PROJECTING LABOR REQUIREMENTS FOR TRANSPORTATION-RELATED CONSTRUCTION

WASHINGTON TECHNICAL INSTITUTE
CENTER FOR URBAN SERVICES
WASHINGTON, D.C. 20008

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FINAL REPORT

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Prepared for

DEPARTMENT OF TRANSPORTATION

OFFICE OF THE SECRETARY

Office of the Assistant Secretary for Environment and Urban Systems

Washington, D.C. 20590

OFFICE OF THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

ASSISTANT SECRETARY

I am pleased to forward this report on "Projecting Labor Requirements for Transportation Related Construction." The object of this study was to research and develop for inclusion in the transportation planning process a procedure that would adequately provide for the consideration of labor demand and labor supply in a given region in determining the need for future transportation systems. This process would also include projections of the opportunity for minority participation in construction, operation and maintenance of a transportation system as well as provide the basis for training programs which may be needed in specific job areas to implement the transportation plan.

The research for this study has involved extensive study of labor and manpower statistics from a variety of sources. The resulting conclusions and recommendations should be of value to transportation planners as they participate in the development of improved plans for comprehensive community development.

Sincerely,

John E. Hirten
Assistant Secretary for
Environment and Urban Systems

Enclosure

DOT-OS-10206

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The contents of this report reflect the views of the Center for Urban Services of the Washington Technical Institute which is responsible for the facts and the accuracy of the data contained herein. The contents do not necessarily reflect the official views or policy of the Department of Transportation.

ABSTRACT

The Department of Transportation considers that the ideal urban transportation planning process should include appropriate consideration of labor market impact, including projections of the opportunities for minority participation in construction, operation, and maintenance of a transportation system and reliable forecasts of the training output needed in critical occupations. The report: (1) outlines the role of labor market impact analysis in a comprehensive urban planning process; (2) reviews the literature concerning the projection of employment in the construction industry; (3) examines sources of secondary data concerning population, labor force participation, and construction employment in a metropolitan area, including occupational breakdowns; (4) explores the problems in obtaining secondary source data specific to transportation-related employment; (5) outlines procedures for developing projection models from primary sources and establishing EEO goals with sufficient lead time to permit initiation of training programs.

Major conclusions include: (1) demographic and economic projections on a metropolitan area basis involve difficulties with respect to localizing assumptions and obtaining historical data with the desired specificity; (2) secondary data on employment do not provide the industrial or occupational specificity required to make projections useful in the transportation planning process; (3) transportation-related construction moves in response to public policy and may be independent of trends in other construction; (4) greater attention needs to be given to cyclical variation in projecting construction industry employment; (5) various types of construction generate very different labor usage factors and occupational patterns; (6) development of labor usage factors and occupational patterns directly from representative construction project payrolls is the most adequate approach to producing employment projection models; (7) minority training and utilization goals require identification of future labor demand in specific occupational terms.

Recommendations cover: (1) establishment of statistical standards for reporting and processing data on transportation-related employment including occupational classification and nomenclature; (2) development of labor requirement projection models from project payroll data; (3) modification of established procedures for developing area manpower projections to provide EEO guidelines; (4) incorporation of labor component considerations throughout the urban transportation planning process, including minority utilization.

MAJOR CONCLUSIONS

(References are to Sections and Appendixes of this report)

1. Commercially compiled guidelines for estimating labor requirements from specifications and a "bill of materials" cannot be used early enough in the planning process to be of value to long-range planners (1.2.1).

2. The occupational composition of transportation-related construction employment has not been systematically ascertained with a completeness, regularity, frequency, or specificity which will meet the needs of transportation planners (1.2.1).

3. Very few attempts have been made to project the occupational distribution of the labor requirements for an industry on a metropolitan area basis (2.1).

4. There is general agreement that economic prediction in general, and industry-occupational projections in particular, may be very inexact, should be used with considerable caution, and should be modified as soon as new evidence is available (2.1).

5. Instituting a new set of economic controls has introduced a new set of factors which will influence economic relationships for an unpredictable period, thereby increasing the unreliability of labor usage projections made on the basis of historical data (2.2).

6. Assumptions made around 1960 in connection with projections of employment by industry have not been substantiated very well by subsequent events (2.2).

7. Projections for an industry on a metropolitan area basis involve the same assumptions as for the national economy and additional ones concerning local variations; the greater the number of basic assumptions and the smaller the data base, the greater the difficulty in producing reliable projections (2.3).

8. The economic forces influencing an industry's labor requirements and its labor market differ markedly among types and sizes of metropolitan areas (2.3).

9. The concept of a constant geographic definition of a metropolitan area (SMSA) should be employed; earlier data should be adjusted upward to conform to any expansion of the boundaries (3.1).

10. The Cohort-Component Method should cover race as well as sex and age when projecting total population and the labor force for a metropolitan area with a higher proportion of non-white population than the national norm (3.2).

11. Population projections for the Washington SMSA made by A.D. Little, Inc., appear to be the most realistic, although probably too high (Appendix A, par. 4d).

12. The limited sub-classifications of the construction industry employed in Bureau of the Census Publications do not provide the industrial specificity required to establish trends for transportation-related construction either nationally or on a metropolitan area level (3.4).

13. The occupational detail employed in Bureau of the Census publications for metropolitan areas does not provide the occupational specificity required to develop occupational patterns for transportation-related construction, operation, and maintenance (Appendix C).

14. Transportation-related construction moves in response to public policy decisions which may be independent of the trend in construction generally; therefore, available historical series of data on construction employment are not a valid basis for projecting either level or direction of transportation-related construction (3.4).

15. Projections of construction employment based on historical data and trend assumptions have been so unreliable that it has been necessary to revise the projections at frequent intervals (3.4).

16. The BLS Employment and Earnings series, adjusted for excluded classes of workers, is the most useful historical measure of total construction employment in a metropolitan area (Appendix B, par. 3e).

17. The assumption of an uninterrupted compound annual rate of growth in an area's construction industry needs to be challenged and attention given to the possibility of cyclical deviations (Appendix B, par. 4d).

18. Forecasts made by employers during a period of relatively rapid expansion of their industry are likely to overestimate future levels of employment in their industry and area (Appendix B, par. 5c).

19. Various types of construction generate very different labor usage factors and occupational patterns; to project future needs it is necessary to take into consideration the unique requirements of each type of construction (4.1.1 and 4.1.2).

20. The occupational mix among major occupations in highway construction nationally has not substantially changed in more than a decade (4.1.2).

21. Highway and street construction in metropolitan areas involve labor usage factors and occupational patterns sufficiently different from nation-wide or state-wide experience to require development of metropolitan labor requirement models (4.1.3).

22. In the case of transportation-related construction it would be very misleading to assume that the project-type mix, and therefore the occupational mix, is the same for metropolitan areas as for the nation, or even for a group of states (4.1.3).

23. The occupational pattern for highway construction which can be derived from FHWA EEO report summaries is the only compiled source with a reasonable degree of occupational detail; however, this source should be used only if it can be established that July employment is reasonably representative in occupational usage (Appendix D, pars. 4 and 11).

24. If the FHWA EEO data are to be used on a continuing basis to develop occupational patterns, steps should be taken to improve the occupational reporting by contractors and states to achieve greater specificity and accuracy (Appendix D, pars. 2 and 3).

25. Since the FHWA EEO data are for one time of the year, they are probably not an adequate source for developing a jobs-to-dollars ratio (Appendix D, par. 7).

26. In the case of highway construction, the BLS jobs-to-dollars ratio is the best available but should be modified by pooling various professional judgments before application to a metropolitan area (Appendix D, pars. 9 and 10).

27. Projections of requirements by occupation made for Washington's METRO need to be revised to conform to the experience to date and to bring occupational classifications into line with reporting practices (4.2.2).

28. Adequate labor usage data pertaining to the construction of airport structures and airways control facilities are not available from secondary sources; original compilation from appropriate payrolls is required (4.3).

29. Development of labor usage factors and occupational patterns directly from representative construction project payrolls is the most adequate approach to producing employment projection models for transportation-related construction in metropolitan areas (5.1.1).

30. Reasonably good statistical techniques exist for estimating, by occupation, a metropolitan area's gross replacement needs and new demand due to industry growth, provided that good assumptions are made concerning population changes, labor-force participation, and industry gorwth (5.3.1).

31. Projections for an area's construction industry need to be adjusted for special occupational detail developed for transportation-related construction (5.3.2).

32. The introduction of minority employment objectives (such as the Washington Plan) requires modification of the traditional methods used to measure the replacement and growth demand in selected occupations to provide appropriate identification of the minority job opportunities to be created (5.3.3).

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1. INTRODUCTION

1.1 Purpose and Scope of Study

1.1.1 Background. The Department of Transportation requires from transportation-related construction industries a high level of progress and achievement toward reaching the equal employment opportunity goals of the Federal Government. No comprehensive planning procedure has yet been developed to investigate the gap between the construction industry's present performance and reasonable equal employment opportunity goals. There is a need to determine what additional training is required to permit citizens to qualify for skilled and technical employment as the construction industry strives to meet both its expanding labor requirements and its equal employment opportunity obligations.

During the next decade, a variety of transportation-related heavy construction projects will be undertaken in many metropolitan areas. Although construction contractors will be required to adhere to the Equal Employment Opportunity (EEO) provisions of Federal, state and local governments, a large number of job opportunities may go unfilled due to the unavailability of skilled and semi-skilled minority construction workers. Despite earnest efforts by governmental agencies and cooperating organizations, progress in achieving EEO goals will continue to be limited by: (1) the absence of adequate procedures for identifying opportunities for primary contract and sub-contract awards to minority-owned and minority-controlled construction firms; and (2) the inability of contractors of all types to meet minority hiring requirements in specific occupational specialties because of the absence or inadequacy of vocational training programs in the areas.

1.1.2 Relevant Research Objectives of the Department of Transportation. The Department of Transportation desires to research and develop procedures which planners in all areas of the country may use to identify employment opportunities for minority-group members in transportation-related fields. Procedures are desired which will enable planners to communicate employment needs, by skill categories, to educational and vocational training institutions in a format which will permit relevant and timely training programs to be designed and conducted to fill new job requirements as they materialize on into the future.

It should be recognized that to establish goals and procedures for minority training and employment, it is first necessary to develop adequate projections of total labor requirements in specific occupational terms for transportation-related projects planned for a given metropolitan area. Such broader research objectives are the primary subject of this report and are summarized as follows:

a. Development of a model or set of procedures through which transportation planners may make ten-year forecasts of manpower requirements in the construction of transportation facilities and systems.

b. Development of the capability to identify future employment opportunities by occupation, especially for minority-group members in transportation-related construction.

c. Development of the capability to make ten-year forecasts of the manpower supply to be available for transportation-related construction.

d. Development of the capability to predict manpower shortages with sufficient lead time to permit the design and implementation of educational or training programs in the transportation field.

e. Development of the capability to project employment to be generated through transportation-related construction on specific projects in order that the economic and social impact can be weighed by interested groups.

1.1.3 Research Interests of the Washington Technical Institute. The overall objectives of the Washington Technical Institute closely correspond with the research objectives of the Department of Transportation. Under the legislation which created it, the Institute was given the mission to provide "(a) vocational and technical education designed to fit individuals for useful employment in recognized occupations; and (b) vocational and technical courses on an individual, non-credit basis."

Consistent with this, the Institute set as its basic goal, the preparation of students for employment in occupations that:

a. Are technically and service oriented.

b. Incorporate a "career-ladder" that offers entrants realistic opportunity for increasing responsibility and compensation.

c. Require some post-secondary training.

1.2 The Labor Component in Transportation Planning

1.2.1 Background. Long-range planning for transportation related facilities has characteristically been concerned with (a) requirements in terms of goods and people to be transported by various means between various places, and (b) estimates of the socio-economic impact of the mobility to be provided.

Planning research has concentrated on such matters as population growth and density; passenger-miles of traffic by air, rail, and highway; ton-miles of freight movement; probable impact upon retail trade of an area; and on-the-job opportunities to be created as an end result of the transportation to be made available. However, little or no attention has been given to estimating the labor requirements in specific skill classifications to be generated by the construction, operation, and maintenance of the planned transportation facilities per se, nor the probable availability of qualified workers to meet the projected demand.

As long-range plans move into the engineering study phase, considerable attention is given to estimating the materials requirements, project by project. Data on material components have been compiled and engineering handbooks and estimator's guides contain information on cubic yards, tons, linear feet and other measurements of the materials needed to put in place a given highway or structure and its related facilities. To a limited extent, guidelines exist for estimating the labor component by occupation in terms of the man-hours required to put in place a given unit of material. However, to use the latter a detailed bill of materials is necessary and since the material requirements cannot be ascertained until near the time for inviting bids, this technique is not of value to the planner.

The data collection systems connected with transportation-related construction have been devised to accumulate a great wealth of statistics on material requirements, particularly in the field of highways and bridges. These material requirements can be related to the dollar value of contracts by type of construction and a basis established for projecting material requirements in relation to planned dollars of expenditure. However, the labor component, on a continuous basis, has only been measured in terms of total man-hours and total payroll costs for a completed project without a breakdown by occupational specialty. This is comparable to reporting and compiling gross material requirements in terms of total pounds, without differentiation among types of items.

Occasionally, one-time studies have been made to provide a basis for estimating the distribution of total man-hours among principal occupations. These efforts will be described in later sections of this report. However, no evidence has been found that the occupational composition of the labor component has been systematically ascertained with a regularity, frequency, or specificity to satisfy the needs of long-range planners.

1.2.2 The Requirement for Labor Market Impact Information.

a. Transportation planners should have available to them the means to predict the following for each type of transportation

facility planned for the future in a given metropolitan area:

(1) The probable number of jobs to be generated in each significant occupation.

(2) The probable ability of the local labor market to supply the required number of workers in each skill category with appropriate participation from minority groups.

(3) The capability of existing institutions or agencies to train new workers or to upgrade skills of individuals to meet the requirements in occupations anticipated to be in short supply.

(4) The availability of individuals to be trained or retrained to acquire the required skills.

b. If the projected requirements in an occupation exceeds estimates of the future supply, one or more of the following planning actions may be taken:

(1) Reduce the scope of the plans or modify specific features.

(2) Stretch out the accomplishment of the plans.

(3) Plan to induce relocation of qualified workers from areas of surplus supply.

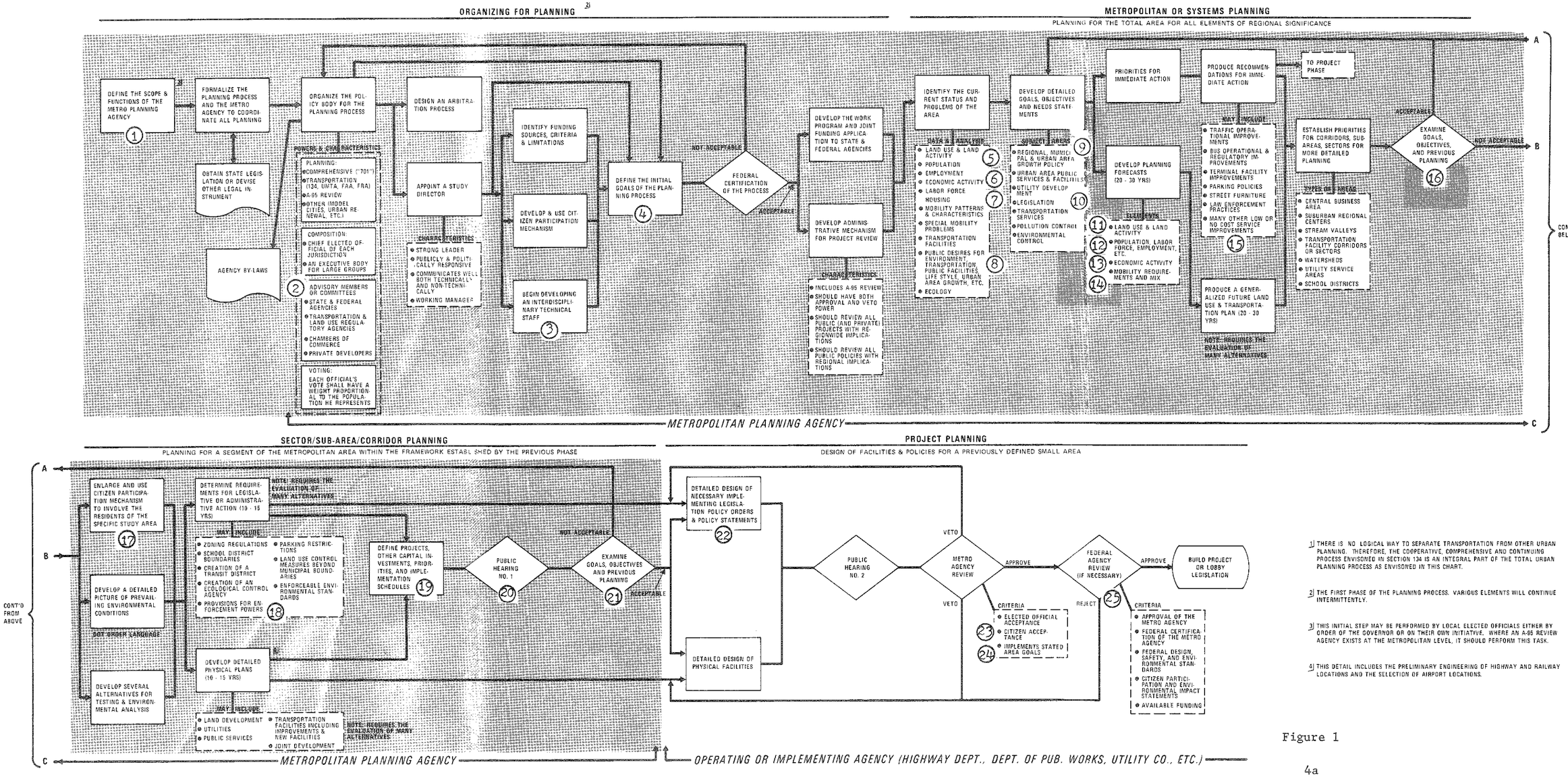
(4) Plan to augment the local supply in shortage occupations by appropriate training initiated with the required lead time.

c. In connection with a Department of Transportation study on urban transportation planning, a concept of "The Ideal Urban Planning Process" was charted (Figure 1). Throughout the planning process there are numerous opportunities for the introduction of labor market impact information for its value in the formulation of policy, planning and scheduling projects, and in obtaining public acceptance of the planners' proposals. A discussion of the potential uses of labor market data in the ideal planning process follows, keyed to Figure 1 by numerals enclosed in a circle.

"ORGANIZING FOR PLANNING"

(1) "Define the scope and functions of the metropolitan planning agency."

THE IDEAL URBAN PLANNING PROCESS [1]



1] THERE IS NO LOGICAL WAY TO SEPARATE TRANSPORTATION FROM OTHER URBAN PLANNING. THEREFORE, THE COOPERATIVE, COMPREHENSIVE AND CONTINUING PROCESS ENVISIONED IN SECTION 134 IS AN INTEGRAL PART OF THE TOTAL URBAN PLANNING PROCESS AS ENVISIONED IN THIS CHART.

2] THE FIRST PHASE OF THE PLANNING PROCESS. VARIOUS ELEMENTS WILL CONTINUE INTERMITTENTLY.

3] THIS INITIAL STEP MAY BE PERFORMED BY LOCAL ELECTED OFFICIALS EITHER BY ORDER OF THE GOVERNOR OR ON THEIR OWN INITIATIVE. WHERE AN A-95 REVIEW AGENCY EXISTS AT THE METROPOLITAN LEVEL, IT SHOULD PERFORM THIS TASK.

4] THIS DETAIL INCLUDES THE PRELIMINARY ENGINEERING OF HIGHWAY AND RAILWAY LOCATIONS AND THE SELECTION OF AIRPORT LOCATIONS.

Figure 1

Include a recognition that: (a) analysis of labor market impact and (b) planning to meet unusual manpower requirements are integral parts of the total planning process.

(2) "Organize the policy body for the planning process - Advisory members or committees."

Among the state and federal agencies to be represented, include the local manpower agencies. In addition, include representatives of organized labor. With representatives of labor and employers (chambers of commerce, private developers, contractors associations) a Manpower Advisory Committee should be created.

(3) "Begin developing an interdisciplinary technical staff."

The staff should include an Economist with background in labor economics and manpower resources management.

(4) "Define the initial goals of the planning process"

Include statements of goals with respect to the analysis of labor requirements and resources in terms of specific occupational specialties and taking into consideration equal employment opportunity for members of minority groups.

"METROPOLITAN OR SYSTEMS PLANNING - PLANNING FOR THE TOTAL AREA FOR ALL ELEMENTS OF REGIONAL SIGNIFICANCE."

"Identify the current status and problems of the area - data collection and analysis."

(5) "Population"

Historical data and current estimates of the area's population should be assembled to include the data on minority composition and occupational charateristics, and trends related thereto. Minority data are needed to establish a basis for policies and procedures with respect to equal employment opportunity and minority input into vocational training.

(6) "Employment"

a. Data on total employment in a metropolitan area and its geographic distribution in relation to the residence of workers is essential to a determination of existing commuter patterns. The use of such data as a starting

point for determining future transportation requirements is a recognized part of transportation planning. These data need not be in occupational terms.

b. Data are needed in a fair degree of occupational detail, however, concerning current employment directly related to transportation construction, operation, and maintenance in order to establish a base line for projections to be made later in the planning process. These data are needed broken down to indicate the existing proportions of minority representation in each skill category.

(7) "Labor Force"

Data on the size and charateristics (sex, race, age, and occupation) of the current labor force are needed to establish base lines for projecting the probable labor supply for various dates in the future and computing replacement and growth needs for those occupations of direct concern to transportation construction, operation, and maintenance. The area's historical trend in the labor force participation rate should be established, by race and age group, in order to project future labor composition based on population projections.

(8) "Public desires for . . . urban area growth, etc."

a. In the past, it has been generally assumed that "maximum growth" was a desirable goal. Current attention to ecology and population has raised many questions concerning desirability of unplanned growth. Costs as well as benefits of growth are entering the public consciousness. In the ideal urban planning process, it is possible that decisions should be made, in the greater social interest, to limit various physical aspects of urban growth. The concept of "optimum growth" requires examination of many factors - a process of bringing to bear upon a problem a great amount of information and systematic analysis concerning alternative courses of action and their consequences.

b. A planning group seeking public acceptance of its proposals is obligated to present to the public the information necessary for intelligent choice. Just as there are environmental impact statements coming into use, there should be an economic impact statement which, among other things, should describe the labor market impact of a given course of action. The short-run impact

may seem to be the generation of job opportunities. The long-run effect, particularly in specific occupations upon completion of a unique project, may be to create future employment, relocation, or retraining problems. If the facts are known, and adequate estimates of future consequences are made, the planning group and the public can weigh the various trade-offs involved.

"Develop Detailed Goals, Objectives and Needs Statements"

(9) "Regional, municipal and urban area growth policy"

As indicated above, labor market impact should be a part of the input in the process of developing detailed statements of needs and the formulation of a growth policy. The need to stimulate, or retard, particular segments of the labor market may be a factor in making choices among alternative area growth policies, at least in timing if not in direction.

(10) "Legislation"

If equal employment opportunity laws and regulations do not exist to control future training, recruitment, and employment of minority-group workers, goals and objectives for minority representation in employment by occupations should be established and appropriate legislation and regulations proposed. This need should be recognized early in the planning process and broad community support obtained, especially minority-group support. Failure to plan in advance for minority opportunity, both in terms of contractors and workers, may result in community economic and political opposition which may delay construction or operation of a system. The development of a plan acceptable to all elements of the community should be achieved before bids on projects are invited. Bidders should know what minority employment goals need to be met in order for them to anticipate their recruiting and training problems.

"Develop Planning Forecasts (20-30 years)."

(11) "Population"

Projections of population should include analysis of minority composition and trends related thereto to establish a basis for policies and plans with respect to equal employment opportunity. A tendency to over-project metropolitan area population growth should be avoided (see sec. 3.2 and App. A).

(12) "Labor Force"

Projections of the probable labor supply should be the product of population and labor force participation rate projections in various sex, race, and age groups. Occupational breakouts should be accomplished for all specialties directly involved in transportation construction, operation, and maintenance. It should be recognized that the data normally available by race will not fully identify all the minority groups for which equal employment opportunity needs to be planned. In areas with any significant proportion of French or Spanish speaking workers, additional refinement of minority projections must be made on the basis of local information concerning these segments of the labor force.

(13) "Employment"

a. Projection of total employment in a metropolitan area and its geographic distribution in relation to the residence of the workers is essential for an analysis of future commuter flow patterns and is a recognized part of transportation planning. Such projections do not need to be in terms of occupational specialties.

b. Employment to be directly or indirectly generated by the construction, operation, and maintenance of planned transportation needs to be projected in specific occupational classifications and for specific time phases in order to analyze the labor market impact of the proposed developments. In relation to labor force projections, these requirements forecasts will serve as a basis for estimating training needs in critical skill categories.

(14) "Economic Activity"

Long range forecasts of total economic activity in a metropolitan area should make clear the nature of the competition for workers, particularly in occupations of vital concern to the implementation of the transportation plans. Forecasts of per capita income, housing costs, and consumer price indexes will describe the general economic climate which can be expected to influence wage demands (labor costs) and have a direct bearing upon estimates of the future costs of transportation construction, operation, and maintenance.

"Produce Recommendations for Immediate Action"

(15) Training Programs (add)

On the basis of projections of the labor force and requirements in specific occupations, training needs can be established and recommendations made for the initiation of appropriate training programs (apprenticeships, on-the-job training, formal vocational courses, or a combination of them).

(16) "Examine goals, objectives, and previous planning"

At each stage of examination by a metropolitan planning agency, the labor component in planning should be reviewed for adequacy, including affirmative action programs to assure equal employment opportunity. Staff research should be reviewed for statistical adequacy and community inputs should be evaluated for their validity and reliability.

"Sector/sub-area/corridor planning - planning for a segment of the Metropolitan area within the framework established by the previous phase."

(17) "Enlarge and Use Citizen Participation Mechanism to Involve the Residents of the Specific Study Area."

Provision should be made for minority representation, both as potential users of the proposed transportation facilities and as groups most directly concerned with equal employment opportunity.

"Determine Requirements for Legislative or Administrative Action (10 - 15 years)."

(18) "Provisions for Enforcement Powers"

Should include provisions for enforcement of equal employment opportunity regulations, particularly in those occupations determined to have an under-representation of minority workers.

(19) "Define Projects . . . and Implementation Schedules"

The probable availability of a sufficient future supply of workers in critically needed occupations should be considered in scheduling projects. There should be an interplay between timing the creation of new, and possibly unusual, labor requirements and the ability of the community to recruit or train workers in shortage occupations. For example, the construction of an urban rail transit system may engender a demand for specialists not normally present in the community, such as tunnel construction workers, tracklayers, third rail power

system specialists and signal system installers. Failure to anticipate out-of-area recruiting or in-area training problems may invalidate work schedules and result in costly delays.

(20) "Public Hearing No. 1"

In any public hearing the object is to give the public information concerning alternative courses of action, obtain public input to the planning process, and obtain public support for the course of action the planners recommend as the most feasible. Labor market impact information should be included in terms of jobs to be created (directly and indirectly), income to be produced and its contribution to the areas economy (mutiplier effect) and the opportunity for up-grading of occupational skills, particularly among minority-group workers. Generally speaking, job opportunities are an affirmative influence on community attitudes toward a major development. When the job impact is presented with a well-developed affirmative action program for equal employment opportunity, acceptance of a total plan by all segments of the public is enhanced.

(21) "Examine goals, objectives, and previous planning"

See Comment No. 16 above.

"PROJECT PLANNING - DESIGN OF FACILITIES FOR A PREVIOUSLY DEFINED SMALL AREA"

(22) "Detailed design of necessary implementing legislation, policy orders, and policy statements"

Within the goals and objectives established for the metropolitan area, operating or implementing agencies primarily responsible for project planning should refine labor market impact estimates for their segment of the total system and develop policy orders and enforcement procedures with respect to equal opportunity employment. As detailed design of physical facilities progresses, labor requirements can be estimated with greater precision, and in more detail, and critical skills better identified.

"Metropolitan Agency Review"

(23) "Citizen acceptance"

The review should include evaluation of the public participation during the planning and design process, including public reaction to the labor market impact statements and equal employment opportunity policies and procedures. The input of

representatives of employers and organized labor should be examined for their influence upon citizen acceptance.

(24) "Implements stated area goals"

Project plans should be reviewed for conformity to metropolitan goals, including adequacy of treatment of the labor component in the detailed planning process.

(25) "Federal agency review"

As in previous reviews, policies and plans should be evaluated for adequacy of consideration given to the labor component, including labor market analysis, plans for recruitment or training of workers for critically needed skills, assurance of equal employment opportunity, and the degree of citizen participation and acceptance.

1.2.3 Major Problems in Providing Localized Labor Information for Transportation Planners. The major problems are of five types:

a. Difficulties inherent in making demographic and economic projections on a metropolitan area basis.

b. Absence or inadequacy of historical data (secondary source material) which is specific to labor requirements in transportation or labor requirements in other endeavors which are transferable to transportation.

c. Difficulty in establishing firm projections of the transportation-related developments to take place in a metropolitan area for as much as ten years into the future in view of unpredictable changes in public policy and fiscal capability and the resolution of various public controversies.

d. Assumptions to be made as to the purchasing power of the future transportation dollar in relation to jobs likely to be generated per unit of expenditure.

e. Assumptions to be made as to future technological development in construction methods and materials as they may affect labor usage.

2. REVIEW OF LITERATURE ON MANPOWER PROJECTIONS

2.1 General

Most attempts to project manpower requirements have been concerned with total employment in major industrial segments of the total national economy. A survey of available publications, mainly in the Libraries of the U. S. Department of Labor and the U. S. Department of Commerce, reveals very few attempts at projection of the number of workers in specific industries on a state or metropolitan area basis. Even fewer attempts have been made to project the occupational distribution of an industry's workers for a metropolitan area - the goal of the U. S. Department of Transportation.

All the makers of employment projections, whether national or local, start with an estimate of the current situation, make various judgmental assumptions concerning demographic, political, and economic developments, and end up with numerous qualifications concerning the end results. They all agree that economic predictions may be very inexact, should be used with considerable caution, and should be modified as soon as new evidence is available.

2.2 Validity of Assumptions

In 1966, the Bureau of Labor Statistics (BLS) published projections to 1970 by major industries on a national basis which included tables adjusted for employment coverage to be comparable with the Employment and Earnings series (1). With 1965 as the starting point, projections were made for 1970 assuming both three percent and four percent unemployment by 1970. The basic model at four percent unemployment yielded a projection of 3,663,000 wage and salary workers. The Employment and Earnings series, however, shows the 1970 actual annual average as 3,345,000, indicating an overprojection of almost 10 percent. This projection also failed to anticipate the extent of the turn-down and subsequent slow-down in growth of contract construction which began at the start of the projection period. Both models assumed a low rate of unemployment in comparison with the 1970 actual annual average of 4.9 percent of the civilian labor force 16 years of age and older and a rate of 5.6 percent by the end of the year.

In an article, "How Good Were Manpower Projections for the 1960's?" Sol Swerdloff of the Bureau of Labor Statistics (2) said that employment projections by individual industrial groups misfired in a number of cases, including the construction industry. Construction employment had been projected to increase by 30 percent

or more but actually increased by only about 13 percent by 1968 . He also pointed out that skilled workers increased somewhat slower than had been projected, particularly in the construction trades. According to Swerdloff, the key assumptions made around 1960 were:

a. Absence of war or any other cataclysmic event which would substantially alter the rate of economic growth.

b. Relatively high levels of economic activity with low rates of unemployment, around four percent in 1970.

By mid-decade, increased military activity with considerable economic dislocation, including manpower diversion, invalidated the first assumption. The second assumption was generally born out by events. The decade started with unemployment nationally around 5.5 percent and ended in 1969 with only 3.5 percent of the civilian work-force unemployed. However, 1970 and 71 ushered in a new decade with unemployment surpassing the 1960-61 level at a rate which may seriously upset projections which were made for the 1970's.

In a 1965 article, "Manpower Needs by Industry to 1975" (3) Howard Stambler of the Bureau of Labor Statistics also discussed the assumptions and hazards underlying estimates of future employment:

> Projecting future manpower requirements is a difficult and hazardous task. They can be affected by a great variety of possible events: new scientific discoveries and inventions, national and international political developments, natural catastrophies, and the vagaries of consumer preferences. Even if these non-economic influences were all that had to be considered, the task would still be difficult since our knowledge of past economic trends and of the forces governing economic relationships is incomplete and imperfect.

Stambler in 1965 listed a number of assumptions which he considered basic to employment projections to 1975:

a. Relatively full employment in 1975 (about three percent unemployment).

b. Continuity of economic and social patterns and relationships, including patterns of consumption.

c. No war or other cataclysmic event.

d. The size of the armed forces will remain approximately as in 1965.

e. Defense expenditures will remain at 1965 levels.

It is too early to tell whether these assumptions will prove to be valid for 1975. On the basis of events between 1965 and 70, it can be said that none were fully valid for 1970, the mid-point of the projection. In addition, the institution of economic controls in mid 1971 has introduced an unforeseen factor which may influence economic relationships in the near future, either by restoring the previous relationships or establishing new ones. Generally, it can be said we are not experiencing a "continuity of economic and social patterns." At both the national and international level, we are experiencing a period of realignment, including a reordering of priorities through major shifts in fiscal and monetary policies. At this moment, it is doubtful that anyone can make a reliable projection for 1975, let alone 1980.

W. F. Hahn, in a 1971 article entitled "Construction Manpower Needs by 1980 " (4) described the projections as:

> . . . meant to be reasonable approximations of manpower requirements in 1980 under the assumptions outlined, rather than predictions of actual employment levels that year.

The art of economic projection is such that all analysts make similar qualifying statements, even when dealing in broad industrial or occupational groupings for the total national economy. Hahn listed a rather extensive list of assumptions underlying the BLS projections to 1980:

a. The international climate will improve; U.S. will no longer be fighting a war but there will be no major reduction in armaments.

b. The Armed Forces strength will drop back to about the level before the Vietnam escalation.

c. The institutional framework of the American economy will not change radically.

d. Economic, social, technical and scientific trends will continue, including the relative value placed on work, education, income and leisure.

e. Fiscal and monetary policies will achieve a satisfactory balance between low unemployment rates and relative price stability without reducing long term economic growth.

f. All levels of government will spend more in joint efforts to meet a wide variety of domestic needs; however, total government expenditures will represent a somewhat smaller proportion of the GNP by 1980 and more funds will flow to State and local governments.

In addition, Hahn reported that two different demand structures were assumed for 1980:

a. Continuation of the long-term shift toward purchase of more consumer and public services.

b. A slower growth rate in the trend toward services with corresponding greater emphasis on durable goods production.

With each set of demand projections, two alternate assumptions were made regarding the unemployment rate. One assumed three percent unemployment by 1980 and the other four percent. The projection discussed in the article was limited to the three percent unemployment model with continuing shift toward more consumer and public services.

Geoffrey H. Moore, Commissioner of Labor Statistics said in 1970(5):

> Manpower needs are inextricably interwoven with the changing nature of the economy . . . Economic projections are only the beginning, not the end, of considering the future. They provide a framework within which economic and social policies, public and private, must be weighed and debated. In effect, they say: In the light of all that is known about current and future economic developments, the 1980 economy will look like this . . . But the future is not immutable. And whether or not projected economic growth and manpower requirements will lead to equality of opportunity, improved job satisfaction, or a richer life depends

> not on projections, but on the human will and spirit.

Moore's statement is particularly applicable to future developments in transportation inasmuch as they are shaped to a very large extent by willful public policy rather than the free interplay of economic forces.

2.3 Projections for a Metropolitan Area

If Swerdloff's, Stambler's, and Hahn's observations are correct concerning the limitations in projecting employment by industry on a national level (a relatively closed economy) the complexity and unreliability of making projections on the basis of historical data for a metropolitan area can be expected to be greater. Metropolitan projections involve the same assumptions concerning the economy as a whole and additional ones concerning local variations. The greater the number of basic assumptions that have to be made and the smaller the data base, the greater the difficulty in producing a reliable projection.

Stanback and Knight of Columbia University, in a study for the Manpower Administration, U.S. Department of Labor (6) analyzed metropolitan labor markets for 32 industries to investigate specific forces that lead to expansion and contraction. They concluded that:

a. Industrial composition varies by size and principle economic function of a metropolitan area.

b. The composition of jobs added and jobs destroyed differed markedly among types and sizes of metropolitan areas.

c. A single policy for all labor markets is inconsistent with the differing needs of each metropolitan area.

E. F. Shelley and Company, in a 1968 study presenting manpower projections for the Washington Metropolitan area (7) set forth the following qualifying statements:

> Projections in this study should not be treated as absolutes but as trends which may be reliably used as one factor in the planning process . . . For a number of reasons, projections of industrial growth are a hazardous undertaking . . . Construction is one of the most highly unpredictable of industries.

In a 1966 study for the U.S. Department of Labor, the Bureau of Economic and Business Research of Temple University (8) stated that in connection with area studies, "Trend projections provide only a first look at the future, use alone only in the absense of other information."

The Bureau of Labor Statistics in its publication Tomorrow's Manpower Needs (9) made a similar statement:

> Occupational projections developed through the use of relatively mechanical systems. . . should be viewed only as first approximations. They provide the local manpower analyst a base upon which to begin his evaluation.

In connection with the application of several projection methods, the same publication states that :

> On the basis of limited test, several tentative conclusions can be drawn . . . knowledge of local industry is indispensable to improving the quality of the results . . . The greatest industry detail available should be used.

In a similar vein, the American Vocational Research Corporation (10) included the following statement:

> In general, then, job demand projections are like any other projections in that they should be viewed more as indicators of trends rather than indicators of exact levels. Thus, the data in the following matrices should be used as a guide or tool since precise numerical accuracy is questionable.

To make possible a closer follow-up of various "War on Poverty" measures, the U.S. Department of Labor instituted a new system for collecting labor market data for selected metropolitan areas. In a 1969 article, New Directions in Area Labor Force Statistics (11) Howard V. Stambler of the BLS Division of Employment and Unemployment Analysis made the following statement:

> Development of the new area data (UES). . . represents only the first step in a long and costly road. . . after publication of the 1970 census data, . . . the need will remain to expand and revise area data.

He identified the following shortcomings in available metropolitan area data:

a. Too few individual areas.

b. Samples generally too small for development of detailed data.

c. Too little data are available on some significant labor force items - data has not been obtained by occupation or industry.

2.4 Shortcomings of Secondary Source Data

In an article entitled "Construction in an Expanding Economy - 1960 - 2000" (12), Dr. Elmer C. Bratt of Lehigh University pointed out the conceptual and statistical difficulties in dealing with the construction industry:

> Important weight was given to the fact that conceptually 'construction' is not a well defined economic endeavor. The procedure for projecting specific types of construction had to be consistent with the availability of statistical data, but the conceptual limitations on the data involved constituted a major analytical problem. We may not expect economic and institutional changes to influence the rate of construction activity, but the very meaning of the term 'construction' 40 or even 15 years from now will be different.
>
> The inadequacy of statistics using present definitions for measuring construction activity is also a problem . . . The use of shorter periods for projections is also risky. Current conditions seldom reflect effective supply and demand adjustments, and short term changes often obscure probable trends.
>
> Because the type of data needed to establish behavior that might be projected into the future is not available, it was necessary to base projections on both theory and historical patterns . . .

More recently, Martin Ziegler of the Bureau of Labor Statistics in a paper prepared for the North American Conference on Labor Statistics in 1971 (13) made the following statement:

> The whole question of productivity measurement in the construction industry is currently being examined in the U. S. Department of Labor . . . the most frequently quoted measures of productivity for this industry are seriously deficient for a number of reasons. First, because of the heterogeneous nature of the products produced, price measurement and the measurement of real output have serious limitations. Current dollar values of construction are now deflated by cost indexes rather than price indexes. To a large extent this assumes that all increases in wages and material prices results in price increases for the final construction product. With this assumption, productivity gains resulting from labor and material savings can be understated. Second, shifts in the geographical composition of demand and changes in product mix have a significant affect on unit labor requirements, and cause extreme difficulties for productivity measurement. (Emphasis added)

Francis Hahn in his 1971 article, "Construction Manpower Needs by 1980", cited above (4), also made the following observation:

> Although considerable progress has been made in recent years in measuring the performance of contract construction, it should be recognized that weaknesses still exist in output, price, employment, and productivity data that necessarily limit the accuracy of the projected requirements levels particularly as related to occupations. (Emphasis added).

It is important to keep in mind that the studies of the Bureau of Labor Statistics have been concerned with selected segments of construction activity for the nation as a whole and, in some cases, large regions of the country. Whatever is said about the difficulties and limitations in determining national and regional manpower requirements for various types of construction applies with greater force to more localized analyses.

3. EXAMINATION OF SOURCES OF EXISTING DATA FOR METROPOLITAN AREAS

3.1 The Standard Metropolitan Statistical Area (SMSA)

Prior to 1950, metropolitan areas had been defined in somewhat different ways for different purposes and by various agencies. To permit all federal statistical agencies to utilize the same areas for the publication of general purpose statistics, a number of standard metropolitan statistical areas (SMSAs) were agreed upon and used for the first time in connection with the 1950 U. S. Census of Population.

The relative newness of the SMSA basis for publishing area statistics means that historical series for metropolitan areas may be limited to a base year around 1950. This limits the period of time for observing or computing trend behavior, thereby limiting the ability to make reliable extrapolations of trends. At the present time, only three decennial reference points are, or will soon be, readily available (1950, 60 and 70). When comparable data are available on a county and city basis for dates prior to 1950, an SMSA series may be reconstructed backwards in time. However, difficulties may be encountered because of different levels of detail published for small areas.

SMSA boundaries are periodically redefined as contiguous areas meet rather specific criteria for inclusion. In 1967, the Washington SMSA was enlarged by the addition of Loudoun and Prince William counties in Virginia. It is anticipated that the next revision will result in the inclusion of Charles County, Maryland.

The changing definition of a particular SMSA gives rise to some debate as to the necessity for revising a time series to conform to the current definition. Inasmuch as the criteria for inclusion of contiguous jurisdictions are synonymous with area economic growth, increases in population, employment, production, trade, etc., resulting from additions to the area are considered by some analysts as area growth. From this point of view, it is considered undesirable to adjust earlier data to the new boundaries, thereby minimizing the area growth rate (14).

The more common practice is to take the SMSA's most current geographic definition and, using this boundary, redefine the SMSA's boundary for earlier years as if the current boundary were applicable in those earlier years. For the purpose of this study, it seems that this concept of a constant geographic area should apply and earlier data should be adjusted upward by the inclusion of the

additional areas. Not to do so will result in over-estimating future growth of transportation-related employment by producing steeper trend lines.

In the following examination of secondary sources, it will be necessary at times to compare data which are based on different definitions of the geographic boundaries of the Washington SMSA. In the main text and appendixes of this report, differences in data which may be due in whole or in part to differences in area definition will be noted. In most cases the differences due to area definition will not be significant since the 1967 expansion has not to date introduced any major alteration in the construction employment picture of the total area.

3.2 Population and its Projection

It is generally accepted that a circular relationship exists between population and employment. An increase in population in a metropolitan area, whether natural or by net in-migration, increases jobs in private and public services, local trade, and construction of related facilities, including transportation facilities. The population-induced employment opportunities attract adult workers and their families and the cycle becomes accelerated. Some analysts who subscribe to this explanation overestimate the growth potential and tend to make high projections of future population and employment levels. The more sophisticated forecasts result from techniques which achieve a reasonable consistency between population and employment estimates.

A comparative analysis of population projections made for the Washington metropolitan area shows more variation than one might expect.

a. Some are in error because of high base points estimated for 1965 or 66 before the turndown in the fertility ratio was fully evident. The Washington Center for Metropolitan Studies (15) has revealed that the Washington SMSA has experienced a decline in the proportion of the population under five years of age much larger than the decline nationwide and that the area is approaching zero population growth. (Appendix A, paragraph 3)

b. Some of the population projections, including those of the Bureau of the Census, depend on an analysis of five-year age groupings by sex without regard to race and assume that the national experience with fertility and mortality is valid for a local area. As dicusssed more fully in Appendix A, this

assumption is of questionable validity for an area such as the Washington SMSA because of the unusually high proportion of non-white population with both higher fertility (now reducing) and higher mortality than the white component. In such an area, the Cohort-component method by age and sex should be extended to include race.

Arthur D. Little, Inc., in a study for the D. C. Government, Manpower Requirements in the Washington SMSA (16), did provide for the race differentials by conducting the Cohort-component analysis separately for the predominantly white suburbs and the predominantly black core city and using race-specific birth and mortality rates for the latter.

Although population projection is only indirectly related to projections of labor requirements in a specific industrial segment, it is directly essential to projecting labor supply in a metropolitan area. Inaccuracy in projecting the working-age population and its labor-force participation can have a profound influence on estimates of total demand to meet the needs of annual replacement and annual growth in specific occupations at specific points of time. Appendix A presents a comparative analysis of various population projections of the Washington SMSA and points out the errors made in short-range projections as indicative of the difficulties inherent in making longer-range projections on a metropolitan area basis.

3.3. Labor Force Projections

From projections of total population in various sex and age groups, it is necessary to estimate the probable size of the labor force. The Bureau of Labor Statistics compiles labor force participation data for the total U. S. and published projections for 1975, 80, and 85 (17). This series shows only a slight rise in the participation rate from 59.2 percent in 1960 to 60.8 percent in 1985, both sexes combined. However, the male rate is shown declining from 82.4 percent in 1960 to 79.1 percent in 1975 and returning to 79.6 percent in 1985. Women account for the net increase, and their participation rate is expected to rise from 37.1 percent in 1960 to 43.2 percent in 1985.

The contradictory trends by sex in the labor force participation rate will have no appreciable effect upon the supply of workers in the construction labor force where women have constituted a neglible proportion. It can be assumed that over the next decade there will not be a major change in this relationship.

If it is decided that a given metropolitan area does not conform to the national norm with respect to labor force participation, local population census data should be analyzed to determine the local trend, taking into account any social, economic or political factors which might influence the participation rate by sex, age and race. As with projections of total population, the projection of the labor force for the Washington SMSA should take into consideration the racial composition of the population.

3.4. Level of Employment in the Construction Industry and its Projection

A number of sources of historical data and projections concerning construction employment in the Washington metropolitan area have been examined. Out of nine sources discovered, only four attempt projections (one governmental agency and three private research organizations). The historical series and attempts at projection are described and compared in some detail in Appendix B.

All of the sources deal with the construction industry on a metropolitan basis as a single entity except the County Business Patterns publication of the Bureau of the Census (18). The latter breaks down "Contract Construction" into:

General Building Contractors
Heavy Construction Contractors
Special Trade Contractors
Administrative and Auxiliary (very minor)

This breakdown is of no direct benefit in providing a base for projecting transportation-related construction (hereafter referred to as TRC). The latter is itself composed of buildings, heavy construction, and special trade work. Part of the problem lies in knowing whether or not the mix of these components in the total industry of the area is representative of the mix among transportation-related projects. Furthermore, transportation-related buildings do not necessarily involve the same labor requirements as the sub-classification of "General Building Contractors". The latter includes single-family houses, apartment houses, commercial stores and warehouses, industrial plants, public utility structures, and many others.

The limited sub-classifications offered by the Bureau of the Census do not provide the industrial specificity required to establish the trends for TRC. For example, a period of high interest rates was accompanied by a slow-down in residential and commercial con-

struction in this area during the latter part of the 60's. However, TRC does not have the same dependence upon the commercial supply of money. Since funding is primarily from various governmental sources, it is possible for TRC to move contrary to the trend in the construction industry as a whole or in any of its established sub-classifications. For example, the construction of METRO, the modernization of National Airport, and the building of urban freeways will move ahead or be delayed in accordance with public policy rather than in step with private construction. In fact, depending on the fiscal policy being employed by government at a given time, TRC and other public works will most likely be accelerated when the private sector of construction declines.

For the reasons stated above and in Appendix B it is believed that existing historical series of data on construction employment are not a valid basis for projecting either the level or direction of TRC employment. Their value lies solely in delineating the probable future economic environment within which TRC activity must operate in meeting its labor requirements in competition with other construction demands.

Even as background, projections based on available trend data are seriously limited by our ability to make valid assumptions concerning population trends; labor force participation; patterns of consumption; social, economic, and political policy; technological development; and various considerations difficult to express in quantitative terms (see 2.2 above).

As demonstrated in Appendix B, relatively sophisticated and computerized projections of construction employment based on historical data and trend assumptions have been so unreliable, even in the short run, that it has been necessary to revise the base point and trend assumptions at frequent intervals.

The only alternative to historical trend projection which has been applied to the Washington construction scene has been employer surveys in which employers were asked to project their labor requirements by occupation for a period of five years. The D. C. office of the U. S. Employment Service (Appendix B, paragraph 5) conducted two "Area Skill Surveys" among employers. The one conducted in 1962 successfully projected the 1967 level of employment in "Contract Construction, Repair and Maintenance." However, as demonstrated in Appendix B, the one conducted in 1967, near the end of a long upswing in construction activity, failed to anticipate a downturn and produced a very erroneous projection for 1971.

E. F. Shelley & Company, as part of a multidiscipline approach, attempted a survey of both private and governmental employers in 1968 (Appendix B, paragraph 6). Shelley's report (7) contains the following statement:

> As strictly defined, the results of the questionnaire survey do not constitute a statistical study, and no attempt should be made to generalize about the total technical and semi-professional needs of the Metropolitan Washington community from this focused 'sample'. . . responses appearing in this study are not intended to state conclusively the actual characteristics of the Washington Metropolitan Area, presently or in the future . . . all projections were intended to show reasonably possible eventualities based on employer assumptions about the future . . . although it is felt that the data on occupational growth resulting from the employer responses is too questionable to use as a basis for detailed projections, it does indicate certain parallels to the results developed from the primary methodology . . . There is a generic weakness in asking employers to project manpower needs into the future because they tend to measure tomorrow's needs in terms of today's problems . . . (emphasis added)

Arthur D. Little, Inc., in a study for the District of Columbia government (16), conducted 60 interviews with representatives of companies in 16 major industrial sectors. They were asked to forecast growth of employment during 1971-75 in their industry in the area and for their company in particular. In the report, ADL states that, "Frequently data were not as readily available as we had hoped, but we were able to get a feeling for the trends and significant qualitative information . . ." ADL, however, relied mainly on regression analyses using available historical statistics and national occupational patterns with some local modification.

All things considered, it appears that the search for methods of projecting the future level of TRC employment, and its occupational distribution, requires investigation of sources of information other than published series of statistical data.

3.5 Occupational Distribution of Employment in the Construction Industry

Although there are a number of different sources of data on the level of employment in the construction industry in a given metropolitan area, there is only one source which compiles such data with some degree of occupational detail. The Bureau of the Census, in connection with the decennial Census, publishes a table showing the industry group of the employer, by occupation and sex, for SMSA's. The construction industry in all cases is treated as a single entity among 43 industries and the occupational distribution for the Washington SMSA provides for 57 categories for men and 30 for women. Not all of these occupations are relevant to the construction industry, therefore some have zero incidence (6 for males in 1960). The number of relevant occupational classifications was only 51 for males and some of these had a low incidence, as few as four men.

The Bureau of Labor Statistics periodically publishes national occupational patterns for various industries. Based on 1960 Census of Population data, BLS has published national industry-occupational matrices for 1960 and projected for 1975 (9). These matrices have been starting points for the studies by Shelley (7) and Little (16). Since these patterns are based on the occupational and industrial classification of the decennial Censuses they have a fair degree of occupational detail in major industry groups. However, development of a localized pattern for a metropolitan area is limited by the occupational consolidation in the Census data published for SMSA's. Even the full occupational range of approximately 300 occupations on a national basis lacks identification, or specificity of identification, for many jobs of special significance to transportation construction, operation, and maintenance (Appendix C).

The Bureau of Labor Statistics also periodically publishes special studies of manpower requirements in specific types of federally aided construction (Appendix E, paragraph 2 and 3). As a by-product of these productivity studies, BLS compiles data on the occupational distribution of man-hours directly from contractor's payrolls, except in the case of highway construction. In the latter case, BLS has published occupational distributions in only four major groupings of workers obtained from data previously compiled by the Bureau of Public Roads from contractors' reports (Appendix D, paragraph 5).

As previously noted in a review of the literature concerning construction employment, there is complete agreement that labor requirements differ in both quantitative and qualitative terms according to the type of construction, the end-product. Analysis of the limited available data on highway construction also supports this conclusion and demonstrates that the labor requirements differ among types of highway projects. For this reason, as well as other limitations, U. S. Census and BLS publications are not an adequate source of occupational patterns for TRC. A more detailed analysis of available information specific to TRC is set forth in the following section.

4. FINDINGS CONCERNING TRANSPORTATION-RELATED CONSTRUCTION DATA

4.1 Federal-Aid Highway Construction

4.1.1 Employment Generated by Type of Project. In 1962, BPR compiled material and labor cost data, by states, for Federal-aid primary highway construction projects completed during 1960. BPR computed a labor factor expressed as thousands of manhours per million dollars of construction cost. To produce labor factors differentiated by type of work, 1479 projects were selected as representative of each type and grouped as follows:

	Labor Factor - 1960 (Thousands of man-hours per $million)*			
Types of Work	Total US	DC	MD	VA
Roadway:				
Grading & drainage	119	67	-	142
Aggregate bases	116	-	-	-
Bituminous surfaces	91	118	128	110
Concrete surfaces	81	122	110	94
Combination bases & surfaces	95	-	100	-
Bridges:				
Steel	69	95	75	104
Concrete	111	-	83	-
Prestressed concrete	95	-	-	-
Steel and concrete	99	98	85	101

*Source: U.S. Department of Transportation, Federal Highway Administration

The above table shows that the labor factor by type of work nationally had a spread in 1960 from a low of 69 to a high of 119, indicating that the number of jobs likely to be generated by a given expenditure can vary greatly according to the type of highway work being planned. Any substantial change in the highway mix (more or less interstate highways in relation to primary and secondary roads, more or less urban construction in relation to rural) will change the probable number of workers per unit of expenditure and their occupational distribution. Ideally, projections of labor requirements should be based on reasonably discrete types of work and then aggregated (Appendix E, paragraph 4a).

On a national basis, the data on man-hours per million dollars of construction has a broad statistical base and can be considered to have a reasonable degree of reliability. For a state, however, the statistical base becomes extremely thin in many cases, and produces labor factors of questionable reliability. The preceeding table shows the variability among the jurisdictions of the District of Columbia, Maryland, and Virginia. For example, there was only one grading and drainage project completed in DC during 1960. The low labor factor may reflect peculiar circumstances of one urban project, or the performance of one contractor, and may not be typical of what can be expected in the future, either in the short-run or long-run. The high labor factor for Virginia was based on two projects and likewise may not be typical of the geographic area. Maryland had no project exclusively of this type completed in 1960.

Similarly, the data for steel bridges are based on three bridge projects in DC, one in Virginia, and 12 in Maryland. In the case of Maryland, with a larger representation of completed projects, the labor factor more closely approximates the national average. The Maryland data for concrete bridges and combination steel and concrete bridges are based on only one project of each type.

Bituminous surfacing projects were the most common, about 44% of the national total in the BPR study of 1960 completions. However, in Maryland the proportion was 36% and in Virginia 63%. Although these proportions are based on projects without regard to the dollar volume of the work, they illustrate that in any one year the highway mix can vary considerably from locality to locality. Therefore, base lines and trends for employment projections cannot be reliably established for a locality on the basis of either national or local data for total highway construction (all types of work combined). Furthermore, data concerning the labor factor is needed on a continuous basis or at least for several years at a time with periodic up-dating.

4.1.2 Occupational Distribution of Employment. The Bureau of Public Roads (BPR), based on July-August 1958 data, made a study of highway construction as an employment generator (19). The data was obtained in connection with 3425 of approximately 6,600 Federal-Aid Highway Construction projects with work in progress between July 13 and August 9, 1958. Although the statistical base is large, the results are not necessarily representative of the year-round occupational-usage pattern. It is well known that highway construction is highly seasonal in its volume and phasing of various operations. It is not known to what extent this seasonality influences the occupational mix at different times of the year. Although July and August represent a period of peak employment, further research is needed to sample other seasons of the year to test the July-August occupational distribution for representativeness (see Appendix D, par. 4).

A comparison of the occupational pattern of on-site construction man-hours involved in Federal-aid highway construction in the United States as of July 1958 and 1969-71 indicates a remarkable consistency with respect to major occupations.

Occupation[a]	1958[b]	1969-71 (Average)[c]
Foreman	6.3%	7.9%
Truck Drivers	12.3	12.3
Equipment Operators (Operating Engineers)	27.1	26.3
Mechanics	5.7	3.2[d]
Skilled Craftsmen	14.3	13.9
Carpenters	(6.8)	(6.4)
Concrete Masons	(2.2)	(3.1)
Steel Wkrs, Welders, Reinforcing Iron Wkrs.	(1.7)	(3.1)
Other skilled craftsmen	(3.6)	(1.4)[e]
Semi-skilled occupations	--	13.4)) 36.4
Unskilled occupations	34.3	23.0)
	100.0%	100.0%

[a]Excluding officials, managers, superintendents, professionals, and administrative personnel (primarily off-site workers).

[b]Source: Public Roads, A Journal of Highway Research, Bureau of Public Roads, U. S. Department of Commerce, April 1961; data for four-week period July 13 - August 9, 1958.

[c]Source: EEO Report, Office of Civil Rights, Federal Highway Administration, U.S. Department of Transportation; data for last payroll period preceding the end of July 1969, 70, and 71.

[d]1958 data include oilers and helpers, probably included in the semi-skilled category in 1969-71.

[e]Difference may be due to classification procedures; apprentices and on-the-job trainees in 1969-71 were distributed to appropriate skilled trades; for the 1958 data, apprentices were included in "other skilled craftsmen."

BPR data on productivity (man-hours of on-site labor per thousand dollars of contract value) has changed considerably between 1947 and 1964. Expressed in constant 1958 dollars the number of man-hours required has declined from 171 to around 80 (20) and the decline has continued since, although at a slower rate. Estimated by graphic inspection, the requirement per constant thousand dollars (in terms of 1958) may decline to 68 or 70 man-hours by 1980.

The evidence indicates that, although the increasing use of more efficient construction equipment and changes in materials used in highway construction have significantly reduced on-site man-hours, the occupational mix has not substantially changed in the past 13 years. This suggests that the occupational pattern may not substantially change during the next decade, unless there are revolutionary technological developments.

BPR also analyzed the 1958 labor usage by occupation for each type of project. Table 1 illustrates that the various types of construction generate a very different occupational pattern. Truck drivers ranged from a low of 3% of the man-hours to a high of 25%; operators of tractors, loaders, scrapers, dozers and rollers as a group ranged from around 2% on bridges to near 38% on grading and drainage. Conversely, operators of cranes, hoists, draglines, and power shovels ranged from a low of around 2% on grading and drainage projects to 9% on concrete bridges. The hand crafts were high on bridge projects (33-38%) and low on roadway projects (5-7%).

TABLE 1

OCCUPATIONAL DISTRIBUTION OF MAN-HOURS USED ON FEDERAL-AID HIGHWAYS, BY TYPE OF CONSTRUCTION, TOTAL UNITED STATES, FOUR WEEKS ENDING AUGUST 9, 1958, (PER CENT)

			SURFACING		BRIDGES	
	All Projects	Grading, Drainage	Bitumi nous	P. C. Concrete	Concrete	Steel
Professional, Managerial, Clerical & Serv.	10.62	11.24	9.81	9.52	9.44	12.17
Truck Drivers	11.82	7.15	24.94	20.70	3.74	3.00
Constr. Equip. Operators	25.95	48.32	29.18	21.24	12.38	11.08
Tractor & Loader Oper.	5.20	13.30	5.68	1.76	.78	.86
Grader Oper.	4.14	7.33	5.85	3.58	.16	.23
Scraper Oper.	4.07	14.58	.90	2.50	.20	.17
Crane, hoist, dragline, & shovel oper.	3.98	2.17	2.26	2.31	8.96	7.11
Bulldozer Oper.	3.85	7.14	3.23	1.80	.65	.78
Roller Oper.	1.83	2.58	5.02	1.51	.18	.21
Concrete mixing & paving mach. oper.	.67	.12	.22	4.24	.59	.24
Asphalt plant & paving mach. oper.	.49	.26	2.90	.14	.00	.03
Concrete & asphalt finishing mach. oper.	.41	.00	.48	2.14	.08	.14
Rock crusher & gravel plant oper.	.40	.14	1.77	.20	.00	.00
Pile driver oper.	.34	.08	.00	.00	.65	1.20
Other oper. & apprentices	.57	.62	.87	1.06	.13	.11

TABLE 1 (continued)

Crafts associated with equipment operators	5.43	7.68	5.36	4.90	2.07	3.23
Skilled Craftsmen	13.67	5.54	6.25	7.18	33.04	37.83
Carpenters	6.55	1.89	.63	1.14	23.04	19.21
Concrete Masons	2.06	.42	.86	3.22	3.81	2.93
Stru. Steel Workers & Welders	1.01	.40	.51	.19	1.52	10.29
Reinforcing Steel	.64	.07	.09	.27	2.29	2.03
Painters	.12	.00	.14	.00	.10	1.39
Drillers, Mud jack oper.	1.05	1.34	.23	.22	.58	.59
Metal Form Setters & Form Tamper Oper.	.56	.08	.20	1.69	.67	.00
Bit. Paving Workers	.44	.02	2.53	.11	.08	.09
Other Skilled Crafts.	1.24	1.32	1.06	.34	.95	1.30
Unskilled Workers	32.51	20.07	24.46	36.46	39.33	32.69
TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

This one-time study used the most detailed occupational breakdown of any labor usage study found in the search of the literature on construction employment. It is not possible to compare the patterns by type of construction with any recent data. Since, as we saw above, the job pattern has remained consistent for all highway projects combined, it is a fair assumption that the pattern for each type of construction has also remained substantially the same.

Within the federally-aided highway system a distinction is made between Interstate, Primary, and Secondary highways. The 1958 labor-usage data were analyzed by BPR for differences among the three classifications of highways without regard to type of construction (surfaces, bridges, etc.). The Interstate projects were found to utilize fewer man-hours per unit of cost and to generate fewer jobs (based on BPR method of estimating from data for four-weeks only.

Table 2 shows the differences in how the man-hours were distributed among principal occupations within the three major highway systems. Compared with the other systems, secondary highways were characterized by a higher usage of truck drivers and construction equipment operators and a lower incidence of most kinds of skilled craftsmen. Secondary roads used skilled craftsmen as a group at half the rate found on Interstate projects. These differences in occupational pattern are probably the result of a different mix in the type of work undertaken (grading, surfacing, and structures) in connection with each class of highways.

It should be noted that the 1958 data by highway systems were a by-product of a study of differences among projects classified by type of work. The projects included in the analysis were selected to be relatively pure examples of each specific type of work and excluded contracts of a mixed character. It is not known what differences in occupational pattern among the road systems would have resulted from an analysis of all projects or a sample which had been selected to be representative of all projects.

Martin Ziegler, in his 1971 paper, BLS Construction Labor Requirements Program, (13) said:

> Technical and economic relationships between inputs and outputs are unique for each construction type. Different combinations of factors, inputs, materials and technical processes exist within the industry. These are reflected in the occupational and material requirements for each construction product . . . To project future needs, therefore, it is necessary to take account of the unique requirements of each segment of the industry. (emphasis added).

TABLE 2

OCCUPATIONAL DISTRIBUTION OF MAN-HOURS USED ON FEDERAL-AID HIGHWAYS, BY HIGHWAY SYSTEMS, TOTAL UNITED STATES, FOUR WEEKS ENDING AUGUST 9, 1958 (PER CENT)

		HIGHWAY SYSTEM		
	All Projects	Inter-state	Primary	Second-dary
Professional, managerial, clerical & service	10.62	10.52	10.85	10.37
Truck Drivers	11.82	10.35	12.03	14.63
Construction equipment operators	25.95	24.40	26.07	29.46
Tractor, loader, scraper bulldozer & roller operators	14.95	14.14	14.46	17.58
Motor grader operators	4.14	3.23	4.17	5.84
Crane, hoist, dragline & shovel operators	3.98	4.13	4.21	3.49
All other operators & apprentices	2.88	2.90	3.23	2.55
Crafts associated with equipment	5.43	6.06	4.96	5.01
Skilled Craftsmen	13.67	16.66	12.82	8.38
Carpenters	6.55	8.45	5.54	4.12
Concrete Masons	2.06	2.48	2.10	1.07
Structural steel workers, welders	1.01	1.32	.98	.42
Reinforcing steel workers	.64	.92	.51	.24
Drillers, mud-jack operators	1.05	1.24	1.10	.73
Other craftsmen	2.36	2.25	2.59	1.80
Unskilled Workers	32.51	32.01	33.27	32.15
TOTAL	100.00%	100.00%	100.00%	100.00%

From the above observations, it appears that any projections of future manpower requirements by occupation should be made for each type of construction being planned and then aggregated for an area (see 4.1.1 above and Appendix E, para. 4).

It is possible to make a rough comparison of the occupational distribution of employment at several points of time between Federal-Aid Highway construction (all classes of highway work combined) and the total construction industry. Because of differences in the degree of occupational detail employed by different agencies, some regrouping is necessary to achieve a fair degree of comparability in percentage distributions. The Bureau of Labor Statistics has developed an occupational distribution pattern for a number of industries based on 1967 employment and projected for 1980. The Federal Highway Administration's Office of Civil Rights has compiled occupational data for 1969-71.

For the construction industry as a whole throughout the nation, the BLS projection for 1980 does not radically alter the occupational pattern which BLS has estimated for 1967. They project a higher proportion of professional, technical and clerical workers, operating engineers, and vehicle operators, and a decline for skilled construction trades as a group and unskilled laborers.

A comparison of the FHWA OCR data (1969-71 average) with the BLS 1967 estimate for the whole construction industry shows radically different occupational patterns. In comparison with the total construction industry, Federal-Aid Highway construction reveals the following major differences in the number of workers in each occupational group per thousand workers:

Managers, officials, and proprietors - less than one-half as many.

Clerical workers - a little more than one-third as many.

Foremen - about 2½ times as many.

Skilled construction trades - less than one-third as many.

Carpenters - less than half as many.

Cement and concrete masons - over twice as many.

Welders and flame cutters - about 2½ times as many.

Construction equipment operators - almost five times as many.

Truck and tractor drivers - almost three times as many.

Unskilled and semi-skilled workers - about twice as many.

The foregoing observations, although clouded by problems of classification comparability, demonstrate that the occupational pattern developed nationally for the entire construction industry cannot be applied specifically to highway construction employment and probably is not a valid pattern for other transportation related construction (mass transit, airports, etc.).

4.1.3 Occupational Distribution of Highway Construction Employment, States and Metropolitan Areas. Examination of the data derived from the EEO reports submitted by states to the FHWA Office of Civil Rights, indicates that there are sufficient differences in the occupational pattern by jurisdictions to make it desirable to develop localized patterns for a given metropolitan area rather than use a national pattern (Appendix D, para. 6). The District of Columbia is the only totally urban jurisdiction reporting to FHWA. Its occupational pattern is so radically different from the national pattern, and the pattern of adjacent states, that it raises a number of questions concerning the direct use of existing national or state data for the analysis and projection of labor requirements in metropolitan highway construction. Comparable data have not been compiled for metropolitan areas. This could be done by going to the contractors' EEO reports now in the possession of the states.

The present analysis leads to the conclusion that it would be very misleading to assume that the project-type mix, and therefore the occupational mix, is the same for metropolitan areas as for the rest of the country, or even for a group of states. Further evaluation of this conclusion and investigation of whether or not a single matrix can be developed which would be suitable for all metropolitan areas, or metropolitan areas of specific sizes, will require compilation of data from each of the following original sources:

a. Project completion reports (Form PR-47), in the possession of the Contract Administration Branch, Construction and Maintenance Division, FHWA, which contain total man-hours used (without occupational breakdown), construction type code, final construction cost, date started, date completed, and location by county and state.

b. Occupational distribution of employment from contractors' EEO reports in the possession of the states, selected to cover projects which can be identified as metropolitan. Occupational

distribution from this one-time-of-year source needs to be tested for year-round representativeness (Appendix D para. 4).

4.1.4 Projecting Metropolitan Area Highway Construction. The District of Columbia government compiles a six-year Capital Improvement Program which includes the estimated project cost for each highway and street construction project phased over the period 1972-77. The projects are identified by Project Number and location within the city. Further description concerning the type of work (grading, surfacing, bridges, etc.) would need to be ascertained from the Department of Highways and Traffic in order to translate the planned construction into the probable volume of employment to be generated and its probable occupational distribution year by year.

No similar publication has been found for the adjacent areas of Maryland and Virginia to complete the metropolitan picture. Planned highway construction for the suburban jurisdictions comprising the Washington SMSA would need to be obtained from the Maryland and Virginia Highway Departments in unpublished form and consolidated for the metropolitan area.

4.2 Urban Mass Transit Construction for the Washington Metropolitan Area

4.2.1 Projected and Actual Volume of Employment. The Washington Metropolitan Area Transit Authority, in planning for the construction of METRO, prepared estimated requirements for construction workers phased by quarters from July 1970 through October 1980. The total number of "construction workers" was projected for July 1971 to be 1916. The METRO EEO Officer reported that in July 1971 there were 1,241 such workers (65% of estimate) on the payrolls of contractors. Some of the discrepancy may be due to differences in occupational classification, some may be due to operations being out of phase. To the extent, that the former is true, there is indicated a need for standardized estimating and reporting by occupation. To the extent that the latter is the case, a difficulty inherent in long-range planning of construction is demonstrated.

4.2.2 Projected and Actual Employment by Occupation. The occupational titles used to forecast METRO requirements for construction workers do not fully line up with those used in compiling EEO reports from information submitted monthly by contractors. However, following is a comparison of the projected and actual numbers as of July 1971 in those classifications which are reasonably discrete and not subject to serious definitional error:

Occupation	Construction Division Projection for July 1971	EEO Projection for Sept. 1971	EEO Actual for July 1971
Carpenters	221	175	72
Cement Masons	44	75	5
Electricians	110	40	9
Operating Engineers	259	125	222
Rodmen	49	20	5
Steamfitters (Pipefitters)	41	40	1
Teamsters	218	175	54
Tracklayers	14	20	0

The two projections are not reasonably close to each other and both overestimated in most cases. If recruiting or training had been based on either projection, and if the number actually on payrolls is assumed to have met the requirements in July 1971, a serious oversupply in a number of categories would have resulted. This observation raises a question as to whether contractors were short in various skill classifications but functioned through substitution of workers in lower skill categories. In any case, it is very likely that the forecasters lacked a realistic basis for estimating what contractors are likely to do in putting together an adequate workforce. Further investigation for other points of time would be required to ascertain whether the observed differences are due to work being out of phase with respect to scheduled operations or whether base data and procedures for making projections are inadequate.

4.3 Airport Capital Improvement in the Washington Metropolitan Area

The Federal Aviation Administration has very limited information on planned construction in connection with the Washington National Airport and the Dulles International Airport. Of an estimated $40 million for FY '73 construction, $8.5 million are for grading, drainage, paving runways, paving taxiways, paving airfield parking areas, and constructing service roads. These latter projects

are probably similar enough to appropriate types of work on highways to permit estimating labor requirements as for highways. However, the other planned construction ($31.5 million worth for FY '73) is probably unique to airports.

For FY '74 the planned airport construction places much more emphasis on highway-type work, $27.7 million as against only $4.6 million in structures and control systems. Present planning extends only through FY '77. By then, construction is expected to taper off to $11.5 million in highway-type work and only $750 thousand in other facilities.

The studies completed in the recent past by the Bureau of Labor Statistics on labor requirements for various types of construction (Appendix E. par. 2) are not likely to provide a valid formula for airport structures and airways facilities. What is needed is an analysis of payroll data for recently completed airport facilities.

At the present time, there is considerable uncertainty concerning the future status of the area's major airports. The release of National and Dulles from direct Federal ownership and control may drastically change the type and scheduling of airport improvements.

5. PLAN FOR DEVELOPING PROJECTION MODELS

In the preceding section the sources of information on transportation-related construction (TRC) in the Washington metropolitan area were identified and evaluated. It was found that there is no single, comprehensive system of data collection and compilation covering all types of TRC from which the level of employment and its occupational distribution can be projected in the aggregate. More data has been assembled for highways than for any other kind of TRC but even here, we have seen, highway construction should not be treated in the aggregate without attention to the type of projects.

There is a need for a systematic and reasonably uniform approach to developing models for projecting employment by occupation for each type of TRC. This section sets forth, in general outline, a proposed procedure for the development and application of such projection models, basically modeled on the techniques employed by the Bureau of Labor Statistics in its series of studies on the labor and material requirements for selected types of construction (20).

5.1 Development of Projection Models from Primary Sources

5.1.1 Payrolls as Primary Source of Data. There are statutory requirements that all construction contracts to which the Federal Government is a party (Davis-Bacon Act) and those that are in connection with federally aided construction (in a variety of separate acts) provide for compliance with wage standards established by the Secretary of Labor. The U. S. Department of Labor has issued regulations which require contractors performing work under the various statutes to submit copies of their payrolls to the supervising federal agency, or office designated by it, for compliance review. Complete sets of submitted payrolls are retained by the monitoring agency for a number of years after completion of a construction contract.

a. They contain the actual number of hours worked each week by each worker. This permits compiling total man-hours used in each occupational classification rather than a maximum body count of workers employed sometime in a given period regardless of the degree of utilization (such as EEO reports).

b. They provide for greater occupational detail than is customary in reports submitted in summary form with various job groupings, not always under well-defined, standardized conditions (Appendix D, para. 2). Grouping after extracting data from original payrolls may be accomplished in a manner which best serves the objectives of the projection models. For example, the positions of survey instrumentman, draftsman,

and soil analyst have a low enough incidence not to be separately identified in summary reports. However, from a vocational training point of view there is a need for separate identification.

c. Job-titles used by the contractors can be checked for reliability against the hourly rates of pay whereas summary reports, such as EEO reports, cannot be subjected to an internal consistency check.

d. Each payroll is identifiable as pertaining to a specific construction project and the labor usage can be related to:

(1) A reasonably discrete category of work. Summary reports, such as FHWA's EEO compilations, are not broken down by type of project and to do so would require going back to individual contractor's reports in the possession of state highway departments.

(2) A specific dollar value of a completed project. Although FHWA's EEO summary includes the total dollar amount of the individual contracts, a satisfactory ratio of labor requirements to dollars cannot be developed. The number employed at one point of time is not a satisfactory measure of the level of labor usage throughout a project, start to finish, and does not allow for short workweeks at one point of time and over-time work at other times, so characteristic of construction operations because of unpredictable climatic factors.

e. Project payrolls are the only source from which both man-hours expended and their occupational distribution can be ascertained and related to type of project and dollar value in one operation. Forms PR-47 on completed highway projects yield total man-hours, but not differentiated by occupation. Development of the total man-hours data for a given metropolitan area would require going back to individual contractor's reports in the possession of FHWA, selected for the location of projects. This would involve considerable effort involving original source documents without producing occupational patterns.

f. Project payrolls are the only universal source for comparable data for all categories of TRC (roadways, bridges, airports, mass transit, and parking facilities). Other sources are not only inadequate with respect to specificity of data but differ so much in method and format that the available data cannot be aggregated to represent the totality of TRC in a given area.

g. Payrolls can be assembled for representative projects in a metropolitan area to provide localized projection models. As previously demonstrated, there is evidence which indicates that the urban pattern of labor usage on highway construction differs greatly from nation-wide or state-wide patterns (see 4.1.1 and Appendix D, par. 6). A number of the BLS studies on labor requirements show regional differences for various types of construction. It may not be necessary to go to original payroll sources for each metropolitan area for which TRC projections are desired. It is possible that a tryout for several metropolitan areas may prove that a single set of metropolitan models is feasible. Determination of what is feasible depends on experimental development of primary source data.

5.1.2 Use of Data from Payrolls to Develop Projection Models. Assuming that further investigation establishes the feasibility of using a single metropolitan area projection model, the major steps which would be involved are briefly identified in Appendix E, par. 4. The details of each step will depend upon whether manual or ADP procedures, or a combination of them, are adopted. The steps as presented assume that relatively simple ADP support will be available and used.

5.2 Application of Projection Models

The man-hour-to-dollar ratio and the occupational matrix developed as above for each type of project needs to be applied to the dollar estimates of the construction of each type planned for a metropolitan area, phased by years, for as far in the future as plans are available. The steps necessary to this process are briefly described in Appendix E, par. 5.

In the case of urban mass transit systems, such as Washington's METRO, the procedure must be modified. At the present time, METRO type systems are so recent and unique that payroll analysis of completed projects will not be possible. As noted in Section 4.2, there are disturbing inconsistencies in labor usage projections made for METRO during the planning stage. At this time, a special study is needed to analyze payrolls for labor usage to date and revise the remaining projections to be more realistic. An analysis of completed, comparable segments of San Francisco's BART system is also needed to help improve Washington's METRO projections. For this purpose, the total BART system needs to be broken down into reasonably homogeneous segments judged to be generally comparable to Washington's METRO segments, such as underground stations, above ground stations, subway trackage, above ground trackage, etc. Upon completion of several urban mass transit systems, a body of labor-usage data will have been accumulated to serve as an objective base for projecting requirements for later systems.

5.3 Area Projections for the Total Construction Industry

5.3.1 Existing Techniques. The procedures discussed above will produce labor requirements projections for transportation related construction (TRC). As previously pointed out, TRC must compete with the construction industry generally for most of its manpower needs (see 3.4 and Appendix B, par. 8b). Techniques for projecting future needs of an area by industry and occupation have been rather fully developed by the Bureau of Labor Statistics and well described in its publication, Tomorrow's Manpower Needs (9). These techniques have been applied to the Washington Metropolitan area, with varying base data and growth assumptions by Shelley (7), Little (16) and NPA (14). Comparison of their population and construction industry growth projections are presented in Appendix A and B.

As noted in Appendix B, the 1960 Census data on construction industry employment differed considerably from estimates derived from other sources. Although the A. D. Little projections had the advantage of being based on 1970 population counts, they did not have the benefit of 1970 Census data on employment by industry and occupation (not yet available). In view of the 1960 discrepancies, there is a need for re-examination of all projections as soon as 1970 U. S. Census data are available (due for publication during the Summer of 1972). Such re-examination may call for a revision of the WSMSA projections for the construction industry. Until such a re-examination is made, it is difficult to select the most appropriate projection from among the three attempts identified above. At this writing, it appears that the ADL projection is probably the best, although on the high growth side.

To repeat, reasonably good statistical techniques exist for estimating, by occupation, loss replacement needs (death, retirements, dropouts) and new demand due to industry growth, provided that good assumptions are made concerning population growth rates, labor-force participation rates, and industry growth.

5.3.2 Adjustment of Construction Industry Projections for TRC Requirements. As previously concluded, TRC may not expand or contract in unison with the construction industry as a whole (see 3.4). The labor requirements developed for TRC must be integrated with the best possible area estimate for the construction industry of which it is a part. If opposite or divergent trends are projected, the estimate for the industry as a whole should be adjusted on a judgmental basis.

Industry-wide projections also need to be adjusted for special occupational detail. TRC projections will include a different level of occupational detail because of unique requirements. For example, because METRO is a component of the area's TRC, there will be a requirement for tracklayers in the occupational matrix for certain periods of time. Tracklayers do not appear in the decennial census tabulations by occupation and industry, and therefore do not appear in the BLS occupational pattern for the construction industry.

Inasmuch as area projections for the total construction industry include TRC requirements, the integration of special levels of detail for TRC must be carefully accomplished to avoid duplication (double counting). This consideration can be theoretically anticipated but specification of a procedure cannot be very well set down until the data are in hand, the adjustment requirements better known, and an informed judgment made with respect to procedure.

5.3.3 Minority Employment Opportunities. The projections of area occupational requirements made by Shelley, Little and NPA were made without consideration of minority employment as a separate element of the requirements. For selected occupations, however, specific objectives have been established for the employment of minority workers. Specifically in the area of construction, plans have been formulated to expand minority employment. One such plan is known as the Washington Plan (24). The existence of these plans calls for refinement in the method of projecting labor demand in those occupations specifically covered by the plans in order to measure the replacement and growth demand for minority workers in specific trades. Here growth means a share of normal industry expansion and the increased share set by regulations.

The desired refinement will require starting with separate estimates of the number of majority and minority workers in the base period, estimating separate loss replacement rates for each, and allocating industrial growth demand between them in such a way as to achieve the objective set by public policy. This can be done after the 1970 Census data on occupations is available and April 1970 can be established as the starting point for projections.

6. RECOMMENDATIONS

A. That a Statistical Standards Task Force be established in DOT. At the present time there is no uniformity in the collection and presentation of statistical information on labor requirements among the various major elements of DOT. Integration, aggregation, and comparative analysis are made difficult because the independent data collection efforts and end products differ in very fundamental ways. A DOT Statistical Standards Tasks Force should be composed of representatives of all major elements and be charged with devising and proposing procedures which will achieve the following objectives and others the Department may establish:

1. Standardization of basic terms and their definition (labor requirements, manpower requirements, labor factors, labor usage, contract price, on-site, off-site, construction workers, nonproductive workers, wage and salary employees, etc.).

2. Standardization of the level of detail in classification of construction contracts by type of work (grading, surfacing by type, structures by types, etc.).

3. Standardization of the level of occupational classification detail for workers employed on construction projects.

4. Standardization of occupational titles and definitions employed in reporting systems, including the initial input of contractors and processing by intermediate agencies.

5. Standardization or coordination of "as-of" dates employed in reporting systems.

6. Determination of the most desirable and reasonable frequency for reporting labor utilization data, including minority utilization.

7. Providing, to the extent feasible, for integrated data collection and processing under a system which will serve the needs of a number of DOT elements in one operation, or at least provide a common input with specialized outputs (Data Bank concept).

It is further recommended that the Task Force be instructed to confer with appropriate staff members of the Bureau of Labor Statistics and the Bureau of the Census.

B. That labor requirements projection models be developed from project payroll data. For numerous reasons discussed in this report and its appendixes, secondary sources of current and historical data are not adequate for projecting the labor requirements of transportation-related construction. As a primary source, project payrolls in the possession of government agencies at various levels are the most adequate source of the desired data for reasons set forth in Section 5.1.1.

C. That projection models developed from payroll data for a sample of metropolitan area projects be tested for their general applicability to all metropolitan areas. The limited evidence available on transportation-related construction in a metropolitan area indicates that such areas generate labor requirements which differ from nation-wide and state-wide experience. There is no evidence to indicate whether or not there can be a satisfactory single metropolitan area model.

D. That the labor requirements projections for Washington's METRO system be revised in the light of experience to date with actual payrolls. Urban mass transit systems can be expected to be unique to each metropolitan area over the next decade. Inasmuch as their labor requirements will very likely be unique, for some time to come, such labor requirements will need to be projected by special procedures and then added to the other projections for the area. Analysis of the experience to date with BART and METRO is essential to improving projection techniques for UMTA projects.

E. That the established procedures for developing area manpower projections by industry and occupation be modified in cooperation with the Bureau of Labor Statistics to incorporate established objectives for minority job opportunities in selected occupations. As previously noted, various statutory and regulatory requirements concerning minority employment in specific occupational classifications make it desirable to refine the labor market projection procedures (5.3.3).

F. That metropolitan planning agencies give consideration to the labor component throughout the urban planning process, with particular attention to minority training and utilization in critically needed skills. Appropriate attention to equal opportunities in employment of minority workers and participation of minority contractors, starting early in the planning process, will facilitate achievement of EEO goals, aid in obtaining public acceptance of proposed systems, and provide a basis for required training programs (1.1.4).

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APPENDIX A

POPULATION PROJECTIONS FOR METROPOLITAN AREAS

1. Basic to projections of employment by occupation and/or industry for an area is a reasonable projection of population for the area, preferably by age and sex and taking into account separately for each sex and age group the components of change consisting of births, aging, deaths, and net-migration. This procedure, known as the "cohort-component" method, is employed by the Bureau of the Census. In addition, the Bureau of the Census makes separate projections based on different assumptions concerning fertility and mortality rates. For SMSA projections they use the highest and next to the lowest fertility ratios from among four ratios.[1]

2. The Bureau of the Census uses a single set of mortality rates and two alternative assumptions of fertility for all metropolitan areas. This procedure makes no allowance for area differences in either fertility or mortality experience.

   a. Inasmuch as areas differ in their racial and ethnic composition, the assumption of uniform national rates is not necessarily valid for given metropolitan areas. For example, the Department of Health, Education, and Welfare compiles estimates of life expectancy by sex, race, and age groups which show that, for all age groups which constitute the category of "prime working years," the white population has a significantly longer life expectancy than the non-white population.

   b. In metropolitan areas with a racial composition similar to the nation as a whole, the Bureau of the Census procedure may be reasonably valid. However, in the Washington SMSA the non-white population in 1970 was 25.7 percent of the total compared with 12.6 percent nationally. In terms of the central city population, the Washington SMSA stands first among all SMSAs in the proportion non-white, 72.4 percent.

3. As noted above, the Bureau of the Census uses two assumptions covering fertility in making metropolitan area high and low projections of population by sex and age groups.

   a. Comparison of 1960 and 1970 census findings by age indicate that there has been a marked decline in the fertility ratio nationally, and very dramatically in the Washington metropolitan area. The area's under-5 population

grew by only about 20,000 in the 1960-70 decade, the slowest rate of increase (9 percent) of any major age category. This is a decline from a 39 percent growth for the same age group in the 1950s. An unprecedented high rate of increase among young adults was paralleled by an exceptionally low rate of increase among children. Nationally, the under-5 category is 15.5 percent smaller than a decade ago. In the District of Columbia the decline was 25 percent. The Center for Metropolitan Studies concludes that a "declining rate of population growth and possibly eventual stability now seem to be realistic prospects for metropolitan Washington."[2]

b. There are a number of reasons for believing that the fertility rate will continue to decline before stabilizing, both nationally and in the Washington area. All earlier projections of population, made before the extent of the drop in fertility was revealed by the 1970 census, need to be carefully evaluated and possibly scaled down.

4. In connection with different studies for different purposes, several projections of total population have been made for the Washington SMSA.

a. The Bureau of the Census in January 1969 published Washington SMSA population projections for 1975 based on estimated 1965 population characteristics, as follows (excluding Loudoun and Prince William counties):

1960	Actual	1,989,377
1965	Estimated	2,409,000
1970	Low Interpolation	2,703,000
	Actual	2,712,871
	High Interpolation	2,762,000
1975	Low Projection	3,034,000
	High Projection	3,166,000

Assuming a compound annual growth rate 1965-75 (2.34 percent low and 2.77 percent high) the low interpolation for 1970 would be 2,703,000 and the high would be 2,762,000. Compared with the 1970 actual population of 2,712,871, the low interpolation is very close but on the low side. If the differentials in life expectancy between the white and non-white population had been taken into account, the 1970 projections may have been even lower. This illustrates the difficulties in making even short range projections for a metropolitan area considering the fact that the Bureau of the Census has a frequent look at population changes through the Current Population Survey (a monthly sampling of households).

b. E.F. Shelley and Co., in a study for Washington Technical Institute briefly discussed population trends in the Washington area. Although Shelley and Co. did not make a specific projection for 1970 they gave an estimate of where the total population stood in 1967 and implied that an average annual growth rate of around 5 percent may be expected for the near future. Shelley set forth the following, apparently excluding Loudoun and Prince William counties (1960 definition of the SMSA):

1960	1,989,377	1960 U. S. Census
1967	2,730,000	Shelley estimate
1970	3,127,000	Extrapolation at same compound annual growth rate (4.63 percent)

Calculations from the Shelley data yield a compound annual growth rate for 1960-67 of 4.63 percent whereas the BOC data yields a 1960-65 compound rate of 3.91 percent. Extrapolation of the Shelley compound rate to 1970 produces a population projection of 3,127,000. This projection exceeds the 1970 actual population by 15.3 percent. Inasmuch as the Shelley report does not set forth population change assumptions or the method of projection, the cause of high over-projection is not identifiable.

c. The Center for Economic Projections of the National Planning Association (NPA) prepared projections through 1985 for 224 metropolitan areas.[4] The NPA report includes actual figures for 1950 and 1960, an estimate for 1966 and projections for 1975, 80, and 85 without adjustments for changes in the boundaries of the SMSA on the theory that expansion of the area by definition is a part of the area growth.

(1) NPA started with an estimate of 1966 population of 2,612,000. This is high compared with the BOC estimate for 1965 which, extrapolated at the 1960-65 compound annual growth rate, yields 2,504,000 for 1966. It appears that the NPA estimate for 1966 does not include Loudoun and Prince William counties. Inasmuch as the BOC estimates for 1965 also exclude these counties, the differences are not due to area definition.

(2) The NPA projected total population as follows:

1966	2,612,000	(excluding Loudoun and Prince William counties)
1975	3,217,600	(including Loudoun and Prince William counties)
1980	3,598,800	(including Loudoun and Prince William counties)
1985	4,005,000	(including Loudoun and Prince William counties)

NPA did not publish a projection for 1970 and the change in area definition creates interpolation problems. However, following the NPA practice of no adjustment of earlier data for boundary changes and employing the compound annual rate of change for their 1966-1975 projection, the interpolation for 1970 is 2,865,200. This is very close to the 1970 census figure of 2,861,123.

(3) The NPA projections through 1985 may be too high, however, unless allowance was made for the recently confirmed drop in the fertility ratio.

d. The Arthur D. Little (ADL) study[5] incorporated population projections made in cooperation with Dudley W. Gill and Associates. Starting with 1960 and 70 census data, ADL presents projections for 1975, 80 and 85 in four series: assuming net migration in comparison with the 1960-70 rate to be zero, 25 percent, 50 percent, and 75 percent. These projections were tested for reasonableness against various projections of employment opportunity and the 25 percent migration series was chosen as the most reasonable:

	Low	"Most Reasonable" In Thousands	High
1960		2,077*	
1970		2,862*	
1975	3,038	3,168	3,427
1980	3,227	3,517	4,154
1985	3,432	3,916	5,096

*Actual U. S. Census

The "most reasonable" projection for 1975 is very close to the BOC high projection and was achieved by assuming a decreased rate of net growth compared with the decade of the 60s. The projections for 1975-85, however, resume an annual increment about the same as 1960-70 and closely parallel the NPA projections at a somewhat lower level. The ADL study assumed that "future levels of fertility will decrease, though only very slightly." The "very slightly" qualification, however, may indicate that ADL projections still may be too high with respect to natural population growth. On the other hand, assuming 25 percent of 1960-70 migration may be on the conservative side. All things considered the ADL presentation seems well balanced, has been tested for reasonableness, and has the advantage of a 1970 base point.

e. The American Vocational Research Corporation (AVRC) made a study for the District of Columbia School Board.[6] Their report includes an analysis of population trends in the Washington SMSA based on decennial census data, including data for 1970. However, the AVRC projection of 1975 population is for the District of Columbia only. Since their report does not contain a forecast for the SMSA, the AVRC projection is not comparable with those previously discussed.

5. Summary comparison of various population counts, estimates, and projections for the Washington SMSA (in thousands): (See Chart A-7).

Year	BOC	Shelley	NPA	ADL[a]
1960	1,989*	1,989*	2,018*	
	2,064			
1965	2,409*			
1966	2,504*[b]		2,612*	
1967	2,602*[b]	2,730*		
1970	2,703*[c]			
(actual)	2,713*	3,127*[e]		
	2,762*[c]			
(actual)	2,861		2,865[f]	
1975	2,919*[b]			
	3,034*[d]		3,218	
	3,166*[d]			3,168
1980			3,599	3,517
1985			4,006	3,916

*Excluding Loudoun and Prince William counties

[a]ADL's "most reasonable" projections

[b]Extrapolation 1960-65 compound annual growth rate

[c]Low and high interpolations of 1965-75 projections

[d]Low and high projections 1965-75

[e]Extrapolation 1960-67 compound annual growth rate

[f]Interpolation 1966-75 compound annual growth rate

6. Conclusions:

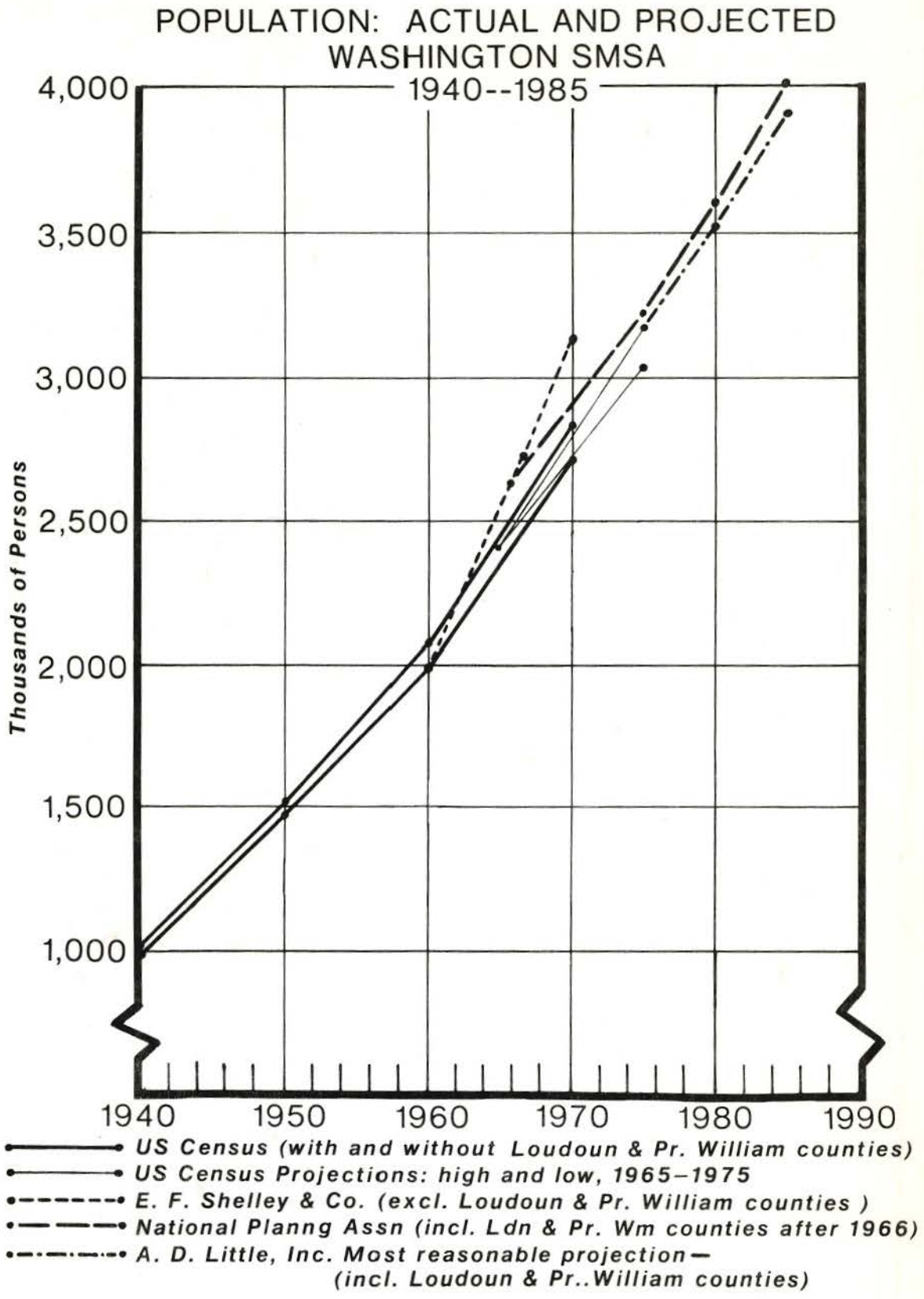
a. In projecting total population and the labor force for the Washington SMSA, the cohort-component method should include race as well as sex and age. In effect, separate projections should be made for the white and non-white populations and then combined for projections of the total population.

b. The fact that various estimates for the years 1966 and 1967 were wide of the mark on the high side indicates the difficulty inherent in making longer-range projections on a metropolitan area basis and casts doubt upon the validity of the various assumptions upon which they had been based.

c. Projections for the Washington SMSA based on the 1970 census should take into consideration the local experience with a fertility ratio declining more than nationwide. However, this fact does not affect the size-of-labor-force projections made through 1980 inasmuch as children born after 1965 will not be a part of the labor force until after 1980.

d. Factors may be at work which make metropolitan growth self-limiting. If this is the case, geometric or even arithmetic progressions may be the wrong statistical approach. It is possible that a given metropolitan area may be on the rapid growth sector of a third degree exponential growth curve. Some statistical or judgmental basis may be needed to decide when a more sophisticated growth curve should be used as the basis for long-range population projections.

e. The Arthur D. Little population projections for the Washington SMSA appear to be the most realistic although probably on the high side. With some adjustment in relation to Bureau of the Census projections and correction for the area's marked decline in the fertility rate, the ADL projections should serve as the framework for employment projections for the Washington metropolitan area.


POPULATION: ACTUAL AND PROJECTED
WASHINGTON SMSA
1940--1985
4,000
3,500
3,000
2,500
2,000
1,500
1,000
Thousands of Persons
1940
1950
1960
1970
1980
1990
US Census (with and without Loudoun & Pr. William counties)
US Census Projections: high and low, 1965–1975
E. F. Shelley & Co. (excl. Loudoun & Pr. William counties)
National Planng Assn (incl. Ldn & Pr. Wm counties after 1966)
A. D. Little, Inc. Most reasonable projection—
(incl. Loudoun & Pr..William counties)

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APPENDIX B

COMPARISON OF ACTUAL AND PROJECTED DATA ON CONSTRUCTION EMPLOYMENT IN THE WASHINGTON METROPOLITAN AREA

1. Various attempts have been made to forecast the level of employment in the construction industry in the Washington metropolitan area. Direct comparison of various historical data and projections is complicated by differences in the following:

a. Area Definitions (see Section 3.1) - Some series include Loudoun and Prince William counties, Virginia, others do not.

b. Location of Workers - Some series are from employer tax returns or industrial censuses and yield counts based on place of work rather than place of residence as in the population census or current population surveys.

c. Inclusion or exclusion of certain classes of workers - Sources differ with respect to treatment of self-employed, unpaid family workers, multiple job holders, and government employees engaged in construction work.

d. Inclusion or exclusion of certain classes of employees - Some sources exclude employers of less than a given number of employees; some exclude contracts of less than a given dollar value; the Treasury Department tax returns exclude employers not under the social security system, such as railroads.

e. The "As of Date" - Some sources represent the number of employees on the payroll for the pay period including the twelfth of March of each year; others give the annual average of monthly data; one source gives the number employed the last payroll period in July of each year.

f. Industrial Classification - (1) Some series cover "contract construction" without further breakdown; some cover one or more breakdowns such as general building, heavy construction, highways, bri bridges, airports, and various special trade contracting. The more detailed breakdowns are available only for U. S. totals, not for states or metropolitan areas.

(2) Series based on employer tax reports or censuses are perhaps more accurately coded under the Standard Industrial Classification system. Data from population censuses or surveys are dependent upon the accuracy of employer identification provided by some family-member respondent who may not be well informed.

g. Sampling Variation - Some of the data are based on the monthly sampling of the Current Population Survey or sample surveys of business establishments and therefore subject to sampling error, particularly in the case of small industrial segments of a metropolitan area. Total contract construction accounts for about six percent of Washington SMSA's non-agricultural employment. Establishment tax-report data, although not obtained by sampling, nevertheless have some shortfall because of non-reporting, late reporting, or statutory exclusion.

2. The Office of Business Economics (OBE), U. S. Department of Commerce, has compiled data on growth patterns in employment for every state and county.[1] This publication is based on the 1940, 1950, and 1960 population censuses and presents an analysis of growth components which relates each county or city to the national growth, the national industry mix, and alteration in the regional share. No projections are presented. Although the OBE uses the term "Contract Construction," the figures are the same, or almost the same, as those compiled directly from the decennial census publications which use the term "construction."

3. The Bureau of Labor Statistics (BLS) issues a series of reports on Employment and Earnings,[2] which covers "Contract Construction." This series is based on employment data reported each month by a sample of employers and periodically adjusted to levels indicated by social insurance statistics (first quarter tax returns). Comparison with the decennial censuses indicates the BLS figure for 1950 to be considerably below the Census of Population figure for the same metropolitan boundaries. In 1960, the relationship was reversed with the BLS figure a little higher than the census figure. At this time, a 1970 comparison is not possible. (See attached Table 1).

CONSTRUCTION EMPLOYMENT

Washington SMSA (Excluding Loudoun and Prince William Counties)

	1950	1960
U. S. Census of Population (April)	43,346	48,813
BLS Annual Average as published	39,600	50,000
BLS Series Adjusted for Excluded Categories of Workers (**approximate**)	49,000	61,000

The observed change in relationship is not readily explainable and may be the net effect of a number of the variables identified in paragraph 1 above.

a. The fact that the BLS data are annual averages of monthly estimates and the census data represent the number of persons employed "last week" at the time of enumeration in April, or even later, does not explain any marked shift from one decade to the next.

b. Another principal difference is in coverage. The census data include the self-employed, unpaid family workers, and government employees engaged in construction work. The BLS series, based on employer reports of private wage and salary employees, excludes the above classes of workers. The self-employed and working partners are a significant proportion in the construction industry. Some sources indicate that these omitted classes combined accounted for 14,500 construction workers in the area in 1967, an increase of 22.7 percent over the BLS estimate of private wage and salary workers. If the BLS series is adjusted upward by this proportion, assuming a constant relationship, the adjusted estimate for 1950 would be around 49,000 and for 1960 around 61,000. Such adjustment brings the BLS series into closer agreement with the census for 1950 but causes the 1960 figure to exceed the census by an unreasonable amount which cannot be readily explained by other variables (See Chart A).

c. The behavior of the data suggests that the private sector of construction may have been in a deep slump with considerable unemployment around April of 1960, at the time of census enumeration, with enough recovery during the balance of the year to bring the BLS average month up to a high level compared with April. A look at the figures for unemployment among construction industry workers

obtained in the BOC/BLS household sample (total U.S.), indicates that April 1960 had a higher unemployment rate than either March or May but only a little higher than the annual average. It was in 1961 that April had a rate significantly higher than the annual average for that year. Unless unemployment among experienced construction workers in the Washington metropolitan area during April and May of 1960 was considerably higher than in the nation as a whole, the relationship observed between the census and BLS establishment data cannot be fully explained by temporarily depressed construction employment.

d. The above observations illustrate the difficulties inherent in choosing a particular historical series as a base point for forecasts. Further investigation is required to reconcile these historical data.

e. The BLS Employment and Earnings series possesses certain advantages and disadvantages as a source of historical data for making projections of construction employment:

(1) Advantages -

(a) Readily available for major metropolitan areas (SMSA)

(b) Available monthly and as annual averages thus permitting both seasonal and cyclical analysis.

(c) On an annual basis the series is adjusted for level of employment to March benchmarks derived from comprehensive, authoritative sources (primarily employer tax returns).

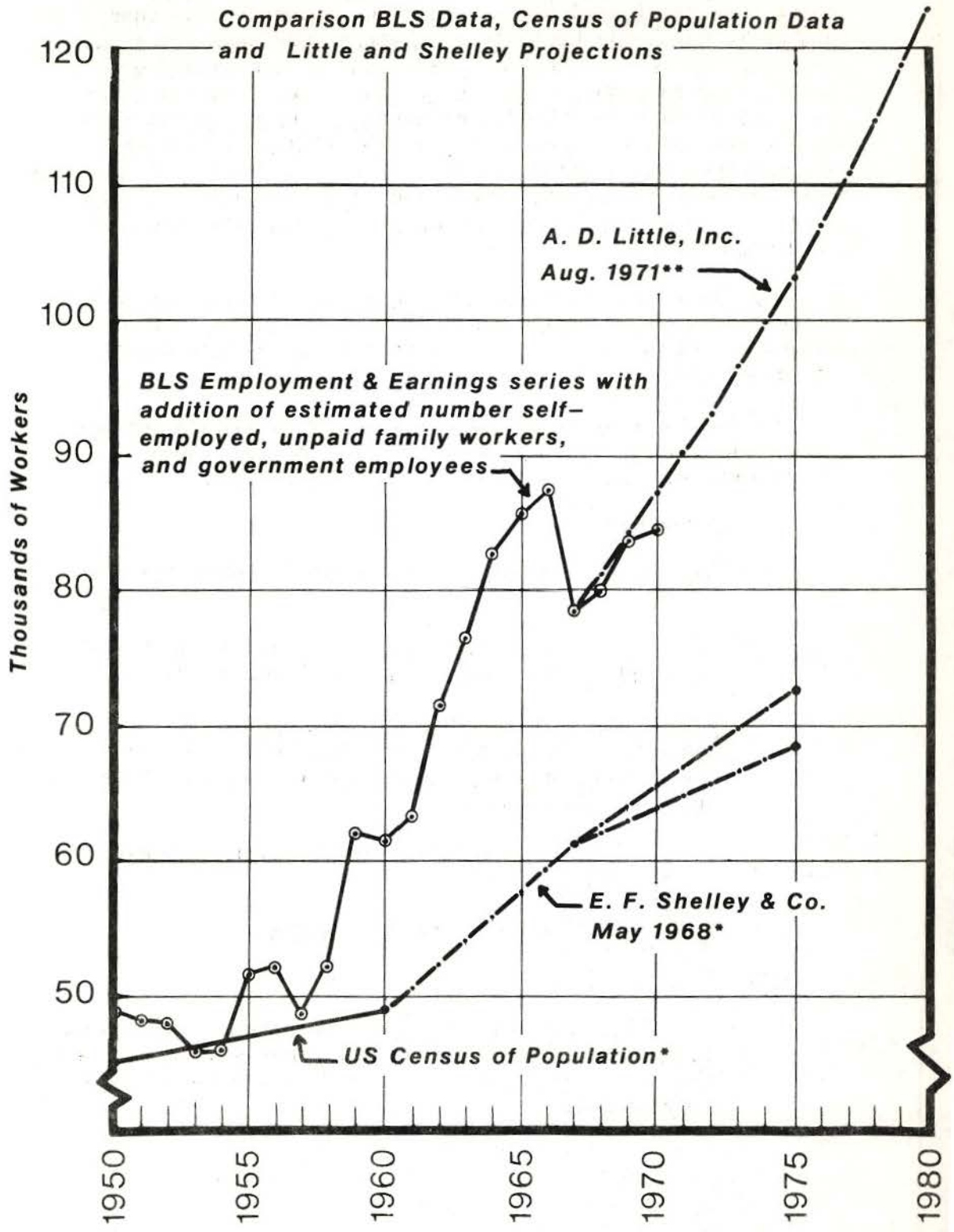
(d) The data are published monthly, soon after the "as-of" data.

(e) Sensitive to short-run changes.

(2) Disadvantages -

(a) "Contract Construction" is a broad, undifferentiated grouping of all types of construction; reflects the net effect of various trends in different types of construction.

CHART A–CONSTRUCTION EMPLOYMENT IN THE WASHINGTON SMSA



*Excludes **Includes Loudoun & Pr. Williams counties

(b) Excludes a large segment of workers (self-employed unpaid family workers, and government employees).

(c) Includes workers not residents of the area (place-of-work establishment data versus place-of-residence census data); occupational distribution is available only on place-of-residence basis (from Current Population survey and decennial census).

(d) Monthly data is subject to sampling error which may be serious for any one industrial segment in a given metropolitan area.

4. The Bureau of the Census, with the assistance of the Social Security Administration, annually publishes County Business Patterns (CBP)[3] based on first quarter employment and payroll information reported to the Treasury Department in accordance with the Federal Insurance Constributions Act (FICA). This series is similar to the BLS Employment and Earnings series in that it excludes government employees, self-employed, railroad workers subject to the Railroad Retirement Act, and various categories of no direct concern to the construction industry. The CBP data are published by county and summarized for standard metropolitan statistical areas. Employment data are based on the number of wage and salary employees on the payroll as of mid March (payroll period including March 12).

a. The CBP figure for "contract construction" employment as of mid March 1970 stands around 60,800, considerably under the BLS figure of 68,700. Here again, the figures are not directly comparable: one-time data for mid-March versus average month for the year: total coverage of tax returns versus sample survey of employers adjusted annually to first-quarter tax returns.

b. Inasmuch as the CBP data are probably more reliable as an indicator of level of employment and the BLS monthly survey can be accepted as showing monthly changes, it seems reasonable to adjust the CBP mid-March figure to an annual average equivalent by using the ratio of the BLS March data to the BLS annual average. The following table illustrates the relationship between the CBP and BLS series:

Contract Construction Employment
Thousands of Wage and Salary Workers

Washington SMSA	BLS		CBP	
	March[a]	Ann Av[b]	March[c]	Ann. Equiv[d]
1951	40.3	39.6	41.1	40.4
1953	34.6	36.3	35.8	37.6
1956	40.2	41.9	39.0	40.7
1959	47.3	50.3	47.1	50.1
1962	49.1	56.3	48.3	55.9
1964	62.6	64.2	61.6	63.2
1965	64.0	70.9	66.4	73.6
1966	66.5	70.8	69.5	74.0
1967	60.8	62.7	63.7	65.7
1968	60.4	62.4	59.8	61.8
1969	64.8	67.1	62.5	64.7
1970	64.2	67.9	60.8	64.3

[a]Employment and Earnings, Bureau of Labor Statistics, monthly, prior year data extracted each month.

[b]Annual average computed from data collected as in "a" above.

[c]County Business Patterns, Bureau of the Census, mid-March data based on first quarter FICA reports.

[d]Annual average equivalent estimated on basis of the relationship BLS March data to BLS annual average.

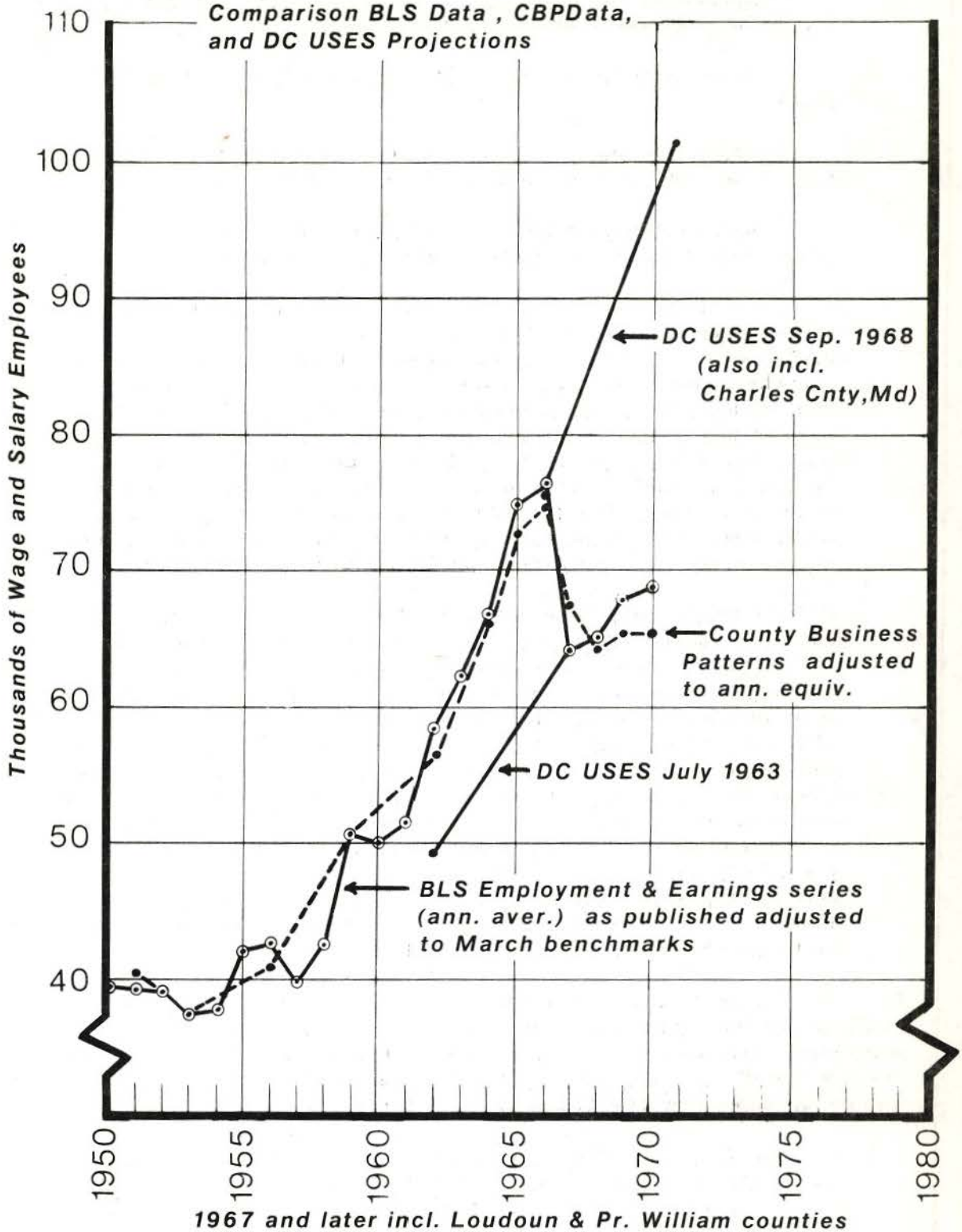
c. The mid-March figures of the CBP series are too low because of the seasonal nature of construction activity. March is characteristically on the spring upswing but consistently below the annual average (except in 1951). When adjusted for the seasonal behavior revealed by the monthly BLS series, the estimated CBP annual average equivalent more closely approximates the BLS series with the same direction of yearly change in level of employment except for the 1967 - 1968 period (See Chart B). There is no ready explanation why the BLS series shows some 1968 recovery from the 1967 recession and the CBP series shows the recession continuing into 1968.

d. The above table and attached Chart B clearly demonstrates the cyclical nature of the contract construction industry. The BLS series indicates that the growth of the industry in the Washington area was so great for the twenty years ending 1966 that cyclical movement was overshadowed. There was a period of slow decline for four years, 1951 to 1954, a little dip in 1957 and again in 1960. Thereafter, a period of six years of rapid expansion has served as the basis for leading forecasters into over-optimistic projections. The decline of 1967-1968 was of sufficient magnitude (between 7,000 and 10,000 workers depending on the series used) seriously to undermine projections when no allowance was made for the recession and subsequent slower rate of growth. A comparative look at various projections is presented in the sections which follow.

5. The United States Employment Service for the District of Columbia in 1963 published results of a 1962 survey in which area employees were asked to estimate their employment requirements through 1967[4]. Returns were incomplete and weighted in the tabulation to represent the total in each industrial classification.

a. The DC USES office estimated 1962 employment in "Contract Construction, Repair, and Maintenance" to be 49,400. This figure is presented as "non-government" employment and also excludes the self-employed and unpaid family workers. This base estimate, if adjusted for these exclusions, would have

CHART B–CONTRACT CONSTRUCTION EMPLOYMENT IN THE WASHINGTON SMSA



been around 60,600, considerably higher than a census based estimate of 50,700 for 1962 (1960 extrapolated at a 3.5 percent compound annual growth rate for the construction industry). It is unfortunate that at this writing that the 1970 census data by industry are not available.

b. The DC USES 1962 base point estimate of 49,400 is, however, very low compared with the annual average of 58,300 reported in the BLS Employment and Earnings series for 1962 with essentially the same coverage (See Chart B).

c. In 1968, the DC USES published the results of a new area skill survey[5]. On the basis of data available for 1966, the DC USES office concluded that the 1962 survey under-projected the 1967 level of construction employment as well as other employment. They established a considerably higher-level baseline of 75,400 for contract construction in 1966 on the basis of their own establishment survey. This new starting level is only a little higher than the BLS estimate of 71,200. However, 1966 data placed the contract construction industry at a high point right before a serious decline in 1967 and 1968 (See Chart B). Employer forecasts were surely unduly influenced by the rapid expansion of the 1961-66 period. The projection of 101,200 for 1971 has turned out to be excessively high due to over-optimism generated by the experience of the five rapid growth years preceding the forecasts.

d. Straight-line interpolation of the 1966-71 USES projection produces an estimate of about 96,000 wage and salary employees by June 1970. This is very high compared with the actual level of 60,800 reported for mid-March in County Business Patterns and the annual average of 68,700 reported in Employment and Earnings (Table 1 and Chart B). In area definition and work coverage the three sources are basically comparable. The inclusion of Charles County in the DC USES survey does not account for much of the difference. Even after adjustment of the CBP data to an annual basis (64,300) the DC USES forecast of 96,000 is still excessive. In its report, the DC USES included the following statement; ". . . these anticipated needs for additional workers may prove to be too optimistic because they were made before the slowdown in growth was apparent".

e. It appears that in 1962 the local employers made good assumptions concerning their growth for about four years ahead. However, they had no reasonable basis for anticipating the downturn which began during the second half of 1966. High interest rates are known to have slowed down new construction of many types,

particularly residential and commercial building. Although it is true that construction is usually only deferred until more favorable conditions return, postponement seriously affects any employment projections which did not anticipate the period of reduced activity.

6. E. F. Shelley and Company[6] in 1968, starting with 1960 Census of Population data and the growth trend indicated by the BLS series, estimated "Construction" employment for 1967 in census terms and made high and low estimates for 1975 for the unexpanded SMSA (See Table 1 and Chart A).

a. The projections appear to be too conservative. Even the high projection for 1970 (65,200), after allowing for the addition of Loudoun and Prince William counties, falls far below the BLS annual average adjusted roughly for excluded categories of workers (around 84,000). Since Shelley started with the 1960 census and applied a growth rate developed from the BLS series, the projection may be too low because of the characteristics previously noted in the 1960 census information (see paragraph 3 above). Had Shelley and Company started with a 20 percent higher baseline, their projections for 1970 would have been more reasonable than the others included in this comparative analysis.

b. The following is quoted from the Shelley report: "Construction is one of the most highly unpredictable of industries. Spurred by the rapid expansion of private dwelling, office, and road construction, the industry increased rapidly until 1967, at which point it experienced a considerable downturn in the Washington area. The projection for growth in the construction industry is based on the assumption of a resumption of growth over the next eight years but at a rate somewhat lower than that preceding the 1967 downturn."

7. The National Planning Association (NPA) operates a Center for Economic Projections and periodically publishes projections of population, employment in major industries, personal income and other economic indicators for all metropolitan areas (SMSA). In 1967, the NPA published projections for metropolitan areas through 1975 and promptly published two revisions and extended the projections to 1980[7]. These revisions were mixed in direction for different industries.

a. The January 1969 report contains the following statement: "A review of the revisions which have been made leads to the following conclusions. Improvement of metropolitan area projections requires frequent and continuous reexamination of

national projections which are used as input data for metropolitan area projections and improvements of metropolitan area historical data including the most recent benchmark year. For these reasons, metropolitan projections should be periodically revised . . ."

b. The NPA starts with estimates of private wage and salary workers and adds estimates of the number of self-employed and unpaid family workers. No allocation of government workers is made. The NPA series, therefore, is not directly comparable to any other. To establish a degree of comparability, the BLS series needs to be adjusted upward for the self-employed and unpaid family workers only (roughly + 13 percent rather than the + 22.7 percent used to achieve comparability with the decennial census). Chart C compares the BLS series adjusted by + 13 percent with the three latest NPA projections for the Washington SMSA.

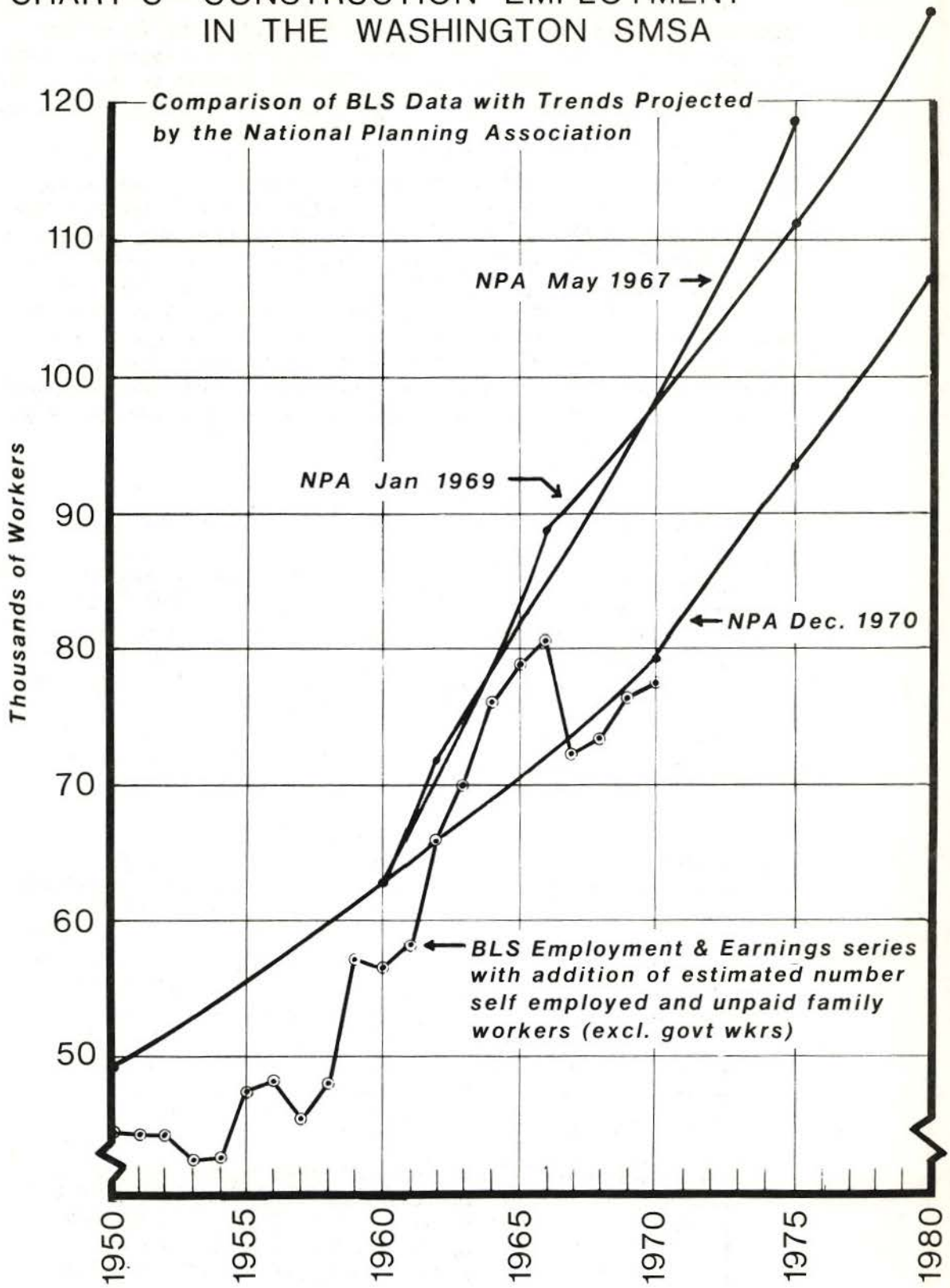
(1) For all three projections, NPA used a 1960 level (62,600) considerably in excess of the 1960 census figure (48,800) and in excess of the 1960 BLS annual average adjusted by + 13 percent (about 56,500). It is not known whether the NPA had reason to believe that the 1960 census figure was seriously understated. It now appears that the NPA used 1960 and 1962 base points better than the population census figures, although somewhat too high. However, in both the 1967 and 1969 projections they used a growth rate influenced too much by the 1960-66 expansion (Chart C).

(2) The January 1969 revision established an unreasonably high 1966 base point, about 8,000 in excess of the BLS level adjusted for comparable coverage, and reduced the subsequent growth rate (Chart C).

(3) Compared with the BLS annual average for 1970 adjusted by + 13 percent (77,600) the NPA 1969 short term projection of 97,700 proved to be very high, indicative of a high 1966 base point rather than the assumption of an excessive rate of growth. The NPA assumed rate of growth for 1966-75 is supported, in the short run, by the trend of the 1968-71 BLS data.

(4) The December 1970 revision lowered the 1962 and 1966 estimates and established a 1970 base point more realistic in relation to the then current BLS figure. The assumed growth rate thereafter roughly parallels the growth assumed in the January 1969 projection and

CHART C – CONSTRUCTION EMPLOYMENT IN THE WASHINGTON SMSA



may prove to be too high in view of current population trends (see Appendix A).

c. Table 1 indicates that the latest NPA projections for 1971 (81,900) is considerably lower than the DC USES forecast. However, coverage is not comparable. If the latter is adjusted upward for excluded categories (to about 114,300) the difference becomes even greater. The DC USES forecast appears to be far more unrealistic than the NPA forecast.

8. Arthur D. Little, Inc. (ADL), in a planning study for the District of Columbia government[8], also started with the BLS Employment and Earnings data for 1967 adjusted by the addition of an estimate of the number of self-employed, unpaid family workers, and government employees (+22.7 percent). Table 1 shows the ADL projections to 1985 and Chart A to 1980 in comparison with the BLS series adjusted by +22.7 percent. The ADL projection to 1980 assumes a compound annual growth rate of 3.5 percent, reduced for 1980-85 to 3.2 percent.

The ADL and NPA projections are not directly comparable because of the exclusion of government workers in the latter. The ADL projection closely parallels the NPA 1969 and 1970 projections with ADL using a higher growth rate. If the 1970 NPA figures are roughly adjusted for government workers in construction, the latest NPA projection is shown to have estimated the 1967 level to be 3,500 higher than the ADL baseline and the BLS reported level after comparable adjustment. The net effect of the differences in level and assumed growth rate yields an ADL projection for 1980 about 4,000 higher than the latest NPA revision adjusted for comparability of coverage.

The ADL and latest NPA projections roughly support each other. On the basis of preliminary BLS data for 1971, it appears that both organizations may have assumed too high a growth rate, with the NPA 1970 revision perhaps the more realistic one. It is too early to evaluate these projections more definitely. However, in view of the behavior of NPA's three projections, early revision seems likely, most probably in the direction of slower growth.

9. The American Vocational Research Corporation prepared a study for the District of Columbia Board of Education[9] with emphasis on projecting 1975 employment by occupation for the Washington SMSA and the Washington-Baltimore Region. Their report does not include projections of employment by industry.

10. Conclusions:

a. None of the historical series of data are specific enough to serve as a base for estimating either present or future labor requirements for transportation-related construction.

b. Existing historical and forecast series of data on construction employment are of value to a study of transportation-related construction only in indicating the general trend of employment in that segment of the labor market in which transportation-related demand must directly compete.

c. Projections of construction employment based on available historical series tend to be invalidated by the cyclical nature of the industry. The assumption of an uninterrupted compound annual rate of growth needs to be challenged and more attention given to the possiblity of cyclical deviations.

d. The marked seasonal nature of the construction industry impairs the value of one-time-of-the-year data as a basis for projections (decennial census April data, mid-March data from employer tax returns, end-of-July data from contractors' EEO reports). Such series need adjustment for seasonal variation. Since seasonal variations are distorted by long-term trends and cyclical fluctuations, relatively long-range forecasts should be made using annual averages (or annual average equivalents). If required, the annual average can be converted by using an established seasonal pattern to arrive at an estimate for a particular point of time within a future year.

e. There are advantages and disadvantages associated with all available series of data on construction employment. All things considered, the BLS Employment and Earnings series seems to be the most useful (see paragraph 5e above) provided that it is adjusted upward for excluded classes of workers and downward for multiple job holders.

f. The behavior of the BLS series in relation to the CBP series (adjusted to annual equivalent) suggests that the BLS figure for 1960 adjusted for excluded categories is probably more realistic than the 1960 Census of Population figure (see Charts A and B). The magnitude of the difference (about 10,000 or 20 percent above the census figure) seems greater than can be explained by place-of-residence versus location-of-employer differences, multiple job holding, and seasonal variation.

g. Forecasts made by employers five years ahead tend to be reasonable so long as the industry trend holds steady. However, projections made at the end of a period of expansion are likely to be over-optimistic and not anticipate periods of slow-down or turn-down, even when imminent or already happening.

h. Wide shifts in the relatively sophisticated NPA projections, involving revisions made only about a year and a half apart, demonstarate the difficulty in making even short-term projections for a broad industrial grouping in a particular metropolitan area. For a given area, assumptions concerning net population change, age distribution, labor force participation, local share of national growth in a given industry, etc., are not necessarily as valid as assumptions made for the national economy, a relatively closed system within which diverse local movements may cancel one another.

TABLE 1

Construction Employment in the Washington Metropolitan Area (SMSA)

Comparison of Historical Data and Projections, By Sources

(Thousands of Workers)

	1940	1950	1960	1962	1964	1966	1967	1969	1970	1971	1975	1980	1985
1. U.S. Census of Population													
Pre 1967 SMSA boundaries	31.2	46.3	48.8										
2. Bureau of Labor Statistics,													
Employment and Earnings		39.6	50.0	58.3	67.2	71.2	64.0	67.8	68.7				
3. County Business Patterns,													
Mid March		41.1	47.1	48.3	61.6	69.5	63.7	62.5	60.8				
Adjusted, Annual Av. Equiv.		40.4	50.1	55.9	63.2	74.0	65.7	64.7	64.3				
4. D.C. USES													
July 1963				49.4	55.4[f]	61.3[f]	64.3						
September 1968						75.4	80.6[f]	90.9[f]	96.0[f]	101.2			
5. E. F. Shelley & Company													
November 1968													
Low Projection[d]			48.8	52.0[f]	55.4[f]	59.1[f]	61.0	62.8[f]	63.7[f]	64.6[f]	68.3		
High Projection[e]								63.7[f]	65.2[f]	66.6[f]	72.7		
6. National Planning Association													
May 1967		49.2	62.6	71.4	77.2[g]	83.5[g]	86.8[g][h]	93.8[g]	97.6[g]	101.5[g]	118.6		
January 1969 Revision						88.1	90.4[h]	95.2[h]	97.7[h]	100.3[h]	111.2	126.3[k]	
December 1970 Revision			62.6	65.6[i]	68.8[i]	72.1[i]	73.9[i]	77.4[i]	79.3	81.9[j]	93.1	106.8[m]	
7. Arthur D. Little, Inc.													
August 1971							78.5		87.0[b]		103.4	122.8	142.4[c]

See attached explanatory notes

Explanatory Notes for Table 1

1. U. S. Census of Population, Vol. 1, Characteristics of the Population.

   a. Household enumeration yields employed persons by place of residence, not place of employment.

   b. No duplication of multiple job holders, each employed person counted once according to job at which they worked the greatest number of hours during the reference week.

   c. Includes self-employed, unpaid family workers, and government employees allocated to appropriate industries.

   d. Includes persons who had a job but were not at work temporarily (may not appear on establishment payrolls).

   e. Pre 1967 SMSA boundaries exclude Loudoun and Prince William Counties in Virginia.

2. Bureau of Labor Statistics (BLS), U. S. Department of Labor, Employment and Earnings Series.

   a. Source: establishment surveys (monthly)

   b. Annually adjusted to March benchmarks (primarily based on mid-March payroll data from FICA tax returns).

   c. Each year based on then-current definition of SMSA.

   d. Excludes self-employed, unpaid family workers, and government employees.

   e. Excludes employed persons temporarily in a non-pay status (not on payroll at time of survey).

   f. Includes multiple job holders more than once.

   g. Includes part-time and full-time wage and salary workers.

3. County Business Patterns, Bureau of the Census, U. S. Department of Commerce.

a. Source: Primarily 1st quarter Treasury Form 941 (SSAERP); adjusted for multi-unit employers by special survey; adjusted by estimating in case of incompletely or improperly reported units and non-reporting employers.

b. Employment as of mid-March (payroll covering 12 March).

c. Place-of-work establishment data.

d. Includes Loudoun and Prince Williams Counties, Virginia 1967 on.

e. Force-account employees (direct hire construction workers employed by a non-construction establishment) are excluded from contract construction data.

f. Excludes:

(1) Government employees (local, state, and federal).
(2) Employees under the Railroad Retirement System.
(3) Self-employed and unpaid family workers.
(4) Employees of establishments not covered by FICA.
(5) Industries that do not have at least 100 employees or 10 reporting units in the area are not a line item in published tables.

4. United States Employment Service for the District of Columbia,

a. "Contract Construction, Repair and Maintenance"

b. Excludes Loudoun and Prince William Counties, Virginia 1962-67 period; included plus Charles County, Maryland in 1966-71 projection.

c. Excludes self-employed, unpaid family workers, and government employees.

d. Sources: Employer questionnaire survey 1962 and 1966.

e. Not adjusted for multiple job holding.

f. Estimated by straight-line interpolation.

5. E. F. Shelley and Company, Metropolitan Washington Manpower Projection with Curriculum Implications, New York, N.Y., November 15, 1968

a. "Construction" based on 1960 Census of Population.

b. Excludes Loudoun and Prince William Counties, Virginia.

c. Includes:

(1) self-employed
(2) unpaid family workers
(3) government employees (Federal, state and local) and establishments not covered in series based on FICA tax returns

d. Low projection for 1975 based on 1960 Census of Population and the 1960-75 national industrial change factor, plus other adjustments.

e. High projection for 1975 based on 1960 Census of Population and a local industrial growth matrix developed from annual BLS data, "appropriately adjusted on the basis of generally recognized local industry factors".

f. Interpolated using CAGR of .0143 low and .0222 high.

6. National Planning Association (NPA), Center for Economic Projections, Economic and Demographic Projections for 224 Metropolitan Areas, Reports 67-R-1 May 1967, 68-R-1 January 1969, and 70-R-2, December 1970, Washington, D. C.

a. Principal source: BLS Survey of Current Business (establishment data).

b. Includes full-time and part-time jobs.

c. Standard Industrial classification at the one digit level.

d. Wage and salary workers with the addition of the self-employed and unpaid family workers; excludes government employees.

e. Data relate to SMSA boundaries as defined in each year without revision of prior years for 1967 expansion.

f. Count of persons employed in the area in terms of place of work, not by residence.

g. Interpolated using compound annual growth rate (CAGR) of .0398 for 1962-75.

h. Interpolated using CAGR of .0262 for 1966-1975.

i. Interpolated using CAGR of.0239 for 1960-1970.

j. Interpolated using CAGR of .0326 for 1970-1975.

k. CAGR of .0258 for 1975-1980.

m. CAGR of .0278 for 1975-1980.

7. Manpower Requirements in the Washington Standard Metropolitan Statistical Area: A Guide to Planning Education and Training for Public Education in the District of Columbia, Arthur D. Little, Inc., Washington, D. C., August 1971.

a. Private wage and salary workers from BLS Employment and Earnings series adjusted by addition of estimates of federal, state and local government employees, self-employed, and unpaid family workers.

b. Interpolated 1967-1980 compound annual growth rate of 3.5%.

c. 1980-85 compound annual growth rate of 3.2%.

d. Includes Loudoun and Prince William counties.

e. Not adjusted for multiple job holders.

REFERENCES

1. Growth Patterns in Employment by County, 1940-1950 and 1950-1960, U. S. Department of Commerce, Office of Business Economics, Washington,D.C.,1965.

2. Employment and Earnings (Monthly), and Employment and Earnings, States and Area, 1939-1969, BLS Bulletin No. 1370-7, U. S. Department of Labor, Bureau of Labor Statistics, Washington, D. C.

3. County Business Patterns, U. S. Department of Commerce, Bureau of the Census, Washington, D. C.

4. Employment in Metropolitan Washington, U.S. Employment Service for the District of Columbia, U.S. Department of Labor, Washington, D. C. July 1963.

5. A Supplement to Employment in Metropolitan Washington, An Area Skill Survey with Employment Projections to June 1971, U.S. Employment Service, Manpower Administration for the District of Columbia, U.S. Department of Labor, Washington, D.C. September 1968.

6. Metropolitan Washington Manpower Projections with Curriculum Implications, prepared for the Washington Technical Institute by E.F. Shelley and Company, Inc., New York, N.Y., November 1968.

7. Economic and Demographic Projections for 224 Metropolitan Areas, National Planning Association, Center for Economic Projections, Washington, D.C., Report No. 67-R-1, May 1967, Report No. 68-R-1, January 1969, and Report No. 70-R-2, December 1970.

8. Assessment of Manpower Needs in the District of Columbia, American Vocational Research Corporation, Washington, D.C., May 1971.

APPENDIX C

OCCUPATIONAL AND INDUSTRIAL CLASSIFICATION
IN THE U. S. CENSUS

1. Occupational Classification: The 1960 U. S. Census system consists of 494 items, 297 of which are specific occupation categories and the remainder are subgroupings (mainly on the basis of industry) of 13 of the occupation categories.

a. In Chapter D, Detailed Characteristics,[1] several levels of classification are used. The most detailed list for the Washington metropolitan area appears in Table 121, Detailed Occupation of the Employed, by Sex. For this table, certain categories were combined and the list consists of 479 items. For the cross-tabulations by race, class of worker, year last worked, age, and earnings, use is made of intermediate occupational classifications with 161 categories for males and 70 for females. However, in Table 125, which cross-tabulates occupation and industry, 57 occupation categories appear for males and 30 for females, with 43 industry categories for both men and women.

b. For the DOT project, we are primarily interested in the occupation-by-industry breakout (Table 125). Several occupations of great importance to the construction and transportation operation industries are not included in the list of specific occupations and are, therefore, buried in "other" or "n.e.c." classifications.

(1) For example, only the following occupations which are both relatively unique and important to the construction industry are separately identified for male workers.

Civil engineers
Surveyors
Carpenters
Cranemen, derrickmen and hoistmen
Electricians
Plumbers and pipe fitters
Tinsmiths, coppersmiths and sheet metal workers
Laborers (not further identified).

(2) In the Washington SMSA in 1960, male employment in the above occupations accounted for 47 percent of the 46,248 males employed in the construction industry. However, a large part of the remainder was carried in catchall categories as follows:

Other professional, technical and kindred workers	473
Social scientists (unspecified)	16
Other engineers (unspecified)	28
Other engineering and physical science technicians (unspecified)	111
Managers and Officials (salaried)	2,128
Other technicians (unspecified)	9
Managers and officials (self-employed)	2,598
Foremen (unspecified)	1,188
Other clerical and kindred workers	661
Mechanics and repairmen (unspecified)	1,112
Other craftsmen and kindred workers	10,731
Apprentices (unspecified)	481
Other operatives and kindred workers	1,560
Other service workers	40
Occupation not reported	422
	21,558

About 46 percent of the total male employment in the construction industry was not identified in meaningful occupational terms; about 54 percent were in reasonably well-defined occupations.

(3) One related pair of items illustrates the problem most clearly; 11,212 "Other craftsmen" and "Apprentices" constitute almost one-fourth of male construction employment. "Other craftsmen" and their apprentices include workers in the following building trades not specifically listed in Table 125 by industry but which appear as a coded occupation in the BOC Classified Index of Industries and Occupations-1970:[2]

Code	Title
410	Brickmasons and stonemasons
412	Bulldozer operators
421	Cement and concrete finishers
436	Excavating, grading and road machine operators, exc. bulldozer
440	Floorlayers, exc. tile setters
445	Glaziers
452	Inspectors, n.e.c.
510	Painters, construction and maintenance
512	Paperhangers
520	Plasterers
534	Roofers and slaters
546	Stonecutters and stone carvers
550	Structural metal craftsmen
560	Tile setters
	Apprentices:
	474 Auto mechanic
	491 Mechanic, exc. auto
	411 Brickmason and stonemason
	416 Carpenter
	431 Electrician
	521 Plasterer
	523 Plumber and pipe fitter

536 Sheet metal

571 Specified craft, n.e.c.

(4) The one item of "Mechanics and Repairmen" in Table 125 does not differentiate among the following categories important to the construction industry:

Air conditioning, heating and refrigeration
Automobile mechanics and apprentices (cars and trucks)
Heavy construction equipment, including diesel, and apprentices
Elevator installers and repairmen
Escalator installers and repairmen
Track mechanic (tracked vehicles)

(5) The classification "Other Operatives and Kindred Workers" covers the following of special significance to the construction industry:

Asbestos and insulation workers
Blasters and powdermen
Chainmen, rodmen and axmen (surveying)
Dry-wall installers and lathers
Earth drillers
Oilers and greasers, exc. auto
Riveters

(6) The classification "Other Operatives and Kindred Workers" covers the following of special significance to the "other Transportation" industrial classification:

Boatmen and canalmen
Bus drivers
Conductors and motormen, urban rail transit
Taxicab drivers and chauffeurs (inc. ambulances)

2. Industrial Classification: The 1960 Census provided for 13 major industry groups and 151 specific industries. Several different levels of classification were used. The most detailed industry list appears in Table 127 Detailed Industry of the Employed, by Sex, which consists of 149 categories. In cross tabulation by occupation, Table 125, only 43 categories were used.

a. There is only one broad classification for "construction," without regard to type of construction (residential, public utility, commercial, industrial, highway, railroad, rivers and

harbors, etc.). The Bureau of Labor Statistics uses these broad industrial classifications to develop national occupational patterns for industries and it has been the practice to apply these national distributions to local estimates or projections of the level of employment in an industry. This practice assumes that local areas have a very similar mix in types of construction and comparable productivity of the local labor supply across occupations. Such assumptions need to be tested for their validity in specific metropolitan areas, particularly one as unique as the Washington SMSA.

b. In the field of transportation, three industry classifications were provided in the cross tabulation with occupations.

Railroads and railway express service
Trucking service and warehousing
Other transportation

This means that data coded under the following industries were aggregated into "Other Transportation."

408 Street railway and bus lines

409 Taxicab service

419 Water transportation

427 Air transportation

428 Pipe lines, exc. natural gas

429 Services incidental to transportation

3. Conclusions:

a. For the construction industry in the Washington metropolitan area, the distribution of employment by occupation cannot reasonably be approximated by the use of national occupational patterns derived from the decennial census.

b. The occupational pattern for future transportation related construction, operation, and maintenance cannot be derived from

census data with sufficient specificity to provide for manpower planning, including vocational training.

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[1] U. S. Census of Population: 1960, Vol. I, Characteristics of the Population, Part 10, District of Columbia, U. S. Department of Commerce, Bureau of the Census, Washington, D. C., 1963.

[2] 1970 Census of Population Classified Index of Industries and Occupations, U. S. Bureau of the Census, Washington, D. C. September 1971.

APPENDIX D

OCCUPATIONAL PATTERNS FROM CONTRACTORS' EQUAL EMPLOYMENT OPPORTUNITY REPORTS

1. To permit monitoring of EEO compliance, various federal agencies require contractors to submit periodic reports indicating their employment of minority group members in specified skill classifications. The Federal Highway Administration (FHWA) requires that contractors and subcontractors on projects costing more than $10,000 must file with state highway departments reports on total and minority employment by skill classification (FHWA Form 1391). Each state submits to FHWA a summary of the contractors' reports (FHWA Form 1392). These summaries are further consolidated into national totals by FHWA, Office of Civil Rights.

2. FHWA Forms 1391 and 1392 were designed to meet the needs of monitoring the EEO program in a limited number of occupational classifications, as follows:

Officials (managers)	Cement masons
Supervisors	Electricians
Foremen	Pipefitters, Plumbers
Clerical workers	Painters
Equipment operators	Laborers, semi-skilled
Mechanics	Laborers, unskilled
Truck drivers	(Total above)
Ironworkers	Apprentices
Carpenters	On-the-job trainees

The forms convey no other description or instructions than the above titles.

a. Job title usage may differ among reporting contractors. For example, the Department of Labor's Dictionary of Occupational Titles lists "ironworker (construction)" as an alternate title for "structural steel worker" (801.781). The Dictionary also defines as a separate classification "reinforcing-iron worker" (801.884). A contractor's payroll usage may involve any of a number of common titles and he may, without classification guidelines, report reinforcing-iron workers either as "ironworkers" or "laborers, semi-skilled." The latter term is not a recognized classification in the Dictionary of Occupational Titles, although the Dictionary lists 122 laborer titles.

b. Similarly, "equipment operator" is not a Dictionary title and may lead to the inclusion of operators of equipment the use of which is only incidental to relatively unskilled jobs, such as backfill tamper, air-hammer operator, concrete-chipper man, etc.

Skilled operators of heavy construction machines should be classified as "operating engineers" (859.883).

3. As a source of information on occupation usage patterns, the FHWA reports may be subject to a number of job classification deficiencies. When the Bureau of Labor Statistics compiles occupational pattern data directly from contractor's payrolls, they audit for such deficiencies by checking the reasonableness of job title in relation to the wage rate and making further investigation to reconcile discrepancies. Unfortunately, in compiling manhour data for federal-aid highway projects, BLS did not work from payrolls but worked up data from existing Bureau of Public Roads reports which provided manhour data only in the following categories:

Administrative and supervisory
Construction trades
Laborers, helpers and tenders
Other (including truck drivers)

The EEO reports, therefore, are the only readily available source of somewhat greater occupational detail.

4. The FHWA EEO summarizations are a source of data on national and state employment on federal-aid highway construction as of the last payroll period preceding the end of July of each year, beginning with July 1969. Although July normally is a peak month of total highway construction employment, it is not necessarily representative of the occupational pattern covering a year of man-hour input. Depending on the seasonality of project starts and completions, July may have a lower proportion of workers engaged in earth moving and grading and a higher proportion in concrete pouring and surfacing than the annual average. This would not be a problem in non-seasonal industries; however, construction is recognized as highly seasonal, particularly with respect to specific phases of operations. Any projections made on the basis of occupational distribution in July must be carefully identified as an estimate of the most probable distribution in July of future years, assuming no major shifts in seasonality. Such projections would have definite shortcomings in anticipating manpower training needs and may result in misplaced emphasis in training programs.

5. In broad occupational groupings (para 3 above), a comparison can be made between the occupational distribution estimates published by BLS and those put together from FHWA EEO employment records. The original source of the BLS data was the Bureau of Public Roads (BPR). It is not known for sure how the BPR grouped certain occupations. It is assumed, subject to verification, that BPR grouped foremen with

craftsmen in accordance with BLS and Bureau of the Census practice. The FHWA summary of the EEO reports for 1969 carried apprentices and on-the-job trainees as separate categories. For 1970 and 71 these two categories were counted in the appropriate craft. These and other possible differences keep the comparisons imprecise. However, rough comparison indicates a reasonable degree of consistency, considering trends over the period of time covered by the data. The BLS/BPR data are available for 1958, 61, and 64 and the FHWA data are available for 1969, 70, and 71. It is unfortunate that there is no time overlap in the two series to permit comparison for approximately the same point in time. BLS has scheduled an update of the highway study. However, BPR has discontinued collecting man-hour data in the four broad occupational groupings formerly used. BLS is now exploring alternative sources for the occupational distribution, including the FHWA EEO July reports. The percentage distribution by broad occupational groups for total U. S. federal-aid highway construction has been as follows:

	BLS/BPR			FHWA - July		
Occupational Group	1958	1961	1964	1969	1970	1971
Administrative & supervisory	10.4	10.2	9.7	6.7	6.2	6.0
Construction trades (incl. foremen)	38.2	39.1	44.0	43.5	45.2	45.6
Laborers, helpers, tenders	29.6	29.9	25.8	23.4	21.7	20.6
Other occupations (incl. truck drivers, mechanics, "semi-skilled laborers")	21.8	20.8	20.5	26.4	26.9	27.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

6. The FHWA July employment data are available for the fifty states and the District of Columbia. It is possible, therefore, to develop an occupational pattern for a localized region. The percentage distribution by occupation has been computed separately for total U. S., District of Columbia, Maryland and Virginia and for the latter three combined. A comparison of these distributions indicates that there are sufficient differences to make it desirable to develop more localized patterns rather than use a national pattern. The following illustrates the larger differences as of July 1970:

	U. S.	Region	D. C.	Maryland	Virginia
Equipt. op.	24.52%	19.13%	10.49%	21.62%	18.38%
Truck dr.	11.23	9.02	7.08	10.63	6.44
Iron wkrs.	2.71	2.95	5.08	2.03	3.82
Carpenters	6.25	8.62	13.01	7.69	8.24
Cement masons	2.85	3.57	4.31	3.46	3.42
Semi-skilled laborers	12.68	11.90	19.45	9.93	12.10
Unsk. laborers	21.69	27.72	21.44	28.15	30.33

The District of Columbia shows the most divergence from the U.S. total and also differs considerably compared with adjacent jurisdictions. Data are not available in this form for other urban centers but there is reason to believe that highway construction in densely populated and developed areas, such as cities, involves less earth moving and grading and more building of bridges and related structures. The above table shows D. C. relatively very low on equipment operators and truck drivers and relatively very high in the proportion of iron workers, carpenters, cement masons, and semi-skilled workers.

a. The above observations about inner city highway construction suggests that adjacent suburban areas composing a metropolitan area may resemble the inner city pattern more than they conform to statewide experience. Such suburban areas probably fall somewhere between the two.

b. If it is true that suburban areas fall between statewide patterns and inner city patterns, the development of an occupational pattern for the Washington metropolitan area needs to be more sophisticated than merely adding together the employment of D. C., Maryland and Virginia, as illustrated above. The three components need to be combined with appropriate weighting so the relatively large-scale operations in the two states do not have a disproportionate influence in determining the metropolitan area pattern. The dollar value of federal-aid highway construction should be readily available for the local jurisdictions comprising the Washington metropolitan area and should serve as a basis for developing a set of weights to be applied

to the statewide employment figures. This procedure will give some consideration to rural-urban differences in highway construction requirements although it is not an adequate substitute for direct analysis of payroll composition, project by project, in the metropolitan area.

7. The FHWA July data also includes the dollar value of the construction in progress and total number of employees on the payroll as of the last pay period ending before July 31. It is possible, therefore, to compute the ratio of employees to a million dollars of contract price, as follows:

	July 1969	July 1970	July 1971
Total U.S.	21.812	20.309	18.437
DC, MD, VA Region	21.125	21.848	12.053
District of Columbia	23.232	15.226	9.108
Maryland	23.387	24.660	24.469
Virginia	19.820	23.211	17.591

Between 1969 and 1971 the total number employed on D.C. projects declined from 1682 to 1031. However, the total valuation of projects jumped from $72,400,000 to $113,200,000, thus substantially reducing the ratio of jobs-to-dollars (see table above). It is not clear whether this resulted from a change in the nature of projects or is an aberration due to July seeing the start of some high-value projects with starting payrolls containing few employees. This relationship needs further investigation. It is possible that further investigation may reveal that one-point-of-time employment cannot reliably be related to dollar value of contracts. If so, the FHWA EEO reports will not be an adequate source of data for projecting future levels of employment based on planned dollar expenditures.

8. Projection of future labor requirements by occupation for an industrial segment involves basically two steps:

a. Projecting the probable level of total employment, preferably in terms of the number of workers in relation to planned dollar expenditures in the case of construction.

b. Projecting the probable distribution of the workers by occupation according to the type of end-products.

These two stages do not necessarily require data from the same source.

9. For step 8a above, the level of employment in federal-aid highway construction can be projected by means of the latest ratio of jobs per billion dollars of contract price, as developed by the BLS from the BPR data, applied to the dollar estimates of the construction planned each year for the metropolitan area. The BLS/BPR ratio is based on total federal-aid highway construction in the U.S. Its use for a metropolitan area requires making the following assumptions:

a. The mix of highway construction in the area conforms with the mix in the nation as a whole (cuts and fills, bridges, culverts, and other structures per mile of roadway). As noted in paragraph 6 above, this is not necessarily true for urban/suburban areas.

b. The cost of material and labor in the area closely approximates the average cost nationwide. This assumption can be tested by examining standard price indexes for both the area and the nation (Dodge Reports, Engineering News-Record, and various Department of Commerce and Department of Labor publications). An area with relatively high material prices and relatively low wage rates compared with the national average would require a different employment-to-dollar ratio. It may be possible to adjust the national ratio to reflect the differences found in the relationship between major components of material and labor.

c. The availability of both skilled labor and materials in the area is typical of the nationwide average experience. A labor shortage may drive up wage rates in relation to material costs or cause the substitution of equipment for workers, resulting in greater productivity per worker and a lower-than-normal job-to dollar ratio. Non-availability of certain materials, or excessive cost of procurement, may require the use of direct-hire, off-site labor to prepare local materials for use (sand, gravel, crushed stone, timber, etc.,).

d. Highway construction technology will not change to a degree that will materially disturb the job/dollar ratio (such as mechanization, prefabrication or off-site preparation, new materials and new construction methods).

e. The terrain characteristics of a particular area resemble the national norm (grades, soil types, drainage, vegetation, river and stream crossings, etc.). Some of the natural obstacles and difficulties can increase the labor and equipment factors in relation to materials. These factors do not lend themselves to statistical treatment and adjustment for this would depend upon informed engineering judgments.

f. The climatic characteristics of a particular area are similar to the national norm (rainfall, ground frost, snow, ice, etc.). These natural conditions influence the productivity of workers and determine differences in specifications of materials and methods of construction. As above, statistical cost adjustment does not seem feasible and must depend on informed engineering judgments.

10. Some of the above geographic variables are interrelated. It is possible that the net effect of the various factors will tend to normalize the job/dollar relationship unless an area is notably unique in being strongly affected by one of the factors. A decision as to whether the various local factors cancel each other out or have a cumulative push in one direction should be the result of pooling informed judgments (professionals such as labor market specialists, construction material purchasing specialists, construction cost estimators, and civil engineers).

11. For step 8b above, the occupational distribution of the employment can be anticipated by developing an occupational pattern for the local area from the FHWA EEO July reports and applying it to the total employment projections derived as described in paragraph 9 above. Although limited in occupational breakout, this source is superior to the BLS/BPR compilation in occupational detail and has the additional advantage of being localized rather than national. The use of a pattern derived from this source involves the following assumptions:

a. That the job mix in July is representative of employment throughout the year (see paragraph 4 above).

b. That the composite job mix of all construction in D. C., Maryland and Virginia is representative of the Washington metropolitan area or can be made reasonably representative by appropriate weighting (see paragraph 6 above).

c. That changes in highway construction technology will not materially change the occupational pattern over the period of years for which construction has been planned and reasonably firm cost estimates made (five to seven years).

d. That the supply of various classes of skilled workers will keep in balance with demand. Any serious imbalance resulting from loss of workers to another area, upward mobility, failure to recruit new workers, other major shifts in the labor force will cause contractors to change their hiring practices and alter the occupational mix or the labor/equipment relationship.

12. Conclusions:

a. The jobs-to-dollars ratio from the BLS/BPR source is the best available and may be modified to apply to the Washington metropolitan area to project the level of highway construction employment.

b. Local area modification of the jobs-to-dollars ratio would require pooling of various professional judgments in addition to statistical adjustment.

c. The occupational pattern derived from regional data selected from the FHWA EEO reports is the only compiled source with a reasonable degree of occupational detail.

d. The data from FHWA EEO reports should be used to develop occupational patterns only if it can be established that July employment is reasonably representative.

e. The FHWA EEO occupational data for D. C., Maryland and Virginia should be appropriately weighted to take account of apparent rural/urban differences in highway construction.

f. If the FHWA EEO data are to be used on a continuing basis to develop occupational patterns, steps should be taken to improve the occupational reporting by contractors and states to achieve greater specificity and accuracy.

APPENDIX E

USE OF PAYROLL DATA IN PROJECTING MANPOWER REQUIREMENTS BY OCCUPATION FOR SPECIFIC TYPES OF CONSTRUCTION

1. With minor exceptions, all construction under contracts awarded by a federal agency is subject to the Davis-Bacon Act which requires monitoring of pay rates for various classes of workers. Various other statutes extend this requirement to federally-aided construction. To check compliance with this law, an administrative regulation requires that each contractor on federal construction file a copy of his weekly project payroll with the supervising agency. These payrolls are a primary source of data on direct production man-hours worked and wages paid by occupation.

2. The Bureau of Labor Statistics (BLS) of the U.S. Department of Labor has used stratified samples of project payrolls to develop estimates of total man-hours requirements and their occupational distribution for the following types of construction:

a. Schools

b. Highways

c. Federal office buildings

d. Hospitals

e. River and harbor civil works

f. Public housing

g. Private residential dwellings

h. College student housing

i. Sewage disposal construction

BLS is now in the process of updating several of these studies.

3. The BLS studies were designed to measure the number of man-hours represented by a fixed dollar volume ($1,000). The reports differentiate between direct on-site construction labor

and labor required to produce and deliver the materials and equipment used in the construction.

a. The former is compiled simply and directly from contractor's payrolls throughout the duration of a project.

b. The latter (off-site indirect labor estimate) is developed by complex and indirect estimating methods which involve, in general, converting the producers' values of the bill of materials to man-hour requirements for their production by the use of employment-to-output ratios developed from the survey of manufacturers. Inter-industry relationship studies are used as a basis for establishing the indirect contribution of each sector of the economy to the bill of materials and the employment-to-output ratios for each sector are applied to the sum of these contributions to estimate secondary labor requirements.

4. For the purposes of the DOT/WTI study, only the simpler direct-labor requirement approach is necessary. The following major steps would be involved:

a. Definition of Categories of Construction. As a tool for projecting manpower requirements, the man-hours by occupation per unit of contract must be developed for a representative sample of construction projects which are reasonably comparable with respect to the man-hour/dollar ratio and the distribution of man-hours by occupation. For example, if the occupational mix per unit of a two-lane concrete highway is different than the mix for eight-lanes, separate projection bases should be developed. It is to be expected that river-crossing bridges will differ in their manpower requirements in relation to total cost as compared with highway over-pass bridges. In fact, different types of river-crossing bridges (suspension, steel panel, concrete arch) may involve different skills or at least a different mix of the same skills. Preliminary examination of typical payrolls from different types of construction projects will be necessary to a decision as to which project classification should be used. One or more project classifications will probably be required for at least the following broad categories of transportation-related construction:

1. Highways

2. Bridges

3. Airports and related facilities

4. Urban mass transit and related facilities

5. Public parking facilities

b. Design of Construction Project Sample. For each of the project classifications resulting from step "a" above, some measure should be developed of the total universe of such projects in the nation (recent new construction) and how they distribute in cost range. For each project classification (type) a sample of appropriate size should be selected in each project-cost stratum in a manner which will also provide for geographic spread. Selection of the sample may be restricted by the availability of project payrolls in the hands of supervising agencies and in the uniqueness of some projects (subway systems such as BART).

c. Assemble copies of the required project payrolls to fit the sample design.

d. Audit payrolls for reasonableness of job title in relation to rate of pay and reconcile discrepancies from internal evidence or contact with the contractor.

e. Develop tabulating plan, devise codes for required data and write ADP programs.

f. Code payroll source data and punch data processing cards.

g. Tabulate data.

h. Analyze and interpret tabulated data and draw up plan for estimating future requirements for specific projects.

5. Having developed a basis for estimating manpower requirements in relation to type and value of planned construction, the following major steps will yield projections for a given metropolitan area.

a. Assemble information on all transportation-related construction in the area, underway or planned, including project classification as in 4a above, total value and value of each subcontract, and phasing of work.

b. Express the total value of future projects each year in terms of constant dollars by selecting an appropriate deflator.

c. Apply the appropriate probable manpower requirement formula to each project type to arrive at an estimate of total man-hours required.

d. Apply the appropriate occupational distribution pattern for each project type to arrive at the probable man-hours required in each occupation.

e. Distribute the estimated man-hours (by occupation) in accordance with the known work phasing.

f. Translate the projected man-hours into the equivalent number of full-time workers in each occupation in each construction phase.

g. Aggregate the employment estimates for each project to arrive at the total manpower impact upon the area for various time periods.

6. This procedure will yield long-range projections only if all the most probable projects are planned, and their dollar value accurately estimated, well in advance of actual construction. It is unlikely that these conditions will be met very well for more than three to five years into the future. Beyond that time, the starting dates, phasing dates, and dollar estimates are likely to be very unreliable. Longer range projections, therefore, will need revision every three or four years.

7. Whenever it appears that technological developments, changes in worker productivity, and other factors are disturbing the relationship of man-hours to dollars or the occupational mix, the formulas reflecting these relationships will need to be re-examined for continued validity. These formulas will probably need periodic updating during a decade.

8. The manpower requirements in relation to type and value of construction, developed in accordance with paragraph 4 above, can probably be used for metropolitan areas nationwide provided that some adjustments are made for obvious differences in climate, terrain, and pay scales. The procedures described in 5 above, however, apply only to the planned and projected projects of a specific metropolitan area.

9. Conclusions:

a. The BLS method of measuring the actual number of direct man-hours represented by a fixed dollar volume offers

the best promise for developing a basis for projecting occupational utilization patterns for transportation-related construction in a given metropolitan area. Other methods, depending on secondary source data, do not provide the appropriate degree of specificity.

b. The BLS method of measuring direct labor requirements by occupation is relatively uncomplicated provided the payrolls are readily available for a recent time period and use accurate job titles.

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