Labor and Material Requirements for Sewer Works Construction

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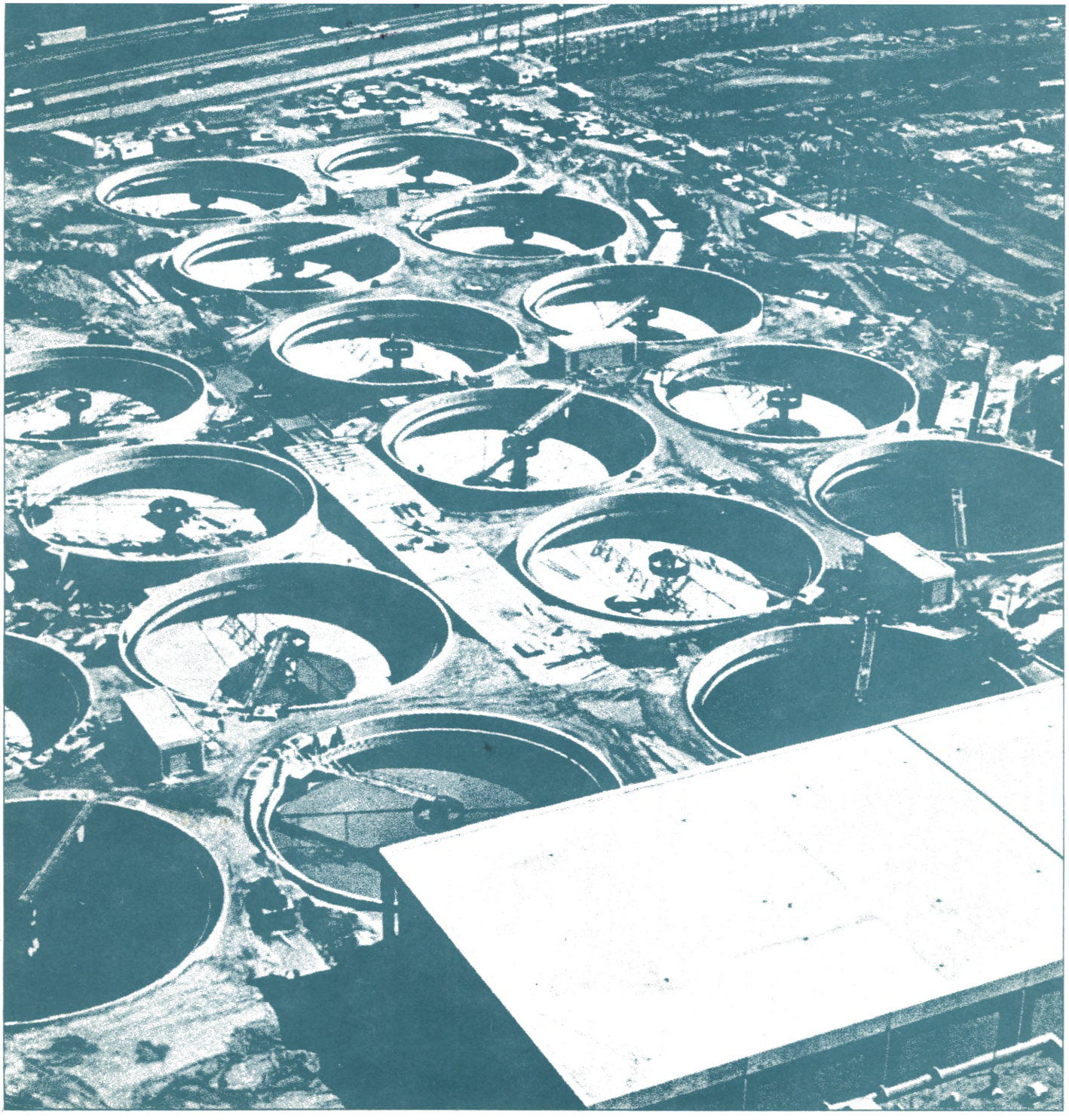

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Labor and Material Requirements for Sewer Works Construction

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Preface

This study of labor and material requirements for the construction of sewer facilities is one in a series of studies conducted by the Bureau of Labor Statistics of various types of construction activity. The sample projects for this study were selected from among all sewer works construction projects built in the 48 contiguous States between January 1, 1969, and August 31, 1973. All of the projects received Federal funds under programs administered by the Environmental Protection Agency or the Department of Housing and Urban Development. Other published studies in this series cover highways, hospitals, schools, private one-family houses, private multifamily housing, public housing, college housing, Federal office buildings, and civil works.

This study is the second one conducted on sewer works construction; the first (presented in BLS Bulletin 1490) covered projects completed during 1962–63. This study includes not only the presentation and analysis of the current survey data but also an analysis of changes in labor and materials usage since the initial survey. In addition, estimates of the employment impact of sewer works construction during calendar year 1976 are included.

The Bureau gratefully acknowledges the generous cooperation of the Environmental Protection Agency (EPA) and the Department of Housing and Urban Development (HUD). Mr. Robert L. Michel of the Municipal Construction Division of EPA provided invaluable assistance in the selection of the universe and sample projects from the EPA data bank. The Bureau also wishes to thank the 3,000 general and special trade contractors who provided data for the survey.

This study was prepared in the Bureau's Office of Productivity and Technology by Joseph T. Finn, assisted by Maurice G. Wright, under the supervision of Robert Ball in the Division of Technological Studies, John J. Macut, Chief.

A summary of the results of this study was published in the November 1976 issue of the *Monthly Labor Review* ("Labor and materials requirements for sewer works construction," by Robert Ball and Joseph T. Finn, pp. 38–41).

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Chapter I. Introduction

The BLS program of construction labor requirements studies was started in 1959 when Congress recognized the need for information on the possible employment-generating effects of various types of construction. Since then, the Bureau has conducted a series of studies presenting data on the total amount of employment and employee-hours, both onsite and offsite, per $1,000 of construction expenditures and, for some studies, per 100 square feet of space.

These studies provide occupational data which are important in planning for training requirements as well as in determining skill shortages or bottlenecks for various types of construction. Resurveys of a given type of construction over time can contribute information about changes in costs and productivity for onsite construction labor. Market research analysts and companies manufacturing equipment and supplies are interested especially in lists of materials used for construction.

Sewer works construction is a major component of construction and a prime source of employment. Jobs are created not only at the construction site but also in many manufacturing, trade, transportation, mining, and other industries which furnish the materials and services for construction.

The study shows for sewer lines and treatment plants (1) the amount of labor required to complete an average installation; (2) detailed characteristics by contractor and occupation; (3) ratios per $1,000 of construction contract cost; (4) materials used by type; (5) distribution of costs; and (6) total labor requirements generated by the manufacture, sale, and delivery of these materials.

The multiplier effect of jobs created by the respending of wages and salaries of workers and profits of contractors is not included in the present study, nor are the accelerator effects of capital expenditures.

Scope of survey

The current survey was designed to measure the number of employee-hours and the value of materials, supplies, and equipment required for each $1,000 of sewer works construction. Survey sample projects were selected from a universe of federally supported sewer works construction projects started in the 48 contiguous States during calendar year 1969 and completed by August 31, 1973. The survey covers an extended period because of the long-term nature of sewer construction. In general, the data refer primarily to construction during 1971.

A sampling frame of over 1,500 units was developed from lists of 907 projects supplied by the Environmental Protection Agency (EPA) and the Department of Housing and Urban Development (HUD). The EPA list consisted of 874 projects. The HUD list consisted of 33 projects. These lists were stratified by (a) the four broad economic regions, (b) type of construction: Sewer lines, treatment plants, pumping stations, etc., (c) location: Standard Metropolitan Statistical Areas (SMSA) or nonmetropolitan areas, and (d) construction contract cost class.

Survey methods

Labor requirements for onsite construction were tabulated from payroll data supplied by contractors and HUD and HEW regional offices. Labor requirements other than for onsite construction were developed by translating the requirements for materials, equipment, and supplies produced in the various industries of the economy into the labor expended to mine, process, transport, and distribute them. Estimates were derived by first classifying and aggregating material values by type and then deflating by an appropriate wholesale price index to match the base year of the 1963 interindustry study of the Bureau of Economic Analysis, Department of Commerce. These deflated values were grouped in the appropriate industry sectors in input-output tables to generate estimates of final demand. Sector productivity factors then were applied to derive employee-hours by industry group. Further details on survey methods are given in appendix A.

Nature of the industry

The basic function of a wastewater treatment plant has been to speed up the process of purifying water. Generally, this function is divided into three levels of treatment (primary, secondary, and advanced) requiring different facilities to be constructed with different materials, built-in equipment, and labor requirements.

In primary treatment, large objects are screened out and remaining solids are allowed to settle from the water in tanks or ponds. In secondary treatment, wastewater is purified by aiding natural biological processes in the breakdown of organic material. Advanced treatment is a relatively new process which goes beyond the objectives of the first two forms of treatment.

Wastewater treatment in the past was aimed at cleaning up domestic and simple industrial wastes. Water pollution was then primarily a local matter, but this is no longer the case. Population and industrial growth coupled with the large-scale use of such products as chemical fertilizers, synthetic and organic pesticides, inorganic chemicals from mining, manufacturing, and agricultural sources, and other pollutants have required that wastewater in some areas be subjected to further treatment to remove or dilute these materials. Such processing is referred to as advanced wastewater treatment (AWT). Advanced wastewater treatment plants are more efficient than other types of plants and require more advanced equipment.[1]

The value-put-in-place (VPIP) for publicly constructed sewer systems during 1971 was $1.8 billion; the comparable figure for 1976 was $5.3 billion.[2] The large increase in VPIP from 1971 to 1976 reflects, to a great extent, the impact of inflation. Therefore, a comparison of the VPIP for these two periods should be made on a constant-dollar basis. The VPIP in 1967 dollars was $1.4 billion for 1971 compared with $2.2 billion in 1976.[3]

An additional indication of the economic impact of sewer works construction on the local economies can be inferred from the following data on the funding level of the EPA grant program for the construction of sewer works by State and local authorities, authorized by the Federal Water Pollution Control Act (Public Law 92–500). The figures reported by EPA as of February 28, 1978, show 11,587 active projects: 6,369 in Step 1 (planning) with grants of $518 million, 1,568 in Step 2 (engineering) at $376 million, and 3,650 in Step 3 (construction) at $16 billion. There were 3,731 projects completed under PL 92–500 (75–percent grant money), including 787 construction projects that took Federal grants of $811 million.[4]

According to a survey of 66 major sanitary districts in the United States which was reported in *Engineering News-Record*, these districts planned to spend $1.9 billion in fiscal year 1978, 73 percent more than they spent in fiscal year 1977. Almost 46 percent of the proposed expenditure was to be for new, upgraded or expanded treatment plants. When the survey was conducted, Congress had not passed the proposed amendments to the 1972 Water Pollution Control Act. Therefore, many sanitary districts were being very conservative when planning for fiscal 1979, and reported plans for $1.1 billion during 1979.[5] During December 1977, the Congress approved a 5-year spending authority amounting to $24.5 billion for the grant program for municipal sewage treatment plants.[6]

[1] Advanced wastewater treatment ranges from extensions of biological treatment for removal of nitrogen and phosphorus nutrients to physical-chemical separation techniques such as coagulation, adsorption, distillation, and reverse osmosis. For a detailed explanation of sewer system facilities, refer to "A Primer on Wastewater Treatment" by the Federal Water Pollution Control Administration, U.S. Department of the Interior, the forerunner of the current Environmental Protection Agency.

[2] See table 1 of Report C30–74S and table 2 of Report C30–77–10, Bureau of the Census.

[3] See table 2 of Report C30–74S and table 3 of Report C30–77–4, Bureau of the Census.

[4] *Activities of the Grants Assistance Programs, February 1978* (U.S. Environmental Protection Agency), pp. 17–19.

[5] *Engineering News-Record*, Oct. 6, 1977, p. 40.

[6] *Engineering News-Record*, Dec. 22, 1977, p. 39.

Chapter II. Highlights of the Study

General findings

Sewer works construction required 124 employee-hours for each $1,000 expended on construction contracts in 1971. (See table 1.) Fifty-one of these hours were expended in the construction sector directly, 48 of them at the site and 3 in offsite construction.[7] This compares with 204 employee-hours total, 90 construction (85 onsite and 5 offsite) for a similar study conducted in 1963.[8] (See chart 1.)

In addition to the direct hours, 73 employee-hours were created in industries which produce, transport, and sell the materials, equipment, and supplies used in sewer works construction. For 1963, 114 hours were created in the supporting industries. (Employee-hours by type of industry are shown in table 1.)

When adjusted for inflation (by applying the EPA's cost indexes for sewer systems),[9] the resulting employee-hours per $1,000 spent in 1971 totaled 183. The construction sector generated 75 hours, 71 onsite and 4 offsite, and the supporting industries generated 108. The average annual rate of decline of onsite hours per $1,000 in constant dollars was 2.2 percent. (See table 2.) While this is not a pure measure of onsite labor productivity, the decline does point to some improvement in productivity between the two survey periods.

[7] Not covered by the survey were construction inspection by government employees and installations by public utility employees. Excluded from other industry employee-hour requirements was labor generated by money spent by builders or contractors for taxes (including payroll taxes) and other overhead items such as real estate commissions, rent, bonds, financing, utilities, business services, and legal and professional services. These payments probably generate little direct employment. Employment created by the respending of wages and profits of the workers and their employers—the multiplier effect—was also outside the scope of the study.

[8] See Roland V. Murray, "Labor and Material Requirements for Sewer Works Construction," *Monthly Labor Review*, March 1966, pp. 288–90, and *Labor and Materials Requirements for Sewer Works Construction*, Bulletin 1490 (Bureau of Labor Statistics, 1966).

[9] The EPA's price indexes for sewer lines and treatment plants were used to compare the change in total employee-hours per $1,000 of sewer works construction completed between 1963 and 1971 expressed in 1963 dollars. However, the change in the cost of the materials used to construct projects was measured by comparison of the wholesale price indexes for these construction materials, for the years 1962 and 1970. The assumption was made that the materials used to construct the survey projects were mostly purchased during these years.

The employee-hours per $1,000 of contract costs varied very little between lines and plants, as shown in table 1. For example, in 1963 dollars, $1,000 in 1971 generated 180 employee-hours for lines and 183 for plants, all industries included. The totals for the construction sector were 72 hours for lines and 75 hours for plants. The total for other industries, however, was 108 for both lines and plants.

Employment estimates

The $1.8 billion spent on sewer works construction in 1971 generated 116,900 full-time jobs in construction and in other industries supplying materials and equipment to the job site: 51,500 in construction and 65,400 in other industries. The employment distribution among the industry sectors was as follows:

	Number of full-time jobs in 1971
All industries	116,900
Construction	51,500
Onsite	48,800
Offsite	2,700
Other industries	65,400
Manufacturing	44,300
Wholesale trade, transportation, and services	14,200
Mining and other	6,900

The number of full-time jobs generated by a given amount of expenditures for sewer construction has decreased in recent years because of inflation and im-

The cost index used to express the employee-hours data for 1971 and 1976 in 1963 dollars is an unweighted average of the EPA price indexes of lines and plants (1967 = 100). The index values and the unweighted averages for the years 1963, 1971, and 1976 were:

	Lines	*Plants*	*Unweighted average*
1963	90.9	90.9	90.9
1971	134.3	133.8	134.0
1976	221.0	219.7	220.4

The productivity estimate used is the inverse of the change in onsite employee-hours per $1,000, adjusted for price change, between 1963 and 1971. The average annual rate of change was 2.2 percent over the period.

Table 1. Employee-hours per $1,000 of contract cost for sewer works construction, by industry, 1963 and 1971

Industry	Current dollars						1963 dollars		
	1963			1971			1971		
	Total	Sewer lines	Sewer plants	Total	Sewer lines	Sewer plants	Total	Sewer lines	Sewer plants
All industries	204	204	203	124	123	125	183	180	183
Construction	90	91	88	51	49	51	75	72	75
Onsite	85	86	83	48	48	47	71	71	69
Offsite	5	5	5	3	1	4	4	1	6
Other industries	114	113	115	73	74	74	108	108	108
Manufacturing	78	76	80	50	49	52	74	72	76
Wholesale trade,[1] transportation, and services	23	23	23	15	16	15	22	23	22
Mining and other	13	14	12	8	9	7	12	13	10

[1] In the input-output tables used to generate the "other industries" employment inpact, the Bureau of Economic Analysis (BEA), U.S. Department of Commerce, classifies lumberyards in the retail trade sector. Thus, by excluding the labor impact of retail trade in these figures, the employment-generating effects of materials sold to contractors by lumberyards were not counted. As a result, these figures are slightly understated. If all retail trade were included, about 4.0 employee-hours would be added to the 1963 figures and 3.0 to the 1971 data in current dollars. However, it cannot be determined what portion of these hours should be included. Lumber and wood products are used extensively in residential construction, but the impact for sewer works construction is less significant. For the 1972 input-output tables, BEA is planning to reclassify lumberyards selling mainly to contractors from retail trade to wholesale trade. When these data become available, future studies will be adjusted to reflect the labor-generating effects of purchases by contractors from such lumberyards.

NOTE: Detail may not add to totals because of rounding. Data for 1963 are based on the 1963 input-output table inverse matrix and the data for 1971 are based on the 1970 tables with adjustments for productivity between 1970 and 1971. Revised data for other industries are shown for 1963.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics.

proved productivity. Estimates of the number of jobs generated in 1971 and 1976 were based on employee-years of 1,800 hours in onsite construction and 2,000 hours in offsite construction. By these estimates, the $5.3 billion spent on sewer construction in 1976 generated 191,600 jobs—79,000 in construction and 112,600 in other industries.[10] This is only about one and one-half times the number of construction jobs generated by the $1.8 billion spent in 1971.

BLS surveys also indicate that, in 1975, funds spent on sewer plant construction created more jobs than the same amount of funds spent on school and Federal office building construction but fewer than those spent on residential construction, although the demand for workers in each occupation varies significantly with the type of construction.

Estimates for 1976, developed from the survey data, indicate that each billion dollars spent on sewer plant construction generated the equivalent of about 36,600 full-time jobs, compared with 36,500 (preliminary) for funds spent on elementary and secondary schools and 35,500 for Federal office buildings. In residential construction in 1976, the equivalent of about 35,500 full-time jobs were created for each billion dollars spent on private single-family houses, 39,300 for private multi-family housing, and 39,200 for public housing.[11]

[10] More workers would be employed than indicated by the full-time job estimates because of the seasonal nature of employment in the construction industry. Furthermore, transients and part-time workers tend to inflate actual employment figures. Because different assumptions are used for the number of employee-hours in construction and in other industries, employee-hour ratios do not apply to employee-year estimates. In other industries, in 1971, employee-year estimates were 2,069 in manufacturing, 1,939 in wholesale trade, transportation, and services, and 2,135 in mining and other. In 1976, the figures were 2,053, 1,803, and 2,074, respectively. Retail trade is excluded from these estimates because purchase transactions for materials are assumed to be made at the wholesale level only. Some retail transactions are made, but the extent of such purchases in construction is not known.

Requirements by occupation

Over 62 percent of sewer works onsite labor requirements in 1971 were accounted for by only three occupational groups: Laborers, helpers, and tenders; operating engineers; and superintendents and blue-collar supervisors. These occupations provided about 74 percent of the onsite employee-hours used to construct sewer lines and 47 percent for treatment plants.

In 1963, these three groups accounted for an even larger share of all hours—over 66 percent for sewer works (see table 3). In both time periods, i.e., 1963 and 1971, the percentages of total onsite employee-hours credited to operating engineers and to laborers, helpers, and tenders were greater in lines than in plants. The percentages of onsite employee-hours provided by superintendents and blue-collar supervisors were about the same for both lines and plants in both survey periods.

[11] See John G. Olsen, "Decline Noted in Hours Required to Erect Federal Office Buildings," *Monthly Labor Review*, October 1976, pp. 18–22; Joseph T. Finn, "Labor Requirements for School Construction," *Monthly Labor Review*, August 1968, pp. 40–43; Robert Ball, "Labor and Material Requirements for Apartment Construction," *Monthly Labor Review*, January 1975, pp. 70–73; Robert Ball and Larry Ludwig, "Labor Requirements for Construction of Single-Family Houses," *Monthly Labor Review*, September 1971, pp. 12–14; and Joseph T. Finn, "Labor Requirements for Public Housing," *Monthly Labor Review*, April 1972, pp. 40–42.

Table 2. Percent distribution and average annual rate of change of employee-hour requirements per $1,000 of contract cost for sewer works construction, by industry, 1963 and 1971

(1963 dollars)

Industry	1963			1971			Average annual rate of change, 1963–71		
	Total	Lines	Plants	Total	Lines	Plants	Total	Lines	Plants
All industries	100.0	100.0	100.0	100.0	100.0	100.0	−1.4	− 1.6	−1.3
Construction	44.1	44.6	43.3	41.0	40.0	41.0	−2.2	− 2.9	−2.0
Onsite	41.7	42.2	40.9	38.8	39.4	37.7	−2.2	− 2.3	−2.2
Offsite	2.5	2.5	2.5	2.2	.6	3.3	−2.7	−18.0	2.3
Other industries	55.9	55.4	56.7	59.0	60.0	59.0	− .7	− .6	− .8
Manufacturing	38.2	37.3	39.4	40.4	40.0	41.5	− .7	− .7	− .6
Wholesale trade, transportation, and services	11.3	11.3	11.3	12.0	12.8	12.0	− .6	.0	− .6
Mining and other	6.4	6.9	5.9	6.6	7.2	5.5	−1.0	− .9	−2.2

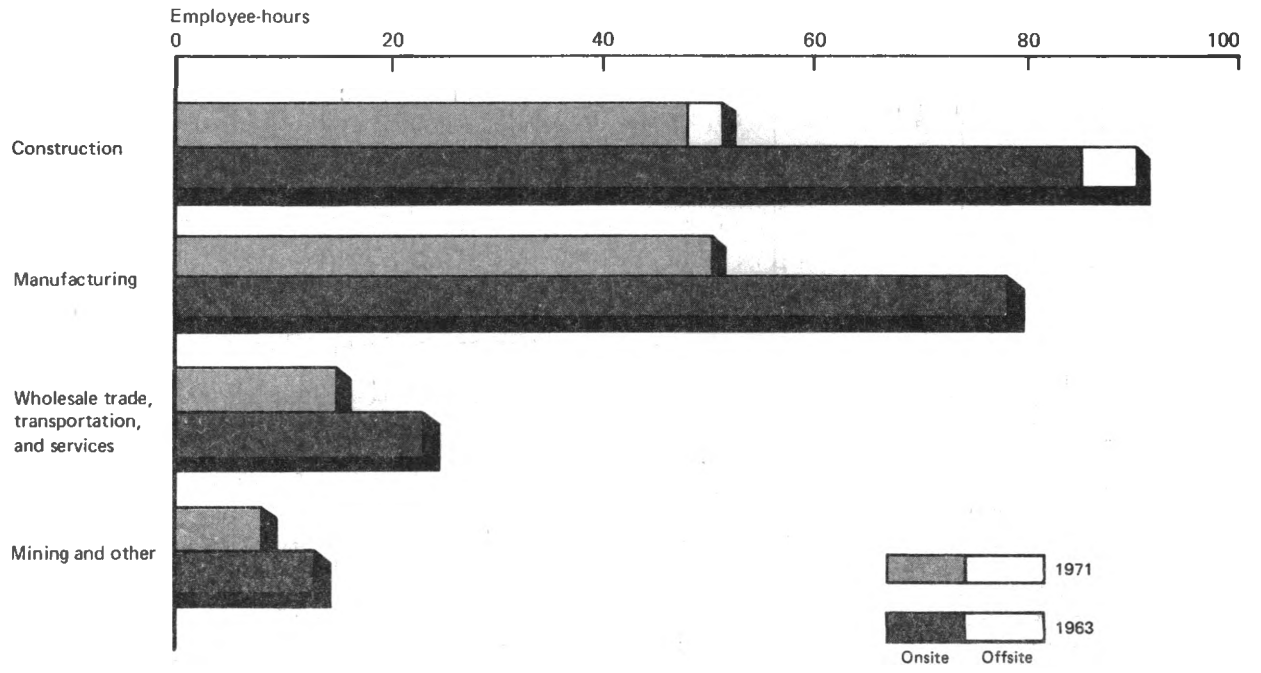
NOTE: Percents and rates of change calculated on rounded data. Detail may not add to 100.0 percent because of rounding.

Distribution of costs

Onsite labor costs accounted for about 25 percent of total contract construction costs in 1971. (See chart 2.) This was virtually the same percentage as in 1963. While onsite wages and salaries remained very stable as a percent of costs, other factors of production changed considerably in sewer works construction.

The survey indicates that the largest component of contract construction costs was for materials, built-in equipment, and supplies, excluding contractors' equipment. Nearly 41 percent of costs in 1971 were accounted for by these factors. However, this represents a decline of about 6 percentage points since 1963. The most important types of materials including contractors' equipment were stone, clay, glass, and concrete products; machinery except electrical; contractors' equipment; primary metal products; and fabricated metal products. Together, these five groups of products made up 86 percent of the contract cost of all materials, equipment, and supplies used for sewer works construction in 1971. The same groups also accounted for

Chart 1. Employee-hours per $1,000 of contract cost for sewer works construction, 1963 and 1971



about 86 percent of contract costs in 1963.

While contractors' capital equipment costs increased slightly (about 1 1/2 percentage points), the overhead and profit segment increased substantially, from 18 percent in 1963 to 23 percent in 1971. The overhead and profit segment contains numerous cost elements which were not collected separately, such as labor payroll costs for office and warehouse employees, supplemental wage benefits for onsite workers, cost of construction financing, other overhead expenses, and contractors' profit.

Regional differences

Differences in construction characteristics of sewer works reflect regional conditions under which projects are erected.[12] For example, average onsite hourly earnings were the lowest in the South ($3.97) and highest in the Northeast ($6.35) but onsite wages and salaries as a percent of total costs for these two regions were nearly identical. The reason for this apparent productivity difference is that the relatively cheaper labor in the South is utilized more extensively than the rela-

[12] Data from the study were provided for the continental United States and four broad geographic regions: *Northeast*—Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; *North Central*—Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; *South*—Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; and *West*—Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Table 3. Onsite employee-hours per $1,000 of contract cost for sewer works construction, by occupation, 1963 and 1971

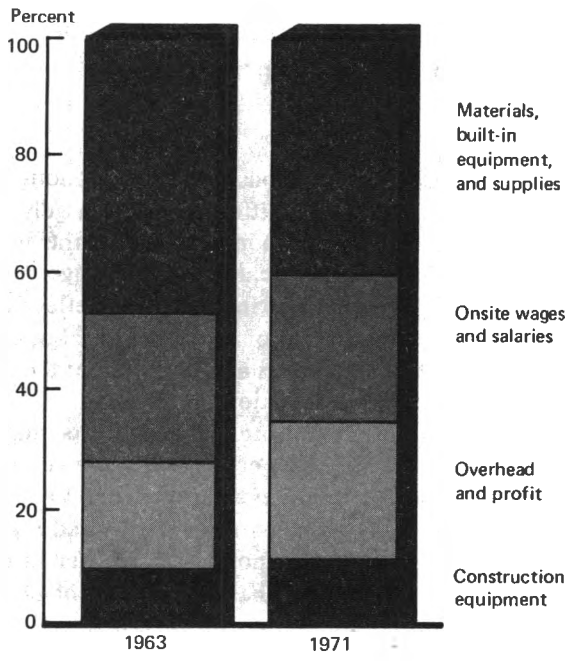
Occupation	1963						1971					
	Total		Lines		Plants		Total		Lines		Plants	
	Employee hours	Percent distribution	Employee hours	Percent distribution	Employee hours	Percent distribution	Employee hours	Percent distribution	Employee hours	Percent distribution	Employee hours	Percent distribution
All occupations	84.5	100.0	85.9	100.0	82.7	100.0	48.0	100.0	48.0	100.0	47.0	100.0
Professional, technical, and clerical	1.3	1.5	1.0	1.2	1.7	2.0	.6	1.2	.4	.8	.9	1.9
Superintendents and blue-collar supervisors	8.2	9.7	8.9	10.4	7.4	9.0	5.6	11.7	6.1	12.7	4.9	10.4
Skilled trades	30.5	36.1	21.8	25.4	40.8	49.3	20.5	42.7	15.4	32.0	26.5	56.3
Bricklayers	1.4	1.7	1.1	1.3	1.7	2.0	.5	1.0	.1	.2	.9	1.9
Carpenters	6.5	7.7	2.1	2.4	11.8	14.3	3.3	6.9	.6	1.2	6.7	14.3
Cement finishers	1.1	1.3	.4	.5	1.9	2.3	.9	1.9	.7	1.5	1.3	2.8
Electricians	1.3	1.5	.1	.1	2.7	3.3	1.4	2.9	.2	.4	2.7	5.7
Ironworkers	1.6	1.9	.3	.4	3.2	3.9	.9	1.9	.1	.2	2.1	4.5
Operating engineers	14.7	17.4	16.8	19.6	12.1	14.6	9.8	20.4	13.1	27.3	5.4	11.4
Painters	.6	.7	—	—	1.2	1.5	.4	.8	—	—	.9	1.9
Plumbers	2.1	2.5	.3	.4	4.2	5.1	1.6	3.3	—	—	3.4	7.2
Other skilled trades	1.2	1.4	.6	.7	1.9	2.3	1.7	3.5	.6	1.2	3.1	6.6
Oilers	2.4	2.8	2.7	3.2	2.1	2.5	.9	1.9	.9	1.9	1.1	2.3
Pipelayers	5.1	6.0	8.2	9.6	1.3	1.6	2.0	4.2	3.0	6.2	.4	.9
Power and handtool operators	1.2	1.4	1.0	1.2	1.4	1.7	2.4	5.0	4.0	8.3	.3	.6
Truckdrivers	2.7	3.2	3.5	4.1	1.7	2.1	1.6	3.3	2.0	4.2	1.0	2.1
Laborers, helpers, and tenders	33.0	39.1	38.6	44.9	26.3	31.8	14.4	30.0	16.2	33.7	11.8	25.1

NOTE: Detail may not add to totals because of rounding. Dash denotes no data reported.

Table 4. Range of onsite employee-hours per $1,000 of contract cost for sewer works construction, 1971

Principal type of contract	United States	Northeast	South	North Central	West
Total sewer works	10 — 237	10 — 237	18 — 163	19 — 98	20 — 85
Total lines	10 — 237	10 — 237	18 — 163	28 — 98	20 — 64
Sewer lines	10 — 237	10 — 237	18 — 163	28 — 70	20 — 64
Lift stations	27 — 54	27 — 43	32 — 54	44 — 44	——
Sewer lines and other	18 — 101	18 — 71	29 — 101	31 — 98	31 — 61
Total plants	19 — 85	24 — 62	39 — 85	19 — 71	28 — 85
Primary treatment plants	27 — 76	40 — 40	41 — 76	27 — 34	39 — 50
Secondary treatment plants	19 — 84	27 — 62	39 — 84	19 — 71	28 — 41
Pumping stations	24 — 65	24 — 50	65 — 65	33 — 33	33 — 35
Waste stabilization ponds	28 — 85	——	85 — 85	——	28 — 85

Chart 2. Percent distribution of contract costs for sewer works construction, 1963 and 1971



tively more expensive labor in the Northeast. That is, in the Northeast, machinery and equipment are substituted more freely for relatively more expensive labor. Consequently, there is a large differential in the number of onsite employee-hours required between the two regions—43 hours per $1,000 of cost in the Northeast as opposed to 67 hours in the South, as shown in the following tabulation:

	Onsite employee-hours per $1,000 of contract cost	*Average hourly earnings*
United States ...	48	$5.35
Northeast	43	6.35
North Central	39	5.92
South	67	3.97
West	39	5.77

The largest disparities among the cost factors were in construction equipment costs between the Western and the Southern regions, about 6 percent and 15 percent, respectively, materials, supplies, and built-in equipment costs of 51 percent and 37 percent for the Western and North Central regions, respectively, and in overhead and profit between the Southern and the North Central regions, about 16 and 29 percent, respectively. For further details, see "Distribution of construction contract costs" in chapter IV of this bulletin.

Chapter III. Labor Requirements and Characteristics

Onsite

Onsite labor requirements per 1,000 current dollars of contract value averaged 48 hours in 1971 for sewer works at the national level. The requirements were virtually identical for lines and plants—48 and 47 hours, respectively. The comparable data for 1962–63 were 86 hours for lines and 83 hours for plants. A major portion of the decline in onsite labor hours was the result of inflationary forces and the concomitant reduction in the purchasing power of construction capital. The tabulation below compares the onsite labor hours of the two studies on a constant-dollar basis.

	Employee-hours per $1,000, 1963 dollars		*Average annual percent change*
	1962–63	*1971*	
Total	85	71	−2.2
Lines	86	71	−2.3
Plants	83	69	−2.2

After removing the effects of cost inflation, onsite labor hours declined over 2 percent a year for both lines and plants. However, this decline cannot be attributed solely to improved efficiency in the utilization of onsite labor. Other factors involved are shifts in the mix of materials, construction methods, and characteristics of the structure. Nevertheless, there is an indication of improved onsite worker productivity.

Labor requirements by region. Onsite employee-hours per $1,000 of construction cost for 1971 for each region are indicated below:

	Total	*Lines*	*Plants*
United States	48	48	47
Northeast	43	37	46
North Central	39	42	36
South	67	67	66
West	39	41	38

The data demonstrate that on the national level there is no significant difference between the labor requirements for sewer lines compared with treatment plants. However, except in the South, the regional data show significant variation in the onsite employee-hour requirements. These regional differences are largely the result of the regional variation in project mix, the available labor supply, and the local prevailing wage rates. The high labor requirements in the South reflect the existence of a large local pool of unskilled labor and low wage rates; hence, there is a preference for the use of labor rather than construction machinery.

The onsite labor hours for individual projects ranged nationally from 10 to 237 per $1,000 in sewer line construction, and for treatment plants, from 19 to 85 hours per $1,000. (See table 4.) For the United States as a whole, the variation in hours was greater in the construction of sewer lines than for treatment plants but the range varied among the regions. In the Northeast the onsite employee-hour spread was the same as for the United States. However, the spread was narrower in the other regions.

Labor requirements by occupation. Forty-three percent of the onsite employee-hours required to construct sewer facilities were performed by operating engineers and other skilled tradesworkers, e.g., carpenters, electricians, etc. (See table 3.) Unskilled and semiskilled workers, i.e., laborers, helpers, tenders, truckdrivers, etc., accounted for 44 percent of onsite labor requirements. However, the occupational distribution of sewer line construction differs from that for treatment plants.

Operating engineers were credited with 27 percent of the onsite hours required to construct sewers, whereas they performed only 11 percent of the onsite hours used to erect the treatment plants. The other skilled trades accounted for only 5 percent of the onsite labor for sewer lines. On the other hand, these trades provided 45 percent of the onsite employee-hours required to build treatment plants. Unskilled and semiskilled workers performed a substantial portion of the onsite employee-hours required by both types of construction. They accounted for 54 percent of the onsite hours for sewer lines and 31 percent for treatment plants.

The occupational pattern for sewer lines is one that is naturally associated with construction that requires excavating, pipe handling, and backfilling. These activities call for operators of a large amount of heavy construction equipment—backhoes, cranes, trench-

ers—in addition to a substantial amount of semiskilled and unskilled labor. This is shown by the fact that 82 percent of the onsite labor requirements for sewer line construction and only 42 percent of the onsite labor hours for the erection of treatment plants were performed by these occupations.

Regionally, the percentage distribution of onsite employee-hours among operating engineers, skilled tradesworkers, and semiskilled and unskilled workers generally resembled the national pattern. However, there were a few significant exceptions. In the construction of treatment plants, the South showed relatively greater use of operating engineers and semiskilled and unskilled workers, and less use of the other skilled tradesworkers. On the other hand, in the North Central region the relationship was reversed, as is shown in the following tabulation:

	Percent distribution of onsite hours for treatment plants		
	United States	*South*	*North Central*
Operating engineers.....	11.4	19.6	6.3
Other skilled tradesworkers..	44.9	27.3	57.7
Semiskilled and unskilled workers	31.0	36.8	26.9

There are two other significant departures from the national averages. These occurred in regard to the use of skilled tradesworkers[13] in sewer line construction. In the North Central region only 1.7 percent of onsite labor hours were attributable to these occupations, compared to 9.2 percent in the West. The national average was 4.7 percent. Regional differences in the distribution of employee-hours by occupation are difficult to interpret. They may be due largely to the chance occurrence of projects with unusual features or to local differences in job classification.

Since operating engineers made up such a large percentage of sewer works construction hours, a separate tabulation was made of labor requirements by type of operating engineer. (See table 5.) Five types of operating engineers—bulldozer, front-end loader, backhoe, crane-shovel dragline, and pump and compressor operators—made up over 80 percent of this occupational group at the national level. These types of operating engineers generally are dominant in each of the four regions.

Apprentice onsite employee-hours. The 1963 survey showed that employee-hours for apprentices as a percent of skilled onsite employee-hours were significant mainly in the plumbing and electrical trades. The 1971 study found that, while apprentices continued to be utilized extensively in these two trades, their proportion of the total onsite employee-hours increased substantially in the carpentry, bricklaying, cement finishing, and ironworking trades. (See table 6.)

[13] Other than operating engineers.

Offsite

Offsite employee-hours represent builders' administrative office and warehousing activities, and the labor to produce and distribute the materials, equipment, and supplies required at the construction site. Major categories involved are: (1) Offsite construction, (2) manufacturing, (3) wholesale trade, transportation, and services, and (4) mining and other industries either directly or indirectly involved in the production and distribution process. (See chart 3.)

Offsite or indirect labor requirements are higher than onsite requirements as a percent of total labor demand and have grown larger since 1963. Offsite requirements, including offsite construction, went from 58 percent of total requirements in 1963 to 61 percent in 1971 for sewer works construction. This trend is expected to continue as the prefinishing of materials offsite and the use of more complex, expensive equipment shift jobs away from the construction site to industries such as manufacturing.

Builders' offsite employee-hours. Three employee-hours per $1,000 of contract costs were expended in this category for sewer works in 1971.[14] This includes contractors' administrative, coordinating, estimating, scheduling, engineering (but not design work), maintenance, site protection, and warehousing activities. The figure for 1963 was 5 hours. Both of these figures represent slightly more than 2 percent, a relatively small portion, of total labor requirements for sewer works construction. This is so because general contractors often limit their major responsibilities to overall coordination, scheduling, control, and supervision of construction.

Manufacturing. Manufacturing was by far the largest and most important contributor of offsite employee-hours because the bulk of materials, supplies, and equipment required for construction were produced in that sector. Manufacturing contributed 50 employee-hours per $1,000 of contract cost in 1971 and 78 hours in 1963. This represents over 40 percent of total labor

[14] Offsite construction employee-hours were estimated from the ratio of nonconstruction workers to total workers for total contract construction as shown in the March issues of *Employment and Earnings* (Bureau of Labor Statistics) for the years covered or *Employment and Earnings, United States, 1909–72*, Bulletin 1312–9 (Bureau of Labor Statistics). The resulting ratio was applied to the onsite hours obtained from the survey. An adjustment was made to remove administrative and clerical hours already counted in the onsite figures.

Table 5. Operating engineers: Onsite employee-hours and percent distribution per $1,000 of contract cost, United States and regions, 1971

Type of operating engineer	United States						Northeast					
	Total		Lines		Plants		Total		Lines		Plants	
	Employee hours	Percent of total hours	Employee hours	Percent of total hours	Employee hours	Percent of total hours	Employee hours	Percent of total hours	Employee hours	Percent of total hours	Employee hours	Percent of total hours
Total	9.8	20.4	13.1	27.3	5.4	11.4	7.1	16.4	9.5	25.7	4.7	10.3
Bulldozer operator	1.7	3.5	1.9	4.0	1.2	2.6	.6	1.4	.7	1.8	.6	1.2
Roller operator	.0	.0	.1	.2	.0	.0	.1	.2	.2	.4	.0	.0
Trencher operator	.4	.8	.7	1.5	.0	.0	.0	.0	.0	.0	.0	.0
Front-end loader operator	1.5	3.2	2.5	5.0	.3	.7	1.5	3.5	2.7	7.5	.4	.8
Backhoe operator	1.6	3.3	2.2	4.5	.8	1.6	1.0	2.3	1.1	3.0	.9	2.0
Crane-shovel dragline operator	1.8	3.7	2.1	4.4	1.3	2.7	1.4	3.3	1.5	4.0	1.3	2.9
Tractor operator	.1	.2	.1	.2	.0	.0	.0	.0	.0	.0	.0	.0
Pump and compressor operator	1.3	2.7	2.1	4.3	.3	.7	.8	1.8	.9	2.5	.6	1.3
Scraper operator	.1	.3	.2	.5	.0	.0	.0	.0	.0	.0	.0	.0
Other operating engineers	1.3	2.7	1.2	2.6	1.5	3.1	1.7	3.9	2.4	6.5	.9	2.1

Type of operating engineer	North Central						South					
	Total		Lines		Plants		Total		Lines		Plants	
	Employee hours	Percent of total hours	Employee hours	Percent of total hours	Employee hours	Percent of total hours	Employee hours	Percent of total hours	Employee hours	Percent of total hours	Employee hours	Percent of total hours
Total	8.0	20.4	11.2	26.6	2.3	6.3	17.6	26.2	19.2	28.6	12.9	19.6
Bulldozer operator	1.5	3.8	1.9	4.6	.7	1.9	3.5	5.2	2.9	4.3	4.7	7.1
Roller operator	.0	.0	.0	.0	.0	.0	.0	.0	.1	.2	.0	.0
Trencher operator	.2	.6	.4	.9	.0	.0	1.4	2.1	1.9	2.9	.1	.2
Front-end loader operator	1.4	3.7	2.2	5.2	.1	.2	1.8	2.7	2.5	3.7	.3	.4
Backhoe operator	1.8	4.6	2.8	6.5	.1	.2	2.6	3.8	2.7	4.0	1.8	2.7
Crane-shovel-dragline operator	1.7	4.3	2.1	5.1	.8	2.2	2.4	3.6	2.9	4.3	.8	1.2
Tractor operator	.1	.2	.2	.4	.0	.0	.0	.0	.0	.0	.0	.0
Pump and compressor operator	.1	.2	.0	.0	.2	.5	4.0	5.9	5.3	7.9	.3	.4
Scraper operator	.1	.2	.1	.3	.0	.0	.4	.6	.6	.9	.0	.0
Other operating engineers	1.1	2.8	1.5	3.6	.4	1.3	1.5	2.3	.3	.4	4.9	7.6

Type of operating engineer	West					
	Total		Lines		Plants	
	Employee hours	Percent of total hours	Employee hours	Percent of total hours	Employee hours	Percent of total hours
Total	5.4	13.8	10.7	26.1	3.2	8.5
Bulldozer operator	1.0	2.6	2.7	6.3	.3	.9
Roller operator	.0	.0	.0	.1	.0	.0
Trencher operator	.0	.0	.0	.0	.0	.0
Front-end loader operator	1.0	2.6	2.3	5.7	.4	1.0
Backhoe operator	.9	2.3	2.2	5.4	.3	.9
Crane-shovel-dragline operator	1.4	3.7	1.8	4.4	1.3	3.4
Tractor operator	.4	.9	.6	1.5	.3	.7
Pump and compressor operator	.0	.0	.2	.5	.0	.0
Scraper operator	.0	.0	.1	.2	.0	.0
Other operating engineers	.7	1.7	.8	2.0	.6	1.6

Chart 3. Employee-hours per $1,000 of contract cost for sewer line and plant construction, 1963 and 1971

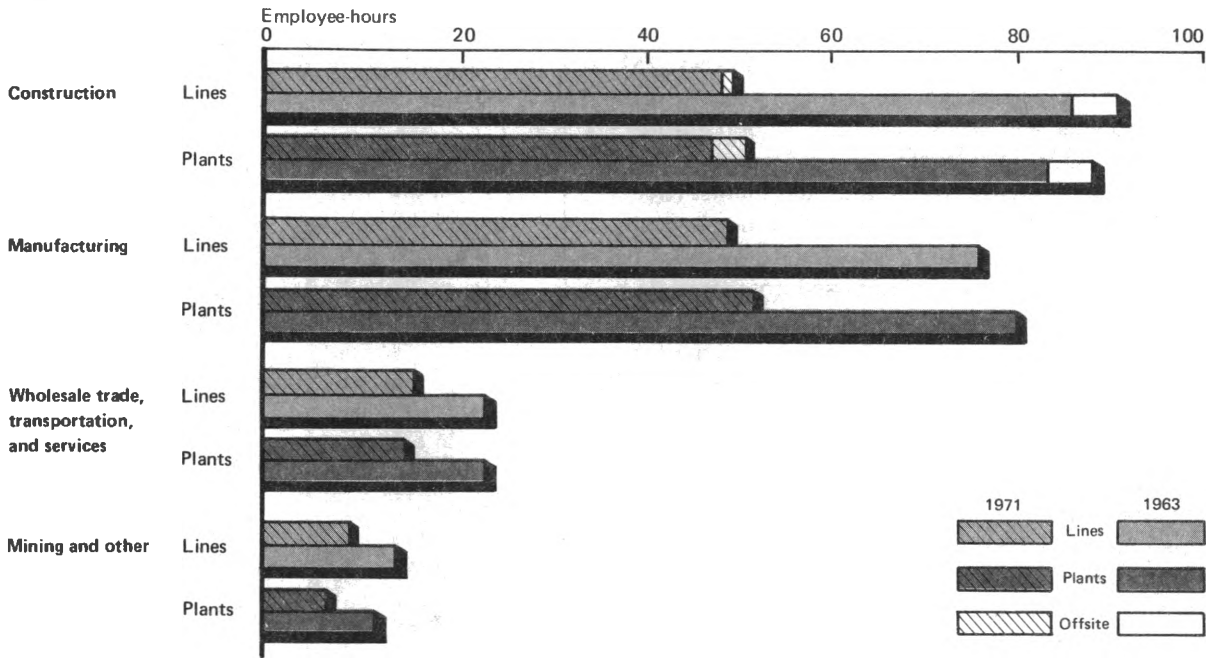


Table 6. Apprentice employee-hours as a percent of skilled onsite employment for sewer works construction, by occupation and major construction type, 1963 and 1971

Occupation	1971			1963		
	Total	Lines	Plants	Total	Lines	Plants
All skilled trades	3.5	0.1	5.9	2.2	1.1	2.9
Operating engineers	.3	.1	1.0	.2	.4	—
Carpenters	6.3	—	7.0	2.0	4.6	1.5
Plumbers	7.8	6.2	7.8	8.9	18.9	8.0
Ironworkers	2.6	.7	2.6	1.4	—	1.6
Bricklayers	4.6	—	5.5	1.5	—	2.7
Electricians	13.4	3.6	14.2	14.1	8.3	14.5
Cement finishers	2.3	—	3.9	1.0	—	1.2
Painters	2.5	—	2.6	1.7	—	1.8
Other skilled trades	5.5	.2	6.8	5.2	.4	7.1

requirements in 1971 and about 38 percent in 1963. Important components of this sector are stone, clay, glass, and concrete products; construction equipment; and machinery, except electrical.

Wholesale trade, transportation, and services. For sewer works construction, about 15 employee-hours per $1,000 were generated in industries which provide transportation or other services for materials, either between processing stages or between the last stage of manufacturing and the construction site. About 23 hours were generated in 1963. Wholesale trade, transportation, and services accounted for about 12 and 11 percent in 1971 and 1963, respectively, of total employee-hour requirements. In future studies, an attempt will be made to include the employee-hours expended in the retail trade sector. This would have the effect of raising labor requirements a few hours per $1,000 of contract cost.

Mining and other industries. Measured in this category is the labor impact of producing materials, equipment, and supplies from mining, agriculture, communications, public utilities, finance, insurance, real estate, and government enterprises. This sector accounted for 8 employee-hours per $1,000 of contract cost for sewer works in 1971 and 13 hours in 1963, contributing about 7 and 6 percent, respectively, of total labor requirements.

Chapter IV. Distribution of Costs and Wages

Distribution of construction contract costs

The distribution of costs in 1971 was as follows: 25 percent for onsite wages and salaries, 52 percent for materials, supplies, and equipment, and 23 percent for overhead and profit. (See table 7.) The cost distribution varied only slightly between lines and plants. (See chart 4.) However, there was a major difference in cost components between lines and plants regarding the use of construction equipment as opposed to materials, supplies, and built-in equipment. Construction equipment accounted for about 17 percent of the cost for lines and about 6 percent for plants. On the other hand, materials, supplies, and built-in equipment accounted for a much larger share for plants than for lines, i.e., about 47 and 35 percent, respectively.

Onsite labor costs as a percent of total cost for sewer line construction did not change between 1963 and 1971. Materials, equipment, and supplies declined to 51.9 percent in 1971 from 55.7 percent in 1963, while the percentage allocated to profit and overhead increased to 23.8 percent from 20.0 percent.

A similar shift in the allocation of the construction costs occurred for treatment plants surveyed. Onsite labor costs decreased only slightly, to 25.2 percent in 1971 from 26.6 percent in 1963. On the other hand, the share of materials, equipment, and supplies dropped to 52.6 percent in 1971 from 57.4 percent in 1963. Profit and overhead climbed to 22.2 percent in 1971 from 16.0 percent in 1963.

The total cost allotted to materials, equipment, and

Chart 4. Percent distribution of contract costs for sewer line and plant construction, 1963 and 1971

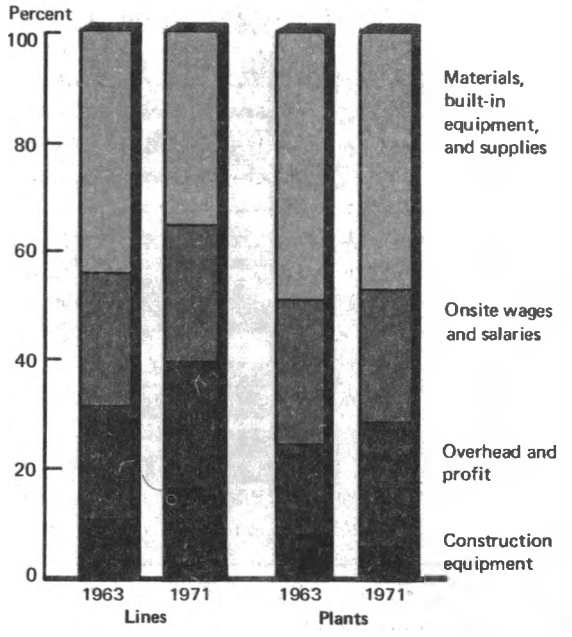


Table 7. Percent distribution of contract costs for sewer works construction, United States, 1963 and 1971, and regions, 1971

Type of cost	United States						Regions, 1971											
	1963			1971			Northeast			North Central			South			West		
	Total	Lines	Plants	Total	Lines	Plants	Total	Lines	Plants	Total	Lines	Plants	Total	Lines	Plants	Total	Lines	Plants
Total expenditures	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Onsite wages and salaries	25.3	24.3	26.6	24.7	24.3	25.2	26.0	24.1	27.4	23.4	24.2	21.8	25.5	25.3	26.0	22.2	21.2	22.6
Materials, built-in equipment, and supplies	46.6	44.5	49.2	40.7	35.2	47.0	37.9	35.1	39.8	36.5	29.0	51.3	43.2	39.2	53.5	50.6	41.4	54.2
Construction equipment	9.9	11.2	8.2	11.5	16.7	5.6	11.7	19.1	6.5	10.8	14.5	3.6	15.0	17.9	7.4	5.8	10.8	3.8
Overhead and profit[1]	18.2	20.0	16.0	23.1	23.8	22.2	24.4	21.7	26.3	29.3	32.4	23.3	16.3	17.6	13.1	21.4	26.6	19.3

[1] Overhead costs include salaries of offsite workers, supplemental benefits, interest expense, bonding, office expense, inventory and other overhead and miscellaneous expenses.

NOTE: Detail may not add to 100.0 percent because of rounding.

supplies declined by 6.8 percent for sewer lines and 8.4 percent for plants. (For more detailed description of material costs, see next section.) However, the profit and overhead portion increased by 19 percent for sewer lines and 38.7 percent for plants. This sharp change in the relative position of these components is largely the result of differential shifts in costs among the various categories. The cost of sewer works construction increased over 47 percent between the two survey periods, as measured by the EPA price indexes for sewer lines and treatment plants, while the wholesale price index for all construction materials rose only 20 percent.

The cost distributions for the regions were similar to the distribution for the Nation, but there were some differences. The North Central region showed the greatest proportion of contract dollars allotted to overhead and profit for sewer lines (32.4 percent). The South had the lowest percentage in that cost category for both sewer lines and plants: 17.6 and 13.1 percent, respectively. In both regions, the materials, equipment, and supplies cost component exhibited the same inverse relationship with the profit and overhead component that was observed nationally: As one decreased the other increased. The survey did not provide information regarding the items included in overhead. One of these items would be the cost of fringe benefits received by the worker. These benefits would tend to be less costly in an area like the South, where unions are not strong, than in the more highly unionized areas, such as the North Central region. The variation in the level of fringe benefits may partially explain the fact that the percentages of the total contract cost allotted to profit and overhead in the regions differ markedly. A definitive explanation of this situation cannot be made without further research.

Wages as a percent of contract costs

When the percent distribution of the weighted total cost of all contracts was arrayed by region and type of construction in class intervals by percent of construction contract amount allocated to onsite wages, the class with the greatest percent of the weighted total contract value (the modal class) was usually 20 to under 30 percent. (See table 8.) The exceptions were the Northeast and the West for sewer line construction where the modal class was 10 to under 20 percent. However, at the national level the modal class for both lines and plants was 20 to under 30 percent in 1963 and 1971.

Materials, equipment, and supplies

The total of all expenditures for materials, supplies, and equipment per $1,000 of construction contract cost for sewer works construction in the 1971 survey was $522.01 (table 9), a decline of $42.69 or 7.6 percent from the previous study. The cost of materials, equipment, and supplies for lines in 1971 was $519.23; the cost for plants was $525.20. These represent decreases since 1963 of 6.8 and 8.5 percent, respectively.

Materials, equipment, and supplies used in sewer works construction accounted for 52.2 percent of each $1,000 of construction contract cost (table 10). For lines it was 51.9 percent and for plants 52.5 percent. The comparable data for 1963 were: All sewer works construction, 56.5 percent; lines, 55.7 percent; and plants, 57.4 percent.

These declines were largely the result of the increase in the proportion of the construction dollar represented by other cost factors, primarily costs allocated to profit and overhead.

The distribution of materials shown in table 10 indicates the relative importance of the various product groups. The stone, clay, glass, and concrete products category ranked first with 29 percent of the total product value for sewer works constructed in 1971; contractor equipment was second with 22 percent. This group was followed by machinery except electrical, 18 percent; primary metal products, 9 percent; and fabri-

Table 8. Percent distribution of contract cost for sewer works construction by percent of contract cost expended for wages, United States, 1963 and 1971, and regions, 1971

Wages as a percent of contract cost	United States				Regions, 1971							
	1963		1971		Northeast		North Central		South		West	
	Lines	Plants	Lines	Plants	Lines	Plants	Lines	Plants	Lines	Plants	Lines	Plants
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Under 10	2.5	1.1	.4	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0
10 and under 20	30.8	8.7	25.0	19.9	49.5	9.8	5.8	26.7	14.2	16.0	57.2	39.0
20 and under 30	47.2	61.5	65.9	63.4	35.1	62.8	87.4	61.1	82.6	71.1	21.4	61.0
30 and under 40	15.8	28.4	8.7	14.7	15.4	23.1	6.8	12.2	2.1	12.9	21.3	0.0
40 and under 50	3.7	.3	0.0	2.0	0.0	4.4	0.0	0.0	0.0	0.0	0.0	0.0

NOTE: Detail may not add to 100.0 percent because of rounding.

cated metal products, 8 percent. These product groups ranked in the same order with regard to sewer works construction in 1963.

As would be expected, the various construction products that were used to construct sewer lines were used in proportions that differed sharply from those required to erect sewage treatment plants. The following tabulation shows the percent of the total made up by the leading groups of materials, equipment, and supplies used to construct sewer works in 1971:

Product group	*Sewer lines*	*Treatment plants*
Total	100	100
Stone, clay, glass, and concrete products	41	16
Contractor equipment	32	11
Primary metal products	7	11
Petroleum refining and related products	5	1
Machinery, except electrical	4	34
Fabricated metal products	2	14
All other	9	13

Over 50 percent of the value of the stone, clay, glass, and concrete products used to construct sewer lines consisted of concrete pipe. A comparatively insignificant amount of concrete pipe went into the erection of the sewage treatment plants. The leading product group used for treatment plants, machinery except electrical, consisted largely of built-in sewage processing equipment.

There were a few significant shifts in the distribution of the major groups of materials, supplies, and equipment between 1963 and 1971. There was a decline in the percentage allotted to stone, clay, glass, and concrete products for lines; an increase in the proportion spent on machinery, except electrical, for plants; and an increase in the proportion spent on contractor equipment for lines. Several factors can account for these shifts. In addition to the general decline in materials costs for a given unit of costs (i.e., $1,000), substitution of one type of material for another and relative price changes can account for the change.

Total materials, equipment, and supplies used to construct sewer works break down into 11 major groups. The expenditures for six of these groups increased between 1963 and 1971 while the expenditures for the remaining five groups decreased during the same period. The decreases were sufficiently large to offset the increases that occurred in the remaining six groups.

The following tabulation lists selected products that showed significant shifts between 1963 and 1971 in value per $1,000 of contract cost of the total materials, equipment, and supplies used to construct sewer lines and plants:

	1963	*1971*	*Percent change*
Sewer lines:			
Asphalt paving	$7.40	$15.06	+ 104
Asbestos cement pipe	7.20	14.31	+ 99
Contractor equipment	112.50	167.28	+ 49
Pumps, compressors, and pumping equipment	15.80	2.84	− 82
Reinforcing rods and bars-joist	4.70	2.69	− 43
Sand and gravel	22.80	14.75	− 35
Treatment plants:			
Steel pipe	6.70	12.41	+ 85
Asphalt paving	1.60	2.72	+ 70
Chlorinators	2.40	3.78	+ 58
Electric meters and measuring equipment	3.90	.87	− 78
Mechanical collectors	34.10	8.47	− 75
Power distributors and specialty transformers	4.30	1.72	− 60

Table 9. Materials, equipment, and supplies used in sewer works construction, 1963 and 1971

Item	Per $1,000 of contract cost					
	1963			1971		
	Total	Lines	Plants	Total	Lines	Plants
Total materials, equipment, and supplies	$564.70	$557.20	$573.90	$522.01	$519.23	$525.20
	Materials, built-in equipment, and supplies					
Total materials, built-in equipment, and supplies	466.10	444.70	492.10	406.80	351.95	469.57
Agricultural products	1.00	.40	1.80	1.08	1.28	.84
Nursery	1.00	.40	1.80	1.08	1.28	.84
Mining and quarrying of nonmetallic minerals except fuels	20.10	25.90	13.00	12.22	17.80	5.83
Sand and gravel	17.70	22.80	11.50	10.06	14.75	4.70
Other nonmetallic minerals except fuels	2.40	3.10	1.50	2.16	3.05	1.13

Table 9. Materials, equipment, and supplies used in sewer works construction, 1963 and 1971—Continued

Item	Per $1,000 of contract cost					
	1963			1971		
	Total	Lines	Plants	Total	Lines	Plants
	Materials, built-in equipment, and supplies					
Lumber and wood products except furniture	6.70	4.40	9.40	10.28	7.96	12.92
Dimension lumber	5.40	4.20	6.90	5.81	3.13	8.87
Other lumber and wood products	1.30	.20	2.50	4.47	4.83	4.05
Chemical and allied products	3.60	2.00	5.60	5.28	5.93	4.56
Dynamite and caps	1.80	1.30	2.50	2.79	4.99	.29
Paint	1.10	.10	2.40	1.12	.06	2.34
Other chemical and allied products	.70	.60	.70	1.37	.88	1.93
Petroleum refining and related products	14.00	16.80	10.60	16.44	25.03	6.54
Fuels, diesel fuel, gas, oil, grease	8.70	9.20	8.00	6.45	9.38	3.14
Asphalt paving	4.80	7.40	1.60	9.30	15.06	2.72
Other petroleum products	.50	.20	1.00	.69	.59	.68
Stone, clay, glass, and concrete products	214.50	311.30	96.30	151.22	211.71	82.03
Concrete pipe	88.00	147.40	15.70	64.48	108.05	14.82
Ready mixed concrete	29.80	16.30	46.30	24.99	16.81	34.35
Concrete block	2.50	2.40	2.70	1.29	.49	2.20
Asbestos cement pipe	6.00	7.20	4.50	9.05	14.31	3.04
Other stone, clay, glass, and concrete products	88.20	138.00	27.10	51.41	72.05	27.62
Primary metal products	64.20	49.00	83.10	47.98	38.32	58.94
Cast iron pipe	34.10	28.50	41.00	23.05	20.15	26.38
Steel pipe	8.00	9.00	6.70	10.55	8.93	12.41
Structural steel	8.80	.70	18.70	6.17	1.05	12.02
Cast iron products (manholes, etc.)	5.50	8.80	1.40	3.51	5.31	1.45
Fence posts, fencing	1.80	.50	3.40	2.21	.96	3.61
Other primary metal products	6.00	1.50	11.90	2.49	1.92	3.07
Fabricated metal products	41.50	13.30	75.50	39.84	11.43	72.85
Reinforcing rods and bars; joist	15.30	4.70	28.20	10.94	2.69	20.83
Pipe fittings and plumbing fixtures	8.30	2.30	15.70	9.42	1.61	18.36
Metal plate products	4.20	1.70	7.30	1.94	.04	4.13
Fabricated metal plate products	3.40	.60	6.70	1.62	.08	3.39
Metal doors, windows, and frames	2.50	.80	4.60	1.74	.08	3.66
Other fabricated metal products	7.80	3.20	13.00	14.18	6.93	22.48
Machinery, except electrical	66.40	16.80	128.20	94.55	23.29	176.01
Sewage "packaged" equipment	N.A.	N.A.	N.A.	32.59	19.35	47.75
Other sewage injector and disposal equipment	N.A.	N.A.	N.A.	10.05	(1)	21.54
Blowers, exhaust and ventilating fans	2.40	.20	5.00	1.02	.23	1.93
Chlorinators	1.10	(1)	2.40	1.82	.11	3.78
Pumps, compressors, and pumping equipment	27.20	15.80	41.00	15.44	2.84	29.86
Collectors, mechanical	15.40	(1)	34.10	3.96	.01	8.47
Digesters, clarifiers	10.00	.10	22.10	11.69	.07	24.98
Diffusers	5.10	(1)	11.40	3.09	.08	6.52
Other machinery, except electrical	5.20	.70	12.20	14.89	.60	31.18
Electrical machinery, equipment, and supplies	26.80	4.10	54.60	19.26	5.33	35.31
Power distribution and specialty transformers	1.90	(1)	4.30	1.56	1.43	1.72
Electrical switchboards and panel boards	12.80	1.40	26.80	6.96	1.48	13.64
Electric motors and generators	1.40	.20	3.00	1.95	1.14	2.88

Table 9. Materials, equipment, and supplies used in sewer works construction, 1963 and 1971—Continued

Item	Per $1,000 of contract cost					
	1963			1971		
	Total	Lines	Plants	Total	Lines	Plants
	Materials, built-in equipment, and supplies					
Electric meters and measuring equipment	2.10	.60	3.90	.51	.20	.87
Conduit and conduit fittings	1.60	.40	3.20	1.69	.28	3.31
Current-carrying devices	1.20	.20	2.40	.47	.15	.84
Lighting fixtures and nonelectric lamps and bulbs	1.00	.20	2.10	1.15	.07	2.38
Other electric equipment and supplies	4.80	1.10	8.90	4.97	.58	9.67
All other types of materials, built-in equipment, and supplies	7.30	.70	14.00	8.65	3.87	13.74
	Contractor equipment					
Total, contractor equipment[2]	98.60	112.50	81.80	115.21	167.28	55.63
Drill rigs	N.A.	N.A.	N.A.	29.54	46.70	9.87
Front-end loaders	N.A.	N.A.	N.A.	16.12	26.89	3.78
Trucks	N.A.	N.A.	N.A.	11.98	17.20	6.03
Power cranes, drag lines, shovels	N.A.	N.A.	N.A.	15.44	18.36	12.11
Tractors and bulldozers	N.A.	N.A.	N.A.	14.24	16.96	11.13
Other	N.A.	N.A.	N.A.	27.89	41.17	12.71

[1] Insufficient data.

[2] Rental value if rented, depreciation or equivalent rental value if owned.

N.A. = Not available.

NOTE: Dollar figures for 1963 are rounded to the nearest 10 cents. Detail may not add to totals because of rounding.

Table 10. Percent distribution of materials, equipment, and supplies for sewer works construction, 1963 and 1971

Item	Percent					
	1963			1971		
	Total	Lines	Plants	Total	Lines	Plants
Total materials, equipment, and supplies	100.0	100.0	100.0	100.0	100.0	100.0
	Materials, built-in equipment, and supplies					
Total materials, built-in equipment, and supplies	82.54	79.81	85.75	77.93	67.78	89.41
Agricultural products	.18	.07	.31	.21	.25	.16
Nursery products	.18	.07	.31	.21	.25	.16
Mining and quarrying of nonmetallic minerals except fuels	3.56	4.65	2.27	2.34	3.43	1.11
Sand and gravel	3.13	4.09	2.00	1.93	2.84	.89
Other nonmetallic minerals except fuel	.43	.56	.26	.41	.59	.22
Lumber and wood products except furniture	1.19	.79	1.64	1.97	1.53	2.46
Dimension lumber	.96	.75	1.20	1.11	.60	1.69
Other lumber and wood products	.23	.04	.44	.86	.93	.77
Chemical and allied products	.64	.36	.98	1.01	1.14	.87
Dynamite and caps	.32	.23	.44	.53	.96	.06
Paint	.19	.02	.42	.21	.01	.45
Other chemical and allied products	.12	.11	.12	.26	.17	.37
Petroleum refining and related products	2.48	3.02	1.85	3.15	4.82	1.25
Fuels, diesel fuel, gas, oil, and grease	.54	1.65	1.39	1.24	1.81	.60
Asphalt paving	.85	1.33	.28	1.78	2.90	.52
Other petroleum products	.09	.04	.17	.13	.11	.13

Table 10. Percent distribution of materials, equipment, and supplies for sewer works construction, 1963 and 1971—Continued

Item	Percent					
	1963			1971		
	Total	Lines	Plants	Total	Lines	Plants
	Materials, built-in equipment, and supplies					
Stone, clay, glass, and concrete products	37.98	55.87	16.78	28.97	40.77	15.62
Concrete pipe	15.58	26.45	2.74	12.35	20.81	2.82
Ready mixed concrete	5.28	2.93	8.07	4.79	3.24	6.54
Concrete block	.44	.43	.47	.25	.09	.42
Asbestos cement pipe	1.06	1.29	.78	1.73	2.76	.58
Other stone, clay, glass, and concrete products	15.62	24.77	4.72	9.85	13.88	5.26
Primary metal products	11.37	8.79	14.48	9.19	7.38	11.22
Cast iron pipe	6.04	5.11	7.14	4.42	3.88	5.02
Steel pipe	1.42	1.62	1.17	2.02	1.72	2.36
Structural steel	1.56	.13	3.26	1.18	.20	2.29
Cast iron products (manhole covers, etc.)	.97	1.58	.24	.67	1.02	.28
Fence posts, fencing	.32	.09	.59	.42	.18	.69
Other primary metal products	1.06	.27	2.07	.48	.37	.58
Fabricated metal products	7.35	2.39	13.16	7.63	2.20	13.87
Reinforcing rods and bars; joist	2.71	.84	4.91	2.10	.52	3.97
Pipe fittings and plumbing fixtures	1.47	.41	2.74	1.80	.31	3.50
Metal plate products	.74	.31	1.27	.37	.01	.79
Fabricated metal plate products	.60	.11	1.17	.31	.02	.65
Metal doors, windows, and frames	.44	.14	.80	.33	.02	.70
Other fabricated metal products	1.38	.57	2.27	2.72	1.33	4.28
Machinery, except electrical	11.76	3.02	22.34	18.11	4.49	33.51
Sewage "packaged" equipment	N.A.	N.A.	N.A.	6.24	3.73	9.09
Other sewage injector and disposal equipment	N.A.	N.A.	N.A.	1.93	(1)	4.10
Blowers, exhaust and ventilating fans	.43	.04	.87	.20	.04	.37
Chlorinators	.19	(1)	.42	.35	.02	.72
Pumps, compressors, and pumping equipment	4.82	2.84	7.14	2.96	.55	5.69
Collectors, mechanical	2.73	(1)	5.94	.76	(2)	1.61
Digesters, clarifiers	1.77	.02	3.85	2.24	.01	4.76
Diffusers	.90	(1)	1.99	.59	.02	1.24
Other machinery, except electrical	.92	.13	2.13	2.85	.12	5.94
Electrical machinery, equipment, and supplies	4.75	.74	9.51	3.69	1.03	6.72
Power distribution and specialty transformers	.34	(1)	.75	.30	.28	.33
Electrical switchboards and panel boards	2.27	.25	4.67	1.33	.29	2.60
Electrical motors and generators	.25	.04	.52	.38	.22	.55
Electrical meters and measuring equipment	.37	.11	.68	.10	.04	.17
Conduit and conduit fittings	.28	.07	.56	.32	.05	.63
Current-carrying devices	.21	.04	.42	.09	.03	.16
Lighting fixtures and non-electric lamps and bulbs	.18	.04	.37	.22	.01	.45
Other electric equipment and supplies	.85	.20	1.55	.95	.11	1.84
All other types of materials, built-in equipment, and supplies	1.29	.13	2.44	1.66	.75	2.62

Table 10. Percent distribution of materials, equipment, and supplies for sewer works construction, 1963 and 1971—Continued

Item	Percent					
	1963			1971		
	Total	Lines	Plants	Total	Lines	Plants
	Contractor equipment					
Total, contractor equipment[3]	17.46	20.19	14.25	22.07	32.22	10.59
Drill rigs	N.A.	N.A.	N.A.	5.66	8.99	1.88
Front-end loaders	N.A.	N.A.	N.A.	3.09	5.18	.72
Power cranes, drag lines, shovels	N.A.	N.A.	N.A.	2.96	3.54	2.31
Tractors and bulldozers	N.A.	N.A.	N.A.	2.73	3.27	2.12
Trucks	N.A.	N.A.	N.A.	2.29	3.31	1.15
Other	N.A.	N.A.	N.A.	5.34	7.93	2.42

[1] Insufficient data.

[2] Less than .01 percent.

[3] Rental value if rented, depreciation or equivalent rental value if owned.

N.A. = Not available.

NOTE: Detail may not add to 100.0 percent because of rounding.

Chapter V. Comparison with Previous Surveys

Comparison of cost components, all sewer works construction studies

The earliest BLS studies of labor and material requirements for sewer works construction were for 1934, 1940, and 1949.[15] Differences in scope, sampling, classification, and data collection between these earlier studies and the latest two studies limit the usefulness of comparisons.

However, some generalizations seem reasonable. For 1963 and 1971, onsite wages as a percentage of the total contract costs have declined from the earlier studies. The percentage of combined overhead and profit appears to be increasing. The materials, supplies, and built-in equipment category is decreasing as a percent of total costs.

	Percent distribution of sewer works construction contract cost				
	1934	*1940*	*1949*	*1963*	*1971*
Total costs	100	100	100	100	100
Onsite wages and salaries	26	30	32	25	25
Materials, supplies, and built-in equipment	51	50	44	47	41
Overhead and profit and other costs, including construction equipment	23	20	24	28	35

Comparison of all construction labor requirements studies

Total labor requirements for sewer works were lower than for all other types of construction studied except highways. The major disparity between sewer and highway construction was in the higher indirect requirements for sewer works, indicating the greater amount of embodied labor in the more expensive, complex materials and equipment used.

[15] "Relative Cost of Material and Labor in Construction of Water and Sewage System," *Monthly Labor Review*, January 1935 (based on data collected about 1934), pp. 145–46; "Expenditures for Labor and Material and Man-Hours of Labor Created per $1 Million of Contracts Awarded for Sewers and Sewage Systems," BLS release, November 1944 (based on data collected about 1940); "Expenditures per Million Dollars for Construction of New Water Supply and Sewage Disposal Systems," BLS release, May 1951 (based on data for 1948–50).

Employee-hour requirements for sewer works construction during 1971 were higher than those required for federally aided highways during 1973. (See table 11.) These two types of construction are roughly comparable.

Comparison of the percent distribution of the onsite employee-hour requirements for the various types of construction (table 12) shows that sewers and highways have in common extensive use of operating engineers. They fulfilled over one-fourth of all labor requirements for highways and over one-fifth for sewer works. For sewer lines the figure is even higher, over 27 percent. This reflects the heavy use of construction equipment for these projects, as shown in table 13.

Comparison of cost figures in table 13 shows that the percentage of total costs expended for onsite wages and salaries was virtually identical for sewer works and highways. Materials, supplies, and built-in equipment, however, represented a slightly larger proportion of total costs for highways than for sewer works. The cost of construction equipment, while not available separately for highways, is a substantial portion of total costs for both of these activities. The figure for highways is estimated to be relatively close to the figure for sewer works, about 12 percent.

The heavy use of construction equipment for highways has to be inferred from a comparison of the percent of contract costs that is allocated to the combined contract cost category, "construction equipment and overhead and profit," for sewer works and highways. This analysis is necessary because construction equipment for highways is included in the contract cost category "overhead and profit."

Table 14 also demonstrates that in both highways and sewer works projects a comparatively large proportion of the cost of materials, supplies, and equipment is allocated to construction equipment.

A higher percentage of all materials, equipment, and supplies was expended for stone, clay, glass, and concrete products for sewer works than for highways. Of course, a large proportion, over one-fifth, of sewer works expenditures for materials was for machinery and built-in equipment for which there was no equivalent expenditure for highways. A much larger proportion for highways, on the other hand, was spent on petroleum products (asphaltic tars and pitches, bitu-

mens, etc.), fabricated metal products (structural steel for bridges and steel bars and mesh for reinforcing highways), and mining and quarrying of nonmetallic minerals (gravel, stone, clay, etc.).

Table 11. Employee-hour requirements per 1,000 current dollars of contract cost, by industry, all construction studies, 1958–73

Type of construction	Year of construction	Total, all industries	Onsite construction	Offsite construction	Manufacturing	Wholesale trade, transportation, and services	Mining and all other
Second studies:							
Sewer works	1971	124	48	3	50	15	8
Lines	1971	123	48	1	49	16	9
Plants	1971	125	47	4	52	15	7
Federal office buildings	1973	N.A.	43	7	N.A.	N.A.	N.A.
Federally aided highways	1973	114	44	6	37	18	8
Single-family housing	1969	137	52	10	41	20	14
Public housing	1968	160	80	14	42	16	8
General hospitals	1965–66	178	76	10	64	18	10
Elementary and secondary schools	1964–65	188	72	9	65	26	15
Initial studies:							
Sewer works	1962–63	204	85	5	78	23	13
Lines	1962–63	204	86	5	76	23	14
Plants	1962–63	203	83	5	80	23	12
Multifamily housing	1971	126	50	8	43	15	10
Single-family housing	1962	203	72	12	61	31	26
College housing	1960–61	226	94	11	72	31	18
General hospitals	1959–60	224	89	11	76	31	18
Public housing	1959–60	237	114	12	62	29	20
Civil works:							
Land projects	1959–60	201	85	4	53	35	24
Dredging	1959–60	238	134	10	57	24	14
Elementary and secondary schools	1959	222	86	10	74	33	19
Federal office buildings	1959	228	97	10	72	31	17
Federally aided highways	1958	237	97	10	66	39	24

1 Indirect data revised from original study results due to reprocessing materials through improved input-output tables.

N.A. = Not available.

NOTE: Detail may not add to totals because of rounding.

Table 12. Percent distribution of onsite employee-hour requirements per 1,000 current dollars of contract cost, by occupation, all construction studies, 1958–73

Type of construction	Year of construction	All occupations	Administrative and supervisory	Bricklayers	Carpenters	Electricians	Ironworkers	Operating engineers	Painters	Plasterers and lathers	Plumbers and pipe fitters	Other skilled construction trades	Laborers, helpers, and tenders	Other occupations (including truckdrivers)
Second studies:														
Sewer works:														
Total	1971	100.0	12.9	1.0	6.9	2.9	1.9	20.4	.8	—	3.3	5.4	30.0	14.4
Lines	1971	100.0	13.5	.2	1.2	.4	.2	27.3	—	—	—	3.0	33.7	20.6
Plants	1971	100.0	12.3	1.9	14.0	5.7	4.5	11.5	1.9	—	7.2	9.8	25.1	5.9
Federal office buildings	1973	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Federally aided highways	1973	100.0	5.9	—	6.1	1.1	2.5	25.5	.3	—	.2	[1] 8.9	34.0	[2] 19.0
Single-family housing	1969	100.0	2.8	5.7	34.9	3.0	—	1.8	7.3	1.7	4.3	20.0	27.9	.5
Public housing	1968	100.0	3.6	7.8	20.3	5.8	3.5	3.1	4.9	3.0	9.3	6.6	30.2	1.9
General hospitals	1965–66	100.0	3.2	5.0	13.0	9.9	3.1	1.8	2.6	6.1	15.6	13.1	25.7	.7
Elementary and secondary schools	1964–65	100.0	3.6	9.2	16.5	7.3	3.1	2.7	3.5	2.0	9.6	10.1	30.9	1.5
Initial studies:														
Sewer works:														
Total	1962–63	100.0	11.2	1.7	7.7	1.5	1.9	17.4	.7	—	2.5	2.7	39.1	13.4
Lines	1962–63	100.0	10.1	1.3	2.4	.1	.4	19.6	—	—	.4	2.7	44.5	18.5
Plants	1962–63	100.0	9.0	2.0	14.3	3.3	3.9	14.6	1.5	—	5.1	6.6	31.7	8.0
Multifamily housing	1971	100.0	5.8	5.0	25.4	5.9	2.3	2.9	4.0	1.7	7.6	11.3	25.8	2.3
Single-family housing	1962	100.0	3.0	5.5	34.6	2.8	—	1.4	9.5	2.0	5.2	12.2	23.3	.5
College housing	1960–61	100.0	3.4	10.0	16.9	6.6	3.9	1.7	3.6	3.4	9.7	7.8	31.8	1.1
General hospitals	1959–60	100.0	3.9	5.4	13.2	8.8	3.5	1.6	2.8	6.2	14.2	12.0	26.7	1.7
Public housing	1959–60	100.0	4.0	7.6	19.1	4.1	2.1	2.7	4.4	6.8	7.8	6.5	30.9	4.0
Civil works														
Land projects	1959–60	100.0	10.1	—	6.4	—	3.1	24.1	—	—	—	6.9	23.0	26.4
Dredging	1959–60	100.0	4.7	—	—	—	—	1.1	—	—	—	1.7	1.7	[3] 90.8
Elementary and secondary schools	1959	100.0	3.9	9.3	18.7	7.1	2.8	1.9	3.3	2.7	9.4	7.9	29.1	4.0
Federal office buildings	1959	100.0	6.0	5.2	12.6	9.1	4.2	2.4	2.1	3.8	8.7	11.8	32.5	1.5
Federally aided highways	1958	100.0	10.4	[4]	[4]	[4]	[4]	[4]	[4]	[4]	[4]	[5] 38.2	[4]	[6] 51.4

[1] Includes apprentices and on-the-job trainees.

[2] Includes blue-collar supervisors.

[3] Includes mostly ships' masters, captains, mates, crewmen, and support personnel.

[4] Detail by occupation not available.

[5] Excludes apprentices and on-the-job trainees.

[6] Includes apprentices and on-the-job trainees and laborers, helpers, and tenders.

N.A. = Not available. Dash denotes no data reported.

NOTE: Detail may not add to 100.0 percent because of rounding.

Table 13. Percent distribution of contract costs, all construction studies, 1958–73

Type of construction	Year of construction	Total contract costs	Onsite wages and salaries	Materials, supplies, and built-in equipment	Construction equipment	Overhead and profit[1]
Second studies:						
Sewer works:						
Total	1971	100.0	24.7	40.7	11.5	23.1
Lines	1971	100.0	24.3	35.2	16.7	23.8
Plants	1971	100.0	25.2	47.0	5.6	22.2
Federal office buildings[2]	1973	100.0	34.0	50.0	(3)	16.0
Federally aided highways	1973	100.0	24.6	44.5	(4)	30.9
Single-family housing[5]	1969	100.0	20.4	43.4	.9	35.3
Public housing	1968	100.0	32.4	41.9	1.5	24.2
General hospitals	1965–66	100.0	29.6	50.4	1.3	18.7
Elementary and secondary schools	1964–65	100.0	25.8	54.2	1.0	19.0
Initial studies:						
Sewer works:						
Total	1962–63	100.0	25.3	46.6	9.9	18.2
Lines	1962–63	100.0	24.3	44.5	11.2	20.0
Plants	1962–63	100.0	26.6	49.2	8.2	16.0
Multifamily housing	1971	100.0	27.9	44.2	3.0	24.8
Single-family housing[5]	1962	100.0	22.1	47.2	1.0	29.7
College housing	1960–61	100.0	29.3	52.6	1.6	16.5
General hospitals	1959–60	100.0	28.2	53.2	1.2	17.4
Public housing	1959–60	100.0	35.5	45.0	2.5	17.0
Civil works:						
Land projects	1959–60	100.0	26.0	35.0	19.3	19.7
Dredging	1959–60	100.0	32.3	17.3	24.9	25.5
Elementary and secondary schools	1959	100.0	26.7	54.1	1.4	17.8
Federal office buildings	1959	100.0	29.0	51.4	1.9	17.7
Federally aided highways	1958	100.0	23.9	50.6	(4)	25.5

1 Includes offsite wages, fringe benefits, construction financing costs, inventory, and other overhead and administrative expenses as well as profit.
2 Estimated.
3 Equipment included in materials.
4 Equipment included with overhead and profit.
5 Includes selling expenses.

NOTE: Detail may not add to 100.0 percent because of rounding.

Table 14. Percent distribution of cost of materials, supplies, and equipment, by product group, all construction studies, 1958–73

Type of construction	Year of construction	Total materials, supplies, and equipment	Mining and quarrying of nonmetallic minerals except fuel	Lumber and wood products except furniture	Furniture and fixtures	Chemicals and allied products	Petroleum refining and related products	Stone, clay, glass, and concrete products	Primary metal products	Fabricated metal products[1]	Machinery except electrical	Electrical machinery, equipment, and supplies	Construction equipment	Other materials and supplies
Second studies:														
Sewer works:														
Total	1971	100.0	2.34	1.97	.10	1.01	3.15	28.97	9.19	7.63	18.11	3.69	22.07	1.76
Lines	1971	100.0	3.43	1.53	—	1.14	4.82	40.77	7.38	2.20	4.48	1.03	32.22	1.00
Plants	1971	100.0	1.11	2.46	.22	.87	1.25	15.62	11.22	13.87	33.51	6.72	10.59	2.54
Federal office buildings	1973	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Federally aided highways	1973	100.0	14.26	1.65	—	.73	17.18	15.17	—	21.21	—	—	(2)	29.98
Private single-family housing	1969	100.0	.89	37.40	3.28	1.82	1.80	21.33	5.05	12.90	1.90	6.77	2.00	4.87
Public housing	1968	100.0	.80	14.40	.30	2.00	2.20	24.70	9.20	27.20	2.50	11.30	3.50	1.80
General hospitals	1965–66	100.0	.51	4.66	.44	.77	.80	18.40	8.61	31.11	12.11	15.62	2.50	4.47
Nursing homes	1965–66	100.0	.53	9.06	.27	1.24	1.82	20.16	6.23	33.32	11.03	10.78	2.15	3.41
Elementary and secondary schools	1964–65	100.0	1.55	10.20	2.69	.96	2.27	23.44	5.50	32.29	4.50	9.76	.82	4.01
Initial studies:														
Sewer works:														
Total	1962–63	100.0	3.56	1.19	—	.64	2.48	37.98	11.37	7.35	11.76	4.75	17.46	1.47
Lines	1962–63	100.0	4.65	.79	—	.36	3.02	55.87	8.79	2.39	3.02	.74	20.19	.20
Plants	1962–63	100.0	2.27	1.64	—	.98	1.85	16.78	14.48	13.16	22.34	9.51	14.25	2.75
Private multifamily housing	1971	100.0	1.34	18.67	3.89	2.21	1.74	22.12	8.85	15.59	3.72	9.36	6.51	6.00
Private single-family housing	1962	100.0	.79	40.05	—	2.22	2.30	23.58	5.50	14.60	.46	6.49	2.03	1.99
College housing	1960–61	100.0	.78	10.67	1.70	1.18	1.05	25.78	6.11	33.90	2.92	11.36	2.94	1.62
General hospitals	1959–60	100.0	.42	4.16	.86	.81	.97	18.98	6.82	35.05	8.48	15.60	2.06	5.89
Public housing	1959–60	100.0	.80	14.10	.30	1.80	1.70	27.10	8.00	28.50	2.30	8.40	5.30	1.80
Civil works:														
Land projects	1959–60	100.0	17.46	4.15	—	3.87	12.65	9.09	1.33	13.20	.59	.24	35.39	2.05
Dredging	1959–60	100.0	—	—	—	3.93	28.07	—	—	1.49	1.40	—	58.98	6.13
Elementary and secondary schools	1959	100.0	.69	9.67	1.88	1.41	2.02	24.22	7.52	32.34	1.79	10.48	2.51	5.50
Federal office buildings	1959	100.0	.41	3.31	.34	1.03	.88	21.60	7.32	32.81	6.91	18.20	3.59	3.61
Federal aided highways	1958	100.0	11.34	1.76	—	.80	17.09	16.77	—	19.48	—	—	(2)	32.75

[1] Fabricated metals include some stone, glass, and concrete products (vitreous china fixtures) except for single-family and multifamily housing.

[2] Construction equipment estimate included in "other materials and supplies."

N. A. = Not available. Dash denotes no data reported.

NOTE: Detail may not add to 100.0 percent because of rounding.

Appendix A. Survey Scope and Methods

Universe characteristics and sample selection

The study included all sewer works construction projects which were subsidized by the Environmental Protection Agency (EPA) and the Department of Housing and Urban Development (HUD) located in the 48 contiguous States and started during calendar year 1969 and completed by August 31, 1973. The development of a sampling frame consisting of over 1,500 units began with 907 projects on lists supplied by the EPA and HUD. The EPA list consisted of 874 projects. The HUD list consisted of 33 projects. Each sewer construction project within the scope of the survey was contained on one of these lists. A project could consist of several distinct units of construction—multiple treatment plants, pumping stations, or several separate stretches of sewer lines.

The lists were stratified by (a) the four broad economic regions, (b) type of construction: Sewer lines, treatment plants, pumping stations, etc., (c) location: Standard Metropolitan Statistical Areas (SMSA) or nonmetropolitan areas, and (d) construction contract cost class. Previous experience indicated that these variables were also good stratification variables for the sewer works studies. Therefore, they were used again as they were available on the sampling frame.

These lists showed a total cost figure for each project which included the cost of items such as architectural and engineering fees, land acquisition, clearing, and landscaping costs. These costs are out of the scope of this survey, which was intended to develop data for the onsite labor and materials used to construct these projects as a ratio of each $1,000 of construction contract value.

Approximately 1,500 general contracts were selected from the above-mentioned lists. These contracts involved a total of about 3,000 general contractors and subcontractors. Because of the limited resources available and experience from similar surveys, the survey sample size was set at 150 of these general contracts. In order to maintain the sample size of 150 units it was necessary to survey 196 sample units.

These 196 sample units were randomly selected from the stratified universe. Within a stratum each sample contract was assigned equal probability and a random sample was selected without replacement. When the data for a selected sample contract could not be collected, an additional sample contract was selected at random to maintain the size of the sample at the 150-unit level.

Initial weights for sample units within a cell were calculated by using the reciprocal of the probability of selection. Whenever a unit was encountered which was out of the scope of the study, it was deleted along with its weight since the experience of the sample units within each cell was considered representative of what would be discovered if all the units in the cell were surveyed. Nonresponse was compensated for within a cell by increasing the weights associated with all the responding units in that cell by a single factor.

Collection experience

Of the 196 sample contracts for which data were originally sought, 30 were found to be out of the scope of the study and 21 could not be studied because the contractors did not cooperate or could not be located. Therefore, the final sample for this survey consisted of the remaining 145 sample units. This was 5 less than the 150 sample units specified. The reduction in sample size was not expected to have a significant impact on the survey results.

If data were missing partially or completely for a given subcontractor, the subcontractor was asked to provide an estimate for the missing data. If the subcontractor was not available, an estimate was obtained from the general contractor.

The sample contracts were divided into two major groups: (a) Sewer lines and (b) sewage treatment plants. These major groups were each divided into two subgroups designated as (a) maximum contract data (maxi) and (b) minimum contract data (mini). The data collected for a maxi contract included occupational detail for onsite employee-hours and a detailed listing of the value of materials, equipment, and supplies used in construction. The data collected for a mini contract provided no detail on onsite occupations or materials, equipment, and supplies. Only the total onsite employee-hours and the total value of materials, equipment, and supplies were obtained.

The division of the total sample between the mini and the maxi projects was determined by an analysis of

the probable cost of collecting the data for (a) a maxi or (b) a mini survey. The results of this cost analysis determined that the most efficient allocation of available resources required 100 maxi sample units and 50 mini units. One hundred and forty-four of these sample units were selected from the list of 874 projects that was furnished by EPA. The remaining 6 units were selected from the HUD list of 33 projects.

The tabulation below shows the distribution of the 145 sample units for which all the required data were collected, with regard to lines and plants, and the number of maxi and mini contracts in each category.

	Lines	*Plants*
Total	82	63
Maxi	54	40
Mini	28	23

In addition, among the maxi contracts, there were 21 nonrespondents and 19 out of the scope of the survey. The mini contracts had no nonrespondents but 11 that were out of scope.

Most of the value-put-in-place for the above-mentioned 145 sample units was constructed during calendar years 1970 and 1971. (Value-put-in-place is a measure of the value of construction installed or erected at the site during a given period.)

Error

Except for the nonresponding sample units and the data estimated by the contractors, there are no known sources of nonsampling error. Sampling variances are available at the Bureau of Labor Statistics.

While the overall estimates of employment are believed to be reasonably accurate, the detailed data would have a wider margin of sampling error and may be subject to other limitations. Employee-hour and material requirements are affected by a number of factors such as location, size of project, type of structure, architectural design, availability of certain materials or equipment, labor skills, and local building codes and customs. The effects of these separate factors cannot be isolated.

Data collection procedures

Three major stages were employed to fulfill the objective of reliable data for each project in the study: (1) Pretest and training, (2) visits to national and area offices of the Environmental Protection Agency (EPA) and the Department of Housing and Urban Development (HUD), and (3) visits to project sites and contractors.

Pretest and training. Education and orientation were accomplished in two ways. First, experienced data collectors from three regional offices assembled in Washington, D.C., to discuss the survey and prepare for the pretest. The Washington staff explained the purpose of the complex study and proposed collection schedules. Informal discussion was conducted to clarify specific points, and agreement was reached on the data required to meet the objectives. A pretest was conducted and all data were forwarded to Washington with a critique and recommendations for improvements and modifications to the survey approach. The Washington staff revised and improved final schedules and field instructions.

Next, representatives from all eight BLS regional offices met in Washington, D.C., for a training session. All facets of the program were explained in detail with the use of training aids, collection instructions, and schedules for data collection. Findings of the pretest survey were presented and potential problems were discussed. Regional coordinators generally transmitted this information to data collectors at a regional conference.

During the survey planning stage, the BLS requested that EPA and HUD send letters describing the survey to all EPA and HUD area offices to solicit their cooperation when a BLS representative would visit. This approach assured entree to the area offices with EPA and HUD endorsements for the survey.

The BLS data collectors had three missions to perform when visiting the area offices: (1) Obtain project payrolls, (2) obtain project characteristics, and (3) obtain listings of all contractors involved in the project construction.

The data collectors arranged to have payroll data of the general contractor and subcontractors forwarded on loan to the BLS regional office. (Contractors are required to keep these records for 3 years to comply with the Davis-Bacon Act.) In some cases, the payrolls had been placed in a Federal storage depository and authorization had to be obtained to secure them. In other cases, copies of the original payrolls were made and forwarded to the BLS regional offices.

Next, the BLS data collectors obtained the name, address, contract value, and type of contract for all general and prime contractors and subcontractors on the sample contracts. Missing payrolls were identified so that the contractor could later furnish supplemental information.

Visits to project sites and contractors. After completing their research at the EPA or HUD area offices, data collectors often visited the construction sites to become as familiar as possible with the structural characteristics of the projects before visiting the general contractors. If a general contractor should refuse to

cooperate, the project would have to be dropped from the survey and another one substituted. The substitution of sample projects is time consuming and costly and, in addition, could bias the survey results. Therefore, every effort was made to enlist the cooperation of the general contractor by explaining the nature of the survey and the reasons for conducting it. Of the approximately 3,000 general contractors and subcontractors who were interviwed in order to compile the list of 196 general contracts from which the sample of 145 contracts was derived, only a small number refused to cooperate or could not be located.

If the contractors agreed to cooperate, they were asked to verify the final contract value, including change orders, and the list of subcontractors and their current addresses. Additional payroll data were obtained for onsite workers who were not covered by the Davis-Bacon Act, such as the superintendent, technical personnel, and guards. Finally, the data collectors recorded the type of material item, the purchase cost, and the name and fair rental value or equivalent of any equipment used on the job. Each of the subcontractors also was contacted to obtain similar data.

After all the data for a sample project were collected, they were checked for completeness and internal consistency by the regional offices and forwarded to Washington, D.C., for final analysis, editing, and coding for computer processing.

Data collected for the sewer works construction survey were very complex and required experienced personnel for processing.

Development of employee-hour estimates

Onsite and offsite employee-hour estimates were combined to obtain estimates of total employee-hour requirements for sewer works construction.

Onsite (direct) employee-hours, as explained in the previous section, were obtained from payrolls submitted by the contractors to the EPA and HUD. Offsite (indirect) employee-hour requirements, representing the hours to produce, transport, and sell the materials, supplies, and equipment used in construction were developed by use of the 1963 Interindustry Study of the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. BLS field representatives collected the basic data on materials, supplies, and equipment from each prime contractor and his subcontractors (or estimated in a relatively small number of cases).

The materials listings thus obtained were categorized according to the four-digit industry classification of the *Standard Industrial Classification Manual* (1967 edition, Office of Management and Budget). For each product group, the average amount required for $1,000 of construction cost was calculated. This bill of materials was deflated to the 1963 price level by application of the appropriate wholesale price indexes. The resulting deflated value for each group was reduced by the ratio of producers' value to purchasers' value. (This ratio was based on data provided by BEA.) The differences between purchaser and producer valuation were allocated to trade and transportation sectors. The deflated values were matched to the sector coefficients in the 1963 interindustry study of BEA. For each group of materials, the interindustry study provided information on the amount of products required from each of the 367 industry sectors. The product data were converted to employee-hours by use of output per employee-hour ratios for each industry. While processing the data, the Economic Growth Division of BLS adjusted for price and productivity changes from the base year of the tables (1963) to the study year. The results were the average total (indirect) employee-hours per $1,000 of contract cost required to produce, transport, and sell the materials used to construct the projects covered by this survey.

These employee-hours, plus the builders' offsite employment, were combined with direct or onsite employee-hours to determine total employee-hours within the definition of the study. Offsite employment of each construction contractor was not obtained directly from the contractors since it would be difficult to allocate a portion of total offsite employment to a particular project. Instead, an estimate for the offsite employee-hours was developed by applying to the onsite employee-hours collected for this study the ratio of construction workers to all employees in the total construction industry for 1971, as reported in *Employment and Earnings, United States*, 1909–72 (BLS Bulletin 1312–9).

Appendix B. Forms Used for Data Collection

BLS 2651.02A

Office of Management and
Budget No. 44-R 1381
Approval expires: 12-31-73

U.S. DEPARTMENT OF LABOR
Bureau of Labor Statistics
Washington, D.C. 20212

GENERAL INFORMATION

SURVEY OF
CONSTRUCTION LABOR REQUIREMENTS
FOR
SEWERS AND SEWAGE TREATMENT PLANTS

The Bureau of Labor Statistics will hold all information furnished by the respondent in strict confidence.

Name of Local Government Sponsoring Agency _____

EPA or HUD Project Number _____

OFFICE USE ONLY	Survey Ident	Schedule Number	Sample	Weight	Region	SMSA
	0 | 2	| | |		| |		| |

I. TYPE OF CONSTRUCTION

When you are reporting more than one type of construction, code for the type which represents the largest dollar value.

Sewer lines include lift stations (sometimes called pumping stations) associated with the sewer lines. Lift stations push sewage up inclines or raise sewage to a level high enough to allow it to flow by gravity thru the lines.

Consider "outfall" sewer lines, i.e., lines which carry treated sewage from a treatment plant, as part of a treatment plant. Do not include construction which is primarily for outfall sewers in this "sewer lines" section.

A new treatment plant is an entirely new facility. It may be a simple pond or a more sophisticated facility.

An addition to an existing plant is an addition of equipment, or equipment and building, or pond or outfall sewer, to an existing facility. Construction of building(s) only with no equipment, or outfall sewer or pond, is out-of-scope.

NOTE: If construction provides secondary treatment capability to an existing primary treatment facility, use code "2". Under these conditions the "type of construction" is considered new treatment plant construction.

A pumping station related to a treatment plant is a station housing relatively large pumps. The function of a pumping station is to push all or any portion of incoming waste liquid thru and from a treatment plant. (Stations that push waste liquids to a treatment plant are to be classified as sewer line lift stations.)

II. VALUE OF CONSTRUCTION CONTRACT(S)

The value you report here will, when added to values reported in all other "A" forms submitted for the "assignment", add to the total value of the assignment. Thus, report the combined value of any general or prime construction contracts related to the construction activity represented by this "A" form.

III. CONSTRUCTION DATES

For the construction being reported, enter the beginning and ending dates of on-site activity and the total number of elapsed weeks from beginning to ending dates.

ALWAYS COMPLETE SECTIONS I, II, III, VIII, IX AND X

I. TYPE OF CONSTRUCTION

Is the construction represented by this "A" form primarily? ..... | | 1 |

Code
1 - Sewer line and/or lift station *(go to IV)*
2 - New treatment plant *(go to V)*
3 - Addition to existing treatment plant *(go to VI)*
4 - Pumping station related to treatment plant *(go to VII)*

II. VALUE OF CONSTRUCTION CONTRACT

What is the total dollar value of the general and/or prime contract(s) related to this construction? ..... | $ | 2 |

III. CONSTRUCTION DATES

Beginning (mo./day/yr.) ..... | / / | 3 |

Ending (mo./day/yr.) ..... | / / | 4 |

Total number of construction weeks (including down time) ..... | | 5 |

Complete Section IV Only if the Type of Construction is primarily SEWER LINE and/or LIFT STATION

IV. SEWER LINE CHARACTERISTICS

a. Construction is for— ..... | | 6 |

Code
1 - Sewer line only
2 - Lift station only
3 - Sewer line and other (specify) _____

_____

If code 2, skip to IVh.

g. If the entire sewer line is above ground, enter "0" for both the minimum and maximum depth.

   If the sewer line is partly above and partly below ground, enter "0" for the minimum depth.

h. Report the maximum amount of sewage that the installed pipe can handle in one day.

IV. SEWER LINE CHARACTERISTICS—Continued

b. What was the principal type of pipe? ..... | | 7 |

Code
1 - Asbestos cement
2 - Concrete
3 - Cast iron
4 - Vitreous clay
5 - Reinforced fiberglass or plastic
6 - Steel (except corrugated steel)
7 - Corrugated sheet metal
8 - Other (specify) _____

c. How many linear feet of pipe were laid for this sewer line(s)? ..... | | ft. | 8 |

d. What is the size (diameter in inches) of the predominant pipe used? ..... | | in. | 9 |

e. Is the pipe primarily underground or aboveground? ..... | | 10 |

Code
1 - Underground
2 - Aboveground

f. What was the principal method of laying pipe? ..... | | 11 |

Code
1 - Trenching
2 - Tunneling
3 - Other (specify) _____

g. What is the minimum and maximum depth of the trench or tunnel in feet? (Round to nearest foot).

Minimum depth ..... | | 12 |

Maximum depth ..... | | 13 |

h. What is the peak flow rate (gallons 1 day) of the sewer line (or lift station)? ..... | | gal. | 14 |

i. (If a lift station) is a majority of equipment installed for the lift station "packaged"? ..... | | 58 |

GO TO VIII WHEN COMPLETED WITH IV

V. CHARACTERISTICS OF NEW TREATMENT PLANTS

a. The inflow for a primary treatment plant is the raw sewage from sewer lines. "Primary treatment" removes solid wastes from sewer water.

The inflow for a secondary treatment plant is the sewer water discharged from a primary treatment facility. Secondary treatment removes organic matter suspended in sewage which has already been given primary treatment.

Waste stabilization ponds are shallow ponds which hold raw sewage and where micro-organisms in the atmosphere partially decompose the raw sewage.

NOTE: New plants otten are designed to provide both primary and secondary treatment. Such plants are to be coded "secondary treatment plant", code 2.

b. Answer this question only if IV. a. is coded "2".

In the activated sludge type of treatment waste liquid, air and sludge loaded with bacteria are mixed in an aeration tank. Bacteria decompose suspended organic matter and the sludge is then settled out of the liquid.

In the trickling filter type of treatment waste liquid is trickled over a bed of rocks. Bacteria on the surface of the rocks cause the organic matter in the waste liquid to decompose.

c. "Packaged" sewage treatment equipment usually consists of a large prefabricated tank unit which provides all the treatment processes desired by the purchaser. It also contains all wiring, metering, and input/output piping necessary to make a complete, integrated unit.

d. Incinerators are devices used to burn sludge. After incineration, all that remains is a non-burnable ash.

Drying beds are open areas where sludge is spread-out, exposed to the air, and dehydrated.

Outfall lines are large pipe lines which carry treated waste liquid from a treatment facility to a point of final discharge or disposal (stream, lake, etc.).

Removal equipment is any kind of new, heavy equipment (e.g., bulldozer, loader, conveyor system, dump truck) which is used in the treatment plant's disposal system.

e. The BOD removal rating is a measure of the effectiveness of a sewage treatment plant.

A BOD removal rating of 85% means that the treatment process will remove approximately 85% of the suspended organic matter in the waste liquid treated.

Secondary treatment plants ordinarily have BOD removal rating of 85-95%.

f. Report the maximum number of gallons of waste liquid the plant can handle in one day.

g. Population design is a measure of a plant's capacity. It is expressed in terms of numbers of people the plant is designed to serve. When a treatment plant processes a combination of residential and industrial/commercial generated sewage, the industrial/commercial volume should be converted to a population equivalancy for reporting purposes.

Complete Section V Only if the Type of Construction is primarily a NEW TREATMENT PLANT

V. CHARACTERISTICS OF NEW TREATMENT PLANTS

a. Is construction primarily for a— ..... | | 15

Code
1 - Primary treatment plant
2 - Secondary treatment plant
3 - Waste stabilization pond
4 - Other (specify) _____

b. (If a secondary treatment plant) is it— ..... | | 16

Code
1 - Activated sludge type
2 - Trickling filter type
3 - Other (specify) _____

c. Is a majority of the equipment installed for this facility "packaged"? ..... | | 17

Code
1 - Yes
2 - No

d. Does the construction contract(s) provide for any of the following types of sewage disposal? (Enter "1" if "yes")

Incinerators		18
Drying beds		19
Outfall lines		20
Removal equipment		21
Other (specify) _____		22

e. What is the biochemical oxygen demand (BOD) removal rating (percentage) of this facility? ..... | | % 23

f. What is the capacity flow rate (gallon 1 day) of this facility? ..... | | gal. 24

g. What is the maximum population design of this facility? ..... | | 25

GO TO VIII WHEN COMPLETED WITH V

b. Leave blank if VI. a. is coded "2".

c. "Equipment" covers the entire range of products usually associated with waste treatment including tanks, filters, drums, pumps, aerators, incinerators, etc. Equipment may be located inside buildings or in open areas.

Complete Section VI Only if the Type of Construction is primarily an ADDITION TO AN EXISTING PLANT

VI. CHARACTERISTICS OF ADDITIONS TO PLANTS

a. Does this construction involve a— ..... | | 26

Code
1 - Primary treatment capability
2 - Secondary treatment capability
3 - Waste stabilization pond
4 - Other (specify) _____

b. (If a secondary treatment capability) is it— ..... | | 27

Code
1 - Activated sludge type
2 - Trickling filter type
3 - Other (specify) _____

c. Does this construction primarily involve— ..... | | 28

Code
1 - An addition of building(s) only
2 - An addition of building(s) and equipment
3 - An addition of equipment only
4 - An addition to pond(s)
5 - Other (specify) _____

d. Is a majority of equipment installed for this facility "packaged"? ..... | | 29

Code
1 - Yes
2 - No

e. Does the construction contract(s) provide for any of the following types of sewage disposal? (Enter "1" if "yes".)

Incinerators		30
Drying beds		31
Outfall lines		32
Removal equipment		33
Other (specify)		34

VI. CHARACTERISTICS OF ADDITIONS TO PLANTS—Continued

g. Enter the <u>increase</u> in the BOD removal rating which resulted from the <u>addition</u> represented by this "A" form.

If the BOD removal rating did not change, enter "0".

VII. CHARACTERISTICS OF PUMPING STATIONS (RELATED TO TREATMENT PLANTS)

a. Packaged pumping stations are prefabricated units in which all necessary equipment is installed and connected prior to delivery to the construction site. The "package" includes pumps, motors, valves, piping, controls, wiring, etc. It is a complete, integrated unit ready to be connected to treatment plant pipes.

b. Report the maximum amount of sewage this pumping station can handle in one day.

VI. CHARACTERISTICS OF ADDITIONS TO PLANTS—Continued

f. What was the biochemical oxygen demand (BOD) removal rating (percentage) of the entire facility prior to this addition? ..... % 35

g. What was the increase of the BOD removal rating (percentage) as a result of this addition? ..... % 36

h. What is the capacity flow rate (gallon 1 day) of the equipment installed for this facility? ..... gal. 37

i. What is the maximum population design of this facility? 38

GO TO VIII WHEN COMPLETED WITH VI

Complete Section VII Only if the Type of Construction is primarily for PUMPING STATIONS (RELATED TO TREATMENT PLANTS)

VII. CHARACTERISTICS OF PUMPING STATIONS

a. Is this primarily a "packaged" pumping station(s)?..... 39

Code
1 - Yes
2 - No

b. What is the capacity flow rate (gallons 1 day) of this station? ..... gal. 40

c. What is the maximum population design of the pumping station?..... 41

GO TO VIII WHEN COMPLETED WITH VII

VIII. BUILDINGS AND ADDITIONS TO BUILDINGS

a. Did the construction activity represented by this "A" form include work on buildings? 42

Code
1 - Yes
2 - No

If "no," skip to Section IX.

VIII. BUILDINGS AND ADDITIONS TO BUILDINGS—Continued

b. Did the building construction involve a new building or an addition to an existing building? ..... [ ] 59

Code
1 - New building
2 - Addition to existing building
3 - Both

c. Did work include construction of "office" space? ..... [ ] 60

Code
1 - Yes
2 - No

d. What was the principal building material used in construction of each of the following:

Foundation walls ..... [ ] 43

Code
1 - Vertically poured concrete
2 - Concrete block
3 - Other (specify) _____
4 - No foundation wall

Frame ..... [ ] 44

Code
1 - Structured steel
2 - Concrete block
3 - Precast concrete
4 - Cast-in-place concrete
5 - Wood
6 - Other (specify) _____
7 - No frame

Exterior wall ..... [ ] 45

Code
1 - Metal siding
2 - Concrete block
3 - Precast concrete
4 - Cast-in-place concrete
5 - Curtain wall
6 - Brick
7 - Wood
8 - Other (specify) _____
9 - No exterior wall

Roof base ..... [ ] 46

Code
1 - Concrete
2 - Sheet metal
3 - Wood
4 - Other (specify) _____
5 - No roof base

Roof cover ..... [ ] 47

Code
1 - Built-up
2 - Sheet metal
3 - Asphalt shingle
4 - Wood shingle
5 - Other (specify) _____
6 - No roof cover

e. What type of building heating was installed? ..... [ ] 48

Code
1 - Forced air
2 - Hot water
3 - Other (specify) _____
4 - No heating

f. Was central air conditioning installed? ..... [ ] 49

Code
1 - Yes
2 - No

g. Were elevators installed? ..... [ ] 50

Code
1 - Yes
2 - No

GO TO IX AND X

IX. WORK STOPPAGES AND SLOWDOWNS

a. Sum up the number of days during the construction period when all on-site work was completely stopped because of strikes, bad weather, etc. Convert this to an equivalent number of work weeks and round to a whole number.

If there were no stoppages enter "0".

b. If anything happened during construction which required major redesign of the project, or which greatly prolonged the construction time, or which greatly increased the cost of construction, code "yes" and explain the circumstances. This question should reflect any such occurances which could not be reported in question IX. a.

X. NUMBER OF CONTRACTS

a. If this information cannot be accurately completed at the initial interview, it should be completed later by the agent after all contractors have been scheduled.

b. Enter "0" for Sample 2 assignments.

XI. TOTAL ON-SITE MAN-HOURS

Do not complete this section for Sample 1 assignments.

Line 996 - This line is reserved for "office use only". Leave this line blank.

Line 997 - This is an aggregate of all hours which ordinarily would be reported in contractor "B" forms.

Line 998 - This line is reserved for "office use only". Leave this line blank.

IX. WORK STOPPAGES AND SLOWDOWNS

a. Were there any complete work stoppages during the construction of this project (due to material shortages, strikes, disruptive weather, etc.)? Enter the total number of weeks lost due to such stoppages. (Round to whole numbers.) .... [ ] 51

Please explain any complete stoppages:

____

____

b. Where there any unanticipated events or circumstances that affected the construction process and cost (such as unexpected water table level, unexpected rock formations, etc.)? .... [ ] 52

Code
- 1 - Yes
- 2 - No

Please explain any such events or circumstances:

____

____

X. NUMBER OF CONTRACTS

a. How many contracts were let for the construction represented in this "A" form?

General and prime contracts		53
Subcontracts		54
Sub-subcontracts		55
TOTAL		56

b. How many B schedules are attached for this project? .... [ ] 57

Complete Section XI only for SAMPLE 2 Assignments

XI. TOTAL ON-SITE MAN-HOURS

From EPA or HUD payrolls		996
Other		997
TOTAL		998

BLS 2652.02B

Office of Management and
Budget No. 44-R 1381
Approval expires: 12-31-73

Contract No.

U.S. DEPARTMENT OF LABOR
Bureau of Labor Statistics
Washington, D.C. 20212

CONTRACT INFORMATION

SURVEY OF CONSTRUCTION LABOR REQUIREMENTS FOR SEWERS AND SEWAGE TREATMENT PLANTS

The Bureau of Labor Statistics will hold all information furnished by the respondent in strict confidence.

Name of Local Government Sponsoring Agency _____

EPA or HUD Project No. _____

I. CONTRACTOR IDENTIFICATION

a. Name _____

Address _____

Telephone number _____

b. Record of personal visits:

Date of visit	Official contacted	Field representative

c. Contract codes:

	Schedule No.	Contract No.										
From the "A" form												

	Superior Contract No.		
From the "C" form			

Leave blank if this schedule is for a general or prime contractor.

II. CONTRACT AMOUNT

What was the final contract amount, including all change orders? (Exclude land costs and exclude adjustments for performance clauses. Round to whole dollars.) .....

$	001

III. SUBORDINATE CONTRACTS (Except by General Contractors)

List below the identification of any subordinate contractors who performed any operations for this contract? Also provide the contract operations code, the contract value, and the contract number assigned (form the "C" form).

Name, address, and telephone number of subordinate contractor(s)	Contract operation code	Value of contract	Contract number assigned
		$	
		$	
		$	
		$	

IV. DESCRIPTION OF WORK PERFORMED BY THIS CONTRACTOR

a. In the space below, describe the work performed and the important kinds of heavy equipment, materials, and labor supplied under this contract. (Exclude work which the contractor has sub or sub-sub-contracted.)

Example: "Dug trench for sewer line. Used backhoe, bull-dozer and heavy truck. Important occupations included operating engineer, truckdriver, and laborer."

b. Major operations code ..... | 1 | 002 |

REMARKS

V. CONSTRUCTION EQUIPMENT—RENTAL COST

a. On this page, report the rental cost (or the rental cost equivalent if the contractor owns the equipment) for the time the equipment is used on-site. This category will include all heavy equipment and any non-heavy equipment that is actually rented. Do not include operator's wages.

Description of equipment	Equipment code	Rental cost (whole dollars)	
		$	100
			101
			102
			103
			104
			105
			106
			107
			108
			109
			110
			111
			112
			113
			114
			115
			116
			117
			118

b. Total on-site rental costs (exclude equipment operator's wages). .....

$	199

V. CONSTRUCTION EQUIPMENT—RENTAL COST—Continued

Description of equipment	Equipment code	Rental cost (whole dollars)	
		$	119
			120
			121
			122
			123
			124
			125
			126
			127
			128
			129
			130
			131
			132
			133
			134
			135
			136
			137
			138
			139
			140
			141
			142

VI. MATERIALS AND SUPPLIES

a. What was the total cost of all materials and supplies used during construction? .....

$	599

b. What materials and supplies were used during construction and what was "delivered on-site" cost of each?

Name and description of materials and supplies	Materials code	Cost (whole dollars)	Percent of sales tax to be added	
		$		200
				201
				202
				203
				204
				205
				206
				207
				208
				209
				210
				211
				212
				213
				214
				215
				216
				217
				218
				219

VI. MATERIALS AND SUPPLIES—Continued

Name and description of materials and supplies	Materials code	Cost (whole dollars)	Percent of sales tax to be added	
		$		220
				221
				222
				223
				224
				225
				226
				227
				228
				229
				230
				231
				232
				233
				234
				235
				236
				237
				238
				239
				240
				241
				242

VII. LABOR REQUIREMENTS

a. Did this contractor have a labor agreement covering any of the work performed on this contract? ..... | | 003 |

Code
1 - Yes
2 - No

b. What were the total wages paid for on-site labor for this contract? (Exclude profit and overhead, and exclude any supplemental benefits.) ..... | $ | 004 |

c. Are EPA or HUD payrolls being submitted for this contract? ..... | | 005 |

Code
1 - Yes
2 - No

d. Complete the following for any on-site labor not already reflected on the payrolls filed with the local authority, (e.g., missing payrolls, hours and earnings of exempt employees who performed on-site work but who are not subject to EPA or HUD reporting requirements).

Occupation code	Hours	Earnings related to hours	
		$	600
			601
			602
			603
			604
			605
			606
			607
			608
			609
			610

VII. LABOR REQUIREMENTS—Continued

Occupation code	Hours	Earnings related to hours	
		$	611
			612
			613
			614
			615
			616
			617
			618
			619
			620
			621
			622
			623
			624
			625
			626
			627
			628
			629
			630
			631
			632
			633
			634
Total earnings			999

WORK AREA

VIII. CONTRACT RECONCILIATION

Total value of subcontracts let by this contractor	$	006
Total equipment cost (approx.) (From line 199)	+	007
Total material cost (approx.) (From line 599)	+	008
Total labor cost from this B form (approx.) (From line 999)	+	009
Total labor cost from attached payrolls (approx.)	+	010
Total on-site costs (approx.)	$	011

Total contract amount (From line 001)	$	012
Total on-site costs (From line 011)	-	013
Approximate total profit and overhead	$	014

% profit and overhead = $\frac{\text{Approx. total profit and overhead}}{\text{Total contract amount}}$ =

	%	015

IX. SCHEDULE STATUS

a. Is this a complete B form for this contract? .....

	016

Code
1 - Yes
2 - No

b. If "no," please explain:

_____

_____

_____

_____

_____

_____

_____

Appendix C. Bibliography

Construction Labor Requirements Studies by the BLS Office of Productivity and Technology

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Labor and Material Requirements for Civil Works Construction by the Corps of Engineers (BLS Bulletin 1390), 1964, 28 pp.

A statistical study of onsite and offsite employee-hour and wage requirements for dredging and land projects in the U.S. Corps of Engineers' civil works program from 1959 to 1960.

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Discussion of labor and material trends in highway construction between 1958 and 1970.

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Study providing measures for 1958, 1961, and 1964 of the labor and material requirements for federally aided highways, with separate measures of the requirements for onsite and offsite construction. For onsite construction, the study also provides a comparison of annual labor requirements for 1947–64.

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Wakefield, Joseph C., "Labor and Material Requirements: Highway Construction, 1958 and 1961," *Monthly Labor Review*, April 1963, pp. 394–98.

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A statistical study of 26 new office building projects completed in 1973 under the jurisdiction of the General Services Administration. In addition to data on labor requirements, the study provides information on building characteristics and contract operations.

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A statistical study of onsite and offsite labor requirements for 22 Federal office building projects in various localities of the United States over a 3-year period from the fall of 1957 to 1960.

Murray, Roland V., "Labor Requirements for Federal Office Building Construction," *Monthly Labor Review*, August 1962, pp. 889–93. A summary of BLS Bulletin 1331.

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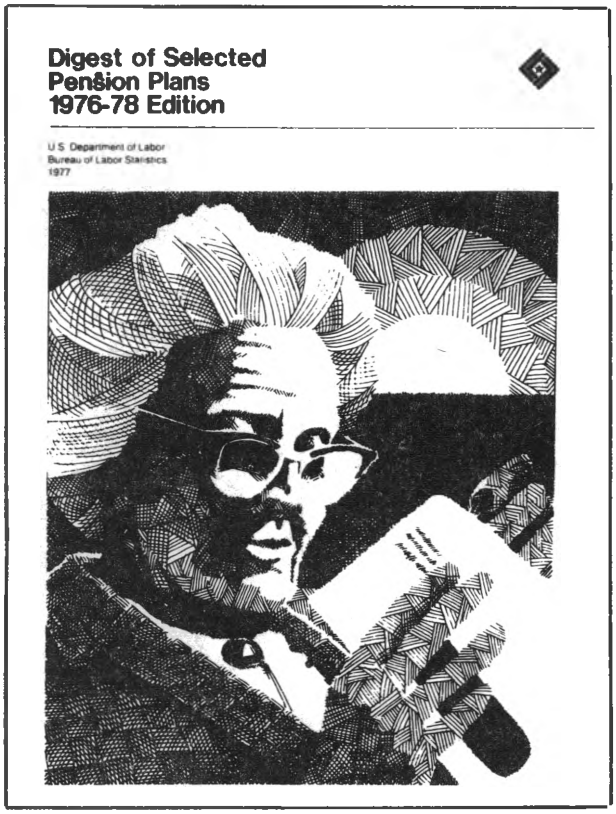

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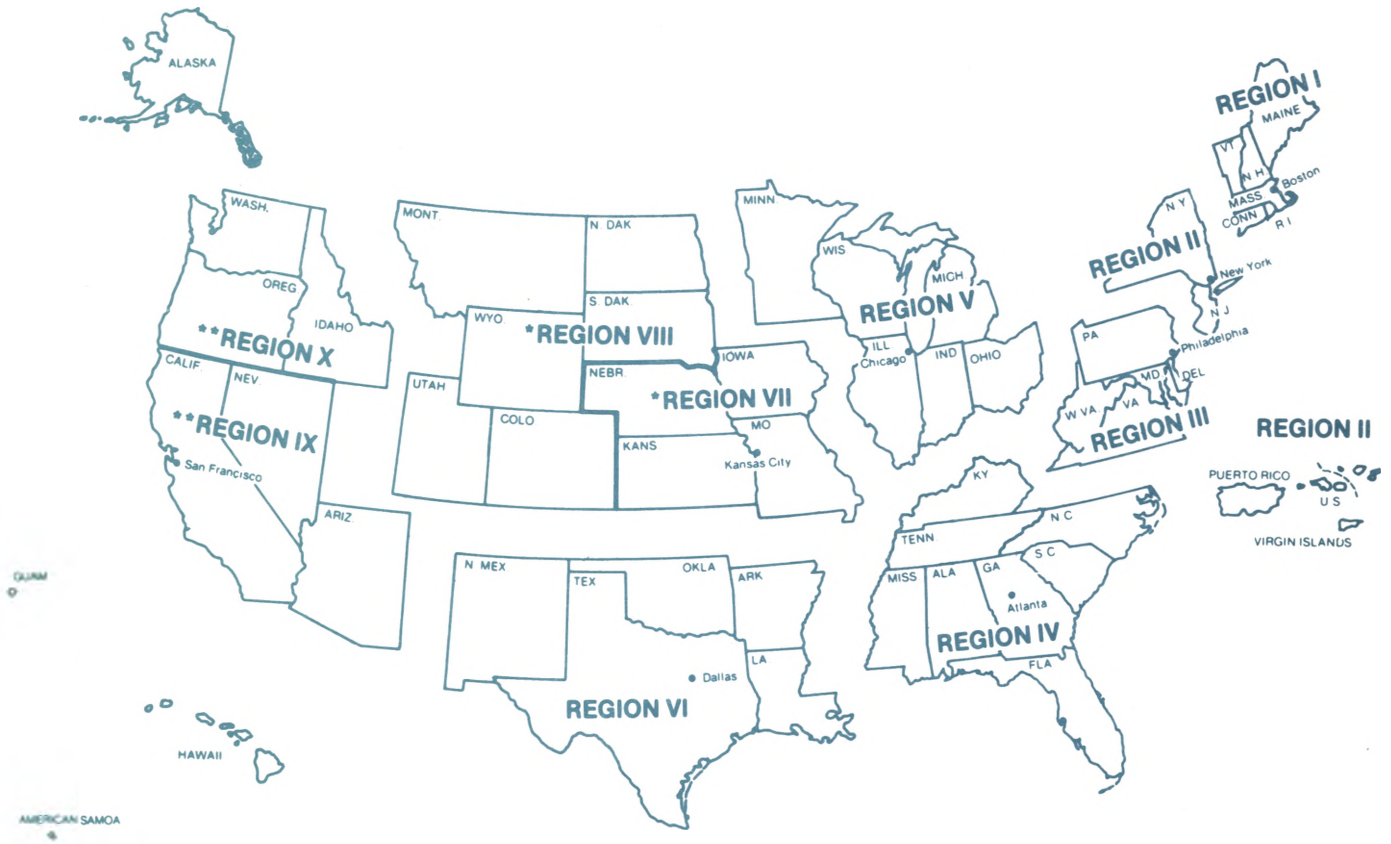

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