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## CHAPTER 3. Geographic Work

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## Chapter 3. GEOGRAPHIC WORK

### INTRODUCTION

#### General

The taking of a nationwide census is a unique type of operation, requiring the preparation of specialized geographic materials. The maps and records must be as up-to-date and accurate as possible, showing all information pertinent to census-taking; the maps to be used in individual field operations must be of a scale and detail suitable to carrying out the enumeration; and the base maps must be acceptable for use in preparing the maps which accompany the published reports of census data. The objectives of the Bureau's geographic work in preparation for the 1970 census, therefore, were to identify by name and boundary the areas for which census data would be tabulated, to define and prepare maps of small areas for use by census takers in the field, to provide geographic identification by means of codes for the data-processing phase of the census, and to provide area-identification maps and other maps and charts to aid the users of census data.

The work was carried out in nine broad, overlapping operations: (1) collection of maps and boundary information, 1962 to 1969; (2) preparation of base office maps, 1962 to 1969; (3) definition and delimitation of statistical areas, 1965 to 1970; (4) designation of ED's, 1968 to 1970; (5) preparation of maps for field use, 1968 to 1970; (6) coding and numbering of all defined geographic areas being used as tabulation areas in the 1970 census, 1968 to 1971; (7) construction of the various address coding guides (ACG's) and geographic base files, and related files, 1965 to 1971; (8) area measurement of selected areas, 1969 to 1971; and (9) preparation of the maps and graphs for the census publications, 1968 to 1972.

Planning for the geographic work was primarily the concern of the Census Bureau's geographic and computer personnel in Suitland, Md., whereas the clerical operations were centered mainly in the Bureau's Jeffersonville, Ind., facility. Approximately 430 Bureau staff members participated in the planning and implementation of this work in Suitland and Jeffersonville.

A total of 26,200 maps were prepared for the 1970 census, including 22,305 mapsheets prepared for enumerators' use and covering counties and places, and 3,234 Metropolitan Map Series sheets. The geographic workload (expressed in some cases as approximate totals) for providing boundaries and code numbers was as follows:

<u>Kind</u>	<u>Number of units</u>
States and District of Columbia.....	51
Puerto Rico and outlying areas.....	6
Congressional districts.....	435
Standard metropolitan statistical areas (SMSA's) <sup>1</sup> .....	247
Urbanized areas <sup>1</sup> .....	252
Potential urbanized areas (not all of which became urbanized areas as a result of the census).....	52
Counties and county equivalents.....	3,141
Minor civil divisions (MCD's).....	28,130
Census county divisions (CCD's) <sup>1</sup> .....	7,068
Incorporated places.....	18,666
Census tracts <sup>1</sup> .....	34,709
Wards.....	5,000
Enumeration districts (ED's).....	234,593
Blocks (estimated number).....	1,700,000
Military installations.....	750
Unincorporated places, for which data were published.....	2,102
Unincorporated places, data not published due to insufficient population.....	987

<sup>1</sup>See text subheading, "Special Statistical Areas," p.9.

An increased amount of basic geographic information (e.g., commercial mailing address lists) and a marked increase in the production of relatively large-scale maps, especially by the U.S. Geological Survey, in the late 1950's and early to mid-1960's were factors in the decision to adopt census-by-mail procedures for some areas in 1970. Improvements in drafting materials and techniques (such as scribing) and modifications in the design of census maps (e.g., single-line street maps instead of the double-line street maps used through the 1960 censuses) helped to make the changes possible. The use of scribing and single-line streets are illustrated in the description of the Bureau's Metropolitan Map Series on p. 2 ff.

In the 1970 census there were three kinds of enumeration districts (ED's): computer ED's, prelist ED's, and conventional ED's. (The general requirements for establishing ED's are described on p. 28.) The first two represent distinct innovations compared with the ED's used in the 1960 censuses.

Computer ED's.--Master lists of addresses on computer tapes were purchased and updated for the mail-out/mail-back census areas which comprised the urban cores of most of the larger metropolitan areas. Addresses were listed sequentially by the computer: block by block within tract, place, and congressional district. The addresses then were

combined into groups of approximately 300 to 400 contiguous addresses, depending on estimates of the difficulty of enumeration. ED definitions for enumeration purposes in such areas consisted, therefore, of computer lists of addresses by blocks. Maps of computer ED's were supplied to the census district offices, but not to the census enumerators. There were 95,220 computer ED's.

Prelist ED's.--Since no uniformly suitable computer list of addresses was available for the mail census areas beyond the urban core areas, census employees prepared lists of addresses by making field canvasses in 25,987 ED's. This was called "prelisting" because it was done before the enumeration (in 1960 households were listed as they were canvassed). Maps of ED's whose boundaries had been previously delineated by the Census Bureau were provided to the employees doing the listing work so that they could code each address that they listed to the proper ED and, if applicable, to the block in which the address was located.

Conventional ED's.--Beyond the area's covered by computer and prelist ED's were the 108,034 "conventional" ED's in the United States in which the enumeration was carried out by direct canvass. There were also 5,501 conventional ED's in Puerto Rico and the five so-called "outlying areas" (American Samoa, Canal Zone, Guam, the Trust Territory of the Pacific Islands, and the Virgin Islands).

Several improvements since 1960 in geographic methods and techniques were used to assist in census work. The use of the relatively new map area computer linked to a key punch greatly shortened the amount of time needed to measure ED's areally in order to determine the number of square miles in urbanized areas, incorporated places, and other units. Many maps prepared for use in the enumeration subsequently were converted to other scales by photographic processes and used in preparation of maps for publication. Local groups, both public and private, had contributed greatly to census geographic work in previous censuses, such as in the definition of census tracts, donation of maps, etc., but the amount of geographic assistance rendered by them for 1970 far exceeded that of any previous census.

Finally, the amount and availability of geographic products and tools were greatly increased to assist users of 1970 census statistics. The increase included maps in the Metropolitan Map Series, address coding guides (ACG's) in the form of printed listings or on magnetic tape, and geographic base files to provide code numbers, geographic coordinates, and street names as supplements to information contained in the ACG's. These products and tools are described in chapter 13, "Research and Assistance in Data Use." The sections below deal with those geographic activities required for the conduct and completion of the decennial census itself.

### Costs

The costs for the geographic and related work for the Nineteenth Decennial Census shown in this chapter include depreciation, but they do not include the cost of general administration, other general expense, or capital outlay which were recorded only at the appropriation

level. These costs are shown in the 1970 Census of Population and Housing cost summary in chapter 1 of the procedural history.

The costs for the Metropolitan Map Series were considered to be part of the address coding guide program and are listed on page 21; costs for the DIME (Dual Independent Map Encoding) system and for preparation of place-of-work coding guides and tape address registers are listed under those respective headings. Except for the activities just mentioned, separate costs for the other geographic activities are difficult to arrive at as they were intermixed by budget project. A list of these projects, with the totals charged to them, follows. (Figures are rounded.)

Total.....	\$6,616,000
Geographic planning.....	284,000
Preparation of Bureau master maps.....	677,000
Designation of enumeration districts.....	165,000
Preparation of field maps.....	1,045,000
Geographic reference tape operations.....	1,585,000
Census tract delineation.....	342,000
Definition and delineation	
Urbanized areas.....	369,000
Unincorporated places.....	182,000
Census county division boundaries.....	89,000
Geographic procurement.....	59,000
Political area boundary and annexation surveys.....	306,000
Map compilation.....	110,000
Land area measurement.....	19,000
Boundary overlays.....	395,000
Preparation of publication maps.....	963,000
Late annexations.....	5,000
Miscellaneous geographic activities.....	21,000

## METROPOLITAN MAP SERIES

The 1960 census experience revealed an urgent need for improved mapping of the larger urban areas in the country. To meet this need a map improvement program was initiated in 1961 to test the feasibility of producing single maps of uniform scale and content for the urban concentrations within selected SMSA's.

The first area to be remapped was St. Louis, Mo., where 137 maps, consisting of 169 sections, were replaced by a single map of 29 sheets. Since that time more than 3,200 sheets of maps have been prepared, covering the urbanized portions of all the SMSA's in the United States and Puerto Rico that had been established at the time of the 1970 census. This series of maps, called the Metropolitan Map Series (MMS), now encompasses over 100,000 square miles.

The MMS sheets were widely used in various Bureau-sponsored programs and internal operations related to the 1970 census, primarily as follows:

1. As a basic record on which all boundaries within the urban areas were marked.
2. As a basic tool in developing address coding guides and geographic base files.
3. As source maps for the prelist operation in which address registers were prepared for certain areas of the country enumerated by the mail-out/mail-back technique, and for the location of new addresses at the time of the census.
4. As enumerators' maps.
5. As the standard reference source for verifica-

tion of geographic identification codes contained in the files used to tabulate the 1970 census data.

Each mapsheet in this series measures 1-1/2 by 2 feet, with the final maps on a scale of 1 inch to 2,000 feet. Streets and roads are shown by single lines, and almost all are named. Also shown are other features such as railroads, streams and other water bodies, airports, and special-purpose areas such as universities, parks, golf courses, Government and military reservations, etc. The maps were compiled using the U.S. Geological Survey 7-1/2-minute quadrangle maps to establish the control base. The quadrangle sheets were photographically enlarged and then updated with information from the latest available local and county maps obtained from city, county, and metropolitan planning agencies and from State highway departments. For most of the mapsheets, the desired features were scribed (marked) and an overlay prepared with the names of these features. Local planning and coordinating agencies assisted in reviewing and correcting the maps for their respective areas. The Bureau then transferred these corrections to its master mapsheets.

**Figure A. Preparing U.S. Geological Survey Maps For Use in the Metropolitan Map Series**



**Figure B. Scribing Metropolitan Map Series Maps**

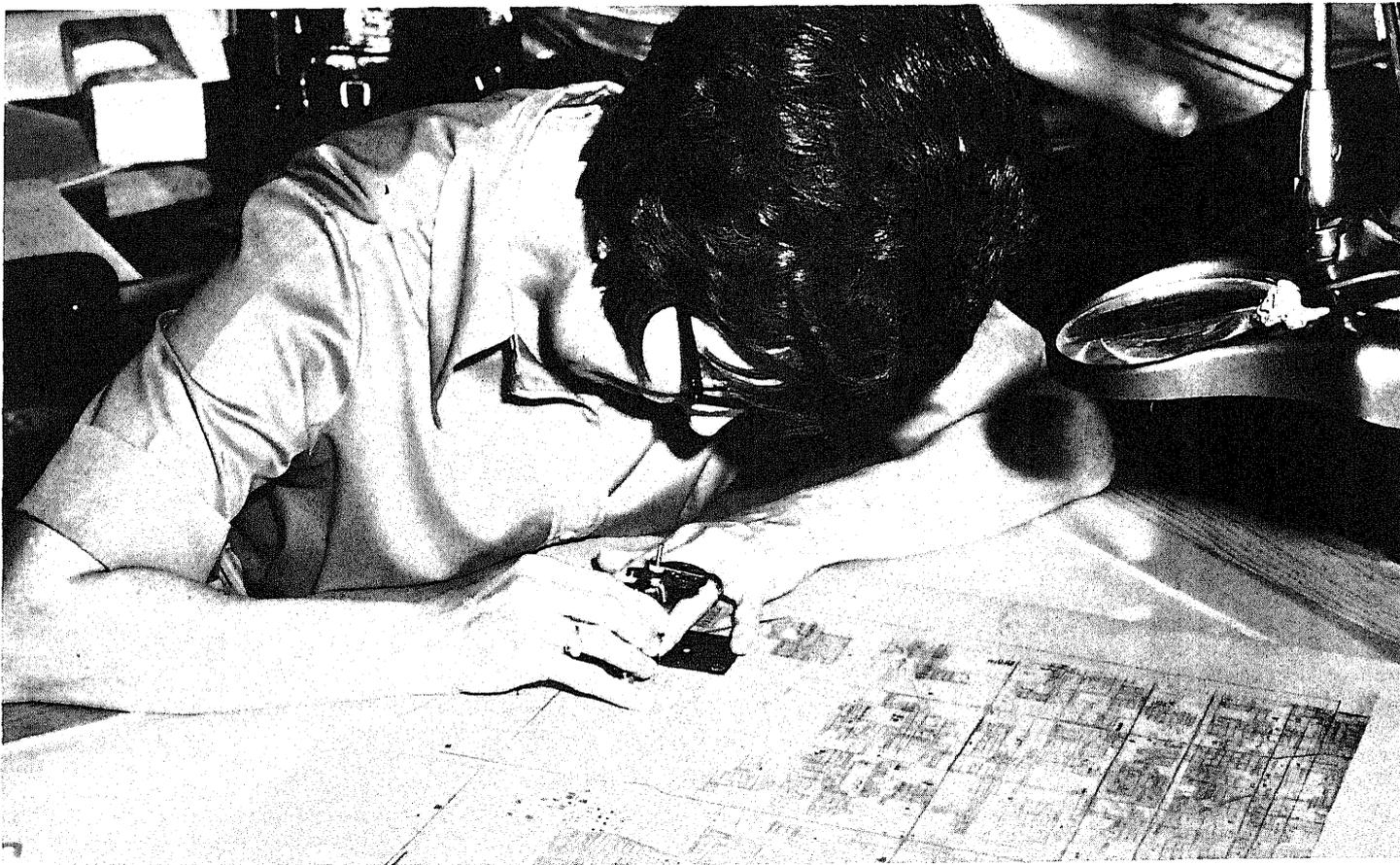
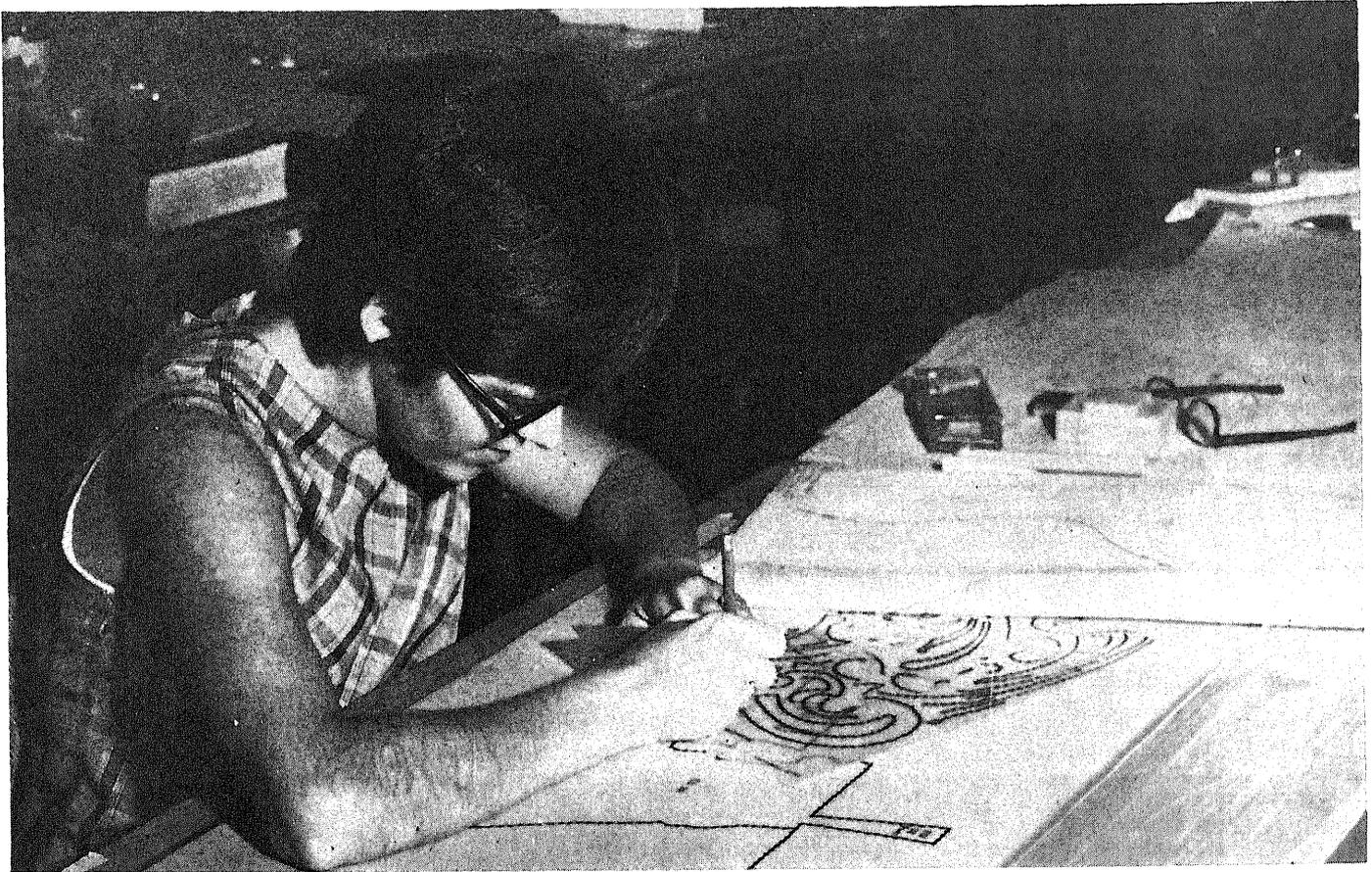


Figure C. Preparing Map Overlays



The maps, as originally drawn, showed boundaries only for States and counties. Block identifications and other boundaries, including those of incorporated places, wards, census tracts, minor civil divisions (MCD's) and census county divisions (CCD's), congressional districts, and other geographic areas needed for taking the 1970 census, were marked on a series of overlays. Each mapsheet was prepared in two forms, a color-coded office base map and a version that could be reproduced in black and white. (Eventually, a third form, printed in black and green, accompanied the published block statistics reports.) The distinguishing feature between the first two forms was the method used for defining boundaries on the map. The political and statistical boundaries on the MMS office base maps were drawn following a color code for easy identification. For example, boundaries of States, counties, MCD's, and CCD's were red; boundaries of incorporated places were light green; and boundaries of congressional districts were blue. The use of this map form was limited by the time and cost involved in preparing copies by hand-copying the boundaries onto reproductions of the original base map. To save time and reduce costs the Bureau developed a standardized set of monochrome screened symbols (see fig. D) to define each political and statistical area. The symbol maps could be reproduced quickly and easily at a modest cost. All boundary symbols were applied to the overlays in black ink. Screens then were

interposed in the photographic process to produce an "intermediate," i.e., a reproducible map from which copies could be made by a dry copy process, with tone as well as symbol variations between the tract, ED (enumeration district), and political area boundaries. To avoid the possibility that two or more coinciding boundaries might obscure one another, the symbols were designed to overlay each other in combination and still be identifiable.

Both the office base maps and the symbol maps were prepared in the Bureau's Jeffersonville, Ind., facility. The office base maps were maintained there for use by Bureau personnel. The intermediates of the symbol maps were used to reproduce copies of each mapsheet; these were sent to the Bureau's field offices for use by field workers during the enumeration (see fig. E). Intermediates also were filed in Jeffersonville and subsequently were used to reproduce more prints to fill map orders from other Bureau users and from other Government agencies, private organizations, and individuals.

The Metropolitan Map Series marked the first time that standardized, up-to-date maps were prepared for all the large cities of the United States and Puerto Rico and their environs. This series is being extended to cover entire SMSA's in preparation for future censuses. For costs see p. 21.

Figure D. Principal Boundary Symbols Used in the Metropolitan Map Series

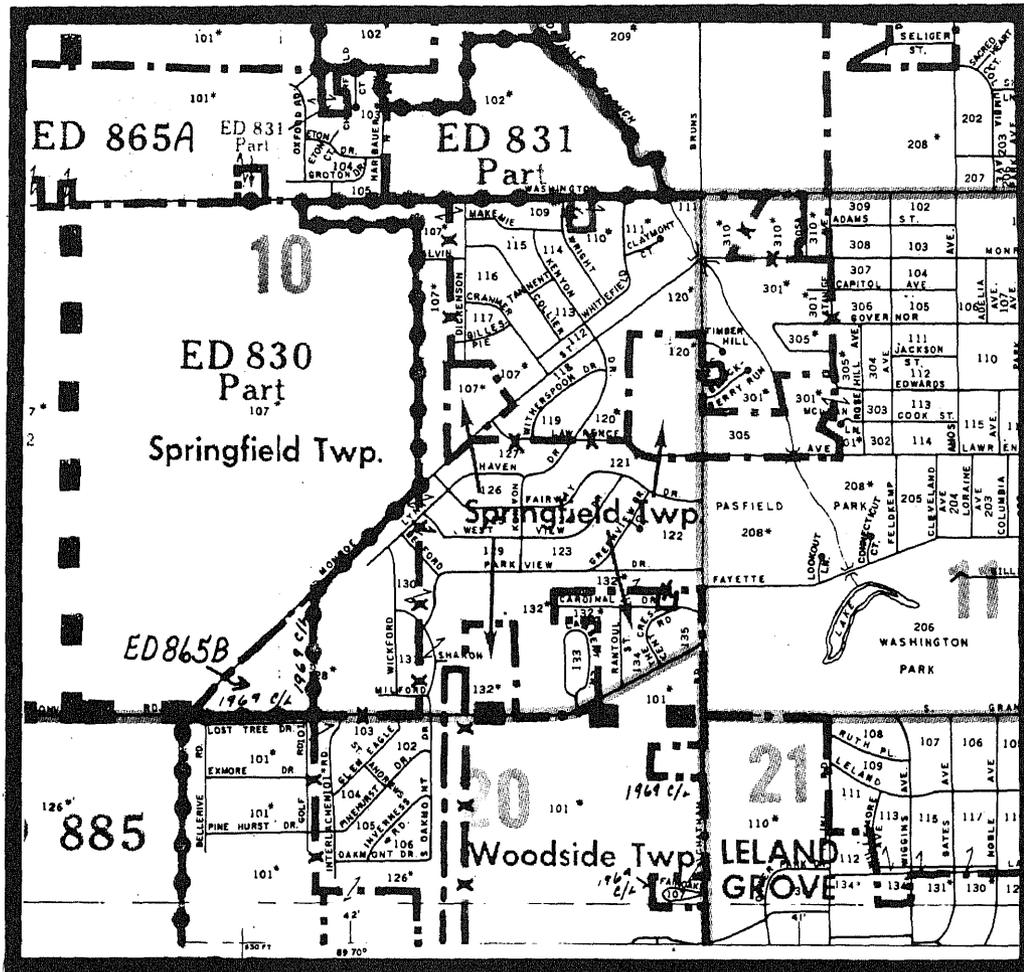
### Boundary Symbols And Identifications

	International
	State
	County
	Minor Civil Division or Census County Division
<b>Adams Div.</b>	Minor Civil Division or Census County Division Name
	1970 Incorporated Place Limit,
<b>WAYNE</b>	Incorporated Place Name
<b>WAYNE*</b>	Incorporated Place or Places Coextensive With Minor Civil Division or Census County Division
	1960 Incorporated Place Limits Where Different From 1970
	Unincorporated Place Limits
<b>DALE</b>	Unincorporated Place Name
	Ward Line In Incorporated Places
<b>15</b>	Ward Number
	Congressional District
<b>15</b>	Congressional District Number
	Census Tract
	Urbanized Area Limit
	County Tie-in
	Enumeration District
<b>ED 50</b>	Enumeration District Number

### Symbol Combinations That Frequently Coincide

	Corporate Limit Where Different From 1970 And Minor Civil Division Or Census County Division
	Minor Civil Division Or Census County Division And Unincorporated Place
	Minor Civil Division Or Census County Division And Incorporated Place
	Minor Civil Division Or Census County Division And Congressional District
	Enumeration District And County Tie-In Line
	Census Tract And Corporate Limit
	Minor Civil Division Or Census County Division And County Tie-In Line
	Corporate Limit And County Tie-In Line
	Census Tract And Minor Civil Division Or Census County Division
	Census Tract and Ward

Figure E. Portion of MMS Mapsheet Showing Delineation of ED's (Enumeration Districts)



Census Tract

399

Census Tract Number  
(Numbers over 9399 are  
Block Numbering Areas)

947

Block Number

947\*

A Flag To Indicate That A Block Number Is  
Repeated On An Adjacent Map Sheet, Or  
Elsewhere Within The Block



ED 3

Features Crossed By These 'Fish-Hooks'  
Are Not Block Boundaries

Enumeration District  
(Enumeration District Symbol Is Always  
Shown Along The City Delivery Limits)

Enumeration District Number  
(Enumeration Districts Are Not Shown In  
Areas For Which A Computerized Mailing  
List Is Available)

## COLLECTION OF MAPS AND BOUNDARY INFORMATION

### Background

The Census Bureau tabulates data by State, county, minor civil division (MCD) or census county division (CCD), incorporated place, and other areas. To do this it must have accurate, up-to-date boundary information for these areas for use during enumeration.

Collection of political boundary information for the 1960 and 1970 decennial censuses differed primarily in the number of times boundary data were requested and the cutoff dates set for boundary changes. In preparation for the 1960 census, county and municipal officials were contacted in April 1958 and asked to submit maps showing the current political boundaries of their respective jurisdictions. At that time the officials were asked to keep the Bureau informed of any boundary changes occurring on or before April 1, 1960 (Census Day), the final cutoff date. Between January 18, 1960, when maps were shipped to the district offices, and April 1, 1960; there had been more than 2,000 boundary changes requiring extensive last-minute changes to the maps.

To prevent excessive numbers of corrections and to eliminate as many errors as possible in drafting political boundaries and tabulating census data by political area, the boundaries observed in the 1970 census were those in effect on January 1, 1970, rather than on April 1. The pertinent authority, found in two sections of Title 15, Chapter 1, Code of Federal Regulations (Amended), was as follows:

Sec. 70.1. The Bureau of the Census will recognize only those boundaries in effect on January 1, 1970, for the tabulation and publication of data from the 1970 Censuses of Population and Housing. Respondents will be enumerated on the census date as residing within the legal limits of municipalities, wards, the county subdivision areas, and counties as these limits existed on January 1 of the census year.

Sec. 70.3. Changes in boundaries that become effective after January 1, 1970, will not be recognized by the Bureau of the Census in taking the 1970 Federal censuses. The residents of any area which is transferred to another jurisdiction after January 1, 1970, will be enumerated in the censuses as residents of the area in which their respective residences were located on January 1.

Request to local officials for boundary information contained the following paragraph:

Should a change be made in the boundary of your municipality between December 1, 1969, and January 1, 1970, please notify the Census Operations Division in Jeffersonville. Because of the time necessary to update our records and maps and distribute these corrections to our enumerators for use during the census in April, we must request that you notify our Jeffersonville office no later

than January 23, 1970, of any boundary changes which occur on or before January 1, and which have not been previously reported to the Census Bureau. If the failure, by a municipality, to advise the Bureau of boundary changes by January 23 leads to inaccuracy in census results, corrective action will be taken only at the request and expense of the municipality.

Boundary information for the 1970 enumeration was obtained in several surveys conducted by the Bureau, beginning in February 1968. The counties (or county equivalents) were surveyed only once--in July 1968--while incorporated places were contacted at three different times--February 1968, May-June 1969, and November 1969. For the county survey a questionnaire was addressed to the chief official of each county, while for each of the three incorporated place surveys a questionnaire was directed to the chief official of each municipality. The addresses of these officials were obtained from a file maintained in Bureau headquarters; the actual mail-out of requests and the check-in of returns were performed in Jeffersonville.

### Administrative and Political Areas

Counties and minor civil divisions.--For the county survey the counties were divided into two types: those having minor civil divisions (MCD's) and those having census county divisions (CCD's). (CCD's are permanent statistical areas within counties of 21 States whose minor civil divisions are not suitable for statistical reporting; they are established cooperatively by the Census Bureau and local government authorities.) Each county (parish in Louisiana) was sent a map--usually a county highway map--on which the county boundaries were shown. The county official was asked to review the boundaries and make any necessary corrections on the map. He also was asked to review a list of incorporated places in the county and make any necessary additions, deletions, or other corrections (e.g., name changes) to it. For each county whose MCD's were to be used in the census, the map supplied was marked with MCD boundaries; the official was asked to review these boundaries and a list of MCD's in the county, making any necessary corrections to the map or listing.

Incorporated places and wards.--The February 1968 survey was directed to those incorporated places on the 1960 census MCD-place listing plus any newly incorporated places discovered by the Bureau from various sources, such as the publications of State municipal leagues, questionnaires from economic censuses, or notifications from State officials. Places known to have been disincorporated were excluded from the mail-out. In February each incorporated place was sent a map showing the corporate limits of that place as they appeared in the Bureau's file, and was asked to review the map and make any corrections necessary. Certification by an appropriate local official regarding the accuracy of the corporate limits as of January 1, 1968, was requested.

Information obtained from the counties concerning mergers, disincorporations, incorporations, etc., was used in the incorporated place mail-outs in the spring and fall of 1969. As soon as a new incorporation came to the Bureau's attention the area's officials were

contacted in order to obtain a map and to verify the date of incorporation, status (city, town, village, or borough), and the correct spelling of the place's name.

In a second survey in May and June 1969, officials of all incorporated places were asked to report any boundary changes which had occurred between January 1, 1968, and April 1, 1969. Where the response received in the 1968 survey indicated that a boundary change would be unlikely, no map was sent with the questionnaire. Officials to whom a map was sent were asked to review the corporate limits shown on the map, make any necessary corrections, and certify the accuracy of the boundaries as of April 1, 1969. All other incorporated places were asked to send the Bureau a map showing the new corporate limits if there had been any changes since January 1, 1968. In this survey any place which had more than one name or more than one spelling of its name was asked to indicate its preference for the name to be used in 1970 census publications.

In the final survey taken in November 1969, all incorporated places again were divided into two groups: those to which a questionnaire and a map were to be sent, and those which were to be sent only a questionnaire. The officials of all incorporated places with a 1960 population of 2,500 or more (or a population of 2,500 or more certified in a special census after 1960) who had reported annexations in one or both of the previous surveys, and the officials of each place incorporated since 1960 that had not been canvassed in a previous survey, were sent a map and asked to review it, make any necessary corrections, and certify the accuracy of the boundaries as of November 1, 1969. The officials of the remaining incorporated places were sent letters asking them to send a map if there had been any changes in municipal boundaries between April 1, 1969, and November 1, 1969. Both types of letters requested that the Bureau be notified no later than January 23, 1970, of any corporate limit changes occurring between November 1, 1969, and January 1, 1970.

In all three surveys officials of places in the 2,500+ population category were asked to delineate wards on the maps if the current estimated population was at least 3,000. (In the fall 1969 survey, however, the Bureau did not send a map or request the delineation of wards unless annexations had been reported previously.)

A secondary objective of these surveys was to alert local officials to the nature of the boundary and annexation information in the Bureau's files, and to have them review it for accuracy. (Publication of this information concerning types of change such as annexation, detachment, merger, etc., ordinance number, effective date, area and population, or number of housing units involved in each change, was planned but not effected until after the 1970 census was taken.) In the second and third surveys of incorporated places each place was sent a computer-generated listing of information about its boundary changes; officials were asked to review the listings and make any corrections or additions. Places with a 1960 population of 2,500 or more (or a post-1960 special census population of 2,500 or more) also were asked to indicate the estimated area and population or number of housing units involved in each change.

Letters were mailed to approximately 18,600 incorporated places in each of the three surveys; 25 percent of these places were in the 2,500-and-over population category. The cities of Baltimore, Md., Boston, Mass., New Orleans, La., New York, N.Y., Philadelphia, Pa., St. Louis, Mo., San Francisco, Calif., and Washington, D.C., whose boundaries had been static for a long period of time and were not likely to change, were excluded. The District of Columbia and the following counties or county equivalents also were deleted from the mail-out as they were coextensive with their respective municipalities: San Francisco County, Calif., Denver County, Colo., Orleans Parish, La., and Bronx, Kings, New York, Queens, and Richmond Counties, N.Y. The independent cities in Maryland, Missouri, and Virginia, and the counties which were coextensive with cities, also were excluded from the mailing to county officials. No county questionnaires were mailed to Alaska and Hawaii, as the required information was secured from State officials. No places were surveyed in Hawaii, either, because there were no incorporated places in that State.

Unincorporated places.--The State highway departments provided the Bureau with maps which showed the streets and/or suggested boundaries for all unincorporated places which were estimated to have 800 or more inhabitants and were located outside the urbanized areas defined in 1961.

The census tract committees, through the census tract key persons in each SMSA, assisted in a similar way by providing boundary information for unincorporated places which were expected to have 5,000 or more inhabitants and were located in the urbanized areas. (See the following sections on the development and delineation of special statistical areas.)

Congressional districts.--The congressional districts used for the tabulation of 1970 data were those used in electing members to the 91st Congress in 1968. Information on the location of the district boundaries was taken from the State laws establishing the congressional districts within the various States; copies of these laws were secured from the Secretaries of State.

Puerto Rico and outlying areas.--The collection of maps and boundary information extended to the Commonwealth of Puerto Rico and to the five "outlying areas"--American Samoa, the Canal Zone, Guam, the Trust Territory of the Pacific Islands, and the Virgin Islands. Maps for Puerto Rico on which the boundary information required by the Bureau had been drawn were supplied through a contract with the Puerto Rico Planning Board. Maps were sent by the Bureau to the Governors' offices in American Samoa, the Canal Zone, Guam, and the Virgin Islands with the request that boundary information be added or corrected and the maps returned. Because of the Bureau's limited association with census taking in the Trust Territory of the Pacific Islands, a Bureau representative was sent with copies of all maps that could be accumulated of the several thousand islands that compose the Territory; while there, and with the help of many local persons, this representative located the approximate boundaries of districts, municipalities, and towns on these maps and divided the Trust Territory into ED's.

## Other Areas

Maps and boundary information were collected for other areas as well, including "potential" urbanized areas, contract block areas, and military installations.

Potential urbanized areas.--In addition to the central cities known from a previous census to have 50,000 or more inhabitants, which automatically qualified them as urbanized areas<sup>1</sup> in 1970, there were about 50 cities where a reasonable possibility existed that 50,000 or more inhabitants might be enumerated during the 1970 census. Maps which extended well beyond the corporate limits of these cities were prepared, so that an urbanized area could be defined for each city which did in fact pass the 50,000 population mark in the census. Some of these areas were mapped using materials and specifications followed in the preparation of the Metropolitan Map Series (MMS) maps; others were mapped with whatever source materials could be obtained.

Contract block areas.--Block statistics were published routinely for all cities having 50,000 or more inhabitants in an official census prior to 1970 in the United States and Puerto Rico, and for the urbanized areas (and the immediately adjacent territory) around such cities. In addition to issuing these regular block statistics, however, the Bureau collected, tabulated, and published statistics for approximately 200,000 blocks in 966 areas outside urbanized areas. This was arranged by special contract between the Bureau and six States--Kansas, New York, Tennessee, Virginia, Washington, and Wisconsin--as well as between the Bureau and areas in 41 States and Puerto Rico; but about two-fifths of the contract block statistics program areas were located in New York State. All contract work carried out involved reimbursement of cost to the Bureau by the requesting area or State, but any area which made such a contract with the Census Bureau in advance of the 1970 census, and which reached a population of 50,000 or more in the census, had its contract fee refunded.

Officials or other representatives from each area were asked to submit a map to the Bureau which covered the area included in the contract. Maps were to approximate the quality of MMS mapsheets. The areas were block-numbered by the Bureau, and the routine necessary to gather data on a block basis in these special areas was fitted into the enumeration procedures. A large proportion of these maps had to be redrawn following enumeration to satisfy the Bureau's map publication requirements.

Military installations.--The Department of Defense provided liaison with the Army, Navy, and Air Force to assist the Bureau in obtaining maps of installations in which military personnel resided. These maps were provided in response to directives from the Department to individual installations or, when necessary, were obtained through direct contact between Bureau staff members and the map depository personnel of the

service or individual installation concerned. A liaison representative was named by the Coast Guard to provide the Bureau with maps of its larger bases. Altogether, maps of more than 650 military installations were obtained; this map collection and boundary information program also included most of the military installations in the outlying areas as well.

## SPECIAL STATISTICAL AREAS

In addition to collecting and publishing census data for administrative and/or political areas (see p. 7), the Census Bureau also presents data for areas which are defined and delimited for special statistical purposes not possible by following the established administrative or political boundaries. The methods used in establishing these statistical areas are described below.

### Standard Metropolitan Statistical Areas (SMSA's)

A standard metropolitan statistical area (SMSA) consists of a county or group of counties (except in New England, where towns are used) containing at least one city (or twin cities) having 50,000 or more inhabitants, plus adjacent counties which are metropolitan in character and economically and socially integrated with the central city (or cities).

A definition of "standard metropolitan areas" first was issued in 1949 by the Bureau of the Budget (now the Office of Management and Budget). It was developed to replace at least four different sets of definitions of statistical areas then in use for various statistical series of the Bureau of the Census and other agencies: "metropolitan districts," "metropolitan counties," "industrial areas," and "labor market areas." Because of the use of different definitions it had not been possible to relate the statistics on population, industrial production, labor markets, and other series for a metropolitan area because each series included different territory. The word "statistical" was added before the 1960 census to emphasize that the areas were defined for statistical purposes. These criteria for establishing SMSA's were adopted in 1958 following their revision in that year by the Bureau of the Budget with the advice of the Federal Committee on Standard Metropolitan Statistical Areas, which is comprised of representatives of major Federal statistical agencies. (The criteria originally were developed in 1949.) The revised criteria, which were used for the 1970 census, were as follows:

### Criteria Followed in Establishing Standard Metropolitan Statistical Areas

The definition of an individual standard metropolitan statistical area involves two considerations; first, a city or cities of specified population to constitute the central city and to identify the county in which it is located as the central county; and, second, economic and social relationships with contiguous counties<sup>2</sup> which are metropolitan

<sup>1</sup>An "urbanized area" (UA) is defined as one which contains a central city (or twin cities) of 50,000 or more population, plus the surrounding closely settled incorporated and unincorporated areas which meet certain criteria of land use and population size or density.

<sup>2</sup>A "contiguous" county either adjoins the county or counties containing the largest city in the area, or adjoins an intermediate county integrated with the central county. There is no limit to the number of tiers of outlying metropolitan counties so long as all other criteria are met.

in character, so that the periphery of the specific metropolitan area may be determined. Standard metropolitan statistical areas may cross State lines, if this is necessary in order to include qualified contiguous counties.

### Population Criteria

1. Each standard metropolitan statistical area must include at least:

- (a) One city with 50,000 or more inhabitants, or
- (b) Two cities having contiguous boundaries and constituting, for general economic and social purposes, a single community with a combined population of at least 50,000, the smaller of which must have a population of at least 15,000.

2. If two or more adjacent counties each have a city of 50,000 inhabitants or more (or twin cities under 1(b)) and the cities are within 20 miles of each other (city limits to city limits), they will be included in the same area unless there is definite evidence that the two cities are not economically and socially integrated.

### Criteria of Metropolitan Character

The criteria of metropolitan character relate primarily to the attributes of the county as a place of work or as a home for a concentration of nonagricultural workers. Specifically, these criteria are:

3. At least 75% of the labor force of the county must be in the nonagricultural labor force.<sup>3</sup>

4. In addition to criterion 3, the county must meet at least one of the following conditions:

- (a) It must have 50% or more of its population living in contiguous minor civil divisions<sup>4</sup> with a density of at least 150 persons per square mile, in an unbroken chain of minor civil divisions with such density radiating from a central city<sup>5</sup> in the area.
- (b) The number of nonagricultural workers employed in the county must equal at least 10% of the number of nonagricultural workers employed in the county containing the largest city in the area, or be the place of employment of 10,000 nonagricultural workers.
- (c) The nonagricultural labor force living in the county must equal at least 10% of the number of the nonagricultural labor force living in the county containing the largest city in the area, or be the place of residence of a nonagricultural labor force of 10,000.

5. In New England, the city and town are administratively more important than the county, and data are compiled locally for such minor civil divisions. Here, towns and cities are the units used in defining standard

<sup>3</sup>Nonagricultural labor force is defined as those employed in nonagricultural occupations, those experienced unemployed whose last occupation was a nonagricultural occupation, members of the Armed Forces, and new workers.

<sup>4</sup>A contiguous minor civil division either adjoins a central city in a standard metropolitan statistical area or adjoins an intermediate minor civil division of qualifying population density. There is no limit to the number of tiers of contiguous minor civil divisions so long as the minimum density requirement is met in each tier.

<sup>5</sup>Central cities are those appearing in the standard metropolitan statistical area title.

metropolitan statistical areas. In New England, because smaller units are used, and more restricted areas result, a population density criterion of at least 100 persons per square mile is used as the measure of metropolitan character.

### Criteria of Integration

The criteria of integration relate primarily to the extent of economic and social communication between the outlying counties and central county.

6. A county is regarded as integrated with the county or counties containing the central cities of the area if either of the following criteria is met:

- (a) If 15% of the workers living in the county work in the county or counties containing central cities of the area, or
- (b) If 25% of those working in the county live in the county or counties containing central cities of the area.

### Area Titles

7. The following general guidelines are used for determining titles for standard metropolitan statistical areas:

- (a) The name of the standard metropolitan statistical area is that of the largest city.
- (b) The addition of up to two city names may be made in the area title, on the basis and in the order of the following criteria:
  - (1) The additional city or cities have at least 250,000 inhabitants.
  - (2) The additional city or cities have a population of one-third or more of that of the largest city and a minimum population of 25,000, except that both city names are used in those instances where cities qualify under criterion 1(b).
- (c) In addition to city names, the area titles will contain the name of the State or States included in the area.

(U.S. Bureau of the Budget, Standard Metropolitan Statistical Areas, 1967. Washington, D.C., 1967, pp. I-3.)

The list of SMSA's published in 1967 included 231 areas which qualified at that time. Two additional areas qualified by January 1, 1970, and 14 more qualified as a result of the 1970 census, making 247 in all; of these, four are in Puerto Rico. These 247 SMSA's were recognized in the 1970 census reports.

### Census Tracts

Census tracts are small areas delineated for statistical purposes by local committees in cooperation with the Bureau of the Census. Census tracts were established by January 1, 1970, within the 233 SMSA's defined at that time, and in approximately 100 smaller areas. In general, the boundaries of these tracts are maintained constant so that comparisons can be made from one census to another. A tract is delimited originally to include an area containing about 4,000 residents who are generally homogeneous with respect to social characteristics, economic status, and living conditions. (For specific criteria, see U.S. Bureau of the Census, Census Tract Manual, Fifth Edition, Washington, D.C.,

1966, pp. 32 ff., and individual issues of Census Tract Memos published irregularly by the Bureau since 1961.)

Immediately after the 1960 census the Census Bureau began to work with local tract committees to establish census tracts in previously untraced areas. It was decided that all SMSA's would be traced in their entirety. Each new census tract plan was reviewed by the Bureau to see if the established criteria had been observed, and wherever necessary was returned to the local committee with questions and suggestions for change. When the plan for a specific area was approved, descriptions and/or maps of the final census tracts were prepared.

In 1950 there were about 12,500 tracts in approximately 70 traced areas. In 1960, 23,365 tracts were recognized in 178 SMSA's, of which 136 were completely traced and 42 others were partially traced; 127 tracts were recognized in areas which were not SMSA's. In 1970, 34,709 tracts were recognized, of which 32,394 were in SMSA's and 2,315 were outside SMSA's.

In 1970, 241 SMSA's were completely traced: the 233 SMSA's recognized prior to the census, plus eight of the 14 qualified as a result of the census. The remaining six SMSA's (Caguas, P.R., Danbury, Conn., LaCrosse, Wis., Nashua, N.H., Owensboro, Ky., and Petersburg-Colonial Heights, Va.) were not traced before the census. The 241 completely traced SMSA's plus small traced areas outside SMSA's, included 259 cities of 50,000 inhabitants or more, all of which cities were traced. Areas which had been traced by 1970 contained approximately 72 percent of the total population of the United States and Puerto Rico.

### Urbanized Areas

In the 1970 census statistics were presented for 252 urbanized areas. This type of statistical area was established in 1950, primarily to distinguish the urban from the rural population in the vicinity of large cities where the urban population does not necessarily reside inside incorporated places of 2,500 inhabitants or more. Urbanized areas differ from SMSA's principally in that the urbanized areas include only the densely settled areas in and adjacent to the central city of the SMSA. In 1970, for the first time, an incorporated place could be only partially within an urbanized area. If it was determined that part of a place was rural in character, that part was excluded from the urbanized area. Cities thus classified as part urban and part rural were called "extended" cities. On the other hand, a number of urbanized areas in 1970 included areas beyond the limits of their SMSA counties. In some cases, where two SMSA's were adjacent to each other, the urbanized area of the central city of one SMSA extended into a county (or town in New England) of the adjacent SMSA.

In 1970 there also were a number of SMSA's which contained more than one urbanized area, and there was one SMSA (New London-Groton-Norwich, Conn.) which did not contain an urbanized area. Another characteristic of urbanized areas, which appeared in 1970 more than

in 1950 and 1960, was the continuity of urban development between one central city and the next in numerous parts of the country; these urban areas could be separated only arbitrarily, usually along SMSA lines.

In 1970, as in 1960, the urbanized areas were delimited in terms of the current (i.e., 1970) census results, rather than being delimited prior to the census as had been done in 1950. For this purpose, a peripheral urban fringe zone was created around each 1960 urbanized area consisting of "blocked parcels" (groups of blocks) in the mail census areas, or small ED's--usually smaller than one square mile--in the conventional census areas. Block parcels or small ED's also were delimited in a peripheral zone around central cities of SMSA's which did not have urbanized areas in 1960 but appeared to be approaching a population of 50,000 in 1970. Both block parcels and small ED's were designed to group together areas of similar population density. Approximate density was determined from the street patterns on maps, recent aerial photographs, and 1960 (or later) census information. The zone was extended outward until a completely rural area was reached.

Those block parcels, ED's, and places in the urban fringe which met specified criteria of contiguity and population density were included within the final urbanized area boundaries. In unincorporated areas the density requirement for block parcels or ED's to be included within the final urbanized area boundaries was 1,000 or more inhabitants per square mile. The land area of these parcels or ED's was measured by using the Bureau's map area computer. Large nonresidential areas of urban land use and water areas were eliminated from the parcel or ED area, and the population density of the balance of the parcel or ED area was then determined (see also the section on area measurement on p. 32).

In extended cities (i.e., those cities with significant amounts of rural territory within their corporate boundaries) considerably different criteria were used to determine whether a part of the incorporated place should be eliminated from the urbanized area, thus defining the place as part urban and part rural. An area was classified as rural in such incorporated places only if (1) a population density of less than 100 people per square mile extended over a contiguous area of at least 5 square miles, and (2) the total land in such rural areas made up (a) at least 25 percent of the area of the city or (b) totaled 25 square miles or more. Such areas were eliminated from the urbanized areas and classified as rural.

In almost all cases the new Metropolitan Map Series (see p. 2) was used for both the establishment of block parcels and small ED's prior to the census and the determination of the final urbanized areas after the census. Several of the areas for which urban fringe zones were delimited, because a city (or twin cities) was approaching the 50,000+ population figure necessary to make it a central city of a new urbanized area, were treated on maps other than those compiled by the Bureau. These maps did not always meet the specifications of the Metropolitan Map Series; this situation occurred for 22 areas.

Another facet of the preparatory work on urbanized areas which was entirely new for 1970 resulted from the fact that many of these areas were covered by computer-generated ED's. In these cases, all of the urbanized area operations were accomplished by computer methods (see p. 37 ff. for discussion) except for the determination of the original fringe zone and of the final urbanized area.

### Census County Divisions (CCD's)

Prior to the census of 1950 it became evident that minor civil divisions (MCD's) were not always satisfactory units for reporting statistics, because their boundaries either changed frequently or consisted of imaginary lines that were not well known locally. For example, most of the counties in the State of Washington were subdivided into election precincts whose boundaries were changed frequently, and which followed township lines or other boundaries which were not easily identified on the ground. To provide divisions with stable boundaries, therefore, the Bureau, in cooperation with State and local groups, created census county divisions (CCD's) as permanent statistical areas in the State of Washington.

In delimitation, consideration was given to recognizing the trade or service areas of principal settlements and in some cases major land use or physiographic differences. The boundaries normally followed physical features such as roads, highways, railroads, power lines, streams, and ridges. The larger incorporated places were recognized as separate CCD's, and the boundaries of these divisions changed when annexations occurred. In some cases the CCD's included more territory than the incorporated places.

In the 1950's the program was extended to 17 more States in which the pattern of MCD's was not well suited to statistical purposes--Alabama, Arizona, California, Colorado, Florida, Georgia, Hawaii, Idaho, Kentucky, Montana, New Mexico, Oregon, South Carolina, Tennessee, Texas, Utah, and Wyoming.

In the decade preceding the 1970 census the program again was extended to include three more States--Delaware, North Dakota, and Oklahoma. In these three States there were a total of 636 CCD's, whereas there had been 3,327 MCD's plus numerous unorganized territories (see p. 13) in the same States in the 1960 census. The decrease in the number of reporting units resulted in a considerable saving to the Bureau by reducing the number of areas for which data were separately mapped, enumerated, tabulated, and published. However, this saving was secondary to the principal objective which was improvement in the usefulness of census information.

There were 6,558 CCD's in 18 States at the time of the 1960 census. The number in these 18 States was reduced to 6,432 in 1970, mainly through consolidations around certain urban areas, but the establishment of 636 CCD's in the three additional States and the splitting of a number of whole-county CCD's into several parts increased the total number of CCD's to 7,068 in 21 States for 1970, as follows:

Alabama	446	Florida	345
Arizona	86	Georgia	689
California	560	Hawaii	44
Colorado	224	Idaho	183
Delaware	30	Kentucky	590

Montana	250	Tennessee	535
New Mexico	142	Texas	995
North Dakota	253	Utah	102
Oklahoma	353	Washington	455
Oregon	310	Wyoming	75
South Carolina	401		

CCD's in certain counties were revised for 1970 from their 1960 counterparts. Of the 1,206 counties in the 18 States which had CCD's in 1960, 596 counties had some revision in division boundaries for 1970; in 446 of these counties, however, revisions were so minor that they did not seriously affect the comparability of statistics from 1960 and 1970. In only 150 counties were there any major revisions of CCD boundaries, and in only 43 of these (chiefly in SMSA's and newly tracted counties) was there a large-scale revision affecting most CCD's in the county. Most changes involved a slight adjustment where a feature used as a boundary in 1960 (road, railroad, stream, etc.) had changed in alignment or disappeared altogether by 1970. Other changes were made where city limits formed a division boundary and the city had annexed or detached areas; in such cases the division boundary was adjusted to the new city limits. Major changes occurred in SMSA counties and other counties which were tracted for the first time in 1970. Where the census tracts did not conform to the CCD boundaries, the division boundaries were adjusted to follow tract boundaries in order to avoid having two unrelated sets of areas. In counties where city limits have been changing frequently in recent years, and where tracts are no longer bounded by city limits, certain CCD's which formerly were coextensive with cities were adjusted outward to include the parts of the tracts which extended beyond the city limits. This was done in order to avoid major changes in CCD's in the future.

### Alaska Census Divisions and Subdivisions

The Government of the State of Alaska and the Bureau of the Census agreed to recognize 29 census divisions as major statistical reporting areas for the 1970 census to which the Bureau would accord the same statistical treatment as the counties in other States. These census divisions were designed to utilize, so far as possible, the 24 election districts observed as county equivalents in 1960 (but which were combined in 1961 into 19 election districts) and the 10 organized boroughs established during the 1960's. Boroughs are the only organized primary units of government in Alaska except for incorporated cities located within the divisions and boroughs.

The boundaries established for the new boroughs did not follow the boundaries of the old election districts precisely, but in a number of instances they closely approximated them, and the borough boundaries were used as census division boundaries in these areas. In some cases the borough had been established as only a part of an election district; where this occurred the borough was recognized as one division and the remainder of the district as another. A number of the election districts did not include boroughs and were not adjacent to them, so these were recognized as census divisions that were exactly equivalent to the old election districts. The relationships between the 19 election districts of 1970, the 24 election districts of the 1960 census, and the 29 census divisions of the 1970 census are indicated in appendix A, p. 49.

Subdivisions of the census divisions in Alaska are recognized as the equivalent of county subdivisions (MCD's or CCD's) in other States. These subdivisions made it possible to show data for each of the boroughs where they were not coextensive with the census divisions. Boroughs were defined by State law to exclude military and Indian reservations, which are held as subdivisions where they are specifically excluded from boroughs. In one case a borough, Kenai Peninsula, was split between two census divisions--Kenai-Cook Inlet and Seward--and in another case a division (Skagway-Yakutat) has two non-contiguous portions. Only six census divisions were subdivided into two or more parts.

### Unorganized Territories

Unorganized territories, which are areas within counties not included within the civil divisions, exist in a number of States. When census county divisions (CCD's) were established within some of these States these unorganized territories were assigned to various CCD's for statistical reporting purposes.

In the 1950 census each individual surveyed township (township and range) within unorganized territories was reported separately; this proved both costly and statistically unsatisfactory. To reduce costs in 1960, the unorganized territory in each county was reported as a single unit, regardless of the fact that in some counties the unorganized territory consisted of several separate parts or comprised a very large area. This solution was not satisfactory to many users who wanted the data for each of the separate pieces of unorganized territory.

In 1970, therefore, in the States of Maine, Minnesota, and South Dakota, where this problem was particularly acute, each separate piece of unorganized territory was recognized as a separate subdivision of the county or, in cases of very large areas, was divided into two or more subdivisions. Each subdivision, as in the case of CCD's in other States, was given a name; this name was preceded by the designation "Unorganized Territory of" and data were reported by subdivision. Small, isolated units of unorganized territory which exist in counties in a few other States were single units in a county and were so reported.

### Unincorporated Places

The term "place" as used for the decennial census refers to any delimited concentration of population, regardless of the existence of legally prescribed limits, powers, or functions. In the 1970 census, as in 1950 and 1960, the Bureau delineated boundaries of densely populated unincorporated population centers. The residents of these places live in closely spaced housing units; the places have streets, usually with block patterns, and, in general, have the same physical characteristics as incorporated places of comparable size, but lack legally established boundaries.

Outside the 1960 urbanized areas, places with an estimated minimum population of 800 were identified and delimited for 1970. Data were published for those places with 1,000 or more inhabitants, unless the place was included in the 1970 urbanized area. In such cases the data were not published unless the place had 5,000 or

more inhabitants (see below). Each unincorporated place was designated by a generally recognized place name or, for the comparatively few places for which there were no generally recognized names, by one that indicated the place location.

Inside 1970 urbanized areas, boundaries were established and data were published for unincorporated places with 5,000 or more inhabitants if the places were recognized locally and that recognition was communicated to the Bureau. Unincorporated places were not recognized within urbanized areas in New England. Recognition of places with 5,000 or more people in urbanized areas was in contrast to 1960 when only places with 10,000 or more inhabitants were recognized.

Comprehensive listings and a card file were established in 1967 for more than 6,000 unincorporated places. The primary sources for this file were previous Bureau publications and listings, a commercial atlas for 1967, and information received from local sources after the 1960 census data were published. The State highway departments revised and added to these listings and provided maps which either showed the settled areas or which gave delimitations for all places outside the 1960 urbanized areas if the places were estimated to have 800 or more inhabitants. Instructions for delimitation of unincorporated places for census purposes were included for State highway department use as appendix 4 of the Guide for a Road Inventory Manual of Instructions, published by the U.S. Bureau of Public Roads in April 1967.

The census tract committees, through the census tract key persons in each SMSA, as well as other local organizations and individuals, assisted in revising the Bureau's list of unincorporated places which were expected to have 5,000 or more inhabitants in each urbanized area and in providing delimitations for these places.

Concentrated residential areas in or attached to military reservations were recognized as unincorporated places for the first time in the 1970 census; the required information for these places was obtained from various offices in the Department of Defense.

In delimiting places, great care was used to designate as boundaries readily identifiable features such as highways, streets, streams, and power lines; or, in mountain areas, clearly defined ridge lines.

In two States, Hawaii and Alaska, unincorporated places were treated differently. In Hawaii, where there are no incorporated places comparable with those in the rest of the country, the limits of 93 places were recognized and defined by the Hawaii Department of Planning and Economic Development under authority of State law and approved by the Census Bureau. The Bureau agreed to recognize and treat these places and their limits in the same way as incorporated places in other States. In Alaska, where unincorporated places of even extremely small size are important, places with as few as 25

inhabitants were reported separately during the enumeration and data were published for them as for other unincorporated places. Individual maps showing boundaries for these smaller places were not prepared. There were 183 of these small unincorporated places reported for Alaska, as well as 19 places of 1,000 inhabitants or more.

In Puerto Rico, cities, towns, and villages were treated similarly to unincorporated places in the United States. A total of 328 were delimited by the Puerto Rico Planning Board, and statistics were published for the 103 which had the required 1,000 or more inhabitants.

In all cases census criteria for unincorporated places and for boundaries were applied in the Bureau to determine whether a place would be recognized and what were acceptable boundaries. Control forms and maps were prepared for 3,089 unincorporated places (not including those in Hawaii and Puerto Rico, and additional small unincorporated places in Alaska), of which 805 were in urbanized areas. Of the 2,284 unincorporated places outside urbanized areas, 591 failed to attain a population of 1,000 or more in 1970. At least 113 others were deleted because of annexation of all or part of their area to municipalities, because of the establishment of new incorporations, or because in the final analysis they fell within urbanized areas in New England, where unincorporated places were not identified. Data were published for 1,580 of these unincorporated places. Of the 805 in urbanized areas, 249 either did not have a population of 5,000 required for publication or else had been annexed or incorporated; data were published for 556. The total number of unincorporated places for which statistics were published was 2,102.

While the manner by which the military unincorporated places were defined followed generally the pattern by which other unincorporated places were defined, there were certain considerations which were unique to military installations:

1. Unincorporated places in military reservations were bounded regardless of the position of MCD, CCD, tract, or congressional district lines.
2. Where there were two settlements, one of which was inside a military installation, or the installation consisted of two parts separated by civilian territory, two unincorporated places were established.
3. When two contiguous settlements occurred, one inside the installation and the other just outside, both areas were included in the same unincorporated place.
4. In those cases where it was difficult to bound a potential military unincorporated place, it often was found practical to include the entire area of the installation as one unincorporated place, provided the area of the entire installation was not too large in comparison to the housing area.
5. Whether establishing a potential unincorporated place was warranted was determined by adding the population of the barracks and family housing together.

## Towns and Townships

The concept of presenting the towns in New England and townships in Pennsylvania and New Jersey as urban places according to the special rules developed for the 1960 census was not used for 1970. Most of the population of these "special rule" areas, however, was classified as urban because it was included either in an urbanized area or in an unincorporated place of 2,500 inhabitants or more within these towns or townships.

## Census Blocks and Block Groups

A census block is an area bounded on all sides by features shown on the map (such as a street or a stream) used for block designation. While it is identical with a city block in most cases, a census block can be larger or, infrequently, smaller than a typical city block. It is the smallest area for which census data are published (the smallest area identifiable in the census basic record tapes is the block side). For the 1970 census, census blocks were defined and numbered by first dividing census tracts, wards, or major portions of untraced areas called "block-numbered areas" into block groups, and then dividing these block groups into individual census blocks.

Data for census blocks were tabulated for all places having 50,000 inhabitants or more in 1960 or in special censuses conducted between 1960 and 1970 and for the urbanized areas surrounding these places. Block statistics also were tabulated for 966 contract block areas having less than 50,000 inhabitants (see p. 9). Block numbers were assigned to all of these areas by the Bureau (see p. 28 for the delineation and numbering procedures).

## GEOGRAPHIC CODING GUIDES

### Introduction

In 145 of the 230 SMSA's (standard metropolitan statistical areas) in the United States at the time of the 1970 census, the enumeration was conducted by a mail-out/mail-back procedure that entailed mailing a census questionnaire to each household. In the urban cores of these SMSA's the addresses for 31.4 million of these households were listed on computer tapes in the Bureau's master address file, which closely approximated Post Office city delivery service for these areas. Questionnaire address labels and address registers (complete lists of addresses for control of returns and nonresponse followup) for these areas were generated by computer. As some statistics for the urbanized areas of these SMSA's were to be tabulated at the block level, codes for each household address with reference to a particular census block had to be assigned. (Such a system was necessary because in mail-out/mail-back areas covered by computer ED's enumerators did not canvass and record geographic information as they had in 1960, but confined their activities to enumerating at housing units where returns were missing or incomplete.) These geographic codes were assigned to each address in the Bureau's master address file through the use of computerized address coding guides (ACG's) constructed for each area. (An additional 7.2 million addresses were obtained in areas lying outside the Post Office city delivery zones of mail-out/mail-back SMSA's by a procedure known as "prelisting." In this procedure Census Bureau employees

canvassed the areas and listed the addresses and their census block numbers. These addresses normally were not covered by the ACG's.)

Further, the Bureau planned to tabulate data on place of work at the block level within the urbanized areas of all 230 SMSA's in the United States for special origin and destination studies of the U.S. Department of Transportation. This required the geographic identification of commercial and industrial addresses that are not within the scope of the decennial census enumeration. (No 1970 place-of-work data were published below the tract level.)

In order to code the addresses of these places of work, geographic guides were prepared for the use of the Bureau clerks who manually coded the sample questionnaires. For the 145 "mail" SMSA's covered by the ACG's these guides were based on street information contained in the ACG's. For the remaining SMSA's, where the census was taken by conventional procedures rather than by mail in 1970 (enumerators canvassed every housing unit and geographically coded the household address on the completed questionnaire but had no means of coding the place of work), geographic coding guides for the clerks were prepared mainly as (1) a product of a national program in which computerized DIME (Dual Independent Map Encoding) files were constructed for 79 "nonmail" SMSA's, and (2) from ACG's prepared for two "nonmail" SMSA's (El Paso, Tex., and Savannah, Ga.). (For the names of the SMSA's and the number of records for each, see appendix C (ACG's) and appendix D (DIME files).)

Tract-level place-of-work coding guides were prepared separately for four "nonmail" SMSA's not in the DIME program (Lafayette-West Lafayette, Ind., Lafayette, La., Lake Charles, La., and Wilmington, N.C.) as well as for several counties (Morris County, N.J., and Richmond and Rockland Counties, N.Y.) that were enumerated by mail but were not covered by ACG's. In addition, guides were prepared for two areas not recognized as SMSA's, but for which ACG's had been constructed. These were Appleton-Oshkosh, Wis., and New Brunswick (Middlesex County), N.J.

The construction of ACG's and DIME files was of considerable importance, not only to the Census Bureau for geographic coding and controlling of census data, but also to Federal, State, and local agencies with computerized information systems that aggregate data geographically. These agencies collaborated in performing the clerical ACG and DIME coding necessary at the local level, while the Bureau provided maps, worksheets, technical assistance, and final processing as part of its decennial census operations. The procedures whereby address registers were compiled by computer are described on p. 38 ff; the development of ACG's and DIME files, and the subsequent preparation of place-of-work coding guides, are discussed below.

### Address Coding Guides

Background.--In the early 1960's the need for the standardization of geographic codes was generally recognized, so that computers could be used to identify geographically data from a variety of sources. The

Census Bureau had used geographic codes mechanically in the past (e.g., the 1960 Censuses of Population and Housing, the 1962 Census of Governments, the 1963 Economic Censuses and the 1964 Census of Agriculture), and some manual coding had been done for the 1954 and 1958 Economic Censuses, but the codes used in the different censuses were not compatible unless they were recoded by computer. For some years census tract committees in various cities had prepared census tract-street indexes for local coding, and a few of these were adapted to machine methods, but were of no use in coding below the tract level. The Bureau had census tract-street indexes in its own files for about one-third of all the tracted areas in the United States, but these indexes were expensive to produce and required clerical intervention to look up an address and record the tract number on a questionnaire.

In preparing for the 1963 Economic Censuses and in earlier studies, the Bureau investigated the possibility that the locations of business firms by census tract and place could be identified from telephone exchange boundaries or other public utility records, as post office addresses were insufficient for pinpointing locations to a census tract--or even, at times, to a small town or place. The cost of preparing an address coding guide for all of the business establishments in the United States from scratch would have been prohibitive, so the Bureau began looking for such a guide already in existence. It was discovered that a national directory firm had amassed such a guide for use in relating census data and sales statistics to sales areas for purposes of market research and analysis. This guide covered the city delivery areas of post offices located in cities which had populations of 25,000 or more, and it consisted of street names, street directions, and house number ranges by postal zone for areas which were roughly comparable to census tracts. After several successful tests in 1962-63, the Bureau purchased this guide to serve as the nucleus of an address reference file (ARF) to be used in processing the 1963 Economic Censuses. The ARF included census tract codes for addresses in the Post Office city delivery areas of 700 cities of 25,000 inhabitants or more, and for approximately 600 small cities around them. In the economic census processing approximately 99 percent of the establishments were coded to State, county, and place by computer, and 75 percent of the acceptable street addresses were coded to tract level by matching them with the ARF on the basis of the name, type (street, avenue, road, etc.), and direction of the street, and the house number range on that street within the census tract.

Thus, by 1964 (when the 1963 economic census processing began) the Bureau had determined that there was no insurmountable technical difficulty in coding establishment addresses to county, place, and central business district tract by computer, but for purposes of the population and housing census two basic needs remained to accomplish block coding for 1970: (1) suitable address files for residences (as distinguished from business establishments), and (2) adequate maps, with uniform scales and address range information.

In April 1965 the Bureau conducted a pretest of some of the decennial census procedures in Cleveland, Ohio, using a commercial mailing list of "occupant" residential addresses on computer tape. During the fall and winter of 1964-65 the Bureau compiled an address coding guide

(ACG) for use in relating these addresses to census blocks by computer. An ARF (address reference file) for Cleveland was already in existence, but it would have required extensive revision to obtain the proper type of tract coding. The Bureau therefore obtained approximately 6,000 punchcards containing precise, center-of-street, 1960 census tract coding information for residential addresses. These cards were processed on a computer and the census tract address ranges were expanded to provide separate cards for even- and odd-numbered sides of streets and for each block side. Approximately 43,000 cards resulted from this expansion. The Bureau added street codes for approximately 600 nonresidential streets, and all of the cards were assigned census block numbers. After necessary corrections had been made, the information was transferred to computer tape. In the ensuing computer assignment of block codes to individual addresses, 99 percent of the addresses were coded, with an error rate of only 0.5 percent (as compared with 2.2 percent for the same area using 1960 manual block-coding techniques).

By early 1965 the Bureau had collected sufficient source materials in terms of city directories and block maps to create blockface-header files for several other cities. A blockface header was simply a record containing the name, direction, and type (street, avenue, road, etc.) for a given street, and the range of house numbers along one side of one block along that street. To simplify the computer matching of addresses to such a reference file, however, it was highly desirable that the basic source for creating the reference file be the same addresses that would comprise the census mailing list for 1970. Given such a list in a standardized form on computer tape, the standardized conventions of the addresses in terms of street codes, etc., could be built into the blockface-header file.

Accordingly, the Bureau obtained from a commercial mailing list supplier several header files on computer tape which matched the firm's residential address lists. These header files contained only sufficient information to code addresses to 1960 census tract or postal ZIP code area, but, when merged with another tape containing street intersection and house number information from a city directory, the results needed only the addition of census tract and block numbers. This was done by printing out by computer the merged information from the tapes onto paper forms. Clerks compared the information on the forms with Census Bureau block maps, added tract and block numbers obtained from the maps, and made any other necessary corrections. The completed forms then were "read" by FOSDIC (Film Optical Sensing Device for Input to Computer) and transferred back to computer tape. The resultant reference file was tested in a study of the completeness of various address lists in Wilmington, Del., in 1966. On the basis of this test and other experiments in 1965 and 1966 the Bureau decided that commercial mailing lists and their corresponding header files, all on computer tape, would become the bases for the address registers and for the geographic coding system in mail census areas: The individual addresses would be used to mail questionnaires and control their return; the address ranges and other geographical identification contained in the header files for these addresses would be input for ACG's for each of the 145 "mail" SMSA's. These ACG's would contain records for approximately 5.5 million block faces.

The most feasible approach to creating ACG's on a national basis (aside from a field canvass by Bureau employees which would have been prohibitive in cost) was to have local governments and planning organizations help construct the ACG's, using uniform procedures. Further, because of the wide variation in the format, quality, and detail in local source materials such as maps, directories, and utility and assessment records, knowledgeable local authorities could detect and correct errors in ACG materials more readily than Census Bureau personnel.

Between January 1966 and the summer of 1967 Bureau staff members conducted approximately 60 conferences in various parts of the country, at which local agencies engaged in updating the Metropolitan ("Metro") Map Series maps (see p. 2) for the Bureau were told about the ACG program. They were asked to participate by reviewing the address ranges and geographic codes for all the ACG blockface records (on worksheets to be provided by the Bureau) in their SMSA's in return for copies of the completed ACG's for their areas. This review would entail adding block numbers, ward numbers, annexation information, etc., where necessary; adding, deleting, or correcting information on the "Metro" maps and on the block face records; and adding unique serial (optional field) numbers to the ACG records so they could be keyed to local data systems. Other Federal agencies (the Departments of Housing and Urban Development (HUD), Transportation (DOT), and Health, Education, and Welfare, and the Office of Civil Defense of the Department of the Army) encouraged local participation in the development of ACG's because of their value as management tools for those working with transportation, housing, health, and other information systems. In furtherance of these goals HUD made "701" fund grants available to local agencies to cover two-thirds of the cost of editing and updating the coding maps and completing the ACG worksheets. These grants were announced in September 1966. State highway planning and research funds also were made available for these purposes; the U.S. Bureau of Public Roads (now the Federal Highway Administration in the DOT) encouraged State participation in the local coding programs.

Between April and September 1966 local source materials were examined and ACG worksheets were prepared for the New Haven, Conn., SMSA, where a pretest of 1970 census procedures was scheduled for April 1967; this pretest covered approximately 108,000 household addresses. The worksheets to be coded were prepared by computer, using tapes containing information taken from published city directories and other street address records. Computer programs and specifications for clerical coding and quality control were developed during this period as well.

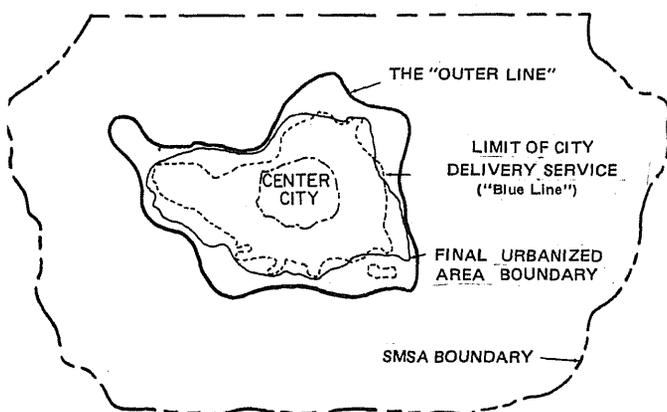
The worksheets, preprinted by computer with street and address range information, were sent to New Haven where local coders were supplied and supervised by a regional planning agency, with the Bureau providing training and technical support. Clerical addition of block and other codes to the FOSDIC-readable worksheets was done in October and November 1967. The worksheets then were shipped to the Bureau where they were micro-filmed; the data then were converted to magnetic tape in the FOSDIC process and printed by computer. Printouts were compared with the master list of addresses, and discrepancies were reviewed and corrected clerically. No computer programs had been developed for mechanical

editing because the clerical quality control operation was expected to keep errors within acceptable limits. After the ACG tape had been edited manually approximately 4 percent of the addresses on the master address list still could not be coded to tract and block, and had to be sent to New Haven to have these codes determined by local inspection.

The New Haven ACG project was the Bureau's first encounter with creating a large-scale ACG for use in computerized operations. Although this ACG served its intended purpose of coding addresses to census blocks by computer, it was found that over 10 percent of the ACG records required some type of correction. Work began immediately to modify the worksheet used in New Haven and to develop further clerical and mechanical procedures for reviewing and correcting the coding. Some of these procedures were tested in two of the 1970 dress rehearsal censuses--Dane County, Wis. (Madison SMSA), and Trenton, N.J.--in 1968.

Delineation of ACG limits.--In the summer of 1967 the Bureau conducted a postal city delivery bounding test in 12 cities in which it was determined that city delivery boundaries could be determined with 90 to 95 percent accuracy. In January 1968, therefore, postmasters of all post offices having city-delivery type service in the 145 SMSA's to be covered by ACG's were requested to furnish the Census Bureau with maps showing the city delivery areas in their jurisdictions. This canvass involved approximately 2,500 postmasters. Bureau personnel used the limits shown on the postmasters' maps as the basic definition of the boundary between (1) the urban areas for which questionnaire address labels would be generated from computerized lists of individual addresses automatically coded to political and statistical subdivisions by use of the ACG, and (2) the predominantly suburban non-city delivery mail areas (for which the questionnaires were hand addressed from information contained in address registers prepared by Bureau employees who conducted field canvasses ("prelisting") to identify and list the addresses). These city-delivery/ACG limits were drawn with a blue pencil on Metropolitan Map Series census maps; this boundary, therefore, was known as the "blue line" (see fig. F).

Figure F. Boundaries Affecting Census Processes



Since the blue line was to define the boundary between two mail enumeration procedures as well as the outer

limits of the area for which an ACG could be constructed, it was essential that this line be clearly and specifically mapped to avoid duplication or omission of coverage. Accordingly, the Bureau replaced the actual limit of the Post Office city delivery areas by a modified definition. Generally, this adjustment cut off "fingers" of a city delivery area in order to achieve a definition that followed the center line of streets or other suitable features. In some instances, the Census Bureau's version of the city delivery limit extended a little beyond the actual coverage in order to bring substantial groups of houses into the computer-list method enumeration areas. The path of the blue line often was very winding, and in some cases formed a non-city delivery enclave surrounded by a city delivery area, or a city delivery enclave surrounded by a non-city delivery area. However, efforts were made to avoid splitting a block between the computer-list (ACG) and hand-list areas.

Precoding processing of ACG materials.--In the spring of 1966 the header records (see p. 16) for the commercial master address file were received, essentially in one shipment of 14 reels of computer tape. These records represented the Post Office city delivery areas in the 145 SMSA's. A program was used to convert these tapes to the language of the Bureau's computer equipment in preparation for production processing.

The Census Bureau also contracted to buy city directories. One commercial firm supplied a large number of computer tapes on which the street guide portions of many of its city directories had been recorded. (Street guides contained streets by name, address range, and intersecting street.) In addition, the Bureau purchased a number of city directory volumes from several publishers and obtained locally produced street guide tapes from some planning agencies. The tapes were processed through a series of programs which produced tapes, cards, and computer printouts in which the records were so arranged and keyed that they could be linked with the header record file. The required information from book-form city directories was transcribed clerically and transferred to punchcards; the cards then were processed to produce the same end products as the street guide tapes.

The next phase of computer operations was divided for production purposes into three series of computer programs; each series was dependent upon all aspects of the previous series being correct.

The first series of programs involved clerical operations which took place in the Bureau's Jeffersonville facility and computer operations at the Bureau's headquarters in Suitland. Essentially, the objectives of these operations were to produce computer tapes (called the "J" tapes) and printouts of them which were consistent with the commercial header records, but which also included the further information about address ranges and intersecting streets contained in the city directory tapes, split into odd and even ranges. Along with this, a series of codes was introduced into the records to provide a maximum amount of useful information for those who would perform the verification and completion of the coding in subsequent stages of creating the ACG's (described below). The clerks compared computer printouts with information on the appropriate "Metro" maps,

and corrected or modified the information on the tapes as necessary. The resultant changes were transcribed, punched into cards, and transmitted via datalink (telephone) to Suitland.

The "J" tapes' contents were printed out in the form of fanfold FOSDIC-readable worksheets, Form GEO 70-1 (see fig. G) for review by local coding agencies. The "W" entries (see fig. G, line 4), which FOSDIC read as binary numbers according to their positions on the line, made it possible to match the record produced by FOSDIC to the parent tape. The street and address range information, plus certain geographic codes, was eye-readable, but provision was made for correction via FOSDIC entries (blacking out the dotted numbers) where necessary.

The final preprinted worksheets were checked for quality and quantity, and a significant proportion of the sheets was rejected because the printing did not meet FOSDIC reading requirements. Shipments were delayed while these were reprinted. A number of other delays encountered in completing the precoding phase of the ACG project were caused by the following: (1) low computer priorities were assigned to the production and printout of the "J" tapes, especially during the summer of 1968 when data from the 1967 Economic Censuses were being processed; (2) some local source materials used to prepare the worksheets were late in arriving; (3) preparation of worksheets was held up in some cases to await approval of applications for HUD funds; and (4) some areas were delaying coding until the summer of 1968 in order to hire students. By October 1967, shipments had been made to 60 of the 145 mail SMSA's. A deadline of June 1968 was set for the balance, but even with an expansion of the clerical work force in Jeffersonville it was not possible to complete this phase of the ACG operations until October 1968. It was not necessary for the Bureau to prepare worksheets for about 16 SMSA's that already had local address coding guides or address data which the Bureau could use to prepare ACG's, but in each case the system used to prepare the ACG and verify its accuracy had to be tailored to the individual area.

Local coding.--A local agency in each of the remaining SMSA's to be enumerated by mail-out/mail-back procedures in 1970 received one set of the preprinted worksheets for its area, plus a supply of blank worksheets for use in coding street segments (typically, the two sides of a street between two intersections) for which no preprinted worksheets existed. Also provided were supervisors' and coders' manuals, control forms, special worksneet-marking pencils, sufficient sets of each of the Metropolitan Map Series mapsheets to be used in coding the area, lists of codes to be used, and comparability lists of 1960 and 1970 census tracts with accompanying maps. The coding agency was expected to provide its own local street and address reference materials, such as plat maps, utility companies' street maps, and other types of street indexes or directories which could be used to verify the preprinted address ranges or to add necessary information.

Bureau headquarters and regional office personnel trained the local agencies' staffs to perform the coding operation, and monitored their activities to check on progress and to make certain that the Bureau's accuracy standards were met.

Clerks in the local agencies reviewed the "Metro" maps on which block numbers appeared to make certain that the maps were correct, and then compared the listings on the preprinted worksheets with the appropriate maps. Based on the map information, the clerks entered on the worksheets the block numbers for each street segment listed, checked the accuracy of all other codes associated with that segment, making changes as necessary, and added to the optional field of each record (see fig. G, lines 12 and 30) a unique local serial number, if the local agency desired it. In all other cases the Bureau used this field for a 6-digit entry to serialize the records in the file.

The clerks corrected spelling on the maps but they made no changes in the street name or street type entries on the preprinted worksheets, even if these were wrong, as these entries were the links whereby the ACG records would match the commercial mailing list header file. Therefore, any street name or type error in the header file was carried over into the ACG. The clerks were expected to enter the correct street name and type when adding new sheets, however. The resultant variations later caused problems in processing.

As each clerk coded, he outlined the coded segment in red on the map used for block coding; thus after all the worksheets had been reviewed any segment still uncoded was readily seen upon an inspection of the map. Coding was confined to "street features" only; such map features as shorelines and streams which might form block boundaries, but which had no addresses, were not coded.

Coding began in the spring of 1967 in Lima, Ohio, and continued in various cities until June 1969, when the last area, Boston, Mass., was completed. About two-thirds of the initial coding (before correction) was finished before the December 31, 1968, target date for completion of all local coding. All coded materials were shipped to the Bureau's Jeffersonville facility.

Quality control.--Quality control at the local level was not included in the original ACG budget proposals, and it was instituted as a formal operation only after the coded worksheets had been received from the first few areas in 1967 and were found to contain serious deficiencies in coding. Working instructions were issued as soon as the need for local quality control was recognized, and final instructions were issued in March 1968.

Quality control was designed to be carried out in three phases, which are described below. In preparation, Bureau clerks in Jeffersonville selected a systematic sample of blocks from the "Metro" maps for each area: 10 blocks per mapsheet for Phase I, a 1:30 sample of different blocks from the same mapsheets for Phase II, and 25 blocks for Phase III.

The block numbers were entered on sample block records, using information available in the Jeffersonville files. The coded forms were sent to a commercial mapping firm, where address ranges were entered for each listed block; the forms then were forwarded to the Bureau's regional offices where any address ranges not filled in by the mapping firm's staff were added by field listing. The entries on the forms then were ready to be

# Figure G. Portion of Preprinted ACG Worksheet, Form GEO 70-1, Before Local Coding

U.S. DEPARTMENT OF COMMERCE  
BUREAU OF THE CENSUS

00018 39567 PAGE 465 2

Geographic Coding Worksheet (HSP-FOSDIC)

10072 37212

GEO 70-1 (Rev. 12-1-66)  
28-1

STREET NAME		STREET DESCRIPTION		ANNEX	
FARRAGUT AV		FROM MAIN ST N TO RUHL AV		NO ANNEX	
1	W	W	W	W	W
2	W	W	W	W	W
3	W	W	W	W	W
4	W	W	W	W	W
5	W	W	W	W	W
6	TRACT	27 04	DIXON WYOMING	85201	
7	POST OFFICE, STATE, AND ZIP CODE				
8	27 04	DIXON WYOMING 85201			
9	EVEN SIDE FROM	SHERWOOD RD	TO	DEAD END	
10	Tract	27 04		Area	140 12
11	Block Number	214	High Address	452	Low Address
12	Street Side	N	Change	Ch.	Ch.
13	Street Side	S	Change	Ch.	Ch.
14	Street Side	E	Change	Ch.	Ch.
15	Street Side	W	Change	Ch.	Ch.
16	Street Side	C	Change	Ch.	Ch.
17	Void Cell				
18	Word				
19	Optional				
20	Word				
21	Word				
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276	Word				

compared with corresponding entries copied from the locally coded ACG worksheets.

A number of delays were experienced in preparing the sample records, especially negotiating the contract with the mapping firm and then completing the field listing. By the time the sample records were ready it was too late to carry out Phase I (the quality check of local source materials) and to insist on field listing if the materials failed to meet minimum standards of accuracy. Many local agencies had begun coding, and a number of HUD "701" Federal funding applications already were being processed. These applications generally presented budgets based on the assumption that no field listing would be necessary. It became apparent, also, that a 10-block sample per mapsheet was too small for an adequate appraisal of varied collections of source materials. In practice, therefore, Census Bureau personnel performed a limited, informal inspection of most local agencies' source materials.

When local coding had been underway for 1 or 2 weeks, Phase II of quality control began. A Census Bureau representative visited the coding operation to verify at least five worksheets from each coder. Evidence of unsatisfactory work led to the retraining or replacement of the coder. After the initial review all work units were put through a systematic verification program conducted by local personnel and based on the prepared 1:30 block record sample. The coding for the sides of the sample blocks was compared with the data on the Bureau's independently coded copy of the record and with the original worksheet. Census regional office personnel reviewed all of the rejected records that were corrected, in order to determine the causes of the errors. The quality control plans employed were designed to limit the average outgoing error rate to 5.5 percent at the national level. Correction was the responsibility of the local agency.

After the completed materials were received in Jeffersonville, Bureau representatives conducted a final check, Phase III, of incoming quality. In this check an independent verification of the coding of 25 blocks on the worksheets uncovered cases where Phase II had not been carried out properly and provided an independent estimate of Phase II outgoing quality at the national level. As this final quality check in Jeffersonville tended to reveal unacceptable work after local coding had ceased and clerks had been released, it was moved back to the field in October 1968 so that rectification could be accomplished sooner. The areas' files held up in Jeffersonville awaiting correction of unacceptable worksheets were released for microfilming (see below), and the corrected worksheets were microfilmed and added to the files later.

The two phases of quality control used generally were adequately designed--insofar as was possible within the limitations of the ACG program--and in most places were carried out effectively to detect errors in field coding in time to be corrected prior to computer processing. (Possible omissions of areas which should have been added to the ACG were not checked in the quality control program; this was a function of the local coding supervisor, and few such omissions were encountered.) Rectification of coding deficiencies, though, caused major problems, particularly for those local agencies which had requested and received funds for their initial work before the quality control program was instituted and were financially unable

to perform the additional work needed to bring the quality of their ACG output up to an acceptable level.

No precise estimate of the final Phase III outgoing error rate is possible because the error level was not rechecked after Phase III reworking of the records for 28 areas which failed Phase III--representing about 15 percent of all the blocks coded in the ACG program. However, if their final error rate had been as high as 7 percent, the overall quality of ACG field coding would be 5 percent, well within the target level. If no errors had been corrected in the Phase III rework, the estimated overall final error rate would be 6.42 percent.

Detailed analysis of the error rates found in Phase III, when compared with those computed in Phase II, indicated that in several cases local quality control in Phase II had not been carried out effectively. The 28 areas which failed Phase III showed an estimated outgoing Phase II error rate of 4.77 percent in their records, but this rate was estimated at 15.67 percent in the Bureau's Phase III check. The 132 areas which passed Phase III reflected an overall downward bias in their own Phase II outgoing error rate estimates (3.74 percent as against the independent Phase III Bureau estimate of 4.60 percent). Of 160 coding operations checked (several of the 145 SMSA's had multiple coding operations), 118 had higher error rates in Phase III than in Phase II, while only 42 had lower rates. Two-thirds of the block coding errors involved coding an address range to the incorrect block--usually to one a block away in either direction.

Despite these estimates of ranges of final coding quality, when files were subjected to the first computer edits (see below) rejection rates of 20 and 30 percent before correction were common, and rates were considerably higher for a few areas. The contributions of various error sources such as errors in reference tapes and program and system "bugs" cannot be estimated.

Processing of coded materials.--Approximately 1,350,000 completed FOSDIC worksheets were shipped from the local agencies to the Bureau's Jeffersonville facility, where they were microfilmed. After the microfilm was checked for FOSDIC readability it was sent to Suitland for FOSDIC processing in which the data were converted to magnetic tape. The original worksheets were stored in Jeffersonville for reference purposes. Over 10 percent of the incoming records failed the readability check. The original worksheets then had to be located and remicrofilmed after the FOSDIC markings on them had been darkened. (This was a factor in the decision not to use FOSDIC worksheets in subsequent geographic coding programs devised by the Bureau.)

The updated block coding maps which were returned with the completed worksheets were used to update the Bureau's master set of "Metro" maps in Jeffersonville. These became the bases for district office enumeration maps and publication maps for the decennial census; they also were used to prepare a file of acceptable geographic codes, and copies were used as reference maps in clerical correction of records rejected in computer editing of the ACG data tapes.

The data tapes resulting from the FOSDIC processing of the microfilmed worksheets for each area were subjected to a series of computer edits (see appendix E), reviews, corrections, and additions.

A comprehensive list of all streets not appearing originally on the preprinted FOSDIC worksheets (but identified on the supplementary worksheets added during local coding) was prepared clerically in Jeffersonville, and the data for these streets were inserted into the file by means of punchcards and card-to-tape processing.

One of the computer operations, called the "hundreds range match," compared a summarization of the addresses from the commercial mailing list with the address ranges found in the master edit file to make certain that all addresses in the list were covered by the ACG. Any address ranges not found were reviewed clerically. If they were outside the ACG "blue line" boundaries (i.e., the limits of the area covered by the ACG) the records were deleted. Other cases were resolved by consulting street directories and maps, and any cases which remained unresolved were sent to the field for checking. Ultimately, about 28 percent of the hundreds range workload, or 1.7 million records, required correction. The clerical work itself was satisfactory, but about 660,000 cases, or approximately 11 percent of all the ACG records, were sent to the field for resolution--a far larger proportion than anticipated. Only \$50,000 had been budgeted for this purpose (at \$1 per case). Procedures were instituted whereby most cases were resolved locally by reference to maps rather than by physical inspection of the blocks in question. Except for about 25,000 cases still in the field at the time, the hundreds range operation was completed in October 1969.

All of the addresses (approximately 33.9 million) in the master address lists were printed out on labels which were attached to cards. These cards were sent to the Post Office for verification; local mail carriers checked the cards against the addresses and ZIP codes for all housing units on their city delivery routes and added, corrected, or deleted addresses as necessary. (For further details, see p. 39 and the section on Post Office operations in chapter 4.) The resultant corrections were punched and cycled through the ACG tapes as well as the master address lists. Additions to the lists averaged 11 to 12 percent, with about one-third of these representing extensions of address ranges or new streets to be located and coded for the ACG's. About one-third of the postal changes to the ACG were handled by a staff of about 35 Census Bureau clerks; the balance were handled by computer.

Nearly 40 percent of the records contained in the ACG required clerical review after the first cycle of computer edits. The force of 20 clerks employed for that purpose in Jeffersonville was expanded to 60 during the summer of 1969 so that the first cycle of computer corrections could be punched and run close to the cycle's June 30, 1969, deadline. The augmented work force reached only 50 percent of its production standard, however; the problems requiring resolution were complex and varied, and the learning process therefore was long. Consequently, even with overtime the first cycle of clerical review was not completed until the end of August. First cycle computer corrections were finished in September 1969.

The second cycle of clerical review, including handling of Post Office changes, continued through October 1969, when a closeout schedule was instituted and material was accepted with fewer quality checks, sometimes with

incomplete hundreds range corrections, and without all of the Post Office "adds." Approximately 4.3 million cards were punched in Jeffersonville and in Pittsburg, Kans., to correct the ACG records. At the height of ACG processing during the summer and fall of 1969, nearly 500 clerks in Jeffersonville and 50 clerks in Pittsburg were involved in the various operations.

The corrected master address lists and ACG's were matched by computer, with about 6 percent of the addresses remaining unmatched. These cases required further field checking in order to allocate the unmatched addresses (i.e., those for which a tract and block number could not be assigned from the ACG) to the proper ED's (enumeration districts) for the census. Approximately 2.34 million "yellow cards" for unmatched addresses had to be checked by Bureau personnel in Jeffersonville and in the field. (The ACG budget was based on an expected workload of only 240,000 yellow cards.)

Because of time and budgetary pressures, tract and block numbers assigned in the yellow card operation were not carried back to the ACG's, and all but three of the 145 ACG's were declared complete at the end of December 1969, 6 months after the original June 30 target date for ACG completion.

These ACG's were used to prepare place-of-work coding guides for the 1970 census during the spring of 1970, and tapes or printouts of the final ACG's were given to all of the local cooperating agencies.

Costs and financing.--The amounts budgeted for construction of the ACG's were included with other, larger Bureau operations, and therefore cannot be compared with the expenditures. The charges to ACG-related projects for actual costs incurred, from fiscal years 1966 through 1972 (as of December 1971), are listed below. Most costs were incurred in fiscal years 1966 through 1970.

Total Bureau costs <sup>1</sup> .....	\$7,100,000
Geographic coding guides	
Planning.....	\$ 673,000
Procurement.....	183,000
Research.....	20,000
Preparation of a geographic coding system.....	4,066,000
Small-city address reference files.....	72,000
Metropolitan Map Series <sup>2</sup>	
Base maps.....	876,000
Revision of base maps.....	481,000
Procurement (including preparatory work by the U.S. Geological Survey).....	372,000
Block numbering.....	357,000

<sup>1</sup>See p.2.

<sup>2</sup>Includes three areas not in the ACG program.

Of the 145 mail SMSA's in the ACG program, 112 received grants from the Department of Housing and Urban Development (HUD) (see also p.16), and there were 10 areas covered by one regional association which received some financial help from HUD. There were 23 areas which did not require financial help. In addition to the 145 mail SMSA's in the ACG program, there were five nonmail SMSA's (to be enumerated by "conventional" procedures in 1970) that also received grants from HUD for ACG or Metropolitan Map Series work. ACG's were prepared for two of these SMSA's, El Paso, Tex., and Savannah, Ga. (see appendix C), and DIME files for the

other three, Des Moines and Sioux City, Iowa, and Corpus Christi, Tex. (see appendix D). It is estimated that the cost of local area review of the ACG's (see p. 16) was approximately \$3 million.

### The DIME System

Experimentation with the ACG for the New Haven, Conn., SMSA in the Bureau's New Haven Census Use Study in 1966-67, in which it was discovered that the ACG was too limited for use in computer mapping and area calculation, led to the development of a new coding system called Dual Independent Map Encoding (DIME). (For details, see chapter 13.) Briefly, the DIME system is based on graph theory. Each street, political boundary, railroad track, stream, or other physical feature such as a ridge line can be considered as one or more straight line segments; curved lines can be divided into a series of straight line segments. When features intersect or when line segments change direction, vertices (or node points) are formed. In the DIME system each vertex (i.e., intersection or node point), line segment, and the area enclosed by these segments is uniquely identified. Thus the area covered by a map is viewed as a series of interrelated nodes, lines, and enclosed areas, all of which can be coded and recorded on computer tape for mechanical editing and subsequent use as a geographic coding guide. Means were devised for adding DIME features to existing ACG's, and these were implemented in an ACG Improvement Program beginning in 1968. This program was not part of the 1970 Census of Population and Housing procedures, however, but was initiated to make ACG's more useful locally. It was known, also, that the program could not be completed in time for use in 1970 census processing. It was feasible, though, within the time remaining before 1970, to create DIME files for the nonmail SMSA's which did not have ACG's and to prepare census place-of-work coding guides from these DIME files. (There were 88 nonmail SMSA's but two of them--El Paso, Tex., and Savannah, Ga.--were included in the original ACG program.)

Preparations.--In February 1969 the Bureau began preparing half-scale (1 inch equals 4,000 feet) "Metro" maps for nonmail SMSA's, showing the extent to which local agencies should code so that workloads could be estimated; decisions on which tracts to include were based on street configuration on the maps. Samples of blocks to be used for quality control were selected, their geographic codes were transcribed to quality control records, and maps were prepared for the field listing of the sample blocks. (Bureau regional office employees completed the field listing--i.e., they visited the blocks in question and listed address range and intersection information--in September 1969.) Coding manuals were completed and worksheets were printed in the spring of 1969 so that local coding could begin that summer and the last DIME file could be scheduled for completion in the Bureau in June 1970 (shortly before place-of-work coding guides would be needed).

The Department of Housing and Urban Development (HUD), as part of its support of local planning efforts, announced in April 1969 the availability of grants to local agencies so that they could participate in the DIME program. These grants, as in the ACG program, were

based on local financing of one-third of the coding costs (see p. 16). Highway planning and research funds also were made available through State highway planning departments.

Between mid-May and the end of August 1969 Bureau staff members contacted the appropriate agencies in all of the prospective areas. Of the 86 SMSA's, the Bureau decided not to include the Mayaguez, Ponce, and San Juan, P.R., SMSA's (although a DIME file was created for two barrios in San Juan); and four--Lafayette-West Lafayette, Ind., Wilmington, N.C., Lake Charles and Lafayette, La.--elected not to participate. The Brownsville-Harlingen-San Benito, Tex., SMSA was separated into two areas for the purpose of constructing DIME files, so that the DIME "base" was 80 areas. Of these, the file for Greenville, S.C., already had been created in testing the DIME system during its development stages, so that only 79 areas needed to be coded. (As an addition, however, the file for the central city of Roanoke, Va., which was another DIME test site, was extended to the limits of the city-address type area.) The Bureau prepared place-of-work coding guides separately for the four U.S. SMSA's not in the program, and also for Lynchburg, Va., which was used as a test area so that its place-of-work coding guide could be compared with its DIME file. (Tract coding guides also were prepared for Morris County, N.J., and Richmond and Rockland Counties, N.Y.--mail areas that were not covered by ACG's.)

Based on the experience gained in creating and processing DIME files in the fall and winter of 1968-69 (see chapter 13), the Bureau's cost for preparing DIME files for place-of-work coding at the block level was estimated at \$951,000 in April 1969. Budget adjustments for 1970 raised the question whether place-of-work coding should be limited to the tract level, but this contingency was rejected. Because not all the prospective areas entered the program and the amount of processing was cut back, it was possible to set the Bureau's nonmail DIME file budget at \$734,000.

Coding and quality control.--As soon as local agencies' source materials were evaluated (Phase I of the quality control program) and approved, they received coding maps, a supply of blank Form GEO 70-31 worksheets, (see fig. H) and a set of coding manuals. Bureau staff members conducted area training sessions for local supervisors, who in turn trained their own clerks. Coding, which began as soon as clerks were trained, entailed editing the coding maps (i.e., checking them for completeness), marking and numbering nodes on the maps according to the established DIME procedures, determining from local source materials the address range (if any) for each segment, and then transcribing the resultant data to the worksheets (see figs. I and J). The DIME worksheets differed mainly from those used in the ACG program in that they were not preprinted with street information and were not FOSDIC-readable. All information was entered by hand and then transferred to punchcards. Each DIME worksheet had space for the entries for 28 segments, listed by street or nonstreet-feature name within tract. Each clerk's work was subjected to systematic quality control inspection; the records for any rejected tract were reworked until they were acceptable.







Local coding was finished in February 1970, about 2 months behind schedule, and resulted in the recording of data for approximately 200,000 blocks and 754,000 segments.

Learning from experience gained in the ACG program, the Bureau began its final quality check of coding when a local agency had completed 75 to 80 percent of its workload, so that corrections could be made before the local coding force was disbanded. This schedule also allowed testing of the computer edit programs on the early receipts. In practice most edit corrections were made within the Bureau; the local agency usually was contacted only when address range errors were involved--and then only when the area's address range error rate was 5 percent or over and could not be lowered by clerical review in the Bureau.

The overall outgoing error rate (after rework) for local coding was estimated from local records to be less than 3.74 percent. The independent Phase III estimate of Phase II outgoing quality (which became Phase III incoming quality) was 8.55 percent; the discrepancy resulted largely from the Phase II reports of 21 areas which showed an average error rate of less than 3.51 percent, but the records for these areas reflected a 17.2-percent error rate in Phase III incoming quality checks. The estimated overall Phase III outgoing error rate (after the coding for these 21 areas was corrected) was 4.78 percent.

The quality control experience with this DIME coding was similar to that in the original ACG program. Some local quality control was not always effective: 51 of 78 areas had higher error rates in the final check conducted by the Bureau than in the quality control checks carried out by the local agencies and reviewed by Bureau personnel. Most of the errors were clerical in origin (rather than stemming from defective maps or source materials), were in the address ranges, and--as in the ACG program--usually involved codes that were one block off in either direction.

Processing.--After the node-numbered maps and coded worksheets were received and checked in at the Bureau's Jeffersonville facility, the master DIME file for each area was prepared in the following manner:

Control figures were recorded for the number of segment records coded, and the records were punched on 80-column punchcards. After conversion to tape the segment records were matched to header records (each containing the geographic codes and address ranges for a given street or nonstreet feature within one census tract) by header number, and a single file was created which contained both header and segment data. The file then was imaged (i.e., a logically equivalent record was created with the "from" node and the "to" node, as well as tract-block left (see below) and tract-block right transposed from the original record), sorted by tract boundary and "tract-block left" (i.e., the number of the census tract and block to be found on one's left when standing on a particular street segment at the "from" node and facing toward the "to" node--usually in the direction of increasing address numbers) to facilitate further editing, and a serial number was assigned to each record in the sorted file.

The master file for each SMSA then was subjected to computer edits in which the blocks and address ranges were checked for completeness (see appendix F for descriptions of the block chaining and address range edits).

If relatively few corrections were needed they were made in Suitland, where the computer facilities were maintained, and isolated errors were changed to conform with surrounding data. If more than 5 percent of the blocks were found to have any type of error the entire area was rejected, and the records were reviewed and corrected by clerks in Jeffersonville, where the original coding maps were kept. The reject listings generated by the computer in the block chaining edit were reviewed by one group of clerks and another group reviewed the rejected address range listings. Changes were registered on punchcards and transmitted by datalink to Suitland, and the files were recycled on the computer.

When these aspects of the file were acceptable after one or more edit and correction cycles, the file was subjected to a further computer operation (see appendix F) in which geographic codes were added.

By April 1970 all 80 nonmail area DIME files had been put through the first edit cycle, and all areas requiring them were completed through three edit and correction cycles by the end of June 1970, allowing the creation of place-of-work coding guides to begin in mid-July.

Only about 50 percent of the errors appeared to be caught and corrected in the first cycle of edits and corrections. The possible reasons for this were that (1), the first error detected in a block record was sufficient for rejection and listing of that block by the computer, even though the records for that block might contain more than one error; and (2), poor correction on one block could cause an error in the records for an adjacent block.

For a time all clerical review and correction of the computer edits was subjected to quality control procedures. Several different methods of control were tested, in which the time required for verification and adjudication ranged from 6 to 9 1/2 minutes per block in error. Verification itself was subject to error, not only because of the human element but because of differences in the source materials used. (For example, a set of utility records might have been consulted for local coding, while Bureau clerks referred to a city directory for the same information.) In March 1970 quality control of the first cycle clerical edits was discontinued, as the types of errors found in the quality control operation appeared to be detectable in the second cycle of computer edits.

Costs.--Although the Bureau's budget for preparing DIME files for the nonmail SMSA's ultimately was fixed at \$734,000, the actual costs incurred were \$645,000 for the various operations (see p. 2). With local costs estimated at \$500,000, the over-all cost of the DIME program for the nonmail SMSA's were slightly over \$1 million.

Local agencies reported the following costs:

No. of areas	Source and amount of funds			Total funds	Total blocks coded	Cost per block
	Local	HUD"701"	HP&R <sup>1</sup>			
80	\$115,298	\$88,962	\$276,963	\$481,223	<sup>2</sup> 186,360	(av.) \$2.47
<sup>3</sup> 31	44,615	88,962	-	<sup>4</sup> \$133,577	61,623	1.84
45	52,909	-	\$276,963	329,872	116,960	2.82
4	17,774	-	-	17,774	7,777	2.28

<sup>1</sup>Highway Planning and Research Funds.

<sup>2</sup>Excluding San Juan, P.R., there were 199,360 blocks in the finished files (see appendix D, p. 53).

<sup>3</sup>Includes San Juan, P.R. A DIME file was prepared for two of its barrios, but this file was not included in the over-all DIME program.

<sup>4</sup>Excludes \$4,511 for Des Moines and Sioux City, Iowa, and Corpus Christi, Tex., expended in the Metropolitan mapping portion of the ACG program (see p. 22).

There may have been additional costs incurred for overruns in coding or for additional map review; many of these costs probably were not reported and the amounts were absorbed by the local agencies.

### Place-of-Work Coding Guides

Computer programs for producing place-of-work coding guides for the use of Bureau clerks coding the sample questionnaires were written and tested in December 1969. In the computer process the ACG and DIME records were reformatted so that they appeared alphabetically or numerically by street name within each SMSA. The address ranges for blocks along each street were "collapsed" so that only the low and high structure numbers on that street within the tracts covered by the ACG or DIME file were shown on one line, together with the appropriate ZIP and street codes. Internal checks were built into the computer programs to make certain that all records were accounted for. In the case of the tract coding guides prepared for the areas without either an ACG or a DIME file (see p. 15) the same street-by-tract information was obtained by field listing, and then was transcribed, punched, and converted to magnetic tape for printout by computer.

The guides for 230 SMSA's in the United States, and for two non-SMSA areas--Appleton-Oshkosh, Wis. (not including Fond du Lac, although that city had been included in the Appleton-Oshkosh ACG), and New Brunswick, N.J.--were generated by computer printout in the spring of 1970. Copies were reproduced in sufficient quantities for the coding operations. By referring to the guide for an SMSA the clerk determined whether a given street was inside the urbanized area of that SMSA and, if so, coded the address to a 5-digit ZIP code, a 6-digit structure number, and a 5-digit street code. In subsequent computer processing this 16-digit combination was converted to a block number by automated reference to the appropriate ACG or DIME file.

For cost purposes, establishing the entire place-of-work coding system was part of the Bureau's data processing program rather than geographic work. Establishment costs included \$102,000 for personal and computer services and \$165,000 for printing. Preparing the place-of-work coding guides constituted the major portion of this project.

## ENUMERATION MAP PREPARATION AND COMPILATION

The task of preparing enumeration maps for the 1970 census involved the selection and, in many cases, the redrafting of incorporated and unincorporated place maps. Other tasks involved block numbering both for urban areas covered by the Metropolitan Map Series (MMS) and the areas covered by the contract block program, and designation of enumeration districts (ED's) in areas not covered by the ACG's.

### Selection and Redrafting of Place Maps

After the replies from the Bureau's boundary and annexation surveys (see p. 7ff.) were processed and questions or ambiguities were resolved, each accompanying map was examined to determine if it was acceptable for use as the basis for the official census incorporated place map.

For places located within the coverage of the MMS, "Metro" maps were used automatically for place map information. In the early developmental stages of the MMS preliminary edition sheets were forwarded to each incorporated place with instructions to correct any errors in boundary or street data, or to furnish a more reliable map showing this information. Thus the final editions of the MMS sheets reflected local editing by each incorporated place.

Map selection for areas outside the MMS was done by county. Maps in the Census Bureau's current map file were compared with those received in the boundary and annexation survey. The maps which best met the Bureau's specifications--preferably the ones with the latest dates--were selected. However, when an earlier map was better suited for the Bureau's purposes, new information was transferred to the earlier map. If there were significant differences in street patterns, a new map was drafted, based on U.S.G.S. quadrangle topographic sheets ("quads"), county maps, and information from local officials. Each map selected was considered a part of a county work unit and included in the mappackage for that county. An "intermediate"--a plastic film sheet which carries the image of the completed map and from which diazo prints can be reproduced--was prepared for each selected map.

In addition to the incorporated place maps, it was necessary to prepare maps for over 2,100 unincorporated places recognized by the Bureau and not covered in the MMS. Since unincorporated places do not have municipal governments which could furnish maps to the Bureau, suitable maps had to be obtained or derived from other sources. Where available to the Bureau, local or State highway department maps were selected, and the Bureau established boundaries on them following visible features for each unincorporated place. (By definition, an unincorporated place has no legal limits.) U.S.G.S. "quad" maps were used as a base on which to delimit the boundaries of unincorporated places for which no other map coverage could be obtained. Where a "quad" map was used it was enlarged, and the boundary of the unincorporated place was traced and identified on it. These

maps became the official Census Bureau maps of the unincorporated places.

### Census Block Numbering

For the 1970 census, census blocks were defined and numbered by first dividing census tracts, wards, or major portions of untraced areas called "block-numbered areas" (BNA's) into block groups, and then dividing these block groups into individual census blocks. (See also section on "Census Blocks and Block Groups" on p. 14).

Tracts consisting of less than six blocks were not subdivided into block groups. (Very small blocks or parcels of land, e.g., traffic islands, segments of a highway interchange, etc., were not counted in determining the number of blocks in a census tract.) Each tract with six or more blocks and population estimated at less than 1,500 persons also was considered as one block group. Each tract with six or more blocks and 1,500 or more inhabitants was divided into two or more block groups, each generally containing about the same amount of residential land and bounded by major geographic features. In these tracts one block group was created for each 1,000 to 1,200 people estimated to be living in a tract. A maximum of eight groups normally was allowed for each tract, however a ninth group could be added for large open or rural areas of a tract.

Each block group then was divided into census blocks. A fishhook symbol was used to indicate that a block continued across features such as railroads, streams, highway interchange ramps, and boundaries of parks, cemeteries, hospitals, etc. Military reservations usually were assigned a single block number within each tract. Both block groups and census blocks were bounded on all sides by features which were visible to an enumerator in the field, or by a tract line.

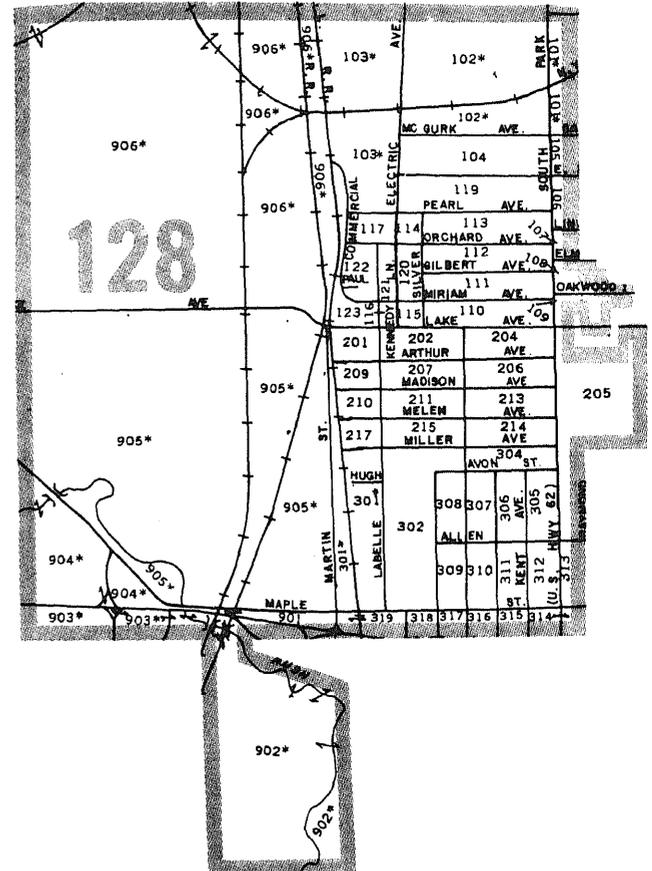
Each block was given a 3-digit number. The first digit of each block number identified the block group; i.e., the blocks in the first group began with the number 101, those in the second group with 201, etc. Large open areas in a tract generally were assigned block numbers beginning with "9." Block groups were numbered in a clockwise fashion, with the first group assigned to the northeast corner of the tract. All the blocks in the group were numbered consecutively, following a serpentine pattern. An attempt was made to keep consecutive numbers as adjacent to one another as possible. The last number in one group was made adjacent to the first number in the next group in the same tract. (See fig. K.) This practice, however, sometimes made a serpentine numbering pattern impossible. As a result of map editing during preparation of address coding guides or geographic base files some boundary features were deleted; this required omission of some block numbers, and there were resultant gaps in numbering and fragmented block groups.

### Designation of Enumeration Districts

An enumeration district (ED) is a small statistical area established by the Bureau as a basic unit for data collection and tabulation; the ED generally contained 250 to 750 housing units and represented the average workload for one enumerator. The principal consideration in delimiting ED's was that the entire area included within each

had to be within the same political and statistical area; an ED could not cross the boundaries of other areas for which data were collected and tabulated. The basic work unit used in establishing and numbering ED's was the county (or its equivalent); within a county ED's could not cross the boundaries of MCD's and CCD's, incorporated places, recognized unincorporated places, congressional districts, potential urbanized areas, city wards, census tracts, areas annexed since April 1, 1960 to cities having 2,000 or more inhabitants in 1960, or areas included in the contract block statistics program.

**Figure K. Tract Map Illustrating the Census Block Numbering System. (Only a portion of the tract is shown.)**



The serpentine pattern of numbering begins in the northeast corner of the tract. The "900" block group designation is used for the outlying areas within the tract. Blocks 901-904 and 906 have "fishhooks" linking together parts of each block separated by features which are not considered as block boundaries.

In 1970, Metropolitan Map Series (MMS), county, and place maps were used as the base maps for delineating and numbering ED's. All boundaries which had to be observed were drawn on the appropriate map. Every area enclosed by any combination of these boundaries comprised an ED planning area (EDPA); each EDPA then was subdivided into ED's. Some EDPA's formed only one ED. In case an area was broken into several small sections by piecemeal annexations or new incorporations, a single multi-part ED was created for all the small areas.

The number of ED's established in each EDPA varied according to the State and the type of area (rural, urban fringe, urban, or central city) and whether it was to be

enumerated by mail or by conventional procedures. In any case, no ED was supposed to exceed 300 square miles, regardless of its population, except in Alaska, where there was no geographic size limit.

ED plans suggested by local planning agencies and other organizations were accepted as proposed, provided the ED's contained the required number of housing units and used acceptable boundaries. Where the Bureau delimited the ED's an estimate of the number of households was made by reference to 1960 ED counts, various commercial and governmental data sources, and special censuses conducted by the Bureau. ED plans for approximately 200 counties that had experienced rapid population growth during the 1960's were reviewed and revised by the Bureau's regional offices to minimize extensive splitting of ED's during data collection because they were too populous. The entire delineation process was designed to avoid splitting ED's into smaller portions later in the field because the original ED's were too large; on the other hand, the ED's had to be large enough so that their total number would not make the task of census-taking excessively costly and administratively unwieldy.

In metropolitan areas covered by the Bureau's address coding guide (ACG), the ED's were designated by computer (see below), and not outlined on maps except for district office use. ED's for areas outside the ACG but within the urban fringe zone were designated on MMS mapsheets; beyond the coverage of the MMS, county and place maps were used for the delineation of ED's.

Every ED within a State was identified by a 4-digit ED code and a 3-digit county code (the numbers included leading zeros if necessary). The numbers were assigned in sequence and in serpentine fashion beginning with the MCD or CCD in the northeast corner of each county. The ED's for all the incorporated and unincorporated places within that county subdivision, taken in alphabetical order, were numbered first, followed by all other areas.

In all, 237,462 ED's were defined before the census began. This total included 95,220 computer-generated ED's, 28,679 ED's in prelisted areas, 108,112 in conventional areas in the United States, and 5,451 in Puerto Rico and the outlying areas. These totals were increased by an average of 5 percent during and after the enumeration because of splitting of ED's for administrative and other purposes.

Computer-generated ED's.--In areas in which the ACG was used, ED's were created by the computer. The address for every housing unit on the census mailing list on magnetic tape that matched corresponding ACG records was assigned census codes for State, county, census district office, area (a combination of MCD or CCD and place), census tract, and block. The addresses were sorted according to these codes and aggregated into ED's by the computer. The first ED number was prespecified; all subsequent ED number within a given ACG area were consecutive, except that a gap (usually not less than 50 numbers) was left whenever the district office or county code changed. No suffixes to ED numbers were assigned by computer.

The ED's were developed by assigning the same ED number to each address in the lowest numbered block in

the first tract, and to each address in each consecutively numbered block in that tract, until a prespecified total number of housing units was accumulated. This total was based on the anticipated difficulty of enumeration in the area, and varied between 400 and 750 housing units per ED. Normally, ED's contained only complete blocks; therefore, if the specified total was reached before half of the block being processed was assigned, the entire block was given to a new ED. In areas with large numbers of housing units per block, such as those containing high-rise apartment houses, special programming permitted the splitting of addresses in the same block among two or more ED's.

The computer produced ED control lists that showed, when printed out, the ED numbers, the codes for each ED, and the blocks included in the ED. These so-called "computer ED's" were plotted in color on one set of maps which was provided to the district offices for their use in assigning followup cases to enumerators, and in coding addresses reported by the Post Office as not appearing on the original mailing list. During the map plotting operation, ED's with obviously erroneous codes were adjusted, and areas found not covered by ED's were assigned ED numbers based on those of adjacent ED's, but with an alphabetic suffix added to the number. (For example, an unassigned area adjoining ED 0036 was given the ED number 0036A.)

Special ED's.--In the 1970 census, as in the 1960, military reservations, Indian reservations, national parks, large institutions (e.g., hospitals, orphanages, and prisons), and other facilities such as hotels, motels, boarding houses and college dormitories, were referred to as "special places." Military reservations, Indian reservations, large recreational areas such as national monuments, parks, etc., Federal prisons, and U.S. Public Health Service hospitals were enumerated separately as special ED's. Military reservations were assigned single ED numbers as in the past, but separate parts of larger, complex military installations were assigned different ED numbers. Indian reservations generally were considered as single ED planning areas composed of a number of ED's. Special places were not enumerated by mail as it was impossible to pre-determine the number of questionnaires required and because housing data would not be obtained for these places.

Crews-of-vessels (CV) enumeration districts.--The procedure for allocating crews of vessels to geographic areas was carried out in the same manner as in 1960 (see chapter 8 for details). Areas with facilities for vessels, i.e., piers, ship berths, naval bases, etc., were located with geographic information available in the Bureau. This included lists of locations of home port installations for naval vessels (U.S. Navy and U.S. Coast Guard) and information on the home ports for nonmilitary vessels; the latter was supplied by ship owners through the Maritime Administration of the U.S. Department of Commerce.

Vessel facilities--piers, berths, naval bases, etc.--within each census area which had them were assigned to ED's on the following basis: Within each tract and in every untraced area one ED was created for each naval

base and one ED for the civilian facilities, or each part thereof if split among two or more tabulation areas. These "water ED's" were numbered as follows: In conventional enumeration areas, water ED's were assigned ED numbers beginning with 9900 in each county. In mail areas the highest computer-assigned ED number for a county, district office, or combination thereof was determined. The figure 30 was added to this number, and the total was rounded upward to the next multiple of 50; this final figure was the first number assigned to a water ED. (For example, if the highest ED number assigned among the district offices in a given county was 0956, 30 would be added, giving a total of 0986. The next higher multiple of 50 would be 1000, and this number would be assigned to the first water ED.)

### Preparation of Field Enumeration Maps

Three basic types of maps, containing all political and statistical boundaries to be observed during enumeration, were prepared for the 1970 census: Metropolitan Map Series (MMS) sheets, county maps, and place maps. Intermediates of these maps were used to reproduce black-and-white paper prints of each for the field staff. The following maps were prepared and issued:

1. One map of each prelist and conventional enumeration district (ED) for the enumerator.
2. Several complete sets of maps of the area covered by each of the 393 census district offices. These included half-scale (1 inch equal to 1600 feet) MMS mapsheets, county maps (1 inch equal to 1 mile to 1 inch equal to 4 miles), place maps (1 inch equal to 400 feet to 1 inch equal to 1500 feet), and maps of military establishments, or a combination of all four, depending on whether any or all of the district office's areas were covered in the MMS.
3. One complete set of full-scale MMS mapsheets at 1 inch equal to 800 feet, showing the computer-generated ED's in the area covered by each mail census district office.

ED maps for prelist and conventional areas.--ED maps for the prelist areas were required for address listing in the fall of 1969 and the spring of 1970. These were sent to the district offices on a flow basis from July through October 1969 for the fall listing areas and September through December 1969 for the spring listing areas. After the fall address listing was completed the used maps were returned to Jeffersonville, and later were reshipped to the district offices when they opened; the spring listing maps were retained in the district offices for use in the enumeration. Shipment of ED maps for conventional areas began in June 1969 for pre-census review in the regional offices and continued through February 1970. The first complete sets of maps for field supervisors and crew leaders were shipped from Jeffersonville in November 1969. These shipments continued on a "ship when ready" basis and were completed in January 1970.

Metropolitan Map Series.--In the areas covered by the Metropolitan Map Series (MMS), these mapsheets were used as field enumeration maps. In the computer

areas a master set of MMS sheets showing computer-listed ED boundaries was prepared for each district office having such areas in its jurisdiction. This was accomplished by using a computer listing of the ED's in the district office's area as a guide for determining the blocks included in each ED. All the block numbers in the ED, as well as the tract, area code, congressional district, and annexation code were shown on this list. Based on this information, the computer ED's were plotted on the maps. Each ED was numbered and outlined with orange pencil for the district office's guidance in indicating enumerators' assignments.

Outside the computer areas, individual ED maps for enumerators were prepared from cutouts or enlargements of the ED's shown on the MMS mapsheets. In most cases the size and scale of the ED on the MMS sheet were too small to make an adequate map for the enumerator. Therefore, a microfilm enlargement of the map of the ED was made by processing the microfilm negative on electrostatic reproduction equipment to produce a print of the ED map at a scale suitable for the enumerator, but not exceeding 1 inch equaling 400 feet. Although the boundary of each ED was shown on the photocopy by monochrome symbols, the boundary also was outlined with orange pencil for the enumerator's benefit. The photocopied prints then were affixed to cardboard sheets and sent along with the master set of maps and crew leaders' maps to the appropriate district office.

County and place maps.--All areas not mapped in the MMS were covered by census county and place maps. Since most of the county and incorporated place maps were altered forms of the maps furnished by local officials, there was a wide variation in size and scale among them. Accordingly, to make them suitable as individual enumeration maps, some of the maps had to be reduced or enlarged. Typically, the map scales for ED's on the county maps, and often on the incorporated place maps covering detailed areas, were too small and had to be enlarged. On the other hand, the ED's in some sparsely settled incorporated places were at such a large scale that they had to be reduced. The unincorporated place maps usually did not require a change in scale since most of them had been prepared from enlargements of the U.S. Geological Survey "quad" maps.

When reduction or enlargement of a county or place map was required, the same microfilm electrostatic reproduction process described above was used. Each ED map prepared from a county or place map was outlined with orange pencil to clearly indicate the boundary of the ED to the enumerator, and the map was affixed to a cardboard sheet.

Corrections to field enumeration maps.--Field map preparation was continued into March and April 1970 in order to supply replacement maps with revisions, e.g., annexations and enumeration district splits reported by the field offices. Corrected ED and crew leader district maps were made and sent to the district offices to replace maps sent in the original shipments. For conventional enumeration areas, ED revisions were accumulated and a single revised map or set of maps was sent to the district office in March 1970. Additional revisions were accumulated, and

another mailing of revised maps was made in late April 1970. After the maps were sent out for the spring and fall prelisting, no further ED revisions for the mail areas were made prior to the enumeration; all corrections were accumulated and a shipment of corrected maps was made in late April 1970. Approximately 175,000 enumerator, crew leader, and district office maps were delivered to the field by the end of April 1970.

## PREPARATION OF MAPS INCLUDED IN CENSUS PUBLICATIONS

At least 6 months prior to April 1, 1970, a small staff began preparation of the maps to appear in the 1970 census publications. A map of the United States showing county boundaries and maps of the States showing county subdivisions were the first to be prepared, followed by those maps that would appear in the population and housing census reports, census tract reports, block statistics reports, reports of outlying areas, and the U.S. population summary report.

### U.S. County Outline Map

An outline map of the United States, showing county boundaries, at the scale of 1:5,000,000, and 26 by 41 inches in size, was published in two editions: one was printed with all boundaries and information in black, the other with State boundaries printed in black and county boundaries and names printed in non-photographic blue. The latter edition was prepared for users desiring to have county boundaries available for reference and also wishing to plot data on the original but allow reproduction of the map without the county boundaries and names showing on the copies. This U.S. county outline map was the latest in a series of similar county maps published by the Bureau since 1930. Earlier United States maps showing county boundaries and names were published in census reports as early as 1840.

### State-County Subdivision Maps

With a few exceptions, the preparation of the State-county subdivision maps in separate sheet format consisted mainly of taking the 1960 maps and updating the geographic data to 1970. Exceptions to this procedure included three new State maps (for North Dakota, Oklahoma, and Delaware) where new census county divisions were assigned, and one for Alaska which was redrawn to show census divisions rather than the election districts used in 1960. The maps in this series varied in scale from 1 inch for every 50 miles in Alaska to 1 inch for every 3 miles in Puerto Rico; the scale in most States was approximately 1 inch to 12 miles. Each map contained a county location index.

The maps showed subdivisions of counties--i.e., minor civil divisions (MCD's) and census county divisions (CCD's), and the location of all incorporated places and those unincorporated places for which population figures were published. (MCD's are political and administrative subdivisions set up by the State, such

as civil townships, election districts, magisterial districts, towns, and gores; CCD's are statistical areas established by the Census Bureau in collaboration with the States involved (see p. 12).

### Maps Incorporated in Published Reports

Maps in the PC(1)-A (Nos. 2-52) Population Census Reports.--For each final State report in the series PC(1)-A, Number of Inhabitants, three sets of maps were prepared: (1) a State map showing the county subdivisions and all incorporated and unincorporated places of all counties in the State, (2) a State map showing counties, SMSA's, and places with 25,000 or more inhabitants (for selected States, places of 25,000 to 50,000 population that were not central cities of SMSA's were shown only outside SMSA's), and (3) a map of each urbanized area (UA) in the State.

The preparation of the State maps showing the county subdivisions (either MCD's or CCD's) involved dividing each State map into groups of counties convenient for reproduction at page size when reduced to a common scale for publication. The preparation of the State maps showing county boundaries and SMSA's involved taking the maps compiled for the Bureau's 1967 Economic Censuses and updating the boundary data. For the 252 urbanized areas maps showing the extent of the UA's (as well as the extent of the incorporated and unincorporated places) were prepared from tracings based on the photo-reduction of the MMS sheets for each UA at a scale of 1 inch to 1 mile.

Census tract maps in the PHC(1) Reports.--A census tract map was made for each of the 241 tracted SMSA's in the country. These maps showed the boundaries of the areas for which the tract statistics were presented. (Boundaries of a tracted area generally constituted those of an SMSA as well; a few tracted areas, however, included the SMSA plus an adjoining area outside it, and were so mapped.) Each map also identified the location and number of each tract and, where appropriate, the limits of cities, townships, counties, or other subdivisions of the tracted area. Scales in the series varied, depending on the size of the SMSA covered and the amount of detail required to give an adequate picture of the tract pattern in the central city (or cities).

In general, the tract maps prepared for the 1970 census were more accurate than those for the 1960 census principally because the 1970 maps were based on the Metropolitan Map Series, which was not available in 1960.

Block statistics maps in the HC(3) (Nos. 1-278) Housing Reports.--The block statistics reports, published for 236 UA's, each contain a set of "Metro" maps. These maps were prepared by reducing the Metropolitan Map Series (MMS) maps on which the final 1970 urbanized area lines had been plotted. The printed copies showed the census tract boundaries and numbers and the enumeration district lines by the use of a second color--green; the block numbers and political boundaries were printed in black. In the case of a few cities with extremely complicated boundary structures, the central city of the urbanized area was

shaded in a light green tone. A key map also was included showing the layout of each of the MMS sheets included within the scope of the report.

In addition to the sets of maps covering the regular block statistics program, 42 States had selected areas covered by sets of maps in the Bureau's contract block statistics program (see p. 9). This program provided block data to participating communities not included in the regular block tabulation program. The maps prepared for this purpose were based upon maps furnished to the Bureau by the municipal officials of the areas involved. In a few cases the maps submitted by a municipality were adequate for the Bureau's use, but in most cases they had to be redrafted. The maps then were reproduced at an acceptable scale and the required block numbers and census tract lines were added. Maps in the MMS were also used where they covered contract block areas.

Again, as in the case of the tract maps, the block statistics maps prepared for the 1970 census were more accurate than those for the 1960 census primarily because the MMS coverage did not exist in 1960.

Maps in the PC(1)-A (Nos. 53-58) Population Census Reports of Outlying Areas.--Maps accompanying the outlying area reports were largely updated versions of those used in the 1960 census. However, in the case of the Trust Territories of the Pacific, enumerated for the first time by the Bureau in the decennial census in 1970,<sup>6</sup> a new set of maps showing districts, municipalities, islands, atolls, and places was drawn up for publication purposes.

Maps in the U.S. Summary Report PC(1)-A1.--A total of 32 pages of maps, graphs, and charts in color were prepared for the U.S. summary report. Of these 32 pages, 22 were devoted to maps showing distribution and change in population, urban and rural population, metropolitan and non-metropolitan population, and other statistical and geographic information. A number of maps were updated versions of those included in the report in 1960, but some were entirely new. The Bureau made greater use of color in its 1970 reports to improve the clarity of the graphics over those prepared for 1960.

## UNPUBLISHED ENUMERATION MAPS

The Bureau prepared for sale to census users maps with geographic detail below the level of those accompanying the published reports. These included county maps, place maps, "vicinity" maps, and the original MMS maps at 1 inch to 2,000 feet scale.

County maps, usually at a scale of 1 inch to 2 miles, showing boundaries for MCD's, CCD's, incorporated places, tracts, and enumeration districts, were made available for all counties or county equivalents not covered by the Metropolitan Map Series. Generally, there were one or two mapsheets per county, with more for counties that were large in area.

<sup>6</sup>In 1958 the High Commissioner of the Trust Territories conducted a census, the results of which were tabulated and included in the aggregate population totals of the 1960 U.S. census.

Separate place maps, varying in scale from 1 inch for every 400 feet to 1 inch for every 1,200 feet, were prepared for most incorporated and unincorporated places not shown in the MMS. These place maps provided greater detail than the county maps and showed boundaries for tracts (where applicable) and enumeration districts, wards, etc., that were located within places.

"Vicinity" maps, at a larger scale than the county maps, were developed to show blocks in the vicinity of cities which contracted for block statistics beyond their corporate limits, or for use in defining potential urbanized areas around places which might qualify as central cities of urbanized areas as a result of the 1970 census. In some instances the detail of census geography for the city appeared on these maps, and in other cases--because the scale was too small for the urban detail of the city to be legible--it appeared on a separate place map. The scales and sheet sizes of the "vicinity" maps varied.

Although complete "Metro" map sets for urbanized areas of SMSA's were published as part of the block statistics report series HC(3), copies of the original MMS maps also were made available on a scale of 1 inch to 2,000 feet. These sheets lacked the color overlay used in the published maps; rather, the overlay information was shown in monochrome.

## AREA MEASUREMENT

The figures for the areas of the United States, States, and counties reported in the 1970 census were updated from those used in the 1960 area measurement reports to reflect changes in area which occurred during the decade.

The basic area measurement work for the United States was carried out prior to the 1940 decennial census. In 1937, based on the most accurate maps and geographic tables available at the time, the total area (land plus water) of the United States was determined. This task was followed by measurement of State and county areas. Upon completion, the State area totals were adjusted to the U.S. total area, and the county area totals were adjusted to those of the States. For the measurement of the areas of counties and minor civil divisions, a wide variety of maps of varying scales had to be used.

During the 1960's a new device, the map area computer, was developed by the Bureau for measuring areas of maps. It eliminated the need for hand recording and manipulation of figures together with the use of the planimeter (an instrument for measuring area by passing a tracer around its boundary lines) that characterized area measurement processes in the past. The map area computer uses electronic techniques to measure the surface of any thin insulating material that has been cut as a template to represent a specific area of land and/or water. The area, measured in square inches, is recorded automatically on a punch card that contains geographic identification codes for the template.

## Remeasurement of County Areas

Much of the remeasurement of areas carried out for the 1970 census centered on changes in land and water figures during the previous decade. Most of these changes resulted from the creation of reservoirs

or, in rare instances, landfills. In remeasuring the land and water areas, the 1940 criteria were used. A small number of changes resulted from alterations in county boundary lines and the creation of independent cities.

**Determination and Measurement of Urbanized Areas**

The calculation of population densities for use in defining the extent of urbanized areas required the area measurement of block parcels and ED's for all urbanized and potential urbanized areas (see p. 11). The measurement was accomplished electronically.

As most urbanized and potential urbanized areas were delineated on uniformly scaled Metropolitan Map Series (MMS) mapsheets, the block parcels and small ED's were cut out as individual pieces for machine measurement. As the pieces were put through the map area computer, the size of each piece was recorded in square inches on a punch card. Another computer converted the square inches to square miles and adjusted the computation for any deviation from scale that might have resulted from the map reproduction process. The resulting computer printouts were reviewed, corrections and reruns were made as necessary, and the final results were matched with population data to determine whether the areas in question might qualify as urbanized areas; approximately 53,000 separate pieces of maps were measured.

**Measurement of Urban Places**

Data on the area of urban places came from two sources. Local officials were requested to supply data on the area of each incorporated place; responses were

received from most of these places. These data were accepted as received, unless verification appeared to be necessary. The areas of all unincorporated places and those incorporated places that failed to respond to the Bureau's request were measured by means of the map area computer, but conversion from square inches of map to square miles of land was done manually and the results were checked by examining the county maps in order to avoid errors caused by the use of inaccurate map scales.

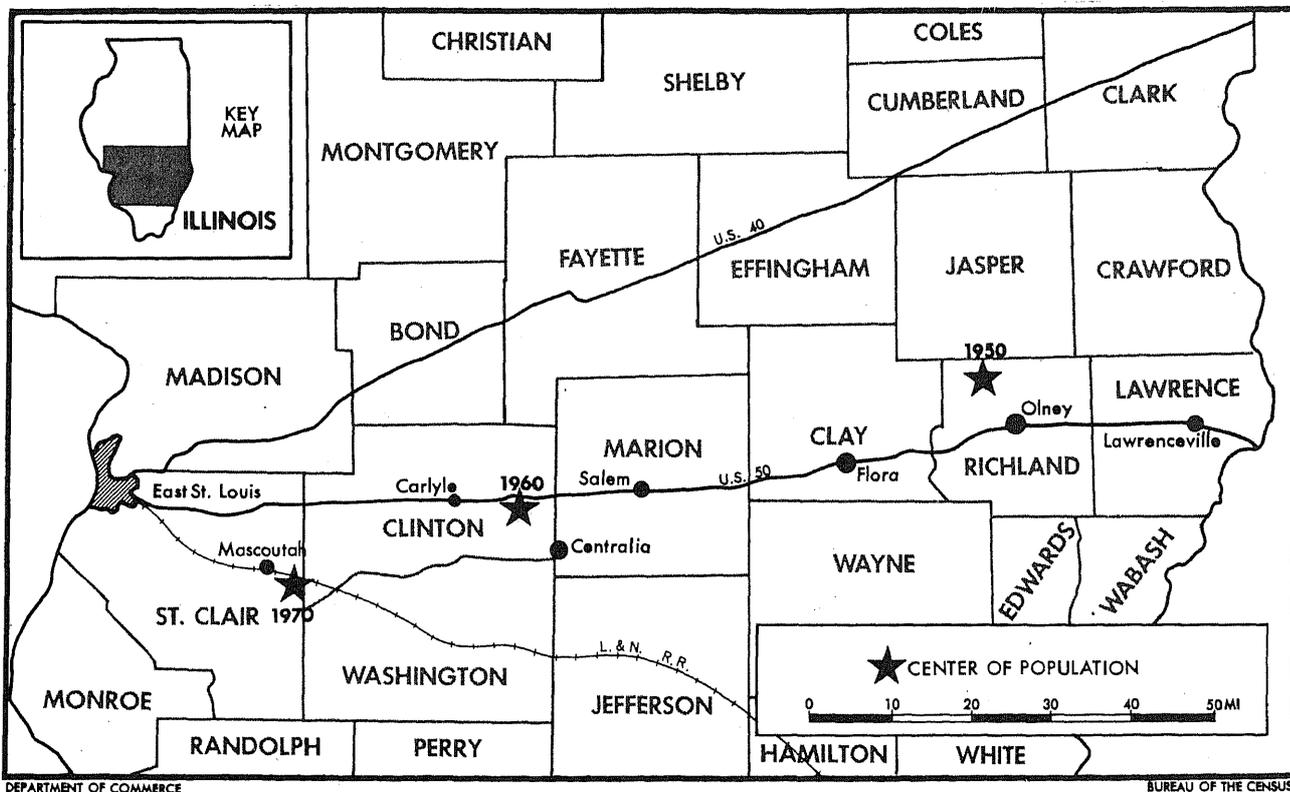
**Measurement of Congressional Districts**

Areas of congressional districts (CD's) were determined by reaggregating the data contained in the 1960 area measurement reports. In those cases in which CD boundaries divided units reported in the area measurement reports, a map of each affected unit was cut out and then cut again along the CD line. Both parts were measured to determine the proportion of the unit's area in each CD; this proportion was applied to the data for the affected unit when the area of the congressional district was computed.

**U.S. Center of Population, 1970**

The Bureau defines the center of population as the point at which an imaginary flat, weightless, and rigid map of the United States would balance if weights of identical size were placed on it so that each weight represented the location of one person on April 1, 1970 (Census Day). Approximately 250,000 geographic points, representing centers of the population of ED's and block groups, were involved in the complex electronic process (for description, see appendix B, p. 50). This figure is about six times that of the approximately 43,000 geographic points, representing centers of population of

**Figure L. U.S. Centers of Population: 1950, 1960, and 1970**



tracts, places, wards, MCD's, and CCD's used in the 1960 census. The great increase over 1960 in the number of points used in the calculations serves to improve the precision of the location of the 1970 center.

The 1970 center was located in St. Clair County, Ill., at a point about 5 miles southeast of the city of Mascoutah, 26.9 miles west and 9.4 miles south of the 1960 site near Centralia, Ill. (See fig. L.) A marker was placed at the 1970 site on May 16, 1971. (Following the Seventh Decennial Census in 1850, the center of population was calculated for the decennial censuses taken from 1790 on. This practice was continued in subsequent censuses, but markers were placed only at the 1950, 1960, and 1970 sites.)

## PREPARATION OF THE MASTER REFERENCE FILE

### Introduction

The master reference file (MRF) is a set of computer tapes containing a record for each enumeration district (ED) in the United States sorted under appropriate geographic names (State, county, MCD/CCD, and place). Each ED and name record contained appropriate geographic and tabulation codes for processing. The ED was the smallest unit in the MRF except for mail-area counties where blocks for each ED were listed. It was from the MRF that various control files were obtained for the gathering, tabulating, and publishing of census data.

Planning for the MRF began in 1968. The basic MRF was created from a selective merging of a modified 1960 name tape and selected codes from the 1960 MID (master identification) tape. This basic MRF tape, consisting of 120,000 records, was then updated in five major phases which are described on the following pages. These phases were:

1. Addition of new counties, minor civil divisions (MCD's) or census county divisions (CCD's), places, and the newly established enumeration districts (ED's) for prelist and conventional areas.
2. Addition of all pertinent geographic codes.
3. Computer merge of the address coding guides (ACG's) with the MRF and the addition of ED's in ACG areas.
4. Recycling of corrections and computer rejects.
5. Insertion of computer-assigned codes.

After the basic MRF tape was updated, a geographic reference tape (GRT) and a master enumeration district (MEDList) tape were extracted. The GRT, which was a 1970 version of the 1960 master identification (MID) tape, was used to process the data obtained in the 1970 enumeration. The MEDList was designed to furnish area names and their geographic codes, and to provide 1970 population and housing counts for these areas, and for the areas' ED's and block groups. (A "block group" was the equivalent of an ED for post-census purposes, and was selected by computer from the computer-generated address register listings.) A block group consisted of a series of blocks whose numbers or codes had the same first digit. This method of designation

saved costs, as both computers and data users could readily identify the block groups, whether on tapes or maps, without the need for separate coding or mapping of these areas.

### Preparatory Work

To create the basic MRF (a skeletal version of the final MRF, minus ED's and some associated data), the 1960 name tape was modified and specific codes were taken from the 1960 MID tape in October 1968.

The 1960 name tape contained approximately 60,000 State, county, MCD/CCD, and place name records. Each record consisted partly of at least one of the following codes: census code (1960) for State, census code (1960) for county, MCD/CCD, and place. The 1960 State, county, and place codes remained in the basic MRF as they had been extracted from the 1960 name tape. Population and housing counts, place description, name, name type (State, county, MCD/CCD, or place), and place size were also extracted from the 1960 name tape. The Federal standard (1970) State and county codes were added to the name lines. The 1970 State code was assigned sequentially to the States in alphabetical order. The area code (the equivalent of an MCD or place code) was assigned on the basis of the 1960 MCD/CCD and place codes. From special lists the quasi-State, place status (city, town, village, or borough), and publication codes were assigned. The county code field used for tabulation was filled with the 1970 Federal standard county code. The part indicator code (a 1-digit code inserted on the "name" line to indicate that the place was in more than one MCD, CCD, or county) was computer-assigned where applicable for those records present in the basic MRF at this time. The name lines were assigned a record type "1" in the first column, identifying the line as a name record.

The 1960 MID tape contained approximately 270,000 ED records composed of geographic data used in the 1960 census. The MRF detail line also contained all of the data on the name line except for the name of the area and the 1960 population and housing counts. The detail lines were assigned a record type "5" in the first column, identifying the line as containing geographic codes (detail) down to the ED level.

A control number was assigned to each "1" and "5" record in order to locate the record for correction purposes; a control number was later assigned also to "7" (ZIP code) records. (It was intended originally to have ward and block records in the MRF as well, using a record type "9," but it was decided subsequently not to carry this level of detail on the MRF computer tapes.) The control number was composed of eight digits, where the first two digits were the 1960 State code, the next five digits made up the record serial number, and the last one was a check digit.

A checklist was used as a control source for every county. The codes listed, where applicable, were the following: Central county code (CCC), standard metropolitan statistical area (SMSA), urbanized area (UA), tracted area (TA), New England sequence number (NESN), standard consolidated area (SCA), congressional district (CD), universal area code (UAC), central business district (CBD), publication, overbounded place (extended city), and part. A duplicate of each county folder was kept in the Bureau's Jeffersonville facility for use there. The CBD, UAC, publication, and part codes were inserted by special computer programs. Procedures for the initial transcription, punch, and verification of the universal area codes (UAC's) were written in mid-1969.

## Transcribing and Processing the MRF Data

Modified Post Office city delivery boundaries for census mail areas were added to the census district office maps prepared for the 1970 census. Starting in September 1968, ED's were delineated on prelist and conventional area district office maps in Jeffersonville according to geographic descriptions contained in "ED Directories for Map Plot." Any changes resulting from this operation which altered the ED descriptions were allocated in the directories and later transcribed for use in correcting the MRF.

In January 1969, because of a need for a list of 1970 ED's for use in each of the Bureau's regional offices, an ED control listing punch document was designed. The following data were transcribed to it, where applicable, for each prelist and conventional ED: basic ED number and suffix, type (ACG--i.e., computer-generated "block group," prelist, or conventional), congressional district, district office, ward, tract, annexation flag (indicating that the ED was annexed to an incorporated place after 1960), MCD/CCD, and place codes, alphabetic footnote (references to required comments on changes since 1960 for publication purposes), and block numbers. The work was performed in Jeffersonville, using the district office maps on which all necessary political and ED boundaries had been drawn. The workload consisted of approximately 125,000 lines transcribed. At about the same time, a worksheet was designed and used to transcribe approximately 1,500 MCD/CCD and place name records to be added to the MRF. The use of this worksheet was necessary to ensure the presence of name records in the MRF when the ED numbers were added. Included on the supplemental worksheet were the 1960 population and housing counts, type of name, place or MCD/CCD name, place description, place status, MCD/CCD code, place code, area code, and part flag.

A 100-percent independent verification procedure was instituted for both the transcription to the worksheet and supplementary worksheet and for the punching from these forms. Computer edits were performed on the punchcards, those rejected were examined clerically, and corrections were made using three different worksheets.

The second processing phase covered adding, deleting, and correcting pertinent geography to update the MRF using two of the worksheets. One provided the means for revising the MRF with regard to the State, county, and place codes in the name records (card type "1") and also with regard to the detail records (card type "2"). The other was used to replace a range of blocks, and to add or replace individual blocks. The third worksheet was used to add or delete ZIP codes. The pertinent geography included data compiled in the county folder and the information recycled after rejection in a previous MRF updating operation. (See fig. M for the record layout of the updated MRF.)

The third phase of MRF preparation was as follows: Based on data in the address coding guides (ACG's), ED's (i.e., block groups) in mail areas were designated and merged into the updated MRF along with corresponding ZIP codes and their percentages,<sup>7</sup> block numbers and

<sup>7</sup>For a given ED, the ZIP code or codes were listed with the percentages of households in the ED covered by each ZIP code.

their associated address serial numbers (ASN's), congressional district, census district office, tract, SMSA, and annexation codes. Those ACG ED's that did not match the MRF in the merge operation were reviewed and corrected; the corrections were transcribed, punched, and verified. In some instances the MRF had to be corrected and the two files were merged again.

The advance transmittal listings of ED's and population and housing unit counts (Forms D-132 and D-134) to be used in controlling and recording the first results of the census were extracted from the MRF starting in early 1970. These listings were reviewed and hand-corrected if necessary before they were shipped to the district offices.

Listings from the various computer edits of the MRF were made available to clerks and professional staff members to help them review and correct the MRF. Between March and late December 1970, professional staff members conducted a series of reviews of the MRF from the standpoints of their respective subject-matter disciplines. Each reviewer reviewed one State's MRF at a time and then passed it to the next reviewer for consideration.

Starting in May 1970, geographic specialists in Jeffersonville reviewed the cartons of completed questionnaires (packed by ED) arriving from the field during the check-in operation. Resultant changes to ED's were annotated in red on the latest updated MRF printout. These red annotations were the sources of the information transcribed on the various edit worksheet forms used to update the MRF during the fourth phase of the processing operation. These corrections eliminated "999" blocks (artificial blocks in the ED's containing addresses which could not be coded to actual blocks listed in the ACG), changed tract and other geographic codes, and noted ED splits. (ED's were sometimes split into several parts for administrative purposes or because of recent annexations which changed political boundaries. These actions were recorded on the advance transmittal listings, Forms D-132 and D-134.) Elimination of "999" blocks was based on information received from the Bureau's regional offices. Additional ED corrections were transmitted from the field and from the breaker sheet preparation unit in Jeffersonville, as well as from the various divisions involved in the MRF review operation.

The fifth phase included the computer assignment of universal area codes (UAC's) to the MRF from a separate UAC tape starting in June 1970. A procedure was written and carried out in Suitland for the reviewing and correcting of revisions made to the UAC tape and the coders' manuals required by constant changes to the MRF itself. Other computer-assigned codes included the CBD, publication, and part codes. This program was run at several stages throughout the development of the MRF.

In July 1970 review began of the geographic reference tape (GRT) that had been extracted from the latest updated MRF. The GRT was similar to the MRF, except that it did not contain the name and ZIP code records. One worksheet was designed and used to transcribe corrections to detail lines (except for block and address serial numbers), and another worksheet was used to transcribe corrections to the blocks and address serial numbers.



During the processing of the 1970 census data, the GRT was updated according to instructions from the subject-matter divisions. This updating included changing the codes for unincorporated places and for potential SMSA's and UA's which did not qualify for tabulation as such as a result of the first-count data processing. The GRT updating work was done in Suitland, and was completed in December 1970 (for all practical purposes). In mid-1971 the ZIP codes in the MRF were edited and reviewed before the processing of the fifth-count data.

The final MRF consisted of approximately 62,000 name records and 250,000 ED and 250,000 ZIP code records which together covered some 1.7 million blocks.

### Problems

The overall problem in preparing the MRF was the unexpected volume of revisions and the number of computer cycles required to complete phase four. The complexity of the MRF and its edits required that the edits be carried out in three separate steps instead of the planned single step.

Failure to maintain the same area codes both in the ACG's and in the materials used to produce the MRF caused 10 percent of the ACG ED's (approximately 10,000 records) not to match the MRF in phase III. Both files had to be reviewed and corrected clerically.

## BLOCK PARCEL TAPE PREPARATION

### Introduction

To delineate the 1970 urbanized areas (UA's)<sup>8</sup> it first was necessary to determine the urbanization of the growth area outside the established 1960 urbanized area limits. This area was known as the urban fringe zone. The block parcel concept for identifying and delineating this zone was developed in 1967, and involved a technique which adjusted the urban/rural status of an urban fringe zone area after the 1970 preliminary population counts became available. (A "block parcel" was a grouping of census blocks within a census tract or ED designated for measurement to determine if the density of the population might be high enough in 1970 for the parcel to be included in the urbanized area.) For the fringe zone areas, a special block parcel file was constructed prior to the census enumeration. This file included not only those areas considered urbanized in 1960 but also areas which, because of urban expansion, might reasonably be expected to be included in 1970. After the census, the population and housing counts were tabulated for the parcels in the file, and the file was adjusted by deleting those parcels which failed to meet the criteria for urban status. The resultant file was used to identify the 1970 boundaries of the urbanized areas in the United States.

The content of the initial file varied according to the manner in which the enumeration would be conducted in a particular area. In mail-out/mail-back areas covered by computer-generated address registers the ED's were not delineated; for the urban fringe zone in such areas the parcels were designated within census tracts. In mail areas where the address registers were compiled by prelisting, ED's were known and parcels were assigned

within ED. In conventional areas, all urban fringe zone areas were divided into smaller ED's geographically than those in the more rural areas; the entire ED was designated on the parcel tape.

Incorporated places which fell within the urban fringe zone were designated on the parcel tape by area code (the equivalent of an MCD or place code). These places were called satellite places. Block parcels and small ED's also were defined for designated areas inside extended cities (i.e., those containing large areas of very low density settlement).

### Creation of the Block Parcel Tape

The delineation of the parcels on Metropolitan Map Series maps began early in 1968. A punch worksheet was designed for the transcribing of parcel information from the maps to punchcards for processing, and procedures were written for transcribing, punching, and verifying the work done. The clerical transcribing and punching operations began in October 1969; the workload consisted of approximately 30,000 lines.

Each parcel line transcribed included the State, county, UA, area, and parcel type codes. In mail areas parcels were identified within tract by an alphabetic entry in the parcel type field, plus the tract or ED and block numbers. In conventional areas where small ED's were used, the parcels were identified with a dash in the parcel type field, plus tract and ED numbers. An asterisk appeared in the parcel type field for satellite places.

The parcel cards were processed and edited on the computer for legitimacy and consistency. Rejected records were reviewed, and corrections were transcribed, punched, and verified. The reject rate was less than 1 percent for all areas; 60 percent of the rejects were caused by incorrect counts of blocks in each parcel and not because of errors in the basic data. The end product was a block parcel tape with a computer-generated serial number for each parcel line in the file.

The block parcel listing then was reviewed in its entirety from a geographic standpoint; corrections were transcribed, punched, and recycled through the computer. Any corrections that were rejected were reviewed, and again the reject rate was low.

### Block Parcel - Master Reference File Match

The updated block parcel tape then was matched against the master reference file (MRF) to determine the ED with which each parcel or part of a parcel was associated. This required the sequencing of both files in State, county, tract, and area code order. The block codes associated with the parcels on the tape were matched against the corresponding codes in the MRF in order to associate ED's with the parcels. After completion of the match the parcels were grouped into parcel/ED records within tract. For example, if part of the blocks in "parcel A" were associated with ED 1 and the rest of "parcel A" was associated with ED 2, two records were created. Parcels in small ED's were simply confirmed in the match to the MRF. In the match, satellite places were assigned ED numbers by area code, resulting in parcels similar to those in small ED's.

<sup>8</sup>See note on p. 9 for definition.

As a product of the match, five computer listings were produced and reviewed clerically. These listings identified inconsistencies, duplications, and parcels with erroneous or missing geographic codes.

Any necessary corrections were made to the block parcel tape after the match, and were annotated where necessary to the MRF as well. Both files were put through a second match after this updating. Two listings, the complete and the final block parcel lists, were produced as printed outputs of the second match. A block parcel finder tape was also produced.

The complete parcel list (with blocks) was a documentation of all parcels for a State by quasi-State.<sup>9</sup> It was used as a reference list during the determination of an urbanized area. The parcels were listed as they had been transcribed originally, except that "alpha" parcels now had ED numbers, satellite places now appeared as "dash" parcels, and residual parcels (groups of residual blocks) were identified with an asterisk in the parcel type field.

The final block parcel list contained much of the same information as the complete parcel list, except that it excluded blocks and residual parcels. It was used later to identify those parcels which would remain in the urbanized area for 1970.

The block parcel finder tape, in which the parcels remaining in the urbanized area were identified, was used in summing preliminary population counts for each parcel. During this process two listings were produced, the parcel total listing and the State-county-place sums listing.

#### Parcel Modification

The parcel total listing was the same as the final parcel list (excluding the UA code), except that it contained the total population for each parcel that was obtained during tabulation. Each parcel line also contained a work unit number indicating the stage during tabulation at which the listed population count was obtained.

The State-county-place sums listing contained population and housing count totals by quasi-State, county, and place as obtained during tabulation.

The urban or rural status of the parcels in the urban fringe zone, as defined on the complete parcel list, was determined by comparing the population counts from the parcel total listing and the State-county-place sums listing with the area measurement of each parcel and thus computing population density. The serial numbers of those parcels on the final parcel list which were to remain in the urbanized area were circled. The circled serial numbers also were identified on the block parcel finder tape, which then was matched to the GRT (geographic reference tape). The GRT already contained UA codes for each ED in the urban fringe zone. By designating those ED's or groups of blocks which were not urban (deleting UA codes and assigning urban/rural status codes) the final urbanized area was designated in the GRT.

<sup>9</sup>A "quasi-State" is a portion of a large State which is thus identified for data-processing purposes when the data for the entire State exceed the capacity of a single computer work unit.

## Problems

The main problem encountered in the block parcel operation was that of timing. The MRF was not sufficiently complete to be matched to the parcel tape at the time the match was needed.

There was some confusion with area codes in the MRF match, as the MRF was being updated with changed area codes while the parcel tape area codes were not changed.

Residual parcels consisted of blocks within a parceled ED (but not within the designated parcels) which were found in the MRF but not on the parcel tape. There were three basic reasons why residual parcels could occur: (1) a "good" block not transcribed, (2) "good" blocks not shown on the maps, and (3) "bad" blocks in the MRF, such as those resulting from incorrect coding, "999" blocks (artificial blocks containing street addresses that could not be coded to a known block), or duplication of blocks from split ED's. Residual parcels caused several problems in the GRT tabulation process: Inasmuch as all residual blocks for an ED were listed together on the same line on the parcel finder tape (thus forming residual parcels), there was no handle to get at the individual blocks because the parcel modification process (see above) called for action by control number by line. Initially all ED's and blocks in the urban fringe zone were considered urban and were changed to rural only by action taken in the parcel modification program. Thus most residual parcels remained within the urbanized area.

Individual problems arose with differing situations. Some examples included the following:

1. Blocks found on the parcel tape and not in the GRT were put into the GRT. The largest number of these were "999" blocks in the urban fringe area, thereby adding records for unknown blocks to the GRT.
2. If a residual block was within an ED that was entirely urban, there was no problem; if the ED was entirely rural, the UA code could be deleted in the GRT by a special target program correction; but if the ED was split between urban and rural areas it was necessary to identify the individual blocks. This required time-consuming research.
3. The parceling of extended cities in areas covered by ACG's was done strictly on a tract and block basis because the ED numbers were not known. In extended cities which were also satellite places, the parcels sometimes were duplicated. The staff preparing tabulation programs used only whole-ED parcels; thus in many cases extended city parceling was lost, and adjustment and reparcelsing was necessary.

## THE TAPE ADDRESS REGISTERS

### Introduction

For the 1970 decennial census a computerized mailing list of approximately 31.4 million geographically

coded addresses (called the master address file) was compiled for the Post Office city delivery areas of 145 SMSA's (standard metropolitan statistical areas) which were enumerated by the mail-out/mailback procedure. These addresses were obtained from address tapes purchased from a commercial source; these tapes were updated by a Post Office review for completeness and accuracy and underwent a series of computer and clerical matches with the address coding guides (ACG's) to create the Bureau's master address file. The mailing labels for the household questionnaires in areas covered by address coding guides (see appendix C, p. 50) were generated from these master address file computer tapes, as were the necessary records to control the enumeration process, such as the address registers, ED (enumeration district) directories, etc. (In addition to the addresses on tape, approximately 7.2 million addresses--also for mail enumeration--were obtained through an operation known as "prelisting" (i.e., canvassing an area and recording the address for every housing unit prior to enumeration); the address registers for these were compiled manually and the necessary questionnaires were addressed by hand. For details, see chapter 5, "The Field Enumeration.")

The address register process was developed through a series of pretests during the 1960's. In a special census of the Louisville, Ky., SMSA in 1964, two methods were used to construct a mailing register: (1) the 1960 census list (address register) was updated with addresses obtained from building permits and utility connection orders, and (2), all addresses were prelisted. Each of these methods proved to be inadequate, in that the first method required excessive additions and changes, while the prelisted records did not provide a tape address register for future use on a computer.

The use of commercial mailing lists on tape was tested in the special census of Cleveland, Ohio, in 1965. After the lists were updated through a check by the Post Office, they were used to establish a mail register. National sample studies were conducted in the spring of 1966 to see whether commercial mailing lists or listings based on street directories would provide the more complete coverage of addresses. The commercial mailing lists came closer to the Bureau's specific needs, and comparison studies of the leading commercial listings resulted in the ultimate selection of the occupant mailing list supplied by one firm. This list was used as the base in the special census of the New Haven, Conn., SMSA in 1967, and also provided the first test of the Bureau's computer programs for using an address register on tape. The master address file for New Haven was updated by clerical and computer matches with map corrections, addresses obtained by field listing, and changes obtained through a Post Office check. As a result of this test a number of modifications were made to the address register programs.

The 1970 census dress rehearsals conducted in Dane County (Madison SMSA), Wis., and Trenton, N.J., in 1968 provided additional test experience. In Madison both computer-generated and manually prepared address registers were used, while only the computer-generated registers were used in Trenton. For the Trenton test the addresses of "special places"--hotels, large boarding houses, institutions, etc.--were extracted clerically from the classified listings in the local telephone directory,

and were added to the master address list as part of the updating procedure. If a special place address was found to duplicate a residential address already on the master list, the latter was deleted.

Concurrent with the preparation of the 1970 master address file the Bureau developed ACG's (address coding guides) to provide geographic identification for the census data collected at the addresses in the master file. As the ACG's and the master file had to correspond as completely as possible, they were matched (i.e., compared) at several different stages of their development to make certain that changes made in one also appeared in the other. In the first of these matches the addresses on the commercial mailing list for each of the 145 "mail" SMSA's were compared by computer with the corresponding ACG's so that any coverage deficiencies in the ACG's could be detected. Subsequent matches took place after the advance Post Office check described below.

### Advance Post Office Check

The supplier of the commercial mailing list printed address labels for all of the addresses in the Bureau's master address file, which at this point consisted of approximately 33.9 million addresses. These labels were attached to cards which were sent to the Post Office on a flow basis for verification; local mail carriers checked the cards against the addresses and ZIP codes for all residential addresses on their city delivery routes and added, corrected, or deleted addresses as necessary. The carriers also reported duplicate cards and "nixies" (no such address, nonresidential address, undeliverable because of insufficient information, etc.). The advance Post Office check, so called because it was in advance of the census, began with test areas in February 1969 and continued through October 1969; an average of 8 million addresses per month were processed between May and August. (For further details, see chapter 4.) All of the cards were returned to the supplier, who made the necessary changes to the Bureau's master address file; approximately 9.4 million additions and corrections were involved. Of this number, 4.4 million were additions, 3.2 million were deletions, and 1.8 million were within-structure changes (e.g., apartment locations).

The number of changes was affected by such factors as the following: The addresses sent to the Post Office were from a commercial mailing list, the quality of which varied from area to area, depending to some extent on its commercial usefulness to the supplier. The primary purpose of this list for the supplier was the delivery of a piece of mail, and not the identification of a housing unit for possible personal followup as needed for the census. Therefore the advance Post Office check required a change whenever a post office box number or a family name without a street address was shown, or whenever separate living quarters within a multiunit structure were not identified by apartment number or location (front, rear, etc.). Further, to facilitate transfer of the commercial address list to census operations, additions or deletions had been stopped during the second half of 1968. (The supplier's employees involved in this project were covered by the confidentiality oath required of all Census Bureau employees, and, in conformity with

Title 13 of the U.S. Code which prohibits private use of materials obtained for purposes of taking the census, the corporation was not allowed to use the Post Office "adds" to update its own mailing lists.) As the Post Office changes were completed for the various SMSA's, the master address file was shipped to the Bureau in a series of computer tapes between May and November 1969.

### The Address Register Process

The address register process consisted of matching the master address file tapes to the ACG a second time, adjusting the matched result to exclude from the address registers those addresses outside the area designated for mail enumeration (resulting in a file containing approximately 31.4 million addresses), sorting the addresses into ED's for controlling the census returns, and preparing the final address registers, mailing label tapes, and control records. The actual process included five steps, as follows:

1. Controlling input.--Due to the size of the master address file, the inputs (the addresses, received either in State or SMSA order or a combination of the two) were sorted to agree with each file's Postal Finance numbers within State order. (The Postal Finance number identified the area served by one post office, and street codes were assigned uniquely within Postal Finance number.) Multi-State SMSA's (i.e., SMSA's with parts lying in more than one State) were split by State, and all SMSA's or parts of them for a State were sorted by Postal Finance group to coincide with the order of the master address file. In the event a single SMSA required processing a second time, the addresses for that SMSA were split from this file. For convenience in handling, some SMSA's were combined and processed as a unit; for example, the Detroit and Ann Arbor, Mich., SMSA's were processed together, but with each retaining its appropriate SMSA code. There was more than one tape for some large SMSA's (Los Angeles, Chicago, New York, etc.). The first SMSA was ready for further processing in August 1969, and the last SMSA was sorted in December 1969.

2. Additions and deletions.--Just prior to the next match with the ACG described below, the master address file, by State, was processed to reinstate the "nixie'd" addresses later determined to be acceptable (from the "nixie reinstate" tapes) and to delete those addresses determined to be outside the city delivery area (from the "range delete" tapes).

"Nixie reinstates" were addresses from the master address file determined by the Post Office not to be deliverable ("nixies") during the advance Post Office check but later identified as existing locations of residences during a second check. Approximately 115,000 addresses (5 percent of the addresses originally marked undeliverable) were returned to the master address file. The addresses were entered on punchcards at the Bureau's facility in Jeffersonville, Ind., and transmitted to Bureau headquarters at Suitland via

telephone datalink between July and December 1969. These records were in State order, but were sorted and split by Postal Finance group to coincide with the master address file grouping.

"Range deletes" were produced by the Bureau. The master address file was sorted into address ranges by streets; each range covered about 100 consecutive house numbers which were considered to constitute one city block. These so-called "hundreds range" records were matched to the ACG's to pick up the census geographic codes (block, tract, etc.), and those blocks considered to be outside the "blue line" area (see p. 17 above) were deleted. These deletions were also entered on punchcards in Jeffersonville and transmitted to Suitland via datalink between July and December 1969. The records were in State order, and were sorted and split by Postal Finance group.

3. Matching.--The ACG files, by SMSA or multi-SMSA, were processed to split the files by State and to merge the several State parts together. Matching by State took the individual addresses from the master address file and attempted to match them to records in the ACG with identical postal identification (Postal Finance number, ZIP code, street code, and house number). The geographic codes for State, county, SMSA, congressional district, etc., from the ACG record were assigned to each matched address. This process produced four tape outputs: (1) unmatched addresses (i.e., those which could not be coded geographically on the computer) which later were processed as "yellow cards" (i.e., Form D-180 "Tract and Block Follow-up Card" with a label attached on which the unmatched address was printed); (2) matched and coded standard-size addresses; (3) matched and coded oversize addresses (i.e., those which had postal identification other than street name and address, such as building names, apartments, box numbers, etc.); and (4) the unaltered ACG file, by State.

As further processing was to be accomplished on an SMSA basis, all the outputs of the match except the unmatched addresses were sorted by SMSA, and the several parts of each SMSA were merged. The match described above was accomplished between October and December 1969.

The matched addresses, by SMSA, were further refined by removing all the addresses still beyond the city delivery area as determined in the "tract and block delete" process, and by counting the number of housing units at each street address. "Tract and block deletes" were the product of a review of the maps for each SMSA, which indicated the tracts and blocks (rather than the address ranges) coded in the ACG that were actually outside the "blue line" (the boundary of the postal city delivery area). Address records which signaled these deletions were punched in Jeffersonville and transmitted to Suitland via datalink between July and December 1969; these address records were already grouped by SMSA and were processed without resorting. (The geographic records for the tracts and blocks were not removed from the ACG.) The computer program required the

delete records, the ACG file (by SMSA), and the matched standard-size address file (by SMSA) as inputs. There were four outputs, namely: (1) the deleted address records, printed out for review; (2) the ACG file with the tract and block records that were annotated as "C headers" to indicate they were outside the "blue line;" (3) the refined master address file with geographic codes; and (4) a listing of the number of housing units at each address.

4. Structuring.--"Structuring" consisted of grouping the addresses into ED's (enumeration districts), inserting a count of the number of housing units within the ED and within each address, merging the oversize addresses into the ED's, and identifying the sample addresses. The ED's ranged in size from 300 to 400 housing units; the size of an ED was further determined by the density of the housing units and the anticipated household size.

ED-structuring constants were prepared by the Bureau; the constants defined how many addresses were to be included in an ED in terms of codes that defined the geographic and numeric equivalents of housing units within a given State, county, and census district office area. A listing of these constants by SMSA was punched into special program cards (parameters) and fed by SMSA into the appropriate computer programs. Each SMSA listing was run separately on the computer through a series of three programs between July and December 1969 as follows:

Special constants for each SMSA were fed into the first program together with the corresponding ACG with its "C headers" and the tape containing the standard-size addresses that satisfactorily matched the ACG records. As determined by the constants, this program designated ED's by identifying the addresses in a series of consecutively numbered blocks which were to be assigned to a single enumerator. Each ED was assigned a unique number. The same unique number was assigned within a geographic framework to the ACG file.

The tape with the number of housing units at each address was fed into the second program. There the number of ED's within each combination of State, county, and district office was recorded on both the ACG and the address tapes; the number of housing units at each address also was recorded on the latter. The output of the second program was an ACG file with ED identification and counts which, in turn, was used as input to four programs used to produce the control listings.

The oversize-address tape was fed into the third program which inserted these oversize addresses into the master address file, and then split the master file into four outputs as follows:

"Special place" listings and mailing labels covering addresses where an enumeration routine different from the mail-out/mailback procedure was required, such as at military or naval installations, prisons, nursing homes,

etc. These listings and labels were sent to the census operations office in Jeffersonville for processing.

Address tapes, by SMSA, that were further processed by computer to produce the control counts and, ultimately, the mailing labels. This processing included (1) indicating the type of questionnaire to be sent to each housing unit, (2) editing to verify the correctness of the number of each type of questionnaire--i.e., that the proper sample size was maintained for each ED, and (3) producing the control counts that helped determine the *completeness* of the label file and to make certain that all of the address labels were actually produced in the ensuing "videograph" process. Beginning in October 1969 the label tapes were shipped to a private contractor for production of approximately 31.4 million labels. These were attached to the appropriate mailing packages. (For details, see chapter 4.)

The actual address registers (see fig. N), approximately 95,500 in number (one for each computer-generated ED), edited clerically for correctness and completeness and then sent to the field offices for use.

The master address file, held for future processing.

5. Directories.--Three outputs were produced by running each ACG with its appropriate ED-counts tape on the computer, as follows:

The block header record (see fig. O.), which was an alphabetic street name listing for each census district office by ZIP code, by odd-even house number range, by housing unit serial number range, and by block number; 5,177 block header records were sent to the appropriate field offices.

The ED directory (see fig. P), which was a list of the tract and block numbers in each ED; the ED's were in numerical order by district office. This listing was in two parts, differing only in that the State and county codes were not in the 1,432 directories sent to the field; the complete listing, known as the ED Directory to Plot, was retained in the Bureau for geographic coding purposes.

The tract and block directory (see fig. Q), which was a list of tract and block numbers and their appropriate ED's for each district office in an SMSA; 2,657 directories were distributed to the field offices.

## Problems

The Bureau had generated address registers by computer for several well controlled single-city or SMSA pretests of the 1970 census, but never before on a national scale. A number of closely linked computer processes were required, and constant control was necessary to prevent and detect errors in the system. The original time schedule for creation of the tape

address registers was based on limited experience; the quality of the materials to be received could not be gauged, and most of the problems to be encountered in the larger, national operation could not be anticipated.

Because of delays in completing the ACG's (in which the residual errors were more numerous than expected) the address register time schedule had to be shortened. This shortening tended to increase the number of errors carried over to the registers, and additional programming was required to correct errors in SMSA, county, ZIP, district office codes, etc. District office and enumeration district boundaries affecting the computer-generated ED's were being changed up to and during preparation of the address registers; each change required computer program modifications as well as correction of input parameters. Many areas had specific code problems which required additional program changes.

New addresses resulting from the advance Post Office check were not added to the address coding guides for some areas due to lack of time. It was assumed that these addresses would be added by hand through the "yellow card" operation, in which tract and block numbers were assigned in the field. The "yellow card" operation was many times larger than anticipated (see p. 40 above and chapter 5, "The Field Enumeration"), and even though a sizable clerical operation was undertaken within the Bureau to code these addresses from available reference materials, time pressures did not permit adding all of them to the address registers before the field enumeration began.

Since time was critical, some errors--such as duplication of addresses--were accepted in the printed address registers. A clerical operation was maintained to delete as many errors as possible; it was assumed that the remaining errors would be caught when mail carriers reported discrepancies at the time they delivered the addressed questionnaires to the households.

A specific process for printing the address registers and control files was selected on the basis of a workload estimate that proved to be too low. The printing process and its control were unwieldy for the actual amount of printing to be done, and further delays were experienced as a result. While all printing of the initial address registers and related materials was completed by the first week in February 1970, shipping of them to the field required several more days, and a number of district offices were opened meanwhile without these essential items.

### Costs

The following costs, charged to a separate Bureau program called "Address Register Preparation" rather than to geographic work, cover the preparation of the address registers from the initial purchase of the commercial mailing list through storage of the completed registers. Figures are rounded. (See also p. 2.)

Total.....	<u>\$6,831,000</u>
City delivery address list, procurement....	794,000
Address registers, general planning.....	<sup>1</sup> 284,000
Preliminary match of ACG and census headers	<sup>2</sup> 563,000
Preparation of work units and lists.....	26,000
Advance Post Office check, Census Bureau...	274,000
Advance Post Office check, Post Office.....	2,899,000
Advance Post Office check, contractor.....	698,000
"Nixie" review, Census Bureau.....	21,000
"Nixie" review, contractor.....	23,000
Special place operation.....	62,000
Establishment and printing of address registers.....	<sup>3</sup> 1,099,000
Preparation of address registers for delivery.....	70,000
Address register and address tape storage..	18,000

<sup>1</sup>Includes \$86,000 for contractual work.

<sup>2</sup>Includes \$52,000 for contractual work.

<sup>3</sup>Includes preparation of address label tapes.

Figure N. Example of Computer-Generated Address Register Page

The symbols ( $\Delta$ ,  $\bullet$ ) in col. 5 indicated that the household received a sample questionnaire; in col. 9 a check mark showed that a completed questionnaire had been received and a "T" that the household had been interviewed by telephone.

Street (1)	House No. (2)	Apartment number or other location description (3)	Last name of head of household (4)	Type of form (5)	No. of units at address (6)	Block No. (7)	Serial No. (8)	Mail return (9)	Number of persons (10)	Remarks (11)	
LEGION AV	20	APT 1	<i>Burns</i>		3	101	001	✓			
LEGION AV	20	APT 2	<i>Chadwick</i>		3	101	002	✓			
LEGION AV	20	APT 3			3	101	003				
LEGION AV	22				1	101	004				
LEGION AV	24		<i>Silver 362-5891</i>	$\Delta$	1	101	005				
LEGION AV	26				1	101	006				
LEGION AV	28				1	101	007	✓			
LEGION AV	30				1	101	008	✓			
LEGION AV	32				1	101	009	✓			
LEGION AV	36		<i>Adams 448-2000</i>	$\bullet$	1	101	010				
LEGION AV	38		<i>Jones 448-2111</i>		1	101	011				
LEGION AV	40		<i>Bell 448-2233</i>		1	101	012	T			
LEGION AV	42	APT 1	<i>Merle 448-3585</i>		2	101	013	T			
LEGION AV	42	APT 2	<i>Globe 448-6211</i>		2	101	014	T			
LEGION AV	46			$\Delta$	1	101	015	✓			
LEGION AV	50				1	101	016	✓			
LEGION AV	52				1	101	017	✓			
LEGION AV	54				1	101	018				
LEGION AV	56				1	101	019	✓			
LEGION AV	62	APT 1		$\Delta$	2	101	020				
LEGION AV	62	APT 2			2	101	021				
ASYLUM ST	105				1	102	022	✓			
ASYLUM ST	107				1	102	023				
ASYLUM ST	109	APT 1	<i>W/cont 448-8998</i>		2	102	024	T			
ASYLUM ST	109	APT 2	<i>Cristy 440-1667</i>	$\Delta$	2	102	025				
a. ED No.	296	b. ED Page No.	1	OF	16	U.S. DEPARTMENT OF COMMERCE BUREAU OF THE CENSUS					TOTAL PERSONS THIS PAGE
ADDRESS REGISTER - City Delivery Areas 19th Decennial Census - 1970											

Source: Form D-648-2, Enumerators Training Workbook, p.4.

Figure O. Example of Page from Form D-223, "Block Header Record"

ZIP CODE	STREET NAME	HOUSE NO. RANGE		SERIAL RANGE		E. D. NO.	TRACT NUMBER	BLOCK NUMBER
		FIRST	LAST	FIRST	LAST			
08609	GARFIELD AV	2	28	022	027	96	22	203
08609	GARFIELD AV	29	99	001	020	97	22	215
08609	GARFIELD AV	30	95	021	032	97	22	216
08609	GARFIELD AV	100	162	196	218	97	22	305
08609	GARFIELD AV	101	153	219	246	97	22	306
08609	GARFIELD AV	155	199			98	22	405
08609	GARFIELD AV	164	196			98	22	406
08609	GILL AL	1	19			24	9	113
08609	GILL AL	2	4			23	9	111
08609	GILL AL	6	20			24	9	112
08609	GRANT AV	1	65	057	069	88	20	205
08609	GRANT AV	2	66	015	031	88	20	204
08609	GRANT AV	9-15	9-15			88	20	205
08609	GREENWOOD AV	152	398			27	9	221
08609	GREENWOOD AV	301	399	023	035	27	9	220
08609	GREENWOOD AV	400	502	497	530	94	21	606
08609	GREENWOOD AV	800	898	481	507	91	21	111
08609	GREENWOOD AV	891	931			92	21	212

District Office Number

Figure P. Example of Page from Form D-224, "ED Directory"

E.O. NUMBER	NUMBER OF HOUSING UNITS	METHOD OF PAYMENT CODE	TRACT NUMBER	BLOCK NUMBERS	AREA	SPEC PLAC
* 901	0	1	0076	*402	255	0
902	29	1	0048	609 610	010	0
903	2	1	0054	504	060	0
904	133	1	002402	106	065	0
905	586	1	0046	101 102 103 105 108 111	065	0
				205 208		
906	394	1	0046	209 210 211 301 303 304	065	3
				*310 *401 402 403 405 409		
907	574	2	0047	101 102 103 104 105 106	065	1
				107 108 109 110 112 113		
				114 115 116 117 118 201		
				202 203 204 205 206 207		
				208 211 212 213 214 215		
				216 217 218 220 221 222		
				301 302 303 304 307 308		
				309 310		

D.O. 262 District office number

SMSA code number

SMSA 5600

Figure Q. Example of Page from Form D-225, "Tract and Block Directory"

TRACT NUMBER	BLOCK NUMBERS															E. D. NUMBER									
	207	208	209	210	301	302	303	304	305	306	307	308	309	310	311										
12	207	208	209	210	301	302	303	304	305	306	307	308	309	310	311	312	*314	315	*316	317	318	401	402	51	
12	403	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	*421	422					52	
13	101	102	103	104	105	106	107	108	109	110	111	112	113											53	
13	201	202	203	204	205	206	207	*208	301	302	303	304	305	306	307	308	309	310	311	312	313	401	*402	404	54
14	404	405	*406	407	408	409																		59	
14	408	501	502	503	504	505																		60	

District office number

0301

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## APPENDIX A

## 1970 Census Divisions in Alaska, With Equivalent 1970 and 1960 Election Districts

1970 census divisions	1970 election districts	1960 election districts
Prince of Wales Ketchikan and Outer Ketchikan	1. Ketchikan-Prince of Wales	1. Prince of Wales 2. Ketchikan
Wrangell-Petersburg and small part of Sitka*	2. Wrangell-Petersburg	3. Wrangell-Petersburg
Most of Sitka and part of Angoon***	3. Sitka	4. Sitka
Juneau and part of Angoon***	4. Juneau	5. Juneau
Haines and Skagway-Yakutat**	5. Lynn Canal-Icy Straits	6. Lynn Canal-Icy Straits
Cordova-McCarthy Valdez-Chitina-Whittier**	6. Cordova-Valdez	7. Cordova-McCarthy 8. Valdez-Chitina-Whittier
Matanuska-Susitna and small part of Anchorage***	7. Palmer-Wasilla-Talkeetna	9. Palmer-Wasilla-Talkeetna
Most of Anchorage***	8. Anchorage	10. Anchorage
Seward**	9. Seward	11. Seward
Kenai-Cook Inlet**	10. Kenai-Cook Inlet	12. Kenai-Cook Inlet
Kodiak and small part of Bristol Bay*	11. Kodiak	13. Kodiak
Aleutian Islands	12. Aleutian Islands	14. Aleutian Islands
Bristol Bay Borough and most of Bristol Bay***	13. Bristol Bay	15. Bristol Bay
Bethel	14. Bethel	16. Bethel
Kuskokwim**	15. Yukon-Kuskokwim	17. Kuskokwim 18. Yukon-Koyukuk
Yukon-Koyukuk and small part of Fairbanks***	16. Fairbanks-Fort Yukon	19. Fairbanks 20. Upper Yukon
Southeast Fairbanks and most of Fairbanks*** Upper Yukon**	17. Barrow-Kobuk	21. Barrow 22. Kobuk
Barrow Kobuk	18. Nome	23. Nome
Nome	19. Wade Hampton	24. Wade Hampton
Wade Hampton		

\* The relationship of the areas in the second and third columns to the first column is imprecise to a degree that the compilation of accurate population totals for election districts in 1970 would have been difficult. To avoid this difficulty the Bureau established enumeration district (ED) boundaries so that accurate population totals for the election districts could be derived from unpublished census statistics. Of approximately 300 ED's in the State, about six ED's were required to recognize these parts.

\*\* The relationship of the areas of the 1960 and 1970 election districts to the census divisions is imprecise, but the areas involved in the differences are believed to contain little or no population.

\*\*\* A combination of the two relationships described in \* and \*\* above.

## APPENDIX B

### Computation of the 1970 U.S. Center of Population

The concept of the center of population as traditionally used by the Bureau is that of a balance point; that is, the center of population is the point at which an imaginary, flat, weightless and rigid map of the United States would balance if weights of identical size were placed on it so that each weight represented the location of one person on April 1, 1970.

The computation of the center of population by the Bureau of the Census was based on approximately 250,000 small geographic areas for which centers of population had been estimated for another work program. The population centers and the population counts for each of these areas were recorded on punched cards and then transferred to magnetic tape for processing through an electronic computer. The "program" introduced into the computer controlled the mathematical processes which the computer executed.

To avoid unduly complex factors in the computation, the mathematical formulae that were used are those that would be precise for a true sphere. On such a sphere the north-south distances between parallels of latitude are identical and distances in degrees may be used as units of distances. On the other hand, distances between meridians or longitude lines, are not constant but decrease from the equator toward the poles. However, if the length of one degree along the equator is used as the unit of measurement, then the length in degrees of an east-west line at any other latitude can be adjusted to the measurement standard by multiplying by the cosine of the latitude.

The center of population computed by the Bureau is the point whose latitude ( $\bar{\lambda}$ ) and longitude ( $\bar{L}$ ) satisfy the equations

$$\bar{\lambda} = \frac{\sum w_i \lambda_i}{\sum w_i}$$

$$\bar{L} = \frac{\sum w_i L_i \cos \lambda_i}{\sum w_i \cos \lambda_i}$$

where  $\lambda_i$ ,  $L_i$ ,  $w_i$  are the latitude, longitude, and population attached to the basic small units of area used in the computation.

Stated in less mathematical form, the latitude of the center of population was determined by multiplying the population of each unit of area by the latitude of its population center, by then adding all of these products, and by dividing this total by the total population of the United States. The result is the latitude of the population center.

East-west distances were measured, or computed, in a substantially different fashion. For these distances a degree of longitude at the equator was the unit of measurement. East-west distances along the equator could be measured in degrees but any east-west degree distance north of the equator--where all the United States is located--had to be adjusted to recognize the convergence of meridians towards the poles. The adjustment required that each east-west distance, stated in degrees of longitude, be multiplied by the cosine of the latitude. This mathematical relationship is precise for a sphere and a very close approximation for the earth.

The computation required that the longitude of each of the 250,000 points be multiplied by the cosine of the latitude of the point and by the population associated with the point. These products--250,000 of them--were added and divided by the sum of another 250,000 products each of which was obtained by multiplying the cosine of the latitude of a point by the appropriate population figure. The result was the longitude of the center of population.

## APPENDIX C

## Standard Metropolitan Statistical Areas (SMSA's) Recognized as of April 1, 1970, for Which Address Coding Guides (ACG's) Were Prepared for Geographic Coding

Area	Number of records <sup>1</sup>	Area	Number of records <sup>1</sup>
Total number of records in the ACG program..	5,530,038	56. Boston, Mass.....	124,963
Total number of records for 147 SMSA's....	5,497,304	57. Brockton, Mass.....	7,713
Records prepared for other areas <sup>2</sup> .....	32,734	58. Fall River, Mass.-R.I.....	5,939
1. Birmingham, Ala.....	42,665	59. Fitchburg-Leominster, Mass.....	8,981
2. Mobile, Ala.....	22,586	60. Lawrence-Haverhill, Mass.-N.H.....	13,019
3. Phoenix, Ariz.....	53,022	61. Lowell, Mass.....	11,652
4. Anaheim-Santa Ana-Garden Grove, Calif.....	57,688	62. New Bedford, Mass.....	3,727
5. Los Angeles-Long Beach, Calif.....	286,569	63. Pittsfield, Mass.....	29,445
6. Oxnard-Ventura, Calif.....	20,150	64. Springfield-Chicopee-Holyoke, Mass.-Conn...	17,303
7. Sacramento, Calif.....	36,191	65. Worcester, Mass.....	
8. San Bernardino-Riverside-Ontario, Calif.....	46,125	66. Ann Arbor, Mich.....	(included with Detroit)
9. San Diego, Calif.....	70,890	67. Bay City, Mich.....	7,570
10. San Francisco-Oakland, Calif.....	132,029	68. Detroit, Mich.....	196,853
11. San Jose, Calif.....	44,578	69. Flint, Mich.....	24,657
12. Stockton, Calif.....	11,847	70. Grand Rapids, Mich.....	19,048
13. Vallejo-Napa, Calif.....	5,859	71. Jackson, Mich.....	7,228
14. Denver, Colo.....	62,837	72. Kalamazoo, Mich.....	10,052
15. Bridgeport, Conn.....	21,908	73. Lansing, Mich.....	13,399
16. Hartford, Conn.....	20,024	74. Muskegon-Muskegon Heights, Mich.....	10,578
17. Meriden, Conn.....	6,233	75. Saginaw, Mich.....	12,428
18. New Britain, Conn.....	9,155	76. Minneapolis-St. Paul, Minn.....	96,381
19. New Haven, Conn.....	15,349	77. Kansas City, Mo.-Kans.....	69,085
20. New London-Groton-Norwich, Conn.....	6,684	78. St. Louis, Mo.-Ill.....	104,209
21. Norwalk, Conn.....	7,881	79. Omaha, Nebr.-Iowa.....	35,648
22. Stamford, Conn.....	11,790	80. Atlantic City, N.J.....	13,659
23. Waterbury, Conn.....	8,830	81. Jersey City, N.J.....	20,040
24. Wilmington, Del.-N.J.-Md.....	19,625	82. Newark, N.J.....	57,011
25. Washington, D.C.-Md.-Va.....	108,755	83. Paterson-Clifton-Passaic, N.J.....	50,298
26. Fort Lauderdale-Hollywood, Fla.....	43,242	84. Trenton, N.J.....	15,493
27. Jacksonville, Fla.....	43,297	85. Albany-Schenectady-Troy, N.Y.....	27,501
28. Miami, Fla.....	82,262	86. Buffalo, N.Y.....	39,874
29. Orlando, Fla.....	28,351	87. New York, N.Y.....	286,825
30. Pensacola, Fla.....	14,409	88. Rochester, N.Y.....	26,049
31. Tallahassee, Fla.....	6,897	89. Syracuse, N.Y.....	17,731
32. Tampa-St. Petersburg, Fla.....	85,729	90. Utica-Rome, N.Y.....	9,843
33. West Palm Beach, Fla.....	26,313	91. Charlotte, N.C.....	24,489
34. Atlanta, Ga.....	55,802	92. Durham, N.C.....	9,065
35. Savannah, Ga.....	14,906	93. Greensboro-Winston-Salem-High Point, N.C...	29,967
36. Bloomington-Normal, Ill.....	4,628	94. Raleigh, N.C.....	9,715
37. Champaign-Urbana, Ill.....	6,347	95. Akron, Ohio.....	40,122
38. Chicago, Ill.....	267,873	96. Canton, Ohio.....	27,115
39. Decatur, Ill.....	7,612	97. Cincinnati, Ohio-Ky.-Ind.....	49,088
40. Peoria, Ill.....	16,127	98. Cleveland, Ohio.....	67,051
41. Rockford, Ill.....	14,860	99. Columbus, Ohio.....	39,639
42. Springfield, Ill.....	7,897	100. Dayton, Ohio.....	36,514
43. Anderson, Ind.....	7,138	101. Hamilton-Middletown, Ohio.....	9,807
44. Fort Wayne, Ind.....	15,291	102. Lima, Ohio.....	5,430
45. Gary-Hammond-East Chicago, Ind.....	27,981	103. Lorain-Elyria, Ohio.....	10,321
46. Indianapolis, Ind.....	48,238	104. Mansfield, Ohio.....	5,116
47. Muncie, Ind.....	7,254	105. Springfield, Ohio.....	7,088
48. South Bend, Ind.....	17,659	106. Steubenville-Weirton, Ohio-W. Va.....	7,500
49. Terre Haute, Ind.....	8,268	107. Toledo, Ohio-Mich.....	27,931
50. Davenport-Rock Island-Moline, Iowa-Ill.....	19,874	108. Youngstown-Warren, Ohio.....	25,952
51. Topeka, Kans.....	10,136	109. Oklahoma City, Okla.....	36,595
52. Wichita, Kans.....	25,867	110. Tulsa, Okla.....	28,613
53. Louisville, Ky.-Ind.....	39,191	111. Eugene, Oreg.....	11,449
54. New Orleans, La.....	54,277	112. Portland, Oreg.-Wash.....	87,142
55. Baltimore, Md.....	71,647	113. Allentown-Bethlehem-Easton, Pa.-N.J.....	36,188
		114. Altoona, Pa.....	6,273
		115. Harrisburg, Pa.....	22,142

See footnotes at end of table.

**Standard Metropolitan Statistical Areas (SMSA's) Recognized as of April 1, 1970, for Which Address Coding Guides (ACG's) Were Prepared for Geographic Coding—Continued**

Area	Number of records <sup>1</sup>	Area	Number of records <sup>1</sup>
116. Johnstown, Pa.....	8,983	132. Houston, Tex.....	101,746
117. Lancaster, Pa.....	6,077	133. San Antonio, Tex.....	49,371
118. Philadelphia, Pa.-N.J.....	208,316	134. Ogden, Utah.....	8,490
119. Pittsburgh, Pa.....	104,494	135. Salt Lake City, Utah.....	32,045
120. Reading, Pa.....	13,428	136. Newport News-Hampton, Va.....	12,270
121. Scranton, Pa.....	16,898	137. Norfolk-Portsmouth, Va.....	42,703
122. Wilkes-Barre-Hazleton, Pa.....	13,085	138. Richmond, Va.....	31,657
123. York, Pa.....	9,535	139. Seattle-Everett, Wash.....	91,258
124. Providence-Pawtucket-Warwick, R.I.-Mass.....	76,642	140. Tacoma, Wash.....	28,108
125. Memphis, Tenn.-Ark.....	37,698	141. Wheeling, W. Va.-Ohio.....	8,672
126. Nashville, Tenn.....	24,195	142. Vineland-Millville-Bridgeton, N.J.....	5,960
127. Beaumont-Port Arthur-Orange, Tex.....	21,893	143. Green Bay, Wis.....	8,628
128. Dallas, Tex.....	75,060	144. Kenosha, Wis.....	7,635
129. El Paso, Tex.....	20,661	145. Madison, Wis.....	14,711
130. Fort Worth, Tex.....	71,238	146. Milwaukee, Wis.....	62,597
131. Galveston-Texas City, Tex.....	11,351	147. Racine, Wis.....	8,742

<sup>1</sup>Each record represents one block face. As the number of block faces per block varied, and there was no computer edit to calculate the number of blocks, the total numbers of blocks can only be estimated.

<sup>2</sup>ACG's also were prepared for two areas that were not recognized as SMSA's at this time; these were (1) Appleton-Oshkosh-Fond du Lac, Wis., 17,811 records, and (2) New Brunswick (Middlesex County), N.J., 14,923 records.

## APPENDIX D

## Standard Metropolitan Statistical Areas (SMSA's) Enumerated by Conventional Census Procedures for Which DIME (Dual Independent Map Encoding) Files Were Prepared for Place-of-Work Coding

SMSA	Number of blocks in file	Number of segments coded	SMSA	Number of blocks in file	Number of segments coded
Total.....	199,360	753,835	40. Lincoln, Nebr.....	3,236	10,554
1. Gadsden, Ala.....	2,198	7,533	41. Las Vegas, Nev.....	3,362	12,635
2. Huntsville, Ala.....	1,989	9,146	42. Reno, Nev.....	1,727	7,603
3. Montgomery, Ala.....	2,186	6,852	43. Manchester, N.H.....	1,764	7,588
4. Tuscaloosa, Ala.....	1,536	6,426	44. Albuquerque, N. Mex.....	5,193	20,249
5. Tucson, Ariz.....	5,121	18,805	45. Binghamton, N.Y.-Pa.....	2,113	8,500
6. Fort Smith, Ark.-Okla.....	2,079	6,706	46. Asheville, N.C.....	1,389	7,906
7. Little Rock-North, Little Rock, Ark	4,734	18,712	47. Fayetteville, N.C.....	1,651	7,626
8. Pine Bluff, Ark.....	1,646	6,302	48. Fargo-Moorhead, N. Dak.....	1,461	4,416
9. Bakersfield, Calif.....	2,907	9,975	49. Lawton, Okla.....	1,215	3,996
10. Fresno, Calif.....	4,175	16,071	50. Salem, Oreg.....	1,842	5,090
11. Salinas-Monterey, Calif.....	2,429	9,243	51. Erie, Pa.....	2,626	9,138
12. Santa Barbara, Calif.....	1,615	8,156	52. Charleston, S.C.....	3,105	14,613
13. Colorado Springs, Colo.....	2,795	12,906	53. Columbia, S.C.....	4,009	16,596
14. Pueblo, Colo.....	2,291	7,325	54. Greenville, S.C.....	2,386	7,357
15. Albany, Ga.....	1,274	4,916	55. Sioux Falls, S. Dak.....	1,679	5,221
16. Augusta, Ga.-S.C.....	2,392	10,937	56. Chattanooga, Tenn.-Ga.....	5,089	19,275
17. Columbus, Ga.-Ala.....	2,751	12,290	57. Knoxville, Tenn.....	3,528	14,761
18. Macon, Ga.....	2,696	10,343	58. Abilene, Tex.....	2,102	6,813
19. Honolulu, Hawaii.....	3,158	20,320	59. Amarillo, Tex.....	3,863	10,457
20. Boise City, Idaho.....	2,137	8,326	60. Austin, Tex.....	3,911	15,105
21. Evansville, Ind.-Ky.....	2,542	8,729	61. Brownsville-Harlingen-San Benito, Tex.....	2,417	9,225
22. Cedar Rapids, Iowa.....	2,090	8,288	62. Corpus Christi, Tex.....	3,167	11,850
23. Des Moines, Iowa.....	4,240	15,910	63. Laredo, Tex.....	1,930	5,278
24. Dubuque, Iowa.....	807	3,057	64. Lubbock, Tex.....	3,190	10,358
25. Sioux City, Iowa-Nebr.....	2,254	7,692	65. McAllen-Pharr-Edinburg, Tex.....	2,301	7,236
26. Waterloo, Iowa.....	2,178	8,313	66. Midland, Tex.....	2,132	5,966
27. Lexington, Ky.....	1,593	7,971	67. Odessa, Tex.....	2,498	7,264
28. Baton Rouge, La.....	3,683	14,098	68. San Angelo, Tex.....	1,457	5,598
29. Monroe, La.....	2,077	7,147	69. Sherman-Denison, Tex.....	1,781	6,544
30. Shreveport, La.....	3,679	13,984	70. Texarkana, Tex.-Ark.....	1,980	7,251
31. Lewiston-Auburn, Maine.....	1,238	4,751	71. Tyler, Tex.....	1,503	5,772
32. Portland, Maine.....	2,256	8,692	72. Waco, Tex.....	3,394	11,527
33. Duluth-Superior, Minn.-Wis.....	3,119	12,608	73. Wichita Falls, Tex.....	1,927	7,303
34. Biloxi-Gulfport, Miss.....	1,507	5,530	74. Provo-Orem, Utah.....	1,309	6,252
35. Jackson, Miss.....	2,701	11,570	75. Lynchburg, Va.....	1,059	4,428
36. St. Joseph, Mo.....	2,192	7,817	76. Roanoke, Va.....	3,054	11,325
37. Springfield, Mo.....	2,490	9,048	77. Spokane, Wash.....	6,559	20,386
38. Billings, Mont.....	1,458	7,002	78. Charleston, W. Va.....	2,135	8,720
39. Great Falls, Mont.....	1,465	5,298	79. Huntington-Ashland, W. Va-Ky.-Ohio.....	2,638	7,258

## Appendix E.

### Principal Computer Programs Used (in Order) for Preparing Address Coding Guides (ACG's)

1. FP (FOSDIC Preparation) Code Edit--This computer edit determined the acceptability of further computer processing of the ACG data recorded in the FOSDIC process. The program also reformatted the data for subsequent computer runs. If more than 0.5 percent of the data were rejected, the file was reviewed clerically.

2. MERCY--In this computer program the new data tapes, the new street listings, and the basic ACG tape used to produce the original FOSDIC worksheets were merged, and the data were matched for consistency. Again, if more than 0.5 percent of the records were rejected, the file was reviewed and corrected clerically. The resultant tape was known as the "K20" or master edit file.

3. Hundreds Range Match--This computer operation consisted of matching a summarization of the addresses from the commercial mailing list with the address ranges found in the master edit file to make certain that all addresses in the list were covered by the ACG. A match occurred when a header (or address range entry) was found on the "K20" tape that agreed with a range of addresses on the mailing list. (A match also was achieved when an address range on the "K20" tape could be adjusted to agree with or include an address on the mailing list.) The computer run produced four output listings of unmatched records, as follows:

- a. Unmatched Street Segment Header Listing--a listing of the records that were contained in the mailing list but not in the ACG.
- b. ACG Unmatched Street Segment Header Listing--a listing of the records which were in the ACG but not in the mailing list.
- c. Two sets of hundreds range address labels which showed the low-to-high address range for a street segment covered by a mailing list header record for each address in the unmatched street

segment header listing (a) above. One set was separated into individual labels which were attached to Forms D-227, Unmatched Address Range Cards, and the other set was retained as a control file.

d. 90M Street Codes Listing--a listing of new streets with street codes temporarily assigned by local and Bureau coders in the 70,000, 80,000, and 90,000 ranges. This list was forwarded to the mailing list contractor for assignment of permanent street code numbers and then was returned to the Bureau in the form of new "headers" for processing.

4. DEPEND--A list of acceptable geographic codes was prepared, reviewed, updated, and placed on tape. In a computer run the DEPEND edit compared each record on the ACG "K20" tape with the acceptable codes tape, to determine which records could legitimately be included in the file as they had been coded.

5. ACG ED2--An edit in which the computer checked the records for overlaps, parity errors, reversals, high-low address range errors, justification, etc.

The DEPEND (later revised and called NUEDIT) and ACG ED2 edit programs produced an error tally table which presented by type and grouping (address ranges, general geography such as tract and block, postal geography, etc.) all of the records that could not be merged. Acceptance generally was governed by a limit of a 0.5 percent rejection of records with unacceptable entries in the tract and block coding fields, and by an over-all rejection rate for the entire tape of not more than 2.0 percent. If these tolerances were exceeded the file was reviewed, corrected, and recycled through the DEPEND and ACG ED2 edits as necessary--usually after changes resulting from the advance Post Office check.

## APPENDIX F

### Principal Computer Programs Used (in Order) for Preparing DIME Files

1. Block Chaining Edit--This computer edit chained the street segments from node to node around each block and checked the segments for duplicates, reversals, meshes (the same boundary node numbers appearing on three or more segment records), and missing segments. The first program written was limited to a maximum of 851 tract boundary segments and to blocks which had no more than 50 interior segments. A second program expanded this capacity as far as the number of boundary segments was concerned, but no effective edits were developed which easily detected errors in interior block segments, particularly in those blocks with large numbers of interior segments.

(Originally it was planned to perform a node edit as well. While each edit had its distinctive advantages, the functions of the block chaining and node edits were adjudged to be sufficiently similar that a choice could be made between the two if it was necessary to keep costs to a minimum. After testing both edits on the first few files received, the block chaining edit was selected as more suited to the over-all needs of the census.)

2. Address Chaining Edit--This computer edit checked for breaks in street continuity, similar parity (all addresses odd or all even numbers) on individual segment halves, opposit parity accross segment (all the odd-numbered addresses on one side of the street and all the even-numbered addresses on the other side), consistent parity along each street side for its entire length, address overlaps, and changes in address patterns. (This edit

was run at the same time as the block chaining edit. Early in 1970 the address edit was suspended to reduce costs and processing time, despite its contribution to file quality. However, a test conducted with the Laredo, Tex., DIME file indicated that when the address chaining edit was run after the block chaining edit had been run and corrected, the outgoing error rate on the DIME file was reduced from 5.5 percent to 0.35 percent. A simple address range edit therefore was instituted, and 5.0 percent was adopted as the maximum error level acceptable after both of these errors had been corrected. (The combined error rate was the sum of the block error rate (from the block chaining edit) and the segment error rate (from the address range edit).)

3. Geographic Codes--This edit verified the block and area codes associated with a given tract. A match of these codes was built into the block chaining edit in October 1969, and this separate geographic codes edit was eliminated at that time.

4. HLC (High Level Code) Insertion--This program matched the SMSA, area, and tract codes on individual records in the DIME file with the appropriate State, county, congressional district, MCD, place, and census district office codes from the 1970 census master reference file (see text, p. 35). The geographic codes through the State level were added to the DIME file if the match occurred. Unmatched cases were subjected to clerical review, correction, and recycling as necessary.