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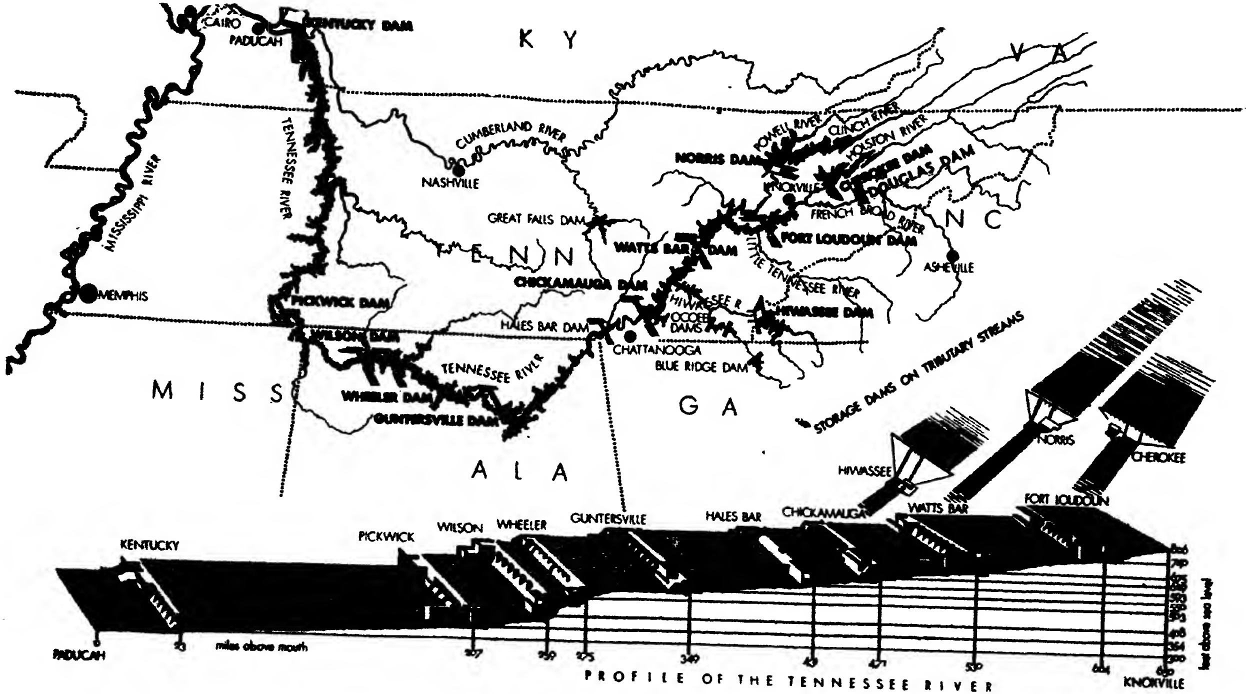

Figure 1. Map of the Tennessee Valley Region. (Tennessee Valley Authority.)

The Tennessee Valley Authority

A Case Study in the Economics of Multiple Purpose Stream Planning

by

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To My Father and Mother

PREFACE

JOINT cost allocation has been one of the more controversial issues of the controversial Tennessee Valley Authority power program. A clearer conception of this problem is indispensable to the formulation of a rational federal power policy. It is a purpose of the present study to contribute toward such clarification. In Part I the existence of multiple purposes at TVA among which joint costs may be divided is established. In Parts II and III theories for dividing joint costs among purposes are examined, and the case for breaking down joint costs is critically appraised. Some concluding observations are ventured as to the implications for public water policy of the maturity of the multiple purpose concept.

But it is with a hope that this volume may have a significance broader than the issue of cost allocation that the author submits it at the present time. In a sense it is an appeal to all who believe in democracy to lay aside their prejudices and examine the facts with reference to an important experiment in their adopted form of government. We are living in a critical age, an age when democracy is challenged by the vaunted efficiency of new and revolutionary forms of social organization. This is not the time to shut our eyes to our problems, nor lightly to cast aside possible approaches to their solution. We must shatter old stereotypes. No longer can we afford the luxury of labelling moderate experiments as "socialistic," *ergo* sinful and to be avoided. We must teach ourselves to draw apart and to see clearly. The demands upon government today are great. Certainly they will be equally great in the longed-for era of post-war adjustment. Throughout the years ahead, keen minds must devote much thought to the problems of adapting democracy to the changing requirements of evolving modern industrial society. In this era of crisis the record of the Tennessee Valley Authority, rehearsed and implied in the following pages, should shine as a beacon of hope. Here is a strong decentralized public agency which has been able to shun the evils of the spoils system and to operate flexibly and efficiently in coping with great problems. In a confused world, here there are facts which are reassuringly clear. *Here is democracy working.*

The author's debts in the preparation of this volume are so numerous and so great that full acknowledgments are well-nigh impossible. It was begun during his term as a field fellow of the Social Science Research Council and was carried forward during the period of a fellowship at the Brookings Institution. Its publication has been made possible by a grant from the Vanderbilt University Institute for Research and Training in the Social Sciences which was arranged through the kindness of Dean John E. Pomfret. The collection of data was facilitated by the generous co-operation of many agencies and institutions, both public and private. Among these were the Bureau of Reclamation, the Commonwealth and Southern Corporation and its subsidiary companies, the Corps of Engineers of the United States Army, the Hudson River Regulating District, the Library of Congress, the National Resources Planning Board and the public service commissions of the states of Alabama, Georgia, Tennessee, and Wisconsin. Professor James C. Bonbright of Columbia University made many helpful suggestions as to the planning of the research program. Congressmen John Jennings and J. Percy Priest of Tennessee assisted through the provision of numerous public documents. To all those who have studied the problem of allocation of TVA joint costs we owe a particular debt, for without their interest and effort our investigation never would have been undertaken. Perhaps most important of all is our obligation to the Tennessee Valley Authority. Without its cordial hospitality and the interested assistance of many members of its staff, the project could not have been prosecuted to a successful conclusion. We mention with especial gratitude and affection the co-operation over a four-year period of members of the Power Section of the Authority under the direction of Dana Wood.

During the composition of the manuscript and the reading of proof the author was aided by the suggestions and continuing assistance of his mother and his wife, Viola S. Ransmeier and Margaret M. Ransmeier.

For permisison to reprint material from W. B. Lawrence's *Cost Accounting* he is indebted to the kindness of the Prentiss-Hall Company.

Much of the prepared manuscript was read by Professor James C. Bonbright, who made many invaluable suggestions. Indeed, his incisive thinking has done much to dispel the clouds surrounding the allocation difficulty. Richard O. Neihoff of the Tennessee Valley Authority read Chapters I through VII of the original manuscript, and James C. Bowman and Sherman Woodward, also of the Tennessee Valley Authority, read Chapters VIII through XIV. The comments of these readers likewise have been of vital assistance. Certain sections of Chapter XVI have benefited from the penetrating thought and advice of Professor John Van Sickle of Vanderbilt University and Dr. Frederick F. Blachly of the Brookings Institution. Proof for the study was read, in whole or in part, by Professors Bonbright, R. A. Brady, Robert Lee Hale, Harold Hotelling, and Robert Livingston of Columbia University. The kindly suggestions of these critics have also been most helpful.

The author alone assumes responsibility for all expressions of opinion.

J. S. R.

Nashville, Tennessee
March, 1942.

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PART I—ORIENTATION

Chapter I

THE DEVELOPMENT OF FEDERAL POLICY IN THE FIELD OF WATER RESOURCES

Summary. One of the outstanding characteristics of the Tennessee Valley Authority program for river control is the fact that it seeks the simultaneous achievement of a number of diverse objectives by means of a series of multiple purpose structures. This has often been described as a new departure in federal water policy. Actually, a review of the development of federal activity in each of the major fields of stream control reveals in every case a strong and steady tendency for original single purpose planning to become ever more comprehensive in scope. Indeed, it is true today that basic legislation in the flood control, water power, navigation, and reclamation fields specifically provides for consideration of co-ordinate objectives of water control in the planning of any project upon streams subject to federal jurisdiction.

It appears to be a reasonable hypothesis that the tendency toward multiple purpose planning has been strongly conditioned by the apparent economies of comprehensive improvement. An incidental reason for the development of power at some recent public projects has been the desire to fashion a public competitive instrument to supplement commission regulation for control of privately owned power companies. Full maturity of multiple purpose planning for entire drainage areas will require a greater co-ordination of public water resource policy than has yet been achieved.

THE ERA OF STREAM DEVELOPMENT FOR NAVIGATION ONLY

Of the various purposes of stream control in which the federal government is presently engaged, the one in which it has been active longest is navigation. This may be attributed in part to the fact that the need for navigation improvement of the inland streams in the days before the development of railroads and modern highways was very great; in part it may be ascribed to the fact that the Constitution was long interpreted as forbidding federal activity in other lines of stream control.

Probably the first major expenditure of federal funds which was designed primarily to safeguard free navigability of an inland waterway was the purchase of the Louisiana territory in 1803. The impelling motive for this transaction, from the American point of view, was to eliminate the noose around the throat of the inland region which was implicit in alien control of the mouth of the Mississippi River, the major trade artery of the inland empire.[1] But the Louisiana purchase could hardly be regarded as constituting a declaration of federal waterway policy. For almost two decades following there was no evidence of a federal interest in the nation's streams. At length, after a preliminary authorization for stream surveys in 1820,[2] in 1824 Congress adopted "An Act to improve the navigation of the Ohio and Mississippi Rivers."[3] This law provided that the federal government, by removing trees and snags and cutting sandbars, should improve the Mississippi River from its mouth to the mouth of the Missouri and the Ohio River from its mouth to the city of Pittsburgh.

Once initiated, federal policy of river improvement for navigation followed an erratic career. At first (1826-39) it developed rapidly as annual river and harbor appropriations became the rule and a number of projects for both channel work and canals were authorized. But the depression of 1837-38 led to a stringency of federal funds, and shortly thereafter increasing railroad com-

[1] Interestingly enough, President Jefferson could find no Constitutional authority for the purchase. See Arthur DeWitt Frank, *The Development of the Federal Program of Flood Control on the Mississippi River*, p. 113; John B. McMaster, *History of the People of the United States*, v. II, p. 803; and Tennessee Valley Authority, *A History of Navigation on the Tennessee River System*, pp. 28-29 (House Document 254, Seventy-Fifth Congress, First Sesison, 1937).

[2] Frank, *op. cit.*, p. 17. Under this law the first Mississippi and Ohio River stream surveys were completed in 1822 by S. Bernard and J. G. Totten of the United States Engineers. Although Bernard and Totten recommended the construction of certain navigation levees, which they pointed out would also be useful for flood control, the estimated expense of the works which they suggested apparently discouraged immediate action.

See House Document 35, Seventeenth Congress, Second Session, 1823; Flood Control Committee Document 17, House of Representatives, Seventieth Congress, First Session.

[3] Act of May 24, 1824, ch. 139, 4 Stat. 32. Less than a month earlier, Congress also adopted an act directing the President to make surveys and estimates for such roads and canals as he might consider important ". . . . in a commercial or military point of view, or necessary for the transportation of the public mail." Act of April 30, 1824, ch. 66, 4 Stat, 22.

petition began to undermine the position of the canal companies. Consequently, from 1840 through the Civil War there was little progress in the adoption of new projects, and existing ones were prosecuted in only a half-hearted manner.[4] During the Civil War almost all ordinary river work was suspended, but after this struggle a new era of generous availability of funds for navigation works began. In part this revival was due to an accumulated arrearage in regular river maintenance which had to be made good. In part it was due to the military victory of those who espoused the philosophy of strong powers for the federal government; no longer was there Constitutional question of the propriety of federal expenditures for navigation.

Although federal navigation policy appeared to be well established by the latter part of the nineteenth century, for a considerable period it remained disjointed and poorly planned. An early effort to bring some order to the program was made by Congress in 1866 when it instructed the United States Engineers to re-examine previously adopted projects in the light of the post-war situation and to prepare revised estimates of their probable costs.[5] In this law Congress also made its first suggestion that policy should be guided, at least to a certain extent, by the relation of anticipated project benefits to project costs.[6] But the theory of benefit valuation was still in its infancy. Throughout the remainder of the century, in the absence of a clear-cut, logical formula for analysis of project economy, regular annual (or biennial) river and harbor appropriations were shaped much more by the pressures of politics than by rational consideration of prospective project costs and benefits.[7] To remedy this situation, in

[4] Leahmae Brown, *The Development of National Policy with respect to Water Resources*, pp. 10-11.

[5] Act of June 23, 1866, ch. 138, 14 Stat. 70.

[6] Section 2 required that the Secretary of War, in reporting to Congress upon any river survey, should indicate, among other things, ". . . . as far as practicable, what amount of commerce and navigation would be benefited by the completion of each particular work. . . . ." 14 Stat. 73. This provision was repeated in the River and Harbor Act of March 2, 1867, ch. 144, 14 Stat. 421.

[7] In 1882 President Arthur returned to Congress with his veto the proposed River and Harbor appropriation on the ground that most of the projects provided for were of purely local importance and outside of the federal interest. (13 *Congressional Record* 6759.) Apparently progress toward planning from the national point of view was slow; for fourteen years later, on May 29, 1896, President

1902 Congress set up the Board of Engineers for Rivers and Harbors in the office of the Chief of Engineers of the United States Army.[8] To this Board it directed that all reports upon examinations and surveys for rivers and harbor works should be referred for review. In arriving at its recommendations as to the prosecution or abandonment of navigation works, the Board was instructed by Congress that it should:

> ". . . . have in view the amount and character of commerce existing or reasonably prospective which will be benefited by the improvement, and the *relation of the ultimate cost of such work, both as to cost of construction and maintenance, to the public commercial interests involved and the public necessity for the work and propriety of its construction, continuance, or maintenance at the expense of the United States.*"[9]

From this provision developed the formula which is used by most federal agencies at the present time for analysis of the economic feasibility of proposed projects. This is to evaluate prospective project costs and benefits, and treat as "feasible" only those improvements for which indicated benefits are in excess of indicated costs.[10]

During the period that a definable federal navigation policy was developing, what was the situation with respect to other major objectives of water control? Throughout the first three-quarters of the nineteenth century these were accorded but scant consideration. Hydroelectric power was as yet unknown, and the problem of irrigation of the western lands had not yet become acute. Only with respect to flood control had there been reason for serious consideration of federal action. In the case of this objective, continual pressure had been exerted upon the federal government to assist in control of the Mississippi River; but for

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Cleveland returned to Congress with his veto the River and Harbor appropriation of that year. In support of his rejection of the bill the President said:

> ". . . . many of the objects for which it appropriates public money are not related to the public welfare, and many of them are palpably for the benefit of limited localities or in aid of individual interests."

(28 *Congressional Record* 5918).

[8] River and Harbor Act of June 13, 1902, ch. 1079, sec. 3, 32 Stat. 372.

[9] *Ibid.* (Italics supplied).

[10] This formula was incorporated by Congress into the Flood Control Act of 1936 and the Reclamation Act of 1939. See below, pp. 23, 27,

many years Congress was extremely skeptical of its constitutional authority to prosecute works in the suggested new field of action.[11] It is true that in 1849 the federal government authorized land grants to the State of Louisiana to provide the latter with funds to prosecute the fight against floods,[12] and that from time to time federal flood surveys of the lower Mississippi River valley were authorized.[13] But legislation of this sort was always carefully justified by reference to the navigation objective.

After the great Mississippi River flood of 1874, the extent of Congressional reluctance to act directly in the flood control field

[11] See Frank, *Development of Federal Flood Control,* Chapters IV and V.

[12] Act of March 2, 1849, ch. 87, 9 Stat. 352. This law was similar in principle to certain early laws which authorized land grants in order that the proceeds of land sales might be applied against the construction costs of navigation works. It authorized grants of swamp and overflow lands to Louisiana on the theory that the state could drain and sell them, and use the proceeds to finance the construction of flood works. In fact, by reducing the area of waste land available for storage of flood backwater, there was a serious danger that a program of this sort would constrict river channel and aggravate the flood problem.

The Act of September 28, 1850, ch. 84, 9 Stat. 519, extended to other states privileges substantially similar to those accorded Louisiana under the Act of March 2, 1849.

[13] Prior to 1850 Congress gave little regard to non-navigation objectives in authorizing Mississippi River investigations. (See 12 *Congressional Globe* 150, January 17, 1843; and 18 *Congressional Globe* 150, January 16, 1844.) In 1850, however, Congress adopted a bill providing for a complete" . . . . topographical and hydrographical survey of the Delta of the Mississippi, with such investigations as may lead to determine the most practicable plan for securing it from inundation and the best mode of so deepening the passes at the mouth of the river as to allow ships of twenty foot draft to enter the same." (Act of September 30, 1850, ch. 90, 9 Stat. 539.)

Two notable reports were filed pursuant to the Act of 1850. The first, completed by Lt. Charles Ellet of the United States Engineers in 1852, was not so detailed as the second; but it revealed an unusual comprehension by its author of the scope of the flood problem. Ellet urged that floods were inevitably a matter of federal concern, and recommended that the Mississippi flood problem be solved by construction of a comprehensive system of reservoirs and diversion channels to supplement levees (which up to this time had been the standard means of flood protection). The report was designated as Senate Document 49, Thirty-Second Congress, First Session. The second report, submitted by A. A. Humphries and H. S. Abbott in 1861, went beyond the Ellet report in that it included detailed plans for a proposed co-ordinated reservoir-spillway-levee system. See Humphreys and Abbott, "The Physics and Hydraulics of the Mississippi River, and the Protection of the Alluvial Region against Overflow," 1861, Washington, Department of War.

Unfortunately, before action could be taken on the reports filed pursuant to the law of 1850, the Civil War supervened, and all talk of expanding flood works was dropped. In the post-war period the need for bringing back into condition existing "navigation" levees seemed more urgent than the construction of new works; and action on the surveys was indefinitely postponed.

became apparent. Although this disaster had centered the interest of the nation in the Mississippi flood problem, although Congress had before it the findings of two studies pursuant to the law of 1850, and although a special commission established by Congress and headed by General G. K. Warren of the United States Engineers recommended direct federal action for control of the Mississippi,[14] nevertheless Congress steadfastly refused to undertake a flood control program. To those who had urged federal participation in the battle for control of the Mississippi it now became apparent that overt assistance from the national government would not soon be forthcoming.

THE DEVELOPMENT OF FLOOD CONTROL AS AN INCIDENT TO NAVIGATION

After the great flood of 1874 had failed to bring Congress to a commitment to control of the Mississippi River, those who had urged such a program determined to seek indirect federal assistance. It had already long been apparent that many of the so-called "navigation" levees served to confine at least moderate floods;[15] and it was further an evident fact that uncontrolled floods tended to disrupt river commerce. Accordingly, it was decided to urge upon Congress the desirability of adopting a program of flood control, not for its own sake, but for the sake of protecting the navigability of the river. It was believed that such a program incidentally would render valuable protection to extensive areas of river lands subject to overflow. Politically, this strategy had the advantage that it was able to enlist the support of commercial interests outside of the valley region which were concerned simply with economical transportation of products into and out of the lower Mississippi valley. It was crowned with success in 1879 when Congress adopted

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[14] Although the Warren commission supported the Ellet, and Humphreys and Abbot reports in the finding that the flood problem was a matter of concern to the federal government, it did not support their recommendations for a comprehensive reservoir-spillway-levee solution to the problem. Instead, it took the position that control must ultimately depend upon the capacity of the leveed channel to pass maximum flood crests downstream without breaks. See House of Representatives, Executive Document 127, Forty-Third Congress, Second Session.

[15] See the Bernard-Totten report of 1823 (citation above).

a law establishing a seven-man "Mississippi River Commission" to prepare:

". . . . a plan or plans and estimate as will correct, permanently locate, and deepen the channel and protect the banks of the Mississippi River, improve and give safety and ease to the navigation thereof, *prevent destructive floods* and promote and facilitate commerce, trade and the postal service."[16]

At length Congress had been manoeuvered into adoption of a program for the control of Mississippi River floods.

While the words of the Act of 1879 clearly committed the federal government to flood control, the interpretation which the new Commission put upon the law was that flood control was authorized only for the purpose of contributing to the primary end of river development for navigation. This position of the Commission was repeatedly endorsed by Congress in river and harbor appropriation laws which made it clear that the Commission should expend funds only for works useful for navigation.[17] Thus, the program for Mississippi River flood control developed but slowly.[18] Only in 1895 did the Commission expand its levee program from maintenance and reinforcement of existing structures to construction of a new levee line. As late as 1906, new works for flood control were adopted only when it was possible to rationalize them as of importance to the program for navigation.[19]

[16] Act of June 28, 1879, ch. 43, 21 Stat. 38, 33 U. S. C. A. 647 (italics supplied). Professor Arthur Frank, to whom the author owes a considerable debt in his discussion of federal flood control policy, considers this law as probably "the most important piece of flood-control legislation in all of our history." *Development of Federal Flood Control*, p. 42.

[17] See, for example, the River and Harbor Appropriation Act of 1884 which specifically stated that funds made available to the Commission should not be used ". . . . to repair or build levees for the purpose of reclaiming lands or preventing injury to lands by overflows." Act of July 5, 1884, ch. 229, 23 Stat. 146.

[18] Rightly or wrongly, prior to the River and Harbor Appropriation of 1892 the Commission considered itself empowered to construct only levee and channel works to facilitate low-water navigation. The law of this year first authorized works for the promotion of commerce ". . . . at all stages of the river." (Act of July 13, 1892, ch. 158, 27 Stat. 107.) Prior to 1892, it would seem that the only contribution of the Commission to control of Mississippi River flood waters was reconstruction and maintenance of certain navigation levees incidentally useful for confining high river tides.

[19] Frank, *op. cit.*, 135, 141.

Despite this hesitant start, as the twentieth century grew older, it became possible to perceive in the Commission's work the outlines of a consistent approach to the flood problem. Strongly conditioned by the early requirement that flood works should be susceptible of rationalization as useful for navigation, this approach consisted of the construction of a high levee line along both banks of the river throughout the entire alluvial valley, so that even the greatest anticipated floods might be confined within the designated channel limits. Whether such a program could achieve the goal of complete protection was vigorously questioned by many who recalled that some of the most thorough river surveys had found a more comprehensive program than the Commission's levees-only scheme would be needed for full river control. But the Commission adhered to its position. Whenever floods broke over the established levee line, it simply declared that the grade had not been high enough and announced a new and higher line for the future.[20]

So strongly wedded was the Commission to the levees-only solution of the flood problem that in 1917, when Congress at last seemed ready to adopt an independent flood control program on the Mississippi River without regard to the navigation objective, it still did not urge that levees be supplemented by other methods of control. Consequently, in the Mississippi River Act of that year, Congress adopted a five-year $45,000,000 program of levee construction but made no provision for reservoirs or spillways.[21] Despite the fact that this program was delayed by the first World War, in 1920 the Commission declared that the established levee line was adequate to control all but the greatest floods; and in 1926 it found that complete protection had been won for the delta region.[22] As though in mockery of the Com-

[20] After the 1897 flood shattered previous records, the Commission adopted as standard for the future a grade adequate to provide three feet of freeboard above the 1897 crest. But the floods of 1912 and 1913 surpassed those of 1897, and once more the grade had to be increased. This change involved an estimated doubling of required levee yardage. But the 1927 crest ran well over this line. Frank, *op. cit.*, 144-148.

[21] Act of March 1, 1917, ch. 144, 39 Stat. 948. The program adopted under this law was enlarged and extended by the Act of March 4, 1923, ch. 277, 42 Stat. 1505, 33 U. S. C. A. 702.

[22] C. McD. Townsend, "Levee Construction on the Mississippi," 53 (1920) *Engineering and Contracting* 37; C. McD. Townsend, "Why the Spillway will

mission's confidence, in 1927 a flood of unprecedented volume rolled down the river valley, overtopped the design levee grade, and demonstrated conclusively that any adequate solution to the flood problem on the Mississippi River must supplement river control by levees with emergency spillways, cut-offs, and perhaps also tributary reservoir storage.

THE STRUGGLE IN CONGRESS FOR COMPREHENSIVE WATERWAY LEGISLATION

While the Mississippi River Commission was laboring with the problem of formulating and executing a flood control program which would harmonize with its navigation objectives, there developed in Congress a historic debate on the issue of the appropriate federal role in the development of stream resources. On the one hand were those who urged that the United States should undertake a vigorous program for comprehensive improvement of streams subject to federal jurisdiction. On the other were those who urged that it should play only a passive role and that it should depend on the initiative of private enterprise, subject to appropriate regulation, to bring about the most satisfactory development of river projects. This controversy came to a head over the water power issue.

Keen observers might have foreseen a greater role for the federal government in stream planning as early as 1882 when hydro-electric energy was first distributed to consumers from central stations. For if valuable energy could be generated at river falls, it was but reasonable to anticipate that the construction of artificial falls, i.e., dams, would prove economical at many sites. Yet government could not consistently countenance the erection of barriers in the navigable streams by privately owned power companies when, at the same time, it was engaged in improvement of the same streams for the sake of commerce. To forestall such situations Congress in 1890 took jurisdiction over the construction and maintenance of all obstructions upon the navigable streams.[23] Thenceforth,

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not solve the Mississippi Problem," 90 (1923) *Engineering News-Record* 23-25; *Annual Report*, Chief of Engineers, United States Army, 1926, p. 1793.

[23] River and Harbor Act of January 27, 1890, ch. 907, 26 Stat. 454, 33

it was stipulated that power rights might be obtained by private parties (or any non-federal organization) only after affirmative approval by Congress of duly filed applications. Rights, when granted, were in fee simple and perpetuity, and no provision was made for the assessment of charges against grantees.

A basic inconsistency of the Act of 1890 soon became apparent. The law originally had been formulated to prevent invalidation of federal investment dedicated to navigation by the construction of power barriers across the navigable streams. It now appeared that the potential energy of the nation's streams was a valuable federal asset, and that the failure of federal legislation to provide for the assessment of charges in return for the right to develop this energy constituted, in effect, a dissipation of public wealth. Perceiving the nature of this situation, a group who came to be known as the "conservationists" protested strongly against it. Not only did they argue that failure of the government to exact a reasonable *quid pro quo* for the resources which it alienated constituted poor administration of its trusteeship of public assets; but they further urged that grants under these conditions were conducive to the development of monoply in the water power industry and would not work toward the optimum improvement of stream resources for all major water uses. In place of the adopted policy of alienation of power rights, they suggested that an agency or agencies of the federal government should be established to construct and operate comprehensive stream control projects in each of the major river valleys.[24] For example, in a 1908 report the Inland Waterways Commission declared:

"We recommend that hereafter plans for the improvement of navigation in inland waterways or for any use of these waterways in con-

U. S. C. A. 403. These provisions were extended in the River and Harbor Acts of August 18, 1894, ch. 299, 28 Stat. 338, and of March 3, 1899, ch. 425, 30 Stat. 1151.

[24] See, for example, a message from President Roosevelt, dated March 14, 1907, creating the Inland Waterways Commission. This stated in part:

"It is becoming clear that our streams should be considered and conserved as great natural resources. Works designed to control our waterways have thus far usually been undertaken for a single purpose. . . . . While the rights of the people to these (single) . . . . uses of water must be respected, the time has come for merging local projects and uses of the inland waters in a comprehensive plan designed for the benefit of the entire country. Such nection with interstate commerce, shall take account of the purification of the waters, the development of power, the control of floods, the reclamation of lands by irrigation and drainage, and all other uses of the waters or benefits to be derived from their control." [25]

The Commission further recommended that a permanent National Waterways Commission be established to prepare a national water plan with reference to which all individual projects should be co-ordinated.

"(Such Commission should) . . . . continue the investigation of all questions relating to the development and improvement and utilization of the inland waterways of the country and the conservation of its natural resources related thereto, and . . . . consider and co-ordinate therewith all matters of irrigation, swamp and overflow land reclamation, clarification and purification of streams, prevention of soil waste, utilization of water power, preservation and extension of forests, regulation of flow and control of floods, transfer facilities and sites and the regulation and control thereof, and the relations between waterways and railways; and . . . . the Commission should be empowered to frame and recommend plans for developing the waterways and utilizing the waters, and as authorized by Congress to carry out the same through established agencies when such are available. . . . ." [26]

Similar in tenor to the findings of the Waterways Commission were those of the water resources division of the National Conservation Commission which was established by President Roosevelt in 1908 to investigate conservation problems in relation to four major classes of resources: forest, water, mineral and land.[27] The Joint Conservation Congress, which reviewed the findings of the Conservation Commission, particularly endorsed the latter's

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a plan should consider and include all the uses to which streams may be put, and should bring together and co-ordinate the points of view of all users of water."

Preliminary Report of Inland Waterways Commission, Senate Document 325, Sixtieth Congress, First Session, (1908) pp. 15-16.

[25] *Ibid.*, p. 25.

[26] *Ibid.*, p. 27 (parenthesis supplied).

[27] The National Conservation Commission was established by letter of the President dated June 8, 1908, and by Executive Order 809 of the same day.

conclusion that ". . . . all uses of the waters and all portions of each waterway should be treated as interrelated." [28]

Although the President and numerous special commissions furnished strong leadership in the matter of water resource planning, Congress followed but hesitantly. A majority steadfastly rejected the idea of direct federal prosecution of a multiple purpose program for the development of stream resources. Instead, they favored a passive federal policy (except for ordinary river and harbor improvement) with the bulk of work for stream utilization to be carried out by private enterprise interested in the harnessing of hydro-electricity. As to just what conditions private companies should be required to fulfill in return for power rights upon the federal streams, there was considerable difference of opinion.

In an effort to clarify this situation Congress adopted two "General Dam Acts," but neither of these was accepted as

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[28] See *Report of the National Conservation Commission*, February, 1909 (Senate Document 676, Sixtieth Congress, Second Session), p. 27. The Commission's full recommendations on the subject of water resource planning were as follows:

"The first requisite for waterway improvement is the control of the waters in such a manner as to reduce floods and regulate the regimen of the navigable rivers. The second requisite is development of terminals and connections in such manner as to regulate commerce.

"In considering the uses and benefits to be derived from the waters, the paramount use should be water supply; next should follow navigation in humid regions and irrigation in arid regions. The development of power on the navigable and source streams should be coordinated with the primary and secondary uses of the waters. Other things equal, the development of power should be encouraged, not only to reduce the drain on other resources, but because properly designed reservoirs and power plants retard the run-off and so aid in the control of the streams for navigation and other uses.

"Broad plans should be adopted providing for a system of waterway improvement extending to all uses of the waters and benefits to be derived from their control, including the clarification of the water and abatement of floods for the benefits of navigation; the extension of irrigation; the development and application of power; the prevention of soil wash; the purification of streams for water supply and the drainage and utilization of the waters of swamp and overflow lands.

"To promote and perfect these plans, scientific investigations, surveys, and measurements should be continued and extended, especially the more accurate determination of rainfall and evaporation, the investigation and measurement of ground water, the gauging of streams and determination of sediment, and topographic surveys of catchment areas and sites available for control of the waters for navigation and related purposes."

Ibid., p. 24. See also President Roosevelt's veto messages relative to the Rainy River project (42 *Congressional Record* 4698-4699) and the James River project (House Document 1350, Sixtieth Congress, Second Session).

a final solution to the key issues of the water power problem. The General Dam Act of 1906[29] was constructive in that it outlined a formula under which applications to Congress for power rights on streams subject to federal jurisdiction should be made; but it did not do away with the requirement for a special act of Congress in the case of each grant. Neither did it fix a limited term for power grants, nor provide for the exaction by government of reasonable fees for valuable rights conferred. To remedy the deficiencies of the Act of 1906 Congress adopted a second General Dam Act four years later.[30] Unfortunately, the Act of 1910 contained so many loopholes and so much loose language that it did little to clarify the earlier situation.[31]

When the make-shift nature of the law of 1910 had become apparent, Congress settled down to the problem of formulating a new general law which would embody a definitive statement of public policy relative to the nation's stream resources. The legislative battle which ensued was marked by a widening of the cleavage which had already existed between the friends of the privately owned power companies and those who were sympathetic to a national "conservation" policy. The latter group urged the establishment of a broadly powered national waterways commission to plan and execute a national program of multiple purpose stream development. If agreement could not be obtained on the creation of such a commission, the conservationists then urged as an alternative that a permanent commission should be set up to consider the applications of privately owned power companies for power rights on streams subject to federal jurisdiction. This commission should be empowered to approve

[29] Act of June 21, 1906, Chapter 3508, 34 Stat. 386. In addition to the provisions noted in the text, the law provided (1) that construction plans for proposed works should be submitted to, and obtain the approval of, the Secretary of War and the Chief of Engineers; (2) that the government might require the grantee to provide locks and other navigation facilities without cost to the United States; and (3) that the United States at all times would retain the right to regulate pool levels and discharges. See Jerome G. Kerwin, *Federal Water-Power Legislation*, pp. 111-113.

[30] Act of June 23, 1910, ch. 360, 36 Stat. 593.

[31] For example, it provided for the assessment of fees in return for the grant of power privileges, but it was by no means definite as to the manner in which fees should be determined or collected. It limited the term of grants to fifty years, but outlined no procedure for federal recapture of private facilities constructed pursuant to grants at the close of the fifty-year period.

applications only when it had determined that they provided for (1) the safe-guarding of all water uses co-ordinate with power; (2) the payment of reasonable charges in return for privileges granted; and (3) the limitation of the term of grants to a relatively short life with provision for subsequent federal recapture of facilities. Friends of the power companies, on the other hand, supported by staunch adherents of the doctrine of "states' rights," rejected completely the idea of a strong federal waterways commission and favored instead the adoption of a general law, with few regulatory features, under which power privileges could be granted to applicant companies without the requirement of a special act of Congress in each case.[32] The former group tended to have its greatest strength in the House of Representatives while the "states' rights" group was stronger in the Senate. The result was that, while "strong" bills (from the conservationist viewpoint) could pass the House and "weak" bills could pass the Senate, neither type could pass both; and the differences between the opposed viewpoints were so fundamental that it was extremely difficult to arrive at a satisfactory compromise. After all kinds of parliamentary tricks to manoeuver passage of one type of law or the other had been tried and had failed, at last, in 1920, a weary Congress agreed to a moderate measure which was neither so strong in its control features that the states' rights and power company interests felt bound to resist it, nor so weak that the conservationists felt it would sanction reckless alienation of the public resources.[33]

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[32] With reference to the arguments of the conservationists this group asserted (1) that the federal government had no legal authority to exact charges for power privileges unless they included some private use of a federal investment; (2) that regulation was within the peculiar province of the states and outside the sphere of the federal government; (3) that under the Constitution, the federal government could not interest itself in any water use other than navigation; (4) that fixed-term grants of power privileges with the right of federal recapture would unduly discourage the investment of capital in water power; and (5) that any stringent regulatory provisions would discourage private investment in water power to the detriment of the fundamental objective of the conservation movement, viz., the preservation of the natural resources (in this case, coal) from rapid exploitation.

See Kerwin's study, *Federal Water Power Legislation*, Chapters IV and V for an excellent discussion of the background of the Federal Water Power Act.

[33] Note should be taken, in passing, of the fact that in the River and Harbor Act of August 8, 1917, the conservationists secured adoption of a section which

In its policy provisions the Federal Water Power Act of 1920[34] appears to have been a victory for the conservationists. True, the new Commission was not empowered to plan and carry out a national program for improvement of stream resources. But the conditions under which it was authorized to grant licenses to private interests desiring to harness the power available in the navigable streams were designed to preserve the possibilities of multiple purpose stream development and to prevent the alienation of valuable federal assets without proper consideration.[35] The assessment of charges against grantees was authorized;[36] and provision was made for recapture of private facilities

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established a "Waterways Commission" charged with the responsibility of bringing:

> ". . . . into coordination and cooperation the engineering, scientific, and constructive services, bureaus, boards and commissions of the several governmental departments of the United States and commissions created by Congress that relate to study, development, or control of waterways and water resources and subjects related thereto, or to the development and regulation of the interstate and foreign commerce, with a view to uniting such services in investigating, with respect to all watersheds in the United States, questions relating to the development, improvement, regulation and control of navigation as a part of interstate and foreign commerce including therein the related questions of irrigation, drainage, forestry, arid and swamp land reclamation, clarification of streams, regulation of flow of floods, utilization of water power, prevention of soil erosion and waste, storage and conservation of water for agricultural, industrial, municipal, and domestic uses, cooperation of railways and waterways, and promotion of terminal and transfer facilities, to secure the necessary data, and to formulate and report to Congress, as early as practicable a comprehensive plan or plans for the development of waterways and water resources of the United States for the purpose of navigation and for other useful purposes. . . . ."

(Act of August 8, 1917, ch. 49, 40 Stat. 269.)

The most serious weakness of this legislation was its failure to confer upon the Commission any real power. While it could advise and make recommendations, it had no ultimate authority to guide the development of stream resources. The life of the Commission was abruptly terminated when Section 29 of the Federal Water Power Act of 1920 repealed the legislation establishing it.

[34] Act of June 10, 1920, ch. 285, 41 Stat. 1063, 16 U. S. C. A. 791-823.

[35] For example, Section 10-a of the law directed the Commission to require that proposed projects be:

> ". . . . adapted to a comprehensive scheme of improvement and utilization for the purposes of navigation, of water power development, and of other beneficial uses; and if necessary in order to secure such scheme the Commission (shall) have authority to require the modification of any project and of the plans and specifications of the project works before approval."

[36] The purpose of these charges was declared to be, first, to reimburse the United States for the costs of administration of the Act, second, to recompense it for the use of its lands and properties; and third, in the absence of effective State regulation, to expropriate excess profits. The Commission was to compute and assess

constructed pursuant to federal grants at the termination of the grants at net original investment ". . . . not to exceed the fair value of the property taken" plus reasonable severance costs.[37] As a check upon the alleged threat of monopoly in the water power industry, the Commission was instructed to give preference to publicly owned organizations in the event of competing applications.[38] Finally, the law provided:

"That whenever in the judgment of the commission the development of any project should be undertaken by the United States itself the commission shall not approve any application for such project by any citizen, association, corporation, State or municipality, but shall cause to be made such examinations, surveys, reports, plans, and estimates of the cost of the project as it may deem necessary, and shall submit its findings to Congress with such recommendations as it may deem appropriate concerning the construction of such project or completion of any project upon any Government dam by the United States."[39]

Unfortunately, although the law of 1920 contained many principles for which the conservationists had bitterly fought, it was also characterized by a number of weaknesses which made its administration difficult. Most critical of such deficiencies was probably the fact that the Commission was not endowed with an independent personnel but was required to function through the personnel of the departments of three cabinet officers who headed it.[40] Not only did this make co-ordination of Commission work difficult, but indirectly it resulted in maintenance of Commission appropriations at a very low level. As a result of inadequate funds and personnel the new agency was unable to carry out the stream surveys and comprehensive river investigations which the Act authorized. A further weakness of the law was its failure to give the Commission jurisdiction over the construction of all projects upon any streams, navigable or non-

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charges in such a way as to avoid increasing the price of power to the consumer. (Sec. 10-e, 41 Stat. 1069.)

[37] Sec. 14.

[38] Sec. 7. For a brief discussion of monopoly in the power industry, see this chapter below.

[39] Sec. 7.

[40] Section 1 of the law named the Secretaries of War, Interior, and Agriculture as members of the Commission.

navigable, which might be subject to federal control.[41] Although later legislation extended the Commission's authority in this regard,[42] the Act of 1920 merely provided that promoters of tributary projects might, in their discretion, file with the Commission a "declaration of intention" to build a project. Upon receipt of such a declaration the Commission was instructed to determine whether the proposed work would affect the interests of interstate or foreign commerce. Upon an affirmative finding construction of the project should be forbidden until it had been duly licensed under the Act. If no declaration were filed, regardless of how significant the Commission might believe the effect of a proposed tributary structure would be upon interstate commerce, it could take no step to forestall construction.[43]

RECENT DEVELOPMENTS IN THE TREND TOWARD MULTIPLE PURPOSE PLANNING

We have noted above that the solution reached in the Federal Water Power Act of 1920 to the issue of multiple purpose planning was, first, to direct the new Commission to safeguard all co-ordinate water objectives in its grants of power rights upon the navigable streams, and second, to authorize the Commission directly to investigate projects whose construction by the United States it believed would serve the national interest. Unfortunately, for some time neither of these provisions took on

[41] Federal jurisdiction over non-navigable streams tributary to navigable streams has since been upheld on the ground that the flow of the former affects the navigable capacity of the latter and hence interstate commerce. See Oklahoma ex rel Phillips, Governor vs. Guy F. Atkinson Co., 313 U. S. 508; 61 Sup. Ct. 1050; 85 Law. Ed. 1487 (1941).

[42] Act of August 26, 1935, ch. 687, sec. 23-b, 49 Stat. 846, 16 U. S. C. A. 817.

[43] The original shortcomings of the Act of 1920 have since been largely remedied. In 1930, after a near-scandal over power company influence over the Commission, the agency was reorganized and given a permanent independent staff. (Act of June 23, 1930, Chapter 572, 46 Stat. 797.) In 1935 the original declaration of intention section was revised to require declarations by ". . . . any person, association, corporation, State, or municipality intending to construct a dam or other project works across, along, over, or in any stream or part thereof, other than those defined herein as navigable waters, and over which Congress has jurisdiction under its authority to regulate commerce with foreign nations and among the several States. . . ." This section of the law was tested in the famous "New River Case" which, after its second trip to the Supreme Court, was at length decided on its merits in favor of the United States. 311 U. S. 377, 61 Sup. Ct. 291; 85 Law. Ed. 243 (1940).

practical meaning. With the exception of navigation, the Commission did little to preserve or develop non-power purposes of water control; and lack of an independent staff prevented it from prosecuting the authorized stream investigations.

While multiple purpose development under the Federal Water Power Act moved forward but slowly, in the navigation field (where works were prosecuted largely by the federal government) the trend to multiple purpose planning continued steadily. We have already observed that early flood control works were developed incidentally to the federal program for navigation improvement of the Mississippi River; and we have noted that in conservationist literature the fundamental unity of all objectives of water control was stressed. These matters had their influence upon river and harbor legislation at length in 1925. In the River and Harbor Appropriation Act of this year Congress requested the Secretary of War to prepare estimates of the costs of carrying out multiple purpose surveys of the navigable streams.[44] When these estimates had been prepared and returned, Congress began to authorize execution of the detailed studies.[45] As reports of the investigations were filed over a period of years, there was gradually built up a valuable inventory of American water resources.[46]

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[44] Act of March 3. 1925, ch. 467, sec. 3, 43 Stat. 1190. The language of the request was as follows:

> "The Secretary of War, through the Corps of Engineers of the United States Army, and the Federal Power Commission are jointly hereby authorized and directed to prepare and submit to Congress an estimate of the cost of making such examinations, surveys, or other investigations as, in their opinion, may be required of those navigable streams of the United States, and their tributaries, whereon power development appears feasible and practicable, with a view to the formulation of general plans for the most effective improvement of such streams for the purposes of navigation and the prosecution of such development in combination with the most efficient development of the potential water power, the control of floods, and the needs of irrigation: Provided, That no consideration of the Colorado River and its problems shall be included in the consideration of estimate provided herein."

The only unfortunate restriction of this authorization was that it required the joint presence of power and navigation at all projects to be investigated. No estimates were authorized for surveys of projects combining either of these objectives with any number of other water control purposes, regardless of how favorable the project might appear, unless the other purpose were also present.

[45] See House Document 308, Sixty-Ninth Congress, First Session.

[46] These studies are generally known as the "308 reports." The first ones were authorized in the River and Harbor Act of January 21, 1927, Chapter 47, 44 Stat,

In the field of flood control as well as that of navigation, the logic of planning led gradually to multiple purpose improvement. We have seen that when flood control was in its infancy it was closely tied to the navigation objective, but that gradually it achieved the status of an independent purpose. Yet even the Act of 1917, which adopted an independent flood control program for the Mississippi River and which was largely conditioned by the levees-only thinking of the Mississippi River Commission,[47] carried one provision which gave recognition to the possibility of co-ordinate development of diverse water uses.[48] This was but a straw in the wind, and for the time being Mississippi flood control continued to be sought by levees and bank revetments. After the flood of 1927, however, it was generally recognized that the established program would have to be revised and expanded. Since levee heights already had been pushed to their practical limits, it now appeared that some method would have to be found to reduce flood crests in the main channel of the river to dimensions which could safely be carried within the levee line.[49] Two methods for the accomplishment of this end were suggested. First, a part of flood crest might be detained in tributary storage to be passed downstream during periods of low "natural" flow. Second, a sub-

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1015. Construction of a number of the projects investigated pursuant to House Document 308 has since been authorized; and the "308 report" on the Tennessee River basin has been a basic source for many TVA studies. (See *Tennessee River and Tributaries*, House Document 328, Seventy-First Congress, Second Session.)

[47] See above, p. 10.

[48] At 39 Stat. 950, 33 U. S. C. A. 701, the law provided that:

". . . . all examinations and surveys of projects relating to flood control shall include a comprehensive study of the watershed or watersheds, and the report thereon, in addition to any other matter upon which a report is required shall give such data as it may be practical to secure in regard to (a) the extent and character of the area to be affected by the proposed improvement; (b) the probable effect upon any navigable water or waterway; (c) the possible economical development and utilization of water power; and (d) such other uses as may be properly related to or coordinated with the project."

[49] Along many critical stretches the addition of further yardage to the levee line would have so added to the weight of the structure that it would have caused a caving of the ground foundations. Further, during unusual floods water pressures at the foot of the levees had already been so great that they had forced waters through beneath the structures to escape behind them. Such "sand boils" would have become a major threat to a levee system raised to a grade adequate to cope with a scientifically estimated "superflood" in the Mississippi valley.

stantial part of crest flow might be routed downstream through specially constructed flood spillways or emergency channels. Advocates of the use of reservoir storage pointed out that this method had the important advantage that it would incidentally make available other useful benefits than flood control.[50] But the Corps of Engineers found that reservoir storage on the tributaries for the relief of the flood problem in the lower valley would not be economical;[51] and tributary reservoirs were not recommended in either of the principal plans finally developed for the solution of the Mississippi River flood problem.[52] One of these plans, comprehending levees, cut-offs and spillways, was adopted for federal prosecution in the Mississippi River Act of 1928.[53]

From the point of view of the present discussion, the Act of

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[50] *Control of Destructive Flood Waters of the United States*, Hearings before Committee on Flood Control, House of Representatives, Seventieth Congress, First Session, parts 1, 3, 4, 5, 6 (November 7, 1927 to February 1, 1928).

[51] Engineer Department, "Report on Control of Floods of Mississippi River by means of Reservoirs," House of Representatives, Committee on Flood Control, Document 2, Seventieth Congress, First Session. The United States Engineers recognized that reservoirs for local flood control on the tributaries might be economical; and they pointed out that such projects, if constructed, might be of substantial benefit to the lower Mississippi. See House Document 90, Seventieth Congress, First Session, and House Committee on Flood Control, Document 2, Seventy-Fourth Congress, First Session.

[52] The two plans were formulated by the Mississippi River Commission and the Chief of Engineers. Although different in important details, each contemplated control of a flood 25 per cent greater than the maximum flood of record by means of a further strengthening of the levee line, by the use of cut-offs to improve channel capacity, and by the construction of strategically located diversion channels. The more significant points of difference between the plans may be briefly noted. The Commission proposed construction of fully controlled concrete spillways and leveed diversion channels; but the Jadwin (Chief of Engineers) plan contemplated no control of spilled waters. The Jadwin plan included one spillway (Birds Point to New Madrid) not incorporated into the Commission plan. The Commission proposed that the United States pay all damages, buy all flowage rights and rights-of-way for floodways, and pay the cost of levees to confine the diverted waters. In short, the Commission proposed that the United States pay the full expense of the program, except for one-third of the cost of raising main river levees to the 1914 grade, estimated at its initial stage to be $407,000,000. The Jadwin plan, on the other hand, included no provision for damages, rights-of-way or diversion channel levees and was estimated to require an outlay (net of such costs) of $300,000,000. A part of this total was to be assessed against local interests.

See Frank, *op. cit.*, 222-248; Brown, *op. cit.*, 75-78; House Document 90, Seventieth Congress, First Session; and Mississippi River Act of 1928 (citation below).

[53] Act of May 15, 1928, ch. 569, 45 Stat. 534, 33 U. S. C. A. 702.

1928 had two very interesting aspects. First, it continued the practice which had been begun in the Mississippi River Act of 1917 of providing for flood control on the Mississippi River without announcing a general federal interest in the problems of flood control on all (navigable) streams.[54] Second, it continued the established practice of seeking control of flood flows on the Mississippi by means of a single purpose system of works. But although the adopted program did not provide for the integration of multiple purpose reservoirs into the flood control system, one section of the Act did expand the scope of the investigations authorized pursuant to House Document 308 and requested their early completion.[55]

The culminating step in the development of federal flood policy was taken in 1936. Undoubtedly this was greatly influenced by the nation-wide floods which occurred during the high water period of 1935 and by the disastrous Ohio River flood of 1936 which reached the highest stage of record at Pittsburgh. On June 22, 1936 Congress adopted an act in which it declared a national flood control policy pursuant to which federal construction of flood works on all navigable streams or their tributaries might thereafter be authorized.[56] Section 2 of this law

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[54] It should be noted that under the Act of 1917 the federal government was committed to a flood control program on one stream other than the Mississippi, namely, the Sacramento River in California.

[55] Sec. 10 provided in part as follows:

". . . . the reports . . . ., in addition to the surveys provided by said House Document 308, Sixty-Ninth Congress, First Session, shall include the effect on the subject of further flood control of the lower Mississippi River to be attained through the control of the flood waters in the drainage basins of the tributaries by the establishment of a reservoir system; the benefits that will accrue to navigation and agriculture from the prevention of erosion and siltage entering the stream; a determination of the capacity of the soils of the district to receive and hold waters from such reservoirs; the prospective income from the disposal of reservoired waters; the extent to which reservoired waters may be made available for public and private uses; and inquiry as to the return flow of waters placed in the soils from reservoirs, and as to their stabilizing effect on stream flow as a means of preventing erosion, siltage, and improving navigation. . . . ." 45 Stat. 538; 33 U. S. C. A 702j.

[56] Act of June 22, 1936, ch. 688, 49 Stat. 1570, 33 U. S. C. A. 701a. Section 1 of the law stated in part:

". . . it is the sense of Congress that flood control on navigable waters or their tributaries is a proper activity of the Federal Government in cooperation with States, their political subdivisions, and localities thereof. . . . ."

raised co-ordinate objectives of water control to a dignity they had not enjoyed under the Mississippi River Acts of 1917 and 1928. In authorizing the Secretary of War to carry out investigations for proposed projects, it described them as "investigations and improvements on rivers and other waterways *for flood control and allied purposes.*"[57] Thus, in the flood control field, as some time earlier had occurred in the navigation field, recognition was made of the fundamental unity of the various co-ordinate objectives of stream control.[58]

A continuous development toward comprehensive planning similar to that in each of the fields discussed above may also be noted in a fourth field of water use, namely, reclamation.[59] In what is now the continental United States irrigation traditionally has been a problem of the arid west.[60] It was first practiced by the white man in 1847 when the Mormons brought artificial water supplies to certain lands in the vicinity of Salt Lake.[61] Most early projects were either private or co-operative undertakings. Because they were frequently poorly engineered and were based upon water sources which were inadequate in dry years, many of them flourished for short periods and then failed.

[57] Italics supplied.

[58] The final enunciation by Congress of a federal flood control policy is here regarded as culminating the development of flood control legislation. A later flood control act was passed, however, which revised the previous formula for determination of local contributions to the costs of flood works. (See Act of June 28, 1938, ch. 795, sec. 2, 52 Stat. 1215, 33 U. S. C. A. 701c-1.)

Pursuant to the Act of 1936 a number of multiple purpose projects have been authorized and are now under construction while others have been completed. Perhaps the most important system of reservoirs is that above Pittsburgh. By storing surplus stream flow of the flood season these reservoirs will provide summer releases in aid of low water navigation on the Ohio River, and several of them will generate hydroelectric energy. Other multiple-purpose projects which have been authorized include the Denison project on the Red River (Texas), House Document 541, Seventy-Fifth Congress, Third Session; the Connecticut River project, House Document 455, Seventy-Fifth Congress, Second Session; and the Willamette River project, House Document, 544 Seventy-Fifth Congress, Third Session. See the Flood Control Act of June 28, 1938 (citation above).

[59] By "reclamation" here is meant the reclaiming of arid lands by the introduction of artificial water supplies. The term could also be used with respect to the rehabilitation of swamp lands or lands unfit for use for whatever reason.

[60] Most irrigation projects have been developed west of the 100th meridean. See "National Irrigation Policy, Its Development and Significance," Senate Document 36, Seventy-Sixth Congress, First Session.

[61] *Ibid.*

Pressure for public action in reclamation steadily mounted. In 1875 and 1877 Congress adopted the Desert Land Law which authorized sale of parcels of the public domain in a number of western states, in amounts up to 640 acres to an individual, on condition that the purchasers provide for their irrigation.[62] Obviously this contributed nothing to solution of irrigation problems on lands already settled. Land sales under the Desert Land Law were disappointing, and in 1894 Congress adopted the Carey Act offering arid lands free to certain western states for sale to settlers on the condition that the states provide for irrigation of the tracts granted.[63] The rationale of this legislation was also doubtful and results pursuant to it were as discouraging as those following the Desert Land Law.

Toward the turn of the century the movement for federal activity in reclamation joined with the rising movement for public conservation of the country's natural resources, and it was urged that multiple use reservoirs, serving irrigation among other purposes, should be constructed by the federal government in the western states.[64] Although Congress resisted this pressure, in 1902 it at length adopted a basic federal reclamation law.[65] The single purpose orientation of this original legislation has since gradually been modified. Just as flood control early proved itself a "natural" incident to the construction of navigation levees, so the generation of electric power soon proved itself an economical incident to the storage of water for irrigation. Further, it soon appeared that the disposition of surplus water supplies to neighboring communities suffering acute water deficiencies was also an appropriate function of a public irrigation improvement. Consequently, the basic reclamation law was shortly amended to authorize federal projects to obtain revenues

[62] Act of March 3, 1875, ch. 160, 18 Stat. 497; Act of March 3, 1877, ch. 107, 19 Stat. 377, 43 U. S. C. A. 321. For a general discussion of the development of federal policy in the reclamation field, see Brown, L., *The Development of National Policy*, p. 83 ff.

[63] The Carey Act is set forth in Section 4 of the Sundry Civil Appropriation Act of August 18, 1894, ch. 301, sec. 4, 28 Stat. 422, 43 U. S. C. A. 641.

[64] See, for example, a bill proposed by Representative Frank W. Mondell of Wyoming, H. R. 10376, Fifty-Seventh Congress, First Session.

[65] Act of June 17, 1902, ch. 1093, 32 Stat. 388, 43 U. S. C. A. 391.

from these incidental sources.[66] Nevertheless, throughout the first two decades of federal reclamation, electric power and domestic water supply were regarded as simply by-products of the primary irrigation objective.

During the nineteen-twenties a gradual change in the nature of reclamation planning began to take place. This was most evident in the case of the Colorado River project. After studious investigation of all water problems of the Colorado basin and analysis of the relative costs and benefits of alternate projects at various favorable sites throughout the river valley, plans for a great multiple purpose development were formulated in the so-called "Weymouth report."[67] This report recommended a project at the lower Black Canyon site[68] to raise the water surface 605 feet and store 34,000,000 acre feet of water. The benefits which it would provide were estimated as follows: (1) regulation of the "500-year-flood" from a crest of 320,000 cubic feet per second (c.f.s.) at Yuma, Arizona (downstream) to 80,000 c.f.s.: (2) an average annual electric power output of four billion kilowatt-hours; (3) a great silt catching basin which would materially reduce the problem throughout the delta region of a steadily rising elevation of the river bed; (4) a regulation of the low-water flow of the Colorado River to safeguard all existing water demands and to supply the Lost Angeles aqueduct and the All-American canal; and (5) a major recreational center.[69] Although the Boulder Canyon project, as authorized by the

[66] Congress, in the law of 1906, authorized the lease, with preference to municipalities, of surplus power or power privileges available at federal reclamation projects. (Act of April 16, 1906, ch. 1631, 34 Stat. 116, 43 U. S. C. A. 522.) Sales of water, with provision for control of profits of distributors on resale, were authorized by the Warren Act of February 21, 1911, ch. 141, 36 Stat. 925, 43 U. S. C. A. 523. (See also Act of February 25, 1920, ch. 86, 41 Stat. 451, 43 U. S. C. A. 521.)

[67] The preliminary version of this report was published as Senate Document 142, Sixty-Seventh Congress, Second Session. The final report, which contains a mine of valuable information on the water problems of the Colorado basin and is far more complete than the preliminary report, was never published.

[68] Now popularly mis-called "Boulder Canyon."

[69] Weymouth did not emphasize the recreational aspect of the development although it has proved very important. Since there was no effective navigation on the Colorado River and none in prospect, this objective was not taken into consideration in the planning of the proposed structure.

Boulder Canyon Project Act of 1928 [70] and constructed by the Bureau of Reclamation, is not identical with the structure outlined in the Weymouth report, the differences are relatively unimportant; each of the objectives, the development of which Weymouth proposed, has been fully provided for in the adopted project.

Influenced perhaps by the way in which its plans for the Boulder project were developing, the Bureau of Reclamation soon found its thinking running in terms of multiple purpose planning. By the middle of the nineteen-twenties it had begun to formulate recommendations for comprehensive projects in several other great river valleys.[71] Although these proposals were uniformly rejected by the Coolidge and Hoover administrations, several such undertakings of the Bureau have been authorized during the Roosevelt "New Deal." [72]

Far more important than any particular project was a general revision of the basic reclamation law which was adopted in 1939.[73] Section 9 of this law presents a clearer expression of the essentially co-ordinate nature of all water control objectives than almost any other legislative expression of the Congress. It provides that any project of the Bureau shall be deemed authorized if the sum of the appropriate ". . . . allocations to irrigation, power, and municipal water supply or other miscellaneous purposes . . . . together with any allocation to flood control or navigation" is equal to, or greater than, ". . . . the total estimated cost of construction." [74] Although the Act does not say so in so many words, the implication may be drawn that no longer is irrigation, or any other single objective or set of objectives, to be

[70] Act of December 21, 1928, ch. 42, 45 Stat. 1057, 43 U. S. C. A. 617.

[71] Perhaps the most notable of these recommendations was for a power-irrigation development in the Columbia River basin. See "Columbia Basin Project," Senate Committee Print embodying Report of Homer Gault, March, 1924; Board of Engineers Report, April 6, 1924; Board of Engineers Report, February, 1925; and Report of Special Commission, August 25, 1925, Sixty-Ninth Congress, Second Session (1927).

[72] Among the more notable of these are the Central Valley project in California, the Grand Coulee project on the Columbia River; the Colorado-Big Thompson project on the Big Thompson; and the Kendrick project in Wyoming.

[73] Act of August 4, 1939, ch. 418, 53 Stat. 1187, 43 U. S. C. A. 485.

[74] 53 Stat. 1193; 43 U. S. C. A. 485h.

treated as "primary" but that all are to be considered as co-ordinate. If this is a reasonable interpretation, then it would follow that planning for future projects of the Bureau may be directed toward the achievement of the optimum proportioning of objectives from a broad social point of view with due regard to the costs of alternate structures. Thus, perhaps to a greater degree than in any other field of water use, in reclamation the forces tending toward the goal of multiple purpose planning have reached maturity.[75]

INTERPRETATION AND CONCLUSION

The foregoing survey of the evolution of federal policy in the water resource field has revealed a prevalent tendency toward multiple purpose planning. Three matters relating to this tendency may be briefly discussed. First, an optimum program of stream improvement can be established only in the light of a unified public water policy. Such a policy does not yet exist.[76] The need for co-ordination in water planning has long been recognized. It was first expressed by the conservationists in urging establishment of a "Waterways Commission" to plan and execute programs for comprehensive improvement of American stream resources. It was reiterated in the debate which culminated in enactment of the Water Power Act of 1920.[77] It has been restated from time to time since in bills before Congress to establish an authority charged with co-ordination of public water policies and occasionally with the construction of favorable projects.[78] But none of these moves matured into

[75] Perhaps it is appropriate that this goal of the conservationists first should have been achieved by an agency whose establishment may be traced directly to their activities.

For a discussion of power development on projects of the Bureau of Reclamation, see Page, John C., "The Place of Hydroelectric Power in Reclamation," *Reclamation Era,* June, 1940

[76] For a more detailed discussion of this point see below, Chapter XVI.

[77] See, for example, the amendment to the Shields bill for a federal water power law which was proposed by Senator Newlands on March 7, 1916. (53 *Congressional Record* 3733 ff.)

[78] See, for example, the O'Connor bill of 1927 (H. R. 5025, Sixty-Ninth Congress, Second Session) which was discussed by Representative James O'Connor (Louisiana) at 68 *Congressional Record* 5678. This bill was directly in the tradition of the waterway commission bills which repeatedly were sponsored by Senator Newlands.

adopted legislation.[79]

Second, it seems quite possible that the quest for the economy of joint costs has been a major factor stimulating the tendency toward multiple purpose planning. At any given project (or in any system), the economy of improving all incidental by-products of greater value than their incremental costs should be apparent.[80] But true multiple purpose planning involves considerations other than simply the production of economical by-products of a major objective. In "multiple purpose" planning, by definition, no objective is primary and none incidental; but rather all are upon an equal basis. Economy requires that each be sought in the light of its incremental costs and according to its relative place upon some scale of values determined by the policy making authority. Planning must have a comprehensive orientation distinct from the orientation of single purpose enterprise.

In practice, public water planning today remains in a transitional stage characterized by primary and incidental objectives. But conceptually the age of pure multiple purpose planning has dawned, and its impending maturity is plainly foreshadowed. The factors which have shaped, and are shaping, the steady unfolding of federal water policy are complex and certainly are not susceptible of easy definition. But it is true that each stage of this evolution has been consistent with greater over-all project (and system) economy. The evidence is consistent with the hypothesis

[79] The conservationists also urged establishment of an agency to prepare a comprehensive national plan for waterway development. A theoretical deficiency of this proposal was its implicit acceptance of the concept of an optimum ultimate water plan. No final plan can be prepared at any given time which will be appropriate to conditions throughout the changing future. The planning function must be dynamic and continuing.

The statement above in no way questions the value of surveys and general programs for stream development within which detailed plans for the future may be prepared and adjusted. See, for example, the report of an interdepartmental committee established by Congress in 1934 to investigate and prepare a plan for comprehensive improvement of American stream resources, "Development of Rivers of the United States," House Document 395, Seventy-Third Congress, Second Session. See also the 1934 *Report* on the Mississippi Valley Committee of the Public Works Administration and the discussion of Chapter XVI below.

[80] By "value" is here meant the anticipated annual value of the stream of by-product benefits. By "incremental cost" is meant the prospective annual increase in total project cost as a result of the inclusion of the by-product objective.

that a drive toward the superior economy of multiple use planning, always guided and conditioned by the legal framework within which policy must live and grow, has been a most important factor influencing the growth of water resource policy.

Third, an important incidental purpose of the inclusion of power at many recent public projects has been to fashion a competitive instrument to supplement commission regulation for control of privately owned power utilities. Many students of the economics of power supply early recognized that this industry is, to a marked degree, naturally monopolistic.[81] Consequently, free private enterprise as an organizing force to determine investment and prices could hardly be relied upon to achieve the same type of theoretical optima as might be expected in more competitive lines of business. Public regulatory commissions, therefore, were set up to apply directed pressures upon rates and returns of power companies in order that the theoretical optima of competition might be approximated as closely as possible. Unfortunately, these commissions encountered difficulties from two directions in seeking to carry out their designated functions. First, the power companies often sought to influence, obstruct, or oppose them. Second, the courts tended narrowly to restrict their authority over company affairs. Under efficient modern regulation the first of these sources of difficulty may be overcome; but the second is more fundamental.

From the legal standpoint, public authority to control the rates of "private" power companies rests in the fact that this industry has been found to be "affected with the public interest." [82]

[81] The extent of required investment, with large implied "fixed charges," and the need for a physical connection between company and customer have been pointed out as particularly important factors making for monopoly.

The view that the industry tends naturally to monoply was not universally accepted. Notable dissenters included President Hadley of Yale University and Professor Philip Cabot of Harvard Univeristy.

[82] This has been the traditional test of public power over rates of utility companies. Because of its vagueness the Court finally abandoned it in the case of Nebbia vs New York. Here, speaking through Justice Roberts, the Court declared:

> "We may as well say at once that the dairy industry is not, in the accepted sense of the phrase, a public utility. . . . .
>
> (But) ". . . . the private character of a business does not necessarily remove it from the realm of regulation of charges or prices. . . . .
>
> "It is clear that there is no closed class or category of business affected

But while this characteristic provides a ground for regulation, the courts have held that it does not justify the taking of property without due process of law and that, when property is taken, adequate compensation must be made. Logically interpreted, these propositions are inconsistent with *any* public power over rates.[83] This may be demonstrated by the following argument. Any rate reduction which will tend, over the long run, to reduce company net revenues constitutes a taking of company property. The common sense of rate control in the "public" utilities is certainly that "extortionate" profits should not be permitted and that when rates appear to be "too high" commissions should require their reduction. To compensate the companies for profits lost as a result of an ordered reduction would leave them in the same position as if the order had never been made, and merely would shift a part of the "unreasonable" rate burden from power consumers to taxpayers. Unless company property (in the sense of capitalized "excess" profits) can be taken without compensation, the power of rate control is quite without meaning. Thus, the principles of the courts led to a logical impasse in the field of rate regulation.[84]

Because of the difficulties under which regulation has been forced to operate, the view has become increasingly general that it should be supplemented by other forms of control (of which the most frequently suggested has been public competition).

with a public interest. . . . . There can be no doubt that upon proper occasion and by appropriate measures the state may regulate a business in any of its aspects, including the prices to be charged for the products or commodities it sells.

"So far as the requirement of due process is concerned, and in the absence of other constitutional restriction, a state is free to adopt whatever economic policy may reasonably be deemed to promote public welfare, and to enforce that policy by legislation adapted to its purpose. The courts are without authority either to declare such policy, or, when it is declared by the legislative arm, to override it. If the laws passed are seen to have a reasonable relation to a proper legislative purpose, and are neither arbitrary nor discriminatory, the requirements of due process are satisfied, and judicial determination to that effect renders a court functus officio."
(291 U. S. 502, 54 Sup. Ct. 505, 78 Law. Ed. 940 [1934].)

[83] One must except from this statement rate regulation which yields increased returns to the companies.

[84] See Robert Lee Hale, "The 'Fair Value' Merry-Go-Round, 1898-1938: A Forty-Year Journey from Rates-Based-on-Value to Value-Based-on-Rates," (1939) 33 *Illinois Law Review* 517.

Adherents of this opinion have supported their position not only by pointing to the difficulties of regulatory commissions but also by calling attention to the accumulated evidence of repeated investigations as to the presence of serious "abuses," including monopoly, in the utility industry.[85] Nevertheless, despite their

[85] The charge of "monopoly" has been bandied very loosely in debate as to public power policy. If the term is rigidly interpreted to imply a single seller in the entire field, it is doubtful if there has ever been any real American power monopoly (although at times there may have been tendencies in that direction). On the other hand, there have certainly been many cases in which a substantial degree of local or regional monopoly has existed. Whatever danger of national monopoly there may have been was made possible by the holding company device; for required capital investment would have prohibited it on any other basis. (See James C. Bonbright and Gardiner Means, *The Holding Company.*) As late as the early nineteen-twenties the "threat" of monopoly was from the great electrical supply companies. Subsequently it was from interests controlling a few great investment banking firms.

Among the more important investigations and reports on the subject of monopoly in the power industry are the following:

(1) Report by the Commissioner of Corporations, Herbert Knox Smith, entitled "Water Power Development in the United States," March 14, 1912. This was one of the first reports to emphasize the alleged presence of monopoly in the power industry and to adduce facts to support the charge.

(2) Report by O. C. Merrill submitted to the Senate of the United States by the Secretary of Agriculture, David F. Houston, under the title, "Electric Power Development in the United States, ... A Report in Response to a Senate Resolution of February 13, 1915 as to the Ownership and Control of Water Power Sites in the United States," January 7, 1916. The resolution requesting this study was sponsored by the late Senator Borah. The completed report comprised three quarto volumes, totalling 1,068 pages, and contained a vast amount of information to support the charge that monopoly was developing rapidly in the power field. A bitter fight to prevent publication of the report was waged by friends of the power industry, but it was finally printed as Senate Document 316, Sixty-Fourth Congress, First Session. (See 53 *Congressional Record* 1734.)

(3) Report by the Federal Trade Commission pursuant to Senate Resolution 329, Sixty-Eighth Congress, Second Session, entitled "Control of Electric Power Companies," and printed as Senate Document 213, Sixty-Ninth Congress, Second Session. This investigation was carried out under the authority of an amended resolution originally sponsored by Senator Norris. Its finding that there was no substantial evidence to support the charge of monopoly in the power industry was quickly hailed by the companies as conclusive proof that earlier charges had been without foundation. Judson King points out, however, that the Commission's findings were based upon data collected by the questionnaire method and that the study was ". . . . in effect, what the utilities had to say about themselves." Judson King, *The Legislative History of Muscle Shoals,* (Legal Division, Tennessee Valley Authority, Knoxville, 1936—unpublished) p. 120.

(4) Report of the Committee on Interstate and Foreign Commerce of the House of Representatives entitled *Relation of Holding Companies to Operating Companies in Power and Gas affecting Control,* House Report 827, Seventy-Third Congress, Second Session, 6 parts. This investigation was the House counterpart of the second Federal Trade Commission investigation which was authorized by the Senate (see below). It presented data on a number of the more important power company groups; and the last volume was devoted to a study of the

best efforts, partisans of "public power" very likely would have failed to overcome popular American skepticism of "government in business," had not bankruptcies of many great utility corporations and the fall of such public idols as Samuel Insull, "philanthropist," virtually destroyed the prestige of the power companies as the 'twenties faded into the 'thirties. At first shocked and then awakened, the public arose to demand effective control of both the holding company, in which so many had lost their savings, and the operating company, to which rate payers had often been obliged to pay tribute to cover the costs of inflated capital. The rebuttal of the companies that the peculiar quality of being "affected with the public interest" characterized only operating companies, which were already subject to thoroughgoing commission regulation, appeared almost frivolous in the light of the record. The first demand was met in the Public Utility Holding Company Act of 1935; and a partial answer to the second was attempted in the "yardstick" aspects of the 1933 legislation establishing the Tennessee Valley Authority.

From the foregoing discussion of the general development of federal water policy let us turn our attention to the evolution of that policy upon a particular stream, the Tennessee River. This will complete our investigation of the background of the Tennessee Valley Authority Act of 1933.

problem of service charges. Its findings tended to support the conclusion that at least several of the larger utility corporations had not been managed in accordance with the public interest.

(5) Investigation of the electric and gas utility industries by the Federal Trade Commission pursuant to Senate Resolution 83, Seventieth Congress, First Session, and entitled *Utility Corporations* (Senate Document 92, Seventieth Congress, First Session.) This investigation, which continued over an eight-year period, was probably the most comprehensive study of any field of "private" enterprise ever carried out by an agency of the federal government. Its printed record and report ran to eighty-four volumes, some of which included several parts. They dealt with every phase of the business activities of every major utility corporation, whether operating or holding company. The findings of the inquiry with respect to abuses in the power industry were undoubtedly of foremost importance in shaping subsequent trends in federal power policy.

Chapter II

THE DEVELOPMENT OF FEDERAL WATER POLICY ON THE TENNESSEE RIVER

(1824-1932)

Summary. In the history of federal policy at the Muscle Shoals site on the Tennessee River one may view in microcosm the evolution of American water policy. After an era of single purpose navigation improvement during the nineteenth century, at the start of the twentieth century this site became involved in the great conservation struggle. Retained in public hands only by the eternal vigilance of the "conservationists," Muscle Shoals was selected for federal development during the World War as a great national defense hydroelectric-air nitrate center. After the passage of the war emergency, the dissipation of the defense motive for prosecuting the improvement brought on a new controversy between those, on the one hand, who favored peace-time integration of the site into a comprehensive public water control system on the Tennessee River (whose hydroelectric aspect would give government a competitive device for control of rates of the American power industry), and those, on the other, who opposed the principle of public operation and favored lease of the site to private industry. Through three post-war national administrations the effort to resolve this controversy continued without success.

EARLY IMPROVEMENTS FOR NAVIGATION

As was true in the case of federal policy generally, the first plans for improvements on the Tennessee River contemplated works in aid of the single purpose of navigation. As early as 1821 steamboat navigation of the river began, and by 1826 regular service between Tuscumbia (a few miles below Florence, Alabama) and New Orleans was inaugurated.[1] But while traffic down-river from Tuscumbia increased with the rising star of the river steamboat, traffic upstream was severely restricted because

[1] A complete discussion of the history of navigation on the Tennessee River has been prepared by the Navigation Section of the Tennessee Valley Authority. See *A History of Navigation on the Tennessee River System,* House Document 254, Seventy-Fifth Congress, First Session.

of the natural barrier at Muscle Shoals.[2] So serious did John C. Calhoun, Secretary of War under President James Monroe, consider this barrier that he designated it as one of the most important river obstacles meriting federal attention.[3] Pursuant to this finding Congress appropriated money for survey of a canal around the Shoals; and, in 1828, it granted to the State of Alabama 400,000 acres of federal lands, proceeds from the sale of which were to be used to finance the surveyed project.[4] Unfortunately, the land sale did not raise sufficient funds to finance the project originally contemplated, and a shorter, substitute ditch around only the stretch known as "Big Muscle Shoals" was adopted. Although completed in 1836 this project proved unsatisfactory, and by 1838 it was already practically abandoned.[5]

After failure of the first canal no further navigation works were undertaken at the Muscle Shoals site for many years. With resurgent federal interest in inland navigation after the Civil War, however, resurvey of the site was authorized in 1871.[6] Four years later a new canal was begun; and at length, in 1890, it was brought to completion. Although superior to its predecessor, the 1890 canal also failed to provide a final solution to the difficulties of navigating the Muscle Shoals stretch of the river.[7] In the following period the initiative in the campaign

[2] "The '37-mile stretch of the Tennessee River between the head of Browns Island and the site of the present Florence Bridge, known as Muscle Shoals' had a fall of 133 feet during low water of 1871." (Quoted from letter from the Tennessee Valley Authority.)

[3] This recommendation followed investigations pursuant to the law of April 30, 1824. (See Chapter I above.)

[4] Act of May 23, 1828, ch. 75, 4 Stat. 290. The device of federal land grants to the states to finance works whose direct construction by the federal government was of doubtful constitutionality was used during the early years of several phases of water policy. In addition to the navigation case mentioned here, note may be taken of the Swamp and Overflow Land Acts in the flood control field and the Carey Act in the reclamation field. See Schlesinger, Arthur M., *Political and Social Growth of the United States*, 1852-1933, p. 329 ff., and Chapter I above.

[5] The 1836 canal had two major deficiencies. First, it was poorly engineered, so that streams emptied into it and caused it to silt up rapidly. Second, it provided only a partial solution (and hence almost no solution at all) to the navigation problem at the Shoals, for there were still dangerous rapids both above and below it. (See House Document 254, p. 127.)

[6] Act of March 3, 1871, ch. 118, sec. 3, 16 Stat. 542.

[7] In fact, the project consisted of two canals, one following the bed of the 1836 ditch around Big Muscle Shoals and a second, upstream, passing around

to improve Muscle Shoals passed from those interested in its navigability to those interested in development of its potential power resource.

THE STRUGGLE FOR POWER RIGHTS AT MUSCLE SHOALS

As we have observed in Chaper I, the growing interest of the infant power industry in throwing dams across the navigable streams led the United States, in the River and Harbor Act of 1890, to take jurisdiction over all structures in federal waterways. Pursuant to this law applications to develop Muscle Shoals were filed by several power interests. In Congressional debate upon these applications most of the issues of the conservation struggle found expression.

Two stages may be distinguished in the struggle for power rights at Muscle Shoals: first, a stage in which small channel works were proposed which would block main river navigation but not interfere with the Muscle Shoals canal; and, second, a stage in which were proposed high dams across the entire river gorge which would flood out the canal and permit the safeguarding of navigation only by the inclusion of locks. From 1899 to 1906 a number of bills to authorize works of the first sort were introduced into Congress and adopted; but the companies to which they granted power privileges apparently were unwilling to accept their exact terms, and no construction was undertaken.[8] By 1907 the old Muscle Shoals Power Company,

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Elk River Shoals. Navigation through both sections was retarded by the requirement of eleven lockages. As with the earlier project, there were difficulties in navigating the approaches to the improved sections; and there were also rapids to be passed in moving between the upper and lower canals. (House Document 254, p. 137 ff.)

[8] For example, in 1899 a bill was introduced to authorize ". . . . inlet and outlet races or canals and a power station" at ". . . . a point or points at or near Muscle Shoals in (the) Tennessee River, that are, and always have been, unsuitable and unused for the purposes of navigation . . . . ," subject to the proviso that such works should not interfere with the federal navigation canal. Before the measure had passed Congress, the clause concerning unnavigability of the Tennessee River was stricken out, and two new clauses were included. The first of these authorized the Secretary of War to assess charges against the power company in return for power privileges granted; the second required that the authorized structures be begun within one year and completed within three. Although the privileges granted under this bill were renewed several times, the

to which most of the earlier privileges had been granted, was succeeded by a new Muscle Shoals Hydro Electric Power Company. This concern quickly made it clear that any scheme of low dam improvement for power would be unsatisfactory and that it was interested only in the construction of high dams.[9]

The plan which the new petitioner [10] put forward proposed full development of the power resource at the Shoals site by means of three high, hollow concrete dams. Since backwater from these structures would drown out the government canal, the company contemplated providing for navigation by the inclusion of locks at each dam. In return for this navigational aspect of the undertaking, it requested that the United States contribute the entire cost of locks and fifty per cent of the cost of dams and spillways. When a bill was introduced into Congress to authorize federal participation in the project under substantially these terms, it was referred in the House to the Committee on Rivers and Harbors which was under the chairmanship of Representative Burton (of Ohio), a leading exponent of the conservationist point of view. Feeling that a proposition of this nature required expert analysis, the Committee forwarded it to the Board of Engineers for Rivers and Harbors. Thus came the first contact of the United States Engineers with private proposals for power development at Muscle Shoals.

After due consideration of the power company plans, a special board which was set up by the Board of Engineers to study the offer reported back to the House Committee on Rivers and

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Company refrained from undertaking the project under the terms defined by Congress. The final bill to extend this privilege was vetoed by President Theodore Roosevelt. Judson King, *Legislative History of Muscle Shoals*, pp. 1-2; 36 *Congressional Record* 3071.

[9] In 1906 Congress authorized the State of Alabama to grant to whomsoever it might see fit rights of power development at the Shoals by means of low dams or wheels fed by lateral canals. (Act of March 6, 1906, Chapter 517, 34 Stat. 52.) But no rights were to be granted for projects which might impair navigability of the federal canal. Since this proviso eliminated the possibility of high dam construction, the Muscle Shoals Hydro Electric Power Company indicated no interest in securing rights under this act.

[10] Among the promoters of the Muscle Shoals Hydro Electric Power Company were Frank S. Washburn, later president of both the Alabama Power Company and the American Cyanamid Company, and J. W. Worthington, long an active lobbyist in the Muscle Shoals debate. King, *op. cit.*, p. 9; and 77 *Congressional Record* 2189.

Harbors through the Secretary of War on March 12, 1908.[11] It found that, while the plans were "not without merit," they did not adequately provide for navigation and their safety could not be assumed in view of the innovation in dam construction which they contemplated. Further, the board noted that the company included no cost estimates in its offer. It suggested there was a substantial chance that the terms of the proposal might require the United States to contribute a greater investment than the alternative cost of completing the Muscle Shoals canal system throughout the length of the river rapids. For these several reasons the board withheld its endorsement of the power company plan.

Despite this set-back the company presented modified versions of its original proposal to subsequent Congresses. In hopes that reconsideration of the matter by the Board of Engineers would lead to a strong unfavorable report which finally would dispose of the proposition, Chairman Burton requested reconvening of the special board to review the initial report. The findings of this review were definite: the project would not be commercially feasible unless the government contributed a greater investment than could be justified for the navigation benefit alone.[12]

Still the company persisted. Consequently, once again in 1910 the Committee turned to the Board of Engineers for review of all previous power company proposals and for revised estimates

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[11] House Document 781, Sixtieth Congress, First Session.

[12] The criterion of justifiable investment was taken to be the alternative cost of completing the canal system. See below, pp. 200 ff., 220.

With reference to the policy issue of government participation in the costs of a privately promoted project the board said significantly:

> "The amount of assistance to be rendered by the Government to private corporations in developing enterprises of this kind when more or less connected with the improvement of navigation, is a question of public policy that the board hesitates to give an opinion on. In general, any partnership relation between the United States and a private corporation is necessarily to be closely scrutinized, as the results in the past have been that the Government, as a party to such agreements, has usually suffered thereby. Public opinion, however, has changed materially within the last few years as to the functions the Government should exercise in conserving the resources of the country, and it may be that within a few years in the future further changes in the views of the people will demand that water powers now going to waste be utilized, even if it should require a new departure in governmental policy. *Such questions as these can, in the opinion of the board, be solved only by Congress.*"

House of Representatives, Committee on Rivers and Harbors, Document 14, Sixtieth Congress, Second Session, p. 20 (italics supplied).

of a reasonable Government contribution to the cost of the proposed project on account of its navigational aspects. The scope of this request for information subsequently was enlarged to include:

> ". . . . a revised report and estimate of the cost of the necessary locks and dams for the improvement of said river for navigation and the development of water power in connection therewith, *considering* not only *the case of no cooperation on the part of the United States with any corporation or water-power company whatsoever,* but also the cases of cooperation with any and all such companies." [13]

A part of the announced purpose of such report was,

> "To allow, if desired of an absolute elimination of any or all co-operation with any corporation in the work of improving the Muscle Shoals reach of the Tennessee River. . . ."

Surprisingly enough, the report which the Engineers now prepared substantially ignored the Committee's request for estimates as to the cost of an independent federal development of the Muscle Shoals site but dealt at length with a revised power company plan. This plan it recommended despite the considerable issues of policy at stake.[14]

In view of the attitude which the Corps of Engineers had taken toward the power company's earlier proposals the new report constituted a sharp reversal of position and occasioned considerable surprise. As a result, when the Engineers requested funds to complete their examinations of the Muscle Shoals site, those who opposed the principle of public participation in the costs of a privately promoted project persuaded Congress to refuse the request. But the Engineers were deter-

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[13] House of Representatives, Committee on Rivers and Harbors, Document 20, Sixty-Third Congress, Second Session, p. 11 (italics supplied).

[14] House of Representatives, Committee on Rivers and Harbors, Document 20, Sixty-Third Congress, Second Session. For a discussion of financial aspects of this three-dam power-navigation proposal, see below, p. 193 ff.

With respect to the policy aspects of this document Judson King states:

> ". . . . with the Kingman report, the engineering department assumed that copartnership with a private corporation in a monopoly set-up was a proper function of the Government without the issue having been determined by Congress."

King, *op. cit.*, p. 31.

mined that the investigations should be completed. Noting that the River and Harbor Act of 1915 called for re-examination of a number of projects including the "Tennessee River, Tennessee, Alabama, and Kentucky," they decided to use this authority for completion of the studies at Muscle Shoals.[15] On March 22, 1916 they submitted their final and most comprehensive report endorsing power company plans for a power-navigation improvement.[16] Conditioning their recommendation, they pointed out that the National Defense Act of 1916 included a provision under which the President was authorized to set aside hydroelectric power sites on the navigable streams for federal development and use in the production of nitrates for munitions. They suggested that final action upon the proposed contract with the power company be delayed pending determination as to whether or not the United States might require the site. When, in 1917, President Wilson did establish a public reservation at Muscle Shoals and order the creation of a public hydroelectric-air nitrate center there, it appeared that the long debate as to federal participation in the costs of a private project at the Shoals had been terminated.

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[15] River and Harbor Act of March 4, 1915, ch. 142, sec. 14, 38 Stat. 1055. A navigation project for the lower Tennessee River had been in existence since 1868. The provision referring to this stream in the act of 1915 was intended to call for a review of this project in anticipation of a recommendation that it be abandoned. Instead, this authority was used to justify further Muscle Shoals investigations. Apparently as a result of this action, the River and Harbor Act of 1916 carried the following clause qualifying the uses to which the appropriation might be put:

> ". . . That no preliminary examination, survey, project, or estimate for new works other than those designated in this or some prior Act or joint resolution shall be made: *Provided further*, That after the regular or formal reports made as required by law on any examination, survey, project, or work under way or proposed are submitted no supplemental or additional report or estimate shall be made unless ordered by a concurrent resolution of Congress."

(River and Harbor Act of July 27, 1916, ch. 260, sec. 2, 39 Stat. 406.

[16] House Document 1262, Sixty-Fourth Congress, First Session. This report contained plans and cost estimates for a three-dam project (including lock and dam number 1 for navigation and reregulation) to develop a maximum power head of 135.5 feet, and also for an alternate project of lower cost to develop a maximum head of 110.5 feet.

THE NATIONAL DEFENSE ACT OF 1916 AND THE CONSTRUCTION OF WILSON DAM

Let us consider for a moment the manner in which the Muscle Shoals project became connected with the problem of nitrate supply. During the "preparedness" emergency prior to the first World War the effectiveness of the German submarine in attacking allied sea communications made it evident that American dependence upon Chilean sources of nitrate might well prove disastrous; and a program of domestic air-nitrate production was inaugurated. Because contemporary commercial techniques in this field required vast supplies of electric power, attention turned to Muscle Shoals as a potential source of energy. As one approach to this problem Mr. Frank S. Washburn, then president of the American Cyanamid Company, suggested in hearings upon the National Defense Act of 1916 that the United States develop the power resource at Muscle Shoals and make energy available to the Cyanamid Company for use in a proposed munitions plant.[17] Although this arrangement was not endorsed in the Committee report upon the legislation, a section of the Committee bill (as reported in the House) provided for construction of a federal hydroelectric-air nitrate project at a site to be designated. When this was attacked as the same old Muscle Shoals proposition "in a new garb," it was abandoned.

On March 10, 1916, Senator Ellison D. Smith (South Carolina) introduced into the upper chamber a bill (S. 4971), quite inde-

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[17] For a discussion of financial aspects of this proposal, see below, Chapter VII. Although the Cyanamid Company had not before made direct efforts to gain control of Muscle Shoals power, its president had long been associated with the Muscle Shoals Hydro Electric Power Company, leading contender for the site. After 1912 the latter organization passed into the control of the Alabama Power Company. It is possible that the Cyanamid Company and the Alabama Power Company arranged an agreement whereby the former would be granted a contract for a large block of power if the Alabama Company could obtain rights to develop the Shoals. (An agreement of this nature had been arranged between the two companies at the time that Congress was considering a bill to permit the Power Company to develop a site on the Coosa River. This bill was vetoed by the President.) If so this would explain the failure of the Cyanamid Company directly to seek power rights at the site. (See King, *op. cit.*, p. 94; United States Congress, House of Representatives, *Muscle Shoals Propositions*, Hearings before the Committee on Military Affairs, February 8 to March 13, 1922, Sixty-Seventh Congress, Second Session, p. 698; Federal Trade Commission, *Utility Corporations*, Vol. 30, p. 370; United States Congress, Joint Committee on Muscle Shoals, *Hearings*, Sixty-Ninth Congress, First Session, p. 508.)

pendent of the still pending National Defense Act, to authorize the President, by executive order, to select and withdraw sites on navigable streams which might be suitable to joint navigation-power improvement and, at such sites, to plan and construct works for the production of power and other products useful and necessary for the manufacture of munitions during periods of defense emergency or fertilizers in time of peace. Two features of this bill were especially unusual: it contained a clause specifically prohibiting any type of co-operative arrangement between government and private enterprise in pursuit of its objectives; [18] and it provided that any defense nitrate plants which might be constructed should be adapted to the production of nitrate fertilizers in peace-time.[19]

Since Senator Smith had played but a small role in the earlier Muscle Shoals debate, his proposal of federal construction and operation of power and nitrate plants occasioned considerable surprise. Although it was offered as an independent bill, it soon came into competition with an amendment to the National Defense Act which was proposed by Senator Underwood.[20] After a bitter debate in which it was hailed on the one hand as a measure to take the profits out of war and condemned on the other as a socialistic violation of basic American principles, it was

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[18] Section 7 of the bill provided: "That the plant or plants provided for under this act shall be constructed and operated solely by the Government and not in conjunction with any other industry or enterprise carried on by private capital." King, *op. cit.*, 67.

[19] Senator Smith later said,

> "I, as you remember, was the author of the bill, and the purpose of the bill was that, since war was imminent, ... we should construct plants of sufficient size to furnish all of the nitrogen the Government might need during the time of war, and that then during times of peace whatever surplus there was over the needs of the Army should be used for agricultural purposes."

United States Congress, Senate, Committee on Agriculture and Forestry, *Production of Atmospheric Nitrogen,* Hearings on S. 3390, Sixty-Sixth Congress, Second Session (1920) p. 7.

[20] The Underwood amendment would have directed the Board of Engineers for Rivers and Harbors to carry out investigations of the possibility of economical government production of nitric acid for munitions in time of war and for fertilizers in time of peace. That Senator Underwood was not completely convinced of the advantages of public ownership and operation was indicated by his subsequent effort to have the Smith bill amended to give the Secretary of War authority to operate *or lease* the plants whose construction the bill authorized. (53 *Congressional Record* 5968.)

at length adopted as a substitute for the Underwood amendment and incorporated into the National Defense Act of 1916. As Section 124 of this law it provided as follows:

"The President of the United States is hereby authorized and empowered to make, or cause to be made, such investigation as in his judgment is necessary to determine the best, cheapest, and most available means for the production of nitrates and other products for munitions of war and useful in the manufacture of fertilizers and other products by water power or any other power as in his judgment is the best and cheapest to use; and is also hereby authorized and empowered to designate for the exclusive use of the United States, if in his judgment such means is best and cheapest, such site or sites upon any navigable or non-navigable river or rivers or upon the public lands, as in his opinion will be necessary for carrying out the purposes of this Act; and is further authorized to construct, maintain, and operate, at or on any site or sites so designated, dams, locks, improvements to navigation, power houses, and other plants and equipment or other means than water power as in his judgment is the best and cheapest, necessary or convenient for the generation of electrical or other power and for the production of nitrates or other products needed for munitions of war and useful in the manufacture of fertilizers and other useful products.

. . . .

"The sum of $20,000,000 is hereby appropriated, out of any money in the Treasury not otherwise appropriated, available until expended, to enable the President of the United States to carry out the purposes herein provided for.

"The plant or plants provided for under this Act shall be constructed and operated solely by the Government and not in conjunction with any other industry or enterprise carried on by private capital." [21]

Under the authority of Section 124 President Wilson established a federal reservation at Muscle Shoals and ordered construction of an experimental Haber process plant. Later, as the American nitrate position deteriorated this order was expanded to authorize a major defense development including a large cyanamid process nitrate plant, the experimental Haber plant, steam power stations, a railroad and quarry, workers village, transmission line to a temporary power source at the Alabama Power Company's

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[21] Act of June 3, 1916, ch. 134, 39 Stat. 215, 50 U. S. C. A. 79.

Warrior River plant, and a large hydroelectric project for a long term power source.[22] Although construction of the nitrate plants was rushed, neither was completed in time to contribute to the war munitions effort. Recognition that the hydroelectric dam and power plant could not be completed before the termination of the defense crisis led to suspension of their construction by the War Industries Board in August of 1918 shortly after work on them had been begun. After the armistice construction was resumed, but by the winter of 1920-1921 available funds had been exhausted. With the defense emergency passed, the "indispensable" character of the project was gone and Congress refused a new appropriation. Only when the Ford bid for a lease of the properties revived interest in them was work again taken up. At last in 1925, after many interruptions the Wilson Dam (Dam Number 2 on the Tennessee River) was completed.[23]

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[22] The President's order that these defense works should be located at Muscle Shoals disregarded a recommendation by the Chief of Ordnance that the site be North Chattanooga, Tennessee. See United States Congress, House of Representatives, *Hearings*, Serial 6, Ordnance 3, Before Subcommittee Number 5 of Select Committee on Expenditures in the War Department, Sixty-Sixth Congress, Second Session (1920); and House Report 998, Sixty-Sixth Congress, Second Session, Finding Number 11.

[23] The Ford offer led to an interesting legislative coalition in favor of resumption of the project between those, on the one hand, who wished to lease it to private interests and those, on the other, who wished the Government to operate it as a public enterprise.

For a number of reasons the ultimate cost of the Wilson Dam was far in excess of pre-construction estimates. In 1916 a summary estimate for Dam Number 2, including $595,000 for Lock and Dam Number 1 (for reregulation and to provide a navigable approach to the locks of Dam Number 2), was $16,000,000. Apparently this included dam and powerhouse substructure but not powerhouse superstructure or cost of units. (House Document 1262, p. 177.) After the war, increased cost levels led to a 75 percent increase in the estimate to $29,290,000. (*Production of Atmospheric Nitrogen*, Hearings before Senate Committee on Agriculture and Forestry, Sixty-Sixth Congress, Second Session, pp. 353-354.) Another 1920 estimate placed the "cost to complete" the project at $25,000,000 which, added to the $7,000,000 previously invested in it, indicated a total anticipated cost of $32,000,00. (*Ibid.*, p. 348.) Although it may be that these estimates were not strictly comparable, none of them approached the final investment figure of $46,950,748 (including cost of units) which represented the cost of the project through June 30, 1933. ("Valuation of Wilson Dam," Report of Valuation Committee to the Board of Directors of the Tennessee Valley Authority, March 10, 1937, p. 38.)

In connection with these cost estimates it is interesting to note the testimony of Col. J. Edward Cassidy, construction engineer, to the effect that some of the early estimates were not made in good faith:

"I have always looked on those figures as a bait. I think the whole proposition

Despite the long construction period required for the Wilson project, Congress was no closer to agreement as to an appropriate peace time use for it when it was finally finished than it had been at the close of the war. Indeed, in retrospect, it appears that while Congress was quick to accept development of Muscle Shoals as a defense measure it would not have accepted public improvement of the site for any other purpose. When the unifying issue of defense was removed, confusion and disagreement were inevitable. In the struggle to bring order out of this confusion and to arrive at a satisfactory arrangement for use of the Shoals properties two major viewpoints developed. The first advocated federal lease of Muscle Shoals to private industrial interests; the second favored direct federal operation of its power and nitrate plants. To the debate between adherents of these viewpoints we turn in the two sections here following.

PROPOSALS FOR THE LEASE OF FEDERAL PROPERTIES AT MUSCLE SHOALS

As early as 1919 the Fixed Nitrogen Administrator, A. G. Glasgow, was instructed by the Assistant Secretary of War to seek to interest private capital in the negotiation of leases for the Muscle Shoals properties subject to the condition that the nitrate plants be used for production of commercial fertilizer. Although Glasgow complied with this order, his efforts proved in vain; and because he considered continual operation of the nitrate plants important from the point of view of national defense, he formulated a recommendation that the plants be operated by the federal government. To implement this recommendation the Kahn-Wadsworth bill for public operation was introduced into Congress.[24] This measure was destined to failure from the start

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was to make so palatable a looking mess that Congress could not fail to bite on it and, once they had started, they would not dare stop."

United States Congress, House of Representatives, Committee on Military Affairs, *Hearings on Muscle Shoals,* Seventy-Second Congress, First Session, Part I, p. 590. See also *Muscle Shoals Propositions,* Hearings before the Committee on Military Affairs, House of Representatives (1922), Sixty-Seventh Congress, Second Session, testimony of Mr. Hugh Cooper at p. 421.

[24] S. 3390, Sixty-Sixth Congress, First Session. Although neither Senator Wadsworth nor Representative Kahn endorsed the measure, it was named after them because they introduced it out of deference to Mr. Glasgow. See letter from

because of active opposition from the power and chemical companies. There then followed an effort by the Harding administration to interest privately owned power utilities in bidding for the prospective power to be made available at Wilson Dam. When this attempt also failed, Congress abandoned appropriations for Muscle Shoals construction.

The Ford Offer

With the situation apparently stalemated, on July 8, 1921, Henry Ford submitted the first private bid for the Muscle Shoals properties. Despite its earlier statement that it was not interested in Muscle Shoals, the Alabama Power Company now quickly changed its mind and submitted a competing offer.[25] The struggle for Wilson Dam had begun.

Mr. Ford's bid consisted of two parts: first, an offer to *purchase* the nitrate plants and all materials and properties constructed or owned and stored by the United States at the Muscle Shoals reservation together with its interest in the Warrior River steam plant of the Alabama Power Company and the transmission line thereto; [26] and second, an offer to *lease* for 100 years Dam Number 2 (then under construction) and Dam Number 3 (which Mr. Ford proposed that the United States construct upstream from the Wilson project).[27] Mr. Ford also planned to meet the terms of Section 124 the National Defense Act (pursuant to which the Shoals works had been built) by using Nitrate Plant Number 2 (the cyanamid plant) for commercial production of nitrate fertilizers.

Glasgow quoted at *Production of Atmospheric Nitrogen*, Hearings before Senate Committee on Agriculture and Forestry, Sixty-Sixth Congress, Second Session, p. 89.

[25] The Company had refused to bid in a letter to the Secretary of War dated May 28, 1921. (See below, Chapter VII.) After the Ford bid, not only did it reverse its position, but its president actually appeared before a Congressional committee to urge support for the company proposal and to attack the Ford offer. See House of Representatives, *Muscle Shoals Propositions*, Hearings before Committee on Military Affairs, Sixty-Seventh Congress, Second Session, p. 850.

[26] As a source of power during construction of the Muscle Shoals plants the Government had financed the addition of 30,000 kilowatts of generating capacity (title to which remained in the United States) to the Warrior River plant.

[27] Financial aspects of the Ford bid, including allocations of joint power-navigation investment, are discussed in Chapter VII below.

When the terms of the Ford bid became known, controversy flared up immediately. Supporters of the proposition declared that it would bring the farmers fertilizers at fifty per cent of existing prices, that it would bring improvement of the Tennessee River with great navigation benefits at practically no cost to the federal government, and that, as the resources of the headwater regions were opened to economical exploitation, the pulse of economic activity throughout the entire mid-south would be stimulated.[28] Opponents of the Ford offer, on the other hand, pointed out that many of its provisions were in direct violation of the Federal Water Power Act of the preceding year, that the payments which Mr. Ford proposed were in no way commensurate with the value of the rights and privileges which the contract would convey to him, that such an arrangement would work toward the establishment and entrenchment of a great industrial monopoly in contravention of basic federal policy, and that despite propaganda to the contrary there would be no binding commitment by the Ford interests to engage in the production of nitrates or of nitrogenous fertilizers.[29] With reference to the assertion that Ford would be able to slash the price of nitrogen

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[28] The navigational aspects of the Ford bid were strongly emphasized by J. W. Worthington, one time promotor of the Muscle Shoals Hydro Electric Power Company, at House of Representatives, *Muscle Shoals Propositions*, Hearings before the Committee on Military Affairs, Sixty-Seventh Congress, Second Session, pp. 370-371; 396. See also *ibid.*, 293, 370, 396, 933-940. W. G. Waldo, of the Tennessee River Improvement Association, endorsed the Ford bid with the statement that under it power users would pay the full costs of river improvement for navigation. (United States Congress, Senate, *Muscle Shoals*, Hearings before the Committee on Agriculture and Forestry, Sixty-Seventh Congress, Second Session [1922], p. 805.) General Lansing Beach, Chief of Engineers, pointed out that the Ford proposal looked toward full development of the water resources of the Tennessee River. (See *Muscle Shoals Propositions*, Hearings before House Committee on Military Affairs [1922], p. 104.) Mr. Hugh Cooper, consultant engineer on the construction of Wilson Dam and one whose business interests were largely connected with the electric power industry, took a much less optimistic view of the navigation aspects of the Ford proposal. (*Ibid.*, pp. 415, 422.)

[29] Senator Underwood defended the proposed Ford contract by arguing that Mr. Ford was not interested in the proposition "as a business to exploit."

> "He has reached the point in life where I do not believe he is ready to develop this thing from a money-making standpoint, but he is prepared to do a great patriotic act for the people of the United States by limiting the amount of his profits and producing fertilizer for them as cheaply as possible."

Muscle Shoals, Hearings before Senate Committee on Agriculture and Forestry, Sixty-Seventh Congress, Second Session, p. 19.

fertilizers by fifty percent as a result of his use of a rumored "secret process" Senator Norris stated:

"I cannot conceive the workings of a man's mind who will say that . . . . He does not say it himself. Somebody else comes here and says it for him, that he has a secret process by which he is going to reduce the cost of fertilizer and save the farmer, and he will use it if you will give him a contract for a hundred years by which he can make millions and millions every year, but he won't put it into writing. There is no agreement to that effect, but somebody told me that somebody else said that Ford told him that he had a process that would do it, and therefore we will give this to him without any agreement to that effect whatsoever. . . . .

. . . .

"Senator Heflin here is always saying, 'Don't you understand Ford has a secret process?' and Ford in your mind is pretty near a saint; and if he is and he has got that kind of a secret process and he does not tell the farmers, who are suffering beneath the load and in the clutches of this great fertilizer trust that has been so often pictured, he is a demon instead of a philanthropist, and instead of being given a favor he ought to be sent to jail for the balance of his life and ought to spend the remainder of time in purgatory." [30]

The line-up of interest blocs in Congress found a considerable part of the farm group supporting the Ford bid, but the chemical and power company interests united with the advocates of public operation in opposing it. During the Sixty-Seventh Congress the issue did not come to a vote; but during the first session of the Sixty-Eighth a bill designated as H.R. 518 to authorize a lease and sale of properties at Muscle Shoals to Henry Ford passed the House. In the Senate, however, it received a very strong adverse report from the Committee on Agriculture.[31] On October 18, 1924, between sessions of Congress and before the Senate had undertaken consideration of H.R. 518, Mr. Ford publicly withdrew his bid.

Power Company Bids for Muscle Shoals

The Underwood Leasing bill. Although H.R. 518 remained upon the calendar of the Senate for the second session of the

[30] *Ibid.*, p. 19.

[31] Senate Report 678, parts 1 and 2, Sixty-Eighth Congress, First Session. (Part 2 is a minority report by Senator Ladd approving the Ford offer.)

Sixty-Eighth Congress, it was not generally anticipated that any serious effort would be made to bring about its passage. Accordingly, it was something of a surprise when an amendment in the nature of a substitute for the Committee bill, offered by Senator Underwood, was endorsed by the administration and strong pressure was exerted for its passage.[32] This "Underwood substitute" authorized the President to lease the Muscle Shoals properties for a period of up to fifty years, presumably subject to adequate guarantees that the nitrate plants would be used for the production of low cost fertilizers. With Ford out of the picture, the bill appeared to look toward a lease to the power companies. Once more, with a somewhat revised line-up, a bitter legislative battle began. After an extraordinary career in which successive substitute bills of quite divergent viewpoints were several times adopted, the Senate at length agreed to the Underwood version of H.R. 518.[33] Since this was quite another measure than the House bill to authorize a lease to Henry Ford, it was sent to conference where it was modified and whence it was reported back favorably to both houses.[34] Detecting that the conference bill contained new material in no way justified by the parliamentary theory of conference as a technique for the achievement of compromise of differences between House and Senate, Senator Norris moved the report out of order and forced reconsideration of the legislation by the conference committee.[35] By

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[32] The Senate Committee on Agriculture and Forestry had substituted a public operation measure for the bill which had passed the lower chamber. See below, p. 54 ff.

[33] As finally adopted the bill was substantially stronger than the measure originally introduced, but it still contained loose language and possible loopholes by which a lessee might evade his intended obligations. (See 66 *Congressional Record*, 703, 1809.)

Financial aspects of power company bids are discussed in Chapter VII below.

[34] Some question was raised as to whether the House and Senate versions of the bill were sufficiently close to justify a conference. But the suggestion in the House that the Senate bill should be sent to a standing committee for consideration was rejected. 66 *Congressional Record*, 2294, 2555.

For the conference report, see United States Congress, House of Representatives, "Muscle Shoals" Conference Report to accompany HR 518, Report 1410, Sixty-Eighth Congress, Second Session.

[35] 66 *Congressional Record* 4023, 4124, 4133.

the time a second conference bill[36] could be formulated the second session of the Congress was about to adjourn, and H. R. 518 was not again called up for consideration.

The Muscle Shoals Inquiry of 1925 and the Morin-Deneen bill. While Congress was struggling with the Ford bid and the Underwood leasing bill, the United States Engineers were bringing Wilson Dam to completion. Every day, therefore, the problem of determining a wise use for the finished structure was becoming more pressing. Ostensibly to throw light upon this question, in the closing days of the Sixty-Eighth Congress (when it had become apparent that H. R. 518 could not pass) a coalition in the House of all those opposed to public operation and favorable to the lease principle secured passage of a resolution calling upon the President to set up a commission to determine ". . . . the most favorable conditions under which this property may be leased primarily to secure nitrates for fertilizers in time of peace and explosives in time of war. . . ." [37] Complying with this request, President Coolidge established a Muscle Shoals Commission and to it named five members, all known to be opposed to public operation of the properties.[38] No one was surprised when this Commission reported back to the opening session of the Sixty-Ninth Congress its finding that a satisfactory lease could be negotiated for Muscle Shoals under which nitrate fertilizers would be produced by private enterprise to sell at prices substantially less than those generally prevailing. Its recommendation was that such a lease be negotiated.[39]

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[36] United States Congress, Senate, "Muscle Shoals, Comparative Print Showing HR 518 as passed by the Senate and as Agreed to in Conference," Document 217, Sixty-Eighth Congress, Second Session.

[37] The Commission was to be entirely of the "fact-finding" type. It had no authority to negotiate a lease for the Shoals. House Resolution 457, Sixty-Eighth Congress, Second Session.

[38] The Commission was made up of Representative McKenzie (who had sponsored the Ford bill in the House), Senator Dial, Dr. Harry A. Curtiss (industrial chemist), William McClellan (electrical engineer) and Russell F. Bower (of the American Farm Bureau Federation and a strong supporter of the Ford offer).

[39] Although the Commission divided on certain details, on the great policy issue at stake it was united. Thus, the majority report stated:

> "We appreciate individual effort, commend private initiative, and respect vested rights."

United States Congress, House of Representatives, ***Message from the President of the United States transmitting the Majority and Minority Reports made by the***

Acting upon the Commission report, Congress now set up a "Joint Committee on Muscle Shoals" to receive bids, conduct negotiations with prospective lessees, and report back a recommended lease for final Congressional consideration.[40] Although it was generally thought that failure of the Underwood bill had spelled defeat for the power companies and that the Joint Committee would favor a lease to one of the chemical companies,[41] the Deneen Committee reported back a strong endorsement of a bid of the "Associated Power Companies."[42] Almost as soon as this report was made public it became evident that the bill it proposed was doomed; for it provoked the active opposition of three groups, the farm bloc, the liberals, and the friends of the chemical companies. Indeed, support for the measure was so slight that it was never considered in the House

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Muscle Shoals Inquiry, Sixty-Ninth Congress, First Session, House Document 119 (December 10, 1925), p. 2.

The minority stated that it saw many causes working ". . . . to bring disaster to every venture in business by the Government. We therefore consider private leases at Muscle Shoals indispensable." *Ibid.,* 77.

[40] House Con. Res. 4, Sixty-Ninth Congress, First Session. Appointed to the Joint Committee were Senator Charles S. Deneen, Chairman, Representative W. Frank James, Vice-Chairman, and Senators Sackett and Heflin, and Representatives Morin and Quin. The Committee was instructed to consider no bid which did not meet the requirements of H.R. 518 in respect of guaranteed fertilizer production. See 67 *Congressional Record* 5512-5519.

[41] 67 *Congressional Record* 4902.

[42] The only serious competitor to the Associated Power Companies bid was an offer of the American Cyanamid Company filed through its subsidiary, Air Nitrates Corporation.

The Power Companies offer proposed operation of the properties through two subsidiaries, the Muscle Shoals Power Distributing Company and the Muscle Shoals Fertilizer Company. This bid was found to be superior to all others on grounds of national defense, monetary return, cheap and abundant fertilizer, and economical distribution of surplus power. The Committee pointed out that, in addition to the terms of the lease contract, a power company lessee would be subject to normal utility regulation whereas the chemical companies would not be subject to such supplementary public control. See United States Congress, Senate, Joint Committee on Muscle Shoals, "Report to accompany S. 4106," Sixty-Ninth Congress, First Session, Report 672 (April 19, 1926), pp. 60-66; 68 *Congressional Record* 4742-4759.

In a vigorous minority report Vice-Chairman James (Michigan) labelled the majority report and bill a power company measure, declared there was strong evidence of collusion between the majority and the power companies, and charged that the so-called fertilizer guarantee of the power company offer was a sham. See Senate Report 672, Part 2, "Minority Views of Mr. James," 11-12.

Investment allocations in the bids submitted to the Joint Committee are discussed in Chapter VII below.

and was buried in committee in the Senate. So died the last serious effort to turn Muscle Shoals over to the privately owned power companies.

Chemical Company Bids for Muscle Shoals

From Henry Ford and the power companies the quest for a reasonable lease of Muscle Shoals next turned to companies in the chemical industry.[43] From this group the leading bid was submitted by the American Cyanamid Company in "harmonious union" with the Union Carbide Company. This offer ostensibly provided for an annual payment to the United States of four percent upon federal investment for power at the Shoals site and pledged the lessee to an annual production of 20,000 tons of fixed nitrogen for fertilizer.[44] Although it collided with a Norris bill for public operation of the Muscle Shoals plants, a bill to authorize lease to the Cyanamid Company on these terms was given strong support by leading farm organizations.[45] Prospects

[43] It will be recalled that through its president, Mr. Washburn, the American Cyanamid Company had long been interested in Muscle Shoals. One may wonder why it did not sooner enter actively into the competition for the site which was set off by the Ford bid. The explanation may lie in the fact that during the war the Company constructed Nitrate Plant Number 2 at the Shoals on a cost-plus contract which was later criticized as being extremely unfair to the United States. Because of this ill-feeling, the Company may have believed that Congress would not seriously consider any offer it might have made for the Shoals properties. (See United States Congress, House of Representatives, "Report of Ordnance Subcommittee of Select Committee to Investigate Expenditures in the War Department," House Report 998, Sixty-Sixth Congress, Second Session, where the nitrate plant contract is described as ". . . . unilateral and unfair and unjust to the Government." See also *Production of Atmospheric Nitrogen,* Hearings before Senate Committee on Agriculture and Forestry, Sixty-Sixth Congress, Second Session, p. 229.)

Investment allocations in the chemical company bids are discussed in Chapter VII below.

[44] The present worth of the ostensible four percent interest payment was substantially lessened by the stipulation of a lengthy development period. The "commitment" to produce fertilizers was hedged by a joker to the effect that ". . . . should such manufacture and sale prove competitively impracticable or commercially uneconomical" production might be abandoned. The company was unwilling to include in the lease a clause which would return the power properties to the United States if fertilizer production should be abandoned. 69 *Congressional Record* 8228.

[45] The Caraway lobby investigation revealed that a large part of the cost of a campaign in support of the Cyanamid bid by the American Farm Bureau Federation was financed by the Cyanamid Company and the Union Carbide Company. Senate Report 43, Seventy-First Congress, Second Session, Part 7, p. 3.

for such a lease were seriously impaired, however, when a report by the executive secretary of the Federal Power Commission found that it would yield annual profits to the company of from $1,600,000 to $7,300,000.[46] A final effort to resuscitate the Cyanamid Company bill was made by Representative Reese of Tennessee in the second session of the Seventieth Congress, when he reported a revised version of the measure out of the House Committee on Military Affairs.[47] This effort proved abortive when the Committee chairman, Representative Morin, attacked the Reese report and declared that it did not have the support of the majority of the Committee.[48]

The Hoover Muscle Shoals Commission

With the rejection of the American Cyanamid Company offer the last major bidder for Muscle Shoals was eliminated. Nevertheless, for several years it was impossible to reach agreement upon the only remaining alternative, public operation. When, in 1931, Congress accepted this solution to the long impasse, the Chief Executive returned the measure with a strong veto message.[49] In this he declared his unalterable opposition to government competition with private enterprise and urged that Congress authorize the States of Alabama and Tennessee, which were most directly concerned with the use to which Muscle Shoals might be put, to set up a joint commission to study the disposition of the properties with ". . . . full authority to lease the plants . . . . in the interest of the local community and agriculture generally."[50] As had occurred in the case of the 1925 Muscle Shoals Inquiry, the membership of the new Commission was drawn overwhelmingly from those whose public record evidenced their support of the lease principle.[51] It was not surprising that its report re-

[46] Senate Document 209, Sixty-Ninth Congress, Second Session.

[47] H.R. 8305 and House Report 2564, Seventieth Congress, Second Session.

[48] House Report 2564, Seventieth Congress, Second Session, Part 2; the Morin statement was printed at 70 *Congressional Record* 4616-4623.

[49] See below, p. 59 ff.

[50] 74 *Congressional Record* 7046-7048.

[51] An analysis of the personnel of the Commission in Bulletin 150 of the National Popular Government League (July 22, 1931) concludes:

"It is clear then that out of nine opponents NINE are known to be safely peated the same generalities as to the advantages of private initiative and the feasibility of low cost fertilizer production at the Shoals by a joint power-nitrate plant lessee.[52] Congress found no real contribution to the solution of the Muscle Shoals problem in this study, and no new legislative efforts of any importance resulted from it. By this time the futility of all efforts to arrive at a satisfactory lease for the properties seemed clear.

THE NORRIS BILLS FOR PUBLIC OPERATION AT MUSCLE SHOALS

Throughout the long and fruitless post-war Muscle Shoals debate there was continually before Congress, as an alternative to lease of the properties, some version of a proposal for their public operation and development. We have already noted that the Wadsworth-Kahn bill of the Sixty-Sixth Congress was of this nature. So also were various Norris bills of subsequent Congresses.

The first bill proposed by Senator Norris for public operation of the federal properties at Muscle Shoals was introduced into the Sixty-Seventh Congress, and was reported out of the Senate Committee on Agriculture and Forestry as a substitute for the McKenzie bill (to adopt the Ford offer).[53] In this report, after relentlessly pointing out the weaknesses of the proposed contract with Henry Ford, Senator Norris turned to a discussion of the advantages of his substitute measure. He pointed out that it provided for thorough development of the water resources of the Tennessee drainage basin by the Secretary of War and for the maintenance and operation of water control properties by a Fed-

hostile to public operation of Muscle Shoals, with EIGHT of the NINE having been active in opposition, as shown by public records, by political or organizational work."

The Muscle Shoals Commission was authorized to study the feasibility of negotiating a reasonable lease for the federal Muscle Shoals properties, but it was not empowered to negotiate such a lease.

[52] See Muscle Shoals Commission, *Muscle Shoals, A Plan for the Use of the United States Properties on the Tennessee River by Private Industry,* November, 1931 (Senate Document 21, Seventy-Second Congress, First Session).

[53] Senate Report 831, Sixty-Seventh Congress, Second Session, Part 1. Although the majority of the Committee agreed in rejecting the House bill, only a minority endorsed Chairman Norris' substitute.

eral Chemical Corporation. This corporation would employ available hydroelectric power for the manufacture of finished fertilizers which it would sell either to consuming groups or to the established fertilizer trade with provision for control of resale prices. Surplus power would be sold with preference to public agencies. The primary objective of the corporation, as its name implied, apparently would be both experimental and quantity production of fertilizers; [54] but heavy emphasis was also laid upon the flood control and navigation benefits which would result from development of the Tennessee River.[55] Despite its comprehensive nature the bill had two major deficiencies: first, it gave no overt consideration to the matter of stream planning for flood control; and second, it conferred upon the administering corporation no authority to construct transmission lines in order to reach local publicly owned distribution agencies.

In the following Congress the Ford offer was again formulated in legislation which passed the House as H. R. 518 and was referred in the Senate to the Committee on Agriculture and Forestry. Once more this group rejected the House bill, and the majority of the Committee now endorsed the substitute public operation measure of the Chairman.[56] This new Norris measure

[54] 64 *Congressional Record* 3296; *Muscle Shoals,* Hearings before Senate Committee on Agriculture and Forestry, Sixty-Seventh Congress, Second Session, p. 930.

[55] For a statement of flood control aspects of the proposal, see *Ibid.,* p. 31; see also *ibid.,* pp. 51, 457, 902 and 933; and *Muscle Shoals,* Hearings before House Committee on Military Affairs, Sixty-Seventh Congress, Second Session, pp. 62, 113, and 422.

Section 1 of the bill, which carried the authorization for examinations, surveys and construction of water control works, provided as follows:

> ". . . . The Secretary of War is authorized and directed to cause surveys to be made above said dams (numbers 2 and 3 which he was authorized and directed to complete) on the Tennessee River and its tributaries for the purpose of locating storage reservoirs, and if a suitable site or sites can be found upon such investigation, where practicable storage reservoirs can be obtained at reasonable cost, the Secretary is directed to take the necessary steps to secure such sites and to build the necessary dams for the impounding of water therein. If the Secretary of War, under authority of this act, constructs one or more dams for the purpose of impounding the waters of said rivers he shall give due consideration in the construction of such dams to the possibility of the development of hydroelectric power and the necessities of navigation." S. 3420, Sixty-Seventh Congress, Second Session.

[56] S. 2372, Sixty-Eighth Congress, First Session. Under this bill the Secretary of War was authorized and directed to complete dams numbered 2 and 3 and to conduct surveys and investigations for, and construct, such upstream storage

laid even greater emphasis than had the 1922 bill and report upon the importance of comprehensive watershed planning. Thus the report stated:

> "It is . . . . apparent that to develop the maximum amount of hydroelectric energy the entire stream and all its tributaries should be considered as a whole. Every dam site should be selected with reference to all other dam sites, keeping always in view the question of navigation. In addition to this, it is important that in order to regulate the flow in any stream and keep it as nearly uniform as possible we should construct storage dams where large amounts of flood waters can be stored and let out at times of low water, thus decreasing the maximum and increasing the minimum flow." [57]

A distinctive new orientation could be discerned in the power provisions of the second Norris bill. In reporting it, the Senator emphasized the remarkable power potentialities of the Tennessee River (and of the Muscle Shoals site in particular) and pointed to the wonderful new outlook of the power industry as a result of the recent development of the high tension technique of long distance energy transmission. He then suggested that there was one danger implicit in the situation. This was the threat of "monopoly." As a great competitive instrument for control of

reservoirs as he might find feasible. Upon completion such projects were to be turned over to a Federal Power Corporation for operation and maintenance. The Muscle Shoals nitrate plants were to be turned over to the Secretary of Agriculture (for experimentation and the production of low-cost fertilizers) and the Corporation was instructed to make available to him stated power supplies. The construction of transmission lines by the Corporation was authorized, and in sales of surplus power, preference was to be given to publicly owned distribution organizations. See United States Congress, Senate, "Muscle Shoals, Report from the Committee on Agriculture and Forestry," Report 678, Sixty-Eighth Congress, First Session. (Part I is the majority report, Part II is a dissenting minority report endorsing the Ford bill and opposing the Norris plan.)

[57] Senate Report 678, Part I, p. 8. Senator Ransdell, in supporting the bill, also emphasized its multiple-purpose aspects:

> "He (the Secretary of War) is not to make big dams merely to generate power, but in making those dams he is to improve for first-class navigation on one of the greatest rivers in America, ... and he is to safeguard in every possible way flood control on a river which has many dangerous floods, which is one of the greatest feeders of the lower Ohio and the Mississippi Rivers. These three great matters are provided for in the Norris bill." 66 *Congressional Record* 1368. See also statements of Senator Norris at 66 *Congressional Record* 121-122, and of Senator Gooding at *ibid.*, 1458-9, 1462.

the power industry he urged public development and operation of the potential power of the Tennessee River system.[58]

Caught up in the crazy career of H. R. 518 in the second session of the Sixty-Eighth Congress, the second Norris bill was seriously debated but failed of passage. In the first session of the following Congress debate centered upon a proposal to establish a Joint Committee to consider leases of Muscle Shoals (pursuant to the recommendations of the Muscle Shoals Inquiry), and scant regard was paid to a new Norris bill along lines similar to the second one. Recognizing that there was now small hope for adoption of a bill providing for a truly comprehensive federal program in the Tennessee Valley but hoping to forestall a long term lease of Muscle Shoals, Senator Norris introduced into the second session of the Sixty-Ninth Congress a drastically modified measure. This abandoned the provisions of the earlier bills which had looked toward complete development of the entire Tennessee watershed and simply directed the Secretary of War to complete the power installations at Dam Number 2 and to operate this project, giving preference in power sales to public agencies. Profits from power operations would be segregated in a special fund in the Treasury and made available to the Secretary of Agriculture for large-scale experimentation in the production of

[58] Senator Norris, in the report, stated:

"To the writer, there is one possible danger in such a scheme, and that is the danger of monopoly. With a network of wires spread over the country, carrying light, power, and heat to all the people, it is absolutely incumbent upon governmental authority to provide by proper regulation that such a great plant shall not be utilized for the financial benefit of individuals or corporations and that those controlling such a system should not in any way be permitted to utilize the great power in their hands, unrestrained and unregulated. Practically all the States have commissions that regulate not only the price of electricity, but the service as well, but in addition to such regulation, the most effective help to save the people from such a monopoly would be to have the Federal Government own at least some of the power-producing elements that enter into such a system.

"It is therefore important that the Government should retain the ownership and management of Muscle Shoals. In the system that I have above outlined, Muscle Shoals, if properly developed and improved by the construction of storage dams on the Tennessee River and its tributaries, will be the greatest one unit in the entire system. It will be, as it were, a partner in this great plan (of a nation-wide power grid). It will have a direct voice in the management and control of the entire system. It can therefore more directly control any tendency toward monopoly than can be done by State commissions, however valuable their service may be."

Senate Report 678, Part I, p. 11. (Parenthesis supplied.)

low-cost fertilizers.[59] As had been the lot of the third Norris bill, this one also received little consideration.

Undiscouraged, once more in the Seventieth Congress Senator Norris introduced a compromise measure. By this time the failure to discover a reasonable offer for lease of Muscle Shoals had worn thin Congressional patience; and the Senate now accepted the modified public operation proposal.[60] In the House the Senate bill was amended by adoption of the Morin substitute which provided for construction of the Cove Creek (tributary) dam as well as completion of installations at Dam Number 2, and for administration of these properties and the Muscle Shoals nitrate plants by a Muscle Shoals Corporation. This Corporation was authorized under rigidly defined conditions to negotiate a lease of the properties; but failing to do so, it was charged with the production of concentrated fertilizers and the generation and sale of surplus power. With the House version of the bill the Senate disagreed, and conference was asked. From conference the bill emerged largely as the original Senate measure but with the House addition of the Cove Creek project retained. So modified, the measure was accepted by both houses and sent to the President for signature. Hope that the long impasse as to use of the Shoals had been resolved was dashed when President Coolidge refused to sign the bill and it died by a pocket veto.[61]

[59] S. J. Res. 163 and S. Report 1633, Sixty-Ninth Congress, Second Session.

[60] S. J. Res. 46 and Senate Report 228, Seventieth Congress, First Session. Concerning the compromise nature of this bill Senator Norris stated:

> "I had a vastly different plan. This bill before us is a compromise. I have compromised on most of my plan as to what I thought was the thing that ought to be done with Muscle Shoals, because I realize that legislation can only be reached by compromise. It will be remembered that the several bills . . . . which I have been trying to have passed through the Senate, provided for the development of the Tennessee River and all of its tributaries from the mouth to the source of every one of the rivers.
>
> "It provided for a complete survey of the entire Tennessee Valley and all the tributaries of the Tennessee River, and the building and location of the dams wherever, in the judgment of the officials making the survey, they should be placed in order to produce three things—the maximum amount of navigation, the maximum amount of flood control, and the maximum amount of power."

69 *Congressional Record* 3441.

[61] At the time there was some question as to whether acts of Congress which were allowed to go unsigned at the close of a session of Congress other than the final one should be considered as having been accorded a veto or as having become law without presidential signature. In the Okanogan Indian Case the Su-

Despite this rebuff, in the following Congress Senator Norris introduced once again a bill closely resembling the vetoed measure.[62] Like its predecessor it passed the Senate; but in the House an amendment in the nature of a substitute looking toward lease of the properties was adopted.[63] Inevitably the wide divergence between House and Senate measures made conference agreement difficult; but at length a compromise was worked out which was accepted by both houses and sent to President Hoover for signature.[64] Ill-starred as its forerunner, S. J. Res. 49 received no silent veto but called forth a full-throated blast against the principle of public operation" which the President termed "degenerate."[65] So died the sixth Norris bill and another attempt to put to use the idle Muscle Shoals investment.

preme Court ruled that acts unsigned under such circumstances did not become law. 49 Sup. Ct. 463, 279 U. S. 655, 73 Law. Ed. 894 (1929).

[62] S. J. Res. 49, Seventy-First Congress, First Session. The major change from S. J. Res. 46 was the inclusion in the later bill of a provision that five percent of gross revenues of federal power sales from Muscle Shoals should be paid to the State of Alabama and five percent of the proceeds of power sales from Cove Creek dam should be paid to the State of Tennessee. A clause very similar to this was incorporated into the Tennessee Valley Authority legislation of 1933 and experienced a stormy career until amendment in 1940. See below, Chapter III.

[63] 72 *Congressional Record* 9667 ff. The leasing bill which was reported out of the House Committee on Military Affairs was weak for several reasons: first, it provided no minimum terms for a fair lease; second, it provided no alternative of public operation if a satisfactory lease could not be negotiated; and third, it provided no procedure for federal recapture of the Cove Creek project whose construction and lease it authorized.

[64] The conference bill retained most of the power features of the Senate measure but gave the President blanket authority for one year to lease the nitrate plants. If no satisfactory lease for the latter properties were negotiated within this period, then provision was made for their operation by the United States.

[65] Mr. Hoover stated his approval of incidental power generation at projects primarily devoted to navigation, flood control or reclamation, but added that:

> ". . . . for the Federal Government deliberately to go out to build and expand such an occasion to the major purpose of a power and manufacturing business is to break down the initiative and enterprise of the American people; it is destructive of equality of opportunity amongst our people; it is the negation of the ideals upon which our civilization has been based.
>
> . . . .
>
> "This bill would launch the Federal Government upon a policy of ownership and operation of power utilities upon a basis of competition instead of by the proper Government function of regulation for the protection of all the people. I hesitate to contemplate the future of our institutions, of our Government, and of our country if the preoccupation of its officials is to be

Indefatigable, once more in the following Congress Senator Norris proposed a program of public operation at the Shoals.[66] As had been the lot of some of his earlier bills this one received scant consideration.[67]

CONCLUSION

By 1932 the Muscle Shoals controversy had led up to an almost hopeless impasse. On the one hand, the executive branch of the government held out relentlessly for lease of Muscle Shoals against every suggestion of public operation. But the majority of Congress, after long experience, had concluded that a "fair" lease according to Congressional standards could not be negotiated, and therefore it had come to favor public operation. For a solution to the problem it was necessary either that a new and far more remunerative lease offer (from the point of view of the United States) be received, or that the national administration revise its views on the policy issue of public operation. With the problem no nearer solution than when President Harding had taken office in 1921, the national elections of 1932 were held.

no longer the promotion of justice and equal opportunity but is to be devoted to barter in the markets. That is not liberalism; it is degeneration."
74 *Congressional Record* 7046-7048.
For Mr. Hoover's economic analysis of possible public power operations at Muscle Shoals, see Chapter VII below.

[66] S. J. Res. 15, Seventy-Second Congress, First Session.

[67] The only Muscle Shoals proposal to receive serious consideration in this Congress was a measure sponsored by Representative Lister Hill, H.R. 11051, to authorize a lease along the lines suggested by the Hoover Muscle Shoals Commission. But this bill did not pass either house.

Chapter III

THE TENNESSEE VALLEY AUTHORITY ACT OF 1933 AND ITS AMENDMENTS

Summary. Congressional debate as to an appropriate use or disposition of Muscle Shoals finally was terminated in 1933 when, under the leadership of the President, an act was adopted to establish a Tennessee Valley Authority. This Authority was charged with the integration of the Muscle Shoals properties into a comprehensive program for conservation and improvement of the land and water resources of the entire Tennessee watershed. In many respects this legislation was reminiscent of bills for public operation and development in the Tennessee Valley which Senator Norris had sponsored in Congress a decade earlier. Two aspects of the 1933 law, as amended, merit particular notice: it provides for administration of a comprehensive regional program by a decentralized agency of the federal government; and second, it emphasizes the possibile cost-finding significance of the agency's power program.

Legal opposition from established power interests retarded the early progress of TVA power marketing and made necessary several clarifying and amplifying amendments of the original law. Further amendments were required to authorize the Authority to purchase certain privately owned power properties and to revise its payments in lieu of taxes. By 1941 most of the major problems of the shift to public ownership and operation of the power business in the Tennessee Valley appeared to be solved.

THE ENACTMENT OF THE TENNESSEE VALLEY AUTHORITY ACT OF 1933

Of the many issues of policy on which the Presidential candidates of the two major political parties disagreed in the campaign of 1932, on none were they more at odds than the matter of "public power." The record of Mr. Hoover over many years spoke eloquently of his faith in the principle of private enterprise in the power industry, qualified only by the moderate controls of regulatory commissions; the record of Mr. Roosevelt, on the other hand, revealed a firm conviction that at least limited public competition was an essential supplement to the commission pattern of regulation.[1] When the election tide swung in favor of the Democratic nominee, prospects for resolution of the Muscle Shoals impasse by agreement upon the principle of federal operation appeared brighter than at any time since the Coolidge pocket veto.

As had become customary in previous Congresses, during the first few days of the Seventy-Third Congress a number of Muscle Shoals bills were introduced; [2] but the pressure of emergency legislation at this time was so great that none of these was given immediate consideration. On April 10, 1933, however, a remarkable message from the President directed Congressional attention to Muscle Shoals and recommended a comprehensive program for development of the resources of the entire Tennessee drainage basin. The text of this document follows:

"The continued idleness of a great national investment in the Tennessee Valley leads me to ask the Congress for legislation necessary to enlist this project in the service of the people.

"It is clear that the Muscle Shoals development is but a small part of the potential public usefulness of the entire Tennessee River. Such use, if envisioned in the entirety, transcends mere power development: it enters the wide fields of flood control, soil erosion, afforestation, elimination from agricultural use of marginal lands, and distribution and diversification of industry. In short, this power development of war days leads logically to national planning for a complete river watershed involving many states and the future lives and welfare of millions. It touches and gives life to all forms of human concern.

"I, therefore, suggest to the Congress legislation to create a Tennessee Valley Authority—a corporation clothed with the power of government but possessed of the flexibility and initiative of a private enterprise. It should be charged with the broadest duty of planning for the proper use, conservation, and development of the natural resources of the Tennessee River drainage basin. . . . . This Authority should also be clothed with the necessary power to carry these plans into effect. . . . .

[1] For example, Mr. Roosevelt had strongly supported legislation establishing the New York Power Authority while he was governor of New York. See also speeches of Mr. Roosevelt at Portland, Oregon on September 21, 1932, and at Milwaukee, Wisconsin on September 30, 1932. (The *New York Times*, September 22, 1932, and October 1, 1932.)

[2] Among these was S. J. Res. 4, a Norris compromise bill similar to those vetoed by the two preceding chief executives.

"Many hard lessons have taught us the human waste that results from lack of planning. . . . . It is time to extend planning to a wider field, in this instance comprehending in one great project many states directly concerned with the basin of one of our greatest rivers.

"If we are successful here we can march on, step by step, in a like development of other great territorial units within our borders."[3]

Since none of the pending Muscle Shoals bills contemplated as comprehensive a program as that envisaged by the President, a new bill following his specifications was formulated by Senator Norris. Introduced into the Senate the day after the President's message, this bill provided:[4]

(1) That the objectives of the proposed law should be flood control, national defense, promotion of agricultural and industrial development, improvement of navigation, development of hydroelectric power, reforestation and proper use of marginal lands;

(2) That the Act should be administered by a Tennessee Valley Authority to consist of three members appointed by the President with the advice and consent of the Senate;

(3) That the Authority should carry on experiments in the production of fixed nitrogen or other fertilizer ingredients;

(4) That the Cove Creek dam on the Clinch River in Tennessee should be completed and interconnected with Dam Number 2;

(5) That the Authority should have power to construct additional dams, reservoirs and power works in the Tennessee Valley;

(6) That the Authority should have power to produce and sell surplus electrical energy, that in sales of energy preference should be given to publicly owned organizations, and that to facilitate energy sales the Authority might construct power transmission lines;

(7) That the Authority should pay to Tennessee and Alabama five percent of its gross revenues derived from sales of power generated in each state;

(8) That the President might conduct surveys and demonstrations, and formulate plans for the general improvement of the resources of the Tennessee Valley region.

In the House a companion bill to the Norris Senate measure was sponsored by Representative Rankin (Mississippi), but primary consideration was given to a measure of somewhat more restricted scope backed by Representative Lister Hill (Alabama).[5]

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[3] House Document 15, Seventy-Third Congress, First Session, printed in full text at 77 *Congressional Record* 1423.

[4] S. 1272 and Senate Report 23, Seventy-Third Congress, First Session.

[5] H.R. 5081 and House Report 47, Seventy-Third Congress, First Session.

As compared with the Norris-Rankin version the following aspects of the Hill bill are significant:

(1) It also provided for the establishment of a Tennessee Valley Authority dedicated to the prosecution of a multiple purpose program; [6]
(2) It proposed a vigorous program not only of experimental fertilizer production but also of large scale fertilizer manufacture;
(3) It sought to guarantee the economy of the proposed river improvement works by forbidding construction of projects unless it appeared that the demand for power which they would generate would be adequate to repay over sixty years the entire project investment and meanwhile to return two percent annually for interest charges assignable to power investment; [7]
(4) It qualified the Authority's power to construct transmission lines by a dangerous clause against paralleling existing lines. A qualification of this nature was an open invitation to harassing litigation against any program for power distribution.[8]

After due consideration the Hill bill was adopted by the House and sent to the Senate where the Norris measure was adopted

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[6] The clause of the Hill bill establishing the administering corporation provided as follows:

> "That for the purpose of maintaining and operating the properties now owned by the United States in the vicinity of Muscle Shoals, Alabama, in the interest of the national defense and for agricultural and industrial development, and to improve navigation in the Tennessee River, and to control the destructive flood waters in the Tennessee River and Mississippi River Basins, there is hereby created a body corporate by the name of the Tennessee Valley Authority of the United States."

H.R. 5081, Sec. 1, quoted at 77 *Congressional Record* 2181-2185.

[7] These rigid financial prerequisites to project construction were lauded by backers of the bill as one of its most important points of superiority over the Rankin measure. Thus, Representative Hill said, "We have provided here, gentlemen, in this bill, a business proposition—the construction of these dams on a sound financial structure." 77 *Congressional Record* 2187. See also *ibid.*, 2169-71, 2194; and remarks of Representative Montet (Louisiana) at *ibid.*, 2267-2268.

Despite this strong support for the requirement that prospective power revenues be adequate to amortize 100 percent of project cost, it is evident that such a clause could easily prevent the construction of projects very economical from the multiple purpose viewpoint but permit the construction of less economical ones of which power was the predominant benefit. Thus, it seems directly inconsistent with the pursuit of multiple purposes.

[8] The clause in question stated that in order to prevent duplication of investment the Board of Directors of the Authority was authorized to negotiate with power companies having transmission lines needed by the Authority and to purchase such lines at fair and reasonable prices. If negotiations should fail, the Board was authorized to resort to condemnation. But no new lines were to be built ". . . . except where none now exists." House Report 47, Seventy-Third Congress, First Session.

as a substitute. Conference was then asked. At length, after a White House meeting of the conferees had broken an incipient deadlock, agreement was reached upon a conference bill which preserved most of the features of the Senate measure but made concessions to the House in the matter of the Authority's fertilizer program.[9] So revised, both houses accepted the legislation. It was now sent for signature to a President eager to grant it his approval. So, at long last, a program of public development and operation of water control projects in the Tennessee River valley was born.

AMENDMENTS TO THE ACT OF 1933

The Legislation of 1935

Although one might have hoped that peace would settle over the Tennessee Valley with the final disposition of the Muscle Shoals problem, in fact the Act of 1933 served only to bring the ancient conflict between public and private operation to a climax. That this would be the case clear-sighted observers might have foreseen; for when the infant public authority undertook its power marketing program, there already existed within the valley numerous privately owned power utilities with which it was

[9] The title of the final bill was,

> "AN ACT To improve the navigability and to provide for the flood control of the Tennessee River; to provide for reforestation and the proper use of marginal lands in the Tennessee Valley; to provide for the agricultural and industrial development of said valley; to provide for the national defense by the creation of a corporation for the operation of Government properties at and near Muscle Shoals in the State of Alabama, and for other purposes."

Act of May 18, 1933, ch. 32, 48 Stat. 58, 16 U. S. C. A. 831.

For a comparison of the Norris, Hill and Conference bills see Powell, Bolling R., Jr., *Congressional Debates on the Right of the Federal Government to Operate Electric Power Projects,* xxix to xliii. The concession in the matter of fertilizer was typified by a clause dedicating the Authority to the policy of increasing the production of fertilizer whereas Senator Norris had urged rather an experimental fertilizer program. Also in deference to the House the Act included a clause carried over from the decade of lease debate under which, for a period of twelve months, the President was authorized to lease Nitrate Plant Number 2 and the Waco quarry to any responsible farm organization for a period not to exceed fifty years:

> ". . . . subject to the express condition that the lessee shall use said property during the term of said lease exclusively for the manufacture of fertilizer and fertilizer ingredients to be used only in the manufacture of fertilizer by said lessee and sold for use as fertilizer."

(Section 5n.)

almost inevitable that it would collide. True, in Congressional hearings executive spokesmen of the utility system with the largest southeastern holdings had gone on public record in favor of the proposed Tennessee Valley Authority (TVA), but this endorsement had been conditioned by an urgent recommendation that the power activities of the new agency be limited to sale at the switchboard of energy made available by a comprehensive water program.[10] Inasmuch as such a restriction would have severely curtailed or perhaps completely eliminated any possible contribution of the new agency toward the control of retail power rates, it had been rejected by Congress.[11] Still hoping to forestall public competition, the power companies approached the Authority directly with the proposal that it sell to them at the switchboard all of its available energy.[12] Believing that such an arrangement would be contrary to the spirit if not the plain language of the 1933 Act, TVA also rejected it and proceeded to the formulation of an independent public power program. Although it is not our function here to judge the sincerity of either side in

[10] Mr. Wendell L. Willkie, President of the Commonwealth and Southern Corporation stated:

> "I want to say, Mr. Chairman, that no one has read or referred with more gratification than we have of this magnificent proposed development of the Tennessee Valley. As the responsible executive officers representing this investment in the Tennessee Valley, the largest investment in that valley, we view with a great deal of anticipation the proposed program of the President of the United States with reference to that valley. And we do not come here either as opposition or protestant witnesses against that proposition."

United States Congress, House of Representatives, *Muscle Shoals,* Hearings before Committee on Military Affairs, Seventy-Third Congress, First Session (1933), p. 107.

Under cross examination Mr. E. A. Yates, Vice-President of Commonwealth and Southern, added the following testimony on the same point:

> Mr. HILL. Mr. Yates, as I understood Mr. Willkie, he said that you all did not oppose the President's plan or program for the development of the Tennessee River. Is that correct?
>
> Mr. YATES. That is true; yes, sir.
>
> Mr. HILL. As I understand it, the only thing to which you dissent is the construction of transmission lines. Is that true?
>
> Mr. YATES. That is right.

Ibid., p. 118.

[11] From the time of Senator Norris' 1924 bill, a major objective of his proposals for public operation was the potentiality of public competition as a device for rate control in an industry threatened by "monopoly." See above, p. 56.

[12] United States Congress, House of Representatives, *Tennessee Valley Authority,* Hearings before Committee on Military Affairs, Seventy-Fourth Congress, First Session (1935), p. 253.

desiring to establish a situation under which this program might exist and develop side by side with service in neighboring areas by privately owned utilities, it does appear to be a fact that early efforts at co-operation degenerated into rivalry, mutual distrust and soon into bitter legal controversy. Thus, while the TVA program for river control proceeded approximately according to schedule, injunctions and court proceedings against its transmission program, against the loans and grants which prospective TVA publicly owned customers had obtained from the Public Works Administration, and against the construction activities of TVA local distributors greatly retarded and at times almost brought to a standstill the power marketing program. To reduce the scope for such legal controversy Congress, in 1935, undertook to clarify the aims and powers of the Authority.

Perhaps the respect in which clarification of the 1933 law was most urgently needed was the place of power generation and sale in the Authority's comprehensive program. Already Judge Grubb in a District Court opinion in the Ashwander case had narrowly interpreted the meaning of the "surplus" energy which TVA was authorized to sell as simply that surplus which might be developed in a program designed to produce as closely as possible the exact amount of power required by the corporation for the prosecution of its other authorized functions.[13] Although

[13] George Ashwander, et. al., vs. Tennessee Valley Authority, et. al., 9 F. Supp. 965 (1935). The opinion was, in part, as follows:

"It (TVA) has a right to sell the surplus energy defined to be the energy over and above what the Tennessee Valley Authority creates for the use of some one of its granted constitutional powers, and used for that purpose; for instance, actuating of the locks with reference to navigation, the lighting of villages, or many other things of that kind, that give it the right to use electrical energy. If there is a surplus, recognizing the impossibility of making the exact amount of electric power to cover the needs, it has an implied right to sell any power created over and above that, provided the surplus is legitimately created; that is, created in the exercise of a bonafide effort to only make such power as is needed to carry on the constitutional power, either national defense, or navigation, or perhaps others.

"I believe that the evidence shows that there is not substantial relation between the power created and disposed of and intended to be disposed of under the plan of the Tennessee Valley Authority, and a surplus that is merely over what is needed to carry the Government operation on physically; and that cannot be made exact, and is, therefore, an approximation. I don't believe that the idea of the Tennessee Valley Authority in making the power and planning like they have planned is that. I think their idea is that anything is a surplus which is over and above what they actually use, and that that gives them the right to generate what they see fit, and, in fact, TVA did not accept this interpretation and did not believe that the Supreme Court of the United States would accept it, it was eager that all question on this important matter should be dispelled. Consequently, it welcomed incorporation into the organic law of a provision defining Congress' conception of the place of power generation and sale in the comprehensive program. This was accomplished in part by an amendment to the effect that the Authority should seek:

> ". . . . to regulate the stream flow primarily for the purposes of promoting navigation and controlling floods. So far as may be consistent with such purposes, the Board is authorized to provide and operate facilities for the generation of electric energy at any dam for the use of the Corporation and for the use of the United States or any agency thereof, and the Board is further authorized, whenever an opportunity is afforded, to provide and operate facilities for the generation of electric energy in order to avoid the waste of water power, to transmit and market such power as in this act provided, and thereby, so far as may be practicable, to assist in liquidating the cost or aid in the maintenance of the projects of the Authority."[14]

The rationale of the water control program was further defined by an amendment of the Authority's original grant of power to construct dams and reservoirs. It was now provided that:

> "(The Authority) . . . . shall have power to construct such dams

> to plan an independent utility system, permanent in character, and supported by twenty or thirty year contracts before the governmental use is defined.
>
> "As I see it, it would be essential to be shown either that this power that is being disposed of, or intended to be disposed of, was actually needed for some of these constitutional functions, or that it was the excess over and above what was so created by that function, and the amount used, and that what was created in excess, was created in good faith and not with an intention to make a different disposition of it while it was being created and when it was being distributed."

For a discussion of this case in the Supreme Court see "Note" at end of this chapter.

[14] Act of August 31, 1935, ch. 836, sec. 5, 49 Stat. 1076, 16 U. S. C. A. 831h-1.

With reference to the revised interpretation of "surplus power," Director Lilienthal of TVA stated:

> "We are quite certain that the history of the act, the reports of Congress, the history of the Reclamation Service and of the United States Army engineers all indicate that Congress intended to mean by 'surplus power' what we have written out in some detail here."

United States Congress, House of Representatives, *Tennessee Valley Authority,* Hearings before the Committee on Military Affairs, Seventy-Fourth Congress, First Session, (1935) p. 85.

and reservoirs in the Tennessee River and its tributaries, as in conjunction with Wilson Dam, and Norris, Wheeler, and Pickwick Landing Dams, now under construction, will provide a nine-foot channel in the said river and maintain a water supply for the same, from Knoxville to its mouth, and will best serve to promote navigation on the Tennessee River and its tributaries and control destructive flood waters in the Tennessee and Mississippi River drainage basins; and shall (have) power to acquire or construct power houses, power structures, transmission lines, navigation projects, and incidental works in the Tennessee River and its tributaries, and to unite the various power installations into one or more systems by transmission lines."[15]

The gist of these two amendments was that in both the construction and operation of its water control system TVA should give primary consideration to the requirements of navigation and flood control but that, in so far as it might be consistent with these objectives, hydroelectric power should be generated so as to make a maximum contribution to liquidation of the costs of the comprehensive system.

A second respect in which amendment of the TVA Act of 1933 appeared to be in order in 1935 was the matter of power rate policy. Already the Authority had prescribed unusually low resale rate schedules in its contracts with publicly owned distribution agencies, and a violent controversy was raging as to whether or not revenues from the power program either to the Authority or to its "contractors" were adequate to cover power "costs."[16] Opponents of the Authority pointed out that whereas its river control investment was large and steadily increasing its power revenues remained but a mere trickle. They argued that TVA should be put under a rigid cost-accounting system, that it should file its rates with the Federal Power Commission, that these rates should be non-discriminatory as among classes of customers, that all receipts and expenditures should be reported to the General Accounting Office, and that no power sales should be permitted at rates which would not be adequate to return revenues

[15] Act of August 31, 1935, ch. 836, sec. 2; 49 Stat. 1075; 16 U. S. C. A. 831c.

[16] For a brief discussion of the economy of the wholesale power program see below, p. 124 ff. For a discussion of the resale program see Appendix to Part I.

at least equivalent to costs.[17] To those who were unaware of the role which litigation was playing in forestalling the normal development of TVA revenues or who had no understanding of the nature of a "development period" in a business requiring large capital investment [18] these suggestions seemed reasonable. But friends of the Authority saw in them the possibility that the entire power program might be tied in red tape and subjected to even more harassing litigation than had handicapped it theretofore.[19] All suggested amendments which they regarded as possible "jokers" capable of providing fuel for legal controversy, they earnestly opposed. At length, these differences were recon-

[17] See, for example 105 *Electrical World* 1002, 1505, and 1598; and "March of Events" 16 (1) *Public Utility Fortnightly* 163 (1935). Those who held these views typically indicated no clear comprehension of the complexities of isolating costs of TVA electrical service.

[18] When a great new plant has just been brought into service and before normal customer load is attached, it often would be disastrous to attempt to recoup full project costs from initial customers. In the case of TVA the problem of a power development period was aggravated by the fact that the "primary" navigation and flood control objectives largely set the pace at which generating capacity came into existence. Thus, during the early years power capacity was developed further ahead of demand than it otherwise would have been.

[19] One proposed amendment to the TVA Act which may have been calculated to tie the Authority up in court proceedings would have revised its power to construct transmission lines by subjecting it to the requirements of the original Hill bill of 1933 with respect to purchase of existing lines by negotiation or condemnation rather than duplicate construction. 16 (1) *Public Utility Fortnightly* 163.

With regard to a proposed amendment that the Authority be prohibited from making any sales of energy at less than cost, Representative Hill stated:

> "I think we all agree on one principle; that is, that neither you nor anyone on this committee wants the Tennessee Valley Authority to sell power at the expense of the taxpayers of the country. But I think there might be grave danger in endeavoring to write such a provision into this law. . . .
>
> "I can foresee that, for instance, in your rural electrification program, you might sell some of that power perhaps under cost, and you might sell other power to cities or towns or industries above cost. But, if you wrote such a provision into the act, that you should not sell any power below cost, you might find yourself in court, tied up with injunctions, and all that kind of thing."

United States Congress, House of Representatives, *Tennessee Valley Authority*, Hearings before the Committee on Military Affairs, Seventy-Fourth Congress, First Session (1935), II, 777.

A more moderate suggestion than that revenues from every customer should fully cover all costs incurred in his service was that revenues from all classes of power customers should cover the total of power costs. TVA opposed this proposed requirement on the ground first, that it gave no recognition to the developmental nature of TVA power load during the first few years of power operations, and second, that it would eliminate any possibility of flexible financial policy to accept losses in bad years and make them up by surplus revenues of good ones, ciled by agreement upon an amendment which expanded the Authority's functions of cost finding and cost reporting and which stated further:

"It is hereby declared to be the policy of this Act that, in order, as soon as practicable, to make the power projects self-supporting and self-liquidating, the surplus power shall be sold at rates which, in the opinion of the Board, when applied to the normal capacity of the Authority's power facilities, will produce gross revenues in excess of the cost of production of said power and in addition to the statement of the cost of power at each power station as required by section 9 (a) of the 'Tennessee Valley Act of 1933,' the Board shall file with each annual report, a statement of the total cost of all power generated by it at all power stations during each year, the average cost of such power per kilowatt hour, the rates at which sold, and to whom sold, and copies of all contracts for the sale of power." [20]

In addition to the provisions of the 1935 amendatory legislation already noted several other clauses to modify or extend the Act of 1933 were adopted. Among these were the following:

(1) The Authority was empowered to prescribe resale rate schedules in its contracts with power distributors.[21]

(2) It was authorized to assist, by grants of credit, states, counties, municipalities and non-profit organizations desiring to purchase existing distribution facilities in order to contract for TVA power. To finance such grants TVA was empowered to issue up to $50,000,000 in bonds.[22]

(3) It was given veto power over the construction of any subsequently proposed works upon the Tennessee River or any of its tributaries.[23]

[20] Act of August 31, 1935, ch. 836, sec. 8, 49 Stat. 1077, 16 U. S. C. A. 831m. This section also provided that the Authority should file its allocations of the value of completed properties with Congress. See below, pp. 174, 214. It further directed the Board to:

". . . . keep complete accounts of its costs of generation, transmission, and distribution of electric energy" and ". . . . a complete account of the total cost of generating and transmission facilities constructed or otherwise acquired by the Corporation, and of producing such chemicals, and a description of the major components of such costs according to such uniform system of accounting for public utilities as the Federal Power Commission has, and if it have none, then it is hereby empowered and directed to prescribe such uniform system of accounting. . . ."

[21] Chapter 836, sec. 6, 49 Stat. 1076, 16 U. S. C. A. 831i.

[22] Chapter 836, sec. 7 and 9, 49 Stat. 1076, 1078, 16 U. S. C. A. 831k-1, n-1.

[23] Chapter 836, sec. 11, 49 Stat. 1079, 16 U. S. C. A. 831y-1.

The Legislation of 1939

Despite the clarifying effect of the 1935 legislation upon the original TVA Act, the Authority remained locked in legal battle for existence until in 1939 it finally won a favorable decision from the United States Supreme Court in the Tennessee Electric Power Company case.[24] During this period the Authority took over many small privately owned power properties at negotiated prices,[25] but very little progress was made toward determination of terms for the transfer of key properties belonging to the Commonwealth and Southern system but lying in the heart of the TVA "natural" service area. When TVA was victorious in the "Eighteen Power Company" (or TEP) case, stalled negotiations with the Commonwealth and Southern Corporation were resumed;[26] and on February 4, 1939, agreement was announced that the Tennessee Electric Power Company should transfer its electrical properties in the state of Tennessee to TVA and its associated non-profit municipal and co-operative distributors for a consideration of $78,600,000.[27] It was further indicated that segments of the Georgia Power Company and Alabama Power Company systems which appeared to lie within a reasonable TVA service area would be transferred shortly.

In order that these negotiated transactions might be consummated, TVA and the distribution organizations were faced with the necessity of raising the required purchase price. The Authority's $100,000,000 bond authorization was more than adequate to supply the required funds, but it did not appear that this

[24] 306 U.S. 118; 59 Sup. Ct. 366; 38 Law. Ed. 543. This decision came almost five years after the first injunctions against TVA and its distributors. See "Restraining Orders and Injunctions Instituted Against Public Electric Properties," Seventy-Fourth Congress, Second Session, Senate Document 182.

[25] For the terms of some of these transfers see United States Congress, Joint Committee Investigating the Tennessee Valley Authority, Exhibits 562 and 563 submitted by TVA, Seventy-Sixth Congress, First Session.

[26] For information on TVA negotiations with the Commonwealth and Southern Corporation see United States Congress, Joint Committee Investigating TVA, *Report*, Senate Document 56, Seventy-Sixth Congress, First Session, pp. 204, 206. See also index to *Hearings* before Joint Committee Investigating TVA under "Tennessee Electric Power Co. properties," "Alabama Power Company properties," "Commonwealth and Southern Corporation, Negotiations with," and "Chattanooga, Tenn., Position in negotiations with Tennessee Electric Power Company."

[27] See *Wall Street Journal*, February 4, 1939, 1:1; *New York Times*, February 5, 1939, I, 1:4.

authorization would justify the raising of money for the purchase of privately owned steam generating stations or of hydroelectric stations outside of the Tennessee watershed, or for the advancing of credit to local agencies for the purchase of such plants. Since TEP properties included such facilities and were to be bought as a unit, the Authority requested Congress to amend its bond power to permit these otherwise unauthorized uses of borrowed funds. After bitter debate Congress complied with this request, and the Tennessee Electric Power deal was consummated.[28]

With the Authority and its local contractors alone in the power field in the Tennessee Valley the last great cause for friction between the federal government and the privately owned companies of the southeast appeared to be removed. But a final solution of the Tennessee Valley power problem had not been achieved.

The Tax Amendment of 1940

Although transfer of the power business in the Tennessee region from private to public ownership and operation involved surprisingly few major social and economic adjustments, it did give rise to serious problems in the field of taxation. Since the nature of these problems was seriously obscured by tremendous propaganda to the effect that TVA was effectively tax-free, it may be helpful to discuss them briefly. Public purchases of "private" power facilities under the TVA program have been in part by the federal agency and in part by municipal and cooperative distribution organizations. With respect to plant taken over by municipalities, public ownership in few cases has involved relief for power customers from previous tax burdens; for TVA distribution contracts typically require municipal systems to assess against operations taxes determined by the sum of state,

[28] The position with respect to the TVA bond bill of those in Congress who were friendly to the power companies but opposed to TVA was somewhat incongruous. Since both TVA and the power companies favored the bill, it was impossible to oppose TVA without opposing the power companies; *vice versa,* it was impossible to support the power companies without at the same time supporting TVA. The continuance of Congressional debate upon the bill required several extensions of the term of the original contract.

The report of the conference committee on this bill is printed at 84 *Congressional Record* 9140. See Act of July 26, 1939, ch. 366, 53 Stat. 1083, 16 U. S. C. A. 831n-3.

county, and local assessment rates. Since the states and counties usually have refrained from collecting taxes against municipal enterprise, the result of this arrangement for the municipal systems has been a one-sided apportionment in favor of the municipalities of an adequate tax return. Second, TVA contracts require co-operative distributors to assess taxes against operations at going rates. Because tax rates for co-operatives usually have been less than those applicable to privately owned power properties, the result of this arrangement typically has been a reduction in the tax on co-operative properties computed in power costs.[29]

But by far the most important problems of tax adjustment were not in the distribution field but in the fields of generation and transmission where properties were turned over to the Tennessee Valley Authority. Here the only provision for tax payments was in the 1933 TVA Act which directed the Authority to pay five per cent of its gross revenues from power sales to the states in which the marketed energy was generated. This formula had two major weaknesses. Whereas in 1933 five percent of TVA gross revenues had seemed an adequate allowance for replacement of tax payments of the "private" power companies (when consideration was also taken of payments by the TVA contractors), general increases in tax rates after 1933 tended to call for a greater TVA contribution by 1940. More important than any deficiency in the amount of the TVA tax payment was the fact that this payment was directed only to the states and was apportioned among them according to relative kilowatt-hours of TVA energy generated. No consideration was given to relative assessment value of TVA properties within states or to relative revenues contributed to TVA by consumers in the different states. Nor was any authorization granted for payments to counties or local governments.[30]

[29] To the extent that co-operatives have extended service to areas where it did not exist before, it is incorrect to compute as a "tax loss" the difference between the tax return a privately owned utility would file if it were doing the co-operative's business and the return the co-operative actually makes. Here, the entire return of the co-operative is so much net incerase. (For strict accuracy, of course, the alternative expansion which might have taken place in private service if the co-operative had not been in existence should be taken into account.)

[30] The position of certain counties which had relied upon taxes assessed against privately owned generating plants for the bulk of their revenues became

Recognizing the unsatisfactory nature of the "tax" section of the original TVA Act, the Authority worked out a suggested revision whereby larger total payments in lieu of taxes would be apportioned according to a carefully stated formula among the different states and counties affected by TVA operations. Incorporated into the Norris-Sparkman bill, this plan was introduced late in the first session of the Seventy-Sixth Congress.[31] At first it met firm opposition from those who were, as a matter of principle, skeptical of any proposal favored by TVA; but as the financial position of some of the valley counties became so critical that there was threat of an imminent suspension of essential public services, the good judgment of Congress triumphed over its prejudices and the new tax section was adopted.[32]

For the first year in operation of the new tax provision,[33] total TVA payments in lieu of taxes amounted to $1,499,394 as compared with former property taxes on facilities transferred to the Authority from private ownership of $1,128,000. Taxes and tax equivalents provided by municipalities and co-operatives dis-

desperate shortly after these generating stations passed into public ownership. Public policy obviously demanded that provision be made for restoring at least a considerable part of this tax return.

That there was a need for adjusting the apportionment of total TVA "tax" payments was indicated by the fact that, although the transfer to public ownership meant reduced total tax payments on transferred properies, the State of Alabama actually tended to receive increased payments under the formula of the 1933 Act. (*Tennessee Valley Authority,* Hearings before Subcommittee of the House Committee on Military Affairs, Seventy-Sixth Congress, First Session [1939], 311 ff.)

[31] S. 2925 and H.R. 7424, introduced on June 31, 1939. See 84 *Congressional Record* 10460-10463.

[32] Act of June 26, 1940, ch. 432, sec. 39, 54 Stat. 626, 16 U. S. C. A. 831d.

Two motives for opposition to this amendment may be distinguished on the part of those who were unfriendly to the Authority. First, some hoped to secure adoption of a measure which would lay a heavier tax burden upon TVA than would the Norris-Sparkman bill. Second, some thought that TVA and the cause of public ownership would suffer in popular prestige if tax payments of the privately owned utilities were not replaced. A variation of this second motive was the reluctance of opponents of public ownership to give up a favorite argument, namely that publicly owned enterprise never pays its fair tax burden.

In connection with the motive to undermine TVA good-will, one may recall the suggestion of Wendell L. Willkie that the valley counties might well "stew in their own juice . . . ." rather than obtain relief as proposed in the TVA tax bill. (See *Tennessee Valley Authority,* Hearings before Subcommittee of House Committee on Military Affairs on S. 1796, Seventy-Sixth Congress, First Session [1939] p. 298.)

[33] Year ending June 30, 1941.

tributing TVA power for the same year were $1,788,743. Combined total "tax" payments by TVA system properties were $3,288,137.[34]

"(This amount exceeds) . . . . by about $700,000 the property taxes of $2,600,000 formerly paid on power production and distribution properties when they were in private ownership. In comparison with this excess, the business taxes, such as income, franchise, gross receipts, hydro-generation, gasoline, and other motor vehicle levies, applicable to the properties under private ownership have been estimated at about $700,000." [35]

THE TVA AND STEAM POWER

Although TVA is primarily an agency for resource conservation and development, any discussion of TVA legislation would be incomplete if it failed to take note of the Authority's power to supplement its hydroelectric program with steam station generation. True, Congress has not made a direct grant of such power in so many words. But by implication steam generation by the Authority had been authorized in 1939 when Congress gave its approval to TVA's purchase of all the properties including the steam electric stations of the Tennessee Electric Power Company. If any doubt lingered after this, it was certainly dispelled in the following year when, under pressure of increasing national defense power requirements, money was appropriated to the Authority for construction of a 120,000 kilowatt

[34] Tennessee Valley Authority, *Annual Report,* 1941, p. 60; Tennessee Valley Authority, "Financial Statements for Fiscal Year ending June 30, 1941 of Municipalities and Co-operatives Purchasing Power from TVA."

[35] TVA Press Release of May 1, 1941.

Although the evidence suggests that the public power system has completely replaced tax revenues lost when the power industry passed from private ownership, there is room to question whether sound policy required complete replacement of these losses. The assumption seems to be that the tax structure at the time of transfer of the properties was an optimum one. It must be recognized that the TVA program has brought vast benefits to the Tennessee Valley. These benefits tend to improve the private tax base in the region and so, indirectly, contribute to replacing "lost" tax revenues. Furthermore, in some cases it is true that the taking of lands by TVA has reduced necessary expenditures of certain levels of government by making unnecessary former public services such as, for example, maintenance of roads flooded out. See *Tennessee Valley Authority,* Hearings before House Committee on Military Affairs, Seventy-Sixth Congress, Third Session, testimony of William C. Fitts at pp. 9-19, 196-227.

steam electric generating station.[36] It is probably true that every power system is unique; but in recent years the weight of expert testimony has agreed that the most economical power system is usually neither 100 percent hydroelectric nor 100 percent steam but rather a combination of the two.[37] It will now be possible for TVA, while preserving all of its comprehensive water objectives, to develop an optimum power system on this basis.

CONCLUSION

So stands the TVA Act today. After more than forty years of disagreement, controversy, and debate, at last the power issue in the valley appears to be settled. Privately owned power concerns in the heart of the region have transferred their properties to public ownership in return for apparently reasonable prices. Privately owned concerns outside the valley but in territory adjacent to it have tied their systems in with the TVA system so that all may live and serve side by side.

It is a conspicuous fact that the great majority of the amendments adopted in later years to the original Tennessee Valley Authority Act have related to the Authority's power program. This is not surprising, for here TVA has come into its most violent conflicts with other interest groups. Consequently, here clear and specific statements of powers and policies have been most urgently required. Yet the essence of TVA lies not in its power program but in its comprehensive orientation. To a consideration of the outstanding features of this orientation we turn in the following chapter.

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[36] Act of July 31, 1940, ch. 648, 54 Stat. 781. The Authority was later authorized and directed to double the capacity of this station.

[37] See Justin, Joel D., "Improvements in Utilization of Energy," *Proceedings*, American Society of Civil Engineers, December, 1937, p. 1920; Uhl, W. F., "Costs of Energy Generation, Recapitulation," *Ibid*., April, 1938, p. 732.

A NOTE ON SUPREME COURT TESTS OF THE CONSTITUTIONALITY OF THE TVA POWER PROGRAM

The leading cases testing the constitutionality of the TVA power program are George Ashwander, et. al. vs. Tennessee Valley Authority et. al., decided February 17, 1936,[1] and Tennessee Electric Power Company et. al. vs. Tennessee Valley Authority et. al., decided January 30, 1939.[2] These cases have been discussed at length in legal literature but are mentioned here because of their vital influence upon the unfolding of the TVA power program.

In the Ashwander case a group of minority stockholders of the Alabama Power Company protested the sale, by contract of January 4, 1934, of certain power properties by the Company to the Authority and the agreement by the Company to purchase electrical energy from the Authority.[3] They urged that the TVA power program represented an unconstitutional incursion by the federal government into the field of local utility regulation which was the proper province of the States; further, they urged that the power of the federal government to dispose of public property entitled it merely to lease or sell physical assets which it might have constructed or come to own in the normal exercise of federal functions but not the services which these assets might produce (in the present case, electric power); further, they argued that even if it were assumed the federal government had authority to sell electric power it had no authority to construct transmission lines and enter into a continuing utility business to carry out such sale. These assertions were all denied or considered irrelevant by the Tennessee Valley Authority, which asserted that its power program was a lawful exercise of the commerce power

[1] 297 U. S. 288; 56 Sup. Ct. 466; 80 Law. Ed. 688.

[2] 306 U. S. 118; 59 Sup. Ct. 366; 83 Law. Ed. 543.

[3] For the terms of the contract of January 4, 1934, see "Re Alabama Power Co.," Alabama Public Service Commission, Docket 6604, (1934) 4 *Public Utility Reports* (N. S.) 228ff; 238.

and the power to dispose of public property. The majority opinion of the Court, written by Chief Justice Hughes, refused the Authority's suggestion that the petitioners be declared without standing in court and held that the only issue involved in the case was the validity of the contract of January 4, 1934. It refused to pass upon the general question of the constitutionality of the entire TVA program and dealt only with power sold from Wilson Dam under this particular agreement. With respect to this narrow issue the Court held that Wilson Dam had been lawfully constructed in the exercise of the commerce and national defense powers, that the water power available at Wilson Dam was the property of the United States and accordingly could be disposed of by it in any reasonably appropriate manner, and finally that construction of transmission lines as a means of reaching a favorable market was an appropriate method for disposal of this federal property. Therefore, the contract should be considered valid.

Two minority opinions were filed. One, written by Justice Brandeis and concurred in by Justices Stone, Roberts, and Cardozo (none of whom disagreed with the conclusion of the Hughes opinion), held that the petitioners should be declared without standing in court on the ground that their company had accepted the benefits of the contract in question. The other, by Justice McReynolds, held that the question at issue had been unduly limited, that the case should have turned on the constitutionality of the entire TVA power program, and that it should have been decided in favor of the power companies.[4]

The Ashwander decision was hailed as a new link in the chain of cases dealing with federal power to engage in the hydroelectric power business at water control projects. Previous decisions, of which the most important recent one had been in the Boulder Dam case,[5] had established the right of the United States

[4] For argument of petitioners, see Ashwander et. al., vs. Tennessee Valley Authority (1936) 297 U. S. 296 ff; for argument of respondent, see *ibid.*, 307 ff; for opinion of the Court (by Chief Justice Hughes), see *ibid.*, 315 ff; for opinion of Justice Brandeis, see *ibid.*, 341 ff; and for opinion of Justice McReynolds, see *ibid.*, 356.

[5] Arizona vs. California, 283 U. S. 423; 51 Sup. Crt. 522; 75 Law. Ed. 1154 (1931). Equally important was a much older case, U. S. vs. Chandler-Dunbar Water Power Co., 229 U. S. 53, 73 (1913).

to generate and sell electric energy at the switchboards of lawfully constructed projects. The Ashwander decision now took the next logical step by authorizing the Government to construct transmission lines in order to reach markets at favorably situated load centers.

Since the Ashwander decision had not dealt with the issue of constitutionality of the TVA power program, the southeastern utility companies once again took the Authority to court in an effort to make a direct test of this point. In the resultant case (known as the "eighteen power company case" or "TEP case") they urged that the TVA power program did not exist simply as an incident to the Authority's pursuit of the lawful objectives of national defense and protection and promotion of interstate commerce, but that, in the guise of exercising granted powers, the Act sought to exercise powers not delegated to the United States. Further, the companies claimed that the TVA power program contravened the fifth, ninth, and tenth amendments of the Constitution ". . . . since the sale of electricity on the scale proposed will deprive the appellants of their property without due process of law, will result in federal regulation of the internal affairs of the states, and will deprive the people of the states of their guaranteed liberty to earn a livelihood and to acquire and use property subject only to state regulation."[6] Once more the Authority argued that these assertions were incorrect or irrelevant, that the power program was a lawful incident to the development of lawful federal objectives, and that the power companies should be ruled without standing in court on the ground that only the people of the states could attack the Authority for usurping functions lawfully reserved to the states.

The opinion of the Court, written by Justice Roberts, held that although the power companies might suffer by the competition of the TVA program, this program had not been shown to be in violation of any of their constitutional rights; that only the states or local government units could bring suit against TVA for invading fields of action normally reserved to such units (and that all evidence indicated that these governments sup-

[6] Quoted from Justice Roberts' opinion analyzing the declarations of the power companies. 306 U. S. 136.

ported rather than opposed the TVA program); and that, consequently, on no ground did the power company suit deserve standing in court. It followed that no decision of the case upon its merits was required, and the lower court ruling in favor of the Authority was affirmed.[7]

Although the Tennessee Electric Power Company decision did not finally establish the legality of the TVA power program, it appeared to render it safe from all further attack by the privately owned power companies. Further, it had wide implications for other federal ventures in the power business whenever it could be shown that energy would be generated as an appropriate incident to the exercise of delegated federal powers. Although an opening did remain for attack upon the program by the states or local government agencies, there appeared small immediate likelihood that any challenge of this sort would be forthcoming.[8]

[7] A minority dissenting opinion by Justice Butler and concurred in by Justice McReynolds stated that the power companies should have been accorded standing in court and that the case should have been decided upon its constitutional merits. 306 U. S. 147.

[8] For more thorough discussion of legal aspects of the TVA power program, see "Constitutionality of TVA as a Power Development Program," (1935) 48 *Harvard Law Review* 806; "Validity of Tennessee Valley Authority Act," (1936) 84 *University of Pennsylvania Law Review* 787; "Recent Cases" (1939) *Harvard Law Review* 68; "Note," (1936) 4 *George Washington Law Review* 399; "Note," (1938) 6 *George Washington Law Review* 378; and H. M. Martell, "Legal Aspects of the Tennessee Valley Authority," (1939) 7 *George Washington Law Review* 983.

Since the TVA cases, federal authority over the nation's streams has been extended by decisions in the New River and Red River cases. See United States vs. Appalachian Electric Power Co., 311 U. S. 377, 61 Sup. Ct. 291, 85 Law. Ed. 243 (1940); and Oklahoma ex rel Phillips vs. Guy F. Atkinson Co., 313 U. S. 508, 61 Sup. Ct. 1050, 85 Law. Ed. 1487 (1941).

CHAPTER IV

THE COMPREHENSIVE PROGRAM OF THE TENNESSEE VALLEY AUTHORITY

Summary. The initial chapters of this study have been designed to furnish a background for discussion of the TVA program. In order that this discussion may take on greater meaning it may be helpful to consider briefly the social-economic milieu in which this program is unfolding.

It would not be correct to regard the Tennessee Valley as a compact economic, sociological, or cultural unit, for there are vast differences between the lower valley and the mountain hinterland. Nevertheless, certain generalizations may be made with respect to the entire "Tennessee Valley region." It is endowed with a variety of abundant natural resources, many of which have not yet been commercially exploited. Two of its greatest original resources, however, its soil and timber, have been recklessly dissipated. Yet the region's predominantly rural population has amassed but small supplies of capital and is still heavily dependent upon the land. Its greatest problem is poverty.

The underlying rationale of the program of the Tennessee Valley Authority is to seek to improve economic opportunity in the valley region. It does this through activities along four major lines: soil conservation, technical research and industrial development, water resource conservation, and power marketing. In executing its program, TVA derives substantial advantages from its character as a decentralized, multiple purpose agency.

PROBLEMS OF THE TENNESSEE VALLEY REGION

Without attempting a complete enumeration, one may classify the more pressing social-economic problems of the Tennessee Valley region under the headings of land, income, housing, public health, and education.[1] Although there are interrelations among these categories, there are sufficient distinctions between them

[1] For a summary introduction to key southern problems, see National Emergency Council, "Report to the President on Economic Conditions of the South," 1938. For a comprehensive study, see Howard W. Odum, *Southern Regions of the United States.* The gist of Professor Odum's work is presented by Gerald W. Johnson in *The Wasted Land.*

to make the classification useful. It is certainly true that the TVA comprehensive program is having an impact upon all of these problems, but it is most directly concerned with those of land and income.[2] Let us consider the latter in more detail.

Soil

In terms of the physical environment certainly the most pressing problems of the Tennessee Valley region are those which cluster about the use of land and the treatment of forest resources. These problems have two major aspects: first, regular replacement in the soil of those elements which normal maintenance of plant and animal life require continually to be taken from it; and second, preservation of the body of the soil from depletion by erosion. If a limited physical area could be set apart from the rest of the world and observed as a controlled environment, it would be found that a natural balance would tend to be established whereby all essential elements which growing plants might extract from the ground would be returned either directly as plants might die and decay or indirectly as they might be consumed by animals and returned to the soil as waste or again as decay. In nature the same tendencies toward ecological balance exist, but the size of the environment has made it possible for mankind seriously to interfere with their working. For example, it is a commonplace that modern transportation and communication have made possible geographic specialization of industry and growth of the great city. Necessary implications of this type of society are regular trade channels whereby plant and animal produce of agricultural regions may be shipped to great consuming centers. For the agricultural regions there results a

[2] The Authority has become involved in the problem of housing as a result of the defense emergency and has developed a factory built portable cottage. A number of these have been produced at Muscle Shoals. (See TVA News Release dated March 28, 1941.) The Authority's malaria control work, which is discussed below in this chapter, is but one aspect of its program which touches upon public health. (See "Malaria and Its Control in the Tennessee Valley," Health and Safety Department, Tennessee Valley Authority, Chattanooga: February, 1941.) Educational aspects of the Authority's activities are discussed in a special issue of the *Journal of Educational Sociology*, XV:129-192, dated November, 1941 and entitled "The TVA Program—The Regional Approach to General Welfare" (Julius Yourman, Issue Editor).

deficiency in the normal return of soil ingredients. This must be made good artificially. Hence, fertilization.

Although there are perhaps a dozen soil minerals essential for normal plant growth, only a few are subject to rapid and dangerous depletion. Of these the most important are nitrogen, potassium, and phosphorus.[3] Fortunately, there is available a natural reservoir of nitrogen which is almost inexhaustible, for this element is a major constituent of the air. It may be fixed in the soil by growing and plowing under leguminous plants. In the case of potassium the problem is somewhat more difficult, but abundant supplies of potash recently found in the western states guarantee that there will be no early difficulty in maintaining this element of soil fertility. In the case of phosphorus, the reserves upon which the United States may draw to feed hungry soils are by no means as great. True, we have regularly exported phosphate rock during recent years, but there is every indication that this has been done while American farm lands have been receiving a return of only about ten percent of the phosphate which annual crops have taken from them. The tendency has been steadily toward a critical phosphate position for American agriculture. The gravity of this situation is underlined by the fact that nitrogen fixing legumes will not flourish in phosphate deficient land and that a phosphate shortage implies an imminent nitrate shortage as well. The importance to American agriculture of cheap and abundant phosphate fertilizers can scarcely be exaggerated.

Complementary to any program for restoration to the soil of ingredients essential to its fertility must be a program for protection and preservation of the body of the topsoil itself. Typically unshielded by cover crops from the rains of the winter wet season, sloping Tennessee Valley farm lands are likewise afforded little protection from summer cloudbursts by an agriculture which specializes in the production of row crops.[4]

[3] "Elements of Life," Bulletin of Tennessee Agricultural Experiment Station (June, 1940).

[4] The most important of such crops in the valley are cotton, corn and tobacco. It is worth noting that in the North winter precipitation, falling as snow, runs off more gradually (as a rule) than do southern rains. In some cases fields are already protected by "winter" crops by the time snows melt.

Plant foliage, ground litter, and roots do little to hold the ground or absorb rainfall well in excess of the national average; and hurrying waters seeking muddy streams carry with them a heavy soil burden.[5] The report of the National Emergency Council, noting that the "South" already uses five and a half million tons of fertilizers annually (or three-fifths of the national total), indicates the critical nature of the erosion situation:

"Moreover, southern farmers cannot pile on fertilizer fast enough to put back the essential minerals which are washing out of their land. Each year, about 27,500,000 tons of nitrogen and phosphorus compounds are leached out of southern soil and sent down the rivers to the sea.

"The South is losing more than $300,000,000 worth of fertile topsoil through erosion every year. This is not merely a loss of income —it is a loss of irreplaceable capital." [6]

Fortunately, although soil once lost is only slowly rebuilt, the processes of erosion are by no means impossible to check if they are caught in time. To a predominant extent soil wash results from ill-advised methods of land utilization. Modern principles of land planning to reduce the ravages of this toll on the

[5] Under natural conditions it has been estimated that topsoil tends to be rebuilt as rapidly as it may be washed away. But, in the Mississippi Valley:

". . . . misuse of the land by man has enormously speeded up erosion, and some measurements at our erosion experiment stations show that the simple removal of grasses and the plowing of the land has increased erosion 5,000 times. It has speeded up the run-off of water nine times. These data apply to a very extensive soil area in the Mississippi River valley."

United States Congress, House of Representatives, *Comprehensive Flood Control Plan for Ohio and Lower Mississippi Rivers*, Hearings before Committee on Flood Control on H.R. 7393 and H.R. 7646, Seventy-Fifth Congress, First Session (1937), statement of H. H. Bennett of the Soil Conservation Service at p. 168.

With respect to the Piedmont section of North Carolina Mr. Bennett stated:

"We have had in the southern Piedmont country, just east of the Appalachian Mountains and south of Washington, thirteen major reservoirs which have been built, and filled with soil to the top of the dam, within a period of less than thirty years, on the average. These reservoirs were filled with soil, the product of accelerated erosion."

Ibid. Although the erosion situation in the Tennessee Valley is severe, with the exception of the Ducktown-Copper Hill area it is probably not as critical as in the Piedmont region.

[6] *Report to the President on Economic Conditions of the South*, p. 12. For a comprehensive discussion of the erosion problem, see *Soil Erosion, A Critical Problem in American Agriculture*, Part V of Supplementary Report of the Land Planning Committee to the National Resources Committee, Washington, 1935,

land resource are available. It remains to secure the thoroughgoing co-operation of all land users in their application.[7]

INCOME

The basic social-economic problem of the South is its poverty. Let us consider a few statistical expressions in this regard. Table 1 below indicates that the average of southern incomes is substantially below that for the nation as a whole. Not only is

TABLE 1

AMERICAN FAMILY INCOMES

The South Compared with the Nation as a Whole, 1935–1936[a]

Type of Average	Nation as a Whole	South
Arithmetic	$1,622	$1,326
Median	1,160	905

[a]Income is here taken to include both money and non-money returns in so far as it is possible to estimate values for the latter. National Resources Committee, *Consumer Incomes in the United States, Their Distribution in 1935-1936* (1938).

this true, but in the South the downward dispersion of incomes from the median (ideally, from the mode) is much more pronounced than for the country as a whole or for any other section. Whereas only 27.13 percent of families over the country have incomes of $750 or less, 41.3 percent of all southern families have such incomes.[8]

Deficient as is the South in income, does it have abundant supplies of capital upon which to support itself pending the

[7] This problem is complicated by the fact that frequently in southern regions land users are not land owners and feel no pecuniary inducement to conserve the soil. Such inducements should be established. If they are not, circumstances will almost certainly force the adoption of sanctions against soil eroding farm practices. In a democratic society whenever they can accomplish the same end inducements to do "right" are far to be preferred to sanctions against doing "wrong."

[8] *Ibid.*, 18, 98. Furthermore, 55.7 percent of all southern negro sharecropper families had annual incomes of less than $500, and 70 percent of negro "non-farm rural" families had such incomes. In the case of white farm operators, 10.9 percent failed to receive in excess of $500. *Ibid.*, p. 100. (Fifty-nine percent of southern farm families were classed as "white operators," 13.4 percent were negro sharecroppers, and there were 332,000 negro "non-farm rural" families, *Ibid.*, 102.)

development of a more productive mode of economic life? Unfortunately, it does not. With almost half of its population agricultural and a large part of this population tilling lands they do not own, opportunities for the amassing of private capital have not been great. True, since the close of the first World War, there has been a considerable industrial development of limited areas within the South, but most of the capital for such enterprise has been invested by outside sources.[9] A logical result of the inadequacy of private incomes and wealth in the South has been difficulty for the different levels of government in raising taxes to finance essential public services. Consequently, in that part of the country where the people have been in most critical need of public aids government has been least able to render assistance.

While we are here simply concerned with pointing out, in general terms, the presence and intensity of the low income problem in the South, it may not be out of place to suggest that the severity of this problem could probably be considerably alleviated by the development of a more balanced economic structure. In 1935-1936, with 30.5 percent of the nation's families the South had 50.0 percent of its farm group but less than its proportional share of wage earners, clerical workers, professional workers, and independent business men.[10] With abundant labor available for the land but with capital relatively scarce, it is in the nature of an economic axiom that returns to workers must be relatively low. Improvement of incomes for the mass of the southern population evidently is contingent upon either substantial increases in the supply of capital relative to labor or major technological improvements.[11] If, over a period of time, ad-

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[9] The most notable cases of such recent industrialization are perhaps the textile industry in the Carolinas, the steel industry in Alabama, and the oil industry of Texas. With regard to income paid out by southern industry the President's Emergency Committee stated:

> "The South's industrial wages, like its farm income, are the lowest in the United States. . . . . In income from dividends and interests the South is at a similar disadvantage."

Report, 22.

[10] National Resources Committee, *Consumer Incomes in the United States*, 104.

[11] Changes of this sort would tend to give labor a larger share of a larger total income. Theoretically, if its bargaining power were increased, labor might achieve a larger share of the same total income for a limited period without these changes.

ditional investment in the South should open new opportunities for industrial employment and stimulate purchasing power, and if communities should grow up about the new industrial centers in which would develop opportunities for trade and the practice of the professions, it would seem a reasonable expectation that the acuteness of the present poverty problem might be substantially reduced.[12]

RESOURCES OF THE TENNESSEE VALLEY REGION

Faced as it is with problems of the type discussed above, what resources are available to the Tennessee Valley for exploitation in the effort to arrive at their solution? Perhaps the outstanding single resource is the Tennessee River. Starting in east Tennessee at the junction of the Holston and French Broad Rivers four miles above Knoxville, this stream flows southwest to the corner of Georgia, then west across northern Alabama to Mississippi, and finally north across Tennessee and Kentucky to empty into the Ohio River a short distance above Paducah.[13] Over its 652 mile course, it falls from an elevation at its source of 800 feet (M. S. L.) to 302 feet where it discharges into the Ohio River.[14] Rainfall over the basin averages about 51 inches annually with a normal run-off of 48,500,000 acre feet (i.e., 43.8 percent).

Improved bargaining power for labor alone, however, can hold little hope for a long run solution to the poverty problem of the South.

[12] A phantom problem of the South which perhaps should be mentioned is the matter of absentee ownership. It is urged as a primary southern problem that the bulk of industrial capital invested in the South is owned outside of this region. In so far as absentee ownership exists, it is a symptom and expression of the unbalanced nature of the southern economy and the inadequacy of southern incomes. But in the modern era of a national capital market it is not clear that absentee ownership has a great deal of significance. (The really significant point seems to be the split which has developed between management and ownership. See Adolf A. Berle and Gardiner Means, *The Modern Corporation and Private Property.*) Certainly many southerners who have accumulated savings have invested in national corporations located largely outside of the South. From the point of view of southern incomes, the great need is for greater investment of capital in the region, regardless of ownership. To this end, barriers to industrial expansion in the South, such as discrimnatory freight rates or perhaps artificially inflated wage rates, should be eliminated.

[13] *Tennessee River and Tributaries,* Seventy-First Congress, Second Session, House Document 328 (1930), p. 30.

[14] Three hundred and two feet is the normal level for the pool behind Lock No. 52 on the Ohio River into which the Tennessee River empties.

Within the Tennessee drainage basin there is a wide variety of country. Shortly below Chattanooga where the river cuts through the Cumberland plateau a sharp constriction cuts the valley into upper and lower sections of about equal areas. In the mountains of the upper basin, where much of the rock dates from the pre-Cambrian age, a wide variety of minerals has been found. Included have been magnetic iron ore, feldspar and mica, kyanite, talc, corundum and emery, and some copper, gold, chromite, tin, graphite, and asbestos. In the valleys are limestone (often in the form of marble), iron, manganese, and phosphorus with some zinc, barite, bauxite, and fluorite. In the geologically younger lower basin, plateaus and gently rolling country replace the mountains and valleys of the headwater country. Here there are coal (with some attendant oil), gas and asphalt, fire clays and shales, bauxite, iron carbonate, and clays, greens and marls.[15] At one time the valley was able to boast of extraordinary timber resources. Although these now have been heavily depleted, there remain some tracts of valuable hardwood as well as an abundance of second and third rate slash.[16] Despite the tolls of erosion the region retains a variety of soils; and it joins with its generous rainfall a mild climate with a long growing season.

Not the least of the resources of the Tennessee Valley is its population. Largely native Americans of Anglo-Saxon ancestry the residents of the region have been found by industrialists to be alert and intelligent, and adept in mastering quickly even the more difficult skilled trades. But because the economic advance of their homeland has been slow, their opportunities have been slight. Thus, in the age of the great city the Tennessee Valley region can boast of but five centers which can be consid-

[15] Edwin C. Eckel, *Engineering Geology and Mineral Resources of the Tennessee Valley Authority Region*, Tennessee Valley Authority, General Engineering and Geology Division, Geological Bulletin Number 1., pp. 11-13. For a statement by Major Eckel of the potential national defense significance of the resources of the Tennessee Valley region, see *Tennessee Valley Authority*, Hearings before the House Committee on Military Affairs, Seventy-Fourth Congress, First Session (1935), p. 453.

[16] There are also considerable stretches of waste land classified as "forest" which are well adapted to eventual development of productive forest growth. See TVA pamphlet, "Forests and Human Welfare."

ered as urban,[17] and of these only two, Knoxville and Chattanooga, are within the Tennessee drainage basin proper. More than half of the population continues to reside on farms, and as yet only one person in five or six lives in an "urban center." [18]

THE TVA COMPREHENSIVE PROGRAM

Recognizing the problems and potentialities of the Tennessee Valley, Congress established a Tennessee Valley Authority to guide the conservation and development of the region's resources. As guides for action it outlined certain broad directives of policy and specific responsibilities which should be binding upon the agency. But as is the case with all wise "commission" legislation, considerable scope was left to TVA for the exercise of discretion in interpretation of the law. One point, however, was clear. The Authority was dedicated to a comprehensive valley-wide program.[19]

[17] The suggested urban centers are Birmingham, Alabama, and Chattanooga, Knoxville, Memphis and Nashville, Tennessee.

[18] See National Resources Committee, *Consumer Incomes*, 1935-1936, table 35B. Speaking of the population of the Tennessee Valley, Miss Odette Keun has written:

> "In great minority are the prosperous farmers on good phosphatic lands or on middling lands which they have fructified. The typical Valley landowner lives on soil which was usually no great shakes from the start, which he bled in every conceivable way, and which now brings in for himself and his generally large family—that stews in the same juice—from 100 to 150 dollars a year. Then there are the tenant farmer and the sharecropper, white and black, in varying stages of poverty and devoid, moreover, of the independence of the poor landholder. These three categories of people, their minds, their circumstances, and their future, are at the heart of all that the TVA is planning and doing."

A Foreigner looks at the TVA, p. 75.

[19] Among other things, the Act provided for development of the Tennessee River for navigation; control of its destructive floods; generation, transmission and sale of "surplus" electric energy with preference to domestic and rural customers and sales to industry as a secondary purpose for the maintenance of load factor and improvement of revenue returns; experimentation in the production of nitrogen or other fertilizers or fertilizer ingredients and the manufacture and sale of such products; co-operation with existing State or other public experiment stations in promoting use of new types of fertilizer and in preventing soil erosion; making of surveys and plans to assist public authority in ". . . . fostering an orderly and proper physical, economic, and social development . . . ." of the Tennessee basin and adjoining territory; development and presentation to Congress from time to time of recommendations for legislation looking toward the achievement within the region of ". . . . (1) the maximum amount of flood control; (2) the maximum development . . . . for navigation purposes; (3) the maximum generation of electric power consistent with flood control and navi-

The scope of TVA's activities has not generally been appreciated. Too often there has been a tendency to regard the agency as primarily concerned with the production of power, the building of dams, or the manufacture of low-cost fertilizers. Too rarely has there been an effort to view each of these programs from a broad perspective in order to interpret its place in the entire TVA scheme of things. Yet there is a consistent rationale for all of TVA's activities. It is to seek through every appropriate means the improvement of democratic economic opportunity for the people of the Tennessee Valley.[20]

The administrative organization of TVA has been a great asset to the Authority in seeking to cope with the formidable problems which have inevitably confronted it. For TVA is endowed with federal prestige and power, but, unlike most federal agencies, it dwells in the region where its problems exist. Because of its national character, it is able to co-ordinate its work with the programs of other federal agencies.[21] Because

gation; (4) the proper use of marginal lands; (5) the proper method of reforestation of all lands in said drainage basin suitable for reforestation; and (6) the economic and social well-being of the people living in said river basin . . . ."; preparation of a unified plan for improvement of the Tennessee River basin; and veto power for the Authority over all proposed water control projects within the river basin. (See Chapter III above.)

[20] "At the outset it should be indicated what is meant by the 'economic opportunity' which the methods of the TVA will broaden and strengthen. Briefly put, it is the opportunity for a continuous and major expansion in the production and the use of goods and services—in short, a constantly rising standard of living for the whole people. By economic opportunity is meant, further, that these increasing material benefits shall be enjoyed under a democratic regime. . . . . And finally, let it be made clear that in discussing the expanding economic opportunity in this country the writer does not refer to the opportunity for the relatively limited number of already powerful business or governmental institutions to add to their strength; but rather the economic liberty of the average man, of human beings rather than institutions, and particularly of the nine-tenths of our population now insecure, whose economic freedom is threatened by the steadily rising tide of concentration of power."

David E. Lilienthal, "The Widening of Economic Opportunity Through TVA" (Knoxville: Tennessee Valley Authority, 1940), p. 1.

"Every plan and every operation in TVA is undertaken and must be judged not separately, but in its relation to the whole task of raising the income level and expanding the economic opportunity of a people of a region, by the development and use of their natural resources."

D. E. Lilienthal, "The Development of a Region's Resources," Address before Southwest Valleys Association, Little Rock, Arkansas, October 17, 1941.

[21] For example, the TVA soil program is carried out in co-ordination with farm organizations, the Department of Agriculture, and the land-grant colleges:

it is decentralized, it is able to carry out its activities with a maximum of flexibility. The latter point has been well put by TVA Director Lilienthal:

". . . . the TVA job is not run from Washington. After its general policies are approved and its projects are authorized TVA carries out its program in the field close to the problems it is trying to solve, in touch with the communities and human beings who will be affected by its decisions. There general regulations are adapted to fit local conditions, there mistakes are plain and can be swiftly corrected, there opportunities are visible and can be embraced before they vanish." [22]

Varied as are TVA's activities, it is perhaps reasonable to classify them under four major headings: soil protection; tech-

"All such relationships are in turn correlated through a written memorandum of understanding signed on behalf of his Department by the Secretary of Agriculture, co-ordinating the policy of the Department and the land-grant institutions with that of the TVA."

"The TVA Plant Food Program," *The Nation's Agriculture,* February, 1937, p. 16.

[22] D. E. Lilienthal, "The Development of a Region's Resources." Mr. Lilienthal advocated the general case for decentralized administration in the United States as follows:

"To find means through which national programs can be successful in their local application is a pressing necessity. For we must face the fact that the powers and the responsibilities of our central government are constantly increasing. The trend is inevitable. Issues once local are now nation-wide in scope and local agencies are powerless to cope with them. I believe in a strong central government, responsive to the needs of its citizens. But in common with many others in the government and in private life I do not believe in the central *administration* of all those central powers. All the laws enacted in Washington to promote the well-being of citizens throughout the land need not be administered from our national capital. When statutes are enacted that change the daily life and uproot the settled habits of men, those laws must as far as possible be administered at the grass roots, where the men who make and apply each regulation can see the effect of their decisions and learn the lesson of that observation. This country is too varied, the traditions and the customs of its people are too different, for general regulations to be successful from coast to coast. No man in Washington can fully foresee the impact of his several acts when he must decide for Arkansas and North Dakota, when his rules and regulations must apply alike to Florida and Maine.

"This country is not only too varied, it is too vast for centralized administration to be effective. When every recommendation, every adaptation of a general policy and every requisition must go to Washington for consideration and approval, delays pile upon delays, and thereby the confidence of its citizens upon which a democracy must ultimately rest is threatened by uncertainty and by delay. Day-by-day decisions should be made in the field. That is what Congress has authorized us to do, and that is what we have done in TVA."

Ibid.

nical research; stream resource conservation; and the marketing of power. Let us see how the Authority works along these lines to improve economic opportunity in the Tennessee Valley.

As we have pointed out in Chapter III, under the terms of its organic act TVA inherited the two Muscle Shoals nitrate plants of World War days and was instructed to use them for fertilizer production. After consultation with farm authorities and independent research, the agency found that phosphorus is the plant food ingredient most critically needed in modern soil nutrients,[23] and the decision was made to convert the nitrate plants to production of concentrated phosphatic fertilizers. After the construction and successful operation of a small pilot plant, conversion was carried out and the Authority, while continuing experimentation, undertook large scale fertilizer production.

Production of fertilizer was but a first step toward the improvement of soil resources and hence the widening of economic opportunity in the Tennessee Valley. It remained to test the fertilizer under actual farm conditions, to demonstrate its advantages, and to influence valley farmers to increase their fertilizer applications and adopt soil conserving principles of farm management. In co-operation with the State Agricultural Extension services TVA promulgated a program of fertilizer testing on a number of "test-demonstration" farms. Willing farmers, selected by groups of their neighbors, carry out these demonstrations. To the demonstrators TVA promises free phosphatic plant food to be used in connection with soil conserving crops, and local agents promise limited technical guidance. In return the farmers agree to reduce acreage in erosive cash crops and to increase areas in grass and woodland. Occasionally they undertake to terrace hilly fields. They contract to keep careful operating

[23] See "Phosphate Resources of the United States," Report of Joint Congressional Committee . . . . Pursuant to Public Resolution 112, Seventy-Fifth Congress, Senate Document 21, Seventy-Sixth Congress, First Session; "Elements of Life," Popular Bulletin 1, University of Tennessee, Agricultural Experiment Station, June, 1940; "Report of the Joint Committee of the Association of Land-Grant Colleges and Universities and of the United States Department of Agriculture on the Conservation and Use of our National Phosphate Resources for the Permanent Benefit of the American People," October 7, 1936; and "TVA Experimental Fertilizers," Tennessee Valley Authority, April 1, 1941.

and financial records, and to open their farms and accounts to their neighbors.[24]

The economic success of the test demonstrators has been remarkable. Unfortunately, the barrier of low incomes makes it difficult for many of the poorer farmers operating small units on hilly lands to follow their example. This class has traditionally relied upon cash crops for necessary money income. But the cash crops are just those row crops, such as corn and tobacco, which give soil least protection. Here is a dilemma: continued cultivation along traditional lines threatens a declining living standard and eventual soil bankruptcy; but renunciation of such crops promises immediate financial ruin. To solve this dilemma and break through the low income barrier TVA has fostered a program of technical research looking toward ways of improving money income of the small farmer.

In a relatively short period the TVA technical program has achieved surprising successes. Out of it has come the low-cost community refrigerator which, by saving meat which otherwise would spoil, relieves the farmer of the necessity of certain food purchases and is the equivalent of increased cash income. It has produced the furrow-seeder for the planting of small grains in legume grass on hilly farms. This makes possible ". . . . a year-round erosion-combatting soil cover, yielding both grain and forage on the same land." [25] Supplementing the furrow-seeder, it has developed a small threshing machine for mountain farming. While it did not originally produce the quick-freezing process, it vastly improved upon early techniques and achieved a method applicable to the Tennessee strawberry crop, much of which formerly had rotted in the fields for lack of a market. A new electric procedure for the curing of sweet potatoes was discovered, and an electric hay drier ". . . . costing less than 10

[24] Except for fertilizer free at Muscle Shoals, the test farmers bear all expenses of the program including all ". . . . material, livestock, and machinery required by the adjustment, including freight charges on the phosphate." (Lilienthal, *loc. cit.*) In 1941 it was estimated that there were 27,000 TVA test demonstration farms in operation. In many counties the Authority pays the expenses of an assistant local agent to supervise the program although such agents are technically employed by the State Agricultural Extension services.

[25] John P. Ferris, "Engineering and Social Progress in the South," State of Georgia Engineering Experiment Station Bulletin, December, 1938.

per cent of the cheapest commercial drier previously available . . . ." was also developed.[26]

Instead of itself undertaking to produce the several types of farm machinery which it has developed, TVA typically has sought to interest private enterprise in their manufacture. Thus it has contributed to the establishment of a modest number of new businesses in the Valley. Not all of these are concerned with the production of farm equipment. Some are putting into commercial use techniques developed by the Authority to make profitable the exploitation of native resources such as kaolins for ceramics, olivine for magnesium, and ore-bearing clays for aluminum.[27]

One of the Authority's most valuable and at the same time most dramatic achievements in technical research emphasizes the co-ordinate nature of the problems with which it deals and the interrelationships among agriculture, industry, and what TVA calls "economic opportunity." This is its development of a pressure cottonseed cooker. Into its seed go most of the rich minerals which cotton, as a crop, takes from the soil. After extraction of cottonseed oil, most of these minerals remain; and the seed can be ground into meal and fed to livestock. In this way up to eighty percent of the fertilizing value of the seed can be returned to the soil, and much of the depleting effect of cotton culture can be eliminated. In the South a number of cotton oil mills have long been in existence, but most of them have operated upon narrow profit margins. Technology stagnated, and the menace of increasing cottonseed exports from the region grew. In co-operation with the University of Tennessee, TVA undertook to study the problem. A new pressure cooker was developed, and was carried through the stages of laboratory experiment and pilot plant to actual factory practice. The favorable performance of the new cooker made it possible to interest a private manufacturer in its commercial production. A

[26] Lilienthal, *loc. cit.;* Ferris, *loc. cit.;* and "TVA Aids Private Business," *Business Week*, May 25, 1940, pp. 26-35.

[27] Lilienthal, *loc. cit.* Fruitful research by the Authority, begun prior to the defense emergency, to seek ways of reclaiming aluminum from abundant clays of the upper valley now promises to have national (and perhaps international!) rather than simply regional significance.

number of cookers have been sold in the region and are now in profitable operation. The cotton oil mills have gained a new lease on life; and availability of cottonseed meal for feed now seems assured. Meanwhile, favorable results have attended efforts to cope with the other phase of the problem, namely, to induce cotton farmers to raise livestock and use cottonseed meal as feed.

While the TVA land program has been pursued vigorously in its own right, it tends to make an important incidental contribution to another phase of the Authority's work. This is its program for stream control. Whereas run-off from bare fields or fields planted to row crops is rapid and carries with it a heavy soil burden, much of the precipitation which falls upon forested or grassed lands is held by foliage or ground debris and is slowly passed down to ground water storage or evaporated back into the air. Whereas flash floods with heavy silt burden are to be expected on bare or burned over watersheds, heavy rains falling upon well-covered areas yield only moderate increases of reasonably clear stream flow.[28]

Just as the TVA soil program and industrial research are oriented toward improvement of the economic well-being of the valley population, so also are its water control and power marketing programs. First, let us consider the navigation program. The inauguration of low cost transportation along the length of the main river and well up many of its tributaries should facilitate economical exploitation of as yet undeveloped resources. This will mean new opportunities for employment in mining and transportation, and possibly in raw material processing. But

[28] As an integral part of its program for conservation of soil resources and improvement of Tennessee Valley incomes, TVA has sought to encourage conservationist methods of lumbering and forest management. (See Tennessee Valley Authority, "Forests and Human Welfare," 1940.)

There has been considerable debate as to whether watershed afforestation can affect the peak discharge of maximum floods on major streams. In great floods it is argued that ground litter would be saturated well in advance of the run-off which would build up flood crest. Nevertheless, it is not disputed that afforestation can reduce the frequency and crest of flash floods along tributaries. See *Hearings on First Deficiency Appropriation Bill of 1936*, House Committee on Appropriations, 312 ff.; Frank, *Development of Federal Program of Flood Control*, 12-13; and *Comprehensive Flood Control Plans*, Hearings on Report of the Chief of Engineers, April 6, 1937 . . . . , before House Committee on Flood Control, Seventy-Fifth Congress, Third Session (1938), p. 335 ff.

even if no new industries develop, the improved river will broaden the market for produce of existing industries of the region and facilitate imports from outside. Although the river highway is as yet only partially developed and is not yet adequately provided with terminals, traffic has been steadily growing. (See Figure 2.) By 1940 more than fifty percent of water shipments were made up of grain, petroleum, and automobiles whereas only in 1937 movements of these commodities on the river were negligible.

The TVA flood control program is also in harmony with the Authority's general objective of improving economic welfare. It will provide a large measure of security along the main stream of the Tennessee and will contribute greatly to control of floods along the lower Ohio and Mississippi Rivers. While these benefits defy exact pecuniary measurement, they are plainly substantial. They imply greater security of life and health, less danger of disastrous interruptions of economic life, and the possibility of making advantageous use of areas formerly unavailable because subject to periodic overflow.[29]

The TVA power program likewise is designed to forward economic opportunity in the valley. Working through municipal and co-operative distributors, TVA promulgated sharply reduced power rates for all classes of customers.[30] It sought not only to introduce electricity to the farm and the unelectrified home, but it sought to make electricity pay. To this end its technical staff developed for farm use low cost items of electric equipment capable of contributing to farm incomes. When the transfer of the power business to public ownership threatened the financial foundation of government in several of the valley counties, TVA carefully studied the problem and prepared a solution which was

[29] It may be pointed out that important benefits from TVA technical research, navigation, and flood control are gained by business firms rather than private individuals. A public policy dedicated to broadening of economic opportunity for the entire population should give consideration to the way in which benefits to business firms are treated. Certainly they should not be permitted to contribute to the entrenching of private monopoly. (See Chapter XVI below.)

[30] See below, Appendix to Part I. At the close of the fiscal year, 1941, TVA estimated that its rate reductions had yielded to consumers in the valley total savings in the amount of $9,285,000. (Tennessee Valley Authority, *Annual Report*, 1941, p. 98.)

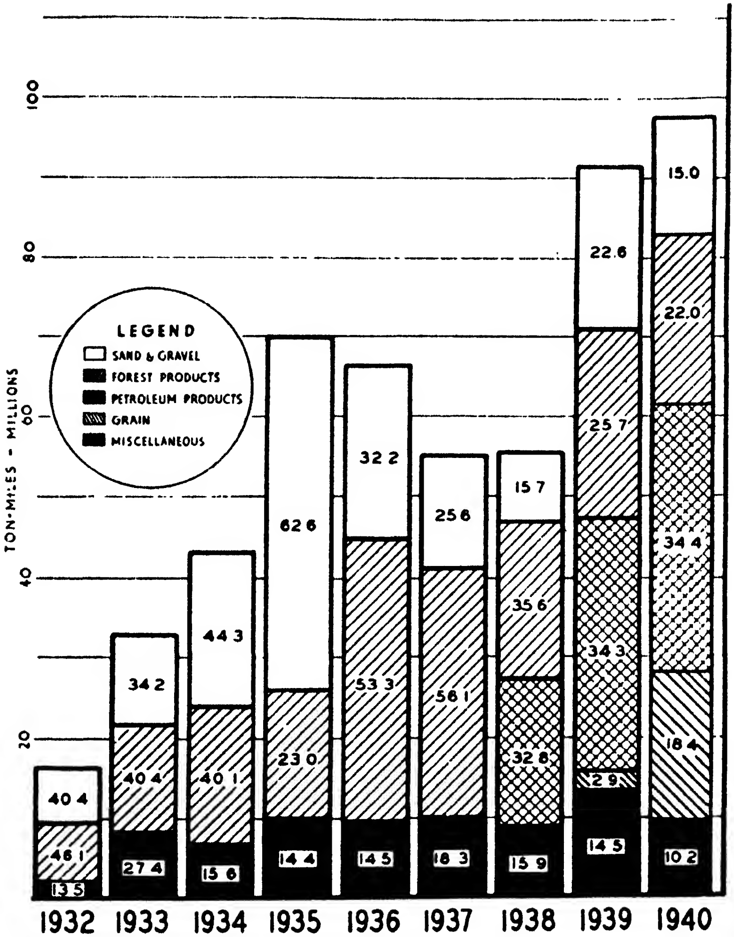

Figure 2. Traffic on the Tennessee River, 1932 to 1940. (This chart was prepared before figures for the calendar year, 1941, were available. In this year traffic rose to 138,400,000 ton miles, an increase of more than forty percent over the previous year and more than 750 percent over 1932. The Tennessee River appears to have become a major artery of southeastern trade and commerce. Source: Tennessee Valley Authority.)

later adopted by Congress and which seems to be adequate.[31]

In prosecuting its program for water conservation, TVA dis-

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[31] See Chapter III above.

covered in the region a resource which had not before been adequately recognized, namely, its recreational possibilities. By making modest provision for conservation of this resource, the Authority has been able to add a new and significant increment to public and private incomes in the valley region.[32]

The intimate way in which the various TVA activities are related to the problems and resources of the Tennessee region makes clear the importance of administering the TVA program within the valley rather than from the outside. Nevertheless, the question might be raised, Is it best that a single agency deal with over-all planning for the valley or should separate regional agencies deal with each major cluster of valley problems, e.g., those relating to land, water, and industrial development? In the light of the preceding discussion, to ask this question should be to answer it. The close relations between the various problems of the valley and the importance of a unified philosophy in their solution combine to make a single authority the appropriate agency for conservation planning. Only within a single organization and under a single management can the inevitable conflicts among diverse programs be harmonized in the most effective manner. An example of how this co-ordination is worked out at TVA is indicated in the following quotation:

> "These so-called conflicts are not black and white situations but situations in which colors shade into each other and the principal task or the principal device that co-ordination serves or that co-ordination must make use of is to get the participants to realize the extent to which these conflicts do not so much involve conflicts of facts as conflicts of assumptions; that conflicts then are made up of the conflicts of judgment and not the conflicts of fact. Any of you who have sat in on a discussion of reservoir operation, water dispatching and fixing the operating curves for the coming year, where power, flood control, navigation, fish and wild life and malaria control have been involved, have certainly been struck with this one thing at least, that so long as the argument is kept on a hypothetical basis as to what *may* happen . . . . there is no end to the argument because there is no limit to the variability of the assumptions. We had that illustrated not long ago. Wheeler reservoir is, as you know,

[32] Director Lilienthal has quoted an official of the State of Tennessee as estimating this new income in his state as amounting to approximately $25,000,000. Lilienthal, *loc. cit.*

the toughest thus far from the standpoint of malaria control. Our water control engineers were projecting an operating schedule back in March, or February, in which was being set the approximate date for the seasonal drawdown to begin and an approximate date at which the weekly fluctuations would take place for malaria control. Well, immediately that operating schedule was distributed for discussion speculation was rife as to what would happen if that were done, or what would happen if this were done, and much of what would happen was based upon conflicting assumptions as to what would take place between the time they were discussing it and the time the action was scheduled to take place. The malaria control people, for instance, made it clear they would not know until the first of May, or thereabouts, as to when the breeding season would be. If we had warm weather it would be earlier; if it was cool it would be later. The power people were not certain as to their problem except on the basis of certain assumptions and the same could be said about fish and wild life with its concern over operating effects upon the spawning season for fish. If we had a lot of rain it would affect it one way, if we didn't the effect would be something else. Some one suggested that there was only one thing to be decided at that time in March, and that was when is the critical period during which the best decisions could be made that would effect most favorably all of these objectives. That critical period was identified and everyone was content that the objectives in mind would be given adequate consideration by identifying this critical period and at that time going over the facts together. Then, upon the basis of what they would know at that time, they could work out an operating schedule that would fill the bill, always having in mind, of course, that the statutory obligations of the TVA must come first. . . . . Well, that critical time has come and some of the problems that loomed large last March were not problems at all the first of May. I don't mean that all elements of conflict have been eliminated by the operating curve that has been projected but by that agreement upon procedure which brings decisions close to facts the major conflicts have resolved themselves."[33]

CONCLUSION

Tennessee Valley Authority is a regional agency of the federal government which is dedicated to conservation and development of the resources of the Tennessee Valley as a means toward im-

[33] Gordon R. Clapp, "The Problems and Methods of General Management in a Multiple-Purpose Regional Agency," Paper delivered to Seminar on the Economics of River Development Programs, Personnel Department, Tennessee Valley Authority, May 22, 1941 (italics omitted).

provement of economic well-being within the region. The Authority has accomplished substantial results in a rather brief career. This has been possible because of the unified philosophy which has characterized all of TVA's diverse activities and because TVA has the advantage of living in the region where its problems exist.

Of several major phases of TVA activities, one is centered in the conservation of Tennessee Valley water resources. It has sometimes been alleged that this phase is oriented exclusively toward the maximum generation of hydroelectric energy. In the chapter which follows we survey the technical considerations which have governed TVA stream planning and find that power has been but one of three major purposes and that navigation and flood control have been accorded precedence over it.[34]

[34] This statement is applicable to TVA normal peace-time operation. During the war it appears likely that the Authority will be required to operate its system so as to produce a maximum power output.

CHAPTER V

TECHNICAL ASPECTS OF THE TVA WATER CONTROL AND WHOLESALE POWER PROGRAMS

Summary. The TVA water control program is a multiple purpose undertaking which benefits by co-ordinated operation of reservoirs along an entire river system. In the planning of system construction and operation, due consideration has been given to the "primary" purposes of the TVA Act, navigation and flood control. Only in the light of rules to safeguard these purposes has power been maximized. Power generated at the water control projects is disposed of to two major classes of customers: publicly owned distribution organizations and large industrial firms. The problem of the power rate yardstick relates to the rates at which the distributors resell TVA energy. It is not directly involved in TVA power rates proper. Revenues to the Authority from power sales are adequate to cover all direct power costs and the greater part of costs common to power, navigation, and flood control. Over-all economy of the water control program is contingent upon the ability of navigation and flood control to bear their direct costs and only a small balance of system common charges.

THE ADVANTAGES OF INTEGRATED WATER CONTROL OPERATIONS

TVA has been engaged in the construction of two great groups of water control projects: first, a series of dams and pools along the main Tennessee River from Paducah to Knoxville to provide, in conjunction with existing pools, a nine-foot navigable channel; and second, a number of great storage reservoirs on upstream tributaries of the main river. Operated independently, any one of these projects would produce significant benefits, probably of a multiple purpose nature. But for maximum effectiveness in any direction each individual project must be made a unit of a co-ordinated reservoir system. The value to navigation, for example, of a number of isolated slack water developments would be in no way comparable to the value of an integrated chain of lakes joined by locks.[1] Similarly, unified operation of a number of reservoirs for flood control can do much more to reduce extreme flows than could un-co-ordinated operation of reservoirs storing perhaps an even greater volume of water. Likewise, the power value of a system of interconnected projects operated as a unified system far exceeds the value which might be realized from the same set of projects operated independently.[2] Thus, even when dealing with a reservoir system developing but a single benefit, economy requires careful co-ordination of operations at the several projects. When the objectives of water control comprehend not a single purpose but a group of purposes, the necessity for careful planning of reservoir use is even greater.

[1] In this respect the importance of completion of the Kentucky project may be remarked, for it is the critical link which is required to provide nine-foot navigation from the Mississippi River system to Chattanooga on the Tennessee River. (With the completion of the Fort Loudoun and Watts Bar projects the nine-foot channel will be extended to Knoxville.) Already considerable investment has been committed to provide the remainder of this channel, but it will not become fully productive as long as slack water is not available down to the junction of the Tennessee with the Mississippi River system. Pending completion of the Kentucky dam, releases from upstream storage can increase navigable depths in this open channel stretch of river. Nevertheless, a six-foot depth is all that can be maintained during a major dry spell, and this could probably not be held in a critical dry year. Thus, the full navigation value of the main river pools cannot be realized prior to completion of main river canalization.

[2] The economies of unified operation were well described by former TVA Director Arthur E. Morgan as follows:

> "Take the Wheeler Dam, the Wilson Dam and the Pickwick Dam; those three close together on the main river. The Wilson Dam has about storage enough for twelve hours; that is, it can use in twelve hours the flow of the river for twenty-four. There is only about a foot or two of feasible variation in regulating its reservoir; but it can take care of hourly variations in demand.
>
> The Wheeler Dam has storage for two weeks. It can take care there of a drop in power over the weekend by storing the unneeded water, and if a little freshet puts a lot of water into that reservoir, it can take care of such fluctuations in flow.
>
> "So Wheeler Dam can regulate the flow for two or three week periods; Wilson Dam can regulate it day by day, and Pickwick Dam can be handled to let the water out for navigation below. (Such operation of Pickwick can be dispensed with when the Kentucky project is completed.)
>
> "Taking the three dams together, we can smooth out that flow and save all the fluctuations that are not longer than two or three weeks, and then the storage dams on the (tributaries) can take care of the greater fluctuations between winter and summer. Taking them all together, we will not have any secondary power. It will all be turned into prime power."

Tennessee Valley Authority, Hearings before the House Committee on Military Affairs, Seventy-Fourth Congress, First Sesison (1935), p. 101.

Let us consider the programming of water control operations by the Tennessee Valley Authority.

SYSTEM PLANNING FOR NAVIGATION

Perhaps influenced by the requirement of the TVA Act that navigation and flood control should be "primary" objectives, the procedure of the Authority in scheduling reservoir utilization has been to determine, first, a reasonable and appropriate program of operation for navigation, second, a reasonable and appropriate program for flood control consistent with planned navigation operations, and third, a program for the development of maximum power consistent with the adopted navigation and flood control operations.

The navigation requirement of the TVA Act is that the Authority should develop a nine-foot navigable channel along the length of the main Tennessee River and that it should operate its reservoir projects for the benefit, among other things, of navigation on the Tennessee and Mississippi Rivers. The Act leaves it to the discretion of the Authority to determine by what system of projects and what program of operation this requirement should be met. It implies that, in so far as it is feasible to do so, navigation operations should be harmonized with other possible purposes of stream control. The use of "dead" navigation storage for power head is thus authorized. On the other hand, summer drawdown of main river reservoirs below the minimum level required for maintenance of a nine-foot channel apparently is prohibited under law since this would conflict with the "primary" interest of navigation.

Since navigation is a primary objective whose interests must always be safeguarded, there is little room for reservoir operations for other purposes to be of incidental aid to the navigation program. In one regard this point must be modified. To the extent that flood control or power operations lead to the release of storage during low water seasons they tend to have incidental navigation value along open channel stretches of river. True, when the main river of the Tennessee is completely canalized there will be no possibility of such a benefit along this stream, but pending that date this contribution of power-flood control operations may be of some importance. Afterward, open channel benefits from storage releases will continue and perhaps indeed become of even greater importance along the lower Ohio and Mississippi Rivers to which the Tennessee is tributary.[3]

Although navigation may receive incidental benefits from low water regulation by tributary reservoirs, it is fair to say that its interests are primarily concerned with the maintenance of appropriate head in the main river pools. Given this condition, navigation places few restrictions on reservoir operations for flood control and power. To the considerations which govern these operations let us now direct our attention.[4]

SYSTEM PLANNING FOR FLOOD CONTROL

Prerequisite to the formulation of any flood control program is the answering of two basic questions. First, precisely what areas are to be protected? and second, against how great a flood is protection to be sought? In the case of the Tennessee Valley system the focus of the flood problem was determined to rest at Chattanooga, for here were the greatest property values liable to

[3] Colonel Parker, Chief Engineer of the Authority, testified before a committee of Congress that during the 1939-1940 dry season water released from storage in the Tennessee basin constituted twenty-five percent of the flow of the Mississippi River below Cairo and that it raised low water stages above Memphis by about nine inches. Since this was a year of low stream flow, it is reasonable to suppose that this increment to natural flow made it possible either for river shippers to transport larger cargoes over critical shoals with greater continuity than would otherwise have been possible, or for the Army Engineers to reap economies through avoided dredging costs.

The greater part of 1939-1940 low water regulation on the Tennessee was accomplished by the Norris project. Had other tributary projects and the Kentucky reservoir been in operation at this time, the increment to natural flow would have been much greater. (See United States Congress, House of Representatives, *Hearings on Independent Offices Appropriation Bill for 1941* before a Subcommittee of the Committee on Appropriations, Seventy-Sixth Congress, Third Session, 1803 ff.)

[4] Before leaving the navigation objective, attention should be drawn to one phase of the TVA navigation program which is most important although it does not involve difficult problems of co-ordination with other TVA activities. This is the planning of river terminal facilities. Probably a major explanation of the failure of many previous federal navigation developments has been neglect to provide satisfactory terminal facilities for river shipping. TVA policy in this regard is still in a developmental stage. So far it has taken the position that terminals should be developed by state and local interests in harmony with the comprehensive valley program. It has regarded its role as that of a stimulator, helper, and over-all co-ordinator. (See TVA Press Release of February 17, 1940 entitled "Public Use Terminal Development at Chattanooga, Tennessee.")

the greatest danger of overflow. Further, control at Chattanooga supplemented by available surcharge at main river reservoirs downstream would furnish reasonably adequate control along the entire river.[5] An answer to the second question, the flow characteristics of the design flood, was more difficult to determine. But after careful investigations of past stream records, it was decided that protection should be provided against a peak flow of 730,000 cubic feet per second (or 34 c. f. s. per square mile of drainage area above Chattanooga) with a seven-day volume of 9,300,000 acre feet (and a fifteen-day volume of 14,200,000 acre feet).[6]

With the flood problem defined, attention next logically turned to an examination of alternative methods for its solution. Should the flood control system be one of reservoirs only, should it be of levees only, should it be of diversion spillways and channel works only, or should it be a combination of two or more of these types of works? At Chattanooga diversion spillways could at once be excluded, for there are no natural sites available for emergency channels and the costs of excavating them would be prohibitive.[7] Whatever minor channel rectifications might prove feasible could have no significant effect upon maximum flood stages.[8] In the

[5] It is also true that the most economical sites for large scale flood storage (by the criterion of cost per acre foot) are in the upper valley where the majority of the major tributaries of the Tennessee River are located (e.g., the Holston, French Broad, Nolichucky, Powell, Clinch, Emory, Little Tennessee and Hiwassee). The Duck and Elk Rivers are the only two large tributaries in the lower valley.

[6] Tennessee Valley Authority, *Chattanooga Flood Control Problem*, Seventy-Sixth Congress, First Session, House Document 91 (1939), p. 22.

The crest of this flood was determined by the conservative relation suggested by a special board of consultants as follows:

Peak run-off (in c. f. s.) $= 5000 \sqrt{\text{Drainage Area (in square miles)}}$

(This relation would be expected to vary as between different watersheds.) The resultant estimate for crest of the super-flood exceeds that of the great flood of 1867 by sixty percent. Two-thirds of this excess may be regarded as allowance for a greater flood than any of record and one-third as a margin of safety.

Volume of flow over time was estimated from stable relations observed in the past between flood crest and total volume. Conclusions were checked by study of the nature of transposed maximum floods of other watersheds when centered in the Tennessee basin above Chattanooga.

[7] It was estimated that a cut-off across the neck of Moccasin Bend to reduce river stage by approximately one foot during moderate floods would cost $11,000,000. *Ibid.*, 47.

[8] The moderate gradient of the river at Chattanooga narrowly restricts the possible contribution of channel rectification works.

solution of the Chattanooga flood problem primary reliance had to be placed upon reservoir and levee protection.

Ideally it would appear that complete protection for Chattanooga could be provided either by the construction of a reservoir system to store the entire excess of flood flow above normal high water or by the construction of a levee system adequate to contain the crest of the maximum flood. In fact a combination of these two methods of control provides a far more feasible system from both an engineering and an economic point of view than a system composed exclusively of either type of work. Although reservoirs are well adapted to the cutting off of flood crest, the greater volume of flow contained in the central and lower sections of the flood hydrograph requires ever larger volumes of storage for each additional foot by which maximum stage is reduced. The cost of 100 percent control of a great flood by the reservoir method would be prohibitive. On the other hand, safe levees can be erected for protection against moderate flood flows; but as the levee grade is increased to control more and more severe floods, the required volume and cost of the structures increases rapidly.[9] Complete protection of Chattanooga by means of levees would be no more feasible than protection entirely by reservoirs. The remaining approach to the problem is by an integrated system of reservoirs and levee works. Such a system would be planned so that reservoir storage would cut off flood crest and the remainder of the flood mass would be passed downstream between levees adequate to contain the modified flow.

If a joint reservoir-levee system for flood control at Chattanooga is more feasible than reservoir-only or levee-only alternative works, the question remains as to what is the optimum balance from both an economic and an engineering point of view between the two elements of the joint system. It is known that levee protection against the first few feet of flow at the base of the flood hydrograph is relatively inexpensive but that the cost of additional levee protection increases rapidly. It is also known

[9] Moreover, as levee grade is increased pressure at the base of the structure mounts and its safety becomes questionable. At Chattanooga, whereas the confined stage of the maximum flood (730,000 c. f. s. crest) might be expected to reach 77 feet, the safety of works to confine any flow substantially in excess of 60 feet (486,000 c. f. s. crest) would be doubtful.

that reservoir protection against the last few feet of flood crest is relatively inexpensive but that the cost of scaling crest down additional feet increases rapidly. The point of economic balance between levees and reservoirs, therefore, is that point of indifference at which a given increment of flow could be controlled equally cheaply by either additional storage or increased levee grade.[10] This suggested technique of analysis is applied to the Tennessee River situation at Chattanooga below.

TABLE 2

COST OF FLOOD PROTECTION BY LEVEES AT CHATTANOOGA

Flood Crest	Levee Investment Cost	Investment for Last Foot of Control
53	$12,700,000	
54	12,900,000	$ 200,000
55	13,200,000	300,000
56	13,600,000	400,000
57	14,000,000	400,000
58	14,400,000	400,000
59	14,900,000	500,000
60	15,500,000	600,000
61	16,400,000	900,000
62	17,700,000	1,300,000
63	19,800,000	2,100,000

Source: Data read from Figure 3.

The cost of levees-only protection against flood crests of varying heights are indicated in Figure 3 and in Table 2. Corresponding costs for scaling down flood crests from the design maximum discharge of 730,000 c. f. s. to stated controlled crests by means of reservoir storage are indicated in Table 3. Comparative costs of the last foot of control indicate that for the design flood levee protection against all flow up to a 62-foot stage is more economical than reservoir storage but that control of all flow in excess of 63 feet can be achieved more favorably by the latter method. With a levee grade to confine a flood of 62 to 63 feet and reservoir storage adequate to scale the maximum flood to this crest approximate balance between reservoirs and levees is indicated.

[10] This statement assumes equal effectiveness and safety for each method of control. It will be recognized as an elementary application of marginal theory. The theory of flood control planning is examined in greater detail in Chapter XV below.

Four points leading to modification of the foregoing analysis may be made. First, it was assumed that all costs of reservoir storage were to be charged against flood control. If it is feasible to employ flood storage capacity for other useful purposes without impairing its value for flood control, then the net capital value of such other uses may be credited against reservoir costs to determine a net charge against flood control.[11] Second, it must be recognized that reservoirs

TABLE 3

COSTS OF RESERVOIR CONTROL OF MAXIMUM TENNESSEE RIVER FLOOD AT CHATTANOOGA TO STATED CRESTS[a]

Controlled Crest		Required Storage		
Stage in Feet	Flow (c.f.s.)	Volume in Millions of Acre Feet	Total Investment Cost	Cost of Last Foot of Control
59	470,000	2.83	$32,000,000	$3,800,000
60	483,000	2.60	28,200,000	2,200,000
61	495,000	2.45	26,000,000	2,000,000
62	508,000	2.23	24,000,000	2,000,000
63	520,000	2.08	22,000,000	2,000,000
64	535,000	1.90	20,000,000	2,000,000
65	550,000	1.70	18,500,000	1,500,000

[a] The indicated costs of moderate reductions in flood stage are probably understated since they are determined largely by the cost of storage at the Norris project. For actual reservoir control of flood flows to the 65-foot level, capacity would be required on several tributaries. The example is adequate to indicate the method of analysis here under discussion, but in practice greater consideration would have to be paid to the location of required flood storage in estimating reservoir capacity costs.

Source: The data of this tab e have been read from charts as follows: flow corresponding to indicated river stage has been taken from Figure 4; reservoir capacity required to scale the maximum flood to the indicated crest flows has been determined from Figure 5; and cost of reservoir storage has been found from Figure 6.

contribute flood control benefits along the length of the stream whereas levees provide only local protection. Third, the engineering safety of Chattanooga levees becomes subject to increasing question as the grade is raised above sixty feet.[12] And fourth, because of the impossibility of perfect flood prediction and reservoir operation to store only the exact crest of the flow, a generous margin of safety should be provided in any estimate of reservoir storage required to achieve given reductions in crest. The first three of these considerations work toward a point of balance between reservoirs and levees with a levee height somewhat less than the preliminary height of

[11] This procedure is appropriate if reservoirs are undertaken primarily for the flood control objective. If the objectives of the program are multiple, it may be argued that a share of project economy should be granted other purposes and that the credit against total costs on their account should be something less than the figure at which the market would normally fix their capital value. See below, Part II and Chapter XV.

[12] House Document 91, p. 46.

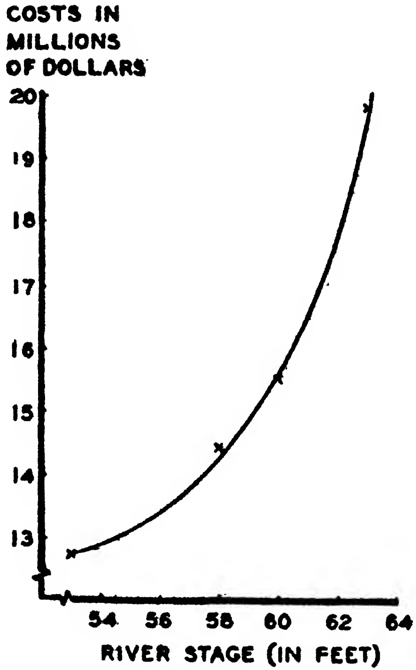

Figure 3. Cost of levee protection against floods of varying heights at Chattanooga, Tennessee River. (Based on House Document 91, Seventy-Sixth Congress, First Session, 45, 63.)

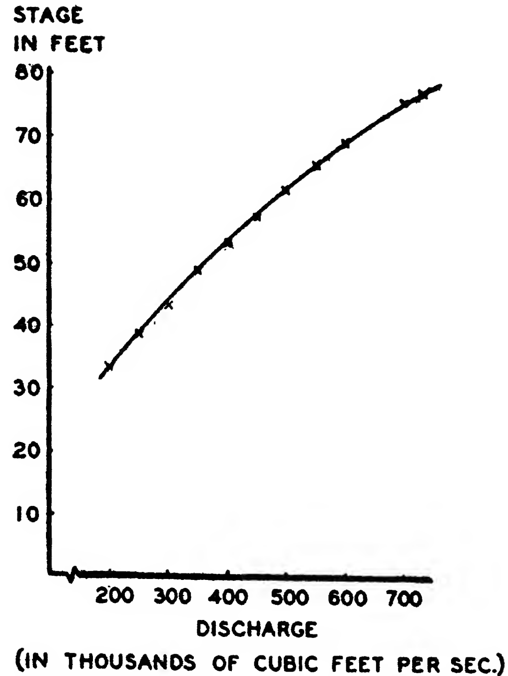

Figure 4. Stage-discharge curve, great floods of Tennessee River at Chattanooga. (Based on House Document 91, p. 43, Table X.)

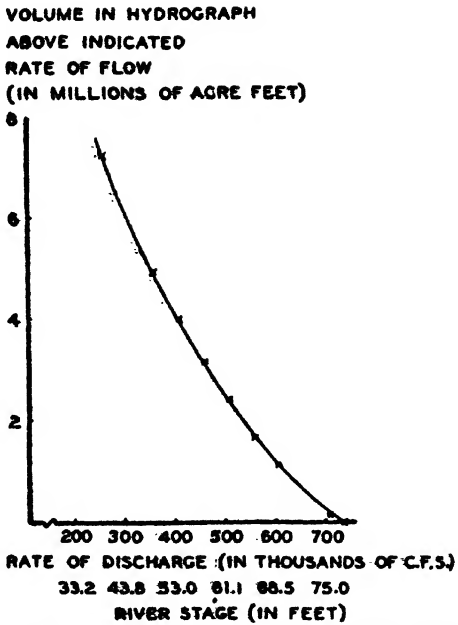

Figure 5. Volume in hydrograph of design flood above uniform rates of flow. (Based on House Document 91, Table X.)

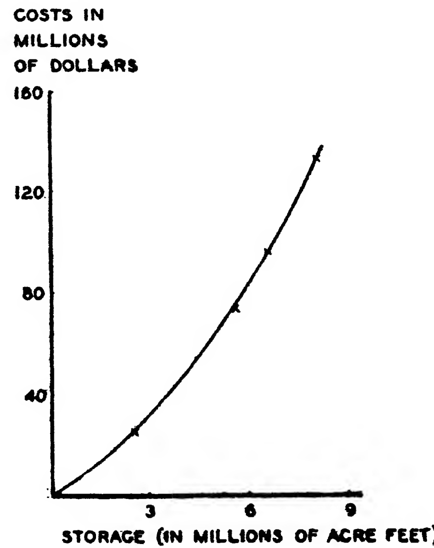

Figure 6. Cost of single purpose flood storage, upper Tennessee Valley. (Based on House Document 91, p. 44, with storage provided at successive sites as follows: Clinch River, 2,500,000 a.f. @ $10.50; Holston and French Broad Rivers, 3,000,000 a.f. @ $16.00; Tennessee River, 900,000 a.f. @ $24.20; and Little Tennessee River, 1,500,000 a.f. @ $25.00.)

62 or 63 feet suggested above; the latter consideration tends toward a point of balance with levees somewhat higher. Although the nature of the problem, as now modified, no longer suggests a single optimum point of reservoir-levee balance, the decision of TVA to meet the Chattanooga flood problem by combining levees constructed to a sixty-foot grade with reservoir storage adequate to control the maximum flood to this level appears quite consistent with our data and discussion.

With the requisite height of levees and the necessary volume of flood storage capacity determined, the problem arises of reconciling flood control operations with operations for other stream control purposes. The possible benefit to open channel navigation of stored flood waters during subsequent low water periods has already been suggested. Beyond this, navigation has little interest in the management of tributary storage so long as adequate water is regularly passed downstream to maintain head in the main river pools.[13] The hydroelectric objective, on the other hand, is vitally interested in the technique of stream regulation which is adopted; for maximum power production is contingent upon the maintenance, so far as possible, of full reservoirs to provide both head and a source for low water flow. Since the interest of flood control is in maintenance of storage *capacity available to serve* (i.e., unfilled capacity except when flood waters are being stored), there appears to be a fundamental conflict between this purpose and the power objective.[14] Fortunately, when the flood danger is unmistakably seasonal, this conflict is more apparent than real. For it is then possible to hold capacity required for control of great floods available during the flood season (except as it is actually used for flood storage) but to allow it to fill for use in

[13] This is not to argue that river navigation does not benefit from the prevention of great floods which require suspension of commerce, shift channels, and destroy warehouse and dockage facilities. But such benefits may be listed as direct benefits of flood control.

[14] This apparent conflict has been accepted by many as a convincing reason why the federal government should not seek to develop hydroelectric energy at its reservoir projects for flood control. See statements of O. S. Barrett and Alan N. Jordan at *Hearings on Comprehensive Flood Control Plans,* Committee on Flood Control, House of Representatives, Seventy-Fifth Congress, First Session (1937), p. 337; and statements of Representative Andrew May and Representative George W. Johnson at *Hearings on Comprehensive Flood Control Plans,* House Committee on Flood Control, Seventy-Fifth Congress, Third Session (1938), pp. 962, 964.

power generation after the period of flood danger is passed.[15] Preliminary to undertaking such operations, determination must be made as to what seasonal schedule of power use of flood storage capacity is consistent with maximum power generation at no expense to system effectiveness for flood control.

The seasonality of great floods on the Tennessee River is indicated in Table 4. This table reveals that the flood season is quite clearly included between the fifteenth of December and the fifteenth of April and that the peak of the flood "danger" occurs in March.[16] During this season, it is imperative that sufficient capacity be held available in the reservoir system above Chattanooga to control the design flood to not more than the crest of the (proposed) Chattanooga levee system. Although Table 3 above indicates that such control could be achieved by 2.60 million acre feet of storage capacity ideally placed, allowance for uncertainties of operation and for the peculiarities of particular storms suggests that approximately four million acre feet would be required to make certain that the design crest could be re-

[15] When the flood danger is not seasonal, joint power-flood control projects are economical only if the cost of capacity in a large reservoir is less than the cost of equal space in two smaller ones. Under such circumstances it is economical to superpose flood storage capacity on top of storage for power rather than to construct separate projects for the two purposes. This rationale appears to have been used by the United States Engineers in recommending a number of recent projects. See report on the Denison Project, Seventy-Fifth Congress, Third Session, House Document 541; and statement of Maj. Gen. Julian Schley at *Hearings on Comprehensive Flood Control Plans* (1938), p. 24.

[16] The following statement on the seasonality of Tennessee River floods is relevant:

> "Although extreme storms causing serious floods over limited areas may occur on the Hiwassee River in the summer months as they have occurred on some of the other Tennessee River tributaries, the record fails to show any substantial general flood on the Tennessee River during the months of May to November, inclusive. The flood record in the Tennessee Valley is short as compared with other river systems, but the data available appear sufficient to warrant the use of storage reservoirs for purposes other than flood control in the months mentioned."

Tennessee Valley Authority, Water Control Planning Department, Project Planning Division, "The Hiwassee Project on the Hiwassee River," Report 5-309, February, 1939, p. 23.

See also House Document 479, Seventy-Sixth Congress, Second Session, p. 17; and Exhibit 3 of House Document 91, Seventy-Sixth Congress, First Session.

TABLE 4

SEASONAL DISTRIBUTION OF FIFTY GREATEST FLOODS ON THE TENNESSEE RIVER[a]

Date	Gage Height (feet)	Discharge (c.f.s.)
November 22, 1906	33.3	222,000
December 21, 1915	34.4	210,000
December 29, 1926	38.4	247,000
December 31, 1875	34.4	230,000
December 31, 1932	37.6	240,000
January 2, 1902	40.8	279,000
January 12, 1895	32.1	213,000
January 15, 1879	38.1	257,000
January 17, 1892	38.0	257,000
January 19, 1882	40.4	275,000
January 23, 1883	38.6	261,000
January 24, 1922	35.8	223,000
January 31, 1875	32.6	216,000
February 1, 1918	42.7	289,000
February 9, 1899	38.6	261,000
February 11, 1884	36.9	249,000
February 13, 1921	34.5	211,000
February 14, 1891	37.5	253,000
February 20, 1893	33.4	222,000
February 26, 1897	35.2	236,000
March 1, 1875	53.8	410,000
March 2, 1890	42.6	294,000
March 2, 1903	31.1	206,000
March 4, 1902	38.0	257,000
March 6, 1934	34.1	208,000

Date	Gage Height (feet)	Discharge (c.f.s.)
March 7, 1917	47.7	341,000
March 10, 1884	42.9	297,000
March 11, 1867	57.9	459,000
March 11, 1891	38.9	264,000
March 14, 1897	38.2	258,000
March 17, 1913	31.3	207,000
March 18, 1880	38.4	260,000
March 22, 1897	33.5	223,000
March 22, 1899	40.2	274,000
March 23, 1875	34.3	229,000
March 25, 1929	38.7	250,000
March 28, 1917	34.1	208,000
March 29, 1936	37.1	235,000
March 30, 1913	33.3	222,000
March 31, 1902	31.3	207,000
March 31, 1912	31.3	207,000
April 3, 1886	52.2	391,000
April 5, 1896	40.5	276,000
April 5, 1920	43.6	298,000
April 9, 1892	34.6	231,000
April 9, 1936	35.4	220,000
April 11, 1903	32.0	212,000
April 26, 1883	32.8	218,000
May 25, 1901	33.0	219,000
August 17, 1901	33.2	221,000

[a]Source: House Document 91, Seventy-Sixth Congress, First Session, p. 69.

duced to sixty feet.[17] The contributions which the Authority proposes that its presently authorized tributary projects should make toward this required capacity are indicated in Table 5. Although these storage reservations could be increased to provide a full four million acre feet, the capacities already reserved provide practically full control of the streams upon which the projects are located.[18] Consequently, to make up the total capacity estimated by TVA as necessary to provide full control of the Tennessee River at Chattanooga (in conjunction with local levee works) the balance indicated in Table 5 should be provided on as yet uncontrolled tributaries.[19]

It will be noted from Table 5 that considerably more space is reserved for flood control on January 1 than on April 15. This gradual accumulation of storage during the flood season is accomplished without substantially impairing control by each project of the tributary upon which it is situated. It is useful in reducing the Tennessee River contribution to winter and early spring floods on the Mississippi, in providing a cushion against any false starts which might be made toward the use of flood storage in advance of the main flood during very wet seasons, and in providing a water supply for summer low water regulation. One of the schedules developed by TVA to guide the gradual filling of reservoirs during the winter flood season is

[17] TVA suggests that this capacity should be provided entirely upon tributary streams and that it should be supplemented by available surcharge at main river projects. Although this is a reasonable suggestion it may be regarded as quite conservative, particularly in the light of the generous margins for error which were allowed in estimating the maximum flood.

[18] The minimum flood storage capacity (or the maximum water elevation to be tolerated during the flood season) for the Hiwassee reservoir was determined as follows: Given a water surface elevation of 1465 at the start of the design flood, it was found that with proper operation of the gates (opening the conduit gates when the imminence of a great flood became evident and the spillway gates as the elevation of stored water approached the spillway crest) the entire flow of the stream could be held for the twenty-four hour period corresponding to the crest at Chattanooga. With such operation the contribution of the Hiwassee River over the forty-eight hour period corresponding to crest at Chattanooga would not exceed 12,000 c. f. s. Such control would completely fill the reservoir; but in so doing it would reduce the crest of the design flood at Chattanooga by 35,000 c. f. s. (from 730,000 to 695,000 c. f. s.). Accordingly, elevation 1465 was selected as the maximum water surface elevation for the Hiwassee pool during the flood season. (During much of the year it has been planned to hold the reservoir considerably below this level. See below, Table 6.)

[19] See Table 5, note b.

indicated in Table 6. After April 15 the flood season is considered to have passed, and storage is then accumulated as rapidly as possible for power use.[20]

TABLE 5

CONTROLLED TRIBUTARY FLOOD STORAGE AVAILABLE ABOVE CHATTANOOGA AT START AND CLOSE OF FLOOD SEASON

Project	Acre Feet of Storage	
	January 1	April 15
Cherokee[a]	1,257,000	581,000
Hiwassee	350,000	266,000
Norris	1,943,000	989,000
Subtotal	3,550,000	1,836,000
Supplementary flood storage required[b]	450,000	2,164,000
Total	4,000,000	4,000,000

[a]Based on tentative Cherokee multiple purpose operation.
[b]These figures represent the balance of storage capacity required for full protection of Chattanooga in conjunction with a local levee line adequate to confine a crest of sixty feet. Since the text was written and this table was prepared, additional TVA projects have been authorized on the Hiwassee and Holston watersheds (above the existing Hiwassee and Cherokee projects), at the Fontana site on the Little Tennessee River, and at the Douglas site on the French Broad River. These are defense undertakings, and for the duration of the war they will be operated exclusively for power. After the war, when multiple purpose operation is inaugurated, they will virtually assure complete flood control along the main Tennessee River.
Source: Tennessee Valley Authority.

Although the bulk of TVA flood storage is provided in tributary reservoirs, limited storage is also available at some of the main river projects as surcharge above dead storage elevations maintained for navigation. Operating rules for the management of main river "live storage" have also been formulated. These provide for the reservation empty of almost all such storage during the flood period but for the subsequent filling of much of it for malaria control and power. Limited surcharge is kept available at some of the pools against the possibility of summer flash floods. Of the several main river reservoirs, by far the most important from the flood control standpoint is the Kentucky project which is to yield its benefits, not in the Tennessee Valley, but downstream along the lower Ohio and the Mississippi.

Let us consider now the problems of co-ordinating power

[20] Of course sufficient capacity must be reserved to control summer flash floods. At most TVA projects such capacity is kept available as surcharge above normal "full" elevations.

operations with the navigation and flood control requirements which have been discussed above.

SYSTEM PLANNING FOR POWER

The two basic determinants of quantity of hydroelectric power are volume of stream flow and the head over which this flow falls. Reservoir operation for power, therefore, is interested in maintaining as much storage as possible in order both to preserve the highest possible head and also to provide a source for regulation of dry season flow. Although TVA flood rules prevent the accumulation of storage out of the abundant stream flows of winter and early spring (except in accord with Table 6), in many years the onset of the summer dry season is sufficiently delayed after April 15 to permit the filling of reservoirs. In relatively dry years, however, the delay in filling under flood rules causes loss of water when it is available and prevents the achievement of full pools. Power supply is thus adversely affected. Since primary power (that power which is available 100 percent of the time)[21] determines the power value of a system, it follows that TVA flood rules impair system power value.

TABLE 6

TRIBUTARY FLOOD CONTROL RULE CURVES

Date	Reservoir Elevation[a]		
	Norris	Hiwassee	Cherokee[b]
January 1	960	1425	1010
February 1	976	1439	1023
March 1	981	1450	1035
April 1	1000	1461	1047
April 15	1005	1465	1053
Top of Gates	1032	1526	1075

[a]Between dates indicated reservoirs are filled on a straight line according to volume (except for flood operation and moderate tolerance allowances).
[b]All data for Cherokee multiple purpose operation are tentative. Throughout the defense emergency this project is to be operated for power only.
Source: Tennessee Valley Authority.

[21] For obvious reasons, primary power is not usually taken as the minimum in the dryest possible year of the future but rather as that available in every

The amount of primary power lost as a result of flood control operations may be determined by a comparison of power estimated as available under TVA rule curve operation with power which would be available if the reservoir system were operated for power purposes only. The procedure by which system power availability is computed involves complicated problems of engineering which we can scarcely undertake to discuss here;[22] but in Table 7 below there is indicated a short-cut method for estimating primary power of the TVA "ten-dam" system. Due to the observation of flood control rules, tributary storage at the start of the dry period is 68,420 and 6,360 week-second-feet at the Norris and Hiwassee projects respectively as contrasted with capacities for the two reservoirs of 108,000 and 26,500 week-second-feet. Likewise main river storage is less than capacity. Under these circumstances indicated primary power is 485,000 kilowatts. In the absence of the flood control objective all reservoirs would have been filled at the start of the critical period with a resultant substantial increase of primary power. Table 8 indicates an estimate of what this increase might have been if only the two tributary reservoirs had been filled at the start of the period.[23] If flood control rules had been eliminated at the main river projects as well, the increase in available primary would have far exceeded this 72,000 kilowatt figure.[24]

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year except, say, one year in twenty-five. Power available in wet years but not available "100 percent of the time" is classed as secondary. Although it commands a market among industrial firms, it is not nearly as valuable as primary.

[22] See, for example, discussion under heading "Basic Assumptions for Stream Flow and Power Studies" in the *Engineering Report of the Joint Committee Investigating the Tennessee Valley Authority*, Pursuant to Public Resolution 83, Seventy-Fifth Congress, Third Session, p. 321 ff. (Although it is not indicated as such, this appears to be a reprint of a TVA office memorandum, "Preliminary Report on Basic Assumptions Used in General Power Studies," Power Planning Division, Hydraulic and Power Section, May 20, 1936.)

[23] Although this is a substantial adjustment, it is not to be regarded as an estimate of the loss of primary which results for the entire system through flood control operations. First, it takes no consideration of differences in storage at the main river projects under "power only" operation; second, the constants (kilowatt-weeks per week-second-foot) which are used have not been closely estimated; and third, under revised operations the length of the critical period might change.

[24] Mr. Lilienthal estimated the loss of primary power resultant upon flood control operation of the three-dam (Norris-Wheeler-Wilson) system at 40,000 kilowatts, or more than twenty percent of power available in the system without

TABLE 7

ESTIMATED PRIMARY POWER OF TVA TEN-DAM SYSTEM AS DETERMINED BY STREAM FLOW OF 1925 LOW WATER PERIOD[a]

Project	Natural Flow	Total Storage at Start of Dry Period		Total Water	Constant (kw. wks. per w.s.f.)	Total Energy (kw. wks.)
		At Project	Upstream[b]			
Norris.......	38,680	68,420	....	107,100	11.90	1,275,000
Hiwassee.....	19,224	6,360	....	25,584	13.90	356,000
Fort Loudoun	131,800	......	1,500	133,300	4.54	605,000
Watts Bar....	247,140	......	10,000 68,420	325,560	4.43	1,440,000
Chickamauga.	322,400	......	21,500 74,780	418,680	3.08	1,290,000
Guntersville..	362,800	......	21,500 74,780	459,080	2.69	1,235,000
Wheeler......	382,000	16,900	21,500 74,780	495,180	3.43	1,700,000
Wilson.......	399,700	......	21,500 91,680	512,880	6.63	3,400,000
Pickwick.....	430,000	13,700	21,500 91,680	556,880	3.87	2,155,000
Kentucky....	523,730	31,000	21,500 105,380	681,610	3.64	2,480,000

Total energy, all projects, say,......................15,940,000

Average power available over dry period 15,940,000/28 or 569,000 kw.
Less: Leakage and evaporation....32,000
Utilization losses (9½%).....52,000

84,000

Net primary power at station busbars..................485,000 kw.

[a]The 1925 low water period continued for 28 weeks from the 14th to the 41st week.
[b]Upper figure, privately owned storage before transfer of Tennessee Electric Power Company; lower figure, TVA storage.
Source: Tennessee Valley Authority.

flood control. *Hearings* before Joint Committee Investigating the Tennessee Valley Authority, p. 782.

The several estimates of power loss quoted here refer to TVA hydroelectric operations without consideration of steam relays to "firm up" secondary.

Finally, mention should be made of TVA generation of "secondary" energy. During years of generous stream flow power well in excess of the primary level is available, and it is generated and sold as secondary. Since its availability cannot be guaranteed, its market is limited. Nevertheless, the Authority has

TABLE 8

INCREASE IN PRIMARY POWER OF TVA TEN-DAM SYSTEM RESULTANT UPON OPERATION OF NORRIS AND HIWASSEE PROJECTS FOR POWER ONLY

Project	Additional Flow Available (w.s.f.)	Kilowatt-weeks per w.s.f.	Total Additional Energy Over Dry Period (kw. wks.)
Norris.	39,580	40.67[a]	1,610,000
Hiwassee.	19,640	39.00[b]	766,000
			2,376,000

Average weekly increase in power over dry period. . . . . .2,376,000/28 or 84,700 kilowatts
Less: Leakage and evaporation (say). 4,700

80,000 kw.
Utilization losses (9½%). 7,950

Net total increase in primary power at generating station busbars. . . . . .72,050 kw.
Say, 72,000 kilowatts

[a]Based on constants for main river projects from Watts Bar to Kentucky as indicated in Table 7 and on increase of Norris constant to 12.9 kw. wks./w.s.f.

[b]Based on constants for main river projects from Chickamauga to Kentucky as indicated in Table 7 and on increase of Hiwassee constant to 15.66 kw. wks./w.s.f.

negotiated a number of contracts for this class of power at relatively attractive prices. In order to determine when secondary energy is available and when secondary customers must be cut off to protect primary demand, the Authority has prepared a "primary power rule curve" which is, in effect, based upon an envelope of the minimum stream flows of past dry seasons. When reservoir storage supplemented by stream flow predicted on this ultimately pessimistic basis is only adequate to carry primary power through the prospective dry season, secondary is no longer considered available.

OTHER ASPECTS OF WATER CONTROL PLANNING

Although navigation, flood control, and power are the major objectives of TVA water control activities, two incidental purposes, malaria control and recreation, also have an interest in this program.

Since the chain of TVA main river lakes runs through malaria country, unusual precautions must be taken to prevent their use as breeding centers by the malarial mosquito. One reasonably effective prophylactic measure which has been used by the Authority has been to spray shore lines from the air with oil and gasoline. But it was soon found that this method was not completely satisfactory, and a further approach to the problem was sought. After careful study of the breeding season and the time required for breeding of malaria carrying mosquitoes, it was determined that an optimum reservoir program for malaria control would require filling the pools to a maximum level during the winter and early spring and then gradual lowering of them to normal operating levels about the fifteenth of June. A schedule of this nature would retard shore vegetation, strand floatage, and leave a clear shore line. Beginning about the middle of June reservoir elevations should be fluctuated over a range of about a foot every week or ten days in order periodically to drown out or dry up possible breeding pools. Unfortunately, although such a schedule could be harmonized with the interests of navigation, it would be quite in conflict with the interests of flood control and power. Therefore, a modified plan was prepared which gives promise of reconciling the various objectives and also effectively preventing the breeding of malaria carrying mosquitoes. This plan provides for holding pools at flood control levels through the thirteenth week, then filling them as rapidly as possible to an "upper summer elevation" and holding them at this through the twentieth week. A gradual summer drawdown is then inaugurated during which weekly fluctuations of elevations are practiced. After the thirty-ninth week (September 30) the malaria season is considered closed, and pools are then refilled to the "upper summer elevation" for power purposes (if water is available). After the forty-seventh week drawdown is begun for the flood season of the following winter; and at the close of the fifty-second week the schedule calls for the return of pools once more to flood elevations.

Although this program for harmonizing the various stream control objectives is indeed ingenious, it must be recognized that the pool elevation fluctuations for malaria control during the spring and summer reduce storage head available for use in the generation of hydroelectricity. It is at a slight but perceptible cost to its power program that the Authority has assumed its social responsibility to prevent the use of its reservoirs as breeding grounds by the malarial mosquito.

Finally, the relation of the water control program to the optimum development of the Tennessee valley for recreation should be noted. Already the TVA chain of lakes has become one of the outstanding scenic resources of the central south.[25] To a considerable extent the activities of the TVA in the recreation field have been restricted by a lack of legislative authority for a thorough program. Nevertheless, the Authority has given direction at a number of points to water-side park planning, to access road construction, and to dock construction; it has maintained fish hatcheries, and it has studied problems of wild life adjustment to the changes which the water program has effected in the natural environment.[26] During the period in which this program has been under development tremendous increases in sales of fishing and boating equipment throughout the valley have revealed a rapidly mounting interest in water sports. Meanwhile, out-of-state interest in the TVA projects, as evidenced by increas-

[25] See "Recreation," Preliminary Report of the Tennessee State Planning Commission, Bulletin No. 15, Nashville, Tennessee, January, 1939.

[26] Such authority as TVA has had for activities in the recreation field in the past has been pursuant to section 22 of the TVA Act and Executive Order No. 6161 of June 8, 1933. This is restricted to the execution of surveys and preparation of general plans, and the carrying out of ". . . . studies, experiments, or demonstrations."

On the Authority's role in the recreational development of the Tennessee Valley see "Recreation Development of the Tennessee River System," Seventy-Sixth Congress, Third Session, House Document 565. See also, for example, the *Knoxville News-Sentinel*, May 28, 1940, p. 22.

ing numbers of tourist visitors to the valley, has given promise of developing a prosperous tourist industry in the region.[27]

A minor problem but a quite interesting one exists in reconciling the interests of recreation with those objectives of stream control which require summer drawdown at the tributary reservoirs, for recreation is best served by the establishment of beaches and a permanent shore line. This has been solved at several of the TVA reservoirs by the construction of cut-off dams across the mouths of small inlets or other indentations into the shore lines of the main pools. The small resulting ponds may then be held at constant levels throughout the summer recreational period to be used for swimming and small boating while the main pool is drawn down as much as needed.[28] This principle was employed near Caryville, Tennessee to prevent the appearance of mud flats with reservoir drawdown.[29] At the Hiwassee project the problem of mud banks near Murphy, North Carolina has also required special study. One contemplated solution has been to draw harder on Norris during the early summer in order to be able to hold Hiwassee at a relatively high level until after the close of the recreation season.

Except for the complications attendant upon reservoir drawdown suggested above there appear to be few important conflicts between recreation and the other objectives of stream control. The auspices thus seem favorable to the success of any large scale effort to integrate recreation into the comprehensive program for water control. Meanwhile, with but little stimulation the recreational advantages of the water control program have already proved a surprise to most persons connected with the Authority.[30] It is very possible that in years to come this objective, of which Congress scarcely dreamed when it enacted the original TVA legislation, may well prove to represent one of the more important contributions of TVA.

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[27] At p. 83 of House Document 565 it is pointed out that only thirty percent of the guests at the cottages in Norris park in 1937 were from Tennessee.

[28] The Big Ridge recreation pool on Norris Lake is of this nature. *Ibid.*, 45-46.

[29] *Ibid.*, p. 50.

[30] There has been little direct investment by the Authority for recreation. Some of the costs which may be charged against this objective, however, include parks and landscaping, rest-rooms, visitor service, observation facilities, boat docks, and special artistic care in project construction.

PLANNING FOR THE DISPOSITION OF SURPLUS POWER

A final aspect of TVA operations which commands attention is the program for marketing energy generated at the multiple purpose stream control projects. Despite harassing litigation and vigorous opposition on the part of established utility systems, TVA has developed a public transmission network over which it delivers energy to two major classes of customers. These are first, a group of publicly and co-operatively owned distribution organizations which purchase power for resale to all classes of consumers in the local power market, and second, a group of great industrial concerns to which sales are made pursuant to law to improve system load factor and revenue returns.[31] To carry out the stipulation of the TVA law that the power program shall be oriented primarily toward the benefit of the domestic and rural customer the Authority has prescribed in all of its power contracts with distributors resale rate schedules of the inducement type. Against these resale rates, especially against those for domestic customers which are known as the TVA "yardstick," the most bitter attacks of TVA's opponents have been launched.

So far as the financial soundness of the power program of the Authority proper is concerned, attention must be directed not to the resale rates but to the rates at which TVA disposes of energy to its industrial and publicly owned customers. For energy available from the "ten-plant system" (without steam relay) it was estimated that these rates would yield revenues as indicated in Table 9. At first glance the data of this table seem to show that preferential customers are required to pay higher rates for primary energy than are the great industrials. The average figures which give this impression, however, take no account of the varying load factor conditions under which different classes of customers take energy.[32] If, for example, the standard A-1

[31] The Act provides that the former of these two groups shall be deemed preferential.

[32] They also ignore differences in transformation and transmission services rendered by TVA.

rate schedule, according to which bills of preferential customers are determined, were used to compute the bill of a hypothetical customer using 1,440,000 kilowatt-hours monthly at 100 percent load factor, the average rate per kilowatt-hour would be only 2.4 mills or less than the average primary rate of industrials.[33]

TABLE 9

ESTIMATED ANNUAL REVENUES UNDER TVA RATES FROM ENERGY OF TEN-PLANT SYSTEM[a]

Class of Customer	Class of Energy	Energy Taken (in millions of kwh.)	Annual Revenues	Rate per kwh.
Municipalities and Co-operatives	Primary	2,846.4	$12,236,000	4.30
Industrials	Primary	770.0	2,133,480	2.77
Industrials	Interruptible	633.6	1,247,820	1.97
Industrials and TVA Fertilizer	Secondary	2,300.0	4,133,750	1.80
....	Dump	....	500,000	....
			$20,251,050	

[a]Source: *Hearings before the Joint Committee on the Investigation of the Tennessee Valley Authority*, Seventy-Fifth Congress, Third Session, Pursuant to Public Resolution Number 83, Table 7, p. 5338.

Even were a simple comparison of energy charges per kilowatt-hour for different classes of customer meaningful, the fact that large industrials were able to purchase primary energy more

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[33] Computation of this hypothetical bill is as follows:

Demand Charge		
2000 kilowatts at $.90		$ 1,800
Energy Charge		
100,000 kwh @ $.00400	$ 4,000	
200,000 kwh @ .00300	6,000	
420,000 kwh @ .00250	10,500	
280,000 kwh @ .00200	5,600	
440,000 kwh @ .00125	6,600	
		32,700
Total bill		$34,500
Rate per kilowatt-hour: $34,500/1,440,000 kwh., or		$0.0024 (ca.)

cheaply than could the "preferential" customers would not automatically establish that the Authority had violated the preference clause of the act. For no consideration of rates for primary energy sold to industrials can be complete without consideration of the supplementary problem of rates for secondary energy. TVA contracts for sale of the latter class of power were estimated to yield an average of 1.80 mills per kilowatt-hour; if "interruptible" power were included as secondary (of rather high grade), this average would increase to 1.83 mills. The customers who have agreed to pay these rates are largely great chemical concerns which are able to schedule their operations so as to be able to shut down periodically when power is not available. It is a reasonable presumption that they would not have been willing to pay as attractive prices as they did accept if they had not also been able to obtain a certain minimum of inexpensive primary energy which would be available for plant maintenance and overhauling work during shutdowns. If one makes the purely arbitrary assumption that five percent of the very handsome 1.83 mill yield on secondary was made possible because of the reasonableness of the primary rate, then $270,000 of annual secondary revenues should be credited to primary. This would increase the average yield on primary from industrial customers by .35 mills per kilowatt hour to 3.12 mills. Taking both this adjustment and the matter of load factor into consideration, there does not seem to be any significant differentiation between the rates assessed TVA preferential and TVA industrial customers.[34]

Quite another problem than the fairness of relative power

[34] Although there may be no discernable rate preference in favor of public bodies, they do seem to be accorded another type of preference: this is in the Authority's carefully guarded readiness to serve their ever growing demand. To this end TVA has staggered the maturities of its industrial power contracts in order that primary energy may be released from time to time to take care of the expansion of preference demand.

An interesting interpretation of the preference clause was required in the case of the application of Bessemer, Alabama for a TVA power contract. The Authority did not believe that construction of a transmission line to Bessemer would be economical and therefore rejected the application. Bessemer then proposed to construct its own transmission line to the Authority network. Although TVA discouraged this undertaking, when Bessemer persisted TVA considered itself bound by the Act to grant it a contract on a parity with other publicly owned customers. *Tennessee Valley Authority,* Hearings before House Committee on Military Affairs, Seventy-Sixth Congress, Third Session (1940), p. 196.

charges as among different classes of customers is the question of the over-all adequacy of rates to cover power "costs." Whereas a privately owned and operated business enterprise dealing in a single commodity can usually arrive at a fair approximation as to its total annual costs (even if apportionment among particular units of output is difficult),[35] accurate cost determination for different objectives of a publicly owned and operated multiple purpose enterprise gives rise to difficulties which are well nigh insoluble. In public enterprise almost all of the problems of cost apportionment which confront private business are present, and there are in addition difficult questions to be settled as to the appropriate treatment of interest, taxes, and the division of common costs.[36] With the first two of these categories we are not directly concerned in the present study; with the third, however, we shall be concerned throughout Part II below. Here it may be pointed out that for the "ten-plant system" estimates have placed total annual "direct" power operating costs plus "fixed" costs upon facilities useful only for the power objective (on the basis of certain assumptions)[37] at $13,756,701. Total annual common costs (including both operating and "fixed" costs) of the water control program were put at $9,530,000. Under an apportionment of these costs tentatively suggested by TVA[38] 38.1 percent

[35] Even in the case of private single purpose enterprise, the problem of depreciation often gives rise to serious difficulties in determining annual costs of the business. When a firm produces several goods or services, the problems of cost determination are still more complicated. One writer has argued that in the power industry, accurate apportionment of costs among different classes of service is impossible. See Philip Cabot, "An Analysis of the Domestic Business of the Hartford Electric Light Company, 1914-1926," 30 *The Annalist* 780 (November 18, 1927). Contrast with this viewpoint the work of the New York Power Authority in seeking to achieve reasonable apportionments of costs among different classes of customers. See *Annual Reports* of the New York Power Authority, especially for 1938.

[36] A variation of the interest problem is the determination of proper return upon public investment. A number of less important problems arise in accounting for free services to public agencies by other public agencies (e.g., the franking privilege, Treasury assistance in the floating of securities, or the use of the Government Printing Office).

[37] The most important assumptions underlying this estimate were three percent interest and three percent sinking fund depreciation.

[38] This is an allocation of the "ten-plant system" along the same lines as the three-plant allocation which was submitted to the President and approved by him. See House Document 709, Seventy-Fifth Congress, Third Session.

The cost estimates cited in the present paragraph of the text are taken of common "fixed" costs and 33⅓ percent of common operating costs (or $3,555,632) should be charged against power. This would indicate total annual "nominal" power costs of $17,312,333. Compared with annual prospective revenues from the ten-plant system of $20,251,050 (from Table 9), such costs would leave net annual power income of $2,938,717. Putting these data otherwise, revenues to this TVA system under established rate schedules would be adequate to pay all costs directly traceable to the power program and to contribute in addition $6,494,349 annually toward common costs. Compared with the nominal allocation of 40 percent of common costs to power for the three-plant system, established TVA rates apparently are adequate to contribute revenues after all power costs equivalent to 68.2 percent of common costs. Economy for the entire water control program is thus contingent upon the ability of other objectives to bear their separate costs plus only 32 percent of common costs.[39]

CONCLUSION

Throughout the first five chapters of this study we have surveyed the broad background of the TVA legislation and sought to establish the place of TVA in federal policy. We have found that the Authority is not unique as a public multiple purpose undertaking, but that it is unique as a decentralized federal agency dedicated to comprehensive conservation and improvement of the resources of an entire drainage basin. We have examined the technical considerations which guide and determine TVA water planning, and have found that the assertion that power is accorded priority over all other stream control objectives appears to be without foundation.

The multiple purpose character of TVA stream planning gives rise to challenging problems in the apportionment of system

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from "Liquidation Analysis of the Ten-Plant System," *Hearings before the Joint Committee on the Investigation of the Tennessee Valley Authority*, pp. 5327-5356.

[39] Once more these figures are on the basis of three percent interest and three percent sinking fund depreciation. They are also based upon the original tax provision of the 1933 Act. Assuming ten percent payment to the states instead of five percent, the contribution of power revenues to common costs would be $5,481,799, or 57.5 percent. This modified figure is still more than 50 percent in excess of the allocation tentatively suggested by TVA.

costs and the determination of economic criteria for system planning. These important difficulties command detailed analysis. The first is considered in Part II below and the second in Part III. Before taking up this discussion, we outline in an Appendix to Part I the nature of the TVA program for distribution of electricity by municipal and co-operative contractors purchasing TVA energy for resale.

APPENDIX TO PART I

AN ANALYSIS OF TVA RESALE POWER RATES

Summary. The contribution of the Tennessee Valley Authority to rate regulation of the power industry has been made through the agency of publicly owned distribution organizations which sell TVA energy at retail. The rates at which these sales are made are prescribed by TVA in its power contracts with the distributors and constitute sharp reductions from rates which generally prevailed in the Valley prior to the inauguration of the TVA program. The theory which led to these reductions has two major premises: first, that the elasticity of demand for electric power is high; and second, that fixed costs play an important role in the power distribution business. In the working out of the resale program over the years during which TVA inducement rates have been in effect, both of these premises appear to have been validated.

The promotional rates of TVA contractors represent far greater absolute reductions from the previously existing level of retail rates than can be explained by any concession in TVA wholesale rates. These retail rates make up the now famous TVA "yardstick." Although differences in operating conditions in different communities as well as rules of law prevent any general requirement that American utilities engaged in power distribution meet the "yardstick," the forces of direct and potential competition have been effective in stimulating many of them to approach it. The rate policy of the southeastern power companies in particular has been more aggressive since 1933 than it was during the preceding decade. Present evidence lends support to the position that the companies will find promotional rates as economical as have TVA contractors. Nevertheless, it must be recognized that the basic technique of regulation in the utility field remains the regulatory commission. The public interest requires that the commissions make every effort to encourage the utilities in sincere experimentation in the making of inducement rates. If such encouragement fails, the chance is great that public yardstick competition will directly force the privately owned industry to adopt promotional rates. Surprisingly enough, in yielding to the compulsion of the yardstick, private enterprise in the power industry may find its institutional salvation.

THE PLACE OF RESALE RATES IN THE TVA POWER PROGRAM

One of the most interesting developments of modern industrial organization has been the tendency of firms in many lines of business to expand their areas of control by means of horizontal and vertical integration. Both aspects of this tendency may be noted in Tennessee Valley Authority. It has engaged in horizontal integration by bringing under a single control the power generating and transmitting business of the Tennessee Valley region. It has engaged in vertical integration by extending its water control activities back beyond stream control to control of water on the land and by extending its power marketing program forward beyond the sale of power at wholesale to control of the conditions under which power is sold at retail.[1] It is significant that the latter phase of this integration has been accomplished without corresponding expansion of the proprietary activities and rights of ownership of the Authority. Co-operative arrangements with existing agencies have been employed as instrumentalities whereby the Authority might influence farm practices; and resale power contracts have been used to specify the conditions under which energy might be sold at retail to the ultimate consumer. It would appear that any study of TVA as an economic institution must recognize that certain of its functions are carried out through other organizations. In the present appendix it is our purpose to present a cursory analysis of the operations of one group of such organizations, the TVA power contractors.[2]

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[1] Still another aspect of integration at TVA is the integration of multiple objectives into the water control program.

[2] The extent of TVA control over the contractors is indicated in the following extract from an early memorandum by Mr. Lilienthal to his fellow board members suggesting principles which TVA should incorporate into its contracts for the sale of energy to distribution organizations:

> "The basic terms of contracts with municipalities—since the Authority is concerned not merely with supplying electricity at wholesale at reasonable rates and under conditions which will promote the general economic objectives of the law, but also in the rate to the ultimate consumer—the contracts with municipalities should contain terms expressing the following principles:
>
> (1) Sound business management of the municipally owned agency apart from the city council or town board, and by the selection of a competent superintendent;

THE THEORY OF THE INDUCEMENT RATE

In accord with the preference clause of the TVA Act the Authority has negotiated contracts with two types of publicly owned agencies for sale of the bulk of its available primary power. These are, first, municipally owned power distribution boards and second, rural distribution organizations which are co-operatively owned. Through these agencies the vast majority of ultimate power customers in the Tennessee Valley region are served.

The keystone in the arch of TVA resale rate policy, as embodied in power contracts with the distributors, has been concisely described by Director Lilienthal as follows:

> "One principle of pricing (for power) must be clearly recognized, or the entire significance of the TVA electricity program is obscured: *the rate charged for electricity, within wide limits, determines the cost.* No analysis of rates for domestic electricity is worth serious consideration unless it is based on this principle." [3]

In terms of economics this statement is based upon two premises: first, that the elasticity of demand for electrical energy is high; and second, that a large part of all costs of distributed energy is fixed. Let us consider the latter premise for a moment.

Perhaps the agency which has prosecuted the most intense research into electric power costs is the Power Authority of the State of New York. Although most of this work has been done since 1933, there was available at the time TVA was formu-

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(2) Requiring municipal utility to stand on its own bottom (i.e, to be wholly self-supporting) and (on the other hand) not to be a source of tax relief, at the expense of rate payers, beyond a fair return to the city's general fund on the city's utility investment;

(3) These two objectives require the keeping of accounts according to uniform practices. . . . ;

(4) Requiring fair and nondiscriminatory rates at retail, to insure that the general principles of a more extensive use of power and other objectives of the Authority may be achieved, and where opportunity affords, cities and towns should seek a policy of serving adjoining rural areas at rates within a certain range. No inflexible rule should be exacted, at least for the time being. Service at wholesale to co-operative farm groups."

Hearings before the Joint Committee on the Investigation of the Tennessee Valley Authority, Seventy-Fifth Congress, Third Session, Pursuant to Public Resolution 83, p. 757 (quoting "A Plan of Action," Memorandum of August 22, 1933).

[3] David Lilienthal, "Is TVA Really Hurting Private Utilities," 17 (1936) *Public Utilities Fortnightly* 744 (italics and parenthesis supplied).

lating its initial resale rate schedules a preliminary draft of the "Clegg Report" (dated October 1, 1933) which examined the effects of increasing consumption upon distribution costs. The conclusion of this study was as follows:

> "Distribution costs per kilowatt-hour go down as the use goes up. By doubling the consumption the unit cost per kilowatt-hour is about cut in half. The annual distribution cost per average domestic consumer is almost a fixed amount independent of the quantity of electricity used. Cost factors other than use tend to offset one another." [4]

As a follow-up of the Clegg report a more comprehensive analysis of the costs of energy distribution was later undertaken by the Power Authority. Data were collected from a large number of both publicly and privately owned distribution agencies over the country and subjected to careful analysis and interpretation in order to discover the behavior of the several major elements of distribution cost with increasing consumption. Combining the trends of these various components, the effect upon total costs of changing consumption could be determined. Allowing for all variable expenses, nine percent upon investment annually for "fixed" charges (including return, depreciation and insurance), and fifteen percent of other annual costs for taxes, the Power Authority found that the following amounts should generally prove adequate to cover the costs of domestic energy distribution when applied upon a regional basis: [5]

(1) For an average use of 600 kilowatt-hours annually the cost per customer should not exceed $15.00, or an average of 2.5 cents per kilowatt hour;

(2) For an average use of 3,000 kilowatt-hours annually the cost per customer should not exceed $19.00, or an average of 0.633 cents per kilowatt hour (the incremental cost of the 2,400 kilowatt hours added being $4.00 or .167 cents per kilowatt hour);

(3) For an average use of more than 3,000 kilowatt-hours the incremental cost should not exceed .100 cents per kilowatt hour.[6]

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[4] Quoted in *Hearings before the Joint Committee on the Investigation of the TVA*, p. 791.

[5] The proviso as to regional application of the findings was included so that territories of dense utilization might be available to recover any deficits which might be incurred in serving thinly settled areas.

[6] New York Power Authority, *Annual Report*, 1938, pp. 275-276. It should

If these distribution costs are combined with a reasonable figure for energy before distribution, it is possible to synthesize a schedule of power costs which bears a remarkable resemblance to the domestic schedule of the TVA contractors. This was done by Mr. Leland Olds, formerly Executive Secretary of the Power Authority and more recently Chairman of the Federal Power Commission, in the manner of Table 10. From this analysis

TABLE 10

PRIVATE POWER COSTS COMPARED WITH TVA RESALE RATES FOR DOMESTIC CUSTOMERS

Monthly Use (in kwh.)	Power Costs[a]			TVA Domestic Rate[a]
	Supply	Distribution	Total	
50	.7	2.5	3.2	3.0
100	.7	1.7	2.4	2.5
200	.7	1.1	1.8	2.3
400	.7	.7	1.4	1.6
800	.7	.4	1.1	1.0

[a]The body of the table is in cents per kilowatt-hour.
Source: *Reports and Exhibits,* Joint Committee on the Investigation of the Tennessee Valley Authority, p. 224.

it would appear that if commercial and industrial resale schedules are not out of line with domestic ones, both TVA contractors and privately owned competing power utilities should be able to earn at least modest returns under TVA rates.[7]

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be pointed out that these figures do not include any allowance for working capital and provide no margin for error. Since the several components of cost were separately estimated, however, one might reasonably expect errors to be compensating.

[7] This statement assumes energy available for distribution at a cost not to exceed seven mills. On this matter Mr. Olds declares that studies by the Power Authority suggest that energy could be supplied for distribution in the Tennessee Valley from privately owned steam plants for "somewhat less than . . . . 0.65 cents," *ibid.* See also Mr. Olds' statement, "The Alabama Power Company as a Wholesale Yardstick," *ibid.*, pp. 235 ff.

Figures beginning around seven mills and ranging considerably upward were found typical of the "net cost of power supply" for companies in New York State by the New York Power Authority. But this analysis took no account of possible overstatements of invested capital by the companies. See *Eighth Annual Report* (1938) of New York Power Authority, Appendix 7, "Report on the Cost of Power Ready to Distribute. . . . ." Assuming a favorable load factor and the relatively economical operating conditions of the southeast, an average cost of supply in the neighborhood of seven mills would not be inconsistent with this report. See also "Economic Aspects of Energy Generation, A Symposium," *Proceedings,* American Society of Civil Engineers, December, 1937 to September, 1938, *passim.,* and "Costs of Energy Generation, Second Symposium on Power Costs, *ibid.,* April, 1938 to October, 1938, *passim.*

With this introduction to the cost theory upon which TVA inducement resale rates are based, let us turn to a discussion of how they have worked out in practice. We shall proceed along the following lines: first, a consideration of the character of the various classifications of resale rates; second, a study of the response of consumption to the promotional quality of these rates; and third, an analysis of the trends of net revenues of TVA contractors. The present appendix will close with a few remarks on the controversial "yardstick" issue.

THE NATURE OF TVA RESALE RATES

The rate schedules prescribed by TVA in its power contracts with publicly owned distributors represent for all classes of customers substantial reductions from previously prevailing rates

TABLE 11

TYPICAL RESIDENTIAL POWER BILLS OF TVA CONTRACTORS COMPARED WITH BILLS UNDER 1932 RATES OF SIX PRIVATELY OWNED POWER COMPANIES

Company	Monthly Energy Consumption (in kilowatt-hours)		
	25	100	250
Alabama Power Company (Montgomery)	$1.92	$4.75	$8.50
Birmingham Electric Company	1.92	4.62	8.71
Georgia Power Company (Atlanta)	2.25	5.00	9.00
Memphis Power and Light Company	1.75	4.80	9.30
Tennessee Electric Power Company (Chattanooga)	2.14	5.13	9.41
Tennessee Public Service Company (Knoxville)	2.20	5.85	9.80
Six-company simple arithmetic average[a]	2.03	5.025	9.12
TVA contractors (Schedule B-1)	.75	2.50	5.00
Percent reduction, TVA contractors from six-company average	63.05	50.25	45.18

[a] For many purposes a more useful average would be one which was weighted according to number of residential customers of the different companies or total residential kilowatt-hour sales. The simple average is used to indicate a figure in some sense typical of the companies without regard to their size. It may be compared with median figures for the three levels of consumption of $1.965, $4.90, and $9.15.

The basic source for this table was Exhibit 549 submitted to the Joint Committee Investigating the Tennessee Valley Authority.

in the region. For residential customers a comparison between the standard TVA resale schedule (B-1) and the schedules of six southeastern privately owned power companies for 1932 is included below as Table 11. For commercial customers a similar comparison between bills under TVA resale rate schedule, B-2 (adjusted by a ten percent development surcharge), and the comparable 1932 schedules of six privately owned power companies is indicated in Table 12. Although possible differences in criteria of customer classification require that comparisons of commercial schedules be made with care, it does not seem probable that differences of this sort could account for the extent of the reductions indicated in this table. Finally, in Table 13 typical bills under TVA resale rates for industrial customers are compared with bills of five privately owned power companies for comparable use under schedules in effect in 1932. As in the

TABLE 12

TYPICAL COMMERCIAL POWER BILLS OF TVA CONTRACTORS COMPARED WITH BILLS UNDER 1932 RATES OF SIX PRIVATELY OWNED POWER COMPANIES

Company	Monthly Peak Demand in kilowatts and Energy Consumption in kilowatt-hours				
	.75 kw. 50 kwh.	1.5 kw. 150 kwh.	3.0 kw. 375 kwh.	6.0 kw. 750 kwh.	12.0 kw. 1500 kwh.
Alabama Power Company	$ 3.95	$ 9.40	$20.65	$40.90	$ 76.40
Birmingham Electric Company	3.83	10.80	23.63	40.50	74.25
Georgia Power Company	4.00	10.00	21.75	40.50	79.00
Memphis Power and Light Company	4.00	11.00	25.00	45.00	77.50
Tennessee Electric Power Company	4.28	10.26	23.37	46.74	84.49
Tennessee Public Service Company	4.70	12.75	28.75	50.50	94.00
Six-company simple arithmetic average[a]	4.13	10.70	23.86	44.02	80.94
TVA contractors (Schedule B-2)[b]	1.65	4.95	9.90	15.40	25.08
Percent reduction, TVA contractors from six-company average	60.0	53.7	58.4	65.0	69.1

[a]See note on use of simple arithmetic average in Table 11.
[b]The rates used for computation of these bills are the basic B-2 rates plus ten percent for developmental surcharge.
Source: Exhibit 549 submitted to the Joint Committee on the Investigation of the Tennessee Valley Authority.

case of commercial rates, a warning must be entered against making too precise comparisons of the indicated industrial bills since it is possible that certain of the companies were more rigid than others in enforcing restrictions against the use of industrial energy for lighting or motive power.[8]

[8] It should be remarked here that TVA supplements industrial sales of its contractors with direct sales to certain very large customers. See above, Chapter

Consideration of the data of Tables 11, 12 and 13 reveals two significant points. First, for each of these three major classes of customers at every level of consumption it appears that TVA resale rates represent major reductions from rates which prevailed generally in the southeastern territory in 1932.[9] The allegation which has sometimes been made that the Authority has inaugurated low rates for certain classes of customers at the expense of others does not seem consistent with the facts. Second, the greatest reductions appear to have been in the domestic and commercial classifications. This appears reasonable enough since these classes have usually had but little bargaining power in seeking rate reductions from the companies and have been generally thought to pay relatively "high" rates.[10]

THE RESPONSE OF CONSUMPTION

One of the premises of TVA rate theory was that the elasticity of demand for electrical energy at former rate levels, especially by commercial and residential customers, was high and that the promulgation of low rates of the inducement type[11] would lead to substantial increases in consumption. What has been the experience of the TVA contractors in this regard?

Any statement of the "response" of consumption to rate policy of whatever type must be conditioned by a reminder of the difficulty of empirically studying cause and effect relations in the social sciences. If one is interested in the responsiveness of

V. For an analysis of TVA industrial power contracts, see *Engineering Report* of the Joint Committee on the Investigation of the Tennessee Valley Authority, p. 497 ff.

[9] The year 1932 has been chosen for comparison throughout the present discussion since that was the last complete year before the inauguration of the TVA program. A strong case can be made for attributing at least some of the rate reductions in the southeastern territory after the middle of 1932 to the growing threat of public competition as the position of Mr. Roosevelt on the public power issue became increasingly clear.

[10] The industrial customers are not only more important to the companies in respect of demand and volume of use, but they are able to back up their requests for low rates with the threat of establishment of independent power plants.

A further rationalization of the relative reductions prescribed by TVA for the different customer classifications rests in the preference clause of the Act.

[11] The "inducement" character of a rate is determined not only by a low average cost but also (and most significantly) by a low follow-on rate for incremental consumption.

TABLE 13

TYPICAL INDUSTRIAL POWER BILLS OF TVA CONTRACTORS COMPARED WITH BILLS UNDER 1932 RATES OF FIVE PRIVATELY OWNED POWER COMPANIES

Company	Monthly Peak Demand in kilowatts and Energy Consumption in kilowatt-hours							
	75 kw.		150 kw.		500 kw.		1000 kw.	
	15,000 kwh.	30,000 kwh.	30,000 kwh.	60,000 kwh.	100,000 kwh.	200,000 kwh.	200,000 kwh.	400,000 kwh.
Alabama Power Company	$322.50	$462.50	$562.50	$822.50	$1580.00	$2280.00	$2905.00	$4005.00
Birmingham Electric Company	213.00	325.50	426.00	651.00	1420.00	2120.00	2460.00	3785.00
Georgia Power Company	269.32	434.02	508.95	778.68	1408.05	2107.35	2606.85	3805.65
Tennessee Electric Power Company	313.75	453.75	566.25	796.25	1601.25	2301.25	2966.25	4266.25
Tennessee Public Service Company	308.75	436.25	530.00	785.00	1562.50	2412.50	3037.50	4737.50
Five-company simple arithmetic average[a]	285.47	422.40	518.74	766.69	1513.36	2244.22	2795.12	4119.88
TVA contractors (Schedule B-3)	205.00	295.00	375.00	500.00	1010.00	1310.00	1810.00	2410.00
Percent reduction, TVA contractors from five-company average	28.2	30.1	27.7	34.8	33.2	41.8	35.2	41.5

[a]See note on use of simple arithmetic average in Table 11.

Source: Tennessee Railroad and Public Utilities Commission, Alabama Public Service Commission, Alabama Power Company, Georgia Power Company, and Georgia Public Service Commission.

domestic consumers to a downward revision of their light and power rate schedules, the most promising approach to an answer would appear to be through comparison of their energy consumption before and after such a change.[12] But the inevitable passage of time during the course of observation necessarily casts some doubt upon the reliability of any relations observed. For although rates are of fundamental importance as determinants of power consumption, many other factors also influence this category. If, for example, over the period of the "experiment" there are significant changes in consumer incomes, tastes, or expectations, in the prices of services competing with or complementing electricity, or in physical conditions (such as weather), one may fall into serious error by imputing changes in energy consumption simply to a rate variation.[13] In contrast to the physical sciences in which it is possible to hold "other factors" comparatively constant while studying the behavior of particular variables,[14] in the social sciences the practical impossibility of holding "other things equal" effectively precludes the possibility of establishing definite causal relations. At the best one can

[12] This is not the only method of studying the question. One might conduct a canvass by personal interview or send out questionnaires to inquire of consumers what their reactions might be. The best result of such an investigation could only be a determination of how people might think they would respond to a hypothetical change in conditions, not how they would respond to an actual change.

[13] Considerations of this sort have caused much difficulty to those who have sought to develop statistical demand and supply curves. The journal literature on this question is considerable, but the following articles may be cited: A. C. Pigou, "Statistical Derivation of Demand Curves," 40 (1930) *Economic Journal*, 384; J. M. Cassels, "Pigou's Method for deriving Demand Curves," 43 (1933) *Ibid.* 575; Holbrook Working, "Statistical Determination of Demand Curves," 39 (1925) *Quarterly Journal of Economics* 503; E. W. Gilboy, "Demand Curves in Theory and Practice," 44 (1930) *Ibid.*, 601, and "Leontief and Schultz Methods for deriving Demand Curves," 45 (1931) *Ibid.* 218.

[14] Consider, for example, the case of "Boyle's law" which states that if one of three variables is held constant certain interrelations may be traced in the behavior of the other two (the three variables being pressure, volume and temperature of a gas). The social scientist is often in much the same position as would be the physicist seeking to establish relations between pressure and volume with no way to measure or control temperature. Incidentally, it may be noted that even in the physical sciences the modern tendency is to speak rather in terms of observed sequences than of mechanical and inherent "causes."

The above matters have been given an interesting exposition from the point of view of the social scientist by Professor Frederick C. Mills who suggests that this type of research worker is often in the position of a chemist obliged to carry out experiments in dirty test tubes. See Mills, *Statistical Methods*, pp. 453 ff, 549-550.

establish typical or customary sequences in the behavior of variables; at the worst the continual flux of uncontrolled factors prevents any meaningful observations.

With these general words of caution let us consider consumption trends of customers attached to TVA contractors. The usual statistics consulted on this question are figures as to average annual use per customer in the domestic and commercial classifications (and occasionally total consumption by industrial consumers).[15] They are deficient in that they fail to take into account the effects which lower rates may have had in inducing new customers to attach themselves to the plant. Since new customers do not typically have a fully developed appliance load, the effect of their attachment upon average utilization figures is apt to be depressive. If the inauguration of inducement rates should lead attached customers to increase their loads but also stimulate many new customers to ask for power service, it would be possible that the latter might provide a complete offset for the increase in use of the former: average consumption figures might reveal no change.

Another shortcoming of the use of average domestic consumption figures for "TVA contractors" or "TVA municipalities" is the fact that the particular distribution systems comprehended in these groups have not remained the same year after year. If during a given year a number of new contractors should be established in communities in which "high" rates had long been in effect, one would expect their average consumption figures to be low and to tend to pull down the averages of the larger group of "TVA contractors" of which they had become a part. It is conceivable that a situation might arise in which the final figure for average domestic consumption of TVA contractors as a group might actually decline between two years as the result of attachment of a number of new contractors in communities of this sort although both average utilization among established contractors and average utilization among attached

[15] In the industrial field there has not been as great emphasis upon responsiveness of consumption to price; and consequently there has not been as great interest in empirical evidence as to elasticity.

customers of plants taken over during the year by the new contractors might increase.

Fortunately neither of the above difficulties is serious. Usually the number of new customers taken on in any particular year is not sufficient to exert a major effect upon average utilization figures. Furthermore, since the attraction of new customers with perhaps low initial utilization is an effect of the institution of reduced rates, it would not seem reasonable to abstract from this aspect of the response of demand. In practice, therefore, we may work directly with average customer consumption figures without attempting corrections for the tendency of new customers to hold these averages below levels appropriate to original attached customers. As for the second difficulty, this can be coped with by examining the tendencies in average consumption for particular TVA contractors from the time of their first adoption of resale schedules as prescribed by the Authority. A modification of this approach has been adopted in Table 14 which indicates trends in average customer utilization and number of customers in the domestic and commercial classifications for all TVA contractors which were in business throughout 1936.[16] This table indicates in a striking manner the response of customers in these classes to inducement rates. In a more general way and without regard to customer classifications, Figures 8 and 10 also reflect the response of customer use to promotional rates.

Although there is abundant evidence of steadily rising consumption among TVA contractors, the extent to which this may be ascribed to promotional rate policy is not clear. Many of the factors other than rates which were suggested at the start of this section as affecting utilization have changed greatly during the period of the TVA program. How may that part of increased use which is due to rate policy be identified? One approach to an answer to this question is to compare trends in power use in the Tennessee Valley with trends over the nation as a whole. If the forces affecting consumption over the country

[16] Appropriate statistics to reveal the response of use among industrial customers and for street lighting are not available. It has generally been argued that the elasticity of demand for industrial power is slight. But see below, note 18.

have been the same as those affecting it in the Valley except that in the latter promotional rates were adopted, then any divergence between trends in consumption for the Valley and the country as a whole presumably may be ascribed to the difference in rate policy. Unfortunately, it is possible to make comparisons of this sort only in the case of domestic consumers. This has

TABLE 14

TRENDS IN POWER USE OF DOMESTIC AND COMMERCIAL CUSTOMERS ATTACHED TO TVA CONTRACTORS IN OPERATION THROUGHOUT FISCAL YEAR 1936

Year Ending June 30	Municipalities		Co-operatives	
	Domestic	Commercial	Domestic	Commercial
1936				
Number of customers...	4173	1451	4323	1386
Use per customer[a]......	1203	2873	1102	1912
1937				
Number of customers...	5947	1850	5339	1536
Use per customer......	1410	3438	1282	2310
1938				
Number of customers...	6968	2036	6145	1656
Use per customer......	1571	3533	1390	2463
1939				
Number of customers...	7717	2130	6892	1749
Use per customer......	1624	3680	1422	2424
1940				
Number of customers...	8859	2300	7919	1837
Use per customer......	1737	3860	1458	2536

[a]Use in all cases is indicated in kilowatt-hours annually. Figures for 1941 are not shown since a program of defense power conservation was inaugurated in May of that year.

Source: Compiled from TVA *Annual Reports* for 1935, 1936, and 1937; and from *Financial Statements for Municipalities and Cooperatives Purchasing Power from TVA*, 1938, 1939, 1940.

been done below in Table 15 which reveals a far more rapid increase in average residential power use in the Tennessee Valley than over the United States. This finding is consistent with the argument that the aggressive rate policies of TVA contractors have led to a more rapid expansion of consumption than otherwise would have occurred. But if one is interested in learning how much more consumption in the Valley increased than it would have if no rate adjustments had been made, then even here our data are deficient because national average consumption itself has tended to increase because of rate reductions over the country. In fact, the response of consumption in the Tennessee Valley to rate reductions is greater than is indicated by simple comparisons with national averages.

For commercial customers an analysis along the lines of Table 15 is impossible for the reason that there is no available series of figures for national average consumption by this class of customer which uses the same criteria of classification for 1940

TABLE 15

TRENDS IN AVERAGE RESIDENTIAL CONSUMPTION—TVA CONTRACTORS IN OPERATION THROUGHOUT 1935 COMPARED WITH UNITED STATES AS A WHOLE

	Consumption in kilowatt-hours		Per Cent Increase 1935–1940
	1935[a]	1940[a]	
TVA contractors	916	1567	71
National average	648	925	43

[a]Data for fiscal years ending June 30. The national average figure for 1935 was estimated as the arithmetic mean of the average figures for the calendar years, 1934 and 1935. Source: By letter from the Tennessee Valley Authority.

as it did for 1935 or 1936.[17] For industrial customers the absence of any central tendency in utilization prevents the determination of meaningful averages either in the Tennessee Valley or for the country as a whole. Study could be made of relative trends in total power use by industry in the Valley and over the country, but over the short run industrial power use probably varies much more with the general level of prosperity than with variations in power rates even when these variations are relatively large.[18] Any differences in consumption tendencies inside and outside the Tennessee Valley would therefore have to be interpreted with extreme caution.

A simpler method for estimation of the response of consumption to inducement rates than comparison with national averages would be study of consumption trends of different classes of

[17] The Edison Electrical Institute publishes a series of statistics on commercial and industrial service for the years 1926 to 1940 and includes a sub-heading, "Small light and power." Unfortunately, the basis of classification for this series was apparently revised between 1936 and 1937, so that the series is not continuous. Nor does the present classification appear to be comparable to that prescribed by TVA. See Edison Electrical Institute, "The Electric Light and Power Industry in the United States," Statistical Bulletin 8, May, 1941.

[18] It is possible that over a period of time industrial power demand might be quite elastic; for in the designing of equipment economy of motive power is a factor which must certainly be of importance. Over the short run, technical processes are rather rigidly fixed; and for this period industrial power demand is probably quite inelastic.

consumer before and after the rate adjustments. For two reasons this method cannot be relied upon for precise information in the case of TVA. First, since TVA inducement rates were promulgated when the contractors were set up, no comparison between their operations before and after the rate reduction is possible. The only comparisons which could be made would be either with operating figures of privately owned power companies which served in the area prior to the organization of the contractors or with the figures for the initial period of contractor operation before a consumption response could have time to develop. Due to differences in criteria for customer classification, comparisons between power company averages and later contractor averages cannot be relied upon as reflections of demand response to rate changes.[19] As for the second type of comparison, the importance of the seasonal factor in power consumption would set a year as the minimum initial period of contractor operation which could be used as a base for comparison with subsequent periods. But to study the response of consumption by comparing the fourth year, for example, with the first year after a rate adjustment certainly would not be precise since all of that part of the response which occurred during the initial period would be eliminated from consideration.

Second, comparison of consumption figures before and after rate changes would be subject to the disadvantage that it would fail to make even ostensible provision for separating secular growth in consumption from response to price.[19a] Indeed, any results which it might indicate would inevitably be subject to question because of the continual flux over time of factors other than rates which affect consumption.

Despite the difficulties of closely estimating the response of consumption to inducement rates, the weight of evidence supports the qualitative conclusion that these rates have influenced customer utilization to a substantial extent.[20] This is well indi-

[19] An exception to this proposition may be noted in the case of domestic customers for whom the differences in classification are comparatively unimportant.

[19a] Comparison with national averages would not suffer from this weakness since it could be assumed that the national figures would reflect, at least in part, secular tendencies.

cated by Table 16 which shows that TVA contractors which have maintained inducement rates for a considerable period of time tend to have higher average customer use than the entire group of TVA contractors, many of which have been in operation a relatively short period of time.

TABLE 16

COMPARISON OF 1940 AVERAGE CONSUMPTION OF CUSTOMERS ATTACHED TO ALL TVA CONTRACTORS WITH 1940 CONSUMPTION OF CUSTOMERS ATTACHED TO TVA CONTRACTORS IN OPERATION THROUGHOUT 1936

	Municipalities		Cooperatives	
	Domestic	Commercial	Domestic	Commercial
1. Average 1940 consumption, 1936 contractors	1737	3860	1458	2536
2. Average 1940 consumption, all contractors	1398	3599	1008	2048
3. Percent excess, Line 1 over Line 2	24	7	45	23

Source: Table 14 and *Financial Statements of Municipalities and Cooperatives Purchasing Power from TVA, 1940.*

Whatever the complex of causes which may be responsible, there can be no question but that energy consumption among customers of TVA contractors has increased steadily. Let us now turn to a financial analysis of contractor experience.

FINANCIAL RESULTS OF CONTRACTOR OPERATION UNDER INDUCEMENT RESALE RATES

We have pointed out above that one of the premises in the rationale of TVA resale rates is comparative inflexibility (or "fixity") of distribution costs. The validity of this premise may be appraised in the light of Figures 7, 8, 9, and 10. Over years of

[20] It was suggested above that for residential customers response of use could be studied by comparison of figures for the privately owned power companies in the year prior to the inauguration of contractor promotional rates with consumption of customers attached to the contractors in their first or second years of operation. For six privately owned power companies in the Tennessee Valley region the simple arithmetic average of residential consumption in 1932 was 648 kilowatt-hours, and in 1933 it was 645 kilowatt-hours. The seven TVA contractors which purchased TVA energy throughout the fiscal year 1935 (first complete year of contractor operation) reported an average residential use of 916 kilowatt-hours for this year, an increase from the six-company average of 40.4 percent. (Source: Table 20 and by letter from TVA.)

contractor operation it is evident that there has been a very noticeable tendency for costs of the distribution agencies to increase. But these costs have increased at substantially less rapid rates than have total kilowatt-hours purchased for distribution by the contractors. Further, cognizance must be taken of the fact that the period of operation on which these charts are based was one of rapid expansion and improvement of plant by the contractors. As a result certain elements of cost which would normally be comparatively rigid increased substantially with years of operation. In view of these points, the slopes of the curves in the charts seem consistent with a high degree of inflexibility in total distribution costs.

Meanwhile, what has happened to contractor revenues? It is interesting that a scatter diagram of contractor revenues would yield a curve for both municipalities and co-operatives lying between the curves for costs and kilowatt-hour sales. Thus, the tendency has been for contractor operations to become steadily more favorable. By 1940, not only were the contractors which had been in operation for a number of years established upon a profit-making basis, but each major group of contractors (including new as well as old distributors) was making a positive return upon investment. This is indicated in Table 17 below. Perhaps the most interesting aspect of this table is the superiority in the showing of the municipalities and metropolitan areas as compared with the co-operatives.[21] To a certain extent this may be attributed to the lower customer density natural to the rural systems. But also very important is the fact that many of the co-operatives are serving territory not previously electrified, and consequently the development period is longer than is typically the case for municipalities. There is reason to believe that, under normal development, the financial results of co-opera-

[21] During the first few years of TVA it was customary to consider contractors in two groups, municipalities and co-operatives. For many purposes this is still the most convenient break-down. Nevertheless, recently there has been a tendency to separate Knoxville, Chattanooga, Memphis, and Nashville from the remaining contractors and treat them as a separate group of "metropolitan areas." Statistically, the reclassificaion is well justified.

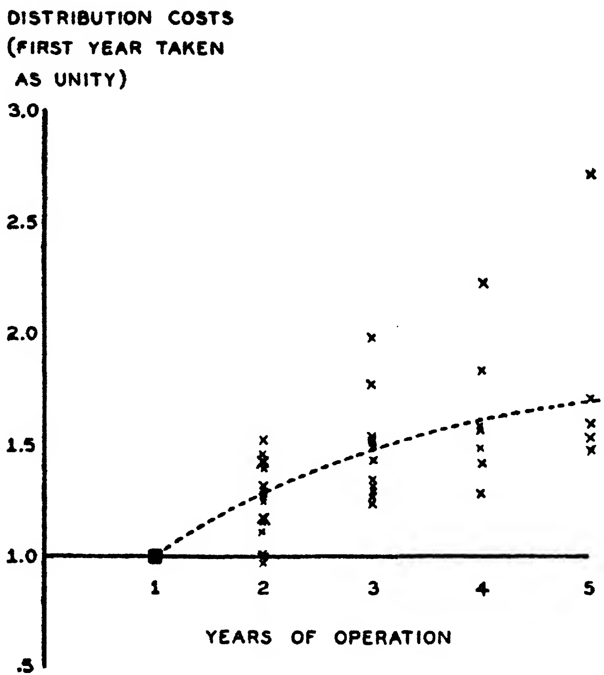

Figure 7. Scatter diagram showing trend in total costs excluding costs of purchased power for TVA municipalities over years of operation. (Based on records of municipalities which served throughout the fiscal year, 1939.)

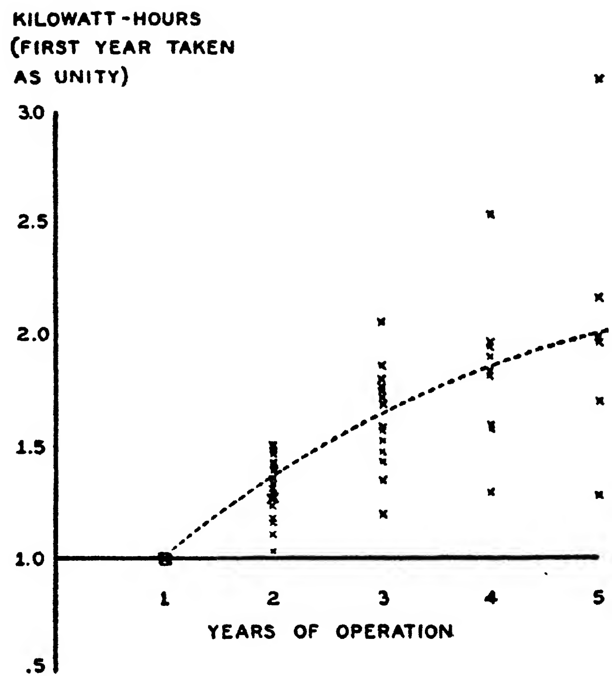

Figure 8. Scatter diagram showing trend in kilowatt-hours purchased for distribution by TVA municipalities over years of operation. (Based on records of municipalities which served throughout the fiscal year, 1939.)

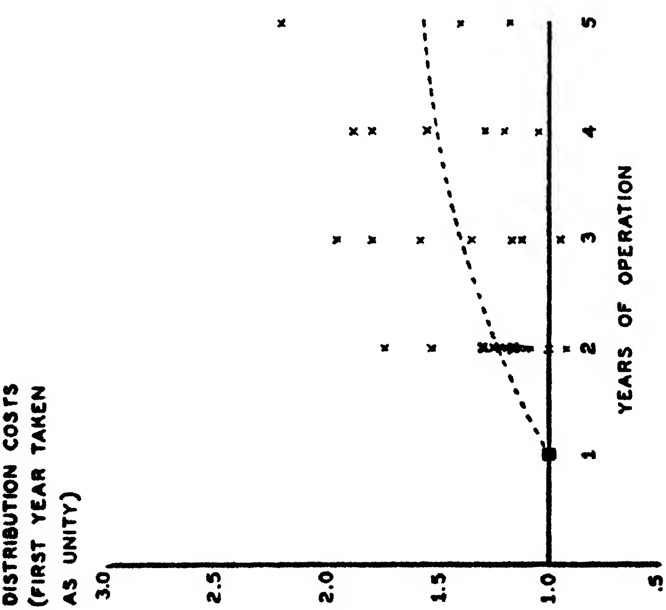

Figure 9. Scatter diagram showing trend in total costs excluding costs of purchased power for TVA co-operatives over years of operation. (Based on records of co-operatives which served throughout the fiscal year, 1939.)

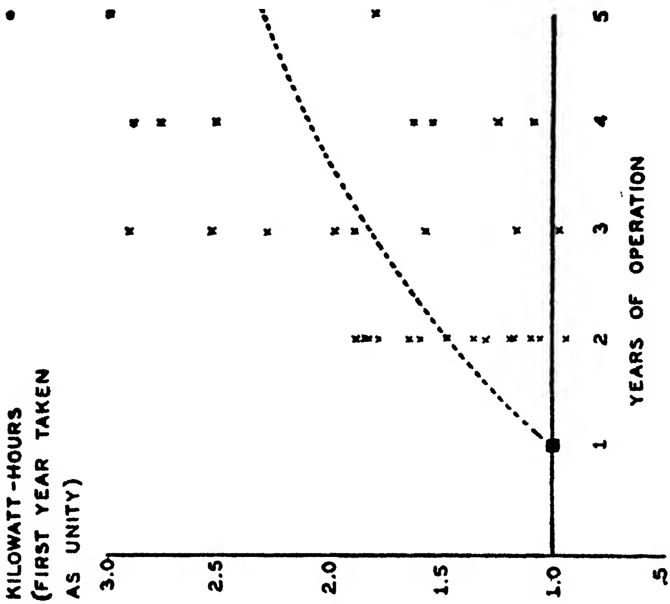

Figure 10. Scatter diagram showing trend in kilowatt-hours purchased for distribution by TVA co-operatives over years of operation. (Based on records of co-operatives which served throughout the fiscal year, 1939.)

tive power distribution will become increasingly favorable in the future.[22]

TABLE 17

INCOME, ASSETS AND RATES OF RETURN OF TVA CONTRACTORS 1940–1941

Class of Contractor	Net Income before Interest	Total Assets (Depreciated)	Rate of Return	Net Income after Interest
Metropolitan Areas[a]				
1940	$3,944,770	$ 60,137,423	6.57%	$2,751,081
1941	4,136,250	62,298,889	6.65	2,812,005
Municipalities[b]				
1940	1,646,308	19,840,704	8.29	1,160,256
1941	1,971,733	24,067,511	8.19	1,321,043
Cooperatives[c]				
1940	466,193	15,648,044	2.98	111,664
1941	481,230	20,007,567	2.40	33,215
All contractors				
1940	6,057,271	95,626,171	6.34	4,023,001
1941	6,589,213	106,373,967	6.18	4,166,264

[a]Includes Chattanooga, Knoxville, Memphis and Nashville.
[b]Includes 70 municipalities for 1940 of which 6 made net losses totalling $18,560. Includes 72 municipalities for 1941 of which 3 made net losses totalling $33,341 after fully writing off $51,980 of acquisition-adjustment expense.
[c]Includes 32 co-operatives for 1940 of which 15 made net losses totalling $149,000. Includes 38 co-operatives for 1941 of which 19 made net losses totaling $143,881. The latter losses were covered and more than offset by amortization collections in the amount of $241,437.
Source: *Financial Statements of Municipalities and Cooperatives Purchasing Power from TVA*, 1940, 1941.

In the light of the contractors' apparently favorable record, how have critics of TVA justified the charge that resale rates are "too low"? In general, their position has been that the apparent prosperity of the contractors has been achieved by understatement of the fair and proper costs of the power business. Perhaps their most far-reaching allegation has been that understatement of the value of distribution plant has permitted unreasonably low "fixed" charges (on account of debt, depreciation, and taxes). Mr. Willkie, for example, has repeatedly asserted that

[22] Under the provisions of TVA power contracts the balance of returns to municipal contractors above six percent annually upon municipal investment must be applied either to amortization of investment or to rate reductions. Somewhat similar provisions are included in contracts with the co-operatives. Under this policy several of the contractors have already made substantial headway toward retirement of debt. It may be remarked that a rate program which provides simultaneously for depreciation and debt amortization is unusually conservative since it looks toward the eventual achievement of an interest and debt free plant.

the properties transferred to TVA by the Commonwealth and Southern subsidiary companies were undervalued.[23] Since the prices at which properties were acquired have furnished the bases for the valuations at which they have been set upon the books of the distributors, it would follow that if the prices were unduly "low" then "fixed" charges of distributors also tend to be understated. On the other side of this question, it is only fair to note that TVA has maintained that the prices at which properties have been acquired have been perfectly reasonable.[24] Regardless of which side is correct in this argument, as time passes the point at issue will become of steadily diminishing importance. Under TVA accounting regulations all replacements and additions to contractor properties must be charged at cost. As the original properties depreciate and additions and replacements are made, the purchase cost of properties will become an ever smaller part of total plant valuation.

A second allegation of those who question the adequacy of TVA resale rate schedules has been that contractors have

[23] See, for example, *Tennessee Valley Authority*, Hearings before House Committee on Military Affairs, Seventy-Fourth Congress, First Session (1935), p. 252. Here Mr. Willkie stated that the Mississippi Power Company (a Commonwealth and Southern subsidiary) purchased certain properties in Alcorn County in 1925 for $456,000 and that to this it added new investment of $160,900 making a total investment of $617,000. These properties, Mr. Willkie claimed, were then transferred to TVA for only $234,000 in 1934. The Authority, after taking out substations, transmission lines and a steam standby plant, sold the balance to the Alcorn County Co-operative for $114,632.

Without undertaking an analysis of this particular transaction, one may suggest that several points should be studied before concluding that Mr. Willkie's story "proves" that the contractor received properties at less than their fair value. First, what was the original condition of the properties in 1925? Was the $456,000 value a reasonable one or was this a property acquisition at an excessive price which the company believed could easily be worked into the rate base? Second, was the "new investment" in the properties during the period of Mississippi Power Company ownership really addition to capital investment or did it include considerable capitalized maintenance which should have been charged as expense? Third, how much did the properties depreciate during the 1925 to 1934 period?

[24] In the case of the acquisition of the Tennessee Electric Power Company, for example, TVA has stated that the negotiated price was in excess of both the present reproduction cost of the properties less accrued depreciation, and the original investment less depreciation. The full purchase price was justified, the Authority claimed, only because of the substantial "nuisance value" of the privately owned system. See *Tennessee Valley Authority*, Hearings before Subcommittee of House Committee on Military Affairs, Seventy-Sixth Congress, First Session, pp. 6-8. See also *Report* of Joint Committee on the Investigation of the Tennessee Valley Authority, p. 206, and *Hearings* before the same, p. 5525 ff.

been recipients of valuable free services from TVA and other public agencies.[25] Two federal investigations have undertaken to study this charge, but neither has found evidence to substantiate it. In 1937 the Federal Power Commission, surveying the operations of the Tupelo, Alcorn County, and Athens (Alabama and Mississippi) contractors, found that in a few unusual situations TVA had supplied assistance for which the distributors had not paid in full; but it reported that the established policy of the Authority was to require fair reimbursement for all services rendered. Nor did it find that any important services were being supplied free of charge to the contractors by other public agencies.[26] In the following year a much more exhaustive study of the contractors was carried out by the engineers attached to the Joint Committee which was set up by Congress to investigate various phases of the TVA program. Once again no evidence of subsidies was found.[27]

A special case of the "subsidy" charge is the assertion that TVA wholesale rates to contractors are unreasonably low.[28] The re-

[25] See Morgan, Arthur E., *The Power Operations of the Tennessee Valley Authority*, Part III, "The Yardstick Power Program." This is a study prepared for the Joint Committee on the Investigation of the Tennessee Valley Authority and is printed in the record of its *Hearings* at p. 4896 ff.

[26] Federal Power Commission "Report on the Finances and Operations of the Electrical Systems of Tupelo, Mississippi and Athens, Alabama, and the Alcorn County Electric Power Association" (1937), introduced as Exhibit A before the Joint Committee on the Investigation of the TVA.

[27] The engineering staff of the Committee reported as follows:

> "We therefore conclude that the Tennessee Valley Authority retail rates appear to be fair measures of the cost of electricity to the ultimate consumers in the Tennessee Valley Authority system. The statistical data comparing these rates with others, tend to bear out this conclusion.
>
> "It may be noted that the plan of action adopted by the Board of the Tennessee Valley Authority on August 22, 1933 provides that—
>
> > The municipal utility should stand on its own bottom (i.e., be wholly self-supporting) and (on the other hand) not to be a source of tax relief, at the expense of ratepayers, beyond a fair return to the city's general fund on the city's utility investment.
>
> It is believed from the analysis made above that the results of operations under the contracts made between the Tennessee Valley Authority and the municipalities and co-operatives substantially carry out the policy of the Board expressed above."

Engineering Report of the Joint Committee on the Investigation of the Tennessee Valley Authority, Appendix B to the Committee Report, p. 243.

[28] See statement of Arthur E. Morgan before the Joint Committee at pp. 4895-4896 of the *Hearings;* and statement of Dean E. L. Moreland at *ibid.*, 3955-3956.

lationship of revenues to be produced by these rates to the costs of the comprehensive water control and power system has been investigated above.[29] It was found that anticipated revenue per kilowatt-hour from sales to preferential customers was 4.3 mills; for fiscal 1940 the actual figure was 4.49 mills (or say, 4½ mills) per kilowatt hour. This cost of supply for the distributors compares with estimated costs for private generation and supply at load centers, as suggested by Mr. Leland Olds, of seven mills.[30] Although the relative difference between these indicated costs of supply seems great, the absolute difference of only 2.5 mills is but an insignificant part of the total reductions of TVA resale rates from formerly prevailing rate levels. Since TVA wholesale rates are not seriously out of line with private power costs but contractor resale rates are sharply below the retail rates general at the time they were formulated, it follows that the secret of the economy (or diseconomy) of resale rates must be sought in the operations of the contractors themselves. Any charge of subsidy of contractors by TVA through understatement of power costs can have but little real significance.[31]

A third indictment of TVA contractors has alleged that their interest charges understate appropriate charges to the extent that they are less than the rates which privately owned power companies would be obliged to pay for funds. It is difficult to understand why publicly owned enterprise should pay in addition to all incurred costs purely hypothetical costs which it

[29] See Chapter V.

[30] See above, p. 134n. Mr. Olds made a careful analysis of one privately owned company in the southeastern area and reported as follows:

> "A reasonable allocation of the legitimate investment in the Alabama Power Company properties to the function of wholesale power supply, based on historical data . . . . , shows that the system could provide wholesale power supply ready to distribute at an average cost of 6.4 mills with private fixed charges, and 5.06 mills with public fixed charges based on a government interest rate of 3½ percent. With 3 percent interest, the cost per kilowatt-hour would fall to 4.8 mills. This would cover all fixed and operating costs for generation, transmission and transformation to distribution voltage, with 15 percent of gross revenue allowed for taxes."

Reports and Exhibits, Joint Committee on the Investigation of the Tennessee Valley Authority, p. 236.

[31] The importance of this point is not easily exaggerated. Its logical implication is that discussion as to TVA joint cost allocation, interest, or tax policy can have very little relevance to the problem of contractor resale rates.

in no way incurs (either directly or indirectly through other agencies of government).[32] Nevertheless, the data of Table 17 indicate that most of the contractors could bear the burden of higher interest rates without sacrificing all of net income.

Finally, it has been alleged that the contractors do not meet taxes nor make provision for depreciation. To a great extent this charge has probably been made by persons not closely familiar with the requirements of TVA power contracts, for these documents in every case set forth clear requirements in respect of these two elements of cost. Whether these requirements are stringent enough to provide for full payment of all fair and proper tax and depreciation expense, conservatively computed, is a most complicated question which we can no more than touch upon here. The general nature of the tax obligations of the contractors has been outlined in Chapter III above. The theory upon which tax payments of the entire TVA system are based is one of replacing revenues to different governmental units lost as a result of transfer of the power business in the Tennessee Valley region from private to public ownership. In the fiscal year, 1940, the co-operatives paid out four percent of their gross revenues in taxes, the municipalities paid seven percent, and, as a group, the contractors paid taxes at the rate of six and one-half percent.[33]

The problem of fixing proper depreciation charges for many of the contractors has been complicated by the fact that up to the present time studies of original cost and accrued depreciation on purchased properties have not been completed. Some municipalities have based their depreciation accounting on the renewal-and-replacement-fund requirements of their bond contracts. But most of the contractors, at least in principle, have adopted the

[32] Were the small municipalities able to float loans only at rates substantially above those at which privately owned utilities could borrow funds, it is interesting to speculate as to whether the latter would then argue that the contractors should not charge themselves with their full interest expense but only with such interest costs as private enterprise would be required to pay.

[33] In order to determine total tax payments of the TVA system, one must take into consideration additional payments in lieu of taxes by the Authority proper at a rate of ten percent of its gross revenues. The public system is estimated to have replaced in full taxes formerly paid by privately owned power companies in the region. See above, pp. 75-76.

straight-line principle of accruing depreciation.[34] In 1940, TVA municipalities and co-operatives set aside $3,797,683 to cover depreciation expense. This represented 13.87 percent of their gross revenues and 3.96 percent of the undepreciated asset value of their electric plant at the middle of the year. The latter figure may be compared with a rate of 3.00 percent which the New York Power Authority estimated would be adequate to cover depreciation on distribution investment for a typical regional system, ". . . . that is, for a system which serves a territory combining high and medium density, village and rural loads in normal proportions. . . . ."[35] While a need may arise for modifications and adjustments in contractor depreciation policy in the future, there seems no reason to believe that present charges are substantially understating actual depreciation expense.[36]

THE YARDSTICK RECONSIDERED

Let us turn now from the above discussion of the operations of the "TVA power system" to consider briefly the impact of these operations upon privately owned power utilities in the Tennessee Valley region.

It will be recalled that sponsors of the TVA legislation hoped that the direct competition of the federal agency would provide an effective supplement to commission regulatory control of the power industry. In the cost experience of TVA it was hoped to find a "yardstick" by which the rates of "private" companies might be appraised. In the course of partisan debate on this issue the meaning of a "yardstick" has been more obfuscated than clarified, but, nevertheless, two primary interpretations of the term stand out. First, the "yardstick" has been taken to

[34] "The straight-line method of accruing depreciation has received general acceptance by the municipalities and co-operatives served by the Authority. Pending classification of purchased property at original cost and the determination of accrued depreciation at acquisition, it is difficult to establish depreciation provisions and to appraise the accuracy of depreciation reserves." (Tennessee Valley Authority, "Financial Statements for the Fiscal Year ending June 30, 1941 for Municipalities and Co-operatives Purchasing Power from TVA," p. 5.)

[35] The Power Authority of the State of New York, *Eighth Annual Report* for the year ended December 31, 1938, p. 215.

[36] See *Tennessee Valley Authority*, Hearings before House Committee on Military Affairs, Seventy-Fourth Congress, First Session, I, 831. Time will perhaps be the best test of the adequacy of current depreciation allowances.

measure that minimum level of rates at which any efficiently operated, privately owned power company could afford to sell energy (usually to domestic customers) at retail and still earn a fair return upon its capital investment. Second, it has been considered as simply a competitive force which, when supplemented by public opinion and brought to bear upon otherwise inflexible "private" power rates, is able to bring adjustments in rate schedules which are notably out of line.[37]

The potential usefulness of public competition upon "yardstick" lines was recognized long before the time of the Tennessee Valley Authority.[38] But the practical possibilities of federal adoption of the principle of public competition did not appear bright until, during the 1932 Presidential campaign, Candidate Roosevelt said:

"It is necessary for government to have a 'birch rod in the cupboard'—two birch rods in fact. One of them is the development

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[37] The following quotations from 1935 debate in the House on the yardstick issue are helpful to an understanding of Congress' conception of the term:

Rep. Rogers of New Hampshire. "Why, Mr. Speaker, if we pass this bill, as stated by the majority leader on the floor of this House last Saturday, it will provide what the United States needs, which is a yardstick by which the public utility commissions of this nation may know by true and accurate figures the real cost of the production and distribution of power, and thus be able to fix reasonable and fair rates all over this nation for the protection of the common people." (77 *Congressional Record,* 2262.)

Rep. Knute Hill of Washington. "The great purpose of this Muscle Shoals development is to establish a yardstick for the cost of production which will serve throughout the United States. . . . . Of course it will be competition, and that is what we need." (*Ibid.,* 2281.)

Rep. Pierce. "The necessity for this bill lies in the excessive charges of the electric power companies for light and power and energy which they are developing. . . . . The proper way to regulate is by the development of power by the Government." (*Ibid.,* p. 2260.)

A position contrary to that of most of the members of the House was taken by Rep. Cochran of Pennsylvania. "I make the statement after considerable study and mature thought that the cost of electric energy in a given locality cannot be used as a yardstick to determine what should be the cost in another locality. The factors entering into such cost are never identical. Nature has favored some localities over others." (*Ibid.,* 2281.)

[38] The rate significance of public competition in the power field had been urged as early as the conservationist debate prior to the enactment of the Federal Water Power Act of 1920. The term "yardstick" was apparently first used by Walter Durand in 1926. See "Need for Public Yardstick," 47 *New Republic* 30, May 26, 1926.

by government of certain great water-power resources, to be used as a yardstick for the benefit of the people." [39]

After the election of Mr. Roosevelt and the adoption by Congress of the TVA legislation, one of the Authority's directors, Mr. David E. Lilienthal, was charged with the task of implementing the yardstick. Mr. Lilienthal expressed his conception of the term as follows:

> "It is generally recognized that such (state commission) regulation has not been entirely adequate to protect the public interest. And so, to supplement regulation, Congress has provided for a measure of public operation on a limited scale. This public operation is to serve as a yardstick by which to measure the fairness of electric rates. It has an additional function. It is a reminder that electricity performs a public service and that unless it is exercised by private corporations with fairness, with efficiency, without financial jugglery and with a due sense of responsibility to the paramount public interests involved, that the public, at any time, may itself assume the function of providing itself with this necessity of community life." [40]

That a multiple purpose federal enterprise could achieve the first yardstick objective which we have suggested, namely, provide a measuring rod for appraising the fairness of the rates of privately owned power utilities, vested interests in the power industry have vigorously denied. First, they have argued that private enterprise in the power business is essentially single purpose whereas, for constitutional reasons in the present stage of development of federal law, any federal "yardstick" project must be multiple purpose. It is unfair, they charge, to compare the power costs of a multiple purpose project in which a part of "common" cost is apportioned to non-power purposes with the costs of a single purpose project at which no co-ordinate objectives are available

[39] Address at Milwaukee, Wisconsin on September 30, 1932. Text printed in *New York Times*, October 1, 1932, p. 8.

[40] Address at Memphis on October 17, 1933. See also statement of Mr. Lilienthal at Atlanta, November 10, 1933 quoted in hearings before House Committee on Military Affairs, *Tennessee Valley Authority*, Seventy-Fourth Congress, First Session (1935) II, 780; TVA Press Release of January 5, 1934; and statement of Mr. Lilienthal quoted at 108 *Electrical World* 1871.

to share the cost burden.[41] A partial answer to this assertion is to suggest that cost apportionment at public projects is justified because of the fact that they *are* multiple-purpose whereas the single purpose orientation of private enterprise furnishes no justification for any assignment of charges to non-power purposes (except for occasional costs of locks required by law). A more complete answer is to point out that after all at TVA the allocation issue is very nearly irrelevant since the great clash between public and private rates in the Tennessee Valley is rather on the retail than the wholesale level. This Mr. Lilienthal has repeatedly pointed out.[42]

A second objection of the privately owned utilities to the use of a "public yardstick" as a measuring rod for appraisal of "private" utility costs attacks the conception of a cost standard at its heart by urging that every project is unique in respect of costs. Accordingly, diversity among rate schedules is reasonable and proper. One writer has put this point as follows:

"Hence, when comparisons are made between costs or prices in different locations under monopolistic conditions, the cost or price standard of comparison may be vitiated by the fact that the differentials revealed are really rent differentials due to the use of superior

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[41] See, for example, Henry Spurr, "Futility of Yardsticks," 11 (1933) *Public Utilities Fortnightly* 448; Corey, Herbert, "Quit Hanging Rainbows Over the Tennessee," 17 (1936) *Ibid.*, 806; *Tennessee Valley Authority,* Hearings before House Committee on Military Affairs, Seventy-Fourth Congress, First Session (1935), Volume I, p. 280. See also Justice Butler's opinion dissenting from the majority ruling in the Tennessee Electric Power Company case:

"The yardstick for wholesale rates is the wholesale rate charged by the Authority. It is unreasonable and confiscatory as a measure of complainant's rates in that it excludes the cost of the major part of the investment necessary to render the service and excludes necessary operating expenses." (306 U.S. 150.)

[42] For example, in the 1935 TVA hearings before the House Committee on Military Affairs, he stated:

"The wholesale end, the part the TVA is directly concerned with, ... occupies about one-tenth, which would be about 4 inches of the yardstick, and the rest of it is in the distribution end." (Vol. II, p. 822; see also II, 831.)

Dr. A. E. Morgan, at this time Director of the Authority, added:

"(The TVA yardstick) . . . . includes nothing for watered stock, it includes nothing for obsolete equipment left on the books, it includes nothing for fictitious debts charged by holding companies for fictitious service; and it includes nothing for $100,000 salaries. It contains, we believe, every *legitimate* cost that would be charged against a private company."

(*Ibid.*, 721, italics supplied.)

productive agents rather than a differential traceable to the fact that management is either public or private." [43]

Another writer has made the same point by inquiring why several federal yardsticks are necessary, as the proponents of "public power" have urged, and answering his own question by suggesting that several yardsticks are needed because conditions vary as among different projects so that no one can provide an adequate measure for all purposes.[44] Superficially, this appears to be a valid criticism of the conception of the yardstick as a rate standard. But with more mature consideration it appears to lose much of its force. With efficient, high load factor operation, even substantial differences in generating conditions do not necessarily lead to large absolute differences in the costs of power before distribution;[45] and if operation is on a regional basis, usually favorable distribution conditions in certain localities will offset adverse conditions in others. The point does retain sufficient validity to require that the yardstick be employed as a cost standard only with proper discretion and an eye to the peculiarities of each operating situation. But it does not prevent establishment of the "yardstick" as an ideal towards the meeting or passing of which every power company should devote its efforts. Upon any company which fails by a wide margin to meet the yardstick the burden of proof before the bar of public opinion should rest to justify whatever differentials it retains in its rate schedules.

Irrespective of whatever logical case can be developed to sup-

[43] Martin Glaeser, "Wanted, A Standard Yardstick," 10 (1932) *Public Utilities Fortnightly* 669. See also comments of Dean Moreland along the same line in *Hearings* before the Joint Committee on the Investigation of TVA, 3775.

[44] Henry Spurr, "Popular Misconceptions," 17 (1936) *Public Utilities Fortnightly* 246-48. See also editorial in the *New York Times* of September 16, 1933. Even if the logic of the argument as to the sufficiency of a single yardstick program from the cost standard viewpoint were accepted, several public projects might still be justified under the conception of the yardstick as a device for competitive rate control.

[45] The most important condition here is the stipulation of a favorable load factor. If it is a "fact" that a system is situated in such an unfavorable territory that it simply cannot develop a good load factor, then it must be accepted that its kilowatt-hour costs will tend to be high. Often wise rate policy and an aggressive program to develop off-peak demand can do much to improve what once appeared to be a most unsatisfactory situation.

port the use of yardstick rates as a measure of reasonableness of power charges, the courts will probably continue to side with those who urge that each utility property is unique, has its own cost and rate problems, and cannot be judged by reference to the operations of any other enterprise.[46] In the words of Professor Glaeser:

> "I am not very sanguine that all the hopes of the yardstick proponents can and will be realized. To my mind it is certain that public service commissions the country over will in the future, as they have in the past, be constrained to rest the reasonableness of their orders upon the special facts provided by each utility, but their wits and conclusions will be sharpened by the potentiality of these comparisons." [47]

Although the yardstick cannot be embodied in commission orders and backed by rules of law to eliminate "high" rates of privately owned power companies, it may in another way accomplish much toward the relief of unfavorable rate situations. This is through its demonstration of the possibilities of public ownership and its threat of potential public competition. Probably it is to this aspect of the TVA yardstick that one should credit the inauguration since 1933 by most southeastern power companies of more dynamic rate policies than were typical of the same companies during the nineteen-twenties. In the domestic field, where rates had been most rigid, the tendency toward reductions after 1933 was most apparent. Rate trends of six southeastern power companies for this class of customer are indicated below in Table 18. At every level of consumption each of these companies adopted greater rate reductions in the eight years following 1932 than in the eight years preceding. This point is summarized in Table 19 which indicates comparative

[46] Long ago the courts decided that rates in one city could not be determined *per se* by comparison with the rates of other cities. See Spurr, "Futility of Yardsticks," 11 *Public Utilities Fortnightly* 451. See also Re Cons. Gas. Co. (N. Y.) *Public Utilities Reports* (P.U.R.) 1928 E, 19; Anderson vs. Moran Electric Light and Power Company, P.U.R. 1921 C, 118; and further discussion by Spurr at 17 *Public Utilities Fortnightly* 249.

[47] Glaeser, "The Federal Government's Tennessee Valley Project," Part III, 13 (1934) *Public Utilities Fortnightly* 12.

TABLE 18

DOMESTIC POWER BILLS OF SIX SOUTHEASTERN POWER COMPANIES FOR VARYING LEVELS OF CONSUMPTION, 1924–1941

	Alabama Power Company (Montgomery)	Tennessee Public Service Company[a] (Knoxville)	Georgia Power Company (Atlanta)	Tennessee Electric Power Company[b] (Chattanooga)	Memphis Power and Light Company[c]	Birmingham Electric Company
25 KWH						
1924	$1.92	$2.48	$2.02	$2.14	$2.00	$1.92
1932	1.92	2.20	2.25	2.14	1.75	1.92
1933	1.55	1.85	2.20	2.08	1.75	1.55
1934	1.45	1.45	1.45	1.45	1.38	1.55
1935	1.45	1.45	1.45	1.45	1.38	1.55
1936	1.45	1.45	1.45	1.45	1.38	1.45
1937	1.20	1.45	1.22	1.20	1.38	1.00
1938	1.20	1.45	1.22	1.20	1.38	1.00
1939	1.20	.....	1.22	1.20	.86[d]	.98
1940	1.20	.....	1.22	.....	.....	.81
1941	1.20	.....	1.22	.....	.....	.81
100 KWH						
1924	5.67	6.60	6.07	5.13	5.10	4.92
1932	4.75	5.85	5.00	5.13	4.80	4.62
1933	4.05	5.60	4.97	5.30	4.80	4.05
1934	3.95	3.95	3.95	3.95	4.25	4.05
1935	3.95	3.95	3.95	3.95	4.25	4.05
1936	3.95	3.95	3.95	3.95	4.25	3.95
1937	3.50	3.95	3.85	3.50	4.25	3.20

(All footnotes at end of table.)

TABLE 18 (CONTINUED)

DOMESTIC POWER BILLS OF SIX SOUTHEASTERN POWER COMPANIES FOR VARYING LEVELS OF CONSUMPTION, 1924-1941

	Alabama Power Company (Montgomery)	Tennessee Public Service Company[a] (Knoxville)	Georgia Power Company (Atlanta)	Tennessee Electric Power Company[b] (Chattanooga)	Memphis Power and Light[c] Company	Birmingham Electric Company
1938	3.50	3.95	3.85	3.50	4.25	3.20
1939	3.50	.....	3.85	3.50	2.87[d]	3.20
1940	3.50	.....	3.50	....	....	2.75
1941	3.50	.....	3.50	....	....	2.75
250 KWH						
1924	9.00	12.59	8.77	9.41	9.60	11.75
1932	8.50	9.80	9.00	9.41	9.30	8.71
1933	7.80	9.80	8.97	8.55	9.30	7.80
1934	6.58	6.58	6.57	6.58	8.75	7.80
1935	6.58	6.58	6.57	6.58	8.75	7.80
1936	6.58	6.58	6.57	6.58	8.75	7.50
1937	6.13	6.58	6.57	6.13	8.75	6.95
1938	6.13	6.58	6.57	6.13	8.75	6.95
1939	6.13	.....	6.57	6.13	5.75[d]	6.95
1940	6.13	.....	6.12	....	....	6.13
1941	6.13	.....	6.12	....	....	6.13

[a]Knoxville Power and Light Company prior to 1932. Transferred to public ownership, Sept. 2, 1938.
[b]Transferred to public ownership, Aug. 15, 1939.
[c]Transferred to public ownership, June 27, 1939.
[d]Rate reduction in competition with municipal plant.
Source: Compiled from Exhibit 549, Joint Committee Investigating TVA; F. P. C., "Typical Monthly Bills for Electric Service," 1939, 1940, 1941; letters from Georgia and Alabama Public Service Commissions; and data at Tennessee Railway and Public Utilities Commission.

average rate reductions for the six companies over the 1924-1932 and 1932-1940 periods. Certainly the data indicate that whatever the forces at work to cause rate reductions during the initial period, they were in no way comparable with those which were active during the later years.[48]

TABLE 19

COMPARATIVE AVERAGE RESIDENTIAL RATE REDUCTIONS OF SIX PRIVATELY OWNED POWER COMPANIES FOR 1924–1932 AND 1932–1940

(For stated levels of consumption)

Monthly Consumption in kwh.	Six-Company Average Rate[a] (in cents per kwh.)				Relative Reduction (in percent)		
	1924	1932	Last year of private operation or 1940[b]	1940[c]	1924–32	1932—Last year of private operation or 1940	1932–1940
25	8.32	8.12	5.16	4.31	2.40	36.45	46.92
100	5.58	5.03	3.35	3.25	9.86	33.40	35.39
250	4.07	3.65	2.46	2.45	10.31	32.60	32.88

[a]The average here employed is the simple arithmetic mean.
[b]Rates in this column computed as averages of 1940 rates for Alabama Power Company, Birmingham Electric Company and Georgia Power Company, 1939 rates of Memphis Power and Light Company and Tennessee Electric Power Company and 1938 rates of Tennessee Public Service Company.
[c]This column computed as three-company average of Alabama Power Company, Birmingham Electric Company and Georgia Power Company.
Source: Table 18.

The unanimity with which the large southeastern power companies abandoned static for aggressive rate policies after 1932 is perhaps the most convincing evidence which can be adduced in support of the proposition that TVA "yardstick" rates through their competitive effects have done much to moderate hitherto "high" rates. A few additional points as to the role of the Authority in bringing about the reductions indicated in the preceding tables may be made. First, beginning with the Alabama Power Company on October 1, 1933, the Commonwealth and Southern subsidiaries introduced an objective rate plan to stimulate in-

[48] The companies have frequently pointed to steadily declining average charges per kilowatt-hour of customer consumption during the period prior to 1935 as evidence of dynamic rate policy during these years. But such reductions resulted largely from the gradual movement of increasing numbers of consumers into higher consumption brackets of block rate schedules. This could occur with no changes whatsoever in the schedules themselves. (It is worth noting that in the case of the Tennessee Electric Power Company bills for the three levels of consumption considered in Table 17 were unchanged between 1924 and 1932.)

creased consumption at lower rates.[49] Although the companies claim that this plan had long been under consideration, its timing certainly gives good ground for the opinion that fear of public competition stimulated the action. Second, in negotiating a contract for power sale and interchange with the Tennessee Electric Power Company, TVA required a commitment on the part of the Company that it would file a stipulated reduced rate schedule for domestic customers.[50] Third, early in 1934 the Alabama Public Service Commission brought together in conference representatives of fourteen privately owned utilities operating in the state and urged upon them the importance of matching TVA inducement rates as closely as might be possible.[51] Fourth, Mr. Wendell L. Willkie, formerly of the Commonwealth and Southern Corporation, has repeatedly complained that TVA forced his companies to reduce their rates.[52] A close observer of the power industry, Mr. Thomas R. Tate of the Federal Power Commission, concurs in Mr. Willkie's opinion as to the effective-

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[49] See Kennedy, William F., *The Objective Rate Plan* (New York: Columbia University Press, 1937).

[50] Director Lilienthal estimated that these rate revisions would save consumers eighteen to twenty percent on subsequent power bills. *Tennessee Valley Authority,* Hearings before House Committee on Military Affairs, Seventy-Fourth Congress, First Session, II, 781.

This contract was the famous agreement of January 4, 1934 between TVA and the Commonwealth and Southern system companies against which minority stockholders of the companies protested in the Ashwander Case (See "Note" appended to Chapter III above.) Among the contract's provisions were a temporary apportionment of territory, a transfer of certain utility properties to the Authority, and an agreement by the companies and the Authority to co-operate with the Electric Home and Farm Authority in the stimulation of electric appliance sales throughout the Tennessee Valley region. In consideration for its benefits under the contract the Authority agreed to pay certain cash consideration to the companies. "Re Alabama Power Company," Alabama Public Service Commission Docket 6604, 4 (N.S.) *Public Utilities Reports* 228-231.

[51] 104 *Electric World* 1172.

[52] Mr. Willkie, before a Congressional committee, stated:

> "That act (TVA) has forced us to cut some rates, and let me tell you why. I do not know what business you are in, but if the Federal Government will go to your town and set up a competitive business to yours, you will lower your rates in order to meet them in order not to have your capital destroyed."

Tennessee Valley Authority, Hearings before House Committee on Military Affairs, Seventy-Fourth Congress, First Session, I, 246.

ness of federal competition in bringing about "private" rate adjustments.[53]

As was true in the case of TVA contractors the reductions in power rates by the privately owned companies shortly called forth unusual increases in consumption. The nature of these increases for each of six southeastern companies is shown in Table 20 below. Beginning at a level not far removed from the national average in 1932 (+7.8 percent), six-company average residential consumption diverged steadily from the national average during the following years. By 1937 (the last complete calendar year during which all six of the companies were in existence) it had risen to 33.3 percent above the figure for the United States. For the three companies which remained in existence throughout 1940 the simple average domestic consumption figure was 38.2 percent in excess of the national average.[54]

The result of the strong response of consumption to power company rate reductions was a substantial cushioning of the shock which otherwise would have been dealt to net income. Since one of the tenets of many of those who favored the "birch rod" application of the yardstick was that many of the power companies were charging "excessive" rates and making "unreasonable" returns upon their legitimate capital investment, these persons had not been concerned with maintaining a high level of power company profits under reduced rates. Nevertheless, increases in consumer utilization pursuant to rate adjustments did provide surprisingly complete protection to gross income of each of the six power companies whose records we have examined above. It is true that company net incomes have not yet returned under reduced rates to the peak levels which were recorded in the late nineteen-twenties; but the explanation for this to a very great

[53] Speaking of the operations of all power interests in the Tennessee Valley, Mr. Tate said:

> "The consumption in that area has been stimulated by the low rates, which I personally believe were effected due to a great extent by the rates announced by the TVA. . . . ."

Ibid., II, 695.

[54] A weighted arithmetic average of the three companies would probably have given a figure fifty percent in excess of the national average. (The unweighted figure is heavily burdened by the low consumption of customers attached to the Birmingham Electric Company, the smallest of the three companies.)

TABLE 20

TRENDS IN AVERAGE DOMESTIC POWER CONSUMPTION OF SOUTHEASTERN POWER COMPANIES COMPARED WITH THE NATIONAL AVERAGE

(in annual kilowatt-hours)

Company	1929	1932	1933	1934	1935	1936	1937	1938	1939	1940
Alabama Power Company	571	798	793	871	997	1149	1289	1382	1413	1466
Birmingham Electric Company	416	519	493	521	599	684	760	820	881	956
Georgia Power Company	592	797	795	879	1039	1183	1313	1399	1446	1527
Memphis Power and Light Company[a]	509	618	606	612	662	721	773	831	....	....
Tennessee Public Service Company[b]	457	567	571	623	736	857	952	....	....	....
Tennessee Electric Power Company[c]	503	591	612	774	965	1176	1353	1461	....	....
Six-company simple arithmetic average[d]	508	648	645	713	833	962	1073	1179	1247	1316
National Average	502	601	600	629	677	735	805	853	897	952

[a]Company properties conveyed to Tennessee Valley Authority et. al. on June 27, 1939.
[b]Company properties conveyed to Tennessee Valley Authority et. al. on September 2, 1938.
[c]Company properties conveyed to Tennessee Valley Authority et. al. on August 15, 1939.
[d]Six-company average, 1929 to 1937; five-company average, 1938; three-company average, 1939 and 1940.

Source: Compiled from Complainant's Exhibits filed in case of Tennessee Electric Power Company et. al. vs. Tennessee Valley Authority et. al. and printed in transcript of record to the Supreme Court, Case Number 27, October Term, 1938 (306 U.S.118); Exhibit 549 submitted to Joint Committee on the Investigation of the Tennessee Valley Authority; by letter from Alabama Power Company, Georgia Power Company, Alabama Public Service Commission, Georgia Public Service Commission; and by courtesy of Tennessee Railroad and Public Utilities Commission extent appears to rest elsewhere than with recent rate policy. Local, state, and federal utility taxes have increased substantially since 1929. In that year the Tennessee Electric Power Company (T.E.P.) paid total taxes of $2,024,000. By 1938 taxes levied against the company had risen to $3,007,000, an increase of $983,000. Yet, in the latter year under drastically reduced rates T. E. P. earned net income of $2,739,000, only $1,211,000 short of the 1929 figure. The increase of taxes was equivalent to more than eighty percent of the loss of net income. A further explanation of the failure of company net revenues to return to the 1929 level is given by the fact that in most cases company depreciation requirements became considerably more rigid during the nineteen-thirties. Earlier many of the companies did not pursue carefully planned depreciation policies but simply maintained what they regarded as reasonable "retirement reserves." The burden of higher depreciation charges against revenues inevitably has left smaller balances available for net income. *Despite the handicap of "government competition," the general adoption of reduced power rates, the payment of higher taxes, and the charging of depreciation upon a more conservative basis, in no year during the depression or after did any one of the six southeastern power companies here considered experience a deficit in net earnings.*

CONCLUSION

The foregoing discussion has been concerned with the nature and impact of the TVA resale power program. Fundamental to this program is a promotional rate policy which provides but a small spread between the cost and price of power before and after distribution. Its financial success depends upon apportioning a rather inflexible total of distribution costs over an increased volume of production sold at lower prices per unit. Present indications are that the program will prove to be economical.

The substantial issues between TVA and the privately owned power utilities rest in the retail field. Here the possibilities of fruitful cost analysis are not complicated by problems of taxes on federal properties, allocations of multiple use investment, and depreciation rates on properties of indefinite life. Many have believed that the operations of TVA and its contractors will provide standards of reasonable costs which privately owned companies may be required to meet, but there seems no possibility of legal enforcement of such standards. Nevertheless, the potentiality of public competition has apparently had much to do with the recent adoption by most southeastern power companies of dynamic rate policies which have brought many of them close to TVA schedules. In this regard Professor Ben W. Lewis has written:

> "The Tennessee Valley Authority is certainly spreading the use of power directly through its own facilities, and, in the judgment of the writer, on a paying basis. But it is in its capacity as a coercive regulatory instrument that the Authority may be making an equally valuable contribution.
>
> . . . .
>
> "Events seem to be establishing the TVA as an effective adjunct to commission regulation in uncovering the potentialities of attracting, and rendering service economically to, wider ranges of consumption; and in forcing private industry, by the threat of competition, to a fuller development of these possibilities"[55]

Certainly the outstanding lesson to the economist of the TVA resale rate program and the experience of the privately owned companies in retailing "cheap" electricity has been the responsiveness of consumption to rate reductions. Indeed, in the domestic and commercial fields the sensitivity of power demand to downward price adjustments seems to have been so great that it is surprising that the privately owned companies had not experimented more in the possibilities of promotional rate making. To be sure, certain power interests had experimented in this field prior to TVA. Probably the most notable of these was the Ontario Hydroelectric Commission. But Samuel Ferguson's Hartford Electric Company had also pioneered promotional rates and so had a number of municipal electric systems. Speaking generally, however, prior to 1933 neither the American power industry nor the typical regulatory commission had achieved any clear understanding of the significance of the elasticity of demand for power. The companies tended to look upon every rate reduction as

[55] Leverett S. Lyon, Victor Abramson and Associates, *Government and Economic Life*, p. 743.

PART II

THEORIES AND PROBLEMS OF JOINT COST ALLOCATION

Chapter VI

THE SETTING OF THE ALLOCATION PROBLEM—THEORETICAL

Summary. In Part I above we have discussed the TVA comprehensive program and its place in American water policy. A most important phase of this program is its multiple purpose development of the Tennessee River. This gives rise to the challenging economic problem of cost apportionment among water control objectives. To this problem we shall devote our attention in Part II.

From the point of view of theory, three families of costs may be identified at TVA water control works. First, certain costs may be traced to particular units of output of particular benefits. Second, certain costs may be traced to particular benefits but not to particular units of output. These two families together make up a total which may be treated as "direct" cost so far as the several system benefits are concerned. Third, there is a class of cost which may not be traced to particular purposes. These may be termed "joint" costs. Close students of TVA have noted that the sum of joint costs is not a homogeneous category. A part of this total is made up of costs joint as between power, navigation, and flood control; and other parts are joint simply as between different combinations of dual purposes. It has been urged by some that these several components of the total joint cost complex should be segregated as a step preliminary to cost apportionment to individual purposes. But the analytical difficulties of isolating the several subsidiary joint cost categories appear to be overwhelming. Furthermore, it is by no means clear that the problems of achieving a "proper" allocation to particular purposes would in any way be reduced if such a preliminary breakdown of total joint costs could be accomplished. For purposes of the present study there seems to be no need for a preliminary segregation of the several joint elements of total joint costs.

According to another principle of classification, TVA joint costs may be divided into "fixed" charges upon joint investment and joint operation and maintenance expenses. This classification has been used by the Authority. The problem of cost allocation then reduces to the determination of an appropriate division among purposes of the two categories of total joint cost. In its allocation research TVA has recognized the tremendous importance of "fixed" charges as compared with operation and maintenance expenses. It has adopted the admittedly arbitrary principle of equal apportionment for the latter, and has concentrated its energies upon the problem of properly apportioning total joint investment.

COST ALLOCATION PROVISIONS OF THE TVA LAW

The obligation upon TVA to prepare allocations of its multiple use costs is stated in Section 14 of the TVA Act, as amended.[1] The language of the requirement is as follows:

> "The Board shall make a thorough investigation as to the present value of Dam Numbered 2, and the steam plants at nitrate plant numbered 1, and nitrate plant numbered 2, and as to the cost of the Cove Creek Dam, for the purpose of ascertaining how much of the value or the cost of said properties shall be allocated and charged up to (1) flood control, (2) navigation, (3) fertilizer, (4) national defense, and (5) the development of power. The findings thus made by the Board, when approved by the President of the United States, shall be final, and such findings shall thereafter be used in all allocations of value for the purpose of keeping the book value of said properties. In like manner, the cost and book value of any dams, steam plants, or other similar improvements hereafter constructed and turned over to said board for the purpose of control and management shall be ascertained and allocated.
>
> "The Board shall, on or before January 1, 1937, file with Congress a statement of its allocation of the value of all such properties turned over to said Board and which have been completed prior to the end of the preceding fiscal year, and shall thereafter in its annual report to Congress file a statement of its allocation of the value of such properties as have been completed during the preceding fiscal year." [2]

Just what was it that Congress wanted when it asked the Authority to submit statements of its "allocation of the value" or cost of completed properties? What is a reasonable allocation? By what procedure may it be determined? And by what criteria should alternative proposed allocations be judged? These and many similar questions the Authority was obliged to settle in order to prepare the reports required of it under Section 14. With some of the problems which arose in connection with these questions we shall be concerned in the following chapters.

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[1] It is perhaps significant that this is the same section of the Act which enunciates the policy that the power projects shall be self-supporting and self-liquidating.

[2] Act of May 18, 1933, ch. 32, sec. 14, 48 Stat. 66; Act of August 31, 1935, ch. 836, sec. 8, 49 Stat. 1077; 16 U.S.C.A. 831m.

THE MEANING OF COST ALLOCATION

Webster defines the term "allocate" as "to distribute or assign, allot, or apportion" and states that an allocation is an "allotment or apportionment, as an allocation of shares." [3] In accounting, he adds, allocation is "the apportionment of general expenses of a business to the account of its particular departments, according to some arbitrary rule." Two aspects of the latter definition are important: first, allocation relates to a technique for the treatment of *general* costs or expenses which cannot be traced directly to particular departments (or objectives); and second, allocation is usually carried out by the application of an appropriate "arbitrary rule." [4] Before concerning ourselves with the manifold considerations which enter into the determination of a "rule" for allocations, let us consider in the present chapter the TVA cost situation with reference to which an appropriate rule of allocation is required.

THE NATURE OF JOINT COSTS

Any large industrial enterprise is apt to incur two major types of cost, "direct" costs and "overhead" costs. Direct costs are those items of outlay which are traceable to the production of particular units of product (as is often possible with costs of raw materials). Overhead costs, on the other hand, cannot be so traced. In essence, they are simply all "other costs." [5] Although there are a number of categories of overhead costs, our attention will here be concentrated upon but one of these, namely,

[3] The term, allocation, is derived from *allocatus*, past participle of *allocare* based upon the Latin *ad*, meaning "to" and *loco*, "place."

[4] Professor J. M. Clark, discussing costs as viewed by the cost accountant, emphasizes the importance of a *rule* for the determination of allocations when he says:

> "Cost in this sense always includes cost plus a percentage of indirect cost which is allocated *in some uniform fashion.*"

Economics of Overhead Costs, 64 (italics supplied).

[5] Professor Clark defines overhead costs with the following statement:

> "They refer to costs that cannot be traced home and attributed to particular units of business in the same direct and obvious way in which, for example, leather can be traced to the shoes that are made from it. And most of the real problems involve one other fact; namely, that an increase or decrease in output does not involve a proportionate increase in cost."

Ibid, 1.

joint costs.[6] Joint costs are peculiar to enterprise producing heterogeneous output. They are those costs the incurrence of which contributes to the production of two or more project benefits at a smaller total outlay than if each purpose were pursued independently.[7] So defined, it is apparent that the joint cost problem runs the gamut of modern industry. Today there are few great business firms which concentrate their entire resources upon the production of a single commodity; the great majority produce a line of related (and sometimes unrelated!) products. The focus of the present study will be upon the problems of joint cost apportionment in the TVA water control program, but it is not beyond the range of possibility that our conclusions may be of somewhat broader applicability because of the general nature of the type situation with which we shall be dealing.

Up to the present point we have made rather free use of the terms "single purpose" and "multiple purpose." Let us sharpen these concepts. Stemming from early by-product theory, modern joint cost theory seems to accept as the criterion of dishomogeneity of output the question whether or not the entire product of an enterprise is disposed of in the same market. If it is sold in diverse markets then it is heterogeneous, and it follows that joint costs may be present.[8] If it is sold in a single market,

[6] The present use of "overhead cost" is essentially orthodox and is in conflict with a usage which would treat this type of cost as equivalent to "burden" (or "general expense") which is incurred in the production of a single commodity and is difficult to trace to particular units of output.

From a functional standpoint the significance of a distinction between joint cost as we define it and other types of general overhead is somewhat questionable. For example, are not fixed costs of equipment producing a single product essentially "joint" as between units of output produced at different times?

[7] It is significant that economy is of the essence of jointness. Total costs at a multiple purpose enterprise may be classified as direct costs traceable to particular units of output, direct costs traceable to particular classes of product but not to particular units, and joint costs which are traceable to no single class of output. (Under this usage certain classes of overhead cost may become "direct.")

The joint cost definition here given may be made more rigid by limiting the variability of proportionate output of the several joint products.

[8] To those initiated into economic jargon it may appear that the language of the text above provides no real help toward achievement of a precise definition of heterogeneity. For the question now arises, What is a market? If we define a market as the meeting of buyers and sellers for the purchase and sale of a particular commodity, it is clear that we shall have completed a circle. We have

such indirect costs as may be present must be non-joint and may be apportioned according to usual techniques for the distribution of burden. Although in some cases problems of definition of the terms "commodity" and "market" might make difficult the differentiation of single and multiple purpose enterprise, at federal stream control projects no such uncertainties exist; for there is little room to question that navigation, irrigation, flood control, and power are diverse objectives.

The use of the market criterion to determine whether commodities should be regarded as distinct gives rise to an interesting joint cost complication in the case of imperfect competition. Let us assume that different units of an identical product (from a physical viewpoint) are differently branded and advertised so that potential purchasers come to regard one sector of output as much more desirable than the other. Carried to its logical conclusion, this process results in the development of a "gap" between the two "commodities" so that the one can no longer be freely substituted for the other. Simply as a result of the branding process certain elements of indirect cost which formerly had been of the nature of "burden" now seem to become joint. If one takes the position that customary methods for the apportionment of burden are not applicable when costs are "truly" joint, does this mean that financial techniques for the apportionment of these elements of cost must be revised in the light of the changed situation? Since distinct demand conditions have come into existence for each of the "commodities," this conclusion would be by no means as unreasonable as it might appear at first sight.

An alternative solution to the difficulty above would remove it entirely from the joint cost field by adopting a qualification of the definition of joint cost originally proposed. This would

defined commodities in terms of their markets and markets in terms of commodities. This type of definition can have little practical use. Solution to this difficulty has been sought by some in such definitions of a commodity as that of Mrs. Robinson (to the effect that a commodity is something about which there is a "marked gap" in the chain of substitutes). (*Economics of Imperfect Competition*, p. 17.) But it is probably correct to say that in the last analysis only by the exercise of intelligent judgment can lines be finally drawn to delimit either commodities or markets.

restrict joint costs to those outlays contributing ***in a fixed proportion*** to the production of two or more benefits.[9] A somewhat more moderate qualification would treat joint costs as existing whenever some aspect of the productive process fixes limits upon the extent to which variations may be made in the proportionate output of the several "joint" products. (Such limits would exist, for example, in the production of cotton and cotton seed.) In so far as proportions between products may be varied so that an increase in one may be achieved by sacrifice of a part of the output of the other, the relation between the products is not complementary and their costs are not joint. But if beyond a certain point further production of "A" cannot be achieved by additional reductions in output of "B," then, to the extent that "A" automatically contributes to output of "B," joint costs are present.

If either of these suggested qualifications of our original definition of joint cost is applied to the hypothetical case of differently branded products, the indirect costs of this problem are at once excluded from the joint cost classification. Since the two "commodities" are physically identical except for brand name, any decrease in the number of units selected for one brand automatically would increase the number available for the other. Rather than the proportions of output of the two products being fixed, they are completely variable over a range from 100 percent production of one brand to 100 percent production of the other. Instead of being technically complementary, these differently branded, physically identical goods are plainly competitive from the production standpoint.[10]

[9] Professor Clark treats this as a second type or "stage" of joint cost. (*Op. cit.*, 98-99.) This seems to be what Professor Wallace has in mind in his discussion of joint costs and railway rate policy, for he says:

> "The essential element in joint supply which prevents equating of marginal utility and average cost is a fixity of proportion in the productive capacities available to meet the demands of different consumers."

He adds:

"The essence of joint supply is the inability to increase or decrease the relative capacities except in the same proportion."
"Joint and Overhead Cost and Railway Rate Policy," 48 (1934) *Quarterly Journal of Economics* 586, 593.

[10] One element of jointness might still exist in this situation. Average overhead cost might well be a diminishing function of price. If this were true, the greater the output of one brand the less the average overhead cost to be divided among the two brands. In this case, or in any similar case in which production

With this introduction, let us turn now to consider the joint cost situation at the Tennessee Valley Authority.

JOINT COSTS AT TVA

Since the TVA program for stream control is directed more to the achievement of multiple objectives than any other single phase of the Authority's activities, it is not surprising that here the focus of TVA joint cost problems rests.[11] Throughout the remainder of this chapter we shall seek an understanding of what is meant by TVA "joint costs."

Estimated "direct" costs and remaining "joint" costs for an authorized ten-dam TVA system were submitted by the Authority to a Joint Congressional Committee[12] in the form of Table 21. It is not within the scope of the present study to appraise the accuracy of these estimates, but a few remarks about them may be in order. First, the indicated costs are project investment costs. Since the reality of cost rests in the rate of cost per unit of time, the data would have much more meaning if put upon an annual basis. Should such an adjustment be made, it would have to consider not only a reasonable rate of fixed charge to apply against the indicated investment, but it would also have to take into account annual expenses for operation and maintenance.[13] Second, "direct" costs are not restricted simply

and sale of one commodity contributes to the possibility of economical production and sale of another, at least a limited degree of jointness would seem to exist.

It is significant that all joint products must have value. If some of them are non-salable (as navigation or flood control) but valuable, the condition as to jointness suggested above may be revised to require that the production of one commodity (or benefit) contribute to the economical production and distribution to the consumer of one or more others.

[11] If one were to take the quite reasonable position that primary and secondary electric energy are distinct commodities, it would be possible to detect elements of joint cost among the so-called "direct" costs of power facilities. In the present study discussion will be limited to the larger issue of costs joint as between the diverse major purposes of reservoir operation.

[12] This joint committee was established in 1938 pursuant to Public Resolution 83, Seventy-Fifth Congress, Third Session. Its exhaustive investigation of almost every phase of TVA business may be traced through fourteen volumes of printed hearings entitled *Investigation of the Tennessee Valley Authority*. The committee's report, in three parts including appendices, was printed as Senate Document 56, Seventy-Sixth Congress, First Session.

[13] "Fixed Costs" are here taken as all costs other than operation and maintenance. The major components are interest, depreciation, and taxes. There is no

to "costs visibly traceable to particular purposes" but are in the nature of incremental or "prime" costs.[14] For example, direct cost for flood control is determined as the difference between the anticipated cost of each proposed structure and the cost of an alternative structure to provide equivalent benefits for all purposes other than flood control but no flood control benefits. Similarly, direct costs for power and for navigation, respectively, were computed by determining incremental investment on account of each of these purposes.[15] Third, the sum of remaining joint costs for the several projects of the ten-dam system is a heterogeneous category. This follows from the residual method by which joint costs are computed and is symbolically suggested by Figure 11. The upper chart of this figure represents an estimated total cost of $40,000,000 for a hypothetical project. But this investment includes direct (incremental) costs of features useful for particular objectives. The lower figure represents only net multiple use investment. Expensive features of the more complex structure, such as powerhouse and facilities, lock, and special flood gates, are replaced by concrete bulkhead and ordinary gates. The difference in cost between the upper and lower figures represents the sum of direct costs for various purposes, and the plain lower figure represents project "joint" investment. If we substitute for our hypothetical project the TVA Wilson project (at which the flood control objective is not present), it is evident that the total of joint cost is common to navigation and power. On the other hand, if we substitute the Joe Wheeler project, a part of joint investment is common only to navigation and power, a part to power and flood control, and

intention to imply that these costs are indeed *fixed* over the very long run, but they are certainly rigid by comparison with other elements of cost.

[14] See Marshall, *Principles of Economics*, Fifth Edition, 359, 394, and Robinson, Joan, *op. cit.* 39, 48. Professor J. M. Clark, on the other hand, has defined direct costs as ". . . . costs visibly traceable to a given job or order or class of business without the need of difficult studies or allocations." (Clark, *op. cit.* 40, 56.) To costs of the type termed "prime" by the English economists Professor Clark has applied the term "differential." (*Ibid.* 49.) Professor F. H. Knight has referred frequently to this class of cost as "incremental." It is interesting that Marshall apparently conceived of direct and prime costs as identical, for he wrote that "special, direct, or prime cost" together with "supplementary cost" make up total cost. (Marshall, *op. cit.* 359.)

[15] See Technical Appendix A.

a part to all three purposes. At other TVA projects total joint investment is useful in different proportions for different combinations of dual and triple purposes.

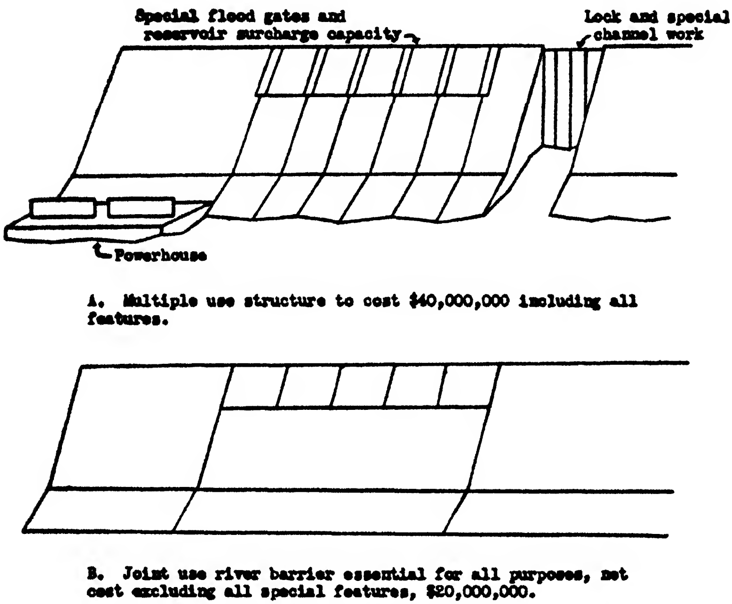

Figure 11. Symbolic diagram indicating nature of direct costs and of joint cost complex at a hypothetical three-purpose project.

It has sometimes been urged that a first step toward the allocation of joint costs to particular purposes should be the segregation of total joint costs into the several categories of dual and triple purpose investment. Let us consider this problem at the Wheeler project. Here total joint investment is estimated at $22,304,000.[16] The part of this investment incurred on account

[16] This amount is determined as follows:

Cost of multiple use barrier		$21,328,000
Add:		
Non-overflow section to replace lock	$202,000	
Bulkhead to replace powerhouse and intakes	774,000	
		976,000
Total Joint Cost, Wheeler project		$22,304,000

Source: Tennessee Valley Authority.

TABLE 21

ESTIMATED DIRECT COSTS AND REMAINING JOINT COSTS, TVA TEN-PLANT SYSTEM

Project	Direct Costs			Remaining Joint Costs	Estimated Total Costs
	Navigation[a]	Flood Control[b]	Power[c]		
Norris	....	$ 2,600,000	$ 4,542,389	$ 24,389,731	$ 31,532,120
Hiwassee	....	258,000	6,312,000	15,045,100	21,615,100
Fort Loudoun[d]	$ 6,290,000	2,060,000	5,560,000	14,510,000	28,420,000
Watts Bar	4,100,000	....	9,415,000	22,000,000	35,515,000
Chickamauga	8,370,812	1,152,000	9,026,788	22,181,514	40,731,114
Guntersville	3,846,000	....	10,336,000	20,046,000	34,228,000
Wheeler	1,884,610	....	15,194,775	22,304,157	39,383,542
Wilson[e]	2,654,197	....	19,982,171	19,138,546	41,774,914
Pickwick	6,929,000	1,194,000	13,973,000	13,599,979	35,695,979
Kentucky[d]	11,139,000	26,499,000	16,635,000	49,416,000	103,689,000
Total	$ 45,213,619	$ 33,763,000	$110,977,123	$222,631.027	$412,584,769
Wilson Depreciation	332,819	....	2,092,158	2,349,928	4,774,905
Adjusted Total	$ 44,880,800	$ 33,763,000	$108,884,965	$220,281,099	$407,809,864

[a]Direct charges to navigation include cost of lock and channel improvements less cost of structure to replace lock. Costs at Chickamauga include charge for channel improvements in Hales Bar Reservoir. At Wilson project, costs of raising Wilson Dam and Lock and Dam Number 1 to provide 9-foot net navigation are not included.

[b]Direct charges to flood control are estimated as costs saved if projects had been for navigation and power only. These charges are based upon tentative estimates.

[c]Direct charges to power consist of costs estimated for powerhouse and equipment less substitute non-overflow dam section.

[d]Fort Loudoun and Kentucky projects were formerly known as Coulter Shoals and Gilbertsville.

[e]"Reconstruction Cost New" as estimated in *Report* of Valuation Committee to the Board of Directors of the Tennessee Valley Authority dated March 10, 1937.

Source: *Investigation of Tennessee Valley Authority*, Hearings, p. 5352, and Technical Appendix A.

of reservoir capacity up to elevation 548 [17] is jointly serviceable for navigation and power, for each of these purposes benefits from project dead storage (head) which is held continually to (or above) this level. That part of investment incurred for capacity between elevations 548 and 550 [18] is jointly serviceable for all three objectives. With only moderate flow, navigation derives benefit from a channel somewhat deeper than that provided by storage to elevation 548; and power and flood control both benefit by the operation of live storage.[19] That part of capacity above elevation 550 [20] is useful only for flood control and power, for additional depth over a generous nine-foot channel is of only minor value to navigation. On the basis of this classification of purposes benefiting from different levels of Wheeler storage, how may the several two- and three-purpose components of total joint cost be determined?

A number of methods may be considered for analysis of the joint cost complex. First, the several components may be fixed according to the costs of multiple use barrier and reservoir estimated to be incurred between the several critical elevations. All costs for land and works up to elevation 548 may be charged jointly to power and navigation. Costs between 548 and 550 may be assessed jointly against all three objectives. All costs incurred above elevation 550 may be charged jointly to power and flood control. Assuming reasonable techniques for division of construction overheads, this method of breaking down multiple use costs would be quite feasible. But while feasible, it is quite illogical. Height of a dam is a primary determinant of required thickness at the base and hence of the volume of concrete required between any two elevations. Consequently, cost of structure below elevation 548 at Wheeler is considerably more because of live storage provided up to elevation 556.3 than it would be if spillway crest were no more than 548. To assess all cost up

[17] Approximately 650,000 acre feet.

[18] Approximately 100,000 acre feet.

[19] See above, Chapter V.

[20] Approximately 350,000 acre feet of controlled storage to top of gates at elevation 556.3 with an additional 140,000 acre feet of uncontrolled storage to elevation 558 useful for flood control.

to elevation 548 of the multiple purpose barrier with a crest at elevation 556.3 jointly to purposes deriving benefit from storage below 548 results in overcharging the latter objectives and undercharging those benefiting from storage in the upper part of the pool.

A second method which has been suggested for "determining" the several joint components of total joint cost is to assume that the latter is incurred in direct linear proportion to reservoir capacity and to divide it among combinations of purposes according to relative use of total joint capacity.[21] This procedure is illustrated in Table 22. Although it is perhaps more satisfactory than the method for analyzing the joint cost complex suggested above, it is deficient on two major counts. All objectives are not equally interested in *volume* of storage (as opposed to head), and total joint costs often do not vary in a linear fashion with reservoir capacity.[22]

Still a third method for segregation of the various elements of joint cost has been suggested. This is somewhat more complicated than either of the two indicated above, and it assumes a very rigid definition of jointness. At a comprehensive navigation-power-flood control project an estimate of total investment cost may be regarded as composed of the following elements:[23]

Direct costs
- For navigation
- For power
- For flood control

Joint costs
- Between navigation and power
- Between navigation and flood control

[21] In effect this method is an application of use theory of joint cost allocation. (See below, Chapter XII.)

[22] For example, if joint costs per unit of capacity increase with increasing reservoir volume (as might result from the flooding of increasingly valuable reservoir lands), it is doubtful whether objectives interested merely in the impounding of water for head (such as power and navigation for storage below elevation 548 at Wheeler) should be assessed joint costs proportionate to their share of total reservoir volume.

[23] Conceptually, it is possible that one or more of these elements might be zero or negative.

Between power and flood control
Among navigation, power, and flood control

Following the same classification, a cost estimate for single purpose flood control improvement at the same site could be regarded as composed of the following elements:

Direct costs
For flood control

Joint costs
Between navigation and flood control
Between power and flood control
Among navigation, power, and flood control

Of the cost components of the larger development the estimate for the smaller project would exclude only three: direct cost for power; direct cost for navigation; and costs joint as between power and navigation. Since we already have available a procedure for determining direct costs, it follows that if we can prepare a single purpose flood control estimate we can isolate the remaining unknown, costs joint as between power and navigation. Working along similar lines with single purpose navigation and power estimates, we can also isolate costs joint as between flood control and power, and navigation and flood control. Finally, knowing all dual purpose costs, we may deduct their sum from the total of the joint cost complex to determine as a remainder costs joint as among all three purposes (navigation, flood control, and power). This technique has been applied to analysis of the joint cost complex at Wheeler Dam in Table 23 and at Pickwick Dam in Table 24.[24]

Despite a certain superficial logicality, this third method of joint cost analysis is subject to serious criticisms. From a practical standpoint, its application to any triple purpose project requires cost estimates for six projects other than the one actually

[24] Algebraic and graphic equivalents to this method of joint cost analysis are explained in Technical Appendix B.

constructed.[25] Three of these estimates are required for isolation of the total joint cost complex as a preliminary to any attempt at allocation, but three others are required only for this particular method of determining the elements of total joint cost. Reasonableness of the results which the method determines is completely dependent upon the accuracy of estimates for these hypothetical projects.[26] Theoretically, the method is deficient because

TABLE 22

BREAKDOWN OF JOINT COST COMPLEX AT WHEELER DAM ACCORDING TO PROPORTIONATE RESERVOIR CAPACITY USEFUL FOR VARIOUS COMBINATIONS OF PURPOSES

Purposes Benefiting from Use of Capacity	Between Elevations	Reservoir Volume[a]		Proportionate Share of Joint Cost
		acre feet	percent	
Power and Navigation.....	496–548	650,000	59.1	$13,181,000
Power, Navigation and Flood Control..........	548–550	100,000	9.1	2,030,000
Power and Flood Control..	550–556.3	350,000	31.8	7,093,000
Total: All Purposes......		1,100,000	100.00	$22,304,000

[a]Volumes between elevations read from Wheeler reservoir area and volume curves dated July 15, 1938. (Source: Tennessee Valley Authority.)

it assumes a rigidity in the proportions of benefits at the TVA multiple use projects which does not exist in fact. It is true that there is a technical complementarity among the several TVA objectives and that this complementarity is reinforced by institutional factors which limit the variability in proportions of TVA benefits. But a moderate scope for relative variation of benefits remains, and this is quite inconsistent with the type of jointness which this method assumes. This theoretical weakness seems

[25] The required estimates are for single purpose navigation, flood control, and power projects and dual purpose navigation-flood control, navigation-power, and flood control-power projects. All estimates must contemplate development at the site selected for the multiple purpose project.

[26] It is essential that the hypothetical projects provide benefits approximately equivalent to those of the adopted project. (Available estimates for single purpose projects on a larger or smaller scale would have to be adjusted before they could be used.) For example, if the single purpose flood control project would yield benefits greater than the flood control benefits of the adopted project, the tendency would be toward understatement of costs joint as between power and navigation.

TABLE 23

ISOLATION OF TYPES OF JOINT COST IN THE JOINT COST COMPLEX AT WHEELER DAM

	Navigation-Power Joint Costs (Analyzed by Reference to Flood Control-Only Costs)		Flood Control-Power Joint Costs (Analyzed by Reference to Navigation-Only Costs)		Navigation-Flood Control Joint Costs (Analyzed by Reference to Power-Only Costs)		Power-Navigation-Flood Control Joint Costs
	(All costs in thousands of dollars)						
Total of Joint Cost Complex		22,304		22,304		22,304	22,304
Cost of relevant single purpose project (excluding costs joint between missing objectives)	14,400		20,785		37,114		
Less direct cost for objective of single purpose project	......		1,885		15,195		
Net "joint" costs at single purpose project		14,400		18,900		21,919	
Remaining two-purpose joint cost		7,904		3,404		385	
Total two-purpose joint cost							11,693
Remaining three-purpose joint cost							10,611

Source: Table 21 for direct costs and total of joint cost complex. Single purpose cost estimates are provisional since they come from preliminary work sheets at TVA.

TABLE 24

ISOLATION OF TYPES OF JOINT COST IN THE JOINT COST COMPLEX AT PICKWICK DAM

	Navigation-Power Joint Costs (Analyzed by Reference to Flood Control-Only Costs)		Power-Flood Control Joint Costs (Analyzed by Reference to Navigation-Only Costs)		Navigation-Flood Control Joint Costs (Analyzed by Reference to Power-Only Costs)		Power-Navigation-Flood Control Joint Costs
	(All costs in thousands of dollars)						
Total of Joint Cost Complex		13,600		13,600		13,600	13,600
Cost of relevant single purpose project (excluding costs joint between missing objectives)	14,454		19,561		25,867		
Less direct cost for objective of single purpose project	1,194		6,929		13,973		
Net "joint" costs at single purpose project		13,260		12,632		11,894	
Remaining two-purpose joint cost		340		968		1,706	
Total two-purpose joint cost							3,014
Remaining three-purpose joint cost							10,586

Source: Table 21 for direct costs and total of joint cost complex. Single purpose cost estimates are provisional since they come from preliminary work sheets at TVA.

to provide the major explanation for the somewhat surprising results of Tables 23 and 24.[27]

CONCLUSION

To what conclusion does the foregoing discussion lead? First, are so-called joint (or multiple use) costs at TVA really joint? The essence of jointness is twofold: economy and multiple purpose utility. TVA investment in multiple use facilities is characterized by both of these attributes.[28] Some writers have further urged that jointness requires fixity in the proportions of benefits or at least limits in the extent to which proportions may be varied. Although fixity in the proportions of joint benefits does not exist at TVA, technical and institutional factors combine to limit the extent to which proportions may be varied.[29] The joint character of TVA multiple use costs may be accepted.

Second, accepting that TVA multiple use costs are joint, should one make an effort to break them down into subsidiary joint components or should they be treated as a single category? Although thoroughness might appear to require a breakdown, it is more expedient for a number of reasons to work tentatively with the total of joint costs. The technical difficulties of segregating the elements making up the joint cost complex are great, if not insuperable. Further, if the strict logic of the argument for breaking down joint costs were carried to its conclusion, non-homogeneity within the several type components of joint cost would require separate treatment of every feature of joint investment at every project. This would lead to a tremendous further complication of an already complicated problem. It

[27] How otherwise may one explain the existence of $385,000 of joint flood control and navigation investment at Wheeler Dam? At the Pickwick Dam, how can one explain a navigation-flood control joint investment of $1,706,000 as compared with a power-navigation investment of $340,000 when all dead storage is jointly serviceable for the latter pair of objectives and no part of reservoir capacity is reserved solely for navigation and flood control?

[28] The economy of the program has been touched upon in Chapter V above. Further information in this regard is presented in Chapters IX and X below.

[29] For example, the nine-foot channel requirement sets limits upon reservoir drawdown for power and flood control but also guarantees a minimum power head. Flood control rule curves similarly set limits upon power availability in dry years.

would make allocations to particular purposes on a system basis impossible.

Third, the bulk of the discussion above has been concerned with analysis of joint investment cost although the significance of cost lies in its annual burden. To this annual burden both "fixed" charges upon investment and operation and maintenance costs contribute. Inasmuch as TVA has confined its attention in its allocation research primarily to the problem of allocating joint investment, we shall concentrate upon this aspect of the allocation problem throughout the remaining chapters of Part II. Although our immediate concern will be with the apportionment of TVA joint investment, we enter here the reservation that this discussion is purely provisional. Any method selected for allocation of joint investment will have to be reviewed in the light of the non-homogeneity of the joint cost complex and of the fact that charges on investment are supplemented by common operation and maintenance expense.

Chapter VII

THE SETTING OF THE ALLOCATION PROBLEM—HISTORICAL

Summary. In order to gain an understanding of Congress' conception of the nature and purposes of cost allocation it will be helpful to review the development of the allocation idea.

The tap roots of modern allocation thinking go back to the early River and Harbor laws under which Congress took jurisdiction over all interstate navigable waterways. In keeping with the spirit of these laws, the General Dam Acts of 1906 and 1910 authorized the United States to contribute the costs of locks and navigation facilities to proposed "private" structures upon the navigable streams. From these provisions it was but a short step to proposals of the Muscle Shoals Hydro Electric Power Company that the United States contribute the full navigation value of a proposed power-navigation improvement at Muscle Shoals. Modified to provide that such value should be measured by the costs estimated for stream development by an alternate system of low navigation dams, this proposal was endorsed by the United States Engineers. Very likely only the supervention of the first World War forestalled federal participation in the project according to these terms.

After the War, the allocation idea matured rapidly. In 1921 a group of southern power companies declared that a major reason why they could not submit a bid for the power output of Wilson Dam was because the government had not made clear what part of project costs would be considered as chargeable to navigation. In the various proposals for leasing or operating Muscle Shoals allocation provisions were generally included. Meanwhile, Congress passed the Federal Water Power Act in 1920 and the Boulder Canyon Project Act in 1928, both of which contained provisions looking toward cost allocations. By 1932 so general had allocation thinking become that it seemed that at Muscle Shoals disagreements in the future would be more concerning the propriety of particular recommended allocations than the reasonableness of the allocation principle itself.

Although it is true that cost allocation provisions of the Tennessee Valley Authority Act represented the final maturing of long evident tendencies, the allocation problem which confronted the Authority was unique. Because it was the first federal agency to encounter a problem of this nature on a large scale, TVA did not find at hand a generally acceptable solution. But it did have available in

the long background of allocation thinking information which could aid it to an understanding of the objectives of allocation and the criteria by which a suggested allocation might be appraised.

THE BIRTH OF THE ALLOCATION IDEA

Although the allocation concept was given its first mature expression in federal legislation in the TVA act and its amendments, it was not a new idea in 1933. As early as the General Dam Acts of 1906 and 1910 [1] Congress had implied something akin to allocation when it authorized (under certain conditions) federal participation in the costs of "private" power or other structures to the extent of the direct costs of locks or navigation facilities. But allocation in this sense did not relate to the joint cost problem since it merely contemplated that the United States might assume the burden of gross direct investment for navigation if it saw fit.[2]

A long step toward development of the modern point of view toward allocation was made in a series of proposals of the Muscle Shoals Hydro Electric Power Company for federal participation in a joint navigation-power improvement of the Tennessee River at Muscle Shoals. The first bill introduced into Congress for acceptance of one of these proposals contemplated that the Company should bear the burden of all investment on account of facilities useful only for power, the Government should bear all investment for navigation only, and the Company and Government should share equally the costs of jointly useful investment.[3]

[1] See above, Chapter I.

[2] Investment was "gross" in that it took no account of the possible multiple-use contribution of lock section as bulkhead. On the other hand, it was net of certain costs since owners of water control projects were required to convey to the United States without charge lands on which navigation structures might be built and construction power for prosecution of the work.

Both the laws of 1906 and 1910 also provided that the Chief of Engineers and the Secretary of War might require the grantee to construct and maintain navigation facilities at his own expense if they saw fit.

[3] See H. R. 24453, Fifty-Ninth Congress, Second Session, introduced by Representative Richardson on January 18, 1907, and Judson King, "The Legislative History of Muscle Shoals," Legal Division, Tennessee Valley Authority (1936), 10.

This initial proposal included no estimate as to how great the several elements of cost might be. As later modified the Company estimated that its plan of development would require an expenditure of $20,198,800. It suggested that

This proposal was never seriously considered, but a modification of it as well as a subsequent proposition along the same lines was rejected by the United States Engineers on the ground that it would require expenditures in excess of the alternate costs of completion of the Muscle Shoals navigation canal.[4]

Having established this record, the Engineers reversed themselves in 1914 to recommend a federal contribution of $8,575,000 to a proposed four-dam improvement at Muscle Shoals.[5] This charge was justified as follows:

Estimated cost of locks at Dams Number 2, 3, and 4	$6,741,000
Cost of Lock and Dam Number 1 and canal to Lock Number 2	850,000
Cost of six-foot navigation from Browns Island to mouth of Flint River (45 miles)	987,000
Total, say	$8,575,000

the United States contribute $5,683,200 of this and that it contribute the balance of $14,515,600. A special board of engineers to which the House Committee on Rivers and Harbors referred this proposition found it unsatisfactory on several grounds. Revising the Company's plans in order to include Lock and Dam Number 1 to provide a navigable approach to the main development and substituting gravity type structures for hollow concrete dams, the review board estimated the cost of proper development of the site at $32,000,000. Since the Company remained adamant that $14,515,000 was the maximum it could contribute to project cost, it appeared that river improvement along the lines suggested by the board would require of the United States an investment of $17,485,000. But it was estimated that only $6,741,000 of federal investment would be required for completion of the then-existing Muscle Shoals canal project; and the board considered this the maximum contribution which should be made by the United States to the power-navigation development. Therefore, acceptance of the Company proposal was not recommended. (See House Document 781, Sixtieth Congress, First Session.)

[4] See note 3 above. This was the first use of alternate single purpose cost to fix a maximum reasonable allocation at a multiple purpose project.

In reviewing a 1908 proposal of the power company the special board again fixed $6,741,700 as a maximum federal contribution and added that ". . . . this stretch of river could be satisfactorily improved for navigation in other ways for a somewhat less amount than this." (Document 14 of the House Committee on Rivers and Harbors, Sixtieth Congress, Second Session, p. 20.) The Board of Engineers for Rivers and Harbors took notice of the fact that satisfactory navigation would require that the alternate canal system be supplemented by a downstream lock and dam which it estimated would cost $1,000,000. It therefore fixed $7,741,000 as a maximum federal contribution to any plan of multiple purpose river improvement between the head of Elk River shoals and the Florence railway bridge. (*Ibid.*, 26.)

[5] The cost of the four-dam improvement for all features exclusive of powerhouse superstructure and equipment was estimated at $16,835,000. The report presenting the Engineers' new recommendations also carried an estimate of $18,701,000 for a three-dam revision by the Muscle Shoals Hydro Electric Power Company of the Engineers' four-dam plan. This revision contemplated increasing the height of Dam Number 2 and eliminating the proposed Dam Number 3. See

The balance of project cost, estimated to amount to $8,260,000, was nominally to be regarded as chargeable to power and to be borne by the Muscle Shoals Hydro Company. Actually the Company claimed that it could not raise so large a sum, and it therefore proposed to meet the Engineers' requirements by paying $3,000,000 to the United States in cash upon completion of the works and annually thereafter for 100 years interest at three percent and amortization upon the balance.[6]

This scheme of financing had a number of interesting aspects. First, it would have implicitly committed the United States to the principle of a 100-year lease. Second, it would have permitted the Company to take advantage of the credit standing of the federal government in order to secure funds at a lower interest rate than that at which it could have obtained them upon the open market. Third, since the plan provided that the United States build the projects and turn them over to the Company for stated payments, it contemplated that the United States risk incurring costs above $8,575,000 if construction estimates should prove low.[7] Despite these features of the Company plan, J. W. Worthington, who submitted it, declared:

> "It is a plan by which, through the development of water power, the United States Government is repaid all of its expenditures for navigation and water power development and becomes the sole possessor of all the things for which that expenditure was made." [8]

As the defense emergency prior to the first World War became acute, interest began to develop in the possibilities of pro-

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Document 20 of the House Committee on Rivers and Harbors, Sixty-Third Congress, Second Session, p. 32.

[6] The Company was also to deliver free of charge to the United States energy for operation of project locks; it was to pay annually $ .35 per horsepower of installed generating capacity, payments to begin the first year after installation of 200,000 horsepower but not later than after twenty years. Since installations would be scheduled according to trends in development of load, the present value, as of the date of lease, of the latter provision could not be exactly computed. A later analysis suggested that under varying assumptions the present value, as of the start of the lease period, of this commitment to the United States would be from $1,778,000 to $5,552,000. (House Document 1262, Sixty-Fourth Congress, First Session, 36-37.)

[7] See proposal of the Muscle Shoals Hydro Electric Power Company dated December 10, 1913 and reprinted in Committee Document 20, p. 75 ff.

[8] *Ibid.*, 76.

duction of nitrates at Muscle Shoals. In this regard Frank Washburn of the American Cyanamid Company submitted his proposal that the United States harness the hydroelectric energy available at Muscle Shoals and make it available to his company for use in the manufacture of munitions and fertilizers in return for annual company payments of three percent upon federal investment in power facilities. Since this basis of rate making was obviously unreasonable, it is not surprising that the proposal received scant attention.[9]

After the early Muscle Shoals debate the next important expression of the allocation principle was in the Federal Water Power Act of 1920. Two sections of this law are relevant here. First, it provided that under certain circumstances the Commission might make recommendations to Congress as to appropriate federal participation in the costs of power-navigation improvements upon the navigable streams.[10] But apparently it was not contemplated that under any circumstances the United States should bear a greater share of project costs than direct investment for navigation. Although there was here an issue of cost participation by the federal government, there was no real problem of joint cost allocation. A second relevant provision of the law was to the effect that the Commission, in considering applications for power rights at government dams, should require ". . . . a reasonable annual charge for the use thereof."[11] Since power applicants would bear all annual power expenses, capitalization of the annual fee set by the Commission at a reasonable rate of fixed charge would determine the effective power allocation at any project. Although the Federal Power Commission did not typically approach the problem of setting fees for private use of government dams from the point of view of apportioning a total joint investment among various objectives, the fact that the effect of such fee-setting was an apportionment of joint

[9] In effect it allocated to non-power purposes (navigation) all costs other than a minimum interest charge on power facilities. The Washburn proposal has been mentioned in Chapter II above.

[10] Act of June 10, 1920, 41 Stat. 1070, ch. 285, sec. 12, 16 U.S.C.A. 805.

[11] 41 Stat. 1069, sec. 10e.

investment gives the legislation a place in the development of federal allocation policy.

ALLOCATION IN THE POST-WAR MUSCLE SHOALS CONTROVERSY

The emergent allocation conception was given further content during the post-war debate as to an appropriate use or disposition of the federal Muscle Shoals properties. The Ford offer, which we have seen touched off this debate in 1921, ostensibly provided for interest at four percent and amortization over 100 years upon all investment required for completion of Dams Number 2 and Number 3 as well as for full payment by Mr. Ford of all operating and maintenance expenses. Supporters of the bid claimed as one of its unique advantages that it would lead to full navigation improvement of the Tennessee River at no cost to the United States.[12]

Study of the terms of the Ford bid scarcely supports this contention. First, Mr. Ford proposed no payments whatsoever upon investment "sunk" in Wilson Dam at the time of his bid. Since such investment was in the neighborhood of $17,000,000, disregard for it constituted either a major write-down of the cost value of the project or else a significant allocation of cost to navigation. Second, although propaganda in support of the bid emphasized that it would provide interest and amortization upon the full costs of completing Dams Number 2 and Number 3, testimony in Congressional hearings indicated that the Ford conception of "costs of completion" carefully excluded all costs "properly chargeable to navigation." Very likely this explains the substantial differences between the estimates of the United States Engineers and Mr. Ford's engineers as to new investment required under the Ford bid.[13] One very important item in total

[12] Mr. W. G. Waldo of the Tennessee River Improvement Association supported the Ford bid with the statement:

> "At Muscle Shoals, ... by setting up a long-term sinking-fund the water power can be made to pay the whole cost of the navigation structure, Senator. That is the idea of that feature in the Ford Proposal; you will amortize not only the cost of your dam, but your locks as well, and ultimately the Government receives its navigation facilities free of cost."

United States Congress, Senate, *Muscle Shoals*, Hearings before the Committee on Agriculture and Forestry, Sixty-Seventh Congress, Second Session (1922), p. 805.

[13] In this regard the following testimony is relevant:

Mr. HILL. "Now we have a range, say from $30,000,000 to $50,000,000, project cost which Mr. Ford proposed to exclude from the investment base upon which he would pay interest and amortization was cost of reservoir flowage. Thus, the evidence does not support the view that the Ford bid looked toward a power-navigation development of the Tennessee River under which 100 percent of investment cost would be charged against the former objective.[14]

one being Mr. Ford's estimate and one being the estimate of the Army engineers, for the completion of the project.

Mr. WORTHINGTON. "Taking Mr. Ford's estimate at $30,000,000, and leaving out, which he did, the cost of that portion of the work that should be charged at the two dams to navigation, you cannot quite draw a parallel, because in the case of the engineers' estimate, of course, they included the locks."

Muscle Shoals Propositions, Hearings before the House Committee on Military Affairs, Sixty-Seventh Congress, Second Session (1922), p. 383.

[14] With regard to costs of reservoir lands, consider the following testimony:

Representative JAMES. "When the Judge Advocate General was before the Committee the other day the matter concerning the cost of flowage rights came up, and he stated that Mr. Ford believed the Government could acquire those cheaper than anybody else, and there was not any doubt in his mind but that Mr. Ford intended to reimburse the Government for those expenditures. . . . . What have you to say about that?

Mr. MAYO. I differ from his opinion: I do not think Mr. Ford intends to have that charged up against the project at all.

Mr. JAMES. It makes quite a difference to the Government whether it has to pay for them or whether Mr. Ford is going to pay for them.

Mr. MAYO. I have stated before that Mr. Ford thought that the cost of those flowage rights should be charged up to navigation.

Ibid., p. 258.

It is also worth pointing out that the Ford bid contemplated an annual payment by Mr. Ford to the United States of $55,000 on account of costs of operation and maintenance of dams and reservoirs. Should this amount have proved inadequate to meet the full costs of operation and maintenance, the United States would have been required to make up the deficit. With regard to federal non-hydraulic properties at the Shoals reservation, Mr. Ford proposed to pay $5,000,000 consideration for transfer to him of fee simple title. Scrap value of these properties had been estimated substantially above this amount. (See Senate Report 831, parts 1 and 2, Sixty-Eighth Congress, Second Session; Senate Report 678, Sixty-Eighth Congress, First Session; and House Report 143, parts 1 and 2, Sixty-Eighth Congress, First Session.)

O. C. Merrill, then Executive-Secretary of the Federal Power Commission, estimated that the present worth as of July 1, 1922 of the consideration proposed in the Ford offer would fail by $28,000,000 of covering federal investment passed to Ford under its terms. He added:

"I think Mr. Ford's offer gives more to him than there is any necessity for the United States giving in order to get that property operating down there. It seems to me that it is sheer, outright subsidy not only with respect to fertilizers, which might be justified, but that it is a sheer, outright subsidy to Mr. Henry Ford in his private operations."

Hearings before Senate Committee on Agriculture, Sixty-Seventh Congress, Second Session (1922), p. 639.

In contrast to Mr. Ford who sought to disguise the allocation features of his bid behind a propaganda barrage to the effect that he would repay the entire costs of Dams Number 2 and Number 3, other bidders for Muscle Shoals were more open in presenting the allocation aspects of their proposals. In 1921, when Major Lansing Beach, the Chief of Engineers, contacted a number of southeastern power companies to inquire if they would be interested in bidding for the lease of Dam Number 2, the Alabama Power Company replied:

> "This company is not advised as to the extent to which the Government is disposed to consider a portion of the investment as being due to the war emergency; or what portion may properly represent its power supply for nitrate purposes; in addition to which it is assumed that a portion will be charged to the improvement of navigation on the Tennessee River. These are vital considerations, inasmuch as excessive costs would burden the entire future of the power development, increase the cost of power to consumers, and tend to discourage industrial enterprises which, with low power costs, should supply a market for part of the Muscle Shoals power." [15]

In somewhat similar language a letter from the "Associated Southeastern Power Companies" also declared that these companies could not consider bidding for Muscle Shoals until the United States had made it plain that a substantial part of the cost of Dam Number 2 would be charged to non-power purposes.[16]

Despite its earlier position, when the Ford bid was announced

[15] Letter addressed to the Secretary of War from the Alabama Power Company and written over the signature of Thomas W. Martin, President, dated May 28, 1921. Quoted at *Hearings on Muscle Shoals*, before House Committee on Military Affairs, Sixty-Seventh Congress, Second Session (1922), pp. 38-40.

[16] The letter stated:

"If it is true (as estimated by the Government engineers) that the cost of the completed dam and hydraulic power plant and navigation improvements at Muscle Shoals, Tennessee River, will be $50,000,000, exclusive of transmission costs according to the plans upon which it is being at present constructed, a large portion of that amount will have to be charged off or charged to war loss and improvement of navigation, because the portion of the cost upon which the sale to the public service market of the commercially usable available power output can be made to derive a reasonable rate of interest is limited definitely by the existing regulation by public authorities of rates and service in the southeastern territory."

Ibid., p. 121.

the Alabama Power Company reconsidered the situation and promptly submitted a competing offer.[17] This proposed that the company be granted a fifty-year lease of the Wilson Dam power output and title to two government steam plants as follows:

Warrior River, original cost	$ 4,676,000
Nitrate Plant No. 2, original cost	12,326,392
Total original cost	$17,002,392

In return the company would bear all costs of completing and operating Dam Number 2, pay the United States $5,000,000 less the cost of locks at the dam, and deliver to the United States 100,000 horsepower of nine-month secondary energy for use as the Government might see fit (presumably in production of nitrate fertilizers). The Company pointed out that it was in a position to make such a generous offer because it could use large storage sites which it owned on the Tallapoosa and Coosa watersheds in Alabama to prime much of the "secondary" energy at Muscle Shoals.[18] Yet upon analysis this bid did not far surpass the Ford proposal. Beyond a moderate supply of second rate energy the United States stood to receive in return for a $34,000,000 investment turned over to the company only about $2,500,000 in cash and title to a hydroelectric project it could not use for fifty years.[19]

Although the early Muscle Shoals bids contemplated allocations of project costs, they were not based upon careful analyses of either joint investment or alternate single purpose costs. Congressional committees, on the other hand, in considering and appraising these bids accomplished much toward clarification of the allocation issue. One of the clearest early statements on this matter was by Col. W. J. Barden of the Corps of Engineers be-

[17] Dated February 15, 1922, the Alabama Power Company bid was transmitted to Congress by Secretary of War Weeks in House Document 192, Sixty-Seventh Congress, Second Session. *Ibid.*, pp. 808-809.

[18] *Ibid.*, p. 698; and *Muscle Shoals*, Hearings before the Senate Committee on Agriculture, Sixty-Seventh Congress, Second Session (1922), p. 153.

[19] The figure of $34,000,000 for government investment is made up of $17,000,000 for steam plants and $17,000,000 for sunk costs at Dam Number 2. (These investment figures are, of course, undepreciated.)

fore the Senate Committee on Agriculture and Forestry. It is quoted at length below:

Col. BARDEN. "The 'value to navigation' of such a combined scheme for power and navigation is a somewhat indefinite term. Assuming these two dams to be built for the development of power only, the cost of providing for navigation would be merely the excess cost of putting in locks over that of a solid section of dam across the upper end of the lock and into the abutment. The approximate cost of this would be $2,860,000 for Dam Number 2 and $1,425,000 for Dam Number 3, or $4,285,000 for both dams.

"The pool formed by Dam Number 2 extends some 15 miles upstream, and that formed by the proposed Dam Number 3, on account of the flatter slope of the river above, would be over 4 times as long. The two dams together will provide six-foot navigation from the site of Dam Number 2 to the Flint River, a distance of approximately 80 miles.

"The cheapest way in which navigation could be provided over this stretch of river would be by (a) dredging and the construction of low dams or dikes in the river above the upper section of the present Muscle Shoals Canal; (b) the construction of a low dam across the river at Lock Number 1 of the lower section of the present canal to provide sufficient depth in the 8 miles of open river between the two sections; and (c) the construction of a lock at the site of Dam Number 2, or the Wilson Dam, with low dams connecting the islands across to the south bank to submerge the rapids at Little Muscle Shoals, and thus provide access to Lock 9 (the lowest lock) of the lower section of the existing canal. All of this work would be for the purpose of completing and making effective the present Muscle Shoals Canal, which cannot now be used to full advantage. . . . . The cost would be approximately $8,600,000, but a five-foot depth only would be provided, and the channel would be narrow and somewhat difficult of navigation. It would, of course, be far less suitable for the development of navigation than that which would be provided by the two high power dams now under construction.

"To provide a six-foot channel over this stretch of river the present canal would have to be reconstructed, and work done in the river above and below and between its two sections, similar to that described in the preceding paragraph, but more extensive. The estimated cost of this work would be approximately $25,786,000. This estimate is based on plans contained in a survey report of Major Harts, Corps of Engineers, of March 21, 1910, published in House Document 360, 62d Congress, 2d Session, and may be assumed as representing the best and cheapest method of providing for a six-foot navigation over this 80 miles of river if no attention were paid to the development of power. But since large and valuable power can be developed by the completion of Dam Number 2 and the construction of Dam Number 3 at a total cost of only a little more than $50,000,000, and an even better navigation channel provided, it is not believed that any serious consideration should be given to such a scheme, and that the 'value to navigation' should be considered as being something between the mere additional cost of putting locks in these two dams, namely $4,285,000, and the cost of providing a six-foot channel by a lateral canal, namely, $25,686,000; and probably not less than the $8,600,000, which would be sufficient to provide a five-foot depth.

. . . .

The CHAIRMAN. "Now then, your plan if you did not have these dams, to carry out that plan of navigation would in fact be a canal, would it not?

Col. BARDEN. "It would be a lateral canal.

The CHAIRMAN. . . . . Even if you spend $25,000,000 to make this part of the river navigable, its navigability would not be as practical or as good as we will have by the construction of Dams Number 2 and Number 3?

Col. BARDEN. That is correct.

So that *the part of these improvements that we are talking about, the construction of dams Number 2 and Number 3, that should be charged to navigation, and the part that should be charged to power development ought in no case be less than what it would cost to make the river navigable to the same depth—that is, six feet—and in no case—I mean in no case more than that and in no case less than the actual additional cost of constructing the locks of Dams Number 2 and Number 3. . . . .*

The CHAIRMAN. *Now then, that price that is properly chargeable to navigation would be somewhere between $4,000,000, speaking in round numbers, and $25,000,000?*

Col. BARDEN. *Yes.*

The CHAIRMAN. *You could not logically put it above $25,000,000 and you could not logically put it below $5,000,000, and men may disagree as to where it should be between those two figures.*

Col. BARDEN. Yes sir; but in my opinion, it should not be put much less than $8,600,000, which is the cost of getting five-foot navigation; in other words the cost of completing the incomplete canal.[20]

[20] When he was later asked if the $8,600,000 figure could be regarded as a wise investment for navigation in view of potential commerce, Colonel Barden refrained from venturing an opinion but pointed out that the United States Engineers had recommended such an investment in 1916. *Muscle Shoals,* Hear-

The CHAIRMAN. Five feet is not as good as six, of course?

Col. BARDEN. No. I have put the lower limit $8,600,000 rather than $4,285,000.

The CHAIRMAN. And as to just where you would put that figure between $4,000,000 and $25,000,000 will have a very important bearing on what you would say would be the cost of the development of any unit of power?

Col. BARDEN. Yes, sir.[21]

Proceeding along the lines suggested by Colonel Barden, Major Burns, engineer for the Senate Committee on Agriculture and Forestry in 1922, prepared a tentative allocation of the estimated costs of Dams Number 2 and Number 3. This is included below as Table 25. The method here followed is to charge navigation with the full alternate costs of completing the Muscle Shoals canal to provide a five-foot channel over the eighty-mile stretch to be improved by Dams Number 2 and Number 3. Since a lateral canal already existed along most of the length of the prospective pool behind Dam Number 2, this project is credited with navigation value equivalent only to the cost of locks, and the bulk of navigation value was credited to Dam Number 3. The method does not proceed from the determination of direct costs and the isolation of joint costs to the apportionment of joint costs among project objectives. Rather it determines first a reasonable total charge to navigation by reference to alternate single purpose navigation investment; then by deduction of direct costs from this total the effective apportionment of joint investment to navigation is fixed. Finally, investment chargeable to power is determined as a remainder.

Two problems in connection with this procedure call for comment. First, it is not clear what charge to navigation would be proper if direct investment on account of locks should exceed the alternate costs of single purpose navigation improvement. Apparently the theory here suggested would permit the charging of navigation with only that share of its direct costs which would be equal to the alternate costs of channel development. Very likely the solution to this absurd situation, in which

ings before Senate Committee on Agriculture, Sixty-Seventh Congress, Second Session, (1922) p. 50.

[21] *Ibid.*, pp. 47-49 (italics supplied).

an objective would be charged less than its direct costs, can be found in its hypothetical nature. In reality it is doubtful if such a relationship among costs would ever occur. Far more serious is a second point, namely, that this technique of cost apportionment is based entirely upon cost relationships and takes no account of benefit values, demand, or economic feasibility. Assume that prospective savings to commerce as a result of construction of a given project would be just adequate to cover direct navigation costs but would fail by a considerable amount to meet alternate navigation costs. Assume further that power

TABLE 25

MAJOR BURNS' ALLOCATION OF ESTIMATED COSTS OF DAMS NUMBERED 2 AND 3—ADJUSTED, 1922

	Total	Dam No. 2	Dam No. 3
Allocation to Navigation			
Cost of lock	4,285,000	$ 2,860,000	$ 1,425,000
Cost of structure	4,315,000	....	4,315,000
Total nominal charge to navigation (after Burns)	$ 8,600,000	2,860,000	5,740,000
Plus costs of flowage at Dam No. 3	2,331,000[a]	....	2,331,000[a]
Total effective allocation to navigation[a]	$10,931,000[a]	$ 2,860,000	$ 8,071,000[a]
Allocation to Power			
Total project cost	$67,363,000	$38,876,400	$28,486,600
Less nominal charge to navigation	8,600,000	2,860,000	5,740,000
Gross allocation to power	$58,763,000	$36,016,400	$22,746,600
Less costs of flowage at Dam No. 3	2,331,000[a]	....	2,331,000[a]
Net charge to power	$56,432,000	$36,016,400	$20,415,600
Less cost of equipment	10,830,000[b]	3,200,000[b]	7,630,000
Cost of structure charged to power	$45,602,000	$32,816,400	$12,785,600

[a]Major Burns uses $5,740,000 as the allocation to navigation at Dam No. 3. But he determines his allocation to power by subtracting the navigation allocation from estimated total project costs net of flowage costs. The effect of this procedure would be either under statement of costs and subsidy to the power purpose or an effective increase in the navigation charge as we have shown here.
[b]Includes initial installation of four units at Dam No. 2.
Source: Based upon data submitted to the Senate Committee on Agriculture by Major Burns at *Hearings on Muscle Shoals*, Sixty-Seventh Congress, Second Session (1922), p. 913.

is the only other objective present and that the power aspect of the development is sufficiently favorable to permit moderate rates to cover all investment and operating costs net of direct charges (fixed and operating) on account of locks. As a complex, power and navigation could be economically sought at such a site, for prospective returns would be adequate to cover all costs. But if it were required that the method of cost apportionment outlined above be followed, economical development could not be achieved because of the inability of navigation to carry charges upon investment equivalent to its full alternate costs.[22]

Once again in 1924 allocation became a major issue in the Muscle Shoals discussion. In that year the House passed the McKenzie bill authorizing a lease to Henry Ford and the Senate substituted the Underwood leasing bill.[23] Since the Ford offer had been publicly withdrawn while the legislation was under consideration, the conference committee accepted the bill very much as it passed the Senate. One respect in which it modified the Senate measure, however, was to adopt a proviso with reference to a requirement of the original bill that a stipulated minimum return upon federal investment at Muscle Shoals be assured. This proviso was as follows:

"That no interest payment shall be required upon the cost of the locks at Dam Number 2 and Dam Number 3, *nor upon an addi-*

[22] Although Major Burns and Colonel Barden gave no overt consideration to the value of the prospective navigation benefit to result upon construction of Dams Number 2 and Number 3, both of them must have been implicitly considering it when they accepted as a minimum charge to navigation investment required for a five-foot channel. The navigability of such a channel was clearly inferior to that of the channel to be developed by the two high dams, and strict interpretation of the alternate investment theory would have required the use of a figure for alternate investment representative of the cost of developing a channel comparable with that afforded by the high dams.

A number of witnesses before Congressional committees emphasized the importance of prospective commercial savings from use of the navigation channel as setting a limit upon reasonable navigation investment. See statements of Secretary of War Weeks at *Muscle Shoals Propositions,* Hearings before House Committee on Military Affairs, Sixty-Seventh Congress, Second Session (1922), p. 62, and Mr. Hugh Cooper at *ibid.,* 422. See also testimony of Major Burns at *Muscle Shoals,* Hearings before the Senate Committee on Agriculture, Sixty-Seventh Congress, Second Session (1922), p. 933.

[23] See above, Chapter II.

tional amount to be determined by the President as representing the value of this development to navigation improvement." [24]

By the insertion of this simple language the conference committee sought to gain Congressional approval of the principle of allocation for determination of a power investment base at Muscle Shoals. The committee established no range within which navigation value of the projects should be fixed nor any criteria of a satisfactory procedure for estimation of such value. The extent of discretion left to the President under this proviso was vigorously attacked by Senator Norris who was largely responsible for the failure of H.R. 518 to pass the Sixty-Eighth Congress.[25]

The failure of the Underwood leasing bill was followed by the Coolidge Muscle Shoals Inquiry. Among other things this Inquiry found that $9,000,000 of the cost of Wilson Dam (Dam Number 2) should be charged against navigation and that a part of the cost of the proposed Cove Creek project (now known as the Norris project) might wisely be charged against naviga-

[24] Conference Report to Accompany H.R. 518," House Report 1410, Sixty-Eighth Congress, Second Session, pp. 3-4. (Italics supplied.)

[25] On the range of this discretion the following discussion in the Senate is interesting:

> Senator NORRIS. . . . . I want to ask the Senator if he will not agree to this, that under the language of the bill it is within the power of the President to charge it (the entire investment in Dams Number 2 and Number 3) all up to navigation?
>
> Sen. UNDERWOOD. I think if it were someone else than the President, if it had been detailed to somebody who was amenable to an injunction, the language would be subject to that construction.
>
> Sen. NORRIS. Does the Senator think, assuming we had a right to begin injunction proceedings against the President, that there would be any basis in law for an injunction if the President decided that the value to navigation was the entire cost of the dam? Could he not do that under this language if he wanted to do it?
>
> Sen. UNDERWOOD. I think so. I think he would then be subject to an injunction.
>
> Sen. NORRIS. Where would the Senator draw the line that the injunction would lie?
>
> Sen. UNDERWOOD. I can draw one line very clearly, and that is the cost of the powerhouse. If he allocated the entire cost of the construction there to navigation, of course the court would enjoin him from going beyond the terms of the bill.
>
> But I am not arguing the amount. I do not know what it will be. I have confidence in the President of the United States, and I do not think he will make any unreasonable deduction. . . . ."

66 *Congressional Record* 4133.

tion if that project were built.[26] Acting upon a recommendation of the Inquiry, Congress now established the 1925 Joint Committee on Muscle Shoals to consider lease proposals.[27] As had been true of earlier bids, most of the offers submitted to this Committee included implicit or explicit provisions for allocation of costs of river control works. The offer of the Air Nitrate Corporation (American Cyanamid Company) guaranteed the United States a four percent return upon all investment made in Dam Number 2 after May 31, 1922, but stated that prior investment of about $17,000,000 was ". . . . properly allocable to war costs and navigation purposes." With regard to Dam Number 3 the Company offered to pay four percent upon total investment net of $6,000,000 ". . . . which amount is deemed properly applicable to the navigation purposes as distinguished from power purposes of the improvement."[28] The Union Carbide offer, while making no explicit apportionment of the costs of Dam Number 2, stipulated a return to the Government of four percent upon investment in Dam Number 3 net of $4,300,000 ". . . . representing the value of said dam and locks as navigation facilities."[29] Indeed, of the leading bids only that of the Associated Power Companies failed to contain some allocation features.[30]

[26] House Document 119, Sixty-Ninth Congress, First Session, pp. 68, 102. Although these findings of the Inquiry seem to endorse the allocation principle, a letter was included in its report from Major Harold C. Fiske of the Corps of Engineers in which it was stated that power developments along the Tennessee River could economically bear all costs of channel improvement for nine-foot navigation. No mention was made of allocation in this letter.

It is possible to reconcile the Inquiry's proposals of allocations at Wilson and Cove Creek with the Fiske letter by noting that they are consistent in their broad policy implications. The former would make more feasible a lease of Muscle Shoals to private enterprise; the latter would discourage any public program of improvement of the Tennessee River and encourage dependence upon the "private" power companies to develop the water resources of the Valley.

[27] See above, Chapter II.

[28] Senate Report 672, Sixty-Ninth Congress, First Session, p. 76. The $17,000,000 charge at Dam Number 2 is reminiscent of the nominal allocation to navigation in the Ford bid. Presumably the $6,000,000 figure for Dam Number 3 was determined along lines similar to those suggested in Table 25.

[29] *Ibid.*, 142. In return for its use of Dam Number 2 the Company proposed graduated payments beginning at $750,000 annually and increasing to $2,150,000 at the end of ten years.

[30] This offer provided for graduated payments on Dam Number 2 beginning at $600,000 the first year and increasing to $2,000,000 annually after eighteen years. For Dam Number 3 it provided the typical four percent annual pay-

When the Joint Committee failed to obtain a satisfactory bid for Muscle Shoals, Congressional attention turned increasingly to Senator Norris' proposals for public operation. Two aspects of these proposals led toward cost allocation. They contemplated multiple purpose development of the water resources of the Tennessee River basin; and they emphasized the cost finding possibilities of public operation in the power field and the potentialities of public competition as a device for control of "private" utility rates. Nevertheless, not until 1926 was a specific allocation section included in a Norris bill. In that year Section 8 of the Senator's bill, S. 2147, provided as follows:

"Upon the completion of the construction of Dam Number 3 by the Secretary of War, and upon the completion of all other dams to be subsequently constructed as herein provided for, when the same are turned over to said corporation, the Secretary of War and said corporation shall, if possible agree upon the value of any such dam so turned over, and in fixing its value there shall be deducted from the total cost of any of said dams, the proportionate cost of the locks, if any, and also the amount of benefit to be derived from the construction of any such dam, to flood control. Such amounts shall be deducted from the total cost of any such dams. If the Secretary of War and the said corporation are unable to agree upon the value of any of said dams, the same shall be submitted to the President of the United States, whose decision shall be final. It shall be the duty of said board from its revenues, to amortize the cost of any such dam so that the same can be completely repaid to the Government of the United States as nearly as may be within not more than fifty years. . . . ." [31]

The language above is somewhat confusing since it shifts from detailed instructions as to the manner in which the "value" of projects should be determined to an injunction that the administering agency (a "Federal Power Corporation") should amor-

ments upon project investment but provided that such investment should not exceed $30,000,000.

It would be more correct to say that under this bid allocations between power and non-power purposes of Dams Number 2 and Number 3 were implicit than that they did not exist. Indeed, Senator Norris claimed that prospective revenues from a lease under the Power Companies' terms would be less than could be derived from sale of energy by the government upon a day to day basis. (See debate upon the Deneen Bill, S. 4106, Sixty-Ninth Congress, First Session, 68 *Congressional Record* 4742 ff.)

[31] S. 2147, Sixty-Ninth Congress, First Session.

tize project "costs" within a fifty-year period. Since in the determination of "value" navigation and flood control benefits are to be deducted from costs, this category seems to be in some sense a net amount chargeable to power. Thus, regardless of the requirement that revenues be sought to return project costs within a fifty-year period, it appears reasonable to assume that the bill contemplated determination of power rates according to project "value" rather than *total* project cost. So interpreted the 1926 bill is a milestone in two regards: it was the first bill for public operation of Muscle Shoals or development of the Tennessee River which included a provision for allocation of total project costs among the several major objectives of stream control; and it was the first bill (whether looking to public or private development of the Tennessee River) which gave flood control a rank co-ordinate with power and navigation among the purposes of stream control.

After the failure of S. 2147 the later Norris bills abandoned most of the multiple purpose features of the earlier measures, and allocation sections were not deemed necessary. In vetoing one of these modified bills, President Hoover undertook a cursory economic analysis of public power operations from Muscle Shoals in which he made use of allocations of the cost of Wilson Dam and the estimated cost of the Cove Creek dam.[32] Pursuant to a recommendation of the Hoover veto the 1931 Muscle Shoals Commission was set up.[33] This agency made little independent analysis of the possibilities of public development of the water resources of the Tennessee basin but adopted as its own a report by Lt. Col. M. C. Tyler which found that no public program

[32] S. Doc. 321, Seventy-First Congress, Third Session, reprinted at 74 *Congressional Record* 7046. The President estimated that approximately $100,000,000 of *new* money would be required from the Federal Treasury to develop even a modest public operation and that the cost of energy would be about 9.15 mills per kilowatt-hour. This estimate was later strongly criticized by Col. J. Edward Cassidy who estimated that the entire project could be put into operation with a total investment chargeable to power of only $90,000,000 and that, with an 80 percent load factor, energy could be marketed at 3.28 mills per kilowatt-hour. (*Hearings on Muscle Shoals*, House Committee on Military Affairs, Seventy-Second Congress, First Session [1932], I, 621.)

[33] See above, Chapter II.

of waterway development in the basin could be economical.[34]

The Tyler report could scarcely be considered to mark a new advance in the theory of multiple purpose river planning. True, it credited against the total estimated costs of main river projects costs of alternate low dam river development for navigation. But at the Cove Creek project it charged 100 percent of investment against power despite the downstream navigation benefit from low water regulation by this reservoir pending complete canalization of the main river. The report was also woefully weak in its economic analysis of flood control. In estimating power availability and costs at Cove Creek, it formulated a rule curve schedule for reservoir operation to afford downstream flood protection and specified that 387,000 acre feet of controlled flood storage should be continually held available (except when in use to store flood waters). For main river projects it contemplated ". . . . a ten-foot surcharge prism to be held available for flood control during the months of greatest floods and until April 15 of each year."[35] Yet in its economic appraisal of Cove Creek no credit was given the project for its flood control contribution. The only apparent ground for this failure was Tyler's position that tributary storage cannot be very valuable because it can control the run-off of but a single upstream watershed. This can scarcely explain the fact that the contemplated main river projects above Chattanooga were also refused credit for their flood control benefits.[36]

[34] The Commission modified the Tyler report in one regard: it recommended immediate construction of the Cove Creek project. Members of the Commission also (in effect) made the novel suggestion that power customers of a. lessee at the Shoals should subsidize low cost fertilizer sales. Muscle Shoals Commission, *Muscle Shoals, A Plan* (1931), p. 78. (See United States Congress, House of Representatives, *Hearings on Muscle Shoals* before Committee on Military Affairs, Seventy-Second Congress, First Session, testimony of S. F. Hobbs at I, 27 and 52, and of E. O. O'Neal at I, 308.)

[35] Muscle Shoals Commission, *op. cit.,* 89.

[36] *Ibid.,* 87-90.

The report also analyzed the prospective economy of a public power system to dispose of energy produced by a series of multiple purpose dams and reservoirs along the Tennessee River. Its finding was that such a program could not be self-liquidating. This aspect of the Tyler report, especially its estimates for a public transmission system to market energy produced by the water control system, was later subjected to very strong criticism. Col. J. Edward Cassidy pointed out that Tyler had changed his position radically since a report he had prepared reaching opposite conclusions in the mid nineteen-twenties. (See *Hearings on Muscle*

A final study which must be mentioned in any review of the development of allocation thinking is the "308 Report" on the Tennessee River.[37] Undertaken pursuant to the River and Harbor Act of 1927 and the Mississippi River Act of 1928,[38] this investigation found that multiple purpose improvement of the water resources of the Tennessee basin could be economically carried out to provide full flood protection at Chattanooga, nine-foot navigation on the main river and six-foot navigation along many of the tributaries, and 25,000,000,000 kilowatt-hours of electric energy annually (with 2,600,000 to 3,000,000 kilowatts of primary power).[39] To Congress the report recommended, first, adoption of its proposed plan for comprehensive development of the Tennessee River as a guide for carrying out the provisions of the Federal Water Power Act, and second, adoption of a project along the main Tennessee River for a nine-foot navigable channel to be provided by movable or low fixed dams. In the report of the District Engineer the latter recommendation was conditioned by a proviso as follows:

> ". . . . that under the provision of the Federal water power act there may be substituted for any two or more of the low dams herein provided for, a high dam if the resulting cost to the Federal Government will be less than by the estimate herein for the low dams thus rendered unnecessary." [40]

Since the Federal Water Power Act authorized the Power Commission simply to recommend to Congress what *part* of the costs of *"navigation structures"* at proposed projects on the navigable streams might wisely be assumed by the United States, this recommendation apparently would have restricted federal contributions toward the costs of proposed Tennessee River projects to a maximum of direct costs for navigation. Reviewing the

Shoals, House Committee on Military Affairs, Seventy-Second Congress, First Session [1932], I, 603; and statement of Judson King at *ibid.*, I, 694.)

[37] House Document 328, Seventy-First Congress, Second Session.

[38] See above, Chapter I.

[39] In its cost analysis this report did not make overt use of joint cost allocations. Navigation was charged with its direct costs, and power was assessed all other costs (including all joint costs and direct costs of flood control). See *ibid.*, p. 93.

[40] *Ibid*, 101.

report, the Board of Engineers for Rivers and Harbors revised the proviso above to read as follows:

> "*Provided further*, That whenever it shall be demonstrated that the construction of any of the power dams included in this project is not economically feasible without participation by the United States in the cost of portions of the works not required solely for navigation, the Chief of Engineers shall submit to Congress a special report thereon with recommendations as to the method, most advantageous to the United States, of obtaining 9-foot navigation through the section of the river covered by the pool of the said power dam, with the estimated cost thereof.[41]

Reviewing the recommendations of the Board of Engineers, the Chief of Engineers revised the proviso further to read:

> "That in case high dams are built before the United States shall have built the projected locks and low dams which are to be replaced, the United States shall contribute to the cost of the substituted structures an amount equal to the estimated cost of the works of navigation for which substitution is made."[42]

Three months later, in the River and Harbor Act of July 3, 1930, Congress adopted the Chief of Engineer's proposals:

> "The project for the permanent improvement of the main stream of the Tennessee River for navigable depth of nine feet in accordance with the recommendations of the Chief of Engineers in House Document Numbered 328 . . . . is hereby authorized. . . . ."[43]

Thus, it became federal policy on the Tennessee River that in the event alternate single purpose navigation costs exceeded direct costs for navigation at proposed high dams the United States should contribute toward joint investment up to full alternate navigation cost.

Although the Tyler report is convincing evidence that in 1931 the long Muscle Shoals debate had not yet produced agreement as to the economy of multiple purpose planning, a

[41] *Ibid*, 25.
[42] *Ibid*. 7.
[43] Chapter 847, sec. 1, 46 Stat. 927.

review of this debate does reveal that all parties to it accepted at one time or another the reasonableness of the allocation principle.[44] Under varying circumstances the power companies, the chemical companies, the Republican national administration, and the advocates of public operation all took the position that power investment at Muscle Shoals or other projects along the Tennessee River should be computed as total investment net of appropriate allowances for navigation (and in some cases for flood control). Such allowances were not to be determined simply by direct costs for non-power purposes but more usually by alternate single purpose costs. Whether recognized or not, the implication of this method of cost apportionment was that to the extent single purpose costs might exceed direct costs joint costs should be "allocated" to non-power purposes.

ALLOCATION IN THE BOULDER CANYON PROJECT ACT OF 1928

While Congress was groping for a solution to the Muscle Shoals problem, on another watershed it undertook construction of a great new multiple purpose project, the Boulder Dam. The act which authorized this structure gave evidence of the maturing allocation idea, for it directed that the investment base on which power revenues should earn interest and amortization should be determined as total project cost net of $25,000,000 chargeable to flood control.[45] Yet it fell short of a complete expression of allocation thinking in that it failed to provide for allocation of remaining project costs among the several other

[44] One should perhaps be careful in asserting that the allocation *principle* was accepted although the evidence in this regard is certainly impressive. Nevertheless, it might be more correct to say that different interests, under varying circumstances, accepted the results of various particular allocations (because they believed they would work out to their benefit) rather than that they accepted the principle of allocation. For example, the power companies supported the idea of allocation when they submitted their bids for Muscle Shoals; but they urgently opposed it when the United States contemplated public operation of the properties or their lease to Henry Ford.

[45] Act of December 21, 1928, Chapter 42, 45 Stat. 1057, 43 U. S. C. A. 617. See *Federal Reclamation Laws, Annotated*, 1936 edition, pp. 381-382. The law was unique in that Congress itself determined the amount of an appropriate allocation instead of leaving this question to the administering agency. See also Boulder Canyon Project Adjustment Act of July 19, 1940, ch. 643, sec. 7, 54 Stat. 777, 43 U.S.C.A. 618.

objectives present at the site but required instead that power bear their full burden.

It is worthy of particular attention that rate making for Boulder Dam power was not influenced by allocations of joint costs. Rather than determining annual project costs and annual energy output and dividing the latter into the former to arrive at reasonable revenue per killowatt-hour, rates were set at this great multiple use project by reference to the alternate cost value of Boulder Canyon energy.[46] With rates so determined, prospective annual power revenues were estimated and compared with estimated annual charges (net of charges on $25,000,000 apportioned to flood control). When it was found that prospective revenues, so determined, were in excess of prospective costs, the project was deemed feasible and construction was undertaken.

[46] In fact, at Boulder Canyon the United States sells falling water available for generation of power rather than power itself. The value of falling water was determined as follows:

(1) Firm power which could be delivered from the Boulder project to the low side of a substation 280 miles away (at a southern California load center) was estimated on the assumption of twelve percent losses in transmission and transformation;

(2) Required substitute generating capacity, including reserve, for delivery of equivalent power from a steam station located at condensing water 25 miles from the load center was estimated with an assumption of 2½ percent losses in transmission;

(3) Required investment and annual charges on the equivalent steam generating and transmission system of (2) above were computed. Such annual charges represented the gross annual value, delivered, of Boulder Dam power (and are here designated as "a").

(4) Required investment in transmission facilities to deliver Boulder Dam power 280 miles from the powerhouse and annual charges on this investment were next computed. These were deducted from the gross annual value of Boulder Dam power, delivered, to determine gross annual value of power at the generating station switchboard, "b."

(5) Investment and annual cost of steam standby reserve necessary to guard against outage of the heaviest hydro transmission circuit together with annual charges on transmission from this standby to the load center were next determined. This annual charge for transmission standby was then deducted from "b" above to determine net annual value of power at the generating station switchboard, "c."

(6) Finally annual charges which power customers would have to bear on account of Boulder Canyon hydro plant and equipment were determined. These were deducted from "c" above to leave as a remainder estimated net annual value of falling water at the Boulder Canyon site.

John R. Walker, and W. C. Beatty, "Report on Rates which Public and Private Corporations can afford to pay for Power at Boulder Canyon," Bureau of Reclamation, Technical Memorandum 106, September 10, 1929.

COST ALLOCATION IN THE TVA ACT

In the introductory section of Chapter V there were quoted the provisions of the TVA law which deal with cost allocation. Let us consider now the thinking of Congress which led to the adoption of these provisions.

The essence of the argument for cost allocation at TVA is as follows. The Authority's program is multiple purpose. Its two primary purposes are navigation and flood control; an important secondary purpose is the generation of hydroelectric power.[47] Although there is a significant complementary relationship among the several purposes of water control, it is plain that system construction and operation have not been planned to maximize power output. Therefore, a "reasonable" share of cost should be charged against flood control and navigation; and power revenues should be required to bear only the remainder. In discussing the allocation section of the law with Senator Vandenberg, Senator Norris stated:

> "If the board undertook to charge off all the expenditures for power, of course they could not sell the power because they would have to put it at such a price that would make it unsaleable. On the other hand, in my own humble judgment, if the part allocated to power is properly apportioned and rates were made based on that allocation, they could make a reasonable rate and make a great deal of profit." [48]

The point of view of those who supported the Norris Senate

[47] A great many words have been spoken and written in futile argument as to whether or not power has been, in fact, the primary purpose of TVA. In the absence of a clear criterion or set of criteria as to primacy, it is not surprising that this debate has been barren. It may well be that the Authority's program has no "primary" purpose if purposes are to be defined as power, navigation, and flood control. Perhaps the only dominant objective of the Authority to which all other purposes must yield is the general welfare of the valley population. Certainly the ultimate end of all of the Authority's activities (with the possible exception of emergency defense work) is a broadening of economic opportunity, particularly in the Tennessee Valley region.

[48] 77 *Congressional Record* 2262-2263. Senator Norris added that the major objectives of construction of the Cove Creek storage reservoir would be navigation and flood control. Power, he declared, would be incidental.

> "If I were guessing about it, I should say that of the Cove Creek Dam expenditure not more than 25 percent ought to be allocated to power. Perhaps that is too great. It may not be great enough, it is true."

Ibid, 2263.

bill was that allocation was a procedure preliminary to the determination of something in the nature of a power rate base. Apparently those who supported the 1933 House bill[49] (sponsored by Chairman McSwain of the Committee on Military Affairs) either did not adhere to this point of view or were not so consistent in their thinking. Like the Norris bill this measure also included provisions for the allocation of project costs among the various TVA objectives. But it stipulated that power revenues should be adequate to cover power operating costs, all fixed charges upon investment allocated to power, *and* amortization over a sixty-year period of all investment in water control projects without regard to allocations.[50] One could easily understand reasoning which would have resulted in a requirement that power revenues cover charges upon 100 percent of project investment (including amortization thereof) or reasoning which would have required power revenues to cover fixed charges (including amortization) upon only a reasonable allocation of total investment. It is difficult to understand the thinking which led to a combination of allocation and no-allocation features in the bill which the House actually adopted.

As adopted by Congress, the TVA Act followed closely the lines of the Senate bill, one feature of which was a rate base theory of allocation. But although this law required the Authority to prepare allocations of the cost or value of the Wilson Dam and of such additional reservoir projects as TVA might construct, by 1935 no such allocations had been carried out. To stimulate the Authority to action, Congress in this year amended the original allocation section to require that TVA file with it, on or before January 1, 1937, an allocation statement for investment in all of its projects completed prior to the end of the preceding fiscal year. Congress also added to Section 14 (the allocation section of the law) a statement of policy to the effect that the TVA power program should be "self-supporting and self-liquidating."[51]

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[49] See above, p. 63 ff.

[50] H. R. 5081, Seventy-Third Congress, First Session, sections 4(k) and 25.

[51] See above, Chapter III.

Although during the Muscle Shoals controversy many different interests came to "accept" the allocation principle and its implications with regard to a power rate base, not a few of those who were unfriendly to public operation in the power field took the position that the TVA power program should bear 100 percent of the costs of the water control projects. Senator Austin of Vermont, for example, asserted that allocations permitted TVA to show economy in its power operations because they permitted a flagrant understatement of power capital.[52] Congressman May of Kentucky declared it unfair for TVA to deduct navigation and flood control allocations from its water control investment for determination of its power rate base when privately owned power companies were unable to make similar deductions.[53] But despite this attitude of the dissenters, the majority in Congress seemed to accept the allocation principle on some such ground as Representative Costello (California) who declared:

"The TVA, I think, is justified in charging off a great deal of the original investment in these properties due to the fact that much of the money was spent for purposes other than power purposes. They should charge only that amount which was necessarily expended to produce the power which they are actually generating. In other words, the flood control, fertilizer, or nitrate-production features are entirely apart from the power-generating feature and should not be charged to it."[54]

INTERPRETATION AND CONCLUSION

In opening our discussion of the setting of the allocation problem, we quoted the allocation requirements of the TVA Act and pointed out that it was left to the discretion of the Authority to determine an appropriate allocation procedure. The chapter which we now conclude has been designed to indicate the extent to which TVA could draw upon the accumulated knowledge of the past in coping with this problem. It has contributed to a clarification of the objectives of allocation. In the light of

[52] 79 *Congressional Record* 7402.
[53] *Ibid.*, 11185-11186.
[54] *Ibid.*, 11308.

these clarified objectives it will be possible to formulate a set of preliminary criteria of a satisfactory allocation procedure.

The Objectives of Allocation

Those who have favored the allocation of investment costs of water control projects in the past typically have done so because they have been interested in the cost-revenue relation for some particular purpose of a multiple purpose project. Of the several purposes of water control the one which has been carried out on the greatest scale for the production of revenue is power. It is not an accident that the history of allocation is tied up closely with the evolution of multiple purpose projects at which the power objective has been present. From the time of the Muscle Shoals Hydro Electric Power Company, private commercial interests which sought to obtain leases of the power output of multiple purpose projects on the Tennessee River supported the principle of allocation on the ground that it would be unreasonable to levy against power customers 100 percent of the cost of projects producing significant non-power benefits. For the same reason Senator Norris proposed that allocations should be carried out in connection with the power phase of any multiple purpose program which the United States might undertake along the Tennessee River.

With regard to the TVA there have been some who from the first have opposed the principle of allocation. Many critics of the Authority, however, have been more opposed to particular proposed allocations than to the abstract principle of allocation. They have taken the position that if TVA were to adopt "proper" allocations and determine its costs in a "fair and reasonable" manner it would find its power cost burden so great that its present "low" level of wholesale rates could not be remunerative.[55] For this reason opponents of TVA were most eager that

[55] See statements submitted to the Joint Committee on the Investigation of the Tennessee Valley Authority by witnesses for the Commonwealth and Southern Corporation as follows: Dean Moreland at p. 3891 ff. of *Hearings*, Ford Kurtz at *ibid.*, 3958 ff. and Major Rufus Putnam at *ibid.* 3967 ff. This was also the position of the representatives of the privately owned utilities in the court tests of TVA constitutionality.

the Act should require the power program to be self-liquidating.

Whereas many of those opposed to public power accepted allocation as a principle because they believed that a fair allocation would validate rates of "private" companies, friends of "public power," on the other hand, supported allocation for a diametrically opposite reason. They were confident that a "proper" joint cost allocation at a public multiple use development on the Tennessee River would reveal the rates of the "private" companies to be unreasonably high (as judged by a cost standard). While these two groups differed sharply as to what would constitute a "fair" allocation, they agreed upon one point. Power rates at multiple use projects should be set at a level adequate to cover "costs," and power "costs" should be computed to include proper charges upon investment fairly allocable to the power purpose. Because of this common faith in allocation these two groups may be classed together as "allocationists."

Balancing the position of the "allocationists" have been two other groups which may be termed "anti-allocationist." One of these has taken the stand that, in so far as power is either directly or jointly responsible for costs, it should bear their *full* burden. It has justified this attitude by pointing out that privately owned power companies cannot compute power capital as net of joint cost allocations to non-power purposes. The second group has argued that at a multiple purpose project neither the total nor any part of truly joint costs may be assessed against any objective for the purpose of determining whether or not it is "self-liquidating." It recognizes that direct costs may be accurately charged; but it declares that by definition any allocation of joint costs must be arbitrary. As a meaningful cost-finding technique, allocation, it says, must be barren.

Let us return to a point which was touched on above. Why is it that the problem of allocation has arisen only at multiple purpose projects involving revenue-producing objectives? And why is it that the focus of attention in allocation is always upon investment charged to such objectives? Are not the costs of navigation and flood control just as important as those of power (or irrigation)? May not federal funds be as easily squandered upon non-revenue producing purposes as upon revenue producing ones? What is the explanation of this peculiar directional orientation of allocation thinking? We suggest that it rests in the character of the capitalistic economic environment in which multiple purpose enterprise has evolved. This environment is typified by competitive production of goods and services by private enterprise in the quest for profits as measured by the spread between costs and prices. So long as the economic activities of government do not include production of goods and services for sale, they are not usually subjected to the same standards of economy as the market inexorably requires of competitive private enterprise. But when government does undertake production in competition for the consumers' dollar with free private enterprise, those who believe in the profit system as a guide for the apportionment of economic resources (regardless of whether or not they favor public operation in a particular area of that system) tend to agree that certain standards of commercial economy should be required of it. Over a "normal" period they argue that government investment should be made only in fields where there is a prospect that revenues will cover costs.[56] Hence the case for allocation. If government commercial operation is a phase of a multiple purpose undertaking, joint costs must be apportioned to determine "costs" of revenue-producing utilities and permit analysis of the economy of the operation.[57] At TVA there has been unusual interest in alloca-

[56] This statement is made from a strictly commercial point of view. When political, social, and military considerations are taken into account, it may prove desirable that this criterion be modified. A more general formulation of the proposition would require that there be a prospect that "benefits" be adequate to cover all "costs" (including non-pecuniary social costs).

[57] It may be interesting to speculate briefly why private enterprise has not sought to produce and sell at a profit navigation and flood control benefits. The reasons appear to be two-fold. First, requisite investment for the prosecution of programs for these objectives is often beyond the means of private enterprise. Second, the technical adaptability of projects in these fields to the assessment of charges in return for benefits is slight. For example, it is a comparatively simple matter to meter a customer's home or place of business and sell him a measurable supply of power and energy. But it would be quite a different proposition to measure his use of flood control works (particularly in dry years!) and collect from him fees for flood protection. Even if appropriate "prices" for flood control services could be set, there would be no way short of the sanction of public authority to prevent individual landholders (who might refuse to contract for flood protection) from reaping free-of-charge all of the benefits for which their neighbors were assessed. Because its benefits are not adaptable to sale under the

tions because this agency has been in the forefront of the public power-private power controversy of the past decade.

A secondary objective of allocation which sometimes has been suggested is to facilitate the optimum proportioning of multiple use investment. The argument runs that at comprehensive projects rational investment should be concentrated along lines of greatest relative return in such a way that the marginal return to investment for each purpose is equal. Only if the share of investment chargeable to each purpose is known, it is asserted, can the process of equalizing marginal returns be carried out. This ground for joint cost apportionment received relatively little consideration during the TVA allocation debate. We shall defer consideration of it to Chapter XV below.

Preliminary Criteria of a Satisfactory Allocation

In the following chapters we consider a number of suggested procedures for allocation of joint costs at TVA. Before undertaking this discussion, it will be helpful to formulate a set of preliminary criteria by which the suggested procedures may be appraised. The primary criteria which we shall employ are as follows:

(1) The method should have a reasonable logical basis. It should not result in charging any objective with a greater investment than the fair capitalized value of the annual benefit of this objective to the consumer. It should not result in charging any objective with a greater investment than would suffice for its development at an alternate single purpose site. Finally, it should not charge any two or more objectives with a greater investment than would suffice for alternate dual purpose or multiple purpose improvement.

(2) The method should not be unduly complex. In a democracy public agencies should be subject to the understanding scrutiny of the citizen body to the maximum possible extent. The goal should

price system, flood control is essentially a public business, the costs of which must be defrayed by some form of taxation.

In the case of navigation the possibility of setting river tolls to cover system costs would seem quite consistent with improvement by private enterprise. Indeed, there have been many private canal companies in the past. But under American law and tradition navigation upon all interstate streams must be freely available to all. Consequently, this field also is removed from the sphere of possible private development under the price system.

always be presentation of problems and programs for public consideration in clear and simple terms.

(3) The method should be workable. It should not be dependent upon estimates which are difficult to prepare, and it should not require the use of data as to actual operation of the project which will not become available until after the passage of a considerable period of time.

(4) The method should be flexible. It should be equally applicable to an isolated project or a co-ordinated system.[58] In the case of a system it should be applicable to both the initial and ultimate stages of development. It should be readily adaptable to changing conditions over plant or system life.

A final criterion which sometimes has been suggested but which we put forward here only for the sake of discussion is:

(5) The method should apportion to all purposes present at a multiple purpose enterprise a share in the over-all economy of the operation. This point has two implications. First, no purpose should be assessed costs as great as would suffice for alternate single purpose stream improvement. Second, no purpose should be assessed costs as great as its capitalized benefit value.

The primary criteria suggested above seem to be over-whelmingly desirable attributes of any allocation technique and will not here be further discussed. The fifth is controversial and deserves closer attention. Certainly it would not be accepted by the privately owned power companies, for they would claim that it would give public power systems operating from multiple purpose stream control projects an unfair advantage over them. Since they operate in a price economy, they must hold out to investors the prospect of covering all money costs out of income in order to attract capital. Any arrangement whereby public enterprise in the power field might benefit by capitalization of non-revenue producing objectives, from their point of view, would be unfair. This position of the power companies may be answered by accepting as a fact that public enterprise gains a competitive advantage over private enterprise when it capitalizes

[58] The requirement of applicability to an isolated project is valid in the abstract for a generally satisfactory principle of allocation. It need not be met by an otherwise satisfactory method of apportioning TVA joint costs since TVA projects are co-ordinated on a system basis.

non-revenue producing objectives at projects producing electric power, but by asserting that this advantage is not "unfair" but is important as a symptom of the special economy of public enterprise in the field of water resource improvement. When projects are properly planned, government may produce economically joint products of power which private enterprise must ignore.[59]

Although there are sound reasons for rejecting the "unfair competition" argument against granting the power objective a share in the economy of multiple purpose river improvement, a more convincing argument may be suggested to support the same point of view. This proceeds by reference to competitive cost theory. Over the "normal" period the tendency under competition is for price to be set at approximately the cost of production of the "marginal firm." Efficient producers working at advantageous locations reap what are "surplus" rewards over the short period. Over the normal period these surpluses are capitalized and become a part of costs. Only because there is a prospect that normal revenues will cover costs, including a return upon investment, are investors willing to embark capital in economic enterprise. Applied to the power field, this reasoning implies that private capital will not be invested in either steam or hydroelectric generating facilities unless there is a prospect that over the life of such properties there will be a market for wholesale power at prices adequate to cover all necessary costs. Should it become a matter of public policy to make generally effective a level of wholesale power rates inadequate to cover these costs (plus necessary costs of transformation and transmission), it would become difficult to induce investment in single purpose power enterprise. If the entire power supply of the future could be generated at public multiple purpose plants, this would not be serious. But the fact is that full development of all favorable multiple purpose hydro sites would still leave a substantial balance of power supply to be contributed by steam stations. Ruling out the possibility of a revision of public rate

[59] Although navigation and flood control are non-revenue producing from the point of view of the agency which provides them, by their broadening of the tax base and improvement of the general level of economic activity they may be productive of revenue (even to the extent of being self-liquidating) from the broad point of view of the federal treasury.

policy, it would appear that government would be obliged either to subsidize continued private operation of these stations or to take them over for public operation at a loss.

Fortunately, the unpleasant eventualities suggested above would not inevitably follow from public adoption of allocations to power at multiple purpose projects less than alternate single purpose costs. First, most companies do not sell power extensively at the switchboard, and costs of generation are but a comparatively small part of delivered costs of energy. If public policy in the setting of rates after transmission and distribution were somewhat less stringent than its procedure in computing costs of generation, many companies no doubt could make up by superior performance in the former fields for their disadvantage in the field of generation. Furthermore, if public allocations did not result in shading "private" costs of generation by too discouraging an amount, they might serve as stimulants to accelerated technological advance in single purpose energy generation. Second, allocation could be divorced from rate making. Rates could be determined on an alternate cost basis, and allocations could be treated simply as capital bases on which power revenues should earn a return in order that operations need not be carried on at a nominal loss.[60] Third, rates for power from public multiple purpose projects could be based upon allocations, but no effort might be made to generalize these rates. "Private" power producers might continue to be allowed full freedom in setting rates above public rates in order to earn a "fair return" upon their prudent investment (or "fair value").[61]

The foregoing discussion will serve as an introduction to the chapters which follow. In them, many of the points which have here been raised will be accorded further analysis. Let us turn first to consider early efforts by TVA to meet the allocation requirements of the Act of 1933 and its 1935 amendment.

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[60] This is very much the procedure which has been adopted by TVA. It evidently renounces allocation as a basis for rates. Question at once arises as to the economic significance of nominal power capital and the utility of the entire allocation procedure.

[61] Independent rate making for each company conforms with the elemental rationale of regulation. Theoretically, it should cause to accrue to consumers the surpluses which under competition accrue to (or are borne by) ownership. It is deficient in that it fails to afford adequate stimulation to producers to reduce costs.

Chapter VIII

THE EQUAL CHARGE THEORY OF ALLOCATION OF WILSON DAM 1933-1935

Summary. TVA research into the problem of joint cost allocation took place in several stages. The first of these was carried out by regular staff members and was devoted to analysis of the equal apportionment principle. Several tentative memoranda and reports embodying this principle were considered. In November, 1934, power cost figures based upon its application to a tentative present value estimate of Wilson Dam were presented to the Alabama Public Service Commission. Two months later, on January 2, 1935, a recommended allocation report based upon equal apportionment was submitted to the TVA Board by the staff in charge of allocations. Although the Board seems at first to have been favorably impressed by this report, it refrained from adopting it. The reason for this may have been that it was reluctant to commit the Authority to an equal charge basis of allocation at Wilson Dam because this would set a precedent in favor of equal charges at other projects where they might be less defensible. This objection points to the critical weakness of the equal charge principle: its inflexibility and its failure to consider the justifiability of the charges it assesses.

CLASSIFICATION OF ALLOCATION STUDIES AT TVA

Our present purpose is to review the applicability of various theories of cost allocation to the joint cost situation at TVA. The most feasible procedure to achieve this end will be first to consider the numerous allocation studies which were prosecuted under the direction of the Authority and later to investigate any other allocation theories which may suggest themselves.

To supply a background against which a discussion of formulae suggested for TVA allocation may take on more meaning it may be helpful to review in a cursory manner the history of TVA allocation studies.[1] The first phase of TVA allocation

[1] Director Lilienthal outlined this history in testimony before the Joint Committee on the Investigation of the Tennessee Valley Authority. The present remarks are drawn largely from this source. See *Hearings* pursuant to Public Resolution 83, Seventy-Fifth Congress, Third Session, p. 707 ff.

research began on August 22, 1933 when the Board of Directors adopted a resolution directing Mr. Lilienthal to prepare a valuation and allocation of the Muscle Shoals properties as required by Section 14 of the TVA Act. On this authority, Mr. Lilienthal assigned to Mr. Edward Falck, then senior rate engineer in the division of rates, research and economics, responsibility for preparing basic valuation and allocation studies. After several months of work, on January 23, 1934 Mr. Falck submitted proposed findings which adopted the equal apportionment principle of allocation for Wilson Dam. Considerably refined, this preliminary report was the basis of tentative allocations which TVA presented to the Alabama Public Service Commission in November, 1934. On January 2, 1935 a more formal report based upon equal apportionment of Wilson Dam joint charges was presented to the TVA Board by the staff in charge of allocations. Although indications had been that there was a strong possibility the Board might adopt this report, protests from TVA consultants against both its findings and its theory apparently led to its abandonment. So closed the first period of allocation research. It may be described as "staff studies under Mr. Lilienthal," and it favored an equal apportionment basis of allocation.

A second phase of TVA allocation began in October, 1935 when a consulting committee of experts in public utility economics was established. This committee, composed of James C. Bonbright, Martin G. Glaeser, and Edward Morehouse,[2] agreed at its organization meeting ". . . . to assume responsibility for recommending the principles of valuation and of allocation, and for the application of the data and estimates made by your (TVA) staff to this value and these allocations." As the committee carried forward its work, it found that the problems of valuation and allocation together required more time and continuity of attention than it could give. It therefore requested

[2] Mr. Bonbright is a professor of economics at Columbia University, Chairman of the New York Power Authority, and author of volumes on *Railroad Capitalization*, *The Holding Company*, and *The Valuation of Property*. Mr. Glaeser is a professor of economics at the University of Wisconsin and author of *Outlines of Public Utility Economics*. Mr. Morehouse was formerly chief of the division of rates and research of the Wisconsin Public Service Commission and is now connected with the Trustees of the Associated Gas and Electric properties and the War Production Board.

that it be relieved of its allocation responsibilities and recommended instead that Professor Glaeser be employed full time to work upon this problem. Acting upon this recommendation, the Board employed Professor Glaeser as a regular staff member to assist in development of principles and policies for allocation of TVA costs (with special reference to power costs). For numerous reasons including sickness and the pre-occupation of TVA personnel with more immediately pressing work,[3] little apparent progress was made toward a final allocation report during this phase of allocation study.

A third stage of allocation research was carried out more or less contemporaneously with the work of Professor Glaeser and the consultants. This consisted of staff studies and reports prepared under the supervision of Director Arthur E. Morgan. There is no apparent Board authorization for these studies, so presumably they were undertaken upon order of Director Morgan under his own authorization. The first fruit of this effort was a proposed allocation of Muscle Shoals investment prepared by E. Lawrence Chandler and dated December 24, 1936. This employed the so-called "relative benefit" principle of cost apportionment. A revised version of this report was completed by Mr. Chandler in April, 1937. A month later, Director Arthur Morgan presented the results of this study to a Congressional Committee and declared that they coincided with his personal views as to a proper solution of the TVA joint cost problem. We shall discuss the relative benefit theory in Chapters IX and X and the alternative justifiable expenditure theory, a special version of benefit theory, in Chapter XI.

A fourth and final period of TVA allocation investigations began on July 12, 1937 when the Authority established a Financial Policy Committee, its membership composed of regular staff employees. This committee was charged with a number of responsibilities in the development of Authority financial policies, one of which was allocation of joint costs. It was initially under the chairmanship of Professor Glaeser, later under Mr. E. L.

[3] The bulk of this other work involved preparation of data for court cases, but the work of the Valuation Committee was also pressed steadily forward.

Kohler, who became comptroller of the Authority in the spring of 1938. It considered a large number of suggested bases of allocation and many variations of the more promising of these. Those to which it gave closest attention were the alternative cost avoidance, justifiable expenditure, and use-of-reservoir-capacity principles. After lengthy consideration it developed a rather special version of the former two of these in combination which it termed the "alternative justifiable expenditure" basis of allocation. To this theory and its own judgment the Committee gave greatest weight in determining the final allocation percentages which it recommended for adoption with regard to the initial three-dam system (including the Norris, Wheeler, and Wilson projects).[4] The work of the Financial Policy Committee will be considered below in parts of Chapters IX, XI, and XII.

In addition to the types of allocation theory suggested above, two further types remain for consideration. The first may be termed "admittedly arbitrary" theories[5] and the second, "incremental cost" theories. One version of the latter was urgently recommended for Authority adoption by Director Lilienthal and Consultant Bonbright. Another brand of the same theory was employed by Dean Moreland (testifying for the Commonwealth and Southern Corporation) in an effort to demonstrate to the Joint Congressional Committee that TVA wholesale power rate schedules were unreasonably low. These types of theory will be considered below in Chapter XIII.

Let us return now to the early staff studies which employed the equal apportionment basis for allocation of investment at Muscle Shoals.

[4] The Committee's recommendations, endorsed by the TVA Board, became official TVA allocations when they were approved by the President as required under Section 14 of the TVA Act. The three-dam allocation report was forwarded to Congress and printed as House Document 709, Seventy-Fifth Congress, Third Session. Later reports, based upon the same principle, have been approved for the four-dam and seven-dam systems (adding consecutively the Pickwick Landing, Guntersville, Chickamauga and Hiwassee projects).

[5] This classification includes the equal charge basis of apportionment which is considered in the present chapter.

TVA PRELIMINARY COST COMPUTATIONS AND THE FALCK ALLOCATION OF JANUARY 23, 1934

A discussion of early proposals for allocation of Wilson Dam should be prefaced with the observation that the problems of valuation and allocation are closely related. For projects constructed by the Authority itself, the TVA Act made the valuation problem very simple by prescribing as an investment base the book cost of project construction. With respect to Wilson Dam, which had been constructed by the United States Engineers some years before TVA, the Act prescribed "present value" as a base for allocations. Since the concept of allocation inherently implies allocation of some base, it is not surprising that early studies treated valuation and allocation as but slightly different phases of a single comprehensive problem.[6] Consequently, although our primary interest is in allocation, from time to time we shall find ourselves concerned with matters bearing very closely upon the valuation of Wilson Dam.

Because it was evident from the first that valuation and allocation would not prove to be easily soluble problems, TVA developed a set of "Preliminary Cost Computations" (dated September 15, 1933) for use in early rate computations for energy to be sold from Wilson Dam. These calculations included figures for valuation of Wilson Dam power plant and other Muscle Shoals power properties, fixed charges on this valuation, other charges, and charges on account of transmission.[7] The valuation of Wilson Dam was based upon a figure of $125 per kilowatt of installed capacity and amounted to $24,375,000. This figure was believed to set a maximum reasonable power charge at the project on a "present value" basis. Therefore, it was believed that power rates could conservatively be based upon this valuation with no danger that subsequent allocations would prove them to be "uneconomical."[8]

[6] This procedure continued until June, 1936 when the Valuation Committee recommended that the problems be dealt with separately.

[7] For a summary of these computations, see Technical Appendix C.

[8] In these computations the steam plant at Nitrate Plant No. 2 was valued at $80 per kilowatt, or $4,800,000. Both investment figures were booked without deduction of depreciation, and annual depreciation was computed upon a sinking fund basis. This preliminary valuation of Muscle Shoals power facilities was

The first memorandum in which precise figures for a valuation and allocation of Wilson Dam were proposed was submitted by Mr. Falck to Director Lilienthal on January 23, 1934.[9] Its recommendations are summarized below in Table 26. Since the working papers upon which these figures were based are no longer available, it is difficult to state with certainty the theory which supported them or the exact manner in which they were determined. With this reservation let us offer our interpretation of the probable back-up for this allocation.

For Wilson Dam the basis for apportionment appears to have been quite similar to that suggested in Table 27. Here the lock is charged entirely to navigation, and the jointly useful spillway is divided equally between navigation and power. Cost for the powerhouse is broken down into reasonable original cost which is charged to power, and "excessive" original cost, which is charged to national defense.[10] The steam plant at Nitrate Plant Number 1 was apparently considered completely obsolete, and national defense was charged with no more than its present scrap value. The basis of allocation of the steam plant at Nitrate Plant Number 2 is not clear. The memorandum indicates that a figure of $100 per kilowatt was used to determine a fair orig-

checked by an equal apportionment allocation of a preliminary estimate of present value. See *Hearings* before Joint Committee Investigating TVA, 740-41.

TVA has often been criticized for formulating rates prior to the development of allocations on the ground that rates so formulated could not have a proper cost basis. (See, for example, H. S. Bennion, "Comments on TVA's Report on Allocation," 6 *Edison Electric Institute Bulletin* 475 [November, 1938].) This point does not seem to be well taken. No new firm could ever begin business unless it set rates on the basis of anticipated costs rather than according to costs actually incurred; for costs are continuous and are conveniently computed only at the close of an accounting period. There seems small room to question the proposition that TVA rates were made after the most careful cost analysis. (See *Hearings* before Joint Committee on the Investigation of the Tennessee Valley Authority pursuant to Public Resolution 83, Seventy-Fifth Congress, Third Session, p. 786 ff.) In so far as wholesale rates are concerned, although it is true that no specific allocation had been determined, the level of rates was set sufficiently high to guarantee "economy" under any reasonable allocation. It follows that even though no final allocation had been adopted, rates were not without a cost basis.

[9] A final version of this memorandum was dated February 2, 1934. (See *Hearings* before Joint Committee, p. 708.)

[10] "Excessive" capital costs were those additional costs incurred because of the unusual conditions under which the plant was constructed. (See above, Chapter II.) Figures for "present value" were obtained by applying a factor of ninety percent to allocations of historical costs.

TABLE 26

PROPOSED VALUATION AND ALLOCATION OF MUSCLE SHOALS PROPERTIES
(January 23, 1934)

	Navigation	Power	National Defense	Total Present Value	Depreciation and Obsolescence	Original Cost
	(All figures in thousands of dollars)					
Wilson Dam						
Historical Cost	12,000	22,300	12,300	......	.....	46,600
Present Value[a]	10,800	20,070	11,070	41,940	4,660	46,600
Steam Plant at Nitrate Plant Number 1[b]	......	......	25	25	.....	25
Steam Plant at Nitrate Plant Number 2						
Historical Cost	......	3,000	9,000	......	......	12,000
Present Value	......	2,400	8,400	10,800	1,200[c]	12,000

[a]Present value computed on the basis of 10 percent depreciation and obsolescence.
[b]Estimated scrap value. Original cost of the plant was $1,200,000, but it was obsolete as soon as it was built because of the failure of the nitrate plant in which it was installed.
[c]Depreciation figured on straight line basis for fifteen years of twenty-five year plant life, but partly charged to national defense.
Source: TVA office memorandum, Falck to Lilienthal, January 23, 1934.

inal cost of $6,000,000 for this property. Depreciated on a straight line basis for fifteen years of a twenty-five year life, the plant would have a resultant present value of $2,400,000 as suggested in Table 26. But determined in this manner, depreciation would be $3,600,000 as compared with $1,200,000 indicated. A somewhat different approach may have been followed. Total original cost ($12,000,000), depreciated on a straight line basis for fifteen years of a twenty-five year life, would yield a present depreciated cost of $4,800,000. But of original investment, fifty percent was for "excessive" cost, and therefore only one-half of depreciated original cost should be charged to power, or $2,400,000. The remainder of present depreciated cost would be chargeable to national defense together with the original $6,000,000 of excess investment. This would leave as a balance chargeable to accrued depreciation only the difference between reasonable original cost ($6,000,000) and present depreciated cost ($4,800,000), or $1,200,000. This is the amount shown in Table 26.

TABLE 27
SUPPORTING DATA TO TABLE 26[a]

Section	Total Historical Cost	Allocated Charge To		
		Navigation	Power	National Defense
Lock and sailing line	4,000	4,000	......	....
Spillway	16,000	8,000	8,000	....
Powerhouse	22,300	......	14,300	8,000
Land, public roads, and miscellaneous	4,300	......	......	4,300
Total	46,600	12,000	22,300	12,300

[a]All figures approximate and in thousands of dollars.
Source: Same as Table 26.

In order to give perspective to later discussion of other allocations proposed at TVA, it may be wise to underline here certain features of this preliminary plan for the division of joint costs. It is based upon the equal apportionment principle of allocation. Joint costs have been computed without consideration of the multiple purpose usefulness of lock and powerhouse sections. The charge to national defense is a complex of present value and incurred loss. The distinction between charges to national defense and to depreciation is not carefully drawn. Only in connection with the power objective is consideration taken of excessive original construction costs. Most of these matters are of sufficient importance to merit further consideration below.

ALLOCATION OF WILSON DAM PRESENTED TO ALABAMA PUBLIC SERVICE COMMISSION, NOVEMBER, 1934

That the equal apportionment report of January, 1934 could serve as no more than a step toward final solution of the troublous valuation and allocation problems was quickly recognized, and in the following months considerable effort was expended in its revision. Meanwhile the Authority was seeking to have carried out the provisions of the January 4 contract with the Commonwealth and Southern subsidiaries under which the Alabama Power Company was to transfer certain properties to TVA and its associated distributors. As a condition to its approval of this transfer the Alabama Public Service Commission stipulated that TVA file with it the schedules under which it proposed to sell power and a justification of these rates.[11] To meet this requirement TVA submitted in hearings before the Commission a series of exhibits of which perhaps the two most important were numbered seventy-six and seventy-seven. The first of these was a statement, entitled "Expense and Income, Wilson Dam Power Properties," which indicated the prospective economic balance of power operations from Wilson Dam. The second, "Cost and Present Value of Wilson Dam and Other Properties in the Muscle Shoals Area," presented a justification of the power valuation figures used in the income and expense computations. It is with the latter exhibit that we are here concerned.

[11] The Authority complied with certain requirements of the Commission but stipulated its position that such compliance was voluntary and that, in fact, the Commission had no power over it. If there was any legal doubt on this issue—and the case of TVA seems strong—it was removed when the Alabama legislature passed the Carmichael Act specifically renouncing any jurisdiction of the regulatory commission over the federal agency. See Alabama Acts, Regular Session, 1935, Number 1. See also Tennessee Public Acts, 1935, c. 45 at 98.

The Authority described its procedure in arriving at the investment allocations of Exhibit 77 as follows:

"In ascertaining the apportionment or allocation of the cost or 'present value' of these properties to the various functions indicated above, the following was the basic theory:

(a) Since Navigation, Flood Control, and Power Production are matters of joint cost, costs were first divided into those definitely segregable and those incurred jointly. Joint costs were then apportioned upon an equitable basis as explained below in detail.

(b) Since these properties owe their initiation to war emergency, national defense was charged with the full historical cost except as it can be shown that these properties have a 'present value' for other purposes.

(c) No attempt was made to estimate the present value of fertilizer production. The process of salvaging for this purpose has just begun and will have to be made a continuous process of credits to National Defense and charges to Fertilizer Production when and in proportion as these costs are salvaged.

(d) No allocation is made to flood control with respect to Wilson Dam because the benefit is slight and not easily measurable.

In ascertaining the 'present value' of Wilson Dam for purposes of power production it was necessary to secure a measure of the reduced cost of constructing a similar hydroelectric plant at the present time. Present values were not ascertained for the lock and spillway sections applicable to navigation, nor to the items of land and public roads. These are shown at historical cost. Joint costs, represented by the spillway section and land, are divided equally between Power and Navigation. The Power component of the spillway section is reduced to reflect present values and the difference charged to National Defense." [12]

Table 28 below summarizes the allocation of the Muscle Shoals properties determined by Exhibit 77. Tables 29, 30 and 31 indicate the development of the figures for Wilson Dam quoted in Table 28. It is interesting to note that replacement cost new on June 30, 1933 of investment chargeable to power at Wilson Dam was estimated at $23,609,464 as compared with

[12] Exhibit 77, "Cost and Present Value of Wilson Dam and Other Properties in the Muscle Shoals Area," filed by Tennessee Valley Authority before Alabama Public Service Commission in hearings on Consolidated Causes 6604-6636, Alabama Power Company, Petitioner, November 5-7, 1934.

$24,375,000 suggested in the Preliminary Cost Computations as a probable maximum charge to power.[13]

TABLE 28

RECOMMENDED ALLOCATION OF HISTORICAL COSTS OF ALL FEDERAL MUSCLE SHOALS PROPERTIES
(November, 1934)

Feature	Historical Cost	Charge To: Power	Charge To: National Defense	Charge To: Navigation
	(All charges in thousands of dollars)			
Wilson Dam				
Cost of construction	46,603	19,181	14,273	13,148
Additional costs to June 30, 1933	348	348	....	....
Total	46,951	19,529	14,273	13,148
Nitrate Plant Number 1				
Villages and public works	3,552	....	3,552	....
Nitrate plant and land	8,063	....	8,063	....
Steam electric plant	1,272	....	1,272	....
Total	12,888	....	12,888	....
Nitrate Plant Number 2				
Villages and public works	11,964[a]	....	11,964	....
Nitrate plant, land, Waco quarry and railroad	40,221	....	40,221	....
Steam electric plant	12,326	1,920[b]	10,406	....
Total	64,512[c]	1,920	62,592	....
GRAND TOTAL	124,351	21,449	89,753	13,148

[a]Cost of temporary buildings amounting to $5,174,377 has been distributed as overhead to permanent plant.
[b]Charge based upon replacement cost new estimated at $80 per kilowatt for 60,000 kilowatts and depreciated on straight line basis for fifteen years of estimated twenty-five year life.
[c]Partially disposed of inventories originally costing $3,043,516 are not here included.
Source: Exhibit 77 filed by Tennessee Valley Authority before Alabama Public Service Commission in hearings of November 5-7, 1934.

[13] Mention should perhaps be made of the fact that in October, 1934, the Authority had appeared before the Tennessee Railroad and Public Utilities Commission and had justified its rates on the basis of the Preliminary Cost Computations. The Authority was subjected to some criticism on the ground that within a month's time it scaled down its charge to power at Wilson Dam from $24,375,000 to $19,529,000, the "present value" for power suggested in Exhibit 77. Llewelyn Evans, TVA engineer, pointed out that the difference between these two valuations was much more apparent than real since they were used in connection with different techniques for computation of depreciation:

"The original calculation contemplated retirement or depreciation in fifty years thereafter, whereas, the present valuation contemplates retirement of the main structures in a remaining life of forty-three years, and machinery and equipment in a remaining life of eighteen years, so that, in short, the original valuation represents the value depreciated to date. In that connection, the

Examination of the data of Tables 28 to 31 reveals that several of the comments made above with reference to the allocation of January 23, 1934 are once more in order. The equal apportionment principle has again been adopted. Joint costs have been estimated without consideration of the multiple purpose service-

TABLE 29

PRELIMINARY ALLOCATION OF HISTORICAL COST OF WILSON DAM
(November, 1934)

Project Section	Total Cost	Cost Chargeable to		
		Power	Navi-gation	Roads and Public Works
	(All costs in thousands of dollars)			
Lock	4,255	......	4,145	110
Spillway	17,555	8,149	8,149	1,256
Powerhouse	23,085	22,281	....	804
Land	1,708	854	854	....
Total	46,603	31,284	13,148	2,170

Source: Same as Table 28 above.

ability of lock and powerhouse sections. Most important of all, the allocations to different objectives have not yet been placed upon comparable bases. The charge to national defense is a composite of incurred loss, depreciation of prudent investment, and residual asset value. The charge to power is upon a present value basis. The charge to navigation is upon an original cost basis with no deduction of accrued depreciation.

Two additional criticisms of Exhibit 77 may be made. First, presumably the charge to power is based upon depreciated present replacement cost of the Wilson Dam power plant. But the unit costs actually employed in developing the indicated "present value" were only in part "replacement costs" and for

original cost new was arbitrarily set down at $125.00 per kilowatt for 195,000 kilowatts based on our best judgment applied to all factors known. The present valuation is built up from unit quantities and prices. There is not an exact relation between the two valuations, although the resulting costs computed from these valuations are remarkably close."
(Quoted from Hearings of November 5-7, 1934 before Alabama Public Service Commission, p. 40 of mimeographed record.)

many items were historical costs.[14] This procedure was justified by the argument that:

"The equipment involved is not of the same type as would be installed at the present time, and it was felt that the historical cost was a more accurate measure of present replacement cost than could be obtained by securing present day prices." [15]

TABLE 30

SHARE OF POWER ALLOCATION ON HISTORICAL COST BASIS CHARGEABLE TO NATIONAL DEFENSE

(November, 1934)

Project Section	Power Allocation on Historical Cost Basis (1)	Replacement cost new (2)	Present Power Value (June 30, 1933)[a] (3)	Share of Power Allocation Chargeable to National Defense[b] (4)=(1)—(3)
	(All costs in thousands of dollars)			
Spillway	8,149	5,609	4,649	3,501
Powerhouse	22,281	17,147	13,678	8,602
Land	854	854	854	......
Subtotal	31,284	23,609	19,181	12,103
Add public roads				2,170
Total	31,284	23,609	19,181	14,273

[a]Figures in Column (3) are less than those of Column (2) because of depreciation which has been computed on a straight line basis for seven years out of an estimated twenty-five year life for machinery and superstructure and seven years out of fifty year life for main substructure.

[b]National Defense is charged with costs incurred in project construction due to a price level above that of 1933 and with the diminution in project value from adjusted original value due to depreciation and obsolescence.

Source: Same as Table 28 above.

In effect, present value was determined as a composite of reproduction cost, replacement cost, and original cost. Second, present value chargeable to power was estimated after deduction of accrued depreciation computed upon a straight line basis. But Exhibit 76 indicated that annual depreciation was to be charged upon a sinking fund basis. The inconsistency of this shift was unfortunate. It would have been more reasonable either to

[14] In the spillway section this was true for coffer dams, preparation of foundations and grouting, and spillway gates and operating mechanism. In the powerhouse section it was true of many items, the most important of which were powerhouse superstructure, switchhouse machinery and electrical equipment (amounting to $9,678,272 of total "replacement costs new" for this section of $17,147,111).

[15] Exhibit 77.

charge off accrued depreciation and continue future annual depreciation upon a straight line basis or to use an undepreciated "present" power value and compute future depreciation upon a sinking fund basis.[16] Although these observations may seem

TABLE 31

RECOMMENDED ALLOCATION OF HISTORICAL COST OF WILSON DAM
By Sections
(November, 1934)

Section	Total Cost	Charge To: Power	Charge To: National Defense	Charge To: Navigation
	(All figures in thousands of dollars)			
Lock and sailing line	4,145	......	......	4,145
Spillway	16,299	4,649	3,501	8,149
Powerhouse	22,281	13,679	8,602	......
Public Roads	2,170	......	2,170	......
Land	1,707	854	......	854
Subtotal	46,603	19,181	14,273	13,148
Add: Costs after completion to June 30, 1933	348	348	......	......
Total	46,951	19,529	14,273	13,148

Source: Same as Table 28 above.

much more closely related to the problem of valuation than of allocation, they are in order here because the method of allocation under review makes charges to the several objectives contingent upon an estimated present valuation of the power purpose.

THE PROPOSED ALLOCATION OF JANUARY 2, 1935

Not long after the submission of the November allocations to the Alabama Public Service Commission Mr. Falck completed and forwarded to the Board a new version of a proposed official allocation of TVA properties.[17] This report, dated January 2, 1935, may be regarded as a final revision of all earlier equal apportionment studies and as the culmination of the first period of TVA allocation research. It introduced a far-reaching adjustment from earlier studies in that it sought to separate the valuation and allocation problems and to deal only with allocations of estimated present values. Unfortunately, this procedure was

[16] The latter procedure was employed in the Preliminary Cost Computations.

[17] It should be emphasized that the allocations of Exhibit 77 were never represented as anything other than provisional pending more final determinations.

not followed with complete consistency for all elements of plant at Muscle Shoals.

For Wilson Dam, present cost of replacing the property new (as of June 30, 1933) was set at $34,214,437. Adding interest during construction at 3.5 percent for a thirty-six month period and deducting accrued depreciation over seven years of plant life, present value was set at $33,193,404.[18] The difference between present value and recorded original cost ($13,757,344) was treated as recorded loss not subject to allocation and was charged to a reconciliation "sunk cost" account. The problem of allocation of present value was then approached carefully in the light of the TVA Act. No charge to flood control was considered justified since it was recognized that Wilson Dam flood storage was very slight. Likewise, no charge was considered appropriate against fertilizer production. It was conceded that fertilizer operations would benefit from the availability of Muscle Shoals power, but arrangements had already been made whereby this power would be supplied upon a commercial basis. Consequently, to assess a part of Wilson Dam investment against fertilizer would have been to duplicate charges. In the case of national defense the problem was more difficult. In theory it was thought that a charge to this objective should be determined according to the ". . . . extent to which national defense is aided by the existence of such a power plant in the possession of the United States Government and by the possibility of using the power output for emergency war purposes." The possibility of rationally fixing any precise figure to reflect this phase of Wilson Dam value was obviously slight. It did appear feasible, however, to estimate "present value" of certain highways and public works at the dam which would contribute in time of emergency to maximum defense utilization of the Muscle Shoals reservation. On this basis, a present value charge of $1,434,902 ($1,494,701 on a replacement cost new basis) was levied against national defense. The balance of present value, or $31,758,502, was considered as chargeable to remaining project objectives, navigation and

[18] Depreciation was computed upon a sinking fund basis. Structure service life was set at fifty years, substructure at twenty-five (or forty-one years for the composite property). An interest rate of 3.5 percent was assumed.

power. The core of the allocation problem lay in apportioning charges between these objectives.

As an initial step in allocation, direct and joint costs were isolated. Separable cost of locks (replacement cost new) was estimated to be $2,885,420; cost of replacing locks with substitute non-overflow abutment was set at $145,992; and the difference, or $2,739,428, was taken as direct cost for navigation. Similarly for power, replacement cost new of the powerhouse was estimated at $17,356,265; cost of substitute non-overflow abutment was set at $3,121,882; and the difference, or $14,234,383, was taken as direct power cost. Joint costs, on a replacement cost new basis, were computed as follows:

Value of Wilson Dam, Replacement Cost New		$34,214,000
Deduct direct costs:		
National Defense	$ 1,495,000	
Navigation	2,739,000	
Power	14,234.000	
		18,468,000
Remaining joint costs		$15,746,000

The problem of apportioning joint costs between power and navigation was then solved as follows:

"In the present instance a dam constructed solely for the development of navigation would incur precisely the same cost for duplicating the structure included in the joint cost total as would a dam constructed solely for the development of power. Stated differently, the saving in total cost arising from the combination of both programs into a single co-ordinated activity is exactly equal in amount to the joint cost total. If, therefore, the two programs are considered to share equally in the saving arising out of the joint operation, it follows that the joint cost should be allocated on the basis of fifty percent to each program. Since the single purpose costs to each program are equal, it is considered fair to divide the total joint cost equally between the two programs." [19]

[19] "Report on Valuation of Wilson Dam and Other Federal Properties at Muscle Shoals" (Knoxville: Tennessee Valley Authority, January 2, 1935), p. 28. It may be pointed out that the rationale explained here strongly foreshadows allocation according to alternate costs avoided. (See "Note" appended to Chapter IX.)

On this basis of allocation, total charges at Wilson Dam were worked out as indicated in Table 32. The derivation of this table is indicated in Tables 33 and 34. Table 35 summarizes the allocation of January 2, 1935 for all federal Muscle Shoals properties.

TABLE 32
PROPOSED ALLOCATION OF WILSON DAM VALUATION
(January 2, 1935)

Objective	Replacement Cost New Basis	Present Value Basis
Navigation	$10,612,000	$10,188,000
Power	22,107,000	21,571,000
National Defense	1,495,000	1,435,000
Total	$34,214,000	$33,193,000

Source: Tables 33 and 34.

A comparison of the January 2 allocation with earlier proposals for the apportionment of TVA joint costs indicates several important adjustments in the method of the later report. An apparent endeavor was made to place all charges upon a comparable present value basis. The former use of national defense as a residual account was abandoned and a special reconciliation account was established to carry accrued depreciation and sunk costs. Past depreciation was estimated upon a sinking fund basis so that it would be consistent with planned future charges for annual depreciation. Interest during construction was taken into account in computing present value. The multiple purpose utility of lock and powerhouse sections was recognized in the estimation of joint costs. Replacement cost was determined much more largely in the light of present prices and recent experience for comparable work at Wheeler Dam than according to historical costs.[20]

While most of these changes seem to have been well advised, we may note several respects in which the allocation remained upon uncertain ground. First, the cost of roads and bridges was

[20] Most of these points were brought out by Mr. Falck in a memorandum submitting the report of January 2, 1935.

charged entirely to national defense although ready access to lock and powerhouse structures is clearly essential to the navigation and power purposes. Second, with the exception of the

TABLE 33

PROPOSED WILSON DAM ALLOCATION ON REPLACEMENT COST NEW BASIS

(January 2, 1935)

Cost Classification and Project Feature	Historical Cost Basis[a]		Replacement Cost New, June 30, 1933[b]	
	(All costs in thousands of dollars)			
Determination of Joint Costs				
Land		1,708		1,351
Spillway section		16,299		11,127
Non-overflow abutments equivalent to lock and powerhouse		3,268		3,268
Total		21,274		15,746
Assignments to Power Program				
Powerhouse	22,281		17,356	
Less displaced abutment	3,122		3,122	
Direct power cost	19,159		14,234	
Add fifty percent of joint costs	10,637		7,873	
Total assignment to power		29,796		22,107
Assignments to Navigation Program				
Lock	4,024		2,885	
Less displaced abutment	146		146	
Direct navigation cost	3,878		2,739	
Add fifty percent of joint costs	10,637		7,873	
Total assignment to navigation		14,516		10,612
Assignments to national defense				
Separable cost of public roads		2,291		1,495
TOTAL		46,603		34,214

[a]Historical cost as of June 30, 1926, excludes $347,802 for new work from 1926 through June 30, 1933.

[b]Replacement cost estimated by application of 1933-1934 prices to historical quantities.

Source: Tennessee Valley Authority, "Report on Valuation of Wilson Dam," January 2, 1935.

steam plant at Nitrate Plant Number 2, the present value basis of charge to national defense which was employed in allocation of Wilson Dam was abandoned at the nitrate plants. Once more the sum of the national defense account is a complex of present value and sunk cost.[21] Third, although the sinking fund method was adopted for computation of depreciation, present

TABLE 34

PROPOSED WILSON DAM ALLOCATION ON PRESENT VALUE BASIS AS OF JUNE 30, 1933

(January 2, 1935)

Basis of Charge	Objective		
	Power	Navi-gation	National Defense
	(All figures in thousands of dollars)		
Total assignment, replacement cost new....................	22,107	10,612	1,495
Add interest during construction[a]	1,161	557	78
Total replacement cost new.....	23,268	11,170	1,573
Less accrued depreciation[b]......	2,045	982	138
Present value of property which existed in 1926..............	21,223	10,188	1,435
Add new work, June 30, 1926, to June 30, 1933[c]..............	348	......	.....
Present value of Wilson Dam as of June 30, 1933, by objectives	21,571	10,188	1,435

[a]Interest during construction computed at 3.5 per cent for hypothetical three year construction period.
[b]Depreciation accrued on sinking fund basis for seven-year period. Interest assumed at 3.5 per cent. Estimated life of structure is fifty years, of superstructure and equipment, twenty-five years.
[c]This account is apparently undepreciated.
Source: Same as Table 33 above.

value of Wilson Dam was determined by deducting accrued depreciation from present replacement cost. The propriety of this

[21] At Nitrate Plant Number 1 full historical cost of $12,888,000 was temporarily charged to national defense with the stipulation that when and as present value could be shown for other programs they would be appropriately debited and national defense would be credited. Apparently it was contemplated that when full "present value" to other programs had ultimately been charged, the balance in the national defense account would be scaled down to "present" national defense value and the amount of the write-down would be charged to reconciliation sunk costs.

At Nitrate Plant Number 2, procedure was similar to that for Nitrate Plant Number 1 except for the steam plant. For this feature present replacement cost new was estimated at $4,800,000 (at $80.00 per kilowatt). Accrued depreciation by the sinking fund method for fifteen years of a twenty-five year life was deducted, and present value was set at $2,422,000 (as of June 30, 1933). "The difference between present value and historical cost is in the nature of a sunk cost of $9,904,402." (Tennessee Valley Authority, "Report," January 2, 1935.)

TABLE 35

PROPOSED ALLOCATIONS OF ALL FEDERAL PROPERTIES AT MUSCLE SHOALS

(January 2, 1935)

Plant	Historical Cost	Assignment of Historical Cost			
		Power	National Defense	Navigation	Reconciliation Sunk Costs
	(All figures in thousands of dollars)				
Wilson Dam					
Construction cost as of June 30, 1926	46,603	21,223	1,435	10,188	13,757
Additional costs to June 30, 1933	348	348	......	......	......
Subtotal	46,951	21,571	1,435	10,188	13,757
Nitrate Plant Number 1					
Villages and public works	3,552	......	3,552	......	......
Nitrate plant and land	8,064	......	8,064	......	......
Steam electric plant	1,272	......	1,272	......	......
Subtotal	12,888	......	12,888	......	......
Nitrate Plant Number 2					
Villages and public works	11,964	......	11,964	......	......
Nitrate plant, land, Waco quarry, and railroad	40,221	......	40,221	......	......
Steam electric plant	12,326	2,422	......	......	9,904
Subtotal	64,512	2,422	52,185	......	9,904
GRAND TOTAL	124,351	23,993	66,508	10,188	23,662

Source: Same as Table 33 above.

procedure seems doubtful.[22] A more reasonable solution would have maintained a cost-new valuation base in order that the full annual return contemplated in sinking fund computations might have been earned.[23]

The report of January 2, 1935 had been eagerly awaited within the Authority. At first it was thought that perhaps a final solution to the allocation problem had been achieved. Indeed, while awaiting word from its technical consultants the TVA Board granted the report its preliminary approval and ordered the drafting of a letter of submittal to accompany it to the President. It was without doubt a disappointment that subsequent comprehensive analysis of the report caused the Board to feel compelled to rescind its action of tentative approval and reopen the whole valuation and allocation issue.

CONCLUSION

What were the critical weaknesses of the report of January 2? None of the three criticisms suggested above seems so fundamental that it could not have been met by a limited modification of the original study. Yet no such modification was ever accepted. We may suggest two considerations which apply with equal force to each of the allocations considered in the present chapter and which may have determined the fate of the report of January 2.

First, none of these allocations effectively escapes from a historical cost basis of valuation of Wilson Dam. The January, 1934 report estimated "present value" as historical cost less ten percent for depreciation and obsolescence; the November allocations frankly used the whole of historical cost as a basis of computations. Each of these allocations employed the national defense account as a residual catch-all to permit adjustment of the power charge to something approximating present value

[22] Under sinking fund depreciation, the figure used for "present value" could really be present value only if future depreciation were to be charged against an undepreciated base.

[23] Consultant Edward W. Morehouse made the three points suggested here in a letter to Mr. Falck dated January 10, 1935. He urged further that if annual depreciation was to be computed to include obsolescence the depreciation base should rather be cost new of an identical plant than cost of a substitute plant. In theory, obsolescence expense might be charged off twice if cost new of a substitute plant were depreciated.

on a "replacement" or reproduction cost less depreciation basis. The January 2, 1935 allocation made a more determined effort than its predecessor to place charges upon a present cost basis. Nevertheless, by introducing the "sunk cost" account it unwittingly continued to focus attention upon original cost. From the point of view of the Board it no doubt seemed dubious policy for TVA accounts to continue to show full historical costs of the Muscle Shoals properties. Congress had specifically requested a determination of "present value"; and TVA power rates had quite properly been determined according to estimated fair "present" power value of Wilson Dam. Only confusion and misunderstanding could result from continual reference back to historical cost.

A second factor which may have led to the failure of the allocation of January 2 is that the Board may have been reluctant to set a precedent for future allocations by adoption of equal apportionment at Wilson Dam. This suggests an examination of the theoretical basis for equal charges. We have already noted above a statement of the rationale of this principle emphasizing the reasonableness of equal participation by each coordinate objective in the joint savings of multiple purpose improvement. A different and somewhat more negative ground for acceptance of the equal charge formula was suggested by Professor Bonbright. After examining a number of competing theories for joint cost allocation and finding none of them satisfactory, he concluded:

". . . . in default of any specific reason for charging more of the joint cost to the one service than to the other, the assumption of equal responsibility for costs is the most reasonable one." [24]

The basic assumption of the equal charge theory is that it is reasonable for each objective to share equally in joint costs. There is no pretension that joint costs have been broken down and traced in a functional manner, half to one objective and half to the other (assuming a dual purpose project). But it is argued

[24] Letter from Bonbright to Lilienthal dated November 30, 1934. Professor Bonbright later revised his position to support a version of incremental cost theory. (See below, Chapter XIII.)

that because costs are joint no competing method of apportionment can be any more reasonable. In the absence of any convincing argument for dividing costs unequally, equal sharing is the fairest solution.

Let us appraise the equal apportionment principle by the preliminary criteria of a satisfactory allocation suggested above in Chapter VII.

(1) Assuming that separable costs are computed on an incremental basis, the method is logical in that it does not apportion to any objective a greater investment than would suffice for single purpose development. On the other hand, the method is illogical in that it does not give any consideration to relative benefit values of the various purposes. For example, if the "value" of the benefit from any objective exceeds its direct costs, its inclusion in a multiple use development is economical. But such inclusion would appear uneconomical if the equal apportionment principle were employed and the value of the benefit were not sufficiently in excess of direct costs to carry the added objective's proportionate share of joint costs.

(2) The method is readily understandable.

(3) The method is workable.

(4) The method has little flexibility. Its arbitrary nature makes it ill adapted to application in a growing system.

(5) From a cost point of view equal apportionment assures each objective a share of multiple use economy. On the other hand, there is no assurance that it may not burden one or more objectives with costs greater than the value of benefits.

In sum, the equal charge principle is simple, workable, and superficially logical. But it is inflexible and it takes no account of the justifiability of the charges it assesses. The significance of the latter weakness is emphasized by consideration of the two hypothetical and quite different projects of Table 36. Although both of these undertakings might be feasible economically, it is not clear that in each case each objective would be able to bear its proportionate share of common capital cost. For example, at Project B, equal costing would assign power approximately \$365 of common investment per kilowatt of equivalent primary power added to the system by the plant. Such a charge, when added to direct power investment, would probably make the power end of the development unfeasible. Yet power could easily cover all of its direct costs and make a moderate contribution toward the costs of joint facilities. Thus, equal apportionment breaks down because of its inadaptability to the peculiar economic features of particular projects.

TABLE 36

BENEFITS OF HYPOTHETICAL MAIN RIVER PROJECTS

	Project A[a]	Project B[a]
Power		
Added system primary (in kilowatts)....	25,000	8,000
Added system secondary (in kilowatts)..	1,000	16,000
Miles of navigable channel added.........	50	160
Controlled flood storage (in acre feet).....	200,000	100,000
Total joint costs........................	$15,000,000	$15,000,000

[a]It is assumed that the two projects are equally strategically located for all major purposes.

In Chapter IX, which here follows, there are discussed some applications of a theory which is designed to avoid the critical weaknesses of the equal charge method. This theory may be described as allocation according to the relative benefits of each project purpose.

Chapter IX

SUGGESTED APPLICATIONS OF THE RELATIVE BENEFIT METHOD OF ALLOCATION

Summary. The second stage of TVA allocation research was carried out by the Authority engineering staff under the direction of Chairman Arthur E. Morgan. This work centered about an effort to develop an allocation of joint costs according to the relative benefit values of the various purposes served by the multiple purpose system. Perhaps the most difficult problems which arose in the practical application of this method of allocation were the definition and estimation of benefits. Early benefit allocations at TVA defined benefits in pecuniary terms and evaluated them according to estimated alternate costs of developing each objective of the multiple purpose system by an equivalent single purpose program.

GENESIS OF THE BENEFIT METHOD

When private enterprise analyzes a business opportunity to determine whether or not it should invest funds, its judgment is governed by its conclusion as to whether or not prospective revenues are adequate to cover all prospective costs including a satisfactory return upon risked capital. When government considers investment in a non-revenue producing enterprise (such as stream improvement for navigation or flood control), this commercial standard of economy is not available. To take its place there has been evolved the benefit criterion of justifiable public expenditure. According to this criterion, government projects are justifiable from an economic point of view only when prospective benefits are in excess of prospective costs.[1] At multiple purpose projects application of this test requires evaluation of diverse project benefits. Since the values determined represent the limit of justifiable investment for each purpose, it is not surprising that the suggestion has been made that joint costs be apportioned according to relative benefits.

[1] The problem of project feasibility is discussed below in Chapter XV.

Perhaps the best introduction to benefit theories of allocation is contained in the "Notes on Allocation" which accompanied the TVA Three-Dam Allocation Report. The following paragraphs are taken from this statement:

"The theory of allocating joint costs of multiple-use dams on the basis of estimated benefits from the completed development has been strongly urged. This basis draws its chief protagonists from the ranks of flood-control engineers. It has been suggested by the National Resources Board and its subcommittees; [2] by the Mississippi

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[2] The following quotation presents the position of the National Resources Planning Board with respect to the benefit theory of allocation:

"Since the great national undertakings, proposed or under construction, for flood control, irrigation, water power, or navigation will perform more than one function and provide more than one benefit, it is reasonable that the costs of such projects should be borne in the proportion of the several functions or benefits. The magnitude of many current projects and the possibility of directly recovering some of the costs involved through revenues, such as those from power sales, have emphasized the fact that there is at present no generally accepted procedure to determine a fair sharing of the costs.

"It would seem self-evident that in a public undertaking the value of the benefits should guide the allocation of the costs, and that where revenues can be obtained the costs in turn should finally govern the rates to produce such revenues. But such an allocation of costs depends on an evaluation of the benefits, and some benefits cannot be measured closely. . . . . Some important benefits are general and intangible; for some, there are no accepted standards by which they can be expressed in dollars and cents.

"Nevertheless, the necessity for fixing rates for certain benefits makes it mandatory to evaluate all benefits involved. Failure to include an estimate for any benefit known to exist is equivalent to an appraisal of zero value, demonstrably false. Clarification of cost-allocation methods and of resulting rate procedures is evidently required.

. . . .

"To allocate the costs of a project without regard to the relative values of the several benefits involved is unwise as a public policy. If the costs allocated to power should include only the bare cost of adding power facilities to the project, the costs assigned to the primary purpose, say irrigation, may be more than the water users can pay, and thus the development may be rendered infeasible. Again, power rates fixed in such a manner might be so much below the level of power costs naturally inherent in a region as to result in an unwarranted burden upon national taxpayers for the benefit of specially favored groups or localities.

. . . .

"Estimates of the value of power from a project should be based upon the costs of power from alternative sources, either steam-electric plants or other hydroelectric plants, so planned as economically to supply the future needs for power in the area.

. . . .

"It is recommended that . . . . Any multiple-purpose project should be considered as a joint development for the several purposes involved, and the

Valley Committee,[3] and by various regional planning committees. In reports dealing with this subject, the discussion is usually limited to the nature of the allocation problem. It is asserted that these joint or common expenses should be shared on the basis of some measure of the benefit accruing to each function from the joint expense, and to this end it is urged that data be collected to measure in a pecuniary way the special benefits conferred.

"Historically, the benefit theory of allocating costs had its origin in the law of special assessment. The benefit principle is there used as a basis for taxing or assessing the cost of special improvements upon those sustaining a special benefit. Thus, the cost of an irrigation works has been made a charge against the land comprised within irrigation districts whose economic value has been enhanced by the improvement. Similarly, expenditures for street improvements, for park and recreation facilities, and for flood protection have been assessed against abutting or other properties in proportion to the

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costs should be allocated among the several purposes, with proper regard to the value of the respective benefits."

(*Drainage Basin Problems and Programs, 1937 Revision*, pp. 68, 94.)

For further discussion by the National Resources Planning Board and its subcommittees of the benefit principle for cost apportionment, see *Public Works Planning* (1936), p. 167 ff., and *Development of Resources and Stabilization of Employment* (1941), I, 33, 42-43.

[3] While it is correct to say that the Mississippi Valley Committee lent support to the benefit theory, we have been unable to find any statement of the Committee which specifically adopted this principle. In its report the Committee states:

"An accurate estimate of value of flood protection, even to a single piece of property, is difficult to make. . . . . When a community is involved, as is usually the case, these difficulties are greatly multiplied. . . . ." (P. 27.)

Allocation of multiple use costs, however, on some basis is necessary, for:

"Only those outlays reasonably chargeable to navigation should be included in these navigation costs. Where a river project is built for joint or multiple use, each of the purposes—recreation, power, flood control, etc.—should have allocated to it the *proper* percentage of the total outlay." (P. 40.)

What allocation, then, would be best?

"In view of the complex network of intangible benefits connected with most public improvements, a precise allocation of responsibility and costs is not in all cases ascertainable. The immediate tangible benefits, therefore, while they are indispensable as an instrument of planning and administration, should not be allowed to create an insuperable obstacle to action. *The ideal allotment of costs would be that which would produce the best total economic effect within the limits of public support and of administrative practicality, with due regard for all equitable considerations.*" (P. 218.)

But the Committee does not define the criteria for measuring the quality of economic effects of allocation in order to determine which would have the best total effect.

(Quotations have been taken from *Report* of the Mississippi Valley Committee of the Public Works Administration, October 1, 1934, and italics have been supplied.)

special benefit conferred.[4] It should be noted that these procedures are usually applied where the expenditures are for a single use, such as flood control, and where expenditures are made jointly only for those drawing the same kind (even though not the same amount) of benefit from the improvement. In these cases the assessment as a total is limited strictly to the cost of the improvement but assessed to the individual beneficiaries in proportion to ascertainable special benefits. To extend this idea to improvements serving more than one function or conferring more than one class of benefits, it is necessary to reduce all benefits to a common denominator of economic value as measured by money.[5] Applied to the allocation

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[4] The following discussion of the Miami (Ohio) Conservancy District illustrates the development of the benefit theory from the law of special assessment and its application in the field of flood control:

> "The theory of the special assessment for a local improvement is that, in addition to the general benefit to the community accruing from the improvement, certain individual property owners enjoy a special benefit to their property. . . . . It is the theory of the special assessment that this special increase in the value of land should be drawn upon to pay all or a portion of the cost of the improvement.
>
> . . . .
>
> "In Ohio following the Dayton flood the Ohio conservancy law was enacted in 1914. Under this law conservancy districts can be set up for the following purposes: Flood control, channel improvement, reclamation of wet lands, and irrigation. They are given some control also over the utilization of the waters under their jurisdiction for power and water purposes.
>
> . . . .
>
> "A conservancy district is a public corporation having perpetuity, the power to tax, to issue bonds, and a superior right of eminent domain.
>
> . . . .
>
> "The costs of the improvements are to be distributed according to benefits received. The benefits are to be determined and the costs apportioned by three appraisers nominated by the board and appointed by the court of common pleas. . . . . Maintenance charges are also apportioned on the basis of benefit.
>
> . . . .
>
> "In the Miami District the entire cost of the flood-protection project ($33,000,000) was assessed on the district on the basis of benefit.
>
> . . . .
>
> "In the Miami District the board of appraisers ascertained benefits and damages to each property, relying chiefly on three basic factors: The degree of flood menace, the degree of protection provided by the project, and the value of the property.
>
> . . . .
>
> "The final assessments were proportional to the estimated benefits of $77,000,000."

Quotations from National Resources Committee, *Public Works Planning*, December, 1936, pp. 202-203.

[5] The benefit method has been employed for allocation of costs of multiple purpose storage reservoirs by river regulating districts in New York State. Legally these districts are closely related to the Ohio conservancy districts. They are public

required by section 14 of the Tennessee Valley Authority Act, the benefit theory was presented by Dr. Arthur E. Morgan in a letter dated April 6, 1936, addressed to his co-directors:

"'Active development of the Tennessee River for navigation compelled decision as to whether that development should have in view navigation alone, with perhaps the consequent sacrifice of other possible values, or whether it should take the form of the unified development of the Tennessee River System, giving legal primacy to navigation, but keeping the whole development in good proportion, so as to serve the public welfare to the greatest total extent which is feasible. The Tennessee Valley Authority Act adopted this latter policy. While navigation is primary among the objectives to be achieved, yet the feasibility of the development depends not on the value of navigation alone, but upon the value of the total development for all purposes. The distribution of costs should not be on the assumption that the improvement would have been justified by navigation alone, unsupported by other beneficial results. The facts are to the contrary, as everyone knows. The value of flood control to agricultural lands, wholly in addition to navigation benefits, and the value for power development, wholly in addition to navi-

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corporations with perpetual existence, power of eminent domain, power to tax, and power to issue bonds. The board of each district is directed to apportion its costs, ". . . . less the amount which may be chargeable to the State, among the public corporations and parcels of real estate benefited, ***in proportion to the amount of benefit*** which will inure to each such public corporation and parcel of real estate by reason of such reservoir." (*Public Works Planning*, p. 203, italics supplied.) In the upper Hudson district the Sacandaga Reservoir cost about $12,000,000. Of this amount, ninety-five percent was charged against power companies or industrial plants downstream and only five percent against flood control.

Despite the proportions of the Sacandaga allocations, the project has already demonstrated great value for non-power purposes. In the 1936 flood it is estimated to have scaled approximately 50,000 c. f. s. from maximum flood flow at Albany, or four feet on the river gage. But for this reduction, the 1936 flood would probably have been the greatest of history for the Hudson River at the Albany station. The reservoir has also improved minimum low water flow on the river, increased dry period controlling depths, and reduced frequency of traffic interruptions because of summer and fall floods. During August, 1936, Sacandaga releases constituted fifty-five percent of stream flow at Albany. It seems certain that these releases forestalled a serious pollution problem which might have forced many industrial establishments along the stream to curtail operations and reduce employment. In sum, although the benefit for which the reservoir was primarily designed is stabilization of power production in dry periods, its operation under the law is calculated to forward the public welfare in many directions. Whether the values of these benefits properly merit consideration in a "benefit allocation" of the costs of Sacandaga Reservoir is a question which one might ponder. (See National Resources Planning Board, *Public Works Planning*, 1936, p. 204, and *Energy Resources and National Policy*, January, 1939, p. 310; and Sargent, Edward H., "Operation of Sacandaga Reservoir," *Civil Engineering*, November, 1938, p. 720 ff.)

gation benefits, were actual and significant factors in determining whether the improvement as a whole would be economically justified. By recognizing and providing for these and other benefits, and by having them share in the cost to a proper degree, it becomes economically reasonable to provide a higher quality of navigation than might be economically justified if navigation alone had to carry the entire burden.

" 'A theoretically proper and reasonable method for allocating the costs between the various types of benefit would be to allocate the common cost among the various uses in proportion to the benefit received by each from the common expenditure, and to charge to each type of benefit the total cost incurred specifically and solely for that particular use or benefit. For instance, the generators in a power plant have value, not for navigation or for flood control or for fisheries, but solely for power development, and their total cost should be charged to power. On the other hand, at the Pickwick Dam five feet of storage is provided primarily for flood control. Ignoring for the sake of illustration any possible value to power or navigation from this excess storage, we may say that the cost of this surplus storage should be charged wholly to flood control, and not to navigation or power. As still a different case, for purposes of flood control, power, fisheries, recreation, *et cetera,* it might be most feasible economically to locate a dam at a certain place; but the interests of navigation may require that the dam be built in another location where the expense is much greater. This additional or incremental cost made necessary by the particular purpose of navigation and not useful for other purposes should be charged to navigation alone.

" 'The theoretically correct principle of allocation would be as follows: expenditures which result in serving two or more useful purposes should be allocated to those purposes in proportion to the benefits received. Expenditures which serve only one purpose should be charged entirely to that purpose.

" 'In different cases there may be different approaches to the estimation of benefits. The application of this principle is complicated by the fact that for some or all of the kinds of benefits no definite measure of value may be had. Navigation developments are undertaken on the broad, general assumption that, if navigation is provided, the production of raw material and of manufactured products of the region will be stimulated, and that the navigation facilities will be used enough to justify the development. Moreover, it is not possible to make a precise estimate as to the relative value of high and low dams. Similar difficulties are encountered in efforts to measure other benefits, yet those difficulties do not abrogate the principle of allocation, which should be applied as far as it is possible to do so.'

"The great practical benefits to be derived from the navigation and flood control functions of these dams are unquestioned. A benefit is something that promotes welfare. Any measure of benefits attending the unified development of the water resources of the Tennessee Valley hinges on an interpretation of the term 'benefit' and a determination of the scope of its application." [6]

Against the background of this introduction, let us consider two attempts to apportion TVA joint costs according to relative benefits. We may then proceed to a more general discussion of the benefit theory.

THE CHANDLER BENEFIT ALLOCATION OF APRIL 19, 1937

Description

On December 24, 1936 a preliminary allocation of Wilson Dam according to relative benefits was completed by engineers working under Dr. A. E. Morgan. With some revisions the method of this study was applied to the Norris, Wheeler, and Pickwick projects in addition to the Wilson project in a proposed allocation dated April 19, 1937. The results of this allocation were presented by Director A. E. Morgan to the House Committee on Appropriations in the following May.[7]

Technically, the allocation of April, 1937 [8] employed what may be termed a "remaining relative benefit" method. Total "present value" (as of June 30, 1933) of Wilson Dam was estimated on a depreciated replacement cost basis to be $31,300,000. This was segregated into categories of direct and joint costs as indicated in Column (3) of Table 37. Present capital value of the prospective flow of benefits from each objective was then estimated, direct costs were deducted, and joint costs were divided among purposes according to the proportions of remaining benefits. Let us con-

[6] House Document 709, Seventy-Fifth Congress, Third Session.

[7] See *Hearings* on Second Deficiency Appropriation Bill for 1937 before Subcommittee of House Committee on Appropriations, Seventy-Fourth Congress, Second Session, 379-387.

[8] This report is commonly known as the Chandler allocation after its author, E. Lawrence Chandler, formerly TVA engineer and more recently Chief Engineer of the Chattanooga Flood Control District.

sider the method by which benefit values for the different purposes were appraised.

(1) Benefit to flood control. Flood storage available at the Wilson pool was taken as three feet on the surface of the reservoir or a total of 48,000 acre feet. At a "conservatively" estimated value to the Lower Tennessee and Mississippi Valleys of $15.00 per acre foot, Wilson flood storage was evaluated at $720,000.[9]

(2) Benefit to navigation. Benefit value for navigation was estimated to be equivalent to the alternate cost of a single purpose low dam navigation scheme. This was considered justified by the terms of the River and Harbor Act of 1930.[10] Determined in this way, navigation benefit at the Wilson project was set at $22,207,000.[11]

(3) Benefit to fertilizer. No direct benefit to fertilizer production was considered properly creditable to Wilson Dam or other water control facilities. Inasmuch as fertilizer operations were to take power from the multiple purpose system upon a commercial basis, a direct charge of a share of Wilson Dam value against them would have involved double accounting.

(4) Benefit to national defense. This aspect of the benefit value of the Wilson plant was evaluated in two stages. The excess of present value of roads and bridges above "present" replacement costs of facilities adequate to meet all requirements of navigation, flood control, and power ($1,188,282—$538,937= $649,345) was established as an initial national defense benefit. This figure was adjusted upward to $5,000,000 because of the strategic value of the Wilson Dam powerhouse.[12]

[9] For a discussion of some of the problems of evaluating flood control benefits, see below, Chapter X.

[10] See above, Chapter VII.

[11] The alternate navigation scheme included four low dams to carry navigation up to the elevation of Wilson high dam pool. Capital costs of the alternate projects were adjusted by a factor of twenty percent to allow for the higher annual operating and maintenance costs of the low dam plan.

[12] "The powerhouse is able to supply a large amount of power for war purposes when necessary. This plant could begin the manufacture of war materials on about 30 days' notice. If the plant were not in existence it would require at least a year to build a steam plant of like capacity and have it in readiness for use. It is difficult to estimate in dollars the very large value of the possible saving of eleven months' time in putting such a plant into use during war, but

(5) Benefit to power. The best measure of the power benefit of the Wilson plant was taken to be the cost of such an alternate steam plant as ". . . . would most economically supply power in a manner equally favorable with the Wilson installation." From total fixed and operating costs of such an alternate plant Wilson Dam operating costs for power were subtracted, and the difference was capitalized. Resulting benefit value of power was $40,000,000. It was recognized that addition of upstream storage would increase power availability at the Wilson site, but it was planned that such increments would be credited to the tributary plants.

With the several categories of project costs and benefits determined, allocation became a matter of mechanics. For each purpose direct costs were subtracted from total benefits, and joint costs were divided in the proportions of remaining benefits.[12a] Total charges were determined by adding direct costs to allocated common costs. Table 37 recapitulates the Chandler allocation of Wilson Dam as determined in this manner, and Table 38 summarizes Chandler's estimate of the results of this method of allocation for the Wilson-Wheeler-Norris system. It may be interesting at a later point to compare the percent allocations suggested here with those determined by other methods of cost apportionment.

Preliminary Analysis

Without undertaking at this time an evaluation of the benefit method of allocation, we may nevertheless note here several matters bearing upon the particular estimates of benefits presented above for Wilson Dam. First, the suggested benefit value for national defense is evidently an arbitrary figure. It seems extremely doubtful whether any accurate figure could possibly be established for the ". . . . worth of having plant available" in the

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the benefit value of the present plant for stand-by purposes for national defense, including the bridge mentioned above and other benefits, is estimated to be conservatively $5,000,000." (Quoted from Allocation of April 19, 1937.)

[12a] The necessity for adjusting benefits for direct costs is discussed below in chapter X, note 44.

TABLE 37

PROPOSED BENEFIT ALLOCATION OF PRESENT VALUE OF WILSON DAM

(April 19, 1937)

Objective (1)	Total Benefit Value (2)	Direct Cost[a] (3)	Remaining Benefit Value (4)	Allocation of Joint Cost[b] (5)	Total Charge to Objective (6)
	(All figures in thousands of dollars)				
Flood Control	720	......	720	199	199
Navigation	22,207	2,549	19,658	5,433	7,983
Fertilizer	......	......	......	......	......
National Defense	5,000	679	4,321	1,194	1,873
Power	40,000	14,082	25,918	7,163	21,245
Total	67,927	17,310	50,617	13,990	31,300
Joint costs		13,990			
Total "present value," Wilson project		31,300			

[a]Direct costs have been computed upon an incremental basis.
[b]Total joint costs have been apportioned among objectives in the proportions of Column (4).
Source: Table 2 of memorandum and tentative report on allocation dated April 19, 1937. (The columns have been rearranged and certain of the captions altered.)

event of a defense emergency.[13] Question may therefore be raised as to whether it would not be more reasonable to treat the value of plant for national defense as an intangible not susceptible of pecuniary definition.

TABLE 38

TENTATIVE BENEFIT ALLOCATION OF THREE-PLANT SYSTEM
(April 19, 1937)

Project	Flood Control	Navigation	Power	National Defense	Total
	(All charges in thousands of dollars)				
Part 1. Allocations of common costs					
Wilson	199	5,433	7,163	1,194	13,990
Wheeler	2,397	10,747	6,579	.....	19,723
Norris	7,203	4,525	9,029	.....	20,757
Total	9,799	20,705	22,771	1,194	54,470
Percent of total	*18.0*	*38.0*	*41.8*	*2.2*	*100.0*
Part 2. Allocations of total charges					
Wilson	199	7,983	21,245	1,873	31,300
Wheeler	2,941	12,529	15,663	.....	31,133
Norris	9,220	5,121	17,339	.....	31,680
Total project costs, three plants	12,360	25,632	54,247	1,873	94,113
Percent of total costs	*13.2*	*28.0*	*57.7*	*1.1*	*100.0*
Add residual values					5,349
Total cost, three plant system					99,462

Source: Compiled from memorandum on allocation by E. L. Chandler dated April 19, 1937.

Second, the basis of the suggested valuation of flood storage at $15.00 per acre foot is not presented. This unit figure may have been determined by estimated benefits of flood height reductions downstream as a result of Wilson reservoir operation. It may have been fixed by estimated unit costs of storage at flood control-

[13] In 1941, several years after this allocation was prepared a defense emergency had arisen, but the peculiar national defense value of having Wilson Dam power plant available was no more susceptible of precise evaluation than it was when the Chandler study was prepared. It may be added that there is nothing unique in the readiness of public projects to serve the national defense. Under its emergency powers the federal government could take over any privately owned power plant in the country for defense purposes. Yet national defense allocations at private plants are scarcely in order.

only reservoirs in the Tennessee Valley. It may have been a judgment figure which was influenced by information available on both benefits of flood stage reductions and alternate reservoir costs.

Third, the criterion of benefit value for navigation is the alternate cost of single purpose improvement. This standard is defended on the ground that existence of the multiple purpose plant saved the United States from being obliged to pay to some independent developer of the Muscle Shoals site alternate low dam costs under the River and Harbor Act of 1930. Yet, if by the term "benefit" is implied the benefit to the country from opening the headwaters of the Tennessee River to low-cost river transportation,[14] it seems quite possible that navigation benefit might be something either more or less than alternate cost of low dam river improvement. The use of alternate single purpose navigation costs as a measure of benefits is also subject to criticism on the grounds that (1) no low dam scheme can be a close substitute for a high dam plan since the types of river channel which the two would develop would not be similar; and (2) any low dam plan would carry with it the necessity of sacrifice of all other purposes of river control. The latter point suggests that alternate low dam costs should include an adjustment to reflect the value of the foregone opportunity to develop a favorable multiple purpose system along the river.[15]

Fourth, alternate costs of "equally favorable" or "equivalent" power from steam sources have been taken as a measure of the

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[14] This type of definition would seem to be required if navigation is to be treated in a manner consistent with the national defense benefit.

[15] In theory the adjustment should be computed as follows: Capitalize the annual surplus of benefits over costs of the multiple purpose system, development of which is foregone by adoption of the single purpose alternate. Capitalize the annual surplus of benefits over costs of the adopted single purpose system. Capitalize the annual surplus of benefits over costs of the most favorable possible alternate use for the balance of investment saved by adoption of the single purpose plan rather than the multiple purpose improvement. Subtract the latter two factors from the first. The remainder represents the net loss to the community from the foregone opportunity to carry out the multiple purpose plan.

Practically speaking, accurate determination of the estimates required for the above adjustment would almost certainly be impossible. Nonetheless, one of the real costs of an alternate single purpose navigation scheme would certainly be its obstruction of co-ordinate purposes of stream improvement. (This discussion is developed further at the close of Chapter XI below.)

power benefit of the Wilson project. Mr. Chandler later gave these terms content by defining them to require that the alternate steam plant develop primary and secondary power equal to the output of the hydro plant and that it also have equal peak capacity.[16] As Professor Bonbright pointed out, the critical weakness of this interpretation was its implicit assumption that the alternate steam plant would actually have been constructed to meet power needs, had the Wilson plant not been in existence. As a matter of fact, it is very unlikely that a steam plant "equivalent" to the Wilson hydro project would have been constructed since the ratio of Wilson installation to primary power would have been most uneconomical for a steam station. Moreover, a key argument for construction of the hydro plant had been its superior economy to steam power sources. There is a strong likelihood that $40,000,000 overestimated the benefit value of Wilson power in that the market would not have been able to bear such a capitalization of the Wilson power source.[17]

If one accepts Chandler's valuations of flood control and national defense benefits, it is evident that the result of understatement of the navigation benefit and overstatement of the power benefit is understatement of the "proper" navigation allocation and overstatement of the "proper" power charge. The fact that a given error in the estimation of a benefit produces only fractionally as great an error in the final charge to an objective does not serve to return the allocation to a sound basis.[18]

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[16] It was also assumed that the alternate steam plant would be isolated rather than a unit of a steam-hydro system. As additional dams might be brought in, it was planned that alternate steam costs would be computed upon a system basis.

[17] This line of argument was developed by Professor Bonbright in a letter to Mr. Chandler dated April 11, 1937.

[18] Mr. Chandler pointed out that an overestimate of $1,000,000 for the power benefit would result in overstatement of the allocation to that purpose by only $138,000. He added:

> "This indicates that in following this method of allocation, any error which may creep into the assumptions as to total benefit value loses a great deal of its force by the time the figures have been reduced to the actual allocations to objectives."

(Letter, Chandler to Bonbright, dated July 26, 1937.)

THE "JUSTIFIABLE EXPENDITURE" THEORY AS SUBMITTED TO THE FINANCIAL POLICY COMMITTEE ON FEBRUARY 15, 1938

Description

Although the "benefit" method of allocation was first developed at TVA under the direction of Director Arthur E. Morgan, it was one of the three or four major theories to which the Financial Policy Committee gave closest attention when it came to grips with the allocation problem. As a member of this Committee Mr. Chandler submitted a tentative "justifiable expenditure" allocation in February, 1938 which, in effect, was simply a revision of the benefit allocation of the previous April. Its rationale was set forth as follows:

"Costs in themselves, do not afford a suitable basis for allocation. However, it is a fact that Congress has ordered the Authority to develop navigation to certain standards and to develop flood control storage within the Valley. Evidently Congress is satisfied, as a result of investigation extending over long periods of years, that these developments are advisable and that the benefits to be derived from them justify the expenditures necessary to accomplish them. Therefore, the cost of attaining navigation equivalent to that being developed by TVA, by means of the cheapest single-purpose scheme desirable, may surely be considered as a lower limit of measure of benefits to accrue from the navigation development. A complete measure of benefits would fix the maximum amount of justifiable expenditure. Lacking an accurate measure of total benefits, we are at least justified in expending the amount of the lower limit. In the same way the cost of accomplishing flood control by the cheapest development that could be devised within the Valley may be considered as a measure of the flood control benefit to be derived from the Authority's work.[19] This introduces comparison on the basis of cheapest alternate costs for single purpose systems. The computations are not concerned with individual single purpose projects. . . . ."[20]

Alternate single purpose costs of the different objectives were computed as follows:

[19] But it is perhaps important that Congress authorized the multiple purpose program and did not authorize three single purpose plans. Whether it would have authorized the single purpose programs if it had been unable to achieve multiple objectives by a single unified plan is a debatable question.

[20] "Statement Relative to the Justifiable Expenditure Theory of Allocation," submitted for consideration of the Financial Policy Committee, February 15, 1938.

(1) Navigation. An alternate navigation scheme was set up. This was not one of the low dam plans of the United States Engineers nor yet a high dam scheme, but instead included some low dams, some high ones, and some of intermediate height. Allowance was made for savings in operation and maintenance costs by the multiple purpose system. Total alternate costs were broken down among the multiple use projects to establish individual benefits.

(2) Flood Control. Flood storage of the multiple purpose system was evaluated at $20.00 per acre foot. This figure was based upon TVA experience and was checked by estimates of the United States Engineers.[21] It was thought reasonable for use at all projects of the multiple purpose system although storage at particular plants of an alternate system probably would have varied from considerably less to considerably more than the overall figure.

(3) Power. Justifiable expenditure for power was established by reference to cost of a hypothetical alternate hydro system. Average alternate cost per kilowatt of installed capacity was employed to break down total alternate power cost among plants of the multiple purpose system.[22]

(4) National Defense. On a quite arbitrary basis certain charges to national defense were established. These were justified on the ground that lands, bridges, construction camps, and highways might have significant value in the event of a war emergency.

With justifiable expenditure determined, the mechanics of allocation were carried through in the manner of the April, 1937 report. For the Norris, Wheeler and Wilson projects the resulting charges are shown in Table 39. They are summarized in Table 40.

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[21] See below, Chapter XI.

[22] As in the case of the alternate flood control estimate above, it was believed that there might be some inconsistencies in the break-down of alternate power cost among projects. The adopted method was defended on the ground that:

> "Plant output is related to installed capacity. The size of installation is fixed for a system which may be under consideration, and it is a simple, definite. and easily understandable basis on which to work."

(*Ibid.*)

TABLE 39

TENTATIVE ALLOCATION OF COST OF NORRIS, WHEELER, AND WILSON PROJECTS BY JUSTIFIABLE EXPENDITURE METHOD
(February 15, 1938)

Project and Objective	Justifiable Expenditure	Direct Cost	Remaining Justifiable Expenditure	Allocation of Common Costs[a]	Total Charge to Objective
	(All figures in thousands of dollars)				
Norris Project (2 units)					
Flood Control	40,272	3,930	36,342	12,263	16,193
Navigation	10,000	......	10,000	3,375	3,375
Power	18,000	8,168	9,831	3,317	11,485
	68,272	12,098	56,173	18,955	
National Defense					1,000
Non-project cost					4,309
Total					36,362
Wheeler Project (5 units)					
Flood Control	7,000	509	6,491	3,143	3,652
Navigation	21,026	1,912	19,114	9,257	11,169
Power	30,057	15,005	15,052	7,290	22,295
	58,083	17,426	40,657	19,690	
National Defense					1,000
Non-project cost					855
Total					38,971
Wilson Project (13 units)					
Flood Control	800	100	700	163	263
Navigation	19,468	2,549	16,919	3,939	6,488
Power	58,467	18,481	39,986	9,308	27,789
	78,735	21,130	57,605	13,410	
National Defense					2,000
Total					36,540

[a] Common costs for each project are divided among purposes according to the proportions of remaining justifiable expenditure.
Source: "Statement Relative to Justifiable Expenditure Theory of Allocation," submitted to Financial Policy Committee, February 15, 1938.

TABLE 40

SUMMARY OF TENTATIVE ALLOCATION OF THREE-DAM SYSTEM BY JUSTIFIABLE EXPENDITURE METHOD (February 15, 1938)

Project	Flood Control	Navi-gation	Power	National Defense	Total
	(All charges in thousands of dollars)				
Part 1. Allocations of common costs					
Wilson	163	3,939	9,308	2,000	15,410
Wheeler	3,143	9,257	7,290	1,000	20,690
Norris	12,263	3,375	3,317	1,000	19,955
Total	15,569	16,571	19,915	4,000	56,055
Percent of total	*27.8*	*29.6*	*35.5*	*7.1*	*100.0*
Part 2. Allocations of tota charges					
Wilson	263	6,488	27,789	2,000	36,540
Wheeler	3,652	11,169	22,295	1,000	38,116
Norris	16,193	3,375	11,485	1,000	32,053
Total project costs	20,108	21,032	61,569	4,000	106,709
Percent of total costs	*18.8*	*19.7*	*57.7*	*3.8*	*100.0*
Add non-project costs					5,164
Total cost, three-plant system					111,873

Source: Compiled from "Statement Relative to Justifiable Expenditure Theory of Allocation," February 15, 1938.

PRELIMINARY ANALYSIS

Many of the weaknesses of the benefit allocation of 1937 recur in the one presently under review. Charges to national defense again are arbitrary. The alternate low dam method of estimating navigation benefits takes no account of the necessity of foregoing comprehensive stream improvement when low dams are constructed. No demonstration has been made of the marketability of power produced at the costs estimated for the alternate hydro system.[23]

Despite important lines of similarity between the 1937 benefit allocation and the 1938 "justifiable expenditure" apportionment, the later study introduced one important adjustment in method: both individual multiple purpose dams and alternate projects

[23] But the basis of the evaluation of flood control benefits is stated much more precisely than in the 1937 memorandum.

were treated as units of systems rather than as isolated plants. This change in perspective gave rise to two technical problems. What particular multiple purpose system should be allocated? And how should allocations to individual plants be determined? The latter of these difficulties is examined in Charper XI below. For purposes of the present discussion we shall make the favorable assumption that a satisfactory method of breaking down system allocations among plants is available. What of the former problem?

In a growing system each multiple purpose plant but the last one constructed is a unit of more than one system, and relative benefits [24] of purposes tend to vary considerably as smaller systems give way to larger. Suballocations of initial projects based on relative benefits of two- or three-dam systems, therefore, would not be the same as suballocations of the same projects considered as units of larger systems. This problem can be treated in either of two ways. Allocations can be determined successively for each stage of the growing system, and the total change in charges with the addition of a new plant can be debited entirely to the added project. Or an initial allocation of total estimated cost of an "ultimate" system can be determined, project suballocations may be fixed, and allocations of intermediate systems may be found by summing appropriate suballocations.[25]

In the February, 1938 allocation the method of summing suballocations appropriate to an ultimate system was adopted. Unfortunately, it was apparent that even if the method of breaking down allocations of the ultimate system among projects were sound, these project charges could have no *a priori* validity as correct suballocations of *initial* systems. To meet this difficulty in the case of suggested power allocations, Chandler indicated three possible adjustments of anticipated ultimate charges:

(1) A proportionate share of ultimate power allocation determined by the ratio of present direct power investment to ultimate direct power investment might be placed temporarily in a "sus-

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[24] These benefits in the present case are taken as alternate costs.

[25] Under this method it would seem that intermediate allocations could be only *pro forma* until the ultimate system was complete and cost estimates could be supplanted by actual investment figures.

pense" account. As additional units might be installed, suspended investment could be credited and active investment debited.

(2) All common investment chargeable to power might be immediately assessed, but incremental power investment initially incurred because of provision for future units (e.g., costs of empty bays) might be held in suspense pending installations.

(3) All common costs and costs of provision for future units might be immediately assessed, but estimated costs of future units and their installation might be held in suspense.

Application of these several adjustments of the power allocation determined by the 1938 study for the Norris, Wheeler, and Wilson projects is shown below in Table 41. This table also shows the allocation of April, 1937 for comparative purposes. Table 42 compares the percent allocations determined by the 1937 and 1938 reports. It is interesting to observe that the total allocations to power in percent terms are the same in each study. Examination of the details of the allocations reveals that this is quite coincidental. A reduction in the percent allocation of common cost to power in the later study is just offset by an increase in direct power investment.[26] If attention is directed to Part I of Table 42 it will be clear that there are substantial differences between the results of the two studies. The extent of this difference gives some hint of the possible range of "reasonable" benefit allocations with different assumptions and different criteria of benefits.

CONCLUSION

In the present chapter we have reviewed two proposed applications of benefit theory for apportionment of TVA joint costs. Each of these studies employed alternate costs as the fundamental criteria of benefits, but despite this similarity in basic method there were substantial differences in indicated results. Both of the studies were deficient in that they failed to investigate the justifiability of the estimated alternate expenditures. The question arises as to whether some other criterion of benefits than unadjusted alternate cost might not provide a more satisfactory

[26] A substantial increase in direct power investment at the Wilson and Wheeler projects in the 1938 allocation results from the fact that this study is based upon "ultimate" installations, i.e., installations appropriate to the ten-plant system.

TABLE 41

SUMMARY COMPARISON OF POWER ALLOCATIONS PROPOSED FOR NORRIS, WHEELER AND WILSON PROJECTS
(Allocations of April, 1937, and February, 1938)

	Allocation of Common Cost			Allocation of Total Cost		
	Active	Suspense	Total	Active	Suspense	Total
	(All charges in thousands of dollars)					
Allocation of April, 1937	24,358	......	24,358	54,247	......	54,247
Allocation of February, 1938[a]						
Basis (1)	13,325	6,590	19,915	34,824	26,745	61,569
Basis (2)	19,915	......	19,915	41,404	20,165	61,569
Basis (3)	19,915	......	19,915	50,408	11,161	61,569

[a]For definition of bases of adjustment of total charges to suspense accounts, see text above, pp. 265-266.

Source: Computed from "Tentative Allocation of the Value of Wilson Dam," April 19, 1937 ,and "Statement Relative to Justifiable Expenditure Theory," February 15, 1938.

TABLE 42

SUMMARY COMPARISON OF PROPOSED PERCENTAGE ALLOCATIONS OF WILSON, WHEELER, AND NORRIS DAMS BY BENEFIT METHOD

(Allocations of April, 1937, and February, 1938)

	Navigation	Flood Control	National Defense	Power			Totals[a]
				Active	Suspense	Total	
Part 1. Allocations of Common Cost							
Allocation of April, 1937	38.0	18.0	2.2	41.8	....	41.8	100.0
Allocation of February, 1938[b]							
Basis (1)	27.8	29.6	7.1	23.8	11.7	35.5	100.0
Basis (2)	27.8	29.6	7.1	35.5	....	35.5	100.0
Basis (3)	27.8	29.6	7.1	35.5	....	35.5	100.0
Part 2. Allocations of Total Cost							
Allocation of April, 1937	28.0	13.2	1.1	57.7	....	57.7	100.0
Allocation of February, 1938[b]							
Basis (1)	19.7	18.8	3.8	32.6	25.1	57.7	100.0
Basis (2)	19.7	18.8	3.8	38.8	18.9	57.7	100.0
Basis (3)	19.7	18.8	3.8	47.2	10.5	57.7	100.0

[a]For the allocation of April, 1937, total common cost was $54,470,000 and total cost was $94,113,000. For the allocation of February, 1938, total common cost was $56,055,000 and total cost was $106,709,000.

[b]For definition of bases of adjustment of power allocations to suspense account, see text above, pp. 265-266.

Source: Compiled from Tables 38, 40, and 41.

basis for allocations. In Chapter X here following we investigate the case for the benefit principle when benefits are interpreted as the value to final beneficiaries over the entire nation of the several system utilities. In Chapter XI we consider a modified version of the method of the present chapter in which the concept of justifiable expenditure is introduced to guard against overstatement of "avoided" costs.

A NOTE ON THE ALTERNATE COST AVOIDANCE THEORY OF ALLOCATION

The discussion of the chapter above has been concerned with certain initial attempts to apportion TVA joint costs on the basis of relative benefits of the several system objectives. We have observed that these allocations were, in effect, apportionments on the basis of simple alternate costs. Originally put forward as quite different from benefit theory but in fact almost indistinguishable from the versions of this theory discussed above was the so-called "alternative cost avoided" method of allocation. The present "Note" is designed to indicate the reasoning which supported this method and suggest the results to which it might have led. Since Professor Glaeser was its closest student at TVA, the following discussion is based largely upon two memoranda of which he was the author.[1]

The alternative cost avoidance theory stresses the economy of joint costs. Its basic tenet is that each objective should carry a share of these costs proportionate to its saving from the common undertaking. If a joint expenditure of $30,000,000 enables three objectives to avoid alternate expenditures of $10,000,000, $20,000,-

[1] "Memorandum on Allocation of TVA Properties," and "Memorandum on Alternative Cost Avoided Principle of Allocation" submitted to Financial Policy Committee on February 25-26, 1938 (Exhibit 2/26/38a).

The 1931 *Report* of the Saint Lawrence Power Development Commission investigated the possibility of allocation of the cost of a power-navigation improvement of the International Rapids section of the Saint Lawrence River according to alternate single purpose costs. Estimates for single purpose development were as follows:

Power	$153,000,000	(56%)
Navigation	120,000,000	(44%)
	$273,000,000	(100%)

The resultant division of estimated cost of the dual purpose improvement was as follows:

Power	$114,000,000
Navigation	89,000,000
	$203,000,000

It should be noted that no provision was made for segregation of direct and joint costs at the multiple purpose development. (State of New York, *Report of Saint Lawrence Power Development Commission*, submitted January 15, 1931, p. 23.)

TABLE 43

WORKING SEGREGATION OF PROJECT COSTS—THREE-DAM SYSTEM
(August 26, 1938)

Type of Cost and Objective	Project: Norris		Project: Wheeler		Project: Wilson		Total	
	(All costs in thousands of dollars)							
Incremental costs								
Flood Control	3,930		509		100		4,539	
Navigation	.....		1,912		2,549		4,461	
Power	8,168		12,884		17,433		38,485	
Subtotal		12,098		15,305		20,082		47,485
Multiple-use costs		19,955		20,690		14,731		55,376
Subtotal		32,053		35,995		34,813		102,861
Non-project costs		4,309		855		679		5,843
GRAND TOTAL		36,362		36,850		35,492		108,704

Source: Tennessee Valley Authority, Financial Policy Committee, Exhibit 8/26/38a.

000, and $30,000,000 respectively, then the joint investment should be apportioned in shares of $5,000,000, $10,000,000, and 15,000,000.[2] The criteria of alternate expenditure are estimated costs for single purpose projects which might otherwise have been constructed to produce benefits equivalent to those of the multiple purpose plant.

In applying the cost avoidance principle to the TVA system, Professor Glaeser first segregated incremental and common investment at each project. He then prepared estimates for alternate single purpose navigation, flood control, and power systems which would produce benefits equivalent to those of the projected TVA ten-dam system. For navigation the main river alternate scheme included dams of varying heights, high, low, and medium. For tributary plants alternate navigation value was arbitrarily set at $10,000,000 for the Norris project and $2,000,000 for Hiwassee. The single purpose flood control scheme consisted

TABLE 44

SUMMARY OF ALTERNATE SINGLE PURPOSE COSTS—THREE-DAM SYSTEM

(August 26, 1938)

Project	Flood Control	Navigation	Power	Total
	(All costs in thousands of dollars)			
Norris	23,885	10,000	.....	.....
Wheeler	6,720	19,027	.....	.....
Wilson	825	17,536	.....	.....
Total Alternate Costs, Three-Dam System	31,430	46,563	85,500	163,493

Source: Same as Table 43.

of two tributary developments and three storage projects upon the main river. For power an alternate eight-dam (hydro-only) system was set up. Alternate power and flood control costs of systems short of the ten-dam development were determined by

[2] In Professor Glaeser's words:
"The motivation for joint action lies in the savings to be achieved, and the participation in joint costs is proportional to the costs avoided by each of the participants."

unit costs of the larger alternate systems. Alternate navigation costs of smaller systems were determined by a break-down of total alternate navigation costs among pools of the multiple purpose system. An application of this method of allocation to the Norris-Wheeler-Wilson system is indicated in Tables 43, 44, and 45.

TABLE 45
ALLOCATION OF THREE-DAM SYSTEM ON ALTERNATIVE COST AVOIDANCE BASIS
(August 26, 1938)

	Flood Control	Navigation	Power	Total
	(All costs in thousands of dollars)			
1. Cost of alternate single purpose system	31,430	46,563	85,500	163,493
2. Incremental cost at multiple purpose system	4,539	4,461	38,485	47,485
3. Net alternate cost avoided by joint undertaking	26,891	42,102	47,105	116,008
4. Common costs incurred at multiple purpose system	......	......	......	55,376
5. Distribution of savings from joint undertaking[a]	14,080	22,000	24,552	60,631
6. Allocation of common investment[b]	12,811	20,102	22,463	55,376
6a. Percent allocation of common investment	*23.2*	*36.3*	*40.5*	*100.0*
7. Total allocation of three-dam system	17,350	24,563	60,948	102,861
7a. Percent allocation of total investment, three-dam system	*16.9*	*23.9*	*59.2*	*100.0*

[a]Total savings from joint undertaking are distributed among objectives in the proportions of Row 3.
[b]The proportions of common investment chargeable to objectives are the same as those existing in Row 3. The logic here followed, however, determines Row 6 as Row 3—Row 5.
Source: Same as Table 43.

The allocation of Table 45 is upon a system basis. Since estimates for alternative costs avoided for the navigation and flood control purposes are available for each project, a basis is available for breaking down system allocations to particular plants. This may be accomplished by separately apportioning total navigation and flood control common cost allocations among plants according to avoided costs. These suballocations may then be subtracted from joint costs at each project to determine suballocations to the remaining objective, power. Table 46 below illustrates the procedure for breaking down navigation and power common cost allocations. Summing these suballocations by projects and subtracting them from total project costs, remaining costs chargeable to power are determined as follows:

Norris	$13,848,000
Wheeler	22,448,000
Wilson	24,652,000
Total	$60,948,000

These charges are based upon assumed full power development. At the main river plants they include incremental costs for additional units which are not included in initial installations. As

TABLE 46
BREAK-DOWN OF THREE-DAM ALLOCATION BY PLANTS—CHARGES TO NAVIGATION AND FLOOD CONTROL
(August 26, 1938)

	Norris	Wheeler	Wilson	Total
	(All costs in thousands of dollars)			
Flood Control				
1. Alternate single purpose cost[a]	23,885	6,720	825	31,430
2. Incremental cost at multiple purpose plant[b]	3,930	509	100	4,539
3. Alternate cost avoided[c]	19,955	6,211	725	26,891
4. Suballocation of saving from joint undertaking[d]	10,450	3,250	380	14,080
5. Total charge at project[e]	13,435	3,470	445	17,350
Navigation				
1. Alternate single purpose cost[a]	10,000	19,027	17,536	46,563
2. Incremental cost at multiple purpose plant[b]	......	1,912	2,549	4,461
3. Alternate cost avoided[c]	10,000	17,115	14,987	42,102
4. Suballocation of saving from joint undertaking[d]	5,230	8,950	7,820	22,000
5. Total charge at project[e]	4,770	10,077	9,716	24,563

[a]From Table 44.
[b]From Table 43.
[c]Line 3 = Line 1 — Line 2.
[d]Total for this line from Table 45, Line 5. It is distributed among purposes in the proportions of Line 3.
[e]Line 5 = Line 1 — Line 4.
Source: Compiled from Tennessee Valley Authority, Financial Policy Committee, Exhibit 8/26/38a.

Mr. Chandler had done in his justifiable expenditure allocation, Professor Glaeser showed the effects of three possible adjustments of ultimate allocations for conditions of initial operation. These adjustments were the subtraction of incremental costs not incurred initially ($7,992,000); the subtraction of costs of provision for future units ($7,454,000); and the subtraction of a share of the common cost allocation to power determined by the proportion of initial to planned ultimate generating installation. Applying the first two adjustments to the suballocations to power indicated above, present power charges would become:

Norris	$13,848,000
Wheeler	16,380,000
Wilson	16,274,000
Total	$46,502,000

If all three adjustments were applied, an additional $7,313,000 would be scaled from initial power charges leaving a total net present allocation to power of $39,189,000.

What may be said in appraisal of the alternative cost avoidance principle of allocation? Like other versions of cost theory which we have discussed, it makes the vital assumption that if the multiple purpose program had not been undertaken alternative single purpose programs would have been adopted. For only if "alternate costs" would have been incurred in the absence of the joint program is it correct to speak of the multiple purpose system as having led to their avoidance. This point is supported by the treatment which the study gives to the Norris and Hiwassee projects. Single purpose navigation valuations of these structures have not been fixed upon a cost basis. No alternative to the Norris plant in the Tennessee Valley could possibly be constructed to provide equivalent low water regulation for a cost of $10,000,000. In fact, there has been used here simply a tentative estimate of the *value* of the Norris reservoir for navigation.[3]

As Professor Glaeser points out, the ". . . . motivation for joint action lies in the savings to be achieved." Only if the alternate systems could have been constructed economically, may one regard the difference between the sum of their costs and the sum of incremental costs at the joint system as a measure of the expenditure which the incurrence of joint costs avoids. Once again, we find that strict alternate cost theory must be modified to stipulate justifiability of alternate estimates.

[3] The same is true of the $2,000,000 "alternate cost" of Hiwassee for navigation.

Chapter X

THE RELATIVE NATIONAL BENEFIT THEORY

Summary. Just as equal apportionment proved unsatisfactory because it divided joint costs arbitrarily without consideration of the ability of different purposes to bear the charges assessed against them, so early proposed applications of the benefit method at TVA were weak in that they apportioned charges according to hypothetical alternate costs without adequate consideration of the economic justifiability of these alternates. Clearly, unjustified alternate costs can have no benefit significance.

The question arises as to whether particular items in the stream of national benefits flowing from each system objective may be evaluated and joint costs divided in proportion to the totals for each purpose. At TVA the three dominant stream control objectives are navigation, flood control, and power. Navigation benefits will be gained in part upon the Tennessee River and in part on the lower Mississippi. On the Tennessee they will depend upon the growth of river shipping and the savings per unit of goods transported. On the Mississippi they will depend upon savings which may be gained from reduced dredging costs because of the regulatory effects of Tennessee River releases during low water periods and upon more economical transportation which may be possible in dry periods because of greater controlling depths. Almost insuperable difficulties stand in the way of any precise evaluation of these benefits. Flood control benefits also may be considered in two classes: averted annual damages, and improved property values as a result of security from inundation. Evaluation of the first of these depends, among other things, upon accurate prediction of future flood flows; evaluation of the second depends upon predictions of human reactions to the developing fact of flood protection. While outside limits might be established for these uncertain factors, their reliable evaluation for purposes of allocation does not appear feasible. Since navigation and flood control benefits are not susceptible of reliable evaluation, it follows that no accurate allocation can be based upon relative values of water control benefits. An attempt to appraise power benefits is unnecessary.

Even if allocation according to the relative national benefits of the TVA program were practically feasible, an apportionment on this basis would be unsatisfactory theoretically.

Although allocation in the proportion of relative national benefits

of the TVA dams is not feasible, a benefit allocation in another sense may be possible. This would regard the value of the benefit for any purpose as limited by the alternate cost of its achievement if the TVA projects were not in existence. But no alternate cost would be treated as an exact evaluation unless it appeared justified by the prospective stream of purpose benefits. Unjustified alternate costs would be scaled down to justifiable levels. This alternative justifiable expenditure version of benefit theory is the principle of allocation to which the TVA Financial Policy Committee finally came.

THE RELATIVE BENEFIT THEORY AND THE PROBLEM OF DEFINING BENEFITS

The kernel of the argument for the relative benefit method of allocation may be simply stated as follows. When a number of objectives are jointly served by a given multiple purpose structure, it is only fair and reasonable that each bear a part of costs proportionate to its share in project benefits. Whether this attractive proposition is sound is a matter which we may defer for later examination. First, let us assume that it is and consider how the proportions of benefits may be computed.

The question may fairly be raised, Why not interpret benefits in some broader sense than simply as alternate costs in the manner of Chapter IX above?[1] What other definitions are available? Physically, flood control benefits are in terms of feet of crest scaled from high flows; navigation benefits are in terms of length, depth, and strategic location of improved river channel; and power benefits are in terms of kilowatts of primary and high grade secondary power. These quantities are obviously diverse, and they can scarcely be summed for the purpose of determining relative benefits. Socially, flood control benefits are reaped in terms of physical safety for valley residents, peace of mind, and avoided community disorganization; navigation benefits are in terms of improved health and public morale resulting from lower transportation costs, quickening economic activity, and advancing standards of living; power benefits are in terms of light in dark

[1] In order that alternate costs may have significance as benefit criteria alternate systems must be both economically feasible and susceptible of simultaneous development.

houses, pumps on farms, electrical refrigerators, and again advancing economic activity with cheap industrial power. These categories also are diverse. Perhaps if they could be reduced to a common denominator their proportions might provide a satisfactory basis for TVA joint cost apportionment; for in a fundamental sense it is certainly true that the Authority is engaged in a *social* rather than a narrowly economic program.[2] But no common denominator for social benefits suggests itself. Still another point of view is available for analysis of TVA benefits. Economically, the benefits of flood control are reaped in terms of reduced average annual damages to property within range of the "maximum" flood and improved earning power for such property; navigation benefits are in terms of reduced costs of transportation and the possibility of exploiting hitherto uneconomical resources; and power benefits are in terms of the "fair value" of energy produced by the comprehensive water control system. Superficially, at least, it appears that each of these benefits may be expressed in pecuniary terms and that the ratio of each to the total of all may be determined. If this proves to be the case, then allocations may be carried through according to these relative benefits.

Economic benefits of the TVA program may be appraised from either of two points of view. First, they may be considered as the value to the country as a whole of having navigation, flood control, and power supplied along the Tennessee River;[3] or second, they may be regarded as the value of having available the particular projects provided by TVA to supply these services rather than having the river undeveloped. The latter values, disregarding the time factor, obviously are limited by the alternative costs of gaining equivalent benefits. In the present chapter let us consider the possibility of allocation according to the former, more general, conception of economic benefits.[4]

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[2] This is simply to say that the success of the Authority in achieving its comprehensive objectives may not be appraised entirely in terms of costs and revenues (or tangible benefits).

[3] We here ignore secondary purposes of the Authority such as recreation, wild life conservation, and pollution abatement.

[4] Chapter XI deals with allocation according to relative benefits defined as alternative justifiable costs.

THE EVALUATION OF TVA BENEFITS

(1) Benefits from Flood Control

Flood control benefits of the TVA program fall naturally into two classifications: benefits within the Tennessee Valley and benefits along the lower Ohio and Mississippi Rivers. Since the latter considerably exceed the former, we may discuss them first.

A basic source for any discussion of the value of flood protection to the lower Mississippi River valley is a TVA report entitled, "Value of Flood Height Reduction from Tennessee Valley Authority Reservoirs to the Alluvial Valley of the Lower Mississippi River." We shall refer to this document as the "Okey Report," after its author.[5] Since it deals with most of the problems to be encountered in evaluating flood control, our most convenient procedure will be to review its methods and findings.

It will be recalled from Chapter I that after the great flood of 1927 Congress adopted the Mississippi River Act of 1928 in which the traditional levees-only policy of flood protection was abandoned in favor of a comprehensive levee, floodway, and outlet plan. Although work upon this adopted program went steadily forward and although several extensions of its original provisions were made in subsequent years, high water of 1937 revealed that completion of the modified adopted project would not afford reliable protection against a conservatively estimated superflood.[6]

[5] The report was the work of Charles W. Okey, Principal Civil Engineer. It was transmitted by TVA to the President who in turn forwarded it to Congress. It was printed as House Document 455, Seventy-Sixth Congress, First Session.

[6] This was true for a number of reasons. First, adopted freeboard was only one foot for a flood twenty-five percent greater than the maximum of record. It was considered that three feet would be a minimum safe freeboard. Second, although 1937 flow was 400,000 c. f. s. less than estimated crest below Cairo for the project flood, 1937 stages between Cairo and Hickman rose above estimated crest of the project flood. This indicated that the combined capacity of the Birds Point-New Madrid floodway and the main river channel was not as great as anticipated. Okey estimated that the Cairo gage could be expected to reach sixty-three feet rather than the original estimate of fifty-nine feet in the event of the project flood, 2,400,000 c. f. s. Third, the 1937 flood approached record flow and reached record gage heights below Cairo with almost no contribution from the upper Mississippi River. With a moderate contribution from this watershed a project flood of 2,600,000 c. f. s. (rather than 2,400,000 c. f. s. estimated in House Document 259, Seventy-Fourth Congress, First Session) and a gage of sixty-five feet might be expected. To carry such a flood with a three-foot freeboard, levees would have to be raised from six to eight feet in the Cairo to New Madrid stretch of the river and from three to five feet below New Madrid to the

Nor did it appear that levees could be economically constructed to provide such protection, for as Professor Woodward explained:

"It is commonly stated that the levee system should be perhaps two feet higher to have a safe freeboard in the biggest floods. The additional height needed varies considerably in different parts of the system and authorities do not agree as to the exact needs. The physical difficulties of making the levees higher are very great. In many places the soil can scarcely support the weight of the existing levees. During flood stages the water level in the river is from fifteen to twenty or more feet above the surface of the adjacent land, and at many points water seeps through the ground under the levees and appears in such quantities as to cover adjacent fields. The saturated levees sometimes slump and fail without being overtopped. It is often stated that it is impracticable to raise the levees further. At Cairo, for instance, there is already considerable danger from seepage and sand boils back of the levees, under the pressure of high floods. When needed for the protection of cities or other vital points, by sufficient expenditure it is of course possible to make levees thick enough and with flat enough side slopes to carry some increased height, but to increase materially the height of the levee system as a whole would require an extravagant expenditure." [7]

Thus, it did not appear that the benefit which would result from scaling two feet from the crest of the maximum flood could properly be evaluated by reference to the alternate cost of increasing levee heights two feet.[8] Instead it was thought that benefits should be studied in terms of the pecuniary significance of improved protection to valley residents and their properties. The procedure by which estimates for these benefits were determined was as follows:

A. Lump-sum benefits.

1. Increased land values as a result of added security.

Surveys were made of farm land values within the alluvial valley. It was found that lands with a long record of full protection from floods had highest values, that lands with shorter records of protec-

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mouth of the White River. (Source: House Document 455, Seventy-Sixth Congress, First Session, p. 11.)

[7] *Ibid.*, from "Introduction" by Sherman M. Woodward, p. xii.

[8] Two feet was selected as the amount of reduction to be studied since it represented the difference between revised recommended and adopted freeboard. *Ibid.*, 15-16.

tion had intermediate values and that lands with little or no protection had lowest values. On the average, well-protected lands seemed to be valued about $20.00 per acre more than partially protected lands and about $45.00 per acre more than unprotected lands. Landholders believed that even protected lands would appreciate in value if there were a complete guarantee against overflow under any contingency. Okey concluded:

"The modified adopted project was planned to give protection against a flood about 25 percent greater than that of 1927 to 12,000,000 acres of land, with a levee freeboard of only one foot. If flood heights are lowered two feet, it is conservatively estimated that the resulting increase in value, judged by census values of 1930, for farm lands in the alluvial valley would be at least $25 per acre, or $300,000,000 for the 12,000,000 acres involved. Further reduction in flood heights would bring additional value to these lands. Benefits of flood height reduction to the remaining 8,000,000 acres of land in the alluvial valley will be considered separately." [9]

2. Savings in costs of local protection works to cities.

Benefits to cities of a two-foot flood height reduction were estimated according to avoided costs of alternative levee protection. At Cairo complete protection against a maximum flood would require an increase of at least six feet in height of concrete river wall and earth ring levee. In addition, filling of low places would be necessary within the city to reduce seepage, facilitate flood drainage, and alleviate the dangers of sand boils. Estimated costs of such a program were $3,000,000. "A reduction in flood heights of 2 feet is estimated to confer a proportional benefit which amounts to $1,000,000." [10]

At Memphis protection against the project flood with adequate freeboard was estimated to require a seven-foot increase of the main river levee and new works to protect low industrial areas north and south of the city. The reduction in necessary cost of such work because of a two-foot reduction in flood height was estimated at $2,000,000. At Helena the value of reduction of probable frequency of inundation of low parts of the city by backwater from once in ten to once in twenty years (together with the value of reduced annual costs of storm and sewage pumping) was set at $200,000. At Greenville (Mississippi) it was thought the contemplated reduction in maximum flood height would render the modified adopted project safe. The value of this benefit was set at $500,000, an amount slightly in excess of the costs of an avoided ring levee (because the latter type of structure would involve many undesirable

[9] *Ibid.*, p. 17.

[10] *Ibid.*, p. 20.

features). For other valley towns it was considered that alternate ring levees costing $100,000 each (a total of $3,000,000) were avoided.[11]

3. Savings in costs of raising railroads above floods.[12]

Under the modified adopted project several stretches of railroad would remain in danger of inundation in event of a maximum flood. Measuring the value of a two-foot reduction in the flow line of the project flood by the reduced costs of raising tracks to maximum water elevation, total benefits to railroads were estimated at $10,550,000.

4. Savings in costs of raising highways above floods.

A large number of miles of important connecting highways would be unprotected by the modified adopted project.

"It would require approximately 25,000,000 cubic yards of embankment to raise [these] highways . . . . up to the flow line of the 1927 flood if it were confined by modified adopted project levees. If this flood were lowered 2 feet, it would require about 6,000,000 yards less of embankment, a saving of about $1,500,000."[13]

B. Benefits from reduction in annual damages.

1. Reduction in frequency of overflow in lands in floodways.[14]

Average annual damages from overflow were studied independently for each floodway. Consideration was given to the usual quality, yield, and price of crops, the proportional distribution of crops over agricultural lands, the probable date of recession of flood waters, and the possibility of planting late crops after floods. For six "present" floods equal in height and occurring at the same dates in the year as the last six floods which would have required use of the Birds Point-New Madrid spillway, total crop damages per acre were found to be $146.60, or an average loss per acre per flood of $24.40. Assuming that a two-foot reduction of flood heights would decrease the frequency of use of the floodway from once in ten to once in twenty years, average annual crop damages from flooding would be reduced from $2.44 to $1.22. Applied to 65,400 acres in the floodway and capitalized at six percent, the value of this annual saving would be $1,330,000.

In addition to crop loss, emergency use of floodways involves damages to farm buildings and personal property. On the basis of surveys during the 1937 flood, farm property damage from use of the Birds Point floodway was placed at $1,392,650. Assuming flooding every ten years, average annual loss would be $139,265. A

[11] *Ibid.*, 20-21.

[12] *Ibid.*, 21-26.

[13] *Ibid.*, p. 27.

[14] *Ibid.*, 28-33.

two-foot flood height reduction, halving the frequency of use of the spillway, would imply an annual saving of $69,630. Capitalized at six percent, this saving would be worth $1,160,000. Finally, reduced use of the floodway would result in annual savings on replacing the fuse plug levee section. Estimated at $20,000 annually and capitalized at four percent, this saving would be worth $500,000. Total benefits to the Birds Point-New Madrid floodway from a two-foot flood height reduction were thus placed at approximately $2,990,000.

For the Eudora and Atchafalaya spillways benefits of a two-foot flood height reduction, computed in a similar manner, were estimated to be $4,823,000 and $3,491,000 respectively.

2. Benefits to unprotected lands.[15]

In western Kentucky and Tennessee, and in southwestern Mississippi and eastern Louisiana there are unprotected areas of land which are subject to overflow in times of moderate flood. Reservoir storage sufficient to scale two feet from the project flood would also reduce the frequency of inundation of these lands. For the two regions similar methods were employed to evaluate this benefit. We consider first the western Kentucky and Tennessee area.

As had been done in the case of floodway lands, investigation was first made of the proportion of overflow land area in cultivation, the types and yields of crops, values of crops, and dates of planting and lengths of growing season. For floods occurring at different dates throughout the spring and early summer a schedule of typical figures for crop loss per acre flooded was determined. This schedule was applied to areas actually covered and dates of past floods for the period from 1901 to 1933 in order to determine losses which would presently be incurred from floods similar to those of the past. The result of this computation was an indicated average crop loss per acre per year of $14.40 for land actually overflowed. Areas inundated by past floods as compared with areas which would have been inundated had flood heights been reduced two feet were then determined. Average crop loss per acre per year was applied to the differential area to determine the average annual reduction in losses which would be effected by a two-foot reduction of flood heights. Computing savings for cultivated lands only (13,095 acres), the capitalized value of reduced loses was found to be $3,143,000.

It remained to ascertain benefits to farm buildings and personal property. Study had already been made of average annual damage to farm improvements by floods of varying heights on the Cairo gage.[16] These figures were compared with figures for annual

[15] *Ibid.*, 33-41.

[16] House Document 188, Seventy-Second Congress, First Session.

damages determined by adjustment of gage frequencies for a two-foot flood height reduction. The difference, or $17,850, was taken as the annual benefit of a two-foot reduction in flood heights to farm improvements. On the basis of Bureau of the Census and Department of Agriculture studies, it was then found that damages to farm supplies and equipment might reasonably be expected to be about twice as great as damages to "farm improvements." Total annual damages to buildings and personal property which could be avoided by a two-foot flood height reduction were therefore set at $53,550. Capitalized at six percent, these savings were equivalent to a capital value of $892,000.

Benefits of two-foot flood height reductions to unprotected lands in Mississippi and Louisiana were estimated in the same manner as indicated above. They were found to have a present capital value of $2,147,000.

3. Reduction in area of lands covered by backwater.[17]

The benefits of flood height reduction to lands covered by backwater in times of moderate and extreme flood were determined in a manner very similar to that in which benefits to unprotected lands were estimated. We shall not recapitulate these computations, but their results were as follows:

Saint Francis River area	$ 6,390,000
White-Arkansas River area	6,475,000
Yazoo River area	10,711,000
Red River area	8,664,000
Total	$32,240,000

4. Reduction in expense of maintaining levees during high water periods.[18]

During any great flood extraordinary expenditures must be incurred in the emergency battle to hold the levee line. For days and sometimes weeks every foot of levee must be patrolled. Much of it must be sandbagged and protected from washing by waves. At low spots emergency bulkheads must be raised and maintained. The cost of a high-water fight is considerable and it increases with increases in flood crest.

The value of the benefit of reduced annual high water costs as a result of a two-foot reduction in all floods was determined by application of a table of frequencies of past flood stages to an indicated empirical relation between high water costs and flood crests. Average annual expense was determined to be $583,000. This was compared with indicated average annual expense on the assumption of a two-

[17] House Document 455, Seventy-Sixth Congress, First Session, pp. 41-56.

[18] *Ibid.*, 56-58.

foot reduction in all stages, and the difference ($211,550) was capitalized at four percent. Indicated present value of high water costs which would be avoided by scaling all floods down two feet was $5,290,000.

5. Reduction in area of lands damaged by seepage during floods.[19]

Whenever the flow line of the river rises substantially above the elevation of adjacent farm lands, danger develops that water will be forced through permeable strata beneath the levees and rise to the surface of adjacent lands. During extreme floods of the past, seepage frequently has inundated lands located at least a mile from the river. Carrying with it sand burden and destroying crops, such seepage causes serious damages whenever it occurs.

Assuming no seepage until water elevation is twelve feet above adjacent lands but assuming area of seeped lands to increase with increases of river elevation up to sixty feet on the Cairo gage at a rate indicated by 1929 experience, average differential area saved from seepage by a two-foot reduction in crests of all floods was estimated at 38,060 acres. Evaluating seepage damages at $12.00 per acre, average annual saving from a two-foot flood height reduction would be $456,720. Capitalized at six percent the value of this benefit would be $7,612,000.

Under Assumption A, Table 47 contains a recapitulation of the benefits evaluated above. Under Assumption B are indicated such benefits as Okey estimated might accrue from flood height reductions equivalent to those which may reasonably be anticipated as a result of operation of the TVA Kentucky project.[20]

For a complete inventory of flood control benefits of TVA reservoirs it is necessary to take into consideration not only the Mississippi Valley but also the Tennessee Valley. Benefits in

[19] *Ibid.*, 58-59.

[20] Benefits listed under Assumption B are described by Mr. Okey as based upon a ". . . . 2-foot reduction in floods from Cairo, Illinois, to mouth of Arkansas River. 1-foot reduction from there to the mouth of Red River, and no reduction at and below that point." (House Document 455, p. 64.) In his introduction to the Okey study Prof. Woodward states:

> "Studies of the Tennessee Valley Authority indicate that the Kentucky Reservoir will reduce flood heights by at least 2 feet from Cairo to the mouth of the Arkansas, and probably by at least 1 foot between the Arkansas and the Red." (*Ibid.*, p. xiii.)

On the basis of later studies, Director Lilienthal stated that the entire TVA system of dams would be adequate ". . . . to diminish the floods a total of 3 feet from Cario to the mouth of the Arkansas and to reduce by 2 feet flood heights from the Arkansas River to the mouth of the Red," (Address at Little Rock, Arkansas entitled "The Development of a Region's Resources," October 17, 1941.)

the latter have been given considerable study although not in the same detail as those along the Mississippi. On a 1929 basis the United States Engineers estimated average annual direct flood damages along the Tennessee River at $1,780,000.[21] Since this figure excluded indirect damages, it could not be taken as an estimate of the average annual benefit from elimination of all

TABLE 47

ESTIMATED BENEFITS OF FLOOD HEIGHT REDUCTIONS ON THE MISSISSIPPI RIVER

	Assumption A[a]		Assumption B[b]	
	(All figures in thousands of dollars)			
Lump-Sum Benefits				
Increase in land values	300,000		150,000	
Savings to cities	6,700		6,700	
Saving in costs of raising railways	10,550		7,300	
Saving in costs of raising highways	1,500		1,000	
Subtotal		318,750		165,000
Capitalized Annual Reductions in Flood Damages				
Floodway lands in cultivation	11,304		5,313	
Unprotected lands in cultivation	6,182		4,990	
Backwater lands in cultivation	32,240		13,950	
Levee maintenance	5,290		3,173	
Lands affected by seepage	7,612		4,567	
Subtotal		62,628		31,993
GRAND TOTAL		381,378		196,993

[a]Definition of Assumption A: two-foot flood height reduction for all floods on Mississippi River from Cairo, Illinois to New Orleans, Louisiana.
[b]Definition of Assumption B: two-foot flood height reduction on Mississippi River for all floods between Cairo, Illinois and mouth of Arkansas River; one-foot flood height reduction for all floods from mouth of Arkansas to mouth of Red River; and no flood height reduction below mouth of Red River.
Source: House Document 455, Seventy-Sixth Congress, First Session, pp. 59, 64.

Tennessee River floods. Nor could it be interpreted as the average annual direct benefit of TVA flood control since the TVA multiple purpose system will not be adequate to eliminate all of the damages included in the estimate. On a somewhat later basis, TVA estimated average annual tangible flood loss at Chattanooga at $1,739,000. By reasoning analagous to that used to determine

[21] House Document 328, Seventy-First Congress, Second Session, p. 39.

expenditure justifiable for fire insurance the Authority considered that twice the tangible loss, or $3,500,000, might reasonably be paid out annually to avoid the apparent loss.

"Such an annual expenditure would provide interest, amortization, operation, and upkeep on a total expenditure of $60,000,000 for flood prevention works.

. . . .

"The value of complete removal of such hazards to property, to health, and to life itself, and the resulting advantages for future growth when complete flood protection is attained, clearly exceeds the amount of damage occurring according to the appraisal previously described, if only floods of record were repeated. Consideration of these facts indicates that a conservative estimate of the over-all benefits from such complete flood protection at Chattanooga might be of the order of $70,000,000 or $80,000,000." [22]

Two additional factors must be taken into consideration before a final estimate of flood control benefits of the TVA reservoir system is possible. First, estimates of Mississippi Valley benefits include no consideration of reduced annual damages to rural lands not in crops. Significant areas of these lands are at present in cut-over timber, but if the flood danger were reduced a large number of acres might be cleared for cultivation. The value of a two-foot reduction in all flood stages to such lands when cleared was estimated by Okey to be $65,000,000. The value to them of a two-foot reduction from Cairo to the mouth of the Arkansas River and a one-foot reduction from the Arkansas to the mouth of the Red River would be approximately $25,000,000.[23] Second, we have given no consideration to the value of the benefits of TVA flood protection at other points in the Tennessee Valley than Chattanooga. Although such benefits are not great, they do exist. Let us evaluate them arbitrarily at $5,000,000. It is now

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[22] "The Chattanooga Flood Control Problem," House Document 91, Seventy-Sixth Congress, First Session, pp. 35, 37.

[23] Charles W. Okey, "Value of Flood Height Reduction to the Alluvial Valley of the Lower Mississippi River" (Tennessee Valley Authority, Engineering and Construction Departments, Project Planning Division, Preliminary Report of June 8, 1937), p. 104.

possible to summarize total benefits of TVA reservoir flood control as follows:

Benefits along the Mississippi River, Table 47, Assumption B		$200,000,000
Add benefits to timbered lands in the Mississippi Valley		25,000,000
Benefits of flood control at Chattanooga	$70,000,000	
Less costs of local protection at Chattanooga	20,000,000[a]	
		50,000,000
Benefits elsewhere in the Tennessee Valley		5,000,000
Total		$280,000,000

[a] These costs must be incurred to make reservoir protection fully effective.

To place the above benefit upon an acre foot basis it must be divided by the volume of storage required to produce it. Total capacity of the TVA ten-plant system useful for storage of flood water (taken as the difference between maximum surcharge content and minimum content in advance of floods) is approximately 8,900,000 acre feet.[24] For full protection of Chattanooga this system must be supplemented by perhaps 1,600,000 acre feet of additional tributary storage. Thus, total capacity required to produce indicated flood control benefits is, say, 10,500,000 acre feet, and benefit value of storage per acre foot is conservatively $26.50.[25]

We have presented above a rather detailed review of a procedure whereby flood control benefits of the TVA program may be estimated. The question now arises, How precise are the results which this procedure determines? Unfortunately, we believe that they are accurate only within a wide margin of error. Our reasons for this position may best be brought out by an analysis of the Okey computations.

First, the estimate for lump-sum increases in land values is extremely problematical. It is based upon the value differential

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[24] These storage estimates are on the basis of the flat pool assumption. See below, Chapter XI.

[25] This figure compares with $21.60 estimated by TVA in the three-dam allocation report and $30.00 estimated in a rough office memorandum of April 7, 1938. The additional storage here estimated as required is as of January 1. Taking TVA rule curve operation into account, the necessary addition might be as much as 2,600,000 acre feet. (See Table 5.) This would reduce the value of storage per acre foot to $24.30.

which now exists between "partly" and "fully" protected lands. But the qualitative improvement in protection of lands in the flood zone from a two-foot flood height reduction is not demonstrably equivalent to the differential in protection which now exists between "fully" and "partially" protected lands; and there is no *a priori* reason to accept the $25 figure for probable appreciation per acre. We do not assert that it is incorrect. The evidence in support of it is simply not convincing. We can conceive that the enhancement of values per acre might amount to as little as ten or fifteen dollars. On the other hand, it might mount to as much as, say, forty dollars. The essence of a calculation of this sort is a prediction of the future, and it is inherently subject to great uncertainty.

A further difficulty which must be considered in connection with an appraisal of the estimate of increased land values is the fact that the full amount of the increment will only be realized over a period of time as the flood protection scheme proves itself. If, for example, we assume that the increment of value upon a given acre of property would accrue at the rate of one dollar a year for twenty-five years (making an ultimate accrual of $25 as estimated by Okey), the present value of the total increment at six percent interest would be only $12.78. Actually, it is probable that a large part of the increment would be achieved shortly after the protection works had come into operation and that thereafter the remainder would accrue at a gradual, and perhaps decreasing, rate. Assuming that value for an acre of land would increase by $5 a year for the first two years and $1 a year for the next fifteen years, the present worth of the increment at six percent interest would be $17.81. Applied to 12,000,000 acres of fully protected land in the alluvial valley, this would indicate a present worth of an ultimate $25 per acre appreciation in land values of $213,720,000 as compared with $300,000,000 suggested for the full appreciation in Table 47 above. It is interesting that the difference between these estimates is more than twice the total amount of any other item of benefit value included in the Okey computations and more than the total of estimated TVA flood control benefits in the Tennessee Valley.

In sum, a correct present figure for lump sum increases in land values as a result of increased reservoir flood storage is dependent upon three factors: the total anticipated valuation increment; the rate at which this increment will accrue over time; and the appropriate rate of discount. These factors are inherently so uncertain that any estimate of present value of a prospective increment can be accurate only within a wide margin of error.

Second, in evaluating benefits to cities, estimates for a two-foot flood height reduction have been determined by pro-rating benefits of a considerably larger reduction. This method of apportionment may be as good as any if the total benefit is achieved at a single construction stage. On the other hand, it may be argued that it will exaggerate the proper credit to a two-foot reduction if all additional protection required to make this reduction fully effective is not simultaneously provided. For example, at Cairo two additional feet of protection alone would not be worth one-third the value of total protection which could be achieved by a six-foot addition to the flood wall. The pro-rating procedure seems to have validity only if it is assumed that each protective work is part of a system providing complete security.

Along most of the length of the river full security would be the joint product of proposed reservoir storage and the existing (or an improved) levee line. Yet in the study reviewed above benefits from avoided costs of city ring levees and lump sum increases of land values are credited entirely to the chronologically marginal factor, reservoir protection. This does not seem to be consistent with the pro-rating procedure employed at Cairo.[26] Furthermore, from the point of view of the comprehensive reservoir-levee system, it is not clear that it is strictly logical. Irrespective of the two-foot reduction in heights of all floods the anticipated appreciation of land values would not develop and ring levees would not be avoided, were it not that the main levee line is of such a height that the contemplated reduction in flood crests represents the critical margin between security and danger in times of superflood. The propriety of crediting particular units

[26] Nor is it consistent with the arbitrary evaluation of a one-foot reduction in flood heights from the Arkansas River to the Red River at one half the value of a two-foot reduction.

of a system with benefits which are inherently joint seems open to question.

From another point of view it seems quite proper to credit incremental benefits to incremental works. This is for analysis of the economy of possible extensions or improvements of an existing system. Employing the "benefit criterion," any extension would be justifiable which would yield a greater increase in benefits than in costs. This would be true regardless of the relation which might exist between sunk system investment and its present capacity to produce benefits. But a favorable benefit ratio for an extension of an existing system, of course, would carry no implication as to economy of the system as a whole. This point has relevance to the problem of analyzing the economy of projected new flood works. Any appraisal of benefits should be made carefully. If protection is to be afforded against less than a "maximum flood," the presumption should be against crediting initial works with any benefits which cannot be salvaged until additional construction is carried out. Rigid adherence to this rule would serve to guard against the development in stages of projects or systems which, taken as a whole, would be unjustified.

Third, lump sum savings to railroads are taken as the avoided costs of raising these utilities above the flow line of the project flood. These costs can scarcely be considered as having been avoided and hence as measuring benefits unless it can be shown that greater losses would be incurred by the rails from failure to raise tracks. No such demonstration has been made. It is conceivable that in some cases lines would be left subject to occasional overflow.

Fourth, lump sum savings to highways are taken as the avoided costs of raising certain key routes above the flow line of the 1927 flood. As was the case for estimated benefits to the railroads, no evidence has been presented to show that alternative costs of raising highways would have been justifiable expenditures. One may also wonder why the flow line of the 1927 flood rather than that of the project flood has been used as a basis for estimates. Indeed, since the adopted levee project is designed to carry the 1927 flood with a considerable margin of safety, there would be no reason to raise highways only to this level. Avoided costs of raising highways are either nothing at all or they are the costs of filling to a flow line approximately as high as that of the project flood.

Fifth, in several cases annual reductions in flood damages have been capitalized at private rates of interest. Before appraising this procedure, we must set up a hypothesis as to the purpose of benefit evaluation. Let us suggest that this purpose is to determine total government expenditure justifiable to achieve the reduction in flood heights under consideration. Let us assume further that expenditure is justifiable up to the full amount of anticipated benefits, regardless of to whom they may accrue. At first glance Table 47 seems to indicate that \$380,000,000 might justifiably be invested to achieve a reduction of two feet in all Mississippi River floods. But such a level of investment would leave no surplus of benefits available to meet costs of operation, depreciation, and insurance upon flood control works. If these should be \$3,000,000 a year and the public interest rate four percent, a total public investment of $\$380{,}000{,}000 - \frac{\$3{,}000{,}000}{.04} = \$305{,}000{,}000$ would seem to be justified. On an annual basis the justifiable rate of public expenditure would be \$15,200,000. Surprisingly enough, although this is apparently the limit of justifiable expenditure it is substantially less than the annual rate of benefits (\$22,500,000) which it would yield.[27] The difference is accounted for by the difference in public and private interest rates. By fixing total capital value of benefits as the limit of justifiable capital value of public annual expenditure, it is automatically determined that the annual public expenditure cannot be as great as annual benefits to be achieved so long as any benefits accrue to individuals or organizations for which the appropriate rate of interest is greater than that for the federal government.[28] If it should be accepted that the reality of cost is in fact in its annual impact and if the

[27] In the computation of benefits we have used a public interest rate of four percent and a private rate of six percent. This is consistent with the Okey report.

[28] Theoretically, an additional clause should be added to this sentence as follows: ". . . . and are not off-set by benefits accruing to individuals or organizations for which the rate of interest is less than for the federal government."

logic of the justifiable expenditure formula should be carried out on this basis, total justifiable investment in the situation described above would become not $305,000,000 but $487,500,000.[29] At such a level of investment annual costs would be equal to annual benefits.

The foregoing paragraph suggests the importance which attaches to the determination of proper rates of capitalization. If the purpose of benefit evaluation is to determine the limit of justifiable public investment, it would seem that the rate should be appropriate to public authority rather than private enterprise, irrespective of to whom the benefits might accrue. This procedure would establish as a limit of investment a level at which the flow of annual costs would exactly equal the flow of annual benefits. If, on the other hand, the present conservative practice of determining justifiable public investment by the unadjusted capital value of benefits should be continued, recognition at least should be made of the fact that annual costs are being held below annual benefits.

Sixth, a number of details of the computation of capitalized annual damages may be noted. (A) Annual damages are based upon frequencies of past floods of various heights. Statistically, past averages can be no more than a best guess for the future. Variations from averages are to be expected. At best we can determine only a range within which future flood flows should fall. Yet in order to determine accurately the present value of protection against future floods, we should know not only what average future flood flows will be but also when each future flood will occur and how great it will be.[30] Only with such information could we discount future damages to determine the present worth of avoiding them. (B) Assuming that we could determine exactly when future floods would occur and what their heights would be, we should then face the problem of evaluat-

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[29] $I = \frac{22,500,000-3,000,000}{.04} = 487,500,000.$

[30] It might be suggested that, in the absence of information as to exact dates of future floods, the value of protection could be estimated on an actuarial basis if the probabilities of floods of varying heights could be determined. Since the principle of insurance requires a "gathering of risks," its applicability to the flood problem of a single Tennessee River would be questionable.

ing the damages they would cause if uncontrolled. We have indicated above something of the care with which Mr. Okey prepared his estimates in this regard. But even in his workmanlike report there were required a number of far-reaching assumptions, the reliability of which is open to some question. For example, will ratios of land in different crops be the same in the future as they have been in the past? Will future crop prices be similar to those used in Okey's estimates? Will the ratio of crop to personal property damages in times of flood be constant over time? (C) Assuming that dates and heights of future floods could be predicted and that damages they would cause if uncontrolled could be evaluated, the problem would remain of discounting these future damages to arrive at the present worth of avoiding them. In many respects this difficulty is simply a reflection of the problem of capitalization rates mentioned above. But even if choice is made between the use of public and private interest rates, one would still have to decide between present interest rates, anticipated interest rates over the life of the reservoir system, anticipated interest rates over the period the system will be building, or an average of interest rates over the recent past. Perhaps none of these would be ideal, but it is clear that the choice of a capitalization rate leaves much room for the play of judgment. The great importance of what is, in effect, the indeterminacy of a correct rate of capitalization is revealed by the fact that if a rate of 3.5 percent rather than 4.0 percent had been used in the computation of note 29 above the resulting level of justifiable public expenditure would have been $557,000,000 rather than $487,500,000. The difference is greater than total estimated benefits of reservoir flood protection to the Tennessee Valley.

The foregoing analysis has not been intended to be unduly critical of the Okey report. We believe that this report was based upon carefully collected data and was studiously carried out, often with a large amount of ingenuity. Although strict theory would require readjustment of certain estimates of the study, it is not clear whether the net effect of such changes would be to increase or to decrease the final estimate of the value of a two-foot flood height reduction on the Mississippi. The important conclusion to which our discussion leads is that no single value for the benefits of a comprehensive flood control program can be calculated. Time and again judgment must enter into the determination of any estimate of benefits, and even the most expert and impartial judgment is unable to predict the statistical uncertainties of the future. Regardless of how "scientific" the approach may be, no estimate of flood control benefits can be reliable within less than a very considerable margin of error. With slight variations in the assumptions of the Okey study, benefits which were evaluated at $380,000,000 might have been set as low as $200,000,000 or as high as $600,000,000.

(2) Benefits from Navigation

TVA navigation benefits may be considered under the headings: benefits on the Tennessee River and benefits on the Mississippi River. Tennessee River benefits are contingent upon two factors: rate of growth of river traffic and savings per unit of goods transported. A number of methods might be employed to estimate future river shipments. Traffic trends of the recent past might be extrapolated. Estimates might be based upon shipments on comparably improved streams in similar economic regions. Or informed judgment based on all relevant information might be used. Unfortunately, only the latter of these three methods is applicable to the Tennessee River under TVA. Extrapolation of past trends must be rejected since it assumes that the forces which have been determining in the past will continue to govern river shipping as they evolve in the future. The change which TVA is carrying out in the natural geography of the river valley will alter drastically the forces which formerly affected river shipping. The method of comparison with other streams also must be ruled out, for the Tennessee Valley region is in many respects unique and there is no other comparably improved river artery.

An application of the judgment method of determining probable future traffic trends might proceed as follows. In 1932 river shipments amounted to 750,000 tons. This figure may be accepted as the base of our estimate. It is reasonable to expect a natural annual traffic growth of, say, 100,000 tons. But natural growth takes no account of the improvements in river channel which TVA is making. The immediate effect of these improvements may not be great, but it will tend to increase steadily with the passage of time. Let us suggest as a figure representative of this tendency 4,000 tons a year multiplied by the square of the period between the given year and the base year. Finally, account must be taken of the fact that with the passage of time new transportation agencies will compete increasingly with existing ones until they divert the bulk of their traffic. An adjustment for this consideration may be made by subtracting a factor which varies with the cube of time from the base year to the given year. In this manner the following trend equation for shipping on the Tennessee River is determined:[31]

$$Y = 750{,}000 + 100{,}000X + 4{,}000X^2 - 100X^3$$

Although the applicability of this estimate to the long future cannot be appraised by records for a few years, it may nevertheless be interesting to check the results of the 1932-1940 period. During the first few years after 1932 actual traffic was well above trend. By 1937 trend had risen to 1,338,000 tons while actual traffic was 1,377,000 tons. In 1940 actual shipping was 2,168,000 tons and trend was 1,755,000 tons.

With an estimate of the volume of river shipping determined, savings per ton could be estimated in order to arrive at annual benefit values. These savings might be fixed according to differences in prospective rates for hauls by water carriers and rates which shippers would have to pay to other carriers in the absence of the possibility of river transportation. Tentatively savings might be set at $1.25 per ton in 1932 and be reduced by one cent each year to a level of $1.00 per ton in 1957.[32]

[31] The X variable is expressed in terms of years since 1932; the Y variable is trend tons of river shipping.

[32] To select a single over-all figure as representative of "savings per ton" is extremely elliptical, for it must be recognized that a reduction in transportation charges tends to bring forth new traffic which would not have moved at original rates. The full amount of a rate reduction is properly creditable only to traffic which would have moved at original rates, and varying shares of the total reduction are creditable to traffic brought forth by the change. Rigidly interpreted, the saving on new traffic is measured, in the manner of a consumers'

On the basis of estimated future shipping and estimated savings per ton, annual benefits from river transportation could be determined as far into the future as one felt it reliable to project his estimates. The present value of these benefits could then be computed by discounting them at an appropriate rate. Once again the difficulties of defining such a rate would have to be overcome. If the purpose of the study were to determine the amount which government could justifiably expend each year to achieve the benefits in question and if the benefit criterion were strictly adhered to, it would seem proper to discount future savings at rates of interest appropriate to the organizations which will obtain those savings. If it were arbitrarily assumed that there would be no shipping by public authority, such a rate might be six percent. The sum of present values of savings for each year of the prospective life of the navigation project would indicate its total present capital value. The annual value, as a perpetuity, of this capital value could then be determined by application to it of the interest rate used in the calculation above, say six percent. This annual value could then be capitalized at an appropriate rate for public annual costs upon a waterway improvement (say five percent to cover all items of cost). The resulting figure would indicate the level of justifiable investment to obtain the indicated navigation benefit.

On the Mississippi River the benefit of TVA reservoir storage releases to navigation has two primary aspects: the reduction in dredging expense which results from improved low water flow as a result of Tennessee River regulation, and the saving in transportation expense which is made possible by greater controlling depths on the Mississippi during periods of low natural flow. The dredging problem on the Mississippi is concentrated in the 400-mile reach of the river between Cairo and the mouth of the White River in Arkansas. In dry seasons this stretch is a series of pools connected by crossing grades or shoals. Natural stream

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surplus, by the area under the demand curve for river shipping between volumes corresponding to the old and the new level of rates and above the new traffic charge.

The procedure here suggested for estimation of navigation savings from a rate reduction would also appear to be the theoretically correct method for estimating "consumers' savings" under reduced power rates.

flow tends to scour navigable crossings between pools, but this requires a certain amount of time. At the start of any low water season maintenance of project depths require substantial dredging. This is also usually the case after summer pop-up floods, which tend to shift channel regimen.[33] How may the value of TVA storage releases in terms of reduced dredging be estimated?

Let us assume that the normal low-water season on the Mississippi is 150 days beginning August 1, that natural low water flow is approximately 120,000 c. f. s. (2.2 feet on the Memphis gage), and that TVA storage will supplement this flow with releases of 25,000 c. f. s (raising the Memphis gage to 4 feet). Let us assume further that average pop-up floods rise to 9.5 feet on the Memphis gage and that bottom elevations at crossings increase one-half as much as surface elevations. On these assumptions the increase in stage in event of an average pop-up flood (with TVA regulation before but not during the flood) would be 5.5 feet, and bottom elevations at shoals would rise 2.75 feet. In order to preserve a 10-foot gross channel[34] throughout and after summer floods, it would follow that the minimum controlling depth in advance of floods should be 10+2.75=12.75 feet. Gage-discharge relations for critical shoals from Memphis to the mouth of the White River indicate that a flow of 168,000 c. f. s. would be required to maintain a 12.75 foot channel. This represents an increase of 48,000 c. f. s. from natural low water flow assumed above. If it could be obtained, it would eliminate approximately sixty percent of average annual dredging costs. On the basis of 1930-1934 experience it would yield annual savings of $660,000, or, say, $13.75 per c. f. s. of regulation. On this basis, 25,000 c. f. s. of low water releases from TVA storage would be worth $343,000. Capitalized at 4.5 percent for all costs of a public reservoir system, this benefit would justify an investment of $7,600,000.[35]

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[33] Tennessee Valley Authority, Powell to Barker, June 30, 1936, revised June 24, 1938, "Value of Storage Releases to the Lower Mississippi River for Navigation during the low water Season."

Bottom elevation rises with the surface during pop-up floods, and after the flood stage subsides remains higher until scoured out again.

[34] Ten-foot depth is a practical minimum for nine-foot navigation.

[35] The analysis here presented is based upon the memorandum cited above in note 33.

Increased low water flow on the Mississippi would also be valuable in that it would permit substantial reductions in the costs of moving river traffic during low water periods. This is true since low water requires that barges travel partially loaded and that tows proceed against strong bottom friction. The following procedure has been suggested to evaluate this benefit. Annual ton-miles on the Mississippi between Cairo and Vicksburg are approximately 1,250 million, and of these ninety percent are moved in barges capable of nine-foot draft. Assume an average annual delay to this traffic on account of inadequate depths of one-quarter of the low water period (one month), assume that one-third of the traffic which would normally move is lost, and assume that extra expense incurred for traffic moved is 2.5 mills per ton mile. The total annual cost of traffic delay then becomes:

$$1{,}250{,}000{,}000 \times .90 \times .0833 \times .667 \times \$\ .0025 = \$156{,}188.$$

If a 48,000 c. f. s. increment to low water flow would completely eliminate these costs, the value of low water regulation per c. f. s. would be $3.26. At this rate TVA regulation would have an annual value of $81,500. Capitalized at 4.5 percent for all public costs, an investment of $1,810,000 would be justified to achieve these benefits.

We shall not pause to appraise in detail the technique reviewed above for evaluation of navigation benefits. While it may be as satisfactory as any which could be devised, it is almost certainly no more reliable than the method by which flood control benefits were estimated above. Trends for the volume of future river traffic and the costs and prices at which it will be transported cannot be predicted with accuracy. The problem of capitalization or discount rates is extremely complex. The estimates of benefits upon the Mississippi River are dependent upon many assumptions. In sum, we see little hope in the methods here discussed for an accurate evaluation of navigation benefits.[36]

(3) Benefits from Power

Our present investigation of the possibilities of evaluating the

[36] It should be pointed out that there is a serious danger of double accounting in treating as navigation benefits both avoided dredging expense and transportation savings.

economic benefits to the country as a whole of the several utilities provided by the TVA program was undertaken in an attempt to fix benefits according to the relative values of which TVA joint costs might be apportioned. Inasmuch as we have found that no dependable estimates can be determined for national flood control and navigation benefits, it follows that this approach to allocation must be abandoned. It is, therefore, unnecessary to attempt an evaluation of TVA power benefits from the point of view of the national economy.

THEORETICAL DEFICIENCIES OF THE RELATIVE BENEFIT METHOD

The discussion above has been concerned with some of the practical problems of evaluating the benefits of the TVA program to the country as a whole. The question may now be raised as to whether, even if relative benefits could be determined, joint cost allocations in the proportions of these benefits would be meaningful.

The relative benefit method cannot be supported as a procedure for determining the respective shares of joint cost *functionally incurred* for particular objectives. Joint costs are an expression of physical and technological relations. By definition, they contribute to the production of a complex of benefits and cannot be divided into parts useful for single purposes.[37] This point may be clarified by consideration of a test case. Assume that two men are standing in a doorway in uptown New York City on a rainy day and that both have important appointments downtown. Assume further that neither has available a means of transportation and that taxi fares are such that two can ride for the price of one. A taxi now passes by; the two men hail it and agree to ride downtown together. Their total fare, and it would be the same for either of them alone, is $2.00. Rather than miss his appointment or chance awaiting a second cab, Smith would have been willing to pay $15.00, and Jones would have been willing to pay $5.00. The value of the benefit of the cab ride to Smith appears to be three times that for Jones; and

[37] See below, Chapter XIV.

on this basis Smith should pay $1.50 of the joint cost and Jones 50 cents. But certainly it is not correct to argue that three-quarters of the joint cost is incurred because Smith is transported. Had Jones been standing in the doorway alone, he would have taken the taxi and gladly paid the $2.00 fare himself. Thus, the full charge would have been incurred by either passenger independently of the other, and the incremental cost of carrying the added passenger is zero. The accident of relative benefits gained by Smith and Jones from the ride is wholly divorced from the problem of responsibility for incurrence of shares in joint cost.

The conclusion above is the same if benefits are defined as alternate costs avoided rather than as something in the nature of total utility. Assume that Smith could have rented an automobile for the afternoon and driven downtown for $3.00 and that Jones could have rented a car for $5.00. On the basis of of these relative benefits, Smith should pay 75 cents of the joint cab fare and Jones $1.25. Obviously these amounts have no significance with regard to cost responsibility on the part of each of the two passengers of the joint taxi trip.[38]

Although relative benefits fail to provide a means for dividing joint costs into parts functionally incurred for particular objectives, it might still be urged that they provide a convenient method for apportioning admittedly joint costs *fairly* among co-ordinate purposes.[39] Since navigation and flood control are non-revenue producing from the point of view of the federal government, this assertion reduces to the proposition that the benefit principle provides a fair method of dividing costs of comprehensive works between the local power consumer and the federal taxpayer. It is difficult to formulate a convincing test of an intangible such as "fairness," but the case for the benefit method seems very weak.

The local power consumer would appear to be upon firm

[38] The taxi cab case of joint cost is discussed by Smith, Dowling, and Hale in *Cases on Public Utilities*, (1936) p. 631.

[39] It is assumed throughout the following discussion that the purpose of a "fair" division of joint costs is to achieve a base for the making of rates for vendible utilities (i.e., at TVA, power).

ground in declaring that he should not be assessed greater charges for energy taken from a comprehensive system than would suffice for energy supply from an alternative single purpose power source.[40] Yet if benefits should be interpreted in the general sense contemplated in the present chapter, the assessment against power would have no necessary relation to alternate cost and might exceed it. On the other hand, the local power consumer could not make a strong case for receiving energy at substantially less than alternate single purpose cost. If the federal taxpayer fully finances the cost of a comprehensive improvement and makes generous supplies of energy available to all classes of customers at no more than minimum alternate cost, this is a generous contribution. A claim on the part of the local customer for special advantages (in the form of rates below single purpose cost) because the comprehensive enterprise also serves federal purposes other than power would seem somewhat presumptuous. Yet, under allocation according to relative national benefits, the allocation to power might be less than alternate cost.[41]

There is a further reason why allocations for purposes of rate making should not be less than avoided single purpose cost.[42] As has been pointed out, the advantage from rates below alternate cost is reaped by local power consumers at the expense of the federal taxpayer. In so far as power customers are in domestic and commercial classifications, the savings are insignificant because the bulk of retail power cost is incurred for transmission and distribution. For industrial customers, on the other hand, the savings could be of some importance. If the effect of adoption of the benefit principle were to reduce power costs throughout the entire economy, it might be anticipated that ultimately rate savings would be passed along to consumers of manufactured commodities. But there are not enough multiple purpose hydro sites available for hydroelectricity ever to make steam

[40] Single purpose costs should not be for hydro development at favorable multiple purpose sites where there would be substantial intangible opportunity costs of foregone navigation and flood control. (See below, Chapter XI.)

[41] If a definition of benefits as avoided single purpose costs were accepted, the assessment automatically would be less than alternate cost.

[42] This is on the assumption that rates determined by such a standard would be feasible.

power obsolete. Thus, power rates in certain areas must continue to cover steam costs (unless the steam branch of the power industry is to be forced into bankruptcy or permanently subsidized). The probability would appear to be that industrial customers enjoying rates below single purpose costs would absorb as rents the greater part of their rate savings.[43] It would seem the part of a sound public policy to avoid, or tax, such surpluses rather than to stimulate them. It must be counted as a deficiency of the benefit principle that it would permit them to develop.

CONCLUSION

Let us come now to an appraisal, in the light of the preliminary criteria of Chapter VII, of the principle of joint cost allocation according to relative national benefits.

First, no version of benefit theory can be defended as fixing shares of joint cost functionally incurred for particular objectives. Nevertheless, the idea of apportioning joint costs according to "benefits" has a certain superficial plausibility as a "fair" basis of allocation. Upon careful reflection, however, it appears that no allocation formula which wholly ignores alternate costs, as does the relative national benefit method, can be reasonable. Moreover, it appears that strong arguments can be marshalled against any rate base allocation which results in charges either substantially above or below the alternate cost level.

Second, the benefit method for allocation is inherently complex. Considerable research must be carried out in order to obtain the raw materials for cost apportionment. This is true of the expression of benefit method considered in the present chapter; it would also be true of a version of the theory in which benefits were interpreted as alternate costs avoided. After benefits have been determined, the mechanics of allocation are also complicated. For example, joint costs may not be apportioned according to the simple proportions of relative benefits; but benefits for each purpose must be adjusted by the subtraction of direct costs at the multiple purpose system before the apportionment can be carried out.[44]

[43] For a competitive industry including marginal units operating outside the area served by energy from the multiple purpose system, the entire saving from power rates less than alternate cost would tend to be absorbed as a producers' rent. For monopolistic competitors a greater or less part of the saving would be passed to consumers depending upon the elasticity of the demand curves for the products of the individual firms purchasing power from the comprehensive system.

[44] It could be argued that the necessity for this adjustment detracts from the

Third, the relative national benefit method is quite unworkable. Common units for physical and social benefits are not available; and economic benefits cannot be appraised within a reasonable margin of error.

Fourth, any version of benefit theory would seem to provide a flexible basis for allocation. With changing conditions and varying benefits, original allocations could be revised periodically as might seem wise. Unfortunately, the revision of allocated values entered upon permanent financial records inevitably would give rise to very serious accounting difficulties. These might be so important as to make readjustment of established allocations very nearly impracticable. If this should be the case, then the benefit method might seriously restrict rate flexibility.

Fifth, the relative national benefit method divorces allocations entirely from alternate costs. If this method could be practically applied, it would be impossible to predict whether or not it would grant all purposes a share in the economy of multiple purpose improvement. Presumably all objectives would be apportioned charges less than "benefits," but assessments might exceed alternate costs.

In sum, it appears that the relative national benefit method must be discarded for both practical and theoretical reasons. A version of benefit theory designed to overcome some of the weaknesses of apportionment according to relative national benefits is the alternative justifiable expenditure method. This avoids one of the more obvious failings of the allocations of Chapters VIII and IX by scaling alternate costs down to justifiable levels. While it is still subject to certain inherent weaknesses of benefit theory, the modified method seems to provide a more workable version of this theory than the version of the present chapter. The alternative justifiable expenditure method is the principle for joint cost apportionment to which the investigations of the TVA Financial Policy Committee led. We consider it in Chapter XI here following.

superficial attractiveness of benefit theory. The following example indicates why the adjustment is necessary: At a given project assume that the benefit for each major purpose is $40,000,000; assume that direct costs for power are $25,000,000 and that navigation and flood control have no direct costs; and assume further that joint costs are $60,000,000. If no adjustment is made for direct costs, total allocations will be: navigation, $20,000,000; flood control, $20,000,000; and power, $45,000,000. The latter allocation is in excess of the power benefit.

If benefits are adjusted for direct costs, remaining benefits become: for navigation, $40,000,000; for flood control, $40,000,000; and for power, $15,000,000. Allocations then will be: to navigation, $25,250,000; to flood control, $25,250,000; and to power, $34,500,000. Total charges to each objective are within the measure of its benefit.

Chapter XI

THE ALTERNATIVE JUSTIFIABLE EXPENDITURE THEORY

Summary. Although TVA has never officially adopted any single basis of cost allocation, it has been primarily influenced by the alternative justifiable expenditure method. This method is a version of benefit theory according to which the costs of alternate single purpose systems or maximum justifiable expenditures, whichever are less, are taken as measures of benefits. When alternative justifiable expenditures may be determined upon a project basis, this principle of apportionment may be extended to achieve suballocations of individual plants. Suballocations may also be obtained by subtraction of successive systems, but this method does not restrict charges to justifiable levels.

The alternative justifiable expenditure method is perhaps the most satisfactory version of the benefit principle, but it suffers from serious disadvantages. There is wide scope for the play of judgment in definition of the term "alternate" in establishing alternate systems. Assuming such systems to be set up, close estimates of money costs of construction require exhaustive preliminary examinations of sites. Even if money costs for alternate single purpose systems are closely estimated, they are not satisfactory measures of full alternate costs, for they take no account of the opportunity costs involved in blocking possible multiple purpose improvement. A final practical difficulty arises from the fact that the alternate systems must not overlap. In a reasonably well developed watershed there simply would not be enough available non-overlapping single purpose alternate sites to carry allocations out. In a relatively undeveloped watershed, how should the more favorable sites be apportioned among purposes?

Even if the alternative justifiable expenditure method were not faced with almost insuperable practical difficulties, it would still be subject to the theoretical weaknesses of any expression of benefit theory. In sum, this method does not provide a solution to the problem of joint cost allocation.

THE ALTERNATIVE JUSTIFIABLE EXPENDITURE THEORY

In Chapter X above it was suggested that there are two possible versions of allocation according to relative economic benefits. The first of these would interpret benefits for each purpose in a broad sense as the national value of having the stream of utilities provided by the improved Tennessee River available. This is the conception of benefit method which was investigated in the preceding chapter and found unsatisfactory. The second version of benefit theory would allocate joint costs in the proportions of remaining alternate justifiable expenditures.[1] This represents a refinement of the alternate cost allocations discussed above[2] in that the concept of justifiable expenditure is introduced to guard against exaggeration of "avoided" costs.[3] According to this modified theory, the benefit of having any objective available on the Tennessee River cannot exceed the alternative cost of developing an equivalent benefit if the first did not exist.[4] But benefits may be less than alternate costs. When they appear to be so, they should be traced down and evaluated as closely as possible. These justifiable expenditures should then be used in the allocation formula.

As with other versions of benefit theory, the alternative justifiable expenditure method requires the compilation of certain data as a prerequisite to allocation. These data may be summarized as (1) a breakdown of the costs of the multiple purpose system into categories of direct and joint investment; (2) estimates of costs of alternate single purpose systems to provide benefits equivalent to those of the multiple purpose system; and (3) valuations of the components of benefits for purposes and projects at which it appears that alternate costs might not be justified.

[1] Benefits are "remaining" in that total alternate costs or total justifiable expenditures are adjusted by subtraction of direct costs incurred for the different purposes at the multiple purpose development.

[2] See Chapter IX.

[3] The adjustment in the theory to incorporate the idea of justifiable expenditure is described in TVA "Notes on Allocation" as follows:

> "The concept of alternative cost is premised on the theory that the expenditure in single-use projects would be justified by the benefits obtainable; hence, the alternative cost may be taken as a measure of the investment which the individual purposes would be justified in expending in a joint venture. Where such a cost would not have been justified, it is necessary to substitute a lower estimate based on evaluation of benefits."

(House Document 709, Seventy-Fifth Congress, Third Session.)

[4] This proposition is supported in economic theory by the axiom that no rational person would pay more for a given commodity than the cost of obtaining it from an alternative source (disregarding the time factor).

The first of these sets of data has been presented above in Table 21 for the TVA ten-plant system, and we need not repeat it here. Let us therefore turn at once to the problem of estimating costs of alternate single purpose systems.

TVA ESTIMATES OF ALTERNATE COSTS OF BENEFITS OF THE TEN-DAM SYSTEM

The following discussion indicates the procedure and problems of an alternate justifiable expenditure allocation. The estimates which are quoted are provisional and are not intended to have precise validity. Although most of them are drawn either from a tentative 1938 allocation of the TVA ten-dam system or from computations which supported this allocation, it should be understood that this study did not represent a final and definitive apportionment of costs. Such an apportionment would have to wait upon a closing of the books of costs for all of the plants of the system. It would also merit a much closer investigation of alternate costs than the Authority was able to carry out in connection with the study we shall review.

We have chosen the ten-dam system for consideration rather than some smaller one for which a final allocation would be available for a number of reasons.[5] The larger system includes the Kentucky project which is a key plant in Authority planning for flood control. The larger system is the first stage of TVA development in which the mandate for a nine-foot navigable channel on the Tennessee River will be accomplished. Much of our discussion in Chapter V above has dealt with the problem of programming operation of the ten-plant system. This system is the one with reference to which we have considered the problems of evaluating TVA benefits in Chapter X above. The ten-plant system is the largest system for which tentative allocations are available at the time of writing. It is reasonable to suppose that it is most representative of tendencies in Authority river planning before the defense emergency led to a reorientation of policy

[5] As of September, 1941, final allocations had been prepared for all systems from three through seven plants beginning with the Norris-Wheeler-Wilson system and adding successively Pickwick Landing, Guntersville, Chickamauga and Hiwassee projects.

toward maximum power production. Reiterating that our discussion is intended as an exposition and criticism of allocation method rather than an analysis of precise allocation figures, let us consider now the problems of estimating alternate costs of the TVA navigation, flood control, and power benefits.

(1) Alternate Cost of Navigation

In theory it would seem that the alternate cost of any benefit in a multiple purpose development should be the cost of producing an equivalent benefit at the most economical unimproved single purpose site. Equivalence, as here used, implies both quantitative and qualitative equality between benefits of the multiple purpose and alternate projects.

The basic study to which attention naturally turned in the formulation of an alternate to the TVA navigation scheme was Plan D of House Document 328.[6] This plan, envisaging improvement of the main Tennessee River for nine-foot navigation from Paducah to Knoxville by thirty-two low dams, had been estimated to require an outlay of $74,709,000.[7] After the Authority had investigated it carefully, however, it concluded that the indicated estimate could not suffice for a satisfactory navigation improvement. Although the detailed features of Plan D were not included in Document 328, it appeared to contemplate achievement of a channel with a minimum width of 150 feet and minimum depth of nine feet by movable wicket dams. In view of general practice upon the inland waterways, the Authority believed that the proposed dimensions would have to be expanded to 300 by 11 feet in order to be in accord with modern standards of river improvement.[8] Such a revision would require dredging and raising of pool elevations beyond provisions of

[6] Seventy-First Congress, Second Session. (This was the "308 report" on the Tennessee River.)

[7] This is the figure usually quoted from the report, but it contemplated development of a channel with 110 by 600 foot locks. For an improvement with locks of this size below Muscle Shoals and locks 56 by 360 feet above, the Engineers estimated costs at $60,739,000. The latter lock dimensions would approximate those of TVA which are 110 by 600 feet below Muscle Shoals and 60 by 360 feet above.

[8] The eleven-foot channel depth was considered necessary to permit free navigation by vessels of nine-foot draft.

the estimates of Plan D. It appeared that new estimates for an alternate navigation improvement would be required.

After the War Department had concluded the investigations for its 308 report on the Tennessee River, it had supervised two other investigations for low dam improvements on this stream. The first of these was carried out in 1931 by W. H. McAlpine and dealt with the lower river. The second, treating the section between Riverton, Alabama and Knoxville, was prepared in 1932 by the United States Engineers at Chattanooga. Combination of these schemes gave a development similar to that contemplated in Document 328 but more satisfactory in its channel dimensions. Since detailed estimates were available for the 1931 and 1932 plans, TVA was able to bring them down to date by substituting later prices and overheads, adding allowances for additional dredging, and modifying lock estimates. For projects common to both the revised scheme and Plan D, resultant present estimates were compared with costs quoted in Document 328. An average correction factor of 1.89 was found. This was applied to estimates for the remaining sites of Plan D. Finally, separate provision was made for raising the dams of Plan D to give a net nine-foot channel (eleven-foot depth) at an average rate of $100,000 per foot. The resulting estimate for capital cost of thirty-two low dams was $134,740,000. But this figure took no account of the cost of an alternate low dam development equivalent to the Wilson project nor of the high annual operating and maintenance costs of the low dam scheme relative to the TVA high dam plan. Adjusting for these omitted items, equivalent cost of the alternate low dam navigation plan became $204,033,000.[9]

Although under normal stream flow conditions a low dam plan might provide a useful navigable channel, it could scarcely be

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[9] Total alternate navigation cost was determined as follows:

Estimated capital cost, 32 low dams	$134,740,000
Add capitalized value of operating and maintenance costs ($1,900,000 ÷ .04)	47,500,000
Add cost of alternate high dam for navigation-only at Wilson site	21,793,000
Total equivalent cost of low dam navigation plan	$204,033,000

as satisfactory as the TVA high dam plan.[10] A modified alternate scheme of eighteen fixed overflow dams of intermediate height was therefore considered. Estimates for projects of this alternate system were developed on the basis of unit costs derived from TVA experience with construction of high dams. Capital cost for the system was set at $141,726,900. Adding an alternate for the Wilson project, cost became $163,520,000; and capitalizing annual operation and maintenance expense ($1,272,000) at four percent, total equivalent capital cost of the eighteen-dam alternate was set at $195,320,000. For purposes of allocation, TVA decided to use alternate cost unadjusted for operation and maintenance expense. Benefit value of navigation at the ten-dam system, therefore, was set at $163,520,000. (See Table 48.)

(2) Alternate Cost of Flood Control

To estimate alternate cost for flood control TVA set up a hypothetical single purpose reservoir system which would provide flood storage equivalent to that of the multiple purpose reservoirs at equally strategic locations. This was accomplished by apportioning storage of the multiple purpose system among a series of five alternate projects on the lower, middle and upper main river, and on two important tributaries. Cost per acre foot was computed for each alternate plant, and these unit costs were applied to available storage at multiple purpose plants to fix total alternate flood control costs.[11] Table 49 indicates esti-

[10] Specific aspects of the inferiority of the low dam alternate are discussed below at p. 317.

[11] "Available flood storage" was computed as reservoir capacity between minimum elevation in advance of floods and maximum controlled surcharge. Storage of projects in the ten-plant system was apportioned among alternative sites as follows: Kentucky and Pickwick Landing storage to alternate Kentucky project; Wilson, Wheeler, and Guntersville storage to alternate Wheeler project; Chickamauga, Watts Bar, and fifty percent of Hiwassee storage to alternate Watts Bar reservoir; fifty percent of Hiwassee and all of Fort Loudoun storage to Mossy Creek (Cherokee) alternate site; and Norris storage to alternate flood control-only reservoir at Norris site.

mates for costs of the single purpose flood control system. Since this system would store 10,940,000 acre feet as compared with 8,-895,000 acre feet for TVA multiple purpose reservoirs, its total unadjusted costs would exaggerate alternate flood control cost

TABLE 48

ALTERNATE NAVIGATION SCHEME—TEN-DAM SYSTEM[a]

PROJECT	TOTAL ESTIMATED COST
Reynolds Bar	$ 9,806,200
Suck Bar	13,656,000
Wolf Island	10,606,000
Parkers Landing	10,871,000
Head Colbert Shoals	7,280,000
Wilson high dam	21,793,000
Wheeler high dam	21,541,000
Buck Island	10,445,800
Widows Bar	6,077,000
Sherman Hill	8,061,000
United States Quarry	8,520,500
Kelly Shoals	5,696,400
White Creek	8,488,000
Seven Island Shoals	7,826,000
Bussell Shoals	7,143,000
Georges Branch	5,709,000
Total Cost, Navigation Alternate to Ten-Dam System	$163,519,900

[a] The navigation plan here indicated, which TVA tentatively accepted for allocation of the ten-dam system, represents slight modification of the original eighteen-dam plan as follows: it includes an alternate for the Wilson project; it excludes lock and dam number 1 below Wilson site; it replaces low (or intermediate height) dams at Wheeler site, Milton Bluff, and Triana with a substitute Wheeler high dam.

Source: *Investigation of the Tennessee Valley,* Hearings pursuant to Public Res. No. 83, Seventy-Fifth Congress, Third Session, p. 5353.

of the ten-dam system. Unit costs of plants in the single purpose system, therefore, were applied to available storage of the multiple purpose projects to determine alternate cost of flood control. Table 50 indicates the derivation of a figure of $140,826,000 for this cost.[12]

[12] As was true of alternate navigation cost, no account is here taken of operating and maintenance costs of the alternate system. Were such costs capitalized at four percent and included in unit alternate costs, total system alternate cost would be $147,500,000.

TABLE 49

COSTS OF SINGLE PURPOSE FLOOD CONTROL PROJECTS ALTERNATE TO TVA TEN-DAM SYSTEM

	Kentucky Project		Wheeler Project		Watts Bar Project		Mossy C eek Project		Norris Project		Total, Five Alternate Plants
	(All costs in thousands of dollars unless otherwise indicated)										
Budget estimate, multiple purpose improvement		94,657		32,474		29,200		34,926		31,552	
Deductions for flood control-only development											
For omitted power	11,374		8,415		3,100		5,150		4,542		
For omitted navigation	9,036		1,576		4,100		6,033		.....		
Miscellaneous (add)	2,426		800		*450*		.....		.....		
		17,984		9,191		7,650		11,183		4,542	
Capital cost, flood control-only		76,673		23,283		21,550		23,743		27,010	172,259
Flood storage (in thousands of acre feet)		5,000		950		890		1,550		2,550	10,940
Capital cost (in dollars per acre foot)		15.30		24.51		24.20		15.30		10.58	15.74
Annual operation and maintenance expense		85		64		60		49		59	317
Operation and maintenance capitalized at 4 percent		2,125		1,600		1,500		1,225		1,475	7,925
Total equivalent capital cost		78,798		24,883		23,050		24,968		28,485	180,184
Total equivalent capital cost (in dollars per acre foot)		15.80		26.20		25.90		16.10		11.20	16.54

Source: Tennessee Valley Authority (workbooks supporting tentative ten-dam allocation).

(3) Alternate Cost of Power

Determination of alternate power cost of the ten-plant system required an estimate of primary and secondary power available in that system, a basis for converting secondary to equivalent primary, and an estimate of cost of producing total TVA equivalent primary in a power-only system. The procedure by which available power of the ten-dam system was estimated has been suggested above in Chapter V.[13] We need not review it here. The results of these computations indicated that this system could

Table 50

Estimated Alternate Flood Control Cost of TVA Ten-Dam System

Multiple Purpose Project	Flood Storage Available (in acre feet)	Alternate Cost per acre foot	Alternate Cost of Project Flood Storage
Kentucky	4,570,000	$15.30	$ 69,920,000
Pickwick Landing	416,000	15.30	6,365,000
Wilson	43,000	24.51	1,054,000
Wheeler	440,000	24.51	10,784,000
Guntersville	242,000	24.51	5,931,000
Chickamauga	325,000	24.20	7,865,000
Watts Bar	337,000	24.20	8,155,000
Hiwassee[a]	181,000	24.20	4,380,000
Hiwassee[a]	181,000	15.30	2,769,000
Fort Loudoun	140,000	15.30	2,142,000
Norris	2,020,000	10.58	21,372,000
System Total	8,895,000	$15.83	$140,826,000[b]

[a]In the alternate system, Hiwassee storage is divided equally between the Watts Bar and Mossy Creek projects. Although Hiwassee capacity could have been added to that contemplated at the alternate Norris project, it would not have been as strategically located there as at the sites selected.

[b]This alternate cost was used by TVA. The sum of items shown in the column is $140,737,000.

Source: *Investigation of the Tennessee Valley Authority*, Hearings, p. 5354.

produce approximately 485,000 kilowatts of continuous power plus 350,000 kilowatts of secondary available seventy-five percent of the time.

The translation of secondary into equivalent primary was somewhat difficult from a theoretical point of view since in many respects primary and secondary are as unlike as apples and

[13] See Table 7.

oranges. The Authority solved this difficulty by reducing each class of power to pecuniary terms. On the basis of the TVA A-1 wholesale rate schedule, annual revenue per kilowatt of primary power was estimated at $35.49. Under the terms of the industrial power contract with the Aluminum Corporation of America (dated July 20, 1937), annual value of a kilowatt of secondary available seventy-five percent of the time was estimated to be $13.30.[14] Indicated value of secondary relative to primary was 13.30/35.49, or approximately three-eights (or .375). Translating secondary of the multiple purpose system into equivalent primary, total equivalent primary power of the ten-plant system became 485,000 + 3/8 x 350,000 = 485,000 + 131,000 = 616,000 kilowatts.

The problem remained of estimating alternate costs of generating this primary power. On the basis of the best information available to it at the time, TVA found that the most favorable power-only system to generate approximately the same power as the multiple purpose system would be made up of eight hydroelectric plants. As a system these projects would produce 547,500 kilowatts of continuous primary plus 120,000 kilowatts of seventy-five percent secondary, or a total output of 592,500 kilowatts of equivalent primary. With requisite installations to meet peak demands,[15] costs of the alternate power system were as indicated in Table 51. For purposes of allocation alternate op-

[14] Primary was evaluated on the basis of an assumed sale of 20,000 kilowatts at sixty percent load factor. The computation was as follows:

Demand charge per continuous kilowatt	$18.00
Energy charge per continuous kilowatt	17.49
Total annual charge per continuous kilowatt	$35.49

The value of seventy-five percent secondary was determined as follows:

Assumed annual load factor	100%
Annual bill (.06x365x.75)	$16.40
Less penalty for average of one interruption per year	3.10
Net annual value per kilowatt of 75% secondary	$13.30

[15] Installations were planned to carry primary at sixty percent load factor, secondary at ninety-five percent load factor and station use with a modest reserve. Total planned installation was 1,204,000 kilowatts. Under normal conditions, this would be adequate for twenty-nine percent reserve above primary peak and thirteen percent above peak of primary and secondary. It would be sufficient to meet primary peak throughout the maximum expected flood.

TABLE 51

ALTERNATE COST OF POWER—TVA TEN-DAM SYSTEM

Part 1. ***Cost estimates for eight-dam power-only system***

Project	Budget Estimate, Mutiple Purpose Project, Initial Stage	Add Adjustments[a]					Project Cost for Power Only
		For No Navigation	For No Flood Control	For Added Power	Miscellaneous	Total	
	(All costs in thousands of dollars)						
Pickwick	31,608	.....	.....	.....	.....	*4,538*	27,070
Wilson	34,895	*2,559*	.....	5,944	*704*	2,681	37,576
Wheeler	32,474	*1,576*	.....	5,244	*179*	3,490	35,963
Guntersville	34,228	*3,846*	.....	.....	*500*	*4,346*	29,882
Hiwassee	20,115	.....	*258*	1,500	.....	1,242	21,357[b]
Watts Bar	29,200	*4,100*	*450*	5,130	.....	580	29,780
Norris	31,532	.....	*1,264*	928	1,033	697	32,230
Mossy Creek	34,926	*6,033*	*221*	.....	*832*	*7,086*	27,840
Total capital cost, power only system	......	....	.....	.....	.....	.....	241,698

Part 2. ***Power cost per kilowatt—eight-dam alternate system***

Capital cost, alternate eight-dam system	$241,698,000
System equivalent primary capacity (in kilowatts)	592,500
Alternate capital cost of equivalent continuous primary (per kilowatt)	$ 408[c]
Annual operation and maintenance expense (alternate eight-dam system)	$ 1,815,520
Operation and maintenance expense capitalized at 4 percent	$ 45,388,000
Total equivalent capital cost, eight-dam system	$287,085,000
Total equivalent capital cost per kilowatt of equivalent primary	$ 484

[a] Red figures shown in italics.

[b] TVA working papers and the tentative ten-dam allocation show $20,357,000 for single purpose cost at Hiwassee. This figure was determined by the following computation:

Estimated multiple purpose cost (including additional unit)	$23,030,000
Less cost of switchyard and flood sluiceways	1,673,000
Project cost for power only	$20,357,000

It appears that there was an error in subtraction here, and therefore we show $21,357,000, the apparently correct figure. Actually, cost data for the completed multiple purpose project indicate that the estimate used by TVA was conservative. (See below, p. 336.)

[c] TVA uses $406 per kilowatt because of the difference in estimates for power-only development at the Hiwassee site. (See note b above.)

Source: Tennessee Valley Authority.

eration and maintenance expense was disregarded, and alternate capital cost per kilowatt of equivalent primary was applied to total equivalent primary of the multiple purpose system. At $406 per kilowatt, total alternate power cost of 616,000 kilowatts was $250,096,000[16]

REMARKS ON ESTIMATED ALTERNATE COSTS

The foregoing section has outlined the procedure employed by TVA to determine alternate costs for a tentative allocation of the ten-plant system. We shall accept the Authority's estimates for quantities, unit costs and overheads in construction of both multiple purpose and alternate systems. There are, however, certain problems of method and of theory in the use of the alternate costs quoted above as measures of benefits of the ten-plant system which it will be well for us to explore.[17]

(1) The Alternate for Navigation

The alternate cost for navigation employed in the ten-dam allocation was checked in November, 1938 when the Authority completed a re-estimate for a thirty-two low dam alternate improvement from Paducah to Knoxville. To accommodate shipping of nine-foot draft, this study contemplated a minimum channel depth of eleven feet and a usual gross depth of twelve feet. This was believed to be ". . . . in accordance with the War Department's present practice for the Mississippi River system."[18] Pool levels were planned as much as four feet above crests contemplated in House Document 328, and costs of raising Lock and Dam Number 1 to provide standard depths were included.[19]

[16] With reference to TVA use of $406 per kilowatt, see Table 51, note c. Had capitalized operation and maintenance expense been included in alternate cost computations at the rate indicated in Table 51, total alternate power cost would have been $298,000,000.

[17] These matters are aside from the issue of economic justifiability of the alternate systems. We consider this question in a separate section below.

[18] Tennessee Valley Authority, Design Department, Engineering and Construction Department, "Alternate 32 Dam Scheme, Navigation Only—Revised TVA Estimate of November, 1938," pp. 1-2.

[19] The latter costs had been excluded from estimates of the United States Engineers.

Revised estimated capital costs of the alternate low dam plan were $143,883,000, and annual operation and maintenance expense was estimated at $1,945,000. Capitalizing the latter costs at four percent and adding cost of Wilson high dam, equivalent capital cost of the revised low dam plan became $214,301,000.

Although the November, 1938 revised estimate corroborated the earlier conclusion that the estimate of House Document 328 would not suffice for a satisfactory improvement of the main Tennessee River, it did not indicate a capital cost for low dam development as great as the Authority had estimated for development of the river by a series of projects of intermediate height. Why, one may ask, was the Authority justified in adopting the more expensive alternate for purposes of allocation? The answer is that the low dam plan would be qualitatively inferior to the TVA high dam series of lakes in so many respects that it could scarcely be considered an alternate to the adopted program. Some aspects of the inferiority of low dams may be mentioned. An improvement along the length of the river by low dams would require more time for entering, passing, and leaving locks since more passages would be required. It would be typified by higher channel velocities which would slow down navigation and require higher tow power. It would yield shallow and narrow pools which would imply high bottom friction, a devious channel, and again, reduced speeds and higher necessary tow power. It would be characterized by more variable river stages and higher costs of terminal facilities; navigation would be subject to more frequent interruption during floods. Navigability of tributaries would be but slightly benefited by main river improvement. Annual costs for operation and maintenance would be high.

If cost of low dam improvement of the Tennessee River could not be considered an adequate index of "alternate cost" of the TVA navigation benefit, two procedures seemed to be available to arrive at a more satisfactory estimate. Either costs of the low dam plan might be directly adjusted by a factor determined by judgment (or otherwise) to represent the extent to which the low dam plan would be less satisfactory than would a high dam plan,[20] or an estimate could be made of the cost of a more adequate channel improved for navigation only. In the tentative ten-dam allocation TVA chose the latter alternative, and alternate navigation costs were appraised by estimated costs of a system of fourteen dams of intermediate height and two high dams. When the Authority came to review the initial estimates for this system, it found that they would have to be revised upward substantially.[21] For a few projects study revealed that an average upward adjustment of approximately 35 percent might be required. If this rate were applied to each project of the intermediate navigation-only system, alternate cost would be increased from $164,000,000 to $220,000,000 (ca.). This would exceed the probable cost of a single purpose system of high dams only, so the Authority made no attempt to revise the estimates for river improvement by dams of intermediate height.[22] There seems little room to question the proposition that the estimate of $163,500,000 was clearly conservative as an expression of the alternate money cost of securing navigation benefits on the Tennessee River equivalent to those of the TVA multiple purpose system.[23]

(2) The Alternate for Flood Control

Three questions present themselves for consideration in any appraisal of the adequacy of the TVA estimate of $140,826,000

[20] In a manner not entirely clear, Major Rufus W. Putnam, testifying before the Joint Committee on the Investigation of the Tennessee Valley Authority, arrived at an estimate of 70.6 percent for the navigation efficiency of the TVA multiple purpose waterway as compared with an efficiency of 67.4 percent for a proposed low dam improvement. See *Investigation of the Tennessee Valley Authority*, Hearings, p. 3970.

[21] The necessity of speedily preparing the tentative ten-dam report for submission to the Joint Committee had required selection of sites for the intermediate system without careful investigations. Some of these sites proved unsatisfactory upon detailed examination, and several relocations were necessary. It also appeared that original estimates had not contemplated spillways adequate to pass as high a flood flow as the multiple purpose system, and in a few cases impractical earth overflow sections had been figured in estimates.

[22] An alternate navigation scheme of high dams only would have the significant theoretical advantage that its benefits would be qualitatively of the same nature as those of the multiple purpose system. It is interesting that this seems to be the type of alternate toward which the Authority has been moving in its periodic allocation reports as the multiple purpose system has expanded since 1938.

[23] It is of some importance that the "alternate" system for which estimates have been quoted includes no provision for low water storage releases, a feature of TVA operation which is of considerable significance to navigation on the Mississippi River below Cairo.

as the alternate cost of flood storage available in the ten-dam system. Are the alternate projects by which the multiple purpose system is appraised the most favorable ones which are as strategically located for flood control as the reservoirs of the adopted system? Is the acre foot a proper unit in which to express flood control capacity of a project? May unit costs of projects with large flood storage be employed to estimate alternate costs of multiple purpose projects of lesser active capacity?

It is very difficult to determine whether or not the single purpose system selected by TVA for its alternate flood control estimates is more economical than any other possible alternate in the valley. Possibly somewhat lower unit costs might have been achieved at other alternate sites or by a different apportionment of multiple purpose storage among alternate plants.[24] But the requirement that alternate plants provide capacity located equally as strategically as the multiple purpose projects placed strict limits upon the degree to which departure could be made from adopted sites. For the volume of storage provided, average alternate capital cost per acre foot ($15.74) seems quite reasonable. It is less than the average storage cost which the United States Engineers determined for another system of Tennessee Valley flood reservoirs providing approximately equal storage.[25] Moreover, the

[24] The only large storage site on the Tennessee watershed which might have been substituted at any considerable saving for one of the projects of the adopted alternate system is on the French Broad River near Dandridge, Tennessee (commonly known as the Douglas site). The United States Engineers estimated that flood storage at this site could be provided for $10.80 per acre foot as compared with the TVA estimate of $15.30 for Mossy Creek on the Holston River. It is not clear that these estimates were upon comparable bases. If they were, the adjustment in total alternate flood control cost as a result of substituting the Dandridge site would still not be great due to the small storage which was planned for Mossy Creek. Indeed, the reduction in total alternate flood control cost would be only $1,540,000 or 1.1 percent. (Unit costs for the Dandridge site have been taken from *Comprehensive Report on Reservoirs in the Mississippi River Basin,* House Document 259, Seventy-Fourth Congress, First Session [1936], pp. 38-43. See also House Document 328, Seventy-First Congress, Second Session, p. 55.)

[25] See House Document 259, Seventy-Fourth Congress, First Session, pp. 44-48. Contemplating operation primarily for flood control on the Tennessee River system with incidental advantage to the lower Mississippi River basin, the Engineers estimated acre foot costs at $16.40. For all tributaries above Cairo (including low cost storage on the Kansas and Missouri Rivers), they set unit flood control costs at $15.70 per acre foot. For all reservoirs in the Ohio basin above Cairo, they put costs at $20.40.

Engineers' system would have required substantially higher annual expenditures for operation and maintenance than the TVA alternate system. Taking these costs into account and capitalizing them at four percent, equivalent capital cost of the selected alternate was $16.54 as compared with $20.50 for the system of House Document 259. The evidence does not seem to support the contention that the alternate system for flood control chosen by TVA was excessively expensive as compared with other possible systems.[26]

We come now to the problem of the significance of the acre foot as an index of the flood control utility of a reservoir project. Just what is the acre foot capacity for flood storage of a given reservoir? It is perhaps surprising that this apparently simple question has no single determinate answer. Customary procedure is to compute flood capacity as total reservoir volume at the start of a flood between the elevation corresponding to water surface at the dam and the elevation at the top of gates. The

[26] Note may here be taken of the alternate flood control system proposed by Mr. Ford Kurtz in testimony for the Commonwealth and Southern Corporation before the Joint Committee on the Investigation of the Tennessee Valley Authority. Mr. Kurtz' plan contemplated control of all major tributaries above Chattanooga by means of detention reservoirs. Available storage below reservoir crests in his system was 6,024,000 acre feet; estimated capital cost was $81,133,000 and annual operation and maintenance was set at $400,000. On an acre foot basis, capital cost was $13.50 and capital cost plus operation and maintenance capitalized at four percent was $15.10.

Although unit costs for Mr. Kurtz' system are not substantially out of line with TVA estimates, Kurtz' estimate for a total alternate system was considerably below that of the Authority because he believed the smaller storage of his plan would provide complete control at all strategic points on the Tennessee River.

The conflict between the Kurtz estimate and the TVA alternate plan for flood control is more apparent than real. The TVA ten-plant system includes only approximately 3,200,000 acre feet of controlled storage above Chattanooga. The Authority has estimated that complete control at that key point requires that the ten-plant system be supplemented by additional storage capacity on upstream tributaries in the amount of 1,600,000 acre feet (and be integrated with a planned system of levee works at the city). This is a somewhat smaller storage capacity than that planned by Kurtz (although his scheme also would have required local levee works). For TVA storage on the lower river, and especially for the Kentucky project which will provide 4,570,000 acre feet of controlled capacity for flood storage, the Kurtz plan would provide no substitute whatever. Had it included provision for downstream control equivalent to that planned by TVA, the Kurtz plan very probably would have required an expenditure even greater than that estimated by TVA for the adopted alternate flood control system.

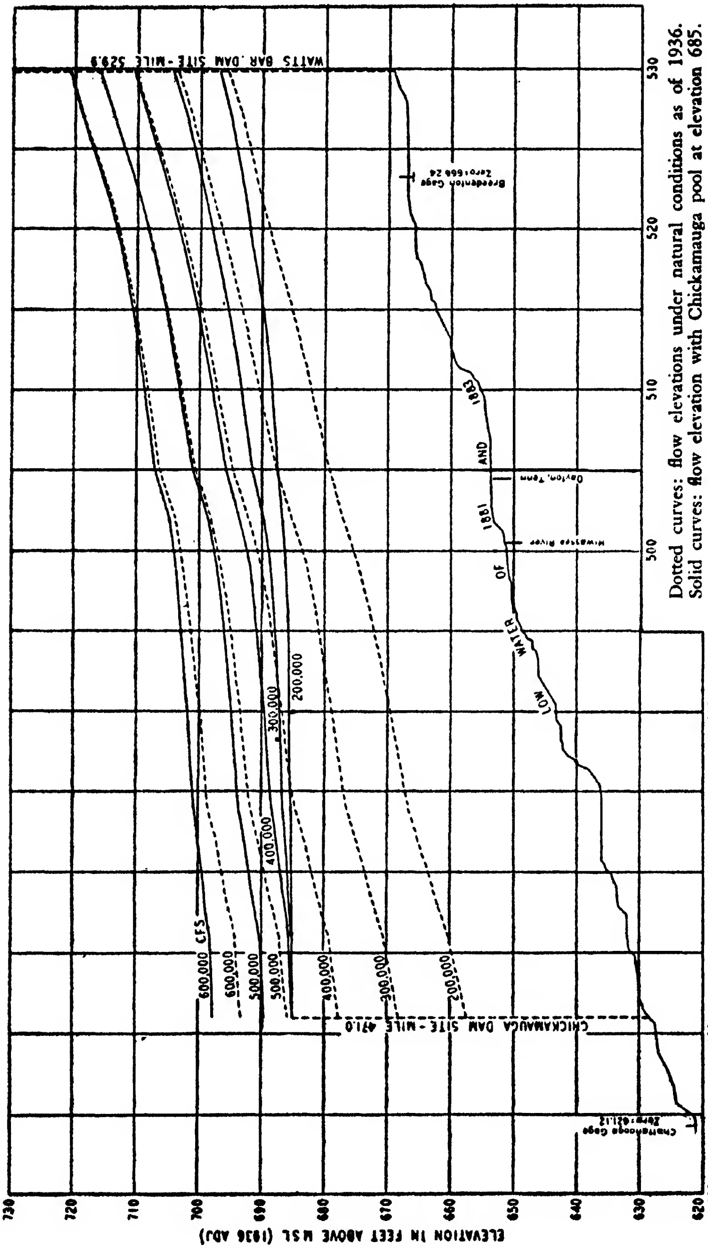
(See *Investigation of Tennessee Valley Authority*, Hearings, 3875, 3958 ff. and 4791 where Colonel Parker, TVA Chief Engineer, states that Kurtz' alternate flood control costs are "grossly underestimated.")

assumption is made that water rests behind the dam as a flat pool, and, by making use of detailed reservoir contour maps, close estimates of capacity between particular elevations are possible.

Unfortunately, the flat pool assumption does not conform to the facts. As long as there is flow in the stream, backwater from the dam is sloping. Let us assume that a great flood is forecast, and that the Chickamauga reservoir is drawn down in anticipation of dangerous flows. As a result of this management assume that reservoir elevation is held to 675 at the time that natural flow at the dam reaches 200,000 c. f. s. Under such circumstances acre feet of storage available to reduce the crest of the rising flood would certainly not be the simple volume of reservoir between elevation 675 and 685 (top of gates). Already, as Figure 12 suggests, surface elevations along upper reaches of the pool would be well above elevation 685. What, then, would be useful flood storage? The answer to this question would depend upon how much of stream flow it would be necessary that the project cut off. If the goal were to shut off 100 percent of stream flow during the flood period and any overflow spelled complete failure, then useful flood storage would be capacity between a backwater curve drawn for 200,000 c. f. s. flow at elevation 675 at the dam, and elevation 685. If the objective were to hold flow past the dam to no more than 200,000 c. f. s., then flood storage would be capacity between backwater curves drawn for 200,000 c. f. s. flow at elevations 675 and 685 at the dam. Finally, if the objective were to hold flow to no more than 400,000 c. f. s., available storage might be computed as volume between backwater curves for 200,000 c. f. s. at elevation 675 and 400,000 c. f. s. at 685 (both elevations at the dam).[27] Each of

[27] The fact that a part of this storage would have been accomplished by natural flow at a rate of 400,000 c. f. s. does not affect the line of the argument although it may affect the expenditure justifiable for the benefit. The critical requirement of any program for flood control is that floods be properly routed. That is to say, pools should be so operated that a maximum of the volume stored is scaled from the crest of the hydrograph. Operation to store equivalent amounts of water at different periods of a flood would imply quite varying contributions to reduction of flood crest.

The Authority has given considerable attention to the relative effects of controlled reservoir storage and uncontrolled valley storage on flood crests. For three floods of recent years the effectiveness of natural storage relative to controlled



Dotted curves: flow elevations under natural conditions as of 1936.
Solid curves: flow elevation with Chickamauga pool at elevation 685.

Figure 12. Backwater curves for Chickamauga project. (Source: Tennessee Valley Authority.)

these volumes is different, but each has significance as a volume of flood storage at the Chickamauga site. Indeed, volumes computed in this manner are of more real significance than volumes based upon estimates dependent upon the flat pool assumption.

Unfortunately, the technical difficulties of determining volumes between various backwater curves for various elevations at the dam are extraordinary, and for this reason their customary use is impractical. The substitute use of acre feet of available storage based upon the flat pool assumption is an evidently crude basis for comparing flood control costs of different projects. With different topographic characteristics downstream, with different flow characteristics of floods, and with different reservoir contours producing different backwater curves with equal rates of flow, it could well be that no method of operating one reservoir could be as effective in reducing either maximum stream flow or peak gage heights downstream as could a given method of operating another reservoir of equal capacity on the flat pool assumption.[28]

A third point touching on the TVA estimate for alternate flood control is that this alternate cost is determined by unit costs of a single purpose system which would store a considerably greater volume of water than the multiple purpose system. Is it reasonable to take Norris unit costs based upon storage of 2,550,000 acre feet or Mossy Creek unit costs based upon storage of 1,550,000 acre feet as indices of alternate costs of projects storing substantially less water? If any part of construction cost is fixed or if variable costs increase at varying rates as a project grows from small to medium and then to large scale, the assumption would not seem to be warranted.[29]

storage for reduction of flood crest in the Chickamauga reservoir was estimated as follows:

1917	30.3%
1926-1927	23.0%
1936	31.4%

The superior value of controlled storage is plain. (Tennessee Valley Authority, Memorandum, W. L. Voorduin to Dana Wood, April 15, 1938.)

[28] Mr. James S. Bowman, Head Project Planning Engineer at TVA, disagrees with this line of argument.

[29] The only project of the alternate system at which any considerable correction in unit costs would seem likely on account of the point here suggested is Mossy Creek. Since only 321,000 acre feet of the 8,895,000 acre feet of storage of the

Finally, it must be suggested that there is a certain qualitative difference between TVA multiple purpose flood storage and the type of storage which an alternate single purpose system would provide. This rests in the fact that the alternate system could be operated all of the time entirely for flood control. Although this might be a wasteful procedure from an economic point of view in that it would require sacrifice of potential joint products, the fact that capacity for flood storage would be continuously available should be recognized. This does not imply a necessary qualitative superiority in the flood protection of the alternative system. If detailed stream records are carefully examined and if seasonal flood rules are conservatively formulated to provide protection against any flood flow reasonably possible within a generous range of statistical variation, then any multiple purpose operation which scrupulously respects these rules may be considered of as high qualitative character as is necessary.

(3) The Alternate for Power

Alternate costs for the power benefit of the ten-dam system were estimated at $250,000,000. These costs were derived from estimated alternate costs per equivalent kilowatt for a single purpose hydro system. We see no reason to question either the Authority's estimates for construction cost of projects in the alternate power system or for power capacity of that system. There are, however, three possible grounds upon which one might question the $250,000,000 figure. First, it is conceivable that some other group of hydro plants or some combination of steam and hydro plants might be more economical than the alternate single purpose system selected for consideration. Although this is possible, the low cost per kilowatt-hour of equivalent primary of the alternate system does not indicate that it is probable.[30]

Second, the method employed for conversion of secondary power to equivalent primary assumes the validity of existing power rate structures. If allocation is to have any bearing upon

ten-dam system are assigned to this plant, even a considerable adjustment of Mossy Creek unit costs would not materially affect the estimate for system alternate flood control cost. (See above, Note 24.)

[30] See below, pp. 328-329.

power rates, it seems that any use of rates in the mechanics of allocation involves circular reasoning. This difficulty is of some theoretical importance, and no ready solution suggests itself. A possible approach would be to add to the costs of the multiple purpose system costs of priming its supply of secondary energy, treat this additional investment as direct cost for power (temporarily held in suspense), and allocate joint cost according to remaining alternate cost of developing primary equivalent to original primary plus primed secondary of the multiple purpose system. Whether this solution would be correct if the market for secondary were sufficiently favorable to permit its sale at rates making conversion to primary unattractive is questionable.

Another method whereby circularity might be avoided in computing alternate power cost of a system developing both primary and secondary energy would be as follows: The two most favorable alternate systems developing approximately the amounts of primary and secondary of the multiple purpose system might be set up. Unit costs of primary and secondary might be determined by using quantities of each type of power in each system as co-efficients, equating their sum in each case with system costs, and solving two equations in two unknowns.[31] If if were felt that reliable relations between classes of power could not be determined by observation of but two systems, a number of alternate systems could be studied. Quantities of primary and secondary power available in each could be determined, and unit costs for each class of power could be determined by means of statistical

[31] Assume that power available in the multiple purpose system is made up of ten units of primary and two units of secondary. Investigation of two alternate systems reveals that at Alternate Number 1 an investment of 10 units will return 8 units of primary and 4 units of secondary. At Alternate Number 2 an investment of 12 units will return 10 units of primary and 1 unit of secondary. On the basis of these alternates, alternate cost of the multiple purpose system could be determined as follows:

$$\begin{aligned} 10\,p + s &= 12 \\ 8\,p + 4s &= 10 \\[6pt] 32\,p &= 38 \\ p &= 1\tfrac{3}{16} \\ s &= \tfrac{1}{8} \end{aligned}$$

Alternate cost of multiple purpose system:
$10\,p + 2\,s = 11\tfrac{7}{8} + \tfrac{1}{4} = 12\tfrac{1}{8}$

"normal" equations.[32] Unfortunately, this simultaneous equation technique appears to make two assumptions which are contrary to fact: first, that the same laws govern availability of different classes of power at single and at multiple purpose plants, and second, that primary and secondary are equally important objectives of a power system. Since secondary is always a subsidiary objective and since the laws which govern multiple purpose operation decree that secondary shall be relatively greater than at power-only plants, the inaccuracy of these assumptions would cause this method of costing to overstate alternate power costs of multiple purpose systems.

Still a third method is available whereby circularity may be avoided in dealing with secondary power. This would overtly recognize secondary as a by-product. The alternate power system would be proportioned to supply simply primary power equivalent to the multiple purpose system. For purposes of allocation, cost of this alternate would be adjusted downward for capitalized market value of its available secondary. The power allocation of common cost, determined according to this alternate cost, would then be chargeable entirely to primary. Secondary would be disposed of at the most favorable rate the market would bear.

A final score upon which one might question the alternate cost for power tentatively proposed for the ten-plant system is that power available in the alternate system is not as great as in the multiple purpose system. If any phase of the alternate system is in a state of decreasing costs, the result is a tendency toward overstatement of alternative power cost. If the alternative system is throughout in a condition of increasing cost, there is a tendency toward understatement of alternate power cost.[33]

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[32] Frederick C. Mills, *Statistical Methods* (1939), p. 250.

[33] In explanation of the fact that both the alternate power and alternate flood control systems produce somewhat different quantitative benefits than the ten-dam multiple purpose system, we may point out that it would be almost impossible to select an economical alternate system which would produce benefits identical to those of the multiple purpose system. Almost surely optimum economic development of alternate sites would lead to the development of something other than the exact amount of benefits of the multiple purpose system.

JUSTIFIABILITY OF ALTERNATE COSTS

An essential feature of the alternate justifiable expenditure theory is review of alternate costs to determine their justifiability. In Chapter X above we have already examined the problem of evaluating the major benefits of the TVA multiple purpose program. Let us apply the findings of that discussion to the alternate costs which we are here considering. First, the alternate cost of the TVA flood control program seems less than any probable fair valuation of the benefits of this objective. Appraised in this manner, the alternate flood control system is "justified."

The benefit value of the navigation program relative to its alternate cost is not clear. Annual costs for the alternate system (on the assumption of 3.5 percent to cover interest and sinking fund depreciation and $1,272,000 for annual operation and maintenance expense) would be in the neighborhood of $7,000,000. If we assume that the saving in shipping costs as a result of water transportation is $1.25 per ton, annual river traffic would have to be perhaps 4,800,000 tons in order that, in conjunction with other benefits of the navigation program, total annual costs of the alternate system might be justified. Although river transportation has been increasing, it is still only about one half the 4,800,000 ton figure. On these grounds it might be urged that alternate navigation cost should be scaled down to a maximum "justifiable" figure. We refrain from doing this for two reasons. First, it is not demonstrable that full alternate cost is not justified. The future development of river traffic may be sufficient so that, even when its savings are discounted for their present value, high annual costs are presently justified.[34] There may also be a hidden annual saving from the navigation program because of railway rate reductions on hauls competitive with water transportation. Second, from the point of view of the Authority the navigation program was directed and not discretional. In 1930 Congress adopted a project for a nine-foot channel on the Tennessee, and in 1935 it directed TVA to execute this project. Congress is

[34] A dispatch reported from Washington by J. Lacey Reynolds to the Nashville *Tennessean* and published on Sunday, October 26, 1941 quotes the Authority as having estimated annual savings from the navigation program at $3,000,000 for 1945 and $15,000,000 annually by 1960.

convinced of the justifiability of a nine-foot improvement of the river, and it is not the province of another instrument of government to question this finding.

Finally, the alternate cost of the power program appears to be justified. Assuming four percent annual charges to cover interest, sinking fund depreciation and insurance, annual alternate cost per kilowatt of equivalent primary would be $19.31, and cost per kilowatt-hour would be 2.21 mills.[35] On the basis of TVA experience, 1.5 mills per kilowatt hour are adequate to cover general administration, transmission, sales taxes and miscellaneous costs. Combining these figures, the resultant wholesale cost of energy delivered from the alternate system would be 3.71 mills per kilowatt-hour, less than one percent in excess of the average revenues per kilowatt-hour which the Authority estimated its wholesale rates established for multiple purpose operation would yield.[36] This difference is within the limits of accuracy of the estimates. The readiness with which the Authority has marketed power of the multiple purpose system at its established rate schedules provides abundant evidence of the justifiability of an alternate system whose costs so closely approximate revenues under these rates.

We may conclude that for purposes of allocation none of the

[35] The Authority has found 3.91 percent adequate for fixed charges on dams, reservoirs and generating station equipment. For the alternate system this rate of fixed charge would be equivalent to 2.16 mills per kilowatt hour.

[36] With a fixed charge rate of 3.91 percent, cost of the alternate system would be less than average revenues of 3.675 mills per kilowatt-hour which the Authority forecast from multiple purpose operation.

Costs per kilowatt hour for the alternate system have been computed as follows:

Rate of fixed charges	3.91%	4.00%
Operation and maintenance (per kilowatt)	$ 3.07	$ 3.07
Fixed charges (on $406)	15.87	16.24
Annual costs per kilowatt	$18.94	$19.31
Annual kilowatt hours	8760	8760
Annual cost per kilowatt-hour	$ 0.00216	$ 0.00221
Add general administration, transmission, sales, taxes and miscellaneous	.00150	.00150
Total cost of wholesale delivered power per kilowatt-hour	$ 0.00366	$ 0.00371

alternate cost estimates which we have summarized above is demonstrably "unjustifiable." We may proceed, therefore, to the mechanics of allocation according to the alternative justifiable expenditure principle.

MECHANICS OF ALLOCATION OF THE TEN-PLANT SYSTEM BY THE ALTERNATE JUSTIFIABLE EXPENDITURE METHOD

Since the alternative justifiable expenditure principle is a version of benefit method, alternate justifiable expenditure for each objective must be adjusted for direct cost of that purpose

TABLE 52

ALLOCATION OF COST OF TVA TEN-DAM SYSTEM

	Navigation	Flood Control	Power	System Total
	(All costs in thousands of dollars)			
1. Total alternate cost	163,520	140,826	250,096	554,442
2. Direct cost[a]	45,214	33,763	110,977	189,954
3. Remaining alternate cost	118,306	107,063	139,119	364,488
3a. Percent of remaining alternate cost	*32.4*	*29.4*	*38.2*	*100.0*
4. Allocation of system joint cost[a]	72,132	65,454	85,045	222,631
5. Total charges[b]	117,345	99,217	196,022	412,584
5a. Percent distribution of total charges	*28.4*	*24.1*	*47.5*	*100.0*

[a]Direct and total joint costs are taken from Table 21.
[b]These charges are computed on the basis of replacement cost new of Wilson Dam. According to the report of the TVA Valuation Committee, present value of Wilson Dam on January 1, 1933, was $31,300,000 and replacement cost new was $34,895,000. Consequently, the accounts reflected above include $4,775,000 of depreciated investment at Wilson Dam. In a final table of its tentative ten-dam allocation TVA adjusts for this depreciation. The resultant allocation of $407,810,000 of estimated original investmen value to the Authority is 28.4 percent to navigation, 24.3 percent to flood control and 47.3 percent to power.
Source: *Investigation of the Tennessee Valley Authority*, Hearings, 5335–5336.

in the multiple purpose system.[37] Allocation of joint cost is then carried out in direct proportion to remaining alternate justifiable expenditures. Application of this technique of cost apportionment to the TVA ten-dam system is made in Table 52.

PROBLEM OF SUBALLOCATIONS TO PROJECTS

We have now traced through the TVA tentative allocation of cost of the ten-dam system. The question next arises as to how

[37] See above, Conclusion to Chapter X.

suballocations to particular projects may be determined. Two approaches to the problem of suballocation have been suggested. Let us consider first the method of "subtraction of successive systems."

In a report and accompanying notes dated November 18, 1940 TVA presents allocations of its five-, six- and seven-plant systems. By subtracting allocated costs of the six-plant system from those of the seven-plant system, which adds the Hiwassee project, it is possible to determine the manner in which the addition to system investment as a result of the inclusion of Hiwassee has been effectively allocated. This procedure has been carried out in Table 53.

TABLE 53

SUBALLOCATION OF HIWASSEE PROJECT BY SUBTRACTION OF SUCCESSIVE SYSTEMS

	Navigation	Flood Control	Power	Total
	(All costs in thousands of dollars)			
Total charges, seven-plant system	64,648	36,518	109,113	210,279
Total charges, six-plant system...	63,332	29,513	100,452	193,297
Total charges at added plant (Hiwassee)..................	1,316	7,005	8,661	16,982
Direct costs at added plant......	....	210	3,254	3,464
Allocation of common costs at added plant..................	1,316	6,795	5,407	13,518
Percent allocation of common cost at added plant...........	*9.7*	*50.3*	*40.0*	*100.0*

Source: Compiled from report of Tennessee Valley Authority on "Allocation of Investment in the Wilson, Norris, Wheeler, Pickwick Landing, Guntersville, Chickamauga and Hiwassee Projects," submitted to the President on November 18, 1940.

Although the method of Table 53 is attractive because of its simplicity, it has certain logical deficiencies. The most important of these is its implicit assumption that all projects are equally favorable as judged by the standard of total remaining benefits [38] relative to project joint costs. If a particular added plant has a smaller ratio of remaining benefits to joint costs than is typical for the system to which it is added, it is quite possible that the method of subtraction of successive systems would yield suballocations to one

[38] Throughout the following discussion there has been substituted for the phrase "alternative justifiable expenditure" the less cumbersome term, "benefit."

or more purposes which would not be justifiable by the addition which the plant makes to benefits for those purposes. Table 53 seems to suffer from exactly this defect, for the indicated charge to navigation at Hiwassee is $1,316,000 as compared to an estimated project contribution to system navigation benefits of $1,000,000.[39]

Let us explore this difficulty further. The principle of system allocation which we are here analyzing apportions joint costs according to remaining benefits. Let us assume the addition to a three-purpose system of a project useful for but two purposes. Total remaining benefits and total joint costs will be greater than before the project was added. But remaining benefits for the purpose not present in the added project will presumably be constant. It follows that remaining benefits for this purpose relative to total remaining benefits must be less than formerly, and the *proportion* of joint cost chargeable to it must decline. But while the proportion of joint cost chargeable to the purpose omitted at the added project will decline, it may not decline by exactly the proper amount to maintain the absolute allocation to this purpose at a constant level. If the relative increase of joint cost is greater than the relative decrease in proportion of such cost chargeable to the missing objective, then the total allocation to the missing purpose will increase.[40] If the relative increase in joint cost is equal to the relative decrease in the proportion chargeable to the missing purpose, then the total allocation to this purpose will be constant. Finally, if the relative increase in joint cost is less than the relative decrease in the proportion of such cost chargeable to the missing purpose, the total allocation to this purpose will be less than formerly.

In general terms, the difficulty with the subtraction of systems method for determination of suballocations is that it assumes the change in total allocations with the addition of an extra

[39] The net increase in system remaining benefits from addition of Hiwassee may be estimated as approximately $18,000,000, or, say, eight percent. On the other hand, the net increase in system joint costs from the addition of Hiwassee is $13,518,000, or approximately 11.5 percent. Because the relative increase in joint costs exceeds the relative increase in remaining benefits, an "excessive" allocation to navigation is possible.

[40] This is the condition which obtains for the navigation objective at the Hiwassee project in Table 53.

project is an index of the characteristics of the added plant. In fact, the increments to relative benefits as a result of adding a particular plant may be of insufficient weight to be reflected fully in the final allocation proportions. The difference in total allocations of the six- and seven-plant systems is not a precise index of the characteristics of Hiwassee project. The weight of the proportions of alternate costs of the initial six plants carries over to affect the allocation of the system after inclusion of the seventh. This is the secret of the "excessive" charge to navigation at Hiwassee in Table 53.

Under certain circumstances an alternative and far more satisfactory procedure for breaking down allocations among projects is available. In essence, this method is an extension of the logic of the remaining alternate justifiable expenditure method of system allocation. It presupposes two things: first, that total system allocations have been determined, and second, that remaining alternate justifiable expenditure may be fixed for each purpose (or for all purposes but one) at every project. With these conditions filled, suballocations are achieved by breaking down total allocations for each purpose among plants according to the proportion of total remaining alternate cost contributed by each plant. If there is one purpose for which alternative justifiable expenditure cannot be divided among particular projects, suballocations may be found for all other system purposes and the remainder of total cost at each project represents the appropriate suballocation for the residual purpose. An application of this method of suballocation to the Hiwassee project as part of the seven-plant system is presented below in Table 54. It will be observed that no purpose for which alternate justifiable expenditure can be computed.is assessed a burden greater than is justifiable.

As an application of the alternative justifiable expenditure theory the procedure of Table 54 has most of the strengths and weaknesses of this basis of allocation. As a technique for allocating plants which are part of a still growing system, however, it has a particular weakness. This is that the allocation of a given project does not remain the same as the system expands. For accounting purposes this deficiency is very nearly fatal, for it is certainly impracticable to revise allocated values entered upon permanent financial records whenever an additional plant is added to the system.[41]

TABLE 54

SUBALLOCATION OF HIWASSEE PROJECT BY THE REMAINING ALTERNATE JUSTIFIABLE EXPENDITURE METHOD

Part 1. *Suballocations to navigation and flood control.*

	Navigation		Flood Control	
	Seven-Plant System	Hiwassee Project	Seven-Plant System	Hiwassee Project
	(All costs in thousands of dollars)			
1. Alternate justifiable expenditure	106,160	1,000	63,260	10,950
2. Direct cost	17,178	.....	4,871	210
3. Remaining alternate justifiable expenditure	88,982	1,000	58,389	10,740
3a. Percent of remaining alternate justifiable expenditure	*100.0*	*1.1*	*100.0*	*18.4*
4. Assignment of common cost[a]	47,470	533	31,647	5,830
5. Total charge for purpose	64,648	533	36,518	6,040
5a. Percent of total charge	*100.0*	*0.8*	*100.0*	*16.5*

Part 2. *Suballocation to power.*

	Total Cost of Hiwassee Project (1)	Charges to Navigation and Flood Control (2)	Charges to Power[b] (3)
	(All charges in thousands of dollars)		
Direct cost	3,464	210	3,254
Common cost[c]	13,518	6,363	7,155
Sum of charges	16,982	6,573	10,409

[a] Common cost suballocated to Hiwassee project according to the percentage figures of line 3a.
[b] Column (3)=Column (1)—Column (2).
[c] Percent allocations of Hiwassee common cost are as follows: navigation, 3.9 percent; flood control, 43.2 percent; and power, 52.9 percent. These figures compare with suballocations determined by subtraction of successive systems of 9.7 percent, 50.3 percent and 40.0 percent respectively. (See Table 53 above.)
Source: Compiled from Seven-Dam Allocation Report of November 18, 1940.

The present discussion of suballocations may be concluded with the observation that so long as some version of benefit principle is to be employed for allocation it is very doubtful whether any meaningful joint cost assignments can be determined for par-

[41] Yet logically it seems eminently reasonable to assert that the value of any plant would tend to vary according to the system of which it might happen to be a part.

ticular projects of a comprehensive system. The fact is that system benefits are not additive results of operation of individual projects but that they are in the nature of a chemical product of the co-ordinated operation of separate plants. This is true not only for the navigation program where it is obvious that a small break in the continuity of the river channel could force complete suspension of through shipping but at least equally for the power and flood control programs as well. If benefits themselves cannot be traced to particular projects, it is difficult to conceive how the benefit principle can be employed to apportion allocated common costs among plants.

ALLOCATION OF THE THREE-DAM SYSTEM

For purposes of comparison with other proposed allocations we include below in Table 55 a division of the costs of the Norris-Wheeler-Wilson system according to the alternative justifiable expenditure principle. This was the allocation to which the Authority gave greatest weight in determining the percentages which it adopted for apportionment of costs of the three-dam system. Since the method of Table 55 is identical with that of Table 52, we need not discuss the details of this allocation.

ANALYSIS OF THE ALTERNATIVE JUSTIFIABLE EXPENDITURE PRINCIPLE

We come now to the problem of appraising the alternative justifiable expenditure method of allocation as an application of benefit theory. This analysis may be carried forward under four headings.

(1) Uncertainty of Alternate Costs

Despite its ostensible accuracy, the alternative justifiable expenditure method suffers a deficiency common to all types of benefit theory, namely, there is wide room for variation among different estimates of benefit values of the various purposes. This is true even if those making estimates are honest and impartial experts, for there is wide scope for the play of judgment in interpretation of such terms as "alternate system" or "equivalent benefit." This difficulty is perhaps of but minor importance if alternate projects differing but slightly in design from adopted multiple purpose plants may be assumed. But if alternate schemes differ greatly from the adopted system,[42] the room for adoption of divergent assumptions is so great that there can be small hope of arriving at any single "correct" allocation.

TABLE 55

ALLOCATION OF COST OF TVA THREE-DAM SYSTEM
(June 9, 1938)

	Navigation	Flood Control	Power	System Total
	(All costs in thousands of dollars)			
1. Total alternate cost	48,334	33,210	79,230	160,774
2. Direct cost	4,409	2,600	26,059	33,068
3. Remaining alternate cost	43,925	30,610	53,171	127,706
3a. Percent of remaining alternate cost	*34.4*	*24.0*	*41.6*	*100.0*
4. Allocation of joint cost[a]	22,643	15,779	27,410	65,832
5. Total charges[b]	27,052	18,379	53,469	98,900
5a. Percent distribution of total charges[c]	*27.4*	*18.6*	*54.0*	*100.0*

[a]System joint costs are distributed according to the percentages of line 3a.
[b]Total charges are the sum of line 2 and line 4.
[c]This allocation is based upon replacement cost new of Wilson Dam as reported by the TVA Valuation Committee. If accrued depreciation at Wilson Dam on January 1, 1933, is taken into account, the division of cost becomes as indicated in Table 55-A below.

TABLE 55-A

THREE-DAM ALLOCATION ADJUSTED FOR WILSON DAM DEPRECIATION

Purpose	Direct Cost	Allocation of joint cost		Total Charge to Purpose	
		Total	Percent	Total	Percent
	(All costs in thousands of dollars)				
Navigation	4,076	21,432	33.8	25,508	27.1
Flood Control	2,600	15,713	24.7	18,313	19.5
Power	23,967	26,338	41.5	50,305	53.4
System total	30,643	63,483	100.0	94,126	100.0

Source: House Document 709, Seventh-Fifth Congress, First Session.

It may be worth while to indicate the effects upon allocation percentages for the ten-dam system of quite possible variations in alternate justifiable expenditures. We have already pointed

[42] For example, this would be the case with either a low dam navigation alternate to the TVA high dam plan or a series of detention reservoirs as an alternate to TVA flood storage.

out the possibility that full alternate cost for navigation may not be justified. If $50,000,000 represents maximum justifiable expenditure for navigation and if alternate justifiable expenditures for flood control and power should be $150,000,000 and $300,000,000 (rather than $141,000,000 and $250,000,000 as determined by Tables 50 and 51), the allocation of common cost to power should be increased from 38.2 percent to 60.8 percent. On the other hand, if alternate justifiable expenditures for navigation and flood control should each be $200,000,000 and alternate justifiable expenditure for power should be $260,000,000 then the allocation of common cost to power should be decreased from 38.2 percent to 31.6 percent of common costs.

Although we do not contend that TVA estimates for alternate systems are inaccurate, we do contend that they are not demonstrably correct as opposed to other possible estimates for alternate systems. In their very essence, future or hypothetical costs such as those which govern the alternative justifiable expenditure basis of allocation are uncertain. Estimates of them can be no more than approximate. This point is well illustrated by TVA experience. Original working estimates for the Hiwassee project contemplated an expenditure of $20,115,000 for the initial stage of this plant. In the seven-dam allocation report, which was issued with the Hiwassee books of construction cost practically ready to close, total cost for the initial stage was set at $16,982,000, a reduction of 15 percent from the original figure. While this reflects creditable conservatism in TVA working estimates and efficiency in TVA construction work, the fact remains that in advance of construction the Authority could not determine with certainty how much it would cost to develop a particular site. If this is so for a site which had been as exhaustively drilled and thoroughly surveyed as had Hiwassee, it is obviously much more true for sites at which preliminary investigations have not been carried out in careful detail. Estimated costs for alternate systems including such sites can be no more than roughly approximate.

(2) Failure to Consider Annual Operation and Maintenance Costs of the Alternate Systems

A particular deficiency of the TVA version of the alternative justifiable expenditure principle is the fact that the Authority does not include in its computations of alternate expenditures any consideration of necessary costs for operation and maintenance of the alternate systems. It cannot be repeated too often that the reality of costs lies in their annual burden rather than simply in total investment figures. Two otherwise identical systems which differ in necessary annual operation and maintenance expenses would not be equally favorable. True, the difficulties of including figures for operation and maintenance in the allocation computation are considerable, for they include not only estimation of the annual burden of these costs but also determination of an appropriate rate at which to capitalize them. But if no effort is made to overcome these difficulties and differences in operation and maintenance are simply ignored, the result is arbitrarily to weight allocations in favor of purposes for which alternate systems would involve relatively high operating costs and against purposes for which alternate systems would involve relatively low operating costs.

Adjustment of the ten-plant allocation of Table 52 to include consideration of operation and maintenance costs of alternate systems capitalized at four percent is indicated in Table 56. The effect of the adjustment is slightly to increase charges to power and navigation (for which alternate operating costs would be relatively high) and to decrease charges against flood control (for which alternate operating costs would be relatively low).[43]

(3) Overlapping of Alternate Systems

A vital weakness of the alternative justifiable expenditure principle, as applied by the Authority, is the fact that the so-called alternate systems typically overlap. This seems inconsistent with the rationale of the benefit principle. This rationale is essentially that construction of the multiple use system and the incurring of

[43] It might be argued that total joint costs of the multiple purpose system should also be adjusted for capitalized joint costs of operation and maintenance. Such an adjustment of joint cost would have no effect upon allocation percentages.

joint costs forestalls and avoids costs of attaining equivalent benefits by single purpose plants (in so far as such plants would have been economically feasible). Since each purpose benefits by relief from its single purpose costs, it is considered reasonable to divide joint costs proportionately to these avoided costs. Because all purposes exist contemporaneously at the multiple purpose undertaking, logic requires that the "avoided" systems also be such that they could be co-existent in time. It follows that no alternate

TABLE 56

ALLOCATION OF COST OF TEN-DAM SYSTEM ACCORDING TO REMAINING ALTERNATIVE JUSTIFIABLE EXPENDITURE INCLUDING CAPITALIZED OPERATING COSTS

	Navigation	Flood Control	Power	System Total
	(All costs in thousands of dollars)			
1. Total alternate cost[a]	195,320	147,500	298,000	640,820
2. Direct cost	45,214	33,763	110,977	189,954
3. Remaining alternate cost	150,106	113,737	187,023	450,866
3a. Percent of remaining alternate cost	*33.3*	*25.2*	*41.5*	*100.0*
4. Allocation of joint cost[b]	74,110	56,110	92,410	222,630
5. Total charges[c]	119,324	89,873	203,387	412,584
5a. Percent distribution of total charges[d]	*30.0*	*21.8*	*49.2*	*100.0*

[a]Alternate cost figures include operation and maintenance expense capitalized at 4 percent.

[b]Total joint cost is divided according to the percentages of line 3a.

[c]Line 5 = Line 2 + Line 4.

[d]The percentages of Line 5a compare with allocations of total cost in Table 52 of 28.4 percent to navigation, 24.1 percent to flood control, and 47.5 percent to power. The reduction in the total charge against flood control is $9,344,000, or 9 percent of the original allocation.

project is eligible for inclusion in more than one alternate single purpose scheme. Violation of this rule tends to deprive the sum of alternate costs of any meaning as a measure of "benefits." If total alternate costs have no significance as benefits of the several project purposes considered, no allocation according to the proportions of parts of this total can be a proper application of benefit theory.

Superficially, this difficulty does not seem to go to the heart of the alternative justifiable expenditure theory, for apparently it can be overcome by simply determining alternate expenditures for non-overlapping single purpose systems. But in fact the remedy is not so simple. If we agree that no project shall be included in more than one alternate system, then we must arrive at a basis for assigning favorable and unfavorable sites among purposes. Two methods for such a distribution may be suggested. First, an effort could be made to divide the more and the less favorable sites among purposes more or less equally so that no one objective would benefit greatly at the expense of the others. Second, the optimum complete alternate system for one objective could be determined; out of remaining sites, the optimum system for a second objective could be determined; and finally, out of still remaining sites, the best alternate for the third purpose could be set up. Obviously, the results of allocation would vary tremendously according to which method were employed and which purposes were given priority. Yet there seems to be no compelling *a priori* reason for apportioning sites in any particular way among purposes.

It is quite possible that recognition of the fact that alternate systems should not overlap will spell the doom of the alternative justifiable expenditure method of allocation. It will almost certainly doom the method so far as are concerned multiple purpose systems in well developed watersheds; for there simply will not be enough alternate sites available for distribution among the several purposes.[44] An effort to apply the method would yield unjustifiable alternate costs which would have to be scaled down to a justifiable level. Since justifiable expenditure is inherently uncertain, the hope for exactness in allocation (which originally led to the adoption of a cost criterion of benefits) would be defeated. The method might as well be abandoned.

(4) Failure to Consider Opportunity Costs

A final weakness of the TVA application of the alternative justifiable expenditure method of allocation is perhaps unavoidable in this method. This is its failure to consider the opportunity costs which would be involved in developing alternate single purpose systems. In theory the cost of acquiring a given resource cannot be less than the highest value it might reasonably be ex-

[44] In a river valley with many favorable sites, the method might be applied to a small multiple purpose system.

pected to have in an alternate use. Capital, for example, would not be loaned to a given industry for less than six percent if it could fairly be expected to yield six percent in any one of many competing investment lines (other things being equal). Similarly, resources will not be alienated for prices which reflect less than the capitalized value of their alternate earning power.[45]

TABLE 57

EXAMPLE OF OPPORTUNITY COSTS OF SINGLE PURPOSE RIVER DEVELOPMENT

	Multiple Purpose Project	Project for Navigation Only
Capital cost	$20,000,000	$10,000,000
Rate of return	6%	3%
Public rate of interest	3%	3%
Rate of return in best alternate use for $10,000,000 saved if project for navigation-only is selected	....	4%
Total equivalent annual return on capital cost of multiple purpose project	$ 1,200,000	$ 700,000
Annual loss from selecting project for navigation only	....	$ 500,000
Capitalized value of annual loss from selecting project for navigation only[a]	....	$16,666,667

[a]At capitalization rate of 3.0 percent.

But it is important that earning power in the sense here implied means value productivity only in fields susceptible of development by private enterprise. It does not include value productivity in alternate fields suited only to development by public authority. Let us clarify this point by an example.

[45] To the student of economics this latter point has significance in connection with the costs of reservoir projects which flood out valuable farm lands. It has often been argued that projects involving high overflow costs are relatively less favorable than projects producing equivalent benefits at equal pecuniary costs but at lower costs for land. The reasoning seems to be that land is a peculiarly productive agent, the effect of the loss of which to society is not fully measured by price. This argument fails to recognize that labor and capital as well as land are "productive." Projects whose costs for the former factors are relatively high and whose costs for land are relatively low need not be socially more desirable than otherwise equivalent projects with relatively higher costs for land: just as has land, so also have the other factors alternative uses. If the money costs of two projects involving different land costs are alike, we may assume that the labor and machinery saved in the project with relatively high land costs during the period of construction will create alternative goods or services of a value equivalent to the extra value of the land submerged.

This argument may be applied to the project of the Tennessee Valley Authority at the Douglas site on the French Broad River. From a cost-benefit standpoint

Assume that multiple purpose development of a given river is feasible and that it would return a large surplus of annual benefits over annual costs. Assume further that a single purpose navigation improvement along the same stream (which would block multiple purpose development) would also yield an apparent surplus of annual benefits above annual costs but that the rate of excess would not be as great as for the more comprehensive project. Should the single purpose navigation plan be considered "feasible" under rigid economic reasoning? We submit that it should not. The fact is that its costs are crucially understated by strict consideration of money outlay only. A most important hidden cost of the single purpose alternate would be the foregone opportunity to develop the favorable multiple purpose improvement. On the basis of hypothetical costs, rates of return and rates of interest, the analysis of Table 57 suggests the nature of opportunity costs involved in single purpose improvement.

The analysis above may be applied to TVA estimates of alternate costs of developing benefits equivalent to those of the ten-dam system. If multiple purpose improvement at alternative sites (for example, Mossy Creek) would be substantially more economical than single purpose, the necessity of foregoing co-ordinate benefits in choosing to develop a single purpose should be treated as one of the costs of a single purpose choice. If both types of improvement were susceptible of development by private enterprise, the cost of the foregone favorable opportunity would tend to be included in the prices of resources used in the less favorable

this site is extremely favorable, but its improvement was long delayed because of the fact that it would flood out large areas of valuable agricultural land. From a strictly economic point of view the extremely low cost of potential power and flood storage at Douglas (including payment for land based upon its present or reasonably prospective earning power in alternate uses) seems to indicate that the site is better suited for development of a storage reservoir than for use in agriculture. It appears that resources would have been mis-apportioned if storage development of Douglas had been neglected for improvement of some higher cost site.

The analysis above makes several assumptions which should be noted. First, it assumes a probability of employment of resources saved by improvement of the "low cost" site. Second, it assumes that monopoly is not a significant factor affecting prices of resources. Third, it assumes that economic costs are a fair index of social costs. In fact, the social distress of readjustment of large populations as a result of flooding an apparently favorable reservoir might justify selection of a site somewhat less favorable from a pecuniary standpoint.

development. But because private enterprise cannot profitably develop resources for non-salable (but valuable) benefits, money costs do not reflect maximum value productivity of resources to Government when a part of productivity would be in such lines as navigation or flood control. In any particular case correct evaluation of opportunity costs would surely be a difficult, if not impossible, task. But no joint cost allocation according to alternate single purpose costs which ignores the existence of opportunity costs can be theoretically sound.

CONCLUSION

We may now close our discussion of the alternative justifiable expenditure principle for allocation. We believe this to be the most satisfactory version of benefit theory. Largely upon the basis of its interpretation of this principle TVA has determined its official allocations. Unfortunately there are a number of serious practical difficulties which make a logically consistent application of alternative justifiable expenditure method very difficult to achieve. These include the setting up of feasible, non-overlapping alternate systems, the apportioning of favorable alternate sites among purposes, and the evaluation of opportunity costs. Almost on a par with these problems are the uncertainties of estimating alternate costs and justifiable expenditures.

Even if a logically consistent application of alternative justifiable expenditure method could be achieved, it would be inherently subject to the theoretical disadvantages which were indicated in the preceding chapter as typical of any expression of benefit method. It would not trace costs in a functional manner, and there seems no reason to believe that it would provide a basis for rate making consistent with wise public policy.

Quite different from the several versions of benefit theory of allocation were a number of proposals that TVA joint costs be apportioned according to the relative use made of reservoir capacity by each purpose. Since amount of use seems to be a measurable quantity, it was asserted by some that a use basis for allocation could avoid the uncertainties of the benefit principle. We consider reservoir use theories in Chapter XII below.

Chapter XII

THE USE THEORIES OF JOINT COST ALLOCATION

Summary. The failure of different versions of benefit theory suggests resort to a principle for cost apportionment dependent upon definable and measurable physical relations. The most promising such principle would seem to be some version of allocation according to relative use of reservoir capacity for each purpose. Such a principle would be analogous to the division of overhead costs of manufacturing enterprise according to man-hours or machine-hours.

There are two leading versions of so-called "use" theory for allocation of reservoir costs. The first of these is the reservoir content method. According to this principle, total joint cost at each project is broken down on a proportionate capacity basis among horizontal sections of storage. Pro-rated cost for each section is then divided equally among the purposes which it serves. This method has the logical advantage that total project costs and usually joint costs are related more or less closely to reservoir capacity. It is weak because of the arbitrary assumptions it makes in arriving at the costs of reservoir sections and because it employs an arbitrary principle for dividing the costs of particular sections.

A second "use" method is allocation according to relative use of reservoir storage. This resembles the reservoir content method in that it divides total joint costs into parts proportionate to capacity in successive layers of total storage. It attempts a more rigorous application of the use principle, however, by dividing the different subdivisions of joint cost according to the relative use of capacity in each section by the several beneficial purposes. For both theoretical and practical reasons the use-of-storage method is less satisfactory than the reservoir content method.

Relative use does not provide a solution to the problems of joint cost apportionment.

GENESIS OF THE USE THEORIES

According to the use principle of allocation, joint costs of a multiple purpose system should be divided among purposes according to the relative use which each makes of the joint expenditure. This principle has long been familiar in the general manufacturing field where it has been applied primarily to the distribution of overhead costs rather than the division of strictly joint costs as we have defined them in Chapter VII. For example, in discussing costing for service departments,[1] Lawrence states:

> "There are several bases of measurement which can be used to measure and distribute the cost of service rendered by a service department. For example, some classes of service may be measured with meters; other services may be rendered in proportion to the number of workers receiving the service, to the total labor cost of the departments served, or to the floor space or cubic space occupied; and in some cases the cost of each department served may be used as the basis of measurement.
>
> "The chief problem involved in the distribution of service department costs is to select some basis of measurement which will apply the cost of the service department correctly to the departments served."[2]

Each of the bases of apportionment suggested in the quotation above is regarded to have validity to the extent that it measures the *use* of service department facilities by other manufacturing departments.

The ordinary manufacturing enterprise is also confronted with the problem of apportioning indirect manufacturing expense among units of different kinds of product.[3] Direct labor cost or time required for production are usually considered the most satisfactory criteria for allocating such expenses.[4] Choice is made between these methods according to which seems to vary more closely with the class of indirect cost to be apportioned. The rationale once again is that indirect costs should be divided according to relative use, this time relative use of machines or other plant facilities.

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[1] In a manufacturing enterprise, service departments include those doing work of a primarily clerical nature, those engaged in handling materials, those engaged in heating, lighting and maintaining plant, and those providing general conveniences. (W. B. Lawrence, *Cost Accounting* [Prentice-Hall, 1935], p. 196.)

[2] *Ibid.*, 197.

[3] If the enterprise produces only a single grade of a single commodity, a proportionate basis is available. Few firms today produce but a single product.

[4] *Ibid.*, 219.

An interesting example of a recent tendency to apportion costs according to use may be noted in the utility servicing industry. Fees for services were formerly levied primarily upon a percent-of-gross-revenue basis. Under Section 13 of the Public Utility Holding Company Act of 1935, the practice has been established for most service companies of dividing costs into direct costs incurred in serving, and remaining costs. The former are assessed against the companies to which they may be traced, and the latter are apportioned according to gross revenues of served companies. The new procedure is considered to give a rather effective use apportionment.[5]

In Great Britain the use theory of allocation has been applied to the problem of apportionment of the costs of the nationalized telegraph and post office which are under a single administration. A large share of expenditure for each class of service is directly chargeable, but a residual share is useful for both purposes. When the telegraph was first taken over it was contemplated that it would be charged only with its differential cost. But as both services grew and the amount of common staff and plant increased, the estimation of differential cost became more and more difficult. Some basis for apportionment of indirect costs became necessary. When the commercial accounts in their present form were set up, the basis of proportionate use was adopted. Although an objective criterion of use was not available, it was believed that the best estimates by responsible local officers of relative use of plant and personnel over which they might have authority could be satisfactorily employed. This basis was adopted.

A number of other applications of use bases for cost apportionment may be noted. In accounting for railway costs, charges for track and roadbed useful for both freight and passenger traffic (or jointly useful to two or more companies) have often been apportioned according to relative train miles, car miles, or locomotive miles for each class of traffic (or company) using the

[5] "It is also contended that . . . . the [percent-of-gross-revenue method] levies charges in a rough approximation to the use of services and that, given a long enough period of time, the direct charge method and the percentage-of-gross method result in practically the same total billings to each company." William F. Kennedy, "The Allocation of Utility Servicing Costs," 17 (1941) *Journal of Land and Public Utility Economics* 184.

common asset.[6] In Wisconsin there are a number of reservoir companies which develop regulatory storage upon the headwaters of streams.[7] By storing surplus flow of the spring season, these reservoirs are able to release storage in low water periods for the benefit of downstream utilities and industrials. Under Wisconsin law the costs of these headwater projects are assessable against downstream beneficiaries, and the Wisconsin Public Service Commission is empowered to regulate the manner in which charges are levied.[8] The Commission reports:

"In all instances the allocation has as a base the quantity of water and head available at the point of use. This base is, of course, adjusted if the installed capacity at the site of use is insufficient to use the available released water."[9]

In effect, the allocation is based upon relative use of storage releases for the generation of power. In New York State, the Sacandaga Reservoir on a tributary of the Hudson River provides regulation similar to that of the Wisconsin companies but also useful for navigation, flood control, and prevention of stream pollution. Ninety-five percent of the cost of this reservoir has been charged to power and seems to have been distributed among power companies and industrial concerns according to the relative use which each can make of storage releases.[10]

[6] Conference with officials of Nashville, Chattanooga and Saint Louis Railway Company. See *Uniform System of Accounts for Steam Railroads,* Accounting Classifications . . . . Prescribed by the Interstate Commerce Commission, Published by Association of American Railroads, Revised to January 1, 1941, Section on "Operating Expenses, Special Instructions for Joint Facility Accounts."

[7] Examples of such companies are the Chippewa River Improvement Company, the Wisconsin River Improvement Company, and the Flambeau River Improvement Company.

[8] This provision of Wisconsin law is somewhat analagous to Section 10 (f) of the Federal Power Act which provides as follows:

"That whenever any licensee hereunder is directly benefited by the construction work of another licensee, a permittee, or of the United States of a storage reservoir or other headwater improvement, the Commission shall require as a condition of the license that the licensee so benefited shall reimburse the owner of such reservoir or other improvements for such part of the annual charges for interest, maintenance, and depreciation thereon as the Commission may deem equitable."

16 U. S. C. A. 803 (f).

[9] Letter from George P. Steinmetz, Chief Engineer of Wisconsin Public Service Commission, October 9, 1941.

[10] See above, p. 252n. It is of some importance that when an apportionment of joint cost is among beneficiaries using water for the same general purpose, a use allocation is practically indistinguishable from one on a benefit basis. If a

Most of the examples of use theory which we have suggested above are applied to costs which are in the nature of general overhead rather than joint costs as we have defined them. The case of the Wisconsin reservoir companies is an example of the application of a use basis for division of costs which are joint as between beneficiaries but not joint as between classes of service (i.e., system objectives). The question which we now turn to examine is whether or not the use principle may be extended to apply to the apportionment of TVA costs which are joint as between system purposes. Two major versions of use theory for TVA joint cost allocation will be considered. The first may be termed the reservoir content method and the second the use of reservoir storage method.

ALLOCATION OF TVA JOINT COSTS BY RESERVOIR CONTENT METHOD

Description

The simplest form of use theory divides total reservoir capacity into several horizontal layers useful for different combinations of purposes. Joint cost for each layer is determined on a proportionate capacity basis and is divided equally among the purposes served. For example, at TVA main river projects, storage below minimum elevation in advance of floods is jointly useful for power and navigation head. According to the reservoir capacity method, cost for this section of storage should be divided equally between power and navigation. Dead storage at tributary projects, on the other hand, is useful only for power, and it should be charged directly to this purpose. Capacity for low water regulation at tributary sites is useful for holding seasonal flood flows and later releasing them to supplement dry period flow for navigation and power. Proportionate cost of such triply useful capacity should be divided equally among all beneficial purposes.

The reservoir content method of allocation has been considered

kilowatt-hour of energy has the same value to each power improvement downstream from a storage project, apportionment of storage costs according to relative effective use of releases would be identical to apportionment according to relative value of downstream power benefits.

by the United States Engineers at a number of projects. It was adopted in the Flood Control Act of 1938 to determine a fair public contribution to the cost of private improvement of the Blakely Mountain site on the Ouachita River for multiple purposes.[11] A variation of it was employed by the Bureau of Reclamation when it decided to expand the Arkins Reservoir in the Colorado-Big Thompson project from 25,000 to 50,000 acre feet and to divide the total reservoir cost equally between the purposes served, namely, power and irrigation.[12]

The reservoir content method of allocation is applied to the TVA three-plant system in Table 58. Table 59 indicates the result of its application to the ten-plant system. In comparing these allocations with percentage apportionments determined by other methods, it is important to note that joint costs are here interpreted to include incremental costs of dam and reservoir for flood control whereas in other allocations such costs have been charged separately.[13] The only meaningful comparisons, therefore, are between suggested total allocations. It is interesting that

[11] The relevant language of the Act is as follows:

"For the purposes of preventing or controlling floods, and of facilitating navigation on the Ouachita River in Arkansas and Louisiana, authority is hereby conferred on the Secretary of War and the Chief of Engineers to participate on behalf of the United States in the cost of construction of a multiple-use reservoir at the Blakely Mountain site on the Ouachita River in Arkansas, according to plans and estimates duly approved by the Secretary of War . . . . *Provided*, that the sum of money expended in said participation shall not exceed a just and reasonable proportion of the total cost of the multiple-use reservoir as allocated according to the proportionate storage capacity reserved or utilized for flood control purposes, nor exceed the estimated value of the flood control to be achieved, nor in any event to exceed the sum of $2,000,000. . . . ."

Act of June 28, 1938, Chapter 795, 52 Stat. 1218-1219.

[12] "In normal years a reservoir here (at the Arkins site) with a capacity of 25,000 acre feet could take care of the storage demands on the eastern slope. . . . . By increasing the capacity to 50,000 acre feet, more Colorado River water can be brought over in the winter time which will increase the winter time power output. There is considerable water in the Big Thompson River during the summer months that can be utilized for power to make up for the smaller amount derived from the Colorado River water. The result then of this 25,000 acre feet additional would be to increase the total annual power output. . . . . For this reason one half the cost of the Arkins Reservoir is assessed against power. . . . ."

M. E. Bunger, "The Colorado-Big Thompson Project, Final Report," United States Department of Interior, Bureau of Reclamation, April, 1937, IV:76 (434).

[13] In so far as direct flood control costs are not for reservoir capacity but are for special flood gates, this interpretation leads to illogical results.

TABLE 58

TENTATIVE ALLOCATION OF WILSON, WHEELER, AND NORRIS PROJECTS BY RESERVOIR CONTENT METHOD

	Norris	Wheeler	Wilson	Total	Percent of Total
Reservoir Elevation (in feet above mean sea level)					
1. Flood surcharge	1,034	556.3	506.1		
2. Malaria surcharge	1,020	556.3	506.1		
3. Flood period	955–1005	554.3	505.4		
4. Minimum for low water regulation	955	550.3	503.4		
5. Minimum in advance of floods	....	550.3	503.4		
Reservoir Content (in thousands of acre feet)					
6. Flood surcharge	2,567	1,100	600		
7. Malaria surcharge	2,047	1,100	600		
8. Flood period	547	970	589		
9. Minimum for low water regulation	547	750	557		
10. Minimum in advance of floods	....	750	557		
Dedication of Reservoir Content (in thousands of acre feet)					
11. To flood control only[a]	520	....	....		
12. To navigation and power for seasonal releases and to flood control[b]	1,500	130	11		
13. To navigation and power for head and to flood control[c]	....	220	32		
14. To navigation and power for head[d]	....	750	557		
15. To power for head[e]	547	....	....		

All notes at end of table.

TABLE 58 (CONTINUED)

TENTATIVE ALLOCATION OF WILSON, WHEELER, AND NORRIS PROJECTS BY RESERVOIR CONTENT METHOD

	Norris	Wheeler	Wilson	Total	Percent of To
Dedication of Reservoir Content to Particular Purposes (in thousands of acre feet)					
16. To flood control:					
From line 11	520	....	....		
From line 12	500	43⅓	3⅔		
From line 13	....	73⅓	10⅔		
Total	1020	116⅔	14⅓		
17. To navigation:					
From line 12	500	43⅓	3⅔		
From line 13	....	73⅓	10⅔		
From line 14	....	375	278½		
Total	500	491⅔	292⅚		
18. To power:					
From line 12	500	43⅓	3⅔		
From line 13	....	73⅓	10⅔		
From line 14	....	375	278½		
From line 15	547	.....	.....		
Total	1047	491⅔	292⅚		
19. Percent of project storage useful for stated purposes[f]					
Flood control	39.73	10.60	2.39		
Navigation	19.48	44.70	48.81		
Power	40.79	44.70	48.81		
Total	100.00	100.00	100.00		

All notes at end of table.

TABLE 58 (CONTINUED)

TENTATIVE ALLOCATION OF WILSON, WHEELER, AND NORRIS PROJECTS BY RESERVOIR CONTENT METHOD

	Norris	Wheeler	Wilson	Total	Percent of Total
	(All costs in thousands of dollars)				
Apportionment of Costs					
20. Allocations of joint costs[g]					
To flood control	10,329	2,249	354	12,932	20.9
To navigation	5,063	9,475	7,239	21,775	35.1
To power	10,603	9,475	7,239	27,317	44.0
Total	25,995	21,199	14,831	62,025	100.0
21. Direct costs					
For flood control	.....	.....	.....	......	....
For navigation	.....	1,912	2,549	4,461	10.4
For power	6,058	15,005	17,433	38,496	89.6
Total	6,058	16,917	19,982	42,957	100.0
22. Total charges					
To flood control	10,329	2,249	354	12,932	12.3
To navigation	5,063	11,387	9,788	26,238	25.0
To power	16,661	24,480	24,672	65,813	62.7
Subtotal	32,053	38,116	34,814	104,983	100.0
Add non-project costs	4,309	855	679	5,843	.....
TOTAL	36,362	38,971	35,492	110,826	.....

[a]Line 11 = line 6 — line 7.
[b]Line 12 = line 7 — line 8.
[c]Line 13 = line 8 — line 9.
[d]Line 14 = line 10 for main river plants.
[e]Line 15 = line 9 for Norris project.
[f]Based on totals of sections 16, 17 and 18.
[g]Total joint cost for each project divided in proportions of section 19 above.
Source: "Tentative Allocation of Hydro Project Costs, Reservoir Content Method," Tennessee Valley Authority, Department of Power Planning, February 3, 1938.

the percent apportionment of total cost suggested in Table 59 is very close to that determined by the TVA version of the alternative justifiable expenditure method in Table 52 above.

TABLE 59

PERCENT ALLOCATIONS OF TVA TEN-PLANT SYSTEM BY RESERVOIR CONTENT METHOD

	Navigation	Flood Control	Power
Allocation of common cost	31.8	33.3	34.9
Allocation of total cost	28.9	20.2	50.9

Source: Compiled from "Tentative Allocation of Hydro Project Costs," February 3 1938.

PRELIMINARY APPRAISAL

The reservoir content method has a number of advantages. It is flexible and takes into account the peculiarities of operating rules at each project. It employs the acre foot as a common measure of use. (If the flat pool assumption is accepted,[14] relative use on the basis of this unit can be estimated with reasonable accuracy.) It is logical in that total costs do tend to vary with reservoir capacity. Finally, project utility for particular purposes normally tends to vary with capacity available to serve each purpose.

But the reservoir content method also suffers from important disadvantages. It employs unit costs per acre foot to break down total joint costs among reservoir sections as a step preliminary to allocation. At a large project, unit costs might vary considerably with capacity. In such a case the propriety of use of average unit cost would be questionable. For example, assume a project at which 1,000,000 acre feet of storage at an average cost of $10.00 per acre foot would be required to provide a satisfactory nine-foot channel to the next site upstream. Assume further that storage of 2,000,000 acre feet would be required for the dual purposes of flood control and navigation and that this would cost $15.00 per acre foot. If the project were built to the larger capacity and 1,000,000 acre feet were permanently maintained for navigation, would it be proper to charge navigation with its proportionate share of total project cost, $15,000,000, or simply with

[14] See above, Chapter XI.

the investment which would have sufficed to serve navigation as a single purpose, $10,000,000? Perhaps the answer to this question is contingent upon the priority of purposes. If navigation is the primary objective and flood control is incidental, it would seem correct to charge navigation at the $10.00 rate and to levy all incremental costs upon the incidental purpose. If the two objectives are co-ordinate, then flood control might as reasonably be provided at the low cost of the first million feet of capacity as navigation. Under such circumstances, each purpose might be charged with incremental cost of the first million acre feet of capacity and the remainder of cost might be considered joint.

A further weakness of the reservoir capacity method is that it is arbitrary and that use is not really employed to break down the costs of joint reservoir sections. For example, in Table 58, capacity at the main river plants between malaria surcharge and normal flood period elevation (line 12) is considered as useful for all project purposes. Cost of this capacity, as determined by the proportionate capacity method, is not divided according to relative use but as apportioned equally among purposes. In effect, this is simply a refined version of equal charging. It is subject to many of the points of criticism made of that method in Chapter VIII above.

In order to overcome the weakness of arbitrary charging, the reservoir content method was revised to take account of the relative use of joint capacity by different project purposes. This modified version may be termed allocation according to use of reservoir storage.

ALLOCATION OF TVA JOINT COSTS BY USE-OF-RESERVOIR-STORAGE METHOD

Description

As is true of the reservoir content method, the use-of-reservoir-storage method of allocation requires that total capacity be divided into a number of horizontal sections, each serving a particular purpose or combination of purposes. At TVA main stream projects, these sections may be determined as follows. If a given project were planned for power alone, normal operation would contemplate storage up to elevation Ph for head. (See Figure 13.) Similarly, if the project were planned for navigation alone, normal operation would contemplate permanent storage for head up to elevation Nh. Assuming that the project is constructed to serve both power and navigation, cost of storage to the lower of these two elevations (say, Nh costing Nc) may be considered as joint; and the balance of cost up to elevation Ph may be charged directly to power. Assume now that the project is expanded to comprehend flood control. Cost of capacity up to elevation Nh remains joint as between navigation and power. (Since flood control requires empty capacity, it can gain no benefit from capacity providing dead storage.) According to the use-of-storage theory it should be apportioned between these two purposes according to relative use. Such use cannot be estimated on the basis of relative consumption of water since dead storage is not periodically filled and depleted but is permanent. For navigation it provides depth over dangerous shoals, and for power it provides head over which regulated stream flow may fall. Under the theory it is argued:

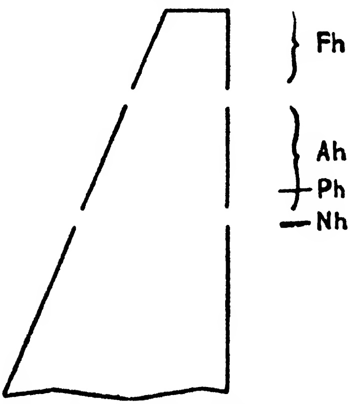

Figure 13. Symbolic diagram to illustrate use of reservoir storage method of joint cost allocation.

". . . . this water is used completely and simultaneously for the two purposes, and as the water is used equally the joint costs should be shared equally."[15]

In addition to permanent storage, most TVA main river projects provide capacity for moderate power load factor fluctuations, for seasonal navigation releases, for malaria operations, and for flood control. Such jointly useful capacity may be treated as that behind elevation Ah (above Nh), and its cost may be set at Ac. Under the use-of-storage theory, this cost should be appor-

[15] Tennessee Valley Authority, Department of Power Planning, blue-print entitled "Water Use Allocation Theory."

tioned according to the relative use made of Ah by the different purposes. This use may be measured either by the extent to which Ah is used to supplement or to reduce natural stream flow.[16] Let us adopt the former criterion. All releases from storage up to an amount necessary to maintain a satisfactory navigable channel downstream are useful for nagivation. All releases passed through the water wheels are useful for power. Finally, all releases before or during the flood season are useful for flood control since they tend to increase capacity available for flood storage. For a representative period of time, releases for each purpose may be determined, the total of beneficial releases may be found and total joint costs may be apportioned according to the proportionate share of each purpose in the sum of beneficial releases. It may be remarked that this sum exceeds actual releases since jointly useful regulation is counted more than once. This is not considered to affect the logic of the method.[17]

At some TVA projects a reservoir section, Fh, above Ah is reserved exclusively for flood operations. Any water caught in this surcharge pool is immediately released at the termination of the flood crisis during which it was stored without regard for the interests of navigation or power. Since non-flood objectives obtain no benefit from flood surcharge capacity, the cost, Fc, may be assessed directly against flood control.

Practical application of the reservoir-use method of allocation at TVA is very difficult since Authority projects are new, and no records for any considerable period of water use are available. Nevertheless, an effort was made to apply the principle to the

[16] These are, after all, but different aspects of a single operation.

[17] This discussion may be clarified by an example. Assume that on January 27, 1943, total regulated flow at the Pickwick site, modified by all upstream releases, is 14,000 c. f. s. Below Pickwick and prior to the completion of the Kentucky project, 18,000 c. f. s. are required for navigation. Assume that the forecast of a flood leads to the release of 16,000 c. f. s. from Pickwick storage making total regulated flow downstream 30,000 c. f. s. of which 24,000 c. f. s. are passed through the Pickwick wheels. This use of Pickwick storage may be analyzed as follows: release useful for power: 24,000 — 14,000 = 10,000 c. f. s.; release useful for flood control: 30,000 — 14,000 = 16,000 c. f. s.; release useful for navigation: 18,000 — 14,000 = 4,000 c. f. s. Quantities of storage used for each beneficial purpose could be determined by applying these rates of release to the period over which they continued. At the end of a representative period of time, quantities determined in this manner could be summed for each purpose, and cost of the project for storage between minimum draw-down in advance of floods and maximum multiple purpose elevation could be divided in the proportions of use so measured.

TABLE 60

ALLOCATIONS OF COST OF WILSON AND NORRIS PROJECTS ACCORDING TO USE-OF-RESERVOIR-CAPACITY METHOD

	Norris		Wilson	
	Absolute	Percent	Absolute	Percent
Dedication of Capacity (in thousands of acre feet)				
1. To power only	1,547	21.3	....	....
2. To active storage useful for power, navigation, and flood control	500	58.5	43	7.2
3. To permanent storage useful for navigation and power	.....	....	557	92.8
4. To surcharge capacity useful for flood control only	520	20.2	....	....
5. Total capacity	2,567	100.0	600	100.0
Apportionment of Joint Costs Among Reservoir Sections[a]				
6. To power only	5,540	21.3	.....	....
7. To active multiple purpose capacity	15,190	58.5	1,061	7.2
8. To multiple purpose capacity providing permanent storage	.....	....	13,770	92.8
9. To flood control only	5,265	20.2	......	....
10. Total joint costs	25,995	100.0	14,831	100.0
Proportionate Use of Active Capacity[b]				
11. Total releases useful for navigation	486,360	18.2	74,000	21.6
12. Total releases useful for flood control	1,799,900	67.4	57,630	16.9
13. Total releases useful for power	385,700	14.4	210,370	61.5
14. Sum of beneficial releases	2,671,960	100.0	342,000	100.0
Break-Down of Cost of Active Capacity According to Proportionate Use[a]				
15. Charge to navigation	2,760	18.2	230	21.6
16. Charge to flood control	10,240	67.4	179	16.9
17. Charge to power	2,190	14.4	652	61.5
18. Total estimated cost of active capacity[c]	15,190	100.0	1,061	100.0

All notes at foot of table.

TABLE 60 (CONTINUED)

ALLOCATIONS OF COST OF WILSON AND NORRIS PROJECTS ACCORDING TO USE-OF-RESERVOIR-CAPACITY METHOD

	Norris		Wilson	
	Absolute	Percent	Absolute	Percent
Break-Down of Cost of Permanent Storage[d]				
19. Charge to navigation	....	....	6,885	50.0
20. Charge to flood control	....	....	....	....
21. Charge to power	....	....	6,885	50.0
22. Total estimated cost of permanent storage	....	....	13,770	100.0
Summary of Joint Cost Allocations[a]				
23. Charge to navigation	2,760	10.6	7,115	48.0
24. Charge to flood control	15,505	59.7	179	1.2
25. Charge to power	7,730	29.7	7,537	50.8
26. Total joint costs	25,995	100.0	14,831	100.0
Direct Costs by Purposes[a]				
27. For navigation	....	....	2,549	....
28. For flood control	....	....	....	....
29. For power	6,058	....	17,433	....
30. Total direct costs	6,058	....	19,982	....
Allocations of Total Project Costs[a]				
31. To navigation	2,760	8.6	9,664	27.8
32. To flood control	15,505	48.4	179	0.5
33. To power	13,788	43.0	24,970	71.7
34. Total project cost	32,053	100.0	34,813	100.0

[a]All costs in thousands of dollars.
[b]Based on use during 1936 water year.
[c]From line 7.
[d]Costs from line 8 apportioned equally among purposes served.
Source: Compiled from Table 58 and Tennessee Valley Authority office memorandum, C. P. Almon to C. L. Karr, "Water Use Allocation Theory Applied to Wilson and Norris Dams," June 9, 1937.

Norris and Wilson plants, the first projects which TVA put into operation. The resultant percent allocations (based upon water use during the 1936 calendar year) are shown in Table 60.

Although Table 60 reveals that the use-of-storage theory may be given practical application, the figures which it suggests could not reasonably be used for final allocations of the Wilson and Norris projects since they are greatly influenced by temporary conditions. For example, all Norris releases necessary to maintain 15,000 c. f. s. at Florence were considered useful for navigation. After 1945 no such releases will be needed for this purpose on any part of the Tennessee River. At both projects regulation of moderate fluctuations of stream flow was credited to flood control since it was useful to protect work at downstream plants under construction. At Wilson certain special storage for experimental purposes was credited to navigation. Although these several credits were quite proper for 1936, there will not be similar credits after the chain of main river lakes is completed. It would not seem proper that allocations of the Wilson and Norris projects as parts of the completed system should be materially influenced by these considerations.

An interesting modification of the definition of flood control use which was stated in the text above was employed in computing the figures of Table 60. Here use was interpreted as all additions to storage during flood season, rather than as all releases before and during the season to provide capacity available to serve. This revised interpretation seems more in accord with common sense than the one originally suggested. It was avoided in our basic formulation of the use-of-reservoir-capacity method in order to forestall any danger of double accounting in dealing with both increases and decreases of storage. Double accounting need not result from the modified method, however, if care is taken that flood control be charged only with increases in storage and not subsequently with releases as well.[18]

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[18] The reason for the adjustment of method was as follows:
"(Our adopted method) . . . . is the reverse of the method set forth in the text of the 'Water Use Allocation Theory,' wherein flood control use is obtained by providing space for flood water when the reservoir is lowered. This method suggested in the text applied over a long period of years will probably give the same answer as the one used. However, a large flood control

Preliminary Appraisal

Although the use-of-reservoir-capacity method of allocation is designed as a refinement of the reservoir content method, it is subject to many criticisms. As is true of the simpler method, no convincing technique is available for initial determination of the parts of total joint cost properly chargeable against the different sections of capacity. Estimates determined by pro-rating total joint costs on a relative capacity basis are questionable whenever unit cost would vary for reservoirs of different sizes. The use-of-storage method also fails to offer any improvement over the reservoir content method for dealing with the costs of dead storage. In fact, no satisfactory use units seem to be available for this type of storage.

A significant practical weakness of the use-of-storage principle is that data as to reservoir operation can be accumulated only over considerable periods of time. If allocations must be determined within a limited period after project construction, a proper application of use theory would seem to be out of the question. Conceivably this difficulty could be overcome by determination of figures for relative use of storage based upon stream flow records for a representative period of the past. But what would be a "representative period"? Even if such a period could be defined, there would be no reason to anticipate that stream flow records for the future would duplicate those of the past, for variation is a fundamental attribute of nature. If the use-of-storage method has validity at all, it would seem to be for the determination of allocations at the close of project useful life rather than at its outset.

A further weakness of the use-of-storage method is that it assumes that all benefits are co-ordinate. It seems questionable

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use will be shown in a dry year in which the reservoir is drawn to a minimum elevation, and small flood control use will be shown for a wet year when there is little use for power and navigation. The method adopted in this study, on the other hand, charges water stored for flood control during the period when flood control is actually effective. This results in high flood control allocation in wet years, and high navigation and power allocations in dry years."

C. P. Almon to G. L. Karr, "Water Use Allocation Theory Applied to Wilson and Norris Dams," Tennessee Valley Authority, June 9, 1937.

to charge equally a major purpose and an incidental minor purpose for storage releases governed entirely by the major objective but incidentally utilized to the best possible advantage by the secondary purpose.

Another deficiency of the use-of-capacity method, as we originally formulated it, is its treatment of flood control. Although most releases from storage behind Ah (Figure 13) are either releases of accumulated flood waters or releases which assist in emptying capacity to make possible future flood storage, some operation of storage behind Ah may be entirely without flood control significance. For example, late in a dry summer Norris reservoir might be drawn down to winter flood control elevation. Rains in the fall might permit partial refilling of storage, but drawdown would have to follow before the onset of the winter wet season to regain flood elevations. It would scarcely be correct to charge flood control with all flow in excess of natural flow on the occasion of each of these drawdown periods. The interest of flood control would have been served when the pool was first reduced to flood elevation. If this drawdown was credited to flood control but was later partially nullified by accumulation of storage for power purposes, subsequent releases to regain flood elevations would not be properly chargeable to flood operations. This difficulty could be eliminated by fixing as a limit of releases chargeable to flood control in a given season the total flood storage accumulated during the preceding flood period. If this rule were adopted, the effort to measure reservoir flood use by releases from (rather than additions to) storage might as well be abandoned, and additions to storage be employed instead. This is the adjustment of method which was made in connection with the Norris project in determining the figures of Table 60.

A final weakness goes to the heart of the use-of-storage method. Flood control is a fundamental purpose of TVA. Past stream flow records both in the Tennessee basin and on other watersheds have been thought to justify a considerable investment to safeguard against a possible superflood on the Tennessee. There is no certainty as to when, if ever, such a flood will occur, but the danger that it may occur recurs every high water season. Whether great flows make flood storage necessary or not, a multiple purpose system which provides security against the potential damages of floods clearly performs a valuable function. This proposition is supported by reference to the practice of insuring against risks. A man who takes out insurance against the loss of his life does not make a bad investment if he survives the period for which the insurance is effective. Meanwhile he has had valuable protection against the hazard of death. In flood planning, the goal is protection against the hazard of flood. If floods do not occur, the security which derives from the readiness-to-serve of protective works is, nevertheless, of value. It follows that in so far as flood control is concerned, allocation according to reservoir *capacity* is upon a substantially firmer footing than is allocation according to use of storage.

The question now arises, What is the logical basis of the use-of-storage method? We can conceive of two grounds upon which this method might be rationalized. First, it might be argued that benefits for purposes tend to be proportional to storage use, and hence that relative use provides the best key to a proper benefit allocation. Second, it might be argued that costs tend to vary with reservoir use and that for this reason purposes making greater use of storage should be assessed a greater share of costs.

Let us consider the suggestion that use is an index of benefits. If benefits were achieved only by operation of storage (and not by maintenance of dead storage or empty capacity) and if releases could not be jointly useful for more than one purpose, then it would follow that rational reservoir operation would seek to govern releases for all purposes so that the significance of a marginal unit of release at any given time would be the same for all purposes. But even if this were the situation and releases were governed in this way, it would not follow that the significance of total releases for the several purposes would be proportional to quantities of releases. Even under the drastic assumptions here suggested, there would be no reason to accept relative use of storage as a proper index of relative benefits. Since the assumptions themselves are in striking contrast to fact, the benefit basis for use theory crumbles.

What may be said for the suggestion that joint costs tend to vary with use of storage? If depreciation and joint costs of operation were the only charges against TVA joint assets and if these charges varied directly and proportionately with use, then the use method would have much to support it. It is true that in accounting for depreciation of certain classes of manufacturing machinery great emphasis is sometimes laid upon use.[19] But even if charges for joint operation and maintenance, and depreciation varied closely with use at TVA, these elements of cost would be heavily outweighed by charges for interest. Since interest is comparatively inflexible and is affected almost not at all by reservoir use, we must conclude that total joint charges do not vary in any reliable way with use of storage.[20] The second version of a rationale for the use-of-reservoir-capacity method also crumbles.

CONCLUSION

The advantages and disadvantages of the use theories of allocation may be summarized in the light of our preliminary criteria of a satisfactory allocation as follows:

(1) When use is interpreted as capacity ready and available to serve, the use principle has a tinge of theoretical validity due to the fact that reservoir costs are primarily governed by capacity. Unfortunately, there is no satisfactory measure available for determination of relative use of joint capacity by different purposes. Usually the principle of equal apportionment is adopted. We have already seen that this principle is deficient on several counts.

When use is interpreted as use of storage to regulate natural stream flow, the use principle loses theoretical validity. Neither relative benefits nor rates of joint cost vary closely with use of storage.

All versions of use theory suffer from the fact that it is difficult to determine the shares of joint cost properly chargeable to different

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[19] Depreciable value of machinery is determined by subtracting scrap value from cost new. Machine life is estimated in terms of hours of use or units of output. Depreciation is then charged proportionately to hours of operation or volume of production.

[20] In view of the dominant weight of interest in charges upon joint investment, it is unnecessary to examine the question of variability of joint charges for depreciation and operation. We venture here the opinion that charges for depreciation are very nearly as inflexible as charges on account of interest. In other words, we believe depreciation upon TVA joint property is more a function of time than of use. On the other hand, it is possible that a somewhat stronger case could be made for apportioning joint costs of operation according to reservoir use.

sections of reservoir storage. They are also deficient in that they do not limit allocations to levels which are justifiable in the light of benefits and alternate costs.

(2) The reservoir content method is simple. The use-of-reservoir-capacity method is somewhat more complex, but it is not unduly difficult.

(3) The reservoir content method is workable. The use-of-reservoir-capacity method is dependent upon the accumulation of data as to project operation over a period of time. It is not well adapted to allocation of investment at new projects.

(4) Both versions of use theory considered in the present chapter are comparatively flexible.

(5) It is impossible to determine in advance whether or not application of either of the use principles of allocation will apportion a share of multiple purpose economy to each purpose.

We may conclude that the use-of-reservoir-capacity method must be discarded as impracticable and without adequate theoretical support. The reservoir content method is perhaps slightly more satisfactory from a theoretical standpoint, but it also is unfortunately arbitrary. Neither method can be defended as fixing costs functionally incurred for the several joint objectives; and there is no reason to believe that either would provide a wise basis for the making of rates for vendible utilities. Relative use does not provide an effective solution to the problem of joint cost allocation.

We have now examined but found unsatisfactory for one reason or another all of the more comprehensive theories which were proposed for allocation of TVA joint costs. Let us next consider a number of other allocation principles which were suggested for application by the Authority.

CHAPTER XIII

OTHER PRINCIPLES FOR JOINT COST ALLOCATION

Summary. The foregoing chapters have analyzed the more comprehensive techniques which were considered for apportionment of TVA joint costs. None of these has been found fully satisfactory from a theoretical point of view, and few have been found workable. Because of the inadequacy of more complex formulae, numerous suggestions were put forward that TVA joint costs be divided among purposes according to less complicated criteria. With the exception of the vendibility method, each of these secondary principles has the virtue of practical applicability. None of them, however, provides a satisfactory theoretical basis for apportionment of *joint* costs. It appears that *only direct costs can be assigned to particular purposes.*

THE 100 PERCENT METHOD

Many representatives of the privately owned power industry have urgently supported the position that all TVA joint costs should be apportioned to power. Perhaps most vocal has been the Commonwealth and Southern group which was formerly under the leadership of Wendell L. Willkie. Mr. Willkie asserted that a major end of TVA was to determine a power rate yardstick on the basis of its cost experience to which privately owned utilities would be expected to conform. Such a yardstick could not be fair, he argued, unless TVA costs took into account all proper costs of privately owned utilities. Any scaling down of public costs through allocations to non-power objectives would, he believed, constitute an unjustifiable "subsidy" of the public power program. Mr. Willkie's point of view is expressed in the following quotation:

"Under the provisions of the Federal Water Power Act, utilities which build hydro electric dams, such as Norris and Joe Wheeler Dams, on navigable rivers such as the Tennessee River are required to make and have made provision for navigation and such dams are just as useful for flood control as these government dams.

"The TVA, however, plans to allocate, according to its latest statement on the subject, something over 50% of the cost of its new dams to flood control and navigation and charge up only the remaining balance as the basis for the sale of hydro electric energy. The private utilities get no such subsidy, which subsidy of the TVA is entirely a bookkeeping entry at the expense of the Federal taxpayer, so far as the generating of power is concerned." [1]

In close agreement with Mr. Willkie was Mr. E. A. Yates, Vice President of the Commonwealth and Southern Corporation. In the spring of 1935 Mr. Yates submitted to the House Committee on Military Affairs an analysis of the cost computations which TVA had presented to the Alabama Public Service Commission during the preceding November (and subsequently to the House Committee).[2] Whereas TVA had determined "present" power value of the Muscle Shoals properties by deducting from original cost $27,421,942 for credits to national defense (largely for incurred loss) and navigation, Mr. Yates deducted only $4,255,012 for the original cost of Wilson lock. His resultant estimate of an investment base against which fixed charges should be applied was $42,695,736 as compared with $19,528,806 indicated in TVA computations.[3] Mr. Yates defended his revision of the TVA estimates in cross examination as follows:

MR. THOMASON. "In your comparison of rates with the TVA, did you charge the TVA with the total original cost of their power development projects, or do you give them some credit, and, if so, how much, for navigation, flood control, and national defense?

[1] Address by Wendell L. Willkie entitled "Government and the Public Utilities," delivered at Joint Meeting of the Economic Club of New York and the Harvard Business School Club, January 21, 1935, New York City.

In a subsequent address delivered in Washington on May 1, 1935, Mr. Willkie stated that the American utility industry could lead an upswing of business activity out of the depression if it were freed of three threats, one of which was:

> "The transmission and distribution of electric energy by the Federal Government from Federal built and subsidized hydro plants in competition or threatened competition with existing privatelv owned facitities. . . . ."

[2] See above, Chapter VIII.

[3] United States Congress, House of Representatives, *Tennessee Valley Authority*, Hearings before the Committee on Military Affairs, Seventy-Fourth Congress, First Session, March 28 to April 10, 1935, I, 279.

For Director Lilienthal's answer to Mr. Yates' analysis, see *ibid.*, 361 ff.

MR. YATES. "I charge them the entire cost of the development, less the cost of the locks for navigation.

"In other words, my thought in that comparison was to put them on exactly the same plane as pertains to the construction and cost of hydroplants which were built by the power company in Alabama.[4]

. . . .

MR. YATES. (The Alabama Power Company has constructed and operates three major dams on the Coosa River and a large storage dam on the Tallapoosa River.) "Upward of seventy miles of the Coosa River has been rendered navigable, and provision was made in the dams for locks which may be constructed by the Government at small expense at any time.

"These developments are similar to the developments now being constructed on the Tennessee River by the Authority and yet the entire cost of the developments was borne by the power company, without Government subsidy. It would seem fair, therefore, to charge the entire cost of Wilson Dam, less the cost of the lock, or $42,695,736, to power.[5]

. . . .

MR. THOMASON. "What would be the percentage of allowance that you would make in the TVA set-up on power rates for flood control, navigation, and national defense?

MR. YATES. "Well, I set this thing up on the basis of an absolute comparison with what the utility company has actually done in the way of providing navigation and flood control on the Coosa River.

MR. THOMASON. "But it would not be a fair yardstick to charge them up with the total cost and make no allowance for these other activities?

MR. YATES. "We provide navigation in our dams. We provide flood control. . . . . We operate those dams under the jurisdiction of the Federal Power Commission, under rules and regulations as laid down and prescribed by them.[6]

. . . .

MR. YATES. (The Wilson Dam) ". . . . was built after the war, and at the same time we were engaged in building a series of dams

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[4] *Ibid.*, 352.

[5] *Ibid.*, 280.

[6] *Ibid.*, 352. Despite Mr. Yates' assertions as to the navigation and flood control utility of the dams of the Alabama Power Company, these facts are clear: (1) in the absence of locks, navigation past the Company's dams is impossible; (2) the Company reservoirs provide no permanent controlled surcharge for flood control; (3) the Company projects are not operated according to seasonal rule curves to provide empty storage capacity during the periods of greatest flood menace.

on the other rivers. In building those dams we provided for navigation. We stood the entire expense and had no subsidy whatever from the Government.

THE CHAIRMAN. "If I understood you, ... your argument was intended to be this: That all of the actual cost of Wilson Dam ought to be charged against power rather than a certain considerable part of the actual cost allocated to national defense and not charged against the cost of power.

MR. YATES. "As a matter of fact, I think that is so." [7]

Applied to the three-dam system, the 100 percent principle would have increased charges to power from $53,469,000 as determined by the alternative justifiable expenditure method to $91,891,000, an increase of 72 percent. For the ten-plant system the corresponding increase would have been from $196,022,000 to $333,608,000, an increase of 70 percent.

We have presented in Chapter V above a discussion of the comprehensive considerations which guided TVA in planning its programs for reservoir construction and operation. This statement emphasized that sites for TVA main river projects were fixed primarily by the requirements of navigation. Tributary sites, on the other hand, were governed by a complex of factors including cost per unit of capacity, location with regard to flood control at Chattanooga, and availability of head for power. We also pointed out that navigation requirements determined maximum drawdown levels on the main river, and that at all projects flood control rule curves were formulated to fix maximum elevations during the high water season. Only with "primary" purposes safeguarded, did the Authority proceed to plan operations to maximize the value of available stream flow for power purposes. We believe that the record convincingly supports the proposition that TVA is dedicated to, and is engaged in, a program of multiple purpose stream improvement. The contrast between this type of river planning and a power-only operation

[7] *Ibid.*, 333-334. See also Commonwealth and Southern Corporation, "Comments on TVA Report to the President on Cost Allocation of Dams," June 25, 1938.

is so clear that we can see little to support the 100 percent theory.[8]

THE EQUAL CHARGE METHOD

A second admittedly arbitrary principle for allocation which was suggested for use at TVA is equal apportionment. This principle was used in a preliminary agreement between the United States Engineers and the New York Power Authority with respect to the Saint Lawrence project[9] and was embodied in a Joint Resolution passed by the House of Representatives endorsing this undertaking.[10] In Chapter VIII above we reviewed a number of studies in which TVA investigated the applicability of equal charges for apportionment of Wilson Dam joint cost. Our position as to the merits and demerits of this method remains as there indicated. Its critical weakness is its inaccurate indication that no purpose is feasible which is unable to carry its full share of pro-rated joint cost in addition to its incremental cost.[11]

We indicate in Table 61 below the results of an equal apportionment of the TVA ten-plant system.

[8] This is not to argue that costs of hydro generation based upon allocations of investment in dams and reservoirs can provide a yardstick for the *generation* of energy at other power sources. See James C. Bonbright, "Public Ownership and the National Power Policy," 28 (N. S.) *Yale Review* 36-49, September, 1938. The TVA yardstick, however, exists on the retail rather than the wholesale level.

[9] Agreement between the Power Authority of the State of New York and the Corps of Engineers, United States Army, dated February 7, 1933.

[10] House Joint Resolution 157, Seventy-Third Congress, First Session. (See 77 *Congressional Record* 2348 ff.) In the fall of 1941 the project was revived as a defense undertaking. The equal apportionment principle of the February 7, 1933 agreement was again employed to determine an appropriate division of project costs. (See H. R. 5993, sec. 2 (b) as reported by the House Committee on Rivers and Harbors, Seventy-Seventh Congress, First Session, and House Report 1431, Seventy-Seventh Congress, First Session, p. 110.)

[11] In commenting upon equal apportionment, the TVA Three-dam Allocation Report states:

> "Where potentiality of use is equal, as is the case with reservoir volume used to produce head for both navigation and power, an equal sharing principle is applicable; but it does not commend itself as a method which will produce reasonable results where the respective uses for each function are not equal."

House Document 709, Seventy-Fifth Congress, Third Session.

This discussion seems to revert to the weaknesses of the use theory. What is meant by equal potentiality of use? At an otherwise feasible project, navigation which can cover its incremental cost is feasible even if it is unable to return anything toward common cost of the pool which it uses jointly with other purposes.

ALLOCATION ACCORDING TO DIRECT CHARGES

The suggestion has occasionally been made that TVA joint costs should be apportioned according to the proportions of direct cost incurred for each purpose. Table 62 presents the results of an allocation pursuant to this theory.

TABLE 61

ALLOCATION OF THE TVA TEN-PLANT SYSTEM BY THE EQUAL CHARGE METHOD

	Navigation	Flood Control	Power	Total
	(All charges in thousands of dollars)			
Direct charges	45,214	33,763	110,977	189,954
Distribution of joint costs				
Absolute	74,210	74,210	74,210	222,630
Percent	*33.3*	*33.3*	*33.3*	*100.0*
Total charges				
Absolute	119,424	107,973	185,187	412,584
Percent	*28.9*	*26.2*	*44.9*	*100.0*

Source: Based upon project estimates of Table 21.

Allocation according to direct costs represents the application to TVA of a principle analogous to the familiar principle of cost accounting that certain types of manufacturing expense may be distributed according to direct labor costs incurred in production.[12] As Lawrence points out, however:

"Any method of distributing manufacturing expense to production in proportion to the labor cost incurred on the product is based on the theory that manufacturing expense is incurred proportionately as direct labor costs are incurred." [13]

Applied to TVA, this qualification would require that joint cost should be incurred proportionately to direct cost. At many of the Authority's projects both direct power cost and total direct cost will change greatly with changing upstream development, but total joint cost will remain constant. Thus, there is no clear relation between joint cost and either direct costs for particular purposes or total direct costs. In the absence of such a relation joint cost allocations determined by the proportions of direct cost

[12] In Chapter XII above it was pointed out that this accounting principle is also consistent with the division of joint cost according to proportionate use.

[13] Lawrence, W. B., *Cost Accounting* (1935), p. 220.

can have no functional significance.[14] Nor would there be any *a priori* reason to believe that such allocations would represent "reasonable" or "equitable" divisions of admittedly joint costs.

TABLE 62

ALLOCATION OF THE TVA TEN-PLANT SYSTEM ACCORDING TO DIRECT CHARGES FOR PURPOSES

	Navigation	Flood Control	Power	Total
	(All charges in thousands of dollars)			
Direct charges	45,214	33,763	110,977	189,954
Distribution of joint costs				
Absolute	53,100	39,630	129,900	222,630
Percent	*23.8*	*17.8*	*58.4*	*100.0*
Total charges				
Absolute	98,314	73,393	240,877	412,584
Percent	*23.8*	*17.8*	*58.4*	*100.0*

Source: Based upon project estimates of Table 21.

We see no hope for a solution of the allocation problem in this theory.

THE VENDIBILITY THEORY OF ALLOCATION

The vendibility theory is an expression of the classical theory of joint cost. According to this theory, under conditions of perfect competition a firm which produces two joint products in fixed proportion will determine its output (just as would a single product firm) at the point at which marginal cost of the composite production unit is equal to composite price. If the proportionate output of the joint products is subject to variation, it is possible to determine individual marginal costs for each. Under these conditions, production of the two goods tends to be proportioned so that marginal cost for each is equal to its selling price.[15]

[14] TVA, in the Three-Dam Allocation, points out that the characteristic of variation with direct cost is much more apt to typify costs in the nature of general burden that it is joint costs. Perhaps it was because these two types of cost had been confused that some quarters put forward the suggestion of allocation according to direct cost.

[15] See Marshall, Alfred, *Principles of Economics* (8th ed.; London: Macmillan and Co., 1936), p. 390. In accord with the theory of perfect competition, price for both joint products is here accepted as given in so far as the individual producer is concerned. Under these conditions, if the proportionate output of the joint products is subject to variation, relative demand is the fundamental determinant of relative output. (See Henderson, *Supply and Demand* [New York: Harcourt Brace and Co., 1922], 72 ff.)

For long term equilibrium, revenues from the joint products must be equal to fixed plus variable costs of the combined output. Under these circumstances an imputed allocation of total joint cost could be determined by subtracting from revenues for each product direct costs incurred in its production and capitalizing remaining revenues at the appropriate rate for charges on jointly used facilities.[16]

The conditions requisite for application of a defensible version of vendibility theory are quite missing in the case of TVA joint costs. Only one of the three major benefits of the reservoir program is disposed of at a price. The others return no revenues to the Authority whatever.[17] It is true that the suggestion has sometimes been made that the Authority should charge navigation tolls and levy assessments for flood control benefits. Such charges might be established. But they could not be set by the forces of competition since there is no competition between TVA and other producers of navigable channels along the Tennessee or other producers of flood control benefits in the Tennessee and lower Mississippi River valleys. Revenues derived from these charges would lack the sanction of a competitive market, and any allocation based upon them would be but an imperfect expression of vendibility theory.[18]

[16] For a lucid statement of the problem of joint products, see Boulding, Kenneth E., *Economic Analysis* (1941), p. 523. Professor Boulding remarks that under conditions of joint supply:

> "The average total cost cannot . . . . be calculated by dividing the total cost by the output unless the total cost can be 'allocated' in some way to the two products. Usually, however, it is impossible to allocate the total cost."

Ibid.

[17] In the Three-Dam Allocation Report, TVA discusses the vendibility theory and explains at considerable length that the prices at which it disposes of fertilizer are not competitive. This, it suggests, detracts from the applicability of the vendibility method for allocation of the joint costs of its reservoirs. Since the fertilizer objective is not directly involved in the multiple purpose waterway program, the conditions under which fertilizer is distributed would not seem to be relevant to the issue of applicability of any theory for apportionment of waterway costs.

[18] Strictly interpreted, such an allocation would have to be accepted as a version of vendibility theory since the benefits would obviously be "vendible" at the rates at which they would return revenues. The absence of competition in fixing charges, however, would deprive such an imputed allocation of any possible equilibrium significance.

THE CAPITALIZED INCOME THEORY OF ALLOCATION

Closely related to the vendibility theory is the principle of allocation according to capitalized income net of direct charges for revenue producing purposes. This principle recognizes that not all objectives of multiple purpose enterprise are vendible, but provides for allocations to those that are according to their revenue-producing capacity.

Many divisions of cost by the Bureau of Reclamation may be classified as capitalized income allocations. They have usually been determined as follows. Soil and climate conditions at prospective sites have been examined, and estimates have been made of probable water requirements per acre, crop yields, and settler costs and incomes. Reasonable charges for water then have been determined. Applied to dependable water supply, these charges have fixed prospective annual irrigation revenues. Prospective operation and maintenance costs have been subtracted, and remaining revenues have been capitalized at an appropriate rate of fixed charge to determine a reasonable allocation of capital to irrigation.[19] Project feasibility has been dependent upon this allocation being as great as total project costs, or upon the ability of other project purposes to carry the burden of remaining annual costs.[20]

[19] As a rule the Bureau has not included interest in fixed charges. Analysis of major projects has frequently assumed a fixed charge rate of 2.5 percent to provide simply for retirement of project investment over a forty-year period.

Responsibility for the Bureau's failure to include interest in fixed charges would seem to rest with Congress, for that body could easily have required inclusion of interest in the Bureau's financial justifications of proposed projects. It is probably correct to say that the United States has sponsored interest-free reclamation projects for reasons of policy.

[20] Power is the secondary purpose which most frequently has contributed to carrying project costs. Power rates are normally set at the level generally prevailing in the region, and energy is usually disposed of to existing privately owned utilities.

The method for determining allocations which is outlined in the text above was employed in analysis by the Bureau of the feasibility of the Kendrick project. See J. R. Iakisch, "Engineering Report on Casper-Alcova Irrigation Project," Department of the Interior, Bureau of Reclamation, June, 1930; Report of Secretary of Interior to the President on the feasibility of the Kendrick Project, dated August 27, 1935; and *Interior Department Appropriation Bill, 1940,* Hearings before Subcommittee of House Committee on Appropriations, Seventy-Sixth Congress, First Session, January 30, 1939. See also "Colorado-Big Thompson Project," Senate Document 80, Seventy-Fifth Congress, First Session.

The case for the capitalized income theory of allocation has been well reviewed by Mr. Leland Olds, Chairman of the Federal Power Commission. Writing in a report of the National Resources Committee, Mr. Olds notes a statement of the Committee in a previous study to the effect that estimates of the value of power at a project should take into account the costs of power supply from alternate sources. He continues:

"This raises the question whether practical procedure might not establish first the wholesale rates for power from multipurpose Government projects on the basis of the most economical possible alternative power supply in the region and then determine, on the basis of the revenue to be derived from such rates, the portion of the cost of the entire project which power could sustain.

"On this theory, in most regions the determining factor in the establishment of wholesale rates, for power supply from transmission lines interconnecting Federal hydro developments, would be the cost of equivalent power supply from the best modern steam stations in the region. This would follow the precedent set by the private power industry which, in the past, has capitalized water-power developments on the basis of alternative steam costs. Provision should be made, however, for periodic readjustment of such rates in conformity with changes due to technological progress, as well as for ultimately giving the people the advantage of amortization of the project cost.

"If this principle should be adopted, matters of cost allocation between irrigation, flood control, navigation, and power should not adversely affect private power systems. Consequently, such power interests could not fairly object to a program which would accelerate the construction of hydroelectric projects as part of a public works program to absorb unused labor in periods of depression and unemployment." [21]

The capitalized income method has much to recommend it. From a practical point of view, its application would hold promise of eliminating much of the misunderstanding which has been general in the past with reference to public retail rate yardsticks for energy distributed from multiple purpose waterway projects. Theoretically, the method is a modest extension of the theory of normal competitive equilibrium under which vales of stra-

[21] National Resources Committee, *Energy Resources and National Policy*. January, 1939, p. 434.

tegically located or scarce resources are fixed by capitalization of the surpluses which exist between their costs and the costs of marginal resources.

Unfortunately, a number of difficulties stand in the way of adoption of Mr. Olds' conception of the capitalized income method of allocation. First, from a theoretical standpoint the determination of marginal steam costs is difficult. Costs of the best present alternate steam source properly may be regarded as marginal for the fixing of rates over time only if the industry operates under conditions of historic constant costs. If the industry is subject to long term increasing or decreasing costs, rates based upon these marginal costs would have to be periodically adjusted. Second, as is true of many other allocation procedures, this method makes allocations contingent upon estimated costs of hypothetical plants. Valuation experience in estimation of reproduction costs for existing plants provides abundant evidence that it would be difficult to establish any particular level of costs as representative of the best alternate steam performance. Probably the most that could be accomplished would be to define a range within which alternate cost should lie.[22]

Third, it would be extremely difficult to determine when project cost had been amortized in order that power customers might be given the "advantage" of amortization. Indeed, the meaning of amortization in connection with this mode of allocation is not at all clear. According to the strict theory of alternate cost rate making, provision for amortization might be included in estimated costs of the alternate steam source. Rates for the hydro plant would then be set to yield revenues equivalent to these costs, hydro operating costs would be deducted, and the remainder would be capitalized. A proper rate of capitalization would include provision for amortization as well as for other

[22] For discussions of steam power costs, see Gaffert, Gustav A., *Steam Power Stations* (1940); L. W. W. Morrow, "Power Costs in Large Steam Plants," 92 *Electrical World* 827 (October 27, 1928), and "Steam Station Cost Survey," 105 *Ibid.* 2799 (November 23, 1935); Justin and Mervin, *Power Supply Economics* (1934); and American Society of Civil Engineers, *Proceedings*, "Economic Aspects of Energy Generation, A Symposium," December, 1937 to September, 1938, p. 1884 *infra.*, and "Costs of Energy Generation, Second Symposium on Power Costs," April, 1938 to October, 1938, p. 638 *infra.*

fixed charges. Whether inclusion of amortization would increase or decrease the imputed allocation to power would depend upon the relative retirement periods contemplated for the hydro project and the alternate steam plant. In any event, nominal power costs would plainly be higher than in the absence of amortization. A second method of returning power investment would be to determine an appropriate charge to power by the capitalized income method without consideration of amortization and then to add to rates an amortization surcharge.[23] Under this method reserves equivalent to the nominal power allocation would be accumulated at the close of the retirement period.

Whatever method of amortization might be chosen, the question would arise at the close of the retirement period as to how far rates might justifiably be reduced. Under alternate cost theory the minimum level would seem to be the operating costs of a hypothetical alternate steam plant. Capital cost of this plant would presumably already have been retired. On the other hand, if the imputed power allocation were accepted as the capital "cost" of power, it would be difficult to attack a reduction of rates to the level of hydro operating costs.

Fourth, several important but more or less obvious deficiencies of the capitalized income method may be noted. (A) It has no utility from the rate-making standpoint since it is the resultant rather than the determinant of rates. (B) If the power allocation were not regularly revised, it might place embarrassing restrictions upon the flexibility of rate policy.[24] (C) It provides no real solution to the allocation problem since it does not define a proper method for determining a correct capitalization rate for returns above operating costs. Slight variations in rates for capitalization would cause great variations in imputed allocations.

Application of the capitalized income method of allocation at

[23] Under stringent competitive conditions it is conceivable that wholesale rates adequate to cover alternate costs plus amortization computed in this way might not be feasible.

[24] In certain phases of the business cycle it is possible that sound policy might dictate the making of rates at levels less than adequate to cover full fixed costs. Certainly in strict theory the floor for rates should be no more than incremental costs for operation (excluding all fixed charges whether on direct or joint investment).

TVA produces interesting results. For the ten-plant system, if we assume the "value" of primary at the generating station switchboard is five mills and the "value" of secondary one and a half mills,[25] total annual "value" of power is approximately $24,650,000. Assuming sinking fund depreciation and interest at 3.5 percent, annual direct power cost would be $14,548,000, and remaining income available for fixed charges would be $10,102,000. Capitalized at 3.91 percent,[26] this remaining income would support a joint cost allocation of $258,000,000, or 17 percent more than the estimated *total* of joint cost in the ten-plant system.[27] Although this result pays tribute to the economy of TVA construction, it also points to a final questionable feature of the capitalized income method: it prevents power consumers from enjoying any benefit whatsoever from the economy of hydro development.

INCREMENTAL CHARGE THEORIES OF ALLOCATION

The Moreland Method

Two versions of incremental cost theory have been considered in discussions of TVA allocations. One of these was developed by the "private" utilities in the TVA court cases and was presented to the Joint Committee Investigating TVA by Dean Edward L. Moreland of Massachusetts Institute of Technology. According to this version, investment chargeable to power should be determined as the remainder of system cost after subtraction from total cost of estimated single purpose costs of developing equivalent navigation and flood control. Dean Moreland employed this method to determine an allocation of the estimated cost of a TVA eleven-dam system.[28] For his estimate of single

[25] Allowing one and a half mills for transmission to load centers, our estimate of the "value" of primary becomes six and a half mills. This seems to be within the range probable alternate steam cost. See above, 134n.

[26] This figure is estimated to be adequate to cover interest at 3.5 percent, sinking fund depreciation, and insurance upon dams and reservoir properties.

[27] Valuation of primary at 4.5 mills and secondary at 1.5 mills would yield revenues adequate to support an allocation of $205,000,000, or 93 percent of total joint costs.

[28] This system added the Fontana project to the TVA ten-plant system. It was described by the Authority in a report dated March, 1936 and published under the title, "The Unified Development of the Tennessee River System."

purpose navigation cost he employed a report by Major Rufus Putnam which accepted the estimate of the United States Engineers in House Document 328 of $74,709,000 for a low-dam improvement the length of the river.[29] Major Putnam estimated total alternate navigation cost at $92,000,000, the additional allowance being for four *low* dams alternate to the Wilson project.[30] For alternate flood control Dean Moreland used the Ford Kurtz estimate of $81,134,000 for a system of storage basins on the headwaters of the Tennessee River system.[31] On the basis of these single purpose estimates and treating power as a residual purpose, Dean Moreland arrived at the following allocation of the eleven-dam system:[32]

Total system cost . . .		$505,240,000
Allocation to:		
Navigation	$91,809,000	
Flood Control	81,134,000	
		172,943,000
Remaining allocation to Power		$332,297,000

Of total estimated system cost, 18.2 percent was assessed against navigation, 16.0 percent against flood control and 65.8 percent against power.

We have already subjected the United States Engineers' low dam navigation estimate and the Ford Kurtz flood control esti-

[29] *Investigation of the Tennessee Valley Authority,* Hearings pursuant to Public Resolution 83, Seventy-Fifth Congress, Third Session, 3967 ff. See also above, Chapter XI.

[30] In cross examination, Attorney Francis Biddle, Counsel for the Committee, called attention to the following quotation from Chief Justice Hughes' opinion in the Ashwander case:

> "The Wilson Dam project, adopted in 1918, gave a nine foot slack water development, for 15 miles above Florence, over the Muscle Shoals rapids, and, as the District Court found, 'flooded out the then existing canal and locks which were inadequate. . . . .' The District Court also found that a *'high dam of this* (Wilson) *type was the only feasible means of eliminating this most serious obstruction to navigation.'* "

297 U. S. at 329 (italics supplied). See also *Hearings* before Joint Committee, 3860.

[31] See above, Chapter XI, note 26.

[32] *Hearings* before Joint Committee, 3887, and Exhibits 444 and 555.

mate to careful examination. This need not be repeated, but we may point out that the evidence does not support the contention that either of these estimates would have been adequate to achieve the end it contemplated. If we accept the Moreland method but employ more carefully authenticated estimates for alternate single purpose costs, we derive the following apportionment of cost of the ten-plant system.[33]

Total system cost		$407,811,000
Allocation to:		
Navigation	$143,883,000	
Flood Control	140,826,000	
		284,709,000
Remaining allocation to Power		$123,102,000

According to this computation, 35.3 percent of total cost would be charged to navigation, 34.5 percent to flood control, and 30.2 percent to power.

It is interesting that if we had employed in the computation above the TVA estimate for alternate navigation which was used in the ten-plant allocation, the resultant charge to power would have been but $103,465,000, or $5,420,000 less than direct power cost. This suggests the critical theoretical weakness of the Moreland method. True incremental costs at a multiple purpose system are those added costs which are incurred peculiarly because of the inclusion of each particular purpose in the complex of system objectives. At a three-purpose system, incremental cost for any purpose is that extra cost incurred above the cost which would be required for a dual purpose system excluding the purpose under consideration. Moreland's method fails because it computes incremental cost as the excess of system cost above the

[33] Alternate cost for navigation is taken from TVA revised estimate for thirty-two low dams, and alternate cost for flood control is taken from TVA tentative allocation of the ten-plant system. (See Chaper XI above.) Total cost of the multiple purpose system is from Table 21. It differs from the total used by Dean Moreland in that it excludes the cost of certain electrical transformation equipment which the Authority charged directly to power and which was taken into account twice in Moreland's estimates for the TVA power system, and it excludes the Fontana project entirely.

sum of alternate single purpose costs for all purposes but the one under consideration.

THE DIRECT-CHARGE-ONLY METHOD

A second version of incremental charge theory would assess against each purpose the special costs for which it is responsible and would treat joint costs as a complex which cannot be functionally distributed. This basis of charging was first given strong support in a journal article by Professor Horace Gray in June, 1935.[34] Professor Gray pointed out that three difficulties stood in the way of achieving a meaningful division of joint costs at public multiple purpose waterway improvements. These were the non-vendibility of benefits, their intangible nature, and the tendency of many of them to vary with time.[35] A further factor which he thought complicated the allocation problem was that some benefits are "individualized or local" while others are "socialized" or general. Where benefits are of the latter type and their incidence cannot be traced, it is apparent that no rational method can be devised whereby beneficiaries can be assessed a part of joint cost. Costs of this sort, said Professor Gray, should be met out of public funds. He continued:

"The same reasoning, however, does not apply in the case of special costs incurred specifically for the benefit of particular individuals, groups or communitites; here the direct beneficiaries should bear the separable costs incurred for the special benefit. In respect to hydroelectric power, this theory leads straight to the 'by-product' method of charging for electricity. Power from such multiple-purpose projects would be charged only with the separable costs, such as power

[34] Horace M. Gray, "Joint Costs in Multiple-Purpose Projects," 25 *American Economic Review* 224-235 (June, 1935).

[35] "Shall some definitive allocation, which will bind coming generations, be made now or shall present arrangements be regarded as merely tentative and subject to future adjustment? . . . . In view of the fact that these multiple-purpose projects are designed to promote economic welfare of the people over a long period, it would seem unwise to establish at the time of construction some rigid allocation of costs which may be entirely out of harmony with the conditions of the future. . . . . If the burden of supporting these public undertakings is to be apportioned over a long period in some approximate accordance with changing scales of values, then present cost allocations should be tentative and subject to periodic adjustment." *Ibid.*, 233.

house, turbines, generators, transmission lines and auxiliary equipment. Rates would be set at a level sufficiently high to cover the fixed charges, including amortization, on these separable items of investment. The joint costs, however, such as dams and storage reservoirs, would be charged against the general public revenue in the same way as other social services. It is obvious that single-purpose, privately-owned hydro-electric plants, which must recover all costs from the sale of electricity alone, cannot compete with these multiple-purpose, publicly owned plants when the latter are operated on the 'by-product' principle. . . . It is not, as the proponents of private ownership would have the public believe, an issue of government 'subsidy' or 'unfair competition.' Rather it is the displacement of one institution by another which is economically and socially superior." [36]

Whether or not Professor Gray's article influenced the thinking of the TVA Valuation Committee is not clear. Not long afterward, however, the Bonneville legislation came before Congress, and pressure was exerted upon the Committee to achieve some sort of findings which might assist Congress in the formulation of power policy for the new project. In reply to an inquiry from Director Lilienthal as to the status of the Committee's thought and work, Professor Bonbright submitted a memorandum dated December 18, 1935 endorsing the direct-charge-only theory and indicating his belief that the Committee would recommend this principle for adoption both at Wilson project and also at the Authority's other multiple purpose plants.[37] Professor Bonbright supported the proposal to refrain from dividing joint costs among purposes with three main arguments. First, any allocation of joint cost must be "almost 100 percent" arbitrary. Second, the only plausible basis for allocation, apportionment according to relative benefits, is precluded on practical grounds since no one could hope to estimate with any accuracy the relative benefits of the several services of a multiple purpose system. For example, any estimate of the relative advantage of the navigation and power aspects of the Wilson project would be ridiculous upon its surface. Third, not only would an allocation be useless and meaningless, but if it were employed as a guide to power rate making it would be positively detrimental. Rates, Professor Bonbright

[36] *Ibid.*, 235.

[37] See *Hearings* before Joint Committee, p. 727.

asserted, should be set in the light of the competitive power market and the general policy provisions of the TVA Act.

Professor Bonbright recognized that there would be certain difficulties attendant upon the adoption of an incremental basis of allocation. The allocationists would argue that failure to apportion a share of admittedly joint costs to power would invalidate the TVA yardstick. This argument could be countered by pointing out that *no* "costs" of power generation at a public multiple purpose project could conceivably have yardstick significance for private enterprise in the power industry. Certainly costs based upon a 100 percent allocation could not have such significance if the multiple purposes were *bona fide*. Equally certainly, no apportionment of admittedly joint costs could be found which would fix a line between subsidized and self-liquidating power operations. The real yardstick should be recognized to exist in the fields of transmission and distribution. Here costs of the TVA public system should be considered to set a working standard, or first approximation, departure from which by privately owned companies should be accepted when good ground for variation could be shown.

A further deficiency of the direct-cost-only principle would be its failure to provide a pseudo-cost basis for future rate making.[38] As the following quotation indicates, Professor Bonbright did not agree with Professor Gray's contention that rates should be set to return no more than direct costs:

"In recommending that power be charged only with incremental costs we by no means imply that the TVA should fix rates at no more than enough to yield fixed charges on these costs. On the contrary, it is our opinion that by and large rates for large industries should be fixed on the principle of securing the maximum revenue for government. Domestic rates, on the other hand, should be fixed at levels which will encourage wide spread use of electricity and which will give the country the benefit of an experiment in the social and economic effects of cheap electricity. It may well be that this rate-making policy will permit government to secure a handsome revenue over and above the fixed charges on incremental costs for power which can be returned to the Treasury as a partial liquidation of its

[38] This could also be considered an advantage since it would permit great flexibility.

entire commitment in the Tennessee Valley. This excess revenue, however, should be treated as profit rather than as a mere return on cost and it should be allowed to follow the rate-making policies rather than predetermining them. The significance of the incremental costs which would go on your books would lie in their indicating those minimum costs on which government must earn fixed charges or must otherwise admit that the power end of the TVA development is subsidized. Under the TVA Act as it now stands, it is the clear intention of Congress that rates so far as feasible shall be self-supporting. If the rates do not support incremental costs they will clearly fall below this standard. But the setting of any higher standard covering a share of joint costs would be the setting of a purely arbitrary goal of profits which would have no objective meaning."[39]

Professor Bonbright's letter was apparently given careful consideration by Director Lilienthal. In March, 1936, when TVA was considering rates for two long term industrial power contracts, Mr. Lilienthal submitted to the Board a memorandum outlining a recommended wholesale power policy. Two of the three major points of this memorandum were reminiscent of Professor Bonbright's proposals. They were as follows:

(1) "That the rates for wholesale power charged to large industries should not be less than the value of the power. In other words, that we should secure for the power as much as in our judgment we can secure, all the competitive and alternative factors being taken into consideration. That is, even though cost computations would show that a somewhat lower rate could be charged to the Aluminum Company, for example, that rate should not be agreed to if the power is saleable at a somewhat higher rate. . . . .

(2) "That the minimum (not necessarily the actual) rate should be based upon a computation of fixed charges in which the rate base shall be the property devoted exclusively to the production of power; that is the additional investment required over and above the navigation and flood control capital expenditures necessary to avoid the waste of incidental water power created by the navigation and flood control structure."[40]

[39] Letter, James C. Bonbright to David E. Lilienthal, December 18, 1935.

[40] Tennessee Valley Authority, office memorandum entitled "Wholesale Rates," David E. Lilienthal to the Board, March 21, 1936, quoted in *Hearings* before the Joint Committee, 675.

A year later, in replying to an inquiry from Senator Homer Bone as to TVA's allocation policies, Director Lilienthal indicated that he remained substantially in accord with the point of view expressed in his 1936 memorandum.[41] Largely because this point of view was misconstrued to imply that TVA power *rates* should be set at no more than incremental power costs, both Mr. Lilienthal and Professor Bonbright were subjected to a great deal of unjustified criticism.[42]

In the light of the criteria of a satisfactory technique for allocation established in Chapter VII, the following advantages of of the direct-cost-only method may be noted:

(1) It is logical.
(2) It is simple.
(3) It is workable.
(4) It is flexible.
(5) It permits any distribution of project economy among purposes which is considered consistent with good public policy.

Counterbalancing the advantages of the direct-charge-only method are two fundamental disadvantages. First, it is arguable that this is not a method of allocation at all, for it provides no basis for breaking down joint costs. Since the TVA Act makes no provision for a joint account in its requirement that the Authority apportion costs among purposes, it is not clear that the method would meet the requirements of the law. Second, the permanent removal of power rates from a cost basis, even though this basis be shadowy and of doubtful theoretical validity, would open the possibility that under a weak board rates might be scaled down in the face of political pressure below reasonably justifiable levels. Interestingly enough, both of these difficulties are primarily political rather than economic.

THE JUDGMENT METHOD

A final technique for allocation may be termed the judgment method. This method provides that investigations be made of

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[41] Letter, David E. Lilienthal to Senator Bone, March 2, 1937.

[42] See statement of Arthur E. Morgan, *Hearings* before Joint Committee, 4821 ff.

all of the more promising allocation principles and the results which they suggest. These investigations should be interpreted in the light of the strengths and weaknesses of each method. A final judgment allocation should then be fixed "in the light of all relevant data."

In its Three-Dam Allocation Report, TVA seems to take the position that its allocations are primarily based upon the judgment method. This is suggested in the following language:

> "A number of theories of cost allocation were studied carefully by the Committee in its attempt to reach a conclusion as to the shares of the joint investment that should be assigned to the various functions. All reasonable possibilities were explored in order to reach a result. . . . . Every method of allocating the common plant investment necessarily involves assumptions and estimates the formulation of which is dependent on widely varying opinions of individuals.
>
> "Of the total investment in the Authority's multi-purpose projects the only definite portion that can be associated with any one purpose is the added cost made necessary by the inclusion of that purpose. Whether the required additional expenditure is warranted is a question of policy necessitating the consideration of many factors the relative importance of which cannot always be determined by a common unit of measurement. The problem is one of judgment rather than scientific calculation.
>
> "This question becomes of considerable importance where a dam construction project is justified, as required by the Tennessee Valley Authority Act, primarily for navigation and flood-control purposes. Latent water-power, an inevitable consequence of the expenditure for navigation and flood-control, may be allowed to go to waste, or an additional expenditure may be made to convert it into electrical energy. Power may thus be considered self-supporting when the power revenues are just sufficient to cover the additional cost incident to the establishment and operation of the power facilities. How much higher such revenues should be in order that a portion of the remaining costs may be liquidated is a policy which the Act leaves to the Board. *The Committee's conclusions are, therefore, in the form of a recommended policy based on judgment and not on any one allocation theory.*" [48]

[48] House Document 709, Seventy-Fifth Congress, Third Session (italics supplied). Some of the language quoted is reminiscent of the direct-charge-only method, but the Committee's recommendation of a breakdown of joint costs is inconsistent with this method.

Although the Authority's own statement suggests that it has employed the judgment method, the evidence is not inconsistent with a somewhat different interpretation. This is that the Authority actually adopted the alternative justifiable expenditure method, but arrived at its final divisions of cost by rounding off the allocations determined by this method in the light of judgment. In demonstrating the alternative justifiable expenditure method, the TVA Financial Policy Committee determined allocations of common cost for the three-plant system as follows: to navigation, 33.8 percent; to flood control, 24.7 percent; and to power, 41.5 percent. The allocations which the Authority adopted were: to navigation, 35 percent; to flood control, 25 percent and to power, 40 percent. The differences are so slight that we believe the interpretation suggested above in this paragraph is correct.[44]

There is little to recommend the pure judgment method for allocation. In many regards it resembles what Professor Lewis has called the "trance method" of utility valuation to which the "rule" of Smyth vs. Ames gave rise. Allocation according to judgment "in the light of all relevant data" is inherently subjective. In a given situation it is more than doubtful if two well-intentioned experts would reach similar conclusions.[45] Certainly no allocation of this sort could be demonstrated to be correct as opposed to all alternatives. Nor could it be argued that this method holds the potentiality of achieving objectively meaningful distributions of joint cost. In sum, judgment allocations scarcely can be relied upon to guide public policy.

CONCLUSION

In the present chapter we have reviewed a number of secondary allocation techniques, most of which are admittedly arbitrary. With the exception of the vendibility method, which is not appli-

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[44] See *Hearings* before Joint Committee, p. 4788.

[45] The arguments here suggested do not apply with equal force to the rounding off of allocations determined by some formal principle. Since we have found no method of apportioning joint costs which is logical, reliable, and readily workable, certainly no objection could be made to rounding off the evidently uncertain results which any selected principle might indicate.

cable where major purposes are non-revenue producing, we have found that all of these methods are more or less workable. The simplest are the one hundred percent, equal charge, and direct-charge-only methods, but of these the first two are very weak from a theoretical standpoint. Similarly, the Moreland method and the judgment method are deficient upon logical grounds. There remain for consideration only the capitalized income and the direct-charge-only methods.

It has been pointed out that the direct-charge-only method might not be considered adequate under the terms of the TVA Act. The same deficiency would be equally true of the capitalized income method, for this provides no means of apportioning among non-vendible utilities joint costs remaining after the allocation to power, the revenue producing objective of the Authority. Both the major advantage and the major disadvantage of the capitalized income method is the fact that it establishes a pseudo-cost basis for future rates above the level of direct charges. This provides a firm anchor against shifting currents of political pressure, but unfortunately it is artificial in that the nominal power charge is not in any sense functionally traceable to that objective. The adoption of this principle might introduce a dangerous element of inflexibility into power rate policy. The direct-charge-only method is sound from a theoretical standpoint in that it assesses against each objective all costs incurred solely in its behalf. It leaves full room for the formulation of rates for vendible utilities in accord with a progressive public policy and in the light of alternate costs, and it does not limit rate flexibility by the introduction of hypothetical assignments of joint costs. Finally, it has the advantages of simplicity and equal applicability to all purposes. We must conclude that the direct-charge-only method is the most satisfactory technique of dealing with the allocation problem.

Chapter XIV

CONCLUSIONS AS TO METHODS FOR JOINT COST ALLOCATION

Summary. This chapter begins with consideration of several aspects of TVA allocations which have not yet been noted. It next points out that most of the standard methods of allocation are Euclidean in that they suggest charges to particular purposes such that the sum of charges is equal to total cost. But analysis of the field of available allocation procedures has shown that only the non-Euclidean direct-charge-only method is both theoretically and practically sound. Further support for this method derives from a re-examination of the nature of joint costs. It appears that by definition these costs are insusceptible of apportionment.

Our pessimistic conclusion as to the feasibility of allocation of joint costs suggests a re-examination of the case for allocation. This case rests on two grounds: that allocation is needed to establish rate bases for vendible utilities; and that allocation is needed to guide investment in multiple purpose enterprise. The first need can be obviated through the use of competitive prices or alternate costs as guides for rate making. Whether the second need can also be obviated requires further detailed analysis.

COMMENTS ON TVA ALLOCATIONS

The Tennessee Valley Authority elected to meet the allocation requirements of Section 14 of its organic act through the adoption, in effect, of a modified form of alternative justifiable expenditure principle. TVA allocations therefore, are, subject to the criticisms of this principle set forth above in Chapter XI. Without repeating the remarks of that chapter we may add a number of further comments upon the Authority's allocations.

Although the TVA Act directed that the Authority charge up to each of five objectives its appropriate share of project cost, the adopted allocations provide for charges to only three objectives. Fertilizer and national defense, the remaining purposes, are assessed no part of waterway joint costs. We have already pointed out that the only benefit to fertilizer production from these costs is through the availability of power. Since power for the fertilizer plants is taken from the hydro system on a commercial basis, the fertilizer allocation is implicitly included in the formal allocation to power. Had the power allocation been determined according to the alternate cost of power net of that used in the fertilizer works, the resultant charge would have been less than that which was actually assessed.[1]

More complicated than the problem of dealing with the fertilizer objective in relation to allocation is the problem of properly charging the end of national defense. Perhaps the key to the solution of this difficulty rests in the fact that the waterway program can assist defense only in three ways: by the protection of defense activities from interruption by floods; by facilitation of transportation and relief of railroads from the burden of emergency shipping; and by generation of power for defense industry.[2] As a purpose of the water control program national defense is not upon the same level as flood control, navigation, and power. The latter are immediate ends (or perhaps one should say intermediate ends), and stand in the relation of means to the more ultimate ends of national defense or, in time of peace, economic progress. Two methods may be suggested whereby allocations to immediate objectives and also to national defense might be shown. First, total costs might be allocated among the former, and these charges might be sub-classified between ultimate ends of defense and economic progress. The disadvantage of this method would rest in the difficulty of determining criteria by which to arrive at figures for the sub-classification. Second, total joint costs might be apportioned among immediate ends according to peace-time criteria, but direct investment incurred simply for emergency preparedness (regardless of the intermediate end through which preparedness might be served) would be charged to defense. For example, in planning power-

[1] An allocation to fertilizer could be determined as that part of the total power allocation given by the proportion of equivalent continuous kilowatts used in fertilizer operations to total equivalent continuous kilowatts of the system.

[2] Of course, exceptions to this statement are conceivable. An invading army might be checked at the Tennessee River line; or destruction of Norris Dam might drown out an invading force. These contingencies are remote, and they certainly cannot be evaluated in economic terms.

house construction TVA has occasionally provided stalls for greater installations than it would anticipate using under the normal development of its multiple purpose program. During a defense emergency new units placed in these stalls and power-only reservoir operation can contribute to rapid expansion of Authority power capacity.[3] Incremental costs of these stalls should be charged directly to the ultimate end of defense. Similarly, it is conceivable that investment in dock and harbor facilities might be pushed beyond the point justifiable for peacetime commerce on the Tennessee River in order that capacity might be available to handle rapidly and efficiently an emergency volume of shipping.[4] As in the case of extra power stalls, costs of such surplus terminals should not be assessed against a peacetime objective incidentally served but should be charged directly against defense. This second method of determining charges to defense seems more workable than the first, and we would recommend its adoption. If some procedure is not developed to handle charges for special defense plant being constructed during the present emergency, it is quite possible that the termination of the crisis will find peace-time power capital significantly overstated.

Another point concerning TVA allocations which has occasioned some confusion is that at several dams "non-project" cost has been charged off before computations have been undertaken to determine allocations to river control objectives.[5]

[3] Colonel Parker, TVA Chief Engineer, estimated that primary power of the seven-dam system might be increased approximately twenty-five percent by power-only operation. *Hearings* before Joint Committee, 4781.

[4] We do not mean here to suggest that the Authority has already invested in terminal facilities. So far as we know, it has not. Its policy has been that terminals should be developed locally.

[5] See for example, Edison Electric Institute, "Comments on TVA's Allocation of Investment in Norris, Wheeler and Wilson Dams," August 18, 1938.

H. S. Bennion, in an article published in the *Edison Electric Institute Bulletin* for November, 1938, pp. 469-476, asserts that it is questionable whether TVA makes proper provision for overheads and general expenses in its cost accounting. For a "correct" statement of costs of Wheeler and Norris dams he applies to TVA's official figures an additional factor of ten percent.

This statement was apparently made without full knowledge of TVA cost policy. The following cost summary for the Wheeler project indicates the extent to which the Authority includes non-direct costs in its cost reports:

For example, in costing for Norris Dam the Authority excluded most of the cost of Norris town. This town is equipped with many permanent homes, with paved streets, with water and electric utilities. It was intended and constructed as an experiment in municipal planning. Today, with the dam complete, the town survives with an expanding population. Certainly the cost of this community is not properly a part of the cost of Norris Dam. True, some sort of construction camp would have been required if the town had not been built. But the Authority's procedure of charging the dam with depreciation at the town over the period of dam construction is not palpably unreasonable.[6] Other elements of non-project cost at Norris include lands outside of the reservoir which were purchased to protect the upstream watershed or to make possible recreational parks. With the general theory which treats outlays such as these as non-project cost we have no quarrel. It is possible that in particular cases items have been allowed to slip into this classification which should have gone into project costs. But no exceptions of this sort have come to our attention.

A final point which deserves emphasis is that TVA has not

Land costs	$ 4,784,395	
Direct construction costs: labor, material and other charges	20,891,002	
Camp and other indirect costs	1,616,208	
Total direct and indirect construction costs		$27,291,605
Distributive general expenses:		
Design and construction engineering		1,452,902
Executive and administrative costs		1,366,782
Other general costs		267,601
Total Cost, Wheeler multiple purpose project (including switchyard)		$30,378,889

Similar treatment is given non-direct costs on all TVA construction work. (See TVA published report on the Wheeler project.)

[6] The dam was originally charged with the full cost of Norris town. When construction was completed, the dam was credited with a charge of $3,722,135 for the following:

"Depreciated cost of permanent dwellings, buildings, streets and roads, sewage system, water system, and related facilities at Norris Town which are not necessary in their entirety to the operating project, and which will be treated as general plant useful in all programs of the Authority."

(House Document 709, Seventy-Fifth Congress, Third Session.)

An alternative procedure would have charged the dam simply with the cost of an alternate temporary construction camp.

established its power rate structure on the basis of its allocations. These have been interpreted simply as "fair" divisions of joint costs; and rates appear to have been set to a great extent upon a policy basis in the light of alternate costs. Thus, power revenues have tended to be substantially in excess of nominal power costs.[7]

EUCLIDEAN AND NON-EUCLIDEAN ALLOCATIONS

Throughout most of our discussion of allocation principles we have accepted as a premise that allocation is a process of dividing actually incurred costs. Thus, we have assumed that the total of allocated costs should exactly equal total project (or system) cost. The question may now be raised, Are there not conditions under which the sum of allocations might properly be either more or less than total project (or system) cost? An answer to this query must rest upon the purpose which allocation is designed to fulfill. If the objective is to fix investment bases on which charges can be figured to determine appropriate rates for the disposal of vendible utilities, the capitalized income method might be used and total allocations in excess of incurred costs would frequently be justified.[8] On the other hand, if allocation is intended simply to define the level of costs which revenues from particular purposes should cover in order that no objective may be subsidized, then the direct-charge-only method should be used, and the sum of allocations would be less than total incurred costs (by the amount of joint costs). Finally, if

[7] It is an interesting question whether TVA allocations which have been submitted to, and approved by, the President subsequently could be revised in the light of changed conditions. Without affirmative Congressional action it does not seem that they could; for the TVA Act states that:

> "The findings (as to allocation) thus made by the Board, when approved by the President of the United States, *shall be final*, and such findings shall thereafter be used in all allocations of value for the purpose of keeping the book value of said properties."

(Act of May 18, 1933, ch. 32, sec. 14, 48 Stat. 58, 16 U. S. C. A. 831. Parenthesis and italics supplied.)

[8] For example, at a power-irrigation project a moderate charge for water might earn sufficient revenue so that power could be sold well below either its market value or alternate cost, and yet it would still cover the balance of project costs. For rate-making purposes a power allocation in excess of remaining project capital cost might be justified.

the purpose of allocation is to determine some kind of "fair" apportionment of total cost, then obviously the sum of charges must equal total cost. Unfortunately, our review of allocation theories has revealed no satisfactory method of achieving this type of apportionment. Superficially, some version of benefit method would appear to be plausible. But allocation according to relative national benefits is neither sound theoretically nor workable practically. Allocation according to alternative justifiable expenditures, while somewhat more satisfactory than the more general version of benefit theory, is also deficient for both theoretical and practical reasons. Both of the use methods are weak theoretically, and the same is true of all of the secondary methods discussed in Chapter XIII with the exception of allocation according to direct-costs-only. But this method is not adapted to determination of a "fair" apportionment of joint costs. We are forced to conclude that no satisfactory objective procedure to achieve this end is available.

With the failure of methods proposed to apportion joint costs, choice of an allocation technique reduces to a decision between the capitalized income and direct-cost-only methods. For the reasons suggested in Chapter XIII, we recommend the latter. If this method is inconsistent with the TVA Act and with the Authority's adopted allocations, the Act should be amended. In all future Congressional legislation dealing with public multiple purpose projects, impossible requirements as to joint cost apportionment should be avoided.

THE AFFIRMATIVE CASE FOR REFRAINING FROM ALLOCATION OF JOINT COSTS

The case for the direct-cost-only theory which was presented in Chapter XIII was primarily negative. A strong affirmative case for this theory may also be made.

The customary interpretation of joint cost apportionment is that it is a procedure whereby the joint cost complex is broken down among a number of purposes which are each functionally responsible for the incurring of a part of total joint cost.[9] No

[9] For example, former Chairman A. E. Morgan, in testifying before the Joint Committee on the Investigation of TVA, asserted:

problem of apportionment exists with respect to single-purpose costs, for these are functionally separable; they are traceable to the purposes which they serve. But the peculiar economy of multiple purpose enterprise is contingent upon the existence of a certain amount of jointness among objectives, and hence upon the existence of joint costs. In their essence, joint costs serve several purposes and are indivisible as among them. By definition, they are the remainder after all traceable costs have been assigned. It follows that no allocation technique, however ingenious, can isolate out of the joint complex a part chargeable to a particular purpose, say power, which has economic significance and which power revenues should cover in order that power consumers may not be subsidized. The critical level for determination of subsidies at multiple purpose enterprise is the direct-cost-only level. So long as power revenues are adequate to cover direct costs, power must be regarded as self-liquidating. If revenues are also sufficient to bear a part of joint charges, they should be considered as contributing to the support of investment in excess of that allocable to power. At TVA, thirty-eight percent of joint cost of the ten-dam system was tentatively assigned to power. We can see no meaningful economic distinction between a situation in which power revenues might be either more or less than sufficient to cover charges on this allocation. Great or small, any contribution toward joint cost is qualitatively the same.

Although allocation as a cost finding technique must fail, the suggestion sometimes has been put forward that it may determine "fair" divisions of admittedly joint costs. Rates for vendible utilities should then be adequate to cover charges on these

"The reason for allocating costs after the dams are built is to enable the public to know whether Tennessee Valley Authority power is being sold at a profit or at a loss."
(*Hearings*, 4799.)

"The fair cost of power investment . . . . is about twice as great as would be shown by an allocation on the by-product theory. That difference is a measure of the fair cost of power investment which would have been a concealed subsidy if the Tennessee Valley Authority had been committed to the by-product theory."
Ibid., 4797.

fair allocations. We have not found that introduction of the concept of equity facilitates solution of the allocation problem. Indeed, a special argument may be put forward against any cost apportionment which is without basis in incurred costs. This is that not only are such allocations obviously artificial from an economic standpoint, but that there is a danger they may impair desirable flexibility of wholesale rates. An allocation which today is fair and yields rate bases for vendible utilities consistent with wise public policy may not be fair tomorrow. To change it, however, would require revision of recorded asset values spread through the permanent financial accounts. This would involve difficulties so great that they very likely would discourage anything other than drastic revisions of original assignments of joint costs. In practice, rate base allocations might make it very difficult for a public power system to maintain proper wholesale rate flexibility in the light of evolving steam electric technology.

A FINAL QUESTION

Some students of multiple purpose economics have urged that joint cost allocation is a prerequisite to sound planning of multiple purpose enterprise.[10] This position was developed in a recent report of the National Resources Planning Board as follows:

> "Evaluation of costs and benefits is basic to any sound programming of public works. No public work can be considered acceptable unless the total benefits, to whomsoever they may accrue, exceed the total cost. Furthermore, there may be many more works which meet this criterion than available funds will finance. This requires a selection on the basis of those projects with the most favorable ratio of benefits to cost. In this selective process, social as well as financial costs and benefits should be taken into account.
>
> . . . .
>
> "In connection with multiple purpose projects—principally those involving some combination of flood control—the development of comparable measures of costs and benefits will also make a significant indirect contribution to the evaluation process. *While the total dollars and cents costs of a specific project may be estimated with*

[10] See statement by Arthur E. Morgan before Joint Committee on the Investigation of TVA. *Hearings* before the same at 4999.

reasonable accuracy, the problem of apportioning costs of multiple purpose projects is exceedingly difficult. Efficiency and sound public policy demand that all project plans consider all possibilities for serving related purposes regardless of the primary purpose of the project. Unless a commonly acceptable method for determining costs and benefits is developed and adopted, there is no objective basis for comparing the costs and benefits of each separable function of a proposed multiple purpose undertaking with the costs and benefits of either (1) *an alternative single purpose project to serve the same separable purpose or* (2) *other projects which though unrelated in purpose must be compared in terms of their right to be included in a public works program.* There, may, for instance, be a proposed multiple purpose project for power, irrigation, and flood control, all of which affect the land use of the area involved. The manner in which the joint costs are allocated among these functions will in part determine the ratio of costs to benefits assigned to any one function, as irrigation. By following one method of apportioning joint costs, the irrigation function would be deemed a desirable part of the combination, while under another method, irrigation would appear to be too costly.[11]

If it is true that joint cost allocations are essential to sound project or system planning, our conclusion that meaningful allocations are impossible to achieve must be dismal indeed. In the chapter which follows we shall present our understanding of the criteria which should govern multiple purpose planning and indicate our reasons for rejecting the premise as to the necessity of allocations. Finally, in Chapter XVI we shall consider the implications of the maturity of multiple purpose enterprise relative to public policy in water resource planning.

[11]National Resources Planning Board, *Development of Resources and Stabilization of Employment in the United States* (January, 1941), Part III, "Functional Development Policies," 9-10 (italics supplied).

Part III

PLANNING AND POLICY

CHAPTER XV

THE ECONOMICS OF FEASIBILITY

Summary. One of the major ends which joint cost allocation has been claimed to serve is facilitation of the optimum economic apportionment of investment in proposed projects or systems for the achievement of different joint objectives. In the present chapter we review the theory of water planning and demonstrate that the view that allocations should affect the development of multiple purpose enterprise is without foundation.

To the student of economic theory the criteria which should govern project or system planning will be readily apparent. Investment is justifiable if prospective annual benefits exceed prospective annual costs for some scale of development. Within the range of feasible improvement, an undertaking should be expanded at the expense of additional annual costs up to the point at which the added benefits obtained are precisely offset by the added costs incurred. In a comprehensive system, prospective annual benefit from the last dollar of annual cost for each purpose or each project should be the same.

Practical application of the pure theory of project or system planning encounters numerous difficulties. The most critical of these are that government is not interested in water control from a strictly commercial standpoint and that social and intangible economic benefits are not susceptible of pecuniary evaluation. It follows that public policy rather than prospective economic returns typically must be the final guide of public investment.

THE PURE THEORY OF SINGLE PURPOSE FLOOD CONTROL

In closing the discussion of Part II above we noted the view which frequently has been held that allocation of joint costs is needful, or at least helpful, in achieving the optimum proportioning of multiple purpose enterprise. In the present chapter we set forth the principles which we believe should govern planning and show that allocation is not relevant to this problem. Because the theory of planning is complex, it will be convenient to begin with analysis of single purpose flood control. We shall next proceed to the pure theory of an isolated multiple purpose project. Finally, we shall deal with the planning of a multiple purpose system.[1]

The first difficulty to be overcome in planning for flood control is properly to balance reservoir and levee protection. Let us assume a situation in which all flood damages are concentrated at a given town above which there is a single reservoir site available for storage. Let us assume further that both tangible and intangible annual flood damages are very great and that residents of the town are willing to pay an extravagant price to gain safety against a possible 500-year flood. How should they proportion expenditure between local protective works and upstream reservoir control in order to gain maximum security for minimum outlay? A problem similar to this has been discussed above in connection with TVA planning for flood control at Chattanooga.[2] A graphic procedure for solution is suggested in Figure 14. In order to take account of differences in annual maintenance and depreciation expense for reservoirs and levees, costs are given in annual terms. Assuming that annual costs are conservatively stated to allow for all necessary safety factors, the optimum system for complete control, from an economic standpoint, is determined by the minimum point of the curve of combined total cost.[3] For the conditions of Figure 14, optimum development would require total annual costs of $400,000 for reservoir control of the anticipated superflood to 200,000 c. f. s. and for levee and channel works adequate safely to carry this flow.

Somewhat more complicated than the problem of balancing a reservoir-levee system is the planning of a valley-wide system of flood protection. First, let us assume that the estimated super-

[1] We should like to acknowledge a debt in this chapter to a paper by Mr. Calvin C. Davis of the Tennessee Valley Authority entitled "Reservoir Economics." This paper was given before a seminar on the "Economics of Multiple Purpose Projects" which was conducted during 1940-1941 by the Training Division of the TVA Personnel Department.

[2] See Chapter V.

[3] Attention may be called to the fact that the curves of this chart are for total rather than average or marginal cost. Hence, the minimum point of the curve of combined cost is not directly above the intersection of the separate reservoir and levee curves.

flood for the watershed has been determined, and that there is no question of the economic justifiability of seeking complete control of this flow along the main river channel. The only

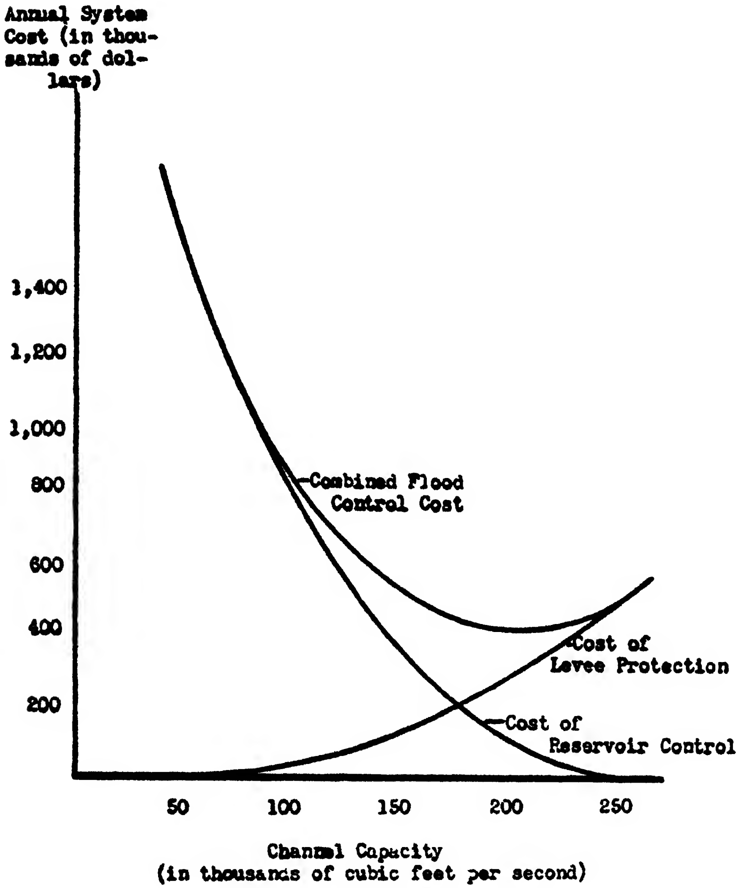

Figure 14. Cost of combined reservoir-levee protection for hypothetical town against estimated 500-year flood of 250,000 cubic feet per second. (Read curves as cost of levee protection against flows as high as indicated, and cost of reservoir control to reduce superflood to flow indicated.)

issue rests in determining the best proportions between development at available reservoir sites and levee protection. Solution should proceed as follows. Storage should first be planned at the most favorable site, i.e., the site able to scale down the project flood at the lowest cost per foot of flood height reduction. Additional capacity for this site should be planned beyond the stage of minimum average cost to the point at which marginal cost of an additional unit scaled from crest is equivalent to minimum average cost at the next most favorable site. This site should then be added, and additional required storage should be apportioned between the two sites so as to maintain at each constant equality of cost of an additional increment of flood height reduction. At the point at which marginal costs for the first two sites rise above minimum average cost of a third, the new site should be added and further storage should be allotted to the three sites so as to maintain equality of rising marginal costs. Meanwhile, levee control of the base of the flood hydrograph should be contemplated as soon as marginal cost of storage of an additional foot of crest exceeds cost for the first foot of levee protection. Additional levee should be planned co-ordinately with additional storage to maintain constant equality between marginal levee and marginal storage cost. The most economical system for total control will be determined by continually expanding the reservoir-levee system under the guidance of marginal costs until protection is provided against all flow of the project flood above normal channel capacity.[4]

Let us now modify the assumptions of the analyses above by introducing uncertainty of economic feasibility. Up to the present point we have been concerned with planning the least costly system to achieve a given degree of control. We now encounter the difficulty of determining how much control it is economically feasible to undertake. This is the problem of planning expenditures in the light of prospective returns. In order that it may be dealt with "scientifically," the nature of benefits from different alternative flood control plans and the way in

[4] Under this method of apportioning storage, additions to system capacity are discontinuous when new sites are added. Difficulty would develop if a point should be reached at which marginal costs for early sites exceeded minimum average cost for a new site but storage for the marginal site corresponding to its minimum average cost exceeded the increment in system storage required for complete security. Decision between further storage at existing sites, "under-development" of the marginal site, or both would be contingent upon which plan promised to provide the added required storage at the least added cost.

which these benefits tend to vary with different degrees of control must be investigated.[5] If we assume that benefits can be determined and evaluated and that beyond a certain scale of investment additional benefits from given increments of investment decrease, it is possible to define an equilibrium point of flood control investment. If no scale of improvement will

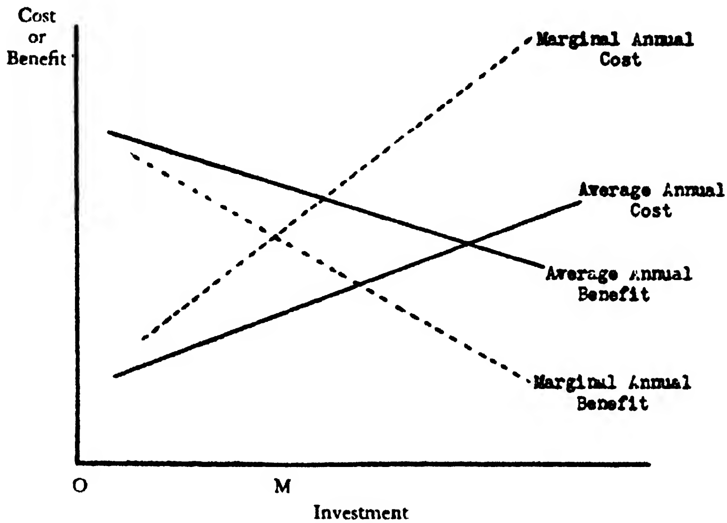

Figure 15. Theoretical equilibrium of a single purpose flood control system.

achieve total benefits equal to total costs, no development is feasible (from an economic standpoint). If for some scale of investment total benefits equal total cost (or average benefits equal average costs), improvement is feasible. Investment should then be carried to the scale at which the marginal annual benefit from a slight expansion of the system would be just offset by the marginal annual cost incurred. Incidentally, as Figure 15 makes clear, the equilibrium point (at OM investment) is neither the point at which total benefits bear the greatest ratio to total costs nor the point at which total benefits equal total costs.

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[5] Each scale of investment must be analyzed in terms of its maximum potential yield of benefits as determined by optimum proportioning of investment.

PURE THEORY OF THE ISOLATED MULTIPLE PURPOSE PROJECT

Somewhat more complicated than planning for single purpose flood control is planning for multiple purpose improvement. It will be convenient to consider first the case of a hypothetical tributary project serving the dual purposes of power and flood control.[6] We shall assume that the site for this project is isolated so that its development will not affect other potential improvements. We shall assume further that there are no problems of navigation, stream pollution, or water supply on this tributary or downstream from it. Formulation of a plan for our project requires (1) determination of the relative feasibility of its proportioning in a number of different ways for each of several possible elevations, and (2) determination of which elevation would represent the optimum economic development of the site.

We present in Table 63 the relative costs and benefits as estimated for a development with top of gates at Elevation 1600 for different proportions between power and flood control. The most favorable proportion is evidently Plan B which provides 750,000 acre feet of permanent flood surcharge capacity and 750,000 additional acre feet of seasonal storage through March 15 of every year. This plan is most favorable, not because it yields the highest rate of return or the lowest ratio of annual costs to annual benefits, but because the net gain in total annual benefits as a move is made to it from either Plan A or Plan C is greater than the net increase in total annual costs.[7]

The question now arises, Does Elevation 1600 represent the optimum economic development of the site. In order to answer this question we must compare the optimum project built to this elevation with the most favorable alternate projects which

[6] The characteristics of the fictional project here discussed are purely hypothetical and are not intended to be representative of any existing project. The analysis is simply a demonstration of procedure.

[7] This criterion must be interpreted with regard to arithmetic signs. Normally, for developments greater than the optimum the net decrease in annual benefits as a shift is made back to the optimum is less than the net decrease in annual costs.

It is possible that some intermediate Plan D might be still more favorable than Plan B, but we may accept the latter as the optimum improvement to elevation 1600 for purposes of the present discussion.

might be built to other elevations. Optimum proportions between power and flood control for each of these other elevations should be determined in the same way in which we found Plan B to be the best plan for a project to Elevation 1600. Estimated costs and benefits for improvement to a number of alternate elevations are shown in Table 64. The critical index for planning is the ratio of added costs incurred to added benefits gained from expanding the project (line 18). As long as this ratio is less than unity, an increase in project elevation is advantageous. As soon as it rises above unity, any further increase of elevation would fail to cover its added costs and would be uneconomical. Of the several elevations shown in Table 64, rational planning would adopt a project to Elevation 1625. Compared with this development, the costs avoided would be less than the benefits lost if Elevation 1600 were chosen; and the added benefits gained from raising crest to Elevation 1650 would be less than the added costs which would have to be incurred.[8]

Figure 16 suggests a graphic method for selecting the optimum elevation for top of gates. Beyond a certain point it is always true that as elevation is increased annual costs tend to rise at an increasing rate whereas annual benefits tend to increase at a decreasing rate. Optimum construction will raise the top of gates to that elevation for which the rate of increase of costs and benefits is the same, i.e., to the elevation for which the slopes of curves of annual costs and annual benefits are equal. This is Elevation OA in the chart, and it corresponds approximately to Elevation 1625 for the hypothetical project here under discussion.

Attention must now be called to a number of feasibility indices in Tables 63 and 64 which have not yet been discussed. Lines 19 and 20 reflect the feasibility of the power and flood control programs in terms of their added costs. These ratios must be less than unity if each of the separable purposes is to cover its traceable costs. Should the ratio for any purpose exceed unity,

[8] It is possible that some intermediate elevation might be still more favorable than 1625, but for our purposes this may be considered as a satisfactory approximation of the optimum development for the site in question.

TABLE 63

PROPORTIONING A HYPOTHETICAL PROJECT TO ELEVATION 1600

	Plan A	Plan B	Plan C
	(All costs or benefits in thousands of dollars)		
Flood Control-Power Balance			
1. Permanent flood surcharge capacity (in acre feet)	1,000,000	750,000	500,000
2. Seasonal flood capacity (in acre feet)[a]	1,000,000	750,000	500,000
3. Available primary power (in kilowatts)	145,000	160,000	164,000
Investment Cost			
4. Powerhouse	14,000	14,000	14,000
5. Added units	......	1,500	1,500
6. Transmission and interconnection	12,000	14,000	14,500
7. Subtotal for power only	26,000	29,500	30,000
8. Flood control only	10,000	8,000	7,000
9. Joint investment	50,000	52,000	53,000
10. Total investment	86,000	89,500	90,000
Annual Cost			
11. Power only	2,080	2,360	2,400
12. Flood control only	400	320	280
13. Joint cost	2,000	2,080	2,120
14. Total	4,480	4,760	4,800
Annual Benefits			
15. Power[b]	4,710	5,200	5,330
16. Flood control[c]	1,400	1,350	1,000
17. Total	6,110	6,550	6,330

All notes at end of table.

TABLE 63 (CONTINUED)

PROPORTIONING A HYPOTHETICAL PROJECT TO ELEVATION 1600

	Plan A	Plan B	Plan C
	(All costs or benefits in thousands of dollars)		
Feasibility Ratios			
18. Excess of annual benefits lost over annual costs avoided by moving from Plan B[d]	160	....	260
19. Flood control traceable costs relative to flood control benefits	.287	.237	.280
20. Power traceable costs relative to power benefits	.441	.454	.450
21. Total costs relative to total benefits	.733	.727	.758
22. Flood control multiple purpose operation:			
(a) Kilowatts of power foregone	50,000	30,000	20,000
(b) Annual value of power foregone[e]	1,000	600	400
(c) Power benefit foregone relative to flood control benefit gained	.714	.444	.400
Rate of Return			
23. Total annual benefits	6,110	6,550	6,330
24. Total annual cost	4,480	4,760	4,800
25. Cost of interest[f]	3,010	3,130	3,150
26. Annual cost before interest[g]	1,470	1,630	1,650
27. Net annual return before interest[h]	4,640	4,920	4,680
28. Annual rate of return[i]	5.39%	5.50%	5.20%

[a]Seasonal flood capacity available every year from January 1 through March 15.
[b]Transmitted power valued at $32.50 per kilowatt.
[c]Flood storage under Plan A valued at $.70 per acre foot, under Plan B at $.90 per acre foot and under Plan C at $1.00 per acre foot.
[d]See p. 404, note 7.
[e]Valued at $20 per kilowatt.
[f]Interest is throughout taken at 3.5 percent.
[g]Line 26 = line 24 — line 25.
[h]Line 27 = line 23 — line 26.
[i]Line 28 = line 27 ÷ line 10.

TABLE 64

DETERMINING MOST ECONOMICAL ELEVATION OF A HYPOTHETICAL PROJECT

	Elevation 1575	Elevation 1600	Elevation 1625	Elevation 1650
	(All costs or benefits in thousands of dollars)			
Flood Control-Power Balance				
1. Permanent flood surcharge capacity (in acre feet)	500,000	750,000	750,000	750,000
2. Seasonal flood capacity (in acre feet)[a]	750,000	750,000	1,000,000	1,000,000
3. Available primary power (in kilowatts)	145,000	160,000	190,000	225,000
Investment Cost				
4. Powerhouse	14,000	14,000	17,500	19,000
5. Added units	....	1,500	1,500	3,000
6. Transmission and interconnection	12,000	14,000	16,300	19,000
7. Subtotal for power only	26,000	29,500	35,300	41,000
8. Flood control only	7,000	8,000	9,000	10,000
9. Joint investment	48,000	52,000	58,000	75,000
10. Total investment	81,000	89,500	102,300	126,000
Annual Costs				
11. Power only	2,080	2,360	2,824	3,280
12. Flood control only	280	320	360	400
13. Joint cost	1,920	2,080	2,320	3,000
14. Total	4,280	4,760	5,504	6,680
Annual Benefits				
15. Power.[b]	4,710	5,200	6,170	7,310
16. Flood control[c]	1,125	1,350	1,488	1,488
17. Total	5,835	6,550	7,658	8,798

TABLE 64 (CONTINUED)

DETERMINING MOST ECONOMICAL ELEVATION OF A HYPOTHETICAL PROJECT

	Elevation 1575	Elevation 1600	Elevation 1625	Elevation 1650
	(All costs or benefits in thousands of dollars)			
Feasibility Ratios				
18. Ratio of added costs to added benefits from raising project to next higher elevation	.671	.672	1.028	....
19. Flood control direct cost relative to flood control benefits	.240	.237	.242	.269
20. Power direct cost relative to power benefits	.442	.454	.458	.449
21. Total costs relative to total benefits	.735	.727	.719	.760
22. Flood control multiple purpose operation:				
(a) Kilowatts of power foregone	20,000	30,000	45,000	50,000
(b) Annual value of power foregone[d]	400	600	900	1,000
(c) Power benefit foregone relative to flood control benefit gained	.355	.444	.605	.672
Rate of Return				
23. Total annual benefits	5,835	6,550	7,658	8,798
24. Total annual cost	4,280	4,760	5,504	6,680
25. Cost of interest[e]	2,840	3,130	3,580	4,410
26. Annual cost before interest[f]	1,440	1,630	1,924	2,270
27. Net annual return before interest[g]	4,395	4,920	5,734	6,528
28. Annual rate of return	5.43%	5.50%	5.60%	5.18%

[a] Seasonal capacity available every year from January 1 through March 15.
[b] Transmitted power valued at $32.50 per kilowatt.
[c] For alternatives planned to Elevation 1575 and 1600, flood control valued at $.90 per acre foot; for projects to Elevation 1625 or 1650, flood storage is valued at $.85 per acre foot.
[d] At $20 per kilowatt.
[e] Interest throughout assumed to be 3.5 percent.
[f] Line 26 = line 24 — line 25.
[g] Line 27 = line 23 — line 26.
[h] Line 28 = line 27 ÷ line 10.

so far as the economic criterion is concerned that purpose would not merit inclusion in the comprehensive project. The ratio of line 21 tests the ability of the project as a whole to cover its cost. If this ratio is not less than unity for some elevation at a given site, no development is justifiable. The same information that is supplied in line 21 is also indicated below in line 28 ("Annual

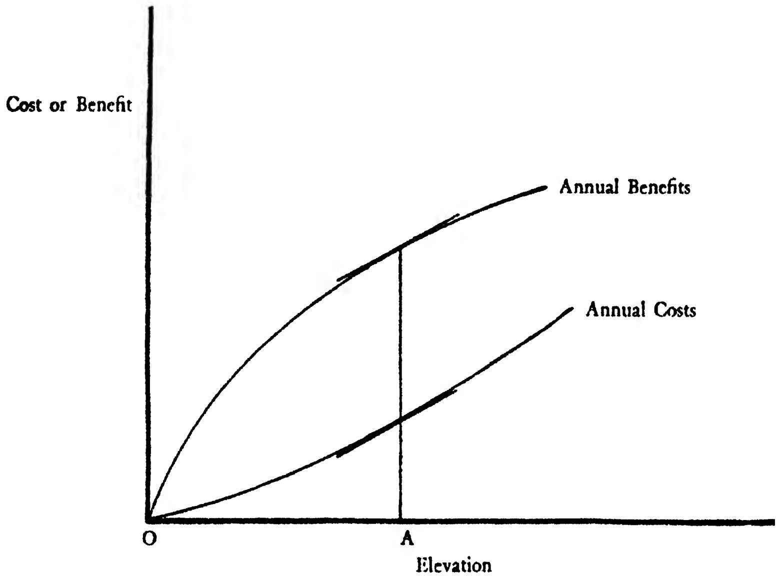

Figure 16. Graphic determination of optimum crest elevation for hypothetical multiple purpose project. (Elevation OA corresponds to optimum.)

rate of return"). If there is no elevation to which the project could be raised for which the rate of return would be as great as the rate of interest for public funds, no improvement can be considered feasible. It is most important to note, however, that the optimum development is not necessarily the one for which the rate of return is a maximum (or the ratio of costs to benefits a minimum). More often than not the index of line 18 will indicate that the optimum improvement is somewhat greater than the one for which the rate of return is a maximum. That which should be maximized is not the rate of return but rather the total amount of the surplus of returns over costs. Plainly, it is good economy to expand a project so long as the added costs incurred remain less than the added benefits gained.[9] Finally, lines 22 (a) to 22 (c) analyze the feasibility of flood control in terms of the opportunity cost of the power foregone. It is conceivable that line 19 might indicate feasibility of inclusion of flood control but that superior economy of the project for power might raise the ratios of line 22 (c) above unity. If this should happen, the indication would be that development of the site for power only would be more favorable than joint improvement. Since all of the ratios of line 22 (c) in both Tables 63 and 64 are less than unity, the economy of multiple purpose development is clearly shown.

The type of analysis here suggested for the planning of an isolated power-flood control project may be extended to apply to any isolated multiple purpose improvement.

PRELIMINARY PLANNING FOR AN ULTIMATE MULTIPLE PURPOSE SYSTEM

The discussion above has dealt with the pure theory of isolated multiple purpose projects. The question now arises, What economic criteria should govern the development of a unified multiple purpose system? If we assume that annual costs and benefits of different alternative systems may be estimated with reasonable accuracy, these criteria are closely similar to those which rule the development of a single purpose flood control system. For different investment levels estimates should be made of annual benefits under optimum development.[10] The relative variation of annual costs and benefits for optimum systems at different levels of investment should be determined, and the ultimate plan should contemplate development of that system

[9] It appears that rational improvement of a multiple purpose hydro site gives rise to most of the problems which are involved in rational administration of a rent yielding source. Incidently, one may note that the longevity of great dams places a premium upon accuracy in initial planning decisions.

[10] By optimum development we mean that the benefit yield from the last dollar of annual cost at each project would be the same. (If it were not, total benefits could be increased with no increase in total costs simply by appropriately reducing expenditures at one or more projects and increasing them at others.)

beyond which additional annual benefits could be gained only at the expense of greater annual costs.

In system planning the problem arises of defining the natural area within which a unified program of water development should be unfolded. For navigation, flood control, and stream pollution, the drainage basin seems to be the most logical unit with which to work. For power the advantages of interconnection and load diversity are so great that the tendency, at least, is toward national, or perhaps even continental, planning. Nevertheless, even with planning on such a scale, it remains necessary to deal with units of the general plan. Because of the interrelations among all phases of water use, it seems reasonable to accept the drainage basin as the most workable geographic unit within which to carry out system development. "Drainage basin," however, is an ambiguous phrase. In the valley of the Mississippi, for example, which of the following watersheds constitutes the unit within which system planning should be carried out: the Nolichucky, the French Broad, the Tennessee, the Ohio, or the Mississippi basin as a whole? It seems probable that the Nolichucky drainage area would be too small to serve as a unit in a national plan. Certainly the Mississippi, comprising almost half of the land area of the United States, would be too large. On empirical grounds, it seems reasonable to suggest that a watershed approximately the size of the Tennessee would often be a convenient unit within which to develop a unified water plan.[11]

THE THEORY OF SYSTEM CONSTRUCTION

We have outlined above the theoretical considerations which should govern planning for an ultimate multiple purpose system in a given drainage basin. Since the construction of major water

[11] Units of this approximate size would be well suited for co-ordination of stream planning with general planning for the conservation and development of natural resources.

The Ohio basin might be divided into the following sections: the upper Ohio including all drainage area above Pittsburgh; the middle Ohio, including area drained by the river between Pittsburgh and Cincinnati; the Tennessee-Cumberland region; and the lower Ohio, including all area draining into the Ohio River below Cincinnati with the exception of the Tennessee-Cumberland region. The interrelations between these regions would be of fundamental importance in the derivation of plans for their development.

control works is a time consuming process,[12] there is considerable scope for variation in the procedure by which a planned ultimate system may be attained. Attention should be given to the programming of system construction as well as to the formulation of an ultimate basin plan. Other things being equal, those projects which yield high cost-benefit ratios for their initial stages should be developed first. In this way, the present value of the surplus of benefits over costs for the construction period may be maximized (or the deficit minimized). Cost estimates for alternative construction programs should give consideration to the possibilities of machinery and labor economy through development of successive projects located closely together.[13]

Important as are other considerations in the programming of system development, there is little doubt but that the most important single feature of any construction program should be its flexibility. We hold strongly to the view that a master water plan should be prepared for every drainage area, and that no project incompatible with such a master plan should be authorized irrespective of how favorable it might appear as an isolated

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[12] An extreme example is Boulder Dam. Initial excavation began May 16, 1931. Not until February 1, 1935 was storage of water begun. The last block of dam crest was completed on March 23, 1935; the construction was accepted from the contractors by the Bureau of Reclamation on March 1, 1936; and finally, in the fall of 1936, generation of energy began. Excluding all preliminary investigations, four years passed before the project was useful for flood control, and five before it was useful for power. (See booklet, *Construction of Boulder Dam,* prepared by Boulder Dam Service Bureau in collaboration with the Department of Interior, Bureau of Reclamation.)

[13] TVA has found substantial possibilities for economies in construction cost through the careful planning of jobs, so that machinery and equipment may be spread over several jobs rather than depreciated fully into the costs of individual plants. In this regard, the Authority has written as follows:

> "In the actual construction of dams, the value of a unified program and of an orderly sequence of development is evident. The major items of cost are construction equipment, operating equipment, labor, and cement. By a well-planned sequence of operation, construction equipment can be moved from job to job and can be used to its fullest value. Similarly, the key men for specialized work can be passed from job to job, and a high degree of skill maintained."

(Tennessee Valley Authority, "The Unified Development of the Tennessee River System," March, 1936, p. 32.)

Potential economy from the use of Cherokee Dam equipment in the development of the near-by Douglas site was a significant factor in the 1941 debate as to whether the Douglas project should be authorized as a defense undertaking.

development.[14] But no master plan conceived today can meet all the requirements of the future. Every "ultimate" system must be subject to continual revision during the period of its construction in the light of changing conditions. As old benefits increase or fade away and new ones develop, original optimum plans become obsolete. Even after a watershed system is constructed, rules for its operation should be subject to adjustment and modification in the light of varying circumstances.[15]

COMMENTS ON THE THEORY OF FEASIBILITY

The foregoing discussion represents an excursion into the pure theory of water planning. We must now call attention to some of the more important assumptions which have underlain these remarks. First, we have assumed that benefits from such non-revenue producing purposes as flood control are susceptible of estimation so that a project (or system) may be planned to maximize the complex of diverse benefits which it yields. In the discussion of Chapter X we have already found that there are grave obstacles in the way of any close evaluation of present benefits. Estimates for the future are even more speculative. If this is true of major benefits such as navigation and flood control, it is certainly also true of lesser benefits such as wild life conservation, pollution control, and recreation.[16] Yet under the strict

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[14] See below, Chapter XVI.

[15] For example, TVA originally planned to draw its pools to flood period elevations by December 15. Operating experience and careful research indicated that these rules impaired system power and were unnecessary for flood safety. Consequently, the flood control rule curve was modified, and January 1 is now treated as the start of the flood season.

[16] In a paper on "Economic Justification of TVA Multiple Purpose Projects," Harry Wiersema, TVA General Office Engineer, mentions such benefits of the TVA program as ". . . . conservation of wild life, improvement of educational opportunities, increase in per capita income after system development, and regional improvement—better balance between industry and agriculture." He adds:

> "While I do not deny that such incidental benefits exist, I contend that there is no logical or sound basis on which they can be evaluated. I am reminded of the valuation that Dr. Cahn put on the TVA system based on the production of fish. He said that 'the engineers tell me that the TVA system when completed will have a reservoir area of about 600,000 acres. The Japanese are able to grow 1,000 pounds of fish per acre per year, and certainly we Americans should be able to do as well. This shows that we can easily produce 600,000,000 pounds of fish per year. These should be worth 20 cents per pound, but cutting this in two and allowing only 10 cents per pound, this would indicate a revenue of $60,000,000 per year. Why worry

theory of public planning of comprehensive improvements for the general welfare, it would seem that all significant social benefits should be taken into account. We believe that the uncertainty of tangible benefits and the difficulty of estimating intangible ones are so great that rational economic planning of a water control system to maximize benefits and minimize costs is impossible.[17]

Second, we have assumed that government should plan its expenditures according to customary commercial criteria. Since we are dealing with "economic" theory, we have taken no account of "non-economic" considerations. Nevertheless, social considerations, such as danger of loss of life during floods, may lead government in all wisdom to adopt a water plan yielding something less than the optimum benefit return from a strictly pecuniary standpoint. Our assumption that government is interested in maximizing the surplus of benefits above costs for its national water program is thus open to question. Furthermore, it must be recognized that the federal government of the United States is a government of delegated powers. Whether one of these powers is authority to develop single purpose power projects is doubtful. It may be, therefore, that for constitutional reasons government is foreclosed from seeking optimum economic development of water resources.[18]

Third, we have assumed that the benefits of flood control tend to increase at a decreasing rate. In fact, these benefits may increase at a slow initial rate, accelerate rapidly as complete protection is approached, and then cease increasing altogether. Under these circumstances, an excess of benefits over costs might justify a project, but any sort of marginal adjustment would be out of the question. Development of the project would be either

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about any further justification?' "
(Paper presented to seminar on the "Economics of Multiple Purpose Projects" which was conducted during 1940-1941 by the Training Division of the TVA Personnel Department.)

[17] There is a much better chance of minimizing the cost of gaining a given objective than there is of maximizing the benefit from a given scale of expenditure.

[18] Indeed, it has often been argued that constitutional reasons provide the primary explanation for inclusion of navigation as an objective of the Tennessee Valley Authority Act of 1933.

as a unit or not at all. This is an example of "lumpiness" or, as Marshall would say, discontinuity.

Fourth, we have accepted the drainage basin as the unit for system planning. But we have also pointed out that drainage basins are interrelated. Wise planning must consider not only the problems of a particular basin but also the problems of neighboring basins. In Colorado a system is being developed which diverts stream flow from the upper Colorado River basin through a tunnel beneath the Great Divide into the watershed of the Big Thompson River.[19] This diversion achieves more economical development of power head than would be available west of the Divide and also provides a useful supplement to deficient stream flow of the Big Thompson for irrigation purposes. On the whole, the diversion seems in accord with planning for optimum water use. It provides a significant example of the interrelationship of watersheds.

More obvious than the relations of adjacent watersheds is the interdependence of tributary basins and the valleys into which they drain. If the four planning areas which were suggested above for analysis of water problems of the Ohio basin were established, it would certainly be of the utmost importance that the agencies administering the regional plans should keep in close touch with one another. Their plans and programs would be interrelated not only with respect to the Ohio Valley but also with respect to the Mississippi Valley for which many other agencies would simultaneously be planning.

SYSTEM PLANNING BY THE TENNESSEE VALLEY AUTHORITY

In the preceding sections we have analyzed the theoretical considerations which should govern water control planning and have found that joint cost allocations have no necessary relevance to this problem. It remains to indicate some of the factors which have governed multiple purpose planning by the Tennessee Valley Authority. Much of the discussion of Chapter V above

[19] This is the so-called Colorado-Big Thompson project of the Bureau of Reclamation. (See above, Chapter XII, note 12.)

bears upon this matter, but a few additional remarks may be ventured here.

Unless the term "economics" were interpreted from a very broad point of view indeed, it would not be correct to say that TVA has regarded its problems of system planning as essentially economic. Actual decisions have been influenced and often determined as much by statutory requirements of the TVA Act, by engineering considerations, or by general social policy as they have been by "economics." Consider the planning of main river projects. The Act requires TVA to develop a nine-foot channel in the Tennessee River from Paducah to Knoxville in such a way as to conserve the power of the stream and provide for control of its floods. This can be accomplished only by a series of moderately high dams. But engineering investigations have revealed that geological substructure along much of the stream is not strong enough to support heavy concrete works. Therefore, "regardless of economics," structures of sufficient crest elevation must be erected at feasible sites to carry the nine-foot channel to the next available site upstream. So minimum crest elevations for several of the main river plants have been set.

As a matter of fact, decisions of the sort above are not made "regardless of economics." Very likely, if the engineers were willing to pay a sufficient price, they would be able to erect safe and water-tight dams even at nominally infeasible sites. But because the costs of such works would be extravagant, no serious consideration is given to them.

More obvious than their role in fixing minimum crest elevations along the main river has been the effect of economic factors in limiting maximum elevations. It is the practice of the Authority to require a "project justification" under the benefit criterion for every authorized plant. As we have noted above, beyond a certain point as pool elevations are raised there is an inevitable eventual tendency for costs to increase more rapidly than benefits. This may be partly ascribed to mounting costs for more and more massive dam structure and partly to accelerating expense for backwater lands overflowed. Often a critical point in land damages is reached as backwater approaches a densely settled section or a town. In order that projects may remain justifiable, flooding of such areas must be foregone. So maximum pool elevation for power and flood control operations has been determined.

Statutory requirements grant the Authority much more freedom in the planning of its tributary projects than is the case for those along the main river. In choosing tributary sites, TVA engineers typically carry out thorough studies of as many potential sites as possible. These are appraised from a variety of standpoints including geological substructure, river gorge configuration, flood control utility, probable acre feet of storage, and area and type of backwater lands for different possible crest elevations. For the apparently more favorable sites, estimates are prepared and power studies are run. In the light of all relevant considerations recommendations for improvements are made.

Precisely what are these critical "relevant considerations?" This is a most difficult question. Within certain limits cost-benefit relations at competing sites certainly play an important role. For example, when the Watts Bar project was being considered, its economic features were compared with two tributary projects according to the method of Table 65. But an analysis of this sort raises many questions. Of all the structures which might be built at each of the sites considered, how were the characteristics of the selected projects determined? What fixed the balance among benefits in each case? And how were crest elevations selected? In theory we argue that cost and benefit variation should govern such decisions, but if these categories cannot be closely evaluated their application to project planning in any meaningful manner is impossible. The inclusion in Table 65 of more than one assumption as to flood control benefits suggests a quite proper uncertainty as to the value of this utility, and indicates that a rational calculus of maximizing benefits relative to costs for each plant could scarcely have been carried out.

Very likely the economic characteristics of the several plants of Table 65 were determined somewhat as follows. Crest elevation was fixed according to some sort of engineering concept of "full development" at the sites.[20] On the main river the navigation benefit was fixed automatically by the alternate cost of low dams to carry the project channel to the next high dam site upstream; and power and flood control benefits were governed by a reasonable rule curve for the operation of active storage. At the tributary sites the balance among benefits was

TABLE 65

ECONOMIC COMPARISON OF PROJECTS AT WATTS BAR, CHEROKEE, AND SITE A

	Watts Bar	Cherokee	Site A
	(All figures in thousands of dollars)		
Benefits			
Flood Control[a]			
Assumption A	7,400	22,500	20,880
Assumption B	5,550	16,250	15,080
Navigation[b]	29,437	....	....
Power[c]	24,600	28,200	56,500
Total Benefits			
Flood control assumption A	61,437	50,700	77,380
Flood control assumption B	59,587	44,450	71,580
Costs			
Project capital costs	34,162	28,061	55,802
Feasibility Ratios			
Flood control assumption A	1.80	1.81	1.39
Flood control assumption B	1.74	1.58	1.28

[a]Assumption A: flood control valued at $20.00 per acre foot at Watts Bar and $18.00 per acre foot at Cherokee and Site A. Assumption B: flood control valued at $15.00 per acre foot at Watts Bar and $13.00 per acre foot at Cherokee and Site A.

[b]Navigation valued at estimated alternate cost of low dams avoided.

[c]Value of power determined by capitalizing estimated net revenues added to the system under TVA rate schedules after operating costs; capitalization rate based on TVA fixed charges estimated at 3.91 percent.

Source: Tennessee Valley Authority

determined on a policy basis in the light of the Act. This implies that flood storage was planned substantially to control upstream watersheds during the rainy season; and the value of the power benefit was then measured by equivalent primary power added to the system in the light of flood control rules.

The interpretation above of the way in which the economic characteristics of the projects of Table 65 were determined is also applicable, in a general way, to the planning of most TVA

[20] A part of this concept is the requirement that works be justified under the benefit criterion.

multiple purpose projects. Neither allocations of joint costs nor tenuous cost-benefit studies have been of any final significance in the determination of project economic characteristics. Indeed, even such general comparisons between sites as those of this table undoubtedly have been interpreted with considerable conservatism. It is interesting to note that a moderate variation in the unit value of flood storage here assumed is sufficient to shift the comparison from being in favor of one project to being in favor of another.

In addition to whatever general significance TVA may have attributed to over-all benefit-cost ratios, its project planning has also been strongly influenced by numerous imponderable and intangible factors. These include the class of land to be flooded by reservoir backwater and number of people living thereon, the qualitative advantages of different sites for flood control purposes, the importance of integrating present construction into the requirements of the long future, and, recently, the need for speed in the construction of emergency power sources. Intangible considerations of this sort explain the early construction of the Hiwassee project and the long deferring of the Douglas project which has always been recognized to occupy an important natural place in any Tennessee basin plan for water control.

CONCLUSION

The present chapter has reviewed the theory of planning for water control. It has stressed the unity of the several objectives of multiple purpose enterprise. In so far as rational economic administration of water resources is possible (and desirable), the objective should be maximization of the complex of benefits relative to costs rather than maximization of any particular benefit. We have found no need for allocations of joint costs in the planning of multiple purpose enterprise. Indeed, the danger is not inconsiderable that allocations would accomplish more harm than good by becoming confused in the issues of project or purpose feasibility. The feasibility of a project is contingent simply upon the relation of total project cost to total benefits; the feasibility of a purpose at a project is contingent upon direct cost for the purpose relative to purpose benefits. So falls the final argument for joint cost allocation. We must conclude that apportionment of this type of cost is at best a meaningless ritual.

Although allocation is not a relevant factor in system planning, it appears that rational administration of water resources requires reasonably accurate appraisals of prospective benefits from alternative proposed improvements. The difficulties of achieving such accurate appraisals are so great that we question whether it is possible to formulate a program of water resource development according to strict cost-benefit relations. We believe the effort is doomed to fail. In the end social considerations and public policy rather than hypothetical benefit valuations will be found to provide the more honest and satisfactory guides for public water planning.

System planning by the Tennessee Valley Authority seems to have been carried out consistently with the general findings of this chapter. Economic criteria have set broad limits within which decisions have been made, but actual plans have been primarily determined by general policy considerations. Cost allocations have had no affirmative part in system planning.

Throughout this study we have been concerned with one of the most fundamental aspects of the TVA stream control program. This is its multiple purpose orientation. The most baffling economic problem to which this characteristic gives rise is the allocation of joint costs. We have examined this difficulty at length. It remains to consider, in conclusion, some of the broad implications as to public policy of the maturity of multiple purpose planning for entire drainage basin areas.

Chapter XVI

TOWARD A CO-ORDINATED FEDERAL WATER POLICY

Summary. The planning and administration of federal water policy has failed to keep pace with the evolution of multiple purpose technology. Today federal water policy is confused and un-co-ordinated. At the opening of the present chapter some of the ways in which this policy might be clarified and unified are discussed. We then direct attention to the problem of formulating a national water plan. We believe that master plans should be prepared for all major drainage basins of the country and that these should be consolidated into a national plan by a co-ordinating committee for water resource planning. There should also be developed a six- to ten-year program for achievement of the initial stage of the national plan. Both the proposed initial stage and the ultimate plan should be submitted for review to advisory committees on conservation problems, legal problems, and transportation. Appropriately modified, programs for achievement of the plans should be submitted for review by a committee on the fiscal aspects of public works disbursements. With the recommendations of this committee both the proposed national plan and the construction program should be forwarded to the President, and, through the President, to the Congress.

In Congress it is possible that the existing committee organization would not be found well suited to handle legislation for a comprehensive nation-wide water plan such as we here advocate. Eventually the logic of events points toward the formation of Congressional standing committees on water resources. Meanwhile, working arrangements between existing committees could be employed to handle the new comprehensive legislation.

The administration of a national water program should be entrusted to decentralized drainage basin agencies. Consideration should be given to the possibility of participation of state and local governments in the planning and financing of basin systems. Ways of assessing beneficiaries of traceable benefits should be investigated. Every effort should be made to preserve flexibility, both in system construction and operation. Stream planning by the basin agencies should be integrated with general planning for conservation and improvement of the regional resource base.

In the system of water planning and administration which we

here contemplate private hydroelectric enterprise should continue its existence and development in so far as it is able to do so consistently with the adopted master plans. But if the requirement of optimum basin improvement is established and maintained the inability of private enterprise to capitalize non-revenue producing benefits probably foreshadows the end of new private construction in the nation's streams.

ATTRIBUTES OF A DESIRABLE WATER POLICY [1]

At the opening of this study stress was laid upon the pervasive tendency which has been common to all fields of water control for planning to become ever more comprehensive.[2] Although this tendency in the technology of water control is unmistakable, it is also quite apparent that many institutional adjustments to the new era of planning have yet to be made.[3] Some of these adjustments are discussed in the present section.

A sound national water policy should provide for a continuing program of research and inventory into the national water resources. Only in the light of full knowledge of the nature and economic availability of resources is it possible to plan wisely for their utilization. A thorough inventory of water resources should include investigations in three major directions. It should provide for an extensive program of mapping along drainage basin lines for all areas where improvements might be feasible.[4] Equal-

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[1] On this subject see National Resources Committee, *Water Planning*, February, 1938.

[2] See above, Chapter I.

[3] In a report dated January, 1941, the National Resources Planning Board makes this point as follows:

> "In various special fields, the Congress has taken successive steps toward the formulation of a comprehensive policy. The statutory record of the past decade reveals a spreading conviction that haphazard development of water resources is harmful economically and socially and that the co-ordinated development of multiple-purpose projects for the complete utilization of these great resources on a national scale is essential. More is needed, however, than the revamping of old policy and old procedures. The time is now ripe for the next step in the evolution of policy. What is needed is the adoption by the Federal Government of a unified water policy under which provision can be made for prudent, orderly, balanced, full development of the water resources of the nation."

Development of Resources and Stabilization of Employment in the United States, Part III, p. 23.

[4] The problem of mapping has been tremendously simplified in recent years through the development of aerial photography. Nevertheless, detailed maps for

ly as vital as the need for maps is the need for thorough-going hydrologic research. Some matters which this research should investigate would be snow-cover, precipitation, run-off, stream flow, and ground water supply.[5] Finally, careful geological explorations should be made at all sites at which improvements appear to be feasible. Intelligent planning requires information not only as to valley contours and water supply, but also as to the nature of geological substructure and its ability to bear the weight of proposed works for water control.[6]

National water policy also should visualize the interrelations among water uses and the unity of problems within drainage areas. Multiple purpose planning of the past has too often been interested primarily in particular ends and only incidentally in co-ordinate purposes.[7] No doubt this has been partially attributable to immaturity of the theory of multiple purpose planning, but it certainly has also been conditioned by the necessity of developing each project in the light of the limited powers of the federal government. From a social or economic point of view, the objective of sound policy should be to maximize the complex of benefits rather than any particular benefit from a given scale of expenditure. Within the limits of the Constitution, therefore, we stipulate that water policy should be dedicated to achievement of the maximum surplus of (social or economic) benefits above costs. Since non-vendible benefits are immeasurable, this maximum cannot be determined objectively. It follows that Congress, or some agency of Congress, must choose on a policy basis what complex of benefits it regards as most desirable.

great areas of the United States have yet to be prepared. See National Resources Board, *Report on a National Mapping Program*, December, 1934.

[5] Since data of this nature have meaning only in the perspective of a record extending well into the past, it will take a number of years to illuminate the numerous blind spots which exist today. See National Resources Committee, *Deficiencies of Basic Hydrologic Data*, 1936, and *Deficiencies in Hydrologic Research*, 1940.

[6] The Geological Survey, established under the Act of March 3, 1879 (20 Stat. 394; 43 U. S. C. A. 31 ff.) would seem to be well suited to carry out such investigations. The United States Engineers have also frequently engaged in core drilling at prospective dam sites.

[7] See statement of National Resources Committee at p. 75 ff. of *Drainage Basin Problems and Programs*, 1937 Revision.

An adequate national water policy should provide for co-ordination of water planning by different interested agencies of government. As long as planning was predominantly single purpose, there was no substantial probability of an overlapping in the activities of different planning organizations. But as the multiple purpose project has come of age, the possibility has arisen that two or more agencies may simultaneously be engaged in planning improvement of the same site for the same complex of purposes with little or no co-operation and without unity of outlook. It could easily occur that they might formulate reports recommending quite different programs of improvement.[8] Such divergent reports would produce understandable confusion in the mind of Congress.

Present lack of co-ordination among public agencies engaged in planning and executing surveys and investigations results in inefficient use of expert personnel and in needless duplication of effort. Authority for interchange of expert services between agencies at different levels of government should be provided or expanded wherever it now exists, and the practice of interchanging views and services between agencies should be encouraged.[9]

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[8] The National Resources Planning Board refers to the Cherry Creek project (Colorado) as a case in point. See *Development of Resources,* Part III, p. 26. The allegedly divergent reports were prepared by the Corps of Engineers (House Document 426, Seventy-Sixth Congress, First Session) and the Bureau of Reclamation ("Report on Cherry Creek, Colorado," A. N. Thompson, Engineer, April, 1938.)

[9] A 1936 report of the National Resources Committee made the following statement on the subject of interchange of personnel:

> "Every well-organized public-works department or bureau has its own designing staff or utilities engineering consultants, or both. One of the organization problems in the public-works field is the interchange and availability of the expert knowledge in one bureau by the staff of other bureaus in the Federal, State or local Government. Greater flexibility in the use and exchange of expert services is needed in our governmental organization."

(*Public Works Planning,* 9.)

Some time later, the National Resources Planning Board, successor to the Committee, thought that the need for authority to interchange services had been substantially met.

> "Federal agencies have adequate authority to co-operate with one another in order to promote efficient construction of water projects. Any of them may use the services of other agencies on a reimbursable basis under the provisions of the Economy Act of 1932 and other statutes. One agency may transfer full responsibility for building water-control works to another better-qualified agency, or responsibility may be shared by two or more agencies. Accordingly, no major changes are recommended in present policy affecting

Several timorous efforts to bring unity to federal water planning have already been made. Perhaps the most important of these is contained in Executive order 8455.[10] The purpose of this order was interpreted by the National Resources Planning Board as ". . . . to promote the correlation of public-works construction programs and to avoid conflicts in priority and design. . . . ."[11] Among the requirements of the Order is a stipulation that all federal construction agencies report to the Resources Board whenever they either undertake or complete investigations looking toward eventual construction work. Also worthy of mention as a step toward the co-ordination of water planning is the so-called "Three Party Agreement of August 8, 1939" which provides for co-operative investigations of prospective sites by the Departments of War, Interior, and Agriculture. Despite these beginnings toward co-ordination, present policy remains woefully disjointed. This deficiency must be overcome if policy is to be established upon a sound basis.

A satisfactory water policy must employ reasonable and consistent techniques for analysis and evaluation of benefits and costs of proposed water improvements. The confusion typical of the situation today is summarized in the quotation below:

"Methods of evaluation have grown up in haphazard and unrelated fashion. Each agency involved has developed its own criteria of benefits worthy of consideration, its own systems of cost determination. Methods differ not only as between different functions; they also differ markedly and frequently as between different agencies dealing with the same function. Such discrepancies and contradictions become particularly striking when multiple purpose projects bring into juxtaposition dissimilar methods for the various functions involved.

"*Present Practice: Benefits.*—Present evaluation techniques applied to benefits are seriously inconsistent. In the field of navigation, benefits are variously estimated as equivalent to rate savings on expected traffic compared with existing rail rates, rate savings compared with rail costs, the maximum possible yield from tolls if tolls

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direct construction operations."
(*Development of Resources,* III, 38.)

[10] Executive Order 8455, dated June 26, 1940 and published in the *Federal Register,* June 29, 1940.

[11] *Development of Resources,* III, 27.

were charged, or the actual expected revenue from tolls postulated at various levels. Calculations of flood-control benefits rest upon average annual flood damages in the past, estimated annual flood damages based upon the development in the flood plain, increments in property values ascribed to the avoidance of flood risk, savings in cost of alternative protection works, or upon some combination of these factors. Power benefits are commonly evaluated at the cost of the cheapest alternative means of supplying equivalent service. They are sometimes considered, however, merely as the savings to consumers under various projected rate schedules, and sometimes as the value to consumers in terms of increased incomes made possible by electrification. Irrigation benefits are generally based upon the increased value of crop yields attributable to the control of water or to the supply of additional water. Domestic water-supply benefits may be placed at the highest possible sales price, the actual sales price expected at various rate levels, or the cost of the cheapest alternative means of supplying the equivalent service. Secondary benefits, including unemployment avoidance, and intangible benefits such as recreation, national defense, wild life conservation, economic rehabilitation, and the like are either not evaluated at all, or values are placed on them by a variety of expedients.

"*Present Practice: Costs.*—Evaluations of costs for purposes of project justification present fewer difficulties and fewer anomalies in practice than do evaluations of benefits. Inadequate consideration has been given, however, to indirect costs. Striking variations also occur with regard to three elements of direct and tangible costs. (1) Allowance for interest on capital is made for most purposes, but not for irrigation under the policy consistently followed by the Congress since the passage of the National Reclamation Act of 1902. (2) Variations in annual cost calculations are produced by the selection of differing periods of amortization for water projects, none whatever being provided in some cases. The most common period is 40 years, although in the case of the Boulder Canyon project, a 50-year period was allowed. (3) Finally, no consistent policy has yet been established with regard to payments to States and localities in lieu of taxation." [12]

Our position in the matter of benefit evaluations has already been developed at length. For vendible utilities, competitive value, market price, or alternate cost may be used as valuation standards. For non-vendible utilities, the alternate cost criterion is occasionally satisfactory, but it is scarcely precise. When benefits

[12] *Ibid.*, 33 (numerous italics omitted).

are inherently uncertain and to a great extent intangible, the impossibility of fixing rational pecuniary valuations should be frankly recognized.

The need for consistent standards of cost evaluation among all agencies interested in water planning is plainly great. An adequate cost policy should include consideration of all operation and maintenance expenses plus interest and depreciation.[13] Normally we believe that taxes (or payments in lieu of taxes) should not be regarded as a necessary cost of federal works, for such works usually produce local values fully capable of bearing the burden of tax loss incident to federal taking of local lands and properties. Under unusual conditions, however, payments might be contemplated up to the costs of displaced state and local levies.

When it is possible to ascertain benefits with considerable accuracy and no non-economic factors are involved, feasibility should be appraised by the prospective cost-benefit relation.[14] Priority should be granted to projects having the lowest ratios. But for projects developing benefits which cannot be evaluated, meaningful cost-benefit ratios are not available. Priorities among such projects must be determined according to the wisdom of Congress, and no particular sequence can be argued to be economically correct.

A final element of a sound public water policy is that it must be consistent with other aspects of public policy.[15] If control of public utility holding companies and downward pressure upon electric power rates are accepted ends of public action, the sale of all energy produced at public projects to privately owned utilities with no provision for control of resale rates would

[13] Presumably this would include interest during construction. To the extent provision might be made for investment amortization, depreciation would not seem a necessary cost.

[14] The practice of the United States Engineers is to employ the reciprocal of the ratio here suggested as an index of feasibility. According to their criterion, projects showing a ratio of less than unity are infeasible; and projects showing a high ratio are granted priority.

[15] Under Executive Order 8455 any "construction agency" submitting a report to Congress or any member thereof on an investigation or a proposed project must include a statement by the Bureau of the Budget as to "the relationship of such report to the program of the President."

scarcely be defensible. Similarly, if conservation of fuel resources is an accepted end of public policy, no power rates or allocations should be adopted at multiple purpose projects which might tend to forestall the installation of hydroelectric units which could earn revenues at least adequate to cover direct power costs. If control or the breaking up of monopoly is an avowed goal of government, benefits of public enterprise should not be allowed to accrue to private monopolistic business institutions without full provision for compensatory assessments.[16] Finally, if general public works construction is planned to relieve unemployment and to mitigate the extremes of economic fluctuations, development of water resources should be carried out in harmony with the general program.

Against the background of the essential elements of a public water policy discussed above, let us turn to a recommended procedure for planning and programming the improvement of American water resources.

TOWARD THE PREPARATION AND ADOPTION OF A NATIONAL WATER PLAN

A national water plan should be formulated on the basis of proposed regional plans for drainage basin districts approxi-

[16] This raises the question as to whether the tradition of free navigation upon American inland streams should be continued when heavy federal investment is made to develop commercial navigability. On the Tennessee River shipments of gasoline have risen very rapidly during the era of the Tennessee Valley Authority. Although these shipments have achieved savings for the oil companies, there is no evidence that a share in the economy has been passed on to consumers. Indeed, since the oil industry is carried on under conditions of oligopoly, there is no reason to believe that savings will be passed on unless public sanctions are enforced to achieve this end. If such sanctions are not adopted it might be wise for government to reconsider the case for license fees for shipping privileges or tolls for use of locks. (See National Resources Committee, *Drainage Basin Problems and Programs,* 1937 Revision, p. 97.)

More difficult than the problem of levying charges for navigation benefits is the problem of assessing charges for flood control benefits. Under the Constitution all direct federal taxes (other than the income tax) must be levied upon the people of the several states proportionally to population as shown by the Census. In the light of this requirement, the legality of special federal assessments against the beneficiaries of particular federal works might be questioned. To date, the direct or indirect nature of such assessments has not been tested in the courts. There has, however, already been established the feasibility of recouping flood control costs through assessment districts created as instruments of the States. (See National Resources Planning Board, *Development of Resources,* III, 37.)

mately the size of the Tennessee-Cumberland area. These basin plans should be prepared by regional committees appointed by a central co-ordinating board on water resource planning.[17] Membership of the committees should be composed of representatives of major federal agencies interested in water problems in each area and of independent experts on water resources among the public. Provision should be made for presentation to the regional committees of state and local views on water problems. This might be accomplished through the establishment of regional advisory committees to consult with the basin committees or through the nomination of non-voting state and local representatives upon the planning organizations.

The regional committees should first prepare exhaustive inventories of water resources and sites available for improvement in the areas under their authority. Previous surveys should be thoroughly canvassed, but should be supplemented by additional investigations whenever necessary. To facilitate investigations, provision should be made for loan to the committees of staff and equipment from other federal agencies[18] as well as from state and local agencies.[19] Surveys should give consideration to all prospectively feasible projects whether primarily of national or local interest. Costs should be estimated according to standard procedures with respect to overheads, interest rates, depreciation, and amortization. Vendible benefits should be evaluated by reference to alternate cost or competitive value, whichever is less. The nature and extent of non-vendible benefits should be defined as accurately as possible, their separable costs should be estimated, and preliminary agreements should be negotiated with state and

[17] Duplication of function between existing drainage basin committees of the National Resources Planning Board and the recommended basin committees should be avoided. This might require some curtailment of the functions and authority of the existing committees.

[18] The agencies which could be of greatest assistance would include the Corps of Engineers, Geological Survey, Coast and Geodetic Survey, Federal Power Commission, National Resources Planning Board, Bureau of Reclamation, Public Health Service, Weather Bureau, Tennessee Valley Authority, and National Park Service.

[19] The administrative problems of arranging such loans upon a large scale might become important. An effort should be made to schedule surveys in different drainage areas so as to smooth out the demands for loaned personnel to as great an extent as possible.

local interests as to the amounts which they might be willing to contribute toward achievement of such objectives.

In the light of thorough knowledge of the water resources and social-economic problems of the region under its authority, each basin committee should prepare a proposed master water plan. This should set forth the committee's recommendations for optimum basin development. It should be supported by estimates of costs, evaluations of vendible benefits, and full descriptions of non-vendible benefits. It should indicate prospective state and local cost co-operation. Each committee should also prepare a proposed six-year construction program including only projects with a "must" or "strongly recommended" rating.[20] Abstracts of these proposed plans with maps and estimates should be forwarded by each committee to a central co-ordinating board for water resource planning.

The function of the co-ordinating board should be to analyze the proposed plans of the basin committees and to evolve from them a recommended national water plan. To achieve this end the board would review the plans submitted to it. It would check the assumptions upon which different plans were prepared to ensure their consistency. Its technical staff would study the interrelations of proposed basin master plans. For example, it would analyze the effects which plans for the Ohio, Missouri and Upper Mississippi watersheds might have upon flood (or low water) flows along the lower Mississippi River. If it appeared that modifications of basin plans might advisedly be made because of inter-basin relationships, it might suggest joint meetings of committees for related basins in order that satisfactory adjustments might be worked out. In other cases, it might ask re-estimates on the basis of changed assumptions. The board would then prepare a proposed six-year program for construction of water control works. This program would comprehend not only works exclusively of federal interest but also works primarily of local interest but incidentally of federal concern. Presumably

[20] Under Executive Order 8455 all existing "construction agencies" of the federal government are required to prepare and keep up to date six-year advance construction programs, indicating priorities among projects. These programs must be submitted annually to the Bureau of the Budget and the National Resources Planning Board for review.

it would include all projects which the board recognized as having a "must" status; normally it would include additional favorable projects also.

The six-year program of the co-ordinating board would be submitted to a number of advisory committees for review. The first of these might be an advisory committee on legal problems. Such a committee would be in a position to counsel the board on the matter of federal-state or federal-local relations. A second advisory committee on conservation problems might be asked to review the tentative timing of the program. It might urge early construction of projects developing hydro-electric power in regions dependent upon petroleum or natural gas as sources of energy; it might recommend special methods for the protection of fish and other wild life. A third advisory committee would be concerned with transportation policy. This committee would consider proposed stream development for navigation in the light of existing transportation facilities. It would analyze the adequacy of proposed channel and lock provisions, study required shipping capacity and terminal plant, and appraise the possibilities of integrating the new artery into the regional and national transportation networks. Opinions of the advisory committees would be submitted to the co-ordinating board in writing. The board would then prepare its final recommendations for a six-year program of stream improvement.

The revised recommendations of the co-ordinating board would next be submitted to a public works planning agency. This organization would review the timing of proposed expenditures in the light of federal fiscal policy and the business cycle.[21] It would also consider prospective expenditures upon other public works. It would adopt such modifications of the proposed pro-

[21] For the role of a public works planning agency in the timing of public works, see National Resources Committee, *Public Works Planning* (December, 1936) pp. 13-23. Under Executive Order 8455 the National Resources Planning Board and the Bureau of the Budget perform most of the fiscal review functions here contemplated. But the logical place to establish the co-ordinating board for water resource planning would seem to be under the National Resources Planning Board. It would not appear wise for the same authority to rule the co-ordinating board and the fiscal advisory agency. Therefore, we should suggest the establishment of an independent advisory agency on fiscal policy, much of its personnel to be taken from the existing staff of the Resources Board.

gram as it considered needful and proper, and would forward it to the President. The President would submit it to Congress for legislative consideration.

In the Congress it is quite possible that the existing committee organization would not prove well suited for analysis of such a long-term, comprehensive water program as we here suggest.[22] Temporary solution might be found in joint sessions of committees now interested primarily in single purpose improvements. Ultimately, it seems probable that efficient procedure will require the merging of all committees interested in particular purposes of water control into a single "Committee on Water Resources." Subcommittee structure for this enlarged committee might be functional or geographic. To assist the committee in the rather formidable task of analyzing such a comprehensive water program as we here recommend, there should be employed on a full-time basis a committee economist. It should be the function of this expert to sit in with the co-ordinating board at many of its sessions and to sit in also with the public works planning agency at its sessions dealing with water resources. In this way he would be fully familiar with the water plan when it reached Congress. His task would then be to prepare analyses of different phases of the plan for the Committee members.

Because of a different viewpoint on matters of policy, the Committees of Congress might report substantially different programs for water resources than those submitted by the co-ordinating board through the public works planning agency. Nevertheless, it would be important that Congress follow the board in two important respects. Authorizations should be upon a system (or drainage basin) basis, and they should contemplate a plan of improvement over a period of time rather than for a single fiscal period. Each year the advance program for the previous year

[22] Present committee organization is still geared to single purpose improvements. The leading water resource committees in the House are the Committee on Rivers and Harbors (navigation), the Committee on Flood Control, and the Committee on Irrigation and Reclamation. It is true that since the Flood Control Act of 1936 the Committee on Flood Control has regularly held hearings on so-called "Comprehensive Flood Control Plans" in which attention has been given to projects developing multiple benefits. But this Committee scarcely has the authority or the background to take over the analysis of legislation for a long-term, national program of water resource improvement for multiple purposes.

should be brought down to date by modification of original estimates and inclusion of newly authorized works to extend the program an additional year into the future. Under normal circumstances respect for these rules would facilitate economies in system construction and the orderly acquisition of sites. Under emergency conditions they would facilitate rapid expansion of public works activity.

RECOMMENDATIONS FOR THE EXECUTION OF A NATIONAL WATER PLAN

Administration of the adopted national water plan should be entrusted to decentralized drainage basin agencies or "authorities." The administrative areas of these agencies normally should coincide with those of the original basin master plans. The agencies should be responsible for both the construction and operation of the basin systems.

Decentralization of the administrative agencies would be a requirement of the most fundamental importance. Efficiency of internal organization would be promoted by such an organization because the agencies would be compact. Flexibility would be preserved and the wastes of bureaucracy would be minimized because administrators would be "on the ground." Those making decisions would have intimate knowledge of local conditions. Under centralized administration the geographic factor—expressed in terms of travel time and expense to Washington—drastically would limit the possibilities of co-ordinating the policies of different levels of government and of maintaining local good will. Under decentralized administration ready contacts between the agency and state and local interests would tend to nurture understanding and co-operation. Decentralized administration would also facilitate the growth in each agency of an organization morale which would contribute to efficient operation. Such operation could be stimulated further by the development of a kind of pseudo-competition among agencies based upon statistical cost yardsticks.[23]

[23] See for example, the 1941 publication of the Federal Power Commission entitled, *Electric Utility Cost Units and Ratios.* In this report the Commission presents ". . . . statistical yardsticks of costs in the electric utility industry. . . . ." (Quoted from announcement of the report.)

That the virtues of decentralized administration are not hypothetical is plainly evident from a study of the emergency record of the Tennessee Valley Authority. One writer reviewed this record in the light of the issue at hand as follows:

"TVA . . . . is virtually the only decentralized agency of the federal government. The functions of all the other agencies are concentrated in Washington, far removed from the locale where their administrative duties are exercised. Control is lodged in the hands of officials who, because of the distance, cannot have the intimate knowledge of local conditions which would be possible if they were 'on the ground'.

"On the other hand, TVA functions in the field where it carries out its power, flood control, navigation, soil conservation and other programs.

"Its success in completing the Cherokee Dam, for instance, in less time and at less cost than originally estimated is credited to the fact that its board of directors and its engineers were located at the site of the project—at the 'grass roots,' so to speak. They knew the land; they knew the people, and as a result they know how to build dams more quickly and economically.

"Its success in this and also other projects—notably the Muscle

The importance of decentralized administration has recently been stressed by two members of TVA staff as follows:

"Most of us are familiar with, and the present experiences of many European and Asiatic nations sharply emphasize, the hazards of overcentralized administration of the programs of government and its corollary—the abuse or denial of the right of local self-determination. Even a century ago these hazards were clearly set forth by the French statesman and writer, De Tocqueville, in the following significant remarks: '. . . . Indeed, I cannot conceive that a nation can live and prosper without a powerful centralization of government. But I am of the opinion that a centralized administration is fit only to enervate the nations in which it exists, by incessantly diminishing their local spirit. Although such an administration can bring together at a given moment, on a given point, all the disposable resources of a people, it injures the renewal of those resources. It may insure a victory in the hour of strife, but it gradually relaxes the sinews of strength. It may help admirably the transient greatness of a man, but not the durable prosperity of a nation.' Thus, of fundamental importance to the democratic realization of the objectives of a multiple-purpose regional agency is the power to make decisions in the field where the problems of the people occur and where adjustments can be realistically achieved. A flexible, decentralized administration, necessary in single-purpose programs, becomes particularly urgent when a group of interrelated functions are subject to unified administration at the scene of operation. The range of affected jurisdictions and local interests is extended, and the possibilities for voluntary co-operation are multiplied far beyond the correlation of the direct responsibilities of one to another."

Gordon R. Clapp and Howard K. Menhinick, "The Approach of the TVA to the Solution of Regional Problems,"(1941) 15 *Journal of Educational Sociology* 141.

Shoals housing project—is to be contrasted with the experience of several old-line and bureaucratic federal agencies, such as the War Department. The Army's projects have consistently exceeded estimates, and generally taken longer to build than predicted." [24]

The foregoing general statement is supported by the following facts. For the Norris, Guntersville, and Chickamauga peace-time projects the periods elapsing between project authorization by TVA and initial concrete pouring were ten months, ten months, and twelve months respectively. For the Cherokee emergency project all preliminary work was completed and concreting was begun after only four months. The TVA record for rate of pouring concrete prior to Cherokee was 93,000 cubic yards in a single month and 350,000 cubic yards over a six-month period at Norris. (This compares with 400,000 cubic yards, ca., poured in six months at the Oklahoma-Texas Marshall Ford project constructed under the supervision of the United States Engineers.) At the Cherokee project the Authority poured a maximum of 130,000 cubic yards in a single month and approximately 500,000 cubic yards over a six-month period. With regard to earth fill the Authority's best previous record was 262,000 cubic yards placed in a single month and 1,150,000 cubic yards placed over a seven-month period at the Fort Loudoun project. At the Chatuge project on the Hiwassee River, a defense development, 560,000 cubic yards were placed in a single month and 1,850,000 cubic yards were placed over a five-month period. Despite this acceleration of construction—which has inevitably implied some rising unit costs—over-all costs have been kept well within bounds. As compared with an original estimate for the Cherokee project of $34,500,000, present indications are that cost books for the plant will close with a total investment of approximately $31,000,000. Such are the accomplishments of an alert management with a continuing organization working in the field.[25]

One of the greatest difficulties which would confront decentral-

[24] Washington dispatch by J. Lacey Reynolds to the *Nashville Tennessean*, January 25, 1942, I, 4:1.

[25] Factual data of the foregoing statement are from the Tennessee Valley Authority.

ized multiple purpose agencies administering regional programs would be to pursue their objectives with full integrity and at the same time to maintain good relations with the local population and with all levels of government concerned in their activities. This difficulty would center in the planning and financing of agency activities. Several methods to handle these matters might be attempted. First, the agencies might be set up as wholly federal corporations. Financed by Congressional appropriations (except for revenues from vendible utilities), they might be directed to pursue their objectives without concern for the views of other levels of government. Second, the agencies might be set up as independent federal corporations, but, like TVA, they might be encouraged to negotiate understandings with state and local interests to facilitate achievement of their ends. As with the first type of agency, this one also would be exclusively financed by the federal government.

A third alternative again would work through regional federal corporations but would seek to capitalize objectives which yield no pecuniary return to TVA. In the case of navigation, this might be done through the setting of tolls for the use of locks or the requirement of licenses for navigation upon canalized river channel. The problems of securing revenues in return for pollution abatement and flood control services would be more difficult. Due to legal complications, the power of any purely federal authority directly to assess costs against recipients of these benefits is open to question. A possible solution might be to negotiate, in advance of system construction, agreements with state and local governments that they contribute stated sums toward basin development costs on account of these types of benefits.[26] If prospective benefits were great and if there were every probability that state and local units could levy assessments to cover the costs of their contributions, the latter might enter agreements of this sort.[27] But

[26] It has been suggested above that preliminary negotiations along these lines should be undertaken by the drainage basin planning committees.

[27] Inducements to this end might be held out in the form of understandings that the state and local units might levy assessments somewhat greater than the amount of their financial contributions. The policy implications of establishing pollution abatement and flood control upon a profit basis should be given careful consideration before adoption of such a plan.

benefits are elusive and difficult to appraise, and the propitious conditions might not exist. Furthermore, even if they did, there would be no certainty that the agreements could be reached. The precedent of federal assumption of costs of water control works of significant regional and local concern frequently has been established in the past, and it might be difficult to break. Many state and local units probably would be inclined to gamble that, though they withheld their financial support, federal interest in stream control would be so great as to lead to federal construction of works of much incidental significance to them.[28]

A final method which might be used to reconcile the interests of the several levels of government concerned in a comprehensive stream program would be the establishment of joint federal-state-local organizations to administer the basin programs.[29] This might be accomplished by incorporation of

[28] Of course, in refusing to contribute to system cost, the state and local governments would forfeit any "right" to a voice in the planning of system construction.

[29] On the matter of administrative organization for execution of national water policy the National Resources Planning Board has said:

> "A satisfactory operating policy for water will regard each river system as an operating unit with respect to its projects having more than local significance. Administrative control of the unified operation of regulatory and developmental works on most important rivers could not be exercised by a single State, since with few exceptions such rivers traverse or border two or more States. It could not well be exercised wholly by the Federal Government, since recognition must be given to relevant State laws, and since the power to tax the property of local beneficiaries will be needed if they are to share directly in costs. In any event, the States and communities immediately affected by the operation of the works are entitled to a voice in determining specific policies and procedures to be followed in operating them in accordance with the American doctrine of government by consent of the governed. The Federal Government should retain, however, a degree of control commensurate with the national investment involved, the national interest in the purposes served, and the national responsibility for the success of the enterprise.
>
> "One means of accomplishing these objectives might be the organization of a Federal-State corporation for a given river basin to operate water development and control projects in that area. Subject to general directives set up by the Congress in enabling legislation, to adequate safeguards for the repayment of project costs, and to relevant State laws and interstate compacts, the operating policies of such a corporation would be determined by representatives of the Federal Government and of the several groups of beneficiaries, including State and local political units and organizations, lying wholly or partly within the area. The key to continuing local cooperation and support is local popular control of the distribution function for vendible benefits. In any such corporation, administrative authority and responsibility, as distinct from the power to determine operating policies,

the agencies and issuance of shares at nominal prices to interested governments. In recognition of federal authority over the navigable streams, the chairman of the board of each agency should be an appointee of the federal government. Appointive power should rest with the President, subject to the advice and consent of the Senate, and the term of each representative should be lengthy (say, six to ten years). Interested states might also be represented upon the boards of the basin authorities, and interested local governments could be grouped together and given representation. Voting power presumably should be distributed according to the respective interests of the several levels of government in the agency program.[30]

As a condition to the issuance of shares in a basin agency to any government, the subscriber should be required to accept a detailed statement of rights and responsibilities. This statement should outline the major principles of agency policy and should stipulate that states and local units agree to contribute financial support to the agency according to annual assessments. Limits for such assessments might be indicated, and the principle should be enunciated that no state or local unit might be assessed a greater levy than in the opinion of the agency could be financed through taxation of traceable benefits. Authority should be provided for share-holding state and local units to employ, at cost, the services of the agency to solve water problems of their exclusive concern. Finally, federal interest in national purposes of stream control should be cited, and it should be declared that shares held by state and local units convey no claim against revenues derived from federal purposes.

Which of these methods of financing and administering basin improvement would be most satisfactory? Perhaps without trial of several of the plans, an answer to this question is impos-

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would no doubt be concentrated in a competent executive authority.

"No definite conclusion has been reached as to whether or not such an organization would be practicable and effective, and no recommendation with respect to it is made at this time."

Development of Resources, III, 39.

[30] These relative interests might be determined according to the proportions of the anticipated financial contributions of the different governments toward achievement of the basin master plan.

sible. Nevertheless, a remark or two may be ventured relative to each. A completely federal program, without even the formality of consultation with state and local interests, almost inevitably would arouse local opposition and ill-will. These would certainly restrict its success. A federally financed program, planned in consultation with non-federal interests, would have a substantial chance of success. Its major deficiency would be its failure to impose local responsibilities commensurate with local benefits.[31] A federally sponsored program, planned in co-operation with non-federal interests and partially financed by such interests, would have a somewhat smaller chance of success due to the difficulties of eliciting financial support from state and local governments. This approach might be tried, however, and if it did not succeed it could be modified into a federally financed program, executed with the co-operation of non-federal interests. Finally, a program sponsored jointly by the various governments interested in water planning in each drainage basin superficially would seem to have a favorable chance for success. Organization of such agencies might be difficult, however, and it would be quite possible that rivalries for internal power might make their effective functioning impossible.

Whatever the plan selected for administration and financing of the basin agencies, it should be adapted to unified programming of system construction. In particular, it should include authority for each regional agency to construct major water control works of exclusive interest to state or local governments at appropriate stages in the development of its general basin plan.[32] Such construction should normally be at cost.[33] Assessments

[31] Private beneficiaries would stand to reap large economic rents from certain phases of the program without requirement of even token payments. Such rents would accrue, for example, as a result of land value appreciation attendant upon the introduction of flood control. This appears to be a deficiency of the TVA program.

[32] Thus, TVA should have authority to contract with Chattanooga for the construction of local levees for the protection of that city. This project should be integrated into the Authority's unified program, and should be executed at an appropriate time when men, machines, and material are conveniently available.

[33] If it were considered desirable to give special treatment to states, counties, or municipalities which had joined a regional authority or contributed to system costs for traceable benefits, such co-operating governments might be granted the privilege of work at cost and non-co-operating units might be charged cost plus a modest percentage.

should be payable partially in advance with the balance payable as costs might be incurred. Standard practices for cost determination, including full consideration of interest and overheads, should be adopted.

A problem which frequently would arise to make difficult the execution of system construction pursuant to a unified program would be inability or unwillingness of state and local governments to finance their share of construction in accord with schedules of the basin agencies. During the expansion phase of the business cycle, if advance plans were carefully prepared, this difficulty might not be severe. Indeed, it would be quite possible that in prosperous times state and local units might wish to push construction ahead of the basin program. But during the contraction phase the difficulties of maintaining the flow of state and local expenditures as scheduled by the basin agency might become very great. Perhaps a flexible system of federal grants-in-aid, favoring depression outlays, could contribute to the solution of this problem.[34]

An important feature of any plan for development of American water resources by decentralized regional agencies should be provision for the integration of stream planning with general planning for the conservation and improvement of natural resources. Particular recognition should be given to the interrelations between land and water planning. The purpose of each agency should be to seek the maintenance and intelligent improvement of the resource base of the region subject to its jurisdiction. All activities should be tested for consistency with this

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[34] Of course, the more generous the grants-in-aid, the less would be the effective local responsibility.

A flexible system of grants-in-aid similar to that here suggested has been proposed by Professor Van Sickle of Vanderbilt Univeristy. He has also noted the tendency of state and local expenditures to vary inversely with the level of national prosperity. (See John V. Van Sickle, "Public Works, Economic Stabilization, and the Rural South," Papers of the Institute of Research and Training in the Social Sciences, Vanderbilt University, January, 1942.) This point has also been emphasized by a recent Department of Commerce publication, *Fluctuations in Capital Outlays of Municipalities*, the preliminary announcement of which states:

> "A marked decline in the capital outlays of municipalities during the depression at a time when Federal expenditures for recovery were strongly increased suggests the importance of program planning and the need for review of factors influencing municipal outlays. . . ."

(Announcement 2-10103 of Economic Series Publication No. 10.)

fundamental objective. The methods of the agencies should be democratic, and emphasis should be placed upon demonstrations and guidance rather than upon compulsions.

Several additional aspects of a sound plan for agency improvement of drainage basin water resources may be remarked. Affirmative provision should be made that no political considerations be allowed to influence either the appointment of members of the agency boards or the employment of staff. The agencies should be authorized to take over all plans and records of the basin planning committees. They should be authorized and encouraged to interchange expert personnel with other instruments of government, whether state, federal, or local. A procedure should be prescribed whereby modification of the original basin master plan might be achieved.[35]

Finally, there is the problem of operation of the basin systems. As guides in this regard clear directives of policy should be prescribed in legislation establishing the agencies. Subject to these directives, each regional authority should be allowed reasonable discretion in its implementation of policy. A number of general factors which should be taken into account in planning system operation may be mentioned. First, those interested in particular purposes of stream control should be without authority over multiple purpose operation. They should assist in the formulation of reservoir rule curves, and from time to time they should present to an impartial stream dispatcher their "requirements" as to reservoir operation. The dispatcher, however, should have ultimate authority to make all water control decisions.[36] Second, plans for operation of tributary systems should take account of the problems of downstream basins. Continued research should be prosecuted into the technical aspects of water control, basin water resources, and the interrelations between water problems of different basins. Third, all operating rules should be flexible and subject to change in the light of varying conditions or newly

[35] This might be through negotiations with the co-ordinating board. The agencies also, of course, would have the right to be heard before Congress if the co-ordinating board should refuse their proposals.

[36] Under certain circumstances the degree of priority of one purpose might be so great that storage might be operated entirely in its behalf. Such a purpose might be flood control in a valley affording few favorable storage sites.

acquired information. Fourth, efforts should be made to safeguard not only major but also incidental purposes of stream improvement. Such incidental purposes include wildlife protection, pollution abatement, and recreation. Fifth, no program of water control should be adopted without adequate provision for protection of public health. Potable water supplies should be safeguarded, and malaria control measures should be adopted whenever necessary.

CONCLUSION

Present American water policy is not adequately co-ordinated. Although the technology of basin planning for multiple purposes has evolved rapidly, governmental practice in formulating and administering a program of water resource improvement has failed to keep pace. We do not subscribe to the belief that there is any single "correct" national water plan. Nevertheless, we suggest that present procedures for analyzing and presenting to Congress proposed projects can be greatly improved. So far as possible, the overlapping between agencies which has come to exist as planning has evolved into the multiple purpose stage should be eliminated. Perhaps this could be achieved most effectively through the establishment of a co-ordinating board for water resource planning. Such a board would maintain an active file of all water investigations being carried out by any agency of government. It would employ this file to promote co-operation among different agencies interested in related problems in the same areas. It would have the power to cause initiation of investigations as well as to review completed ones. At the present time the National Resources Planning Board has several of the powers we propose. Either its powers should be expanded along the lines we have suggested, or they should be turned over to a new water resource co-ordinating board with broader authority. We also recommend for immediate adoption the elements of a sound water policy which were discussed in the first section of this chapter. These elements are of equal validity regardless of the administrative organization for planning or the execution of plans.

In contrast with the readily feasible recommendations above, we recognize that our proposals for a thorough streamlining of water resource planning and for decentralized administration involve major institutional adjustments.[37] We accept the proposition that these adjustments can be accomplished only over a period of time, but we believe that they are implicit in the logic of the situation today. Already the National Resources Planning Board has divided the nation into forty-five drainage basin planning districts and has made studies along the lines of this geographical classification.[38] On the administrative side, precedent for decentralized drainage basin agencies exists in the Tennessee Valley Authority. Three aspects of the experience of this institution should be of particular assistance in guiding future public action in water resource improvement. TVA has demonstrated the importance of integrating water resource planning with general planning for conservation and development of a region's resources. It has shown that a broadly empowered, decentralized agency can move flexibly to meet the changing and unpredictable requirements of a comprehensive conservation program. It has shown that an effective conservation program yields important non-vendible utilities to individuals and business firms. The last of these points raises the question as to whether a technique should not be evolved to assess financial burdens upon some of these private beneficiaries. Large and obvious rents which are unjustified by public social policy should not be allowed to accrue to individuals or organizations at public expense without even the formality of token assessments.

The question finally arises as to the place of private enterprise in the scheme for water resource development which we have outlined. We have no intention of suggesting or implying that private enterprise should be barred from the field. But we do assert that no agency, public or private, should be permitted to construct water control works which are inconsistent with the

[37] For example, many of the functions which we believe should be entrusted to regional authorities are now executed by single purpose agencies, notably by the Corps of Engineers.

[38] See National Resources Committee, *Drainage Basin Problems and Programs*, December, 1936 and 1937 revision.

master plan for the drainage basin concerned. It does not seem probable that private power enterprise often could develop economically, and in an optimum manner as judged from a social standpoint, sites well adapted to multiple purpose improvement. Moreover, with steadily increasing public interest in flood control and the secondary purposes of water resource improvement, the number of sites adapted to single purpose power development will decline. If the requirement of optimum basin improvement is established and maintained and if the decision is not made to subsidize private enterprise for the achievement of such improvement, the probability seems great that the rise of the public multiple purpose system foreshadows the end of new private construction in the nation's streams. Although it is quite possible that other factors may combine to do so, this alone need imply neither the immediate decline of existing private hydroelectric enterprise nor the ultimate decline of the privately owned power industry as a whole.[39]

[39] It should be pointed out that, although conflict with privately owned power companies usually places serious obstacles in the paths of public systems distributing electrical energy, nevertheless, this rivalry is not entirely a disservice to the cause of efficient operation of public enterprise. For while it gives rise to baffling and often exasperating difficulties, it also flings a challenge to efficiency which is as effective as economists traditionally have regarded price competition to be, in other fields, in bringing about low-cost production and distribution of goods and services. While this particular rivalry may not be indispensable to efficient operation of public power enterprise, it is quite possible that it would have to be replaced by alternative rivalries and incentives, should private ownership in the power industry cease to exist.

TECHNICAL APPENDICES

Appendix A

DETERMINATION OF JOINT AND DIRECT INVESTMENT FOR PROJECTS OF THE TVA TEN-DAM SYSTEM [1]

Kentucky Project[2]

Construction Feature	Estimated Construction Cost			
	Power-Navigation-Flood Control Project El. 375	Power-Flood Control Project El. 375	Power-Navigation Project El. 365	Navigation-Flood Control Project El. 375
Powerhouse, intake, and equipment, excluding switchyard[a]	18,068	18,068	18,068	....
Concrete dam and spillway	12,305	12,305	11,169	13,473
Embankments, etc	4,304	4,539	3,242	5,783
Lock	11,374	....	9,661	11,374
Reservoir	57,638	57,638	35,050	56,424
Total	103,689	92,550	77,190	87,054

[a]Including four units and two empty stalls.

Total investment cost, multiple use project			103,689
Direct cost for navigation:			
Cost of three-purpose project	103,689		
Cost of power-flood control project	92,550		
Remaining direct cost for navigation		11,139	
Direct cost for flood control:			
Cost of three-purpose project	103,689		
Cost of navigation-power project	77,190		
Remaining direct cost for flood control		26,499	
Direct cost for power:			
Cost of three-purpose project	103,689		
Cost of navigation-flood control project	87,054		
Remaining direct cost for power		16,635	
Total direct costs			54,273
Remaining joint cost			49,416

[1]The data of this appendix are from unpublished estimates of the Tennessee Valley Authority which constitute the backup for Table 21 of the text. They are dated 1938 and for several of the projects have been superceded by final cost reports. Except as separately indicated, all estimates include spread of general expenses, overheads, and contingencies.

[2]All figures in thousands of dollars.

Pickwick Project[5]

Total investment cost, multiple use project				35,695
Direct cost for navigation:				
Total estimated cost of lock	5,830			
Less cost of bulkhead to replace	423			
Net cost of lock		5,407		
Add costs of channel works		1,522		
Total direct cost for navigation			6,929	
Direct cost for flood control:				
Cost of multiple use project (to El. 418)		35,696		
Cost of power-navigation project (to El. 414)		34,518		
Remaining direct cost for flood control			1,178	
Direct cost for power:				
Cost of powerhouse (four bays, two units)	10,710			
Additional installations (two bays, four units)	4,087			
		14,797		
Less cost of non-overflow section to replace powerhouse		824		
Remaining direct cost for power			13,973	
Total direct costs				22,080
Remaining joint cost				13,615

Wilson Project[4]

Total cost, multiple use project (replacement cost new, with 16 units)			41,776
Direct cost for navigation:			
Cost of lock and bascule span	2,779		
Less cost of bulkhead, including roadway, to replace lock and span	125		
Remaining direct cost for navigation		2,654	
Direct cost for flood control		......	
Direct cost for power:			
Powerhouse and equipment	17,004		
Cost of eight additional units	6,880		
	23,884		
Less cost of bulkhead to replace powerhouse structure	3,902		

Wilson project (Continued)			
Remaining direct cost for power		19,982	
Total direct costs			22,636
Remaining joint costs			19,139
Computation of direct costs at this project with allowance for depreciation over the 7¾ year period which elapsed between the time at which the Wilson Dam was completed and the date it was taken over by TVA is as follows:			
Replacement cost new less depreciation, multiple purpose project (16 bays, 8 units)			30,120
Direct costs after depreciation:			
Navigation		2,321	
Power		11,010	
			13,331
Joint costs (replacement cost new less depreciation)			16.789
Wheeler Project[5]			
Total investment cost, multiple use project			39,385
Direct cost for navigation:			
Cost of lock	1,734		
Add bridge over lock	179		
	1,913		
Less cost of non-overflow section to replace lock	202		
	1,711		
Add: Channel improvements	44		
Dredging below dam	130		
Total direct cost for navigation		1,885	
Direct cost for flood control		......	
Direct cost for power:			
Cost of powerhouse structure with two units installed	9,189		
Cost of four additional units	6,780		
	15,969		
Less costs of bulkhead structure to replace powerhouse and intakes	774		
Remaining direct cost for power		15,195	
Total direct costs			17,080
Remaining joint costs			22,304

Guntersville Project [6]

	Estimated Construction Cost (Crest elevation, 595)	
	Multiple Use Project 4 Stalls, 3 Units	Cost of Substitute River Barrier
Powerhouse and equipment	11,382	946[a]
Concrete dam	3,293	3,293
Embankments	1,280	1,280
Lock	3,281	612[a]
Reservoir	13,815	13,815
Subtotal before channel dredging	33,051	19,946
River channel improvement	1,177	....
Total project cost	34,228	19,946

[a]Costs of earth fill dikes to replace power intake section and lock.

Total investment cost, multiple use project				34,228
Direct cost for navigation:				
Cost of multiple use project		34,228		
Cost of power-flood control project:				
River barrier	19,946			
Plus powerhouse and intake	11,382			
	31,328			
Less cost of earth fill replaced by intake	946			
Net cost of power-flood control project		30,382		
Remaining direct cost for navigation			3,846	
Direct cost for flood control:				
Cost of multiple use project		34,228		
Cost of power-navigation project		34,228		
Remaining direct cost for flood control			.... ..	
Direct cost for power:				
Cost of multiple use project		34,228		
Cost of flood control-navigation project:				
River barrier	19,946			
Plus lock	3,281			
	23,227			

[6]All figures in thousands of dollars.

Guntersville Project (Continued)[7]

Less earth fill replaced by lock	612			
	22,615			
Plus channel improvement and contingencies	1,277			
Net total cost of flood control-navigation project		23,892		
Remaining direct cost for power			10,336	
Total direct costs				14,182
Remaining joint cost				20,046

Chickamauga Project[8]

Total investment cost, multiple use project (El. 685.44 at top of gates)			40,731
Direct cost for navigation:			
Cost of lock	5,219		
Less cost of bulkhead substitute	751		
	4,468		
Add cost of channel improvement	3,903		
Direct cost for navigation		8,371	
Direct cost for flood control:[9]			
Saving from two-foot reduction in spillway gate heights	52		
Saving on reservoir lands from two-foot reduction of water crest elevation	1,000		
Saving on cost of lock from two-foot reduction in peak water surface elevation	100		
Total direct cost for flood control		1,152	
Direct cost for power:			
Total cost of powerhouse and equipment	11,051		
Less cost of substitute bulkhead to replace powerhouse section	2,024		
Total direct cost for power		9,027	
Total direct investment			18,550
Remaining joint cost			22,181

[7] All costs in thousands of dollars.
[8] All figures in thousands of dollars.
[9] Estimated as saving if project had been constructed only to elevation 683.

Watts Bar Project[10]

Total investment cost, multiple use project				35,515
Direct cost for navigation:				
Cost of lock	2,515			
Less cost of substitute bulkhead	297			
	2,218			
Net direct cost adjusted for overheads and contingencies at 57.75 percent		3,500		
Plus channel improvements and investigations		585		
Total direct cost for navigation		4,085		
Say,			4,100	
Direct cost for flood control			......	
Direct cost for power:				
Cost of powerhouse and equipment (initial stage)	2,800			
Less bulkhead to replace powerhouse intakes	831			
	1,969			
Adjusted for overheads and contingencies at 57.75 percent, say		3,100		
Add cost of additional units, ultimate stage		6,315		
Total direct cost for power			9,415	
Total direct costs				13,515
Remaining joint cost				22.000

Fort Loudoun Project[11]

Total investment cost, multiple use project				28,420
Direct cost for navigation:				
Cost of lock		6,082		
Less cost of substitute bulkhead		450		
		5,632		
Plus channel improvements		654		
Total direct cost for navigation, say,			6,290	
Direct cost for flood control:				
Total reservoir costs, multiple purpose project		8,318		
Reservoir costs for navigation-power project		6,347		

[10] All figures in thousands of dollars.
[11] All figures in thousands of dollars.

Fort Loudoun Project (Continued)			
Incremental reservoir cost for flood control, say,	1,970		
Incremental cost of gates for flood control	90		
Total direct cost for flood control		2,060	
Direct cost for power:			
Powerhouse and equipment, initial stage	1,712		
Less bulkhead to replace	395		
	1,317		
Plus overheads and contingencies	820		
Direct cost, initial stage	2,137		
Add cost of additional installations	3,423		
Total ultimate direct investment for power		5,560	
Total direct costs			13,910
Remaining joint cost			14,510
Hiwassee Project[12]			
Total investment cost, multiple use project			21,615
Direct cost for navigation		......	
Direct cost for flood control:			
Costs of third and fourth ring follower sluice gates	158		
Plus concrete	4		
	162		
Provision for overheads, contingencies and investigations at 58.69 percent	96		
Total direct cost for flood control		258	
Direct cost for power:			
Cost of powerhouse and equipment	3,032		
Provision for overheads, contingencies, and investigations at 58.69 percent	1,780		
	4,812		
Plus cost of second unit	1,500		
Total direct cost for power		6,312	
Total direct costs			6,570
Remaining joint cost			15,045

[12]All figures in thousands of dollars.

Norris Project[13]

Total investment cost, multiple use project (top of gates, Elevation 1032)................			31,532
Direct cost for navigation......		......	
Direct cost for flood control:[14]			
Savings on reservoir.........	950		
Savings on dam and spillway.	1,655		
Savings on sluice gates and operating machinery.......	308		
	2,913		
Less spillway gates and cranes	302		
Remaining direct cost for flood control, say		2,600	
Direct cost for power:			
Powerhouse and control buildings, including intake section	1,327		
Utility building.............	602		
Intake gates.................	2,073		
Water wheels, turbines and generators................	342		
Miscellaneous electrical equipment....................	198		
Total direct cost for power[15]..		4,542	
Total direct costs.............			7,142
Remaining joint cost..........			24,390

[13]All figures in thousands of dollars.
[14]Estimated as saving if project had been constructed only to elevation 1020.
[15]The powerhouse at Norris Dam does not constitute a part of the dam structure and therefore no adjustment is made for a bulkhead to replace it.

Appendix B

PROPOSED TECHNIQUE FOR SEGREGATING TYPES OF JOINT AND DIRECT INVESTMENT AT A MULTIPLE PURPOSE ENTERPRISE

PART I

DERIVATION OF FORMULAE TO SEGREGATE THE SEVERAL CATEGORIES OF JOINT AND DIRECT INVESTMENT

The following series of formulae is developed to provide a technique for isolation of the several categories of investment cost at a multiple purpose enterprise. Since it represents an algebraic expression of the method suggested in the text at p. 184 ff., it is subject to the same limitations. The example here suggested is of a triple purpose undertaking, but the method employed could be extended for use with projects involving a greater complex of purposes. The formulae have validity only on the assumption that joint costs imply absolutely fixed proportions among project benefits. The final formulae reveal that isolation of all classes of cost at a triple purpose project requires information as to the cost of the project, and also as to the costs of alternate single and dual purpose projects at the same site to provide equivalent benefits for each particular objective and for all combinations of two objectives.

(1) Definition of symbols:

Let a represent incremental investment for flood control.
Let b represent incremental investment for navigation.
Let c represent incremental investment for power.
Let d represent investment common to power and flood control.
Let e represent investment common to power and navigation.
Let f represent investment common to flood control and navigation.
Let t represent investment common to flood control, navigation, and power.

(2) Composition of total costs of various alternate projects:

Single purpose projects,

Flood Control Only ...... Total Cost (A) $= a+d+f+t$.
Navigation Only .... Total Cost (B) $= b+e+f+t$.
Power Only .... Total Cost (C) $= c+d+e+t$.

Dual purpose projects,

Flood Control and Navigation
Total Cost (D) $= a+b+d+e+f+t$.
Flood Control and Power
Total Cost (E) $= a+c+d+e+f+t$.
Power and Navigation
Total Cost (F) $= b+c+d+e+f+t$.

Three-purpose project, Flood Control, Navigation and Power,
Total Cost (T) $= a+b+c+d+e+f+t$.

(3) Summary of results:

Direct costs (in sense of incremental investment costs),

For Flood Control .... $a = T-F$ (i)
For Navigation .... $b = T-E$ (ii)
For Power .... $c = T-D$ (iii)

Dual purpose joint costs,

For Power and Flood Control
$d = D+F-T-B$ (iv)

For Navigation and Power
$e = D+E-T-A$ (v)

For Flood Control and Navigation
$f = E+F-T-C$ (vi)

Three-purpose joint costs common to Flood Control, Navigation and Power.
$t = A+B+C+T-D-E-F$ (vii)

(4) Derivation of formulae:

(i) Direct costs for Flood Control

$$\begin{aligned} a &= (a+b+c+d+e+f+t) - (b+c+d+e+f+t) \\ &= T-F \end{aligned}$$

(ii) Direct costs for Navigation

$$\begin{aligned} b &= (a+b+c+d+e+f+t) - (a+c+d+e+f+t) \\ &= T-E \end{aligned}$$

(iii) Direct costs for Power

$$c = (a+b+c+d+e+f+t) - (a+b+d+e+f+t)$$
$$= T-D$$

(iv) Dual purpose joint costs, Power and Flood Control

$$d = (a+2b+c+2d+2e+2f+2t) - (a+2b+c+d+2e+2f+2t)$$
$$= (a+b+d+e+f+t) + (b+c+d+e+f+t) - (a+b+c+d+e+f+t) - (b+e+f+t)$$
$$= D+F-T-B$$

(v) Dual purpose joint costs, Navigation and Power

$$e = (2a+b+c+2d+2e+2f+2t) - (2a+b+c+2d+e+2f+2t)$$
$$= (a+b+d+e+f+t) + (a+c+d+e+f+t) - (a+b+c+d+e+f+t) - (a+d+f+t)$$
$$= D+E-T-A$$

(vi) Dual purpose joint costs, Navigation and Flood Control

$$f = (a+b+2c+2d+2e+2f+2t) - (a+b+2c+2d+2e+f+2t)$$
$$= (a+c+d+e+f+t) + (b+c+d+e+f+t) - (a+b+c+d+e+f+t) - (c+d+e+t)$$
$$= E+F-T-C$$

(vii) Triple purpose joint costs, Flood Control, Navigation and Power

$$t = (2a+2b+2c+3d+3e+3f+4t) - (2a+2b+2c+3d+3e+3f+3t)$$
$$= (a+d+f+t) + (b+e+f+t) + (c+d+e+t) + (a+b+c+d+e+f+t) - (a+b+d+e+f+t) - (a+c+d+e+f+t) - (b+c+d+e+f+t)$$
$$= A+B+C+T-D-E-F$$

PART II

GRAPHIC PROCEDURE FOR ISOLATING TYPES OF DIRECT AND JOINT COSTS

Figure 17 presents a graphic solution to the problem approached algebraically in Part I above. The symbols used are the same as those there defined. The method used in preparation of the figure was as follows:

Set up co-ordinate lines XX′ and OY

Lay off to the right of OY, Bar (i) equal in length to T and, by definition, made up of the components a+b+c+d+e+f+t. The problem is to isolate these several components.

Lay off to the right of OY and above Bar (i), Bar (ii) equal in length to F. Since F is made up of the components b+c+d+e +f+t, a perpendicular dropped from the end of Bar (ii) cuts off a section of Bar (i) equal to a.

Lay off to the left of OY along XX′ a length equal to a and erect the perpendicular MM′. From MM′ and above Bar (ii) lay off to the right Bar (iii) equal in length to E. Since MA is equal to F + a = T, a perpendicular dropped from the end of Bar (iii) will cut off a distance BA along OX equal to b.

Lay off to the left of MM′ a distance equal to b along XX′ and erect the perpendicular NN′. From NN′ and above Bar (iii) lay off to the right Bar (iv) equal in length to D. Since NB is equal to E + b = T, a perpendicular dropped from the end of Bar (iv) will cut off a distance CB along OX equal to c.

Above Bar (iv) lay off to the right of NN′ Bar (v) equal in length to a + B. Since a + B differs from D by an amount equivalent to d, a perpendicular dropped from the end of Bar (v) cuts off a distance DC along OX equal to d.

Lay off to the left of NN′ along XX′ the distance NP equal to d and erect the perpendicular PP′. From PP′ lay off to the right

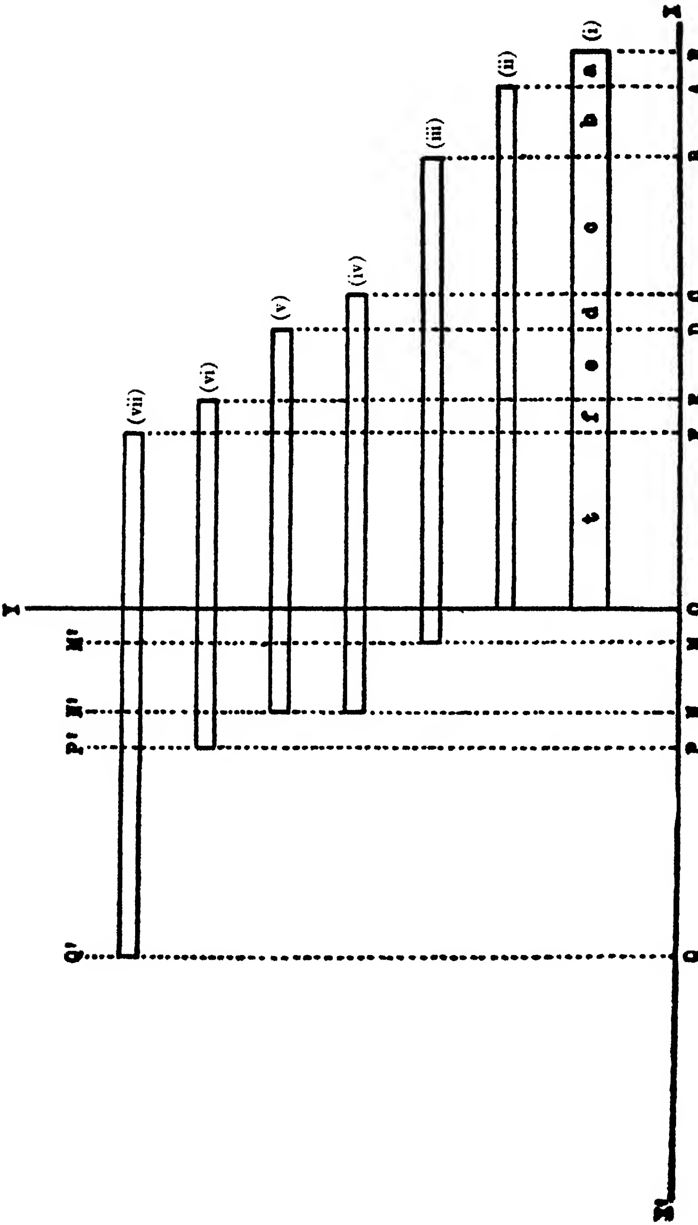

Figure 17. Graphic procedure for isolating types of direct and joint investment at a multiple purpose project.

above Bar (v), Bar (vi) equal in length to A + b. Since PD = d + a + B = a+b+d+e+f+t and A + b = a+b+d+f+t, a perpendicular dropped from the end of Bar (vi) cuts off a distance ED along OX equal to e.

Lay off to the left of PP′ along XX′ the distance PQ equal to c + e, and erect the perpendicular QQ′. From QQ′ lay off to the right above Bar (vi), Bar (vii) equal in length to a + b + C. Since QE = A + b + c + e = a+b+c+d+e+f+t = T and a + b + C = a+b+c+d+e+t, a perpendicular dropped from the end of Bar (vii) cuts off a distance FE along OX equal to f.

Since the total distance OR is equal to T = a+b+c+d+e+f+t and since AR = a, BA = b, CB = c, DC = d, ED = e, and FE = f, it follows that OF = t.

Figure 17 is, in effect, an application of the algebraic procedure suggested in Part I of this appendix above. Like it, it is subject to the limitations of the method suggested in the text at p. 184 ff.

Appendix C

TENNESSEE VALLEY AUTHORITY PRELIMINARY COST COMPUTATIONS (Dated September 15, 1933)

1. VALUATION:

(a) Wilson Dam Power Plant	$24,375,000
(b) Nitrate Plant No. 2 Steam Plant	4,800,000
(c) Other buildings, fixtures and grounds	500,000
	$29,675,000

Say $30,000,000

2. FIXED CHARGES:

(a) Interest @ 3½%	$ 1,050,000
(b) Reserve for taxes (Retirement of Capital)	233,000
(c) Depreciation	200,000
(d) Gross earnings state taxes	150,000
	$ 1,633,000

3. OTHER CHARGES:

(a) Operation and Maintenance—Hydro	$ 150,000
(b) Overhead—including new business	100,000
(c) Steam plant, added expense running	100,000
(d) Total generation cost	$ 1,983,000

(e) Say $2,000,000
(f) Or 2.67 mills per KWH at average of 750,000,000 KWH per year at Bus Bar
(g) Nitrate Plant—320,000,000 @ .1c
(h) $1,700,000 for firm power output of
(i) 430,000,000 KWH or 3.95 mills per KWH

4. TRANSMISSION:

(a) $50.00 per KW

(b) Interest and redemption	4.3%
(c) Depreciation	3.5%
	7.8%

(d) Or $3.90 per KW per year

(e) Operation and maintenance	$ 100,000
(f) On 150,000,000 KWH	.67 mills

(g) Or $2.68 per KW per year
(h) $6.58 per KW. Total—based on 4,000 hrs.
(i) Plant cost....$8.70 per KW (based on 195,000 KW)
(j) Transmission $6.60
(k) $15.30 per KW

(l) Based on 100,000 KW:
(m) Transmission $ 6.60
(n) Generation 17.00
(o) $23.60 per KW year

Appendix D

APPROPRIATIONS TO THE TENNESSEE VALLEY AUTHORITY[a]

Fiscal Year	Annual Appropriation	Cumulative Total Appropriated
1934	$ 50,000,000	$ 50,000,000
1935	25,000,000	75,000,000
1936	36,000,000	111,000,000
1937	39,900,000	150,900,000
1938	40,166,270	191,066,270
1939	40,000,000	231,066,270
1940	39,003,000	270,069,270
1941	65,000,000	335,069,270
1942	196,800,000	531,869,270
1943	136,100,000[c]	667,969,270[b]

[a]Amounts here shown represent Congressional appropriations to TVA for regular corporate activities.

[b]At the close of the fiscal year, 1941, TVA reported total fixed assets, valued upon a cost (or reduced original cost) basis, of $411,455,178. After depreciation value of these assets was $385,646,404. In order of importance the major components of this capital and their sources were as follows: new plant financed through expenditure of regular Congressional appropriations; electrical properties purchased from privately-owned power companies with the proceeds of public bond issues; and Wilson Dam vested by Congress in the Authority by the TVA organic act.

[c]As of September 1, 1942.

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