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FIRE PROTECTION SERVICES FOR RURAL TENNESSEE COMMUNITIES: A BENEFIT-COST ANALYSIS

A Dissertation

Presented for the

Doctor of Philosophy

Degree

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T. Morris Jones

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ABSTRACT

Little attention has been given to the provision of fire services in most rural Tennessee areas, where these services are virtually nonexistence or severely inadequate. Recognizing this problem of inadequate fire protection services in the rural areas, this study was undertaken with the following objectives: (1) to review the fire protection services available in the rural areas of Tennessee; (2) to obtain information on the need for fire protection services for rural residents and for businesses and institutions in rural areas; and (3) to develop fire protection service alternatives for rural areas which would provide for different levels of fire protection.

Several agencies which have fire prevention and protection responsibilities within the state government were investigated to determine the impact or potential impact they could have on the delivery of rural fire prevention and protection services. The fire services offered by the municipalities of Putnam and White counties, which were selected for specific study, were reviewed. The two principal functions of the Insurance Services Office--the grading of municipalities on their fire defenses and the establishing of fire insurance rates--were reviewed. The legal framework for providing county-wide fire prevention and protection services was also examined.

Data for accomplishing objectives two and three were collected by means of two rural surveys and numerous interviews with officials and persons associated with fire protection services. No fire insurance coverage or the lack of fire insurance coverage and the estimated fire

losses for rural structures and contents were used to reflect the need for fire protection services. The results indicated that many rural property owners in Putnam and White counties do not have adequate fire insurance coverage or have no fire insurance coverage. Data on adjusted fire insurance premiums together with state-wide fire loss ratios were used to estimate annual fire losses for the two counties. The results indicated that almost 50 percent of the estimated fire losses were not covered by fire insurance.

To provide for different levels of fire protection, three alternatives (the minimum service alternative, the insurance reduction alternative, and the full service alternative) were analyzed. Six options were considered under the first two alternatives. The full service alternative was developed with changes in the water system.

A method of estimating fire loss savings was devised which made use of the estimated fire loss data and data collected from fire chiefs. Fire loss savings were estimated for all three alternatives. In addition, fire insurance premium savings were estimated for the insurance reduction alternative and the full service alternative. The initial outlay costs and the annual operating costs were estimated for each of the counties separately and for the counties combined (except for the full service alternative).

Benefit/cost ratios and the present values of the net benefits were calculated for all the options under the various alternatives at a 6 percent discount rate. The benefit/cost ratios were computed in order to determine which option would give the greatest amount of benefits for each dollars of costs and the present values of the net benefits were

computed in order to determine which option would maximize the total net benefits (fire loss and fire insurance premium savings). This was done for each county separately and for both counties combined. Sensitivity analysis was used to determine if the recommended options of the two criteria would change.

A simple location-allocation model was used to locate the fire stations needed as a result of utilizing the benefit-cost criterion. Possible fire station location sites were selected and focal or demand points were established. The site which minimized the total travel distance was considered as the one that should be selected.

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CHAPTER I

PROBLEM STATEMENT AND OBJECTIVES

I. INTRODUCTION

Population increases in the United States in the last few decades have brought about a rapidly increasing demand for public services at all levels of government. Rising consumer incomes and educational levels have also been contributing factors to this increased demand. When funds have permitted, most urban-type services have been provided by municipal governments. Some urban-type services are now being increasingly extended to rural areas.

Providing urban-type services to rural areas has been the concern of a greater number of people in recent years. Part of this concern has been brought about by the pressing nature of urban problems, such as overcrowded housing, traffic congestion, and the lack of recreational, educational, and other type facilities. These urban problems have been aggravated by the massive influx of rural residents into the "heart" of the cities. Recognizing that the problems in the urban areas stem in some measure from the heavy out-migration of the rural populace has led researchers to reconsider the needs and wants of rural people.

The satisfaction people derive from living in rural areas is related to the adequacy of rural institutions. These institutions in turn may be an important determinant of rural peoples' willingness to continue such residency. To meet the needs of rural residents, many essentially urban services such as fire prevention and protection services must be provided.

Many rural areas in the United States are experiencing population increases; yet, these areas have a limited ability to provide urban-type

services. Moving into rural areas or along the fringes of cities and towns has been the pattern chosen by many people. Apparently, these people think the amenities and costs of living in rural areas outweigh the advantages of having urban services and living in an urban environment. Due to population increases, some rural areas can now afford at least some minimum type of fire services. It may also be that rural areas which have a high population density can afford the full range of fire services.

II. THE RURAL FIRE SERVICE PROBLEM

The magnitude of the nation's rural fire problem can best be seen in relation to the overall fire problem in the United States. Fire deaths, for example, in the United States are estimated to be 12,000 lives annually. Additionally, 300,000 American people are injured by fire every year. Annual property losses for the United States are estimated to be $2.7 billion. Other annual fire costs (fire department operations, burn injury treatment, operating cost of insurance companies, and productivity loss) are estimated to be $8.7 billion (71, pp. 1-2). The United States, on a per capita basis, has more deaths and property loss from fire than any of the major industrialized nations. When compared with second-ranking Canada, the United States has twice as much death loss (57.1 versus 29.7 deaths) per million people. In per capita property losses, the United States has a third more than Canada (71, pp. 1-2). The National Commission on Fire Prevention and Control blames much of the fire losses on the forces of ignorance and indifference--both on the part of the American people who view fire as a remote danger until it

appears and on the part of individuals and on organizations who are entrusted with public or private fire protection (71, p. 2). The ironical fact about the American public is that although there are several hundred thousand residential fires every year, the average American citizen gives little thought to the threat of fire. There are also those in the fire services who do not keep abreast of the technological advances in their field or who pay lip service to fire prevention but do little to promote it (71, p. 2).

New technology is available in several fire service areas, but there are economic, political, and psychological barriers which hinder the use of known technology in fire fighting (26, p. 36). Most efforts and programs, however, deal with technological problems, and not the economic, political, and psychological (26, p. 36). There are 25,000 fire departments scattered across the United States which are largely ingrown in nature, thus inhibiting the spread of innovations. Each fire department has its ideas about what equipment it needs and has its own procedures for purchasing supplies and equipment. The desires and needs of the fire departments are so diverse that the techniques of mass production and product-line standardization cannot be achieved (26, pp. 38-39). The rural fire problem in the United States is due in part to the forces of ignorance and indifference, but probably is more fundamentally due to the "hands-off" policy at all levels of government.

The statistics which are available on fire losses point to a need for fire services in rural areas. For example, the fire losses to farm property in the United States jumped from $165 million in 1960 to a preliminary estimate of $242 million in 1970 (42, p. 36). The

differential burden that rural areas may suffer as a result of fires is aptly expressed by the Insurance Information Institute:

> When fire occurs on rural property, damage is three to six times greater on the average than when it occurs on city property. Isolation, lack of fire fighting facilities in many rural areas, less rigid wiring and construction standards, and poorer heating equipment in some instances, have contributed to this situation. Fires and lightning strike about two out of every 100 farms each year (42, p. 36).

Also, insurance costs are about six times greater on unprotected farm property than on protected (113, p. 3).

While the economic losses from a fire may prove to be quite disastrous, fire losses which are not economic in nature may be more substantial. The annual estimated death toll from rural fires in the United States is 1,000 lives (113, p. 3). The rate of fire deaths per 100,000 white Americans in nonmetropolitan areas is 50 percent greater (4.0 versus 2.7) than the rate for whites in metropolitan areas. The disparity in the rate among the nonwhites who live in nonmetropolitan areas versus those who live in metropolitan areas is even greater (15.3 versus 8.1 per 100,000) (71, p. 93). The loss of lives and the injuries sustained as a result of fires represent a needless waste of human resources. The social and psychological losses following fires may be not only traumatic to the individual but may also put an additional burden on certain community services. Rural fire research may bring some savings in terms of lives and property, but may be more rewarding in terms of the social and psychological well-being of people who live and want to live in rural areas.

The Tennessee Rural Fire Service Problem

Fire protection services are virtually nonexistent or severely inadequate in the rural areas of Tennessee. Furthermore, information on economic losses due to fire in rural Tennessee is essentially not available.[1] It is clear, however, that rural areas may suffer a differential burden as a result of fires.

Tennessee is considered to have the lowest level of public fire protection in the rural areas of any state in the Southeast due to lack of approved legislation (state or local) for providing legally created, organized and operated fire department areas under the direct control of the people they serve (99).[2] In fact, Tennessee is the only state that permits a privately owned commercial type fire department to set up operations without being under the control of some type of state authority such as the Public Service Commission (99).[3] The results have been an

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[1] In 1971 estimated fire losses incurred in Tennessee by insurance companies were approximately $67 million (18). A breakdown of losses for the rural areas is not available. The number of fire deaths in Tennessee in 1971 was 196. Again, a breakdown of deaths in rural areas is not available. However, if the ratio of rural fire deaths and rural property losses in Tennessee have a similar pattern as the U. S. ratio, then around 16 people die from fire each year in Tennessee rural areas and approximately $6 million in farm property damage occurs each year in Tennessee due to fires. This does not include farm property which is underinsured or not insured or nonfarm property.

[2] The Tennessee Legislature in 1973, however, approved legislation that would allow counties to set up county-wide fire protection without having to get a private act passed by the Legislature.

[3] Tennessee has the largest city in the United States without a public fire department (East Ridge, Tennessee). This city has a population of approximately 25,000 and a Class 10 fire classification rating.

uneven, inadequate type of fire protection for rural areas.[4] Tennessee is the only Southeastern state that does not have a rural fire insurance classification and standard (99).

A further indication of the lack of fire protection in the rural areas of Tennessee can be found by an examination of Table 1.1. In the table the number of municipalities in Tennessee in the various fire protection classifications are cross-tabulated with population size.[5] Most of the towns classified are in rural areas.

It should be noted that practically all municipalities (96 percent) with less than 500 persons have a fire protection classification of 10. Nearly two-thirds (63 percent) of the municipalities with population

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[4]Private subscriber type fire departments tend to protect only the homes of the subscribers. A case in point is the West Knox County Fire Department which allowed a $45,000 home of a nonsubscriber to be destroyed by fire. It is possible the house could have been partially saved but the fire department only protected the nearby homes of subscribers (61). Another case in Knox County is the Halls Fire Department which allowed a county school to burn several minutes while seeking guaranteed payment for their fire fighting services from county officials (62). Similar incidents have happened in some other areas of the state with private fire departments (99).

[5]Evaluation of systems for delivering fire protection is generally based on standards compiled by the Insurance Services Office (ISO). These standards provide a framework for determining what is needed in each component of the system in order to meet ISO requirements, including the water distribution system; plant, equipment and manpower; fire service communications; and fire safety control. The ISO assigns all cities a fire insurance rating ranging from Class 1 through 10 with Class 1 as the best and Class 10 the poorest. Class 10 is indicative of very limited or no fire fighting capability. (In Tennessee, the Insurance Services Office, with headquarters in Nashville and branch offices in other cities, is responsible for rating most cities on their fire protection facilities. A copy of the agency's report may be obtained from the Insurance Services Office, P. O. Box 127, Nashville, Tennessee 37202. These reports advise cities of deficiencies in their fire protection systems, based on the standard schedule for grading cities and towns of the United States with reference to their fire defenses and physical condition.)

Table 1-1. Number of cities and their fire rating classification by population categories, Tennessee, July 1, 1973

Population category	Fire rating classification[a]										
	1	2	3	4	5	6	7	8	9	10	Total
	Number of cities										
Under 499								2	1	74	77
500-999								24	3	46	73
1,000-2,499				1		2	12	37	3	13	68
2,500-4,999					1	8	17	6	1	7	40
5,000-9,999						10	13	4		2	29
10,000-19,999						13	1		2		16
20,000-39,999				1	7	1	1			1	11
40,000-139,999					1						1
140,000-599,999			3								3
600,000 or more		1									1
Total	0	1	3	2	9	34	44	73	10	143	319

[a]A public fire protection classification of "1" is the best and "10" is the poorest. Class 10 indicates very limited or no fire protection.

Source: Adapted from Insurance Services Office, Classification of Public Fire Protection, Bulletin FP73-17 (Nashville: Insurance Services Office, July 1, 1973) and State Planning Division, Tennessee State Planning Office, Certified Population of Tennessee Incorporated Municipalities (Nashville: State Planning Division, 1972).

ranging between 500 and 1,000 also have a 10 classification rating. Likewise, 19 percent of the towns in the population category 1,000 to 2,500 and 18 percent of the towns in the population category 2,500 to 5,000 have the lowest rating possible.

There are many rural areas of Tennessee that now have water supply systems, but these are generally inadequate for fire fighting purposes. In the Nashville-Davidson County metropolitan area, for example, there are many areas both in the Urban Services District (USD) and in the General Services District (GSD) which have water distribution facilities that are not capable of supporting fire flow requirements. These areas also lack fire hydrants that are appropriately spaced (66, p. 2). The efforts of private fire departments (eight private fire departments and one municipal department)

> generally results in service areas which extend beyond even the most permissive AIA distribution standards. Consequently, many customers residing outside the legitimate service areas of several private fire departments not only receive poor fire protection coverage but also fail to realize even the slightest reduction in fire insurance rates (66, p. 16).

Certain Tennessee municipal fire departments which formerly responded to fires in rural areas no longer do so.[6] In fact, many fire departments are encouraged not to respond to fires outside the city limits without a charter or legislative authorization (70, p. 11) and then only

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[6]The Algood Fire Department responded to fire calls in rural areas prior to December 4, 1973. The Baxter Fire Department also answered calls in rural areas prior to 1973.

if the fire department has additional apparatus and manpower (45,44). Most of the municipal fire departments in Tennessee do not have the extra manpower and equipment necessary to respond to fires in rural areas even if they wanted to. These fire departments would be in danger of losing their fire classification rating if they did respond to fires in rural areas and left their towns unprotected.

The question of tort liability has affected the provision of fire protection services to rural areas by municipalities. Generally, the Tennessee courts have taken the position that municipalities are immune from tort liability when acting in a governmental capacity but not when acting in a proprietary capacity (106, p. 21). "Several city attorneys have ruled that once a city's fire engine leaves the corporate limits, it is no longer acting in a governmental capacity but in a proprietary capacity" (106, p. 21). Some of the municipalities that formerly answered calls outside their incorporated limits no longer do so because of the cost of paying for extra equipment or liability insurance and because of the restrictions placed on them by the Insurance Services Office.

The number of utility districts and private fire departments which offer fire protection in the state is unknown; however, five utility districts and four private fire departments have been rated and approved by the Insurance Services Office (38). Most of these are in the larger metropolitan counties.

III. OBJECTIVES

Throughout most of rural Tennessee, fire protection is provided either haphazardly or not at all. In the past researchers and other

people concerned with fire protection have given very little attention to the provision of fire services in rural Tennessee counties. Recognizing this problem of inadequate fire services in the rural areas, this study was undertaken with the following objectives: (1) to review the fire protection services available in the rural areas of Tennessee; (2) to obtain information on the need for fire protection services for rural residents and for businesses and institutions in rural areas; and (3) to develop fire protection service alternatives for rural areas which would provide for different levels of fire protection.

IV. ANALYTICAL FRAMEWORK

Objectives I and II

To determine the present status of rural fire protection services in Tennessee in general, and more particularly in Putnam and White counties, interviews were conducted with officials of fire departments, municipal and county officials, representatives of state and federal agencies concerned with fire protection services, insurance company representatives, and selected rural leaders. Data on fire department facilities, personnel, water supply system, fire service communications, and fire prevention activities were collected specifically in Putnam and White counties. For an inventory of the fire department facilities, information was obtained on the buildings, their location, equipment, and supplies. Detailed information was obtained on the personnel and the organizational arrangements of the various fire departments within the two counties.

Information on the fire services offered at the county level by various state agencies and departments was also collected. Such state

agencies as the Division of Fire Prevention of the Department of Insurance, Division of Forestry of the Department of Conservation, Division of Civil Defense within the Military Department of Tennessee, and the Division of Vocational Education within the State Department of Education were discussed.

To determine the need for fire protection services for rural residents, 172 household heads and/or their spouses living in Putnam and White counties were interviewed in 1973 on the extent of insurance coverage for fire losses on their house and its contents and on their farm buildings and farm personal property.[7]

The sample of rural residents was randomly selected by area sampling from the 1970 Census of Population of Putnam and White counties after excluding all incorporated municipalities. The sample was drawn in proportion to the number of housing units in each enumeration district relative to the number of housing units in each county. A 1 percent sample was sufficient to obtain reliability and representativeness of the estimates generated from the sample data.[8] The total sample size was

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[7]Since many of the household heads and/or their spouses could not tell the enumerators what their insurance coverage was, the individual insurance agents were contacted with the homeowner's permission.

[8]Applying the sampling rate to each of the enumeration districts in each county, the sample size was determined for each enumeration district. On a clear sheet of plastic, four bisecting lines were drawn and numbered in a clockwise fashion with the line pointing north representing Line 1. Using a table of random numbers, one primary line and two alternatives were selected for each enumeration district. The plastic sheet was overlaid on county highway maps in such a way that the center point formed from the bisecting lines was over the approximate center of the enumeration district. The area or land segment to the right of the primary line formed the sampling area for each enumeration district. Only identifiable landmarks such as intersections, buildings, streams, and bridges were used to determine the boundaries of the segment.

For each segment (sampling area) an enlarged map was drawn and

185 with 108 interview schedules obtained in Putnam County and 77 in White County. The survey work was done during the summer and fall months of 1973.

To determine the insurance coverage against fire losses for rural businesses, 91 owners or managers of such establishments in Putnam and White counties were interviewed the same year. Likewise, the management of 25 public institutions serving the rural residents supplied information on insurance protection against fire losses.[9] Data were also obtained on current market values or on replacement values of items insured, whichever was appropriate, and on other relevant characteristics relating to fire protection coverage.[10]

A list of businesses and institutions for sampling purposes was obtained by driving on the principal roads within the two counties and

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was used by the enumerator in the field for sampling purposes. The enumerator drove around the segment and plotted the houses that were not on the map. The houses were then numbered beginning at the northernmost part in a clockwise direction. The sampling interval for each enumeration district was determined by dividing the number of houses in each segment by the sample size needed in each enumeration district. If there were no way in which the sample size could be obtained in the primary segment, the first alternate segment was used. Using a table of random numbers, a starting point, or house, was selected. Alternate starting houses were also picked for each segment and were used in the case of refusals, unoccupied houses, rentals, or after one callback was made.

[9]Many of the owners or managers could not give information on insurance coverage; therefore, with the approval of the owners or managers, the individual insurance agents were interviewed.

[10]Current market values were obtained on the value of the house, the contents of the house, farm buildings, and on farm personal property from the rural residents. For rural businesses and institutions, current market values were obtained only on the contents of the buildings. For the buildings housing the businesses and institutions, the replacement value was obtained from the respondents.

making a list of the businesses and institutions located on each road.[11] The names of some businesses, which were plotted on the county highway maps and were located on the minor roads within the county, were also obtained. Most of these businesses were of the general merchandise and grocery type. Churches which were located off the principal roads were counted from the highway maps and were included in the list of churches on the principal roads for sampling.

After obtaining a list of the businesses and institutions, they were classified by using the Abstract Schedule (105). The exceptions to this were auto sales and motels and tourist courts. The result was that the businesses were divided into eight categories and the institutions were divided into three categories. Since it was expected to be exceedingly difficult to obtain the appropriate data on some of the businesses and institutions, especially the churches, the total sample size was kept within reasonable limits but was made large enough to secure an adequate representation of the various types. A sampling rate[12] was

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[11]Other means of securing a list of businesses were examined. The Deputy County Court Clerk of Putnam County was contacted about securing a list of businesses from the business tax records. However, the list of businesses included both those in the county and in the city and it was impossible to tell where they were located. Also, the business name that appeared on the record often was not the same name that was used on the building housing the business. The county tax assessor's records were also examined to determine if a list of businesses could be made from them. Since the tax assessor's records listed the business owner's name(s) and not the name of the business, it was impossible in most cases to tell what kind of business it was. Therefore, neither of these two record systems could be used to make a list for sampling purposes.

[12]If the number of businesses and institutions in a particular class were equal to or more than 100, then a sampling rate of 10 percent

determined and then applied to the first seven business categories and two of the institutional categories. A sampling rate was not applied to the last (eighth) business category or to one of the institutional categories (the schools). For the last (eighth) business category all the owners or managers of the businesses were contacted. This category included all businesses which could not be included in the categories listed (first seven).[13] All the schedules for the schools were obtained because the information was available from the county officials or from the insurance agents.

Objective III

Information gained from a literature review and from public and private agencies was utilized to construct fire protection alternatives for Putnam and White counties. The general procedure used was the economic-engineering approach. Three alternative fire services were constructed from the standards determined from published research and from officials associated with providing fire protection services. Six subalternatives or options were considered under the first two alternatives. An assumption underlying the first two alternatives was that present water and road systems would remain essentially as they are.

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was applied. A sampling rate of 20 percent was applied to those categories with 20 or more sampling units; 30 percent to 10 or more; and 40 percent to five or more. No category had less than five sampling units.

[13] A few businesses were included in this category which were not representative of the first seven classes. These latter businesses generally had replacement values exceeding three times the average value of the type of businesses in the first seven classes.

The third alternative encompassed changes in the water system. The costs and benefits associated with these alternatives were estimated.

Alternative I. This alternative was referred to as the "minimum service alternative."[14] In other words, this alternative was designed so that most rural houses and buildings could be provided limited fire protection. This alternative, if implemented, would serve all areas of the two counties which have a Class 10 public fire protection rating with approximately the same level of fire services. (The incorporated municipalities were excluded.) No attempt was made to improve or to establish a new water system within the confines of this alternative. Various subalternatives or options were also investigated.

The costs and benefits of implementing and operating Alternative I over a given time period were estimated. The benefit estimated for this alternative was a reduction in fire losses.

Alternative I was set up for each county individually and then for the two counties as a whole. Cost or "size" economies were estimated.

Alternative II. The next alternative was called an "insurance reduction alternative" since it was developed in such a way as to achieve the lowest fire protection class consistent with the existing road and water system. This alternative was constructed to meet the minimum standards as required by the ISO. The costs and benefits of implementing and operating this alternative were estimated. Also, the alternative was constructed for each county individually and then for both counties combined so that the costs could be compared.

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[14] Minimum protection was defined in terms of time and the kind of equipment needed to suppress most rural fires.

Alternative III. The last alternative was referred to as a "full service alternative." This alternative was built so that limited areas of the counties, i.e., a utility district or a fire protection district, could achieve a Class 8 fire protection rating.[15] The primary difference between this and the other alternatives was an analysis of the water system. The minimum requirements as set forth by the ISO were met. The costs and benefits associated with this alternative were estimated.

Particular data problems arose with regard to estimation of benefits associated with fire protection. Reduced fire insurance costs and reduced fire losses were considered the primary benefits arising from the establishment of a fire system.[16] Published data were not compiled on a county basis and the information that was available could not be broken down on a rural areas basis. Therefore, the information on benefit data came either from the two surveys completed as part of this study or from individual interviews with numerous officials associated with fire protection.

Fire insurance costs were estimated for the two counties in order to ascertain the reduction in insurance costs that would result from

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[15]The Class 8 fire protection rating was deemed an acceptable goal since three of the four rated communities (Algood, Monterey, and Sparta) in the two counties have this rating. Cookeville has a Class 6 rating and Baxter and Doyle have a Class 10 rating. More communities in Tennessee have a Class 8 rating than any other rating except for Class 10. To get this rating (Class 8) a community has to have an acceptable fire department and water system.

[16]The main fire losses which were considered in this study were real and personal property damages. Data on loss of life were available but were not evaluated due to the lack of a method to estimate reductions in loss of life caused by the use of a particular fire department's resources. Since data on other fire losses, such as injuries and loss of property taxes, were not available, they were not evaluated in this study.

improved or newly established fire services within the two counties. From the survey data the names of insurance agents of the respondents were obtained and then contacted to determine what the approximate reduction in premiums would be for the different fire protection classification ratings.

Estimating expected annual fire loss costs for the rural areas of the two counties proved to be a formidable task since data on the number and kind of fires and the loss per fire were very sparse. Insurance companies having fire losses in Tennessee only report the total fire insurance losses (including liability and extended coverage) to the Department of Insurance. Consequently, no breakdown was available on the number of fires, kind of fires, and loss per fire from the Department of Insurance. The totals were not broken down by counties or by rural versus urban areas.

Contacts with insurance agents within the two counties in anticipation of using their insurance records to project annual fire loss costs also proved to be unsuccessful. The insurance agents that were contacted said that their records were all filed alphabetically but there was no way of finding who had fire losses unless all the records were examined. Then, there would be no way of finding whether the fire losses occurred in rural or urban areas. A random sample could not be taken of those who had fire losses unless some estimate could be made of the total number.

It was decided not to use the survey of rural homeowners and the survey of rural businesses and institutions to estimate expected annual fire losses in terms of the probability of having a fire and the

associated loss from the same fire. Generally, it was felt that information obtained on the number of fires and associated losses would not give meaningful results for the county as a whole. However, data on insurance coverage as reported in the two surveys together with data on expected fire damage obtained from the fire chiefs within Putnam and White counties and from fire chiefs in counties known to have county-wide fire protection services were used to estimate expected annual fire losses.

V. THE STUDY AREA

The research study was conducted in the Upper Cumberland Development District in north central Tennessee. Specifically, data were collected in Putnam and White counties, Tennessee. These two counties lie mainly in two physiographic regions and in the edge of another. The eastern portion of the counties, including the city of Monterey in Putnam County, is located in the Cumberland Plateau Region. The Highland Rim Region encompasses most of the two counties, especially the middle portions. Most of the land in this Region of the two counties is level to undulating while parts are quite rough and hilly. This land area includes the municipalities of Cookeville, Algood, Baxter, Sparta, and Doyle. The western fringe of Putnam County lies on the slopes of the Highland Rim as they descend into the Central Basin (106, pp. 3-4; 118, p. 27).

Putnam County is about 40 miles long as measured either by U. S. Highway 70N or Interstate 40 from east to west and averages approximately 14 miles in width from north to south. Other highways which cross the

county in a north to south direction are state highways 84, 42 and 56. State Highway 135 leads northwest and 136 northeast out of Cookeville.

White County is about 25 miles long as measured by U. S. Highway 70 from east to west and averages approximately 16 miles in width. U. S. Highway 70S leads out of Sparta in the southeastern direction. Other major state highways are 42, 84 and 111. This system of major roads and other connector type roads within the two counties provide good access to most parts of the two counties and will be an important asset in providing fire protection services to the counties.

The population in Putnam County in 1970 was 35,487. Of this total, 14,270 lived in Cookeville, 2,351 in Monterey, 1,808 in Algood, 1,229 in Baxter, and 15,829 lived in the unincorporated portion of the county. According to the Environmental Protection Agency (EPA) population projections presented in the Comprehensive Water and Sewer Plan Update 1973-1993, the county's population is expected to increase to 40,500 by 1980, to 49,900 by 1990 and to 57,200 by the year 2000. The population in White County in 1970 was 16,355 persons. Of this total, 5,665 lived in Sparta, 472 in Doyle, and 10,218 lived in the unincorporated portion of the county. According to the EPA population projections, the county's population is expected to increase to 17,400 in 1980, to 19,900 in 1990 and to 25,200 by the year 2000 (117, pp. 207-213).

The primary reason for doing a study in Putnam and White counties was that the County Judge in Putnam County contacted the Tennessee State Planning Office (TSPO) and asked that a study be done for Putnam County. As a result of this contact, a representative of the TSPO contacted the author and inquired if he would like to take part in the study that one of the TSPO staff members was planning on doing in Putnam County. After

examining the proposed project of the TSPO staff member, a decision was made to use Putnam County in this research. White County was also included since I wanted to examine the possible economies of "size" in providing rural fire protection services.

Other factors were also considered in the selection of the two counties: both have an increasing population, are in the same development district, have similar topography, and are about the same distance from the University of Tennessee. Other criteria such as a high incidence of fire losses were considered but were rejected due to lack of data.

VI. LIMITATIONS OF THE STUDY

An economic-engineering analysis as used in this study was based on the specific alternatives constructed. The results are valid only for the alternatives analyzed. However, the analytical technique incorporates a great deal of flexibility. For example, a county official wishing to set up fire protection services can relate the situation in his county to the situations presented here under the various alternatives. Once appropriate adjustments are made in the level of services his county needs, valid conclusions can follow.

While fire protection is the central focus of this research, it is recognized from the outset that it is a competing public good and should, in the final analysis, be considered as part of the comprehensive planning process of a community. Since the fire department is a resource using organization, county officials are faced with the problem of allocating funds between the fire department and the other public

services. In many rural areas of Tennessee (and in many urban areas), fire protection has not been an important consideration in the total comprehensive planning process. As a result, expenditures are sometimes made on facilities and services without adequate planning for the future. For example, many water systems were installed in rural areas without adequate consideration given to the eventual provision for fire protection services. The water systems installed in many areas are thus generally inadequate for fire protection purposes. This greatly hinders the extension of fire protection services to these areas, especially since the cost of replacing inadequate water mains may double or triple the original costs. Costs such as these can be generally avoided if future needs are comprehensively planned. Land-use regulations can be used to effectively control the installation of water lines and fire hydrants, the proper type roads and bridges, and the spacing and height of various rural structures.

There are other limitations to the study that should be mentioned. The problem of financing fire protection services for rural areas was not examined. Providing ambulance services in conjunction with rural fire protection services was not investigated although the provision of these services may prove to be economically feasible. The feasibility of merging police and fire personnel also was not investigated.

A related area not covered in this analysis is fire prevention services. Fire prevention is one of the four objectives of fire protection, the other three being: to prevent loss of life and property when a fire occurs; to confine a fire to the place where it started; and to suppress the fire. The primary purpose of a fire department's

existence is to prevent loss of life and property. However, this purpose has not been accomplished because many communities have put little emphasis on fire prevention. Fire protection often has greater support in a community in that it requires dramatic and positive action and the results can be immediately seen, whereas the results of fire prevention programs are usually not directly visible.

The National Commission of Fire Prevention and Control recognized the imporatnce of fire prevention in rural areas when it recommended that rural residents and others living some distance from a fire station install early-warning devices and alarms in their homes (71, p. 94). New Hampshire fire officials estimated that rural fire deaths could be cut as much as 75 percent if all rural homes had early-warning detectors (71, p. 93). The National Commission on Fire Prevention and Control also placed heavy emphasis on educational programs and home inspections. The Commission pointed out fire prevention programs which were quite successful in reducing fire deaths, burn injuries, and property losses (71, pp. 105-125).

Fire prevention research may be more important in terms of reducing fire losses in the rural areas of the state than fire protection research. It is not difficult to imagine the impact that one county rural fire inspector may have on reducing fire losses within a county. To justify his salary, a rural fire inspector would only have to be responsible for saving one medium valued house per year.

VIII. USEFULNESS OF THE STUDY

Little research has been done on fire protection services for rural residents in Tennessee. The degree to which persons living in

rural homes need fire protection services is unknown. Information on alternative methods for fighting fires on rural homesteads is inadequate and cost estimates for fire services is lacking. No model currently exists which provides a rational way for deciding whether and/or which fire protection services should be made available to rural areas. This study should indicate the needs of rural people with regard to fire services and provide local government officials with criteria for making meaningful decisions about rural fire services. A knowledge of the alternatives available should enhance the decision-making process regarding the provision of fire services. Research in this area is timely because of the increased interest on the part of local government officials and planning agencies and because of possible funding from revenue sharing or from rural development funds.[17]

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[17] The Economic Development Administration (EDA) of the U. S. Department of Commerce conducted a survey of business firms in 1973 in order to determine the local characteristics which are given major consideration by firms planning for future expansion. Of the firms planning to expand, more firms indicated fire protection as a critical factor in plant expansion than any of the other 22 local attributes. Fire protection was of critical importance to 43 percent of the firms planning to expand and was of critical to significant importance to 93 percent of the firms (16, pp. 34-36).

CHAPTER II

REVIEW OF LITERATURE AND RELATED CONSIDERATIONS

I. INTRODUCTION

Theoretical Concepts

The United States Department of Agriculture (USDA) has been at the forefront in sponsoring research aimed at preventing, controlling and suppressing forest fires. Most of this research has been summarized in a book, Fire: A Summary of Literature in the United States from the Mid-1920's to 1966 (13). None of the references in the book, however, deal specifically with fire research for rural structures such as houses and business and institutional places.

The concepts discussed in this section are (1) minimum total fire cost concept, (2) adequate-control concept, and (3) other pertinent fire research.

Minimum total fire cost concept. A theoretical framework for analyzing rural fire protection problems is provided in A Study of Fire Problems (6) by the National Academy of Sciences. The theoretical approach is described in terms of the "minimum total fire cost" method.[1] In this method, the total cost is broken down into "fire-control cost" and "fire loss."[2] For a given community or area, the optimum level of

[1]This method in forestry literature is known as the least-cost-plus-damage approach. The total fire cost is the sum of prevention, presuppression, suppression, and damage costs.

[2]Fire-control costs include the cost of prevention and suppression of fires and the cost of compliance with laws enacted in the interest of

fire-control expenditures can be determined by equating the last dollar spent on fire control with the last dollar received in benefits (i.e., a reduction in fire losses, a reduction in insurance premiums, etc.) from fire control. When this point is reached, total fire cost is at a minimum and the marginal benefits and the costs of fire control are equal. A hypothetical situation is illustrated in Figure 1-1. If no expenditures are made on fire control, then the total fire cost may be quite high. As expenditures are made on fire control, fire losses are expected to decrease until a point (X) is reached where there is an economic balance between the benefits received and the costs incurred for fire control. Beyond this point, expenditures on fire control will exceed the benefits gained from the reduction in fire losses. Since the benefits from fire-control expenditures should at least equal the costs, the community decision-maker is not economically justified in operating at a point to the right of the minimum total fire cost at X.

Although this approach has a sound economic basis, it has two critical shortcomings: (1) the data on losses are difficult to obtain, and (2) the association between various fire-control costs and fire loss costs are in most cases not known. This is especially true for rural fire losses and for fire-control expenditures which may be made in rural areas to protect rural houses and businesses. A further weakness of this approach is the necessity of using historical data to derive the curves.

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fire control. Fire losses include the personal and real property damage, insurance costs, loss of life, injuries, loss of property taxes, loss of use of facilities, loss of productive capacity, and other costs.

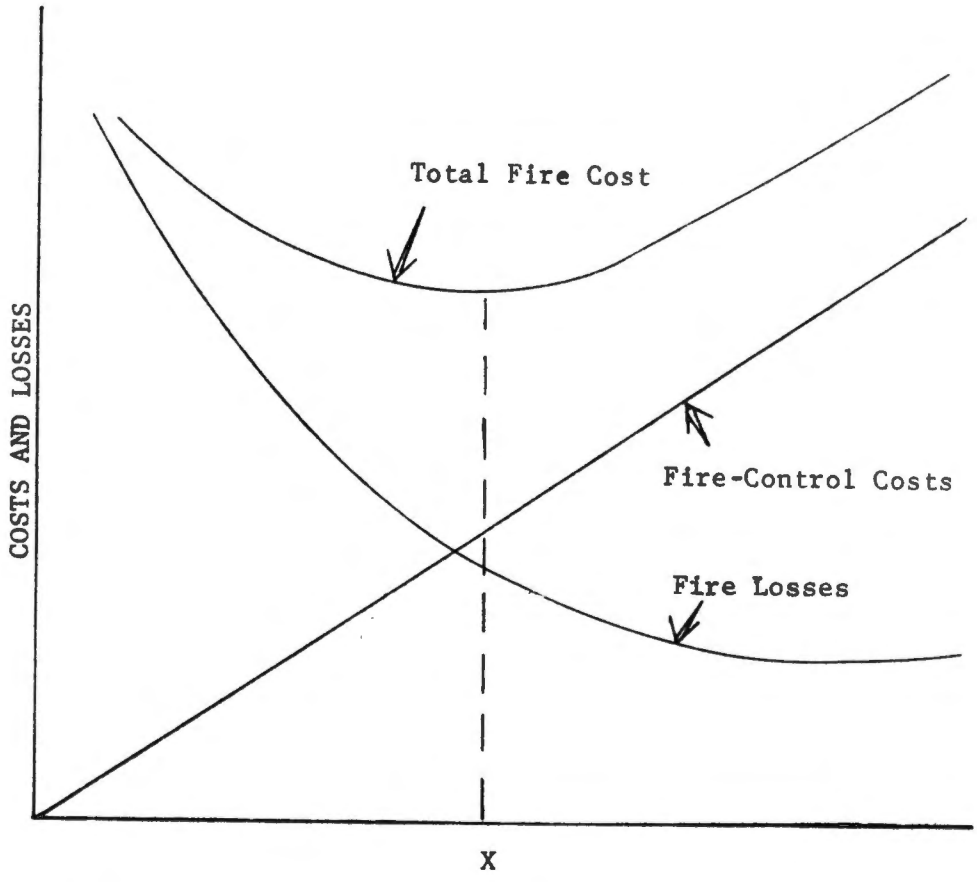

Figure 1-1. Balance between costs and benefits.

Changes may occur in the variables which may lead to inaccurate projections for the future. The approach has, therefore, remained largely a theoretical construct and useful only in understanding fire-control problems.

Adequate-control concept. Most fire-control studies have used the "adequate-control" method in an attempt to find an economic balance between the benefits received and the costs incurred for fire control.

It is an approach which may be used

> to achieve a desired level of fire control "equal or sufficient to the need." This is the precise meaning of adequate, which then becomes the key word. It places the emphasis on integrated planning but provides no formulas or precise guidelines for arriving at "adequate forest fire control." The adequate-control concept was first specifically formulated by Flint (1928), who defined it as "that degree of protection which will render the forest property as safe on the average from destruction by fire as are other forms of destructible property in which moderately conservative investors are willing to place their funds." A natural corollary is a degree of control that makes forest properties insurable at reasonable premiums (9, p. 626).

While the adequate-control concept is not an economic theory, it is, nevertheless, a useful concept and realistic in the sense that it gives "due consideration to time, place, and circumstances" (9, p. 626). The objective of the approach is to balance fire-control expenditures with needs. Defining "needs" makes it a business-social-political concept and in the final analysis it is a subjective approach. This does not mean that it is based on subjective decisions alone. An underlying assumption of adequate control is that professional fire-control men, based on years of experience, will have "developed an appreciation for

all of the values at stake, both monetary and nonmonetary, and will set fire-control goals consistent with that appreciation" (6, p. 27).

Many fire studies have been made in the area of forestry in order to determine a reasonably adequate level of fire-control expenditures. These studies follow a common pattern: "(1) a statistical analysis of control costs, fire occurrence, and area burned, (2) estimates of damage, and (3) an attempt to define some justifiable level of control" (9, p. 627). While neither this method nor the "minimum total fire cost" method is directly applicable to rural fire programs involving rural homes and businesses, a combination of the two approaches may greatly increase the validity of comparisons made in a cost-benefit analysis.

Other pertinent fire research. Other than the forestry studies, there is little research on rural fire protection, especially for rural homes and businesses.[3] The USDA and the National Fire Protection Associ-

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[3]The reason for the extreme disparity between research on forest fire control versus that on fire control for rural homes and businesses is not known. (A parallel to this is the heavy emphasis placed on research concerning living things such as plants and animals rather than on people and families by the public institutions in this country in the past.) One of the apparent reasons may be the relatively high loss which could result from a forest fire as compared with the loss of a house or a business. A more important reason is the lack of data on nonforest fire losses in rural areas. A great deal of time and expenditure is made to collect data on forest fire losses even at the county level. Based on the fire loss data, the forestry officials can then recommend a certain level of fire-control expenditures. No such data collection system is available for rural nonforest properties (and for many urban communities); hence, local, state, and federal officials do not have, and have not had, the necessary data to make meaningful decisions concerning fire protection for rural nonforest properties.

ation (NFPA) have published a few bulletins, leaflets, and pamphlets which were designed to help rural property owners prevent and suppress fires.[4] An NFPA study deals with organization and training, equipment, water supplies, and similar items relating to rural fire departments (77). Another book has been published by the International City Managers' Association for municipalities entitled Municipal Fire Administration (3). These two books would be quite useful to community organizers or county decision-makers who wish to have fire department services provided in their area.

The full extent to which rural areas in the United States have fire protection is unknown; however, there are some states which have taken an active interest in providing fire protection services for rural areas. The Florida Forestry Department, for instance, has been instrumental in getting equipment and in providing liaison for rural fire departments (1). The Cooperative Extension Service of Kansas State University has established a rural fire program in Kansas with the aid of the USDA.[5] An agreement was entered into between Kansas State University and established state rural fire districts. Kansas State University provides guidance and technical assistance to the rural fire districts. Also, they assist the rural fire districts in acquiring

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[4] A few years ago, the United States Department of Agriculture distributed bulletins and other literature on fire prevention and protection to rural residents but this service has been discontinued.

[5] Authorization for a Cooperative Rural Fire Program is provided by the Clarke-McNary Act of 1924 as amended and the Federal Property and Administration Act of 1949 as amended.

excess military equipment and supplies. The excess equipment is converted into fire trucks for fire-control use (7). New York State also has a large number of special fire districts particularly in the rural areas. These fire districts may cross town, village, and county lines but are nonexistent within the cities. The fire district boundaries are usually not coterminous with other units of local government (33, p. 163).

Previous research on fire protection which most closely relates to the present research effort was done by Pickett (82) and Hitzhusen (33). Pickett developed statistical cost functions for 11 Missouri cities. Total fire department expenditures were used as the dependent variable in estimating a total cost function for each community in the sample and a total cost function from cross-sectional data. The statistically significant variables for most of the communities were the number of firemen and the duty hours of firemen. Two other statistically significant variables were the number of occupied housing units and the total sales of business establishments. By using the estimating equations developed, a community is able to estimate its total fire department expenditures and to compare these expenditures with actual expenditures. If the two have a significant divergence, an examination can be undertaken to determine the cause (82, pp. 39-56).

Pickett also presented a theoretical treatment of the trade-off relationship between fire department expenditures and the cost of fire insurance. Pickett did not make an attempt to determine the costs of making the necessary improvements in order to realize a change in the fire protection classification of a municipality. In Pickett's research, however, the framework of benefit-cost analysis as the criterion of

economic efficiency in the provision of fire protection services was developed. A community could produce the optimal quantity of fire department services where marginal benefits equal marginal costs..." (82, pp. 60-72). The idea here is the same as the approach presented in A Study of Fire Problems (6).

One of the most comprehensive studies of fire protection was done by Hitzhusen (33). In this study, Hitzhusen mentioned additional studies which are applicable to the present research. One of these studies was by Hirsch who studied data on 32 St. Louis area fire departments for the years 1952 and 1956 in an attempt "to determine the factors related to per capita total current expenditures plus debt service for fire protection." Hirsch found only limited evidence of economies of scale for a population size up to 100,000 and substantial diseconomies of scale for a larger population size. Hill, in a study of 38 cities ranging in size from 50,000 to one million population, found evidence of major economies of scale up to a population size of 300,000. From that point on, the economies of scale are barely existent. These studies, according to Hitzhusen, had substantial analytical problems due to limitations of secondary data, the failure to control for output quality variations, and failure to include related public and private costs (33, pp. 71-76). Hitzhusen, therefore, sought to fill in some of the research gaps in fire protection. Hitzhusen used five progressively more comprehensive measures of unit costs and two measures of output quantity in order to account for variations between municipalities in unit costs of fire protection. The five measures of costs progressively included the following variables: adjusted 1969 fire department operation costs;

annual capital charge; annual charge for volunteer effort; annual charge for water supply; and private fire insurance costs. An additional definition of private fire insurance costs was also developed. The two measures of output quantity were the total number of people protected and the total value of property protected.

Utilizing an ordinary least squares multiple regression technique to estimate a cost-output model for Texas, Hitzhusen found that a higher percent of the total variation in fire protection costs per unit of property value protected was explained when the more comprehensive measures of unit costs were used. Opposite results were achieved when the fire protection unit costs were based on the population protected. A further finding was the existence of "size" economies in the provision of fire protection but the economies were exhausted at a population protected of around 10,000 people (33, pp. 130-162).

In the latter part of his study, Hitzhusen did a benefit-cost analysis of fire protection for 75 Texas municipalities and for 11 New York villages and six fire districts. Three estimates (high, medium, and low) of the net annual benefits and the benefit/cost ratio were made for each type of improvement. Using the net-benefit criterion for the Texas sample, water supply improvements ranked first among improvements under the high estimates. Utilizing the benefit-cost criterion, improvements in fire department records and reports ranked first under all three estimates followed by structural condition, fire alarm, and attendance at the state training school. For the New York data, Hitzhusen obtained a positive net benefit or a benefit/cost ratio greater than one only for fire prevention and building department improvements (33, pp. 193-221).

Burtner suggested a method of quantitatively evaluating fire protection costs primarily from an engineering instead of an economic analysis standpoint (11, pp. 5-14). He derived cost data for various components of the fire protection system and expressed these costs as a percentage of the total property value at risk. Burtner compared the derived costs with the costs obtained from a sample of private firms and concluded that the cost for installed fire protection systems of about 2 to 2.5 percent of the value of the property protected is considered economically sound. While the conclusions of Burtner's research may not be applicable to municipal or rural fire systems, some of the aspects of the economic-engineering approach that he used were beneficial.

In Tennessee, the Metropolitan Planning Commissions of Nashville and Davidson County and Memphis and Shelby County have prepared fire protection studies for their respective counties (66, 29). The Memphis and Shelby County report is out of print but the one for Nashville and Davidson County is available. Inventory studies have been conducted by the East Tennessee Development District (22, 23). In November, 1972, the Putnam County Judge set up a committee to determine if and what kind of fire protection the county should have. The Committee on County-wide Fire Protection recommended a program in conjunction with the cities whereby the county would provide limited amounts of money and equipment and the cities would provide space and manpower to answer calls in rural areas (12). Several of the things considered in these studies were evaluated and included in the present research.

A recent study prepared by the TSPO dealt with county-wide fire protection in Putnam County but essentially came up with the same recommendation on county-wide fire protection as the previously mentioned

Committee on County-wide Fire Protection. No attempt was made in the study to estimate costs of providing fire services and only a cursory examination was made regarding benefits. However, this report did consider many of the legal problems and planning considerations that a community decision-maker must face in order to provide fire protection services for his community. In addition, several recommendations were made, which if implemented, would greatly improve the fire protection available to the county residents (106).

The Tennessee Valley Authority (TVA) in June, 1973, prepared an operation plan for the Cumberland County Fire Department. The plan included a discussion of the organization and operations of the fire department, fire department apparatus and equipment, and other functions and programs the fire department would need to get involved in (107, pp. 1-21). During the spring of 1974, the first piece of equipment was put into service by the Cumberland County Fire Department (120, p. 22).

While information from the above sources is useful, they provide only a limited amount of information applicable in solving rural fire service problems in Tennessee. There are no data available on the needs of rural homeowners and business and institutional owners with regard to fire services. Information on the alternative methods and costs of preventing and fighting fires on rural homesteads is inadequate. Information on benefits to be derived from various fire protection services is especially lacking.

II. FIRE SERVICES OFFERED BY THE STATE

The Division of Fire Prevention

There are departments within the state government which have responsibilities for fire investigations, forest fire control, training, and civil defense fire emergencies. The Division of Fire Prevention of the Department of Insurance[6] is responsible for fire safety inspections in nursing homes, hospitals, orphanages, schools, and in other types of property or areas of concern that would present hazards to the public. Also, the Division of Fire Prevention investigates suspected arson cases and makes many electrical inspections[7] each year. In 1971, for example, the Division made approximately 9,000 fire safety inspections, closed files on 561 arson investigations, and made nearly 79,000 electrical inspections (18, pp. 2-3).

The Division of Fire Prevention does not regulate fire departments; neither do they keep records of fire losses within the state. An attempt by the Division was made to collect fire loss data from fire departments but since there was no law requiring the fire departments to report fire loss data, the idea received only limited response from the fire departments (57). Where the municipalities have their own inspection systems, the State Fire Marshall does not interfere. Electrical inspections are made only on new wiring; however, if any new wiring is done in a building

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[6]The Commissioner of the Department of Insurance serves as the State Fire Marshall.

[7]The National Fire Code has been adopted by the state as the required minimum standard for all electrical installations within the state (19, pp. 2-3).

with old wiring, certain requirements must be met. Even though old wiring may present hazards in some buildings, the State Fire Marshall has no authority to initiate action against the owners of such buildings (8).[8]

The Division of Forestry

The Division of Forestry in the Tennessee Department of Conservation is responsible for forest fire control on all state owned and privately owned forest lands in the state. (The United States Forest Service and the United States Department of the Interior have responsibility for parts of several counties in the eastern section of Tennessee.) For fire-control purposes, funds are received from state, federal (50 percent), county, and private sources (20, pp. 1-18). All but three counties (Bedford, Lake, and Crockett) in the state cooperate with the Division of Forestry (2).

While the number of acres protected by the Forestry Division has increased from 10.2 million acres in 1960 to 12.5 million acres in 1972, the percent of total protected area burned has been generally less than one-half of 1 percent. The percent of total acreage burned declined from an average of .29 percent for the years 1960-1964 to an average of .17 percent for the years 1968-1972.[9] The number of fires has usually been more than 3,000 per year and the number of acres burned per year has usually been in the 20,000 to 30,000 range (21).

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[8] H. M. Bowling, who is the present Assistant Chief Electrical Inspector of the Division of Fire Prevention in Tennessee, mentioned that some electrical cooperatives within the state are requiring their members to correct hazardous wiring (8).

[9] The percentage decline would only be from .22 to .19 if the high fire year of 1963 and the low fire year of 1972 were removed from the calculations.

The Division of Forestry has over 200 lookout towers in the state used for detecting fires. At approximately 75 of these lookout stations, houses are maintained for the purpose of storing equipment and having communications around the clock. All the towers are manned from 9:00 a.m. until 5:00 p.m. during the main fire season.[10] Also, during this season, checks are made at night, but this depends on the weather conditions. The Division has approximately 500 full-time men and usually hires 700-800 men to work during the spring and fall. It has around 120 mobile fire plow units, a few dozers, over 100 light jeeps, approximately 75 small slip-on pumping units each with a 120 gallon tank, and a number of hand-tools and communication devices (25, 83).

Since debris and trash burning account for 41 percent of all the forest and grass fires and the burn percent is within tolerable limits, the Forestry Division decided to initiate in 1973 a "Contact Program" in 20 pilot counties where the historical fire losses have been the greatest. Some of the Tennessee counties already had this program partially in existence. The objective of the program was to inform the public through personal contact about the need for forest protection and improved forest management practices on private forest lands in Tennessee (2).

Although the Forestry Division has an effective fire-control program for the privately owned forests in the state, it is not organized in such a manner as to render much service to owners of rural houses or other buildings. The lookout towers are manned only during the main fire season from 9:00 a.m. to 5:00 p.m. Even during the main fire season,

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[10]The main fire season varies some but usually runs from October 15 to December 15 and from February 15 to May 15.

the towers are not manned when there is rainy or snowy weather. The full-time men have other duties which preclude their being used for preventing and fighting fires on rural structures. The bulk of the fire fighting force (crew members, most of the lookouts, and most of the crew leaders) is hired only during part of the year. It is, therefore, evident that the Forestry Division would have to change the thrust of its work if it were to protect rural property other than forests from fires.

The Division of Civil Defense

The division of the state government which probably has the greatest potential for helping counties set up county-wide fire departments is the Division of Civil Defense within the Military Department of Tennessee. Originally, civil defense units at the county level were created to deal with major disasters such as flood, tornado, fire, hurricane, blizzard, earthquake, or an enemy attack. After a period of time, the emphasis began to shift also to individual emergencies such as rescue and ambulance services. Approximately three-fourths of the counties have rescue operations set up under the auspices of the civil defense and one-half of the counties have police operations (119).

Surplus and excess equipment[11] have been provided through the

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[11]"Surplus equipment" is equipment that has been declared useless by some agency of the federal government and no other agency of the federal government needs it. Local county civil defense units can get this equipment when available by paying the handling and transportation costs. This equipment is usually stored in Nashville. "Excess equipment" is equipment that has been declared by some agency of the federal government to be in excess of what they need or are authorized. Local county civil defense units, when eligible and when equipment is available,

Civil Defense program to at least 12 counties and the other counties which have civil defense units have received training instruction and materials (79). Most of the equipment has been used for purposes other than fire control. A few of the counties which received equipment have been able to convert the equipment and use it for rural fire protection. The Lebanon-Wilson County Civil Defense, which in 1971 had added rural fire services to its program, for example, obtained a surplus pumper[12] for $50 and mounted a 700 gallon surplus tank on it. By using some of the volunteer men of the county civil defense unit, 60 rural fire calls were answered in the first year (1972). The civil defense and county officials decided they needed another truck, so in 1973 the county bought a 1,200 gallon tanker-pumper from a private fire department which had gone out of business. In January, 1974, this truck was wrecked. The county civil defense office then investigated the possibility of obtaining a truck through the government surplus program and outfitting it with the equipment necessary for a rural fire service program. Due to a number of factors--insurance and maintenance costs higher, slower speed, and unavailability of parts--the responsible officials decided to buy a commercial chassis and outfit it with a locally built 1,350 gallon

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usually have to go out-of-state to get this equipment, but they only pay for the expense of picking it up. While the title to surplus equipment is obtained immediately, the title to the excess equipment is not given to a county until the equipment has been loaned to the county for five years. This equipment is of such nature that even with modifications it cannot be used to obtain lower fire insurance rates (119, 79). The following are some of the types of equipment that can be obtained under these programs: generators, aircraft, trucks for conversion to rescue vehicles or fire trucks and ambulances.

[12]Primary fire fighting units such as this one are very limited and usually expensive to maintain (119).

tank and other necessary equipment.[13] The truck was put in operation during the month of May, 1974. One hundred and sixty-nine fire calls were answered by the civil defense unit in rural areas of Wilson County in 1973 and in the first four months of 1974, 74 fire calls were answered. No charges were made for any of these calls (80).

Another county where the local civil defense organization has been instrumental in obtaining equipment and providing manpower for rural fire protection is Lincoln County. The Fayetteville-Lincoln County Civil Defense received a 500 gallon pumper through the excess property program and was provided a 1,000 gallon tanker by the county. In addition to this, an 800 gallon skid tank was mounted at no cost on a GMC truck, both of which were received through the excess program. At that time, no pumping unit had been installed on the latter truck. The truck will be used to haul extra water when needed (63).

The Tennessee Valley Authority (TVA) started a program of technical assistance to counties interested in rural fire protection during the fall of 1972. The first county in Tennessee that TVA helped was Cumberland County. TVA prepared detailed drawings which indicate how surplus military vehicles can be converted for use as 1,000 gallon tankers. (The cost of conversion was approximately $6,000 each.) TVA converted three vehicles and turned two of them over to the Cumberland

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[13]The local civil defense director indicated that the trucks were not a problem to get, but that the costs of converting the trucks would be approximately $5,000. He further stated that even with matching funds provided by the federal government, it was not economically feasible for their purposes to convert one of these for fire control (80). The availability of parts for these trucks is not a problem for some county civil defense units since it depends on the make of the truck that is obtained.

County Fire Department and kept one for demonstration purposes. The Cumberland County Fire Department in turn built five more vehicles based on the plans TVA provided. Copies of these plans are available to any county or governing body interested in fire protection (120, pp. 22-23).

It appears that the surplus and excess property program can be relied on by some counties wishing to set up a rural fire protection program. As in Cumberland County, it may be possible to secure several trucks and convert them to attack pumpers. As in Lincoln County, it may be possible to secure a truck in good condition, mount a water tank on it and use it for backup purposes. Since these water tanks have been available only recently, no accurate assessment can be made of their usefulness in fighting rural fires.

The area in which the county civil defense units can be used most advantageously is in the provision of manpower for rural fire protection. Some of the men who perform rescue and ambulance services, can also serve as fire fighters.

The Division of Vocational Education

The Division of Vocational Education within the State Department of Education is responsible for directing the Tennessee State Fire Service Training Center in Murfreesboro. The Training Center offers a continuing education program with classes and training in fire control and prevention, inspection, and pumper operation. In addition, there is an "itinerant" program which provides training for firemen in the various communities (70). Although this free program has been used primarily by municipalities in the past, county officials who set up rural fire programs can take advantage of this program.

III. MUNICIPAL GRADING AND THE FIRE INSURANCE RATING SYSTEM

Municipal Grading

During the first decade of this century, the capital stock fire insurance companies became concerned with the recurrence of major fires in American cities. Believing that the conditions which are conducive to large disastrous fires can be recognized and corrected, the National Board of Fire Underwriters (NBFU), which was the service organization of that group, made a detailed study of fire hazards and fire protection in many of the large U. S. cities. Since the study revealed that factors responsible for major fires could be identified and corrected, the Engineering Department of the NBFU was created (110, p. 4).

The Engineering Department of the NBFU developed a set of standards which would provide an equitable basis for appraising cities from the standpoint of their fire protection facilities and fire loss possibilities. This led to the development of the "Standard Schedule for Grading Cities and Towns with Reference to Their Fire Defenses and Physical Conditions" in 1916. Five new editions of the Standard Schedule have been issued since that time. The present schedule is called the "Grading Schedule for Municipal Fire Protection." These standards were arrived at by the application of engineering principles and a study of performance records and pertinent conditions over an extended period of time (110, 46). In time, a set of numerical classifications was constructed to indicate the degrees of fire protection.

At first the insurance companies used the Grading Schedule as a means of evaluating the risk of insuring a given property. However, some years later the fire insurance rating bureaus used the classification

resulting from the application of the Grading Schedule as a measure of fire protection and hence as one of the factors considered in making fire insurance rates. In theory the numerical classification allowed a city with better public fire protection to have lower fire insurance rates (33, p. 101).

The American Insurance Association (formerly the National Board of Fire Underwriters) determines the strength of the fire defenses of all cities over 25,000 in population (3 , pp. 16-17). In Tennessee, the Insurance Services Office (ISO)[14] surveys communities[15] whose population is less than 25,000. In both instances the Grading Schedule is used to measure the relative value of a community's fire defenses. The primary responsibility of the ISO is "to establish fire insurance and related rates that are fair, reasonable, and adequate for the safety of the insurer" (25, p. 1). These rates should not "unfairly discriminate between risks in the state involving essentially the same hazards or between risks in the application of like charges and credits" (25, p. 1). In order to establish rates which are reasonable, adequate, and not unfairly discriminatory, the ISO must find a beginning point or base by establishing the fire protection class of a community. This is done by

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[14]The Insurance Services Office (ISO), which has its main office in Nashville, is a private, nonprofit organization maintained at the state level and is supported on a subscription basis by most of the fire insurance companies doing business within the state. The ISO is subject to regulation by the Tennessee Department of Insurance. In addition to grading communities on their fire defenses, a principal function of the ISO is to establish fire insurance rates under the regulation of state laws.

[15]In this context a community will refer to any city, town, county, utility district, or community which may at some time be graded by the ISO.

applying the Grading Schedule to the fire defenses and physical conditions of a community.

The Grading Schedule has four broad categories used for grading and rate-making purposes. These categories include water supply, fire department, fire service communications, and fire safety control. Standards have been established for each of these broad classes and any deviation from these standards will result in a certain number of deficiency points depending on the importance of the subitems and the degree of deviation. The maximum allowable deficiency points for each class and the relative importance of each class can be seen by an examination of Table 2-1.

Table 2-1. The Insurance Services Office grading features by relative values and maximum deficiency points

Feature	Percent	Points
Water supply	39	1,950
Fire department	39	1,950
Fire service communications	9	450
Fire safety control	13	650
Total	100	5,000

Source: Insurance Services Office, Grading Schedule for Municipal Fire Protection (New York: Insurance Services Office, Municipal Survey Service, 1973), p. 2.

It can also be seen from the table that the fire department (includes manpower, apparatus, and fire fighting equipment) and the water supply account for 78 percent of the total points in the grading system. Fire service communications and fire safety control account for the rest of

the deficiency points. In addition to this, certain deficiency points can be assigned for adverse climatic conditions such as high winds, tornadoes, or excess snowfall, and for adverse conditions or occurrences such as forest fires, civil disturbances, landslides, or floods. Further deficiencies can be assigned for an excessive divergence between the water supply and the fire department. A town could conceivably have an excellent water supply, yet have a fire department which could not effectively utilize the water facilities available. Therefore, additional deficiency points will be given to this town.

There are 14, 17, 10 and 8 items considered under the water supply, the fire department, fire communications, and fire safety control, respectively. (See Table B-1 in Appendix B.) Each of the 14 items under water supply is investigated separately and compared to an accepted standard. If the item fails to meet the established standard, a deficiency is noted in percentage terms. The percent is then translated into a corresponding number of deficiency points against the particular item. The total deficiency points allowed for the water supply is 1,950, with each of the 14 items allotted a relative weight in terms of deficiency points. A very detailed examination is made for each broad class and their corresponding subitems.

Any utility district, county, town, or city which does not have a rating can request the ISO to evaluate their fire defenses to see if a rating can be assigned. The ISO can be contacted before expenditures are made on items in the four categories mentioned above. This can be done at the planning stage and can be done by any community regardless of whether they contemplate getting a rating assigned. Similarly, a

community which already has a rating can contact the ISO about improvements they plan to make with respect to fire defenses.

Once the ISO is contacted, a team of inspectors will visit the community and check all aspects of the fire department, water supply, fire service communications, and fire safety control. After the survey, the total number of deficiency points are determined and a classification number is assigned based on a given number of deficiency points with the highest number of deficiency points being assigned the highest classification. A community that best meets the accepted standards and has the fewest deficiency points is assigned the lowest rating. The grading process culminates in the assignment of a number ranging from 1 to 10, with one being the highest obtainable rating. The relationship between the number of deficiency points and the relative class of a community is presented in Table 2-2.

The total number of possible deficiency points that a community can receive is 5,000. The community which receives 500 or less deficiency points is given a Class 1 rating, those receiving between 501 and 1,000 deficiency points a Class 2 rating, and so on. Even though a community has less than 4,001 deficiency points, it will be assigned a Class 9 rating if it has no recognized water supply. A community will be assigned a Class 10 rating if it has no fire protection, has a water supply and no fire department, has a water supply but a fire department with more than 1,755 points, or has more than 4,500 deficiency points.

No community in Tennessee has a Class 1 rating and only Memphis has a Class 2 rating. As of July 1, 1973, three communities had a Class 3 rating, two had Class 4, nine had Class 5, 34 had Class 6, 46 had Class 7, 77 had Class 8, 10 had Class 9, and the rest are in Class 10 (37).

Table 2-2. The Insurance Services Office relationship between points of deficiency and the relative class of a municipality

Points of deficiency	Relative class of the municipality
0-500	First
501-1,000	Second
1,001-1,500	Third
1,501-2,000	Fourth
2,001-2,500	Fifth
2,501-3,000	Sixth
3,001-3,500	Seventh
3,501-4,000	Eighth
4,001-4,500	Ninth[a]
More than 4,500	Tenth[b]

[a]A ninth class municipality is one (a) receiving 4,001 to 4,500 points of deficiency, or (b) receiving less than 4,001 points but having no recognized water supply.

[b]A tenth class municipality is one (a) receiving more than 4,500 points of deficiency, or (b) without a recognized water supply and having a fire department grading over 1,755 points, or (c) with a water supply and no fire department, or (d) with no fire protection.

Source: Insurance Services Office, Grading Schedule for Municipal Fire Protection (New York: Insurance Services Office, Municipal Survey Service, 1973), p. 3.

The Fire Insurance Rating System

After the fire protection classification of a community has been determined, the ISO has a starting point for determining the rates that homeowners and owners of business and institutional property will pay for fire insurance. Generally, the cost of fire insurance, within certain limits, to a given community will be lower the better the fire protection that a community has. Thus, the community's classification is important in that it indicates the insurance rate base to be used on different classes of property such as a large residential group and it is the foundation for the basis rate which is used in calculating individual rates on commercial, industrial, and public properties (33, p. 104; 25, p. 1).

The basis rate is the starting or foundation rate that is used to determine the fire insurance rates for almost all buildings in a community and "reflects two factors: (1) the strength of the city's fire defenses, the conflagration hazard, local legislation on building construction and hazards and (2) the fire loss experience of the whole state" (3, p. 15).[16] Also, a small percentage for operating expenses

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[16]Since the state-wide fire loss is used in the computation of the basis rate, the fire loss record of a particular community does not affect the basis rate unless it significantly affects the total fire losses of the state. Thus, a community in Tennessee can spend thousands of dollars on fire prevention, for instance, and reduce its fire losses considerably and yet have little or no credit on its fire insurance. The only state that considers the fire loss experience of an individual community in the establishing of fire insurance rates is Texas. The ISO (formerly AIA) Grading Schedule is not used in determining the fire insurance classification (and hence, fire insurance rates) of a community, but rather the Texas Key Rate Schedule. A community with a bad fire loss record is penalized under this latter schedule and one with a good fire loss record is given credits. The original purpose was to promote fire prevention when effective building codes were nonexistent and when there were very few paid inspectors (33, pp. 108-109).

is figured in the basis rate. (To a limited extent the community can control the items listed under the first factor.)

Since the basis rate is used in the computation of the building insurance rate, the fire insurance rates are inversely related to the quality of the public fire protection facilities. That is, as the quality of the public fire protection gets higher, the fire insurance rates should become less. The basis rate also varies according to the building construction. For example, the basis rate for a fire resistive or frame building should be lower in a Class 2 community than in a Class 6 community for similar construction (25, p. 1).

Once the basis rate is determined for the various classes of public fire protection and types of construction, the ISO can establish a fire insurance rate for a specific building and its contents.[17] The other factors which affect the fire insurance rate are: occupancy (grocery, office, manufacturing, etc.), internal hazards, exposure from possible fires in adjacent structures, and interior fire protection (automatic sprinklers, watch service, fire extinguishers, etc.) (3, p. 15). (The owners of a building can exercise some degree of control over these factors.) The ISO uses a rating schedule to analyze the effect of each of these factors and thus to determine the fire insurance rate on the building and its contents.[18]

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[17]The ISO will advise, on a no-cost basis, any individual or group of individuals (owner, building occupants, architect, or contractor) on the proper construction and protection of new or old property. The advice they give may substantially reduce the fire insurance cost on the building and its contents. (See reference number 25.)

[18]For a comprehensive discussion of the total insurance industry in Tennessee, including the insurance rate making process, the ISO

Buildings used for business or institutional purposes that are not rated by the ISO are rated by the use of the Abstract Schedule (105). The Abstract Schedule is used by insurance agents to find a rate on most of the buildings (and their contents) in rural (Class 10) locations. If, through the application of the Abstract Schedule, the insurance agent cannot determine a rate, the ISO is contacted. The rates used in the Abstract Schedule are based on state-wide experience for different types of construction and occupancies (25, p. 5).

Dwelling and farm property rates are also based on state-wide experience, i.e., these properties are class rated.[19] These rates, as well as the rates above, are filed with the state insurance commissioner. An insurance company may either cooperate in making rates with other insurance companies through the rating bureau (ISO) or it can file rates independently. Subscribers to a rating bureau may also deviate from bureau rates upon prior approval from the state insurance commissioner. Since most insurance companies are licensed by the state insurance department and are required to file rate schedules (i.e., the procedures for establishing rates) with the department, they simplify matters by subscribing to the ISO which is recognized by the state insurance department. In fact, an insurer is required to be a member of a rating organization if it does not file its own rates (98, p. 101). In 1958 there were 13 rating organizations licensed by the Department of Insurance,

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(formerly the Tennessee Inspection Bureau), and the rate regulatory structure, the reader may wish to examine the thesis by Spencer (98).

[19]Class rated risks "generally include churches, apartment houses, dwellings and other properties so homogeneous that it would not be economically feasible to differentiate between one or another" (98, p. 58).

but the Tennessee Inspection Bureau (now the ISO) accounted for over 90 percent of the rating and rate promulgation in the state (98, p. 101).

IV. LEGAL CONSIDERATIONS IN PLANNING FOR RURAL FIRE PROTECTION[20]

Legal Considerations

The legal framework under which a service is provided to a community is one of the most important considerations in planning any type of service. The State of Tennessee has the authority to give to local governments, which are creatures of the state, certain powers necessary for their operation. These powers are vested either through general acts which apply to all local governments (counties or cities) within the state or through local acts which apply only to a particular county or city. Special legislation of the latter type are referred to as "private acts."

"Dillon's rule" has long been considered the foremost explanation of the grant of powers by the state to local governments. It states that

> It is a general and undisputed proposition of law that a municipal corporation possesses, and can exercise, the following powers, and no others: first, those granted in express words; second, those necessarily or fairly implied in, or incident to, the powers expressly granted; third, those essential to the declared objects and purposes of the corporation --not simply convenient, but indispensable (65, pp. 95-96).

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[20] Unless noted otherwise, this section has been largely extracted from a report prepared by the Tennessee State Planning Office in conjunction with the Putnam County Regional Planning Commission and the Committee for County-wide Fire Protection entitled Fire Protection Study, Putnam County, Tennessee, Preliminary Report, April, 1974, Chapter 4, pp. 15-22 (106).

Due to this point of law, cities have been able to provide the full range of public services to their residents, while counties have been hampered in their efforts to provide urban type services such as fire protection. Municipalities, which are incorporated under Tennessee law, have long been allowed to establish and provide through general statutes a full range of public services such as police and fire protection and to establish and enforce building and other codes. Because they were not provided authority to do so under the general statutes, counties that wanted to provide such services had to do so by means of a private act. The expense and inconvenience of having a private act passed discouraged many counties from providing certain urban type services such as fire protection. In 1973 the Tennessee legislature recognized the importance of rural fire protection by enacting legislation that would allow all counties to set up and operate county-wide fire departments.

Three alternatives currently exist under Tennessee law for providing fire protection to the unincorporated portions of counties. It can be provided by volunteer or other private fire departments, by utility districts, or by the county government. The Tennessee Code Annotated permits the establishment of private fire companies in municipalities. These include volunteer fire departments as well as private companies which provide fire protection services as a business (104, p. 453). The Code does not mention the establishment of volunteer fire departments in rural areas and counties; however, it can be implied from statements contained elsewhere about volunteer fire departments in rural areas, that they are permitted by Tennessee law. This point is substantiated by the fact that in 1971, Section 5-901 of the Code entitled, "Purposes for Which Appropriations Are Authorized," was amended

to allow county courts to appropriate monies "to volunteer fire departments, which do not charge for their services" (103, p. 6).

Utility districts created in accordance with Chapter 26 of Title 6 of Tennessee Code Annotated are authorized to provide fire protection as well as a number of other urban type public services. Utility districts are created upon petition to the county judge by 25 property owners located in the boundaries of the proposed district (104, p. 463). Once created, districts are empowered to

> conduct, operate and maintain a system or systems for the furnishing of water, sewer, sewage disposal, natural gas, artificial gas, police, fire protection, garbage collection and garbage disposal, street lighting, parks and recreational facilities, transit facilities, transmission of industrial chemicals by pipeline... (104, p. 470).

Several utility districts within the state are currently providing fire protection service.

In 1967, general enabling legislation was passed which allowed all counties in Tennessee to establish certain urban type public facilities. These were defined as

> sanitary and storm sewer lines and facilities, plants for the collection, treatment and disposal of garbage, trash, ashes, and other waste matter, and/or water supply and distribution lines, facilities and plants, chemical pipelines and docks (104, p. 157).

The services would be provided by some agency of the county already in existence, a public works department to be created, or by a county board of public utilities. The legislation also defined "urban type public facilities" to include fire protection in counties "having a population according to the 1960 federal census or any subsequent federal census of not less than 11,900 or more than 11,925; or less than 17,300 nor more

than 17,500; and not less than 600,000" (104, pp. 157-158). The parameters included Shelby, Wayne and Hardin counties.

The most significant piece of legislation authorizing counties to provide fire protection services was introduced by the Shelby County delegation and passed by the Tennessee General Assembly in 1965. It was a general act with special application and applied only to counties of more than 600,000 according to the 1960 Federal Census (Shelby County) (89, p. 469). The act was amended in 1968 to apply also to "any county which now has or may hereafter have a metropolitan form of government as defined by Tennessee Code Annotated, Section 6-3701 (Davidson County)" (90, p. 654). It was further amended in 1974 to apply to all counties within the state (87, p. 647). In 1975, the Tennessee General Assembly passed legislation allowing counties to contract with municipalities for fire protection services (88 , p. 9).

The act authorizes each county within the state to establish a new agency to be known as the "county-wide fire department" for the purpose of providing fire protection service to the entire county. Instead of creating a new agency, these powers may be delegated to an existing agency (104, p. 158).

The county-wide fire department is empowered to do "all things necessary to provide coordinated fire protection to all areas of the county." They include but are not limited to the following:

> (a) To sue and be sued; (b) to take or acquire real or personal property of every kind, or any interest therein, within the county, by grant, purchase, gift, devise or lease, and to hold, manage, occupy, dispose of, convey and encumber the same and create a lease-hold interest in the same for the benefit of the county; (c) to exercise the right of eminent domain but only with the consent of the county quarterly court or other governing body; (d) to establish,

equip, operate and maintain a county-wide fire department and to establish and enforce regulations including, but not limited to, those for the administration, operation, and maintenance thereof; (e) to appoint and employ necessary employees and to define their qualifications, duties, and responsibilities, and to provide for payment in reasonable sums for such duties; (f) to employ counsel; (g) to enter into and perform all necessary contracts, including, but not limited to, contracts for the supply of water where necessary for fire protection, contracts to have existing fire departments and others provide fire protection services in any area of the county, including, but not limited to, contracts with incorporated towns and utility districts to provide such service within or without their corporate limits, contracts to provide fire protection services for any city, town, district, or any part thereof within the county, contracts to provide and be provided training and maintenance, contracts to provide and be provided all special service functions such as arson investigations, inspection, and emergency ambulance and rescue services; (h) to provide and maintain all special service functions necessary for the prevention of fires, including the investigation of the cause of fires and the enforcement of regulations to prevent harmful fires and smoke; (i) to provide and maintain an emergency ambulance, first aid and rescue service; (j) to make regulations, in order to prevent harmful fires and smoke, which shall have the force of law when approved by the quarterly court or other governing body; (k) to give aid anywhere in the county in the event of fire, flood, or other disaster; (l) to assist local and volunteer fire departments whenever necessary. Such assistance shall include, but not be limited to, financial aid and shall be upon such terms as agreed to by both parties; (m) to provide training and maintenance services for the benefit of any fire department; (n) to set up a central communications network connecting all fire and emergency units in the county; (o) to train, equip, maintain, and provide for the payment of volunteers at the discretion of the county-wide fire department; (p) to recommend the boundaries of fire tax district or districts to the county quarterly court or other governing body, in order to have the fire taxes more nearly reflect the cost of services to be rendered in each area of the county, and to recommend the amount to be spent in each such district; (q) to make reasonable charges for any services rendered which are not included in the fire tax of the district;

> (r) with the approval of the county quarterly court or other governing body, to make agreements in writing for allocation and conveyance of any or all public functions, rights, duties, property, assets and liabilities of the county-wide fire department that justice or reason may require in the circumstances, to any annexing municipality; (s) in those counties which now have or may hereafter have a metropolitan form of government, the powers described in paragraphs (a), (b), (c), (e), (f), and (i) shall be vested in the metropolitan government, to be exercised in the manner provided by its charter (104, pp. 164-165).

The act further provides that the agency shall be headed by an official whose title would be "county fire chief." The fire chief would be appointed by the county court and would be vested with all the powers of the agency and the right to delegate those powers as he saw fit. He would serve at the will and pleasure of the county court (104, p. 165).

The county-wide fire department would be required to submit an annual budget to the county court stating anticipated revenues and expenditures. The legislation allows the establishment of fire districts within the county by the county court. A fire tax could be levied on the property owners of each district at a rate sufficient to pay the district's share of the total budget of the fire department. "The fire tax would be assessed in the same manner as the county property tax and collected as an addition thereto." The act further provides that nothing contained therein should be construed as limiting in any way the fire departments of municipalities or utility districts but authorizes the county department to contract with such established agencies to coordinate fire protection service county-wide (104, pp. 165-166).

Tort Liability

One legal consideration that has had an effect on the provision of fire protection service in Tennessee has been that of tort liability. The approach to tort liability taken by Tennessee courts and followed for over a hundred years is as follows: "A municipality is immune from suit in tort when acting in its governmental capacity, but when acting in a proprietary capacity its liability for torts is the same as that of an individual" (93, p. 14). Fire protection within a municipality is a governmental function and any municipality which provides fire protection inside its corporate limits may not be liable for damages arising from an accident. But, what happens when a municipal fire department answers a fire alarm outside its corporate limits without some sort of authority such as a contract? More than likely, the courts will rule that the fire department was acting in a proprietary function and thus be liable for damages (3, p. 44). In Tennessee, several city attorneys have ruled that once a city's fire engine leaves the corporate limits, it is no longer acting in a governmental capacity but a proprietary capacity, and is therefore liable for torts which may be committed by its employees.

This point of law concerning the proprietary versus the governmental function of fire department has had a significant influence on the provision of fire protection services in unincorporated areas of the state. In the past, some municipal fire departments answered fire calls in the unincorporated and unprotected portion of the county beyond their city limits and charged the property owner for the call. Due to the tort liability question and the ISO's rating policy, this procedure has almost been eliminated. Because of the risks involved, the higher insurance

premiums that would be brought about, or the loss of its fire insurance rating, most cities have ceased answering calls outside their city limits except where provided for by mutual-aid agreements with the fire departments of other governmental units.

Since all counties in Tennessee now have the legislative authorization to enter into contracts with existing municipal fire departments and other type fire departments, the municipalities with contracts can operate their fire apparatus in rural areas and not be liable for injury or damage. It is generally considered as operating in a governmental capacity (3 , p. 44). However, there are other items that should be considered by a municipality when entering into a contract with a county to provide fire protection services outside the city limits. The International City Managers' Association (ICMA) has listed a number of questions which should be considered by a municipality in determining whether fire protection should be supplied to outlying areas. These questions are as follows:

1. Does the municipality have any legal right (in state law, city charter, or ordinance) to use apparatus and men outside its boundaries?
2. Are firemen protected as to compensation, injury, and pensions in case of an accident occurring outside the city and resulting in injury to firemen?
3. What is the position of the city in case of liability or property damage suits against it resulting from injury or damage while apparatus is outside the city?
4. What is the maximum number or length of runs that can be permitted without considering outside response as materially reducing local protection in the municipality?
5. Is the fire equipment of the municipality designed to meet the requirements for rural fire fighting?

6. What effect would provision of outside service have on the insurance classification of the city?
7. On what basis should charges be made, if any?
8. To what extent does such service discourage the organizing of new fire departments outside the corporate limits (3 , p. 43)?

In the book on Municipal Fire Administration, the ICMA has presented two typical ordinances regulating the fire services outside the city limits (3 , pp. 376-379).

Fire Prevention and Other Codes

Fire protection, to be fully effective, not only involves the fighting of fires but should include fire prevention as well. One of the means of preventing fires is through an effective code enforcement system. The adoption and enforcement of building, housing, plumbing, electrical, gas, and fire prevention codes assures the inspection of new and existing construction and the prevention or correction of structural hazards which may cause fire.

Unlike cities, county governments until 1975 did not have general enabling legislation which would permit them to adopt and enforce such codes. Because of this and other reasons, few counties in the state have a code enforcement system. The few counties that have adopted the codes have done so after the passage of private acts. In 1975, the Tennessee General Assembly passed legislation which would allow counties to adopt, by reference, building, plumbing, and gas codes (91 , pp. 1-2).

As a result of recent changes in Tennessee legislation, considerable latitude exists in providing fire protection services on a county-wide basis in Tennessee. Within the existing legal framework, county

governments have the power to establish total county-wide fire protection systems. To adopt and enforce fire prevention codes, however, a county will still need to have a private act passed by the state legislature.

CHAPTER III

EXISTING MUNICIPAL AND RURAL FIRE SERVICES

This part of the study focuses on the existing level of fire and related services in Putnam and White counties.[1] The purpose is twofold: (1) to inventory the fire systems and facilities which have an impact (or a potential impact) on county-wide fire protection services and (2) to set the stage for developing the alternatives for fire protection services.

I. EXISTING MUNICIPAL FIRE AND RELATED SERVICES

All the municipalities--Algood, Baxter, Cookeville, Monterey, Doyle and Sparta--in Putnam and White counties have fire departments. These municipalities have a public fire protection rating ranging from Class 10 to Class 6, with Class 6 being the higher rating. Cookeville has a Class 6 rating; Algood, Monterey and Sparta have a Class 8 rating; and Baxter and Doyle have a Class 10 rating.

All the fire departments basically have a line type of organization, that is, the chain of command flows from the mayor or city manager down to the fire chief, assistant fire chief, captains, lieutenants, sergeants, and firemen, in that order (Table 3-1). None of the fire

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[1] Unless otherwise noted, the data for this chapter came from personal interviews with the fire chiefs of Algood, Baxter, Cookeville, Monterey, Doyle and Sparta and from the City Manager of Sparta.

Table 3-1. Manpower of municipal fire departments by county and municipality, Putnam and White counties, Tennessee, 1973

County and municipality	Number of men	Rank	Status of firemen[a]
Putnam			
Algood	1	Fire chief	Part-paid
	1	Assistant fire chief	Part-paid
	1	Captain	Part-paid
	1	Lieutenant	Part-paid
	12	Firemen	Part-paid
Total	16		
Baxter	1	Fire chief	Volunteer
	12	Fireman	Volunteer
Total	13		
Cookeville	1	Fire chief	Part-paid
	1	Assistant fire chief	Part-paid
	2	Captains	Full-time
	2	Captains	Part-paid
	4	Lieutenants	Full-time
	4	Lieutenants	Part-paid
	8	Firemen	Full-time
	9	Firemen	Part-paid
	2	Dispatchers[b]	Full-time
Total	33		
Monterey	1	Fire chief	Part-paid
	1	Assistant fire chief	Part-paid
	1	Captain	Part-paid
	1	Lieutenant	Part-paid
	1	Sergeant	Part-paid
	13	Firemen	Part-paid
	1	Dispatcher[c]	Full-time
Total	19		
White			
Sparta	1	Fire chief	Volunteer
	1	Assistant fire chief	Volunteer
	4	Firemen	Full-time
	23	Firemen	Part-paid
	2	Dispatchers[b]	Full-time
Total	31		
Doyle	1	Fire chief	Volunteer
	10	Firemen	Volunteer
Total	11		

[a]Full-time refers to firemen which receive a regular weekly or monthly salary. Part-paid refers to firemen which receive some compensation for their services. Volunteer firemen receive no compensation. Part-paid and volunteer firemen usually have employment not connected with the fire services.

[b]Serve both the police and fire department.

[c]On duty from 4:00 p.m. to 7:00 a.m. to answer only fire calls. The office personnel in the City Hall answer calls during the hours from 7:00 a.m. to 4:00 p.m.

Source: Personal interviews with the fire chiefs of Algood, Baxter, Cookeville, Monterey, and Doyle and the fire chief and city manager of Sparta, December 11-13, 1973.

departments have reached the size where they can have a line and staff type organization.[2] The staff functions within the fire departments of the two counties are usually performed by one of the firemen. Although some of the men, such as the dispatchers, have full-time nonfire duties, they still come under the regular chain of command.

Fire Department Facilities and Personnel

The basic fire department unit within the two counties is the fire company.[3] The fire company is a basic component of the platoon system.[4] None of the fire departments have enough companies to require battalion or district officers.

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[2]Fire departments in large cities usually have separate departments or bureaus which have responsibility in areas such as training, fire prevention, personnel administration, communications, administrative services, equipment, fire investigations, and fire extinguishment and rescue operations. The officers in charge of these staff functions report directly to the fire chief or to some other executive officer.

[3]The fire company is the basic fire department unit in the United States. The term "fire company" in many communities, especially the small communities with volunteer fire departments, is often used to mean the whole fire department. In paid fire departments, the term often means the force that is assigned to each fire station. In the larger cities, however, the "fire company" commonly means the force assigned to one pumper or ladder truck. Under this latter definition, more than 70 percent of the communities in the United States with fire departments have only one or, at most, two fire companies (3, p. 158). The fire company may operate one or two major pieces of equipment and in addition may also be assigned reserve or special duty apparatus. One fire station may house one or more companies. In the larger cities the following types of companies may be found: pumper, truck or ladder, pumper-ladder truck, rescue or squad, salvage, fireboat, water-tanker and special apparatus (3, p. 34).

[4]A fire department with a platoon organization has the firemen organized into companies and the companies grouped in battalion districts. In the larger fire departments, the battalions may be further grouped into divisions. The platoon system is in common use in the United States. Most of the paid fire departments use this system and have companies

The Cookeville Fire Department. The Cookeville Fire Department refers to the firemen assigned to each truck as a company. Two companies (or fire trucks with the assigned men) are sent to residential fires and three are sent to commercial or other high-hazard fires. When a residential or commercial fire occurs, however, all men, other than the dispatcher, leave the fire station regardless of the number of pieces of apparatus sent out. For minor fires, such as burning leaves or a burning car, only two men leave the station. The other fire departments within the two counties do not have fire companies associated with particular trucks; rather, the entire fire department of these municipalities is synonymous with the term "fire company."

Cookeville, which is the county seat of Putnam County and is situated nearly in the center of the county, has a modern four-bay fire station located in the Cookeville Municipal Building at 45 East Broad and Fleming Streets. The city officials in December, 1973, were in the process of planning for two more fire stations. They wanted to build two more fire stations for $200,000. If the two fire stations cannot be built for this sum, then only one fire station will be built. One of these fire stations will probably be located in the northern part of the city and the other near the industrial park on Burgess Falls Road. The northern location has been approved by the ISO, but the ISO also wants a

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ranging in size from 8 to 30 firemen (3, p. 158). Each company is usually commanded by a captain and assisted by junior officers. The ISO does not require battalion or district officers until there are more than eight companies (46, p. 30). When the fire department has between two and five battalions (16 to 40 companies), the platoon organization would require additional chiefs or division commanders (3, p. 37).

fire station built in the southern part of the city as soon as possible. Since two pieces of apparatus are required at each substation, at least two bays are needed. However, the fire stations probably will have three bays and will be built so that extra bays can be added if needed.

Cookeville is the only municipality within Putnam County that has a fire department with a full-time force of firemen (Table 3-1). There are eight men (one captain, two lieutenants, four firemen and one dispatcher) on duty at all times. The firemen work 24 hour shifts beginning at 8 a.m. The fire chief and assistant fire chief are volunteers who receive a monthly payment for their services. There are also 15 volunteers (two captains, four lieutenants and nine firemen) who receive a quarterly payment. The Cookeville Fire Department has a total force of 33 men. In the future the Cookeville Fire Department would like to have a full-time paid department so that the city can have a Class 5 public fire protection rating.

It is the policy of the Cookeville Fire Department to try to send all the men to the Tennessee State Fire Service Training Center at Murfreesboro. If possible, four men are sent to each class conducted by the Division of Vocational Education of the State Department of Education. In addition to this training, monthly training sessions are held at the fire station in Cookeville. All rookie firemen are required to attend some of the classes at Murfreesboro but sometimes they are on the force a year before they can be sent to the school.

The Cookeville Fire Department has seven pumpers and one 100-foot ladder truck (Table 3-2). The ladder truck and the three newest pumpers

Table 3-2. Inventory of fire apparatus, Putnam and White counties, Tennessee, 1973

County and municipality	Quantity of equipment	Type of equipment	Pumper capacity (gpm)	Water tank capacity (gallons)
Putnam				
Algood	1	1963 Ford-American La France pumper	750	500
	1	1958 Chevrolet tanker[a]	250	1000
Baxter	1	1973 Ford-American La France pumper	1000	500
	1	1943 Ford-Hale pumper[a]	500	250
Cookeville	1	100-foot ladder truck	b	b
	2	1971 Mack pumpers	1000	500
	1	1965 Mack pumper	1000	500
	1	1952 Ford-Peter Pirsch pumper[a]	750	250
	1	1941 Chevrolet-Peter Pirsch pumper[a]	750	250
	1	1924 La France[a] pumper	750	150
Monterey	1	1957 G.M.C.-Peter Pirsch pumper	750	350
	1	1934 Ford pumper	350	150
White				
Doyle	1	1952 International-W. S. Darley pumper	500	750
Sparta	1	1974 American La France pumper[c]	1250	750
	1	1974 American La France pumper[c]	1000	750
	1	1955 Ford-Oren Roanoke pumper	500	750
	1	1946 American La France pumper	1000	180

[a]In storage or in need of repair.

[b]Not applicable.

[c]On order.

Source: Personal interviews with the fire chiefs of Algood, Baxter, Cookeville, Monterey, and Doyle and the fire chief and city manager of Sparta, December 11-13, 1973.

are kept in the four-bay fire station.[5] The 1952 and 1941 pumpers are in storage but will be placed in the new substations when they are built. (The ISO allows some credit on old pumpers when used in conjunction with new pumpers.) The 1924 La France pumper is used for social or political activities.

The Algood Fire Department. Algood, which is located at the northeastern edge of Cookeville, has a two-bay station located on West Main Street near Second Street. The Algood Fire Department has a volunteer force of 16 men who receive a monthly fee for their services. These payments are used to offset the personal costs of the firemen, such as damaged clothes, gasoline, and other expenses associated with fire fighting. The number and rank of the 16 firemen are presented in Table 3-1.

None of the firemen are sent to the Fire Service Training Center at Murfreesboro. However, representatives of the Training Center come to Algood about once a year to conduct a three-day training school. In addition to this, the firemen meet twice monthly for training.

The Algood Fire Department has one 1963 pumper and one 1958 tanker (Table 3-2).[6] The tanker was used to answer calls in the

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[5]This equipment is adequate for most fires that the city may have. For large commercial or institutional fires, the fire department can request aid from fire departments of other cities with whom they have mutual aid agreements. Cookeville has mutual aid agreements with most of the municipalities within Putnam County and in adjacent counties. "Mutual aid" refers to "reciprocal arrangements between nearby units of local government whereby each agrees to send fire fighting forces to the aid of the other in the event of a situation which cannot be successfully handled by one unit alone" (3, p. 43).

[6]A gasoline truck was obtained by the fire department and converted

rural areas of the county until December 4, 1973.

The Monterey Fire Department. Monterey, which is situated near the eastern edge of Putnam County, has a one-bay fire station located at 101 South Chestnut Street. The fire department has a volunteer force of 18 men and one paid city employee who is the fire alarm operator at night. All the men receive a small yearly fee for their services (Table 3-1).

None of the firemen have been to the Fire Service Training Center in two or three years. Most of the men are employed in nonfire jobs and cannot lay off and the city does not seem to be interested in paying the firemen for the time they do take off. The fire department does, however, have regular meetings for training purposes.

The fire department has a 1957 and a 1934 pumper (Table 3-2). Since first-line pumpers must be less than or equal to 20 years of age in order to receive ISO rating credit (69), the 1957 pumper will need to be replaced in 1977.

The Baxter Fire Department. Baxter, which is located in the midwestern portion of Putnam County about six miles west of Cookeville, has its fire department housed in a two-bay station located at the City Hall Building on Main and Third Streets. The department has an unpaid volunteer force of 13 men (the fire chief and 12 firemen) (Table 3-1). Training sessions are held intermittently at the fire station. The fire department has one new (1973) pumper and one old pumper in need of repair (Table 3-2).

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to a water tanker with a pump. It was necessary to install a pump and put other equipment on the truck before it could be used for fire-control purposes.

The Sparta Fire Department. The county seat of White County is Sparta which is situated nearly in the center of the county. The Sparta Fire Department is housed in two new two-bay fire stations, one located at the junction of West and East Broadway Streets in the eastern portion of the city and the other one is located on Johnson Street in the western portion of the city. The fire stations were built in 1973 through grants received from the Environmental Protection Agency (EPA) of the United States Department of Commerce.

The fire department has a force made up of 31 volunteer and full-time firemen (Table 3-1). The fire chief and assistant fire chief volunteer their services. There are four full-time firemen and 23 volunteers. The full-time force was started in September, 1973. The volunteers are paid a bonus at the end of the year based on a point system. There are also two full-time dispatchers who serve both the police and the fire departments. The full-time firemen and dispatchers work in 24-hour shifts. Although the fire department has a chain of command set up, it has not organized itself into fire companies. If a fire occurs in a residential area, the two full-time firemen will take one truck to the fire. If a fire occurs in a commercial area, both trucks will be used to fight the fire. Volunteer firemen will respond to both type fires.

As of December, 1973, the fire station located on Johnson Street had not been manned. The City Manager had plans to hire two more men for the main fire station on West Broadway Street because in times of sickness, vacation, holidays the forces are inadequate. Also, the City Manager planned to hire full-time men for the other new fire station.

The City Manager is authorized to send the full-time firemen to three of the courses offered by the Fire Service Training Center at Murfreesboro. In addition to this, the fire department has bimonthly training sessions.

As of December, 1973, the fire department had a 1946 pumper and a 1955 pumper (Table 3-2). The department had ordered two more American La France pumpers. Part of the money from revenue sharing funds were used to pay for these pumpers.

Building new fire stations, buying new fire engines, hiring full-time men, installing hydrants, and updating the alarm system are some of the requirements of the ISO that the city will have to meet in order to eventually have a Class 6 fire protection rating. The City Manager hopes that the city can meet those requirements sometime during 1974.

The Doyle Fire Department. Doyle is located about five miles south-southwest of Sparta. It has its fire department in a one-bay station on Circle Drive. The department has an unpaid volunteer force of 11 men (one fire chief and 10 firemen) (Table 3-1). None of the firemen have had training at the Fire Service Training Center at Murfreesboro but some of them have received some training from the Sparta Fire Department. The Doyle Fire Department has one 1952 pumper.

Fire Service Communications

Through the Model Cities program,[7] the Cookeville Fire Department has been able to obtain an elaborate communications system. When the

[7]The Model Cities program is a federal program administered by the Department of Housing and Urban Development (HUD). HUD was authorized

dispatcher or fire alarm operator receives a call over the telephone or from a box alarm about a fire, he can sound the alarm within the station; and if the need arises, he can alert firemen at their homes through monitors placed in the homes. The firemen can hear all conversations concerning the fire and based on what is heard they can respond to the fire at a particular location or they can silence the receiver. Both the police and fire departments use the communications system in the fire station but each one has a different frequency. The fire alarm operator can also maintain radio communications with fire companies away from the fire station.

Most of the factories in Cookeville, especially in the fringe areas, have alarm systems tied into the automatic alarm system at the fire station.

Algood has an outside fire alarm system which can be activated by the person receiving the call. During the day, employees at City Hall answer fire calls by telephone, secure the necessary details about the fire, and then turn in the alarm. At night, fire calls are received on a multiple telephone hookup at four firemen's homes. A button can be pressed at any one of the four phones to set off the siren at the fire station.

Monterey has an outside fire alarm system which can be sounded during the day (8 a.m. to 4 p.m.) by personnel at City Hall who answer fire calls. This person then calls the fire department to relay the

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to provide funding and technical assistance to a selected number of cities throughout the country to deal with social, economic, and physical problems in slum and blighted areas. No new commitments were made for the Model Cities program after June 30, 1973 (28 , pp. 248-250).

necessary information concerning the fire. From 4 p.m. until 8 a.m., the fire department has a man to stay at the fire hall and answer fire calls.

From 8 a.m. to 4 p.m., Baxter has personnel at City Hall who will answer fire calls and set off the outside alarm at the fire station. Also, individual firemen may receive calls during the day. At night, either the fire chief or one of the other firemen are called. They then have to go to the fire station to trip the alarm.

As of December, 1973, the Sparta Fire Department had an outside fire alarm system for alerting volunteers. Fire calls are received at the fire station by the dispatcher who sounds the alarm at the station and begins to telephone the volunteer firemen. If a commercial fire is reported, then the dispatcher calls all volunteers. If the fire is of a minor nature, then only the two full-time firemen at the station answer the call. A new radio system will be installed and at that time the volunteer and off-duty firemen will be alerted by monitors. By using the monitor system the firemen will know the urgency of the fire. Several businesses are connected to the automatic fire alarm system at the fire station.

During the day, fire calls for Doyle are received at the service station owned by the fire chief and at night fire calls are received at the fire chief's home. When a fire call is received, someone goes to the fire station (which is not very far away) to set off the fire siren.

Fire Safety Control

Cookeville has a number of laws or ordinances which deal with fire prevention, building construction, electrical, and ventilating

installations. Information as to the degree to which these ordinances meet the standards of the Fire Prevention Code or the National Building Code recommended by the AIA and/or the applicable standards of the NFPA as required by the ISO is not available.[8]

The Cookeville Fire Department uses one of its regular firemen to serve as a fire inspector. This man receives additional pay for his fire inspection duties.[9]

The Sparta Fire Department does not have a full-time fire inspector. The fire prevention work is done by the fire chief. However, the fire chief needs someone to help him with the electrical, plumbing, building and other type inspections. Sometime during 1974, the City Manager would like to hire a full-time inspector. The city has fire prevention and other type codes but these need updating and enforcing. The fire inspector they plan to hire will be of great assistance in this area.

The other fire departments (Algood, Monterey, Baxter and Doyle) do not have full-time fire prevention inspectors. Inspection work is done by the fire chief or by one of his assistants. Monterey has a number of ordinances dealing with fire prevention, building construction, electrical and other type installations. The other cities have adopted

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[8]The ISO evaluates laws or ordinances by comparing them to the standards as recommended by the AIA and the NFPA. Not only must the ordinances meet the required standards, but they must also be enforced. Charges are made against a city for having inadequate ordinances or enforcement thereof.

[9]A Class 6 municipality such as Cookeville is required by the ISO to have a fire prevention inspector (70, p. 6).

a number of codes or ordinances dealing with fire prevention. These ordinances need to be updated.

Water Supply

Cookeville presently obtains its water from City Lake, an impoundment of the Falling Water River located east of the city and from the Minelick Creek branch of the Center Hill Lake located southwest of Cookeville. The water treatment plant at City Lake has a designed capacity of 4.8 million gallons per day (gpd) but, during the period from January to September, 1972, operated only 16 hours per day to produce approximately 3,063,000 gpd. The total storage capacity of the system is 6.75 million gallons consisting of one five-million gallon tank, three one-half million tanks and one quarter of a million gallon tank (117, p. 29).

The water treatment plant on Minelick Creek in Putnam County was recently constructed and has a designed capacity of 7.5 million gpd. A 30-inch transmission line leads from the plant to the five-million gallon tank located on the southern edge of Cookeville (117, p. 29).

These two plants also serve the seven utility districts in Putnam County and parts of White County. The utility districts in Putnam County are the Bangham Utility District, the Falling Water Utility District, the Dry Valley Utility District, the Double Springs Utility District, the Cookeville Boat Dock Road Utility District, the Old Gainesboro Road Utility District and the Baxter Utility District. During January-February, 1972, these utility districts (excluding the Baxter Utility District) used an average of 259,800 gpd (117, p. 29).

Cookeville has good fire hydrant coverage and with the exception of newly annexed areas, hydrants are spaced at intervals of 500 to 1,000 feet.

The water for Algood is obtained from a spring and a well with a combined capacity of 240,000 gpd. There is also a reserve well capable of producing 50,000 gpd. For the period from January to September, 1972, the city had 771 water connections and consumed approximately 180,000 gpd. The distribution system contains one storage tank with a capacity of 200,000 gallons. The water treatment plant is operated about 13.3 hours per day and has a capacity of 288,000 gpd but, during the peak water months of May to September, 1972, this capacity was often exceeded. There are several distribution pipes that are less than six inches in diameter (117, pp. 5-6). Algood is adequately covered with fire hydrants.

Monterey obtains its water from an impoundment fed by a spring. The water treatment plant has a designed capacity of 345,600 gpd. There are three storage tanks with a combined capacity of 725,000 gallons. The plant operated during January-September, 1972, about 18.1 hours per day and produced about 200,000 gpd. There are a few water lines under six inches in diameter.

The water supply for Baxter is obtained from an impoundment fed by two springs and from the City of Cookeville. The water treatment plant has a capacity of 216,000 gpd and the water distribution system has a combined storage capacity of 189,000 gallons. From January-September, 1972, the city had 409 water connections and produced an average of 132,100 gpd. Some of the water mains are undersized and some are old, requiring frequent maintenance (117, p. 11).

Sparta obtains its water from the Calfkiller River. The water treatment plant has a designed capacity of 1.9 million gpd and operated an average of 13.1 hours per day to produce approximately 1,103,000 gpd during January-September, 1972. The water system has a storage capacity of 1.65 million gallons. Three utility districts (De White, O'Connor and Quebeck-Walling) are served by Sparta and each used an average of 192,900 gpd (117, p. 105).

Doyle obtains its water from Sparta through the De White Utility District. Several of the distribution lines are less than six inches in diameter (117, p. 45).

Police and Ambulance Services

The police departments in the various municipalities in Putnam County and the Putnam County Ambulance Service work in conjunction with the fire departments. The police respond to all fire calls in Cookeville and Baxter and normally respond to most of the fire calls in Algood and Monterey, but this depends on whether the police hear the fire siren or whether they are on police calls in the latter two cities. The Putnam County Ambulance Service answers fire calls only if requested to do so by the fire departments. Although the ambulance service is partially subsidized by the county, it still charges for each call it makes ($30 per call in town).

In White County, the White County Ambulance Service, which is county owned and operated, goes to the scene of any fire when requested to do so by the fire departments. The Sparta Police Department responds to all fire calls.

II. EXISTING RURAL FIRE AND RELATED SERVICES

Offered by the Municipalities

All the fire departments in Putnam and White counties at one time answered fire calls in the rural areas of the two counties. The Algood Fire Department ceased answering fire calls in rural areas of Putnam County on December 4, 1973. In the four years prior to terminating rural fire service calls, the Algood Fire Department answered an average of 17 rural fire calls per year at no charge and an average of 10 of these were for rural houses on fire (Table 3-3).[10] Fire calls to rural areas were stopped by the department for a number of reasons: (1) the tanker truck used to answer fire calls was getting old and the pump would need overhauling in the near future; (2) the volunteer firemen had to leave their homes on several occasions when it was dark, cold, and rainy; and (3) the people on the outer fringes of the city were opposing annexation by the city. The city was also in danger of losing its fire protection rating.

The Cookeville Fire Department answered fire calls to rural areas of Putnam County years ago but had to stop in order to maintain the fire protection rating it had. In addition, the people outside the city limits of Cookeville opposed annexation. The Baxter Fire Department stopped going out to the rural areas of Putnam County in the early part of 1973 because the volunteer firemen (mostly younger men now) did not want to go and also because the fire engine was new. Baxter also wants

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[10] The official figures as reported to the ISO by the Algood Fire Department seem to be low. The Committee on County-wide Fire Protection for Putnam County reported that the Algood Fire Department had responded to over 80 fires in the county in 1972 (12, p. 1).

Table 3-3. Total and average number of fire alarm calls made by municipal fire departments to urban and rural areas, Putnam and White counties, Tennessee, 1969-73

County and municipality	Fire alarms inside and outside city limits (1969-73)		Residential fire alarms inside city limits (1969-73)		Residential fire alarms outside city limits (1969-73)		Fire alarms other than residential inside city limits (1969-73)		Fire alarms other than residential outside city limits (1969-73)	
	Number	Average	Number	Average	Number	Average	Number	Average	Number	Average
Putnam										
Algood	121[a]	30[a]	9[a]	2[a]	40[a]	10[a]	44[a]	11[a]	28[a]	7[a]
Baxter	90[b]	18[b]	45[b]	9[b]	[c]	[c]	45[b]	9[b]	[c]	[c]
Cookeville	933	233	183	46	[d]	[d]	750	150	[d]	[d]
Monterey	118[e]	30[e]	40[e]	10[e]	7[e]	2[e]	65[e]	16[e]	6[e]	2[e]
White										
Doyle	[c]	[c]	[c]	[c]	41[b]	8[b]	[c]	[c]	[c]	[c]
Sparta	143[f]	48[f]	79[f]	26[f]	40[bf]	13[bf]	14[f]	5[f]	10[bf]	3[bf]

[a]For the period 1970-73.

[b]Estimated by fire chief or by city manager.

[c]Unknown.

[d]None.

[e]For the period 1969-72.

[f]For the years 1969, 1970, 1972.

Source: Adapted from personal correspondence with P. N. Rychen, Assistant Supervisor, Public Protection, ISO, Nashville, Tennessee, March 20, 1974, and from personal interviews with the fire chiefs of Algood, Baxter, Cookeville, Monterey, and Doyle and the fire chief and city manager of Sparta, December 11-13, 1973.

to obtain a fire protection rating. The Monterey Fire Department answers rural calls within a limited distance (approximately 2.5 miles) of the Monterey city limits. However, in the case of danger to life, it does go farther distances. For the years from 1969 to 1972, the Monterey Fire Department answered 13 calls outside the city limits and over half of these calls were to rural houses on fire (Table 3-3).

Since the fire departments of the municipalities in Putnam County have stopped serving the rural areas of the county or have limited their service, the rural areas of the county are virtually without fire protection.

In the near future Cookeville will have to build one or more fire stations, buy more equipment, and add more men to the fire department force in order to keep the rating it now has. In order to provide fire protection to the rural areas of the county, Cookeville must have men and equipment above the requirements needed by the city. Algood, Baxter, and Monterey must also have additional equipment and men before they can provide adequate service to the rural areas of the county.

The situation is somewhat different in White County. The rural areas of the county have in the past been served by the volunteer departments of Doyle and Sparta. It was estimated that the Doyle Fire Department fought approximately eight residential fires per year in the areas outside the city limits (Table 3-3). The Sparta Fire Department fought an estimated total of 17 fires per year of which 13 were residential fires in the areas outside the city limits.[11]

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[11]The data as reported to the ISO by the Sparta Fire Department

In September, 1973, Sparta began hiring full-time firemen. These firemen now answer fire calls in rural areas. With the full-time force, the firemen are able to respond to fire calls in rural areas in a much shorter period of time. In order to help defray the costs of the full-time men, the county appropriated $20,000 to Sparta. In addition to this, the county appropriated $1,500 to Doyle so that the fire department in Doyle can answer fire calls in the rural areas, especially in the southern portion of the county. The fire department at Sparta used to charge $100 a call for its service to rural areas but it no longer does this.

The County Judge of White County was interested in having a fire study done in White County to find out if the present fire service arrangements with the two cities were worth the money spent. The County Judge was also interested in finding out about other alternatives that may be more beneficial to White County.

Offered by the State[12]

The Division of Forestry in the Department of Conservation is responsible for forest fire control and other forestry programs on 274,500 acres of forest in Putnam and White counties (148,500 and 126,000 acres for each county, respectively). For the period 1960-1972,

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seem to be underestimated. The City Manager and the Fire Chief of Sparta did a study in 1973 and found that during a 12-month period in 1972-1973, the Sparta Fire Department responded to 137 fire alarms and that approximately 35 percent of these were in the areas outside the city limits.

[12]In addition to the data obtained from the fire chiefs of Putnam and White counties, other data for this section were obtained by personal interviews with representatives of state and local governments.

the Division fought an average of 23 fires per year that burned an average of 174 acres per year in Putnam County. During this period of time, the percentage of forest acreage burned in Putnam County was only .12 percent which was nearly a third less than the state average (.17 percent) for the years 1968-1972. In White County the Division fought an average of 21 fires per year that burned an average of 338 acres per year for the period 1960-1972. (If the high fire year for White County of 1963 is deleted, the average number of acres burned per year would only be 151.) During this same time interval, the percentage of forest acreage burned in White County was .27 percent (only .12 percent if 1963 is excluded) (21). Although the Division of Forestry is set up primarily to control forest fires, there are many grass fires which are also controlled by them.

Putnam and White counties are in the fourth district in the second forestry region. (There are nine districts in the three regions within the state.) The district forester is in charge of 12 counties which make up the fourth district. In the chain of command under the district forester are the area foresters, the county rangers, ranger aids, crew leaders, crew members and lookouts. The area forester is usually in charge of three or four counties while the rest of the personnel normally work in a given county. During fire emergencies, these personnel can be used in other counties. Some of the crew leaders and most of the lookout men and crew members are seasonal personnel.[13] All the other men are

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[13]Seasonal workers are hired during the main fire season which normally runs from October 15 to December 15 and from February 15 to May 15. These dates depend on how dry it is.

hired full-time. The county ranger is in charge of one county, the ranger aid assists the county ranger and has a fire plow assigned to him and the crew leader is in charge of the crew members and lookout at each fire tower.

There are two lookout towers in Putnam County and three in White County. One of the towers in Putnam County is located about one mile southwest of Monterey and the other is located about the same distance southeast of Cookeville. The towers in White County are located in the mideastern, midsouthern, and midnorthern areas of the county. The fire towers in both counties are located in such a manner as to allow the lookout men to have the best view of the forests for fire detection purposes. During the main fire season, the crew leader, the lookout man, and a two-man handcrew are assigned to each fire tower. Although these men stay at the fire tower from 9 a.m. until 5 p.m. during the main fire season, they are on call 24 hours a day, seven days a week. When it is very dry or when there are fire emergencies, the men may stay at the fire tower during part of the night also. The men do not normally stay at the fire tower when it is rainy or snowy. If the lookout man is not needed at the tower at night, he serves as a crew member.

The ranger aids in both counties are provided a house to live in. The fire plow, which can be hauled on a two-ton truck, and other equipment such as a two-way radio are stored at or in the house. When fire emergencies occur, communications can be maintained between the house, the trucks, and the fire towers.

In addition to having the fire plows, the trucks, tools and communication equipment, the agency also has a slide-in pumper with a

100-gallon tank that can be put on a regular pickup. This pumper is used mostly to fight grass fires.

Since most of the fires in the state and in the two counties are caused by debris burning, the forestry personnel inspect sites before giving permits to burn debris and trash. The state law requires a person who wishes to burn trash or debris within 500 feet of forests or grasslands to obtain a permit during the period from October 15 to May 15. The permit is good then only from 12 noon until 5 p.m. and cannot be issued more than 24 hours prior to the time set for the fire.

Since the personnel of the Forestry Division keep a tally only on forest fire statistics, the value of houses and other rural type structures they save is not available. Also not available is the number of times they respond to nonforest fires. When the personnel of the Division answer a fire alarm, they will do everything they can to put out the fire regardless of the type of fire. However, it must be pointed out, that under the present set-up, the Division of Forestry does not have the resources to deal effectively with most rural structural fires. The reasons for this are several: (1) the equipment is inadequate, (2) the towers are not manned most of the year and are not usually manned at night during the main fire season, (3) the full-time men have other duties, and (4) the principal fire fighting crews are hired only seasonally.

The Division of Civil Defense of the Military Department of Tennessee has been instrumental in setting up local civil defense units in Putnam and White counties. The local civil defense units are known as the Putnam County Civil Defense and the Sparta-White County Civil

Defense. These civil defense units have had limited impact on the provision of fire protection services to the rural areas of the two counties. In Putnam County the local civil defense director has obtained several pieces of equipment for the county's use: four two and one-half ton trucks, three 800-gallon skid tanks, a generator mounted on a trailer, a jeep and some other minor types of equipment. Monterey obtained one of the trucks which was single-wheeled but did not use it for fire purposes because it was slow and could easily turn over. Baxter also received one of the trucks for $100 but never did use it for fire-control purposes. In December, 1973, Baxter officials were in the process of selling the truck so that the money could be used to help fix the old pumper truck. Two trucks, one which is in need of repair, are still held by the Putnam County Civil Defense. Monterey and Algood each have received one of the skid tanks and the other is being held by the Putnam County Civil Defense. As of December, 1973, none of the tanks had been mounted on a truck or trailer and used for fire-control purposes.

The Sparta-White County Civil Defense unit has not received major pieces of equipment that could be used to fight fires. However, minor types of equipment which have been received can be used for other purposes.

Another agency within the state government which has rendered services to urban fire departments and which might be able to render services to rural fire departments is the Division of Vocational Education within the State Department of Education. Firemen from the Cookeville and Sparta fire departments have attended the Tennessee State Fire Service Training Center at Murfreesboro. The fire chief at Algood

also mentioned that the personnel from the Division of Vocational Education have come to Algood and have provided training to the firemen.

The Tennessee Department of Public Health has a potential impact on the delivery of fire protection services to the rural areas of Putnam and White counties. The agency approves all water systems designed and installed in the state. These water systems must be designed to meet the minimum requirements as set forth by the Department of Public Health.

The Rural Water Distribution System[14]

Cookeville provides water to six utility districts which serve Putnam and parts of White County and also provides some water to the Baxter Utility District which in turn supplies some rural areas located in the western portion of Putnam County. The six utility districts are Bangham, Falling Water, Dry Valley, Double Springs, Cookeville Boat Dock Road and the Old Gainesboro Road. In White County, Sparta supplies water to the De White, O'Connor and Quebeck-Walling utility districts. In addition to these three utility districts, a new utility district known as the Bon-DeCroft Water Association was constructing a water system to serve the eastern portion of White County. The water system was under construction in 1973. These utility districts will be discussed in this section.

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[14]Unless otherwise noted, the data for this section came from a report prepared by the Upper Cumberland Development District (117) and from information supplied by the TSPO (32).

Bangham Utility District. The Bangham Utility District is located in the northern portion of Putnam County. The water mains extend north along Freehill Road and then along the Dodson Branch Road (Highway 135) to the Jackson County line. Another water main extends north along the Hilham Road (Highway 136) and terminates about three miles from the Overton County line. The water system serves portions of several other roads. For the period January-September, 1972, there were 160 connections serving approximately 850 people with about 27,000 gpd.

Cookeville Boat Dock Road Utility District. The Cookeville Boat Dock Road Utility District in Putnam County serves the area southwest from the Cookeville city limits to the DeKalb and White county lines. Water mains extend from Cookeville along the Burgess Falls Road to the White County line. Another water line extends along the Cookeville Boat Dock Road from its intersection with the Burgess Falls Road to the Cookeville Boat Dock on Center Hill Lake. Secondary mains extend north and south to serve several roads. Within the boundaries of this district lies a new water treatment plant which has a capacity of producing 7.5 million gpd. A 30-inch transmission line extends from the water treatment plant on the Minelick Creek branch of Center Hill Lake to the five million-gallon storage tank located on the southern edge of Cookeville. Also, a 12-inch pipe about a mile long was laid in 1973 from Baxter south to the 30-inch transmission line. For the period from January-September, 1972, the Cookeville Boat Dock Road Utility District had 397 connections serving approximately 1,170 people with an average of 51,200 gpd.

Double Springs Utility District. The Double Springs Utility District serves the area west of Cookeville to Baxter and then north to

the Jackson County line. The water mains extend west along the Buffalo Valley Road, then north to Double Springs and along Highway 56A to Bloomington Springs. Other mains serve populous areas along and to the north of Highway 70N. During the period from January-September, 1972, the utility district had 285 connections and used an average of 37,300 gpd.

Dry Valley Utility District. The Dry Valley Utility District serves the area southeast of the Cookeville city limits. Water mains extend five miles along Highway 70N and south along Cherry Creek Road extending one and one-half miles into White County. Another water main starts east on Poplar Grove Road and crosses Falling Water River. The line then stays south of Interstate 40 and extends through Rocky Point. The utility district during January-September, 1972, served over 600 people an average of 26,800 gpd.

Falling Water Utility District. The Falling Water Utility District serves the area extending south along Highway 42 and the Bunker Hill Road from the Cookeville city limits to a point three and one-half miles into White County. Populous areas along the Bunker Hill Road and Highway 42 and the community of Hamptons Crossroads are served by this utility district. There were, during the period from January-September, 1972, 150 water connections with an average daily use of 70,000 gpd.

Old Gainesboro Road Utility District. The Old Gainesboro Road Utility District serves the area northwest of Cookeville to the Jackson County line. The water main follows the Old Gainesboro Road to the Jackson County line. Secondary lines extend north and south to serve

adjacent populous areas. The utility district used during January-February, 1972, an average of 9,230 gpd.

Baxter Utility District. The Baxter Utility District produces some of its water and purchases the rest from Cookeville. In addition to serving Baxter, the Baxter Utility District also serves several communities west and southwest of Baxter. An estimated 1,400 persons are served by the utility district.

Currently, the Putnam County rural water system which includes mains out of Cookeville, Algood, Monterey that are not part of the above utility districts serve roughly 2,358 homes or about 42 percent of the homes in the unincorporated areas (118, p. 83).

De White Utility District. The De White Utility District is located in western White County and serves the area west and southwest of Sparta to the DeKalb and Warren county lines. Water lines serve Hensley Chapel, Dibrell, Oakdale and Doyle to the south of Sparta. Another water main extends west on Highway 70 to serve Cassville, Center Point, Yaterton and Peeled Chestnut communities west of Sparta and then extends into DeKalb County to serve the area between the county line and Center Hill Lake. From January-September, 1972, the utility district had 308 water connections which used an average of 19,000 gpd. The water was purchased from Sparta.

O'Connor Utility District. The O'Connor Utility District is located in the northern part of White County. Water mains extend north from Sparta along Highways 42 and 84. An extensive network of secondary mains exist serving several small communities in the northern portion of the county. The system has one 300,000-gallon storage tank and one

100,000-gallon tank. The utility district had 400 water connections and used an average of 137,500 gpd from January-September, 1972. The water was purchased from the City of Sparta.

Quebeck-Walling Utility District. The Quebeck-Walling Utility District is located in the southern portion of White County. Water mains extend from Doyle along Highway 70S to the Van Buren and Warren county lines. The system serves the communities of Quebeck, Walling, Mt. Pisgah and the area southeast of Doyle. One 100,000-gallon tank provides storage for the system. The district had, during the period from January to February, 1972, 300 water connections and used an average of 36,900 gpd. The water was also purchased from Sparta.

Bon-DeCroft Water Association. The Bon-DeCroft Water Association will serve portions of the eastern section of White County when completed. The system will include a 300,000-gallon storage tank, 22 miles of water mains, a water treatment plant with a daily capacity of 200,000 gallons, and will serve about 1,200 persons.

The present water distribution system in the rural areas of Putnam and White counties is shown in Figures 3-1 and 3-2. The figures indicate the mains which are six inches in diameter or greater and the mains which are less than six inches.

With the present rural water distribution system in Putnam and White counties, the best public fire protection rating that the counties or parts of the counties can receive is Class 9. Before any rural area or areas of the counties can receive a Class 8 public fire protection rating or better, the rural water system will have to be improved. Many of the water mains within the rural areas of the two counties are less

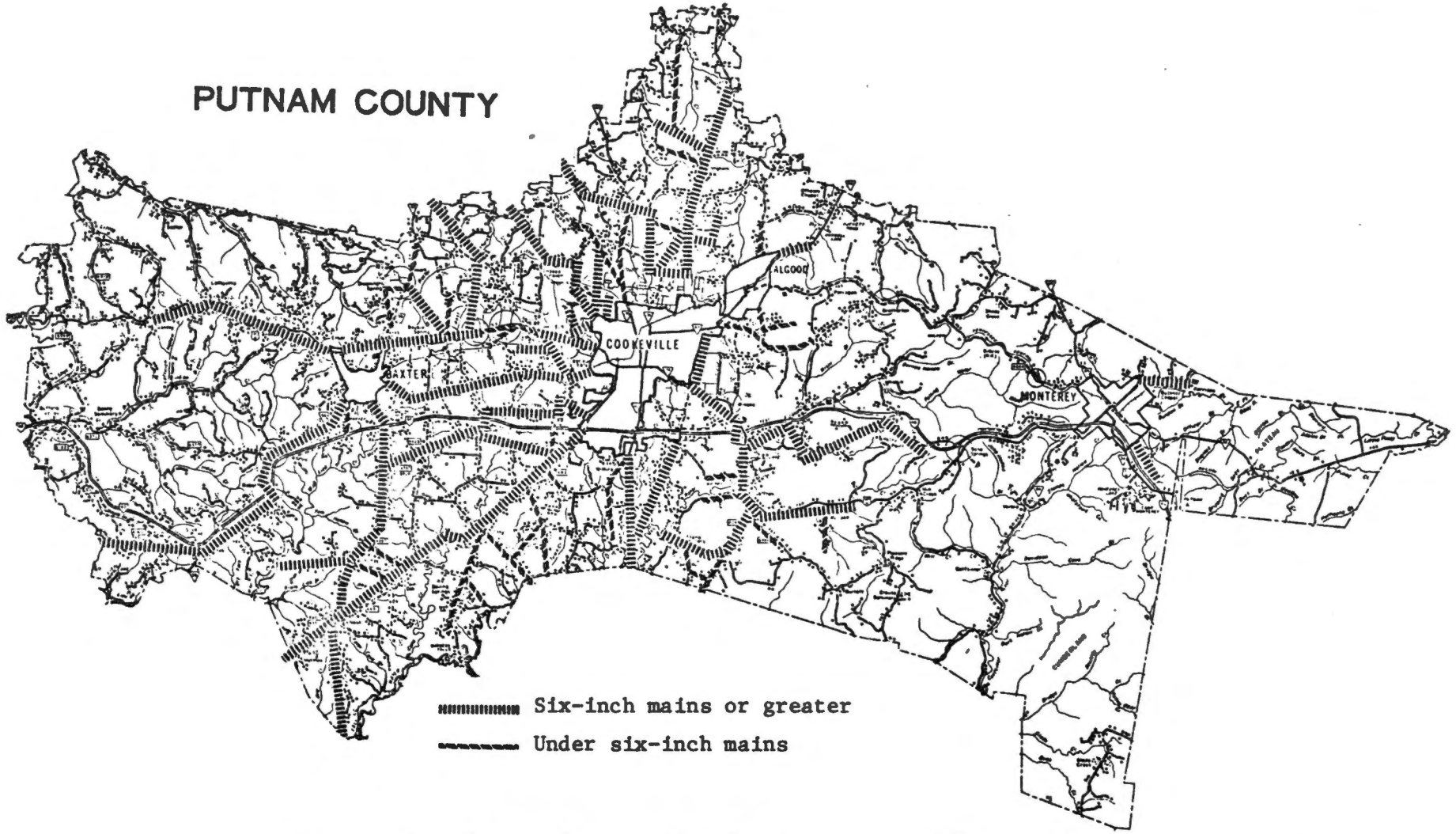

Figure 3-1. The rural water distribution system of Putnam County

Source: Adapted from Upper Cumberland Development District, Comprehensive Water and Sewer Plan Update 1973-1993, Report No. TN-UPPD-73-1006 (Cookeville: Upper Cumberland Development District, February, 1973) and a map furnished by the Middle Tennessee Regional Office, Tennessee State Planning Commission, Cookeville, Tennessee, 1974.

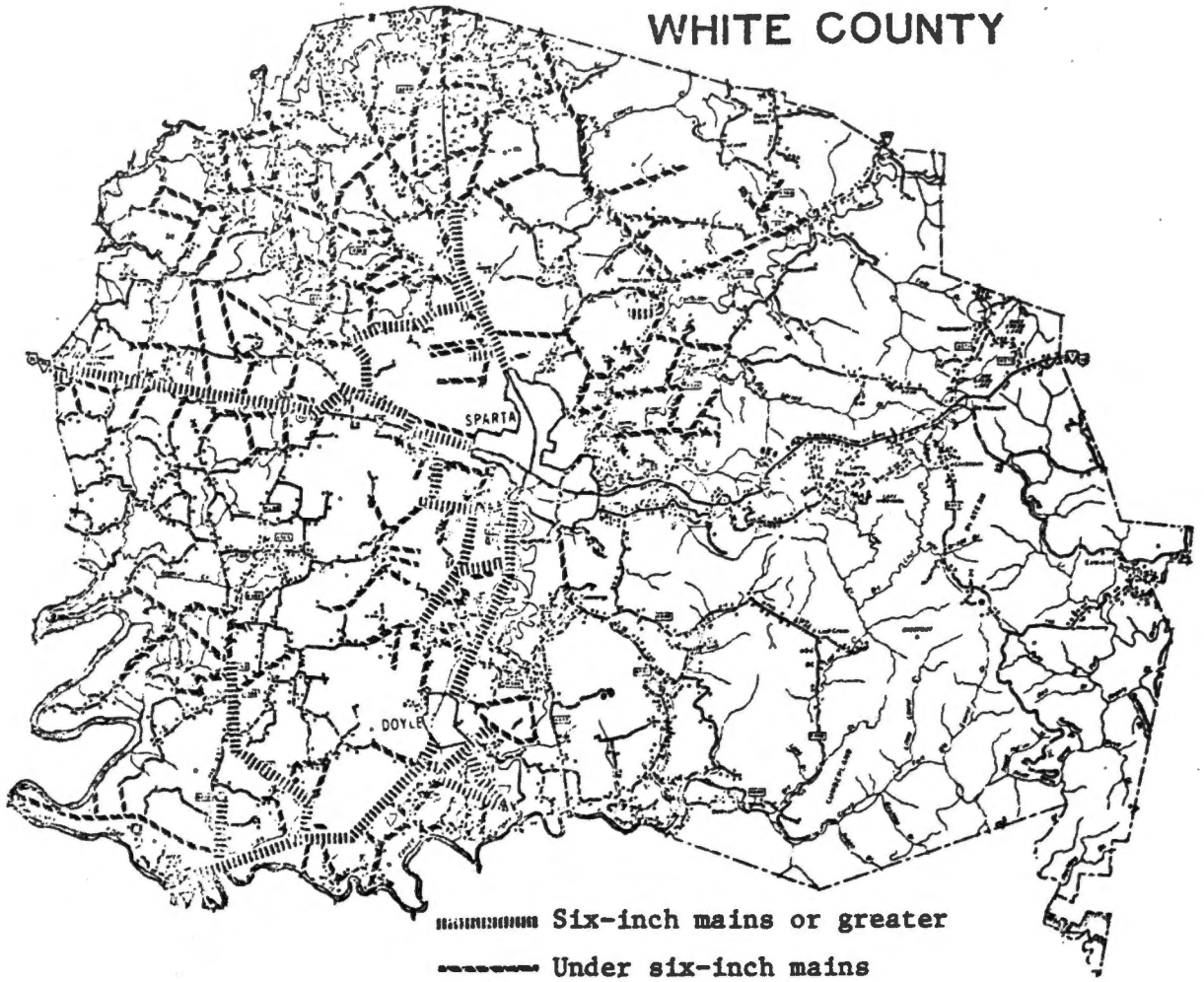

Figure 3-2. The rural water distribution system of White County

Source: Adapted from Upper Cumberland Development District, Comprehensive Water and Sewer Plan Update 1973-1993, Report No. TN-UPPD-73-1006 (Cookeville: Upper Cumberland Development District, February, 1973).

than six inches in diameter, which is the size water mains must be to have fire hydrants connected to them.[15] These mains will have to be replaced in order to support the necessary fire flows. Since there are only a few fire hydrants within the rural areas of either county, fire hydrants will have to be installed at appropriate places on all the mains. This is necessary in order to receive a Class 8 rating or better.

The Rural Road System and Topography

The system of state and federal roads makes most of the areas of Putnam and White counties readily accessible to fire fighting equipment, especially the more heavily populated areas (Figure 3-3). Other paved roads branch out from the state and federal roads and connect to numerous unpaved or gravel roads. Most of the people who are located on gravel or unpaved roads live no more than two or three miles from a paved road.

The land in the middle and western portions of Putnam and White counties, where most of the population live, is generally level to rolling. Therefore, most of the roads in this area would present very little, if any, problems to the movement of fire fighting equipment. A few of the gravel or unpaved roads in the western area of Putnam County, however, are rough and hilly and may be inaccessible to certain types of fire equipment. Since these gravel or unpaved roads have only a few houses located on them, the problem of inaccessibility is a minor one.

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[15] For a Class 8 municipality, the ISO requires a fire hydrant be installed to a six-inch water main or larger (45, p. 2). The Tennessee Department of Public Health also has this requirement (95, p. VIII-1). Smaller water lines are approved by the Department of Public Health but these lines must not have fire hydrants connected to them (24).

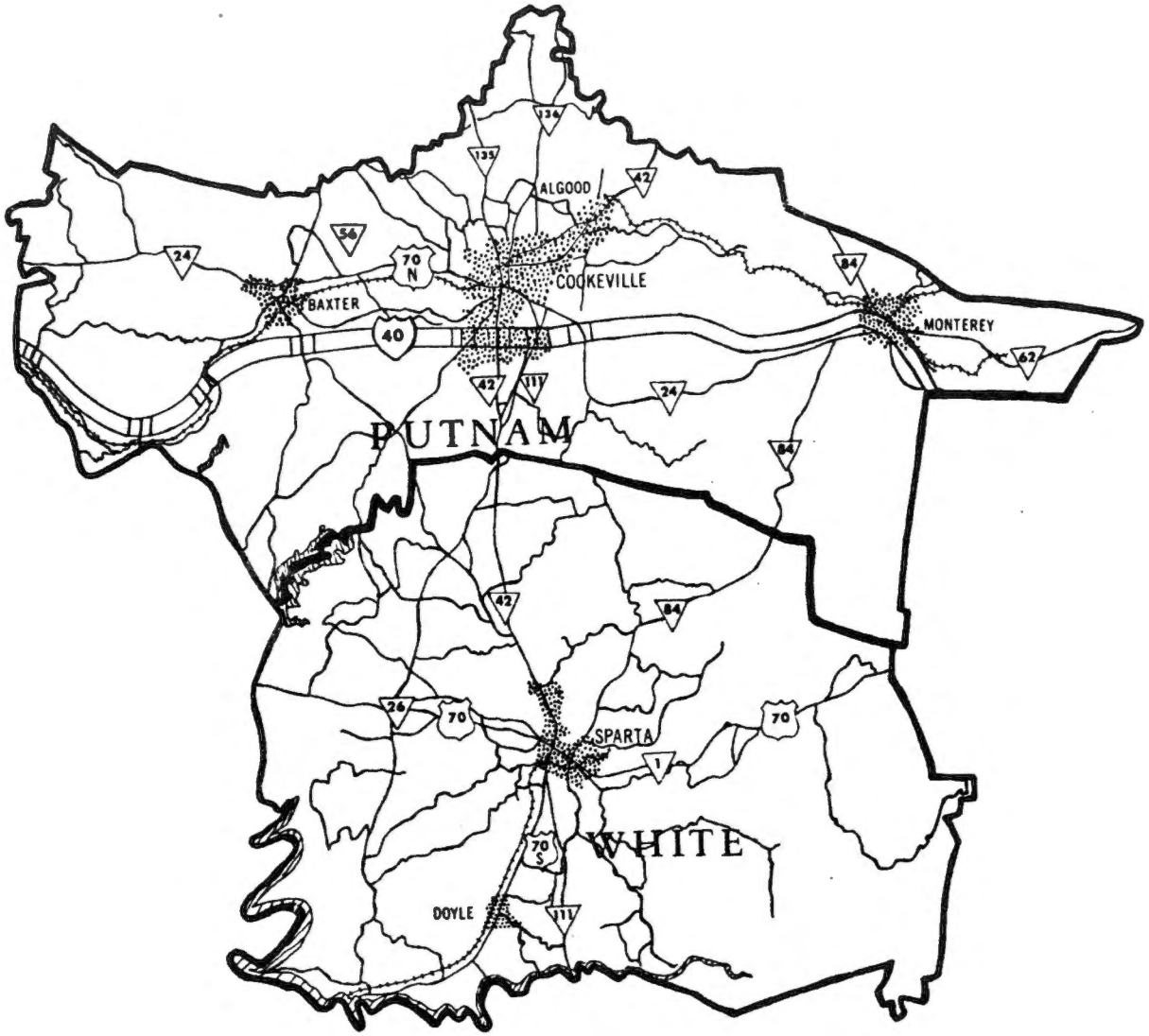

Figure 3-3. The rural road system of Putnam and White counties

In the eastern section of the two counties, the land is generally very rough and hilly and sparsely populated. Fortunately, the population of this area live primarily on roads easily accessible to fire fighting equipment.

There are a few bridges within the two counties that are either not wide or strong enough for certain types of fire fighting equipment. However, alternate routes, which are not very much out of the way, can usually be found so these bridges will not have to be crossed.

CHAPTER IV

RURAL FIRE INSURANCE COVERAGE AND ESTIMATED FIRE LOSSES

I. INTRODUCTION

The analysis as presented here examines the need for fire protection services by the rural residents of Putnam and White counties. This was done by examining data on rural property owners' fire insurance coverage and on estimated fire losses. Nearly all of the rural areas of Putnam County were found to have no fire protection. White County has limited fire protection services provided by the cities of Sparta and Doyle; however, these services are inadequate for much of the population. The inadequacy of fire protection services points to the need for such services.

Another way the need for fire protection services can be shown is by the absence or presence of private fire prevention and protection equipment and practices. The extent to which private efforts are made by rural property owners to prevent and suppress fires is a determining factor in evaluating the need for public fire protection services. Generally, if greater private efforts are made, the need for public fire protection services should be less. For example, if fire extinguishers were placed in all homes and the responsible persons were taught how to use them, fire losses should decrease and, consequently, the need for public fire protection services should also decrease. Although it would be rather easy to obtain information on private fire prevention and protection efforts, it would be extremely difficult to estimate the effect these efforts would have on fire losses. Therefore, no attempt was made to quantitatively analyze private fire prevention and protection efforts.

It was assumed that the need for fire protection services could best be shown by presenting the values of property at risk within Putnam and White counties and by showing the losses that are likely to occur on these properties.

The data for this part of the study were obtained mainly from a survey of rural residents and from rural business and institutional establishments. Information was obtained on property insured, property underinsured, and property not insured. Additional information was obtained on the cost of fire insurance.

II. RURAL FIRE INSURANCE COVERAGE

Fire Insurance Coverage for Rural Residential Properties

Rural farm. The average value per owner of rural farm property in Putnam and White counties on which there was fire insurance was $33,013 (Table 4-1).[1] Nearly half of this value, 47 percent, or $15,721, was the value of the house; 15 percent, or $4,827, the value of the contents of the house; 13 percent, or $4,227, the value of farm buildings; and 25 percent, or $8,238, the value of farm personal property.

When these values were compared with actual fire insurance coverage of property per rural farm owner, the results showed that the house was insured at 69 percent of its value; the contents of the house

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[1] Property includes the house, its contents, the farm buildings, and the farm personal property which consists of tractors, farm machinery, equipment, tools, crops, and livestock normally kept in the farm buildings during the winter season.

Table 4-1. Average value of property and amount of insurance coverage against fire losses of rural farm, rural nonfarm, and all rural resident property owners with fire insurance and with no fire insurance, 172 rural resident property owners, Putnam and White counties, Tennessee, 1973[a]

Rural resident property owners	Rural resident property owners with fire insurance				Rural resident property owners with no fire insurance		
	Number	Average value of property	Average amount of insurance coverage	Percentage insurance coverage was of average property value	Number	Average value of property	Percentage of rural residents with no fire insurance
		Dollars	Dollars	Percent		Dollars	Percent
Rural farms							
House	77	15,721	10,799	69	23	7,793	23
Contents of house	77	4,827	3,756	78	23	2,617	23
Farm buildings	72	4,227	1,572	37	19	2,872	21
Farm personal property[b]	61	8,238	588	7	18	4,029	23
Rural nonfarm							
House	64	17,020	12,905	76	8	9,044	11
Contents of house	64	5,070	6,026	119	8	3,181	11
All rural residents							
House	141	16,311	11,755	72	31	8,116	18
Contents of house	141	4,937	4,786	97	31	2,763	18
Farm buildings	72	4,227	1,572	37	19	2,872	21
Farm personal property[b]	61	8,238	588	7	18	4,029	23

[a]Computed from survey data.

[b]Farm personal property includes tractors, farm machinery, equipment, tools, crops, and livestock normally kept in the farm buildings during the winter season.

at 78 percent; the farm buildings at 37 percent; and the farm personal property at 7 percent.

Twenty-three percent of the rural farm owners had no fire insurance on their houses or the contents of their houses at the time the survey was taken. Twenty-one percent did not have fire insurance on their farm buildings and 23 percent had no fire insurance on farm personal property. The average value of property per farm owner without fire insurance was $17,311, or 52 percent of the value of the property of the farm owners who had insurance.

When the above values were aggregated for the two counties, the total value of the rural farm property which was covered by some fire insurance was $63.4 million (Table 4-2). Fifty-three percent, or $33.7 million, of this amount was covered by fire insurance and 47 percent, or $29.7 million, was not. Nearly $10 million was not covered by insurance. Thus, over half (54 percent) of the rural farm property was uninsured.

Rural nonfarm. Rural nonfarm property owners who had fire insurance on their house and its contents estimated the value of the house and contents at $22,090 (Table 4-1). The house comprised 77 percent of this value and the contents, 23 percent. The value of the house and contents per rural nonfarm property owner averaged $1,542, or 7 percent, more than the value of the house and the contents per rural farm property owner.

Rural nonfarm residents had fire insurance coverage on their houses averaging 76 percent of the value of the house. The value of the contents of the house was overinsured by 19 percent. Most of this excess coverage can be explained by the fact that two-thirds (67 percent) of the

Table 4-2. Estimated value of property and amount of insurance coverage against fire losses of rural farm, rural nonfarm, and all rural resident property owners with fire insurance and with no fire insurance, 9,299 rural resident property owners, Putnam and White counties, Tennessee, 1973

Rural resident property owners	Total number of rural residents[a]	Rural resident property owners with fire insurance				Rural resident property owners with no fire insurance	
		Number[b]	Total value of property[c]	Total amount of insurance coverage[c]	Total value not covered by insurance[c]	Number[b]	Total value of property[c]
			1000 Dollars				1000 Dollars
Rural farms							
House	2,657	2,046	32,165	22,095	10,070	611	4,762
Contents of house	2,657	2,046	9,876	7,685	2,191	611	1,599
Farm buildings	2,418	1,910	8,074	3,003	5,071	508	1,459
Farm personal property[d]	2,099	1,616	13,313	950	12,363	483	1,946
Total			63,428	33,733	29,695		9,766
Rural nonfarm							
House	6,642	5,911	100,605	76,281	24,324	731	6,611
Contents of house	6,642	5,911	29,969	35,620	-5,651	731	2,325
Total			130,574	111,901	18,673		8,936
All rural residents							
House	9,299	7,957	132,770	98,376	34,394	1,342	11,373
Contents of house	9,299	7,957	39,845	43,305	-3,460	1,342	3,924
Farm buildings	2,418	1,910	8,074	3,003	5,071	508	1,459
Farm personal property[d]	2,099	1,616	13,313	950	12,363	483	1,946
Total			194,002	145,634	48,368		18,702

[a]Based on adjustments made in census data. (See Appendix A, Section I.)

[b]Derived by multiplying the number of residents given in column two by the corresponding percentage of residents with and without insurance as indicated in Table 4-1.

[c]Derived by multiplying the numbers in column three and column seven by the respective averages given in Table 4-1.

[d]Farm personal property includes tractors, farm machinery, equipment, tools, crops, and livestock normally kept in the farm buildings during the winter season.

nonfarm residents had insurance policies that simultaneously insured the contents at half the value of the insurance coverage on the house. The value of the contents as estimated by these same residents was less than the value of the insurance coverage. Eleven percent of the nonfarm residents had no fire insurance on their house and/or its contents.

When the above values were aggregated for the two counties, the total value of the rural nonfarm property which was covered by some fire insurance was $130.6 million (Table 4-2). Eighty-six percent, or $111.9 million, of this amount was covered by fire insurance and 14 percent, or $18.7 million, was not. Nearly $9 million in rural nonfarm property was not covered by fire insurance. Thus, 20 percent of the rural nonfarm property was uninsured.

Fire Insurance Coverage for Rural Business and Institutional Properties

Rural businesses. Rural business properties in Putnam and White counties are inadequately insured against losses that may result from fire (Table 4-3).[2] Many of the businesses, especially the smaller ones, are not insured. For example, 57 percent of the general merchandise and grocery stores, a fourth (25 percent) of the automobile service stations,

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[2]It is possible that rapid depreciation (in an accounting sense) has reduced the "value" of business property below its appraised value. If this is the case, then it may be logical to underinsure the business; that is, the marginal cost may be greater than the marginal benefit when the marginal benefit is artificially less because of depreciation.

Table 4-3. Average value and amount of insurance coverage against fire losses of rural businesses and institutional properties with fire insurance and with no fire insurance, 91 rural businesses and 25 institutions, Putnam and White counties, Tennessee, 1973[a]

Type of businesses and institutions[b]	Number of firms in the study area surveyed	Percentage of firms in the study area surveyed	Rural businesses and institutional properties with fire insurance			Rural businesses and institutional properties with no fire insurance	
			Average value of property	Average amount of insurance coverage	Percentage insurance coverage was of average property value	Average value of property	Percentage of properties with no fire insurance
			Dollars	Dollars	Percent	Dollars	Percent
Businesses							
General merchandize and grocery stores	14	14	24,041	10,606	44	26,863	57
Automobile service stations	4	29	28,000	18,333	65	31,000	25
Restaurants	6	32	44,715	20,500	46	25,000	67
Service type businesses	6	29	59,750	22,875	38	9,250	33
Auto sales	3	43	--	--	--	16,500	100
Garage and body shops	5	20	38,270	6,000	16	22,833	60
Motels and tourist courts	2	29	223,750	104,875	47	--	--
Other type businesses[c]	51	100	471,940	386,227	82	18,150	20
Institutions							
Public buildings	3	38	31,200	30,000	96	11,500	33
Churches	15	9	45,563	18,387	40	--	--
Schools	7	100	202,400	97,150	48	131,667	43

[a] Computed from survey data.

[b] The businesses and institutional properties except for auto sales and motels and tourist courts, were classified by using the Tennessee Abstract of Schedules (105).

[c] Other type businesses include all businesses which could not be included in the categories listed. A few businesses were also included which had replacement values exceeding three times the average value of the type of businesses in the categories listed.

two-thirds (67 percent) of the restaurants, and 60 percent of the garage and body shops are not insured against fire losses.[3]

Of the rural businesses insured, many are underinsured. When the average values of the various types of rural businesses that were insured against fire losses were compared with the actual fire insurance coverage on these properties, the results showed that general merchandise and grocery stores were insured at 44 percent of their value; automobile service stations at 65 percent; restaurants at 46 percent; and garage and body shops at 16 percent.

The rural businesses classified as "other"--those with large investment in buildings and equipment which had some insurance coverage--were insured at 82 percent of their estimated replacement value. While 20 percent of the businesses classified as "other" were not insured, the total value of such businesses at risk were proportionately less than the total value of the small businesses included in the categories indicated.

When the insurance values were aggregated for the two counties, the total value of the rural businesses which were covered by some fire insurance was $23.8 million (Table 4-4). Seventy-five percent, or $17.7 million, was covered by fire insurance and 25 percent, or $6.0 million,

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[3]An important reason for the lack of adequate fire insurance coverage or for no fire insurance appears to be the high cost of fire insurance. For example, the premium rate per year for $100 of insurance on a restaurant located in an area that has a Class 10 fire classification rating and having hollow block and steel construction is $4.00 for the building and $4.25 for the contents. Thus, if no allowances are made in the rate, the annual fire insurance premium for a restaurant and its contents valued at $45,000 would exceed $1,800. For a grocery store in a similar location and of similar construction, the premium rates per $100 of fire insurance is $2.20 on the building and $2.35 on its contents. Thus, a grocery business valued at $25,000 would be assessed a premium of more than $550 annually for full coverage against possible losses due to fire (105).

Table 4-4. Estimated value and amount of insurance coverage against fire losses of rural businesses and institutional properties with fire insurance and with no fire insurance, 247 businesses and 178 institutions, Putnam and White counties, Tennessee, 1973[a]

Type of businesses and institutions[b]	Number of firms in the study area	Rural businesses and institutional properties with fire insurance				Rural businesses and institutional properties with no fire insurance	
		Number of firms[c]	Total value of property[d]	Total amount of insurance coverage[d]	Total value not covered by insurance[d]	Number of firms[c]	Total value of property[d]
			1000 Dollars				1000 Dollars
Business							
General merchandise and grocery stores	103	44	1,058	467	591	59	1,585
Automobile service stations	14	11	308	202	106	3	93
Restaurants	19	6	268	123	145	13	325
Service type businesses	21	14	837	320	517	7	65
Auto sales	7	--	--	--	--	7	116
Garage and body shops	25	10	383	60	323	15	342
Motels and tourist courts	7	7	1,566	734	832	--	--
Other type businesses[e]	51	41	19,350	15,835	3,515	10	182
Total	247	133	23,770	17,741	6,029	114	2,708
Institutions							
Public buildings	8	5	156	150	6	3	35
Churches	163	163	7,427	2,997	4,430	--	--
Schools	7	4	810	389	421	3	395
Total	178	172	8,393	3,536	4,857	6	430
All businesses and institutions	425	305	32,163	21,277	10,886	120	3,138

[a]Computed from survey data.

[b]The businesses and institutional properties except for auto sales and motels and tourist courts were classified by using the Tennessee Abstract of Schedules (105).

[c]Derived by multiplying the total number of firms given in column two by the corresponding percentage of firms with and without insurance obtained from Table 4-3.

[d]Found by multiplying the numbers in column three and column seven by the respective averages given in Table 4-3.

[e]Other type businesses includes all business which could not be included in the categories listed. A few businesses were also included which had replacement values exceeding three times the average value of the type of businesses in the categories listed.

was not. Nearly $3 million of rural business property was not covered by fire insurance. Thus, 33 percent of the total business property was not insured.

Rural institutions. Like the rural businesses in Putnam and White counties, institutional properties were also inadequately insured against fire losses (Table 4-3). The institutional properties included public buildings, churches, and elementary schools. A third (33 percent) of the public buildings and 43 percent of the schools were not covered by fire insurance whereas all the churches had some fire insurance coverage.

When the replacement values of the buildings and the current value of the contents of the different institutional properties that were insured against fire losses were compared with the actual fire insurance coverage on these properties, it was found that the average values of the public buildings and their contents were insured at 96 percent of their value, schools at 48 percent, and churches at 40 percent.

In terms of the value of all institutional properties at risk, 21 percent of the value was not insured. Of that which was insured (79 percent), about half (47 percent) was insured at its replacement value and the remainder was underinsured.

When these values were aggregated for the two counties, the total value of the rural institutions which were covered by some fire insurance was $32.2 million (Table 4-4). Two-thirds (66 percent), or $21.3 million of this amount, was covered by fire insurance and 34 percent, or $10.9 million, was not. Over $3 million in rural institutional property was not covered by fire insurance. Thus, 40 percent of the total institutional property was not insured.

Looking at the rural property owners' fire insurance coverage figures revealed that many rural homeowners in Putnam and White counties do not have adequate fire insurance or have no fire insurance coverage. Similarly, most of the business and institutional properties are under-insured according to the value at risk or have no fire insurance. Where there is no fire insurance coverage on the property or where the fire insurance coverage covers only a portion of the full value of the property and the property is completely destroyed by fire, most of the loss is borne by the property owner. The need for fire protection services in this case is greater. When more of the property is insured, more of the loss is shifted to the insurance companies. Since much of the property in Putnam and White counties is not insured or is not adequately insured, much of the loss resulting from fires will be borne by the rural property owners in the two counties. This indicates a need for fire protection services within the two counties.

III. ESTIMATED FIRE LOSSES

The need for fire protection services in Putnam and White counties can also be shown by the value of the estimated annual fire losses which occur within the two counties. To determine the annual fire losses for rural property owners, it was necessary to develop a procedure that made use of the fire insurance premium data from the rural surveys. Basically, the idea was to find out how much of the fire insurance premiums were expected to be lost each year by insurance companies and to use this result as a proxy for annual fire losses. The estimated insurance losses were found by multiplying the state-wide fire loss ratio for different

types of property (residential and commercial)[4] by the total fire insurance premiums. Before this was done, however, most of the premium data, which included the insurance costs for fire insurance, extended coverage, and liability, for rural farm and nonfarm property had to be adjusted to reflect the costs of fire insurance only.[5] For business and institutional premium data, the liability and extended coverage portions were excluded at the time the insurance agents were contacted about the policies. Finally, the estimated average fire loss for farm property was calculated by dividing the value of insurance losses by the number of farm property owners in the survey. Similar averages were computed for nonfarm and business and institutional properties. The details and calculations for this procedure are presented in Appendix A, Section II.

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[4]The state-wide fire loss ratio for residential property was calculated by first summing the direct premiums earned for the years 1958-1972 (except for 1959, 1961, 1963, and 1964) on fire and homeowners multiple peril policies and summing the direct losses incurred on these same policies. The direct losses incurred were then divided by the direct premiums earned to yield the state-wide fire loss ratio of .59682 for residential property. To obtain a state-wide fire loss ratio on commercial and institutional property (.53108), the direct losses incurred for the same years for fire and commercial multiple peril policies were divided by the direct premiums earned. In addition to these two loss ratios, a loss ratio (.76761) was computed for White County Mutual Fire Insurance Company policies by dividing the net losses paid by the total income for the same years. The data for these calculations were obtained from the Annual Report of the Department of Insurance for the years mentioned (17).

[5]The extended coverage and liability portions of the premium data were excluded by using factors obtained from a representative of the Tennessee Farmers Mutual Insurance Company (68), one of the leading insurors of rural farm and nonfarm property in Tennessee. A representative of the Department of Insurance of the State of Tennessee was contacted to check on the validity of these factors for other insurance companies (10). These factors were essentially correct for the other insurance companies. For farm owner policies, the factors .65 and .75 were used to exclude the liability and extended coverage portions of the premiums. For homeowner policies, the factors .85 and .75 were used to exclude liability and extended coverage. For other type policies, which do not include coverage for liability, the extended coverage was excluded by using .75 as the factor.

Estimated Fire Losses on Rural Residential Properties

Rural farm. Table 4-5 shows the values of the estimated annual fire losses for rural farm and rural nonfarm owners. The average annual fire losses are further shown for those rural property owners with fire insurance and those with no fire insurance. The estimated fire loss for a farmer with fire insurance was $79.15 each year. Approximately 49 percent of this amount, or $38.72, was paid by insurance companies and the rest ($40.43) was borne by the farmer. Those farmers without fire insurance were estimated to have a greater annual fire loss ($93.60) than farmers with fire insurance. Part of this difference was revealed in the survey data which showed that farmers without fire insurance had a higher proportion of older homes and more of their homes were of frame construction than farmers with fire insurance.

When the annual fire losses were aggregated for all farm property owners in the two counties, the estimated annual losses were over $161,900 for all farm property owners with fire insurance and nearly $57,200 for all farm property owners without fire insurance (Table 4-6). Sixty-four percent of the estimated losses on farm property was not covered by fire insurance.

Rural nonfarm. Rural nonfarm property owners with fire insurance were estimated to have an annual fire loss averaging $43.05 per owner, of which 83 percent was covered by fire insurance. The rural nonfarm property owners without fire insurance were estimated to have an annual value per fire loss of $70.57 per owner. This was 64 percent higher than the fire loss value per nonfarm property owner with fire insurance.

When annual fire losses were aggregated for all nonfarm property owners in the two counties, estimated annual fire losses on nonfarm

Table 4-5. Estimated annual fire losses per rural farm and nonfarm owner with fire insurance and with no fire insurance, 172 rural resident property owners, Putnam and White counties, Tennessee, 1973[a]

Type of rural resident property owner	Number of residents in the study area surveyed	Estimated annual fire loss per rural property owner with fire insurance				Estimated annual fire loss per rural property owner with no fire insurance	
		Percentage of residents in the sample surveyed	Average covered by insurance	Average not covered by insurance	Average covered and not covered by insurance	Percentage of residents in the sample surveyed	Average
			----------Dollars----------				Dollars
Rural farm[b]	100	77	38.72	40.43	79.15	23	93.60
Rural nonfarm[c]	72	89	35.54	7.51	43.05	11	70.57

[a]The procedure used to compute the average estimated fire losses is presented in Appendix A, Section II.

[b]Property owned by rural farm residents includes the house, contents of house, farm buildings, and farm personal property such as tractors, equipment, tools, crops, and livestock normally kept in the farm buildings during the winter season.

[c]Property owned by rural nonfarm residents includes the house and the contents of the house.

Table 4-6. Total estimated annual fire losses of all rural farm, rural nonfarm and all rural resident property owners with fire insurance and with no fire insurance, 9,299 rural resident property owners, Putnam and White counties, Tennessee, 1973

Type of rural resident property owner	Number of residents[a]	Estimated annual fire losses of rural property owners with fire insurance				Estimated annual fire losses of rural property owners with no fire insurance	
		Number of residents[a]	Total covered by insurance[b]	Total not covered by insurance[b]	Total covered and not covered by insurance[b]	Number of residents[a]	Total[b]
			Dollars				Dollars
Rural farm[c]	2,657	2,046	79,221	82,720	161,941	611	57,190
Rural nonfarm[d]	6,642	5,911	210,077	44,392	254,469	731	51,587
All rural residents[cd]	9,299	7,957	289,298	127,112	416,410	1,342	108,777

[a]See Table 4-2.

[b]Derived by multiplying the numbers in columns three and seven by the respective averages given in Table 4-5.

[c]Property owned by rural farm residents includes the house, contents of house, farm buildings, and farm personal property such as tractors, equipment, tools, crops, and livestock normally kept in the farm buildings during the winter season.

[d]Property owned by rural nonfarm residents includes the house and the contents of the house.

property with fire insurance coverage were about $254,500 and without fire insurance were approximately $51,600. A greater percentage (69 percent) of nonfarm property fire losses were covered by fire insurance than farm property (36 percent). Total estimated annual fire losses for all rural farm and nonfarm property in the two counties were slightly over half a million dollars, of which 55 percent was covered by fire insurance.

Estimated Fire Losses on Rural Business and Institutional Properties

Rural businesses. The estimated annual fire loss per rural business with fire insurance ranged from a low of $221 for automobile service stations to a high of $1,266 for motels and tourist courts (Table 4-7). For rural businesses without fire insurance, the low fire loss estimate was $85 for service type businesses and the high estimate was $585 for restaurants.

When estimated annual fire losses were aggregated for all businesses in the two counties, the fire losses for rural businesses with fire insurance were approximately $90,800 and for rural businesses with no fire insurance, about $37,800 (Table 4-8). For rural businesses with fire insurance, 21 percent of the estimated annual fire losses for garage and body shops were covered by fire insurance while 70 percent of such losses were covered for other type businesses. For the rest of the businesses with fire insurance, less than 50 percent of the fire losses were covered by insurance.

Rural institutions. The estimated annual fire loss per rural institution was the highest ($219) for churches and the lowest ($73) for

Table 4-7. Estimated annual fire losses per rural business and institution with fire insurance and with no fire insurance, 91 rural businesses and 25 institutions, Putnam and White counties, Tennessee, 1973

Type of business and institution[a]	Number of firms in the study area surveyed	Estimated annual fire loss per rural business and institution with fire insurance				Estimated annual fire loss per rural business and institution with no fire insurance	
		Percentage of firms in the sample surveyed[b]	Average covered by insurance[c]	Average not covered by insurance[d]	Average covered and not covered by insurance[c]	Percentage of firms in the sample surveyed[b]	Average[c]
			Dollars				Dollars
Businesses							
General merchandise and grocery stores	14	43	138.90	143.28	282.18	57	315.06
Automobile service stations	4	75	103.38	117.37	220.75	25	404.68
Restaurants	6	33	522.59	646.85	1,169.44	67	584.75
Service type businesses	6	67	153.62	271.91	425.53	33	84.98
Auto sales	3	--	--	--	--	100	211.55
Garage and body shops	5	40	120.29	455.40	575.69	60	360.96
Motels and tourist courts	2	100	570.12	695.98	1,266.10	--	--
Other type businesses[e]	51	80	828.41	350.47	1,178.88	20	289.92
Institutions							
Public buildings	3	67	65.59	7.17	72.76	33	79.66
Churches	15	100	94.01	124.87	218.88	--	--
Schools	7	57	112.19	96.56	208.75	43	329.45

[a]The businesses and institutional properties, except for auto sales and motels and tourist courts, were classified by using the Tennessee Abstract of Schedules (105).

[b]Computed from Table A-4, Appendix A.

[c]Calculated by dividing the estimated fire losses given in Table A-4, Appendix A, by the corresponding number of firms or institutions.

[d]Obtained by subtracting the numbers in column four by the corresponding numbers in column six.

[e]Other type businesses includes all businesses which could not be included in the categories listed. A few businesses were also included which had replacement values exceeding three times the average value of the type of businesses in the categories listed.

Table 4-8. Total estimated annual fire losses for all rural businesses and institutional properties with fire insurance and with no fire insurance, 247 rural businesses and 178 institutions, Putnam and White counties, Tennessee, 1973

Type of business and institution[a]	Number of firms in the study area	Estimated annual fire losses of rural businesses and institutional properties with fire insurance				Estimated annual fire losses of rural businesses and institutional properties with no fire insurance	
		Number of firms[b]	Total covered by insurance[c]	Total not covered by insurance[c]	Total covered and not covered by insurance[c]	Number of firms[b]	Total[c]
			----------Dollars----------				Dollars
Businesses							
General merchandise and grocery stores	103	44	6,112	6,304	12,416	59	18,589
Automobile service stations	14	11	1,137	1,291	2,428	3	1,214
Restaurants	19	6	3,136	3,881	7,017	13	7,602
Service type businesses	21	14	2,151	3,806	5,957	7	595
Auto sales	7	--	--	--	--	7	1,481
Garage and body shops	25	10	1,203	4,554	5,757	15	5,414
Motels and tourist courts	7	7	3,991	4,872	8,863	--	--
Other type businesses[d]	51	41	33,965	14,369	48,334	10	2,899
Total	247	133	51,695	39,077	90,772	114	37,794
Institutions							
Public buildings	8	5	328	36	364	3	239
Churches	163	163	15,324	20,353	35,677	--	--
Schools	7	4	449	386	835	3	988
Total	178	172	16,101	20,775	36,876	6	1,227
All businesses and institutions	425	305	67,796	59,852	127,648	120	39,021

[a]The businesses and institutional properties, except for auto sales and motels and tourist courts, were classified by using the Tennessee Abstract of Schedules (105).

[b]Obtained by multiplying the percentages in Table 4-7 by the corresponding numbers in column two.

[c]Calculated by multiplying the numbers in columns three and seven by the corresponding averages in Table 4-7.

[d]Other type businesses include all businesses which could not be included in the categories listed. A few businesses were also included which had replacement values exceeding three times the average value of the type of businesses in the categories listed.

public buildings (Table 4-7). Schools without fire insurance coverage had a higher estimated annual fire loss ($329) per school than schools with fire insurance coverage ($209). The higher estimated fire loss per school without fire insurance was because such schools had a greater value.

When the estimated fire losses were aggregated for the two counties, estimated annual fire losses for all institutions with fire insurance were approximately $36,700 and for institutions without fire insurance, over $1,200 (Table 4-8). For institutions with fire insurance, 90 percent of the estimated annual fire losses for public buildings were covered by fire insurance; for churches, 43 percent; and for schools, 54 percent.

When estimated annual fire losses were added together for all rural property in the two counties, the value was nearly $691,900. About 52 percent, or $357,100, of this total was covered by fire insurance. Thus, almost 50 percent of the estimated fire losses that occur within the two counties is borne by the property owners themselves. The high annual fire losses and the resultant burden to the rural property owners point to a need for fire protection services.

CHAPTER V

FIRE PROTECTION ALTERNATIVES AND ESTIMATION OF BENEFITS AND COSTS

I. INTRODUCTION

When rural governing bodies are confronted with the necessity of providing fire protection services to their jurisdiction, there are several alternative systems from which they can choose. What they would normally like to do is to choose a system which would offer the greatest net benefits within the constraints of budgetary allowances. One of the possible choices is a fire system designed to provide minimum coverage to an area with the central consideration being a reduction in fire losses to property and life. Or, a system can be designed with the central consideration being a reduction in fire insurance premiums. Fulfilling the goal of reducing fire insurance premiums may be in harmony with the goal of reducing fire losses. A fire system can also be designed in between these two ranges of protective services. The possible alternatives discussed here are (1) the minimum service alternative, (2) insurance reduction alternative, and (3) the full service alternative. Under the minimum service alternative, six different subalternatives or types of fire departments (called options) are detailed.

II. ALTERNATIVE I: THE MINIMUM SERVICE ALTERNATIVE

Alternative I is the "minimum service alternative." The primary consideration was to develop one or more fire systems which would provide limited fire protection to the rural areas of Putnam and White counties. The question examined is: What can the government officials in the two

counties do to reduce fire losses with a given but limited budget for such purpose? The key items that need to be considered are: the level of fire protection, the reduction of fire losses (referred to as fire loss savings), and costs.

Level of Fire Protection

One of the ways of looking at the appropriate level of fire protection services is to see what kind of protection has been offered to rural areas and to estimate reductions in fire losses associated with these different types of services. For this reason, fire chiefs were asked questions about the kind of fire departments they were in charge of (whether volunteer, full-time, or a combination of volunteer and full-time), what kind of equipment was used to suppress fires in rural areas, and what was the average distance in miles that the fire department traveled before arriving at the scene of a fire.[1] Six different types of fire departments (called options) used in rural areas are identified.

Option I. Option I is identified as a volunteer city fire department which has a pumper with a rated capacity of 500 gallons per

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[1]Distance in miles is used as a proxy for response time which is defined as the time necessary for the fire department to arrive at the scene of a fire after the fire was first reported. The popularity of using response time in research has been derived from four assumptions: (1) fire property losses and injuries increase as the time from ignition of the fire to arrival of suppression forces increases; (2) the resources required to control a fire increase as the time from ignition to arrival of suppression forces increases; (3) response time is more easily measured and studied than fire losses; and (4) response time is a significant part of the time from fire ignition to arrival of suppression forces (often referred to as pre-burn time) (27, p. 133).

minute (gpm) and a water tank capacity of 250 gallons. The maximum one-way distance that the apparatus could travel to each rural structure that caught on fire would be approximately five miles.

Option II. Option II is identified as a volunteer city fire department which has a pumper with a rated capacity of 250 gpm and a water tank capacity of 1,000 gallons. The maximum one-way distance that the apparatus could travel to each rural structure caught on fire would be approximately seven miles.

Option III. Option III represents a volunteer city fire department which has a pumper with a rated capacity of 500 gpm and a water tank capacity of 750 gallons. The average one-way distance for each rural alarm would be approximately 6.5 miles.

Option IV. Option IV represents a county rural fire department manned by civil defense workers. It has a pumper with a rated capacity of 250 gpm and a water tank capacity of 1,000 gallons. The average one-way distance for each rural alarm would be approximately 13.5 miles.

Option V. Option V represents a county rural fire department manned by civil defense workers. It has a pumper with a rated capacity of 250 gpm and a water tank capacity of 700 gallons. The average one-way distance for each rural alarm would be approximately 17 miles.

Option VI. Option VI represents a full-time city fire department which has a pumper with a rated capacity of 500 gpm and a water tank capacity of 750 gallons. The average one-way distance for each rural alarm would be approximately 6.5 miles.

Each option can provide a minimum service to the rural areas of Putnam and White counties and thus are considered under the minimum service

alternative. However, the primary reason for discussing these options is to show what kind of fire department resources have been used in rural areas and to find out what the savings in fire losses would be if Putnam and White counties were to adopt one of these options. Since data were not available on the fire loss savings that would accompany the implementation of one of these options, a method was devised to estimate the fire loss savings.

Estimating a Reduction in Fire Losses for the Six Options Under the Minimum Service Alternative

Fire chiefs in Putnam and White counties and in two other counties whose departments responded to calls in rural areas were asked to provide the percentage of rural structures that would have been completely destroyed had the fire department not answered the fire call. Unanimously, the fire chiefs reported nearly 100 percent of the rural structures would have been completely destroyed.

The fire chiefs were also asked to give the percentages of rural structures that were completely destroyed, three-fourths or less destroyed, one-half or less destroyed, and one-fourth or less destroyed when the fire department answered the fire calls. For example, the fire chief operating under Option I estimated that 5 percent of the rural structures was completely destroyed, 0 percent was three-fourths or less destroyed, 20 percent was one-half or less destroyed, and 75 percent was one-fourth or less destroyed. Similar losses under the other options considered are as follows:

	Options					
	I	II	III	IV	V	VI
Totally destroyed	5	20	25	35	52	8
Three-fourths or less destroyed	0	10	9	0	0	19
One-half or less destroyed	20	20	38	33	8	18
One-fourth or less destroyed	75	50	28	32	40	55

These percentages were used to represent the portions of the rural structures that were saved and to derive an estimate of the savings in fire losses due to the use of a particular fire department's resources.

The procedure for estimating the annual reduction in fire losses (fire loss savings) is presented in Appendix A, Section III. The total estimated annual fire loss savings for the six fire protection options are shown in Table 5-1. If, under the minimum service alternative, the fire suppression resources could be obtained and allocated so that the constraints in terms of miles could be fulfilled, then the estimated annual savings in fire losses can be claimed as benefits for the different options. These annual fire loss savings are further broken down into those that would accrue to the rural property owners and those that would accrue to the insurance companies.

The estimated annual fire loss savings that would result for rural property owners by adopting one of the options in Putnam County ranged from $73,664 for Option V to $161,389 for Option I. The yearly savings in fire losses of a fire department with a volunteer force of firemen (Option I to Option V) were inversely associated with distance in miles, that is, as the distance increased the benefits decreased. The yearly savings in fire losses of a fire department with a full-time force of firemen (under Option VI) were $140,788. Option VI is comparable to Option III in which the annual fire loss savings were $114,007. Thus,

Table 5-1. Total estimated annual fire loss savings for six fire protection options by group benefiting, Putnam and White counties, Tennessee, 1973[a]

County and group benefiting	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Putnam						
Rural property owner savings	161,389	126,718	114,007	105,306	73,664	140,788
Insurance company savings	115,282	82,090	62,433	63,829	59,888	88,902
Total	276,671	208,808	176,440	169,135	133,552	229,690
White						
Rural property owner savings	112,370	88,027	79,300	73,418	65,592	97,602
Insurance company savings	69,308	49,088	36,567	37,645	36,084	53,224
Total	181,678	137,115	115,867	111,063	101,676	150,826
Putnam and White						
Rural property owner savings	273,759	214,745	193,307	178,724	139,256	238,390
Insurance company savings	184,590	131,178	99,000	101,474	95,972	142,126
Total	458,349	345,923	292,307	280,198	235,228	380,516

[a]Based on survey data. See the procedure for estimating fire loss reductions (savings) presented in Appendix A, Section III.

the use of a full-time force rather than a volunteer force of firemen would result in a greater savings in fire losses.

Similar savings were found for White County but on a smaller scale. The annual savings ($73,418) in fire losses in White County under Option IV can be claimed by the Sparta and Doyle fire departments since most areas of the county can be reached when the average distance is 13.5 miles. These two fire departments were under a yearly contract in 1973 to furnish fire protection to the rural areas of the county for $21,500. The estimated annual savings in fire losses are over three times the expense that the county incurred; thus, the amount of money spent by White County in 1973 on fire protection was found to be economically justified through a reduction in fire losses.

A similar pattern of reductions in fire losses were found for the insurance companies. The annual fire loss savings for the insurance companies in Putnam County ranged from $59,888 for Option V to $115,282 for Option I. In White County the yearly insurance company savings ranged from a low of $36,084 for Option V to a high of $69,308 for Option I.

If a certain option is adopted by the county officials and the rural property owners receive the savings as indicated by way of a reduction in fire losses, then theoretically the rural property owners would be willing to support this option provided the costs of establishing this option did not outweigh the savings. If an option costs more than it will yield in savings, then the rural property owner will be inclined to be against such an option. Since the savings that would go to the insurance companies will not go to the rural property owners (unless there is a

reduction in insurance premiums), these savings cannot be claimed for this option.[2]

Estimating Costs for the Six Options Under the Minimum Service Alternative

The cost of implementing the minimum service alternative depends upon which option is chosen and the necessary facilities, manpower, and equipment required for that option. The major cost items that must be considered are costs of the fire station, building equipment, communications equipment, apparatus, land, firemen equipment, firemen training, firemen salary and fringe benefits, firemen insurance, utilities, office supplies, and fuel.

Fire station costs. The fire station costs used in this study were $15.00 per square foot (psf) and $6.85 psf.[3] When only one fire station is needed, it was assumed to be the central fire station and the cost of the building was assumed to be $15.00 psf. The estimated cost of building a two-bay masonry fire station having a minimum of 1,720 square feet was $25,800.[4] A fire station this size can hold two pumpers

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[2]It is assumed that the rural property owners will be the ones that are called on to finance the option; therefore, fire loss savings which would not go to these property owners cannot be claimed for the various options. However, it is quite possible that the insurance companies could be required to subsidize the option equal to the fire loss savings that they receive.

[3]Unless otherwise mentioned, the data on size of and cost of fire stations were obtained from Jim Isham, Fire Chief, Cumberland County Fire Department, Cumberland County, Tennessee (50).

[4]A fire station with two bays or more is recommended in most research. The county can use this space to hold auxiliary equipment or to meet the standards required by ISO.

or other type apparatus and have enough extra space for housing two or three full-time men (if used), bathroom facilities, storage space, and a communications area.

When more than one fire station was needed under a particular option, the total cost used for the main fire station was $25,800 and the total cost used for the additional masonry fire stations was $3,726 each, except under Option VI. The space requirements in the additional fire stations was 544 square feet[5] which was enough for the apparatus only. For Option VI, 249 square feet was added to the one-bay fire stations to allow enough space for sleeping quarters, a bathroom, and for living space based on the building space requirements published in Design of Fire Stations by the Standards Committee of the Washington Fire Chiefs (67, pp. 14-15). At $15.00 psf, the cost for the one-bay fire station was $11,895.

A repairs and maintenance cost for the fire stations was calculated by using a maintenance factor of 1.76 percent per year on the original investment in the fire stations. This factor was based on prior research (11, p. 9). A cost for insurance on the fire stations was based on a rate of $.303 per $100 of insurance paid by White County officials for most of the insurance on county owned buildings and contents during 1973. The rate included coverage for fire, extended coverage, and vandalism and malicious mischief.

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[5] A minimum floor space of 544 square feet was suggested as necessary for pumpers by the Circul-Air Corporation in its book on Fire Station Design (109, p. 2).

Building equipment costs. The estimated cost for minimum equipment necessary for the central fire station was $700 (50, 51). The minimum equipment included: one four-drawer filing cabinet, one desk, and 14 chairs. If two full-time men were to be housed at the central fire station, then $200 for beds and bedding was added to the minimum building equipment costs (50, 51). For Option VI, $450 was allowed for a desk, two chairs, and two beds, and for bedding at all fire stations other than the central fire station. A maintenance factor, which was based on previous research (96, p. 76), of 1.5 percent of original cost was used for building equipment. The same insurance rate used on fire stations was applied to building equipment.

Communications equipment costs. There are several possible ways that a fire alarm can be received by a fire department and the volunteer or off-duty men alerted for fire duty. One of the possible ways is for each of the counties to set up its own telephone alerting system by installing one phone at the central fire station (if there are full-time men or a dispatcher on duty) or at the fire chief's home and several extension phones in the homes of volunteers or off-duty men. A phone system such as this may work satisfactorily if there is only one fire station and enough volunteer and off-duty men who live close by that can be contacted for fire duty. Since firemen cannot constantly stay by the phone waiting on a fire call, it may prove difficult to get an adequate number of men to answer a fire alarm. Also, the turnover of volunteer firemen will necessitate the installation of more phones.

Another possible way of receiving fire calls and alerting volunteers would be by a radio network system in which all volunteers

are alerted by pagers. The county would have the option of installing a radio system in its central fire station or by making use of the radio system of the Cookeville Fire Department in Putnam County or the Sparta Fire Department in White County. The use of the ratio system is superior to the use of phones and thus was used in this study. It was assumed that the radio facilities of the Cookeville Fire Department or the Sparta Fire Department will be used by the county fire departments. The additional costs that the county will need to fund would be the costs of the pagers and the purchase and installation of two-way radios in each apparatus. The cost of the two-way radios was included in the costs of the apparatus. The cost of a pager was $297, which included a charge for a battery and a charger (50). It was assumed that the fire chief and the assistant fire chief plus five men for each fire station planned would have pagers (48). A maintenance cost of 1.5 percent of the original investment in pagers was used (96, p. 76). An insurance rate of $.303 per $100 of insurance was used to insure the pagers.

Apparatus costs. Apparatus costs were obtained from manufacturers of fire equipment, fire chiefs, and other fire officials. The costs of pumpers from manufacturers ranged from $21,500 to $70,000 depending on the chassis, capacity of the pump, the water carrying capacity, and the auxiliary equipment selected. The minimum capacity of the pumps was 500 gpm and the water carrying capacity was 750 gallons or more. These pumpers will meet or exceed the requirements listed under Options I, III, V, and VI, but not Options II and IV.

A few rural fire departments (for example, Wilson, Lincoln, and Cumberland county fire departments) had pumpers built with a rated capacity

of the pumps of 250 to 300 gpm and a water carrying capacity of 1,000 to 1,350 gallons. The Cumberland County Fire Department, with the help of the Tennessee Valley Authority (TVA), has built several pumpers which have a 1,000-gallon water tank and a pump capacity of 300 gpm. The cost of building and equipping these pumpers ranged from approximately $10,000 to $17,000 depending on whether an army surplus or a commercial chassis was used. (The Cumberland County Fire Department is gradually trying to get away from the use of army surplus trucks.) Two-way radio costs were included in the cost estimated. These pumpers will meet or exceed the requirements listed under Options II, IV, and V.

Thus, a cost of $17,000 for a pumper was used in the analysis for Options II, IV, and V. A cost of $21,500 for a pumper was used for Options I, III, and VI.

A repairs and maintenance cost for the pumper-tankers was calculated by using a maintenance factor of 1 percent of original cost for the first 10 years and 2 percent of original cost for the second 10 years assuming an estimated life for apparatus and accessory equipment of 20 years (3, p. 146).[6] The insurance cost for the apparatus was $368 per year for the $17,000 pumper and $446 for the $21,500 pumper (81).

Land costs. The land costs used in this study came from the survey of rural property owners. An average land cost as computed from the survey of rural property owners was 2.25 cents psf. A land cost of 2.25 cents psf was used for all fire station sites. The recommended size

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[6]The bases for these maintenance factors came from personal correspondence with two equipment manufacturers and Assistant Chief V. E. Popejoy of the Knoxville Fire Department, Knoxville, Tennessee (14, 78, 85).

of the fire station site was obtained from the Fire Protection Handbook published by the NFPA (112, p. 10-90). For a rural fire station, the NFPA recommended that the minimum size of a fire station site be 43,200 square feet. Thus, the cost of $972 was used for all fire station sites.[7]

Firemen equipment costs. The minimum equipment needed according to fire chiefs for firemen was a helmet, coat, and boots. The cost of $104 for these items was obtained from a manufacturer's catalog (31).

Firemen training costs. It was assumed that all the necessary training could be obtained from one of the city fire departments in the two counties, from the Tennessee State Fire Service Training Center, or from TVA.

Firemen salary and fringe benefit costs. Under Option VI, full-time firemen were required. An annual salary of $6,650, which was the average annual salary paid to the firemen of the Cumberland County Fire Department during the fiscal year from July 1, 1974, to June 30, 1975 (50), was used for each full-time fireman. At least two full-time firemen, working 24-hour shifts, are needed at each fire station (50, 51). To have a minimum response of three full-time men at each fire as recommended by ISO (48) (for other than minor type fires), one off-duty full-time man will need to be called. Each full-time fireman was assumed to have a pager. Fringe benefits were assumed to be 10 percent of the salary costs (51, 69).

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[7]The price of $972 for nearly an acre of land fell between the range of prices ($200 to $2,300 per acre) as estimated by persons (real estate agents, a land auctioneer, and an FHA official) having personal knowledge of land prices in the two counties.

For the volunteer fire departments, a minimum response of five men to each fire is recommended by the ISO (48). Five volunteer firemen (other than the chief and assistant fire chief) were assumed as the standard for the volunteer fire departments for each fire station planned. Each volunteer fireman was assumed to have a pager.

Fire insurance costs. A death and disability benefits insurance cost for firemen was obtained from an insurance company representative (81). The approximate cost per fireman was $11 per year. This insurance cost was used for volunteer firemen only since the fringe benefits for the full-time firemen included the insurance cost.

Utility costs. The costs for utilities were obtained from fire chiefs and other fire officials. The electrical cost used for the central fire station was $696 per year (51) and for the one-bay fire stations, except for Option VI, was $103 (41). For Option VI, $696 was used as the electrical cost for all fire stations. The water was assumed to be furnished at no cost by the various utility districts (51). Since it was assumed that the radio system in the city fire departments would be used, no cost was included for telephones.

Office supply costs. The cost used for cleaning and office supplies was $200 per year (50).

Fuel costs. The annual fuel costs were estimated to be approximately $225 per vehicle (50).

To determine total costs for each option under the minimum service alternative, it was necessary to estimate the number and kind of fire stations needed and the associated costs for each fire station. Since five miles was the response distance under Option I, the fire

stations needed to be located so that most areas in the county were not more than five miles from a fire station. Using a clear sheet of plastic, circles were drawn with a radius of five miles and positioned in such a manner that all areas of the two counties were covered. These circles were counted to determine the number of fire stations. When a circle fell in an area without population, the circle was deleted from the count. Similarly, the number of fire stations for the other options were determined.

The number and kind of fire stations, pumpers, and firemen needed for each option under Alternative I are given in Table 5-2. When both of the counties were combined, Option I required one less fire station than when both of the counties were considered separately. Option II required two less. All other options required the same number of fire stations as when the two counties were considered separately.

The numbers presented for the fire department items in Table 5-2 were used to obtain the total cost of providing fire protection services for the six options under the minimum service alternative. These data for Putnam, White, and the two counties combined are presented in Tables 5-3, 5-4, and 5-5.

In Putnam County the initial outlay costs for the options with volunteer manpower (Options I to V) varied from a low of $47,279 to a high of $220,997 (Table 5-4). It would take nearly five times as much funds to implement Option I rather than Option V in Putnam County. Options II and III had the same number of fire stations, but Option III had a higher total cost due to the higher apparatus costs. While the initial outlay costs for the full-time option (Option VI) fell between

Table 5-2. Total number and kind of fire stations, pumpers, and firemen needed for six fire protection options under the minimum service alternative, Putnam and White counties, Tennessee

County and fire department item	Option I	Option II	Option III	Option IV	Option V	Option VI
	Number					
Putnam						
Fire stations						
Central - two-bay	1	1	1	1	1	1
Other - one-bay	6	3	3	1	0	3[a]
Pumpers	7	4	4	2	1	4
Firemen[b]	37	22	22	12	7	16
White						
Fire stations						
Central - two-bay	1	1	1	1	1	1
Other - one-bay	5	3	4	0	0	4[a]
Pumpers	6	4	5	1	1	5
Firemen[b]	30	22	27	7	7	20
Putnam and White						
Fire stations						
Central - two-bay	1	1	1	1	1	1
Other - one-bay	11	5	8	2	1	8[a]
Pumpers	12	6	9	3	2	9
Firemen[b]	60	32	47	17	12	36

[a]Extra space added for housing two full-time men and for bathroom and living space.

[b]Includes the fire chief and assistant fire chief.

Table 5-3. Total cost of providing fire protection for six fire protection options under the minimum service alternative by cost component, Putnam County, Tennessee, 1973

Cost component	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Initial outlay costs						
Fire station(s)	48,156	36,978	36,978	29,526	25,800	61,485
Building equipment	700	700	700	700	700	2,250
Communications equipment	10,989	6,534	6,534	3,564	2,079	4,752
Apparatus	150,500	68,000	86,000	34,000	17,000	86,000
Land	6,804	3,888	3,888	1,944	972	3,888
Firemen equipment	3,848	2,288	2,288	1,248	728	1,664
Total	220,997	118,388	136,388	70,982	47,279	160,039
Annual operating costs						
Firemen salaries and fringe benefits	--	--	--	--	--	117,040
Firemen insurance	407	242	242	132	77	--
Utilities	1,314	1,005	1,005	799	696	2,784
Office supplies	200	200	200	200	200	200
Fuel	1,575	900	900	450	225	900
Repairs and maintenance - fire station(s)	848	651	651	520	454	1,082
Repairs and maintenance - building and communications equipment	175	109	109	64	42	105
Repairs and maintenance - apparatus[a]	1,505	680	860	340	170	860
Insurance - fire station(s)	146	112	112	89	78	186
Insurance - building and communications equipment	35	22	22	13	8	21
Insurance - apparatus	3,122	1,472	1,784	736	368	1,784
Total	9,327	5,393	5,885	3,343	2,318	124,962

[a]Represents annual repairs and maintenance cost for first 10 years of 1 percent on original investment in apparatus and auxiliary equipment. After 10 years the annual maintenance cost used was 2 percent on original investment.

Table 5-4. Total cost of providing fire protection for six fire protection options under the minimum service alternative by cost component, White County, Tennessee, 1973

Cost component	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Initial outlay costs						
Fire station(s)	44,430	36,978	40,704	25,800	25,800	73,380
Building equipment	700	700	700	700	700	2,700
Communications equipment	8,910	6,534	8,019	2,079	2,079	5,904
Apparatus	129,000	68,000	107,500	17,000	17,000	107,500
Land	5,832	3,888	4,860	972	972	4,860
Firemen equipment	3,120	2,288	2,808	728	728	2,080
Total	191,992	118,388	164,591	47,279	47,279	196,460
Annual operating costs						
Firemen salaries and fringe benefits	--	--	--	--	--	146,300
Firemen insurance	330	242	297	77	77	--
Utilities	1,211	1,005	1,108	696	696	3,480
Office supplies	200	200	200	200	200	200
Fuel	1,350	900	1,125	225	225	1,125
Repairs and maintenance - fire station(s)	782	651	716	454	454	1,291
Repairs and maintenance - building and communications equipment	144	109	131	42	42	130
Repairs and maintenance - apparatus[a]	1,290	680	1,075	170	170	1,075
Insurance - fire station(s)	135	112	123	78	78	222
Insurance - building and communications equipment	29	22	26	8	8	26
Insurance - apparatus	2,676	1,472	2,230	368	368	2,230
Total	8,147	5,393	7,031	2,318	2,318	156,079

[a]Represents annual repairs and maintenance cost for first 10 years of 1 percent on original investment in apparatus and auxiliary equipment. After 10 years the annual maintenance cost used was 2 percent on original investment.

Table 5-5. Total cost of providing fire protection for six fire protection options under the minimum service alternative by cost component, Putnam and White counties, Tennessee, 1973

Cost component	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Initial outlay costs						
Fire station(s)	66,786	44,430	55,608	33,252	29,526	120,960
Building equipment	700	700	700	700	700	4,500
Communications equipment	17,820	9,504	13,959	5,049	3,564	10,692
Apparatus	258,000	102,000	193,500	51,000	34,000	193,500
Land	11,664	5,832	8,748	2,916	1,944	8,748
Firemen equipment	6,240	3,328	4,888	1,768	1,248	3,744
Total	361,210	165,794	277,403	94,685	70,982	342,144
Annual operating costs						
Firemen salaries and fringe benefits	--	--	--	--	--	263,340
Firemen insurance	660	352	517	187	132	--
Utilities	1,829	1,211	1,520	902	799	6,264
Office supplies	200	200	200	200	200	200
Fuel	2,700	1,350	2,025	675	450	2,025
Repairs and maintenance - fire station(s)	1,175	782	979	585	520	2,129
Repairs and maintenance - building and communications equipment	278	153	220	86	64	228
Repairs and maintenance - apparatus[a]	2,580	1,020	1,935	510	340	1,935
Insurance - fire station(s)	202	135	168	101	89	367
Insurance - building and communications equipment	56	31	44	17	13	46
Insurance - apparatus	5,352	2,208	4,014	1,104	736	4,014
Total	15,032	7,442	11,622	4,367	3,343	280,548

[a]Represents annual repairs and maintenance cost for first 10 years of 1 percent on original investment in apparatus and auxiliary equipment. After 10 years the annual maintenance cost used was 2 percent on original investment.

the initial outlay costs for Options I and II, the annual operating costs for Option VI were much higher than the operating costs for the other options due to the salaries and fringe benefits that would need to be paid to full-time firemen. Operating costs for Option I were more than four times the operating costs of Option V.

Similar results were found for White County (Table 5-4). The initial outlay costs for fire protection ranged from $47,279 for Option V to $191,992 for Option I. Option III required one more fire station and higher apparatus costs than Option II; thus, the initial outlay costs for Option III were higher. Annual operating costs for Options V and I were $2,318 and $8,147, respectively. Both the initial outlay costs and the annual operating costs for Option VI were higher in White County than in Putnam County since one more fire station was required.

When cost information was figured for the two counties combined, initial outlay costs for Option I were $361,210 (Table 5-5) which were $51,779 less than the initial outlay costs for the two counties having separate fire systems. Under Option V the initial outlay costs for the two-county area were $70,982 and for the two counties independently, $94,558. A difference of nearly $71,000 was found for Option II when the initial outlay costs were compared for the two counties combined versus the two counties considered independently. The results point to the fact that there are some economies of "size" in providing fire protection to a single area comprising both counties rather than to the two counties separately.

There were also some economies of "size" in operating costs for the two counties when they were combined. For example, Option I operating costs for the two counties having separate fire systems were

$17,474 compared with $15,032 for the two counties considered as a whole. Comparisons of the operating costs using the other options also revealed that there are some economies of "size" in providing rural fire protection to the two counties as one area rather than two distinct areas.

The benefits (fire loss savings) that were estimated for the various options can be claimed by any combination of fire department resources which meet or exceed those listed under the different options. It may be possible for a county to use fewer resources (less equipment, manpower, and other resources) under all the options and still be able to have the same fire loss savings as estimated for the various options; however, this contention cannot be verified with present data. There are a few variations of the options which meet or exceed option requirements and which can be adopted by Putnam or White County. These are: adopt the TVA system, contract with municipalities, or contract with private fire departments.

Possible Option Variations Under the Minimum Service Alternative

The TVA system. One possible variation of all the options is to use the TVA plan, as adopted in Cumberland County, and still meet the requirements in terms of resources and miles listed under the different options.[8] Option II is closely associated with the TVA system, as adopted in Cumberland County, in terms of miles. Option II was identified

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[8]The information about the Cumberland County Fire Department was furnished by Jim Isham, Cumberland County Fire Chief, Cumberland County Fire Department, Cumberland County, Tennessee (50) and Billy E. Townsend, Tributary Area Development Representative, Office of Tributary Area Development, Tennessee Valley Authority, Knoxville, Tennessee (111).

as a volunteer fire department which responded to rural structures caught on fire within a distance of seven miles. Since the fire stations of the Cumberland County Fire Department (which TVA helped set up) have an approximate distance of seven miles to the various areas of the two counties and the fire department resources meet or exceed those under Option II, the benefits under Option II can be realized by implementing the TVA program in Putnam or White counties. The costs would be somewhat more due to the particular setup of the Cumberland County Fire Department. If the TVA system were set up under the other options, the benefits under these options could also be claimed, provided the constraints are met.

For fire protection purposes, TVA divided Cumberland County into eight fire districts with District 1 being the location of the central fire station which contains the radio receiving and dispatching unit. Each district has an attack tanker and has five or more volunteer firemen (called minutemen) which will respond to a fire alarm. These minutemen are the primary response unit in the sense that they will go directly to the scene of a fire rather than to the fire station. Each minuteman has, in his own private vehicle, a kit (called a minuteman kit) containing two 10-pound and one 2½-pound ABC fire extinguishers, first-aid kit, ax, fire hat with face shield, fire coat, pants, boots, compound lever bar, search light, pocket pager, and 50 feet of ½-inch manila handline. The purpose of having minutemen with minutemen kits is to have a quick response to a fire call and to make a fast initial attack against the fire. In addition to the minutemen kits, there is a 30-minute air pack for each district. The "duty" minuteman (fireman responsible for the air pack) is responsible for driving the district attack tanker to the

scene of the fire. Also, the "duty" minutemen in adjacent districts drive tankers to the scene of the fire if asked to do so by the central dispatcher.

In addition to the attack tanker located in District 1, there is a mini-pumper located there which is driven to all fires by the fire chief or one of the other firemen on full-time duty. The mini-pumper serves as a secondary response unit. There are six full-time men (including the fire chief) who work 56 hours a week (24 hours on duty, 28 hours off duty) at the central fire station. Three of the men are paid by the county and three are paid from federal funds. The annual salary of the three county paid men was $7,000 each and the annual salary of the three federal paid men was $6,200 each.

In order to set up a program in Putnam and White counties similar to the one in Cumberland County, additional costs were estimated for salaries and fringe benefits, fuel, air packs, minutemen kits, and a minuteman pumper. A second two-bay fire station costing $20,055[9] was used when the two counties were combined. A fully equipped minuteman pumper was used in each county and costs approximately $20,000 and the minuteman kit--less the boots, coat, fire hat, and pager--costs approximately $300. The self-contained breathing mask (air pack) cost was already included in the pumper costs. The initial outlay costs of setting up the TVA program for Putnam County, for White County, and for Putnam and White counties considered as one area were $145,188, $145,188 and

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[9]The minimum floor space for a one-bay fire station was doubled and 249 square feet was added for sleeping quarters, bathroom, and living space. A cost of $15 psf was used.

$231,401, respectively (Table 5-6). Thus, the initial outlay costs would be less if the TVA plan were adopted for both counties rather than in each one separately. The annual operating expenses ($97,697) for both counties would also be slightly less than the expenses ($100,108) for the two counties having separate county-wide fire departments.

Contract with municipalities. It may be possible for the Putnam County officials to contract with the Cookeville Fire Department, which has a force of full-time firemen, to provide fire protection to the rural areas of the county. By doing this, the fire loss savings ($73,664) under Option V for Putnam County can be claimed because Option V only requires one centrally located fire station. Since Option V is a volunteer rural fire department, the fire loss savings are likely to be more for the full-time Cookeville Fire Department. Under Option V, the initial outlay costs were $47,279 and the annual operating costs were $2,318 for a volunteer rural fire department. The county officials could offer the Cookeville Fire Department the initial outlay costs in a lump sum (or prorated over several years) and the annual operating costs; however, these payments may not be enough to induce the Cookeville Fire Department to take on the additional responsibility. Since the fire loss savings by using the Cookeville Fire Department are likely to exceed those under Option V, the county may be willing to pay the full amount of the fire loss savings ($73,664) that were estimated for Option V.

Similarly, Putnam County officials could contract with the Cookeville, Baxter, and Monterey fire departments. The fire loss savings ($105,306) under Option IV can then be claimed as a minimum. The initial

Table 5-6. Total cost of providing fire protection under the TVA plan for Putnam and White counties by cost component, Tennessee, 1973[a]

Cost component	Putnam County	White County	Putnam and White counties
	Dollars		
Initial outlay costs			
Fire station(s)	36,978	36,978	60,759
Building equipment	900	900	1,350
Communications equipment	6,534	6,534	9,504
Apparatus	88,000	88,000	142,000
Land	3,888	3,888	4,860
Firemen equipment	8,888	8,888	12,928
Total	145,188	145,188	231,401
Annual operating costs			
Firemen salaries and fringe benefits	43,890	43,890	87,780
Firemen insurance	176	176	220
Utilities	1,005	1,005	1,804
Office supplies	200	200	200
Fuel	1,125	1,125	1,800
Repairs and maintenance - fire station(s)	651	651	1,069
Repairs and maintenance - building and communications equipment	112	112	163
Repairs and maintenance - apparatus[b]	880	880	1,420
Insurance - fire station(s)	112	112	184
Insurance - building and communications equipment	23	23	33
Insurance - apparatus	1,880	1,880	3,024
Total	50,054	50,054	97,697

[a]The number of fire stations, pumpers, and firemen used for Option II were used to derive the cost figures.

[b]Represents annual repairs and maintenance cost for first 10 years of 1 percent on original investment in apparatus and auxiliary equipment. After 10 years the annual maintenance cost used was 2 percent on original investment.

outlay costs under Option IV are $70,982 and the annual operating costs are $3,343. Since only two fire stations are required under Option IV and four under Option II, the fire loss savings should fall between the two estimates ($126,718 and $105,306 for Options II and IV, respectively).

In White County, the county officials have contracted with the Sparta and Doyle departments to provide fire protection to the rural areas of the two counties. (The Sparta Fire Department has a full-time force of firemen.) The annual fire loss savings that can be claimed by these two fire departments should fall between the savings as estimated for Options II ($88,027) and V ($65,592). Option II requires four fire stations while Options IV and V require only one. The initial outlay costs and annual operating costs for Options IV and V are $47,279 and $2,318, respectively.

Contract with private fire departments. Currently, there are no private fire departments which operate in Putnam or White County. However, if the county officials in Putnam County decided to contract with a business or an individual to provide county-wide fire protection, then the fire loss savings ($73,664) as estimated for Option V should be realized as a minimum. A full-time private fire department may bring about greater fire loss savings. Assuming that the private fire department will have a full-time force of at least two firemen around the clock, then the initial outlay costs ($47,279) and the annual operating costs ($2,318) as estimated for Option V would not be enough to make the business a viable firm. Since the fire loss savings are likely to be greater for a full-time private fire department, the county officials would have the alternative of defraying the additional costs of the private fire department.

III. ALTERNATIVE II: THE INSURANCE REDUCTION ALTERNATIVE

Alternative II is the "insurance reduction alternative." The purpose of this alternative was to develop a fire protection system to achieve the lowest fire protection class consistent with the existing road and water system. In achieving this purpose, the minimum standards as required by the ISO were met.

ISO Standards Required for the Insurance Reduction Alternative

When considering fire protection under the insurance reduction alternative, the ISO will recognize three types of fire departments for insurance credit: an approved private fire department, a Class A or B rural fire department, or a fire department with a Class 9 public fire protection rating.

Private fire department. Generally, the ISO will allow premium reductions for rural nonfarm property owners living in an area with a Class 10 fire protection rating if their dwelling is located within three miles of an approved private fire department and they maintain a subscription to this fire department (47, p. 2).[10] The private fire department must be one that is approved by the ISO. The ISO requires four full-time men around the clock for a private fire department (40), but does not make this requirement for a Class 8 public fire department

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[10] A few insurance companies will allow the above insurance credit. Also, a few insurance companies will charge the rates applicable to a Class 8 rating when the dwellings are in a Class 10 area provided the dwellings are within 1,000 feet of a standard fire hydrant connected to a public water supply system and are within three miles of an approved private fire department (108, p. 2).

(45). The requirement of three miles to get fire insurance credit under the private fire department is more stringent than the five miles required for a Class 9 public fire department (94). Because of the ISO requirements, it would be more beneficial for a county to consider a public fire department; therefore, the costs of establishing a private fire department was not investigated under the insurance reduction alternative.

Class A or B rural fire department. For purposes of allowing premium credits for rural farm property, the ISO will approve a Class A[11] or B rating for a rural fire department provided the appropriate standards are met. The minimum standards are set forth in the "Specifications for Rural Fire Departments" published by the ISO (48) (see Appendix C, Section I). The major requirements consist of (1) a department organized by ordinance or resolution and under supervision of the county government;[12]

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[11] Generally, the Class A or B fire classification rating is for farm property and the Class 1 to 10 ratings are for nonfarm property. Farm property located within a municipality which has a Class 9 fire protection rating or better can be given the insurance credit allowed for a Class B rural fire department. If the farm property is located within a city, town, or utility district which has a Class 8 rating and is not located more than 1,000 feet from a public fire hydrant and five miles from a fire department which will respond, then a credit of 10 cents per $100 of insurance coverage may be allowed (49, p. 17). If the rural fire department has a Class B rating, then a credit of three cents per $100 of insurance is allowed but only for farm property. For a Class A rural fire department, six cents per $100 of insurance is allowed on farm property. Because the Class A fire insurance premium reductions fall between those allowed for a Class 9 or 8 public fire department and are only applicable to farm property, the Class A rural fire department was not considered under the insurance reduction alternative. Although the Class A and Class 9 fire departments require about the same resources, it would be better for a fire department to have a Class 9 rating since premiums can be reduced for all property.

[12] A suggested ordinance or resolution for creating and organizing a rural fire department has been published and is available from ISO.

(2) a department having a chief, an assistant chief, and sufficient company members to assure response of at least five firemen to all fire alarms; (3) adequate fire station facilities; and (4) reliable fire apparatus with proper equipment. Other specifications deal with records, clothing, training, and fire alarm facilities. The Class B rural fire department is required to have one truck with a pumping capacity of 50 gpm or more and a water carrying capacity of 500 gallons.

Class 9 public fire department. The ISO requirements for a county to be approved for a Class 9 public fire protection rating are spelled out in the "General Outline of Requirements for Ninth Class Public Fire Protection" (44) (see Appendix C, Section II). The additional requirements mentioned in the publication but not in the "Specifications for Rural Fire Departments" are (1) the county should adopt and enforce building and fire prevention codes and enact a house numbering system; (2) the department should consist of a chief, assistant chief, and 12 firemen; (3) the department should have a truck with a pumping capacity of 60 gpm and a water tank of 500 gallons or more. Other requirements obtained from the ISO are (1) the maximum distance for one and two family dwellings without standard hydrant protection to be considered for fire insurance credit is five miles; (2) the maximum distance for one and two family dwellings with standard hydrant protection to be considered for fire insurance credit is 10 miles; and (3) one reserve pumper is required for every eight pumpers or major fraction thereof required to be in service (94). Since no changes were made in the water system for the insurance reduction alternative, the maximum distance considered was five miles. It was assumed that the county officials would adopt and enforce the necessary building and fire prevention codes.

Estimating Benefits for the Six Options Under the Insurance Reduction Alternative

The principal benefits that are expected to result from implementation of the insurance reduction alternative are fire loss savings (a reduction in fire losses) and fire insurance premium savings. These benefits are expected to arise either after the implementation of a Class B rural fire department or a Class 9 public fire department.

Benefits for a Class B rural fire department. In order to claim the annual fire loss savings as estimated for the various options under the minimum service alternative (Table 5-1, p. 119), the resources required for a Class B rural fire department must meet or exceed those required for the different options. The ISO minimum requirements, however, for apparatus for a Class B rural fire department do not meet those required for the various options; thus, the apparatus required for a Class B rural fire department was improved some so that the fire loss savings for the different options under the minimum service alternative can be claimed.

Provided the appropriate standards are met, the ISO will approve a Class B rating for a rural fire department and, once this is done, the rural farm property owners should receive some reduction in fire insurance premiums. In the Tennessee Farm Schedule, there are two additional requirements that must be met in order for farm property to receive fire insurance credit: (1) the buildings must be located in the area served by an approved rural fire department and must be located not more than 10 miles from the headquarters of the department, the distance being measured over highways accessible to fire department apparatus; and

(2) the buildings must be provided with telephone service through which an alarm of fire can be promptly communicated to the headquarters of the rural fire department (49, p. 17). From the survey data, 90 percent of the households had telephones; thus, the telephone requirement was essentially met.

For a Class B rural fire department, three cents per $100 of insurance is allowed by ISO. Assuming the two requirements above are met, then the reduction in insurance premiums on farm property as presented in Table 5-7 can be claimed for the Class B rural fire department for the six different options under the insurance reduction alternative. Under Option V, which has a response distance of 17 miles, one fire station centrally located in each of the counties will cover most of the area in the two counties; however, some of the farms would be located beyond the 10-mile distance as required by the ISO. A count was made from a county map of the number of farm units that were beyond a circle, with a 10-mile radius, drawn in the center of each of the counties. By using this count, the premiums were adjusted downward in the two counties. Under Option IV, the premiums were also reduced in White County.

The annual premium savings, except under Option V, on farm property in Putnam County were $3,905 for a Class B rural fire department (Table 5-7). Under Option V the annual insurance savings were $2,321. In White County the yearly premium savings, except for Options IV and V, were $1,048 for a Class B rural fire department. The annual reduction in insurance costs in White County was $943 under Options IV and V.

Table 5-7. Total estimated annual benefits (fire loss and fire insurance premium savings) for a Class B rural fire department for six fire protection options under the insurance reduction alternative, Putnam and White counties, Tennessee, 1973[a]

County and type of benefit	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Putnam						
Fire loss savings	161,389	126,718	114,007	105,306	73,664	140,788
Fire insurance premium savings - farm property	3,905	3,905	3,905	3,905	2,321[b]	3,905
Total	165,294	129,813	117,912	109,211	75,985	144,693
White						
Fire loss savings	112,370	88,027	79,300	73,418	65,592	97,602
Fire insurance premium savings - farm property	1,048	1,048	1,048	943[c]	943[c]	1,048
Total	113,418	89,075	80,348	74,361	66,535	98,650
Putnam and White						
Fire loss savings	273,759	214,745	193,307	178,724	139,256	238,390
Fire insurance premium savings - farm property	4,953	4,953	4,953	4,848	3,264	4,953
Total	278,712	219,698	198,260	183,572	142,520	243,343

[a]Computed from survey data.

[b]Approximately 75 percent of the farms covered by insurance are included.

[c]Approximately 90 percent of the farms covered by insurance are included.

The estimated annual reductions in insurance premiums on farm property were added to the estimated annual fire loss savings to get the annual total benefits that would go to the rural resident property owners under the six options (Table 5-7). The fire loss savings were assumed to begin occurring during the year after the establishment of one of the options. Since it takes some time for the ISO to approve a particular fire department after it has been established, a lag of one year was assumed for the insurance premium reduction benefits.

Benefits for a Class 9 public fire department. In order to claim the annual fire loss savings as estimated for the various options under the minimum service alternative (Table 5-1, p. 119), the resources required for a Class 9 public fire department must meet or exceed those required for the different options. The ISO minimum requirements, however, for apparatus for a Class 9 public fire department do not meet those required for the various options; thus, the apparatus required for a Class 9 public fire department was improved some so that the fire loss savings for the different options under the minimum service alternative can be claimed.

The fire insurance premium reductions for farm property for a Class 9 public fire department are the same as those for a Class B rural fire department. For nonfarm property other than businesses and institutions, the average annual premium savings as computed from the sample survey data were $4.78 per household. The average premium savings were multiplied by the estimated number of nonfarm housing units with fire insurance (3,820) to give the total annual premium savings of $18,260 for Putnam County for a Class 9 public fire department. Similarly, the

average annual premium savings were multiplied by the estimated number of nonfarm housing units with fire insurance (2,091) to give the total annual premium savings of $9,995 for White County. These annual premium savings ($18,260 and $9,995 for Putnam and White counties, respectively) were used only for Option I because five miles was the limit under this option and under a Class 9 public fire department. For the other options, the yearly premium savings were calculated by multiplying the annual premium savings for Option I by the ratio of the miles (five) for Option I to the miles for the other options.

For the business and institutional property owners, the estimated annual premium savings for the various options were computed in a manner similar to that for the nonfarm property owners. The estimated annual fire insurance savings ($3,976 and $2,369 for Putnam and White counties, respectively) were used only for Option I. For the other options, the yearly premium savings were calculated by multiplying the annual premium savings for Option I by the ratio of miles (five) for Option I to the miles for the other options.

The estimated annual fire insurance savings ($3,976 and $2,369 for Putnam and White counties, respectively) for business and institutional property owners were added to the annual fire insurance savings for the farm and nonfarm property owners. The fire insurance savings on all rural property along with the fire loss savings are shown in Table 5-8. In Putnam County the total estimated annual benefits that are expected to result from the implementation of a volunteer Class 9 public fire department ranged from a high of $187,530 for Option I to a low of $82,525 for Option V. For Option VI, which has a full-time force of

Table 5-8. Total estimated annual benefits (fire loss and fire insurance premium savings) for a Class 9 public fire department for six fire protection options under the insurance reduction alternative, Putnam and White counties, Tennessee, 1973[a]

County and type of benefit	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Putnam						
Fire loss savings	161,389	126,718	114,007	105,306	73,664	140,788
Fire insurance premium savings - farm property	3,905	3,905	3,905	3,905	2,321[b]	3,905
Fire insurance premium savings - other property	22,236	15,883	17,105	8,236	6,540	17,105
Total	187,530	146,506	135,017	117,447	82,525	161,798
White						
Fire loss savings	112,370	88,027	79,300	73,418	65,592	97,602
Fire insurance premium savings - farm property	1,048	1,048	1,048	943[c]	943[c]	1,048
Fire insurance premium savings - other property	12,364	8,831	9,511	4,579	3,636	9,511
Total	125,782	97,906	89,859	78,940	70,171	108,161
Putnam and White						
Fire loss savings	273,759	214,745	193,307	178,724	139,256	238,390
Fire insurance premium savings - farm property	4,953	4,953	4,953	4,848	3,264	4,953
Fire insurance premium savings - other property	34,600	24,714	26,616	12,815	10,176	26,616
Total	313,312	244,412	224,876	196,387	152,696	269,959

[a]Computed from survey data.

[b]Approximately 75 percent of the farms covered by insurance are included.

[c]Approximately 90 percent of the farms covered by insurance are included.

firemen, the estimated yearly benefits ($161,798) fell between those for Options I and II. A similar pattern of savings was found for White County, with Option I having annual benefits of $125,782 and Option V, $70,171.

Estimating Costs for the Six Options Under the Insurance Reduction Alternative

Costs for a Class B rural fire department. The fire department resources required for the minimum service alternative meet or exceed those required for a Class B rural fire department under the insurance reduction alternative. Thus, the costs as estimated for the six options under the minimum service alternative (Tables 5-3, 5-4, 5-5; pp. 130-131) were used for the Class B rural fire department for the six options under the insurance reduction alternative.

Costs for a Class 9 public fire department. The additional costs that are required for a Class 9 public fire department that are not required for a Class B rural fire department would be for an extra pumper (one extra pumper is required for every eight pumpers that a fire department has) and additional facilities, manpower, and equipment associated with the use of the extra pumper. An extra pumper costs $17,000. Additional communications equipment (pagers) and firemen equipment were required for the five or ten men that were needed to man the extra pumper(s). The cost of the pagers was $297 each and the cost of firemen equipment was $104 for each fireman.

When the two counties were considered as one area, Options I and III required a two-bay fire station rather than a one-bay station to

house an additional pumper. The space requirements (544 square feet) and costs ($3,726) for a one-bay fire station under the minimum service alternative were doubled to get a cost of $7,452 for the two-bay fire station. When the two counties were combined under Option VI, an extra two-bay fire station was needed rather than a one-bay station to house an additional pumper and two additional firemen. As under the minimum service alternative, 249 square feet plus an additional 150 square feet were added to the two-bay fire station to allow enough space for sleeping quarters, bathroom, and living space. At $15.00 psf, the cost was $22,305 for the extra two-bay fire station.

The annual operating costs used for the minimum service alternative were adjusted to reflect the additional costs for salaries and fringe benefits, firemen insurance, utilities, fuel, repairs and maintenance, and insurance for the Class 9 public fire department under the insurance reduction alternative.

The initial outlay costs and the annual operating costs for a Class 9 public fire department for six fire protection options under the insurance reduction alternative are presented in Table 5-9 for Putnam County. The initial outlay costs for a volunteer Class 9 public fire department ranged from a low of $66,284 for Option V to a high of $240,002 for Option I. The annual operating costs were $3,163 and $10,173 for Options V and I, respectively. In White County the initial outlay costs were $66,284 and $210,997 for Options V and I, respectively (Table 5-10). Under the full-time option (VI), the initial outlay costs were higher than those for any other option in White County. The annual operating costs were $3,163 for Option V and $8,992 for Option I.

Table 5-9. Total cost of providing fire protection for a Class 9 public fire department for six fire protection options under the insurance reduction alternative by cost component, Putnam County, Tennessee, 1973

Cost component	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Initial outlay costs						
Fire station(s)	48,156	36,978	36,978	29,526	25,800	61,485
Building equipment	700	700	700	700	700	2,450
Communications equipment	12,474	8,019	8,019	5,049	3,564	5,940
Apparatus	167,500	85,000	103,000	51,000	34,000	103,000
Land	6,804	3,888	3,888	1,944	972	3,888
Firemen equipment	4,368	2,808	2,808	1,768	1,248	2,080
Total	240,002	137,393	155,393	89,987	66,284	178,843
Annual operating costs						
Firemen salaries and fringe benefits	--	--	--	--	--	146,300
Firemen insurance	462	297	297	187	132	--
Utilities	1,314	1,005	1,005	799	696	2,784
Office supplies	200	200	200	200	200	200
Fuel	1,800	1,125	1,125	675	450	1,125
Repairs and maintenance - fire station(s)	848	651	651	520	454	1,082
Repairs and maintenance - building and communications equipment	198	131	131	86	64	126
Repairs and maintenance - apparatus[a]	1,675	850	1,030	510	340	1,030
Insurance - fire station(s)	146	112	112	89	78	186
Insurance - building and communications equipment	40	26	26	17	13	25
Insurance - apparatus	3,490	1,840	2,152	1,104	736	2,152
Total	10,173	6,237	6,729	4,187	3,163	155,010

[a]Represents annual repairs and maintenance cost for first 10 years of 1 percent on original investment in apparatus and auxiliary equipment. After 10 years the annual maintenance cost used was 2 percent on original investment.

Table 5-10. Total cost of providing fire protection for a Class 9 public fire department for six fire protection options under the insurance reduction alternative by cost component, White County, Tennessee, 1973

Cost component	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Initial outlay costs						
Fire station(s)	44,430	36,978	40,704	25,800	25,800	73,380
Building equipment	700	700	700	700	700	2,900
Communications equipment	10,395	8,019	9,504	3,564	3,564	7,128
Apparatus	146,000	85,000	124,500	34,000	34,000	124,500
Land	5,832	3,888	4,860	972	972	4,860
Firemen equipment	3,640	2,808	3,328	1,248	1,248	2,496
Total	210,997	137,393	183,596	66,284	66,284	215,264
Annual operating costs						
Firemen salaries and fringe benefits	--	--	--	--	--	175,560
Firemen insurance	385	297	352	132	132	--
Utilities	1,211	1,005	1,108	696	696	3,480
Office supplies	200	200	200	200	200	200
Fuel	1,575	1,125	1,350	450	450	1,350
Repairs and maintenance - fire station(s)	782	651	716	454	454	1,291
Repairs and maintenance - building and communications equipment	166	131	153	64	64	150
Repairs and maintenance - apparatus[a]	1,460	850	1,245	340	340	1,245
Insurance - fire station(s)	135	112	123	78	78	222
Insurance - building and communications equipment	34	26	31	13	13	30
Insurance - apparatus	3,044	1,804	2,598	736	736	2,598
Total	8,992	6,237	7,876	3,163	3,163	186,126

[a]Represents annual repairs and maintenance cost for first 10 years of 1 percent on original investment in apparatus and auxiliary equipment. After 10 years the annual maintenance cost used was 2 percent on original investment.

When the two counties were considered as one area rather than two distinct areas, the initial outlay costs varied from $89,987 for Option V to $402,946 for Option I (Table 5-11). The initial outlay costs for the two counties considered independently were the highest ($450,999) for Option I and the lowest for Option V ($132,568). If the two counties were combined, the cost savings would be $48,053 for Option I and $42,581 for Option V. However, the greatest cost savings ($89,987) for the two counties considered as one area would be realized under Option II. There would also be some economies of "size" in annual operating costs when the two counties are considered as one distinct area.

If the TVA program were implemented in Putnam County, White County or in both counties combined under the insurance reduction alternative, the costs ($145,188, $145,188, and $231,401 for Putnam County, White County, and the counties combined, respectively) would be the same as those presented under the minimum service alternative. The TVA program meets the requirements for a Class 9 public fire department; thus, the Class 9 benefits ($146,506) for Option II under the insurance reduction alternative can be claimed. Under Option I the full Class 9 fire insurance premium savings on other than farm property cannot be realized since the five-mile constraint required by ISO is not met. If the TVA system is designed so that the ISO requirements are fully met, then, conceivably, the Class 9 benefits ($187,530) for Option I under the insurance reduction alternative can be claimed.

Under the present setup in White County, the ISO may allow Class 9 premium reductions to some rural property owners. If so, the annual benefits that can be claimed will be those for Option V ($70,171).

Table 5-11. Total cost of providing fire protection for a Class 9 public fire department for six fire protection options under the insurance reduction alternative by cost component, Putnam and White counties, Tennessee, 1973

Cost component	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Initial outlay costs						
Fire station(s)	70,512	44,430	59,334	33,252	29,526	131,370
Building equipment	700	700	700	700	700	4,900
Communications equipment	20,790	10,989	16,929	6,534	5,049	13,068
Apparatus	292,000	119,000	227,500	68,000	51,000	227,500
Land	11,664	5,832	8,748	2,916	1,944	8,748
Firemen equipment	7,280	3,848	5,928	2,288	1,768	4,576
Total	402,946	184,799	319,139	113,690	89,987	390,162
Annual operating costs						
Firemen salaries and fringe benefits	--	--	--	--	--	321,860
Firemen insurance	770	407	627	242	187	--
Utilities	1,932	1,211	1,623	902	799	6,264
Office supplies	200	200	200	200	200	200
Fuel	3,150	1,575	2,475	900	675	2,475
Repairs and maintenance - fire station(s)	1,241	782	1,044	585	520	2,312
Repairs and maintenance - building and communications equipment	322	175	264	109	86	270
Repairs and maintenance - apparatus[a]	2,920	1,190	2,275	680	510	2,275
Insurance - fire station(s)	214	135	180	101	89	398
Insurance - building and communications equipment	65	35	53	22	17	54
Insurance - apparatus	6,088	2,576	4,750	1,472	1,104	4,750
Total	16,902	8,286	13,491	5,213	4,187	340,858

[a]Represents annual repairs and maintenance cost for first 10 years of 1 percent on original investment in apparatus and auxiliary equipment. After 10 years the annual maintenance cost used was 2 percent on original investment.

IV. ALTERNATIVE III: THE FULL SERVICE ALTERNATIVE

Alternative III is the "full service alternative." The purpose of this alternative was to develop a fire protection system so that limited areas of the counties, i.e., a utility district or a fire protection district, could achieve a Class 8 fire protection rating.[13] The primary difference between this and the other alternatives was an analysis of the water system. The minimum requirements as set forth by the ISO were met. The costs and benefits associated with this alternative were estimated.

In consultation with Frank Kirk, who is a consultant on Engineering-Public Works, Municipal Technical Advisory Service (MTAS), Institute for Public Service, University of Tennessee, Knoxville, Tennessee, the Cookeville Boat Dock Road Utility District (referred to as Utility District) was selected for study. The Utility District serves the Putnam County rural area southwest of the Cookeville city limits. The water supply is obtained from the Cookeville water system, which in turn obtains its water from City Lake, an impoundment of the Falling Water River located east of the city and from the Minelick Creek branch of the Center Hill Lake located southwest of Cookeville. As of 1973, the water distribution system of the Utility District extended about 14 miles from the city limits of Cookeville and was made up of

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[13] The reasons for selecting a particular utility district rather than the entire county for an analysis of the full service alternative was (1) the difficulty of obtaining maps and other necessary data for existing utility districts and (2) the difficulty of estimating water system costs for areas of the county without a water distribution system.

61,200 feet of six-inch mains and 160,350 feet of under six-inch mains. The water distribution system consists of long lengths of pipe which, except in a couple of cases, do not form a grid system.[14] There were no fire hydrants in the system. In order for the water system to be approved for fire protection purposes, the system will have to be improved to meet the standards as required by ISO. The Utility District has a Class 10 fire classification rating.

ISO Standards Required for the Full Service Alternative

When considering fire protection under the full service alternative, the ISO will recognize a Class 8 or better fire department. The general requirements for a municipality or a utility district to obtain a Class 8 fire protection rating are outlined in "General Outline of Requirements for Public Fire Protection" published by the ISO (45) (see Appendix B, Section 3). Other requirements are set forth in the Grading Schedule for Municipal Fire Protection (46). The standards which are different from those mentioned for a Class 9 department are: (1) the fire department, which may be volunteer, should consist of 15 members, including a chief and an assistant chief; and (2) the department should have an approved fire department pumper, with a pumping capacity of not less than 750 gpm, a water tank of not less than 300 gallons, and other auxiliary equipment. One and two-family dwellings should be within five miles of the fire station if standard hydrant protection is provided (94)

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[14] A grid system consists of a network of water mains (primary feeders, secondary feeders, and distributors) which reinforce each other and make up the water distribution system.

and the average separation of such buildings must be 100 feet or more (46, p. 24). Also, a reserve pumper is required for every eight pumpers or major fraction thereof required to be in service (94).

The primary requirements that differentiate a Class 8 municipality from a Class 9 municipality concern the water system. The requirements deal with the water supply, pressure, elevated storage, pumping equipment, water mains, gate valves, fire hydrants, and records. In order to meet the ISO requirements, certain assumptions were made with respect to the Utility District. It was assumed that the necessary water for consumption and fire protection purposes could be supplied by the Cookeville water system and the pumping equipment was sufficient to meet the ISO requirements. These assumptions appeared to be reasonable since Cookeville obtains its water from two water treatment plants which together have a designed capacity of 12.3 million gpd. The other requirements that need to be discussed concern pressure, elevated storage, water mains, gate valves, and fire hydrants.

In residential sections, or where buildings are chiefly one or two stories in height, the ISO requires the fire flow at each fire hydrant be not less than 500 gpm at 10 pounds residual pressure for a two-hour period (45, p. 2).[15] The basic fire flow rate is in addition

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[15]In the "General Outline of Requirements for Public Fire Protection," the ISO requires that the fire flow at fire hydrants be 500 gpm at 20 pounds residual pressure. However, due to negotiations with the Public Technology, Inc., the ISO agreed that 10 psi may be used if acceptable to the health authorities and there is no deficiency in the distribution, size, type, and installation of hydrants (92, p. 17).

to the maximum daily consumption rate.[16] The normal ability of the water distribution system to maintain the maximum daily consumption rate plus the basic fire flow rate will be considered by ISO (46, p. 12). For the Utility District, this requirement can be met by installing the minimum size mains along with elevated storage tanks which together will deliver the maximum daily consumption rate plus the basic fire flow. The capacity of the elevated storage tanks should not be smaller than 100,000 gallons (45, p. 2). Eight-inch mains are required in residential districts where long lengths of pipe are necessary, where dead ends and a poor gridiron are likely to exist for a considerable period, or where the layout of the roads and the topography are not well adapted to a good gridiron (46, p. 11). In case there is a break in the water mains, no deficiency will be assigned by the ISO if the water system can continue to deliver the basic fire flow for two hours at any time during a period of three days with consumption at the maximum daily rate (46, p. 18).

Additional requirements deal with the spacing of gate valves and the type and spacing of fire hydrants. Gate valves are required to be placed at the point of connection between a smaller main and a larger main and to be placed at strategic locations on each main so that no more than two fire hydrants are controlled by one group of valves. Preferably, gate valves should be sufficient in number to insure that no single case

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[16]The maximum daily consumption rate is the maximum total amount of water used during any 24-hour period; it is the average rate of consumption on the maximum day. Records for at least the past three years are used to determine the maximum daily consumption. Otherwise, the maximum daily consumption is estimated by looking at the consumption figures in other municipalities of similar character and climate, but such estimates must be at least 50 percent greater than the average daily consumption (46, p. 10).

of breakage or repair will necessitate cutting out more than 800 feet in a residential section. Fire hydrants should be a standard type and should be spaced 500 to 700 feet[17] in residential sections. Where hydrants are connected to a six-inch or larger main, gate valves should be provided in the hydrant connections (45, pp. 2-3).

Estimating Benefits for the Full Service Alternative

The principal benefits that are expected to result from adoption of the full service alternative for the Utility District are fire loss savings (a reduction in fire losses) and fire insurance premium savings. The fire loss savings are expected to occur during the same year after implementation of the full service alternative and assuming that the ISO approves the established alternative within the first year, the fire insurance premium savings are expected to occur the second year.

Since the required distance (five miles) for a Class 8 public fire department is the same as under Option I and the resources required for a Class 8 fire department exceed those under Option I, then, the fire loss savings associated with this option can be claimed as a minimum. Because the number of households, businesses, and institutions are considerably less than the number in the county, the fire loss savings will also be less. As of 1973, the Utility District had 420

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[17] In the "General Outline of Requirements for Public Fire Protection," the ISO requires that hydrants be located no more than 600 feet in residential sections. However, K. G. Hulme, who is Superintendent of the Rating, Inspections and Fire Protection Department of the ISO of Nashville, Tennessee, recommended that fire hydrants be spaced approximately 700 feet apart in residential districts of Crossville, Tennessee (39). This recommendation was followed in this study.

households connected to the system. Also, there were 11 businesses and 13 institutions. The fire loss savings were estimated for these groups using the procedure outlined in Section III, Appendix A. The estimated annual fire loss savings were $16,341 for all the rural property owners in the Utility District.

Besides the fire loss savings, there should be some insurance premium savings to the property owners in the Utility District if the Utility District is approved for a Class 8 fire protection rating. Farm property may be allowed a credit of 10 cents per $100 of fire insurance coverage if it is located in a municipality or utility district having a Class 8 rating or better and located not more than 1,000 feet from a fire hydrant and within five miles of a fire department, measured over roads suitable for fire department use (49, p. 17). Based on survey data, the average annual insurance premium savings per farm were $15.07 when the 10-cent credit was used. When the annual premium savings ($15.07) were multiplied by the estimated number of farms (79) with fire insurance, the result was $1,190 for the yearly savings in insurance premiums for farm property in the Utility District. Based on survey data, the average annual insurance premium savings were $17.31 for each nonfarm dwelling. When the annual premium savings ($17.31) were multiplied by the estimated number of nonfarm dwellings (282) with fire insurance, the resulting savings were $4,881 for rural nonfarm property owners in the Utility District.

The annual premium savings for the 11 businesses and 13 institutions were calculated in a similar manner. The premium savings for the businesses and institutions with fire insurance were estimated to be $614 each year.

When the fire loss savings were added to the fire insurance premium savings, the total estimated annual benefits would be $23,026 if the Utility District were approved for a Class 8 fire protection system.[18]

Estimating Costs for the Full Service Alternative

The costs that need to be discussed under the full service alternative but were not discussed either under the minimum service alternative or under the insurance reduction alternative are apparatus and water system costs.

Apparatus costs. The apparatus cost of $29,950 for a 750 gpm pumper was obtained from a company that manufactures fire engines. Two fire engines were necessary for the central fire station and one for the other fire station.

Water system costs. As of 1973, the Utility District was built to deliver water for consumption purposes only; therefore, the complete construction cost can be allocated to consumption. Now, the question is: What would it have cost to build the Utility District water system so that the system could deliver water for consumption and fire purposes? The difference between the cost for consumption and fire purposes and the cost for consumption purposes alone was used to represent the part of the water system costs that should be allocated to fire protection.

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[18] If a Class 6 fire protection system were approved, the additional fire insurance savings per year would be $2,371. Under a Class 6 fire protection system, the ISO requires two full-time men around the clock for each apparatus (40). At a salary cost of $6,650 per year, the benefits would not be enough to pay for one full-time fireman; therefore, further consideration of the Class 6 fire protection system was dropped.

In order to determine the construction cost of the Utility District for consumption purposes only, it was necessary to obtain data on bid tabulations from the engineering firm which represented the Utility District. The original bid data were for January 6, 1970, and additional bid data were for July 26, 1973. When it was possible, the price data for the various items for July 26, 1973, were used to estimate the construction costs as of 1973 for the Utility District. Other costs were obtained from Bid Data on Current Municipal Works published by the Municipal Technical Advisory Service (58, 59). The estimated construction cost for the existing Utility District water distribution system is presented in Table 5-12. The total cost of the water distribution system was estimated to be $401,295, which was for consumption purposes only.

In consultation with Frank Kirk, the required items for the Utility District to deliver water for consumption and fire protection purposes were determined. In order for the water system to deliver a fire flow of 500 gpm at 10 psi, a decision was made to use 150,000-gallon elevated storage tanks located at different points along the water distribution system. At a height of 115 feet, a storage tank would be able to deliver the required fire flow at 10 psi for about 20,000 feet with eight-inch mains being used.[19] Using this criteria (20,000 feet) and considering the elevation within the Utility District, three storage

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[19]At a height of 115 feet, the static pressure created by the elevated water tank is approximately 50 psi. When water is delivered to the households, the pressure loss is about 2 psi for each 1,000 feet of water mains. Thus, 40 pounds of pressure are lost when the water mains are extended 20,000 feet, leaving a residual pressure of 10 psi. The height of the storage tanks can be varied to accommodate the elevation existing within the Utility District.

Table 5-12. Estimated construction cost for the existing Cookeville Boat Dock Road Utility District water distribution system, 420 service connections, Putnam County, 1973

Item description	Quantity	Unit	Unit price	Total Cost
	Number		-------Dollars-------	
6" (200 psi) pvc pipe	61,000	linear foot	1.91	116,510.00
4" (200 psi) pvc pipe	97,000	linear foot	1.30	126,100.00
3" (200 psi) pvc pipe	21,000	linear foot	1.12	23,520.00
2" (200 psi) pvc pipe	42,100	linear foot	.96	40,416.00
6" ductile iron pipe	200	linear foot	4.12	824.00
4" ductile iron pipe	100	linear foot	2.77	277.00
2" ductile iron pipe	150	linear foot	1.57	235.50
Cast iron fittings	10,000	pound	.60	6,000.00
6" gate valve with box	21	each	120.00	2,520.00
4" gate valve with box	45	each	105.20	4,734.00
3" gate valve with box	8	each	85.08	680.64
2" gate valve with box	31	each	69.28	2,147.68
Rock excavation	1,000	cubic yard	15.00	15,000.00
Air relief valve with box	10	each	125.00	1,250.00
Blow-off connections	37	each	115.00	4,255.00
Pressure reducing stations	2	each	1,482.50	2,965.00
3/4" service connections	420	each	62.00	26,040.00
5/8" x 3/4" water meters	420	each	35.00	14,700.00
3/4" pvc service line	13,800	linear foot	.15	2,070.00
Master meter complete	1	each	4,000.00	4,000.00
Crushed stone street replacement	1,450	ton	3.00	4,350.00
Bituminous road replacement	450	square yard	6.00	2,700.00
Total				401,294.82

Source: Adapted from Sverdrup and Parcel and Associates, Inc., Tabulation of Bids, Contract I--Water Distribution System--Cookeville Boat Dock Road Utility District and Tabulation of Bids, Contract I--Additions to Water Distribution System--Cookeville Boat Dock Road Utility District (Nashville: Sverdrup and Parcel and Associates, Inc., January 6, 1970, and July 26, 1973) and Frank E. Kirk, editor, Bid Data on Current Municipal Public Works, Technical Bulletin Numbers 67 and 68, Municipal Technical Advisory Service, Institute for Public Service in cooperation with the Tennessee Municipal League, the University of Tennessee (Knoxville: Municipal Technical Advisory Service, January and July, 1973).

tanks were used.[20] In addition to the needed storage tanks, fire hydrants and gate valves for hydrant connections were needed. The number of fire hydrants needed were determined by using a map of the Utility District furnished by an engineering firm and locating the fire hydrants so that each rural structure was no more than 350 feet from a fire hydrant. The number of needed gate valves along the water mains were determined by dividing the number of needed fire hydrants by two. It was assumed that the calculated number of gate valves would be sufficient to meet the requirements of the ISO.[21]

The unit prices and the estimated construction cost for the Utility District water distribution system with fire protection costs added are shown in Table 5-13. The total construction cost was $989,718. When the total construction cost of the water distribution system for consumption purposes only (Table 5-12) was subtracted from the total construction cost for consumption and fire protection purposes (Table

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[20]In case of breakage or repair work on the mains, the three 150,000-gallon storage tanks will deliver enough water to meet consumption and fire flow requirements. The average daily consumption per household for four utility districts in Putnam County was 187 gpd (117, pp. 90-92). The average daily consumption of 187 gpd was multiplied by 150 percent to give the maximum daily consumption per household of 281 gpd. To get the maximum daily consumption for all the households in the Utility District, 281 gpd was multiplied by 420. The maximum daily consumption (118,020 gpd) and the required fire flow of 500 gpm for two hours (60,000 gallons) can be delivered by the three storage tanks for three days as required by the ISO.

[21]This assumption is not entirely valid because the ISO requires that no more than 800 feet of pipe be cut out in a residential section due to breakage or repair. In order to meet the ISO requirements for the Utility District, an elevated storage tank would be needed almost every 800 feet since the Utility District has a poor grid system. Thus, the criterion of having not more than two fire hydrants controlled by a set of valves was thought to be reasonable.

Table 5-13. Estimated construction cost for the Cookeville Boat Dock Road Utility District water distribution system with fire protection costs for water added, 420 service connections, Putnam County, 1973

Item description	Quantity	Unit	Unit price	Total cost
	Number		------Dollars-----	
8" (200 psi) pvc pipe	221,100	linear foot	2.46	543,906
8" ductile iron pipe	450	linear foot	5.60	2,520
Cast iron fittings	10,000	pound	.60	6,000
8" gate valve with box	142	each	160.00	22,720
6" gate valve with box	283	each	120.00	33,960
Rock excavation	1,000	cubic yard	15.00	15,000
Air relief valve with box	10	each	125.00	1,250
Blow-off connections	37	each	115.00	4,255
Pressure reducing stations	2	each	1,482.50	2,965
3/4" service connections	420	each	62.00	26,040
5/8" x 3/4" water meters	420	each	35.00	14,700
3/4" pvc service line	13,800	linear foot	.15	2,070
Master meter complete	1	each	4,000.00	4,000
Crushed stone street replacement	1,450	ton	3.00	4,350
Bituminous road replacement	450	square yard	6.00	2,700
Fire hydrants	283	each	375.00	106,125
Elevated storage tanks	3	each	65,719.00	197,157
Total				989,718

Source: Adapted from Sverdrup and Parcel and Associates, Inc., Tabulation of Bids, Contract I--Water Distribution System--Cookeville Boat Dock Road Utility District and Tabulation of Bids, Contract I--Additions to Water Distribution System--Cookeville Boat Dock Road Utility District (Nashville: Sverdrup and Parcel and Associates, Inc., January 6, 1970, and July 26, 1973); Frank E. Kirk, editor, Bid Data on Current Municipal Public Works, Technical Bulletin Numbers 67 and 68, Municipal Technical Advisory Service, Institute for Public Service in cooperation with the Tennessee Municipal League, the University of Tennessee (Knoxville: Municipal Technical Advisory Service, January and July, 1973); and personal interviews with Frank E. Kirk, Engineering-Public Works Consultant, Municipal Technical Advisory Service, Institute for Public Service, the University of Tennessee, Knoxville, Tennessee, August, 1974, and August, 1975.

5-13), the total cost ($588,423) for fire protection alone was found. A yearly maintenance cost of 1.5 percent was used for the portion of the cost allocated to fire protection (60).

The initial outlay and annual operating costs of establishing a Class 8 fire protection rating for the Utility District are detailed in Table 5-14. The initial outlay costs were $712,211 and the annual operating costs were $14,041. The water system costs for fire protection are 83 percent of the initial outlay costs and 63 percent of the annual operating costs.

Table 5-14. Total cost of providing fire protection to a Class 8 utility district under the full service alternative by cost component, Cookeville Boat Dock Road Utility District, Putnam County, Tennessee, 1973

Cost component	Costs
	Dollars
Initial outlay costs	
Fire station(s) - two	29,526
Building equipment	700
Communications equipment	5,049
Apparatus	89,850
Land	1,944
Firemen equipment	1,768
Water system	588,423
Total	712,211
Annual operating costs	
Firemen insurance	187
Utilities	799
Office supplies	200
Fuel	675
Repairs and maintenance - fire station(s)	520
Repairs and maintenance - building and communications equipment	86
Repairs and maintenance - apparatus[a]	899
Repairs and maintenance - water system	8,826
Insurance - fire station(s)	89
Insurance - building and communications equipment	17
Insurance - apparatus	1,743
Total	14,041

[a]Represents annual repairs and maintenance cost for first 10 years of 1 percent on original investment in apparatus and auxiliary equipment. After 10 years the annual maintenance cost used was 2 percent on original investment.

CHAPTER VI

BENEFIT-COST ANALYSIS AND FIRE STATION LOCATION

I. BENEFIT-COST ANALYSIS

The Estimation Procedure

Two criteria can be used to recommend a fire protection option for adoption for Putnam County, White County, and for both counties combined: (1) the present value of net benefits criterion and (2) the benefit-cost criterion.

A net benefit or net savings formula for each option can be expressed as follows:

$$\text{Net benefits} = \sum_{t=1}^{T} \frac{B}{(1+i)^t} - \sum_{t=1}^{T} \left[\frac{OMR}{(1+i)^t} + K \right]$$

where

B = annual benefits (fire loss and fire insurance premium savings)

OMR = annual operating, maintenance, and repair costs

K = initial investment or capital costs

i = discount or interest rate

T = planning or time horizon

If the objective is to maximize net benefits (fire loss and fire insurance premium savings) or to minimize the total fire costs (fire protection costs and fire losses), the net benefit formula is the appropriate criterion to select. Alternatively, if one is primarily concerned with determining which fire protection option would result in the greatest fire loss and fire insurance premium reductions per dollar of

fire protection costs, the appropriate criterion is the ratio of benefits to costs which may be expressed as follows:

$$\text{B/C ratio} = \sum_{t=1}^{T} \frac{B}{(1+i)^t} \div \sum_{t=1}^{T} \left[\frac{OMR}{(1+i)^t} + K \right]$$

where all variables have been previously defined.

With the benefit-cost criterion, the county government having a limited budget can choose the option that will give the greatest benefit (fire loss and fire insurance premium savings) per dollar spent on fire protection. On the other hand, if the budget is flexible, the responsible officials of the county may wish to allocate funds to the option which will yield the greatest net benefits to their constituency. In the long run, the total fire costs will be reduced the most by selecting that option which gives the greatest net benefits. Thus, the nature of the budget constraint is the key consideration in choosing among a set of potential fire protection options.

To make a formal comparison of benefits and costs of fire protection in dollar terms, it was necessary to determine the planning horizon and discount rates to be used in the analysis. It was also necessary to compute the present value of the benefits and costs for each fire protection option.

Planning horizon. The planning period chosen should be roughly comparable to the economic life of the project. Gittinger states that "a convenient starting point for establishing the period of the analysis is the technical life of the major investment item" (30 , p. 87). The major cost item for most of the options was for apparatus. Twenty years was chosen as the planning horizon for all the options since the apparatus had an assumed life of 20 years (3 , p. 146). Also, the ISO requires

that first-line equipment be no older than 20 years (69). Since the survey data for estimating benefits were obtained in the late summer and fall months of 1973, 1973 was selected as the base year for the planning horizon.

Discount rates. Discounting was required to compare the values of the benefits and costs estimated for different points in time. According to Davie and Duncombe, the "fundamental reason for discounting is to reflect the value of resources in alternative investment uses" (15 , p. 81). For society as a whole, resources may be allocated between the public and private sectors or between the provision of current and future goods and services. The social rate of time preference is generally used to solve the current and future resource allocation problem. The best measure of the social rate of time preference is thought to be the yield on long-term, federal government securities (15 , p. 86).

The rate of return on private uses of resources is used for the allocation of resources between the public and private sector. Baumol states that "the correct discount rate for the evaluation of a government project is the percentage rate of return that the resources utilized would otherwise provide in the private sector" (5 , p. 489). Due to taxes, risks, and externalities, there may be some discrepancies in the rates of return earned in the private sector and capital may not be optimally allocated within that sector. Unless the rules of optimal investment procedure are put into operation in the private sector of the economy, it is not necessarily true that the rules are applicable to the public sector (5 , p. 501).

Due to the difficulties in determining an appropriate discount rate, many have resorted to the use of sensitivity analysis to show the

sensitivity of the benefit-cost outcome to alternative values for the discount rate. A variation of this procedure was utilized in this study.

The discussion about discount rates thus far has been concerned with rates that could be used for government projects which have implications for all of society. The discount rates used for a regional or national analysis may not be appropriate for a local project. From the point of view of local government officials, the appropriate rate for discounting depends on what alternatives are available for investing the money other than for fire protection purposes. If money has to be borrowed to pay for fire protection services, then the appropriate rate would appear to be the interest rate that has to be paid for the funds borrowed. If funds are made available from grants or revenue sharing, then the appropriate rate would depend on what these funds could be loaned out for. The local bond rates in the two counties were approximately 6 percent in 1973-1974 and the amount paid on time deposits was approximately 5 to 6 percent (51, 69, 97). Using these criteria, a discount rate of 6 percent was used to rank the options by the net benefits criterion and the benefit-cost criterion. All the options were further subjected to sensitivity analysis at discount rates of 7 and 8 percent to determine if the ranking of the projects would change from the 6 percent rate.

Present value of benefits and costs. To simplify the analysis, it was assumed that one of the options was adopted in 1973 and that the option was operational within a few months after adoption. All initial or capital outlay costs were assumed to occur during the first year and all operating, maintenance and repair costs were assumed to begin accruing during the same and ensuing years. Similarly, all fire loss savings were

assumed to begin accruing immediately after implementation of the project. Since it would take about a year after the implementation of one of the options to obtain ISO approval and assign a fire protection rating, the fire insurance premium savings were assumed to begin accruing during the second year after the start of the project.

All costs items were calculated in terms of 1973 dollars. Since the primary purpose was to find which option ranks the highest under the net benefits criterion or the benefit-cost criterion, all costs and benefits for the 20-year period were calculated in constant 1973 dollars for comparison purposes. This is equivalent to deflating all costs and benefits by a price index. If the prices used to compute costs and benefits rise uniformly over the 20-year period, the relative values of the costs and benefits will not change. But, if the prices have a different impact on costs than on benefits, or vice versa, then the analysis should reflect the change in relative prices. For this analysis, there was no underlying reason to believe that costs would rise faster than benefits, or vice versa. Thus, for comparative purposes the assumption of constant 1973 dollars was retained throughout the analysis.

To compute the present value of costs and benefits, assumptions were made about the salvage values and replacement costs. The expected life of a fire station is approximately 50 years (96, p. 74) but the planning horizon was for only 20 years. A stream of useful services was expected from the fire station for another 30 years after the planning horizon had ended. This stream of useful services was estimated by using straight line depreciation and added to the benefits that were to be

received during the final year (20) of the planning horizon. Three-fifths of the water system cost under the full service alternative was also added to the benefits during the final year since the estimated life was 50 years (60). The estimated life for building, communications, and firemen equipment was 15 years (96, p. 76); therefore, the original investment cost for these items was used to replace these items at the end of the fifteenth year and two-thirds of the replacement cost was added to the benefits for the final year. Land costs were assumed to neither appreciate nor depreciate; thus, the full amount of the land costs was added to the benefits to be received during the final year of the planning horizon.

Operating, maintenance, and repair costs were discounted for 20 years. The cost for maintenance and repairs on apparatus and accessory equipment was assumed to be 1 percent of original investment during the first ten years and 2 percent of original investment during the second ten years.

All benefits, except for fire insurance premium savings, were discounted for 20 years. Fire insurance premium savings were discounted for the last 19 years.

Results of the Analysis

Results of the benefit-cost analysis for the different options under the three alternatives for Putnam County are presented in Table 6-1 at a 6 percent discount rate. The present value of the benefits and costs, the present value of the net benefits, and the benefit/cost ratio are shown for each of the options. For example, under Option I of the

Table 6-1. Benefit-cost analysis of six fire protection options by alternative, Putnam County, Tennessee, 1973

Alternative[a]	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Minimum service alternative						
Present value of benefits[b]	1,865,476	1,463,552	1,317,758	1,215,125	850,778	1,629,341
Present value of costs[b]	340,645	187,013	211,396	113,023	76,028	1,600,485
Present value of net benefits	1,524,831	1,276,539	1,106,362	1,102,102	774,750	28,856
Benefit/cost ratio	5.48	7.83	6.23	10.75	11.19	1.02
Insurance reduction alternative						
Class B rural fire department						
Present value of benefits[b]	1,906,582	1,495,368	1,358,864	1,256,231	875,210	1,670,447
Present value of costs[b]	340,645	187,013	211,396	113,023	76,028	1,600,485
Present calue of net benefits	1,565,937	1,308,355	1,147,468	1,143,208	799,182	69,962
Benefit/cost ratio	5.60	8.00	6.43	11.11	11.51	1.04
Class 9 public fire department						
Present value of benefits[b]	2,141,066	1,672,268	1,539,337	1,343,344	944,470	1,850,877
Present value of costs[b]	370,889	217,234	241,617	143,244	106,260	1,965,390
Present value of net benefits	1,770,177	1,455,034	1,297,720	1,200,100	838,210	-114,513
Benefit/cost ratio	5.77	7.70	6.37	9.38	8.89	.94
Full service alternative						
Class 8 public fire department						
Present value of benefits[b]	375,575	[c]	[c]	[c]	[c]	[c]
Present value of costs[b]	885,140					
Present value of net benefits	-509,565					
Benefit/cost ratio	.42					

[a]The three alternatives and the six options are described in Chapter V.

[b]Computed at a 6 percent discount rate.

[c]The full service alternative was not considered under this option.

minimum service alternative, the present value of the benefits ($1,865,476) is the discounted value of the fire loss and the fire insurance premium savings over the 20-year planning horizon. The present value of the costs ($340,645) is the discounted value of the initial outlay and the operating, maintenance, and repair costs over the planning horizon. The present value of the costs was subtracted from the present value of the benefits to obtain the present value of the net benefits. The present value of the net benefits ($1,524,831) is the amount of benefits, net of costs, that can be obtained using Option I under the minimum service alternative (denoted as Option I (msa)) in Putnam County. The benefit/cost ratio was obtained by dividing the present value of the benefits by the present value of the costs. For Option I (msa), the benefit/cost ratio of 5.48 can be interpreted as the amount of fire loss and fire insurance premium savings that is expected to be received for every dollar of costs. In other words, for every dollar spent on fire protection costs under Option I (msa), the county is expected to receive over $5 in benefits.

Assuming that Putnam County has a limited fire protection budget and the decision-making officials of the county wish to get the most benefits out of every dollar spent on fire protection, then the results indicate that a Class B rural fire department under the insurance reduction alternative should be chosen. (Options I-V are volunteer options while Option VI is a full-time option.) The particular option that should be chosen is Option V. For each dollar spent on fire protection for a Class B rural fire department under Option V, the county should receive nearly $12 in benefits. Option V (msa) has the next highest benefit/cost ratio; but, since the costs under the minimum service alternative are the same as those for a Class B rural fire department,

the Class B rural fire department under Option V should be chosen since it has the greatest benefit/cost ratio.

A further examination of Table 6-1 indicates that for any given option, except Option I, the Class B rural fire department should be chosen using the benefit-cost criterion. For Option I, the Class 9 public fire department should be selected. The full-time option (VI) has a benefit/cost ratio greater than one for the Class B rural fire department and for the minimum service alternative but a benefit/cost ratio less than one for the Class 9 public fire department.

Assuming that Putnam County has the necessary funds and assuming that the decision-making officials' goal is to maximize the net benefits of the county residents, then the net benefit criterion should be used. As shown in Table 6-1, Option I will maximize the benefits, net of costs, when the Class 9 public fire department is adopted. Another way of stating this is that the total fire costs (fire losses and fire protection costs) will be reduced the most by adopting a Class 9 public fire department under Option I.

The results of the benefit-cost analysis for White County are shown in Table 6-2 using a 6 percent discount rate. Without exception, the Class B rural fire department had the highest benefit/cost ratio under all the options; however, the benefits per dollar expenditure decline as the more expensive fire departments are used. The Class B rural fire department under Option IV had the highest benefit/cost ratio (11.28); whereas, in Putnam County, the highest benefit/cost ratio was for a Class B rural fire department under Option V. A benefit/cost ratio of 11.28 under Option IV indicates that the county should receive over $11 in benefits for every dollar spent on fire protection costs for a

Table 6-2. Benefit-cost analysis of six fire protection options by alternative, White County, Tennessee, 1973

Alternative[a]	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Minimum service alternative						
Present value of benefits[b]	1,301,649	1,019,771	921,090	847,956	758,193	1,136,957
Present value of costs[b]	296,051	187,013	254,464	76,028	76,028	1,995,557
Present value of net benefits	1,005,598	832,758	666,626	771,928	682,165	-858,600
Benefit/cost ratio	4.40	5.45	3.62	11.15	9.97	.57
Insurance reduction alternative						
Class B rural fire department						
Present value of benefits[b]	1,312,681	1,030,803	932,122	857,883	768,119	1,147,988
Present value of costs[b]	296,051	187,013	254,464	76,028	76,028	1,995,557
Present value of net benefits	1,016,630	843,790	677,658	781,855	692,091	-847,569
Benefit/cost ratio	4.43	5.51	3.66	11.28	10.10	.58
Class 9 public fire department						
Present value of benefits[b]	1,443,247	1,124,178	1,032,657	906,500	806,810	1,248,480
Present value of costs[b]	326,283	217,234	284,696	106,260	106,260	2,360,448
Present value of net benefits	1,116,964	906,944	747,961	800,240	700,550	-1,111,968
Benefit/cost ratio	4.42	5.18	3.63	8.53	7.59	.53

[a]The two alternatives and the six options are described in Chapter V.

[b]Computed at a 6 percent discount rate.

Class B rural fire department. Under Option VI, the full-time option, the benefit/cost ratios were all less than one.

Utilizing the net benefits criterion, the Class 9 public fire department under Option I had the greatest present value of the net benefits ($1,116,964), which was the same option that gave the greatest value of the net benefits in Putnam County. If the budget of White County is such that a Class 9 public fire department can be afforded, then this type fire department under Option I should bring the greatest benefits to the rural residents of the county.

A comparison was made in White County between the rural fire protection system that existed in 1973 and Options II and IV of the minimum service alternative. In 1973 the local government officials contracted with the Sparta and Doyle fire departments for $21,500 yearly to provide fire protection to the rural areas of the county. The present value of $21,500 beginning in 1973 for 20 years is $246,603 at a 6 percent discount rate. Using this present value of costs ($246,603) and the present value of benefits ($847,956) under Option IV (msa), a benefit/cost ratio of 3.44 was computed. Whereas, under Option IV (msa), the estimated benefits that would be received were about $11 per dollar of expenditure, the new benefit/cost ratio (3.44) indicates that between $3 and $4 of benefits would be received for each dollar of expenditure. Since the contract with the Sparta and Doyle fire departments involved two fire departments (and the Sparta Fire Department was full-time), benefits greater than those under Option IV, which required only one fire station, may be received.

The next level of comparison in White County was with Option II (msa), which had a benefit/cost ratio of 5.45 and which required three

fire stations. Using the present value figure of $246,603, a benefit/cost ratio of 4.14 was calculated. A comparison of the benefit/cost ratios indicate that the county would receive more benefits out of each dollar of expenditure if it were to adopt Option II (msa). More specifically, it should strive for a Class B or Class 9 fire protection rating since the present value of the costs is less under both of these fire protection types than under the existing system. Of course, this is assuming that the benefits to be derived from having protection from the Sparta and Doyle fire departments would be no higher than for a Class 9 public fire department under Option II.

In Table 6-3, the counties were considered as one area. Without exception, the Class B rural fire department had the greatest benefit/cost ratio under all the options. When the Class B rural fire department benefit/costs ratios found in Table 6-3 were compared with the ratios found in Tables 6-1 and 6-2, Options I, II, IV, and V had the highest ratios when the counties were combined. The benefit-cost calculations in Table 6-3 indicate that a Class B rural fire department under Option V has the greatest benefit/cost ratio (14.50). The comparable ratios for Option V were 11.51 and 10.10 for Putnam and White counties, respectively. Thus, if the counties were to combine for fire protection, they should realize about $15 in benefits for every dollar they spend on a Class B rural fire department.

Utilizing the net benefits criterion, the Class 9 public fire department under Option I had the greatest present value of the net benefits ($2,958,337) when the two counties were considered as one area (Table 6-3). This figure was $71,196 more than the present value of the net benefits when the two counties were considered as two separate areas.

Table 6-3. Benefit-cost analysis of six fire protection options by alternative, Putnam and White counties, Tennessee, 1973

Alternative[a]	Option I	Option II	Option III	Option IV	Option V	Option VI
	Dollars					
Minimum service alternative						
Present value of benefits[b]	3,161,268	2,476,047	2,234,406	2,058,639	1,604,528	2,763,603
Present value of costs[b]	554,561	260,992	426,815	150,006	113,023	3,575,850
Present value of net benefits	2,606,707	2,215,055	1,807,591	1,908,633	1,491,505	-812,247
Benefit/cost ratio	5.70	9.49	5.24	13.72	14.20	.77
Insurance reduction alternative						
Class B rural fire department						
Present value of benefits[b]	3,213,405	2,528,184	2,286,544	2,109,671	1,638,886	2,815,740
Present value of costs[b]	554,561	260,992	426,815	150,006	113,023	3,575,850
Present value of net benefits	2,658,844	2,267,192	1,859,729	1,959,665	1,525,863	-760,110
Benefit/cost ratio	5.79	9.69	5.36	14.06	14.50	.79
Class 9 public fire department						
Present value of benefits[b]	3,579,153	2,788,753	2,568,248	2,244,985	1,746,420	3,098,611
Present value of costs[b]	620,816	291,212	493,059	180,250	143,244	4,318,521
Present value of net benefits	2,958,337	2,497,541	2,075,189	2,064,735	1,603,176	-1,219,910
Benefit/cost ratio	5.77	9.58	5.21	12.45	12.19	.72

[a]The two alternatives and the six options are described in Chapter V.

[b]Computed at a 6 percent discount rate.

Thus, if the counties were to combine their resources to obtain a Class 9 public fire protection rating under Option I, they should realize more benefits than if each county had a separate fire department.

Benefit/cost ratios were also computed for the TVA system for Putnam County, for White County, and for both counties combined. The TVA system was set up under Option II since the miles (seven) were comparable. (The TVA system could have also been set up under the other options.) Under the TVA system, full-time firemen are used at the central fire station and volunteer firemen are used at the other stations. For a Class 9 public fire department under Option II in Putnam County, the benefit/cost ratio was 7.70; whereas, the benefit/cost ratio was 2.29 under the TVA system. The lower benefit/cost ratio (2.29) indicates that the benefits per dollar of expenditure are much less than those that would be received for a volunteer Class 9 public fire department. It must be pointed out, however, that the benefits for the TVA system may be much greater since it has a full-time force of firemen. Even with the benefits for a Class 9 public fire department under Option I, the benefit/cost ratio would be only 2.93 for the TVA system.

For the TVA system under Option II in White County, a benefit/cost ratio of 1.54 was calculated; whereas, the benefit/cost ratio of 5.18 was computed for the Class 9 public fire department under the same option. Similar ratios were computed for the two counties combined (2.04 for the TVA system and 9.58 for the Class 9 public fire department under Option II).

All the options were subjected to sensitivity analysis to determine if there would be any changes in the recommended options for the two

counties under the benefit-cost criterion and the net benefits criterion. The benefit/cost ratios and the present values of the net benefits for six fire protection options under the three alternatives are presented in Tables 6-4 and 6-5. The ratios and present values were computed at discount rates of 7 and 8 percent for Putnam, for White, and for the two counties combined. An examination of the tables revealed that the recommended options for the two criteria did not change. In Putnam County, the Class B rural fire department under Option V still had the greatest benefit/cost ratio and the Class 9 public fire department under Option I still had the largest present value of the net benefits. The Class B rural fire department under Option IV in White County still had the largest benefit/cost ratio and the Class 9 public fire department under Option I still had the largest present value of the net benefits. The Class B rural fire department under Option V for the two counties. combined had the largest benefit/cost ratio and the Class 9 public fire department under Option I had the largest present value of the net benefits.

The full service alternative under Option I was subjected to further analysis. The benefit/cost ratio was less than one (.42) for the full service alternative when there were only 420 residential structures to be served. In a hypothetical situation, it is possible to have 2,216 rural households within the area served by the Cookeville Boat Dock Road Utility District and still keep the average distance between the dwellings 100 feet or more, which is required by the ISO in order to keep from having any additional capital or operating, maintenance and repair costs for the fire department (46, p. 24). If the additional dwellings can all be considered nonfarm, then the yearly fire loss

Table 6-4. Benefit/cost ratios for six fire protection options for Putnam County, for White County, and for Putnam and White counties combined, by alternative, 1973

Alternative[a]	Putnam County		White County		Putnam and White counties	
	Discount rate		Discount rate		Discount rate	
	7 percent	8 percent	7 percent	8 percent	7 percent	8 percent
Minimum service alternative						
Option I	5.20	4.95	4.18	3.97	5.42	5.15
Option II	7.45	7.09	5.19	4.94	9.03	8.60
Option III	5.93	5.64	3.44	3.27	4.97	4.73
Option IV	10.23	9.75	10.62	10.11	13.06	12.44
Option V	10.65	10.15	9.49	9.04	13.51	12.87
Option VI	1.01	1.00	.56	.56	.77	.76
Insurance reduction alternative						
Class B rural fire department						
Option I	5.32	5.06	4.21	4.00	5.51	5.24
Option II	7.61	7.24	5.24	4.99	9.22	8.78
Option III	6.11	5.81	3.48	3.31	5.09	4.83
Option IV	10.58	10.07	10.74	10.23	13.39	12.75
Option V	10.96	10.44	9.62	9.16	13.80	13.15
Option VI	1.03	1.02	.57	.56	.78	.77
Class 9 public fire department						
Option I	5.48	5.21	4.20	3.99	5.48	5.20
Option II	7.32	6.97	4.92	4.68	9.11	8.67
Option III	6.05	5.75	3.44	3.27	4.95	4.70
Option IV	8.92	8.49	8.12	7.73	11.85	11.28
Option V	8.46	8.05	7.23	6.88	11.60	11.05
Option VI	.93	.93	.52	.52	.71	.70
Full service alternative						
Class 8 public fire department						
Option I[b]	.38	.35				

[a]The three alternatives and the six options are described in Chapter V.

[b]The full service alternative was not considered under Options II-VI.

Table 6-5. Present value of the net benefits for six fire protection options for Putnam County, for White County, and for Putnam and White counties combined, by alternative, 1973

Alternative[a]	Putnam County		White County		Putnam and White counties	
	Discount rate		Discount rate		Discount rate	
	7 percent	8 percent	7 percent	8 percent	7 percent	8 percent
	Dollars					
Minimum service alternative						
Option I	1,390,846	1,272,268	913,516	832,048	2,379,193	2,177,813
Option II	1,169,428	1,074,632	759,537	694,762	2,032,555	1,870,996
Option III	1,010,913	926,446	602,565	545,910	1,647,625	1,506,052
Option IV	1,012,032	932,313	708,932	653,185	1,755,112	1,619,195
Option V	711,538	655,600	626,024	576,349	1,371,699	1,265,636
Option VI	13,447	-72	-809,202	-765,288	-778,254	-747,879
Insurance reduction alternative						
Class B rural fire department						
Option I	1,428,565	1,306,992	923,639	841,367	2,427,035	2,221,856
Option II	1,198,566	1,101,404	769,660	704,081	2,080,397	1,915,039
Option III	1,048,632	961,169	612,688	555,229	1,695,467	1,550,095
Option IV	1,049,752	967,036	718,041	661,570	1,801,940	1,662,304
Option V	733,958	655,600	634,132	584,734	1,403,226	1,294,659
Option VI	51,166	34,652	-799,080	-755,969	-730,412	-703,836
Class 9 public fire department						
Option I	1,614,395	1,476,533	1,014,123	923,135	2,698,306	2,468,162
Option II	1,331,634	1,222,426	826,028	754,443	2,290,186	2,106,636
Option III	1,184,923	1,085,104	675,614	611,627	1,889,628	1,725,417
Option IV	1,100,372	1,012,107	733,327	674,113	1,896,770	1,748,073
Option V	768,186	706,220	641,309	588,891	1,472,586	1,356,981
Option VI	-121,693	-127,905	-1,045,281	-986,042	-1,160,546	-1,107,646
Full service alternative						
Class 8 public fire department						
Option I[b]	-536,650	-559,375				

[a]The three alternatives and the six options are described in Chapter V.

[b]The full service alternative was not considered under Options II-VI.

savings would be $36,959 for the farm and nonfarm dwellings. If the premium savings for a Class 8 public fire department are added to the fire loss savings, the total benefits would come to $71,323. If the insurance company estimated fire loss savings net of insurance premium reduction ($8,731) are further added to these benefits, then the total estimated benefits would be $80,054, which would represent the benefits that would accrue to the public rather than to private individuals.

Some additional water costs under the full service alternative would have to be incurred to accommodate the 2,216 households. Four 500,000-gallon elevated storage tanks were needed rather than three 150,000 storage tanks. Thirty-four more fire hydrants and 34 gate values for the fire hydrant connections were needed. The unit prices for these items were obtained from Bid Data on Current Municipal Works published by the Municipal Technical Advisory Service (58, 59). The additional costs for these items are summarized below:

Quantity	Description	Unit cost	Total cost
4	500,000-gallon tank	$110,350	$441,400
34	Fire hydrants	375	12,750
34	Gate values	120	4,080
		Total	$458,230

When the cost ($65,719) of the three 150,000-gallon elevated storage tanks was subtracted from $458,230, the total additional cost was $261,073 for a water system to accommodate 2,216 residents for consumption and fire protection purposes. This brought the total construction cost of the water system to $1,250,791, of which $849,496 was allocated to fire protection. A yearly maintenance and repair charge of 1.5 percent was used for the portion of the cost allocated to fire protection.

Benefit/cost ratios were computed for the full service alternative using the above benefit and cost data. At a 6 percent discount rate, the benefit/cost ratio was less than one (.88) when private savings and insurance company fire loss savings net of insurance premium reductions were considered. The ratio (.88) indicates that, under the assumed conditions, the costs to society of installing a water system for fire protection purposes would outweigh the benefits.

It must be pointed out, however, that in water systems with a good grid system, the storage tanks and some of the eight-inch mains may not be necessary; therefore, the costs may be considerably less than those presented. Moreover, society may be able to realize a reduction in costs (which can be considered a form of benefits) if the water system is initially designed for consumption and fire protection purposes. Otherwise, at some future date, parts of the old water system for consumption purposes only may have to be replaced when a water system is built for both purposes. If these additional cost changes are considered in the analysis, then, the benefits to society may indeed outweigh the costs.

II. FIRE STATION LOCATION

Fire station location requires consideration of a number of factors. Among these are (1) ISO requirements, (2) potential fire hazards, (3) first responding fire suppression unit[1] and possible rein-

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[1]The fire suppression unit refers to a pumper and the manpower assigned to the pumper in a particular area, whose primary function is the control and extinguishment of fires.

forcements, (4) multiple alarms, (5) historical property losses and fatalities due to fire, (6) topographical features such as rivers and mountains, (7) the rural road system, and (8) response time or possible travel speed. The ISO requirements and the average distance traveled in miles, which was used as a proxy for response time, were discussed in Chapter V. The rural road system and the topographical features of the two counties were presented in Chapters I and III. Since data on historical fire losses in rural areas of Putnam and White counties were not available, this factor was not considered in locating the fire stations, although it is one of the key factors used in locational studies.

To apply a simple location-allocation model[2] to the rural areas of the two counties, certain assumptions were made. For purposes of location, each fire suppression unit was assumed to serve the immediate area, denoted by the area of a circle formed at a given distance from the fire station. It was further assumed that the fire suppression unit was assigned to one fire station at a fixed location and that the unit would respond from this fixed location. It was also assumed that a fire suppression unit was available when required and that only one unit was required to respond to each alarm. Finally, it was assumed that the potential fire hazard in an area could be represented by the number of housing units in each census enumeration district and that the focal point (demand) for fire services could be represented as being at the

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[2]For a discussion of the location-allocation models see: United States Department of Commerce, Fire Services Location-Allocation Models, NBS Technical Note 774, National Bureau of Standards (Washington: Government Printing Office, June, 1973) and David E. Fyffe and Ronald L. Rardin, Fire Protection Service Management (Atlanta: Georgia Institute of Technology, October, 1974).

center of each enumeration district. Under the assumed conditions, the following minimization model was used to locate the fire stations:

$$\text{Minimize: } TTD = \sum_{j=1}^{m} D_{ij} W_j$$

where

TTD = total travel distance

D_{ij} = travel distance from fire station location i to center of enumeration district j

W_j = number of housing units in enumeration district j

m = number of enumeration districts

In the model only one fire station location was considered at a time and the location which gave the smallest value for the objective function was considered as the one that should be selected. Minimizing the total travel distance would mean that the county residents could be served better and at a lower travel cost, assuming that the incidence of fires was evenly distributed in the county.

The Benefit-Cost Criterion

The citizens of a county having a limited budget would realize the most benefits per dollar of expenditure if the county government officials adopted the fire protection option which had the greatest benefit/cost ratio. In Putnam County a Class B rural fire department under the insurance reduction alternative had the highest benefit/cost ratio. The highest benefit/cost ratio occurred under Option V, which had an average one-way distance to each rural alarm of approximately 17 miles. One fire station was required for Option V in Putnam County. For White County the highest benefit/cost ratio was for a Class B rural

fire department under Option IV, which had an average one-way distance to each rural alarm of approximately 13.5 miles. One fire station was required for Option IV in White County. For the two counties combined, the highest benefit/cost ratio was for a Class B rural fire department under Option V. Two fire stations were required when the two counties were combined.

Two possible fire station locations were selected in Putnam County and four in White County (Figure 6-1). These locations are:

County	Selected fire station locations
Putnam	(1) Junction of Interstate 40 and Highway 42
	(2) Junction of Interstate 40 and Burgess Falls Road
White	(1) North of the Sparta city limits on Highway 42
	(2) South of the Sparta city limits on Highway 70S
	(3) West of the Sparta city limits on Highway 70
	(4) Junction of Highways 70 and 70S in Sparta

Interstate 40 practically bisects Putnam County from east to west and thus a fire station location near this highway was considered a logical choice. A location at one of the two selected junctions would provide good access to all areas of the county. Junctions with Interstate 40 farther to the east were not selected because most of the population was located in the northern and western sections of Putnam County. Possible fire station locations in White County were also selected based on the road system and the population concentration. Although the selection of these locations may mean that some rural households may be greater than the distance as indicated for the option, the total travel distance for the fire department would be minimized, assuming that the incidence of fires was evenly distributed in the county.

The travel distance in Putnam County was measured from each of the two selected locations to each of the 17 rural census enumeration

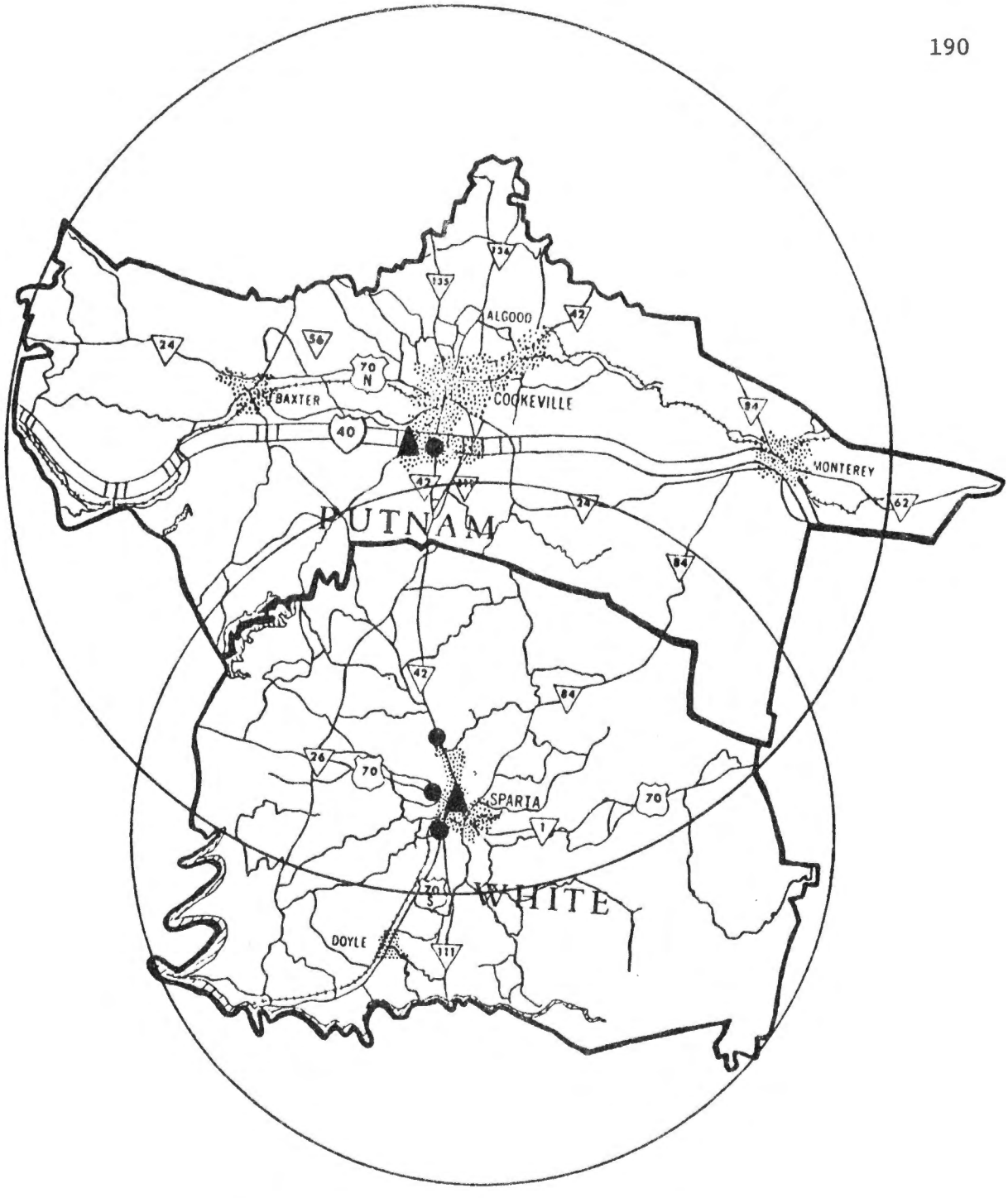


Figure 6-1. Possible Class B rural fire department locations for the rural areas of Putnam and White counties

districts using county highway maps. Similarly, the travel distance in White County was measured from each of the four selected locations to each of the 11 rural census enumeration districts. When these distances for each location were weighted by the number of housing units in the corresponding enumeration districts, the following results were found:

County	Selected location	Total travel distance
Putnam	1	49,273
	2	50,322
White	1	32,533
	2	29,972
	3	28,673
	4	27,300

Thus, in Putnam County the number two location (junction of Interstate 40 and Burgess Falls Road) would minimize the total travel distance. The difference in the total travel distance of the two locations is so small, however, that the final choice may depend on the cost of a fire station site and certain political considerations.

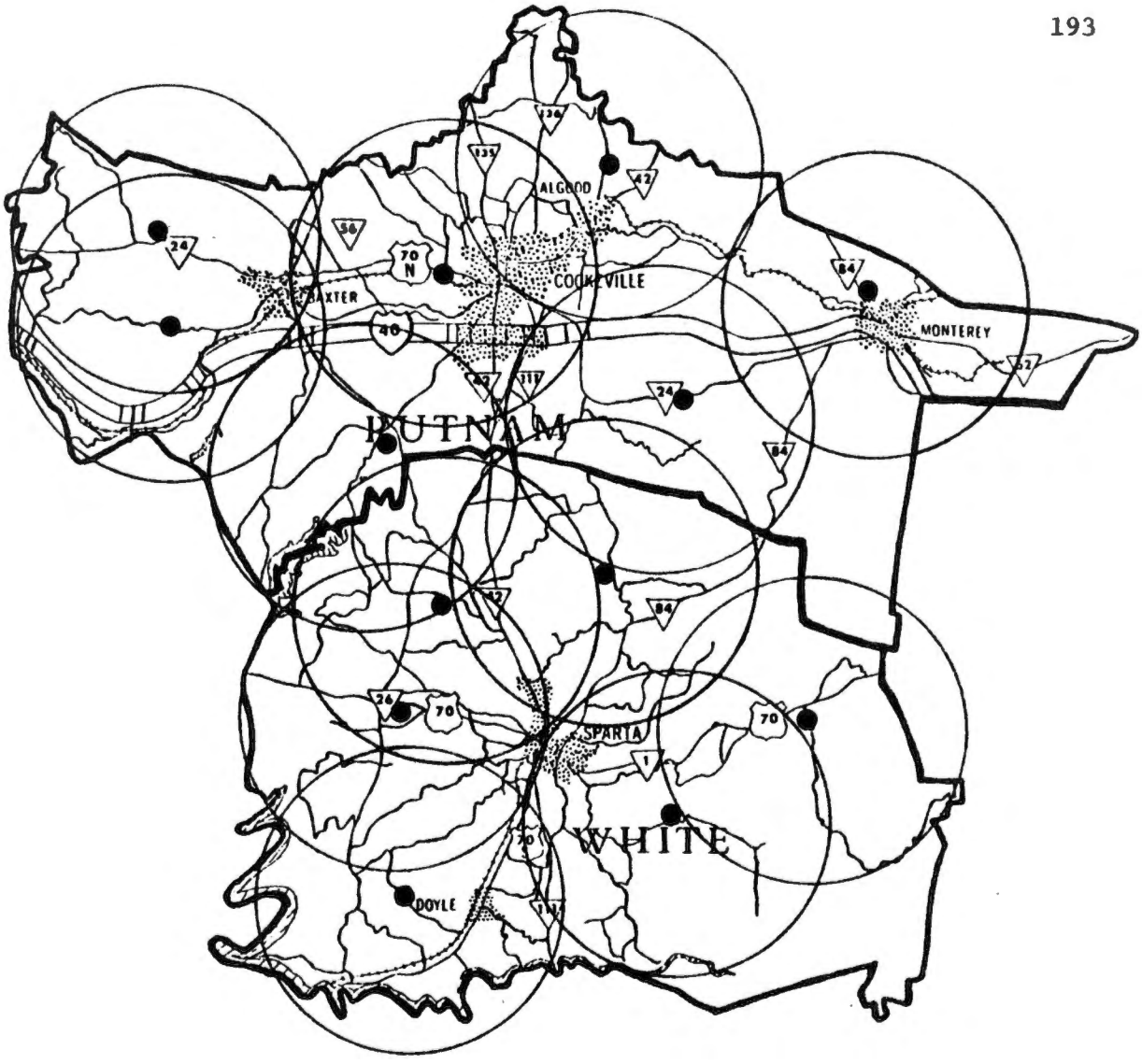
In White County the location that would minimize the total travel distance is the junction of Highways 70 and 70S within the Sparta city limits. Land costs and political considerations may not make this a feasible location. Also, the Sparta Fire Department has a fire station located less than half a mile from this junction. The other fire station locations which should be considered in order are the west, south, and north of the Sparta city limits locations.

Locations for both counties combined were not considered because of the problem of overlapping enumeration districts. Some of the enumeration districts would need to be assigned to a given location before minimizing the total travel distance, although part of the same enumeration districts could best be served from other locations.

The Net Benefits Criterion

A local county government having a flexible budget would bring the greatest benefits to its residents if it adopted the fire protection option that had the largest present value for the net benefits. Utilizing the net benefits criterion, a Class 9 public fire department under Option I would give the greatest net benefits to the residents of either Putnam or White County or to the two counties combined. The net benefits were larger when the two counties were combined than when the two counties were considered separately. Seven fire stations were required in Putnam County and six in White County while only 12 were required for the two counties combined.

For a number of reasons, the location-allocation model was not used to locate Option I fire stations in either of the counties. One of the reasons was that the enumeration districts in some cases were larger than the area served from a particular location. Also, there was some overlapping involved in selecting the sites. Finally, most of the time there was only one good location for a fire station. However, some of the possible sites that could be selected are indicated in Figure 6-2.



● Possible fire station locations

Figure 6-2. Possible Class 9 fire department locations for the rural areas of Putnam and White counties

CHAPTER VII

SUMMARY AND IMPLICATIONS

I. SUMMARY

Many rural areas in the United States are experiencing population increases; yet, these areas have limited provision for urban-type services, such as fire protection. The rural fire problem in the United States is due in part to the forces of ignorance and indifference, but probably is more fundamentally due to the "hands-off" policy at all levels of government. The United States has twice the death loss (57.1 versus 29.7 deaths) per million people when compared to second-ranking Canada and a third more per capita property losses than Canada. Fire losses to farm property in the United States jumped from $165 million in 1960 to a preliminary estimate of $242 million in 1970. Each year rural fires cause an estimated death toll of 1,000 lives in the United States. The loss of property and lives and the injuries sustained as a result of fires represent a needless waste of nonhuman and human resources.

Fire protection services are virtually nonexistent or severely inadequate in most rural areas of Tennessee. Forty-five percent of the municipalities in Tennessee have a Class 10 fire protection rating and all of the rural counties have this rating. The low level of public fire protection services has resulted partially from the lack of approved state or local legislation. Many municipal fire departments were encouraged not to respond to fires outside the city limits without a charter or legislative authorization and, in fact, several municipal fire departments which formerly responded to fires in rural areas no longer do so. The municipal officials found that they could be personally sued in a court of law for the actions, wrongful or otherwise, committed by

firemen in rural areas. These officials also knew that their cities would be in danger of receiving a lower fire classification rating if the fire departments were allowed to respond to fires in rural areas and left the cities unprotected.

Throughout most of rural Tennessee, fire protection is provided either haphazardly or not at all. Little attention has been given to the provision of fire services in rural Tennessee counties. Recognizing this problem of inadequate fire services in the rural areas, this study was undertaken with the following objectives: (1) to review the fire protection services available in the rural areas of Tennessee; (2) to obtain information on the need for fire protection services for rural residents and for businesses and institutions in rural areas; and (3) to develop fire protection service alternatives for rural areas which would provide for different levels of fire protection. Putnam and White counties were selected for specific study. Data were collected from two rural surveys and numerous interviews with officials and persons associated with fire protection services.

A review of literature revealed that little research has been done on fire protection services for rural areas. Most of the research that has been accomplished was done in the area of forestry. Forestry research is generally not applicable to providing fire protection services to rural structures.

Of the several agencies within the state government which have fire prevention and protection responsibilities, the Division of Civil Defense within the Military Department of Tennessee appeared to be the agency which could help the most to provide fire protection to rural

counties in Tennessee. The Division of Civil Defense has helped several rural counties obtain surplus and excess government equipment and has provided the county civil defense units with training and instruction materials. At least two counties have used the manpower of the county civil defense units and surplus equipment to provide fire protection to the rural areas of the counties. TVA and the Cumberland County Fire Department have converted several surplus military vehicles to pumper-tankers that can be used for fire protection purposes. However, because of the slowness of these vehicles on hills and the problem of getting replacement parts, the Cumberland County Fire Department is gradually replacing these vehicles.

The Division of Vocational Education within the State Department of Education is responsible for directing the Tennessee State Fire Service Training Center in Murfreesboro. County government officials can send their firemen to the Training Center or take advantage of the "itinerant" program offered by the Division of Vocational Education.

The grading of municipalities on their fire defenses and the establishing of fire insurance rates are the principal function of ISO, which is a private organization supported by insurance companies and regulated by the Tennessee Department of Insurance. The grading schedule used by ISO to grade municipalities on their fire defenses gives 78 percent of the total possible score to the water supply and the fire department. Only 22 percent of the total possible score is given to fire service communications and fire safety control. Under the system of establishing fire insurance rates, the fire loss record of a particular community is not considered unless it significantly affects the total fire

losses of the state. Thus, a county or municipality is discouraged from spending money on fire prevention efforts since such spending has little effect on the fire classification rating and, consequently, on fire insurance premium rates.

In 1973 the rural county government officials were given authority by the state legislature to set up county-wide fire protection, and in 1975 they were allowed to adopt, by reference, building, plumbing, and gas codes. In the legislation, the county governments were allowed to contract with any agency, public or private, in order to provide fire protection for their counties. If general enabling legislation is passed which would allow counties to adopt and enforce fire prevention codes, then the legal framework would be such that the counties could establish a total county-wide fire prevention and protection system.

All the municipalities--Algood, Baxter, Cookeville, and Monterey--in Putnam County have fire departments and at one time answered fire calls in the rural areas of the county. When the Algood Fire Department ceased answering fire calls in the rural areas in December, 1973, the rural areas of the county were virtually without fire protection. Due to ISO requirements, none of the fire departments have adequate facilities, equipment, and manpower to answer fire calls in the city limits of the municipalities and in the rural areas of the county. To make the facilities, equipment, and manpower adequate for both areas, additional costs will have to be incurred. The Putnam County government officials may have to offset some or all of the additional costs to get the municipalities to provide fire protection to the rural areas of the county.

In White County limited parts of the rural areas have in the past been served by the volunteer fire departments of Doyle and Sparta. The Sparta Fire Department charged on a per call basis. Faced with a

possible reduction or elimination of services from the two municipal fire departments, the county in September, 1973, appropriated $1,500 to Doyle and $20,000 to Sparta to provide fire protection at no charge to the rural residents of the county.

An examination of the state agencies within the two counties revealed that none of the agencies have had much impact on providing fire protection services to rural houses and businesses and institutional places.

Six utility districts in Putnam County and four in White County serve most of the rural areas of the two counties. The utility districts were designed primarily to serve the consumption needs of the rural residents. Many of the mains installed were less than six inches and only a few fire hydrants were installed.

To accomplish the second objective, survey data on rural property owners' fire insurance coverage and estimated fire losses in the two counties were examined. The results indicated that many rural homeowners in Putnam and White counties do not have adequate fire insurance coverage or have no fire insurance coverage.

The average value per owner of rural farm property in Putnam and White counties with fire insurance was $33,013, with no fire insurance, $17,311. For those owners with insurance, the house was insured at 69 percent of its value; the contents of the house at 78 percent; the farm buildings at 37 percent; and the farm personal property at 7 percent. When the values of the farm property were aggregated, the total value was $73.2 million, of which $39.5, or 54 percent, was not insured.

The house and the contents of the house of nonfarm rural residents averaged $22,090 per owner, 7 percent more than the house and the contents of the house of the rural farm owners. For the nonfarm residents, insurance coverage against fire losses averaged 76 percent of the value of the house. The contents were insured at 19 percent more than their estimated value. Eleven percent of the nonfarm residents did not have fire insurance on their house and its contents at the time of the survey compared with 23 percent of the rural farm residents. When the values of the nonfarm property were aggregated, the total value was $139.5 million, of which $18.7 million, or 20 percent was not insured.

Fire insurance coverage on rural businesses and institutional properties in the two counties was, in general, inadequate. While all the churches carried fire insurance, such protection covered only 40 percent of their replacement value. A third (33 percent) of the public buildings and 43 percent of the elementary schools were not insured against fire losses. The aggregated results showed that 33 percent ($8.7 million) of the total business property and 40 percent ($5.3 million) of the institutional property was not insured.

The estimated annual fire losses in the two counties were nearly three quarters of a million dollars ($691,900). Rural nonfarm property owners were estimated to have the largest share of the annual fire losses ($306,100). The estimated annual fire losses were slightly over $219,100 for all farm property owners. For rural business owners, the estimated annual fire losses were about $128,600 and for institutional property owners, $38,100. Sixty-four percent of the estimated annual fire losses on farm property was not covered by fire insurance; 31 percent on nonfarm property; 60 percent on business property; and 58 percent

on institutional property. About 52 percent, or $357,100, of the annual fire losses on all property was covered by fire insurance. Thus, almost 50 percent of the estimated fire losses that occur within the two counties is borne by the property owners themselves.

To accomplish the third objective, three alternatives (the minimum service alternative, the insurance reduction alternative, and the full service alternative) were analyzed. Six options were considered under both the minimum service alternative and the insurance reduction alternative while only one was considered under the full service alternative. The first five options were volunteer and the sixth was full-time.

The minimum service alternative was developed in such a manner that limited fire protection could be provided to the rural areas of Putnam and White counties. Under the minimum service alternative, the only benefits that were estimated were fire loss savings. The insurance reduction alternative was designed so that the lowest fire protection classification could be reached without changing the existing road and water systems. Under the insurance reduction alternative, fire loss and fire insurance premium savings were estimated. Finally, the full service alternative was developed with changes in the water system. Fire loss and fire insurance premium savings were estimated for the full service alternative.

Under the minimum service alternative in Putnam County, the estimated annual fire loss savings for rural property owners were the lowest ($73,664) for Option V and the highest ($161,389) for Option I.

The estimated annual savings in fire losses were inversely associated with distance in miles for the options with a volunteer force of firemen (Options I to V). Option VI, the full-time option, resulted in a greater annual savings in fire losses to rural property owners than a comparable volunteer force of firemen under Option III. The annual insurance company fire loss savings ranged from a low of $59,888 for Option V to a high of $115,282 for Option I. In White County the annual fire loss savings under the minimum service alternative were similar to those found in Putnam County but on a smaller scale.

Under the minimum service alternative in Putnam County, the initial outlay costs for the options with volunteer manpower varied from a low of $47,279 to a high of $220,997. Operating costs for Option I ($9,327) were more than four times the operating costs of Option V ($2,318). Similar results were found for White County. Annual operating costs for Options V and I were $2,318 and $8,147, respectively.

When the two counties were combined under the minimum service alternative, the results indicate that there are some economies of "size" in providing rural fire protection to the two counties as one area rather than two distinct areas.

The second alternative which was considered was the insurance reduction alternative. Three types of fire departments were considered under this alternative: an approved private fire department, a Class B rural fire department, and a Class 9 public fire department. It may be possible for the Putnam County officials to contract with an individual or a business to provide private fire protection to the rural parts of the county; however, due to the cost of establishing and operating a

private fire department and the stringent requirements of the ISO in allowing premium credits, the private fire department was dropped from consideration.

Annual premium credits of three cents per $100 of insurance are allowed on rural farm property if the property is within 10 miles of the Class B rural fire department. As expected, the fire insurance premium savings to the farm property owners in Putnam and White counties were quite small when compared with the fire loss savings. Under Option I, which is the best volunteer option, the estimated annual premium savings were only $3,905 in Putnam County and $1,048 in White County. When these estimated annual premium savings were added to the estimated fire loss savings under Option I, the total annual benefits that could be obtained by having a Class B rural fire department were $165,294 in Putnam County and $113,418 in White County. Under Option V the total estimated benefits in Putnam County were $75,985 and in White County, $66,535.

For a Class 9 public fire department, fire insurance premium savings are allowed on all property. Still, the estimated annual premium savings were quite small when compared with the estimated annual fire loss savings. Under Option I in Putnam County the estimated annual premium savings were $26,141 and in White County they were $13,412.

The small premium savings for a Class B or a Class 9 fire department may be one of the factors which has tended to discourage some counties from providing fire protection to the rural areas since the premium savings would not be enough to pay for a fire protection system. Lacking an estimate of the possible fire loss savings, the county government officials could not know what the total benefits might be.

The final alternative considered was the full service alternative. For this alternative, the costs for a Class 8 public fire department and the water system were estimated for the Cookeville Boat Dock Road Utility District. The estimated cost of constructing the water system for consumption purposes only ($401,295) was subtracted from the estimated cost of constructing the water system for consumption and fire protection purposes ($989,718) to give that portion of the water system cost which should be allocated to fire protection ($588,423). The initial outlay costs for the full service alternative were $712,211 and the annual operating costs were $14,041. The estimated annual benefits were $23,026 for a Class 8 fire protection system.

Benefit/cost ratios and the present value of the net benefits were computed for all the options under the various alternatives at a 6 percent discount rate. Utilizing the benefit-cost criterion in Putnam County, the Class B rural fire department under Option V gave the highest benefit/cost ratio (11.51). No other option will yield this amount of benefits for each dollar of costs.

When both of the counties were combined, the Class B rural fire department again had the highest benefit/cost ratio (14.50), which occurred under Option V. This benefit/cost ratio (14.50) was higher than either of the ratios for the counties considered separately.

Utilizing the net benefits criterion, the Class 9 public fire department under Option I had the highest present value of the net benefits when both counties were combined and when both counties were considered separately, which indicated that a Class 9 public fire department under Option I would maximize the total net benefits (fire

loss and fire insurance premium savings) to the rural residents. If the county governments have a flexible budget, then the Class 9 public fire department under Option I should be selected.

When the options were subjected to sensitivity analysis at discount rates of 7 and 8 percent, the results indicated that the recommended options of the two criteria did not change.

A simple location-allocation model was used to locate the fire stations needed as a result of utilizing the benefit-cost criterion. Two possible fire station locations were selected in Putnam County and four in White County. The location which minimized the total travel distance in Putnam County was the junction of Interstate 40 and Burgess Falls Road. In White County the location which minimized the total travel distance was the junction of Highways 70 and 70S in Sparta.

II. IMPLICATIONS

An important implication of this study is that counties which are located in close proximity may be able to realize sizable cost savings if the fire protection systems of the counties are combined. Sufficient evidence is generated to suggest that there are some economies of "size" both in initial outlay costs and in operating costs. If the borders of the counties are not contiguous for some distance, the economies of "size" may not be realized. If the borders are contiguous for some distance, the counties should cooperate and consider consolidation for fire protection purposes. The results also indicate that it may be advantageous for the counties to consider cooperative and contractual arrangements with municipalities.

The premium savings for a Class B or a Class 9 fire department tended to be rather small when compared with the fire loss savings, particularly the fire loss savings of the insurance companies. Insurance companies have not provided as much premium reductions to rural residents as the insurance companies get in benefits from having some type of rural fire department. An implication is that insurance companies may need to be required to rebate some of the fire loss savings or to lower the insurance premiums to the rural residents. Further research is needed to determine if there is any discrimination in the fire insurance rates charged to rural residents versus other property owners.

The fire loss estimates presented in this study can be validated by having a state-wide data collection system on fire losses in rural areas. Data are needed on type of property loss, whether the property was insured, the amount of insurance coverage on the property, and the amount of the loss covered and not covered by insurance. Also, data are needed on the portions of the rural structures saved by the fire department, the response time (and/or travel distance), and an estimate of the loss that would have occurred had the fire department not answered the fire alarm. With these data, the techniques of this study can be used to estimate the fire loss savings that occurred by using a particular fire department. Fire loss savings can be estimated for insurance companies and for rural property owners. Decision-makers at all levels of government can use the results from studies on fire losses and fire loss savings to make responsible decisions concerning fire protection in rural areas.

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APPENDICES

APPENDIX A

I. PROCEDURE FOR DETERMINING NUMBER OF HOUSING UNITS

Before aggregating the sample data for Putnam and White counties, the number of farm and nonfarm housing units needed to be adjusted to reflect the 1973 sample data. The following procedure was used to adjust the census data:

The 1970 population census for the rural areas of Putnam County was 15,829 and the number of rural housing units in the county was 5,462 (115, pp. 85-86). Dividing the population by the number of housing units gives 2.898 persons per housing unit. The increase in the total population of Putnam County from 1970 to 1980 is expected to be 14.13 percent (117, p. 209). Assuming this percent increase will also occur in the rural areas of the county, then the population increase from 1970 to 1980 will be 2,237, or 223.7 persons per year. If 223.7 is multiplied by three and added to 15,829, then the 1973 rural population will be about 16,500. If the 1973 rural population is divided by the number of persons per housing unit, there will be 5,694 rural farm and nonfarm housing units in 1973.

The number of Putnam County farm units for 1973 was estimated by using the data from the 1969 Census of Agriculture (114, p. 569). The number of 1969 farms (1,610) was subtracted from the number of 1964 farms (1,870) to give 260 farms, or a decrease of 52 per year for the five-year period. Assuming that this decline has continued, then, by 1973, there was a further reduction of 208 farms. Subtracting 208 from 1,610 gives

an estimated number of 1,402 farms for Putnam County in 1973. Subtracting the number of farms (1,402) from the total number of housing units estimated for 1973 (5,694) gives 4,292 rural nonfarm housing units for Putnam County in 1973.

This same general procedure was followed for estimating the number of farm and nonfarm housing units in White County. The results were that in 1973 there were 1,255 farm and 2,350 nonfarm housing units.

II. PROCEDURE FOR ESTIMATING FIRE LOSSES

To determine the fire losses for rural property owners in Putnam and White counties, insurance premium data from the rural surveys were used. The premiums that were paid by rural farm and nonfarm residential property owners in 1973 are presented in Table A-1. Also, the premiums needed to give coverage on the full value of the property are shown.

The premiums are presented without the extended coverage and liability in Table A-2. The liability and extended coverage portions of the premiums, except for the White County Mutual Fire Insurance Company policies (referred to as county mutual policies), were excluded from the premiums shown in Table A-1 by using the factors .65 and .75, respectively, for homeowner policies. (The source of these factors were discussed in Chapter IV.) For county mutual policies, the premiums were figured for fire directly by using the fire insurance rate of $.30 for $100 of insurance charged by the White County Mutual Fire Insurance Company. For all other type policies, the extended coverage was excluded by using .75 as the factor.

The estimated annual fire losses for rural farm and nonfarm property owners by policy type are shown in Table A-3. The annual fire

Table A-1. Total premiums paid under different policies by rural farm and nonfarm property owners with fire insurance and with no fire insurance, 172 rural resident property owners, Putnam and White counties, Tennessee, 1973[a]

Type of property owners and fire insurance policies held	Premiums paid by rural resident property owners with fire insurance		Premiums needed to cover the total property of rural resident property owners with no fire insurance
	Present premiums paid[b]	Premium cost for full value of property[c]	Premium cost for full value of property[c]
	Dollars		
Rural farm			
County mutual policies[d]	996	2,913	
Farmowner policies	1,778	3,308	
Homeowner policies	1,575	2,546	
Other type policies	3,082	6,196	3,607
Rural nonfarm			
County mutual policies[d]	173	291	
Homeowner policies	4,248	5,084	
Other type policies	1,284	1,523	946

[a]Based on survey data.

[b]These were the premiums paid by the rural property owners in 1973.

[c]These were the premiums that the rural property owners would have had to pay in 1973 in order to cover the full value of the property they had which was subject to fire. These full value premiums were based on the types of policies that the respondents had and therefore included extended coverage and liability premiums.

[d]Refers to policies sold by a county mutual fire insurance company located in White County.

Table A-2. Total premiums paid, excluding extended coverage and liability, under different policies by rural farm and nonfarm property owners with fire insurance and with no fire insurance, 172 rural resident property owners, Putnam and White counties, Tennessee, 1973

Type of property owners and fire insurance policies held	Premiums paid by rural resident property owners with fire insurance		Premiums needed to cover the total property of rural resident property owners with no fire insurance
	Present premiums paid[a]	Premium cost for full value of property[b]	Premium cost for full value of property[b]
	Dollars		
Rural farm			
County mutual policies[c]	632.70	1,811.20	
Farmowner policies	866.78	1,612.65	
Homeowner policies	1,004.06	1,623.08	
Other type policies	2,311.50	4,647.00	3,607.00
Rural nonfarm			
County mutual policies[c]	108.45	181.50	
Homeowner policies	2,708.10	3,241.05	
Other type policies	963.00	1,142.25	946.00

[a]The premiums paid for county mutual policies, which exclude extended coverage, were calculated by dividing the amount of insurance coverage ($210,900 and $36,150 for rural farm and nonfarm, respectively) by 100 and multiplying this result by the fire rate only ($.30 per $100 of insurance). The fire premiums for farmowner policies were calculated by multiplying the premiums in Table A-1 by .65 to exclude the liability portion of the premium and the result further multiplied by .75 to exclude the extended coverage portion of the premium. Similarly, for homeowner policies, .85 and .75 were used to adjust the premiums. For the other type policies, .75 was used to exclude the extended coverage.

[b]The same procedure was used as in footnote "a" to figure the premiums without liability or extended coverage. The values of the property used in computing the premiums for the county mutual policies were $603,732 and $60,500 for the farm and rural nonfarm, respectively. No adjustments were made in the premiums for those residents with no fire insurance since these premiums were computed without extended coverage or liability.

[c]Refers to policies sold by a county mutual fire insurance company located in White County.

Table A-3. Estimated annual fire loss under different policies per rural farm, nonfarm and rural resident property owner with fire insurance and with no fire insurance, 172 rural resident property owners, Putnam and White counties, Tennessee, 1973

Type of property owner and fire insurance policies held	Estimated fire loss per rural property owner with fire insurance[a]				Estimated fire loss per rural property owner with no fire insurance[a]	
	Number of residents	Average covered by insurance	Average not covered by insurance	Average covered and not covered by insurance	Number of residents	Average
		Dollars				Dollars
Rural farm						
County mutual policies[b]	21	23.13	43.07	66.20		
Other type policies	56	44.57	39.44	84.01	23	93.60
Total	77	38.72[c]	40.43[c]	79.15[c]	23	93.60
Rural nonfarm						
County mutual policies[b]	6	13.87	9.35	23.22		
Other type policies	58	37.78	7.32	45.10	8	70.57
Total	64	35.54[c]	7.51[c]	43.05[c]	8	70.57
All rural residents	141	37.28[c]	25.48[c]	62.76[c]	31	87.66[c]

[a]The estimated fire losses for the county mutual policies were calculated by multiplying the premiums in Table A-2 by the county mutual fire insurance loss ratio and dividing the result by the number of residents, i.e., 632.70 x .76761 = 485.67 ÷ 21 = 23.13. Similarly, the estimated fire losses for all other type policies were computed by using the state-wide fire loss ratio (.59682) for residential property.

[b]Refers to policies sold by a county mutual fire insurance company located in White County.

[c]Computed by multiplying the average for each type policy by the number of residents, summing the results and dividing by the total number of residents for the different types of policies.

loss per farm and nonfarm property owner insured by the White County Fire Insurance Company was computed by multiplying the premiums in Table A-2 by the county mutual fire insurance loss ratio (.76761) and the result divided by the corresponding number of residents. Similarly, the estimated annual fire losses for all other type policyholders were computed by using the state-wide fire insurance loss ratio (.59682) for residential property. (The derivation of the loss ratios were discussed in Chapter IV.)

The estimated annual fire loss per rural business and institution was derived in the same manner as those for rural farm and nonfarm property owners, except that the liability and extended coverage portions of the premiums were excluded at the time the survey was taken (Table A-4). The full value premiums are also shown.

Except for the county mutual policies, the estimated annual fire loss for each business and institution was computed by multiplying the premiums paid by the state-wide fire insurance loss ratio (.53108) for business and institutional property. The county mutual premiums were multiplied by the county mutual fire insurance loss ratio (.76761).

III. PROCEDURE FOR ESTIMATING FIRE LOSS SAVINGS

The four fire loss categories as described in Chapter V (totally destroyed, three-fourths or less destroyed, one-half or less destroyed, and one-fourth or less destroyed) along with the corresponding percentages of property in each category that were destroyed were used to estimate the annual reduction in fire losses (fire loss savings) due to the adoption of a particular set of fire department resources. As an example, Option III was chosen to illustrate the procedure for estimating fire

Table A-4. Total premiums paid and estimated annual fire loss per rural business and institution with fire insurance and with no fire insurance, 91 rural businesses and 25 institutions, Putnam and White counties, Tennessee, 1973

Type of business and institution	Premiums paid and estimated fire loss per rural business and institution with fire insurance					Premiums needed to cover the total property and estimated fire loss per rural business and institution with no fire insurance		
	Number of firms or institutions	Present premiums paid[a]	Estimated fire loss on present premiums[b]	Premium cost for full value of property[a]	Estimated fire loss on full value premiums[c]	Number of firms or institutions	Premium cost for full value of property[a]	Estimated fire loss on full value premiums[d]
		Dollars					Dollars	
Businesses								
General merchandise and grocery stores	6	1,559	833.40	3,163	1,693.06	8	4,746	2,520.51
Automobile service stations	3	584	310.15	1,247	662.26	1	762	404.68
Restaurants	2	1,968	1,045.17	4,404	2,338.88	4	4,405	2,339.41
Service type businesses	4	1,157	614.46	3,205	1,702.11	2	320	169.95
Auto sales	--	--	--	--	--	3	1,195	634.64
Garage and body shops	2	453	240.58	2,168	1,151.38	3	2,039	1,082.87
Motels and tourist courts	2	2,147	1,140.23	4,768	2,532.19	--	--	--
Other type businesses[e]	41	63,921	33,964.90	90,799	48,334.12	10	5,459	2,899.17
Institutions								
Public buildings	2	247	131.18	274	145.52	1	150	79.66
Churches	15	2,596	1,410.14	5,962	3,283.15	--	--	--
Schools	4	845	448.76	1,572	834.86	3	1,861	988.34

[a]Obtained from survey data. These premiums were for fire only.

[b]Calculated by multiplying the premiums paid by the state-wide fire loss ratio of .53108 for business and institutional property. The exception to this is that the premiums paid on county mutual policies were multiplied by .76761. The premiums for the county mutual policies and the type of business or institution were as follows: $23, general merchandise and grocery stores; $133, churches; and $75, other type businesses. These latter premiums were for businesses and institutions with fire insurance.

[c]Calculated the same as in footnote "b" except that the premiums for the county mutual policies and type of business or institution were as follows: $56, general merchandise and grocery stores; $494, churches; and $476, other type businesses.

[d]Calculated by multiplying the premiums paid by the state-wide fire loss ratio (.53108) for business and institutional property.

[e]Other type businesses includes all businesses which could not be included in the categories listed. A few businesses were also included which had replacement values exceeding three times the average value of the type of businesses in the categories listed.

loss savings in Putnam County. The fire chief operating under Option III estimated that 25 percent of the rural structures was completely destroyed, 9 percent was three-fourths or less destroyed, 38 percent was one-half or less destroyed, and 28 percent was one-fourth or less destroyed when the fire department answered fire calls. (The fire loss categories and percentages are shown in columns 1 and 2 of Table A-5.)

In columns 3 and 8, the total estimated fire losses without fire department services are shown. These fire losses are based on 100 percent destruction as estimated by the fire chiefs. The fire losses for each category were computed by multiplying the number of housing units (1,080 and 322 rural farm properties covered and not covered by insurance, respectively) by the corresponding percents for the different fire loss categories (column 2) and then the result by the corresponding average estimated annual fire losses given in Table 4-5 (columns 6 and 8), e.g., $21,371 = 1,080 x .25 x $79.15.

Columns 4 and 9 give the total fire losses that are estimated to occur after adoption of Option III. These fire losses represent only partial rather than total destruction (that is, portions of the fire losses in column 3 are saved--not destroyed--after the adoption of Option III) and were computed by multiplying the fractions in column 1 (1, 3/4, 1/2, and 1/4) by the total fire losses without fire services given in columns 3 and 8. The total net savings of those rural property owners with fire insurance that are estimated to result from having fire services (column 5) were calculated by subtracting the total fire losses with fire services (column 4) from the total fire losses without fire services (column 3). These are the savings that are estimated to result after the adoption of an Option III fire protection system. Similarly,

Table A-5. Total estimated annual fire losses and fire loss savings of an Option III fire protection system, 5,694 rural resident property owners, Putnam County, Tennessee, 1973[a]

Property type and fire loss category	Percent of property	Estimated fire losses and fire loss savings of rural property owners with fire insurance					Estimated fire losses and fire loss savings of rural property owners without fire insurance			
		Total fire losses without fire services	Total fire losses with fire services	Total net savings with fire services	Insurance company savings	Property owner savings	Total fire losses without fire services	Total fire losses with fire services	Total net savings with fire services	Property owner savings
		Dollars								
Rural farm										
Totally destroyed	25	21,371	21,371	0	0	0	7,535	7,535	0	0
3/4 destroyed or less	9	7,693	5,770	1,923	0	1,923	2,712	2,034	678	678
1/2 destroyed or less	38	32,483	16,242	16,241	0	16,241	11,453	5,727	5,726	5,726
1/4 destroyed or less	28	23,935	5,984	17,951	5,725	12,226	8,439	2,110	6,329	6,329
Total	100	85,482	49,367	36,115	5,725	30,390	30,139	17,406	12,733	12,733
Rural nonfarm										
Totally destroyed	25	41,113	41,113	0	0	0	8,327	8,327	0	0
3/4 destroyed or less	9	14,801	11,100	3,701	1,119	2,582	2,998	2,248	750	750
1/2 destroyed or less	38	62,491	31,246	31,245	20,344	10,901	12,657	6,329	6,328	6,328
1/4 destroyed or less	28	46,046	11,512	34,534	26,502	8,032	9,327	2,332	6,995	6,995
Total	100	164,451	94,971	69,480	47,965	21,515	33,309	19,236	14,073	14,073
All rural residents		249,933	144,338	105,595	53,690	51,905	63,448	36,642	26,806	26,806

[a]Computed from survey data.

the total net savings of those rural property owners without fire services were calculated.

The insurance company savings (column 6) are the savings that would accrue to the insurance companies when the insurance losses resulting from an Option III fire protection system are less than the insurance losses that would have resulted without an Option III fire protection system. No savings would accrue to the insurance companies when the insurance losses that would have resulted with an Option III fire protection system are equal to the insurance losses that would have resulted without an Option III fire protection system. Insurance company savings were computed by multiplying the number of housing units by the corresponding percents for the different fire loss categories (column 2) and then multiplying the result by the corresponding average estimated annual fire losses given in Table 4-5 (column 4). For example, insurance losses without an Option III system for the fourth fire loss category would be 1,080 x .28 x $38.72 = $11,709. With an Option III system, the insurance losses would be only $5,984. Thus, the insurance companies would reap windfall benefits of $5,725 ($11,709 - $5,984).

Rural property owner fire loss savings (columns 7 and 11) are the total net savings that would accrue to the property owners by having fire services. These are the savings that do not accrue to the insurance companies.

The total estimated fire loss savings for rural businesses and institutions using an Option III fire protection system in Putnam County are shown in Table A-6. These fire loss savings were computed in the same manner as those for the rural farm and nonfarm property owners.

Table A-6. Total estimated annual fire losses and fire loss savings of an Option III fire protection system, 155 rural businesses and 100 rural institutions, Putnam County, Tennessee, 1973[a]

Property type	Estimated fire losses and fire loss savings of rural businesses and institutional properties with fire insurance					Estimated fire losses and fire loss savings of rural businesses and institutional properties without fire insurance			
	Total fire losses without fire services	Total fire losses with fire services	Total net savings with fire services	Insurance company savings	Rural business and institutional savings	Total fire losses without fire services	Total fire losses with fire services	Total net savings with fire services	Rural business and institutional savings
	Dollars								
Businesses	59,234	34,208	25,026	7,635	17,391	23,370	13,496	9,874	9,874
Institutions	20,564	11,876	8,688	1,108	7,580	1,068	617	451	451
All businesses and institutions	79,798	46,084	33,714	8,743	24,971	24,438	14,113	10,325	10,325

[a]Computed from survey data.

APPENDIX B

Table B-1. Items considered in the Grading Schedule for Municipal Fire Protection

Grading feature and item number	Description
Water supply	
1	Adequacy of supply works
2	Reliability of source of supply
3	Reliability of pumping capacity
4	Reliability of power supply
5	Condition, arrangement, operation, and reliability of system components
6	Adequacy of mains
7	Reliability of mains
8	Installation of mains
9	Arrangement of distribution system
10	Additional factors and conditions relating to supply and distribution
11	Distribution of hydrants
12	Hydrants - size, type, and installation
13	Hydrants - inspection and condition
14	Other conditions adversely affecting adequacy, reliability, or operation of the system
Fire department	
1	Pumpers
2	Ladder trucks
3	Distribution of companies and type of apparatus
4	Pumper capacity
5	Design, maintenance, and condition of apparatus
6	Number of officers
7	Department manning
8	Engine and ladder company unit manning
9	Master and special stream devices
10	Equipment for pumpers and ladder trucks
11	Hose
12	Condition of hose
13	Training
14	Response to alarms
15	Fire operations
16	Special protection
17	Other conditions adversely affecting operations

Table B-1 (continued)

Grading feature and item number	Description
Fire service communications	
1	Communication center
2	Communication center equipment and current supply
3	Boxes
4	Alarm circuits and alarm facilities including current supply at fire stations
5	Material, construction, condition, and protection of circuits
6	Radio
7	Fire department telephone service
8	Fire alarm operators
9	Conditions adversely affecting use and operation of communications facilities and the handling of alarms
10	Credit for boxes installed in residential districts
Fire safety control	
1	Flammable or compressed gases
2	Flammable or combustible liquids
3	Special hazards
4	Miscellaneous hazards
5	Supplemental fire prevention activities
6	Building laws
7	Electricity
8	Heating and ventilating installations
Additional deficiencies	
1	Adverse climatic conditions
2	Other adverse conditions or occurrences
3	Divergence between water supply and fire department

Source: Insurance Services Office, Grading Schedule for Municipal Fire Protection (New York: Insurance Services Office, Municipal Survey Service, 1973), pp. 6-7.

APPENDIX C

I. SPECIFICATIONS FOR RURAL FIRE DEPARTMENTS

General

Rural fire protection to render satisfactory service must consist of the same fundamental facilities that go into the make-up of municipal fire service, namely: (1) organized by ordinance or resolution and under supervision of county government; (2) an adequate number of well organized and properly trained firemen; (3) reliable fire apparatus with proper equipment; (4) reliable fire alarm facilities; (5) adequate fire station facilities; (6) proper operational records; (7) map showing area covered with all streets or roads, road names, water mains, valves, hydrants, and street numbers of all properties.

The following specifications are to be considered minimum requirements. National Fire Protection Association Pamphlet No. 192, "Standards on Volunteer Fire Departments for Rural and Small Community Service" is suggested as a supplemental guide.

Organization

Department (volunteer or call) shall meet and train at least four hours monthly and shall consist of a chief, an assistant chief, and sufficient company to assure response of at least five firemen to all fire alarms. Response of three full-time firemen is satisfactory.

Fire Station

Apparatus to be suitably housed and acceptable facilities to be provided for care of hose and equipment.

Records

Records to be kept of all fires, indicating names of men responding; meeting and training sessions; maintenance of apparatus and equipment, and the district covered, type of building, occupancy, loss on building and contents, cause of fire, etc.

Clothing

Fire service coats, helmets and boots to be carried on the apparatus or readily available for men responding.

Alarms

Electric siren or other acceptable device for sounding alarm to be centrally located and arranged so that it can be controlled from a place where alarms of fire are received and which is attended at all hours. A telephone reserved for fire alarms only must be provided. Fire alarms to be audible to all firemen required to respond to alarms. Facilities for promptly indicating fire location to responding firemen to be provided.

Apparatus

All apparatus to be of proper design, power and arrangement with respect to NFPA Pamphlet No. 19 and U.L. certified.[1] Total weight of each unit when loaded for service, not to exceed the chassis manufacturer's maximum gross vehicle weight rating.

Class A. Two or more trucks; the primary unit to be a U.L. certified pumper and auxiliary units to have suitable facilities for transferring water to the pumper. At least 1,500 gallons of water to be transported to a fire (first alarm response) with not less than 500 gallons on each truck.

Class B. One truck equipped to carry not less than 500 gallons of water. The pump provided to be of acceptable design having a capacity of 50 gpm or more at 120 psi when operating from draft.

Minimum Equipment Required

The following is the minimum equipment required: one 200-foot reel of approved booster hose with combination spray and straight stream nozzle; 500 feet of 2½-inch hose with one shut-off nozzle[2] having suitable tips, preferably combination spray and straight stream type; 400 feet of

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[1]Apparatus for Class B departments are not required to be certified by U.L.

[2]Class B apparatus need not carry this equipment.

Fire Apparatus and Equipment

Motor fire apparatus must be provided, and should have a water tank of not less than 500 gallons exclusive of tanks on any auxiliary apparatus. The pump should be designed to deliver a rated capacity of not less than 60 gpm at 400 pounds pressure. Two reels, each with not less than 200 feet of 3/4 or one-inch high-pressure (booster) hose, and with suitable combination fog-straight stream nozzles, should be provided, or two 200-foot leader lines of 1½-inch cotton rubber-lined hose (preferably preconnected), equipped with combination fog-straight stream nozzles, should be provided. Other equipment should include: one 14-foot ladder with folding hooks; one extension ladder of the fire department type, extending to not less than 24 feet but preferably 30 feet; one pick-head axe; two electric lanterns of the fire department type; two portable fire extinguishers; one 10-foot pike-pole and one crowbar. The motor fire apparatus should be purchased from a reliable manufacturer of fire equipment; homemade and secondhand apparatus invaribly proves to be unsatisfactory. Fire apparatus must not respond to alarms outside the corporate limits unless additional apparatus and manpower are provided.

Fire Station

This should be an unexposed masonry building near the mercantile district. A telephone with a loud ringing bell should be installed, also a switch for operating the fire alarm siren. The building should be heated in cold weather. The apparatus should not be housed in a commercial building such as a public garage, unless it is entirely separated from the remainder of the building by a tight noncombustible partition and have a separate exit to the street.

Fire Alarm

Unless there will be someone on duty at the fire station at all times, arrangements should be made for alarms to be telephoned to some other place where there is constant attendance, and should be sounded by means of a five-horsepower siren. This telephone and siren switch should be in addition to those provided at the fire station (44).

III. GENERAL OUTLINE OF REQUIREMENTS FOR PUBLIC FIRE PROTECTION

The following requirements are intended only as a general guide for small incorporated municipalities or utility districts contemplating the installation of water works systems and other public fire protection facilities, with a view to obtaining credit in fire insurance rates.

The state laws of Tennessee require that all public water works installation costing in excess of $5,000 shall be supervised by an engineer holding a license from the state to practice his profession in Tennessee. Consequently, the first step is to secure the services of a licensed engineer who specializes in this type of work. The engineer should submit his plans to the Insurance Services Office for review before proceeding with the actual installation, in order that the town may know if the water works plans, in conjunction with a suitable fire department, fire alarm and building ordinances, will obtain a satisfactory reduction in fire insurance rates. As soon as the construction of the water works has begun, the town should organize a fire department, provide suitable fire fighting equipment and fire alarm, and adopt suitable building and fire prevention ordinances, so that the entire scheme of fire protection may be inspected and graded at the time the water works is completed.

Water Works

Water supply. The supply shall be adequate at all seasons of the year, and in no case should it be less than 250 gpm. If the supply is from wells, there should be at least two wells. A master meter should be provided so that the amount of water pumped each day can be recorded.

Elevated storage. Elevated reservoirs or tanks lessen the requirements for supply, filter, and pumping equipment, hence the elevated storage should be as large as possible. The capacity of the elevated storage should never be smaller than 100,000 gallons. Whenever possible, the elevated storage should be on the opposite side of town from the pumping station or source or supply.

Pressure. The height of the elevated storage, pressure developed by the pumping equipment, and the size of supply mains should be such that the following fire flow (in addition to domestic consumption) can be delivered for at least two hours in the mercantile or other high value districts at a residual pressure of not less than 20 pounds. Static pressure should be at least 60 pounds.

An estimate of the fire flow required for a given fire area may be determined by the formula:

$$F = 18\ C\ (A)^{0.5}$$

where

F = the required fire flow in gpm
C = coefficient related to the type of construction
  C = 1.5 for wood frame construction
  = 1.0 for ordinary construction
  = 0.8 for noncombustible construction
  = 0.6 for fire-resistive construction

A = the total floor area (including all stories, but excluding basements) in the building being considered. For fire-resistive buildings consider the six largest successive floor areas if the vertical openings are unprotected; if the vertical openings are properly protected, consider only the three largest successive floor areas.

Note: For types of construction that do not fall within the categories given, use a coefficient reflecting the differences. Such coefficients shall not be greater than 1.5 nor less than 0.6 and may be determined by interpolation.

Note: In residential sections, or where buildings are chiefly one or two stories in height, there shall be available at each fire hydrant not less than 500 gpm at 20 pounds residual pressure.

Pumping equipment. No general rule can be given for the size and other feature of the pumping equipment, as this will have to be determined by consulting engineers for each individual town. Pumping equipment should be in duplicate and arranged so that the total pumping capacity may be available simultaneously. Pumping station should be unexposed and contain as little combustible material as possible, and should be heated in cold weather, or insulated, to prevent damage from freezing.

Water mains. Mains serving fire hydrants should be six inches or larger. Mains should have 30 inches cover to protect against freezing and traffic damage.

Gate valves. All mains in the underground distribution system should be gated at each point of connection with a larger main, and additional gate valves should be strategically located on each size main so that not more than two fire hydrants will be controlled by one group of valves. Preferably, gate valves should be sufficient in number to insure that no single case of breakage or repair will necessitate cutting out more than 500 feet of pipe in the mercantile district, or 800 feet in the residential sections. Care must be taken to see that valve box covers are maintained at street level when streets are graded or resurfaced.

Fire hydrants. These should be of American Water Works Association standard type, having not less than two 2½-inch outlets and with National Standard Threads, i.e., 7½ threads per inch, and 3 1/16-inch outside diameter. All hydrants in the mercantile and manufacturing sections should also have a large suction outlet. Hydrants should be set so that outlets are not less than 18 inches above the ground, and so turned as to be unobstructed by poles or other objects. Hydrants should be spaced 300 to 400 feet apart in the high value sections, and 500 to 600 feet in the residential sections. Full credit will not be given to buildings of other than the dwelling class, where situated over 300 feet from a hydrant, measurements to be taken to middle of rear wall of building along public thoroughfares, and not across vacant lots. Connection between street main and hydrant shall be six inches where the street main is six inches or larger. Where hydrants are connected to a

six-inch or larger mains, gate valves should be provided in the hydrant connections. Hydrants should be flushed and inspected not less than two times a year, also they should be examined after use at each fire in freezing weather, and daily in high value sections during protracted periods of severe cold.

Map and records. When the installation is completed, the engineer should furnish the town and the Insurance Services Office with a correct map showing the water mains, valves, hydrants, etc. The town should keep its copy of the map corrected as changes in the system are made. Records should be kept of consumption, hours of pumping, pressures, repairs, hydrant and valve inspections and all phases of water department operation.

Fire Department

Organization. A fire department must be organized by municipal ordinance or by resolution in utility districts and should consist of 15 members, including a chief and assistant chief. In small towns, the department may be volunteer, but it is generally necessary to pay the members a nominal sum in order to maintain an efficient organization. The members of the department should be drilled twice a month in the proper use of the equipment. Rules and regulations governing fire department matters should be adopted, and the chief given full authority for rigid enforcement. (Suggested regulations will be furnished by this office on request.)

Apparatus. An approved fire department pumper, with a pumping capacity of not less than 750 gpm (in most cases a capacity of 1,000 gpm is preferable), should be provided. It should meet the suggested specifications of the National Fire Protection Association and the International Association of Fire Chiefs; it should be of a model which has been certified by the Underwriters' Laboratories, Inc., as having passed a three-hour acceptance test witnessed by a representative of the Underwriters' Laboratories. In addition to the pump, the apparatus should have the following equipment as a minimum: hose body with a capacity for not less than 1,200 feet of 2½-inch and 400 feet of 1½-inch fire hose; a water tank of not less than 300 gallons capacity (preferably 500 gallons); two axes (one flat head and one fire department type); one pike-pole; one 14-foot roof ladder; one 24-foot extension ladder; one 30-inch claw tool; one 36-inch crowbar; 20 feet of hard suction hose and strainer; one set of double connections for 2½-inch hose; suction adapters for each size hydrant outlet; two electric hand lanterns; two approved type portable fire extinguishers, 200 feet of one-inch booster hose with a combination fog-straight nozzle; two shut-off nozzles for 2½-inch hose, with several extra tips ranging from one-inch to 1¼-inch; two combination fog-straight stream nozzles for 2½-inch and two for 1½-inch hose; six hose coupling spanners; two hydrant wrenches; two Bureau of Mines approved self-contained breathing masks; six hose straps; two salvage covers (size 12 feet x 18 feet); one 2½ x 1½ x 1½-inch gated wye; one 2½-inch distributing nozzle. Required apparatus must not respond outside the city limits.

Hose. There should be provided, in towns up to 1,500 population, not less than 1,800 feet of standard 2½-inch fabric covered rubber-lined hose made for public fire department use. Larger towns should have 2,400 feet or more. Cheap hose is unsatisfactory and unreliable, and it will be found more economical in the long run to purchase a good grade of hose. Hose ordinarily cannot be depended upon after five or six years of use. Therefore, each year it will be necessary to purchase 250 to 300 feet of new hose in order to keep the required amount of serviceable hose on hand. Hose lasts much longer if properly cared for. All hose which has not been used should have water run through it every three months to keep the rubber lining from cracking. Afterward, and after use at a fire, the hose should be thoroughly cleaned and then dried. Hose must be tested at 250 psi each year.

Fire station. This should be an unexposed masonry building near the mercantile district, with adequate room for the motor fire apparatus, hose drying facilities and sleeping quarters for several men. A telephone for fire alarm only, with loud ringing bell, should be installed, also a switch for operating the fire alarm siren. The building should be heated in cold weather. Preferably, one or more of the firemen should sleep at the fire station, as this enables quicker response to be made to alarms at night. The apparatus should not be housed in a commercial building such as a public garage, but there is usually no objection to a combination fire station and city hall.

Records. The fire chief should keep complete records showing cause of fire, number and names of firemen responding, drills, method of fighting fire, loss, insurance, hose test, etc., and should make a yearly report to the mayor and board and to this office.

Fire Alarm

Unless there will be someone on duty at the fire station at all times, arrangements should be made for alarms to be telephoned to some other place where there is constant attendance, and should be sounded by means of a five-horsepower or larger electric siren, preferably by wards. This telephone and siren switch should be in addition to those provided at the fire station.

Ordinances

Modern building and fire prevention ordinances should be adopted and arrangements made for their enforcement. These ordinances should define the fire limits, within which only buildings having masonry walls may be erected, and should regulate roofing materials, chimney construction and similar matters.

Enact an ordinance adopting a house numbering system in cooperation with Post Office officials. Rate credit will be contingent upon such numbers being posted upon building entrances.

Inspections

After a town has installed public protection, it will be visited approximately once a year by a representative of this office to determine if the protection is being kept up to standard. On such inspections the town may be required to call the fire department together for drill or instruction, or the water works department required to cooperate in making certain pressure tests. After the inspection, recommendation will be made to the town officials in order to bring the protection up to standard, or to provide better protection to care for future growth (45).

VITA

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From January, 1969, to September, 1971, he was employed by the United States Department of Agriculture as an agricultural statistician and computer programmer-systems analyst. Then, he returned to The University of Tennessee as a graduate research assistant. He went to Mobile College, Mobile, Alabama, in September, 1974, where he is teaching economics and computer science. He received the Doctor of Philosophy degree in December, 1975. He is a member of the American Agricultural Economics Association and the Southern Agricultural Economics Association.

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