Economics of Water Delivery Systems in Rural Oklahoma

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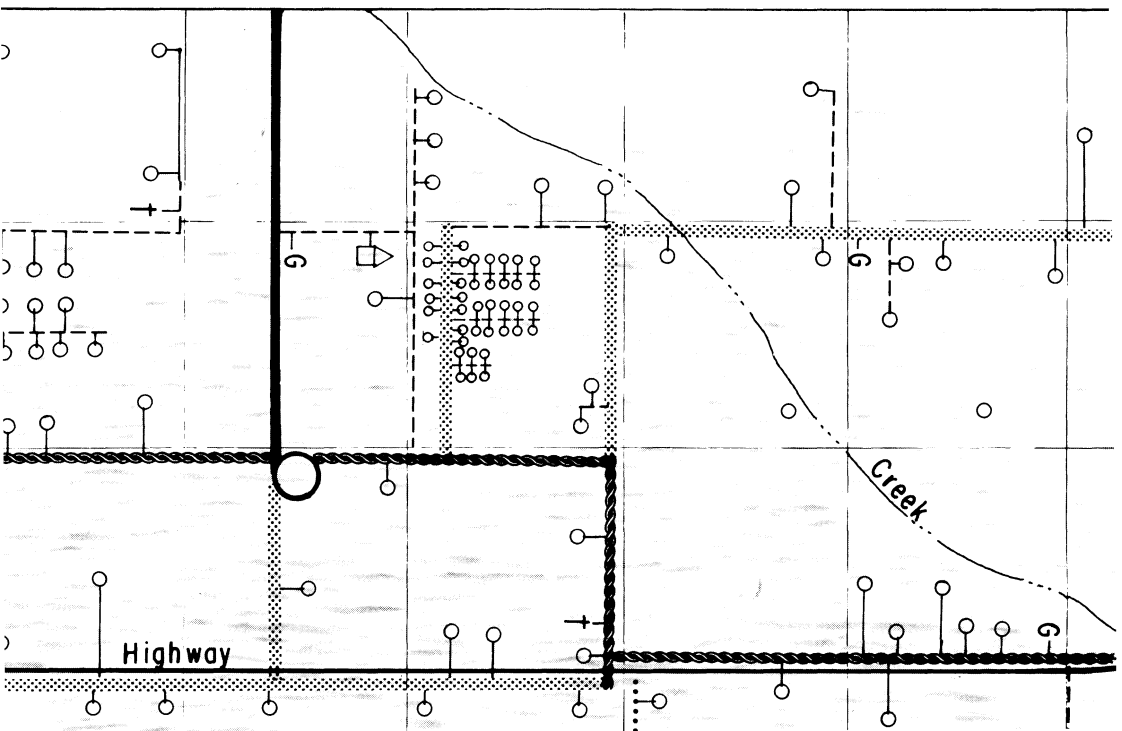

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Preface

This bulletin was prepared for use by other economists and by rural decision makers are they work with persons from such organizations as Cooperative Extension, FmHA and the Oklahoma and National Rural Water Associations to examine rural water needs and conduct preliminary evaluations of alternative systems to meet such needs. Parts of the publication can be utilized as a workbook. Cost data and blank work forms are presented which can be utilized to facilitate the above specified applications.

The authors are deeply indebted to Royce Jones, Chief, Community Services, Farmers Home Administration for his cooperation in data collection and review, and to Gene Womack, Phil Brown and Cecil Wildman, FmHA engineers for their expertise and assistance in developing the technical aspects of the study.

We are also indebted to other reviewers who provided numerous suggestions and insights related to rural water systems and the application of the methodology and work forms contained herein, these reviewers include:

Ed Henderson - Area Specialized Agent, Oklahoma State Extension Service

R. K. Johnson - President, Oklahoma Rural Water Association

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Their interests in the needs of rural water systems in Oklahoma were indicated by their thorough reviews.

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Economics of Water Delivery Systems in Rural Oklahoma*

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Introduction

Over the past twenty years, the Federal Government has injected hundreds of millions of dollars into rural areas for the express purpose of improving the quality of life in these areas. This policy was prompted largely by a desire to slow rural to urban migration by providing rural residents with employment opportunities and community services that were comparable to those in urban areas.

A major determinant of the quality of life is an abundant supply of high quality water. For years, rural areas were dependent upon either groundwater or hauled water for their supplies. Many areas of the country, however, do not have adequate supplies of quality water from these sources and, as a result have not had enough water to meet their needs. To help alleviate this problem, the Consolidated Farmers Home Administration Act of 1961 was enacted by Congress, enabling Farmers Home Administration (FmHA) to make loans to small communities or groups of rural residents hoping to establish rural water systems.

Passage of the 1961 legislation has resulted in a large number of FmHA loans and grants being made to establish rural water systems. In Oklahoma, there were 110 loans and 87 grants made for establishment or expansion of systems in fiscal year 1977. During fiscal year 1978, 93 loans and 49 grants were made.

The need for upgrading the quality, capacity and service area of rural water systems because of growth pressures has caused rural leaders to be more concerned about the economic stability of their systems. It is becoming increasingly important that persons responsible for planning new systems and the expansion of existing systems have at their disposal as much information as possible to assist them in avoiding financial problems.

*Research conducted with funds available under Title V of the Rural Development Act of 1972.
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Objectives

The primary objective of this study was to develop information useful in evaluating the economic feasibility of a rural water system. The specific objectives of the study were to:

1. develop procedures, applicable on a widespread basis, to estimate current water needs by user types;
2. develop information to enable rural water districts to establish complete capital and operating budgets and water rate structures dependent upon their specific needs;
3. summarize State and Federal laws and regulations relevant to rural water districts; and
4. summarize sources and methods of funding available to rural water districts.

The information developed and compiled in this study is presented in handbook form in the following pages. The first section deals with the determination of water needs, followed by a discussion of the formulation of capital and operating cost budgets for rural water systems. The third topic covered is determination of rural water rates structures. These procedures are then applied to the analysis of an example system to estimate net revenues for alternative rate structures. Then a section on Federal and State regulation will be presented. Finally, there will be a project summary and, in an appendix, a set of forms to be used by rural decisionmakers to conduct financial analysis to fit their particular needs.

Data and Study Area

The data used in this study came largely from records in the Farmers Home Administration State Office in Stillwater, Oklahoma. The Community Services Division maintains a filing system which made it possible to collect most of the necessary data. Engineering bids on the systems expanded or created since October 1, 1976, provided capital cost information, while audits of the systems made it possible to obtain operating revenues and expenditures for the same time period. Customer and water consumption data were acquired from either the state or county FmHA office or from water system managers.

All of Oklahoma was included within the study area. Information from 82 different water systems was utilized in the analysis which follows. The systems were selected on the basis of data availability and were well dispersed geographically around Oklahoma.

Determining Water Needs

The first step in formulating capital, operating budgets and rate structures was estimation of total water consumption by the prospective users so that proper system size can be established. Thirty different rural water systems from around the state were selected for this phase of the analysis. Information was obtained from state and county Farmers Home Administration Offices and from system managers. For purposes of this study, the term "user" was employed to describe any rural water service hookup. Numbers of each type of user (rural household, farm, commercial[1] and industrial) and volume of water sold annually for 1976 and 1977 were used in arriving at average use estimates. Preliminary analysis of water use by all four types of users revealed few

[1]This group includes businesses, schools, churches and other institutional users.

differences. In further analysis, user types were aggregated into only two groups: 1) rural households and farms and 2) commercial and industrial users. Averages for the 30 selected systems showed the two categories to have annual water usages of 82,629 and 203,557 gallons per year or approximately 6,900 and 17,000 gallons per month respectively.[2] These average use figures will be applied in determining system storage capacities and rate structures.

Formulation of Capital Cost Budgets

Capital costs are generally thought of as expenditures on equipment, structures and land. In this study of rural water systems, however, capital costs are defined as any costs involved in completing construction of systems or system improvements, including material, labor, interest and professional services.

To arrive at a set of average costs for commonly used construction items, 48 recent construction projects were examined. Average costs for some of the most frequently used construction items appear in Table 1. No real cost differences were found because of system type, size or location. There were cases in which too few observations occurred for certain items or where the observed cost values were very erratic. In these instances, no average costs were reported.

The average cost figures in Table 1 were derived from engineering bids. Each division of Table 1 (pipes, valves, meters, taps, hydrants and connectors, etc.) will be discussed to facilitate full understanding of criteria for grouping items and estimating average costs.

Pipe

Several different types of pipe are used in the construction of a rural water system.[3] Polyvinyl chloride (PVC) pipe is by far the most frequently used type. The cost per foot for the PVC pipe given in Table 1 includes trenching, bedding and covering of the line as well as all materials and is a state wide average of individual costs. These costs may vary with the local topography involved. For instance, cost per foot of pipe would be much higher in rocky or hilly terrain than in flat, sandy terrain.

Valves

Valves are generally placed in a system to provide either pressure regulation or flow maintenance. They are necessary at points where pipe size changes (gate valves), topography changes (gate, pressure and/or blow-off valves) or within storage facilities to maintain water levels (altitude valves). All valve costs presented in Table 1 are for installed and operational valves which meet the minimum FmHA design standards.

Meters, Taps, Hydrants and Connections

The costs for meters indicated in Table 1 are for fully installed and operational meters. Master meters are used to gauge total water used by the system and service meters are used to gauge total water volume used by each customer. Service taps

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[2]Ordinary Least Squares Regression was used to analyze the data in obtaining the water use coefficients. Several models were tested, with the following model selected as the most appropriate:

TOTVOL = 82628.62 HOUSE + 203556.56 BUSNES R^2 = .9125
(.0001) (.0466)

where:

TOTVOL = Total volume of water consumed by the system annually.
HOUSE = Total number of farm and rural user hook-ups.
BUSNES = Total number of commercial and industrial user hook-ups.

An intercept term was found to have little effect on the results of the models tested, so for practicality and ease of understanding by laymen, no intercept term was included in the final model. Numbers appearing in parentheses represent the observed significance level of the variable as determined by the "student-t" values.

[3]Cast iron, ductile iron, asbestos-cement and PVC.

Table 1. Average costs of commonly used items in rural water systems' construction, 1977.

Item	Cost (Installed)
Pipe (per foot)	
1. 6″ Class 200 PVC Pipe	$ 3.50
2. 4″ Class 200 PVC Pipe	1.90
3. 2″ Class 200 PVC Pipe	.93
4. 8″ Class 160 PVC Pipe	3.97
5. 6″ Class 160 PVC Pipe	2.50
6. 4″ Class 160 PVC Pipe	1.48
7. 3″ Class 160 PVC Pipe	1.15
8. 2½″ Class 160 PVC Pipe	.84
9. 2″ Class 160 PVC Pipe	.75
10. 1″ Class 315 PVC Pipe	1.36
11. 1″ Copper Type K Service Line	1.36
Valves	
1. 8″ Gate Valve	296.00
2. 6″ Gate Valve	246.00
3. 4″ Gate Valve	180.00
4. 3″ Gate Valve	144.00
5. 2½″ Gate Valve	130.00
6. 2″ Gate Valve	111.00
7. 4″ Pressure Valve	2,112.00
8. 2″ Pressure Valve	1,351.00
9. ¾″ Pressure Valve	37.00
10. 2″ Blow-off Valve	156.00
11. 2″ Altitude Valve	1,657.00
Meters, Taps, Hydrants, Connections	
1. 4″ Master Meter	2,443.00
2. 2″ Master Meter	1,799.00
3. ¾″ Service Meter	113.00
4. Service Tap[1]	68.00
5. 6″ Rural Hydrant	603.00
6. 4″ Rural Hydrant	491.00
7. Large Pipeline Connection	1,310.00
Crossings[2]	
1. Creek Crossing	$ 2,586.00
2. River Crossing	4,981.00
3. County Road Crossing	257.00
4. Highway Crossing	1,132.00
5. Turnpike Crossing	7,500.00
6. Railroad Crossing	1,132.00
Pumps, Housing, Wells	
1. Labor	2,557.00
2. Chlorinator	2,335.00
3. Settling Facility	13,933.00
4. Miscellaneous Equipment[3]	4,222.00
5. Miscellaneous Improvements[4]	16,204.00
6. 35 HP Pump, complete	6,929.00
7. 15 HP Pump, complete	4,078.00
8. Pump Station, complete	16,053.00
9. Treatment Plant, complete[5]	
a. 200 residential, 10 commercial 40 gpm capacity	111,430.00
b. 500 residential, 15 commercial 90 gpm capacity	149,257.00
c. 1000 residential, 25 commercial 180 gpm capacity	208,449.00
10. Wells	-not estimated-

Table 1. cont.

Item	Cost (Installed)
Storage Facilities, Complete	
1. 0-20,000 gallons capacity	11,280.00
2. 20,001-40,000 gallons capacity	26,694.00
3. 40,001-70,000 gallons capacity	36,852.00
4. 70,001-100,000 gallons capacity	52,360.00
5. 100,001-200,000 gallons capacity	55,771.00
6. 200,001-400,000 gallons capacity	95,351.00
7. Over 400,000 gallons capacity	156,993.00
Other Costs (Professional Fees)[6]	
1. Legal	3.0%
2. Engineering	7.0%
3. Interest	2.5%
4. Inspection	2.0%
5. Contingencies	5.0%

[1]In most rural water systems, the user is responsible for the service tap.
[2]Crossings include boring and steel casing.
[3]Includes such items as: clarifiers, holding tanks, pipeline markers and cables, wiring and other electrical equipment.
[4]Includes such items as: relocation and rennovation of storage facilities, painting of buildings, fencing, paving, excavation and upgrading of water treatment facilities.
[5]Complete treatment plant costs include costs for equipment necessary to perform and maintain coagulation, flocculation, sedimentation, filteration and chlorination of raw water. The costs were derived from Environmental Protection Agency Publication EPA-600/2-78-182.
[6]These figures are to be used as percentages of total construction costs.

include actual "hook-ups" for water use and are also installed and operational. Rural hydrants are provided in some areas to help facilitate fire protection. Costs for hydrants in Table 1 are for 3-way operational hydrants. The term "connections" refers to the connecting of water supply lines or large water mains to smaller lines and includes all labor and material costs involved.

Crossings

The crossings sub-section of Table 1 includes costs of boring and of stream and road crossings. Creek and river crossing costs include all labor and materials as required in traversing streams with the water lines. County road crossings consist of taking the lines across any unpaved county operated roads, while highway, turnpike and rail crossings involve boring under the paved roadway.

Pumps, Housing and Wells

Average costs for two sizes of pumps used by systems for wells and booster pumps are presented in Table 1. Specific costs for other types of pumps can be obtained locally. "Labor" includes electrical and special plumbing labor. Chlorinators and settling facilities, often used for systems with wells or treatment plants, were found to be fairly consistent in costs from system to system. "Miscellaneous Equipment" includes any capital items which may be used in special cases, such as line markers, filters, holding tanks and the like. This may or may not be reflected in each system's final cost. "Miscellaneous Improvements" consists of relocation of storage facilities, repairs, painting and replacement of old or faulty parts in existing equipment. Pump stations are completely functional, with housing, pump, valves and fencing. No costs are estimated for wells, as they vary greatly depending upon the depth capacity and nature

of drilling. Cost estimates for operational wells may be obtained locally according to each system's needs. The cost figure shown for treatment plants was derived from an Environmental Protection Agency study which computed the cost per user for a complete "package water treatment plant."[4] Actual on-site costs may vary up to 50 to 70 percent because of changes in specifications of plants made by system engineers.

Storage Facilities

All average costs figures for storage facilities are for operational facilities, complete with tower, valves, fencing, foundation and labor (Table 1). There will be some discrepancies in local site construction costs of specific sizes of facilities within each capacity grouping.

Other Costs

Costs for professional fees were derived as a percentage of the total construction costs. Thus, the 2.5% figure for interest does not refer to the interest rate on the loan, but to the percentage cost of using the borrowed money during construction.

Formulation of Operating Cost Budgets

All data used in formulating average operation and maintenance costs were obtained from State Farmers Home Administration Office records. Annual audits of 42 different rural water systems provided the necessary information on all aspects of operating costs.

Unlike the capital cost data, operating costs are reported on a per user basis. A per user approach allows each system to approximate operating costs for their particular system. Operation and maintenance costs of 42 systems from all parts of Oklahoma were used to arrive at the average per user cost figures presented in Table 2-4.

It was hypothesized that all three types of water system (purchased water, wells and water treatment) would have differing cost structures and that these cost structures would change as the size of system changed. To test these hypotheses, operating costs were disaggregated into several categories dependent upon the type and size of the water system.

Table 2. Average annual operating costs per user of rural water systems utilizing purchased treated water, 1977.

Item	Cost/User
Wages	$14.63
Utilities	3.11
Office	1.76
Insurance & Bonds	1.32
Taxes	1.20
Professional Fees	1.75
Repairs	7.23
Water Purchase	24.65
Miscellaneous	14.60
Total	$70.25

Source: Farmers Home Administration records, State Office, Stillwater, Oklahoma.

[4]USEPA publication EPA-600/2-78-182.

An attempt was made to detect possible economies of size within each system type. Upon analyzing the available data (by comparing average costs) it was found that annual operating costs do differ by system type, but there was not conclusive evidence to indicate that economies of size existed over the range of observations involved in this study (Tables 2-4). It is hypothesized that economies of size might be detected if larger systems had been analyzed or if more observations had been available.

The nature of the items appearing in the operating cost budget should be discussed. The item designated as "Wages" refers to payment to employees of the district—generally a clerk, manager and "trouble-shooter" for repairs. Typically, systems with fewer than 500 users have no full-time employees. There is generally a clerk who works part-time in billing users and taking care of district correspondence and a "trouble-shooter" who handles necessary repairs. Meter reading may be done by a part-time employee, or individual users may be responsible for reading their own meters.

Depreciation varies with each district depending upon the make-up of the district. Many own pick-up trucks and other equipment which may be considered depreciable. The larger districts and those which have wells or treatment facilities typically have

Table 3. Average operating costs of rural water systems utilizing groundwater supply, 1977.

Item	Cost/User
Wages	$23.12
Utilities	9.33
Office	2.24
Insurance & Bonds	3.39
Taxes	1.46
Professional Fees	3.62
Repairs	10.41
Water Purchase	3.94
Miscellaneous	10.50
Total	$68.01

Source: Farmers Home Administration records, State Office, Stillwater, Oklahoma.

Table 4. Average Annual Operating Cost Per User of Rural Water Systems Utilizing a Water Treatment Plant, 1977.

Item	Cost/User
Wages	$20.13
Utilities	7.66
Office	1.63
Insurance & Bonds	2.67
Taxes	1.18
Professional Fees	1.78
Repairs	6.56
Water Purchase	1.95
Miscellaneous	9.68
Total	$53.24

Source: Farmers Home Administration records, State Office, Stillwater, Oklahoma.

higher depreciation costs. Most systems utilizing groundwater have agreements with other water suppliers which allow them to purchase supplemental water during periods of peak use. Other cost items, particularly office expenses, utilities, repairs and miscellaneous expenses, were similar regardless of the size or type of the system.

Caution should be used when interpreting the average annual per user operating costs of individual items shown in Tables 2-4 as expected costs of such items for specific systems. There may be significant potential for error in such interpretations because of different methods of classifying and accounting for costs. However, the total annual operating costs shown should be reasonably reliable, and can be useful to system managers and decisionmakers in estimating costs for specific systems.

Formulation of Appropriate Rate Structures

A necessary element in the planning of a rural water system is the determination of a water rate structure. Different systems necessitate different approaches to rate setting, but several factors should be kept in mind when establishing rates. Rural leaders usually wish to provide customers with adequate water at the lowest possible cost while at the same time maintaining solvency of the district. Rates are ideally set not only to minimize needs for rate increases but also to prevent excess accumulation of capital. They are traditionally rather easy for the customer to remember and do not involve a series of complex charges. Six examples of water rate structures for use as guides in setting water rates for individual systems are presented in Table 5.

Table 5. Sample rate schedules for rural water systems.

A.	0-4000 gallons	$12.00 minimum
	4001-10000 gallons	$ 2.00/1000 gallons
	over 10000 gallons	$ .75/1000 gallons
B.	0-4000 gallons	$10.00 minimum
	4001-10000 gallons	$ 1.50/1000 gallons
	over 10000 gallons	$ .75/1000 gallons
C.	0-2000 gallons	$10.00 minimum
	3001-5000 gallons	$ 2.00/1000 gallons
	5001-10000 gallons	$ 1.50/1000 gallons
	over 10000 gallons	$ .75/1000 gallons
D.	0-2000 gallons	$ 7.00 minimum
	2001-7000 gallons	$ 1.50/1000 gallons
	7001-10000 gallons	$ 1.50/1000 gallons
	over 10000 gallons	$ 1.00/1000 gallons
E.	0-3000 gallons	$ 8.00 minimum
	3001-10000 gallons	$ 2.00/1000 gallons
	over 10000 gallons	$ 1.00/1000 gallons
F.	0-2500 gallons	$ 8.00 minimum
	2501-5000 gallons	$ 2.00/1000 gallons
	over 5000 gallons	$ 1.00/1000 gallons

Designing a Sample System[5]

The following section of this handbook will give some practical application to the material presented thus far, including the design of a sample system and the use of forms created to allow leaders of rural water district to evaluate the financial status of their system.

So that capital and operating budgets can be logically developed, a sample system will be illustrated; this is an example only. It approximates a system which would be correct from an engineering standpoint and one which would supply a wide range of user types. Specific topography, however, was not considered; it was assumed that no major hills or ravines were contained within district boundaries.

The example system (XYZ Rural Water District) is assumed to be 50 miles square in size and serve 200 households and 10 businesses (Figure 1). It is assumed that within the district there are several county roads, a major highway, a railroad and a creek. There are two housing additions in the district, the remainder of the users being fairly scattered. Storage facilities are centrally located to allow more even distribution of water. Water is purchased from a nearby city and is carried to the system through a 10-inch supply line.

Size of watermains is determined by the number and type of users to be served. Table 6 provides a general rule-of-thumb for size of line needed to serve varying types and numbers of users. These guildelines were adhered to as nearly as possible in designing the sample system. (It was assumed that each user was responsible for placement of service line from the watermains to the service hookup). Valves for prevention of excess water loss because of breaks in lines and for pressure regulation and flow maintenance were placed at points where sizes of pipe changed or where topographical changes required them.

Farmers Home Administration suggests storage capacity of at least twice the average daily use of the system. Applying the water use coefficients and the number of users, this amount of storage is slightly more than 100,000 gallons. Booster pumps and pump houses will be required at certain points to ensure adequate water supply to all parts of the system.

Table 6. Recommended[1] water line size for maintenance of adequate water supply.

Pipe Size (PVC)	Maximum Volume of Water Carried	Families Served
1" (Service Line Only)	3 gpm[2]	2
2"	20 gpm	10
3"	55 gpm	30
4"	120 gpm	70
6"	300 gpm	200

[1]Recommendations made by Farmers Home Administration.
[2]Gallons per minute.
Source: Farmers Home Administration Guidelines, State Office, Stillwater, Oklahoma.

[5]Personal visits with Cecil Wildman, Gene Womack and Phil Brown of the Farmers Home Administration were extremely helpful in developing understanding of basic system construction, line requirements, storage, pressure requirements and valve placement.

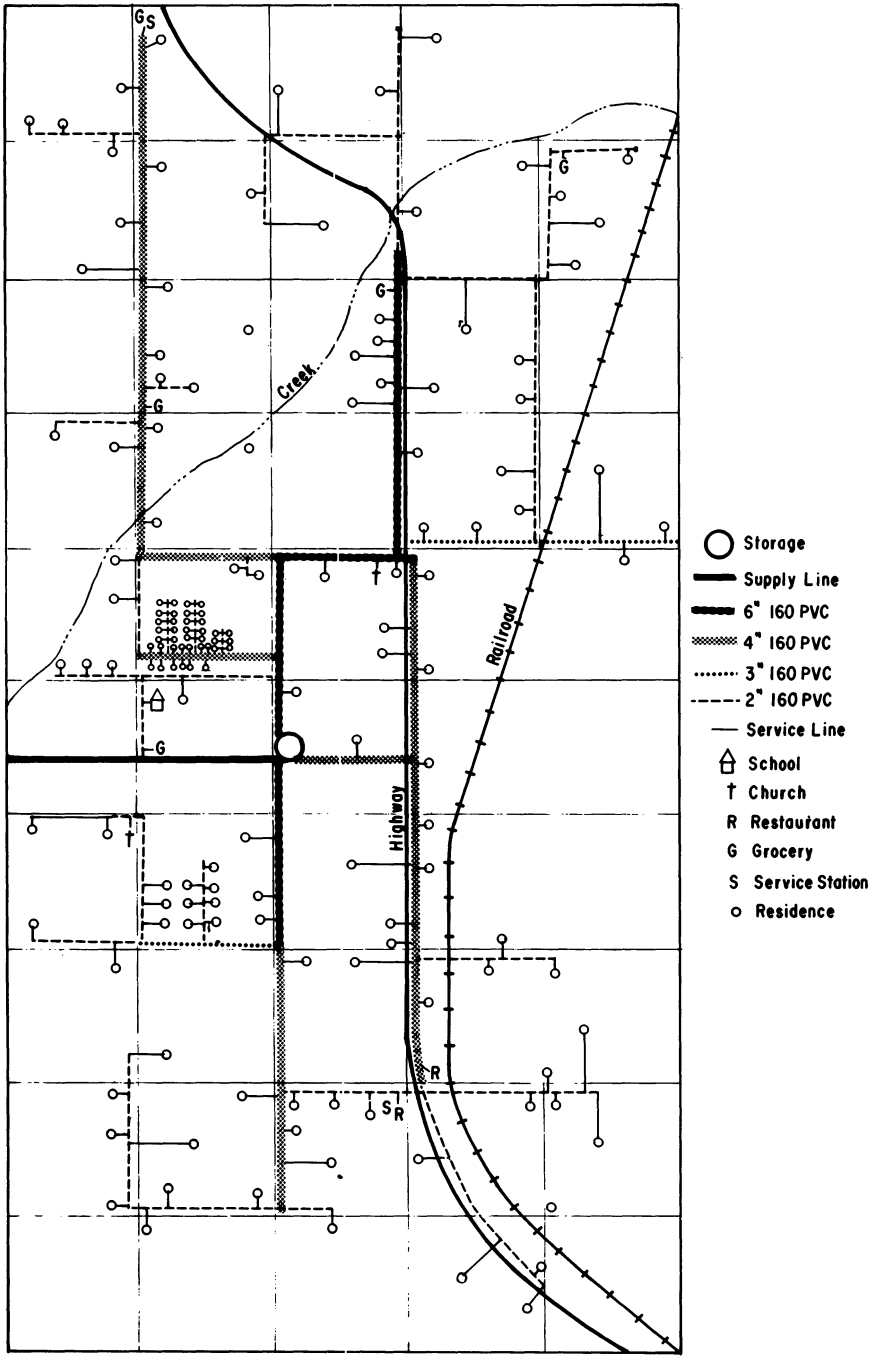

Figure 1. Schematic diagram of the XYZ rural water district.

Capital Cost and Operating Cost Budgets for the Sample System

Upon examining the construciton needs for the XYZ District, a list of material and labor items was made. (For each system this should be done by local decisionmakers familiar with the area and its needs). The Sample Capital Costs Budget (Form 1) which follows has been completed for the XYA Rural Water District as an expample. It must again be stressed that all amounts of construction items are only estimates and that real figures can only be obtained by having an engineer-designed system. Inflation should also be considered, as the prices given in Table 1 are subject to constant change.

A Sample Operating Costs Budget (Form 2) follows to illustrate the use of the average costs given in Tables 2 through 4. For the XYZ Rural Water District, System A of Table 2 was used. Blank copies of Forms 1 and 2 are available in the Appendix for use by persons interested in establishing or expanding a rural water system.

Determining Annual Loan Payments, Annual Revenues and Net Returns

Now that capital and operating budgets have been developed, it becomes possible to examine the financial situation of the district. The first step is to determine the yearly payment to the lending institution for capital expenditures. Numerous methods of financing are available, including member contributions, loans and grants. Six alternative financing arrangements and their respective annual payments for the sample system are shown on Form 3.

For any system there are many possible combinations of rate structures. Some example rate schedules for rural systems are shown in Table 5. Utilizing the monthly water use information presented earlier (6,900 gallons/residential user and 17,000 gallons/commercial user) and utilizing the specific number of users in the system, an annual total revenue figure may be estimated for each rate structure. Several revenue alternatives for the XYZ Rural Water District are presented on Form 4.

With the information provided on Forms 3 and 4, it is possible to determine which set of financing alternatives and rate structures will provide water to users at the lowest cost while maintaining the financial stability of the district. A summary of the financial information which has been developed with the XYZ District is presented on Form 5, Annual Profit/Loss Statement. The Appendix contains a blank copy of Forms 3, 4 and 5.

Form 1

Sample Capital Costs Budget for Rural Water Systems Construction

Type of System Purchased

Residential Users 200

Commercial Users 10

A. Lines (Materials, Placement & Labor):

	Pipe Description Type & Strength	Size	No. Feet		Cost/Unit		Total Cost
1.	160 PVC	10"	18480	X	4.50	=	83160
2.	160 PVC	6"	33000	X	2.50	=	82500
3.	160 PVC	4"	67320	X	1.48	=	99634
4.	160 PVC	3"	15840	X	1.15	=	18216
5.	160 PVC	2"	120120	X	.75	=	90090
6.				X		=	
7.				X		=	
8.				X		=	
9.				X		=	
10.				X		=	
	Sub Total				A =		373600

B. Crossings (Materials, Placement & Labor):

		Number		Cost/Unit		Total Cost
1.	Highway (Paved)	5	X	1132	=	5660
2.	County Road (Unpaved)	26	X	257	=	6682
3.	Railroad	2	X	1132	=	2264
4.	Stream	2	X	2586	=	5172
5.	Turnpike		X		=	
6.			X		=	
	Sub Total			B =		19778

C. Storage Facilities (Complete Operational):

	Capacity		Number		Cost/Unit		Total Cost
1.	120000	gallons	1	X	55771	=	55771
2.		gallons		X		=	
3.		gallons		X		=	
4.		gallons		X		=	
	Sub Total			C =			55771

D. Valves & Meters (Material, Placement & Labor):

	Description Type	Size	Number		Cost/Unit		Total Cost
1.	Altitude Valves	2"	1	X	1647	=	1647
2.	Gate Valves	6"	5	X	246	=	1230
3.	Gate Valves	4"	9	X	180	=	1620
4.	Gate Valves	3"	2	X	144	=	288
5.	Gate Valves	2"	6	X	111	=	666
6.	Pressure Valves	2"	2	X	1351	=	2702
7.	Pressure Valves	3/4"	18	X	37	=	666
8.	Blow Off Valves	2"	3	X	156	=	468
9.	Master Meters	4"	1	X	2443	=	2433
10.	Service Meters	3/4x5/8"	210	X	113	=	23730
11.				X		=	
12.				X		=	
13.				X		=	
14.				X		=	
15.				X		=	
	Sub Total			D =			35450

E. Pumping & Well Facilities (Materials, Placement & Labor):

	Description Type	Size	Number		Cost/Unit		Total Cost
1.	Pump, complete	35HP	1	X	6929	=	6929
2.	Pump, complete	15HP	1	X	4078	=	4078
3.	Pumping Station		2	X	16053	=	32106
4.	Well			X		=	
5.				X		=	
6.				X		=	
	Sub Total				E =		43113

F. Other Construction Costs:

	Description Type	Size	Number		Cost/Unit		Total Cost
1.	Miscellaneous Labor			X		=	2557
2.	Miscellaneous Equip.			X		=	4222
3.	Rural Fire Hydrants	6"	6	X	603	=	3618
4.				X		=	
5.				X		=	
6.				X		=	
7.				X		=	
8.				X		=	
9.				X		=	
10.				X		=	
	Sub Total				F =		10397

Total Construction Costs (A + B + C + D + E + F) 538109

G. Legal (3% Construction Cost) G = 16112

H. Engineering (7% Construction Cost) H = 37595

I. Interest During Construction (2½% Construction Cost) I = 13427

J. Inspection (2% Construction Cost) J = 10741

K. Contingencies (5% Construction Cost) K = 26853

Total Project Costs (Add items A through K) 642837

$$\text{Total Project Costs} \times \frac{\text{Current Construction Cost Index}^1}{\text{1977 Construction Cost Index}} = \text{Total Project Cost in Current Dollars}$$

$$642837 \times \frac{173.0}{156.6} = 710158$$

[1]See Table 1, Appendix I.

Form 2

Sample Operating Costs Budgets

Type of System Purchased

Residential Users 200

Commercial Users 10

	Cost/User		Total No. Users		
Wages	14.63	x	210	=	3072.30
Utilities	3.11	x	210	=	653.10
Office	1.76	x	210	=	369.60
Insurance & Bonds	1.32	x	210	=	277.20
Taxes	1.20	x	210	=	252.00
Professionals Fees	1.75	x	210	=	367.50
Repairs	7.23	x	210	=	1518.30
Water Purchases	24.65	x	210	=	5176.50
Miscellaneous	14.60	x	210	=	3066.00
Total					14752.50

$$\text{Total Operating Costs} \times \frac{\text{Current Consumer Price Index}^1}{\text{1978 Consumer Price Index}} = \text{Total Operating Cost in Curren Dollars}$$

$$14752.50 \times \frac{156.0}{144.8} = 15893.58$$

[1]See Table 1 , Appendix I.

Form 3

Repayment Schedule for FmHA Loan for Expansion or Establishment of a Rural Water System

Type of System Purchased

Residential Users 200

Commercial Users 10

	Case I 0 % Grant 100 % Loan	Case II 25 % Grant 75 % Loan	Case III 50 % Grant 50 % Loan
A. Total Project Cost (Current dollars)[1]	710158	710158	710158
B. Initial Service Charge 1. Residential $ 250 /meter x 200 users	50000	50000	50000
2. Commercial $ 500 /meter x 10 user	5000	5000	5000
C. Total Funds Needed (A-B1-B2)	655158	655158	655158
D. Grant Funds Received	0	163790	327579
E. Amount of Loan Required (C-D)	655158	491368	327579
F. Ammortization Factor[2] (For Appropriate interest rate and payback period for loan)	.0583	.0583	.0583
G. ANNUAL PAYMENT (E x F)	38195.71	28646.75	19097.86

[1]See Form 1.
[2]See Table 2 , Appendix I.

Form 4

Calculation of Annual Revenue from Water Sales

Rate A

1. 200 res. users x 12.00 / 4000 gallons x 1 units x 12 months = 28800
2. 10 comm. users x 12.00 / 4000 gallons x 1 units x 12 months = 1440
3. 200 res. users x 2.00 / 1000 gallons x 2.9 units x 12 months = 13920
4. 10 comm. users x 2.00 / 1000 gallons x 6 units x 12 months = 1440
5. 10 comm. users x .75 / 1000 gallons x 7 units x 12 months = 630

Total A = 46230

Rate B

1. 200 res. users x 10.00 / 4000 gallons x 1 units x 12 months = 24000
2. 10 comm. users x 10.00 / 4000 gallons x 1 units x 12 months = 1200
3. 200 res. users x 1.50 / 1000 gallons x 2.9 units x 12 months = 10440
4. 10 comm. users x 1.50 / 1000 gallons x 6 units x 12 months = 1080
5. 10 res. users x .75 / 1000 gallons x 7 units x 12 months = 630

Total B = 37350

Rate C

1.	200	res. users	x	(0.00	/ 3000	gallons x	1	units x	12	months =	24000
2.	10	comm. users	x	10.00	/ 3000	gallons x	1	units x	12	months =	1200
3.	200	res. users	x	2.00	/ 1000	gallons x	2	units x	12	months =	9600
4.	10	comm. users	x	2.00	/ 1000	gallons x	2	units x	12	months =	480
5.	200	res. users	x	1.50	/ 1000	gallons x	1.9	units x	12	months =	6840
6.	10	comm. users	x	1.50	/ 1000	gallons x	5	units x	12	months =	900
7.	10	comm. users	x	.75	/ 1000	gallons x	7	units x	12	months =	630
Total										C =	43650

Rate D

1.	200	res. users	x	9.00	/ 2000	gallons x	1	units x	12	months =	21600
2.	10	comm. users	x	9.00	/ 2000	gallons x	1	units x	12	months =	1080
3.	200	res. users	x	1.75	/ 1000	gallons x	4.9	units x	12	months =	20580
4.	10	comm. users	x	1.75	/ 1000	gallons x	5	units x	12	months =	1050
5.	10	comm. users	x	1.50	/ 1000	gallons x	3	units x	12	months =	540
6.	10	comm. users	x	1.00	/ 1000	gallons x	7	units x	12	months =	840
Total										D =	45690

Form 5

Annual Profit/Loss Statement for Rural Water Districts

	Alternative 1 0 % Grant 100 % Loan Rate Schedule C	Alternative 2 25 % Grant 75 % Loan Rate Schedule A	Alternative 3 50 % Grant 50 % Loan Rate Schedule B
A. Annual Revenue (Form 4)	43650.00	46230.00	37350.00
B. Annual Loan Payment (Form 3)	38195.71	28646.75	19097.86
C. Annual Operating Cost (Form 2)	15893.58	15893.58	15893.58
D. Total Annual Costs (B+C)	54089.29	44540.33	34991.44
E. Profit/Loss (A–D)	– 10439.29	+ 1689.67	+ 2358.56

Federal and State Regulations Concerning Rural Water Systems

In 1972, Congress enacted the Safe Drinking Water Act to help ensure that quality water was supplied by all public water systems.[6] The Oklahoma Legislature was the first state legislature to empower its State Health Department to enforce the Safe Drinking Water Act. In all cases, Oklahoma regulations[7] equal or surpass the federal regulations in terms of stringency and thoroughness. Any questions not answered in publications of the Oklahoma State Department of Health (OSDH) are covered in the American Water Works Association guidelines.

Title II, Oklahoma Statutes 1961, sections 298 and 299 delineates the authority of cities and towns to protect their water supplies. This empowers citizens to form water districts as legal entities and requires them to publish all proceedings of their business meetings. However, all rights for use of surface or groundwater must be granted by the Oklahoma Water Resources Board *unless* the water is to be obtained from a Corps of Engineers water retention structure.

In general, all extensions of water systems or maintenance which may incorporate changes in size, location, storage, distribution or treatment must be submitted to the OSDH for approval. All final plans *must* be done by an engineer. Some engineering assistance is available from OSDH and the State Farmers Home Administration staff.

Oklahoma State Department of Health Engineering Bulletin 0589 sets forth strict guidelines as to the construction standards for public water systems. Plan documents for any water works must be submitted to the State Commissioner of Health in Oklahoma City. Detailed guidelines exist for all facets of the supply and treatment for both surface and groundwater. The following are areas covered with regards to surface water: (1) source, quality and reliable yield of water, (2) water demand projections, (3) sanitation of reservoirs, (4) water intake sites, pumps and pumping stations, (5) valves, water control devices and meters, (6) capacity and equipment specifications of treatment plants and (7) mineral, biological and turbidity standards for water as well as requirements for aeration, filtration and chemical treatment. Similar guidelines exist concerning groundwater utilization as follows: (1) sources of industrial, agricultural and domestic pollution, (2) minimum depth of wells, (3) dependable yield, (4) disinfection of wells, (5) water treatment specifications, (6) well casing and pipe specifications and (7) venting and plumbness of well shafts.

Distribution guidelines are also made available through OSDH Bulletin 0589. They cover the following: (1) size of water mains, (2) valve capacity and locations, (3) desired water pressures, (4) disinfection of water mains, (5) storage facility location and design recommendations, (6) deadend mains flushing requirements and (7) safety specifications for all facilities.

The OSDH, as authorized by Title 63, Oklahoma Statutes 1971, Section 1-904, is designated to regulate water quality. Control checks on chemical, radiological, physical and bacterial levels of the water should and may be made by the operator of the system. These checks can be sent to the OSDH for laboratory analysis by the technicians there. All checks will be made there except for turbidity, which should be made by

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[6]A system is considered public if it has 10 service connections and/or 25 full-time customers for 60 days per year.

[7]Statutes delineating the duties of the OSDH protecting public health in public water supplies are Sections 904, 90, and 907, Article 9, Senate Bill No. 26, 29th, State Legislature of Oklahoma. These sections in general, deal with standards for health checks of water supplies, filing and approval of water works plans with the State Commissioner of Health, and investigation and appeals of water quality.

the operator of the system. Chemical and radiological tests are picked up by the OSDH whereas bacteriological tests must be mailed to their office in Oklahoma City. Systems which purchase water from others must keep a monthly record of the operation and maintenance of the system in addition to all laboratory tests. (The vendor of the water is responsible for the testing). Further details on safe water drinking standards are available from the Water Quality Service of the Oklahoma State Department of Health.

Assistance in preliminary engineering design and loan application is available through the OSDH at no cost. Agencies dealing with water quality and rural water districts in particular include:

Oklahoma State Department of Health
Water Quality Services
N.E. 12 and Stonewall
Oklahoma City, OK 73152

Oklahoma Water Resources Board
Jim Thorpe Building
Oklahoma City, OK 73152

State Commissioner of Health
3400 North Eastern
Oklahoma City, OK 73111

Farmers Home Administrations
Community Services
USDA Building
Stillwater, OK 74074

Oklahoma Rural Water Association
P.O. Box 1604
Duncan, OK 73533

Certain publications are available from these agencies and may be obtained to aid in planning systems from engineering, health and legal standpoints. Assistance is also available from OSU Cooperative Extension personnel for conducting feasibility studies and from sub-state planning district personnel in gathering and processing information directed toward obtaining grants and loans.

Summary

This handbook can be used by rural leaders as they evaluate alternative financial considerations to decide what course to take in developing or expanding a rural water system. Initial design approximations can be made, which will enable the leaders to make budgetary and rate structure decisions regarding their district. Capital and operating budgets repayment options, rates for water sale, annual revenue and net profit/loss forms presented herein facilitate an orderly progression through the decisionmaking process.

A major concern of rural decisionmakers is the problem of rural water systems which are adequately designed at the time of construction but become undersized with area population growth. One solution to this problem is to overdesign the system's capacity at construction to allow for additional users. This decision carries with it both advantages and disadvantages. Overdesign will allow for increased water delivery as population density within the service area increases. It can also facilitate service expansion to fringe areas not in the original service area and it can allow for increased per capita water use. However, over design will result in larger initial capital costs for system construction which means that current users will have to pay for benefit to future users. The analysis procedures presented in this handbook can be used for comparative analyses of alternative systems designed to satisfy differing levels of local water need over time.

It should again be emphasized that this is only a guide for preliminary evaluation of potential water systems. If it is determined, after going through the procedure presented in the handbook, that a system may be feasible, an engineering firm should be brought in to design the system. Farmers Home Administration and Oklahoma State Department of Health personnel are also available for assistance in system formation and design.

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Appendix I

Table 1. Indices used to adjust construction and operating costs to reflect price changes.

Period	Construction Cost Index with 1972 = 100	Consumer Price Index with 1972 = 100
1972	100.0	100.0
1973	108.4	106.2
1974	126.1	118.0
1975	138.2	128.6
1976	143.5	136.1
1977	156.6	144.8
1978	173.0[1]	156.0

[1]Estimate based on January-June composite costs.

Source: Construction cost index compiled from (U.S. Dept. of Com. composite cost index, Construction Review, Domestic and International Business Administration, Bur. of Domestic Commerce, U.S. Dept. Com., Washington, D.C.). Consumer price index compiled from Consumer Price Index, Bur. of Labor Statistics, U.S. Dept. Labor, Washington, D.C.

Table 2. Ammortization factors for various repayment periods and interest rates for the calculation of annual loan payment.

Rate of Interest (Percent)	Years for Repayment				
	20	25	30	35	40
5	.0802	.0710	.0651	.0611	.0583
6	.0872	.0782	.0726	.0690	.0665
7	.0944	.0858	.0806	.0772	.0750
8	.1019	.0937	.0888	.0858	.0839
9	.1095	.1018	.0973	.0946	.0930
9.5	.1135	.1060	.1017	.0991	.0976
10	.1175	.1102	.1061	.1037	.1023
10.5	.1215	.1144	.1105	.1083	.1070
11	.1256	.1187	.1150	.1129	.1117

Form 1

Sample Capital Costs Budget for Rural Water Systems Construction

Type of System _____ Residential Users _____

Commercial Users _____

A. Lines (Materials, Placement & Labor):

	Pipe Description				
	Type & Strength	Size	No. Feet	Cost/Unit	Total Cost
1.	_____	_____	_____	X _____	= _____
2.	_____	_____	_____	X _____	= _____
3.	_____	_____	_____	X _____	= _____
4.	_____	_____	_____	X _____	= _____
5.	_____	_____	_____	X _____	= _____
6.	_____	_____	_____	X _____	= _____
7.	_____	_____	_____	X _____	= _____
8.	_____	_____	_____	X _____	= _____
9.	_____	_____	_____	X _____	= _____
10.	_____	_____	_____	X _____	= _____

Sub Total A = _____

B. Crossings (Materials, Placement & Labor):

		Number	Cost/Unit	Total Cost
1.	Highway (Paved)	_____	X _____	= _____
2.	County Road (Unpaved)	_____	X _____	= _____
3.	Railroad	_____	X _____	= _____
4.	Stream	_____	X _____	= _____
5.	Turnpike	_____	X _____	= _____
6.	_____	_____	X _____	= _____

Sub Total B = _____

C. Storage Facilities (Complete Operational):

	Capacity	Number	Cost/Unit	Total Cost
1.	_____ gallons	_____	X _____	= _____
2.	_____ gallons	_____	X _____	= _____
3.	_____ gallons	_____	X _____	= _____
4.	_____ gallons	_____	X _____	= _____

Sub Total C = _____

D. Valves & Meters (Material, Placement & Labor):

	Description Type	Size	Number	Cost/Unit	Total Cost
1.	Altitude Valves	_____	_____	X _____	= _____
2.	Gate Valves	_____	_____	X _____	= _____
3.	Gate Valves	_____	_____	X _____	= _____
4.	Gate Valves	_____	_____	X _____	= _____
5.	Gate Valves	_____	_____	X _____	= _____
6.	Pressure Valves	_____	_____	X _____	= _____
7.	Pressure Valves	_____	_____	X _____	= _____
8.	Blow Off Valves	_____	_____	X _____	= _____
9.	Master Meters	_____	_____	X _____	= _____
10.	Service Meters	_____	_____	X _____	= _____
11.	_____	_____	_____	X _____	= _____
12.	_____	_____	_____	X _____	= _____
13.	_____	_____	_____	X _____	= _____
14.	_____	_____	_____	X _____	= _____
15.	_____	_____	_____	X _____	= _____

Sub Total D = _____

E. Pumping & Well Facilities (Materials, Placement & Labor):

	Description Type	Size	Number		Cost/Unit		Total Cost
1.	Pump, complete	_____	_____	X	_____	=	_____
2.	Pump, complete	_____	_____	X	_____	=	_____
3.	Pumping Station	_____	_____	X	_____	=	_____
4.	Well	_____	_____	X	_____	=	_____
5.	_____	_____	_____	X	_____	=	_____
6.	_____	_____	_____	X	_____	=	_____
	Sub Total				E =		_____

F. Other Construction Costs:

	Description Type	Size	Number		Cost/Unit		Total Cost
1.	Miscellaneous Labor	_____	_____	X	_____	=	_____
2.	Miscellaneous Equip.	_____	_____	X	_____	=	_____
3.	Rural Fire Hydrants	_____	_____	X	_____	=	_____
4.	_____	_____	_____	X	_____	=	_____
5.	_____	_____	_____	X	_____	=	_____
6.	_____	_____	_____	X	_____	=	_____
7.	_____	_____	_____	X	_____	=	_____
8.	_____	_____	_____	X	_____	=	_____
9.	_____	_____	_____	X	_____	=	_____
10.	_____	_____	_____	X	_____	=	_____
	Sub Total				F =		_____

Total Construction Costs (A + B + C + D + E + F) _____

G. Legal (3% Construction Cost) G = _____

H. Engineering (7% Construction Cost) H = _____

I. Interest During Construction (2½% Construction Cost) I = _____

J. Inspection (2% Construction Cost) J = _____

K. Contingencies (5% Construction Cost) K = _____

Total Project Costs
(Add items A through K) _____

$$\text{Total Project Costs} \times \frac{\text{Current Construction Cost Index}^1}{\text{1977 Construction Cost Index}} = \text{Total Project Cost in Current Dollars}$$

_____ X _____ = _____

[1]See Table 1, Appendix I.

Form 2

Sample Operating Costs Budgets

Type of System _____ Residential Users _____

Commercial Users _____

	Cost/User		Total No. Users		
Wages	_____	X	_____	=	_____
Utilities	_____	X	_____	=	_____
Office	_____	X	_____	=	_____
Insurance & Bonds	_____	X	_____	=	_____
Taxes	_____	X	_____	=	_____
Professionals Fees	_____	X	_____	=	_____
Repairs	_____	X	_____	=	_____
Water Purchases	_____	X	_____	=	_____
Miscellaneous	_____	X	_____	=	_____
Total					_____

$$\text{Total Operating Costs} \times \frac{\text{Current Consumer Price Index}^1}{\text{1978 Consumer Price Index}} = \text{Total Operating Cost in Curre Dollars}$$

_____ X _____ = _____

_____

[1]See Table 1 , Appendix I.

Form 3

Repayment Schedule for FmHA Loan for Expansion or Establishment of a Rural Water System

Type of System _____ Residential Users _____

Commercial Users _____

	Case I _____% Grant _____% Loan	Case II _____% Grant _____% Loan	Case III _____% Grant _____% Loan
A. Total Project Cost (Current dollars)[1]			
B. Initial Service Charge			
1. Residential $_____/meter x _____users			
2. Commercial $_____/meter x _____user			
C. Total Funds Needed (A-B1-B2)			
D. Grant Funds Received			
E. Amount of Loan Required (C-D)			
F. Ammortization Factor[2] (For Appropriate interest rate and payback period for loan)			
G. ANNUAL PAYMENT (E x F)			

[1]See Form 1.
[2]See Table 2 , Appendix I.

Form 4

Calculation of Annual Revenue from Water Sales

Rate A

1. _____ res. users x _____ / _____ gallons x _____ units x _____ months = _____
2. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____
3. _____ res. users x _____ / _____ gallons x _____ units x _____ months = _____
4. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____
5. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____

Total A = _____

Rate B

1. _____ res. users x _____ / _____ gallons x _____ units x _____ months = _____
2. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____
3. _____ res. users x _____ / _____ gallons x _____ units x _____ months = _____
4. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____
5. _____ res. users x _____ / _____ gallons x _____ units x _____ months = _____

Total B = _____

Rate C

1. _____ res. users x _____ / _____ gallons x _____ units x _____ months = _____
2. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____
3. _____ res. users x _____ / _____ gallons x _____ units x _____ months = _____
4. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____
5. _____ res. users x _____ / _____ gallons x _____ units x _____ months = _____
6. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____
7. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____

Total C = _____

Rate D

1. _____ res. users x _____ / _____ gallons x _____ units x _____ months = _____
2. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____
3. _____ res. users x _____ / _____ gallons x _____ units x _____ months = _____
4. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____
5. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____
6. _____ comm. users x _____ / _____ gallons x _____ units x _____ months = _____

Total D = _____

Form 5

Annual Profit/Loss Statement for Rural Water Districts

	Alternative 1 % Grant % Loan Rate Schedule _____	Alternative 2 % Grant % Loan Rate Schedule _____	Alternative 3 _____% Grant _____% Loan Rate Schedule _____
A. Annual Revenue (Form 4)			
B. Annual Loan Payment (Form 3)			
C. Annual Operating Cost (Form 2)			
D. Total Annual Costs (B+C)			
E. Profit/Loss (A−D)			

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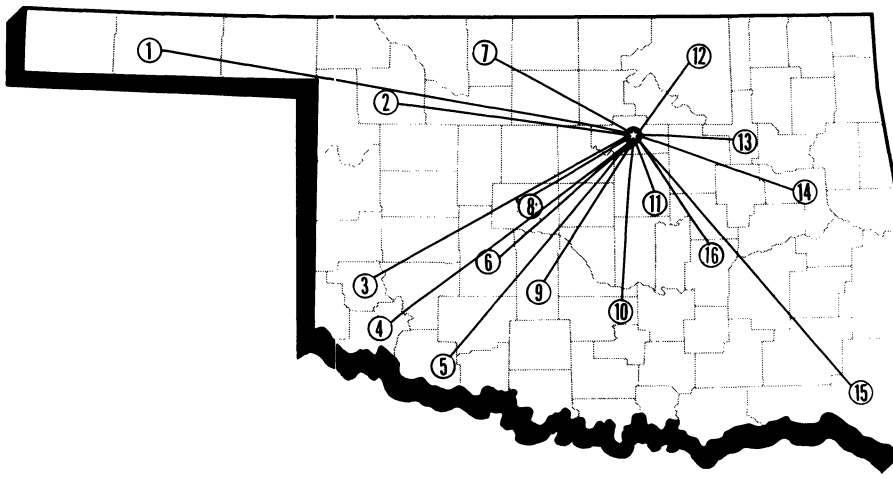

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