Census 2000 Testing, Experimentation,
And Evaluation Program September 26, 2003

Topic Report Series, No. 8

Address List Development in Census 2000

Quality assurance procedures were applied throughout the creation of this report.

This topic report integrates findings and provides context and background for interpretation of results from Census 2000 evaluations, tests, and other research undertaken by the U.S. Census Bureau. It is part of a broad program, the Census 2000 Testing, Experimentation, and Evaluation Program, designed to assess Census 2000 and to inform 2010 Census planning.

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The Census 2000 Testing, Experimentation, and Evaluation Program provides measures of effectiveness for the Census 2000 design, operations, systems, and processes and provides information on the value of new or different methodologies. The results and recommendations from these analyses provide valuable information crucial to planning the 2010 Census. By providing measures of how well Census 2000 was conducted, this program fully supports the Census Bureau's strategy to integrate the 2010 planning process with ongoing Master Address File/TIGER enhancements and the American Community Survey. The purpose of the report that follows is to synthesize results from related Census 2000 evaluations, experiments, and other assessments to make recommendations for planning the 2010 Census. Census 2000 Testing, Experimentation, and Evaluation reports are available on the Census Bureau's Internet site at: http://www.census.gov/pred/www/.

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1. INTRODUCTION

The purpose of the report that follows is to synthesize results of address list development in Census 2000 from evaluations, experiments, and other assessments and to make recommendations for planning the 2010 Census.

There are additional topic reports that address subjects that have some overlap with the information contained in the Address List Development Topic Report:

- The Coverage Improvement Topic Report describes decennial operations and programs from Census 2000 that substantively influenced census coverage. This includes coverage improvements from enumeration operations that are also discussed in this topic report.

- The Coverage Measurement Topic Report describes the efforts to measure coverage in Census 2000, including the coverage of housing units.

- The Special Place/Group Quarters Topic Report describes the address list development for special places and group quarters in Census 2000.

- The Data Collection Topic Report describes the successes and challenges of field data collection in Census 2000. This includes operations that impacted address list development in Census 2000.

To evaluate the address list development process, we looked at all of the operations that contributed to the address list individually and as a group. We also looked at the overall quality of the final census results. Therefore, the results in this report are presented in three sections:

- Individual operation evaluations (Section 2)
- Combined operation evaluations (Section 3)
- Coverage and quality evaluations of the final census results (Section 4)

There were sixteen formal evaluations that fed into this topic report. They provided assessments of each of the address list development operations and they provided information about the coverage and quality of the final census results, including geocoding error. We conducted analysis of the combined impact of the various operations specifically for this topic report; this analysis does not come from any other formal evaluation. In addition, we also used planning documents, operational assessments, and summary documents as input to this topic report. Finally, we used information from a survey of local governments that was not formally part of the Census 2000 Evaluation Program.

Section 5 summarizes the lessons learned and recommendations provided elsewhere in this document.

The individual operation evaluations in Section 2 and the combined operation evaluations in Section 3 start with the assumption that the final census results are accurate. That is, the addresses that ended up in the final census count should have ended up in the final census count. Similarly, these evaluations assume that addresses left out of the final census count should have been left out of the final census count. We know that there are errors in the final census results, but our initial evaluation of operations does not consider this fact. The coverage and quality evaluations of the final census results in Section 4 then provide us with an overall picture of the accuracy of the final product. In some cases, we are able to say things about individual operations through these coverage and quality evaluations; however the design of programs like the Housing Unit Coverage Study are not intended to provide sufficient data to assess individual operations. In Section 4, we also provide estimates of geocoding error in the census.

1.1 Master Address File Overview

This section provides a high level overview of the Master Address File (MAF). See Appendix A for a detailed description of how the address list was developed in Census 2000.

To enumerate and tabulate Census 2000, the Census Bureau identified all living quarters and located these living quarters with respect to the geographic entities for which it reports data. The Census Bureau accomplished this by creating and maintaining a MAF that identifies all living quarters and by spatially locating those addresses using a nationwide automated geographic system, the Topologically Integrated Geographic Encoding and Referencing (TIGER) system database. The building and maintenance of the MAF and TIGER involved partnerships with other federal agencies; state, local, and tribal governments; regional and metropolitan planning agencies; the private sector; and nongovernmental organizations.

For Census 2000 to be as accurate and complete, and as cost effective as possible, the address list that serves as the basic control for the census must be as accurate and complete as possible. If an address is not on the list, then its residents are less likely to be included in the census. If an address is on the list more than once, its residents are more likely to be included more than once in the census. The inventory of all living quarters includes addresses or location descriptions for each housing unit and each group quarters. Except where the address list is created at the time of enumeration, each listing must have a complete address that can be used for mailing or hand delivering a census questionnaire or a location description that can be used by an enumerator to locate the living quarters.

The Census Bureau created and maintained the MAF through a series of operations. The use of an address list development approach in a particular geographic area depended on the types of addresses used for mail delivery in that area and on how the Census Bureau intended to enumerate the population in that area. A full description of the address list development process in Census 2000 is included as Appendix A in this report. Abbreviated descriptions of each operation are provided throughout the report.

Once the MAF was initially created, the Census Bureau determined that a subset of addresses on the MAF was eligible for attempted enumeration in Census 2000. This subset of addresses was then used to create the Decennial Master Address File (DMAF). The DMAF became the source for printing questionnaires, controlling field enumeration assignments, and keeping track of the status of each case during Census 2000. Periodically, as the MAF was updated, updates were then made to the DMAF as well.

1.2 Master Address File Building Process History

This section provides a summary of how the planned process for developing the MAF for Census 2000 changed several times during the decade. First, as a result of testing and second, as a result of joint planning with our stakeholders.

For the 1990 Census, the Census Bureau developed an Address Control File (ACF), which was based on several initial list operations as well as a series of coverage improvement operations. From these operations, the Census Bureau created a computer file that contained the address of every housing unit included in the 1990 Census. The Census Bureau also developed the TIGER database to support its mapping needs for the Decennial Census and other Census Bureau programs.

Following the 1990 Census, the Census Bureau used the 1990 ACF and the TIGER system to support its statistical programs. (TIGER was maintained and updated throughout the decade but the ACF was not.) Despite the successes associated with these resources, there were deficiencies in each of them that led to the Census Bureau's new vision for a continuously updated and increasingly accurate MAF and TIGER database.

To begin implementing the new vision for the MAF, the Census Bureau began laying out the steps necessary to have a nationwide MAF in time for Census 2000. The major components of the initial creation of the MAF for Census 2000 included:

- The 1990 ACF,
- The United States Postal Service's (USPS's) Delivery Sequence File (DSF),
- Address list information from local and tribal governments through the Program for Address List Supplementation (PALS),
- An address listing operation in areas for which the Census Bureau did not intend to use the DSF, and
- Targeted field verification checks.

After creating the initial address list, the Census Bureau was going to give local and tribal governments the opportunity to review the list prior to the delivery of Census 2000 questionnaires in the Local Update of Census Addresses (LUCA) program.

As the Census Bureau began implementing the Census 2000 Dress Rehearsal, the agency identified additional operations that could contribute to a more comprehensive address list for Census 2000. In the summer of 1997, the Census Bureau re-engineered the plan for the address list development for Census 2000. A summary of the updated plan follows:

In areas with mail delivery to predominantly city-style addresses (often referred to as "inside the blue line"[1]):

- Verify the address list through a dependent 100 percent Block Canvassing operation.
- Implement a postal check by the USPS, in which local postal carriers check the list in late January 2000.
- Terminate the limited, targeted field verification checks.
- Terminate the PALS activity.
- Conduct an earlier LUCA operation.

In areas with mail delivery to predominantly noncity-style addresses (often referred to as "outside the blue line"):

- Provide additional attention to updating TIGER maps prior to the address listing operation.

In all areas:

- Increase the amount of time allowed for local and tribal government review of the address list.
- Provide more training/guidance to local and tribal governments to assist their review of the address list.
- Establish stronger relationships with state data centers, metropolitan and regional planning organizations, and councils of government, especially in areas where local governments are unable to participate in a local review of their address list.

To the extent possible, the Census Bureau incorporated components of this re-engineered plan into the Census 2000 Dress Rehearsal. The result was a Census 2000 Dress Rehearsal whose MAF was built with a hybrid system somewhere between the original plan and the intended plan for Census 2000.

By the time the Census Bureau actually implemented Census 2000, the agency had added most of the activities described above. The one exception is that although it planned a postal check by the USPS, in which local postal carriers would have checked the list in late January 2000, the USPS encouraged an alternative operation. In place of a postal check at the local level, the

1 The term 'inside the blue line" harkens back to earlier censuses where different enumeration methodologies were geographically identified by outlining areas on a map using a blue pencil.

Census Bureau added several additional deliveries of the DSF from the USPS. This revised methodology was used based on the results of a comparison of the DSF to the MAF by the USPS, from analysis of the Dress Rehearsal results, and from the heightened efforts by the USPS to increase the currency and accuracy of the DSF. The Census Bureau also added a New Construction Program, which allowed participants in the LUCA Program to provide addresses for units newly constructed between January and April of 2000. Although the Census Bureau gave LUCA participants more time to complete their review, a survey of local and tribal governments showed that they would have appreciated even more time to review. An estimated 50 percent of the LUCA participants who provided no updates said that they either had insufficient personnel or said that the volume of work was too much.

1.3 Limits

The evaluations of address list development for Census 2000 have various limits. Individual evaluation reports provide exhaustive descriptions of specific limits that affect their results. In this section, we present some key limits that affect our interpretation of the results presented throughout this report. We present additional limits throughout this report where appropriate.

The basic street address size variable was overstated

The variable showing the number of units at a basic street address (BSA) on the MAF included all addresses indicated as DMAF deliverable during the census process. Only a subset of these addresses remained in the census. Therefore, the size of BSA variable on the MAF is overstated relative to the size of BSA as of the end of the census.

Additionally, the size of BSA variable was only determined for units with city-style address information. Units with non-city-style addresses are considered single units. Due to the error, first explained in section 2.2.1, all units in Puerto Rico have non-city-style address information for them on the MAF and are recorded as single units regardless of their actual BSA size.

We are unable to determine whether an address is used to receive mail

In these evaluations, we look at address information in the following categories: complete city-style, complete rural route, complete P.O. box, incomplete or no address. The way the address information is stored on the MAF does not allow us to distinguish between addresses that are used for mailing and those that are used for locating addresses in field operations.

Comparing results to previous censuses

The type of enumeration areas, enumeration methodologies, and analysis variables for Census 2000 may differ from previous censuses. Caution should be taken when comparing results across censuses. An example of an analysis variable that has changed from 1990 is size of structure--the closest approximation being size of basic street address in Census 2000. In the 1990 Census,

the Census Bureau had a census question asking the respondent the size of structure. In Census 2000, the Census Bureau defined the size of basic street address based on an address-level algorithm.

2. METHODOLOGY AND RESULTS FROM INDIVIDUAL OPERATION EVALUATIONS

During Census 2000, the Census Bureau used three different major approaches for initially building and subsequently improving the MAF for different geographic areas (defined at the census block level). The use of an approach in a particular geographic area depended on the types of addresses used for mail delivery in that area and on how the Census Bureau intended to enumerate the population in that area. In this report, we label these three approaches by the primary types of enumeration areas that they contain: Mailout/Mailback, Update/Leave, and List/Enumerate. We first discuss the individual operation evaluations separately for these three approaches (Sections 2.1 through 2.3). We then discuss the individual operation evaluations for operations that crossed these approaches (Section 2.4).

2.1 The Mailout/Mailback Approach Operations

In this section, we discuss the individual operation evaluations for:

- The USPS's DSF
- LUCA 1998
- Block Canvassing
- New Construction
- Urban Update/Leave

For an explanation of how these operations related to each other during the census, see Appendix A.

Note that we also refer to Urban Update/Enumerate in this section, but the detailed results are provided in the next major section of the report on "Update/Leave Approach Operations."

2.1.1 The United States Postal Service's Delivery Sequence File

Most of the information in this section came from Rosenthal (2002c).

Other than the 1990 ACF, the DSF was the most significant contributor of addresses in Mailout/Mailback areas in Census 2000. The United States Congress authorized the USPS to share its address list, the DSF, with the Census Bureau in the Census Address List Improvement Act of 1994. The USPS provided the Census Bureau a series of DSFs throughout the years

leading up to and including Census 2000. These included:

- November 1997 or earlier
- September 1998
- November 1999
- February 2000 (adds only)
- April 2000

The November 1997 or earlier category refers to a national DSF delivery to the Census Bureau in November 1997 and sub-national DSF deliveries of earlier DSFs such as for the 1995 census test sites. The February 2000 DSF was a file of added addresses only. The other DSFs included all addresses on the DSF at that time.

There were 116,550,536 unique addresses on one or more of these DSFs. Eighty-five percent of these addresses were enumerated as either occupied or vacant in Census 2000. The other 15 percent were not enumerated because they were not geocoded to a census block, didn't exist as verified residential addresses by two or more census operations, or were duplicates discovered during the census. Sixty-four percent of the DSF addresses matched to addresses in the 1990 ACF. Of the matched addresses, 97 percent were in the final results of Census 2000. Of the DSF addresses that did not match to the 1990 ACF, 63 percent were in the final results.

The Census Bureau did not observe complete consistency between DSF deliveries. That is, housing units appeared and disappeared from one delivery to the next. The following table demonstrates the changes from one delivery to the next.

Table 1. Changes in the inventory of addresses on the Delivery Sequence File over time

DSF	Total number of addresses on the file	Total addresses not on any previous DSF	Total addresses not on the immediately preceding DSF	Total addresses not on the current file that were on the immediately preceding DSF
November 1997 or earlier[1]	106,792,959	32,219,712	32,219,712	524,300
September 1998	100,407,869	3,000,454	3,260,202	9,645,292
November 1999	103,281,784	4,274,404	4,850,176	1,976,261
February 2000 (adds only)	985,365	836,431	903,556	N/A[3]
April 2000[2]	103,969,951	1,121,998	1,275,379	1,490,768

[1] November 1997 is compared to the 1990 ACF since there is no previous DSF to compare it to.

[2] The April 2000 DSF is compared to a combination of the February 2000 and November 1999 DSFs since the February 2000 DSF only contained adds.

[3] Since the February 2000 DSF was adds-only, it doesn't make sense to do this comparison to the previous DSF.

To the extent that the Census Bureau could geocode new DSF addresses, the agency added them to the MAF, regardless as to whether they coded to inside or outside of the blue line. However, in Census 2000, the Census Bureau only used the DSF as a source of addresses inside the blue

line. If a DSF address that is outside of the blue line is in the final census results, it is generally the case that some other operation independently added the same address. Of all of the DSF addresses added to the MAF, Table 2 provides the distribution of those addresses to inside or outside of the blue line.

Table 2. Distribution of Delivery Sequence File added addresses by inside or outside of the blue line

DSF	Percent of new addresses inside the blue line	Percent of new addresses outside the blue line	Percent of new addresses not geocoded to a block (as of 03/01)
11/97	72.17	23.49	4.33
09/98	52.53	37.18	10.29
11/99	51.81	26.47	21.72
02/00	43.82	24.45	31.73
04/00	52.82	15.83	31.35

The increasing number of addresses delivered from the DSF that were not geocoded as of 03/01 represent the fact that during the census, there were major attempts to clear out the backlog of new DSF addresses that the Census Bureau could not geocode. This was done to maximize the number of addresses from the DSF that could then be used in the Census.

As mentioned earlier, only new DSF addresses geocoded to inside of the blue line were added to the frame of addresses that the Census Bureau attempted to enumerate in Census 2000. There was some clustering of new units added by the DSF.

Table 3 provides counts of collection blocks by the number of new housing units per block for new addresses inside the blue line on the September 1998 DSF.

Table 3. Counts of collection blocks by the number of new housing units per block for new addresses inside the blue line on the September 1998 Delivery Sequence File

Number of new housing units	Number of blocks	Percent of blocks
1 or more	333,978	100.00
1	186,046	55.7
2-9	119,977	35.9
10-19	14,129	4.2
20-59	10,180	3.0
60-99	1,967	0.6
100+	1,679	0.5

Over 44 percent of the blocks had at least two new addresses from the DSF. Just fewer than 36 percent of the blocks had between two and nine new addresses. Over four percent of the blocks had between ten and 19 new addresses, and 3.0 percent of the blocks had between 20 and 59 new addresses from the DSF. From this same DSF delivery, 71.7 percent of the new addresses were single unit addresses. Over six percent of them were in multi-unit addresses that had between two and four housing units. Close to 11 percent of them were in multi-unit addresses with over 50 housing units.

Recommendations

As a primary source of addresses nationwide, the DSF was the most significant contributor of addresses to Census 2000 since the 1990 ACF. The Census Bureau should continue to work closely with the USPS to better understand all of the information provided on the DSF so as to maximize its use. The Census Bureau should also put its own efforts into better understanding the quality of the DSF. For example, the USPS is planning to assign a permanent ID to all addresses on the DSF. This will allow us to better understand the stability of the DSF and it will help us to better identify addresses with changes.

2.1.2 Local Update of Census Addresses 1998

Most of the information in this section came from Owens (2003) and ITS Services, Inc. (2002).

The Census Bureau conducted the LUCA 1998 program in mailout/mailback areas of the country from May 1998 to June 2000. The Census Bureau invited local and tribal governments to participate and those who participated were sent lists of housing units in the census blocks in their area. Governments updated the lists by adding, deleting, or correcting addresses. The Census Bureau then verified most of those updates.

There were 17,424 governmental units eligible to participate in the LUCA 1998 program. A total of 9,263 governments participated. The housing units in these participants' jurisdictions geographically covered approximately 92 percent of the housing units in areas eligible for the program. Although 53 percent of the eligible governments participated, only 36 percent provided any updates in the form of adds, deletes, or corrections. The majority of eligible governments were in the Midwest region of the United States; however that region had the lowest participation rate. In general, governments with fewer housing units (as determined by the number of housing units in the government's jurisdiction in 1990) had lower participation rates than larger ones. Governments may not have participated because they did not have enough resources to do the task or they knew that a different level government agency with jurisdiction in or knowledge of their area was already updating addresses for the Census Bureau. For example, a town may not have participated if it knew that the county government participated.

The Geography Division hired a contractor to survey local governments who:

- Did not participate in LUCA,
- Participated but did not provide any updates, and
- Participated and provided updates

The contractor did not provide the results of this survey separately for the LUCA 1998 and LUCA 1999 programs. However, the overall results are useful for the future planning of this program.

Approximately two thirds of the responding governments indicated that their government was satisfied, somewhat satisfied, or very satisfied with its experience related to the LUCA Program for Census 2000. Over three fourths of the responding governments indicated that they were somewhat interested or interested in participating in future LUCA-like programs.

Of the responding non-participants in the LUCA program, 62.1 percent reported that they did not recall or remember the program. For those who remembered the program, 76.5 percent said that the volume of work required to conduct the review was a factor in their non-participation. About the same amount (75.5 percent) said that they had insufficient personnel to conduct the review.

Of the responding participants who did not provide any updates, approximately 50 percent said that they had insufficient personnel and just slightly less said that the volume of work was a factor in their not providing updates. Just fewer than 48 percent of the governments who participated but did not provide updates said that the Census Bureau's address list and/or maps were accurate.

Of the responding participants who did provide updates, about 78.8 percent of them said that having changes in their housing inventory was a major factor in participating. Just 5.9 percent fewer (72.9 percent) said that they had addresses available to provide and that figured in their decision to participate.

The governments who did review their address lists added a total of 5,302,094 addresses to the MAF. (An additional 991,034 adds were provided but already existed on the MAF.) There were 3.8 million blocks in areas where the LUCA 1998 program was available. The Census Bureau sent out addresses to local governments for approximately 2.7 million of those blocks. About 18 percent of those blocks had at least one address added by a LUCA 1998 participant.

Approximately 95 percent of LUCA 1998 participant adds were included in the initial census address list. Many were added to the initial list as "provisional" adds to be verified after the first census mailing. This occurred because the Census Bureau did not have enough time in the schedule to verify all LUCA adds prior to the mailout. Approximately 58 percent of adds were confirmed to exist as residential addresses in the Block Canvassing operation or the LUCA 1998

Field Verification operation. Coincidentally, about 58 percent of adds were in the final census housing unit inventory.

The LUCA 1998 participants deleted (or declared nonresidential) a total of 490,613 addresses. Of the 2.7 million blocks that were reviewed by participants, about 5 percent had at least one participant delete. The LUCA 1998 participants corrected a total of 2,762,050 addresses on their address lists. The corrections included geographic as well as address information. Of the 2.7 million blocks that were reviewed, about 6 percent had at least one participant address correction.

LUCA 1998 participants appealed a total of 313,853 addresses. The Census Address List Appeals Office that was set up by the Office of Management and Budget added a total of 303,410

of those addresses to the MAF after approval. Only 141,580 of these addresses were included on the final census address list.

The participants of the LUCA 1998 program contributed to the address list in many areas. Although the updates had a large impact on the update of the MAF for Census 2000, the timing of the program with other Census 2000 address updating operations introduced some complexity in determining the true impact of updates to the final census results. Although LUCA participants provided over 5 million adds, we estimate that only 505,530 addresses in the final census were provided by LUCA participants and were not provided by any other census operation. This estimate does not reflect how many addresses would have been missed had it not been for the LUCA program. In areas where LUCA was conducted prior to Block Canvassing, it is unclear how many added units from LUCA, Block Canvassing would have added if there were no LUCA program.

Recommendations

In order to understand the true impact of LUCA in the future, we recommend that the Census Bureau allow sufficient time for the completion of government updates prior to any Block Canvassing activities. This would reduce the complexity of the processing, as well as eliminate the need for another operation to validate updates.

We also recommend that the Census Bureau investigate ways to increase government participation. This should especially focus on ways to aid the governments once they have agreed to participate. However, given the amount of updates that were provided but not ultimately used, it is equally important that participants have sufficient sources and resources necessary to provide valid locatable addresses.

We also recommend that the Census Bureau look at the appeals process. Of the addresses that the Census Bureau was told to include in the final enumeration, fewer than 47 percent of them actually ended up in the final census count.

2.1.3 Block Canvassing

Most of the information in this section came from Burcham (2002).

The Block Canvassing operation was one of the largest operations the Census Bureau conducted to update the MAF in preparation for Census 2000. It occurred in the winter/spring of 1999. The operation required field listers to conduct a 100 percent canvass of residential addresses in blocks containing predominantly city-style addresses. A total of 91,612,770 addresses were in the universe of addresses to be verified in Block Canvassing. The operation occurred in 3,801,560 blocks in the nation. This number represents 51 percent of the total 7,421,899 blocks in the nation (not including water blocks). Block Canvassing occurred in parts of 2,119 counties out of a total 3,141 counties in the nation.

In Block Canvassing, listers canvassed addresses printed in the listing books and used maps as aids in locating structures that contain living quarters. The listers compared each address found on the ground with those in the listing book and recorded all corrections, additions, and deletions (including duplicates, uninhabitable addresses, and nonresidential addresses) on its listing pages. The listers also updated census maps to show additions, corrections, and deletions to road features. The listers stopped at every third door to inquire about the addresses on either side of that address as well as to identify any "hidden" units.

For each housing unit located in the Block Canvassing search area, results from the Block Canvassing listers were used to assign each housing unit to one of six basic action code categories:

- *Verify*
- *Add*
- *Delete (including duplicates, uninhabitable addresses, and nonresidential addresses)*
- *Address Corrected*
- *Geographic Corrections*
- *Add and Verify*

The first four categories came directly from the actions taken by the listers. When processing the results of Block Canvassing, the Census Bureau created the "Geographic Corrections" and "Add and Verify" categories. A geographic correction resulted from an address indicated as an add in one block matching with an address indicated as a delete in a different block. An "Add and Verify" address resulted from an address indicated as an add matching with an address indicated as a verify. Obtaining both "Add" and "Verify" actions for the same address was an inconsistency in the field operation. The Census Bureau had to determine which action to accept. The Census Bureau decided to treat these addresses as being located in the blocks in which they were added. For some of these addresses the add and verify were originally in the same block. For others, the add and verify were originally in different blocks.

Block Canvassing listers added a total of 6,389,271 addresses to their listing pages. Around 29 percent of addresses added by Block Canvassing actually were on the MAF before Block Canvassing occurred but were either:

- Ungeocoded until Block Canvassing geocoded them,
- Moved to different blocks by Block Canvassing, or
- Considered non-residential until Block Canvassing determined that they were residential units

In the first situation, if the Census Bureau did not have a block code assigned to a housing unit on the MAF, it excluded it from the Block Canvassing operation. There was no mechanism for determining which lister should receive these cases. Also, the Block Canvassing operation was not intended to be an address location operation.

Block Canvassing listers deleted a total of 5,146,320 addresses from their listing pages. Any Block Canvassing field deletes (other than duplicates) that otherwise appeared to be valid at the time of the creation of the LUCA Field Verification universe were sent to be verified in LUCA Field Verification. The Census Bureau required a second confirmation of deletes in order to exclude them from the census address universe. Over 2.3 million Block Canvassing deletes were sent to LUCA Field Verification (46 percent of the total Block Canvassing deletes).

About 48 percent of the Block Canvassing field deletes sent to LUCA Field Verification were indicated as field deletes again. Almost 2.5 percent were indicated as non-residential or uninhabitable in LUCA Field Verification. About 33 percent of the Block Canvassing field deletes were verified as existing housing units where no address correction was needed. Almost 16 percent of the Block Canvassing field deletes were verified as existing housing units and received a corrected address.

A high number of deletes sent to LUCA Field Verification (49 percent) were verified as existing units in LUCA Field Verification. This result appears to confirm the need for validating deletes before dropping them from the census. However, we do not know the number of deletes that LUCA Field Verification correctly reinstated compared to the number that it erroneously reinstated.

One factor that contributed to the high number of Block Canvassing deletes that were verified as existing in LUCA Field Verification is the fact that some Block Canvassing duplicate addresses were coded as field deletes (instead of being coded as duplicates) by the listers. Cases coded as duplicates were not sent to LUCA Field Verification. However, duplicate addresses coded as field deletes were sent to LUCA Field Verification and had a high probability of getting reinstated, due to the fact that LUCA Field Verification was not a comprehensive check of the list, but a search for selected addresses. If an address was a duplicate, there was a good chance that the listers would find it and mark it as "verify," even though another version of the address was already on the list.

Block Canvassing listers corrected 2,295,168 addresses (approximately 2.5 percent of the universe). Over 91 percent of the blocks canvassed had no corrections. Of the blocks with corrections, about 84 percent of them had between one and nine address corrections. That is, the corrections of addresses were not very clustered.

The Block Canvassing operation resulted in 2,948,414 addresses being moved to a different block. This resulted when one lister deleted the address and another lister added the same unit in a different location. (Listers were not allowed to directly move an address from one block to another.) Approximately 96 percent of these block changes remained as the final block code for these addresses. Over 52 percent of the blocks that had at least one address whose block code changed, actually had between two and nine addresses experience a block code change. An additional 30 percent of the blocks with at least one address whose block code changed only had one address change.

Around 78 percent of the added units were valid housing units in Census 2000, while almost 24 percent of the deleted addresses actually were later enumerated as housing units in the census. About 96 percent of addresses coded as existing by Block Canvassing ended up as valid housing units in the census. Also, 96 percent of all addresses sent to Block Canvassing to be verified showed consistent results between Block Canvassing and the census.

A total of 1,186,240 blocks (out of 3,801,560 blocks) did not receive any updates from Block Canvassing. These blocks had an accurate address list before Block Canvassing, and did not gain anything from Block Canvassing. Some blocks did not contain any residential units and other blocks had actions of "verified" for all residential units in the block.

Recommendations

Duplicate addresses coded as field deletes that were sent to LUCA Field Verification (instead of being coded as duplicates and being left out of the LUCA Field Verification) had a high probability of getting reinstated, due to the fact that LUCA Field Verification was not a comprehensive check of the list, but a search for selected addresses. Because of this, we recommend that all future field-listing operations, intended to verify the status of individual units, must include a check against all addresses currently listed in the same block with a complete set of possible actions. This review is intended to make sure the address is not already reflected on the address list, perhaps in a different form. We also recommend that more attention be given to correctly coding units as duplicates so that they can be distinguished from other field deletes.

Although Block Canvassing resulted in almost 3 million addresses being moved by one lister deleting the unit and another lister adding the same unit, the Assessment Report for Block Canvassing recommends that the Census Bureau test procedures for allowing listers to make changes to house numbers and geographic moves. We concur with this recommendation. This type of update might remove some of the duplication created in this operation as it is currently

designed. This duplication occurs when the Census Bureau require two different listers to provide different but consistent actions on the same address.

Because of the large number of blocks that had no updates in the Block Canvassing operation, we would also recommend that the Census Bureau research ways to identify stable blocks to avoid the cost of canvassing them when there is nothing to update. However, omitting blocks from Block Canvassing may not be reasonable. Although we could probably identify blocks that had a high likelihood of not requiring updating, we would not be able to ensure the same coverage quality that comes from canvassing all blocks. We, therefore, cannot recommend omitting blocks from future Block Canvassing operations.

2.1.4 New Construction

Most of the information in this section comes from Moul (2003).

Local and Tribal governments were given one more opportunity to assist in ensuring the completeness of the MAF for Census 2000 in the New Construction Program. Starting in January 2000, the Census Bureau provided participating governments an updated MAF to review. Only those governments that were eligible to participate in the LUCA 1998 program were eligible to participate. Participating local and tribal governments were asked to provide addresses for any residential structures newly constructed and existing as of Census Day, April 1, 2000.

There was no formal evaluation of this operation. Some basic statistics about this program follow. This operation yielded 371,812 addresses that were sent to the Coverage Improvement Followup (CIFU) operation for enumeration. Of these, 196,792 addresses (52.9 percent) were deleted in the CIFU operation. Most of the rest (175,009 cases) were enumerated as either occupied or vacant. The remaining 11 cases had an unknown status coming out of the operation.

2.1.5 Urban Update/Leave

Most of the information in this section came from Rosenthal (2002a)

The United States Census Bureau conducted the Urban Update/Leave operation from March 3 to March 31, 2000. The objective of the Urban Update/Leave operation was to improve coverage in the following ways:

- Improving the deliverability of the questionnaires and
- Updating address information and census maps

The Urban Update/Leave operation targeted areas deemed unsuitable for Mailout/Mailback. Primarily these are:

- Multi-unit buildings where the USPS delivers the mail to a drop point instead of to individual unit designations and
- Urban communities that had city-style addresses but many residents pick up their mail at a post office box.

The Urban Update/Leave operation relied on the Census Bureau Field Regional Offices to identify areas based on their knowledge of whether the USPS could adequately deliver the census questionnaires.

In Urban Update/Leave areas, enumerators delivered the census questionnaires and updated their address registers and census maps concurrently. Residents were asked to complete and mail their census questionnaires. Eight of the twelve regional offices identified areas to use Urban Update/Leave. Nationwide, 12,843 blocks were covered by this operation. The address list contained housing units in 7,657 of these blocks (59.6 percent).

There were 13,131 additions during questionnaire delivery, a 4.9 percent increase to the 267,005 addresses printed in the address registers for this operation. Updates accounted for 48,233 of these addresses; reflecting either deletes or address corrections or block corrections.

There were 2,114 blocks (27.6 percent) out of 7,657 blocks with housing units in the census where 75 percent or less of the housing units in the block matched to addresses on the USPS's DSF. Such blocks would presumably present mail delivery challenges for the USPS

Recommendations

In some areas, this operation appears to have done what it was intended to do. That is, the Census Bureau was able to deliver questionnaires when it is likely that the USPS would not have done so. In that context, we recommend that this operation remain as part of the Census Bureau's enumeration methodology for the 2010 Census. However, it also appears to be the case that this success was limited to a small number of blocks chosen for this operation. Forty percent of the blocks chosen for this operation contained zero housing units. This operation is not primarily intended to improve coverage by updating the address list at the time of questionnaire delivery. Its primary purpose is to successfully deliver questionnaires when the Census Bureau does not believe the USPS will succeed in doing so. So it is unclear why these blocks were chosen for this type of enumeration. At the same time, there may have been other blocks where this operation would have proved useful. We therefore recommend that the Census Bureau look closely at the methods for choosing blocks to be in Urban Update/Leave and consider the pros and cons of making this operation mandatory for blocks that meet certain pre-determined conditions.

One additional suggestion is to define this type of enumeration at the address level. That is, do not require an entire block to be defined as Urban Update/Leave. Reserve the use of this enumeration method for high-rise buildings and use Mailout/Mailback enumeration for single unit addresses in the same block. To the extent that this can be made feasible, this suggestion should be considered.

2.1.6 Update/Enumerate

This enumeration methodology was used in areas that would otherwise have been Mailout/Mailback areas (Urban Update/Enumerate) and in areas that would otherwise have been Update/Leave areas (Rural Update/Enumerate). For the most part, data on this enumeration method are combined, so we present all of the data in one place in this report. Because just fewer than 93 percent of the addresses in Update/Enumerate were in Rural Update/Enumerate areas, we present the results in the "Update/Leave Approach" section of this report. See Section 2.2.4 of this report for more information.

2.2 The Update/Leave Approach Operations

In this section, we discuss the individual operation evaluations for:

- Address Listing
- LUCA 1999
- Update/Leave
- Update/Enumerate

For an explanation of how these operations related to each other during the census, see Appendix A.

2.2.1 Address Listing

Most of the information in this section came from Ruhnke (2002).

The Census Bureau conducted the Address Listing operation from July 1998 to May 1999 and used the results to create the initial address list for areas that would be enumerated using Update/Leave methodology during Census 2000. In the Address Listing operation, census enumerators canvassed door-to-door to identify the mailing address and physical location of addresses in areas where the Census Bureau believed that problems were likely with developing an accurate mailing list and delivering census questionnaires through the mail. The enumerators also located each housing unit with a map spot on a block map and collected an occupant name and telephone number, when possible.

Stateside, about 22 million housing units were listed in the Address Listing operation. Since the Address Listing operation targeted mostly rural areas of the country, the majority of the units

from the operation were in the southern and midwestern parts of the United States. The South had close to half of all the units listed during the operation.

An additional 1.4 million addresses were listed in Puerto Rico. All of Puerto Rico was canvassed during the Address Listing operation and was enumerated using Update/Leave methodology. The Census Bureau had problems processing the keyed addresses from Puerto Rico. Because of unexpected address configurations, the address standardizer could not be used. The Census Bureau decided to load the entire address field in the location description field on the MAF. Due to this problem we cannot identify the types of addresses provided by the listers in Puerto Rico.

Despite Address Listing occurring in mostly rural areas of the United States, over 73 percent of the adds had complete city-style (house number, street name) addresses. About 14 percent of the units had incomplete or no address information, but location descriptions of the units were recorded for over 95 percent of those. Both city-style address information and location descriptions enable enumerators to locate the units on the ground when they deliver the census forms during Update/Leave and other census field operations. The presence of a map spot, a unique identifier for a housing unit on a census map within a block, is also crucial when trying to locate a unit in rural areas. Over 99 percent of the Address Listing addresses have map spots. It is also interesting to note that 42.5% of the addresses listed during Address Listing matched to residential units on the DSF.

In the mostly rural areas in which Address Listing was done, there are not likely to be many large apartment buildings, therefore it should be expected that most of the addresses were single-unit structures. Single units account for about 90 percent of the total addresses in these areas, and less than four percent of the addresses were in structures with ten or more units.

Recommendations

The Census Bureau is not planning to conduct an independent address listing operation in the 2010 Census. Instead, the Census Bureau plans to use the addresses collected in Census 2000 as a starting point for any listing operations. Therefore, we have no specific recommendations for the operation in the future. However, because of the large percentage of city-style addresses found during the Address Listing operation, we do recommend that the Census Bureau continue to research ways to maximize mailing out questionnaires. We cannot say for certain how many of the city-style addresses actually are addresses to which the USPS would deliver. We do, however, expect the mail delivery to areas implementing new house number/street name address numbering systems to continue to increase over the decade.

2.2.2 Local Update of Census Addresses 1999

Most of the information in this section came from Owens (2002).

The Census Bureau conducted the Census 2000 LUCA 1999 program in Update/Leave and Update/Enumerate areas of the country from January of 1999 to June of 2000. The Census Bureau invited local and tribal governments to participate, and those who participated were sent counts of housing units in blocks and lists of addresses (collected in the Address Listing operation) in their area. Governments identified any block counts they deemed inaccurate, and the Census Bureau recanvassed those blocks.

There were 30,375 functioning governmental units eligible to participate in the LUCA 1999 program. A total of 10,925 governments participated and they covered approximately 67.9 percent of the housing units in eligible areas. About 36 percent of eligible governments participated; 17 percent of eligible governments challenged any blocks.

The majority of eligible entities were in the Midwest; however that region had the lowest participation rate. Larger governmental units (as determined by the number of housing units in the government's jurisdiction in 1990) participated at higher rates.

The Census Bureau sent the 117,073 blocks that the local governments challenged out to be recanvassed in the LUCA 1999 Recanvass Operation. A total of 2,186,765 addresses in the United States and 35,563 addresses in Puerto Rico were sent out for review.

LUCA 1999 Recanvass field representatives deleted (or declared nonresidential) a total of 145,378 addresses from their listing pages in the United States and 2,534 addresses in Puerto Rico. Of the 110,728 blocks that had at least one address update in LUCA 1999 Recanvass, about 36 percent had at least one address deleted. The deletes represent 6.7 percent and 7.1 percent of the addresses on the list before the Recanvass in the United States and Puerto Rico, respectively.

LUCA Recanvass field representatives corrected a total of 388,838 addresses in the United States and Puerto Rico. Of the 110,728 blocks that had at least one address update in LUCA 1999 Recanvass, about 55 percent had at least one address corrected. About 85.5 percent of corrections were made to single unit structures and about 81.1 percent of corrected units had complete city-style address information on the MAF.

In addition to making these updates to the address list, field representatives for the LUCA 1999 Recanvass operation added any units that existed as a residential unit in the block that were not already on the list. They added a total of 328,174 addresses, which represents a 15 percent increase in housing units in Update/Leave enumeration areas in the United States (excluding Puerto Rico) that were recanvassed. Field representatives added a total of 9,874 addresses in Puerto Rico, which represents an approximate 28 percent increase in housing units in areas that were recanvassed.

Approximately 99.5 percent of LUCA 1999 Recanvass adds in the United States and Puerto Rico were included on the initial census address list. About 85.2 percent of those adds were in the final census housing unit inventory.

After participating local governments received feedback from the Census Bureau they could appeal specific addresses. Participants appealed a total of 18,442 addresses. Appealed addresses that the Census Address List Appeals Office (in the Office of Management and Budget) approved were added to the MAF. Approximately 54 percent (10,053) of the addresses appealed by local governments were included on the final census address list. This is further evidence to support the recommendation in Section 2.1.2 that the appeals process be reviewed for possible improvements prior to the 2010 Census.

The LUCA 1999 program did aid the updating of the address list in some areas. Given these results, it seems plausible that additional local and tribal governments would have benefited from participating in the LUCA 1999 program.

Recommendations

As with the LUCA 1998 Program, we recommend for the LUCA 1999 Program that the Census Bureau investigate ways to increase local government participation.

2.2.3 Update/Leave

Most of the information in this section came from Pennington (2003).

In the Census 2000 Update/Leave operation, questionnaires with preprinted address labels were hand-delivered to every housing unit on the address list. Existing housing units that were not listed on the address register also required questionnaires, but these questionnaires were hand-addressed and added to the address register. Since staff was in the field delivering the questionnaires, they could also make other updates to the address list and to the maps during the operation.

Stateside, there were 21,881,083 addresses on the initial address registers that went into the Update/Leave operation. In Puerto Rico, there were 1,359,438 addresses at the start of the operation. The operation added 1,755,961 addresses. Most of these addresses (1,644,174) were added stateside and 111,787 were added in Puerto Rico.

The number of corrections in stateside areas was 9,045,814, with 751,156 in Puerto Rico. Given the universe size, this may seem like a large number of corrections. However, corrections in this operation went beyond corrections to the street name or unit designation. Any corrections made to the records, including obtaining or changing a telephone number or occupant name, were coded as corrections. Some places underwent wholesale telephone area code changes, requiring a correction to almost every unit. In Puerto Rico, there was also a problem with address fields,

resulting in large numbers of address corrections. (See Section 2.2.1 for more information.) The number of deletes, either as nonexistent or as nonresidential, was 1,228,987 in stateside areas and 122,815 in Puerto Rico. In addition, when processing the updates from this operation, some units that were deleted in Update/Leave were matched up to addresses that were added in the operation; this resulted in 24,265 moves, all of which were stateside.

Units on the address list for Update/Leave that did not receive any of these field actions were considered verified. Although the field staff provided action codes verifying each address on the list that they could find, the Census Bureau did not update the MAF with these specific "verified" actions in order to save time and resources. There were 11,582,017 of these stateside and 485,467 of these in Puerto Rico.

Not every address added in the Update/Leave operation was included in the census. Some records were not included because they did not contain sufficient address information for adding to the address list or they did not contain sufficient information to be assigned to a block. Other added records were found in subsequent operations to represent housing units that did not exist in the designated block, either because the unit was nonexistent or because the unit existed in another block.

Of the 1,644,174 stateside Update/Leave adds, 1,401,169, or 85.2 percent, were in the final Census counts. In Puerto Rico, 93,607 of the 111,787 added addresses, or 83.7 percent, were included in the counts.

Recommendations

In future updating operations one of the requirements should always be to distinguish the types of corrections made during the operation. It would have been useful to know how often these corrections were to address information versus corrections to occupant name or telephone number.

2.2.4 Update/Enumerate

Most of the information in this section comes from Rosenthal (2002b).

The Update/Enumerate method of enumeration targeted communities with special enumeration needs and where most housing units may not have had house number and street name mailing addresses. These areas included resort areas with high concentrations of seasonally vacant housing units, selected American Indian reservations, and colonias; the latter generally are Hispanic-occupied unincorporated communities near the Mexican border. Going directly to the field saves time and money in areas where the Census Bureau has concerns about responsiveness and address integrity. In Update/Enumerate areas, enumerators updated their address registers and census maps and enumerated the housing unit at the time of their visit. The Census Bureau conducted the Update/Enumerate operation from March 13 to June 5, 2000. This enumeration

methodology was used in areas that would otherwise have been Mailout/Mailback areas (Urban Update/Enumerate) and in areas that would otherwise have been Update/Leave areas (Rural Update/Enumerate). For the most part, data on this enumeration method are combined, so we present all of the data here (not just that part of Update/Enumerate that was conducted in otherwise Update/Leave areas).

Nationwide, 183,889 blocks were covered by Update/Enumerate and 75,827 of these blocks (41.2 percent) contained housing units. Ultimately, 956,214 addresses were included in the census in these areas. Just under 93 percent of these addresses (886,231 addresses) were in Rural Update/Enumerate areas. The rest of the addresses (7.3 percent) were in Urban Update/Leave areas.

The registers that were sent out to enumerators for conducting Update/Enumerate contained 926,861 addresses. Address verifications accounted for 61.9 percent of these addresses. Address corrections were provided for 30.7 percent of the addresses. Enumerators deleted 6.6 percent of the addresses as either being nonexistent or nonresidential.

Enumerators added 129,692 addresses during the enumeration. This represents a 14.0 percent increase to the addresses in the registers. Of these addresses, 122,735 were in the final census counts. The 6,957 addresses that were not in the final census included cases that for some reason were not geocoded or they were determined to not be housing units at the end of the census process. These 129,692 added addresses were contained in 29,844 blocks. Only one add was found in 45.1 percent of these blocks. Between two and nine adds were found in 46.8 percent of the blocks.

Enumerators deleted 60,936 addresses in Update/Enumerate. These addresses were contained in 20,786 blocks. A majority of these blocks (53.5 percent) had just one delete from this operation. Most of the remaining blocks (42.2 percent) had between two and nine units deleted.
Field Division Regional Office Staff identified the areas where Update/Enumerate would be used.

The areas where this methodology was used exhibited higher-than-national average enumeration rates of American Indian/Alaskan Natives, Hispanics, and vacant housing units. This indicates that the local staff succeeded in targeting areas intended for this operation.

Recommendations

Update/Enumerate appears to have successfully accomplished what it set out to do. This operation should remain as part of the Census Bureau's enumeration methodology for the 2010 Census.

2.3 The List/Enumerate Approach Operations

2.3.1 List/Enumerate

Most of the information in this section comes from Zajac (2002).
List/Enumerate is an operation used in sparsely populated areas of the country for Census 2000. During this operation, census enumerators are assigned areas to canvass and are given census maps for these areas. The enumerators are responsible for listing addresses within their area on blank address register pages, locating the addresses on census maps (map spotting), and conducting an interview to collect census information for each address. The operation, which included reinterview and field followup components, was carried out from mid-March 2000 to the beginning of July 2000.

List/Enumerate was responsible for adding 392,368 addresses nationwide to the MAF. Of these 392,368 addresses, 389,749 addresses were actually included in the final census count. This represents 99.3 percent of all added List/Enumerate addresses. (The 2,619 addresses that were not in the final census count were deleted during data processing for a variety of reasons.)

About 50.3 percent of the addresses added during List/Enumerate were complete city-style type addresses. The complete rural route address category and complete post office box address category each represented around 9 percent of all List/Enumerate addresses. In both of these categories, the majority of addresses had an associated location description. There were 28.2 percent of List/Enumerate addresses with no address information. Of these addresses, a large majority had a location description.

Of the addresses that did not have a complete city-style or complete rural route address (complete post office box, incomplete, and no address information), about 85.2 percent had a location description.

Enumerators were instructed to provide a map spot for each address during List/Enumerate. For map spotting, an enumerator marks the location of a residential structure on a census map corresponding to the physical location of the unit on the ground. The purpose of a map spot is to help locate the address in the future. If a map spot is present on the map and corresponds to a line in the address register, it is considered to be valid. Of the 392,368 addresses added during the operation, 387,424 addresses had a valid map spot. This represents 98.7 percent of all List/Enumerate addresses. In List/Enumerate areas, 18% of the addresses listed match to residential addresses in the DSF.

Recommendations

The Census Bureau does not currently plan to use List/Enumerate in the 2010 Census. Because the Census Bureau successfully captured and stored on the MAF and TIGER map spots and location descriptions for virtually all addresses in this operation, these blocks can be handled as

Update/Enumerate blocks in the 2010 Census. Focusing these remote areas in a single enumeration operation appears to have been successful. We recommend its continued use, where appropriate, in the 2010 Census.

2.4 Operations That Cross Enumeration Approaches

2.4.1 Nonresponse Followup Operation

Most of the information in this section comes from Moul (2002).

The primary objective of Nonresponse Followup (NRFU) was to obtain completed questionnaires from households in the mailback areas that did not respond by mail. If a questionnaire was not checked-in before the NRFU Universe Selection Process began, the housing unit was targeted for NRFU. The final workload for NRFU, including Puerto Rico, was 42,372,965 or 35.6 percent of the eligible universe. The operation started on April 27, 2000 and ended on June 26, 2000.

Although completing interviews with nonrespondents from the mailback enumeration is the primary purpose of NRFU, enumerators were also asked to keep an eye out for residential addresses that did not appear to be on their address registers. If they found any "adds" they were instructed to enumerate them as well. Also, there were several situations where the Census Bureau conducted ad hoc "windshield survey" operations when whole communities appeared to be missing from the address list or the from mailout. The results of some of these operations were captured as NRFU actions.

There were 690,480 addresses added during NRFU. Almost all of these adds were geocoded to blocks in the mailback areas. However, 1,536 adds were coded to List/Enumerate, Update/Enumerate, or Remote Alaska blocks. Assuming the geocode is correct, these cases represent situations where the enumerators went out of their assignment areas and added additional units. In doing so, this may have resulted in duplication in the census. This is because address lists in List/Enumerate, Update/Enumerate, and Remote Alaska areas were created or updated independently of NRFU.

In addition to the adds, NRFU deleted 6,023,232 addresses. Table 4 provides the distribution of the NRFU universe, NRFU adds, and NRFU deletes by Type of Enumeration Area (TEA), for the TEAs where NRFU was intended to occur.

Table 4: Distribution of added and deleted addresses in NRFU by TEA

	NRFU universe		Added addresses		Deleted addresses	
TEA	#	%	#	%	#	%
Total	42,372,965	100.0	688,944	100.0	6,023,232	100.0
▸ Mailout/Mailback	33,064,507	78.0	466,776	67.8	4,853,310	80.6
▸ Update/Leave	9,186,008	21.7	220,092	31.9	1,148,106	19.1
▸ Urban Update/Leave	122,450	0.3	2,076	0.3	21,816	0.4

Data Source: DMAF and MAF

Table includes data for Puerto Rico and excludes data for Hialeah, FL (LCO 2928). Hialeah was excluded because irregularities in its enumeration during NRFU resulted in a complete re-enumeration during CIFU.

As can be seen in the table, the distribution of NRFU deletes by TEA is fairly similar to the distribution of the original NRFU universe. However, the distribution of NRFU adds does not match the distribution of the original universe. There is a disproportionate number of adds in Update/Leave areas. The Update/Leave areas were canvassed prior to Census Day so one would not expect the address list to be terribly incomplete in these areas at the time of NRFU. However, even though the Update/Leave enumerators added housing units that were missing from the address register, these adds were not processed in time to update the NRFU address registers. Consequently, enumerators were more likely to see what appeared to be missing units during NRFU and thus inflated the percentage of added addresses in this TEA.

Table 5 provides the distribution of the NRFU universe, NRFU adds, and NRFU deletes by single and multi-unit addresses.

Table 5: Distribution of added and deleted addresses in NRFU by unit type

	NRFU universe		Added addresses		Deleted addresses	
Unit Type	#	%	#	%	#	%
Total	42,372,965	100.0	688,944	100.0	6,023,232	100.0
▸ Single Unit	26,047,160	61.5	473,691	68.8	3,428,782	56.9
▸ Multi Unit	16,325,805	38.5	215,253	31.2	2,594,450	43.1
2 - 4 Units	5,677,905	13.4	78,400	11.4	1,064,443	17.7
5 - 9 Units	2,174,450	5.1	31,811	4.6	352,893	5.9
10 - 19 Units	1,899,429	4.5	23,936	3.5	255,074	4.2
20 - 49 Units	2,031,729	4.8	26,486	3.8	265,060	4.4
50+ Units	4,542,292	10.7	54,620	7.9	656,980	10.9

Data Source: DMAF Table includes data for Puerto Rico and excludes data for Hialeah, FL (LCO 2928). Hialeah was excluded because of irregularities in its enumeration during NRFU resulted in a complete re-enumeration during CIFU.

As can be seen in this table, when compared to the NRFU universe, added addresses seemed to occur at a higher rate in single unit addresses than in multi-unit addresses. This finding is consistent across all multi-unit address sizes. On the other hand, deleted units occurred at a higher rate in multi-unit addresses. This seems to be completely attributable to the smallest size of multi-unit addresses (two-four units). One limitation with this number is that the size of the multi-unit address is defined from the universe of addresses going into NRFU, not from the results of the operation. So, this larger rate of deletes in two-four unit structures may really be a representation of the deletion of duplicate single unit addresses that appeared to be multi-unit addresses with two units.

Recommendations

To the extent possible, planners for the 2010 Census should design a system that allows for updates from Update/Leave to be data captured in time to make an impact on the NRFU universe. This would avoid the needless addition of some addresses to the NRFU workload. Another benefit of this was reported in the Assessment for Update/Leave and Urban Update/Leave. By not capturing adds from Update/Leave earlier, nonrespondents could not be followed up on until the Coverage Improvement Followup operation. Delaying the enumeration of these households (farther from Census Day) could have a negative impact on the accuracy of the data collected.

2.4.2 Coverage Improvement Followup Operation

Most of the information in this section comes from Moul (2003).

Coverage Improvement Followup (CIFU), an operation that followed NRFU, was designed to improve coverage of housing units in the mailback areas of the country. The workload, including Puerto Rico, consisted of 8,854,304 housing units. Most of this workload consisted of units that were identified as vacant (44.4 percent of the sample) or delete (29.4 percent) in NRFU. The primary reason for conducting CIFU is to verify the identification of the addresses coded as vacant or delete in NRFU. Past censuses have shown that there is sufficient error in the identification of vacants and deletes in NRFU to warrant this verification. Additional components of CIFU included:

- Adds from the New Construction operation (4.2 percent)
- Adds from the Update/Leave and Urban Update/Leave operations that did not mail back a questionnaire (8.8 percent)
- Blank mail returns (5.4 percent)
- Lost mail returns (0.7 percent)
- Non-respondents in several panels of the Response Mode and Incentive Experiment (0.1 percent)
- February 2000 and April 2000 DSF adds (6.2 percent)

- Adds from the LUCA 1998 and LUCA 1999 Appeals process (0.2 percent)
- Various other miscellaneous units (0.7 percent)

There were several situations where the Census Bureau conducted ad hoc "windshield survey" operations when whole communities appeared to be missing from the address list or from mailout. The results of some of these operations were captured as CIFU actions.

The CIFU was conducted in three separate waves as groups of local census offices completed NRFU. Wave 1 began on June 26 and Wave 3 ended on August 23. The CIFU operation added 10,465 units and deleted 2,627,741 addresses.

Table 6 provides the distribution of the CIFU universe, CIFU adds, and CIFU deletes by TEA.

Table 6: CIFU added and deleted addresses by TEA

	CIFU universe		Added addresses		Deleted addresses	
TEA	Number	Percent	Number	Percent	Number	Percent
Total	8,854,304	100.0	10,465	100.0	2,627,741	100.0
› Mailout/Mailback	6,037,885	68.2	8,898	85.0	2,108,616	80.2
› Update/Leave	2,771,176	31.3	1,527	14.6	496,862	18.9
› Urban Update/Leave	45,243	0.5	40	0.4	22,263	0.8

Data Source: MAF/DMAF/HCUF/HCEF_D' Combo File

As can be seen in the table, while the majority of the housing units in the CIFU universe were in the mailout/mailback areas, a substantially higher percentage of adds and deletes were in the mailout/mailback areas. The authors of this report are uncertain why there would be a substantially higher percentage of adds in mailout/mailback areas.

The higher percentage of deletes in mailout/mailback areas can partially be explained by the inclusion of New Construction and February and April 2000 DSF addresses in the operation. These sources of addresses were highly likely to be new construction that may not have actually been valid housing units as of Census Day. In the end, 52.9 percent of the New Construction addresses were deleted in CIFU. Also, 58.5 percent of the DSF addresses were deleted in CIFU.

Table 7 provides the distribution of the CIFU universe, CIFU adds, and CIFU deletes by single and multi-unit addresses.

Table 7: CIFU added and deleted addresses by unit type

	CIFU universe		Added addresses		Deleted addresses	
Unit Type	Number	Percent	Number	Percent	Number	Percent
Total	8,854,304	100.0	10,465	100.0	2,627,741	100.0
› Single Unit	5,218,821	58.9	7,471	71.4	1,283,842	48.9
› Multi Unit	3,635,483	41.1	2,994	28.6	1,343,899	51.1
2 – 4 Units	1,414,252	16.0	895	8.6	547,721	20.8
5 – 9 Units	471,745	5.3	335	3.2	176,705	6.7
10 – 19 Units	362,912	4.1	285	2.7	113,263	4.3
20 – 49 Units	389,913	4.4	360	3.4	123,632	4.7
50+ Units	996,661	11.3	1,119	10.7	382,578	14.6

Data Source: MAF/DMAF/HCUF/HCEF_D' Combo File

Similar to the NRFU distributions related to single and multi-unit addresses, when compared to the CIFU universe, a higher percentage of added addresses were in single unit addresses. Also similar to the NRFU distributions, a higher percentage of the deletes were in small multi-unit addresses. Again, this might be attributable to single unit addresses that were represented by more than one unit going into the CIFU operation where CIFU deleted one of the duplicated units.

2.4.3 Be Counted and Telephone Questionnaire Assistance Programs

Most of the information in this section comes from Carter (2002) and Chesnut (2003).

The Census 2000 Be Counted Program provided a means for persons to be included in Census 2000 who may not have received a census questionnaire or who believed they were not included on one. The program also provided an opportunity for persons who have no usual address on Census Day to be counted in the census. The Census 2000 Be Counted Form contained short form questions, a question indicating whether the form is being completed for the respondent's whole household, and several additional questions needed to geocode the respondent's address and process the completed forms. The Be Counted Forms were available in targeted locations on March 31, 2000 and were removed from the sites on April 17, 2000. These dates coincided with Census Day (April 1, 2000) and the start of the NRFU operation.

The Telephone Questionnaire Assistance (TQA) Program was implemented to assist the public in completing their census forms. Respondents were able to call the TQA number and, if they met certain criteria, they could provide their short-form data over the telephone with or without a Census ID. The TQA program allowed respondents to provide a short form interview over the telephone without a Census ID from March 22, 2000 to June 30, 2000. In addition, respondents were able to request a mailed census form given they needed a replacement questionnaire or never received a form. If a respondent was able to provide their Census ID, they received a

replacement of their original census form. For respondents that did not know their Census ID, they were mailed a census form labeled with a TQA processing ID. These cases without a Census ID but with a TQA processing ID were treated just like Be Counted forms.
The addresses on the Be Counted Forms were matched to the addresses on the MAF and the DMAF. If the address on the form matched to the MAF or the DMAF, the form was linked to the ID on these files that had the corresponding address. If the address from the form only matched to an address on the MAF that was not geocoded or it did not match to an address on either file, the address from the Be Counted Form was sent to geocoding. If the address geocoded, it was sent to Field Verification. Field Verification consisted of an enumerator visiting the address provided by the respondent and determining the status. The status from Field Verification could be one of the following:

- verified as existing,
- determined not to exist (delete) or
- determined to be a duplicate of an address already in the DMAF.

If these addresses were verified to exist, the address and person information was included in the census. If the address was determined to be a delete or a duplicate, it was not included in the census. If the address could not be geocoded, regardless of whether it matched or not, it was not included in the census.

There were a total of 579,365 Be Counted Forms from the Be Counted Program checked in during the Census. Over 80 percent of the forms were returned by April 22, 2000, with 99 percent returned as of one week later. The TQA program yielded 199,775 interviews without Census IDs, which were processed as Be Counted Forms. Together with the paper forms there were 779,140 Be Counted Forms received.

The Non-ID Evaluation File had 804,939 Be Counted Forms on it. This is a difference of 25,799 from the count referred to above from check-in. Currently there is no explanation for this difference. About half (50.7 percent) of these cases (408,098 cases) matched to existing Census IDs. The Census Bureau was unable to geocode 22.2 percent of them (178,768 cases). Therefore, they were left out of the final census results. The remaining 25.0 percent (201,519 cases) were potentially new addresses that were sent to Field Verification.

The largest number and percent of Be Counted Forms in Field Verification were verified (48.6 percent). These forms were assigned a new ID and included in the DMAF. This number is the housing unit coverage gain by this program. The people on these forms would not have been included in the census without the Be Counted program. Addresses that were classified as a delete, a duplicate, or no results reported were excluded from the Census. Unless persons on theses forms were counted elsewhere, they were excluded from the Census because the Census Bureau could not locate the addresses they provided. They accounted for 51.4 percent of the addresses that were sent to Field Verification.

When looking at housing unit coverage, it is important to consider how the Be Counted Forms were returned in conjunction with other forms. Be Counted Forms were processed after all other census operations had finished being conducted. This means that a housing unit could have returned a Be Counted Form and then later been enumerated in NRFU or some other operation. There were a total of 595,293 housing units that returned a Be Counted Form. 131,636 forms (22.1 percent) were from housing units that returned a Be Counted Form and were not enumerated in any other way. Housing units that returned Be Counted Forms but were also enumerated in at least one other way accounted for 463,657 cases (77.9 percent). Most of these cases (379,470 housing units or 81.8 percent) were also enumerated in NRFU.

Recommendations

The Be Counted Program and the TQA Program did add housing units that would otherwise have been left out of the census. However, many of the returns from these programs were also enumerated in other operations, particularly NRFU. The Census Bureau should continue to use programs such as these, but the Census Bureau should also consider ways of reducing the duplication of enumerations. One approach would be to conduct the Be Counted Program after the NRFU operation instead of before.

3. METHODOLOGY AND RESULTS FROM COMBINED OPERATION EVALUATIONS

In this section of the report, we conduct an analysis of the combined operations that led to the final results in the census. We conduct this analysis by examining three sets of addresses:

- Those addresses that were in the final census count
- Those addresses included in the enumeration process, but the addresses were not in the final census count (addresses in the DMAF)
- Those addresses that just reside on the MAF, but where the Census Bureau never attempted enumeration

Most of the information in this section came from tallies produced specifically for this topic report.

3.1 Overall Analysis

As of March 2001, there were 151,109,336 individual MAF Identification numbers (MAFIDs) on the MAF representing potential addresses that were not flagged as duplicates of other addresses nor coded as special place or group quarters addresses. Of these addresses, 76.7 percent were in the final census count. A much smaller percentage (6.5 percent) were included in the Census 2000 enumeration process, but were not coded as valid housing units and 16.8 percent of the MAFIDs reside on the MAF but were never included in the Census 2000 enumeration process.

Table 8. Final Census 2000 Status of all MAFIDs not flagged as duplicated or special place/group quarters

Final Status	Number of MAFIDS	Percent of MAFIDS
MAFIDS in the final census count	115,904,641	76.70
MAFIDS not in the final census count	35,204,695	23.30
In the DMAF	9,752,206	6.45
Not in the DMAF	25,452,489	16.84
Total	**151,109,336**	**100.00**

Before examining each of these components separately, we first look at where all of these addresses came from.

3.1.1 Original Source of Addresses in the Master Address File

Identifying the original source of each address is not as straightforward as it might seem. An original source variable, which did not exist on the MAF, was defined and created by staff in the Planning, Research, and Evaluation Division and the Decennial Statistical Studies Division specifically for evaluation purposes. This variable identifies the first operation or file to add the address to the MAF, with the following three qualifications:

- If one operation added an address, but a later operation also identified the address in a different TEA, the first operation does not receive credit for adding this address.
- An address may not have sufficient operation information to indicate how the address was added to the MAF.
- In cases where one MAF-building operation overlapped with at least one other MAF-building operation and the address was added independently in each operation, we give credit to each operation. An example of this is the original source category "LUCA 1998 and Block Canvassing."

Therefore, the original source variable identifies the first operation or operations to add the address to the TEA in which it exists for the census, provided there is sufficient information to identify a TEA and an operation. For additional information on how this variable was defined, see United States Census Bureau, 2001a.

Note that throughout the remainder of this report, we present original source information sorted by the number addressed contributed by the source. Another logical way to present this information would have been by chronological order (based on when the operations took place). Since we chose not to use this sort in presenting the information, we include in Table 1 at the end of Appendix A, information on the timing of each of the operations and sources that provided updates to the MAF.

Table 9 is the distribution of original source for each of the addresses on the MAF that were neither flagged as duplicates of other addresses nor coded as special place or group quarters addresses.

Table 9. Distribution of original source of addresses on the Master Address File

Original Source	Number of Addresses	Percent of total
1990 ACF	80,563,788	53.31
11/97 (or earlier) DSF	26,787,573	17.73
Address Listing	21,877,609	14.48
11/99 DSF	4,841,157	3.20
Block Canvassing	3,961,959	2.62
LUCA 1998	2,615,298	1.73
Questionnaire Delivery[1]	2,332,465	1.54
09/98 DSF	2,182,274	1.44
04/00 DSF	1,128,957	0.75
02/00 DSF	963,416	0.64
LUCA 1998 and Block Canvassing	568,939	0.38
LUCA 1998 and 09/98 DSF	410,868	0.27
NRFU[2]	399,729	0.26
LUCA 1999 Recanvassing	327,241	0.22
New Construction	310,218	0.20
Be Counted Program	181,953	0.12
TQA Program	141,867	0.09
CIFU[2]	100,465	0.07
1998 Dress Rehearsal	74,765	0.04
Special Place/Group Quarters Enumeration	73,007	0.05
Special Place/Group Quarters Master File	52,910	0.03
04/00 DSF and New Construction	44,080	0.03
Field Verification	27,988	0.02
02/00 DSF and New Construction	27,544	0.02
LUCA 1999 Appeals	18,018	0.01
All other combinations	1,095,248	0.72

[1]Questionnaire Delivery refers to any operation where the address list was updated during the initial delivery of a questionnaire or during the actual enumeration. These operations include Update/Leave, Urban Update/Leave, Update/Enumerate, List/Enumerate, and Remote Alaska.

[2]Includes the results of several ad hoc "windshield survey" operations when whole communities appeared to be missing from the address list or mailout.

The data in the above table are not terribly surprising. Over half of the addresses on the MAF came from the 1990 ACF. Close to 18 percent came from the first use of the DSF. Just fewer than 15 percent of the addresses came from the Address Listing that the Census Bureau did outside of the blue line.

A more interesting way of looking at these data is to consider for each address source what percent were in the final census count, what percent were in the enumeration process but were not in the final census count, and what percent were in the MAF, but were never in the enumeration process in Census 2000. Table 10 provides this distribution. Since the focus of the data in this table is each individual operation or source, we collapsed original source categories so that all addresses that are at least partially attributed to a source are included in its count. Note that since some original source categories gave credit to more than one source, the data in this table do not sum to the total number of addresses in the MAF.

Table 10. Distribution of In Census Status for addresses by their original source

Original Source	Number of Addresses	Percent in Census	Percent in DMAF only	Percent in MAF only
1990 ACF	80,563,788	88.60	3.20	8.19
DSF	36,386,985	46.60	5.58	47.82
Address Listing	21,877,609	94.46	4.66	0.89
Block Canvassing	4,530,898	71.04	28.89	0.07
LUCA 1998	3,595,105	43.58	49.98	6.43
Questionnaire Delivery[1]	2,333,982	83.77	10.66	5.57
NRFU[2]	399,729	86.87	9.31	3.82
New Construction	382,271	46.45	51.81	1.74
LUCA 99 Recanvassing	327,241	85.47	13.98	0.55
Be Counted Program	182,379	32.11	55.03	12.86
TQA Program	142,293	37.87	49.08	13.04
CIFU[2]	100,465	81.34	15.17	3.49
1998 Dress Rehearsal	74,765	22.12	63.21	14.67
Special Place/Group Quarters Enumeration	73,007	75.98	24.02	0.00
Special Place/Group Quarters Master File	52,910	43.29	56.71	0.00
Field Verification	27,988	97.07	2.93	0.00
LUCA 99 Appeals	18,322	54.56	45.35	0.09

[1]Questionnaire Delivery refers to any operation where the address list was updated during the initial delivery of a questionnaire or during the actual enumeration. These operations include Update/Leave, Urban Update/Leave, Update/Enumerate, List/Enumerate, and Remote Alaska.

[2] Includes the results of several ad hoc "windshield survey" operations when whole communities appeared to be missing from the address list or mailout.

The following sections provide detailed analysis of addresses in the census, addresses in the DMAF but not in the census, and addresses in the MAF but not in the DMAF or in the census. However, from just reviewing this table one can see several interesting things. Addresses that are in the DMAF but not in the final census counts contribute inefficiency in the census because the Census Bureau attempted to enumerate them only to find out that they were not valid housing units or they were duplicates of other housing units also in the enumeration process that the Census Bureau eventually removed. The largest contributors of addresses, the 1990 ACF and the DSF did fairly well at providing valid addresses for enumeration. That is, of the addresses from these sources where the Census Bureau attempted enumeration, a fairly small percentage ended up not being in the final census (3.2 percent and 5.58 percent, respectively). Also note that although 47.82 percent of DSF addresses were only in the MAF, this is not surprising. These DSF addresses include addresses that are considered non-residential and addresses that geocoded to outside of the blue line where the Census Bureau never intended to use the DSF as a source for Census 2000. See Section 3.4 for more discussion of addresses in the MAF that were never delivered to the DMAF

The LUCA 1998 program provided a substantial number of addresses that ended up not in the census. Just under 50 percent of adds from this program were in the enumeration process but were not considered valid housing units or were considered duplicates at the end of the census. The fact that they were in the enumeration process is due to the fact that the Census Bureau had not completed the verification of LUCA adds in time for the mailout of census questionnaires. As was mentioned earlier in this report, we recommend that in the future, all LUCA adds must be verified prior to the mailout of census questionnaires.

The Block Canvassing operation provided few addresses for which the Census Bureau could not attempt enumeration, but a large number of addresses for which the Census Bureau attempted enumeration and ended up concluding that they were not valid housing units or were duplicates of other housing units.

Recommendations

Although Block Canvassing is a major contributor of valid housing units in the census, the Census Bureau should continue efforts to improve the quality of this operation. One important improvement would be to verify all Block Canvassing deletes prior to the creation of the universe for questionnaire mailout. Since not all deletes from Block Canvassing were verified in time for the mailout of census questionnaires, many of them were included in the mailout.

3.2 Addresses in the Final Census Count

Of the 115,904,641 addresses in the final census count, we first look at general characteristics of these addresses and then we analyze where they came from and how they ended up in the census.

Final Census Count Addresses by Type of Enumeration Area

Table 11 presents a distribution of the addresses in Census 2000 by TEA.

Table 11. Final census count addresses by Type of Enumeration Area

TEA	Number of Addresses	Percent of total
Inside the blue line	92,810,614	80.08
Mailout/Mailback	92,502,415	79.81
Urban Update/Leave	238,216	0.21
Urban Update/Enumerate	69,983	0.06
Outside the blue line	23,094,027	19.92
Update/Leave	21,788,559	18.80
List/Enumerate	392,235	0.34
Remote Alaska	27,002	0.02
Rural Update/Enumerate	886,231	0.76
Total	**115,904,641**	**100.00**

As can be seen in the table, the vast majority of addresses (80.8 percent) were in areas considered to be inside the blue line. These are areas where the primary method of building the address list was to:

- Use the 1990 ACF,
- Update it with a series of deliveries of the DSF from the USPS,
- Obtain updates from local governments in the LUCA 1998 program, and
- Conduct Block Canvassing to update the address list.

Almost all of these addresses (99.7 percent) were in Mailout/Mailback areas. Extremely small percentages of addresses inside the blue line were handled using Urban Update/Leave or Urban Update/Enumerate.

The other 19.92 addresses in Census 2000 were outside of the blue line. The vast majority of these addresses were in Update/Leave areas. In these areas, the address list was created by:

- Initially listing addresses in the Address Listing operation,
- Allowing local governments to challenge block counts in the LUCA 1999 operation,
- Recanvassing blocks challenged in the LUCA 1999 operation, and
- At the time of the census, updating the addresses in Update/Leave areas while delivering census questionnaires.

The 886,231 addresses in Rural Update/Enumerate represent areas where the initial address list was also developed during Address Listing and LUCA 1999, but the enumeration was conducted in the field at the same time that enumerators updated the list.

There were 419,237 addresses that were enumerated in either List/Enumerate or Remote Alaska. These areas are where the Census Bureau conducted a single operation to obtain the addresses and enumerate the households.

Final Census Count Addresses by Type of Address Information

Table 12 contains a distribution of the type of address information the Census Bureau was able to obtain for the addresses in Census 2000. We classify addresses into five categories based on the highest criteria met. The categories are: complete city-style, complete rural route, complete P.O. Box, incomplete addresses, and no address information.

- The city-style category includes all units that had complete city-style addresses, which consists of a house number and street name.
- The rural route category includes units that did not have a complete city-style address but did have a complete rural route address, such as Rural Route 2, Box 3.
- The P.O. Box category includes units that did not have either a complete city-style or a complete rural route address but did have a complete P.O. Box address, such as P.O. Box 5.
- The incomplete category includes units that had some address information but did not have a complete address of any type.
- The no address information category includes units that are missing house number, street name, Rural Route, and P.O. Box information.

Addresses are further delineated by whether or not the address had a physical/location description provided during a census field operation. For additional information on how this variable was defined, see United States Census Bureau, 2001a.

Table 12: Final census count addresses by type of address

Type of Address Information	Number of Addresses	Percent of Total
Complete City-style	109,448,403	94.43
Complete Rural Route	2,051,571	1.77
With Location Description	2,016,562	1.74
Without Location Description	35,009	0.03
Complete P.O. Box	885,713	0.76
With Location Description	849,027	0.73
Without Location Description	36,686	0.03
Incomplete address information	504,313	0.44
With Location Description	310,284	0.27
Without Location Description	194,029	0.17
No address information	3,014,641	2.60
With Location Description	2,978,743	2.57
Without Location Description	35,898	0.03
TOTAL	**115,904,641**	**100.00**

As can be seen in Table 12, almost all addresses in Census 2000 (94.43 percent) had a complete city-style address. The next largest group (2.60 percent of the addresses) had no address information but either had a location description or a map spot or both. An additional 1.77 percent of the addresses had a complete rural route address, with over 98 percent of these also having a location description.

Final Census count Addresses by Original Source

Table 13 provides the distribution of final census addresses by original source.

Table 13. Final census count addresses by original source

Original Source	Number of Addresses	Percent of Total
1990 ACF	71,381,708	61.59
Address Listing	20,664,652	17.83
11/97 (or earlier) DSF	14,552,313	12.56
Block Canvassing	2,706,472	2.33
Questionnaire Delivery[1]	1,954,176	1.69
09/98 DSF	995,103	0.86
LUCA 1998	659,276	0.57
11/99 DSF	578,274	0.50
LUCA 1998 and Block Canvassing	512,091	0.44
LUCA 1998 & 09/98 DSF	395,575	0.34
NRFU[2]	347,233	0.30
LUCA 1999 Recanvassing	279,692	0.24
04/00 DSF	195,936	0.17
02/00 DSF	174,648	0.15
New Construction	111,626	0.10
CIFU[2]	81,723	0.07
Be Counted Program	58,380	0.05
Special Place/Group Quarters Enumeration	55,468	0.05
TQA Program	53,712	0.05
04/00 DSF and New Construction	40,094	0.03
Field Verification	27,169	0.02
02/00 DSF & New Construction	25,475	0.02
Special Place/Group Quarters Master File	22,906	0.02
1998 Dress Rehearsal	16,539	0.01
LUCA 1999 Appeals	9,710	0.01
All other combinations	4,690	<0.01
TOTAL	115,904,641	100.00

[1]Questionnaire Delivery refers to any operation where the address list was updated during the initial delivery of a questionnaire or during the actual enumeration. These operations include Update/Leave, Urban Update/Leave, Update/Enumerate, List/Enumerate, and Remote Alaska.

[2] Includes the results of several ad hoc "windshield survey" operations when whole communities appeared to be missing from the address list or mailout.

The 1990 ACF provided 61.59 percent of the addresses in Census 2000. That is quite reasonable, given that although the housing inventory changes over time, we expect most housing units to remain as valid housing units from one census to the next. One might have expected this percentage to be higher, but recall that outside of the blue line, the Census Bureau did not use the 1990 ACF as a source of addresses. The Census Bureau developed the address list in those areas from scratch.

As was seen in Table 11, over 23 million addresses in the Census were outside of the blue line.

As expected, we can see that 17.83 percent of the addresses in Census 2000 originated in the Address Listing operation, which was conducted in most areas outside of the blue line.

The next substantial contribution of addresses in Census 2000 was the USPS, which provided a combined 14.24 percent of the addresses in the Census from its various deliveries of the DSF. Most of these addresses came on the first DSF, which was used in the initial creation of the MAF.

Finally, the Census Bureau's field updating operations of Block Canvassing (inside the blue line) and Questionnaire Delivery (primarily outside of the blue line) are the only other operations to have provided us with more than 1 percent of the addresses in the census (2.33 percent from Block Canvassing and 1.69 percent from questionnaire delivery).

The remaining operations and combinations of operations make up 2.32 percent of the addresses in the Census.

Combining the various LUCA programs accounts for 0.92 percent of the addresses in the Census (not counting situations where LUCA and other operations both received credit as the original source). This is a low percentage of addresses, given the effort that these operations required of both Census Bureau staff and local government staff. However, it is important to recognize that this program also provided successful partnership benefits early in the Census process. This program gave local governments the opportunity to examine the results of our processes to correct errors and to gain confidence in our address list development operations.

Programs such as Be Counted, TQA, NRFU, and CIFU have other major purposes in the Census. The fact that the Census Bureau picks up some addresses from these operations is useful, but one cannot measure the full success of these programs by their contribution to the address list. The Special Place/Group Quarters operations were targeted towards enumerating special populations and were not specifically intended to proved additional housing units to the census list.

3.2.1 Combined Analysis of Addresses in the Final Census – Mailout/Mailback Areas

The majority of addresses in the country are in census blocks where the Census Bureau used Mailout/Mailback for enumeration. In these areas, the USPS uses, for the most part, city-style addresses for mail delivery. A city-style address contains a house number and street name (for example, 101 Main Street) and may also contain identifiers for specific housing units within a structure (for example, Apartment 2). The Census Bureau created the address list in these areas by using addresses from the 1990 Census and addresses from USPS files. As can be seen in Table 14, 99.75 percent of the addresses in the census in these areas had complete city-style addresses. Almost all of the remaining addresses had location descriptions.

Table 14. Final census count addresses in Mailout/Mailback areas by type of address

Type of Address Information	Number of Addresses	Percent of Total
Complete City-style	92,269,368	99.75
Complete Rural Route	24,600	0.03
With Location Description	23,667	0.03
Without Location Description	933	<0.01
Complete P.O. Box	5,395	0.01
With Location Description	4,547	<0.01
Without Location Description	848	<0.01
Incomplete address information	180,976	0.20
With Location Description	163,759	0.18
Without Location Description	17,217	0.02
No address information	22,076	0.02
With Location Description	16,905	0.02
Without Location Description	5,171	0.01
TOTAL	**92,502,415**	**100.00**

Table 15 provides the original source of all addresses in the census in Mailout/Mailback areas.

Table 15. Final census count addresses in Mailout/Mailback areas by original source

Original Source	Number of Addresses	Percent of Total
1990 ACF	71,175,987	76.95
11/97 DSF	14,485,330	15.66
Block Canvassing	2,683,882	2.90
09/98 DSF	990,196	1.07
LUCA 1998	653,769	0.71
11/99 DSF	575,769	0.62
LUCA 1998 & Block Canvassing	509,653	0.55
LUCA 1998 & 09/98 DSF	394,665	0.43
NRFU[2]	218,064	0.24
04/00 DSF	195,709	0.21
02/00DSF	173,901	0.19
New Construction	111,097	0.12
Questionnaire Delivery[1]	64,590	0.07
CIFU[2]	55,235	0.06
Be Counted Program	42,245	0.05
04/00 DSF and New Construction	40,030	0.04
Special Place/Group Quarters Enumeration	30,332	0.03
02/00 DSF and New Construction	25,333	0.03
TQA Program	24,651	0.03
Field Verification	24,418	0.03
1998 Dress Rehearsal	11,157	0.01
Special Place/Group Quarters Master File	10,174	0.01
All other combinations	6,228	< 0.01
TOTAL	**92,502,415**	**100.00**

[1]Questionnaire Delivery refers to any operation where the address list was updated during the initial delivery of a questionnaire or during the actual enumeration. These operations include Update/Leave, Urban Update/Leave, Update/Enumerate, List/Enumerate, and Remote Alaska.

[2] Includes the results of several ad hoc "windshield survey" operations when whole communities appeared to be missing from the address list or mailout.

Within the areas where the Census Bureau's enumeration method was Mailout/Mailback, 76.95 percent of the addresses had an original source of the 1990 ACF. The DSFs provided 17.75 percent of the addresses. Just fewer than three percent came from the Block Canvassing operation. Only 0.71 percent of the addresses came from the LUCA 1998 program alone. However, if you consider addresses that came both from LUCA 1998 and other operations happening at the same time (the September 1998 DSF and Block Canvassing) the percent of addresses with an original source of LUCA goes up to 1.69 percent. These are units we know would have been picked up in other operations, whereas for the 653,769 units with just the LUCA Original Source, there is some chance they would have been missed without LUCA. The next largest contributor of addresses in these areas is the NRFU operation, which provided 0.24 percent of the addresses.

In trying to understand the relationship of all of the operations conducted in Mailout/Mailback areas, we limited our analysis of addresses in the final census to the combination of the following operations:

- 1990 ACF
- The first three DSFs
- Block Canvassing
- LUCA 1998

We did this because if we were to try to account for all combinations of actions from all operations in these areas, we would have to address over 90,000 combinations of actions. When we consider only these operations, we account for 93.59 percent of the 92,502,415 addresses in these TEAs.

Appendix B, Table 1 summarizes the distribution of actions taken from these different operations on addresses that ended up in the final census counts.

From Appendix B, Table 1, we see that the largest percentage (66.25 percent) of addresses in the census from Mailout/Mailback areas are cases that:

- Were on the 1990 ACF,
- Were considered residential on at least one of the first three DSF deliveries,
- Contained a positive action from Block Canvassing (either verified, corrected, or moved), and
- Contained a positive action from LUCA 1998 (either corrections or no action from the LUCA participants).

Just fewer than 10 percent of the addresses had all of the same characteristics with the exception of not being on the 1990 ACF.

The next largest percentage (5.527 percent) of addresses in the census in these areas:

- Were on the 1990 ACF,
- Were considered residential on at least one of the first three DSF deliveries,
- Contained a positive action from Block Canvsassing (either verified, corrected, or moved), BUT
- Were **not** in the LUCA 1998 universe

Approximately 3.5 percent of the addresses had all of the same characteristics with the exception of not being on the 1990 ACF.

Just considering the several rather straight forward combinations described above accounts for over 85 percent of the addresses in the census in Mailout/Mailback areas.

The next largest combinations of addresses were situations where Block Canvassing added the units. In the first of these situations, 1.46 percent of the in-census addresses were:

- Not on the 1990 ACF
- Were considered to be residential on at least one of the first three DSFs,
- Were not in the LUCA 1998 Universe, but
- Were added in Block Canvassing.

The fact that these addresses were residential on an early DSF but they were also added in Block Canvassing probably implies that the Census Bureau was unable to geocode the DSF addresses prior to Block Canvassing. Block Canvassing had to independently add them in order to get them in the mailout.

Just slightly fewer addresses (1.44 percent) had the same characteristics as above except they were not considered to be residential on any of the first three DSFs. Had it not been for Block Canvassing, these addresses would most likely have been missing from the census.

Recommendations

The series of combinations used to build the address list in Mailout/Mailback areas and the number of addresses that made their way into the census from each of them, demonstrate that no one operation could have resulted in an adequate address list. It took the use of the 1990 Census address list, information from the USPS, Block Canvassing, and information from local governments to collectively give the Census Bureau a complete address list. Each of these sources played a key role in identifying addresses that the others may have missed. For example, although the DSF provided a large number of addresses in Census 2000, the DSF Assessment Report identified that at times the DSF fell short of the Census Bureau's needs when it identified multi-unit structures as single delivery points rather than identifying each housing unit individually. It took operations like Block Canvassing or LUCA to provide the actual number of housing units in those multi-unit structures along with their unit designations. We recommend that this important series of address sources continue to be the basis for the Census Bureau's approach to building the address list for the 2010 Census. That is, the Census Bureau should start with the final Census 2000 address list, use updates from the USPS, acquire input from local governments, and canvass the ground as necessary. Note that the Census Bureau expects to maintain the address list during the decade. Rules for updating the Census 2000 list should be tested sufficiently so that the updated address list can be the starting point of updates for the 2010 Census as the 1990 ACF was for Census 2000.

3.2.2 Combined Analysis of Addresses in the Final Census Count – Update/Leave Areas

In the Update/Leave areas, noncity-style addresses are more common. Noncity-style addresses occur in the forms of rural route/box numbers, post office box numbers, highway contract route numbers, and general delivery addresses. It is difficult to establish their census block locations through automated matching because they are less systematic and are not always associated with the location of the residence. Post office boxes and general delivery addresses, as a rule, have no

relationship to physical location. Thus, the initial MAF creation method for areas where these types of addresses predominate is through field compilation by census staff. In Update/Leave areas, the Census Bureau initially created the address list by using address listing. Table 16 presents the distribution of the type of address information in Update/Leave areas.

Table 16. Final census count addresses in Update/Leave areas by type of address

Type of Address Information	Number of Addresses	Percent of Total
Complete City-style	16,091,926	73.85
Complete Rural Route	1,937,531	8.89
With Location Description	1,906,503	8.75
Without Location Description	31,028	0.14
Complete P.O. Box	753,756	3.46
With Location Description	725,266	3.33
Without Location Description	28,490	0.13
Incomplete address information	278,352	1.28
With Location Description	119,067	0.55
Without Location Description	159,285	0.73
No address information	2,726,994	12.52
With Location Description	2,712,654	12.45
Without Location Description	14,340	0.07
TOTAL	**21,788,559**	**100.00**

As can be seen, a smaller percentage of addresses in these areas have city-style addresses when compared to mailout/mailback areas. This is exactly what was expected. However, the Census Bureau was still able to obtain a complete city-style address for almost 74 percent of the addresses in Update/Leave areas. Although 12.35 percent of the addresses in these areas have complete rural route or post office box addresses, 12.57 percent of these Update/Leave area addresses have no address information. In all of these cases where the Census Bureau does not have a complete city-style address, it is the location description and map spot that is critical for enumeration. Since the Census Bureau does not mail census forms to rural route addresses or post office box addresses, it is the location description and map stop that is critical for getting the enumerators to the correct units to deliver the questionnaires. Location descriptions were acquired over 95 percent of the time when the address was noncity-style. (This was determined by taking all of the addresses in Table 16, subtracting those with complete a city-style address, and looking at the percentage of those with a location description.) We cannot tell from this evaluation how many of these location descriptions are truly specific enough to help enumerators get to the correct housing units.

Table 17 provides the original source for all addresses in the final census in Update/Leave areas.

Table 17. Final census count addresses in Update/Leave areas by original source

Original Source	Number of Addresses	Percent of Total
Address Listing	19,906,710	91.36
Questionnaire Delivery[1]	1,349,222	6.19
LUCA 1999 Recanvassing	266,198	1.22
NRFU[2]	128,183	0.59
TQA Program	28,273	0.13
CIFU[2]	26,295	0.12
Special Place/Group Quarters Enumeration	21,476	0.10
Be Counted Program	15,225	0.07
Special Place/Group Quarters Master File	11,896	0.05
LUCA 1999 Appeals	8,780	0.04
11/97 DSF	7,411	0.03
1998 Dress Rehearsal	5,307	0.02
1990 ACF	4,346	0.02
LUCA 1998	3,467	0.02
Field Verification	2,376	0.01
All other combinations	3,394	0.01
TOTAL	21,788,559	100.00

[1]Questionnaire Delivery refers to any operation where the address list was updated during the initial delivery of a questionnaire or during the actual enumeration. These operations include Update/Leave, Urban Update/Leave, Update/Enumerate, List/Enumerate, and Remote Alaska.

[2] Includes the results of several ad hoc "windshield survey" operations when whole communities appeared to be missing from the address list or mailout.

Within the Update/Leave areas of the country, 91.36 percent of the addresses had Address Listing as their original source. An additional 6.19 percent came from the Update/Leave operation. The only other original source that contributed more than one percent in these areas was the LUCA 99 Recanvassing operation, which provided 1.22 percent of the addresses. The next highest contributor was the NRFU operation, which provided 0.59 percent of the addresses in Update/Leave areas.

Overall, in Update/Leave areas, the combinations that are reflected in Appendix B, Table 2, can explain approximately 96.37 percent of the 21,788,559 addresses.

The largest combination of operations yielding good census addresses in Update/Leave areas is when addresses were added in Address Listing, no LUCA recanvass action was taken and Update/Leave either verified or corrected the address. This accounted for 78 percent of the addresses in Update/Leave areas. An additional 8.4 percent of the addresses in Update/Leave areas were added in Address Listing and had a positive action from the LUCA recanvass operation and were either verified or corrected during Update/Leave. LUCA recanvass adds accounted for 1.16 percent of the good census addresses in Update/Leave areas and Update/Leave adds accounted for 6.1 percent. It is interesting to note that just under 2.5 percent of the addresses in the final census count in Update/Leave areas were added in Address Listing, had no LUCA recanvass action, but were either deleted in Update/Leave or coded as nonresidential. These addresses were either deleted

in error in Update/Leave or reinstated in error by operations intending to verify the delete action in Update/Leave.

Recommendations

As in Mailout/Mailback areas, it appears that the full complement of operations used in Update/Leave areas was necessary for obtaining a complete address list. Because we have now captured address information in these areas, along with map spots, we recommend that in the 2010 Census, this combination of address canvassing, local government updates, and Update/Leave at the time of enumeration be used again in areas where DSF updating is still not feasible. In the meantime, because of the large percentage of city-style addresses, it may be less critical to obtain map spots for addresses in Update/Leave areas in order to be included in the Census.

Given the address problems in Puerto Rico the Census Bureau should attempt to clean up the Puerto Rico addresses before reuse in 2010. See Section 2.2.1 for more information on the address problems in Puerto Rico. Our understanding is that some efforts have already been done to clean up this problem. Also, more planning time should go into anticipating the best way to collect and process addresses in Puerto Rico in advance of the census.

3.2.3 Combined Analysis of Addresses in the Final Census Count – List/Enumerate Areas

List/Enumerate areas were sparsely populated areas where the Census Bureau intended to use a single, all-in-one operation to list addresses and enumerate them. These are the most remote areas where the Census Bureau conducts the census. Because of this, and because the Census Bureau only intends to visit these addresses once during the census, it is less likely that it will collect city-style addresses in these areas. Table 18 provides the distribution of the type of address information in List/Enumerate areas.

Table 18. Final census count addresses in List/Enumerate areas by type of address

Type of Address Information	Number of Addresses	Percent of Total
Complete City-style	198,454	50.60
Complete Rural Route	34,548	8.81
With Location Description	32,695	8.34
Without Location Description	1,853	0.47
Complete P.O. Box	37,170	9.48
With Location Description	33,515	8.54
Without Location Description	3,655	0.93
Incomplete address information	12,282	3.13
With Location Description	6,155	1.57
Without Location Description	6,127	1.56
No address information	109,781	27.99
With Location Description	96,611	24.63
Without Location Description	13,170	3.36
TOTAL	**392,235**	**100.00**

As can be seen, just over 50 percent of addresses in these areas have city-style addresses. This percentage is expectedly lower than in Mailout/Mailback or Update/Leave areas but still relatively high. Although 18.29 percent of the addresses in these areas have complete rural route or post office box addresses, just fewer than 28 percent of these List/Enumerate area addresses have no address information. Re-contact of respondents in List/Enumerate areas during a census is rare. It is usually restricted to quality control checks of the List/Enumerate operation. These addresses have been added to the MAF and the American Community Survey and future censuses intend to use these addresses. It appears that location descriptions were acquired 87 percent of the time when the address was noncity-style, incomplete, or missing. We cannot tell from this evaluation how many of these location descriptions are truly specific enough to help enumerators get to the correct housing units.

As stated earlier in this report (See Section 2.3.1), 389,749 addresses were enumerated in the census using the List/Enumerate operation. That accounts for over 99 percent of the 392,235 addresses in the final census that were coded to List/Enumerate blocks. The bulk of the remaining 2,486 cases were housing units that were enumerated through the Special Place/Group Quarters operation. See the Table 19.

Table 19. Number and Percentage of final census count addresses in List/Enumerate areas by combinations of sources

Operations	Number	Percent of Total
Listed in List/Enumerate operation	389,749	99.37
NOT Listed in List/Enumerate operation	2,486	0.63
Special Place/Group Quarters Enumeration Master File	1,334	0.34
Be Counted/TQA	623	0.16
Field Verification	421	0.11
Other	108	0.03
Total Housing Units in TEA 3	**392,235**	**100.00**

3.2.4 Combined Analysis of Addresses in the Final Census Count in Remote Alaska

Remote Alaska areas were sparsely populated areas in the State of Alaska where the Census Bureau intended to use a single operation to list addresses and enumerate them. The Census Bureau also provided lists of addresses to sworn village officials so they could help locate and identify any addresses that may have been missed. In this way, the Census Bureau could enumerate these missed addresses while they were still there. Within Remote Alaska areas, there was a much lower percentage of addresses that had complete city-style addresses. Table 20 provides the distribution of type of address information for the cases in these areas.

Table 20. Final census count addresses in Remote Alaska areas by type of address

Type of Address Information	Number of Addresses	Percent of Total
Complete City-style	5,401	20.00
Complete Rural Route	229	0.85
With Location Description	227	0.84
Without Location Description	2	0.01
Complete P.O. Box	10,767	39.87
With Location Description	10,588	39.21
Without Location Description	179	0.66
Incomplete address information	247	0.91
With Location Description	135	0.50
Without Location Description	112	0.41
No address information	10,358	38.36
With Location Description	10,285	38.09
Without Location Description	73	0.27
TOTAL	**27,002**	**100.00**

Only 20 percent of the addresses in this TEA had complete city-style addresses, whereas just under 40 percent had complete post office box addresses with almost all of them having location descriptions. An additional 38.36 had no address information, most of which did have a location description.

Virtually all addresses in the final census count in these areas came from the Remote Alaska operation. See Table 21.

Table 21. Number and percentage of final census count addresses in remote/Alaska areas by combinations of sources

Operations	Number	Percent of Total
Enumerated in Remote Alaska operation	26,987	99.94
Enumerated by another valid source	15	0.06
Be Counted/TQA	6	0.02
Field Verification	1	<0.01
SP/GQ Master File or SP/GQ Enumeration	7	0.03
Total Housing Units in TEA 4	**27,002**	**100.00**

3.2.5 Combined Analysis of Addresses in the Final Census Count in Rural Update/Enumerate

In Rural Update/Enumerate areas, the Census Bureau built the address list in the same manner as in Update/Leave areas. The only exception is that instead of leaving questionnaires to be mailed back, the Census Bureau enumerated the housing units while in the field updating the address list. These areas included resort areas with high concentrations of seasonally vacant housing units, selected American Indian reservations, and colonias. The Census Bureau anticipated that many of these areas would have poor address information.

Table 22. Final census count addresses in Rural Update/Enumerate areas by type of address

Type of Address Information	Number of Addresses	Percent of Total
Complete City-style	578,310	65.26
Complete Rural Route	54,655	6.17
With Location Description	53,462	6.03
Without Location Description	1,193	0.13
Complete P.O. Box	78,600	8.87
With Location Description	75,086	8.47
Without Location Description	3,514	0.40
Incomplete address information	29,641	3.34
With Location Description	19,180	2.16
Without Location Description	10,461	1.18
No address information	145,025	16.36
With Location Description	142,009	16.02
Without Location Description	3,016	0.34
TOTAL	**886,231**	**100.00**

Although 65 percent of the addresses were complete city-style addresses, this is lower than in Update/Leave areas where close to 74 percent of the addresses were city-style. These areas had a higher percentage of cases with no address information (16.36 percent in Update/Enumerate areas versus 12.52 percent in Update/Leave areas).

Table 23 provides the original source for all addresses in the final census in Rural Update/Enumerate areas.

Table 23. Final census count addresses in Rural Update/Enumerator areas by original source

Original Source	Number of Addresses	Percent of Total
Address Listing	756,061	85.31
Questionnaire Delivery*	112,090	12.65
LUCA 1999 Recanvassing	13,481	1.52
Special Place/Group Quarters Enumeration	2,492	0.28
Special Place/Group Quarters Master File	535	0.06
TQA Program	445	0.05
Be Counted Program	323	0.04
LUCA 1999 Appeals	317	0.04
11/97 DSF	185	0.02
Field Verification	78	0.01
1998 Dress Rehearsal	75	0.01
All other combinations	149	0.02
TOTAL	886,231	100.00

*Questionnaire Delivery refers to any operation where the address list was updated during the initial delivery of a questionnaire or during the actual enumeration. These operations include Update/Leave, Urban Update/Leave, Update/Enumerate, List/Enumerate, and Remote Alaska.

Address Listing was the original source for 85.31 percent of the addresses in Rural Update/Enumerate areas. An additional 12.65 percent have an original source of Rural Update/Enumerate. The only other original source with more than one percent of the addresses is the LUCA Recanvassing. LUCA Recanvassing was the original source for 1.52 percent of the addresses in Rural Update/Enumerate.

In Rural Update/Enumerate areas, 98.92 percent of the addresses in the final census can be attributed to some combination of actions from Address Listing, LUCA Recanvassing, and Rural Update/Enumerate. These operations really should represent 100 percent of the operations in this TEA. The distribution of combinations is found in Table 24.

Table 24. Rural Update/Enumerate census addresses by most frequent action code combinations

Address Listing action	LUCA 99 action	Rural Update/Enumerate "U/E" action	Count	Percent
Address Listing Adds	no LUCA 99 action	(+) Rural U/E action[3]	692,698	78.16
		(-) Rural U/E action[4]	4,300	0.49
	(+) LUCA 99 action[1]	(+) Rural U/E action	54,474	6.15
		(-) Rural U/E action	489	0.06
	(-) LUCA 99 action[2]	(+) Rural U/E action	145	0.02
		(-) Rural U/E action	7	0.00
	LUCA 99 Adds	(+) Rural U/E action	13,231	1.49
		(-) Rural U/E action	176	0.02
		Rural U/E Adds	111,095	12.54
TOTALS			**876,615**	**98.92**

[1] (+) LUCA 99 action = Postive action from the LUCA 99 Recanvass, including Verifications and Corrections
[2] (-) LUCA 99 action = Negative action from the LUCA 99 Recanvass, including Deletes and Nonresidentials
[3] (+) Rural U/E action = Positive action from the Rural Update/Enumerate operation, including Verifications, Corrections and Moves
[4] (-) Rural U/E action = Negative action from the Rural Update/Enumerate operation, including Deletes and Nonresidentials

The largest combination of operations yielding good census addresses in Rural Update/Enumerate areas is when addresses were added in Address Listing, no LUCA recanvass action was taken and Rural Update/Enumerate verified or corrected the address. This is similar to Update/Leave areas and accounted for 78.16 percent of the addresses in this type of enumeration area. An additional 6.15 percent of the good census addresses in Rural Update/Enumerate areas were added in Address Listing, had positive actions from the LUCA recanvass operation and were verified or converted during Rural Update/Enumerate operation. LUCA recanvass adds accounted for 1.51 percent of the good census addresses in Rural Update/Enumerate areas. Rural Update/Enumerate adds accounted for 12.54 percent of the addresses in this type of enumerator area.

3.2.6 Combined Analysis of Addresses in the Final Census Count in Urban Update/Leave

Table 25 provides the distribution of the type of address information collected for addresses in the census in Urban Update/Leave areas.

Table 25. Final census count addresses in Urban Update/Leave areas by type of address

Type of Address Information	Number of Addresses	Percent of Total
Complete City-style	236,090	99.11
Complete Rural Route	6	<0.01
With Location Description	6	<0.01
Without Location Description	0	0.00
Complete P.O. Box	23	0.01
With Location Description	23	0.01
Without Location Description	0	0.00
Incomplete address information	1,960	0.82
With Location Description	1,352	0.57
Without Location Description	608	0.26
No address information	137	0.06
With Location Description	120	0.05
Without Location Description	17	0.01
TOTAL	**238,216**	**100.00**

In Urban Update/Leave areas, the Census Bureau built the address list in the same manner as in Mailout/Mailback areas. The only exception is that instead of mailing out questionnaires, the Census Bureau hand delivered the questionnaires and updated the address list during that delivery. This was done because the Census Bureau believed that these urban areas were unsuitable for mail delivery either because there were multi-unit buildings with single mail drop points or there was widespread use of post office boxes. Similar to Mailout/Mailback areas, over 99 percent of the addresses in Urban Update/Leave areas were complete city-style addresses.

Table 26 provides the original source of all addresses in the census in Urban Update/Leave Areas.

Table 26. Final census count addresses in Urban Update/Leave areas by original source

Original Source	Number of Addresses	Percent of Total
1990 ACF	165,260	69.37
11/97 DSF	40,534	17.02
Block Canvassing	15,228	6.39
Questionnaire Delivery[1]	5,682	2.39
09/98 DSF	3,131	1.31
LUCA 1998 & Block Canvassing	1,855	0.78
LUCA 1998	1,479	0.62
11/99 DSF	1,414	0.59
NRFU[2]	983	0.41
02/00 DSF	576	0.24
LUCA 1998 & 09/98 DSF	505	0.21
04/00 DSF and Questionnaire Delivery	384	0.16
New Construction	218	0.09
04/00 DSF	194	0.08
CIFU[2]	192	0.08
Be Counted Program	167	0.07
02/00 DSF and New Construction	112	0.05
TQA Program	71	0.03
New Construction and Questionnaire Delivery	62	0.03
Special Place/Group Quarters Master File	42	0.02
Special Place/Group Quarters Enumeration	37	0.02
04/00 DSF and New Construction	34	0.01
04/00 DSF, New Construction, and Questionnaire Delivery	27	0.01
Field Verification	23	0.01
All other combinations	6	< 0.01
TOTAL	**238,216**	**100.00**

[1]Questionnaire Delivery refers to any operation where the address list was updated during the initial delivery of a questionnaire or during the actual enumeration. These operations include Update/Leave, Urban Update/Leave, Update/Enumerate, List/Enumerate, and Remote Alaska.

[2]Includes the results of several ad hoc "windshield survey" operations when whole communities appeared to be missing from the address list or mailout.

Although the sources of addresses in Urban Update/Leave areas are fairly similar to Mailout/Mailback areas, the distribution of original sources shows some differences. Just over 69 percent of addresses in Urban Update/Leave Areas had the 1990 ACF as their original source compared to almost 77 percent in Mailout/Mailback areas. The DSF was the original source for 19.24 percent of the Urban Update/Leave address compared to 17.75 percent of Mailout/Mailback cases. Block Canvassing was the original source for 6.39 percent of the Urban Update/Leave address. This is a much higher percentage than the 2.68 percent in Mailout/Mailback areas. This higher percentage of cases with an original source of Block Canvassing makes sense given that Urban Update/Leave was intended for urban areas with large concentrations of persons who use post office boxes and for areas where the USPS has a single drop point for large multi-unit addresses.

However the higher percentage of cases with an original source of the DSF in these areas is not consistent with the purpose of Urban Update/Leave areas. We do not have an explanation for this increase in cases with an original source of the DSF. Finally, just fewer than 2.4 percent of the Urban Update/Leave cases had an original source of the Urban Update/Leave operation itself. That is, by visiting these urban areas and dropping off questionnaires the Census Bureau managed to pick up 2.4 percent of the cases in this type of enumeration area.

Similar to Mailout/Mailback areas, we limited our analysis of the contributors of source to the following operations:

- 1990 ACF
- The first three DSFs
- Block Canvassing
- LUCA 1998

This accounted for 89.73 percent of the 238,216 addresses in Urban Update/Leave areas.

Just fewer than 62 percent of the addresses in Urban Update/Leave were:

- On the 1990 ACF
- Considered residential on at least one of the first three DSF deliveries, and
- Counted as a positive action from Block Canvassing

An additional 15 percent had all of the same characteristics with the exception of not being on the 1990 ACF. Fewer than 5.3 percent of the addresses were not on the 1990 ACF or considered residential from one of the first three DSFs but were added in the Block Canvassing operation.

3.2.7 Combined Analysis of Addresses in the Final Census Count in Urban Update Enumerate Areas

Table 27 provides the distribution of the type of address information collected for addresses in the census in Urban Update/Enumerate areas.

Table 27. Final census addresses in urban Update/Enumerators areas by type of address

Type of Address Information	Number of Addresses	Percent of Total
Complete City-style	68,854	98.39
Complete Rural Route	2	<0.01
With Location Description	2	<0.01
Without Location Description	0	0.00
Complete P.O. Box	2	<0.01
With Location Description	2	<0.01
Without Location Description	0	0.00
Incomplete address information	855	1.22
With Location Description	636	0.91
Without Location Description	219	0.31
No address information	270	0.39
With Location Description	159	0.23
Without Location Description	111	0.16
TOTAL	**69,983**	**100.00**

In Urban Update/Enumerate areas, the Census Bureau targeted communities with special enumeration needs or where they expected low mail returns because of such things as seasonal vacants. Just like Mailout/Mailback areas and Urban Update/Leave areas, in Urban Update/Enumerate areas, the vast majority of addresses were complete city-style (98.39 percent). In this type of enumeration area, 1.22 percent of the address had incomplete address information, with over 74 percent of them having location descriptions.

Table 28 provides the original source of all addresses in the census in Urban Update/Enumerate areas.

Table 28. Final census count addresses in Urban Update/Enumerate areas by original source.

Original Source	Number of Addresses	Percent of Total
1990 ACF	35,993	51.43
11/97 DSF	18,718	26.75
Block Canvassing	6,545	9.35
Questionnaire Delivery*	5,887	8.41
09/98 DSF	1,103	1.58
LUCA 1998 & Block Canvassing	541	0.77
LUCA 1998	505	0.72
11/99 DSF	395	0.56
LUCA 1998 & 09/98 DSF	157	0.22
Be Counted Program	39	0.06
New Construction and Questionnaire Delivery	31	0.04
TQA Program	23	0.03
Special Place/Group Quarters Enumeration	18	0.03
Field Verification	13	0.02
Special Place/Group Quarters Master File	13	0.02
All other combinations	2	<0.01
TOTAL	**69,983**	**100.00**

*Questionnaire Delivery refers to any operation where the address list was updated during the initial delivery of a questionnaire or during the actual enumeration. These operations include Update/Leave, Urban Update/Leave, Update/Enumerate, List/Enumerate, and Remote Alaska.

Again, the address list development in Urban Update/Enumerate area was fairly similar to Mailout/Mailback area and Urban Update/Leave areas. This TEA has even less reliance on the 1990 ACF (51.43 percent) for original source and more reliance on the DSF (28.89 percent), Block Canvassing (7.96 percent) and the Urban Update/Enumerator operation itself (8.41 percent).

3.3 Addresses That Were Not In the Final Census Count But Were In the Decennial Master Address File

The MAF delivered 9,752,206 addresses to the DMAF that were not in the final census counts.

Table 29 provides the original sources of the addresses that were in the DMAF but were not in the final census counts.

Table 29. Distribution of original source for addresses in the Decennial Master Address File but not in the final census count

Original Source	Number of Addresses	Percent of Total
1990 ACF	2,580,192	26.46
LUCA 1998	1,726,278	17.70
11/97 DSF	1,506,592	15.45
Block Canvassing	1,252,226	12.84
Address Listing	1,019,257	10.45
Unknown: TEAs 1-9	274,774	2.82
Questionnaire Delivery[1]	248,728	2.55
New Construction	192,214	1.97
11/99 DSF	186,753	1.91
09/98 DSF	135,945	1.39
04/00 DSF	112,670	1.16
Be Counted Program	100,131	1.03
TQA Program	69,606	0.71
02/00 DSF	67,935	0.70
LUCA 1998 & Block Canvassing	56,845	0.58
1998 Dress Rehearsal	47,259	0.48
LUCA 1999 Recanvassing	45,736	0.47
NRFU[2]	37,221	0.38
Special Place/Group Quarters Master File	30,004	0.31
Special Place/Group Quarters Enumeration	17,539	0.18
CIFU[2]	15,238	0.16
LUCA 1998 & 09/98 DSF	13,836	0.14
LUCA 1999 Appeals	8,292	0.09
04/00 DSF and New Construction	3,848	0.04
02/00 DSF and New Construction	1,923	0.02
Field Verification	819	0.01
All other combinations	345	<0.01
TOTAL	**9,752,206**	**100.00**

[1]Questionnaire Delivery refers to any operation where the address list was updated during the initial delivery of a questionnaire or during the actual enumeration. These operations include Update/Leave, Urban Update/Leave, Update/Enumerate, List/Enumerate, and Remote Alaska.

[2]Includes the results of several ad hoc "windshield survey" operations when whole communities appeared to be missing from the address list or mailout.

In reviewing this distribution, it is helpful to look back at Table 9, which provided the overall distribution of original source for addresses in the MAF.

The 1990 ACF provided 26.46 percent of the addresses where the Census Bureau attempted enumeration but ended up coding them as not valid housing units. Given that this was the largest source of addresses overall, this is not surprising. The various DSF deliveries provided 20.61 percent of the addresses in the DMAF but not in the census.

Probably the most striking statistic regarding the original source of addresses where the Census Bureau attempted enumeration, but ultimately coded the addresses as not valid housing units is that 17.70 percent of them came from LUCA 1998. However, it is important to recognize that the Census Bureau included most LUCA 1998 added addresses on the DMAF because it was not able to verify their existence prior to the mailout. However, once the Census Bureau was able to conduct LUCA Field Verification, many of these LUCA adds were removed from the census. In the final census count, LUCA 1998 was the original source for 659,276 addresses. Meanwhile, the Census Bureau attempted enumeration at an additional 1,726,278 addresses with an original source of LUCA 1998, only to find the units as invalid.

The New Construction Program is the only other operation that showed a substantially large percentage of cases (relative to the number in the census) where the Census Bureau attempted enumeration and coded the cases as invalid. New Construction was the original source for 111,626 cases in the final census counts. Meanwhile, this operation was the original source for 192,214 cases in the DMAF but not in the final census. These statistics provide a strong case for the need to verify locally provided addresses before including them in the enumeration.

In Table 30 we present the distribution of addresses in the DMAF but not in the census, by the operation where they were deleted.

Table 30. Addresses in the Decennial Master Address File but not in the census by census exclusion process

Census Exclusion Process	Total # of Housing Units deleted by process	Percent of Housing Units deleted by process
Killed	8,312,547	85.24
Deleted as a result of housing unit status assignment	22,352	0.23
Deleted as a result of unclassified estimation	46,196	0.47
Confirmed delete in the unduplication process	1,371,111	14.06
Total	**9,752,206**	**100.00**

The vast majority of these addresses (85.24 percent) were deleted in the "Kill" process. Section 3.3.1 further describes these addresses. A relatively small number of housing units (22,352) were deleted through a process that assessed cases with inconsistent information, but eventually were ultimately determined to not be housing units. An example of an address deleted during this process would be a case that came back from NRFU as a completed case, but once the form was processed,

the Census Bureau realized that there were no data for the address. A slightly larger number of housing units (46,196) were deleted through the unclassified estimation process. This was an imputation procedure that imputed a housing unit status for cases that had no housing unit status at the end of census operations. Finally, over 1.3 million addresses were deleted in the housing unit unduplication operation. More details on this operation are described in Section 3.3.2.

3.3.1 The Kill Process

This process identified MAFIDs that most likely did not uniquely identify housing units as of Census Day. One example of the type of unit that was excluded from the census as a result of this process is:

- There was no census form returned for the unit,
- The unit was deleted in NRFU, and
- The unit was confirmed as a delete in the CIFU operation.

Table 31 provides the distribution of kills by kill reason. An address can meet the criteria of more than one of the kill reasons. In the processing of the census data, a kill was identified in the order in which the reasons appear in Table 31. Once an address was identified as a kill, the other kill reasons were not checked. For this analysis, we only present the number of housing units killed because of a unique reason. If more than one reason applied it was tallied in the "Any Combination of Categories" row.

Table 31. Addresses in the DMAF deleted by the "Kill" Process

Category		Unique Housing Units	
		Number	Percent
Total		8,312,547	100.00
A.	Double Delete, no mail return	1,411,310	16.98
B.	Old DSF Address, no mail return	630,800	7.59
C.	Undeliverable as addressed and a NRFU delete	2,452,596	29.50
D.	Update/Leave and NRFU Delete	498,132	5.99
E.	Urban Update/Leave and NRFU Delete	10,683	0.13
F.	Update/Enumerate Delete	5,430	0.07
G.	NRFU and CIFU Delete	1,430,072	17.20
H.	NRFU Delete Only	281,757	3.39
I.	CIFU Delete Only	526,921	6.34
J.	Field Verification Delete or Duplicate	427,173	5.14
K.	Usual Home Elsewhere from Special Place/Group Quarters that were not allowed to provide a Usual Home Elsewhere	248,898	2.99
L.	Any Combinations of Categories	388,775	4.68

The kill reason with the largest number of cases is the situation where addresses were Undeliverable as Addressed by the USPS and in following up these addresses NRFU deleted them. The next largest kill reason is the "double delete." These are situations where Block Canvassing and LUCA 1998 Field Verification both identified the unit as not existing. This happened in one of two ways. Either Block Canvassing deleted the unit and LUCA 1998 Field Verification verified the delete or LUCA 1998 added the unit, Block Canvassing did not independently add the same unit, and LUCA 1998 Field Verification deleted the unit. In both of these situations, it would have been much more efficient for the census to have removed these units prior to the mailout of questionnaires.

The remaining reasons for kills required the mailout or delivery of the questionnaires and subsequent enumeration attempts. Additional information about the quality of these kills is found in section 4.3.2.

Recommendations

Earlier in this report, we recommended allowing enough time for all LUCA actions to be verified during the Block Canvassing operation. In addition to that, we recommend that Block Canvassing deletes be verified prior to the mailout of questionnaires. This would result in a cleaner address list at the time of enumeration and would have saved us from mailing approximately 1.5 million unnecessary questionnaires.

3.3.2 The Housing Unit Unduplication Operation

This operation consisted of two phases. The first phase involved the identifications of potential duplicates on the DMAF through address and person matching algorithms. The second phase involved the development of rules to determine which housing units would be excluded from the census. As a result of applying the rules, just fewer than 1.4 million housing units were excluded from the census. See sections 4.2 and 4.3 for more information about the assessment of potential duplicates removed from the census or left in the census.

3.4 Addresses That Were In the Master Address File But Were Never Delivered To the Decennial Master Address File

A total of 27,843,868 addresses were in the MAF as of March 2001, but were never sent to the DMAF to be included in the Census 2000 enumeration. Of these addresses, 2,391,379 are in the MAF coded as duplicates of other addresses. When initially updating the MAF from various operations, these units were thought to be unique addresses. However, prior to sending addresses to the DMAF for the Census 2000 enumeration, the Census Bureau was able to identify these situations as duplicates.

The remaining 25,452,489 addresses are described in Table 32.

Table 32. Distribution of unduplicated addresses in the Master Address File that were never sent to the Decennial Master Address File

Reason left out of the DMAF	Number of Addresses	Percent of total
Total	**25,452,489**	**100.0**
Unlocatable Address	11,165,411	43.9
Missing geography	7,494,247	29.4
No mapspot	3,649,883	14.3
No address information	21,281	0.1
Invalid operation	3,937,923	15.5
In Mailout/Mailback areas	3,892,904	15.3
In other areas	45,019	0.2
Non-residential on the DSF and not added by any other operation or in the 1990 ACF but not on the DSF	8,235,963	32.3
Undetermined	2,113,192	8.3

Of the 25,452,489 addresses on the MAF that were never delivered to the DMAF, 43.9 percent had some characteristic that made them unlocatable as far as Census 2000 was concerned. The largest group among these addresses is where there is no geocode information. If an address on the MAF did not have a block code, the Census Bureau did not attempt to enumerate it. Because of the magnitude of field operations in the census, the Census Bureau never burdened field staff with attempting to enumerate an address if it could not identify in what block the address was. Also at the end of the census, every housing unit in the census required a block code so that the population associated with that housing unit could be assigned to geography for the purposes of apportionment, redistricting, and other uses of final census results. Among these addresses, 35.6 percent originated from the 1990 ACF. Over 50 percent of them originated from a DSF from the USPS. These should not necessarily be considered to be addresses that were not enumerated in the census. In many of these cases, the addresses resided outside of the blue line where the Census Bureau did not intend to use the DSF or the 1990 ACF as a source. The Census Bureau most likely picked up another form of these addresses when it canvassed the ground prior to the enumeration.

There were 3,649,883 addresses that were missing map spots and were in areas that required map spots. Again, the vast majority of these addresses (over 98 percent) originated from the 1990 ACF or one of the DSFs. The Census Bureau only excluded addresses missing map spots from the DMAF when they were geocoded outside of the blue line. Since the Census Bureau never intended to use the 1990 ACF or any of the DSF deliveries as sources of addresses outside of the blue line, the exclusion of these units from the DMAF is legitimate.

Just over 21,000 records were left out of the DMAF because they had no address information at all. Almost 79 percent of these records originated from the Address Listing operation. Somehow, the

Census Bureau had captured information indicating the existence of living quarters in this operation, but did not actually capture address information for them. We expect that if these represented housing units, the Update/Leave operation picked them up as adds. However, there is no way to confirm this since we do not have address information for these cases to match against Update/Leave adds.

The planned use of an automated instrument to conduct address list updating operations in the 2010 Census should be able to minimize the number of addresses added in an operation but without sufficient information to be used in future operations. Built in edits can require enumerators to provide map spots before closing out a case and require them to provide at least minimal address information every time they add a new address.

Approximately 15.5 percent of the addresses on the MAF that were left out of the DMAF were considered to be the result of invalid operations. Almost all of these were coded to blocks in Mailout/Mailback areas. Most of these were cases that the USPS coded as neither residential nor non-residential on a DSF and had no actions from other operations.

Finally, over 32 percent of the addresses in the MAF that were left out of the DMAF were Non-residential on the DSF and not added by any other operation (just under 76 percent) or they were in the 1990 ACF but were never reflected on a DSF, nor added by any other operation (24.3 percent). For the most part, these are likely to represent true non-residential addresses delivered to the Census Bureau from the USPS on the DSF or they represent old residential addresses that were in the 1990 Census, but were no longer associated with valid housing units by Census 2000. It is possible that some of these addresses represent valid housing units in which case they would represent undercoverage. Operations such as Block Canvassing should have picked these up. See Section 4.3 for more information on this situation.

4. METHODOLOGY AND RESULTS FROM COVERAGE AND QUALITY EVALUATIONS OF THE FINAL CENSUS RESULTS

4.1 Housing Unit Coverage in Census 2000

Most of the information in this section came from Barrett et al. (2003).

The Housing Unit Coverage Study (HUCS) measured the Census 2000 housing unit coverage using data from the Accuracy and Coverage Evaluation. The 2000 Accuracy and Coverage Evaluation survey was conducted in a nationwide sample of block clusters to measure the overall and differential coverage of the United States population and housing units. Dual system estimation was used to estimate the net coverage of housing units. This study also examined the estimated percentages of housing units missed as well as housing units erroneously enumerated. These two components of the dual system estimate, evaluated separately, are used to measure the completeness and accuracy of the final address list on April 1, 2000.

The overall coverage of housing units in Census 2000 was not significantly different from the 1990 Census except for the percent of erroneous enumerations. Both censuses resulted in a net undercount of less than one percent (0.61 percent in Census 2000) and both censuses missed about four percent of the housing units (3.62 percent in Census 2000). The percent of erroneous enumerations in Census 2000 (2.31 percent) was slightly better (lower) than the 1990 estimate (2.84 percent). This difference is statistically significant.

Vacant housing units were undercounted significantly more than occupied units (3.37 percent for vacant units and 0.33 percent for occupied units). This finding was similar in 1990.

Census 2000 missed more housing units in the Northeast (4.23 percent) and in the South (3.92 percent) than in the Midwest (2.67 percent). The Northeast and South also had more erroneously enumerated housing units than the Midwest (2.73 percent, 2.58 percent, and 1.80 percent, respectively).

Although the percent net undercount was not significantly different among single units, small multi-units (two-nine units), and large multi-units (ten plus units), the percent of non-matches and the percent of erroneous enumerations for small multi-units (6.94 percent and 4.78 percent, respectively) were both significantly higher than for single units (3.18 percent and 1.78 percent, respectively) and for large multi-unit structures (3.39 percent and 2.97 percent, respectively).

Of the cases that were identified as erroneous enumerations, 57.05 percent were coded as "not a housing unit." Duplicates accounted for 24.81 percent of the erroneous enumerations and 16.15 percent were coded as geocoding error.

Recommendations

Because of the significantly higher percent of non-matches and erroneous enumerations in small multi-unit addresses observed in this evaluation, we recommend that specific research be done to better understand the cause so that the Census Bureau can reduce this error rate in the 2010 Census.

4.2 Housing Unit Duplication in Census 2000 as Measured in the Housing Unit Coverage Study

Most of the information in this section came from Jones (2003).

We conducted additional analysis of the addresses that were coded as duplicates in the HUCS in order to understand the extent of duplication, to give the characteristics of housing units most likely to be duplicates, and to identify the nature of duplicate housing unit addresses. This analysis was limited by the fact that housing units that were thought to be potential duplicates, but were eventually reinstated in the census were not present during the HUCS. Also, since the Accuracy and Coverage Evaluation search area was primarily limited to sample block clusters,

duplicates of units located outside of this search area are not accounted for here. Finally, all of these duplicates were identified without the benefit of person-level data (which would have identified additional housing unit duplicates).

Of the duplicates identified in the HUCS, there were no statistically significant differences in duplication rates among Census Regions. Large and medium sized Metropolitan Statistical Areas where the Census Bureau used Mailout/Mailback methodology had significantly lower rates of duplication than in non-Mailout/Mailback areas. The duplication rate was 0.31 percent in large Metropolitan Statistical Areas where the Census Bureau used Mailout/Mailback. In medium sized Metropolitan Statistical Areas where the Census Bureau used Mailout/Mailback the duplication rate was 0.35 percent. In non-Mailout/Mailback areas, the duplication rate was 1.01 percent.

Single unit structures had significantly lower percentages of duplicates (0.36 percent) than small multi-units (1.40 percent). Owner-occupied units had significantly lower percentages of duplicates (0.34 percent) than Non-Owner-occupied units (0.62 percent) and vacant units (2.01 percent).

When duplicates were identified, the characteristics of the two addresses were examined to see where the Census Bureau had weaknesses in its ability to find duplicates. Only 13.6 percent of the duplicates had rural route and box numbers. However, among these, 87.4 percent of the time, this information differed between the two addresses. Just under half (49.2 percent) of all duplicates had unit designations and 89.1 percent of these cases had different unit designations. Among the duplicates, 85.7 percent had house numbers. For the duplicates that had house numbers, 49.8 percent had different house numbers. Among the duplicates, 88.2 percent had street names. For the duplicates that had street names, 45.1 percent had different street names.

Regarding street name inconsistencies, 39.4 percent of the time, one of the two units was missing a street name entirely. The two units had different street names 23.5 percent of the time. The two units had different street identifiers (e.g., avenue, place, boulevard) 24.1 percent of the time. The two units had different spellings of the same street name 13 percent of the time.

Regarding unit designation inconsistencies, 49.2 percent of the time, one of the two units did not have a unit designation. The two units shared the same unit number but had a different identifier (e.g., Apt 4 vs. #4) 24.8 percent of the time.

4.3 Housing Unit Coverage in the Master Address File

Most of the information in this section came from Ruhnke (2003).

The HUCS was designed to measure the coverage of housing units in the final census. We wished to better understand the processes and decisions the Census Bureau used to determine which housing units should be considered valid housing units at the end of the census. To do

this, we conducted an evaluation where we attempted to see if any housing units considered as missing by the HUCS were in fact in our processing systems but determined to not be housing units at the end of the census. From this research, we were able to produce estimates of the number of housing units in the MAF but not in the census. We were able to further delineate these situations into:

- Those units that were never delivered to the DMAF
- Those units delivered to the DMAF that were killed in the "Kill" process.
- Those units delivered to the DMAF that were deleted as a result of the housing unit status assignment
- Those units delivered to the DMAF that were deleted as a result of unclassified estimation, and
- Those units that were delivered to the DMAF, but then later coded as deletes in the unduplication process.

Each of these situations is discussed further in sections below.

The housing units in our analysis represent a weighted estimate of 1.3 million units coded as erroneously excluded from the census as measured by the HUCS and this additional evaluation study. There is a limitation with this estimate in that in some cases these units may have actually been in the Census, but represented with other address forms that were not recognized as the same as units listed independently by the HUCS. It is important to consider this limitation when interpreting these results.

Table 33. Housing Units on the Master Address File coded as erroneous exclusions

Exclusion Process	Estimated number erroneously excluded	Total Percent	Total Number Excluded by this process	Estimated Exclusion Error Rate
Never delivered to DMAF	373,757	28.26 (1.79)*	25,452,489	1.47 (0.12)
Killed	652,779	49.35(1.78)	8,312,547	7.85 (0.41)
Deleted as a result of housing unit status assignment	1,116	0.08 (0.05)	22,352	4.99 (3.20)
Deleted as a result of unclassified estimation	9,348	0.71 (0.16)	46,196	20.24 (4.51)
Confirmed delete in the unduplication process	285,793	21.61 (1.11)	1,371,111	20.84 (1.03)
Total	1,322,793	100.01		

*Standard errors are shown in parenthesis.

As can be seen by the table, most of the addresses coded as erroneously excluded from the census were actually delivered to the DMAF and were part of the enumeration process. Just over 28 percent of the cases coded as erroneously excluded from the census were left out of the enumeration process entirely. We estimate that out of all of the addresses on the MAF that were

left out of the census, this represents just 1.47 percent. More analysis of these cases is provided in Section 4.3.1.

Just about half of the cases were removed in the "Kill" process. The "Kill" process identified cases that most likely did not uniquely identify housing units as of census day. The process deleted a total of 8.3 million potential housing units. In this evaluation, we estimated that just over 650,000 of them were deleted in error. Even though the "Kill" process was responsible for the largest number of erroneous exclusions in this table, it had a relatively small error rate. More analysis of these cases is provided in Section 4.3.2.

Over 21 percent of the cases we coded as erroneously excluded from the census were deleted during the unduplication operation. Of the total number of housing units deleted in the unduplication operation, this represents 20.84 percent, demonstrating a very high error rate. However, there is an important limitation regarding this estimate. The amount of erroneous deletions from the Unduplication Operation as measured by this evaluation is potentially overstated. This comes from the fact that the Housing Unit Coverage Study may have coded something as missing from the Census, when it was actually included in the Census with a different form of the address. The Unduplication Operation may have recognized the duplication but removed the version of the address that the Housing Unit Coverage Study listed.

Recommendations

We recommend that further research be done to refine procedures for identifying and deleting units we believe to be duplicates. By matching HUCS addresses coded as missing in the census to addresses on the DMAF but not in the census, we found that despite the limit stated above, the unduplication process may have deleted many units, which should have been included in the census.

4.3.1 Further Analysis of the Housing Units Left Out of the DMAF

As mentioned above, a little over 28 percent of the addresses in the MAF that were erroneously left out of the census were never delivered to the DMAF. There are a number of reasons why units on the MAF would have never made it to the DMAF as a result of the Census Bureau's rules for developing the Census 2000 address frame.

In Table 34, we look at the original source of addresses that were never delivered to the DMAF and attempt to explain why these units were removed from the census process. Because there are different rules for the development of the Census 2000 address frame for different TEAs, we look at the inside the blue line TEAs separately from outside the blue line TEAs.

Table 34. Erroneously excluded units on the Master Address File only and inside the blue line by original source

Original Source	Count*	Percent+
DSFs	118,182	63.50 (4.81)
1990 ACF	63,139	33.92 (4.75)
Non-ID adds/Unknown	3,822	2.05 (0.87)
Be Counted/ Telephone Questionnaire Assistance	584	0.31 (0.23)
Dress Rehearsal	394	0.21 (0.21)
Total	**186,122**	**99.99+**

*Counts and percentages are weighted; standard errors in parentheses

+ Percentages may not sum to 100 due to rounding.

Table 34 shows that about 64 percent of the inside the blue line addresses left off of the DMAF had a DSF as the original source of the address and about 34 percent had the 1990 ACF as the original source. Tables 3 and 4 in Appendix B provide additional breakdowns of these cases.

Of the 63,139 units that came from the 1990 ACF, about 17 percent were identified as duplicates during the Block Canvassing operation and were therefore excluded from the DMAF. About 60 percent had other negative actions from the Block Canvassing operation including deletes, nonresidentials, and uninhabitables. Those units were not deliverable to the DMAF when they also were not indicated as residential on the September 1998 DSF. About 24 percent of the 1990 ACF units were not included in the Block Canvassing universe, which suggests they were not geocoded to a census collection block at the time of the operation. Those addresses were also kept off the DMAF.

Of the 118,182 units with a DSF as the original source, about 63 percent were not indicated as residential on the November 1997 DSF or the September 1998 DSF and about 27 percent were indicated as residential on the November 1997 DSF but as non-residential on the September 1998 file. The remaining units were either coded as duplicates during Block Canvassing or were not geocoded to a block in time to be included in the Block Canvassing universe.

Table 35 provides the distribution of cases coded as erroneously excluded that are located outside of the blue line.

Table 35. Erroneously excluded units on the Master Address File only and outside the blue line by original source

Original Source	Count*	Percent*
DSFs	125,361	66.81 (4.73)
1990 ACF	52,445	27.95 (4.79)
Address Listing	7,553	4.03 (1.08)
Non-ID adds/Unknown	1,392	0.74 (0.40)
Questionnaire Delivery	652	0.35 (0.35)
LUCA 1999 Recanvass	232	0.12 (0.12)
Total	**187,635**	**100.00**

* Counts and percentages are weighted; standard errors in parentheses

Table 35 shows that almost 95 percent of the MAF only addresses in outside the blue line TEAs came from the 1990 ACF and the DSFs. By design, the Census Bureau did not use addresses from those two sources in those TEAs. These units are most likely represented in the census by other forms of their address. During the creation of the address list in these areas, a different form of the address may have been provided, but the Census Bureau was unable to match it to the form of the address that came from the 1990 ACF or the DSF during census processing. However, we were able to match it to the HUCS. These addresses either represent units not captured in our outside the blue line operations or they reflect an inability of the HUCS to match to other forms of addresses that were included in the census.

The remaining five percent of addresses were intended for use in outside the blue line TEAs. Those addresses were deleted by LUCA 99, did not have a map spot in TIGER, or did not have sufficient address information or location descriptions to be delivered to the DMAF.

4.3.2 Housing Units That Were Removed By the Kill Process

As mentioned above, most of the addresses coded as erroneously excluded from the census were delivered to the DMAF and about half of those were deleted in the "Kill" process. Table 36 provides a distribution of these cases by the reason that they were "killed."

Table 36. Erroneously killed addresses by reason they were killed

Kill reason	Number coded as erroneously killed*	Percent+
Double Delete, no mail return	43,728	6.70 (1.17)
Old DSF Address, no mail return	66,179	10.14 (1.05)
NRFU delete, not in CIFU, not a CIFU add, no mail return	320,773	49.14 (2.42)
Update/Enumerate delete, no mail return	2,072	0.32 (0.10)
NRFU delete, CIFU delete, no mail return	127,220	19.49 (1.65)
Not in NRFU, CIFU delete, no mail return	49,187	7.54 (1.39)
Field Verification delete or duplicate, not a NRFU add, not a CIFU add	39,365	6.03 (0.74)
Usual Home Elsewhere (UHE) addresses#	4,254	0.65 (0.21)
Totals	**652,779**	**100.02+**

* Counts and percentages are weighted; standard errors in parentheses

+Percentages may not sum to 100 due to rounding.

#Adds from the July 7, 2000 update of the DMAF which were UHE addresses that were generated from Special Place/Group Quarters which were not allowed to provide a UHE address.

As seen above, about 49 percent of the erroneously killed units met the following criteria:

- No census form was returned by mail,
- The unit was deleted during NRFU,
- The unit was not included in the CIFU universe of addresses, and
- The unit was not added in the CIFU operation.

In Table 37 we look at the breakdown and error rates associated with the kill reasons for the 320,773 units discussed above.

Table 37. Error rates for a specific kill reason by other census actions

Census Actions	# number coded as erroneously killed	% coded as erroneously killed	ALL KILLS	Percent killed in error[+]
Undeliverable as Addressed	217,762	67.89 (3.38)	2,453,235	8.88 (0.70)
Update/Leave delete	25,903	8.08 (1.24)	498,132	5.20 (0.75)
Urban Update/Leave delete	617	0.19 (0.19)	10,683	5.78 (5.78)
Not a UAA or Update/Leave or Urban Update/Leave delete	76,491	23.85 (3.46)	281,757	27.15 (4.91)
ALL types of "NRFU delete, not in CIFU, not a CIFU add, no mail return"	**320,773**	**100.01[+]**	**3,243,807**	**9.89 (0.73)**

* Counts and percentages are weighted; standard errors in parentheses
[+]Percentages may not sum to 100 due to rounding.

As can be seen from the table, when the Census Bureau did not receive any information about the unit from the post office, there was a significantly higher deletion error rate (27 percent) than when the post office identified the address as Undeliverable as Addressed (UAA) (nine percent). The higher deletion error rate in that category is probably caused by the fact that only one operation deleted the unit. These cases represent a universe of NRFU deletes that were initially coded as completed cases from that operation. However, when the Census Bureau completed processing, it realized that these units should have been deletes. This is different than the other situations represented in table 37 because the three other situations all provided a second confirmation that the unit should be deleted. Because of the planned introduction of mobile computing devices in the 2010 Census, the Census Bureau should be able to avoid the situation where a NRFU questionnaire is allowed to be checked-in as complete when it has no data. Therefore, this class of errors from Census 2000 is not likely to be repeated in the 2010 Census.

Although there was a much lower error rate for NRFU deletes that were undeliverable as addressed by the USPS, it may be possible to lower this error rate in the future. When the USPS sends back census forms as undeliverable they usually provide a reason. If the Census Bureau captured this reason they could make a distinction between housing units the USPS believes exists (e.g. vacants) and housing units the USPS believes do not exist. In Census 2000, all UAAs that the Census Bureau deleted in NRFU were deleted from the Census. By capturing the housing unit status from the USPS, the Census Bureau could send inconsistent cases back to the field in CIFU. For example, a case coded as a vacant unit by the USPS that was then coded as a deletes in NRFU should probably have the NRFU delete status confirmed in CIFU.

4.4 Geocoding Error of Collection Blocks and Tabulation Blocks

Most of the information in this section came from Green and Rothhaas (2002) and Ruhnke (2003).

Not only is it important to account for every housing unit in the census and to avoid including erroneous cases in the census, it is also important to code housing units to the correct census block in the census. One of the primary uses of census results is for redistricting. Counting each person in the correct census block allows us to give states and local governments accurate tallies that they can use when they redraw political boundaries. During the Census, there are two types of census blocks: collection blocks and tabulation blocks. Collection blocks are geographic areas that are usually defined by visible features and are used by the Census Bureau to conduct field operations. Sometimes collection blocks cross governmental unit boundaries such as city or town boundaries. At the end of the Census, the Census Bureau redefines the census blocks by taking into account the governmental and other boundaries required for data tabulation purposes. These redefined blocks are known as tabulation blocks. Correctly coding housing units to the correct tabulation block ensures delivery of accurate tabulated data to state and local governments. To assign a housing unit to the correct tabulation block, the Census Bureau must first have included that housing unit in the correct collection block. Then in those instances where tabulation boundaries split collection blocks, the Census Bureau must assign the housing unit to the correct portion of the collection block to get it into the correct tabulation block. In areas where the Census Bureau has collected map spots during the census, it can assign tabulation blocks using the known location of the governmental boundary and the collected location of the address by way of the map spot. In areas where the Census Bureau has not collected a map spot, it uses address range information to impute the location of units within split blocks.

In order to assess how accurate the Census Bureau was in assigning housing units to the correct tabulation blocks, we first evaluated the accuracy of the assignment of housing units to the correct collection blocks. Then for those collection blocks that are split for tabulation purposes, we evaluated the accuracy of the assignment of housing units to the correct portion of the split collection block. Note that with many uses of census data, blocks are aggregated to produce statistics. If a housing unit was coded to the wrong block that does not necessarily imply errors in tabulation. If the housing unit was coded to an adjacent block, there is a good chance that aggregated statistics would not be affected. In these evaluations we were not able to determine the significance of the errors we found. We were only able to estimate the number of actual geocoding errors at the block level.

In the next section we describe the estimates of collection block geocoding error. The following section describes the error associated with splitting collection blocks for tabulation purposes. We then combine the two sets of results to estimate an overall geocoding error rate.

4.4.1 Geocoding Errors of Collection Blocks

To compute estimates of geocoding error in collection blocks, we built on work done by the HUCS. In that study, an independent list of housing units was matched against the addresses in the census. The HUCS sometimes identified cases as being geocoded to the wrong census block. However, HUCS only searched for units within one ring of blocks surrounding the sample blocks in the study. We took all cases confirmed to exist in the HUCS blocks that were initially coded as missing from the Census and we matched them against all addresses in the same census tract or surrounding census tracts. By expanding the search area, we were able to identify additional addresses that were actually in the census, but coded several blocks away from where they actually existed.

From this research, the estimated percentage of census addresses that were geocoded to the incorrect Census 2000 collection block is 4.8 percent. The geocoding error estimate varied among the different TEAs.

Table 38. Census geocoding error estimates by Type of Enumeration Area

TEA	% Geocoding error*
All TEAs	**4.80 (0.27)**
Mailout/Mailback	5.52 (0.33)
Update/Leave	1.71 (0.16)
List/Enumerate	1.15 (0.81)
Update/Enumerate (Rural & Urban)	1.70 (0.60)
Urban Update/Leave	11.59 (7.93)

* Percentages are weighted; standard errors in parentheses

To some extent, we expect less geocoding error in Update/Leave and List/Enumerate areas because the address list was created on the ground through field operations and therefore geocoding was based on first-hand field observation. This is different from Mailout/Mailback areas where geocoding was based on a combination of procedures, including an automated geocoding process. That combination could contribute to the higher geocoding error estimate in that enumeration area. However, there is a limitation to this evaluation that may help explain the lower geocoding error estimates in Update/Leave and List/Enumerate areas. Those areas have a higher occurrence of noncity-style addresses, which makes it harder for us to detect geocoding errors due to matching limitations. We were very limited in our ability to match the rural addresses and were therefore unable to find as many cases of geocoding error in rural areas as we were in Mailout/Mailback areas. Another reason for the lower error rates in the more rural areas is that there are fewer multi-unit addresses in these areas. See the discussion of Table 40 later in this section for more details.

From this evaluation we were also able to determine that collection block geocoding error did not vary much by region of the country.

Table 39. Census geocoding error by census region

Census Region	% Geocoding error*
All Regions	**4.80 (0.27)**
Northeast	4.42 (0.58)
Midwest	3.79 (0.35)
South	5.66 (0.55)
West	4.71 (0.55)

* Percentages are weighted; standard errors in parentheses

The Midwestern area of the country had a significantly lower geocoding error estimate than the South. There were no other significant differences.

We also looked at geocoding error by size of the basic street address (BSA).

Table 40. Census geocoding error by size of Basic Street Address

BSA size	% Geocoding error*
All Housing Units	**4.80 (0.27)**
single unit	3.37 (0.14)
two units	3.17 (0.34)
small multi (3-9)	4.93 (0.69)
large multi (10+)	11.33 (1.37)

* Percentages are weighted; standard errors in parentheses

Geocoding error is more prevalent among housing units in multi-unit structures. Table 40 presents the estimated percentage of housing units geocoded erroneously by size of structure.

Housing units in both small and large multi-unit structures have significantly higher geocoding error estimates than single units or two-unit structures. Additionally, housing units in structures with ten or more units have a significantly higher geocoding error estimate than housing units in structures with three to nine units. We would expect geocoding error to be higher for units in multi-unit structures because geocoding error is a structure-based problem. Geocoding of the structure to the wrong block causes every unit in that structure to be geocoded to the wrong block, if all units at the structure had the same basic street address on the MAF. The larger the structure is, the larger the number of geocoding error cases will be if the structure is geocoded to the incorrect block.

Note that it would have made sense to conduct this geocoding error rate analysis at the Basic Street Address level along with the unit level analysis done here. Unfortunately, the current structure of the MAF does not allow the identification of which housing units are part of which Basic Street Addresses.

4.4.2 Geocoding Errors of Blocks Split for Tabulation Purposes

To evaluate the block splitting process, we selected a sample of 1,000 collection blocks that had at least one tabulation boundary that split the block for field verification. Field representatives determined whether the housing units in these blocks were allocated to the correct side or the wrong side of each tabulation boundary.

About five and one half percent of the 5.1 million collection blocks in the country were split for tabulation purposes. A little more than ten percent of the 115.5 million housing units were located in split collection blocks.

Over 26 percent of the 283,000 split collection blocks contained at least one housing unit allocated to the wrong side of the tabulation boundary. Although this percentage is high, these blocks represent less than two percent of the collection blocks in the country. About 3.65 percent of the 12 million housing units affected by block splitting were allocated to the wrong side of a tabulation boundary. These errors represent 0.37 percent of the housing units in the country.

There was no statistically significant difference in error rates for blocks and housing units inside the blue line compared to blocks and housing units outside of the blue line. The error rate also did not vary significantly between city-style addresses and noncity-style addresses.

4.4.3 Overall Geocoding Error Estimates

Summarizing the results of the last two sections, approximately 4.8 percent of housing units in the country were coded to the incorrect collection block. One can assume that these housing units were therefore coded to the wrong tabulation block as well. Meanwhile, just over five percent of the collection blocks in the country were split for tabulation purposes. Within these blocks, 3.65 percent of the housing units were geocoded to the wrong tabulation block. These erroneously tabulated housing units make up just 0.37 percent of the housing units in the country. Therefore, this error did not contribute substantially to the 4.8 percent geocoding error estimate based on collection blocks. We therefore conclude that the overall geocoding error estimate for tabulated housing units in the country in Census 2000 was just under five percent.

Although collection block error did differ by inside versus outside of the blue line, errors within split collection blocks did not differ in these areas.

Recommendations

The Census Bureau is currently researching the possibility of collecting Global Positioning System (GPS) coordinates for addresses in the census. One reason for doing this is to help enumerators find their assignments. Another reason would be to ensure geocoding units to the correct block. If using GPS coordinates for improving geocoding is a high priority, the Census Bureau's emphasis for the use of GPS should not be entirely focused around rural areas (where help in locating units is more likely to be needed). Instead, the Census Bureau should consider getting better geocoding for the areas with the highest geocoding error rates, which, at the collection block level, are inside-the-**blue line** areas.

In the meantime, the Census Bureau's approaches for assigning housing units to the correct tabulation block when collection blocks were split appear to have done equally well in areas where the Census Bureau had map spots and in areas where they used imputed address ranges. From this evaluation, we cannot justify the need for GPS coordinates to resolve split block issues. However, the geocoding error statistic was overwhelmingly due to errors in collection block assignments and that may be reason enough to pursue the collection of GPS points inside the blue line. An alternative approach to reducing this error would be to plan towards more training and more quality assurance which will require additional funding for field operations that impact the placement of housing units in the correct blocks.

5. LESSONS LEARNED AND RECOMMENDATIONS FOR THE 2010 CENSUS

TEA Delineation

Just under 74 percent of addresses in Update/Leave areas had complete city-style addresses. Because of this, we recommend that the Census Bureau continue to research ways to maximize mailing out questionnaires. We cannot say for certain how many of the city-style addresses actually are addresses to which USPS would deliver. We do, however, note that that 42.5% of the addresses listed during the Address Listing operation (conducted in Update/Leave areas) directly matched to residential units on the DSF. Even in more remote areas where we conducted List/Enumerate, 18% of the addresses matched to residential units on the DSF. We also expect the mail delivery to areas implementing new house number/street name address numbering systems to continue to increase over the decade. Monitoring this information throughout the decade and attempting to understand which city-style addresses will be deliverable by the USPS standards will go a long way towards increasing the efficiency of taking the census. We understand that Geography Division has already begun researching these issues by attempting to classify each Census block by its address characteristics. This appears to be a great start at this effort. Also, the Census Bureau should attempt to minimize the time between TEA delineation and the actual enumeration. This will maximize the appropriateness of enumeration methods used throughout the country.

Address List Development "Inside the Blue Line"

The series of operations used to build the address list in Mailout/Mailback areas, and the number of addresses that made their way into the census from each of them, demonstrate that no one operation could have resulted in an adequate address list. It took the use of the 1990 Census address list, information from the USPS, Block Canvassing, and information from local governments to collectively give the Census Bureau a fairly complete address list. Subsequent operations, such as NRFU, contributed to the completeness of the address list as well. Each of these sources played a key role in identifying addresses that the others may have missed. For example, although the DSF provided a large number of addresses in Census 2000, the DSF Assessment Report identified that at times the DSF fell short of the Census Bureau's needs when it identified multi-unit structures as single delivery points rather than identifying each housing unit individually. It took operations like Block Canvassing or LUCA to provide the actual number of housing units in those multi-unit structures along with their unit designations. We recommend that this important series of address sources continue to be the basis for the Census Bureau's approach to building the address list for the 2010 Census. That is, the Census Bureau should start with the final Census 2000 address list, use updates from the USPS, acquire input from local governments, and canvass the ground as necessary. Note that the Census Bureau expects to maintain the address list during the decade. Rules for updating the Census 2000 list should be tested sufficiently so that the updated address list can be the starting point of updates for the 2010 Census as the 1990 ACF was for Census 2000.

As a primary source of addresses nationwide, the DSF was the most significant contributor (other than the ACF) of new addresses to Census 2000. The Census Bureau should continue to work closely with the USPS to better understand all of the information provided on the DSF so as to maximize its use. The Census Bureau should also put its own efforts into better understanding the quality of the DSF.

In order to understand the true impact of LUCA in the future, we recommend that the Census Bureau allow sufficient time for the completion of government updates prior to any Block Canvassing activities. This would reduce the complexity of the processing, as well as eliminate the need for another operation to validate updates. We also recommend that the Census Bureau investigate ways to increase government participation. This should especially focus on ways to aid the governments once they have agreed to participate. It is important that local governments have sufficient sources and resources to provide valid locatable addresses. This is the case because local governments provided 6.2 million addresses, almost 1 million of them were already on the MAF, and ultimately, we estimate that only approximately 500,000 of the submitted addresses were provided by LUCA participants and were not provided by any other census operation. We also recommend that the Census Bureau look at the appeals process. Of the addresses that the Census Bureau was told to include in the final enumeration, fewer than 47 percent actually ended up in the final census count. Overall, LUCA provided many addresses that, in the end, did not appear in the final census results. We believe that with improvements to the program, the Census Bureau can do a more successful job of acquiring valid usable address

information from local governments. In the meantime, the partnership benefits of the LUCA program appear to have been a success. This program gave local governments the opportunity to examine the results of our processes, to correct errors, and to gain confidence in our address list development operations. On this measure, we consider LUCA to have been a success and we continue to support the legislation that authorizes the program and we encourage further attempts to improve the process.

Although Block Canvassing is a major contributor of valid housing units in the census, the Census Bureau should continue efforts to improve the quality of this operation. Although Block Canvassing resulted in almost 3 million addresses being moved by one lister deleting the unit and another lister adding the same unit, the Assessment Report for Block Canvassing recommends that the Census Bureau test procedures for allowing listers to make changes to house numbers and geographic moves. We concur with this recommendation. This type of update might remove some of the duplication created in this operation as it is currently designed. Because of the large number of blocks that had no updates in the Block Canvassing operation, we would also recommend that the Census Bureau research ways to identify stable blocks to avoid the cost of canvassing them when there is nothing to update. However, omitting blocks from Block Canvassing may not be reasonable. Although we could probably identify blocks that had a high likelihood of not requiring updating, we would not be able to ensure the same coverage quality that comes from canvassing all blocks. We, therefore, cannot recommend omitting blocks from future Block Canvassing operations. Finally, we recommend that Block Canvassing deletes be verified prior to the mailout of questionnaires. This would result in a clearer address list at the time of enumeration and would have saved us from mailing approximately 1.5 million unnecessary questionnaires.

In some areas, Urban Update/Leave appears to have done what it was intended to do. That is, the Census Bureau was able to deliver questionnaires when it is likely that the USPS would not have done so. In that context, we recommend that this operation remain as part of the Census Bureau's enumeration methodology for the 2010 Census. However, it also appears to be the case that this success was limited to a small number of blocks chosen for this operation. Forty percent of the blocks chosen for this operation contained zero housing units. This operation is not primarily intended to improve coverage by updating the address list at the time of questionnaire delivery. Its primary purpose is to successfully deliver questionnaires when we do not believe the USPS will succeed in doing so. So it is unclear why these blocks were chosen for this type of enumeration. At the same time, there may have been other blocks where this operation would have proved useful. We therefore recommend that the Census Bureau look closely at the methods for choosing blocks to be in Urban Update/Leave and consider the pros and cons of making this operation mandatory for blocks that meet certain conditions.

One additional suggestion is to define this type of enumeration at the address level. That is, do not require an entire block to be defined as Urban Update/Leave. Reserve this designation for high rise buildings and use Mailout/Mailback enumeration for single unit addresses in the same block. To the extent that this can be made feasible, this suggestion should be considered.

Address List Development "Outside the Blue Line"

As in Mailout/Mailback areas, it appears that the full complement of operations used in Update/Leave areas was necessary for obtaining a complete address list. Because the Census Bureau has now captured address information in these areas, along with map spots, we recommend that in the 2010 Census, this combination of address canvassing, local government updates, and Update/Leave at the time of enumeration be used again. Given the address problems in Puerto Rico (see section 2.2.1) the Census Bureau should attempt to clean up the Puerto Rico addresses before reuse in 2010. Also, more planning time should go into anticipating the best way to collect and process addresses in Puerto Rico in advance of the census.

As with the LUCA 1998 Program, we recommend for the LUCA 1999 Program that the Census Bureau investigate ways to increase local government participation.

To the extent possible, planners for the 2010 Census should design a system that allows for updates from Update/Leave to be data captured in time to make an impact on the NRFU universe. That is, the number of new units added during NRFU could have been reduced if all adds from Update/Leave were reflected in the NRFU universe. Another disadvantage of not processing Update/Leave actions in time for NRFU was reported in the Assessment for Update/Leave and Urban Update/Leave. By not capturing adds from Update/Leave earlier, non-respondents could not be followed up until the Coverage Improvement Followup operation. Delaying the enumeration of these households (farther from Census Day) could have a negative impact on the accuracy of the data collected.

Update/Enumerate appears to have successfully accomplished what it set out to do. This operation should remain as part of the Census Bureau's enumeration methodology for the 2010 Census.

The Census Bureau does not currently plan to use List/Enumerate in the 2010 Census. Because the Census Bureau successfully captured and stored on the MAF and TIGER map spots and location descriptions for virtually all addresses in this operation, these blocks can be handled as Update/Enumerate blocks in the 2010 Census. Focusing these remote areas in a single enumeration operation appears to have been successful. We recommend their continued use, where appropriate, in the 2010 Census.

Geocoding

The Census Bureau is currently researching the possibility of collecting GPS coordinates for addresses in the census. One reason for doing this is to help enumerators find their assignments. Another reason would be to ensure geocoding units to the correct block. If using GPS coordinates for improving geocoding is a high priority, the Census Bureau's emphasis for the use of GPS should not be entirely focused around rural areas (where help in locating units is more likely to be needed). Instead, the Census Bureau should consider getting better geocoding for the

areas with the highest geocoding error rates, which, at the collection block level, are inside-the-**blue line** areas. Note that the large number of inconsistent actions on the same addresses in block canvassing (one lister adding an address and a second lister verifying the same address) should also be reduced by the introduction of GPS technology. "You are here" functionality will help keep listers from going beyond the boundaries of their assignment areas.

In the meantime, the Census Bureau's approaches for assigning housing units to the correct tabulation block when collection blocks were split appear to have done equally well in areas where the Census Bureau had map spots and in areas where the Census Bureau used imputed address ranges. From this evaluation, we cannot justify the need for GPS coordinates to resolve split block issues. However, the geocoding error statistic was overwhelmingly due to errors in collection block assignments and that may be reason enough to pursue the collection of GPS points inside the blue line. An alternative approach to reducing this error would be to work towards more training and more quality assurance, which will require additional funding for field operations that impact the placement of housing units in the correct block.

Unduplication

There were quite a few things we learned about housing unit duplication in Census 2000.

Some addresses coded as field deletes during Block Canvassing were sent to LUCA Field Verification. If they really represented duplicates, they had a high probability of getting reinstated, due to the fact that LUCA Field Verification was not a comprehensive check of the list, but a search for selected addresses. Because of this, we recommend that all future field-listing operations, intended to verify the status of individual units, must include a check against all addresses currently listed in the same block. This review is intended to make sure the address is not already reflected on the address list, perhaps in a different form.

The Be Counted Program and the TQA Program added housing units that would otherwise have been left out of the census. However, many of the returns from these programs were also enumerated in other operations, particularly, NRFU. The Census Bureau should continue to use programs such as these, but the Census Bureau should also consider ways of reducing the duplication of enumerations. One approach would be to conduct the Be Counted Program after the NRFU operation instead of before.

We recommend that further research be done to refine procedures for identifying and deleting housing units the Census Bureau believes to be duplicates. By matching HUCS addresses coded as missing in the census to addresses on the DMAF but not in the census, we found that the unduplication process may have deleted many units that should have been included in the census.

Advantages Associated With the Use of Mobile Computing Devices

The Census Bureau is currently planning to introduce the use of a mobile computing device to

assist with the enumeration in the 2010 Census. There are several things we learned in the evaluation program that help justify this plan.

The planned use of an automated instrument to conduct address list updating operations in the 2010 Census should be able to minimize the number of addresses added in an operation that ended up with insufficient information to be used in future operations. Built in edits can require enumerators to provide map spots before closing out a case and require them to provide at least minimal address information every time they add a new address.

Because of the planned introduction of mobile computing devices in the 2010 Census, the Census Bureau should be able to avoid the situation where a NRFU questionnaire is allowed to be checked-in as complete when it has no data. These cases that were killed in the "kill process" had a high error rate. This class of errors from Census 2000 is not likely to be repeated in the 2010 Census.

In future updating operations one of the requirements should always be to distinguish the types of corrections made during the operation. In the Update/Leave operation, it would have been useful to know how often corrections were to address information versus corrections to occupant name or telephone number. The use of a mobile computing device could allow us to capture sufficient information to better distinguish these types of corrections in the future.

Small Multi-Unit Addresses

In the Housing Unit Coverage Study, there was a significantly higher percent of non-matches and erroneous enumerations in small multi-unit addresses. We recommend that specific research be done to better understand the causes so that the Census Bureau can reduce this error rate in the 2010 Census. Perhaps targeted field updates and enumeration of some entire multi-unit addresses are required.

6. ACKNOWLEDGEMENTS

The authors would like to acknowledge a few people who made both this report and the entire address list development evaluation program for Census 2000 a success. First, we would like to acknowledge the assistance of Joseph Burcham, Diane Barrett, Miriam Rosenthal, Karen Owens, Lionel Howard, Kevin Zajac, and Cindy Rothhaas who helped this report's authors lay the groundwork for the entire Census 2000 address list development evaluation program. It was their combined vision that resulted in the full compliment of evaluation efforts successfully completed with this report. Second, the authors wish to acknowledge the staff in Geography Division who answered or tried to answer all of our questions along the way. In particular, we would like to thank Carl Hantman, Dave Galdi, Linda Franz, Linda Pike, Brian Beck, Vic Meiller, Joel Sobel and Dan Sweeney. However, for a solid two years, it was Larry Bates and Bob Damario of the Geography Division that we kept consistently on the hot seat and the

evaluations are much better because of it. Next, the authors would like to thank Gail Leithauser, Karen Field, and Andrea Johnson who helped with both our understanding of field operations and with the development of several key field evaluations.

We wish to thank the authors of each of the evaluation reports that we had at our disposal in order to put this report together. We would especially like to acknowledge all of the processing that Megan Ruhnke provided which allowed us to do much of the specific analysis conducted for this report. We would like to thank our bosses, Jon Clark and David Hubble who provided much needed guidance along the way. We would like to thank Jerry Imel who turned most of our data sets into usable SAS files, which gave most of the evaluators tremendous power with the use of the data. Finally, we would like to thank Earl Letourneau, and Kathy Conklin without whose help this topic report would never have become a final and complete document.

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Appendix A

Address List Compilation in Census 2000

To support Census 2000 and other demographic data collection activities such as the American Community Survey, the Census Bureau developed a nationwide list of individual living quarters (either addresses or location descriptions) called the Master Address File (MAF). The MAF is linked to the Census Bureau's nationwide automated geographic system, the Topologically Integrated Geographic Encoding and Referencing (TIGER) database. This linkage allows us to provide a census block location in the MAF for each address or location description. Providing a census block location allows us to relate individual addresses to all the higher levels of geography (e.g., census tract, incorporated place, and so on) to which the Census Bureau tabulates data.

During Census 2000, the Census Bureau used three different major approaches for initially building and subsequently improving the MAF for different geographic areas (defined at the census block level). The use of an approach in a particular geographic area depended on the types of addresses used for mail delivery in that area and on how the Census Bureau intended to enumerate the population in that area. These three approaches are identified here by the primary types of enumeration areas that they contain: Mailout/Mailback, Update/Leave, and List/Enumerate.

Mailout/Mailback Approach

This approach includes the following types of enumeration areas: Mailout/Mailback, Military Blocks in otherwise Update/Leave Areas, Urban Update/Leave, and Urban Update/Enumerate.

The majority of addresses in the country are in census blocks where the Census Bureau used the Mailout/Mailback approach for address list development. In these areas, the United States Postal Service (USPS) uses, for the most part, city-style addresses for mail delivery. A city-style address contains a house number and street name (for example, 101 Main Street) and may also contain identifiers for specific housing units within a structure (for example, Apartment 2). The Census Bureau initially created the address list in these areas by using addresses from the 1990 Census and addresses from the USPS's DSF.

1990 Census Address Control File and an initial Delivery Sequence File from the United States Postal Service

Since 1995, under the provisions of Public Law 103-430 and a subsequent Memorandum of Understanding with the Census Bureau, the USPS has periodically provided to the Census Bureau its list of individual mail delivery points, known as the DSF. Initially the Census Bureau used the DSF to update the streets, street names, and address ranges in the TIGER database, from

the 1990 Census, in order to improve TIGER's ability to later assign block codes to individual MAF addresses.

Subsequently, the Census Bureau used the DSF in the initial creation of the MAF by using it to update the 1990 Census housing unit address list (the 1990 Census Address Control File (ACF). For the majority of the country, the initial update of the 1990 ACF was done with the November 1997 DSF. Earlier DSFs were used in areas of the country that were involved in tests of the American Community Survey or in the Census 2000 Dress Rehearsal.

The merging of information from the DSF with the 1990 ACF was not straightforward since the Census Bureau and the USPS use address lists for different purposes and therefore have differences in address list requirements. For example, the Census Bureau requires a record of each housing unit (apartment) in a multi-unit structure while in some cases the USPS requires only the basic street address for the structure.

Local Update Census Addresses 1998

Following the initial creation of the address list, the Census Bureau began the LUCA program. P. L. 103-430 calls for the Census Bureau to work with tribal, state, and local governments to improve the MAF. In Mailout/Mailback areas, this program is referred to as LUCA 1998. In this program, the Census Bureau sent invitations for participation to all eligible functioning local and tribal governments. These governments contained at least some census blocks that were in Mailout/Mailback enumeration areas. For those governments that agreed to participate and signed a confidentiality agreement, the Census Bureau provided address lists and census maps. Local and tribal governments could either receive paper or electronic materials. Participants were asked to provide updates and corrections to the address lists and maps. These updates included:

- correcting existing addresses
- deleting addresses on the list that did not exist
- adding new addresses to the list
- correcting the names and locations of features on the census maps

Local and tribal governments could return updates either electronically or on paper. The National Processing Center keyed all paper address updates and, independently, they data captured map feature updates by scanning and digitizing updated census map information. The Geography Division then updated the MAF and TIGER databases with the electronically provided updates and the data captured updates.

The original intent was to incorporate these LUCA 1998 updates into the MAF and TIGER prior to producing materials for conducting the Block Canvassing operation (see the later section on Block Canvassing) for all participating governments. However, this only occurred for a small number of local and tribal governments. For most local and tribal governments, initial LUCA submissions were provided at the same time as the Block Canvassing operation. For

approximately 700 additional local and tribal governments, the results of Block Canvassing were incorporated into the MAF prior to producing any materials for the governments' review. This was done because the address lists for these governments were determined to be deficient by comparing current MAF counts with 1990 housing unit counts. The Census Bureau decided to postpone the review for these entities until the Block Canvassing operation was completed and its results were added to the MAF.

September 1998 Delivery Sequence File

Ten months following the initial address list creation, the USPS sent the Census Bureau the September 1998 DSF. This file contained all addresses currently in the DSF, not just changes from the previous delivery. The Geography Division updated the MAF by adding new addresses and updating existing addresses with address corrections. If an address was no longer on the DSF or was now coded as a non-residential address, this information was updated on the MAF as well. Because of the timing of this update, most LUCA 1998 participants did not receive initial address lists from the Census Bureau with the September 1998 DSF updates incorporated, but some did.

Block Canvassing

Following the update of the MAF with the September 1998 DSF and some LUCA 1998 results, the Block Canvassing operation occurred in the winter/spring of 1999. Prior to this operation occurring, headquarters staff realized that some areas assigned as Mailout/Mailback should probably have been assigned to the Update/Leave enumeration method. Field staff were given one last opportunity to review specific census blocks and to decide whether the address list should be developed using the Mailout/Mailback approach or whether it should convert to the Update/Leave approach.

For blocks that remained in the Mailout/Mailback approach, field staff updated the address list and maps by canvassing every block and attempting to contact persons at every multi-unit address, every new address, and every third single unit address in order to confirm the address information in the MAF. Canvassers were asked to provide updates and corrections to the address lists and maps. These updates included:

- verifying all existing addresses
- correcting existing addresses
- deleting addresses on the list that did not exist
- adding new addresses to the list
- correcting the names and locations of features on the census maps

The National Processing Center keyed all address updates and, independently, they data captured map feature updates by scanning and digitizing updated census map information. The Geography Division then updated the MAF and TIGER databases with the data captured updates.

Note that while the MAF was being updated, the Geography Division could identify block corrections through matching addresses deleted from one block to addresses added in another block.

Once Block Canvassing results were incorporated in the MAF, the initial Decennial MAF (DMAF) was produced. This file was the initial source of addresses to be mailed or delivered census forms.

1998 Local Update of Census Addresses Field Verification

Once the results of Block Canvassing were incorporated into the MAF, subsequent LUCA operations could take place. The next steps depended on the relationship between the LUCA operation and the Block Canvassing operation for each participating government.

For those governments whose updates were incorporated into the MAF before the Block Canvassing operation, any discrepancies identified by the Block Canvassing operation were provided back to them as feedback to their initial submissions. In these situations, field verification was not needed because Block Canvassing was the field verification.

For those governments whose MAF addresses were considered deficient when compared to 1990 address counts, these governments were provided their initial address lists for review after Block Canvassing. Note that in this situation, any adds and corrections provided by the local and tribal governments were accepted and included in the census process without being field verified.

For those governments who provided updates independent of the Block Canvassing operation (most governments), the Census Bureau compared the results of these two operations. When there were discrepancies, the discrepant units were sent to be verified in the field during LUCA Field Verification. At this time, any units identified as deletes in the Block Canvassing operation were also sent to the field to verify the delete status. In LUCA Field Verification, enumerators were required to verify all addresses provided to them and make any corrections to the list. Possible updates in the field verification operation included:

- Verification of an existing address
- Deletion of an address
- Address correction or a change of status to nonresidential
- Block change

The National Processing Center keyed all address updates and, independently, they data captured map feature updates by scanning and digitizing updated census map information. The Geography Division then updated the MAF and TIGER databases with the data captured updates. Once all updates were made, the Census Bureau provided feedback to the local or tribal governments on their initial submissions. Note that the initial DMAF was created without the resolution of discrepancies between LUCA 1998 and Block Canvassing and without verification

of block canvass deletes. That is, unverified LUCA adds and unverified block canvass deletes were included in the DMAF and in the mailout of questionnaires. Now that LUCA 1998 Field Verification had taken place, any confirmed deletes that were mailed census questionnaires would be kept out of the Nonresponse Followup operation.

November 1999 Delivery Sequence File

In late 1999, the USPS sent the Census Bureau the November 1999 DSF. This file contained all addresses currently in the DSF, not just changes from the previous delivery. The Geography Division updated the MAF by adding new addresses and updating existing addresses with address corrections. If an address was no longer on the DSF or was now coded as a non-residential address, this information was updated on the MAF as well. Any added addresses that could be assigned to a census block were added to the mailout of census questionnaires.

The New Construction Program

Once the November 1999 DSF updates were made to the MAF, Local and Tribal governments were given one more opportunity to assist in ensuring the completeness of the MAF for Census 2000 in the New Construction Program. Starting in January 2000, the Census Bureau provided participating governments an updated MAF to review. Only those governments that participated in the LUCA 1998 program were eligible to participate. Participating local and tribal governments were asked to provide addresses for any residential structures newly constructed and existing as of Census Day, April 1, 2000. Any new addresses provided at this time were enumerated during the Coverage Improvement Followup operation.

February & April 2000 Delivery Sequence Files

The USPS provided two more updated DSFs that the Census Bureau incorporated into the MAF for Census 2000. In February 2000, the USPS provided a special file of just new units since the November 1999 delivery. In April 2000, the USPS provided a file with all addresses currently in the DSF, not just changes from the previous delivery. The Geography Division updated the MAF by adding new addresses and updating existing addresses with address corrections. If an address was no longer on the DSF or was now coded as a non-residential address, this information was updated on the MAF as well. Depending on the timing of obtaining a block code for any new addresses from these DSFs, these addresses were either enumerated during Nonresponse Followup or during Coverage Improvement Followup.

Local Update of Census Addresses 1998 Appeals

Once local and tribal governments were given feedback on their initial submissions, they had an opportunity to appeal the Census Bureau's status for any given submission. The Census Address List Appeals Office was established as a temporary office, in the Office of Management and Budget, outside the Department of Commerce to resolve appeals cases. If the Appeals Office

ruled in favor of the local or tribal government, the Census Bureau would attempt an enumeration at the appealed address.

Questionnaire Delivery

For the vast majority of areas where the address list was developed as described above, the Census Bureau mailed out questionnaires to all potential housing units and residents were asked to complete and mail back their census questionnaires. (Mailout/Mailback).

In a small number of areas, where the Census Bureau built the address list using this Mailout/Mailback approach, enumerators updated the address list and delivered the census questionnaires. Residents were asked to complete and mail back their census questionnaires (Urban Update/Leave). These were areas that were identified by the local census staff where the Census Bureau anticipated multi-unit buildings where the USPS delivers the mail to a drop point instead of individual unit designations or urban communities that had city-style addresses but many residents picked up their mail at a post office box.

In yet another small number of areas, where the list was built using the Mailout/Mailback approach, enumerators updated the address list and enumerated the housing units at the time of their visit (Urban Update/Enumerate) These were areas with special enumeration needs and where most housing units may not have had house number and street name mailing addresses. These areas included resort areas with high concentrations of seasonally vacant housing units, selected American Indian reservations, and colonias; the latter generally are Hispanic-occupied unincorporated communities near the Mexican border.

Nonresponse Follow Up Operation

In Mailout/Mailback areas and in Urban Update/Leave areas the Census Bureau conducted the Nonresponse Followup operation. The primary objective of NRFU was to obtain completed questionnaires from households in these areas that did not respond by mail. If a questionnaire was not checked-in on or before April 10, 2000, the housing unit was targeted for NRFU. Although completing interviews with nonrespondents from the mailback enumeration is the primary purpose of NRFU, enumerators were also asked to keep an eye out for residential addresses that did not appear to be on their address registers. If they found any "adds" they were instructed to enumerate them as well. As part of this process enumerators also coded units as vacants or deletes.

Coverage Improvement Followup Operation

The Coverage Improvement Followup (CRFU) operation followed the NRFU operation. It had many purposes. Its primary purpose was to verify any housing units that were coded as vacant or deleted by the NRFU enumerators. In this operation, the Census Bureau also attempted enumeration for the first time for addresses that were added in the New Construction program,

the LUCA 1998 Appeals process, or from any DSF if the address was finally geocoded to a census block in Mailout/Mailback areas. The Census Bureau also followed up on any addresses for which they did not receive a mail return from the Urban Update/Leave program. The Census Bureau also attempted to enumerate cases for which they had received blank mail returns or they had lost the mail returns. During this operation, enumerators may have coded cases as vacants or deletes.

Update/Leave Approach

This approach includes the following types of enumeration areas: Update/Leave, Rural Update/Enumerate, and Update/Leave Areas that were originally Mailout/Mailback Areas but were converted just before the Block Canvassing operation.

Outside of Mailout/Mailback areas, noncity-style addresses are more common. Noncity-style addresses occur in the forms of rural route/box numbers, post office box numbers, highway contract route numbers, and general delivery addresses. It is difficult to establish their census block locations through automated matching because they are less systematic and are not always associated with the location of the residence (especially in the case of post office boxes and general delivery addresses). Thus, the initial MAF creation method for areas where these types of addresses predominate is through field compilation by census staff. In Update/Leave areas, the address list was initially created by using address listing.

Address Listing

Address Listing occurred from August of 1998 through May of 1999. In this operation, field staff created an address list by listing all residential addresses in these areas and simultaneously adding the addresses to Census maps with a location designation known as a map spot. Listers were also expected to correct the names and locations of features on the census maps.

The National Processing Center keyed all addresses and, independently, they data captured map spots and map feature updates by scanning and digitizing updated census map information. The Geography Division then updated the MAF and TIGER databases with the data captured information.

Local Update of Census Addresses 1999, Local Update of Census Addresses 1999 Recanvass, and Local Update of Census Addresses 1999 Appeals

Following the initial creation of the address list, the Census Bureau began the LUCA 1999 program. In this program, the Census Bureau sent invitations for participation to all eligible functioning local and tribal governments. These governments contained at least some census blocks that were in Update/Leave areas. For those governments that agreed to participate and signed a confidentiality agreement, the Census Bureau provided address lists, census maps, and counts of addresses by census block. Local and tribal governments could either receive paper or

electronic materials. Participants were asked to identify census blocks where they believed the block counts were incorrect (higher or lower).

All eligible challenged blocks were recanvassed in LUCA 1999 Recanvass. In this operation, field staff recanvassed the entire block to verify all addresses on the address list, to make corrections to the list, and to add any missing addresses from the list. Staff also were expected to update the census maps with corrected names and locations of features and to add any new addresses as map spots on the maps.

The National Processing Center keyed all address updates and, independently, they data captured map spots and map feature updates by scanning and digitizing updated census map information. The Geography Division then updated the MAF and TIGER databases with the data captured information.

Once all updates were made, the Census Bureau provided feedback on the challenged blocks to the local and tribal governments. In the meantime, the initial Decennial MAF was produced. This file was the initial source of addresses to be delivered by enumerators.

Once local and tribal governments were given feedback on the challenged blocks, they had an opportunity to appeal individual addresses that they believed were still missing from the address list. The Census Address List Appeals Office was established as a temporary office, in the Office of Management and Budget, outside the Department of Commerce to resolve appeals cases. If the Appeals Office ruled in favor of the local or tribal government, the Census Bureau would attempt an enumeration at the appealed address, by mailing out questionnaires and by including these addresses in Nonresponse Follow up if the questionnaires were not returned.

Update/Leave

Since the initial address list in Update/Leave areas was created 18 months in advance of Census Day and not every government participated in the LUCA 1999 Program, it was important to update the address list at census time.

During Update/Leave, enumerators updated Census address lists and maps, while delivering questionnaires to all housing units in blocks identified as Update/Leave blocks.

During the U/L operation, enumerators visited their assignment areas with an address binder containing the list of addresses captured during Address Listing and supplemented during the LUCA program. The enumerators updated the addresses in the binder and delivered a questionnaire to each housing unit located within each block in their assignment areas. They also corrected address information or identified addresses as deletes. When delivering questionnaires, if no resident was home, the enumerators placed the questionnaire in a bag and hung it on the doorknob. The enumerators compared the physical location address or description and mailing address to the housing unit to verify they were at the correct housing unit on the list. At the time

of questionnaire delivery, the enumerators attempted to collect any information missing from the address binder (for example, mailing address and occupant name) and to verify information collected during previous operations. There were no telephone or personal visit callbacks to get any missing information.

When enumerators found a housing unit that was not in the address binder, they added it to the U/L Add Page, assigned the next highest available map spot number in the block, and spotted the location on the census Block Map. For an added unit within a multi-unit building, enumerators assigned the unit the map spot number for the building and changed the number in parentheses next to the map spot number on the map to reflect the actual number of units. Enumerators prepared a census questionnaire for each added housing unit for the household to fill out and mail back. The U/L Add Page for each Assignment Area showed the proper sampling pattern for long and short forms for the Assignment Area.

The National Processing Center keyed all addresses and, independently, they data captured map spots and map feature updates by scanning and digitizing updated census map information. The Geography Division then updated the MAF and TIGER databases with the data captured information.

Rural Update/Enumerate

In a small number of blocks, instead of leaving questionnaires, enumerators updated the address list and enumerated the housing units at the time of their visit (Rural Update/Enumerate) These were areas with special enumeration needs and where most housing units may not have had house number and street name mailing addresses. These areas included resort areas with high concentrations of seasonally vacant housing units, selected American Indian reservations, and colonias; the latter generally are Hispanic-occupied unincorporated communities near the Mexican border.

Nonresponse Follow Up Operation

In Update/Leave areas the Census Bureau conducted the Nonresponse Followup operation. The primary objective of NRFU was to obtain completed questionnaires from households in these areas that did not respond by mail. If a questionnaire was not checked-in on or before April 10, 2000, the housing unit was targeted for NRFU. Although completing interviews with nonrespondents from the mailback enumeration is the primary purpose of NRFU, enumerators were also asked to keep an eye out for residential addresses that did not appear to be on their address registers. If they found any “adds” they were instructed to enumerate them as well.

Coverage Improvement Follow Up Operation

The Coverage Improvement Followup (CRFU) operation followed the NRFU operation. It had many purposes. Its primary purpose was to verify any housing units that were coded as vacant or

deleted by the NRFU enumerators. In this operation, the Census Bureau also followed up on any addresses for which they did not receive a mail return from the LUCA 1999 Appeals process. The Census Bureau also attempted to enumerate cases for which they had received blank mail returns or they had lost the mail returns.

List/Enumerate Approach

This approach includes the following types of enumeration areas: List/Enumerate and Remote Alaska.

For a small number of areas, instead of using the Update/Leave approach, the Census Bureau used the List/Enumerate approach.

In these areas, there was no address list development prior to enumeration. At the time of enumeration, enumerators developed the address list, updated maps with map spots for each added address and with feature name and location corrections, and enumerated all identified housing units, in person. In Remote Alaska, the Census Bureau also provided lists of addresses to sworn village officials so they could help locate and identify any addresses that may have been missed. In this way, the Census Bureau could enumerate these missed addresses while they were still there.

Additional Updates in All Areas of the Country

There were several other activities that lead to updates of the MAF in Census 2000. These include the Be Counted and Telephone Questionnaire Assistance Programs, the enumeration of Special Places/Group Quarters, the Unduplication Operation, and final processing of census data.

Be Counted and Telephone Questionnaire Assistance Programs

The Census 2000 Be Counted Program provided a means for persons to be included in Census 2000 who may not have received a census questionnaire or believe they were not included on one. The program also provided an opportunity for persons who have no usual address on Census Day to be counted in the census. The Census 2000 Be Counted Form contained short form questions, a question indicating whether the form is being completed for the respondent's whole household, and several additional questions needed to geocode the respondent's address and process the completed forms. The Be Counted Forms were available in targeted locations on March 31, 2000 and were removed from the sites on April 17, 2000. These dates coincided with Census Day (April 1, 2000) and the start of the NRFU operation.

The Telephone Questionnaire Assistance (TQA) Program was implemented to assist the public in completing their census forms. Respondents were able to call the TQA number and, if they met certain criteria, they could provide their short-form data over the phone with or without a Census ID. The TQA program allowed respondents to provide a short form interview over the phone

without a Census ID from March 22, 2000 to June 30, 2000. In addition, respondents were able to request a mailed census form given they needed a replacement questionnaire or never received a form. If a respondent was able to provide their Census ID, they received a replacement of their original Census short form or long form. For respondents that did not know their Census ID, they were mailed either a Census short form or long form labeled with a TQA processing ID. To maintain the national sampling rate of households selected to complete a long form, every sixth respondent received a Census long form. These cases without a Census ID but with a TQA processing ID were treated just like Be Counted forms.

The addresses on the Be Counted Forms were matched to the addresses on the MAF and the DMAF. If the address on the form matched to the MAF or the DMAF, the form was linked to the ID on these files that had the corresponding address. If the address from the form only matched to an address on the MAF that was not geocoded or it did not match to an address on either file, the address from the Be Counted Form was sent to geocoding. If the address geocoded then it was sent to Field Verification. Field Verification consisted of an enumerator visiting the address provided by the respondent and determining the status of this address. The status from Field Verification could be one of the following:

- verified as existing,
- determined not to exist (delete) or
- determined to be a duplicate of an address already in the DMAF.

If these addresses were verified to exist, the address and person information was included in the census. If the address was determined to be a delete or a duplicate, then it was not included in the census. If the address could not be geocoded, regardless of whether it matched or not, it was not included in the census.

Special Place/Group Quarters Enumeration

Separate from the enumeration of housing units, the Census Bureau conducted a series of operations in order to enumerate special places and group quarters (GQs). GQs are places where people live or stay other than the usual house, apartment, or mobile home. Examples of GQs include college and university dormitories, hospital/prison wards, and nursing homes. GQs are contained within special places such as prisons, hotels, migrant farm camps, or universities. During the development of the master file of special places and GQs, the Census Bureau sometimes identified regular housing units at these special places and GQs. When this occurred, the Census Bureau checked to see if these regular housing units were already on the MAF. If they were not, they added them to the MAF. During the actual enumeration of special places and GQs, enumerators may have also identified regular housing units at these places. Again, when this occurred, they checked to see if these regular housing units were already on the MAF and if they weren't, the Census Bureau added them.

The Unduplication Operation

There was some evidence in early 2000 that there were too many units on the address list. Duplication was a side effect of using exact matching on addresses coming from many different sources. An example of how duplicates arose is the situation of unmarked apartment numbers. It was improbable that different sources would submit the same apartment designations. An ad hoc operation researched such problems and implemented some rules for deleting some units from Census 2000.

The Final Processing of Census Addresses

After the completion of the enumeration, the Census Bureau assigned a final status to each address. For the vast majority of cases in the enumeration process, the Census Bureau obtained completed enumerations and therefore kept those addresses as valid addresses in the census. For the remaining addresses, they needed to assign a final status. Some addresses were deleted through the "Kill" process. This process identified addresses that most likely did not uniquely identify housing units as of Census Day. One example of the type of unit that was excluded from the census as a result of this process is:

- There was no census form returned for the unit,
- The unit was deleted in NRFU, and
- The unit was confirmed as a delete in the CIFU operation.

Other addresses had incomplete information coming out of the enumeration. An example of this would be where the enumerator could not determine if the address was a residential address or not. In this case, the Census Bureau needed to impute a final status of the address. Once the final processing of census addresses was done, the Census Bureau updated the MAF one final time with the results of this processing.

Timing of the Individual Sources that Provide Addresses to the MAF in Census 2000

In Section 3.1.1, we define the concept of original source, which is used throughout this report. Because we present original source information sorted by the number addressed contributed by the source instead of in chronological order, we present here information about the chronology of the operations and sources of addresses to the MAF in Census 2000. Unless otherwise noted, the start date and completion date refer to when the Master Address File was updated with the results of the operation.

Table 1. Chronological Description of the Operations/Sources of Addresses in Census 2000

Operation/Source	Start Date MAF is Updated	Finish Date MAF is Updated
1990 ACF	12/03/96	08/08/98
11/97 (or earlier DSF)	11/97	08/08/98
Census 2000 Dress Rehearsal	01/97	7/98
LUCA 1998	10/02/98	12/01/99
Address Listing	12/10/98	06/29/99
Block Canvassing	4/21/99	07/30/99
09/98 DSF	09/98	09/98
LUCA 1999 Recanvassing	06/29/99	03/02/00
LUCA 1999 Appeals	03/17/00	04/20/00
11/99 DSF	12/08/99	01/06/00
LUCA 1998 Appeals	03/22/00	06/08/00
Special Place/Group Quarters Master File	11/23/99	12/14/99
02/00 DSF	02/14/00	03/02/00
New Construction	05/18/00	06/08/00
Update Leave & Urban Update/Leave	05/18/00	06/08/00
NRFU (when conducted)	04/27/00	06/26/00
CIFU (when conducted)	07/30/00	09/13/00
Be Counted and TQA	07/00	07/00
Update/Enumerate and List/Enumerate	08/10/00	08/15/00
04/00 DSF	04/28/00	05/11/00
Special Place/Group Quarters Enumeration (when completed)	06/00	06/00

Appendix B Table 1. Percentages of in-census addresses by combination of action codes in Mailout/Mailback areas[1]

Block Canvassing Action	LUCA 98 Action	1990 ACF & residential on 1 (or more) of the first 3 DSFs[2]	1990 ACF & never residential on a DSF[3]	Not on 1990 ACF & residential on 1 (or more) of the first 3 DSFs	Not on 1990 ACF & never residential on a DSF	TOTAL
(+) Block Canvassing Action[4]	(+) LUCA 98 action[6]	66.249	1.374	9.907	0.002	77.533
	Added in LUCA 98	0.797	0.013	1.150	0.048	2.007
	(-) LUCA 98 action[7]	0.091	0.013	0.030	< 0.001	0.136
	Not in LUCA 98 universe	5.527	0.158	3.495	< 0.001	9.181
	SUBTOTAL	*72.663*	*1.558*	*14.582*	*0.050*	*88.854*
Added in Block Canvassing	(+) LUCA 98 action	0.504	0.014	0.299	0.154	0.971
	Added in LUCA 98	0.023	0.007	0.488	0.147	0.665
	(-) LUCA 98 action	0.004	0.001	0.002	0.001	0.008
	Not in LUCA 98 universe	0.096	0.024	1.464	1.441	3.025
	SUBTOTAL	*0.626*	*0.046*	*2.252*	*1.743*	*4.668*
(-) Block Canvassing Action[5]	(+) LUCA 98 action	0.037	0.005	0.011	< 0.001	0.055
	Added in LUCA 98	< 0.001	< 0.001	< 0.001	< 0.001	0.002
	(-) LUCA 98 action	< 0.001	< 0.001	< 0.001	< 0.001	0.002
	Not in LUCA 98 universe	0.004	< 0.001	0.005	< 0.001	0.011
	SUBTOTAL	*0.042*	*0.006*	*0.017*	*< 0.001*	*0.066*
TOTAL		**73.332**	**1.610**	**16.851**	**1.793**	**93.587**

[1] Percents are of all in-census units in Mailout/Mailback areas. The percents in tables 1.A. through 1.D do not add up to 100. The numbers in tables 1.A through 1.D only account for 93.59 percent of the census units in Mailout/Mailback areas.

[2] The first 3 DSFs include the 11/97(or earlier), 9/98 and 11/99 DSFs

[3] Never residential on the 11/97(or earlier), 9/98, 11/99, 2/00, or 4/00 DSFs

[4] (+) Block Canvassing action = Positive action from the operation, including Verifications, Corrections and Moves

[5] (-) Block Canvassing action = Negative action from the operation, including Deletes, Nonresidentials and Duplicates

[6] (+) LUCA 98 action = Positive action from LUCA 98, including Corrections and units in the LUCA 98 universe with no action

[7] (-) LUCA 98 action = Negative action from the operation, including Deletes and Nonresidentials

Table 2. Census addresses by combination of action codes in Update/Leave areas

Address Listing Action	LUCA 99 action	Update/Leave action	TOTAL		Self-response		Enumerator Return [5]	
			count	%	count	%	count	%
Address Listing Adds	no LUCA action	(+) U/L action[3]	16,995,134	78.000	11,031,860	50.631	5,963,274	27.369
		(-) U/L action[4]	542,519	2.490	25,553	0.117	516,966	2.373
		SUBTOTAL	*17,537,653*	*80.490*	*11,057,413*	*50.749*	*6,480,240*	*29.741*
	(+) LUCA 99 action[1]	(+) U/L action	1,831,472	8.406	1,235,950	5.672	595,522	2.733
		(-) U/L action	44,122	0.203	2,603	0.012	41,519	0.191
		SUBTOTAL	*1,875,594*	*8.608*	*1,238,553*	*5.684*	*637,041*	*2.924*
	(-) LUCA 99 action[2]	(+) U/L action	2,521	0.012	1,397	0.006	1,124	0.005
		(-) U/L action	584	0.003	14	0.000	570	0.003
		SUBTOTAL	*3,105*	*0.014*	*1,411*	*0.006*	1,694	*0.008*
	LUCA 99 Adds	(+) U/L action	234,996	1.079	142,357	0.653	92,639	0.425
		(-) U/L action	18,909	0.087	870	0.004	18,039	0.083
		SUBTOTAL	*253,905*	*1.165*	*143,227*	*0.657*	*110,678*	*0.508*
		Update/Leave Adds	1,327,233	6.091	776,511	3.564	550,722	2.528
TOTALS			**20,997,490**	**96.369**	**13,217,115**	**60.661**	**7,780,375**	**35.709**

[1] (+) LUCA 99 action = Positive action from the LUCA 99 Recanvass, including Verifications and Corrections
[2] (-) LUCA 99 action = Negative action from the LUCA 99 Recanvass, including Deletes and Nonresidentials
[3] (+) U/L action = Positive action from the Update/Leave operation, including Verifications, Corrections and Moves
[4] (-) U/L action = Negative action from the Update/Leave operation, including Deletes and Nonresidentials
[5] Enumerator return includes all units with a positive action from either the NRFU or CIFU operations

Overall, in Update/Leave areas, there are 223 different combinations of actions from the Address Listing, LUCA 99, Update/Leave, NRFU, and CIFU operations. Approximately 96.37 percent of the HUs are represented by 35 different combinations. Another 0.36 percent of the addresses do not have actions from any of the above operations and are made up of units that were added to the MAF because of Be-Counted, TQA, SPGQ operations, Dress Rehearsal or inside-the-**blue line** operations. 187 different combinations of actions from the Address Listing, LUCA 99, Update/Leave, NRFU and CIFU operations represent the remaining 3.27 percent of census addresses in Update/Leave areas.

Table 3. Inside-the-blue line Master Address File-only matches with a 1990 Address Control File original source

DMAF exclusion reason	Count*	Percent*
Block Canvassing duplicate	10,534	16.68 (7.31)
Negative action from Block Canvassing and not residential on Sept. 98 DSF	37,734	59.76 (8.39)
Not in Block Canvassing universe; not geocoded at the time of initial DMAF	14,871	23.55 (7.19)
Total	**63,139**	**99.99+**

*Counts and percentages are weighted; standard errors in parentheses
+Percentages may not sum to 100 due to rounding.

Table 4. Inside-the-blue line Master Address File-only matches with a Delivery Sequence File original source

DMAF exclusion reason	Count*	Percent*
Not residential on Nov. 97 or Sept. 98 DSF	73,909	62.54 (5.89)
Residential on Nov. 97 and non-residential on Sept. 98 DSF	31,465	26.62 (4.60)
Block Canvassing duplicate	1,475	1.25 (0.76)
Not in Block Canvassing universe; not geocoded at the time of initial DMAF	11,334	9.59 (2.74)
Total	**118,183**	**100.00**

* Counts and percentages are weighted; standard errors in parentheses