602.116, whenever a supply has been constructed without a construction permit, the Agency may require submission of "as-built" plans prepared by a person qualified as described in § 602.105. Any deficiencies requiring correction must be corrected within a time limit set by the Agency. This does not relieve the owner or official custodian from liability for construction of the supply without a permit. Liability under the Environmental Protection Act arises pursuant to Ill. Rev. Stat. ch. 111 1/2, § 1042(a), which provides a civil penalty up to $10,000 and an additional $1000 per day. The law, id., § 1044(a), also prescribes a criminal penalty.
68. Subtitle F, § 602.102.
69. Id. §§ 602.109, 602.113.
70. Id. § 602.103.
71. Id. § 602.110
72. Id. § 602.113, as amended, 8 Ill. Reg. 2157, effective Feb. 7, 1984.

73. Subtitle F, § 602.110, as amended, 8 Ill. Reg. 2127, effective Feb. 7, 1984.
74. *Id*. § 602.107.
75. *Id*. § 602.112.
76. *Id*. § 602.114.
77. *Id*. § 602.118. Ill. Rev. Stat. ch. 111 1/2, § 1040 (1983) provides that the applicant may petition for a hearing before the Board, where the Agency shall appear as a respondent. The burden of proof rests with the petitioner.
78. Technical policy statements are available on request from the Illinois EPA, Division of Public Water Supplies, Springfield, Illinois.
79. See Illinois Administrative Procedure Act, Ill. Rev. Stat. ch. 127, §§ 1001-1021 (1983). The first notice period required by the Act is the 45-day period following publication in the Illinois Register; public hearing may be required. The second notice period provides time for review by the Joint Committee on Administrative Rules. *Id*. § 1005.01. Adopted rules must be filed with the Secretary of State and published in the Illinois Register. *Id*. § 1006. See also Ill. Rev. Stat. ch. 111 1/2, § 1028.
80. These are to be codified as Subtitle F, Parts 651-654.
81. Subtitle F, § 602.104. The written confirmation may be conditioned on receipt and approval of the "as-built" plans.
82. Ill. Rev. Stat. ch. 111 1/2, §§ 1030, 1031 (1983). These sections provide for Agency investigations on request of the PCB or receipt of information concerning an alleged violation of the Act or its rules or regulations. If the investigation discloses that a violation may exist, the Agency must issue proper notice to the person complained against, who must then answer the complaint at a hearing before the Board. Any person may file a complaint with the PCB, but the burden of proof at the hearing is on the complainant or the IEPA.
83. These include (but are not limited to) an Illinois Commerce Commission Certificate of Convenience and Necessity, a Department of Mines and Minerals Well Drilling Permit, or a Department of Transportation Permit for a Change to Existing Waterways. See Subtitle F, § 602.120.

84. *Id*. § 603.101.
85. *Id*. The EPA must be notified within 15 days of any change in ownership or responsible personnel. *Id*. § 603.105. Notification is not valid unless the new owner or responsible personnel indicates acceptance of the duties in the notification document.
86. Ill. Rev. Stat. ch. 111 1/2, §§ 501-523 (1983).
87. Water that has not yet passed through the treatment system is known as raw water.
88. Subtitle F, § 604.501.
89. *Id*. § 604.502.
90. *Id*. §§ 604.101-.405.
91. *Id*. §§ 604.101-.105
92. *Id*. §§ 604.201-.204.
93. *Id*. §§ 604.301-.303.
94. Subtitle F, Part 605.
95. *Id*. § 605.102.
96. *Id*. § 605.103-.108.
97. *Id*. § 605.109.
98. *Id*. § 604.401.404. See Ill. Rev. Stat. ch. 111 1/2, § 1017(b) (1983), which specifies criteria for exemption from the chlorination requirement. This law was amended recently. See Technical Policy Statements, *supra* note 80, § 653.607, which incorporates the requirements of the amended statute.
99. Ill. Rev. Stat. ch. 111 1/2, § 121gl (1981). This Act requires that a flouride ion concentration reported as F of 0.9 to 1.2 mg/liter be maintained in all public water supply distribution systems. See also Subtitle F, § 604.405.
100. *Id*. § 604.101-.103.
101. *Id*. § 606.101.
102. *Id*. § 606.102. Reports must be made within 40 days after the test, measurement, or analysis, and failures to comply must be reported within 48 hours.
103. *Id*. § 607.106.

104. *Id.* Records of bacteriological analyses must be kept for not less than five years; records of chemical analyses must be kept for not less than ten years.

105. *Id.* These records must be kept for a period of not less than three years.

106. *Id.* These records must be kept for a period of not less than ten years.

107. *Id.* Variances from Agency regulations are granted, pursuant to Ill. Rev. Stat. ch. 111 1/2, §§ 1035-1038 (1983), only on a showing that compliance with a regulation or requirement would impose an arbitrary or unreasonable hardship. The variance process involves a petition to the Agency, an Agency investigation, and a hearing before the Pollution Control Board.

108. *Id.* § 607.101.

109. *Id.* § 607.102.

110. *Id.* § 607.103. If the official custodian fails to act, IEPA can issue the boil order. Boil orders are also required for certain water pressure emergencies.

111. *Id.* § 607.103.

112. *Id.* § 607.104. Cross connections link two different sources of supply.

113. *Id.*

114. *Id.* § 606.201.

115. *Id.* § 606.201-.204. Notice to IEPA is required by § 606.102.

CHAPTER 5

GENERAL CHARACTERISTICS AND COST ANALYSES OF RURAL WATER SYSTEMS

The expenditure and general physical properties of rural water districts in Illinois are first described in this chapter. Subsequently, analyses of operating costs and selected capital costs are presented. The purpose of these descriptions and analyses is to 1) provide an understanding of the nature of rural water systems regarding their volume of output, number of users, density of users and miles of pipeline, 2) suggest the general costs of rural water services per user and per quantity of water provided and the relationship between operating outlays and debt service, and 3) analyze the factors influencing the operating and initial capital costs of rural water systems with special emphasis on impact of size.

Three data sources are employed in the cost and physical characteristic analysis. The first source is from a brief mail survey of the 59 Illinois rural water districts. A total of 51 surveys were completed and returned for a response rate of 86 percent. Survey data included information on years of operation, miles of pipeline, number of users, water source and current water rate schedule. The survey data was supplemented with expenditure information available in the files of the Illinois state office of the Farmers Home Administration. Because of the paucity of complete records, expenditure data for the years 1978 through 1980 were collected. The sample of water districts used in the operating cost analysis included observations on 36 different districts over the three years for a combined total sample size of 62. Some districts had data in more than one year. To account for price level changes, data were adjusted to a 1978 base using the GNP implicit price deflator for state and local government purchases. Matching the expenditure data and the survey data to provide observations on user density reduced the number of complete expenditure records to 45. This sample provided the descriptive information on district cost characteristics and was also used to statistically analyze per unit operating costs.

The third data set on selected capital costs from Illinois rural water systems was obtained from bid tabulations filed at the Illinois state office of the Farmers Home Administration. A total of 180 bid tabulations of construction projects awarded during the period 1970 to 1981 was collected. The projects undertaken were for the creation and/or expansion and improvement of rural water distribution systems in the state.

GENERAL CHARACTERISTICS

The water systems studied in Illinois serving unincorporated areas that have received financial assistance from the Farmers Home Administration vary in size from 15 to 2,400 users and range in output from about 3 to 158 million gallons per year (Table 5.1). The majority of Illinois

Table 5.1

General Characteristics of Illinois Rural Water Districts, November 1982

Characteristic	Mean	Median	Minimum	Maximum	Number Reporting
Years in Operation	8.6	8	1	17	51
Number of Users	400.6	278	15	2,400	50
Miles of Line	71.0	50	2	380	44
Customers Per Mile of Line	5.6*	--	1.9	33.3	43
	Ground (%)		Surface (%)		
Water Source	53		47		51
	Yes (%)		No (%)		
Purchase Water	84		16		51

* A weighted mean obtained by dividing total users by total miles of line.

systems are between five and 10 years old. About 19 percent had been in operation less than five years, while 28 percent were in operation for more than ten years in 1982. Reported miles of pipe varied from 2 to 380 with a mean of 71 miles and a median of 50 miles. The median number of users reported was 278 while user density ranged between 1.9 and 33.3 users per mile of pipe.

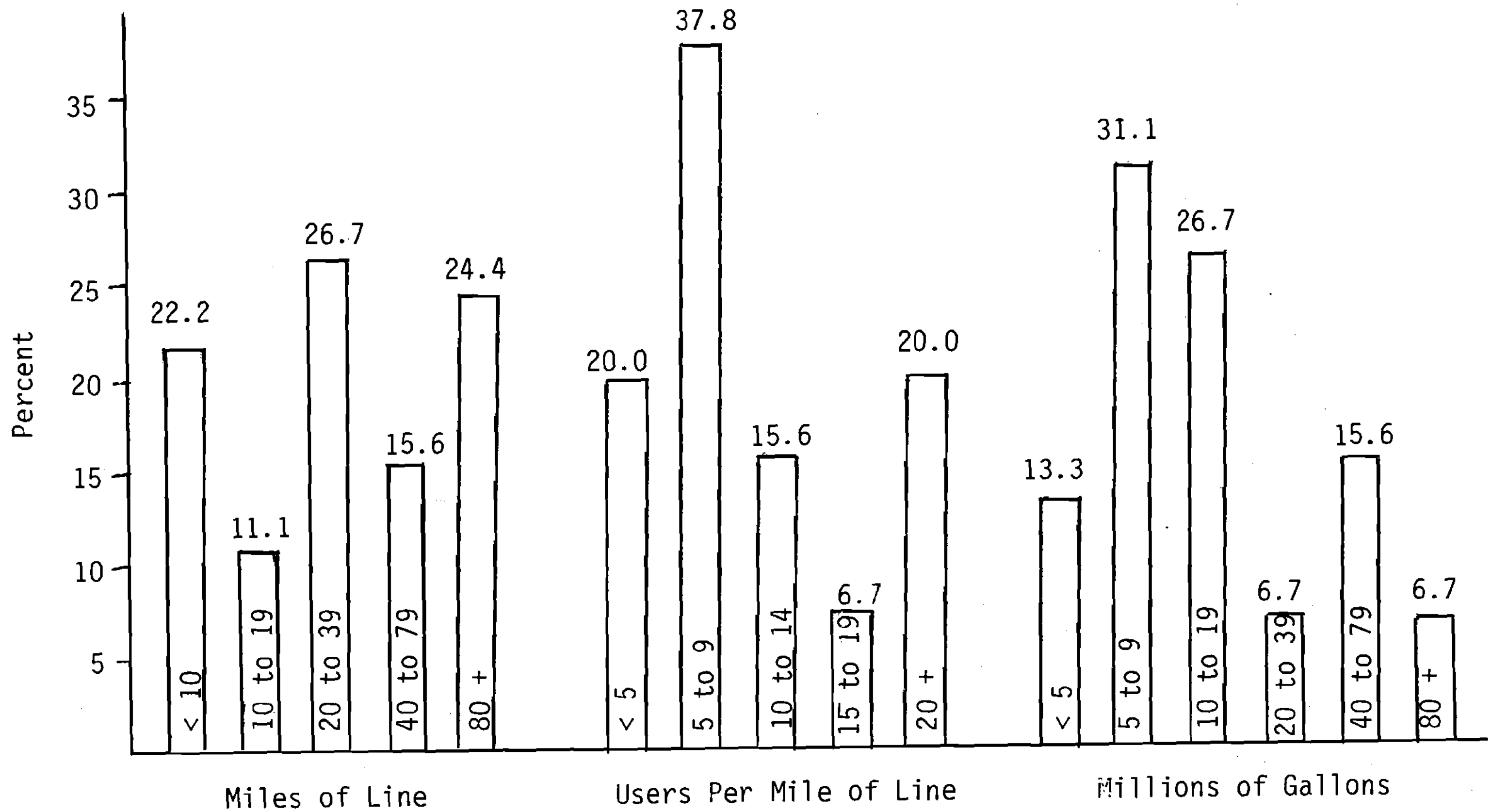
Interestingly, about 53 percent of the districts reported their source of water as well or ground water while 47 percent indicated they relied on surface water sources--rivers, reservoirs, lakes. Most districts indicated they purchased water--treated or raw. Only 16 percent said they buy no water. This suggests the interconnection of water systems, to some extent, for the buying and selling of water among districts, with cities or towns and with other possible sources. Neither the degree of interconnection nor the details on water transfers and transactions were obtained. Additional information on water "wholesaling" including contract terms, pricing policies and legal implications would be of interest for water policy planning and analysis.

Additional details on selected district characteristics are presented in Figure 5.1. Surprisingly, about the same proportion of reporting districts had 80 or more miles of line as had less than ten miles. About 27 percent of the districts reported from 20 to 39 miles of line.

Two common measures of water system size that are important in understanding the uniqueness of providing potable water to farmers and other residents in the countryside are 1) users per mile of pipe or user density and 2) volume of production generally measured in millions of gallons per year. The first size measure incorporates two aspects of collectively provided rural water service. The first is the generally small number of users. A 1965 Illinois study of urban public water supply utilities that included 485 systems serving 71 percent of the state's population reported that 56 percent of the urban systems served populations over 1,000 (Afifi and Bassie, 1969). In contrast,

Figure 5.1

Distribution of Selected Rural Water District Characteristics



only 5 rural systems in Illinois reported over 1,000 customers with 74 percent reported serving less than 500 customers and about 30 percent serving less than 200 customers. A study of rural water systems in the 5 states of Iowa, Missouri, Nebraska, North Dakota, and South Dakota reported 61 percent of the systems in these states served 500 or fewer users (Gessaman and Janovec, 1982).

The second dimension of rural water service reflected in the user per mile of pipe measure of size is the spatial aspect of the service. Rural water system users are not concentrated or clustered in communities but scattered in low densities across the countryside living on farms, rural acreages and noncontiguous residential sites.

About an equal proportion (20 percent) of systems reported user densities of less than 5 users per mile of pipeline and 20 or more users per mile of line. However, the 5 through 9 user per mile of line category dominates. About 38 percent of the districts fell in this size range. About 22 percent of the districts had between 10 and 19 users per mile of line.

The second size measure, gallons of water sold, indicates that the majority (71 percent) of the reporting districts sell less than 20 million gallons of water annually with about 13 percent reporting sales of less than 5 million gallons, 31 percent with sales of 5 through 9 million gallons, and 27 percent with sales of 10 through 19 million gallons. Only 7 percent reported annual sales of 80 or more million gallons of water.

Table 5.2 reports additional district characteristics broken down by users per mile of line. This breakdown is for the 45 cases in the more detailed data set that includes the cost information. Two general trends are suggested by the information in this table. First, the districts with lower user densities tend to have both more miles of pipe and more users. As rural districts include a larger area in their jurisdiction, as indicated by the miles of line, to increase the number of customers, the users per

Table 5.2

Selected Illinois Rural Water District Characteristics by Users Per Mile of Line

Users Per Mile of Line	Average Number of Users Per Mile of Line	Average Miles of Line	Average Number of Users	Average Gallonage of Water Sold Per Year (m gal.)	Water Per User Per Year (t gal.)
Less than 5	3.9	145.6	553.6	25.82	46.64
5 to 9	7.5	54.0	397.5	20.65	51.95
10 to 14	11.8	37.0	410.0	35.43	86.41
15 to 19	17.2	8.6	144.3	23.27	161.26
20 and Over	28.1	7.1	186.2	9.17	49.25
Full Sample	12.2	57.3	371.6	21.86	58.83

mile of line declines. Second, the average gallons of water sold does not vary substantially among the categories of user densities. The exceptions are districts with 20 and over users per mile of line. One explanation for this might be that these systems serve fewer farms which may have higher consumption rates than nonfarm customers.

A similar set of descriptions are presented in Table 5.3 but with the districts classed by the quantity of water sold. The information in Table 5.3 reinforces the notions evidenced in the previous table. First, as the quantity of water sold increases, the average miles of line and the average number of users also increase and concomitantly the average number of users per mile of line generally declines. This suggests that if there are economies of size in the provision of water services, as most studies of the water utility industry have reported, rural water systems may face a dilemma if lower user densities are associated with diseconomies (Afifi and Bassie, 1969; Kitchen, 1977). To capture lower per unit costs through increased output, systems need to add customers.

Table 5.3

Selected Illinois Rural Water District Characteristics
by Quantity of Water Sold Per Year

Quantity of Water Sold Per Year (m gal.)	Average Number of Users Per Mile of Line	Average Miles of Line	Average Number Of Users	Average Gallonage of Water Sold Per Year (m gal.)	Water Per User Per Year (t gal.)
Less than 5	20.9	11.8	127.0	3.83	30.16
5 to 9	12.4	22.6	167.8	7.09	42.25
10 to 19	10.3	41.2	282.9	12.86	45.46
20 to 39	13.9	125.3	570.7	28.45	49.85
40 to 79	8.6	108.5	733.6	48.42	66.00
80 and Over	8.4	186.7	1,122.7	94.34	84.03
Full Sample	12.2	57.3	371.6	21.86	58.83

And in adding customers, the initial evidence suggests that user density declines possibly countering the lower costs captured with increased water sales.

In general, the rural water systems in Illinois are small, in a relative sense, whether measured by user density or volume of water sales. Because these two characteristics are argued to be major factors in determining the cost of providing rural water service, they are used as classification categories to describe the expenditures of the Illinois rural water systems using the cost sample of 45 cases (Moberg, 1976).

RURAL WATER DISTRICT COSTS

Unlike many services provided collectively, water service has traditionally been treated as a self supporting enterprise not subsidized with local tax revenues. Water services are generally paid for by users.[1] Thus, to be self supporting in the long run, enough revenue must be collected from customers to cover costs.

All costs must be considered, including capital and operating and maintenance costs. Another classification of costs is whether they are variable or fixed. In applying this classification to public water service three categories can be delineated: 1) variable operating costs--source of water, plant payrolls, treatment supplies, electric power, etc., 2) semi-fixed or general--administration, meter reading and customer services, maintenance, accounting and billing, and 3) fixed capacity costs--capital depreciation or reserves, retirement of debt, etc. (Hirshleifer, DeHaven and Milliman, 1969).

The first two categories correspond in general to commodity and customer costs. The first, variable operating cost, varies with the volume of water provided and sold while the second, semi-fixed/general, varies not with the quantity of water but with the number of users. Both categories require current expenditures and fall under operation and maintenance outlays. Variable operating costs is the category from which marginal costs basically derive.

The fixed capacity costs are invariant with the quantity of water and with the number of users once a system has stabilized geographically. These costs are capital costs and *require* no current money outlays unless debt is being retired, which is generally the case. As the capacity costs and semi-fixed/general costs are spread over more units of water produced, the average total costs of water service are expected to decline steadily over the entire range of feasible output. Even without capital or capacity costs, the average operating cost curve for water utilities declines continuously. This is the classic case of a decreasing cost industry with marginal cost lying below average cost within the feasible range of output (see Afifi and Bassie, 1969, pp. 101-103). Marginal-cost pricing, as an efficient pricing rule, results in operating losses since total revenues do not cover total costs. These conditions lead to a two-part pricing system applied through block water rate schedules.

The requirement that all rural water system costs, including capital and operating and maintenance costs, must be considered can be conveniently represented as:

$$C = OE + ER + (DS - S) \qquad (1)$$

where C is the total annual cost, OE is the variable operating and semi-fixed/general costs or operation and maintenance expenditures, and ER + (DS - S) is the annual capacity costs comprised of equipment reserve and depreciation (ER) and net annualized capital costs (DS - S) or debt service. DS is the gross annualized capital cost and S is the annualized adjustment accounting for front-end capital contributions. These front-end contributions, which reduce initial capital borrowings (and increase S) generally include 1) "user benefit units" which are front-end monetary or in kind user contributions, e.g., tap-in or membership fees and/or 2) public subsidies, e.g., a Farmers Home Administration rural water construction grant. The higher the interest charge, the greater is DS. Subsidized interest rates reduce DS.

Under policies of the past two decades, construction grants and/or below market capital charges on construction loans for rural water systems have reduced the net annualized capital cost component of C for rural water systems, permitting lower user fees. The median income level of the service area was the basis, historically, for determining the amount of grant funds that would be made available for subsidizing project construction costs and until 1981 five percent 40 year project loans were available from the Farmers Home Administration (Gessaman and Janovec, 1982, p. 5). Currently, interest rates for loans made under the water and waste disposal Farmers Home Administration program are based on the median family income level in the service area. That is, market rate if the median family income of the service area is more than $16,439 per year; intermediate rate if the median family income of the service area is between $9,900 and $16,439 per year; or the poverty rate of 5% if the median family income is below $9,900. As of December 1983, the market rate was 9.5% and the intermediate rate was 7.25%.

General Cost Characteristics

The monthly estimate of average (DS - S), on a per user basis, for the sample of 45 cases on Illinois rural water systems is about $6.00 (Table 5.4). For the rural systems in five north central states,

Table 5.4

Per User Cost Characteristics of Illinois
Rural Water Districts by Users Per Mile of Line

User Per Mile of Line	Monthly Salary Expense (1)	Monthly Treatment Cost (2)	Monthly Debt Service (3)	Monthly Operating Expense (4)	Monthly Total Expense (3)+(4)
Less than 5	$2.01	$.81	$7.32	$9.29	$16.61
5 to 9	1.75	.97	5.78	8.35	14.13
10 to 14	2.38	.57	5.32	8.49	13.81
15 to 19	3.46	1.03	7.08	11.02	18.10
20 and Over	1.82	.54	5.10	5.64	10.74
Full Sample	2.03	.79	5.97	8.20	14.17

the monthly per user net capital charge varied between $6 for small indebted systems to $20 for large indebted systems. The overall average reported for Iowa, Nebraska, Missouri, North Dakota, and South Dakota was $14 per month per user (Gessaman and Janovec, 1982, p. 24). The comparable figure for rural water systems in Ohio is $11.70. The amortized subsidized capital cost per user of rural systems was reported in Ohio as being between two and four times the amount paid in many urban areas for total monthly water service costs (Whitlatch and Asplund, 1981, p. 310).

In addition to the monthly per user average debt service reported in column (3), Table 5.4, salary expense, treatment costs, operating expense and total expense by user density categories are given. The range of operating and maintenance outlays reported was from $9.29 per month per user for systems with less than five years per mile of line to $5.64 per month per user for systems with 20 and more users per mile of line. There is little evidence of a trend towards lower per user debt service outlays with higher user densities.

The operating and maintenance expenditures (OE) per user averaged $8.20 (in 1978 dollars) in Illinois (column 4, Table 5.4). In 1980 dollars, this is $9.64. A comparable OE figure from the five state study was $16.04 (Gessaman and Janovec, 1982, p. 22). These costs are above earlier estimates of $4.50-$7.50 made by Moberg (1976) using an economic-engineering approach.

ER is generally not a funded expense. Rural water systems appear to be consuming their capital stock. Sinking funds or other provisions for funding the replacement of capital items are generally not established. Thus, ignoring ER, the per user cost of rural water service in Illinois (i.e., C* = OE + (DS - S)), on average per month, is reported as $14.17 in 1978 or about $16 in 1980 dollars. About 40 percent is (DS - S) and 60 percent is OE. As given in Table 5.4, this varies from an average of $16.61 per user for systems with less than five users per mile of line to an average of $10.74 per user for systems with 20 or more users per mile of line.

Table 5.5 presents average monthly debt service and operating expenditures per user with rural water systems grouped by quantity of water sold rather than user density. Per user operating outlays do not vary much across the alternative size groupings (column 4, Table 5.5). However, the per month debt service outlays generally increase as the quantity of water sold increases reaching an average of $8.40 per user in systems providing 80 and over million gallons of water annually.

Table 5.5

Per User Cost Characteristics of Illinois
Rural Water Districts by Quantity of Water Sold Per Year

Quantity of Water Sold Per Year (m gal.)	Monthly Salary Expense (1)	Monthly Treatment Cost (2)	Monthly Debt Service (3)	Monthly Operating Expense (4)	Monthly Total Expense (3)+(4)
Less than 5	$1.54	$.60	$5.90	$6.15	$12.05
5 to 9	2.48	.58	4.78	7.69	12.47
10 to 19	1.41	.84	6.43	7.96	14.39
20 to 39	2.14	.44	5.97	9.42	15.39
40 to 79	2.33	1.25	6.56	10.10	16.66
80 and Over	2.52	1.28	8.40	9.94	18.34
Full Sample	2.03	.79	5.97	8.20	14.17

This is up from an average of $5.90 per user for systems selling less than five million gallons. High volume systems tend to have more miles of line and larger plants requiring more initial capital investment. Evidently, the number of customers is not increased proportionately causing higher per user debt service outlays in systems selling more water. Because of the higher debt service outlays, total monthly average expenditures per user are higher for the larger systems ($18.34) than the small systems when system size is measured by water volume.

The general notion that per unit operating costs vary inversely with user density and with the volume of output is observed in Table 5.6. Here annual expenditure data per million gallons of water sold are organized by user density in the upper half of the table and by quantity of water sold in the lower half of the table. Both breakdowns support the contention that there are economies of size in rural water service provision. Annual average operating expenditures per million gallons declined from $3,026 for systems with less than five users per mile of line to $1,446 for the most dense systems and from

Table 5.6

Cost Characteristics of Illinois Rural Water Districts
by Users Per Mile of Line and Quantity of Water Sold

Users Per Mile of Line	Annual Salary Expense (1)	Annual Treatment Cost (2)	Annual Debt Service (3)	Annual Operating Expense (4)	Annual Total Expense (3)+(4)
			per million gallons		
Less than 5	$678.99	$379.84	$2,330.44	$3,025.99	$5,356.43
5 to 9	437.74	271.69	1,690.23	2,267.93	3,958.16
10 to 14	481.27	86.97	989.52	1,716.76	2,706.28
15 to 19	478.07	42.52	1,255.75	1,743.93	2,999.68
20 and Over	457.01	128.73	1,400.78	1,446.34	2,847.12
Full Sample	499.31	220.72	1,622.42	2,134.56	3,756.98

Quantity of Water Sold Per Year (m gal.)	Annual Salary Expense (1)	Annual Treatment Cost (2)	Annual Debt Service (3)	Annual Operating Expense (4)	Annual Total Expense (3)+(4)
			per million gallons		
Less than 5	$555.22	$325.73	$2,623.90	$2,722.05	$5,345.95
5 to 9	691.55	240.21	1,399.89	2,237.08	3,636.97
10 to 19	381.14	213.84	1,803.62	2,116.33	3,919.95
20 to 39	510.90	79.27	1,475.53	2,306.52	3,782.05
40 to 79	335.43	181.25	1,133.93	1,697.14	2,831.07
80 and Over	333.94	180.76	1,219.81	1,402.71	2,622.52
Full Sample	499.31	220.72	1,622.42	2,134.56	3,756.98

$2,722 for systems selling less than 5,000,000 gallons per year to an average of $1,403 for systems selling 80 or more million gallons annually. The average salary outlays and treatment costs follow a similar pattern. The trend for annual average debt service per million gallons of water sold is somewhat less prevalent, yet under both methods of measuring size, annual average debt service per volume of output was more for systems with the smallest output and those with the least dense service areas than for the systems with the largest output and those with the most dense service areas. For the sample of 45 cases, the average total annual outlay was $3,757 per million gallons of water. Adjusting the operating outlays to 1980 dollars increased the per million gallon average to $4,133.

Operating Cost Analysis

The descriptive evidence suggests rural water systems with a larger output of water may be more efficient and provide water services at lower per unit operating costs. However, other factors, such as user density may inhibit the realization of these efficiencies. To investigate possible size economies in rural water services a statistical cost analysis was conducted. While size economies in the public sector have been the subject of a number of studies, few analyses focus on rural areas where, as has been demonstrated, low densities present particular challenges (e.g., Fox et al., 1979; Hirsch, 1968).

The statistical analysis focuses on the average operating cost of rural water services. Of concern is the impact of a number of factors on the average operating costs of collectively supplying one million gallons of potable water per year to farmers and other customers of Illinois' rural water systems. Of particular interest is the relationship between the quantity of water provided and per unit operating costs.

Water Service Operating Costs. For analytical purposes it is useful to divide local services into those characterized by horizontally integrated production, by vertically integrated production and by circularly integrated production (Hirsch, 1968). This classification provides, among other things, a framework for generalizing about the expected relationship between unit costs of services and output.

Water supply services are produced in vertically integrated processes. Vertically integrated services are expected to exhibit technical efficiencies over a wide range of output levels. The provision of these services is characterized by successive levels of production, which tend to be relatively more capital intensive, all contributing value added to the service. Other vertically produced services in addition to water supplies include sewage disposal, some public health services (e.g., hospitals), public transportation and refuse collection and disposal.

The successive levels of production for vertically integrated water services include 1) the collection or pumping of raw water, 2) the transporting of raw water from a source of supply, 3) the treatment of the water, and 4) the storage and distribution of treated water to users (Hines, 1969). The investigation of the operating cost of these activities involves either 1) the examination of the economic behavior of one production unit or system over a number of years or 2) the analysis of a number of systems in a specific time period. For the former approach to yield information on technical efficiencies, the observations have to be over a time when the system being studied experienced substantial growth. With the latter method, the assumption is that the variation among systems is similar to the variation that would occur within one system over time (Johnston, 1960). The latter method was used here since available data is cross sectional.

Operating costs associated with the four successive levels of water supply service production are the outlays for collection or pumpage, treatment, transmission and distribution, accounting and billing expenses and administration and general overhead. These items include both commodity and customer costs. Factors expected to affect these outlays include the quantity and quality of service produced, service conditions affecting inputs (e.g., raw water quality), factor price levels and the level of technology and productivity (Hirsch, 1965).

Specifically, the amount of potable water provided, as a direct measure of output, is important in determining the relationship between operating costs and the size of water supply systems. Economies of size in water services have been the focus of a limited number of studies of water utilities. These studies have generally been concerned with water supplies in incorporated areas and average variable costs. For example, in a study of municipal water authorities in Pennsylvania, Daugherty and Jansma (1973) observed significant size economies for systems using a surface water supply. Andrews (1971) also found evidence of declining unit operating costs in his study of New England water utilities. The water systems in 79 Ohio cities having over 5,000 people were investigated by Cosgrove and Hushak (1972). Declining average unit cost curves were reported with significant cost reductions available in cities with more than 50,000 people. Hines (1969) regressed average unit cost on adjusted plant investment for water services in selected Wisconsin communities. Since adjusted plant investment and output were positively correlated, Hines suggested that the inverse relationship observed between average unit costs and plant investment revealed economies of size. Kitchen (1977) estimated a U-shaped average operating cost function for water services with data from 49 Canadian cities with populations in excess of 10,000.

Studies of rural water systems include 1) an investigation by Johnson and Hobgood (1973) of 62 Louisiana systems, 2) an investigation of 57 Oklahoma systems by Sloggett and Badger (1974), and 3) an economic engineering study by Moberg (1976). These studies are limited by their use of number of users or density of users as the only output measure.

A complicating factor in studying technical efficiencies in water supply services, as the descriptive characteristics suggest, is that the density of users may have an effect on operating costs and economies of size. As densities become lower, for example, variable delivery costs could increase as the service is provided over a larger area. This aspect of water services becomes critical for rural systems where low user density is the norm. Using an economic engineering approach, Moberg (1976) observed rural water system pre-connection "support costs" to rise as the number of connections decreased. Daugherty and Jansma (1973) found the number of users positively affected municipal water service average unit operating costs. Neither study approached the spatial issue directly by adjusting users for the area served. The number of users may place direct upward pressure on the customer cost portion of per unit operating costs by requiring more outlays for activities like meter reading, operation and maintenance and administrative overhead. In addition, however, the spatial distribution of the users may also impact operating costs as the service is provided at varying densities. Lower densities are expected to place upward pressure on operating costs.

An aspect related to the number of users is the type of users--residential, commercial or industrial. Data limitations prevented any adjustments for type of user. For rural water service, however, residential household water use dominates (Gessaman and Janovec, 1982).

The quality of water supply services is determined primarily by the quality of treated water. The cost of treating raw water depends on 1) the initial quality of the raw water and 2) the quality of the potable water produced. Surface water supplies, which have greater turbidity, more objectionable tastes and/or odors and a higher bacterial count than ground water, commonly yield lower quality raw water than ground water supplies (Cosgrove and Hushak, 1972). Accordingly, the source of supply has been found to have an important bearing on operating costs. Specifically, Kitchen (1977) found operating costs to be $33 more per million gallons when surface supplies, rather than ground water supplies, were used. Thus, the lower the quality of raw water, the higher the average unit operating costs, other things equal.

The purchase of either raw or treated water from another system would be expected to have a positive influence on costs if the seller followed a cost plus pricing policy. Kitchen (1977) found average operating costs were increased $124 per million gallons, on average, when water was purchased.

Other service conditions that affect operating costs are the weather and the topography in the service area. Cold weather will likely increase maintenance outlays, while extreme differences in elevation between source of supply and users will increase collection or pumpage outlays and possibly storage and distribution outlays.

The method of water distribution should have significant effects on operating costs. A gravity system is expected to experience considerable savings over a pump or pneumatic pressure system. None of the systems in the sample of 45 cases used pump systems. The degree of plant capacity utilization by a system is also expected to affect average unit costs. If capacity is defined as the most efficient level of output, operating above or below this level can be expected to increase per unit costs. Unfortunately, a measure of capacity utilization was not available for Illinois rural water systems studied. However, discussions with Farmers Home Administration officials indicated that excess capacity was generally not present in the systems studied and that the variation in capacity utilization among sample systems would not be substantial. These characteristics result from the financial restrictions faced by systems at the time of construction and the associated design limitations.

Factor price levels are important in determining operating costs, and wages are the most important factor price for water supply services. Studies have reported that up to 60 percent of operating costs are outlays for labor (Moberg, 1976, p. 15). About 25 percent of the average operating costs for the sample of Illinois rural water systems were salary expenses. Higher wages are, therefore, expected to result in higher per unit costs.

Finally, differences in technology and productivity among water supply systems need to be considered. Because the advances in water supply service technology have been relatively slow, little variation in the level of technology among systems is expected (Hines, 1977). All systems in Illinois use basically the same level of technology.

To the extent that productivity can be measured, more productive systems can be expected to experience relatively lower operating unit costs. One measure of productivity is the relationship between water produced and water sold. Discrepancies between these amounts may reflect either leakage in the distribution facilities or shortcomings in the metering and billing procedures.

Operating Cost Model and Data. To test the propositions about the impacts of the above variables, including the quantity of water, on average unit operating costs, the following generalized model was estimated.

$$AUC = f(QNTY, QNTY^2, USRS, TRTCST, PRCH, TOPO, CLMT, EFF, WAGE)$$

where:

- AUC = average operating cost per million gallons (PMG) of water per year,
- QNTY = the quantity of water supplied in million gallons per year,
- USRS = number of users or number of users per mile of pipe,
- TRTCST = treatment costs PMG of water supplied in standardized form,
- PRCH = water purchased measured as a percent of water supplied,
- TOPO = 1 for rough topography, 0 otherwise,
- CLMT = county average annual percentage of frost free days,
- EFF = system efficiency measured as a ratio of water supplied to water produced, and
- WAGE = salary outlays PMG of water supplied in standardized form.

The data used to estimate the average unit operating cost model were the sample of cases collected from water district records available in the Illinois state office of the Farmers Home Administration. Average operating cost per million gallons of water (AUC) was measured by subtracting debt payments from reported total operating costs and dividing by the quantity of water supplied. Debt payments were excluded because they more likely reflect the age of the system and initial financial arrangements than the variable production costs associated with providing water services.

The number of users (USRS) refers to the number of billing locations, which is not necessarily the number of connections. Mobile home parks present the most observed deviation. When park owners provide water as part of space rent, parks are counted as one user even though the number of households served is greater than one. Accordingly, USRS understates the number of households served but not by a significant amount. To adjust for user density, in two of the equations USRS was scaled by miles of pipeline available from the survey of Illinois' rural water districts.

The amount of water a district purchases is reported only in dollar terms reflecting both the per unit price and the quantity purchased. Water purchases (PRCH) are measured by the percent of operating costs (excluding debt) represented by outlays for purchased water.

To adjust for topographical differences a binary variable (TOPO) is used. TOPO distinguishes between systems serving relatively flat areas and systems whose areas have more relief. This is admittedly a crude measure and is in need of additional refinement. The proportion of frost free days in the county where a system (CLMT) is located is used to account for variations in climatic conditions.

Treatment costs (TRTCST) are measured on a per unit basis and include the outlays for supplies and chemicals. Total salary outlays were scaled by water supplied to measure WAGE. WAGE, therefore, reflects both factor costs and labor use efficiency. These two variables were standardized using the respective sample means and standard deviations. TRTCST and WAGE as measured are used as surrogates for raw water quality and labor factor cost differences. No direct measures of these variables were available. Because treatment cost and salary outlays represent a major contribution to operating costs, they were standardized for the analysis. As such, they are used as proxies for explaining differences in operating costs due to differences in raw water quality and wage rates.[2] The simple correlation coefficient matrix is presented in Table 5.7 for the sample of 45 cases.

<u>Statistical Cost Estimates</u>. The general cost function was estimated in linear form using OLS regression analysis (see Table 5.8). In general, the model performed reasonably well, accounting for about 70 percent of the variation in average operating costs. Equations 1 and 2 include a

Table 5.7

Correlation Matrix of Operating Cost Model Variables

	AUC	QNTY	$QNTY^2$	USRS	USRS/PIPE MILES	TRTCST	WAGE	EFF	TOPO	CLMT	PRCH
AUC	1.00000										
QNTY	-.27893	1.00000									
$QNTY^2$	-.25048	.95065	1.00000								
USRS	-.04349	.86041	.74461	1.00000							
USRS/PIPE MILES	-.41021	-.21719	-.14929	-.36219	1.00000						
TRTCST	.68564	-.07561	-.05508	.02507	-.13250	1.00000					
WAGE	.47931	-.37285	-.28211	-.27782	-.19741	.31287	1.00000				
EFF	-.39469	.06458	.13767	-.08430	.23467	-.32212	.19609	1.00000			
TOPO	-.00706	-.26021	-.31811	-.12108	-.01671	-.03041	.14998	-.07310	1.00000		
CLMT	-.08214	.05847	.04828	.05760	.26067	-.01284	-.04846	-.17055	.35229	1.00000	
PRCH	-.09425	.06667	.04539	.12527	-.32667	-.30608	-.09222	.11896	.19684	-.04517	1.00000

Table 5.8

Statistical Operating Cost Analysis of Illinois Rural Water Systems[a]

Variable	Equation 1	Equation 2	Equation 3	Equation 4
QNTY	-36.53 (2.45)*	-37.49 (-2.54)*	-17.16 (1.21)	-8.94 (2.03)*
$QNTY^2$	0.17 (1.99)*	0.17 (2.02)*	0.08 (0.55)	---
USRS	1.41 (2.29)*	1.45 (2.37)*	---	---
USRS/PIPE MILES	---	---	-33.88 (2.51)*	-34.55 (2.99)*
TRTCST	436.81 (5.26)*	438.39 (5.30)*	459.28 (4.64)*	462.90 (4.90)*
WAGE	559.37 (6.25)*	560.19 (6.29)*	324.75 (1.84)**	316.09 (1.95)**
EFF	-21.65 (3.17)*	-20.68 (3.10)*	-17.77 (2.02)**	-15.46 (1.84)**
TOPO	-238.94 (1.36)	-293.41 (1.86)**	-231.25 (1.08)	---
CLMT	-25.21 (0.72)	---	---	---
PRCH	9.10 (2.50)*	9.19 (2.53)*	2.57 (0.46)	---
Constant	5,233.17 (2.64)*	3,871.71 (6.23)*	4,381.18 (5.80)*	4,024.93 (5.94)*
N	62	62	45	45
Adj R^2	0.737	0.740	0.668	0.669
F	20.03*	22.67*	13.64*	18.81*

a. Numbers in parentheses are the absolute values of the t-ratios.

* Significant at the 5% level.

** Significant at the 10% level.

quadratic variable for QNTY and number of users (USRS). The significant and oppositely signed coefficients for QNTY and $QNTY^2$ suggest a U-shaped relationship between cost and output. The average operating cost declines up to about 110 million gallons of potable water per year and then increases with the quantity of water supplied per year. These results indicate that per unit operating costs decline by about $3.50 as output goes from 100 to 101 million gallons per year, *ceteris paribus*. On the other hand, per unit operating costs increase by about $3.30 as output increases to 121 from 120 million gallons per year. However, only two observations were at or above 110 million gallons per year.

The coefficients on standardized treatment costs (TRTCST) and standardized wages (WAGE) were positive and significantly related to per unit operating costs as hypothesized. As water services became more efficient because of either less water loss and/or reduced management error, per unit operating costs were reduced. This is indicated by the negative significant coefficient for EFF. The coefficient for the proportion of frost free days (CLMT) in equation 1 was negative as expected. However, it was not significant. Thus, CLMT was excluded from the other equations. A more refined measure of climate is probably needed. The coefficient on the proportion of water purchased (PRCH) was positive and significantly related to operating costs in equations 1 and 2.

TOPO was significant at the 10 percent level in equation 2, but had a sign opposite that expected. Because the southern part of Illinois has generally rougher terrain, TOPO may be capturing both a cost reducing climate factor as well as the cost increasing topographical factor. The dominance of the climate factor may underlie the negative sign on the coefficient for TOPO.[3] The change in the size and significance of TOPO's coefficient when CLMT is excluded in equation 2 supports this contention.

The positive significant coefficient on USRS in equations 1 and 2 indicates that an additional user adds about $1.40 to the operating costs of providing one million gallons of water. While this finding is consistent with Daugherty and Jansma (1973), no adjustment is made in this specification

LIST OF MAPS

for the spatial dimension of water services. To investigate the relationship between user density and average operating costs, the cost model was estimated with USRS scaled to miles of pipeline. These results are reported in equations 3 and 4.

The coefficient on USRS/PIPE MILES is negative as hypothesized and significant at the five percent level. In general, for every additional user per mile of pipe, average operating costs declined by about $35 PMG of water. As evident in equation 3, the scaling of USRS by the miles of line reduced the size and significance of the coefficients on QNTY and $QNTY^2$. Also, the TOPO and PRCH's coefficient became insignificant (equation 3).

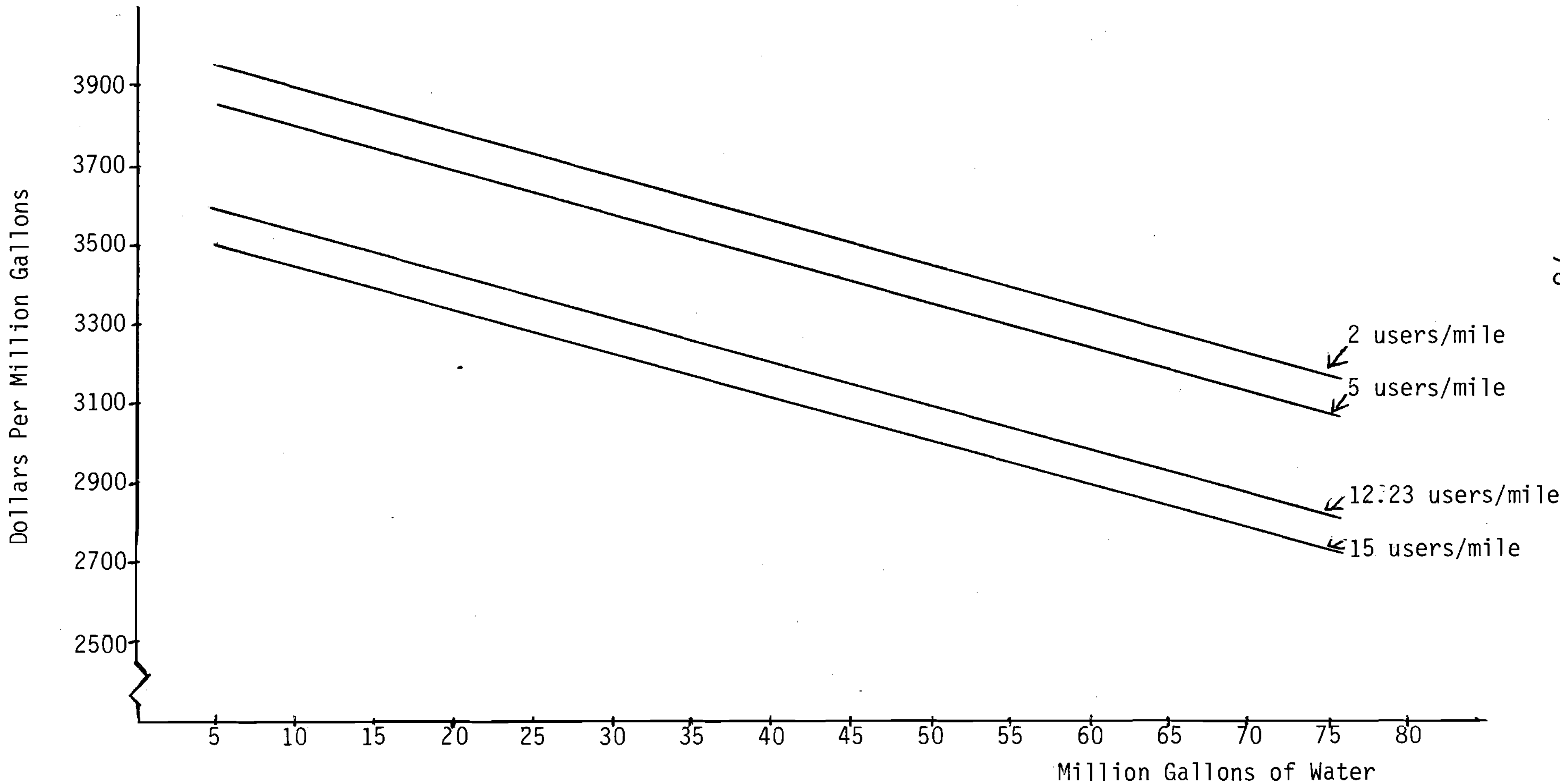
The inclusion of the spatial aspects of rural water services raises questions about the U-shaped relationship between cost and output reported in equations 1 and 2. When the quadratic variable for QNTY was excluded from the model along with other variables shown to be not significant (equation 4), no diseconomies of scale are evident over the size range of Illinois systems studied. The results of equation 4 indicate average operating costs decline by about $9.00 for every additional one million gallons of water provided. The analysis suggests that an additional supply of four million gallons of water per year and a simultaneous reduction in average user density of one user per mile of pipeline would be approximately cost neutral in impact.

The estimated relationship between average operating costs and quantity of water provided is presented in Figure 5.2 for alternative user densities, i.e., 2, 5, 12.23 and 15 users per mile of pipeline. The 12.23 users per mile of line is the average density for the 51 respondent rural water districts. The other densities were chosen to demonstrate the shift in the operating cost function associated with changing user densities.

Implications. While a number of factors affect the unit operating costs of rural water services, the providing organization has little

Figure 5.2

Average Operating Costs at Selected User Densities



control over some factors--e.g., prevailing wages, climate factors, topography, raw water quality. Other cost related factors, however, involve policy choices. An awareness of these factors and their relationship to per unit operating costs is important if the appropriate cost minimization approach is to be followed.

First, while the operating cost of providing rural water service was initially estimated to be the lowest at an output of approximately 110 million gallons per year, this relationship was not substantiated after adjustments for spatial differences were made. Economies of size in operating expenditures were present over the entire range of Illinois systems studied when user density was accounted for. This suggests that per unit operating costs may be reduced with larger scale systems, perhaps through regional service provision. Second, the results indicate that lower user density, which is characteristic of larger systems, will offset somewhat the scale effects associated with greater output.

Capital Cost Analysis

While the analysis of operating costs contributes to the understanding of one cost aspect of providing rural water services, some additional information on rural water system capital requirements is needed. With front-end construction grants from the federal government now reduced and the interest rate on capital borrowed from the Farmers Home Administration now closer to market rates, the annual costs of rural water services, including debt service, which must be reflected in the water charges levied against users, will be higher for newly constructed systems, other things equal. This increases the pressure to keep both the capital and operating outlays for rural water supply systems as reasonable as possible. Capital cost information as a planning tool plays an important role in achieving this objective.

Rural water systems are unique in their design features, as well as the use of materials and construction techniques. In most instances where there are few users per mile, a two-inch diameter polyvinyl chloride (PVC) water line is used rather than the six-inch line required in most urban design criteria. Also, storage tanks tend to be much smaller for rural systems than for urban systems. Part of the difference in design standards stems from the restriction of rural systems to providing water only for domestic use. No fire flow capacity, necessitating lines of six inches or more and greater storage capacity, is engineered into systems serving users in the open countryside (Moberg, 1976; Foster, 1974).

The main objective of this analysis is to present additional evidence on the capital costs of selected items used in rural water systems. This information could be used to help develop initial capital budgets. It also could be utilized in optimization models aimed at least cost design.[4] Capital costs are defined as any expenditure involved in completing construction of systems including material, labor, interest and professional services. Items included are ground and elevated steel storage tanks, the major components of the pipeline system, the distribution network and the treatment plant. Cost data analyzed account for 90 percent of the initial capital costs of water treatment and distribution systems providing farm and nonfarm users in the open countryside domestic water service in Illinois.

Limited, current data are available concerning the capital cost of rural water distribution systems and information for urban systems are not uniformly applicable to the rural design setting. Some arithmetic mean cost data for items commonly used in rural water systems are presented in Goodwin, Doeksen and Nelson (1979), in Kuehn, Fessehaye, Braschler and McGill (1980), and in Nelson and Mostafavi (1981). Cost estimates for installed components of a rural water distribution system are reported by Whitlatch and Asplund (1981), who derive costs statistically using regression analysis. Earlier information is available in Stoltenberg (1969) and Linaweaver and Clark (1964).

There is some evidence that cost estimates for rural water systems, including capital costs, are not readily transferrable among areas. For example, treatment and storage facilities for a typical rural water system of 200 hookups was found to be 25 percent larger in northern Missouri and 53 percent larger in Oklahoma than in the Missouri Ozarks. Distribution system capital costs were also found to vary among these three areas (Kuehn and Nelson, 1981).

Analytical Approach. The data for the analysis of capital costs from Illinois rural water systems were obtained from 180 bid tabulations of construction projects awarded during the period 1970 to 1981 in Illinois. The projects undertaken were for the creation and/or expansion and improvement of rural water distribution systems. Four different contract types were identified for classification of rural water system construction. They are: 1) pipeline and distribution network, 2) water storage facility, 3) water treatment facility, and 4) well installation. This analysis statistically addresses the capital costs of the first three aspects of rural water system construction. The available data on well installation costs were insufficient to permit statistical analysis.

The type of information contained in each bid tabulation varies among projects, although the basic items are essentially similar. The pipeline and distribution network contracts contain data on pipes, valves, pipeline, stream, highway and railroad crossings, pressure reducing valves, hydrants and meters. In addition, some pipeline and distribution contracts include miscellaneous services such as rock excavation, sand back fill, leak meters and pumping stations. As no consistent set of data is available on these latter items (these expenses are peculiar to the location of the system and are a function of terrain and topography), they are not considered for empirical modelling.

The components of the pipeline and distribution network included are 2 inch, 3 inch, 4 inch, 6 inch, 8 inch, and 10 inch pipelines. They represent 90 percent of the total cost of the distribution network. The water storage facility contracts provide the complete construction cost of an elevated or ground storage tank, from site preparation and foundation to fabrication, erection, and painting. Data on both ground and elevated storage tanks were used. Stand pipes and pneumatic or pressurized type storage facilities were not included due to the lack of an adequate number of observations.

Finally, water treatment facility contracts were used for data on construction costs of water treatment plants. Treatment plants are commonly sized in gallons per minute (gpm). This information, however, was not reported in most cases. The storage capacity of the water system in gallons was used as a proxy measure for treatment plant size. It must be noted that not all bid tabulations included data on each item and some contracts had multiple observations for a particular type of component.

The bid data spans a 12 year period. The Handy-Whitman Index of water utility construction cost for the north central region was used to adjust all cost figures to 1981 price levels (Whitman, Requandt and Associates, 1981). The suitability of the Handy-Whitman Index was verified by comparing the unit costs for the different components over the 12 year period with the relevant indices. The respective indices adequately reflected the cost trends in the data. The particular Handy-Whitman Index used is presented in the right hand column in Table 5.9. Also presented in Table 5.9 are the descriptive characteristics of the construction bid data.

The individual components of the distribution network are fixed in pipe dimension but aggregated over type of pipe material (e.g., a 4 inch pipe could be composed of asbestos-cement, cast-iron or PVC). This is felt to be more appropriate for rural water system design since more is likely to be known about pipe dimensions needed to build a particular distribution system than the quality or thickness of pipes. Also, the unit cost of components varies more with size than with quality or material of pipes. The Index used to deflate the pipe cost data was an average of all main components.

Statistical Analysis. Regression analyses relating the adjusted cost of components to size was conducted. Size is the amount of component in the bid (e.g., 10,000 feet of 2 inch pipe).

Table 5.9

Construction Bid Cost Data for Illinois Rural Water Districts[a]

Item	Number of Observations	Size[b]			Handy-Whitman Index Used
		Mean	Standard Deviation	Range	
Distribution Network	100	101.1	159.4	1.8 to 895.0	Mains-Average All Types
2 Inch Pipes	30	20.5	42.4	0.053 to 228.3	"
3 Inch Pipes	68	50.9	86.5	0.010 to 416.5	"
4 Inch Pipes	108	36.4	56.7	0.040 to 436.2	"
6 Inch Pipes	112	27.8	45.9	0.060 to 318.0	"
8 Inch Pipes	37	24.3	26.9	0.040 to 99.8	"
10 Inch Pipes	14	20.8	17.4	1.275 to 62.5	"
Elevated Storage Tanks	85	111.9	119.1	12 to 750	Elevated Steel Tanks
Ground Storage Tanks	20	179.4	154.6	50 to 650	Steel Reservoirs
Treatment Plant	22	133.8	142.6	12 to 650	Small + Large Treatment Plant

[a] Data collected from 108 construction bids over the years 1970 through 1981, Illinois State Office, Farmers Home Administration, USDA.

[b] Size is in 1,000 feet except for storage tanks and the treatment plant where size is in 1,000 gallons.

The different specifications of the regression model tested are:

$$COST = a_0 + a_1\ SIZE + e_1 \quad (1)$$

$$COST = b_0 + b_1\ SIZE + b_2\ SIZE2 + b_3\ SIZE3 + e_2 \quad (2)$$

$$COST = c_0 + c_1\ LNSIZE + e_3 \quad (3)$$

$$LNCOST = d_0 + d_1\ LNSIZE + e_4 \quad (4)$$

where

COST = adjusted cost of component in $1,000,

SIZE = size of component in 1,000 feet or 1,000 gallons,

SIZE2 = $(SIZE)^2$,

SIZE3 = $(SIZE)^3$,

LNCOST = natural logarithm of cost, and

LNSIZE = natural logarithm of size.

Models (1), (3), and (4) form a subset of the group of models considered by Whitlatch and Asplund (1981). Model (2) tests for the presence of economies of scale using quadratic and cubic size variables. To select the model best fitting the data on cost and component size the coefficient of determination (R^2, adjusted for degrees of freedom), the t-ratios of the individual regression coefficients, and the pattern of residuals were considered.

The coefficient of determination, R^2, adjusted for the degrees of freedom measures the percentage of variation in the dependent variable explained by the independent variables. Because the dependent variable is not the same for all models, the R^2 alone is not a sufficient statistic. The t-ratio for individual coefficients and the pattern of the residuals were used in determining if any of the basic assumptions of the ordinary least squares regression technique were violated. The models reported were "best" in terms of these criteria.

A number of rural water system components do not have a size dimension or the size factor was not available in the Illinois bid contracts, e.g., hydrants, gate valves, well installation, meters and building construction. The bids on these items reported per unit costs but generally not the number of units. Table 5.10 lists statistics from

Table 5.10

Cost of Size-Invariant and Other System Components

Item	Number of Observations	Cost[a]				Handy-Whitman Index Used
		Mean	Standard Deviation	Minimum	Maximum	
Hydrants	52	858.66	285.90	363.20	1,431.98	Hydrants Installed
Gate Valves	63	368.40	154.50	213.50	1,238.00	Mains-Average All Types
Pressure Reducing Valves	3	9,011.08	5,001.72	5,800.46	14,774.05	Mains-Average All Types
Service Connections	37	327.45	112.33	197.71	819.24	Mains-Average All Types
Well Installation	18	30,528.17	20,000.75	10,990.00	94,372.00	No Index
Rock Excavation	9	71.61	65.71	10.00	225.00	No Index
Master Meters	25	6,483.67	2,183.37	2,632.42	10,921.34	Meters
Booster Pumps	18	46,404.62	28,624.31	14,836.80	136,311.15	Electric Pumping Equipment
Building Construction	7	53,496.18	21,083.40	30,849.40	86,188.99	Structures and Improvements

[a] Costs are on a per unit basis (in 1981 dollars, except for well installation and rock excavation), e.g., per hydrant, meter, well, etc., except rock excavation which is in dollars per cubic yard.

the bids on a number of these components. As with the components variable in size, the bid costs were adjusted to 1981 price levels using the appropriate Handy-Whitman Index. These indices are listed in the last column in this table. As an example, 52 hydrant bids were available in the Illinois construction bid data. The average cost per hydrant ranged from \$363.20 to \$1,431.98 with a mean of \$858.66. Similarly, the meters averaged \$6,483.67 while the well installation bid mean was \$30,528.17.

Table 5.11 presents the best empirical estimates of the capital cost regression models. The logarithmic model was selected for all pipe sizes except the 2 inch pipe for which the cubic equation was selected. The pipe models suggest some decline in the rate of increase in pipe costs with an increase in bid size. This indicates a reduction in average cost. The elevated storage tank model also suggests a reduction in average cost as size increases.

Ground storage tanks, the distribution network, and treatment plant bid costs are linearly related to size, indicating no cost reduction per unit for larger sizes. These findings, however, are somewhat inconsistent with results reported by Whitlatch and Asplund (1981) in their analysis of rural water systems in Ohio. They reported some economies of scale for ground storage tanks and the distribution network for the range in tanks and networks studied.

A limitation of the models reported in Table 5.11 is that they are valid only for the range of the data recorded in Table 5.9. Thus, the equations should be used only with caution to obtain capital cost information beyond the original data ranges. As indicated by the reported adjusted R^2s, size explains more of the variation in some rural water system components than others. Other factors that could affect construction bids include site specific characteristics such as topography or soil conditions and location. Data on these factors are difficult to obtain, and measurement problems are also common. However, the R^2s in all but three equations approach or exceed 0.90 suggesting a major portion of the variation in bid costs is explained by the size variable(s).

Table 5.11

Regressions of Illinois Rural Water System Components

Item	Dependent Variable[b]	Independent Variables[a]					R^2 (adj.)	F
		Intercept	Size	$(SIZE)^2$	$(SIZE)^3$	LSIZE		
Distribution Network	COST	95.793 (3.330)	3.980 (26.021)				0.874	677.1
2 Inch Pipes	COST	0.988 (0.297)	2.655 (6.075)	-0.0215 (-2.137)	0.000086 (2.370)		0.987	649.6
3 Inch Pipes	LCOST	1.099 (16.517)				0.942 (47.443)	0.972	2,250.9
4 Inch Pipes	LCOST	1.661 (17.448)				0.853 (28.072)	0.880	788.0
6 Inch Pipes	LCOST	1.807 (35.903)				0.903 (51.480)	0.960	2,650.2
8 Inch Pipes	LCOST	1.949 (15.205)				0.957 (21.534)	0.928	463.7
10 Inch Pipes	LCOST	2.440 (15.299)				0.926 (16.397)	0.954	268.9
Elevated Storage Tanks	COST	81.542 (5.937)	0.8391 (3.561)	0.00117 (1.247)	-0.00000229 (-2.438)		0.762	90.85
Ground Storage Tanks	COST	55.937 (4.413)	0.3236 (5.980)				0.647	35.76
Treatment Plant	COST	187.531 (3.250)	1.397 (4.677)				0.498	21.87

[a] Regression coefficients with t-statistics in parentheses.

[b] Cost is in 1,000 of 1981 dollars and size is in 1,000 feet except for storage tanks and the treatment plant where size is in 1,000 gallons.

In spite of these limitations, the study and use of capital cost information, like that developed here, along with other data, can help provide rural water services to farmers and other residents of the open countryside at least cost. This is particularly important in light of the redirection in federal policies that places more of the costs of new rural water service systems on users.

SUMMARY

This chapter has presented the general characteristics of the rural water systems serving farm and nonfarm rural customers in Illinois. In general, the systems are small relative to urban water supply systems whether measured by number of customers or volume of output. Also, the districts are characterized by low user density with over half reporting less than 10 users per mile with an overall mean density of 5.6. Ground and surface water sources were used about equally for supplies of raw water and 84 percent of the rural systems reported buying water from some supplier.

Low user density systems are characterized by relatively more customers and more miles of pipeline than systems with higher densities. The average monthly per user outlay by the rural water systems in Illinois was about $16.00 in 1980 with about 40 percent being for debt service. In general the more dense systems and those with a larger volume of output had lower average per user and average per million gallons of water costs suggesting technical efficiencies in the provision of rural water services.

The operating cost analysis and capital cost analyses affirmed the inverse relationship between per unit costs and size. The former analysis suggested average operating costs decline by about $9.00 (1978 dollars) for every additional one million gallons of water provided. However, an additional supply of four million gallons of water per year and a simultaneous reduction in average user density of one customer per mile of pipeline would be approximately cost neutral in impact. Scale economies were identified for construction bids for water lines and elevated storage tanks which would further reduce the average total cost of water for large rural systems.

Because of the redirection of federal policies, more of the costs of rural water services will be placed on the users of the service. The results of the analysis presented in this chapter should contribute to the provision of rural water services as efficiently as possible.

Footnotes

1. The benefits of quality potable water may include benefits in addition to those captured by individual users. For example, adequate water systems are often considered threshold necessities if a community is to attract industry. The benefits of economic growth may be viewed as public in nature extending beyond the individual user of the water service (Sigurdson, 1982). Financing the water service using only user fees may result in the underprovision of water service in a Pareto sense. Some evidence is available suggesting, however, that in the case of population growth, growth precedes the provision of higher levels of water services, not vice versa (Stam, 1974).

2. TRTCST and WAGE were standardized using $\underset{\sim}{X}_s = (\underset{\sim}{X} - \mu)/\sigma$ where $\underset{\sim}{X}$ and $\underset{\sim}{X}_s$ are the vectors of observations and standardized observations for the respective variables. μ is the mean and σ the standard deviation of the vector $\underset{\sim}{X}$. It is conceivable that the standardized TRTCST and WAGE also include scale effects and other factors such as operating efficiency. To investigate the existence of such effects, the cost function could be specified as a system of simultaneous equations. However, the correlation matrix does not strongly support the need for such a specification.

3. Other functional forms such as logarithmic and semi-logarithmic were fitted to the operating cost data. The linear form yielded the best fit and is reported here. The simple correlation coefficient for TOPO and CLMT with the full sample was .43. Similarly, the coefficient between QNTY and USRS was .75. However, estimates of equations 1 and 2 excluding USRS differed little from those reported suggesting multicollinearity is not a major problem. When $QNTY^2$ was added as reported in equation 1, the coefficient on USRS increased in both size and significance.

4. A linear programming model can be cited as a simple example. The objective function is the total capital cost which comprises of water production and storage, water treatment, and the distribution network. The capital cost analysis provides an approach to estimate the coefficients required in the optimization model.

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CHAPTER 6

RURAL WATER DISTRICT USERS AND WATER DEMAND

Water has become an economic good. The technology is now available to provide potable water in large volume to urban centers and on demand to scattered farms and rural residences in the open countryside. It is a matter of economics and a question of how much users are willing to pay for the desired quality of water at any given location. In this chapter the relationship between quantity of water purchased by households served by rural water systems and price is analyzed. Water prices are organized and levied through block rate schedules. The rationale for these pricing schemes and their application by Illinois rural water districts is discussed in the first part of the chapter. Following this the characteristics of a random sample of Illinois rural water district users are presented. The last section presents information on water consumption and the demand for rural water services.

The descriptions and analyses in this chapter build on the general notion of block rate pricing schemes for natural monopolies (like water supply services) and present detailed descriptions of rural water system users, their water consumption and their water expenditures. From a policy perspective, it is important to understand who the users of rural water services are and something about their water consumption behavior.

The data for these analyses comes in part from the mail survey completed by 86 percent of Illinois' rural water districts which had been financed, at least partially, by the Farmers Home Administration. Water rate schedules were reported by responding districts. Information on the users of rural water systems was obtained from a stratified random sample of households served by rural water districts in Illinois. Through a telephone interview, surveys were completed on 100 randomly selected users. The interview data was matched with monthly water consumption and expenditures for 1982 obtained from the users' ledgers recorded by the respective districts. The sampling procedure and interview instrument are provided in the Appendix along with the mail survey completed by water districts. The interviews were conducted in the spring of 1983.

WATER RATES

Water services are generally priced following a two-part pricing system. This simply means that the total price charged customers is made up of a part independent of the quantity of water used and another part directly related to demand. The first part is a service or minimum charge and the second is a price per unit. More often several ranges of quantity are established with the per unit price declining in each subsequent quantity range or block. Presumably the declining rates reflect declining costs of providing water. This pricing structure is associated with most utility enterprises where, because of large fixed costs, the systems operate at output levels where marginal cost is below average cost so the receipts from marginal-cost pricing would not cover all costs and thus the systems would operate at deficit (Hanke, 1972).

Emphasis on securing adequate revenues to meet the total cost of water systems have led to the adoption of average-cost, not marginal-cost, as the driving force in water rate schedules. This basis for pricing water is argued to be more consistent with the "readiness to serve" and the "going concern" philosophies of utility services. However, the benefits of marginal cost pricing can be realized, in part, through the block rate system, which by its character permits charging low prices for marginal units and making up the deficit by charging higher prices for premarginal units (Afifi and Bassie, 1969, pp. 79-88).

The first charge in the block rate pricing system is looked to as serving several purposes: 1) to cover at least part of the fixed costs of the water plant and distribution system, 2) to provide a stable revenue flow and 3) to cover the customer costs of meter reading, billing, etc. The second charge is related to the cost of providing additional water.

The initial charge may be either a service charge or a minimum charge. The minimum charge is the most common approach and is used by all of Illinois' rural water systems. The major difference between the service and minimum charge is that with the minimum charge the customer is entitled to a fixed minimum quantity of water whether or not it is consumed. About 58 percent of the rural water systems in Illinois provide 1,000 gallons with the minimum charge per month and have a mean monthly minimum charge of $9.76. These districts' minimums ranged from $6.00 to $15.00 per month.

A typical rural water district rate schedule is:

minimum charge	$8.50/month for 1,000 gallons
next	4,000 gallons at $3.15 per 1,000 gallons
next	5,000 gallons at $2.25 per 1,000 gallons
next	10,000 gallons at $1.75 per 1,000 gallons
all use over	20,000 gallons at $1.55 per 1,000 gallons

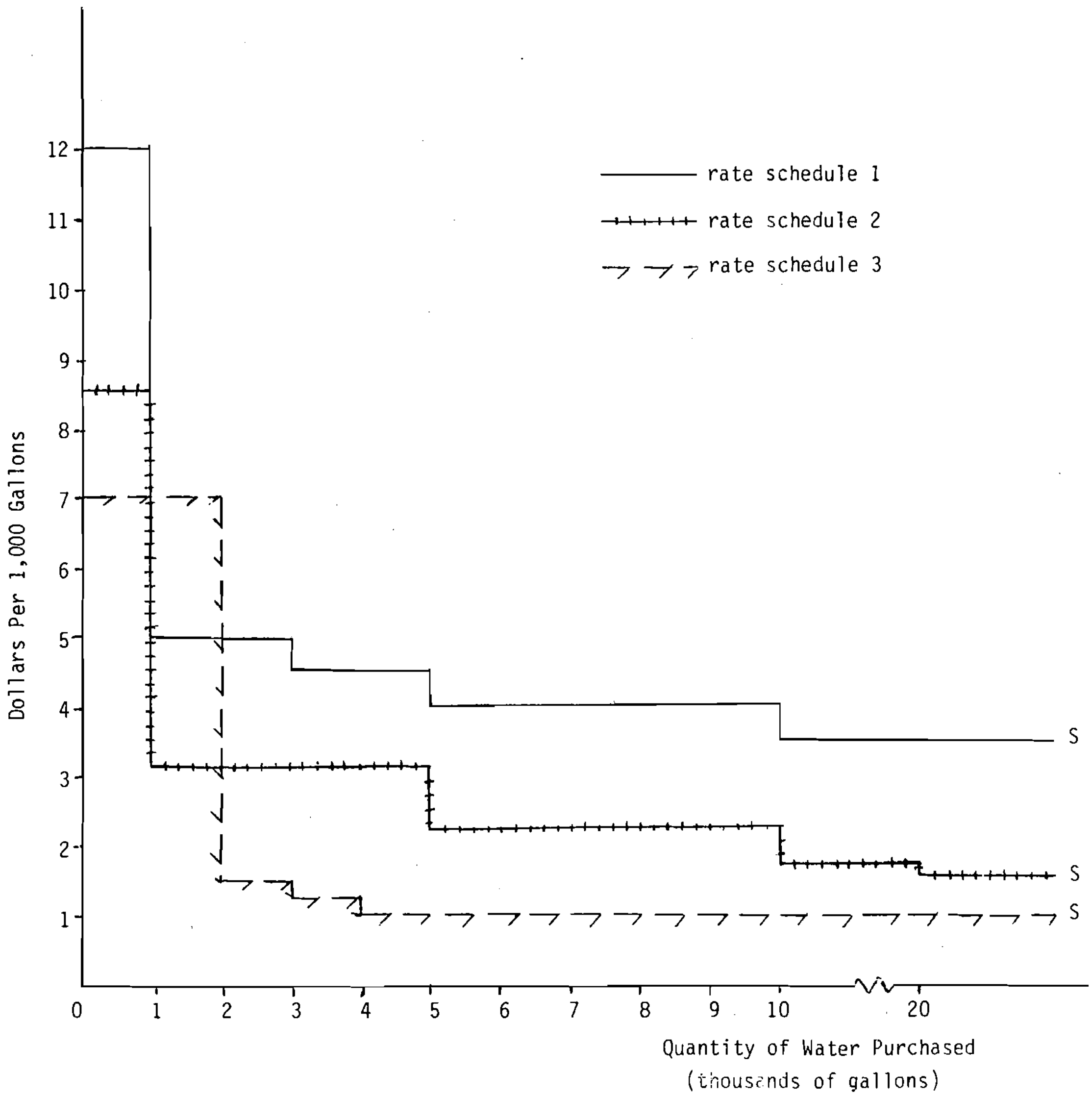
About 30 percent of the rural systems in Illinois provided 2,000 gallons per month with the minimum charge. Other first blocks reported were 1,500 gallons, 3,000 gallons and 4,000 gallons.

The number of blocks ranged from two to seven. About 22 percent of the rural Illinois districts used a two block schedule, 13 percent a three block schedule, 29 percent a four block schedule, and 33 percent a five block schedule. Figure 6.1 graphically presents three example block rate pricing schemes reported by Illinois rural water systems. The minimum charges for the three example rate schedules are $12.00, $8.50, and $7.00 with the first two entitling users to 1,000 gallons of water per month and the latter schedule entitling users to 2,000 gallons. The second blocks for these schedules are 2,000 gallons, 4,000 gallons, and 1,000 gallons respectively.

About one fourth of the rural system rate schedules reported had a 4,000 gallon second block and one fourth had a 1,000 gallon second block. The average rate for the second block for systems entitling 1,000 gallons with the minimum charge was $3.78 per 1,000 gallons. For all systems

Figure 6.1

Example Block Rate Schedules



reporting, the average rate for the second block was $3.70 per 1,000 gallons of water. From a user's perspective, the rate schedule traces the water supply faced in making consumption choices. For example, considering the first schedule in Figure 6.1, if a consumer were to purchase 4,500 gallons of water, the marginal charge or price for the last 1,000 gallons is $4.50. By choosing to consume 5,500 gallons rather than 4,500, the marginal price declines to $4.00 per 1,000 gallons. In general, the two-part pricing structure results in lower marginal and average prices as water use increases.

For the 27 rural water systems in Illinois with a thousand gallons of water associated with the minimum charge, the average price per 1,000 gallons is presented in Table 6.1 for monthly consumption levels of 1,000, 2,000, 4,000, 6,000, and 8,000 gallons. For the 27 districts in this sample, the average price per 1,000 gallons declines from $10.24 to $4.05. As the minimum charge is spread over more gallons,

Table 6.1

Average Price Per 1,000 Gallons of Water
by Number of Users in District*

Number of Customers	Average Minimum Charge	Average Price Per 1,000 Gallons For				Number of Districts
		2,000 Gal.	4,000 Gal.	6,000 Gal.	8,000 Gal.	
Less than 199	$7.65	$5.77	$4.45	$3.59	$3.23	6
200-399	10.77	7.73	5.32	4.56	4.17	14
400-799	10.83	7.76	6.55	6.06	5.80	3
800 and More	10.13	6.60	4.84	4.00	3.57	4
Full Sample	10.24	7.13	5.19	4.43	4.05	27

* Average for 27 districts with 1,000 gallon minimums.

the reduction in the average per unit price becomes smaller. Average prices are also presented by size of water district measured by number of users. Except for the 800 and more category, average per unit price increases as the number of customers increases. For example, for 4,000 gallons, the average price increases from $4.45 per thousand gallons for systems with less than 200 customers to $6.55 for systems with between 400 and 800 customers and then declines to $4.84 for the larger systems. A major factor in this pricing characteristic is the higher minimum average charge reported by the systems with more customers. However, the small number of observations for the larger districts suggests some caution needs to be exercised in generalizing this tendency. One possible explanation for this tendency is that larger systems have greater fixed plant and distribution system costs that are imbedded in debt service requirements and independent of the quantity of water sold. The principal and interest payments require higher minimum charges and thus higher average per unit prices through the rate schedule to meet these obligations. This is consistent with the descriptive evidence on debt service expenditures presented in Chapter 5.

CUSTOMER CHARACTERISTICS

In general, the average Illinois rural water district user would likely be a nonfarm rural resident, report a 1982 income of about $17,000, be 49 years of age, be a household containing 3 or 4 persons, consume 4.64 thousand gallons of water in an average month at an average price of $5.77 per 1,000 gallons and pay a water bill of $20.47 per month, on average. These user characteristics are reported in Table 6.2. Only about 22 percent of the users reported their occupation as farmers.

The characteristics of farm users vary somewhat from those of nonfarm users. As reported in Table 6.2 farm users reported a lower average 1982 income, a higher mean age, a larger household size, more water consumption, higher average water bills, and thus not surprisingly, lower average water prices for a thousand gallons of water than their nonfarm counterparts.

While nonfarm users consumed an average of 4.29 thousand gallons per month in 1982, farm users recorded average monthly consumption rates of 5.91 thousand gallons. Nonfarm users reported

Table 6.2

Selected Characteristics of Illinois Rural Water District Users[a]

Characteristic	Mean	Standard Deviation	Minimum	Maximum
		Full Sample		
Income	$16,958*	---	---	---
Age	49	16.27	22	82
Household Size	3.23	2.32	1	10
Water Consumption (1,000 gal. per month)	4.64	3.76	.18	27.92
Water Bill ($ per month)	$20.47	$10.79	$7.00	$72.84
Average Price ($ per 1,000 gal.)	$5.77	$4.60	$1.41	$39.60
		Farm Residents		
Income	$14,861*	---	---	---
Age	53	16.32	24	79
Household Size	3.41	1.65	1	7
Water Consumption (1,000 gal. per month)	5.91	6.61	.85	27.92
Water Bill ($ per month)	$22.93	$16.29	$9.75	$72.84
Average Price ($ per 1,000 gal.)	$5.32	$2.75	$2.33	$12.52
		Nonfarm Residents		
Income	$17,538*	---	---	---
Age	48	16.24	22	82
Household Size	3.18	2.48	1	10
Water Consumption (1,000 gal. per month)	4.29	2.42	.18	10.67
Water Bill ($ per month)	$19.77	8.63	$7.00	$38.60
Average Price ($ per 1,000 gal.)	$5.89	$5.00	$1.41	$39.60

a. N = random sample of 100 users.

* Estimated from reported income categories.

an average age of 48 years compared to 53 years for farm users. Nonfarm users' 1982 average income was about 18 percent greater than the mean annual income reported by farm users (i.e., $17,538 vs. $14,861).

Figure 6.2 presents details on the distribution of Illinois rural water district users by income and average monthly water consumption. The customers exhibit a bimodal income distribution with 30 percent reporting over $30,000 income in 1982 and 24 percent reporting 1982 incomes of under $10,000. The relatively large number of retired users acounts, in part, for this distribution. About 18 percent of the users in the sample indicated they were retired.

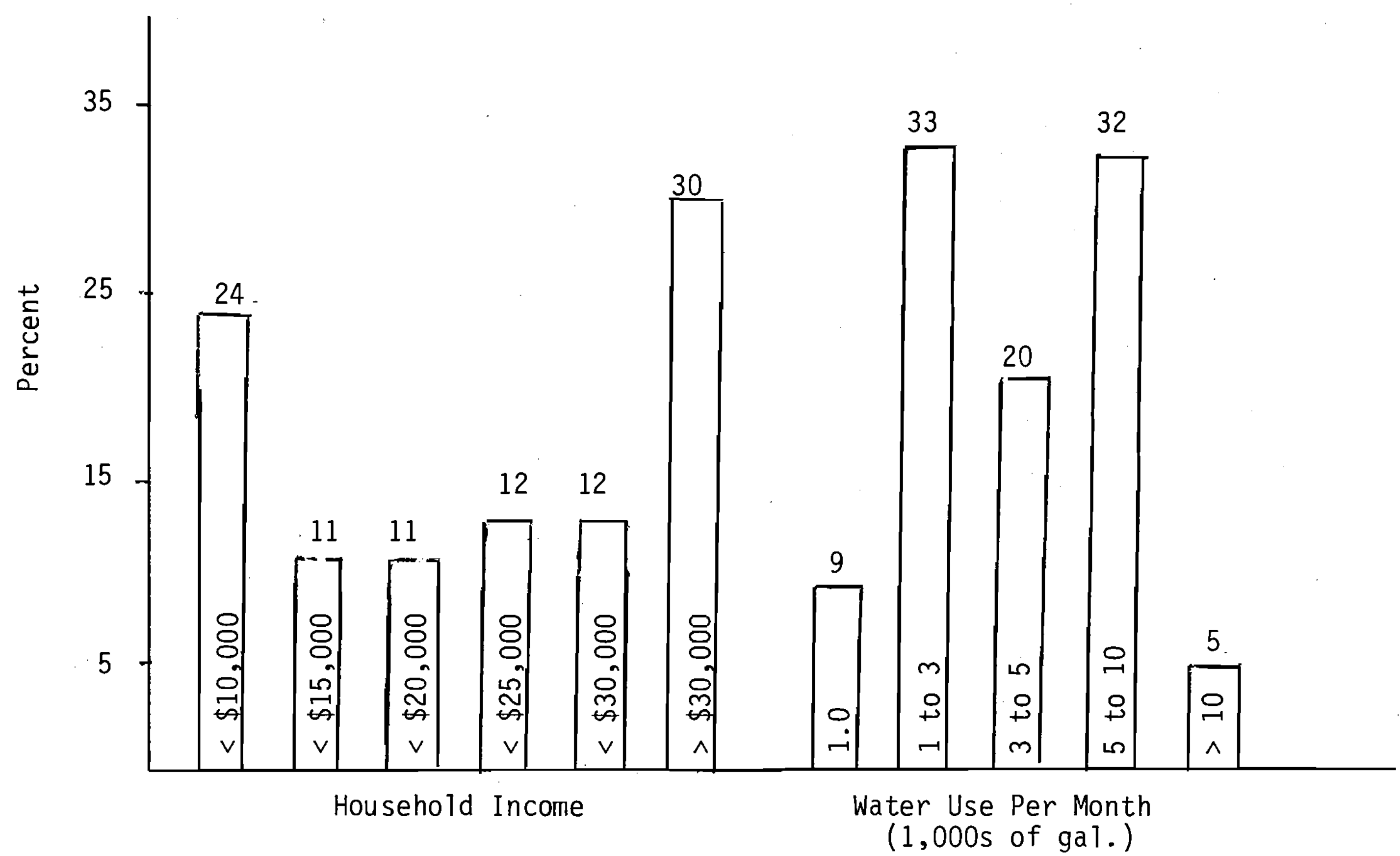
Average water consumption also exhibits a bimodal distribution with consumption clustered around 1 to 3 thousand gallons per month and 5 to 10 thousand gallons per month. About one third of the users recorded water consumption in each of these ranges with 20 percent consuming, on average, 3 to 5 thousand gallons per month.

Tables 6.3, 6.4, and 6.5 present descriptive characteristics of Illinois rural water system users broken down by household income, average monthly water consumption, and average monthly expenditure for water services, respectively. In general, users with higher incomes had higher average water bills. Those with less than $10,000 reported income had 1982 average water bills of $18.19 per month while users reporting incomes of $30,000 and more spent $22.18 per month for water. Consistent with the character of block rate price schedules, the average price per thousand gallons of water was highest for the low income, low water consuming users and lowest for the high income, high water consuming users.

The high average age (63 years) for customers reporting less than $10,000 1982 income is consistent with the large number of users reported to be retired. Retirement incomes are generally lower than the incomes of working individuals. Interestingly, the modal income categories of nonfarm users are less than $10,000 and $30,000 and over. Twenty-six

Figure 6.2

Income and Consumption Distributions for Rural Water District Users[a]



a. N=a random sample of 100 users.

Table 6.3

Selected Characteristics of Illinois Rural Water District Users by Income Levels[a]

Annual Income	Average Water Consumption (1,000 gal. per month)	Average Expenditure Per Month ($)	Average Price Per 1,000 Gal. ($)	Average Age (years)	Average Household Size	Type of Household Farm (%)	Type of Household Nonfarm (%)
Less than $10,000	4.11	18.19	7.54	63	2.85	16.7	26.2
$10,000-$14,999	5.54	21.18	6.06	57	3.00	27.8	6.2
$15,000-$19,999	5.28	19.43	4.51	39	4.00	11.1	10.8
$20,000-$24,999	3.96	22.27	6.41	43	3.40	11.1	12.3
$25,000-$29,999	4.23	20.96	5.41	43	3.20	11.1	12.3
$30,000 and Over	5.65	22.81	4.40	43	2.96	22.2	32.3
Full Sample	4.83	20.87	5.72	49	3.13	100	100

a. N=a random sample of 100 users.

Table 6.4

Selected Characteristics of Illinois Rural Water District Users by Quantity of Water Used[a]

Average Quantity of Water Consumed (1,000 of gal. per month)	Average Water Consumption (1,000 gal. per month)	Average Expenditure Per Month ($)	Average Price Per 1,000 Gal. ($)	Average Age (years)	Average Household Size	Type of Household Farm (%)	Type of Household Nonfarm (%)
Land Under 1.0	.71	9.93	15.32	64	2.33	13.6	7.8
1.01 to 3.0	2.23	16.46	7.04	56	2.18	36.4	32.5
3.01 to 5.0	3.98	21.44	5.21	40	3.35	9.1	23.4
5.01 to 10.0	6.66	22.57	3.14	45	4.21	27.3	33.8
10.01 and Above	15.72	48.65	3.04	36	5.00	13.6	2.6
Full Sample	4.64	20.47	5.77	49	3.23	100	100

a. N=a random sample of 100 users.

percent of the nonfarm users reported incomes in the former category while 32.3 percent reported incomes in the latter. The modal income categories for farm users were $10,000-$14,999 (27.8 percent) and $30,000 and over (22.2 percent). About 17 percent of the farm users reported 1982 incomes below $10,000.

The characteristics of rural water district users broken down by monthly water consumption in Table 6.4 suggest farm users have somewhat higher consumption rates than nonfarm users. About 41 percent of the farm users recorded average monthly water consumption of more than five thousand gallons. Thirty-four percent of the nonfarm users recorded consumption in these categories. However, 13.6 percent of the farm users had consumption rates above 10 thousand gallons per month but only 2.6 percent of the nonfarm users were in this range. Livestock watering could account for these differences, however, few farm users indicated they relied on water from rural systems for livestock.

The average price for 1,000 gallons of water declined continuously across the water consumption categories again reflecting the structure of the block rate schedules. The average price for users buying over 10,000 gallons per month was about one fifth the average price paid by users buying 1,000 gallons or less. The $15.32 average price for the lowest consumption category reflects the minimum charges of the two part pricing system. The mean age of users recording the lowest water consumption rates was 64 years while the mean age of users purchasing 10,000 or more gallons per month was about half this at 36 years.

The relationship between household size and monthly water consumption and expenditures for rural water services is evidenced in Tables 6.4 and 6.5, respectively. Households with more people have higher consumption rates and higher average water bills. On a per person basis, small households paid $4.20 per month, on average, for rural water services while the larger households spending over $20.00 per month, on average, paid over $7.00 per person for water services. As reported in Table 6.4,

Table 6.5

Selected Characteristics of Illinois Rural Water District Users by Monthly Water Bill[a]

Average Expenditure Per Month ($)	Average Water Consumption (1,000 gal. per month)	Average Expenditure Per Month ($)	Average Price Per 1,000 Gal. ($)	Average Age (years)	Average Household Size	Type of Household: Farm (%)	Type of Household: Nonfarm (%)
10.00 and Under	2.23	8.41	8.31	65	2.00	4.5	13.0
10.01 to 15.00	3.18	11.87	5.58	56	2.44	36.4	22.1
15.01 to 20.00	3.34	17.21	5.76	46	2.83	22.7	16.9
20.01 and Above	6.49	29.51	5.24	43	4.13	36.4	48.1
Full Sample	4.64	20.47	5.77	49	3.23	100	100

a. N=a random sample of 100 users.

48.1 percent of the nonfarm users had water bills averaging more than $20 per month, while 36.4 percent of the farm users were recorded in this category. The association between customer age and low water consumption rates and water bills is also evidenced in Table 6.5. The average age of users averaging $10.00 and under per month for water service was 65 years. The mean outlay for this group was $8.41 per month compared to $29.51 for users in the above $20.00 per month category whose average age was 43 years.

WATER CONSUMPTION

The user characteristic descriptions provide evidence that average monthly rural water service consumption is positively influenced by household income, number of persons in the household, and a farm occupation. Concomitantly, because of the block rate pricing schedule, increased consumption caused the average (and marginal) per unit water price paid by customers to decline as more water was purchased.

Residential water use is also seasonal across months and cyclical within a normal day. Evidence exists that the peak hours of use for urban residential customers are between nine and ten in the morning and between seven and eight in the evening. Residential water demand is also higher in the summer months than at other times of the year. A major contributor to the seasonality is the increased demand for outdoor use during the summer months. This includes lawn sprinkling, vegetable and flower garden irrigation, car washing, etc. Although, in-household water demand is also stronger in the hotter, more arid summer season (Wolff, et al., 1966).

The variation in water demand within a day and seasonally at any given price causes peak-load problems. Because of peak-load demands, the determination of appropriate prices and the sizing of initial water system capacity is more complex than when the quantity of water demanded is uniform over time. Sizing systems to meet peak-load results in higher fixed costs and higher revenue needs to cover these costs. Rate structures are concomitantly set to generate total earnings sufficient to cover costs. To help sustain the capacity to meet peak demands, peak-load consumption is encouraged by using uniform pricing systems in which peak and off-peak rates are equal. Hanke (1972) argues that a uniform water pricing policy, in the face of the peak-load problem, results in inefficient resource allocation and an involuntary subsidy to the peak users by the off-peak users. Pricing policies may be improved by varying prices among periods in the consumption cycle and, in addition, by increasing prices as one moves further from the water system's center--assuming marginal costs increase as distance from the center increases (Hanke, 1972, p. 292).

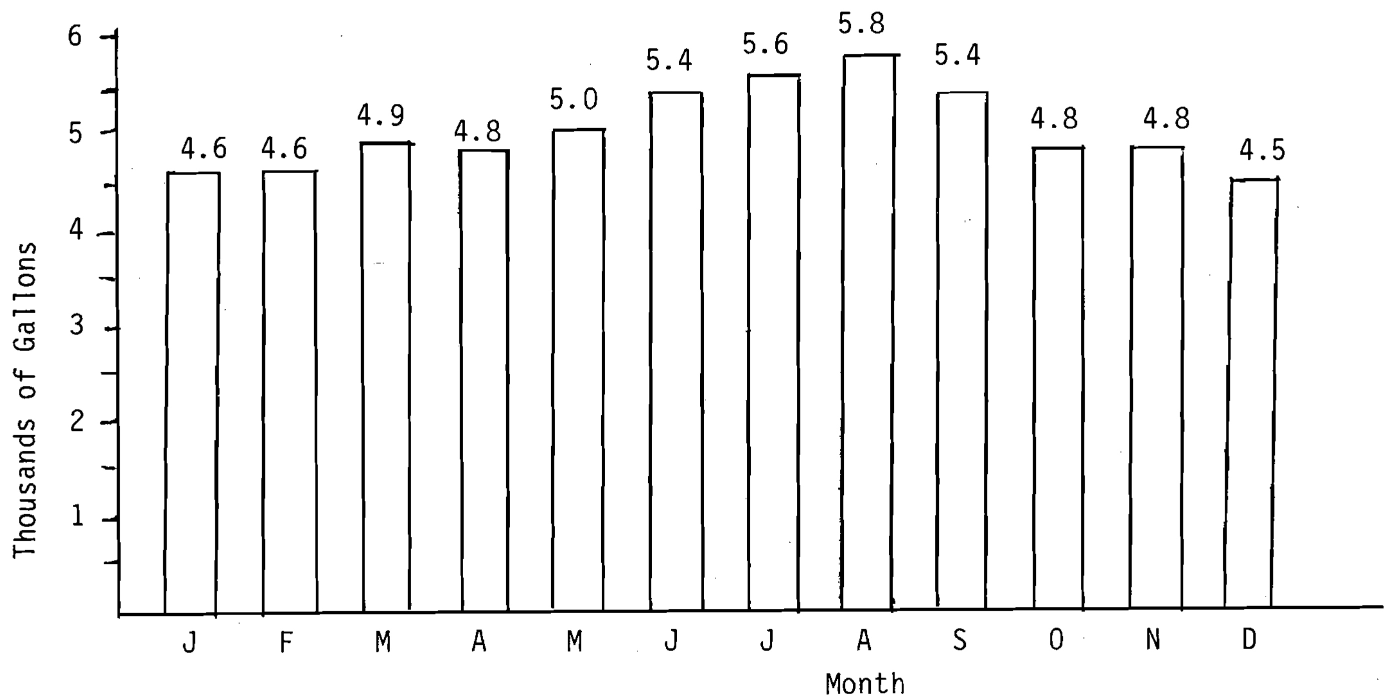
The cost analysis in Chapter 5 provides some evidence that costs of rural water systems do increase with distance, particularly as user density declines. Administrative costs, however, may inhibit the implementation of variable pricing policies in rural water systems. The size and operational simplicity of the Illinois rural water districts may result in administrative costs for complex pricing policies to adjust for time and distance factors that outweigh associated benefits.

Monthly Consumption. Information from the records of the sample districts on average monthly water use is detailed in Figure 6.3 for 1982. From October through April consumption is reasonably stable at between 4.5 and 4.8 thousand gallons per month. The low consumption month is December with an average of 4.5 thousand gallons. Consumption during the months of May through September averaged over 5,000 gallons per month with maximum consumption occurring during the dry month of August at 5.8 thousand gallons.

While there is some seasonality in the water use patterns of rural water district users in Illinois, the variation is not as great as might be expected. Consumption in the peak month was about 29 percent above consumption in December, the lowest use month. The ratio of average summer use (May through September) to average winter use for rural water service consumption in 1982 was 1.15. This is contrasted with a mean

Figure 6.3

Average Monthly Consumption Per User, 1982[a]



a. N=a random sample of 100 users.

ratio of 2.2 reported in a study of ten urban areas in the western sections of the U.S. (Wolff, et al., 1966). The peak-load problem faced by rural water systems in Illinois is not of the magnitude that may exist in other more arid regions or in urban areas where commercial water demand exacerbates peak-loads.

Seasonal variation in water use by farm users is less systematic than that of nonfarm users. In comparing the average monthly consumption information presented in Figures 6.4 and 6.5, the variation in consumption patterns is evident. Because nonfarm customers are dominant among rural water district users, their seasonal pattern of consumption presented in Figure 6.4, essentially mirrors the entire sample. A noticeable difference is in the amount of average monthly consumption, not in use variation. In August nonfarm users consumed 5.4 thousand gallons, on average, per household. The ratio of summer use to winter use for nonfarm users in 1982 was slightly above that for the whole sample at 1.18.

In addition to exhibiting a less systematic seasonal variation in water use than nonfarm customers, farm customers averaged more water use in each month in 1982 than nonfarm users (Figure 6.5). Interestingly, while August was the peak water using month for both types of users, April was the month nonfarm users used the least water, on average, while December was when farmers purchased the lowest gallonage. For farmers April was the third highest water use month. The summer/winter use ratio for farmers at 1.06 was 11 percent less than the nonfarm use ratio. This indicates that peak-load problems of rural water service demand may be more a result of nonfarm user seasonal behavior than the variation in the seasonal demand of farm users.

It is generally believed that the demand for residential water is relatively price inelastic (Hanke, 1972). One reason for this inelasticity is that the water bill of users is a relatively small portion of household expenditures so consumers are not very price responsive in their consumption behavior. Also, because of household technology, fewer and fewer water consumption decisions are now totally discretionary, at least in the short run.

Figure 6.4

Average Monthly Consumption Per Nonfarm User, 1982

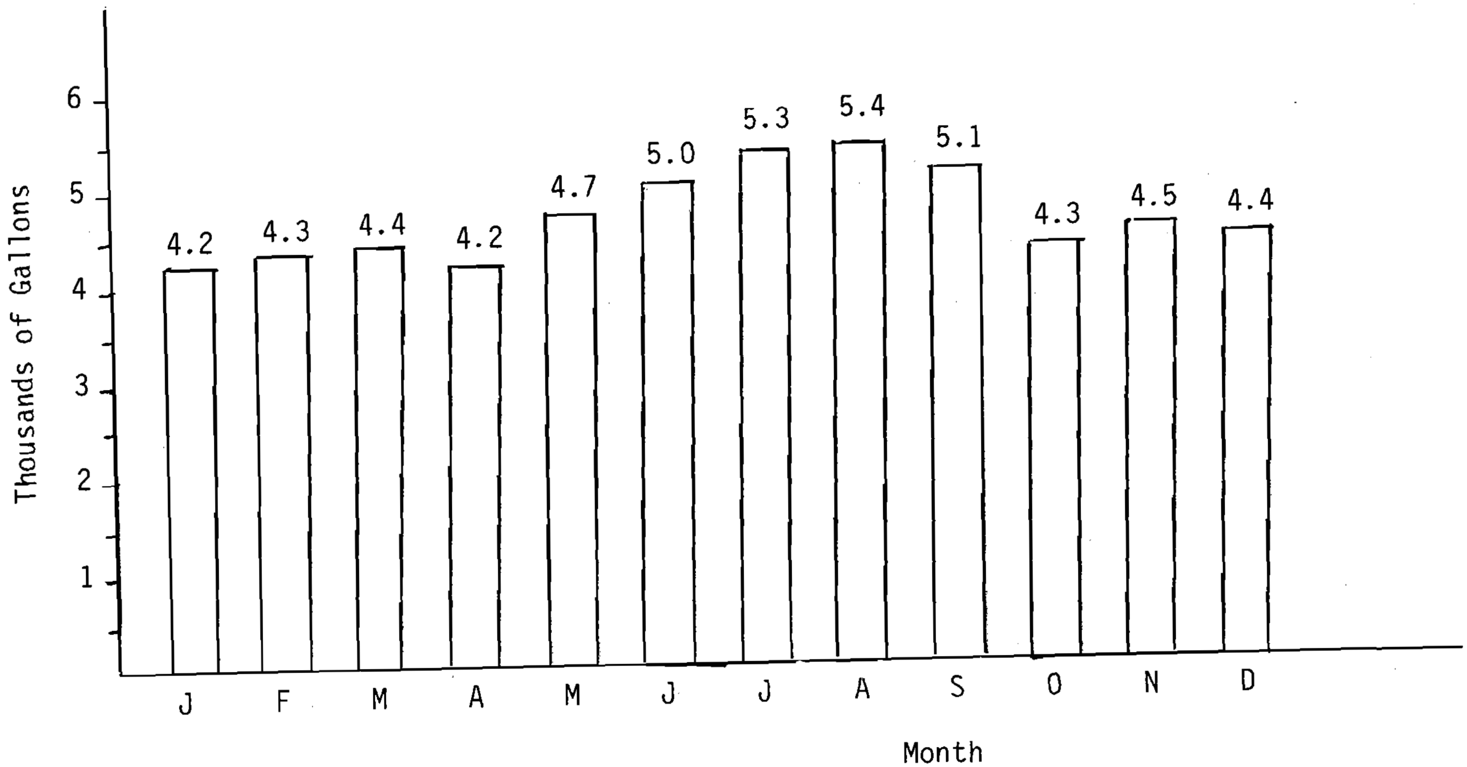
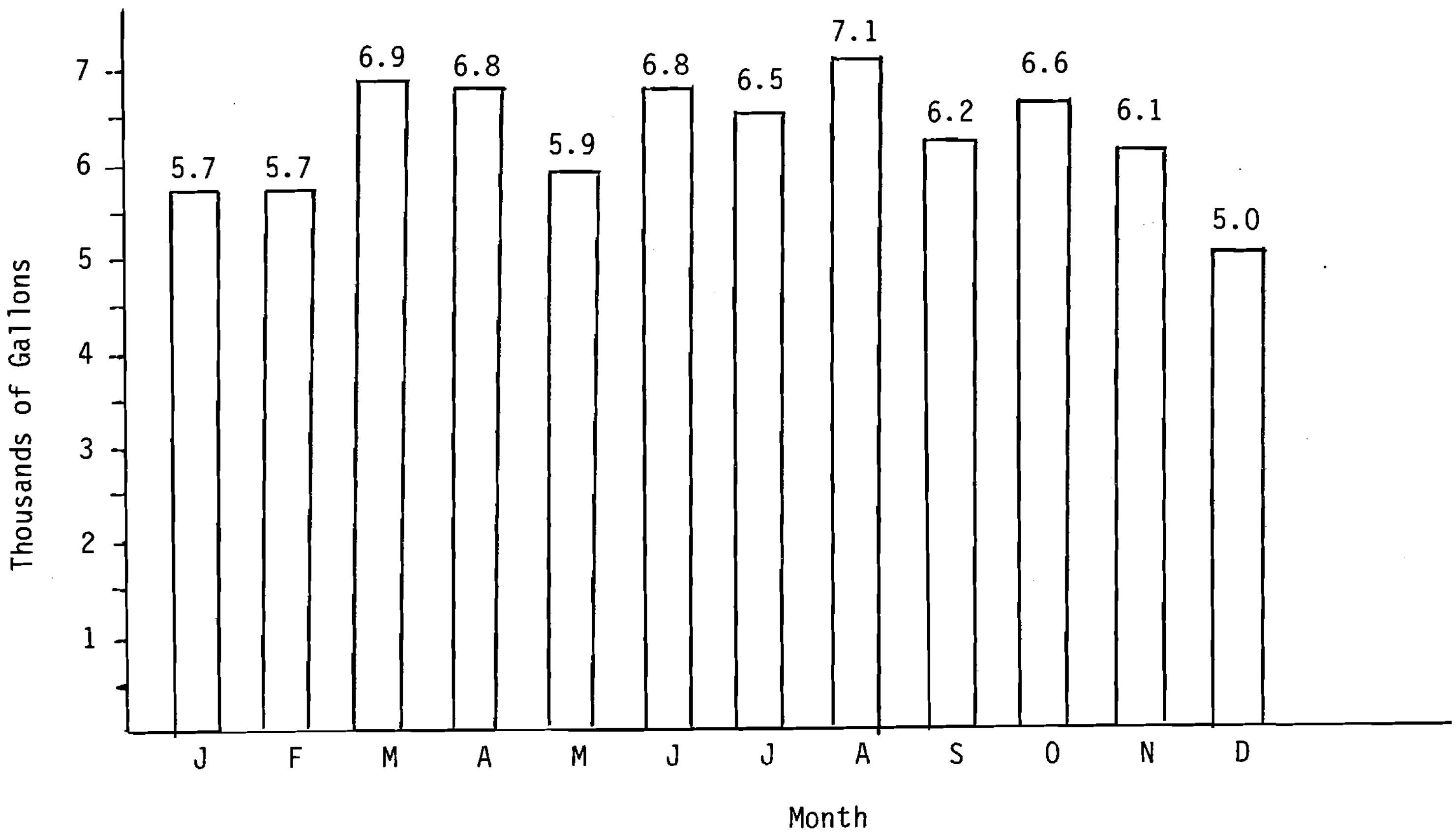


Figure 6.5

Average Monthly Consumption Per Farm User, 1982



To provide some information on the validity of consumers' knowledge about the amount of water purchased and monthly water expenditures, users were asked what they thought their average consumption was in the summer months of calendar year 1982 and the winter months of 1982. Users were also asked to give their estimate of their average monthly water bill for these two periods.

User perceptions on water use and expenditures are presented in Table 6.6 along with actual average monthly use and expenditures. The information is also broken down by average monthly expenditure categories. For the full sample perceived summer consumption was 5.15 thousand gallons per month and actual consumption was 5.57 thousand gallons. Comparable figures for the winter period were 4.18 and 4.80. In general, there was tendency to underestimate water use. The users' perception of their winter monthly water bill was very close to actual average winter bills. For the summer period, customers overestimated average monthly outlays but by only $1.56 ($23.40 vs. $21.84).

Users with larger actual monthly water service expenditures tended to report consumption and expenditure perceptions that were closer to their actual behavior than did customers with lower monthly water bills. Users with average monthly water bills of $10.00 or less reported, for example, summer consumption of 6 thousand gallons per month when their actual summer consumption averaged 2.41 thousand gallons. The perception of their summer bill was almost double actual average monthly expenditures ($16 vs. $8.38) for 1982.

In contrast, users with average monthly water bills exceeding $20 in 1982 underestimated their average summer consumption by only 360 gallons and their average monthly outlay for water by only $1.05. These users were equally as accurate regarding winter water purchases.

The comparison of perceptions and actual water consuming behavior suggests that for users with low actual monthly water bills, there is not a very accurate understanding of their behavior. On the other

Table 6.6

Perceptions Versus Actual Monthly Water Consumption and Water Bill by Monthly Water Bill[a]

Average Expenditure Per Month ($)	Perceptions: Consumption Summer (1,000 gal. per month)	Perceptions: Consumption Other (1,000 gal. per month)	Perceptions: Bill Summer ($ per month)	Perceptions: Bill Other ($ per month)	Actual: Consumption Summer (1,000 gal. per month)	Actual: Consumption Other (1,000 gal. per month)	Actual: Bill Summer ($ per month)	Actual: Bill Other ($ per month)
10.00 and Under	6.00	2.00	16.00	10.90	2.41	2.42	8.38	8.41
10.01 to 15.00	2.11	1.51	15.09	12.32	4.06	3.20	13.04	11.48
15.01 to 20.00	2.90	2.62	20.50	18.35	3.95	3.52	18.18	16.89
20.01 and Above	7.51	6.52	30.44	28.55	7.87	6.78	31.49	28.84
Full Sample	5.15	4.18	23.40	20.78	5.57	4.80	21.84	20.02

a. N=a random sample of 100 users.

hand, users with larger monthly outlays, where water costs are possibly a larger proportion of monthly household income, have a more accurate understanding of their behavior. This suggests that the demand for water services may be somewhat more elastic for customers with higher monthly average water bills than for customers with lower monthly average water bills based largely on the accuracy of the information on water consumption held by the different classes of users.

The observed variation in the difference between perceived and actual consumer behavior is logical. Knowing more about water use and monthly expenditures is of little value to users who pay the minimum charge. Most rural water district users with monthly outlays of $10.00 or less are billed the minimum charge which by definition is not a function of the quantity of water consumed. More accurate information would not assist these users in reducing their monthly water expenditures by changing their behavior. Consequently, they know less about the particulars of the amount of water they use and what they pay for water.

WATER DEMAND

If the demand for rural water services were totally inelastic, the analysis of this demand for pricing policy and other purposes would be somewhat irrelevant since price would then not affect the rate at which water is consumed. The demand for water for residential household use, however, is not totally inelastic. Therefore, understanding the relationship between price and quantity is important for policies internal to the management of rural water systems and for the public policies of the federal and state governments. This latter policy aspect is most critical in the 1980s as federal subsidies for rural water service are not as readily available as in past years. This policy change will increase, on average, the price of rural water service available from new systems. An understanding of the price impact on water purchases will be useful in evaluating capital investments in plant and distribution systems. Demand analysis can also be used to estimate consumer surplus for rural water services for use in determining project feasibility and evaluating rate or pricing schedules (Sigurdson, 1982).

Early studies of water demand focused on urban residential demand and were based on a requirements concept. This concept assumed that the price elasticity of demand is zero, that the impact of price changes on the quantity of water demanded is negligible and that population and industrialization determined the quantity required (Hanke, 1972, p. 295; Foster and Beattie, 1979).

The assumption implicit in the requirements concept is that the relevant economic variables of price and income had no impact on the quantity of water demanded in an area or by a household. This assumption is no longer considered appropriate. Most of the more recent studies of urban residential water demand depart from the requirements concept (see Foster and Beattie, 1979). However, little research on the demand for rural water services is available. The survey of Illinois rural water district users provided household characteristic data that when matched to household consumption and water expenditure information provided the data needed to estimate a demand function for Illinois rural water services.

Demand Model

The neoclassical theory of consumer behavior indicates four principal determinants of quantity demanded: 1) the price of the good, 2) prices of related goods, 3) income, and 4) preferences and tastes. Considering these factors the following model is hypothesized as representing the demand for rural water service:

$$Q = f(PRI, INC, NUM, RES, BATH, DISH) \quad (1)$$

where:

Q = quantity of water demanded per customer household (average per month in 1982 in thousands of gallons),

PRI = average price per 1,000 gallons (12 month average price per thousand gallons for 1982),

INC = 1982 household income (dollars per year),

NUM = number of persons in the household,
RES = 1 if a farm customer, 0 otherwise,
BATH = number of bathrooms in the house, and
DISH = 1 if a dishwasher was used, 0 otherwise.

The price of a consumer good is expected to be the most single important factor affecting quantity demanded. There is controversy over the appropriate price variable to use in demand studies of goods like water priced under block rate systems. Concern centers on whether an average price or the appropriate marginal block price should be the measure of price in demand estimates. Under the assumption of perfect knowledge by consumers, Nordin (1976) demonstrated, theoretically, that a correct specification requires the inclusion of both marginal price and an expenditure differential variable equal to the excess of the actual total payment over what the total payment would have been if the marginal price had prevailed in all blocks. However, Foster and Beattie (1981) argue that the perfect knowledge postulate implicit in the marginal block price specification is unacceptable and that average price is more likely the price motivating consumer response. They also argue that the measure(s) of price to which consumers actually respond is an empirical question and show a marginal price specification for urban water demand performing similarly to an average price model. A related empirical problem is the fact that average price is not strictly independent of the observations on quantity of water purchased, the dependent variable (Hanke, 1972).

The descriptive characteristics on rural water district user perceptions of water purchases suggest that there is possibly a threshold expenditure below which the value of time is greater than the additional expenditure foregone by undertaking detailed marginal analysis. Reality in consumer demand estimations depends on consumers' perception of prices rather than what in fact exists. Following the logic of Foster and Beattie (1981), average price per thousand gallons of water (PRI) is the price variable used.

Theoretically, the water demand model should include prices of substitutes and complements as well as the price of water. Practically speaking, water has no close substitutes and is complementary to other goods only in the sense that it is used in appliances such as washing machines and in waste disposal. Because of these only indirect relations to complements, all cross-price effects were assumed negligible and only the price of water was included in the model. To adjust for differences in consumption due to variation in household technology among rural water district customers, the number of bathrooms in the house (BATH) and the presence of a dishwasher (DISH) were also included. All households that had a dishwasher also had a washing machine. However, washing machines were essentially universal appliances in user households. Both the number of bathrooms and the presence of a dishwasher are expected to positively impact the quantity of water purchased.

Household income (INC) is also expected to be a significant determinant of rural water demand. Higher income households are expected to have a higher water demand, other things equal, since water is not an inferior good. To adjust for household size and farm vs. nonfarm users NUM and RES were included in the model. Larger households and farm customers were shown to have higher average consumption in the bivariate descriptions presented earlier. Both these determinants are expected to be positively related to the quantity of water demanded.

Empirical Estimates

Using OLS regression analysis, the demand model was estimated in linear form and in a logarithmic-linear form. In the latter statistical model, the explanatory variables are in exponential form. When estimated in log form, the coefficients from this model lead to the calculation of percentage changes in the quantity demanded (Q). For a unit change in an explanatory variable, the percentage change in Q equals $(e^{b_i} - 1) \times 100$.[1] The models were also estimated with price and quantity variables averaged over the summer months of May through September and over the other seven nonsummer months.

Annual Demand. The results of the regression analysis with the price and consumption variables averaged over 12 months are presented as Model AA in Table 6.7 and as the Annual Model in Table 6.8. The former table reports the linear models and the latter the log-linear models.

In Table 6.7 Model AA, the results of the analysis are generally as hypothesized. All coefficients had the expected sign and were significantly different from zero at or above the ten percent level. Exceptions are the presence of a dishwasher and the farm user. Both these variables had signs on their coefficients opposite expectations but neither were significantly different from zero, statistically. While farm users appeared to have higher average consumption rates in the descriptive characteristics, once adjustments were made for household size, technology, income, etc., rural water consumption by farmers is not significantly different from the consumption of nonfarmers. In Model AB, the two statistically insignificant variables were excluded.

The regression results in Model AB suggest that a $1,000 increase in household income is associated, on average, with an increase in water consumption of 40 gallons per month, other things equal. For each additional person in customer households, average monthly water use increases 290 gallons while an additional bathroom increases average monthly water purchases 1,271 gallons. These factors cause the demand function to shift up in price-quantity space.

Overall, the linear demand model performed reasonably well. Approximately 56 percent of the variation in the quantity of rural water demanded is associated with variation in household income, household size, the number of bathrooms and average water price paid per month.

Of particular interest is the relationship between quantity of water demanded and the price variable. The results of Model AB indicate that for every one dollar increase in average price per 1,000 gallons, the quantity of rural water demanded declined about 200 gallons. The estimated demand for water from Model AB is price "inelastic." Household

Table 6.7

Linear Estimates of Rural Water Service Demand

Variable	Annual[a]		Summer[a]		Nonsummer[a]	
	Model AA	Model AB	Model SA	Model SB	Model NSA	Model NSB
Household Income	.00004* (2.18)	.00004* (2.38)	.00005* (2.15)	.00005* (2.35)	.00003 (1.52)	.00003** (1.73)
Household Size	.293* (3.25)	.290* (3.25)	.315* (2.82)	.310* (2.79)	.273* (3.08)	.272* (3.13)
No. of Bathrooms	1.236* (3.67)	1.271* (4.18)	1.761* (4.24)	1.821* (4.82)	.853* (2.59)	.892* (3.01)
Dishwasher	-.033 (0.06)	---	-.029 (0.04)	---	.054 (0.10)	---
Farm/Nonfarm	-.550 (0.99)	---	-.896 (1.32)	---	-.318 (0.59)	---
Average Price	-.224* (4.72)	-.222* (4.77)	-.260* (4.18)	-.259* (4.20)	-.211* (4.79)	-.211* (4.89)
Constant	2.21	2.04	1.72	1.45	2.75	2.64
R^2 Adjusted	.56	.56	.55	.56	.48	.50
S.E.E.	1.75	1.74	2.16	2.16	1.72	1.70
F-Ratio	16.43	24.75	16.36	24.17	12.61	19.27

[a] The dependent variable for the annual models is the annual household consumption divided by 12 and the price variable is the annual expenditure on water divided by the annual household consumption expressed as per 1,000 gallons. The dependent variable and the price variable for the summer models are computed considering only the months of May through September and for the nonsummer models considering the seven other months.

Absolute values of t statistics are in parentheses.

* Significant at the 5 percent level. ** Significant at the 10 percent level.

demand elasticity for this model was -.2899 at the means of Q and PRI. Thus, purchases of water from Illinois rural water districts would drop only 28.99 percent for a 100 percent increase in price. This is similar to elasticity estimates of urban residential water demand (e.g., Hanke, 1972, p. 299, Lynne and Gibbs, 1976, Billings and Agthe, 1980).

Exponential form demand models are common to the literature (see Lynn and Gibbs, 1976, Foster and Beattie, 1979). This form of the demand model, estimated as a log-linear function, for the Illinois rural water systems is presented in Table 6.7 as the Annual Model. A model with price in exponential form allows the price elasticity to vary directly with price. High elasticities occur with high prices and low elasticities are associated with low prices. In this form, only household income and the price variable had coefficients significantly different from zero. These two determinants of rural water service demand are the only variables included in the exponential functions reported in Table 6.8. About 68 percent of the variation in the dependent variable, lnQ, was associated with variation in household income and price.

Table 6.8

Nonlinear Estimates of Rural Water Service Demand

Variable	Annual[a]	Summer[a]	Nonsummer[a]
Household Income	.00002* (4.22)	.00002* (4.26)	.00002* (3.45)
Average Price	-.110* (10.28)	-.117* (9.33)	-.107* (10.37)
Constant	1.57	1.59	1.57
R^2 Adjusted	.68	.65	.67
S.E.E.	0.42	0.46	0.42
F-Ratio	79.63	69.18	75.05

[a] See footnote of Table 6.6 for description of dependent variable calculation. The dependent variables in the nonlinear estimates are in natural logarithms.

Absolute values of t statistics are in parentheses.

* Significant at the 5 percent level.

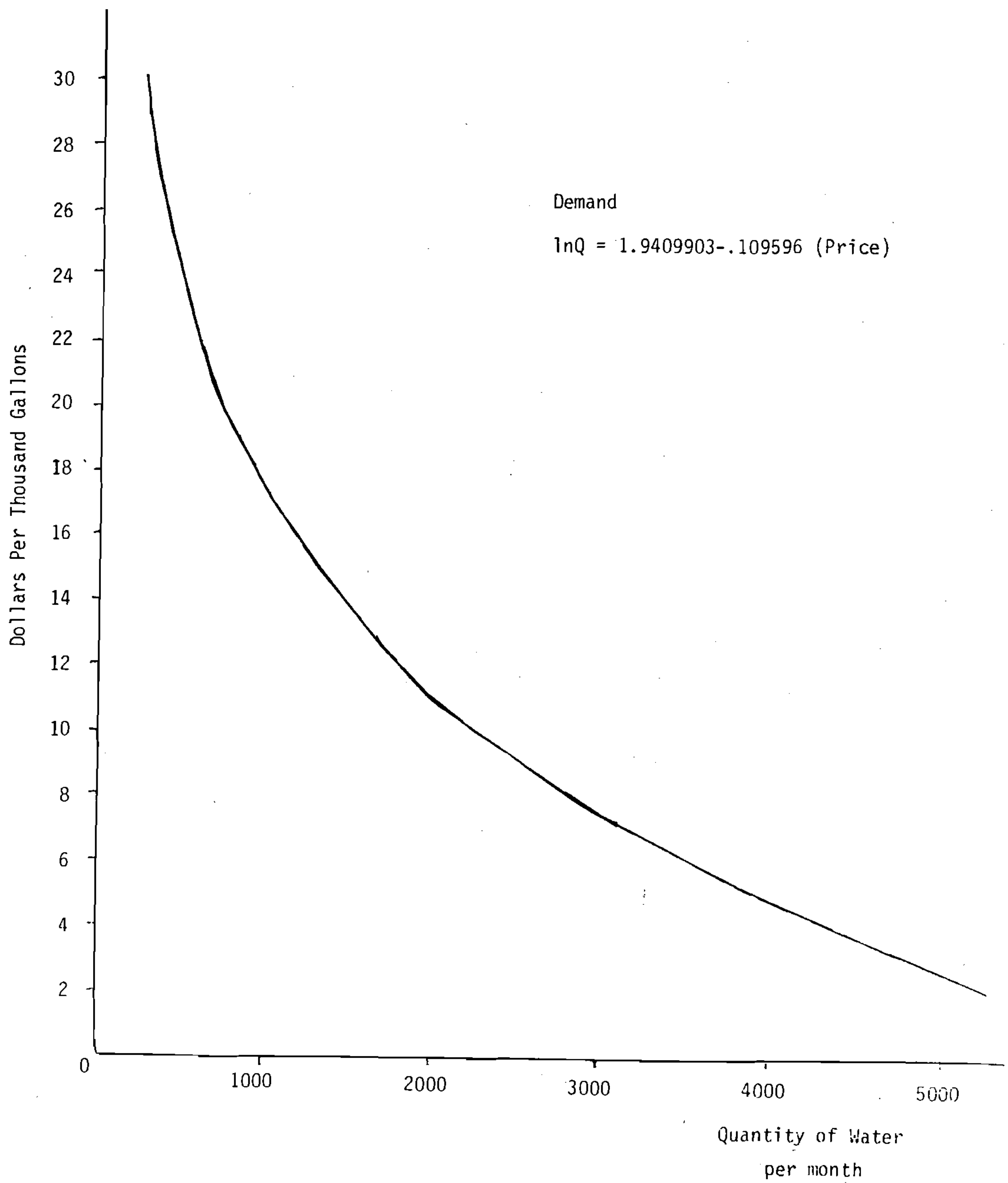
The results of the annual model suggest a $1,000 increase in household income is associated, on average, with a 2 percent increase in the quantity of water demanded. A one dollar per 1,000 gallon increase in price is associated with an 11.63 percent reduction in the quantity of water purchased by the customers of Illinois' rural water systems.

For prices in the lower price range, as expected, households had a more inelastic demand than for higher prices.[2] For example, purchases would be expected to drop 2.20 percent for a ten percent increase in price from $2.00 to $2.20 per thousand gallons. At high prices, demand is more elastic. A ten percent increase in price from $6.00 per thousand gallons would reduce the quantity demanded by 6.60 percent. The inelastic response exists for all prices below $9.09 per thousand gallons. The elastic response above this price means households change consumption levels by a larger percentage change than the percentage change in price. For example, a ten percent increase in prices from $11.00 per thousand gallons would reduce consumption by an estimated 12.1 percent. However, the range of price observations was from $1.41 to $39.60, most of which fell in the inelastic portion of the estimated rural water demand function. Figure 6.6 graphically presents the exponential demand function for the mean household income.

Seasonal Demand. The description of average monthly water consumption of rural water district customers provided some evidence of a seasonal pattern. Seasonal demand functions for urban residential water use have been reported in the literature (e.g., Lynne and Gibbs, 1976). To investigate the existence of seasonal demands by households using rural water services, both the linear and the log-linear forms of the demand model were estimated with the quantity (Q) and price (PRI) variables measured over the summer months and the winter months, respectively. These estimates are reported in the Summer and Nonsummer columns in Tables 6.7 and 6.8. The months of May through September were defined as summer with the remaining months categorized as nonsummer. These estimates are similar to the annual model in most regards and suggest that there possibly are seasonal rural water demands.

Figure 6.6

Estimated Demand for Rural Water Services



To statistically investigate if in fact water use during May through September is greater than water use during other months, an intercept and a slope dummy variable were added to demand model (1). The seasonal demand model is

$$Q_S = f(PRI, INC, NUM, RES, BATH, DISH, D, DPRI) \qquad (2)$$

where:

Q_S = quantity of water demanded per customer household (average per month for May through September and average per month for the remaining months in 1982 in thousands of gallons),

D = 1 if Q_S is summer quantity demanded, 0 otherwise (the intercept dummy variable),

DPRI = D times PRI (the slope dummy variable), and

the other variables are as previously defined.

If the coefficient on D is positive and statistically different from zero, water use in the summer months is significantly greater than water use in the other months. A significant coefficient on DPRI would indicate the slope of the demand function also varies by season. The seasonal model was estimated in linear and log-linear form and is presented in Table 6.9. To estimate the model, two cases were created for each household in the rural water user data set. The first case had water consumption averaged over the summer months and D equal one. The second case had water consumption averaged over the other months and D equal zero.

The coefficient on the seasonal dummy variable in the linear form is positive and significantly different from zero. However, the coefficient on this variable in the exponential demand form although positive is not significant above the ten percent level. The coefficient on the slope dummy variable, DPRI, is negative in both forms of the demand model, but not significant in either estimate.

These results certainly do not provide conclusive evidence that water use during the summer months was significantly greater than water use during the other months. However, there is some seasonal difference in demand and this was captured in the linear seasonal demand model. The

Table 6.9

Estimates of Seasonal Rural Water Service Demand

Variable	Linear[a]	Log-Linear[a]
Household Income	.00005* (3.18)	.00002* (5.53)
Household Size	.599* (5.16)	---
No. of Bathrooms	1.23* (5.03)	---
Average Price	-.159* (3.45)	-.101* (9.99)
Summer/Winter	1.151* (2.27)	.139 (1.22)
Summer/Winter x Price	-.096 (1.47)	-.014 (.96)
Constant	.58	1.50
R^2 Adjusted	.55	.66
S.E.E.	2.00	.45
F-Ratio	29.79	73.72

[a] The dependent variables are Q_S and LNQ_S for the linear and log-linear models, respectively.

Absolute values of t statistics are in parentheses.

* Significant at the 5 percent level.

inconclusiveness of these results demonstrate the need for additional research on the seasonality of water demands of households served by rural water systems.

SUMMARY

The logic of declining block rate pricing schedules for water service, in general, and rural water services in Illinois, in particular, were shown to cause the average price per thousand gallons of water to decline as purchases increased. Most rural water districts provide 1,000 gallons of water with the minimum monthly charge that averaged $9.76. The number of blocks in the rate schedules ranged from two to seven.

The customers of Illinois rural water districts purchased, on average, 4.64 thousand gallons of water a month at an average price of $5.77 per 1,000 gallons. Farm users, which account for about 22 percent of sampled users, had consumption rates averaging slightly above this level at 5.91 thousand gallons per month. Farm users also reported 1982 annual incomes that averaged 18 percent below the sample rural nonfarm households served.

In general, water users with higher income had higher monthly water bills and purchased more water per month. In addition to income, the description of water user behavior suggested household size, price and a farm occupation were related to the amount of water purchased. In the estimation of rural water service household demand functions, price and income were the two consistent determinants of water use. Household demand was price inelastic over much of the range of quantities purchased. However, the elasticity estimate from the exponential demand form became elastic for prices above approximately $9.00. In the multivariate analysis, farm user consumption was not significantly different than the consumption behavior of nonfarm customers.

While the descriptive characteristics of water purchases suggested seasonal variation in monthly water use, the existence of seasonal variation in water demand was not verified conclusively in the statistical estimation of demand. However, on average, the ratio of summer purchases to winter purchases was 1.15 for all customers and 1.18 for the nonfarm users.

Understanding who the users of rural water services are and what their consumption behavior is provides a base for policy making to enhance the internal management of districts and for public policy by higher levels of government. In particular, water demand analysis is fundamental to pricing policy adjustments, identifying the impacts of federal policy redirection, such as reducing capital subsidies for rural water service construction and guiding capital investment decisions in rural water system plants and distribution networks. The analyses presented in this chapter contribute to this understanding.

Footnotes

1. The linear model is $Q = a + b_1$ PRI + b_2 INC + b_3 NUM + b_4 RES + b_5 BATH + b_6 DISH + e. For the logarithmic-linear model, the natural logarithm of both sides of the following equation are taken and the dependent variable is lnQ:

$$Q = EXP(a_1 + b_1 \text{ PRI} + b_2 \text{ INC} + b_3 \text{ NUM} + b_4 \text{ RES} + b_5 \text{ BATH} + b_6 \text{ DISH} + e)$$

EXP is the exponential function. Since as bi approaches zero, $(e^{bi} - 1)$ approaches bi, small values of bi in the exponential function will approximate the percentage change in Q for a unit change in the i^{th} explanatory variable.

2. From the definition of price elasticity, $\frac{\partial q}{\partial p} \cdot \frac{p}{q}$, the exponential form price elasticity is $[q(-.110)] \frac{p}{q} = -.110p$.

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CHAPTER 7

RURAL WATER DISTRICT GEOGRAPHIC/SPATIAL ANALYSES

INTRODUCTION

The first step in this project was to survey the literature on special districts generally, and rural water districts specifically. While information is available on the legal and political mechanisms of special districts, information specifically on water districts is sparse. Neither a catalog search of the University of Illinois library system, nor an electronic literature survey of professionally prepared bibliographies located sources which identified and mapped rural water districts. Nor did the literature search find previous studies on water districts which had attempted to relate the district and its impact on its service area to regional or natural resource planning. Because of this lack of published information, other sources had to be located and a methodology for this study developed.

Initially information from both the Farmer's Home Administration (FmHA) and the Illinois Environmental Protection Agency (EPA) was collected. FmHA had files on 59 districts, the Illinois EPA had information on over 2,000 districts. This study has limited itself to the districts which FmHA monitors, as they have more uniform information available.

The FmHA administers a loan program for construction of rural water and sewer systems. They keep complete files on each district: that includes the financial agreements between FmHA and the district, contractor's reports, operating costs, user fees, district organization, etc. However, the files contain very little spatial information. Only those districts which have construction in progress may have the engineer's plans which show the district's layout in their files.

Since a part of this study is an attempt to examine the relationship between the water distribution system and the area surrounding it, two water districts in central Illinois were visited to see what information was available in the district's offices.

The two districts, the Sangamon Valley Public Water District in Mahomet and the Clearwater Service Corporation in Mattoon, were chosen for their easy accessibility to the research group as well as their difference in regulatory restrictions and service areas. The determination of type of information available in these instances was used in the selection of the final systems chosen for study.

The Sangamon Valley Public Water District serves several subdivisions surrounding the village of Mahomet, approximately 500 mobile homes, an apartment complex and a golf course. The water district has its own well, pump and water tower, and could conceivably service 500 additional homes. The water district appears to work harmoniously with the village of Mahomet, and will not service any area which the village services and vice versa. However, this arrangement is informal. The water district does not have to conform to the village's anticipated growth plans, nor do they have to submit expansion plans to any governmental or planning agency for approval (unless required by FmHA loan requirements). The water district _itself_ does not have any maps of distribution lines or users; however, their engineering firm made these available to us.

The second district visited, the Clearwater Service Corporation, was much more rural in character compared to Sangamon Valley's almost suburban service area. This system is currently operating at capacity. Increasing the system's service population would be possible only if more service lines were installed. Current users include residents of the village of Lerna and rural home dwellers. Before the system could expand service to a new area or rural subdivision, they are required to submit their plans to the Coles County Regional Planning Commission for approval.

While there is a good supply of groundwater in the Mahomet area, there is very little good well water available in the Mattoon area. So, while the Sangamon Valley Public Water District's function is that of water distributor, the Clearwater Service Corporation helps to upgrade the water quality in the area, as well as distributing it. Many farms in the Clearwater system are now able to use washing machines, dishwashers, etc. for the first time.

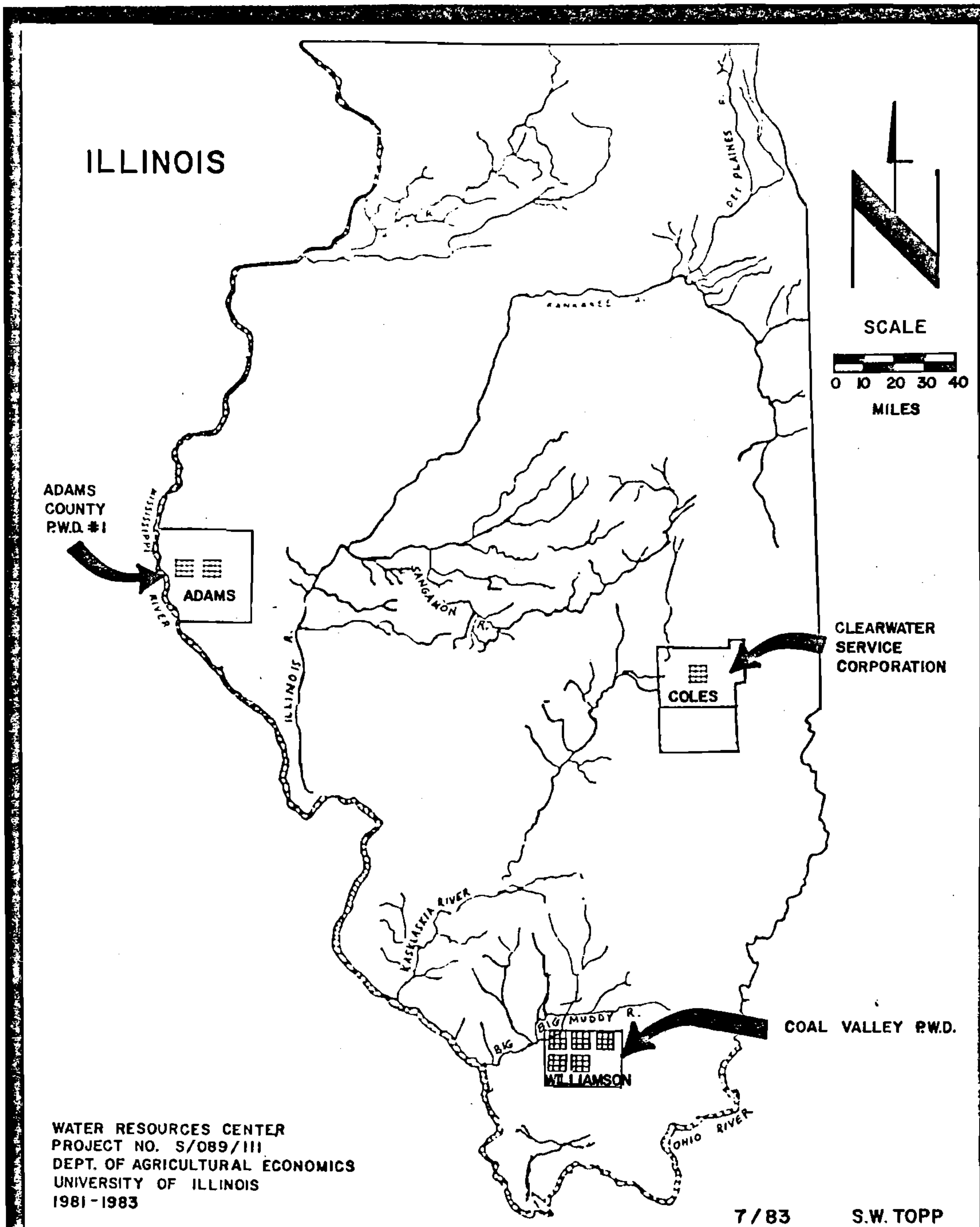
Mapped information on all of the districts is very limited. No district contacted had a complete system map. So, a decision was made to compile comprehensive data on representative districts and analyze their spatial layouts. Three districts were selected to be studied, on the basis that these would provide a reasonable representation of different areas of the state. Additionally amount and kind of information available for each district was considered. Sources of information include County Highway Departments, Regional Planning Agencies, Census information, ASCS aerial photos, USGS topographical maps and SCS soil maps. Questions concerning scale of maps and photos, land use data - prior and post water system construction, water resources planning, and population characteristics were raised.

A secondary consideration in choosing the districts for study was their geographic location. Districts in different areas of the state were sought, in order to ascertain if geographic location affects water district construction.

However, as the Farmer's Home Administration has to date no funded rural water districts in the upper northern section of the state, the study was somewhat limited in how diverse a geographic selection was available.

Using these criteria, the three districts chosen for this study were the Clearwater Service Corporation, Adams County Public Water District #1, and the Coal Valley Public Water District.

It should be noted that the previously mentioned sources of information yielded very little usable material. Land use plans for the areas were oftentimes not current, aerial photos covered too large an area or were unobtainable, very little in the way of comprehensive water resources planning seems to exist anywhere in the state, and the water districts themselves often had no notion of any impacts which their system had, or might have had, on the surrounding landscape.



SYSTEMS SELECTED FOR PROJECT

SOURCE: FARMER'S HOME ADMINISTRATION

For that reason, two of the three districts in this study were contacted and visited (the Coal Valley Public Water District was not visited*). Interviews with the districts' managers and engineers yielded much more up-to-date and comprehensive information than any other source. Information from these interviews and from the districts' own files made it possible for system maps to be completed for each of the three districts. The primary sources of information (the districts themselves) vary in amounts, precision and uniformity of information available. Exact user information was difficult to obtain. While the general layout scheme of each map is accurate, the exact location of identified users may not be. People join and leave the systems regularly and this cannot be reflected in the maps in this study.

THE DISTRICTS

Clearwater Service Corporation

The Clearwater Service Corporation is located in the southeastern portion of Coles County and the northwestern tip of Cumberland County. The district was formed in the early 1970's, instigated by a group of local engineers who recognized that the area had no reliable supply of potable water. To form the district, 80% of the potential users in the service area had to sign a service contract, committing them to district membership.

The 8 inch line in Mattoon Township, with a 200,000 gallon standpipe storage tank, lies east of Route 45 and Interstate 57. This 8 inch pipe branches off into a series of 6 inch lines with users scattered along the lines. Section 26 has a cluster of 11 users in the Hickory Hills Subdivision, but this is the only subdivision in the township. In Sections 9, 10 and 11 the line becomes 4 inch and serves 11 users. There are no villages in this township.

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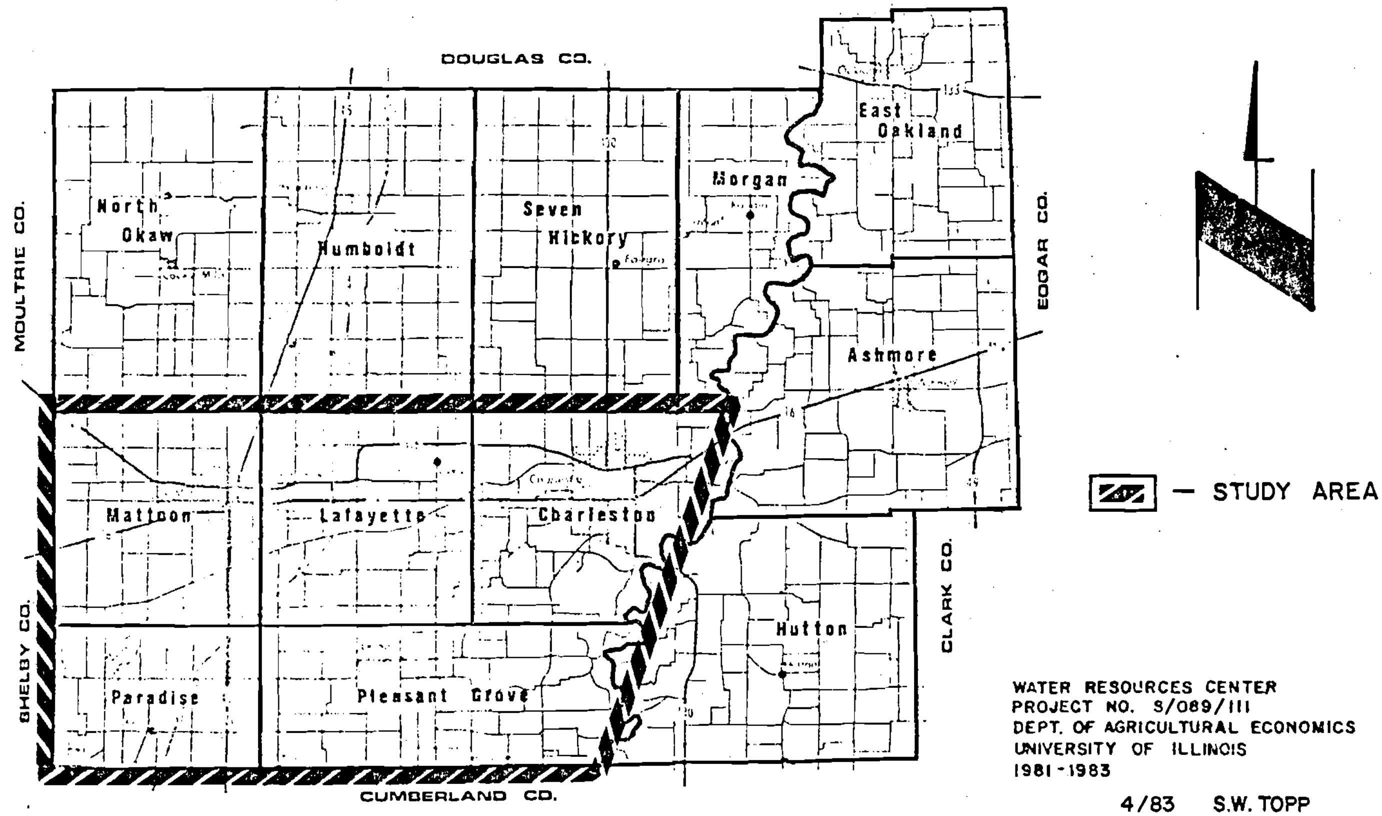
* The Coal Valley Public Water District, located in Williamson County, experienced a tornado during the early stages of the research project, thus preventing travel to the area for data gathering purposes.



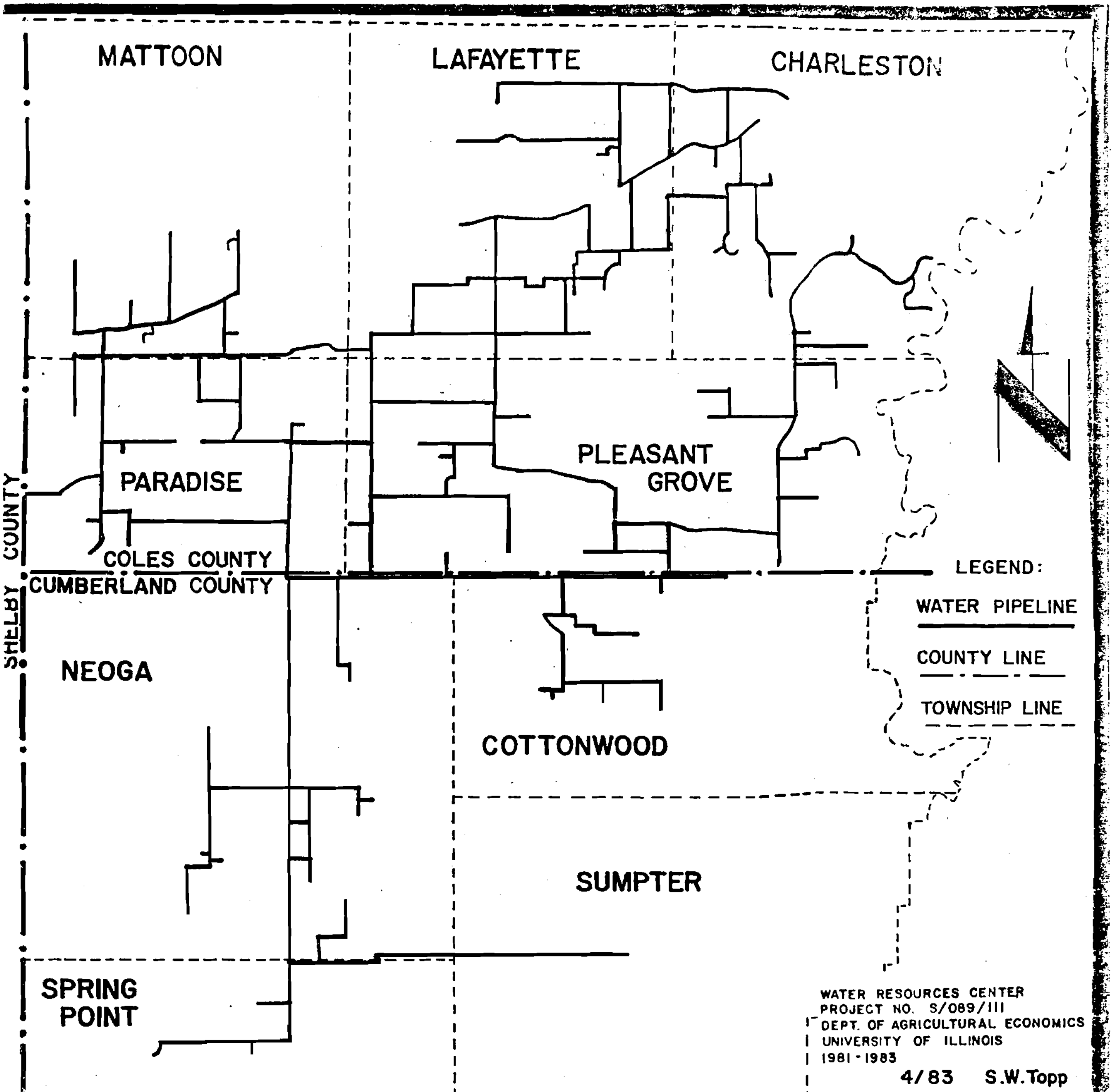
COLES COUNTY

SOURCE: COLES COUNTY REGIONAL PLANNING COMMISSION

The system continues into Charleston Township with 6" line. There are three subdivisions in this township. Ramblewood Estates in Section 20 has 11 users and Nobles Subdivision in Section 28 has 4 users. Most of the pipe extending into Charleston Township are 6" in diameter. However, Section 17 has a segment of 8" pipe leading into Ramblewood Subdivision. Also, there are short segments of 3" and 4" pipe branching off from the 6" extensions. These smaller lines follow county roads and service clusters of customers along them. The Charleston storage tank, located southwest of Charleston, holds 60,000 gallons.

The system continues southward into Pleasant Grove and Paradise Townships. There are three pipeline extensions into Pleasant Grove Township. In Section 6 there is 8" line which narrows to 6" in Section 7 and continues to the county border. There are three 4" offshoots from this line. The only densely occupied section in this area is Section 8, with 19 users clustered along the 4" pipe, and a 3" extension from it. The second extension into Pleasant Grove Township is in Section 4. 6" pipe narrows to 4" in the southern end of Section 3 and serves the Village of Lerna, which has 138 users. The 6" line continues south and east to the village of Janesville, which has 33 users and the Janesville storage tank which has a 75,000 gallon capacity. The third extension into Pleasant Grove Township is east of Janesville. 6" line runs through Sections 4, 9, 16 and 21. This 6" line also has 4" and 3" extensions from it into Sections 3 and 4, 5 and 6, 8, 9 and 10, and in Section 17. There are scattered customers throughout these sections.

Paradise Township has a highly concentrated area of users in the Lake Paradise Subdivision. There are 68 users clustered along the 6" pipe which borders Lake Paradise. This subdivision occupies parts of Sections 4, 5, 8 and 9. There are two segments of 8" pipe in this township, one in Sections 17 and 18, leading from the systems source, and one in Sections 2 and 3 by the Magnet storage tank. The 8" pipeline which leads from the source branches both north and south in Section 14. The 6" pipe heading north connects the Lake Paradise Subdivision and the 6" pipe heading south connects the village of Etna, which has 20 users. When this line reaches Route 45, it again splits north and south. The



CLEARWATER SERVICE CORPORATION

SERVICE AREA — COLES AND CUMBERLAND COUNTIES

SOURCE: CLEARWATER SERVICE CORPORATION

SCALE: MILES 0 1 2 3 4

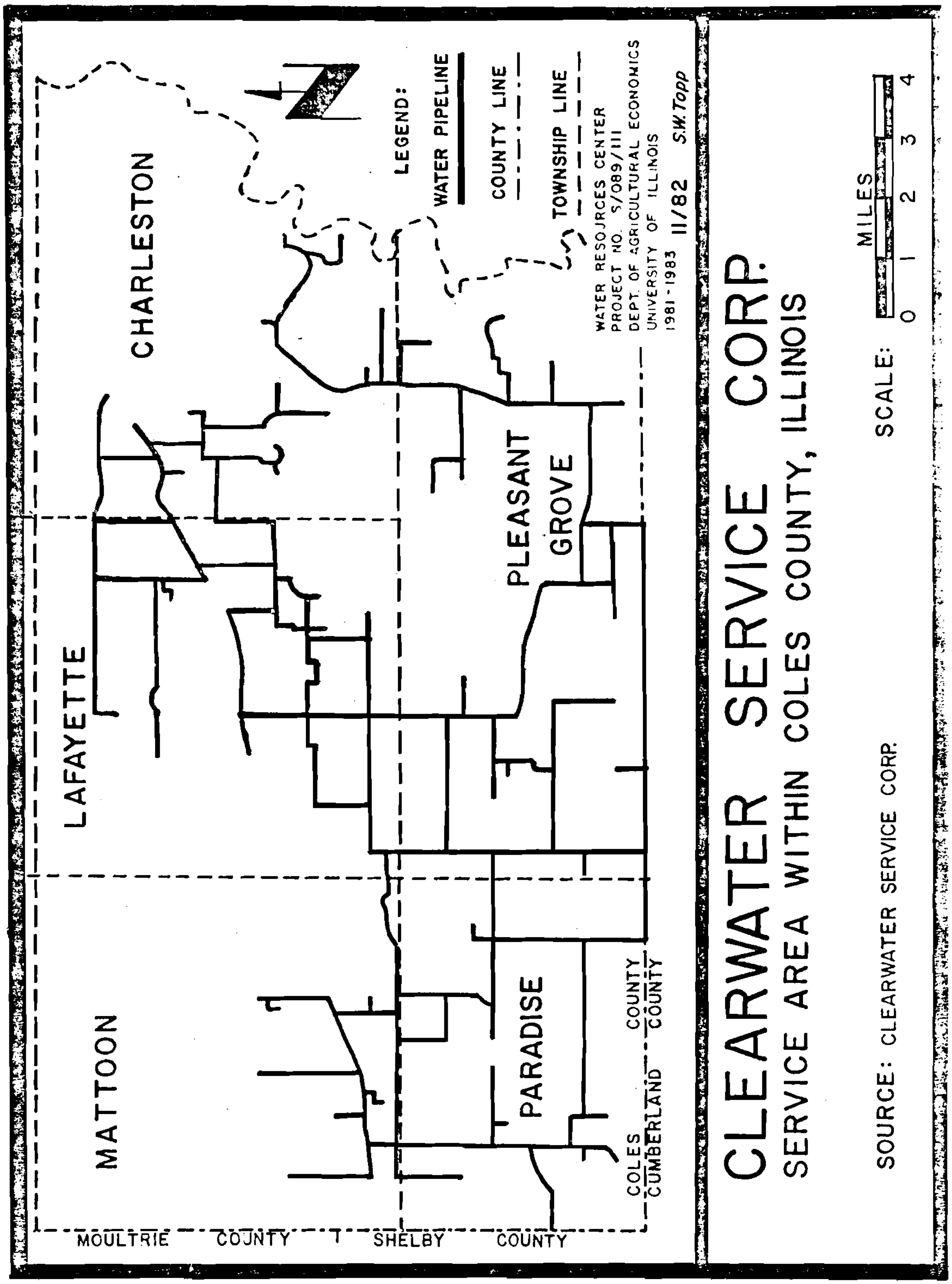
north section connects with the lines that lead into Pleasant Grove Township. The pipeline that heads south splits at the county border, part of it runs due east, paralleling the border, and the part of it extends southward into Cumberland County.

In Cumberland County there are two major pipeline extensions. The first one runs straight south, through all of Neoga Township and into Spring Point and Sumpter Townships. The pipe size is 6" until it reaches Section 36 in Neoga Township, and then changes to 4". From this long extension of pipeline there are four offshoots. One is a 4" extension westward into Sections 10, 11 and 14 and 15 which branches off into 3" pipeline in Sections 3, 10, 15, 22 and 27. There are twelve users on this extension line. The second offshoot extends eastward into Sections 7, 12, 13, 18 and 24 of Neoga Township. There 3" and 4" pipeline form a closed loop which serves 24 users. Nineteen users are served by pipeline which extends from this closed line. The fourth offshoot from this section extends to the town of Toledo. Thirty-seven users are served along this segment of 6" and 4" line.

The second major extension into Cumberland County runs into Sections 26, 27, 34, 35 and 36 of Cottonwood Township. The pipeline is 4" in diameter, with three small extension 3" in diameter. This segment of the Service Corporation's line serves 27 users.

A brief summary of the district layout is as follows. The system's source is in Mattoon Township. Eight inch pipe feeds the water from the source to the system's pipelines. Pipelines fan out from the source, decreasing in diameter size as the outskirts of the system are reached. The largest amount of pipe is six inch and four inch in diameter. Three and two inch pipe is used only on the edges of systems where only a few users or clusters of users are found. The greatest number of users and pipeline is found in Coles County. There are only three main arms of pipeline extending into Cumberland County.

The district's water supply is purchased from the city of Mattoon. The district's contract with Mattoon stipulates that Mattoon may not refuse to supply water to the district. Despite this stipulation, the district


CLEARWATER SERVICE CORP.
SERVICE AREA WITHIN COLES COUNTY, ILLINOIS
SOURCE: CLEARWATER SERVICE CORP.
SCALE:
MILES
0 1 2 3 4
LEGEND:
WATER PIPELINE
COUNTY LINE
TOWNSHIP LINE
WATER RESOURCES CENTER
PROJECT NO. S/089/111
DEPT. OF AGRICULTURAL ECONOMICS
UNIVERSITY OF ILLINOIS
1981-1983
11/82
S.W. Topp
CHARLESTON
LAFAYETTE
MATTOON
PLEASANT GROVE
PARADISE
COLES COUNTY
CUMBERLAND COUNTY
MOULTRIE COUNTY
SHELBY COUNTY

has drilled an experimental well on its property and is determining whether it can realistically service its customers from its own well.

The construction of Clearwater Service Corporation was completed in two phases. The first phase, completed in 1978, is comprised of approximately 60 miles of pipeline and now serves approximately 738 users (including the Lake Mattoon Public Water District - not shown on the map). The second phase of construction added 130 miles of pipeline and serves an additional 770 users (this figure considers the 138 users in the Village of Lerna as one user). The average usage varies from as high as 4600 gallons per minute in summer, to a low of 3,500 gallons per month in winter.

The pipe size for the mains in the district varies from 8" at the district's water source to 2". From the main to the meter vault on each user's property the district uses 1 3/4" pipe. The owner is responsible for whatever other distribution lines are needed. There are six (6) storage tower tanks in the system.

Description of System. For the purposes of analysis, the districts have been divided into township survey sections. Individual sections or clusters of sections will be analyzed. The Clearwater Service Corporation covers 168 sections. Although the district is not allowed to serve customers within a one and one-half mile radius around any incorporated municipality, the sections outside this boundary, which surround the cities of Mattoon and Charleston have the largest number of rural users.

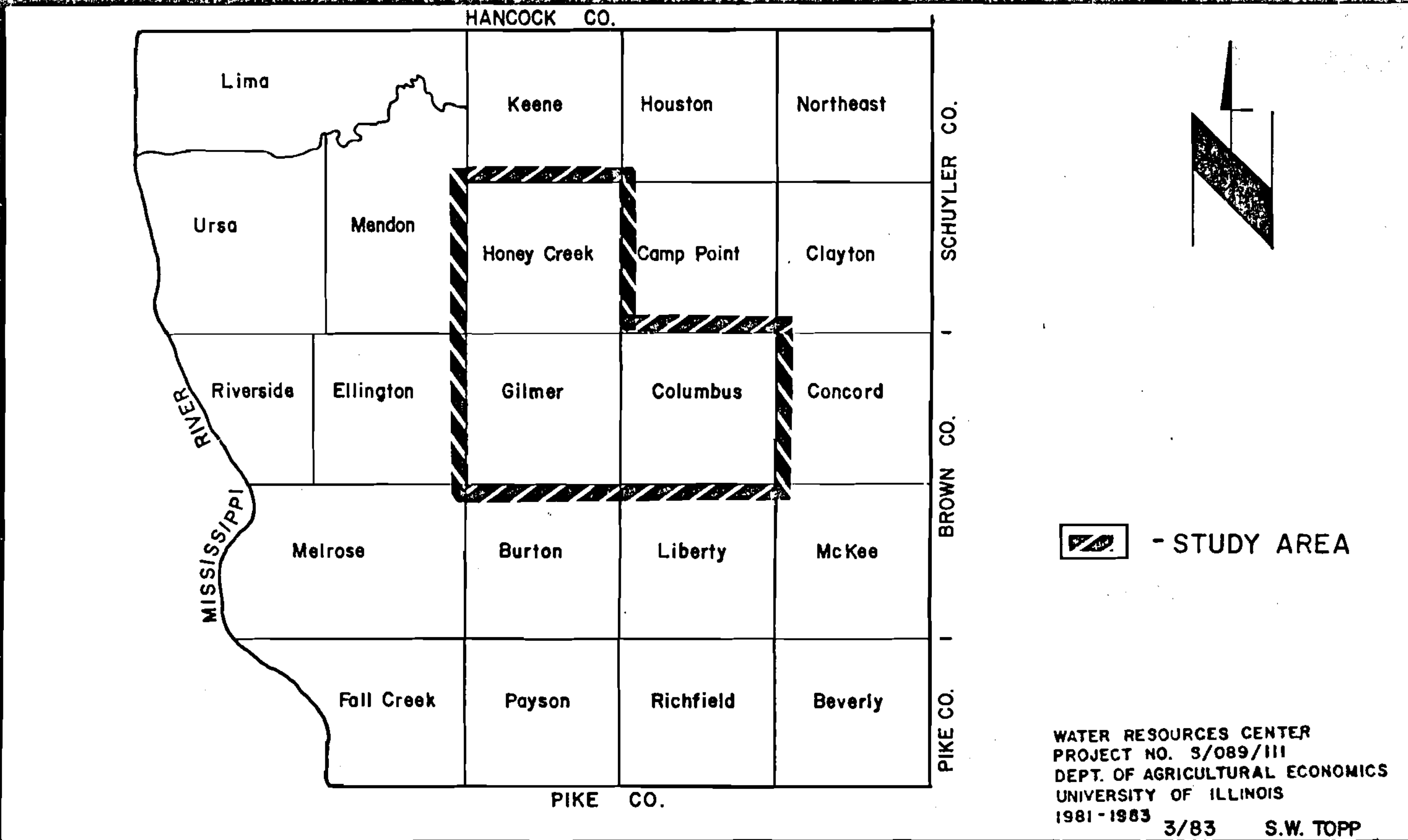
In Mattoon Township is one of the system'ssix storage tanks. The Magnet storage tank holds 75,000 gallons. Lincoln Trails Subdivision is also in Mattoon Township and has 41 users. Next to this subdivision are the adjacent sections 21, 27, and 33. These sections have 37 users along a 6" segment of pipe. 6" line then extends into Section 32. From this 6" pipe, 3" line extends into Sections 30, 31, 32 and 33. There are 8 users along this segment of pipe.

Because Clearwater Service Corporation extends into two counties, analysis of the impacts of the district on its service area is difficult. There is a great disparity of information available on the district and on land-use planning within the district's boundaries. Coles County has a regional planning commission, Cumberland County does not. Before the Clearwater Service Corporation could agree to serve a new development in Coles County the developer would have to get a permit from the Coles County Planning Commission allowing it to be built. The Service Corporation could not serve anyone who did not have this permit. This is not true in Cumberland County. If service expansion were feasible, the corporation could operate in any area of Cumberland County, regardless of the impacts that this would have on land use or water resources. No permit system or guiding agency exists.

Public Water District #1

Public Water District #1 (PWD #1) is located in central Adams County, a west central Illinois county which borders on the Mississippi River. It is different from the other two districts studied in that it is a confederation of four settlements, Fowler, Paloma, Columbus and Coatsburg, and only incidentally serves the rural user. The district was originally formed in 1973 with the intention that the water supply for the four settlements would come from the McKeesport Conservancy District, a water project which had not yet been constructed. The water district was built, relying on this not yet available source and using a well in Fowler as an interim supplier. Funding for the McKeesport Conservancy District project never materialized, so PWD #1 was forced to buy its water from the deep wells on the Mississippi River which belong to the Clayton-Camp Point Water District. These wells will be PWD #1's permanent source. (Source: John Klinger, Klinger and Associates, engineers for the district.)

The most recent annual report available from the water district (1982) lists 293 users and an average annual water consumption total of approximately 13,200,000 gallons.



ADAMS COUNTY

SOURCE: ATLAS MAP OF ADAMS COUNTY, ILLINOIS

SCALE: MILES 0 5 10

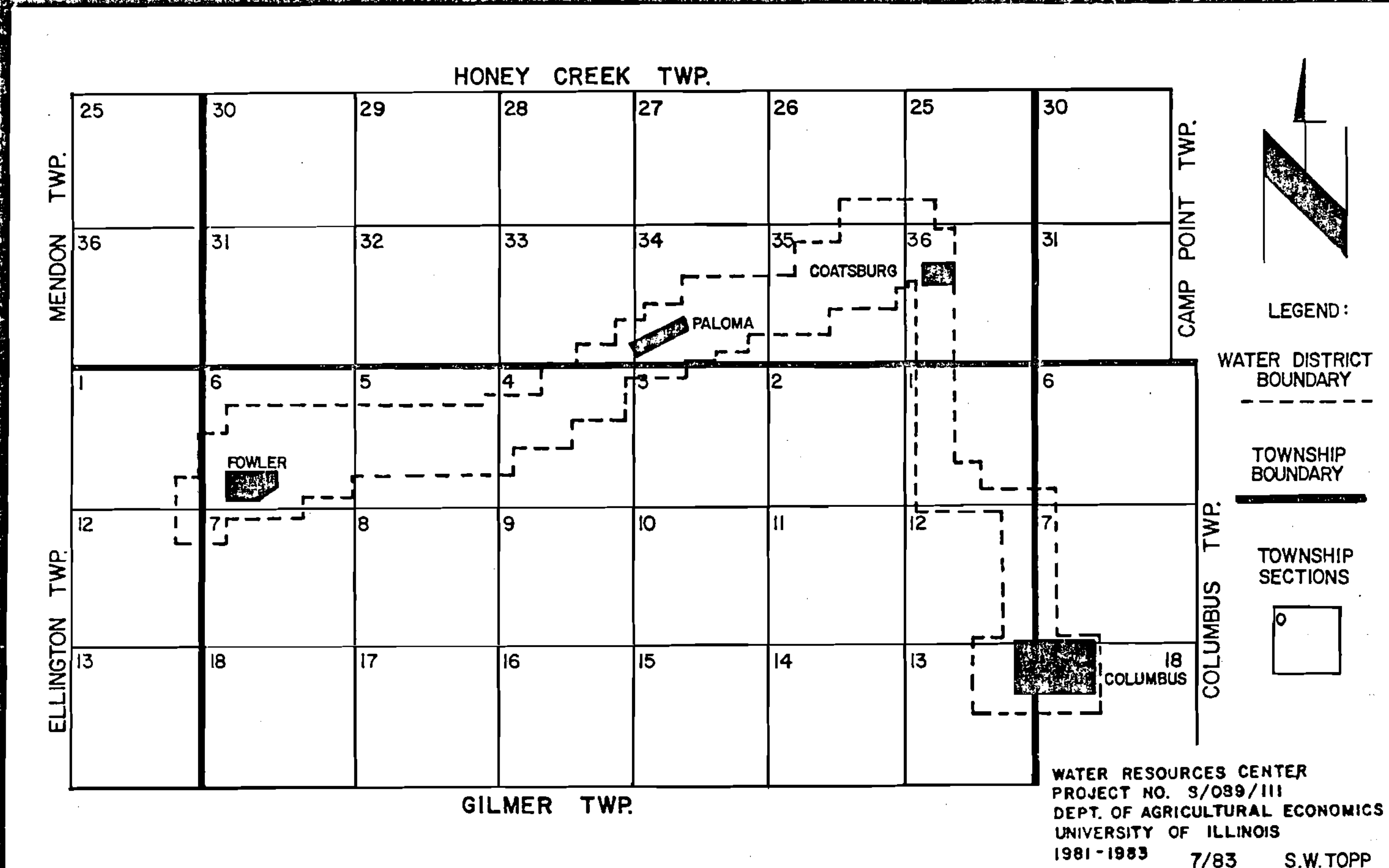
Description of System. The layout of Public Water District #1 is simple to describe. Again, the study area has been divided into sections. The water district is located in Gilmer, Columbus, Honey Creek Townships and includes 16 sections in its service area. The district's boundary lines are shown on the map of the district. All of the pipeline outside of the settlements which are served by the system is 6" in diameter. Water district records show that there are only 32 water meter hookups outside of the four settlements in the district. According to John Klinger, engineer for the district (interview on June 9, 1982), there is only one large user on the system and that is a trailer court located between Catsburg and Paloma. The trailer court relies on only one meter, so it is indicated that way on the study map.

The district's distribution system in each of the settlements is comprised of 4" pipe. There are domestic users located along these lines. One school, located in Fowler is also included among the district's customers.

Water enters the system from a point in Fowler, where the Clayton-Camp Point Water District's pipeline system meets PWD #1's system's pipes. There is one 75,000 gallon storage tank located in Coatsburg. However, this is not needed, since the system's water comes through Fowler, and is currently being dismantled.

Since the only users to join the system since its formation have been rural/farm users already located there, it seems safe to conclude that the district's impact has been minimal. No other new construction has taken place in the district's service area since this reliable water supply source has become available.

It should be noted that neither the water district itself, the regional planning agency (the Two Rivers Regional Council of Public Officials), FmHA or the SCS keep any kind of records on number of building permits issued, land use changes (i.e. from agricultural land to some other usage) in the district's service area or total water consumption in the district as a percentage of water available from the district's source. The system was built because reliable drinking water sources were so hard to tap, and yet no record is being kept of how the sources used by the



ADAMS COUNTY PUBLIC WATER DISTRICT #1

SOURCE: ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

SCALE: 0 1/2 1 2 MILES

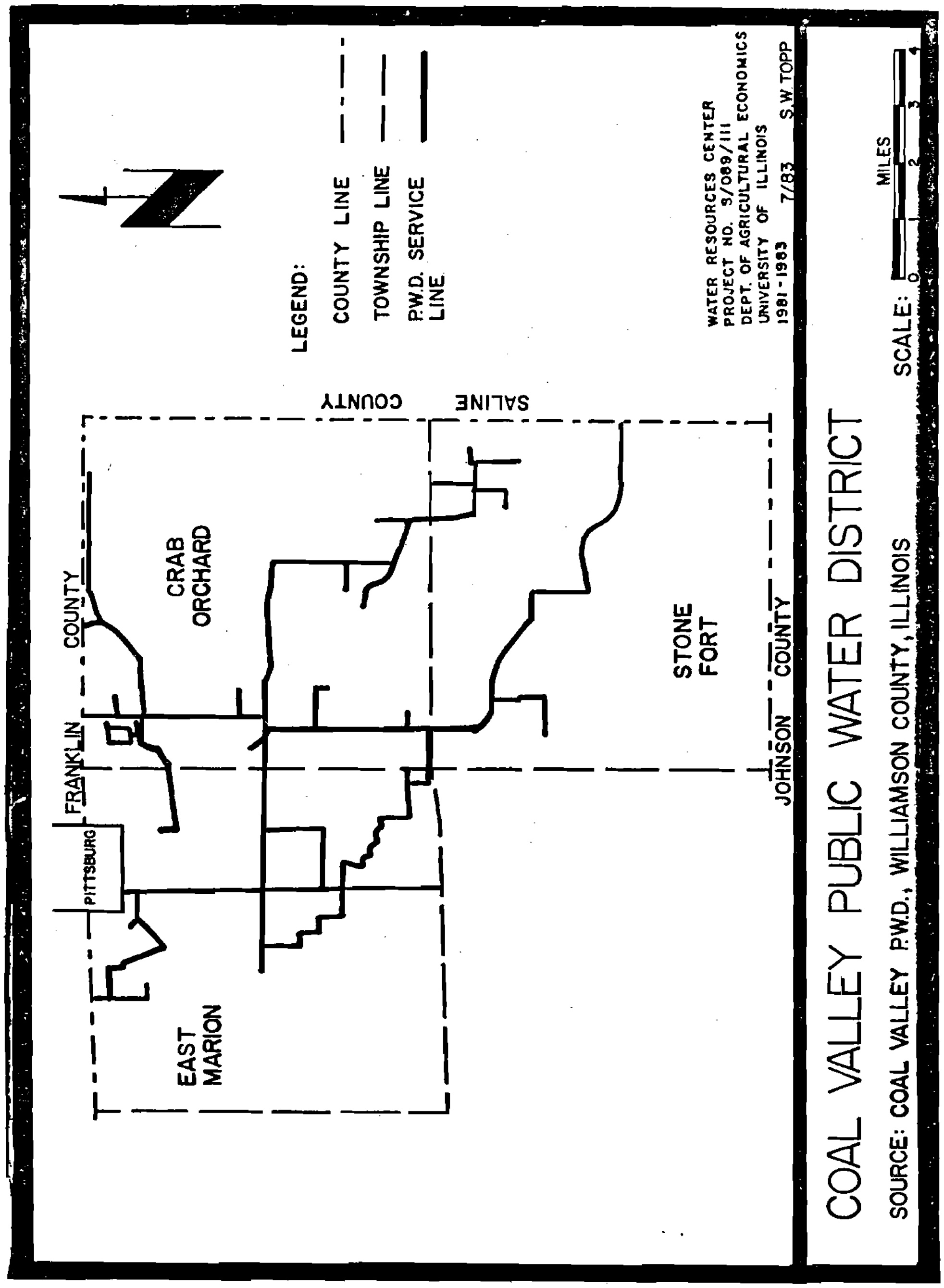
district are affected by the increased usage resulting from district construction. A field trip to the area showed that the land is farmland, there are no new developments in the district, since district construction.

Coal Valley Public Water District

The Coal Valley Public Water District is located in eastern Williamson County in southern Illinois. A field trip to this district was not possible because during the time that this district was studied, a tornado hit the area around the district (city of Marion and environs) closing down many parts of the area. Therefore information had to be gathered by telephone interviews and letters. The same agencies that would have been visited, the regional planning agency, the system's engineers and the district itself were contacted. The description of this district illustrates some of the problems inherent in this study. The major problem is that some information just does not seem to be available. The district's description is incomplete because neither the district itself nor the district's engineer had a complete map, showing pipelines and users in their files. Often, if a district is constructed in phases, only piecemeal maps and descriptive information on the layout is available.

Description of System. The Coal Valley Public Water District is similar to the Clearwater Service Corporation in terms of its layout. It is located in east-central Williamson County, covering 42 sections. However, it is different from the other district studied in that a large amount of the pipeline, extending throughout the district, is 2 1/2" in diameter. The other districts rely on 8", 6" and 4" pipe for most of their main extensions. The district is near to the city of Marion. There are two villages in the service area.

Starting in the northwestern corner of the district's service area, the system consists of 2" and 3" pipe. 2 1/2" pipe leads from one



COAL VALLEY PUBLIC WATER DISTRICT

SOURCE: COAL VALLEY P.W.D., WILLIAMSON COUNTY, ILLINOIS of the 6" sections of pipe. 6" pipe runs east-west through the middle of the district's service area and is bisected by a 6" length of pipe which runs north-south. This 6" pipe narrows to 4" and then meets the 2 1/2" pipe in the southwestern corner of the district. This pipe forms a loop in the southernmost portion of the district. The eastern portion of the district is an addition to the original system. This part of the system consists of 4", 3" and 2" pipe. There are 53 users on this newer portion of the system. The northeastern corner of the system is part of the original system and the pipeline is also 2" and 3" in diameter.

Comparisons

Comparisons should not only consider engineering requirements, but also the reasons behind the system's construction, the type and number of users and surrounding land uses.

The Clearwater system provides water for several townships in the immediate vicinity of two growing cities (Mattoon and Charleston). The system does not serve these cities and so is used primarily by rural dwellers. There are several subdivision developments located in the rural areas and making use of the system. The system is prepared to add users, but is limited in capacity and therefore will at some future point require additional capacity should demand increase.

Adams County PWD #1 was constructed as a result of the residents of four settlements forming an authority to initiate the construction of this system. The system, therefore, exists primarily for the residents of these settlements and associated rural residents. Access to the system is restricted, requiring the approval of the members comprising the authority. The system is capable of providing for additional users if approval is received. The four settlements are relatively small and rural in nature and have not experienced development of any large or significant degree.

In summary, the two systems were constructed based on an observed need - PWD #1 by the residents and Clearwater by the corporation. They have attracted users sufficient to maintain operations while not overburdening the systems' present capabilities, experienced little or no development as a direct result of the systems availability and could provide service for a limited number of new users.

SPATIAL CHARACTERISTICS

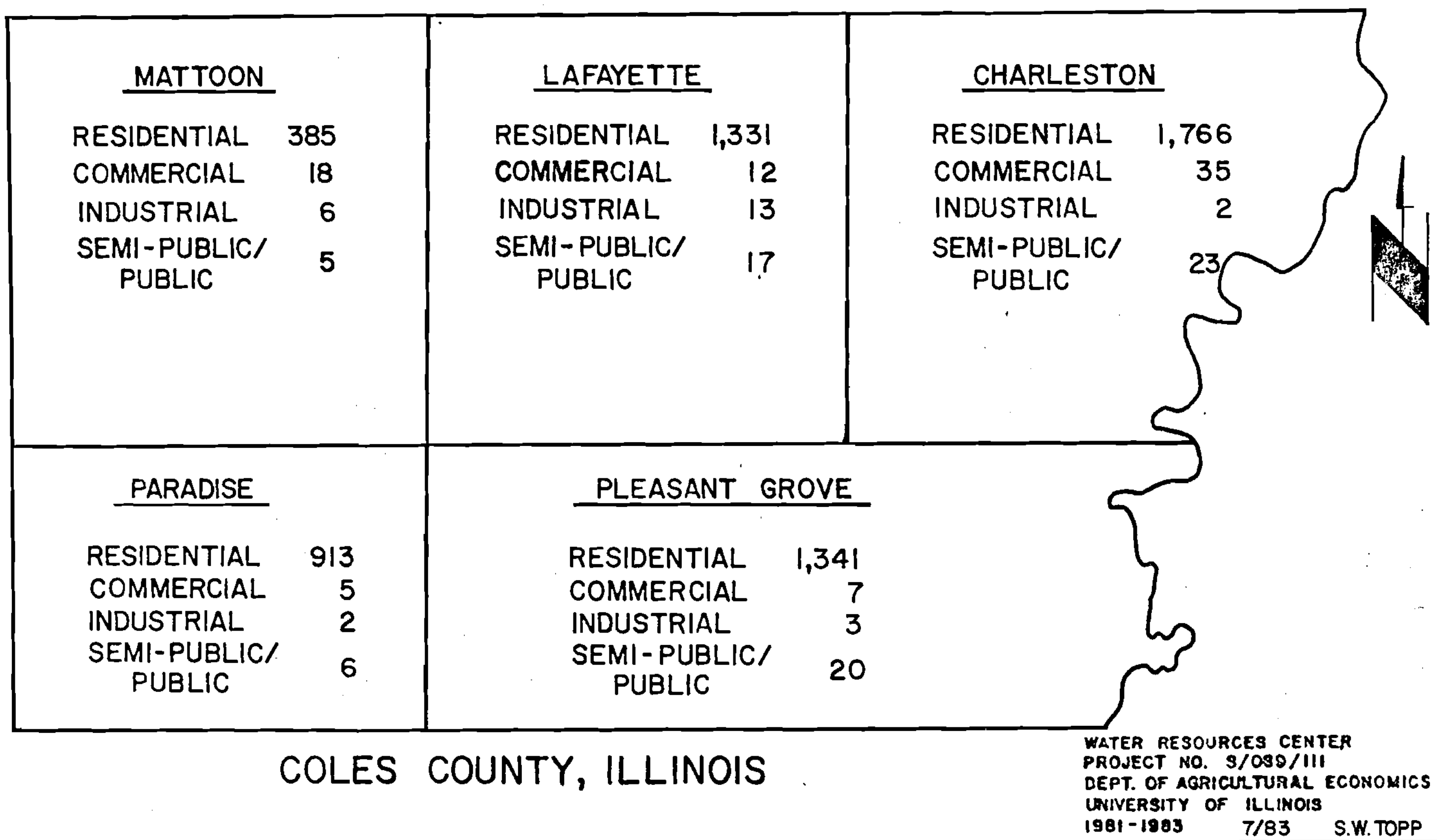
One of the primary sources of information contacted in the districts were the planning agencies responsible for that area. The planning agencies had little information on the systems, but they did have supplementary data pertinent for this analysis (although usually not as complete as desired). The more important information the planning agencies were able to provide was related to land-use, development, population, the various governmental bodies involved, and environmental.

Land Use and Subdivisions

In both study cases, the information obtained indicates that the systems are utilized primarily by persons who were already living in their place of residence before the system was constructed and who connected to the system when it became available. This indicates that in proportion to the total number of users, that percentage of new users after the system became available is small.

The information provided also indicates that there were few changes in land use classification brought about as a result of the provision of these services.

It should be noted that the districts studied were funded by FmHA, which has requirements guarding against large scale developments coming



EXISTING LAND-USE

(OF TOWNSHIPS SERVICED BY THE CLEARWATER CORP. IN COLES COUNTY)
(EXCLUDING THE CITIES OF CHARLESTON AND MATTOON)

SOURCE: COLES COUNTY REGIONAL PLANNING COMMISSION

HONEY CREEK	
RESIDENTIAL	293
COMMERCIAL	16
INDUSTRIAL	4
SEMI-PUBLIC/ PUBLIC	12

GILMER	
RESIDENTIAL	351
COMMERCIAL	7
INDUSTRIAL	0
SEMI-PUBLIC/ PUBLIC	8

COLUMBUS	
RESIDENTIAL	206
COMMERCIAL	5
INDUSTRIAL	0
SEMI-PUBLIC/ PUBLIC	12

ADAMS COUNTY, ILLINOIS

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EXISTING LAND-USE

(OF TOWNSHIPS SERVICED BY P.W.D. #1 IN ADAMS COUNTY)

SOURCE: TWO RIVERS REGIONAL COUNCIL OF PUBLIC OFFICIALS

SCALE: MILES 0 1/4 1/2 1

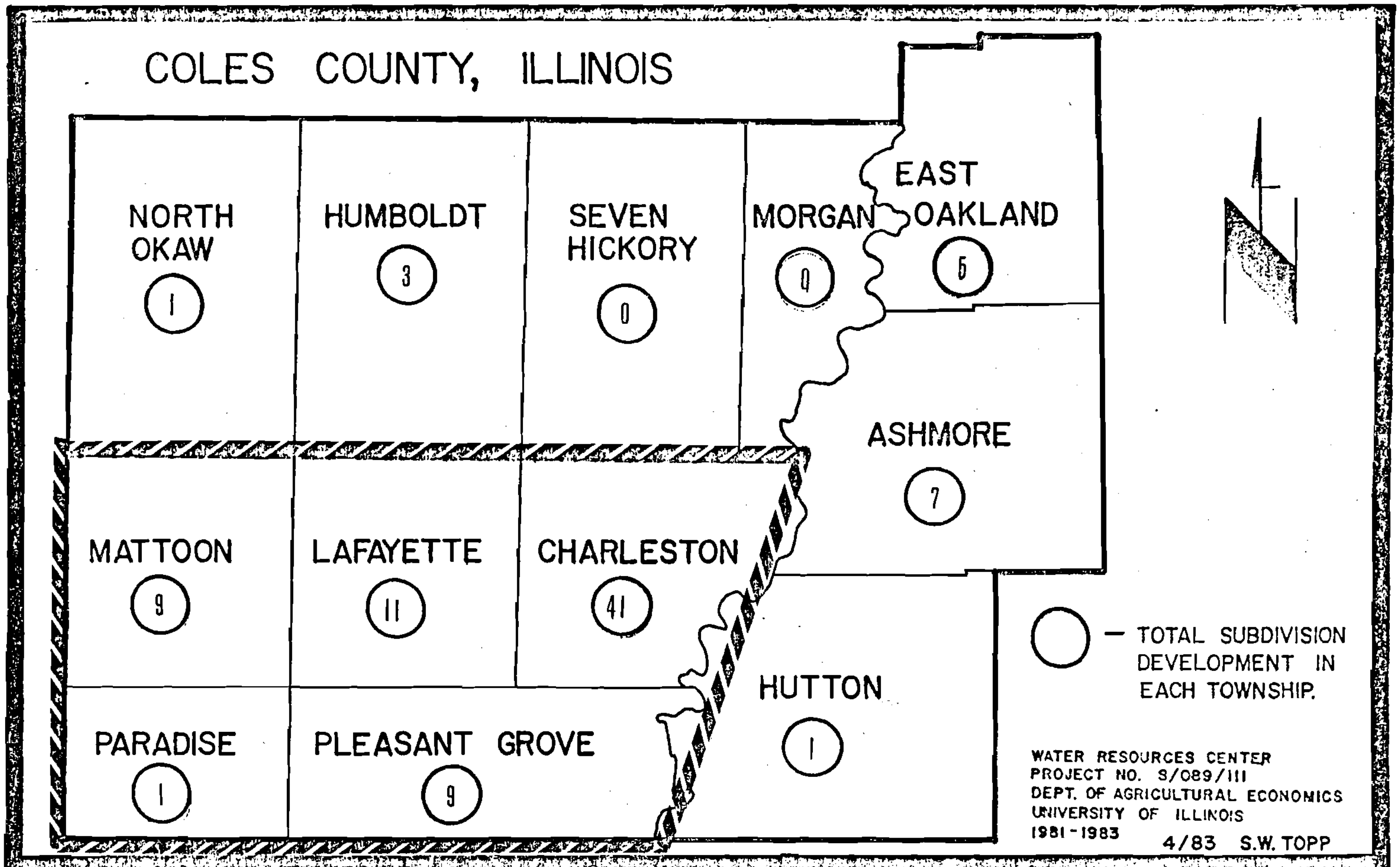
into rural areas to use water from these districts. So, other rural water districts, not reliant upon FmHA for their funding, might experience a greater demand for development and changes in land use classifications.

Consideration should also be given to the fact that this study was undertaken during a time of high interest rates and labor costs, which severely affected the building industry in Illinois.

Existing Land Use: These maps depict the numerical count of the various uses of land within the study area. This gives an indication of the level of activity occurring within the study area and the potential for water usage. The land use is separated into four categories: Residential, Commercial/Business, Industrial and Public/Semi-Public. It can be seen that the residential usage is by far the largest, with the Commercial and Industrial uses being very limited.

Subdivision Development: These maps indicate the number of subdivisions constructed within the study area during a given period. The significance in determining the count of subdivisions can be found in the comparison in rate of this form of development before and after the introduction of the water system and in determining what subdivisions, predominantly residential in use, make use of the system. (This information is also presented in Table form as Appendix B.) 1960-1970: Subdivision development primarily occurring in the townships of Mattoon and Charleston.
1970-1980: Subdivision development in Mattoon and Charleston is large and not unexpected. However, Lafayette and Pleasant Grove experienced unexpected development. 1960-1980: Subdivision development occurred in each of the townships during the 20 year period, but most significantly in Pleasant Grove.

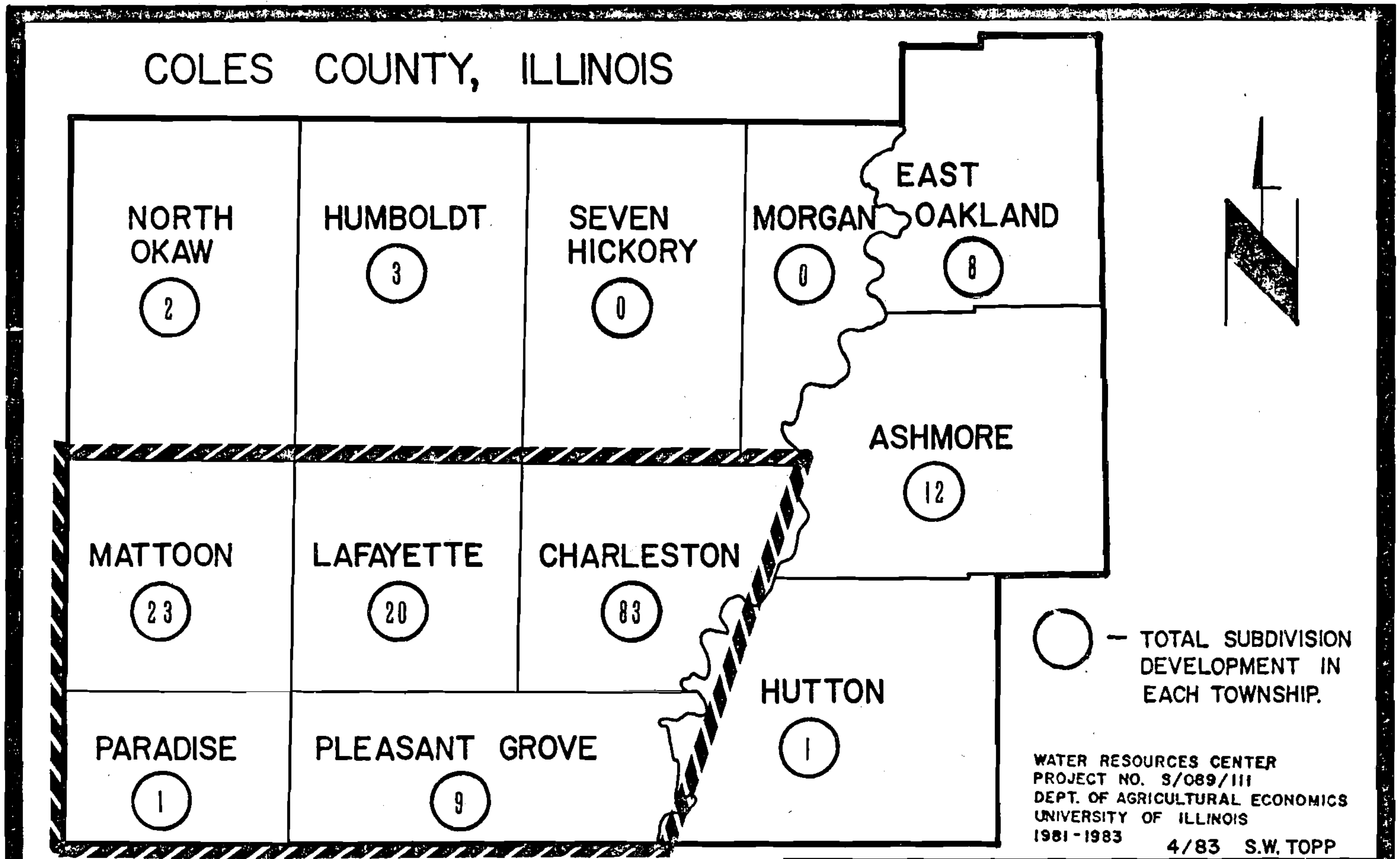
Development in the vicinity of the Clearwater Service Corporation has been extensive, but the majority of construction has been within the city limits of Mattoon and Charleston not serviced by the system. Although there had been a significant amount of subdivision development prior to and after the construction of the system, the majority of these are not serviced by the system and of those that are, not all potential users chose to connect to the system.



SUBDIVISION DEVELOPMENT: 1970-1980

SOURCE: COLES COUNTY, RECORDS DIVISION

SCALE: 0 1 2 3 4 MILES



SUBDIVISION DEVELOPMENT: 1960-1980

SOURCE: COLES COUNTY, RECORDS DIVISION

Population and Housing Units

Although the townships serviced by the respective systems have not experienced significant changes in land use in the immediate vicinity of the service areas, they have experienced a growth in population in the past two decades. This growth has predominantly occurred in those parts of the townships that do not receive the water services, and therefore seems unlikely that the provision of these services has had much of an impact on the growth of the population.

The opposite can also hold true, in that the number of users on the system is a small percentage of the number of potential users and therefore indicates that the systems were not constructed because of the increasing population.

A more significant growth pattern for analysis in this type of study is that of housing units. The U.S. Census Bureau did not begin collecting data on housing unit increase or decrease until the 1970 census. This makes it difficult to analyze any data for a period other than 1970-1980. Any analysis for an earlier period relies on household counts and vacancy rates for an earlier period relies on household counts and vacancy rates for the period, which is somewhat less reliable. (See Appendix for method used in calculating 1960 housing unit counts.) Analysis for the two time periods, 1960-1970 and 1970-1980 indicate that while there were increases in housing units, these units were predominantly in areas not serviced by the study water districts and therefore were not constructed because of the systems. It would therefore seem that provision of water services did little, if anything, to influence housing units.

Coles County/Percentage change in Population 1960-1970: This map is a visual presentation of the percentage change in population during the 1960-1970 period with focus on the five townships containing the system. The figures so depicted show a relatively small change in each of the townships for both growth and loss, except for the township of Charleston which experienced a 48% growth. (The reason the figures are as a percentage is for proportionality between the townships. Two townships can experience the same rate of growth while experiencing farm different numerical growth.)

TABLE 7.1

Service Area Population Data

	1980 Population	1970 Population	Pop. Change
Clearwater Service Corporation:			
Coles Co.	59,922	47,815	+ 5,107
Charleston Twp.	21,121	17,682	+ 3,439
(excluding city of Charleston)	(1,766)	(1,261)	(+ 505)
Lafayette Twp. (excluding cities of Mattoon & Charleston)	1,336	1,381	- 45
Mattoon Twp	18,091	18,696	- 695
(excluding Mattoon)	(1,105)	(812)	(+ 293)
Paradise Twp. (excluding Mattoon)	923	843	+ 80
Pleasant Grove Twp.	1,342	1,155	+ 187
Cumberland Co.	11,062	9,772	+ 1,290
Cottonwood Twp.	556	564	- 8
Neoga Twp.	4,694	3,578	+ 1,116
Spring Point Twp	1,092	956	+ 136
Sumpter Twp.	3,254	2,813	+ 141
Adams Co. PWD #1:			
Adams Co.	71,622	70,861	+ 761
Gilmer Twp. (including pt. of Columbus Village)	1,005	789	+ 216
Honey Creek Twp.	1,066	949	+ 47
Columbus Twp. (including pt. of Columbus Village)	531	448	+ 83
Coal Valley Public Water District:			
Williamson Co.	56,538	49,021	+ 7,517
Crab Orchard Precinct	1,187	986	+ 201
E. Marion Precinct (not including Marion City & Pittsburg Village)	6,212	6,080	+ 1,132
Stonefort Precinct	1,077	929	+ 148

Source: 1980 Census of Population.

Coles County/Percentage change in Population 1970-1980: This presentation of the percentage change shows a general state of increase for the townships within the study area, but not as pronounced as before for Charleston. Also, the township of Lafayette experienced a decrease while existing between two fair-sized cities.

Coles County/Percentage change in Population 1960-1980: This map represents the comprehensive change in population for the period 1960-1980. The figures show a surprisingly low rate of change for a 20-year period, with the exception, of course, of Charleston.

Coles County/Percentage change in housing units 1960-1970: This map depicts the percentage change in housing units during the period 1960-1970 and indicates low rates of change for the townships within the study area, with the exception of Charleston which experienced a growth of 36.8%.

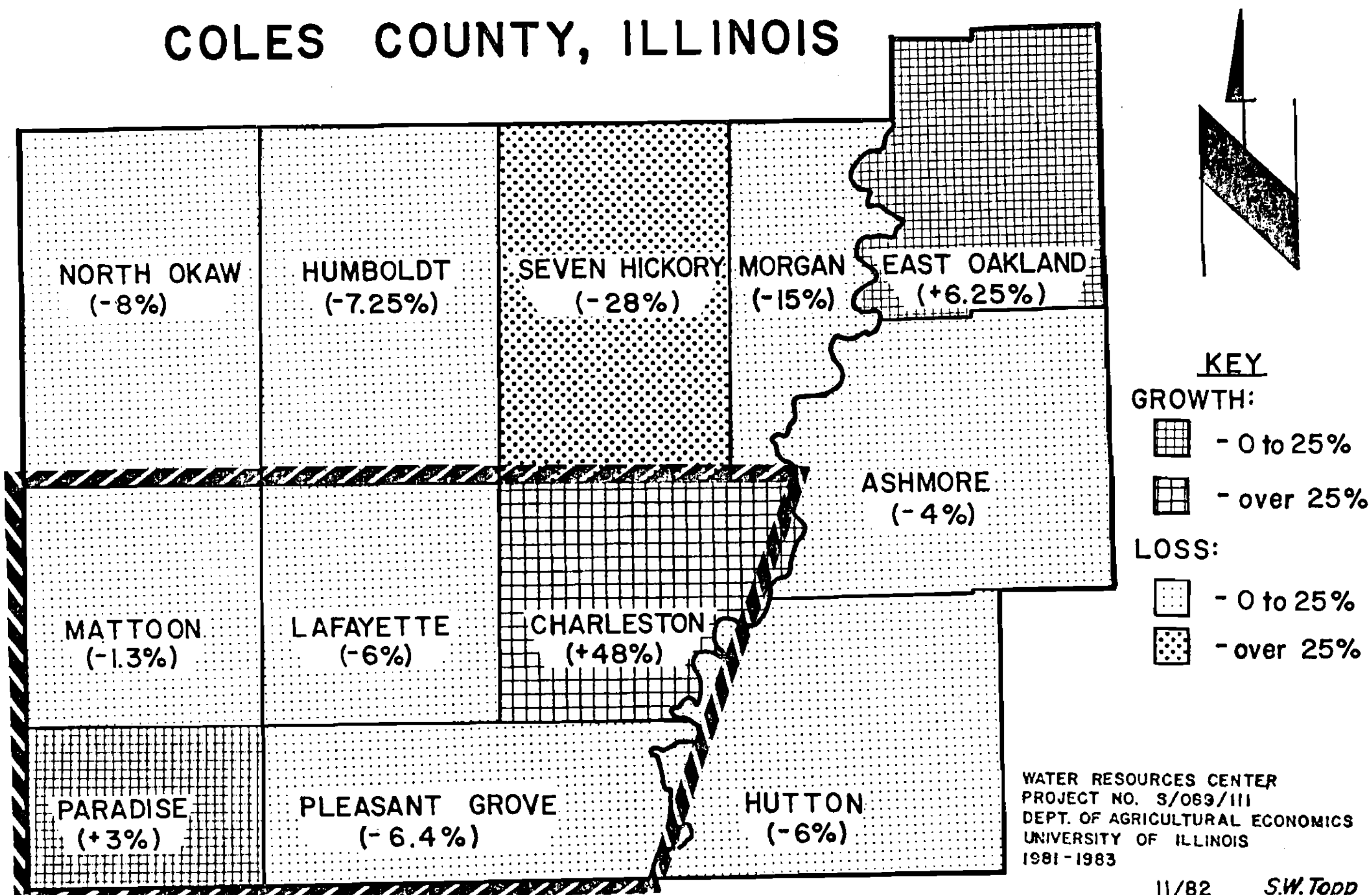
Coles County/Percentage change in housing units 1970-1980: This representation of the figures shows a large rate of growth for the Charleston township - which is not unexpected, and an even larger rate of growth for the township of Paradise - which is unexpected.

Coles County/Percentage change in housing units 1960-1980: This percentage change shows the overall increase in housing units during the 1960-1980 period to be quite large for the townships of Charleston and Paradise and moderately high for Mattoon and Pleasant Grove. The other townships in the county show similar patterns of growth, so this situation should not be construed as unusual.

Comparison of information for percentage change in housing units and percentage change in population in Coles County: The overall concensus of the two forms of information seem to indicate an increasing supply of housing in excess of what can be accounted for from population increases.

Comparison of information from percentage change in housing units-percentage change in population and subdivision development in Coles County: The most outstanding aspect of this comparison is the construction of 20 subdivisions in a township that experienced a 5.6% decrease in housing units and a 9% decrease in population during the same time period.

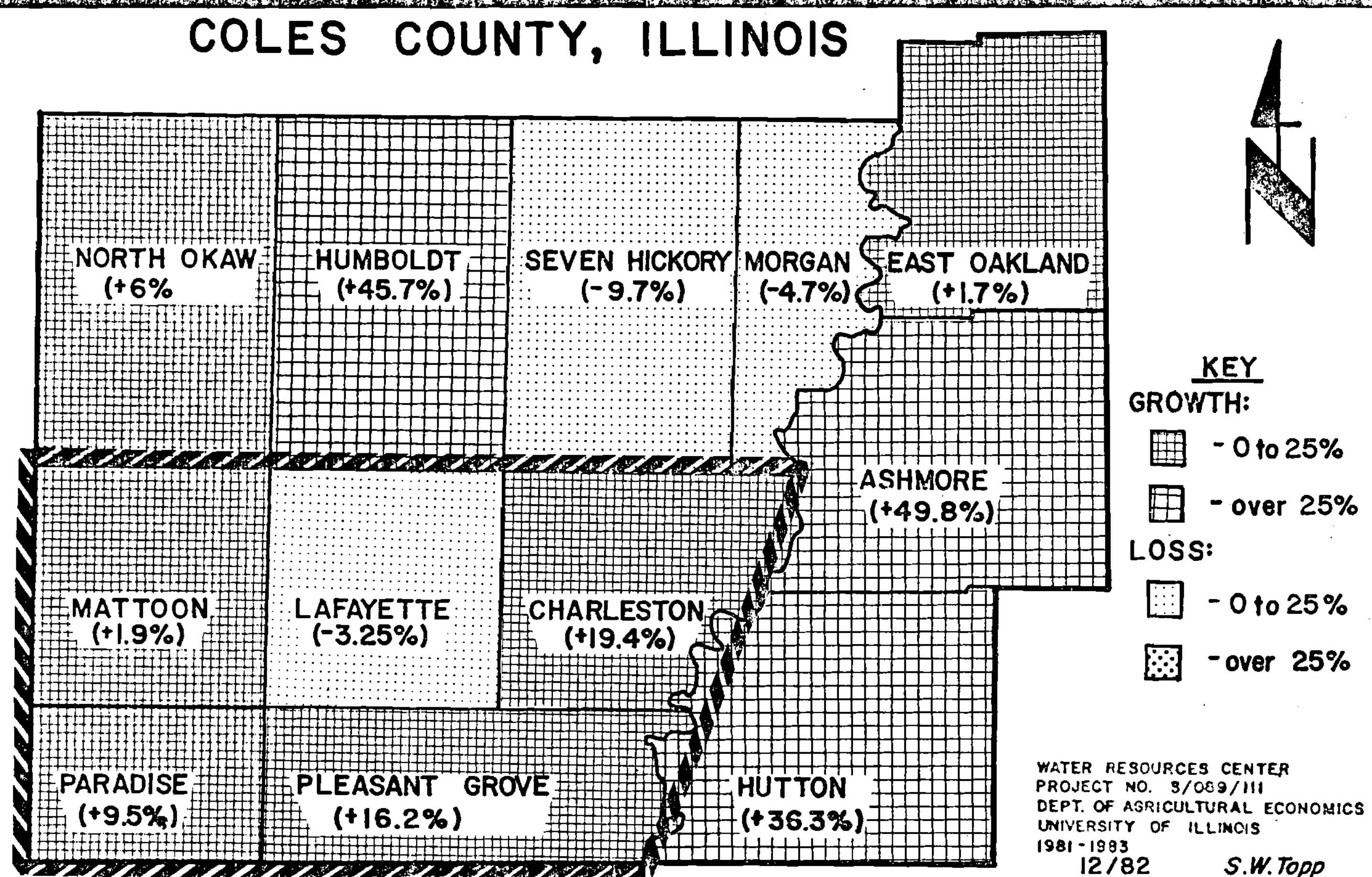
COLES COUNTY, ILLINOIS



PERCENTAGE CHANGE IN POPULATION: 1960 - 1970

SOURCE: COLES COUNTY REGIONAL PLANNING COMMISSION
U.S. 1970 POPULATION CENSUS

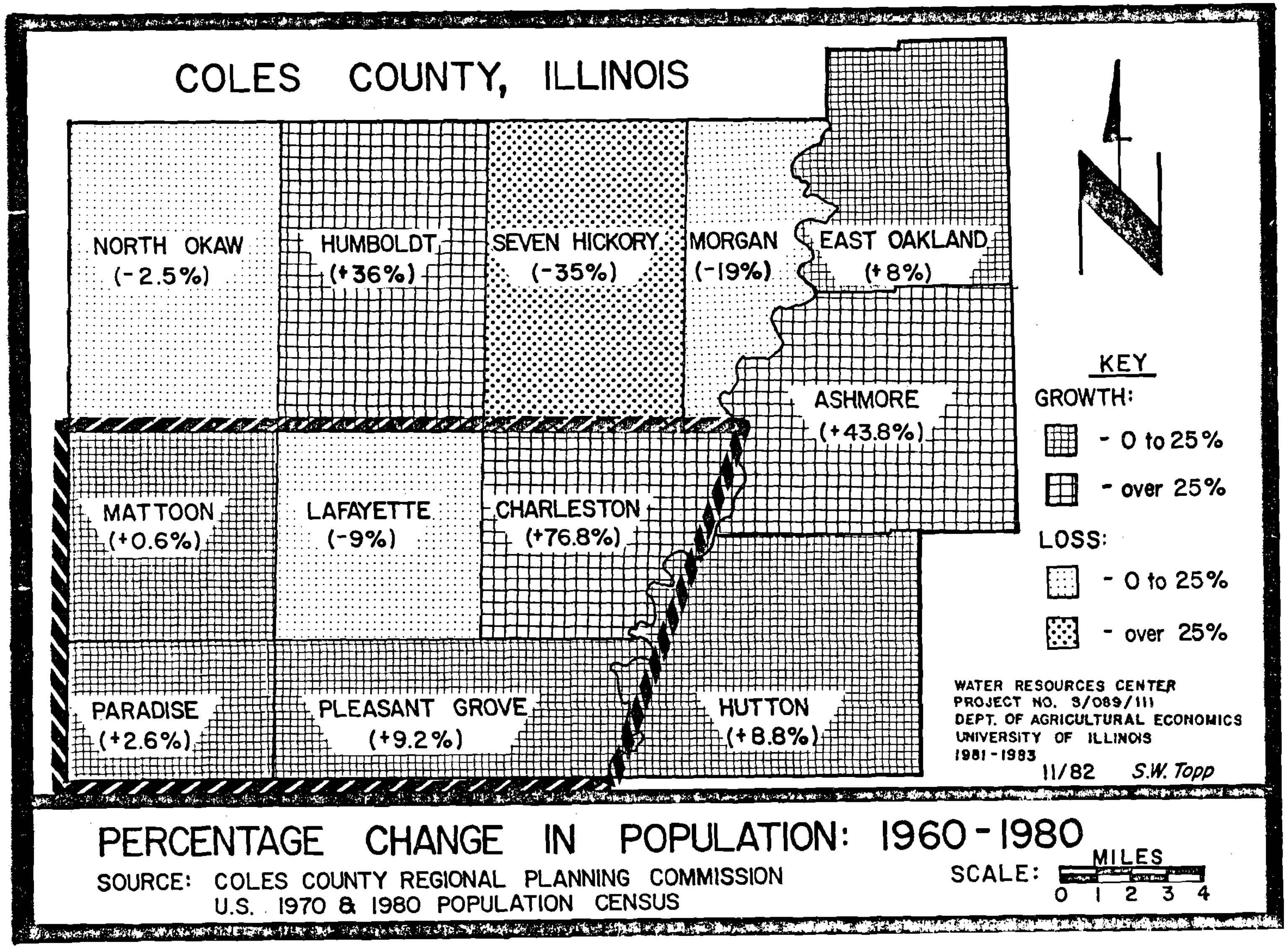
SCALE: MILES 0 1 2 3 4



PERCENTAGE CHANGE IN POPULATION: 1970 - 1980

SOURCE: COLES COUNTY REGIONAL PLANNING COMMISSION
U.S. 1980 POPULATION CENSUS

SCALE: MILES 0 1 2 3 4


COLES COUNTY, ILLINOIS
NORTH OKAW (-2.5%)
HUMBOLDT (+36%)
SEVEN HICKORY (-35%)
MORGAN (-19%)
EAST OAKLAND (+8%)
ASHMORE (+43.8%)
MATTOON (+0.6%)
LAFAYETTE (-9%)
CHARLESTON (+76.8%)
PARADISE (+2.6%)
PLEASANT GROVE (+9.2%)
HUTTON (+8.8%)
KEY
GROWTH:
- 0 to 25%
- over 25%
LOSS:
- 0 to 25%
- over 25%
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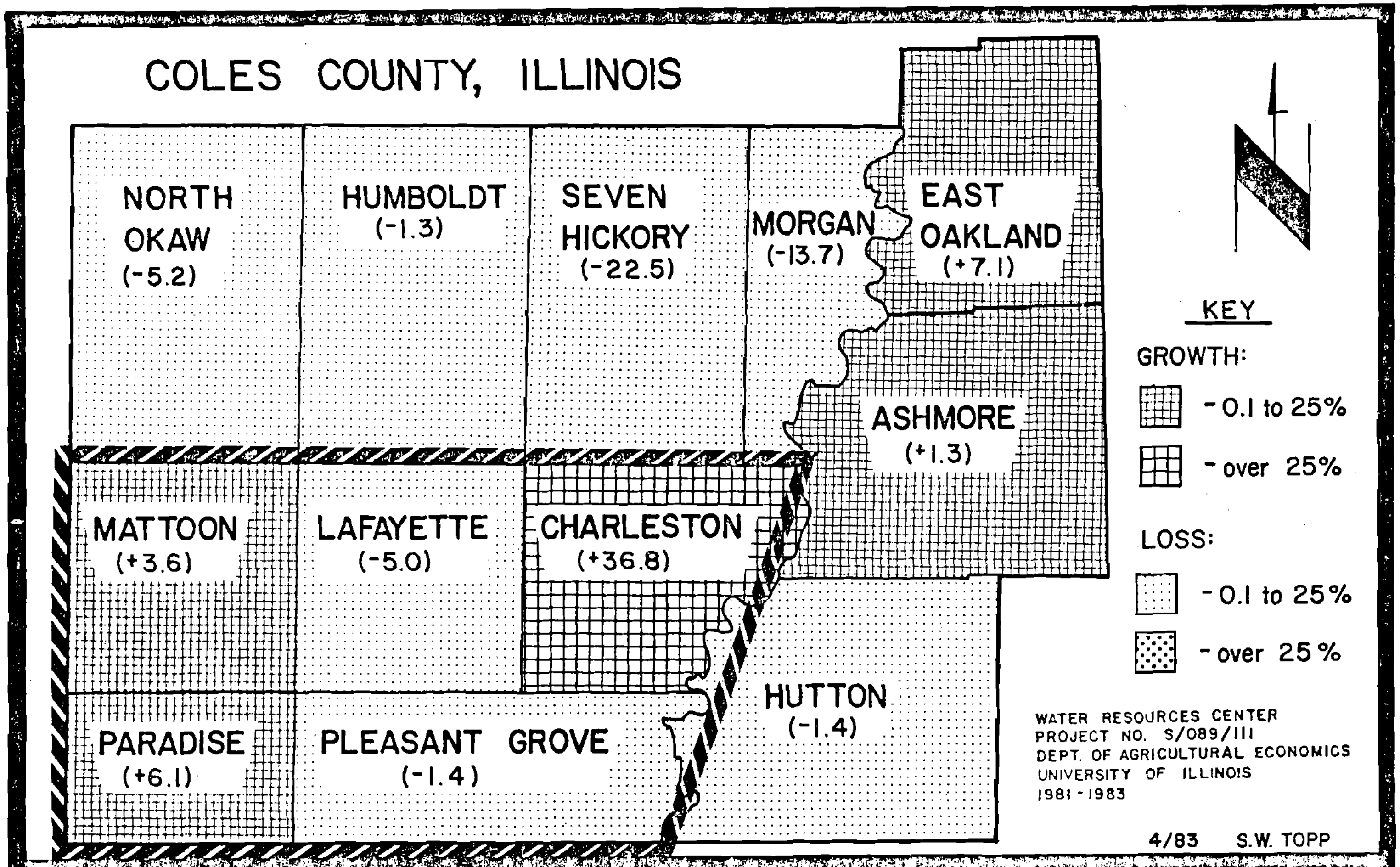
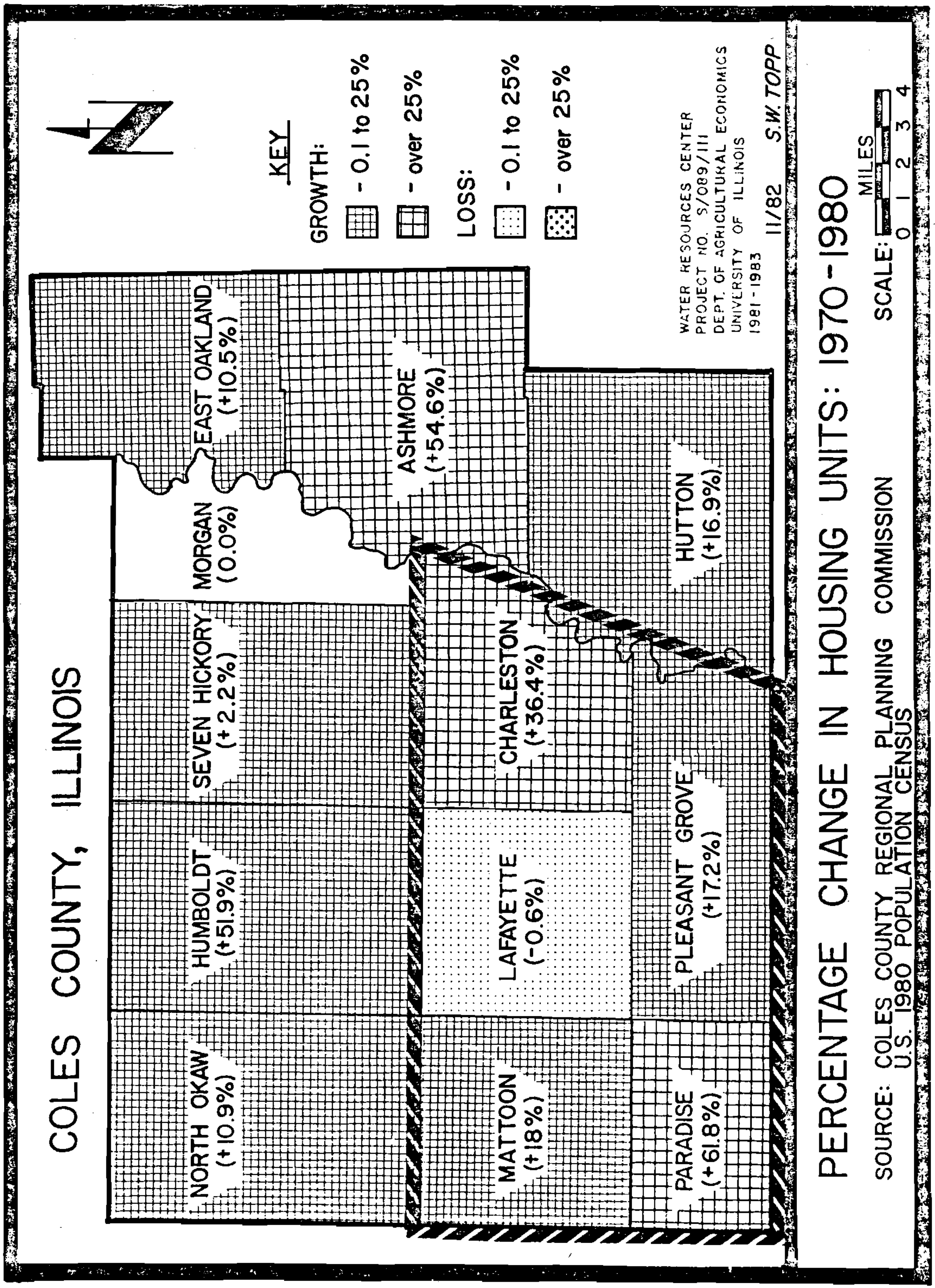
1981-1983
11/82 S.W. Topp
PERCENTAGE CHANGE IN POPULATION: 1960-1980
SOURCE: COLES COUNTY REGIONAL PLANNING COMMISSION
U.S. 1970 & 1980 POPULATION CENSUS
SCALE: MILES
0 1 2 3 4

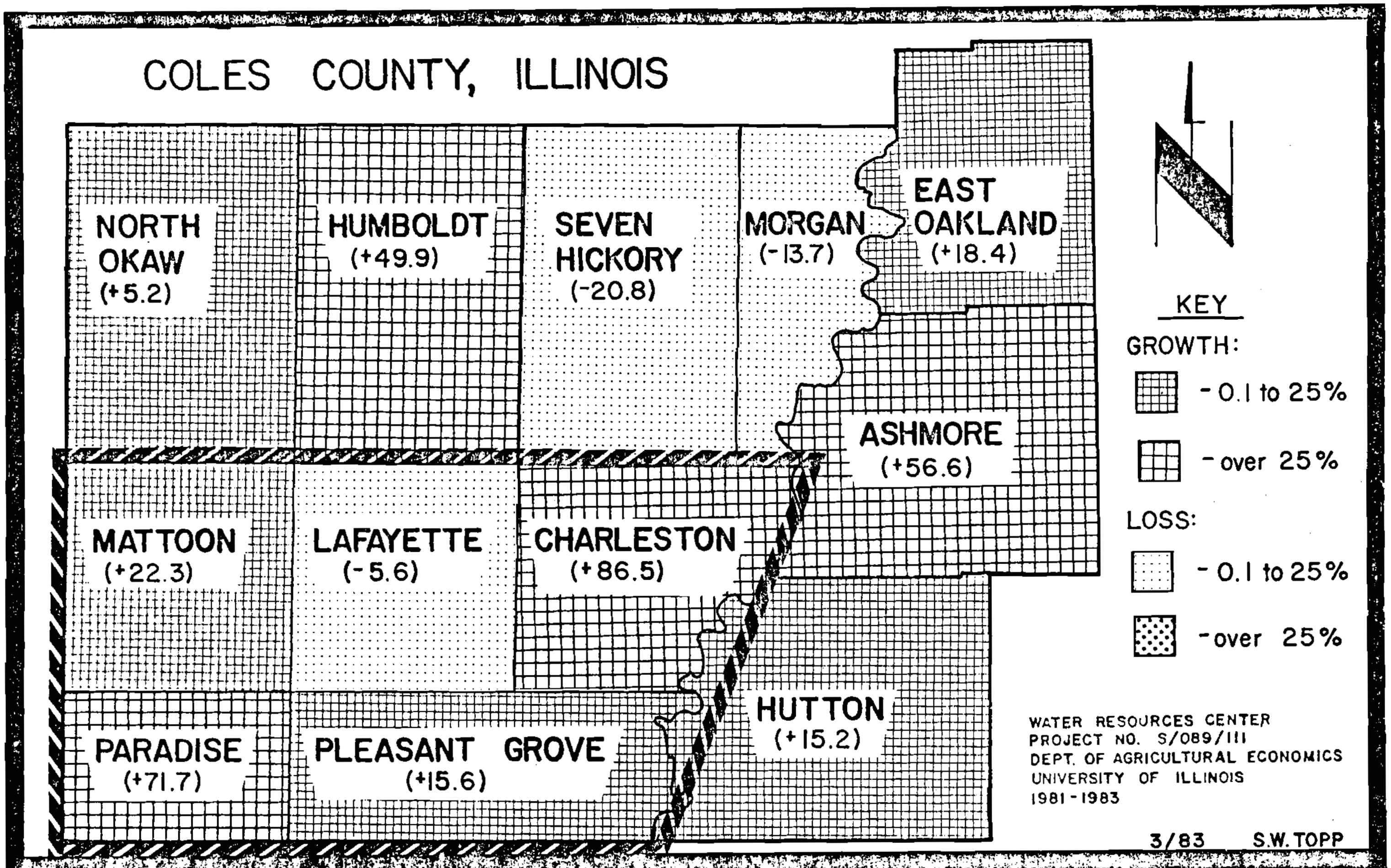


PERCENTAGE CHANGE IN HOUSING UNITS: 1960 - 1970
(SEE APPENDIX A.)

SOURCE: U.S. 1960 & 1970 POPULATION CENSUS
COLES COUNTY REGIONAL PLANNING COMMISSION

SCALE: MILES 0 1 2 3 4


COLES COUNTY, ILLINOIS
NORTH OKAW (+10.9%)
HUMBOLDT (+51.9%)
SEVEN HICKORY (+2.2%)
MORGAN (0.0%)
EAST OAKLAND (+10.5%)
ASHMORE (+54.6%)
MATTOON (+18%)
LAFAYETTE (-0.6%)
CHARLESTON (+36.4%)
PARADISE (+61.8%)
PLEASANT GROVE (+17.2%)
HUTTON (+16.9%)
KEY
GROWTH:
- 0.1 to 25%
- over 25%
LOSS:
- 0.1 to 25%
- over 25%
WATER RESOURCES CENTER
PROJECT NO. S/089/111
DEPT. OF AGRICULTURAL ECONOMICS
UNIVERSITY OF ILLINOIS
1981-1983
11/82
S.W. TOPP
PERCENTAGE CHANGE IN HOUSING UNITS: 1970-1980
SOURCE: COLES COUNTY REGIONAL PLANNING COMMISSION
U.S. 1980 POPULATION CENSUS
SCALE: MILES
0 1 2 3 4



PERCENTAGE CHANGE IN HOUSING UNITS: 1960-1980
(SEE APPENDIX A.)

SOURCE: U.S. 1960, 1970 & 1980 POPULATION CENSUS
COLES COUNTY REGIONAL PLANNING COMMISSION

SCALE: MILES 0 1 2 3 4

Adams County/Percentage change in population 1960-1970: This map is a visual presentation of the percentage change in population during the 1960-1970 period with focus on the three townships containing the system. The figures so depicted indicate a relatively small change, for both growth and loss. (The reason the figures are as a percentage is for proportionality between the townships. Two townships can experience the same rate of growth while experiencing far different numerical growth.)

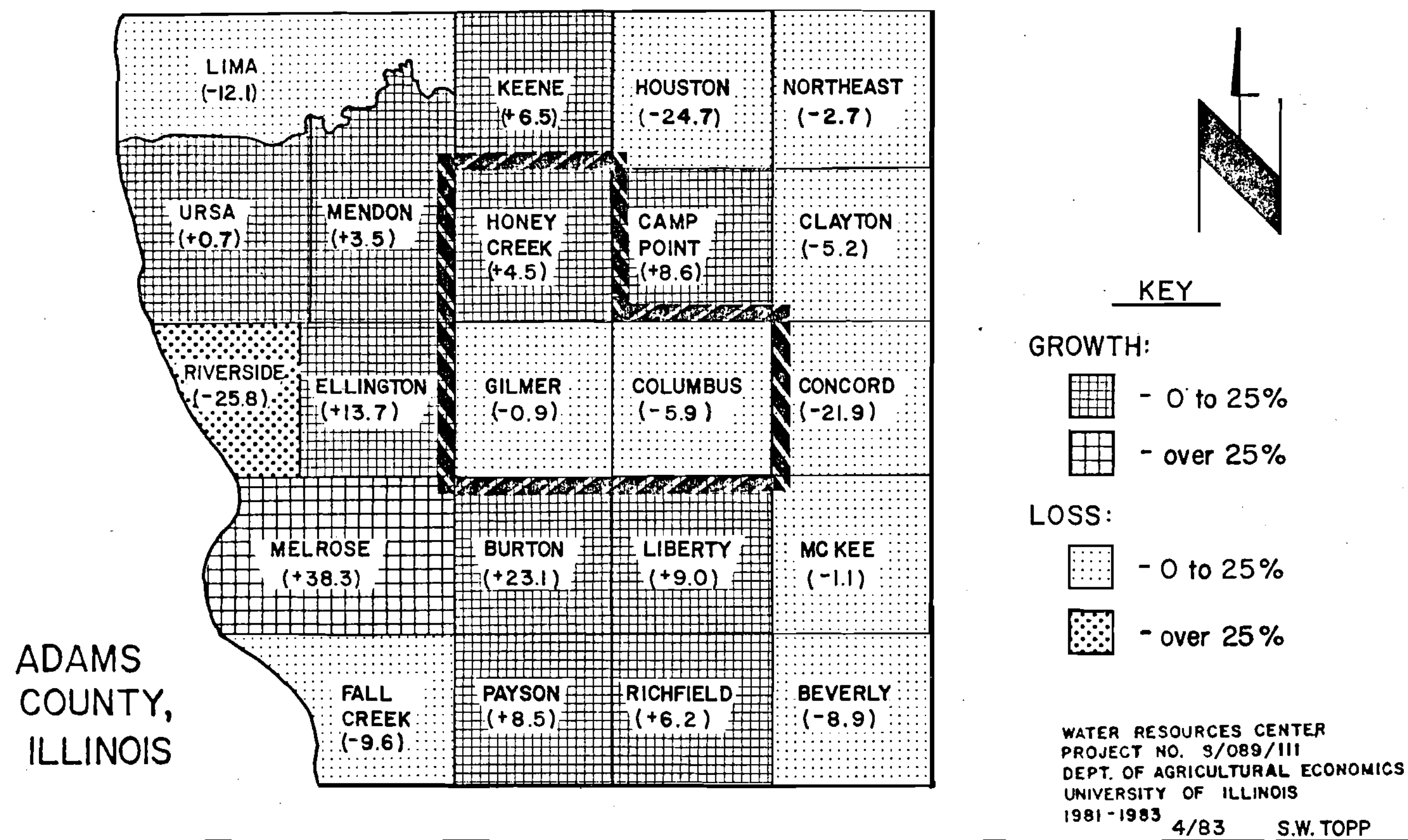
Adams County/Percentage change in population 1970-1980: This presentation of the percentage change shows significant increases in two of the township study areas, with even the third experiencing some measurable growth.

Adams County/Percentage change in population 1960-1980: This map represents the comprehensive change in population for the period 1960-1980. The indications here are that all three townships in the study area experienced significant growth during the twenty year period.

Adams County/Percentage change in housing units 1960-1970: This map depicts the percentage change in housing units during the period 1960-1970 and indicates a moderate increase in two of the townships in the study area, somewhat within the norm of the changes in the surrounding townships.

Adams County/Percentage change in housing units 1970-1980: This representation of the figures shows a very large increase in the Gilmer township area and significant increases in the other two townships in the study area. This is in agreement with an overall pattern of growth for the rest of the county.

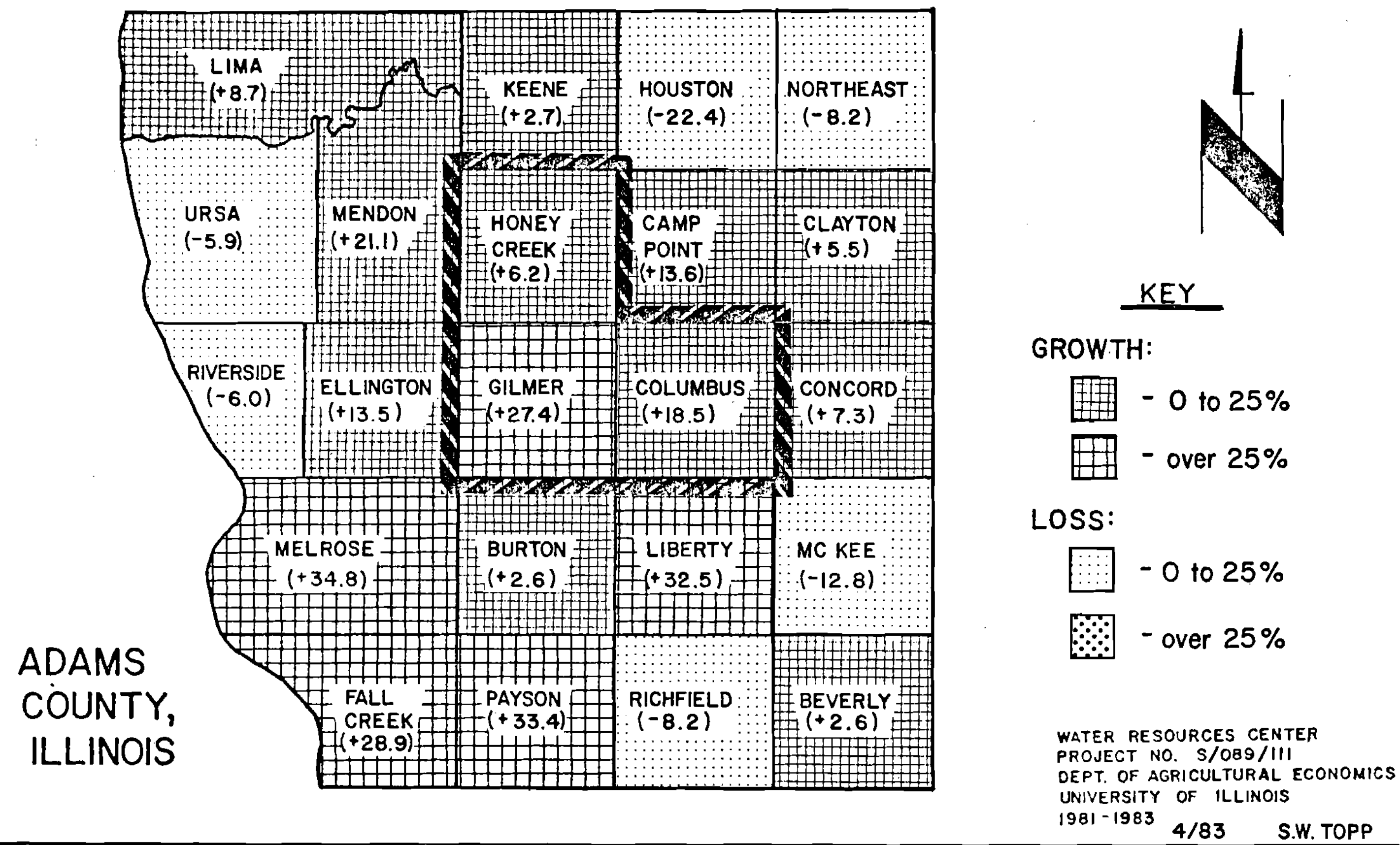
Adams County/Percentage change in housing units 1960-1980: This presentation of the percentage change shows the overall increase in housing units during the 1960-1980 period to be quite large, with an extremely large increase in Gilmer township of 63.3%. However, the other townships surrounding the study area tend to show a large increase as well, therefore indicating the situation is not abnormal.



PERCENTAGE CHANGE IN POPULATION: 1960-1970

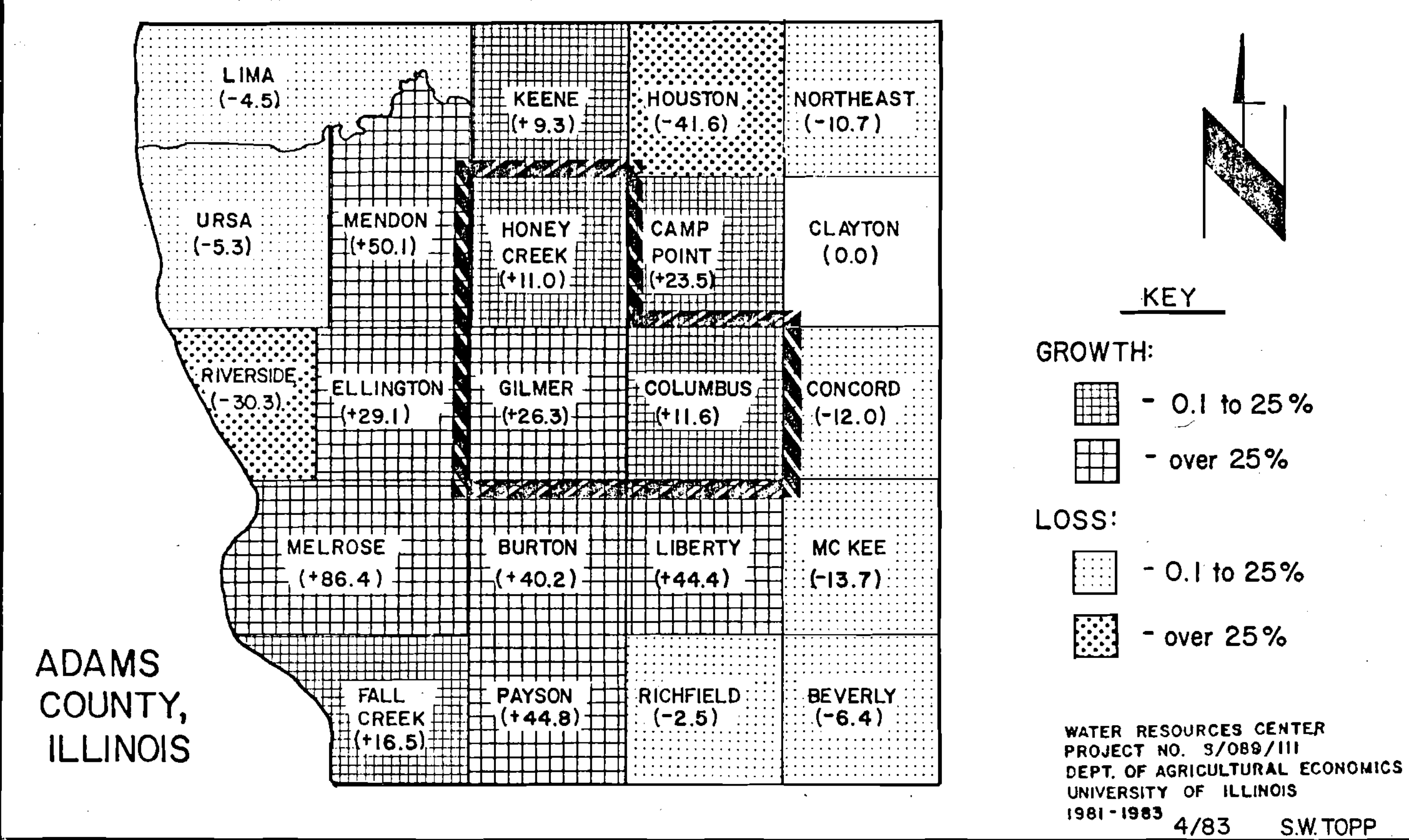
SOURCE: U.S. 1960 & 1970 POPULATION CENSUS
ATLAS MAP OF ADAMS COUNTY, ILLINOIS

SCALE: MILES 0 5 10



PERCENTAGE CHANGE IN POPULATION: 1970-1980

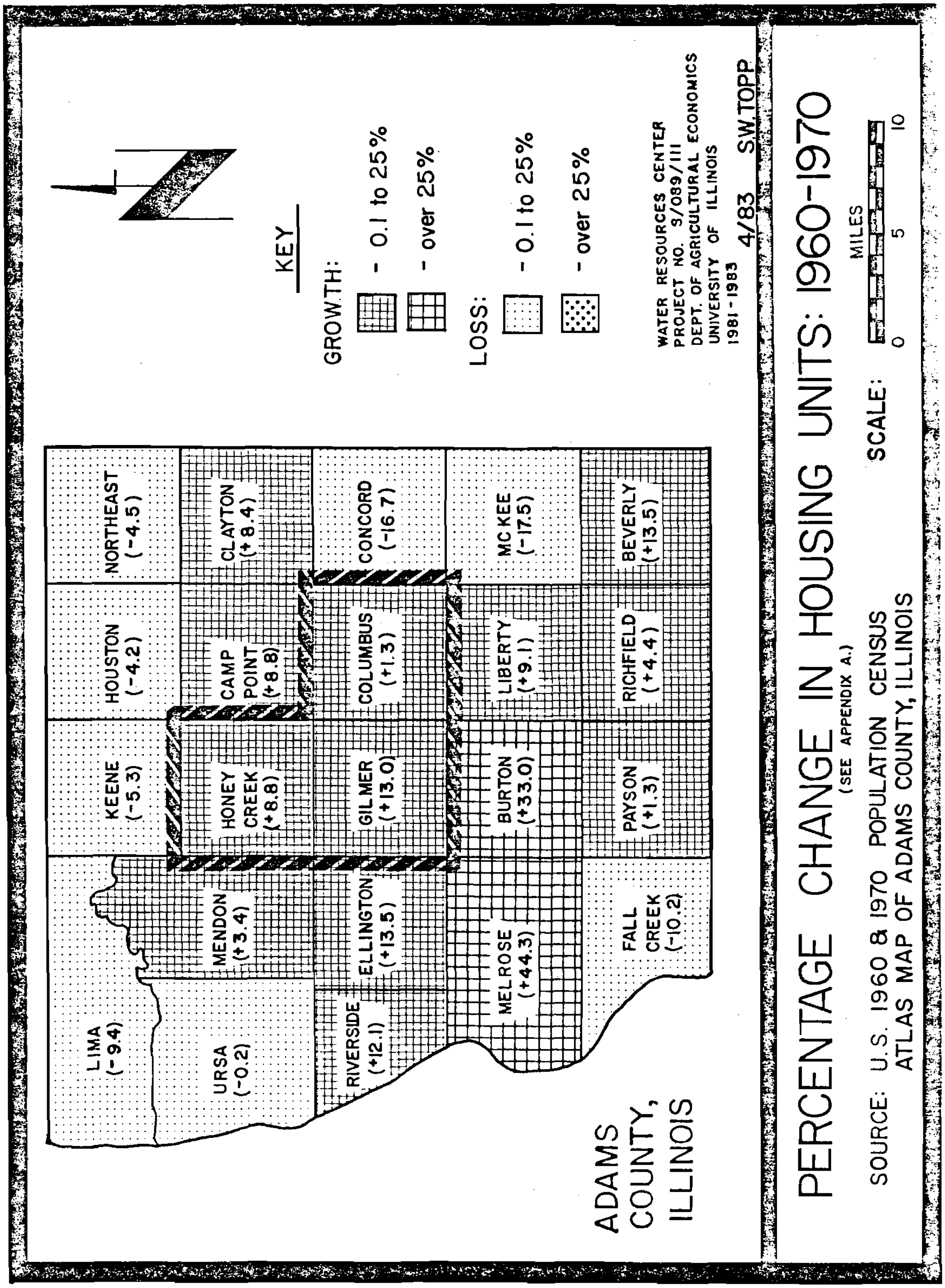
SOURCE: U.S. 1980 POPULATION CENSUS
ATLAS MAP OF ADAMS COUNTY, ILLINOIS



PERCENTAGE CHANGE IN POPULATION: 1960-1980

SOURCE: U.S. 1960, 1970 & 1980 POPULATION CENSUS
ATLAS MAP OF ADAMS COUNTY, ILLINOIS

SCALE: MILES 0 5 10


ADAMS COUNTY, ILLINOIS
NORTHEAST (-4.5)
HOUSTON (-4.2)
KEENE (-5.3)
LIMA (-9.4)
CLAYTON (+8.4)
CAMP POINT (+8.8)
HONEY CREEK (+8.8)
MENDON (+3.4)
URSA (-0.2)
CONCORD (-16.7)
COLUMBUS (+1.3)
GILMER (+13.0)
ELLINGTON (+13.5)
RIVERSIDE (+12.1)
MC KEE (-17.5)
LIBERTY (+9.1)
BURTON (+33.0)
MELROSE (+44.3)
BEVERLY (+13.5)
RICHFIELD (+4.4)
PAYSON (+1.3)
FALL CREEK (-10.2)
KEY
GROWTH:
- 0.1 to 25%
- over 25%
LOSS:
- 0.1 to 25%
- over 25%
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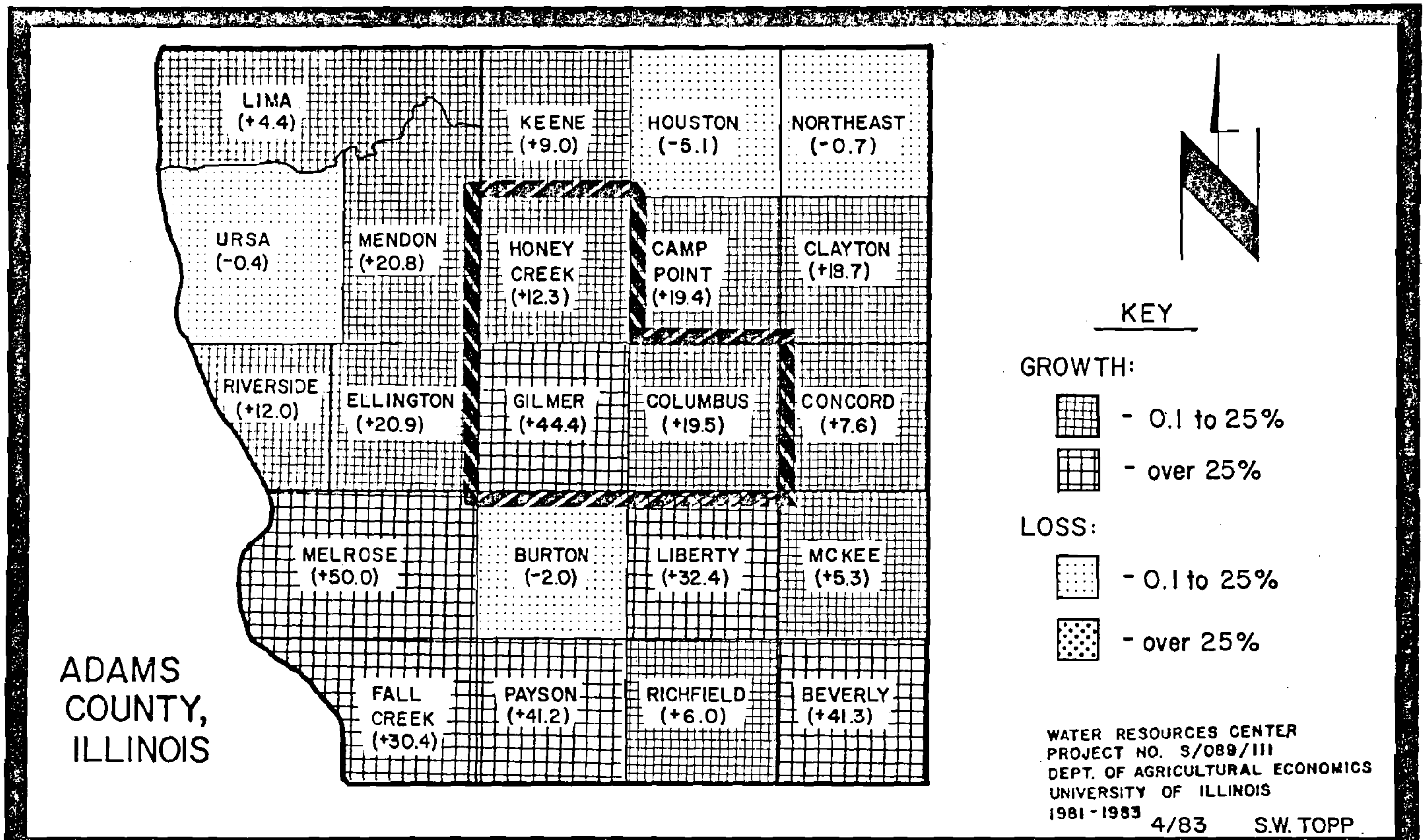
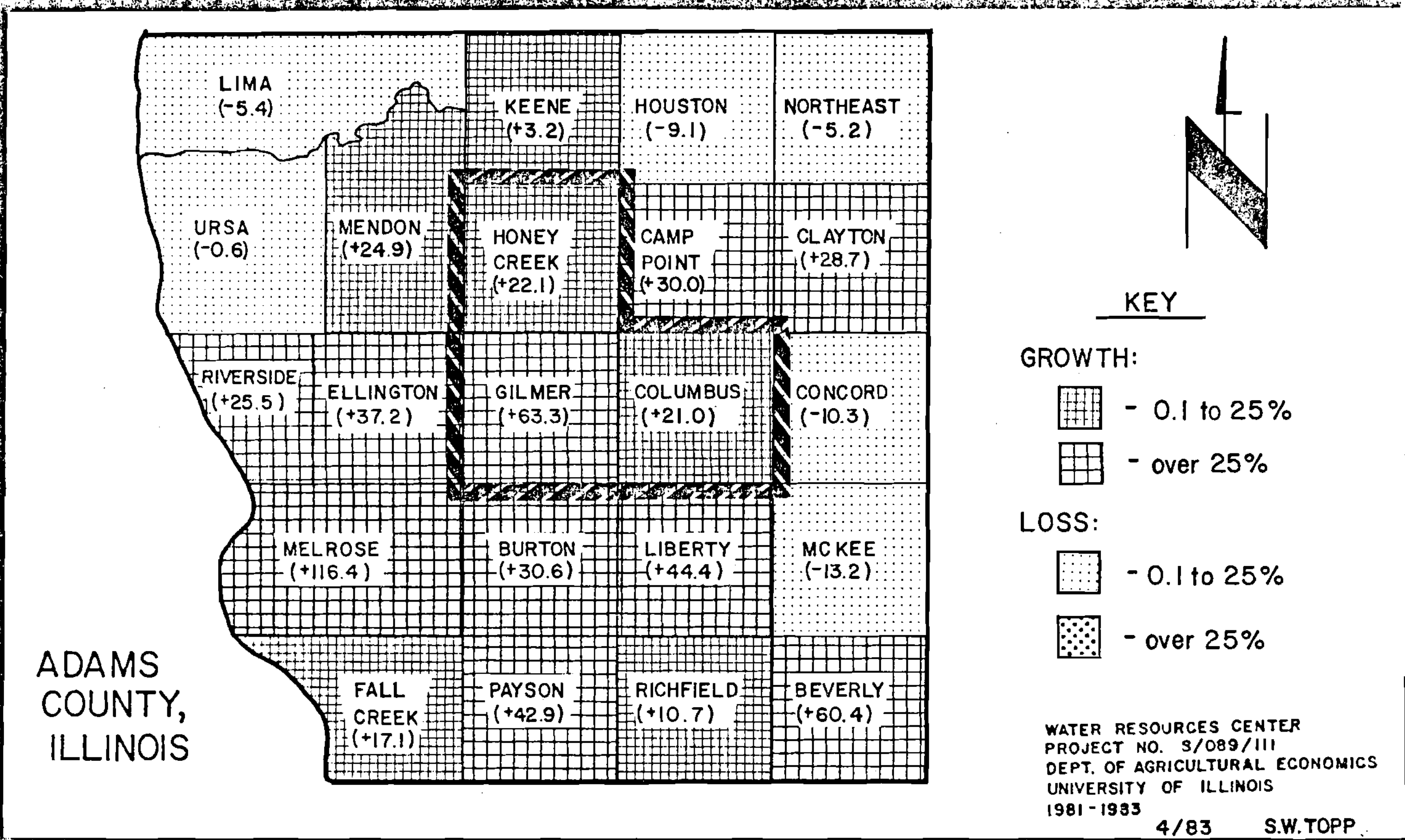
PERCENTAGE CHANGE IN HOUSING UNITS: 1960-1970
(SEE APPENDIX A.)
SOURCE: U.S. 1960 & 1970 POPULATION CENSUS
ATLAS MAP OF ADAMS COUNTY, ILLINOIS
SCALE:
MILES
0
5
10



PERCENTAGE CHANGE IN HOUSING UNITS: 1970-1980

SOURCE: U.S. 1970 & 1980 POPULATION CENSUS
ATLAS MAP OF ADAMS COUNTY, ILLINOIS

SCALE: MILES 0 5 10



PERCENTAGE CHANGE IN HOUSING UNITS: 1960-1980
(SEE APPENDIX A.)

SOURCE: U.S. 1960, 1970 & 1980 POPULATION CENSUS
ATLAS MAP OF ADAMS COUNTY, ILLINOIS

SCALE: MILES 0 5 10

<u>Comparison of information from percentage change in housing units and percentage change in population for Adams County</u>:

1960-1970: shows minimal growth or loss of population within the study area, while showing moderate increases in housing units in two of the townships.

1970-1980: Shows moderate to large growth in population in the townships in the study area, while showing moderate to large growth in housing units in the study area townships and the amount of growth is somewhat proportionately reflected in the respective townships.

1960-1980: shows moderate growth of the population in the townships within the study area while experiencing moderately large to very large growth of housing units in the study area.

Summary: While earlier comparisons are contradictory, the longer period of 1960-1980 shows growth in the population being matched by growth in the number of housing units, and consequently a greater need for potable water supplies.

CONCLUSION

Where the Clearwater Service Corporation is in operation, the number of users as of 1982 was 1,129 (920 in Coles County and 209 in Cumberland County). In view of 6,086 potential customers in Coles County and 9,596 in Cumberland County, actual users account for 7% of possible customers. There are 14 rural subdivisions with a total of 180 housing units with access to the system and of those 180 units, 110 are actually hooked up to the system. These factors plus the fact that only 10-15 housing units presently hooked up to the system were constructed <u>after</u> the service had begun its operations, <u>appears</u> to indicate the provision of the water service has not generated large amount of development, nor contributed significantly to any change in land use.

The results are the same, if not more evident, in Adams County. The establishment of PWD #1 for the settlements of Fowler, Paloma, Coatsburg and Columbus was sought by the residents of these settlements. Some rural residents have connected to the system with the permission of the District, but development in and around the villages has not occurred to any significant amount. Of some interest, however, is the use to which some of the rural residents are putting their water supply - the watering of livestock. This use has increased in popularity, and at present there are 50 potential users* who would like to be connected to the system for this purpose.

Although the water districts studied do not seem to have had a significant impact on land use in their service areas, they have provided a dependable potable water supply of better quality for rural domestic use.

The need for rural water districts, as evidenced by the larger number of districts, is greater in the southern half of the state. According to Mr. Charles Bell of the Illinois Environmental Protection Agency, this is because the northern portion of Illinois has a plentiful ground water supply and the southern portion does not.

The study results are at best tentative and are contrary to conventional wisdom regarding the positive role infrastructure improvement is credited with in encouraging growth and development.

The Clearwater System is in an area of growth attributable to recent trends of population movement toward areas of natural attraction - rural lakes and rivers with forest cover. The water system represents a bonus rather than a necessity.

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* During interviews with agencies and persons concerned with the Adams County PWD #1, mention was made of some of the rural users of the Clayton-Camp Point Water District line, of which PWD #1 is a section, utilizing the processed water for their livestock operations. The rational of the users for utilizing the water in this fashion appears to rest on the assumption that the reduction in the costs of providing water from their own wells and associated veterinarian bills more than makes up for the cost of using the processed water. Whether or not this is a valid assumption would make for an interesting study.

So too, PWD #1 was established in an area already developed. A particularly interesting factor is the rural uses for livestock operations. This phenomena urgently needs additional study. The potential impact on existing systems and on proposed water systems could be highly significant.

A second factor discovered but not investigated is the emergence of regional water supplies (wholesalers) that "open up" large areas for local water delivery systems (retailers), the subject of this study. The formation of these regional systems, given current demographic movement plus a "new" market - the livestock enterprises, have the potential to radically alter the current distribution of population and the agricultural geography of the state.

The paucity of research of water systems in terms of spatial distribution and characteristics severely limited our investigations. This line of inquiry is vital to public policy formation - at the national, state and local levels. We hope this initial attempt to consider spatial attributes contributes to further similar research.

APPENDIX

A. Water District Customer Sampling Frame

B. Water District and District Customer Survey Forms

C. 1960 Housing Unit Estimating Procedure

A. Water District User Sampling

A two stage sampling design was employed to draw a representative sample of Illinois rural water district users in order to insure variability in water prices paid. The target was to obtain 100 completed telephone interviews. The steps in the two stage design were:

1. The Illinois rural water districts were grouped into three strata on the basis of water price schedules--high, medium, and low.
2. From each of the three strata, three districts were drawn with the probability of any district being drawn proportionate to its number of users.
3. From each selected district, 20 users were selected using a systematic random sampling procedure.
4. Steps 1 through 3 resulted in a sample of users per price stratum of 60 or 3 districts times 20 users per district.
5. For each district, a random sub-sample of 11 users was drawn holding 9 customers in reserve. Randomly selected cases from the reserve were used as needed to achieve the target number of about 11 cases per district, 33 cases per stratum and 100 completed interviews.

This design resulted in a sample that was self-weighting within each stratum.

B. Water District and District Customer Survey Forms

WATER DISTRICT PRELIMINARY SURVEY

As part of our research on rural water systems, we intend to study the demand characteristics of household water usage in a rural setting. The analysis of water demand requires data on individual rural water user characteristics and the amount of water purchased. The data on user characteristics can only be collected through a survey of a sample of households served by your water district. Most households will not likely be able to report gallons of water used per month. This information would have to be collected from your billing records. We are conducting this preliminary survey of rural water districts in order to determine: 1) your interest in cooperating in a survey of individual rural water users, and 2) the availability of information on water purchases from your billing records. The survey of water users and the collection of the information would involve a minimum amount of time and expense on your part. We invite you to indicate your interest in participating in our survey by completing the questionnaire below and returning the preliminary survey to us in the envelope provided. Thank you.

1. Name of Water District

2. Number of years of operation. _____ years

3. What is the approximate size of the District? _____ miles of lines
   _____ number of users

4. What is your principal source of water? (check one) Ground _____
   Surface _____

5. Do you purchase water? (check one) Yes _____ No _____

6. Are billing records on water use available at your office? (check one)
   Yes _____ No _____

7. Is information on gallons purchased by individual households available at your office? (check one) Yes _____ No _____

8. How often are water meters read? (check one)
   Monthly _____ Bimonthly _____ Other (please specify) _____

9. Please indicate your present water rate schedule.
   Minimum bill _____ for _____ gal.
   Next _____ gal. for $_____ per _____ gal.
   Next _____ gal. for $_____ per _____ gal.
   Next _____ gal. for $_____ per _____ gal.
   All over _____ gal. for $_____ per _____ gal.

10. Would you be willing to assist us in this survey? Yes _____ No _____

ID#	________	1-5
Stratum	________	6
Study	476	7-9

2/83

University of Illinois
Survey Research Laboratory

Water Demand Study

Hello, may I speak to *(customer or spouse)?* My name is ________ and I am calling from the Survey Research Laboratory at the University of Illinois in Urbana. We are doing a study of rural water systems and I'd like to ask you just a few questions.

1. For how many years have you been a customer of your rural water district?

    ________ years 10-11

    Don't know 98

2. Do you own or have access to another source of water?

    Yes 1 12

    No 2

	Yes	No	
3a. Do you have a dishwasher in your home?	1	2	13
b. Do you have a washing machine?	1	2	14
c. How many bathrooms are there in your residence?	________		15

4. Do you use water purchased from your water district for . . .

	Yes	No	
a. watering a lawn or garden? . . .	1	2	16
b. car washing?	1	2	17

5a. Can you tell ~~me~~ approximately how much your average monthly water bill was during the summer months last year?

$ ____________ 18-20

Don't know *998*

b. About how much was your average monthly water bill during the rest of last year?

$ ____________ 21-23

Don't know *998*

c. Were your average monthly water bills the year before that--in 1981--higher, about the same, or lower than last years?

Higher *(Skip to Q.6a)* . . 1 24

About same *(Skip to Q.6a)* 2

Lower 3

d. Was that because of higher water rates in 1982?

Yes 1 25

No 2

Don't know *8*

6a. On the average, how many gallons of water did you use a month during the summer months, in 1982?

____________ gals. 26-30

Don't know *99998*

b. About how many gallons of water did you use each month during the rest of last year?

____________ gals. 31-35

Don't know *99998*

c. In 1981 did you use more water, less water, or about the same amount as last year?

More 1 36

Less 2

Same 3

Don't know *8*

7. How much *is* your water district's minimum charge?

$ ____________ 37-40

Don't know *9998*

We have just a few questions to help us analyze the results of this study.

8. In what year were you born? ______________ 41-42

9. Are you currently . . .

Employed full time, ... 1

Employed part time, ... 2 43

Temporarily out of work, ... 3

Retired, or 4

Not usually employed? 5

Keeping house/homemaker *6*

Other? (Specify) ____________________ 7

____

10. Including yourself, how many people currently live in your household?

______________ 44-45

11a. Do you live . . .

On a farm, ... 1

In a rural area, but not on a farm, or *(Skip to Q.14)* 2 46

In a small town? *(Skip to Q.14)* 3

b. Did you sell at least $1,000 of agricultural products in 1982?

Yes 1 47

No *(Skip to Q.14)* 2

12a. Do you use any water purchased from your water district for agriculture or livestock?

Yes 1 48

No *(Skip to Q.13)* 2

b. About what percentage of your purchased water is used for agriculture or livestock?

______________ % 49-50

c. About what percentage of all the water used for agriculture and livestock is purchased?

______________ % 51-52

13. About what percentage of your 1982 before tax household income was from farming? *(Same as "net income" for farmers.)*

_____________ % 53–5

14a. In 1982, was your total household income before taxes . . .

Less than $5,000?	Yes 1		55
Less than $10,000?	Yes 2		
Less than $15,000?	Yes 3		
Less than $20,000?	Yes 4		
Less than $25,000?	Yes 5		
Less than $30,000?	Yes 6		
	No 7		
Don't know *8*			
Refused *9*			

(Record b through e below)

b. Was the 1981 total household income before taxes greater than, less than, or about the same as the 1982 figure?

c. By about how much was it (greater/less)?

d. How about 1980 total household net income as compared to 1981--was it greater than, less than, or about the same as 1981?

e. By about how much was it (greater/less)?

	b. 1981		d. 1980	
Greater	1 56		1 57	
Less	2		2	
About the same	3 *(Skip to Q.14d)*		3 *(Skip to Q.15)*	
Difference	c. $__________ or 58–62		e. $__________ or	65–69
	__________ % 63–64		__________ %	70–71

15a. Do you try to limit the use of water in your household?

Yes 1 72

No *(End interview)* . . 2

b. Could you give me some examples?

____ 73–74

____ 75–76

77–78

Thank you very much for your cooperation. 79 | BK

80 | 1

Sex of Respondent

Male *1*

Female *2*

C. 1960 Housing Unit Estimating Procedure

The 1960 Housing Unit counts, and consequently the percentage change in housing units for 1960-1970 and 1960-1980, were derived from correlating the household/population for 1960, 1970 and 1980 with the housing unit/ population ratio for 1970 and 1980, and then estimating what the ratio for 1960 should be according to the pattern established.

	1960	1970	1980
TOWNSHIP	Housing Units / Population	Housing Units / Population	Housing Units / Population
	Households / Population	Households / Population	Households / Population

An example of how the estimation was established is as follows:

North Okaw in Coles County had a population of 1,099 in 1960, 1,011 in 1970 and 1,072 in 1980. The number of households in 1960 was 292, in 1970 was 293 and in 1980 was 334. The number of housing units in 1970 was 313 and in 1980 was 347. This leads to the following ordering of ratios:

	1960	1970	1980	
North Okaw	?	$\frac{313}{1,011}$	$\frac{347}{1,072}$	(housing units)
	$\frac{292}{1,099}$	$\frac{293}{1,011}$	$\frac{334}{1,072}$	(households)

which gives:

1960	1970	1980	
?	.31	.32	(housing units)
.27	.29	.31	(households)

The even increase of households for the three periods of 1960, 1970 and 1980 and an evidently even increase in housing units for the periods of 1970 and 1980 would indicate that a reasonable estimate for 1960 would be .30.

The necessity for estimation comes from a lack of information, as housing unit counts by township were not made available until the 1970 census, and local agencies are not old enough to have gathered the information for their own studies.

ledgers recorded by the respective districts. The sampling procedure and interview instrument are provided in the Appendix along with the mail survey completed by water districts. The interviews were conducted in the spring of 1983.

WATER RATES

Water services are generally priced following a two-part pricing system. This simply means that the total price charged customers is made up of a part independent of the quantity of water used and another part directly related to demand. The first part is a service or minimum charge and the second is a price per unit. More often several ranges of quantity are established with the per unit price declining in each subsequent quantity range or block. Presumably the declining rates reflect declining costs of providing water. This pricing structure is associated with most utility enterprises where, because of large fixed costs, the systems operate at output levels where marginal cost is below average cost so the receipts from marginal-cost pricing would not cover all costs and thus the systems would operate at deficit (Hanke, 1972).

Emphasis on securing adequate revenues to meet the total cost of water systems have led to the adoption of average-cost, not marginal-cost, as the driving force in water rate schedules. This basis for pricing water is argued to be more consistent with the "readiness to serve" and the "going concern" philosophies of utility services. However, the benefits of marginal cost pricing can be realized, in part, through the block rate system, which by its character permits charging low prices for marginal units and making up the deficit by charging higher prices for premarginal units (Afifi and Bassie, 1969, pp. 79-88).

The first charge in the block rate pricing system is looked to as serving several purposes: 1) to cover at least part of the fixed costs of the water plant and distribution system, 2) to provide a stable revenue flow and 3) to cover the customer costs of meter reading, billing, etc. The second charge is related to the cost of providing additional water.

The initial charge may be either a service charge or a minimum charge. The minimum charge is the most common approach and is used by all of Illinois' rural water systems. The major difference between the service and minimum charge is that with the minimum charge the customer is entitled to a fixed minimum quantity of water whether or not it is consumed. About 58 percent of the rural water systems in Illinois provide 1,000 gallons with the minimum charge per month and have a mean monthly minimum charge of $9.76. These districts' minimums ranged from $6.00 to $15.00 per month.

A typical rural water district rate schedule is:

minimum charge	$8.50/month for 1,000 gallons
next	4,000 gallons at $3.15 per 1,000 gallons
next	5,000 gallons at $2.25 per 1,000 gallons
next	10,000 gallons at $1.75 per 1,000 gallons
all use over	20,000 gallons at $1.55 per 1,000 gallons

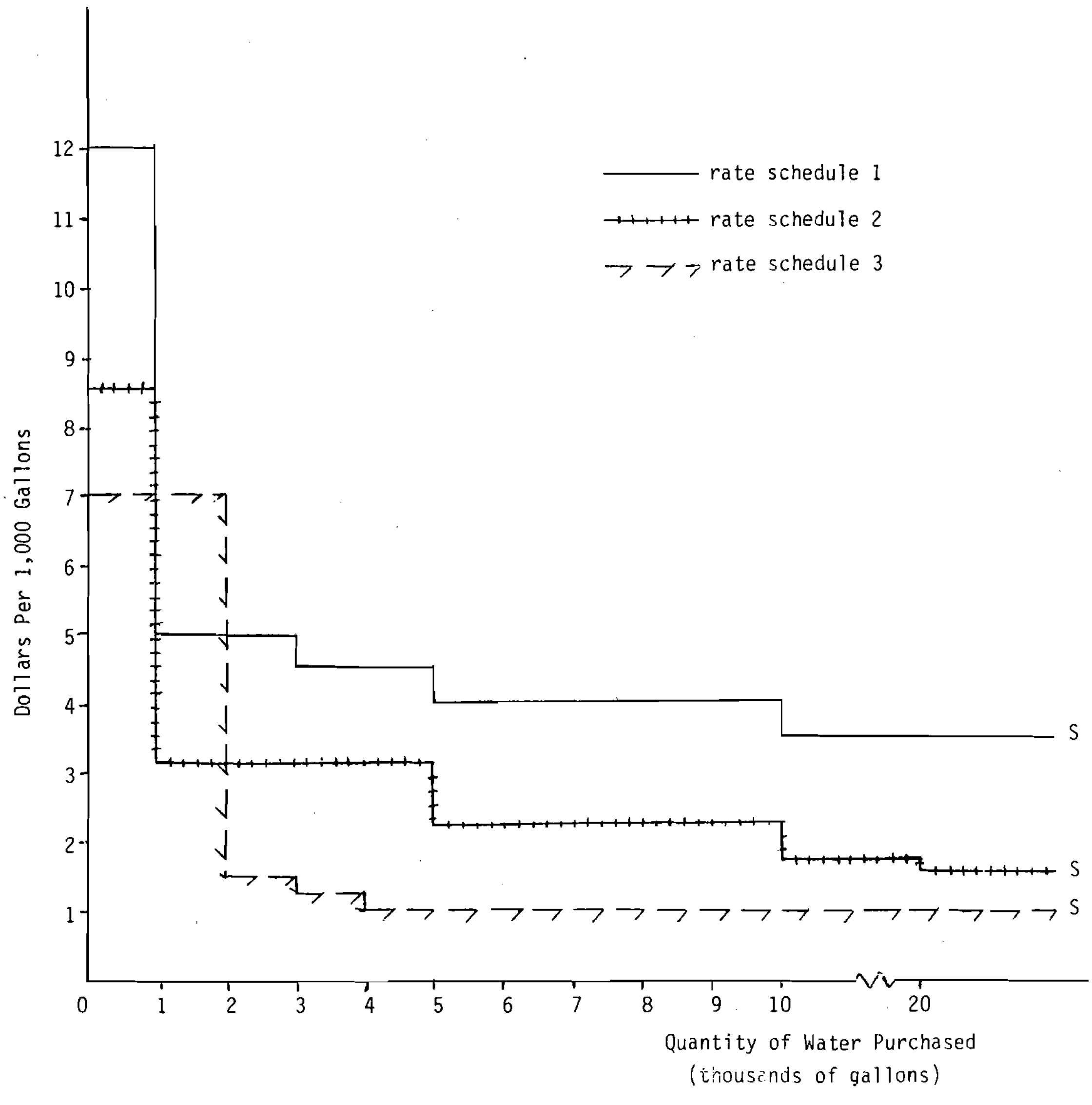
About 30 percent of the rural systems in Illinois provided 2,000 gallons per month with the minimum charge. Other first blocks reported were 1,500 gallons, 3,000 gallons and 4,000 gallons.

The number of blocks ranged from two to seven. About 22 percent of the rural Illinois districts used a two block schedule, 13 percent a three block schedule, 29 percent a four block schedule, and 33 percent a five block schedule. Figure 6.1 graphically presents three example block rate pricing schemes reported by Illinois rural water systems. The minimum charges for the three example rate schedules are $12.00, $8.50, and $7.00 with the first two entitling users to 1,000 gallons of water per month and the latter schedule entitling users to 2,000 gallons. The second blocks for these schedules are 2,000 gallons, 4,000 gallons, and 1,000 gallons respectively.

About one fourth of the rural system rate schedules reported had a 4,000 gallon second block and one fourth had a 1,000 gallon second block. The average rate for the second block for systems entitling 1,000 gallons with the minimum charge was $3.78 per 1,000 gallons. For all systems

Figure 6.1

Example Block Rate Schedules



reporting, the average rate for the second block was $3.70 per 1,000 gallons of water. From a user's perspective, the rate schedule traces the water supply faced in making consumption choices. For example, considering the first schedule in Figure 6.1, if a consumer were to purchase 4,500 gallons of water, the marginal charge or price for the last 1,000 gallons is $4.50. By choosing to consume 5,500 gallons rather than 4,500, the marginal price declines to $4.00 per 1,000 gallons. In general, the two-part pricing structure results in lower marginal and average prices as water use increases.

For the 27 rural water systems in Illinois with a thousand gallons of water associated with the minimum charge, the average price per 1,000 gallons is presented in Table 6.1 for monthly consumption levels of 1,000, 2,000, 4,000, 6,000, and 8,000 gallons. For the 27 districts in this sample, the average price per 1,000 gallons declines from $10.24 to $4.05. As the minimum charge is spread over more gallons,

Table 6.1

Average Price Per 1,000 Gallons of Water by Number of Users in District*

Number of Customers	Average Minimum Charge	Average Price Per 1,000 Gallons For				Number of Districts
		2,000 Gal.	4,000 Gal.	6,000 Gal.	8,000 Gal.	
Less than 199	$7.65	$5.77	$4.45	$3.59	$3.23	6
200-399	10.77	7.73	5.32	4.56	4.17	14
400-799	10.83	7.76	6.55	6.06	5.80	3
800 and More	10.13	6.60	4.84	4.00	3.57	4
Full Sample	10.24	7.13	5.19	4.43	4.05	27

* Average for 27 districts with 1,000 gallon minimums.

the reduction in the average per unit price becomes smaller. Average prices are also presented by size of water district measured by number of users. Except for the 800 and more category, average per unit price increases as