2020 Census In-Office Address Canvassing Operational Assessment Report

A New Design for the 21st Century

Issued August 18, 2022
Version 1.1
Prepared by Lyndsey Richmond, Shawn Hanks
Page intentionally left blank.
# Table of Contents

**Executive Summary**.................................................................................................................................................. vii

1. Introduction ................................................................................................................................................................ 1

1.1 Introduction to In-Office Address Canvassing (IOAC) .......................................................................................... 1

1.2 Operational Changes Resulting from COVID-19 ................................................................................................. 2

2. Background ............................................................................................................................................................ 2

2.1 MAF/TIGER Systems ............................................................................................................................................. 2

   Census Blocks .......................................................................................................................................................... 4

   Basic Collection Units ........................................................................................................................................ 4

   2020 Type of Enumeration Areas ....................................................................................................................... 4

2.2 Census 2000 .......................................................................................................................................................... 5

   Address Listing ..................................................................................................................................................... 5

   Block Canvassing .................................................................................................................................................. 6

2.3 2010 Census .......................................................................................................................................................... 6

   Address Canvassing ............................................................................................................................................ 6

   Group Quarters Validation .................................................................................................................................. 8

2.4 2020 Census Address List Development ............................................................................................................. 9

   United States Postal Service File Updates .......................................................................................................... 9

   The Geographic Support System ....................................................................................................................... 10

2.5 Intercensal Testing of Address Canvassing ......................................................................................................... 12

   Address Canvassing Test .................................................................................................................................. 13

   2018 End-to-End Census Test Address Canvassing Operation ...................................................................... 13

2.6 2020 Census Address Canvassing Operation ...................................................................................................... 14

   In-Office Address Canvassing .......................................................................................................................... 14

   In-Field Address Canvassing ............................................................................................................................ 20

   MAF Coverage Study ........................................................................................................................................ 21

2.7 Schedule ............................................................................................................................................................. 22

3. Methodology .......................................................................................................................................................... 23

3.1 Research Questions ............................................................................................................................................. 23

3.2 Data Sources and Calculations: Production Systems/Reports ........................................................................... 24

3.3 Lessons Learned .................................................................................................................................................. 24
4. Limitations ........................................................................................................................... 24

5. Results ................................................................................................................................... 25

5.1 What are the Outcomes of Interactive Review (IR)? ........................................................ 25

5.1.1 IR Background ............................................................................................................... 25

Overview of IR ......................................................................................................................... 25

IR Quality Control (QC) .......................................................................................................... 28

5.1.2 IR Outcomes and Analysis ............................................................................................ 29

Production IR Work ................................................................................................................ 29

IR QC ........................................................................................................................................... 30

Outcomes of IR .......................................................................................................................... 31

5.2 What are the Outcomes of Triggers? .................................................................................. 37

5.2.1 Triggers Background ...................................................................................................... 37

Trigger Types .......................................................................................................................... 38

Triggers to Support Census Tests and Evaluations ................................................................ 40

Triggers Requiring No Further In-Office Address Canvassing Action ........................................ 41

5.2.2 Trigger Outcomes and Analysis .................................................................................... 42

Active Blocks that are Possibly Passive ................................................................................ 44

Passive Blocks that are Possibly Active .................................................................................. 46

Hold-for-Imagery Blocks with Updated Imagery ..................................................................... 46

Database Correction Triggers ................................................................................................. 47

5.3 What are the Outcomes of Active Block Resolution (ABR)? ............................................ 48

5.3.1 ABR Background .......................................................................................................... 48

ABR Overview .......................................................................................................................... 48

ABR Details ............................................................................................................................... 49

ABR QC ....................................................................................................................................... 51

ABR in the Census Tests .......................................................................................................... 51

ABR Design Assumption Changes .......................................................................................... 52

ABR Software Evolution and Benchmarking ............................................................................ 53

5.3.2 ABR Outcomes and Analysis ....................................................................................... 54

5.3.3 Frame Maintenance ....................................................................................................... 55

Frame Maintenance Background ............................................................................................. 55
Frame Maintenance Outcomes and Analysis ......................................................... 56

5.4 What are the Outcomes of Ungeocoded Resolution (UR)? ........................................... 60
  5.4.1 UR Background ................................................................................................. 60
  UR Production ........................................................................................................ 61
  UR Quality Control ................................................................................................. 62
  5.4.2 UR Outcomes and Analysis ............................................................................. 62

5.5 What are the Outcomes of In-Office Address Canvassing (IOAC) Group Quarters/Transitory Locations (GQ/TL)? ......................................................... 67
  5.5.1 IOAC GQ/TL Background ............................................................................. 67
  IOAC GQ/TL Production ......................................................................................... 68
  IOAC QC/TL Quality Control Process ................................................................... 69
  5.5.2 IOAC GQ/TL Outcomes and Analysis ........................................................... 69

5.6 What are the Outcomes of Local Update of Census Addresses (LUCA) Address Validation (LAV)? ......................................................... 73
  5.6.1 LAV Background ............................................................................................ 73
    Managing the LAV Workload ............................................................................. 74
    LAV Production .................................................................................................... 74
    LAV Quality Control ............................................................................................. 74
  5.6.2 LAV Outcomes and Analysis ........................................................................ 75

5.7 What is the Universe Identified for the In-Field Address Canvassing (IFAC) Operation? ............ 79
  5.7.1. Summary of the Universe Identified for Fieldwork ........................................ 79
  5.7.2 Detailed Information About the Universe Identified for Fieldwork ......... 81

5.8 What is the Summary of In-Office Address Canvassing (IOAC) Operational Metrics? ................ 85

5.9 Innovations and Process Improvements in Training ...................................................... 89

5.10 Enumeration Results of In-Office Address Canvassing .................................................... 91

6. Conclusions and Recommendations ............................................................................ 93
  6.1 Conclusions ......................................................................................................... 93
    6.1.1 Metrics and Analysis ..................................................................................... 93
    6.1.2 Summary of Successes ............................................................................... 95
    6.1.3 Summary of Challenges ........................................................................... 97
  6.2 Recommendations ............................................................................................... 104

7. Review / Approval Table ......................................................................................... 111
List of Tables

Table 1: IOAC Milestones with Scheduled and Actual Completion Dates ................................................................. 22
Table 2: Summary of Nationwide (All TEAs) Outcome of IR .......................................................................................... 31
Table 3: IR Block Status by TEA, after the First Complete Pass of the Nation .............................................................. 32
Table 4: IR Block Status by TEA, at the End of IR Operations ...................................................................................... 33
Table 5: Blocks with Undercoverage by TEA, after the First Complete Pass of the Nation ........................................... 35
Table 6: Blocks with Undercoverage by TEA, at the End of IR Operations .............................................................. 36
Table 7: Summary of Triggers in IR ........................................................................................................................... 43
Table 8: Active Blocks that are Possibly Passive: All Active Trigger Methodologies .................................................. 44
Table 9: Active Blocks that are Possibly Passive: Block Characteristic Criteria .......................................................... 45
Table 10: Active Believed to Possibly be Passive: MAF/Housing Unit Change and IR Coverage Criteria ...................... 45
Table 11: Passive Blocks that are Possibly Active: All Passive Trigger Methodologies ................................................ 46
Table 12: Hold for Imagery: All Hold-for-Imagery Methodologies ............................................................................ 47
Table 13: Database Correction Triggers ..................................................................................................................... 47
Table 14: ABR Results by TEA ........................................................................................................................................ 54
Table 15: ABR Address Breakdown for Resolved Addresses .......................................................................................... 55
Table 16: Frame Maintenance Outcomes for Addresses Sent to MAF Update* .............................................................. 57
Table 17: Frame Maintenance Addresses Sent to MAF Update by Action* ................................................................. 58
Table 18: Frame Maintenance Results by TEA ............................................................................................................... 59
Table 19: Frame Maintenance Results by Work Period ................................................................................................ 60
Table 20: UR Universe by Benchmark ........................................................................................................................ 63
Table 21: UR Cumulative Totals ...................................................................................................................................... 64
Table 22: UR Records Worked by TEA* ......................................................................................................................... 65
Table 23: Number of Coded Records by UR Resolution Code ....................................................................................... 66
Table 24: Roads Added or Reshaped in UR .................................................................................................................... 67
Table 25: In-Office Address Canvassing Group Quarters/Transitory Locations (IOAC GQ/TL) Final Phone Call Result by Flag Status ........................................................................................................ 71
Table 26: In-Office Address Canvassing Group Quarters/Transitory Locations (IOAC GQ/TL) Outcomes .................... 72
Table 27: LAV Action Code Totals .................................................................................................................................. 77
Table 28: Number of LAV Records Reviewed by TEA .................................................................................................... 77
Table 29: Number of LAV Records Reviewed in TEA 1 – Self Response ....................................................................... 78
Table 30: Number of LAV Records Reviewed in TEA 6 – Update Leave ..................................................................... 79
Table 31: Overview metrics for the total number of BCUs and housing units and the proportion included in the final IFAC universe ........................................................................................................... 80
Table 32: Summary of Blocks at the Conclusion of In-Office Address Canvassing (IOAC) Error! Bookmark not defined.
Table 33: Summary of Metrics About the Workload Designated for In-Field Address Canvassing (IFAC) ................. 84
Table 34: BCUs Containing Blocks by Status and IFAC Workload* ............................................................................ 85
Table 35: Timeline of IOAC Components in Production by Fiscal Year ........................................................................ 86
Table 36: Total Costs Charged to In-Office Address Canvassing by Division and Fiscal Year .................. 87
Table 37: IOAC Total Workloads and Average Time ................................................................................. 88
Table 38: IOAC Staff Number Ranges by Component* ............................................................................. 89
Table 39: Enumeration Results of TEA-1 MAF Units that were worked in In-Office Address Canvassing (IOAC) and were not sent to In-Field Address Canvassing (IFAC) ........................................................................................................... 91
Table 40: Direct-To-Field Triggered Blocks ............................................................................................... 120
Table 41: Passive-Headquarters Triggered Blocks ..................................................................................... 120
Table 42: Action Codes in ABR and Frame Maintenance .......................................................................... 121
Table 43: ABR QC Sample Criteria ........................................................................................................... 121

List of Figures

Figure 1: Example path of a block triggered more than once in the same timeframe ......................... 42
Figure 2: Visual Timeline of IOAC Components in Production by Fiscal Year ..................................... 86
Executive Summary

The Census Bureau needs the address and physical location of each living quarter in the United States and Puerto Rico to conduct and tabulate the census. The Census Bureau developed innovative methodologies for updating the Master Address File (MAF)/Topologically Integrated Geographic Encoding and Referencing (TIGER) System throughout the decade, and the 2020 Census was the first census to conduct In-Office Address Canvassing (IOAC). IOAC is the process of using empirical geographic evidence to assess and improve the Census Bureau address frame in an office setting. Instead of canvassing the entire nation in person, the 2020 Address Canvassing operation prepared the 2020 Census address frame by first working all blocks in IOAC and then sending a portion of those blocks to be canvassed in In-Field Address Canvassing (IFAC).

IOAC staff reviewed addresses or blocks using some or all of the following: satellite and aerial imagery; MAF counts or data; United States Postal Service (USPS) data; local, county, or state Geographic Information Systems (GIS) viewers; and third-party data. IOAC included multiple components:

- **Interactive Review (IR)** identified undercoverage or overcoverage of addresses in the 2020 Census address frame compared to housing visible in aerial imagery. Additionally, IR used imagery to identify changes in the residential landscape since the 2010 Census. Reviewers classified blocks without apparent coverage issues and no residential growth or decline as passive, those with coverages issues and/or residential growth or decline as active, and those that could not be classified (for example, because of cloudy imagery) were on hold until they could be classified.

- **Triggers** were indicators, based on data from a process or an event, that suggested it may be necessary to change the classification status of a block. Since housing unit change is dynamic and not always visible in imagery, most Triggers were designed to identify blocks that may have had coverage issues that were not identified in IR or experienced change since the first pass of IR was completed.

- **Active Block Resolution (ABR)** researched and updated coverage issues in the 2020 Census address frame in blocks IR identified as active. Later, **Frame Maintenance** researched and updated coverage issues in the 2020 Census address frame using enhanced ABR procedures.
• **Ungeocoded Resolution (UR)** resolved ungeocoded records—addresses not assigned to a block during automated processing—by adding or editing spatial features and address ranges in the MAF/TIGER System.

• **IOAC Group Quarters/Transitory Locations (GQ/TL)** identified, updated, and validated GQ and TL addresses by conducting research and calling administrative contacts to conduct a phone interview.

• **Local Update of Census Addresses (LUCA) Address Validation (LAV)** reviewed LUCA submissions using IOAC sources. Reviewers made the determination whether to accept or reject the LUCA participant address records contained in the sample-based workloads.

During IR, about 250 staff classified more than 11 million blocks in the national universe. By June 2017, IR completed the “First Pass” review of all blocks nationwide and classified about 72 percent as passive. Meanwhile, ABR began with a soft start in April 2016 and UR started in April 2017. After the First Pass of IR, as UR and ABR work updated the 2020 Census address frame and other changes occurred, Triggers identified blocks that needed to be re-reviewed in IR. Of the approximately 1.5 million unique blocks triggered, about 73 percent received an updated IOAC IR status, such as changing from active to passive and vice versa. By conducting Triggers, UR, ABR, and Frame Maintenance, the Census Bureau was able to increase the number of passive blocks across all type of enumeration areas (TEAs) from about 72 percent to about 87 percent of all blocks at the end of IR.

About 150 ABR staff resolved about 70 percent of the approximately 74,500 blocks it worked before ABR was discontinued in February 2017 because of budgetary constraints. Applying the lessons learned from ABR, IOAC conducted Frame Maintenance where a smaller staff resolved about 80 percent of the approximately 26,000 blocks it worked. Frame Maintenance was an effort to use available resources to specifically target blocks where specialized staff could correct issues and reduce the future IFAC workload. Frame Maintenance updated about 209,000 addresses nationwide.

UR geocoded more than 1.8 million addresses and added or reshaped more than 96,000 miles of road in MAF/TIGER. Staffing numbers varied from about 30 staff to 400 staff because of funding and prioritization within IOAC during the almost three years UR was in production. UR did not specifically target only active blocks, but UR nonetheless resolved the coverage in numerous blocks and significantly improved the road feature network within MAF/TIGER before enumeration.
IOAC GQ/TL started in July 2017 and encountered unforeseen challenges almost immediately along with funding concerns. As a result, the Census Bureau paused the operation in March 2018. About 30 staff completed about 4 percent of the total GQ/TL universe through Quality Control (QC) before the component was paused.

From April 2018 to March 2019, about 300 LAV staff reviewed about 861,000 addresses from the 2020 Census LUCA operation. Overall, about 61 percent of reviewed addresses were accepted (LUCA add or change record accepted) and about 39 percent were rejected (LUCA add or change record rejected).

As a result of IOAC, the Census Bureau was able to review 100 percent of the United States and Puerto Rico and validate a majority of the decennial address frame in the office. At the completion of IOAC, the Census Bureau sent about 35 percent of housing units within areas where respondents would receive an invitation to participate in the 2020 Census in the mail to In-Field Address Canvassing (IFAC). IOAC successfully reduced the number of addresses in the IFAC universe from more than 143 million to about 50 million, and also helped avoid field canvassing large portions of the nation. Additionally, IOAC also provided a method to validate addresses submitted by 2020 LUCA participants. Finally, IOAC improved the features and geocodes in MAF/TIGER nationwide in preparation for the 2020 Census.

Successes

Overall, IOAC was successful: it greatly reduced the amount of the nation that required in-person canvassing; it updated the address frame ahead of the 2020 Census; and provided a mechanism to validate addresses submitted as part of the 2020 LUCA program. Some additional successes are noted below.

- The Census Bureau created and executed a new and cost-effective methodology and tools for validating an address frame with limited fieldwork.
- IOAC staff created new training methods that were more efficient and effective and allowed them to conduct training remotely when needed.
- IOAC reviewers received feedback on their errors and learned from them. All IOAC components had reviewers assess or correct their errors to help reviewers improve and refine their skills.
- The Census Bureau gained insight from conducting IOAC for the first time and modified components to make them more effective and efficient.
• IOAC made updates and corrections to the address frame ahead of IFAC and the 2020 Census, reducing the need for processing after listing operations.

• Using Agile software development allowed staff to start IOAC production relatively quickly, gain knowledge from real data, and add additional features along the way.

• Most components used a soft start to prepare software, procedures, and support staff before full production.

**Challenges**

The decade leading up to the 2020 Census was the first time IOAC was conducted. Some of the associated challenges are listed below:

• Canceling ABR resulted in higher workloads in IOAC and other operations. It changed the design of IOAC, affected how Triggers were used, removed the primary method of updating and correcting MAF/TIGER to resolve complicated coverage issues, and changed the design of IOAC GQ/TL, which subsequently affected the GQ/TL frame for the 2020 Census.

• Staff encountered multiple unanticipated obstacles in the IOAC GQ/TL component. For example, GQ/TL staff were often reluctant to provide their information over the phone or questioned the authenticity of the call. The lack of a successful IOAC GQ/TL program was one of several factors that affected the GQ/TL frame overall in the 2020 Census.

• The planned work processes for UR, ABR, LAV, and IOAC GQ/TL were hindered by the skill set of the Census Bureau’s National Processing Center (NPC) staff hired for these components and this resulted in significant replanning, changes to procedures, and training adjustments to complete the work successfully. The work was completed successfully but with mitigation measures that took extra time and resources.

• Hiring new staff was often difficult and staffing numbers fluctuated over the course of IOAC components. Clearing and onboarding new staff was sometimes not carried out in a timely manner. New staff sometimes were lost to other Census Bureau jobs or other job opportunities, particularly in the local economy near the NPC in Southern Indiana and the Louisville, Kentucky, area.

• IOAC used 2010 tabulation blocks as the work unit while IFAC used a different work unit that was more suitable for fieldwork, the basic collection unit (BCU). Because of the complex relationship between blocks and BCUs, it was difficult to estimate with precision
how IOAC was affecting the IFAC target universe and work needed to be prioritized based on block-BCU relationships.

- Other update processes to the MAF/TIGER System occurred at the same time as IOAC and since both worked on the same address frame, IOAC sometimes was complicated by these other update processes.

- The 2020 LUCA schedule did not allow LUCA to be used as a Trigger or allow IOAC to set the IFAC universe after LUCA updates had been processed and possibly changed the status of some blocks.

- IOAC uncovered more preexisting coverage issues or problematic older data in MAF/TIGER than the Integrated Project Team (IPT) originally anticipated. These issues were not unique to IOAC or past canvassing operations, but IOAC often needed to correct them to fix coverage issues and none of the IOAC components were designed to undertake a large clean-up process.

- The number of addresses submitted in LUCA was four times higher than estimated. As a result, rather than reviewing every address, LAV had to move to sampling addresses within each entity in order to complete the workload.

- Software to track the status of blocks was adequate but it did not account for the ideal flow of blocks given multiple processes and components happened simultaneously.

- Onboarding and training sometimes faced coordination challenges: partially unfilled training sessions, training sessions with staff who have not completed prerequisites, and staff who sometimes missed the first day of training and needed to be caught up. These challenges were mitigated by the training innovations developed by IOAC staff.

- Good source data, such as county GIS viewers, were important to ABR, UR, and LAV, but not always readily available. Without good source data, LAV could not evaluate the addresses and ABR and UR needed additional time to find good data or sometimes could not resolve blocks or addresses.

- Some areas of the country have persistently obstructed imagery (i.e., by clouds or other obscuring issues), and it was not possible to get clear imagery for some blocks. Because most IOAC work requires good imagery, there were some blocks that could not be resolved in IOAC and needed to be sent to IFAC.
• Lack of software resources affected ABR: Business rules in the software were not programmed until about a year into ABR production work, sample QC was not in place when full ABR production began, and there were software failures in the training environment.

• Unified Tracking System (UTS) and IOAC worked within different models because IOAC was different from traditional decennial operations. For example, IOAC had a nonlinear workflow by design. Block Assessment, Research, and Classification Application (BARCA) and UTS had difficulty integrating and the Address Canvassing leadership team decided in April 2018 to continue with reports from BARCA and have subject-matter experts manually create and send a daily report.

• IOAC details were sometimes challenging to understand, especially for nongeographers or people unfamiliar with MAF/TIGER. Furthermore, the Census Bureau did not always fully coordinate on messaging or have IOAC materials catered to different groups such as the advisory groups, stakeholders, or leadership and oversight.

Recommendations

• **Hire higher grade staff with geographic knowledge or experience for future operations or programs similar to IOAC.** The grade-levels hired for UR, ABR, LAV, and IOAC GQ/TL were not aligned with the work for those components. The nature of geography work has changed and requires staff with skills to interpret multiple sources of information (some of which may conflict), assess the existing address frame, make the best decision in every unique situation, and correctly apply updates.

• **Address preexisting coverage issues and develop strategies to prevent them in the future.**
  - Plan and fund a component, similar to ABR/Frame Maintenance, where appropriate grade-level staff with geographic experience are hired to perform research and correct complicated coverage issues.
  - Research methods for identifying areas that need updates that cannot, or cannot efficiently, be completed by other programs or listers, such as more complicated situations or areas needing feature reshaping.
  - When designing processes for updating and maintaining the geographic frame, consider how to reduce the number of new coverage issues. New coverage issues could be introduced through partner programs such as LUCA, batch updates, and other operations.
• **Conduct research on the best methods to update GQ/TL information and plan any future efforts with awareness of the issues encountered in this component.** Explore what GQ/TL information can be obtained from Geographic Support and Frames Programs and other sources internal to the Census Bureau. If phone calls are considered, planning must include research and an effective transformation of the current model of making phone calls. Consider coordinating with other operations such as American Community Survey (ACS) and staff in the regional offices, especially for larger institutions.

• **Research how the next decade will track the status of the address frame, including monitoring address frame updates and identifying areas where updates are needed.** Research developing an integrated, flexible system that identifies, manages, and tracks the flow of blocks (or another unit) through multiple components/activities, uses various data sources, allows subject-matter experts to establish and modify criteria and prioritize blocks, and provides useful, real-time data monitoring.

• **Investigate how future listing and future update efforts will manage their work (using blocks, addresses, or another unit) and include considerations in planning for any translation or overlap of geographies.**

• **Consider the availability of good and authoritative sources of data and imagery in planning future work.**

• **Continue support for new training methodologies including computer-based training, remote training, training exercises that can be graded automatically or with simple queries, helpful tools like decision trees, and conducting refresher trainings.**

• **Determine how future work will assess quality.**
  - Quality of the design: the quality in choosing how areas or blocks are prioritized, the efficiency of the staff skill set chosen, and how the work is structured. Continue to use a design that will allow for robust feedback.
  - Quality of the work: consult with Decennial Statistical Studies Division (DSSD) to develop statistically sound quality control plans, implement them in future work, and meet periodically to assess if the work and staff are meeting quality standards and what those standards mean.
  - Quality of the address frame: consider how to measure both the quality and completeness of the address frame. Assess the results from future studies focused
on the address frame and implement program or design changes as need to improve the quality of the address frame.

- **Evaluate** how to prioritize work in a constrained fiscal environment and mitigation strategies for times when there is a lapse in appropriations.

- **Investigate** strategies for hiring to address past challenges and plan for changes resulting from the recommendation to hire higher grade staff with geographic knowledge or experience.

- **Research** the timing of LUCA in determining where listing operations are needed in 2030 and coordinating how LUCA updates the address frame with future work similar to IOAC.

- **Create** plain language messaging about complicated geographic work similar to IOAC because it can be challenging for nongeographers or people without knowledge of MAF/TIGER to understand. Ideally there would be a set of materials for three audiences: the advisory groups, Census Bureau staff, and oversight staff.
1. Introduction

This section has an overview of In-Office Address Canvassing (IOAC) and the operational changes resulting from COVID-19.

1.1 Introduction to In-Office Address Canvassing (IOAC)

The 2020 Census Address Canvassing (AdCan) operation implemented methods to improve and refine the U.S. Census Bureau’s address list in advance of the 2020 Census enumeration. The Census Bureau needs the address and physical location of each living quarter in the United States and Puerto Rico to conduct and tabulate the census. An accurate list ensures that residents receive an invitation to participate in the census, and that the census counts residents in the correct location. To support this effort, the Census Bureau developed innovative methodologies for updating the Master Address File (MAF)/Topologically Integrated Geographic Encoding and Referencing (TIGER) System throughout the decade.

During the 2010 Census, AdCan field staff, referred to as listers, traversed almost every block in the United States and Puerto Rico, comparing their observations on the ground with the Census Bureau’s address list. Listers verified or corrected addresses that were on the list, added new addresses to the list, and deleted addresses that no longer existed. Listers also collected map spot locations (latitude/longitude coordinates) for each structure and added new streets.

Historically, the Census Bureau considered this method the best way to establish a complete address list, but it was very expensive. For the 2010 Census AdCan field operation, 8,213 crew leaders managed 111,105 listers during production listing and 3,083 crew leaders managed 37,784 listers during quality control listing for a cost of $443,591,299 (Address List Operations Implementation Team, 2012). Additional costs were incurred for field infrastructure and information technology infrastructure support.

Research showed that this method is not always the most effective way to update the address frame. (U.S. Census Bureau, 2014). Advancements in technology enabled continual address and spatial updates to occur throughout the decade. The availability of up-to-date high quality, high-resolution satellite and aerial imagery, and street view tools, along with multiple sources of address information, provided a viable tool to reduce fieldwork in many parts of the United States, especially in areas that have been residentially stable.

The 2020 Census AdCan operation included a suite of both field and office components that validated and/or updated the address list and map data used for the 2020 Census enumeration. These components are referred to as In-Office Address Canvassing (IOAC) and In-Field Address
Canvassing (IFAC). The IOAC conducted a full canvass of the United States and Puerto Rico and IFAC only canvassed areas within the United States that IOAC identified as needing fieldwork.

This document provides both qualitative and quantitative information about the IOAC components of the 2020 Census AdCan operation. The qualitative information is based on insight from stakeholders involved in the development and implementation of the operation. The Geography Division (GEO), the Decennial Statistical Studies Division (DSSD), and the Decennial Census Management Division (DCMD) provided quantitative data, summarized in this assessment.

This assessment does not provide detailed operational information and previously documented decisions but provides references to the appropriate documents for such information. The References section in this report contains a list of reference documents, including edition dates and authors.

1.2 Operational Changes Resulting from COVID-19

There were no operational changes resulting from COVID-19 since all activities finished by February 2020.

2. Background

This section includes a description of the Address Canvassing (AdCan) operation and related address frame-building activities. Background includes information about previous address listing activities, a brief discussion of previous research and operational tests, information about the redesign of the operation for the 2020 Census, an overview of the AdCan process for 2020, and the In-Office Address Canvassing schedule.

2.1 MAF/TIGER Systems

The Master Address File (MAF)/Topologically Integrated Geographic Encoding and Referencing (TIGER) System, which includes software applications and databases, serves as the national repository for all of the spatial, geographic, and residential address data needed for census and survey data collection, data tabulation, data dissemination, geocoding services, and map production. The MAF contains all known living quarters and serves as the base of the address frame. The Census Bureau uses the MAF to deliver questionnaires and postcards, and to facilitate in-person data collection. Each address in the MAF is designed to be linked to a geographic location in TIGER, the Census Bureau’s geographic database. This linkage ensures that the census data are processed and tabulated in the correct geographic location.
The Census Bureau established the first MAF/TIGER System to support Census 2000 enumeration after TIGER was built to support the 1990 Census. Before 1970, the census was conducted in an all-in-one operation in which enumerators were responsible for listing addresses and conducting interviews at the same time. Beginning in 1970, each decennial census has used some form of canvassing to validate and update the Census Bureau address list before mailing census questionnaires. For the 1970, 1980, and 1990 censuses, the Census Bureau began with a commercially purchased address list for available metropolitan areas and then conducted canvassing operations to improve the list. For Census 2000, the goal was to build and maintain a permanent housing unit (HU) address list for future use. The 1990 Address Control File was the initial base for the MAF. The United States Postal Service (USPS) Delivery Sequence File (DSF) provided regular updates to the MAF in city-style address areas. Census 2000 frame operations, including the Local Update of Census Addresses (LUCA), Block Canvassing, and Address Listing, were the first decennial census operations to update the MAF. Census 2000 enumeration operations supplied additional updates to the MAF.

After Census 2000, the advent of the American Community Survey (ACS)—an ongoing household-level survey to collect detailed demographic and housing characteristics, replacing the decennial census “long form”—strengthened the need for MAF/TIGER System updates throughout the decade. Between 2000 and 2010, the Census Bureau continued to use the USPS’s DSF to update the MAF at least twice each year. Additionally, the ACS established the Community Address Updating System (CAUS). CAUS was a program that provided field-verified address updates to the MAF, particularly in areas where the DSF was considered deficient. These updates continued through 2009, when the decennial census conducted a national Address Canvassing operation to update the MAF/TIGER System in preparation for the 2010 Census.

After the 2010 Census, the USPS’s DSF and CAUS data continued to update the MAF/TIGER System, along with other special census and current survey programs. However, the Census Bureau determined that there was a need for a more concerted, larger-scale effort to update and validate the MAF/TIGER System to support census surveys and the 2020 Census. This prompted the development of the Geographic Support System (GSS) Initiative, a continuous plan to provide current, accurate, and complete address, feature, and boundary data. The GSS programs and the Address Canvassing operation worked together to update the MAF/TIGER System and establish the 2020 Census address list.

The MAF/TIGER System houses the various geographies that are used by the 2020 Census, including blocks, basic collection units, and types of enumeration areas.
Census Blocks

Census Bureau address listing work was historically conducted and managed within the confines of a census block. Census blocks are statistical areas bounded by visible features, such as streets, roads, streams, and railroad tracks, and by nonvisible boundaries, such as selected property lines and boundaries of all higher-level census geographic areas. Generally, census blocks are small in area. For example, a block in a city is bounded on all sides by streets. Blocks in suburban and rural areas may be large, irregular, and bounded by a variety of features, such as roads, streams, and transmission lines. However, in remote areas, census blocks may encompass hundreds of square miles. Census blocks nest within all other census geographic entities used to present decennial census data.

In general, the types of blocks as described above are referred to as tabulation blocks. For the purposes of field data collection, the Census Bureau worked within the confines of collection blocks for Census 2000 and the 2010 Census. Prior to 2000, blocks served both data collection and tabulation. Collection blocks are similar to tabulation blocks, but they are bounded by only visible features to the extent possible, allowing fieldworkers to easily observe their boundaries while conducting work.

Basic Collection Units

The Census Bureau developed a new type of collection geography for the 2020 Census known as the basic collection unit (BCU). The BCU replaces both the collection block and assignment area geographies that operations used for the 2010 Census. In short, where collection operations used blocks and assignment areas for the 2010 Census, they used the BCU for the 2020 Census. The Census Bureau tested the use of the BCU for the first time in 2016 during the Address Canvassing Test (U.S. Census Bureau, 2021).

IOAC used the 2010 Census tabulation block as the work unit while IFAC used the BCU. When IOAC software design began, BCUs did not yet exist so IOAC used 2010 tabulation blocks as the work unit. When BCUs were delineated, the decision was made to continue to use the 2010 tabulation blocks for IOAC.

2020 Type of Enumeration Areas

Every BCU in the United States was assigned to one specific type of enumeration area (TEA). The TEA assignment determined the methodology used for frame enhancement and enumeration of the households within the BCU. The TEA assignment for a given BCU was based on address types and other characteristics of the BCU, including an assessment of the likelihood
of residents to self-respond and accessibility of the BCU. Assigning TEAs to BCUs ensured a cost-effective and efficient process to enumerate households in 2020.

All blocks were part of the IOAC operation universe regardless of their TEA. However, the self-response TEA, known as TEA 1, was the only TEA where the Census Bureau selected BCUs as part of the In-Field Address Canvassing operation. For more information on 2020 TEA, please see the 2020 Census Geographic Programs Detailed Operational Plan (2018), Operational Assessment (U.S Census Bureau, 2018d), or online TEA viewer.¹

2.2 Census 2000

The following section describes the process used to create the address list for Census 2000. Census 2000 included two main address list updating operations: Address Listing and Block Canvassing.

Address Listing

The Census 2000 Address Listing operation created the address list in rural or remote areas with a predominance of non-city-style addresses by conducting an independent listing of the addresses instead of updating an existing list. The Census Bureau built the initial address list, which became the MAF, throughout the preceding decade (U.S. Census Bureau, 2004). However, rural or remote areas were known to contain mostly non-city-style addresses that would not be able to receive a Census 2000 questionnaire through the mail. Therefore, from July 1998 to May 1999, Address Listing listers canvassed each block to build a list of addresses or physical location descriptions of the HUs located on the ground and attempted to make contact at every address. While capturing address information on paper registers, listers also annotated paper maps with map spots for each HU and updated road features on the maps so that the maps reflected what was found on the ground. Address and map changes were applied to the MAF and TIGER databases.

GEO used Address Listing results to compare with address counts provided by tribal, state, and local governments in the 1999 Local Update of Census Addresses (LUCA) program and the Census Bureau provided detailed feedback to LUCA participants based on comparison. The addresses were also used to create the initial census address universe for Update/Leave areas for Census 2000. Then, during the Census 2000 Update/Leave operation, field staff returned to

each address, updated the address list when needed, and left (hand-delivered) questionnaires (hence: “update/leave”) in these areas.

Address Listing added a total of 21,920,000 addresses to the MAF (Ruhnke, 2002). The production rate was four cases per hour (Schneider, 2001b).

**Block Canvassing**

The Census Bureau conducted the Block Canvassing operation to update and improve the content and accuracy of the existing MAF and TIGER databases in the Mailout/Mailback enumeration areas before 2000. Block Canvassing was a paper-based operation.

In 1999, listers canvassed collection blocks within areas that contained predominantly city-style (house number and street name) addresses using paper address lists. Listers canvassed the blocks within their assignment areas (AAs) and used paper maps to find the correct blocks to work and to record any street feature updates for each living quarters.

Field staff stopped at approximately every third HU, every multiunit, and every added HU to inquire about the addresses on either side of that address as well as to identify any “hidden” units such as basement apartments (Burcham, 2002). They compared each address found on the ground with those on the listing pages in the listing book for each AA and annotated all corrections, additions, duplicates, and deletions on the listing pages. They updated census maps to show additions, corrections, and deletions to map features. The addresses from Block Canvassing were compared with the address lists submitted LUCA ‘98 program participants, and the Census Bureau provided detailed feedback to LUCA participants based on the matching outcomes. The addresses were also used for the census invitation mailouts for TEA 1 (Mailout/Mailback) areas, and the address and map updates were available for the 2000 Census nonresponse follow-up field staff.

Block Canvassing occurred in 3,802,000 blocks throughout the country, which represented 51 percent of the total blocks in the nation (Burcham, 2002). The production rate was 24.11 cases per hour (Schneider, 2001a).

**2.3 2010 Census**

The following section describes the process used to create the address list for the 2010 Census.

**Address Canvassing**

The 2010 Census Address Canvassing (AdCan) operation was the primary address list validation and update activity in support of the development of the 2010 Census enumeration frame. In
the decade leading up to 2010, the Census Bureau continued to maintain the national address inventory that had been built for Census 2000, such as using records provided in biannual deliveries of the U.S. Postal Service’s Delivery Sequence File (DSF). However, in order to better ensure a complete and accurate national inventory for 2010, from March 30 to July 10, 2009, AdCan sent out listers to canvass the vast majority of the United States and all of Puerto Rico to update the census address list and maps.

The areas for both Mailout/Mailback and Update Leave were combined into one operation, and the results were compared with 2010 LUCA submissions to help validate them and generate detailed feedback for Local Update of Census Addresses (LUCA) participants. Production listing was followed by a multistage quality control (QC) phase designed to ensure high-quality data.

The 2010 Census AdCan operation marked the first time in Census Bureau history that a decennial field operation deployed an automated, paperless data collection and transmission process of this magnitude using a handheld computer (HHC). It was also the first decennial census where GPS was used to collect structure locations in the field. This data collection methodology allowed the Census Bureau to deliver updates more quickly to the MAF/TIGER database for subsequent census operations, such as Group Quarters Enumeration or Nonresponse Followup. However, during the 2008 Dress Rehearsal, it was discovered that the HHC had trouble processing blocks with large numbers of addresses. As a result, the Census Bureau conducted the Large Block Address Canvassing (LBAC) operation using laptop computers in blocks determined to have too many addresses—set at 1,000 or more—to be processed efficiently using the HHC. The Census Bureau leveraged Community Address Updating System (CAUS) hardware and processes for the LBAC.

The 2010 Census AdCan universe included addresses of housing units (HUs), group quarters (GQs) that were in the Census 2000 GQ inventory, and potential GQs from various sources including administrative records. AdCan listers classified addresses in the universe as a HU with or without changes to the address components, other living quarters (OLQs) with or without changes to the address components, duplicate, nonresidential, nonexistent, or uninhabitable (Williams et al).

For the 2010 Census, the Census Bureau opened 12 regional census centers (RCCs) across the nation. The RCCs managed decennial operations in specific geographic areas. Each RCC managed between nine and 17 early opening local census offices (ELCOs) for a total of 151 ELCOs across the United States and Puerto Rico. The AdCan operation was managed out of the ELCOs.
The 2010 Census AdCan operation occurred in nearly 6 million collection blocks containing more than 143 million initial addresses stateside and about 1.5 million initial addresses in Puerto Rico. The production rate was 15.37 cases per hour for production in non-large blocks, while the production rate in large blocks was 25 cases per hour. During the MAF/TIGER update process, about 62 percent of the final address actions verified the address (Schneider, 2012).

For more information about the results of evaluations following the 2010 Census and the decision to research and implement the 2020 Census AdCan operation using a suite of both field and office components, please see the 2010 Census Address Canvassing Targeting and Cost Reduction Evaluation Report (Boies et al., 2012).

**Group Quarters Validation**

In an effort to ensure the 2010 Census had a complete and accurate listing of group quarters before the Group Quarters enumeration, the Census Bureau conducted the Group Quarters Validation (GQV) operation after the Address Canvassing operation and before enumeration to improve the GQ frame. Field staff visited specific addresses to determine the status, such as GQ or transitory location (TL), conduct an in-person interview with the GQ contact person to determine the type of GQ, and collect additional information to plan for enumeration. During the GQV operation, specially trained field staff verified other living quarters (OLQs) as HUs, GQs, transitory units, nonresidential, vacant, or nonexistent.

Specifically, GQV listers completed the following actions using the GQV questionnaire and census maps:

- Verified the address had the correct census geography.
- Classified the type of GQ and collected the maximum number of residents who could live or stay at the address if validated as a GQ.
- Added GQs, HUs, and TLs not already included on the address list.

---

2 GQs are defined as a place where people live or stay in a group living arrangement owned or managed by an entity or organization providing housing and/or services for the residents. GQs include such places as college residence halls, residential treatment centers, skilled nursing facilities, group homes, correctional facilities, and workers’ dormitories, among many others.

3 TLs are defined as sites that contain movable or mobile housing that may include transitory units such as boats, motorized recreational vehicles or trailers (RVs), tents, or other types of portable housing. TLs also include hotels or motels if being occupied on a transitory basis because the occupants have no other residence.
2.4 2020 Census Address List Development

Although the 2020 Census AdCan operation is a key address list development activity leading into the 2020 Census enumeration, it did not work alone to ensure a complete and accurate list. The 2020 Census address list development started soon after the Census Bureau finalized the 2010 Census count of living quarters. The Census Bureau retained the 2010 Census addresses in the MAF, which were subject to continuous updates from the DSF, as well as new sources, to support the 2020 Census. For example, an initiative for the Geographic Support System (GSS) program started work to improve the address frame in fiscal year (FY) 2011. The GSS and the DSF, in conjunction with the Address Canvassing operation, updated the address frame throughout the decade.

This section describes the address list updating activities conducted to maintain the address list for use in the 2020 Census.

United States Postal Service File Updates

The USPS is the authoritative source for mail delivery addresses and postal codes in the United States and Puerto Rico. The USPS shares its address list, known as the DSF, with the Census Bureau in accordance with Public Law 103-430, the Census Address List Improvement Act of 1994. The USPS typically provides the data to the Census Bureau in the spring and the fall each year.

The DSF is the list of all addresses maintained by the USPS for the purpose of mail delivery. The Census Bureau also uses the Locatable Address Conversion Service (LACS) file from the USPS, which identifies known address conversions. These conversions can represent city-style to city-style address conversions as well as rural route to city-style conversions. The MAF/TIGER System processes the DSF and LACS, along with other data from the USPS, through a project collectively known as the “DSF Refresh.” The DSF Refresh includes the following general steps:

- Match the new DSF file to the MAF to update existing MAF addresses with DSF source information and add new, unmatched city-style DSF addresses to the MAF.
- Process the USPS Zone Improvement Plan (ZIP) code file to update existing ZIP codes for all addresses on the MAF, even those addresses that did not originate from the DSF.
- Process the LACS file to account for address conversions.
- Attempt to assign DSF addresses to a state, county, tract, and census block (i.e., run the geocoding process).
Assignment of a block-level geographic code is critical for inclusion of an address in the census. The codes provide a geographic location for assigning fieldwork and are the foundations for all census data tabulations. If the DSF address matches an existing MAF address that already has a census block assignment, then the DSF address is geocoded. For those DSF addresses that have no matches to an existing MAF address, the MAF/TIGER System compares the address number to address ranges in TIGER in an attempt to assign the address to a census block code. In some cases, the street feature or house number range may not exist in TIGER, and the DSF address remains on the MAF without a census block. The Census Bureau refers to these addresses as ungeocoded addresses.

The DSF adds approximately 500,000 addresses to the MAF every six months. The Census Bureau does not use all records on the DSF to update the MAF. The update specifically excludes nonresidential addresses, as well as non-city-style addresses, including post office box addresses and rural routes. The inability to link these types of addresses to a physical geographic area is the reason for the exclusion.

**The Geographic Support System**

The GSS is an integrated program of improved address coverage, continual spatial feature updates, and enhanced quality assessment and measurement. It is funded under a specific line item in the annual Census Bureau budget, separate from decennial census and current surveys funding. Its activities contributed to the MAF/TIGER System improvement. The Census Bureau, with tribal, federal, state, and local governments, as well as third-party data providers and all users of MAF/TIGER data, are major participants in the program.

In 2013, the GSS Partnership Program prioritized outreach to partners based on characteristics of the MAF addresses for their area. The objective was to determine whether the GSS could obtain files from partners to confirm that the MAF had sufficient and accurate coverage. The GSS Partnership Program solicited tribal, state, and local governments within these parameters to submit address and road data. For more information, please see Geographic Support System Initiative (GSS) (census.gov).

**Address Source Evaluation Operation**

After GEO received a partner’s address submission, a geographer examined each submission, inventoried the contents, and determined whether the contents complied with data content guidelines for addresses and roads at a file level. Prior to using the partner-provided data, GEO conducted additional automated checks and analytic reviews on address records in the file to determine which addresses would be useful for updating the MAF/TIGER System. This process
included matching partner addresses to the MAF, interactively reviewing nonmatches to avoid duplication in the MAF, and validating those new addresses represent structures that exist on the ground. GEO referred to this entire process for reviewing and updating the MAF/TIGER System with partner-provided addresses as the Address Source Evaluation (ASE) operation.

**Feature Source Evaluation Operation**

Feature Source Evaluation (FSE) was the process used to ensure the spatial and attribute components of local and commercial partner files met accuracy and completeness standards necessary to improve and update the MAF/TIGER System. Upon receiving feature source files, an initial set of content verification checks ensured files acquired met GEO’s minimum standards for accepting incoming feature data, including verification of the presence of metadata, spatial reference information, and centerline attribute data. The partner road centerlines were tested for spatial accuracy and attribute consistency. The partner data was cross walked into the MAF/TIGER model and a series of automated checks were completed including feature name standardization, centerline and change detection, topology validation, and road name verification and completeness. Based on the results of the automated quality and consistency checks, the partner data proceeded through a conflation process and an interactive review of road additions and spatial modifications before affixing the changes to the MAF/TIGER System.

**Address Canvassing Recommendation**

The GSS Partnership Program results, as documented in the *Geography Division Address Canvassing Recommendation* report (Census Bureau, 2014), offered the following conclusions about the availability and utility of partner data:

- The Census Bureau is more likely to acquire partner address and road data in urban and suburban areas,
- The Census Bureau is less likely to acquire and successfully process partner data for sparsely populated rural areas containing non-city-style addresses. The Census Bureau explored alternative methods to supplement the address list in these areas (for example, with third-party data and possibly addresses from administrative records) but

---

4 The Census Bureau does not have an official definition of “suburban” areas.
no adequate sources for these types of addresses have been identified (at the time of publication of the report).

- Partner data adds and modifies roads at highly variable rates. In some areas, GEO made only few updates to roads in the MAF/TIGER System because the road data were already current and of high quality. In other areas, such as new housing subdivisions, adding roads made it possible to geocode the new housing units.

- Matching partner-provided address data to the MAF/TIGER System reduced the number of ungeocoded addresses. Ungeocoded addresses are not included in the address frame because, without a census block location, the enumeration data associated with the address cannot be tabulated to the correct jurisdiction and census block. When ungeocoded addresses are resolved, the coverage for that area improves and reduces the workload for In-Field Address Canvassing.

**MAF Unduplication**

In addition to efforts to add new or missing addresses to the MAF, the Census Bureau identified duplicate MAF addresses as part of the GSS effort. Linkages of MAF duplicate records ensured that only one instance of the address was included on the census address list. The different variations of addresses are kept for the purpose of future matching operations.

During August and September 2017, the Census Bureau conducted an automated match with clerical follow-up in order to identify and resolve duplicates in the MAF. Enhanced software identified potential unlinked duplicate city-style addresses in the MAF using exact and equivocated address matching methods. The process not only identified duplicate pairs, but also clusters of addresses that appeared duplicative based on address information. Census Bureau staff clerically reviewed the matching results to ensure that the addresses identified as duplicates did indeed reflect the same structure on the ground. The staff confirmed that the automated process of identifying duplicates was effective and identified common characteristics of duplicate pairs (or clusters) and categorized them accordingly. The clerical review staff then used the categorical information to inform an automated resolution strategy; categories of the duplicate pairs (or clusters) that were valid were linked by software specifically designed for the task. This process was designed to minimize the risk of potential MAF undercoverage because of the over-identification of duplicate addresses.

**2.5 Intercensal Testing of Address Canvassing**

The following section describes the decennial census testing leading up to the 2020 Census for the AdCan operation.
Address Canvassing Test

The Address Canvassing Test was the first test designed specifically to study IOAC, as described in the 2020 Census Detailed Operational Plan for the Address Canvassing Operation (U.S. Census Bureau, 2018). The Address Canvassing Test examined the Interactive Review (IR) and Active Block Resolution (ABR) components of IOAC, whose address frame was updated primarily from DSF and GSS updates.

The Address Canvassing Test occurred during the fall of 2016 in two sites: Buncombe County, North Carolina, and a portion of St. Louis, Missouri. Buncombe County, which encompasses the Asheville, North Carolina, urbanized area, contained 6,600 contiguous blocks and 116,000 housing units with a mix of urban, suburban, and rural settlement. Buncombe County was selected because it provided the opportunity to test Address Canvassing processes and systems in a growth setting. The St. Louis site contained 6,100 contiguous blocks and 107,000 housing units. The St. Louis site was selected because it experienced sustained population loss and signs of recent redevelopment within its downtown commercial center. The site provided the opportunity to test and evaluate Address Canvassing processes and systems in an area containing a mix of housing types, including small and large multiunit structures, commercial-to-residential conversions, mixed commercial and residential uses, and housing units that were vacant, uninhabitable, or demolished.

The Address Canvassing Test conducted in 2016 found that when comparing IFAC and IOAC, both IFAC and ABR, a component of IOAC, verified a high percentage of addresses in both sites in blocks classified as “resolved” by ABR while some other portions of IFAC and IOAC were inconsistent when compared. The test also found that new automated training methodologies, such as interactive online modules and assessments, were effective in delivering the needed knowledge and skills for Address Canvassing fieldwork. Previously, the Census Bureau delivered operational trainings primarily as a verbatim reading of materials in a classroom setting.

2018 End-to-End Census Test Address Canvassing Operation

The 2018 End-to-End Census Test Address Canvassing operation was the first operational test to include the primary systems planned for use in the IFAC operation of the 2020 Census, including automated systems for hiring, training, workload assignment, geographic optimization, listing, QC sample selection, and listing. This test also included the testing of QC listing for the fieldwork, as well as IOAC creating the IFAC workload.

The IOAC workload consisted of all blocks and residential addresses in the three test sites. The IFAC workload for Providence County, Rhode Island, was 37.4 percent of test site addresses; for
Pierce County, Washington, the field workload was 52.2 of test site addresses; and for Bluefield-Beckley-Oak Hill, West Virginia, the field workload was 76.1 percent of test site addresses. The final IFAC workload across all three test sites was 49.3 percent of addresses within TEA 1. For more information, please see Lane et al. (2019).

The 2018 End-to-End Census Test Address Canvassing operation suggested that the implementation of criteria-based triggers (i.e., business rules) to identify blocks for re-review within IOAC and blocks requiring fieldwork does maintain address frame accuracy and reduces the IFAC universe. Furthermore, analysis of the In-Field workload creation process over the course of the IOAC process led to improved methods for identification of the In-Field workload for the 2020 Census.

2.6 2020 Census Address Canvassing Operation

The 2020 Address Canvassing operation as originally designed included three components: In-Office Address Canvassing (IOAC), In-Field Address Canvassing (IFAC), and the MAF Coverage Study. The 2020 Address Canvassing operation prepared the address frame in all TEA 1 blocks by first working all blocks in IOAC and then sending a portion of those blocks to be canvassed in IFAC. Both IFAC and IOAC included a full QC.

In-Office Address Canvassing

The 2020 Census was the first census to conduct IOAC. IOAC is the process of using empirical geographic evidence (e.g., imagery and comparison of the Census Bureau’s address list to partner-provided lists) to assess and improve the Census Bureau address list. This operation used a continuous process of monitoring the residential and nonresidential landscape to measure, assess, and ensure the completeness and accuracy of the MAF and associated attributes as well as geospatial data. IOAC detected change using high quality imagery, administrative data, and third-party data sources. Administrative data includes data from other government entities, such as the USPS DSF data, and other address and geospatial data provided by tribal, state, and local entities. Third-party data includes data provided by non-government sources, such as online real estate tools.

IOAC allowed the Census Bureau to identify a reduced workload for IFAC—a major change in the design of AdCan for the 2020 Census. IOAC reduced the IFAC workload by identifying stable areas with verified addresses, which did not need an in-person visit, and changing areas with identified address issues, which did require fieldwork.
IOAC included five components and each component is described below:

- Interactive Review (IR)
- Active Block Resolution (ABR)
- Ungeocoded Resolution (UR)
- IOAC Group Quarters/Transitory Locations (IOAC GQ/TL)
- LUCA Address Validation (LAV)

**Interactive Review (IR)**

IR reviewed all blocks in the United States and Puerto Rico to determine if changes had occurred since 2010 and to identify undercoverage or overcoverage of addresses in the address frame compared to housing visible in imagery. IR reviewed MAF data for every tabulation block, including MAF counts and map spots of HUs. During the IR process, staff compared a baseline image from the time of the 2010 Census AdCan operation to a current image to identify growth and decline of living quarters in the residential landscape, as well as overcoverage and undercoverage of living quarters in the census address frame. Reviewers also evaluated blocks for capacity to add more living quarters (that is, whether a block was “built-out”). Each block received one of three general statuses:

- Passive – Blocks with no apparent overcoverage (more addresses on the Census Bureau address list than there are living quarters on the ground) or undercoverage (fewer addresses on the Census Bureau address list than there are living quarters on the ground).
- Active – Blocks containing growth, decline, overcoverage, or undercoverage. The Census Bureau sent these blocks for IFAC.
- On Hold – Blocks with issues such as unclear imagery or those where reviewers saw evidence of ongoing construction (“future growth”). Reviewers placed these blocks On Hold pending acquisition of updated imagery or sufficient time to complete construction. The Census Bureau sent On Hold blocks for IFAC after IOAC concluded.

The IR QC reviewed clerks based on clerk performance. A clerk new to IR, or a clerk who performed poorly, had each subsequent block inspected for QC. A clerk who performed very well had a low inspection rate. The IOAC Interactive Review Quality Control Plan (Marquette, 2017) provides additional detail about the IR QC process.

In 2016, the Census Bureau implemented data-driven processes that identified blocks for re-review, known as “triggers.” Since housing unit change is dynamic and not always visible in
imagery, most triggers were designed to capture address frame coverage issues that were not identified in IR or blocks experiencing change since the first pass of IR was completed. Triggers also indicated when imagery became available to review On Hold blocks or designated specific blocks, such as those affected by natural hazards, to go directly to fieldwork. The IOAC operation refined triggers throughout the IR process. The following is an example of a trigger: An active block, containing a single undercoverage indicator, undergoes (though a separate process) a MAF housing unit count increase of one, and is then triggered for re-review in IR because it is possible that the block may no longer have undercoverage and may now be passive.

**Active Block Resolution**

ABR researched and updated areas identified with growth, decline, undercoverage of addresses, or overcoverage of addresses in the address frame identified by IR. ABR staff used several data sources to update the MAF and to resolve IR Active blocks. The Census Bureau began the ABR program in April 2016 and discontinued it in February 2017 because of funding uncertainty that led the 2020 Census team to reprioritize of work to prepare for the 2020 Census.

**Ungeocoded Resolution**

UR resolved ungeocoded records—addresses not assigned to a block during automated processing—by adding or editing spatial features and address ranges in the MAF/TIGER System. The UR universe included ungeocoded residential, complete city-style addresses that received mail from USPS as indicated on the latest DSF. The number of ungeocoded addresses decreases as UR resolves ungeocoded addresses but increases after every DSF Refresh.

Addresses may fail to geocode because of a missing road, an incorrectly named road, or a road without a correct address range in MAF/TIGER. UR staff researched records using imagery; local, county, or state Geographic Information Systems (GIS) websites; and third-party websites such as Google, Bing, and real estate websites.

UR began working in the spring of 2017 and continued through February 2020. Because the census does not include ungeocoded address records in decennial census enumeration operations, this operation ensured that an attempt was made to include all ungeocoded addresses within the MAF in the decennial census enumeration.
IOAC Group Quarters/Transitory Locations (GQ/TL)

The universe for IOAC GQ/TL component of IOAC included all 2010 Census GQs/TLs, and GQs/TLs added after the 2010 Census from field and office update operations. IOAC GQ/TL identified, updated, and validated the addresses in the universe. Staff conducted research using local GIS data, public data, and commercial information. Staff also called administrative contacts and conducted phone interviews to update information in the MAF. IOAC GQ/TL began production work in July 2017 and stopped work in March 2018 because of the component encountering unexpected challenges and reprioritizing work to prepare for the 2020 Census.

LUCA Address Validation

The LUCA operation provided the opportunity for tribal, state, and local governments to review and comment on the Census Bureau’s residential address list for their jurisdictions before the 2020 Census (Hanks, 2019). Once local entities returned their address list changes, the Census Bureau reviewed participant submissions and attempted to match participant records to existing address records in the MAF/TIGER database. Participant records that did not match an existing MAF record, and those where the participant placed a record in a different block than the current MAF block, were sent to LAV.

LAV reviewed LUCA submissions using office research. Reviewers made the determination whether to accept or reject the LUCA participant address records. They had the ability to accept the record as submitted, accept it in a different block than the participant submitted, or accept it as manually matched to a record already in the MAF. If reviewers made the determination that the record was nonresidential, outside of the LUCA participants’ jurisdiction, or located in an undevelopable location, they had the option to reject the record outright. The reviewer needed to have concrete evidence from a reliable source to reject an address record.

Systems and Tools in In-Office Address Canvassing

The follow is a list of systems used in IOAC:

- **BARCA** (Block, Assessment, Research, and Classification Application)

  BARCA was an interactive review tool that enabled IOAC staff to review the presence of housing units on the geographic landscape using imagery.

  BARCA allowed analysts to assess and classify blocks by comparing housing units in 2009 imagery and current imagery, along with TIGER reference layers, MAF data, and parcel boundary data. BARCA incorporated the Census Bureau’s TIGERWeb application as a web-
mapping service to display TIGER features and reference layers. It also displayed counts of addresses from the MAF to enable staff to understand how many housing units were already captured in each block. IOAC staff conducting both IR and ABR used BARCA to conduct and status their work, as well as to mark/flag areas of growth, decline, undercoverage, and overcoverage.

- **BTD (Block Tracking Database)**

BTD stored block-level summaries of housing unit and feature status and characteristic information. BTD contained the status of each block (such as growth, decline, overcoverage, and undercoverage; as well as missing roads, misaligned roads, and areas of future growth) that was used as input to make the final decisions regarding the universe for IFAC. It also retained block trigger data and block level outputs from the 2020 IR and ABR processes.

- **Geospatial Services**

Services that provide imagery, parcels, and other spatial data used in operations supporting IOAC.

- **GWCS (GSS Workflow Control System)**

GSS Workflow Control System was used to review the availability and status of GSS partner file acquisition and processing.

- **MaCS (Matching and Coding Software)**

MaCS is a system used by clerical staff to match and/or geocode various types of address records. Its base functionality was the starting point for multiple projects, such as In-Office Address Canvassing GQ/TL Review and LUCA Address Validation. MaCS was customized for each individual operation but included modules of functionality that were used by multiple operations such as matching against MAF and TIGER extracts, searches of administrative records, and a mapping utility.

- **MAF/TIGER (Master Address File/Topologically Integrated Geographic Encoding and Referencing System)**

The MAF/TIGER System is the system where all address and spatial data are stored and is the source of the address list, map data, and geocoding services used in address canvassing. Specific components of MAF/TIGER used during address canvassing included:
o **GATRES** *(Geographic Acquis-based Topological Real-time Editing System)*

GATRES is a Census Bureau system within MAF/TIGER that is used to interactively update information in the MAF/TIGER System. GATRES allows concurrent access to the MAF/TIGER System by multiple simultaneous interactive users and is accessible from multiple sites, including the Census Bureau’s regional offices and National Processing Center (NPC). For the IOAC, GEO enhanced GATRES to enable the ABR staff to provide address updates for a particular block. GEO and NPC used this system to edit MAF data marked in BARCA for review.

o **MAF Browser**

MAF Browser is a software tool within the MAF/TIGER System that allows a user to easily search the complex MAF database and return filtered results in a web browser. ABR staff used the MAF Browser to research specific addresses as they compared information from local files to the MAF.

o **MTAG** *(MAF/TIGER Address Geocoding Application)*

MTAG is a part of the MAF/TIGER System that was primarily used to help resolve ungeocoded, residential MAF addresses from the DSF as part of UR. Staff viewed information in the MTAG System for the individual address record. Staff updated TIGER using GATRES and used quality local source address information to determine the appropriate resolution for each record.

In terms of how staff reviewed and updated address information, the tools available to IOAC differed from tools available in IFAC. Overall, most IOAC components had access to more tools and data than IFAC or than listers do. See section 6.1 for analysis and more information.

• Tools varied among different IOAC components with ABR, UR, and LAV having the most. These IOAC components had some or all the following tools:
  
  o **Additional Census Bureau Address Information**

Most IOAC components had the ability to see address history, source, and prior enumerations. Staff could also see records located in other blocks. IOAC staff used this information when making decisions about what updates would correct address coverage issues.

  o **Ability to Edit Features**
Some IOAC components could edit the geography in MAF/TIGER which included reshaping features such as roads, rivers, or geographic boundaries. Staff could also add new features or edit the attributes of a feature. In some blocks, an issue in the underlying geography required a combination of reshaping features and adding new features to correct the address coverage issues.

- Partner and Third-Party Website Address and Feature Information

Most IOAC components had access to address information from partners such as county governments. This information included GIS data, parcel data, tax assessor data, road data, and other geographic data. Several IOAC components also used third-party websites such as real estate websites.

**In-Field Address Canvassing**

IFAC sent listers to visit BCUs identified by criteria defined by GEO. The IFAC operation for the 2020 Census did not include Puerto Rico because of widespread changes resulting from natural disasters. Instead, the Update Leave (UL) operation covered Puerto Rico. UL updated address information while delivering enumeration forms to residences (Census Bureau, 2018b).

IFAC listers and QC listers worked by walking each assigned BCU and checking that each address they saw on the ground matched the electronic address list shown in the canvassing software. Listers updated all required attributes such as location, housing unit status, and structure type. If listers encountered a residential address not displayed on the list, they added the address to the list. After completing the BCU, listers reviewed the unworked addresses in the BCU and verified those addresses were not in the BCU, or if listers saw that an address was located just outside the BCU, they could move an address to “the fringe,” or the area just inside an adjacent BCU. The Census Bureau instructed listers to knock on the door of each address to verify the address information and, when a knowledgeable person 15 years or older was available, to ask about the presence of any additional living quarters or hidden housing units, such as spaces converted to apartments, etc. In some cases, such as large apartments or condominiums, listers could speak to a building manager and request a list of housing units.

If residents or managers informed listers of additional housing units, listers added these to the address list. If listers could not contact a resident, the lister updated the address as best they could by observation. If a lister could not access the property, the lister marked the address as Unable to Work (UTW). Listers were required to enter a reason that they could not access the property and census field managers (CFMs) subsequently reviewed each UTW record or BCU and accepted or rejected the UTW designations.
QC listers followed the same general procedures, with some variations. QC listers began working at a designated location, usually an intersection, and worked a sample of addresses within a BCU. In BCUs with a smaller number of addresses, the sample included all the addresses in a BCU. QC listers worked with the address list information collected by the previous production lister. If the sample of addresses showed an excessive number of critical errors, the QC lister reworked the entire BCU. Each time a production lister’s BCU failed QC, the production census field supervisors (CFS) received a management alert and access to detailed information about the failure so that they could provide feedback and additional training.

In-Field Address Canvassing listers used the Listing and Mapping Application (LiMA), which displayed address records that met the address filter for IFAC. Listers could see these addresses in the block they were assigned to work but not adjacent blocks. Unlike some IOAC components, addresses in LiMA did not have additional metadata such as history or source. The focus of lister training and work was to canvass the block and compare it to the address list in LiMA, however, listers could flag a missing feature, such as a road, or flag misaligned or incorrect features. LiMA had imagery available and showed the lister their GPS location.

The Census Bureau managed the IFAC operation using six regional census centers (RCCs) and 39 area census offices (ACOs). CFMs trained and managed CFSs within their zone of an ACO. CFSs trained listers and QC listers and supervised a production listing team or a QC listing team. The Census Bureau hired listers and CFSs as temporary, operation-specific positions. Seven ACOs began work two weeks earlier than the remaining 32 ACOs. The Census Bureau referred to these as “early start” ACOs. Regional offices chose seven early start ACOs, which allowed the Census Bureau to scale up operations gradually.

The final workload included 53,450,000 addresses (34.9 percent within TEA 1) in production, and 3,438,000 addresses in QC. For more information, please see the IFAC Assessment (Lane et al., 2021).

MAF Coverage Study

The Census Bureau began to conduct the MAF Coverage Study (MAFCS) in 2016. At that time, the Census Bureau intended the MAFCS to be an ongoing field activity to list a sample of nationally representative addresses annually. It was one component of the reengineered Address Canvassing operation for the 2020 Census. The Census Bureau originally planned to conduct the MAFCS each year leading up to the 2020 Census to monitor the quality of the MAF over time (Williams, 2018). However, the Census Bureau discontinued the MAFCS program in 2017 because of budgetary constraints, leaving IFAC and IOAC for the 2020 Census.
The 2016 MAF Coverage Study report found that, based on fieldwork, blocks classified as showing change by In-Office Address Canvassing (IOAC) exhibited higher estimates of both overcoverage and undercoverage than the estimated national rates. Overcoverage refers to including more addresses on the address list than actually exist; undercoverage refers to the opposite condition. Conversely, blocks classified as not exhibiting change had lower estimates of overcoverage and undercoverage than estimated national rates. The study also found lower rates of overcoverage and undercoverage for areas that participated in the GSS partnership program than for those areas that did not participate in the program.

### 2.7 Schedule

Table 1 shows the In-Office Address Canvassing (IOAC) milestones and their scheduled and actual start and finish dates from the Decennial Census Management Division (DCMD) records. The Census Bureau completed the IOAC operation on schedule. The operation ran from September 2015 to February 2020. For a visualization of the schedule, see section 5.8.

**Table 1: IOAC Milestones with Scheduled and Actual Completion Dates**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Baseline Start</th>
<th>Actual Start</th>
<th>Baseline Finish</th>
<th>Actual Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Pass Adjudication</td>
<td>10/1/2015</td>
<td>10/1/2015</td>
<td>6/30/2017</td>
<td>6/8/2017</td>
</tr>
<tr>
<td>ABR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UR QC</td>
<td>5/1/2017</td>
<td>5/1/2017</td>
<td>2/28/2020</td>
<td>2/20/2020</td>
</tr>
<tr>
<td>IOAC GQ/TL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOAC GQ/TL Production</td>
<td>7/24/2017</td>
<td>7/24/2017</td>
<td>3/2/2018</td>
<td>3/2/2018</td>
</tr>
<tr>
<td>IOAC GQ/TL QC</td>
<td>8/1/2017</td>
<td>8/1/2017</td>
<td>3/2/2018</td>
<td>3/2/2018</td>
</tr>
<tr>
<td>LAV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data source: U.S. Census Bureau, 2020 Census IMS and DCMD records
3. Methodology

All 2020 Census operational assessments share a similar methodology. In general, they provide details about the implementation of individual operations and processes (including final volumes, rates, and costs) by presenting data from production systems, files, and activity reports, in addition to information collected from lessons learned and debriefings sessions. These important measures are key ingredients to defining successful completion of the 2020 Census operations and processes. Typical categories of success measures are as follows:

- **Process Measures** that indicate how well the process works, typically including measures related to completion dates, rates, and productivity rates.

- **Cost Measures** that drive the cost of the operation and comparisons of actual costs to planned budgets. Costs can include workload as well as different types of resource costs.

- **Quality Measures** of operational results, typically including things such as rework rates, error rates, and coverage rates.

In addition to planning and managing the implementation of its operation, each Integrated Project Team (IPT) had the responsibility of determining the assessment questions for its operation. In consultation with the Decennial Research Objectives and Methods (DROM) Working Group, each IPT developed assessment questions tailored to the uniqueness of its operation that would yield the most useful information to those planning similar operations in the future. Assessment questions provide the framework for the Results Section appearing in each operational assessment report.

The sections that follow present the assessment questions for this operation and describe the sources of information used to answer them.

### 3.1 Research Questions

1. What are the outcomes of Interactive Review (IR)?
   a. What are the outcomes of the first pass of IR?
   b. What are the final outcomes of IR?

2. What are the outcomes of Triggers?

3. What are the outcomes of Active Block Resolution (ABR)?
4. What are the outcomes of Ungeocoded Resolution (UR)?

5. What are the outcomes of Group Quarters and Transitory Locations (GQ/TL)?

6. What are the outcomes of LUCA Address Validation?

7. What percentage of the nation within type of enumeration area (TEA) 1 was identified for the In-Field Address Canvassing operation?

8. What is the summary of the In-Office Address Canvassing operational metrics?

3.2 Data Sources and Calculations: Production Systems/Reports

Systems and reports varied by In-Office Address Canvassing (IOAC) component. Most components had reports with the data needed for this assessment, but staff also needed to use other methods to get additional data. For example, reports did not have type of enumeration area (TEA) information, so staff combined data from component systems with data from Master Address File (MAF)/Topologically Integrated Geographic Encoding and Referencing (TIGER) to report data by TEA. All data tables are presented with full data that has not been sampled. For more information and specific details, please see the descriptions about the data in each research question in section 5.

3.3 Lessons Learned

The IPT had several meetings where groups of members met to discuss a specific component of IOAC. Members included project managers, subject-matter experts, and staff who designed the component, participated in software development, conducted training, answered clerk questions, and monitored the component. After the meetings, staff created a list of lessons learned and allowed other IPT members to review and add to the list. Finally, the report authors gathered all of the lessons learned and put them into a standard format, grouped common lessons learned shared across components, and organized them into topics. Members of the IPT reviewed the list of lessons learned during IPT review of the document and when they met to discuss and finalize the challenges, successes, and recommendations.

4. Limitations

1. In-Office Address Canvassing (IOAC) ran from fall 2015 through early 2020, which is much longer than past Address Canvassing operations. Additionally, the decade leading up to the 2020 Census was the first time the Census Bureau conducted IOAC. Because of these two unique factors—length and newness of the operation—there were not established processes
for recording and documenting the operation. IOAC successfully tracked block statuses over multiple components and multiple years but sometimes needed to refine reports or processes over time and had less formal documentation for some mid-component adjustments. This assessment has outcome data for all the components and does not consider the changes in reports or processes over time to be a substantial limitation.

2. In section 5.10, the enumeration results data are from the final 2020 Census tabulation products, which include a series of data processing and operational inputs. These include census enumeration operations through October 2020, and final MAF data processing. It is out of scope to explain why addresses finished with a particular enumeration status.

5. Results

The following section provides background, data, and analysis for each In-Office Address Canvassing (IOAC) component and answers each research question. IOAC was a multidivision effort with each playing a critical role. While there are exceptions, in general; the National Processing Center (NPC) completed production and quality control (QC) work; Decennial Census Management Division (DCMD) performed project management; Geography Division (GEO) drafted software requirements, conducted trainings, and provided geographic support; Decennial Information Technology Division (DITD) created software; and Decennial Statistical Studies Division (DSSD) created QC Sampling and Modeling.

5.1 What are the Outcomes of Interactive Review (IR)?

The outcomes for Interactive Review (IR) are divided into IR Background and IR Outcomes and Analysis.

5.1.1 IR Background

Overview of IR

IR was a component of the In-Office Address Canvassing (IOAC) operation. IR reviewers used the Block Assessment, Research, and Classification Application (BARCA) tool to:
1) Complete an imagery-based review that assessed changes in the residential landscape between current imagery and baseline vintage imagery to identify growth, decline, and potential future growth.

2) Measure the extent to which the number of housing units in the Master Address File (MAF) was consistent with the number visible in the current imagery to identify undercoverage or overcoverage.

BARCA had several tools to assist reviewers: imagery (current and baseline), MAF/Topologically Integrated Geographic Encoding and Referencing (TIGER) block address counts, MAF Structure Points (MSPs), and parcel boundary data (where available). Reviews used the BARCA tools to evaluate the block and assign pins to each potential issue they found in blocks. Some blocks had no pins assigned. After assessing the block for needed pins, reviewers chose one of four statuses in BARCA for the block. This BARCA block status (built-out, open, undevelopable, or poor imagery) was internal to IR and different from the ultimate status that resulted from IR (active, passive, or on hold).

---

5 MAF Structure Points, a subset of the MAF, are coordinates that represent the location of the structure containing living quarters. Parcel boundaries subdivide land into land-use types, such as residential and commercial, and/or land ownership. For example, in suburban neighborhoods, parcel boundaries typically show each individual home lot or property.
BARCA Pins:

- **Future growth** – Imagery showed new construction of housing.
- **Growth** – Increased count of residential units in current imagery when compared with baseline imagery.
- **Decline** – Decreased count of residential units in current imagery when compared with baseline imagery.
- **MAF undercount** – The block address count was lower than it appeared on imagery.
- **MAF overcount** – The block address count was higher than it appeared on imagery.
- **Missing features** – Roads that appeared on imagery but were not in MAF/TIGER.
- **Misaligned features** – Roads and block boundaries that significantly did not match imagery.

BARCA Block Status:

- **Built-out** – Block was completely covered by residential structures or a mixture of residential structures and nonresidential land use.
- **Open** – Block had room for growth.
- **Undevelopable** – Block was entirely covered by nonresidential land use and development was unlikely to occur.
- **Poor Imagery: Unable to Rate** – Imagery for the block was problematic possibly because of poor resolution, cloud cover, or imagery for the block was incomplete or missing, etc.

Based on the block status and any pins identified by staff in IR BARCA assigned each block one of three IOAC operation statuses:

- **Passive** – Blocks that had no observable change in the number of housing units over time, as observed in comparing baseline vintage to current imagery, and the MAF accurately represented the number of housing units shown in the current imagery.
- **Active** – Blocks where the reviewer observed changes in the residential landscape (i.e., a gain or loss of structures likely to be housing units), or the number of housing units in the MAF differed from the number shown in the current imagery.
- **On Hold** – Blocks were categorized as hold-for-imagery when a review could not be completed because of poor imagery (e.g., cloud cover obscuring the landscape).
IR production started mid-decade to prepare the address frame ahead of the 2020 Census. NPC GS-4 clerks conducted the IR work, and GS-5 clerks conducted the adjudication QC work. To guide IR reviewers in their work, Geography Division (GEO) staff created procedures, including a cheat sheet and a decision tree, to help guide the review and determination of where pins should be set. The training was implemented when staff joined the project and included training exercises. Additional trainings were provided when procedure updates were implemented, and refresher trainings were provided as needed. Staff conducting adjudication also received training, and the adjudication procedures included a decision aid and special cases/FAQ document. Adjudication staff participated in regular adjudication team meetings at which examples were discussed. Because blocks could change status because of frame updates or change occurring on the ground, GEO selected blocks to be re-reviewed. Section 5.2 will cover this process, known as triggers, in more detail.

**IR Quality Control (QC)**

To maximize the efficiency of having hundreds of geographic staff reviewing and re-reviewing millions of blocks, IR used a flow QC process designed by Decennial Statistical Studies Division (DSSD). DSSD recommended a flow QC over the traditional batch QC because blocks could be finalized more quickly, making IR metrics (i.e., block status counts) more current and making the blocks available to downstream processes sooner.

The flow QC process automatically had staff double-blind review a sample of each other’s blocks. The BARCA application would give a reviewer a block that another reviewer had recently completed, without indicating the block had already been reviewed. If the two reviewers had the same assessment of the block, within specified parameters, then the outcome was verified. If the reviews disagreed, the block would be assigned to an adjudicator, a specially trained reviewer, who would determine the correct assessment of the block. In their assessment, the adjudicator would declare one review to be correct and the other to be in error. If both reviews were in error, the adjudicator would complete their own review. The adjudicator could decline to assign errors if the case was ambiguous.

BARCA’s flow QC process constantly tracked each reviewer’s error rate and, when needed, it would increase the proportion of their blocks that were inspected by a second reviewer, up to 100 percent inspection if a reviewer was not meeting the maximum allowable error rate (5 percent) as measured by their “error-out rate,” instead of their “error-in rate.” The “error-in rate” was each reviewer’s number of reviews in error divided by the number of their reviews inspected. The “error-out rate” was the rate of uncorrected errors expected to be in each reviewer’s stream, their “error-in rate” multiplied by the proportion of their blocks that were uninspected. All inspected blocks were counted as correct, because if initially incorrect, they were corrected by the adjudicator.
To give feedback to reviewers, a function prompted them to view their error blocks before starting the review of new blocks. A function was added to allow reviewers to dispute a limited number of their errors per day and a super-adjudicator role was added to resolve error disputes and overturn errors when warranted.

5.1.2 IR Outcomes and Analysis

Production IR Work

Staff began conducting IR on a census block-level in September 2015. By June 2017, IR had completed an initial review of all census blocks in the United States and Puerto Rico. However, after this “first pass” a block could be “triggered” for an additional review one or more times. Triggers were indicators based on data from a process or an event that detected housing unit or address change (e.g., a Delivery Sequence File [DSF] refresh), or suggested a high probability of change, and sent most blocks back into IR for re-review to determine whether the block should be categorized differently (e.g., it was formerly active, and because of MAF updates it should now be classified as passive). Ongoing triggering and re-review of blocks occurred until the In-Field Address Canvassing (IFAC) universe was identified at the end of March 2019. At that time, the active, hold-for-imagery, and triggered blocks were assigned to IFAC to complete the update of the MAF for the 2020 Census. For more information, please see sections 5.2 (Triggers) and 5.7 (Creating the IFAC Universe).

IOAC used 2010 Census tabulation blocks as the geographic area units because the delineation of the 2020 collection geography was still in progress when IOAC started. Basic collection units (BCUs), which used visible boundaries and were optimized for fieldwork (including IFAC), were finalized in January 2019. IOAC initially planned to translate all work from tabulation blocks to BCUs and to complete IOAC using BCUs. However, after the operations began, it was clear that changing the geography used for IOAC operations would create unnecessary complications. BCUs were intended to have stable boundaries, however, because of changes in requirements and operational needs, BCU boundaries were edited until they were used for field operations. Furthermore, it was advantageous to identify coverage issues within areas smaller than BCUs, which are typically geographically larger than blocks. Therefore, the 2010 Census tabulation blocks, which were stable throughout the course of IR and smaller geographically, remained the unit of work for IOAC for the entire operation, and the IOAC attributes at the block level were translated to BCUs for use in identifying the IFAC universe.

The BARCA interface and database were created and refined using Agile development. The version of BARCA used at the start of IR provided the minimum viable functionality necessary to start the project; additional functionality and improvements to BARCA were identified and developed throughout the course of IR. Overall, the Agile approach was well suited to a new
program that was improving and evolving based on experience. For example, the BARCA database initially lacked the functionality to fully support IOAC work and analysis, such as capturing a block’s status change history. As the project progressed, the Census Bureau determined that recording each block’s status history was critical for analyzing block characteristics to determine which blocks to trigger for re-review to facilitate decision-making regarding changes in status from hold-for-imagery to active, from active to passive, etc. To address this deficiency, the IOAC team created additional tables to track the history of reviews and status changes for all blocks.

**IR QC**

In September 2017, the Commerce Department Office of the Inspector General (OIG) provided critical feedback on the flow QC plan. The OIG found that reviewers could have a personal error rate (“error-in rate”) that was higher than the operation’s target error rate (“error-out rate”). The OIG also found that the number of errors was higher than tracked by the software, because adjudicators could “forgive” errors by declining to assign them in ambiguous cases.

The IOAC team responded with a new QC plan in November 2017, which, based on OIG’s recommendations, used the error-in rate to determine a reviewer’s qualification level (instead of using the error-out rate, which counts adjudicator-corrected blocks as correct) and did not count forgiven error blocks either for or against a reviewer.

Out of an abundance of caution, the new QC plan also added a middle tier of qualification for reviewers. Reviewers had previously been either qualified (error rate at or below 5 percent; 5 percent of blocks given a double-blind review) or not qualified (error rate above 5 percent; 100 percent of blocks given a double-blind review). The new plan added a semiqualified status for reviewers with an error rate between 3 and 5 percent, at which 10 percent of their blocks would receive a double-blind inspection (i.e., more inspections for reviewers who were below, but near, the project error rate threshold). For more information on IR QC, there will be a forthcoming memo, *Analysis Results of In-Office Address Canvassing Interactive Review Quality Control* (Silverman et al, 2021).

---


7 *DSSD 2020 DECENNIAL CENSUS MEMORANDUM SERIES #Q-05R1, For: Deirdre Dalpiaz Bishop, Chief, Geography Division; From Patrick J. Cantwell, Chief, Decennial Statistical Studies Division; Subject: In-Office Address Canvassing Interactive Review Quality Control Plan - Revised. November 7, 2017.*
Outcomes of IR

Over the course or IR, staff reviewed about 14,360,000 blocks. The results of IR are presented at two stages, after the first pass where every block was reviewed once in 2017, and then at the end of the operation in 2019, when blocks may have been re-reviewed and changed status several times. Table 2 presents a high-level summary of the outcomes of IR while tables 3-6 show more detailed data about IR. The outcomes of IR should not be confused with the final outcome of IOAC and the delineation of the IFAC universe, though IR was a component in determining where IFAC would canvass. For more information about determining the IFAC universe, please see section 5.7. Along with the status of blocks, the outcomes include undercoverage, which is critical as it represents the potential of a missed housing unit. Overall, IR initially found about 16 percent of blocks were active after the first review of the nation with 6.4 percent having undercoverage. At the end of IR, about 10 percent of blocks were active and the number of blocks with undercoverage was reduced to 6.0 percent.

Table 2: Summary of Nationwide (All TEAs) Outcome of IR

<table>
<thead>
<tr>
<th></th>
<th>IR “First Pass”</th>
<th>End of IR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent of Blocks</td>
<td>Percent of Housing Units in the Blocks</td>
</tr>
<tr>
<td>Active</td>
<td>16.0%</td>
<td>27.3%</td>
</tr>
<tr>
<td>Undercoverage</td>
<td>6.4%</td>
<td>11.1%</td>
</tr>
<tr>
<td>Passive</td>
<td>71.8%</td>
<td>55.7%</td>
</tr>
<tr>
<td>On-Hold for Imagery</td>
<td>12.2%</td>
<td>17.0%</td>
</tr>
<tr>
<td>Triggered</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Cumulative Number of Block Reviews Conducted by IR Staff</td>
<td>14,360,000</td>
<td></td>
</tr>
</tbody>
</table>

Data sources: Table 3, Table 4, U.S. Census Bureau, BARCA, and housing unit counts are from the ACS2019 MAF benchmark, the benchmark used for IFAC products.

The results of the first complete pass of the nation through IR are summarized in Table 3 and the final results of IR are summarized in Table 4.\(^8\) The first pass of IR resulted in about 16 percent of blocks classified as active, about 72 percent classified as passive, and about 12 percent on hold for imagery. These total percentages are similar to the percentages of active, passive, and on hold blocks for TEA 1 because nationwide TEA 1 had the largest number of blocks, at about 89 percent. In TEA 6, Update Leave (UL), about 14 percent of blocks were

---

\(^8\) Note that TEA assignments change over time, and Tables 3-6 are based on the final TEA assignments that were used for the IFAC operations.
classified as active, about 70 were classified as passive, and more than 15 percent were on hold for imagery.

Table 3: IR Block Status by TEA, after the First Complete Pass of the Nation

<table>
<thead>
<tr>
<th>Percent by block status</th>
<th>Total (All TEA)</th>
<th>Type of Enumeration Area (TEA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TEA 1 Self-response</td>
</tr>
<tr>
<td>Active blocks</td>
<td>16.0%</td>
<td>90.9%</td>
</tr>
<tr>
<td>Active blocks as a percent of all blocks in TEA</td>
<td>16.4%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Passive blocks</td>
<td>71.8%</td>
<td>89.2%</td>
</tr>
<tr>
<td>Passive blocks as a percent of all blocks in TEA</td>
<td>71.8%</td>
<td>85.2%</td>
</tr>
<tr>
<td>Hold-for-imagery blocks</td>
<td>12.2%</td>
<td>86.5%</td>
</tr>
<tr>
<td>Hold-for-imagery blocks as a percent of all blocks in TEA</td>
<td>11.8%</td>
<td>12.4%</td>
</tr>
<tr>
<td>Triggered blocks</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total blocks</td>
<td>100%</td>
<td>11,155,486</td>
</tr>
</tbody>
</table>

* Any block that is partially or wholly within TEA 1 is considered a TEA 1 block. Otherwise, a block is assigned to the TEA it is most contained within. Blocks “Triggered for In-Field Canvassing” are categorized as Triggered.
Data sources: PATHSTATUS derived from earliest IR Review; TEA from BAS19.

As previously stated, many blocks were re-reviewed in IR after the first complete pass of the nation. Some blocks were selected for re-review when evidence suggested the previously observed coverage issue may have been resolved by other operations (e.g., DSF updates, or ongoing MAF maintenance and updates) or a new coverage issues may have been introduced. For more information on the process of identifying blocks for re-review, the IOAC triggers, please see section 5.2. Table 4 shows the final block status outcomes of IR after blocks were triggered and re-reviewed.
Table 4: IR Block Status by TEA, at the End of IR Operations

<table>
<thead>
<tr>
<th>Percent by block status</th>
<th>All TEA</th>
<th>Type of Enumeration Area (TEA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>TEA 1 Self-response</td>
</tr>
<tr>
<td>Active blocks</td>
<td>9.8%</td>
<td>100%</td>
</tr>
<tr>
<td>Active blocks as a percentage of all blocks in TEA</td>
<td>9.7%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Passive blocks</td>
<td>87.0%</td>
<td>100%</td>
</tr>
<tr>
<td>Passive blocks as a percentage of all blocks in TEA</td>
<td>87.9%</td>
<td>90.0%</td>
</tr>
<tr>
<td>Hold-for-imagery blocks</td>
<td>1.6%</td>
<td>100%</td>
</tr>
<tr>
<td>Hold-for-imagery blocks as a percentage of all blocks in TEA</td>
<td>0.6%</td>
<td>8.3%</td>
</tr>
<tr>
<td>Triggered blocks</td>
<td>1.6%</td>
<td>100%</td>
</tr>
<tr>
<td>Triggered blocks as a percentage of all blocks in TEA</td>
<td>1.8%</td>
<td>-</td>
</tr>
<tr>
<td>Total blocks</td>
<td>100%</td>
<td>11,155,486</td>
</tr>
</tbody>
</table>

* Any block that is partially or wholly within TEA 1 is considered a TEA 1 block. Otherwise, a block is assigned to the TEA it is most contained within. Blocks “Triggered for In-Field Canvassing” are categorized as Triggered.

Data sources: PATHSTATUS from BARCA.BTD; TEA from BAS19.

Comparing Table 3 with Table 4 provides a measure of the effect of both the ongoing address frame updates and IOAC triggers and shows how they reduced the number of active blocks. From the first complete pass (Table 3) to the final IR outcome (Table 4), the total number of active blocks was reduced in all TEAs, most notably in TEA 1, where fewer blocks were active at the end of IR operations from about 16 percent active to about 10 percent active. Upon completion of IR, TEA 1 had 9.7 percent of blocks with active status and TEA 6 (Update Leave) had 11.3 percent of blocks in active status. TEA 4 (Remote Alaska) had the highest and most persistent proportion of blocks with a hold-for-imagery status (17.1 percent at first pass and persisting at 13.6 percent upon completion of IR). Reducing the number of active blocks was achieved through geographic updates including Active Block Resolution (ABR), Frame Maintenance, Ungeocoded Resolution (UR), and other processes like the DSF updates and Geographic Support System (GSS) along with IR identifying which blocks had coverage issues.

IR operations identified different types of coverage issues, however, undercoverage is considered a critical metric for the potential deficiency in the completeness of the address frame and the impact on obtaining a complete census count. Undercoverage was defined as a
block potentially containing housing units that may not have been represented elsewhere in the address frame or may have been geocoded to a different location. When reviewing the following data about undercoverage identified in IR, it is important to know that 6.4 percent of blocks at the first pass of IR and 6.0 percent of blocks at the end of IR were suspected of having undercoverage nationwide. The following data break down the characteristics of those approximately 6 percent of blocks. Tables 5 and 6 provide summaries of the blocks with varying levels of undercoverage in each of the five TEAs. Both tables used the final TEA delineation so changes in undercoverage counts in these tables are not because of TEA changes between the start of IR and the finish.

Undercoverage meant that the IR reviewer observed one or more housing units in imagery that were not present in the MAF housing unit count for the block. There were three categories of undercoverage:

- Small undercoverage – one housing unit.
- Medium undercoverage – two to nine housing units.
- Large undercoverage – ten or more housing units.
Table 5: Blocks with Undercoverage by TEA, after the First Complete Pass of the Nation

<table>
<thead>
<tr>
<th>Percent of all blocks</th>
<th>Type of Enumeration Area (TEA)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TEA 1 Self-response</td>
</tr>
<tr>
<td>Blocks with small undercoverage</td>
<td>3.5%</td>
</tr>
<tr>
<td>Small undercoverage blocks as a percentage of all undercoverage blocks, by TEA</td>
<td>55.4%</td>
</tr>
<tr>
<td>Blocks with medium undercoverage</td>
<td>2.3%</td>
</tr>
<tr>
<td>Medium undercoverage blocks as a percentage of all undercoverage blocks, by TEA</td>
<td>35.9%</td>
</tr>
<tr>
<td>Blocks with large undercoverage</td>
<td>0.6%</td>
</tr>
<tr>
<td>Large undercoverage blocks as a percentage of all undercoverage blocks, by TEA</td>
<td>8.8%</td>
</tr>
<tr>
<td>Total blocks with undercoverage</td>
<td>6.4%</td>
</tr>
<tr>
<td>Total IR blocks</td>
<td>11,155,486</td>
</tr>
</tbody>
</table>

*Any block that is partially or wholly within TEA 1 is considered a TEA 1 block. Otherwise, a block is assigned to the TEA within which the largest portion of the block is contained.

Data sources: IR_COV_UDR from earliest IR Review; TEA from BAS19.
The most common type of undercoverage was small undercoverage, which accounted for 55.4 percent of undercoverage blocks at the first pass and 56.5 percent at the end of IR. Medium undercoverage accounted for about 36 percent of undercoverage blocks at both the first pass and at the end of IR. Finally, 8.8 percent of the undercoverage blocks had a large undercoverage at the first pass of IR and that decreased to 7.7 percent at the end of IR operations. TEA 5 (Military) had the highest proportion of large undercoverage blocks; 30.3 percent of all undercoverage blocks in TEA 5 were large undercoverage at the end of IR.

The number of undercoverage blocks increased in TEA 6 between the first pass and the end of IR operations. However, the overall number of blocks with undercoverage decreased, especially in TEA 1 where fewer blocks had undercoverage at the end of IR. The decrease of blocks with undercoverage in TEA 1 was likely because of several factors: the nature of the addresses in TEA 1 meant that they were more likely to benefit from DSF updates, TEA 1 tended to have more resources to be successfully geocoded in UR or resolved in Frame Maintenance. TEA 1 blocks

### Table 6: Blocks with Undercoverage by TEA, at the End of IR Operations

<table>
<thead>
<tr>
<th>Blocks with small undercoverage</th>
<th>Percent of all blocks</th>
<th>All TEA</th>
<th>TEA 1 Self-response</th>
<th>TEA 2 Update Enumerate</th>
<th>TEA 4 Remote Alaska</th>
<th>TEA 5 Military</th>
<th>TEA 6 Update Leave</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blocks with medium undercoverage</td>
<td>2.1%</td>
<td>100%</td>
<td>87.6%</td>
<td>&lt;0.1%</td>
<td>0.1%</td>
<td>0.3%</td>
<td>12.0%</td>
</tr>
<tr>
<td>Blocks with large undercoverage</td>
<td>0.5%</td>
<td>100%</td>
<td>93.3%</td>
<td>&lt;0.1%</td>
<td>0.1%</td>
<td>1.0%</td>
<td>5.6%</td>
</tr>
<tr>
<td>Total blocks with undercoverage</td>
<td>6.0%</td>
<td>100%</td>
<td>87.5%</td>
<td>&lt;0.1%</td>
<td>0.1%</td>
<td>0.2%</td>
<td>12.2%</td>
</tr>
<tr>
<td>Total IR Blocks</td>
<td>11,155,486</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Any block that is partially or wholly within TEA 1 is considered a TEA 1 block. Otherwise, a block is assigned to the TEA within which the largest portion of the block is contained.

Data sources: IR_COV_UDR from BARCA.BTD; TEA from BAS19.
with undercoverage that experienced a subsequent housing unit count increase were triggered for IR re-review, as the undercoverage assessment may have been made obsolete by the address updates.

The increase in the number of undercoverage blocks in TEA 6 over the course of IR was likely because of several factors: some of these addresses were less likely to benefit from DSF updates and tended to have less resources for in-office work in addition to staff re-reviewing test and MAF Coverage Study blocks, including Puerto Rico blocks, which rated some blocks that were previously given a status of “hold for imagery.” All TEA 6 blocks were canvassed in the field while in TEA 1, IOAC determined which blocks were sent to IFAC. Overall, IOAC was able to reduce the number of blocks needing fieldwork by addressing undercoverage in the address frame.

5.2 What are the Outcomes of Triggers?

The outcomes for triggers are divided into Triggers Background and Triggers Outcomes and Analysis.

5.2.1 Triggers Background

In-Office Address Canvassing (IOAC) triggers were a component of IOAC that provided the opportunity to re-evaluate the status of type of enumeration area (TEA) 1 census blocks after the first IR pass. \(^9\) Since housing unit change is dynamic and not always visible in imagery, triggers were designed to capture MAF coverage issues that were not identified in IR or experienced change since the first pass of IR was completed. Without triggers, IOAC would have been a single-faceted process with blocks receiving a status in IR review (passive, active, or on hold) that may have become outdated as housing units in the landscape and/or the address frame changed or new data became available.

Triggers were indicators based on data from a process or an event that suggested it may be necessary to change the status of a block. The primary purpose of triggers was to identify when a block should be re-reviewed\(^{10}\) in order to assign an active or passive status to the block (in the case of hold-for-imagery blocks), or whether housing unit changes observed during address

---

\(^9\) The universe of TEA 1 blocks was refined throughout the IOAC program as automated processes used general criteria to tentatively assign blocks to self-response, and interactive reviews modified the TEA based on operational constraints or other considerations. The triggered blocks were in a TEA 1 status at the time of triggering however, the TEA status of the block may have changed over the course of IOAC.

\(^{10}\) While most triggers did identity blocks for review, two criteria were used to trigger blocks directly to IFAC without additional IR review: areas impacted by natural hazards and blocks with known or suspected coverage issues identified by regional office geographers.
update processes might have resulted in a status change (in the case of active and passive blocks). Implementation of IOAC triggers occurred from the end of 2016 through spring 2019.

The triggers were classified into four types based on the current IR status of the block and the expected outcome of the trigger: Active Blocks that are Possibly Passive, Passive Blocks that are Possibly Active, Hold-for-Imagery Blocks with Updated Imagery, and Database Correction Triggers. After being triggered and worked, the block statuses were reviewed to determine if the trigger-identified blocks resulted in the expected outcome. Triggering methods and block universe identification were also evaluated and improved throughout the course of the IOAC program.

**Trigger Types**

The following describes the trigger types, criteria, and modifications implemented after evaluation of the outcomes of the original triggers. There were four types of triggers:

1. Active Blocks that are Possibly Passive Triggers
   1a. Block Characteristic Triggers
   1b. MAF/Housing Unit Change and IR Coverage Triggers
2. Passive Blocks that are Possibly Active Triggers
3. Hold-for-Imagery Blocks Triggers
4. Database Correction Triggers

**Trigger Type I: Active Blocks that are Possibly Passive**

There are two categories of this trigger type:

1a. Block Characteristic Triggers:

- During IOAC planning stages, the development team determined there was some correlation between the IR outcomes and blocks’ development characteristics, including population size, population density, housing unit count, housing unit density, and housing unit type (e.g., single family or multifamily housing units).
  Block Characteristic Triggers were based on these findings when the count of addresses had changed in the MAF since the latest IR pass.

- Criteria:
  i. Active blocks where development characteristics such as population, housing unit counts, housing densities as well as housing unit types (single family or multifamily) suggest that the block should likely be passive and the block also experienced housing unit changes in the MAF.
ii. Active blocks recently updated through Ungeocoded Resolution and de-duplication efforts.

- After reviewing the results, block characteristic triggers did not efficiently identify active blocks that were made passive because of MAF updates and/or development changes that occurred since the previous pass of IR review (i.e., the majority of blocks maintained their original active status). For this reason, these triggers were only implemented in the early phases of IR triggers.

1b. MAF/Housing Unit Change and IR Coverage Triggers:

- Active blocks were triggered when they contained a coverage issue, identified from the previous pass of IR, and the MAF change indicated the coverage issue may no longer exist. For example, if the MAF housing count increased by one housing unit in an active IR block that contained a single undercoverage pin, we would expect the MAF unit increase may resolve the undercoverage within the block, and upon re-review the block would be categorized as passive.

- Criteria:
  i. Housing unit count change in active blocks with a DSF Reliability score of 100. (For more information about the DSF Reliability score, please see Appendix B.)
  ii. Active blocks having overcoverage and containing zero housing units. This included triggering blocks that lost housing units after a benchmark update and as a logic check on IR results. (For more information about the benchmark, please see Appendix B.)
  iii. Active blocks having overcoverage and having a housing unit count decrease after benchmark updates, and blocks identified as having undercoverage and having a housing unit count increase after benchmark updates.

Trigger Type II: Passive Blocks that are Possibly Active

- The IOAC team triggered passive blocks when they had low confidence that it should remain passive.

- Criteria:
  i. Housing unit count change in passive blocks with a DSF Reliability score of 100.
  ii. Passive blocks having a DSF Reliability score of less than 100 and no local government partnership participation or updates through GSS or LUCA.
iii. Passive blocks containing a higher number of housing units without MSPs. (For more information about MSPs, please see Appendix B.)

iv. Passive blocks containing post-benchmark housing unit count changes.

**Trigger Type III: Hold-for-Imagery Blocks**

- When the block could not be rated in the previous pass of IR because of unclear imagery, the block was assigned a hold-for-imagery status. All hold-for-imagery blocks were later returned to the IR workload with the goal of establishing an active or passive IR status for the block based on better/unobstructed imagery.

- Hold-for-imagery block triggering became more targeted as the team learned more about the triggers and their successful implementation. To improve the rate at which IR could successfully evaluate the block, satellite imagery was replaced with slightly older National Agriculture Imagery Program (NAIP) aerial imagery that did not have cloud cover. The NAIP imagery was used to evaluate hold-for-imagery blocks that were possibly passive, including blocks with zero housing units, blocks with a DSF Reliability score of 100 and, blocks with no housing unit changes over several benchmark updates.

**Trigger Type IV: Database Correction**

- Periodically, after a software improvement, groups of blocks would sometimes fail to update automatically within the system according to the new programming. Triggering the affected blocks often resolved these issues.

**Triggers to Support Census Tests and Evaluations**

Triggers were implemented to support census tests and IOAC evaluations as well. Hold-for-imagery blocks in the MAFCS and 2017 Census Test universes were triggered for re-review in the attempt to assign passive/active status to on hold blocks.

All blocks in the End-to-End Census Test universe were re-reviewed at the same time that IFAC was being conducted. The second IR pass was designed to minimize the effects of the passage of time between IR and In-Field Address Canvassing, to improve the ability to compare the IOAC and IFAC results.

Passive blocks that were possibly active were triggered for the End-to-End Census Test in the Providence site. The triggered blocks were crosswalked to BCUs, and the BCUs were used in assigning sampling strata used in the End-to-End Census Test analysis. Two types of triggers were identified in the strata: BCUs defined as passive in IR that were triggered for additional review and are not missing maps spots, and BCUs defined as passive in IR that were triggered
for additional review because they are missing map spots. The End-to-End Census Test
evaluation assessed the IFAC actions in these triggered BCUs (Johnson and McDougall, 2019).

**Triggers Requiring No Further In-Office Address Canvassing Action**

There were two types of triggers that required no further IOAC Action: Direct-to-Field triggers
and Passive-Headquarters triggers. To see data on these triggers, please see Appendix D.

Two criteria were used to trigger blocks directly to IFAC without additional IR review: areas
impacted by natural hazards, and blocks with known or suspected coverage issues identified by
Regional Office Geographers. There were 40,564 Direct-to-Field triggered blocks at the time the
IFAC universe was created.

The Direct-to-Field triggered blocks consisted primarily of blocks recently impacted by natural
hazards, which were sent to IFAC as the housing landscape was likely dynamic, with some
housing uninhabitable, some housing rebuilt or in the process of being rebuilt, and, in some
cases, having alternate accommodations on the property (e.g., a trailer). Natural hazard events
included for this trigger were tropical storms/hurricanes, flooding, wildfires, earthquakes,
landslides, and tornadoes. The regional office geographers also nominated blocks for field
canvassing, focusing on blocks with known coverage issues, and those with known or suspected
hidden units. HQ further reviewed these nominated blocks, and determined if they would
benefit from field work, removing those that were clearly passive or that were corrected via
other census operations.

Blocks that were reviewed by headquarters staff and determined to be correct and complete,
and not require field canvassing, were triggered to a specific passive status (Passive
-Headquarters). When the IFAC universe was identified, 13,000 blocks were classified as
Passive-Headquarters. Public lands with no population and housing comprised the majority
(9,800) of these blocks. These public lands blocks were given the Passive-Headquarters status
so that they would be considered passive, and not sent to IFAC if they were in TEA 1. Assigning
the Passive-Headquarters status was especially important when the zero population and
housing unit blocks on public lands were assigned the “Hold-For-Imagery” status in IR, which
would have sent the block’s corresponding BCU to field canvassing—provided they were in
TEA 1.

Other types of blocks that were triggered to the Passive-Headquarters status included blocks
reviewed and resolved or blocks determined to be passive (not requiring updates) by Frame
Maintenance and other HQ review projects targeting the review of active blocks that were
likely to be passive within otherwise passive BCUs (considered “high-value review”).
5.2.2 Trigger Outcomes and Analysis

This section provides information about the IR status changes of triggered and re-reviewed blocks based on the four trigger types discussed in the previous section. Although not every block was triggered for re-review, some blocks were triggered multiple times (or retriggered) during the course of IOAC. Nearly half of the frequently retriggered blocks were those with consistently poor imagery across multiple reviews.

Additional retriggering was caused by blocks meeting different triggering criteria either at different timeframes (e.g., often blocks were first triggered under the Active Blocks that are Possibly Passive Trigger methodology using the Block Characteristic Criteria and then retriggered later using MAF/Housing Unit Change and IR Coverage Criteria) or in the same timeframe. Figure 1 depicts an example path of a block triggered under different methodologies in the same timeframe.

Figure 1: Example path of a block triggered more than once in the same timeframe

1. Initial IR completed and assigned the block an active IR status because of detected overcoverage. After the initial IR, the overcoverage was eliminated during the de-duplication of address records.

2. Block meets the methodological threshold for Trigger A, and soon after (before the block is re-reviewed for Trigger A) meets the threshold for Trigger B. The block first enters the IR re-review queue for Trigger A. The block remains on the Trigger B list.

3. Re-review finds no overcoverage in the block and assigns the block a passive IR status.

4. The now passive block re-enters the IR Review queue because it is still on the Trigger B list.

5. Re-review finds the block to be passive, and the block retains passive status.
Triggering the same block more than once in the same timeframe often occurred when there was variable IR staffing. Blocks that met a specific trigger criterion were queued up to be ready for staff when staff were available. While these triggers were in queue, new triggers were developed and sometimes an already triggered block met the new criteria and was triggered again. Once this issue was identified, GEO staff worked to remove duplicates in the IR re-review queue and did not continue to trigger blocks that were already in the IR re-review queue.

Block triggering occurred as overall program changes were implemented, which affected the final classification of active and passive blocks. For example, some blocks were in the Active Blocks that are Possibly Passive trigger queue when the Census Bureau implemented the active/passive designation criteria change. As a result, those blocks that changed from active to passive status may be the product of the criteria change and not necessarily the trigger identifying change.

Table 7 presents a summary of triggers. In total, 13.5 percent of blocks were triggered and the majority of these blocks received an updated status in IOAC.

**Table 7: Summary of Triggers in IR**

<table>
<thead>
<tr>
<th>Of the 13.5% blocks triggered</th>
<th>No change in status</th>
<th>26.6%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Received an updated IOAC IR status</td>
<td>73.4%</td>
</tr>
<tr>
<td>Of the 73.4% blocks that received an updated IR status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active blocks became passive</td>
<td>12.2%</td>
<td></td>
</tr>
<tr>
<td>Passive blocks became active</td>
<td>10.9%</td>
<td></td>
</tr>
<tr>
<td>Hold for imagery blocks rated active or passive</td>
<td>53.8%</td>
<td></td>
</tr>
<tr>
<td>Of the 53.8% hold for imagery blocks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Became active</td>
<td>45.5%</td>
<td></td>
</tr>
<tr>
<td>Became passive</td>
<td>54.5%</td>
<td></td>
</tr>
<tr>
<td>Were retriggered</td>
<td>23.1%</td>
<td></td>
</tr>
</tbody>
</table>

*Total includes Active Blocks that are Possibly Passive, Passive Blocks that are Possibly Active, Hold-for-Imagery and Database Fix triggers, as these triggers are the scope of this report section. Total does not include triggers created for the development and testing of the program, MAFCS, the ADCAN and End-to-End Census Tests, and the “trigger to field” (FT) census blocks.

Data source: Block Assessment, Research, and Classification Application (BARCA)

Tables 8-13 aggregate the trigger outcome for each trigger methodology based on the status of the block when the trigger occurred (either active, passive or hold-for-imagery). The prior status column in each table indicates the IR status of the block when it was re-reviewed, and the post status column provides the outcome IR status, after the re-review.
Note, the majority of prior block statuses are logically associated with the trigger type, for example, Active Blocks that are Possibly Passive, would have an “active” prior status. However, as described above, a small percentage of blocks were triggered by more than one trigger in the same timeframe. In these cases, the prior status may not be logically associated with the trigger type. For example, given the scenario depicted in Figure 1, Active Blocks that are Possibly Passive, would be in a “passive” IR status at the start of review if the block was already triggered and the re-review resulted in an IR status change.

Further, the blocks that were triggered more than once and switched between active and passive statuses more than once would benefit from further study to determine why they were difficult to assess and why their status codes changed with each trigger. An example scenario that would warrant further study is when a block was active, and upon triggering and re-review became passive, and after a subsequent triggering and re-review returned to active.

**Active Blocks that are Possibly Passive**

The Active Blocks that are Possibly Passive Trigger was used 19 times, triggering 571,475 blocks. The results from all active block trigger methodologies are shown in Table 8, indicating 23.6 percent of the active blocks triggered became passive after review, which includes the blocks that were already triggered, re-reviewed, and moved to a hold-for-imagery or passive status before the active block trigger was implemented. Blocks were categorized as hold-for-imagery at a rate of 22.9 percent.

**Table 8: Active Blocks that are Possibly Passive: All Active Trigger Methodologies**

<table>
<thead>
<tr>
<th>Percent of Blocks</th>
<th>Post Status</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Active</td>
<td>Passive</td>
<td>Hold-for-imagery</td>
</tr>
<tr>
<td>Prior Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>43.9%</td>
<td>18.7%</td>
<td>15.5%</td>
<td></td>
</tr>
<tr>
<td>Passive</td>
<td>0.6%</td>
<td>1.0%</td>
<td>0.2%</td>
<td></td>
</tr>
<tr>
<td>Hold-for-Imagery</td>
<td>9.0%</td>
<td>3.9%</td>
<td>7.1%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>53.5%</td>
<td>23.6%</td>
<td>22.9%</td>
<td></td>
</tr>
</tbody>
</table>

Data source: BARCA
Tables 9 and Table 10 show a breakout of the Block Characteristic Criteria and the MAF/Housing Unit Change and IR Coverage Criteria, respectively. The Block Characteristic Criteria comprised 12 triggers and 522,750 blocks. The breakout of the Block Characteristics Criteria shows that a total of 22.3 percent of the blocks triggered resulted in a passive status upon re-review. Blocks were categorized as hold-for-imagery at a rate of 23.2 percent.

**Table 9: Active Blocks that are Possibly Passive: Block Characteristic Criteria**

<table>
<thead>
<tr>
<th>Percent of Blocks</th>
<th>Active</th>
<th>Passive</th>
<th>Hold-for-Imagery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>44.3%</td>
<td>18.2%</td>
<td>15.3%</td>
</tr>
<tr>
<td>Passive</td>
<td>0.5%</td>
<td>0.5%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Hold-for-Imagery</td>
<td>9.8%</td>
<td>3.5%</td>
<td>7.6%</td>
</tr>
<tr>
<td>Total</td>
<td>54.5%</td>
<td>22.3%</td>
<td>23.2%</td>
</tr>
</tbody>
</table>

Data source: BARCA

The MAF/Housing Unit Change and IR Coverage Criteria was used 8 times triggering 48,725 blocks. Table 10 shows that a total of 38.3 percent of the active blocks resulted in a passive status upon re-review. An additional 19.5 percent were identified as hold-for-imagery. These triggers were based on active blocks where the MAF change was in alignment with the IR pins indicating that the overcoverage or undercoverage identified in IR had potentially been resolved. The MAF/Housing Unit Change and IR Coverage Triggers were more successful in identifying blocks that were no longer active than the Block Characteristics Triggers.

**Table 10: Active Believed to Possibly be Passive: MAF/Housing Unit Change and IR Coverage Criteria**

<table>
<thead>
<tr>
<th>Percent of Blocks</th>
<th>Active</th>
<th>Passive</th>
<th>Hold-for-Imagery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>39.0%</td>
<td>24.1%</td>
<td>17.0%</td>
</tr>
<tr>
<td>Passive</td>
<td>1.7%</td>
<td>5.9%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Hold-for-Imagery</td>
<td>1.4%</td>
<td>8.2%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Total</td>
<td>42.2%</td>
<td>38.3%</td>
<td>19.5%</td>
</tr>
</tbody>
</table>

Data source: BARCA
Passive Blocks that are Possibly Active

Similar to the Active Blocks that are Possibly Passive, identification of Passive Blocks that are Possibly Active improved over the life of the program. Table 11 shows that one-third (33.5 percent) of the blocks triggered using this methodology were identified as active after review, while 21.8 percent were identified as hold-for-imagery. While the most common status after review was passive (44.7 percent), these triggers were intended as broad safety nets to ensure that blocks with coverage issues were not left in a passive status.

Table 11: Passive Blocks that are Possibly Active: All Passive Trigger Methodologies

<table>
<thead>
<tr>
<th>Prior Status</th>
<th>Percent of Blocks</th>
<th>Post Status</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active</td>
<td>Passive</td>
<td>Hold-for-Imagery</td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>7.7%</td>
<td>6.9%</td>
<td>4.2%</td>
<td></td>
</tr>
<tr>
<td>Passive</td>
<td>25.7%</td>
<td>37.8%</td>
<td>17.6%</td>
<td></td>
</tr>
<tr>
<td>Hold-for-Imagery</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33.5%</td>
<td>44.7%</td>
<td>21.8%</td>
<td></td>
</tr>
</tbody>
</table>

Data source: BARCA

Hold-for-Imagery Blocks with Updated Imagery

The goal of the hold-for-imagery blocks with updated imagery triggers was to move as many blocks as possible out of a hold-for-imagery status and into the passive or active statuses. The hold-for-imagery trigger was implemented 19 times on different block universes. Overall, 78.4 percent of the re-reviewed hold for imagery blocks were assigned an active or passive status after one or more re-reviews.

Originally, IR used satellite imagery for the “current” imagery, which met the temporal requirements of IOAC but included large areas of the country with cloud cover. After multiple attempts proved unsuccessful in moving the blocks out of hold-for-imagery status using the satellite imagery, alternative aerial imagery sources were identified as a solution to persistent hold-for-imagery blocks.

In December 2018, the IOAC program elected to use slightly older aerial, primarily NAIP, imagery, which was often clearer than the satellite imagery, and therefore enabled IR staff to evaluate the block. Blocks reviewed using the older aerial imagery were persistent hold-for-imagery blocks that were possibly passive, including blocks with zero housing units, blocks with
a DSF reliability score of 100 and finally blocks with no housing unit changes over several benchmark updates.

**Table 12: Hold for Imagery: All Hold-for-Imagery Methodologies**

<table>
<thead>
<tr>
<th>Prior Status</th>
<th>Percent of Blocks</th>
<th>Post Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active</td>
<td>Passive</td>
</tr>
<tr>
<td>Active</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Passive</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hold-for-Imagery</td>
<td>35.7%</td>
<td>42.7%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>35.7%</td>
<td>42.7%</td>
</tr>
</tbody>
</table>

Data source: BARCA

**Database Correction Triggers**

This fourth trigger type is for the remaining triggers that were not identified through data analysis. Periodically after a software improvement, an error occurred where groups of blocks would not automatically update within the system according to the new programming. After this happened, these blocks were re-triggered as the most efficient way to fix them. Retriggering the affected blocks for rework often resolved these issues that could not be fixed by a software update.

**Table 13: Database Correction Triggers**

<table>
<thead>
<tr>
<th>Prior Status</th>
<th>Percent of Blocks</th>
<th>Post Status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Active</td>
<td>Passive</td>
</tr>
<tr>
<td>Active</td>
<td>35.3%</td>
<td>40.3%</td>
</tr>
<tr>
<td>Passive</td>
<td>1.9%</td>
<td>5.0%</td>
</tr>
<tr>
<td>Hold-for-Imagery</td>
<td>0.8%</td>
<td>3.1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>38.0%</td>
<td>48.4%</td>
</tr>
</tbody>
</table>

Data source: BARCA

Through the course of implementing the IOAC triggers, the Census Bureau learned that changes in the MAF housing unit count relative to the IR block status were the best indicators that the IR assessment/block status might no longer be accurate. With ongoing updates, this result is
expected. Comparing the MAF/housing unit count with the IR block status allowed for the successful identification of blocks, where the count of housing units visible in imagery was no longer in alignment with the MAF (becoming active if the block was designated passive) or where the count of housing units became in alignment with the MAF (becoming passive if the block was designated active).

Additionally, the Census Bureau determined that population and housing development variables were not reliable predictors of change. Through conducting triggers, the Census Bureau learned where IOAC block status may have been out-of-date and no longer correct.

Reducing the number of hold-for-imagery blocks through additional rounds of triggering required weighing the benefits and risks of imagery currency over imagery quality. Ultimately, it was determined that triggering hold-for-imagery blocks that were highly likely to result in a passive status assignment upon re-review, was a worthwhile tradeoff for imagery currency.

The Census Bureau also determined that they should use blocks’ relationships with BCUs to prioritize block triggering, to maximize the impact of the work done on triggered blocks. For example, an active block that overlapped multiple BCUs could potentially make each BCU passive if prioritized, re-reviewed and found to be passive.

5.3 What are the Outcomes of Active Block Resolution (ABR)?

The outcomes of Active Block Resolution (ABR) are divided into ABR Background and ABR Outcomes and Analysis. An additional section follows about Frame Maintenance.

5.3.1 ABR Background

ABR Overview

The design of In-Office Address Canvassing (IOAC) included Active Block Resolution (ABR) as one of the five components in the suite of IOAC. ABR was designed to “canvass” active blocks in the years leading up to In-Field Address Canvassing (IFAC) and resolve or make passive as many blocks as possible. With Interactive Review (IR) identifying active blocks starting in 2015, ABR staff could then use additional sources to perform further research to verify every MAF unit and use additional tools to fix overcoverage or undercoverage if possible. Blocks resolved by ABR were made passive and would not go to IFAC unless they were triggered or placed in a BCU with an active block. If ABR could not resolve a block, the block would remain active and go to IFAC if its coverage remained unresolved. ABR reviewers were grade 5 staff.

Within the suite of IOAC, ABR served an important role by making updates to render active blocks passive and ultimately reducing the cost of the in-field operation. In designing IOAC, the Census Bureau believed that some blocks would be best canvassed in person but that some
active blocks could be resolved in the office by ABR. Active blocks with only a small amount of coverage issues were ideal for ABR rather than sending the entire block to IFAC. Blocks with coverage issues originating from an issue in the underlying geography in Master Address File (MAF) Topologically Integrated Geographic Encoding and Referencing (TIGER) Database (MTDB) were also ideal for ABR as IFAC listers could only flag underlying geography issues but ABR reviewers could resolve them. (See the next section for an example.) In addition, IFAC listers could not see adjacent blocks while ABR staff had a detailed view of the area in MTDB and could perform a wider array of updates or changes.

ABR started with a soft start in April 2016 and was discontinued in February 2017 because of funding uncertainty and reprioritization of critical components of the 2020 Census. The original workload estimate for ABR was 1.7 million blocks.

**ABR Details**

ABR reviewers performed research and used multiple sources to resolve coverage issues. Sources included the most recent United States Postal Service (USPS) Delivery Sequence File (DSF), imagery, local Geographic Information Systems (GIS) and assessor websites or databases, Google Maps and Google Street View, Bing Maps and Bing Streetside, and real estate websites. ABR reviewers were also able to view detailed address information for the block, which was more detailed than the address counts used in IR or the filtered address list listers used in IFAC. ABR reviewers had a filtered address list for the block, address history that showed the information from the last DSF refresh, and, if applicable, GPS points for each structure known as MAF Structure Points (MSPs). (For more information about MSPs, please see Appendix B.) ABR reviewers could also see the “pins” identified in IR, which indicated areas of undercoverage, overcoverage, and the degree of the coverage issue.

To guide ABR reviewers in their work, Geography Division (GEO) staff created a decision tree and an action checklist matrix. ABR reviewers also had a complete set of guidelines, but the decision tree helped the ABR reviewer to break down working the block into steps with questions. The action checklist matrix served as a quick reference for ABR reviewers to ensure they filled out the required fields for each action. Using the guidelines, decision tree, and action checklist matrix, ABR reviewers canvassed the entire block in ABR marking each address with an action.

ABR used an address table within a software interface called Geographic Acquis-based Topological Real-time Editing System (GATRES) to view the address records in the block and to make updates. ABR reviewers made feature updates directly to the live TIGER database using GATRES. The address updates were collected in GATRES, but the MAF update occurred later. After completing updates, ABR reviewers set a resolution code. For a full list of codes, please
see Appendix E. Another software application—Block Assessment, Research, and Classification Application (BARCA)—was the mechanism for assigning work to ABR reviewers. Each ABR work assignment consisted of one tabulation block.

To resolve coverage issues, ABR reviewers performed actions such as reshaping edges, removing linear features, or moving MSPs in TIGER. In the MAF, ABR reviewers took actions on addresses that were duplicates, deletes, nonresidential, or ungeocoded, as well as adding new addresses. Updates to resolve coverage issues included:

- Confirming that the address data that appeared in imagery were also in the MAF.
- Updating existing MAF addresses to ensure that they reflected what existed in the source data, as appropriate.
- Adding addresses that appeared to be included in imagery but were missing in the MAF, as confirmed by local sources.
- Indicating when existing MAF addresses no longer represented housing units, as confirmed by local sources.
- Deleting addresses that appeared in the Active block inventory that appeared to be duplicates of other addresses in the Active block.
- Deleting addresses that did not appear to belong in the Active block and local data sources could not confirm their specific location to be within the Active block.
- Adding new, suspected group quarters (GQ) or transitory locations (TL) addresses for input into the In-Office Address Canvassing GQ/TL.
- Adding road features and reshaping misaligned roads where they affected housing units.
- Adding road features to resolve ungeocoded addresses and/or updating geocodes for ungeocoded or misgeocoded MAF addresses, thereby including them in the inventory of addresses for the Active block.

For example, a block boundary could be misshapen in TIGER in a way that causes several housing units, which are actually within the block, to be located in the adjacent block. In addition, some of the housing units could be duplicated between the two blocks, because they have addresses in different formats, and some housing units could be missing entirely, even in the adjacent block. During ABR, a reviewer would reshape the block boundary in TIGER to correct the issue. The reshape could involve adjusting any features, such as roads, that share the same edge as the block boundary or are connected to it. Finally, the reviewer would add, update, or delete addresses in accordance with their research to resolve the coverage issues in the block. The resolution codes for ABR were “R” and “UL.” “R” was “resolved in office” where
100 percent of addresses in the block were resolved. “UL” was “locate address” where at least one address could not be confirmed in the office and needed to be sent for IFAC.

**ABR QC**

ABR QC staff verified that all ABR actions taken in the GATRES ABR table were made according to ABR procedures, the decision tree, and action checklist matrix. ABR QC was designed for staff to send comments back to ABR reviewers to review their failed QC address records. Depending on the failure, ABR QC staff sometimes fixed it themselves and provided feedback or asked the ABR reviewer to fix their errors. ABR QC staff were GIS tech contractors who usually had geographic knowledge or experience.

QC started when an ABR reviewer closed out a block and set the resolution code. The finished block was then added to the QC queue. The ABR QC administrator managed the QC queue and assigned blocks to ABR QC staff. Initially, the ABR QC workflow had two steps: automated QC and interactive QC. After the GATRES business rules were incorporated, the automated QC was no longer used. Blocks with a resolution code of “R” or “UL” had a QC sample set. The ABR QC staff reviewed all the other blocks to determine if the resolution code was set correctly. QC work assignments were managed in BARCA.

**ABR in the Census Tests**

The Address Canvassing Test, which took place in 2016, evaluated ABR by sending the blocks worked by ABR to IFAC in two sites: Buncombe County, North Carolina, and a portion of St. Louis, Missouri. Of the blocks classified as “resolved” by ABR, 90.4 percent of addresses in St. Louis and 91.5 percent of addresses in Buncombe County were verified by both In-Field Address Canvassing and ABR. The test had a few limitations, and the most significant was that each operation inadvertently used two different filters, or rules, to determine the universe of IFAC addresses. This resulted in IFAC receiving additional addresses, likely of poor quality, and consequently IFAC taking additional negative actions (U.S. Census Bureau, 2021).

The 2018 End-to-End Census Test Address Canvassing operation, which included both IFAC and IOAC, took place in three test sites: Pierce County, Washington; Providence County, Rhode Island; and the Bluefield-Beckley-Oak Hill, West Virginia, area. As part of the 2018 End-to-End Census Test Address Canvassing operation, the evaluation drew a sample of BCUs from the Providence County test site to undergo IFAC for the purpose of evaluating the IR, ABR, and triggering components of IOAC. In the BCUs resolved by ABR, the evaluation found that 95 percent of addresses did not have a coverage related change from IFAC. This result means that in all the BCUs ABR resolved, IFAC listers took coverage related actions on 5 percent of the addresses. The ABR-resolved estimates may be overestimated because some addresses deleted in ABR were inadvertently included in the IFAC workload. (Johnson and McDougall, 2019).
test assessment report recommended that the Census Bureau consider reimplementing a refined or updated ABR component for censuses beyond 2020 (Lane et al., 2019).

**ABR Design Assumption Changes**

While ABR was perhaps the most similar to In-Field Address Canvassing, the Census Bureau found that ABR worked best when using techniques modified for IOAC. Staff observed that the original ABR design assumptions needed adjustment in three areas: how staff canvassed a block, the time needed to canvass a block, and sources needed to canvass a block.

Early planning for ABR estimated that ABR reviewers would complete a block in about 20 minutes. Additionally, the Census Bureau originally asked ABR reviewers to canvass blocks using a similar strategy to In-Field Address Canvassing—reviewing each living quarter they saw in the block and updating or verifying the address list. Staff quickly learned that blocks required more time to complete and that about 70 percent of ABR actions were “verify” actions. (See Table 15.) Canvassing the entire block was time intensive and ABR reviewers needed to focus on fixing the address frame rather than spending time marking good addresses with “verify” actions. The Census Bureau planned to modify ABR to resolve coverage issues more efficiently by using a pin-based method to mark areas of overcoverage and undercoverage and have reviewers pass over the portions of the block that already matched the address frame. However, when ABR was paused, the Census Bureau was unable to test the pin-based approach to ABR.

Staff found that ABR was dependent on good or authoritative geographic reference data sources. For example, some websites or local government data sources could have data several years out of date and these sources would not have been appropriate for ABR to use. Good data sources, such as county government GIS files that contained address and location information, parcel data, and other address information such as residence type or additional unit information, along with high quality imagery, was sometimes more information than what was available to field listers during field canvassing. In areas of poor source data coverage, ABR needed additional time to find an appropriate data source or needed listers to canvass the block in person.

In the design of IOAC, the Census Bureau planned for ABR to prioritize work based on data within the Block Tracking Database (BTD). Early ABR was prioritized to complete review of test sites, including the Address Canvassing Test, MAF Coverage Study (MAFCS) sample blocks, and the 2018 End-to-End Census Test Address Canvassing operation sites. Had ABR continued, it would have also prioritized blocks according to the BTD. The addresses in the test sites and MAFCS were primarily classified as self-response (TEA 1) and update leave (TEA 6), though TEA delineation was not final during these tests. The test sites and MAFCS mainly had city-style
addresses that are supported by the USPS for mail delivery. Staff were able to find good sources for the areas in the Address Canvassing Test but the sources for the MAF Coverage Study (MAFCS) and 2018 End-to-End Census Test Address Canvassing operation areas varied in quality and usefulness at that time.

**ABR Software Evolution and Benchmarking**

ABR started with an early software prototype, which allowed staff to begin ABR and identify additional functionality needed in the software through working real cases. In addition, the early software prototype allowed ABR to start work to support the Address Canvassing Test. Business rules, which prevented ABR reviewers from taking actions that may be invalid, were not in place when ABR started so staff performed a manual QC of the business rules until the business rules were programmed. Full block QC was programmed in GATRES later. The early software had the advantage of flexibility and minimal development to permit changes as staff learned about the data but the disadvantage of needing greater quality control because ABR reviewers did not have restrictions on the actions they could take.

Using a software prototype to allow for early production work with the flexibility for changes meant that QC needed to be conducted at a higher rate longer than is typical to ensure good quality. Feedback to staff is an important part of QC because staff can learn and become better reviewers. With production work starting with a software prototype, QC was conducted manually first until business rules were developed in GATRES so that staff could develop the QC software. QC was set at 100 percent during the first months of ABR and full block QC begin in October 2016. As ABR progressed, sample QC was added, and QC then followed a more typical pace. Sample QC criteria was set by both the source and the resolution action. See Appendix E for the full list of criteria.

MAF/TIGER System constraints sometimes hindered ABR. Developers could not load the address data into GATRES nationally and this limitation required staff to submit a list of blocks for developers to load. Because ABR worked in the live MAF/TIGER database, it had to stop all feature update work (road or boundary reshares and MSP work) for benchmarking, a monthlong process during which the database is locked for updates and products are created. Although address work continued during benchmarking, any required feature update had to wait until benchmarking ended. In addition to benchmarking stopping work, it required staff to reload the address data, which was cumbersome. Please see the lessons learned and recommendations sections for more information.
5.3.2 ABR Outcomes and Analysis

Two outcomes were possible for a block worked in ABR:

- ABR was able to resolve the coverage issue(s) in the block, making the block “resolved,” and, thus, passive.
- ABR could not resolve any or all of the coverage issue(s), making the block “unresolved.” These blocks remained active.

Resolved blocks were passive blocks, meaning that the MAF housing count and/or MSPs matched current imagery and/or other sources. Passive blocks could have been triggered for re-review in IR if, for example, the DSF refresh changed the housing unit count. Unresolved blocks were active blocks and would have gone to IFAC unless they were triggered for review and sources became available to resolve the coverage issue.

Table 14 shows the total number of blocks worked by ABR and the outcome of the work: resolved and passive or unresolved and active. The results also include a TEA breakdown. Overall, ABR resolved more than two-thirds of the blocks it worked and under one-third remained active. More than 95 percent of the blocks worked were in TEA 1. ABR was able to resolve 47 percent of the Update Leave (TEA 6) blocks, a higher unresolved rate than in TEA 1, which resolved about 70 percent, though TEA 6 comprised less than 5 percent of the blocks so the universe was small. Also, the universe for the ABR blocks overall was the MAFCS blocks, which were a nationally representative sample, and the test sites. These ABR results should be viewed in context; the ABR universe prioritized the test sites and MAFCS blocks and then ABR ended before it could work blocks nationally based on the BTD and therefore the universe may not have been typical of the nation.

<table>
<thead>
<tr>
<th>Total blocks worked by ABR</th>
<th>Type of Enumeration Area (TEA)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>TEA 1</td>
<td>TEA 6</td>
</tr>
<tr>
<td></td>
<td>74,500</td>
<td>95.7%</td>
<td>4.3%</td>
</tr>
<tr>
<td>Resolved – Passive</td>
<td>68.6%</td>
<td>69.6%</td>
<td>47.0%</td>
</tr>
<tr>
<td>Unresolved – Active</td>
<td>31.4%</td>
<td>30.4%</td>
<td>53.0%</td>
</tr>
</tbody>
</table>

Data source: Copy of BARCA.ABR_REVIEWS table (copied on 10-03-2017) joined to the MAF/TIGER database BCU table. Export results 74500 rows to excel for computation using a Pivot Table.

Table 15 includes all the resolved addresses that completed ABR QC and went to MAF update or were verified. This table does not include “U” or “unresolved” actions or other dependent updates such as feature reshapes and therefore this table does not represent the total workload of ABR. The number of addresses worked is greater than the number of addresses
reviewed because addresses worked includes addresses that ABR added or moved from outside the block into the ABR block. Of the addresses that were resolved, about 73 percent were verified meaning that they did not require correction. About 27 percent of resolved addresses required updates to correct coverage issues in the block.

<table>
<thead>
<tr>
<th>ABR Address Update Status</th>
<th>Number of Addresses</th>
<th>Percentage of Addresses Worked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addresses Reviewed</td>
<td>1,060,000</td>
<td>-</td>
</tr>
<tr>
<td>Addresses Worked (Including adds and address moved into the block)</td>
<td>1,175,000</td>
<td>100%</td>
</tr>
<tr>
<td>Addresses Verified (“V” or “verify” action)</td>
<td></td>
<td>72.8%</td>
</tr>
<tr>
<td>Addresses Updated (Actions other than “V” that updated the MAF)</td>
<td></td>
<td>26.9%</td>
</tr>
<tr>
<td>Addresses Rejected (Reject for MAF update)</td>
<td></td>
<td>0.3%</td>
</tr>
</tbody>
</table>

Table 15: ABR Address Breakdown for Resolved Addresses

Data source and notes: MAFDATA ABR preprocessing tables joined to re-create output of the original ABR_SS_GATRES table that is no longer available. (Only stateside, no Puerto Rico data).
Includes addresses that completed QC and were picked up for MAF update. Does not include addresses that had a “U” action or were reviewed but not completed QC.

5.3.3 Frame Maintenance

Frame Maintenance Background

After ABR was discontinued in February 2017, the Census Bureau looked for additional ways to ensure that the address frame was as up to date as possible. During ABR, staff learned valuable information and they applied this knowledge to a project that could target only the portion of an active block that needed further review or updating. Frame Maintenance implemented the pin-based within-block, targeted update approach that was envisioned for ABR, but could not be integrated into ABR before it was discontinued. Frame Maintenance targeted areas located in active blocks that appeared to be good candidates for in-office resolution of coverage issues in the address frame with the goal that these blocks would not require a field visit during IFAC.

Frame Maintenance started in October 2017 and completed December 2018. Frame Maintenance reviewers and QC staff were contractors and GEO staff that had geographic knowledge or experience. IOAC staff generally identified blocks for Frame Maintenance that they believed would be relatively simple to resolve and would reduce the IFAC universe. TEA was not generally part of the selection criteria because most blocks were in TEA 1 anyway and reducing coverage or underlying issues in other TEAs helped the overall quality of the address frame. Like ABR, Frame Maintenance included additional data, tools, and options that were not available to field staff.

Blocks included in Frame Maintenance generally were:

- Blocks with a small overcoverage.
• Blocks that could be resolved with simple fixes. (See below for more information.)
• Blocks that were active and in a BCU with passive blocks.
• Blocks that were adjacent to a highway median or water block with housing units geocoded incorrectly to the median or water block.
• Blocks that were geographically isolated from other active blocks and would require a lister to travel a large distance to reach.

Examples of simple fixes included geocoding fixes such as moving an MSP that was on the wrong side of a street or boundary to the correct side. An MSP on the wrong side of a street or boundary, and therefore in the wrong block, created a coverage issue. Similarly, if a street or boundary was misshapen in a way that caused MSPs to be in the wrong block, Frame Maintenance staff could reshape the street or boundary to correct the coverage issue. While these fixes were simple, they often required specialized in-office tools. IFAC listers did not have the tools to reshape a street or boundary for example.

Frame Maintenance staff worked blocks using similar methods to ABR but incorporated some process improvements. The pin-based approach allowed reviewers to target their review and update addresses or features that required update, rather than canvassing the entire block. Unlike ABR, which used 100 percent MAF update, Frame Maintenance used a hybrid of actions: MAF only, TIGER only, and combination MAF/TIGER actions.

Frame Maintenance used the same software, a table within GATRES, as ABR did. Frame Maintenance benefited from additional software enhancements that were introduced during ABR. Like ABR, Frame Maintenance work was restricted during benchmarking periods, when updates could not be made to MAF/TIGER. There were four benchmarking periods during Frame Maintenance. For more information on benchmarking, please see Appendix B.

Frame Maintenance used software developed for ABR that was modified to add additional business rules to ensure reviewers could take actions appropriate for Frame Maintenance. Like ABR, Frame Maintenance had a sample QC process. QC staff performed a complete review of the Frame Maintenance reviewer actions and sent feedback to reviewers with instructions to make corrections.

Frame Maintenance Outcomes and Analysis

Frame Maintenance staff could resolve coverage issues by taking an action on an address or performing feature corrections, such as reshaping a road to correct a coverage problem. As a result, the outcomes are presented in a few different ways. Two tables (Tables 16 and 17) display results by address and two tables (Tables 18 and 19) display results by block. In a block,
Frame Maintenance staff may have taken action on some or all addresses, or they may have corrected features without taking actions on addresses.

Frame Maintenance and ABR selected their universes based on different priorities and ABR worked the whole block while Frame Maintenance used a pin-based approach. In ABR about 73% (Table 15) of addresses worked had a verify action. Table 16 shows that Frame Maintenance used the verify action on about 11% of addresses worked. Because the decade preceding the 2020 Census was the first time IOAC was conducted, IOAC staff learned from early components like ABR and then improved the ratio of verify actions to update actions, as shown when comparing tables 15 and 16. Frame Maintenance reduced verify actions by focusing on the issues in the block rather than canvassing the whole block.

**Table 16: Frame Maintenance Outcomes for Addresses Sent to MAF Update***

<table>
<thead>
<tr>
<th>Address Outcomes</th>
<th>Number of Addresses</th>
<th>Percentage of Addresses Worked</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Addresses Worked</strong>** (Including adds and address moved into the block)</td>
<td>237,000</td>
<td>100%</td>
</tr>
<tr>
<td><strong>Addresses Verified</strong> (“V” or “verify” action)</td>
<td></td>
<td>10.7%</td>
</tr>
<tr>
<td><strong>Addresses Updated</strong> (Actions other than “V” that updated the MAF)</td>
<td></td>
<td>88.2%</td>
</tr>
<tr>
<td><strong>Addresses Rejected</strong> (Reject for MAF update)</td>
<td></td>
<td>1.2%</td>
</tr>
</tbody>
</table>

*This table does not represent the full workload of Frame Maintenance since feature work was not sent to MAF update but still resolved blocks.

***“Addresses Worked” includes addresses that received an action code, including addresses added, but does not include addresses that were marked “U” or “unresolved.”

Data sources and notes: MAFDATA ABR preprocessing tables joined to re-create output of the original ABR_SS_GATRES table. (Only stateside, no Puerto Rico data).

Includes addresses that completed QC and were picked up for MAF update. Does not include addresses that had a “U” action or were reviewed but not completed QC.

Table 17 is a breakdown of the approximately 88 percent “addresses updated” category in Table 16. Overall, of the addresses sent to MAF update with a change (nonverify action), 56 percent were actions that affected coverage and 44 percent were actions that did not affect coverage. In most of the 44 percent, the Frame Maintenance reviewer added an MSP or edited the MSP or housing unit type without changing the geocoding. While this type of action did not affect coverage, it improved the address frame and it helped frame and listing operations. For example, IOAC components like IR could better assess coverage when each housing unit had an MSP and that MSP was correctly located with the structure. Listers could also see the MSPs on their listing device when locating housing units during fieldwork. Of the 56 percent of actions that did affect coverage, most were a geocoding correction. These actions may have been made.
in conjunction with TIGER fixes, such as reshaping a road to correct coverage, in addition to moving MSPs or adding a missing address.

### Table 17: Frame Maintenance Addresses Sent to MAF Update by Action*

<table>
<thead>
<tr>
<th>Action</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total number of Addresses: 209,000</strong></td>
<td></td>
</tr>
<tr>
<td>Total for actions that affected coverage</td>
<td>56.0%</td>
</tr>
<tr>
<td>Total for actions that did not affect coverage</td>
<td>44.0%</td>
</tr>
<tr>
<td><strong>Actions that affected coverage</strong></td>
<td></td>
</tr>
<tr>
<td>M, K, or C with block move (geocoding change)</td>
<td>27.4%</td>
</tr>
<tr>
<td>D – Delete</td>
<td>11.8%</td>
</tr>
<tr>
<td>A – Add</td>
<td>4.4%</td>
</tr>
<tr>
<td>N – Nonresidential</td>
<td>0.8%</td>
</tr>
<tr>
<td>L – Duplicate</td>
<td>11.7%</td>
</tr>
<tr>
<td><strong>Actions that did not affect coverage</strong></td>
<td></td>
</tr>
<tr>
<td>H – GQ to HU Conversion</td>
<td>0.0%</td>
</tr>
<tr>
<td>K – Added MSP or moved MSP within the block, added/changed HUTYP and no change to the block</td>
<td>37.5%</td>
</tr>
<tr>
<td>K – Added HUTYP and no change to the block</td>
<td>4.0%</td>
</tr>
<tr>
<td>C – Address change without changing the block</td>
<td>2.4%</td>
</tr>
<tr>
<td>G – HU to GQ Conversion</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

*This table does not represent the full workload of Frame Maintenance since feature work was not sent to MAF update but still resolved blocks.

Data sources and notes: MAFDATA ABR preprocessing tables joined to re-create output of the original ABR-SS_GATRES table. (Only stateside, no Puerto Rico data).

Includes addresses that completed QC and were picked up for MAF update. Does not include addresses that had a “U” action or were reviewed but not completed QC.

Table 18 shows Frame Maintenance work by another unit: blocks. Overall, Frame Maintenance resolved or made passive about 80 percent of the blocks it worked through a combination of MAF actions (represented by Tables 16 and 17) and TIGER or MAF/TIGER actions such as feature reshaping. Like ABR, most of the blocks, about 94 percent, were in TEA 1. In TEA 6, Frame Maintenance had a greater portion of unresolved blocks, but the universe of TEA 6 blocks was small.

Frame Maintenance was able to reduce the IFAC workload and overall resolved about 80 percent of the approximately 26,000 blocks it worked. For the approximately 20 percent of blocks Frame Maintenance could not resolve, IOAC had standards that prevented staff from
taking an action on a block unless they had a strong source and were confident. When reviewing a block, if staff were not confident about how they assessed a coverage issue, they left the block unresolved and it remained a candidate for fieldwork. Examples include blocks where there was a lack of good sources or where imagery or street view was obscured.

**Table 18: Frame Maintenance Results by TEA**

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>TEA 1</th>
<th>TEA 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total blocks worked by Frame Maintenance</td>
<td>26,000</td>
<td>93.7%</td>
<td>6.3%</td>
</tr>
<tr>
<td>Resolved - Passive</td>
<td>79.7%</td>
<td>81.4%</td>
<td>55.7%</td>
</tr>
<tr>
<td>Unresolved - Active</td>
<td>20.3%</td>
<td>18.6%</td>
<td>44.3%</td>
</tr>
</tbody>
</table>

Data source: Table compiled with all GEOIDs tracked by Frame Maintenance. Joined to the MAF/TIGER database BCU table.

Table 19 shows blocks worked by Frame Maintenance broken out by work period between benchmarking processes. Frame Maintenance initially tracked how their staff resolved a block, such as a correction to TIGER, but later simplified the tracking to report the final outcome of the block only. Accordingly, Table 19 reports the “resolved” data broken out for the first two periods and combined for the second two. Some blocks that were referred to Frame Maintenance were resolved before being reviewed because of other processes, such as the DSF update. These blocks were classified by staff as “passive” in first two periods of Frame Maintenance and “resolved” in the second two.

Because Table 18 shows the full Frame Maintenance workload and the resolved to unresolved ratio, the most significant part of Table 19 is the breakdown of how blocks were resolved. About 17 percent in the first work period and 10 percent in the second were already resolved by another process (such as the DSF update) by the time Frame Maintenance staff worked them. IOAC staff learned from conducting IOAC for the first time and recommended future similar work have a way to manage multiple processes to prevent blocks from going to review that were already resolved. The small percentage of blocks resolved by other processes is evidence of the robust, multilayered design of IOAC.

The percentage of blocks resolved by TIGER work alone and MAF/TIGER work is important to consider because these actions were unique to Frame Maintenance and previously, ABR. While the percentages differ between the two work periods, it may have been because of how Frame Maintenance staff completed the work because some coverage issues, such as those involving
geocoding and feature issues, could be resolved in multiple ways. When considering these two categories together, the percentage of blocks resolved is more similar between work periods.

<table>
<thead>
<tr>
<th>Table 19: Frame Maintenance Results by Work Period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Total*</td>
</tr>
<tr>
<td>23,500</td>
</tr>
<tr>
<td>Resolved</td>
</tr>
<tr>
<td>TIGER</td>
</tr>
<tr>
<td>MAF</td>
</tr>
<tr>
<td>MAF/TIGER</td>
</tr>
<tr>
<td>Passive</td>
</tr>
<tr>
<td>Unresolved</td>
</tr>
<tr>
<td>Unworked because of benchmarking</td>
</tr>
</tbody>
</table>

Source: Frame Maintenance used separate excel files to track block assignments and progress. Weekly reports were created for each list. Two excel files compile all final reports for work done by SDUB and its contractors.

The total may include a small amount of duplicate blocks because a few of the reporting periods overlap. The results by work period table does not include all of the blocks identified in Table 18 because of the fact that staff worked additional blocks after these periods but before the IFAC universe was finalized.

Staff resolved about 44 percent of blocks in the first work period and about 32 percent in the second by either using TIGER or MAF/TIGER fixes. This is important because IOAC staff could update TIGER or MAF/TIGER, while the scope of IFAC limited listers to flagging underlying geography issues. Had Frame Maintenance or ABR not resolved these blocks, the blocks would likely have needed additional processing after IFAC when time and resources to update the frame were limited. Conducting ABR and Frame Maintenance enabled IOAC to not only resolve cases without sending them to the IFAC, but also to support necessary changes to the MAF/TIGER System before establishing the enumeration universe for the 2020 Census.

5.4 What are the Outcomes of Ungeocoded Resolution (UR)?

The outcomes of Ungeocoded Resolution (UR) are divided into UR Background and UR Outcomes and Analysis.

5.4.1 UR Background

The UR component of In-Office Address Canvassing (IOAC) was designed to assign a block location, known as a geocode, to residential addresses lacking a geocode in the Master Address File (MAF). UR accomplished this by adding or editing spatial features and address ranges in the MAF/Topologically Integrated Geographic Encoding and Referencing (TIGER) System based on information from local source data. UR started in April 2017 and finished in February 2020.
The United States Postal Service (USPS) provides mailable addresses, to which they can deliver, to the Census Bureau on a regular basis in the Delivery Sequence File (DSF). These addresses include Zone Improvement Plan (ZIP) codes as well as state and county codes that are meaningful for USPS operations. After receipt, the Census Bureau attempts to geocode these addresses to a census tract and census block to provide a more precise location for data collection in the decennial census and other operations like the American Community Survey (ACS). Geocoding is first attempted using an automated process that uses address data within the MAF/TIGER System to determine the appropriate tract and block geocodes by either matching the new address to a geocoded address in the MAF/TIGER System or by matching it to an address range in TIGER. These automated processes were not always able to assign census block codes to all addresses. Some reasons for this include:

- The street feature was not in TIGER or the name was incorrect.
- The street feature was missing all or part of the address range in TIGER or the range was incorrect.
- All or part of the street feature information (e.g., street name spelling, ZIP code) in TIGER was inconsistent with how the address was represented on the MAF.
- The address was in MAF/TIGER but the difference between the MAF/TIGER address and the DSF address did not allow the automated process to match it.

When automated geocoding processes are unable to assign a geocode, these addresses remain ungeocoded and not eligible for inclusion in the 2020 Census. The UR operation enabled staff to manually review these ungeocoded addresses to identify their location so that they could be included in the address frame for the 2020 Census.

**UR Production**

MAF/TIGER created work units (WU) for each five-digit ZIP code within a state and county. The work units were divided into ZIP+4 clusters for assignment to UR reviewers. The UR review was primarily completed by grade 4 cartographic technicians from the National Processing Center (NPC). These staff reviewed the work unit in MAF/TIGER Address Geocoding (MTAG) Application. UR reviewers conducted research using data sources in Matching and Coding System (MaCS) and Geographic Information Systems (GIS) viewers to determine the geographic location of each address in their work unit. GIS viewers are typically maintained by state or county governments and can show location information for an address. UR reviewers used MTAG to record any resolutions by making one of the following TIGER updates using Geographic Acquis-based Topological Real-time Editing System (GATRES):

- Adding a new road feature and address range.
• Adding or editing an address range on an existing road feature.
• Correcting or adding a name on a road feature.
• Changing the feature name or ZIP code.

**UR Quality Control**

To ensure accuracy in UR, QC staff reviewed every Production WU completed. QC staff had equal or more advanced skills than the UR reviewer. For each WU, QC staff reviewed the initial UR reviewer actions and source data to identify any incorrect actions. If QC staff discovered any issues, they provided feedback to the UR reviewer. When a WU in QC did not meet the minimum threshold to pass QC, QC staff returned the WU to the UR reviewer to be reworked. If a WU passed QC review but had errors, QC staff corrected the errors and communicated with the UR reviewer regarding these issues. QC staff were grade 5.

The QC process for UR had two levels: QA Level I and QA Level II. One hundred percent of all cluster records in a WU were reviewed in QA Level I. All users had to pass QC with a score of 95 percent or higher for five consecutive WUs to move to QA Level II. QA Level II reviewed a sample of 25 percent of the clusters within the WU. UR reviewers remained in QA Level II unless they failed two consecutive WUs, at which point, they would return to QA Level I.

The final step of the UR QC check process was Monitoring, which followed the same process as QC, and like the QC process, had up to two levels of review and staff had to successfully work records in order to qualify. Monitoring staff were GIS tech contractors and geographers from headquarters, so they were a higher grade and had geographic experience. Monitoring worked referrals and QC work from MTAG because Monitoring had skilled staff with a geographic background who could work more complex situations and resolve or geocode records that production or QC UR staff could not. While the UR staffing level varied over time, to give perspective on the numbers in QC and Monitoring, on a randomly selected day, there was about 200 staff working production, 30 working QC, and fewer than 15 working Monitoring.

**5.4.2 UR Outcomes and Analysis**

The number of staff working on UR varied over the course of the component because of priorities for other IOAC components, but UR steadily contributed to the address frame for the 2020 Census. Overall, UR geocoded more than 1.8 million addresses and added or reshaped more than 96,000 miles of roads in the MAF/TIGER Database ahead of the 2020 Census.

The UR universe included ungeocoded residential and complete city-style addresses on the latest DSF from USPS and that receive mail. The process used to create the UR universe did not change over the course of UR, however, the UR universe fluctuated after each delivery of addresses from the USPS (the DSF) was processed into the MAF/TIGER System’s biannual
benchmark. Table 20 displays the number of ungeocoded addresses in the UR universe at the time of each MAF/TIGER benchmark. It is important to understand that Table 20 shows the total remaining ungeocoded records as of each benchmark and that this number fluctuated because as UR staff worked records and decreased the number of ungeocoded records, new records were added in the biannual DSF refresh process.

**Table 20: UR Universe by Benchmark**

<table>
<thead>
<tr>
<th>Number of Ungeocoded Addresses</th>
<th>U R U n i v e r s e b y B e n c h m a r k</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall 2016</td>
</tr>
<tr>
<td>2,610,000</td>
<td>2,801,000</td>
</tr>
</tbody>
</table>

Data source: Oracle BI report for UR. Each universe was calculated after benchmarking.

The spring 2019 and fall 2019 number of ungeocoded addresses had fewer ungeocoded addresses than earlier benchmarks because UR successfully worked through the addresses as more addresses were added. During this time, staffing numbers were higher in preparation for the 2020 Census. In addition, the Local Update of Census Addresses (LUCA) operation occurred during this time and the Census Bureau sent LUCA participants ungeocoded addresses from the Census Bureau address frame for the LUCA participants to geocode, removing these ungeocoded addresses from the UR universe. Additionally, LUCA adds could have matched to DSF records that were added after the LUCA products were created, which then LUCA participants may have returned with geocodes, and would have reduced the number of ungeocoded records. For more information, please see the 2020 LUCA Assessment. While Table 20 displays the starting universe for UR, the next table, Table 21, shows the number of addresses geocoded during UR.

Table 21 provides totals for the entire course of the UR component. UR could not always geocode a record (see Table 23) so the number of records assigned a UR resolution, about 2,855,000, is greater than the number of records geocoded, about 1,870,000 records. Because UR production staff were grade 4, and there were grade restrictions on actions they could take in UR, some of their records were referred. Additionally, production (grade 4) and QC staff (grade 5) referred more complicated records that required geographic knowledge to Monitoring. Production staff referred about 983,000 records and QC staff referred about 501,000 records.

The QC/Monitoring records backlog (about 1 million) are records that completed through the production stage and were geocoded but were awaiting QC or were referred to Monitoring. During UR, there were other operations working on the address frame for the 2020 Census,
which required a massive hiring of staff, and there were not enough qualified QC and Monitoring staff to catch up with the high quantity of UR production work, which resulted in a backlog. Additionally, QC and Monitoring staff were moved to production to meet the Nonresponse Followup (NRFU) supplemental benchmark deadline and get as many ungeocoded records eligible to be included in the census as possible, but this also increased the backlog. UR staff continued working QC and Monitoring after UR formally ended in preparation for the 2020 Census tabulation benchmark and geocoded records were eligible to be included in the 2020 Census. In all, UR geocoded nearly 2 million addresses.\(^\text{12}\)

**Table 21: UR Cumulative Totals**

<table>
<thead>
<tr>
<th>Number of Records</th>
<th>Cumulative Address Records Geocoded in UR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,870,000</td>
</tr>
<tr>
<td>Distinct UR Address Records Assigned a UR Resolution</td>
<td>2,855,000</td>
</tr>
<tr>
<td>Production Address Records Worked in UR</td>
<td>2,849,000</td>
</tr>
<tr>
<td>Production Address Records Referred in UR</td>
<td>983,000</td>
</tr>
<tr>
<td>QC Address Records Worked in UR</td>
<td>1,470,000</td>
</tr>
<tr>
<td>QC Address Records Referred in UR</td>
<td>501,000</td>
</tr>
<tr>
<td>QC/Monitoring Address Records Backlog</td>
<td>1,022,000</td>
</tr>
</tbody>
</table>

Data source: “Distinct UR Address Records Assigned a UR Resolution” was a direct query from MTAG tables. All other data from final UR Daily Report, which was created using Oracle BI Report.

Most of the records worked in UR were in the Self-Response type of enumeration area (TEA 1) because approximately 95 percent of all housing units nationwide were in TEA 1.\(^\text{13}\) UR also contributed to geocoding addresses in UL (TEA 6). The purpose of UR was to geocode records for inclusion in the 2020 Census and while UR certainly made some active blocks passive, UR was focused on improving the address frame overall and not necessarily a specific TEA or only active blocks. Addresses that were geocoded to TEA 1 tended to have better sources than addresses that belonged to other TEAs and therefore were more likely to get geocoded in UR. Additionally, as ungeocoded addresses, these records only had a state and county so IOAC staff did not know which TEA the records would be assigned to once geocoded. Finally, UR records

\(^{12}\) During UR, staff geocoded more than 1.8 million records. However, some of the records in the QC and Monitoring Backlog were also geocoded and those records were still eligible for inclusion in the 2020 Census. Headquarters staff continued working on the backlog and thus the total number of records geocoded is closer to 2 million as shown in Table 22.  

\(^{13}\) The percent of housing units in TEA 1 fluctuated slightly over the years UR was in production but for example, the percent of housing units in TEA 1 was 95.45 percent in September 2019.
came from the USPS DSF and therefore they tended to be in areas that have high DSF coverage, which are areas often classified as TEA 1.

**Table 22: UR Records Worked by TEA***

<table>
<thead>
<tr>
<th>TEA</th>
<th>Percentage of Total UR Records Worked**</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – Self Response</td>
<td>95.9%</td>
</tr>
<tr>
<td>6 – Update Leave</td>
<td>4.0%</td>
</tr>
<tr>
<td>2 – Update Enumerate</td>
<td>&lt;0.1%</td>
</tr>
<tr>
<td>4 – Remote Alaska</td>
<td>&lt;0.1%</td>
</tr>
</tbody>
</table>

* All UR MAFIDs with Vintage 73 BCU values.
**The total count of records by TEA is different from the cumulative totals because the totals for this table only includes UR records that were geocoded. (Ungecoded records do not have a TEA.)

Data source: MTAG and MAF tables (MAFTIGER.featmafunitrel)

UR staff could make updates or corrections to the address frame that IFAC (TEA 1) or UL (TEA 6) listers could not make and therefore UR work benefitted blocks that went to in-person canvassing in IFAC or UL as well as blocks that did not. For example, feature updates were not the focus of IFAC and UL listers’ training and listers could not add or correct a road, they could only flag it, which required headquarters work after the operation when time and resources were limited. UR helped to prepare the address frame ahead of IFAC and UL and helped reduce the need for processing after these operations. Furthermore, when UR reviewers added a street or an address range, this work allowed numerous addresses to then be geocoded, including any addresses that may have come in on a future operation or subsequent USPS DSF.

Table 23 shows the codes assigned to UR records and the percentage of records with each code. Missing features and address ranges were the most common reason for addresses failing to geocode. For this reason, more than 43 percent of records had resolution codes for adding address ranges and/or digitizing features (i.e., rows for “Created Linear Feature” and “Created Linear Feature and Address Range.”) An additional 9.5 percent of records were resolved by correcting information. (Codes “Corrected Address Range,” “Corrected Linear Feature Name and Address Range and/or ZIP Code,” “Corrected Feature Name,” and “Corrected ZIP Code.”) Inaccurate address ranges within MAF/TIGER were also a cause of ungeocoded records and resolved through UR. About 5.5 percent of records were resolved by only correcting the address range and about 2.8 percent additional records were resolved by correcting the address range in combination with other corrections.

UR staff referred about 34.5 percent of records to Geography Division (GEO) staff. Records were referred primarily because staff could not identify any local GIS sources to confirm address information. Without a usable local source, UR staff could not properly work UR
records in that entity. Other referred cases were because of GATRES imagery issues. Finally, both grades 4 and 5 staff referred cases they could not resolve because of grade restrictions or were too complicated and required staff with more geography subject-matter expertise to resolve.

Records loaded into the MAF/TIGER Geocoding Application (MTAG) before a benchmark stayed in queue and were worked after MAF/TIGER was unlocked from benchmarking. Such records could be geocoded by MAF update and geocoding of different operations. In these cases, reviewers were assigned a record that possessed a geocode. The user reviewed the geocode to ensure accuracy and fixed issues where necessary.

**Table 23: Number of Coded Records by UR Resolution Code**

<table>
<thead>
<tr>
<th>Resolution Code</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referred</td>
<td>34.5%</td>
</tr>
<tr>
<td>Created Address Range</td>
<td>30.1%</td>
</tr>
<tr>
<td>Created Linear Feature and Address Range</td>
<td>13.4%</td>
</tr>
<tr>
<td>Corrected Address Range</td>
<td>5.5%</td>
</tr>
<tr>
<td>Record Already Geocoded</td>
<td>4.8%</td>
</tr>
<tr>
<td>Duplicate</td>
<td>4.3%</td>
</tr>
<tr>
<td>Refer, DSF Inconsistent</td>
<td>3.4%</td>
</tr>
<tr>
<td>Corrected Linear Feature Name and Address Range and/or ZIP Code</td>
<td>2.8%</td>
</tr>
<tr>
<td>Corrected Feature Name</td>
<td>0.6%</td>
</tr>
<tr>
<td>Corrected ZIP Code</td>
<td>0.6%</td>
</tr>
</tbody>
</table>

Data source: Oracle BI report run at the end of NPC production.

An ancillary result from the UR component was the benefit it provided to linear features in the MAF/TIGER Database. UR staff commonly added and reshaped several thousand miles of roads per month. UR staff were responsible for adding and reshaping any linear feature in the block of their UR record. The nature of ungeocoded records often led UR staff to find new residential developments. In these locations, UR staff geocoded the new construction and digitized the newly constructed roads in the development. Additionally, by adding roads and address ranges, UR allowed addresses that came in on subsequent DSF files to be geocoded automatically. Finally, reshaping helped ensure that already geocoded MAF units were in the correct block. In total, UR added more than 381,000 linear features and added or reshaped more than 96,000 miles of road in the MAF/TIGER Database.
### Table 24: Roads Added or Reshaped in UR

<table>
<thead>
<tr>
<th></th>
<th>Number of Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Miles of Roads Added in UR</td>
<td>66,850</td>
</tr>
<tr>
<td>Number of Miles of Roads Reshaped in UR</td>
<td>29,691</td>
</tr>
<tr>
<td>Total number of Miles of Roads Worked in UR</td>
<td>96,541</td>
</tr>
</tbody>
</table>

Data source: Oracle BI report run at the end of NPC production.

With the UR component running over the course of several years, IOAC staff gained knowledge about how to conduct successful large-scale trainings. Staff applied this knowledge to later UR trainings as well as other IOAC components, and set good practices for other operations, such as manual (clerical) Non-ID processing. For more information about the innovation implemented across multiple IOAC components please see section 5.9.

### 5.5 What are the Outcomes of In-Office Address Canvassing (IOAC) Group Quarters/Transitory Locations (GQ/TL)?

The outcomes of In-Office Address Canvassing (IOAC) Group Quarters/Transitory Locations (GQ/TL) are divided into IOAC GQ/TL Background and IOAC GQ/TL Outcomes and Analysis.

#### 5.5.1 IOAC GQ/TL Background

For the 2010 Census, the Census Bureau conducted the Group Quarters Validation (GQV) operation after the Address Canvassing operation and before enumeration to improve the GQ frame. Field staff visited specific addresses to determine the status, such as GQ or TL, conduct an in-person interview with the GQ contact person to determine the type of GQ, and collect additional information to plan for enumeration. For more information, please see the GQV background section 2.3. However, in support of a more efficient census design strategy, the 2020 Census did not conduct a separate operation to validate GQ information. Instead, because the GQV operation performed a full canvass in 2010, the 2020 Census planned to use the existing information in the Master Address File (MAF) and validate GQ and TL information in

---

14 The Internet Self-Response (ISR) operation collected respondent information through an online questionnaire. When an internet respondent did not provide a Census ID, the case was known as “Non-ID” case and some of these cases went to manual processing to identify the correct block for the respondent’s address or match the record to an existing MAF/TIGER record.

15 GQs are defined as a place where people live or stay in a group living arrangement owned or managed by an entity or organization providing housing and/or services for the residents. GQs include such places as college residence halls, residential treatment centers, skilled nursing facilities, group homes, correctional facilities, and workers’ dormitories, among many others.

16 TLs are defined as sites that contain movable or mobile housing that may include transitory units such as boats, motorized recreational vehicles or trailers (RVs), tents, or other types of portable housing. TLs also include hotels or motels if being occupied on a transitory basis because the occupants have no other residence.
areas of change by contacting GQs and TLs found in Active Block Resolution (ABR) during the Address Canvassing operation.

IOAC GQ/TL was a component of IOAC in which reviewers conducted research and phone interviews to verify, update, and validate post-2010 added GQs/TLs, and later, 2010 GQs and TLs. Some IOAC components (i.e., Interactive Review) determined where fieldwork was needed and others (i.e., Ungeocoded Resolution) improved the address frame. The role of IOAC GQ/TL was to improve the address frame for the 2020 Census and entities worked in IOAC GQ/TL still moved on to another 2020 Census operation. IOAC GQ/TL staff completed research using administrative data, local Geographic Information System (GIS) data, public and commercial information, and made phone calls to administrative contacts. Work began in July 2017 but stopped in March 2018 because of reprioritization of the IOAC components because of funding concerns.

The IOAC GQ/TL component had several changes from its original design. Originally, the scope of IOAC GQ/TL was to contact any GQs or TLs added during ABR. ABR staff would add new or suspected GQs or TLs when they canvassed active blocks. GQs and TLs in blocks marked passive by Interactive Review (IR) did not require address updates and the GQ/TL operation would use the address list already in the MAF. However, when ABR was discontinued in early 2017, the scope of IOAC GQ/TL was changed to include contacting all GQs and TLs in the MAF by phone. The goals were to validate new GQs and TLs found in ABR, confirm that the current MAF GQs/TLs are still used as GQs/TLs, and obtain sufficient contact information for as many GQs and TLs as possible.

**IOAC GQ/TL Production**

The IOAC GQ/TL component researched GQ/TL records that were in the MAF from previous censuses or surveys and validated and/or updated their information. This review used a combination of individual research, a call script to better ensure quality and consistency, and the Matching and Coding Software (MaCS).

The IOAC GQ/TL records were grouped by county into work units that usually contained up to 35 different addresses each to be verified. These work units were organized by facility to conduct the phone interviews in the most efficient way possible. Research using local GIS, as well as public and commercial information, allowed the production reviewers to ascertain as much information as possible about the GQ/TL. Once adequate contact information was obtained through internet research, production reviewers contacted a knowledgeable source for each address and asked a series of questions outlined by the GQ Call Script to validate unconfirmed records and unknown structures as GQs, HUs, TLs, or nonresidential. In addition to classifying each address, they were also geocoded if possible.
If the structure type was determined to be a GQ, the production reviewer collected the GQ type (e.g., college dorm, group home, or shelter); GQ name; GQ address; facility name; primary contact name of the GQ; contact telephone number; and maximum number of people who could live or stay in the GQ. If the structure type was determined to be a TL, the only additional information collected was the date that the TL opened.

The information for each record was updated as necessary, including address and non-address data based on the internet research and phone interview responses. After this process was completed, every address record was assigned a resolution code. IOAC GQ/TL production reviewers were grade 5 staff.

**IOAC QC/TL Quality Control Process**

After Production was complete, the records went to the Quality Control (QC) process, where QC bundles were created for each QC reviewer. The QC bundles consisted of either 50 records or 25 records depending on the complexity of the cases. All records in a QC bundle were from the same production reviewer, and GQ and TL records were placed into separate QC bundles.

The QC reviewers checked the GQ/TL records for accuracy and verified the correct resolution was selected in MaCS. QC was conducted by using the phone when this option was available, or through alternative methods such as internet-based data, maps, and websites. The QC reviewer marked the record as “Pass,” when all the fields were verified. If not all the fields on the record were verified, the QC reviewer made changes or updates to correct the information and marked the record “Pass” or “Fail,” depending on the reason for corrections. The information provided in the record by the QC reviewer superseded the information captured by the production reviewer.

QC bundles were initially checked in its entirety (100 percent of the records in the bundle). If the QC review of the bundle resulted in 95 percent or better accuracy, a smaller sample of 20 percent was used for QC of the next bundle. This sample size continued for each QC bundle, unless the accuracy fell below of 95 percent, in which case the sample size increased to 100 percent again.

**5.5.2 IOAC GQ/TL Outcomes and Analysis**

When ABR was discontinued in early 2017, the scope of IOAC GQ/TL was changed to include calling all GQs and TLs in the MAF that met address standards for the component. This change increased the workload of IOAC GQ/TL to about 212,000 addresses and changed the work of the component from using ABR research to calling GQs and TLs using a phone script. The goal of the component was still to validate and update contact information for GQs and TLs ahead of the 2020 Census.
Staff who called GQs and TLs to conduct a phone interview faced unexpected barriers to successfully gathering information. With many people being aware of questionable soliciting phone calls to their personal cellphones and work phones, these phone interviews faced unforeseen scrutiny from respondents. Many respondents were suspicious of the phone call because the caller identification did not say “US Census Bureau.” Along with the caller identification, the timing—calling about the decennial census in 2017—added to their suspicion. Finally, interviewees often hung up before the IOAC GQ/TL caller finished reading the scripted introduction. It is possible the phone call was mistaken for telemarketing, but the reasons for hang-ups could be manifold. Overall, IOAC GQ/TL calls to GQs and TLs were met with unexpected reluctance. For more information, please see the lessons learned and recommendations sections.

Census Bureau staff also encountered issues even when able to make contact with a GQ or TL. Some GQ or TL staff had recently been visited by the American Community Survey (ACS) and were hesitant to do a similar interview for the decennial census. Larger GQs were reluctant to provide their information over the phone because of the time it would take, and some indicated that they preferred to provide information to regional office staff already dedicated to contacting and updating information for these large institutions. Other GQ or TL staff requested the Census Bureau call back at different hours, some of which were outside of work hours for the Census Bureau calling staff. Some GQ or TL staff requested the interview to be in another language, such as Spanish or Korean. On some calls, the contacts said they could not provide information out of concern for violating health information and confidentiality laws. Finally, the complexity of GQ and TL characteristics and variety of GQ and TL types presented challenges to the staff making the calls in the operation because of the significant level of expertise and knowledge required.

The data presented here are as of the time the IOAC GQ/TL component was paused and include the expanded universe, which included all GQs and TLs after ABR was canceled and the scope of IOAC GQ/TL changed. Table 25 shows phone call flag statuses for the calls made. It is important to note that the status is the final outcome for each case, not each call, and is potentially the result of up to three calls. Callers who initially faced reluctant responders were often able to persuade them to answer or called again and were eventually successful. It is also important to note that the “updated information” statuses did not always mean that callers were able to collect all of the information needed. In some cases, callers obtained partial information. For more information on the outcomes of the IOAC GQ/TL workload, see Table 26 below.
Table 25: In-Office Address Canvassing Group Quarters/Transitory Locations (IOAC GQ/TL)
Final Phone Call Result by Flag Status

Total Number of Call Statuses: 23,500

<table>
<thead>
<tr>
<th>Final Phone Call Result Flag Status</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Updated Information Including Address</td>
<td>22.6%</td>
</tr>
<tr>
<td>Updated Non-Address Information</td>
<td>52.2%</td>
</tr>
<tr>
<td>No Additional Information</td>
<td>8.4%</td>
</tr>
<tr>
<td>Hang-Up/Hostile/Refusal</td>
<td>1.6%</td>
</tr>
<tr>
<td>Bad Connection</td>
<td>0.1%</td>
</tr>
<tr>
<td>No Answer</td>
<td>2.3%</td>
</tr>
<tr>
<td>Invalid Phone Number</td>
<td>3.6%</td>
</tr>
<tr>
<td>Busy Signal</td>
<td>0.3%</td>
</tr>
<tr>
<td>Answering Machine</td>
<td>9.1%</td>
</tr>
</tbody>
</table>

Data source: Prodtran (MACS_GQTL Schema)

Table 26 shows the outcomes of the data obtained in the IOAC GQ/TL component. About 12 percent of GQs and TLs completed review but were awaiting QC review. A little more than 4 percent of GQs and TLs completed QC, however, after some detailed research comparing initial results of IOAC GQ/TL to existing GQ/TL in the MAF, IOAC staff determined that many of these addresses would have duplicated GQs and TLs already in the MAF. About 3 percent of GQs and TLs were on referral. Had IOAC GQ/TL continued, these 3 percent would have gone to a cartographic technician or a geographer for a more in-depth review. If the cartographic technician or geographer was not able to resolve the referred GQs or TLs, they could be flagged for fieldwork. Finally, about 8 percent of GQs and TLs were on hold at the time the IOAC GQ/TL component was paused. IOAC GQ/TL staff put GQs and TLs on hold if they needed to call the contact back at a later time.
### Table 26: In-Office Address Canvassing Group Quarters/Transitory Locations (IOAC GQ/TL) Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Total IOAC GQ/TL Universe: 212,000</th>
<th>Percent of Total Universe</th>
<th>Percent of Total Completed Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Completed Review</td>
<td>12.1%</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Total Referred</td>
<td>3.1%</td>
<td>25.8%</td>
<td></td>
</tr>
<tr>
<td>Total On-Hold</td>
<td>8.0%</td>
<td>66.0%</td>
<td></td>
</tr>
<tr>
<td>Total Completed Quality Control</td>
<td>4.4%</td>
<td>35.9%</td>
<td></td>
</tr>
</tbody>
</table>

Data source: Final (March 5, 2018) IOAC GQ/TL Daily Production Report

The data that resulted from IOAC GQ/TL were unanticipated. After encountering reluctant responders, IOAC GQ/TL staff gathered what information they could but did not always obtain complete information.

While the majority of calls resulted in obtaining some address or non-address information, only about 4 percent of the total GQ/TL universe completed QC. (See tables 25 and 26.) IOAC staff conducted a detailed review on the records that completed QC and found that many of the addresses were duplicates of records already in the MAF. GQs and TLs can be large and the work unit limit in MaCS was 50, which worked for the other program uses of MaCS, but did not allow IOAC GQ/TL staff to see all of the GQs for larger facilities at once. As a result, staff sometimes may not have been able to see the full list of GQs in MaCS, which may have been a factor in staff adding duplicates.

Given the many duplicate addresses and only about 4 percent of the total universe complete through QC, the Census Bureau weighed updating the MAF against other priorities and decided not to update the MAF. The decision to not update the MAF with the limited number of completed addresses was based on multiple factors. First, the Census Bureau believed there was a high number of duplicate addresses in the addresses added in IOAC GQ/TL and updating the MAF would have introduced duplicates into the address frame. Second, the update would have only included a small percentage (about 4 percent) of the total universe therefore this update would not have been an efficient use of priority resources for such a small percentage, especially given that these addresses would also be visited again as part of the Census GQ Enumeration operations. Third, the LUCA operation, which occurred after the IOAC GQ/TL component, would collect GQs and TLs. Finally, the GQ Advance Contact operation, which occurred in February 2020, would contact every GQ to verify or update their information before the 2020 Census.
5.6 What are the Outcomes of Local Update of Census Addresses (LUCA) Address Validation (LAV)?

The outcomes for Local Update of Census Addresses (LUCA) Address Validation (LAV) are divided into LAV Background and LAV Outcomes and Analysis.

5.6.1 LAV Background

The LUCA operation provides, by law, the opportunity for tribal, state, and local governments to review and comment on the Census Bureau’s address list to ensure an accurate and complete enumeration of their communities. For more information about the LUCA program, please refer the LUCA Detailed Operational Plan (DOP) (US Census Bureau, 2018), the LUCA Operational Assessment Study Plan (Hanks, 2019), and the 2020 LUCA Operational Assessment (Huntley-Hall, 2022).

The LAV component of In-Office Address Canvassing (IOAC) consisted of an in-office review of LUCA addresses submitted by the participating entities that were not validated through the automated match to the Master Address File (MAF) and other designated records.

The LAV universe was comprised of the following LUCA address records:

- Participant “Adds”\(^\text{17}\) that did not match to an existing Geographic Support System (GSS) or Master Address File/Topologically Integrated Geographic Encoding and Referencing (MAF/TIGER) record.
- Participant “Adds” that matched to MAF/TIGER, but the local participant located the record in a different block.
- Participant “Changes”\(^\text{18}\) where the local participant moved an address into a different block than the existing address record in MAF/TIGER.
- Participant Records that matched to a nonresidential address in the MAF.

LAV did not adjust any participant address components. The process only determined if an address record existed or if the MAF version was more spatially accurate. LAV reviewers also determined whether the address record belonged in a block other than what the LUCA participant or MAF had indicated.

\(^{17}\) “Adds” are records that LUCA participants submitted with an “add” action and represent new addresses the participant believes the Census Bureau does not have in the address frame.

\(^{18}\) “Change” records are ones where a LUCA participant edited an existing address record from the Census Bureau address frame.
Managing the LAV Workload

LAV prioritized work assignments based on the date the submission was received. As LUCA submissions were processed, the Matching and Coding Software (MaCS) system automatically assigned records into work units of 50 records, grouped by entity, to LAV reviewers. The system also allowed administrators to manually assign work to LAV reviewers and quality control (QC) staff, if desired. Once all records were completed through the QC process within LAV, they were sent back to the main LUCA operation to complete the rest of the LUCA process. Because of higher numbers of LUCA submissions, LAV used entity level sampling. (See section B below for more information.)

LAV production reviewers were grade 4 staff. QC staff were either grade 5 or were contractors with some amount of geographic knowledge or experience.

LAV Production

LAV reviewers used the LAV Production module within MaCS to validate the existence of address records. They used the address components, geocode, and matched MAF information, if it existed, of the LUCA participant address record to determine if the record was spatially accurate or if it already existed in the MAF. LAV reviewers made the determination whether to accept or reject the LUCA participant address record. They had the ability to accept the record and the block geocode assigned by the participant, accept it but assign it to a different block, or manually match it to a record already in the MAF.

If LAV reviewers determined that the record was nonresidential, uninhabitable, outside of the participants’ jurisdiction, located in an undevelopable location, or did not exist, they rejected the record. The LAV reviewer had to have absolute and concrete evidence from a reliable source to reject an address record. If there was any ambiguity as to the existence of a record, the LAV reviewer accepted it.

LAV Quality Control

The LAV QC process focused on reviewing the accuracy of individual records worked by LAV reviewers during production. The QC staff determined whether the action taken by the LAV reviewer was or was not a proper assessment of the LUCA participant’s submission. If the QC staff member determined that the LAV reviewer assigned an incorrect action code, the QC staff member was responsible for correcting the action.

Once the LAV production reviewer completed a work unit of 50 records, a QC bundle was created in the MaCS LAV QC module. The QC staff then examined the work completed by the LAV production reviewer on a record-by-record basis to determine the accuracy of the work. Initially, a LAV production reviewer’s work was sampled for QC at a 100 percent sample rate.
During evaluation, the QC reviewer used the same reference data sources that the LAV production reviewer used to ensure that the records were accurately completed. If the initial QC work unit reached a 90 percent accuracy rate (at least 45 of the 50 records were deemed accurate by the QC reviewer) then the next QC work unit for the reviewer was sampled at a 20 percent sample rate.

Every subsequent QC bundle was sampled at the 20 percent sample rate unless the LAV reviewer fell below a 90 percent accuracy rate (failed one record out of ten) for a QC bundle. If a LAV reviewer fell beneath the 90 percent accuracy level, then the next sampled work unit occurred at the 100 percent rate. The sample remained at the 100 percent rate until the LAV reviewer met the 90 percent accuracy threshold.

QC staff checked each record within the sampled bundle for accuracy based on the information submitted by the LAV reviewers. The QC staff examined the action code, notes, and any associated information to make a determination on whether or not the record was assigned the proper action code and Geographic Identifier (GEOID), MAF Identifier (MAFID), and XY Coordinates (if applicable). Once the record passed or the QC staff resolved the record with a different resolution code, the bundle was marked as complete.

5.6.2 LAV Outcomes and Analysis

This assessment presents data only for LAV. The 2020 Census LUCA Operational Assessment will have additional details about LUCA data, information on which records were sent to LAV, what happened to records after LAV, and final results including enumeration results. For more information, please refer to the 2020 LUCA Operational Assessment (Huntley-Hall, 2022).

Because the number of LUCA submissions was four times higher than expected\[^19\], LAV implemented entity level sampling so that the review could be completed for all LUCA participants on the schedule required for development of the 2020 Enumeration Universe. In files where 200 or more records were eligible for LAV, 20 percent of the entity’s records were randomly selected and loaded in MaCS for review in LAV. Based on the LAV review of the 20 percent of the entity’s records, if an entity passed the 80 percent threshold for acceptable actions, the remaining records were provisionally accepted. If the entity failed the 80 percent threshold, all remaining records were rejected. If an entity had less than 200 records, all records were reviewed in LAV. For more details on LAV sampling, please see Appendix F. The 2020 LUCA Operational Assessment (Huntley-Hall, 2022) will address the effects of LAV sampling outside of IOAC.

\[^19\] The Census Bureau estimated LUCA participants would send about 5 million addresses. In 2020, LUCA participants submitted a total of more than 22 million addresses.
There are two minor data limitations. First, the LUCA Master Table (LMT) was a dynamic table used to store submitted data from LUCA participants and some of the IOAC values were removed after the MaCS data was posted to the LMT. Therefore, there were some addresses that were not able to be accounted for in this analysis. Less than 1 percent of addresses were affected by this issue. Second, in order for staff to compile the data across multiple vintages and types of geography, they used a query that picks a single type of enumeration area (TEA) value for each census block. In actuality, some of the blocks worked in LAV have multiple TEA values since they were split by multiple basic collection units (BCUs). As a result of these two minor data limitations, the total number of records by TEA is slightly (less than 1 percent) different from the total in Table 27.

In total, about 300 staff at NPC and headquarters reviewed about 861,000 addresses sent to LAV by the LUCA operation. Table 27 provides a snapshot of what was gathered during the LAV project. While some rejected addresses were rejected for being nonresidential or outside of the participants’ jurisdiction, most were rejected because there was evidence that the address did not exist or could not exist in the location the participant provided. Overall, about 61 percent of reviewed addresses were accepted (LUCA add or change record accepted) and about 39 percent were rejected (LUCA Add or Change record rejected). Because LAV was a step in the LUCA operation, some of the end results on the MAF may vary based on how the MAF update process handled these cases. In other words, results from other preceding and subsequent processes could have affected the outcome of whether a LUCA participant’s action code was accepted or rejected during the MAF update process. For more information, please see the 2020 LUCA Operational Assessment (Hanks et al., 2022).

\footnote{Again, LAV reviewers had to have absolute and concrete evidence from a reliable source to reject an address record. If there was any ambiguity as to the existence of a record, the LAV reviewer accepted it.}
Table 27: LAV Action Code Totals

<table>
<thead>
<tr>
<th>Description</th>
<th>Code</th>
<th>Accept/ Reject</th>
<th>Percent of Accepted or Rejected</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Number of LAV Records: 861,000</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address Validated</td>
<td>A</td>
<td>Accept</td>
<td>59.8%</td>
<td>36.6%</td>
</tr>
<tr>
<td>Manual Match</td>
<td>L</td>
<td>Accept</td>
<td>6.7%</td>
<td>4.1%</td>
</tr>
<tr>
<td>Move</td>
<td>M</td>
<td>Accept</td>
<td>6.7%</td>
<td>4.1%</td>
</tr>
<tr>
<td>Provisional Add</td>
<td>P</td>
<td>Accept</td>
<td>26.9%</td>
<td>16.5%</td>
</tr>
<tr>
<td><strong>Total Accepted</strong></td>
<td></td>
<td></td>
<td></td>
<td>61.3%</td>
</tr>
<tr>
<td>Address Rejected</td>
<td>R</td>
<td>Reject</td>
<td>76.8%</td>
<td>29.7%</td>
</tr>
<tr>
<td>Nonresidential</td>
<td>N</td>
<td>Reject</td>
<td>23.1%</td>
<td>8.9%</td>
</tr>
<tr>
<td>Outside of Jurisdiction</td>
<td>O</td>
<td>Reject</td>
<td>0.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Uninhabitable</td>
<td>U</td>
<td>Reject</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td><strong>Total Rejected</strong></td>
<td></td>
<td></td>
<td></td>
<td>38.7%</td>
</tr>
</tbody>
</table>

Data sources: MaCS LUCA Address and LUCA Master Tables

Tables 28 – 30 show LAV records by TEA and outcomes. In the breakdown by TEA, the Self Response TEA had the largest number of LAV records with 96.3 percent of all LAV records. In total, 36.2 percent of the approximately 827,000 TEA 1 records were validated and added to the enumeration universe. An additional 137,000 records were provisionally added. LAV staff used the provisional add action code when they were unable to determine the existence of a housing unit on the ground and it was plausible for it to exist. In other words, LAV staff had evidence through local GIS sources, or there was ground clearing evident in imagery giving LAV reviewers the indication it could exist as a living quarter by Census Day. Please see the LUCA Operational Assessment (Huntley-Hall, 2022) for enumeration results of LUCA addresses.

Table 28: Number of LAV Records Reviewed by TEA

<table>
<thead>
<tr>
<th>TEA 1 – Self Response</th>
<th>Total Records by TEA*</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>96.3%</td>
<td></td>
</tr>
<tr>
<td>TEA 2 – Update Enumerate</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>TEA 4 – Remote Alaska</td>
<td>0.0%</td>
<td></td>
</tr>
<tr>
<td>TEA 6 – Update Alaska</td>
<td>3.7%</td>
<td></td>
</tr>
<tr>
<td><strong>Total for all TEAs</strong></td>
<td><strong>860,000</strong>¹</td>
<td></td>
</tr>
</tbody>
</table>

* The records by TEA are slightly different from the LAV total because of changes that occurred in the LMT.

Data sources: TEA values were derived from the MAF/TIGER BCU and TABBLOCK tables. LAV GEOIDs and results were derived from the MaCS LUCA Address and LUCA Master Tables.
Table 29: Number of LAV Records Reviewed in TEA 1 – Self Response

<table>
<thead>
<tr>
<th>Description</th>
<th>Code</th>
<th>Accept/ Reject</th>
<th>Percent of Accepted or Rejected</th>
<th>Percent of TEA 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total TEA 1 LAV Records: 827,000</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address Validated</td>
<td>A</td>
<td>Accept</td>
<td>59.4%</td>
<td>36.2%</td>
</tr>
<tr>
<td>Manual Match</td>
<td>L</td>
<td>Accept</td>
<td>6.7%</td>
<td>4.1%</td>
</tr>
<tr>
<td>Move</td>
<td>M</td>
<td>Accept</td>
<td>6.6%</td>
<td>4.0%</td>
</tr>
<tr>
<td>Provisional Add</td>
<td>P</td>
<td>Accept</td>
<td>27.2%</td>
<td>16.6%</td>
</tr>
<tr>
<td><strong>Total TEA 1 Accepted</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>61.0%</strong></td>
</tr>
<tr>
<td>Address Rejected</td>
<td>R</td>
<td>Reject</td>
<td>76.7%</td>
<td>30.0%</td>
</tr>
<tr>
<td>Nonresidential</td>
<td>N</td>
<td>Reject</td>
<td>23.2%</td>
<td>9.0%</td>
</tr>
<tr>
<td>Outside of Jurisdiction</td>
<td>O</td>
<td>Reject</td>
<td>0.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Uninhabitable</td>
<td>U</td>
<td>Reject</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td><strong>Total TEA 1 Rejected</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>39.0%</strong></td>
</tr>
</tbody>
</table>

Data sources: TEA values were derived from the MAF/TIGER BCU and TABBLOCK tables. LAV GEOIDs and results were derived from the MaCS LUCA Address and LUCA Master Tables.

The Update Leave TEA had the second largest number of LAV records with 3.7 percent of the total. In total, LAV staff worked about 32,000 records in this TEA, of which 73.4 percent were accepted. The remaining 26.6 percent were rejected. LAV contributed to the enumeration universe in Update Leave by validating 48.6 percent records in TEA 6 and provisionally adding 14.9 percent. The effect on the Update Leave operation may be similar to the one mentioned in the TEA 1 breakdown. BCUs in the Update Enumerate and Remote Alaska TEAs were affected less by the LAV operation because, in total, only about 30 addresses were sent to LAV in these TEAs.
Table 30: Number of LAV Records Reviewed in TEA 6 – Update Leave

<table>
<thead>
<tr>
<th>Description</th>
<th>Code</th>
<th>Accept/ Reject</th>
<th>Percent of Accepted or Rejected</th>
<th>Percent of TEA 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total TEA 6 LAV Records:</td>
<td></td>
<td></td>
<td></td>
<td>32,000</td>
</tr>
<tr>
<td>Address Validated</td>
<td>A</td>
<td>Accept</td>
<td>66.2%</td>
<td>48.6%</td>
</tr>
<tr>
<td>Manual Match</td>
<td>L</td>
<td>Accept</td>
<td>4.8%</td>
<td>3.5%</td>
</tr>
<tr>
<td>Move</td>
<td>M</td>
<td>Accept</td>
<td>8.8%</td>
<td>6.4%</td>
</tr>
<tr>
<td>Provisional Add</td>
<td>P</td>
<td>Accept</td>
<td>20.3%</td>
<td>14.9%</td>
</tr>
<tr>
<td>Total TEA 6 Accepted</td>
<td></td>
<td></td>
<td></td>
<td>73.4%</td>
</tr>
<tr>
<td>Address Rejected</td>
<td>R</td>
<td>Reject</td>
<td>80.2%</td>
<td>21.3%</td>
</tr>
<tr>
<td>Nonresidential</td>
<td>N</td>
<td>Reject</td>
<td>19.7%</td>
<td>5.2%</td>
</tr>
<tr>
<td>Outside of Jurisdiction</td>
<td>O</td>
<td>Reject</td>
<td>0.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Uninhabitable</td>
<td>U</td>
<td>Reject</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Total TEA 6 Rejected</td>
<td></td>
<td></td>
<td></td>
<td>26.6%</td>
</tr>
</tbody>
</table>

Data sources: TEA values were derived from the MAF/TIGER BCU and TABBLOCK tables. LAV GEOIDs and results were derived from the MaCS LUCA Address and LUCA Master Tables.

5.7 What is the Universe Identified for the In-Field Address Canvassing (IFAC) Operation?

The information about the universe Identified for the In-Field Address Canvassing (IFAC) Operation is divided into a summary and detailed information.

5.7.1. Summary of the Universe Identified for Fieldwork

One of the ultimate duties of the In-Office Address Canvassing (IOAC) operation was to identify geographic areas that required In-Field Address Canvassing (IFAC) before the 2020 Census enumeration. As the five IOAC components concluded and the Census Bureau prepared to conduct the 2020 Census, IOAC provided input into the identification of the IFAC Universe. IOAC worked current tabulation blocks nationwide without consideration of TEA, but IFAC was designed for only the Self-Response type of enumeration area (TEA) basic collection units (BCUs). At the time of assigning the IFAC universe, multiple decennial processes were occurring to prepare the address frame for the 2020 Census. For example, the Local Update of Census Addresses (LUCA) operation received addresses from partner governments that were added to the Master Address File (MAF). With the conclusion of IOAC and other decennial processes

---

21 Current tabulation blocks were 2010 tabulation blocks that were further subdivided (suffixed) as legal boundaries changed through the decade.
occurring, Geography Division (GEO) prepared a memo outlining the final criteria for determining the IFAC universe.

Blocks IOAC identified as active, hold-for-imagery, and triggered to field were assigned to the IFAC universe. The spatial relationship between the BCUs used for IFAC and the current tabulation blocks used for IOAC was one of the following: one-to-one, one-to-many, many-to-one, or many-to-many. However, the translation of the workload between the two geographies always erred on the side of inclusion. In other words, if any part of a BCU overlapped an active, hold-for-imagery, or triggered block, the entire BCU was included in the IFAC universe. As a result, when the final IFAC universe was determined, there were BCUs that contained both passive and active IOAC blocks, causing some addresses in passive blocks to also be included in the field canvassing workload.

In cases where BCUs were predominantly passive but included one small active block, that active block was prioritized during Frame Maintenance, with the goal of correcting the coverage issues to make the block passive and thereby making the BCU passive. Overall, BCU-to-block incongruences increased the number of housing units included in the IFAC universe by 20.7 percent. However, by choosing to manage IFAC by a geographic unit (BCU) rather than the address level, the Census Bureau planned for a portion of housing units that did not require updating to go to IFAC.

The percent of TEA 1 housing units that went to IFAC was affected by the discontinuation of ABR. IOAC was designed with ABR as the primary component to directly resolve active blocks to passive status. ABR was discontinued in February 2017 because of funding uncertainty and reprioritization of critical components of the 2020 Census. The discontinuation of ABR contributed to the decision to adjust the target of housing units in TEA 1 (self-response) canvassed in the field from 25 to 35 percent.

Despite the adjustments to IOAC, the Census Bureau was able to canvass 100 percent of the United States and Puerto Rico and validate large portions of the address frame, avoiding the cost of field canvassing the entirety of the TEA 1 area. IOAC successfully reduced the number of housing units in the IFAC universe by 65 percent, from 143,400,000 to 50,040,000 (see Table 31).

Table 31 shows the number of BCUs and housing units in the final IFAC universe with the final proportion of BCUs and housing that were sent for IFAC. There is an initial total of BCUs identified for IFAC and a final total. The difference is because of addresses that were removed

---

22 Data is from Table 33. The number of housing units in the IFAC universe (without the evaluation salted and suppressed addresses) divided by the number of housing units in active, on-hold, and triggered. (See row “Number of housing units in IFAC Universe (by status of block)” in Table 33.)
from or added to the IFAC universe for an evaluation of the Address Canvassing operation. Note that as part of the independent evaluation of IFAC, Decennial Statistical Studies Division (DSSD) added a sample of nonexistent addresses (“salted” addresses) to the universe and removed or suppressed a sample of the MAF addresses from the address list. For more information, please see the 2020 In-Field Address Canvassing Assessment (Lane et al., 2021) and the 2020 Census Address Canvassing Evaluation (Johnson, 2019). With these changes, the final IFAC universe included 34.9 percent of housing units.

Table 31: Overview metrics for the total number of BCUs and housing units and the proportion included in the final IFAC universe

<table>
<thead>
<tr>
<th></th>
<th>BCU</th>
<th>HU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nationwide Total</td>
<td>5,370,000</td>
<td>150,400,000</td>
</tr>
<tr>
<td>TEA 1 Total</td>
<td>5,027,000</td>
<td>143,400,000</td>
</tr>
<tr>
<td>IFAC Initial Total</td>
<td>1,115,000</td>
<td>50,040,000</td>
</tr>
<tr>
<td>Evaluation Salted Addresses (added to IFAC)</td>
<td>-</td>
<td>210,000</td>
</tr>
<tr>
<td>Evaluation Suppressed Addresses (removed from IFAC)</td>
<td>-</td>
<td>97,500</td>
</tr>
<tr>
<td>Final IFAC Total</td>
<td>1,115,000</td>
<td>50,150,000</td>
</tr>
<tr>
<td>Percent of TEA 1 in IFAC</td>
<td>22.2%</td>
<td>34.9%</td>
</tr>
</tbody>
</table>

Data sources: Tables 33 and 34

5.7.2 Detailed Information About the Universe Identified for Fieldwork

At the start of IOAC in September 2015, and throughout much of the program, IOAC staff identified active blocks as those containing any observed undercoverage, overcoverage, growth, decline and/or future growth. (For more information, please see section 5.1.) As IOAC progressed, staff better understood the specific ways IOAC could depend on the Delivery Sequence File (DSF) to update the MAF. (For more information, please see appendix B.) This gave rise to development of the DSF Reliability Index, which indicates the extent to which the DSF as a source can be relied upon to keep the address current within the block. The DSF Reliability Index measures the proportion of addresses in a given block that were originally added to the MAF by the DSF, or if the address had a different original source, it appeared on the DSF within 200 days.

In addition, the Census Bureau realized that ongoing, in-office MAF update and maintenance processes could provide a more rapid, cost-effective, and reliable method for resolving small amounts of overcoverage or undercoverage, thereby reducing the need to canvass entire

---

23 Suppressed addresses, even if listers did not add them, were still included in mail out operations.
blocks simply to correct a single address issue. Based on research stemming from these insights, the Census Bureau determined it would no longer be necessary to include blocks with the following conditions when identifying the IFAC workload (i.e., they would be considered passive for IOAC purposes):

1. Blocks with undercoverage that contain only single-family housing and have a DSF Reliability Index of 1.0.

Blocks classified as single-family unit blocks were those that contain only single-family housing units—blocks that are most amenable to IOAC methods and for which the DSF and other address lists are most accurate and complete. DSF-reliable blocks are those in which 100 percent of the addresses have the DSF as the original source code or, if added to the MAF from another source, appeared on the DSF within 200 days. In other words, the DSF is a consistently reliable source of addresses for these blocks. Taking these two conditions together—DSF reliability and single-family-only housing—identifies a set of blocks that are easy to manage in the office using a reliable source of addresses. Sending such blocks to IFAC to obtain address updates was deemed unnecessary since GEO would acquire the same updates from the DSF.

2. Blocks with overcoverage of only one housing unit (and no undercoverage).

Small overcoverage blocks are those in which IR detected overcoverage in the MAF of only one housing unit. At the time of the decision, there were 362,000 blocks in this category, for which the MAF contained a total of 4,369,000 addresses. Of these, 362,000 addresses (one per block) represent overcoverage, while 4,007,000 are valid addresses, correctly located within their respective blocks. IOAC staff suggested that the cost of sending these blocks to IFAC, and their approximately 4.0 million valid housing units, outweighed the gain from deleting the erroneous 362,000 addresses for which the MAF has overcoverage.

3. Growth blocks with DSF Reliability Index of 1.0.

These were blocks in which IR reviewers observed growth when comparing two vintages of imagery, but did not detect undercoverage in the MAF. Because these blocks also had a DSF Reliability Index of 1.0, the IOAC team could rely on the DSF to update the MAF if additional growth occurred.

Detailed block data analysis allowed the Census Bureau to more accurately classify blocks as needing IFAC (active) or reliably accurate (passive), leading to better resource allocation decisions.
As described in section 5.1, IR reviewed every block in the nation. Many blocks were reviewed multiple times, especially where the block could not be rated because of poor or obscured imagery, or where IOAC staff identified cases in which updates in the MAF, from other IOAC components or ongoing processes like the DSF refresh, potentially resolved the conditions contributing to the active status of a block or identified address change in a passive block causing the need re-evaluation. IR identified a variety of block conditions, statuses, and types of coverage issues within the IFAC universe. The following tables provide metrics describing these complexities.

While the TEAs and the IFAC universes were based on BCUs, the IR block status information informed the aggregate conditions within each TEA and the IFAC universe. As stated previously, the spatial relationship between BCUs and blocks was one-to-one, one-to-many, many-to-one, or many-to-many. Note that in the following tables, blocks are counted if they are wholly or partially within each TEA or the IFAC universe. If a block was in more than one TEA (i.e., spanned across more than one BCU, where not all BCUs were assigned the same TEA) or was both inside and out of the IFAC universe, it is counted in both. However, in these cases, the housing units, being point features, are only attributed to one BCU, and the associated TEA.

Table 32 represents the total counts of blocks and housing units within each of the status categories and in TEA 1. These numbers represent the completion of IOAC at the time when the Census Bureau created the IFAC universe. The following tables show information about the IFAC universe.

**Table 32: Summary of Blocks at the Conclusion of In-Office Address Canvassing (IOAC)**

<table>
<thead>
<tr>
<th>Total Number of Blocks</th>
<th>Total</th>
<th>Active</th>
<th>Passive</th>
<th>Hold-for-imagery</th>
<th>Triggered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11,160,000</td>
<td>1,093,000</td>
<td>9,711,000</td>
<td>173,000</td>
<td>178,000</td>
</tr>
<tr>
<td></td>
<td>(100%)</td>
<td>(9.8%)</td>
<td>(87.0%)</td>
<td>(1.6%)</td>
<td>(1.6%)</td>
</tr>
<tr>
<td>Total Number of Housing Units</td>
<td>150,400,000</td>
<td>32,450,000</td>
<td>105,500,000</td>
<td>4,173,000</td>
<td>8,310,000</td>
</tr>
<tr>
<td></td>
<td>(100%)</td>
<td>(21.6%)</td>
<td>(70.1%)</td>
<td>(2.8%)</td>
<td>(5.5%)</td>
</tr>
<tr>
<td>Number of blocks in TEA 1</td>
<td>9,943,000</td>
<td>965,000</td>
<td>8,738,000</td>
<td>62,000</td>
<td>178,000</td>
</tr>
<tr>
<td></td>
<td>(100%)</td>
<td>(9.7%)</td>
<td>(87.9%)</td>
<td>(0.6%)</td>
<td>(1.8%)</td>
</tr>
<tr>
<td>Number of housing units in TEA 1</td>
<td>143,800,000</td>
<td>30,710,000</td>
<td>102,100,000</td>
<td>2,704,000</td>
<td>8,309,000</td>
</tr>
<tr>
<td></td>
<td>(100%)</td>
<td>(21.4%)</td>
<td>(71.0%)</td>
<td>(1.9%)</td>
<td>(5.8%)</td>
</tr>
</tbody>
</table>

Data sources: PATHSTATUS from BARCA.BTD; TEA from BAS19; Housing units from ACS19.
The housing unit counts in this table were pulled from the ACS19 benchmark, the benchmark used for IFAC products.

TEA is a BCU attribute. TEA 1 blocks are defined as blocks found wholly or partially within a TEA 1 BCU. TEA values changed throughout the IOAC process. All TEA-based metrics are based on the 2020 Census collection vintage BCUs from the BAS19 benchmark (the most recent benchmark preceding the end of IOAC). Any block
that is partially or wholly within TEA 1 is considered a TEA 1 block and all the HUs for that block are considered TEA 1 HUs. Blocks “Triggered for In-Field Canvassing” are categorized as Triggered.

Tables 33 and 34 represent the distribution of block conditions within the IFAC workload. While 20.9 percent of all TEA 1 blocks included in the IFAC workload had a passive status, they contained only 6 percent of all TEA 1 housing units in the IFAC universe. Of all the housing units included in the IFAC workload, 61.1 percent were in active blocks, plus an additional 5.3 percent were in hold-for-imagery blocks, and 16.5 percent were in triggered blocks (the latter two categories of blocks were treated as active when the final IFAC workload was assigned because their status could not be determined because of lack of re-review).

Although a BCU could contain blocks with different block statuses, it is informative to assess the type of address canvassing that was expected to occur in the IFAC operation. Nearly half of the IFAC BCUs contained at least some portion of a passive block. However, more than 85 percent of the IFAC BCUs contained active blocks.

| Table 33: Summary of Metrics About the Workload Designated for In-Field Address Canvassing (IFAC) |
|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| Blocks in TEA 1                                              | Total                     | Active                  | Passive                  | Hold-for-imagery                  | Triggered                  |
| 9,941,000                                                   | 9.7%                      | 87.9%                   | 0.6%                     | 1.8%                            |
| TEA 1 Blocks in IFAC Universe                               | 3,279,000                 | 29.4%                   | 63.3%                    | 1.9%                            | 5.4%                        |
| Percent of TEA 1 Blocks in IFAC Universe                    | 33.0%                     | 9.7%                    | 20.9%                    | 0.6%                            | 1.8%                        |
| Housing units in TEA 1                                       | 143,400,000               | 21.3%                   | 71.1%                    | 1.9%                            | 5.7%                        |
| Housing units in IFAC Universe (by status of block)         | 50,040,000                | 61.1%                   | 17.1%                    | 5.3%                            | 16.5%                       |
| Percent of TEA 1 housing units in IFAC Universe             | 34.9%                     | 21.3%                   | 6.0%                     | 1.9%                            | 5.7%                        |

Data sources: PATHSTATUS from BARCA.BTD; TEA from ACS19, Housing units from ACS19.
The housing unit counts in this table were pulled from the ACS19 benchmark, the benchmark used for IFAC products.

TEA is a BCU attribute. TEA 1 blocks are defined as blocks found wholly or partially within a TEA 1 BCU. TEA values changed throughout the IOAC process. All TEA-based metrics are based on the 2020 Census collection vintage BCUs from the ACS19 benchmark (the most recent benchmark preceding the end of IOAC). Any block that is partially or wholly within an IFAC Universe BCU is considered an IFAC Universe block. Only the HUs within the portion of the IFAC Universe block that intersects the IFAC Universe BCU(s) are considered IFAC Universe HUs. Blocks “Triggered for In-Field Canvassing” are categorized as Triggered.
### Table 34: BCUs Containing Blocks by Status and IFAC Workload*

<table>
<thead>
<tr>
<th>Total Number of BCUs: 5,370,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of TEA 1 BCUs: 5,027,000</td>
</tr>
<tr>
<td>Number of IFAC BCUs: 1,115,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent of TEA 1 BCUs containing &lt;STATUS&gt; blocks in IFAC universe</th>
<th>Total**</th>
<th>Active</th>
<th>Passive</th>
<th>Hold-for-imagery</th>
<th>Triggered</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.2%</td>
<td>18.2%</td>
<td>11.0%</td>
<td>1.4%</td>
<td>3.6%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percent of IFAC BCUs containing &lt;STATUS&gt; blocks</th>
<th>Total**</th>
<th>Active</th>
<th>Passive</th>
<th>Hold-for-imagery</th>
<th>Triggered</th>
</tr>
</thead>
<tbody>
<tr>
<td>100.0%</td>
<td>82.1%</td>
<td>49.5%</td>
<td>6.1%</td>
<td>16.2%</td>
<td></td>
</tr>
</tbody>
</table>

Data sources: PATHSTATUS from BARCA.BTD; TEA and ADCNFLG from ACS19. Blocks “Triggered for In-Field Canvassing” are categorized as Triggered.

*Some BCUs are counted in more than one status category because a single BCU can contain multiple blocks with different status values.

**Because some BCUs are counted in more than one status category, the total is not a sum of the individual statuses.

### 5.8 What is the Summary of In-Office Address Canvassing (IOAC) Operational Metrics?

The 2020 Census was the first census to conduct an In-Office Address Canvassing (IOAC) so it cannot be compared to previous canvassing efforts. Also, the operational metrics for IOAC are unique because the operation was completed over a four-year span, and it included multiple components. Over the course of IOAC, different components were active or inactive, often overlapping in time and resources as shown in Figure 2 below. Interactive Review (IR) started in September 2015 and completed the “First Pass” where all the blocks in the nation were reviewed, in June 2017. IR continued working triggered blocks through March 2019. Active Block Resolution (ABR) started with a soft start in April 2016 and was discontinued in February 2017, though ABR QC continued through the end of FY 2017. Ungeocoded Resolution (UR) started in April 2017 and finished in February 2020. IOAC Group Quarters/Transitory Locations (GQ/TL) started in July 2017 and was paused in March 2018. Finally, Local Update of Census Addresses (LUCA) Address Validation (LAV) started in April 2018 and finished in March 2019.
Figure 2 and Table 35 show the timeline of IOAC components and when each component was in production. Production times overlapped for several of the components and many staff working on various components worked on different components depending on the greatest operational needs. In general, training, planning, and software development took place in the year before each component started production.

**Figure 2: Visual Timeline of IOAC Components in Production by Fiscal Year**

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>IOAC Components Running During the Fiscal Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2016</td>
<td>IR First Pass ran for the whole year and ABR ran for 6 months.</td>
</tr>
<tr>
<td>FY 2017</td>
<td>IR for Triggers ran for 9 months and IR for triggers ran for 10 months, ABR ran for 5 months, Frame Maintenance ran for the whole year, UR ran for 6 months, and IOAC GQ/TL ran for 2 months.</td>
</tr>
<tr>
<td>FY 2018</td>
<td>IR for triggers ran for the whole year, Frame Maintenance ran for 3 months, UR ran for the whole year, IOAC GQ/TL ran for 6 months, and LAV ran for 6 months.</td>
</tr>
<tr>
<td>FY 2019</td>
<td>IR for triggers ran for 6 months, UR ran for the whole year, and LAV ran for 5 months.</td>
</tr>
<tr>
<td>FY 2020</td>
<td>UR ran for 5 months.</td>
</tr>
</tbody>
</table>

* ABR was discontinued in February 2017, but staff continued to QC the ABR records worked until September 2017.

Data sources: Table 1 and Frame Maintenance records

---

**Table 35: Timeline of IOAC Components in Production by Fiscal Year**

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>IOAC Components Running During the Fiscal Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2016</td>
<td>IR First Pass ran for the whole year and ABR ran for 6 months.</td>
</tr>
<tr>
<td>FY 2017</td>
<td>IR for Triggers ran for 9 months and IR for triggers ran for 10 months, ABR ran for 5 months, Frame Maintenance ran for the whole year, UR ran for 6 months, and IOAC GQ/TL ran for 2 months.</td>
</tr>
<tr>
<td>FY 2018</td>
<td>IR for triggers ran for the whole year, Frame Maintenance ran for 3 months, UR ran for the whole year, IOAC GQ/TL ran for 6 months, and LAV ran for 6 months.</td>
</tr>
<tr>
<td>FY 2019</td>
<td>IR for triggers ran for 6 months, UR ran for the whole year, and LAV ran for 5 months.</td>
</tr>
<tr>
<td>FY 2020</td>
<td>UR ran for 5 months.</td>
</tr>
</tbody>
</table>

Data sources: Table 1 and Frame Maintenance records
Table 36 shows the total costs charged to IOAC by each division for each fiscal year. Each division can be generally attributed with a role in IOAC: The National Processing Center (NPC) completed production and quality control (QC) work; Decennial Census Management Division (DCMD) performed project management; Geography Division (GEO) drafted software requirements, conducted trainings, and provided geographic support; Decennial Information Technology Division (DITD) created software; and Decennial Statistical Studies Division (DSSD) created QC Sampling and Modeling.

Table 36: Total Costs Charged to In-Office Address Canvassing by Division and Fiscal Year

<table>
<thead>
<tr>
<th>Division</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020*</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPC</td>
<td>$12,417,208</td>
<td>$14,017,308</td>
<td>$13,085,208</td>
<td>$18,048,746</td>
<td>$6,144,411</td>
<td>$63,712,881</td>
</tr>
<tr>
<td>DCMD</td>
<td>$728,102</td>
<td>$302,763</td>
<td>$413,586</td>
<td>$360,293</td>
<td>$87,731</td>
<td>$1,892,475</td>
</tr>
<tr>
<td>DITD</td>
<td>$978,085</td>
<td>$1,225,453</td>
<td>$681,423</td>
<td>$339,836</td>
<td>$106,670</td>
<td>$3,331,467</td>
</tr>
<tr>
<td>GEO</td>
<td>$3,407,107</td>
<td>$3,208,673</td>
<td>$3,332,107</td>
<td>$2,275,758</td>
<td>$337,978</td>
<td>$12,561,623</td>
</tr>
<tr>
<td>DSSD</td>
<td>$342,546</td>
<td>$452,902</td>
<td>$528,829</td>
<td>$54,949</td>
<td>$2,353</td>
<td>$1,381,578</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$17,873,048</strong></td>
<td><strong>$19,207,099</strong></td>
<td><strong>$18,041,153</strong></td>
<td><strong>$21,079,582</strong></td>
<td><strong>$6,679,143</strong></td>
<td><strong>$82,880,024</strong></td>
</tr>
</tbody>
</table>

Data source: Pivot tables by fiscal year and division (including NPC) for In-Office Address Canvassing Project Code (6350x01) from Decennial Budget Office.

Table 37 shows the work completed by each component of IOAC, the total workload, and the productivity. It is important to note that there were large differences between components in the effort and resources needed to complete a work unit even though many used the same unit (i.e., block, address). Therefore, the average time, workloads completed, and associated costs of the components of IOAC should only be compared with caution and understanding of the differences. The purpose of this table is to show the work completed to give additional context to the budget and staffing numbers.

<table>
<thead>
<tr>
<th>Component</th>
<th>Workload Completed</th>
<th>Total Workload</th>
<th>Productivity (for entire component) (minutes(‘) seconds(”))</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR</td>
<td>14,360,000 cumulative blocks reviewed</td>
<td>11,155,486 blocks nationwide</td>
<td>0’55” per passive block</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2’14” per active block</td>
</tr>
<tr>
<td>ABR</td>
<td>74,500 blocks worked</td>
<td>1,373,000 blocks as of 2/1/2017</td>
<td>58’ per block</td>
</tr>
<tr>
<td>Frame Maintenance*</td>
<td>26,000 total blocks</td>
<td>N/A</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>237,000 total addresses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOAC GQ/TL</td>
<td>4.4% of total workload completed QC (12.1% of total workload worked in production total)</td>
<td>212,000 addresses</td>
<td>36’ per production address**</td>
</tr>
<tr>
<td></td>
<td>23,500 total calls</td>
<td></td>
<td>39’ per QC address**</td>
</tr>
<tr>
<td>UR</td>
<td>2,855,000 addresses assigned a resolution code</td>
<td>837,000 ungeocoded address records at Fall 2019 benchmark***</td>
<td>8’17” per record</td>
</tr>
<tr>
<td></td>
<td>96,541 miles of roads added or reshaped</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>381,234 linear features added</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAV</td>
<td>861,000 records reviewed</td>
<td>861,000 records</td>
<td>4’49” per review record</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2’08” per QC record</td>
</tr>
</tbody>
</table>

Data sources: Tables 2, 4, 14, 16, 18, 20, 21, 24, 25, 26, 27 and component production reports
* Frame Maintenance did not have production reports with average time.
** IOAC GQ/TL productivity was calculated assuming 142 workdays (excluding weekends and federal holidays) from September 2017 – March 2018 and assuming 6 total work hours per day.
*** The total workload for UR increased with every DSF refresh so there was never a finite number of records to work. Around the time UR ended, the pool of ungeocoded records was significantly less than when UR started.
Table 38 shows the total number of staff working production or QC for each component. The total minimum staff and total maximum staff includes all staff working records or BCUs for the component, including staff working QC and staff from GEO, if applicable. In some cases, staff were moved from one component to another. For example, during LAV, most UR staff worked on LAV and then went back to UR after LAV.

### Table 38: IOAC Staff Number Ranges by Component*

<table>
<thead>
<tr>
<th>Component</th>
<th>Total Minimum Staff</th>
<th>Minimum QC Staff</th>
<th>Total Maximum Staff</th>
<th>Maximum QC Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR</td>
<td>20</td>
<td>&lt;15</td>
<td>250</td>
<td>70</td>
</tr>
<tr>
<td>ABR</td>
<td>100</td>
<td>20</td>
<td>150</td>
<td>20</td>
</tr>
<tr>
<td>Frame Maintenance</td>
<td>&lt;15</td>
<td>&lt;15</td>
<td>&lt;15</td>
<td>&lt;15</td>
</tr>
<tr>
<td>IOAC GQ/Tl</td>
<td>30</td>
<td>&lt;15</td>
<td>30</td>
<td>&lt;15</td>
</tr>
<tr>
<td>LAV</td>
<td>&lt;15</td>
<td>&lt;15</td>
<td>300</td>
<td>50</td>
</tr>
<tr>
<td>UR</td>
<td>30</td>
<td>20</td>
<td>400</td>
<td>100</td>
</tr>
</tbody>
</table>

* Total staff numbers include QC staff.  
Data sources: Component production reports, Frame Maintenance records

### 5.9 Innovations and Process Improvements in Training

In-Office Address Canvassing (IOAC) components ran from late 2015 until early 2020 and staff used innovations and made process improvements over this time, particularly in training. Process improvements benefited later IOAC components and the Non-ID Processing Operation, especially when it quickly had to move to virtual training and support because of COVID-19. The following are examples of these innovations and process improvements.

Interactive Review (IR), Active Block Resolution (ABR), and Local Update of Census Addresses (LUCA) Address Validation (LAV) used a soft start where staff started the component early on a small scale in order to refine processes with real data and receive feedback on training and procedures. IR had a single unit in National Processing Center (NPC) start IR in late 2015 before full production. ABR used Geography Division (GEO) contractor support staff for a soft start three months before NPC training. As a result, staff were able to receive feedback on training and procedures and make enhancements to the ABR software based on user feedback. LAV also used a soft start. In April 2018, fewer than 15 NPC cartographic technicians or supervisors and managers attended LAV training at headquarters. These soft start participants worked training records and production cases until August when LAV held a training for clerks at NPC. This soft start trained the cartographic technicians and supervisors, and they were a valuable resource.
during the training of the clerks because they had LAV experience and could answer questions during the training and during production.

IOAC staff used knowledge gained from earlier IOAC components to experiment with new remote training techniques. IOAC staff used Skype software to conduct training for LAV, which allowed them to conduct training remotely and more efficiently. Previously, training at NPC required GEO staff from headquarters to travel to NPC to conduct training, which required precise coordination with multiple areas to ensure trainees were hired, onboarded, issued a computer, and had passed required prerequisites. GEO staff were required to travel again to NPC to conduct make-up trainings when the training sessions were not full, trainees did not take all the prerequisites, or trainees did not yet have a computer. Additionally, previous training required additional coordination such as handing out audio receivers to trainees each morning and collecting them at the end of each day. Skype training allowed IOAC staff to conduct training remotely if needed, which helped alleviate make-up session issues, and additionally allowed trainees to easily see and hear the training at their own workstation. Finally, these techniques helped mitigate challenges in hiring and onboarding.

Computer-based training was another new technique that made training more efficient and worked with challenges such as new staff trickling in or not learning at the same pace. IOAC staff successfully created a new computer-based training for Ungeocoded Resolution (UR). Computer-based training allowed new staff to learn the basics of the project at their own pace and provided accountability by allowing managers to track staff completion of training.

IOAC helped staff continue to use correct procedures in their work by creating a decision tree for several components and holding refresher trainings. IR, UR, LAV, and ABR all used a decision tree to guide staff through the process of working each case and help them use geographic principles. IOAC staff updated a decision tree when they observed trends in the data or common points of confusion. In LAV, IOAC staff conducted live demos based on questions trainees asked the previous day. In IR, IOAC staff held regular adjudicator meetings at which examples and feedback were discussed. In IR, LAV and UR, IOAC staff conducted refresher trainings over the course of the component.

Feedback is an important part of helping staff learn and improve, which in turn helps the efficiency and quality of the operation. LAV used a feedback module in Matching and Coding Software (MaCS) to help LAV reviewers improve their quality. The feedback module had a read-only version of MaCS so LAV reviewers could see what QC staff did, as well as notes, and could learn from their errors. ABR created exercises in the training database that could be graded with SQL queries, which allowed IOAC staff to quickly get trainees feedback. In IR, Block Assessment, Research, and Classification Application (BARCA) had reviewers examine the blocks
they received errors on before starting a new block. UR also provided feedback to reviewers and returned the work unit to reviewers to correct when it did not pass QC.

5.10 Enumeration Results of In-Office Address Canvassing

The following data are the enumeration results of TEA 1 addresses that were worked in IOAC and did not go to IFAC. The addresses in these data do not make up the complete TEA 1 universe since new addresses were added to the universe after IOAC finished in February 2020. The category “In Enumeration Universe” represents addresses that were eligible for enumeration in the 2020 Census. Most of these addresses were determined to be occupied or vacant and some (“In Enumeration Universe – Not in Census”) were included in the 2020 Census enumeration universe but later determined to be invalid in the final collection data. For example, Nonresponse Followup (NRFU) or other operations may have deleted addresses in the “In Enumeration Universe – Not in Census” category. The category “Not in Enumeration Universe” represents addresses that were not eligible to be enumerated in the 2020 Census. These are addresses that may have been used in previous censuses and surveys but in 2020, they did not meet the standards for the 2020 Census enumeration universe.

<table>
<thead>
<tr>
<th></th>
<th>In Enumeration Universe</th>
<th>Not in Enumeration Universe</th>
<th>Final Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of MAF Units</td>
<td>88,210,000</td>
<td>5,254,000</td>
<td>93,470,000</td>
</tr>
<tr>
<td>% of final total (column B)</td>
<td>87.0%</td>
<td>5.2%</td>
<td>7,884,000</td>
</tr>
<tr>
<td>% of enumeration universe (column A)</td>
<td>94.4%</td>
<td>5.6%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Data Source: U.S. Census Bureau, 2020 Census, ACS19 benchmark MAF products and 2020 Census final tabulation MAF products. Excludes all Domestic Violence Shelter (DVS) records. Note that MAF units with an IFAC source were not limited to TEA-1 by the time of the final collection universe. About 36,000 MAF units were moved into other TEAs, mainly TEA-6, for final tabulation.

Of the approximately 101,400,000 addresses that were worked in IOAC in TEA 1, 92.2 percent were in the enumeration universe and eligible to be included in the 2020 Census. The address

24 In this document, the designation “in the enumeration universe” refers to addresses that were sent to post-processing.
filters used for IOAC and the enumeration universe were different, which is why some of the addresses worked in IOAC were not in the enumeration universe. For example, the universe of addresses worked by IR and ABR intentionally included non-residential addresses while the enumeration universe did not. In another example, IOAC, especially UR, worked ungeocoded addresses and some of them could not be geocoded. Ungeocoded addresses were ineligible for the enumeration universe. Of the approximately 93,470,000 addresses worked by IOAC that were in the enumeration universe and eligible to be included in the 2020 Census, 94.4 percent were determined to be occupied or vacant.
6. Conclusions and Recommendations

The conclusions are divided into Metrics and Analysis, Summary of Successes, and Summary of Challenges. Recommendations follow.

6.1 Conclusions

Overall, the Census Bureau completed a successful In-Office Address Canvassing (IOAC) operation to update the address frame in advance of enumeration operations. A summary of the analysis of address updates follows below, followed by key successes and challenges. Decennial Census Management Division (DCMD) gathered lessons learned for Interactive Review (IR), Triggers, Active Block Resolution (ABR), Ungeocoded Resolution (UR), IOAC Group Quarters/Transitory Locations (GQ/TL), and Local Update of Census Addresses (LUCA) Address Validation (LAV) by holding sessions with stakeholders.

6.1.1 Metrics and Analysis

When IR started in September 2015, the Census Bureau knew that most blocks would not require in-field address canvassing in the 2020 Census, but not which blocks. During IR, a maximum of about 250 staff, including approximately 70 on quality control (QC), classified the approximately 11,160,000 blocks in the national universe. By June 2017, IR had reviewed all blocks nationwide and classified about 72 percent as passive. Meanwhile, ABR started with a soft start in April 2016 and UR started in April 2017. After the “First Pass” of IR, as UR and ABR work updated the address frame and other changes occurred, triggers identified blocks that needed to be re-reviewed in IR. Of the 1.5 million unique blocks triggered, about 73 percent received an updated IOAC IR status, such as changing from active to passive and vice versa. By conducting triggers, UR, ABR, and Frame Maintenance, the Census Bureau was able to increase the number of passive blocks from about 72 percent to about 87 percent of all blocks at the end of IR. The Census Bureau also reduced the number of undercoverage blocks in TEA 1. Because blocks were re-reviewed, IR staff reviewed a cumulative total of about 14,360,000 blocks in IR.

About 150 ABR staff (with 20 performing QC) resolved about 70 percent of the 74,500 blocks worked in TEA 1 before ABR was discontinued in February 2017. ABR also resolved about 47 percent of the blocks in TEA 6 (Update Leave). After conducting a lessons-learned session, it became clear that some changes to the methodology, and experience in staff performing ABR could have significantly increased the efficiency of ABR. Applying the lessons learned from ABR into Frame Maintenance, an operation based on ABR, significantly increased production rates. During Frame Maintenance fewer than 15 staff and resolved about 80 percent of the blocks worked in TEA 1. Frame Maintenance also resolved a smaller amount of blocks in TEA 6 and updated about 209,000 addresses nationwide.
UR geocoded about 1,870,000 addresses and added or reshaped 96,541 miles of road in MAF/TIGER. Staffing numbers varied over the almost three years UR was in production from between a staff of about 30 and 400 staff (with about 100 of the 400 working QC) because of funding and prioritization within IOAC. UR worked about 2,855,000 distinct address records in total. The purpose of UR was to geocode records to make them eligible for inclusion in the 2020 Census. UR did not specifically target only active blocks, but UR nonetheless resolved the coverage in numerous blocks and significantly improved the road feature network within MAF/TIGER before enumeration and the creation of data products.

UR, ABR, and Frame Maintenance contributed to preparing the address frame for the 2020 Census apart from making blocks passive and worked blocks in other TEAs, particularly TEA 6. These components used specific skills and tools to update Master Address File/Topologically Integrated Geographic Encoding and Referencing (MAF/TIGER) by correcting or adding geographic features. Listing operations staff did not have the training, tools, or reference data to make the same updates so these components helped all listing operations focus on their work—verifying or updating addresses—by reducing frame issues that could cause problems or confusion for listers and improving coverage before enumeration.

- Of the blocks Frame Maintenance staff resolved in the first work period, about 67 percent had their coverage corrected by either TIGER or MAF/TIGER actions alone. Those were actions that could not have been made in field listing operations.

- UR staff geocoded about 49 percent of the addresses they worked by fixing data elements within MAF/TIGER and a portion of the 35 percent of the addresses referred were also resolved by interactive updates to MAF/TIGER. Again, these updates enhanced the quality of the underlying data in MAF/TIGER which in turn made data more accurate and complete for all of the 2020 Census listing and enumeration activities.

- ABR did not track what percentage of their work was accomplished through correcting underlying geography, but ABR also reduced issues in the address frame.

IOAC GQ/TL started in July 2017 and encountered unforeseen challenges almost immediately, and also encountered funding concerns that resulted in pausing the operation in March 2018.

---

25 Some blocks were already passive when reviewed. To clarify, 66.7 percent of blocks were resolved by either TIGER or MAF/TIGER actions out of the total resolved by MAF, TIGER, or MAF/TIGER actions. 17.5 percent of all blocks worked during this period were unresolved. See table 19 for the full data.

26 48.9 percent of UR address records assigned a UR resolution were resolved by “Created address range,” “Created linear feature and address range,” and “Corrected address range.”
During this short operation staff completed about 4 percent of the GQ/TL universe through QC but with a high number of duplicate addresses.

From April 2018 to March 2019, a maximum of about 300 staff (reviewed about 861,000 addresses sent to LAV by the 2020 Census LUCA operation. Overall, about 61 percent of reviewed addresses were accepted (LUCA add or change record accepted) and about 39 percent were rejected (LUCA Add or Change record rejected).

The Census Bureau sent 22.2 percent of BCUs within TEA 1 and 34.9 percent of HUs to In-Field Address Canvassing (IFAC). Of the blocks within the IFAC universe, IR classified 63.3 percent as Passive, 29.4 percent as Active, 1.9 percent as On Hold, and 5.4 percent as Triggered. However, at the BCU and housing unit level, IR classified 61.1 percent of IFAC HUs as Active, 5.3 percent as On Hold, 16.5 percent as Triggered, and only 17.1 percent of housing units as Passive.

As a result of IOAC, the Census Bureau was able to virtually review the nation and send about 35 percent of addresses in TEA-1 to IFAC avoiding field canvassing large portions of the nation. IOAC successfully reduced the number of addresses in the IFAC universe from about 143,400,000 to 50,040,000. Additionally, IOAC improved the address frame nationwide in preparation for the 2020 Census.

**6.1.2 Summary of Successes**

The following are a summary of IOAC successes:

1. The Census Bureau successfully created and executed a new and cost-effective method of ensuring that the address frame was updated and prepared for the 2020 Census by conducting IOAC. With this new method, only 35 percent of the addresses in TEA 1 required field canvassing. This first-time operation was successful in reviewing, tracking, and updating blocks nationwide as well as identifying the universe for In-Field Address Canvassing (IFAC).

2. IOAC staff successfully created new training methods that were more efficient and effective and allowed them to conduct training remotely when needed.
   a. New computer-based training allowed new staff to learn the basics of the project at their own pace and provided accountability by allowing managers to track staff completion of training.
   b. Remote training using Skype allowed training to be broadcast to hundreds of people and was organized without travel for quick refresher trainings or to update staff on a new procedure.
c. Decision trees helped guide staff in each component and ensured they were following procedures.

d. “At your desk” training had trainees use a computer that shared a screen with the presenter and headphones so that all trainees could see and hear the training presentation.

e. Exercises in the training database that could be graded with SQL queries provided trainees quick feedback and were more efficient than having staff manually grade trainee exercises.

3. IOAC reviewers received feedback on their errors and the opportunity to learn from them. All IOAC components included QC and they used QC not only to ensure the work met standards, but also to help reviewers see where they made a mistake or misunderstood a concept and allowed reviewers to increase their skills and knowledge by learning from their mistakes. Overall, users had a positive experience with QC and processes like the blind QC in IR worked well for users as well as the operation.

4. The Census Bureau gained insight from conducting IOAC for the first time and modified components to make them more effective and efficient. For example, IOAC staff learned that canvassing an entire block in ABR was time intensive and inefficient since about 70 percent of actions were “verify” actions. IOAC created a pin-based approach to allow reviewers to pass over areas that already matched the address frame and piloted the method in Frame Maintenance where staff resolved coverage issues in the address frame in preparation for the 2020 Census. In another example, IOAC staff learned from early triggers and refined triggers or developed new ones to better identify blocks that needed to be re-reviewed in IR.

5. IOAC made updates and corrections to the address frame ahead of IFAC and the 2020 Census. For example, UR staff made updates or corrections to the address frame by adding streets and address ranges, which allowed future addresses from the United States Postal Service (USPS) Delivery Sequence File (DSF) to be geocoded and also benefitted IFAC and Update Leave (UL) by preparing the address frame ahead of these operations and limiting listers needing to flag a missing road as well as reducing the need for processing after these operations.

6. Using Agile Software Development allowed staff to develop the software for IOAC components, allowed IOAC to start production relatively quickly, and gain knowledge from staff working with real data and add additional features along the way.
7. Most components used a soft start to identify gaps in software and procedures before full production, get staff ready to help with full production training, and train support staff for when production staff had questions.

6.1.3 Summary of Challenges

Overall, IOAC was successful: it greatly reduced the amount of the nation that required in-person canvassing, which saved money; it updated the address frame ahead of the 2020 Census; and it identified the universe for In-Field Address Canvassing. However, the decade leading up to the 2020 Census was the first time IOAC was conducted, and the team identified improvements that could be made for the future. The next section (6.2) will list all recommendations.

1. Canceling ABR resulted in higher workloads in IOAC and other operations because it:
   - Changed the design of IOAC.
   - Affected how triggers were used.
   - Removed the primary method of updating and correcting MAF/TIGER to resolve complicated coverage issues. Some of the active blocks required complicated updates (such as to the underlying frame) that may have caused confusion for listers, lister error, and resulted in headquarters staff fixing the issue anyway but during the critical period after IFAC.
   - Changed the design of IOAC GQ/TL by adding the full universe of GQ/TL to the component rather than only the GQ/TL added in ABR, which subsequently affected the GQ/TL frame for the 2020 Census.

IOAC was designed with a method to make some active blocks passive by updating them through ABR. Without ABR, blocks identified as active could sometimes be resolved if they received an automated update from source material such as the DSF. However, some blocks could only be resolved by ABR because of the nature of their coverage issues. Some active blocks had only one housing unit causing the coverage issue; these blocks were more efficient to resolve through ABR than sending the entire block (and any others within the same BCU) to IFAC.

Additionally, ABR (and later, Frame Maintenance) used additional tools and information about addresses, such as DSF history, to correct coverage issues in active blocks more efficiently than IFAC listers could have. Some active blocks required complicated corrections to the underlying frame that could not be fully completed by IFAC because ABR (and Frame Maintenance) staff had access to the full set of MAF/TIGER interactive update tools and IFAC listers had to flag issues, for example road feature errors, for
MAF/TIGER interactive update. Conducting ABR and Frame Maintenance had the advantage of updating the frame ahead of the critical time during the 2020 Census when time and resources to update the frame were more limited.

IOAC GQ/TL and triggers were affected by the loss of ABR. In the original design of IOAC GQ/TL, staff were to contact the GQs and TLs added in ABR. After ABR was discontinued, IOAC GQ/TL was significantly expanded to the entire universe of GQ/TL. Triggers were also originally intended to identify blocks for ABR to attempt to resolve coverage issues. When ABR was discontinued, active blocks could have their coverage resolved by DSF updates or UR but there was not a way to target active blocks without ABR.

ABR staff were able to refine the design of ABR once it was in progress and they learned vital information about the process. Early ABR planning asked ABR staff to canvass blocks similar to In-Field Address Canvassing by reviewing each housing unit they saw in the block and updating or verifying the address list. Originally, the Census Bureau estimated that staff would complete a block in ABR in about 20 minutes. However, blocks required more time to complete and about 70 percent of ABR actions were “verify” actions. ABR staff subsequently developed a more efficient pin-based method which required the in-office canvasser to only work on coverage issues within the block. Reviewers could then ignore structures that were already correct in the MTDB. IOAC successfully used this method in Frame Maintenance and refined the technique.

2. Staff encountered multiple unanticipated obstacles in the IOAC GQ/TL component. The lack of a successful IOAC GQ/TL program was one of several factors that affected the GQ/TL frame overall in the 2020 Census.

IOAC GQ/TL encountered several unanticipated issues that will need to be mitigated in any future planning of a similar program:

- The public is very aware of unsolicited calls, many of which are sophisticated and make themselves appear to be conducting a legitimate survey. Many phone respondents were suspicious of the IOAC GQ/TL phone call because the caller identification did not say “US Census Bureau.” Along with the caller identification issue, the timing—calling about the decennial census in 2017—added to their suspicion.
- The calling script included a long introduction and interviewees often hung up before the IOAC GQ/TL caller finished reading the scripted introduction, perhaps thinking the phone call was a marketing or scam call.
- Some GQ or TL staff had recently been visited by the American Community Survey (ACS) and were hesitant to do a similar interview with the Census Bureau.
• Larger GQs were reluctant to provide their information over the phone because of the time it would take. Some respondents also indicated that they preferred to provide information to regional office staff already dedicated to contacting and updating information for these large institutions.

• Some GQ or TL staff requested the Census Bureau call back at different hours, some of which were outside of work hours for the Census Bureau calling staff.

• The complexity of GQ and TL characteristics and variety of GQ and TL types presented challenges to the staff making the calls because of the significant level of expertise and critical thinking required.

The Census Bureau decided not to update the MAF with the limited number of GQ and TL addresses collected during the operation because of quality, resources, and other operations collecting similar data. In addition to the skill set for IOAC GQ/TL not being a good fit for the grade level hired, the model of making phone calls was outdated and will need to be planned differently in the future.

3. The planned work process for UR, ABR, LAV, and IOAC GQ/TL were hindered by the skill set of the NPC staff hired for these components and this resulted in significant replanning, changes to procedures, and training adjustments to complete the work successfully. The work was completed successfully but with mitigation measures that took extra time and resources:

• Additional retraining sessions were needed.

• More time was needed to fix errors or return work to staff to fix their errors than was planned or expected.

• The defined tasks for some pay grades sometimes did not fit the work or restricted what tasks the staff could do.

• Some staff did not know what to do when they had a scenario that was not the same as the scenarios in the documentation.

In the past, geography work for clerks was simpler and more straightforward, such as digitizing maps. Digitizing maps simply involved tracing along boundaries, roads, and other features on paper maps to create a digital file. IOAC was conducted for the first time ahead of the 2020 Census and, with nothing similar ever attempted, IOAC followed past practice of hiring individuals at grades 4 and 5.

After IOAC started, staff realized the nature of some IOAC components was fundamentally different, more advanced, and not always a good fit, like past work was, for grades 4 and 5 staff. IOAC staff found that the work planned for ABR, UR, IOAC
GQ/TL, and LAV was not aligned with the grade levels, and the skill sets possessed by staff at those levels, that were planned for the project. As a result, work for some components was designed to fit the skill set of the clerical staff hired rather than hiring professional staff with the skills, geographic knowledge, or experience needed to carry out the planned work. Future planning will need to consider that the nature of geography work has changed, and that Census Bureau must hire appropriately graded staff with geographic knowledge or experience to do the work. The following are examples of specific challenges or mitigation measures used to meet these challenges:

- Staff with a stronger background in the field of geography, such as a college degree, comprehended the training better and more quickly. The requirements for grade 5 staff for ABR, UL, and LAV did not include geographic knowledge, which resulted in higher grade staff spending more time helping other staff or correcting their errors.

- UR simplified some of the MAF/TIGER Address Geocoding Application (MTAG) software in order to fit grade restrictions for grades 4 and 5. For example, grades 4 and 5 staff could not add a MAF Structure Point (MSP), which limited the actions that could be taken and the number of cases that could be completed.

- Staff could not identify duplicates in MAF Browser, at least for part of UR, which again limited the amount of work they could complete.

- For UR, staff in lower grade levels had fewer sources to use than staff in higher grade levels, which meant that there were fewer addresses they could geocode.

- Because documentation, including the decision tree, could not list every possible scenario staff will encounter, staff needed to be able to use their judgment to make decisions. Some staff did not know what to do when they had a scenario that was not in the documentation.

- Vast differences in skill level among grade 4 staff resulted in some staff needing more help and this presented difficulty for the Census Bureau to estimate the number of staff needed.

- In LAV, staff had difficulty in understanding detailed concepts, especially in-depth explanations of MAF concepts (matching results, preferred vs. nonpreferred addresses, multiple addresses associated to single MAF unit).

- In IOAC GQ/TL, the complexity of GQ and TL characteristics and variety of types presented challenges to the staff making the calls because of the significant level of expertise and critical thinking it required. Most of the addresses IOAC GQ/TL staff updated duplicated addresses already in the MAF.

- Some grades 4 and 5 staff did not have basic computer literacy, and the trainings assumed staff already had this skill.
• Because grades 4 and 5 staff could not openly QC each other’s work, QC sometimes lagged behind.

4. Hiring new staff was often difficult and staffing numbers fluctuated over the course of IOAC components. Many projects were hiring in preparation for the decennial census so new staff sometimes were lost to other areas such as technical support. Additionally, the local economy near NPC had other job opportunities for similarly skilled staff that were often more desirable. Clearing and onboarding new staff was sometimes not carried out in a timely manner. Staff were sometimes moved to another project without IOAC project managers being notified.

An example is the hiring for LAV, though hiring and maintaining staff numbers was a challenge in all components. Hiring for LAV coincided with a period of hiring demand and shortages. A portion of LAV staff worked on verifying and processing LUCA returns, which had the advantage of the staff having experience on a related project but meant that these staff were not available to work LAV until LUCA processing was completed.

The massive staffing needs required for LAV reduced the number of QC and Monitoring staff working on UR. As a result, there were not enough QC/Monitoring staff to work UR QC and Monitoring and the records backlog increased to the point where it was not possible to catch up with the backlog.

Overall, ensuring adequate staff were available was a challenge for IOAC and will need future consideration to address common issues such as competition for similar staff among Census Bureau projects, competition from outside the Census Bureau, coordinating or timing projects with consideration to staffing needs, and onboarding new staff efficiently.

5. IOAC used 2010 tabulation blocks as the work unit while IFAC used the 2020 BCU as the work unit. Blocks and BCUs had complex relationships that changed over time as BCU boundaries changed over time. A BCU could contain both an active and a passive block and be sent to IFAC because of the active block. As a result, while IOAC was in progress, it was difficult for staff to report with precision how IOAC was affecting the target IFAC universe to leaders and oversight without additional resources. Further, triggers and Frame Maintenance work needed to be prioritized based on block-BCU relationships. Additionally, evaluations comparing IOAC to IFAC were hindered by the two different work units each operation used. Finally, BCU-to-block incongruences increased the number of housing units included in the IFAC.

6. The Geographic Support System updates (GSS) occurred at the same time as IOAC, and both worked on the same address frame. Sometimes, the IOAC work was complicated
by GSS updates to the same blocks. For example, if a block was marked with pins according to the current coverage issues in IR and got sent to ABR, but was updated by GSS before ABR worked the block, the block was confusing to the ABR reviewer because the block may no longer have had coverage issues, or it may have had different coverage issues than were identified in IR.

7. The 2020 LUCA schedule did not allow LUCA to be used as a trigger or allow IOAC to set the IFAC universe after LUCA updates had been processed and possibly changed the status of some blocks.

8. IOAC was planned to identify coverage issues in the address frame, including new changes to the residential landscape and older issues that affected coverage. However, IOAC uncovered more preexisting coverage issues or problematic older data in MAF/TIGER than the IPT originally anticipated. These issues were not unique to IOAC or past canvassing operations, but IOAC often needed to correct them to fix coverage issues and none of the IOAC components were designed to undertake a large clean-up process.

9. The number of addresses submitted in LUCA was four times higher than estimated and therefore the final IOAC eligible universe for LAV was much higher than originally anticipated. The IPT planned for LAV to review every address for every entity. Because the response rate for LUCA was so high, LAV had to move to sampling addresses within each entity in order to complete the workload.

10. Software to track the status of blocks was adequate but it did not account for the ideal flow of blocks given multiple processes and components happening simultaneously. It was difficult to track a block through the entire IOAC process. IOAC staff were learning about processes like triggers in real time and sometimes needed more flexibility by having more options in the software such as storing prior block status.

11. Lack of software resources affected ABR: Business rules in the software were not programmed until several months into ABR production work, sample QC was not in place when full ABR production began, and there were software failures in the training environment.

12. Onboarding and training sometimes faced coordination challenges: partially unfilled training sessions, training sessions with staff who have not completed prerequisites, and staff who sometimes missed the first day of training and needed to be caught up. These challenges were mitigated by the training innovations detailed in section 5.9.
13. Good source data, such as county GIS viewers, were important to ABR, UR, and LAV. For example, in areas where source data was strong, ABR was able to resolve more blocks. When ABR had to work specific areas for the test sites, limited sources in some of those areas either meant more time was needed (in order to look for sources) or ABR staff were not able to resolve as many blocks. Similarly, some of the entities that participated in LUCA were lacking authoritative sources to validate the LUCA addresses with. Without good source data, LAV could not evaluate the addresses and had to accept them. Future planning will need to have methods to mitigate lack of source data by allowing more time to find the data and paths for areas where source data does not exist.

14. Some areas of the country have persistently cloudy imagery (or other obscuring issues), and it was not possible to get clear imagery for some blocks. Because most IOAC work requires good imagery, there were some blocks that could not be resolved in IOAC and needed to be sent to IFAC.

15. Trigger development, assessment, and adjustment was at its peak during the December 2018 through January 2019 lapse in appropriations when many Census Bureau staff were furloughed. As a result, less staff and resources were available to triggers at a critical time.

16. Unified Tracking System (UTS) and IOAC worked within different models because IOAC was different from traditional decennial operations. Unlike other operations, IOAC had a non-linear workflow by design and the status of blocks was dynamic because they could be triggered to different points in the process. With triggers, blocks “looped” back through the process, sometimes multiple times. Additionally, the “looping” was designed to continue through a cut-off date rather than when all the blocks had been worked only once, as is usually the case in traditional decennial operations. BARCA and UTS had difficulty integrating and the Address Canvassing leadership team decided in April 2018 to continue with reports from BARCA. Subject-matter experts were tasked with manually generating and sending a daily report. Because these reports were monitored daily, it was important that subject-matter experts (SMEs) create and send them every day, but the task took time during a period when SMEs had a full workload.

17. IOAC details were sometimes challenging to understand, especially for non-geographers or people unfamiliar with MAF/TIGER. Messaging about the more complicated concepts of IOAC was sometimes not sufficient for status reporting to leadership and oversight. Messaging was sometimes not fully coordinated within the Decennial Census Programs Directorate (for example, GEO often named IR and ABR as being the components of IOAC while DCMD listed five components) and did not have materials catered to
different groups such as advisory groups, stakeholders, leadership, and oversight. Finally, the newness of IOAC brought on assumptions or misunderstandings, such as how the timing of IOAC worked and all operations, including field listing, having some degree of error. For example, evaluations often recorded any unresolved triggered block without field updates as an “IOAC error” when IOAC did not intend for this interpretation because some of these blocks simply could not be evaluated because of lack of sources.

6.2 Recommendations

**Recommendation 1:** Hire higher grade staff with geographic knowledge or experience for future operations or programs similar to IOAC.

As described in section 6.1.3, the grade-level hired for UR, ABR, LAV, and IOAC GQ/TL was not aligned with the work for those components. The nature of geography work has changed and requires staff with skills to interpret multiple sources of information (some of which may conflict), the existing address frame, make the best decision in every unique situation, and correctly apply updates. Future work similar to IOAC should carefully consider staff grade level and skill-set requirements based on the lessons learned from IOAC.

**Recommendation 2:** Address preexisting coverage issues and develop strategies to prevent them in the future.

1. Research how to address preexisting coverage issues:
   - Plan and fund a component, similar to ABR/Frame Maintenance, that can perform research and correct complicated coverage issues and ensure appropriate grade staff with geographic experience are hired for it.
   - Consider methods for identifying areas that need updates that cannot, or cannot efficiently, be completed by other programs or listers, such as more complicated situations or areas needing feature reshaping.

2. Develop strategies to prevent coverage issues being introduced into MAF/TIGER:
   - When designing future plans for updating and maintaining the address frame, consider how to reduce the number of new coverage issues. New coverage issues could be introduced through partner programs such as LUCA, batch updates, and other operations.
As described in section 6.1.1, ABR and Frame Maintenance made valuable contributions by correcting coverage issues, many of which required specialized research or knowledge and interactive MAF/TIGER updates.

The 2010 Address Canvassing Operation was a full, nationwide in-field operation that also collected GPS points for each structure. While it improved the MAF, there were also inconsistencies such as geocoding errors, address formatting errors, duplicates, and possible missed units. Over the recent decades, MAF/TIGER has become more detailed, housing has changed, and consequently data collection like field listing and partner files are not as simple. IOAC found that some blocks with overcoverage or undercoverage were not because of recent changes on the ground but rather were because of the cumulative updates from other operations or programs. The Census Bureau used Frame Maintenance and triggers, as well as other programs like the DSF refresh, to improve the address frame ahead of the 2020 Census.

Future planning should assume the MAF will still require some amount of targeted cleanup and the Census Bureau should plan to study and design methods to identify areas and perform needed updates. Because this work will require specialized knowledge and skills, it is recommended that the Census Bureau hire staff with sufficient qualifications to do this work. For example, multiple address sources or address histories may have conflicting information and staff performing this work will need specialized knowledge or skills in order to evaluate the information, make the correct decision about what actions need to occur, and implement those actions. Staff will also need knowledge or training of MAF/TIGER database in order to correctly interpret the existing geography and complete the more complicated fixes.

Recommendation 3: Conduct research on the best method to update GQ/TL information and plan any future efforts with awareness of the issues encountered in this component. Explore what GQ/TL information can be obtained from the Geographic Support and Frames Programs and other sources internal to the Census Bureau. If phone calls are considered, planning must include research and an effective transformation of the current model of making phone calls. Consider coordinating with other operations such as ACS and staff in the regional offices, especially for larger institutions.

As described in section 6.1B, staff encountered multiple unanticipated obstacles in the IOAC GQ/TL Component.

Recommendation 4: Research how the next decade will track the status of the address frame, including monitoring address frame updates and identifying areas where updates are needed.

Research developing an integrated, flexible system that identifies, manages, and tracks the flow of blocks (or another unit) through multiple components/activities, uses various data sources,
allows SMEs to establish and modify criteria and prioritize blocks, and provides useful, real-time data monitoring.

IOAC successfully tracked block statuses (i.e., passive, active etc.), but the IPT identified several considerations for the future. The IPT believes the next decade of geographic updates could be improved by managing the flow of blocks (or another unit) through multiple components and processes. In the future, there will be multiple sources of data that will need to be tracked and prioritized: update processes such as the DSF refresh, data from partners, updates similar to Frame Maintenance, and changes happening in the residential landscape. A system will need to track the paths that work units will take and how those paths are determined or prioritized. Most likely, a system that manages the flow of inputs, processes, and multiple programs would need to be refined over time. In the future, IOAC will likely need to plan for a more integrated system that provides useful data for monitoring and is flexible for needed adjustments over the course of the operation.

- The interactions between different components and processes should be considered in the design of the system. In a simple example, some on hold blocks initially were sent for re-review before imagery was available for the block. As IR progressed, IOAC developed a process for identifying when the imagery was clear for these types of blocks. Ideally, a production control system in the future would ensure that imagery changes are detected automatically. Here is a more complicated example:
  - Blocks were in queue for ABR or Frame Maintenance.
  - While in queue, some blocks received new addresses through another process, such as the DSF refresh or UR geocoding addresses to some of the blocks.
  - During IOAC, these blocks remained in queue for ABR or Frame Maintenance rather than being rerouted to IR to assess if a coverage issue still existed now that the blocks had been updated. Perhaps the blocks no longer required ABR or Frame Maintenance.
  - In IOAC, both ABR and Frame Maintenance received blocks without coverage issues because the coverage issue was resolved by another process before the blocks were worked.
  - A future system should account for multiple processes (i.e., DSF refresh and partner updates) all occurring on the same address frame and use methods to route and prioritize work or blocks accordingly.

- Because in-office update work runs for several years, stakeholders and SMEs would benefit from real-time data during the operation and the ability to adjust or prioritize key parameters based on that data.
SMEs would use parameters in the control system to set flags or certain conditions to alter the flow or selection of blocks based on their findings over time.

For example, a database in the future could track when a block was last reviewed manually and when any addresses in the block last received updates and by what process. SMEs could set and prioritize the queue for an IOAC like process to select blocks with certain characteristics. Perhaps after a year, SMEs review reports about the blocks selected for review and the outcomes. Using the information, SMEs may modify the selection criteria.

In another example, if there are triggers used in the future, perhaps the system allows SMEs to set the priority of triggers and the priority of processes. A block may be selected for update based on certain triggers, but other processes might “overrule” the trigger (or vice versa). Again, SMEs would ideally be able to see metrics about progress and alter which triggers or processes have priority over time.

These examples are merely speculative. The recommendation is to design the system in a way that allows SMEs to monitor the operation over time and refine parameters, processes, or flows and based on the data.

• Reports were run manually. While the reports were always sent out without issues, it would be more efficient to implement automated reporting. Additionally, different organizational areas have different reporting needs. In designing future reporting, consider both SMEs, who need to closely monitor the project, and non-SMEs who may only need to report the summary or basic numbers. Consider highlighting summary figures or adding footnotes with explanations for non-SMEs while maintaining the details that SMEs need.

**Recommendation 5:** Investigate how future listing and future update efforts will manage their work (using blocks, addresses, or another unit) and include considerations in planning for any translation or overlap of geographies.

Any method of Address Canvassing will have some degree of inefficiency where “good” addresses are sent for review, whether in the office or the field, and marked “verify.” IOAC used 2010 Census blocks as the work unit because BCUs were not yet delineated when IOAC began, and BCU boundaries changed over the course of the IOAC operation. Because BCUs and blocks had a complex spatial relationship, when an active block and a passive block were in the same BCU, the entire BCU went to IFAC. However, if IFAC had used blocks, aside from other possible outcomes, IFAC would have canvassed some addresses that were confirmed correct by IOAC as
well as the addresses that required fieldwork. Both listing operations and in-office address frame updates must have a unit of work, whether the units are blocks, BCUs, addresses, address ranges, or something else, and any unit of work must balance efficiency with managing the workload. Future in-office work will need to choose a unit of work early in the decade to start planning and programming software. Plans for the 2030 Census could change after work for future operations like IOAC are well underway.

**Recommendation 6:** Consider the availability of good and authoritative sources of data and imagery in planning future work.

SMEs and the IPT found that IOAC is dependent on having good sources of data, including imagery, address information, parcels data, and more. SMEs found in IOAC that the availability of good sources can vary tremendously between areas. In addition, two different sources of data may conflict. Future IOAC will need good sources of data, especially for areas that have undercoverage, and appropriately skilled staff with the ability to assess multiple sources for an address and make the best decision for the Census Bureau’s needs.

**Recommendation 7:** Continue support for new training methodologies including computer-based training, remote training, training exercises that can be graded automatically or with simple queries, helpful tools like decision trees, and conducting refresher trainings.

As described in sections 5.9 and 6.1.2, IOAC made advances in training that should continue to be supported in the future.

**Recommendation 8:** Determine how future work will assess quality.

1. **Quality of the design:** Future work will need to assess the quality of the design in choosing how areas or blocks are prioritized, the efficiency of the staff skill set chosen, and how the work is structured. The design of IOAC allowed for all components to provide feedback to reviewers and either required the reviewer to fix the error or at least review the error. Reviewers were able to refine their skills over time and become better and more efficient reviewers thanks to this design. Continue to use a design that will allow for robust feedback and consider what other elements can create a quality design.

2. **Quality of the work:** Consult with DSSD to develop statistically sound quality control plans and implement them in future work. Consider meeting periodically to assess if the work and staff are meeting quality standards and what those standards mean.

---

27 In some active blocks, IOAC was able to verify that some of the addresses matched the MAF and did not require update while other addresses in the same block did require IFAC. Since IFAC worked whole areas, IFAC canvassed entire BCUs, and even if IFAC had canvassed blocks, they still would have canvassed some addresses that were up to date and correct in the MAF.
3. Quality of the address frame: Future work should consider how it will measure both the quality and completeness of the address frame. Assess the results from future studies focused on the address frame and implement program or design changes as need to improve the quality of the address frame.

**Recommendation 9:** Evaluate how to prioritize work in a constrained fiscal environment.

In the past, decennial censuses have had greater funding in the years leading up to the census and the census year itself but future operations similar to IOAC will need to prepare the address frame much earlier than past Address Canvassing operations. The 2020 IOAC faced a constrained fiscal environment and two components, ABR and IOAC GQ/TL, were discontinued as a result. Additionally, the IPT reported that limited resources middecade meant that some software functionality was delayed, and these delays caused extra work. For example, ABR did not have business rules programmed until several months into ABR production, which resulted in QC being more time consuming and requiring rework because without business rules, production users had been able to select incorrect value combinations. Future IOAC has the potential to save costs by reducing the need for IFAC, but it will need funding and resources early in the decade.

**Recommendation 10:** Investigate strategies for hiring to address past challenges and plan for changes resulting from the recommendation to hire higher grade staff with geographic knowledge or experience.

- Plan for recruiting and onboarding differences that will occur in the future when hiring more specialized staff than past decades and consider what the peak number of specialized staff will be. Hiring higher grade staff with geographic knowledge will better fit the work (see recommendation 1) but these staff will likely take longer to recruit. Additionally, the IPT expects these staff to have less incentive to leave for other decennial or non-Census Bureau jobs, but the IPT should plan for mitigation measures should the attrition rate not improve as expected.

- The Census Bureau tried to keep a group of staff on IOAC that could move from one component to another with less training on common components, but there was often attrition because of staff moving to other decennial projects or other more lucrative jobs. The Census Bureau should consider the timing of all decennial operations that require staff with geographic skills and develop a plan for hiring, onboarding, and timing so that all operations have sufficient staff during critical years. The IPT should evaluate whether maintaining a group of staff with geographic knowledge is beneficial compared with hiring and training new staff.
• The Census Bureau will need consider process improvements to hire, clear, and onboard new staff for future work similar to IOAC to be successful. The IPT should consider communication protocols that will help them keep track of the hiring process.

**Recommendation 11:** Research the timing of LUCA in determining where listing operations are needed in 2030 or how LUCA updates the address frame before the 2030 Census.

2020 LUCA occurred as usual—directly before the decennial census—for the 2020 Census. However, this timing did not allow LUCA updates to be taken into account when determining which blocks needed IFAC. It is possible LUCA updates changed the status of active or passive blocks. In the future, the Census Bureau should consider the timing of LUCA and if it should occur before determining where listing operations occur in 2030 or determining the status of the address frame before the 2030 Census.

**Recommendation 12:** Create plain language messaging about geographic work similar to IOAC. IOAC was often challenging for non-geographers or people without knowledge of MAF/TIGER to understand. Ideally there would be a set of materials for three audiences: the advisory groups, Census Bureau staff, and oversight staff. Coordinate on messaging within the Decennial Census Programs Directorate and consult with the Communications Directorate.

Census Bureau geographers had experience with MAF/TIGER and knowledge of the many related processes but other Census Bureau staff as well as oversight had different knowledge and sometimes did not fully understand all of IOAC. This affected IOAC when evaluations were designed with metrics not ideal for IOAC or oversight had recommendations based on how they understood the situation. Future work similar to IOAC would benefit from creating materials that could be shared with others who will evaluate that work. This recommendation also includes IOAC QC plans that were sometimes complicated and with a non-linear flow but sent work “backward” to provide reviewers helpful feedback from QC.
7. Review / Approval Table

The individuals or groups that appear in the table below have reviewed and approved this operational assessment report.

<table>
<thead>
<tr>
<th>Role</th>
<th>Approval Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decennial Census Management Division (DCMD) ADC for Geographic Operations</td>
<td>6/30/2021</td>
</tr>
<tr>
<td>Decennial Research Objectives and Methods (DROM) Working Group</td>
<td>9/9/2021</td>
</tr>
<tr>
<td>Decennial Communications Coordination Office (DCCO)</td>
<td>10/21/2021</td>
</tr>
</tbody>
</table>

8. Document Control and Revision History

The table below includes entries for each major version of this operational assessment report along with a brief description of the version and/or any changes made to the preceding version.

<table>
<thead>
<tr>
<th>Version/Editor</th>
<th>Date</th>
<th>Version Description/Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 / Richmond, Hanks</td>
<td>3/5/21</td>
<td>DCMD Internal Review</td>
</tr>
<tr>
<td>0.2 / Richmond, Hanks</td>
<td>4/16/21</td>
<td>IPT Review</td>
</tr>
<tr>
<td>0.3 / Richmond, Hanks</td>
<td>7/2/21</td>
<td>Division Chief Review</td>
</tr>
<tr>
<td>0.4 / Richmond, Hanks</td>
<td>8/26/21</td>
<td>DROM Review</td>
</tr>
<tr>
<td>0.5 / Richmond, Hanks</td>
<td>10/7/21</td>
<td>DCCO Review</td>
</tr>
<tr>
<td>0.6 / Richmond, Hanks</td>
<td>10/29/21</td>
<td>DCCO Updates Incorporated</td>
</tr>
<tr>
<td>0.7 / Richmond, Hanks</td>
<td>1/10/22</td>
<td>Review of enumeration results and additional triggers</td>
</tr>
<tr>
<td>0.8 / Richmond, Hanks</td>
<td>1/26/22</td>
<td>DROM review of enumeration results and additional triggers</td>
</tr>
<tr>
<td>1.0 / Richmond, Hanks</td>
<td>3/4/22</td>
<td>Final Internal Version</td>
</tr>
<tr>
<td>1.1 / Richmond, Hanks</td>
<td>5/20/22</td>
<td>External Version for the Public</td>
</tr>
</tbody>
</table>
9. Acknowledgements

This report benefitted from many people generously sharing their knowledge, providing comments, as well as those in Geography Division who assembled the report data itself and drafted or helped brainstorm analysis. Elizabeth Lane kindly fact-checked the report.

Decennial Census Management Division
Francis McPhillips
Karen Owens
Shawn Hanks
Elizabeth Lane

Geography Division
Andrea Johnson
Michael Ratcliffe
Daniel Keefe
Seth Schowalter
John Pollicino
Gustavo Davila
Gary Baxter
Matthew Bowman
Eugenio Santiago
April Avnayim
Jeff Ocker
Michaelynn Garcia
Tiernan Erickson
Michael Commons

National Processing Center
Rikki Wortham
Shawn Smith
Amanda Burns
Eric Gray

Decennial Statistical Studies Division
Deborah Fenstermaker
RJ Marquette
Aneesah Williams
Lisa Silverman
10. References


U.S. Census Bureau (2021), “Address Canvassing Test Results Memo,” U.S. Census Bureau, Decennial Census Management Division Internal Memorandum Series (forthcoming).

11. Appendix

Appendix A: Glossary of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA</td>
<td>Assignment Area in 2010 Census</td>
<td>ABR</td>
<td>Active Block Resolution</td>
</tr>
<tr>
<td>ACO</td>
<td>Area Census Office</td>
<td>ACS</td>
<td>American Community Survey</td>
</tr>
<tr>
<td>AdCan</td>
<td>Address Canvassing operation</td>
<td>ASE</td>
<td>Address Source Evaluation</td>
</tr>
<tr>
<td>BCU</td>
<td>Basic Collection Unit</td>
<td>BTD</td>
<td>Block [or BCU] Tracking Database</td>
</tr>
<tr>
<td>CAUS</td>
<td>Community Address Update System</td>
<td>CFM</td>
<td>Census Field Manager</td>
</tr>
<tr>
<td>CFS</td>
<td>Census Field Supervisor</td>
<td>DCMD</td>
<td>Decennial Census Management Division</td>
</tr>
<tr>
<td>DITD</td>
<td>Decennial Information Technology Division</td>
<td>DROM</td>
<td>Decennial Research Objectives and Methods Working Group</td>
</tr>
<tr>
<td>DSF</td>
<td>Delivery Sequence File</td>
<td>DSSD</td>
<td>Decennial Statistical Studies Division</td>
</tr>
<tr>
<td>FY</td>
<td>Fiscal Year</td>
<td>GATRES</td>
<td>Geographic Acquis-based Topological Real-time Editing System</td>
</tr>
<tr>
<td>GEO</td>
<td>Geography Division</td>
<td>GEOID</td>
<td>Geographic Identifier</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
<td>GQ</td>
<td>Group Quarter</td>
</tr>
<tr>
<td>GQV</td>
<td>Group Quarters Validation</td>
<td>GSS</td>
<td>Geographic Support System Initiative</td>
</tr>
<tr>
<td>GWCS</td>
<td>GSS Workflow Control System</td>
<td>HHC</td>
<td>Handheld Computer</td>
</tr>
<tr>
<td>HU</td>
<td>Housing Unit</td>
<td>IFAC</td>
<td>In-Field Address Canvassing</td>
</tr>
<tr>
<td>IOAC</td>
<td>In-Office Address Canvassing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acronym</td>
<td>Definition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPT</td>
<td>Integrated Project Team</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR</td>
<td>Interactive Review</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LACS</td>
<td>Locatable Address Conversion System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAV</td>
<td>LUCA Address Validation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LBAC</td>
<td>Large Block Address Canvassing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LiMA</td>
<td>Listing and Mapping Application</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LMT</td>
<td>LUCA Master Table</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LUCA</td>
<td>Local Update of Census Addresses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MaCS</td>
<td>Matching and Coding Software</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAF</td>
<td>Master Address File</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAFCS</td>
<td>Master Address File Coverage Study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAFID</td>
<td>Master Address File Identification Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MC</td>
<td>Monitoring Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSP</td>
<td>MAF Structure Point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MTAG</td>
<td>MAF/TIGER Address Geocoding Application</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MTDB</td>
<td>MAF/TIGER Database</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAIP</td>
<td>National Agriculture Imagery Program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPC</td>
<td>National Processing Center</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRFU</td>
<td>Nonresponse Followup operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OIG</td>
<td>Commerce Department Office of the Inspector General</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OLQ</td>
<td>Other Living Quarter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>QC</td>
<td>Quality Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCC</td>
<td>Regional Census Center</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SME</td>
<td>Subject-Matter Expert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TEA</td>
<td>Type of Enumeration Area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIGER</td>
<td>Topologically Integrated Geographic Encoding and Referencing System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TL</td>
<td>Transitory Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UE</td>
<td>Update Enumeration operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UL</td>
<td>Update Leave operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UR</td>
<td>Ungeocoded Resolution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USPS</td>
<td>United States Postal Service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UTS</td>
<td>Unified Tracking System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UTW</td>
<td>Unable to Work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acronym</td>
<td>Definition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WU</td>
<td>Work Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZIP</td>
<td>Zone Improvement Plan</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix B: Additional Concepts

Benchmark

Multiple operations, programs, and processes update the Master Address File/Topologically Integrated Geographic Encoding and Referencing (MAF/TIGER) database (MTDB) on an ongoing basis. At a predetermined point in time, usually twice a year, the Census Bureau stops all updates to MTDB and prepares MTDB for benchmarking, where a copy of MTDB is made for use in Census Bureau products or extracts. Just before benchmarking, the Census Bureau runs several processes and checks to ensure the benchmark will meet quality standards. After the benchmark is created, MTDB is again opened to updates and edits. Each benchmark has a specific name which usually includes the year and creates specific products or extracts. In short, a benchmark is a snapshot of MTDB at a certain point in time.

DSF Reliability Index

The Delivery Sequence File (DSF) Reliability Index identifies blocks where the DSF is a reliable source for the housing universe. The DSF Reliability Index is calculated for census tabulation blocks by tracing the original source that added each housing unit to the MAF and the first DSF vintage for each unit that passes the decennial filter within the block. A unit that was originally added to the MAF by the DSF or was present on the DSF within one year of being originally added by some other source (e.g., Address Canvassing, GSS partner file acquisitions) is considered a DSF Reliable housing unit. Index values range from zero to one; an index value of one indicates that each housing unit in the given block is DSF Reliable. The higher the index value, the greater the confidence that the DSF would capture coverage changes within the given block and reduce the need for In-Field Address Canvassing.

MSP

A MAF Structure Point (MSP) is a point feature in MTDB for an address marking the physical location of one or more living quarters. A single MSP may be for a single-family home or it could be for a large apartment building with hundreds of units. MSPs are stored in the TIGER database and are protected by Title 13. U.S.C. MSPs were collected for the first time in the 2010 Census Address Canvassing.
Appendix C: List of Types of Enumeration Areas (TEAs), 2020 Census

- **TEA 1 Self-Response** occurs in areas where the majority of housing units (HUs) have mail delivered to the physical location of the HU. Self-Response is the primary enumeration methodology for the 2020 Census.

- **TEA 2 Update Enumerate (UE)** occurs in areas where the initial visit requires enumerating while updating the address frame and occurs in areas that were part of the 2010 Census Remote UE operation, such as northern parts of Maine and southeast Alaska, and select American Indian areas that requested in-person enumeration during the initial visit.

- **TEA 3 Island Area Enumeration** occurs in American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, and the U.S. Virgin Islands.

- **TEA 4 Remote Alaska (RA)** occurs in areas where the initial visit requires enumerating while updating the address frame. The majority occur in remote geographic areas in Alaska that have unique challenges associated with accessibility.

- **TEA 5 Military** occurs in areas on military installations.

- **TEA 6 Update Leave (UL)** occurs in areas where the majority of HUs either do not have mail delivered to the physical location of the HU, or the mail delivery information for the HU cannot be verified.
Appendix D: Triggers Requiring No Further IOAC Action

The following are data tables for the triggers which required no further IOAC action.

Table 40: Direct-to-Field Triggered Blocks

<table>
<thead>
<tr>
<th>Description</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Field Triggered blocks at the end of IOAC: 40,564</td>
<td></td>
</tr>
<tr>
<td>Blocks affected by a recent natural housing event that may have affected housing</td>
<td>95.3%</td>
</tr>
<tr>
<td>Blocks nominated for IFAC by RO and determined to benefit from IFAC</td>
<td>4.7%</td>
</tr>
</tbody>
</table>

Data Source: BARCA

Table 41: Passive-Headquarters Triggered Blocks

<table>
<thead>
<tr>
<th>Description</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Passive-Headquarters blocks at end of IOAC: 13,135</td>
<td></td>
</tr>
<tr>
<td>Public lands with no population or housing</td>
<td>74.6%</td>
</tr>
<tr>
<td>Public Lands no population or housing and classified as Hold for Imagery</td>
<td>56.1%</td>
</tr>
<tr>
<td>Public Lands with no population or housing classified as non-Hold for Imagery pathstatuses</td>
<td>18.5%</td>
</tr>
<tr>
<td>Passive upon headquarters review</td>
<td>25.4%</td>
</tr>
<tr>
<td>Resolved (made passive) as part of Frame Maintenance</td>
<td>22.6%</td>
</tr>
<tr>
<td>Reviewed and determined to be passive as part of HQ &quot;high value&quot; review.</td>
<td>2.2%</td>
</tr>
<tr>
<td>Block nominated for IFAC by RO but determined to not require IFAC</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

Data Source: BARCA
Appendix E: Active Block Resolution (ABR) and Frame Maintenance Actions and Quality Control (QC) Sampling

Table 42: Action Codes in ABR and Frame Maintenance

<table>
<thead>
<tr>
<th>Code</th>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Add</td>
<td>Reviewer adds an address</td>
</tr>
<tr>
<td>C</td>
<td>Change</td>
<td>Reviewer changes address information for a living quarter</td>
</tr>
<tr>
<td>D</td>
<td>Delete / Does Not Exist</td>
<td>Reviewer marks an address as Does Not Exist</td>
</tr>
<tr>
<td>G</td>
<td>HU to GQ conversion</td>
<td>Reviewer converts an address to a GQ</td>
</tr>
<tr>
<td>H</td>
<td>GQ to HU conversion</td>
<td>Reviewer converts an address to a housing unit</td>
</tr>
<tr>
<td>K</td>
<td>Non-address change</td>
<td>Reviewer makes a non-address change to an address, such as a move</td>
</tr>
<tr>
<td>L</td>
<td>Duplicate</td>
<td>Reviewer marks an address as a duplicate of another address</td>
</tr>
<tr>
<td>M</td>
<td>Block Move</td>
<td>Reviewer changes the block of the address without any change to the address</td>
</tr>
<tr>
<td>N</td>
<td>Nonresidential</td>
<td>Reviewer changes address to nonresidential</td>
</tr>
<tr>
<td>V</td>
<td>Verify</td>
<td>Reviewer verifies the address without changes</td>
</tr>
<tr>
<td>T</td>
<td>Transitory Location</td>
<td>Reviewer converts an address to a TL</td>
</tr>
<tr>
<td>U</td>
<td>Unresolved</td>
<td>Reviewer marks an address Unresolved because there is not enough information to confirm the address</td>
</tr>
</tbody>
</table>

Data source: ABR Procedures

Table 43: ABR QC Sample Criteria

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Local GIS</td>
<td></td>
<td>100%</td>
<td>50%</td>
<td>25%</td>
<td>10%</td>
<td>25%</td>
</tr>
<tr>
<td>Surrounding MSPs</td>
<td></td>
<td>100%</td>
<td>50%</td>
<td>25%</td>
<td>10%</td>
<td>25%</td>
</tr>
<tr>
<td>Street Feature</td>
<td></td>
<td>100%</td>
<td>50%</td>
<td>50%</td>
<td>10%</td>
<td>25%</td>
</tr>
<tr>
<td>Commercial</td>
<td></td>
<td>100%</td>
<td>50%</td>
<td>50%</td>
<td>10%</td>
<td>25%</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>100%</td>
<td>50%</td>
<td>50%</td>
<td>10%</td>
<td>25%</td>
</tr>
</tbody>
</table>

Data source: ABR Procedures
Appendix F: Local Update of Census Addresses (LUCA) Address Validation (LAV)

GEO LUCA Address Validation (LAV) Entity Level Sampling

- The sampling process will only be implemented on files where 200 or more records are eligible for LAV.
  - Entities with fewer than 200 records will not be eligible for sampling and will have all records reviewed interactively.
- For sampling eligible entities, if 20 percent of the entity’s records will be loaded into the Matching and Coding Software application (MaCS) for review.
- Records flagged for review are selected by a random sample.
- If the entity passes an 80 percent threshold for accepted actions, the remaining records will be provisionally accepted.
- All sampled records will need to be complete through the QC phase of LAV before having the sampling accepted/rejected threshold calculated.
- We have the option to break the sampling criteria into two categories:
  - LUCA participant Add actions that did not match to the Master Address File (MAF).
  - LUCA Participant Add actions that matched to the MAF (block difference), LUCA participant C actions (block difference), and records that matched to nonresidential.
- For both categories, the results of the sample will be processed as follows:
  - If the entity passes the 80 percent threshold, we can provisionally accept the remaining records.
  - If the entity fails the 80 percent threshold, we can reject the remaining records
- Note: Only unsampled records that meet the criteria of the failed category will be rejected.

DSSD Recommendations:

- **Pass/Fail rate:** The 20 percent sample numbers are sufficient for all entities, regardless of the number of records going to LAV. In fact, a sample of that size is much greater than needed in order to be 90 percent confident that the average percentage of LAV records from the entity would be accepted. If your programmers were to select a random sample of 20 percent or a minimum of 23 records from each category, then it would produce statistically sound estimates of the proportion of records accepted.
- **Final Action:** Per option 3 from the “Non-reviewed LAV records (DSSD options/recommendation)” document, all unsampled records from category 1 were accepted provisionally regardless of the final PASS/FAIL sample result. Unsampled records from category 2 in entities that failed the PASS/FAIL sample threshold were rejected.
Appendix G: Additional Recommendations

Recommendations are presented in section 6.2. Additional recommendations that will not be tracked in knowledge management but may be useful to future efforts similar to IOAC are listed here.

1. Review the 2020 Local Update of Census Addresses (LUCA) Address Validation (LAV) universe, which was much higher than anticipated, and plan mitigation measures for future LAV in 2030.

2. For future LAV, request an early LUCA submission from a partner so that processes and software can be tested and prepared for full production.

3. Research improvements to the onboarding and hiring process such as developing checks and a communication process. Consider measures to ensure staff are not moved to other projects without the IPT being notified.

4. Investigate the ability to flag or work on an adjacent work unit (such as block) in cases where housing is misgeocoded in designing future work similar to IOAC.

5. If a component similar to In-Office Address Canvassing (IOAC) Group Quarters/Transitory Locations (GQ/TL) is conducted in the future:
   a. If calling is needed, use a phone number that identifies as from Census Bureau for future calls along with other ways to affirm the identity of the call.
   b. In order to conduct a future IOAC GQ/TL, staff will need to be able to see the entire facility for GQs or TLs in their work unit. Significant design changes will be needed if a future IOAC GQ/TL would use the full universe of GQs and TLs.
   c. Coordinate with other operations such as ACS and staff in the regional offices, especially for larger institutions. Develop frequently asked questions or quick talking points explaining why IOAC GQ/TL needs to collect their information again if needed.
   d. Research alternatives to calling and/or an online form for GQ or TL staff to fill out in combination with calls.
   e. If calling is needed, consider that calling staff hours may need to be extended.
   f. Investigate alternatives to calling that include other language options and if calling is needed, consider that calling staff who speak other languages may be needed.
   g. If calling is needed, revise calling script including testing the script ahead of a future operation.

6. The IPT should discuss acceptable quality standards and decide what they should be prior to future work similar to IOAC. IOAC components had an advantage in their structure because
they had staff review the errors QC found in their work or required staff to correct their own errors so that staff could refine their skills. However, the acceptable quality standards for data from UR, LAV, and IOAC GQ/TL were not defined. Therefore, the implemented QC plans may not have enforced useful quality standards. For example, the IPT did not discuss the Acceptable Outgoing Quality Limit (AOQL) or the worst quality the IPT would accept prior to these components with the demands of conducting IOAC for the first time.

7. Ensure that obscured imagery is detected automatically so that blocks (or other areas) are not sent to be worked until imagery is available.

8. Software choices and design should account for benchmarking and other processes that may hinder work. For example, using GATRES for Active Block Resolution (ABR) and Ungeocoded Resolution (UR) meant that staff had to stop working during benchmarking.

9. Build in business rules preventing staff from taking specific action codes depending on the decision tree path they are following. Ensure business rules are programmed and tested before production work starts.

10. Ensure sample QC is ready to start at the same time as production.

11. Incorporate the ability to place records or work units on hold into future Matching and Coding Software (MaCS) or other similar software.

12. Investigate giving staff the ability to take an action code on more than one record at a time because it would increase productivity and efficiency.

13. Research implementing a batch update feature in future operations. (LAV did not have one.)

14. Involve applicable staff or subject-matter experts (SMEs) early in software development.

15. Perform the functions of the software and/or conduct detailed research before developing the software.

16. Remove the restriction from the MaCS work assignment page that prevented work units from being reassigned within the past twelve hours.

17. Remove the restriction in MaCS that prevents QC complete records from being viewed in the read-only case search module.

18. If multiple different symbolization methods are used for future operations in MaCS, revisit the method in which the various pins are symbolized in the map. Leverage the legend in the map view and focus on the user experience when viewing and interpreting map pins in the MaCS map view.
19. Investigate incorporating a function in MaCS that allows administrators to change data via a software interface, rather than going through a software spreadsheet and data fix change review (CR) process.

20. Develop methods to complete additional software functionality ahead of full production such as a long soft start or plan for resources to be available to update software mid-operation as new functionality is identified.

21. In triggers, consider “hold for imagery” as a flag rather than a status so that the prior status (if applicable) would be maintained.

22. Ensure that adequate staff are available to re-review blocks when a significant triggering event occurs, such as new imagery for an area.

23. Create training for non-Spanish speaking staff on how to resolve Puerto Rico addresses.

24. Implement online demonstrations throughout the entire course of the project, especially for specific scenarios or procedures/decision tree changes.

25. Make the training and procedures easier to digest for the staff. Elaborate and focus on the importance of what they are doing and how it relates to the Census Bureau mission. Make concepts relatable to everyday life.

26. Have support available during training sessions so that SME training staff can focus on training staff new to the project.

27. In future LAV, identify entities lacking an authoritative source upfront and deprioritize these entities for interactive review.

28. In future large scale projects using MaCS implement a built-in communication module where procedure changes, software alerts, and special case handling are relayed via the software.

29. Create a broadcast message that displays when staff open MAF/TIGER Address Geocoding Application (MTAG) that reminds staff to reference the latest documentation, where to find it, and notifies staff when the decision tree has been updated.

30. In future UR, determine how to evaluate performance and reporting with the work units.

31. Ensure that there are alternatives for imagery during imagery downtimes.

32. In future UR reporting, track how many addresses have completed and how many remain from the previous Delivery Sequence File (DSF) cycle.
33. Reach out to stakeholders early on in the development process to ensure their needs are met when the reports are developed.