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STATE AND LOCAL PUBLIC FACILITY NEEDS AND FINANCING

STUDY PREPARED FOR THE

SUBCOMMITTEE ON ECONOMIC PROGRESS

OF THE

JOINT ECONOMIC COMMITTEE

CONGRESS OF THE UNITED STATES

Volume 1

PUBLIC FACILITY NEEDS

DECEMBER 1966

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LETTERS OF TRANSMITTAL

DECEMBER 14, 1966.

To Members of the Joint Economic Committee:

Transmitted herewith for the use of the Joint Economic Committee and other Members of Congress is a study of State and local public facility needs and financing over the next 10 years. It is a staff study prepared for the Subcommittee on Economic Progress with the assistance of a number of experts.

The study projects estimated capital requirements over the next decade for such essential public facilities as water and sewer installations, electric and gas supply, transportation, schools, hospital and health facilities, and other public buildings. These structures represent an investment that is fundamental to our growth and which must increase substantially in the years ahead.

A companion volume which will be available very shortly will analyze sources of credit funds to finance construction of these facilities. Together it is expected that the two studies will prove valuable to public administrators, policymakers and urban planners, as well as economists.

The committee is grateful to the many experts who gave generously of their time to help us in this important work, and, in particular, to Dr. Arnold H. Diamond, Assistant Director, Office of Economic and Market Analysis, Department of Housing and Urban Development, who, as consulting economist to the committee, undertook the major responsibility for preparing and assembling this study. We are also grateful to the Department of Housing and Urban Development for making him available to the committee.

The views expressed in these materials are those of the contributors and do not necessarily represent the views of the committee, or individual members thereof.

WRIGHT PATMAN,
Chairman, Joint Economic Committee.

DECEMBER 12, 1966.

Hon. WRIGHT PATMAN,
Chairman, Joint Economic Committee,
Congress of the United States,
Washington, D.C.

DEAR MR. PATMAN: Transmitted herewith is a projection of public facility needs in the United States over the next decade. Public services have grown rapidly in the past 20 years with attendant increase in the facilities supplying them. This has been an important factor in raising expenditures at all levels of government, and, from time to time, has given rise to proposals for reallocating fiscal resources among the three levels of government to reflect burdens for these services. These estimates of future requirements, it is hoped, will

offer valuable aid to public administrators, fiscal officials, program planners, economists, and financial analysts.

The study examines the provision of State and local public facilities and the availability of credit resources to help finance them. This study is concerned with existing capital plant and the expected growth in requirements over the next 10 years. The second volume, which will be released shortly, will deal with the credit financing of State and local facilities, with particular reference to the municipal bond market.

The estimates are based on the separate assessment of each important category of public facilities, e.g., roads, schools, sewers, airports, etc., prepared by a number of specialists. While the estimates represent their best judgment of the facilities needed to provide adequately for the growing needs of our society, on the basis of a general economic projection for the period covered, it can be expected that some were more moderate than others in projecting increases.

One mildly surprising aspect of the results is that they are closely in line with three other recent studies, each based on a completely different methodology. One is a projection of capital outlays, presented in chapter I of this study, based on extrapolation from past trends and correlations—in short, "a mathematical projection"—derived from past relationships. The second is based on a recent survey of the 50 States and derived from an economic model prepared by the Federal interagency study of economic growth and employment opportunities. A third study was prepared by the Center for Priority Analysis of the National Planning Association.

It might normally be expected that the projection presented herewith, reflecting the so-called "aspiration standards," might indicate greater expenditures than those based on projections of previous relationships or expectations of public officials. But the fact that it is not higher does not necessarily reveal a downward bias. In the recent past, our rate of growth in the public facility sector has been brisk; and it may be that a continuation of this pace would bring us closer to realistic aspiration standards than one might expect. In any case, comparison of our study with the others will in itself offer a stimulating and productive undertaking for the people who are looking ahead in this field of economic activity.

The professional experts who prepared this study in response to the committee's request have given generously of their time and energy. The committee is grateful to them and to their organizations for so graciously making available their time and talents. The participating experts are identified at the beginning of each chapter and in the table of contents.

The committee is particularly grateful to Dr. Arnold H. Diamond, Assistant Director, Office of Economic and Market Analysis, Department of Housing and Urban Development, who, as consulting economist to the committee, undertook the major responsibility for planning the scope of research, editing and coordinating this study. Eleanor Aeschliman assisted with the editing. The study was under the general supervision of John R. Stark, Deputy Director.

JAMES W. KNOWLES.

STATE AND LOCAL PUBLIC FACILITY NEEDS AND FINANCING

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STATE AND LOCAL PUBLIC FACILITY NEEDS AND FINANCING

Volume 1. PUBLIC FACILITY NEEDS

Introduction and Summary*

INTRODUCTION

In our highly developed economy, we in the United States tend to take for granted that the public services ordinarily provided by State and local agencies will in some way continue to be furnished in increasing amounts that keep pace with population growth. By and large, these public services are furnished by State and local public agencies, but significant portions are supplied by (*a*) private, nonprofit organizations, (*b*) proprietary or profitmaking companies, and (*c*) sometimes the Federal Government.

A large part of these public services involve utilization of buildings, structures, and other public facilities, which may be characterized as the Nation's public facilities capital plant. Financing of this capital plant, or what may be termed "capital outlays," will depend upon the type of institution involved, e.g., the financial resources available to public bodies and to private organizations.

As part of its inquiry into the basic economic aspects of human resource investment, the Subcommittee on Economic Progress of the Joint Economic Committee has undertaken an examination of the provision of State and local public facilities by public and private agencies and the availability of credit and other resources to help finance them. The study comprises 2 volumes: The first volume, which is presented herein, is concerned with the existing public facilities capital plant and the growth in requirements that can be expected over the next decade. The second part, presented in a volume to be issued shortly, is concerned with the credit financing of State and local public facilities, with particular reference to the municipal bond market. It will undertake to show prospective increases in such borrowing requirements and probable sources of credit to finance them.

STATE AND LOCAL PUBLIC FACILITY NEEDS

A. NEED FOR AND USES OF STUDY

1. *Need for the Study*

During the past two decades there has been increasing concern regarding the adequacy of the Nation's public facility capital plant. The Congress has authorized a number of Federal assistance programs to help finance the development of basic community facilities (water supply, sewage disposal, power supply), transportation facilities, educational facilities, health facilities, recreational facilities, and other public facilities. In each instance the legislative committees having

*By Dr. Arnold H. Diamond, consulting economist, Joint Economic Committee.

jurisdiction over the functional area have held hearings or conducted studies, which in time were followed by legislation to authorize a particular Federal assistance program.

The assistance is usually in the form of a grant-in-aid, but at times it has been in the form of direct loans or advances, and sometimes in the form of a loan guarantee.[1] Inasmuch as most of our public facilities are owned and operated by State or local public bodies, the bulk of the Federal assistance has gone to these public agencies, but a substantial amount is made to private, nonprofit organizations. With the passage of years, new unmet public facility needs are delineated, or existing needs are expanded, and the volume of Federal financial assistance has grown. Federal expenditures for public works grants to State and local governments rose from $1,735 million in fiscal year 1958 to an estimated $4,854 million in fiscal year 1967.[2] In fiscal year 1967, Federal expenditures for construction by cooperative and other nonprofit groups is estimated at $390 million.[3]

By definition, the Federal assistance programs are designed to *aid* in the provision of needed public facilities, which means that the Federal assistance under each program is but a partial source of financing for the particular facility. It is of interest therefore to examine the other sources; and to ascertain what proportion of the total financing is accounted for by the Federal assistance. Equally important in terms of understanding a Federal assistance program would be the knowledge of how many of the facilities, to be aided by a particular program, are already in existence—as well as their value, location, and age. It is obviously important to have some notion as to what these facilities now cost to construct and to operate and what charges, if any, are collected for their use. Finally, evaluation of public facility assistance programs could be materially enhanced by periodic assessment of the capital requirements flowing from anticipated needs, which could be compared with the volume being constructed.

One might expect that each of the Federal departments or agencies responsible for the administration of a particular Federal assistance program would have reasonably good information regarding the relative importance of the Federal aid to the financing otherwise available for the type of facility for which the Federal aid is provided. Unfortunately, heretofore, this has not been the case, as evidenced by the Federal agency replies to a questionnaire sent out in 1963 by the House Banking and Currency Committee. Relatively few of the Federal agencies were able to answer the question: "To what extent is the type of facility or applicant aided by the program being financed by private credit without involvement of Federal credit assistance?"[4]

Thus, there is a need to develop quantitative information regarding the "universes" in which the Federal assistance programs operate in terms of inventories of existing capital plant, recent trends of capital outlays, and future capital requirements for the facility. If such data could be developed for each category of public facilities, it would then be possible to array them in comprehensive tables that would

[1] Soil and water loans insured by the Farmers Home Administration.
[2] "Special Analyses of the Budget of the United States for Fiscal Year 1967," p. 67.
[3] Ibid., p. 75.
[4] Replies of the Federal credit agencies administering the 74 credit programs in existence at June 30, 1963, are published in vol. II of *A Study of Federal Credit Programs* (issued by the Subcommittee on Domestic Finance, House Banking and Currency Committee, 88th Cong., Feb. 28, 1964).

permit comparisons to be made among the major groups of public facilities and among the component categories.

In essence, the chapters contained in this volume represent an effort to provide in a systematic way information on the infrastructure of State and local public facilities in the Nation. It answers such questions as: What are public facilities? What services do they render? How many are there and where are they located? What has been the trend of capital outlays and indicated sources of financing? How many more are needed? To some extent, one can obtain part of this information from the statistical compilations prepared by the Bureau of the Census.[5] Similarly, one can obtain some of the information from reports and studies issued by individual Federal agencies on their program accomplishments or by some of the trade associations.

But up to now there is no single source to which one can turn in order to obtain a comprehensive picture of the Nation's public facilities ordinarily provided by State and local public bodies and to some extent by private, nonprofit organizations. The study contained in this volume endeavors to fill this void by presenting a series of chapters on the significant categories of public facilities, each prepared uniformly in accordance with a standard chapter outline.

2. *Uses of the Study*

The vast array of information presented in this volume, much of it available for the first time, is adaptable to many uses, depending upon the needs of the reader. However, several intended uses were envisaged when the study project was inaugurated such as (*a*) providing a quantification of the Great Society capital requirements insofar as they relate to public facilities, (*b*) measuring the apparent gap between these requirements and prospective private credit resources, (*c*) providing basic "universe" data inputs to be used in connection with the planning-programing-budgeting system established by the executive branch, and (*d*) providing new dimensions for the "shelf" of unmet public facility needs. These uses are amplified as follows:

(a) *Great Society Capital Requirements.* In his Message on the "Problems and Future of the Central City and Its Suburbs," [6] the President declared:

> The city is not an assembly of shops and buildings. It is not a collection of goods and services. It is a community for the enrichment of the life of man. It is a place for the satisfaction of man's most urgent wants and his highest aspirations. It is an instrument for the advance of civilization.

In prescribing some of the blueprints for the Great Society, the President further declared:

> By 1975 we will need over 2 million new homes a year. We will need schools for 10 million additional children, welfare and health facilities for 5 million more people over the age of 60, transportation facilities for the daily movement of 200 million people * * *. Among the most vital needs of our metropolitan areas is the requirement for basic community facilities—for water and sewerage. Many existing systems are obsolete or need major rehabilitation. And population growth will require a vastly increased effort in years ahead * * *. A community must offer added dimensions to the possibilities of daily life. It must meet the individual's most pressing needs and provide places for recreation and for meeting with neighbors.

[5] Cf. *Governmental Finances* (issued annually by the Governments Division, Bureau of the Census) and *Construction Review* (issued monthly by the Business and Defense Services Administration and which includes data on permits issued for public and private construction, as compiled by the Construction Statistics Division, Bureau of the Census).

[6] H. Doc. No. 99, 89th Cong., 1st sess. (Mar. 2, 1965).

While the public services flowing from the public facilities described in this volume are not the sum total of the goals and objectives of the Great Society, they form an important component. Consequently, these projections of future capital requirements for the different categories of public facilities provide a reasonable approximation of our public service needs for specified levels of service.

(b) *Capital Requirements and Available Resources.* Enumeration of a series of capital requirements for different categories of public facilities carries no assurance that these facilities will, in fact, actually be provided. Whether such facilities will be produced depends upon (1) an assessment by appropriate authorities of the prospective needs for such facilities, (2) a comparison of the relative urgency of such needs with the needs stemming from alternative public and private objectives, and (3) the availability of financial and "real" resources.

A statement of needs for public services represents a series of qualitative judgments as to what would be "needed," if certain standards of performance are to be met for a given population, with due allowance for the existing capital plant. Generally such judgments are rendered by experts or professionals in the particular field who necessarily regard their sphere of interest as more important than others. Assessment of these "needs" by like-minded experts or professionals can result in considerable refinements and reevaluation of the needs; but the winnowing out process (translating "needs" into actual undertakings) does not become very effective until the "needs" for one purpose are compared to equally meritorious needs for other purposes.

Within the constraints of available labor and material resources, the final arbiter is, of course, the availability of financial resources, be they tax receipts, intergovernmental revenues, borrowing, fees, gifts, or donations. All such resources are limited and must be employed for current operations of the spending units as well as for capital outlays. Conceivably a gap could exist between the capital requirements reflecting prospective needs and the financial resources available to meet them.

The size of this gap could only be determined by first ascertaining what our public facility needs are and then comparing the aggregate of such needs with anticipated financial resources. To bridge such a gap, it would be necessary to make more financial resources available or reduce the dimensions of the purported needs by modification of the standards of performance. A necessary first step in this allocation—budgetary process—would be to find out what our public facility needs are and what criteria were used to estimate these needs.

(c) *Planning-Programing-Budgeting System.* On August 24, 1965, the President announced to members of his Cabinet and heads of major agencies his intention to establish a new planning-programing-budgeting system in the executive branch of the Federal Government. This new system—which had been developing in broad outline in the Department of Defense for several preceding years—was formally established within the executive branch by Bureau of the Budget Bulletin No. 66–3 of October 12, 1965. It has since been adopted by all Federal agencies as one of the more important tools of management.[7]

[7] See 1958 recommendations of Joint Economic Committee study on *Federal Policy for Economic Growth and Stability*, pp. 6–14. See also, 1963 Joint Economic Committee report, *The Federal Budget as an Economic Document*, pp. 8–11.

Essential to the new system are: (1) an output oriented program structure which presents data on all of the operations and activities of the agency in categories which reflect the agency's attainment of end purposes or objectives, and (2) analysis of possible alternative objectives of the agency and of alternative programs for meeting these objectives. Such analyses would include comparison of these alternative programs with respect to costs and benefits. As noted in the Budget Bureau Bulletin, the program objectives and planned accomplishments are to be expressed, wherever possible, in quantitative nonfinancial terms. Where relevant, the physical description of the Federal programs is to be related to the entire universe to be served.

In other words, under this new system Federal agencies are required to ascertain the dimensions of the universe in which a particular Federal program operates and to determine the relative proportion accounted for by the Federal aid program. To do so, they will need, in the case of the programs aiding the provision of public facilities, data showing (1) the existing capital plant of the public facility category, for which the aid is provided, (2) the recent trend of capital outlays, and (3) estimated capital requirements for specified levels of performance.

In analyzing alternative programs to meet indicated objectives, the Federal agencies will eventually have to determine (1) whether the program "needs" can be financed by loans or whether they require some form of grant subsidy; (2) the extent to which funds are being, are likely to be, or could be provided from non-Federal sources; (3) the range of capital and operating costs of the public facility; and (4) the extent to which the prospective users can afford to pay these costs.[8] By and large, such information has not been assembled in any systematic manner heretofore. Yet without these "universe" data and related cost and financing information, the comparative analyses and program memoranda called for by the new system may prove to be difficult to prepare.

(d) *Shelf of Public Facility Needs.* Since the 1930's the view has been expressed by certain analysts [9] that there is a need for a shelf or reserve of planned public works, the construction of which can be started promptly when economic conditions make such action desirable. They look to the employment and income generative effects of public works construction as one of the means of counteracting recession tendencies within the economy. Before such a shelf of public works can be developed, the respective "public works" needs have to be identified and quantified.

While one may question the economic merits of the public works reserve thesis, given the problems associated with the timing of stepped-up public works expenditures, there is no doubt that "public facility" expenditures (by private as well as public agencies) contribute importantly to a growing economy. In fact, a slowdown or curtailment of such expenditures could help initiate a general economic

[8] Much of these remarks is based on the writer's conclusions set forth in vol. I of *A Study of Federal Credit Programs* (issued by the Subcommittee on Domestic Finance of the House Committee on Banking and Currency, 88th Cong., Feb. 28, 1964), especially pp. 179–180.

[9] Cf. National Resources Planning Board, *Economic Effects of Federal Public Works Expenditures, 1933–38* (Washington: Government Printing Office, 1940); Special Assistant to the President for Public Works Planning, *Planning for Public Works* (July 1957); Economic Report of the President (January 1955), p. 57; Robinson Newcomb "Public Works and Economic Stabilization" in *Problems in Anti-Recession Policy* (issued by the Committee for Economic Development, September 1954); and more recently, "America's Need: Social Services and Jobs," AFL–CIO *American Federationist* (August 1963). See also, *Report of the Joint Committee on the Economic Report on the January 1954 Economic Report of the President.* Pp. 13–15.

downturn. Before public facilities can be constructed, they must first be planned, and this planning should be related to some assessment of needs. A periodic assessment of aggregate public facility needs provides, then, a comprehensive picture of the growth potential of an important sector of the U.S. economy, useful to those who have to chart the future course of the economy.

B. PLAN OF THE STUDY

1. *General Considerations*

Initially, assembling the requisite mass of data on the public facilities capital plant in the Nation appeared a formidable, if not impossible, assignment, considering the diversity of ownership patterns and the variety of public facility categories. To confine the study of public facilities to those owned and operated by State and local public bodies would overlook the facilities owned by private, nonprofit organizations, including most of the Nation's hospitals, colleges, and neighborhood centers, and significant amounts of recreational or cultural facilities. On the other hand, the major alternative to State or local public ownership for such public facilities as electric power, gas distribution, airports, marine ports, or parking facilities is ownership and operation by a private, investor-owned company.

To obtain a comprehensive picture of all public facilities, irrespective of ownership, it seemed advisable to develop the study along functional lines; that is, to assemble a series of chapters, each dealing with a specific category of public facilities. Within the chapter appropriate delineations could be made regarding the ownership distribution of the existing capital plant, trend of capital outlays, and prospective capital requirements. The component data by ownership patterns, as well as the totals for each category of public facilities, could then be aggregated, such as is done in the next section of this chapter, or they could be cross-tabulated according to other needs of the user.

The decision to base the study on a series of chapters, each dealing with a specific category of public facilities, materially eased the problem of data assembly. For each public facility category there are groups, generally a Federal agency or a private trade association, that can avail themselves of a substantial amount of knowledge regarding the services rendered, the existing capital plant, costs and user charges, trends of capital outlays, and they are likely to be the most informed as to prospective needs and capital requirements. As evidenced by the chapters in this volume, such materials can be developed by these groups from reports already published, unpublished data in their files, from special surveys, or by informed estimates.

2. *Procedure*

Accordingly, arrangements were made with private associations or Federal agencies, which were believed to be best qualified, to prepare authoritative chapters on designated public facility categories. To assure uniform coverage, and to permit the tabulation of comparative data, each chapter writer was requested to follow a standard outline, set forth in questionnaire form, that was enclosed with the letter of request transmitted by the Chairman of the Joint Economic Committee. (See Supplementary data, pp. 20–21.)

The chapter writers were advised to add such qualifying information and remarks as might be necessary to provide a comprehensive picture of the subject matter. They were given a list of economic assumptions for the years 1966–75 (See Supplementary data, p. 22) as a guide for any projections that may be made for these years. The committee's letter of request prescribed that the requested chapter "should be limited to a factual account of the prevailing or historical situation, supplemented by appropriate estimates and projections. It should omit recommendations, suggestions for changes, or comments on existing or prospective legislation."

The chapters prepared under these instructions were then reviewed and edited by committee staff to delete extraneous materials. Also deleted were recommendations for new or enlarged Federal assistance programs or for other Federal legislation, statements that reflected unfavorably upon other public facility industries and reproductions of Federal statutes or agency regulations.

This editing was deemed necessary to assure that the intended factual presentation did not become a vehicle for promoting the interests of special groups, be they trade associations or Federal agencies. Aside from these changes, the materials presented in the various chapters represent the viewpoints of the respective chapter writers, identified on the first page of the chapter. Because of their expertise in the specialized areas in which they are active, it is presumed that the materials they present fully reflect the information available on the subject.

3. *Identification of Public Facilities*

In setting the ground rules for the individual chapters, it became necessary to clarify what was intended by the term "public facilities." It is recognized that the term *public works* ordinarily applies to undertakings by public agencies [10] and therefore could not be used to describe the physical facilities owned by groups other than public agencies. On the other hand, the term *public facilities* can be interpreted to mean facilities from which *public services* can be rendered, irrespective of ownership of the facilities. Accordingly, the scope of the study has been defined in terms of *public facilities*.[11]

It is further intended the study be confined to *State and local public facilities*, that is, (*a*) public facilities ordinarily provided by State or local public agencies, or (*b*) public facilities that are to a significant extent provided by State and local public agencies or by private, nonprofit organizations. In this way, full recognition would be accorded to the public facilities owned and operated by private, nonprofit organizations, which account for a significant portion of the Nation's public services. Under this definition, facilities entirely owned by the Federal Government (defense installations, post offices, other Federal buildings, space and atomic energy facilities or multipurpose dams) would be excluded from the purview of the study. Similarly excluded would be the capital plant of investor owned private business.

[10] Publicly owned housing is not construed as part of the "public facilities" sector in the economy. Instead, it is regarded as part of the "housing" sector, a sector that also includes housing owned by private, or nonprofit organizations. In a sense, "public facilities" are "nonresidential" structures. However, group housing, such as college dormitories and nursing homes, are regarded by the Census Bureau as "nonresidential," and they are, therefore, construed as part of the Nation's "public facilities."

[11] Urban renewal expenditures to acquire and clear properties are not regarded as *public facilities* expenditures. Cleared land, in itself, does not yield a *public service*.

However, it is recognized that there are categories of "State and local public facilities" where a large part of the facilities are owned and operated by the Federal Government (national parks, regional and river basin water supply systems) or by private investor owned companies (electric power, gas distribution, urban mass transit, airports, parking facilities, nursing homes). These categories of public facilities are included in the study in order to provide a perspective for the facilities within these categories that are owned by State and local public agencies or by private, nonprofit organizations. Moreover, inasmuch as ownership patterns are not immutable, it seems more meaningful to provide the capital requirements over the next decade for, say, the entire electric power industry, rather than the requirements of the small segment of the industry accounted for by State and local public agencies, plus private, nonprofit organizations.

With these definitions in mind, arrangements were made for the preparation of 42 chapters, each covering a designated public facility category. By and large, the public facility categories are those that reflect commonly used identifications; but at times, owing to the nature of the industry or to the availability of data, it became advisable to split an industry into several parts, each with a separate chapter, or sometimes to combine in a single chapter similarly constituted activities.

Under the grouping *Basic Community Facilities* there are three chapters dealing with water supply facilities—regional and river basin water supply systems (including watersheds), public water systems (mainly urban) and rural-agricultural water supply systems (essentially irrigation systems). There are four chapters dealing with sewage collection and disposal—sanitary sewer collection systems, storm sewer systems, water waste treatment plants, and solid wastes collection and disposal facilities. There is one chapter on electric power systems and one on gas distribution systems.[12]

Under the grouping *Transportation Facilities* there are separate chapters on highways, roads and streets (covering rural and urban highways, roads and streets), toll bridges, tunnels and turnpikes, urban mass transit facilities, parking facilities, airports, and marine port facilities.[13] Under the grouping *Education Facilities* there are chapters covering public elementary and secondary schools, nonpublic (private) elementary and secondary schools, area vocational schools, academic facilities for higher education institutions (including community and junior colleges), college housing and related service facilities and educational television.

Under the grouping *Health Facilities* there are separate chapters on hospitals (mainly general hospitals), clinics, and other outpatient facilities (hospital outpatient departments, hospital adjunct services, and freestanding specialized facilities), long-term care facilities (nursing homes, chronic disease hospitals), community mental health centers,[14] facilities for the mentally retarded (community facilities

[12] The possibility of a separate chapter on telephone facilities was explored with the National Telephone Cooperative Association and it was concluded that the negligible amount of publicly owned telephone service did not warrant a separate chapter. In the case of street lighting, it was found that information on the subject was virtually nonexistent, perhaps due to the fact that street lighting is considered in many localities as part of the highway or street capital plant.

[13] The possibility of a chapter on terminal facilities for trucks, buses, and trains operating on interurban routes, was explored with the Department of Commerce and the respective trade associations. All concluded that the prospects of obtaining information for such publicly owned facilities, outside of New York, were slim, and hence no chapter seemed advisable.

[14] As detailed in ch. 25, community mental health centers are expected to be the new type of facility for the mentally ill, and, in time, are expected to displace the traditional State mental institution.

and university affiliated facilities), health research facilities (usually located at universities or hospitals), and medical and other health schools (schools for dentistry, nursing, optometry, osteopathy, pharmacy, podiatry, and public health).

Under the heading *Recreational and Cultural Facilities* there are three chapters on outdoor recreational facilities, one dealing with State and Federal facilities, one with urban local outdoor facilities, and one with rural outdoor facilities. There is a chapter on neighborhood centers for recreation, health and social services (covering the activities of such groups as the Boy Scouts, Boys Clubs, Girl Scouts, "Y's," and other privately operated settlements and neighborhood centers). Other chapters deal with stadiums, arenas, and exhibition halls, theaters and community art centers (cultural centers), museums (including planetariums, zoos, botanical gardens) and public libraries.

Under the heading *Other Public Buildings* are such chapters as residential group care for children (detention homes, institutions for delinquent children, other child welfare facilities), armories, jails and prisons, fire stations,[15] public office and court buildings, and industrial plants financed and owned by local governments.[16]

Owing to the programatic viewpoint of some of the Federal agencies that prepared several of the chapters and the limited detail available on certain of the data, there are several chapters where the information presented overlaps, in part, material contained in other chapters. Thus, there is some overlap between the chapters on (*a*) highways, roads, and streets on the one hand and toll bridges, tunnels, and turnpikes on the other; (*b*) area vocational school facilities, on the one hand, and public elementary and secondary schools and academic facilities for higher education, on the other; (*c*) health research facilities, on the one hand, and hospitals and academic facilities for higher education, on the other; and (*d*) medical and other health schools and academic facilities for higher education. For the first two where the overlap is reported to be near 100 percent, appropriate adjustments are made in the summary compilations. For the latter two, the respective chapter writers advise that the overlap is minimal, and therefore the summary compilations have not been adjusted.

4. *Chapter Content*

Each of the chapters presented in the second part of this volume consists of four sections: (A) nature and composition of public work or facility (B) costs and user charges (C) trend of capital outlays, and (D) needs and prospective capital outlays. The first section is designed to describe the particular public facility in terms of physical characteristics, services rendered and standards of performance. It also provides an inventory of the existing capital plant in terms of number of facilities, location by State and size of city, age distribution, ownership pattern and estimated current value.

The second section is intended to show the current range of construction and operating costs for the particular facility. It also indicates the extent to which user charges are employed to pay for the use of the facilities and the relationship of user charges to capital and operating costs. Section (C) depicts the postwar trend of capital

[15] A parallel chapter on police stations was envisaged, but the International Association of Chiefs of Police found that the available data did not permit the preparation of a useful chapter.

[16] One may question whether a municipally owned industrial plant that is leased for private use is a "public facility." Because of the controversy on this subject, data are presented on municipally owned industrial plants, but excluded from the summary tabulations.

outlays, delineating the ownership patterns for these outlays and their sources of financing. Section (D) presents projections of capital requirements for the facilities over the next decade, with appropriate explanation of the "need" considerations taken into account. To the extent possible, expected ownership patterns and sources of financing for the anticipated capital requirements are also shown. (The standard chapter outline used by the chapter writers is reprinted in the section "Supplementary data," pp. 20–21.)

The purpose of each chapter is to present a factual description of the particular public facility to the extent data are available. In a number of instances such data are sufficient to permit the authors to comply fully with the prescribed chapter outline. In other cases, as evidenced in various chapters, there is a paucity of information available and the authors had to condense accordingly.

Public service needs reflect a series of subjective judgments regarding quantitative and qualitative standards of performance, which may not be acceptable to all. Hence, each author was requested to state explicitly the standards of performance deemed appropriate for the particular facility. Moreover, in projecting capital requirements to reflect future needs, the author was requested to describe the factors taken into account in making the projections. In most chapters these subjective judgments are clearly delineated so that users of the study may make adjustments, if they deem it desirable, in the underlying assumptions. In other chapters, however, the authors presented their considered opinions, without identifying the assumptions and judgments.

5. *General Chapters*

Three general chapters are presented in the first section of this volume to provide a frame of reference for the specific public facility category chapters that follow. The first chapter describes the relative importance of State and local public works expenditures to gross national product during the years 1946–65 and provides "best judgment" projections of the volume of such expenditures that may be expected during 1966–75.

The second and third chapters describe, respectively, the material and labor requirements for State and local public works during the years 1946–75. These two chapters, at least with respect to the projections for 1966–75, are tied to the projections contained in the first chapter.[17] In addition, the chapters examine the importance of State and local public works construction to the material supply, industries and construction employment, trace for the years 1946–65 changes in the capacity of the building materials and construction industries and in the volume of construction employment, automation trends in these industries, cost-price developments, and the adequacy of technically skilled labor to administer the intended public services so as to avoid underutilization of the public facilities capital plant.

[17] These three chapters have been interrelated to assure consistency as to projection assumptions. However, since the writers of these three chapters did not have access to the "capital requirements" projections, that were being prepared simultaneously by those writing the chapters on the specific public facility categories, they could not take them into account. The reader, having all these materials at hand, can determine, as appropriate, whether the future supply of construction labor or materials might constrain meeting the various needs, assuming financial resources are available.

C. SUMMARY OF FINDINGS

1. *General Forces*

As explained above, three general chapters are presented in the first part of this volume to provide an overview of the State and local "public works" [18] sector of the economy. The first analyzes and projects State and local public works expenditures in relation to GNP; the second examines the material requirements for such expenditures, and the third examines their labor requirements.

Since 1958 the ratio of real State and local government expenditures for structures and equipment to real GNP has fluctuated within a relatively narrow range—between 2.8 and a little over 2.9 percent. Assuming an average annual growth rate in real GNP of a little over 4 percent from 1965 to 1975, a 4 percent unemployment rate and a 1.5 percent increase per year in the GNP price deflator, coupled with various other factors detailed in chapter 1, GNP is projected (in current prices) to rise from $676 billion in 1965 to $905 billion in 1970, and to $1,180 billion in 1975 (assumption B). If one assumes the average annual growth rate in real GNP at nearly 4½ percent from 1965 to 1975, the unemployment rate at 3 percent, and a 2-percent increase per year in the GNP price deflator, and taking into account account other described factors, GNP is projected at $940 billion in 1970 and at $1,275 billion in 1975 (assumption A).

From these GNP projections, it is further projected that State and local government purchases of structures and equipment (net of residential buildings), which amounted to $19.5 billion in 1965, would rise to $28.5 billion in 1970 and to $39.1 billion in 1975 under assumption B. Under assumption A, such purchases would rise to $29.9 billion in 1970 and to $44.2 billion in 1975.[19]

After surveying the components of the construction and building materials industries, the authors of chapter 2 conclude that—

> To meet future increases in construction demand in both the private and public sectors it is expected that the construction and building materials industries will increase their productive capacities. Prefabrication and prefinishing have been and will continue to be important sources of promoting innovation and labor-saving devices on construction sites * * *. When one considers all the factors, it is difficult to avoid the conclusion that the construction materials industries should be able to meet the needs of future construction—as they have in the past—through innovation, product development, and increased productive capacity.

After reviewing labor market prospects, the authors of chapter 3 conclude that—

> Employment in the building trades is expected to increase moderately through the mid-1970's, assuming relatively full employment nationally and the high levels of economic activity needed to achieve this goal.

Turning to the OBE projections for 1975, the authors estimate that, allowing for increased productivity, 2,802,000 full-time workers will be needed in 1975 for the $41.7 billion of construction projected under

[18] Owing to the definitions and concepts employed in national income accounting, the three chapters necessarily deal only with State and local government "public works," as distinguished from the "public facilities" concept used throughout this volume. The latter includes expenditures by other owners. Moreover, under national income and product accounting, public works expenditures relate only to construction (or equipment purchase) expenditures, but omit expenditures for land. In contrast, "capital outlays" (or "capital requirements") embrace expenditures for land as well as for construction or equipment purchase.

[19] In July 1966, subsequent to the time when these calculations were made, the estimates in the national income and product accounts were revised for the years 1963–65. The Office of Business Economics advises that the effect of these changes on the above projections is relatively small; the projections of State and local capital expenditures would be raised by about $.5 billion in 1970 and 1975.

assumption A and 2,744,000 for the $36.6 billion [20] of construction projected under assumption B—

Thirty-eight percent of these (1,070,000 and 1,048,000, respectively) would be needed in the construction industry and the balance in sectors supplying the necessary materials and service.

2. *Capital Requirements 1966–75*

Each of the chapter writers in the second part of this volume [21] was requested to present, in part D of the chapter, estimates of capital requirements for the particular public facility category for each of the years during the period 1966–75. The projections were to take into account the current backlog of unmet needs, accommodations of expected population growth, replacement of obsolete facilities, quantitative and qualitative standards of performance. As will be noted, some of the chapter writers distinguished between the current backlog of unmet needs and future requirements, while others combined the two elements. Some of the chapter writers provided projections for each year, as requested; others provided only an estimate for the entire 10-year period.

Table 1 compares the estimated capital requirements for all public facility categories by all spending units during 1966–75 with actual outlays for such facilities in 1965 (to the extent data are available). To facilitate comparisons on an annual basis, estimates are also provided for the capital requirements in 1970 and in 1975.[22] The estimates are grouped under six headings: A. Basic Community Facilities (water and sewer, electric and gas); B. Transportation; C. Education; D. Health; E. Recreational and Cultural; and F. Other Public Buildings.

Estimated capital requirements for public facilities by all spending units during 1966–75 total $499 billion. For 1970 the estimated requirements total $49 billion and for 1975 they aggregate $62 billion, or double the volume estimated for 1965. The largest capital needs are for basic community facilities and for transportation facilities. The following table provides a summary comparison of the estimated requirements with actual 1965 capital outlays, broken down by major groups of facilities.

[20] Projected construction figures include $0.5 billion of residential construction. They differ further from the figures cited above ($44.2 billion or $39.1 billion) by the amounts projected for purchases of equipment.

[21] With the exception of chapter 42 dealing with publicly owned industrial plants.

[22] To assure uniformity in the estimates, the following procedures have been employed: (*a*) the figures for 1966–75 are (1) as provided, or (2) the sum of the unmet backlog plus future requirements, or (3) the sum of annual estimates with interpolations for intervening years; (*b*) the estimates for 1970 and 1975 are (1) as provided, or (2) 9.6 percent and 12.6 percent of the 1966–75 projection, the percentages reflecting an annual rate of increase in requirements of 5.5 percent; and (*c*) all estimates are rounded to the nearest $10 million (except when they are under $10 million). Further explanations are shown in the footnotes to the table.

Summary comparison of total capital outlays for public facilities in 1965 with estimated capital requirements during 1966–75, all spending units

[Dollars in billions]

Group of facilities	Actual 1965 [1]	Estimated		
		1970	1975	1966–75
Water and sewer	$3.9	$7.3	$9.2	$76.2
Electric and gas	6.5	8.8	10.2	84.9
Transportation	9.2	14.6	19.0	151.7
Education	5.9	7.8	10.2	82.2
Health	2.5	4.2	5.5	43.5
Recreational and cultural	2.5	5.2	6.6	53.1
Other public buildings	[2] 5	[3] 7	[3] 9	[3] 7.5
Total	31.0	48.6	61.6	499.1

[1] Adjusted to reflect facility categories where data are not available.
[2] Excludes publicly owned industrial plants.
[3] Includes police stations with estimated capital requirements assumed to be $1,000,000,000 during 1966–75.

As will be noted, these capital requirements relate to all spending units—State and local public agencies, private, nonprofit organizations, private investor-owned companies, and, where appropriate, the Federal Government. Since each of these ownership groups finance their activities in different sectors of the capital market, it is useful to provide estimated capital requirements for each of these ownership classifications. Accordingly, table 2 compares the estimated capital requirements for public facilities during 1966–75 with actual capital outlays in 1965 for State and local public agencies. Table 3 provides a similar comparison for private nonprofit organizations and table 4 presents the information for private, investor-owned companies.[23]

State and local public agency capital requirements for public facilities are estimated at $328 billion for the decade 1966–75. For 1970 these capital requirements are estimated at $32 billion and for 1975 they are estimated at $41 billion, which compares to the $20 billion of capital outlays expended by State and local public bodies in 1965. As shown in the following table, over 40 percent of the anticipated capital requirements are for transportation facilities and nearly 20 percent each are accounted for by education and water and sewer facilities.

[23] Each of the requirement estimates for the organizational sectors is related to the estimates presented in table 1 for all spending units. The distribution patterns are either denoted in the respective chapter in absolute amounts or in percentages of total requirements. Where the distribution is not clearly discernible from the respective chapter, the distribution percentages employed for the estimates are described in the footnotes to the respective tables. Where the chapter does not provide data on the distribution pattern of the estimated capital requirements, the patterns are "assumed," on the basis of such information as seemed appropriate (identified in the footnotes). No separate table has been prepared on federally owned facilities.

Summary comparison of public facility capital outlays of State and local public agencies in 1965 with estimated capital requirements during 1966–75

[Dollars in billions]

Group of facilities	Actual 1965 [1]	Estimated		
		1970	1975	1966–75
Water and sewer	$2.7	$5.5	$6.8	$56.5
Electric and gas	.8	1.3	1.4	12.8
Transportation	8.9	13.5	17.7	141.1
Education	4.9	5.9	7.8	62.0
Health	.8	1.3	1.7	13.1
Recreational and cultural	1.5	3.4	4.4	35.0
Other public buildings	[2] 2.5	[3] 3.7	[3] 3.9	[3] 7.3
Total	20.1	31.6	40.7	327.8

[1] Adjusted to reflect facility categories where data are not available.
[2] Excludes publicly owned industrial plants.
[3] Includes police stations with estimated capital requirements assumed to be $1,000,000,000 during 1966–75.

Public facility capital requirements of private, nonprofit organizations for the decade 1966–75 total $54 billion, or over 10 percent of the total capital requirements of all spending units. Capital requirements for these organizations total $5 billion in 1970 and almost $7 billion in 1975, which compare with capital outlays of somewhat over $2 billion in 1965. As detailed in table 3, the largest segments of these private, nonprofit capital requirements are for college facilities (academic and housing) and for hospitals.

For private, proprietary or investor owned companies the capital requirements for public facilities during 1966–75 are estimated at $105 billion, or over 20 percent of the estimated total requirements. These capital requirements are estimated at $10 billion in 1970 and $12 billion in 1975, as compared to capital outlays of some $6 to $8 billion in 1965. As shown in table 4, over half of the estimated capital requirements of the proprietary companies are for electric power facilities, with sizable amounts for gas distribution systems and storm sewer systems. For Federal agencies the capital requirements for public facilities during 1966–75 are estimated at about $13 billion, mainly for outdoor recreation and electric power facilities.

3. *Existing Capital Plant*

Underlying most projections of prospective needs and capital requirements are assumptions, generally unstated, regarding the existing capital plant for the particular category of public facilities. Such assumptions relate to the existing number of facilities, their age or physical condition, and their degree of utilization. Some of these assumptions can be quantified; others involve qualitative judgments or are susceptible of flexibility.

As evidenced by the data presented in table 5, there is usually very good information as to the number of facilities (or where more meaningful, the volume of public service output) for each of the public facility categories. Moreover, as shown in the table, in most instances the number or volume, according to type of ownership, is also ascertainable. In a majority of the chapters, data are presented regarding the distribution of these facilities by States and by population size of city.

Unlike the situation for many of our durable consumer goods, where style changes, built-in obsolescence, and annual improvements

stemming from technological advances make periodic replacement necessary, most of the Nation's public facility capital plant is constructed with long-time use in mind. To a surprising degree, many public facilities or structures built 25 to 30 years ago are still very usable today, especially if there have been proper repairs and maintenance. On the other hand, when the age of a structure reaches 45 to 50 years or more, it is frequently no longer suitable for use and needs to be replaced.

Significant portions of the Nation's public facility capital plant are still being used, even though they were constructed before 1920. For example, 14 percent of the elementary and secondary schools, and 21 percent of the private elementary and secondary schools, were built before 1920. About 15 percent of the public libraries, and 20 percent of State prisons were built before 1900. Given the limited fiscal resources and the higher priorities for other public expenditures of the communities in which they are located, many of these aged facilities may be expected to continue in use for a number of additional years.

Not only is there use of public facilities for time periods beyond their anticipated lifespan, but in many instances facilities are utilized more intensively than was originally contemplated. Additional schoolchildren are frequently handled by installing more desks in classrooms; hospital overflows are accommodated by placing additional beds in rooms, or even in corridors; and college facilities are more intensively used by afternoon or evening classes and through trimester and four semester school years. Crowded highways are manifested by slow moving, bumper-to-bumper traffic; overtaxed bridges and tunnels are evidenced by long waiting lines for use; overcrowded airports are mirrored by the stacking of airplanes waiting to land; and during rush hours subway passengers are "packed like sardines."

Continued use of over-aged facilities and more intensive use than originally contemplated, are sometimes the practical alternatives to increased capital outlays for public facilities to meet expanding needs. Staggered use of commuter mass transit facilities may help to relieve overcrowding as will double sessions of schools. Popular museums, libraries, or parks are likely to attract large attendances, even though they may be overcrowded; and sports or theatrical events frequently play in "packed" arenas or theaters.

Any assessment of future capital requirements for the various public facility categories, as detailed in the previous section, must in some way take into account existing facilities and the extent and duration of their possible use.

The last column of table 5 shows the current estimated value of the existing capital plant for each of the public facility categories. Allowing for the categories where estimated current values are not available, the estimated value of the existing capital plant of all State and local public facilities is in excess of $450 billion, perhaps as much as $500 billion. This sum is the approximate size of the estimated capital requirements for such public facilities during the decade 1966–75.

4. *Costs and User Charges*

To the extent that data are available, each of the chapters present statistics on capital and operating costs for the respective categories

of public facilities and information on user charges. The cost data provide some basis for judging relative construction costs or, to put it another way, an indication of what $1 million of capital outlay is likely to purchase for different categories of public facilities.

Table 6 analyzes the extent to which user charges are employed for each of the public facility categories. As will be noted, of the 42 public facility categories listed, user charges are employed either substantially or moderately in 33. For this purpose, "substantial" means that user charges are employed in all or most instances or, where they are employed, cover all or a substantial part (over 50 percent) of capital and operating costs. "Moderate" means that user charges are infrequently employed or that they cover only a small part (under 50 percent) of capital and operating costs.

User charges are employed for all categories of public facilities classified as basic community facilities and transportation facilities and for all but one of the categories within the groups classified as health facilities and recreational or cultural facilities. On the other hand, there are no user charges for public elementary and secondary schools, health research facilities, public libraries, and the facilities relating to public safety and administration [armories, jails and prisons, fire (and police) stations, residential group care for children, and public office and court buildings].

Inasmuch as most of the public facilities described in this volume have user charges that cover all or part of capital and operating costs, they are amenable to financing through long-term borrowing, so that the capital costs of the facilities can be prorated over several generations of users, each of which can pay all or part of the apportioned capital costs.[24] Financing through borrowing against future revenues, of course, enlarges the volume of capital outlays that can be accomplished during any specified period, as compared to capital outlays financed entirely out of current receipts.

D. EVALUATION OF DATA

1. *Data Quality*

Essentially, this volume is a data source book, full of facts, figures, and expert projections. Many of the chapters contain a wealth of information, sufficient to satisfy most users. However, in some chapters the information is scanty; and upon reading them, one might be inclined to question whether they reflect the ultimate possibility in conveying information about the subject.

Checking with other sources, one finds that in a number of instances the contents of these chapters are just about all we do know with respect to the kinds of data called for in the committee questionnaire. The paucity of information on capital outlays in the various chapters on health facilities, to cite one area, may be attributed to (*a*) the "programmatic" viewpoint of the Federal agencies concerned with such matters as health, which results in minimal interest in related activities carried on outside Federal assistance programs, (*b*) a lack of detail in the construction statistics compiled by the Bureau of the Census, and (*c*) limited efforts by the executive branch to take the

[24] The increasing concern regarding the adequacy of hospital charges paid by public welfare agencies on behalf of indigent patients and by private group medical plans on behalf of their members suggests that future hospital user charges may cover a larger proportion of hospital capital and operating costs.

necessary steps to see that such data are compiled so that the budget presentations would be more meaningful.

To overcome these data deficiencies, it would be helpful to analysts and policymakers to strengthen the data collection resources of such basic fact gathering agencies as the Bureau of the Census, especially the Construction Statistics Division. This Division is currently responsible for compiling statistics on permits authorized and construction put in place for various groups of public and private construction. If these data are to be useful in delineating the "universes" in which Federal assistance programs operate, they must be broken down in sufficient detail and supplemented by statistics for outlays on land and equipment to permit appropriate comparisons to be made.

2. *Other Projections*

It should be noted that several other studies have been made in recent years dealing in part with public facility needs. One is a study on national goals prepared by the Center for Priority Analysis of the National Planning Association. Based on a series of research memoranda, the study presents a number of projected expenditures (including capital outlays) in 1970 and 1975, taking into account certain "aspiration standards." [25] As detailed in table 7 (which lists the public facility categories in line with the classifications employed in this volume), public and private capital outlays for public facilities are projected to rise from $29.0 billion in 1962 to $51.5 billion in 1970, and to $60.8 billion in 1975. These figures compare with the estimates presented above for all spending units of actual capital outlays of $31.0 billion in 1965 and estimated requirements of $48.6 billion in 1970 and $61.5 billion in 1975.

The second, known as "Project '70", is a study of the State and local government sector involving projections of expenditures and revenues in 1970 of State and local governments for each of the 50 States and the District of Columbia. The projections were made on the basis of a set of economic and demographic assumptions generated by a macroeconomic growth model, chosen from several developed for the Federal Interagency Study of Economic Growth and Employment Opportunities. For 1970, this study projects State and local government capital outlays at $30 billion.[26] This compares with the $31.6 billion of public facility capital requirements for 1970 estimated in this volume for State and local public agencies.

3. *Appraisal*

A priori, one might expect that estimates of public facility capital requirements based on separate assessment of over 50 [27] different categories of need would result in figures considerably larger than projections of past trends. As noted above, the aggregate of the separate estimates by functional category of public facilities (that

[25] Leonard A. Lecht, *Goals, Priorities and Dollars* (New York: The Free Press, 1966.)

[26] S. Mushkin and G. Lupo, *State and Local Government Capital Outlays: Projections to 1970* (note, dated August 1966). Detailed projections are presented in S. Mushkin and E. McLoone, *Public Spending for Higher Education in 1970* (The Council of State Governments, Research Memorandum 374); S. Mushkin and R. Harris, *Transportation Outlays of States and Cities: 1970 Projections* (RM 375); S. Mushkin and E. McLoone, *Local School Expenditures: 1970 Projections* (RM 382); R. Rafuse, Jr., *Water-Supply and Sanitation Expenditures of State and Local Governments: Projections to 1970* (RM 389); and S. Mushkin, *Health and Hospital Expenditures in State and Local Governments: 1970 Projections* (RM 390).

[27] In some of the chapters there were several parts, each of which contained a separate estimate of capital requirements.

are presented in the chapters in this volume) are in line with projected capital outlays reflecting certain "aspiration standards"; and the public agency component of public facility capital requirements in 1970 are close to those projected on the basis of a survey of 50 States.

Moreover, the aggregate 1970 and 1975 estimates for public agencies are in line with the capital outlays projected in the growth models of GNP on the basis of past trends. (The latter are presented in the first chapter.) The GNP growth models project corresponding rises in State and local taxes from Federal financial assistance and from other resources. Consequently, it would appear that the State and local government portion of estimated public facility needs would not require any major alteration of State and local government fiscal resources.

Such a conclusion would appear to be at odds with predictions that growing demands on State and local governments for public services will require some reallocation of fiscal resources. Consequently, one must consider the possibility that (*a*) our estimates of public facility requirements are too conservative or (*b*) that the availability of future fiscal resources of State and local governments may be underestimated by those who suggest reallocation of resources, or (*c*) that public facility capital expenditures is only one element in a growing pattern of required public services, and that services, rather than facilities, will make the biggest demands in the future.

(*a*) It is conceivable that many of the chapter authors preferred to employ conservative judgments, especially since they were asked to state their underlying assumptions. Moreover, while backlogs of current unmet needs can be reasonably described, future needs may be more difficult to perceive, since the economic horizon of many analysts tends to be appreciably shorter than the 10-year period called for in the study. These factors, coupled with the arbitrary allocations among ownership patterns made in this study (when they were not provided in the particular chapters) may have contributed to a downward bias in the capital requirements estimates. But if this is so, it would have to be assumed that there were similar "downward biases" in the estimates made in the aforementioned NPA and "Project 70" studies, which would be a striking coincidence.

(*b*) Recent experience with Federal tax revenues has found that actual receipts exceed estimated revenues by considerable amounts. To some extent this underestimation may be due to lack of familiarity with the fiscal aspects of the "New Economics"; and to some extent it may be due to conservative methods of tax revenue estimation. The GNP growth model projections assume a continuation of the accelerated growth of the economy experienced during the past 5½ years, which suggests that our State and local tax resources will grow faster than the rate our "conventional wisdom" would cause us to expect.

(*c*) The present study is concerned with the Nation's public facility capital plant and its prospective growth. Hitherto, capital outlays have accounted for about one-fourth of State and local government expenditures. Most of the remaining State and local government expenditures represent outlays for public services. While a large part of these public services involve utilization of public facilities, it does not necessarily follow that future capital requirements for public facilities fully measure public service needs and possible expenditures.

It may be that an increasing proportion of public funds should be spent on health and educational services, welfare payments, public safety, transportation, recreational and cultural services, manpower training, and the entire range of other activities that have been, or are likely to be, supported by Federal aid under the Economic Opportunity Act or the model cities legislation. Many more nurses, hospital attendants, health, transportation, and utility technicians and operating staff, or park and recreation supervisors, may be needed than the additional personnel called for by the expansion of the public facilities capital plant. Or it may be that public expenditures for such purposes should not be proportionately increased, but rather the additional fiscal resources required at the Federal, State, and local government levels should instead be decreased through tax reductions (if there are fiscal surpluses) or deferment of tax increases (if there are to be fiscal deficits).

It remains to be seen which of the foregoing explanations, or the estimates themselves, accurately describe what is likely to occur during the next decade. Be that as it may, it is hoped that the study presented in this volume provides sufficient data on an often neglected sector to aid those who are responsible for making the economic decisions that will largely shape the future course of the American economy.

Supplementary and supporting data are set forth on the following pages.

Supplementary Data

PUBLIC FACILITY NEEDS

Chapter Outline*

A. NATURE AND COMPOSITION OF PUBLIC WORK OR FACILITY

1. Describe the particular public work or facility in terms of:
   (*a*) General physical characteristics—structures and equipment.
   (*b*) Services rendered—to residential areas, commercial areas, industrial areas, agricultural areas.
   (*c*) Standards of performance—capacity or quantity of output per capita or equivalent concept, e.g., per capita water consumption, schoolroom facilities per capita, hospital space or library space per capita.
   (*d*) Qualitative standards of performance, e.g., primary, secondary, tertiary treatment of sewage, levels of quality of road surfacing, traffic densities, and speed, durability of structures and equipment, frequency of repairs, ordinary replacement cycle.
2. Existing capital plant in the United States:
   (*a*) As of mid-1965, how many of these facilities or structures were in existence or operation?
   (*b*) What was the distribution of such facilities or structures by States?
   (*c*) What was the distribution of such facilities or structures by population size of city—500,000 or more; 100,000 to 499,999; 50,000 to 99,999; 10,000 to 49,999; 2,500 to 9,999; and under 2,500?
   (*d*) What is the age distribution of such facilities or structures, i.e., built (1) before 1900, (2) during 1901–20, (3) 1921–40, (4) 1941–60, (5) since 1961?
   (*e*) Of these facilities and structures now in operation, what proportion is owned by:
      (1) State governments or State agencies;
      (2) Cities, counties, towns, special districts, public authorities, or other local public bodies;
      (3) Private, nonprofit organizations, and cooperatives;
      (4) Proprietary or profitmaking organizations;
      (5) Federal Government, if appropriate.
   (*f*) What is the estimated current value (as of end of 1965) of these facilities and structures?

B. COSTS AND USER CHARGES

1. Construction costs and operating costs:
   (*a*) On the basis of some standard unit of measure (cost per square foot, cost per mile, cost per connection, etc.), indicate the current (as of 1965) range of typical construction costs for different size facilities or structures of longtime durability;
   (*b*) On the same basis, indicate the current range of typical annual maintenance and operation expenses (includes repairs and replacements) for different size facilities or structures.
2. User Charges:
   (*a*) To what extent are user charges (utility charges, tolls, fees, admissions, lease payments, rentals, assessments, or specific taxes) employed to pay for all or part of the services, occupancy or use of the facilities or structures?
   (*b*) To what extent are such user charges sufficient to cover annual maintenance and operation expenses plus annual debt service payments on the indebtedness incurred to finance the capital costs of the facilities or structures? Are there situations where user charges exceed the sum of prorated operating and capital costs?

*To be followed to the extent feasible.

(c) To what extent are the costs of such facilities and structures met out of the general tax resources and general obligation borrowings of State and local government units?

C. TREND OF CAPITAL OUTLAYS

1. What has been the trend of annual capital outlays (expenditures, construction put in place, or contract awards) for these facilities or structures during the 20-year period 1946–65 in terms of number of units and dollar value (in millions of dollars)? Explain the trend.

2. Of these annual capital outlays, how much or what proportions were accounted for by (A) State governments or State agencies, (B) cities, counties, towns, special districts, public authorities, or other local public bodies, (C) private, nonprofit organizations and cooperatives, (D) proprietary or profitmaking organizations, and (E) Federal Government, if appropriate?

3. What have been the sources of financing for these capital outlays (show dollar amounts or percentage distribution)? From:

(a) Appropriations from tax resources;
(b) Gifts, bequests, donations, fund-raising drives;
(c) Federal Government grant assistance (identify programs);
(d) State grants-in-aid (in how many States);
(e) Tax exempt municipal bond market (for public bodies);
(f) Capital flotations in other security markets (for private corporations and private, nonprofit organizations);
(g) Borrowing from the Federal Government.

D. NEEDS AND PROSPECTIVE CAPITAL OUTLAYS

1. In terms of the Great Society, what are the capital requirements (in millions of dollars) for these facilities or structures during the decade 1966–75?

(a) Describe the factors taken into account in making this projection (current backlog of unmet needs, accommodating expected population growth, replacing obsolete facilities, quantitative and qualitative standards of performance).

(b) If possible, show these estimated capital needs on a per year basis.

(c) To the extent feasible, indicate the proportions of these estimated needs that you would ascribe to (1) cities with populations of 50,000 or more, (2) cities and towns with populations of 2,500 to 50,000, and (3) agricultural-rural areas, cities and towns with populations under 2,500.

(d) To the extent feasible, indicate the proportions of these estimated capital outlays that you would expect to be expended by:

1. State governments or State agencies;
2. Cities, counties, towns, special districts, public authorities, or other local public bodies;
3. Private, nonprofit organizations and cooperatives;
4. Proprietary or profitmaking organizations;
5. Federal Government, if appropriate.

2. On the basis of past experiences, projected trends and emerging developments, what are the expected sources of financing for these prospective capital outlays (in millions of dollars or percentage distribution)? From:

(a) Borrowing in the tax-exempt municipal bond market (for public bodies);
(b) Capital flotations in other security markets (for private corporations and nonprofit organizations);
(c) Borrowing from the Federal Government;
(d) Federal Government grant assistance (existing or new programs);
(e) State grants-in-aid (existing or new programs);
(f) Appropriations from tax resources;
(g) Gifts, bequests, donations, fund-raising drives.

3. If your estimated capital requirements exceed the amounts you estimate will be supplied by the above identified sources of funds, how would you bridge the gap?

Basic assumptions for State and local public facility needs and financing study

Factor	Actual 1961–65 (percent)	Assumed 1966–75 (percent)
A. Annual rates of increase:		
1. Population	1. 5	1. 5
2. Gross national product	5. 9	5. 5
3. Personal income	5. 6	5. 2
4. Gross private domestic fixed investment	4. 9	4. 5
5. Employed civilian labor force	1. 6	1. 9
6. Gross national product deflator	1. 5	1. 5
7. Wholesale price index	. 8	—. 5
8. Boeckh construction cost index	2. 5	2. 0
9. Index of industrial production	5. 6	5. 0
10. Money supply	3. 3	3. 0
11. Selected liquid assets held by public	7. 2	6. 5
B. Annual rates of:		
12. Civilian unemployment	5. 6	4. 0
13. Savings as a percent of disposable income	5. 6	5. 5
C. Other parameters:		
14. Capacity utilization of industry	85. 6	90. 0
15. Average Federal budgetary deficit:		
National income budget (billion)	—$2. 4	0
Cash budget (billion)	—$4. 1	0

TABLE 1.—*Comparisons of total capital outlays for public facilities in 1965 with estimated capital requirements during 1966–75, all spending units*

[Dollars in millions]

Chapter number and type of facility	Actual 1965	Estimated		
		1970	1975	1966–75
A. BASIC COMMUNITY FACILITIES				
1. Regional and river basin water supply systems [1]	$67	$100	$110	$1,060
2. Public water supply systems	1,300	2,380	2,810	24,300
3. Rural-agriculture water supply systems	(2)	[3] 260	[3] 350	2,750
4. Sanitary sewer collection systems	513	930	1,450	10,340
5. Storm sewer systems	1,140	2,450	2,850	25,000
6. Water waste treatment plants	625	[3] 940	[3] 1,240	9,830
7. Solid wastes collection and disposal facilities	170	[3] 280	[3] 360	[4] 2,890
Subtotal, water and sewer facilities	3,815	7,340	9,170	76,170
8. Electric power	5,700	7,800	9,000	75,000
9. Gas distribution systems	809	990	1,200	[5] 9,930
Subtotal, other utilities	6,509	8,790	10,200	84,930
B. TRANSPORTATION FACILITIES				
10. Highways, roads, and streets	8,170	[3] 12,060	[3] 15,830	[6] 125,650
11. Toll bridges, tunnels and turnpikes [7]	[8] 388	[3] 380	[3] 500	[9] 4,000
12. Offstreet parking facilities	(2)	[3] 760	[3] 1,000	7,900
13. Urban mass transit facilities	(2)	1,050	1,370	10,900
14. Airport facilities [10]	313	580	630	5,970
15. Marine port facilities	[11] 160	130	150	1,280
Subtotal, transportation	8,643	14,580	18,980	151,00
C. EDUCATIONAL FACILITIES				
16. Public elementary and secondary schools	[12] 3,650	[3] 4,010	[3] 5,270	41,800
17. Nonpublic elementary and secondary schools	[13] 260	[3] 570	[3] 750	[14] 5,960
18. Area vocational school facilities [15]	(2)	[3] 600	[3] 790	[15] 6,300
19. Academic facilities for higher education	[12] 1,525	[3] 2,250	[3] 2,960	23,500
20. College housing and related service facilities	[16] 483	930	1,220	10,620
21. Educational television	[17] 8	30	40	350
Subtotal, educational facilities	5,926	7,790	10,240	82,380
D. HEALTH FACILITIES				
22. General hospital facilities	[18] 1,926	[3] 1,510	[3] 1,980	15,710
23. Clinics and other outpatient facilities		[3] 310	[3] 410	3,240
24. Long-term care facilities		[3] 600	[3] 780	6,230
25. Community mental health centers		280	450	2,930
26. Facilities for the mentally retarded [19]	(2)	330	400	3,340
27. Health research facilities [20]	(2)	[3] 460	[3] 600	4,800
28. Medical and other health schools	(2)	[3] 690	[3] 910	[21] 7,210
Subtotal, health facilities	(2)	4,180	5,530	43,460
E. RECREATION AND CULTURAL FACILITIES				
29. State and Federal outdoor recreation facilities	743	1,190	1,420	11,800
30. Urban local outdoor recreation facilities	[22] 360	[3] 1,700	[3] 2,200	17,600
31. Rural outdoor recreational facilities	(2)	[3] 460	[3] 600	[23] 4,800
32. Neighborhood centers for recreation, etc	43	[3] 80	[3] 100	780
33. Arenas, auditoriums, exhibition halls	667	[3] 770	[3] 1,010	8,000
34. Theaters and community art centers [24]	(2)	700	910	7,230
35. Museums	25	[3] 90	[3] 120	950
36. Public libraries	103	190	240	1,910
Subtotal, recreation and cultural	1,941	5,180	6,600	53,070
F. OTHER PUBLIC BUILDINGS				
37. Residential group care facilities for children [25]	(2)	[3] 80	[3] 110	840
38. Armories	1	15	15	145
39. Jails and prisons	(2)	[3] 90	[3] 120	920
40. Fire stations	[26] 191	[3] 130	[3] 170	1,370
41. Public office and court buildings	[27] 218	320	400	3,250
42. Publicly owned industrial plants	214			
Subtotal, other public buildings	410	635	815	6,525

[1] Combined figures for water supply capital outlays by Corps of Engineers, Bureau of Reclamation, and Soil Conservation Service.
[2] Not available.
[3] Annual figures derived from 10-year estimated capital requirements.
[4] $2,420,000,000 in constant prices, adjusted to current prices at assumed price increase at rate of 2 percent per year.
[5] Annual rate of increase interpolated during 1971–73 at 3.8 percent per year.
[6] Capital requirements, rather than capital outlays, per chapter table G.
[7] Shown separately, although included in "Highways, roads and streets"; however, excluded from subtotal for "Transportation."
[8] Annual average for years 1946–65.
[9] $2,282,000,000 reported in survey; expanded to $4,000,000,000 on the basis of other materials in the chapter.
[10] All figures estimated at 120 percent of figures for publicly owned facilities.
[11] Average during 1960–62.
[12] Average of estimates for fiscal years 1965 and 1966.
[13] Average 1960–66.
[14] 149,000 classrooms at $40,000 per classroom.
[15] Shown separately, although included in "Public elementary and secondary schools and academic facilities for higher education"; however, excluded from subtotal for "Education."
[16] For 1963–64.
[17] 15 stations at $540,000 each.
[18] Includes general and mental hospitals, clinics, nursing homes, related facilities.
[19] Combination of community facilities and university affiliated facilities for the mentally retarded.
[20] Some of these capital requirements are probably included within the figures shown for "Academic facilities for higher education and hospitals"; but degree of overlap is not ascertainable.
[21] Broken down as follows (in millions of dollars): (a) medical schools, $4,259; (b) dental schools, $590; (c) schools of nursing, $1,641; (d) optometry schools, $58; (e) osteopathic schools, $191; (f) pharmacy schools, $307; (g) podiatry schools, $48; and (h) public health schools, $112. To some extent, these capital requirements overlap with the capital requirements for higher education academic facilities, but the proportion is unknown.
[22] For fiscal year 1964–65.
[23] Average of high-level estimate of $5,300,000,000 and low-level estimate of $4,200,000,000.
[24] Based on discussion with informed sources.
[25] Data on detention homes and institutions for delinquent children in the chapter. Data on other child welfare institutions obtained from Children's Bureau, as follows: Maternity homes, $17,000,000, homes for neglected and disburbed children, $264,000,000.
[26] For 1966.
[27] For 1964. May include in part "police stations."

TABLE 2.—*Comparison of public facility capital outlays of State and local public agencies in 1965 with estimated capital requirements during 1966–75*

[Dollars in millions]

Chapter number and type of facility	Actual 1965 [1]	Estimated		
		1970	1975	1966–75
A. BASIC COMMUNITY FACILITIES				
1. Regional and river basin water supply systems [2]	$2	$20	$30	$170
2. Public water supply systems [3]	1,040	1,900	2,250	19,440
3. Rural-agriculture water supply systems [4]	(5)	110	140	1,100
4. Sanitary sewer collection systems	385	[4] 700	[4] 1,090	[4] 7,750
5. Storm sewer systems	417	[6] 1,570	[6] 1,820	[6] 16,000
6. Water waste treatment plants	625	940	1,240	9,830
7. Solid wastes collection and disposal facilities [7]	130	210	270	2,170
Subtotal, water and sewer facilities	2,599	5,450	6,840	56,460
8. Electric power [8]	[1] 766	1,200	1,350	12,250
9. Gas distribution systems [9]	44	60	70	550
Subtotal, other utilities	810	1,260	1,420	12,800
B. TRANSPORTATION FACILITIES				
10. Highways, roads, and streets	8,170	12,060	15,830	125,650
11. Toll bridges, tunnels, and turnpikes [10]	388	380	500	4,000
12. Offstreet parking facilities	[11] 102	230	300	2,400
13. Urban mass transit facilities	[1] 242	730	960	[12] 7,600
14. Airport facilities	261	480	530	4,980
15. Marine port facilities	[1] 159	[13] 40	[13] 50	430
Subtotal, transportation	8,934	13,540	17,670	141,060
C. EDUCATION FACILITIES				
16. Public elementary and secondary schools	3,650	4,010	5,270	41,800
17. Nonpublic elementary and secondary schools				
18. Area vocational school facilities [14]	(5)	600	790	6,300
19. Academic facilities for higher education	915	1,330	1,750	13,870
20. College housing and related service facilities	[15] 301	520	720	6,080
21. Educational television [16]	5	20	30	230
Subtotal, education facilities	4,871	5,880	7,770	61,980

See footnotes at end of table, p. 25.

TABLE 2.—*Comparison of public facility capital outlays of State and local public agencies in 1965 with estimated capital requirements during 1966–75*—Con.

Chapter number and type of facility	Actual 1965	Estimated		
		1970	1975	1966–75
D. HEALTH FACILITIES				
22. Hospitals	[1] $494	[17] $380	[17] $480	[17] $3,930
23. Clinics and other outpatient facilities [18]		[18] 80	[18] 100	[18] 810
24. Long-term care facilities [19]		[19] 100	[19] 130	[19] 1,060
25. Community mental health centers [20]		140	220	1,470
26. Facilities for the mentally retarded	34	[21] 110	[21] 130	[21] 1,070
27. Health research facilities [22]	([5])	180	240	1,920
28. Medical and other health schools [23]	([5])	280	360	2,880
Subtotal, health facilities	528	1,270	1,660	13,140
E. RECREATIONAL AND CULTURAL FACILITIES				
29. State and Federal outdoor recreation facilities	313	430	530	4,400
30. Urban local outdoor recreation facilities	360	1,700	2,200	17,600
31. Rural outdoor recreational facilities				
32. Neighborhood centers for recreation, etc.				
33. Arenas, auditoriums, exhibition halls [24]	600	690	910	7,200
34. Theaters and community art centers [25]	([5])	350	460	3,620
35. Museums	14	[26] 30	[26] 40	[26] 270
36. Public libraries	103	190	240	1,910
Subtotal, recreation and cultural	1,390	3,390	4,380	35,000
F. OTHER PUBLIC BUILDINGS				
37. Residential group care facilities for children [27]	([5])	[28] 50	[28] 70	560
38. Armories	1	15	15	150
39. Jails and prisons	([5])	90	120	920
40. Fire stations	191	130	170	1,370
41. Public office and court buildings	218	320	400	3,250
42. Publicly owned industrial plants	214	([5])	([5])	([5])
Subtotal, other public buildings	410	605	775	6,250

[1] Where data supplied in chapter seemed unrealistic, capital outlay figures for 1964–65, as reported by the Bureau of the Census, have been used.
[2] For capital outlays financed by Soil Conservation Service; in the case of the Corps of Engineers and Bureau of Reclamation projects, the capital outlays are made by the Federal Government.
[3] 80 percent of estimated capital requirements, per chapter.
[4] Assumed to be 40 percent of estimated total capital requirements, per 1959 Census of Agriculture.
[5] Not available.
[6] 64 percent of estimated total capital requirements, per chapter.
[7] 75 percent of estimated total capital requirements, per 1965 experience.
[8] Municipal plus one-half of "State, cooperative and other."
[9] 5.5 percent of estimated total capital requirements (or 1965 outlays).
[10] Shown separately, although included in "Highways, roads and streets;" however, excluded from "Subtotal for transportation."
[11] Capital outlay in 1964.
[12] Assumed to be 70 percent of estimated total capital requirements, based on informed judgment.
[13] Calculated at 33.6 percent of estimated total capital requirements, per chapter.
[14] Shown separately, although included in "Public elementary and secondary schools" and "Academic facilities for higher education"; however, excluded from "Subtotal for education."
[15] Capital outlay in 1964.
[16] Calculated at 66 percent of estimated total capital requirements, per chapter.
[17] Assumed to be 25 percent of estimated total capital requirements, per 1965 distribution of construction put in place, net of direct Federal construction.
[18] Assumed to be 25 percent of estimated total capital requirements, based on 1964 distribution of ownership of organized outpatient departments, emergency departments and rehabilitation facilities (last, 1963 data).
[19] Assumed to be 17 percent of estimated total capital requirements, based on distribution of ownership of nursing home beds in 1964.
[20] Calculated at 50 percent of estimated total capital requirements, per chapter.
[21] Assumed to be 30 percent of estimated total capital requirements for community centers, based on distribution of ownership of existing mental retardation facilities according to State plans of 46 States; assumed to be 50 percent of total requirements for university affiliated facilities.
[22] Calculated at 40 percent of estimated total capital requirements, per chapter.
[23] Assumed to be 40 percent of estimated total capital requirements, "best judgment."
[24] Calculated at 90 percent of estimated total capital requirements, per chapter.
[25] Assumed to be 50 percent of estimated total capital requirements, "best judgment."
[26] Calculated at 28 percent of estimated total capital requirements, per chapter.
[27] In addition to data in chapter, Children's Bureau estimates—homes for neglected and disturbed children—$40,000,000.
[28] Calculated at 9.6 and 12.6 percent of $520,000,000.

TABLE 3.—*Comparison of public facility capital outlays of private, nonprofit organizations in 1965 with estimated capital requirements during 1966–75*

[Dollars in millions]

Chapter number and type of facility	Actual 1965	Estimated		
		1970	1975	1966–75
3. Rural-agricultural water supply systems [1]	(2)	$130	$170	$1,370
8. Electric power [3]	$300	300	350	3,150
17. Nonpublic elementary and secondary schools	260	570	750	5,960
19. Academic facilities for higher education [4]	625	930	1,210	9,630
20. College housing and related service facilities	[5] 182	400	500	4,540
21. Educational television [6]	3	10	20	120
22. Hospitals [7]	[8] 410	1,070	1,360	11,190
23. Clinics and other outpatient facilities [9]		190	250	1,940
24. Long-term care facilities [10]		80	110	870
25. Community mental health centers [11]		140	220	1,470
26. Facilities for the mentally retarded [12]	(2)	170	200	1,670
27. Health research facilities [13]	(2)	230	300	2,400
28. Medical and other health schools [14]	(2)	420	550	4,330
31. Rural outdoor recreational facilities [15]	(2)	90	120	960
32. Neighborhood centers for recreation	43	80	100	780
33. Arenas, auditoriums, exhibition halls [16]	(2)	10	10	80
34. Theaters and community art centers [17]	(2)	210	280	2,160
35. Museums	10	[18] 60	[18] 80	[18] 620
37. Residential group care facilities for children	(2)	30	40	[19] 280
Subtotal	(2)	5,120	6,620	53,520

[1] 50 percent of estimated capital requirements, per 1959 Census of Agriculture.
[2] Not available.
[3] One-half of "States, cooperatives and other."
[4] Calculated at 41 percent of estimated total capital requirements.
[5] In 1963–64.
[6] Calculated at 34 percent of estimated total capital requirements.
[7] Assumed to be 95 percent of estimated capital requirements for privately owned hospitals, per ownership of hospital beds in 1964.
[8] Includes general and mental hospitals, clinics, nursing homes, related facilities; construction put in place data.
[9] Assumed to be 60 percent of estimated total capital requirements, based on 1964 distribution of ownership of organized outpatient departments, emergency departments and rehabilitation facilities (last, 1963 data).
[10] Assumed to be 14 percent of estimated total capital requirements, based on distribution of nursing home beds in 1964.
[11] Calculated at 50 percent of estimated total capital requirements, per chapter.
[12] Assumed to be 50 percent of estimated total capital requirements, based on distribution of ownership of existing mental retardation facilities.
[13] Calculated at 50 percent of estimated total capital requirements, per chapter.
[14] Assumed to be 60 percent of estimated total capital requirements, "best judgment."
[15] Calculated at 20 percent of estimated total capital requirements, per ownership distribution in chapter.
[16] Calculated at 1 percent of estimated total capital requirements, per chapter.
[17] Assumed to be 60 percent of estimated capital requirements for privately owned facilities (theaters and community art centers).
[18] Calculated at 75 percent of estimated capital requirements for museums, per chapter.
[19] Includes $17 million for maternity homes and $224 million for homes for neglected and disturbed children.

TABLE 4.—*Comparison of public facility capital outlays of private investor-owned companies in 1965 with estimated capital requirements during 1966–75*

[Dollars in millions]

Chapter number and type of facility	Actual 1965	Estimated		
		1970	1975	1966–75
2. Public water supply systems [1]	$260	$480	$560	$4,860
3. Rural-agricultural water supply systems [2]	([3])	6	10	80
4. Sanitary sewer collection systems [4]	128	230	360	2,580
5. Storm sewer systems [5]	720	880	1,030	9,000
7. Solid wastes collection and disposal facilities [6]	40	70	90	720
8. Electric power	4,100	5,500	6,300	[7] 56,000
9. Gas distribution systems [8]	770	940	1,130	9,380
12. Offstreet parking facilities	([3])	[9] 530	[9] 690	5,500
13. Urban mass transit facilities [10]	([3])	320	410	3,300
14. Airport facilities [11]	50	100	110	990
15. Marine port facilities [12]	100	80	90	820
22. Hospitals [13]	([3])	60	70	590
23. Clinics andjother outpatient facilities [14]	([3])	30	40	320
24. Long-term care facilities [15]	([3])	410	540	4,300
26. Facilities for the mentally retarded [16]	([3])	60	70	600
31. Rural outdoor recreational facilities [17]	([3])	370	480	3,840
33. Arenas, auditoriums, exhibition halls [18]	50	70	90	720
34. Theaters and community art centers [19]	([3])	140	180	1,450
35. Museums [20]	([3])	5	6	50
Total	([3])	10,281	12,256	105,100

[1] Calculated at 20 percent of estimated total capital requirements, per chapter.
[2] Assumed to be 3 percent of estimated total capital requirements, per 1959 Census of Agriculture.
[3] Not available.
[4] Assumed to be 25 percent of estimated total capital requirements, per 1965 experience.
[5] Calculated at 36 percent of estimated total capital requirements, per chapter.
[6] Calculated at 25 percent of estimated total capital requirements, per chapter.
[7] Estimated on basis of data furnished for 1966, 1970, and 1975.
[8] Calculated at 94.5 percent of estimated total capital requirements, per chapter.
[9] Calculated at 9.6 and 12.6 percent, respectively, of estimated requirements for 1966–75.
[10] Assumed to be 30 percent of estimated total capital requirements, based on informed judgment.
[11] Calculated at 20 percent of estimated capital requirements for State and local public agencies, per chapter.
[12] Calculated at 64 percent of estimated total capital requirements, per chapter.
[13] Assumed to be 5 percent of estimated capital requirements for private institutions, per 1964 distribution of hospital beds in 1964.
[14] Assumed to be 10 percent of estimated total capital requirements, based on 1964 distribution of ownership of organized outpatient departments, emergency departments and rehabilitation facilities (last, 1963 data).
[15] Assumed to be 69 percent of estimated total capital requirements, based on distribution of ownership of nursing home beds in 1964.
[16] Assumed to be 20 percent of estimated total capital requirements for community centers, based on ownership distribution of existing facilities.
[17] Assumed to be 80 percent of estimated total capital requirements, per ownership distribution of existing facilities.
[18] Calculated at 9 percent of estimated total capital requirements, per chapter.
[19] Assumed to be 40 percent of estimated capital requirements for privately owned facilities.
[20] Calculated at 5 percent of estimated total capital requirements, per chapter.

TABLE 5.—*Existing capital plant of State and local public facilities as of 1965*

Chapter number and type of facility	Unit of measure (number of)	Number of units				Total estimated value (billions)
		Total (all owners)	State and local public agencies	Nonprofit organizations	Private investor owned	
A. BASIC COMMUNITY FACILITIES						
1. Regional and river basin water supply systems	Projects	129				$0.3
2. Public water supply systems [1]	Systems	19,236	13,468		5,501	47.0
3. Rural-agricultural water supply systems [2]	Acreage	17,701	7,038	8,800	573	(11)
4. Sanitary sewer collection systems [3]	Systems	11,655	11,655			8.5
5. Storm sewer systems	Square miles [4]	14,000	14,000			22.0
6. Water waste treatment plants [1]	Plants	9,378	9,378			3.6
7. Solid wastes collection and disposal facilities [5]	Incinerators	[5] 314	311		3	[6] .8
8. Electric power	Billions kilowatt-hours	1,055	75	25	810	[7] 82.0
9. Gas distribution systems [8]	Systems	1,501	773		728	[9] 15.8
B. TRANSPORTATION FACILITIES						
10. Highways, roads, and streets	Millions of miles	3,644	3,644			[9] 63.0
11. Toll bridges, tunnels, and turnpikes	Units	[10] 261	261			9.2
12. Offstreet parking facilities	Lots or structures	(11)	[12] 3,861		[13] 11,269	(11)
13. Urban mass transit facilities	Transit companies	1,152	77		1,075	[9] 4.1
14. Airport facilities	Airports	9,547	3,556		5,988	6.0
15. Marine port facilities	Port facilities	2,121	713	6	1,359	3.4
C. EDUCATION FACILITIES						
16. Public elementary and secondary schools	Classrooms (thousands)	1,550	1,550			58.0
17. Nonpublic elementary and secondary schools	do	227		227		5.7
18. Area vocational school facilities	Institutions	613	613			.3
19. Academic facilities for higher education	Institutions [14]	2,077	744	1,333		11.1
20. College housing and related service facilities	Housing spaces [15]	1,766	977	789		[16] 10.5
21. Educational television	Stations	114	75	39		.1
D. HEALTH FACILITIES						
22. Hospitals (general and T.B.)	Beds (thousands) [16]	936	259	501	62	18.4
23. Clinics and other outpatient facilities	Centers	[17] 12,669	(11 18)	(11 18)	(11 18)	(11)
24. Long-term care facilities	Beds (thousands)	[19] 625	(11 20)	(11 20)	(11 20)	1.5
25. Community mental health centers	do	[21] 550	513	37		(11)
26. Facilities for the mentally retarded	Facilities	2,571	641	1,202	460	(11)
27. Health research facilities	do	760	352	408		.5
28. Medical and other health schools	Institutions	[22] 1,361	468	893		(11)

E. RECREATION AND CULTURAL FACILITIES							
29. State and Federal outdoor recreation facilities	Areas	[23] 20,822	19,076			(11)	
30. Urban local outdoor recreation facilities	Park acres (thousands)	[24] 1,730	1,730				23.6
31. Rural outdoor recreational facilities	Enterprises (thousands)	[25] 132		[26] 25	107	(11)	
32. Neighborhood centers for recreation, etc	Structures	[27] 8,564		8,564		(11)	
33. Arenas, auditoriums, exhibition halls	Buildings	1,200	1,000		200		2.5
34. Theaters and community art centers	Theaters	[28] 440	(11)	(11)	(11)	(11)	
35. Museums	Institutions	4,595	1,424	2,619	230		.5
36. Public libraries	Agencies	[29] 7,257	7,257				1.3
F. OTHER PUBLIC BUILDINGS							
37. Residential group care facilities for children	Institutions	[30] 2,141	627	1,500	14		2.3
38. Armories	Facilities	2,786	2,786			(11)	
39. Jails and prisons	Institutions	[31] 3,369	3,369			(11)	
40. Fire stations	Stations	25,600	24,450	1,150			3.0
41. Public office and court buildings	Structures	24,860	24,860				7.0
42. Publicly owned industrial plants [32]	Plants	526	526				.8

[1] As of 1963.
[2] As of 1959.
[3] As of 1962, municipally owned only.
[4] Square miles of improvement.
[5] In 1965 there were an estimated 280 to 345 public incinerators, 1,000 to 1,250 sanitary land-fills and 17,500 to 21,300 open dumps.
[6] Estimated value of incinerators, land-fills, open dumps, collection vehicles, storage, and maintenance facilities.
[7] According to Federal Power Commission.
[8] Of the 603,410 miles of gas distribution and integrated company pipeline, 564,580 miles, or 94 percent, are operated by investor owned utilities and 38,830 miles by municipal owned utilities.
[9] As of 1964.
[10] Consisting of 58 turnpikes, 193 toll bridges and 10 toll tunnels.
[11] Not available.
[12] City owned parking lots in 1960.
[13] Privately owned parking lots and structures in 1963.
[14] As of 1963; in 1957 the assignable areas of higher education institutions for instruction, research, and general activities totaled 276.8 million square feet, of which 163.8 million were for public institutions and 113 million for were private institutions.
[15] Consisting of 1,689,000 dormitory spaces (917,000 for public institutions and 772,000 for private institutions) and 77,000 married student apartments (60,000 for public institutions and 17,000 for private institutions).
[16] General and tuberculosis hospital beds; located in 7,586 hospitals of which 437 are Federal, 2,033 are State or local government, 3,569 are private, nonprofit, and 1,547 are proprietary.
[17] Data as of 1964–65; includes 2,950 hospitals with organized outpatient departments, 2,244 public health centers, 4,513 diagnostic or treatment centers, 1,339 rehabilitation centers and 1,623 (1959 data) medical groups.
[18] Of 2,950 hospitals with organized outpatient departments, 812 are State or local government, 1,425 nonprofit, 304 proprietary and 409 Federal Government.
[19] Includes about 550,000 beds in skilled nursing homes and 75,000 beds in chronic disease hospitals or units.
[20] A 1964 survey of nursing home beds found 69 percent owned by proprietary groups, 14 percent by nonprofit organizations and 17 percent by public bodies.
[21] Beds in existing mental hospitlas (500,000 in State hospitals, 25,000 in private, nonprofit hospitals and remaining 25,000 in general hospitals distributed equally between public and private hospitals).
[22] Consists of (number of schools): 88 medical, 49 dental, 1,118 nursing, 10 optometry, 5 osteopathic, 75 pharmacy, 5 podiatry, and 13 public health.
[23] 20,822 areas with 312,300,000 acres, of which 19,076 are State areas with 35,400,000 acres, and 1,746 Federal areas with 277,000,000 acres. In Federal or State recreational areas there are 307,810 picnic tables, 18,164 acres of swimming beach, 17,985 acres of boat access, 31,988 acres of ski slopes, 204,310 tent and trailer camping spaces and 34,899 acres of golf courses.
[24] Selected special facilities include 20,932 playgrounds, 4,978 recreation buildings, 4,013 skating rinks, 3,181 swimming pools and 16,616 tennis courts.
[25] Includes swimming, hunting, land based, water based, golf, fishing, playfield, picnicking, cabins, cottages, and related facilities.
[26] 19 percent of total; balance investor owned.
[27] Excluding camps.
[28] Includes 35 Broadway, 35 off-Broadway (but in New York City), 155 used for national tours, 35 resident professional, 150 summer, and 30 musical; excludes community theaters (that may be as many as 40,000), college and university theaters (about 1,500) and community art centers.
[29] As of 1962.
[30] Consists of 281 detention homes, 280 institutions for juvenile delinquents, and 1,580 child welfare institutions.
[31] Consists of 3,050 jails and 279 adult felony institutions.
[32] Measured by number and dollar amount of bond issues during 1956–65.

TABLE 6.—*User charges for State and local public facilities*

Chapter number and type of facility	User charges		
	None	Moderate [1]	Substantial [2]
A. BASIC COMMUNITY FACILITIES			
1. Regional and river basin water supply systems			X
2. Public water supply systems			X
3. Rural-agricultural water supply systems			X
4. Sanitary sewer collection systems			X
5. Storm sewer systems		X	
6. Water waste treatment plants			X
7. Solid wastes collection and disposal facilities		X	
8. Electric power			X
9. Gas distribution systems			X
B. TRANSPORTATION FACILITIES			
10. Highways, roads, and streets			X
11. Toll bridges, tunnels, and turnpikes			X
12. Offstreet parking facilities			X
13. Urban mass transit facilities			X
14. Airport facilities			X
15. Marine port facilities			X
C. EDUCATION FACILITIES			
16. Public elementary and secondary schools	X		X
17. Nonpublic elementary and secondary schools			
18. Area vocational school facilities	X		
19. Academic facilities for higher education		X	X
20. College housing and related service facilities			
21. Educational television		X	
D. HEALTH FACILITIES			
22. Hospitals			X
23. Clinics and other outpatient facilities			X
24. Long-term care facilities			X
25. Community mental health centers		X	
26. Facilities for the mentally retarded			X
27. Health research facilities	X		
28. Medical and other health schools		X	
E. RECREATION AND CULTURAL FACILITIES			
29. State and Federal outdoor recreation facilities		X	
30. Urban local outdoor recreation facilities		X	
31. Rural outdoor recreational facilities		X	
32. Neighborhood centers for recreation, etc		X	
33. Arenas, auditoriums, exhibition halls			X
34. Theaters and community art centers		X	
35. Museums		X	
36. Public libraries	X		
F. OTHER PUBLIC BUILDINGS			
37. Residential group care facilities for children	X		
38. Armories	X		
39. Jails and prisons	X		
40. Fire stations	X		
41. Public office and court buildings	X		
42. Publicly owned industrial plants			X
Total	9	12	21

[1] User charges are infrequently employed or, when employed, they cover only a small part (under 50 percent) of capital and operating costs.

[2] User charges are employed in all or most instances, or where they are employed, they cover all or a substantial part (over 50 percent) of capital and operating costs.

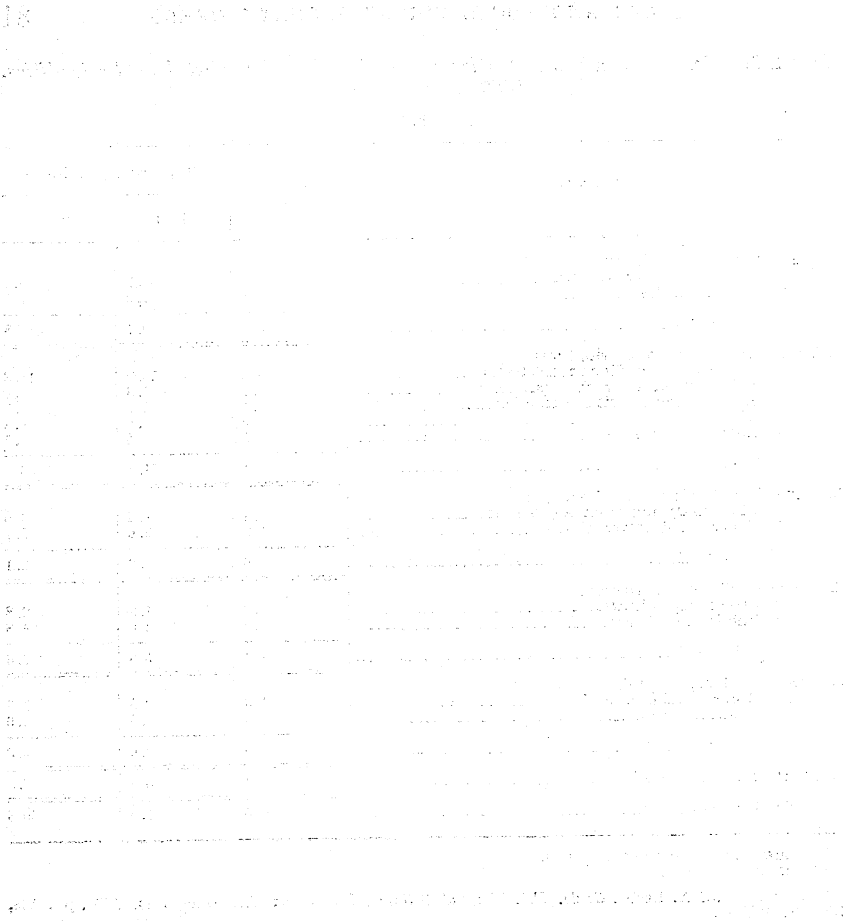
TABLE 7.—*Estimated public and private capital outlays for selected public facilities, 1962, 1970, and 1975*

[Dollars in billions]

Category	Actual 1962	Projected expenditures	
		1970	1975
1. Basic community facilities:			
(*a*) Sewer and water systems	$1.7	$2.7	$3.1
(*b*) Public utilities	4.8	7.0	7.7
Subtotal	6.5	9.7	10.8
2. Transportation capital expenditures:			
(*a*) Highways (excluding urban streets)	8.8	13.9	18.8
(*b*) Urban streets and highways	2.9	5.8	7.0
(*c*) Railroad and transit construction	.1	1.1	1.1
(*d*) Airports	.3	.6	.8
(*e*) Inland waterways [1]	.3	.4	.5
Subtotal	12.4	21.8	28.2
3. Educational facilities capital outlays:			
(*a*) Elementary and secondary schools	3.4	4.4	4.0
(*b*) Colleges and universities	1.2	2.6	2.1
Subtotal	4.6	7.0	6.1
4. Medical facilities construction:			
(*a*) Private expenditures	.8	1.8	2.8
(*b*) Public expenditures	.6	4.0	4.8
Subtotal	1.4	5.8	7.6
5. Recreational and cultural:			
(*a*) Recreational facilities [2]	1.6	2.8	3.3
(*b*) Public libraries	.3	.8	1.0
Subtotal	1.9	3.6	4.3
6. Other public buildings [2]	2.2	3.6	3.8
Total, all categories	29.0	51.5	60.8

[1] Presumably includes port facilities.
[2] In urban areas only.

Source: Leonard A. Lecht, ***Goals, Priorities and Dollars*** (New York: The Free Press, 1966), pp. 103, 139, 161, and 185.



PART I. GENERAL FORCES

Chapter 1

State and Local Government Capital Expenditures in Relation to National Economic Activity With Projections for 1975*

Introduction

In this chapter it is proposed to examine the relation of capital goods purchases by State and local governments to the course of national economic activity and other relevant factors. Projections for 1975 of State and local government purchases of structures and equipment are also prepared, making use of alternative assumptions with respect to future rates of national economic growth, rates of unemployment, prices, and other factors provided by the staff of the Joint Economic Committee. No attempt is made to analyze or quantify existing or future Federal programs designed to provide aid to State and local governments in order to meet the needs of their changing economies and of the growing population. Rather, reliance is placed on extrapolating the fairly stable relations which have persisted in the postwar period among the national economic and other variables and those of State and local governments. Therefore, a basic assumption is that these relationships will continue to hold in the future to substantially the same extent as they have in the past. Should any marked departures develop from the historical patterns of these relations, a reexamination of the projections herein set forth would be required.

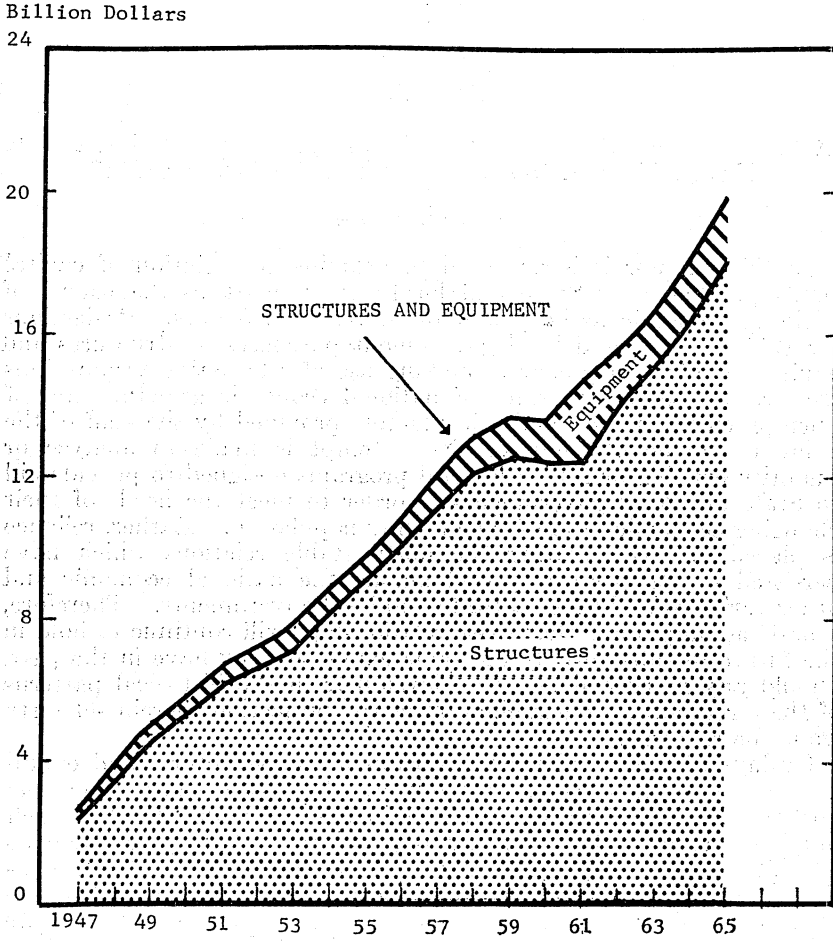
Outlays of State and local governments for structures and equipment;[1] that is, their capital expenditures, have risen sharply over the postwar period in both current and constant dollars. In 1947 such purchases amounted to $2.7 billion, and in 1965 they were about $20 billion—nearly 7½ times as much. (See chart 1.) This expansion compares with a tripling in nonresidential structures and equipment expenditures by private business. Also, in contrast to the private sector where outlays for nonresidential structures in 1965 comprised about one-third of total expenditures for nonresidential structures and equipment, State and local government spending for structures constituted nearly 90 percent of their total capital outlays.[2] This emphasis of State and local governments on structures reflects their efforts to meet the pressing needs of the population for nonresidential buildings, such as schools and hospitals, for highways, sewer and water systems, and for other public facilities.

* By Louis J. Paradiso and Mabel A. Smith, Office of Business Economics, U.S. Department of Commerce, with minor editing by committee staff. Mrs. Irene M. Mattia of the OBE staff assisted in the computations, in developing regressions, and in making charts.

[1] These include State and local new construction plus purchases of existing structures less construction force account compensation, and net purchases of equipment (purchases less sales). The definitions and measurement conform with those used in the national income and product accounts.

[2] State and local government structures include residential buildings which, in 1965, amounted to $500,000,000. Nonresidential structures in 1965 would also comprise 90 percent of capital outlays excluding residential building.

CHART 1.—STATE AND LOCAL GOVERNMENT EXPENDITURES FOR STRUCTURES AND EQUIPMENT



U.S. Department of Commerce, Office of Business Economics

In the early postwar years, 1947 to 1949, State and local government capital outlays nearly doubled, reflecting a surge in demand arising from the deficits in capital acquisitions incurred during World War II. After 1949, however, while the capital expansion programs still continued strong, the increases were considerably more moderate than in the earlier period. Also, it may be noted that capital outlays rose at a faster pace than did total expenditures of State and local governments up to 1956. From 1957 to 1960 the relative increase was less, and since then the rise has about matched the growth of total expenditures.

The following table shows for selected years a breakdown of total State and local government expenditures on a national income and product accounts basis and the relative proportions:

	Expenditures (billions of dollars)				Percent distribution			
	Structures and equipment	Other purchases of goods and services	Other expenditures	Total expenditures	Structures and equipment	Other purchases of goods and services	Other expenditures	Total expenditures
1950	5.6	13.8	2.8	22.3	25	62	13	100
1955	9.8	20.3	2.6	32.7	30	62	8	100
1960	13.6	32.5	3.5	49.6	27	66	7	100
1965	19.9	48.3	4.4	72.6	27	67	6	100

Source: U.S. Department of Commerce.

Purchases of goods and services other than structures and equipment consist mostly of compensation of employees and spending for nondurable goods. The "other" expenditures consist of transfer payments plus net interest less the current surplus of government enterprises; the ratio of these to total expenditures has been declining since 1950, due to the large expansion in the operations of government enterprises resulting in a sharp increase in their current surplus.

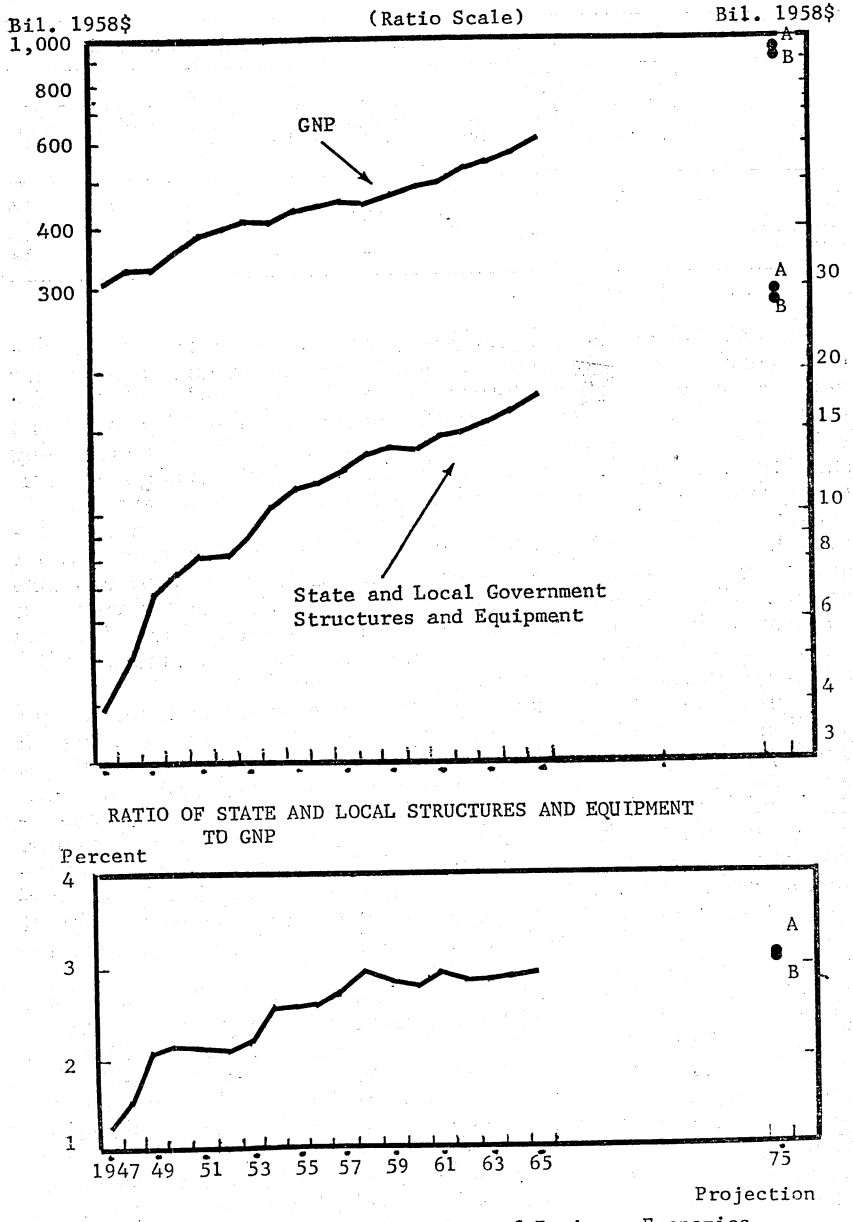
State and local government expenditures for structures and equipment have differed substantially from GNP, both with respect to trend and to general contour, whether compared in current or constant dollars. Since differential price movements affect dollar values, a comparison in constant dollars may be more useful. Chart 2 shows the movements of the two series, State and local government capital purchases and real GNP over the postwar period.

Appropriate price indexes have been compiled for a number of detail groups of structures and equipment purchases, and overall implicit prices derived for the two major aggregates of these outlays. For each of these major groups—structures and equipment—the the implicit price has moved about in line with that for the respective group in the private sector. In the more recent years, however, the implicit price for structures purchased by State and local governments has increased at a somewhat faster pace than that for the corresponding group in the private sector, mainly due to a different composition and relative importance of the subgroups within the major category.

As previously indicated, real capital purchases by State and local governments moved sharply upward in the early postwar years. However, after 1950, the rate of increase moderated considerably, averaging 5.9 percent per year through 1965—still considerably larger than the average growth rate of real GNP of 3.2 percent per year over the same period. The growth rates show further disparities when the period is split into parts. From 1950 to 1957 real purchases of structures and equipment rose at a rate of 7.2 percent per year, but after 1957 the rate was reduced to 4.7 percent per year. In contrast, real GNP increased at 3.3 percent per year in the 1950–57 period but has expanded at an average rate of 4 percent per year since 1957. In both periods the growth rates of State and local government capital purchases exceeded those of real GNP.

CHART 2.—STATE AND LOCAL GOVERNMENT PURCHASES OF STRUCTURES AND EQUIPMENT COMPARED WITH GNP

[In constant prices]



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Another important dissimilarity between the two series is their movement in recession periods. In contrast to the downturn in real GNP in each of the four postwar recessions—the decline in 1961 is not evident in the annual data—State and local government public works continued to rise by as much as, or more than, in the immediately preceding years. It appears that in recessionary periods, total revenues of State and local governments move contracyclically, and their public works outlays also expand. Continuous vigorous State and local government capital programs, financed by increasing tax revenues and borrowing and by rising Federal grants-in-aid, have thus helped in cushioning recessions and have contributed to the growth of the economy. In contrast, investment in structures and equipment by private business has fluctuated widely and has been an important factor in shaping the patterns of the postwar business cycles.

It may be noted that business expenditures for plant and equipment is a lagging indicator, turning down at about the time or shortly after general business activity begins to decline and rising about 6 months after the turnaround in general business. State and local government expenditures for plant and equipment, on the other hand, cannot be considered an indicator in relation to the general economy since it has tended to show a continual growth throughout the postwar period.

The lower panel of chart 2 shows the ratio of real State and local government expenditures for structures and equipment to real GNP. The ratio rose sharply, from 1¼ percent of real GNP in 1947 to nearly 3 percent in 1958. Since then the proportion has fluctuated within a relatively narrow range—between 2.8 and a little over 2.9 percent.

Nonresidential buildings, which include the important categories of public schools and hospitals, and highway construction account for roughly two-thirds of total capital outlays. Most of the major categories of public works grew rapidly in the early fifties, but since then the advances have been more moderate; even so, the expansions have continued at relatively high rates—certainly larger than the rate of growth of the economy as a whole.

The following table shows State and local government expenditures for the major categories of structures and equipment for selected years:

	Structures and equipment [1]	New construction [2] (billions of current dollars)					Purchases of existing structures	Net purchases of equipment
		Total	Nonresidential buildings	Highways	Sewer and water	All other construction [3]		
1950	5.65	5.24	1.89	2.09	0.66	0.61	0.14	0.39
1955	9.82	8.95	3.39	3.78	1.08	.68	.33	.76
1960	13.61	12.24	4.06	5.30	1.49	1.39	.41	1.26
1965	19.91	17.83	5.74	7.23	2.42	2.44	.68	1.78

[1] Includes new construction and purchases of existing structures less construction force account compensation, and net purchases of equipment.
[2] Includes construction force account compensation.
[3] Includes residential buildings, public service enterprises, conservation and development, and other construction not elsewhere shown.

Source: U.S. Department of Commerce.

Much of the impetus to the State and local government construction programs has come from the channeling of Federal funds through grants-in-aid to these governments. These grants have increased steadily throughout the postwar period—from $1¾ billion in 1947 to about $11½ billion in 1965. Considered by function, Federal grants-in-aid allocated to highways are by far the largest, with public assistance and relief, second. In 1964 these two functions absorbed two-thirds of the total grants-in-aid. However, allocations to other functions may be expected to expand rapidly in the coming years as programs such as Federal assistance for health, and the modernization of existing hospitals and construction of new ones get fully underway. Also, the large needs for new educational facilities plus expanding community redevelopment programs and housing development and improvement in urban areas will result in rising Federal assistance for these purposes.

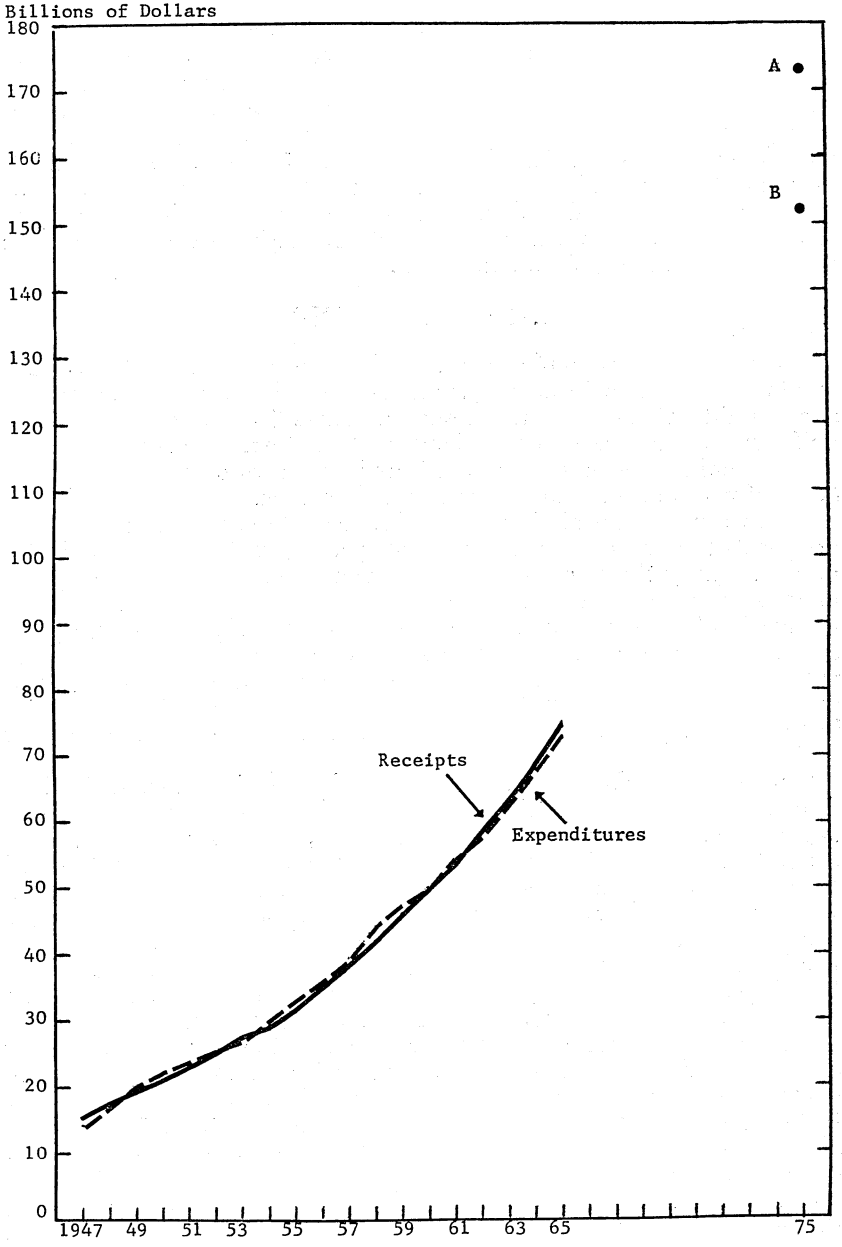
EXPENDITURES OF STATE AND LOCAL GOVERNMENTS

With the rising tempo of economic activity, State and local government receipts have correspondingly expanded and have thus permitted constantly rising expenditures for capital goods and for other purposes. Chart 3 shows that, on a national income basis, expenditures and receipts in the postwar period have been fairly close together with the resulting surpluses and deficits relatively small. The largest deficit—$2.3 billion—occurred in 1958, and the largest surplus—$1.7 billion—in 1965. In the past 9 years, the aggregate deficit has been just about equal to the aggregate surplus on the national income account basis. However, the deficit or surplus in these accounts does not indicate the change in the outstanding debt of these governments, mainly because their receipts and expenditures do not include changes in financial assets and land transactions. Also, because the accounts are on a consolidated basis, they include the operations of the pension trust funds, which have been running a surplus in recent years. Moreover, these governments need a larger volume of funds in liquid form to support their expanding obligations.

Throughout the postwar period State and local authorities have been borrowing sizable sums with the result that there has been a steady increase in the net debt. In the past 3 years this increase has averaged over $6 billion a year, bringing the outstanding debt as of mid-1965 to $92.8 billion. This represents a ratio to their total 1965 expenditures of 1.28. While this ratio has been maintained over the past 3 years, it is higher than in 1955, when it was 1.17, and much higher than in 1950, when it was only 0.93.

If we assume that pension trust fund transactions, net borrowing, and holdings of liquid assets will continue to bear about the same relationship to economic growth as in recent past years, then we may use for purposes of longer-term projection total State and local government receipts as a "proxy" measure of their expenditures.

CHART 3.—STATE AND LOCAL GOVERNMENT RECEIPTS AND EXPENDITURES (ON NATIONAL INCOME ACCOUNTS BASIS)



U.S. Department of Commerce, Office of Business Economics

Projection of State and Local Government Capital Outlays in 1975

State and local government purchases of structures and equipment are dependent principally on their tax receipts, borrowing, Federal aid received, and the needs of the growing population. Apart from the Federal grants, the expenditures of these governments are primarily dependent upon receipts from their own sources, and these receipts are basically a function of the level of economic activity and, particularly, personal income. Thus, the first requirement in projecting State and local government expenditures is to develop projections of these two overall measures of the national economy on the basis of certain specific assumptions.

1. Projection of GNP

The pattern of economic activity and, more specifically, the requirements of State and local governments are influenced by the growth and mobility of the population, and, of course, by many other factors. Shifts in population—from agriculture to industry and from central cities to suburbs—have greatly affected the rates of growth and the types of needs of different industries and regions.

Following the end of World War II, the rate of population growth accelerated markedly to 1.7 percent per year, compared with 1.2 percent during the war period and a much lower rate during the great depression years. The Bureau of the Census has projected the 1975 population [3] at nearly 223 million persons (series B). This implies an average annual growth rate from 1965 to 1975 of 1.4 percent—somewhat less than that in the years since the end of World War II; in absolute terms, however, the average increase is 2.8 million per year in the next 10 years, only slightly less than the average in the postwar period.

The age composition of the population in 1975 is expected to differ from that in 1965, primarily due to a decline in the number of 5- to 9-year-olds. In 1965 the school-age group, 5 to 21 years old, comprised 31.9 percent of the total population; in 1975 the ratio is expected to be somewhat smaller—31.2 percent. While the school-age group will continue to increase in the period ahead, the rate of advance is projected to be considerably less than that of the past decade. This has important implications on the expansion required for new school buildings, teachers, and other requirements for education resulting from the pressure of increases in the school-age group.

The population rise is eventually reflected in the growth of the labor force, and this, in turn, is one of the basic factors in the expansion of our potential production and economic activity. In the decade prior to 1963, the labor force increased at an annual rate of 1.2 percent. Since that year, the increase has accelerated to 1.7 percent per year, reflecting, in large part, the relatively high birth rate in the early postwar years. According to projections of the Department of Labor, the labor force will expand to 93.6 million by 1975 [4]—indicating an

[3] U.S. Department of Commerce, Bureau of the Census, "Population Estimates," series P-25, No. 329, Mar. 10, 1966.

[4] Department of Labor, Bureau of Labor Statistics, "Projections of the Labor Force," 1970-80, Special Labor Force Report, No. 49. The expansion of the labor force is to some extent a function of the rate of economic growth. The 1975 labor force estimate assumes high levels of employment and might be conservative under the assumption of a prolonged high rate of economic activity.

average annual rate of growth of 1.8 percent from the 1965 total of 78.4 million.

It appears that the economy would have to provide about 1½ million new jobs per year over the next 10 years if a low rate of unemployment is to be maintained. In 1965, the rate of unemployment improved considerably, averaging 4.6 percent for the year as a whole, and in early 1966, the rate was reduced to below 4 percent. As the economy continues to grow, as more of our people become better educated and more highly skilled, and as workers are trained to fit the jobs which become available, unemployment may well be reduced below present rates. For projection purposes, an unemployment rate of 3 percent in 1975 is assumed—this with the other associated factors discussed below is designated as assumption A. However, in order to gage the differences if a 3-percent rate should not be achieved, an alternative set of projections has been made on the assumption of a 4-percent rate of unemployment in 1975—this is designated as assumption B.

Another ingredient of production is the number of hours worked per week. Average factory hours reached a postwar low of 39.1 hours in 1949 and a high of 41.1 hours in 1965. Although hours worked tend to rise in a cyclical upswing, a modest decline in the work-year is assumed over the next decade.

The final major component of output is productivity, commonly measured as production per man-hour. Productivity changes have varied considerably year by year in the postwar period. Productivity rises sharply in a year following a recession, and subsequently tends to fall back to the longer term average. In the past decade, the average annual rate of increase in productivity for the total private economy has been 2.8 percent (on the labor force basis).

With continued large expenditures by business on new plant and equipment, much of which is for the purpose of increasing efficiency, the gain in private productivity in the next 10 years is assumed to average 3.2 percent per year, somewhat higher than the average of the past 10 years. This productivity increase is used in conjunction with the 3-percent rate of unemployment (assumption A). A somewhat smaller gain in productivity is used with the assumed 4-percent unemployment rate (assumption B) since investment in more efficient productive facilities may be somewhat less than under assumption A.

Based on the foregoing assumptions and consistent with the 3-percent rate of unemployment (assumption A), the 1975 projection of the GNP would be $940 billion in 1958 prices. This is equivalent to an average growth rate in real GNP of nearly 4½ percent per year from 1965 to 1975. If we assume a relatively stable price movement—a 2-percent increase per year in the GNP price deflator—associated with the foregoing growth in real GNP, then the GNP in 1975, in the prices of that year, would be $1,275 billion, an increase of more than seven-eighths over the 1965 total of $676 billion.

The alternative projection of GNP in 1975 (assumption B) would be $910 billion in 1958 prices, implying an average growth rate of a little more than 4 percent per year from 1965 to 1975. Using a somewhat smaller price increase—1.5 percent per year—associated with the lower growth rate for GNP, would result in a projected GNP of $1,180 billion in prices of 1975.

2. Projection of Personal Income

As already indicated, personal income is another major determinant of receipts of State and local governments. Since 1953 the ratio of personal income to GNP has varied from a low of 78.1 percent in 1955 to a high of 80.8 percent in 1958. The ratio rises sharply in a recession period and declines abruptly in the first year of recovery; thereafter, the changes tend to be relatively small. Fluctuations in this ratio are to a large extent a reflection of changes in corporate retained earnings (these are excluded from personal income but are included in GNP), which fall sharply during a recession and thereafter rebound, particularly in the early phase of the recovery. In 1965 the ratio of personal income to GNP was 78.5 percent—a moderate decline from the 79 percent in the first year following the 1961 recession.

The 1975 projection of personal income is derived by utilizing a regression relating personal income to GNP in current dollars for the period 1953–65, excluding the recession years 1954, 1958, and 1961. The regression equation expressed in billions of current dollars is:

(1) Personal income $=3.752+.7827$ GNP $\frac{2}{r}=.999$.

Using the projected 1975 GNP of $1,275 billion, this relation yields a corresponding personal income of $1,000 billion in 1975 under assumption A. The ratio of personal income to GNP in 1975 is 78.4 percent, only fractionally lower than the 1965 ratio. On the alternative GNP projection of $1,180 billion in 1975 (assumption B), personal income, as set forth by the staff of the Joint Economic Committee, is $895 billion. This implies a significantly lower ratio to GNP than for assumption A.

3. Projection of State and Local Government Receipts

Having projected the GNP and personal income, we are now in a position to estimate State and local government receipts. The major sources of these receipts and their amounts in 1965 are given below.

[Billions of dollars]

Personal tax and nontax receipts	11.5
Property taxes	23.0
All other taxes [1]	28.4
Federal grants-in-aid	11.4
Total receipts	74.3

[1] Includes corporate profits taxes, contributions to social insurance, and all indirect business taxes other than property taxes.

a. *Personal tax and nontax receipts.* Over the postwar period an increasing number of States have inaugurated taxing of personal incomes or have increased their existing rates as a means of obtaining additional revenues. As a result, the ratio of State and local government personal taxes to national personal income has risen steadily over the past decade, from 1.3 percent in 1955 to 2.2 percent in 1965, with the rise in the ratio slowing somewhat since 1960. The share of personal income taken by State and local governments is likely to continue to increase in the years ahead.

A closer relationship between State and local personal taxes and personal income is given by the following regression (in billions of dollars) derived from the more recent period 1960 to 1965:

(2) log (State and local personal taxes) $= -3.507 + 1.679$ log (personal income) $\frac{2}{r} = .992$.

This equation yields a more conservative projection of personal tax receipts over the next decade than that based on the period 1955–65. The relationship indicates that on the basis of the experience of the past 6 years a 10-percent rise in personal income, for example, would yield on the average a 16.8 percent increase in these personal taxes. The equation provides a 1975 estimate of State and local personal tax and nontax receipts of $33.9 billion under assumption A. This projection is equivalent to 3.4 percent of the projected personal income in that year. Under assumption B, the projected personal tax receipts in 1975 would be $28.2 billion.

b. *Property taxes.* State and local governments, particularly local governments, have used property taxes, for the most part, to finance current public school requirements. In response to the rapidly increasing school enrollment throughout the postwar period, these taxes have risen sharply—from $5.3 billion in 1947 to $23.0 billion in 1965, or an average rate of growth of 8.5 percent per year. Despite this large rise, however, the ratio of property taxes to total receipts of State and local governments has been drifting downward over the postwar period. In 1947 the ratio was 35 percent and in 1965 it was down to 31 percent.

Property taxes follow very closely the movement of State and local government wages and salaries for public education as chart 4 shows. The following equation describes the relationship for the period 1950–65, in billions of dollars:

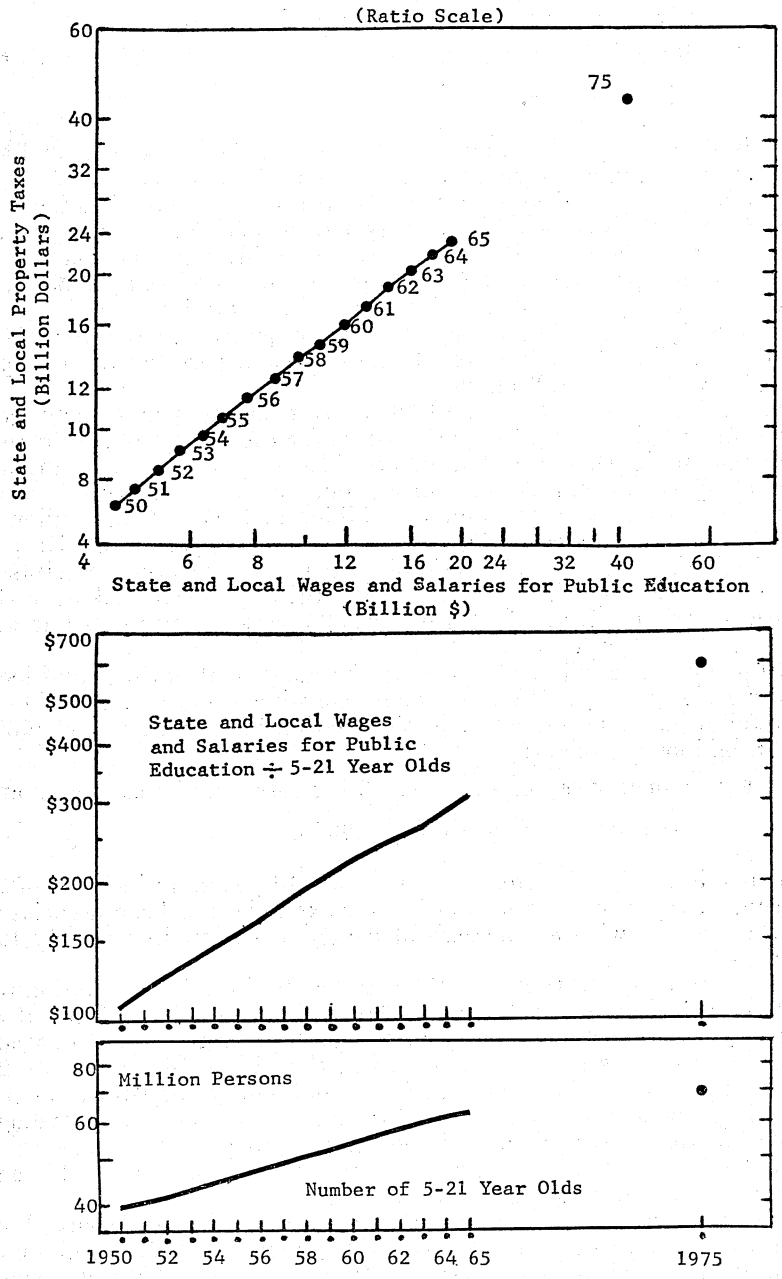
(3) log (Property taxes) $= .353 + .793$ log (State and local wages and salaries for education) $\frac{2}{r} = .9995$.

This relation implies that, over the past 15 years, an increase of 10 percent in these wages and salaries, for example, has been associated on the average with an increase of nearly 8 percent in property tax receipts.

Property tax collections in 1975 may be obtained from equation (3) and a projection of wages and salaries for education. The latter has shown a remarkably steady rate of growth over the past 15 years when expressed as a ratio per person in the school-age group 5 to 21 years old. In 1950 the average wage and salary for education per school-age person was $108; in 1965 it rose to $306. The average rate of increase over this period was 7.2 percent per year; however, it should be noted that the rate of increase in the number in this age group has been decreasing in recent years.

The most recent projections of the Bureau of the Census show that the number of 5 to 21 years olds would total 69.5 million in 1975 compared with 62.1 million in 1965, an average rate of growth of 1.1 percent per year—much lower than the 3.2 percent annual growth rate of the past 10 years. Wages and salaries for public

CHART 4.—STATE AND LOCAL PROPERTY TAXES RELATED TO STATE AND LOCAL WAGES AND SALARIES FOR PUBLIC EDUCATION



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education per 5 to 21 year olds for 1975 are obtained by extrapolating the 1956–65 trend (in terms of logarithms). The 1975 projection averages $600 per person in the school-age group. This average is then multiplied by the projection of the school-age group, 69.5 million persons, to yield a 1975 projection of wages and salaries of $41.7 billion. This total implies a lesser rate of increase in the next 10 years than in the past decade.

The projection of wages and salaries for education, when applied in equation (4), yields an estimated property tax for 1975 of $43.5 billion compared with $23.0 billion in 1965—or a rate of increase of 6.6 percent per year, a considerable reduction from the average rate of gain of 8.2 percent per year in the past 10 years. This projection is the same for both the A and B assumptions.

c. *Tax receipts other than property and personal.* These include State and local sales taxes, corporate profits tax accruals, contributions for social insurance, and other taxes not considered above. In 1965 these taxes amounted to $28.4 billion; they have risen steadily over the postwar period from the total of $6.4 billion in 1947. In the aggregate, changes in these "other" taxes are dependent on long-term developments in economic activity. With the exception of corporate tax accurals, which comprise a relatively small proportion of these taxes, they are not strongly affected by recessionary influences; indeed, in every postwar recession, when the GNP dropped or halted its advance, they have risen in the aggregate. However, the overall relationship of these taxes to GNP since 1951 has been quite close with the only marked deviation from a linear regression occurring in 1961. The regression, in billions of dollars, for the period 1951–65 is:

(4) Taxes other than personal and property $= -7.18 + .0533$ GNP
$r^2 = .996$.

This relation indicates that increases in these taxes have on the average conformed with about 5.3 percent of the increase in GNP over the period 1951–65. Assuming that this relation will hold over the next 10 years, the projection of these taxes in 1975 is $60.8 billion, corresponding to the GNP of $1,275 billion projected in that year under assumption A. This reflects an average growth rate of 7.9 percent per year over the next 10 years—a rate somewhat higher than that of the past decade. For assumption B these taxes are projected at $55.7 billion in 1975.

d. *Federal grants-in-aid.* The role of the Federal Government in relation to the needs of State and local governments is changing rapidly. Not only are the public works needs of our population expanding, but also the costs of the projects are rising—for both labor and materials. State and local bodies are constantly striving to raise their revenues by imposing new taxes or upping existing tax rates, but even so the additional revenues fall short of the necessary required funds. The Federal Government has assumed a larger share of the burden of financing many of the requirements of State and local bodies, and through its new or expanded programs for improving health and education, and through a host of other measures designed to better the standard of all Americans, it will provide increasing aid to State and local governments.

No definitive projections of Federal grants-in-aid to State and local governments can be made at this time because the Federal programs

are in a state of flux. The expanded operations in Vietnam are now a factor in limiting the Federal funds allotted to State and local bodies. When the activity there quiesces or stops entirely, the Government will proceed to implement fully its domestic programs.

Private sources [5] estimate that existing programs would call for a rise in Federal grants-in-aid to $30 billion or more in 1975. Relative to assumption A, a large expansion in Federal receipts is indicated, since GNP and income would grow at a faster pace than during the average of the postwar period. This would permit the implementing of existing Federal aid programs for State and local governments and also would provide for some additional future Federal aids to these bodies. Thus, a large growth in Federal grants-in-aid may be envisaged under this assumption, but the amount of increase can only be surmised at this time. For the purpose of calculations associated with assumption A, the Federal grants total in 1975 is placed at $35 billion—derived by applying the same average percentage rate of increase per year over the next 10 years as that which occurred over the period 1960–65; i.e., 12 percent per year.

In conjunction with assumption B (the 4-percent rate of unemployment) it is assumed that the average annual absolute increase in Federal grants would be somewhat larger than the average absolute increase of $1.1 billion per year experienced since 1962, when annual increases were larger than the average in the earlier postwar years. The assumed total grants for 1975 is $25 billion compared with $11.4 billion in 1965.

The above estimates yield the total State and local government receipts from all sources under assumptions A and B. These are summarized in the accompanying table which includes the projections of the major national variables and of State and local government receipts.

	1965 actual	Projection, 1970		Projection, 1975	
		A [1]	B [2]	A [1]	B [2]
GNP (billion current dollars)	676.0	940.0	905.0	1,275.0	1,180.0
GNP (billion 1958 dollars)	610.0	760.0	750.0	940.0	910.0
Implicit GNP price (1958=100)	111.0	123.0	121.0	136.0	130.0
Personal income (billion dollars)	531.0	740.0	700.0	1,000.0	895.0
Population (millions)	194.6	207.0	207.0	223.0	223.0
School-age population, 5 to 21 years of age (millions)	62.1	67.4	67.4	69.5	69.5
State and local government receipts—total (billion dollars)	74.3	115.8	109.7	173.2	152.4
Personal tax and nontax receipts	11.5	20.4	18.6	33.9	28.2
Property taxes	23.0	32.5	32.5	43.5	43.5
All other taxes	28.4	42.9	41.1	60.8	55.7
Federal grants-in-aid	11.4	20.0	17.5	35.0	25.0

[1] Based on assumption of 3-percent rate of unemployment.
[2] Based on assumption of 4-percent rate of unemployment.

NOTE.—See text for sources and methods and assumptions used in deriving the projections.

Source: U.S. Department of Commerce.

Assuming that State and local government expenditures would equal receipts in 1975, on the national income and product basis, the projected expenditures under assumptions A and B would be about

[5] The National Planning Association has estimated a range in Federal grants-in-aid of between $31 and $43 billion in 1975 in their national-regional economic projections series, Report No. 66-J-1.

$173 billion and $152 billion, respectively. In 1965 total expenditures were $72½ billion, so that these projections represent an average annual rate of increase over the next 10 years of 9.1 percent and 7.7 percent, respectively; these rates compare with 8.1 percent per year from 1955 to 1965.

4. Projection of Structures and Equipment Expenditures

To project State and local government capital outlays realistically would involve an examination of the various types of construction programs and other needs for the period ahead, an appraisal of regional and local requirements, and of the ability of State and local authorities to finance the projects. Also, the scope and nature of Federal Government aids to State and local governments would need to be considered. But even projections based on such thorough considerations would still involve making conjectures and judgments at many points. No long-term programs or plans are available for the major categories of capital outlays by State and local governments. In addition to many other unknowns, there is the question as to how fully existing programs and legislation of the Federal Government affecting State and local government public works will be implemented over the coming years and what new programs and legislation might be forthcoming.[6]

In view of the aforementioned uncertainties, the only other approach to projecting over the longer term is by developing meaningful relations which portray the historical experience, particularly if they have proved to be stable under varying political and economic conditions. Future events can alter the past pattern, but this is the risk involved in any attempt to look ahead, whether short run or long run. This approach, which has been used in making the foregoing projections, is also utilized to project capital outlays.

As already indicated, State and local government expenditures for structures and equipment comprise a fairly large part of their total expenditures. Since the latter are largely dependent upon the receipts of these bodies, the volume of capital outlays, together with the borrowing required to finance them, tend to move with receipts or expenditures. Chart 5 shows that real capital outlays moved up rather sharply relative to real total expenditures[7] up to 1954. Since then the relative movement has been more moderate. A linear regression for the period 1954–65, in billions of 1958 dollars, is:

$$\text{(5)}\quad \text{Capital outlays} = .414 + .287\ (\text{total expenditures}) \qquad \frac{2}{r} = .994.$$

The relationship is very close over this period and implies that the change in real capital outlays has on the average reflected nearly 30 percent of the change in real total expenditures.

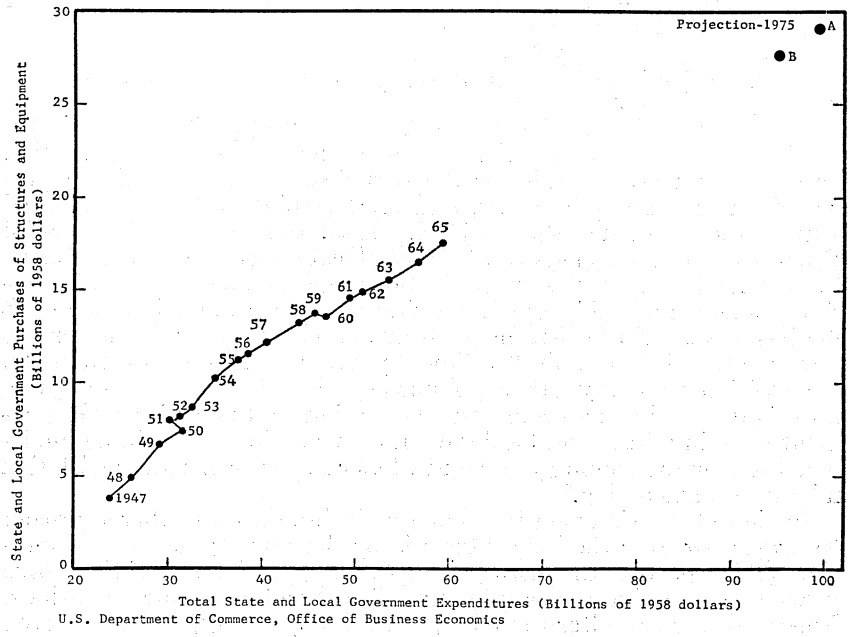
To project real capital outlays it is necessary to estimate real State and local government expenditures; this requires a projection of their implicit price. These prices have moved in a close relation

[6] A detailed analysis for the year 1970 using the foregoing considerations is available in an unpublished manuscript, "State and Local Finances, Project 1970," prepared for the Federal Interagency Committee on Economic Growth by the Council of State Governments.

[7] Since purchases of goods and services comprise the bulk of total State and local expenditures, the latter were converted to real terms by the use of the implicit prices for goods and services—see table 1 in the appendix.

CHART 5.—STATE AND LOCAL GOVERNMENT CAPITAL OUTLAYS RELATED TO TOTAL EXPENDITURES

[In constant prices]



U.S. Department of Commerce, Office of Business Economics

with the total GNP implicit prices over the past 15 years—a 1-percent increase in the latter prices have been accompanied on the average by a 1.7-percent increase in those for State and local government expenditures. This larger relative advance is attributable to the way prices of services (measured by wages and salaries) are treated in the government sector of the GNP; i.e., no productivity gain is imputed in measuring real government GNP. In the government sector real GNP moves proportionately to the man-hours, whereas in the private economy real GNP reflects the productivity times man-hours. Thus, the implicit price movements in the private sector reflect the effects of productivity changes whereas in the government sector they do not.

The relationship of State and local government expenditures implicit prices with those for GNP for the period 1950–65, with each price index on a 1958 base, is as follows:

(6) $\log$ (State and local government expenditures implicit price) $=$

$$-1.419+1.714 \log \text{ (GNP implicit price)} \quad \frac{2}{r}=.985.$$

Equation (6) produces an implicit price index for 1975 of State and local government expenditures of 174 (1958=100) for assumption A (which involves an average rate of increase in the GNP implicit price of 2 percent per year), and an index of 160 (1958=100) for assumption B (which involves a rate of increase in the GNP implicit price of 1.5 percent per year). Using these deflators gives a 1975 projection of real State and local government expenditures of $99.5 billion under

assumption A and $95.2 billion under assumption B, both in 1958 dollars.

Thus, applying these estimates of real total expenditures in equation (5) results in projections of real purchases of structures and equipment by State and local governments in 1975 of $29.0 billion (1958 dollars) under assumption A and $27.7 billion (1958 dollars) under assumption B; these projected real capital outlays imply an expansion over the next 10 years of 65 percent and 57 percent under assumptions A and B, respectively. The increase over the decade 1955–65 was 58 percent.

Of especial interest is the projection of real new construction expenditures by State and local governments which, except for construction force account compensation, are included in expenditures for structures. As indicated earlier, these expenditures in 1965 represented 90 percent of total purchases of structures and equipment. The projection of new construction is derived by subtracting from the projection of structures and equipment those of equipment and "other" structures.

Equipment purchases in constant dollars have risen along a well-defined upward trend since 1958, averaging $110 million per year. An extrapolation of this trend results in a 1975 projection of equipment purchases of $2.8 billion (in 1958 dollars); in 1965 such purchases amounted to $1.7 billion. Subtracting the projections of equipment from those of structures and equipment combined, results in projections of structures of $26.2 billion and $24.9 billion (in 1958 prices) under assumptions A and B, respectively.

Expenditures for structures excluding new construction [8] (in constant dollars) have risen moderately since 1955. On the basis of an extrapolation of the 10-year trend, these purchases are projected at $0.4 billion (in 1958 dollars) for both the A and B assumptions; the 1965 figure was $0.3 billion.

As a result, new construction of State and local governments is projected in 1975 at $25.8 billion for the A assumption and $24.5 billion for the B assumption, in terms of 1958 dollars. These projections imply a growth over 1965 of 65 percent and 57 percent, respectively, for the A and B assumptions.

For certain purposes total capital outlays, excluding residential building construction, are desired, since the latter is affected by special factors. State and local government residential building construction has shown erratic movements over the past 15 years, with no discernible trend either in constant or current dollars. With this pattern in mind and in the absence of a detailed analysis of the factors underlying the movements of residential building construction, the 1975 projection was placed at $0.5 billion in both current and constant dollars—equal to the average of each series for the years 1950–65. This yields projections of new construction excluding residential building of $25.3 billion and $24.0 billion (1958 dollars) for assumptions A and B, respectively.

The foregoing projections have been derived in constant dollars. The current dollar projections are derived from these by the use of the assumed GNP implicit prices and derived relations of the implicit prices of structures and of equipment to the GNP implicit prices in recent years. Since 1959 the implicit prices of State and local govern-

[8] Consists of net purchases of existing structures less construction force account compensation.

ment structures have risen sharply relative to the implicit GNP prices—a 1-percent rise in the implicit GNP price has on the average been accompanied by a 1.6-percent rise in the implicit price of structures—mainly reflecting the relatively faster pace of construction prices generally. On the other hand, in this same period the implicit prices of equipment purchases by State and local governments have shown only a slight rise relative to the movement of the implicit GNP prices. Applying these price adjustments to the constant dollar State and local government capital outlays converts the projections to current dollars. The following table summarizes the 1975 projections in both constant and current dollars:

Projections of structures and equipment purchases of State and local government, 1970 and 1975

	Actual, 1965	Projection, 1970		Projection, 1975	
		Assumption A	Assumption B	Assumption A	Assumption B
Structures and equipment (billion 1958 dollars)	17.6	23.2	22.6	29.0	27.7
Structures	15.9	20.9	20.3	26.2	24.9
New construction	15.6	20.6	20.0	25.8	24.5
Addendum: Residential building	.3	.5	.5	.5	.5
Other [1]	.3	.3	.3	.4	.4
Equipment	1.7	2.3	2.3	2.8	2.8
Structures and equipment (billion current dollars)	19.9	30.4	29.0	44.7	39.6
Structures	18.1	28.0	26.6	41.7	36.6
New construction	17.8	27.6	26.2	41.2	36.1
Addendum: Residential building	.4	.5	.5	.5	.5
Other [1]	.3	.4	.4	.5	.5
Equipment	1.8	2.4	2.4	3.0	3.0

[1] Includes net purchases of existing structures less construction force account compensation. The latter item is deducted here because it is included in compensation of employees of State and local governments in the national income and product accounts.

NOTE.—In July 1966—subsequent to the time when the calculations above were made—the estimates in the national income and product accounts were revised for the years 1963–65. While the upward revisions of GNP and personal income in 1965 amounted to $5,000,000,000 and $4,000,000,000, respectively, the effect of these changes on the above projections is relatively small; for example, projections of State and local capital expenditures would be raised by about $500,000,000 in 1970 and 1975.

Source: U.S. Department of Commerce.

APPENDIX

Regression Equations and Basic Data Used in Deriving the 1975 Projections of State and Local Government Expenditures for Structures and Equipment

The following model was used as the basis for the projections, with all data on a national income and product accounts basis:

		R^2	Period
(1)	$E=R+U$		
(2)	$R=PT+PrT+OT+FG$		
(3)	$\log PT=-3.507+1.679 \log PI$	0.992	60–65
(4)	$\log PrT=.353+.793 \log WS_E$	.9995	50–65
(5)	$WS_E=WS_{EP}\times P$		
(6)	$\log WS_{EP}=2.341+.029t$ (t=0 for 1960)	.998	56–65
(7)	$OT=-7.18+.0533\ GNP$	.996	51–65
(8)	$\log FG=.911+.0499t$ (t=0 for 1962) for Assumption A	.997	60–65
	$FG=9.15+1.15t$ (t=0 for 1963) for Assumption B	.995	62–65
(9)	$SEQ_C=S_C+EQ_C$		
(10)	$SEQ_C=.414+.287E_C$	.994	54–65
(11)	$E_C=E\div I_E$		
(12)	$\log I_E=-1.419+1.714 \log I_{GNP}$	.985	53–65
(13)	$EQ_C=1.458+.115t$ (t=0 for 1961)	.991	58–65
(14)	$S_C=SE_C-EQ_C$		
(15)	$NC_C=S_C-O_C$		
(16)	$O_C=.168+.018t$ (t=0 for 1960)	.611	55–65
(17)	$\log I_S=-1.267+1.624 \log I_{GNP}$	.947	59–65
(18)	$\log I_{EQ}=1.632+.185 \log I_{GNP}$	.728	58–65
(19)	$S=S_C\times I_S$		
(20)	$EQ=EQ_C\times I_{EQ}$		
(21)	$SE=S+EQ$		
(22)	$NC=S-O$		
(23)	$O=.165+.019t$ (t=0 for 1960)	.626	56–65

The notations used in the above equations follow:

(1)	E	State and local government expenditures, in billions of current dollars.
	R	State and local government receipts, in billions of current dollars.
	U	State and local government surplus or deficit, in billions of current dollars.
(2)	PT	State and local government personal taxes, in billions of dollars.
	PrT	State and local government property taxes, in billions of dollars.
	OT	State and local government taxes other than personal and property, in billions of dollars.
	FG	Federal grants-in-aid to State and local governments, in billions of dollars.
(3)	PI	National personal income, in billions of dollars.
(4)	WS_E	State and local government wages and salaries for education, in billions of dollars.
(5)	WS_{EP}	State and local government wages and salaries for education per schoolage person (ages 5–21, inclusive).
	P	Schoolage population (ages 5–21, inclusive).
(7)	GNP	Gross national product, in billions of dollars.
(9)	SEQ_C	State and local government purchases of structures and equipment, in billions of 1958 dollars
	S_C	State and local government purchases of structures, in billions of 1958 dollars.
	EQ_C	State and local government purchases of equipment, in billions of 1958 dollars.
(11)	I_E	Implicit price deflator for State and local government expenditures, represented by the implicit price deflator for goods and services purchased by these governments (1958=100).
(12)	I_{GNP}	Implicit GNP price deflator (1958=100).
(15)	NC_C	State and local government purchases of new construction, in billions of 1958 dollars.
	O_C	State and local government purchases of "other" structures than new construction, in billions of 1958 dollars.
(17)	I_S	Implicit price deflator for State and local government expenditures for structures (1958=100).
(18)	I_{EQ}	Implicit price deflator for State and local government expenditures for equipment (1958=100).
(19)	S	State and local government expenditures for structures, in billions of current dollars.
(20)	EQ	State and local government expenditures for equipment, in billions of current dollars.
(21)	SE	State and local government expenditures for structures and equipment, in billions of current dollars.
(22)	NC	State and local government expenditures for new construction, in billions of current dollars.
(23)	O	State and local government expenditures for "other" structures than new construction, in billions of current dollars.

TABLE 1.—*GNP and State and local government expenditures, 1947–65 and projected 1975*

	GNP			State and local government expenditures		
	Billions of current dollars	Implicit price[1] (1958=100)	Billions of 1958 dollars	Billions of current dollars	Implicit price[1] (1958=100)	Billions of 1958 dollars
1947	231.3	74.6	309.9	14.3	60.4	23.7
1948	257.6	79.6	323.7	17.4	66.4	26.3
1949	256.5	79.1	324.1	20.0	68.9	29.1
1950	284.8	80.2	355.3	22.3	70.8	31.6
1951	328.4	85.6	383.4	23.7	76.9	30.8
1952	345.5	87.5	395.1	25.3	80.6	37.3
1953	364.6	88.3	412.8	27.0	82.8	32.6
1954	364.8	89.6	407.0	29.7	85.3	35.0
1955	388.0	90.9	438.0	32.7	87.5	37.3
1956	419.2	94.0	446.1	35.6	92.7	38.4
1957	441.1	97.5	452.5	39.5	97.3	40.6
1958	447.3	100.0	447.3	44.0	100.0	44.0
1959	483.6	101.6	475.9	46.8	102.6	45.6
1960	503.8	103.3	487.8	49.6	105.9	46.9
1961	520.1	104.6	497.3	54.1	109.4	49.5
1962	560.3	105.7	530.0	57.6	113.2	50.9
1963	589.2	107.1	550.0	62.2	116.5	53.4
1964	628.7	108.9	577.6	67.2	119.3	56.4
1965	676.3	110.9	609.6	72.6	122.8	59.1
1975 projected:[2]						
Assumption A	1,275	135.9	940	173.2	174	98.5
Assumption B	1,182	130.0	910	152.4	160	95.2

[1] Implicit price for State and local government purchases of goods and services.
[2] See foregoing text for details of these assumptions.

Source: U.S. Department of Commerce.

TABLE 2.—*State and local government expenditures for structures and equipment, 1947–65 and projected 1975*

	Billions of current dollars				Billions of 1958 dollars			
	Structures and equipment	Structures[1]	New construction	Equipment	Structures and equipment	Structures	New construction	Equipment
1947	2.7	2.5	2.5	0.3	3.8	3.5	3.5	0.4
1948	3.8	3.5	3.5	.3	5.0	4.5	4.6	.4
1949	5.1	4.8	4.8	.3	6.7	6.2	6.4	.5
1950	5.6	5.3	5.2	.4	7.5	7.0	7.0	.5
1951	6.8	6.3	6.3	.5	8.0	7.4	7.5	.6
1952	7.2	6.5	6.6	.6	8.2	7.4	7.6	.8
1953	7.8	7.1	7.1	.7	8.8	8.0	8.1	.8
1954	9.0	8.3	8.3	.7	10.3	9.4	9.5	.9
1955	9.8	9.1	8.9	.8	11.2	10.3	10.2	.9
1956	11.0	10.1	10.0	.9	11.5	10.6	10.5	.9
1957	12.2	11.2	11.1	1.0	12.2	11.2	11.2	1.0
1958	13.2	12.2	12.1	1.0	13.2	12.2	12.1	1.0
1959	13.7	12.6	12.3	1.1	13.7	12.6	12.4	1.1
1960	13.6	12.4	12.2	1.3	13.6	12.3	12.2	1.2
1961	14.7	13.4	13.3	1.3	14.5	13.2	13.1	1.3
1962	15.5	14.1	14.0	1.4	14.9	13.5	13.3	1.4
1963	16.7	15.1	14.9	1.6	15.6	14.1	13.9	1.5
1964	18.1	16.4	16.1	1.7	16.6	14.9	14.6	1.7
1965	19.9	18.1	17.8	1.8	17.6	15.9	15.6	1.7
1975 projected:[2]								
Assumption A	44.7	41.7	41.2	3.0	29.0	26.2	25.8	2.8
Assumption B	39.6	36.6	36.1	3.0	27.7	24.9	24.5	2.8

[1] Includes new construction less force account compensation, plus net purchase of existing structures.
[2] See foregoing text for details of these assumptions.

Source: U.S. Department of Commerce.

CHAPTER 2

Material Requirements for State and Local Public Works, 1946–75*

I. NEW CONSTRUCTION AND MATERIALS REQUIREMENTS

The value of building materials consumed in State and local construction rose ninefold between 1946 and 1965. Over this period, the value of new State and local construction increased only sixfold.[1] But, the significant factor in the upsurge of total consumption was the physical volume (constant dollar) increase in State and local construction of 300 percent.

Viewed in terms of the proportion of total State and local construction expenditures involved, building materials usage rose from 35 to 50 percent in these years. This increase in the relative importance of materials expenditures reflects advances in laborsaving technology, reductions in onsite labor requirements due to the increased use of prefabricated materials, and the faster growth of the more material intensive types of construction. It is not merely a reflection of price changes.

The backlog of postponed construction projects in the immediate post-World War II period set the stage for an upsurge in both private and publicly owned construction. During the war, new construction had almost come to a standstill, but maintenance and repair work of necessity continued to be strong. This work, however, while providing a limited market for building materials products, at the same time provided a base for maintaining capacity which was instrumental in fulfilling the materials requirements for new construction immediately after the war. Full capacity production levels were reached very quickly in the postwar period in most building materials industries. Significant price increases for many products were the inevitable result, especially for materials which were heavily dependent upon the booming residential market. Capacity-price pressures prevailed for some industries until the end of the Korean conflict in 1953, but since that time materials production has generally not been pressing capacity and price movements have not been primarily associated with this factor.

A. COMPONENTS OF NEW CONSTRUCTION GROWTH

In the first post-World War II year, 1946, the physical volume of new construction, both private and public, was more than double that of each of the preceeding 2 war years. Federal, State, and local con-

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[1] For purposes of this study, State and local construction does not include public housing, which, because of many special factors, lends itself to separate analysis. The State and local construction discussed in this chapter includes, however, federally aided as well as nonfederally aided work.

struction constant dollar outlays in 1946 were about 15 percent of total new construction. Federal Government construction, however, dropped off somewhat with demobilization, but State and local outlays followed the pattern of private construction and many categories showed an enormous spurt between 1945 and 1946. For example, the value of public educational construction activity in constant dollars jumped by almost 50 percent, highways by 75 percent, and sewer and water by more than 75 percent, in only 1 year's time. All of these are primarily owned by State and local governments. One category which not only failed to show a construction spurt but actually dropped in real activity was hospitals where many projects appear to have encountered difficulties.

By 1953, the first post-Korean year, the public sector had grown to almost 30 percent of total new construction. Although dropping slightly in the next few years, since 1958 the public sector proportion remained relatively steady at 30 percent. The physical volume of all new public construction by 1965, was about 250 percent above that of 1947. State and local construction activity, up by about 300 percent was mainly responsible. In general, in the first few years after World War II, the most rapid period of growth for most types of State and local construction expenditures reflected a large backlog of unmet public works needs. This was an inheritance from the prewar depression years as well as from the restrictions of World War II. The stimulus due to the introduction of new programs of Federal aid was taking effect while State and local governments were showing major improvements in their financial condition. Between 1946 and 1949 Federal aid about doubled. Thus, Hill-Burton hospital construction assistance funds, which became available beginning in 1947, stimulated hospital construction to become one of the fastest growing categories of State and local public facilities. State and local hospitals showed an estimated fivefold increase between 1947 and 1949.

Educational construction, even without a comparable stimulus from Federal aid, increased fourfold between 1947 and 1949 and then began to slow down as the wartime backlog was partially eliminated. However, the growing school population as well as a high rate of population mobility, and housing development in suburban areas continued to stimulate school building. By the midfifties expenditures reached a physical volume peak (not surpassed until 1965) which was more than double the 1949 rate of outlays. Average annual growth over the 20-year period for new public educational facilities was the highest among all State and local construction categories (table 1).

TABLE 1.—*State and local construction activity, 1947–65* [1]

	Activity (millions of 1957–59 dollars)		Average annual rate of increase (percent)
	1947	1965	
Total State and local	$3,279	$13,396	8.2
Nonresidential building	635	4,351	11.3
Educational	363	3,042	12.5
Hospital and institutional	75	397	9.6
Administrative and service	57	414	11.6
Other nonresidential	140	498	7.3
Nonbuilding construction	2,644	9,106	7.1
Sewer	329	954	6.1
Water	286	699	5.1
Highways	1,631	6,543	8.0
All other	398	910	4.7

[1] The statistics for 1947 and 1965 are prepared by Business and Defense Services Administration on a comparable basis by using the "old" Bureau of the Census series which terminated with 1965.

The growth of highway construction, traditionally a large expenditure item for State and local governments, was stimulated in the first decade after the war by the ABC Federal-aid program under which the Federal Government contributed 50 percent of funds. But, this growth tapered off by the midfifties, setting the stage for the new Federal Interstate Highway program under which the Federal Government provided 90 percent of funds. The influence of the new 41,000 mile program was not clearly evident until 1958, when constant dollar expenditures for highways rose 15 percent above 1957.

For other types of State and local construction there was also substantial growth from 1946 to 1949 as immediate postwar needs were dealt with. Dips in physical activity took place in the early 1950's, when State and local governments were facing difficulties getting voter approval for financing many projects. In the early 1960's, a new Federal-aid program to aid waste treatment plant construction resulted in a resurgence of growth for this category. The relative affluence of State and local governments as compared to pre-World War II years had a favorable influence on the growth rate for administrative and service buildings.[2]

B. CHANGING MATERIAL REQUIREMENTS OVER TWO DECADES

Between 1947 and 1965 the proportion of total State and local construction expenditures spent for materials increased from 35 to 50 percent (table 2). Seven of the eight major State and local construction categories showed a rising proportion of materials outlays. The eighth category, administrative and service buildings, for reasons not entirely clear, showed a slight decline.[3]

[2] This category includes general office buildings, courthouses, State capitals and city halls, jails and penitentiaries, police stations and firehouses.

[3] The information on materials usage for this State and local category is based on Federal office building construction which may not be typical.

TABLE 2.—*Relationship of selected materials to State and local construction in 1947 and 1965*

	Percent of State and local construction outlays [1]	
	1947	1965
Total materials [2]	35.0	50.0
Metal products [2]	10.0	17.0
Fabricated structural steel	1.8	3.2
Plumbing	.7	1.3
Heating and cooling	1.0	1.9
Metal doors, windows and trim	.3	.9
Reinforcing steel	2.3	3.3
Lumber products	2.7	2.0
Millwork	.7	.9
Stone, clay, and glass products	14.0	17.0
Cement	3.7	2.1
Concrete products	2.8	6.4
Structural clay products	1.4	1.3
Aggregates (rock products)	5.3	5.1
Bitumen (in highways)	2.2	.9
Asphalt (ready-mix)	.9	2.0
Paint	.1	.2
Roofing	.3	.3
Electrical equipment, fixtures, and wiring devices	.7	2.5
Pipe [2 3]	4.0	5.4
Iron	1.5	1.3
Steel	.7	1.1
Concrete	1.0	1.8
Asbestos cement	.4	.4
Clay	.3	.6

[1] Based on the value of construction materials consumed in all State and local construction measured in current dollar values.
[2] Also includes materials not listed in this table. Pipe categories are duplicative of other categories.
[3] Total pipe and the component types of pipe listed below are those used in nonbuilding construction only. This usage accounts for the overwhelming majority of pipe in State and local construction.

Source: Prepared by Business and Defense Services Administration.

Highway construction, which accounted for half the volume of all State and local construction in both 1947 and 1965, is the dominant factor in the increasing overall importance of materials in State and local construction expenditures. For highways the materials share increased from 27 percent in 1947 to 47 percent in 1965. This substantial shift reflects primarily a decline in the importance of on-site wages. Significantly, highway construction in the past two decades had very large increases in labor productivity due mainly to the impact of new road building and earth moving equipment. Higher standards in highway design and construction, which call for more overpasses and better quality pavement, have also strongly influenced materials consumption. Steel usage was particularly affected. Thus, over the span of about 20 years, the use of steel products rose from 5 percent of total costs of highway construction to 13 percent. Similarly, the share of stone, clay, and glass products rose from 14 to 20 percent.

A second major factor in the increase from 35 to 50 percent of the materials share in State and local construction is the higher growth rates since 1947 experienced by the more material intensive nonresidential buildings category. The materials share in recent years was about 55 percent of total costs for that category as compared to 48 percent for nonbuilding construction. The more materials intensive

construction had annual growth rates varying from 7 to 13 percent, whereas the nonbuilding categories had growth rates varying from 5 to 8 percent.

A third element boosting the share of material costs for construction in general over the two decades is the increasing use of off-site fabricated materials which in effect shifts labor costs from the construction site to the factory. For example, concrete products rose considerably in importance in State and local construction while its raw materials, cement and rock products, declined in importance. In highway construction specifically, there was a relative increase in the use of ready-mix asphalt, and a decline in the share of bitumens which are mixed on site. Another example involves metal doors, windows and trim, whose share of total State and local construction outlays tripled between 1947 and 1965, as increasing substitution for lumber products took place.

Finally, as in the case of highways, the trend toward higher standards and improved design in other types of construction has also been partly responsible for the increasing relative importance of building materials. Expenditures on electrical equipment, fixtures and wiring devices have been particularly affected. The share of total expenditures for these products has increased more than three times since 1947, rising from 0.7 percent to 2.5 percent. Similarly, the share of plumbing materials almost doubled during the postwar period, reflecting the inclusion of more laboratories and drinking fountains, and the increasing pipe requirements of new buildings resulting from more one-story spreadout designs in such fast growing buildings types as schools and hospitals.

While on an overall basis materials expenditures were increasing their relative importance, some major building materials and products could not maintain their competitive positions during the past 20 years. Thus, in the case of lumber products, usage declined from about 3 to 2 percent of total construction outlays. For education, the largest building category of public construction, lumber usage declined since 1947 from 8 to about 5 percent. This shift was mainly associated with new trends in the design of schools. New designs also explain another important shift, from brick to concrete products in expenditures for schools. Brick usage declined from 5 to 2 percent of school outlays. The greater popularity of concrete products, more than doubling in usage over the years for all types of facilities is associated with the decline in brick and lumber usage. Finally, a slight decline in materials outlays occurred in iron pipe. This reflects a shift to other types of pipe particularly for water facilities construction.

C. FUTURE MATERIAL NEEDS OF PUBLIC WORKS

The projected increase of from 57 to 65 percent in the physical volume of State and local construction in 1975 over 1965 [4] does not involve the same disparity in growth trends between more material and less material intensive types of construction as during the 1947–65 period. The overall materials share in State and local construction of 50 percent will probably not increase by more than a few percentage

[4] This range relates to the alternate projections of constant dollar State and local construction activity presented in ch. 1.

points in the next decade. This relatively small increase will result mainly from design changes and a continuation of the trend toward off-site prefabrication. These developments as well as the change in the mix of the various types of construction involving the somewhat lesser importance of highway construction, will produce varied effects on the consumption pattern of individual materials. Among the various building materials, fabricated structural steel, lumber products, bitumen, and rock products should decline from 1965 proportions (table 2). Metal doors, windows and trim, concrete products, electrical equipment, and pipe (particularly concrete) should rise. Other materials should remain relatively stable.

With regard to changes in the mix of construction, the greatest rate of increase will probably be in hospital and insitutional construction, spurred by the demands of medicare and other health programs. Administrative and service building construction will also have a higher than average growth rate as expenditures continue to expand for office, fire, police, park, and recreational buildings. While the growth rate of new educational facilities is likely to be considerably below that of the 1947–65 period when the backlog of needs was particularly large, it is still expected to exceed the average growth rate for State and local construction as a whole. The growth of these building types of construction will particularly increase the proportion of total construction expenditures devoted to plumbing, heating, electrical equipment, and metal doors and trim since they are heavy users of these materials. The relative share of expenditures for fabricated structural steel products will be particularly influenced by the growth of administrative and service buildings construction which because of the office building component has a considerably higher usage factor for this material than does other construction. Some types of materials, such as cement, concrete products, pipe and aggregates will be unfavorably affected by the higher growth rate in nonresidential building construction since for these meterials they are inherently comparatively low users.

The growth of sewer construction is expected to be second only to hospitals. This growth is related to the increasing concern for the need for greater control of waste disposal and involving the expansion of Federal aid programs to State and localities for sewer construction. The rapid growth of sewer construction will tend to offset the effects of the lower usage of concrete in nonresidential buildings, since such usage in sewer is double that of the average for all State and local construction. Water construction is also expected to show an above average rate of growth, and like the sewer category will benefit from increased Federal aid. The major implication for materials use is in pipe, since sewer and water construction require from four to five times as much pipe per dollar of total expenditures as in all State and local construction.

Highways is the only category of State and local construction which is expected to have a lower than average growth rate. It will constitute a lower proportion of State and local construction expenditures. The average annual rate of increase for highways in the next decade may drop to less than half of the 8-percent average rate of growth for 1947–65. The stimulus of extensive Federal aid for highways will probably continue as in the past decade, but the satisfaction of other public works needs will receive greater priority. Nevertheless,

in 1975, highway construction will still account for the largest single share of State and local construction outlays, about two-fifths of the total in constant dollars. The rapid rise from 27 to 47 percent in the materials portion of highway expenditures experienced in the past two decades is expected to level off. A rapid rise will, therefore, not be a strong factor in shaping the overall material consumption pattern for State and local construction as in the past. In the next decade, increases in construction productivity due to advances in equipment technology are not likely to be as significant as in the past 20 years. The use of reinforcing bars, cement, aggregates, asphalt, and bitumen, those materials heavily used by highways, will reflect the relatively slower growth of highway construction by accounting for lower shares of total costs than at present.

D. THE DEPENDENCE OF BUILDING MATERIALS INDUSTRIES ON STATE AND LOCAL CONSTRUCTION

New construction activity by State and local governments in 1964 [5] accounted for about one-fourth of all new construction activity. However, for some building materials there was considerably more than one-fourth dependence by supplying industries on State and local construction (table 3). Furthermore, during the past 20 years, many industries became increasingly dependent on State and local construction, because of its above average growth rate.

TABLE 3.—*Share of shipments for new State and local construction, 20 selected materials in 1964*

[Percent of total shipments] [1]

50 percent or more

Vitrified clay pipe
Concrete pipe
Steel reinforcing bars
Aggregates (rock products)

15 to 29 percent

Fabricated structural steel
Heating equipment
Concrete products
Structural clay products
Stone, clay, and glass products

30 to 49 percent

Bitumens
Cast iron pipe and fittings
Portland cement

5 to 14 percent

Metal doors, windows, and trim
Millwork
Iron and steel products
Steel pipe

Less than 5 percent

Electrical equipment, fixtures and wiring devices
Lumber products
Paints

[1] Based on the value of shipments (f.o.b. plant) for new State and local construction, related to the value of total shipments, except for some materials used in highways which are based on physical ratios (cement, reinforcing steel, aggregates, and bitumens).

Source: Prepared by Business and Defense Services Administration.

The four materials for which State and local construction in 1964 consumed more than half of the output, are all primarily related to nonbuilding construction. The needs of highway and sewer construction accounted for more than half of the shipments of concrete pipe, and with water construction accounted for more than three-fifths of all shipments. Sewer construction alone provided the market for about two-thirds of vitrified clay pipe shipments. Nearly half of all aggre-

[5] At the time this analysis was made, 1964 was the latest year for which building materials industries data were available.

gates and reinforcing steel was consumed for pavement, bridges, drainage structures, and pipe in highway construction. In addition, aggregates were also extensively used for highway subbase.

Available statistical data do not make possible the determination of the proportion of shipments consumed in 1947 by State and local construction for most materials. Among the cases where comparisons between 1947 and 1964 could be made, there is only one instance where the proportion of total shipments was lower in 1964—steel pipe. This decline reflects a shift to concrete pipe for State and local use while a greater use of steel pipe materialized in private pipeline construction and in other private uses.

Cement, bitumens, reinforcing and structural steel are products which became increasingly dependent on State and local construction during the past two decades. This trend was particularly influenced by highway construction which has accounted for one-half of the constant dollar value of all nonfederally owned public works, except housing. Whereas highways consumed about 10 percent of all cement shipments in 1947, in more recent years about one-fourth of all shipments went to highways. Reinforcing steel for highway construction represented about one-fifth of all shipments of this product in 1947, but approached one-half of all shipments by the 1960's. Not only has there been a steady trend toward the use of more reinforced concrete in highways but higher standards have called for more use of reinforcing steel per unit of concrete. The use of more bridges and overpasses for highways since 1947 also nearly doubled the 15 percent of total shipments of fabricated structural steel. The dependence of bitumen on new highways is not only due to the influence of higher standards but also reflects a decline in highway maintenance and repair work relative to new construction. Thus, whereas in 1947 new highways accounted for about a fifth of bitumen shipments, by 1964 this proportion almost doubled.

The dependence of materials industries on State and local construction by 1975 is not likely to change markedly from the present. Since the rate of growth in expenditures for State and local construction is expected to be within the range of expectations for all construction, it will continue to account for about one-fourth of total new construction expenditures as it has for the past 8 years. Furthermore, technological and productivity changes in State and local public works will probably be similar to those in the private and Federal sectors so that shifts toward certain materials will be similar in all sectors. One area where the dependence pattern might change because of factors outside the construction industry is iron and steel for which demand depends more on industries other than construction. Assuming no significant shifts in other uses, it is possible that a smaller portion of steel output will be used for construction, particularly in the State and local sector.

II. Building Materials and Construction Costs

A. CAPACITY AND PRICE TRENDS

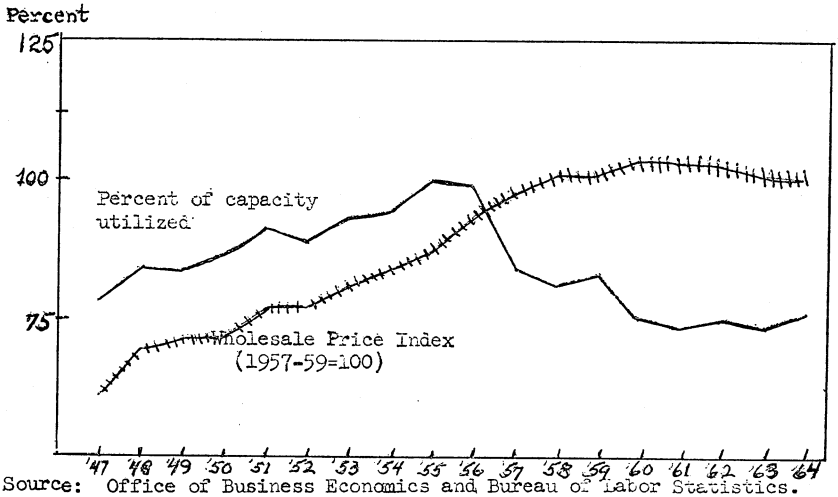
In the immediate postwar period the lifting of price controls and the rush to fill the backlog of unmet construction needs of all types, private and public, sparked a rapid increase in the prices of building materials.

On an overall basis building material prices increased by more than one-third between 1946 and 1947. This was a major factor in the upward spiral of construction costs. Plants producing building materials were operating at or very near capacity. Even these additions to capacity could not keep up with the sizable new construction growth taking place. The Korean conflict of the early 1950's put a temporary damper on capacity expansion and prices of many materials continued to rise even during the period of price controls.

The midfifties saw an upsurge in plant expansion which greatly increased capacity for most building materials industries, still operating at capacity levels. At about the same time some of the newer materials such as aluminum and prestressed concrete began to make inroads into the market of traditional products like lumber and brick. These factors contributed to halting upward price movements.

In the early 1960's many building materials industries were operating well below optimum capacity levels despite the continued growth of new construction. The roofing industry, for example, was operating only a little above half capacity. The cement industry which had tooled up in response to the soaring prospects of the new interstate highway program, expanded very rapidly in the late 1950's and early 1960's. This response seems to have been somewhat greater than was warranted by demand considerations although the need for cost cutting through modernization was an important aspect of plant expansion. Consequently, in recent years cement plants have been generally operating at a level of about three-fourths capacity (chart I). Its price movements effectively depict the imbalance between output and capacity.

CHART I. CAPACITY UTILIZATION AND AVERAGE PRICE OF PORTLAND CEMENT, 1947–1964



Source: Office of Business Economics and Bureau of Labor Statistics.

B. EFFECTS OF PRICE CHANGES ON CONSUMPTION PATTERNS AND CONSTRUCTION COSTS

Price trends for individual building materials, varied greatly during the 20-year period, but because of the dominance of private construc-

tion in affecting total demand, they cannot generally be directly related to changing use patterns in State and local construction. But the substitution of more highly fabricated materials for the purpose of minimizing onsite labor costs and the use of new, inherently less costly materials in all types of construction were factors which influenced price trends.

The average wholesale price rise for all construction materials during 1947–65 was just over 40 percent. However, it should be noted that those materials which are predominantly dependent on the State and local construction sector (table 3) did show above average price changes during the period (table 4), reflecting the more rapid growth of this sector.

Only in the case of structural steel did price rises probably have an impact on its consumption pattern. During the postwar period the prices of structural shapes more than doubled. This contrasts sharply with the price movement of a competitive material, concrete, the price of which increased by only about one-third. Although the value of structural steel increased as a share of State and local construction expenditures (table 2), the steel tonnage consumed per constant dollar of construction activity was less in 1965 than in 1947.

In order to put construction cost developments in the State and local area in perspective it is necessary to sharply distinguish between the divergent cost trends of highways, and those of all other public works.

Because of the precipitous drop-off in unit costs of highway construction between 1948 and 1950, the overall average construction cost for State and local facilities declined. This differed sharply from the cost experience for all new construction in this 2-year period. Cost decreases from 1948 to 1949 reflected the effects of the initial postwar recession. In the 1949 to 1950 recovery period the cost decrease for highways was probably associated with increases in productivity rather than with a decline in the price of materials. Unlike other types of construction, between 1950 and 1959, highway costs were subject to sharp cyclical movements, possible due to the changing mix within highway construction. Since 1960, however, highway cost trends have not differed from overall construction costs (chart II). Prices of materials used for highway construction were stable until 1965, as were the prices of most other types of building materials.

During the early 1960's materials prices going into other than highway construction were not of primary importance in the increase in construction costs which reflected mostly rising wages. The prices of all construction materials from 1961–64 were slightly below the 1957–59 level. This was a period of more than adequate capacity, rising productivity, and strong competition from new products and materials. Actually the prices of some materials such as plywood, aluminum, insulation materials and asphalt roofing dropped markedly and helped to counterbalance the strong forces which were pushing construction costs upward.

The cost of educational and hospital building saw a rapid, almost 90 percent, increase over the 20-year span, but this cannot be primarily ascribed to material price changes. The only cost stable years over this period were 1948–50, during which building materials prices, except for steel and concrete, dropped. These products, which ac-

count for about 20 percent of total expenditures for building construction help explain why overall costs did not drop. Another important material in school and hospital construction, lumber, which accounts for 5 to 10 percent of total construction costs had, aside from the early postwar years, relatively stable prices during the whole 20-year period.

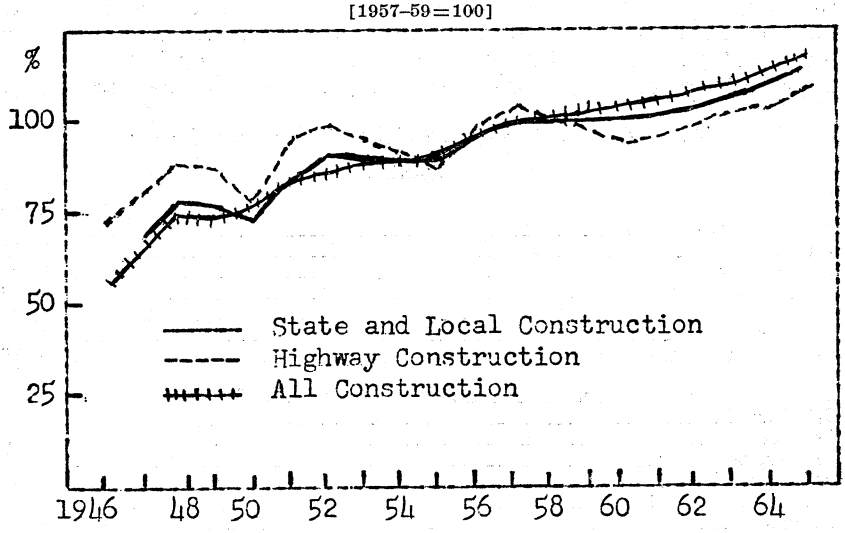
TABLE 4.—*Construction material price changes, 1947–65* [1]

	Total percent change 1947–65
RAPIDLY RISING PRICES [2]	
Structural steel shapes	+143
Wire nails	+115
Reinforcing bars	+107
Asbestos cement shingles	+102
Galvanized sheets	+94
Clay sewer pipe	+77
Steam and hot water heating equipment	+75
ABOVE-AVERAGE PRICE INCREASES [3]	
Window glass	+72
Portland cement	+66
Plaster, base coat	+65
Building brick	+62
Brass plumbing fittings	+62
Millwork	+61
Concrete pipe	+60
Building wire [4]	+56
Concrete ingredients	+54
Selected hardwood lumber	+46
Building paper and board	+44
Gypsum products [4]	+44
Sand, gravel, and crushed stone (rock products)	+43
BELOW-AVERAGE PRICE INCREASES [3]	
Plumbing fixtures and brass fittings [4]	+41
Gypsum lath	+41
Clay tile	+40
Gypsum wallboard	+38
Insulation board	+38
Paint	+37
Concrete products [4]	+35
Metal doors, sash and trim	+33
Enameled iron fixtures	+30
Douglas fir lumber	+29
Vitreous china fixtures	+25
Concrete building block	+25
Plate glass [4]	+24
Heating equipment	+17
Prepared asphalt roofing	+16
Southern pine lumber	+15
Warm air furnaces	+11
Asphalt floor tile	+9
DECLINING PRICES	
Plywood [4]	−5
Insulation materials	−6
Softwood plywood	−8
Nonmetallic sheathed cable	−8

[1] Based on Bureau of Labor Statistics, Wholesale Price Indexes.
[2] The prices of these materials advanced more rapidly during the period than average construction costs which were up 73 percent.
[3] The average increase for all construction materials was 42 percent.
[4] This is a group index. Some of the component materials are also given in this table.

CHART II. CONSTRUCTION COST INDEXES, 1946–1965

[1957–59=100]



Source: Bureau of Public Roads, Bureau of the Census, and Business and Defense Services Administration.

Sewer and water facilities showed a similar 90 percent increase in construction. By far the most important materials for this type of construction, produced by the stone, clay, and glass industry groups, are concrete and clay pipe. Their prices soared by 61 percent and 77 percent, respectively. Large increases in the price of steel products, which account for about 8 percent of total expenditures for these facilities, was also an important aspect of rising construction costs.

III. SIGNIFICANT TRENDS IN BUILDING MATERIALS INDUSTRIES

Output of most building materials industries over the past 20 years has been primarily geared to the needs of private construction. However, the major suppliers of rock products and some types of pipe depend mostly on publicly owned nonbuilding types of construction. The overall growth patterns of building products industries have reflected the substitution of new products for traditional materials as well as the growth and mix changes of construction activity. The impact on a large group of materials differs widely, varying from gains of over 10 percent to declines of 10 percent in average annual change in output (table 5). An example of product substitution is the displacement of radiators and convectors in favor of warm air furnaces. In the case of brick, an average growth rate of 1.7 percent a year occurred despite the substitution of other products such as concrete for traditional brick uses, mainly because of the overall increase in construction activity during the 20 years.

Technological change in construction as a whole since World War II may be characterized best as a wave of change which has been dubbed the "industrialization of building." As a craft-based and geographically fragmented industry, changes in construction technology have in general been initiated from scientifically based external industries,

in many cases the construction materials producing industries. In this connection, perhaps the most striking trend is the relative de-emphasis of on-site craft activities in favor of off-site fabrication in industrial plants. Many new factory-based power tools now produce prefabricated building products and components which formerly were made and put in place with the use of hand tools directly at the construction site. Prefinishing has increased markedly. In the case of aluminum alone, prefinishing was estimated to have tripled between 1957 and 1961. Thus major changes in construction productivity both off and on the site have taken place.

TABLE 5.—*Average annual rates of change in production of selected construction materials* [1] *(1948–63)*

Material	Unit of measure	Production		Average annual percent change
		1948	1963	
FAST GROWTH (5 PERCENT OR MORE)				
Douglas fir (softwood) plywood	Millions of square feet	1,871	9,923	+11.8
Air-conditioning systems, commercial (excluding heat pumps).	Thousands	[2] 84	152	[3] +9.7
Sand and gravel	Millions of short tons	319	831	+6.6
Floor and wall tile, glazed and unglazed.	Millions of square feet	102	266	+6.6
Galvanized sheets	Thousands of short tons	1,643	3,922	+6.0
Asphalt	Millions of barrels	51	111	+5.3
MODERATE GROWTH (0–4.9 PERCENT)				
Warm air furnaces	Thousands	777	1,414	+4.1
Concrete reinforcing bars	Thousands of short tons	1,542	2,683	+3.8
Cement	Millions of barrels	205	353	+3.7
Gypsum, wallboard, including lath	Millions of square feet	5,035	8,658	+3.7
Water heaters, gas	Thousands	1,513	2,602	+3.7
Water closets	do	3,408	5,653	+3.4
Insulating board and hardboard	Thousands of short tons	1,270	2,102	+3.4
Lavatories, total	Thousands	3,303	5,111	+3.0
Flushtanks, vitreous china	do	3,082	4,809	+3.0
Fabricated structural steel	Thousands of short tons	2,718	4,097	+2.8
Calcined gypsum	do	6,249	9,182	+3.6
Cast iron soil and pressure pipe and fittings.	do	1,809	2,590	+2.4
Paint, varnish and laquer	Millions of gallons	272	379	+2.2
Construction paper and board	Thousands of short tons	2,592	3,558	+2.1
Bathtubs, total	Thousands	1,948	2,600	+1.9
Asphalt shingles	Thousands of squares	30,026	39,521	+1.8
Brick, common and face	Millions of standard brick	5,707	7,398	+1.7
Glass, sheet (window)	Thousands of boxes of 50 square feet.	[4] 18,947	24,968	+1.7
Clay sewer pipe and fittings, vitrified	Thousands of short tons	1,433	1,750	+1.3
Steel line pipe	do	1,888	2,260	+1.2
Facing tile, glazed and unglazed (hollow).	Millions of brick	322	366	+.9
Oak flooring	Millions of board feet	832	832	+0.0
DECLINE				
Lumber, total	Billions of board feet	37	35	−.4
Water heaters, electric	Thousands	1,040	950	−.6
Asphalt roll roofing	Thousands of squares	29,913	23,610	−1.6
Gas-fired direct heating equipment	Thousands	2,084	1,218	−3.5
Ponderosa pine doors	do	4,091	1,986	−4.7
Insulated sidings, all types	Thousands of squares	2,560	852	−7.1
Structural clay tile	Thousands of short tons	1,271	377	−7.8
Asphalt siding	Thousands of squares	3,280	794	−9.0
Radiators and convectors	Millions of square feet	60	12	−10.2

[1] Source: "Patterns of Output Growth," Survey of Current Business, September 1964. Measured in physical units.
[2] 1953.
[3] 1957–63.
[4] 1947.

Iron and Steel. The basic iron and steel industry is characterized by a high degree of economic concentration. In 1947, 45 percent of the output of the industry was produced by four major companies, and by the midfifties these companies accounted for more than half of the output. But in terms of fabricated products including most building products, only from one-fifth to one-fourth of the industry's output is concentrated in four companies.

In the basic steel industry there is a long leadtime between the planning stage and effective utilization of new capacity, generally more than 5 years, whereas for all manufacturing the period is shorter. Thus, the steel industry has not been able to respond quickly to capacity pressures. The long leadtime was felt in the immediate postwar years. Production from expanded plant capacity which came in the late forties was not really available until the midfifties when there was a significant increase in output.

However, the lag in increasing capacity has diminished somewhat in the last few years with the development of oxygen injection which reduces the time required for individual heats and increases open-hearth capacity by as much as 30 percent. An increase in capacity in existing plants can be obtained from capital outlays of approximately 20 percent of the cost of equivalent capacity in new plant. It has been estimated that by 1970 about two-fifths of the Nation's capacity may be basic oxygen and this may reach one-half by 1975. The implications for steel construction products are quite favorable from a cost standpoint. In addition, new welding techniques which permit production of a wider range of structural shapes also promises to reduce production costs.

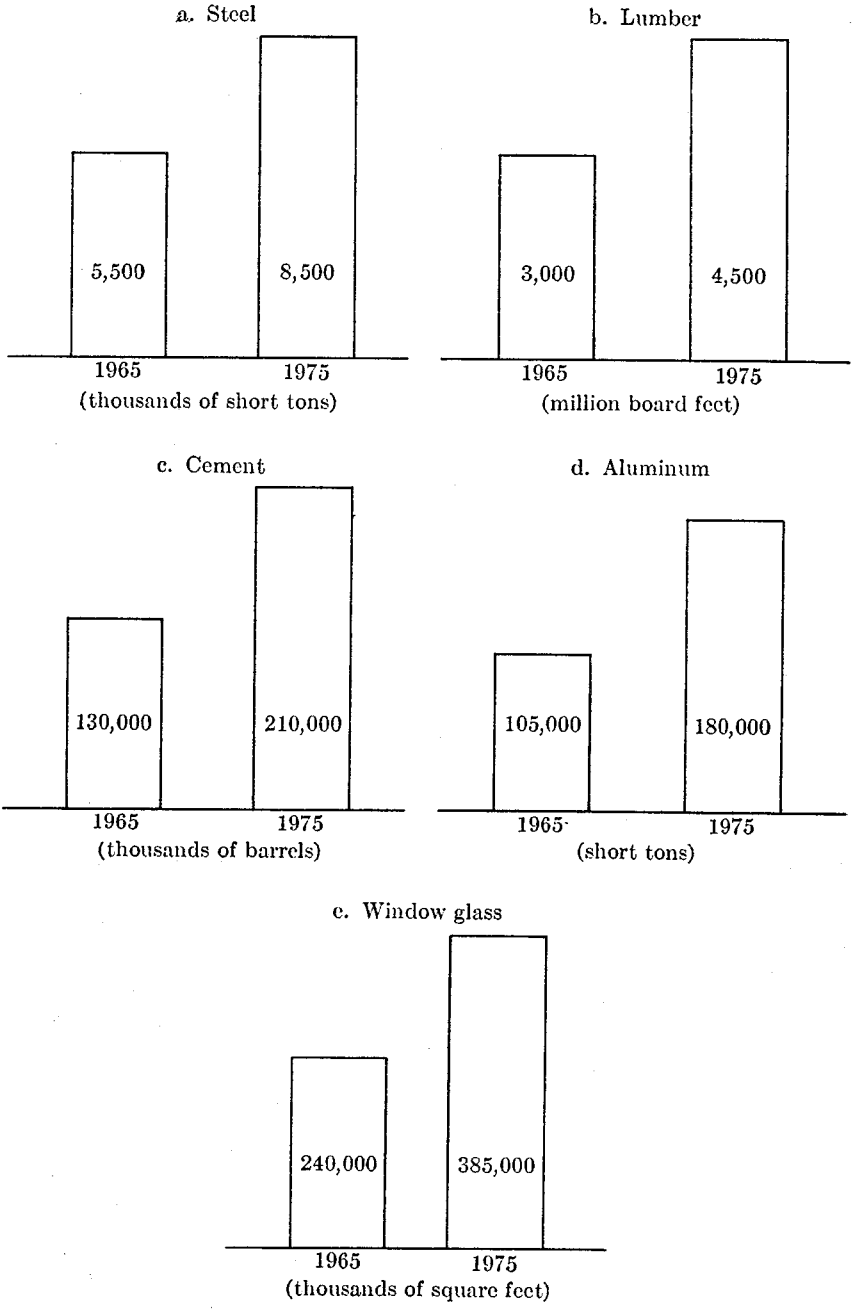
Steel. Iron and steel products will continue to be important in State and local construction although less steel may be used proportionately for structural shapes. The supply of structural steel should be adequate to meet projected construction needs, and domestic production will probably be increasingly supplemented by foreign supply which also may provide considerable price competition for the domestic industry. Another factor pointing toward an increase in steel imports, from the present 10 percent of total supply, is the rising importance of reinforced concrete. The types of steel used in this product are particularly heavy import items.

For State and local construction the growth in aggregate demand for steel will approximate 3 million tons by 1975 (chart IIIa).

Lumber Products. Since the end of World War II substitutions for lumber products have been increasingly made by a variety of other building materials, especially for structural uses (table 2). The production rate of the industry showed an average annual decline of 0.4 percent between 1948 and 1963. In nonresidential buildings the emphasis on fireproof and low-maintenance materials has also resulted in a declining use of many wood products. Although the tendency toward continued substitutions away from lumber will continue, some expansion in the use of wood in nonresidential buildings and the greater use of fire-retardant lumber may reverse this trend. Many building codes and insurance provisions have been revised to allow more use of wood.

While the consumption level of structural lumber used in State and local construction may hold up, it will continue to become a smaller proportion of total lumber used, with concrete particularly gaining more of the market for structurals (chart IIIb).

CHART III.—*Estimated total consumption of five major materials for State and local construction, 1965 and 1975*



Source: Estimated by Business and Defense Services Administration.

Plywood shipments doubled in the 10-year period of 1947–57, and subsequent to 1957 increased at a faster rate than did construction activity. Plywood's growth has been at the expense of less fabricated wood products in applications such as sheathing and subflooring.

Improvements in sawing techniques have resulted in the effective use of much formerly wasted lumber. Leftover material from sawmill operations is used for particleboard, hardboard, and other products. New processes which mold wood by compression into complex forms formerly confined to metals and plastics may also result in some new markets.

Cement. The cement industry, despite a major growth of demand for its products, which forced output to rise 5 percent annually in the postwar period has been encountering serious problems associated with overcapacity. At the end of World II, the industry found that it was somewhat hard pressed to meet the upsurge in demand. Its subsequent major expansion programs, spurred in some measure by highway construction prospects, left the industry by 1960 with much unused capacity which led to falling price levels. Import competition in some areas has also contributed to downward price movements. At the same time, intense competition was developing due partly to the technical changes which took place after the war, and to marketing changes which greatly expanded the geographical scope of the market which could be covered by an individual plant.

The modernization of existing plants and the installation of new, highly efficient equipment in new plants, greatly increased the output capability for a producing unit. Centralized control of instrumentation and the increased use of measurement devices has given the cement iudustry one of the fastest productivity growth rates of all the building materials industries. At the same time, new distribution concepts involving the utilization of low-cost water transportation, along with a system of local distribution facilities made it possible for an individual plant to serve a radius of more than a thousand rather than hundreds of miles.

Expenditures for capital investment are relatively high in the cement industry, but from a technological standpoint, entry has been relatively easy. A very important factor in encouraging entry has been the prospects of high profit to sales ratios.

There is a strong likelihood that cement demand for State and local markets will increase by 1975 by 80 million barrels (chart IIIc).

Concrete Products. The rise in demand for concrete products has grown much more rapidly than construction activity over the past two decades. This rise has been associated with an improvement in the quality of concrete over the years. Improvements have been made in cement, but a major factor has been improved aggregate selection as well as better control of mixing and placement. High strength concrete has been a large factor in high rise buildings in the postwar period. Prior to World War II 16 stories seemed to be the economic and structural limit for the use of concrete but in recent years its use in higher storied buildings is quite feasible. The increased use of concrete products also has been a factor in the average annual growth rate in the production of sand and gravel of almost 7 percent.

An important development in the industry has been the introduction of prestressed concrete. This was used extensively in Europe, but did not make much of an appearance in the United States until

the 1950's. Even by 1959, 78 percent of prestressed concrete producing plants in the United States were less than 5 years old. This growth was generated by a trend toward replacement of steel with concrete, but it is also related to the rise in prefabrication. The rise in demand for concrete products in general seems destined to far outdistance the rise in State and local construction by 1975.

Aluminum. Aluminum construction products have grown quite rapidly during the last few years because of their substitution for wood and other metals. Since 1948 primary aluminum has had an average annual growth rate of over 9 percent a year Its rapidly increasing usage in such items as windows, doors, and trim has been due to its low maintenance requirements, and increasingly important factor in the material demand picture throughout the postwar period.

Growth in aluminum demand stimulated a rapid expansion in plants in the late 1950's. Some new processes, now being developed, promise capital savings of up to 50 percent. The standard reduction process, however, is still expected to produce 90 percent of the primary output in 1975. New metal to metal and metal to nonmetal bonding methods may continue to stimulate new aluminum products for use in construction. An increase in aggregate aluminum consumption of 70,000 tons is in prospect by 1975 (chart IIId).

Other Building Materials and Products. The products of the chemical industry, aside from paints and lacquers, have come into prominent notice as construction materials since World War II. Particularly involved are plastic products. Over most of the postwar period plastics producing industries have grown at an average annual rate of almost 13 percent a year, making them the fastest growing among industries producing building materials. It has been estimated that in recent years about 18 percent of plastics output was for products used in construction. By the mid-1950's about 40 percent of these plastics were in paints, 20 percent in laminates and floor coverings, and another 20 percent in wire coatings and electrical devices. Most of the plastic products are used as substitutes for traditional materials. For example, the use of plastic flooring increased markedly at the expense of oak and maple hardwood flooring, and more recently, plastic pipe and plumbing fixtures have been competing for the markets which have been held by traditional materials.

Advances in insulation have allowed the use of thinner walls in building construction. Foamed materials, especially in glass and plastics for insulation have made possible the rise of curtain wall exteriors and prefabrication.

One of the problems in the expansion of these as well as other new products are the restrictions of local building codes. Current efforts to achieve more unified, flexible and up-to-date codes which put stress on performance rather than enumerating specific materials is a hopeful portent for the next decade.

IV. Future Prospects

The tripling in the volume of new State and local construction over the past 20 years reflects a greater emphasis in the postwar period on satisfying growing public needs rather than viewing construction primarily as an economic stimulus. Public construction volume has been dominated by two types of facilities—highway and educational.

Highway construction alone accounted for about half of State and local construction in the 1947–65 period. The predominance of materials and the development of new laborsaving equipment, which has resulted in higher productivity in this type of construction, has been a dominant factor in the increase of the materials share of public construction outlays from 35 to 50 percent over the past 20 years. In educational construction there have also been new material applications such as increasing use of prestressed concrete in place of brick.

In the next decade it is expected that there will be a further shift in the mix of State and local public works expenditures—with hospital, institutional, sewer, and water construction having the highest growth rates. Highway construction is the only major type which is expected to decrease in relative importance, although in absolute volume it will remain significantly large. These shifts will produce differing growth rates in materials usage. There will be increased emphasis on metal doors, windows, and trim, electrical equipment, pipe, and concrete products with less relative material consumption of fabricated structural steel, lumber products, bitumen, and rock products. Nevertheless, it is expected that the overall materials share of total outlays for construction will remain at about 50 percent.

In the past a steadily growing private market for building materials has been an important factor in stimulating the productive capacity which could also supply the vast volume of public works. Thus, shortages of building materials for State and local construction in the period 1947–65 have not been particularly frequent. Most of the shortages which have taken place have been the result of special factors not directly related to insufficient productive capacity. For example, shortages of structural steel were aggravated by the 1956 steel strike. Shortages of nickel in 1955 contributed to a shortage of stainless steel building sheets. Transportation problems have occasionally caused difficulties for lumbermen in supplying the eastern markets.

During the Korean conflict insufficient productive capacity did finally result in the rationing of such metals as steel and copper. Yet with some product substitution, building materials were available to support a high level of construction activity. In 1955 and 1956 at the height of the economy's investment boom, shortages in a number of building materials occurred. Structural steel and aluminum were in short supply as were gypsum products. From 1954 through early 1957 the cement industry, although expanding rapidly in response to heavy highway construction requirements, was still under pressure to meet demand. Generally, after 1956, few shortages of a serious nature seemed to exist. In 1959, during the extended steel strike, inventories were adequate to supply construction needs throughout the strike period. Construction during the first half of the 1960's seems to have been unhindered by any significant materials shortages.

To meet future increases in construction demand in both the private and public sectors it is expected that the construction and building materials industries will increase their productive capacities. Prefabrication and prefinishing have been and will continue to be important sources of promoting innovation and labor-saving devices on construction sites. This will be particularly true in the lumber and concrete products industries. The trend for prestressed concrete and

softwood plywood to be more heavily used in the place of less fabricated materials will continue. Similarly, aluminum, glass, and plastics should continue to make inroads in the market for traditional materials.

Not to be overlooked is the important role which numerous Federal Government programs will play in stimulating private as well as public construction. Furthermore, actions through appropriate fiscal and monetary policies are likely to avoid sharp swings in the economy. These factors diminish the possibility of shortage or oversupply in the steel industry which requires by its very nature, long leadtimes for the planning and building of new facilities. Since the steel industry must make expansion decisions well in advance of demand itself, it can be expected to respond to a steady growth pattern to which current and future government policy is undoubtedly pointed.

Perhaps one of the big question marks is the effects of inflationary conditions on construction. Prices of building materials have risen about 40 percent over the past 20 years. In the next decade it would not be unreasonable to expect at least a 10–15 percent aggregate rise. Such a rise could, however, reflect mainly general price movements and result from cost-push type of pressures rather than the effects of inadequate capacity.

When one considers all the factors, it is difficult to avoid the conclusion that the construction materials industries should be able to meet the needs of future construction—as they have in the past—through innovation, product development, and increased productive capacity.

APPENDIX

Data for chart I: Capacity and price of portland cement, 1947–64

Year	Capacity	Price 1957–59=100	Year	Capacity	Price 1957–59=100
1947	78	60.9	1956	99	93.2
1948	84	68.7	1957	84	98.0
1949	83	70.6	1958	81	100.5
1950	87	72.1	1959	83	101.5
1951	91	77.7	1960	75	103.5
1952	89	77.7	1961	74	103.3
1953	93	81.5	1962	75	103.1
1954	94	84.4	1963	74	101.5
1955	100	87.7	1964	76	101.0

Source: "Business Statistics, 1965," Office of Business Economics, and Wholesale Price Index, Bureau of Labor Statistics.

Data for chart II: Construction cost indexes for State and local, highway, and all construction, 1946–65

Year	BPR	State and local	Composite	Year	BPR	State and local	Composite
1946	70.7	(1)	56	1956	98.8	95.3	95
1947	80.3	69.8	67	1957	103.1	99.5	99
1948	89.8	77.2	75	1958	100.5	100.2	100
1949	86.7	76.4	74	1959	96.4	99.9	102
1950	78.3	74.6	77	1960	94.1	100.7	103
1951	96.1	83.7	84	1961	95.0	102.2	104
1952	98.9	87.4	86	1962	98.5	104.7	107
1953	95.3	88.6	88	1963	101.0	107.7	109
1954	89.9	87.8	88	1964	102.0	110.9	112
1955	87.3	87.9	90	1965	105.9	114.4	116

[1] Not available.

Source: Bureau of Public Roads, Bureau of the Census, and Business and Defense Services Administration.

Data for chart III: Estimated total consumption of 5 major materials for State and local construction, 1965 and 1975

	1965	1975
A. Steel (thousand short tons)	5,500	8,500
B. Lumber (million board feet)	3,000	4,500
C. Cement (thousands of barrels)	130,000	210,000
D. Aluminum (short tons)	105,000	180,000
E. Window glass (thousands of square feet)	240,000	385,000

Source: Estimated by Business and Defense Services Administration.

CHAPTER 3

Labor Requirements for State and Local Public Works, 1946–75*

This chapter presents estimated construction employment requirements for State and local construction activity. These estimates have been derived in the course of work done in the Bureau of Labor Statistics concerning labor and material requirements for various segments of the construction industry based on contractor's records.

To provide perspective, employment and related data for the total construction industry are also presented in this chapter. It should be noted that employment requirements for State and local government construction activity are estimates for man-years[1] while estimates for the construction industry as a whole are estimates of the number of persons employed (monthly report on the labor force) or number of persons on the payrolls of construction contractors (Bureau of Labor Statistics establishment data).

I. Employment Generating Effects of State and Local Public Works Construction

In 1947, State and local public works construction amounted to a little more than $2.5 billion and resulted in the employment equivalent of 625,000 full-time workers (man-years of employment). Currently nearly $18 billion is being expended, utilizing the equivalent of over 1,800,000 full-time workers (table 1).

TABLE 1.—*Volume of State and local public works construction and estimated man-years of employment, selected years, 1947–65*

Year	Value of construction (in millions of dollars)	Man-years of employment (thousands)				
		Total	Construction			Other[1]
			Total	On site	Off site	
1947	2,598	625	279	(2)	(2)	346
1950	5,494	1,047	451	404	47	596
1955	9,375	1,377	585	518	67	792
1960	12,829	1,570	656	586	70	914
1965	17,864	1,862	752	670	82	1,110

[1] Including workers in architectural and engineering establishments.
[2] Not available.

While dollar volume has increased about 600 percent, employment requirements have risen less than 200 percent. The lower labor requirements per million dollars for the later periods result from two

*Prepared by the Department of Labor, with minor editing by committee staff.

[1] A man-year in the construction trades was considered to be 1,800 man-hours. In other industries, it was considered to be 2,000 hours.

major factors: (1) price increase, which makes the increase in dollar volume overstate the actual increase in physical volume and (2) the increased productivity which has greatly reduced both the on-site and off-site labor requirements.

In 1947 a little less than half (45 percent) of the employment required was in the construction industry. In 1965 the construction industry proportion had dropped to 40 percent, largely reflecting the increased use of prefabrication. It is estimated that a little over half of the employment outside of the construction industry is engaged in making, selling, and transporting the material used to the construction site. The balance of the other employment is utilized in all other sectors of the economy in supplying the raw materials and services required by the construction materials and equipment manufacturing industries. The figures do not include any estimate of resulting government employment or employment generated by the respending of wages and profits which is generally called the "multiplier effect."

In general, the total employment effect of various types of construction do not vary to any great degree. At present, $1 million of almost any type of construction expenditure gives 1 year of employment to approximately 100 men. The only substantial differences in employment effect of various types of construction are in the industries and occupations affected. (See table 2.)

The construction industry gets the majority of the employment only in a few types of construction such as dredging and public housing. In most types of construction the employment created by the manufacture and distribution of the materials is greater, generally by about 25 percent or more.

The principal differences in the employment effect of various types of construction are in the manufacturing industries affected. The lumber industry, for example, is affected twice as much by school construction as for hospital construction. The three manufacturing industry groups most greatly affected by construction are: stone, clay, and glass products; primary metal industries; and fabricated metal products.

Construction trade occupations are also affected in varying degrees by type of construction. For example, three times as many plumbers are used in hospital construction as in an equal amount of home construction.

TABLE 2.—*Estimated 1966 labor requirements for selected types of construction*

Industry and occupation	Man-years per million dollars [1]									
	Private housing (1-family)	College housing	Highways	Land operations	Dredging	Schools	Federal office buildings	Hospitals	Public housing	Sewage projects
Total	99.3	102.9	101.4	92.6	107.3	100.2	102.2	100.8	105.7	103.9
Construction industry	40.4	48.8	44.7	39.3	64.1	42.4	47.2	44.0	55.2	44.2
On-site	34.6	43.7	42.3	37.5	59.1	37.3	42.1	38.6	49.3	40.8
Administrative and supervisory	1.0	1.5	4.3	4.1	3.8	1.4	2.5	1.5	1.9	3.9
Construction trades	25.4	27.8	25.3	18.9	[3] 27.7	23.9	25.4	26.3	31.4	14.7
Bricklayers	1.9	4.4	[2]			3.4	2.2	2.1	3.7	.7
Carpenters	11.9	7.3	[2]	2.4		6.8	5.3	5.1	9.4	3.1
Electricians	.9	2.9	[2]	.1		2.6	3.8	3.4	2.1	.6
Ironworkers		1.7	[2]	1.2		1.0	1.8	1.3	1.0	.8
Operating engineers	.5	.7	[2]	9.0	.7	.7	1.0	.6	1.3	
Painters	3.3	1.6	[2]	.1		1.2	.9	1.1	2.2	.3
Plasterers and lathers	.8	1.5	[2]			1.0	1.7	2.4	3.3	
Plumbers	1.8	4.2	[2]	.1		3.4	3.7	5.5	3.9	1.0
Unskilled	8.2	14.2	12.7	14.3	27.6	11.1	14.2	10.7	15.9	22.0
Off-site	5.8	5.1	2.3	1.8	5.0	5.1	5.1	5.4	5.9	3.4
Other industries	58.9	54.1	56.7	53.3	43.2	57.8	55.0	56.8	50.5	59.7
Manufacturing	27.9	32.4	29.3	22.9	24.4	31.3	30.3	31.9	26.2	33.5
Trade, transportation, and services	19.5	14.2	19.5	20.2	13.6	19.2	18.1	18.4	16.8	18.8
Mining and all other	11.5	7.6	8.0	10.3	5.3	7.4	6.6	6.7	7.6	7.4

[1] Based on 1,800 hours per man-year in construction and 2,000 hours per man-year in other industries.
[2] Data not available.
[3] All skilled workmen, including maritime.

II. Construction Industry Employment and Its Characteristics

EMPLOYMENT TRENDS

Employment in the construction industry [2] increased from 3.6 million workers in 1950 to 4.6 million workers in 1965, an increase of 28 percent. However, most of this gain occurred between 1950 and 1952 when employment rose to 4.2 million persons. Employment fell to 3.8 million in 1955 and, since then, employment has been increasing gradually, except for a few years in the early 1960's. By 1965 employment in the construction industry had reached an all-time high, and indications in early 1966 were that employment would go even higher. Increased State and local public works construction has been an important factor in the 1950–65 increase in construction employment. Construction labor requirements for State and local public works increased from 1950 to 1965 by about 300,000 man-years (table 1). However, the proportion of the total increase in construction employment attributable to State and local construction activity would be even greater than implied by the 300,000 increase in man-year requirements because the average construction worker did not work a full man-year.

The proportion that wage and salary workers make up of all workers in the construction industry between 1950 and 1965 has been relatively constant at about 70 percent. On the other hand, there was some reduction in the proportion of self-employed and unpaid family workers and an increase in the proportion of government workers.

SKILL DISTRIBUTION

Between 1958 and 1965, total blue-collar workers—craftsmen, operatives, and laborers—accounted for about four-fifths of construction industry employment during the period. Construction craftsmen alone maintained a relatively consistent 50 percent of employment in the construction industry.[3] (See table 3.) Operatives increased slightly and construction laborers declined slightly as a proportion of construction employment. In the white-collar group, clerical workers increased their share slightly. Professional, managerial, and sales workers had relatively stable shares up to 1965 when professional workers increased as a percent of construction employment and managerial workers decreased somewhat.

SELECTED SKILLED OCCUPATIONS

Because of the changing mix of construction activity and because of changing construction techniques, some construction craft occupations between 1950 and 1965 grew faster than others and some even declined. Employment of carpenters in the construction industry

[2] The construction industry includes establishments engaged in contract construction and government agencies engaged in construction and related activities such as highway maintenance and land reclamation. The contract construction industry on the other hand includes wage and salary workers in private establishments performing construction activities, including new construction and maintenance and repair, on a contract basis.

[3] The 1950 and 1960 Censuses of Population indicate that the proportion of craftsmen in the construction industry declined somewhat between these years. However, these census data are not directly comparable with the BLS data (Monthly Report on the Labor Force) because the Census of Population data are for April only, a seasonally low month for construction. Also, there are some conceptual differences between the two sources. The census data are also not comparable with data based on establishment surveys. See footnote on table 2.

was significantly lower—by 175,000. Employment of painters, paperhangers, and plasterers was also lower. On the other hand, employment of excavating, grading, and road machinery operators was more than twice as high in 1965 as in 1950. Other significant employment increases were experienced by cement and concrete finishers, electricians, and plumbers.

TABLE 3.—*Employed persons, by major occupation group, in the construction industry, 1958–65* [1]

[Percent distribution]

	Year							
	1965	1964	1963	1962	1961	1960	1959	1958
All occupations	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Professional, technical, and kindred workers	5.1	4.5	4.5	4.4	4.9	4.7	4.4	4.5
Managers, officials, and proprietors, except farm	11.1	12.4	12.9	13.2	12.3	12.2	11.9	12.1
Clerical and kindred	5.3	4.9	4.9	5.3	4.7	4.6	4.5	4.3
Salesworkers	.2	.2	.2	.2	.2	.3	.4	.3
Craftsmen, foremen, and kindred	50.4	50.0	50.8	49.7	51.0	50.4	50.3	49.8
Operatives and kindred	9.9	9.9	9.3	9.2	8.5	8.7	8.7	8.9
Service workers	.5	.5	.5	.5	.4	.5	.4	.5
Laborers	17.5	17.6	16.9	17.4	17.9	18.7	19.4	19.4

[1] The data in this table are based on household surveys. A distribution of employment by occupation based on establishment surveys indicates a somewhat smaller proportion of employed persons in the white-collar occupations and a somewhat larger proportion in blue-collar occupations, especially construction laborers.

NOTE.—Because of rounding, sums of individual items may not equal totals.

Source: Bureau of the Census and Bureau of Labor Statistics.

CONSTRUCTION EMPLOYMENT BY TYPE OF CONTRACTOR

In viewing employment trends in the construction industry, valuable insight can be gained from examining employment shifts by broad type of construction activity. The Bureau of Labor Statistics collects data for private wage and salary employees on the payrolls of general building, heavy construction, and special trades contractors. However, these data are not directly comparable with the construction employment data (from the Monthly Report on the Labor Force) discussed earlier, which are for all employees (wage and salary, self-employed, government, and unpaid family workers). Also, unlike the labor force data an employee may be counted more than once if he appears on more than one payroll.

In 1965, almost half of the workers in the contract construction division were employed by special trades contractors; about 30 percent were employed by building construction general contractors; and the remainder worked for heavy construction general contractors. (See table 4.)

Employment increased by about 80 percent in the special trades contractors major industry group between 1947 and 1965, mainly because of the increasing importance of electrical, plumbing, air conditioning, and other work usually performed by special trades contractors. Employment grew by about three-fourths in the heavy construction contractors major industry group—spurred by a fourfold increase in highway construction (in constant dollar terms), as well as increases in the construction of sewer and water systems, airports,

bridges, dams, and similar projects. Employment by building construction general contractors increased by about 35 percent between 1947 and 1965—less than half as rapidly as in the other two segments; however, employment was 5 percent lower in 1965 than in 1956, reflecting in part, a slowdown in the rate of increase in residential construction activity.

TABLE 4.—*Wage and salary employees in the contract construction industry and major subgroups, annual averages, 1947–65*

[In thousands]

Year	Contract construction		General building contractors		Heavy construction		Special trade contractors	
	All employees	Construction workers	All employees	Construction workers	All employees	Construction workers	All employees	Construction workers
1947	1,982	1,759	762.0	689.0	363.0	321.0	857.0	749.0
1948	2,169	1,924	837.0	756.0	389.0	343.0	944.0	825.0
1949	2,165	1,919	809.0	731.0	401.0	354.0	955.0	834.0
1950	2,333	2,069	875.0	791.0	419.0	370.0	1,039.0	908.0
1951	2,603	2,308	991.4	895.8	461.6	407.0	1,149.6	1,005.2
1952	2,634	2,324	983.2	882.3	481.4	423.6	1,168.8	1,018.2
1953	2,623	2,305	969.2	863.3	480.1	426.7	1,174.0	1,015.2
1954	2,612	2,281	937.1	832.0	471.0	418.7	1,203.5	1,030.5
1955	2,802	2,440	997.2	880.1	483.8	429.7	1,320.8	1,130.1
1956	2,999	2,613	1,074.6	950.4	556.7	493.4	1,367.6	1,168.8
1957	2,923	2,537	986.8	866.2	576.0	512.9	1,360.6	1,158.2
1958	2,778	2,384	893.6	775.2	564.6	498.1	1,320.2	1,110.3
1959	2,960	2,538	959.0	834.4	586.5	516.8	1,414.1	1,186.9
1960	2,885	2,459	908.4	785.4	585.7	511.5	1,390.7	1,162.3
1961	2,816	2,390	874.9	752.6	583.3	505.7	1,357.9	1,131.3
1962	2,902	2,462	882.1	755.8	593.1	514.8	1,426.6	1,191.8
1963	2,963	2,523	914.1	787.0	599.2	522.5	1,449.3	1,213.9
1964	3,056	2,602	956.6	823.9	610.5	526.5	1,488.4	1,251.2
1965	3,211	2,731	1,024.9	880.6	634.1	547.6	1,552.3	1,302.9

Source: Bureau of Labor Statistics.

EMPLOYMENT OUTLOOK FOR BUILDING TRADES WORKERS IN THE CONSTRUCTION INDUSTRY

Employment in the building trades is expected to increase moderately through the mid–1970's, assuming relatively full employment nationally and the high levels of economic activity needed to achieve this goal. (If the high levels of economic activity are not achieved, employment in the building trades will increase at a slower rate than that projected.) In addition to employment growth, tens of thousands of job openings will result from the need to replace experienced workers who transfer to other fields of work, retire, or die.

The moderate increase in total employment in the building trades is expected to result primarily from the rapid rise in the level of construction activity. The factors that will stimulate construction activity include anticipated large increases in population and in the number of households; a continuing shift of families from the cities to the suburbs; increases in government expenditures for highways and schools; a rise in expenditures for new industrial plant capacity; and higher levels of personal and corporate income. In addition, there will be a growing demand for alteration, modernization, and maintenance work on existing structures.

The increase in building trades employment will not be as great as the total expansion in construction activity, because continued technological developments in construction methods, tools and equip-

ment, and materials will permit increasing output per construction worker.

The rates of employment growth will differ among the various building trades. Employment growth is expected to be most rapid for structural metal workers; excavating, grading, and road machinery operators; and cement masons. Among the trades that will have a much slower growth are bricklayers, stonemasons, and marble and tile setters; painters; and carpenters.

TABLE 5.—*Estimated opening for selected craft occupations in the construction industry resulting from growth of employment requirements and from retirements and deaths, 1965–75* [1]

[In thousands]

Occupation	Employment 1965	Employment requirements 1975	Openings, 1965-75		
			Total openings	Net growth	Deaths and retirements
Carpenters	665	670	165	5	160
Bricklayers, stonemasons, and tile and marble setters	180	200	50	20	30
Cement and concrete finishers [2]	55	75	30	20	8
Electricians	165	200	65	35	30
Excavating, grading, and road machinery operators	190	265	105	75	30
Painters	285	305	95	20	75
Paperhangers	10	13	6	3	3
Plasterers	50	55	15	5	10
Plumbers and pipefitters	220	265	90	45	45
Roofers and slaters	55	65	20	10	8
Structural metal workers	40	60	30	20	8

[1] These projections were developed by the Bureau of Labor Statistics in the course of its continuing occupational outlook research program, especially its work for the 1966-67 edition of the Occupational Outlook Handbook.

[2] Includes terrazzo workers.

UNEMPLOYMENT IN THE CONSTRUCTION INDUSTRY

Since the end of World War II, unemployment in the construction industry has averaged more than twice that of all workers. Two major reasons for the higher than average rate of unemployment in the construction industry are: (1) Construction activity is affected by weather and is a very seasonal industry, especially in the less temperate parts of the country where the winter months are a slow season; and (2) construction workers have to spend time finding new jobs as individual construction projects are completed. (Construction workers may work for a dozen or more employers in a calendar year.) Over the 1948–65 period, the unemployment rate for experienced workers in the construction industry has been between 2 and 2½ times the unemployment rate for all experienced workers, except in 1953 when it was 2.7.

SHORTAGES OF CONSTRUCTION WORKERS

Because construction is cyclical as well as seasonal, the demand for construction workers rises and falls significantly over the course of the business cycle. The construction labor force is fairly flexible, with considerable movement of building trades workers between construction and other industries.[4] But, despite this flexibility, the con-

[4] See Special Labor Force Report No. 35—Job Mobility in 1961, Bureau of Labor Statistics, U.S. Department of Labor.

struction industry sometimes is not able to attract sufficient skilled workers during peak periods of demand. Short-term deficiences of skilled building trades workers are not readily alleviated through increased training activity because of the long period generally required to train skilled building trades workers. (In fact, training of apprentices may be reduced during a period of high demand to the extent that some apprentices prematurely terminate their training program because of the ease of obtaining work at the journeyman level.)

Because of the local nature of much of the construction industry, there may be shortages of skilled building trades workers reported in one region—while at the same time unemployment is higher than normal in another region. This, in combination with the ordinarily high level of frictional unemployment associated with the industry, means that shortages for building trades workers can exist even when unemployment rates for these workers are high relative to the national rates for all workers in the labor force.

Current employment data indicate growing pressures on the supply of trained construction manpower during the remainder of 1966. Employment in the construction industry in 1965 averaged 4.6 million, 2.9 percent above 1964. Conversely, unemployment for experienced workers in the industry during 1965 averaged 9.0 percent compared with 9.9 percent in 1964. The current employment rate in construction is the lowest (for comparable months) since Korea. In March 1966, the unemployment rate for experienced workers in the construction industry was 8.8 percent, considerably below the 12.3 percent in March 1965. For carpenters, the rate had fallen from 11.8 percent to 8.1 percent. For other construction craftsmen the rate had fallen from 10.3 percent to 7.8 percent. For laborers the rate fell from 22.7 percent to 15.6 percent. The most recent data indicate that laborers made up approximately one-third of total unemployed construction workers.

Currently, shortages of some building trades workers are being reported, especially in the North Central States. Trades most often mentioned as being in short supply are electrical workers, plumbers and pipefitters, ironworkers, carpenters, bricklayers, and sheet metal workers.

AGE DISTRIBUTION OF EMPLOYEES IN THE CONSTRUCTION INDUSTRY

In 1960 the median age of male employees in the construction industry was approximately the same as for all employed male workers in the American economy. One major difference was a relatively smaller proportion of construction workers employed in the very young group, 14 to 19 years of age. (See table 6.)

This lower proportion of young workers in the construction industry is probably due to regulations prohibiting employment of extremely young workers in many of these occupations in many States.

Data are not available on the age distribution of building trades workers in the construction industry; however, they are available for selected building trades in all industries. (Approximately 70 percent of all building trades workers are employed in the construction industry.) The following table presents these data plus the proportion of workers in each occupation 45 and over—a key factor in determining future replacement needs.

TABLE 6.—*Age distribution and median age of all employed males and males employed in the construction industry, 1950 and 1960 (14 years old and over)*

[Percentage distribution]

Years of age	1960		1950	
	All employed males	Employed in construction	All employed males	Employed in construction
Total	100.0	100.0	100.0	100.0
14 to 19	5.7	3.2	4.9	2.9
20 to 24	8.4	8.4	9.7	9.3
25 to 29	10.4	10.5	12.2	12.3
30 to 34	12.0	12.7	12.2	12.2
35 to 44	24.2	26.2	23.5	24.6
45 to 54	20.7	21.7	18.8	20.1
55 to 64	13.8	13.4	13.0	13.5
65 and over	4.8	3.9	5.6	5.1
Median age (years)	40.6	40.8	39.7	40.4

Source: Bureau of the Census.

TABLE 7.—*Median age and proportion 45 years of age or more for selected building trades, 1950 and 1960 (males, 14 years of age or more)*

Occupation	Median age		Change in years 1950 and 1960	Proportion 45 and over	
	1950	1960		1950	1960
Brickmasons, stonemasons, and tile setters	40.4	37.7	−2.7	39.8	30.4
Carpenters	43.4	43.3	−.1	46.1	45.5
Cement and concrete finishers	41.7	40.0	−1.7	41.6	35.0
Electricians	39.2	40.8	+1.6	34.2	37.8
Excavating, grading, and road machinery operators	37.8	39.8	+2.0	25.6	34.3
Painters	43.6	45.4	+1.8	46.4	50.9
Paperhangers	49.2	50.9	+1.7	57.6	65.5
Plasterers	41.0	40.1	−.9	41.1	36.4
Plumbers and pipefitters	40.9	42.2	+1.3	38.6	41.8
Roofers and slaters	36.3	37.0	+.7	28.3	30.1
Structural metal workers	39.2	41.0	+1.8	33.8	37.0

Source: U.S. Bureau of the Census.

Seven of the eleven selected building trades shown in table 7 experienced an increase in median age between 1950 and 1960. Only two had a change of 2 or more years.

In general, the median age was highest in occupations growing slowest, or even declining, reflecting the relatively slight influx of young workers. For example, the three occupations with the highest median age in both 1950 and 1960—paperhangers, painters, carpenters—recorded employment declines during the 10-year period.

POPULATION AND CONSTRUCTION EMPLOYMENT

Trends in the contract construction industry are closely related to population growth. A growing population requires additional housing units, schools, hospitals, commercial buildings, factories, and highways. Logically, the relationship between population and construction employment would seem to be particularly close for housing, schools, and hospitals. In addition, population growth increases the need for

construction workers to perform remodeling, maintenance, and repair work.

In spite of the importance of population as a longrun determinant of changes in contract construction by State, other factors also play a significant role. Expenditures for national defense, natural resources development, highway construction, and other government programs, as well as shifts in industrial distribution, can obscure the relationship between population and contract construction employment. North Dakota, for example, ranked 3d in contract construction employment growth between 1947 and 1965, although it ranked 45th in population growth increase. Apparently the increase in construction employment was a result in large part of the increase in military prime contract awards and expenditures for construction of new plants.

Employment in heavy construction firms (who build highways, dams, pipelines, refineries, etc.), is not as dependent upon population as employment by general and special trade contractors, who are more likely to work on schools, homes, medical facilities, and perform necessary maintenance and repair.

UTILIZATION OF PUBLIC WORKS FACILITIES

Information gathered from various parts of the Nation revealed that, in the main, public facilities are being fully utilized, although there are a few instances, particularly in medical services, where utilization of facilities is below capacity because of shortages of skilled personnel, especially in the nursing profession.

Several hospitals were found to have delayed opening of additional facilities or new wings because of a shortage of nurses. The information gathered may indicate that in some instances construction of additional facilities may be delayed somewhat because hospital administrators find it difficult to staff additional facilities. However, most hospitals are required to operate and serve the community in spite of all difficulties. If necessary, this may sometimes mean lowering personnel requirements. But in hospitals, which deal with human lives, the possibility of lowering standards for doctors, nurses, etc., is extremely limited. Through the greater use of practical nurses, nurses aids, medical technologists, etc., manpower shortages have been lowered to some extent. In some States, an accelerated 2-year training program has been utilized to train associate nurses, who subsequently qualify as registered nurses.

In general, school systems seem to have much more leeway than hospitals in adjusting to personnel shortages by lowering standards. A school district faced with a pressing school population may be required to utilize all available classroom space with insufficiently accredited teachers. There is no widespread evidence that the education structures of this Nation are not being fully utilized. On the contrary, school construction expands each year throughout the Nation to meet the challenge of a growing population. In New York City, for example, the public school system has had a general shortage of accredited teachers. To solve this problem, the board of education has recruited out-of-city teachers and noneducation degree college graduates as qualified instructors.

TRAINING CONSTRUCTION WORKERS

Workers who entered the construction industry between 1946 and 1965 acquired their skills in a variety of ways. Workers whose skills are not unique to the construction industry, such as accountants, draftsmen, bookkeepers, office machine workers, and secretaries received their training in much the same way as these workers in other industries; for example, through training in high schools, colleges, business schools, correspondence schools, and on-the-job instruction. Although construction craftsmen are employed in nearly every industry, more than 70 percent are employed in the construction industry and their training is more specifically oriented to that industry than the training of the workers referred to above.

Table 8, based on a BLS survey for the Office of Manpower Training and Automation,[5] shows the ways in which construction craftsmen (as of April 1963) learned their skills and what ways they thought most helpful. Formal methods included technical school training, apprenticeship, and training in the Armed Forces. On-the-job learning included instruction by supervisors and fellow workers. Casual methods included learning from friends or relatives or "just picking it up." The study showed that construction craftsmen believed casual methods most important in learning their skills, on-the-job training next important, and formal methods least important. About one in nine construction craftsmen believed that apprenticeship was the most helpful way. However, the contribution of apprenticeship is probably more significant than indicated by this ratio. Most training authorities recommend formal apprenticeship training as the best way to acquire the all-round proficiency of craftsmen in the building trades. This type of training provides the apprentice with a balanced knowledge of his field of work and enables him to perform his operations completely. In large part, apprenticeship provides the highest skilled workers (who provide guidance to others) and a significant proportion of future foremen. A study of apprentices who completed their programs in 1950 found that by 1956 about 20 percent were employed as supervisors, and another 10 percent as contractors.[6] Table 9 shows the average number of apprentices per 100 active journeymen during the 1950–64 period, and provides some indication of the extent of apprenticeship training in the construction trades between 1950 and 1964.

Table 10 shows the number of apprentice registrations,completions, and cancellations for construction craftsmen in Bureau of Apprenticeship and Training registered programs; however, not all apprentices are covered in these data.[7]

Cancellations represent a loss of potentially highly trained workers, but this loss is not as significant as it appears since many apprentice dropouts secure some training and eventually become skilled journeymen through less formal means. Indeed, many apprentices may drop their apprenticeship because of opportunity for employment at the journeyman level. The proportion of apprentices who complete their apprenticeship varies significantly by occupation. (See table 10.)

[5] U.S. Department of Labor, Formal Occupational Training of Adult Workers, Manpower/Automation Research Monograph No. 2, December 1964. Table 11, p. 43.
[6] Bureau of Apprenticeship and Training, Career Patterns of Former Apprentices, Bulletin T–147, 1959.
[7] "Training of Workers in American Industry," U.S. Department of Labor, Bureau of Apprenticeship and Training.

TABLE 8.—*All ways and most helpful way of learning current job, by current occupation, April 1963*

[Percent distribution of civilian workers 22 to 64 years old who completed less than 3 years of college]

Current occupation	Total in occupation	All ways of learning					Most helpful way of learning									Not available
							Formal training			On-the-job learning			Casual methods			
		No training needed	Formal training	On-the-job learning	Casual methods	Not available	School	Apprenticeship	Armed Forces	On-the-job instruction	Company training course	Worked way up	From friend or relative	Picked it up	Other	
Total, all occupations	100	7.5	30.2	56.2	45.4	1.6	8.7	2.0	1.2	29.6	3.6	3.9	6.0	20.4	2.5	14.6
Construction craftsmen	100	1.7	39.4	54.8	57.2	.9	4.3	11.0	2.2	24.8	.9	2.2	10.5	21.9	1.5	19.0
Brickmasons, stonemasons, and tile-setters	100	2.5	44.7	56.6	53.5	-------	6.9	12.6	-------	27.7	-------	1.3	15.1	13.2	-------	20.8
Carpenters	100	2.8	31.1	48.7	67.8	.6	2.4	7.0	2.3	21.9	1.2	2.3	14.2	28.1	1.7	16.2
Electricians	100	-------	72.9	71.2	33.4	-------	10.7	20.5	4.9	24.9	1.9	2.2	1.9	6.6	1.4	24.9
Excavating, grading, and road machinery operators	100	2.2	11.2	47.0	72.2	1.0	.6	.6	2.6	23.6	-------	3.2	8.6	40.6	3.5	14.4
Painters	100	1.9	27.8	46.9	58.7	.5	5.4	12.0	.5	22.9	.9	1.2	17.2	21.5	-------	16.5
Plumbers and pipefitters	100	.7	55.0	66.6	39.1	2.6	3.0	15.6	.7	35.1	-------	2.3	5.3	10.3	2.0	25.1
Tinsmiths, coppersmiths, and sheet-metal workers	100	-------	70.9	58.1	44.4	1.7	10.3	13.7	4.3	20.5	1.7	4.3	-------	27.4	1.7	16.2
Other construction craftsmen	100	1.1	34.1	59.1	68.8	2.3	-------	14.8	3.4	27.9	-------	1.1	9.1	17.0	1.1	24.4
Cranemen, derrickmen, and hoistmen	100	1.7	17.5	60.0	49.2	1.7	-------	-------	7.5	35.0	4.2	4.2	5.8	23.3	3.3	15.0

Source: U.S. Department of Labor, Formal Occupation Training of Adult Workers Manpower/Automation Research Monograph No. 2, December 1964.

NOTE.—Since some persons indicated more than 1 way, sums of ways, when added to "No training needed," exceed 100 percent.

TABLE 9.—*Average ratio of apprentices per 100 active journeymen for selected occupations 1950–1964* [1]

Occupation	Average 1950–64
Bricklayers	7. 4
Carpenters	4. 3
Electricians	13. 2
Iron Workers	5. 0
Painters, paperhangers, and glaziers	3. 3
Plasterers and cement masons	6. 8
Plumbers and pipefitters	10. 2
Roofers	12. 3
Sheet metal workers	12. 7

[1] Based on the number of journeymen working or available for work, to the number of persons working under apprenticeship agreements.

Source: Bureau of Apprenticeship and Training, based on data collected by the Bureau of Labor Statistics from building trades unions in 52 cities with 1950 populations of 100,000 or more.

TABLE 10.—*Registered apprentices in training, new registrations, completions, and cancellations, 1952-64*

Year	In training on Jan. 1—	New registrations [1]	Completions	Cancellations [2]	In training on Dec. 31—
1952	77, 920	33, 316	15, 679	18, 756	76, 801
1953	76, 801	37, 102	13, 523	18, 393	81, 987
1954	81, 987	34, 238	15, 537	18, 951	81, 737
1955	81, 737	47, 238	13, 444	14, 632	100, 899
1956	100, 899	42, 873	14, 588	16, 565	112, 619
1957 [3]	114, 166	38, 506	17, 344	24, 466	110, 862
1958	110, 862	34, 485	20, 255	16, 278	108, 814
1959	108, 814	37, 894	21, 067	18, 942	106, 699
1960	106, 699	33, 939	16, 656	21, 019	102, 963
1961	102, 963	33, 446	17, 251	18, 407	100, 751
1962	100, 751	36, 994	16, 477	18, 222	103, 046
1963	103, 046	36, 763	15, 559	17, 337	106, 913
1964	106, 913	38, 556	16, 286	19, 347	109, 836
1965	109, 836				

[1] Includes reinstatements.
[2] Cancellations are not synonymous with "dropouts," since they included layoffs, discharges, out-of-State transfers, upgrading within certain trades, and suspensions for military service, as well as voluntary "quits."
[3] Lathers included for the 1st time, no prior reports for this trade.

Source: U.S. Department of Labor, Bureau of Apprenticeship and Training.

TABLE 11.—*Apprenticeship completions and cancellations in selected building trades, 1964*

Occupations	Completions	Cancellations [1]
Construction trades	16, 286	19, 347
Brick, stone, and tile workers	1, 369	1, 692
Carpenters	2, 882	6, 255
Cement masons	222	276
Electricians	3, 887	2, 526
Glaziers	266	182
Iron workers	732	755
Lathers	240	502
Painters	770	1, 711
Plasterers	267	223
Plumbers and pipefitters	3, 101	1, 697
Roofers	282	1, 500
Sheet metal workers	1, 742	1, 340
Construction workers, not elsewhere classified	526	688

[1] Cancellations are not synonymous with "dropouts," since they include layoffs, discharges, out-of-State transfers, upgrading within certain trades, and suspensions for military service, as well as voluntary "quits."

The Manpower Development and Training Act of 1962 provides institutional and on-the-job training programs for unemployed, employed but underskilled, and partly employed workers. MDTA training in the building trades occupations, cumulative to December 1965, has provided training and/or retraining to nearly 11,000 construction workers (see table 12). Training is at the entry level (preapprenticeship) or represents an upgrading of skills. For example, 400 journeymen operating engineers and 120 carpenters in California were upgraded in new skill requirements of their trades during 1965. Apprentice-entry bricklayer training programs were started to prepare 300 workers in Georgia and 160 workers in the District of Columbia as apprentice-entry bricklayers.

TABLE 12.—*MDTA training in the building and construction trades occupations, 1962 through 1965*

Occupation	Institutional		On-the-job	
	Projects	Trainees	Projects	Trainees
Total	289	9,045	84	1,674
Bricklayer	41	1,069	12	588
Bulldozer operator	2	48		
Cabinetmaker	24	596	16	139
Carpenter	90	2,333	20	462
Cement finisher	11	341	2	20
Concrete mixer operator			1	2
Electrician	29	694		
Glazier			2	2
Heavy equipment operator			2	8
Structural steelworker	4	172		
Ornamental ironworker			8	132
Painter	12	320	5	36
Pipefitter [1]	13	1,613	3	180
Plumber	17	341		
Power shovel operator	1	16		
Sheet metal worker	41	1,446	13	105
Tile setter	3	41		
Truck crane operator	1	15		

[1] Includes pipefitters trained in ship and boat industry.

Source: U.S. Department of Labor.

The most obvious point that emerges for data on training of construction craftsmen is that it takes place on the job. Even formal apprenticeship combines on-the-job instruction with classroom work. Obviously, construction contractors and unions play a key role in training the future supply of skilled workers, even when through informal means.

III. TECHNOLOGICAL DEVELOPMENTS IN THE CONSTRUCTION INDUSTRY

The Bureau of Labor Statistics has recently prepared a report on the technological developments in 40 important industries.[8] Included in the report are the following statements of technological trends in the construction industry.

"Continuing increases in the size, capacity, power, speed, and durability of earthmoving equipment, such as trucks, tractors, scrapers, and shovels are resulting in the moving of many times the amount of material than was previously possible."

[8] "Techological Trends in Major American Industries," Bureau of Labor Statistics, Bulletin 1474, issued 1966.

"*New portable construction equipment and handtools are increasingly being introduced.*—This equipment, used in all types of building construction to reduce unit labor requirements, job costs, and completion time, includes power trowels, paint and plaster spraying guns, power nailing and stapling machines, and motorized wheelbarrows."

"Improvements in forklift trucks, conveyor belt systems, motorized wheelbarrows, pneumatic pipe systems, and conventional cranes are facilitating the moving and handling of construction materials."

"Another important development in material handling is the tower crane. Especially useful in the construction of tall buildings, tower cranes can be used to deliver material to any part of the top of a tall building—not just near the edge as do conventional crawler cranes—and to hoist material to greater heights. Because tower cranes can be used to deliver material where it is required, labor crews normally needed to shift material about when using conventional cranes are significantly reduced."

"*Significant advances continue to be made in paving.*—Major advances in both asphalt and concrete paving, which are improving the quality of highways and reducing unit labor requirements, construction costs, and completion time of construction jobs, include more portable and automatically controlled mixing plants; larger capacity and higher speed transit mix trucks; and more automatic, electronically controlled grading and paving machines."

"Still another significant advance in concrete paving is the slipform method which eliminates the fixed side forms used in conventional paving. Instead, forms are a part of the paving machine (slip-form paver) and slide forward with it leaving the concrete slab edges unsupported. This method of paving reduces costs by eliminating the need for crews to erect and remove forms."

"*Standardization of dimensions of construction materials and in design (modular coordination) decreases labor and material requirements.*"

"This system, utilizing a standard unit of measurement of 4 inches and its multiples, also is gaining in use in commercial construction."

"*The trend toward prefabrication (preassembly of building components in manufacturing plants) will accelerate.*"

"Prestressed concrete structural elements used for larger buildings and heavy construction, such as beams, roof and floor slabs, columns, and pilings, may increase by 150 percent between 1964 and 1970."

"Among the major factors contributing to this advancing trend toward prefabrication are the significant savings possible in time, materials, and onsite labor requirements, the higher degree of quality control possible in factories, and the greater opportunities fof economies of large-scale production and mass-production techniques in construction. For example, a carpenter can install a complete prefabricated door (prehung in its frame with hardware attached) in about one-tenth to one-sixth of the time usually required to hang a door in the conventional manner."

"*New and improved materials continue to reduce significantly material and labor costs.*—By 1970, new products introduced during the decade of the 1960's are expected to account for a substantial portion of all building products sold in this country, reflecting the continuing advances in plastics, steel, concrete, paints, and other materials."

"Prestressed concrete products, expected to double in sales by 1970 offer considerable labor and other cost savings in many uses. Developments in structural design using high strength steel products can reduce the frame weight of buildings by as much as one-half in some instances, thereby resulting in significant material and labor cost savings."

"New paints require less on-site preparation, flow more smoothly, go on in fewer coats, and last longer, thus reducing costs and substantially reducing maintenance requirements. Adhesives are being more widely used to save time and reduce costs in floor bonding, exterior wall section fabrication, and in drywall erection."

"*Improvements in design are continually being made.*—New concepts of architectural and engineering design make possible cost savings and productivity increases. More than a dozen new structural design concepts—all directed toward the economical utilization of space, materials, and the lowering of costs—have emerged since 1945."

"*New systematic scheduling techniques are gaining acceptance among large contractors on complex projects.*—Techniques such as the program evaluation and review technique (PERT) and the critical path method (CPM), particularly when used in conjunction with electronic computers, significantly improve management's

capability to plan, schedule, coordinate, and monitor all steps involved in the completion of a complicated construction project. Basically, PERT and CPM are systems for charting the work flow of an entire construction project in detail."

The greatly expanded expenditures for construction by State and local authorities have more than offset the increased productivity resulting in a steady rise in employment in this sector of the construction industry.

Since increased efficiency in the production of any material is frequently accompanied by a greater use of that material, the net effect is to offset the disemployment effect of the increased efficiency. For example, the technological changes in the preparation and use of concrete has actually created an increased demand for concrete workers.

It is important to note that the decreased use of certain materials does not always mean a reduction in the number of workers traditionally employed with that material. For example, carpenters frequently install materials which have replaced wood in the modern structures.

IV. Outlook for Labor Requirements for State and Local Public Works, 1966–75

Projections of construction volume for 1975 have been prepared by the Department of Commerce based on two different unemployment rate assumptions. Projection A assumes a 3-percent and projection B a 4-percent unemployment rate for the total labor force. Both of these projections are also dependent on specific assumptions of GNP, personal income, government expenditure, and other factors discussed elsewhere in this analysis.

Projection A assumes a 133-percent increase in current dollar value of such construction reaching $41.7 billion in 1975. Projection B anticipates $36.6 billion of State and local construction, more than double the current rates. The constant dollar estimates for the two projections are $26.3 billion and $25.0 billion.

Allowing for increased productivity, it is estimated that 2,802,000 full-time workers will be needed in 1975 for this work under projection A, and 2,744,000 under projection B.[9] Thirty-eight percent of these (1,070,000 and 1,048,000, respectively), would be needed in the construction industry and the balance in sectors supplying the necessary materials and service.

For on-site construction workers, the estimated man-year requirements for State and local construction are shown in table 13.

[9] The ratio of constant dollar value for A over B is higher than that ratio for employment since the increased growth of A would presumably increase productivity.

TABLE 13.—*On-site employment requirements for State and local public construction, selected occupations, 1950–75*

Occupation	Thousands of man-years			
	1950	1960	1975A	1975B
Carpenters	46	55	73	72
Plumbers	15	20	33	32
Masons	13	20	32	31
Electricians	9	16	32	31
Steel workers	9	13	22	22
Cement finishers	5	10	21	21
Sheet metal workers	5	7	11	11
Painters	5	6	8	8
Plasterers	4	4	8	6
Lathers	3	4	6	6
Operating engineers	66	109	165	162
Unskilled	157	206	307	301
Other	44	68	156	153
Total	378	537	874	856

PART II. PUBLIC FACILITY CATEGORIES

CHAPTER 1

Regional and River Basin Water Supply Systems*

INTRODUCTION

This chapter describes the present situation of storage for municipal and industrial water supply purposes in reservoirs constructed by the Corps of Engineers of the Department of the Army, the Bureau of Reclamation of the Department of the Interior, and the Soil Conservation Service of the Department of Agriculture. In each instance, the reservoirs are the result of dams built for multiple-purpose control of the waters of river basins or other significant drainage areas. Therefore, the dams may involve flood control, hydroelectric power, flow regulation for navigation and pollution control, irrigation, recreation, and fish and wildlife habitat as well as municipal and industrial water supply and other purposes.

Only storage is usually provided for the water supply purpose. Pumps, transmission lines, and treatment works must usually be furnished by municipalities or firms using the water. The storage is authorized by several Federal acts as noted below. In a few cases transmission works and pumps have been provided; but treatment works, like for the District of Columbia, are very exceptional.

Until recently there has been no call for a systematic effort by the Federal Government to appraise the total national status and need for municipal and industrial water supplies. Present Federal legislation, generally, is designed only to assure that municipal and industrial water supply is considered when Federal agencies plan dams for river basin development. However, the Water Resources Planning Act of 1965 now calls for a unified and systematic effort among the Federal agencies and the States to meet all water needs, including water supply. The act requires a biennial appraisal of the demand and supply situation for water for all purposes on a regional and drainage-area basis. Furthermore, the act provides financial assistance to the States to improve their water resources planning including that of municipal water supply. In addition, the Water Resources Council coordinates the efforts of the Federal agencies concerned, and will cooperate with Federal-State river basin commissions authorized by the act in the preparation of comprehensive plans for water resource development by river basins and major regions. The present schedule for the preparations of comprehensive water and related land resource river basin plans calls for the entire Nation to be covered by 1972.

These efforts of the Water Resources Council, related Federal agencies, and the States are designed to produce a systematic appraisal of the municipal water supply situation for the Nation to the year 2000. Until that task is further along, the following information indicates the situation as it is known today as regards the provision of municipal and industrial water supplies in reservoirs con-

*Prepared by the Corps of Engineers, Department of the Army; Bureau of Reclamation, Department of the Interior; and the Soil Conservation Service, Department of Agriculture, with minor editing by committee staff.

structed under the programs of the Corps of Engineers, Bureau of Reclamation, and the Soil Conservation Service.

Department of the Army: Corps of Engineers

A. Nature and Composition of Public Work or Facility

In 1948, the Corps of Engineers initiated a program of providing municipal and industrial water supply storage in reservoir projects. The water so stored is made available to States, municipalities, private concerns or individuals in accordance with specific legislation.

For the existing capital plant in the United States, provided by the Corps of Engineers, see table I, "Water supply storage as of June 30, 1965."

TABLE I.—*Water supply storage as of June 30, 1965*

Project in operation	Storage (acre-feet)	Local agency served
Allatoona, Ga.	13,140	Cob County-Marietta Water Authority.
Baldhill, N. Dak. (1)	69,500	Eastern North Dakota, Water Development Association.
Beaver, Ark.	108,000	Beaver Water District, Ark.
Belton, Tex.	12,000	Fort Hood, Tex.
Do.	113,700	Brazos River Authority, Tex.
Do.	247,000	Brazos River Authority, Tex.
Berlin, Ohio.	19,400	Mahoning Valley Sanitray District.
Canton, Okla.	90,000	Oklahoma City, Okla.
Canyon, Tex.	366,400	Guadalupe-Blanco River Authority, Tex.
Clark Hill, Ga. and S.C.	163	McCormick, S.C.
Do.	92	Lincolnton, Ga.
Council Grove, Kans.	24,400	Council Grove and Emporia, Kans.
Dam B, Tex.	94,200	Lower Neches Valley Authority.
East Brimfield, Mass.	1,140	American Optical Co., Mass.
Fort Supply, Okla.	400	Oklahoma State Board of Public Affairs.
Ferrells Bridge, Tex.	251,100	Northeast Texas Municipal Water District.
Grapevine, Tex.	85,000	Dallas, Tex.
Do.	50,000	Park Cities, Tex.
Do.	1,250	Grapevine, Tex.
Heyburn, Okla.	1,000	Keifer, Okla.
Do.	300	Rural Water District No. 1, Creek County, Okla.
Homme, N. Dak. (1)	3,650	Grafton and Park River, N. Dak.
Hords Creek, Tex.	5,780	Coleman, Tex.
Hulah, Okla.	15,400	Bartlesville, Okla.
Do.	2,000	Oil Recovery Corp., Oklahoma.
John Redmond, Kans.	34,900	State of Kansas.
Lake Texoma, Okla. and Tex.	21,300	Denison, Tex.
Do.	16,400	Texas Power & Light Co.
Do.	1,150	Sinclair Oil & Gas Co.
Lavon, Tex.	100,000	North Texas Municipal Water District.
Lewisville, Tex.	415,000	Dallas, Tex.
Do.	21,000	Denton, Tex.
Littleville, Mass.	9,400	Springfield, Mass.
Monroe, Ind.	159,900	State of Indiana.
Mosquito Creek, Ohio.	11,000	Warren, Ohio.
Navarro Mills, Tex.	53,200	Trinity River Authority, Texas.
Oologah, Okla.	38,000	Tulsa, Okla.
Do.	500	Collinsville, Okla.
Do.	5,000	Public Service Co. of Oklahoma.
Do.	2,500	Claremore, Inc., Claremore, Okla.
Do.	100	Rural District No. 1, Nowata County, Okla.
Pomona, Kans.	230	Rural Water District No. 3, Kans.
Do.	160	Pomona Reservoir Water Co., Kansas.
Proctor, Tex.	31,400	Brazos River Authority.
San Angelo, Tex.	80,400	Upper Colorado River Authority.
Sam Rayburn, Tex. (2)	1,383,500	Lower Neches Valley Authority.
Tenkiller Ferry, Okla.	300	East Central Water Authority, Oklahoma.
Texarkana, Ark. and Tex. (1)	13,400	Cities of Texarkana, Ark. and Tex.
Tom Jenkins, Ohio.	5,800	State of Ohio.
Toronto, Kans.	265	City of Toronto, Kans.
Waco, Tex.	91,074	Brazos River Authority, Tex.
Do. (3)	13,026	Waco, Tex.
W. Kerr Scott, N.C.	33,000	Winston-Salem and Wilkes County, N.C.
Wister, Okla.	1,600	Heavener Utilities Authority.
Total	4,118,520	
Total (rounded)	4,119,000	

B. Costs and User Charges

The Corps of Engineers provides space in multipurpose reservoirs for water supply storage. Where necessary, facilities are incorporated in project structures to provide for the release or withdrawal of stored water for water supply purposes. This water supply storage space is sold to States, municipalities, private concerns, or individuals, who, in turn, may sell water withdrawn from the storage space to others.

The purchase price of the storage space consists of the total investment cost of specific water supply facilities, plus an allocated share of the investment cost of the joint-use facilities. Since the cost of water supply storage space varies with the cost of the structure, it is not practicable to develop a standard unit of cost. The present trend is for costs allocated to water supply storage space to be in the range of $30 to $100 per acre-foot. The Corps has no information concerning the extent to which tax resources or borrowings are used to cover the cost of purchasing water supply storage space, or the user charges for the sale of water to the consumer.

C. Trend of Capital Outlays

Between January 1948 and July 1958 about 3.4 million acre-feet of water supply, worth about $41.3 million, were placed under agreement and included in Corps of Engineers reservoirs. The Water Supply Act of 1958 (title III of Public Law 87–88) greatly expanded the authority to include water supply and, subsequent to passage of that act, agreements have been completed covering water supply storage of about 1.8 million acre-feet of storage worth approximately $87.2 million. In addition, 800,000 acre-feet of storage for which contracts have not been signed are included in projects now under construction. The trend of water supply storage contracts is shown in table II.

Table II

Fiscal year	Water supply acre-feet	Storage space agreements dollar value	Fiscal year	Water supply acre-feet	Storage space agreements dollar value
1948	16,780	$572,030	1958	637,600	$10,931,473
1949	80,351	755,000	1959	42,000	3,489,021
1950	5,800	785,000	1960	86,200	3,241,749
1951	92,500	1,671,420	1961	696,400	20,030,515
1952			1962	443,100	19,307,638
1953			1963	45,540	4,004,970
1954	606,950	6,756,360	1964	16,782	1,415,323
1955	284,200	4,705,791	1965	395,755	29,983,349
1956	251,263	2,150,000	1966	90,781	5,745,575
1957	1,383,500	13,900,000			

Construction of these projects was and is being financed with appropriated funds. The cost of water supply storage is reimbursed by the users in accordance with section 301 of the Water Supply Act of 1958.

D. Needs and Prospective Capital Outlays

It is estimated that approximately 75 million acre-feet of storage will be needed by the year 2000 to assure adequate supplies of water for municipal and industrial use. This projected need is based on expected population growth, anticipated increase in the per capita

consumption of water, and urbanization and industrialization of various sections of the country. The most critical areas of municipal and industrial water supply shortages over the next 35 years are considered to be in the Texas Gulf area and the southern California area.

It is estimated that approximately 8 million acre-feet of municipal and industrial water storage in projects could be constructed by the year 1975, assuming no budgetary or appropriation restrictions. Provision of 8 million acre-feet of water supply storage in Corps of Engineers projects by the year 1975 would require the construction of multiple-purpose projects, including projects currently under construction, having a total cost of approximately $3 billion. Of this amount, it is estimated that approximately $400 million would be chargeable to municipal and industrial water supply. If budget and appropriation actions permit full funding of the above projects and these projects are selected for construction in the order now considered optimum, the estimated portion of future expenditures allocable to municipal and industrial water supply follows:

Fiscal year	*Millions of dollars*
1968 (prior to)	117. 5
1968	34. 4
1969	36. 7
1970	34. 1
1971	33. 9
1972	39. 2
1973	36. 8
1974	37. 4
1975	30. 0

Department of the Interior: Bureau of Reclamation

A. Nature and Composition of Public Work or Facility

The role of the Bureau of Reclamation is one of planning and constructing multiple-purpose water resource developments involving such functions as irrigation, hydroelectric power, municipal and industrial water, flood control, navigation, fish and wildlife, recreation, and water quality control. These relate, generally within the Western States, to the construction of multipurpose dams and reservoirs to regulate riverflows and of the necessary conveyance facilities. Municipal and industrial water supplies are usually developed as a part of a multipurpose project, but a few projects where municipal and industrial water was by far the greatest purpose have been constructed.

The water so produced by the investment of funds appropriated by the Congress is sold to the communities on an acre-foot basis. Needs and requirements for such water are determined after close cooperation with the local entities. Such items as population growth, per capita use, water quality, future industrial growth, and alternative sources of supply are considered.

Because of the nature of large multipurpose dams and reservoirs, it is obvious that they have long economic lives, generally well in excess of 100 years. In the case of conveyance canals and associated features, their lives are somewhat less but still usually in excess of 50 years.

As of June 30, 1965, the Bureau of Reclamation had 44 projects, either authorized, under construction, or constructed, that included the function of municipal and industrial water supply. Table III

indicates the distribution of these projects by States. Except for a few isolated instances, all of these projects were built after 1941. Because of the great variation in the size and types of projects constructed, the sale of water to cities, based on a ranking of population size, varies from a few hundred people to several million.

In cases of relatively simple projects, operation and maintenance of the structures are many times a local responsibility. In those instances where large, complex, multipurpose developments are involved, particularly those including hydroelectric power, the operation and maintenance are performed by the Federal Government. The Bureau of Reclamation, however, maintains title to these projects and, therefore, the ownership remains with the Federal Government.

As of June 30, 1965, the total Federal investment (costs allocated to the municipal and industrial function) was in excess of $400 million.

B. Costs and User Charges

Again because of the highly variable nature of these projects, the range of typical construction costs allocated to municipal and industrial water varies from a few thousand dollars to many millions of dollars. Likewise, the range in operation and maintenance expenses is highly variable, depending upon such things as economic and physical desirability of the damsite, whether only storage is involved, or whether both storage and conveyance are provided.

The construction and operating costs of these multiple-purpose water resource projects are allocated to the several functions served by the project, using an interdepartmentally approved method of cost allocation. Current reimbursement policy requires that the investment costs allocated to municipal and industrial water supply be returned by the water users to the Federal Treasury with interest within 50 years. Under certain conditions, interest may be waived for a period up to 10 years on a portion of the storage investment costs allocated to municipal and industrial water supply. The water users are also required to pay the annual operating costs allocated to municipal and industrial water supply. Under current policy execution of a repayment contract with the water users for repayment of costs allocated to municipal and industrial water supply is required before construction of the multiple-purpose project is initiated. As a minimum, water rates are set at a level which insures the return of the allocated investment costs with appropriate interest within 50 years and covers the annual operating costs. Water rates may be set at a higher level if such revenues are required to assist in the repayment of project costs allocated to irrigation. However, under no circumstances would the rate be set at a level that would exceed the cost of water if that water were developed by the most likely alternative which would be constructed in the absence of the Federal multiple-purpose project.

C. Trend of Capital Outlays

Capital outlays for municipal and industrial water supply facilities made by the Bureau of Reclamation have increased from about $5 million in 1946 to over $35 million in 1965. The annual amounts are shown in table IV. These annual outlays are the proportion of annual construction expenditures for multipurpose projects which are

properly allocable to the furnishing of municipal and industrial water. After 1961 the amounts shown in table IV contain appropriations for operation, maintenance, and replacement costs associated with Federal operation. The pattern of expenditures has not been in response to any overall program to meet municipal and industrial water needs as such but rather to meeting the municipal and industrial water demands of particular service areas of projects authorized to serve as many purposes as can economically be accommodated.

D. Needs and Prospective Capital Outlays

That municipal and industrial water needs will increase in nearly all areas in the future is a foregone conclusion. That there will be an increasing amount of municipal and industrial water in connection with multiple-purpose project development seems equally certain. In special cases it may become necessary to build single-purpose projects to provide municipal and industrial water supplies. Table V shows the expected future expenditures for capital outlays which may be allocable to municipal and industrial water service. These estimates are based upon presently authorized or planned projects and expected construction schedules over the next 10 years.

Table III.—*Number of projects containing municipal and industrial water service features*

State:	*Number of projects*	State—Continued	*Number of projects*
Washington	1	Nevada	1
Oregon	1	North Dakota	1
California	8	South Dakota	5
Arizona	1	Kansas	4
New Mexico	1	Texas	2
Wyoming	2	Oklahoma	4
Montana	4	Idaho	1
Colorado	1		
Utah	7	Total	44

Table IV.—*Portion of annual expenditures allocable to municipal and industrial water service*

Fiscal year:	*Millions of dollars*	Fiscal year—Continued	*Millions of dollars*
1946	5. 5	1956	5. 8
1947	2. 0	1957	6. 8
1948	2. 0	1958	11. 4
1949	4. 9	1959	12. 6
1950	9. 1	1960	9. 1
1951	8. 6	1961	10. 3
1952	8. 1	1962	15. 1
1953	6. 0	1963	22. 6
1954	4. 6	1964	37. 6
1955	6. 4	1965	35. 3

Table V.—*Estimated portion of future expenditures allocable to municipal and industrial water service*

Fiscal year	*Millions of dollars*	Fiscal year—Continued	*Millions of dollars*
1966	34. 1	1971	78. 5
1967	33. 5	1972	65. 3
1968	24. 7	1973	61. 0
1969	36. 7	1974	57. 0
1970	50. 3	1975	53. 0

Department of Agriculture: Soil Conservation Service

Pursuant to the Flood Control Act of 1944, as amended and supplemented, and the Watershed Protection and Flood Prevention Act (Public Law 566—83d Cong.), as amended, the Department of Agriculture cooperates with the States and their political subdivisions in a program to prevent erosion, floodwater, and sediment damages in the watersheds of rivers and streams and to further the conservation, development, utilization and disposal of water. Although watershed protection and flood prevention are basic objectives in watershed projects, other purposes, essential to meeting the watershed community needs, are included in the work plan whenever they can be justified and the local sponsors decide they should be included. These other purposes are improved agricultural drainage, irrigation, public recreational or fish and wildlife developments, water quality control, and municipal or industrial water supply.

The work under the Flood Control Act is carried out in 11 authorized watersheds embracing some 31 million acres in 12 States, whereas authority under Public Law 566 is nationwide. The Soil Conservation Service has general responsibility for administering these programs, except for loans and the repayment of advances. Administration of these provisions is the responsibility of the Farmers Home Administration.

Specific authority to include provisions for municipal or industrial water supply in watershed projects is contained in Public Law 1018, 84th Congress. Included in that legislation also were provisions authorizing the Secretary of Agriculture to make loans or advancements to local organizations to finance the local share of costs of carrying out works of improvement included in watershed projects.

Public Law 87–703, September 27, 1962, amending the Watershed Protection and Flood Prevention Act, authorized the Secretary of Agriculture to advance funds to local organizations for developing water supply for future use in watershed projects. This authority is the same as the Secretary of the Army and the Secretary of the Interior has under the Water Supply Act of 1958 (Public Law 85–500).

A. Nature and Composition of Public Work or Facility

1. DESCRIPTION OF FACILITIES

(*a*) Works of improvement in small watershed projects include multiple-purpose reservoirs for flood prevention, municipal or industrial water supply, irrigation, and fish and wildlife or recreational use. Additional features that may be included as project measures for municipal or industrial water supply are limited to intake and outlet works which are an integral part of the reservoir structure and raw water supply lines leading to a treatment plant. Water treatment plants and distribution systems are not eligible for assistance.

(*b*) Water supply is provided for rural and urban communities for residential, commercial, and industrial use.

(*c*) Water supply needs for municipal or industrial use are determined by the sponsoring organization's staff or private consultant and are based on an evaluation of present and foreseeable needs, adequacy of yield from the watershed drainage area, water quality, and cost comparisons with alternative sources.

(*d*) Multiple-purpose water supply reservoirs normally have a design life of 50 to 100 years based upon the expected sediment accumulation in the reservoir.

2. EXISTING CAPITAL PLANT IN THE UNITED STATES

(*a*) As of June 30, 1965, a total of 31 reservoirs, incorporating nearly 112,000 acre-feet of water supply storage for municipal or industrial use, had been constructed in watershed projects under authority of Public Law 566 or the Flood Control Act of 1944. Thirteen additional reservoirs, having an aggregate municipal and industrial storage capacity of 36,455 acre-feet, were under construction on that date. Watershed work plans had been completed which provide for 79 more reservoirs having a combined municipal and industrial storage allocation of 131,255 acre-feet.

(*b*) Reservoirs completed and in operation on June 30, 1965, are distributed in 12 States as shown in table VI. Reservoirs under construction are located in 10 States. The 79 structures for which plans have been made but not yet under construction represent projects in 24 States.

(*c*) The distribution of these facilities by size of community served is shown in the following tabulation:

Status as of Jan. 30, 1965	Size of community served				
	50,000 to 999,999	10,000 to 49,999	2,500 to 9,999	Under 2,500	Total
Completed (in operation)		7	12	12	31
Under construction	1	2	7	6	16
Planned		13	21	45	79

(*d*) Of the 31 reservoirs in operation, 5 were completed in the late 1950's and the balance since 1960.

(*e*) Water supply facilities installed as integral parts of small watershed projects are owned, operated and maintained by cities, counties, towns, special districts, public authorities or other local public bodies.

(*f*) The estimated current value (end of 1965) of the municipal or industrial water supply storage in the 31 completed reservoirs is approximately $6,500,000.

B. Costs and User Charges

1. CONSTRUCTION COSTS AND OPERATING COSTS

(*a*) *Construction costs.*—A cost analysis of the 126 reservoirs planned to date under the watershed program shows that the cost per acre-foot varies widely. This is due to differences in site conditions and size of reservoir. As might be expected, the unit cost generally is greatest for the smaller reservoirs. The following tabulation illustrates this relationship:

	Size, acre-foot	Cost per acre-foot
79 reservoirs	0 to 999	$141.20
47 reservoirs	1,000 to 9,999	114.86
7 reservoirs	Over 10,000	55.30

(*b*) Local sponsoring organizations, qualified by State law, assume full responsibility for operation and maintenance of municipal and industrial water supply facilities installed under the watershed program. Consequently, only limited information is readily available upon which to determine annual maintenance and operating expenses. From a limited sample of the projects, for which some information is available, estimated operation and maintenance costs range from less than $10,000 to about $50,000 yearly depending upon the size and complexity of the facility.

2. USER CHARGES

As in the case of operation and maintenance costs, only limited data are available on user charges. Therefore, we are not in a position to state the extent to which user charges cover services, operation and maintenance costs, or liquidation of the indebtedness.

C. Trend of Capital Outlays

1. The following tabulation shows the annual accomplishments since provisions for municipal or industrial water supply were included in the watershed program:

Year	Number of reservoirs with municipal and industrial water supply completed	Capital investment (non-Federal)
1957–59	6	$2,084,658
1960	1	3,880
1961	4	1,335,847
1962	4	162,628
1963	5	587,029
1964	8	1,706,856
1965 (to June 30, 1965)	3	409,152

2. All of the capital outlays listed above were accounted for by cities, counties, towns, special districts, public authorities, or other local public bodies.

3. The source of financing for these capital outlays was distributed as follows:

	Percent
Appropriations from tax resources and borrowing in municipal bond market	59
Federal Government grant assistance (ARA)	5
Borrowing from the Federal Government (Farmers Home Administration)	36

D. Needs and Prospective Capital Outlays

1. (*a*) In projecting the needs and prospective capital outlays during the decade 1966–75, consideration was given to such factors as the current backlog of unmet needs, expanding population and increasing per capita consumption, greater industrial needs, and recognition by a growing number of communities of the opportunities afforded by participation in the watershed program.

(*b*) The estimated capital requirements to be met by sponsoring organizations for municpal or industrial water supply facilities installed

in watershed projects are as follows: 1966 fiscal year, $3.2 million; 1967 fiscal year, $11 million; 1968 fiscal year, $12.7 million; 1969 fiscal year, $14.3 million; 1970 fiscal year, $16 million; 1971 fiscal year, $17.8 million; 1972 fiscal year, $19.7 million; 1973 fiscal year, $21.5 million; 1974 fiscal year, $23.5 million; and 1975 fiscal year, $25.5 million.

(*c*) It is expected that these facilities will be provided to different size communities in the following proportions:

	Percent
Over 50,000	1
10,000 to 50,000	17
2,500 to 10,000	32
Under 2,500	50

(*d*) Based upon past experience it is expected that cities, towns, counties, special districts, public authorities, or other local public bodies will assume full responsibility for the capital outlays involved.

2. Contingent upon the availability of appropriated funds, it is anticipated that the percentage of capital outlays to be financed through Farmer's Home Administration loans will increase to approximately 50 percent. The balance would be derived from tax revenue, operating income, or sale of bonds in established municipal bond markets.

TABLE VI.—*Municipal and industrial storage reservoirs in existence or operation June 30, 1965 [constructed under authority of Public Law 566 or Flood Control Act of 1944]*

State	Community served	Storage allocated to municipal and industrial	Non-Federal cost allocated to municipal and industrial	Population served
		Acre-feet	*Dollars*	
1. Alabama	Roanoke	500	21,017	5,288
2. Arkansas	Lincoln	1,500	218,000	820
3. Arkansas	Waldron	2,100	316,600	1,619
4. Georgia	Camelia	150	9,062	2,963
5. Georgia	Temple	72	3,880	788
6. Georgia	Villa Rica	445	23,712	3,450
7. Georgia	Winder	1,200	61,084	5,555
8. Georgia	Dalton	400	40,693	17,868
9. Illinois	Pittsfield	4,391	223,552	3,772
10. Kansas	Sedan	660	41,600	1,677
11. Kentucky	Lewisburg	93	13,577	512
12. Kentucky	Hopkinsville	1,757	218,350	19,465
13. Louisiana	Plain Dealing	710	79,095	1,357
14. Oklahoma	Colgate	3,000	352,721	1,689
15. Oklahoma	Wilburton	3,000	249,547	1,772
16. Oklahoma	Sallisaw	3,000	470,402	3,351
17. Oklahoma	Perry	2,125	59,010	5,210
18. Oklahoma	Chickasha	31,700	1,500,000	14,866
19. Oklahoma	Duncan	10,681	340,396	20,009
20. Oklahoma	do	14,600	323,315	20,009
21. Oklahoma	Marlow	505	97,050	4,027
22. South Carolina	Edgefield	120	15,000	2,876
23. Texas	Brady	24,000	1,012,183	5,338
24. Texas	Kaufman	1,346	17,728	3,087
25. Virginia	Albemarle County	1,600	67,873	30,969
26. Virginia	Culpeper	500	38,400	2,412
27. Virginia	Keysville	200	15,823	733
28. Virginia	Augusta County	304	116,686	37,393
29. West Virginia	Green Valley-Glenwood	241	105,000	600
30. West Virginia	Cameron	129	71,448	1,700
31. West Virginia	Keyser	960	167,415	6,192
12 States, total	Total 30 communities	111,989	6,290,050	207,328

CHAPTER 2

Public Water Supply Systems*

INTRODUCTION

The public water supply utility industry is one of the Nation's oldest industries. Its history can be traced back to colonial times to the system built in Boston in 1652 consisting of wooden pipe and conduits used to convey water from wells and springs to a wooden tank from which people could fill their water buckets. Almost a century later, in 1746, a farmer named Schaeffer piped water from his Pennsylvania farm to the community now called Schaefferstown. This was the first water supply in the United States built to serve an entire town.

Despite these early examples, public water service did not enjoy immediate acceptance. People preferred to take water from their own wells and springs. There were, for example, only 16 public water systems in 1800, and 83 in 1850. The situation changed rapidly, however, during the second half of the 19th century, so that by 1890 there were 1,878 public water supply systems serving 22,500,000 people. Today water utilities constitute one of the Nation's largest and most essential industries, serving almost 160 million people. The industry has established a record for safety, reliability, and service unmatched elsewhere in the world.

A. NATURE AND COMPOSITION OF THE WATER UTILITY INDUSTRY

1. DESCRIPTION OF FACILITIES

(a) *General Physical Characteristics*

The main components of a public water system are:

1. *Source of water supply.* Surface water sources are lakes, ponds, and streams. Water may be taken directly from a stream on a continuous basis, or a dam may be built, creating a reservoir to hold flood waters. Ground water sources are wells, springs, and infiltration galleries, wells being most commonly used for public supply.

2. *Collection works and transmission mains.* Collection and transmission works comprise intakes, pumping stations, and pipelines as necessary to collect and transport the water to the treatment plant or distribution system.

3. *Treatment plants.* Minimum treatment for sources of excellent natural quality usually consists of disinfection as a safeguard. Treatment may be much more extensive in order to produce a safe and palatable water and may include application of various chemicals together with mixing, flocculation, settling, and filtration. Other processes are employed as needed to soften the water and remove objectionable amounts of iron and manganese.

*Prepared by the American Waterworks Association, with minor editing by committee staff.

4. *Distribution works.* Distribution works include pumping and storage facilities, water mains and their appurtenances—such as valves, hydrants, service connections, and meters—all of which are needed to transport the water to the consumer, measure it for billing, and afford fire protection.

(b) *Services Rendered*

Water utilities traditionally provide water service to residential, commercial, and industrial customers, as well as for general municipal purposes. Residential uses include drinking, cooking, bathing, toilet flushing, air conditioning, laundering, and sprinkling. Commercial service is furnished to a variety of businesses, including restaurants, hotels, motels, laundries, and florists, for the same general purposes. A prime factor in attracting and keeping industry is an adequate water supply to meet such varied industrial needs as water for cooling, process use, and cleaning. General municipal service consists of public uses like street sprinkling, swimming pools, fountains, public buildings, and—most important—firefighting. Provisions for the latter represent a substantial portion of the investment in water works facilities, especially for the smaller utilities.

Depending on the type of utility organization and State and local requirements, water utilities render these services both within and outside corporate limits and on both a retail and a wholesale basis An example of wholesale basis would be the sale of water to another utility or community, which then distributes the water to its own retail customers.

An approximate allocation of water to the various categories of users is shown in table 1.

Water production

The water industry uses average daily per capita water production as a measure of output. This is calculated by dividing the total gallons of water produced or purchased by the utility (or both) during the year by 365 and then again by the total population served. This gives a figure in gallons per capita per day (gpcd).

Per capita water production is lowest for small utilities and progresses upward with increasing size of utility, as shown in table 2.

Per capita water production varies among utilities. It also varies regionally, as shown in table 3, which includes data for cities of more than 10,000 population only for the years 1950, 1955, and 1960.

(c) *Standards of Performance*

The following general standard of performance for public water supply systems is taken from a policy statement of the American Water Works Association:

> Delivered water should as a minimum meet U.S. Public Health Service Drinking Water Standards. In addition, it should be as free of objectionable taste and odor, color, turbidity and staining elements, and as noncorrosive as practicable. It should be adequate in quantity for all sanitation and other domestic uses; safe and desirable for industrial and commercial use; adequate for fire protection service, and available on an uninterrupted basis with a minimum of fluctuations in pressure.

The 1962 Drinking Water Standards of the U.S. Public Health Service prescribe requirements for drinking water and water supply systems used by carriers and others subject to Federal quarantine regulations. Most States have adopted these standards as minimum

requirements for public water supplies generally. Because the USPHS standards relate primarily to the health aspects of water, many water utilities have adopted their own higher standards to reflect the improved performance that they are able to attain in their operations. A similar step is being taken by AWWA, which is preparing goals or objectives for water utilities generally to emphasize such consumer aspects of water quality as color, taste, odor, clarity, softness, corrosivity, and staining.

TABLE 1.—*Public water supply use by category* [1]

Type of use:	*Use; percent of total*
Residential	45
Commercial	18
Industrial	32
Municipal	5
Total	100

[1] Hirshleifer, J.; DeHaven, J. C.; Milliman, J. W. "Water Supply Economics, Technology, and Policy." University of Chicago Press (1960), p. 25.

TABLE 2.—*Mean per capita production of water utilities of varying size* [1]

Population served (thousands)	Number of cities	Mean production gpcd
1 to 5	97	121
5 to 10	261	123
10 to 25	308	124
25 to 50	184	137
50 to 100	109	129
100 to 250	80	137
250 to 500	28	131
Over 500	37	147

[1] Seidel, H. F., and Cleasby, J. L. "A Statistical Analysis of Water Works Data for 1960." (Unpublished.)

TABLE 3.—*Regional trends in mean per capita production of water utilities* [1]

Geographic region	Mean production—gpcd		
	1950	1955	1960
New England	111	123	108
Middle Atlantic	145	139	118
Northeast central	132	130	116
Northwest central	127	127	124
South	115	109	119
Mountain	226	220	205
Pacific	189	193	202

[1] For cities of more than 10,000 population only, from Seidel, H. F., and Cleasby, J. L. "A Statistical Analysis of Water Works Data for 1960." (Unpublished.)

In addition to meeting domestic, commercial, and industrial water needs, the water industry has important responsibilities for fire protection. In this regard, the "Standard Schedule for Grading Cities and Towns of the United States With Reference to Their Fire Defenses and Physical Conditions" of the American Insurance Association (formerly the National Board of Fire Underwriters) prescribes standards for grading the fire defenses of cities, guides insurance companies in their underwriting procedures, and serves as the basis for

recommendations for improvement of fire protection. Although the AIA standards are voluntary, they are widely applied throughout the industry.

2. EXISTING CAPITAL PLANT

Table 4 shows the growth in number of water utilities from 1800 to 1963 and gives the populations served in selected years. There were 19,236 utilities as of January 1963, more than 10 times as many as in 1890. The population served in 1963 was 150 million, almost seven times as many as in 1890. Water utilities have amost doubled in number since the 1930's, and the population served today is considerably more than twice what it was in the 1903's.

The distribution of water utilities by State is given in table 5. Table 6 gives a breakdown of utilities according to size of city. It shows that 87 percent of all the utilities serve populations of 10,000 or less. The remaining 13 percent in the over-10,000 population class serve 81 percent of the total population served by public water systems.

TABLE 4.—*U.S. water utility growth, 1800–1963* [1]

Year	Number of utilities	Estimated population served	Year	Number of utilities	Estimated population served
1800	16		1896	3,196	
1825	32		1924	9,850	
1850	83		1934	10,790	
1875	422		1939	12,760	81,243,480
1880	598	11,809,231	1948	16,439	93,455,135
1885	1,013		1958	17,808	133,126,310
1890	1,878	22,678,350	1963	19,236	150,602,164

[1] Statistical summary of municipal water facilities in the United States, Jan. 1, 1963. U.S. Public Health Service, U.S. Department of Health, Education, and Welfare, Washington, D.C. (1965).

TABLE 5.—*U.S. water utilities and populations served, by States* [1]

State	Number of utilities	Population served	State	Number of utilities	Population served
Alabama	297	2,230,935	Nevada	57	287,345
Alaska	39	86,585	New Hampshire	117	488,230
Arizona	224	1,382,815	New Jersey	413	5,604,460
Arkansas	232	1,065,300	New Mexico	252	713,830
California	1,690	17,508,320	New York	1,014	15,653,155
Colorado	314	1,555,225	North Carolina	367	2,292,380
Connecticut	155	2,193,805	North Dakota	178	370,760
Delaware	41	409,845	Ohio	546	7,798,245
District of Columbia	2	1,092,870	Oklahoma	397	1,865,160
Florida	467	3,890,990	Oregon	353	1,373,120
Georgia	419	2,796,250	Pennsylvania	959	9,856,291
Hawaii	83	594,075	Puerto Rico	70	1,643,555
Idaho	192	450,069	Rhode Island	47	816,130
Illinois	913	8,857,430	South Carolina	215	1,420,835
Indiana	394	3,196,060	South Dakota	252	416,680
Iowa	708	1,896,720	Tennessee	277	2,423,290
Kansas	488	1,627,985	Texas	1,160	8,619,510
Kentucky	273	1,806,993	Utah	298	1,001,550
Louisiana	280	2,539,795	Vermont	185	255,959
Maine	159	769,620	Virginia	508	2,590,670
Maryland	169	2,574,085	Virgin Islands	3	23,390
Massachusetts	275	5,061,435	Washington	463	2,427,992
Michigan	506	6,442,370	West Virginia	394	1,171,305
Minnesota	603	2,432,330	Wisconsin	426	2,750,140
Mississippi	234	981,595	Wyoming	102	249,075
Missouri	430	3,530,365			
Montana	165	474,505	Total	19,236	150,602,164
Nebraska	431	1,040,735			

[1] Statistical summary of municipal water facilities in the United States, Jan. 1, 1963. U.S. Public Health Service, U.S. Department of Health, Education, and Welfare, Washington, D.C. (1965).

Table 7 shows the distribution of water utilities by type of ownership. The breakdown gives the number of municipally owned and investor-owned utilities by class size and total population served. Seventy-one percent of the water utilities are municipally owned; 29 percent are investor owned. Municipally owned utilities serve 85 percent and investor owned 15 percent of the population served by public water systems. The examples of dual ownership are so few that they may be safely omitted from the analysis.

Investor-owned water utilities include individual, partnership, and corporate enterprises. This type of utility comes under the regulation of public service commissions in all but two States.

TABLE 6.—*Classification of water utilities according to population size* [1]

Population group	Number of utilities	Population served
Under 500	5,433	1,724,981
500 to 1,000	3,751	2,901,512
1,000 to 5,000	6,054	14,269,131
5,000 to 10,000	1,503	10,150,890
10,000 to 25,000	1,225	16,707,415
25,000 to 50,000	573	14,791,775
50,000 to 100,000	298	12,900,250
Over 100,000	399	77,156,210
Total	19,236	150,602,164

[1] Statistical Summary of Municipal Water Facilities in the United States, Jan. 1, 1963. U.S. Public Health Service, U.S. Department of Health, Education, and Welfare, Washington, D.C. (1965).

TABLE 7.—*Distribution of U.S. water utilities by type of ownership* [1]

Population group	Municipally owned utilities		Investor-owned utilities	
	Number	Population served	Number	Population served
Under 500	3,245	1,127,491	2,078	564,720
500 to 1,000	2,762	2,195,468	922	644,004
1,000 to 5,000	4,692	11,636,921	1,315	2,545,255
5,000 to 10,000	1,113	8,595,635	372	1,471,450
10,000 to 25,000	876	13,768,010	340	2,812,050
25,000 to 50,000	362	12,283,770	204	2,384,570
50,000 to 100,000	173	10,405,000	123	2,411,750
Over 100,000	245	67,843,060	147	8,646,280
Total	13,468	127,855,355	5,501	21,480,079

[1] Statistical Summary of Municipal Water Facilities in the United States, Jan. 1, 1963. U.S. Public Health Service, Department of Health, Education, and Welfare, Washington, D.C. (1965).

Municipally owned utilities include those owned by municipalities, water districts, counties, and other forms of government organization. In all but a few States—notably Indiana, Maine, Montana, Nevada, West Virginia, Wisconsin, and Wyoming—they are not regulated by public service commissions.

At the end of 1965, it is estimated that there were more than 20,000 water utilities serving 157 million people in the United States. Assuming that today's cost to provide water works facilities averages $300 per capita, the current replacement value of the water industry is more than $47 billion.

B. Costs and User Charges

1. CONSTRUCTION COSTS

Table 8 shows the incremental costs of waterworks for varying periods in the development of the water industry. It is interesting to note that the investment for the last decade almost equals the amount spent during the previous 35 years, and that the expenditure since the end of World War II is more than three times the amount spent during the entire previous history of the industry. Average per capita investment in water facilities has risen accordingly and for 1956–65 it averaged $275. It continues to grow as the result of rising costs and the necessity for utilities to go further for new water sources. Figure 1 illustrates water utility cost indexes for two typical types of systems, the weighted components of which are shown in table 9.

TABLE 8.—*Incremental costs of water facilities* [1]

Period	New investments (millions)	Growth in population served (millions)	Per capita investment
Before 1896	$450	22.7	$20.00
1896 to 1910	510	15.3	33.30
1910 to 1920	640	12.0	53.00
1920 to 1946	3,350	40.0	83.75
1946 to 1955	7,050	30.0	233.00
1956 to 1965 [2]	10,200	37.0	275.70

[1] Howson, L. R., "50 Years' Experience With Water Utility Costs and Revenues." Journal AWWA, 51:693 (June 1959).
[2] Figures for 1956–65 have been added to Howson's original table. Population growth is based on data of the U.S. Public Health Service and the U.S. Department of Commerce.

TABLE 9.—*Weighted components for two typical plants* [1]

[In percent]

Component	Plant A	Plant B
Land	1	13
Reservoirs	5	17
Buildings	10	25
Pumps, motors, and so on	5	5
Mains	60	32
Services	10	2
Meters	7	4
Other equipment	2	2
Total	100	100

[1] Fick, H. H., "Cost Indexes for Water Utility Property." Journal AWWA, 56:1021 (August 1964).

Construction costs vary considerably, depending on size of utility, type and proximity of source of supply, type of treatment, and other factors. This is illustrated in figure 2, which shows the total investment in waterworks expressed in dollars per million gallons of average daily capacity for each of six water systems, the general features of which are given in figure 3. Plant investment costs range from $700,000 per million gallons daily to more than $1,700,000 per million gallons daily. Portions of the totals are allocated to various categories: source of supply, pumping station and treatment, transmission and distribution system, fire hydrants, and a miscellaneous category including such things as offices, laboratory, and other equipment. It should be added that the graphs in figure 2 are based upon the historical cost of the works, which are much less than the reproduction cost at current prices.

The annual operations and maintenance expenses for the six utilities, expressed in dollars per million gallons of water produced, are shown in figure 4. Expenses range from $100 to $250 per million gallons, and are broken down into the following categories: source of supply, pumping, treatment, transmission and distribution, customer accounting, and general expenses.

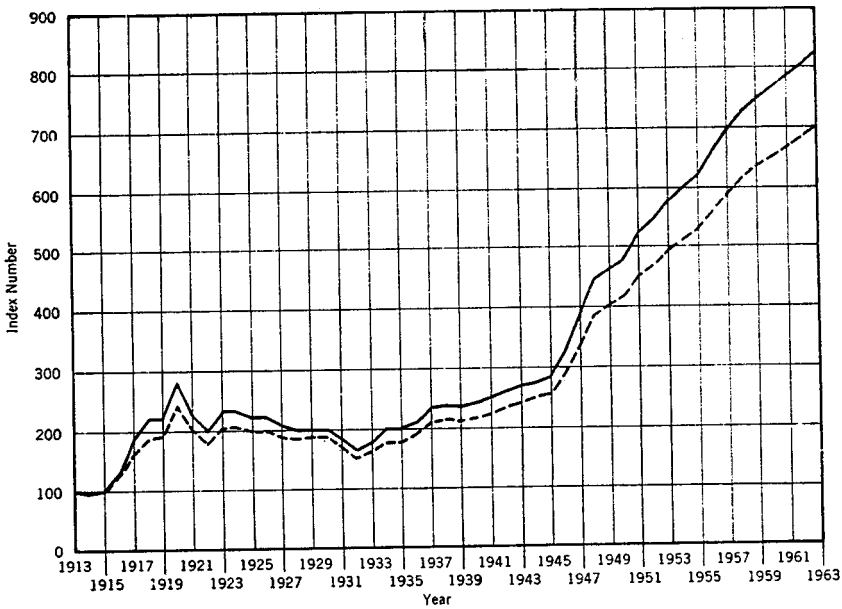


FIGURE 1. TYPICAL WATER UTILITY COST INDEXES

The cost indexes for two existing water plants are shown for the period 1913–63' with 1913 as the base year. The weighted components of water utility property are given in table 9. Data for plant A are indicated by the solid line; data for plant B by a broken line. From: Fick, Henry H., "Cost Indexes for Water Utility Property." Journal AWWA, 56:1022 (August 1964).

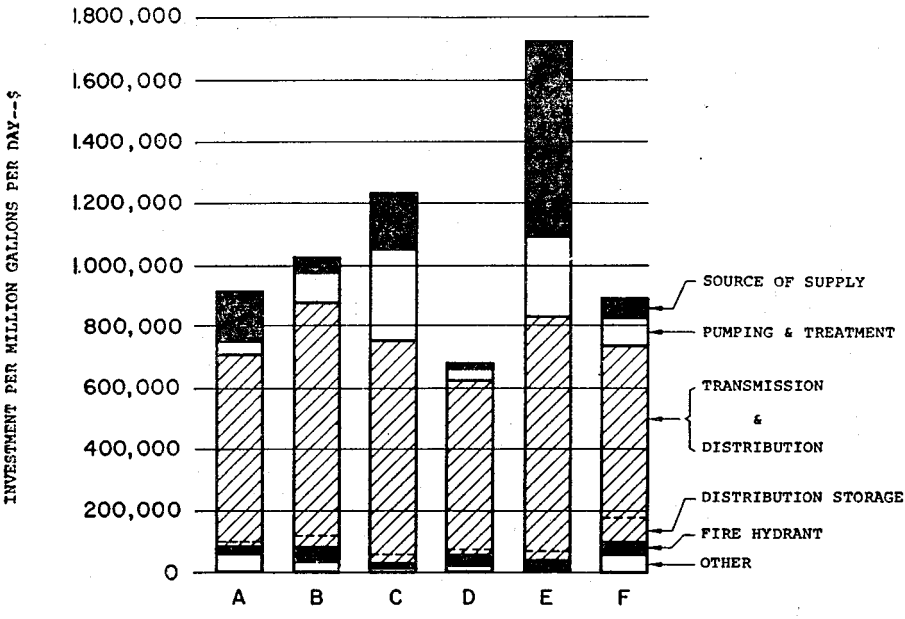


FIGURE 2. PLANT INVESTMENT

From: Hazen, Richard. Water Is Not Free. Proceeding, 8th Sanitary Eng Conference on Cost Aspects of Water Supply, Univ. of Illinois Experiment Urbana, Ill. (1966).

	UTILITY					
	A	B	C	D	E	F
OWNERSHIP	I	I	M	I	M	M
AVE. PRODUCTION - MGD	52	22.3	22.0	17.3	9.2	8.9
SOURCE OF SUPPLY Number	8	1	1	3	1	3
Type	SURF. G.W.	G.W.	SURF.	SURF.	SURF.	SURF. G.W.
PUMPING REQ'D.	PART	YES	YES	YES	YES	PART
FILTRATION REQD.	NO	NO	YES	PART	YES	YES
SOFTENING REQ'D.	NO	NO	NO	NO	NO	PART

FIGURE 3. PLANT FACILITIES

From: Hazen, Richard. Water Is Not Free. Proceedings, 8th Sanitary Engineering Conference on Cost Aspects of Water Supply, Univ. of Illinois Experiment Station, Urbana, Ill. (1966).

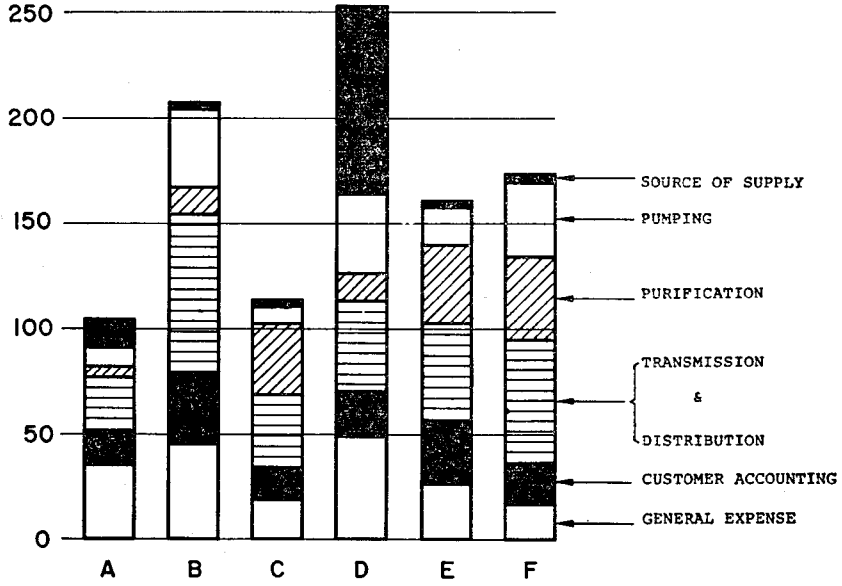


FIGURE 4. ANNUAL EXPENSE, OPERATIONS AND MAINTENANCE

Hazen, Richard. Water Is Not Free. Proceeding, 8th Sanitary Engineering Conference on Cost Aspects of Water Supply, Univ. of Illinois Experiment Station, Urbana, Ill. (1966).

2. WATER UTILITY FINANCING AND USER CHARGES

The following conditions prescribe a test for self-sustaining water utility operations:

To furnish good service, a water utility, whether municipally or investor-owned, should receive sufficient revenue through water sales and other charges to—

(1) cover operation and maintenance expenses, taxes or payments in lieu of taxes, depreciation, fixed charges or return on investment, and

(2) provide sufficient surplus to pay for ordinary capital additions and attract the necessary capital for major expansion.

Investor-owned utilities in all but two States and municipally owned utilities in at least seven States are under the jurisdiction of State regulatory commissions. Under such control, water utilities formulate rate schedules to provide gross revenues approved by the commissions.

Of the total number of utilities, 65 to 75 percent are unregulated. Most of these are municipally owned. Most are supported out of revenue from rates, a few by a combination of rates and taxes. Generally, municipally owned utilities may be classified according to two general types of financial operation:

1. *Self-supporting enterprises.*—Such utilities receive sufficient revenue through rates, charges, and fire protection tax levies to meet all expenses, maintain and expand the system, and contribute funds to the municipality in lieu of taxes. They maintain a separate identity

from other public functions and have control over their funds in separate accounts. To finance large capital additions, they have authority to issue revenue bonds. Their revenues after operating and maintenance expenses must be adequate to pay the interest and redemption.

2. *Tax-supported enterprises.*—Typical of this group is the utility that is budgeted and accounted for within the city's overall operations. Revenues from water sales are deposited in the general municipal fund together with other receipts, including tax receipts, out of which the expenditures for all city operations, including the water utility, are made. In such cases, taxes are levied to meet payments on bonds issued to expand the water system. The bonds would be general obligation bonds backed by the taxing power of the municipality.

Regardless of the type of financial organization—and there are a number of variations—revenues from water rates are employed to a large extent to pay the costs of doing business, including operation and maintenance expenses, taxes, debt service, payments to the general fund (municipally owned utilities) or dividends (investor-owned utilities), and payments to reserves and surplus.

Water utilities obtain most of their income from water sales. A study in 1955 covering 78 municipally owned utilities showed that water sales furnished 92 percent of total income, with residential customers providing 56 percent, commercial customers 18 percent, industrial users 17 percent, and municipal service 1 percent. The largest single source of income after water sales is fire service. Most investor-owned and about one-half of the municipally owned utilities, according to a 1960 AWWA survey, levy a charge for fire service, usually in the form of a hydrant rental in the range of $10 to $50 per fire hydrant per year.

Revenue sources and disposition for 875 municipally owned and 90 investor-owned utilities of all sizes in 1960 are shown in Table 10.

TABLE 10.—*Water utility revenue sources and disposition* [1]

Item	Municipally owned		Investor owned	
	Dollars per million gallons	percent	Dollars per million gallons	percent
Revenue:				
Water sales	302	91.5	382	95
All other	28	8.5	20	5
Total	330	100.0	402	100
Disposition:				
Operating and maintenance	174	53.0	188	47
Taxes	3	1.0	88	21
Debt service	62	19.0	35	9
Current capital additions	48	14.0	35	9
To general funds or dividends	20	6.0	33	8
Reserves and surplus	23	7.0	23	5
Total	330	100.0	402	100

[1] H. F. Seidel and J. L. Cleasby, "A Statistical Analysis of Water Works Data for 1960" (unpublished).

The income of the municipally owned group averaged $330 per million gallons, of which $174 was spent for operation and maintenance and the remainder for taxes, debt service, current capital additions, de-

posits to the general funds, and reserves and surplus. Investor-owned utilities received $402 per million gallons and paid $188 for operation and maintenance. It should be noted that this group paid $88 per million gallons for taxes and $33 for dividends as compared with $3 for taxes and $20 in lieu of taxes paid by the other group.

Both municipally and investor-owned utilities may be able to finance small capital additions out of current earnings. To finance large additions, municipally owned utilities issue revenue or general obligation bonds. Investor-owned utilities issue mortgage revenue bonds and short-term notes.

C. Trend of Capital Outlays

1. ESTIMATED ANNUAL CAPITAL OUTLAY

Various public and private organizations publish data on the capital outlay for water utility facilities, including: McGraw-Hill, Inc., of New York City in its publication "Engineering News-Record"; the U.S. Department of Commerce, in such publications as "Construction Review," issued by the Business and Defense Services Administration, and "Historical Statistics on Government Finances and Employment," a report of the Bureau of the Census; and the U.S. Department of Health, Education, and Welfare, in "Sewage and Water Works Construction," and "Water and Sewer Bond Sales in the United States," both publications of the U.S. Public Health Service.

None of the above-mentioned publications report the total capital outlay for water utility facilities which would represent contract and direct expenditures of both municipally and investor-owned segments of the industry. In fact, the various published data are not strictly comparable because of different collection and reporting methods. They provide, nevertheless, a good indication of the trend in water utility construction expenditure.

Annual values reported by the various organizations for 1946–65 are shown in table 11. Two of the columns in the table are related only to municipally owned utilities. The third represents the Business and Defense Services Administrations' estimates of total construction put in place for both municipally and investor-owned utilities, including contract and force account construction.

The annual expenditure for waterworks construction grew steadily during 1946–65. The rate of growth is indicated by table 12, which compares contract award figures as reported by the U.S. Public Health Service in actual and constant dollars.

Table 12 shows that in actual dollars annual public water utility construction rose during a 13-year period (1952–64) from $227 to $654 million, an increase of $427 million, whereas in constant dollars (1957–59 base), it grew from $303 to $532 million, an increase of only $229 million.

Water utility construction was curtailed during World War II and picked up slowly immediately following the war when prices rose sharply and population expanded rapidly. As a result, the industry accumulated a sizable deficiency in facilities, which it has been correcting gradually ever since. A substantial backlog still exists, as is explained in part IV of this statement.

TABLE 11.—*Indicators of annual water works construction*

[In millions of dollars]

Year	ENR contract awards [1]	USPHS contract awards [2]	BDSA total waterwork construction [3]
1946	109		
1947	139		
1948	209		
1959	207		
1950	215		
1951	209		
1952	231	227	451
1953	247	283	527
1954	245	293	572
1955	314	394	788
1956	356	441	800
1957	369	457	838
1958	306	419	856
1959	373	504	989
1960	454	645	950
1961	430	573	1,145
1962	391	507	1,050
1963		590	1,082
1964		654	1,188
1965			1,300

[1] Annual total public works contracts for waterworks construction reported by "Engineering News Record." Minimum project included for 1946 was $22,500; for 1947–49, $28,000; for 1950–54, $34,000; for 1955–58, $44,000; and for 1959–62, $53,000.

[2] Annual contract awards for public waterworks construction as reported by the U.S. Public Health Service in "Sewage and Waterworks Construction, 1964." The figures exclude engineering, architectural, legal, and financial fees and contract expenditures of investor-owned water utilities.

[3] Construction put in place, including contract construction, force account construction, and materials and equipment for municipally owned and investor-owned water utilities, as provided by the Water Industries and Engineering Services Division, Business and Defense Services Administration, U.S. Department of Commerce.

TABLE 12.—*Comparison of annual water utility contract awards in actual and constant dollars* [1]

Year	Actual dollars (millions)	Constant dollars [2] (millions	Year	Actual dollars (millions)	Constant dollars [2] (millions)
1952	227	303	1959	504	480
1953	283	358	1960	645	597
1954	293	353	1961	573	516
1955	394	453	1962	507	441
1956	441	485	1963	590	500
1957	457	481	1964	654	532
1958	419	419			

[1] Sewage and Waterworks Construction, 1964. U.S. Public Health Service, U.S. Department of Health Education, and Welfare, Washington, D.C. (1965).

[2] Constant dollars are reported on a 1957–59 base, using the "Engineering News-Record" construction cost index.

2. SOURCES OF EXPENDITURE

A breakdown of capital outlay by source of expenditure is unavailable, but an indication is given by table 13 which shows the number and total value of bond issues for municipal waterworks construction in 1964 according to various issuing authorities. Municipal authorities led in number of issues with 381 out of a total of 607, followed by special water districts with 157, and statutory authorities with 36. In total dollar volume, municipalities again led with $305 million out of a total of $769 million, followed by State authorities with $250 million. The State bonds relate to California's huge Feather River project.

Table 14 gives a breakdown of the public bonds issued in 1964 according to type of issue. General obligation bonds accounted for 64 percent and revenue bonds for 36 percent of the total value.

Investor-owned utilities, which comprise 29 percent of the total number of utilities and serve 15 percent of the total population served, obtain capital from various sources—loans, bonds, and common and preferred stock—in proportion to debt ratios prescribed by State public service commissions and in accordance with policies that will assure satisfactory credit rating and low money costs. In its estimates of total waterworks construction in table 11, the Business and Defense Services Administration has assumed that investor-owned utilities account for about 20 percent of the total annual investment in facilities.

TABLE 13.—*Water and sewer bond sales in 1964* [1]

[Dollar amounts in thousands]

Type of issuing authority	Number of issues	Amount	Percent of total
State	3	$250,000	32.5
County	9	12,849	1.7
Municipality	381	305,798	39.8
Township	21	5,653	.7
Special district	157	102,805	13.3
Statutory authority	36	92,202	12.0
Total	607	769,307	100.0

[1] Water and Sewer Bond Sales in the United States, 1964. U.S. Public Health Service, U.S. Department of Health, Education, and Welfare, Washington, D.C. (1965).

TABLE 14.—*Types of water and sewage bonds sold in 1964* [1]

[Dollar amounts in thousands]

Type of issue	Number of issues	Value
GENERAL OBLIGATION BONDS		
Unlimited tax	374	$467,914
Unlimited tax secured by utility revenue	9	6,610
Unlimited tax secured by special assessment	22	3,654
Limited tax	12	11,090
Limited tax secured by utility revenue	1	522
Limited tax secured by special assessments	4	695
REVENUE BONDS		
Utility revenue	179	271,043
Special tax revenue	1	122
Rental revenue	5	7,657
Total	607	769,307

[1] Water and Sewage Bond Sales in the United States. U.S. Public Health Service, U.S. Department of Health, Education, and Welfare, Washington, D.C. (1965).

Both municipal and investor-owned segments of the industry spend substantial sums each year on force account construction and direct purchases of equipment, the investment varying from 20 to 25 percent of the total annual capital outlay, according to studies of the BDSA made during 1952–59. Sources of funds for this work are water sales revenue taxes, short-term loans, bonds, contributions in aid of construction (for example, customers-financed main extensions, service connections, and meter installations), and advances in aid of construction (subject to refund over a period of time). Water utility policies vary considerably in the method of financing of this type of work.

Up to 1965, Federal and State loans and grants were not a significant factor in water utility development, with the exception of the work performed during the 1930's. As is pointed out in part IV, this situation is expected to change as a result of legislation passed in 1965. Prior to 1965, there were the following Federal programs:

1. The Farmers Home Administration of the U.S. Department of Agriculture has made loans for the construction of rural water systems since 1938.

These systems serve farm areas with a low population density that cannot be served economically by conventional public water systems. Rural supplies differ from public supplies in that they are designed to furnish considerably less water per capita, use pipelines of smaller diameter, and do not normally provide conventional fire protection. Table 15 shows the number and amount of FHA loans made during 1961–65.

2. Grants and loans made for the construction of water utility facilities, as provided under the accelerated public works and public facility loan programs, are summarized in table 16.

3. Financial assistance has been provided for storage of public water supply in connection with the reservoir projects of the Corps of Engineers, the Soil Conservation Service, and the Bureau of Reclamation. The terms call for repayment when the storage is used for public water supply.

TABLE 15.—*Farmers Home Administration credit assistance, 1961–65* [1]

Fiscal year	Number of loans		Amount loaned	
	Direct funds	Insured funds	Direct funds	Insured funds [2]
1961	18	15	$1,408,700	$536,900
1962	55	28	5,928,950	4,213,050
1963	72	63	7,054,925	7,638,770
1964	99	168	10,876,680	23,023,000
1965	138	249	13,285,720	37,069,960

[1] This information supplied by the Farmers Home Administration, U.S. Department of Agriculture.
[2] Advanced by private investors and insured by the Government.

TABLE 16.—*Community Facilities Administration—Accelerated public works program grants and public facility loans for water utility construction* [1]

PUBLIC FACILITY LOANS, 1956-65

[Dollar amounts in thousands]

Year	Number of projects	Amount	Estimated total cost
1956	17	$1,624	$1,805
1957	41	7,249	7,443
1958	51	11,611	12,227
1959	37	5,872	6,448
1960	22	6,306	7,728
1961	51	6,791	7,428
1962	87	32,633	35,477
1963	80	18,603	29,830
1964	41	8,031	10,847
1965	68	33,419	45,203
Total	495	132,139	164,436

ACCELERATED PUBLIC WORKS PROGRAM GRANTS, 1962-64

1962	117	23,114	50,096
1963	818	108,147	245,642
1964	86	12,728	25,621
Total	1,021	143,989	321,359

[1] Data supplied by the Community Facilities Administration, U.S. Department of Housing and Urban Development.

D. WATER INDUSTRY NEEDS AND PROSPECTIVE CAPITAL OUTLAYS

1. CAPITAL NEEDS

Public water supply capital investment to meet population and industrial growth requirements, replace worn out and obsolete facilities, and partially eliminate a sizable construction backlog is estimated to grow from $2 billion in 1966 to $3 billion in 1975. The total outlay for the 10-year period would amount to $24 billion, more than twice the amount spent during the previous decade.

Table 17 shows the cost breakdown for the 1966–75 period. The basis for the estimates is given in the following discussions on population growth, depreciation, and deficiencies.

(a) *Population growth*

Of the present U.S. population of 195 million, the industry serves 157 million people or approximately 80 percent of the total. Over the next 10 years, the population is expected to grow at a rate of 1.5 percent, or roughly 3 million per year, reaching 225 million by 1976. Public water supplies will serve at least 80 percent of the annual increase and probably more. It is assumed in this report that 2.5 million more, or 83 percent, will be served each year.

The cost to provide water system capacity for growth alone is estimated to rise from $775 million in 1966 to $1 billion in 1975. This is based on the assumption that the initial cost will be $300 per capita and construction prices will increase 3 percent per year, a low figure in view of the price rise experienced in 1965.

The formation of water district, authority, or metropolitan water systems serving several communities will reduce per capita construction costs. On the other hand, many systems will develop water

sources that are located greater distances away, or provide more extensive treatment for polluted sources, both of which will result in increased per capita costs.

(b) *Depreciation*

To offset depreciation and obsolescence, it is estimated that the industry should spend at an annual rate of 1.5 percent of its current replacement value. This amounts to $630 million in 1966 based on a replacement value of $48.5 billion. The annual expenditure will rise to more than $1 billion in 1975, assuming that population growth needs are met.

TABLE 17.—*Capital requirements of the water utility industry, 1966–75* [1]

Item	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
U.S. population (millions)	195	198	201	204	207	210	213	216	219	222
Population served by public water systems (millions)	157	159.5	162	164.5	167	169.5	172	174.5	177	179.5
Per capita investment to serve population increase (dollars)	310	320	330	340	350	360	370	380	390	400
Total annual investment to serve population increase (millions of dollars)	775	800	825	850	875	900	925	950	975	1,000
Replacement value of systems (billions of dollars)	48.5	51	53.5	56	58.5	61	63.5	66.5	69	72
Annual depreciation and obsolescence [2] (millions of dollars)	730	765	800	840	875	915	950	995	1,030	1,080
Annual cost of correcting deficiencies [3] (millions of dollars)	560	575	595	610	630	650	670	690	710	730
Total annual expenditure (millions of dollars)	2,070	2,140	2,220	2,300	2,380	2,470	2,550	2,640	2,720	2,810

[1] Figures denote population at beginning of year; an annual increase of 3,000,000 is assumed, of which 2,500,000 will be served by public water supplies.
[2] Estimated at 1.5 percent of replacement value.
[3] Based on studies of Picton and Faust and on the assumption that deficiencies will be corrected over a 15-year period.

Investor-owned and some municipally owned utilities provide funds for at least part of this type of expenditure by accruing depreciation reserves from water sales revenues.

(c) *Deficiencies*

R. J. Faust [1] estimated in 1960 that it would take $1.9 billion to improve the quality of the water delivered by public water systems. He was referring to the need for many utilities to go beyond the production of a safe water by providing treatment to remedy objectionable characteristics, including tastes, odors, hardness, and corrosiveness.

W. Picton [2] in 1962 reported that many water systems lacked sufficient capacity to meet the water demands of their consumers under all conditions. He estimated that the cost to correct system deficiencies was $5,157 million (in 1960 dollars).

Although the annual investment in public water systems has increased steadily since the above-cited studies were made, the quality and capacity problems have not been corrected. Lack of adequate system capacity continues to show up in various parts of the country at different times, as, for example, in the Northeast during the

[1] Faust, R. J. "Challenges in the Water Industry." Willing Water, 4:7:3 (July 1960).
[2] Picton, W. L. "Construction Requirements for Water and Sewerage Works, 1962–70." Construction Review (September 1962).

1961–66 drought. In this instance, a survey showed that 129 of 351 water utilities that answered the questionnaire restricted water service during 1964 because of inadequate capacity in source, transmission, treatment, or distribution facilities.

Because a recent analysis of utility deficiencies is not available, the estimates of Faust and Picton have been employed to indicate the investment required during 1966–75 to eliminate the industry's construction backlog. Their cost estimates have been combined, converted to the 1965 price level, and spread over a 15-year period. To account for rising construction prices, it is assumed that the cost to correct deficiencies will increase 3 percent per year.

2. CAPITAL OUTLAY

On the basis of past performance, it is highly unlikely that the water industry will spend $2 billion in 1966 for construction. A realistic estimated would place the total expenditure at $1.3 to $1.5 billion, or $500 to $700 million short of the desired level.

The industry has the resources, however, to achieve a higher level of plant investment and to overcome rising costs. By raising water rates, it can obtain the revenue necessary to finance the projected programs.

It is expected that Federal assistance programs resulting from legislation passed in 1965 will have a prominent part in water utility financing during the next decade.

(a) *Water Rates*

Rate increases have been occurring at the rate of 1 in each 7 utilities in any given year according to an AWWA survey in 1960. Within the 4 years prior to the survey 55 percent of those reporting had had rate increases, and within the 10 years before the survey, 90 percent had raised their rates. A number of rate schedules, however, had been in effect for more than 20 years. Rate increases according to the survey commonly fall in the range of 10 to 35 percent.

A brief review of the history of rate increases since the end of World War II shows that rates and, consequently, water sales revenue rose only slightly during 1945–50, while construction, operation, and maintenance costs increased sharply. As a result, many utilities were unable to finance expansion programs. During 1950–55 some of this lost ground was regained, and during 1955–60 rates improved generally, leaving water utilities in a much healthier financial position. Further increases are required, however, to keep pace with rising costs and to finance improvements.

Water rates traditionally have been kept too low. The average customer pays considerably less for water service than for other utility services, as shown in figure 5, which compares the annual revenue per customer of electric, gas, telephone, and water utilities. The chart, representative of a limited number of utilities located principally in the Midwest, shows that during the 1952–63 period average water utility revenue per customer rose from $40 to $71; electric, $155 to $254; gas $124 to $209; and telephone, $131 to $218.

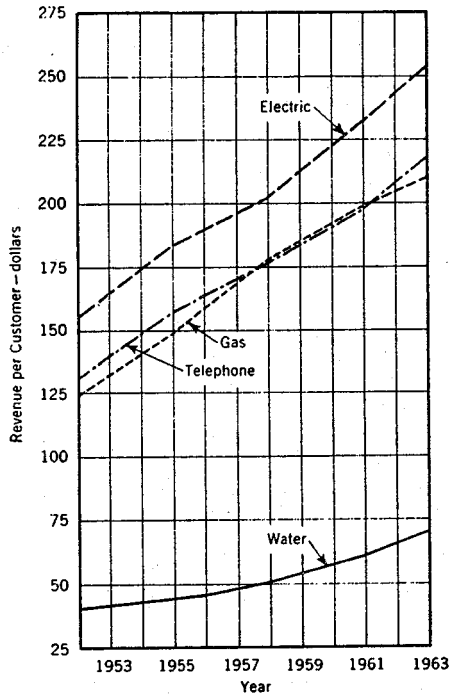


FIGURE 5. AVERAGE ANNUAL REVENUE PER CUSTOMER FOR UTILITIES, 1952–63

Since 1952, average annual revenues per customer have increased as follows: water utilities, from $40 to $71; electric, $155 to $254; gas, $124 to $209; and telephone, $131 to $218. From: Patterson, W. L., Comparison of Elements Affecting Rates in Water and Other Utilities. JOURNAL AWWA, 57:554 (May '65).

(b) *Availability of Private Investment Capital*

The water industry has not experienced difficulty in securing capital funds, nor should it in the future, provided that rates are raised to assure sufficient net income.

Very small utilities pose a special problem because their debt issues are small and costly to underwrite. Investors may regard them as too risky, particularly if their financial records are incomplete. Occasionally, their water supply development costs may be extremely high in relation to potential revenues. The answer in such cases frequently lies in consolidation of the small units into larger district or authority systems. Small systems also may be absorbed by or connect to existing larger systems.

Water utilities generally have low debt ratios. Table 18 shows the ratios of debt to gross plant for 358 municipally owned water utilities in 1960. The median debt ratio for this group was 32 percent. Debt ratios of investor-owned utilities are regulated by public service commissions within prescribed limits.

With adequate rates and sound accounting practices, water utilities would be able to attract capital at reasonable cost.

TABLE 18.—*Ratios of debt to gross plant for municipal water utilities in the United States, 1960* [1]

Gross plant in millions of dollars	Range of ratios of debt to gross plant—Percent													Class total
	No. debt	0.0 to 9.9	10.0 to 19.9	20.0 to 29.9	30.0 to 39.9	40.0 to 49.9	50.0 to 59.9	60.0 to 69.9	70.0 to 79.9	80.0 to 89.9	90.0 to 99.9	100.0 or more	Not available	
	Number of utilities in range													
0.0 to 0.9	4	0	0	3	3	1	2	4	1	2	1	6	7	34
1.0 to 2.4	19	13	11	16	13	7	7	7	2	0	1	1	20	117
2.5 to 4.9	7	8	8	13	10	11	9	4	2	2	0	4	13	91
5.0 to 7.4	3	2	1	9	10	7	1	4	0	1	0	1	9	48
7.5 to 9.9	2	0	2	2	4	4	1	3	3	1	1	0	2	25
10.0 to 14.9	2	4	4	6	1	2	1	1	0	0	0	0	1	22
15.0 to 19.9	0	4	2	4	1	0	0	1	1	1	0	4	4	22
20.0 to 29.9	0	0	1	1	4	0	4	2	0	0	0	0	1	13
30.0 to 39.9	0	1	1	3	2	0	1	1	1	0	0	0	0	10
40.0 to 49.9	0	0	1	1	0	1	0	0	0	0	0	0	1	4
50.0 to 59.9	0	0	0	0	3	1	0	0	1	1	0	0	0	6
60.0 to 69.9	0	0	1	2	0	2	0	0	0	1	0	0	1	7
70.0 to 79.9	0	0	0	1	0	1	0	0	0	0	0	0	0	2
80.0 to 89.9	0	0	0	1	0	0	0	0	0	0	0	0	0	1
90.0 to 99.9	0	0	0	1	0	0	0	0	0	0	0	0	0	1
100.0 and over	0	0	3	1	3	4	0	2	0	0	1	0	0	14
Total	37	32	35	64	54	41	26	29	11	9	4	16	59	417
Cumulative total	37	69	104	169	222	263	289	318	329	338	342	358	417	
Index	10.3	19.3	29.0	46.9	62.0	73.5	80.7	88.8	91.9	94.4	95.5	100.0		

[1] Source: "A Survey of Operating Data for Water Works in 1960." Staff report, American Water Works Association, New York (1964).

(c) *Federal Assistance Programs*

Congress approved several programs in 1965 to assist in the development of water systems.

The Housing and Urban Development Act (Public Law 89–117) authorizes $200 million in grants to finance up to 50 percent of the cost of basic public water and sewer facilities. It is estimated that $50 million of this will be spent on public water supply facilities in fiscal 1966 and again in 1967.

The Public Works and Economic Development Act (Public Law 89–136) authorizes $500 million per year for 4 years in grants of up to 50 percent for public works in economically distressed areas. The law also authorizes $170 million per year for loans to assist in public works development and improvement.

Public Law 89–240, the Rural Water and Sanitation Facilities Act, increases the loan insurance limit of the Farmers Home Administration to $450 million, authorizes $55 million a year in grants for facilities, and provides $5 million in grants for planning. The law covers both water supply and waste disposal systems in rural areas (towns up to 5,500 population). Grants are limited to no more than 50 percent of the project cost.

CHAPTER 3

Rural-Agricultural Water Supply Systems: Irrigation*

INTRODUCTION

This chapter is confined to a discussion of irrigation water supply systems that are either public facilities or group facilities operated by various types of irrigation water organizations. The public bodies and other groups treated here include: mutual irrigation organizations, commercial water suppliers, irrigation districts, the U.S. Bureau of Reclamation, the Bureau of Indian Affairs, and some States and cities.

Much of the information is presented here as complete and comparable only within a broad region, such as the Western or the Eastern United States. The statistical information was supplied mainly by agricultural census publications and Bureau of Reclamation reports.

A. NATURE AND COMPOSITION OF IRRIGATION FACILITIES

1. DESCRIPTION OF FACILITIES

(a) *Physical Characteristics*

Irrigation facilities usually include several systems, the number and type varying between and within regions according to the nature of the irrigation water supply, the time that the facility was constructed, the local topography, soil conditions, etc. Irrigation facilities always include a source of fresh water. This source may be a natural lake or stream, but it is usually a constructed reservoir or a ground water source.

A water conveyance system is also present and consists of canals and ditches and/or pipes leading from the water supply source to the place of use. Large ditches and canals carry water to a system of smaller ditches, called laterals. Some large conveyance canals are hundreds of miles long.

In porous or easily eroded soil the canals and ditches are usually lined with concrete. Gravity serves to propel water from the place of storage through the conveyance system to the point of use. Pumps are used for propelling irrigation water in cases where gravity cannot be employed; for instance, to lift ground water to surface level and from there to the point of use, or to raise water to a higher elevation in a main irrigation canal.

Steel or wooden flow gates and valves, plus flow gages for measuring amounts used by individual growers are often part of the conveyance systems, also.

Water-application and land-preparation systems are typically not a public enterprise, but they are sometimes a group enterprise. Their

*This report was prepared by the U.S. Department of Agriculture. The authors were Clifford Dickason and Howard Hill, Natural Resource Economics Division, ERS, with minor editing by committee staff.

cost, being an associated cost of irrigation, is not readily available in irrigation statistical sources. Most water-application systems fall into three main categories: ditch-furrow systems, piped water sprinkler systems, and field flooding. In the ditch-furrow system, the grower's fields are furrowed in such a way that each of several parallel furrows abuts a water supply ditch. When water is needed in the furrows, the grower usually inserts tubular plastic or metal siphons at the ends of the furrows to siphon water from the supply ditch, over an intervening few feet of ground, and into each furrow. The standard diameter and flow of the siphons assures an equal flow of water in each furrow. The crops are planted between water furrows, and their roots receive moisture soaking through the soil from the furrows.

The ditch-furrow system is employed where the land is quite flat, although the land may have the form of an inclined plane. Ditch-furrow systems are constructed with great care and effort to assure even, level water flow. Often the land itself is meticulously leveled before the furrows are made.

Water sprinkler systems are used in situations where they are more practical than ditch furrows because of somewhat irregular terrain, close planting of crops, or infrequency of irrigation need. The pipes are generally of an aluminum alloy, sometimes supplemented by plastic. They often have steel end connections. The pipes are usually movable; and, having irrigated one sector of a field, are rolled or carried on to the next sector.

Some wheeled pipe-sprinkler systems move themselves slowly across the fields as they spray water. Since piped water sprinkler systems are not inherently difficult to move, it is often not economical for a grower to build a large stationary pipe system that can spray his entire crop without being moved.

Field-flooding is used mainly to suit the characteristics of certain crops, such as rice, alfalfa, and some orchard fruits. Here again, the land is often carefully leveled.

In the dry areas of the United States, where water salinity and soil salinity present a problem, subterranean drainage tile systems are often constructed as an associated part of the irrigation systems. These systems fill with residual irrigation water and conduct soluble salts out of the irrigated fields. This prevents the irrigated soil from becoming increasingly saline because of constant evaporation of the slightly saline irrigation water.

Most of the elements of irrigation facilities, such as are described above, may be publicly owned or group owned as well as individually owned. Piped water sprinkler systems, for instance, may occasionally be owned by a group and moved from one grower's fields to another.

Available cost statistics concerning irrigation water supply systems as public or group facilities usually concern only the cost of supplying the water up to the point at which the grower receives it. Also, land preparation and other associated activities of irrigating crops are usually not done as a group enterprise employing public facilities. Therefore, the treatment of group and public facilities here will proceed only to the point at which water reaches the growers' fields.

(b) *Services Rendered*

An irrigation system, of course, supplies water at the proper times to the growers' crops. A reliable water supply translates into several services to the grower: (1) it is insurance against destruction of the crop by drought; (2) it reduces capricious variation in crop yields from year to year; and (3) it significantly increases the quantity and quality of crop yields per acre in the geographic areas where irrigation is most prevalent.

There are qualitative standards that irrigation systems should meet. For instance, they should provide a reliable, continuously available supply of water to the growers at the times in the growing season when irrigation water is needed by the crops.

The allowable water quality in irrigation varies by crops. Some growers irrigate certain types of crops with the effluent from the sewage system of a nearby community. Rather high levels of salt content can be tolerated without continually increasing the salinity of the soil, as was mentioned earlier; and some crops are considerably more tolerant of salinity than others. Piped water-sprinkler systems, of course, must use water that is filtered free of large particles which would clog the pumps or the sprinkler heads.

2. EXISTING CAPITAL PLANT IN THE UNITED STATES

(a) *Growth and Distribution*

There is a dearth of statistics showing the size and number of various irrigation structures in the United States. Also, there are great variations in size of the various irrigation structures. Therefore, the extent of irrigation facilities provided by various public and quasi-public irrigation organizations can best be expressed in terms of acres of land irrigated.

As of 1959, there were over 33 million acres of irrigated land in farms in the United States. The distribution of acreage irrigated by public and quasi-public facilities is shown in table 1.

TABLE 1.—*Acreage irrigated by organizations; regions and United States, 1920–59*

Year	Acreage			As a percent of total irrigated acreage in—		
	Western States	Eastern States [1]	United States excluding Alaska	Western States	Eastern States [1]	United States excluding Alaska
	1,000 acres	*1,000 acres*	*1,000 acres*	*Percent*	*Percent*	*Percent*
1920	[2] 12,144	(3)	(3)	[2] 65.3	(3)	(3)
1930	[2] 12,906	(3)	(3)	[2] 68.1	(3)	(3)
1940	[2] 16,179	(3)	(3)	[2] 68.3	(3)	(3)
1950	[2] 14,714	(3)	(3)	[2] 55.5	(3)	(3)
1959	[4] 17,786	32	17,818	[4] 56.7	1.8	53.7

[1] Conterminous United States, minus the 17 Western States and Louisiana. The 17 Western States are California, Oregon, Washington, Idaho, Montana, Nevada, Arizona, New Mexico, Colorado, Utah, Wyoming, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas.

[2] The 17 Western States.

[3] Not available.

[4] The 17 Western States, plus Louisiana and Hawaii.

Sources: 1959 Census of Agriculture; vol. III, Irrigation of Agricultural Lands; U.S. Department of Commerce (Washington, D.C., 1962), pp. 5 and XXV; 1959 Census of Agriculture; vol. V, Special Reports, pt. 2, Irrigation in Humid Areas; U.S. Department of Commerce (Washington, D.C., 1962), pp. 3 and 6; and 1950 Census of Agriculture; Irrigation of Agricultural Lands; U.S. Department of Commerce (Washington, D.C., 1952), p. 93.

The total farm acreage irrigated by organizations and single-farm systems appears in table 2.

TABLE 2.—*U.S. farm acreage irrigated, by geographic divisions, 1959*

Geographic division:	*Acres irrigated in 1959, thousands*
New England	31
Middle Atlantic	148
East North Central	111
West North Central	3,066
South Atlantic	597
East South Central	137
West South Central	7,050
Mountain	12,095
Pacific Continental	9,787
Hawaii	141
Conterminous United States and Hawaii	33,163

Source: 1959 Census of Agriculture.

Statistics concerning irrigation in the East—and especially investment and organization statistics—are sparse. A brief qualitative description of irrigation in the 30 humid Eastern States follows: [1]

Irrigation water has much less effect on increasing crop yields in the humid States, because of the more abundant rainfall there. Certain crops respond unusually well to irrigation, however. Arkansas, Florida, and Mississippi were the three States having the largest total area irrigated in 1960. Rice was the leading irrigated crop in Arkansas and Mississippi. Citrus fruits and vegetables were the leading irrigated crops in Florida. In 1960, the largest single irrigated crop acreage in the humid States was rice, which was produced on 424,657 acres.

Wells were the principal source of irrigation water in 1960, supplying water for 61.7 percent of the irrigated acreage in the humid States. Natural streams and rivers were the water source for 14.3 percent of the area irrigated in the Eastern States. Natural lakes and ponds, drainage ditches, farm runoff, springs and seepage, and constructed reservoirs accounted for the remaining 24 percent.

The age distribution of public and quasi-public irrigation facilities is not available.

(b) *Ownership Proportions*

The proportion of ownership of irrigation systems by various classes of irrigation organizations cannot be stated in terms of systems or structures. Of the acreage irrigated by systems operated by organizations in the 17 Western States, the proportion of land irrigated by each of the various types of organizations in 1959 is shown in table 3.

Of the 17.7 million irrigated acres, 6.8 million acres, or 38.4 percent, were supplied partly or entirely from Bureau of Reclamation facilities operated by the Bureau or by the various water users' organizations mentioned.[2] (Usually a completed project's operation is turned over to a water users' organization.) Only 4 percent of the total acreage irrigated by organizations received water from Bureau of Reclamation facilities operated by the Bureau itself.

[1] 1959 Census of Agriculture; vol. V, pt. 2, Irrigation in Humid Areas, pp. XVI and XVII.
[2] Crop report and related data, 1964. U.S. Department of the Interior, Bureau of Reclamation (Wash., D.C., 1965), p. 30.

TABLE 3.—*Distribution of acreage irrigated, by organizations in 17 Western States, 1959*

Type of organization	Irrigated acres (thousands)	Percent
Mutual organizations:		
Unincorporated	2,067	11.7
Incorporated	6,733	38.0
Commercial suppliers	573	3.2
Irrigation districts	6,921	39.2
U.S. Bureau of Reclamation projects or storage operated directly by the Bureau	711	4.0
U.S. Bureau of Indian Affairs	579	3.3
States	44	.2
Cities	73	.4
Total	[1] 17,701	100.0

[1] Total differs from total in table 1 because Hawaii was excluded here.

Source: 1959 Census of Agriculture.

(c) *Current Value of Irrigation Facilities*

Gross capital investment chargeable to irrigation by irrigation organizations in the 17 Western States was estimated at $1.38 billion as of 1950. An additional $1.04 billion was invested by organizations in the period 1950 through 1959.[3] Neither estimate is corrected for capital replacement or for depreciation. Also, the estimates are not corrected for price-level changes. Thus, their total of $2.42 billion does not accurately portray the 1959 net capital value of irrigation systems investments in the Western States.

No estimate of total capital investment in irrigation works is available for the 31 conterminous Eastern States, which contained 1.8 million acres of irrigated land in 1959.

B. Costs and User Charges

CONSTRUCTION COSTS

The Bureau of Reclamation estimates that the average construction costs of future potential projects in the West will be about $920 per acre of irrigated land or irrigated land equivalent, though many proposals exceed this figure considerably.[4] This estimate was developed for projects identified by the Bureau as potential Federal projects. Approximately two-thirds of the projects identified were classified as potential Federal projects. An ex post approximation of irrigation construction cost can be made for the 17 Western States, plus Louisiana, by dividing the total of new capital investment by organizations, 1950–59 ($1,040 million) by the increase in organizations' irrigated acreage, 1950–59 (2.7 million acres).[5] This amounts to $381 per additional irrigated acre. This figure is not corrected for changes in the price level during the 1950's. New capital investment, 1950–59, reported by the Census of Agriculture includes some unknown amount of new capital invested in existing irrigation struc-

[3] "Census of Agriculture, 1959," vol. III; p. 69.

[4] "Water Resources Activities in the United States," Committee Print No. 14, Select Committee on National Water Resources; U.S. Senate (Washington, D.C., 1960), p. 19. Irrigated land equivalent is the number of acres fully supplied with irrigation water. It is made up of (*a*) newly irrigated land, and (*b*) land presently irrigated but not fully supplied with water. For example, a project may (*a*) newly irrigate 10,000 acres, and (*b*) upgrade water supplies for an additional 10,000 acres where supplies had been only 50 percent adequate. The project in this case would be considered to involve 15,000 acres of irrigated land equivalent.

[5] "Census of Agriculture, 1959," vol. III, pp. 30, 77, and 192.

tures that is neither maintenance nor replacement cost and does not necessarily lead to the irrigation of additional acres. Such an investment might have been made to increase a canal's peak flow capacity, or to supplement a pump engine with an additional engine that would increase the capacity of an existing pumping system. Also, supplemental water might have been provided for existing irrigated acreage by the investment of new capital.

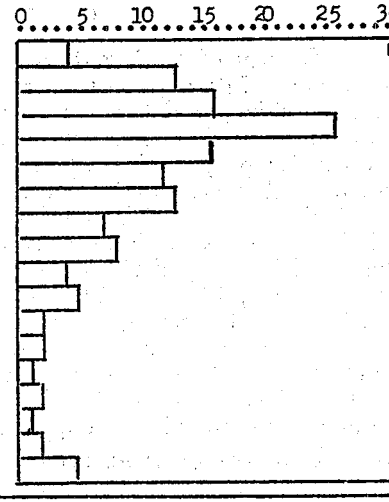
2. OPERATION AND MAINTENANCE COSTS

Operation and maintenance costs of supplying water to growers were estimated to average $4.81 per acre for 1949 in the 17 Western States.[6] No later data are available. There are no comparable statistics available for the Eastern United States.

An approximation of the typical annual range of operation and maintenance cost of irrigation water per acre of irrigated land in the year 1964 was made, using selected data from pages 109–111 of the Bureau of Reclamation's "Report of the Commissioner, 1965; Statistical Appendix." According to this estimate, the current range of typical operation and maintenance costs per irrigated acre in projects constructed by the Bureau of Reclamation is from about $3.90 in the Kansas, Nebraska, Dakota, Wyoming, Utah, Montana, Idaho area to about $19.40 in the Arizona-southern California area. Chart 1 shows the numbers of projects having given annual operation and maintenance costs per irrigated acre.

CHART 1.—FREQUENCY DISTRIBUTION OF SELECTED BUREAU OF RECLAMATION PROJECTS' ANNUAL OPERATION AND MAINTENANCE COSTS PER IRRIGATED ACRE

Cost per acre	Number of projects per O&M cost category
$ 0-$ .99	4
$ 1.00-$ 1.99	13
$ 2.00-$ 2.99	16
$ 3.00-$ 3.99	26
$ 4.00-$ 4.99	16
$ 5.00-$ 5.99	12
$ 6.00-$ 7.00	13
$ 7.00-$ 8.00	7
$ 8.00-$ 9.00	8
$ 9.00-$10.00	4
$10.00-$11.00	5
$11.00-$12.00	2
$12.00-$13.00	2
$13.00-$14.00	1
$14.00-$15.00	2
$15.00-$16.00	1
$16.00-$17.00	2
$17.00 and over	5



Source: U.S. Bureau of Reclamation; Report of the Commissioner, 1965.

[6] "Census of Agriculture, 1950," vol. III, p. 88.

3. USER CHARGES

Complete national cost and revenue statistics from cooperatives, irrigation districts, and other organizations are not available at this time; thus, it is not possible to determine the extent to which irrigation costs are covered by user charges. Irrigation districts are supported in part by tax levies in addition to water charges assessed against users.

Aggregate cost and price statistics are available for Bureau of Reclamation projects. Allocation of project costs (which excludes on-farm associated costs of land preparation, etc.) varies between projects. Revenues for reimbursement of Bureau of Reclamation projects are obtained from payments on repayment contracts, water service, and rental revenues, power revenues, and other sources. Irrigation costs are interest free and are repaid over a contractual repayment period by water users on the basis of their ability to pay, as determined by an economic analysis of the particular project. Irrigation costs above water users' ability to pay are repaid through financial assistance from surplus power revenues, and other miscellaneous project revenues.

In the Bureau's existing reclamation program, including projects authorized, under construction or completed, the total amount of reimbursable expenditures allocated to irrigation purposes as of June 30, 1965, was $3.842 billion of which $1.875 billion, or 49 percent will be paid for mainly by power revenues.[7] Nonreimbursable irrigation costs on Bureau of Reclamation projects as of June 30, 1965, were $78.4 million.[8]

Another source of Federal financing of irrigation water sources is through the Watershed and Flood Prevention Act (Public Law 83–566). Under this program, which is administered by the Department of Agriculture, cost sharing up to 50 percent of total costs is authorized for construction of certain structures, including impoundments for irrigation water.

Comparable statistics concerning charges to irrigators on projects administered by State and local governments are not available.

C. The Trend of Capital Outlays

In 17 Western States and Louisiana, the trend of annual capital outlays for irrigation water supply systems of organizations has been as follows for two recent periods: From 1940 through 1949, $520 million, or an average of $52 million per year. From 1950 through 1959, $1,039.6 million, or $103.96 million per year.[9] These capital outlays have been applied mainly to irrigating additional acreage, but not entirely so.

1. A POSSIBLE ACCOUNTING FOR THE NEW INVESTMENT IN IRRIGATION

Of the $1,045.2 million new capital investment by organizations in the 17 Western States, Louisiana, and Hawaii in 1950–59, $496 million was invested in California and $200.8 million in the State of

[7] Report of the Commissioner, 1965; U.S. Department of the Interior, Bureau of Reclamation (Washington, D.C., 1965) p. 79.
[8] Report of the Commissioner, 1965; p. 77.
[9] "Census of Agriculture, 1959," vol. III, p. 69.

Washington. Various amounts of less than $70 million were invested in new irrigation capital by each of the remaining 15 States.[10]

If we consider the additions to irrigated acreage rather than additions to capital investment, the largest expansion from 1950 to 1959 was recorded in Texas, which experienced an increase of 2,524,104 irrigated acres. Next was Nebraska, with 1,201,667 newly irrigated acres. Third was California, with an increase of 957,246 acres for the 10-year period.[11]

2. PROPORTIONS OF CAPITAL OUTLAY BY ORGANIZATIONS

In the period 1940–50 various proportions of new capital outlays of irrigation organizations for irrigation in 17 Western States were accounted for by the following agencies and other organizations:[12]

	Percent
Mutual, unincorporated organizations	1. 1
Mutual, incorporated	6. 3
Commercial water suppliers	1. 6
Irrigation districts	8. 3
U.S. Bureau of Reclamation	79. 8
U.S. Bureau of Indian Affairs	2. 6
States	. 1
Cities	. 2

There are no comparable statistics showing the proportions of new capital outlays accounted for by various organizations from 1950 to 1959, except that for the 17 Western States and Louisiana the proportion of new capital outlays by the Bureau of Reclamation was 76.5 percent and for all other organizations was 23.5 percent.

3. MEANS OF FINANCING

Bureau of Reclamation irrigation projects have been financed by Federal appropriations, contributions, and advances by water users, by the reclamation fund, and other special funds. The reclamation fund is comprised of collections from Bureau of Reclamation project power revenues, royalties from oil leases, sale of public lands and timber, construction repayments from water users' organizations, and other miscellaneous collections within Bureau of Reclamation projects.

State projects are financed by sources such as appropriations from general tax revenues, bonds, and Federal grants.

For sources of finance cities, towns, and counties issue bonds to the public and also receive U.S. loans. In addition, they may receive nonreimbursable aid from the United States in the form of payments of up to one-half of the cost of certain irrigation system structures (such as dams), that are a part of Public Law 566 projects.

Irrigation districts may sell bonds, where this is allowed by State law. In some cases these bonds are purchased by the State. Irrigation districts sometimes tax local property owners in advance of new capital outlays. The more usual practice, however, is to tax property owners later, when the time comes to retire bonds. If eligible, districts may construct federally assisted Public Law 566 projects, as do cities and towns. In addition, irrigation districts

[10] 1959 Census of Agriculture, vol. III, pp. 69 and XXVI.
[11] 1959 Census of Agriculture, vol. III, pp. 8–27.
[12] 1950 Census of Agriculture, vol. III; p. 95.

are often empowered to accept State or Federal loans (such as Farmers Home Administration loans) and State grants. Irrigation districts are the chief users of irrigation facilities built and financed by the Bureau of Reclamation.

Unincorporated irrigation mutual associations or cooperatives issue bonds and borrow from banks. Incorporated mutual associations issue bonds and borrow on notes secured by liens on fixed capital and water rights, but not on the land. They also receive Federal grants and loans. Their capital stock almost always represents funds of the water users themselves and not "outside" funds.

When the Bureau of Reclamation supplies facilities for irrigation, the Bureau, of course, is the body that supplies the financial resources. Most commonly, the "water users organizations" are irrigation districts, water districts, and conservancy districts. In order to have irrigation facilities constructed, a water users association must assume an obligation to repay the United States for a certain portion of the cost of the irrigation facilities. This is similar to the repayment of a loan. Still, it is not customary for the title to the irrigation facilities to pass from the Bureau to an irrigation district when the obligation has been repaid, although the irrigation district is likely to assume the operation of the facilities soon after construction is completed.

Lastly, commercial water suppliers who are not also water users usually finance construction of facilities with equity capital and with bond sale proceeds.

D. Projected Change in Irrigated Acreage and Development, 1964–75

As of 1959, nearly half of the irrigated acreage in the Western States and nearly all of the irrigated acreage in the Eastern States was supplied with water from privately developed sources. Moreover, farm water-application and land-preparation systems, including those systems on farms supplied by irrigation organizations, are not considered to be public irrigation facilities. These systems do represent some portion of the total capital structure of irrigation, however, and their purchase can be encouraged or facilitated through such means as cost sharing, credit, and watershed project development.

For the United States (mainland), the remaining irrigation potential is estimated to be 40.4 million acres, of which 15.5 million acres are in the East and 24.9 million acres are in the West.[13] Potentials for Federal and non-Federal are estimated to be as follows:

[In millions of acres]

	Federal	Non-Federal	Total
Western mainland	16.2	8.7	24.9
Eastern mainland	4.3	11.2	15.5
United States	20.5	19.9	40.4

In the West, roughly two-thirds of the remaining irrigation potential has been classified by the Bureau of Reclamation as potential Federal projects. The total cost of these projects is estimated by the Bureau

[13] Pavelis, George A. "Irrigation Policy and Long-Term Growth Func ions," Agricultural Economics Research, vol. XVII, No. 2, April 1965. U.S Department of Agriculture, p. 55.

of Reclamation to be about $16.3 billion at 1959 prices, of which about $12.7 billion would be allocated to irrigation under present procedures.

Federal irrigation development in the East is expected to be limited to federally assisted small watershed projects (Public Law 566), mainly in the Southeastern and South Central States.

Projections of irrigated acreages for 1964 and 1975, and the net increase for 1964–75, broken into West and East sectors of the United States are as follows: [14]

[In millions of acres]

	West	East	United States
Projected irrigated acreage, 1975	38.0	3.9	41.9
Estimated irrigated acreage, 1964	34.2	2.8	37.0
Increase in acreage, 1964–75	3.8	1.1	4.9

The increase in irrigated acreage is allocated according to the estimated distribution of total remaining irrigation potentials in each region, as follows:

[In millions of acres]

	West	East	United States
Federal development	2.5	0.3	2.8
Non-Federal development	1.3	.8	2.1
Total additions, 1964–75	3.8	1.1	4.9

Bureau of Reclamation estimates of unit investment costs of western irrigation facilities range from $2,780 per equivalent acre in the South Pacific region to $566 in the lower Arkansas-White-Red region. The average is $920 per equivalent acre. These unit investment costs are for the irrigation water supply portion of projects and do not include farm development costs.

For western projects identified as non-Federal, the investment cost estimates ranged from $140 per equivalent acre in the Colorado region to $659 in the western gulf region. The average was $310 per equivalent acre of irrigated land.

Given existing legislation, Federal irrigation potentials in the East are assumed here to be limited to the acreages that could be irrigated by federally assisted small watershed projects (Public Law 566). At present, there are 15 such projects in the East; costs allocated to irrigation on a per-acre basis are available for 11 of the projects. These costs average $150 per irrigated acre, of which a maximum of half may be borne by the Federal Government. (In practice, approximately half of such costs have been borne by the Federal Government.)

[14] Irrigated acreages for 1964 were not available at the time the chapter was prepared. Projections for 1964 and 1975 were obtained from Pavelis, cited previously. The projection reported here assumes modest development of Federal and non-Federal potentials, resulting ultimately in development of half of the remaining potential of each.

Applying these average cost figures to the projected acreage increases, estimates of capital needs for irrigation development in the next 10 years are as follows:

Federal irrigation development	(*Million dollars*)
West, 2.5 million acres by $920	2,300.0
East, 0.3 million acres by $75	[1] 22.5
Total	2,322.5

[1] Federal share of small watershed project construction costs.

Non-Federal irrigation development	(*Million dollars*)
West, 1.3 million acres by $310	403.0
East, 0.3 million acres by $75	[1] 22.5
Total	425.5

[1] Non-Federal share of small watershed project construction costs borne by local organizations.

The estimated capital requirements for irrigation expansion shown above may be considered capital needs in the sense that additional capital will be required to finance the projected development. The projections do not purport to demonstrate the national need for irrigated acreage by 1975.

There is a wide range for investment decisions in both East and West with respect to future irrigation development. In both regions, the Federal or non-Federal development potential is sufficient to fulfill the projected increase in irrigation development. In the East, non-Federal development is expected to consist chiefly of independent development by private farm operators. Except for small watershed project construction costs borne by local organizations (estimated to be $22.5 million from 1964–75), non-Federal irrigation development in the East is largely independent of State and local government and private organization financing. It is expected that irrigation development in the East will continue to be carried out largely by individual farm operators.

Non-Federal irrigation development in the West includes irrigation by individual farm operators, mutual organizations, commercial water suppliers, irrigation districts, States, and cities. In 1959, non-Federal organizations irrigated 53 percent of all irrigated land in the 17 Western States and Louisiana, and 4 percent of irrigated land was supplied water directly by the Bureau of Reclamation and Bureau of Indian Affairs. Individual farm operators irrigated 43 percent of the West's irrigated land. In the period 1940–50, 35 percent of total capital investment in western irrigation systems was made by single farms; excluding investment in projects operated directly by the Bureau of Reclamation, single-farm investment was 73 percent of the total. Data for single-farm irrigation investment for later periods are not available. However, capital investment by non-Federal irrigation organizations in the West more than doubled between the two periods 1940–50 and 1950–59, from $106 to $244 million. Thus, even if there were no change in the amount of new investment by organizations other than the Bureau of Reclamation by 1975, these organizations would account for over half the projected $403 million non-Federal irrigation investment in the West.

The means by which new investment will be financed may differ greatly by type of organization. Between the two periods, 1940–50 and 1950–59, nearly 90 percent of the increased investment on western projects, excluding those operated directly by the Bureau of Reclamation, was by mutual organizations and irrigation districts. Separate investment data for cities and States are not available for the recent periods, but from 1940–50 their new irrigation investment combined amounted to $1.8 million.

Chapter 4

Sanitary Sewer Collection Systems*

A. The Nature and Composition of Sanitary Sewers

1. DESCRIPTION OF FACILITIES

Sanitary sewer collection systems provide a means of performing one of the most essential services required, if man is to exist in a communal fashion—the removal of wastes generated by him. Man cannot survive when too intimately surrounded by his own body wastes. These wastes including excreta are the breeding grounds of pestilence and the method of transmission of many diseases including cholera, typhoid and paratyphoid fevers, bacillary and amoebic dysentery, hookworm and ascaris infections, poliomyelitis and various other virus infections. As civilization evolved mankind has instinctively improved upon his methods of waste removal.

The origin of sanitary sewer collection systems employing water as the vehicle for transporting the waste is unknown, though portions of the Nippur, India, and Tell Asmar, Turkey, systems were constructed over 6,000 years ago. Waterborne waste systems were constructed throughout the then known world by the Romans. However, with the decline of the Roman Empire waterborne waste systems fell into disuse, and though the nucleus of many systems were subsequently constructed, they were installed as ground or surface drains, and the discharge of excreta into them was prohibited by law. Cesspools and pit privies replaced the water flushed devices in city homes, and as population concentrations increased the privies and cesspools proved to be inadequate. They tended to fill and overflow or otherwise malfunction, polluting the local ground and surface water, creating general nuisances and providing rodents and all manner of pests a friendly environment, thus contributing to the plagues that swept Europe during the middle ages.

Following a series of cholera epidemics in London at the beginning of the 19th century, it was demonstrated that the disease was waterborne through contamination of a water supply by leaching cesspools. To eliminate this problem, London in 1815 legalized the discharge of excreta into the existing drainage system of the city, and undertook the construction of facilities for the explicit purpose of providing drains from the existing cesspools to places where it was then considered safe to discharge their contents. These points of discharge were normally surface streams or rivers where the material would be flushed beyond the reaches of the community.

In providing a method of waste removal an even greater problem was created, that of stream pollution. When cholera again raged

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throughout London in the mid-1840's and early 1850's this problem of stream pollution was recognized, and remedial steps taken through the construction of interceptor sewers to concentrate all of the drains at a few points so that their discharge might be treated rather than pollute the streams. At the same time efforts were made to provide treatment of raw water supplies.

The first American city to follow London's example was Boston, Mass., which legalized the discharge of human wastes into its drainage system in 1833. It was not until 1857, however, that a sewer system in the United States was designed for the specific purpose of collecting waterborne excreta. In that year, both the city of Chicago, Ill. and the (then) city of Brooklyn, N.Y., undertook the construction of comprehensive consolidated sewer collecting systems. These systems were the forerunners of the modern sanitary sewer collecting systems which are currently providing service in over 12,000 communities in the United States.

(a) *Physical Characteristics*

In order that a distinction may be made between the public works categories of sanitary sewer collecting systems, storm sewer collecting systems, and sanitary sewage treatment systems, the following definitions have been employed:

> Sanitary sewage treatment systems include all the various devices used in the treatment or stabilization of sewage or industrial wastes of a liquid nature, including the necessary intercepting sewers, outfall sewers, pumping, power, and other equipment and their appurtenances, and includes any extensions, improvements, remodeling, additions, and alterations thereof.
>
> Storm sewer collecting systems include all the various devices used in the carrying off of, or removal of storm and surface water, street washings and other wash water or drainage, and include any extensions, improvements, remodeling, additions or alterations thereof, but exclude any device used in the carrying off of, or removal of liquids, wastes or drainage of an industrial, commercial or domestic origin.
>
> Sanitary sewers include all the various devices used in the carrying off of, or removal of liquid wastes or drainage of an industrial, commercial, or domestic origin through a pipe or conduit arrangement, either separately (separate sewers), or in combination with storm and surface water, street washings and other wash waters or drainage (combined sewers), including any extensions, improvements, remodeling, additions, or alterations thereof, but excluding all devices included as part of a sanitary sewage treatment systems, and all local buildings and household connections.

The modern sanitary sewer collecting system which evolved from the experience gained in the mid-1800's is a complex arrangement of pipes and conduits strategically located—throughout a community, in such a fashion—as to provide all improved property with a safe and sanitary method of disposal of the waterborne wastes that might originate thereon. The system provides service to not only households, but also to business and commercial establishments and industrial complexes.

Since the systems provide a necessary service to any and all parties on a demand basis, they are generally considered a utility, and as such the public has come to rely upon them for fully automatic service wherever they are employed.

(b) *Standards of Performance*

To be fully functional, collecting sewers must be constructed below the frost line, and at sufficient depth to allow for the drainage of basements adjacent thereto. In order to make the system as automatic as possible, the collecting sewers are laid on continually descending grades sufficient to produce self-cleansing velocities (not less than 2 feet per second when flowing one-third full) but not excessive enough to produce velocities in excess of 15 feet per second when flowing eight-tenths full which might damage the facility. In those areas where excessive depths would needlessly be encountered, it is often economically feasible to employ pumping stations to raise the level of the line to a reasonable depth. Similarly where ravines or other low areas are encountered which cannot be conveniently bridged, due to lack of clearance or for some other reason, or to prevent the sewer line from intersecting some other subsurface facility, inverted siphons are employed.

To facilitate maintenance and eliminate as many potential stoppages as possible, access to the system is provided by manholes strategically located throughout the system. The manholes, normally 4 or more feet in diameter, are spaced not more than 400 feet apart on small lines and 500 feet apart on larger lines (those over 24 inches in diameter). Manholes are also installed wherever the slope, direction or size of a line is charged, where two or more lines intersect, or at the terminus of a line.

In order to provide for the maximum service area with a minimum of pipe footage, the sanitary sewer collecting systems are normally installed in the center of streets or other public rights-of-way, being equally accessible from properties located on either side. Normally, the line or pipe from the building or other facility to be served to the sewer located in the public rights-of-way is the responsibility of the owner of the properties served and is not considered a part of the public sewer collecting system. The location of the sewers in the public domain also provides ready access to the system for purposes of maintenance and repair.

Sanitary sewer systems are normally designed to provide service for the estimated ultimate tributary population, based upon current and projected land use patterns of the area to be served for at least the next 50 years.

In those instances where economies of scale dictate a shorter design period, it should not be for a period of less than 25 years. In addition to the population requirement, adequate allowances for anticipated commercial establishment, institutions such as hospitals and nursing homes, et cetera, and industrial complexes should be taken into consideration.

Smaller sewers, those less than 24 inches in diameter, should be designed so that when they are flowing full, they provide a capacity of at least 400 gallons per day per person served, with adequate allowances for any industrial or commercial wastes and infiltration. In

the case of combined sewers, an additional allowance for storm and other surface runoff tributary to them must be included. Large sewers should have similar capacities, but due to the inherent time lag of concentrating the full flow of the smaller collecting lines in the larger main or trunk sewers, the per capita requirement when flowing full can be reduced to not less than 250 gallons per day per person served.

In order to minimize maintenance and prevent undue stoppages, no sanitary sewer collecting lines should be constructed less than 8 inches in diameter. The selection of material with which the system is constructed should include an appraisal of the characteristics of any possible industrial wastes which might be contributed to the system, the local soil and ground water characteristics, the possibility of septicity occurring in the lines, the durability and strength of the material itself, as well as its ability to withstand abrasion and the continuous pounding caused by traffic passing over it.

Under normal circumstances, sewer conduits have a reasonable life in excess of 50 years, as demonstrated by the many sections of sewer systems throughout the United States that were constructed prior to the turn of the century. Of these older conduits, many have had their efficiency substantially reduced by the failure of the material used for joining the pipes. This failure of the joint material has allowed roots, earth, and ground water to enter the lines, thereby blocking them, or increasing the amount of infiltration thereto, and in some instances even undermining the line to the point of collapse. Routine maintenance alleviates part of these problems through the removal of the tree roots and other materials that tend to block the lines. Infiltration and undermining are often not detected until a major failure on the part of the system is discovered, at which time either replacement of some sections of systems has to be undertaken, not because of structural failure or loss of efficiency of the existing sewer collecting system, but, because of radical changes in the use of the area served by the system. Areas that were originally utilized for single-family dwellings, have through time become locations of high population density concentrations, or even industrial complexes, whose needs far exceed the design capacities of the original system in the area. This problem will continue to persist as long as society continues to be mobile, but can in part be met through the planned orderly growth and development of our metropolitan complexes.

2. EXISTING CAPITAL PLANT

(a) *Growth and Distribution*

The inventory of municipal waste facilities conducted by the Public Health Service of Department of Health, Education, and Welfare in 1962 disclosed that there were 11,420 communities in the United States served by 11,655 sewer collecting systems in 1961. An estimated 118 million people, as well as innumerable commercial establishments and industrial complexes were provided service by these facilities. The number of facilities and the estimated population served by them, population size group and geographic location are presented in table 1.

TABLE 1.—*Summary of sanitary sewer systems in the United States as of 1962*

	Total		Type of sewer collecting system					
			Separate		Combined		Both or undefined	
	Number of systems	Population served	Number of systems	Population served	Number of systems	Population served	Number of systems	Population served
POPULATION SIZE GROUP								
Under 1,000	3,098	1,590,516	2,701	1,347,460	212	134,930	185	108,126
1,000 to 4,999	5,049	9,840,904	4,145	8,014,501	567	1,159,195	337	667,208
5,000 to 9,999	1,357	7,653,310	1,061	5,893,827	149	908,516	147	850,967
10,000 to 49,999	1,510	23,172,045	1,144	15,884,276	188	3,717,515	178	3,507,254
50,000 to 99,999	206	10,207,350	137	6,070,000	36	2,258,960	33	1,878,390
Over 100,000	435	65,907,794	274	20,098,985	57	17,721,939	104	28,086,870
STATES								
Alabama	216	1,495,043	214	1,493,218			2	1,825
Alaska	21	61,620	8	3,260			13	58,360
Arizona	74	710,649	72	689,734	1	20,000	1	915
Arkansas	161	792,675	141	705,285	2	64,300	18	23,090
California	506	11,458,492	477	9,359,536	17	2,057,910	12	41,046
Colorado	176	1,421,106	170	1,309,431	3	107,000	3	4,675
Connecticut	91	1,491,656	66	574,837	15	490,919	10	425,900
Delaware	16	267,241	9	25,158	1	2,700	6	239,383
District of Columbia	1	1,323,470					1	1,323,470
Florida	346	2,170,514	333	2,111,239	2	21,500	11	37,775
Georgia	276	2,268,492	262	1,083,157	6	914,515	8	270,820
Hawaii	27	362,166	27	362,166				
Idaho	91	302,999	79	244,894	10	48,905	2	9,200
Illinois	472	7,908,321	329	1,227,256	107	4,833,140	36	1,847,925
Indiana	321	2,867,845	103	364,915	206	2,445,065	12	57,865
Iowa	438	1,576,800	400	983,090	18	184,760	20	408,950
Kansas	335	1,468,250	325	1,180,005	2	107,000	8	181,245
Kentucky	161	1,263,145	134	563,080	20	658,620	7	41,445
Louisiana	161	2,100,673	158	2,095,553			3	5,120
Maine	109	479,453	37	68,720	39	198,650	33	212,083
Maryland	72	1,352,909	54	1,327,134	7	16,800	11	8,975
Massachusetts	144	4,389,580	81	619,165	40	131,760	23	2,838,655
Michigan	236	6,170,560	110	570,100	66	4,252,685	60	1,347,775
Minnesota	404	2,062,595	373	857,145	27	1,185,710	4	19,740
Mississippi	168	779,456	164	755,056			4	24,400
Missouri	466	2,643,725	411	1,065,225	6	44,945	49	1,533,555
Montana	114	385,220	103	299,680	4	19,600	7	65,940
Nebraska	300	802,230	275	517,470	13	26,790	12	257,970
Nevada	37	314,030	33	233,430	4	80,600		
New Hampshire	78	283,460	19	45,660	29	91,350	30	146,450
New Jersey	210	4,504,015	169	2,314,640	9	366,375	32	1,823,000
New Mexico	76	599,821	76	599,821				
New York	548	13,443,148	389	2,709,148	53	519,525	106	10,214,475
North Carolina	359	1,751,365	355	1,742,940	1	1,020	3	7,405
North Dakota	185	321,175	127	118,930	48	196,855	10	5,390
Ohio	441	6,776,295	241	1,856,930	117	1,735,680	83	3,183,685
Oklahoma	284	1,452,524	279	1,438,724			5	13,800
Oregon	165	927,080	116	270,110	37	610,280	12	49,690
Pennsylvania	682	9,559,417	439	2,687,262	137	707,915	106	6,164,240
Puerto Rico	69	121,634	69	121,634				
Rhode Island	22	561,975	18	174,385			4	387,590
South Carolina	221	927,114	221	927,114				
South Dakota	181	378,257	154	343,162	20	15,925	7	19,170
Tennessee	135	1,478,443	126	1,122,268	5	195,125	4	161,050
Texas	832	6,602,147	826	6,486,007	1	55,100	5	61,140
Utah	75	695,635	75	695,635				
Vermont	52	186,157	8	8,390	7	8,555	37	169,212
Virginia	231	1,866,241	202	1,481,817	1	180,000	28	204,424
Washington	230	1,628,330	133	373,650	46	825,505	51	429,175
West Virginia	176	726,181	98	168,460	48	425,471	30	132,250
Wisconsin	392	2,668,315	306	712,268	34	1,315,600	52	640,447
Wyoming	71	222,275	68	221,155			3	1,120
Total, United States	11,655	118,371,919	9,462	57,309,049	1,209	25,964,055	984	35,098,815

Source: 1962 inventory municipal waste facilities, Public Health Service publication No. 1165.

It should be noted that over 80 percent of all the systems were designed to exclude storm water runoff as well as other surface drainage. The remaining systems which were not so designed pose the single largest problem involving adequate sewage collection facilities which must be resolved during the remainder of this century, if the metropolitan complexes are to continue to grow and prosper. This problem of combined services is discussed in detail later in the chapter.

The physical facilities that made up the 11,655 sewer collection systems included over 270,400 miles of pipe, over 4 million manholes and an indeterminate number of special structures, pumping stations and related appurtenances estimated to have a replacement value in excess of $8.5 billion in 1965 dollars. New systems, additions and extensions of existing systems that have been undertaken since the inventory have increased the total miles of pipe in service to almost 300,000 miles, providing service to over 130 million people living in 12,600 communities. The current replacement cost of 297,500 miles of pipe including all necessary appurtenances is estimated to be in excess of $9.5 billion (1965 dollars).

Though sewers have been constructed in the United States since before the Revolution, comprehensive systems for the collection of water-borne wastes of a domestic nature did not evolve until the mid 1800's.

From its beginning in 1857, the growth in the number of such systems was logarithmic, and closely approximated the growth in the number of communities with populations in excess of 2,500 people, until the mid-1920's. Thereafter though the growth rate continued, many of the systems were built to serve smaller population groups. It is now estimated that over one-third of all the systems serve communities with populations of less than 2,500. Table 2 presents a historical comparison of the number of urban communities and their population, the number of sewer facilities and the population served by them since 1860.

TABLE 2.—*Development of sewer collecting systems in the United States*

Year	Census population (in millions)	Urban communities			Sewer collecting systems			
		Number	Population (in millions)	Population as percent of census population	Number	Population served (in millions)	Population served as percent of—	
							Census population	Urban population
1860	31.4	300	6.0	19	10	1.0	3	17
1870	38.6	650	9.0	23	100	4.5	12	50
1880	50.2	1,050	15.0	30	200	9.5	19	63
1890	62.9	1,420	22.3	35	450	16.1	25	72
1900	76.0	1,800	30.4	40	950	24.5	32	81
1910	92.0	2,310	42.2	46	1,600	34.5	37	82
1920	105.7	2,790	54.3	51	3,000	47.5	45	87
1930	122.8	3,179	69.0	56	5,100	61.5	50	89
1940	131.7	3,485	74.7	57	8,256	70.5	53	94
1950	151.3	4,077	90.1	59	10,600	80.0	53	89
1960	179.3	5,022	113.0	70	11,550	115.1	64	102

Source: Extrapolated data from, "Modern Sewage Disposal" Federation of Sewage Works Association and the "1962 Inventory of Municipal Waste Facilities in the United States," publication No. 1165 (Public Health Service).

In measuring growth, by number of facilities, a conservative picture of the industry is presented since as urban complexes have evolved, existing independent sewer systems have been integrated into larger consolidated systems. Therefore the number of systems reported at any specific time, is not the sum of all systems constructed prior to the time in question, but the number of identifiable systems in service at that time. No precise data are available regarding the number of new systems built, systems incorporated or consolidated into other systems, or portions of systems that have been abandoned.

(b) *Ownership Patterns*

Similarly, no data have been amassed regarding the ownership of sewer collecting systems, since they have normally been regarded as a function of local government. Private, proprietary type systems, though, have been employed for sewage collection where no governmental agency, or cooperative group was available to undertake the activity. Due to the large capital investment and low returns thereon, and the inability to restrict service for nonpayment of service charges, the proprietary systems have tended to relinquish their franchise to governmental bodies wherever possible, through sale or other disposal methods.

Cooperative systems also have been established where governmental agencies have not been able to provide the service. Subdivisions located in rural or semirural counties have accounted for a majority of this type of ownership. On the basis of information collected by the Federal Housing Administration, approximately 5 percent of their caseload of new housing mortgages in 1960 were provided sewer collection service by cooperative or other nonprofit type corporations. By 1965 the number of such mortgages had decreased to less than 1 percent. Applying these figures nationally to sewer collection systems in general, there could be as many as 500 nongovernment owned systems. Considering this indirect method of estimating, it is conceivable that the number has decreased to less than 100, and will continue to decrease as local governments continue to expand their services and consolidate independent systems.

B. Costs and User Charges

1. CONSTRUCTION COSTS

The costs of sewer collecting systems consist of the initial capital cost for construction, and the recurring costs of operating and maintaining the system. The initial construction cost is by far the larger and least determinate cost of the two. Due to the subterranean construction involved in sewer collecting systems, the cost of a given element of a system varies widely geographically, and even within the confines of a single system. As an example, the material cost for 8-inch pipe, which is the smallest size allowed by most jurisdictions, can range from as little as $0.60 per foot to as much as $2.50 per foot, depending upon the material from which it is made. The type of soil, ground water level in which the pipe is to be laid, depth of excavation, and method of placement of the pipe also materially affect the cost of the facility. On a total systems basis, the national average price per foot of pipe when equated to a specific project or

system may produce a meaningless figure because the average number of feet of pipe per person or per unit served varies geographically, and within geographic areas they further vary on account of population densities. Historically, it has required an average of 12.06 feet of pipe per each person served, or 38.59 feet of pipe per unit served. However, in some subdivisions it may require as much as 50 to 60 feet of pipe per person served or 160 to 200 feet of pipe per dwelling unit served.

Though the size of pipe used for sewer collecting systems varies from 6 inches in diameter to massive box-type culverts, over 96 percent of all the pipe in sewer collecting systems are less than 24 inches in diameter. Over 86 percent of the total footage of collecting sewers are 12 inches or less in diameter.

2. OPERATION AND MAINTENANCE COSTS

The large percentage of the smaller sizes of pipe in sewer collecting systems, causes the maintenance and repair cost to be fairly uniform throughout the United States. Though it varies from less than 50 cents per person served to over $10 per person served per year the average maintenance and repair cost is around $2.50 per person per year.

The maintenance of a sewer collecting system involves the periodic removal of solids deposited in the lines as well as the removal of foreign objects, such as junk deposited by vandals, and tree roots which infiltrate sewer lines for moisture. Due to the diverse nature of the materials encountered, separate schedules of maintenance are required. A majority of the problems encountered are solved as they come to light. Routine inspection of lines for necessary repairs are conducted on most systems annually, or semiannually, at which time any deposits or foreign material are removed. Routine inspections are designed to detect areas of pipe settlement, collapse, deterioration, of joint failure, which then must be corrected by unearthing the pipe, or wherever practical from within the pipe. During the past several years great advances have been made in developing equipment for repairing the smaller diameter pipes from within, thus avoiding needless excavation.

The cost of repairs for sewer collecting systems consequently varies more by the method of repair employed, than by the size of facility to be repaired. Since each repair must be evaluated on the basis of the circumstances surrounding it, such as maximum permissible time allowed, disruption to other normal community services, access to the problem, et cetera, no attempt has been made to determine the range of possible costs involved for repairs. It suffices to say, however, that because of the nature of the service, the cost of repairs is insignificant, compared to the damage arising from failure to remedy the situation.

During their early development sewer systems were considered a necessary public service to protect the public health. Their construction was financed through direct assessment or general appropriation, using general obligation funds with no provisions for continuing charges to cover operations and maintenance activities. This practice is still employed in many communities.

3. USER CHARGES

Prior to the 1900's a very small number of communities employed sewer service charges to support the public borrowing necessitated by the construction of sewer facilities. In several instances sewer charges were used to help offset the cost of operating and maintaining the system. With the ever-increasing demands placed upon local governments for additional services, and the high failure rate of general obligation bonds during the early 1930's, a general trend toward sewer service charges by municipal governments began. This trend bolstered sagging tax revenues and provided a means of entering the then rapidly growing revenue secured bond market. As indicated in the sample survey detailed in table 3, the number of communities employing service charges increased over 600 percent during the 20-year period between 1930 and 1950, and an additional 1,100 percent between 1950 and 1960 over the 1930 base figure.

In order to make bond offerings more attractive and to insure collection of the service fees, sewer service charges wherever possible have been combined with water service charges, or established as liens against the property served. In so doing the communities have been able to obtain necessary funding, using combined water and sewer revenue bonds, secured in addition by a general obligation lien on tax resources.

In many States this type bond is not charged against a community's statutory general obligation debt limit, allowing the community to undertake projects which otherwise would have had to be postponed indefinitely. For communities without established credit, the use of revenue bonds is sometimes the only means by which funds to construct a basic system can be obtained through public borrowings.

It is of interest to note, that though the yield on revenue-type bonds is generally higher than on general obligation bonds, the difference between yields has continuously decreased during the past decade, as investors have become better acquainted with revenue issues.

A recent survey in 1961 of municipal sewer systems disclosed that 63 percent of the respondents employ sewer service charges. Almost three-fourths of those supplying information had established rates that are adequate to cover the cost of operating and maintaining the system as well as debt service charges. Of the remaining communities that employed service charges, almost 80 percent receive at least half of their annual fiscal needs from such charges.

The 1961 survey also disclosed that the rate structure employed by the communities for service charges varies greatly. Over 80 percent used water supply data as a base upon which the service charge was fixed. In over 50 percent of the communities, the charge for sewer service was a surcharge based on water consumption. In the remaining communities such items as front footage, number of fixtures used, number of people served, size of water connection or a flat fee were employed to determine the service charge.

An analysis of the outstanding sewer debt of the communities included in the survey disclosed that over 30 percent of the dollar amount of the debt was completely self-supporting or self-liquidating through the use of the service charge. An additional 4 percent of the debt so reported was self-supporting to some degree. The communities that reported their debt to be completely covered, represented 35

percent of the respondents, with an additional 12 percent of the communities utilizing a partially self-liquidating debt program. The balance of the outstanding debt reported by these communities represents general obligation borrowings.

TABLE 3.—*Trend in number of local governments employing service charges by population size group and decade in which service charge was adopted*

Population size group	Decade								
	1900–1909	1910–1919	1920–1929	1930–1939	1940–1949	1950–1959	1960–1961	Date unknown	Total
Under 25,000		1		3	5	27	4	8	48
25,000 to 49,000	1	1		4	4	11		9	30
50,000 to 99,000		1	2	8	10	26	1	7	55
Over 100,000			1	8	11	22	1	6	49
Undefined [1]			1		3	7			11
Total	1	3	4	23	33	93	6	30	193

[1] Special districts for which no assignment by population size group could be made.

Source: Extrapolated data from "Sewer Service Charges" by Lennox L. Moak, Municipal Finance Officers Association of the United States and Canada.

C. TRENDS IN CAPITAL OUTLAY

1. ANNUAL OUTLAYS

In the sewer collecting field, statistics on public undertakings have been compiled only since 1951. Unfortunately, no measurement of the amount of private undertaking is available, though it represents a substantial amount of the total new sewer collecting construction. Many local jurisdictions require that when a builder or developer undertakes a subdivision, he must provide the necessary public water and sewer systems to serve the area. Upon completion, these are dedicated to the local government along with other municipal type facilities such as roads and storm sewers. In order to obtain a measurement of the private undertakings, estimates were prepared using the number of housing starts per year, and the experience of the Federal Housing Administration with respect to the number of mortgages for new housing served by public sewer systems.

Since 1951, the amount of public undertakings as measured by contract awards rose from a low in 1952 of $225 million to a high of $405 million in 1963. Since 1963 contract awards have decreased slightly to their current (1965) level of $385 million. During the same period of time (1952–65) estimated private sewer construction (based on housing starts) held fairly steady at about $150 million annually until 1960 when it started to decrease to its current level of $130 million.

Combining public and private sewer construction activity by year results in a relatively small increase in the amount of work undertaken annually since 1951. (See table 4.) Comparison of the 1952–56 annual average with the 1961–65 annual average, produces an 11-percent increase between the two time periods. This relatively static situation reflects a combination of many factors, especially the great demands placed upon the limited financial resources of municipalities by other public services, primarily educational or other visible tangible

facilities, as compared to "the out-of-sight, out-of-mind" type facility such as sewers.

TABLE 4.—*Contract awards for sewer collecting systems 1952–65*

[Millions of dollars]

	Source of funds		Total
	Public [1]	Private [2]	
Year:			
1952	$225	$157	$382
1953	286	150	436
1954	211	161	405
1955	301	171	472
1956	305	140	445
1957	247	127	374
1958	310	144	454
1959	336	155	491
1960	359	125	484
1961	380	129	509
1962	320	131	451
1963	405	136	541
1964	396	130	526
1965	385	128	513

[1] Source: "Sewage and Waterworks Construction," Public Health Service Publication No. 758.
[2] Estimated from housing statistics as reported by Bureau of Census.

Though the percent of municipal expenditures obligated for sewage, including sewage treatment, has continued to be relatively constant through the years, the increasing emphasis placed on waste treatment facilities has absorbed the increase in funds available as municipal resources have increased.

2. SOURCES OF FINANCING

As indicated in table 4 one-fourth of the capital outlays for sewers annually is undertaken by homebuilders, who in turn pass on the cost of the facility to the individual home buyers. The balance of funds for construction is normally obtained through private borrowings. A limited amount of Federal aid has been provided through the years for sewer construction, either as a part of some other undertaking or for brief periods of time as direct grants to finance construction of sewer facilities (that is, the Public War Housing Act of 1940 and its amendments, $54 million; and the Public Works Acceleration Act of 1962, $128 million).

Though no data are available regarding sanitary sewer borrowings from private sources, the gross amount of such borrowings is exceptionally small. Long-term public borrowings through the municipal tax exempt bond market (as reported by the Investment Bankers Association to the Department of Health, Education, and Welfare (PHS publication No. 965)) however, account for 63 percent of all municipal undertakings. These borrowings are divided into three general categories on a dollar basis as follows:

Fifty-seven percent general obligation bonds
Twenty percent sewer revenue bonds
Twenty-three percent mixed sewer and/or other type revenue bonds with or without general obligation underwritings.

In order to assist local public bodies that cannot sell their bonds on the open market at a reasonable interest rate, the Federal Govern-

ment provides loans through the public facility loans program (which is administered by the Department of Housing and Urban Development). Under the PFL program 224 loans have been made through December 1965 to local public agencies involving $102 million for the construction of sewage collecting systems, and waste water treatment plants. In addition, 141 loans have been made for construction projects involving both water and sewer facilities estimated to cost $76 million. The Department of Housing and Urban Development also administers a program of advances for public works planning, which provides noninterest bearing advances to enable communities to prepare plans for needed public works. The advances become due and repayable only when the planned work is placed under construction. Over 2,400 advances have been processed under this program providing about $57 million to local public agencies to assist in planning of needed sewer facilities, having an aggregate cost in excess of $3.3 billion.

In addition to the Federal assistance, approximately one-third of the States have adopted legislation to provide financial aid for sewerage facilities in the form of grants and/or loans. Most of the State grant programs are keyed to the Federal Water Pollution Control Act, either for purposes of establishing eligibility or determining the amount of aid to be provided. California, Indiana, New Jersey, Ohio and Oregon have loan programs to assist communities to design and/or construct sewerage facilities. Delaware, New Jersey, New Mexico, New York, Pennsylvania, and Vermont have enacted grant programs to communities to assist in the development of sewage systems or part thereof. New Hampshire guarantees loans for sewer facilities and participates in a program of annual payments to defray amortization and operating expenses as do New York and Pennsylvania. The effects of the State aid programs have not been evaluated.

The balance of financing for sewer collecting systems construction which amounts to approximately 25 percent of all sewer construction undertakings, or 37 percent of the municipal undertakings, is obtained from three general sources. They are in order of importance, short term public borrowings, revolving construction funds or sinking funds related to previous borrowings and direct appropriations or "pay-as-you-go" arrangements. The exact amount of each category is unknown, but the general use of short-term public borrowings by municipalities for all purposes has increased from $2.7 billion in 1956 to $6.5 billion in 1965 or an increase of over 140 percent during the last 10 years. The "pay-as-you-go" principle is not adaptable to the sewer collection field generally because of the need to create large surpluses or reserves before construction can be undertaken. However, in areas where small additions to existing systems are to be made, the "pay-as-you-go" method is often employed.

D. Needs and Prospective Capital Outlays

1. FACTORS TAKEN INTO ACCOUNT

President Lyndon B. Johnson in an address at the University of Michigan (Ann Arbor, Mich., May 22, 1964) stated:

> In the remainder of this century urban populations will double, city land will double, and we will have to build homes, highways, and facilities equal to all those built since this country was settled.

In addition to this national challenge, there are over 9 million people now living in urban areas that are not provided with sewer collecting services, yet the areas in which they live have sewer collecting systems serving portions of the communities. Over 59 million people are now served by combination sewers, which must be modified, rebuilt, or replaced during the next three decades, if we are to prevent uncontrollable water pollution. Most of the existing sewer systems currently in service have sections which are in need of extensive rehabilitation or replacement. The sum of these shortcomings is that one-third of the total population of the United States, or one-half of the sewered population, is currently provided with less than desirable sewer collecting services, based upon decent, safe, and sanitary criteria. Yet, capital investment in sewer collecting systems continues to show no increase.

To meet fully the challenge that no urban dweller should be denied the sewer collection service required for decent, safe, and sanitary housing by 1975, facilities to serve 41 million additional people must be provided, as well as the innumerable commercial and industrial establishments necessary to support this population increase. Due to the nature of the service provided; replacement, rehabilitation, and/or modification to existing systems will of necessity also have to be undertaken.

The complex problem of separating combined sewers estimated to cost between $20 and $30 billion, will be begun by many communities, or continued by others, on a relatively small scale, until economic solutions to the problem have evolved. In recognition of this problem, the Congress in 1965 included in the amendments to the Federal Water Pollution Control Act, a $20 million annual authorization for a 4-year program of investigation and demonstration of methods for controlling pollution from storm sewers and from sewers carrying both storm and sanitary wastes. The solutions evolved from this program will not be available for complete evaluation before 1969–70. Consequently, the findings of the program will not be translated into action programs until the mid 1970's, and the problem is not likely to be brought under control until the late 1980's or early 1990's. If new sanitary sewer collecting systems are the ultimate solution, the rate of expenditures for sewer collecting systems beginning in 1970 will have to be twice the currently estimated rate for the period 1971–75. Therefore, until the results of the new demonstration program have been evaluated, no proper distribution of probable activity between sanitary sewer collecting systems, storm sewer systems, and waste water treatment facilities can be made. Yet, the combined effort of the three categories of the public works beginning around 1970, will require annual capital expenditures of from $2 to $3 billion a year for the balance of the century.

As the Nation continues to urbanize, population densities will continue to increase particularly in the existing centers of population concentration. The central cities will continue to rebuild, and as today's suburbs increase in age, they will be replaced by multiunit housing and industrial and commercial complexes. Consequently the number of feet of pipe, or other quantitative measurement of need on a per capita basis will tend to decrease slightly as the population densities increase. This trend will be so small as to be inconsequential, unless there is a phenomenal change in the complex of our urban centers

toward multiunit housing and great open spaces. Such change may gradually occur during the next 30 to 50 years, but during the next 10 years it will be inconsequential, with respect to sewer collecting systems design and construction. With the continuing actual or threatened shortages of water for all purposes, efforts to decrease water uses or consumption for certain purposes through technological advances and changes in living patterns will tend to keep the per capita need at the current level of usage, though many new uses of water will evolve during the period. Consequently, the current design criteria for sewer collecting systems is likely to be continued during the next decade.

2. ESTIMATED CAPITAL REQUIREMENTS

In order to (1) provide for the existing backlog of unsewered urban dwellers and the expected increase in urban dwellers during the next 10 years, (2) replace, modify or repair obsolete or undersized facilities, and (3) commence activities toward solving the combined sewer problem through construction of new separate sanitary sewers, it will be necessary that the total annual investment in sewer collecting systems be more than doubled during the next decade. Table 5 presents the estimated capital outlay requirements in millions of dollars, by population size group for the next 10 years, for sewer collection facilities based upon the foregoing considerations.

TABLE 5.—*Projected total capital construction requirements by community size by year 1966–75*

[In millions of dollars]

Size of community	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Less than 1,000	55	58	60	63	66	74	78	85	94	104
1,000 to 5,000	114	119	124	131	138	154	161	179	196	214
5,000 to 10,000	83	88	91	96	101	113	119	131	145	158
10,000 to 50,000	214	225	234	248	260	289	304	336	370	403
50,000 to 100,000	69	73	75	80	84	94	98	109	120	130
Over 100,000 people	233	240	255	269	283	314	330	365	403	438
Total	768	803	839	887	932	1,038	1,090	1,205	1,328	1,447

3. MEANS OF FINANCING

As in the past, the homebuilding industry will account for a portion of the projected needs. On the assumption that housing starts will increase to an annual rate of over 2 million units per year by 1975, the amount of funds expected from this source for sewer collection system construction will correspondingly increase by 33 percent. The balance of funds required consequently must be provided through public agencies, which must increase their activities in this area by 115 percent.

Based upon past activity, and current estimates of the Investment Bankers Association, the municipal tax-exempt bond market will not be able to absorb more than a 70-percent increase in dollar volume during the next decade. Assuming the two premises are correct (1) a 33-percent increase in private funds and (2) a 70-percent increase in public long-term borrowings, other sources of funds must be tripled by 1975 in order to meet the estimated dollar requirement for sewer collection system construction. Considering the variety of demands

for increased municipal services currently faced by local public bodies, an increase of over 200 percent in the amount of funds available from short-term borrowings, sinking fund and "pay-as-you-go" activities for this specific purpose is problematical. Since the estimated amount of available funds for sewer collecting systems construction will be less than required, the necessary additional funds must come from other sources than those currently employed.

Congress in 1965 recognized the need for an additional source of financial aid to communities to assist them in undertaking needed sewer facilities. As part of the Housing and Urban Development Act of 1965 (Public Law 89–117), the water and sewer facilities grant program authorized appropriations not to exceed $200 million annually through fiscal year 1969, for grants, not to exceed 50 percent of the development cost of specific projects to assist communities in the financing of public water and/or sewer facilities (other than sewage treatment plants and their appurtenances). Since there are three general categories of facilities (i.e., (1) water, (2) sanitary sewer, and (3) storm sewer) eligible for this aid, no attempt has been made to prorate the probable amount of funds which will eventually be expended for each of the categories.

In addition, Congress has also provided assistance under the Public Works and Economic Development Act of 1965 (Public Law 89–136, authorizations not to exceed $500 million per fiscal year through fiscal year 1969), the Appalachian Regional Development Act of 1965 (Public Law 89–4 authorization of $6 million), and the Consolidated Farmer's Home Act of 1961 as amended (Public Law 89–240, authorizations not to exceed $50 million per fiscal year) for grants and/or loans to construct public facilities including sewer collecting systems. Due to the unique purpose for which each of the programs was enacted, no distribution of probable financial assistance among the eligible categories of public facilities construction has been attempted.

An evaluation of the extent to which local public bodies will utilize the various Federal financial assistance programs would be premature.

CHAPTER 5

Storm Sewer Systems*

A. NATURE AND COMPOSITION OF FACILITIES

1. DESCRIPTION OF FACILITIES

(a) *Characteristics, Functions, and Fundamental Principles*

Storm sewer systems consist of manmade and natural channels and conduits which, together with inlets, catch basins and outfall structures, function collectively to convey surface waters to disposal points outside the area of collection. The waters so collected are generally the residual fraction of precipitation remaining on the land surface after other fractions have been lost to surface ponding, evaporation, and infiltration into the ground. This fraction of the total precipitation is referred to as storm runoff, or simply runoff.

Another type of sewer system, frequently installed in urban areas in past years, conveys sanitary and industrial wastes combined with runoff. Sewers of this type are termed "combined" sewers. Such sewers intercept sanitary flow in dry weather for conveyance to a treatment plant. During periods of storms a portion of the combined flow is conducted to a treatment plant and the balance is discharged into the local drainage canals or waterways. Although storm sewers and combined sewers are distinctly different in function, each of these sewer types conveys runoff. To simplify terminology, the term "storm sewers," where used in this chapter, is meant to include both separate storm sewers as well as combined sewers, except where indicated otherwise.

Surface water resulting from various domestic uses of water, such as auto washing, excess lawn watering and cleansing of walks, driveways and parking lots also produce runoff. Many mechanical devices, such as water-cooled air conditioners, sump pumps, condensate equipment and some types of industrial equipment also contribute to the total runoff. The amounts thus contributed, with the exception of that from nonrecirculating, water-cooled air conditioners, either do not constitute significant quantities or are not normally produced during periods of precipitation. Although the cooling water from nonrecirculating water-cooled air conditioners, where disposed of through storm sewer systems, is an important factor in the total quantity of drainage in some localities, this fraction will not be included since the problem is nonexistent in some areas and it can be, and often is, controlled by regulatory measures in others. Thus, runoff is considered here to be only the fraction of precipitation resulting from rainfall or the melting of snow and ice.

The general lack of available records and data relating to design and construction of storm sewers became increasingly evident as this

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study progressed. This lack of information highlights a need for comprehensive and coordinated programs of research and development in the field of urban hydrology and hydraulics.

The inescapable consequence of decisions regarding storm drainage is the selection of space for the temporary storage of storm water. If nothing is done to convey storm water away, it will occupy space near the place where it falls. If a storm sewer is constructed, storm water will occupy space at the downstream end of the storm sewer. Regardless of what decision is made regarding storm drainage, there results a selection of space for the temporary storage of storm water. This is an important fundamental principle.

In urban areas space has typically high economic values. Complete economic analyses must include the cost of the space selected for the temporary storage of storm water, since the use of that space for other purposes is curtailed. This concept is relatively new to the field of storm-drainage economics, and warrants thoughtful consideration by all persons who make decisions in that field. A subsequent part of this paper further develops this concept.

(b) *Services Rendered; Dangers and Damages*

The runoff produced in rural areas can cause considerable damage to crops, soil, animals, farm buildings, and roads and highways. At times it may even result in loss of life in both humans and animals. The U.S. Soil Conservation Service works with local rural groups to plan and construct drainage facilities to alleviate such problems. Corrective measures employed in rural areas must be entirely different from those used in urban areas. Such measures normally include contour plowing, selective area and crop farming, reforestation, maintenance of natural ditches and watercourses, and the construction of embankments and levees along with judicious location of buildings, feedlots, pastures, crop-fields, roads, ponds, and impoundments.

The runoff from urban areas, if not properly conveyed to disposal points, can result in very significant losses. Most important of these is the great damage inflicted upon both real and personal property. As a result of discussing such losses with knowledgeable individuals, it is estimated that the total average annual losses in all parts of the United States in recent years is $1 billion or more. However, this estimate merely indicates the general magnitude of losses since data on the evaluation of losses is not available. Considering the present rate of industrial expansion and population growth in urban areas, it is not difficult to visualize an increase in losses due to such property damage.

Inadequate disposal of runoff often results in widespread loss of valuable time and frequently, causes great inconvenience to urban populations. This is characterized by persons arriving late to places of employment, or perhaps not reporting at all, because of delays in transportation caused by street flooding, or resulting from the need to care for property being endangered by flooding.

Flooding of basements can result from unsatisfactory or nonexistent storm sewer systems. The results may vary, from mere inconvenience and loss of use of basement facilities, upward to very serious threats to health and safety. The extensive use of combined sewers presents a threat of disease to the helpless public in such areas. In commercial areas, where food may be served in basement cafeterias and restau-

rants, such basement flooding admits sewage which could cause disease to spread rapidly to many persons and, if communicable, thence to others over wide geographic areas. In industrial and commercial areas, basement flooding, from combined sewers, frequently causes serious damage to mechanical, electric and process equipment, such as power generating equipment, heating and cooling equipment, transformers, mechanical shop equipment and stored equipment, goods, and supplies.

There are, in many communities, low-lying areas which flood frequently due to the runoff from local storms. There are also areas which are inundated by rising waters of natural watercourses. In the latter case, the protective measures to be employed involve the construction of flood control facilities, which are beyond the scope of, and are not included in, this report. In either of the above cases, funds required to minimize property damage are often not available. In such cases a logical solution to the flooding problem is the use of flood plain zoning. This procedure limits the usage of such areas in a manner which minimizes damages. The construction of permanent structures and improvements are prohibited, in favor of the type of development or usage which will suffer only temporary and relatively small damages. The development of parks and recreational areas in flood plains, in lieu of residential, commercial, and industrial development, is an example. Such zoning does, however, meet with considerable opposition from landowners and, in some cases, persons in the government responsible for fiscal matters.

(c) *Quantitative Standards of Performance and Design*

The measurement of the standard of performance of storm sewer systems is mainly a quantitative one. A system which is entirely adequate would carry off, without damage, all drainage from miscellaneous sources and the runoff resulting from any conceivable storm that may occur in the future, no matter how rare in frequency of recurrence. To conceive and design such a system would be impractical and economically unsound. In fact, a greater storm than heretofore experienced may occur after such a system is constructed. The system is then no longer completely satisfactory.

Today, storm sewer systems are designed for hypothetical rainstorms of an "intensity, duration, and frequency of recurrence" which appears economically justified for the particular locality. At some future date, when sufficient and accurate data are available for a given geographic locality, and after somewhat more refined methods of data analysis and design procedures have been developed, it will be possible to design a storm sewer system for such a locality in a more precise and meaningful manner than is now possible.

The customary design procedure now used is to design storm sewer systems protecting residential areas for the storm likely to be equaled or exceeded, on the average, once in a given period of time. The period used ranges from 2 to 10 years (five is common). Whether the 2-year or 10-year frequency, or another, is selected depends upon the relative value of the property being protected, and the ability to pay. Systems protecting industrial and commercial areas are sometimes designed for storms of greater intensity.

Whether or not a storm sewer system should be built, or improved, should be based, in part, upon a thorough survey and analysis of annual

benefits and costs. The annual total cost of a storm sewer system can be expressed as the sum of the amortized capital investment, interest on investment, operating and maintenance expenses and estimated annual damages occurring after installation of the system.[1] If such costs, when amortized over the estimated life of the system, are less than the annual damage expected to be inflicted under existing or anticipated circumstances, there is economic justification for the installation of the system as designed. However, if the annual cost is estimated to exceed the annual expected damage, the design should be revised and further cost analyses made until the benefit-cost ratio equals or exceeds unity. Further analyses may be made, assuming sufficiency of available data, until the optimum design is determined. Naturally, the economic consideration presented above constitutes only one of the many factors influencing the decisions regarding the need or desirability of a sewer project.

The adequacy of a storm sewer system of an urban area may also be described in terms of the percentage of total urbanized area that is provided with sewer systems, regardless of the design capacities. Unlike many other public services, the contribution made by sewers toward a community's environment is not normally measured per capita.

In summary, the quantitative standards of performance of systems of storm sewers, within an urban area, are generally described in terms of (1) the capacity for handling the runoff from an assumed hypothetical storm, (2) the percentage of the urbanized area which is sewered, and (3) the percentage of the total runoff sewered.

(d) *Qualitative Standards of Performance and Design*

Esthetics can influence the design of storm sewer systems and may be considered as a quality measure. As an example, a very large underground conduit may be constructed to carry runoff from a large drainage area; whereas, an open, paved, trapezoidal channel, constructed more economically on the ground surface may suffice quantitatively. The underground conduit would often be demanded to satisfy the esthetic requirements of many communities, and would also be demanded in some developed areas where the loss of usable land areas creates serious problems.

Construction material and workmanship are also quality measures. Materials and workmanship of the specified quality may usually be assumed. However, an entirely satisfactory design may, if construction inspection is superficial or missing, result in unsatisfactory performance of the system due to the use of materials and workmanship which do not meet the requirements of the plans and specifications of the design engineer.

Systems of "combined" sewers are not regarded as entirely acceptable in most communities because of the pollution often resulting from overflows carrying sanitary wastes, during period of rainfall. The installation of combined sewers is no longer permitted in some areas.

The installation of sewer systems, designed and constructed to meet both quantitative and qualitative standards of performance, often benefits adjacent properties by enhancing land values and by

[1] Knapp, John Williams. "An Economic Study of Urban and Highway Drainage Systems." Johns Hopkins University, Department of Sanitary Engineering and Water Resources, storm drainage research project, Baltimore, Md. 21218, June 1965; 175 pages. Technical Report No. 2.

increasing the usage of existing facilities (such as basements, yards, and streets) and may, therefore, be looked upon as part of a "reclamation" program. The importance of careful and efficient design of sewer systems is an important factor affecting quality.

2. EXISTING CAPITAL PLANT OF STORM SEWERS

(a) *The History of Storm Sewers*

When our country was first settled, sewers were generally nonexistent except for natural ditches and hastily constructed surface swales. It was possible to locate buildings and farm areas in favorable locations and the extent of damages suffered during flooding was small measured in terms of today's consequential damages.

As the urbanization of the country expanded and moved westward, the increased population, commercialization and industrial development imposed demands upon citizens, particularly property owners, to develop means of safeguarding their health and property. One of these safeguards developed through primitive stages (from the hand-dug ditch to the paved gutter, the rubble masonry ditches, and the underground wood sewer) and later developed into the modern underground conduit systems, provided with inlets, manholes, and catch basins; all integrated into a system of laterals, mains, trunks, and outfall sewers.

The development of systems of sanitary sewers naturally received priority as communities became congested. This was necessary to reduce the incidence of epidemics of disease and to provide for the esthetic demands and living standards of a progressing people. As communities grew, transportation became a problem. The horse and wagon, the surrey, and later the horseless carriage, again placed demands upon the citizens to provide negotiable transportation arteries through the growing communities. It was necessary to divert water away from the unpaved roadways. Later, storm sewers were the outgrowth of the communities' progress, and generally developed simultaneously with the construction of street pavements as cities modernized and developed into urban communities.

In many rapidly developing urban areas it became evident that a single system of sewers could be designed to serve both the need for disposal of sanitary waste as well as the surface drainage. Many cities thus began to construct systems of combined sewers. A 1964 publication of the U.S. Department of Health, Education, and Welfare [2] names large cities, including Boston, Chicago, Cleveland, District of Columbia, New York, St. Louis, and many others, as being served by combined sewers. Many large urban areas in the United States are served almost entirely by systems of combined sewers. A noteworthy example is the city of Chicago, Ill. Chicago, as of the year 1965, has approximately 4,000 miles of combined sewers and only a few miles of separate storm sewers.

Combined sewers satisfactorily convey sanitary wastes to disposal points during periods of dry weather but during periods of rainfall, they are generally unsatisfactory, when judged by today's living standards and functional and legal requirements. For example, with the advent of stringent laws regulating the disposal of untreated wastes into lakes and natural watercourses, it became necessary for

[2] U.S. Public Health Service, Division of Water Supply and Pollution Control, "Pollutional Effects of Stormwater and Overflows From Combined Sewer Systems—A Preliminary Appraisal," Washington, D.C., November 1964; 39 pages; publication No. 1246.

many cities to construct elaborate and costly plants for the treatment and purification of domestic and industrial sewage wastes. Where untreated wastes are an integral part of storm water, as in the case of wastes carried through systems of combined sewers, it becomes economically prohibitive to expend the large sums of capital required for the construction of treatment plants of the capacities needed to satisfactorily treat the total flows. In such cases, operating costs would also be extremely high. As a consequence, treatment plants serving areas with combined sewers have almost invariably been constructed of a capacity adequate to treat the sanitary waste and a fraction of the runoff only. During periods when main sewers are carrying flows greater than treatment capacity, combined sewers divert the excess flow into drainage canals, lakes, or natural bodies of water. This flow carries untreated domestic and industrial wastes into our lakes and streams, and often pollutes one of our most precious resources.

Although a few areas continue to construct combined sewers, many urban areas, and most suburban areas, have ceased constructing such sewers, and some areas have begun a program of converting combined sewers into separate systems. Complete conversion is very costly. The District of Columbia began its program of separation in 1954, with plans for completion by the year 2000. The cost for complete separation is estimated to be $300 million. A major research program to determine the feasibility of a rational method of separation of combined sewer systems or at least to minimize pollution from such systems, was commenced in the year 1966. It is hoped that methods will be developed, through research efforts, which will make separation feasible from an economic standpoint. The city of Chicago does not have plans at present for a sewer separation program. It has been estimated that the total cost of such a program in Chicago alone would total $2.3 billion. A remedial plan being studied for Chicago, which appears less costly and which should surpass separation insofar as pollution abatement is concerned, involves the construction of huge tunnels carved in the limestone strata more than 700 feet below ground surface. During periods of overflow, the wastes from the combined sewers would be dropped through vertical spillways into these tunnels which constitute a large temporary detention reservoir. The wastes would later be pumped to the surface, treated at treatment plants, and/or chlorinated and upgraded in temporary retention ponds, and then released to the natural watercourses at controlled rates. Such a system would prevent pollution of water bodies and would eliminate the excessive damages and inconveniences being suffered by citizens during periods of heavy precipitation.

One of the economies being effected in suburban residential areas and parkways results from the construction of open, paved channels, in lieu of underground conduits. Such open channels result in the loss of otherwise usable ground surface, are sometimes hazardous, and are sometimes aesthetically undesirable; they do, however, perform adequately when properly incorporated into a separate storm sewer system. Open channels are frequently improved or constructed through urban areas to serve as major collectors of runoff, and also waters containing a portion of the area's untreated wastes during periods of rainfall. The contamination of receiving waters, from the latter case, is objectionable. In other areas, such major channels carry only runoff, and are usually acceptable.

Surface drainage systems serving State highways and county roads in rural areas are simply constructed. These systems include inlets, short stretches of conduit, paved or sodded ditches, and hillside gutters. Culverts and culvert pipes serve to carry surface drainage beneath the roadway to the opposite side. The drainage from such systems is discharged into existing ditches, creeks, and rivers and sometimes into ponds, lakes, and bays. Storm systems serving urban highways and roads are generally made a part of the urban storm sewer system. Costs are often shared by the local public agency and the highway agency, based upon a formulated costs-benefits agreement. In some areas such costs are the total burden of the municipality. The funds necessary for such facilities are usually obtained from highway appropriations.

(b) *Distribution*

Unlike many other capital investments, systems of sewers are very difficult to measure and evaluate in terms of total capital investment. The reasons for this can primarily be attributed to the general lack of maintaining uniform records of such facilities by the various public and private agencies who were responsible for their construction. Another important factor is that it is difficult for a survey team to make an accounting of existing facilities. Several factors contribute to this; the most important factor is that sewers are generally buried and out of sight. It is often difficult, for survey teams, to determine the conduit sizes involved, the materials of construction, and the total lengths of systems. If such data were generally available from public agencies, and readily accessible upon request, it would be possible to make reasonably accurate summaries of existing storm sewer systems in the United States, on both quantitative and replacement-cost bases. Considerable costly time and effort would be required, however.

As an approach to making an approximate determination of existing storm sewer facilities and future needs in the United States, the American Public Works Association distributed a storm drainage questionnaire in 1965 to all urbanized places in the country with a population in excess of 10,000 persons. Replies were received from 627 of these. In addition, a storm sewer questionnaire was distributed by APWA in early 1966 to the central city of each of the 216 standard metropolitan statistical areas of the United States. Eighty replies were received. A third APWA questionnaire on storm sewers was sent in early 1966 to the regional planning commissions of these same metropolitan areas. Where a regional planning commission did not exist, the questionnaire was directed to the planning department of the central city within the metropolitan area. Seventy-nine replies were received.

As a result of the three surveys made by APWA, as described above, it is estimated that based on 1965 costs the total capital investment in storm sewer systems in this country is more than $22 billion. This estimate includes an appropriate allowance for the investments in combined sewers. The distribution of the capital investment in such facilities by States is given in table I. Totals by geographical regions can also be made. These estimates of capital investments in storm sewer systems, when divided by the corresponding unit construction costs (dollars in millions per square mile), result in an approximation to the square miles of sewered area. In the table expressing capital

investment, all construction cost items are included and the only exceptions are construction costs of such items and structures as would be properly considered to be a part of major flood control facilities. Therefore, dams, floodwalls, and similar construction are excluded.

TABLE I.—*Capital investment in urban drainage improvements in the United States, by region and State, 1965*

Region and State	1960 urban population (thousands)	Estimated value of improvements [1]		Square miles of improvements
		Per State (dollars in millions)	Dollars per capita [2] (urban)	
New England:				
Maine	497	40	80	30
New Hampshire	354	45	130	40
Vermont	150	15	100	20
Massachusetts	4,303	380	90	320
Rhode Island	743	150	200	100
Connecticut	1,986	190	100	190
Middle Atlantic:				
New York	14,332	3,480	240	1,800
New Jersey	5,374	1,760	330	1,000
Pennsylvania	8,102	1,500	185	850
East-North Central:				
Ohio	7,123	1,300	180	770
Indiana	2,910	400	140	370
Illinois	8,140	1,450	180	850
Michigan	5,739	1,100	190	550
Wisconsin	2,522	390	155	330
West-North Central:				
Minnesota	2,123	230	110	190
Iowa	1,463	170	120	140
Missouri	2,877	1,000	350	500
North Dakota	223	50	225	45
South Dakota	267	30	110	30
Nebraska	766	50	65	60
Kansas	1,329	200	150	170
South Atlantic:				
Delaware	293	75	255	25
Maryland	2,254	300	135	200
District of Columbia	764	150	195	60
Virginia	2,205	700	320	500
West Virginia	711	200	280	100
North Carolina	1,802	140	80	140
South Carolina	981	30	30	30
Georgia	2,180	90	40	90
Florida	3,661	1,700	465	800
East-South Central:				
Kentucky	1,353	250	185	250
Tennessee	1,865	200	110	200
Alabama	1,792	80	45	80
Mississippi	821	40	50	40
West-South Central:				
Arkansas	765	300	390	200
Louisiana	2,060	200	100	200
Oklahoma	1,465	150	100	130
Texas	7,187	700	100	500
Mountain:				
Montana	338	35	105	45
Idaho	317	20	65	30
Wyoming	188	20	105	25
Colorado	1,293	260	200	260
New Mexico	626	40	65	50
Arizona	971	200	205	200
Utah	667	15	20	20
Nevada	201	5	25	10
Pacific:				
Washington	1,943	90	45	60
Oregon	1,100	400	365	270
California	13,573	1,430	105	1,000
Alaska	86	10	115	10
Hawaii	485	200	410	150
Total, United States	125,120	21,960	[3] 160	14,160

[1] Replacement value as of mid-1965.
[2] Based on estimated 1965 population.
[3] Average.

Source: Questionnaire survey by the American Public Works Association, 1965.

A breakdown of the total capital investment in storm sewer systems by population groups is presented in table II. These data were analyzed further to arrive at various averages, such as dollars per capita, et cetera. Table III presents these averages.

TABLE II.—*Capital investment in urban drainage improvements in the United States, by population groups of cities, 1965*

Population group (thousands)	Number of cities	Population 1965 estimated (thousands)	Capital investment (millions)	Square miles of improvement
500 or more	28	30,000	$5,900	2,800
100 to 500	109	24,000	4,500	2,400
50 to 100	180	13,000	1,400	900
10 to 50	1,344	30,000	4,500	3,500
2.5 to 10	3,000	16,000	2,700	2,100
Less than 2.5	13,000	9,000	1,300	1,000
Other urban places	1,700	12,000	1,700	1,300
Totals	19,361	134,000	22,000	14,000

TABLE III.—*Capital investment in urban drainage improvements cities of the United States (averages for cities, by population groups), 1965*

Population group (thousands)	Capital investment [1]			
	Per city (millions)	Per capita [2]	Percent of market value of taxable property	Per square mile city area
500 or more	$210	$195	3.7	$270,000
100 to 500	40	185	4.3	225,000
50 to 100	8	110	2.2	105,000
10 to 50	3	150	2.5	385,000
2.5 to 10	.9	170	----	----
Less than 2.5	.2	145	----	----

[1] Replacement value as of mid-1965.
[2] Based on 1965 population.

NOTE.—Estimates for population groups under 10,000 are rough approximations.

Source: Questionnaire survey by the American Public Works Association, 1965.

(c) *Ages of Sewer Systems*

The ages of the country's sewers are variable and difficult to determine. Again, the lack of available records of installations and replacements makes age determinations difficult in many areas, particularly the older urbanized areas. In general, it may be stated that most existing underground urban storm sewer laterals (sewer conduits serving areas in which they are located) were constructed along with the development of property and the construction of buildings in these areas. The construction of main and trunk sewers cannot be traced accurately with population growth as they are generally constructed to serve anticipated urbanization and are often constructed through relatively unpopulated areas to points of discharge.

With good planning, in progressive and economically sound communities, main and truck sewer construction generally precedes population expansion. In areas where backlogs of sewer requirements have developed, the construction of these larger sewers often lags behind urban growth. In some areas storm sewers were installed after urbanization and in these areas the ages of the sewers are not

related to the era of community development. Such installations are not prevalent, however. A preliminary investigation of existing storm sewers reveals that deterioration is not usually a problem. Many old brick sewers, and some wooden sewers, are in service today and many are in good condition. Most replacements of original installations generally can be attributed to insufficient capacity, improper elevations or other factors related to changes or redevelopment within the urban areas. Figure 1 depicts the estimated ages of storm sewers based on the above.

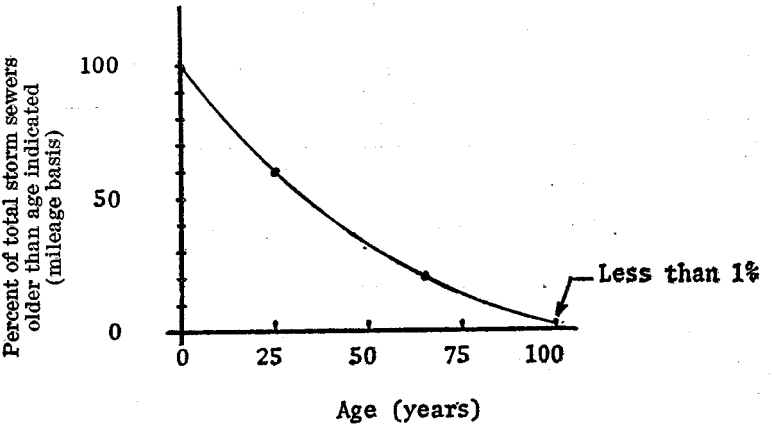


FIGURE 1.—Age of storm sewers in the United States, as of mid-1965.

Source: Prepared by the APWA from information contained in publications of the U.S. Department of Commerce, Business and Defense Services Administration, Water Industries, and Engineering Services Division.

(d) *Ownership of Storm Sewer Systems*

The ownership of underground systems of urban storm and combined sewers in the United States lies almost totally with local public agencies. These include the following: cities, towns, and villages; counties; and sewer districts or authorities. Although such sewers are constructed in urban areas by private land developers and by State highway departments, the ownership of such facilities is usually transferred to local public agencies upon completion and approval of construction.

A survey of storm sewer facilities made in 1966 by the APWA resulted in responses, regarding ownership, from urban areas having a total of 27,461 miles of underground storm sewers, both separate and combined. This mileage represents approximately 15 percent of the total mileage of underground storm and combined sewers in the urban areas of the country. The responses regarding ownership are tabulated in table IV. This indicates that 84 percent of storm sewer facilities are municipally owned, 11 percent county owned, and 5 percent are owned by public sewer districts or authorities.

The same survey indicates that aboveground (open channel) storm sewer systems are also totally owned by local public agencies, although there are some few exceptions. The responses, shown in table IV, indicate for open channels 58 percent municipal ownership,

8 percent county ownership, and 34 percent ownership by sewer districts and authorities.

The ownership of drainage facilities along State-owned highways in unincorporated areas are naturally owned and maintained by the respective States.

TABLE IV.—*Ownership of underground and open channel urban storm sewer systems*

Agency claiming ownership	Underground systems		Open channel systems	
	Miles owned	Percent of total reported	Miles owned	Percent of total reported
Municipalities	22,968	84	791	58
Counties	3,019	11	110	8
Sewer districts or authorities	1,474	5	467	34
Total	27,461	100	1,368	100

Source: From responses of 80 units of local government replying to a 1966 questionnaire survey by the American Public Works Association.

B. Costs, Charges, and Benefits

1. CONSTRUCTION COSTS

The construction costs of storm sewer systems can best be expressed, for the purpose of a general overall cost analysis, on the basis of a square mile sewered. Since a sewer system installed in one area may be designed under different criteria and constructed of different size conduits, under different ground conditions and of different materials than a system installed in another area, extreme variations in construction costs are understandable. Current construction costs reported by 41 cities widely scattered over the United States in a 1966 questionnaire survey by the APWA, indicate a general variation from $0.5 to $2.5 million per square mile of area served, with extreme variations from $0.05 to $3.84 million per square mile. A straight average of all responses resulted in a unit construction cost of $990,000 per square mile. The weighted national average is $1.55 million per square mile.

Although some of the variation in constructed cost can be attributed to variations in labor costs, labor productivity, material costs and local economic conditions, the major factors producing cost variations are (1) the nature of the local topography, (2) the surface and subsurface characteristics, (3) the precipitation characteristics of the area served, (4) the design criteria selected, and (5) the type of system. (The type of system is defined by whether it is primarily a local collecting system, or whether a large percentage of the total length consists of larger sewers, such as mains, trunks, and large open channels and drainage canals.) The first of these factors, the nature of the local topography, can account for construction costs in rather level areas being higher than costs in hilly areas by a factor of two, three, or even more. The underlying reason for this is that although runoff is greater in hilly areas, much larger pipe sizes are required in flat areas to handle a given flow, since the flow velocities are relatively slow in pipes laid on slight grades. Surface and subsurface conditions also contribute to wide cost differences.

Some of these cities were reporting on the costs of combined systems and others on separate storm sewer systems. This is not a factor in the costs analysis since the cost of constructing a storm sewer system, assuming that additions or enlargements of the sanitary sewer system are not included, is the same as the cost of a combined system. This is due to the fact that the size of a satisfactorily designed combined sewer is normally determined by the maximum stormflow, the added sanitary wastes usually not requiring an increase in the size of pipe.

Although "areawide" average cost figures cannot be used to estimate the construction cost of a specific project, they are useful in making projections of capital costs that will be incurred for needed storm sewer systems in various areas of the country where cost-influencing factors are similar. These average reported current construction costs, adjusted downward to account for lower costs in previous years, were used in tables I and II, together with reported figures of capital investments to obtain estimates for the number of square miles of area sewered in the various States and cities.

As stated at the outset of this report, complete economic analyses of storm sewer systems must include the cost of the space occupied by storm water transported by such a system. This concept is relatively new to the field of storm drainage economics, and warrants thoughtful consideration by engineers and others who make decisions in that field.

2. USER CHARGES

Data supplied, in response to a questionnaire distributed in early 1961, by 170 local governments relating to sewer service charges were published [3] by the Municipal Finance Officers' Association. User charges vary widely in amount but are seldom employed by cities, sewer districts or others to defray maintenance and operation costs. Such costs are normally provided for by general tax revenues, motor fuel tax funds, and vehicle registration funds.

It is difficult to separate operating costs from maintenance costs in many cities, since few cities have records available. From answers provided in the APWA survey, annual maintenance and operating costs, combined, were noted to range, generally, from $1,000 to $30,000 per square mile. The extreme variations may be accounted for by the great variation in the maintenance services provided in different areas, the age as well as the type of sewer system, and the effectiveness of street cleaning operations. Most typical large urban areas would probably be found to expend, for maintenance alone (including cleaning operations), from $5,000 to $15,000 annually per square mile of sewered area.

3. BENEFITS

Storm sewer systems enhance the usefulness and hence the value of the areas which they drain. This is the historic economic basis for constructing them. Additional benefits accrue when these systems are designed to serve more than one purpose and when such designs involve the protection of downstream neighbors. An example would be the design of a highway embankment and culvert to serve as a

[3] Moak, Lennox L. "A Survey of the Use and Nonuse of Sewer Service Charges in 339 Local Governments in the United States and Canada." Municipal Finance Officers' Association of the United States and Canada, 1313 East 60th Street, Chicago, Ill. 60637, 1962. 66 pages.

dam and spillway, producing an impoundment upstream from the highway. It is possible that the additional land cost could be offset by the savings in construction cost and the benefits resulting, which would include flood control and recreation facilities.

C. Trends of Capital Outlay

1. EXPENDITURES, 1946–1965

(a) *Trends*

Information regarding expenditures for storm sewer construction in the United States during the 20-year postwar period was submitted by respondents to the 1965 and 1966 APWA storm sewer questionnaires. On the basis of these responses, it is estimated that the total present-day replacement cost of existing urban storm sewer systems in the United States, owned by public agencies, is more than $22 billion including an appropriate allowance for combined sewers. This estimate was made by multiplying the expenditures reported by a factor, the factor being the ratio of total urban population to population encompassed in areas reporting.

It was further indicated by the survey respondents that approximately 49 percent of the total of all capital investments was incurred prior to 1946, and that 18 percent and 33 percent were expended in the decades 1946–55 and 1956–65, respectively. Data published by the Bureau of the Census verify these figures very closely (see table V). These figures show a decided increase during successive time periods. In part, this can be accounted for by the acceleration of urban growth in recent years, higher construction costs, and higher standards of living.

Data published by the Bureau of Census was used in the preparation of table V which is a tabulation of expenditures by cities and counties for urban drainage improvements. From this table it is seen that the expenditures of all urban cities and counties in the United States during the 20-year period (1946–65) are estimated to have totaled $3.85 billion. It is estimated that cities alone expended $2.82 billion in the same period. Based on these estimates, city expenditures were 73 percent of the total expenditures by local governments in urban areas. This percentage was somewhat higher in the decade (1946–55) and slightly lower in the decade (1956–75). Future expenditures could reasonably be expected to follow this same trend, indicating that city expenditures will be approximately 70 percent of all local government expenditures during the next decade (1966–75). Information on annual expenditures made by private land developers is not available; however, it is estimated that the current total expenditures by all private developers approximates $0.72 billion, annually. This annual expenditure is expected to increase during the next decade.

TABLE V.—*Capital expenditures for urban drainage improvements*[1] *in the United States, by year and decade, 1946–65, by public agencies*

[Dollars in millions]

Year	Cities and counties	Cities only	Year	Cities and counties	Cities only
1965	$417	$280	1953	$137	$103
1964	377	255	1952	129	97
1963	352	231	1951	122	92
1962	290	195	1950	118	89
1961	242	182	1949	83	62
1960	256	178	1948	74	56
1959	236	186	1947	67	50
1958	216	174	1946	53	44
1957	197	153			
1956	177	141	Total, 1946–55	1,095	842
Total, 1956–65	2,759	1,975	20-year total expenditures, 1946–65	3,854	2,817
1955	160	128			
1954	152	121			

[1] Values tabulated in this table have been computed from published Bureau of Census data (representing expenditures for sewerage and sewage disposal) by assuming that one-third of all such expenditures represent capital costs of urban drainage improvements.

Source: Department of Commerce, Bureau of the Census.

A publication of the U.S. Department of Commerce,[4] dated February 1966, summarizes the total amount of sewer pipe installed in the conterminous United States during the period from 1940 to 1966, and projects estimated future requirements to the year 1980. This information is presented by category of use and by pipe-size class. Figure 2 presents reproductions from this publication and graphically illustrates the estimated annual installations of sewer pipe (measured in millions of lineal feet), in the size classes indicated. The estimates include pipe used for new construction, improvements, and maintenance and repair of all sanitary and storm sewers and one-half of pipe required in combined sewers. The same publication attributes approximately 10 percent of all usage of pipe in public sewer systems to storm sewer construction. This percentage is less for the smaller pipe sizes and more for the larger pipe. It is then reasonable to assume that the trend in storm sewer construction since 1940 is represented by figure 2, and that the footage of pipe used annually for storm sewers is approximately 10 percent of these estimated usages.

From figure 2 it is seen that the installation of sewer pipe was increasing at a rapid rate during the period 1946–65. The rate of increase was somewhat variable during the period 1946–55; however, it was uniform during the period 1956–65. The total increase in annual usage during this latter decade was less than that during the previous 10 years. The rapid postwar construction rate can be explained by two facts: (1) sewer construction was accelerated to overcome the backlog created by the curtailment of nonessential construction during the war years, and (2) residential construction during these years was progressing at a rapid rate to satisfy the postwar demands. These factors demanded an accelerated sewer construction program, although the shortage of materials and the rapid rise of prices was a temporary deterrent to construction im-

[4] U.S. Business and Defense Services Administration. "Regional Requirements for Sewer Pipe in Sewerage utilities," prepared by K. L. Kollar and A. F. Volonte. Government Printing Office, Washington, D.C. 20402, February 1966. 20 pp.

mediately following World War II. The Korean emergency also slowed construction projects for a few years, beginning in 1950. After about 1955 much of the backlog was fairly well diminished and the rate of increase of total building construction lessened and became somewhat uniform. The rate of progress of sewer construction naturally followed this same trend.

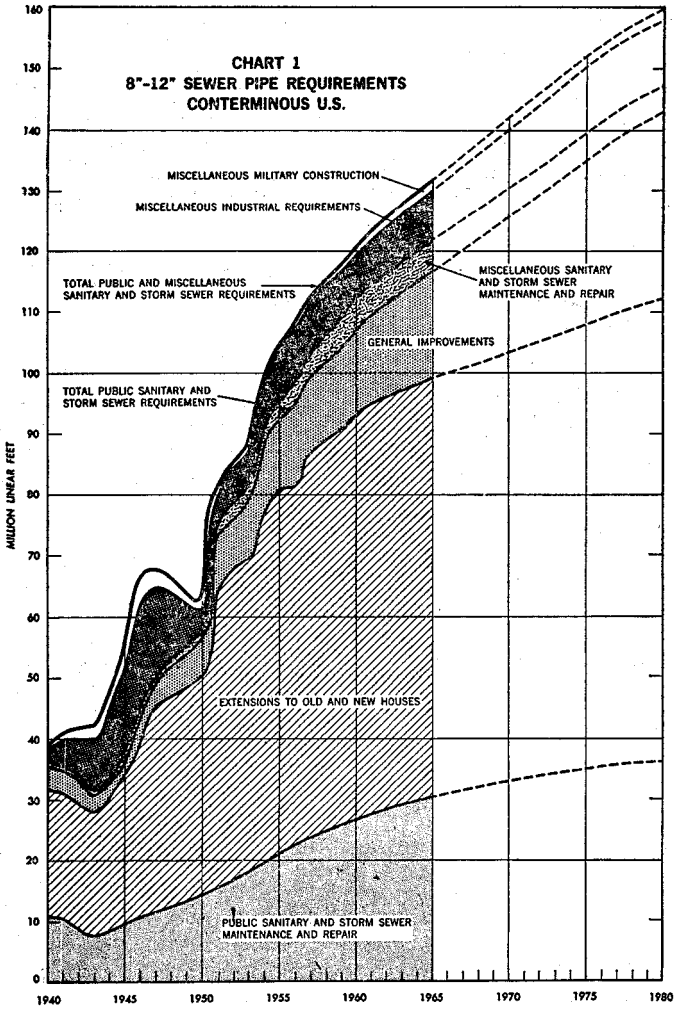
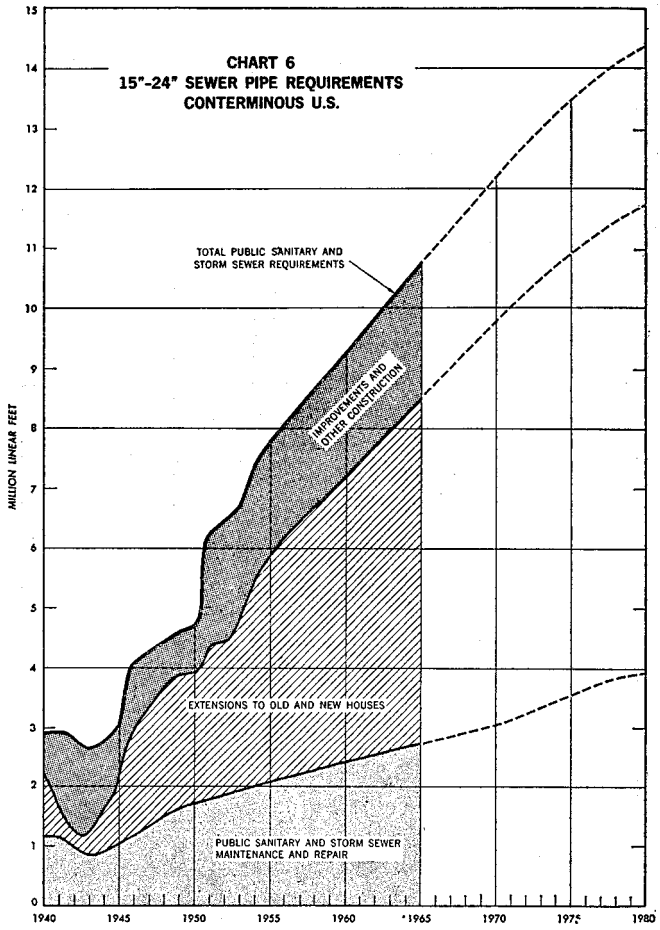


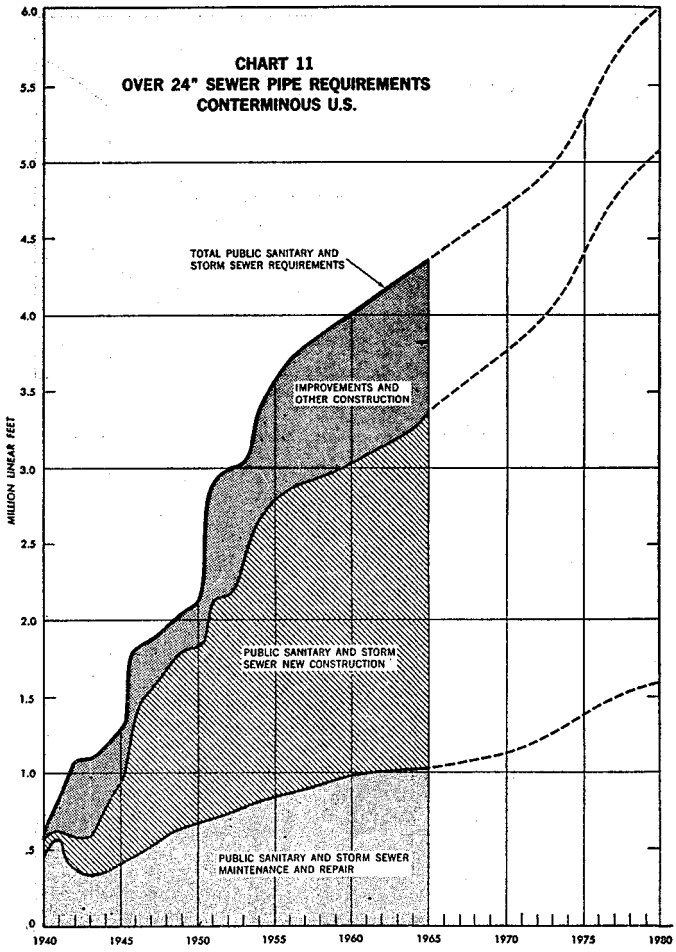
FIGURE 2.—Annual sewer pipe requirements.

[Charts 1, 6, and 11 reprinted from "Regional Requirements for Sewer Pipe in Sewerage Utilities," February 1966; U.S. Department of Commerce; Business and Defense Services Administration.]



(b) *Expenditures by source, 1946–65*

(1) *Private land developers.*—The respondents to the 1966 APWA storm sewer survey, in answer to a question regarding capital expenditures in urban areas, attributed a very large share of such current expenditures to private land developers. In the case of residential, commercial, and industrial land development, most cities reported that the developers must install or pay for storm sewers, where sewers are required by subdivision regulations or ordinances. This trend has been increasing in recent years. A successful land developer necessarily includes such costs in sales prices of land improvements; thus, the buyers or lessees ultimately bear the costs. Many cities surveyed answered that 100 percent of all storm sewer requirements in newly developing areas are paid for by the developer. A few cities reported that the developers shoulder only a portion of these costs, varying from 10 to 90 percent. The majority of cities reported the higher percentages.



It appears that private land developers are currently making a total annual investment of approximately $720 million in storm sewer construction. This estimate is based upon the following assumptions: (1) urbanization is presently producing 1,000 square miles of newly developed land area annually, (2) 60 percent of such land area requires storm sewers, (3) the private developer pays 75 percent of storm sewer costs, and (4) the current average unit construction cost is $1.6 million per square mile. This estimated annual expenditure by land developers will be shown to be double the estimated annual capital investment in storm sewers in urban areas by all units of local government.

(2) *Public agencies.*—Public agencies are responsible for the construction of main and trunk sewers and drainage canals. The capital expenditures in urban areas for all such facilities are made by local units of government. The funds for such expenditures sometimes

include considerable Federal aid. A Government publication [4] attributes to storm sewer construction about 10 percent of the length of all pipe used for sewers. Since the pipe sizes required for storm sewers are usually larger than the sizes required for sanitary sewers, the costs of constructing storm sewers is greater than for sanitary sewers. Although available statistical information is not complete, analysis of Government reports [5] shows that capital outlays by all units of local government in the United States for all types of sewerage, including sewage treatment plants, are expended. Seventy-three percent by cities and 27 percent by all other units of local government.

State and local governments and agencies also expend a large amount of funds in urban and rural areas for drainage facilities required for arterial streets and highways. The funds for such construction, however, are usually obtained from highway appropriations and, therefore, are considered to be a part of the cost of highway and street construction, rather than a cost of sewer construction. Approximately 7½ percent of such capital expenditures is attributed to drainage requirements other than bridges.[6] These will be State, county, and city expenditures provided largely from State and Federal highway funds, supplemented with local government funds.

Local governments and agencies also expend funds for the construction of airport drainage facilities. Although such expenditures are appreciable, such drainage facilities are generally provided by funds appropriated for airport construction, or are provided by revenues from airport operations. Therefore, these are not considered here as a part of storm sewer expenditures.

2. SOURCES OF FINANCING

Federal aid grant assistance has certainly been a substantial source of funds in the financing of urban storm sewers. However, the bulk of the funds has been from local sources. Such local financing has been accomplished, primarily, through tax exempt municipal bonds, special assessments, and appropriations from general tax resources. Therefore, the sufficiency of available funds from each of these sources in a specific local governmental unit is not only dependent upon the tax rate but also upon the level of assessment of property within the jurisdictional boundaries. Government publications report that about 45 percent of all municipal revenue in the United States is obtained from property taxes.

Responses from 627 units of local government regarding the financing of capital storm sewer improvement reveal that the major financing sources are as indicated in table VI. Although this table shows the number and percentage of respondent agencies which use the specified methods of financing, this is not necessarily an indication of the dollar amounts provided from these sources. It is improbable that the larger areawide projects are financed through appropriations from the general tax fund; such projects would most often be dependent upon

[4] U.S. Business and Defense Services Administration. "Regional Requirements for Sewer Pipe in Sewerage utilities," prepared by K. L. Kollar and A. F. Volonte. Government Printing Office, Washington, D.C. 20402, February 1966. 20 pp.

[5] U.S. Bureau of the Census. "Government Finances in 1963-64." Government Printing Office, Washington, D.C. 20402, 1965. 58 pages. Series G-GF 64, No. 1.

[6] Herr, Lester A. "The Place of Hydraulics in Highway Engineering"; presented at the Fifth Annual Highway and Street Conference, Stillwater, Okla., Feb. 22-24, 1966. 13 pages. Apply to: Author, Chief, Hydraulics Branch, U.S. Bureau of Public Roads, Washington, D.C.

bond issues and aid funds. Private land developers generally secure funds by borrowing from private financial institutions.

TABLE VI.—*Sources of financing for urban drainage improvements in the United States; current and past sources of funds*

[Agencies using this source and possibly one or more other sources]

Sources of funds	Number	Percent of total respondents
(a) Appropriations from tax resources	457	73
(b) Bequests	(1)	(1)
(c) Federal Government grant assistance	161	26
(d) State grants-in-aid	57	9
(e) Tax-exempt bonds (including municipal bonds and bonds of sewer districts and authorities)	360	57
(f) Capital flotations in other security markets (private corporations and organizations) by land developers	(2)	(2)
(g) Borrowing from Federal Government	(2)	(2)

[1] No information, but probably negligible in amount.
[2] No information, but appreciable.

Source: Data from 627 respondents to a questionnaire survey of the American Public Works Association, 1965.

D. NEEDS AND PROSPECTIVE CAPITAL OUTLAYS, 1966–75

1. ESTIMATED CAPITAL REQUIREMENTS

The capital required to finance the storm sewer facilities needed in new and expanding urban areas and to overcome deficiencies in present urban areas during the decade 1966–75 has been estimated by the American Public Works Association to total $25 billion. This projection is based upon data supplied by respondents to three APWA questionnaire surveys mentioned previously. The estimate includes $13 billion for present needs and $12 billion to provide storm sewer facilities in all new and expanding urban areas. The above figures include both public and private expenditures in growth areas. However, expenditures to correct present deficiencies will involve public funds only. Funds required for the construction of drainage facilities at airports and along highways, roads, and most arterial streets are not included.

(a) *By Local Public Agencies*

Data used in making the above estimates were supplied, in one survey, by units of local government representing a total population of 78 million. This questionnaire was distributed in 1965 by the APWA Urban Drainage Committee. In another survey, conducted in 1966 by the APWA Research Foundation, data was received from metropolitan planning commissions representing a total population of 33 million. In another questionnaire survey made by the APWA Research Foundation in 1966, data was received from the public works departments of the central cities of many metropolitan areas, the data supplied being representative of 28 million persons. Projections of this data were then made by multiplying reported figures by a factor, being the ratio of the total U.S. urban population to the population represented by those responding to requests for information as indicated above.

The $13 billion estimate of funds required for "present" needs would be expended entirely by local public agencies. The funds

required include requirements for: (1) construction of storm sewers in presently developed areas lacking either storm or combined sewer systems, (2) extensions of existing storm or combined sewer systems into such portions of presently developed areas as are not currently served by these existing systems, and (3) for increasing the capacity of existing storm and combined sewers. Funds required for converting existing combined sewers to separate storm sewer systems, in urban areas which currently have such work underway or committed, are included in the $13 billion estimate for "present" needs. However, since most localities having combined sewers have not taken a definite stand in sewer separation programs, only a small portion of the total national requirements for combined sewer separation is included in this estimate of "present needs."

A 1964 publication of the U.S. Department of Health, Education, and Welfare,[2] based upon a Public Health Service survey, states that the total cost for the separation of all existing combined sewer systems in the United States could amount to "$25 to $30 billion, or even more." This estimate was based on data obtained in surveying 15 U.S. cities, of various sizes and geographical locations, representing sewered populations totaling approximately 21 million (about one-third of the U.S. population served by combined sewers). The estimate indicates an average per capita cost of $465 for each of the 59 million persons presently served by combined sewers. It is also stated in this publication [2] that the estimate of cost is probably too small, since many of the component cost data were based on cost figures prevailing in years prior to 1964.

Local public agencies will also be responsible for a portion of the capital expenditures for storm sewer construction in newly developed urban areas. A portion (in some cases all) of the total cost of major drainage facilities such as sewer mains, trunks, and drainage canals is normally assumed by the local public agency having jurisdiction. The assumption of a portion of such costs by local government is reasonable since storm sewer systems convey runoff from publicly owned lands. A 1955 publication of the Harvard University Press [7] reports that approximately 50 percent of land in urban areas is used for streets, parks, and other public purposes. Assuming that 25 percent of all such costs are to be borne by local public agencies, then $3 billion (25 percent of $12 billion) is the estimated capital need of local government for the construction of storm sewers in urban growth areas.

The total requirements of all local public agencies of the United States for storm sewer construction during the decade (1966–75) is, therefore, estimated to be $16 billion.

(b) *By Private Land Developers*

Approvimately $9 billion is the estimated need of private land developers for the construction of storm sewers during the decade (1966–75). This amount represents the balance of the $12 billion need for sewer construction in urban growth areas, not attributed to local public agencies.

[2] U.S. Public Health Service, Division of Water Supply and Pollution Control, "Pollutional Effects of Stormwater and Overflows From Combined Sewer Systems—A Preliminary Appraisal," Washington, D.C., November 1964; 39 pages; publication No. 1246.

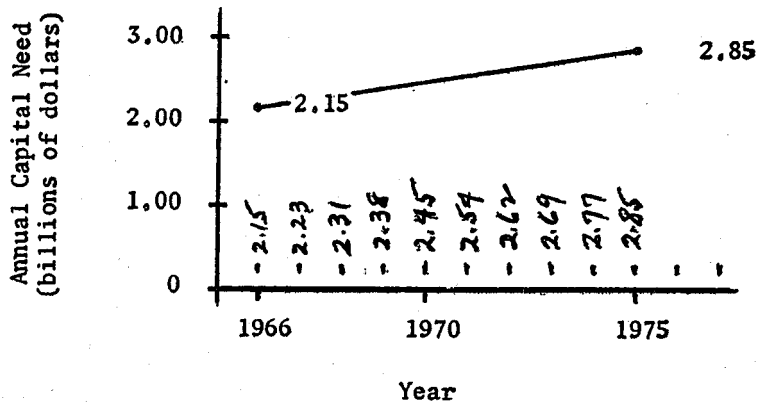
[7] Bartholomew, Harland, "Land Uses in American Cities." Harvard Planning Series, vol. XV, Harvard University Press, 1955.

(c) *Annual Capital Needs*

According to a Department of Commerce publication [4] previously referred to, the requirements for sewer pipe in the United States by the year 1975 will be approximately 25 percent greater than in 1966 (fig. 2). If the total capital needs for urban storm sewers approximates $25 billion, the annual urban need for storm sewers during the decade will probably range from $2.15 billion in 1966 to $2.85 billion in 1975. Whether or not expenditures of this magnitude become a reality is, of course, dependent upon problems which may be encountered in funding these needs. Figure 3 presents the annual needs, graphically.

(d) *Distribution of Capital Needs by Population Groups*

The $25 billion capital needs distributed by population groups of urban areas, in accordance with needs as indicated by respondents to the APWA questionnaires, is shown in table VII. This table also distributes the $22 billion investment in existing storm sewer facilities according to population groups, based upon data supplied by questionnaire respondents.



Source: Estimates of the American Public Works Association.

FIGURE 3.—Capital needs for urban drainage improvements in the United States; Annually, 1966–75

(e) *Expenditures of Funds*

The proportions of the $25 billion of capital needs to be expended by various categories of government agencies and private groups is difficult to forecast. An attempt to roughly approximate such expenditures for the decade 1966–75 is made as follows:

[In billions]	Expenditures
(1) State governments and State agencies	None
(2) Cities, counties, towns, special districts, public authorities, and other local bodies	$16
(3) Private, nonprofit organizations and cooperatives	None
(4) Proprietary or profitmaking organizations (includes land developers)	9
Total (1966–75)	25

TABLE VII.—*Capital needs for urban drainage improvements, 1966–75 in the United States, by population groups*

Population group (thousands)	Existing facilities		Capital needs	
	Amount (millions)	Percent of total	Amount (millions)	Percent of total
500 or more	$5,900	27	$7,550	30
100 to 500	4,500	20	5,010	20
50 to 100	1,400	7	2,370	9
10 to 50	4,500	20	7,450	30
2.5 to 10	2,700	12	1,320	5
Less than 2.5 [1]	1,300	6	650	3
Other urban places [1]	1,700	8	650	3
Total	22,000	100	25,000	100
SUMMARY INTO BROADER POPULATION GROUPS				
Above 50	11,800	54	14,930	60
2.5 to 50	7,200	33	8,770	35
Below 2.5 [1]	3,000	13	1,300	5

[1] Estimates for population groups under 10,000 are rough approximations.

Source: Estimates made by the American Public Works Association, based upon data from 527 responses to a 1965 APWA questionnaire survey.

2. SOURCES OF FUNDS

Statistics regarding the financing of storm sewer systems in previous years are not available in publications. It is therefore difficult to estimate the proportions of the total needs to be supplied by various possible financing sources. Data received, through a 1966 APWA storm sewer survey, indicates that the major sources of financing public storm sewer capital improvements in urban areas would include: (1) general tax resources, (2) tax-exempt municipal bonds, (3) grants from the Federal and State Governments, and (4) borrowing from the Federal Government. These are listed in a descending order of apparent dollar magnitude. Sewers constructed by land developers would normally be financed by private financial institutions.

The majority of respondents to the APWA questionnaire stated that capital needs would exceed the amounts available from all presently known sources of funds. The survey indicated that, of the $16 billion required by local public agencies during the decade (1966–75) for financing the construction of storm sewers, it appears that approximately 60 percent can be obtained from sources presently available to local government. The information was supplied by local governments representing 15.6 million persons. Therefore, 40 percent of the total need (approximately $6.5 billion) must be obtained from other sources or through adjustments of present methods of producing revenue. Some increases of the usual allocations of funds to capital expenditure programs may be feasible within certain units of government.

In response to a question inquiring how the cities propose to bridge this gap, the respondents replied with the following answers:

(*a*) Increase the general property tax rate. (This increase may conceivably be applied to all property within the jurisdiction, or only to property benefited by the sewer construction program.)

(*b*) Enact legislation to permit the issuance of additional municipal bonds. (This may or may not result in the need for an increased sales or property tax, depending upon what schedules are followed in the retirement and issuance.)

(*c*) Enact special assessments against property benefited and build sewers as the area benefited is willing and able to pay (the local unit of government may provide a share of the funds.)

(*d*) Request funds from the Federal Government on a grant basis (in which case payment is not required), or on a cost-sharing basis (which may require partial payment).

(*e*) Request State grants and cost-sharing funds.

(*f*) Utilize a policy of charging a part of the cost of main, submain, and trunk sewers to land developers, where such sewer construction benefits the land being developed.

(*g*) Enact local sales tax legislation, where permitted by State law.

It is important that there be an appreciation of the role that storm sewer systems have in producing safe, healthful, and attractive environments. This appreciation is a necessary adjunct to successful financing as it is also important to understand that, regardless of form, expenditures will be made, one way or another. If the citizens do not support expenditures for construction and improvement programs in areas where sewers are needed, they will incur equivalent costs in the form of property damages and economic losses and will remain burdened with the same unsatisfactory environments.

CHAPTER 6

Waste Water Treatment Plants*

A. NATURE AND COMPOSITION OF PUBLIC WORK OR FACILITY

1. DESCRIPTION OF FACILITY

(a) *Physical Characteristics*

Waste water treatment plants are more commonly referred to as sewage treatment plants. These are facilities built by municipal and other local governments for the treatment of sewage and other waterborne wastes prior to discharge to a watercourse. Treatment is necessary to protect the public health from waterborne disease, to prevent nuisances, and to prevent or abate pollution of the public watercourses.

The treatment facilities serve the entire community. That is, the service is provided for households; commercial enterprises such as hotels, restaurants, and laundries; and industrial firms such as breweries, slaughterhouses, and other food processors and manufacturers. Each user of the service is reached through a collection system of lateral and trunk sewers. The service is essential from a physical standpoint as well as for health and nuisance reasons, for large quantities of water cannot be used without some means of disposal after use. The term "waste water" arises from this necessity.

Treatment facilities are usually built with excess capacity to take care of future growth. Facilities require daily care, oftentimes, with a considerable staff, depending on the scale of the operation and the complexity of the treatment process. Trained operators are necessary in all instances. In large facilities, the staff may consist of sanitary engineers, chemists, biologists, and other professional personnel. Treatment facilities have considerable durability, often lasting as long as 20 years. Still, they require regular maintenance, particularly of pumps, filters, and tanks. Large-scale operations include laboratories for analysis of the wastes at various points during the treatment process. Office space, equipment storage, vehicle space, and considerable grounds requiring landscaping, fencing, and care are also involved.

(b) *Standards of Performance*

The treatment of sewage can be accomplished in a variety of ways. The type of treatment selected depends on a number of factors such as the volume and composition of the wastes and the nature of the watercourse into which the treated effluent will be discharged. In some instances, treatment is provided with a minimum of structure in large lagoons or oxidation ponds. Therefore, the term "facility" is more appropriate and inclusive. Usually, however, there is a definite structure or plant consisting of various arrangements of pipes, screens, chambers or tanks, pumps, filters, basins, and sludge drying beds.

*Prepared by the Federal Water Pollution Control Administration, U.S. Department of the Interior, with minor editing by Committee staff.

The objective is to reduce a given waste material to a condition that is acceptable for discharge to a watercourse without harm to health, esthetics, and the uses for which the particular watercourse is intended. The waste reduction process may include mechanical, biological, and chemical means.

The common references to primary and secondary treatment are not precise distinctions in either process or structure. Usually primary treatment involves the removal of settleable, suspended, and floatable solids. Secondary treatment generally goes beyond this stage to remove or reduce dissolved and colloidal materials not amenable to separation through mechanical means.

Facilities are designed for the particular needs of the community. That is, its scale, treatment process, and management reflect the size of the community, its expected growth rate, the composition and volume of its wastes, and the water quality requirements established for the watercourse into which the wastes are to be discharged. As the result of public insistence now manifested in the administration of the Federal Water Pollution Control Act and in the State programs, more stringent water quality requirements are being established. These requirements will have a subsequent effect both on the design and operation of municipal waste treatment facilities.

2. EXISTING CAPITAL PLANT IN THE UNITED STATES

(a) The latest data on the number of municipal waste treatment facilities (also commonly referred to as sewage treatment plants) in existence in the United States is as of January 1, 1962. These data are published in the "Statistical Summary of Municipal Waste Facilities in United States," Public Health Service Publication No. 1165, 1964. The number of treatment plants as of that date was 9,378.

(b) The distribution of these treatment plants by States is shown in the table below:

State	*Number*	*State*	*Number*
Alabama	112	Montana	106
Alaska	1	Nebraska	221
Arizona	60	Nevada	32
Arkansas	125	New Hampshire	15
California	519	New Jersey	281
Colorado	144	New Mexico	65
Connecticut	62	New York	356
Delaware	20	North Carolina	194
District of Columbia	1	North Dakota	170
Florida	253	Ohio	403
Georgia	156	Oklahoma	259
Hawaii	9	Oregon	132
Idaho	63	Pennsylvania	554
Illinois	519	Puerto Rico	60
Indiana	167	Rhode Island	20
Iowa	357	South Carolina	120
Kansas	310	South Dakota	159
Kentucky	115	Tennessee	110
Louisiana	95	Texas	659
Maine	12	Utah	69
Maryland	98	Vermont	10
Massachusetts	120	Virginia	150
Michigan	265	Washington	173
Minnesota	371	West Virginia	44
Mississippi	89	Wisconsin	414
Missouri	291	Wyoming	61

(c) The distribution of the treatment plants by population size is shown in this table below:

State	Number	State	Number
Under 500	1, 253	10,000 to 24,999	1, 157
500 to 999	1, 830	25,000 to 49,999	420
1,000 to 4,999	5, 015	50,000 to 99,999	200
5,000 to 9,999	1, 409	Over 100,000	136

(d) There are no data on the age distribution of these plants. It is reasonable to say, however, that few of the present-day plants were in existence prior to 1920. A large number of plants still operating were built during the mid-1930's with the assistance of various Federal public works construction programs. Many of these plants have been improved and expanded, though the number is unknown. Construction was deferred during World War II and again during the Korean war. Since 1957, at least 6,789 projects involving waste treatment facilities were constructed.

(e) Virtually all of these waste water treatment plants are owned by local governments. Data on ownership by other entities are not available. The Federal Government owns treatment plants at various Federal installations, particularly at military posts. There are also State-owned treatment plants at State institutions. These Federal and State plants are not included in the 1962 inventory data presented here.

(f) The estimated current value of the water waste treatment plants is $3.55 billion as of January 1, 1965.

B. Costs and User Charges

1. CONSTRUCTION COSTS AND OPERATING COSTS

(a) The construction costs presented are based on three measures: per capita, per population equivalent, and per unit of flow. These data were developed from analysis of 1,504 local government projects built with Federal financial assistance from 1956 through 1963. The data show a range of per capita costs, depending on the design size and type of treatment. For instance, for plants designed to serve a population of 10,000, the per capita costs (1957–59 dollars) range from $14.13 to $34.70, with the variance reflecting different treatment processes. For plants designed for a population of 100,000, the per capita costs range from $4.38 to $18.29 for the same treatment processes shown in the 10,000 population design group. More complete data on this subject is shown in PHS Publication No. 1229, Modern Sewage Treatment Plants, How Much Do They Cost? (U.S. GPO 1964).

(b) Typical annual maintenance and operation expenses for treatment plants designed to serve a population of 10,000 are $1.36 per capita. For plants designed to serve a population of 100,000, the per capita costs are $0.73.

2. USER CHARGES

(a) User charges are utilized extensively in the financing of treatment plants, particularly in regard to new plants. However, there are no precise figures on this subject. It is known that a considerable number of communities, including several large cities, cover all

or part of the costs through the property tax. The extent of user charge financing is indicated by the fact that about 25 percent of the dollar volume of municipal borrowings for treatment plants is through revenue bonds. Recent experience shows that communities are combining the financing of waste treatment plants with waterworks financing. That is, the revenues of each are pooled to support the bond issues.

(b) There are no systematic data on the extent to which user charges cover all operation and maintenance and annual debt service costs.

(c) Undoubtedly, a large portion of municipal sewage treatment plant costs are met through general taxation. A reasonable estimate cannot be proven. It is well to note that borrowing through general obligation bonds does not necessarily mean that the repayment is solely through general property taxation. Oftentimes, user charges, special benefit assessments, connecting charges, and other means are used in conjunction with property taxes to repay borrowings.

C. Trend of Capital Outlays

1. Complete data on annual expenditures for municipal sewage treatment plants date from the year 1957, the year the current program of financial assistance under the Federal Water Pollution Control Act got underway. From 1952 through 1956, the annual average was $272 million. Prior to 1952, no data are available. For the period 1957–65, the figures are as follows:

Annual expenditures for municipal sewage treatment plants

[In millions]

Year	Total expenditures	Total entirely by State and local funds	Total with Federal, State, and local funds
1957	421	278	143
1958	466	258	208
1959	419	228	191
1960	431	223	208
1961	538	281	257
1962	654	369	285
1963	815	375	440
1964	612	200	412
1965	625	225	400

The trend reflects the effect of both Federal financial assistance and the stepped-up Federal-State and interstate programs of pollution control. The high year of 1963 reflects the impact of the Federal accelerated public works program which has now expired.

2. The proportionate annual Federal, State, and local governments expenditures are indicated in the immediately previous table. The Federal share of the projects with Federal financial assistance has been averaging about 20 percent. This percentage is expected to increase as new and expanded Federal programs take effect. Only a minor portion is attributable to State financing, probably less than 2 percent. Local governments, chiefly municipalities and special districts, provide the bulk of the non-Federal funds.

3. The sources of financing have been chiefly public borrowings through the municipal bond market. Because many public works

bond issues are for multiple-purposes and often include storm and waste collection sewers as well as combine waterworks with sewage treatment plants, it is not possible to present precise data on borrowing for sewage treatment facilities exclusively.

There are several financial assistance programs of the Federal Government that include aid for the construction of municipal waste water treatment facilities. The major program is administered by the Federal Water Pollution Control Administration under the authority of the Federal Water Pollution Control Act. The act authorizes $150 million for fiscal years 1966 and 1967 for grants to State, municipal, intermunicipal, and interstate agencies for the construction of waste treatment facilities. The maximum allowable grant is 30 percent of the eligible cost of a project or $1,200,000 whichever is smaller. In the case of a project which will serve more than one municipality, the grant may be increased to a maximum of $4,800,000. The $1,200,000 or $4,800,000 limitation does not apply if the State agrees to match equally all grants made from allocations any appropriations in excess of $100 million. A grant may be increased 10 percent if a project is certified as being in conformity with a comprehensive metropolitan plan developed by an official State, metropolitan, or interstate planning agency.

The Department of Housing and Urban Development has several financial assistance programs. The first is the program of interest-free advances to municipalities to finance the planning of public works. These advances can be used to pay for engineering and architectural services to develop plans and specifications, including the necessary surveys or other fieldwork. These advances are repayable when construction work begins. The second is a program of grants to State and local governments for comprehensive urban planning in metropolitan areas. These grants may not exceed two-thirds of the planning cost. The third is a program of low interest loans to small communities that are unable to obtain loans on reasonable terms elsewhere to finance needed public works.

The Farmers Home Administration, Department of Agriculture, also has a program (Public Law 89–240), providing grants of up to 50 percent of cost, to help finance water supply and waste collection, treatment and disposal systems in rural areas. The law defines a rural area as any area which does not include a city or town of more than 5,500 population. Grants may be made only for projects approved by the State water pollution control agency.

In 1962 and 1963, a number of municipalities benefited from the Accelerated Public Works Act. Funds under this act have been exhausted for some time, but Congress enacted similar legislation last year entitled the Public Works and Economic Development Act of 1965 (Public Law 89–136), administered by the Economic Development Administration of the Department of Commerce. Basic grants of up to 50 percent for public works and development facilities are available for those areas that have been designated as areas of substantial and persistent unemployment. Prior to grant approval, the Secretary of Commerce must make certain findings concerning the project's contribution to economic development. Supplementary grants may also be made which would permit States, or political subdivisions thereof, Indian tribes, or private or public nonprofit organizations and associations to take maximum advantage of Federal

grant-in-aid programs for public works projects. The supplementary grants are regulated by the Secretary of Commerce and may go as high as 80 percent of the project cost when the State or other entity is unable to meet the required local share in other grant-in-aid programs.

Funds are also available in particular instances under the Appalachian Regional Development Act of 1965, Public Law 89–4. Section 212 authorizes $6 million for sewage treatment works through fiscal year 1967. These funds may also be supplemented under the provisions of section 214 of the act.

Several States have legislative authority to provide financial assistance of various kinds for municipal sewage treatment plants. California provides loans at 2 percent interest from a fund of $1 million. Delaware provides 40 percent of the original construction cost or $100,000 whichever is smaller. Georgia has a provision for 30 percent of costs or $250,000 whichever is smaller. Georgia's program, however, has never been funded. Indiana provides for loans for plans and surveys. Maine provides for amounts equal to the Federal contribution and also provides for 50 percent or $2,500 whichever is less for the cost of surveys. Maryland provides for matching the Federal grant, but the total of State and Federal grants may not exceed 50 percent, and also for construction loans and for planning assistance. New Hampshire guarantees the bonds of local governments for sewage treatment works and pays annually 40 percent of the amortization charges on construction costs. New Jersey provides for planning grants and for loans for drawing engineering specifications. New Mexico provides for grants to associations formed in rural and unincorporated areas for treatment facilities. Communities must be in existence more than 25 years and not be adjacent to incorporated places. New York provides for planning assistance and for grants for construction. The grants will cover 30 percent of construction costs and as much as 60 percent until the Federal share is made available. New York also provides for assistance for operation and maintenance costs up to one-third of such costs. Ohio provides for planning advances for villages which do not have a treatment facility. Oregon provides for the purchase of local community bonds when such communities are unable to meet private market requirements. Pennsylvania provides for 2 percent annually of the construction costs. Assistance up to 50 percent of planning costs is also provided. Vermont provides for assistance up to 20 percent of construction costs. Additional assistance is provided for communities with "limited economic base" who are required by the water resources board to construct treatment facilities. Total aid from all sources shall not exceed 75 percent of construction costs.

D. Needs and Prospective Capital Outlays

1. CAPITAL REQUIREMENTS

(*a*) Annual surveys of municipal waste treatment needs are conducted by the Conference of State Sanitary Engineers in cooperation with the Public Health Service. The 1966 survey reports that 1,285 communities presently discharging raw sewage require new plants for the treatment of wastes from a population of 6.7 million. An addi-

tional 1,694 cities and towns with existing treatment plants require new or enlarged facilities because of obsolescence, insufficient treatment or capacity. These communities presently discharge inadequately treated wastes from a population of 24.6 million.

While unsewered towns are not usually major sources of pollution, they frequently experience serious ground water pollution and other public health problems because of individual disposal of sewage. The conference reports 2,661 unsewered communities which require sewer systems and sewage treatment plants for a population of 6.1 million.

The estimated cost of the present backlog of 5,640 needed projects is $2.6 billion for treatment plants, interceptors, outfall sewers, and other ancillary works. This survey includes only those municipalities with treatment needs on January 1, 1966. This survey does not anticipate the upgrading of treatment that may be required at any future date. It should also be noted that there are a number of other municipalities that already have adequate treatment but need to extend their interceptors to serve new areas. This additional group will increase the size of the backlog, but we do not have accurate estimates of the magnitude of this need. It is generally agreed that this study of the backlog of needed facilities is very conservative and that it represents the minimum need. There are no firm figures, however, to indicate the size of the full need.

The population served by sewer systems in the United States increased from 98.4 million in 1956 to 122.4 million in 1962—a 24-percent increase in 6 years. The urban population increased from 96.5 million in 1950 to 125.3 million in 1960—an increase of 30 percent for 10 years. Municipal waste treatment needs for the expanding population have been estimated by the extension of the present (1966) sewered population of 138 million through 1980 using the series B population growth estimate of the Bureau of the Census. Future estimates of population served by sewer systems are as follows:

1970	154, 000, 000
1975	171, 000, 000
1980	190, 000, 000

The cost of providing the waste treatment works needed to serve the increasing population has been estimated on the basis of these population projections and a per capita construction cost of $39.69 for secondary treatment.

The municipal waste treatment works currently in operation will eventually have to be replaced because of obsolescence. For the purpose of estimating annual replacement needs, we have assumed an average effective life of 25 years for treatment plants and 50 years for interceptor and outfall sewers. The cost of replacing the treatment plants reported in the 1962 inventory has been estimated at $3 billion and related ancillary works at $2.6 billion. Annual needs to replace obsolete treatment plants has been estimated at 4 percent of the replacement value of treatment plants and 2 percent of ancillary works.

Annual construction rates required to eliminate the backlog of needed municipal waste treatment works and provide for continuing obsolescence and population growth within specified periods of time have been estimated in terms of today's construction cost. The

actual costs, however, will be higher because of the steady upward trend of construction cost. Our sewage treatment plant construction cost index shows an average annual increase of about 2.3 percent of the 1957–59 base of 100 over the period 1930 to 1963. The index has varied considerably from time to time because of war and the fluctuating economy. Estimates of future trends are risky at best, but projections are necessary and we have estimated an average annual increase of 2.5 percent through 1980. This is less than the 4.6 percent experienced from 1947 through 1957 and higher than the 1.6 percent of the past 5 years.

The application of this data and the estimates indicate that we shall need to spend $341 million annually through 1975 to replace facilities which become obsolescent because of age, technical advancement, or population relocation. An additional $262 million will be necessary to provide for population growth. Thus, we see that an annual expenditure of $603 million will be necessary to maintain the status quo.

If we desire to eliminate the backlog by 1975, we shall be required to spend an additional $264 million annually.

Therefore, elimination of the backlog, replacement of obsolete treatment works, and provision for the continuing population growth in our urban areas, will require an average annual expenditure of over $867 million for municipal waste treatment works through 1975. This, however, is in terms of 1964 dollars and does not account for constantly rising construction costs. When we allow for this factor, the average annual cost increases to $983 million to eliminate the backlog and to remain current on the needs resulting from growth and obsolescence.

(*b*) The estimates contained in (*a*) above assume that equal amounts of the backlog are eliminated each year while keeping current on needs developed by growth and obsolescence. Each year, that construction is postponed, will add to the ultimate cost because of the annual increase in the cost of construction.

(*c*) An analysis of the January 1, 1966 study by the Conference of State Sanitary Engineers shows that the backlog of need falls into the following population size group:

Total backlog: Municipal waste treatment needs—1966

	Number	Population served	Estimated cost in thousands
Population size group:			
Under $500	1,460	419,848	$93,296
$500 to $1,000	1,287	897,510	158,954
$1,000 to $5,000	2,087	4,288,538	715,050
$5,000 to $10,000	350	2,395,813	243,058
$10,000 to $25,000	251	3,826,157	273,764
$25,000 to $50,000	88	3,207,613	198,524
$50,000 to $100,000	58	4,327,534	236,237
Over $100,000	59	18,034,761	724,600
Total	5,640	37,397,774	2,643,483

(*d*) The extent to which various levels of Government will participate in the estimated capital outlays is very difficult to predict at the present time. State programs vary widely as indicated in paragraph C(3) above, and others are considering legislative proposals in this field. For the immediate future, the cities, towns, counties, and special districts will find it necessary to provide most of the capital outlays.

2. FINANCING METHODS

(*a*) No change is expected in the methods used by local communities to finance their share of the cost of constructing waste treatment facilities (see C(3) above). No estimate can be made concerning the Federal role at this time. The present program expires at the end of fiscal year 1967, but Congress is presently considering legislation which would continue the program.

(*b*) The present methods of financing should yield adequate capital to accomplish the objectives. The principal problem is to predict the likelihood of municipalities responding fully to meet their needs within the time indicated. Except in those cases where the States act to assist with the cost of a project, the municipalities must finance 70 percent of the cost of projects. Much has been said in the past concerning the financial problems of municipalities and the competition for the municipal dollar. This competition for the municipal dollar will play a significant role in the response of municipalities to this program.

CHAPTER 7

Solid Wastes Collection and Disposal Facilities*

Information on the generation and disposal of solid wastes is badly lacking in the United States. The parameters for solid wastes are known only partially and at best only on a sporadic basis for an extremely small number of the communities in the Nation.

A. NATURE AND COMPOSITION OF SOLID WASTES COLLECTION AND DISPOSAL FACILITIES

Technologically the state of the art of solid waste collection and disposal appears to be rather rudimentary, yet there are considerable variations in handling practices among U.S. communities. Most communities do not collect all the solid wastes produced within their boundaries because of either voluntary or mandatory self-disposal by the producers themselves. Furthermore, the amount of refuse produced and collected varies according to the nature of a community's economic functions (industrial, commercial, residential), according to the habits and styles of living of the residents, income levels, climate, season of the year, and the frequency of collection.

1. DESCRIPTION OF GENERAL PHYSICAL CHARACTERISTICS AND SERVICES RENDERED

(a) *Terminology and Definition*

The unwanted and discarded material of a community can be gaseous, liquid, or solid. Refuse is the term commonly applied to solid wastes, which are neither waterborne nor airborne.

Refuse is subclassed into garbage, rubbish, ashes and special wastes. These subclasses frequently are defined as follows:

Garbage refers to putrescible wastes derived from the preparation, cooking, serving, handling, storing, selling, and processing of foods.

Rubbish comprises the nonputrescible wastes of a combustible as well as noncombustible character normally produced by a community. Examples include paper, wood, cloth products, rubber, garden wastes, synthetics, metals, plastics, glass, ceramics, stones and dirt.

Ashes are defined as the residue from burning solid fuels and the incineration of refuse.

Special wastes include street refuse, demolition and construction wastes, dead animals, outsize objects such as abandoned vehicles, furniture, stoves, refrigerators and trees, sewage treatment residue, medical and industrial wastes.

According to origin refuse comes either from domestic, municipal, institutional, commercial, industrial or agricultural sources.

The collection of solid wastes involves storage at the place of origin and transportation to the point of disposal. The method of

*Prepared by the American Public Works Association, by Dr. Karl W. Wolf, consultant, with minor editing by committee staff.

collection of refuse is related to the method of disposal. Separate garbage collection is essential if hog feeding of cooked garbage or other salvage operations are included in the methods of disposal. Combined collection of mixed refuse, including garbage, is made if the disposal is done by sanitary landfill or incinerator. Combined collection, of course, permits combined storage.

At the point of origin refuse is stored in a great variety of containers ranging from the familiar metal or plastic garbage can to paper boxes and paper or plastic bags, and from specialized containers at commercial or industrial establishments to open refuse "vaults." The storage of refuse at the source frequently leaves much to be desired.

The hauling of refuse to the disposal site is done in all kinds of vehicles. These include the private car and open trucks as well as specially designed equipment which has an enclosed liquid-tight storage body and provides for some compaction of the collected materials. Regular collection and hauling services usually are performed at least once a week where these activities are organized.

The final disposal of most of the solid wastes is still accomplished in four basic ways: open dump, sanitary landfill, incineration, and by salvage which includes composting and hog feeding. In addition, some of the garbage ground at the points of origin is disposed of through the sewage system.

The severity of the refuse disposal problem is directly related to the density in population settlement patterns. It can be solved more readily by the producer in rural areas where there is ample room for composting, burying, or burning of unwanted materials. The solution is much more difficult in urban areas.

Open dumps are smoldering, smelly places where solid wastes are just deposited—without any regulation or organization. Open dumps frequently are found at the outskirts of both rural and urban communities. To reduce the volume and to control rats, deposited wastes are sometimes burned thus causing considerable air pollution. Open dumps vary in their levels of offensiveness. Some open dumps are worked at irregular intervals with bulldozers to level and compact the refuse. This makes them slightly more tolerable than those open dumps which are not so worked and/or "cleaned up" periodically. Open dumps that are worked, are sometimes called "modified" landfills or "modified" open dumps.

The sanitary landfill method of refuse disposal requires that (1) the wastes be reduced in volume on the disposal site by compacting and/or other means, and (2) that the deposited materials be covered with a layer of earth or other inert material at the conclusion of *each day's* operation. Properly located and operated sanitary landfills produce minimal ground or surface water pollution, prevent the breeding and harborage of insects and rodents, and there is no burning of refuse.

The volume of compacted refuse or disposal capacity of each disposal site is often measured in "acre-feet." One acre foot of refuse is the equivalent of 1 acre filled to a depth of 1 foot with compacted refuse. Once completed, sanitary landfill areas can be used almost immediately for recreational purposes and parking. Depending upon the location and fill-depths, the settlement may continue for a decade or more. However, with proper compaction, and in some cases, foundation piling, the sites may be made usable for commercial and light industrial establishments.

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Incineration reduces the volume of combustible solid wastes by burning at minimum temperatures, generally between 1,250 to 1,800° F. Burning eliminates putrescibles so that the residue from the incineration process may be disposed of in the same manner as any other clean, inert fill material. To minimize air pollution effectively, it is necessary that incinerators be equipped with a variety of air pollution control devices. Incinerators are built in many types and capacities starting from devices akin to backyard burners and in-house units for residences, apartment buildings, hospitals and institutions, to large plants having capacities of more than 2,000 tons per 24-hour period. The newer incinerators are architecturally pleasing and can readily handle mixed refuse.

The disposal of solid wastes in a community is handled in various ways. Excluding disposal by the producers themselves, sometimes public agencies perform the complete task with public employees; in other cases public agencies contract with one or more private, profitmaking organizations; in still other instances, all waste disposal is done through agreements between the individual producer and private enterprise or through various combinations of the above three methods. A 1964 survey of 995 communities with 5,000 or more inhabitants shows the following structure of refuse collection practices:

TABLE I.—*Breakdown of refuse collection practices*

[By type of collection organization 1964]

Collection organization:	*Percent share of total number of communities*
Municipal	44. 3
Contract	17. 6
Private	13. 1
Municipal and contract	3. 3
Municipal and private	15. 2
Municipal, contract, and private	1. 6
Contract and private	4. 4
Unknown	. 5

Source: American Public Works Association in cooperation with the U.S. Public Health Service.

The above data indicate that in 65.2 percent of the communities the control of solid waste collection was vested completely in public authorities through either municipally owned or contractually arranged operations. These data tend to correlate with data from a 1966 APWA survey, according to which in terms of tonnage, 62 percent of the collections were handled by public agencies and 38 percent by private organizations. However, it must be kept in mind that these data do not cover the practices of smaller communities and unincorporated areas for which published data are not available. It is estimated that in the majority of small communities with less than 5,000 population, the disposal is handled by private companies or the producers of the wastes.

Data on the public-private relationship in the ownership of disposal facilities are much more difficult to obtain. The 1965 APWA survey on collection practices indicates that 10.3 percent of the contractors and 13.4 percent of the private collection organizations do not use disposal facilities operated or provided for by public agencies.

Finally, a limited 1966 APWA survey indicates that about 15 percent of the solid wastes in communities of more than 10,000 population are disposed of in open dumps, about 65 percent in sanitary landfills,

about 18 percent through incineration, and about 2 percent by other methods. However, it must be recognized that many sanitary landfills are sanitary in name only and do not meet the requirements of a location, and at least daily coverage of the deposited wastes with suitable materials. Field surveys in some regions indicate that only about 10 percent of the so-called sanitary fills apply cover material on a daily basis. Thus, about 90 percent of the "sanitary landfills" might actually be classified as open dumps, including modified landfills or modified open dumps.

(b) *Qualitative and Quantitative Standards of Performance*

Refuse collection and disposal are generally regulated at the county and municipal levels, although in certain cases State regulations also apply.

According to the APWA Institute for Solid Wastes and the U.S. Public Health Service, the development of comprehensive survey procedures and the establishment of standards and criteria for the handling of solid wastes are sorely needed. At the present time there are significant differences of opinion as to the character and adequacy of disposal services that should be provided. Much depends upon the attitude, tradition, and the economic position of the residents in a particular community.

Qualitatively, the entire process of solid waste collection and disposal should be carried out in such a manner that the public health and safety of the community is protected, that the extent and characteristics of the service are in accord with the desire of the people, and that the operation is conducted effectively and economically. To be entirely free from nuisances and menace to public health, the waste materials must be handled so that odors cannot escape, so that insects and animals cannot have access to the material, so that wastes and dust are not thrown about, and so that the air and the surface and subsurface waters are not polluted.

The varying desires, attitudes, and opinions of the people currently make the problem of refuse collection and disposal somewhat different for each community. The residents of some places insist on healthful and attractive conditions and demand prompt and complete refuse disposal. In other communities, the citizens apparently place a much lower value on sanitation and orderliness. The attitudes, plus the economic capability of a community, determine the division of work between the householder or waste producer and the collection and disposal forces.

2. THE EXISTING CAPITAL PLANT IN THE UNITED STATES

(a) *The Number of Facilities in Operation*

As of mid-1965, it is estimated that there were 280 to 345 noncaptive incinerators, 1,000 to 1,250 noncaptive sanitary landfills, and 17,500 to 21,300 noncaptive open dumps in the United States. Noncaptive installations are those that are not operated for the disposal of the owner's refuse exclusively.

Most open dumps are found in the small rural places having a population of less than 2,500 people. Such places are estimated to account for 12,250 to 15,000 of the open dumps and for 125 to 150 of the sanitary landfills. Urban areas are estimated to account for 5,200 to 6,300 open dumps and 850 to 1,100 sanitary landfills.

A detailed breakdown of the estimates on the number of incinerators is given in table II.

TABLE II.—*Estimated distribution of the number of incinerators by community size, 1965*

Community population (in thousands)	Number of communities in United States, 1960	Percentage of communities with incinerators	Average number of incinerators per community	Distribution of incinerators by community size	
				Number	Percent
1,000 or over	5	80.0	4	16	5.1
500 to 999.9	16	75.0	2	24	7.6
250 to 499.9	30	50.0	1.5	22	7.0
100 to 249.9	81	30.0	1	24	7.6
50 to 99.9	201	25.0	1	50	15.9
25 to 49.9	432	10.0	1	43	13.7
10 to 24.9	1,134	7.0	1	79	25.2
5 to 9.9	1,394	4.0	1	56	17.9
Total	3,293			314	100.0

Source: APWA estimates and calculations.

Using several sources of data and methods of calculation and allowing for a margin of error of 10 percent either way, the number of incinerators in the United States is estimated to range between 280 and 345 units. This excludes privately owned incinerators used exclusively by the owner.

The estimated 1965 distribution of the number of open dumps and sanitary landfills is given in table III on the following page. Again, a margin of error of 10 percent either way should be allowed.

In evaluating surveys on the use of open dumps, modified landfills, and sanitary landfills, one finds that the inventories made by private consultants account for a much higher share of open dumps in the total disposal capacity than shown on questionnaire surveys.

TABLE III.—*Estimated distribution of the number of open dumps and sanitary landfills, by community size, 1965*

Community population	Number of places in United States, 1960	Average number of open dumps and/or sanitary landfills per community	Ratio of open dumps to sanitary landfills (percent)	Distribution by community size			
				Number		Percent	
				Open dumps	Sanitary fills	Open dumps	Sanitary fills
Urban (1,000's):							
1,000 or over	5	4.0	25:75	5	15	----------	1.4
500 to 999.9	16	3.5	34:66	19	37	0.1	3.5
250 to 499.9	30	3.0	50:50	45	45	0.2	4.2
100 to 249.9	81	2.5	60?40	120	82	0.6	7.7
50 to 99.9	201	2.0	70:30	281	121	1.4	11.2
25 to 49.9	432	1.5	75:25	485	163	2.5	15.2
10 to 24.9	1,134	1.0	80:20	910	224	4.7	21.0
5 to 9.9	1,394	1.0	90:10	1,255	139	6.6	13.0
2.5 to 4.9	2,152	1.0	95:5	2,050	102	10.6	9.4
Under 2.5 [1]	596	1.0	99:1	590	6	3.1	0.6
Subtotal urban	6,041	----------	86:14	5,760	934	29.8	87.2
Rural:							
1,000 to 2,550	4,151	1.0	99:1	4,110	41	21.2	3.8
Under 1,000	9,598	1.0	99:1	9,502	96	49.0	9.0
Total	19,790	----------	94:6	19,372	1,071	100.0	100.0

[1] Places with less than 2,500 population located in urbanized areas including the standard metropolitan statistical areas.

Source: APWA—Estimates and calculations.

Estimates of the number of collection vehicles in use are extremely hard to determine. All kinds of vehicles are used and many of the vehicles used serve other purposes as well. Based on a survey of 47 communities, with a total population of 15.5 million people, it is estimated that currently about 30,000 to 40,000 vehicles are more or less exclusively used for the collection of solid wastes. These data also are supported by a 1964 APWA–USPHS survey on refuse collection practices covering a total of 995 communities. Of the Government-owned collection vehicles 68.5 percent are estimated to be compactor trucks, 8.3 percent enclosed noncompactor trucks, and 23.2 percent open dump trucks.

(b) *Distribution of Facilities by State*

According to data from the 1962 U.S. Census of Governments, five States (California, Illinois, New York, Ohio, and Pennsylvania) account for almost 50 percent of the total U.S. governmental expenditures for sanitation other than sewerage. These expenditures cover the collection and disposal of solid wastes but they exclude any debt retirement or interest payments. The State of New York leads the list with 21.9 percent. Another five States (Florida, Michigan, Massachusetts, New Jersey, and Texas) account for more than another 20 percent of the total U.S. expenditures on sanitation other than sewerage. Therefore, 10 States spend more than 70 percent of the total of all such U.S. governmental expenditures excluding the respective debt service payments.

A detailed analysis of the distribution of governmental expenditures on sanitation other than sewerage by State and type of government, is presented in table IV on the following page. Although the data refer to 1962, it is reasonable to assume that the distribution pattern roughly remains valid today. The table furthermore indicates that all sanitation other than sewerage expenditures of governmental units, according to the U.S. census, are made by governments below the State level. On a nationwide basis, 91 percent of these local government expenditures are spent by municipalities, 5.2 by townships, 2.8 percent by counties, and 1 percent by special districts. The table excludes expenditures by private disposal organizations or self-service operations which are believed to be substantial. Unfortunately, no suitable data are available on the geographical distribution of the private disposal effort.

TABLE IV.—*Breakdown of expenditures in local governments on sanitation other than sewerage, 1962, by State*

[Dollar amounts in millions]

State	General expenditure of State and local governments (A)	Percent of general expenditure on sanitation other than sewerage (B)	Percent distribution of total U.S. expenditures for sanitation other than sewerage by State (C)	Percent of total expenditure for sanitation other than sewerage expended in SMSA's,[1] 1962 (D)	Percent of total population living in SMSA's, 1962 (E)	Percentage of total State expenditures for sanitation other than sewerage expended by—				
						Total (F)	Counties (G)	Municipalities (H)	Special districts (I)	Townships (J)
Total, United States	$60,205.5	1.1	100.0	79.0	63.0	100	2.8	91.0	1.0	5.2
Alabama	810.9	.8	.9	65.9	45.6	100	.1	99.9		
Alaska	134.0	.5	(2)			100		100.0		
Arizona	528.4	1.4	1.1	90.5	71.4	100	1.2	98.8		
Arkansas	406.0	.5	.3	39.5	19.1	100		100.0		
California	7,437.1	.8	8.9	93.3	86.5	100	9.0	87.8	3.1	
Colorado	682.4	.6	.6	78.2	68.0	100	.7	99.3		
Connecticut	948.1	1.0	1.4	91.9	77.6	100		71.6	.9	27.4
Delaware	156.3	.7	.1	81.1	68.9	100		100.0		
District of Columbia	330.9	2.4	1.2	100.0	100.0	100		100.0		
Florida	1,548.0	1.7	3.9	80.1	65.6	100	10.1	89.9		
Georgia	1,046.2	1.3	2.0	74.4	46.0	100	13.8	86.2		
Hawaii	295.8	1.3	.5	90.0	79.1	100	10.0	90.0		
Idaho	222.1	.6	.2			100	1.5	98.4		
Illinois	3,246.5	1.5	7.3	96.3	76.9	100	.1	99.9		
Indiana	1,379.7	.7	1.4	70.5	48.1	100	.3	99.7		
Iowa	889.9	.6	.8	62.1	33.2	100	.3	99.7		
Kansas	722.9	.6	.6	47.6	37.4	100		100.0		
Kentucky	899.2	.6	.8	72.7	34.1	100		100.0		

Louisiana	1,135.3	1.0	.1	75.8	50.0	100	10.5	89.5		
Maine	284.3	.4	.1	38.2	19.7	100		65.4		34.7
Maryland	1,037.0	1.2	1.8	90.8	78.2	100	19.7	63.3	17.0	
Massachusetts	1,782.7	1.3	3.4	92.6	85.2	100		73.6		26.4
Michigan	2,778.0	1.1	4.5	93.0	73.1	100		95.4	1.3	3.3
Minnesota	1,261.0	.5	.9	77.4	51.3	100	.6	99.4		
Mississippi	570.8	.6	.5	24.1	8.6	100	.8	99.2		
Missouri	1,166.0	.6	1.0	88.9	57.9	100		100.0		
Montana	245.3	.7	.2	48.2	22.6	100	3.8	96.2		
Nebraska	417.7	.6	.4	69.4	37.6	100		96.7	3.3	
Nevada	167.8	.2	(2)	68.8	74.2	100	13.5	86.5		
New Hampshire	187.7	.9	.2	31.2	17.7	100		84.7	.5	14.7
New Jersey	1,968.1	1.5	4.2	81.7	78.9	100	.6	77.5	4.9	17.0
New Mexico	323.4	1.2	.6	46.3	27.6	100	.4	99.6		
New York	7,046.5	2.1	21.9	97.2	85.5	100		89.4		10.6
North Carolina	1,083.5	1.0	1.6	47.2	24.6	100	.3	99.7		
North Dakota	238.5	.5	.2	22.7	10.6	100		100.0		
Ohio	2,879.6	1.2	5.1	90.7	69.5	100	.4	99.6		
Oklahoma	731.7	.7	.8	56.0	43.9	100		100.0		
Oregon	700.8	.3	.3	60.7	50.4	100	5.5	94.5		
Pennsylvania	3,185.7	1.3	6.2	93.4	77.9	100	3.3	86.6	.4	9.7
Rhode Island	254.6	1.0	.4	92.7	86.2	100		91.4		8.6
South Carolina	493.7	1.1	.8	45.9	32.2	100	5.0	89.4	5.6	
South Dakota	239.7	.3	(2)	5.2	12.7	100		100.0		
Tennessee	884.1	1.1	1.4	78.2	45.8	100	1.0	97.4	1.6	
Texas	2,706.4	1.2	4.8	79.6	63.4	100		99.9	.1	
Utah	326.2	.5	.2	79.7	67.5	100	20.5	79.5		
Vermont	146.5	.2	(2)			100		60.7		39.3
Virginia	1,066.7	1.1	1.7	77.0	50.9	100	18.2	81.8		
Washington	1,172.4	.7	1.2	72.8	63.1	100	6.8	93.2		
West Virginia	456.5	.6	.4	56.3	30.9	100	.1	99.8		
Wisconsin	1,417.3	1.3	2.7	75.0	46.3	100	.2	98.7		1.1
Wyoming	162.9	.7	.1			100		100.0		

[1] Standard metropolitan statistical area.

[2] Less than 0.1 percent.

Source: U.S. Department of Commerce, Bureau of Census, Census of Governments, 1962.

Moreover, the table shows that the bulk of the expenditures is made in standard metropolitan statistical areas. Again, on a nationwide basis, 79 percent of the sanitation-other-than-sewerage expenditures are accounted for by the standard metropolitan statistical areas though only about 63 percent of the population reside in such areas.

Finally, the distribution pattern in the table is based on dollar expenditures. Because of the great variations in the physical capacities of the various facilities, it is judged that expenditures reflect the disposal and collection effort more genuinely than the mere number of disposal installations.

In analyzing the distribution pattern in the foregoing table, it must be recognized that most of the incinerators are found in the Eastern States. The distribution of incinerators by States is estimated to be as follows:

TABLE V.—*Estimated distribution of incinerators, 1965 by State*

State:	*Percent share of total number*	State—Continued	*Percent share of total number*
Alabama	1. 6	North Carolina	2. 1
Connecticut	4. 3	North Dakota	. 5
District of Columbia	. 2	Ohio	9. 2
Florida	3. 7	Oregon	. 5
Georgia	1. 6	Pennsylvania	7. 6
Hawaii	. 5	Rhode Island	1. 6
Illinois	4. 8	South Carolina	. 5
Indiana	1. 6	Tennessee	1. 0
Iowa	1. 0	Texas	1. 6
Kentucky	2. 1	Virginia	3. 7
Louisiana	2. 1	Washington	. 5
Maryland	2. 1	West Virginia	1. 6
Massachusetts	6. 0	Wisconsin	5. 4
Michigan	2. 7	Total for States with less than 0.1 percent of the U.S. total	. 3
Minnesota	1. 6		
Missouri	. 5		
Nebraska	. 5		
New Jersey	11. 9	Total	100. 0
New York	15. 1		

Source: APWA estimates and calculations.

(c) *The Distribution of Facilities by Population Size of the Community*

As in the data on the distribution by State, the information on the distribution of the sanitation effort by population size is based on expenditures rather than the number of installations. Again, data from the 1962 census of governments form the basis for the distribution patterns presented in table VI. However, care should be exercised in drawing conclusions from these data since per capita costs are distributed over the entire population of the county rather than the urban population only which normally receives refuse collection and disposal service. This gives a distorted picture of the actual cost of the service provided.

Table VI, which appears on the next page, shows that almost 75 percent of the governmental expenditures for sanitation other than sewerage are spent in the densely settled counties with 250,000 or more people.

An explanation for this situation is not hard to find; because of their size, large communities have to make self-disposal and backyard burning of refuse illegal. In addition, the population in large communities