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To the Graduate Council:

I am submitting herewith a thesis written by John J. Manning entitled "Tennessee's Water Resources from the Public Viewpoint." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Water Resources Development.

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TENNESSEE'S WATER RESOURCES FROM THE PUBLIC VIEWPOINT

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee

John J. Manning

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ABSTRACT

A statewide survey was conducted on a county basis for the purpose of correlating the views of an individual resident in each county as to the development of the state's water resources and associated parameters.

The results of the survey established significant geographical areas where lack of available water resources and/or lack of revenue potential exerted a suppressive force in respect to development or expansion of the areas' water resources. In addition, rapid growth of industry, housing, recreation and tourism have lead to problems involving the water resource.

The survey also indicated that some of the growth and expansion has been accomplished at the expense of the state's natural resources and that continued growth in the above areas should be carefully considered by various planning and regulatory agencies.

TABLE OF CONTENTS

CHAPTER		PAGE
INTRODUCTION		1
I.	SURVEY OBJECTIVES AND RESPONSE	7
II.	DISCUSSION OF DATA RESPONSE	13
III.	DATA RELEVANCY VERSUS TIME	30
IV.	CONCLUSIONS	55
LIST OF REFERENCES		61
APPENDIX		63
VITA		91

LIST OF TABLES

TABLE		PAGE
1.	Categorized Benefits--Received and Potential	18
2.	Problem Areas Associated with Major Water Source	20
A-I.	Major Water Source by County	64
A-II.	Percentage Use of Major Water Source by County, Population and Land Area	66
A-III.	Benefits from Major Water Source	67
A-IV.	Major Water Source Problems	71
A-V.	Stage of Development of Major Water Source	73
A-VI.	Additional or Secondary Water Sources	74
A-VII.	Total Water Resource Development	75
A-VIII.	Disproportionate Benefits Received	77
A-IX.	Water Pollution from Garbage Dumps, Landfills, Stripmining and Irrigation	78
A-X.	Quality of Total Resources	81
A-XI.	Degree of Difficulty for Water Quality Improvement	82
A-XII.	Problems Relating to Water Quality	83
A-XIII.	Water Quality Index	84
A-XIV.	Thermal Pollution	85
A-XV.	Lowering of the Water Table	86
A-XVI.	Water Level Variations Due to Large Municipal Users	87
A-XVII.	Channelization	88
A-XVIII.	Problems Derived from Stripmining	89
A-XIX.	Specific Comments	90

LIST OF FIGURES

FIGURE		PAGE
1.	Utilization of Major Sources by Population	14
2.	Stages of Development of Major Source	21
3.	Stages of Development of Major Source by County	23
4.	Adequacy of Total Water Resource to Meet Growth Needs . . .	24
5.	Total Water Resource Quality and Degree of Difficulty to Improve Quality	26
6.	Availability of Ground Water in Tennessee	52
7.	Areas of Ground Water Problems by Physiographic Province . .	53

INTRODUCTION

Our space men who travel to the moon and back have called earth the blue planet. A large part of the blue they see is due to water in its various forms. Water has a uniqueness among the chemical compounds. A combination of two active gases, the placid appearance of water belies the multitude of chemical and physical properties which it exhibits. Water is the only substance of any consequence which is found in three physical states. It is the most universal solvent, it has the highest surface tension, the greatest dielectric constant, the greatest heat of vaporization and is second only to ammonia in the heat of fusion. Physical chemists tell us that the above characteristics are due to the polar nature of the water molecule and the hydrogen bonding between molecules. Water is so complex and yet so simple that it is used as an almost universal standard to compare the properties of other elements or compounds. Many of these facts about water have been understood relatively recently, yet water has been a prime sustainer of man from his earliest beginning.

There exists today roughly the same quantity of water that was present when this planet was formed. We have no other source of supply available to us in the foreseeable future. Therefore, it behooves man to protect and conserve this vital resource. Water and oxygen are man's prime life sustainers and should be of utmost importance to him in respect to their quantity and quality. Pure water is not found in nature; pure water is only made in the laboratory. Chemically, water is always stable; water varies only in the physical make-up

of the hydrogen and oxygen atoms. Thus water looks and tastes pretty much the same despite varying isotopic ratios.

In the past, especially the last one hundred years, man has appeared determined to reduce significantly the quality of water. If we look at man's historic association with water, we discover that man, or rather man's precusors, came into existence and were succored by the shallow warm seas of a distant time interval which today we call precambrian time. Throughout man's development water has played an integral part in the process.

Man has to have water to survive so we can readily understand how water has dictated the spread of man around the globe. Man needed water to drink; water was also needed by the animals he hunted. Later he found that water was an easy route to travel. He discovered that water was pleasant to bathe or swim in and contained animals which he could use. Later it became apparent water was a good natural barrier against his enemies and that control of bodies of water was a political and military advantage. Once he ceased to be primarily a hunter, he discovered that water was needed to grow food.

When modern man evolved (roughly 30,000-50,000 years ago), he used water in many ways. In fact, with the exception or irrigation, he used water much the same as did the early nomadic herdsman who about 8,000 years ago became the first farmers. In the last 8,000 years man has developed to the point where he has the ability to destroy all mankind and some say the ability to destroy the planet. Ironically, water supplies a component part of the device which would allow man to accomplish his own self-destruction.

Today man is aware that prophesy is beginning to be fulfilled in respect to another critical aspect in his relationship with water. Man's growth and accomplishments have led to disturbances in the natural order of his environment and in some instances to the destruction of ecological sub-realms such that he now may face a reorganization of his way of life. For several generations dedicated men have warned of coming chaos resulting from the misuse of water and watersheds, municipal and industrial discharges, soils not suited for cultivation, and later of indiscriminate application of fertilizers, insecticides and herbicides.

Today the average man is also aware that something must be done in reverting the trend toward a hostile environment, and that this "something" (whatever it is) will require large expenditures of capital. He is confused as to just how much is needed or how much should be accomplished. It is in this area where the various levels of government have failed to act in a clear concise manner. Most of these government authorities seem to be about as confused as the average man and perhaps with good reason as they are confronted by the pressures of progress, economy, increasing population and industry. Opposed to these pressure factors are the warnings of trouble ahead by experts in various related disciplines. Adding to the clamor are the self-appointed crusaders or minority groups who, for usually small or selfish interests, cloud the issue and make it difficult to reach the core of the problem.

Within the past year several representatives of the top water resource agencies (at both state and federal levels) have stated that

there were no real clear-cut plans or projections as to the best route for a workable water improvement program. They admitted this was partly due to the above mentioned factors. They admit they are essentially using trial and error techniques, that many areas in which water quality is now involved are new and that situations this year may not be the same next year. This aspect of our water resource programs may continue for several years. The everchanging needs or demands upon our water resources bear the necessity for flexibility, such that the resources can be fitted or optimized for a particular time or place. It is reasonable to assume an index of water resource standards will evolve perhaps on the basis of regional or large river drainage basins modeled after some of the more successful river compacts. This could free the control of water resources from the various political entities which sometimes take serious license with the water resource however well intended.

For example, the development of a water resource quality index will be difficult as streams in a large drainage basin will contribute varying concentrations of both common and rare ions due to the soil chemistry from whence the tributaries collect their flows. This assumes that these streams are not presently contaminated by industrial, municipal or agricultural processes. Very few streams fit this criterion; thus it becomes almost impossible to establish a "natural" or "background" standard so as to compare any further or additional man-made contribution.

The indices or standards will then be dictated to a large extent by their relationship to man. Most people perhaps would not

be interested in a complex set of water quality standards. Despite the large group of water recreationalists, the majority of the people only use water for household use. These "nonuser" people still appreciate the aesthetic value of a reasonably clean appearing, non-odorous body of water. Any water recreation user would enjoy a simple water index by which he could recognize if this water fitted his use.

Opposed to the above groups are the purists, people who say man is standing neck-deep in his own pollution of the water resource, that the resource must revert to a pristine state regardless of cost. These people exhibit no middleground, no willingness to compromise, and in fact, no respect for the opinion or desires of anyone except their own. Thus, we have a wide range of people who are involved with the water resource. The professional water resource person must serve as a buffer between the interests, desires and noninterests of these groups. Professionals are defined herein as competent workers in water resource related areas who understand and appreciate the position or needs of other problem areas in respect to their own. Doom forecasting rigid environmentalists are not water resource professionals regardless of their educational attainment. One can see then that the establishment of water resource guidelines, in this case water quality indices, will be difficult to attain such that working enforceable rules can be maintained.

The state of water resource development is comparable to other environmental areas--atmospheric problems; rural and urban land use problems; industrial and agricultural problems are all in a state of change. Once we can establish the proper order of priorities

for the various problem areas, then we have the technology to deal with these problems. It may be that we will have to sacrifice some areas temporarily for more pressing problem areas. For example, we need to progress with the construction and operation of nuclear power reactors in this country. Perhaps it will become necessary to increase the temperature of some rivers a few degrees (temporarily) until we solve the problem of more efficient heat removal from the return effluent. This would be a logical decision, yet we do not want to affect all streams this way so here is a great need for research in heat exchange.

In view of some of the foregoing discussion, and if there existed some indecision as to what may be the optimum route to take in the further development of water resources programs, then what would the so-called average man prefer? What would be his thoughts, needs, and concepts about his local water resources? If the decision were his, what would he do in respect to water demand in industry, or municipal use? For example, what effect would a rapid population increase have on the water resource? Would he like to see one of the aforementioned power reactors in his community? Is there adequate fire protection water in the subdivisions in his community, and so forth?

CHAPTER I

SURVEY OBJECTIVES AND RESPONSE

Objective

The basic purpose of the survey was to determine an attitude which an average resident of any particular county might hold in regard to the water resource of his county. Realizing that any result would be biased in some manner, the survey cover letter specifically requested that the respondent reply, if possible, in an average citizen's viewpoint.

The surveys were sent to the Agricultural Extension leaders (The Agricultural Extension Service, The University of Tennessee) in each county. The author felt that these people would be closer to the individual citizen than any other group available, and were trained to be objective. In general, the extension leaders did personally answer the questionnaire; however, in a case or two other individuals answered. No names were required, the only stipulation being that the county be identified. From the replies it was expected that the variance in attitude would lead to multi-county or regional differences in respect to various water related entities.

Method of Assessment

The questionnaire contained questions which can be divided into five segments. Part one deals with the major water source of the county and its associated conditions. Part two concerns the total water resources of the county. Part three involves water quality.

Part four deals with potential expansion and increasing demand on the water resource and Part Five concerns allied problems in water resource development, ground water loss, thermal pollution, stripmining, channelization and so forth.

The replies to the above segment established various data which are contained in 19 tables in the Appendix. From these data tables the author has categorized the significant information, generally exceeding 5% or more of the state's population, counties and land areas and these data are discussed in detail in Chapter II. The relationship of the data and implied effects upon county development, both past and present, are covered in Chapter III.

Questionnaire and Response

To survey some geographical unit which would provide the viewpoint of an average citizen concerning today's water resource problems seemed reasonable. On a regional basis the similarity in topography, geology, and so forth, would not give the proper divergent conditions which exist state-wide; therefore, with the county as the basic geographic unit, the results could be assessed on a regional and then state-wide basis.

The questionnaire posed some problems. The questions should not be overly complex or too general in nature, such that no usable data would be forthcoming. The questionnaire should be of such length that no more than one hour's time would be required in answering.

The response from the county survey was not as good as expected, with 71 received out of 95 mailed for a 75% return. The response to the questions was about average. Approximately 25% of the surveys

returned were excellent, it being very apparent that considerable thought had gone into the answers. About 50% of the surveys returned answered the questions but volunteered no additional data. The remaining 25% of the surveys were poor in basic information with no elaboration or attempt to clarify apparently conflicting answers to sequence questions.

A listing of the questions on the survey follows:

(1) What is the major water source of your county?

(2) What benefits are received from this source?

(3) What may be some potential benefits which could be received by further development of the source?

(4) What obvious problems, if any, are associated with the major source? For example: pollution, flooding, low flows, too shallow for commercial transportation, heavy silt load and so forth?

(5) At what stage is the development of the major source: (a) overdeveloped, (b) adequate, (c) inadequate, (d) underdeveloped, (e) grossly underdeveloped?

(6) Please record any additional water sources which are available in your county.

(7) Are the total water resources in your county adequate today?

(8) Will your county's total water resource be adequate to meet increasing demands as a result of normal area growth?

(9) If Question #8 is negative, what is the cause of the inadequacy?

(10) Will the total water resource be adequate to meet demands of a sudden population or industrial impaction?

(11) Does any one specific group (that is, industry, agriculture, and so forth) benefit out of proportion to similar groups? If so, how?

(12) Is there any water pollution in your county resulting from: (a) garbage or trash dumps, (b) sanitary land fills, (c) stripmining, (d) irrigation of agricultural lands? Please comment on (a), (b), (c) and (d) if you answer affirmatively.

(13) Do the suburban housing developments in your county have: (a) adequate potable water supply, (b) adequate fire protection water supply?

(14) Please classify the total water resources quality of your county as: (a) excellent, (b) good, (c) adequate but could be improved, (d) fair and is in process of improvement, (e) poor, must be improved.

(15) If the water quality needs to be improved, will improvement be: (a) relatively easy to attain, (b) difficult but, if the people are aware of potential consequences, can be attained, (c) accomplished only by massive motivation from state and federal level, (d) as a last resort, due to failure to meet state standards for example?

(16) Is water quality improvement for the purpose of recreation alone a legitimate cause for improvement?

(17) Have there been any stream-bed changes of a serious nature as a result of stripmining?

(18) Would the people in your county be amenable to a large water source user locating in your area--say a nuclear power plant or paper mill?

(19) Is there any significant irrigation in your county? If so, would you comment upon any water quality deterioration or water quantity reductions as a result?

(20) Is there an adequate farmer education program that stresses agricultural water pollution problems in your county--such as feed lot run-off, fertilizer wash-off, improper watershed management, and antiquated human sanitary systems?

(21) Please list three or four factors which you would like to see incorporated into a water-quality index. Some examples might be: color, smell, general and/or specific bacterial count, safe for water recreation and so on.

(22) Are there any fish farms producing significant quantities of catfish in your county? If so, how many?

(23) Are you aware of the existence of any thermal pollution of the water resource from industry in your area? If so, could you state what the source of heat is?

(24) Are you aware of any problems involving the lowering of the water table by overpumping from wells? If so, how serious are they?

(25) Do you have any knowledge of well drawdown and well recharge time changes that have come about by large municipal users near your county?

(26) Have there been any suggestions for a project of ground water artificial recharge of aquifiers for your county?

(27) What attempts at channelization to improve water resources have been attempted or proposed for your county?

If there is anything you think interesting which is not included in the above, I would appreciate your comments.

CHAPTER II

DISCUSSION OF DATA RESPONSE

The summarized results of the questionnaire are presented in tabular form, denoted by a capital A when mentioned in the text, and are found in the appendix. In order to allow the percentages to be realistic on a state-wide basis, the author arbitrarily assigned major water sources for the 24 counties not reporting. These counties are as follows:

Dyer, Gibson, Benton, Chester, Hardin, Perry, Humphreys, Williamson, Marshall, Rutherford, Wilson, Coffee, White, Cumberland, Morgan, Roane, Rhea, Bradley, Union, Knox, Greene, Sullivan, Unicoi and Carter

It is only in Figure 1 and Tables A-I through A-III that the total 95 counties were used. It is unfortunate that some of the nonreporting counties lie adjacent to each other; therefore, the effect is not minimized as if they were isolated or surrounded by reporting counties. On occasion where counties gave more than one major source, partial counties, population, and land areas were used where appropriate.

The response established 29 categories of major water sources, 28 of these sources originate from surface water. One category, ground water, will be compared to the other 28 surface water sources. This is not technically correct; however, for the purpose of this report we would like to consider ground water as one of the 29 major water sources.

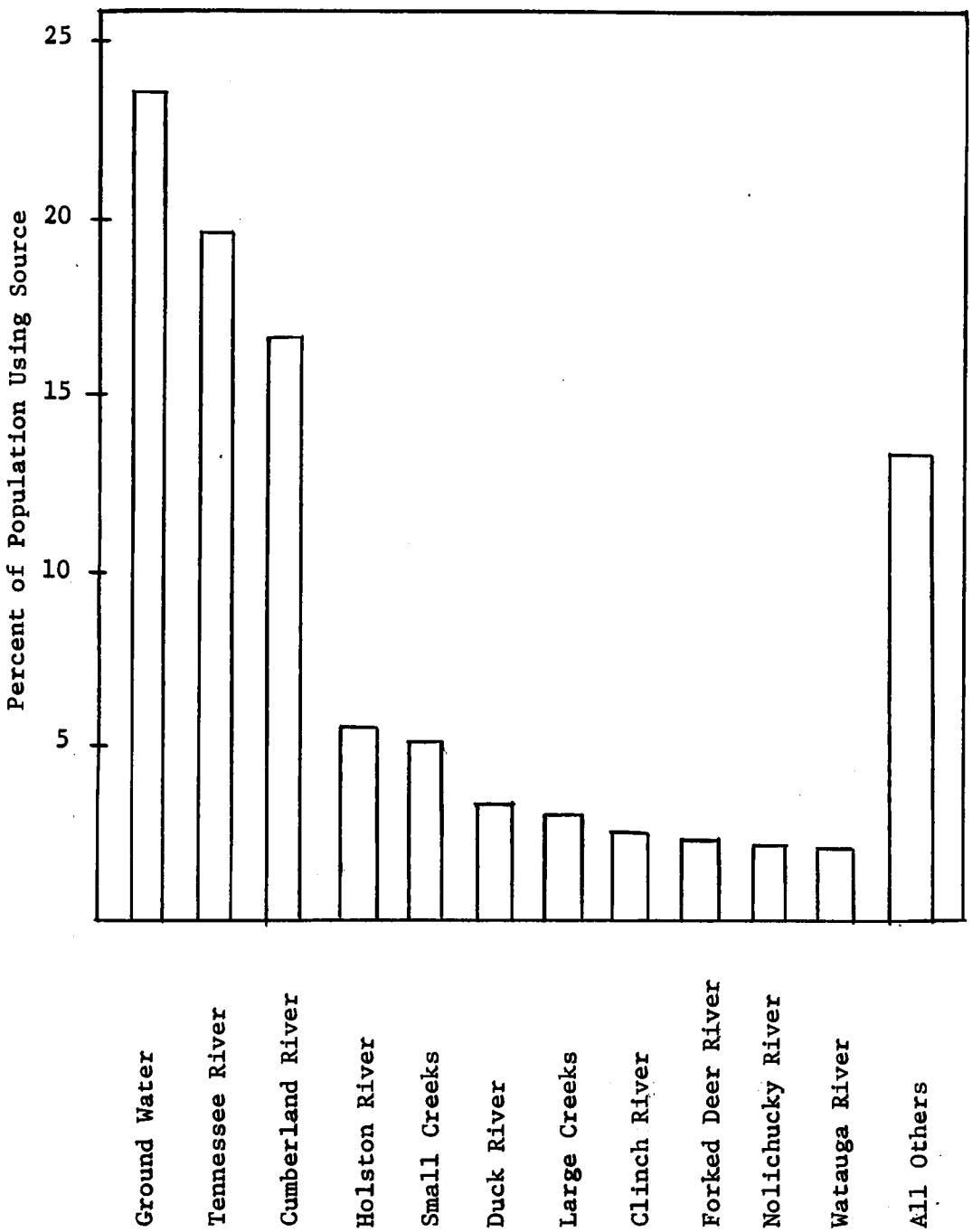


Figure 1

Utilization of Major Sources by Population

Counties' Major Water Sources

If we examine Tables A-I and A-II, we find that the Tennessee River system is claimed by 16 counties as the major water source. We also see that 16.8% of the state's total counties, 19.7% of the total population and 17.1% of the state's total land area benefit from this source. Further examination on a total county basis shows that small creeks, the Cumberland River system, ground water, large creeks, medium-sized rivers and small rivers follow in order. The only anomaly occurs in the ground water category. It ranks fourth in percent of use by counties, yet ranks first in total population use and second on total land area served. Considering just the water source and the people who benefit from this source, then ground water must rank as the state's number one water source as categorized in this report (see Figure 1).

Some of the counties' choices may seem at a glance illogical. For example, five counties border the Mississippi River, yet only Lake and Lauderdale rate the Mississippi as a major source. Of these five counties, only Shelby with its large urban area takes full advantage of the potential the Mississippi River offers. Tipton, Lauderdale, Dyer and Lake Counties, all with low population densities, predominately agricultural in production and with no large industrial base, have no present need to greatly increase their use of the Mississippi.

The small creeks group ranks second based on total county use and serves only about 5% of the total population. From the total land use ranking, they serve about 10% of the state's land area. This

would seem to indicate an area with great future potential, however sufficient water for large developments is just not available. Only Bradley, Putnam and Warren Counties have relatively close (in county) access to reasonably large streams which could handle increased supply for industrial expansion and have sufficient flows for treatment plants that any expansion would bring.

The Cumberland River serves 10% of the total counties, about 16.8% of the population and about 9% of the total land area. The Cumberland River, by its location, is limited to the north middle counties' use. Although not as extensively developed as the Tennessee River, it is well developed as far upstream as Jackson County and has great potential in the downstream counties below Davidson County.

The ground water classification major source serves more people than any other group. All counties in the state benefit from ground water. Counties that have abundantly large streams and reservoirs have most of their rural population utilizing ground water. The county with the largest population in the state (Shelby) uses ground water for municipal and urban supply. Almost all the counties between the western highland rim and the Mississippi flood plain rank ground water as the major water source. Several counties report that the ground water supply is being adversely affected by demand from various factors. Table A-XV lists these factors and they include industrial, municipal, urban and rural users. These increased demands, coupled with dry seasons, have reduced flows, increased well draw-down times to effectively lower the water table such that artificial recharge of the aquifiers may soon have to be considered. An associated problem

with the loss of ground water potential is bio-chemical contamination of the ground water.

Large creeks serve as a major source for about 6% of the counties, 3% of the population, and 6% of the total land area. The medium-sized rivers such as the Duck, Clinch, Elk, Holston and Forked Deer, all fit roughly in a class that serves 4% to 5% of the counties, 2% to 5% of the population and 2% to 6% of the land area. The remaining major sources serve two counties or less, 2% or less of the population and 2% or less of the land area.

Benefits Received and Potential

From Tables 1 and A-III the benefits received and potential benefits are categorized. For benefits received from the major source, by far the majority of counties reported municipal and industrial water supply. Other benefits received included agricultural supply, flood control, water recreation, including hunting and fishing, power generation, commercial water transportation, aquifer recharge, aesthetic values and tourism. Water recreation was a close second to industrial and municipal supply.

Potential benefits were varied in response. The improvement of municipal or industrial supply and raw water quality was mentioned frequently. Respondents from almost all counties reported that they would like to see more recreational development or tourism. Agricultural potential benefits included irrigation, flood control, increase in reservoirs on streams such that siltation was lessened. Increase the commercial transportation and its associated facilities, more

TABLE 1

Categorized Benefits--Received and Potential

	Prime Benefits Received							Potential Benefits					
Major Water Source	Power	Flood Control	Mun. & Indus. Supply	Agricultural Supply	Recreation	Tourism	Aesthetic Values	Increase Transportation and Facilities	Increase Recreation and Tourism	Increase Potable Water Supply	Increase Water Related Industry	Additional Reservoirs	Increase Irrigation
Ground Water			X	X					X	X	X	X	X
Tennessee River	X	X	X	X	X	X	X	X	X		X		
Cumberland River	X	X	X	X		X	X	X	X	X	X		
Holston River	X		X	X	X				X		X	X	X
Small Creeks		X	X	X	X				X	X		X	X
Duck River			X		X				X	X			X
Large Creeks			X		X		X		X	X			
Clinch River	X		X	X	X				X		X		
Forked Deer River			X		X							X	
Nolichucky River			X	X	X				X	X			X
Watauga River			X	X	X				X	X			X

NOTE: X denotes positive response by at least one county utilizing particular source.

wildlife reserves and historical site development were also quoted. Not one county reported a need for additional power generation, either by hydro-electric, steam or nuclear methods.

Problems Associated with Major Source

Problems associated with major sources (Table 2) show that pollution is the most critical detrimental factor to the sources. Pollution of all types was reported--pollution from urban areas, from industrial processes, from large municipalities, from mining and from natural chemical means. Other frequently mentioned problem areas were flooding and low flows, variation of water levels, the lack of water transportation and inadequate resources for commercial transportation. Recreational impaction and the associated cost of damage and clean-up from careless hunters, fishermen or water recreationalists, well-drilling costs and the lack of insect control were cited. The distance or separation of major sources from urban areas, siltation and the ramification of the causes of siltation were reported several times.

Stage of Development of Major Source

Figure 2 shows the stage of development of the major sources. These five classifications from overdeveloped to grossly underdeveloped were the choices offered. No county felt the major source was overdeveloped. Sixteen counties reported that the major source was adequate, 9 counties reported that development was inadequate, 37 reported that development was underdeveloped, and 9 counties said their major source was grossly underdeveloped.

TABLE 2

Problem Areas Associated with Major Water Source

Major Water Source	Major Problem Areas Associated with Resource												
	Pollution	Flooding	Siltation	Low Flows	Municipal and Urban Waste	Recreational Impaction	Too Shallow for Transportation	Insect Control	Variation of Water Level	Pollution from Large Municipalities	Improper Regulation of Fishing Rights	Cost of Drilling Deep Wells	Natural Chemical Pollution
Ground Water	X	X										X	X
Tennessee River	X	X			X								
Cumberland River	X				X	X	X	X		X			
Holston River	X						X		X	X			
Small Creeks	X	X	X	X							X		
Duck River	X	X		X									
Large Creeks	X		X				X						
Clinch River	X		X		X		X		X				
Forked Deer River		X											
Nolichucky River	X				X		X						
Watauga River	X				X		X						

NOTE: X denotes positive response by at least one county utilizing particular source.

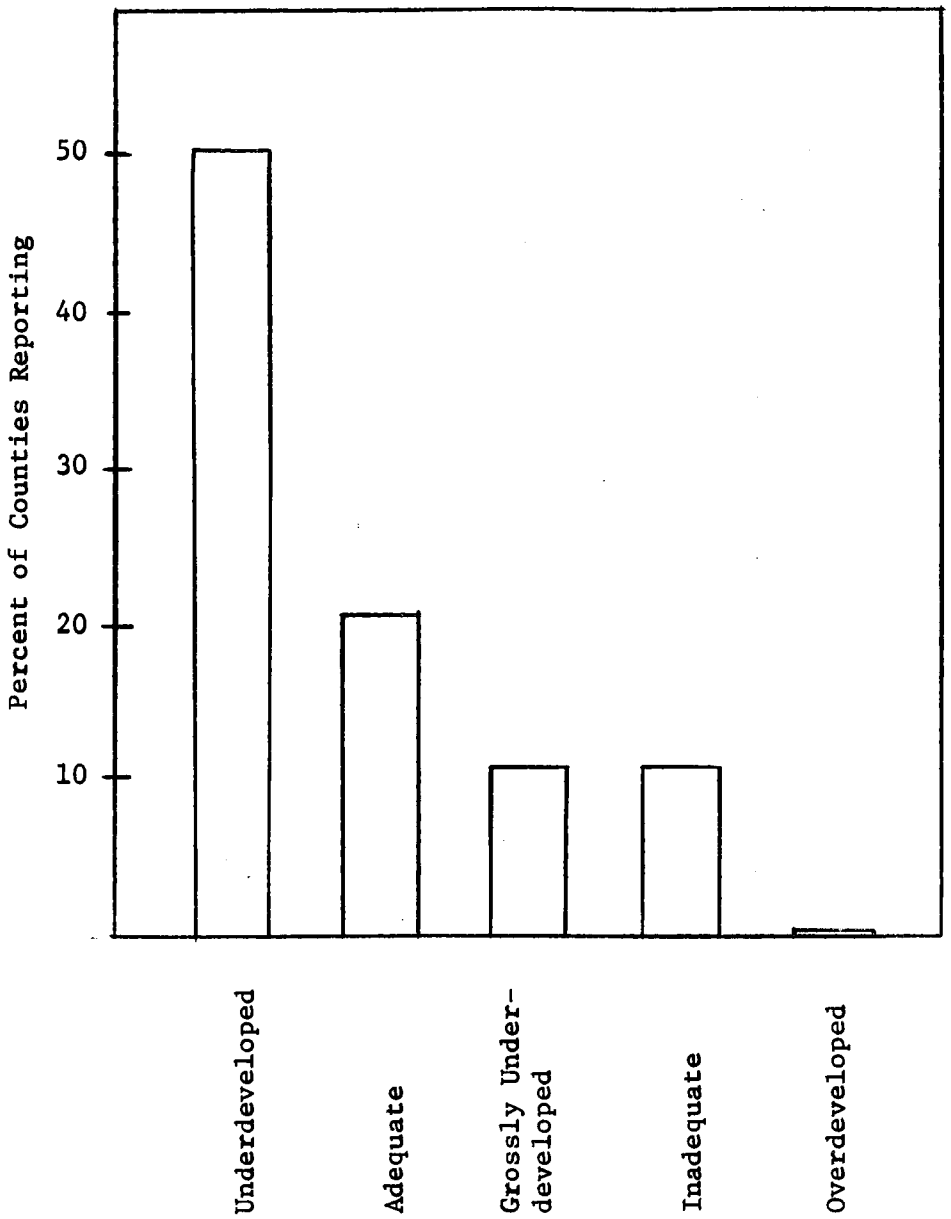


Figure 2

Stages of Development of Major Source

Figure 3 portrays stage of development by county. The distribution shows no apparent pattern in respect to major rivers, except along the Mississippi in southwest Tennessee and along the Tennessee River between Knox and Hamilton Counties.

The listing of secondary sources in the counties is shown in Table A-VI. Eight categories were developed from the replies. In some cases counties reported multiple secondary sources; therefore, some counties are listed more than once in Table A-VI.

County's Total Water Resources

Figure 4 shows and Table A-VII lists the response to the development of total water resources per county. The items involve the adequacy of the total resources today, the ability to meet normal growth demand and the ability to meet demand from a rapid expansion. Fourteen counties commented upon what they consider the reason for inadequate development. Seven of these 14 essentially say limited quantity of water is the reason for the nondevelopment. Poor distribution and the cost of distribution systems was reported as a cause of underdevelopment. A third reason for poor development was that the water systems in the areas were just not keeping pace with other expansion. It is assumed that public apathy and economic difficulties would be the cause for slowness in development. Madison, Lincoln and McNairy Counties have unique problems. From a legal aspect, McNairy has the most interesting one (see Chapter III).

Nonproportionate Benefits

To the item of nonproportionate benefits received, 13 counties responded positively, Table A-VIII. Seven counties reported that

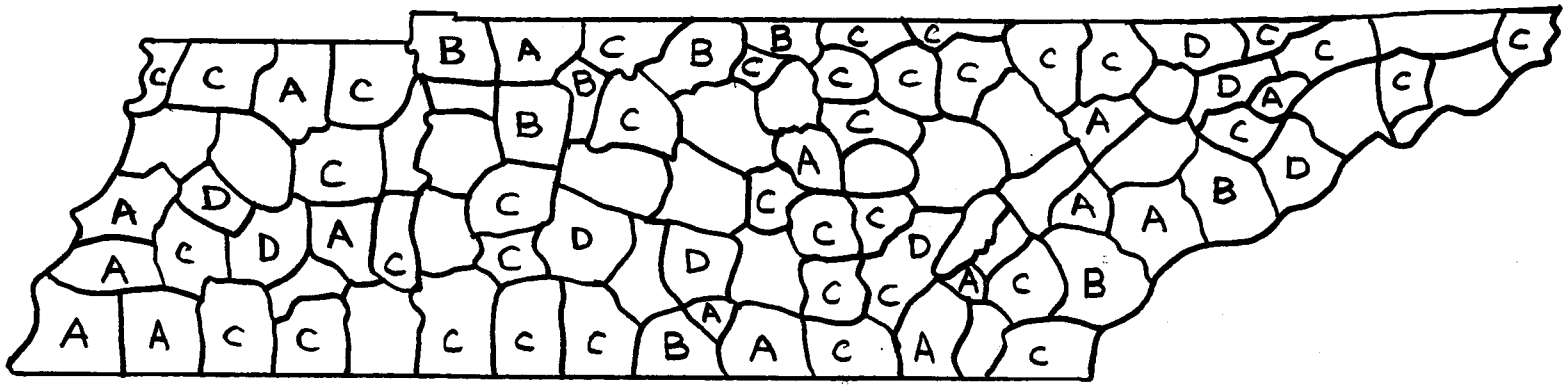


Figure 3

Stages of Development of Major Source by County

A = Adequate
B = Inadequate
C = Underdeveloped
D = Grossly Underdeveloped
(Blanks = Counties not Reporting)

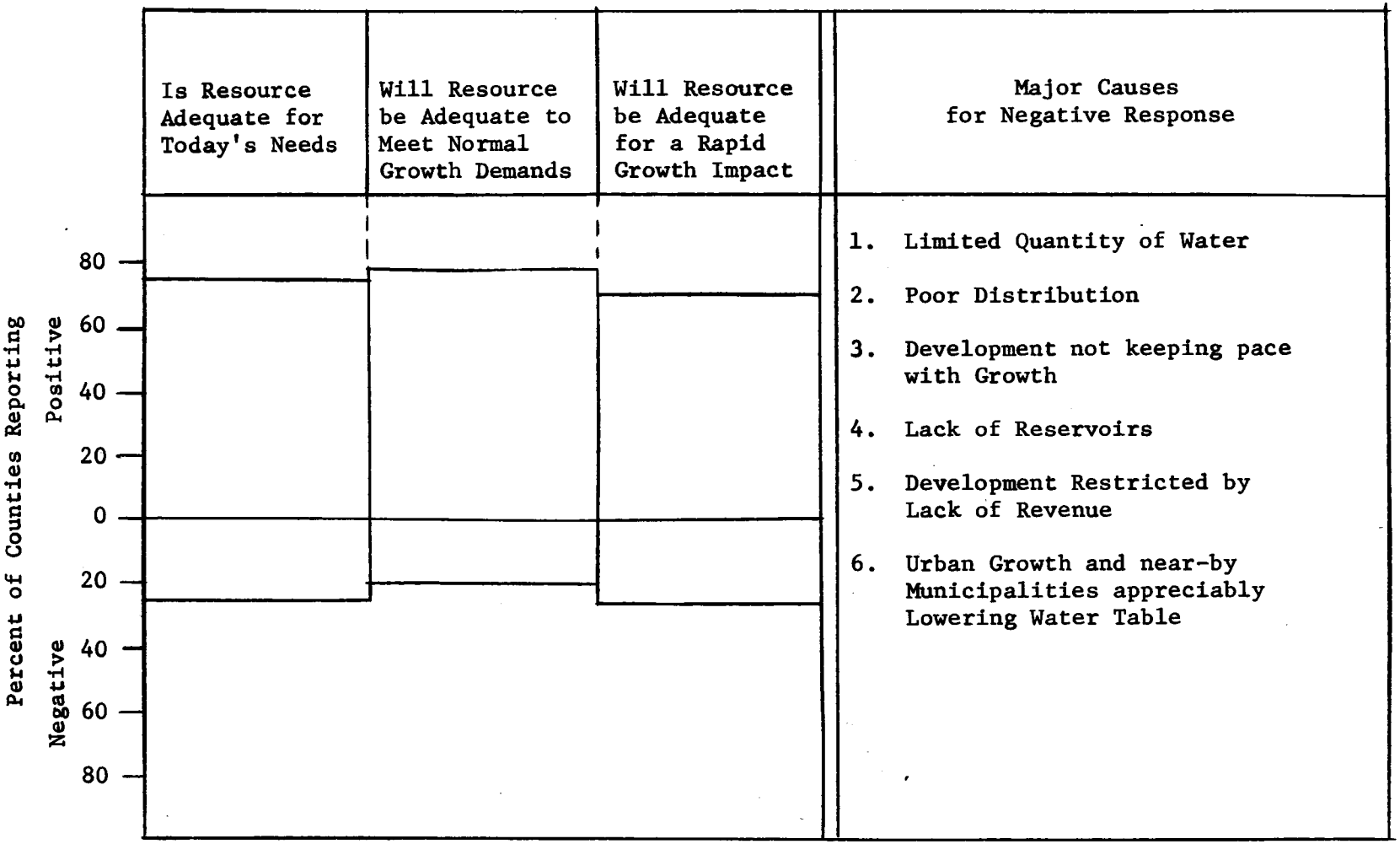


Figure 4

Adequacy of Total Water Resource to Meet Growth Needs

they felt industry received a larger proportionate share of the water resources. Water recreationalists were mentioned as recipients of both sides, sharing out of proportion and of not receiving a proportionate share. Agricultural use was also listed in both categories. One significant statement came from Sumner County, which was that industry, real estate organizations and construction companies benefit at the expense of the farmer by causing unrealistic land values to be established near water sources.

Pollution from Trash, Landfills, Mining and Irrigation

The response to the items of water pollution related to trash dumps, landfills, stripmining and irrigation (Table A-IX) was significant. Forty-Five out of 71 counties responded to this question. It is obvious that the indiscriminate dumping of garbage or trash is a state-wide problem. Stripmining, improper operation and location of landfills, thoughtless recreationalists, industry and municipalities were reported as contributing to the worsening of the state water quality.

Quality of Total Water Resource

Tables A-X and A-XI and Figure 5 show the response to the overall quality of the counties' total water resources and the degree of difficulty required to improve the water quality. To both items an average position was indicated by the majority of counties. Relatively few counties said their water quality was excellent or that the quality was poor. Eighteen counties reported that any water

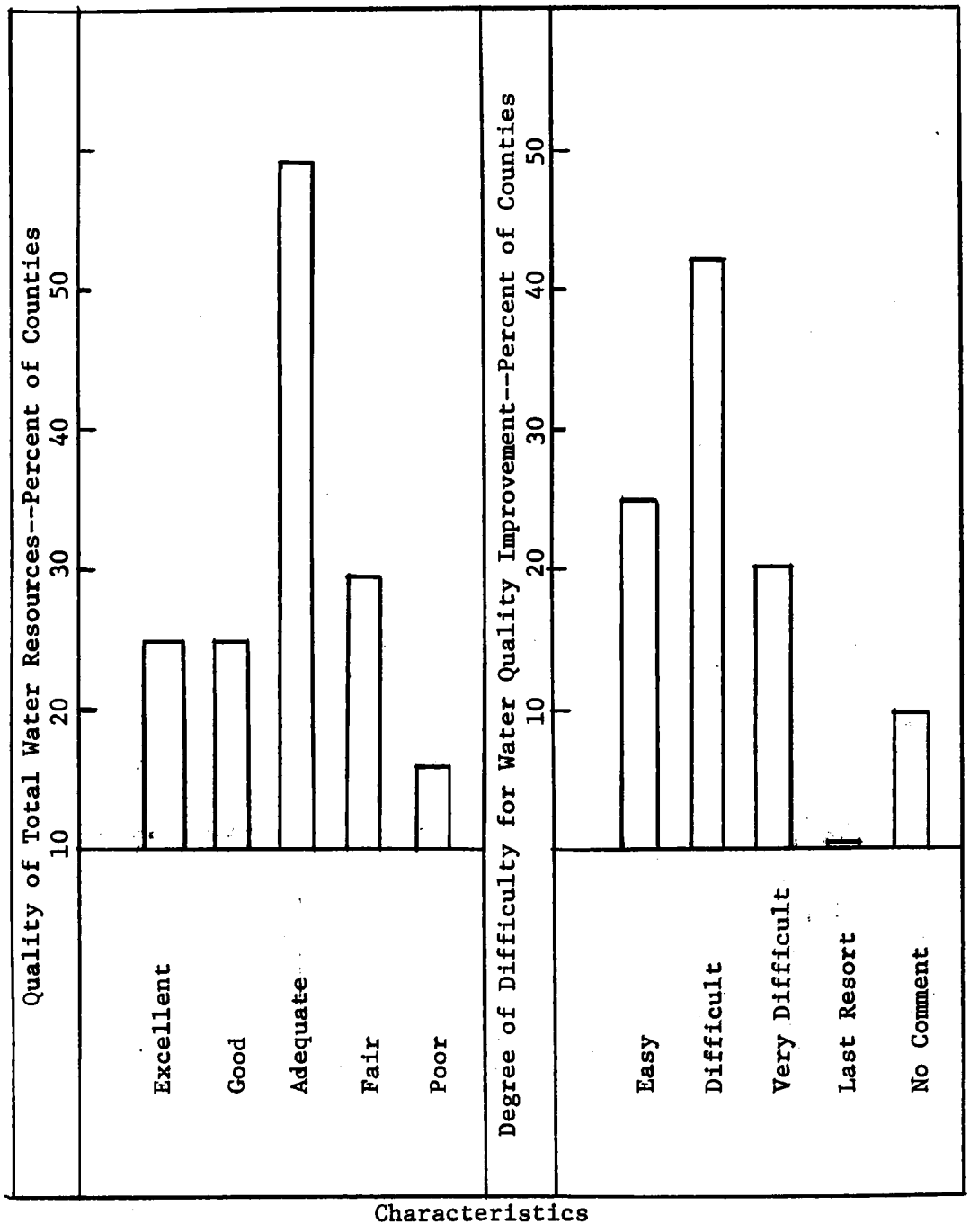


Figure 5

Total Water Resource Quality and Degree of Difficulty to Improve Quality

quality improvement would be relatively easy to accomplish and no county said the difficulty would be the "last resort" or enforced improvement type.

Responses to Items 16 through 20 are listed in Table A-XII. Approximately two-thirds of the counties would approve water quality improvement for the purpose of recreation alone.

Water Quality Index

Table A-XIII gives the response to a simple water quality index. Fifteen factors were reported with four factors mentioned a dozen or more times. Smell, general bacterial count, color and safe for water recreation topped the list. Taste, chemical content, useful for industrial or municipal supply, total solids and siltation factors were next mentioned most frequently. For some reason the factor of safe for animal consumption was low on the list. Two counties stated that the present controls were adequate.

Thermal Pollution

Four counties reported knowledge of thermal pollution (Table A-XIV). Cocke reported industrial cooling water as the source of heat. Hawkins and Sumner reported TVA steam plants as the heat source. Sumner also reported that the steam plant was introducing lagoon cooling and that total heat returned to the supply stream would be significantly reduced. Maury County reported thermal pollution but gave no heat source.

Water Table Levels and Channelization

Table A-XV gives the response by counties to the item of lowering of the water table. Lincoln, Macon, Warren, Dickson, Cheatham and Sequatchie Counties report significant reduction in ground water supply.

Washington and Lincoln Counties report well variation due to lake fluctuation and draw-down caused by municipalities which use springs as a supply of ground water (Table A-XVI).

Table A-XVII gives the response to the item on channelization. Twenty-four counties responded with 19 commenting upon projects, proposed projects or the need for channelization projects. A few counties did not think any channelization was wise. They stated that the natural environment would be the preferred condition by the majority of their people.

Changes Due to Stripmining

Five counties reported significant change to streams or stream beds due to stripmining. Table A-XVIII lists the counties and their comments. Campbell and Overton Counties appear to have the most serious problems. Campbell County reports loss of biological life in streams from acid content of water and siltation resulting from surface run-off. Overton County reports stream coloration and fish spawning--feeding areas damaged. Scott County reports possible serious damage to streams. Sequatchie County reports mud and silt in a few streams from plateau stripmining. Grundy County replied affirmatively but cites no specific instances.

At the end of the survey specific comments not covered in the questions were requested. Ten counties did reply and these comments are listed in Table A-XIX.

CHAPTER III

DATA RELEVANCY VERSUS TIME

Historical Developments

Adequate water supply for municipal and industrial use, water recreation and tourism are terms that are most prominently mentioned throughout the survey. Other factors are mentioned, of course, but these four are used most frequently as these factors are basic to Tennessee's prior and future economic development.

It is not necessary to discuss the origin and growth of the Tennessee Valley Authority or its three cardinal goals--flood control, navigation and electric power. Yet without the existence of these resources and the wide range of benefits associated with them, the Tennessee Valley would not have been at its present state of development. Tennessee then, with the TVA in existence and operating, had all the factors to attract industry. Ample water and a water route to the Ohio and Mississippi, cheap electrical power, cheap land availability, a raw labor market which was agriculturally oriented and little associated with organized labor, all beckoned to industrial management.

With all of the above attractive features, the Valley was not without some disadvantages. Raw material was not readily available. Forest and building stone products, mining of coal, copper and zinc were some of the few industries where the state supplied the raw materials. Textile mills made use of the cotton produced but in general the potential of the state rested upon the nonbasic qualities or on secondary industry. When industry did locate in the state,

it was usually established relative to urban areas where full services were readily available. Only since about 1960, coupled with the growing potential service produced by TVA, has the trend begun to change. In many municipalities the old political regimes were replaced by younger and more vigorous governments. These governments began to offer attractive political compacts such that occasionally water oriented industry would locate around the state. In some cases the competition was very keen even among adjoining counties.

Industrial and Residential Expansion

Sometimes the effort to secure an industry for the county had a beneficial effect upon the water resources of the area. In many cases utility districts or expansion of existing municipal systems were brought about. Sewage treatment plants, however primitive, were also required. The people who staff these industries on occasion did relocate such that a total growing process was evident. Once an industry was established, then the effect to secure the second or third was not as difficult. This process was found to be so successful that through the 1960's many small towns in the state benefitted. Today most of these towns have developed industrial parks which, by the aid of low taxes, cheap water and power, they cater to the industrialists and establish relationships which are mutually beneficial to both public and private sector.

The development of this type industrial growth was haphazard and poorly organized. Although much effort did go into securing the industry for a specific location, relatively little planning was done beyond the municipal or county borders. As a result of incomplete

planning on multi-county or regional basis, the total benefits may not have been distributed or optimized to the maximum number of people. Thus over the last fifteen years industry has been established in small communities throughout the state. Only in the past decade has much attention been given to the effects of such creation and only in the last few years has the environmental aspects of allout industrial proselyting become a familiar theme to the average citizen.

The effects of poorly planned expansion have fostered several problems related to the water resource. Most significant has been the movement or shift of population from the city to the suburban areas, which on occasion was a shift outside corporate limits and thus an escape from city taxes. Another factor is the increase in industrial resources which has increased pressure upon inadequate water and sewage treatment systems. A third factor is the effect of impaction in some areas brought about by the geographical location of various local, state and federal organizations, schools, airports, dams, steam-plants, military posts, recreational areas--anything which could serve as a nucleus for future growth.

These growth factors or shifts in population density then lead to the need for expansion of services in the water and sewage treatment areas. At times no existing services were available. This forced the development of new systems or the use of minimal techniques such as septic field systems for residential areas in conjunction with small diameter water supply lines. Small package units for sewage were installed for school and industrial projects.

The more affluent counties with adequate water districts were not able in all cases to provide county-wide potable water. The survey asked if the suburban housing developments had adequate potable water supply and adequate fire protection supply. Of the 71 counties reporting, 22 said they had both potable and fire protection supply available in the suburban areas. No fire protection supply was reported by 46 counties, and 19 counties reported no potable or fire protection water in the suburban developments. However, a few counties qualified their statements that plans or construction was underway to expand potable water to an all-county service. It then appears that a high percentage of counties in the state do not have at the present time adequately developed water systems for suburban development.

The counties which reported insufficient potable and fire supply water in both rural and urban housing developments were:

Lauderdale, Trousdale, Hamblen, Cannon, Overton, Sumner, Hawkins, Fayette, McMinn, Henry, Davidson, Sevier, Monroe, Sequatchie, Hancock, Lincoln, Bedford, Cheatham and Grundy

Grundy reports that it is a rural county with no suburbs but that the towns have inadequate potable water.

The large metropolitan areas of the state have been rushed to keep abreast of the increasing demand for services, potable and fire protection water, liquid and solid waste disposal facilities all create headaches for the various authorities concerned.

On occasion the unwieldy structure and areas of mixed or cross-purpose responsibility of the regulatory and administrative bodies have allowed inter-agency bickering, local politics, single

actionness and in general nonconcertive approaches to many problems involving suburban development.

If we consider for a moment the number of official bodies involved with the growth of housing areas and the necessary supporting services, then we may do reasonably well considering all factors. At the local level we have the county judge, the county court, the county commission, county health department, possibly a planning commission, water departments or utility boards, sanitation departments, housing authorities, and other interested parties. The state level has the state legislature, the various departments of health, highways, planning, agriculture, conservation, game and fish, economy and county development, and the state courts.

If navigable waters be involved, then all the grandeur of the federal government can be brought into play so that a multitude of agencies, commissions, departments, committees, and so forth, can conceivably be brought into a decision-making process.

From the above lists it would not be too difficult to understand that at times these bodies would not see "eye to eye" and a competing noncooperative atmosphere could arise.

However, due to the demand for urban and suburban housing, these bodies have not been able to stop the evolution of undesirable features from cropping up. Mainly, these features are: inadequate water distribution systems, sewer systems, solid waste disposal systems, and poor surface water drainage.

In the mid to late sixties the above situation began to change. More positive control over housing expansion was instigated at various

levels. The state, counties and cities began to exert a trend toward realistic development of housing and closer examination of proposed industrial expansion. Since 1968 "pump priming" by the federal government, especially in respect to secondary treatment plants and associated sewer distribution systems provided the motivation to build these much needed facilities.

Recreation and Tourism

During the two decades just past and in conjunction with the growth in industry and housing there has been a phenomenal growth of water recreation and tourism in the state. Many factors are responsible for this growth but again the TVA is a prime agent, establishing over 40,000 square miles of reservoirs in a six-state area. This large amount of water surface available, the natural beauty of the state's rural areas, and the close proximity to the nation's high density population areas have increased tourism such that about 700 million dollars[1] was distributed in 1971 by tourists. Although this money does not represent true income to the state, it nevertheless ranks as the state's third largest "industry."

Other factors in the development of water recreation and tourism have been: fishing and hunting on the reservoirs, development of small pleasure boats, development of camping trailers and associated camping areas, continuing expansion of our state park system, and the individual specialized tourist attractions such as Gatlinburg, Chattanooga, Memphis or Nashville.

This development of water recreation and tourism has led to problems which are not without consequences. Water recreationalists

and fishermen are at odds over reservoir usage to such an extent that restricted use areas are coming into use.[2] Reservoirs near large metropolitan areas (Fort Loudoun, Watts Bar, Chickamauga, Kentucky, Old Hickory, Norris, Douglass and Cherokee for example) are at times so impacted by water users at popular areas that unsafe and hazardous conditions exist. TVA has forbidden use of 50-gallon drums in construction of docks, floats and houseboats as they disintegrate and the drums become hazards distributed throughout the reservoir.

Thoughtless, inconsiderate water recreationalists, hunters or fishermen are a plague to privately owned land which borders water resource areas. This type user seldom obtains permission for access. They add to the pollution problem and are responsible for damages to property and livestock.

Another aspect of water recreational development is the prime value of water fronting real estate, the effects of which may be beneficial or detrimental. The individual situation would have to be considered. Some landowners would welcome the high prices received for this type real estate. Other owners who intend to keep utilizing the land would probably not want to see his neighbor sell to developers. The landowner would then face loss of privacy, less freedom in his operation as the population density about him would increase and eventually the possibility of reclassification of his land leading to higher taxes.

The growth of tourism has led to development and expansion of many areas throughout the state. These areas are usually associated with some natural or historical attraction. To some extent water

resources are involved in these developments. Resorts, hunting and fishing facilities are common on the TVA reservoirs; float trips are popular on the scenic streams; white water canoeing on the swift streams of the Cumberland Plateau; trout fishing in the colder eastern streams; scuba diving is becoming increasingly popular; national water ski and boat races are held on the Tennessee River system; all appeal to the whims of the tourist.

A new type of development currently pushed is the year-round vacation home resort. Modeled after some of the successful developments of total family play such as Tansi in Cumberland County, these developments are not totally related to water resources; however, they require some degree of utilization of water. Most of the developments provide boating, swimming and fishing, usually on man-made lakes or ponds. This type operation is viewed with mixed feelings. Some are extensively elaborate with a solid air of permanency, some have an atmosphere of the fly-by-night development. This resort development, if managed properly, fulfills a need and contributes to the economic resources of the state.

The demand for expansion, growth and development of industry, urban and suburban land-use areas, recreation and tourism by virtually every county reporting is a normal response. Progress is a parameter of community life whether located in a large metropolitan area or in a small isolated county community.

Areas Available for Expansion

The desire to realize progress and growth, however, should not override alternate possibilities which exist now or would exist

sometime in the future. The concept of "the most people benefitting at the least cost" is a commendable goal, yet conceivably there are instances where it would not hold absolutely. For example, 19 counties of the state have populations of less than 10,000 and a total land area of about 5,000 square miles. Garrison and Paulson[3] have reported that "Public investments which augment minimum stream flow to 400 CFS or greater favorably alter location characteristics of small areas for manufacturing activities defined as water-intensive." They also state that additional factors such as skilled labor, raw materials and market access play an important role in location of such industry.

The 19 counties with a total population of 127,000 all rank at the bottom of Garrison and Paulson's classification for water-intensive employment (0-249). Eight of these counties have stream-flows which rank in Garrison and Paulson's top classification for stream-flow (1500 CFS or greater).

These 19 counties may not exhibit all the criteria needed to attract industry, yet obviously the areas are somewhat depressed as to community progress. Here should be occasion for selective development and location of specific industry or manufacturing such that low density areas would become appealing for resettlement and providing jobs for existing residents. Low land values, probably lower taxes and in general an overall lower cost of living could be realized. As viewed from other state areas, such development could reduce crowded conditions, would result in improvement or betterment of the low population counties' water, sewage or waste disposal and thus aid in general improvement of community life.

The response of the counties for increasing their water-related resources and decreasing the associated detrimental factors do not consider abstract sociological problems which are an integral part of the growth process. A county or so did mention factors which are in this abstract realm. (What is involved is the impact upon human life as a new and different type of community life evolves.) Abstract or intangible factors such as health, happiness, satisfaction, privacy, independence, accomplishment, knowing oneself and of being known are subject of subtle but powerful pressures when life-styles change. The effect upon a person may be fast or slow, most of the time he does not realize he is being affected. In time the person suddenly realizes that life has changed and that during the adjustment process he has lost portions of the above-mentioned intangibles.

For example, a small farmer may sell his farm to a developer for more money than he ever thought he would have. He invests the money and goes to work at a semi-skilled job, say some type assembly process. He relocates and, therefore, is not well known as he was in the previous location. Even though the man has far more materialistic resources than previously, the effect upon his life may be monumental. His job may become boring, he is confined to a small work area and feels no sense of accomplishment. The tranquil life of the farm is opposed by a less tranquil city life. His relative independence is gone, dictated by an 8:00 a.m. to 4:30 p.m. time-clock. He has few friends and may not know well his neighbors. Suddenly the fact dawns upon him that in spite of his new-found security he is unhappy and unsatisfied. Conversely, this argument does not mention that

in the farmers' new occupation he may have access to better education, health, recreational benefits and certainly more leisure time.

This illustration is an attempt to demonstrate that all-out growth and progress may not necessarily be the correct decision. Some of the 19 counties with low population densities may best contribute to the welfare of the state and community by not becoming involved in industrial or tourism developments. Perhaps limited progress involving whatever agrarian resources available could be utilized such that the rural atmosphere would be preserved. If such areas were strategically located throughout the state, then they could serve as an oasis for the jaded urbanites. If such a decision were made, then the people who would cooperate in such a venture could be subsidized in some manner.

Garrison[4] has investigated the impact of reservoir recreation upon local economy, and the impact of new industry upon small towns. His conclusions in respect to reservoir impact involving Norris Reservoir indicate "that despite the popularity of Norris Lake as a recreation site, the contribution of recreation expenditures to the area's economy has been relatively unimportant." He further indicates that whatever increase in benefits are had, these benefits are not proportionally shared by the work force.

In contrast to the Norris study Garrison compared reservoir recreation against water-oriented industry with a study of the New Johnsonville Area. Since 1957 a nonferrous metals industry and a TVA stream plant have been established in the area. This water-oriented industry has "significantly altered the nature of the local economy."

Population, total personal income and per capita income all increased significantly.

In respect to small towns and new industry, Garrison[5] investigated the effect of new manufacturing plants in five rural Kentucky towns. The typical result was a negative impact upon local government finances. Garrison states that "the school system was the unit of government most likely to be significantly affected; a large negative impact resulted if property taxes were substantially avoided and large numbers of new residents were brought to the community." As the years pass the negative effects become less negative and a positive benefit is eventually realized.

The effect upon local government finances does not consider the economical benefits which are received by the residents of such communities. Although bonded indebtedness for added services may increase, this debt is distributed over a number of years and when compared to the increase in available jobs may affect the negative impact.

It appears then that unregulated or unplanned expansion of industry or water recreation may not meet the needs of local communities; whereas, well planned expansion matched to the communities' resources would be more desired.

Regulation of Water Related Problems

The nondeterministic nature of growth problems involving industry, water recreation and tourism is such that many individuals, both private and public, have to be brought into a decision process. This

type of planning cannot readily be optimized and a course of action may be taken which professional planners or water resource experts may not necessarily feel is the correct action. However, these water related professionals have a responsibility to exert some force upon the development process. The relationship between water resources and the total growth process must be kept so that a minimum of harm is done to each.

Deterministic factors of the state's water resources fortunately can be and are controlled by various designated authorities. The decision process in these parameters is optimized and the water resource professional exerts a formidable presence in these decisions. Water quality, flood control, waste treatment, power generation, watershed control, game and fish structure, any item which involves the collecting, withdrawing and return of stream waters are directly supervised by several agencies. Primarily the state's Environmental Sciences Division of the Public Health Department is responsible for water quality of state streams. The Water Quality Control Act, amended as of 1971, State of Tennessee, contains a statement of policy and purpose:

> Recognizing that waters of the State of Tennessee are the property of the State and are held in public trust for the use of the people of the state, it is declared to be public policy of the State of Tennessee that the people of Tennessee as beneficiaries of this trust have a right to unpolluted waters. In the exercise of its public trust over the waters of the state, the government of the State of Tennessee has an obligation to take all prudent steps to secure, protect and preserve this right.
>
> It is further declared that the purpose of this law is to abate existing polluting of the waters of Tennessee, to reclaim polluted

> waters, to prevent the future pollution of the waters, and to plan for the future use of the waters so that the water resources of Tennessee might be used and enjoyed to the fullest extent consistent with the maintenance of unpolluted waters.

In conjunction with this act, general water quality criteria for control of pollution were amended such that criteria of water conditions were established for domestic raw water supply, industrial water supply, fish and aquatic life, recreation, irrigation, livestock watering and wildlife and navigation. Tenative regulations for plans, approval and operation of sewage treatment plants were proposed in January 1972.

Stream-flow, reservoir levels, flood control, power generation and navigation responsibilities are shared by the Tennessee Valley Authority, the Corp of Engineers, the Soil Conservation Service and the Coast Guard. Selected areas, rivers and size of drainage basins determine which agency has responsibility. Hydrographic data and statistics are kept by the U.S. Geological Survey.

Many interesting phenomena of the water resource are shared by several investigators. These phenomena involve the recently emphasized environmental problems such as heavy metals, thermal pollution, regional optimized studies, mine-acid waters and so forth. These problems are major scientific investigations; therefore, various universities and governmental agencies are pursuing the investigation.

It is easy to reason then that realistic parameters of the water resource can be adjusted, developed or removed by logical, optimized decisions whereas the "nonrealistic" parameters of industry or tourism development do not have the same degree of positive control.

Problems Relating to Water Quality and Control

Problems which confront the counties of the state where the so-called realistic aspect of water resources are involved should be relatively easy to attack. The agencies are available, the regulations and guidelines are in existence, the economic deterrents should then be the parameters to overcome.

Tennessee shares part of three water resource regions established by the United States Water Resource Council.[6] These regions are: The Tennessee, the Ohio, and the Lower Mississippi, with the Tennessee region covering approximately 60%, the Ohio region approximately 20%, and the Lower Mississippi about 20% of the state's land area.

In 1968 the first national assessment of the Water Resources Council stated the following in respect to the Tennessee region:

> The region has an average natural runoff of 42 billion gallons per day, has adequate water for all anticipated needs, but additional seasonal regulations needed in local areas. Pollution must be curtailed and orderly development of residential, recreational and industrial lands along the waterfronts must be effectuated. Upstream watershed treatment and development is needed.

The question of water quality and pollution was a concern of almost every county reporting. The adoption and amending of the state's water quality control acts, establishment and expansion of the Environmental Sciences Division of the Public Health Department so that the problems of water quality, sewage treatment, and air pollution function as an integrated unit will lead to an improved air and water resource. Most citizens, when aware of the consequences, do cooperate with the laws involving our environment. The regulatory agencies are most lenient upon first-time offenders as the agencies

themselves are engaged in an educational program to enlighten the population. Repeated offenses bring fines and, if necessary, court action to shut down flagrant violators.

The problem of solid waste was quoted many times in the survey. Multi-county cooperatives should be established. In the 1930's multi-county electrical cooperatives came into being and have proven very successful. There is no reason why multi-county water and sewage cooperatives could not do the same. In some of the rural counties the concept would not be feasible, but in the counties which have relatively large urban areas and share borders with similar counties, the cooperative would be feasible.

Multi-county solid waste disposal facilities should be established provided cost-benefit projections show feasibility. Location of these facilities should be optimized to rail or water transportation routes. Integrated collection routes and transfer points, coupled with the use of large "dumpster type" semi-automatic handling equipment would facilitate waste disposal. The disposal plants should have the capacity to segregate and collect recyclable materials, use the rail or water transportation for shipment to processing centers, and then return the financial gain back into operation of the system.

Most counties which depend strongly upon ground water did mention that problems existed with supply. In 1964, 8000 new wells[7] were drilled in Tennessee and it is assumed that the annual number has increased since 1964. From the viewpoint of the family well water system, well drilling is costly and operation is dependent upon local electrical power. In times of emergency if local power fails, then

the water system fails. The development of small to medium reservoirs, the cutting of diversion channels to larger sources of water supply or piping through large pipes would relieve the demand on ground water and establish an additional supply of raw water. This situation is ideal for multi-county cooperatives where one very large raw water treatment plant could supply several distribution points or smaller pumping stations with adequate water. The costs then can be distributed over long term bond issues to alleviate the high single cost of family wells.

Siltation of streams was a common problem noted by several counties. Siltation, which is caused by man-use of the water resource, should be relatively easy to control. Industrial and municipal wastes, mining, quarrying and agricultural processes are subject to direct supervision by the regulatory agencies. Siltation, which is caused by natural factors, is much more difficult to abate. Topography, soils, stream velocity, and lack of cover crops are some of the governing parameters of siltation. Flood control is essential in areas of high susceptibility to siltation. Two factors though are primarily responsible for siltation. These are soils and vegetative cover. Vegetative cover impedes surface runoff and provides time for infiltration which further reduces the volume of runoff water. Vegetative cover also provides protection to the soil from the erosive action of falling and running water. Soil characteristics or types govern the rate of erosion. Loose fine sandy types of soil with relatively low bulk density are much more susceptible to erosion than a heavy clay type. Prevention of siltation and resultant loss of top soil demands cooperation and discipline from all concerned.

Approximately 38 percent of the counties using the various major water source categories felt that flooding was a problem. Several counties cited the need for additional reservoirs in conjunction with the flooding-siltation relationship.

Twenty-eight percent of the major source categories replied that commercial river transportation would be a potential benefit provided the facilities were available or flows were sufficient to sustain river transportation. Bulk materials are ideal for water transportation. Petroleum products, cement and building stone, bricks and ceramic products, structural steel, forest products, bulk paper, coal, ores, grains, bulk chemicals, fertilizers, sand and gravel are a few of the materials which use or could use water transportation. Bulk finished products could also be shipped by water.

The cities along the navigable streams of the state which at present do not have docks and have an industrial potential for use of commercial water transportation should investigate the possibility of using water shipping.

Demand for Electric Power

As stated previously, not one county mentioned the need for additional power generation by whatever means. It is assumed that, being in the area served by the Tennessee Valley Authority, the reporters are spoiled and hope that the power will be there when needed or the TVA will have it when we need it.

The U.S. Water Resources Council[6] has stated that present power generation in the United States is about two trillion kw hours

per year; by 1980 the demand will be about three and one-half trillion kw hours; by 2000 the demand will be about nine trillion kw hours and will be twenty trillion kw hours by the year 2020. We will have to increase a factor of almost two by 1980. Most of the increase will be met by nuclear fueled generators.

Thermal pollution of the water resources is a problem which we have had ever since the first large dams were constructed. Whenever large reservoirs are built for hydro-electric power generation utilizing the hydrostatic head of the reservoir to force water through the turbines, then the colder water at the bottom of the reservoir is drawn off. This causes the stream below the dam to be colder and for a time deficient in oxygen. Portions of the Columbia River and the Little Tennessee River are two examples where this has happened. Today the concern is for heat increase from the power generating stations. The first operating power-producing "breeder" reactor will be built on the Clinch River, Watts Bar Embayment at the Oak Ridge complex. This reactor will produce fissionable fuel from an uranium "blanket" surrounding its core. If the experiment and tests go as expected, this reactor will be the prime power device for the western world. England, Germany, Italy, among other nations, will use this design.

At the present time 104 nuclear power stations[8] have applications with the Atomic Energy Commission to receive operating licenses. Only one (the Oak Ridge, Clinch River) is a breeder type. The other stations are boiling water or pressurized water type. These 104 reactors are scheduled to be producing power by 1980. The Tennessee

River will have seven by 1980--three at Brown's Ferry, Alabama, two in Hamilton County, and two at Spring City.

Each reactor on the Tennessee River will produce about 1100 to 1150 million watts of electricity per hour. The amount of water needed for cooling purposes will be about two acre/feet of water per million watts of power.[9] Thus, if lagoon cooling were used, then an impoundment of about 2200 acre/feet of water would be needed.

The heat given off from these power generators is energy and some use should be made of the energy. Industrial complexes should be established in conjunction with the generating stations. The excess heat could be used to heat or cool the buildings. Fish farms, especially catfish farms, could be established to use the warm water. The demand for catfish is much greater than what we produce each year in Tennessee.[2] The 71 counties reported 52 fish farms producing catfish in significant quantities plus 100 acres in Lauderdale and 15 acres in Wayne Counties. Catfish show remarkable growth when the water temperature is 70-90 degrees.

Paper mills where warm digester mixes are needed could utilize the power station's cooling water.

If the warm water from the generating stations is not utilized, then adequate heat exchange or heat dissipation techniques will have to be developed to avoid increasing the receiving streams' temperature above allowable limits.

Regional or State-Wide Correlations

A few counties, especially McNairy, reported that ground water in their area was being affected by large municipal users. The legal

aspects of such a situation, if brought to trial, would be very interesting.

Assume that Shelby County, a very large user of ground water, should be cited by some of the nearby counties who felt that they were being damaged by Shelby County's use of the ground water. There is no way of knowing just how the courts would rule today, but it is conceivable that the situation could eventually come to such an action. The following opinions may give some insight as to the results of such a proceeding.

> Tenn. App. 1931. Where a subterranean stream flows in a distinct, permanent, and well defined channel, it is governed by the same rules as apply to a natural watercourse on the surface; and the owners of land beneath which it flows have the same rights in respect to it as riparian proprietors have with respect to a stream on the surface; and the same is true with respect to large bodies of underground water located in well-defined strata. But all underground waters are presumed to be percolating, and to take them out of the rule in regard to such waters the existence and course of a permanent channel must be clearly shown. Tennessee Elec. Power Co. v. Van Dodson, 14 Tenn. App. 54.
>
> Tenn. App. 1931. The existence of a well defined subterranean stream may be shown by proof that a spring on the land of some of the parties ran surface depressions or sinks, such as mark the course of subterranean streams in limestone regions, through which water below could be seen, or heard, and which extended in a direct line through the lands of other parties, or where if the water was muddied or colored in one excavation or sink it showed up in a short time in other excavations or springs. Tennessee Elec. Power Co. v. Van Dodson, 14 Tenn. App. 54.
>
> Tenn. App. 1936. "Reasonable use" doctrine with respect to underground waters is that rights of each owner being similar and their enjoyment dependent on action of other landowners, their rights must be correlative so that each landowner is restricted to reasonable exercise of his rights and reasonable use of his property in view of similar rights of others. Nashville, C. & St. L. Ry. v. Rickert, 89 S.W.2d 889, 19 Tenn. App. 446.
>
> Tenn. App. 1931. The obstruction or diversion of an underground stream flowing in a defined channel is an actionable injury to

> those whose use of the water is thereby impaired; but no actionable injury results from the obstruction or diversion of percolating waters, thus depriving owners of a supply, save in the few states which recognize the right to an uninterrupted flow of such water. Tennessee Elec. Power Co. v. Van Dodson, 14 Tenn. App. 54.

From the survey's response to the state of development of the counties' major resource and adequacy of total water resources, the results seem to indicate the following: 25% of the counties feel that their total water resource is inadequate; 50% of the counties feel the major water source is undeveloped; and 13% feel that the major source is grossly undeveloped. Geographically there seems to be no real correlation as to a common cause.

Ground-water problems exist in the counties of middle and east Tennessee and limited water problems exist on and bordering the Cumberland Plateau. Several counties state economical problems as cause for lack of development. Some problems were mentioned in association with large metropolitan areas by adjoining counties.

Figure 6 shows the availability of ground water in the physiographic provinces of the state about 1956. Figure 7 indicates cronic ground water problem areas as defined from this survey, by physiographic province.

The only positive regional and state-wide problem reported was the item involving trash dumps. This problem should be one of the least difficult to correct. The solution will require cooperation from every citizen not only refraining from indiscriminate trash dumping but in reporting violators. The local courts could impose maximum fines or sentence transgressors to serve terms in cleaning up areas where dumps exist. It is believed that the great majority of people would support such action.

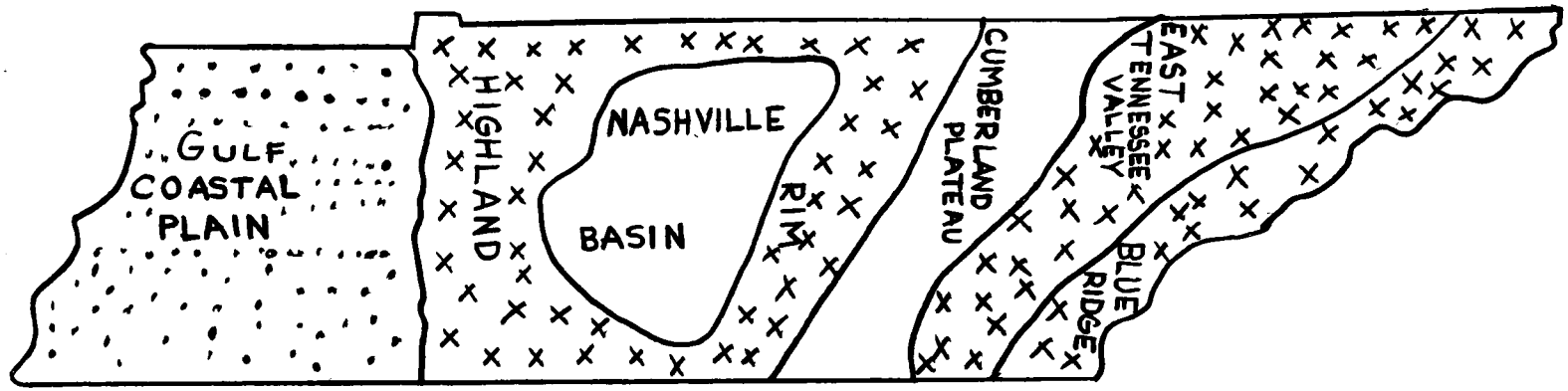


Figure 6

Availability of Ground Water in Tennessee

Estimated from available data by physiographic province.

Source: Tennessee Division of Geology, U.S.G.S., 1956.

Legend:
- Large quantities, generally available
- Modest quantities, some areas
- Small quantities, usually uncertain

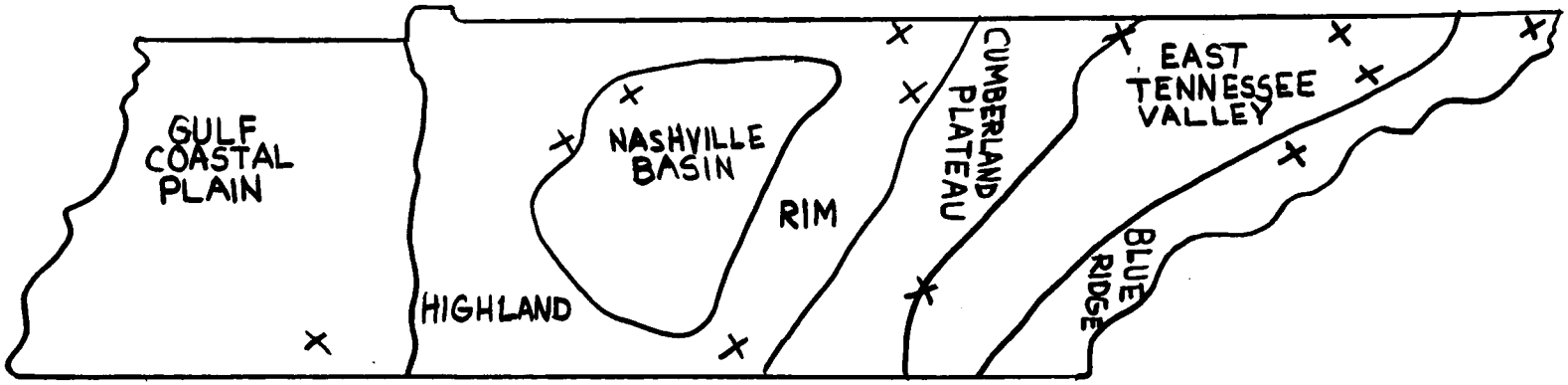


Figure 7

Areas of Ground Water Problems by Physiographic Province

X Denotes counties reporting ground water shortages.

River Basin Development

Water resource planning to Tennesseeans is not a new concept. We in the state are fortunate to have been associated with a comprehensive river basin development for almost forty years. Most say the Tennessee Valley Authority has performed its function as designated by congress. However, as stated earlier, we have become spoiled and lately some have expressed dissatisfaction with the actions of TVA. This dissatisfaction works both routes with some feeling that TVA has gone too far in certain areas, and some feeling that TVA has not gone far enough in other areas.

It is apparent that an agency the size of TVA cannot satisfy everyone, that elements of bureaucracy must exist, and that certain geographical areas of the state may be alienated by TVA decisions.

Today water resource planning is a very involved procedure. The State of Tennessee is not in dire need of economic boosting as it was when TVA first started operations. Yet, there exists need for additional major water resource installations on some of the streams of the state.

Planning for these installations involves many factors, thus several techniques are used to obtain the best possible solution. Systems approach, linear programming, cost-benefit analysis, coupled or interfaced with modern computers provide a wealth of data from which a decision can be made. Environmental impact studies are used, perhaps with good reason as they may include humanistic parameters which the cold logic of the computer does not consider.

CHAPTER IV

CONCLUSIONS

From the survey and research data it is obvious the State of Tennessee has ample water sources. However, the distribution of this water is such that all counties do not share the potential benefits derived from the water source. There are opportunities for retention of surface runoff, for diversion from ample sources and for recharge of aquifers so that the less benefitted counties receive adequate water resource potential.

Whenever practical (from cost-benefit studies) new water and sewage distribution and disposal systems should be considered. Previous experience has shown that short-term projections for water and sewage treatment plants have not been adequate to match the demands of high-growth urban areas. System capacities should be designed with the longest possible time projections consistent with sound economic and planning techniques.

The construction costs of water processing or sewage disposal plants are approximate exponential functions, not linear, thus great savings may be expected in future use if long-term projections can be fitted to the economic factors. The need for this concept has been well established in the large metro areas of the state, not in 50 or 100 years but in 20 to 25 years. From the growth patterns of these areas, it almost appears the systems cannot be built too large.

Solid waste disposal facilities should be established in conjunction with the water and sewage systems and, in my opinion, all three should be operated and maintained by one department or agency. The agency should operate at the county or multi-county level with competent supervision or regulation from the state level.

The state goals for adequate training of water or waste system operations should be vigorously pursued. Once competent, well trained operators are incorporated into a system, then commensurate salary levels should be established for the operators.

From the information received in the survey the most pressing problem directly related to water resources is the ground water supply. Surface water problems exist, for example, flooding and pollution. However, these problems are slowly being improved and will continue to improve with time. Ground water resources, however, will continue to decrease as more demand is exerted on the resource.

The total growth process which we are undergoing in the state also almost guarantees the loss of potential which is necessary for maintaining adequate ground water reserves. Slowly portions of the best land in the state are being converted from agrarian use to urban use. Usually these areas are well suited topographically for adequate recharge of aquifers.

The rough lands which, due to rapid variations in elevation and, therefore, rapid runoff of surface water, are not as desired for urban development as the gently rolling slower runoff types. With urban development comes loss of trees, a redefinement of drainage routes, coverage of a large percent of the land area by roads, streets

and structures such that the original water retention ability of the land may be completely altered.

Another pressure exerted upon the ground water resource by increasing usage is the increasing probability of contamination of the aquifer by higher density well location leading to higher density waste disposal. Though true that infiltration and percolation over sufficient time and distance can greatly improve the quality of ground water, the possibility of contamination is strengthened by areas of karst topography or fractures and joints in and around the aquifer. Thus the chance of danger from contamination has to increase with increasing use.

Certain geohydrological systems by their inherent nature cannot be recharged to any extent. Limitations of catchment areas, aquifer permeability and porosity, soil and overburden characteristics dictate that to keep an equilibrium in the system only certain volumes of water can be pumped. Even if a lake stood over the aquifer and an impervious formation existed between the lake and the aquifer, then no recharge could occur.

Perhaps the areas of the state which rely heavily upon ground water should begin to seek additional sources of supply. Retention of surface water runoff for example can be enhanced if city storm sewer drainage is separate from sanitary sewers and then diverted to small holding reservoirs. Diversion channels to large streams and the construction of reservoirs on smaller streams can add a new dimension for new sources of supply.

In any event, the need to exploit new sources of raw water supply in relief of ground water is evident. The problem is not a simple one to solve. Perhaps new sources of surface water would be easier and cheaper to develop than a comprehensive ground water recharge program.

The pollution problems of the state's major resources will continue to improve. Federal aid to establish secondary treatment plants will alleviate many of the gross biological pollution areas. Self improvement of industrial pollution brought about by more stringent controls will become evident in time.

To the author the most significant aspect of this survey hinges on the demand for progress in the areas of urban growth, industrial growth, and increases in recreation and tourism, the potential that exists in these areas and the resulting effect upon the people and the resources of the state.

The great potential for growth should be a mandate for the most optimum planning in all respects of growth. However, this optimum will probably never be achieved. Many factors (some mentioned previously) affect the course of development; so many in fact that it becomes impossible to regulate all phases of the development. No matter how lofty the ideal situation may be or how logical a solution is proposed, when public investment is involved, then people become involved, many people, representing all facets of the proposal; the effect then is to lose the optimal planning and a fight for survival of the project may ensue. Conversely, when private investment is involved, some promoters can benefit at the expense of the public by

receiving preferential treatment from various authorities in the name of progress. Thus a situation may be developed where some expediency is overcome, yet in the longer view, a more difficult aspect will arise and eventually prove a larger cost to the public.

Ideally, the development of industrial and municipal-urban areas or increasing the recreational and tourist attractions in the state should be a very careful process. This process should be planned such that a possible optimum benefit is received and distributed to a possible optimum number of people.

Who pays for the improvements and development of the water resource? Industry has benefitted from the use of water resources and has not always returned to the stream high quality water. Municipalities have done the same. Public sector investments in the area of water resources are evident throughout the state. Agricultural processes have contributed to problems involving water resources. The responsibility for degradation of the water resource cannot be saddled upon any one group or faction which supports our economy, although there are cases of flagrant disregard for the right to enjoy clean and adequate water by members of the various water users, both public and private.

In all the above there is a common denominator--the people, whether the stockholder, the consumer, or the taxpayer. We receive the ultimate benefits which are accrued from the use of our natural resources and raw materials. The industrialist would not produce any item unless that item had a market; public expenditure for projects involving the water resource would not continue for long unless we

received a benefit. Municipalities or other local governmental levels exist because they can provide services to us cheaper than we can do on our own. Most of the products of agriculture are necessary for our survival, although today most of us survive at an extremely high level of living in respect to utilization of food.

We are responsible for the conservation, maintenance and improvements of our natural resources. We should, and I suppose do, pay for these resources in some manner. Whether we tax or subsidize industry to clean up its return water, the costs are passed on to us eventually. We pay through taxes and rate usage for our local government's services to us; however, we should be more amenable to construction of waste treatment plants when none or inadequate facilities exist. We should be willing to somehow equitably subsidize the farmer for the additional costs he sustains when attempting to improve his processes so that environmental damage is minimized.

We are responsible, not all to the same degree, but nevertheless the individual, the community and the various governments involved, should assume responsibility to our natural resources.

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APPENDIX

TABLE A-I

Major Water Source by County

Major Water Source	Counties
Tennessee River	Henry, Benton, Decatur, Hardin, Wayne, Perry, Humphreys, Houston, Marion, Meigs, Hamilton, Roane, Rhea, Loudon, Knox, Stewart (1/2), Blount (1/2)
Small Creeks	Henderson, McNairy, Lewis, Grundy, Warren, Putnam, Van Buren, Cumberland, Bradley, Unicoi
Cumberland River	Montgomery, Cheatham, Sumner, Davidson, Wilson, Trousdale, Smith, Jackson, Scott, Stewart (1/2)
Ground Water	Tipton, Shelby, Weakly, Haywood, Carroll, Hardeman, Macon, Gibson (1/2), Crockett (1/2), Fayette (1/2), Madison (1/2), Chester (1/2)
Large Creeks	Dickson, Lawrence, Robertson, White, Overton, Fentress (1/2)
Duck River	Maury, Marshall, Bedford, Coffee, Hickman
Clinch River	Anderson, Union, Hancock, Campbell (1/2), Claiborne (1/2), Grainger (1/2)
Elk River	Lincoln, Moore, Giles, Franklin
Holston River	Hamblin, Hawkins, Sullivan, Grainger (1/2), Jefferson (1/2)
Forked Deer River	Dyer, Gibson (1/2), Crockett (1/2), Chester (1/2), Madison (1/2)
Mississippi River	Lake, Lauderdale
Stones River	Rutherford, Cannon
Sequatchie River	Sequatchie, Bledsoe
French Broad River	Cocke, Sevier (1/2), Jefferson (1/2)
Nolichucky River	Greene, Washington (1/2)
Watauga River	Carter, Washington (1/2)

TABLE A-I (continued)

Major Water Source	Counties
Surface Water	Johnson
Wolf River	Fayette (1/2), Fentress (1/2)
Harpeth River	Williamson
Caney Fork River	DeKalb
Obey River	Pickett, Clay
Emory River	Morgan
Ocoee River	Polk (1/2), McMinn (1/2)
Hiwassee River	Polk (1/2), McMinn (1/2)
Powell River	Campbell (1/2), Claiborne (1/2)
Obion River	Obion
Little Tennessee River	Monroe (1/2)
Tellico River	Monroe (1/2)
Little River	Blount (1/2)
Pigeon River	Sevier (1/2)

TABLE A-II

Percentage Use of Major Water Source by County, Population and Land Area

Water Source	Percentage of Counties	Percentage of Total Pop.	Percentage of Land Area
Tennessee River	16.84	19.69	17.08
Small Creeks	10.50	5.25	9.65
Cumberland River	10.00	16.81	9.29
Ground Water	10.00	23.92	12.27
Large Creeks	6.23	3.01	6.35
Duck River	5.36	3.34	6.04
Clinch River	4.47	2.85	3.68
Elk River	4.21	1.97	4.51
Holston River	4.21	5.59	3.74
Forked Deer River	3.16	2.53	3.45
Mississippi River	2.10	0.90	1.55
Stones River	2.10	1.73	2.16
Sequatchie River	2.10	0.36	1.62
French Broad River	2.10	1.32	2.14
Nolichucky River	1.58	2.16	1.87
Watauga River	1.58	2.04	1.24
Surface Water	1.05	0.30	0.72
Wolf River	1.05	0.45	1.44
Harpeth River	1.05	0.88	1.42
Caney Fork River	1.05	0.28	0.70
Obey River	2.10	0.27	0.38
Emory River	1.05	0.35	1.29
Ocoee River	1.05	0.60	1.04
Hiwassee River	1.05	0.60	1.04
Powell River	1.05	0.58	1.12
Obion River	1.05	0.76	1.32
Little Tennessee River	0.53	0.30	1.32
Tellico River	0.53	0.30	0.79
Little River	0.53	0.81	0.79
Pigeon River	0.53	0.36	0.72

TABLE A-III

Benefits from Major Water Source

Major Water Source	Benefits Received	Potential Benefits
Tennessee River	Power, flood control, transportation, municipal and industrial supply, recreation, hunting and fishing, aesthetic values, agricultural uses	Increase transportation, develop recreational home sites, increase recreation, tourism, industry, transportation terminals
Small Creeks	Water districts, irrigation, industrial use, livestock and dairying, erosion control, recreation, hunting and fishing	Increase potable water, recreation and scenic benefits, additional reservoirs, irrigation
Cumberland River	Power, flood control, transportation, municipal and industrial supply, agricultural supply including irrigation, tourism, aesthetic values	Increase economic benefits, flood control, county-wide water systems, recreation, commercial transportation, industry, barge docking facilities
Ground Water	Industrial and municipal supply, agricultural supply including irrigation, individual family supply, "plenty of good water for all uses"	Safer drinking water, increase irrigation, flood control, increase recreational and wildlife benefits, new reservoirs, larger wells, improve sedimentation
Large Creeks	Municipal and industrial supply, recreation, hunting and fishing, aesthetic values	Increase domestic water supplies, improve recreation areas, improve quality of raw water
Duck River	Municipal and industrial supply, water recreation	Increase potable water supply, irrigation, recreation

TABLE A-III (continued)

Major Water Source	Benefits Received	Potential Benefits
Clinch River	Power, municipal and industrial, agricultural including irrigation, water recreation	Develop recreational potential, increase tourism, industrial potential
Elk River	Municipal and industrial supply, power, agricultural, water recreation including hunting and fishing	Industrial and urban development, tourism and recreational development
Holston River	Power, municipal and industrial supply, water recreation, irrigation	Increase recreation and tourism, reservoir or tributaries, irrigation, industry
Forked Deer River	Municipal and industrial, fishing and hunting	Need reservoirs on upper reaches for flood and siltation control
Mississippi River	Industrial supply, agricultural, water recreation including hunting and fishing	Water control, increase crop production (irrigation), increase industrial water
Stones River	Municipal and industrial supply, flood control, water recreation	Increase potable water supply, recreation and flood control
Sequatchie River	Municipal supply, agricultural, recreation	Flood control, increase water recreation, high quality water supply, improve agricultural uses, irrigation
French Broad River	Municipal and industrial, power, water recreation, agricultural	Improve total recreational facilities

TABLE A-III (continued)

Major Water Source	Benefits Received	Potential Benefits
Nolichucky and Watauga Rivers	Municipal supply, irrigation, agricultural, recharge of aquifers, water recreation	Increase potable water supply, irrigation, recreation
Surface Water	Municipal supply, agricultural, water recreation	None quoted
Wolf River	Agricultural, recreation, fishing	Increase recreation and tourism
Harpeth River	No data	No data
Caney Fork River	Power, municipal and industrial	Increase tourism
Obey River	Power, recreation, flood control	Increase tourism, municipal supply, irrigation
Emory River	No data	No data
Ocoee, Hiwassee, and Tellico Rivers	Power, agricultural, municipal use, water recreation	Increase recreation and tourism
Obion River	Adequate supply for almost any purpose	Increase transportation, irrigation and wildlife
Powell River	Power, municipal and industrial supply, agricultural, water recreation	Development recreational potential, increase tourism, industrial potential

TABLE A-III (continued)

Major Water Source	Benefits Received	Potential Benefits
Little Tennessee River	Municipal and industrial, flood control, irrigation, agricultural, water recreation, aesthetic values	Historical site development, additional recreation, agricultural potential, additional industry
Little River	Municipal and industrial, water recreation, fishing, aesthetic values	None quoted
Pigeon River	Municipal and industrial supply, fishing, aesthetic values	Additional municipal and industrial supply

TABLE A-IV

Major Water Source Problems

Water Source	Major Problems Associated with Source
Tennessee River	Pollution, flooding in winter, urban waste, industrial pollution
Small Creeks	Flooding, pollution, heavy silt load, low flows, improper regulation of fishing rights
Cumberland River	Pollution and mosquito control, pollution from large municipalities, too shallow for commercial transportation, urban waste, impaction of recreationalists adds cost of clean-up
Ground Water	Pollution, flooding, too shallow, natural chemical pollution, cost of drilling deep wells
Large Creeks	Pollution, shallow water, distance from population centers, heavy silt load
Duck River	Flooding, low flows in dry seasons, pollution
Clinch River	Too shallow, siltation (stripmining), pollution from urban waste, variation of water level, urban pollution
Elk River	Pollution, flooding and low flows, heavy silt load, lowering of water table
Holston River	Pollution, variation of water level, too shallow for commercial transportation, pollution from larger municipalities
Forked Deer River	Flooding reduces use of flood plain plus heavy siltation
Mississippi River	Flooding, siltation
Stones River	Pollution, flooding and low flow, some siltation
Sequatchie River	Flooding, low flows, heavy siltation
French Broad River	Pollution, variation in water level

TABLE A-IV (continued)

Water Source	Major Problems Associated with Source
Nolichucky River	Pollution, too shallow for commercial transportation, urban waste
Watauga River	Pollution, urban waste, too shallow for commercial transportation
Surface Water	Pollution by urban waste (household)
Wolf River	No data
Harpeth River	No data
Caney Fork River	Pollution from urban waste and recreationalists
Obey River	No data
Emory River	No data
Ocoee River	Pollution
Hiwassee River	Flooding in spring, low for commercial transportation
Little Tennessee River	Unsuited for commercial transportation
Little River	Pollution
Pigeon River	Pollution and flooding

TABLE A-V

Stage of Development of Major Water Source

Stage of Development	Response
Overdeveloped	None
Adequate	Moore, Anderson, Loudon, Montgomery, Hamblen, Tipton, Lauderdale, Henderson, Blount, DeKalb, Fayette, Meigs, Shelby, Hamilton, Weakley, Franklin (16)
Inadequate	Overton, Cheatham, Sumner, Monroe, Sevier, Dickson, Stewart, Macon, Lincoln (9)
Underdeveloped	Houston, Campbell, Carroll, Fentress, Cannon, Decatur, Trousdale, Giles, Putnam, Clay, Wayne, Marion, Hawkins, Davidson, Scott, Jackson, Henry, McMinn, Pickett, Hardeman, Smith, Sequatchie, Johnson, Washington, Lewis, Grundy, Robertson, Van Buren, Polk Hancock, Jefferson, Warren, Obion, Haywood, McNairy, Lawrence, Hickman (37)
Grossly Underdeveloped	Bledsoe, Cocke, Madison, Grainger, Claiborne, Crockett, Bedford, Maury, Lake (9)

TABLE A-VI

Additional or Secondary Water Sources

Water Source	County
Small Lakes	Henry, Campbell, Dickson, Overton, Grundy, Robertson, Madison, Shelby, Bledsoe, Jackson
Small Streams (Creeks Flowing Year Round)	Sumner, Hamilton, Bedford, McMinn, Hawkins, Lawrence, Meigs, Hickman, Maury, Campbell, Carroll, Moore, Fentress, Dickson, Claiborne, Van Buren, Henderson, Sequatchie, Monroe, Sevier, Montgomery, Cannon, Hamblen, Giles, Putnam, Hardeman, Pickett, Warren, Jefferson, Hancock, McNairy, Lincoln, Fayette
Farm Ponds	Carroll, Overton, Sequatchie, Madison, Decatur, Clay, Wayne, Jefferson, Fayette, Meigs, Jackson, Sumner, Scott
Springs	Carroll, Anderson, Loudon, Claiborne, Clay, Washington, Sequatchie, Pickett, Hancock, Bedford, Marion, Hawkins, Houston, Hamilton
Small Rivers or Large Creeks	Lauderdale, Polk, Robertson, Tipton, Trousdale, Cheatham, Smith, McNairy, Lawrence, Hickman, Marion, Sumner, Davidson, Houston, Stewart, Haywood
Individual Family Wells	Hawkins, Hamilton, Grainger, Henderson, Sevier, Washington, Lewis, Montgomery, Hamblen, Lauderdale, Clay, Wayne, Jefferson, Macon, Marion, McMinn, Davidson
Large Reservoirs or Natural Lakes	Blount, Smith, Franklin, Polk, Lake, Obion
Large Rivers	Shelby

TABLE A-VII

Total Water Resource Development

Item	Counties Reporting Yes	No*
Is it adequate today?	53	18
Will it be adequate for normal growth demands?	55	15
Will it be adequate for an impaction from rapid population or industrial expansion?	50	20

*Causes of inadequacy reported by various counties:

Johnson	Poor distribution, limited quantity of water
Smith	Limited quantity of water
Madison	Reservoirs needed to prevent flooding, heavy siltation and to recharge aquifers
Robertson	Lack of revenue to develop adequately
Sequatchie	Poor distribution, low pressure on present distribution system
Grundy	Limited quantity of water
Washington	Poor conservation practices, heavy increase in usage of streams and lakes
Hawkins	Development not keeping pace with industrial development
Jackson	Distribution and limited ground water
Maury	Development not adequate for any growth
Bedford	Drought seasons severely reduces quantity of water available
Lincoln	Urban housing appreciably lowering the water table--utility districts as of now not correcting problem

TABLE A-VII (continued)

Macon	Only public supply is from springs; therefore, any flow variation will affect supply
McNairy	Ground water supply is affected by large municipal user (Shelby County)

TABLE A-VIII

Disproportionate Benefits Received

County	Disproportionate Area
Johnson	Some industries require very large amounts of fresh water
Putnam	Industrial and municipal use benefit out of proportion
Cheatham	Recreationalists have lack of concern for landholders
Madison	Recreationalists may not received proportionate share
Robertson	Industry may benefit out of proportion
Washington	Recreationalists in season benefit out of proportion
Henderson	Recreationalists in season benefit out of proportion
Dickson	Industry has caused fish kills by overloading treatment plants
Carroll	Industry benefits out of proportion
Houston	Farm population does not receive its share of domestic water
Sumner	Industry, real estate and building benefit at expense of farmers by establishing non-realistic land values
McNairy	Agriculture receives benefits which other users do not share due to the geographic location of the individually owned lakes and ponds
Hamilton	Industrial users benefit out of proportion

TABLE A-IX

Water Pollution from Garbage Dumps, Landfills, Stripmining and Irrigation

County	Comment
Hancock	Rivers and streams serve as a dump
Franklin	Pollution from garbage or trash
Hamilton	Garbage and refuse floating in streams
Macon	Rural garbage in or near streams
Lincoln	Scattered stream dumping by individuals
Lawrence	Trash along most streams
Hickman	Numerous unplanned trash dumps
Jackson	Garbage and trash dumps due to no landfills
Henry	Garbage, trash dumps and stripmining have been very bad but are improving through efforts of Health Department, Extension Service, TVA, County Judge, mainstream of "OEO"
McMinn	Garbage and trash dumps are a major problem along roadsides; abandoned mines are being used as dumps now
Marion	Stripmining, but not serious at present time
Hawkins	Garbage and trash dumps in or near water sources
Sumner	Garbage or trash dumps in or near streams
Davidson	Garbage and trash dumps and landfills not properly controlled in some instances
Scott	Garbage and trash dumps all over county; stripmining causing erosion into streams
Houston	Garbage and trash dumps, road construction, careless building site preparation, small feed lots on tributary streams
DeKalb	Light pollution from garbage and trash dumps

TABLE A-IX (continued)

County	Comment
Campbell	County has no garbage system; stripmining on most all perennial streams
Moore	Thoughtless trash pollution by recreationalists
Fentress	Garbage and trash dumps, stripmining
Overton	Over 50 roadside dumping areas all over county, stripmining in five areas of county
Dickson	Irrigation of agricultural lands, pesticides common in all streams
Claiborne	Stripmining, creeks near the mining are devoid of marine life, water is unfit for irrigation or recreation
Polk	Garbage and trash dumps, wells near dumps may be polluted, houseboats dumping waste into lakes and streams, thus sewage is upstream of utility water intake
Stewart	Garbage and trash dumps in or near streams
Crockett	Dumping solid waste in streams
Washington	Garbage and trash dumps, landfills, irrigation, incomplete sewage treatment, raw sewage, landfills improperly located and managed, careless application of fertilizers
Grainger	Due to lack of landfills, trash and garbage end up in streams
Lewis	Garbage and trash dumping in or near streams
Grundy	Garbage and trash dumping in or near streams; stripmining leads to siltation and acid pollution
Sequatchie	Many areas of trash dumps in or near streams, landfills not properly managed, stripmining releasing silt and mineral waters
Robertson	Most streams are polluted by individual dumpings

TABLE A-IX (continued)

County	Comment
Madison	Landfills are located in the flood plain, agricultural pollution from erosion; road right-of-ways also cause siltation from erosion
Sevier	Industrial, municipal and individual pollution
Tipton	Garbage and trash dumps in or near streams; however landfill use is to be soon available
Trousdale	Garbage in all the streams, landfills not approved by state; need for total county garbage pick-up
Montgomery	Garbage and trash dumps in or near streams
Cannon	Garbage and trash dumps in or near streams
Cheatham	Detergents, oil and other wastes from nearby large municipal area (Nashville)
Giles	Garbage and trash dumps, stripmining
Smith	Garbage and trash dumps in or near streams
Clay	Garbage and trash dumps in or near streams
Johnson	Garbage and trash dumps, barnyard waste getting into streams
Hardeman	Large chemical company is dumping waste into a deep ground fill--potential danger to ground water
Pickett	Some pollution from stripmining, but most has been stopped lately

TABLE A-X

Quality of Total Resources

Classification	Number of Counties
Excellent	10.0
Good	10.0
Adequate but could be improved	34.0
Fair and is in process of improvement	12.5
Poor, must be improved	4.5

TABLE A-XI

Degree of Difficulty for Water Quality Improvement

Classification	Number of Counties
Easy to attain	18.0
Difficult but can be accomplished	30.5
Accomplished only by massive motivation	14.5
Only as a last resort	0.0
No comment	8.0

TABLE A-XII

Problems Relating to Water Quality

Item	Yes	No	No Comment
Water quality improvement for the purpose of recreation alone	42	25	3
Would population welcome a large water resource user such as a paper mill	39	43	11
Water quality deterioration due to irrigation	2	69	0
Water quality deterioration due to agriculture pollution problems (non-irrigation)	12	59	0

TABLE A-XIII

Water Quality Index

Quality Factors	Number of Times Mentioned
Color	20
Smell	26
Taste	6
Total solids	3
pH	1
General bacterial count	24
Specific bacterial count	2
Bacterial count for farm supply	2
Chemical content factor	6
Siltation factor	3
Flouridation	1
Useful for industrial and municipal supply	4
Safe for water recreation	17
Safe for animal consumption	2
Fishibility factor	1
Present quality regulations are adequate	2

TABLE A-XIV

Thermal Pollution

County	Comment
Cocke	Cooling water for industry
Hawkins	John Sevier Steam Plant
Sumner	TVA steam plant--lagoon cooling introduced
Maury	Yes, but not source of heat

TABLE A-XV

Lowering of the Water Table

County	Comment
Maury	Minor problems
Lincoln	Residential housing well-use is lowering water table
Macon	Private wells become very low at dry seasons--public supply also suffers
Warren	The water table drops a few inches each year
Dickson	Water levels slowly lowering in all county areas
Scott	Some small areas are lowering
Hawkins	Slow decline, not as yet serious
Washington	Only on the individual farm basis
Cheatham	Less lowering in the past three years due to operation of three water systems being established
Johnson	Minor problems
Cocke	Minor problems
Sequatchie	Many farm wells do not have adequate water, problem worse at present use rate

TABLE A-XVI

Water Level Variations Due to Large Municipal Users

County	Comment
Washington	Lake level lowered by TVA regulations
Lincoln	Municipal water users from large springs lower water table

TABLE A-XVII

Channelization

County	Comment
McMinn	Watersheds (SCS PL 566)
Lawrence	Shoal Creek improvement
Lincoln	Small individual farm efforts
Macon	Long Fork Creek dam proposed
McNairy	Yes
Hamilton	Yes
Obion	Yes
Scott	Yes
Hawkins	Small scale--results questionable
Marion	Battle Creek
Grundy	Yes, project not approved
Grainger	Yes
Decatur	Beech River watershed project
Henderson	Beech River watershed project
Sevier	Yes, Pigeon River project
Monroe	Sweetwater Creek watershed project
Madison	Yes, but results negative
Lauderdale	19,000 acre watershed--30 mi. channel
Wayne	Yes
Shelby	Wolfe and Loosahatchie Rivers
Hardeman	Watersheds
Fayette	Yes
Sequatchie	None, but some is needed
Crockett	Yes

TABLE A-XVIII

Problems Derived from Stripmining

County	Comment
Sequatchie	Few creeks--muddy and silt
Grundy	Yes
Scott	Possible serious damage to streams
Campbell	Loss of biological life from acid content, siltation from surface runoff
Overton	Coloration, fish spawning and feeding areas damaged

TABLE A-XIX

Specific Comments

County	Comment
McMinn	Water quality benefits derived from small watershed programs of SCS-PL 566
Scott	Economic considerations a major factor
Dickson	Enjoys good water quality, people apt to keep it that way--does not need dams, mills, steam plants, and so forth
Sevier	Still has seasonal flooding potential
Monroe	Potential of Little Tennessee as a free flowing stream, agriculture, recreation, tourism, aesthetic value for the Monroe, Blount and Loudon areas
Hardeman	Control of surface water runoff, Hatchie River, watershed project is a by-product of agriculture; low income people have to dig wells 10 to 30 feet; wells 100 feet have iron water, wells 400 feet cost a minimum of $1500.00 each
Sequatchie	Siltation and muddy, water from stripmining on plateau
Smith	Wants a common sense approach to regulating agriculture land for effect of fertilizer on streams
Johnson	Much more work needs to be done in this area
Madison	West Tennessee needs a comprehensive water resource development program involving the Obion and Forked Deer River Basin. The most fertile land in Tennessee and perhaps the nation is in the lower basin. If something isn't done to correct the problems which now exist (as massive flood during the week of August 23, 1971 is a good example), this situation will break many of our best farmers and throw many credit organizations into undesirable positions. There are two major keys to the development doors of West Tennessee. One is a Northwest to Southeast "super" highway from the river bridge at Dyersburg across Interstate 40 and on down to Montgomery and Tampa; the second is the comprehensive development of the resources of the Obion-Forked Deer River Basin

VITA

John Joseph Manning was born September 7, 1925, in Clarksville, Montgomery County, Tennessee. He attended Clarksville public schools. From August 1943 to April 1946 he served in the United States Naval Reserve. He attended Austin Peay State College for the 1948-49 school year, and transferred to The University of Tennessee, Knoxville, for the school years 1949-50 and 1950-51. In November 1951 he was employed by the Oak Ridge National Laboratory, Oak Ridge, Tennessee, as a Laboratory Analyst in the Analytical Chemistry Division. In 1955 he was transferred to the Neutron Physics Division of ORNL where at present he is a Reactor Shift Supervisor. In the spring of 1957 he received the Bachelor of Science degree in Secondary Education, Physical Science Curriculum, from The University of Tennessee, Knoxville.

In 1969 he enrolled at The University of Tennessee, Knoxville, in the Water Resources Development Program, and received the Master's degree in June 1974.

He is married to Ruth E. Caton Manning and is the father of two sons.